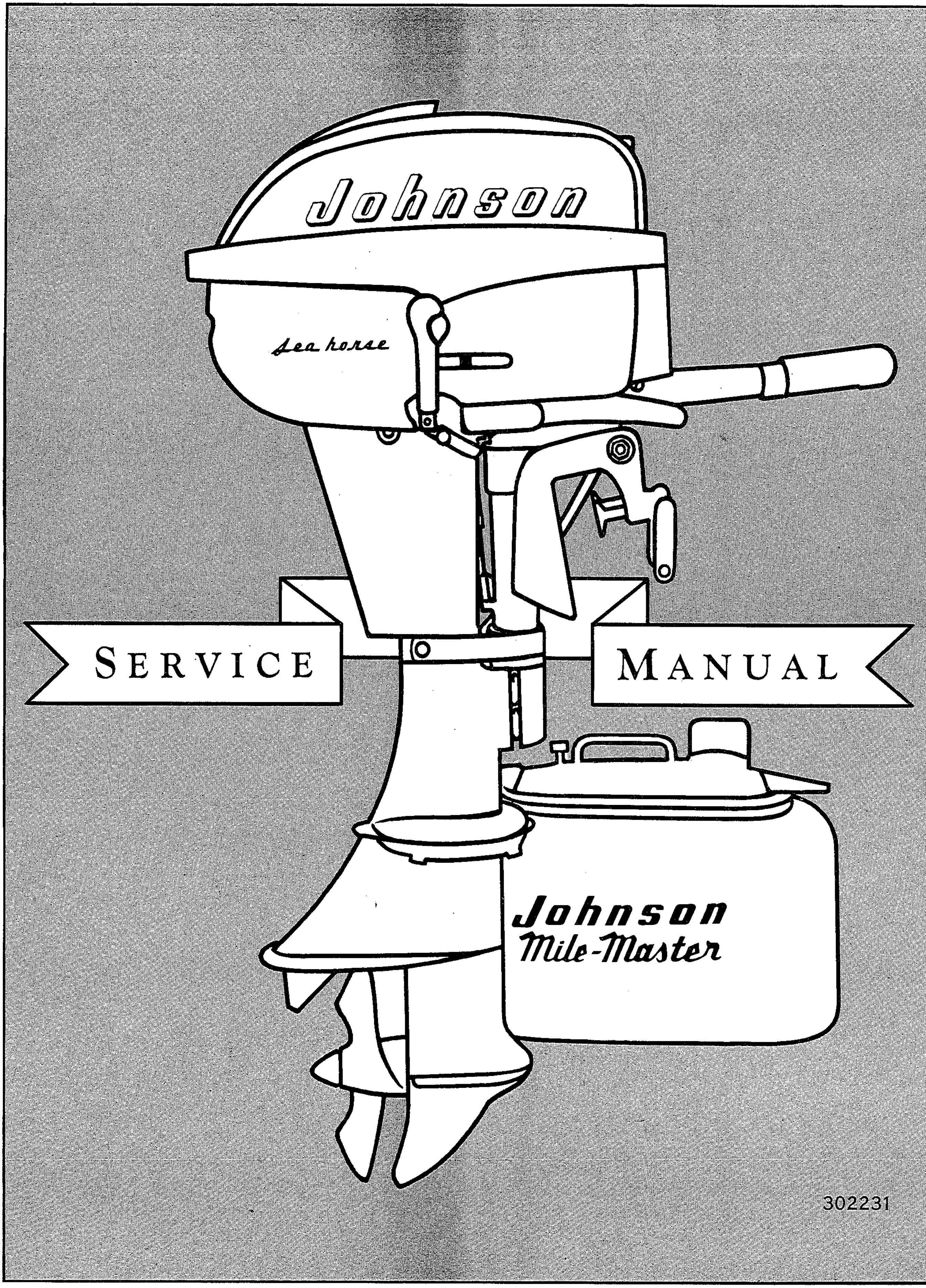
JOHNSON SERVICE MANUAL

THIRD EDITION

JOHNSON MOTORS
WAUKEGAN, ILLINOIS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FOREWORD

They say, "It ain't the fixin' that's so hard, it's findin' out just what needs the fixin'."

Finding (and fixing) trouble requires two things:

1. Knowledge of the Fundamental Principles of Operation.
2. Systematic Search.

Diagnosis (determining just what the trouble is) always precedes the actual job of repair. There is a knack to it which can only be acquired by careful, extended study. It is most important.

This manual is devoted to the maintenance of Johnson Motors and includes information on such repairs and assemblies as are apt to be conducted in the service shop from time to time. It is well to know, nevertheless, that three things are basically required to make any gasoline engine run, regardless of whether it be a two-stroke (Outboard motor) or a four-stroke cycle engine—they are, namely: I—Spark, II—A combustible ratio of air and gasoline or in other words, "Gas" and, III—Compression.

I. Spark must be of sufficient strength to jump the spark plug gap under compression in the cylinder and must be properly timed with relation to position of the piston. It is an easy matter to determine whether or not the magneto is functioning—(1) simply detach spark plug wires (ignition leads) from spark plugs (2) remove spark plugs (3) hold ends of spark plug wires approximately 1/8 inch from cylinder head (4) have someone spin flywheel (5) if magneto is in good order, spark will jump gap at end of wire to cylinder. In bright daylight, spark may not be visible but a distinct audible "snap" should be noted. To check spark plugs, attach spark plug wires, lay plugs on cylinders and proceed in manner like that described above. Spark plugs may be (1) fouled (filled with accumulation of unburned oil and carbon) (2) burned (points burned off) or (3) cracked (porcelain). Don't waste time with questionable spark plugs—install new ones (as recommended for each specific model).

II. Gas must be of correct air-gasoline ratio—that is, if the mixture is too rich (too much gasoline) it will not ignite; also, if too lean (too little gasoline) it will not ignite. This is largely a matter of carburetor adjustment. If the gasoline and oil are properly mixed and the carburetor needles correctly adjusted, gasoline-oil vapor should enter the motor when cranking to start. Note: (1) Vent in filler cap must be open, (where provided), (2) shut-off valve on gas tank must be open and (3) of course, the tank must be filled with gasoline-oil mixture.

III. Compression must be good—amount of compression depending on ability of the piston rings to prevent its escaping. Condition of the cylinder, piston ring grooves and the rings are naturally contributing factors. Turn flywheel by hand to check compression—(spark plugs installed). If compression is present, it can be felt when attempting to complete one revolution of the flywheel. If little or no compression exists, no particular resistance will be noted when turning flywheel. An engine will run with some deficiency if either of the above is slightly off par, but to get the most out of it, there must be (1) spark, (2) gas and (3) compression.

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JOHNSON MOTOR SPECIFICATIONS

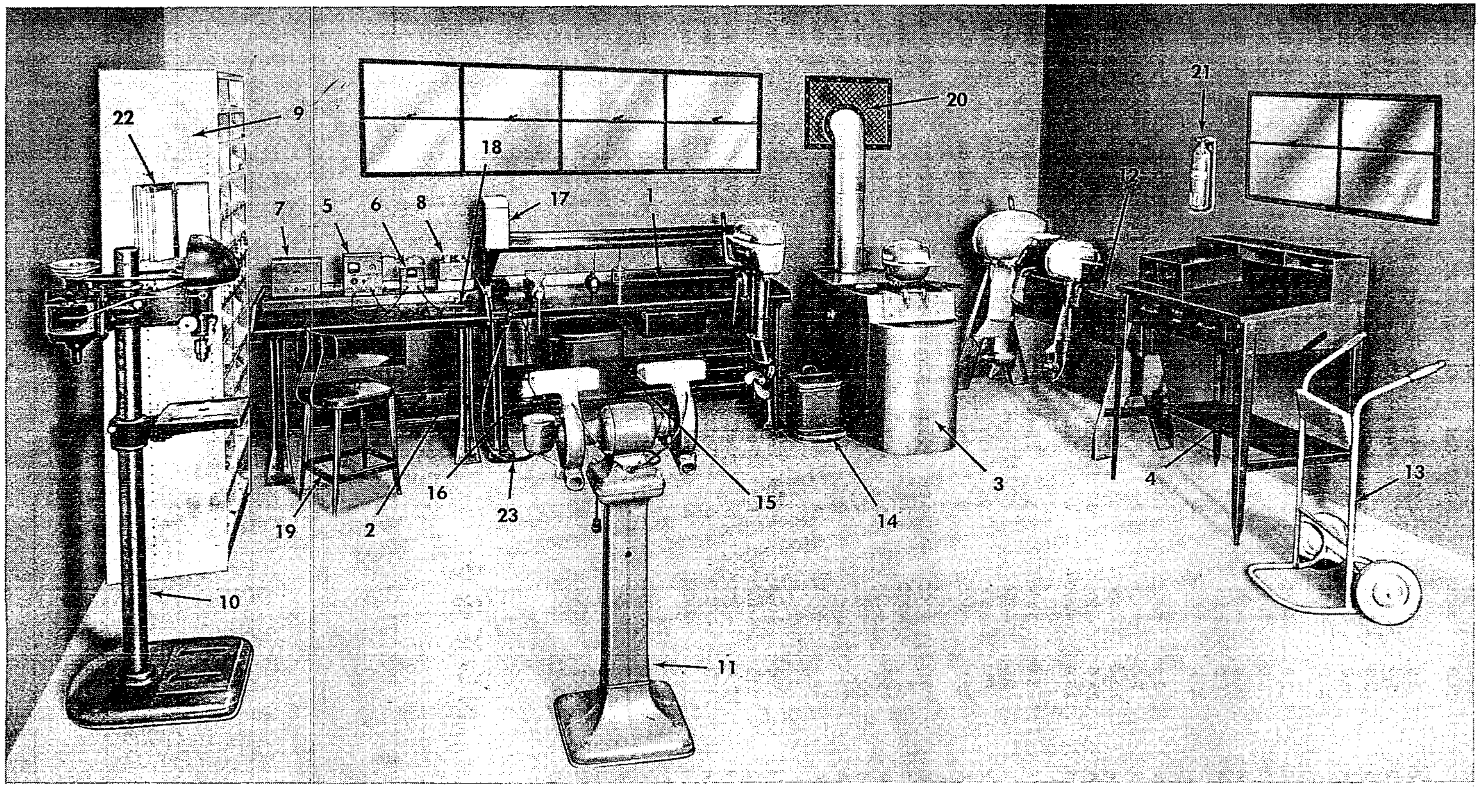
Model	Year	Original List Price	Bore"	Stroke"	H.P.	R.P.M.	Gas Tank Capacity	Spark Plug No.	Propeller Drive Pin	Weight
A	1922-23	$140.00	2	1-1/2	2	2250	3/4 Gal.	Champion C7	13-40	35 lbs.
BN	1922-23	145.00	2	1-1/2	2	2250	3/4 Gal.	Champion C7	13-40	40 lbs.
A	1924	140.00	2	1-1/2	2	2250	3/4 Gal.	Champion C7	13-40	35 lbs.
BN	1924	145.00	2	1-1/2	2	2250	3/4 Gal.	Champion C7	13-40	40 lbs.
A-25	1925	140.00	2	1-1/2	2	2400	3/4 Gal.	Champion C7	13-40	35 lbs.
AB-25	1925	145.00	2	1-1/2	2	2400	3/4 Gal.	Champion C7	13-40	40 lbs.
J-25	1925	125.00	2	1-1/2	1.5	2700	1/2 Gal.	Champion C7	13-40	27 lbs.
A-25	1926	140.00	2	1-1/2	2	2400	3/4 Gal.	Champion C7	13-40	35 lbs.
AB-25	1926	145.00	2	1-1/2	2	2400	3/4 Gal.	Champion C7	13-40	40 lbs.
J-25	1926	125.00	2	1-1/2	1.5	2700	1/2 Gal.	Champion C7	13-40	27 lbs.
P-30	1926	210.00	2-7/8	1-3/4	6	2500	2-1/2 Gal.	Champion C7	7-72	80 lbs.
A-35	1928	140.00	2	1-1/2	2-1/2	2600	3/4 Gal.	Champion C7	13-40	37 lbs.
J-25	1927	125.00	2	1-1/2	1.5	2700	1/2 Gal.	Champion C7	13-40	27 lbs.
P-35	1927	220.00	2-11/16	2-7/16	8	2750	2-1/2 Gal.	Champion R7	7-72	83 lbs.
K-35	1927	180.00	2-5/16	2-1/16	6	2750	1-1/2 Gal.	Champion R7	15-102	60 lbs.
A-35	1928	140.00	2	1-1/2	2-1/2	2600	3/4 Gal.	Champion C7	13-40	37 lbs.
J-25	1928	115.00	2	1-1/2	1.5	2700	1/2 Gal.	Champion C7	13-40	27 lbs.
K-40	1928	165.00	2-3/8	2-1/4	7.15	3500	1-1/2 Gal.	Champion R7	15-102	61 lbs.
P-40	1928	210.00	2-11/16	2-5/8	13.15	3700	2-1/2 Gal.	Champion R7	7-72	85 lbs.
TR-40	1928	275.00	3	3-1/2	25.75	3500	4 Gal.	Champion R1	19-102	110 lbs.
A-45	1929	150.00	2	1-1/2	3	2700	3/4 Gal.	Champion C7	13-40	38 lbs.
J-25	1929	115.00	2	1-1/2	1.5	2700	1/2 Gal.	Champion C7	13-40	27 lbs.
K-45	1929	185.00	2-3/8	2-1/4	7.15	3500	1-1/2 Gal.	Champion R7	15-102	63 lbs.
P-45	1929	230.00	2-11/16	2-5/8	12	3000	2-1/2 Gal.	Champion R7	7-72	87 lbs.
S-45	1929	250.00	2-3/8	2-1/4	13	4000	2.4 Gal.	Champion R7	7-72	99 lbs.
V-45	1929	325.00	2-3/8	2-1/4	26	4000	4-1/4 Gal.	Champion R7	19-102	120 lbs.
SR-45	1929	250.00	2-3/8	2-1/4	16	5200	2.4 Gal.	Champion R1	7-92	102 lbs.
VR-45	1929	325.00	2-3/8	2-1/4	32	5200	4-1/4 Gal.	Champion R1	7-92	138 lbs.
TR-40	1929	275.00	3	3-1/2	25.75	3500	4 Gal.	Champion R1	19-102	110 lbs.
J-25	1930-32	115.00	2	1-1/2	1.5	2700	1/2 Gal.	Champion C7	13-40	27 lbs.
A-50	1930-32	145.00	1-7/8	1-1/2	4	3500	7 Pints	Champion 5M	13-40	45 lbs.
K-50	1930-32	165.00	2-1/8	1-31/32	8	3500	13 Pints	Champion R7	15-102	60 lbs.
KR-55	1930-32	225.00	2-1/8	1-31/32	12	5500	13 Pints	Champion R1	27-156	60 lbs.
P-50	1930-32	245.00	2-3/4	2.52	20	3500	2-1/2 Gal.	Champion R7	19-102	102 lbs.
PR-50	1930-32	350.00	2-3/4	2.52	24	5000	2-1/2 Gal.	Champion R1	7-92	113½ lbs.
PR-55	1930-32	350.00	2-3/4	2.52	27	5500	2-1/2 Gal.	Champion R1	7-92	113½ lbs.
PR-60	1930-32	350.00	2-3/4	2.52	27	5500	2-1/2 Gal.	Champion R11	7-92	113½ lbs.
S-45	1930-32	215.00	2-3/8	2-1/4	13	4000	2.4 Gal.	Champion R7	7-92	99 lbs.
SR-50	1930-32	300.00	2-3/8	2-1/4	16	5200	2.4 Gal.	Champion R1	7-92	102 lbs.
SR-55	1930-32	300.00	2-3/8	2-1/4	18	5500	2.4 Gal.	Champion R1	7-92	103 lbs.
SR-60	1930-32	300.00	2-3/8	2-1/4			2.4 Gal.	Champion R11	29-110	103 lbs.
V-45	1930-32	280.00	2-3/8	2-1/4	26	4000	4-1/4 Gal.	Champion R7	19-102	120 lbs.
VR-50	1930-32	375.00	2-3/8	2-1/4	32	5200	4-1/4 Gal.	Champion R1	7-92	139 lbs.
VR-55	1930-32	375.00	2-3/8	2-1/4	36	5500	4-1/4 Gal.	Champion R1	7-92	138 lbs.
KR-55	1930-32	225.00	2-1/8	1-31/32	12	3500	13 Pints	Champion R1	27-156	60 lbs.
OA-55	1930-32	109.00	2	1-1/2	3	2800	7-1/4 Pints	Champion C7	31-54	45 lbs.
OA-60	1930-32	97.50	2	1-1/2	3	2800	7-1/4 Pints	Champion C7	31-54	45 lbs.
OK-55	1930-32	145.00	2-3/8	2-1/4	8	2800	14-1/2 Pints	Champion R7	33-54	60 lbs.
OK-60	1930-32	135.00	2-3/8	2-1/4	7	2800	13 Pints	Champion R7	33-54	70 lbs.
J-65	1933	72.75	2	1-1/2	*1.4	3000	1/2 Gal.	Champion C7	13-40	27 lbs.
OA-65	1933	96.50	2	1-1/2	2.8	3000	6-1/2 Pints	Champion C7	31-148	41½ lbs.
A-65	1933	125.50	1-7/8	1-1/2	4.1	4000	7 Pints	Champion 5M	13-40	46 lbs.
K-65	1933	144.50	2-1/8	1-31/32	9.2	4000	13 Pints	Champion R7	15-102	63 lbs.
S-65	1933	206.50	2-3/8	2-1/4	13.3	4000	2.4 Gal.	Champion R7	7-72	102 lbs.
P-65	1933	226.50	2-3/4	2.52	21.4	4000	2-1/2 Gal.	Champion R7	19-102	114 lbs.
V-65	1933	278.50	2-3/8	2-1/4	26.1	4000	4-1/4 Gal.	Champion R7	19-102	133 lbs.
J-70	1934	85.00	2	1-1/2	1.4	3000	1/2 Gal.	Champion C7	31-54	38¾ lbs.
F-70	1934	105.00	2	1-1/2	3.3	3000	7 Pints	Champion C7	31-54	43 lbs.
A-70	1934	140.00	1-7/8	1-1/2	4.1	4000	7 Pints	Champion 5M	13-40	46 lbs.
K-70	1934	160.00	2-1/8	1-31/32	9.2	4000	13 Pints	Champion R7	15-102	63 lbs.
S-70	1934	225.00	2-3/8	2-1/4	13.3	4000	2-1/2 Gal.	Champion R7	7-72	102 lbs.
P-70	1934	250.00	2-3/4	2.52	21.4	4000	2-1/2 Gal.	Champion R7	19-102	114 lbs.
V-70	1934	290.00	2-3/8	2-1/4	26.1	4000	4-1/4 Gal.	Champion R7	19-102	133 lbs.
J-75	1935	87.50	2	1-1/2	1.4	3000	4 Pints	Champion C7	31-54	29¼ lbs.
F-75	1935	115.00	2	1-1/2	3.3	3000	7 Pints	Champion C7	31-54	43 lbs.
300	1935	130.00	1-7/8	1-3/8	3.7	4000	6-1/2 Pints	Champion J6	31-54	37 lbs.
A-75	1935	145.00	1-7/8	1-1/2	4.5	4000	7 Pints	Champion 5M	25-280	48 lbs.
K-75	1935	165.00	2-1/8	1-31/32	9.3	4000	13 Pints	Champion R7	15-102	64 lbs.
P-75	1935	255.00	2-3/4	2.52	22	4000	2-1/2 Gal.	Champion R7	19-102	109 lbs.
OK-75	1935	150.00	2-3/8	2-1/4	8.1	2800	14-1/2 Pints	Champion R7	33-54	70 lbs.

Model	Year	Original List Price	Bore"	Stroke"	H.P.	R.P.M.	Gas Tank Capacity	Spark Plug No.	Propeller Drive Pin	Weight
A-80	1936	145.00	1-7/8	1-1/2	4.5	4000	7 Pints	Champion 5M	25-286	48 lbs.
K-80	1936	165.00	2-1/8	1-31/32	9.3	4000	13 Pints	Champion R7	15-102	64 lbs.
J-80	1936	90.00	2	1-1/2	1.7	3300	4 Pints	Champion C7	31-54	28½ lbs.
P-80	1936	255.00	2-3/4	2.52	22	4000	2-1/2 Gal.	Champion R7	19-102	108 lbs.
100	1936	62.50	2	1-1/2	1.7	3300	4 Pints	Champion J8-J	31-54	24¾ lbs.
200	1936	82.50	2	1-1/2	3.3	3300	7 Pints	Champion C7	31-54	38¾ lbs.
300	1936	125.00	1-7/8	1-3/8	3.7	4000	6.5 Pints	Champion J6	31-54	37 lbs.
LS-37	1937	75.00	1-7/8	1-1/2	2.1	4000	2-5/8 Pints	Champion J8-J	13-40	33 lbs.
DS-37	1937	95.00	1-7/8	1-1/2	2.1	4000	4 Pints	Champion J8-J	13-40	39 lbs.
LT-37	1937	105.00	1-7/8	1-1/2	4.2	4000	5 Pints	Champion J8-J	13-40	40 lbs.
DT-37	1937	130.00	1-7/8	1-1/2	4.2	4000	6 Pints	Champion J8-J	13-40	45 lbs.
210	1937	85.00	2	1-1/2	3.3	3300	7 Pints	Champion C7	31-54	38¾ lbs.
110	1937	59.50	2	1-1/2	1.7	3300	4 Pints	Champion J8-J	31-54	24¾ lbs.
AA-37	1937	145.00	1-7/8	1-1/2	4.5	4000	7 Pints	Champion 5M	13-40	48 lbs.
KA-37	1937	175.00	2-1/8	1-31/32	9.3	4000	13 Pints	Champion R7	15-102	64 lbs.
PO-37	1937	260.00	2-3/4	2.52	22.0	4000	2-1/2 Gal.	Champion R7	19-102	109 lbs.
MS-38	1938	49.50	1-3/8	1-3/8	1.1	4000	1.8 Pints	Champion J8-J	43-72	17 lbs.
MD-38	1938	62.50	1-3/8	1-3/8	1.1	4000	2.3 Pints	Champion J8-J	43-72	21 lbs.
LS-38	1938	77.50	1-7/8	1-1/2	2.1	4000	2-5/8 Pints	Champion J8-J	13-40	30¾ lbs.
DS-38	1938	94.50	1-7/8	1-1/2	2.1	4000	4 Pints	Champion J8-J	13-40	38 lbs.
LT-38	1938	109.50	1-7/8	1-1/2	4.2	4000	5 Pints	Champion J8-J	13-40	37½ lbs.
DT-38	1938	129.50	1-7/8	1-1/2	4.2	4000	6 Pints	Champion J8-J	13-40	39¼ lbs.
KA-38	1938	177.50	2-1/8	1-31/32	9.3	4000	13 Pints	Champion R7	15-102	64 lbs.
PO-38	1938	269.50	2-3/4	2.52	22.0	4000	2-1/2 Gal.	Champion R7	19-102	109 lbs.
MS-39	1939	49.50	1-3/8	1-3/8	1.1	4000	1.8 Pints	Champion J8-J	43-72	17 lbs.
MD-39	1939	62.50	1-3/8	1-3/8	1.1	4000	2.3 Pints	Champion J8-J	43-72	21 lbs.
HS-39	1939	79.50	1-3/8	1-3/8	2.5	4000	3-1/2 Pints	Champion J8-J	43-72	21½ lbs.
HA-39	1939	86.50	1-3/8	1-3/8	2.5	4000	3-1/2 Pints	Champion J8-J	43-72	26 lbs.
HD-39	1939	94.50	1-3/8	1-3/8	2.5	4000	3-3/4 Pints	Champion J8-J	43-72	28 lbs.
LT-39	1939	109.50	1-15/16	1-1/2	5.0	4000	5-1/4 Pints	Champion J8-J	25-286	33½ lbs.
AT-39	1939	117.50	1-15/16	1-1/2	5.0	4000	5-1/4 Pints	Champion J8-J	25-286	38 lbs.
DT-39	1939	129.50	1-15/16	1-1/2	5.0	4000	6-1/2 Pints	Champion J8-J	25-286	42 lbs.
KA-39	1939	177.50	2-1/8	1-31/32	9.8	4000	13 Pints	Champion R7	15-102	64 lbs.
PO-39	1939	269.50	2-3/4	2.52	22.0	4000	2-1/2 Gal.	Champion R7	19-102	109 lbs.
MS-15	1940	49.50	1-1/2	1-3/8	1.5	4000	1.8 Pints	Champion J8-J	43-72	19 lbs.
MD-15	1940	62.50	1-1/2	1-3/8	1.5	4000	2.3 Pints	Champion J8-J	43-72	24 lbs.
HS-10, 15	1940	79.50	1-3/8	1-3/8	2.5	4000	3-1/4 Pints	Champion J8-J	43-72	21½ lbs.
HA-10, 15	1940	86.50	1-3/8	1-3/8	2.5	4000	3-1/4 Pints	Champion J8-J	43-72	26 lbs.
HD-10, 15	1940	94.50	1-3/8	1-3/8	2.5	4000	3-1/4 Pints	Champion J8-J	43-72	28 lbs.
LT-10	1940	109.50	1-15/16	1-1/2	5.0	4000	5-1/4 Pints	Champion J8-J	25-286	33½ lbs.
AT-10	1940	117.50	1-15/16	1-1/2	5.0	4000	5-1/4 Pints	Champion J8-J	25-286	38 lbs.
DT-10	1940	129.50	1-15/16	1-1/2	5.0	4000	6-1/2 Pints	Champion J8-J	25-286	42½ lbs.
KA-10	1940	177.50	2-1/8	1-31/32	9.8	4000	13 Pints	Champion R7	15-102	64 lbs.
SD-10	1940	244.50	2-1/2	2-1/4	16.0	4000	2-1/2 Gal.	Champion 5M	45-300079	88 lbs.
PO-10	1940	269.50	2-3/4	2.52	22	4000	2-1/2 Gal.	Champion R7	19-102	109 lbs.
MS-20	1941	55.00	1-1/2	1-3/8	1.5	4000	4.88 Pints	Champion J8-J	43-72	24 lbs.
MD-20	1941	62.00	1-1/2	1-3/8	1.5	4000	4.88 Pints	Champion J8-J	43-72	26 lbs.
HS-20	1941	87.00	1-3/8	1-3/8	2.5	4000	4.88 Pints	Champion J8-J	43-72	27 lbs.
HD-20	1941	94.00	1-3/8	1-3/8	2.5	4000	4.88 Pints	Champion J8-J	43-72	29 lbs.
TS-15	1941	118.00	1-15/16	1-1/2	5.0	4000	7 Pints	Champion J8-J	41-300592	40 lbs.
TD-15	1941	125.00	1-15/16	1-1/2	5.0	4000	7 Pints	Champion J8-J	41-300592	42 lbs.
KS-15	1941	185.00	2-1/8	1-31/32	9.8	4000	13 Pints	Champion 5M	15-102	64 lbs.
KD-15	1941	195.00	2-1/8	1-31/32	9.8	4000	13 Pints	Champion 5M	15-102	71 lbs.
SD-10	1941	255.00	2-1/2	2-1/4	16.0	4000	2-1/2 Gal.	Champion 5M	45-300079	89 lbs.
PO-15	1941	280.00	2-3/4	2.52	22.0	4000	2-1/2 Gal.	Champion R7	19-102	109 lbs.
MS-20	1942	62.00	1-1/2	1-3/8	1.5	4000	4.88 Pints	Champion J8-J	43-72	24 lbs.
MD-20	1942	70.00	1-1/2	1-3/8	1.5	4000	4.88 Pints	Champion J8-J	43-72	26 lbs.
HS-20	1942	97.00	1-3/8	1-3/8	2.5	4000	4.88 Pints	Champion J8-J	43-72	27 lbs.
HD-20	1942	105.00	1-3/8	1-3/8	2.5	4000	4.88 Pints	Champion J8-J	43-72	29 lbs.
TS-15	1942	132.00	1-15/16	1-1/2	5.0	4000	7 Pints	Champion J8-J	41-300592	40 lbs.
TD-15	1942	140.00	1-15/16	1-1/2	5.0	4000	7 Pints	Champion J8-J	41-300592	42 lbs.
KS-15	1942	205.00	2-1/8	1-31/32	9.8	4000	13 Pints	Champion 5M	15-102	64 lbs.
KD-15	1942	215.00	2-1/8	1-31/32	9.8	4000	13 Pints	Champion 5M	15-102	71 lbs.
SD-10	1942	280.00	2-1/2	2-1/4	16.0	4000	2-1/2 Gal.	Champion 5M	45-300079	89 lbs.
PO-15	1942	310.00	2-3/4	2.52	22.0	4000	2-1/2 Gal.	Champion R7	19-102	109 lbs.
HD-25	1946	115.50	1-3/8	1-3/8	2.5	4000	4.88 Pints	Champion J8-J	43-72	29 lbs.
TD-20	1946	154.00	1-15/16	1-1/2	5.0	4000	7 Pints	Champion J8-J	41-300592	42 lbs.
KD-15	1946	250.00	2-1/8	1-31/32	9.8	4000	13 Pints	Champion 5M	15-102	71 lbs.
SD-15	1946	308.00	2-1/2	2-1/4	16.0	4000	2-1/2 Gal.	Champion 5M	45-300079	89 lbs.
PO-15	1946	350.00	2-3/4	2.52	22.0	4000	2-1/2 Gal.	Champion R7	19-102	109 lbs.
HD-25	1947	120.00	1-3/8	1-3/8	2.5	4000	4.88 Pints	Champion J8-J	43-72	29 lbs.
TD-20	1947	160.00	1-15/16	1-1/2	5.0	4000	7 Pints	Champion J8-J	41-300592	42 lbs.
KD-15	1947	250.00	2-1/8	1-31/32	9.8	4000	13 Pints	Champion 5M	15-102	71 lbs.
SD-15	1947	310.00	2-1/2	2-1/4	16.0	4000	2-1/2 Gal.	Champion 5M	45-300079	89 lbs.
PO-15	1947	350.00	2-3/4	2.52	22.0	4000	2-1/2 Gal.	Champion R7	19-102	109 lbs.

* J-65 1933 and all following motors are O.B.C. Certified Horsepower ratings.

Model	Year	Original List Price	Bore"	Stroke"	H.P.	R.P.M.	Gas Tank Capacity	Spark Plug No.	Propeller Drive Pin	Weight
HD-25	1948	120.00	1-3/8	1-3/8	2.5	4000	4.88 Pints	Champion J8-J	43-72	29 lbs.
TD-20	1948	160.00	1-15/16	1-1/2	5.0	4000	7 Pints	ChampionJ8-J	300592	42 lbs.
KD-15	1948	250.00	2-1/8	1-31/32	9.8	4000	13 Pints	Champion 5M-J	15-102	71 lbs.
SD-15	1948	310.00	2-1/2	2-1/4	16.0	4000	2-1/2 Gal.	Champion 5M-J	300079	89 lbs.
PO-15	1948	350.00	2-3/4	2.52	22.0	4000	2-1/2 Gal.	Champion R7	19-102	109 lbs.
HD-25	1949	130.00	1-3/8	1-3/8	2.5	4000	4.88 Pints	Champion J-6-J	43-72	31 lbs.
TD-20	1949	170.00	1-15/16	1-1/2	5.0	4000	7 Pints	Champion J-6-J	300592	44 lbs.
QD-10	1949	300.00	2-3/8	1-7/8	10.0	4000	5 Gal.	Champion J-6-J	301923	56 lbs.
SD-20	1949	350.00	2-1/2	2-1/4	16.0	4000	5 Gal.	Champion 5M-J	300079	85½ lbs.
PO-15	1949	395.00	2-3/4	2.52	22.0	4000	2-1/2 Gal.	Champion R-7	19-102	115¾ lbs.
HD-25	1950	125.00	1-3/8	1-3/8	2.5	4000	4.88 Pints	Champion J-6-J	43-72	31 lbs.
TN-25, 26	1950	170.00	1-15/16	1-1/2	5.0	4000	7 Pints	Champion J-6-J	302333	44 lbs.
QD-10, 11	1950	285.00	2-3/8	1-7/8	10.0	4000	5 Gal.	Champion J-6-J	301923	56 lbs.
SD-20	1950	340.00	2-1/2	2-1/4	16.0	4000	5 Gal.	Champion 5M-J	300079	85½ lbs.
PO-15	1950	395.00	2-3/4	2.52	22.0	4000	2-1/2 Gal.	Champion R7	19-102	115¾ lbs.
HD-26	1951	137.50	1-3/8	1-3/8	2.5	4000	4.88 Pints	Champion J-6-J	43-72	31 lbs.
TN-27	1951	187.50	1-15/16	1-1/2	5.0	4000	7 Pints	Champion J-6-J	302333	44 lbs.
QD-12	1951	295.00	2-3/8	1-7/8	10.0	4000	5 Gal.	Champion J-6-J	301923	58 lbs.
RD-10-11	1951	390.00	2-7/8	2-3/4	25.0	4000	5 Gal.	Champion J-6-J	302566	95 lbs.
RD-12	1951	390.00	2-7/8	2-3/4	25.0	4000	6 Gal.	Champion J-6-J	302566	95 lbs.
JW-10	1952	145.00	1-9/16	1-3/8	3.0	4000	5 Pints	Champion J-6-J	203230	30 lbs.
TN-28	1952	187.50	1-15/16	1-1/2	5.0	4000	7 Pints	Champion J-6-J	302333	44 lbs.
QD-13	1952	295.00	2-3/8	1-7/8	10.0	4000	6 Gal.	Champion J-6-J	301923	58 lbs.
RD-13	1952	390.00	2-7/8	2-3/4	25.0	4000	6 Gal.	Champion J-6-J	302566	95 lbs.
JW-10	1953	145.00	1-9/16	1-3/8	3	4000	4.88 Pints	Champion J6-J	203230	32 lbs.
TN-28	1953	187.50	1-15/16	1-1/2	5	4000	7 Pints	Champion J6-J	302333	44 lbs.
QD-14	1953	275.00	2-3/8	1-7/8	10	4000	6 Gal.	Champion J6-J	301923	60 lbs.
QD-14A	1953	275.00	2-3/8	1-7/8	10	4000	6 Gal.	Champion J6-J	301923	60 lbs.
RD-14	1953	390.00	2-7/8	2-3/4	25	4000	6 Gal.	Champion J6-J	302566	98 lbs.
RD-15	1953	390.00	2-7/8	2-3/4	25	4000	6 Gal.	Champion J6-J	302566	98 lbs.
JW-10	1954	145.00	1-9/16	1-3/8	3.0	4000	4.88 Pints	Champion J6-J	203230	32 lbs.
CD-10-11	1954	210.00	1-15/16	1-1/2	5.5	4000	4 Gal.	Champion J6-J	302333	47 lbs.
QD-15	1954	297.00	2-3/8	1-7/8	10.0	4000	6 Gal.	Champion J6-J	301923	60 lbs.
RD-16, 16A	1954	410.00	2-7/8	2-3/4	25.0	4000	6 Gal.	Champion J6-J	302566	99 lbs.
RDE-16, 16A	1954	498.00	2-7/8	2-3/4	25.0	4000	6 Gal.	Champion J6-J	302566	111 lbs.
JW-11	1955	147.25	1-9/16	1-3/8	3.0	4000	4.88 Pints	Champion J6-J	203230	32 lbs.
CD-12	1955	213.00	1-15/16	1-1/2	5.5	4000	4 Gal.	Champion J6-J	302333	47 lbs.
QD-16	1955	314.50	2-3/8	1-7/8	10.0	4000	6 Gal.	Champion J6-J	301923	67½ lbs.
RD-17	1955	436.00	2-7/8	2-3/4	25.0	4000	6 Gal.	Champion J6-J	302566	110 lbs.
RDE-17	1955	531.00	2-7/8	2-3/4	25.0	4000	6 Gal.	Champion J6-J	302566	125 lbs.

NOTES



SUGGESTED SHOP LAY-OUT

NOMENCLATURE (SHOP PLAN ABOVE)

1. Bench with vise, motor bracket and drawer for tools
2. Magneto—repair bench with drawers for tools
3. Motor test tank—Stolper
4. Shop desk with file cabinet
5. Coil Tester—Stevens
6. Point Tester—Stevens
7. Power Supply—Stevens
8. Magnet Charger—Stevens
9. Parts Cabinet
10. Drill Press
11. Grinder
12. Motor Rack
13. Dolly
14. Waste Can
15. Washing Container (Parts)
16. Pressure Oil Can for Hypoid
17. Gasket Container
18. Lapping Block
19. Stool
20. Exhaust outlet—fan underneath
21. Fire Extinguisher
22. File Index, Part Cab
23. Air Pressure

THE MAGNETO

Section I

MAGNETO

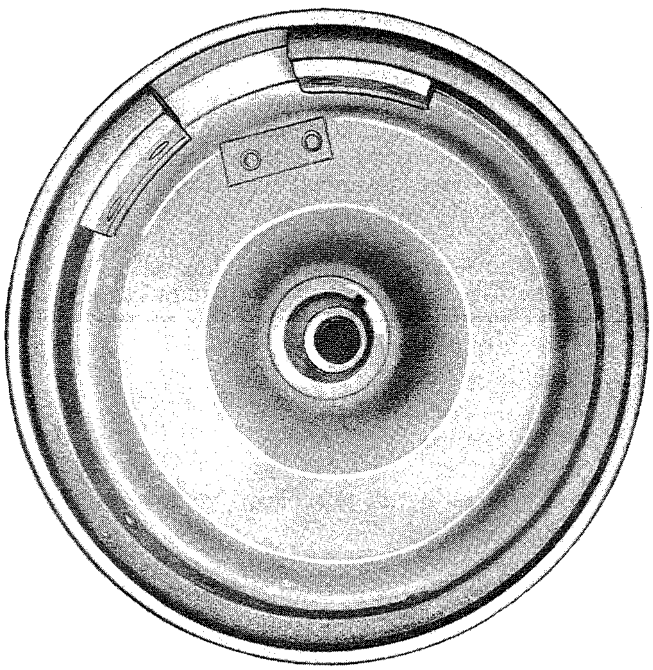
NOTES

THE MAGNETO

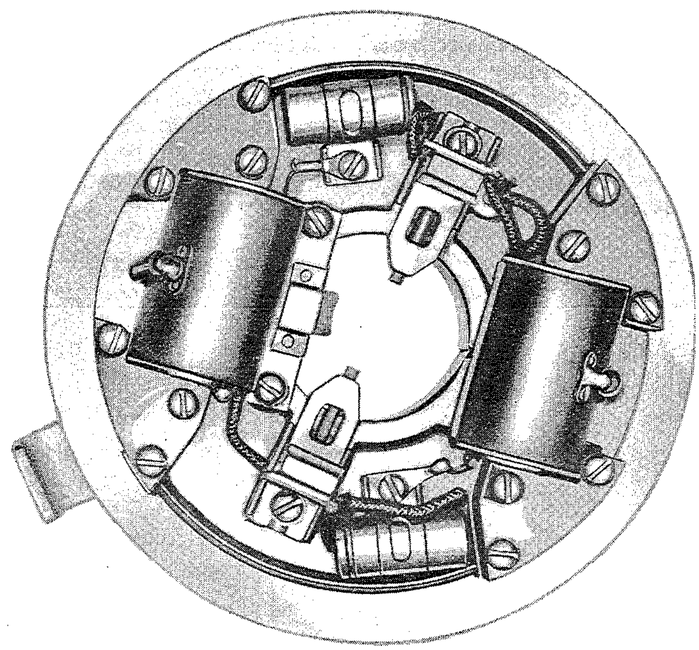
The magneto is a self-contained unit—requiring no assistance from outside sources such as a dry cell or storage battery to produce the strong spark so essential to easy starting. It consists chiefly of an armature plate, on which are mounted the ignition coil condenser and breaker points and a permanent magnet built into the flywheel, or magnet rotor.

Its operation is extremely simple. As the pole pieces of the magnet pass over the heels of the coil, a magnetic field is built up about the coil, causing a current to flow through the primary winding.

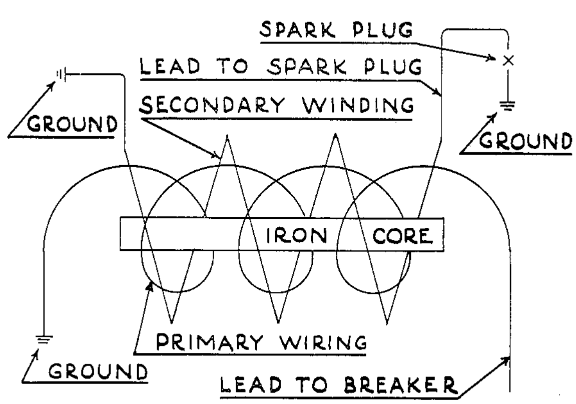
At the proper time, the breaker points are separated by action of a cam, thus breaking the primary circuit. This stops the flow of primary current, which causes the magnetic field about the coil to break down instantly—an electrical current of exceptionally high voltage is induced in the fine secondary windings of the coil, which is conducted to the spark plug where it jumps the gap between the points of the plug to ignite the compressed charge in the cylinder.



Flywheel



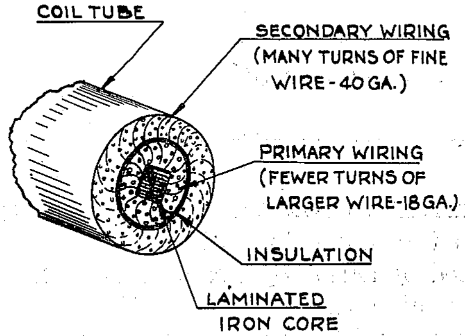
Armature Plate



Schematic Wiring Diagram of Ignition Coil

The ignition coil consists of:

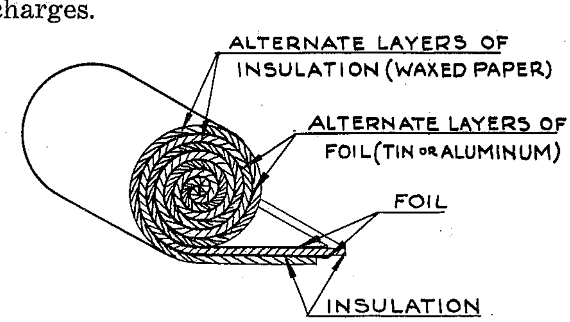
1. A soft iron core made up of a number of soft iron wires or soft iron sheets bound or riveted together to make up a rigid assembly.
2. A primary winding of copper wire (18 gauge) wound around the core.
3. A secondary winding of fine copper wire and of many turns wound around the primary winding, and
4. An insulating tube to contain the unit.



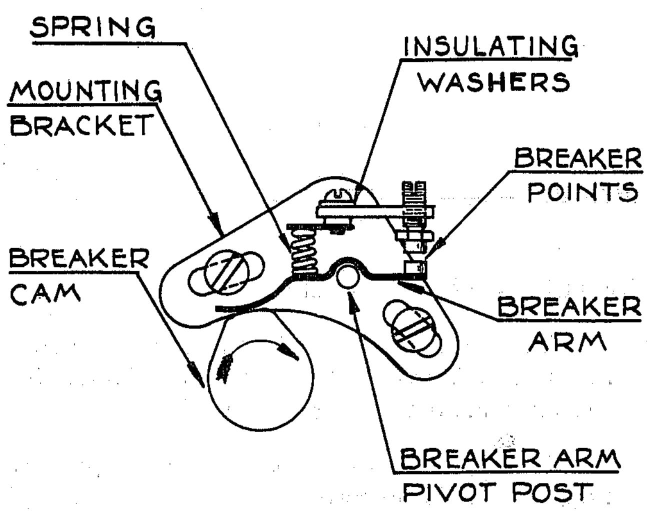
Cross Sectional View of Conventional Ignition Coil

The condenser consists basically of two sheets of tin or aluminum foil laid one on top of the other but separated by a sheet of insulating material (waxed paper, etc.) sandwich fashion. However, to conserve space the sheets are rolled up cylindrically and placed in a metal case for protection and easy assembly.

Fundamentally, the purpose of the condenser is to absorb or store secondary current built up in the primary winding at the instant the breaker points are separated, thus overcoming, to a certain extent, excessive arcing to extend their period of usefulness and to give added impetus to the charge induced in the secondary winding as it (condenser) discharges.



Schematic Diagram of Condenser



Schematic Drawing of Breaker Point Setup

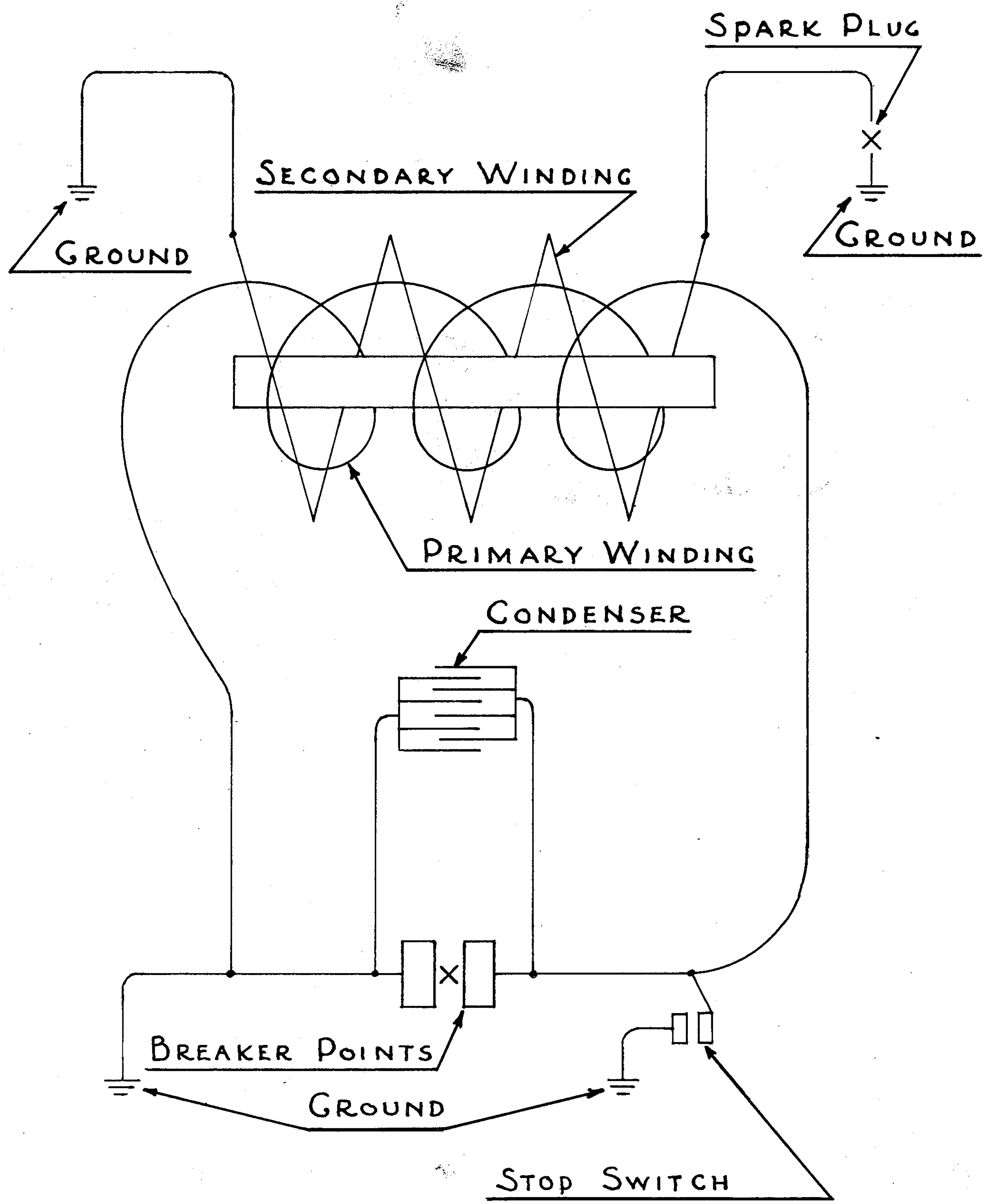
The breaker points, one attached to a stationary bracket and the other to a movable mount but held in contact by a spring to provide for separation (breaking) by action of a cam built into the flywheel or machined on the crankshaft, are constructed of a steel base to which is fused a cap of tungsten. The hard tungsten cap is necessary to withstand constant rapid pounding and arcing as the points open and close during operation of the motor.

Proper diagnosis of magneto (spark) difficulty is most important when attempting to correct faulty spark, but it is not too mysterious if it is remembered that (for practical purposes) electricity flows much the same as water—high pressures (voltage) seeking the level of low pressure and moving in a circuit. Water flows through a pipe—electricity flows or is conducted generally through a copper wire. Thus, a broken water pipe is comparable to a broken wire in that water stops flowing in a prescribed circuit and similarly electricity stops flowing if the wire is broken or the circuit otherwise interrupted. In like manner, a water system does not function as it should if the conductors (pipes) leak nor does an electrical system properly function if the conductors leak (faulty insulation).

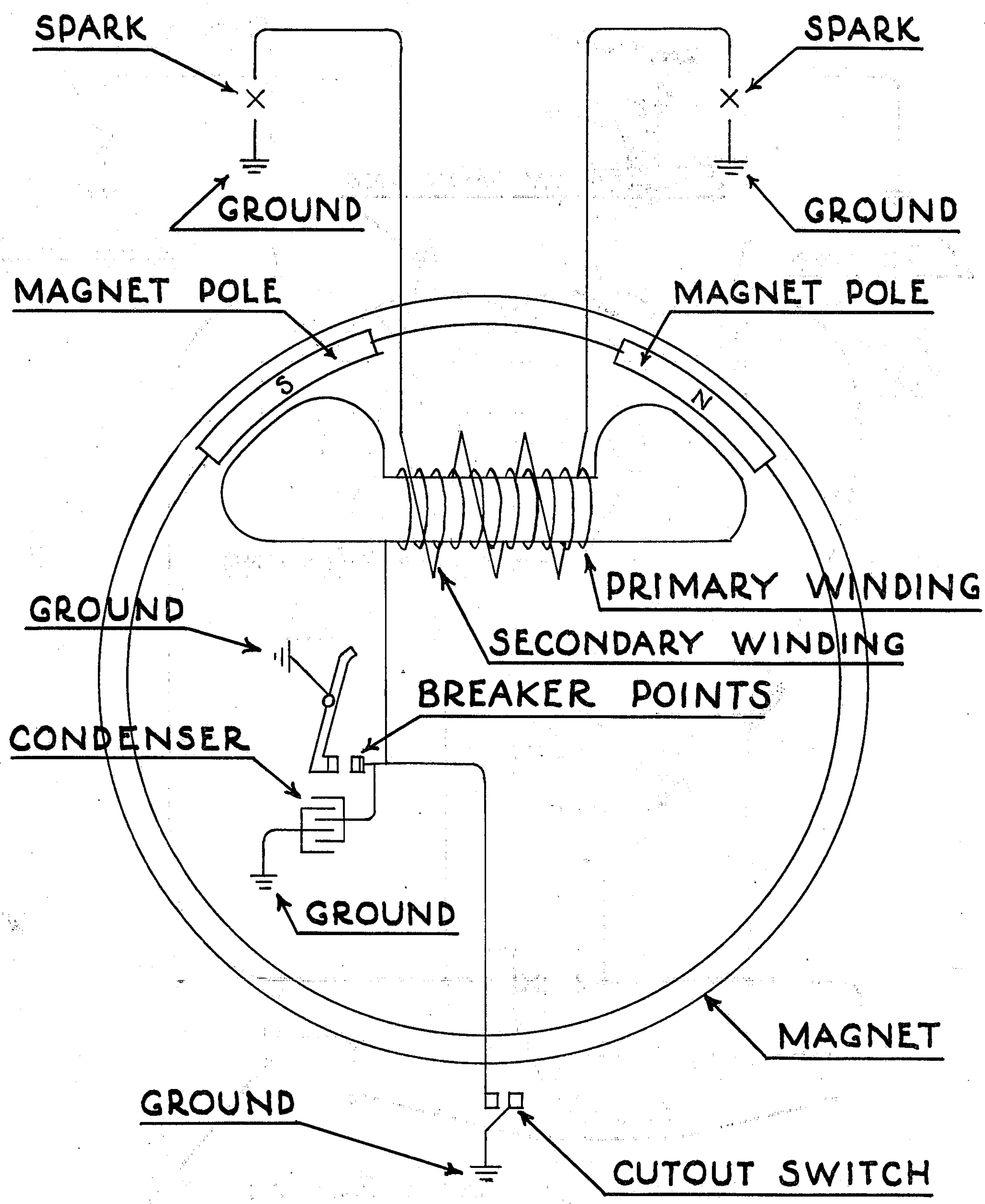
Naturally, any discrepancy in the ignition system makes its presence known by a faulty spark at the plug to result in non-starting, hard starting, misfiring or otherwise irregular operation of the motor. The object is, therefore, to locate the source of difficulty and to arrange for corrective measures.

Proceed with diagnosis carefully and in an orderly manner—start with the spark plug since it is most readily accessible and continue throughout the entire ignition system until the source of difficulty is brought to light.

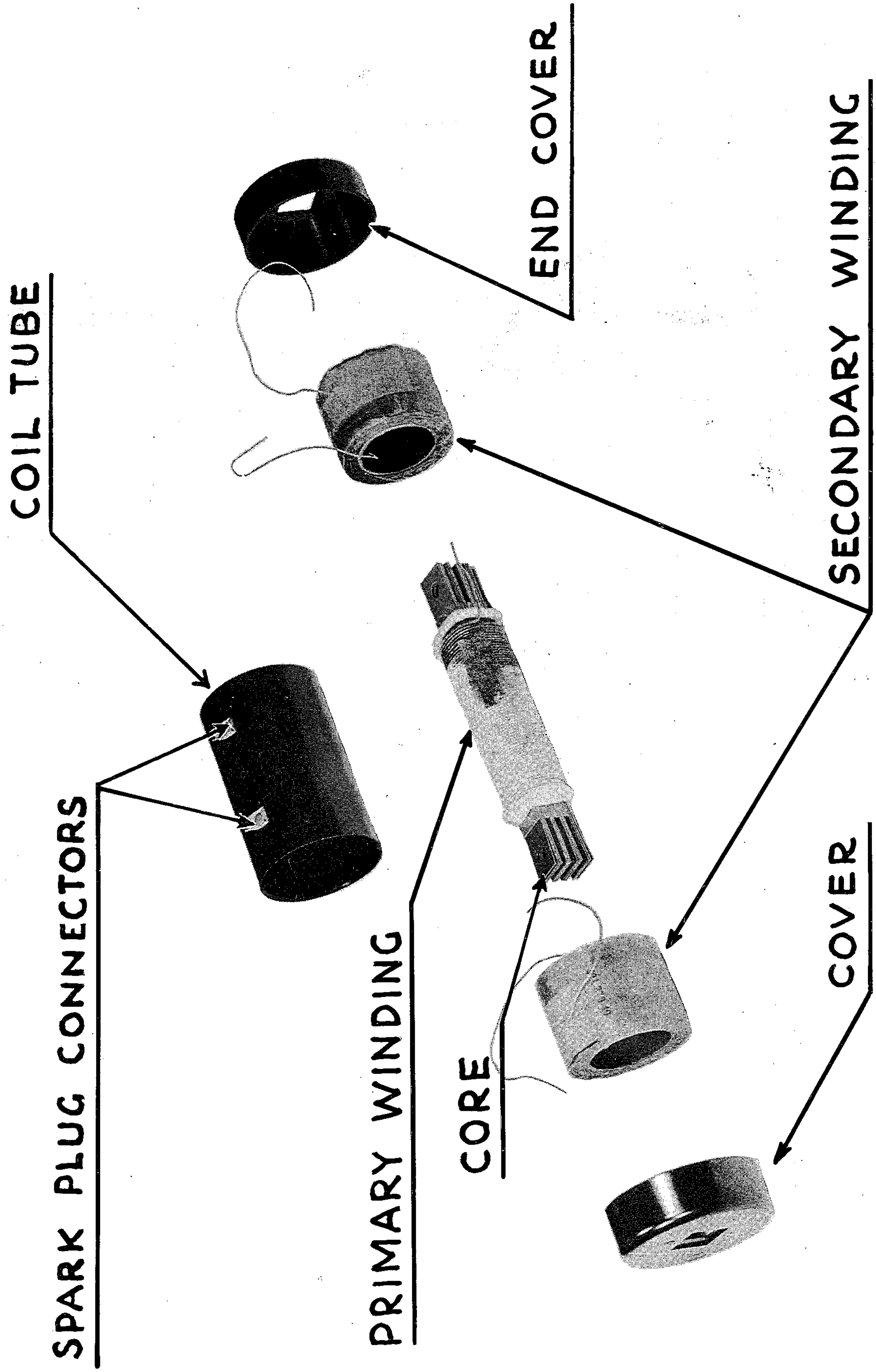
1. Spark plug
   (a) Loose connections
   (b) Fouled
   (c) Wrong type for model motor
   (d) Residue on porcelain—salt water areas
2. Spark plug leads
   (a) Loose
   (b) Faulty insulation—shorting to motor
3. Wiring on armature plate
   (a) Loose or broken connections
   (b) Corroded connections, particularly in salt water areas
   (c) Faulty insulation to cause short circuits
   (d) Faulty connections in ground or cutout switch
4. Breaker points
   (a) Improperly adjusted
   (b) Pitted or corroded
   (c) Breaker arm binding on pivot post or breaker push rod binding in bracket
5. Condenser
   (a) Loose connections
   (b) Faulty
6. Coil heels
   (a) Improperly adjusted with relation to magnet pole shoes
   (b) Rubbing on magnet pole shoes
7. Coil
   (a) Loose connections
   (b) Faulty



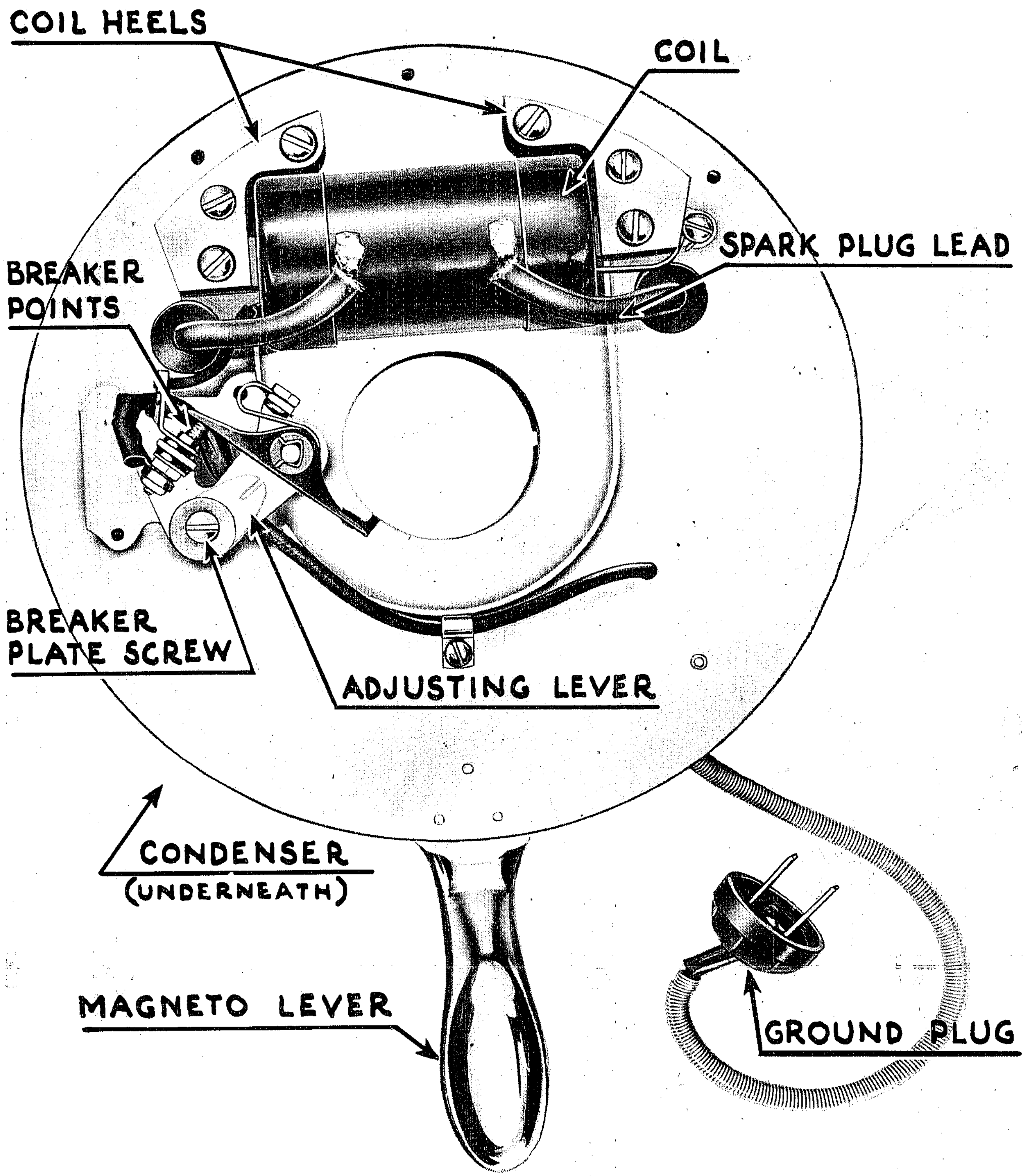
Schematic Wiring Diagram
Showing Hookup of Coil, Condenser, Breaker Points, Stop Switch,
One Spark Plug (Ground-Firing)



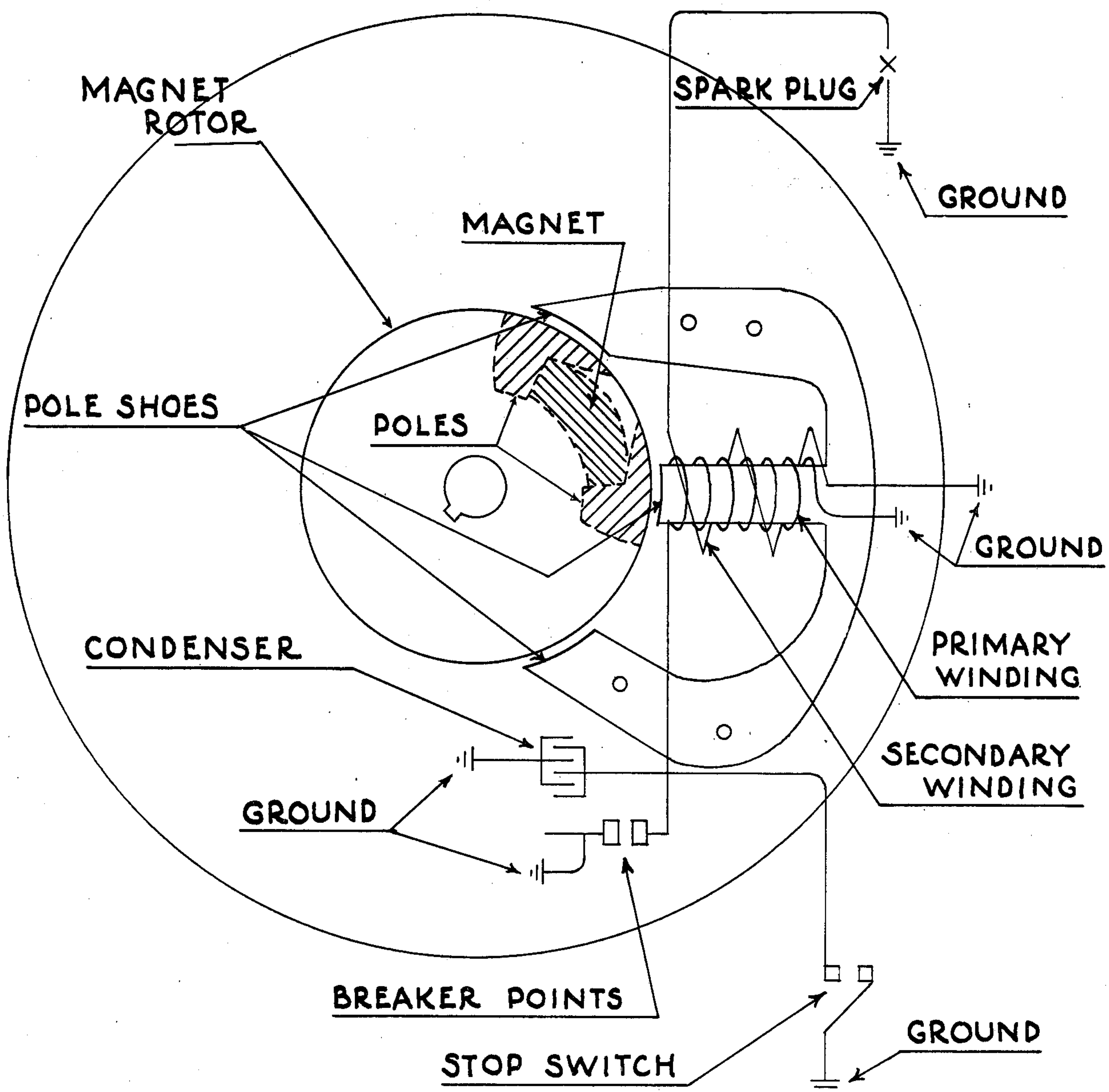
Schematic Diagram of Armature Plate
(Opposed Firing Twin)
Ring Magnet



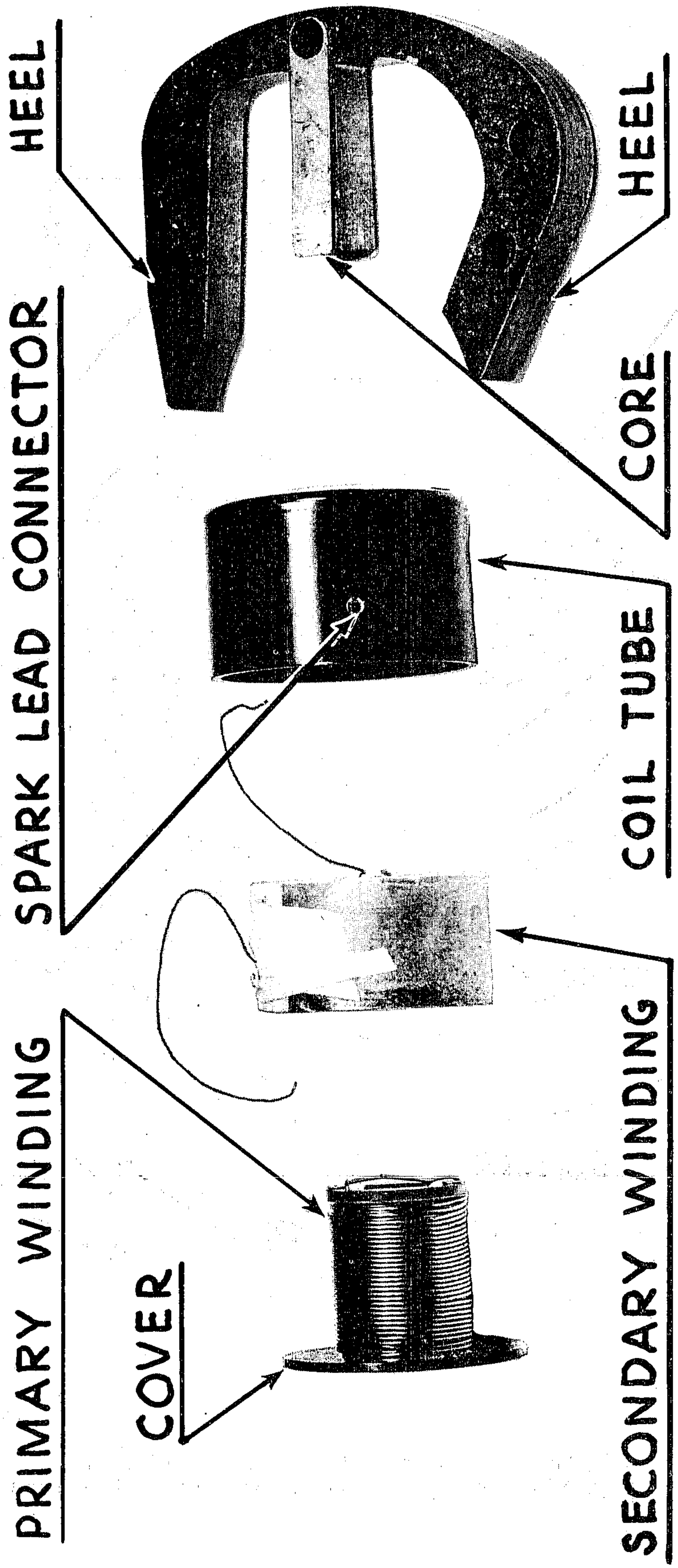
Extended View of Ignition Coil for Opposed Firing Motor
(Note—Coil Firing but One Cylinder Is Provided with a Single Secondary Winding)



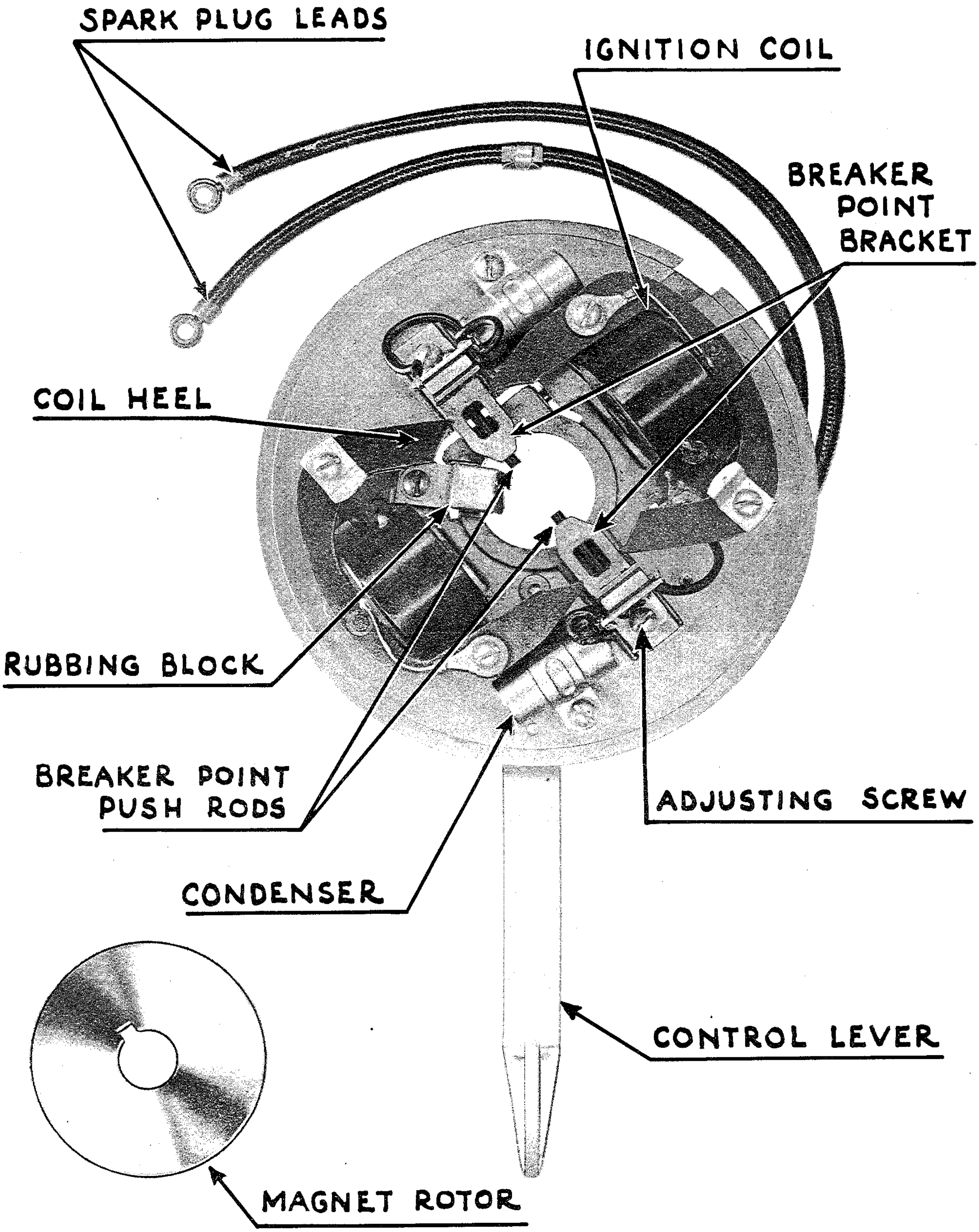
P-PO Armature Plate



Schematic Diagram of Armature Plate – Rotor Type Magnet
(One Unit for Single Cylinder Motor – Two Units for Alternate Firing Twin)

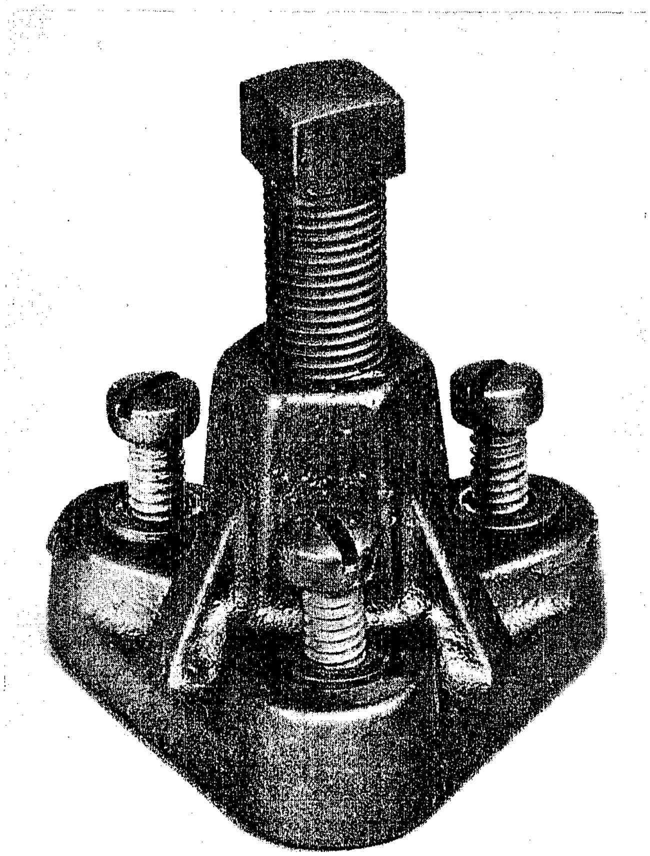


Extended View of Coil Assembly Used on Alternate Firing Motor — H, T & M Models
With Magnet Rotor



HS—HD—TS—TD—Magneto

TO REMOVE FLYWHEEL FOR INSPECTION OF MAGNETO
(All M, H, T, K and SD Models)



Flywheel Puller

1. Remove starter pulley.

2. Remove flywheel nut.

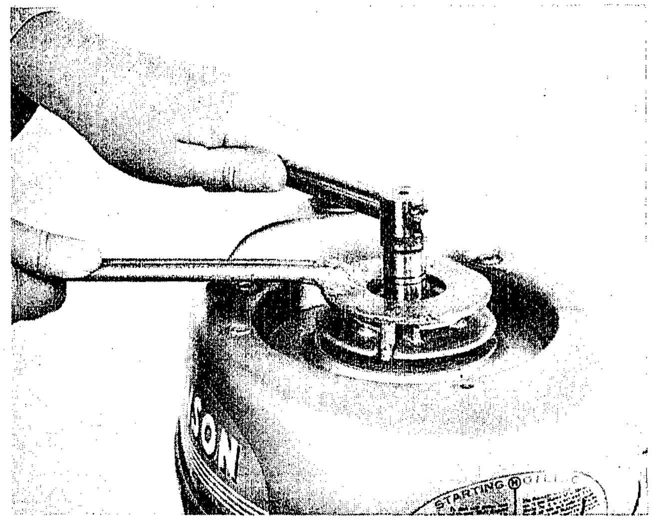
3. Attach wheel puller to flywheel. (Note—puller screws fit threaded holes in flywheel.)

4. Turn puller screw down until it rests firmly against end of the crankshaft.

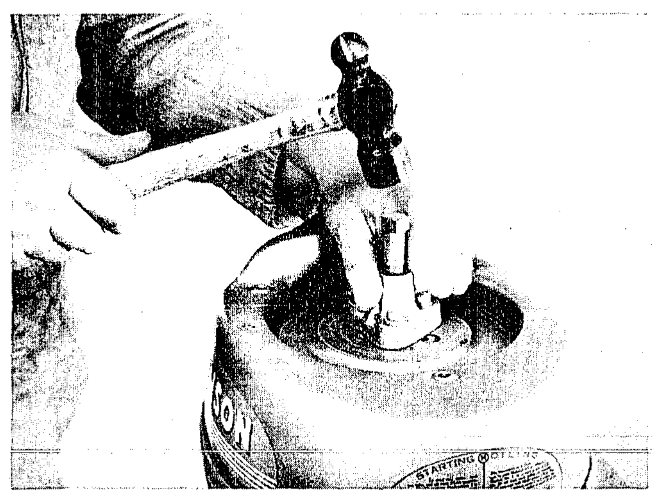
5. Grasp rim of flywheel or puller as shown here. Lift upward to absorb shock—strike puller screw head sharp blow with medium size hammer.

6. If first application fails, draw up further on puller screw and repeat as above. Two or three similar attempts should be sufficient to loosen flywheel on taper of the crankshaft.

7. After having loosened, lift flywheel carefully off crankshaft. Remove puller.



Removing Flywheel Nut

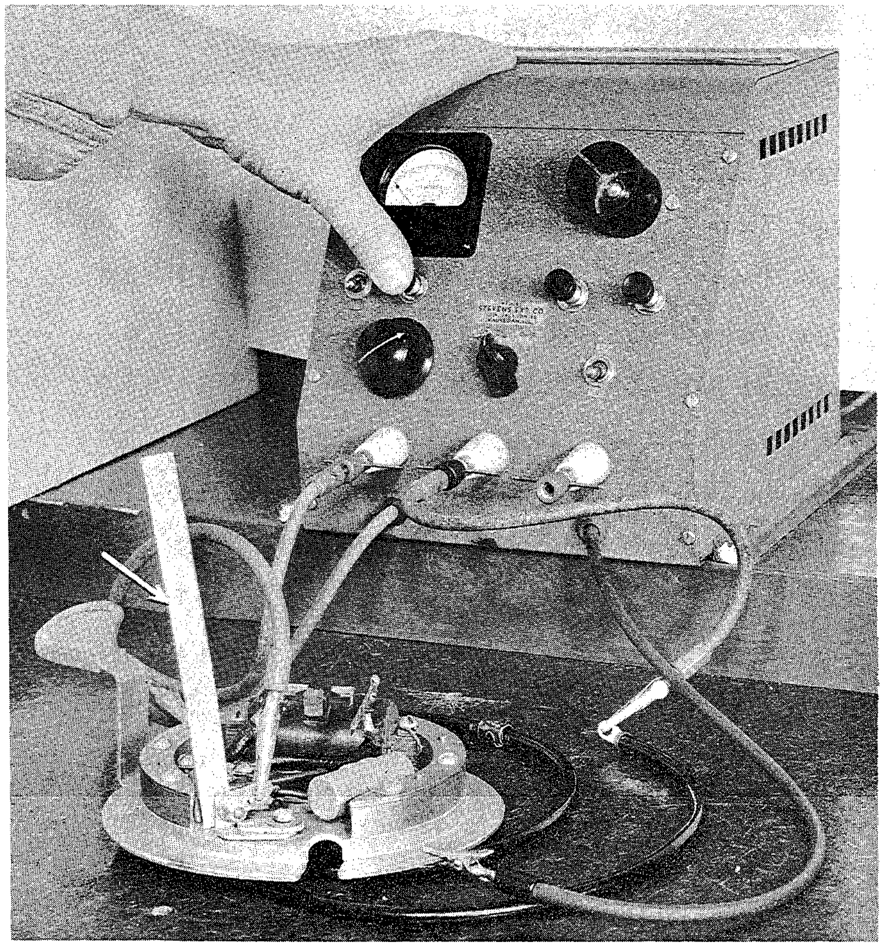


Pulling Flywheel

TO INSTALL FLYWHEEL—ALL MODELS

With cover (starter) plate removed, make certain keys are secure in position on crankshaft. Place flywheel over taper on crankshaft at same time aligning keys and keyway in flywheel hub. Replace flywheel nut—screw down tightly. Strike handle of wrench several sharp blows with hammer or wrench to make fast. Replace cover plate. Start and run motor ten to fifteen minutes—stop to further tighten nut as described above. Newly installed flywheel will settle slightly on taper of crankshaft after a few minutes operation and unless tightened, is apt to cause serious damage to both flywheel hub and crankshaft taper. BE SURE FLYWHEEL NUT IS TIGHT. Repeated shearing of propeller pins for no apparent reason is frequently the result of a loose flywheel.

TESTING IGNITION COIL AND CONDENSER



Coil Testing Unit

Testing equipment, similar to that illustrated here, is essential and necessary to conduct normal magneto repairs. Faulty ignition is indicative of defects in the magneto assembly if not resulting from faulty spark plugs. These defects will be found in the wiring system, the ignition coil, condenser, breaker points, the ground block (if used) or the ground arrangement for cutting out the spark (stopping motor).

Fundamentally, the coil tester merely provides a source of primary current, interrupted by a built-in breaker to induce high voltage current in the secondary winding of the coil on test — intensity of which is in proportion to amount of current (amperage) flowing through the primary circuit.

Primary current is controlled manually by a rheostat in the test unit — a definite amperage (indicated on ammeter) having been established for each coil to be tested. See chart.

When testing any coil mounted on the armature plate, the condenser must first be disconnected and the breaker points separated by a strip of paper as shown in the illustration. One primary lead from the test unit is connected to the armature plate (ground) with the other to the breaker bracket (insulated). This completes the primary circuit for testing purposes.

If the coil is in good condition and suitable for use, the induced secondary (high tension current to spark plugs) current should be of sufficient strength to consistently spark across the gap on the test unit, with primary current adjusted to amperage specified for the particular coil.

An irregular, seemingly weak or hesitating spark across the gap indicates a weak coil (damp or partially broken down secondary). No attempt should be made to improve the spark by increasing primary current — the coil is inoperative if it cannot be made to spark properly on the specified amperage.

A completely "dead" coil is indicated by no spark —definitely shorted out.

See instructions provided with testing unit.

PRIMARY CURRENT VALUES—IGNITION COILS

Amperes Necessary to Jump 1/4" Spark Gap*

Revised 2/15/50

PART NO.	MODEL	AMPERES With Heels	AMPERES Less Heels
72-612	Light Single—all models	2.0 - 2.5	2.6 - 3.0
72-582	Light Twin—1926 and previous	1.1 - 1.6	1.5 - 2.0
72-110	Light Twin	1.1 - 1.6	1.5 - 2.0
72-792	Light Twin—1927, 1928, 1929	1.1 - 1.6	1.5 - 2.0
72-669	Standard Twin—1927, 1928, 1929	1.1 - 1.6	1.5 - 2.0
72-675	Standard Twin—1927, 1928, 1929 (Canada)	1.1 - 1.6	1.5 - 2.0
72-641	Big Twin—Giant Twin—all models	1.4 - 1.9	2.0 - 2.5
72-817	Big Twin—Giant Twin—all models (Canada)	1.4 - 1.9	2.0 - 2.5
72-808	S-45—1929	1.1 - 1.6	1.5 - 2.0
72-813	V-45—1929	1.1 - 1.6	1.5 - 2.0
72-852	S, V, P-50 and up—all models	.8 - 1.3	1.0 - 1.5
72-875	A and K-50 and up—all models	1.2 - 1.7	1.5 - 2.0
72-1005	300	1.0 - 1.5	1.5 - 2.0
72-1018	Iron Horse—all models	1.1 - 1.6	2.0 - 2.5
72-1045	LT, DT, AT-37 and up—all models—NOTE A	1.0 - 1.4	1.3 - 1.7
72-1072	LT, DT, AT-37 and up—all models—NOTE A	1.0 - 1.4	1.3 - 1.7
72-1074	MS, MD-38 and up—all models—NOTE A	2.0 - 2.5	2.5 - 3.0
72-1108	HS, HD, HA—1938, 1940—all models—NOTE A	1.8 - 2.3	2.3 - 2.8
375102	SD-10, SD-15, SD-20	.8 - 1.2	1.0 - 1.3
375189	TS, TD, TN, HS, MS, MD and later	1.5 - 2.0	NOTE*
72-947	200, OA	1.1 - 1.6	1.5 - 1.9
580040	QD-10-11	1.6 - 2.0	NOTE*

NOTE A—Distributor type magnetos—Coil should be tested by grounding first one end of secondary and then the other alternately.

NOTE*—This coil must be mounted on a laminated coil core to test.

When testing coils on armature plate the magneto condenser must be discontinued from the coil or points.

The ultimate test on any coil is whether or not it works when assembled in the magneto. The above testing is principally for diagnosis of trouble.

*THESE READINGS ARE FOR STEVENS' COIL AND CONDENSER TESTERS ONLY.

TESTING CONDENSER

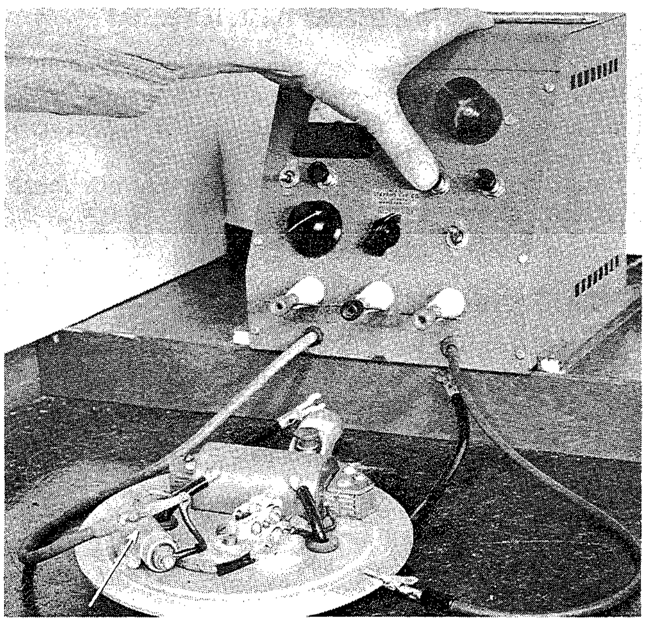
Faults in the condenser can be detected by checking on the testing unit. To check or test the condenser, the insulated lead is detached from the breaker bracket and attached to one of the leads from the test unit as shown here, the grounded end being attached to the second lead. Thus, when checking or testing, the condenser is charged by mechanism in the test unit — if in good condition, it will hold the charge until intentionally discharged by operation of the unit. Discharge will be observed by momentary or flash glow of the neon tube. On the other hand, if the condenser is weak, the neon tube will flash intermittently when attempting to charge. It does not hold its charge and, therefore, not satisfactory for further use. If shorted out completely, the neon tube will glow continuously when charging — there is no charge, the condenser is "dead" and not fit for use.

See instructions provided with testing unit.

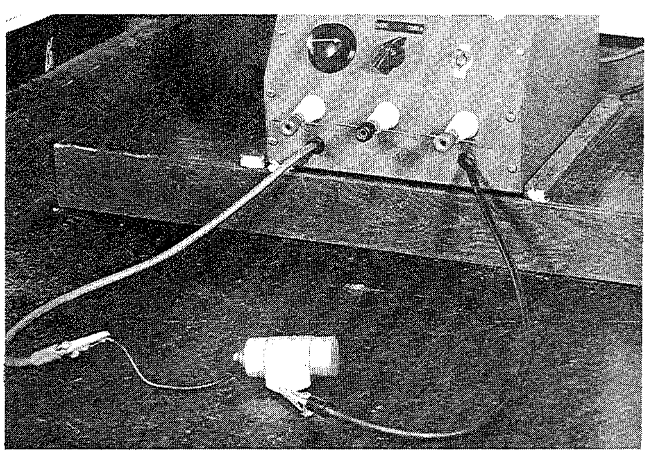
MAGNET CHARGING

While magnets (ring or rotor type) hold their charge (magnetism) considerably well, charging or boosting is occasionally required. This is accomplished with the use of a charging unit similar to that here illustrated. Basically, it consists of a U-shaped iron core about which are wound two coils of copper wire. All charging units of this nature operate on direct current — either directly off of a six- or twelve-volt battery or on AC current converted direct by means of a transformer.

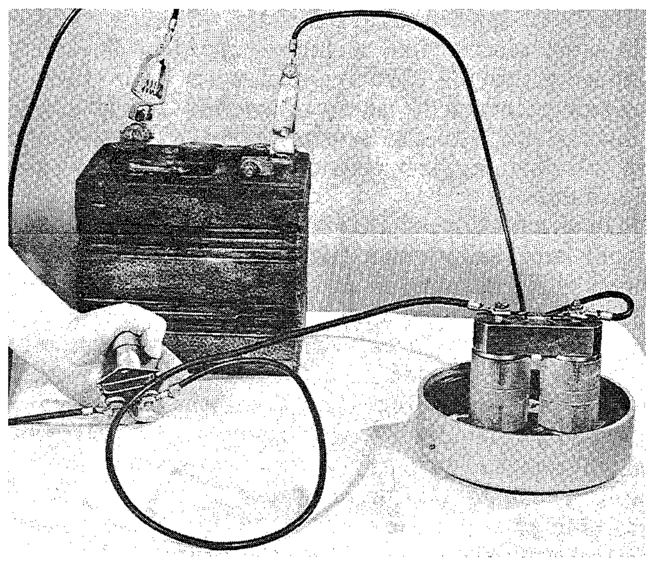
As current flows through the copper windings, the ends of the core become polarized — one north, the other south, thus, when charging, opposite poles (magnet and charger) are placed together to energize the magnet. Instructions for this operation are provided with the charging units by the manufacturer.



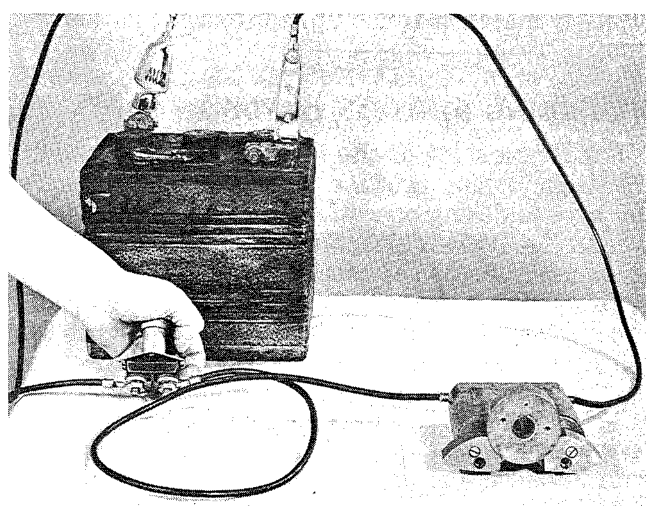
Testing Condenser on Plate



Testing Condenser

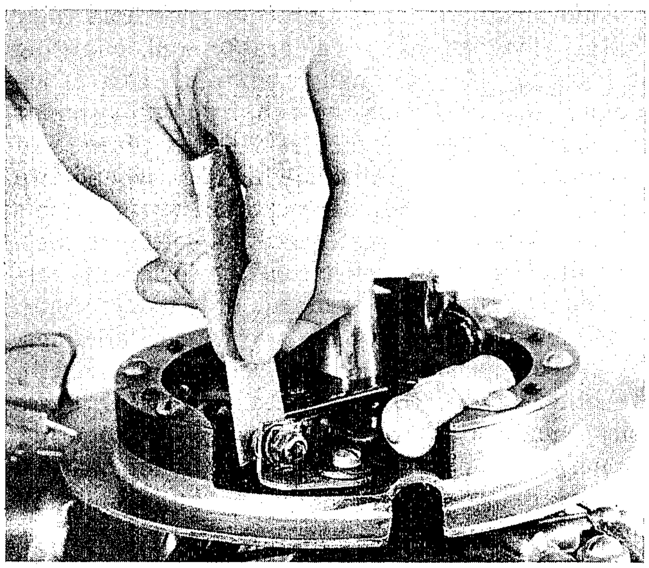


Charging Ring Type Magnet



Charging Rotor Type Magnet

CLEANING BREAKER POINTS (MAGNETO)



In event the points are slightly pitted or require cleaning, simply fold a narrow strip of 00 sandpaper to provide abrasive action on both sides—spread points with screw driver to insert sandpaper strip. Release points and work sandpaper up and down against tension of the spring to clean the points.

On completion of this operation, remove sandpaper and repeat the operation with a piece of clean paper to remove all traces of sand particles. Magneto will not function if sand is left to remain on the point surfaces. Sand is a non-conductor.

Important: Under no circumstances use emery cloth in the operation. Emery will clean the points but being a conductor, will produce short circuits or leaks in the primary wiring system unless the point brackets can be carefully washed off with gasoline or other solvent. Sanding of the points is but a temporary measure—if pitted, they should be replaced.

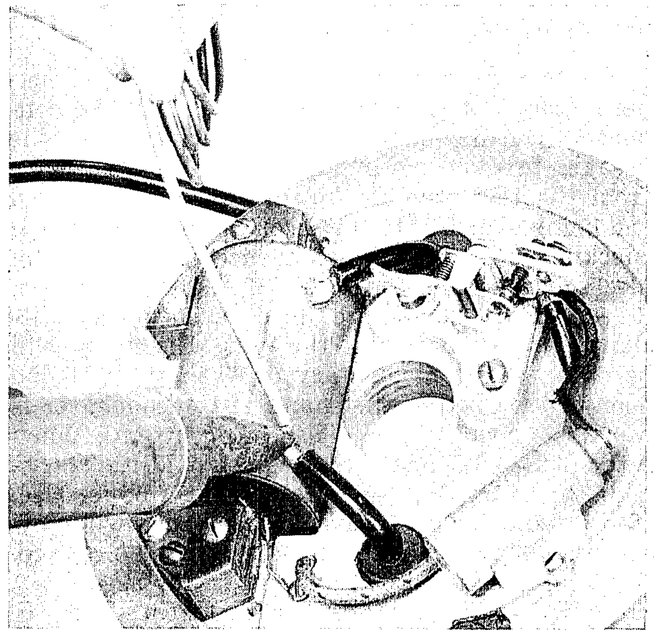
Breaker point surfaces should be smooth and properly matched (lined up) to function efficiently.

SOLDERING IGNITION LEADS TO COIL

Except on some of the real old Johnson models, the high tension ignition lead is attached to the coil by a soldering operation. Extreme care should be exercised when attaching the lead. Many coils are ruined because of carelessness in this respect.

First—**Use a soldering paste**—do not under any circumstances use an acid flux. Acid burns into the coil tube, ruins the connection and produces corrosion, thus, a new coil is rendered useless.

Second—Don't use too much heat—heat the soldering iron just enough to make a good soldered connection. Excessive heat will burn the coil tube and the small high tension wire leading to the terminal post.



Soldering Ignition Leads to Coil

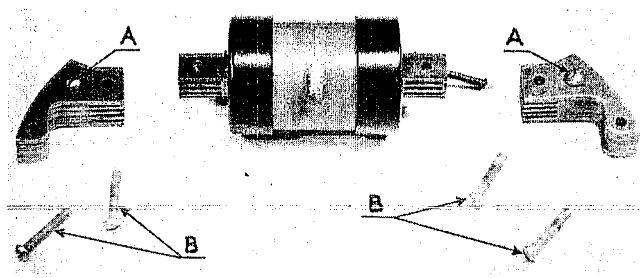
Third—Be careful—don't use too much solder—wipe off excess soldering paste when completed.

Brackets are provided on the LT coils—perform all soldering operations on the brackets.

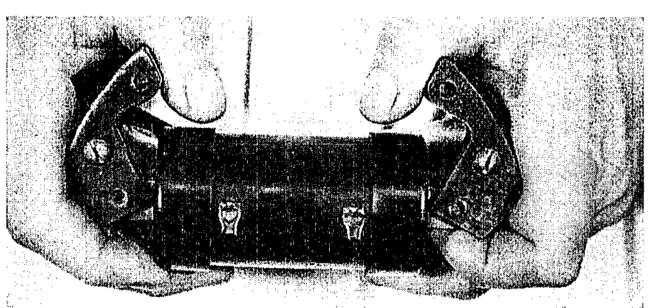
Soldering paste can be obtained from your local electrical shop. DON'T USE ACID FLUX.

INSTALLING IGNITION COIL

With exception of the coils used on the HD-TD models, replacement coils are generally purchased without the heels—using the original heels when making installation since they are still serviceable.

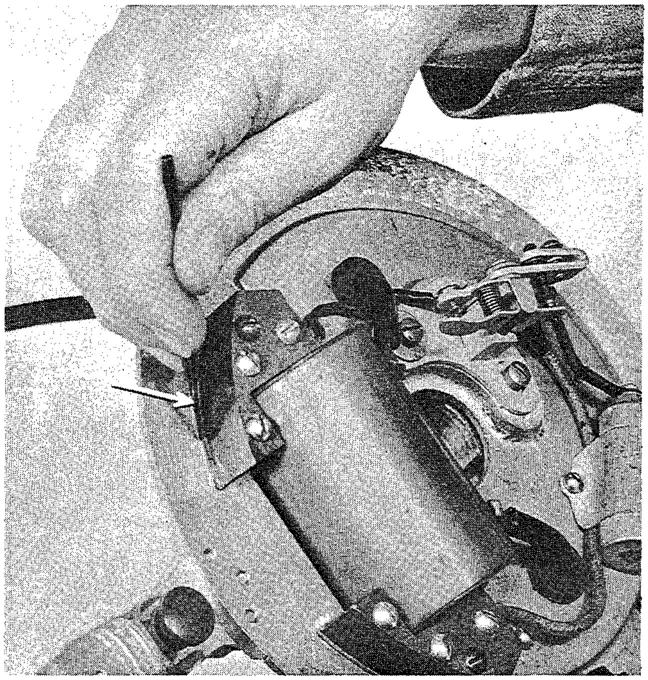


Screws "A" Hold Heel Laminations in Assembly
Screws "B" Attach Coil-Heel Assembly to Armature Plate

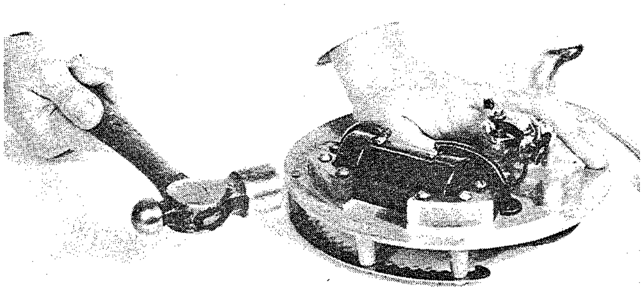


Method of Removing Heels from Coil

The heel laminations are held together with one screw; however, the coil heel assembly is held fast to the armature plate by several screws. See illustration. Screw **not** protruding on reverse side of armature plate holds heel laminations intact.



Scribing Location of Coil Heel Assembly Prior to Removing from Armature Plate.

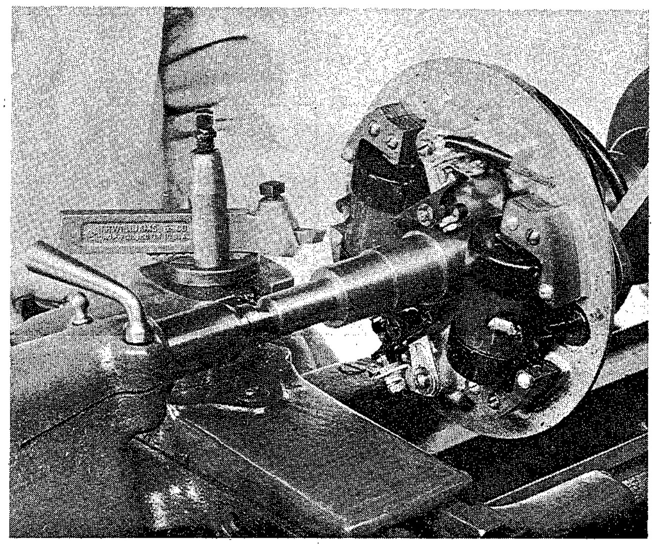


Tapping Coil Heel Into Position

When removing or installing coils, be careful not to remove entirely the screw holding the laminations together. Loosen only enough to permit attaching or detaching from the laminated coil core as the case may be.

In this type of construction it is advisable to mark (with scribe) position of the coil heels on the armature plate before attempting to remove the coil as shown here.

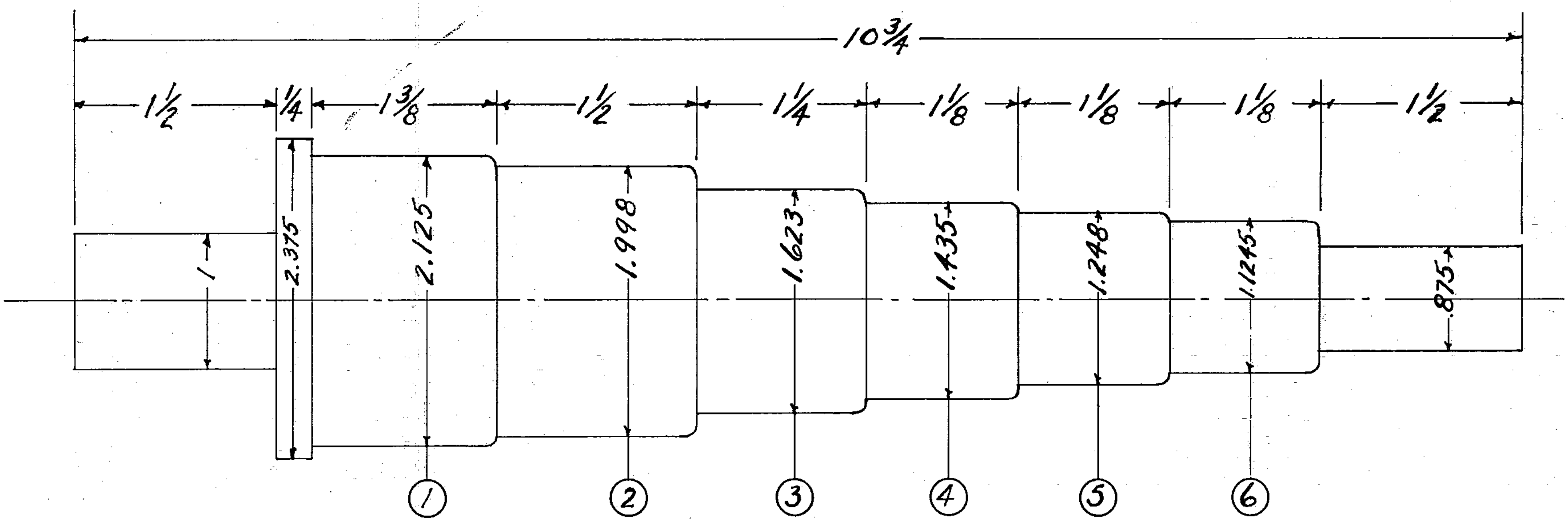
When first attaching new coil (with original heels) to the armature plate, draw up heel screws snugly but not tightly. Tap (with hammer) heels outward beyond scribe mark previously scratched on the plate. Line up edges of heel laminations by tapping with hammer as shown here, but be careful not to drive heels beyond scratch mark. When fairly well lined up, draw up tightly on screws to hold the coil-heel assembly firmly on the plate.



Turning Heel Surfaces to Provide Proper Magnet Clearance

Place armature plate assembly on mandrel and turn heel surfaces down to the scratch mark. (Correct location on some armature plates is governed by a boss on the plate.) This should provide original clearance between the coil heels and magnet pole pieces. Correct clearance is .013″ to .015″. If clearance is too great at this point, or if the heel surfaces are uneven, ultimate spark at the plug will be found to be weak to result in hard starting. On the other hand, if the heels rub or strike against the magnet pole pieces, serious damage is apt to result to magneto parts as well as to interfere with proper sparking at the plug.

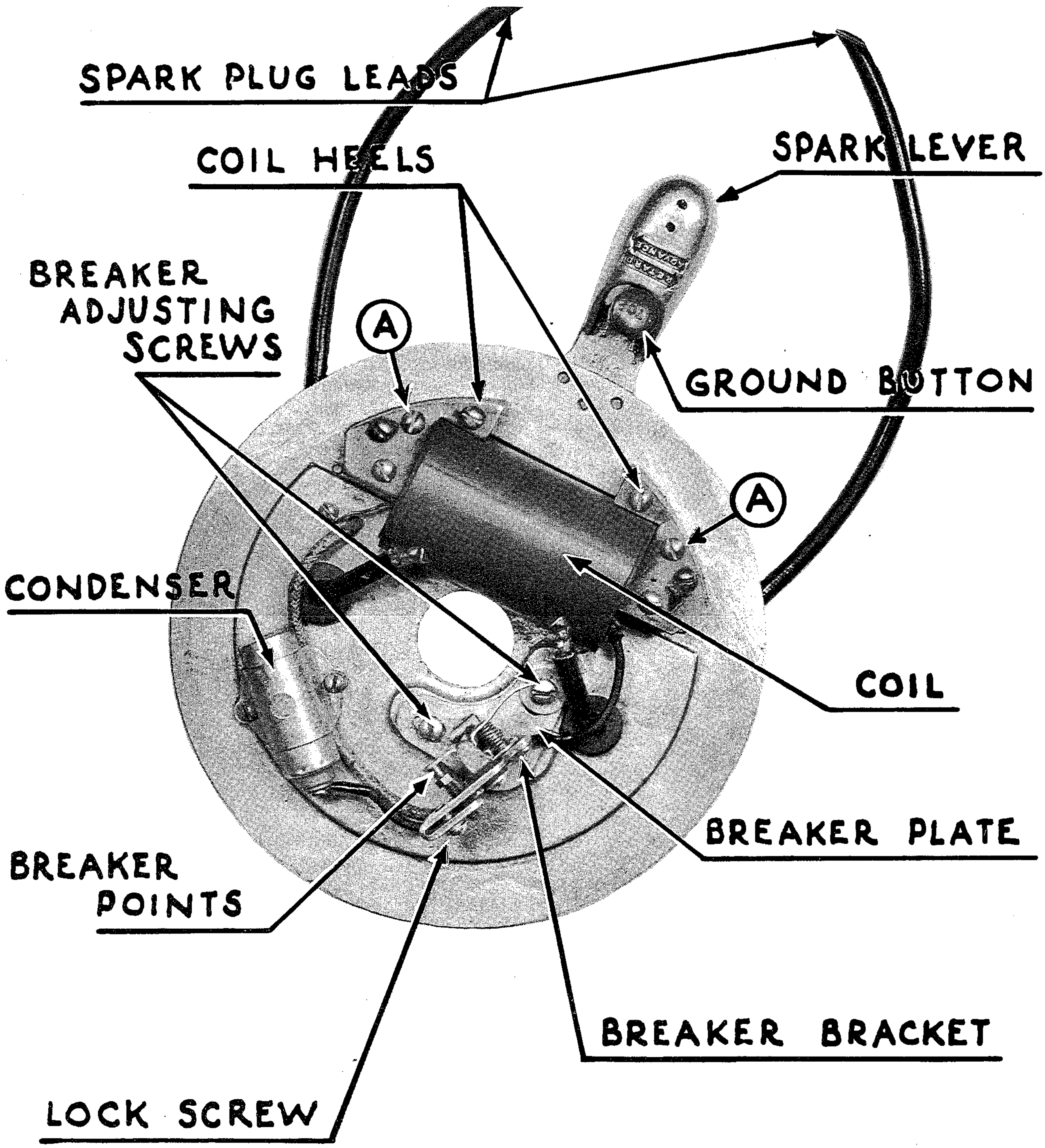
When installing the armature plate—apply coat of grease on crankcase hub to ease operation and to guard against scuffing and seizure later on. Tighten screw sufficiently to prevent armature from "rocking" which affects point setting and heel clearance. This is IMPORTANT.



The mandrel illustrated here can very easily be constructed in any shop where a lathe is available. It can readily be turned from a bar of cold rolled steel to dimension indicated above.

MODELS

1. SD-10, 15.
2. P-50 through PO-15.
3. K-50 through KD-15, A-50 through A80.
4. All Models LT, AT, DT, TS and TD.
5. F-70, 75, 200, 210, A through A45.
6. All H, M, J Models.



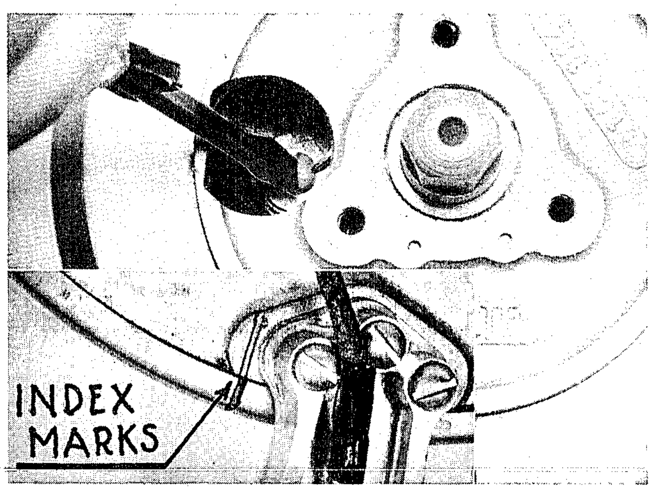
Armature Plate—Models 200-210—Similar to Early Opposed Firing Twins

MAGNETO—MODELS 200-210

The magnetos used on Models 200-210 are similar in construction and operation to those used on all of the opposed firing A, K and P series (except K-50, KD, P-50 and PO) and the single cylinder of series except in this case the coil fires but one cylinder. The coils, condensers, breaker points, etc. are, of course, different in each; otherwise, maintenance and repairs are conducted in like manner for all magnetos of this type.

To Adjust Breaker Points

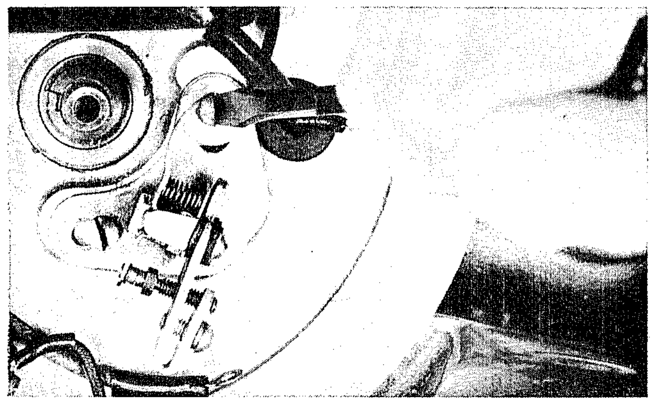
1. Remove starter plate and inspection port cover underneath it. Port in the flywheel is cast in to make the breaker points accessible for inspection or adjustment.
2. Note that breaker points are attached to a movable plate held in position on the armature plate by two screws, and that the points are operated by a cam built into the flywheel. Also, that there is a chisel-like mark on the under side of the armature plate near the outer edge and that a similar mark (line) is stamped on the rim of the flywheel. (Practically all of the older type magnetos are stamped in this fashion).
3. Turn flywheel to observe action and condition of the points. Check gap setting with feeler. Correct setting is .020".
4. If points require gap setting adjustment, loosen the breaker adjusting screws just enough to permit shifting of the breaker point bracket.



5. Shift breaker point bracket as required to obtain a gap setting of .020". Tighten screws to hold the bracket fast.
6. Turn flywheel to a position where the breaker points are just on the verge of opening. Note position of marks on under side of the armature plate and rim of the flywheel. Marks should index (line up) at this point of the operation since current in the coil has reached its maximum intensity.

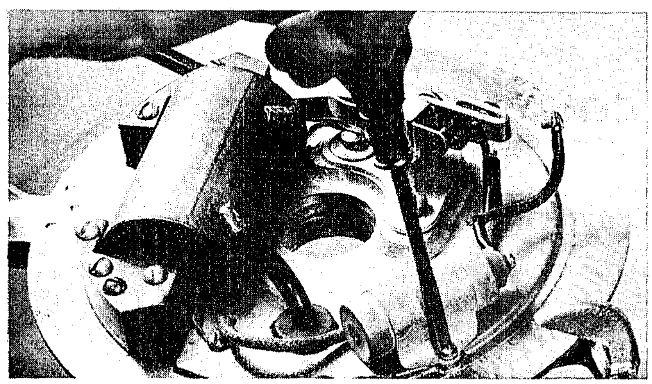
If marks do not index as the points break, shift the breaker bracket as required to obtain breaking of the points as the marks index—at the same time maintaining a .020" gap setting—full open.

7. Tighten breaker adjusting screws to hold the bracket firmly on the armature plate. (Avoid shifting of the bracket to throw points "out of time").
8. Replace inspection cover and starter plate.



To Install Breaker Points

1. Remove flywheel as instructed on page 20.
2. Compress breaker spring enough to permit removing the breaker point lever assembly.
3. Loosen point lock-screw on bracket to remove the stationary point.
4. Install new points in order reverse of that described above.
5. Adjust points as instructed.

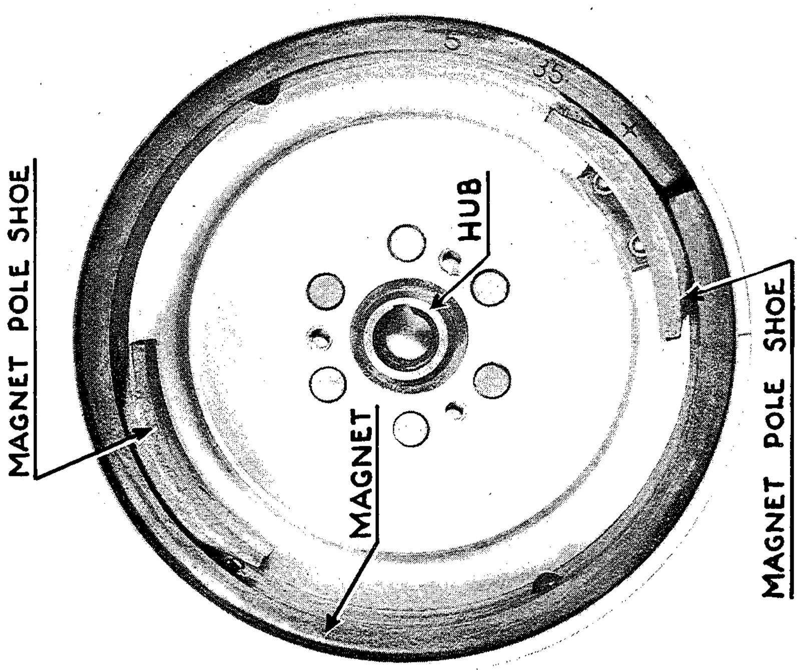


To Install New Condenser

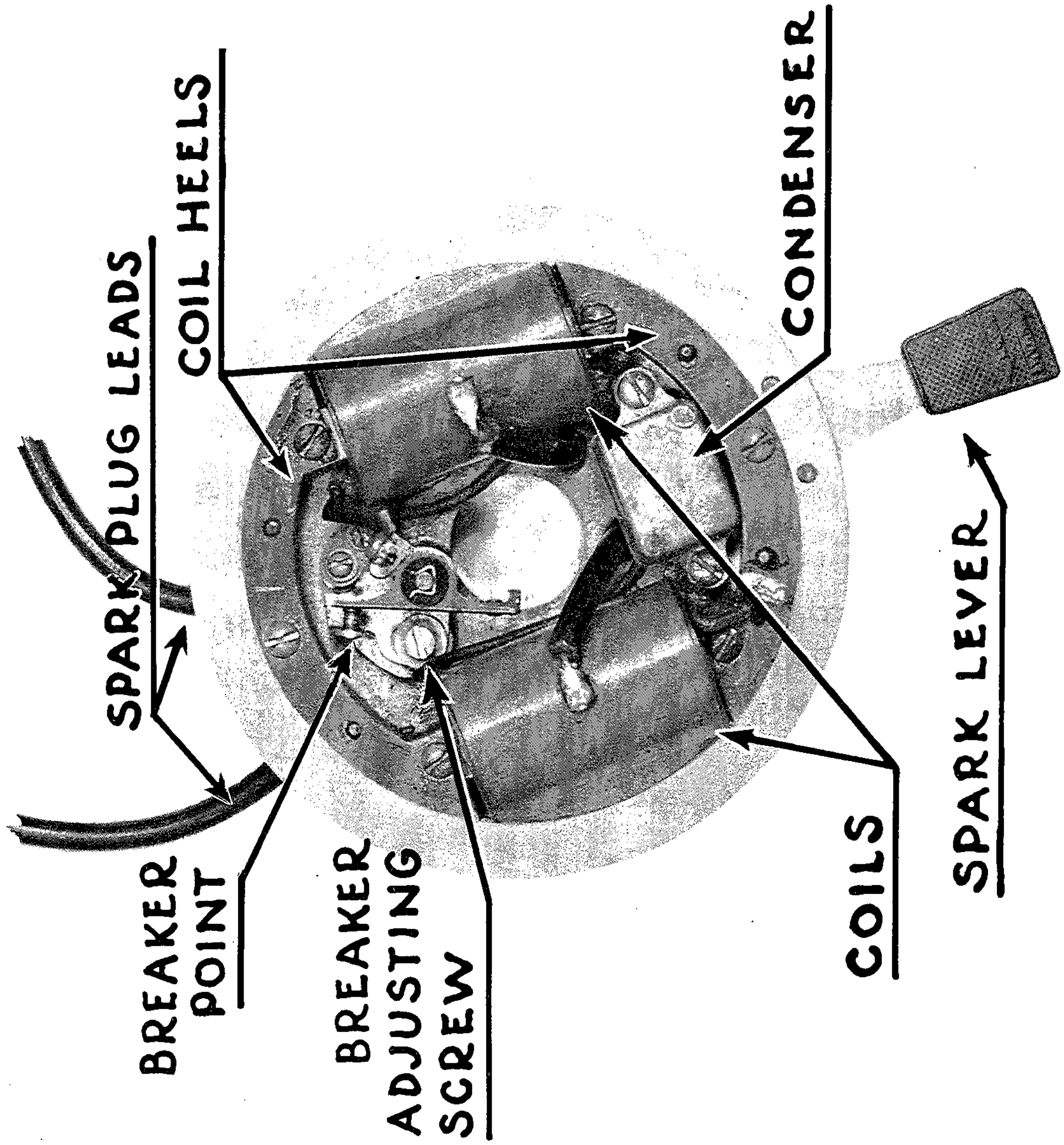
1. Detach condenser lead from breaker point bracket.
2. Check condenser as described on page 23.
3. Remove screws holding condenser fast to armature plate, remove and install new condenser. Be sure all screws and connections are tight and secure to avoid damage as result of loosening while the motor is in operation.

To Install New Coil

1. Test coil as instructed on page 21.
2. Detach spark leads as shown on page 24.
3. Remove screws holding coil-heel assembly to armature plate. Do not remove screws "A" since they are used to hold the heel laminations together. Loosen, but do not remove.
4. Lift coil from armature plate and carefully pry off heel as shown on page 24.
5. Attach coil heels to new coil. Install assembly on armature plate. Line up and turn heels to proper clearance (with respect to magnet poles) as instructed on page 25.
6. Attach spark plug leads as instructed on page 24.

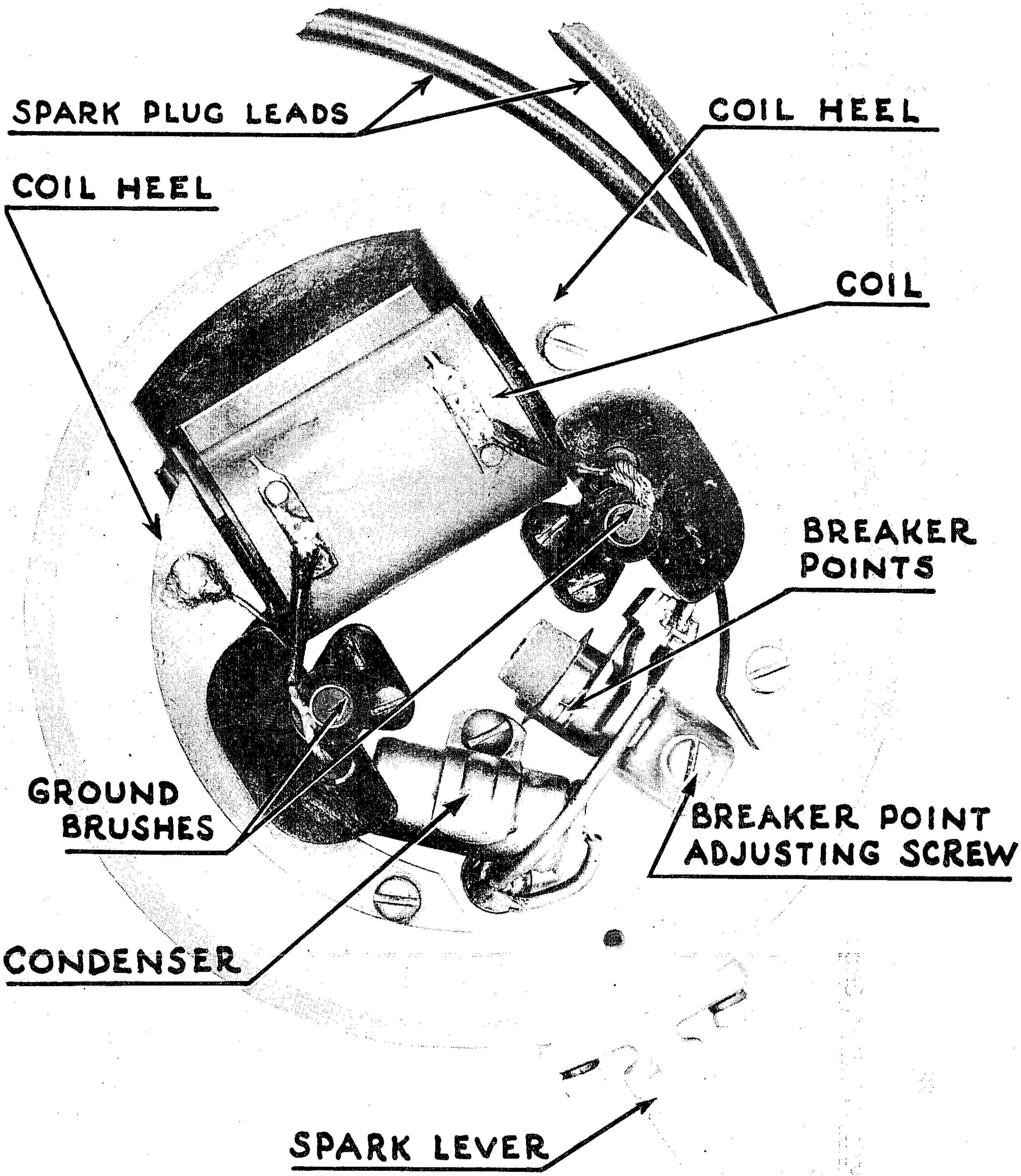


Flywheel



Armature Plate

MODEL 300 MAGNETO



Armature Plate—Models M and H up to and including "15" Series

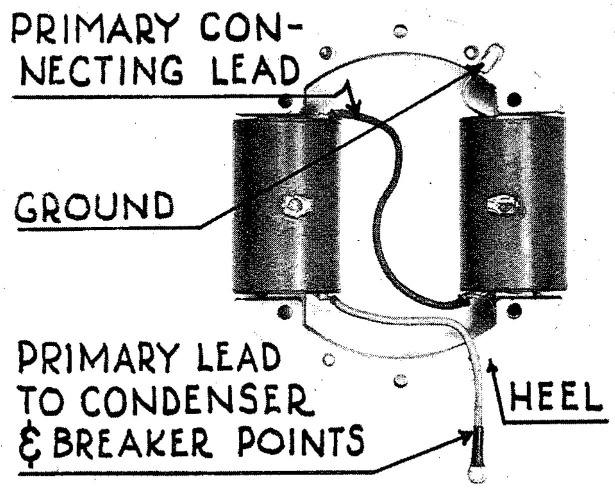
MODEL 300 MAGNETO

The Model 300 magneto is somewhat different in construction from that of preceding models in that two ignition coils are used in an opposed firing motor (both plugs firing simultaneously)—one coil for each cylinder but both operated, however, by one set of breaker points, using one condenser. The primary windings are wired in series with the breaker points and as will be seen in the illustration, coil heels are attached across both ends of the coil cores.

The magnet is somewhat differently arranged, as well. One pole piece is bridged across the ends of the magnet with the second pole piece attached to the center. This feature (not used in earlier models) provides reverse flux as the points open to give added impetus to voltage intensity induced in the secondary winding of each coil. Breaker point action is by a flat milled on the crankshaft, otherwise, the magneto functions in the conventional manner.

Breaker point gap setting is accomplished by loosening the bracket screw and shifting the point-bracket assembly closer to or farther from the flat on the crankshaft as the case may be to obtain correct gap setting of .020″.

The coils, condensers and points are tested or replaced in the customary manner heretofore described.



Coil Assembly

M AND H MAGNETOS UP TO AND INCLUDING "15" SERIES

To Install New Coil

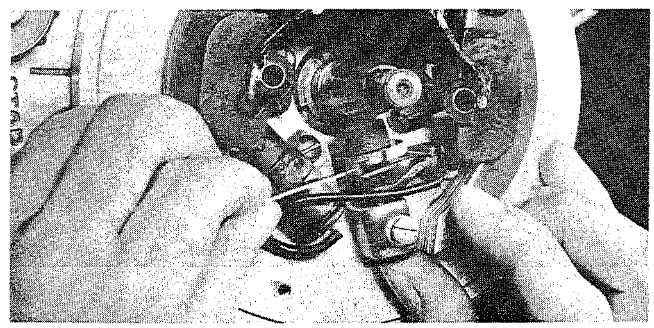
1. Detach ground and high tension leads soldered to coil.
2. Remove screws holding coil and heel assembly fast to armature plate.
3. Pry heels off coil carefully.
4. Attach heels to new coil.
5. Replace coil and heel assembly on armature plate—insert and tighten heel screws firmly.
6. Attach armature plate assembly to mandrel —place between centers of lathe. Turn heels to provide clearance between heel and magnet pole shoes as illustrated, page 25. Correct clearance at this point is .012″ to .014.″
7. Attach ground and high tension leads. Use soldering iron as shown, page 24, but be cautious of temperature of iron—don't let it get too hot. Use soldering paste flux (do not use acid).

To Install New Condenser

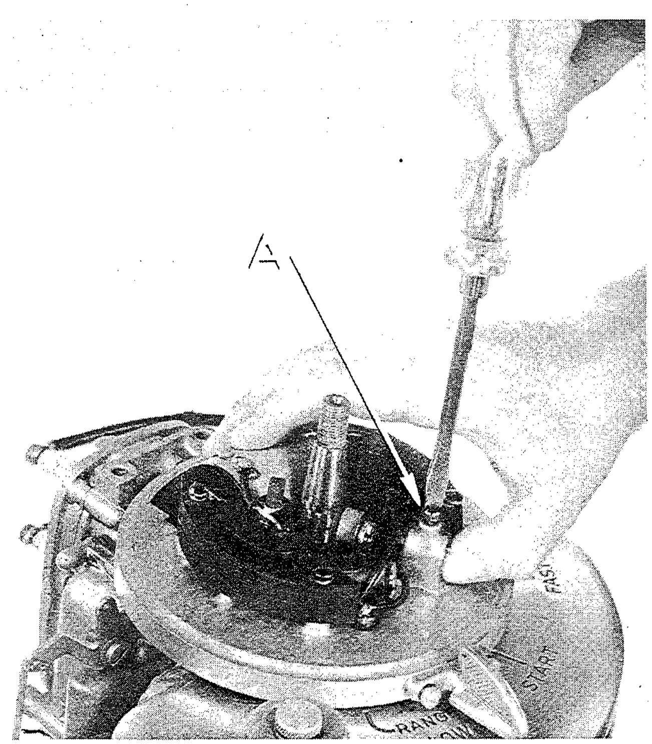
1. Simply remove screws holding condenser in position. Detach lead. Install new condenser in reverse order.

To Adjust Breaker Point Gap

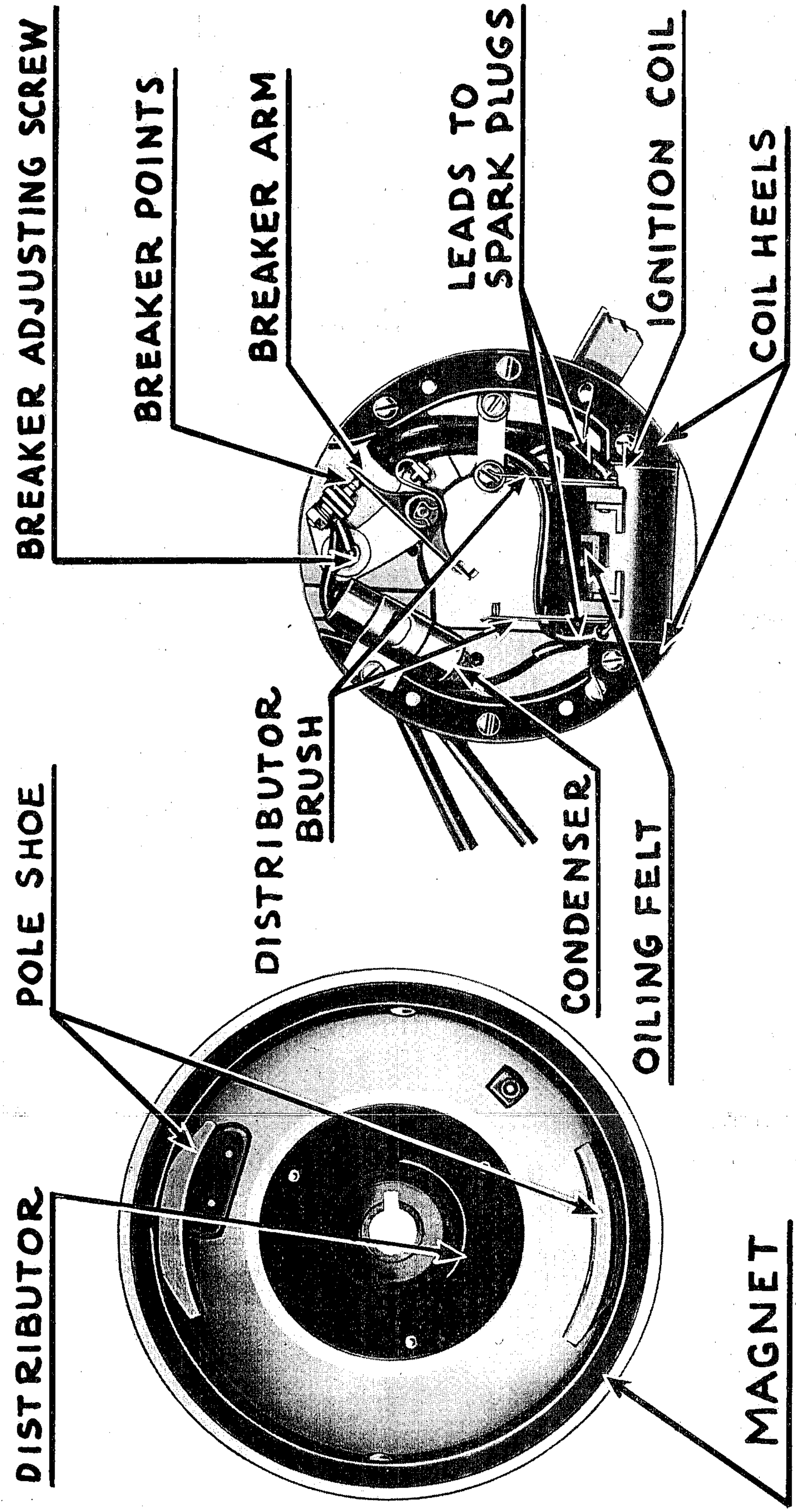
1. Turn crankshaft until push rod, operating breaker points, rides on high side of crankshaft journal.
2. Loosen set screw "A."
3. Correct gap setting is .020″. To increase gap, push breaker assembly towards crankshaft—using thumb as illustrated. To reduce gap setting, move breaker assembly in opposite direction, that is, away from crankshaft.
4. On having attained proper setting tighten set screw "A."



Checking Breaker Points

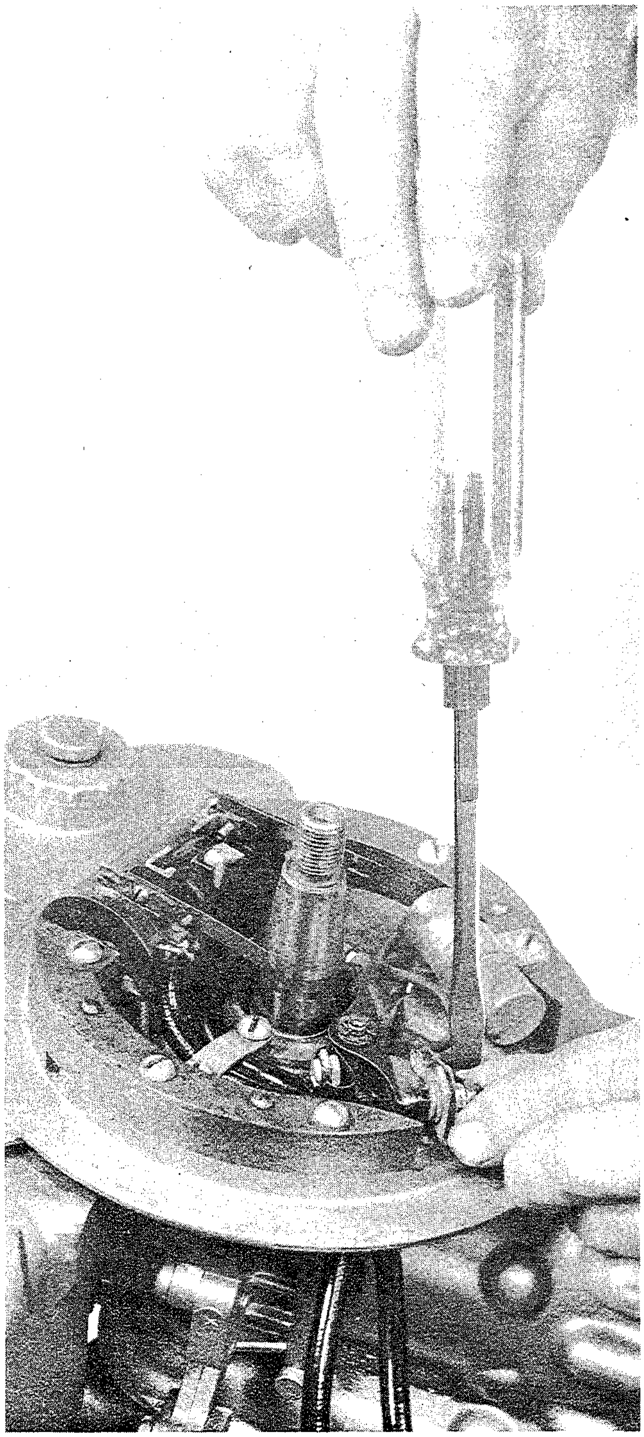


Adjusting Breaker Points



LT SERIES MAGNETO

ADJUSTING BREAKER POINTS ON THE LT-LS SERIES MAGNETO



To adjust breaker points on the LT-LS series magneto — loosen screw holding breaker point plate fast to armature plate. (Note that breaker points are operated by a flat machined into the crankshaft). Shift breaker plate towards or away from the crankshaft to obtain desired gap setting of .020." Tighten breaker plate screw and replace flywheel.

TO INSTALL NEW COIL—MODELS LT AND DT

1. Remove old coil — detach ground wire and other leads soldered to coil. (Do not use excessive heat.) Remove screws attaching coil and heel assembly to armature plate—lift off.

2. Pry heels off old coil and attach to new coil. Attach assembly to armature plate. (Replace screws and tighten). IMPORTANT — Outer edge of coil heels must be flush with outer edge of armature plate. This can be accomplished by tapping heel surfaces lightly with hammer until flush, as on page 25.

If a lathe is available, attach armature plate to a mandrel, place between centers to turn heels flush with edge of plate casting. Page 25. Be sure not to turn below edge of armature plate—doing so will increase gap between heels and pole shoes of magnet (in flywheel).

Correct gap between coil heels and pole shoes of magnet is .015."

Make certain heel screws are tight.

3. Note two flexible wires soldered to high tension outlets—also that two ground brushes and brush holders are supplied with the coil.

4. Assemble brushes to brush holders "B," using small self-tapping screws provided for this purpose Brushes should be located on the inside of brackets. NOTE—Ends of screws should project outward to prevent sparking from screw to distributor segment.

5. Remove clips and long screws from the old coil.

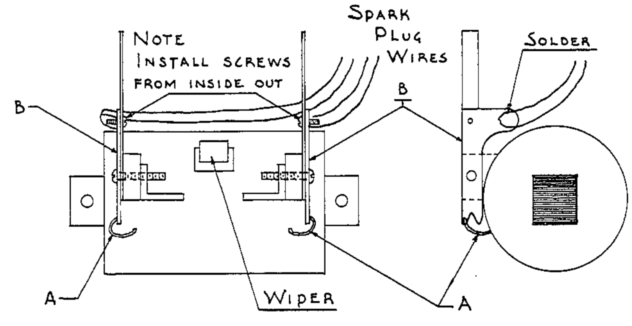
6. Attach brush assemblies to new coil, using long screws and clips removed from old coil.

7. Solder flexible high tension leads on coil to each brush holder, "A." Use **resin base** soldering flux.

8. Remove approximately 3/16" insulation from end of each spark plug lead. Insert stranded wire in hole of brush holder. Flare ends and solder securely in position.

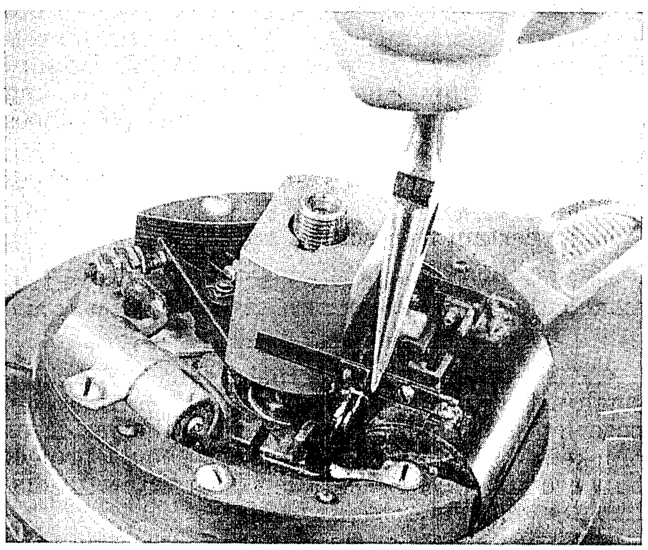
9. Adjust brushes so that proper contact is made with the distributor when flywheel is installed.

10. Apply drop or two of oil on felt.



ADJUSTING GROUND BRUSHES

It is extremely important that ground brushes make contact with segment on hub of the flywheel, when motor is in operation—if not, both plugs will fire simultaneously to interfere with performance. While effect of improperly adjusted brushes is not so noticeable at high speeds, satisfactory slow speed running cannot be attained as result of one plug firing at top of piston stroke in one cylinder and at the bottom of the stroke in the other. This condition is frequently indicated by "popping" back through carburetor when attempting to operate at slow speeds.

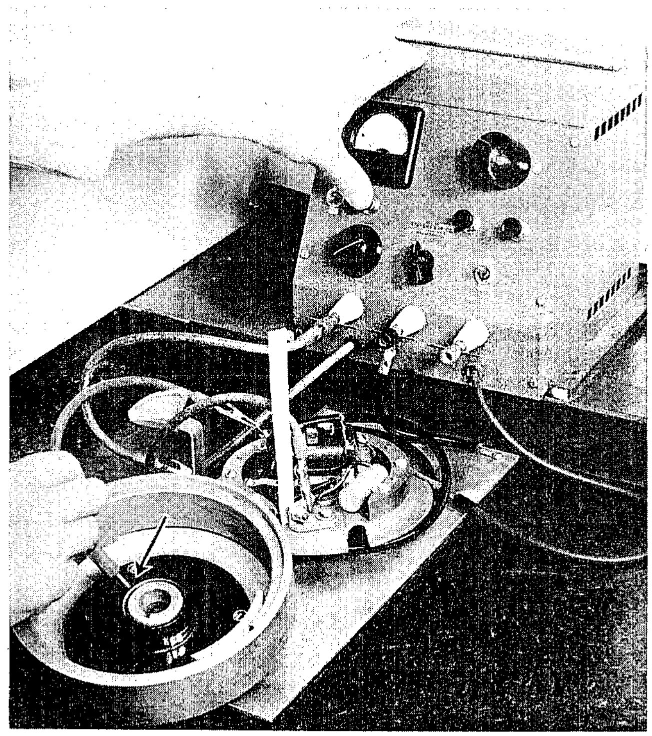


1. The armature plate should first be placed on the motor, then the clampscrew tightened to the proper tension for normal operation.
2. Place S-262 gauge on the crankshaft, making certain that it is perfectly seated on the taper. This is extremely important—the gauge must be seated on the crankshaft taper to insure correct adjustment of brushes.
3. Check each brush for proper setting by turning the gauge around until the steel insert is in line with the brush. Brushes should touch gauge very lightly and yet not be forced outward as gauge is turned into position.
4. In event one or the other of the brushes does not make contact or bear too heavily against the gauge, it will be necessary to bend the brush support in or out, whichever is required to provide correct adjustment. Excessive brush tension will result in rapid wear of the brush to interfere with running of the motor after but short periods of operation. CAUTION: **Do not bend the brushes**—bend the heavy metal strip to which the brushes are attached. See illustration. This should be carefully done to prevent breakage of the bakelite brush support lugs which are moulded onto the ignition coil.
5. After brushes are properly adjusted, remove gauge and carefully install flywheel on motor. Considerable care should be exercised when installing the flywheel to prevent bending or breaking the brushes.

TESTING GROUND (DISTRIBUTOR) BLOCK IN FLYWHEEL

All of the LT series magnetos and those used on the K series, HS-HD-15 inc., are provided with a ground block in the flywheel for the purpose of grounding out one spark plug at a time to prevent both from firing simultaneously to interfere with slow speed performance.

Short circuits created by cracks in bakelite block, carbon streaks, etc., result in improper firing of the spark plugs, thus faulty motor performance. Each plug should be cut (ground) out but at the proper time with relation to position of the piston in the corresponding cylinder. The piston should be down (bottom of the stroke) when plug in that cylinder is grounded out.



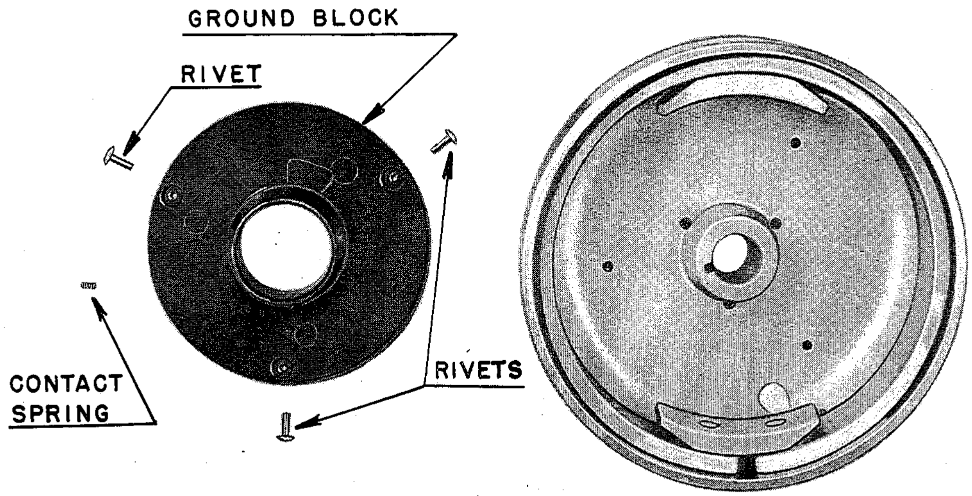
Method of Testing Ground Block for Leaks

The ground (distributor) block segment is grounded thru the flywheel by a small spring (see illustration) which is correctly placed between the ground segment and the flywheel to insure satisfactory contact.

It is a simple matter to test for short circuits in the ground block by setting up the armature plate for checking of the ignition coil but instead place the flywheel ground block in series with one of the high tension (spark plug) leads as illustrated here. Apply current from testing device and move end of lead over bakelite section of the ground block to check for leaks (short circuits). If cracks are present, an arc will be created to indicate short circuits. The coil otherwise is protected by a safety gap on the armature plate.

Replace ground block if defective.

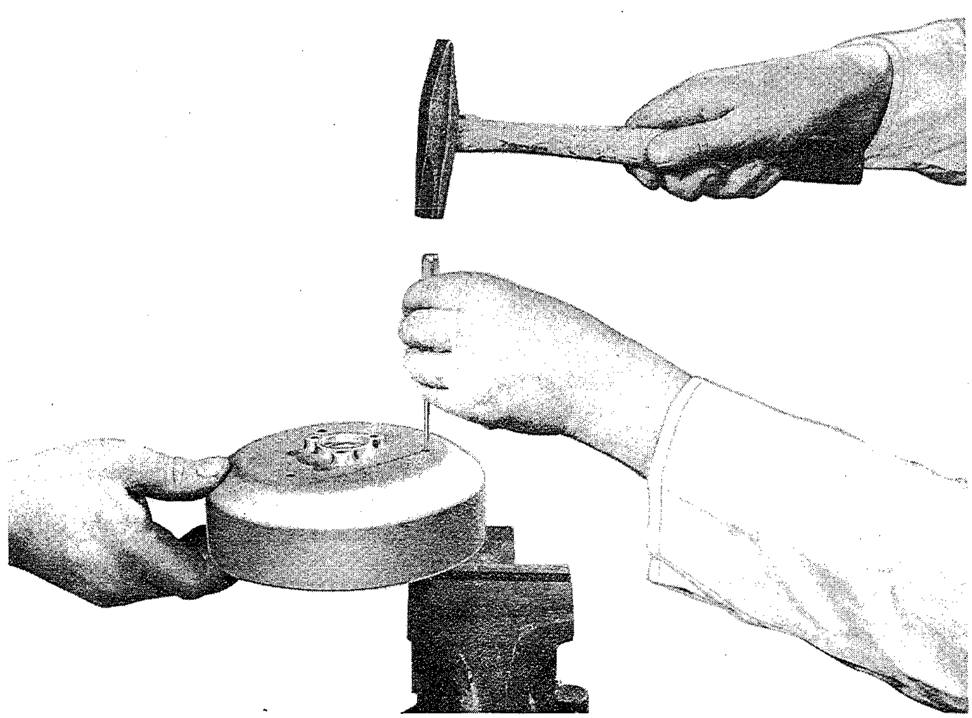
TO INSTALL HIGH TENSION GROUND BLOCK
MAGNETO FLYWHEEL



1. Drive rivets out of old ground block and flywheel—this can be accomplished by using a small straight punch and driving from inside of flywheel. Drive rivet through block and out through flywheel.

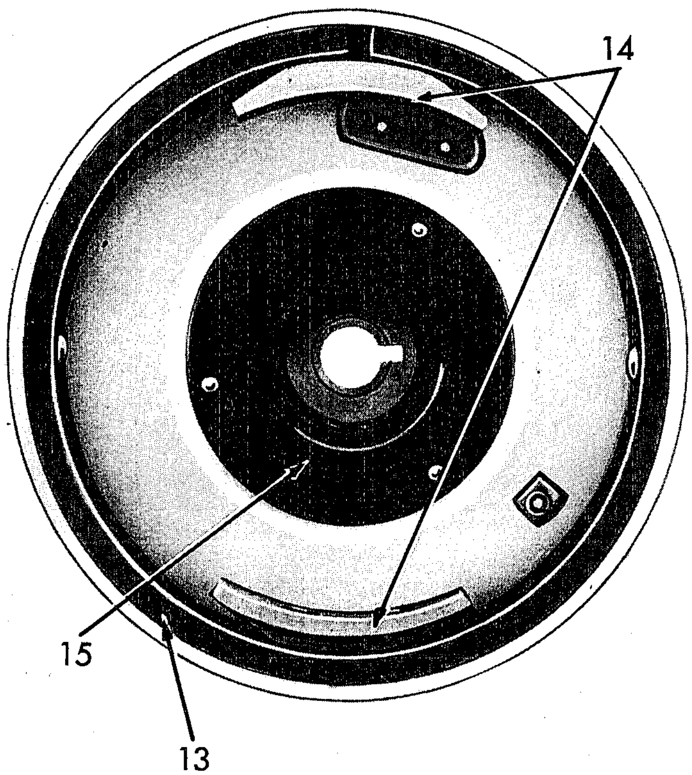
2. Place new ground block in position—insert new rivets and carefully upset hollow end (inside of flywheel) with round end punch. Care should be exercised when performing this operation to guard against cracking of bakelite block.

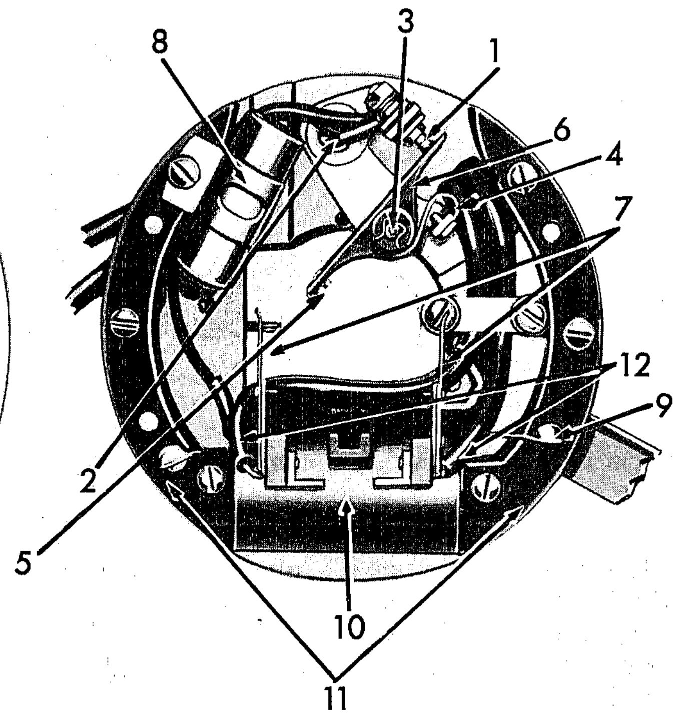
Be sure contact spring is in position in ground block. This is important.



MAGNETO CHECK CHART

(Models: LS-37, 38—LT-37, 38, 39 and 10)





1. BREAKER POINTS—Corroded or improperly adjusted. Correct gap setting is .020."

2. BREAKER POINT ADJUSTING SCREW—Loose, affecting breaker point gap setting.

3. BREAKER ARM PIVOT POST—Tight in breaker arm bushing causing sluggish action of arm. Bushing short circuited.

4. BREAKER ARM SPRING—Weak or broken.

5. BREAKER ARM RUBBING BLOCK—Worn excessively, loose or broken.

6. BREAKER ARM—Broken.

7. HIGH TENSION GROUND BRUSHES—Worn, broken or improperly adjusted (to adjust, use tool No. S-262).

8. CONDENSER—Weak or shorted out.

9. PRIMARY GROUND—Loose or broken.

10. COIL—Weak or broken down.

11. COIL HEELS—Improperly adjusted—clearance between heels and magnet pole shoes (14) should be .015."

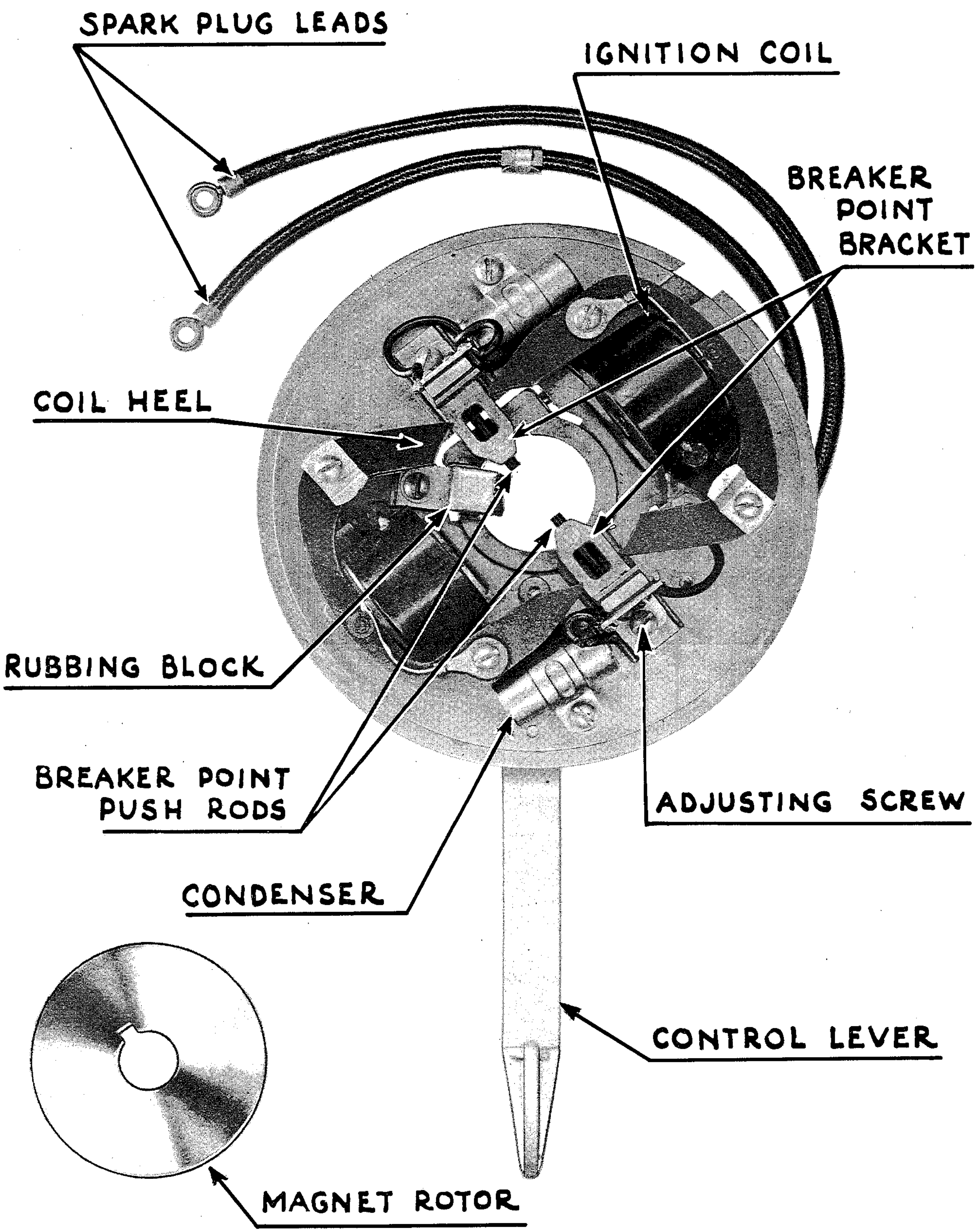
12. IGNITION LEADS — Broken, leakage through insulation. BE SURE all electrical connections are secure and tight. DON'T use acid flux on soldered connections, use SOLDERING PASTE.

13. MAGNET—Weak or broken.

14. MAGNET POLE SHOES, see No. 11 above.

15. HIGH TENSION GROUND BLOCK—Broken, cracked or short circuited.

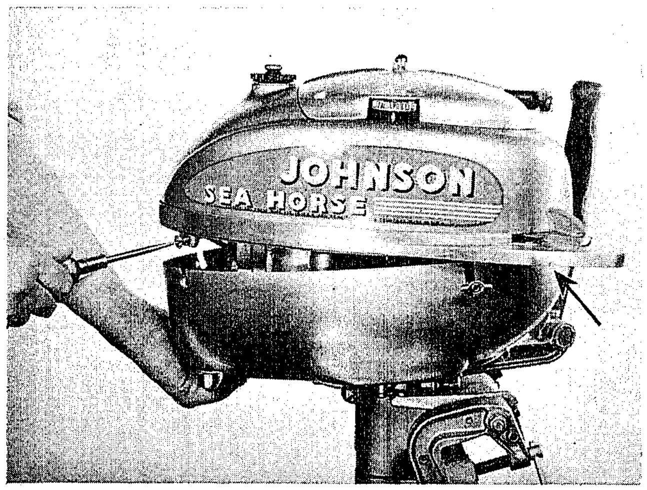
A careful check-up of the above will lead to source of difficulty.



HS, HD—20-25 TS, TD—15-20 MAGNETO

MAGNETO—MODELS H & T—15, 20 & HD-25 TO LOWER OR REMOVE COVER

For inspection of spark plugs, carburetor, etc.—loosen screws as indicated. Four screws are used to hold cover in position — namely, two at rear and two at front, arrow directed to location.

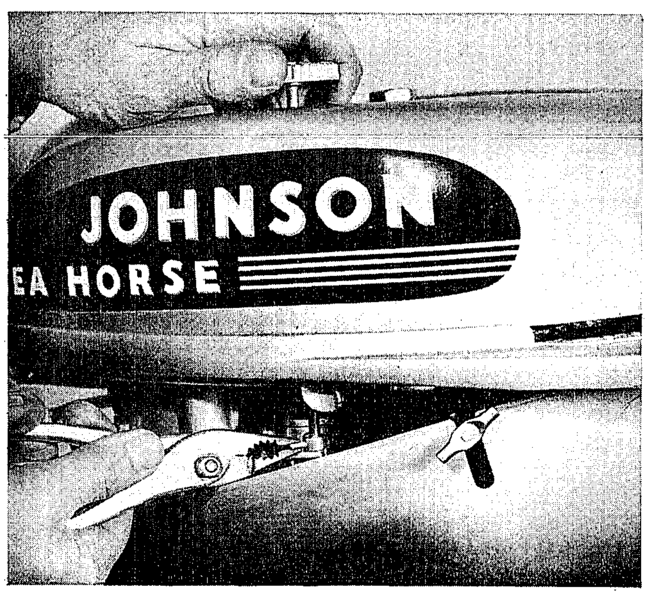


Dropping Spark Plug Cover

TO REMOVE FLYWHEEL WHEN DISASSEMBLING MOTOR

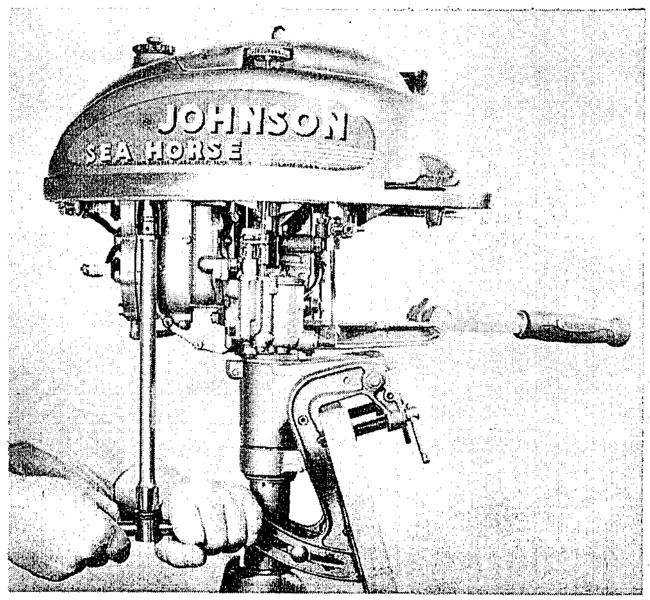
Proceed as follows:

1. Remove spark plug cover as described above.
2. Remove starter pulley and spacer from flywheel. See motor illustration.
3. Remove high speed needle and primer by withdrawing small tapered pin from end of shaft as shown.
4. Disconnect gas line—gas tank is held in position by four ¼-20 x 1-⅛" screws. Remove tank from bracket as illustrated.



Removing Pin from High Speed Needle

5. Remove flywheel nut, using a ¾" socket wrench. Grasp rim of flywheel to prevent turning when unscrewing nut. If nut appears to be too tight to loosen with socket wrench only, strike handle of wrench with a hammer — resulting jar should be sufficient to loosen nut.
6. Attach wheel puller No. S-288 to flywheel as shown.
7. Turn puller screw down until it rests firmly against end of crankshaft. Grasp puller with one hand, as illustrated, lift upward to absorb shock and strike puller screw head sharp blow with medium size hammer.



Removing Gas Tank

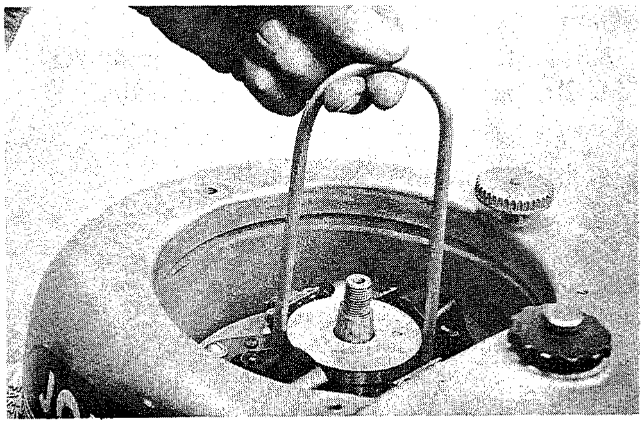
If first application fails, draw up further on puller screw and repeat as above. Two or three similar attempts should be sufficient to loosen flywheel on taper of crankshaft.

8. After having loosened flywheel, simply lift off.

Pulling Flywheel

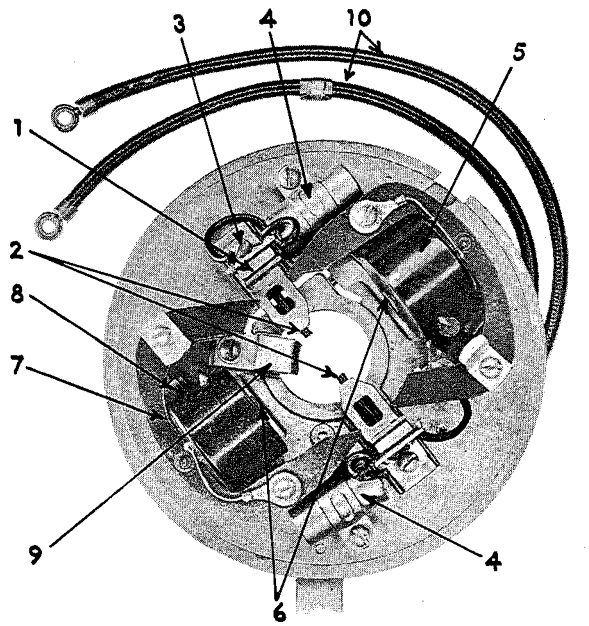
To install flywheel after inspection of magneto, proceed in reverse order of that described above. Note—Be sure flywheel is securely mounted before attaching spacer and starter pulley (Model TS)—the nut must be tight to prevent flywheel from loosening in operation.

To remove magnet rotor, simply insert tool as shown—lift up. Rotor slips over end of crankshaft, but in event fit is found to be a bit snug, apply additional force (pull up). Excessive force not required to replace rotor — slip over end of crankshaft and press down lightly.

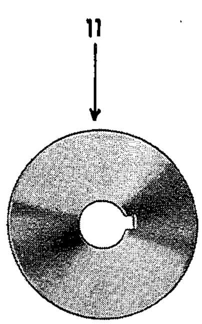


Removing Magnet Rotor

MAGNETO—CHECK CHART



ARMATURE PLATE ASSEMBLY



MAGNET ROTOR

1. Breaker Point Assembly
2. Breaker Point Push Rods
3. Breaker Point Adjusting Screw
4. Condensers
5. Ignition Coils
6. Coil Core
7. Ignition Coil Pole Shoes
8. Maverick Spark Suppressor (under coil shoe), Model TS, TD-15 only
9. Rubbing Block, Apply Oil
10. Ignition Leads
11. Magnet Rotor

Maverick Spark Suppressors—The word maverick means *stray* or, in terms of the cattlemen, unbranded—here it is but whose is it. The word also is associated with the characteristics of an electrical ignition system — a stray spark, unwanted but still present.

Maverick spark does not occur at slow speeds but prevails in the higher speed range, resulting in a spark jumping the spark plug gap before the breaker points actually open. This effects timing, causes pre-ignition and faulty operation of the motor at high speeds. It is not a particularly strong spark and is easily controlled, but if not suppressed is strong enough to interfere considerably. Control consists of installing a small gap in the secondary (high tension) circuit Maverick Spark Suppressor (8). It is located between the armature plate (ground) and ground lead of the secondary winding.

Operation of the Maverick Spark Suppressor is extremely simple—the gap provided merely sets up sufficient resistance to keep the secondary circuit open, thus suppressing the spark (maverick) until the breaker points open, when the controlled spark is strong enough to jump both the plug gap and the suppressor gap. Consequently, every time the plugs fire, a spark jumps the Maverick suppressor gap simultaneously.

MAGNETO—MODELS TS- 15, TD-15, TS-20, TD-20

While outwardly there is no difference in appearance between the TS-, TD-15 and TS-, TD-20 models, there is a difference in the magneto.

1. Maverick Spark Suppressors have been omitted from the TS-, TD-20 armature plate. This has been accomplished by increasing strength of the magnet in the rotor and by machining a longer flat (cam) on the crankshaft to permit breaker points remaining closed over a longer period, thus eliminating the Maverick spark entirely.

2. The new rotor bears the same part number as the rotor originally installed in assembly of Models TS-, TD-15 but can be identified by the letter "V" cast on its top side. The old rotor, with the smaller magnet, is no longer available.

3. The crankshafts on both models (TS-15, TD-15 and TS-20, TD-20) are identical in all respects but one, the difference being in the cam on the top journal which operates the breaker points. Models TS-15, TD-15 use part number 41-300503 crankshaft, machined with a comparatively shorter cam than the cam on crankshaft number 41-301392 for Models TS-20, TD-20. The length of the cam determines the length of time the breaker points remain open and closed, during operation of the motor.

4. The new rotor (with the larger magnet) can be used on Models TS-15 and TD-15. (Maverick Spark Suppressors become more important under this condition. Irregular motor operation results if the suppressors are defective or otherwise fail

to function.) The old rotor (with the smaller magnet) cannot be used with the TS-20, TD-20 crankshaft under any conditions.

5. Models TS-20, TD-20.
   Crankshaft #41-301392
   Rotor #71-300540
   *Armature plate complete #72-375458

*No suppressors required.

6. Models TS-15, TD-15.
   Crankshaft #41-300503
   Rotor #41-300540
   *Armature plate complete #72-375250

*The suppressor #72-375249 must be used on this combination.

TO INSTALL NEW COIL

Remove screws attaching coil and shoe assembly to the armature plate. Detach ground wire, spark plug wire and primary lead to the breaker assembly.

NOTE: Wherever necessary to detach leads previously soldered in position such as the spark plug lead, be careful not to apply too much heat — just enough to break the connection loose. Proceed carefully. Lift coil assembly from the plate and discard if faulty.

Install new coil assembly. Replace coil mounting screws but do not tighten for the time being. Attach all primary leads and solder spark plug lead to the coil. Again—do not apply excessive heat—just enough to provide a good soldered connection. The coil can be ruined by applying too much heat at this point.

IMPORTANT: Under no circumstances use an acid flux — it causes corrosion and ultimately a faulty connection. Use a soldering paste or rosin.

TO ADJUST CLEARANCE BETWEEN COIL SHOES AND MAGNET ROTOR

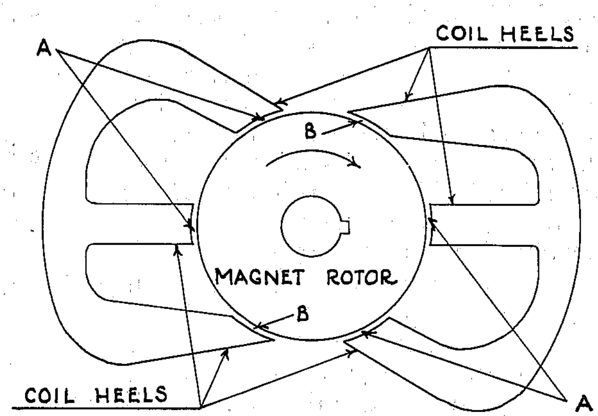
To get the most out of the magneto, one of the important things to consider is correct clearance between the magnet rotor and the coil heels.

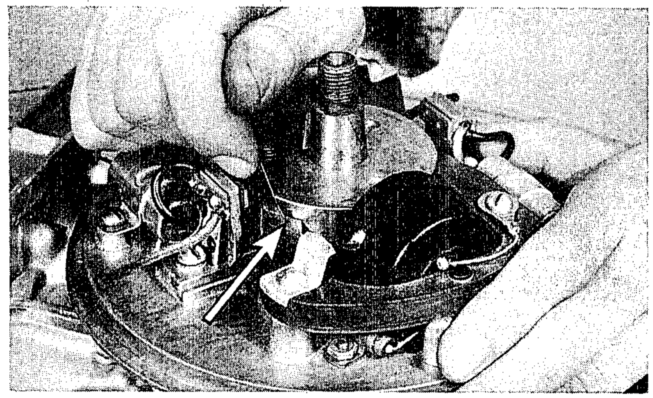
This clearance is obtained by shifting the coil-heel assembly towards or away from the magnet rotor. Proceed as follows:

1. Loosen screws, attaching coil assembly to armature plate, slightly.
2. Adjust position of coil assembly so that clearance at point "A" is .008″ for models HS-HD-20, TS-TD-15 (armature plates equipped with spark suppressors) and .012″ for Models HS-HD-25, TS-TD-20.

NOTE: Clearance at point "B" should not be less than at point "A"—it may be greater. Under no circumstances should the heel be permitted to ride or rub on the magnet rotor.

3. Tighten screws to hold coil assembly fast.
4. Repeat same operation on both coils.





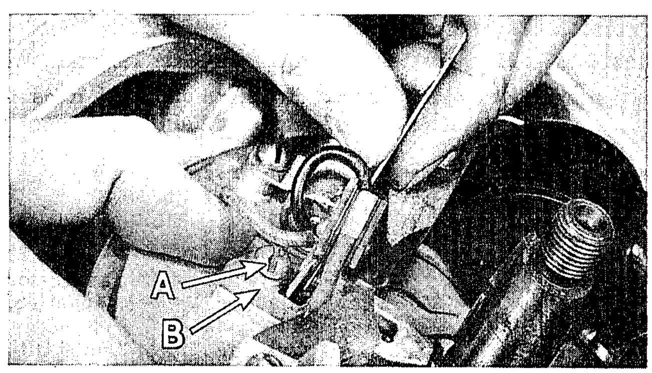
Checking Rotor Clearance

TO ADJUST MAGNETO BREAKER POINTS

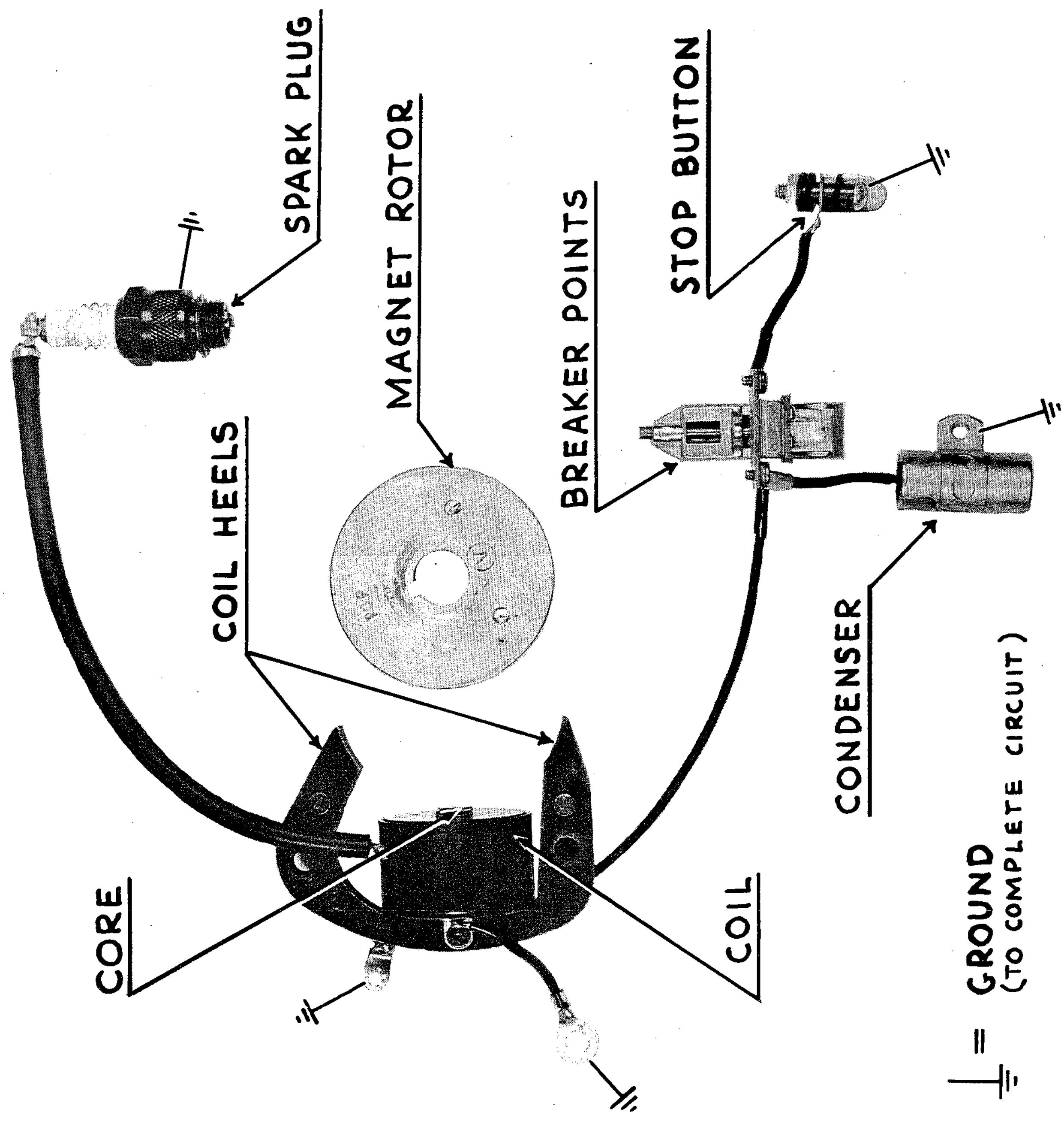
Since two coils are used (one for each cylinder) two condensers and two sets of breaker points are required, both of which may need occasional inspection from time to time.

Note flat machined on crankshaft and two push rods operating both sets of points are open when respective push rods ride on high side of crankshaft—closed when on flat. Correct breaker point gap setting is .020″ (full open).

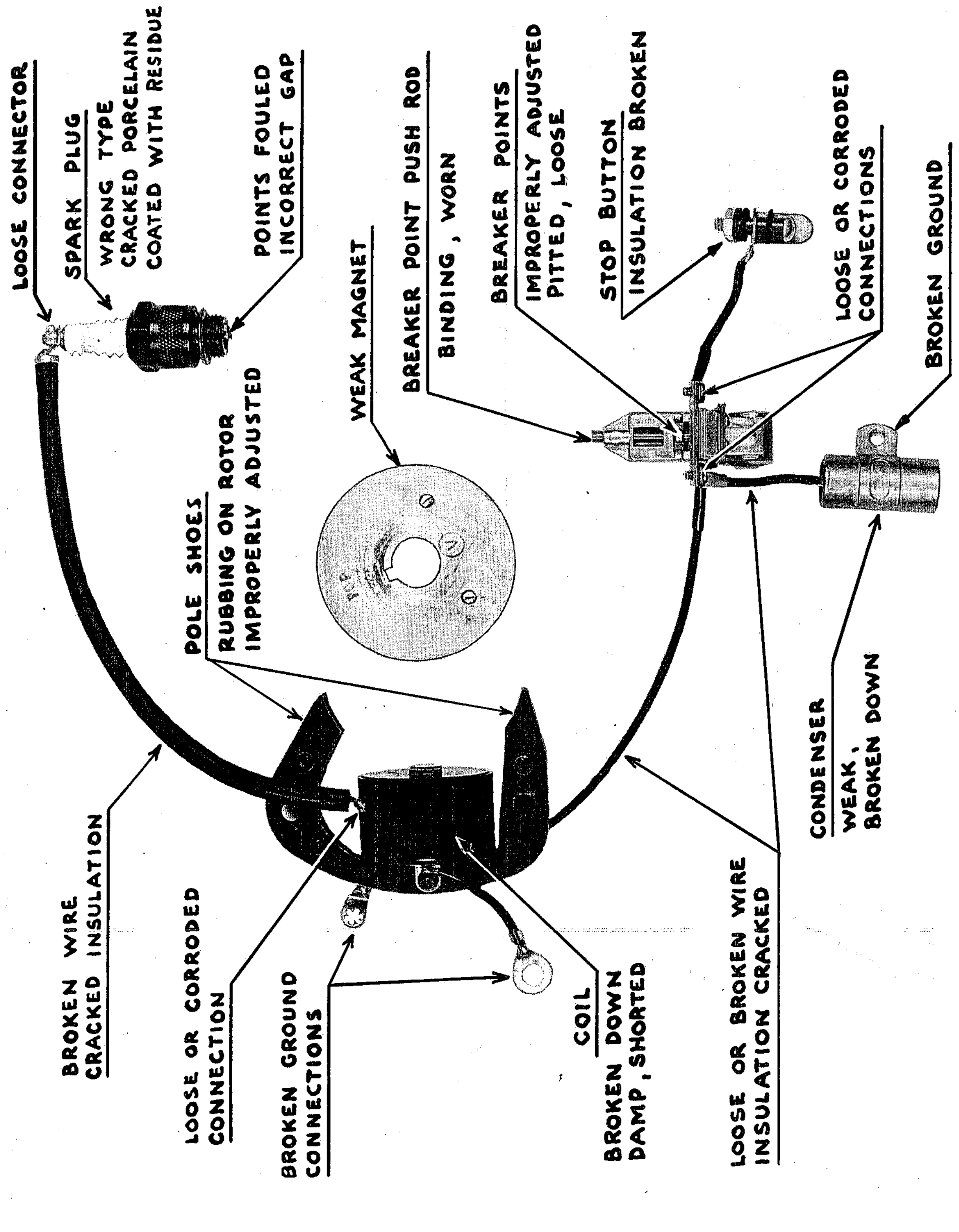
To adjust gap setting loosen screw "A." Turn crankshaft to position where push rod rides on high side. Check gap between points, using .020″ feeler gauge as illustrated. If gap is less than .020″ push breaker point bracket "B" in (towards crankshaft) sufficiently to obtain correct gap setting. Tighten screw "A". If gap is over .020″ slide bracket "B" out (away from crankshaft). Adjust both points in like manner.



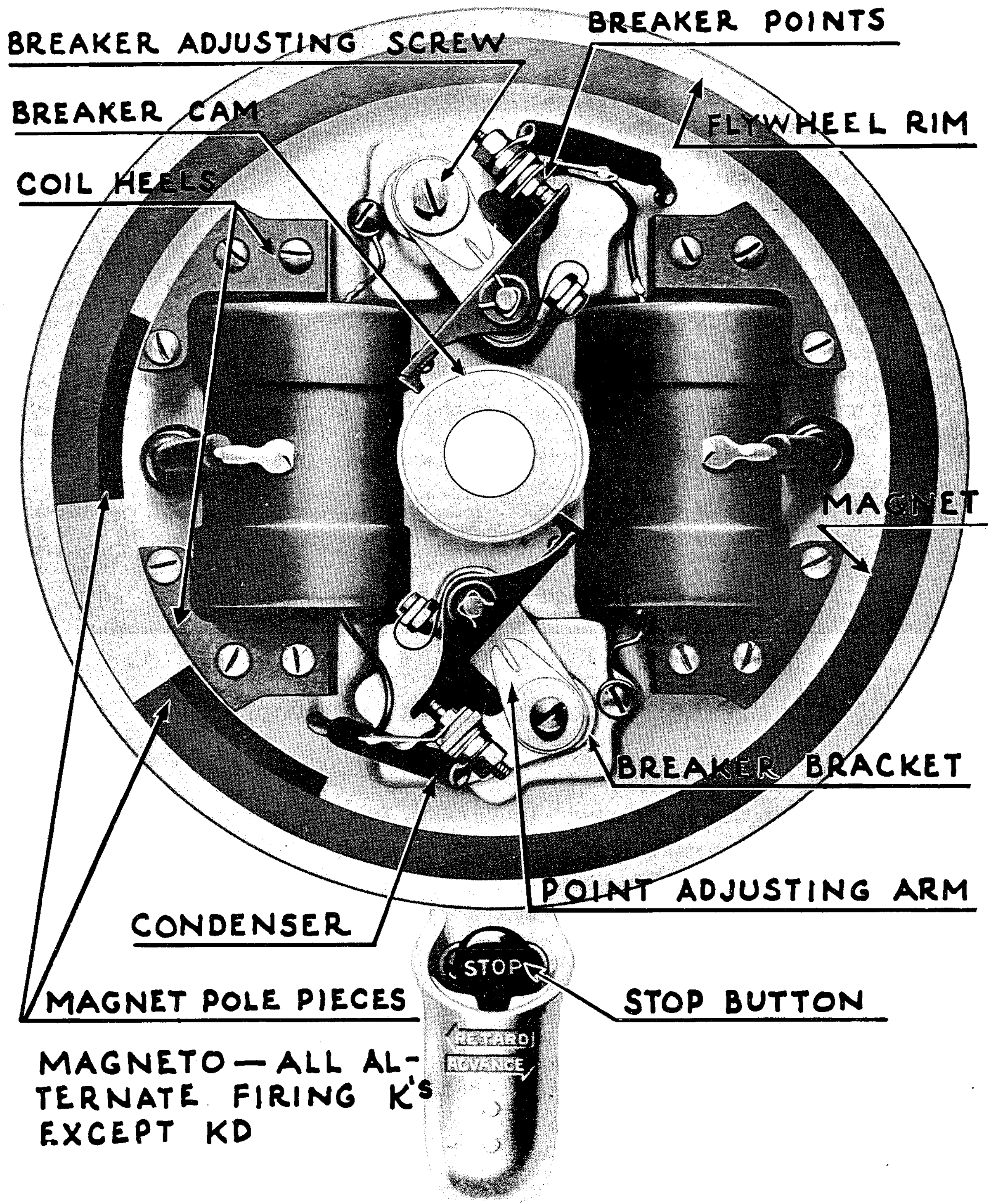
Adjusting Breaker Points



Showing How the Ignition Coil, Condenser, Breaker Points, Spark Plug and Ground (Shut Off) are Connected (Wired) Including the Magnet Rotor.



CHECK CHART – ROTOR TYPE MAGNET



ALTERNATE FIRING MAGNETO
(A & K Series—Alternate Firing Models)

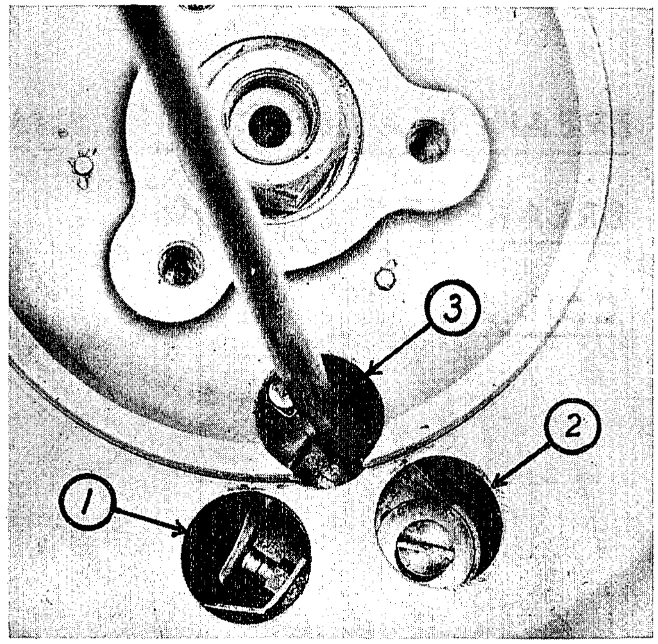
MAGNETO—ALTERNATE FIRING A AND K SERIES

(A-50 to AA-37 inc.—K-50 to KD-15 inc.)

Since no form of distributor for secondary current (high tension to spark plugs) was provided on the magneto for above models, practically two independent ignition systems are required — a coil, a condenser and a set of breaker points for each cylinder, operating with a magnet and breaker cam built into the flywheel.

Regardless of the dual construction, principle of operation is identical, with maintenance and repairs conducted in customary manner. See preceding instructions for testing and installing coils, condensers, breaker points, etc. Correct gap between coil heels and magnet shoes is .015."

NOTE: The KD magneto is currently provided with a breaker point adjusting arm as shown on page 43, to facilitate simpler adjustment. To adjust breaker points in this case, simply loosen slightly the adjusting screw, then with a screw driver, turn the arm right or left as required to obtain correct point gap setting of .020," after which retighten adjusting screw to hold the bracket fast.



METHOD OF ADJUSTING BREAKER POINTS

(Porting Arrangement Shown Here Consists of Three Holes in the Flywheel—(1) to Observe Breaker Point Gap; (2) to Permit Loosening of the Breaker Plate and (3) to Adjust Breaker Gap. Older Model Flywheels are Equipped with a Triangular Shaped Part for the Same Purpose.)

CHECK CHART—ALTERNATE FIRING A AND K MODELS

1. Faulty Spark Plug.

(a) Wrong type—too "hot" or too "cold."
(b) Broken or cracked porcelain.
(c) Residue formation on porcelain — particularly in salt water areas.
(d) Loose terminal connection.

2. Faulty Wiring.

(a) Insulation broken down.
(b) Broken wires.
(c) Faulty connections—poorly soldered joints or loose connections.

3. Faulty Breaker Points.

(a) Improperly adjusted.
(b) Pitted or corroded.
(c) Weak spring on breaker arm.
(d) Breaker arm binding on pivot post.

4. Faulty Condenser.

(a) Weak—partially "shorted."
(b) Broken down—"dead."

5. Faulty Ignition Coil.

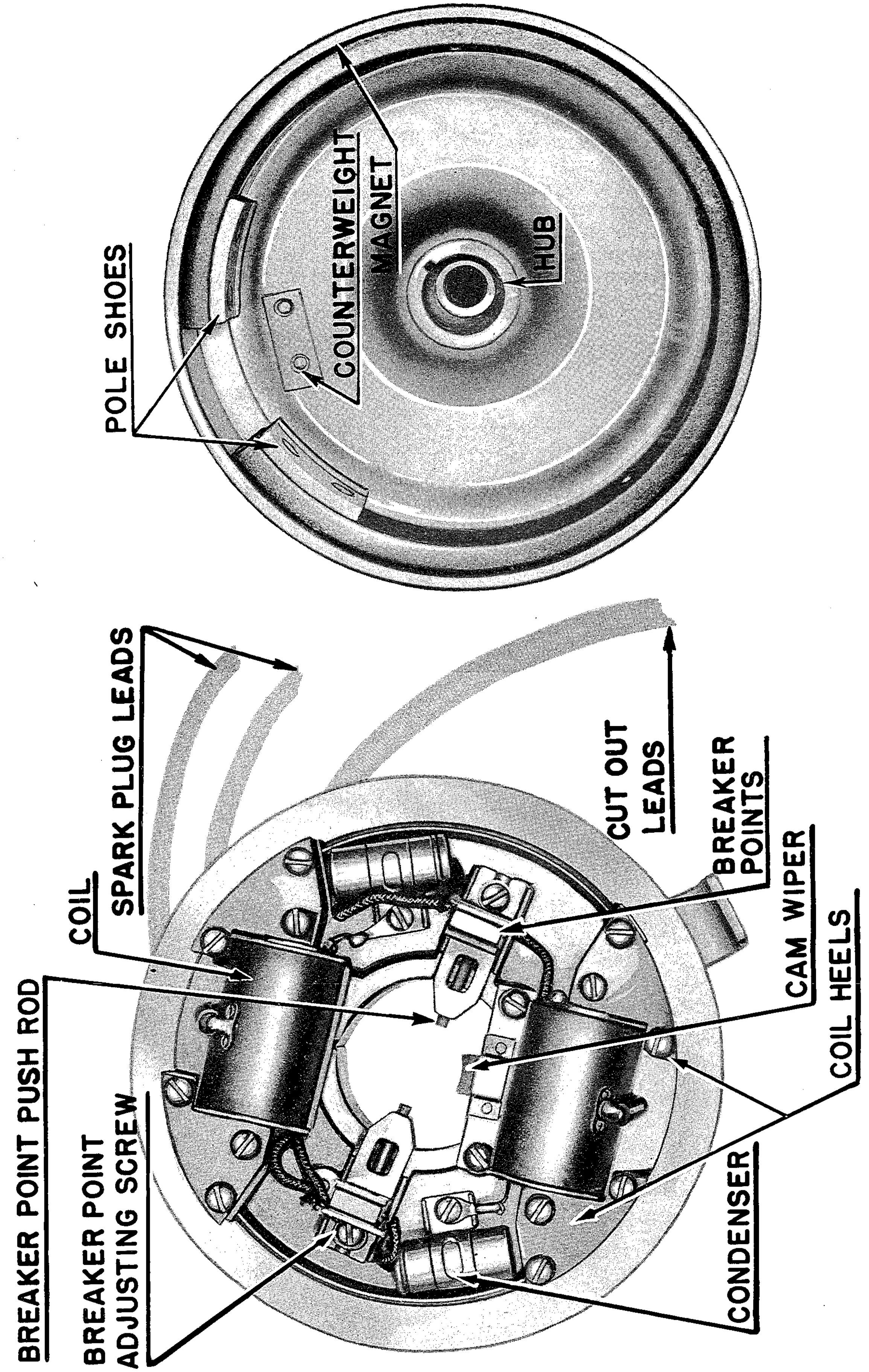
(a) Weak—partially "shorted."
(b) Broken down—"dead."
(c) Faulty connections.

6. Coil Heels.

(a) Excessive clearance (correct .015").
(b) Heels rubbing on magnet pole shoes.

7. Magnets.

(a) Weak.
(b) Cracked.
(c) Broken.


POLE SHOES
COUNTERWEIGHT
MAGNET
HUB
SPARK PLUG LEADS
COIL
CUT OUT LEADS
BREAKER POINTS
CAM WIPER
COIL HEELS
BREAKER POINT PUSH ROD
BREAKER POINT ADJUSTING SCREW
CONDENSER

SD MAGNETO

MODEL SD MAGNETO

The Model SD magneto is constructed similarly to that of the alternating A and K-KD models with exception of the breaker point assembly—principle of operation, however, is identical.

Breaker points are operated by a "flat," machined on the crankshaft, through push rods "B." To adjust points, loosen screws "A." Revolve crankshaft until push rods ride on high side of crankshaft. Move breaker assembly towards crankshaft to a point where the breaker point gap is .020." Tighten screw "A" to properly secure assembly.

NOTE: Push rods "B" have flat and rounded ends—flat end should ride on crankshaft, round end, against breaker spring. THIS IS IMPORTANT.

When removing armature plate from motor, both push rods should ride on high side of crankshaft to prevent their breaking on removal. Be careful, too, that both push rods clear key on crankshaft to prevent breakage.

Service operations on this magneto such as testing and installing coils, condensers, breaker points, etc., are conducted in a manner similar to that previously described. Correct clearance between the coil shoes and magnet pole is .015."

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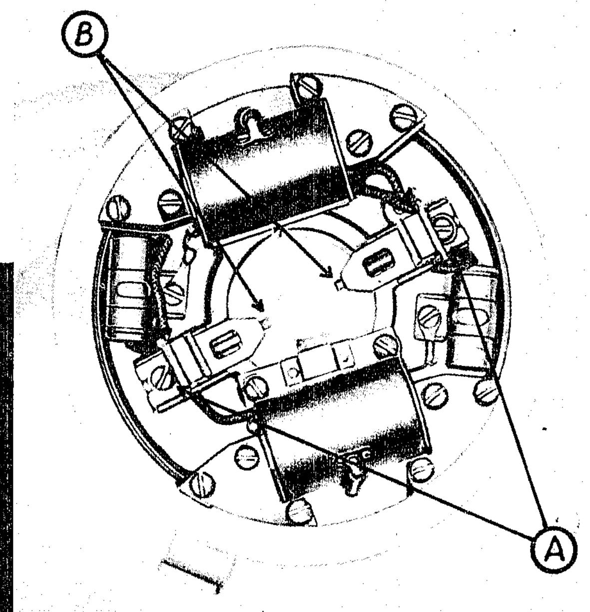

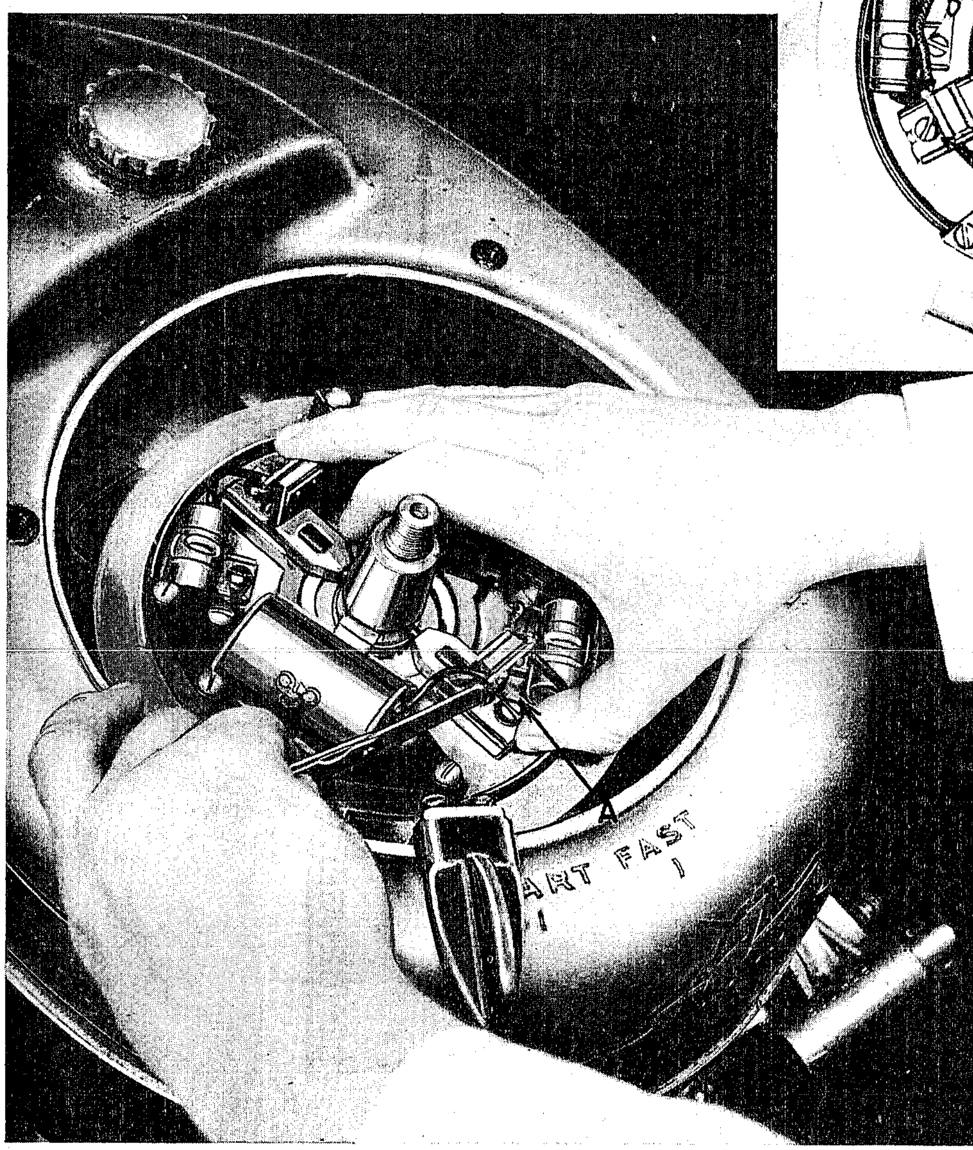

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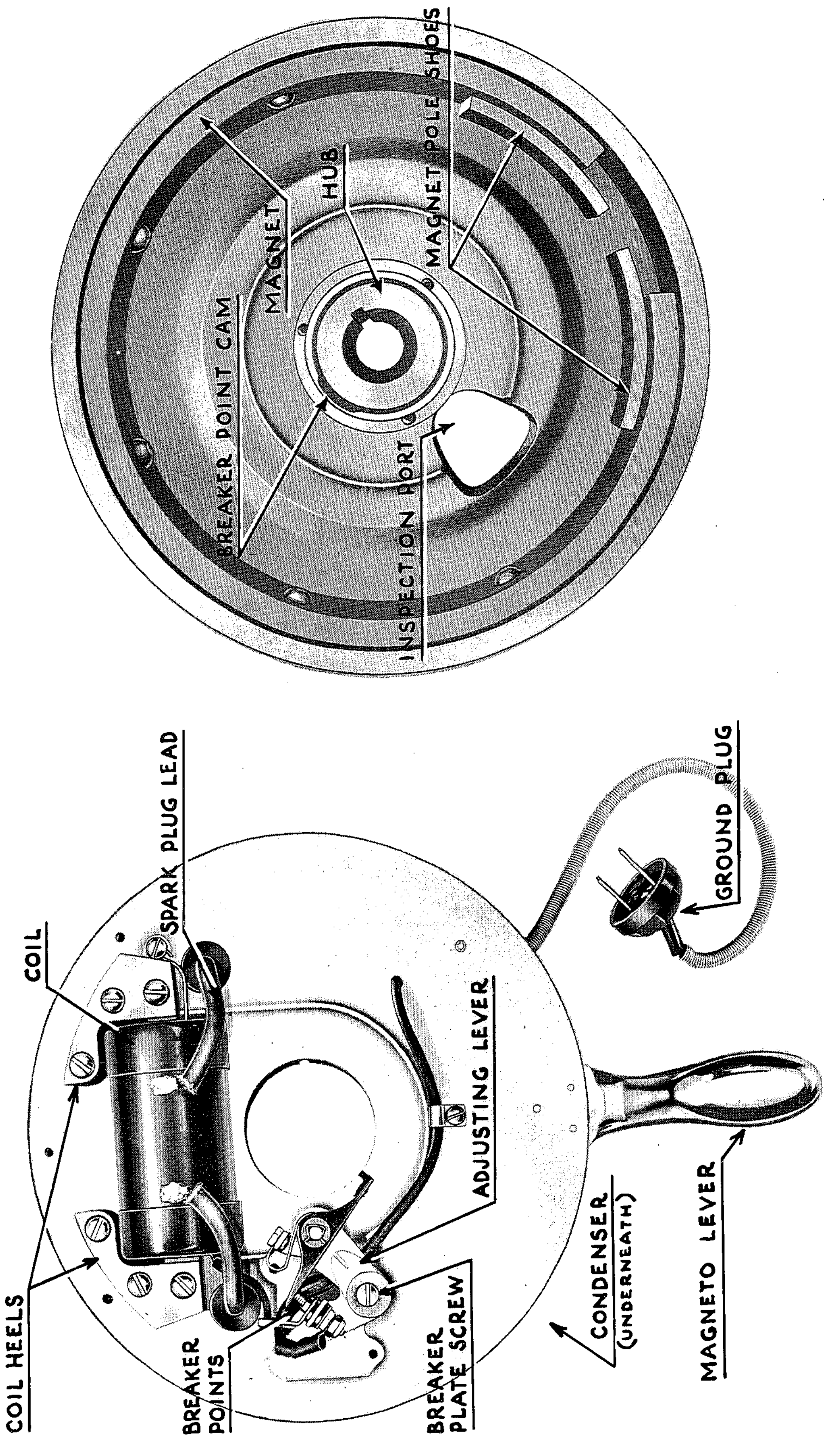
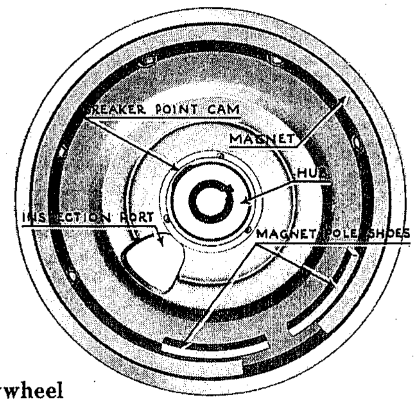


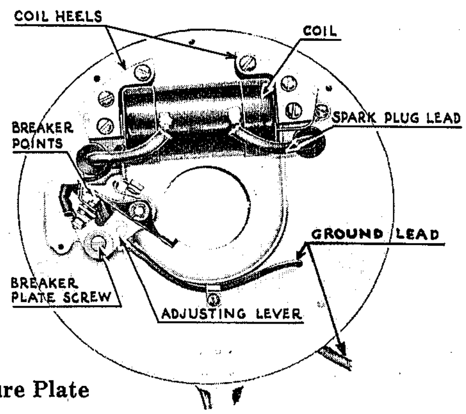
MAGNET POLE SHOES
HUB
MAGNET
BREAKER POINT CAM
INSPECTION PORT
SPARK PLUG LEAD
COIL
GROUND PLUG
ADJUSTING LEVER
CONDENSER (UNDERNEATH)
MAGNETO LEVER
COIL HEELS
BREAKER POINTS
BREAKER PLATE SCREW

P-PO MAGNETO

MODEL PO MAGNETO



Flywheel

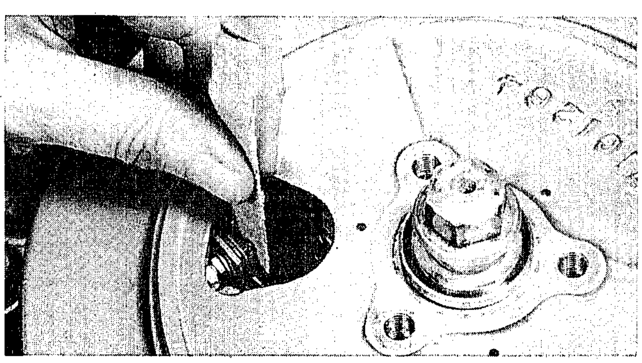


Armature Plate

TO CLEAN BREAKER POINTS

Remove starter plate. Note inspection port in flywheel. Turn flywheel to uncover points and to a position where points are open (spread). Install flexible point cleaner between points. Turn flywheel back until points close on cleaner. Clean or dress points by carefully moving back and forth. Continue operation until point surfaces are clean and smooth. After dressing with cleaner, insert piece of paper between points to remove particles of cleaner which may have lodged on point surfaces. If points are pitted or corroded beyond reconditioning with cleaner, install a new set.

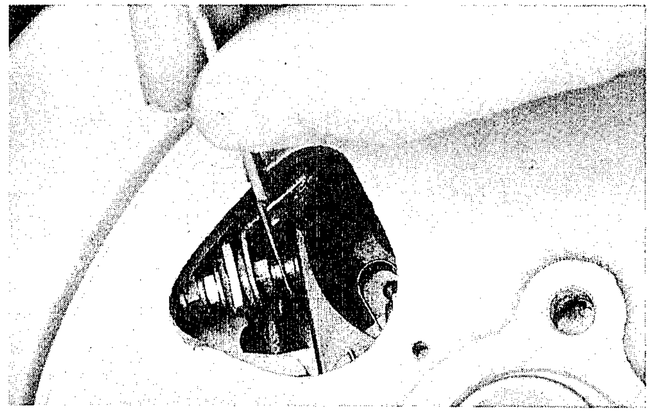
Scrape corrosion, if any, from outside diameter of points so that no loose particles may fall between points.



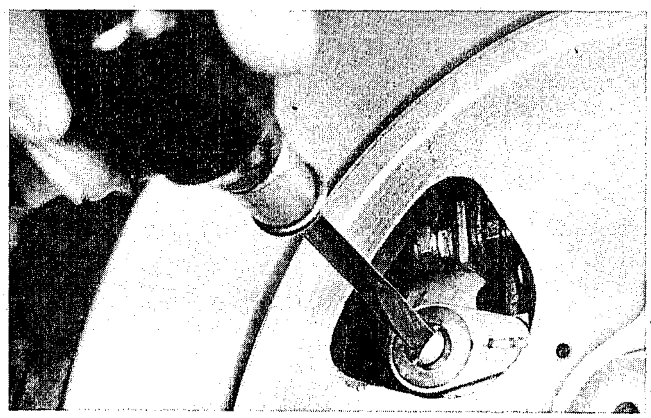
Cleaning Breaker Points

TO ADJUST BREAKER POINT GAP

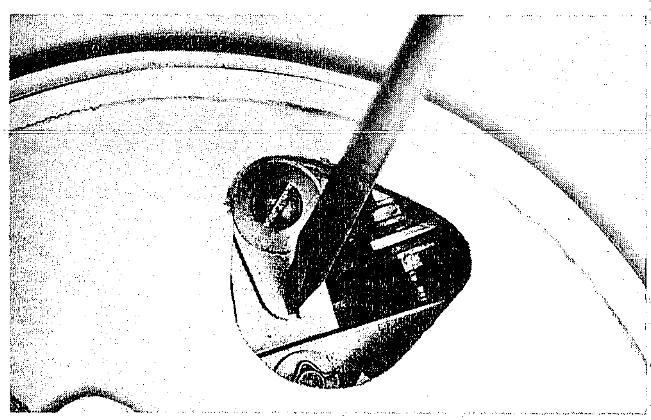
The correct breaker point gap is .020″. After having removed starter pulley, turn flywheel to expose point assembly and to a position where points are full open. Insert feeler gauge (.020″) to check gap. If necessary to adjust gap, loosen screw. Turn adjusting lever to right or left as required to obtain correct gap setting. After setting gap at .020″, tighten screw to lock in position.



Checking Breaker Points



Loosening Screw



Adjusting Breaker Points

NOTE: Since points are operated by breaker arm rubbing block riding on cam attached to flywheel hub, point gap is increased by shifting assembly towards hub—decreased by moving away from hub.

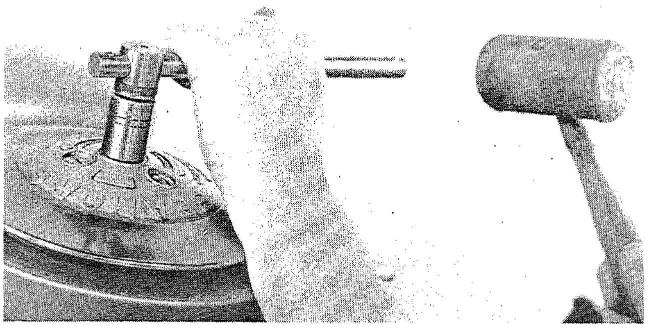
TO REMOVE FLYWHEEL

1. Flywheel nut and cover (starter) plate act in combination as a puller when unscrewing the flywheel nut. The nut is provided with a shoulder and bears against underside of cover plate.

2. Unscrew flywheel nut until it tightens against cover plate. Use socket with "L" handle.

3. Strike handle of wrench sharp blow with hammer or mallet. Two or three similar applications should be sufficient to jar flywheel loose from taper on crankshaft.

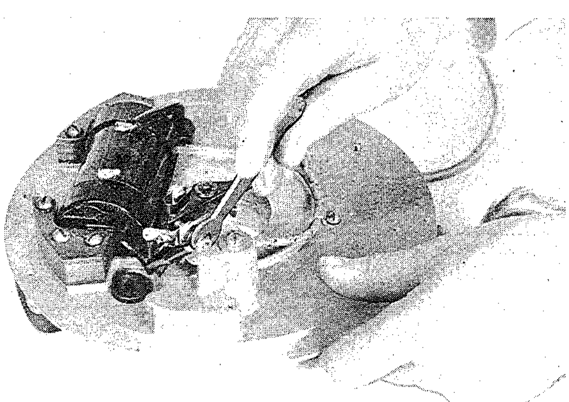
(NOTE: If flywheel puller is not available, flywheels on smaller motors can be removed in like manner.)



Removing Flywheel—Model PO

TO INSTALL NEW BREAKER POINTS
(Breaker Point and Breaker Arm Assembly)

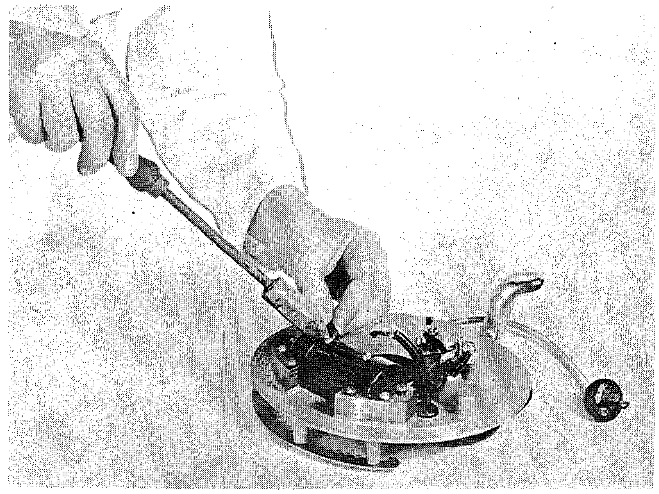
Loosen and remove nut holding breaker arm spring fast to armature plate. Remove small clip holding breaker arm on pivot post. Lift breaker arm assembly off pivot post. Remove nuts and washers holding stationary breaker point in breaker plate. Install new points (stationary point and breaker arm assembly) in reverse order of that described. Be sure breaker arm operates freely on pivot post and that all nuts and washers are drawn up securely. Adjust points as instructed. NOTE: Since the breaker point cam is attached to the hub of the flywheel, the flywheel must be mounted to the crankshaft prior to attempting adjustment of the points—see instructions.



Removing Breaker Points

TO INSTALL NEW CONDENSER

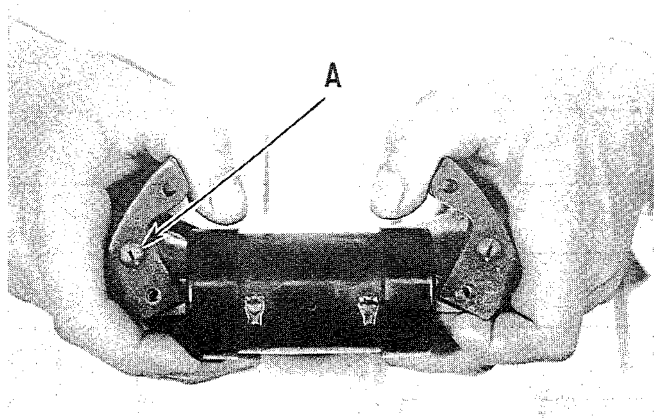
(Note: Condenser is fastened to underneath side of armature plate.) Remove screws. Detach condenser lead soldered to bracket on breaker plate. Lift condenser from cavity in plate. When attaching new condenser, thread small wire (condenser lead) through hole in armature plate provided for this purpose. Solder lead to bracket. Set condenser in cavity and replace screws to hold it fast.



Soldering Leads to Coil

TO INSTALL NEW IGNITION COIL

Detach ground wire from armature plate. Detach primary lead (small wire) soldered to bracket on breaker plate. Detach high tension leads (spark plug wires) soldered to coil. Use small soldering iron and just enough heat to loosen soldered joint to permit pulling wires away. Remove screws (see note below) holding coil heels and coil to plate. Lift coil and heel assembly from armature plate.

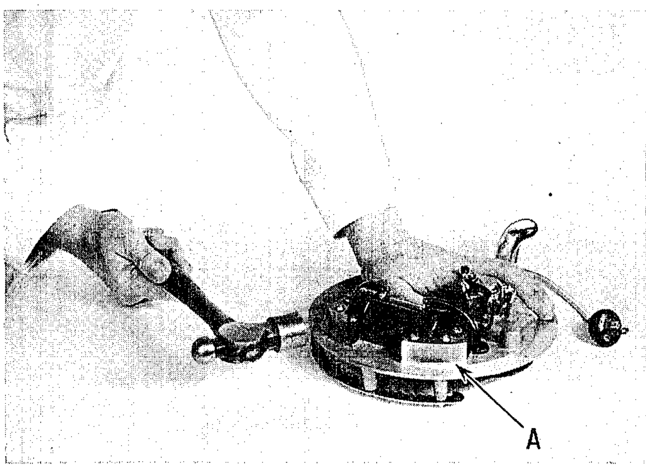


Removing Coil Heels

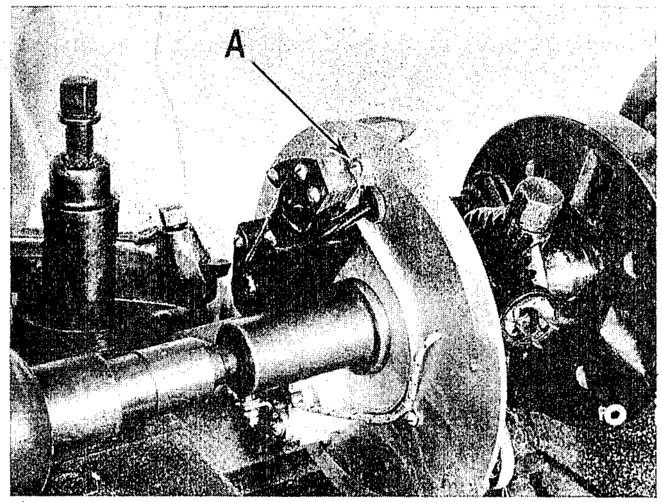
(Note: The middle screw, "A" on each heel is used to hold plates of heel assembly together—do not remove this screw, merely loosen.) Pry heels gently from coil. Simply pull off by hand.

Place coil and heel assembly in position on armature plate. Insert and tighten screws holding assembly to plate. Solder high tension leads (spark plug wires) to coil in their respective positions. Use soldering paste or rosin flux. Do not under any circumstances use acid flux—avoid detrimental effects of corrosion by NOT using acid flux. Use just enough heat, solder and flux to obtain a good substantial connection. Application of excessive heat is apt to burn off small secondary lead from coil. Over use of solder or flux will result in short circuits to render the coil inoperative.

Coil heels must be made flush with boss on armature plate "A" to prevent striking pole shoes of magnet in the flywheel when motor is in operation. This can be accomplished in two ways — namely, by tapping heel assemblies with hammer as illustrated. If a lathe is available, mount armature plate assembly on a mandrel between centers and turn heel surfaces down until flush with boss on armature plate "A". On having completed this operation, draw down further on all screws in heel assembly to make certain coil is securely mounted.

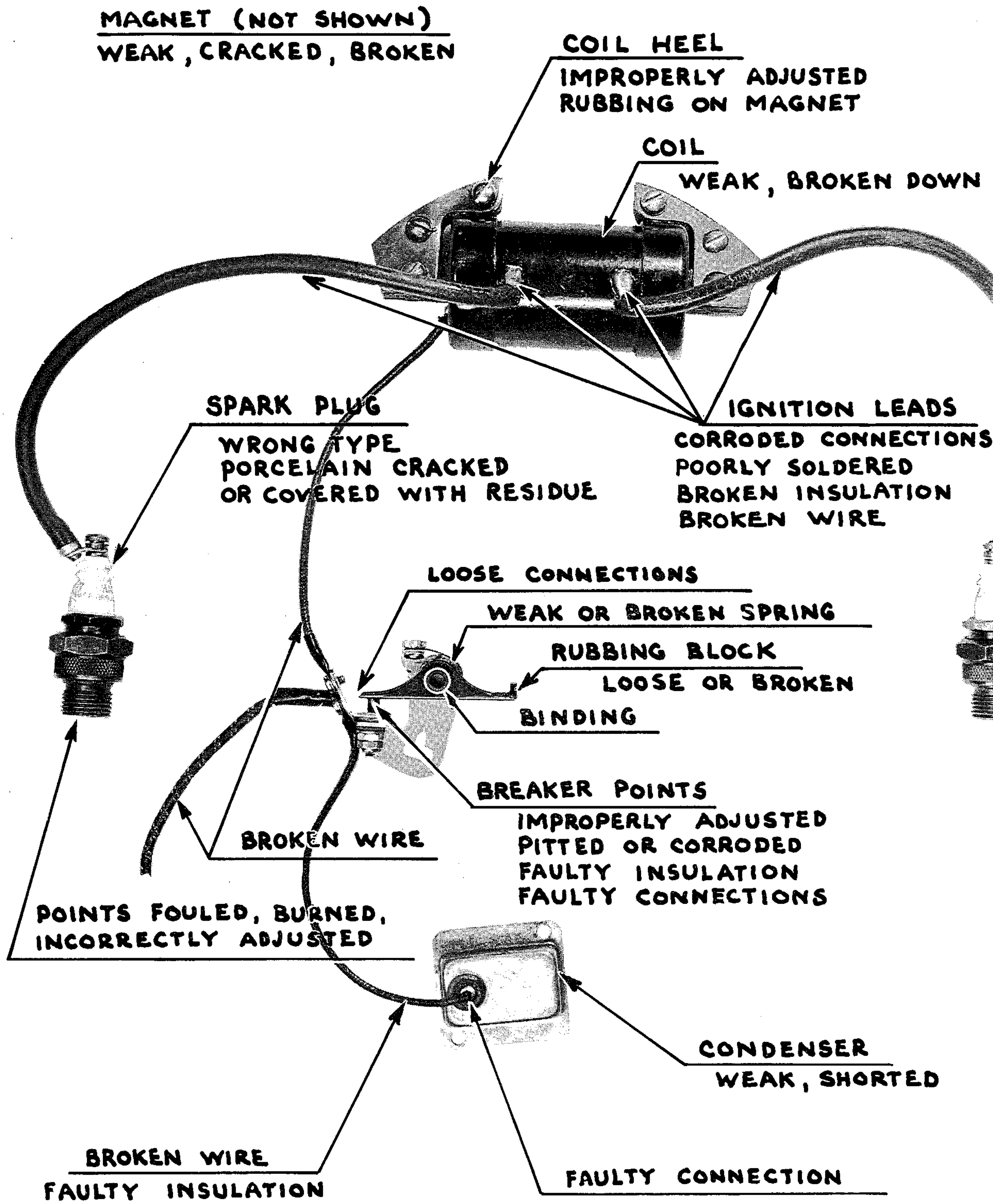


Adjusting Coil Heels



Turning Coil Heels

NOTES



MAGNETO CHECK CHART—OPPOSED FIRING TWIN (P-PO)

SPARK PLUGS

The spark plug is a most important factor to be considered with the proficient service of any outboard motor.

Spark plugs are classified into various types, in accordance with the temperatures at which they are designed to operate, broadly speaking—HOT and COLD.

The HOT plug is one in which there is a large core section (porcelain) exposed to the flame within the cylinder, designed for operation in low compression, low speed engines where the operating temperatures are low.

The COLD plug is one in which the core section, exposed to the flame within the cylinder, is comparatively small (short), designed for operation in an engine of high compression ratio, high speed and operating at high temperatures.

For practical purposes—the principle of construction is such that, in each type spark plug, there is a sufficient portion of the core section exposed to the flame within the cylinder, to absorb enough heat to prevent fouling as result of accumulation of oil and unburned fuel on the porcelain and yet not enough to result in the absorption of excessive heat, causing the points to overheat to result in pre-ignition.

The installation of a COLD plug, in a low compression, low speed engine, will result in consistent fouling, while the installation of a HOT plug, in a high compression, high speed engine will result in pre-ignition, causing the engine to "ping," to run at full R.P.M. for short periods then at a noticeable drop in revolutions. In extreme cases, the plug may be HOT enough to result in the motor stopping entirely.

There are no sharp lines of DISTINCTION between the HOT and COLD spark plug—each group having several classifications, with relation to the temperatures at which they are designed to operate.

If there are reasons to suspect the spark plug, installed in a certain engine, of being too HOT or too COLD—remove it. Should the core section be found to be BLACK, SOOTY or MOIST, the plug is too COLD. If found to be PITTED, BURNED, WHITE, or a LIGHT TAN, it is too HOT. If a LIGHT BROWN, you can be reasonably assured that it will operate efficiently. Should the spark plugs run exceptionally HOT, the motor will continue to fire occasionally after the STOP button has been depressed to cut out the magneto.

[Note: Before CONDEMNING the spark plug as being too COLD, make certain the fuel mixture is correct (according to specifications), and that the carburetor needle valves are properly adjusted.]

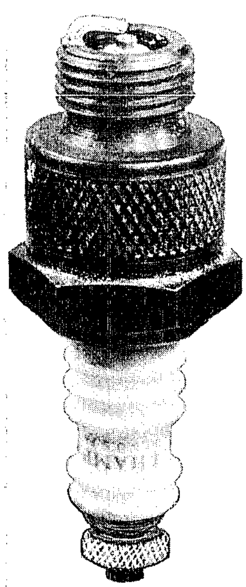
It is EXTREMELY IMPORTANT that any gasoline engine, especially the high speed 2-cycle, be operated with the correct type SPARK PLUGS installed. Unless properly suited for the motor, a situation will arise, largely interpreted as carburetor difficulty by the inexperienced operator.

The correct spark plugs to be installed in any motor, depend upon the type of service to which it is subjected.

Spark plugs furnished with the motor, as standard equipment, are installed for average service.

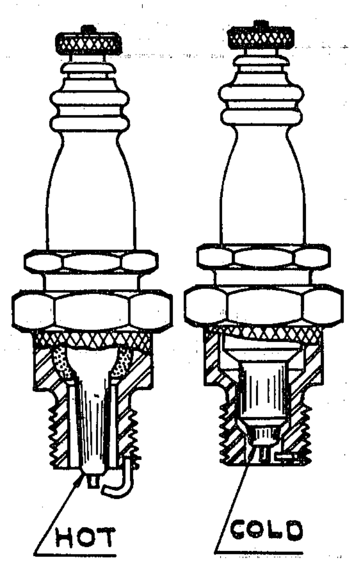
Should the motor be installed on an extremely light, fast hull and operated at top speeds, it may be necessary to install a set of cooler plugs, than those supplied with the motor, to prevent pre-ignition.

At extremely low TROLLING speeds, some plugs have a tendency to foul, due to the oil not burning from the surface of the porcelain exposed to the flame within the cylinder—in such cases, a warmer plug may be required, however, operating temperature will be too great at full throttle to result in pre-ignition. This is a case of extreme temperature range and will be rather difficult to control with the use of one plug. Do not overlook adjustment of carburetor needles—high and slow speed operation.



Champion J-8-J spark plug—note that ground electrode extends but half-way over the center electrode, the only distinguishing feature between the J-8-J and the J-8. This is important since it minimizes the possibility of carbon particles bridging across the point gap to ground out the plug. Otherwise, all Champion J-8 series spark plugs are merely stamped J-8 on the porcelain—J-8-J appearing only on flap of carton for proper identification.

Use the J-8-J plug where specified—not the J-8, for best performance.



SPARK PLUG RECOMMENDATIONS FOR ALL JOHNSON SERVICE MODEL MOTORS

Model Motor	Our Part No.	Recommended	Substitute
J-80	#76-152	Champion #J8J	AC-45S
J-25, 65, 70, 75	#76-334	Champion #C7	
A & A-25 to A-45	#76-334	Champion #C7	
A-50, 65, 70, 75, 80, AA-37	#76-112	Champion #5M-J	AC-83
OA-55, 60, 65	#76-334	Champion #C7	
OK-55, 6, 75	#76-131	Champion #R7	
F-70, 75	#76-334	Champion #C7	
K-35, 40, 45	#76-131	Champion #R7	
K-50, 65, 70, 75, 80, KA-37 KA-38, 39 & 10, KS & KD-15	#76-112	Champion #5M-J	AC-83
P-30	#76-334	Champion #C7	
P-35, 40, 45, 50, 65, 70, 75, 80, PO-37, 38, 39, PO-10 & 15	#76-131	Champion #R7	
TR-40 (Giant)	#76-131	Champion #R7	
S-45, 65, 70	#76-131	Champion #R7	
V-45, 65, 70	#76-131	Champion #R7	
LS-37, 38, DS-37, 38	#76-152	Champion #J8J	AC-45S
LT-37, 38, 39, 10, AT-39, 10, DT-37, 38, 39, 10	#76-152	Champion #J8J	AC-45S
MS-38, 39, 15, 20, MD-38, 39, 15, 20	#76-152	Champion #J8J	AC-45S
HS-39, 10, 15, HA-39, 10, 15, HD-39, 10, 15, HS & HD-20, 25	#76-152	Champion #J8J	AC-45S
TS & TD-15, 20	#76-152	Champion #J8J	AC-45S
100, 110	#76-152	Champion #J8J	AC-45S
200, 210	#76-334	Champion #C7	
300	#76-152	Champion #J8J	AC-45S
SD-10, 15	#76-112	Champion #5M-J	AC-83
Racing Motors	#76-179	Champion #R1	
Racing Motors	#76-130	Champion #R11	

WHAT'S WRONG WITH THE MAGNETO?

Magnetos generally are not too difficult to repair but occasionally a "sticker" shows up—just one of those things—however, there is always a reason for it and of course, a solution.

It's quite easy to determine when the coil and condenser are at fault (with the right kind of testing equipment), but at times it's the other details of the assembly that make repairs a bit difficult.

When suspecting the magneto of being out of sorts, check the following:

1. Spark Plug

(a) Fouled

(b) Cracked porcelain

(c) Residue formed on porcelain to cause periodic shorts

(d) Wrong type for the motor (heat range)

2. Ignition Coil

(a) Weak

(b) Shorted

(c) Improperly mounted

(d) Loose wires

3. Condenser

(a) Weak

(b) Shorted

(c) Improperly mounted

(d) Loose wires

4. Breaker Points

(a) Improperly adjusted

(b) Pitted or corroded

(c) Broken or weak spring

(d) Breaker point loose in its mounting

(e) Loose wires

(f) Breaker point arm binding on pivot post to cause sluggish action or plunger rod binding in the bracket.

(g) Broken cam follower or plunger rod.

(h) Timing marks (old models) must be lined up when points break.

5. Wiring

(a) Loose, corroded or poorly soldered connections.

(b) Broken wires (broken under insulation).

(c) Oil soaked to cause leaks—leaky spark plug wires too.

(d) Faulty ground (stop button).
1—Oil soaked to cause leaks
2—Broken or cracked insulating washers and bushings to cause leaks

(e) Faulty spark suppressors (where used)
1—Shorted

6. Flywheel

(a) Weak magnet

(b) Cracked magnet

(c) Improper clearance between magnet pole pieces and coil heels

(d) Magnet pole pieces sticking or rubbing on coil heels

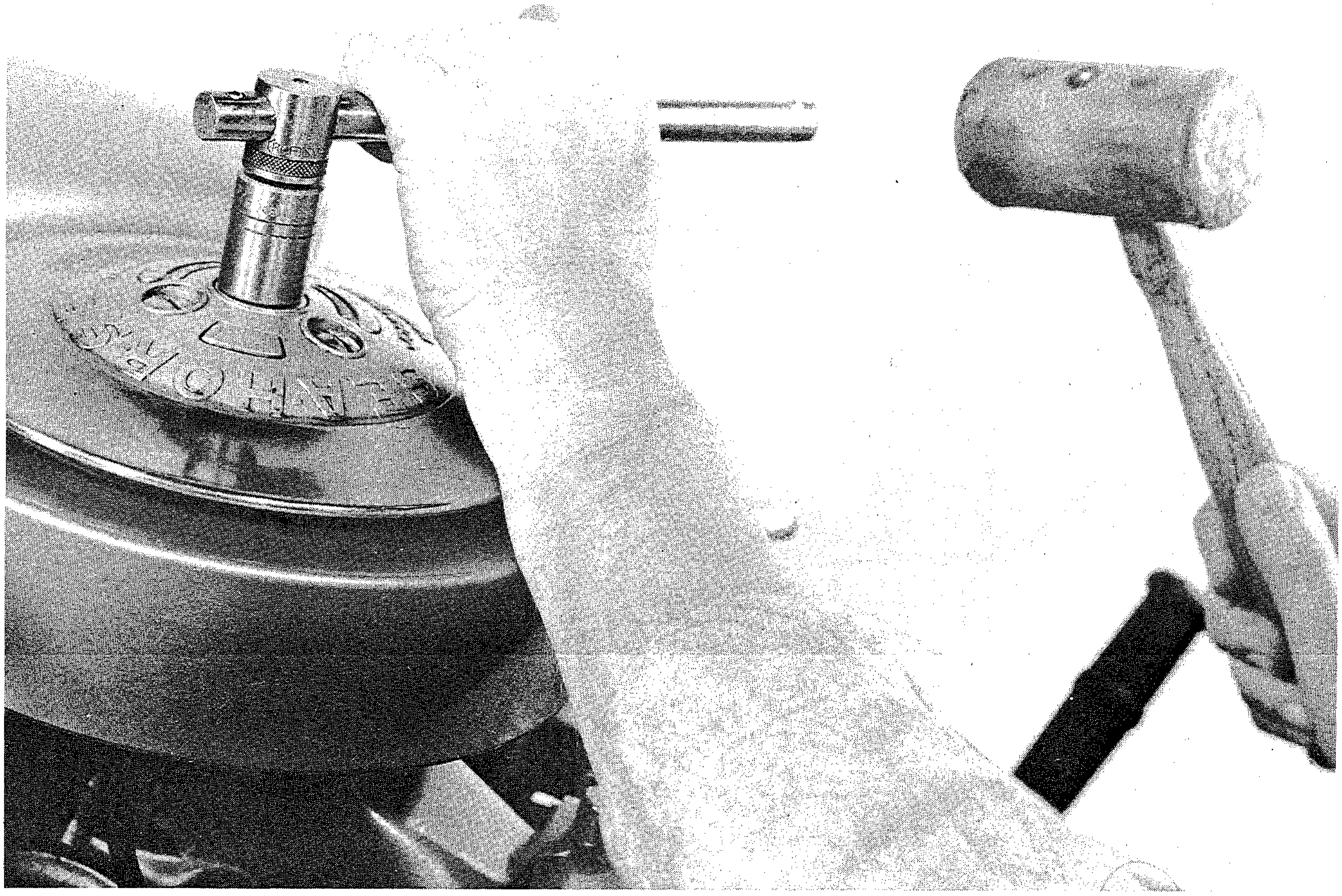
7. If it's NOT the coil—if it's NOT the condenser and if it's NOT the points, then check the wiring system carefully. Look for grounds caused by oily wires and insulating washers, broken insulation, broken or cracked insulation washers. Don't overlook possibility of broken wires under insulation, loose connections or open circuits because of corroded connections. Check every wire on the armature plate if necessary.

8. On the LT series magneto, look for grounds in the distributor block in the flywheel. Bakelite is sometimes carbon streaked to cause grounds. Scrape carbon off carefully. If too badly streaked, install new distributor block (be sure small spring is installed under distributor segment to make proper ground with the flywheel.) Also, check distributor brushes.

On the early H series magneto check condition of brush holders and ground connections in like manner.

It's as simple as all this (on paper) but occasionally it takes a lot of scratching to determine just where the difficulty lies. Keep the above suggestions in mind, nevertheless, when hunting down ignition difficulty.

WATCH THE FLYWHEEL



The flywheel is an important part of the motor —it has a very definite function to perform and being attached to the crankshaft must be securely mounted. When mounting, the flywheel nut should be drawn down tightly — being sure the keys are properly placed.

The motor should then be operated for a short period and the nut retightened since a newly installed flywheel will settle a bit on the taper of the crankshaft. If permitted to run loose, serious damage and expensive repairs soon follow — damage to the flywheel hub, crankshaft taper or possibly the entire power head.

Constant shearing of propeller pins for no apparent reason, on motors not equipped with shock absorber, frequently indicates a loose flywheel.

Watch the flywheel — be sure it is tight on the crankshaft before a repaired motor leaves the shop. Use discretion however, on the smaller models, the flywheel hub can be cracked.

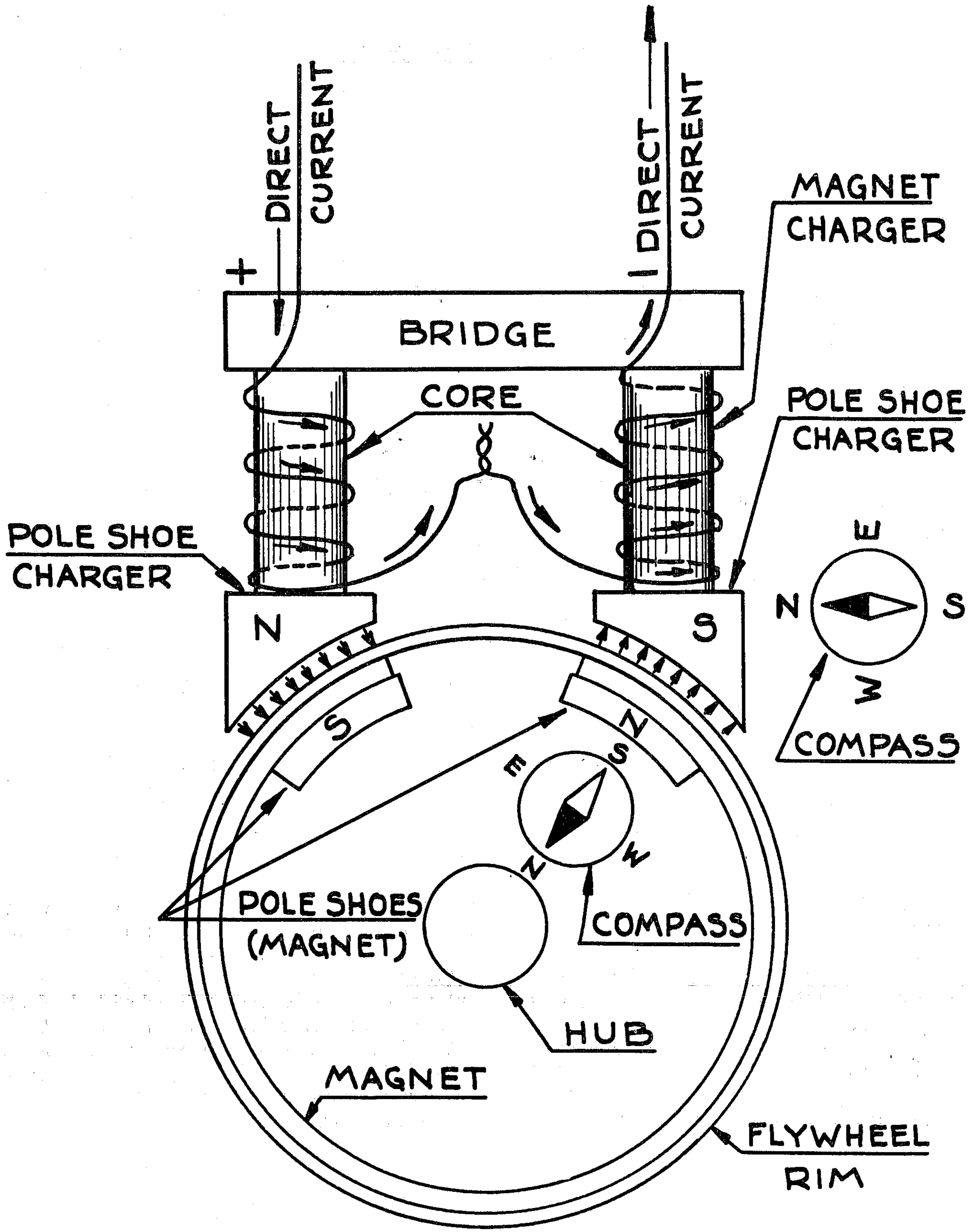
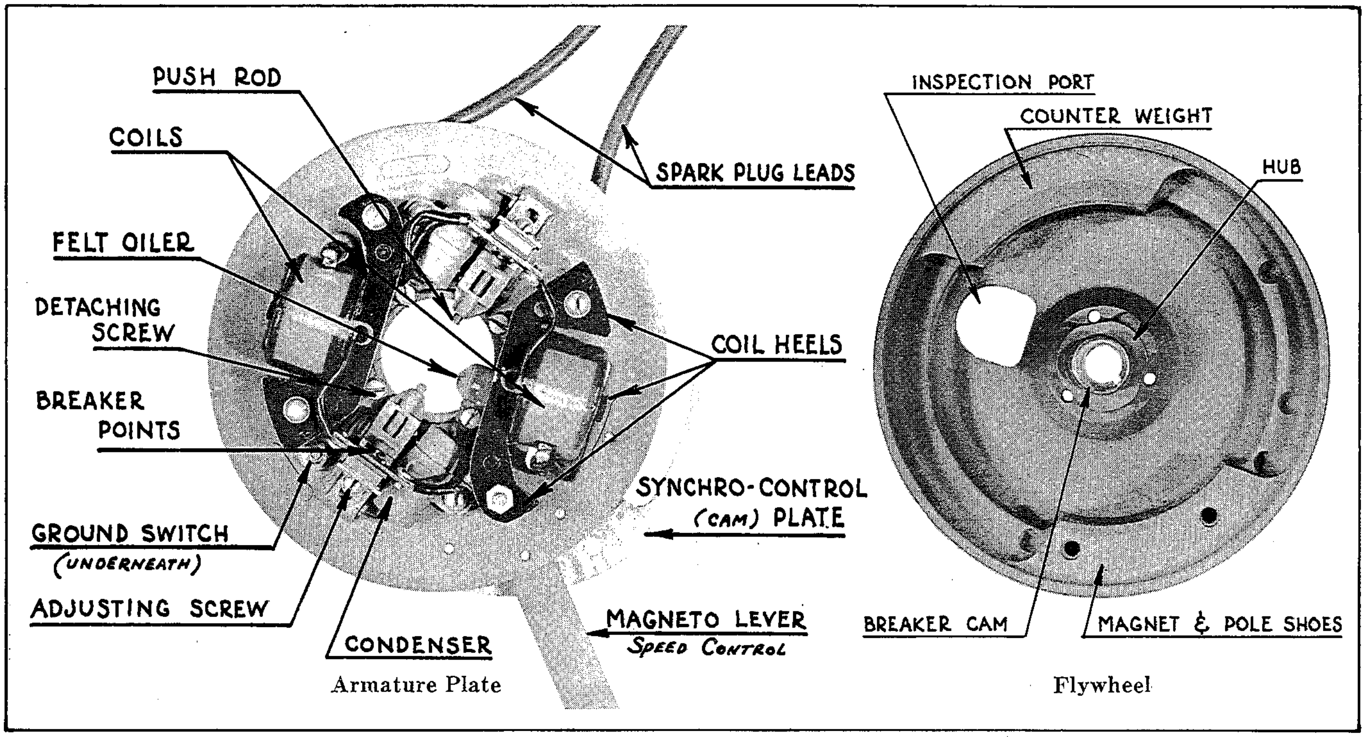


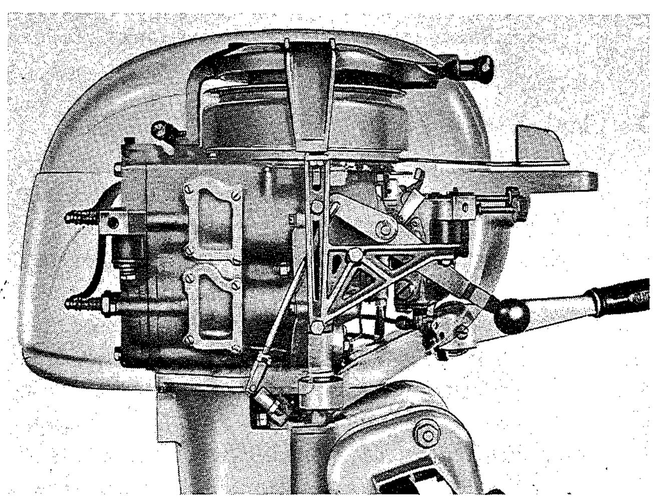
Diagram of Magneto Charger

MODEL QD MAGNETO



Model QD Magneto

Construction of the Model QD magneto does not differ a great deal from conventional Johnson magneto construction except that the customary ring type magnet riveted to the inside of the flywheel rim has been replaced with an Alnico magnet cast into a dome or flywheel of zinc. In size, the magnet itself is rather small, approximately 1⅜"x¾"x½", and occupies a position in the flywheel rim comparable to the pole shoes where the ring type of magnet is employed. Alnico is a composition of aluminum, nickel and cobalt, cast into blocks of various sizes as individual requirements demand. An Alnico magnet is also used in HD and TD magnetos—same being die cast into the magnet rotor rather than into the flywheel.



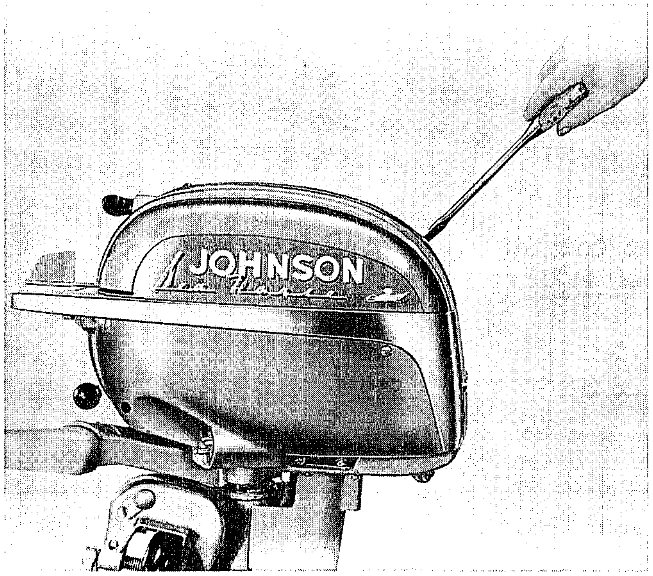
Phantom View–Showing Position of Power Head, Carburetor, Magneto, Ready Pull Starter, etc., Under Cover.

It will be noted from the magneto illustration above that three poles (heels) have been provided for the core of each coil to gain advantage of "reverse flux" at the time of breaker point separation, which results in maximum spark intensity—the strong spark required for easy starting and efficient magneto operation throughout entire speed range of the motor. HD and TD magnetos function on like principle—the difference being only in location of the magnet and pole pieces.

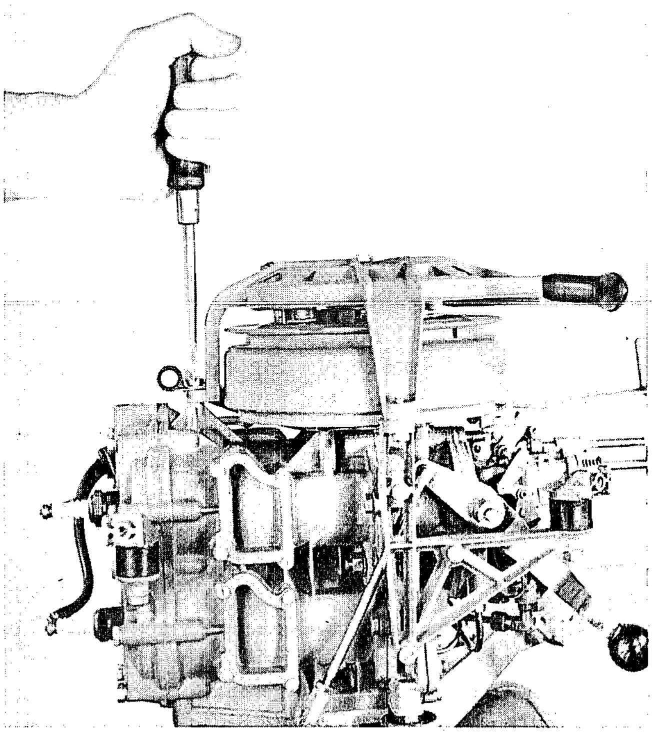
The breaker point assembly is like that of HD, TD and SD magnetos, employing the use of a plunger or push rod to separate the points as it rides against a cam built into the flywheel hub: (In case of HD, TD and SD, a "flat" machined into the crankshaft journal).

The ignition coils and condensers are of conventional construction—see pages 11 to 19. An oiler felt is installed to minimize push rod or plunger wear by providing breaker cam lubrication. The felt should at all times ride against the high side of the cam. Two or three drops of oil should be applied to the felt pad each season—do not over oil. Excessive plunger wear can be laid to lack of lubrication in this respect.

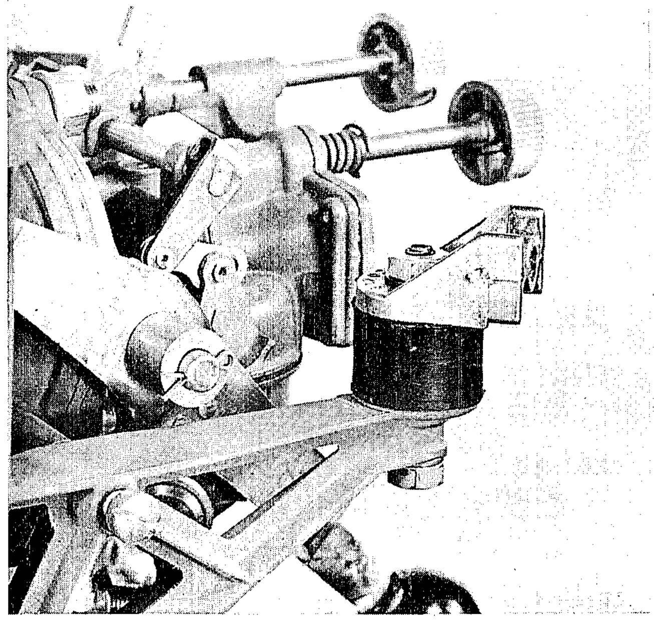
Cam attached to the armature plate controls degree of carburetor shutter (butterfly) opening with respect to position of spark timing as governed by movement of the speed control lever.



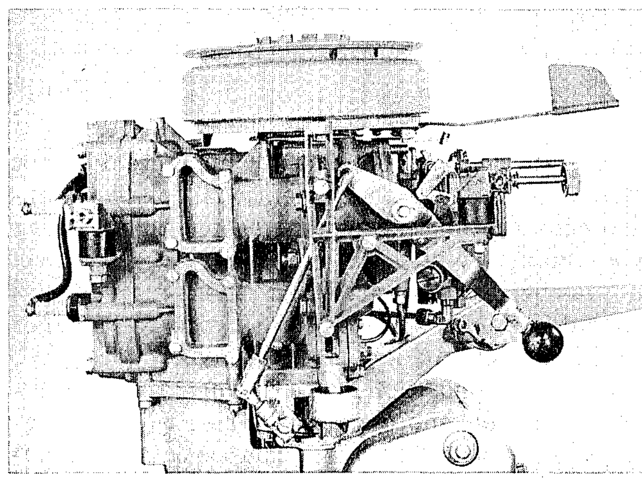
Removing Screws and Side Covers for Access to Power Head.



Side Covers Detached to Permit Excess to Ready Pull Starter, Magneto, Carburetor, etc.



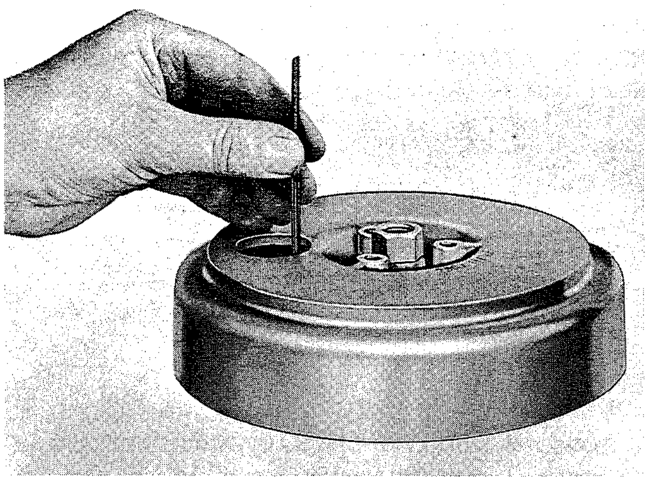
Illustrating Side Cover Flexible Mount—Four of Which Are Provided to Hold Covers Fast and Minimize Vibration Noises.



Side Covers and Starter Removed for Access to Breaker Points for Inspection, Cleaning or Adjusting. Showing also, Position of Shift Lever and Link.

To Clean Breaker Points

After having removed the side covers, starter assembly, starter ratchet and flywheel cover plate, turn flywheel to position where inspection port comes to rest above the breaker point assembly. Carefully spread points with a blunt instrument (small screw driver) then insert point dresser. Release points. Work point dresser up and down until assured point surfaces are clean and smooth. (Excessively rough surfaced points should be replaced). On completion of cleaning operation, insert strip of paper and in like manner work up and down to remove possible traces of dressing material left on point surfaces to interfere with proper contact.

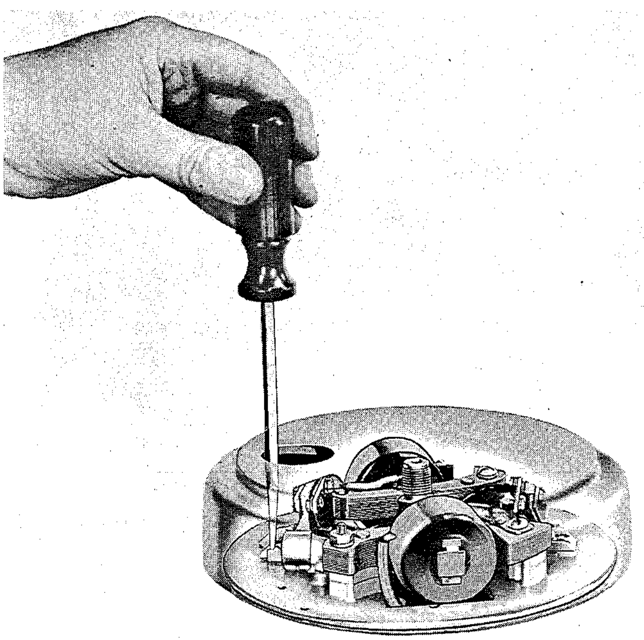


Inserting Breaker Point Dresser and Method of Checking Point Gap with Feeler Strip of Correct Thickness, .020".

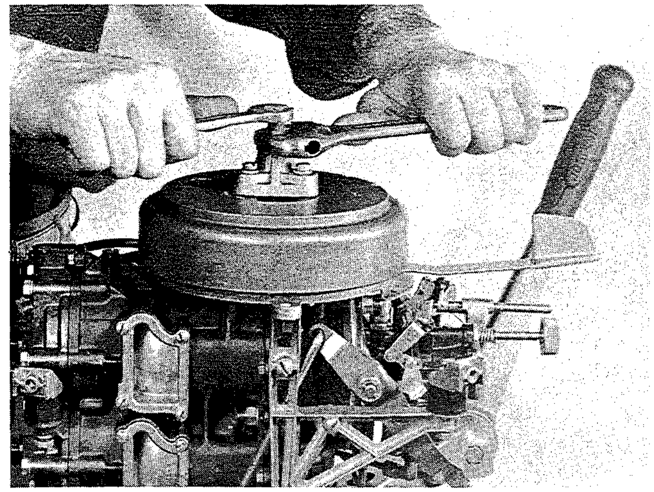
To Adjust Breaker Point Gap

Correct breaker point gap setting is .020" full open.

To adjust, loosen breaker point bracket screw slightly to allow for movement of the bracket. Shift position of assembly either way as required to obtain proper gap opening. Slots are provided on the breaker point bracket and armature plate base to permit accomplishing this adjustment with the aid of a screw driver. Insert screw driver through port in the flywheel—locate in adjusting slots. Turn screw driver to right to increase gap—left to reduce. Check with .020" feeler strip. Tighten screw to secure position of the assembly. Repeat procedure for adjusting other point assembly.



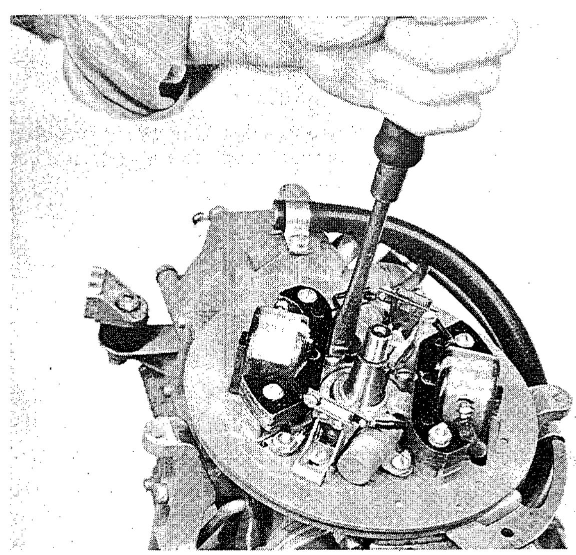
Adjusting Breaker Points.



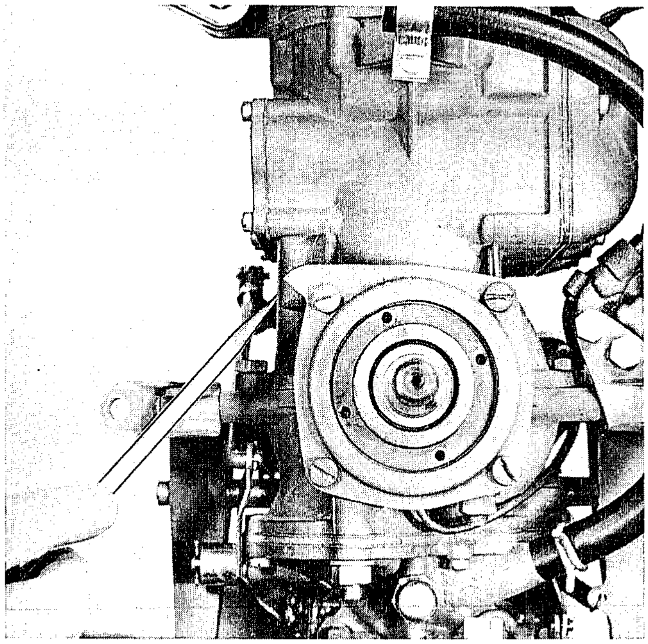
Removing Flywheel as Instructed on Page 20.

Removing the Armature Plate for Repairs

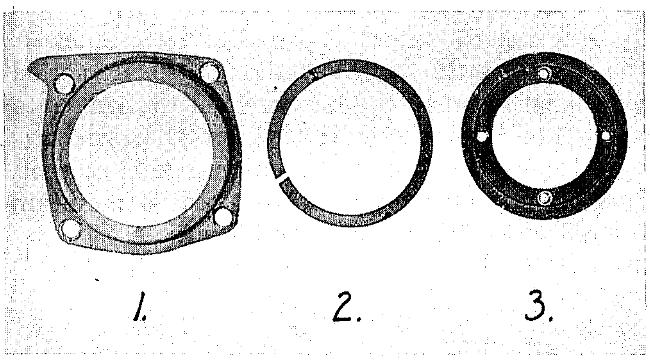
It will be noted that armature plate installation on the Model QD is accomplished in a manner considerably different from that of other models and past conventional Johnson practice. Rather than relying on the customary armature plate clamp and screw to provide mounting on the crankcase, the armature plate in this case is assembled to the crankcase by means of four screws driven into a ring which rides against a comparatively large wave washer (beryllium copper) installed between the ring and a bracket attached to the crankcase. The "wave" in the washer builds up spring action or tension between the bracket and the ring into which the screws are driven from the armature plate to provide necessary friction in this respect. This tension or friction is required to maintain manual setting of speed control lever.



Removing Four Screws Holding Armature Plate Fast to Crankcase.



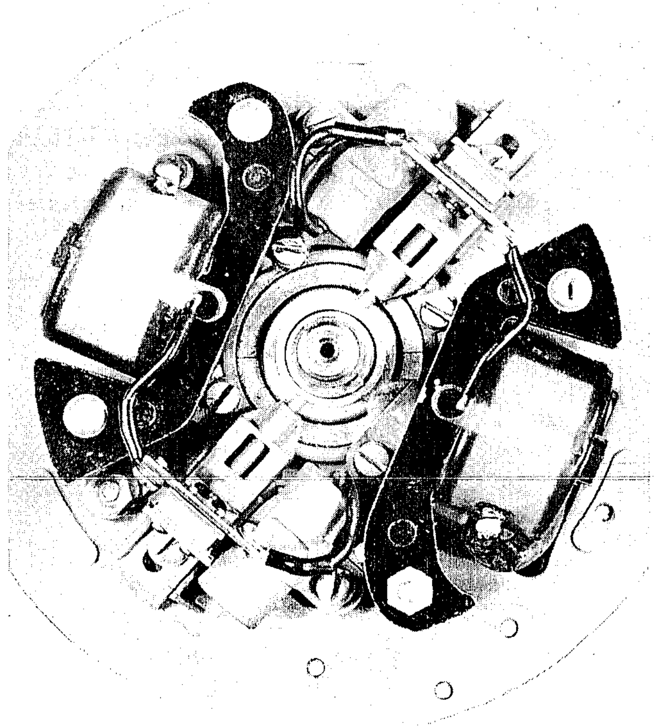
Showing Armature Plate Removed, Bracket Attached to Crankcase Under Which Are Mounted the Wave or Tension Washer and Ring to Which the Armature Plate is Attached. Note Lug on the Bracket Which Acts to Ground Out Ignition When Speed Control Lever is Moved to Extreme Left—Stop Position. Above Shows Proper Installation of the Mounting Bracket—Lug Must Come to Rest as Indicated to Ground Out Magneto When Stopping Motor.



Showing (1) Bracket, (2) Wave Washer and (3) Armature Plate Mounting Ring Removed from the Crankcase Assembly.

Repairs on the armature plate are conducted in the customary manner, which involves the checking of breaker points as described, testing condition of the condenser and ignition coil as instructed on pages 21 and 23, and checking of wiring system as suggested on page 42. Replace condenser and coils as result of testing warrants. Coil heel clearance is automatically maintained if, when installing the coil, the coil heels are all set "flush" with corresponding boss on armature plate. Make certain all connections are tight and free of corrosion—that breaker assemblies, condensers and coils are securely mounted to the armature plate. See instructions for soldering operations, page 24. Perform all operations on a clean bench, with clean tools and clean hands—cleanliness pays off.

When replacing the flywheel, it is necessary first to loosen the breaker assembly mounting screws (adjusting) then move the assemblies as far out as the slot in each bracket will permit—at the same time seeing that the push rods are seated against the breaker point springs. The purpose of this operation is to guard against damage to the breaker push rods (plungers) when assembling the flywheel—the push rods must be set to clear the breaker cam on the flywheel hub.

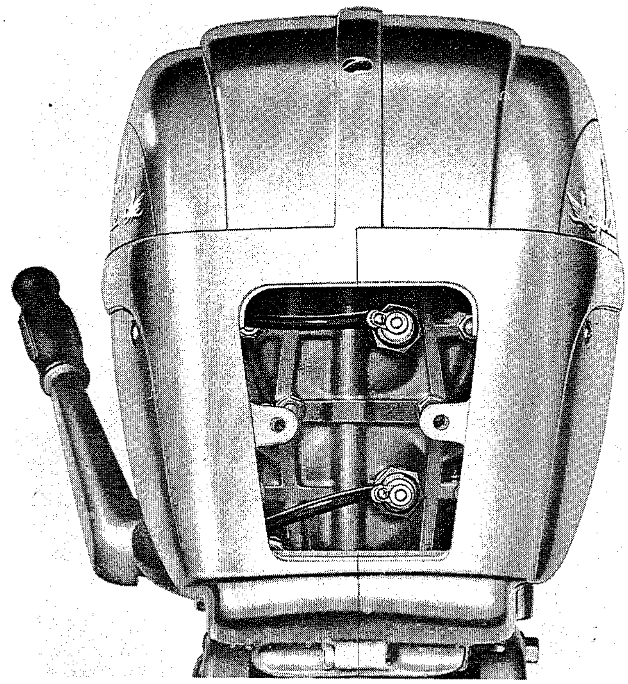


Showing Position of Breaker Brackets and Push Rods Prior to Installing the Flywheel.

Note position of key in taper of the crankshaft and position of keyway in flywheel hub—turn crankshaft so that when the key and keyway in the flywheel hub are in line for assembly, the high side of the breaker cam (on flywheel hub) falls midway between the breaker push rods. Care must be exercised when performing this installation to prevent high side of the cam from causing damage to one of the push rods and possibly the bracket, if forced.

When in proper alignment, carefully push the flywheel down over the crankshaft taper against tension of the bearing seal spring (be sure spring and washers are in place prior to attaching the flywheel). Install and tighten the flywheel nut as instructed, pages 20 and 55. Adjust breaker points as instructed.

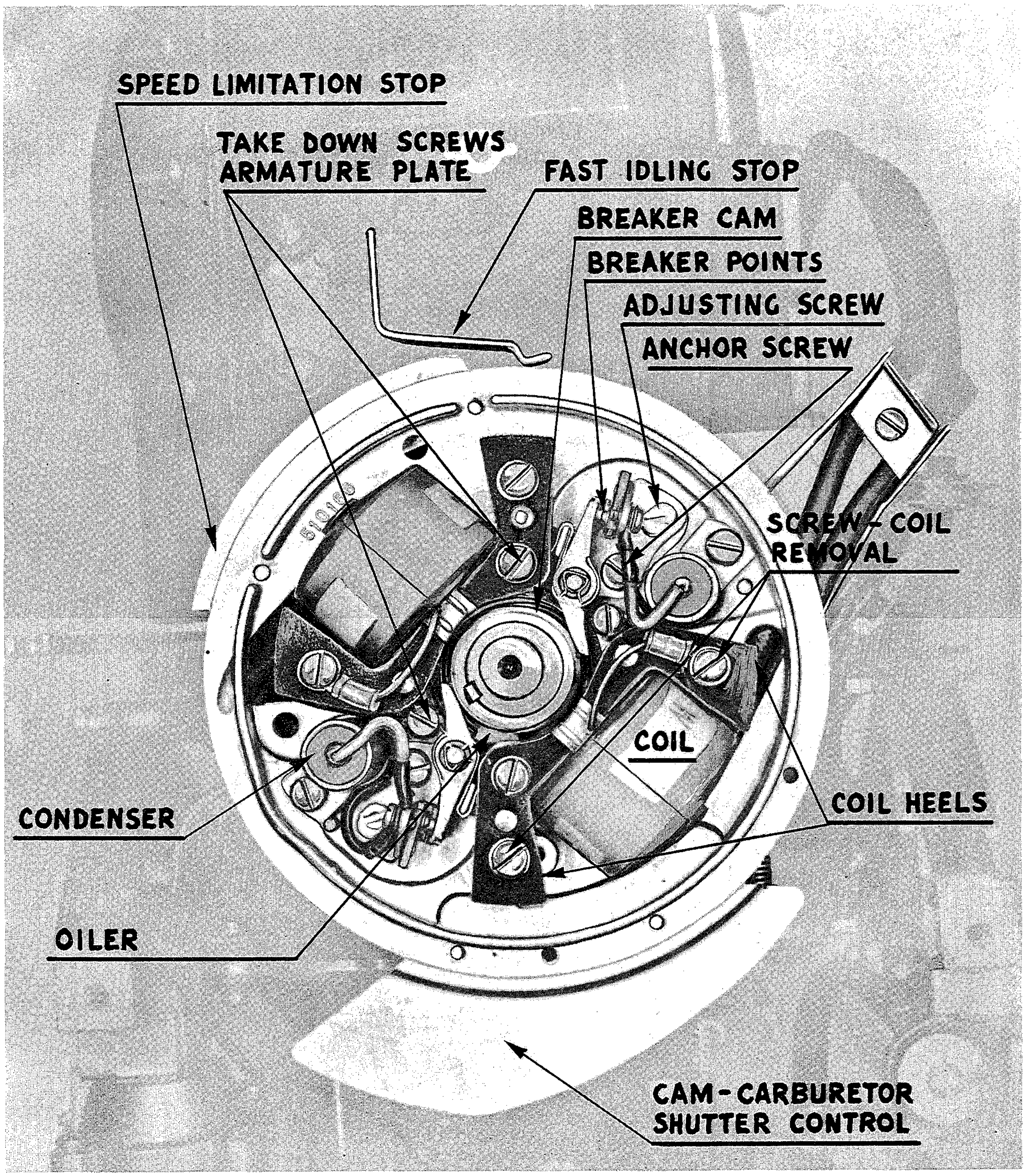
NOTE: If the breaker points are properly set for gap, they need not be disturbed in event it becomes necessary to remove and install the flywheel for other reasons. Simply make sure the high side of the cam in the flywheel comes to rest midway between the push rods and that the push rods are seated against the breaker point spring. They can slip out and be damaged by the cam during flywheel installation unless caution is exercised in this manner.



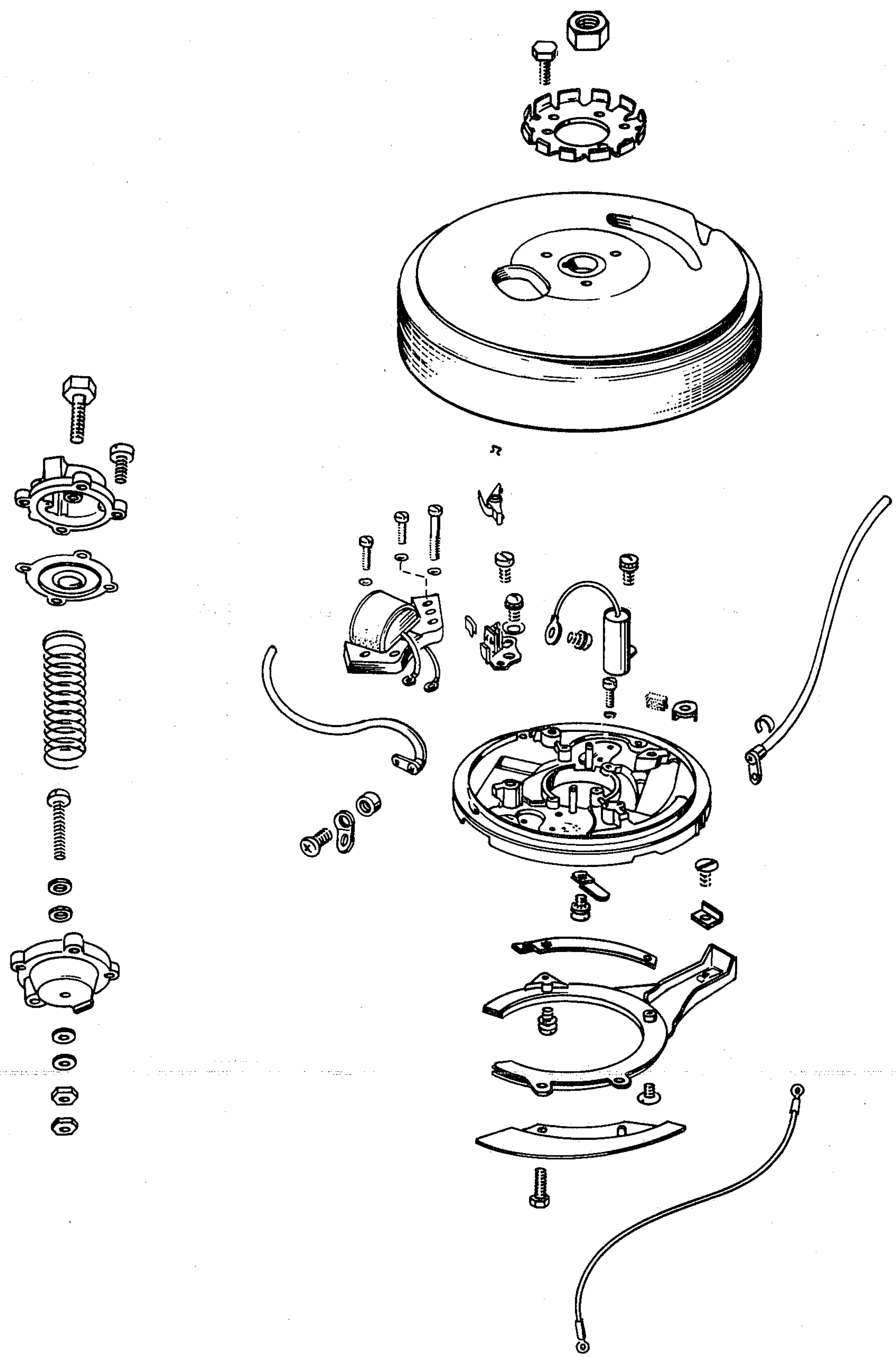
Spark Plug Cover Removed to Make Plugs Accessible for Removal.

NOTES

Don't forget paper between points



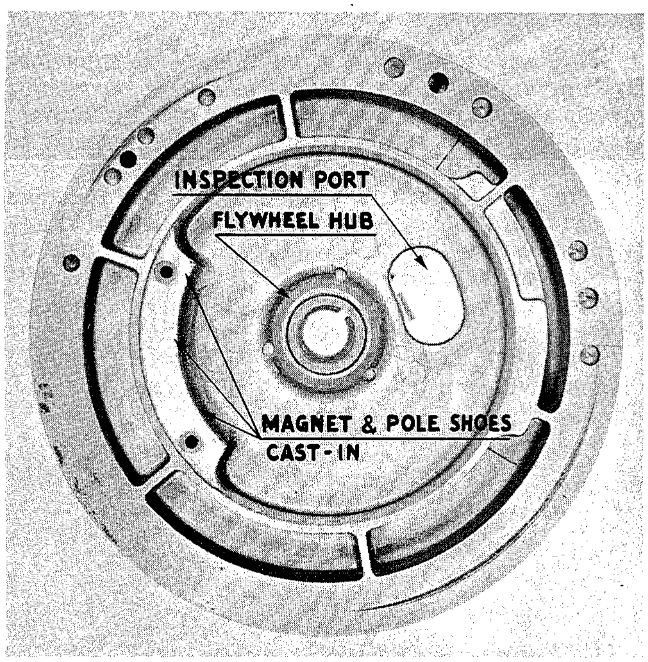
Magneto Armature Plate—Model RD



Assembly Layout—Automatic Cutout and Magneto—Model RD

MAGNETO—MODEL RD

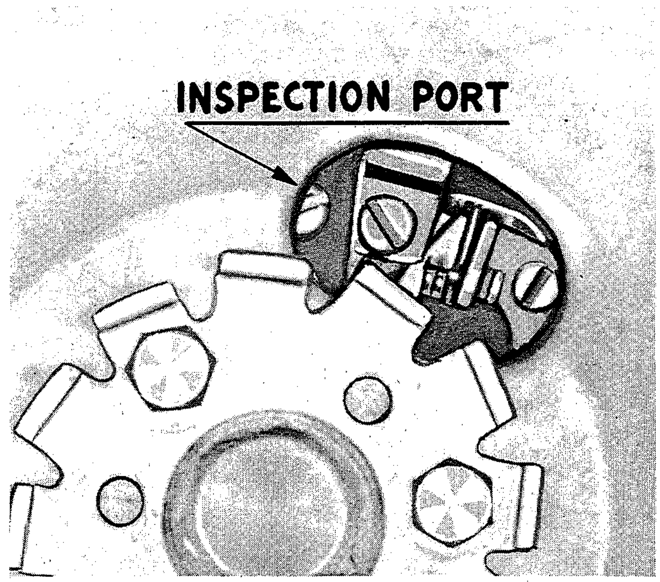
Ordinarily the ignition system requires little attention except for replacing of spark plugs and occasional cleaning and adjusting of the breaker points — at times, replacing the breaker points, ignition coils and/or condensers when necessary to restore sparking at the plugs in event of failure. Should there be reason to suspect faulty ignition because of hard starting, irregular operation of the motor or failure to start at all, disconnect and remove both spark plugs; ground one of the spark plug leads (wires) to a convenient part of the motor—hold the "live" end of the lead snugly against the cylinder block or other part of easy access; hold live end of remaining lead approximately 1/8″ from some part of the motor—not too near the open spark plug port in the cylinder head to guard against igniting fuel vapor escaping from the cylinder; pull rapidly on starter grip to crank the motor; if the magneto is functioning in good order a strong spark should be noted "jumping" the 1/8″ gap between the live terminal lead and the motor block. Repeat operation for other spark plug lead.



Flywheel.

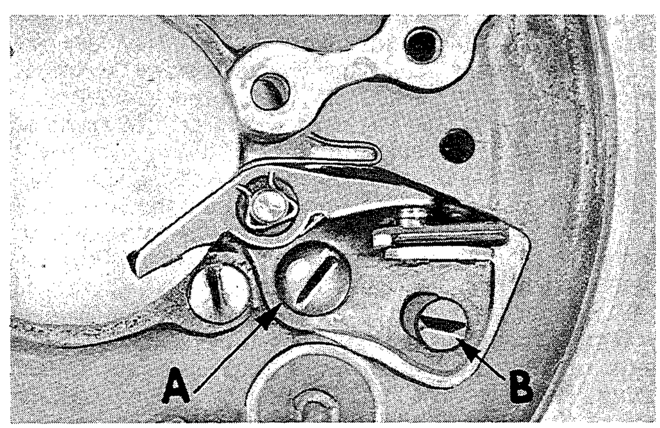
Condition of the spark plugs can be checked in same manner—attach leads to the spark plugs for this operation; however, weak or intermittent sparking (at the spark plug) is often caused by corroded, pitted or improperly adjusted breaker points; faulty condenser; faulty ignition coils; loose electrical connections; faulty insulation. See check chart, page 56-16.

Check the spark plug for excessive carbon accumulation, proper gap between the points—correct setting is .030″. If fouled (shorted) or there is evidence of considerable erosion or "burning" away of the electrodes to make readjusting the point gap impractical, discard the plug for a replacement. Install new Champion J-6-J spark plug.



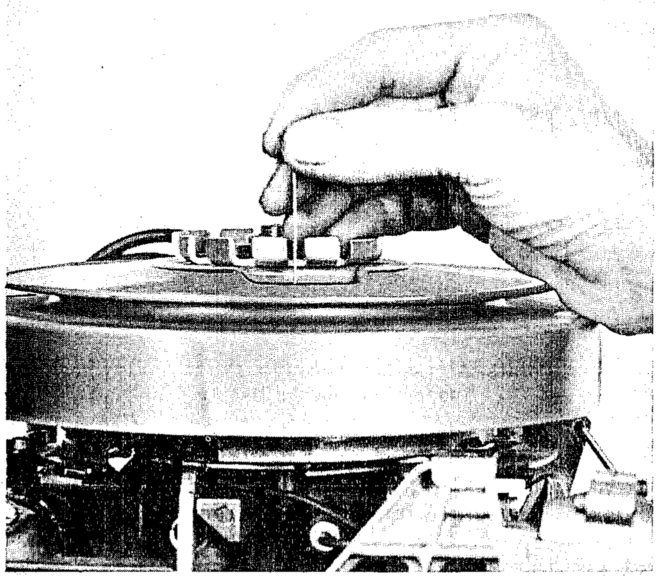
Breaker Points Accessible Through Port in Flywheel for Inspection and Adjusting.

When required to check breaker point gap, clean or adjust the breaker points, turn the flywheel over by hand until port or elongated opening comes to rest immediately above the breaker point assembly to make accessible for the operation. Breaker point surfaces become oxidized or coated, thus requiring occasional cleaning after long periods of idleness which sets up a barrier in the primary circuit to result in faulty sparking at the spark plug or complete failure of spark. In like manner, faulty spark occurs when the breaker point surfaces become "rough" or pitted after long service. To function properly, the breaker point surfaces must bear flatly against each other when gap is closed; be clean and smooth and adjust to recommended gap clearance of .020″ when fully open or separated.



Breaker Point Assembly—Showing Anchor Screw "A" and Adjusting Screw "B."

Breaker points may be cleaned with a breaker point dresser—this operation is carried on through the port in the flywheel. To dress or clean with point dresser, spread points with finger or blunt instrument sufficiently to permit inserting the point dresser after which work up and down until surfaces are clean and smooth. After having dressed or cleaned the points in this manner, insert a piece of paper between the points and in similar fashion work up and down to remove the traces of dressing material which may have lodged between the points to prevent good contact.

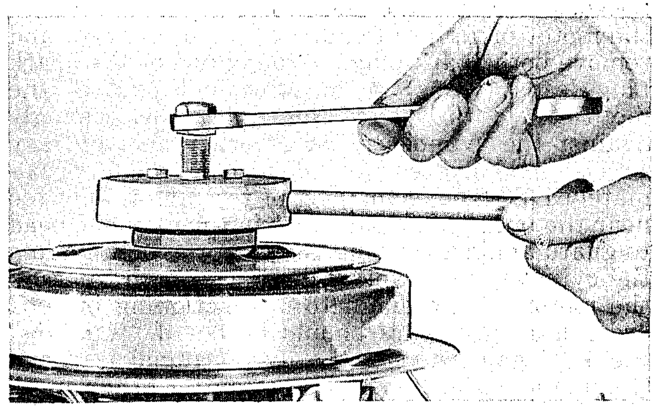


Checking Breaker Point Gap with Feeler Strip Through Inspection Port in Flywheel.

To adjust breaker point gap: Note that breaker point action is by rubbing block on the breaker arm following contour of the cam (eccentric) attached to the crankshaft (since the breaker arm "pivots" on its post, gap opens and closes as the rubbing block rides high and low sides of the cam —eccentric) and that breaker base assembly is held fast to the armature plate by two screws—namely, (A) the anchor or pivot screw and (B) the adjusting screw. Head of the adjusting screw is eccentric and "rides" the elongated slot in the breaker base plate. Turning screw (B) to right or left causes the breaker plate to "swing" or pivot on screw (A)—thus, breaker gap setting is accomplished by shifting the breaker base plate toward or away from the breaker cam on the crankshaft. Breaker point gap is increased by moving the assembly toward the cam—decreased when moved away from the cam.

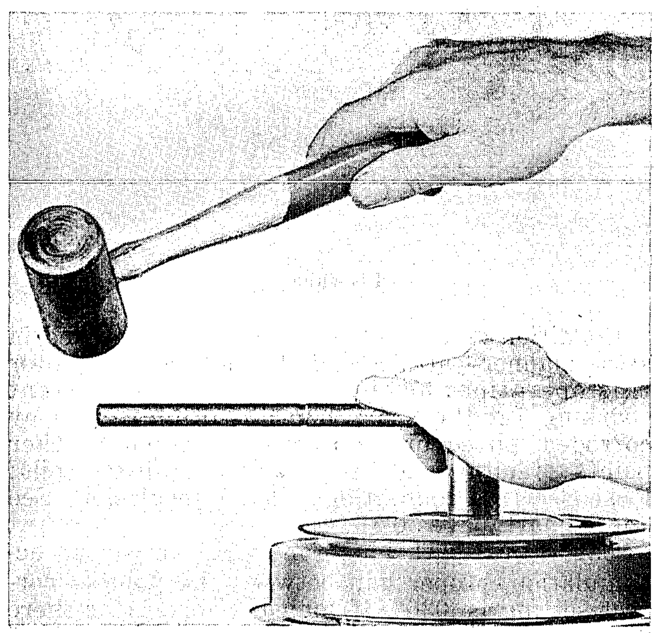
Turn flywheel until rubbing block rides on high side of the cam—maximum gap opening. Insert gauge strip of .020″ thickness to check gap. In event the gauge strip "fits" too tightly or loosely, loosen slightly anchor screw (A); turn adjusting screw (B) to right or left to obtain the desired gap opening. When correct, both faces of the gauge strip should bear slightly against both breaker point faces—"fit" the gap without tightness or excessive looseness. Draw down on anchor screw (A) to insure position of breaker base assembly. Repeat as above to adjust gap of other breaker point set.

To replace or install the breaker point assembly, condenser, ignition coil or spark plug leads, it becomes necessary, after having removed the starter assembly, to remove the flywheel.



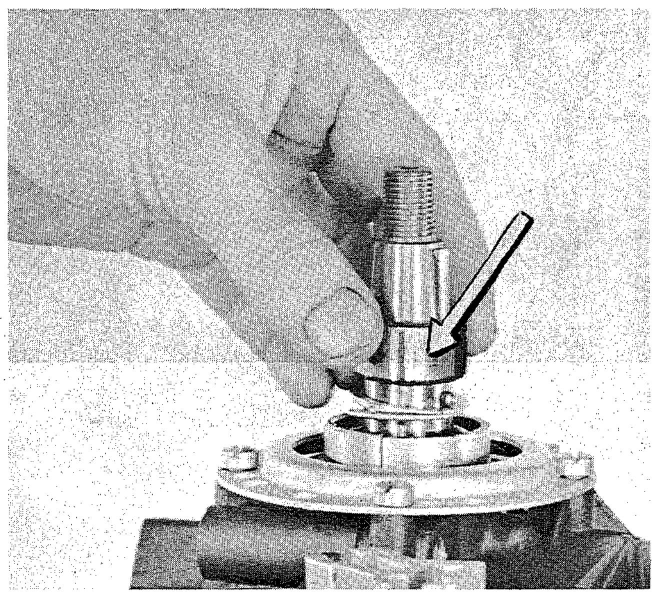
Removing Flywheel from Crankshaft Taper with Puller.

To remove and install the flywheel: Remove the flywheel nut—striking handle of socket wrench of proper size sharply with mallet or small hammer; attach flywheel puller (turn large center screw to outer limit—attach to flywheel with screws provided); turn large center screw down until it comes to rest against the end of the crankshaft; hold flywheel and flywheel puller with bar—turn down on large screw with wrench until flywheel can be lifted from tapered end of the crankshaft. If necessary to jar loose, lift up on rim of flywheel to absorb shock, then strike end of the puller screw sharply with a hammer; detach puller from the flywheel.



Striking Handle of Wrench to Secure Flywheel Nut.

To install the flywheel, check first condition of the flywheel key and its location in the keyway on tapered end of the crankshaft; make certain surfaces of the crankshaft taper and corresponding surface in the flywheel hub are clean, smooth and *dry* (use no oil or grease on surfaces prior to installing the flywheel); carefully place flywheel in position—aligning keyway in hub with key on the crankshaft; install and draw up tightly on the flywheel nut. Note: Be sure to remove traces of oil or grease from crankshaft taper and taper in flywheel—assemble "dry" to properly seat flywheel on the crankshaft. This is IMPORTANT. If torque wrench is available, draw up to 70 lbs. torque, otherwise, strike handle of wrench with a hammer until assured the flywheel is securely and properly seated. This is IMPORTANT to avoid shearing of the flywheel key and subsequent injury to tapered surfaces.

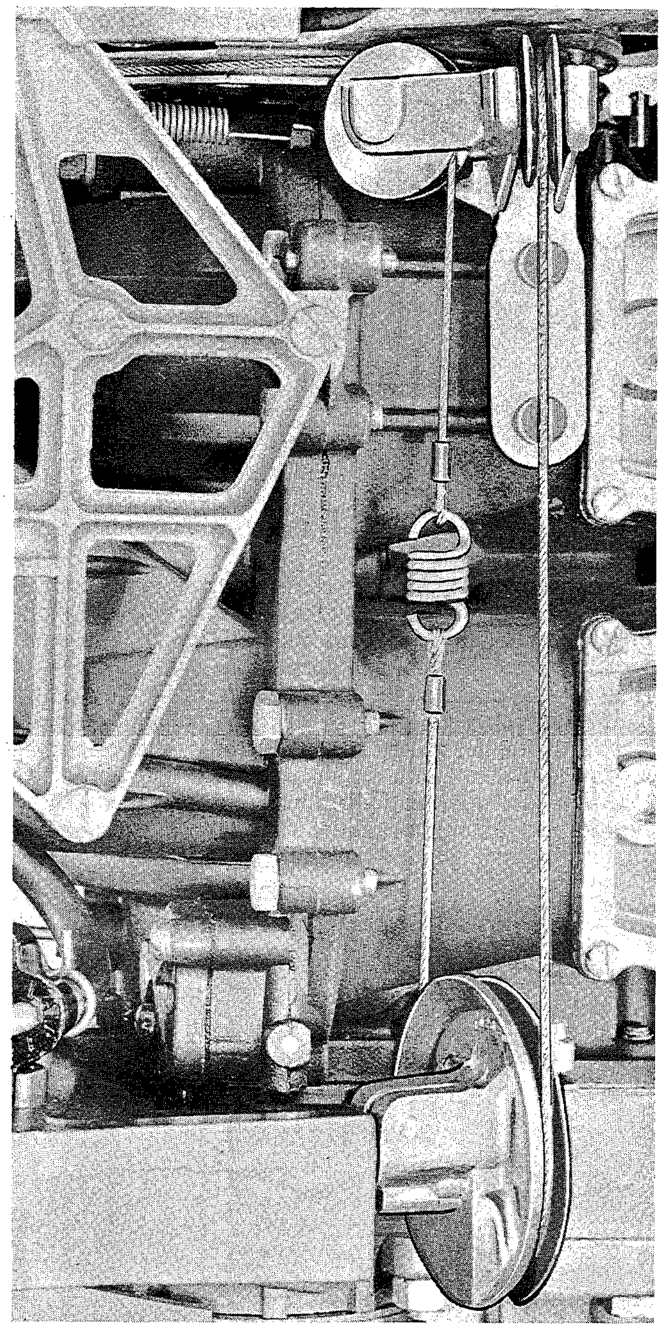


Installing or Removing Breaker Point Cam.

To remove and replace breaker cam: inside surface of the cam is slotted to "fit" over key in crankshaft taper and driving pin near end of the taper—simply lift off to remove; to replace, align slot in cam with key and pin in the crankshaft—push down squarely and carefully over the crankshaft. Do not force—if lined up squarely it will slip easily into position.

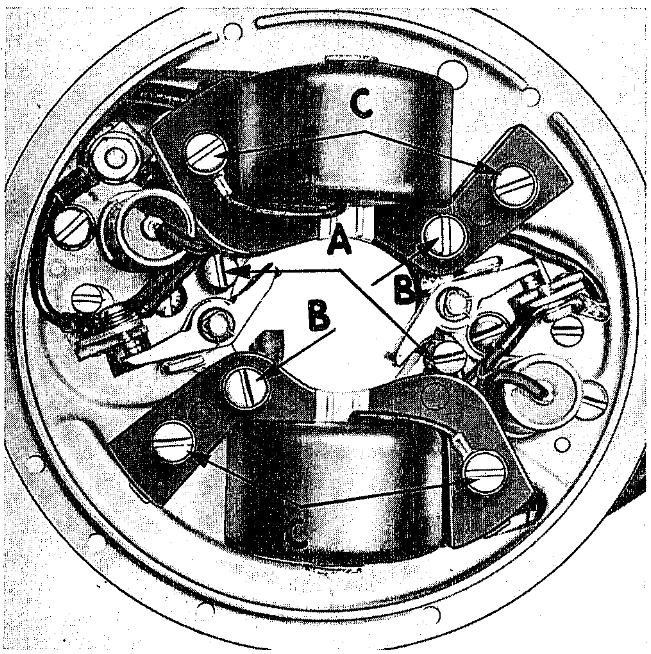
To remove and install condenser: simply disconnect the condenser lead; remove the screw holding condenser fast to the armature plate; lift off; install new condenser in reverse order—making sure that all "contact" surfaces are clean and free of foreign matter and that terminal nuts or screws are made secure to guard against faulty ignition—all electrical connections must be clean, free of corrosion and tight.

To remove and install breaker point assembly: disconnect the ignition coil primary and condenser leads from breaker point assembly; remove anchor and adjusting screws; lift from position; install new breaker point assembly in reverse order and like the condenser, all electrical connections must be free of corrosion, clean and tight to assure proper sparking—adjust wires (leads) to rest close to assemblies to prevent "rubbing" against breaker cam or hub of flywheel to eventually cause short circuit and faulty ignition.



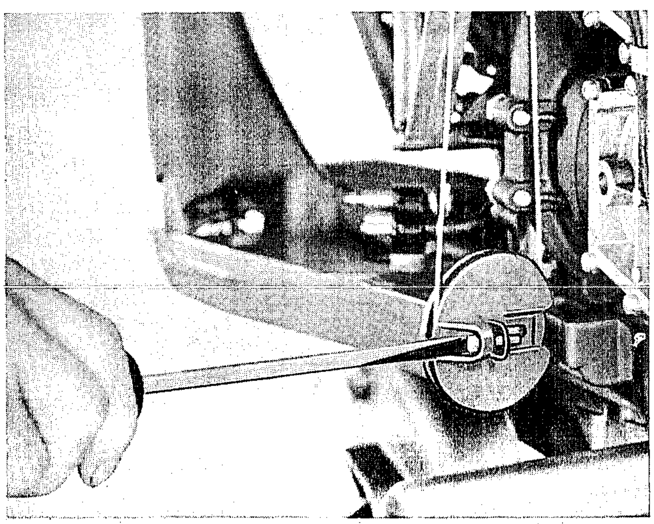
Cable Arrangement—Speed Control.

To remove and replace armature plate: "spark" and "gas" are synchro controlled — functioning through a system of cam and linkage to proportion volume of fuel-vapor charge with respect to degree of spark advance throughout speed range of the motor—desired motor speed is by way of twist grip located at end of the steering handle through pulley and stranded wire cable (anchored to armature plate); reduce tension on stranded cable as shown by releasing the tension adjusting



Armature Plate.

bracket on pulley; loosen clamp screw holding pulley fast to shaft; remove pulley and cable assembly from the shaft; remove screws A, B and C on armature plate; lift armature plate assembly free of the crankcase; replace armature plate and cable assembly in reverse order of that described above. Note the method of attaching ends of cables to the armature and small steel ball "swedged" to the cable to prevent slipping over the pulley and tension adjusting bracket; turn up on tension adjusting screw until the cable is taut with slight

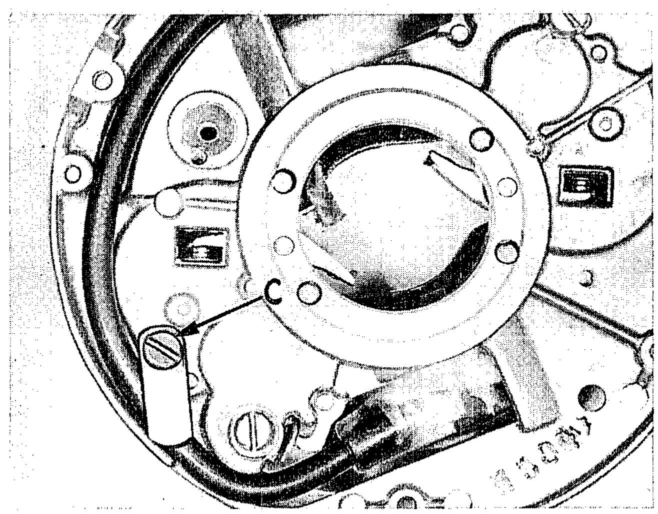


Releasing or Adjusting Tension of Control Cable.

tension only on the spring. Some tension or "drag" against free turning of the armature plate is required for satisfactory speed control. The armature plate in this case is assembled to the crankcase by means of four screws (A and B) driven into a ring which bears against a comparatively large "wave" washer installed between the ring and a bracket attached to the crankcase. Wave or curvature of washer band when compressed, acts to build up spring action or tension between bracket and ring into which screws are driven from the armature plate.

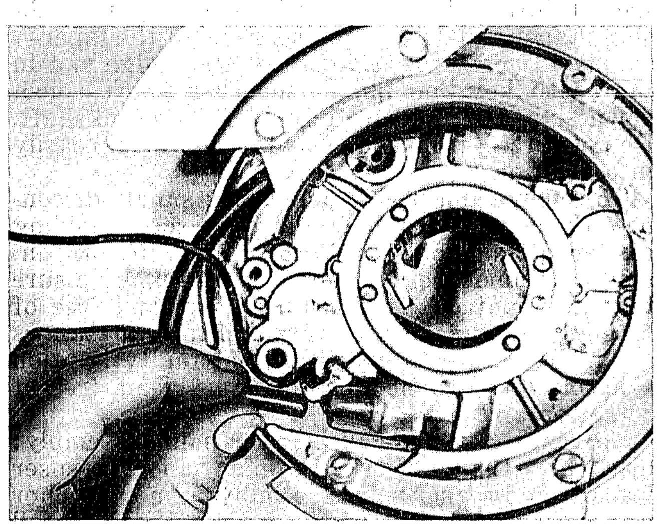
NOTE: When replacing the armature plate, turn high side of the breaker cam (on the crankshaft) toward core in center of the ignition coil indicated by arrow as required to avoid damage to rubbing blocks on the breaker point arms and for ease of assembly.

To remove and replace the ignition coil: Remove screws "A" and "B" to detach armature plate—lift from crankcase; remove screw "D" under the armature plate; pull ignition lead free from coil; remove screw "C"; lift coil from its position. Note



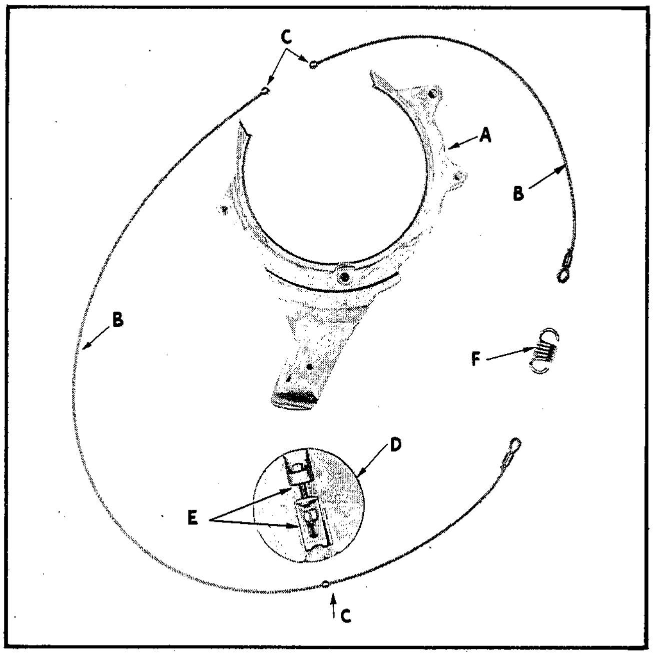
Showing Clip and Screw "C" to Secure Position of Ignition Lead.

that the ignition lead is inserted over a "needle" imbedded in coil tube; install new coil in reverse order—coat end of the ignition lead liberally with DC-4 (a Dow Chemical product) if available, to further insulation at this point; force end of the ignition lead into the coil tube—"needle" penetrat-

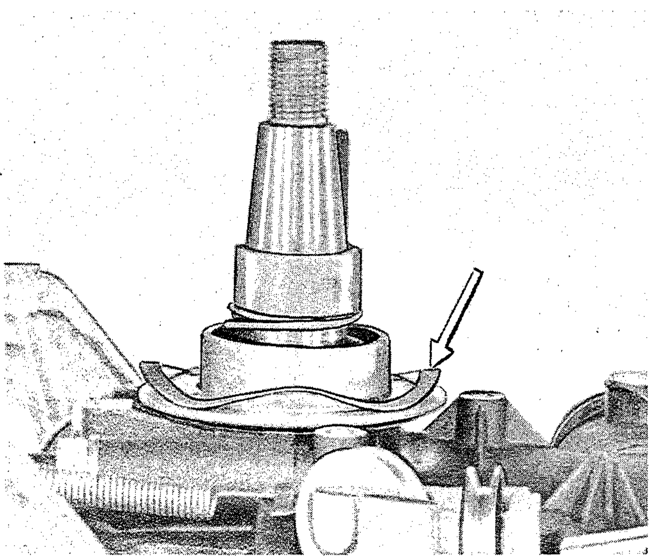


Detaching or Installing Ignition Lead.

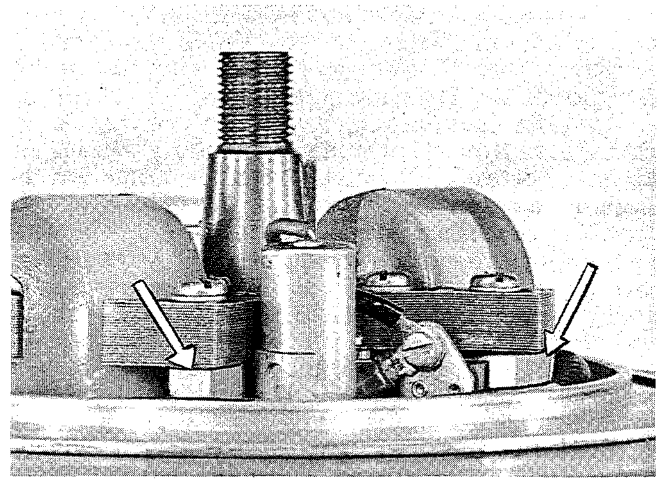
ing standard core of the lead to insure contact. Insert and tighten screws "A" to hold armature plate fast to the crankcase; insert screws "B" and "C" and draw up to hold—snugly but not tightly at this time; note machined bosses on armature plate casting—adjust position of the coil to where face of the coil heel rests "flush" with face of the machined boss; draw up tightly on screws holding coil fast to the armature plate—this operation provides correct clearance or space between coil heels and pole shoes of the magnet cast into the flywheel; replace screw and clip holding ignition lead fast to the armature plate; repeat in like manner for installation of both coils.



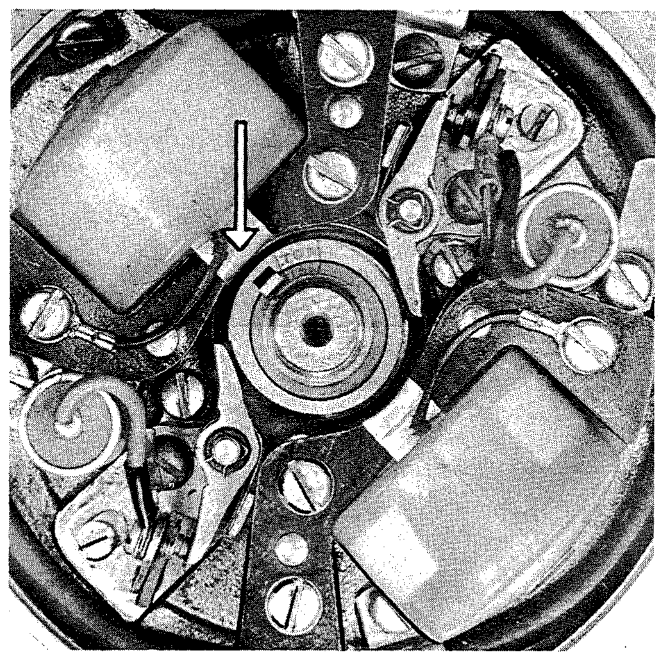
Underside Parts of Armature Plate Showing Synchro-Control Mechanism "A"—Pulley (Attached to Armature Plate); "B"—Control Cable; Beads "C" to Secure Position; Pulley "D" with Arrangement "E" to Adjust Cable Tension Applied to Spring "F."



Showing Location of "Wave" Washer.



Showing Coil Heels Installed "Flush" with Corresponding Boss on Armature Plate Casting.



Showing Position Recommended for Breaker Cam to Avoid Injury to the Breaker Arm Rubbing Blocks when Installing the Armature Plate—High Side of Cam Contour Directed Towards Center Core of the Ignition Coil.

AUTOMATIC CUT-OUT (MODELS RD-10 & 11)

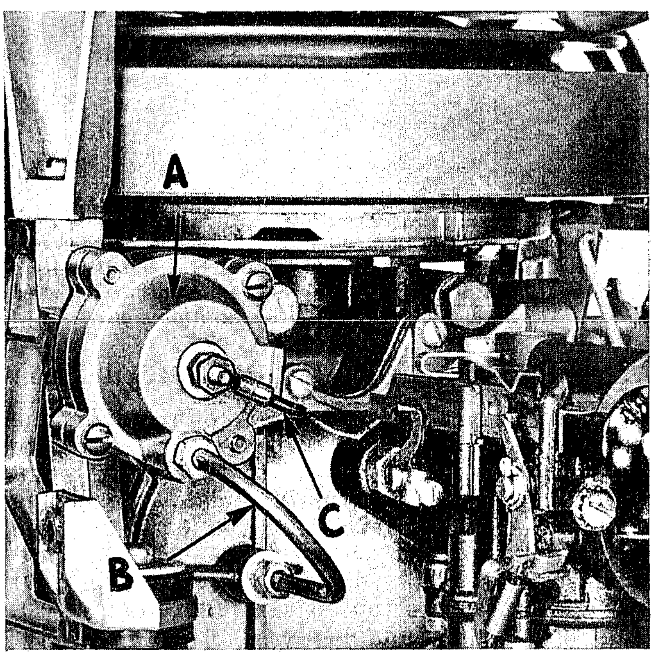
When receiving the new 25 and on removing the motor covers, a device will be noted attached to crankcase assembly, "piped" to the intake manifold and wired to the armature plate—something different—never before employed on a Johnson motor.

The purpose of this device is to momentarily cut out ignition at the top spark plug (idling only), thus, limiting maximum speed at which the motor may operate when set for idling in neutral. It consists of a spring loaded diaphragm encased in a housing and piped to the intake manifold. Action is such that when suction in the manifold reaches a certain predetermined point, the diaphragm flexes against spring tension to make a "ground contact"—cutting ignition at top spark plug. As suction in the manifold decreases the diaphragm resumes its normal position and subsequently breaks ground contact to permit firing of both spark plugs.

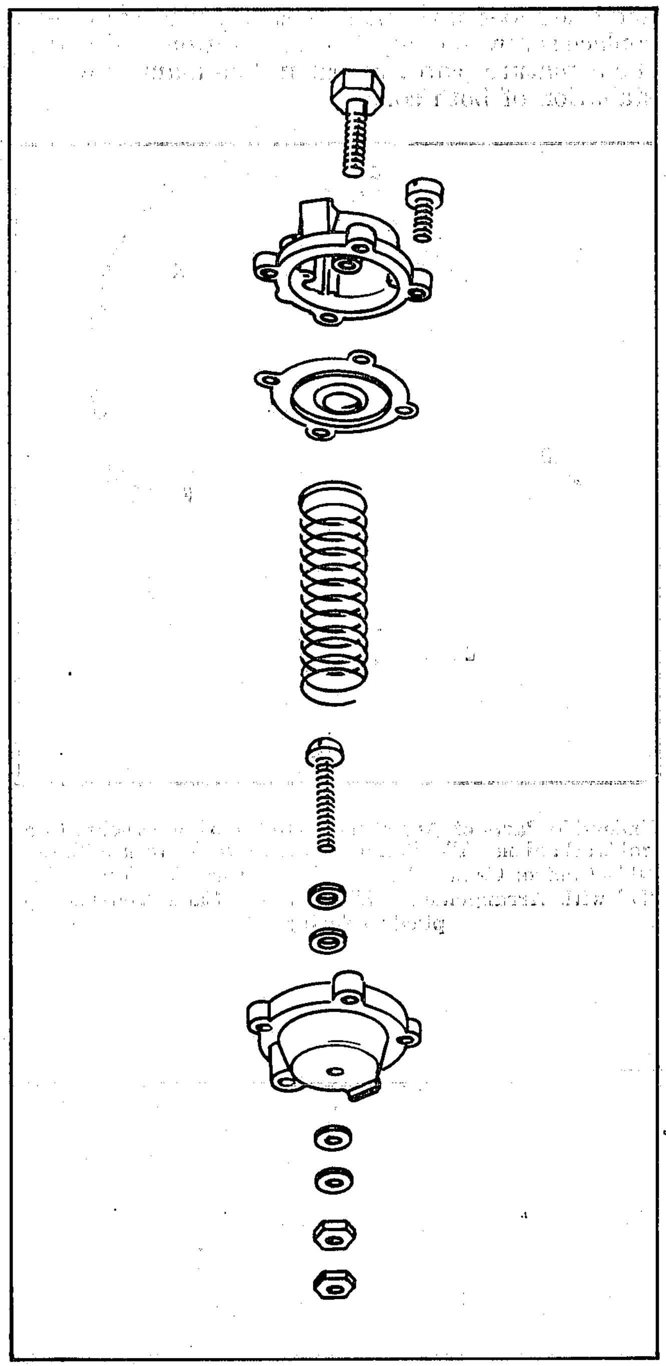
Manifold suction is governed by the degree of carburetor throttle opening and speed at which an engine operates. Normally, manifold suction is high in any engine when operating with closed throttle, becoming proportionately lower with the opening of the carburetor throttle. Otherwise, for purpose of illustration, it may be said that manifold pressure is but slightly less than normal atmospheric pressure (15 pounds per square inch—sea level), with full open throttle and engine running at top r.p.m. (full load)—maximum suction or low pressure occurs when running with closed throttle at a fast idle under no load.

In Models RD-10 and 11, arrangements have been made for Neutral, Forward and Reverse. The motor can be started in Neutral and run at idling speeds as long as the operator desires or until ready to shift into Forward or Reverse. This speed control or automatic cut-out as described, normally acts during Neutral running when suddenly decelerating from fast idle, therefore necessary in a motor (2 stroke cycle) the size of a 25, where provisions are made for idle running; it does not normally function, however, when operating under load in Forward or Reverse.

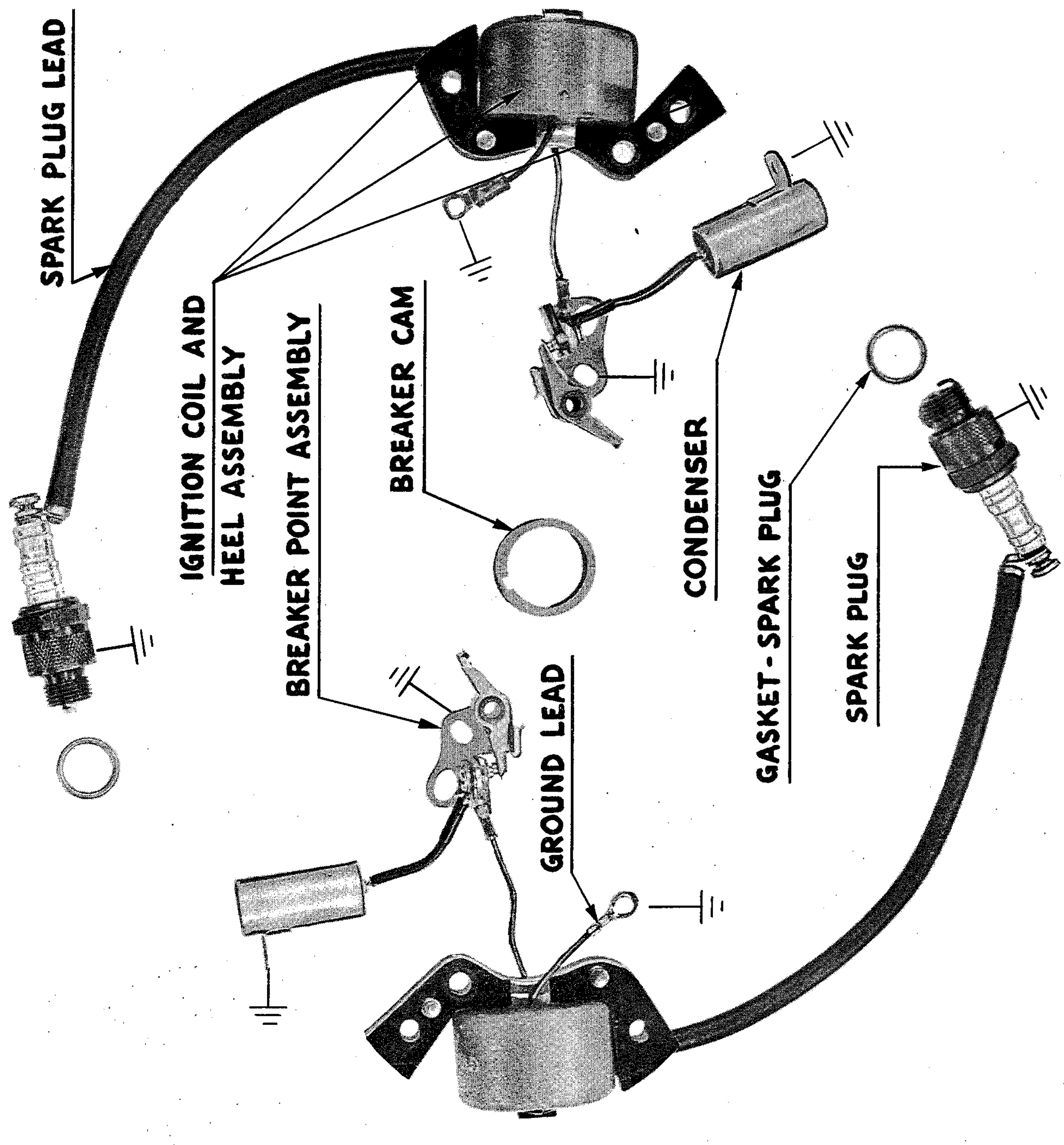
Conditions under which the control operates to limit maximum idling speed are as follows: If, when running the motor at fast idle in Neutral (2000 r.p.m. or more) the throttle is suddenly closed, a surge or sudden increase in manifold suction is introduced. Under influence of abnormal manifold suction in this instance, the mixture is not consistently ignited but will tend towards firing erratically to result in irregular but excessively strong power impulses to speed up the motor even though the throttle is closed. Resultant high motor speed cannot, under the circumstances, be otherwise reduced or controlled by conventional method of simply retarding the spark, thus the necessity of providing other means to accomplish this purpose—the automatic cut-out or speed control as described.



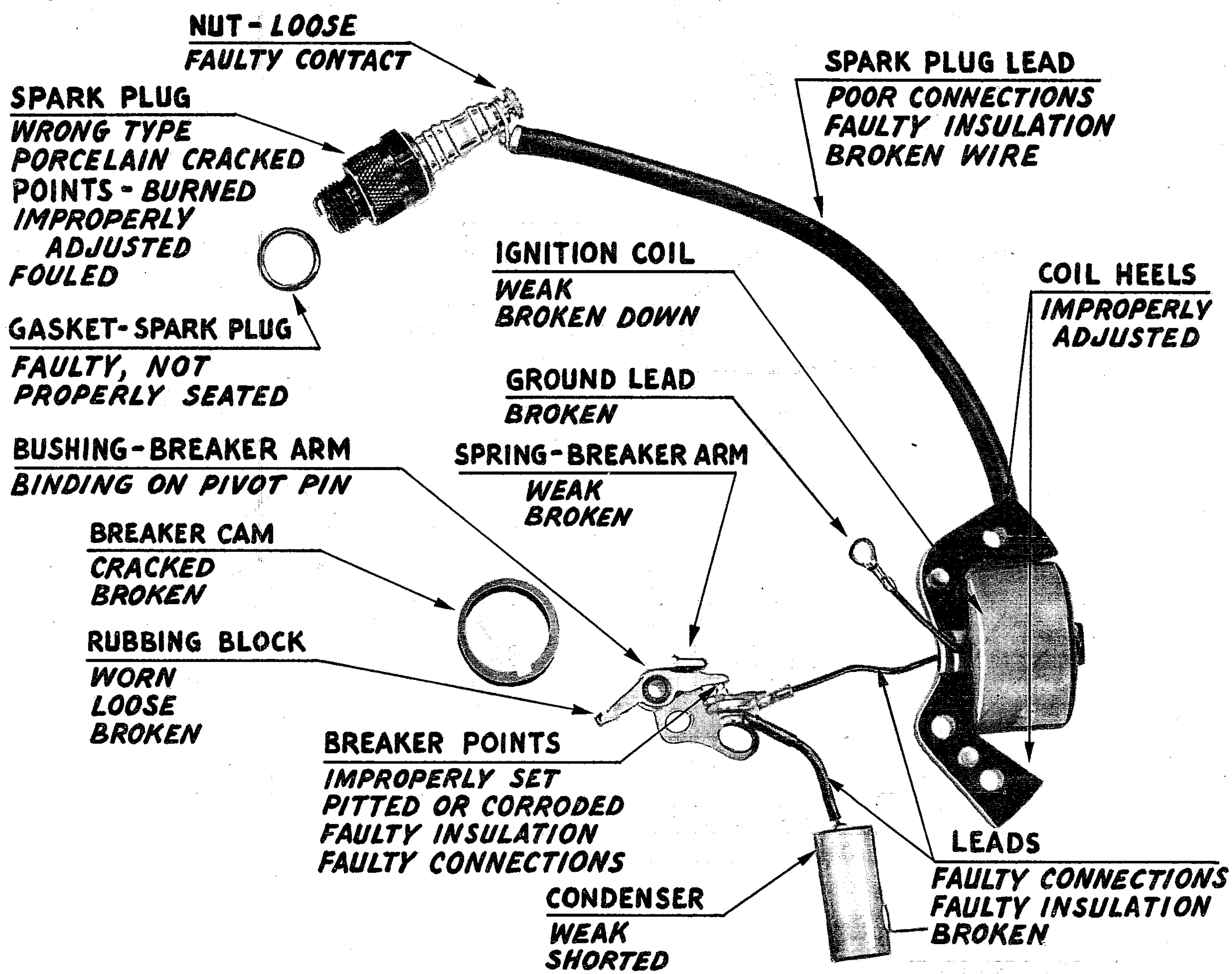
Showing Position of the Automatic Cut-Out "A" Attached to Models RD-10 and 11 Powerheads; "B"—Copper Tube to the Intake Manifold and "C"—Ground Lead to Armature Plate (to Ground Out Momentarily One Set of Breaker Points—See Explanation).



Assembly Layout of the Automatic Cut-Out.

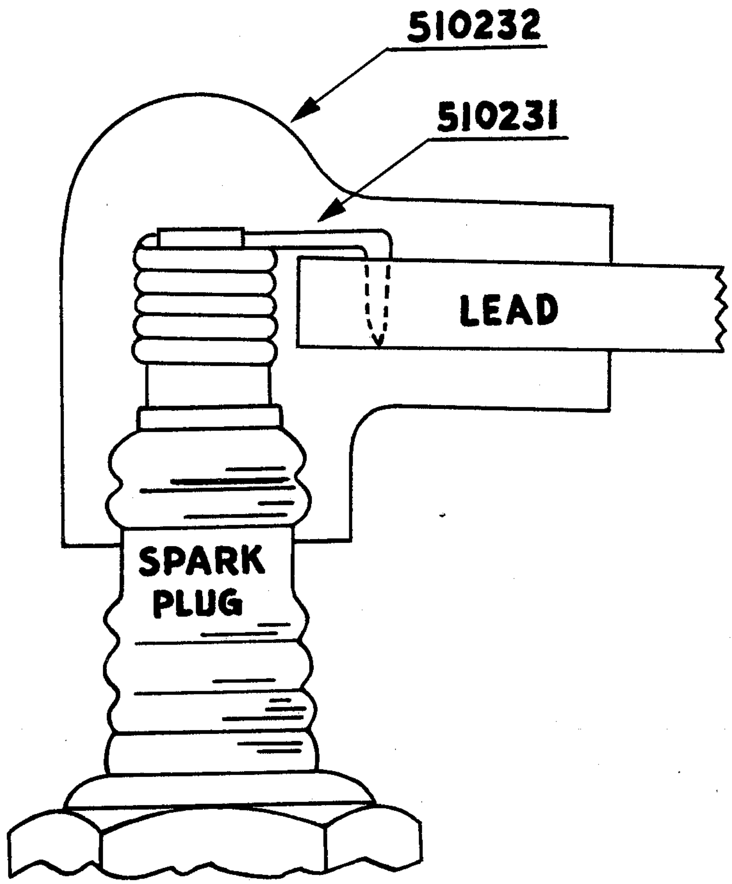


Functional Parts Removed from Armature Plate to Show Wiring System—Actually, a Complete Ignition System for Each Cylinder.



Magneto—Armature Plate Check Chart.

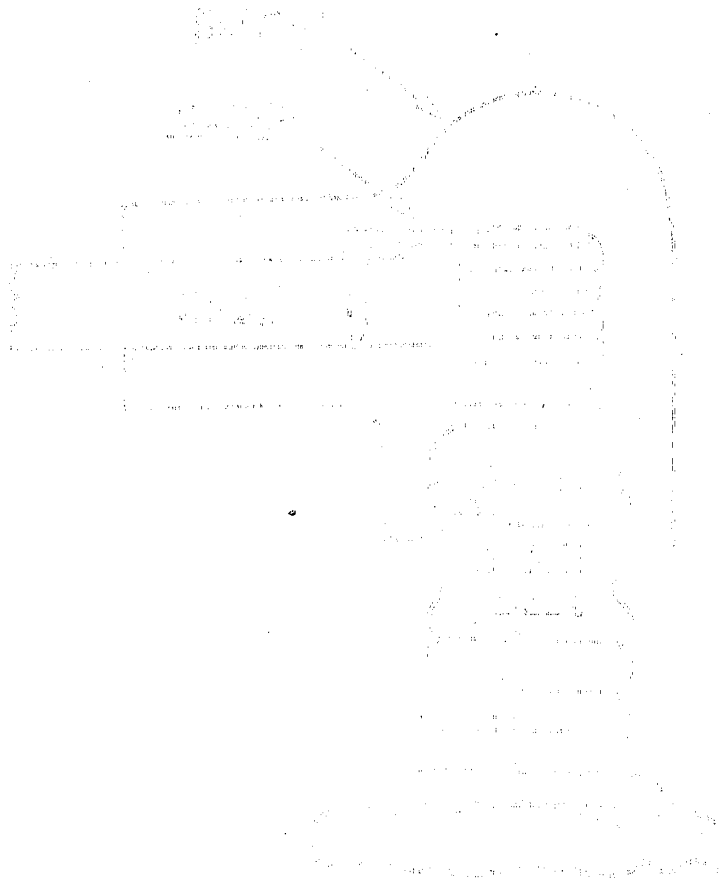
SPARK PLUG COVERS



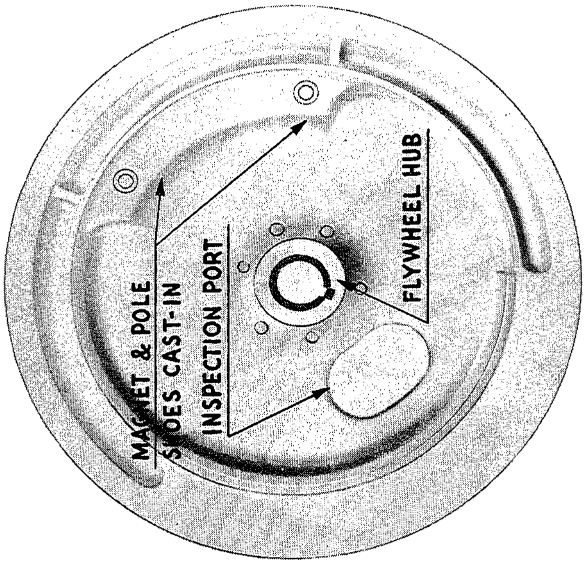
Illustrated here is the new spark plug cover and terminal assembly—consisting of No. 510232 cover and No. 510231 terminal. While carried under our part numbers, the spark plug cover is marketed and nationally distributed under the trade name of "SPARKY"—available ordinarily through automotive supply houses and/or the Johnson District Service Station. (Manufactured by National Products Corp., Waltham, Massachusetts.)

Installation is not too difficult.

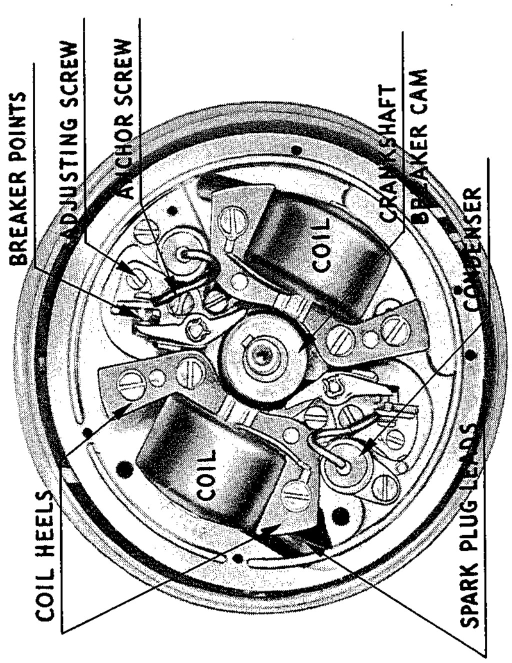
1. Clip end of ignition lead off squarely.
2. Drive pointed end of terminal through the lead to penetrate stranded core as shown.
3. Coat terminal outside area with DC-4 (a silicon product by Dow Chemical Corp., Midland, Michigan, available through many local retail outlets or automotive supply houses).
4. Push wire and lead terminal into the rubber cover, but—make certain it comes to rest in vertical position to permit "slipping" over terminal nut on the plug—see illustration.
5. The long automotive type of slip-on nut will have to be used in this case—spark plugs will be set up accordingly.



UNIVERSAL MAGNETO

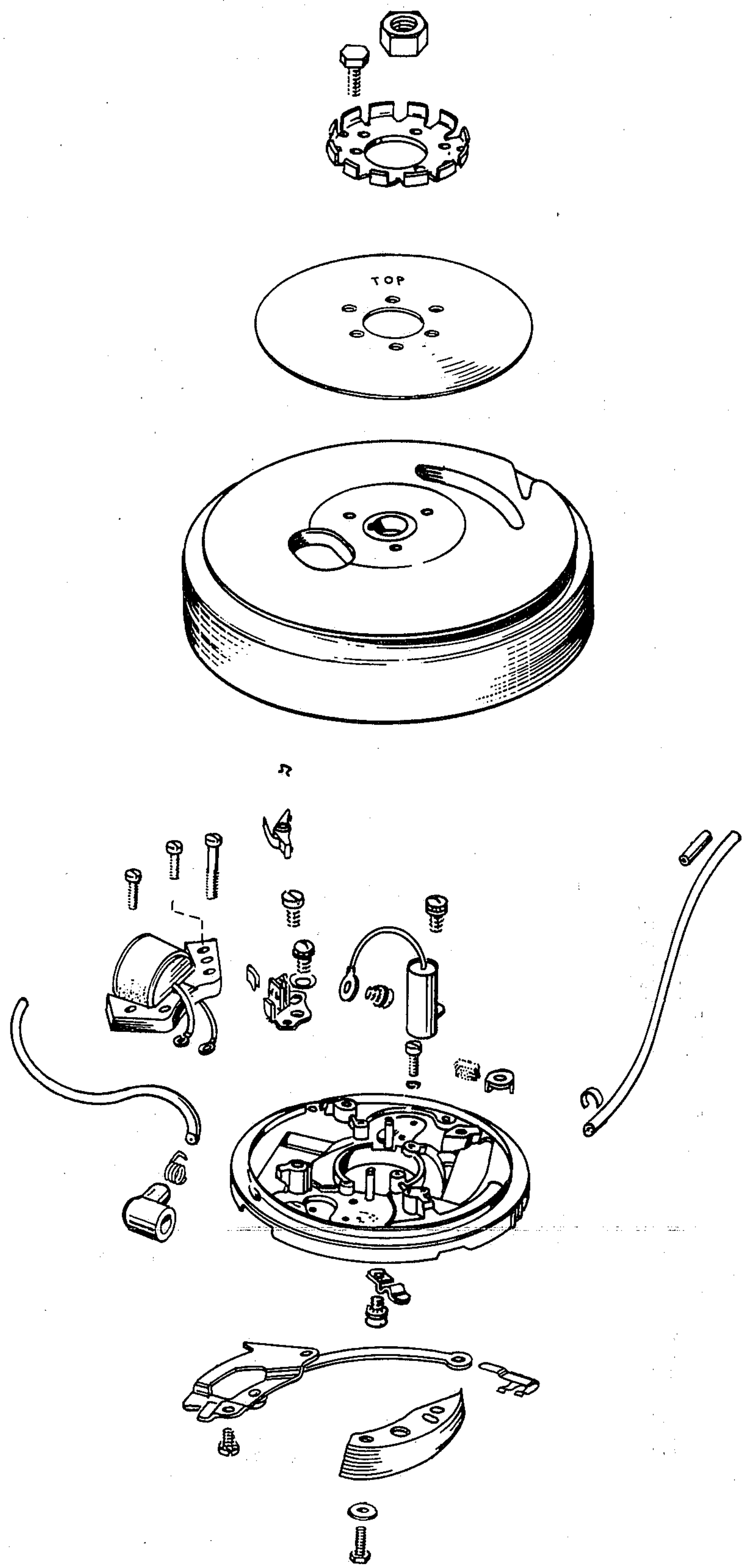


Flywheel



Armature Plate

Models JW, TN-27, 28, QD-12 and up, RD and RDE



UNIVERSAL MAGNETO

MAGNETO—JOHNSON UNIVERSAL INSTALLED ON MODELS JW. TN-27 AND UP, QD-12 AND UP, RD AND RDE

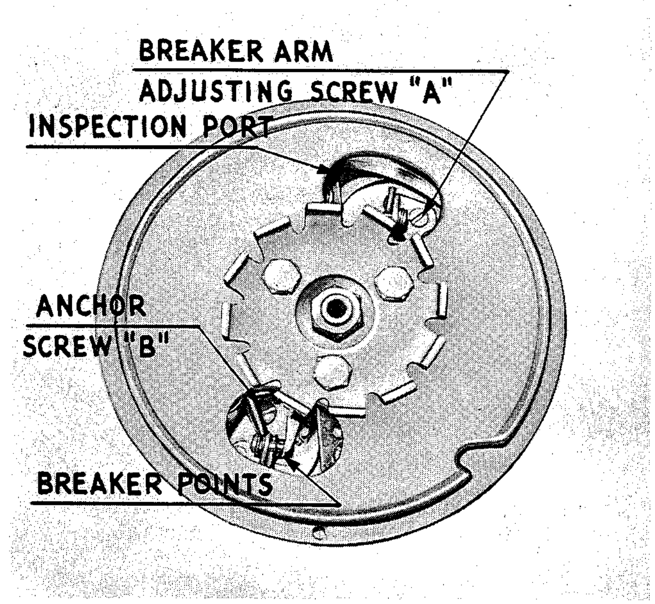
Except for individual flywheels and "trim" parts (carburetor control cams, etc.) magneto assemblies installed on above models are basically alike in construction, employing the use of identical ignition coils, condensers, breaker point assemblies and armature plate castings. Otherwise, mechanical construction is of conventional Johnson design, employing the use of two ignition coils, two sets of breaker points operated by a cam keyed to the crankshaft, and two condensers mounted on an armature plate arranged to swivel on the crankcase boss to accomplish speed control. A flywheel with built-in permanent magneto completes the assembly to energize the coils during starting and operation of the motor.

Its simple construction requires but little attention except for periodic cleaning of the breaker point surfaces and subsequent adjusting of the breaker point gap to overcome faulty sparking and operation of the motor. Long periods of operation cause "pitting" and oxidizing of the point surfaces to interfere with starting and consistent running throughout speed range of the motor. Similarly, storage in areas of high humidity frequently results in oxidation or "scumming" of the breaker point surfaces to cause like results.

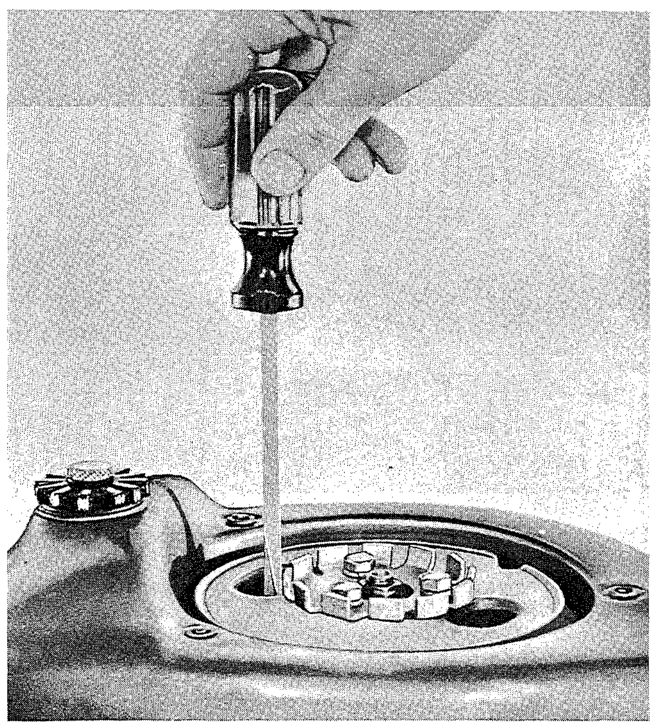
TEMPORARY PROCEDURE FOR CLEANING AND ADJUSTING THE BREAKER POINTS

As noted from accompanying illustrations, the flywheel is provided with two inspection ports to gain ready access to the breaker points for cleaning and gap setting. Proceed as follows:

1. Remove Ready Starter Head.
2. Remove starter ratchet and flywheel port cover.
3. Turn flywheel to expose both sets of breaker points.
4. Carefully spread breaker points with blunt instrument — small screw driver.
5. Insert point dresser between points — remove instrument to release points — work point dresser up and down carefully until relatively smooth surfaces are obtained. (Note — in event the operation is being performed in a shop with parts available, installation of new points is recommended since resurfacing as described here is only a temporary measure.)
6. On completion of the cleaning operation, insert strip of paper and work up and down in like manner to remove possible traces of dressing material left on point surfaces, later to affect starting and normal running of the motor.



Flywheel Port Cover Removed to Expose Breaker Points for Adjusting Gap Setting.

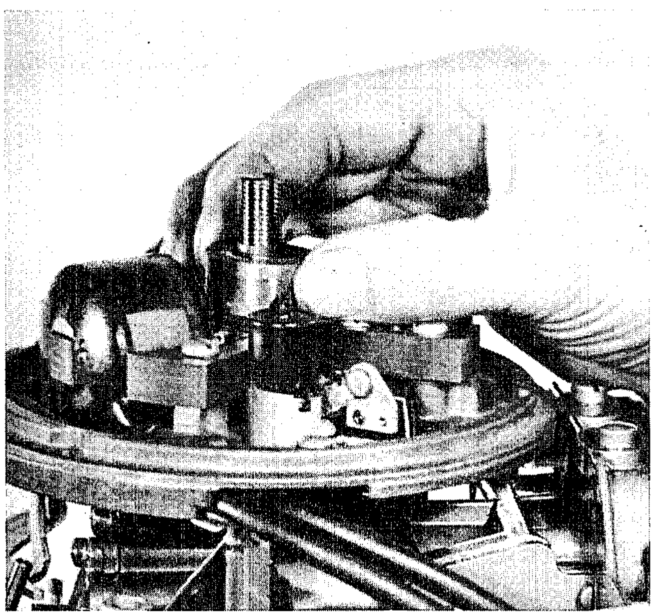


Adjusting Breaker Point Setting Through "Port" in the Flywheel Provided for this Purpose.

To Adjust the Breaker Point Gap

7. Turn flywheel to position where breaker point gap is at its maximum — recommended gap setting is .020″ full open.
8. Insert feeler strip (.020″ thick) to check gap clearance. If gap appears over or under specified .020″, proceed with required adjustment.

Checking Breaker Point Gap with Feeler Strip—Correct Gap Setting is .020" Full Open.

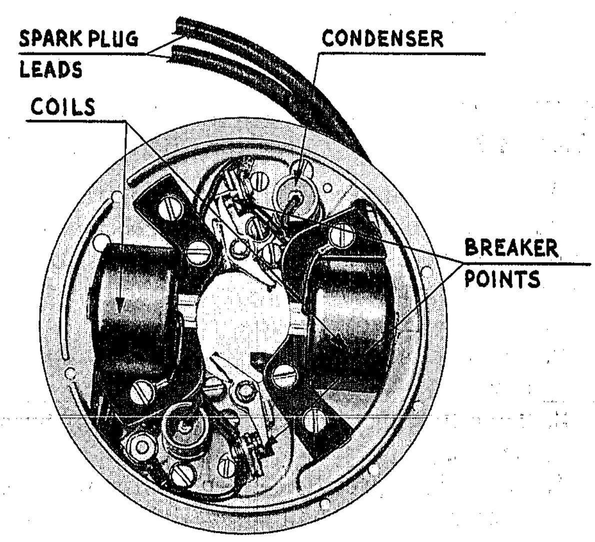


The Magneto Breaker Point Cam or Eccentric is Keyed to the Crankshaft thus, when Installed, "Times" Breaker point Action Automatically with Relation to Degree of Spark Advance, Position of Piston and Since Gas and Spark are Synchronized, with Respect to Volume of Fuel Charge. Do not "Force" Installation of the Cam — Line Up Squarely with the Key and Crankshaft, then Gently Push Down to Position by Hand.

The breaker base bracket is held fast on the armature plate by two screws "A" and "B" as shown in the illustration. Screw "A" is provided with an offset or eccentric head which is inserted through the slotted or elongated hole in the bracket. Turning of screw "A" consequently causes the bracket assembly to be shifted in and out to obtain ultimate breaker gap setting. The bracket assembly thus pivots on screw "B."

Since the rubbing block on the breaker arm follows or "rides" contour of the cam keyed to the crankshaft, actual breaker point gap is obtained by "pivoting" the breaker base and point assembly — pivoted towards cam face, the gap is widened; oppositely, the gap narrows.

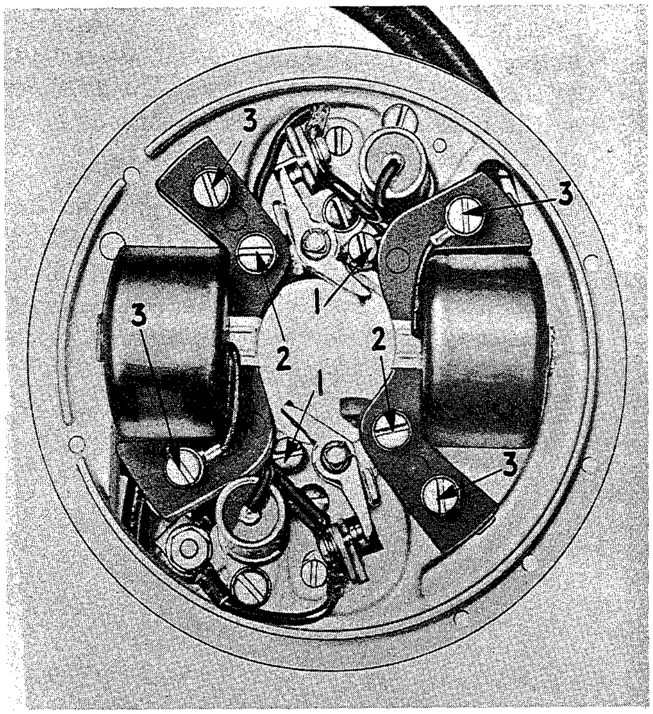
9. Carefully turn adjusting screw "A" to left or right as required to obtain specified gap setting of .020" full open. Note—turning screw "A" to left (counter clockwise) increases the gap — to right (clockwise) reduces or narrows the gap — correct gap setting is attained when the testing feeler strip is felt to bind slightly between the point faces.
10. Check tension on anchor screw "B" to secure assembly.
11. Turn the flywheel back and forth several times — then re-check gap setting to assure gap opening of .020" full open.
12. Repeat same operation on removing breaker assembly.
13. Make certain adjusting screw head seats in breaker bracket slot. IMPORTANT!
14. Replace the inspection port cover, starter ratchet and starter head.



Basic Armature Plate — Universal Magneto.

To replace the breaker point assemblies, simply detach primary and condenser leads, remove entirely both breaker base anchor and adjusting screw—lift assembly from the armature plate.

Obtain and install new assembly in reverse order of that described above. Work piece of paper strip up and down between point faces to insure their cleanliness and absence of foreign particles which otherwise would interfere with starting and operation of the motor.



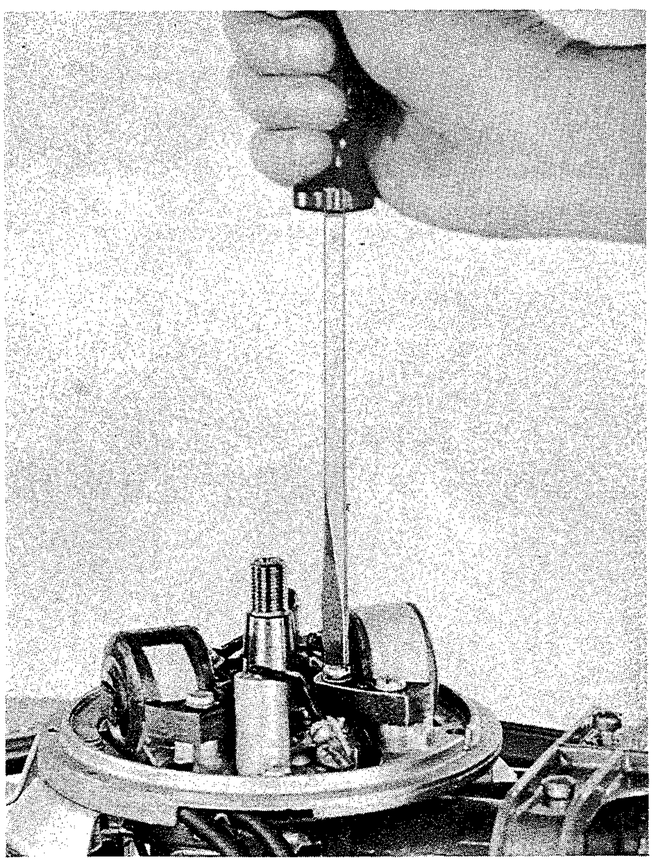
Armature Plate Showing Screws 1 and 2 to be Removed when Detaching from the Powerhead and Screws 3 for Detaching the Ignition Coils.

It is advisable after installing the breaker assemblies to check breaker point contact on the Stevens (continuity) tester assuring that maximum contact is being made to realize full capacity of the magneto assembly. See following instructions for contact checking.

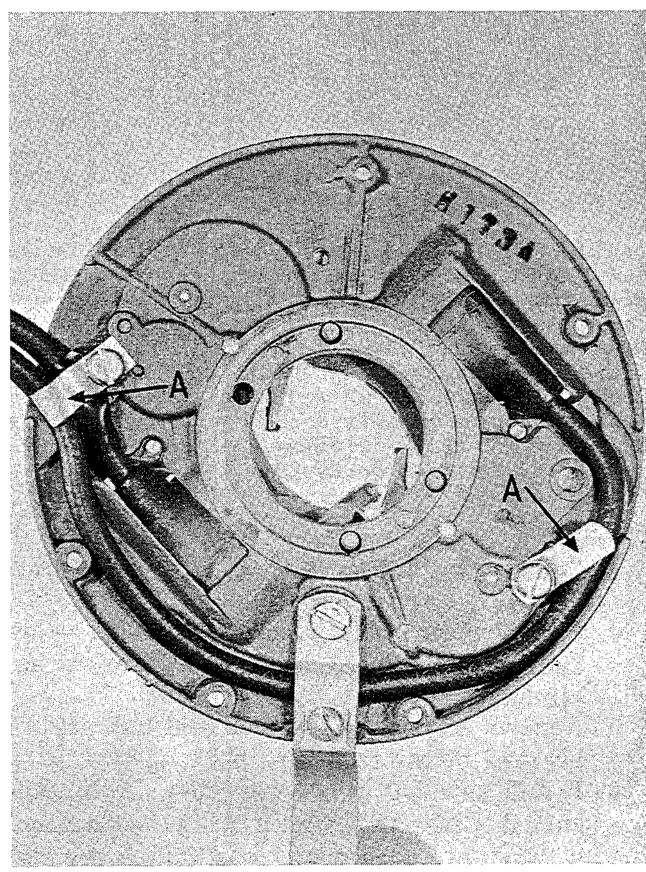
To replace the condenser, detach lead from the breaker assembly — remove screw holding condenser to armature plate — install new condenser in reverse order, making certain all connections are clean, solid and intact. Contact surface (ground) of the condenser mounting bracket and corresponding location on the armature plate must be clean to insure ground contact. Faulty ground contact in this respect has its effect on condenser capacity and function. Similarly loose condenser connections have their effect on condenser performance. See following instructions for checking condensers on the Stevens tester.

To replace the ignition coil, proceed as follows:

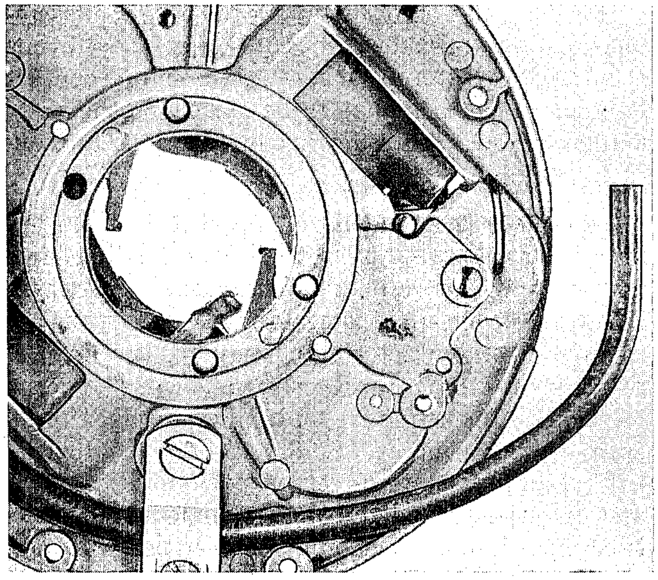
1. Remove screws 1 and 2 (4 screws) to permit detaching armature plate assembly from the powerhead.
2. Turn armature plate over on its reverse side. Remove or loosen brackets "A" holding spark plug leads fast to the armature plate.



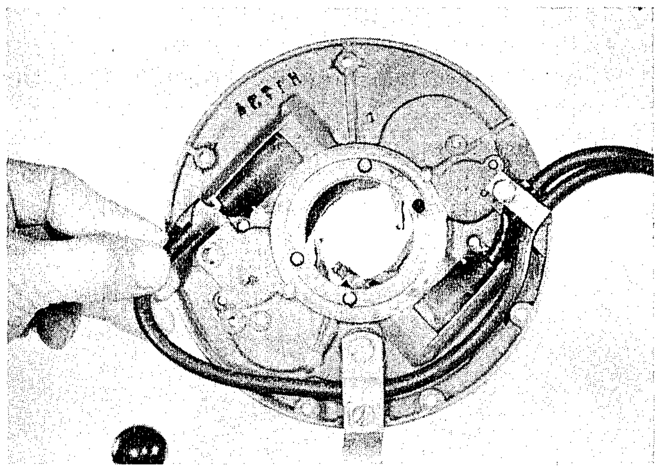
Removing Armature Plate from the Power Head to Accomplish, Remove Screws 1 and 2 as Indicated Above.



Showing Under Side of Armature — Brackets "A" Supporting Spark Plug Leads.



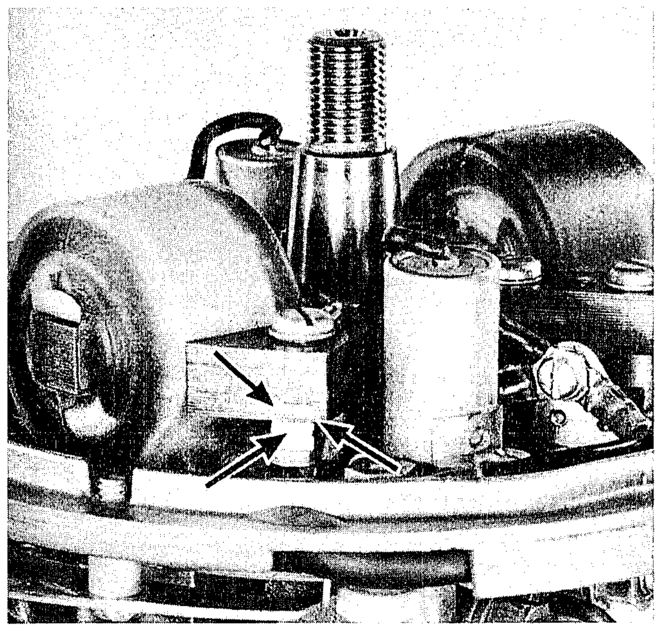
Showing Ignition Lead "Pulled" Free of the Coil.



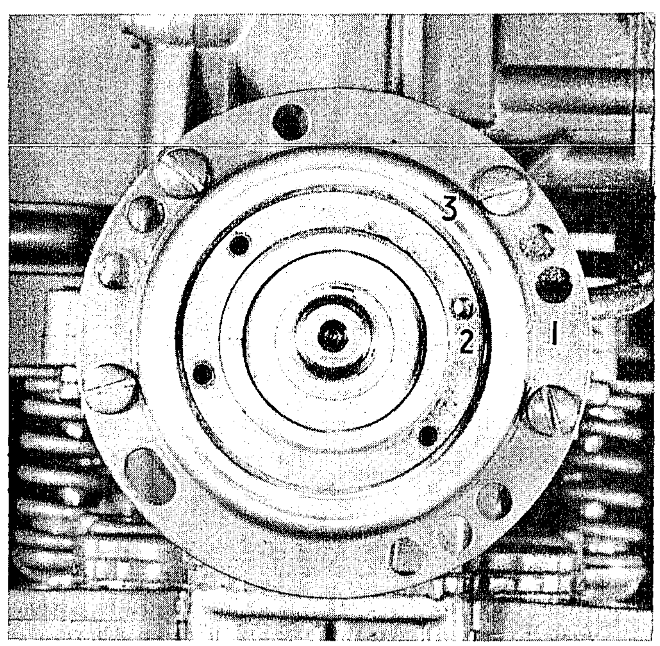
To Detach the Ignition Lead, Simply Pull it "Free" of the Coil. On Installation, Note that Secondary Lead (Coil) Terminates at a Needle Point which Penetrates the Stranded Core of the Lead to Gain Contact. Insert Ignition Lead as shown here until it "Bottoms" — Making Certain the Needle in the Coil has Penetrated the Stranded Core of the Lead. Replace Brackets "A" to Insure Position of the Lead — To Achieve Maximum Insulation at this Point, Coat End of the Lead Liberally with DC-4 (a Silicon Product by Dow Chemical Co.) Prior to Inserting the Ignition Lead.

3. Pull spark plug leads "free" of coil as shown here.
4. Turn armature plate over on its top side — detach primary (coil) leads from breaker assemblies.
5. Remove screws 3 — lift coil and hub assembly free of the armature plate.
6. Install new coil in reverse order. Note, machined bosses on the armature plate to assist in locating and properly positioning the coil with respect to clearance required between face of pole shoes and magnet pole pieces cast into flywheel. Set pole shoe (coil) faces flush with machined bosses on armature plate—tighten screws 3 to hold fast in this position. This is IMPORTANT — excessive clearance or gap between pole shoe faces of the coil assembly and magnet pole pieces in the flywheel will lead to a "weak" spark, resultant hard starting and faulty performance.

Care should be exercised with regard to permitting the coil pole shoe faces "hanging" out beyond machined bosses on the armature plate —this, to avoid possibility of pole shoe faces striking against magnet pole pieces in the fly-

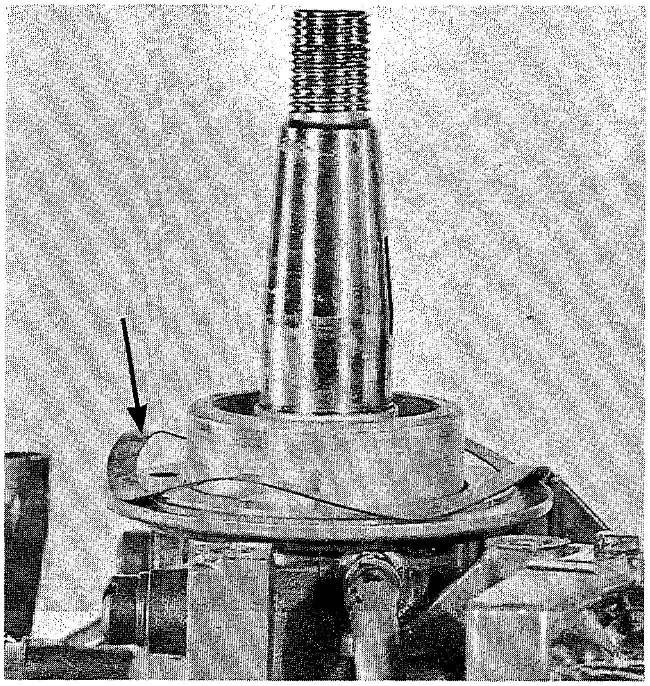


Arrows Indicating Face of Coil Pole Shoe Flush with Machined Boss on Armature Plate Casting.

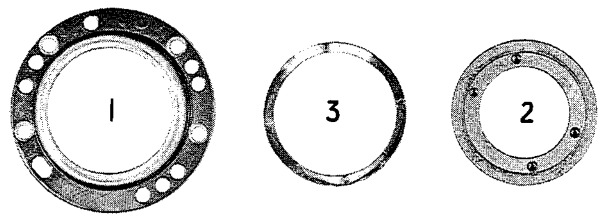


wheel and subsequent damage to trip armature plate assembly and flywheel. Expensive and unnecessary repairs can be avoided by proceeding cautiously at this time.

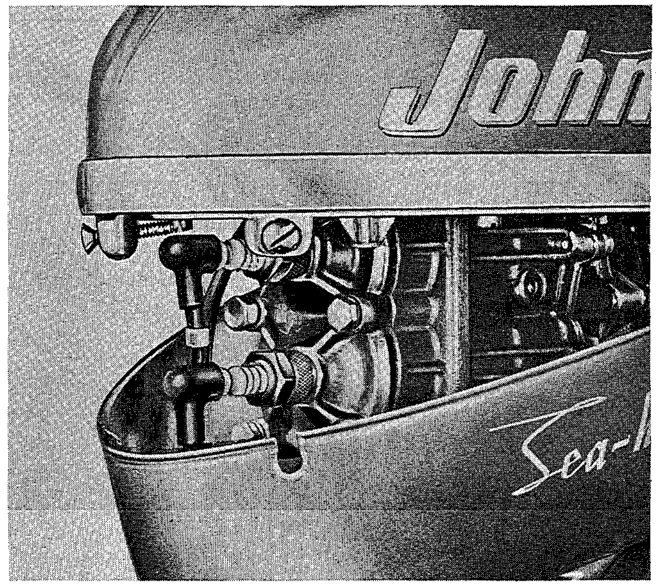
See following instructions for checking the coil on the Stevens Coil Tester. See Magneto Check Chart, page 56-16.



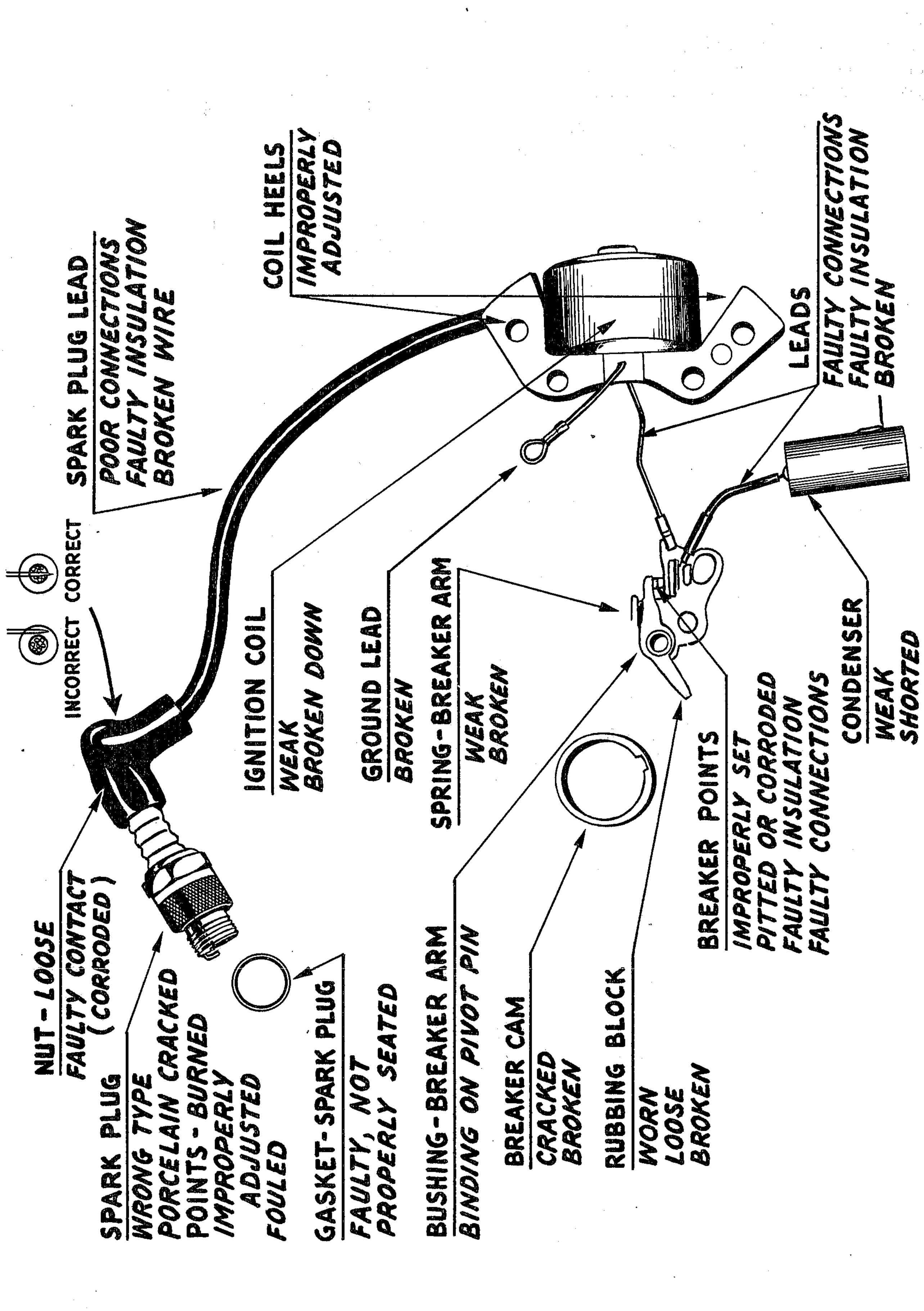
Showing Installation of Spring Washer to Apply Armature Plate Tension. Later Remove where Provisions were made for Remote Control.



Armature Plate Mounting Details — (1) Support, (2) Retaining Ring, (3) Spring Washer.

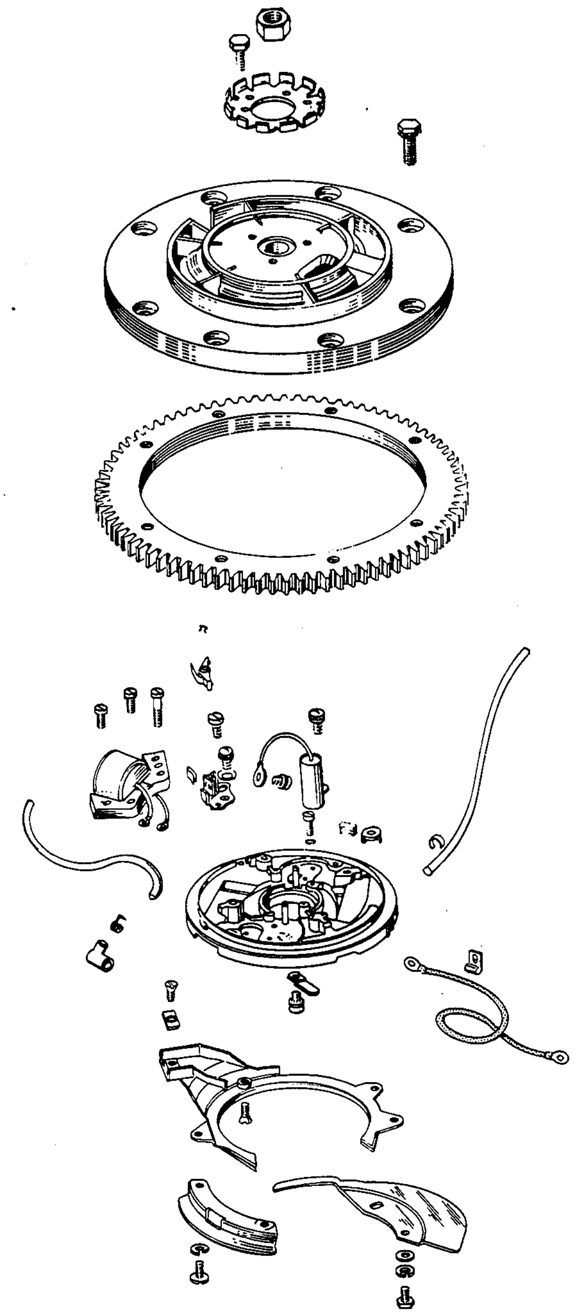


Motor Cover Down to Give Access to the Spark Plugs for Removal and/or Replacement, Showing Spark Cover Installation.



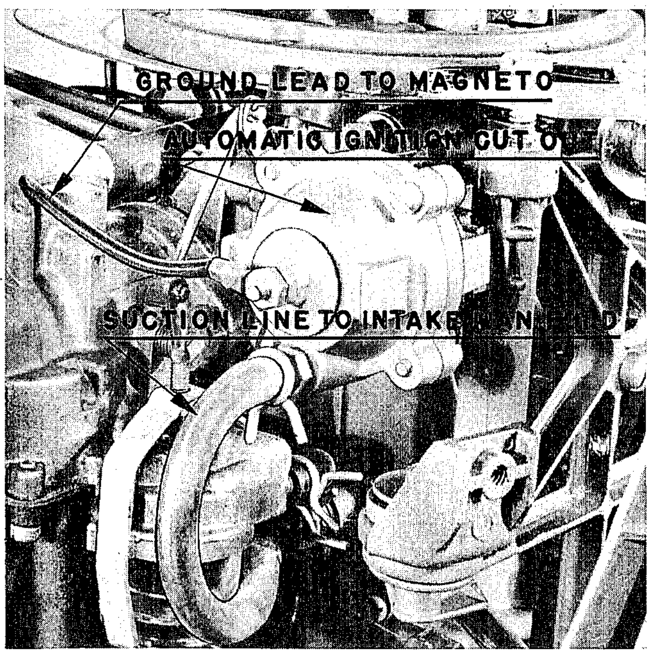
Magneto—Armature Plate Check Chart.

MODEL RDE MAGNETO



Model RDE Magneto Group Layout.

AUTOMATIC IGNITION CUT-OUT— MODELS RD AND RDE



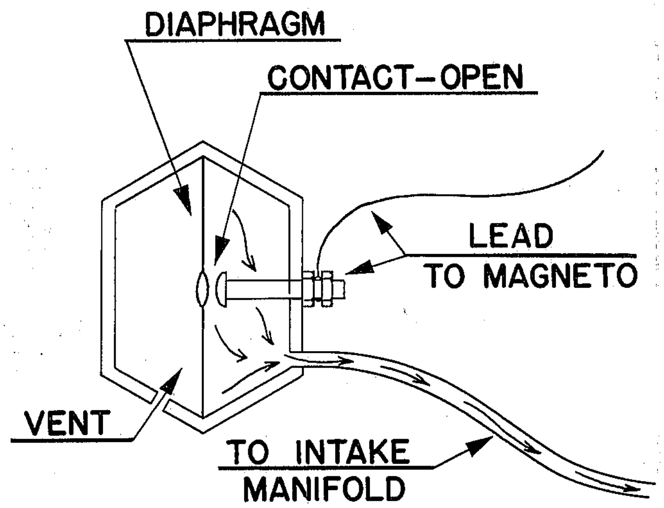
Showing Location of the Automatic Ignition Cut-out.

It will be recalled that in 1951 when the Model RD was in its first year of production, an automatic ignition cut-out attached to the crankcase, piped to the intake manifold and wired to the armature plate, was installed. It was later removed but has since been reinstated in the Model RD and RDE-16.

Construction of the cut-out is of simple design consisting of a housing which includes a spring loaded diaphragm with contact button grounded to the housing and an insulated "contact" with a lead to the insulated side of the lower (cylinder) breaker point assembly to complete the ground circuit when diaphragm contact is established. An outlet leading to the intake manifold is provided to permit manifold pressure (suction) acting on the diaphragm as illustrated and described below.

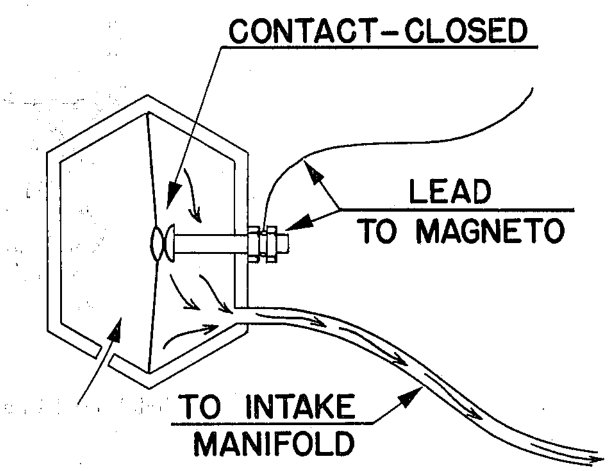
Purpose of the device is to **momentarily** cut out ignition at the bottom spark plug when idling in neutral only, thus limiting maximum speed at which the motor may operate when set for neutral running. It consists of a spring loaded diaphragm encased in a housing "piped" to the intake manifold with a ground contact wired to the breaker point assembly acting on the bottom plug.

Performance is such that when "suction" in the manifold reaches a predetermined point, the diaphragm is caused to flex and overcome tension of a spring acting against it to make ground contact which "cuts" sparking at the bottom plug. Suction in the manifold decreases with resulting drop in motor RPM's — the diaphragm then returns to its normal position to break ground contact and the magneto resumes firing on both plugs — It must be remembered that "grounding" of the bottom plug is but **momentarily** and only when idling in neutral as explained below.



Schematic (sectional) Drawing to Illustrate Position of Diaphragm with Relation to Ground Contact when Operating at Normal Manifold Pressure — Diaphragm Spring Omitted for Purpose of Illustration.

Manifold suction (pressure) is controlled by degree of carburetor throttle opening and speed at which the engine operates; ordinarily high in any reciprocating engine operating at closed throttle and becoming proportionately less with increase of throttle's opening. Otherwise, for the purpose of illustration, it may be said that manifold pressure is but slightly less than atmospheric (approximately 15 pounds per square inch — sea level) with full open throttle and engine running at top RPM— full load. Maximum suction or low pressure occurs when running with closed throttle at fast idle— under no load.

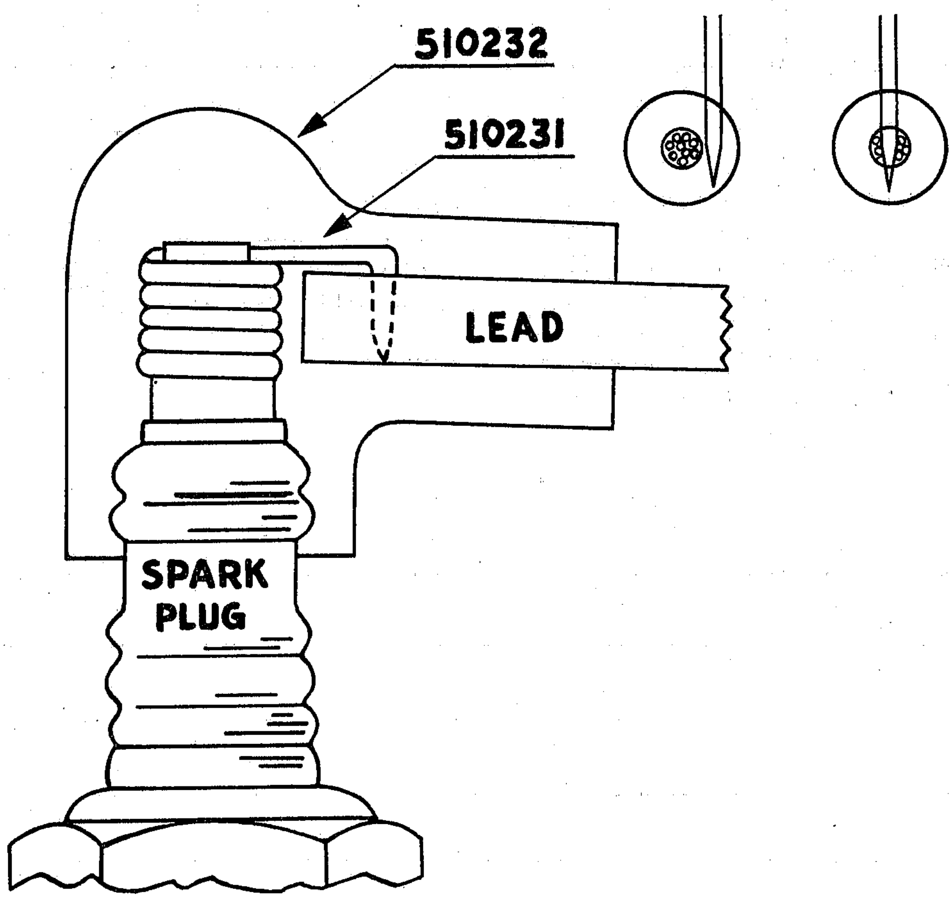


Schematic Drawing to Illustrate Diaphragm Making Ground Contact as Result of Abnormally High Manifold "Suction" on Instant of Rapidly Throttling from High to Slow Idle Speeds when in Neutral—Diaphragm Spring Omitted for Purpose of Illustration.

Conditions under which the cut-out functions to limit maximum idling speed are as follows: If when running at fast idle in neutral (2000 RPM or more), the throttle is suddenly closed, a surge or sudden increase in manifold suction is introduced. Under influence of abnormal manifold suction in this instance, the fuel vapor mixture is not consistently ignited but will tend towards firing erratically (as combustible mixtures form*) to result in irregular but excessively "strong" power impulses to sharply increase motor RPM's even though the throttle is closed — Resultant high motor speed (RPM's) cannot under the circumstances be otherwise reduced or controlled by simply closing the throttle and since no manually operated ground switch is employed, other means are required — thus, the automatic cut-out as described and illustrated above.

*NOTE—A combustible mixture is fundamentally one in which fuel and air are correctly proportioned (mixed) to permit combustion. In event of too much fuel and not enough air, the mixture will fail to ignite (too rich), or, if too much air and too little fuel (lean) the mixture similarly cannot be made to ignite. Thus, at the moment of rapid deceleration, carburetion is temporarily out of control. Resultant fuel mixture (vaporization) becomes momentarily too rich — rich enough to prevent firing but somehow, during idle strokes of the piston, sufficient air enters to form a combustible mixture which accounts for spasmodic or uncontrolled firing.

NOTES



SPARK PLUG COVER INSTALLATION
NO. 510732 (COVER) AND NO. 510231 (CLIP)

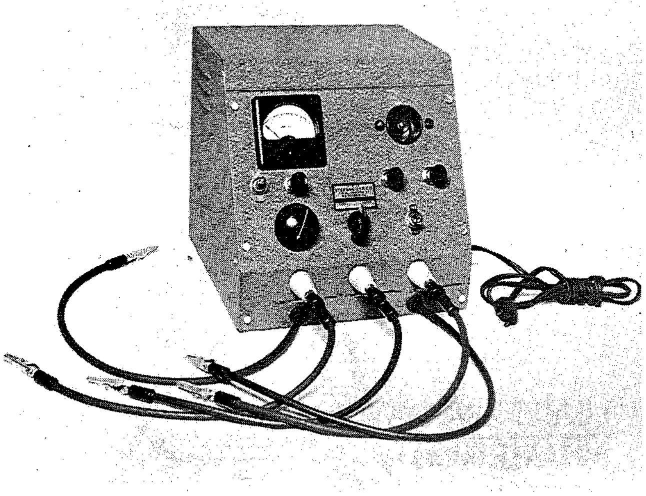
It is possible to encounter ignition difficulty though all familiar details of magneto and spark plugs "fitness" have been checked and found to be in order — often revealed as weak sparking at one of the plugs and resultant uneven running at slow and intermediate speeds or perhaps in starting qualities of the motor.

Wiring naturally becomes a significant matter to be thoroughly gone into in a situation of this sort —check for faulty wiring, loose terminal leads, corroded connections and faulty insulation but beyond this look to assembly of the spark plug cover installation.

As noted in the illustration, the terminal lead (#510231) when properly installed should "pierce" the stranded core (wire) of the spark plug lead. Unless some precaution is taken during assembly, the piercing end may "miss" the stranded core entirely or make but slight contact — the core must be pierced for satisfactory contact.

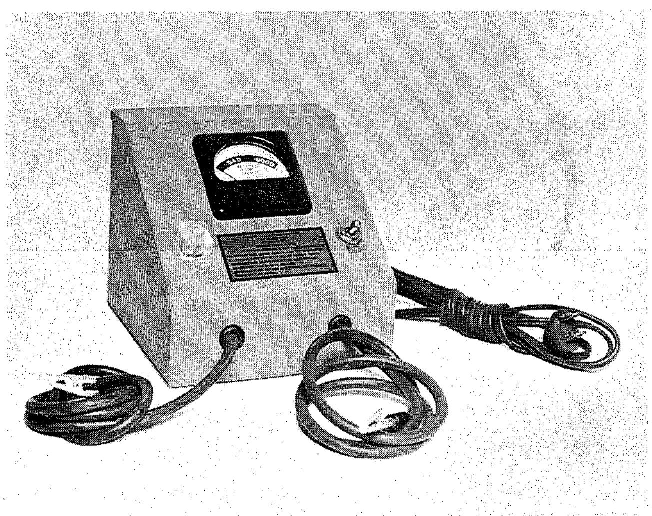
When probing for "fringe" irregularities in the ignition system, make certain the spark plug is properly seated with good gasket and gasket faces. Compression seepage between the spark plug and cylinder head causes irregular performance and alters characteristics of the plug — plug temperatures rise excessively with gasket seepage.

IGNITION SYSTEM TESTING

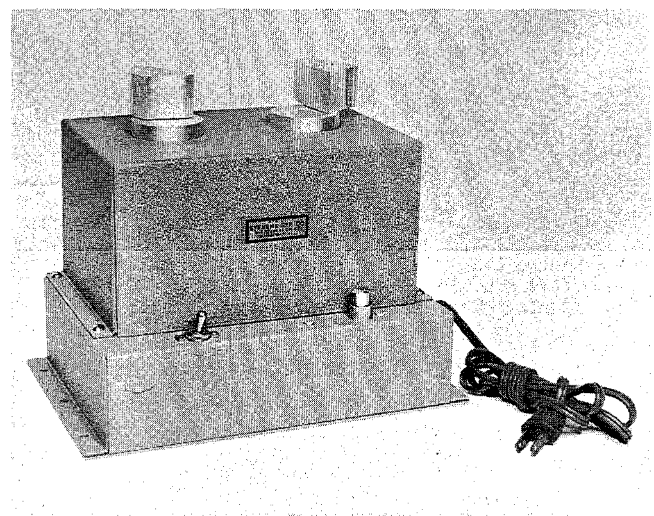


Coil and Condenser Tester.

Power Supply.



Breaker Point Contact Tester

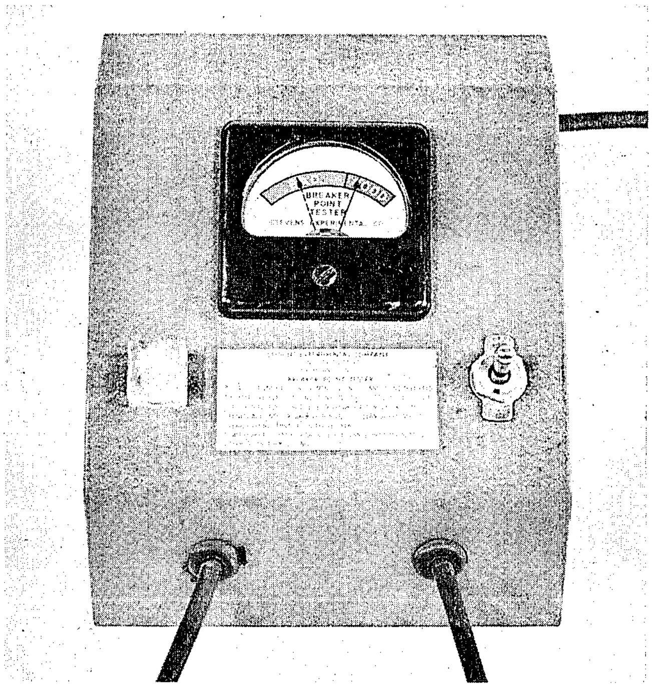


Magnet Charger.

Faulty ignition, exclusive of what difficulty might be experienced with the spark plugs, can ordinarily be attributed to (1) improperly adjusted, pitted or corroded breaker points; (2) a weak or otherwise ineffective condenser; (3) a weak (partially short circuited — secondary winding) or "dead" ignition coil; (4) faulty wiring — insulation broken down to short circuit; loose or corroded terminal connections.

When probing for corrective measures, the simplest details to observe naturally ought to be the first to be investigated — the wiring system (after having checked breaker point gap setting). Be on lookout for loose or defective spark plug connections — broken and/or damaged insulation on spark plug leads. On having removed the flywheel to expose the armature plate assembly, check thoroughly insulation and all terminal connections (ignition coil, primary and condenser leads to breaker point assembly and condenser mounting to insure ground contact). In event a ground (stop) switch wired into the primary system is employed, check for short circuit as result of faulty insulating washers — broken or perhaps oil soaked.

Check Breaker Point Contact—Should inspection of the breaker point surfaces reveal excessive pitting (or corrosion), waste no time — install new points. If otherwise, dress and polish with strip of crocus cloth (or wet and dry paper — grit) folded back to back to permit dressing both point faces simultaneously by moving back and forth gently. When removing the crocus cloth, do not pull it out abruptly but spread points with finger to hold apart while removing; purpose is to prevent points "snapping" together, thereby preventing particles of the "dressing" material (if any) imbedding point surfaces to interfere later on — continue holding points apart. Insert strip of clean paper, work back and forth between point surfaces to remove whatever dressing material might have lodged between the points. Further, point surfaces may be "brushed" off with carbon tetrachloride to assure freedom of scum, lint or other foreign material.

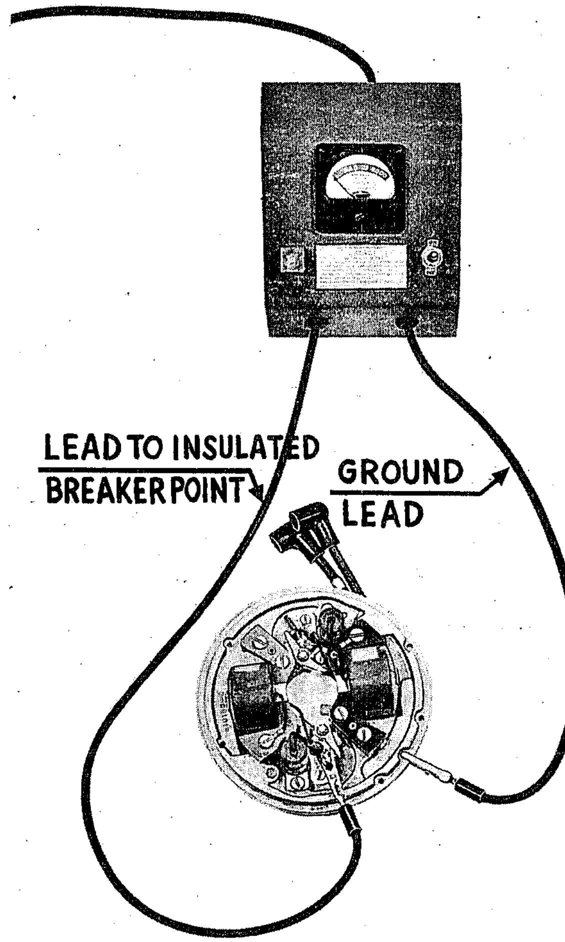


On Magneto Breaker Point Contact Testing—Needle Falling in RED Area Denotes Faulty Contact; in GREEN Area Contact Resistance is within Passable Range.

Since efficiency and intensity of spark is dependent to considerable extent on degree of breaker point contact, a check should be made with an instrument designed for the purpose — designed to measure resistance existing between the "closed" point faces — pitting, corrosion, oxidation, foreign particles, scum, etc., build up resistance to flow of primary current "across" the points to cause faulty spark — hard starting, missing, etc. Point surfaces which may have the appearance of making good contact may not be doing so. Every breaker point installation ought to be checked in this respect to insure the good breaker point action.

To check with the Stevens Contact Tester, attach one terminal of the tester to the armature plate casting (ground) — the other, to the insulated side of the breaker assembly as shown here. "Throw" switch (ON). Note range scale on the instrument panel; "Bad" (red area); "Good" (green area). If contact is good and up to predetermined specifications, needle will come to rest in the green area—if otherwise (poor contact) in the red area.

First application of the test may find needle resting in the **Red** area. Do not in this case presume the points to be faulty but rather look for possible loose or faulty terminal connections — both tester



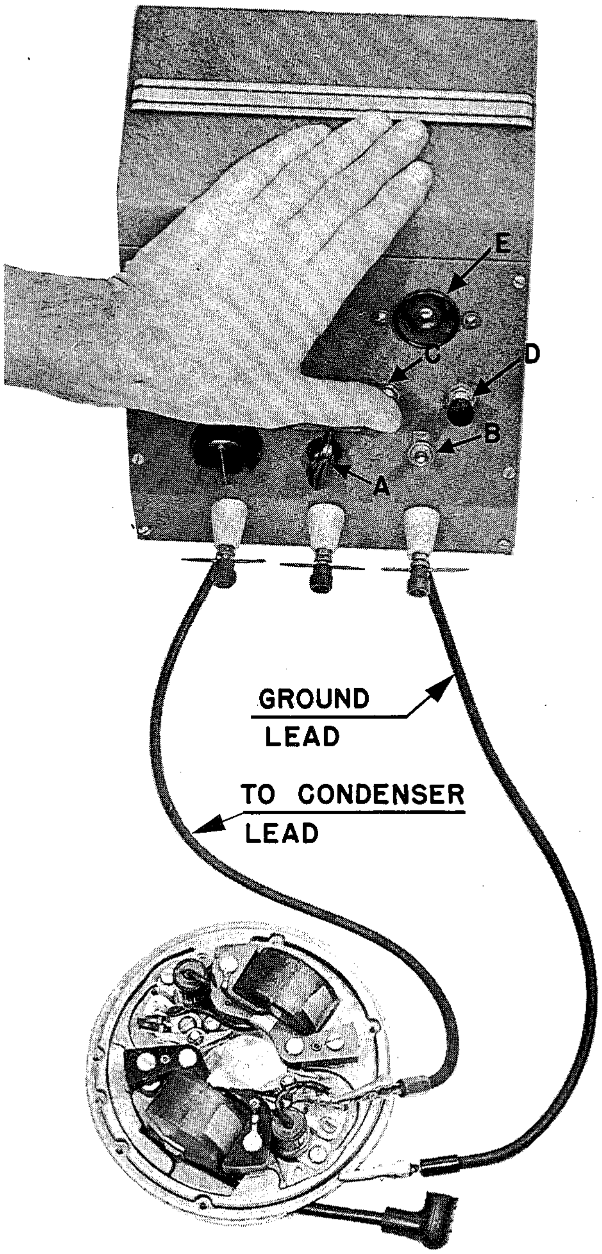
Checking breaker point contact.

and breaker terminals. Investigate point surfaces again for cleanliness — make certain no "bits" dressing material or other foreign particles remain, etc. Repeat test for contact — needle in green area. Install new breaker assembly if necessary.

To Check the Condenser (Stevens testing unit) —Observe first condition of terminal connections, insulation and be certain of good ground contact. Detach the condenser lead. Set selector (A) to position indicated as COND (condenser) on the instrument panel — Throw main switch (B) to position ON. Allow several minutes for the unit to warm up prior actually testing. Attach BLACK (ground) lead to the condenser case or mounting strap and RED (positive) lead to condenser lead terminal.

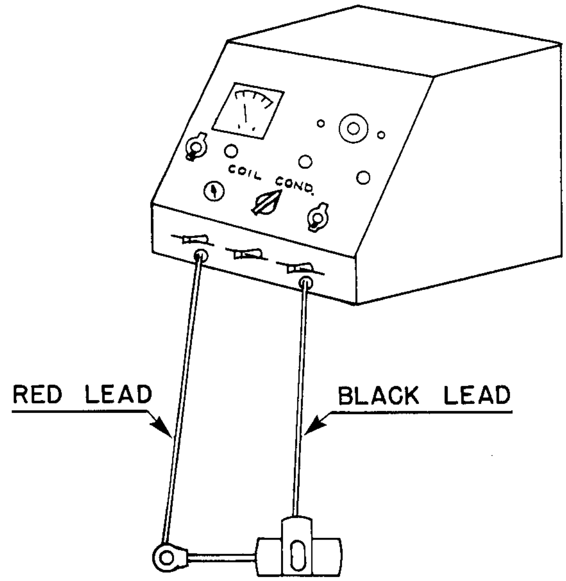
Depress and hold button (C) for at least ten seconds.

Note that but a single "flash" takes place in the neon bulb (E) instantaneously as the button is depressed and held, if the condenser is in good operating condition. Repeated flashes in the tube indicate a partially shorted condenser which should be discarded and replaced. A continual glow in the tube at this time reveals a short circuit — the condenser is unfit for use and should be replaced. Absence of either flash or glow is indication of an open circuit or a "dead" condenser unfit for use.

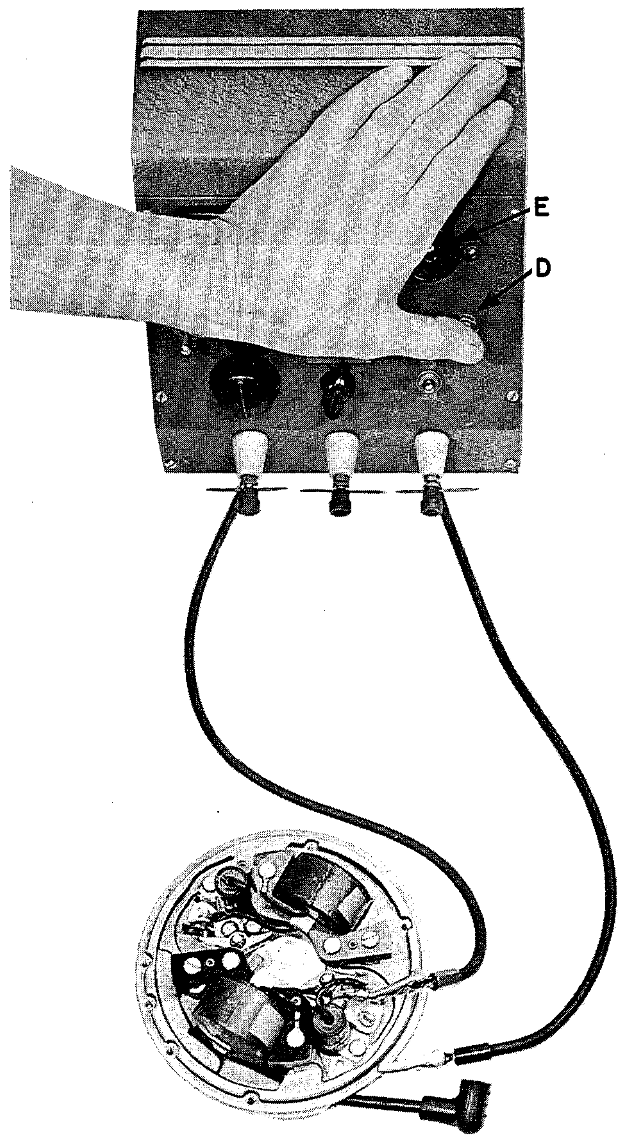


Showing Condenser Wired up for Testing — Charging by Depressing Button "C." The Condenser may be Removed from the Armature Plate and Tested in Like Manner.

Assuming now the condenser is in good condition, having flashed but once at time of charging (when depressing button C), release button C and depress button D to discharge, at which time a distinct flash will be noted in the neon tube.

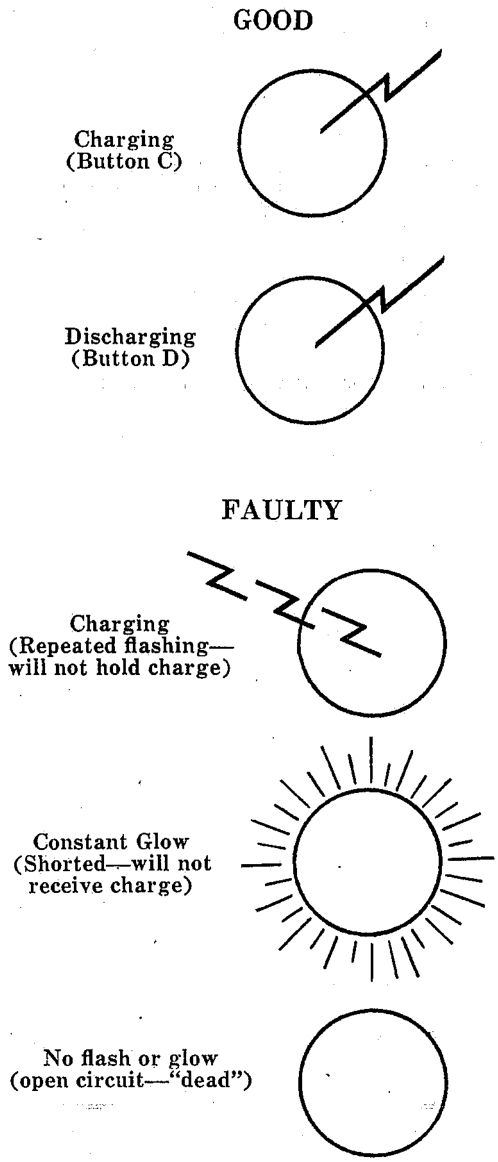


Hook-up for Checking Condensers.

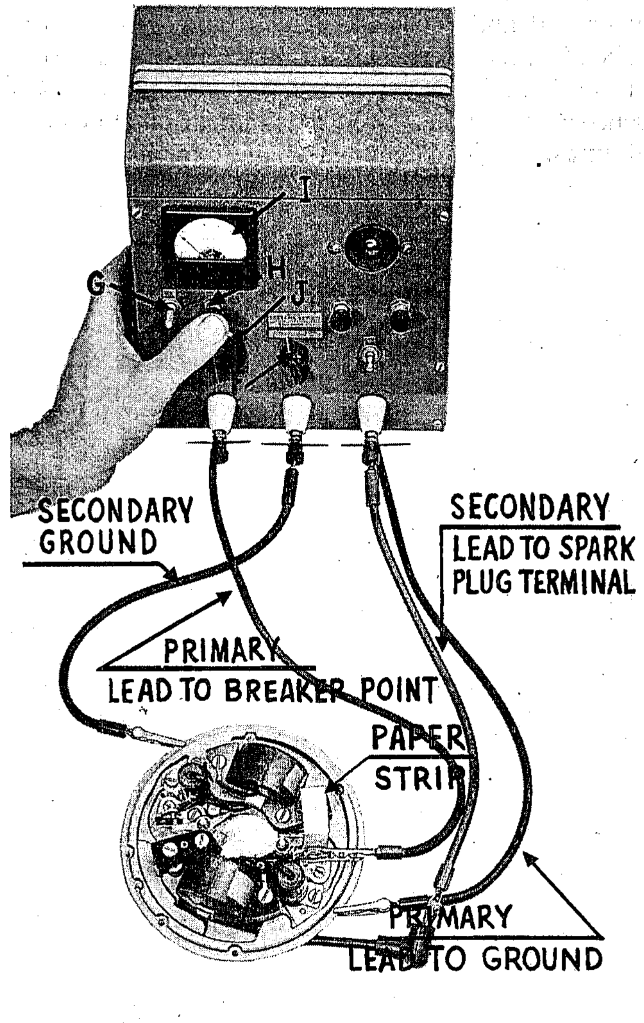


Discharging the Condenser by Depressing Button "D."

Repeated flashing or constant glow in the neon tube at time of depressing button C (charging) reveals a faulty condenser; a single flash on charging (button C) and on discharging (button D) with no intermittent flashing in between (charge and discharge) indicates a good condenser.

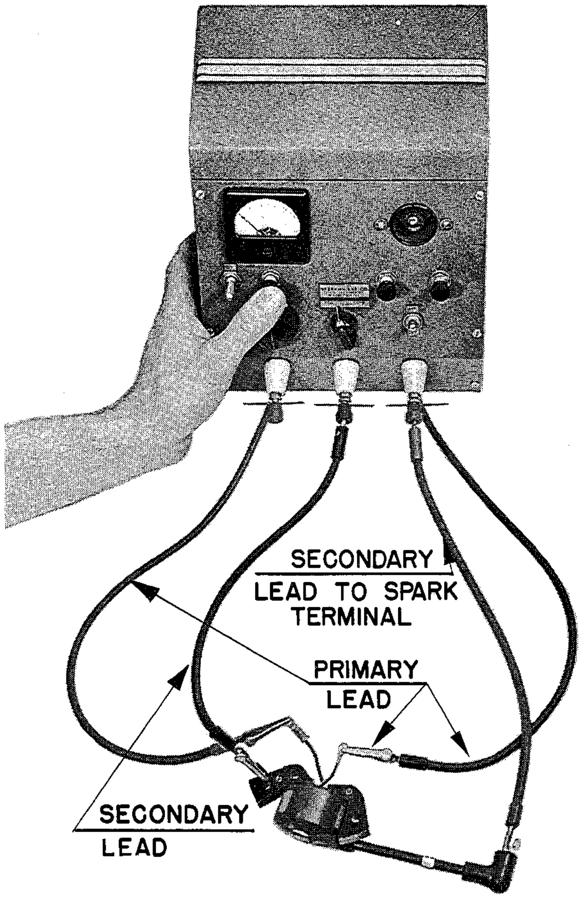


To Test the Ignition Coil—The coils may be tested on the armature plate or as detached, whichever is most convenient at the time. However, in either case, turn selector switch F to position COIL imprinted on the instrument panel. Refer to amperage value (for testing) listed below as designated for the coil to be tested. If amperage range indicated is less than 2, set toggle switch G on panel to position "B"; if range is 2 and over, set toggle to position "A." Adjust breaker gap on instrument to 1/4" (dress needle points periodically with three-cornered file to remove traces of oxide which is resistant to sparking.)

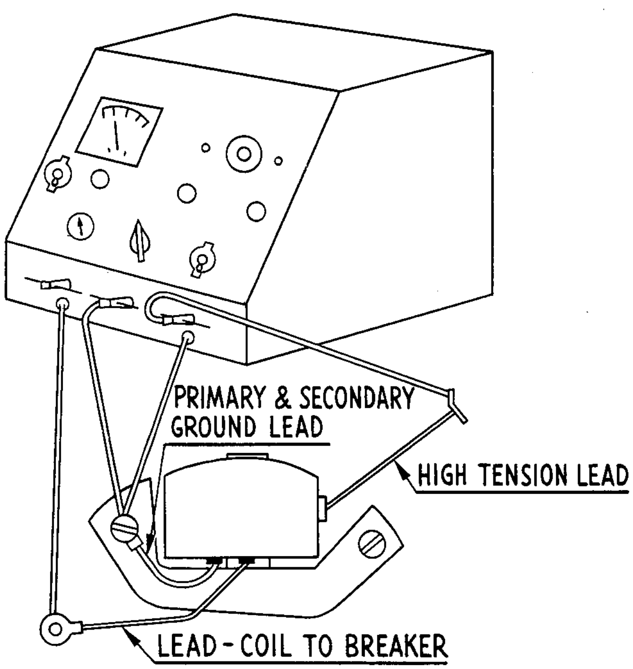


Armature Plate Wired for Testing One of the Two Coils Employed—the Remaining Coil Should be Checked in Like Manner.

Testing with coil attached to the armature plate—(1) Insert paper strip of card thickness to spread breaker points; (2) detach condenser lead (to breaker point bracket); (3) the lower leads on the instrument are PRIMARY—attach Black (ground) lead to the armature plate casting, Red lead to insulated breaker bracket; (4) top row of leads are SECONDARY—attach center (black-ground) to the armature plate casting—attach each of the Red leads to spark plug leads from the coils as shown here; (5) depress button H—note amp-meter reading I—adjust rheostat J knob to ampere reading range specified for the coil on test; (6) a satisfactory coil will yield a strong spark across the 1/4" gap—with a clearly audible "snap" and no indication of "missing" or intermittent hesitancy — should the spark be weak, barely audible and hesitant, the coil is unfit for use and should be discarded. Repeat same operation for testing the remaining coil.



Coil Wired up for Testing as Removed from the Armature Plate.

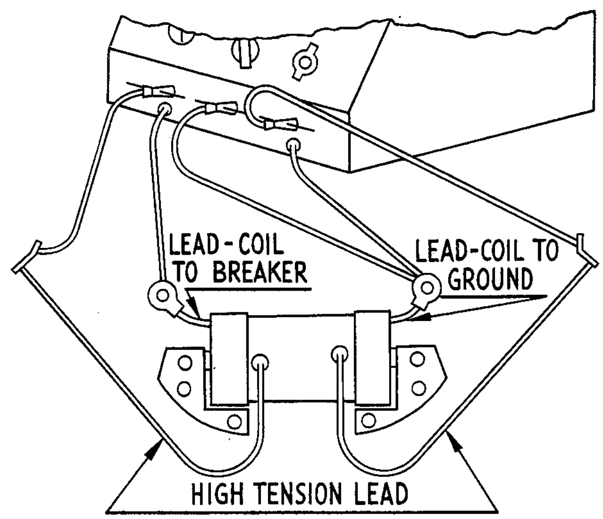


Hook-up for Checking Coils Used on Alternate Firing Engines.

Testing coil removed from the armature plate—

(1) attach primary and secondary (black-ground) leads of the instrument to heel or shoe of coil; (2) attach Red primary lead to primary lead of the coil as shown; (3) attach Red secondary lead from the instrument to secondary or high tension lead from the coil.

A. When testing a twin spark coil (such as employed on opposed twin motors) attach primary and secondary ground (black) leads of the instrument to primary ground lead as shown. Attach both secondary leads (Red) from the instrument to both high tension leads from the coil. Two sparks will appear in this case — one for each side of the coil.



Hook-up for Checking Coils Used on Opposed Firing Engines.

Magnet charging factors affecting spark intensity for maximum efficiency have been given consideration in the foregoing pages — however, magnetic "strength" retained in the magnet (rotor or ring type) should attract attention since it so vitally enters into overall performance of the magneto.

Ring type magnets as installed in the flywheels of earlier production models are constructed of high carbon, hardened steel. The ring type magnet has been replaced by one constructed of Alnico (aluminum, nickel, and cobalt) cast into the magnet rotor or flywheel and provided with laminated pole shoes—See pages 14 and 16. In either case both are magnetically "charged" by being placed across the poles of an electro magnet (charger)— momentarily charged by a "surge" electric current flowing through its windings.

Under certain conditions, magnets are known to lose some of their magnetic strength which affects "sparking" efficiency — though considerably less apt to occur with the Alnico than the ring type (steel) magnet. Magnetic "strength" can be restored when required, by charging on a "Magnet Charger."

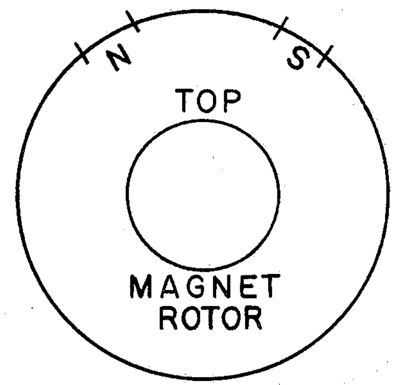
All magnets (permanent, like "charged" hardened steel and Alnico — electro, like the magnet charger depending on an electric current flowing through its windings) have two poles — namely, north and south. Magnetic lines of force flow in the atmosphere around the "poles"—from North (N) to South (S). When charging, the North (N) pole of the magnet to be charged should contact the South (S) pole of the magnet charger; the South (S) pole of the magnet should contact the North (N) pole of the charger, as illustrations below indicate.

When properly charged (polarity), leading pole of the magnet should be South (S) — arrows in illustrations indicate direction of motor rotation.

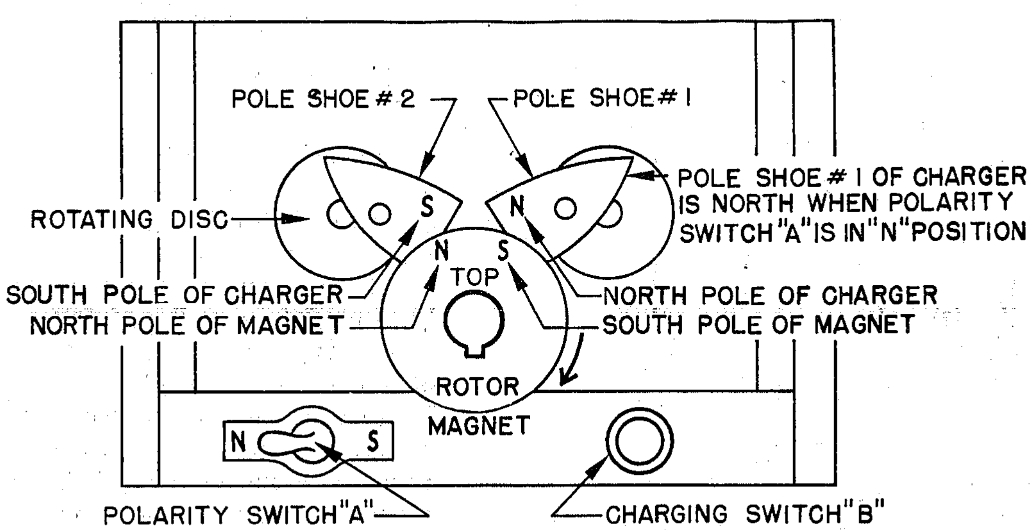
Note curvature on pole shoes of charger (movable pieces) may be adjusted to fit contour of the magnet to be charged. Rotating discs below the pole shoes may be rotated for adjusting by loosening screws in center. Adjust the rotating discs and pole shoes to approximate radius of the magnet to be charged — tighten screws.

Plug charger cord into 110-115 volt, 50-60 cycle, AC current outlet.

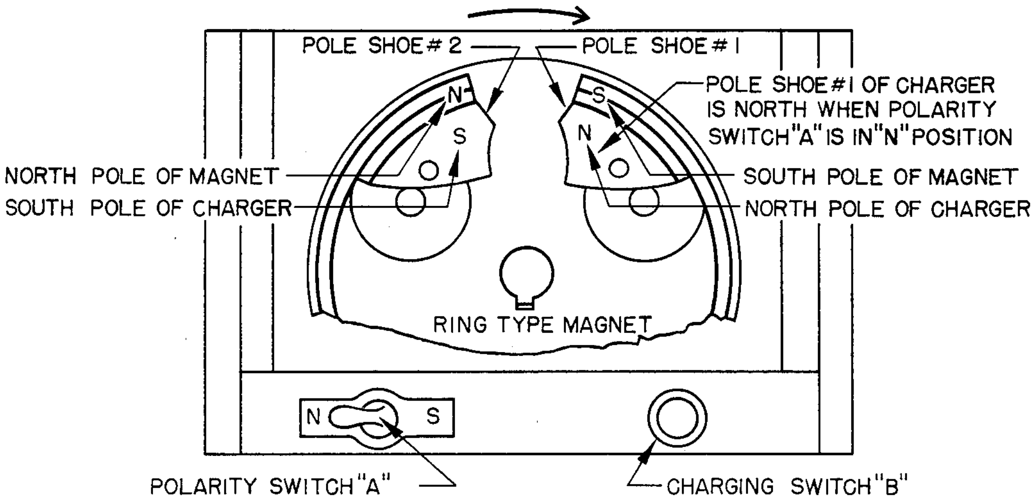
Determine polarity of the magnet to be charged with a compass, if it is not already known. (North seeking pole of the compass points to the south pole of the magnet.)



Note — When testing, precautionary measures should be taken as assurance that line voltage to the instruments is up. If in doubt, your local power company will assist in checking accordingly. Do not, however, "pull" too many instruments, motors, etc., from the same line in the shop. Excessive "drain" in this respect results in line voltage drop to affect efficiency of the testing equipment.

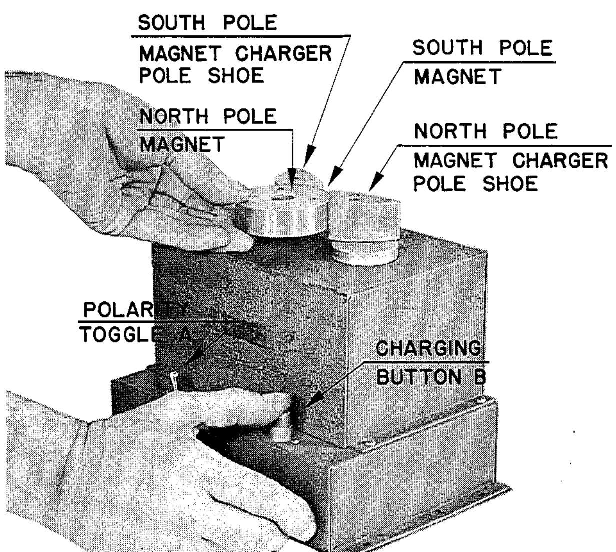


Charging Rotor Type Magnet.

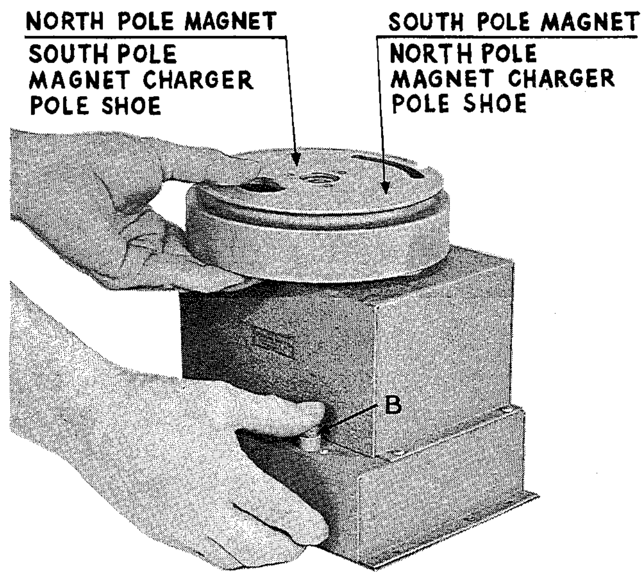


Charging Ring Type Magnet or Flywheel with Alnico Insert.

Shift polarity switch toggle A in position N. Place magnet north pole against pole shoe #2 as in sketch above; south pole of magnet against pole #1. Adjust position of the magnet so that as much of the pole pieces as possible are covered by the pole shoes of the magnet charger. Hold magnet in position while depressing charging switch (button) "B" for not more than **one second.** One second only to safeguard windings of the instrument.



Charging Rotor Type Magnet.



Charging Flywheel with Ring Type Magnet.

Condenser	Capacity
300153	.15 to .205 mfds.
510173	.15 to .205 "
72-702	.27 to .33 "
72-651	.36 to .44 "
72-864	.27 to .33 "
72-873	.20 to .24 "
72-996	.18 to .24 "
72-1036	.18 to .24 "
71-1555	.16 to .20 "

Below are listed revised ignition coil (Johnson) value readings for testing with the Stevens Coil Tester — revised September 15, 1953.

		Amperes			
Part No.	Model	With Heels	Switch	Less Heels	Switch
72-612	Light Single—all models	2.0 - 2.5	A	2.6 - 3.0	A
72-582	Light Twin—1926 and previous	1.1 - 1.6	B	1.5 - 2.0	B
72-110	Light Twin	1.1 - 1.6	B	1.5 - 2.0	B
72-792	Light Twin 1927, 1928, and 1929	1.1 - 1.6	B	1.5 - 2.0	B
72-669	Standard Twin 1927, 1928, and 1929	1.1 - 1.6	B	1.5 - 2.0	B
72-675	Standard Twin 1927, 1928, and 1929 (Canada)	1.1 - 1.6	B	1.5 - 2.0	B
72-641	Big Twin—Giant Twin—all models	1.4 - 1.9	B	2.0 - 2.5	A
72-817	Big Twin—Giant Twin—all models (Canada)	1.4 - 1.9	B	2.0 - 2.5	A
72-808	S-45 - 1929	1.1 - 1.6	B	1.5 - 2.0	B
72-813	V-45 - 1929	1.1 - 1.6	B	1.5 - 2.0	B
72-852	S, V, and P-50 and up—all models	.8 - 1.3	B	1.0 - 1.5	B
72-875	A and K-50 and up—all models	1.2 - 1.7	B	1.5 - 2.0	B
72-1005	300	1.0 - 1.5	B	1.5 - 2.0	B
72-1018	Iron Horse—All models	1.1 - 1.6	B	2.0 - 2.5	A
72-1072	LT, DT, AT-37, and up—all models (NOTE A)	1.0 - 1.4	B	1.3 - 1.7	B
72-1074	MS, MD-38 and up—all models	2.0 - 2.5	A	2.5 - 3.0	A
72-1108	HS, HD, HA-38, 1940—all models (NOTE A)	1.8 - 2.3	A	2.3 - 2.8	A
375102	SD-10, 1940	.8 - 1.2	B	1.0 - 1.3	B
72-947	200 OA	1.1 - 1.6	B	1.5 - 1.9	B
375189	TS, TD, TN-25, HS, HD-20 and 25, MS, MD-20	1.5 - 2.0	B	NOTE *	
580040	QD-10 and QD-11	1.6 - 2.0	B	NOTE *	
580118	HD-26	2.0 - 2.5	B	NOTE *	
580118	TN-26, TN-27, TN-28	2.0 - 2.5	B	NOTE *	
580118	CD-10, 11	2.0 - 2.5	B	NOTE *	
580118	QD-12, QD-13, QD-14, QD-15	2.0 - 2.5	B	NOTE *	
580118	RD-10, RD-11, RD-12, RD-13, RD-14, RD-15	2.0 - 2.5	B	NOTE *	

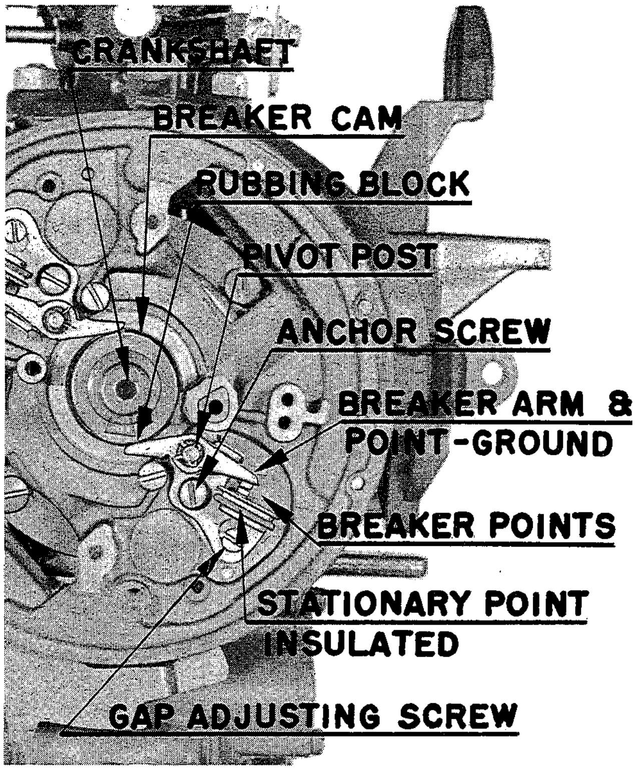
NOTE A—Distributor type magnetos—coil should be tested by grounding first one end of secondary and then the other end alternately.

NOTE *—Coil must be mounted on a laminated core to test. Disconnect condenser from circuit when testing coil on armature plate.

Above readings apply only when using a 1/4-inch spark gap.

Bear in mind when testing that voltage is "up"—in event a storage battery is used, it must be fully charged to gain results. If the Stevens Power Supply unit is employed, line voltage must similarly be up. Periodic check with voltmeter (110 AC) is advisable. Do not operate the Power Unit on an overloaded line — make certain voltage is up when testing. Your local Power Company will be pleased to assist in this respect.

MAGNETO — BREAKER POINT



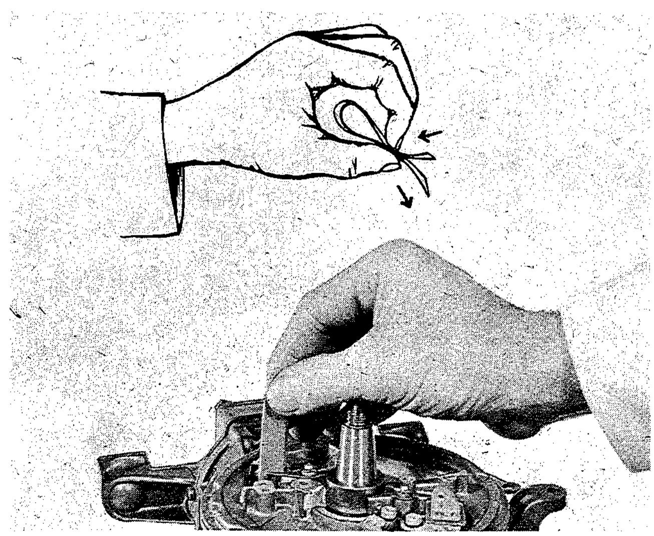
Since efficiency and intensity of spark is dependent to some considerable extent on condition of the breaker point contact surfaces and gap setting, faulty or irregular operation of the motor may often be laid to a deficiency in breaker action. Contact surfaces must be clean, free of pitting and/or corrosion, in alignment and adjusted to the specified .020″ gap with the breaker arm rocking freely on its pivot post to realize the maximum in breaker point performance.

Other factors, of course, enter into the picture of a badly acting magneto, such as a faulty coil, condenser, spark plugs, wiring and particularly "loose" or corroded electrical connections but for the moment consider the breaker point assemblies.

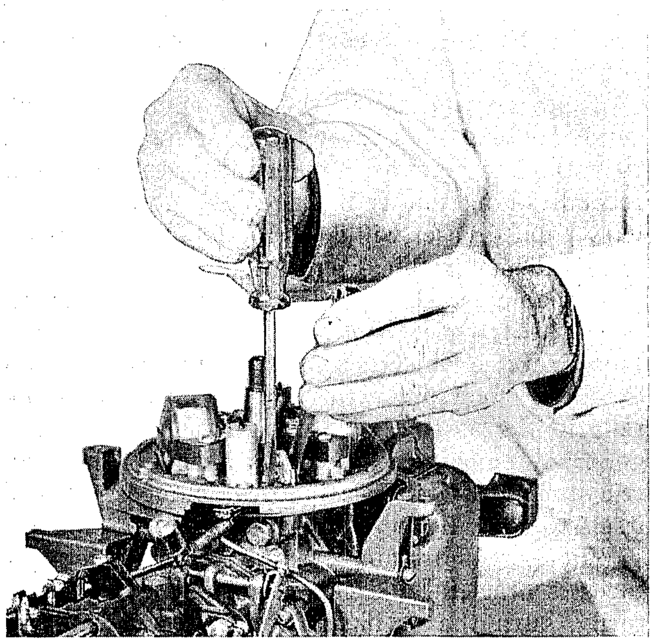
Pitting, discoloration (oxidation) and misadjustment of the gap appear with normal operation of the motor in time and oxidation during periods of inactivity while in storage, etc., to affect starting. Excessive pitting is frequently associated with a faulty condenser, loose or corroded terminal leads at point of attachment, faulty wiring, etc. Abnormal recurrence of breaker gap misadjustment may be attributed to a "rough" or cracked breaker cam surface causing rapid wear of the rubbing block (riveted to the breaker arm) with resultant lessening of the gap to throw spark timing off—that is with relation to "time" of maximum voltage intensity reached in the secondary winding of the coil to cause weak sparking. It is of extreme importance to constantly maintain the specified .020″ gap setting. Install new breaker cam and breaker arm in this event, should condition of the rubbing block reveal too much wear.

Waste no time when there is evidence of excessive pitting—it's economical and more practical to install new point assemblies rather than attempt reconditioning unless in an emergency—an ordinary point dresser will do as a temporary measure of expediency in this event but, when the magneto is available for shop repair, it is advisable to remove the flywheel for a better and more thorough job of service which at the same time provides an excellent opportunity for inspection of other details in the assembly. Tungsten point faces are generally employed, however, in case of the electric starting RD, it's platinum which does not lend itself to reconditioning in the customary manner.

Where reconditioning or resurfacing of the point faces is practical and can be performed satisfactorily, turn the crankshaft (armature plate installed) to position where the points to be worked on close. Spread points with a blunt instrument. Insert strip of crocus cloth or "wet or dry" paper (320 grit) between points—folded to permit dressing both surfaces simultaneously. If using 000 sandpaper, rub cutting faces together slightly as shown to break sharp edges of the grit. Emery and carbide are conductors which require removal of all traces of residue after point dressing. Release points—work dressing paper or crocus cloth strip up and down to resurface. Continue in this manner until surfaces are flat and smooth. Spread points, then withdraw the dresser strip. Do not permit the points to "snap" back against each other, thus avoiding possibility of adhering grit from the dressing material imbedding itself in surface of the points to interfere with establishing proper contact later on.

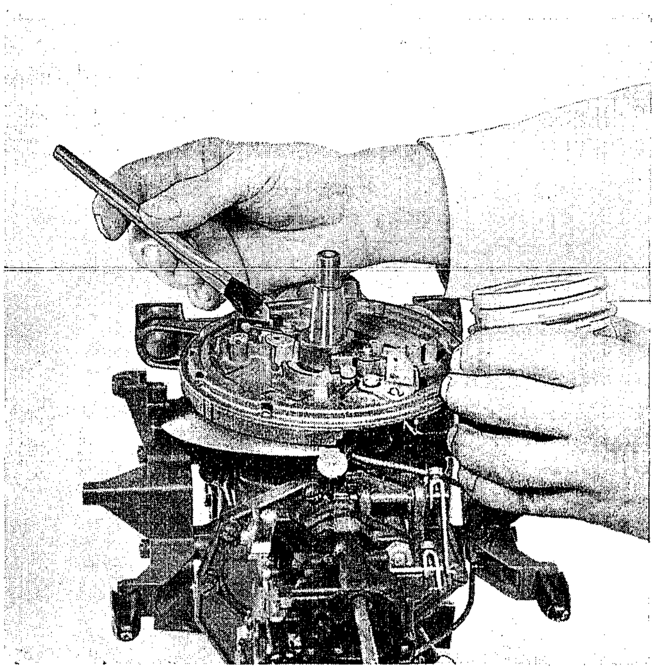


"Dressing" the breaker point faces with crocus cloth or "wet or dry" paper—folded back to back to permit it to accomplish dressing both contact faces simultaneously.



Adjusting breaker point gap to .020".

Draw a clean strip of paper between the points after having released breaker arm tension to remove traces of dressing material or other matter — better still, "swab" contact surfaces with carbon tetrachloride, using a small brush for the application. In either case, do not permit the open points to "snap" closed until assured all traces of dressing material or other foreign matter, lint, etc., have been removed. See page 56-31, pertaining to the checking of contact with the Stevens Contact Tester.



Swabbing breaker point faces with carbon tetrachloride after "dressing" to remove traces of grit, oil or other foreign material detrimental to breaker point efficiency — perform after adjusting gap to assure clean contact faces.

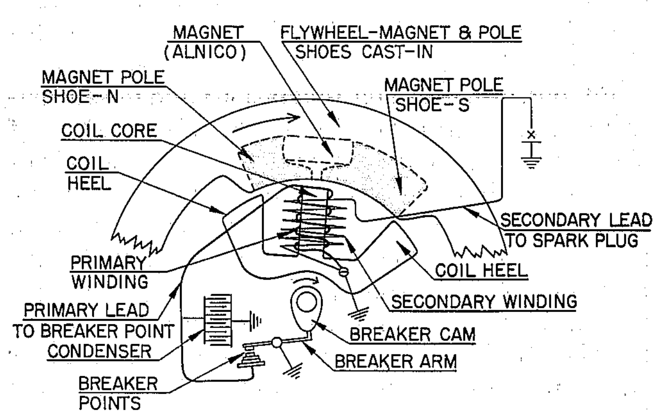
Make certain the breaker cam surface is smooth —roughness acts to wear excessively on the breaker arm rubbing block to rapidly alter gap setting. Cracks in the cam face contribute to like results.

Set breaker points as instructed to .020" gap full open—breaker arm rubbing block "riding" on high side of cam. This is **IMPORTANT** to obtain desired results. After having installed and adjusted new points, run the motor for several minutes (in tank), then recheck gap setting—slight roughness on face of rubbing blocks, perhaps minute burrs, etc., wears down quickly to cause decrease in gap setting until the rubbing surface eventually "smoothens" up. Re-set gap if necessary.

Breaker points and their direct relation to spark efficiency

Fundamentally, the performance of an electric ignition (sparking) system is dependent on current intensity, induced or "built up" first in the primary and subsequently in the secondary windings of the coil during normal functioning of the magneto assembly — revolving flywheel magnet and pole shoe assembly passing by corresponding but stationary pole pieces of the coil to induce primary current and resulting magnetic field.

Due to nature of the magneto's construction and its principle of operation, current generated to cause "sparking" is not maintained at constant level but fluctuates between "points" of high and low voltage. It is readily understood, therefore, that current for maximum "sparking" strength must be "picked up" at the peak of current intensity. The breaker points simply function then as a "trigger" to fire the spark.



Schematic drawing of the magneto layout—showing flywheel magnet installation.

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Greater voltage (pressure) is required to overcome the resistance presented by a ¼″ spark gap under normal atmospheric conditions than a gap of but ⅛″ or, a .030″ gap over one of .010″ under compression (compressed atmosphere) as existing in the combustion chamber at the time of ignition. This fact is responsible for a weak spark firing "outside the cylinder" but failing under compression within the cylinder (combustion chamber).

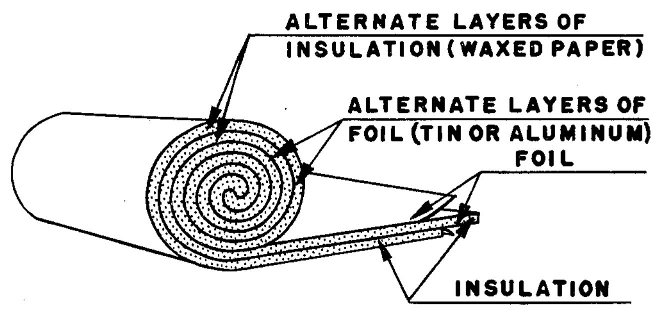
Actually what takes place in the magneto is that with separating or opening of the breaker points, the primary circuit is broken to interrupt flow of current through the primary winding. The attendant magnetic field set up about the coil assembly at this time suddenly collapses to start a current flow of high voltage through the "fine" windings of the secondary coil (induction), which, when conducted to the spark plug terminal, fires across the gap to ignite the compressed fuel charge. Inasmuch as sparking occurs at the instant of breaker point (contact) separation, to gain utmost efficiency of the coil for greatest sparking strength, the magneto points are "timed" to open or "break" at the precise "time" of reaching peak range or maximum current flow through the primary winding. Timing in this respect is predetermined in design but maintained in service by adjusting the breaker gap to .020″ full open for best average setting. Basically, gap setting of greater than the specified .020″ results in proportionately "earlier" breaking or spark occurring on the build-up of current intensity in the primary circuit (prior to reaching its peak) thus, "weaker" sparking; while a gap setting of less than .020″ causes proportionately "later" breaking or spark taking place on the falling side of current intensity (**after** passing its peak)—similarly, "weaker" sparking.

Minor variations in magneto characteristics normally exist during the process of overall production, which occasionally accounts for an individual motor starting more readily with the breaker point gap adjusted to slightly above or below the specified .020″. In this instance there is evidence of variation or tolerance affecting "time" at which current intensity in the primary circuit reaches its maximum.

Beyond adjusting the breaker point gap setting, however, other conditions enter to affect "sparking" efficiency merely as result of normal operation—like "pitting," corrosion or erosion of the breaker point faces. Breaker points "wear out" in time because of constant "pounding" received during ordinary performance. Pitting and erosion, the result of arcing across the points when in normal operation or exaggerated because of deficiencies in the condenser or primary wiring system contribute to faulty spark. The corrosive effect of "salt air" is kindred to breaker point deterioration and performance — platinum faced breaker points, however, are less affected in this manner than those of tungsten. Circulating oil vapor within the magneto assembly is similarly conducive to breaker point deterioration and eventual failure—though considerably more affecting platinum than tungsten.

Breaker point faces ordinarily are finished off extremely smooth but with a slight curvature (contour) to insure good contact and a minimum of arcing when in action—a clean "break" (with just enough arc to assure clean contact surfaces).

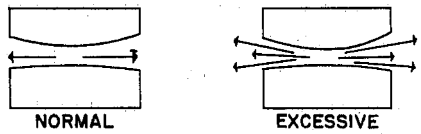
The Condenser—since it is characteristic of the primary current continuing to flow (as result of primary induction) by "jumping" or bridging across the gap created on instant of point breaking some steps must be taken to minimize this tendency towards "arcing" if maximum sparking intensity is to be expected at the spark plug gap — thus, a condenser shunting the breaker point gap.



Schematic Diagram of Condenser

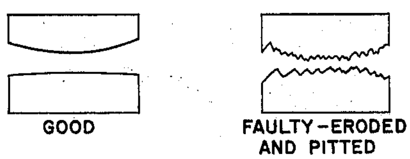
In construction—the condenser consists of alternate layers of a metal foil (tin or aluminum) and waxed paper of proper area specified in design for the particular ignition unit—"rolled" up for compactness. Each layer of foil is then insulated from the other with one side (layer) attached to the insulated (stationary) breaker point by means of a copper wire lead and the other attached to ground.

In operation — fundamentally, function of the condenser is twofold: (1)—to momentarily absorb or "store" induced primary current which otherwise would proceed to "bridge" the gap on instant of point opening and in this respect, avoid contact "arcing"; (2)—when loaded to capacity, the "charge" is suddenly expelled to start a current flowing in the opposite direction, which gives added impetus to the collapsing magnetic field (about the coil at this time) as it affects sparking efficiency at the plug. By this time, however, the breaker gap has been increased or opened (by cam action) beyond ability of current flow to overcome resistance introduced by the wider gap—thereby, avoiding the establishment of an arc or bridge. Surging currents created by action of the condenser in this manner, continue as long as the breaker points remain open but progressively diminish as the induced current characteristically dissipates itself.



Schematic drawings to illustrate normal and excessive breaker point "arcing."

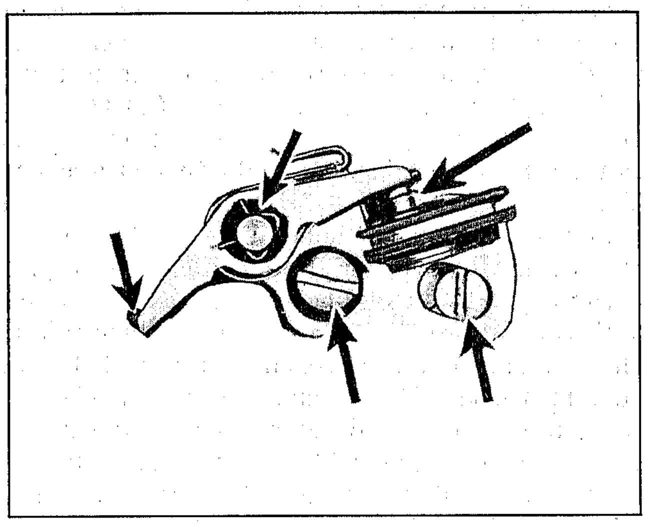
Any interference with condenser capacity, such as "seepage" or short circuiting between the insulated layers of foil, loose or faulty terminal connectors, etc., affects efficiency and as a consequence, results in weak or faulty sparking at the plug. Minor seepage between the foil plates causes a proportionate increase of arcing across the breaker point gap—identified by "flashing." A complete or full "short circuit" across the condenser plates, renders ineffective action of the breaker points—a "dead" ignition system.



Schematic drawings to illustrate good and faulty breaker point faces.

Erosion or pitting of the breaker point faces follows in line with "arcing" to cause faulty spark. Observed "flash" of the arc actually consists of incandescent particles of material vaporized or eroded from the face of the points. This frequently causes a cavity to form on one face and a corresponding pinnacle or dome to build up on the other as result of material transfer during the process from the face of one point to the other.

Maximum sparking intensity at the plug depending on rate or "suddenness" with which the magnetic field (set up about the coil) collapses, demands a "clean" break between the points on instant of separation—absence of excessive arcing. (A minimum or slight amount of arcing is desired to maintain clean active contact area, otherwise oxidized or faulty contact faces retard the "build up" of primary current in the coil to proportionably affect sparking strength.) The introduction of incandescent metal particles to partially bridge the gap because of arcing, causes retarded or gradual interruption of primary current flow and corresponding delay or "laziness" of magnetic field collapse to eventually induce a weak or faulty spark. It can easily be seen then that maximum sparking intensity depends on a condenser in good condition and a "clean" break of contact faces at time of primary current interruption—(breaker action) and of considerable import, clean and "solid" primary terminal connections.



Details of the Breaker Assembly to check when suspecting faulty breaker action.

Oil and other foreign material accumulating on faces of the breaker points contribute to arcing as do "rough" contact faces which similarly affect sparking efficiency. Redressing of the contact faces should be performed only as a temporary measure unless special equipment for "reconditioning" is available. Make no attempt to "redress" contacts of platinum in the ordinary manner.

CARBON SEAL — CRANKSHAFT — TOP END

The carbon seal for the top end of the crankshaft has been changed some in design — this to facilitate a better oil seal at the top face of bearing, the purpose of which is to minimize possibility of oil laden crankcase vapor escaping and eventually accumulating on the breaker point contact faces to interfere with magneto performance.

Above change has consisted of machining a narrow face on the lower side of the seal where it "rides" on the top face of the bearing; the original seal was cut "straight across" to leave a much wider seal face, which doesn't "seal" as well as the narrower face.

IMPORTANT — It is ***important*** that WHENEVER THE FLYWHEEL is removed or on other occasions when presented, the old seal be removed and one of the new design be installed as a safeguard against "oily" points and resultant faulty motor operation. Install with notches UP. Install also a NEW corresponding "O" ring.

The same seal, incidentally, is used on the bottom end of the crankshaft, too.

NOTES

SPARK PLUG RECOMMENDATIONS FOR ALL JOHNSON SERVICE MODELS

Model Motor	Factory Installed Champion	Factory Installed Auto Lite	Alternate Auto Lite	Alternate AC
J-80	#J8J		A7X	45M
J-25, 65, 70, 75	#5MJ		B3X	84M
A & A-25 to A-45	#5MJ		B3X	84M
A-50, 65, 70, 75, 80, AA-37	#5MJ		B3X	84M
OA-55, 60, 65	#5MJ		B3X	84M
OK-55, 60, 75	#R7			82M
F-70, 75	#5MJ		B3X	84M
K-35, 40, 45	#R7			82M
K-50, 65, 70, 75, 80, KA-37 KA-38, 39 & 10, Ks & KD-15	#5MJ		B3X	84M
P-30	#5MJ		B3X	84M
P-35, 40, 45, 50, 65, 70, 75, 80 PO-37, 38, 39, PO-10 & 15	#R7			82M
TR-40 (Giant)	#R7			82M
S-45, 65, 70	#R7			82M
V-45, 65, 70	#R7			82M
LS-37, 38, DS-37, 38	#J8J		A7X	45M
LT-37, 38, 39, 10, AT-39, 10 DT-37, 38, 39, 10	#J8J		A7X	45M
MS & MD-38, 39, 15	#J8J		A7X	45M
MS & MD-20	#J6J		A3X	44M
HS-39, 10, 15, HA-39, 10, 15 HD-39, 10, 15	#J8J		A7X	45M
HS & HD-20, 25, 26	#J6J		A3X	44M
TS & TD-15, 20	#J6J		A3X	44M
100, 110	#J8J		A7X	45M
200, 210	#5MJ		B3X	84M
300	#J8J		A7X	45M
SD-10, 15, 20	#5MJ		B3X	84M
QD-10, 11, 12, 13, 14, 14-A, 15, 16	#J6J	A3X		44M
TN-25, 26, 27, 28	#J6J		A3X	44M
RD-10, 11, 12, 13, 14, 15, 15-A, 16 16-A, 17	#J6J	A3X		44M
JW-10 & 11	#J6J	A3X		44M
CD-10, 11, 12	#J6J	A3X		44M
RDE-16, 16-A, 17	#J6J	A3X		44M

CARBURETION

Section II

CARBURETION

NOTES

THE CARBURETOR

THE TWO STROKE CYCLE

The two (stroke) cycle engine, such as used in all Johnson Outboard Motors, differs somewhat from the four (stroke) cycle engine used in the automobile, this difference being due to the method of conducting gases to and from the cylinder while in operation. The two (stroke) cycle engine employs an arrangement of ports rather than mechanically operated valves to accomplish this purpose, as shown in the following illustrations.

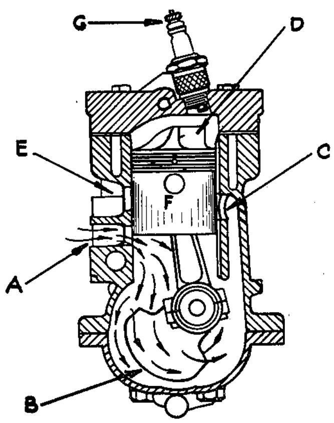


Illustration No. 1

On the first upward stroke of the piston, a partial vacuum or low pressure is created in the crankcase. As the piston progresses in its upward movement and nears the end of the stroke, intake port "A" is uncovered causing fuel vapor from the carburetor to flow into the crankcase—"B." The crankcase is now fully charged. (Three-port type.) (Illustration No. 1).

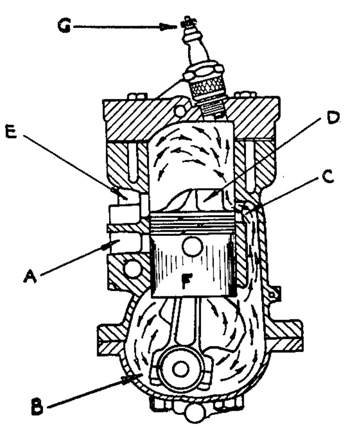


Illustration No. 2

The piston on reaching the end of the stroke reverses its direction and begins a downward movement—covering or closing intake port "A." On its continued downward movement, the vapor charge in the crankcase is compressed until the piston nears the end of the stroke, when the by-pass port "C" is uncovered. This instantly releases the compressed crankcase charge, which flows through the by-pass and into cylinder "D"—being directed upward by the piston deflector provided for this purpose. (Illustration No. 2).

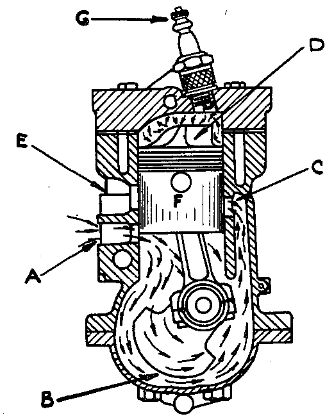


Illustration No. 3

On the following upward stroke, the vapor now having been transferred to the cylinder, is compressed and prepared for ignition. However, during this period a second charge has been drawn into the crankcase through intake port "A." There are now two charges—one compressed in cylinder "D" and the charge in the crankcase. (Illustration No. 3).

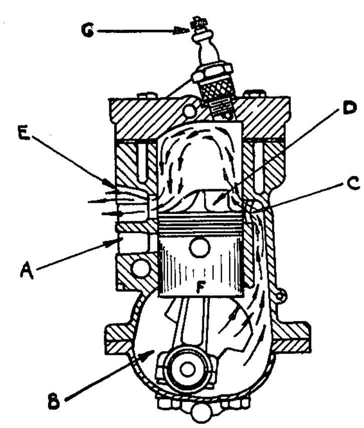


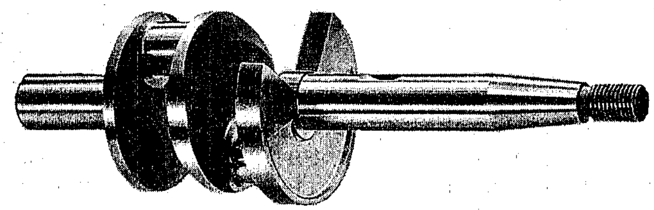
Illustration No. 4

At the end of the compression stroke, a spark, created by the magneto, jumps the gap between the points of spark plug "G"—igniting the compressed fuel vapor in cylinder "D." The vapor in burning expands rapidly, forces piston "F" downward to deliver power required to turn the propeller. Power, however, is not delivered throughout the entire length of the stroke, some time is required to rid the cylinder of burned gases and to receive a fresh charge from the crankcase for the succeeding power impulse. (Illustration No. 4).

As the piston travels downward on its power stroke, the fresh charge previously drawn into the crankcase is being compressed. (Illustration No. 2).

Notice width of exhaust port "E" and by-pass port "C"—"E" is considerably wider than "C," therefore, piston "F" on nearing the end of its stroke uncovers the exhaust port somewhat earlier than it uncovers the by-pass port.

A comparatively high pressure exists within the cylinder at this time, consequently, at partial uncovering of exhaust port "E", the burned gases commence to flow out through the exhaust port. Further travel of the piston uncovers by-pass port "C." The compressed vapor charge now in the crankcase is instantly released, flowing through the by-pass port into the cylinder and directed upward by the deflector. The incoming fresh charge continues to force the burned gases out of the cylinder through the exhaust port and into the atmosphere to complete the cycle.



Crankshaft Construction of Model PO

Models P, PO & SD operate on the same general principle, but the method of inducting the crankcase charge is somewhat different. The intake port, instead of being built into the cylinder wall is built into the crankcase and governed by a similar port or opening machined into the circular throw of this crankshaft. This arrangement is known as the rotary valve.

UPWARD STROKE		DOWNWARD STROKE
Compression	Takes Place ← in → Cylinder	Power Exhaust Intake from Crankcase
Admission of Fuel Vapor	Takes Place ← in → Crankcase	Compression of Fuel Vapor Fuel Vapor Discharge into Cylinder

NOTES

LUBRICATION

POWERHEAD—FUEL MIXTURE

Since fuel vapors are first compressed in the crankcase of the engine, the most practical method of lubrication is by mixing the lubricating oil with the gasoline. Lubrication is obtained as the mixture of oil and gasoline enters the crankcase and is later transferred to the cylinders. Oil being less volatile than gasoline, a larger portion of the fuel-oil mixture remains in the crankcase to lubricate the bearings and other moving parts. The remainder enters the cylinder with the pre-compressed charge to aid in the lubrication of piston and piston rings.

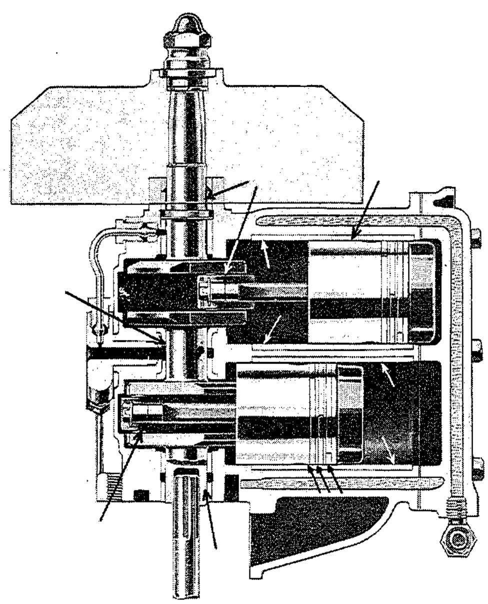
It is extremely important that the oil, in the amounts specified, be thoroughly mixed with the gasoline to insure efficient operation of the motor.

To properly mix the oil and gasoline, they should be mixed in a separate container. Never, except in an emergency, attempt to mix oil and gasoline in the motor tank. It cannot be thoroughly mixed. Should the motor be started under such circumstances, it will operate for a short period on an intensely rich oil mixture, smoking profusely until the poorly mixed fuel is consumed. It will then continue to operate almost entirely on gasoline, with little or no lubrication; overheating, seizure and pre-mature wear are the ultimate results.

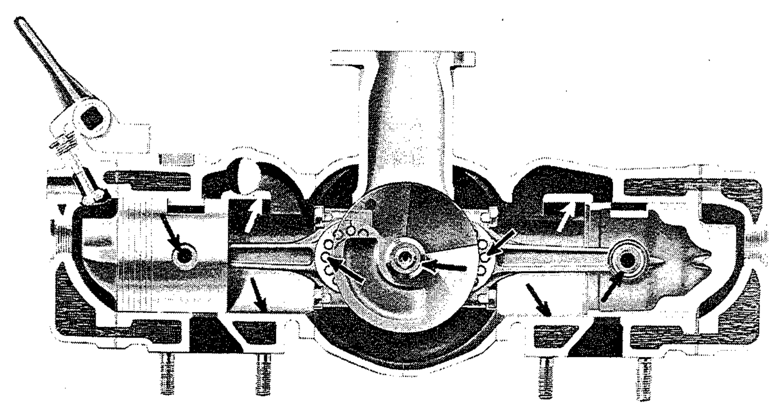
Avoid expensive repairs—take advantage of the qualities built into this motor by thoroughly mixing the oil and gasoline.

(Note: The compression ratio is not high enough to warrant the use of gasoline containing ethyl lead (colored) to overcome certain combustion characteristics, common to high compression, high speed engines; however, since most gasolines now on the market contain ethyl lead in various quantities, it can be used, however, it is advisable to adhere to a gasoline with minimum of lead content. Lead content in excess of 1 cc. per gallon may result in spark plug difficulty.

Due to atmospheric conditions and temperature changes, moisture condensation is more or less continually taking place within the gas tank. This results in water droplets accumulating in the tank, gas line and carburetor which, if excessive, are sufficient to interfere with performance of the motor, causing it to act, in many instances, as though it were starving for gasoline. (Water will not pass through the fine screens and small carburetor jets.) Be sure the fuel system is free of moisture—likewise, all fuel should be run through a fine screen before pouring into gas tank. A funnel with screen installed serves this purpose nicely.



Alternate Firing



Opposed Firing

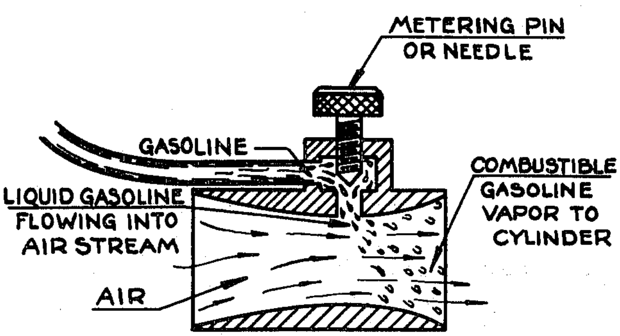
Arrows Indicate Surfaces (Bearings, Cylinder Wall, etc.) Lubricated by Oil Mixed with the Gasoline.

CARBURETION

All gasoline operated engines are of the internal combustion type—that is, the fuel mixture is ignited and burned within the cylinder to result in expansion of the burning charge, thus creating comparatively high pressure which is applied to the head of the piston to force it downward, delivering the power impulse.

The fuel (gasoline and air) must be prepared or mixed for combustion (vaporized) however, by an outside device — the operation being accomplished by a simple mixing valve or carburetor. Air and gasoline must be mixed in certain proportions to provide a combustible vapor — roughly, 1 part gasoline to 8-11 parts of air. Too much or too little of either (gasoline-air) affects combustible quality of the vaporized fuel, likewise performance of the engine. An arrangement is thus required to meter the amount of gasoline flowing into a stream of air created by suction in the cylinder of the engine, as the piston progresses on its downward stroke in a 4 stroke cycle engine. The operation is carried on in a somewhat different manner, however, in a 2 stroke cycle engine (outboard motor) in that suction is created in the crankcase on the **upward** stroke of the piston. **Air must be in motion to vaporize the gasoline**—(gasoline-oil mixture used in the outboard motor).

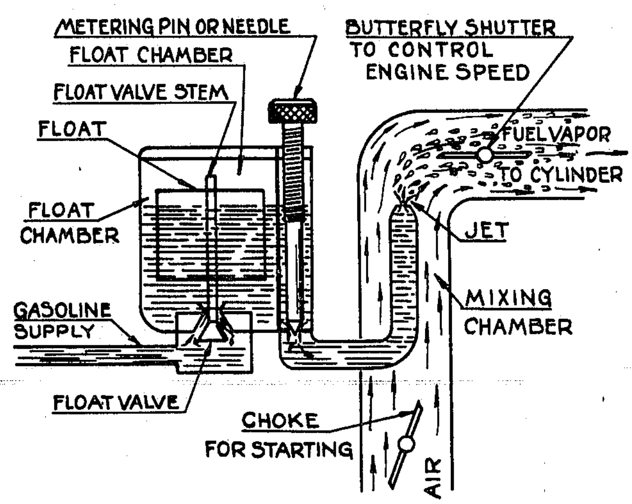
The simple mixing valve consists of an air tube (venturi) to which is attached a metering pin—the pin being threaded to permit variations in metering the flow of gasoline into the air stream.



Schematic Diagram of Simple Mixing Valve

It can readily be seen from the above illustration that the more the metering needle is unscrewed, the more will be the amount of liquid gasoline flowing into the air stream to be vaporized. The vapor thus becomes "rich" in gasoline—if excessively rich, partial combustion results (in the cylinder) due to insufficiency of air to produce sluggish operation of the engine. On the other hand, the more the metering needle is turned down, the less will be the amount of liquid gasoline flowing into the air stream. The vapor then becomes "lean" in gasoline to result in a slow burning fuel charge, evidenced by loss of power and faulty operation of the engine.

The mixing valve is the simplest form of carburetion for practical purposes though while suitable under certain conditions, it is not well adapted to variable speed engines as in the case of an outboard motor. Some arrangements must be made to maintain constant fuel level in proportion to the speed at which the engine is running to realize proper fuel-air ratio at the various speeds once the metering needle is correctly set. This is accomplished by the addition of a float chamber.



Schematic Diagram of Simple Float Feed Carburetor—One Needle to Adjust or Meter Flow of Liquid Gasoline into the Air Stream to be Vaporized

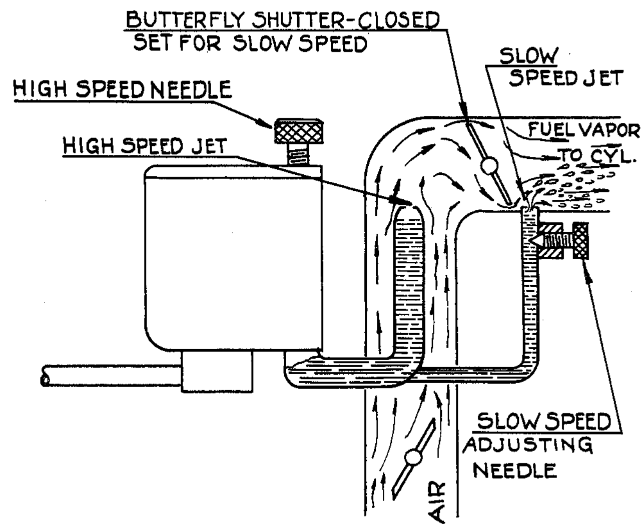
The float chamber or float bowl as it is sometimes called consists of a bowl or cavity large enough to contain a float, usually of cork or a hollow cylinder constructed of thin brass sheet, closed at both ends to permit it to float in a liquid (gasoline, in case of the carburetor). The purpose of the float is to maintain a predetermined level of gasoline in the carburetor by operating a valve (float valve) in the float chamber. Where a cork float is used (as in Johnson carburetors), operation of the float valve is by direct connection as shown in above illustration, otherwise, through an arrangement of levers in conjunction with the hollow metal float.

Naturally, with no gasoline in the float bowl, the float comes to rest at the bottom of the bowl, thus opens the float valve to permit the flow of gasoline. As gasoline flows into the bowl, the float rises to gradually minimize the flow of gasoline by subsequently closing the float valve until a point where maximum level is reached when the float valve closes entirely to close off the flow of gasoline. As gasoline is consumed by operation of the engine, the float settles to permit additional flow of gasoline into the float chamber—this in proportion to the rate of consumption by the running engine. The faster the engine runs, the greater is the fuel consumption, consequently, the float settles deeper in the bowl to proportionately increase the flow of gasoline by greater opening of the float valve. As engine speed is decreased, fuel consumption is lessened and the float rises to decrease the flow of gasoline in proportion to the rate of consumption by the slower running engine. When the engine is stopped, fuel consumption is nil—the float rises to maximum level and closes the float valve to stop flow of gasoline.

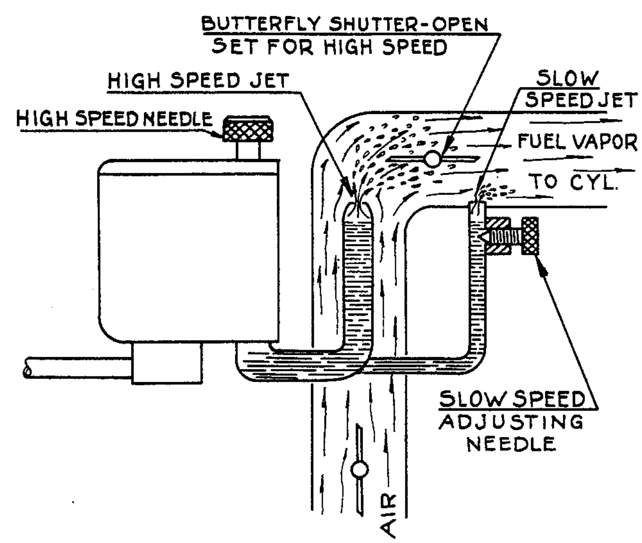
To obtain variable speed performance from any gasoline operated engine, some means must be provided to control the charge (gasoline vapor) admitted into the cylinder. The larger (heavier) the charge, so to speak, the faster the engine runs, conversely, the lesser the charge, the slower the engine runs. Spark timing naturally must be considered at this point since degree of advance is in relation to the fuel charge and engine speed. Engine speed, as far as the carburetor is concerned, is controlled by a damper or shutter, commonly known as the butterfly valve, built into the mixing chamber in such a manner that it can be manually opened or closed at will to increase or decrease speed as desired. See illustration. Full open shutter (butterfly) permits maximum vapor charge being drawn into the cylinder, thus maximum engine power for top speed performance. Various degrees of opening of the butterfly-shutter result in various engine speeds since the degree of opening governs charge to the cylinder.

Since a comparatively rich fuel mixture is required for starting a cold engine, a second shutter (choke) is built into the mixing chamber (forward of the gasoline jet) to restrict the flow of air through the mixing chamber, thus creating high suction at the jet to cause proportionately more liquid gasoline to flow into the air stream as required only for starting. On starting of the engine, the choke is gradually opened as engine temperature rises until open position is reached for normal operation—engine running on proper ratio of gasoline and air for maximum efficient performance.

To obtain greater flexibility of the engine (speed) a second jet is inserted into the mixing chamber (air stream) to provide more efficient carburetion at slow and intermediate speeds. This jet is usually placed slightly forward of closing position of the butterfly shutter and arranged to function at near closed position of the butterfly when air velocity over the high speed jet is not sufficient to properly vaporize the gasoline. See illustration.



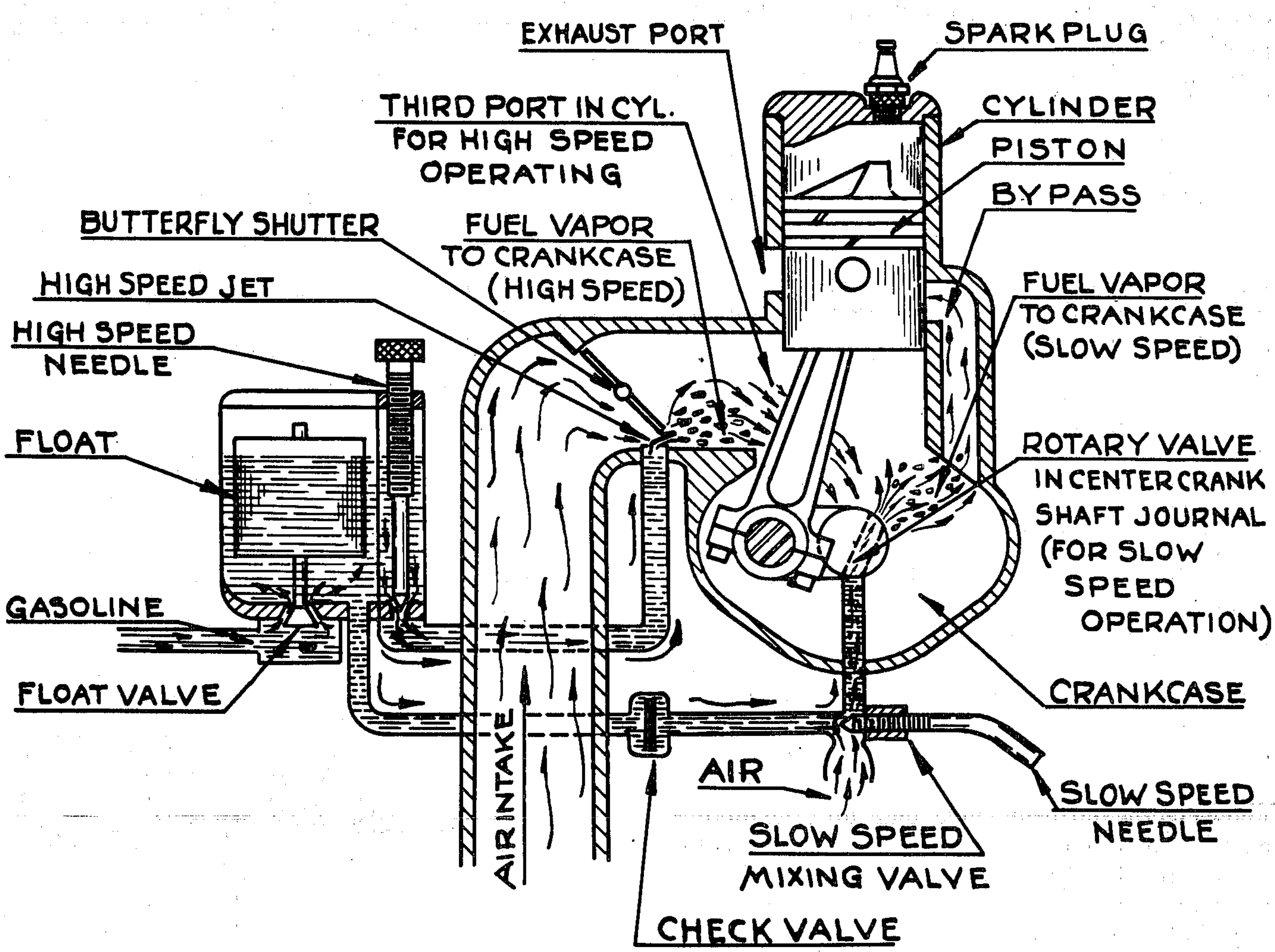
Schematic Diagram of Two-Jet Carburetor, Showing Butterfly Set for Slow Speed Operation and Fuel Being Vaporized at the Slow Speed Jet—Note High Speed Jet is Inactive



Schematic Diagram of Two-Jet Carburetor, Showing Butterfly Set Full Open for Top Speed Performance and Maximum Vaporization at High Speed Jet with a Minimum of Vaporization Taking Place at the Slow Speed Jet

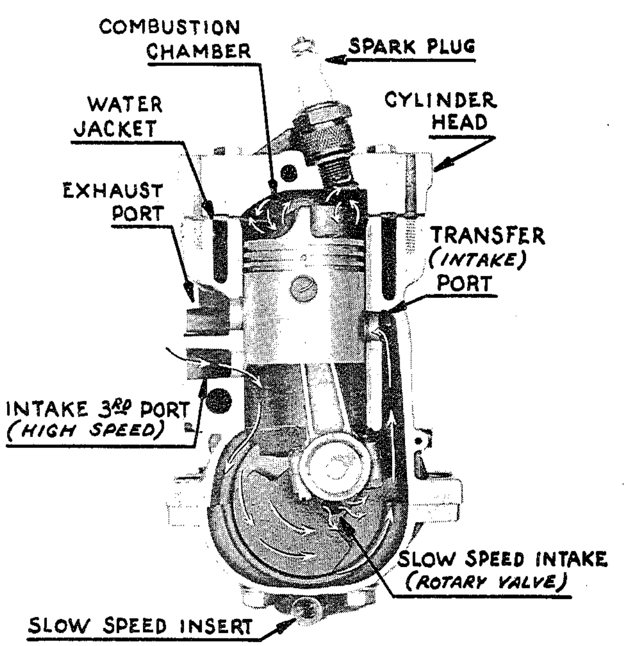
Comparatively high velocity of air over the slow speed jet at near closed position of the butterfly causes the gasoline to be vaporized for slow speed performance. As the butterfly is opened, the engine picks up speed with result that the slow speed jet becomes proportionately less effective since velocity of air through the mixing chamber becomes great enough to cause gasoline at the high speed jet to vaporize. Vaporization at the slow speed jet gradually diminishes as the butterfly shutter is opened for maximum power but becomes effective again as the shutter is closed and engine speed decreases. In this simple arrangement the engine operates entirely on vaporization at the slow speed jet when the butterfly is set for slow engine speed.

Carburetion on the LS, H, LT and T series is dual in that it consists of a simple mixing valve operating in conjunction with a rotary valve in the center journal of the crankshaft for slow and intermediate speed performance and a simple one jet float feed carburetor for high speed, operating through a port in the cylinder (third port). See illustration.

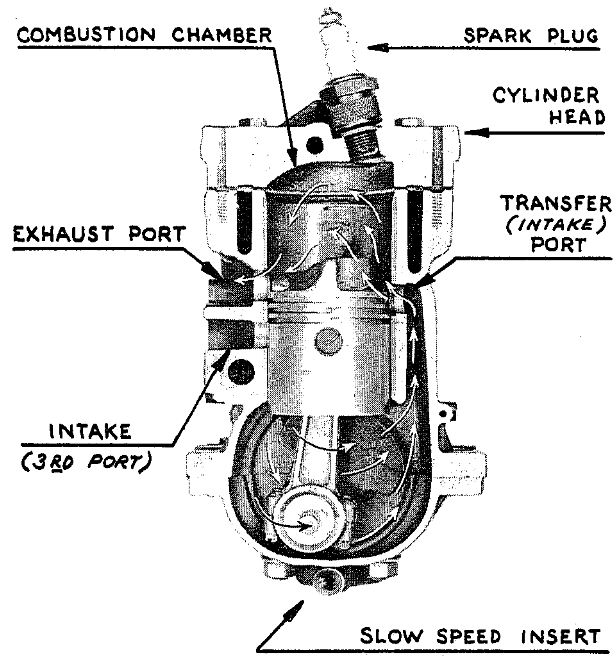


Schematic Diagram of Dual Carburetion, Showing Application of Simple Float Feed Carburetor and Mixing Valve, Also Third Port (Exaggerated in Proportion) in Cylinder and Rotary Valve in the Crankshaft.

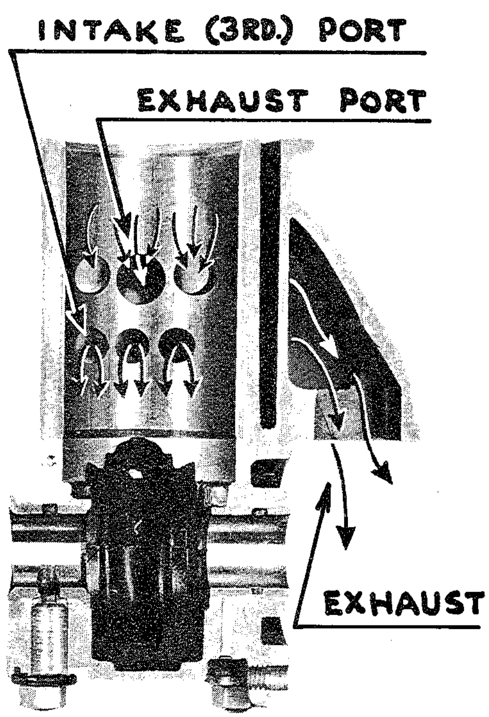
Illustrating Path of Fuel Charge and Exhaust through Crankcase and Cylinder—Dual Carburetion



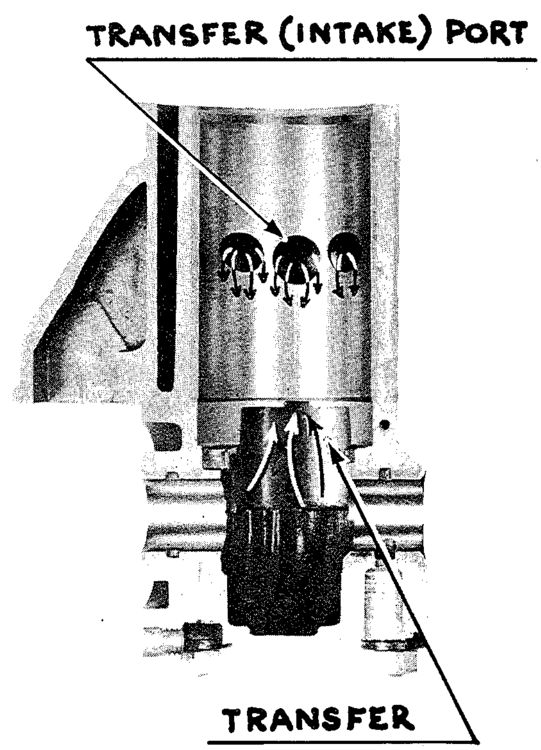
Top Sectional View of Power Head Showing Piston Up and Movement of Vapor Charge



Top Sectional View of Power Head Showing Piston Down, Transfer of Crankcase Charge and Path of Exhaust Gases

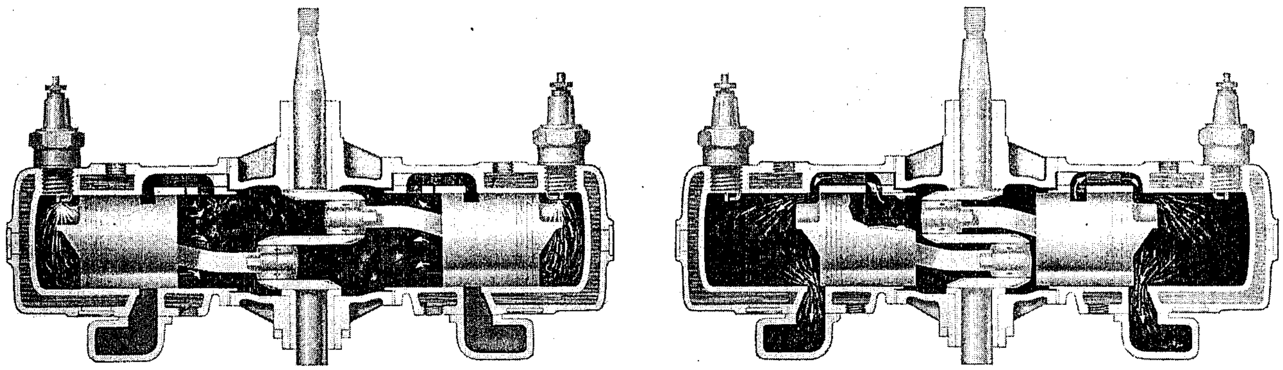


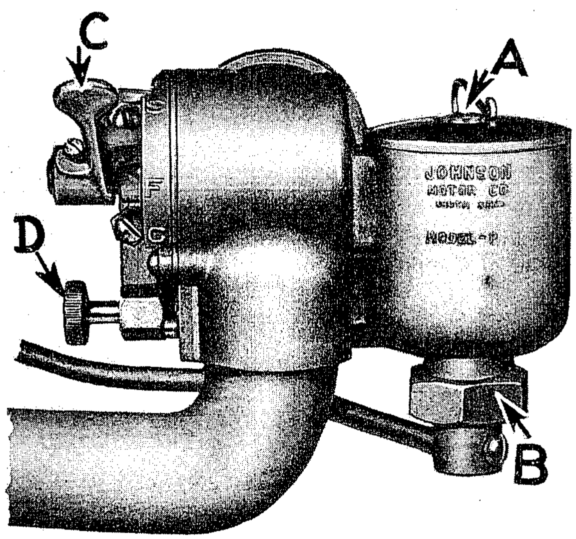
Sectional View of Cylinder Showing Exhaust and Intake Ports and Path of Exhaust Discharge



Sectional View of Cylinder (Showing Transfer and Transfer Port)

CARBURETION—OPPOSED FIRING TWINS (Early Models)

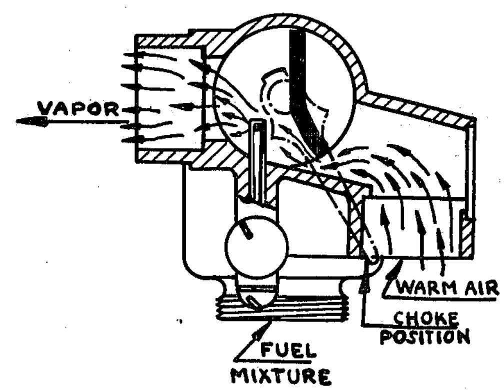




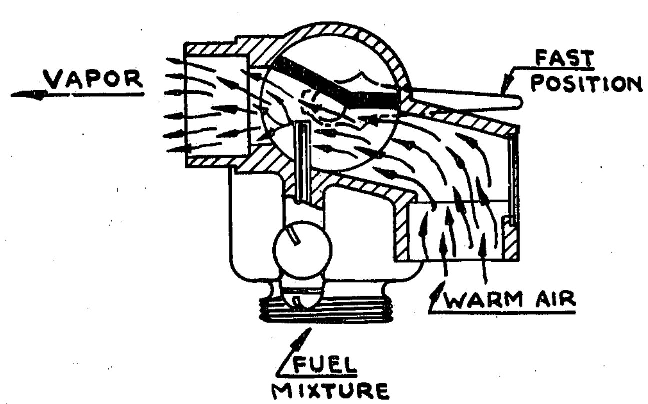
Carburetor used on 110, 210 and older models. "A" Float Pin, "B" Line Nut. "C" Carburetor Lever (Function is Two-Fold: To act as Choke for starting purposes and to control speed of motor). "D" Needle Valve.

The older models of Johnson motors employed the use of a simple float feed, single jet carburetor with but a single needle to meter the flow of gasoline—oil mixture into the air stream, caused to flow through the mixing chamber by suction (or low pressure) created in the crankcase on upward stroke of the pistons. The carburetor in this instance is attached directly to the crankcase by means of a protruding spout to which the throat of the carburetor is clamped—holding it securely in position.

The conventional butterfly shutter and choke, however, are not used in this particular carburetor, having been replaced by a single barrel valve which serves to both govern the fuel charge admitted to the crankcase (controlling motor speed) and to act as a choke, to provide the rich fuel mixture required for starting—see illustration below.

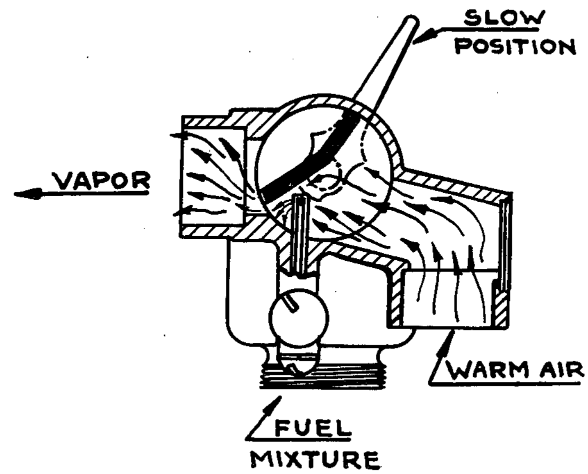


A small lever is attached to the stem of the barrel valve to permit manual control — thus, when pushed down, the barrel is set at choke position to "choke" off most of the air through the mixing chamber. This results in high suction at the jet and subsequently greater flow of liquid fuel into the restricted air stream—the fuel vapor then becoming proportionately richer in gasoline-oil as necessary for starting.



When top speed performance is desired, the lever is moved to horizontal position to permit maximum air flow through carburetor, thus maximum vaporization of fuel for full charge to the crankcase.

Intermediate and slow speeds are obtained by moving the lever upward—beyond the horizontal position. Doing so restricts area of fuel vapor opening exposed to the crankcase spout, proportionately reducing the charge to cause slower operation (r.p.m.'s) of the motor, such as when trolling, etc. Intermediate speeds are realized by further increasing the area of this opening as the lever is moved down again towards the horizontal position.



The carburetor's simple construction makes its maintenance an easy matter. Failure to function is usually caused by one or a combination of the following:

1. Carburetor not horizontal. This can be corrected by loosening the clamp screw to permit twisting the carburetor to horizontal position. (In event the float chamber is high, flooding will result since the fuel level is then above the jet—fuel simply overflows at the jet. Otherwise, if the float chamber is low, resulting fuel-air vapor will be lean, due to lower level of liquid fuel in the jet, to interfere with performance of the motor.

2. Improperly adjusted needle.

3. Water in the gasoline (sediment basin or tank).

4. Clogged screens, gas line, passages in carburetor or jet.

5. Fuel logged float (heavy) to cause continual flooding.

6. Improperly adjusted fuel level to cause either flooding by high level or starving by low level. (Groove in float pin governs fuel level when cotter is properly installed and attached to cork float.)

7. Damaged float valve seat to result in flooding. (A similar condition is caused by a bent float valve stem to produce binding, thus, sluggish or no action of the float.)

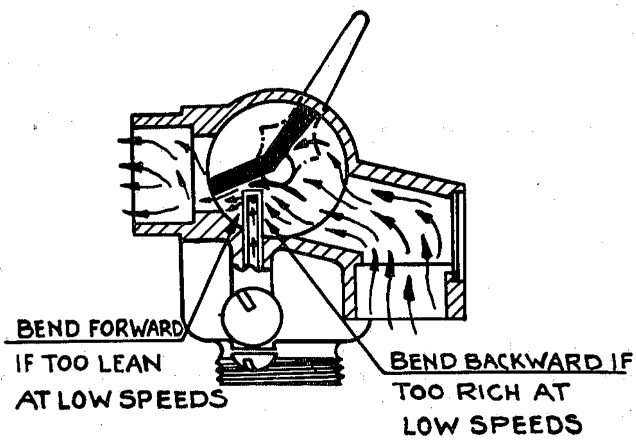
8. Damaged needle seat—caused by turning the needle down too tightly. This spreads or otherwise damages the seat to a point where adjustment becomes acutely critical or impossible.

9. If the carburetor is in good working order (the motor, too, in like condition) with the metering needle properly adjusted (after running temperature is reached), it should be possible to operate the motor throughout its entire speed range without frequently having to vary the adjustment (needle) at different speeds to maintain proper fuel balance for best performance.

For example—it could be possible that, after the needle has been properly adjusted for maximum top speed performance, the mixture (fuel vapor) either "leans" out or becomes too "rich" as the barrel valve is turned towards slow running position to result in sluggish operation which can be overcome only by readjusting the needle for best slow speed performance. Since the needle was originally adjusted for best top speed performance, it can now readily be seen that readjustment will again be required when returning to top speed operation — thus, one setting for maximum top speed performance and a slightly different setting for best slow speed operation.

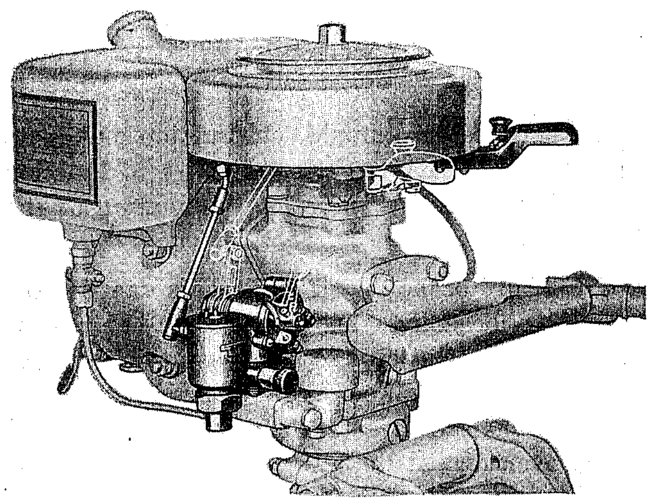
The necessity of continually adjusting and readjusting the carburetor needle as the motor is operated at various speeds becomes rather cumbersome in time. This situation, however, can easily be corrected by a simple adjustment in position of the jet protruding into the mixing chamber.

The fact that it is necessary to turn the needle "down or in" to obtain best setting (carburetion) for slow speed running after having once set the needle for maximum top speed is indicative of rich carburetion at slow speed — the motor runs sluggishly and "smokes" profusely. To correct, remove the barrel valve from the carburetor to expose the jet. Bend the jet backward gently (away from crankcase)—a slight amount at first. Replace barrel and cover—start and operate motor. It should be run long enough to reach operating temperature (note operating conditions at both high and slow speeds) then repeat performance if necessary. This becomes a matter of "cut and try." The jet is correctly positioned in the mixing chamber when one setting of the needle is sufficient for both high and slow (trolling) speeds.



The reverse is true if the needle has to be "opened or unscrewed" when throttling down from high speed. The mixture becomes "lean" to cause sluggish operation and "popping" in the carburetor. In this event, bend the jet carefully forward (towards) crankcase until best position is reached.

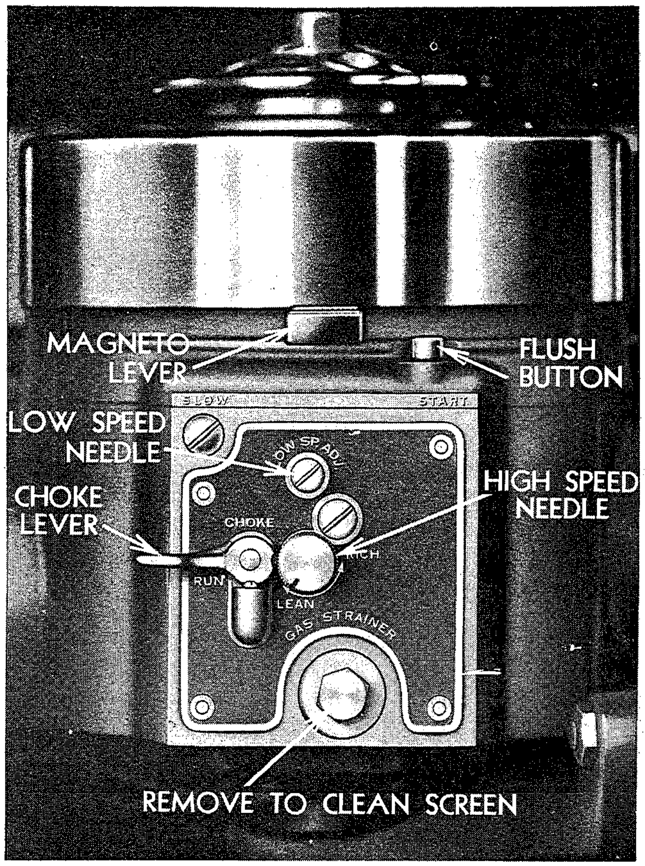
What actually occurs when shifting position of the jet in the mixing chamber is that the jet (the hole in the tube from where the gasoline-oil mixture flows into the air stream) is either moved farther into or away from the air stream. The greater the velocity of air over the jet, the "richer" the resulting fuel vapor becomes. Conversely, if the jet is shifted out of the area of high air velocity, the fuel vapor becomes proportionately "lean" simply because, as the velocity of air over the jet diminishes, suction at the jet is reduced to affect the flow of liquid fuel.



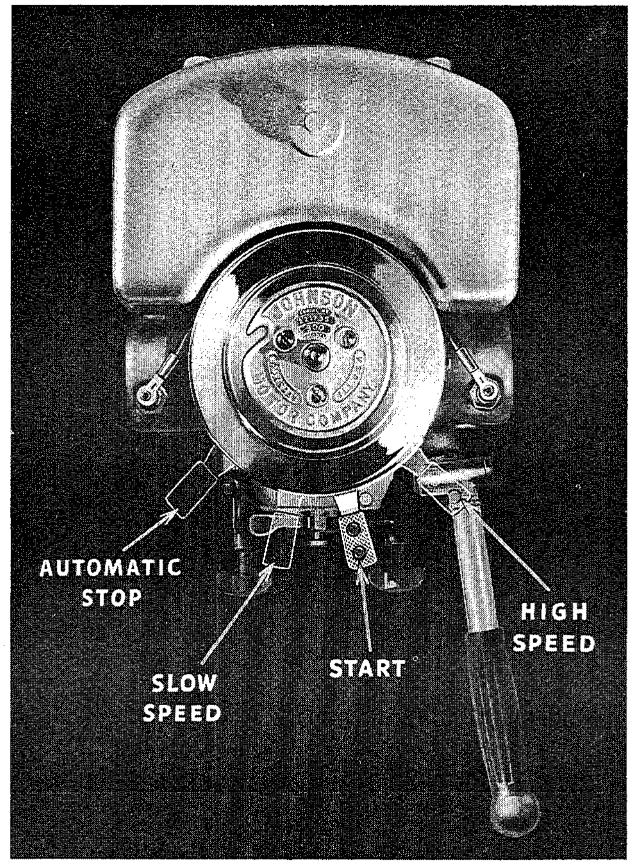
Carburetor Installation—A & K-65 Models Illustrating Synchro Control (Carburetor-Spark)

NOTES

CARBURETOR—MODEL 300



Model 300 Control Panel



Model 300 Synchro Control

The carburetor installed on the Model 300 is of the simple float feed, two jet type (high and slow speed) provided with a choke (damper) and a flush button to enrich the fuel mixture for starting—see illustration above.

Purpose of the flush button is to depress the float in the float chamber which causes the fuel to overflow in the mixing chamber to assist further in providing the necessary rich mixture for starting.

A screen (cylindrical in construction) is built into the carburetor body for the purpose of collecting foreign matters from the fuel to prevent its clogging the jets and fuel passages. It can be removed periodically for cleaning.

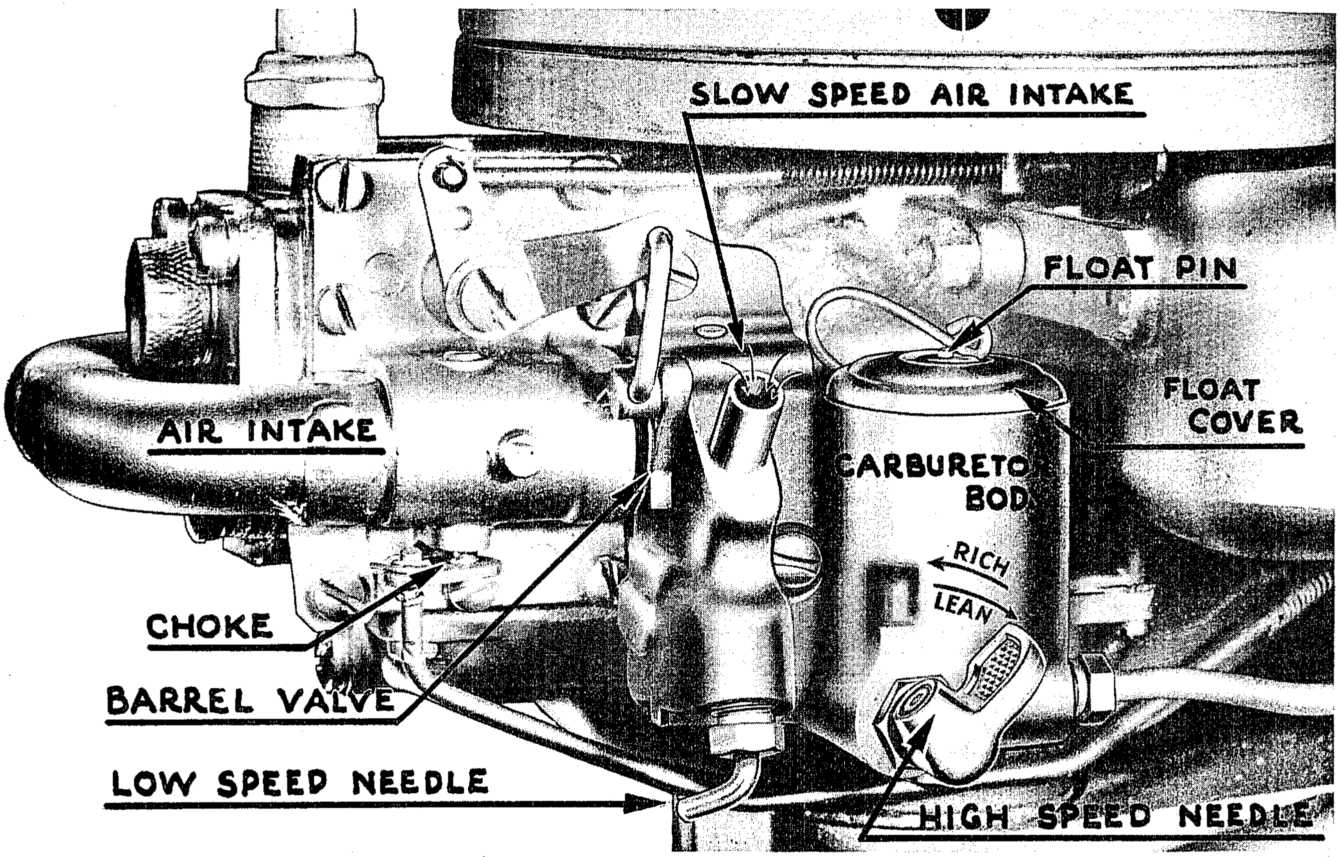
Butterfly shutter and spark lever are synchronized, thus controlling speed of the motor by movement of the lever. Butterfly shutter is full open with extreme spark advance for maximum speed closed at retard position for slow speed performance.

To adjust high and slow speed needles:

1. Open both slow and high speed needles approximately 1/2 to 3/4 turn from closed position.
2. Start motor and run until warm.
3. Set magneto lever to "slow" position—turn slow speed needle right or left as required to obtain smooth running.
4. Advance spark to "high speed" position—turn high speed needle right or left as necessary for maximum speed.

See carburetor Check-Chart for correcting common carburetor difficulties.

CARBURETION—MS-MD



MS-MD Carburetor

To obtain maximum performance throughout entire speed range of the motor, the Model MS-MD carburetor is constructed with two jets, two fuel mixture adjusting needles, one for slow speed and one for high speed, as shown above.

Construction, however, varies somewhat from that of the conventional two jet carburetor in that a separate air intake is provided for mixing fuel-air (vaporizing) for slow speed operation. Otherwise, the high speed jet (adjustable) functions in the usual manner. The barrel type of control valve is employed rather than the butterfly shutter, although the damper type choke is used.

To adjust carburetor needles (high and slow speed).

1. Remove small lever from the high speed needle.

2. Turn high needle down until it comes to rest gently on its seat. Then unscrew approximately 3/4 turn and let it remain at this position for the time being.

3. Turn the slow speed needle down until it rests lightly on its seat and unscrew about 1/4 turn from closed position.

4. Start motor and let it run until operating temperature is reached.

5. Throttle down for slow speed running—turn slow speed needle right or left as required for best running position.

6. Set control levers for top speed performance —turn high speed needle to right or left as required for maximum speed and smooth running.

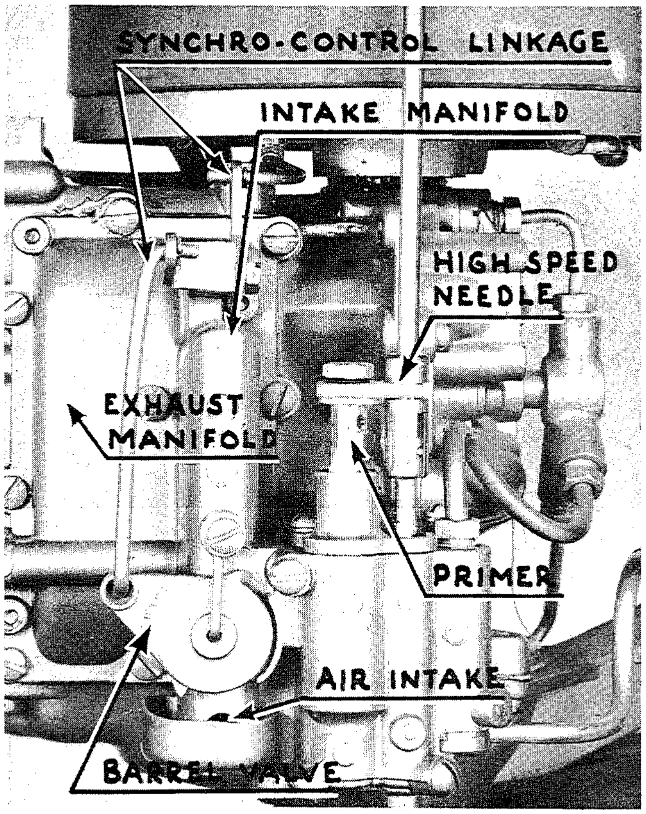
NOTE: Conditions may vary somewhat when making these adjustments in a test tank and on a boat in actual operation. Such minor corrections are, nevertheless, easily accomplished.

7. Replace high speed needle lever in such a position that it provides for slight correction in high speed needle setting, particularly for enriching the mixture as necessary for starting the cold motor. Provide a little leeway for "leaning" the mixture out under certain conditions as they present themselves.

The lever is made fast to the needle stem by a small Allen head-screw.

CARBURETION—HS-HD, LS, LT & T

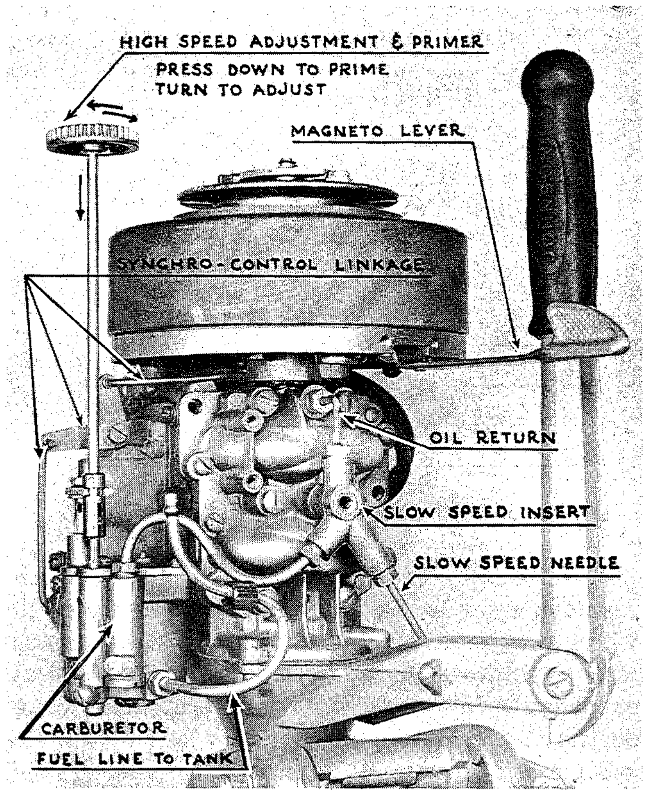
Carburetion is of the full range type, thus providing efficient carburetion at all speeds—some departure from customary construction has been made nevertheless, in that only the high speed needle and jet are built into the carburetor body; the slow speed needle and jet are actually not a part of the carburetor proper—this feature is made a part of the crankcase assembly and functions throughout the entire speed range of the motor.



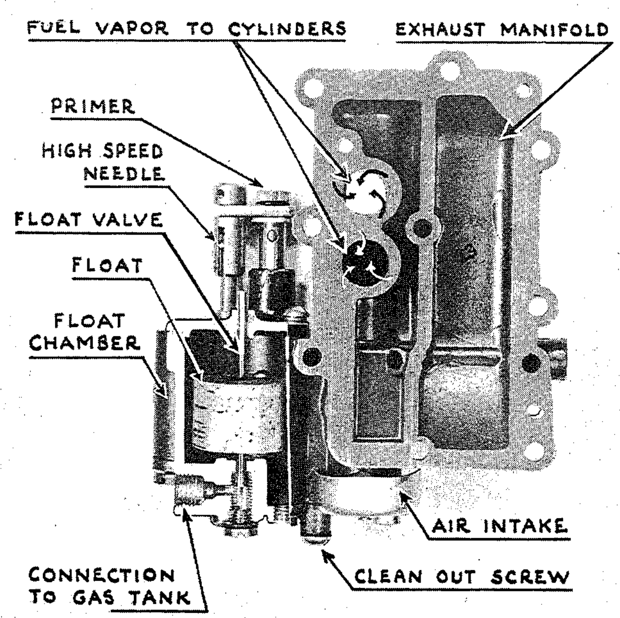
Carburetor and Manifold Assembly

Since both third port and rotary valve principles are employed, there are two independent systems of carburetion. The carburetor itself is of the conventional type—consisting of a float chamber, mixing chamber, throttle valve, needle for adjusting mixture and a connection to the intake manifold. The carburetor and third port operate only at intermediate and high speeds and cease to function entirely at slow speeds. Slow speed operation is maintained, however, by mixing air and fuel in the slow speed mixing valve to produce a combustible vapor which is conducted into the crankcase chamber by way of the rotary valve.

Some difficulty was experienced during the latter part of the summer (1947) with the Model HD-25 in that there was a tendency towards irregular running at high speed. The motors could be easily

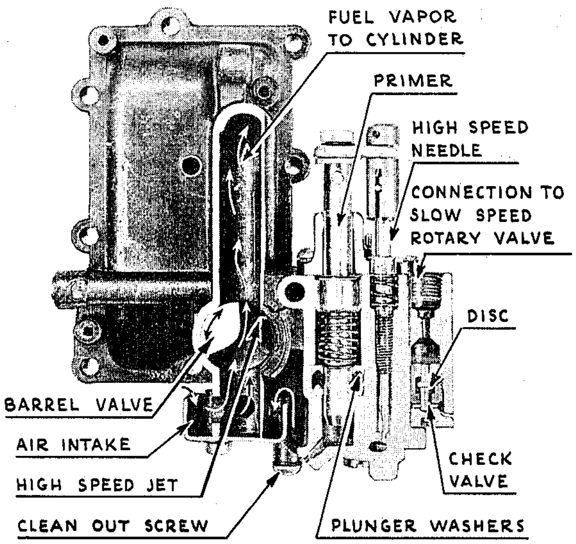


Carburetor and Slow Speed Insert



HS-HD Carburetor, Rear Sectional View

started and operated very well at slow speed for trolling, but at high speed there was a noticeable fluctuation, that is, they would run at high speed for a short period and then momentarily slow down and pick up speed again, etc.

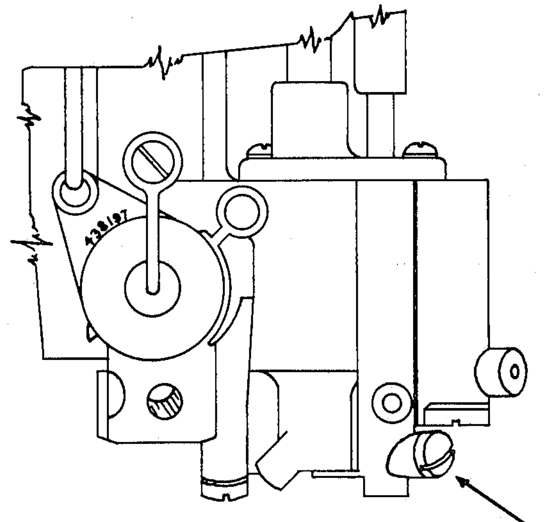


HS-HD Carburetor, Front Sectional View

Performance of this nature is frequently the result of too hot spark plugs; faulty action of the water pump and cooling system, or misalignment of the reciprocating and revolving parts to create excessively high operating temperatures, "drag" on the motor or to cause a vapor lock in the fuel system, etc., but in this particular case, it's different.

Note horizontal clean-out screw underneath the float bowl of the carburetor (see illustration), provided for clearing the passage between the bowl and mixing chamber of foreign matter. Motors prior to #618633 were not equipped with facilities for clearing the passage—those following were, however, the fuel passage was drilled too large which permitted formation of vapor bubbles to interfere with constant flow of fuel to the mixing chamber. Later, production was corrected in this respect.

Wherever necessary to overcome this condition, a small pin (1/8" x 1-5/16") can be installed in the passage to reduce its effective area. This can be accomplished by (1) removing the clean-out screw; (2) then unscrew the high speed needle five or six turns (far enough to clear the passage); (3) insert pin; (4) replace clean-out screw and (5) readjust high speed needle to best running position.



CARBURETOR ADJUSTMENT—HS-HD

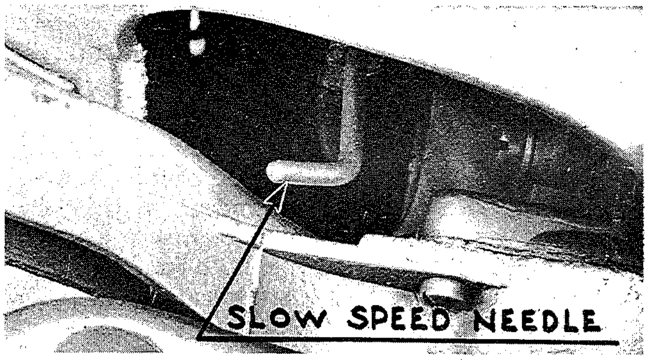
To adjust carburetor, proceed as follows:

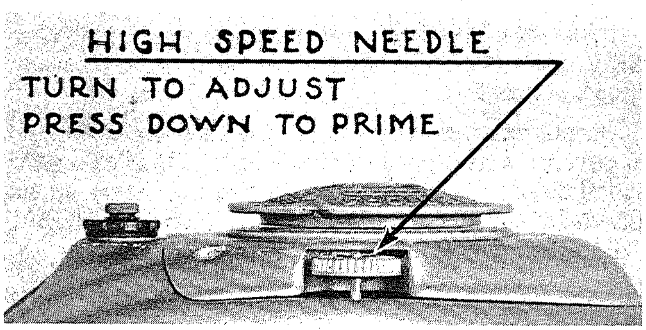
[There are two (2) adjustments—namely, High and Slow speed.]

1. Close slow speed needle, turn right until it rests gently on its seat, then unscrew approximately 3/4 turn. (Turn left.)
2. Close high speed needle, turn right until it rests gently on its seat, then unscrew approximately 3/4 to 1 turn. (Turn left.)
3. Start motor as instructed.
4. Operate at full speed with spark at full advance until normal motor running temperature is reached. Turn high speed needle to left or right as required to obtain maximum speed.
5. Retard spark by moving magneto lever to position midway between center and full retard (left of center facing motor). Turn slow speed needle to left or right as required to obtain smooth and consistent running at slow speeds.

High and slow speed needles should be adjusted separately—adjusted one at a time. Some may prefer to close the high speed needle entirely when making the slow speed adjustment. In this case open the slow speed needle approximately 3/4 turn from closed position, start the motor and run until warm. Retard spark to slow speed range, turn slow speed needle to right or left slightly to obtain consistent slow speed operation.

Move spark lever to full advance position, gradually open the high speed needle until maximum speed is reached.





Do not change position of the slow speed needle to correct high speed performance. Once the slow speed needle is set, it should require little or no attention—do not change setting unless necessary.

In event the slow speed intake is obstructed with foreign matter, simply open the slow speed needle three or four turns — depress primer vigorously several times to force out obstruction. Readjust slow speed needle as instructed above. Be sure check valve screen is clean.

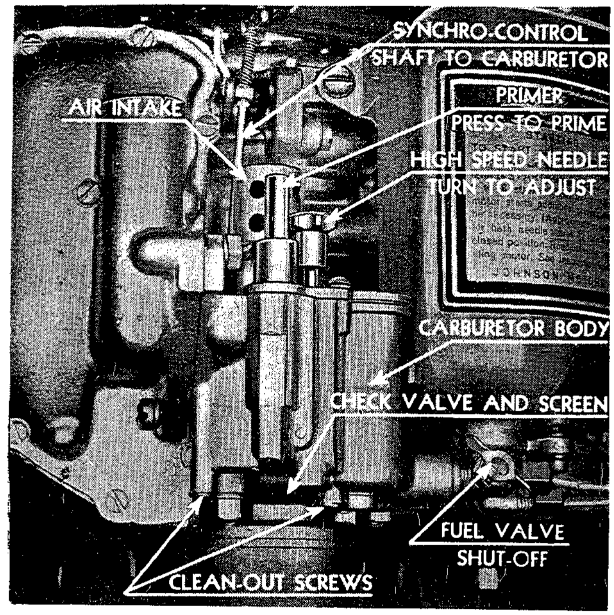
Spark and magneto levers are synchronized, therefore movement of the magneto lever controls both spark and carburetor simultaneously.

THE PRIMER consists of a small cylinder and plunger built into the carburetor body, which, when depressed, forces a small amount of gasoline into the slow speed opening to provide rich starting mixture. Since priming is accomplished through the slow speed opening, the slow speed needle must be open. The motor cannot be primed if the slow speed needle is closed. Do not, however, open the slow speed needle beyond that required for best slow speed operation of the motor.

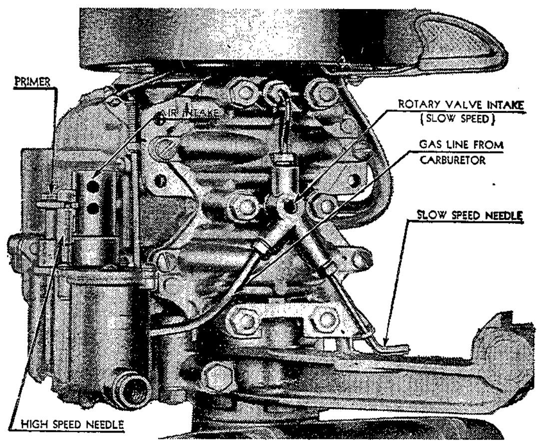
STARTING MIXTURE—LS, LT, AND T

Since a rich starting mixture is essential for starting purposes, some arrangement must be built into the carburetor to accomplish it. Models LT and T do not employ use of the conventional choke built into the carburetor, but rely on a primer (manually operated) to provide additional fuel for starting purposes.

The primer is operated by depressing the plunger or high speed needle adjusting button as desired to obtain necessary starting mixture.



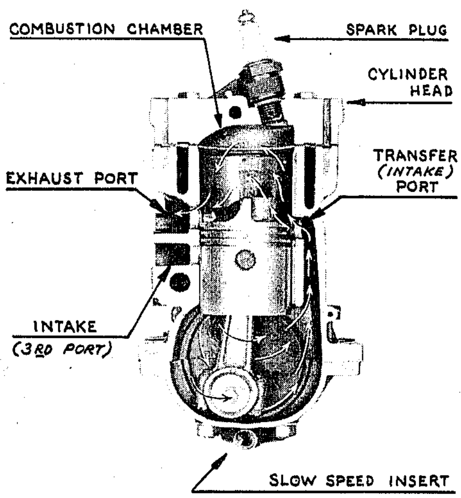
Carburetor—Models LT, DT, AT, TS, TD



CARBURETION—LS, LT, AND T

Carburetion is of the full range type, thus providing efficient carburetion at all speeds — some departure from customary construction has been made nevertheless, in that only the high speed needle and jet are built into the carburetor body; the slow speed needle and jet are actually not a part of the carburetor proper—this feature is part of the crankcase assembly and functions throughout the entire speed range of the motor.

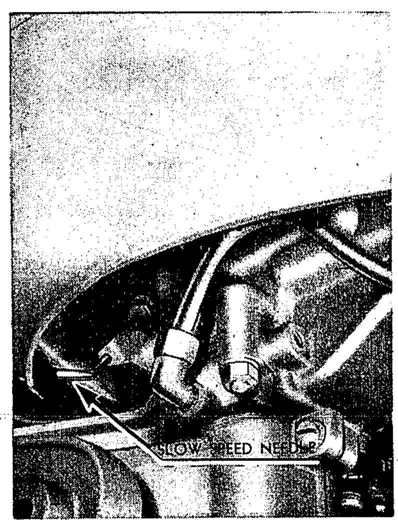
Since both third port and rotary valve principles are employed, there are two independent systems of carburetion. The carburetor itself is of the conventional type—consisting of a float chamber, mixing chamber, throttle valve, needle for adjusting mixture and a connection to the intake manifold. The carburetor and third port operate only at intermediate and high speeds and cease to function entirely at slow speeds. Slow speed operation is maintained, however, by mixing air and gasoline in the slow speed opening which are conducted to the crankcase chamber by way of the rotary valve.



To adjust carburetor, proceed as follows—(note, carburetion is properly adjusted prior to shipping motors from the factory.)

Some adjustment may however be necessary due to type of service or climatic conditions. There are two (2) adjustments — namely, High and Slow speed.

1. Close slow speed needle, turn right until it rests gently on its seat, then unscrew approximately 3/4 turn. (Turn left.)



Showing Location of Slow Speed Needle—Models LT, T

2. Close high speed needle, turn right until it rests gently on its seat, then unscrew approximately 3/4 turn. (Turn left.)

3. Start motor as instructed.

4. Operate at full speed with spark at full advance until normal motor running temperature is reached. Turn high speed needle to left or right as required to obtain maximum speed.

5. Retard spark by moving magneto lever to position midway between center and full retard (left of center facing motor). Turn slow speed needle to left or right as required to obtain smooth and consistent running at slow speeds.

High and slow speed needles should be adjusted separately — adjusted one at a time. Some may prefer to close the high speed needle entirely when making the slow speed adjustment. In this case open the slow speed needle approximately 3/4 turn from closed position, start the motor and run until warm. Retard spark to slow speed range, turn slow speed needle to right or left slightly to obtain consistent slow speed operation.

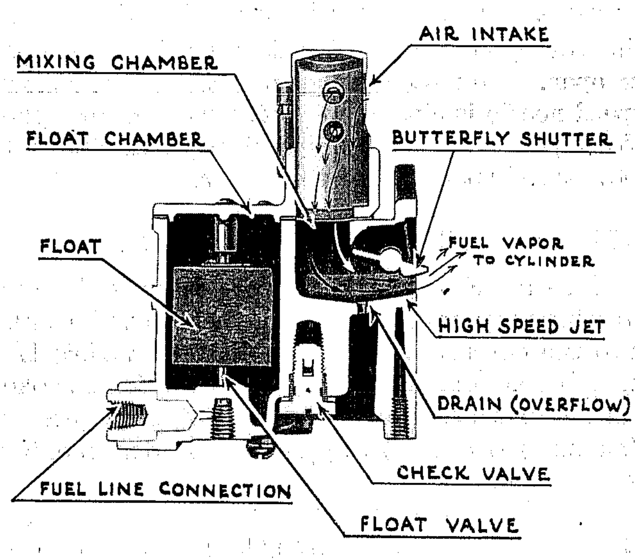
Move spark lever to full advance position, gradually open the high speed needle until maximum speed is reached.

Do not change position of the slow speed needle to correct high speed performance. Once the slow speed needle is set, it should require little or no attention—do not change setting unless necessary.

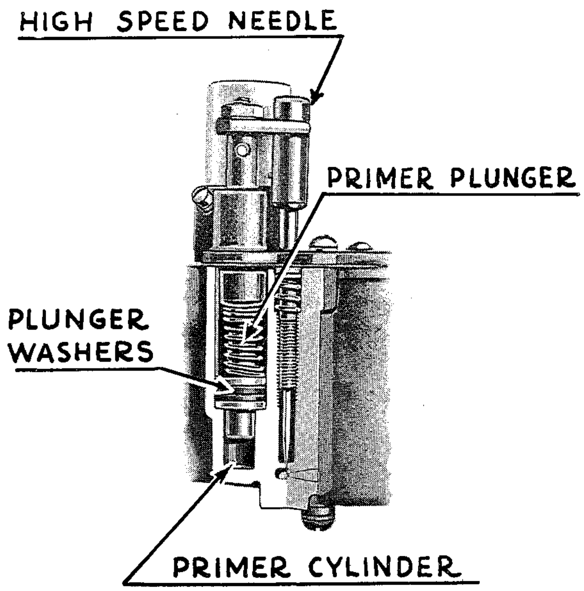
In event the slow speed intake is obstructed with foreign matter, simply open the slow speed needle three or four turns — depress primer vigorously several times to force out obstruction. Readjust slow speed needle as instructed above. Be sure check valve screen is clean.

Spark and magneto levers are synchronized, therefore movement of the magneto lever controls both spark and carburetor simultaneously.

THE PRIMER consists of a small cylinder and plunger built into the carburetor body, which, when depressed, forces a small amount of gasoline into the slow speed opening to provide rich starting mixture. Since priming is accomplished through the slow speed opening, the slow speed needle must be open. The motor cannot be primed if the slow speed needle is closed. Do not, however, open the slow speed needle beyond that required for best slow speed operation of the motor.



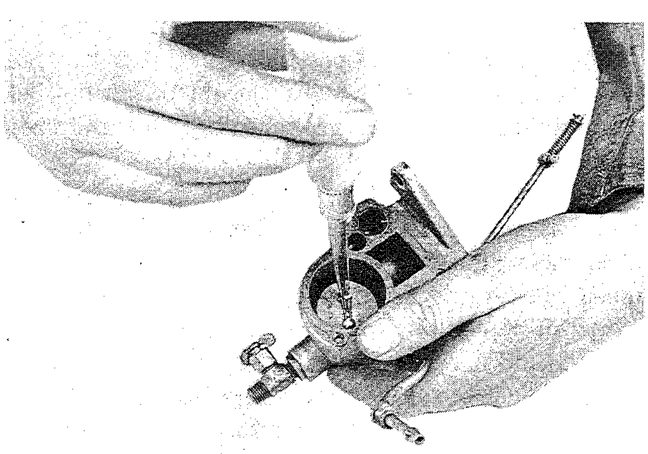
Sectional View of LS, LT & T Carburetor



Sectional View of LS, LT & T Carburetor
(Primer and High Speed Needle)

TO INSTALL NEW CARBURETOR FLOAT

In event the carburetor float becomes gasoline logged, it should be replaced to correct flooding condition produced. Remove cover from float chamber, to expose float and float valve. Float is held in correct position of float valve stem by a small cotter which fits into a groove in the valve stem. To remove float, spread ends of cotter with screw driver, then press down on end of float valve with thumb. Lift float off valve stem.



Removing Float

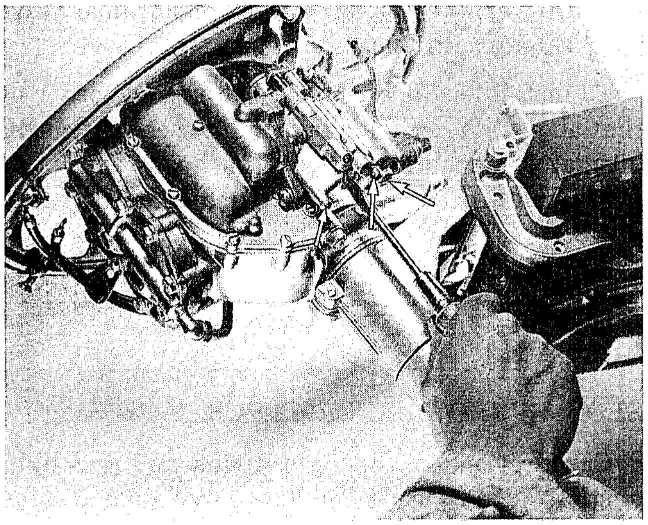
To install new float, proceed in reverse order of that above. Care should be taken to see that cotter ultimately anchors in groove on float valve stem to prevent fuel level being too high or too low.

SLOW SPEED PERFORMANCE

Carburetion on the light twins and the light singles (LS-DS) is accomplished by a dual system, that is, the customary type carburetor for high speed performance and the slow speed mixing valve (attached to crankcase) to obtain slow speed for docking and trolling purposes. Consequently, there are two adjustments—one for high speed (carburetor high speed needle) and one for slow speed (crankcase low speed needle).

It cannot be said that each is entirely independent of the other — the motor can be operated with either the high speed or the slow speed needles closed, but with no degree of satisfaction. Both needles must be properly adjusted to realize maximum performance. The slow speed needle, however, is less dependent on the high speed needle since the motor can be started, operated at slow speeds and at approximately half maximum speed with the high speed needle closed (spark full advanced). If the slow speed needle is closed, it is practically impossible to start the motor — it may be started by full advancing the spark lever and continuous cranking. If started under these conditions, full speed can be obtained only by opening the high speed needle excessively — the motor cannot, nevertheless, be idled down for slow speed performance with the slow speed needle closed. Both high and slow speed needles must be properly adjusted to obtain maximum performance throughout the entire speed range.

To obtain slow speed performance, the motor must of course be in good mechanical condition—the slow speed adjustment functions only if properly adjusted and if in good mechanical condition. The carburetor must be clean, particularly the check valve assembly and screen — the line from the carburetor to the slow speed intake should likewise be clean and free of foreign obstruction as well as the slow speed jet.



Showing Removal of Check Valve Screen Assembly and Drain Screws for Cleaning Purposes (Carburetor).

Check valve and screen are accessible by removing the large screw at bottom of carburetor—rinse off in gasoline if clogged with foreign particles. If a gummy condition exists, rinse in alcohol—this gum is not soluble in gasoline, therefore, little good will come of attempting to remove it with gasoline.

If there is reason to believe the slow speed gas line and intake are obstructed, open the slow speed needle three or four turns—depress primer (on carburetor) several times to force out foreign particles (dirt). In event the system is clogged beyond the possibility of cleaning out in this manner, remove the slow speed gas line and needle—blow out with high pressure air line.

Remove the slow speed needle to note condition of needle and intake seat. If the needle is badly ringed or grooved, it should be replaced. The same is true of the seat in the intake — replace if necessary. It is impossible to obtain slow speed adjustment with a badly seated needle valve. This is the result of the needle having at some time or other been screwed down too tightly against its seat in the intake. Be sure both seats are in good condition.

To remove the slow speed intake from the crankcase, simply grasp with pair of pliers — twist back and forth at the same time prying up from underneath with a screw driver. Install new one by tapping lightly into position. Make certain the new intake fits snugly in the crankcase. It is important too that connections between gas line, slow speed intake and carburetor are air tight — air seepage will interfere with adjustment.

Part No. 42-98—Slow Speed Intake, Models LS and DS-37.

Part No. 41-184—Slow Speed Intake, Models LT and DT-37.

Part No. 42-124—Slow Speed Intake, Models LS and DS-38.

Part No. 41-309—Slow Speed Intake, Models LT and DT-38.

Part No. 41-309—Also for LT, DT and AT-39 and 10, TS and TD-15-20.

Part No. 41-91—Slow Speed Needle for above Models.

Part No. 43-234—Slow Speed Intake, Models HS, HA, HD-39, 10, 15.

Part No. 43-234—Slow Speed Intake, Models HS, HD-20-25.

Part No. 43-227—Slow Speed Needle for above Models.

Excessive looseness in the swivel bracket will cause the motor to wobble or shake considerably, particularly when slow trolling speeds are desired to interfere with smooth running.

Many instances of unsatisfactory slow speed performance, however, can be overcome by simply tightening (not too tight) the adjusting screw on the swivel bracket as shown here but providing, of course, that the motor otherwise is in good mechanical condition.

CLEANING CARBURETOR MODELS LS, DS, LT, AT, DT, TS, TD, HS, HA, HD

Some difficulty may be experienced with hard starting on the above models during the early part of the spring season as a result of foreign substance or corrosion having accumulated in the carburetor during the idle winter months.

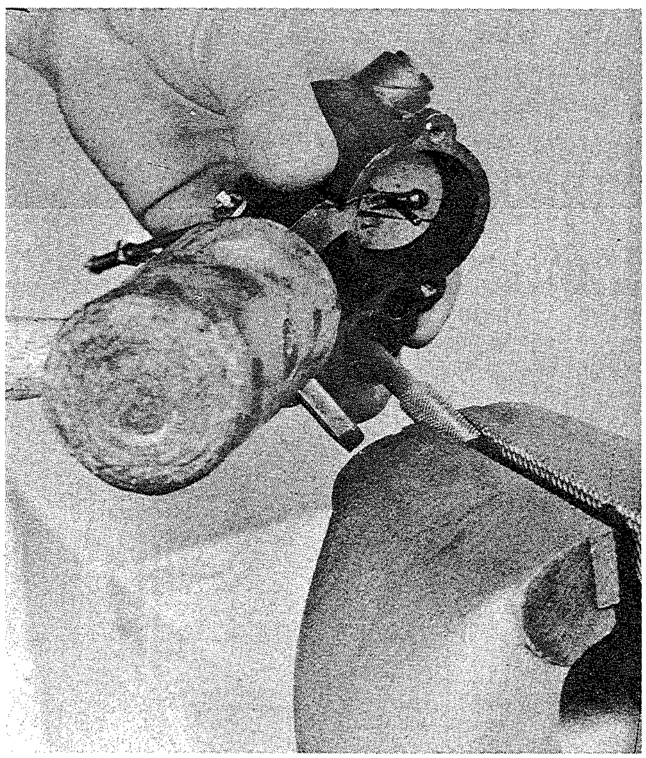
If accumulation is excessive, it is likely to obstruct the small passages to interfere with free flowage of gasoline through the carburetor — all gasoline lines and passages must be clear and free of obstruction.

To properly clean the carburetor, it must be removed from the motor and taken apart for a thorough washing out with gasoline. Remove the high speed needle and float cover to enable getting at the primer plunger and small passages — remove plunger and check valve assembly (large screw on bottom of carburetor.) Submerge carburetor body and parts in gasoline or commercial solvent for rinsing. After rinsing, inspect all parts to be sure they are clean and passages are clear.

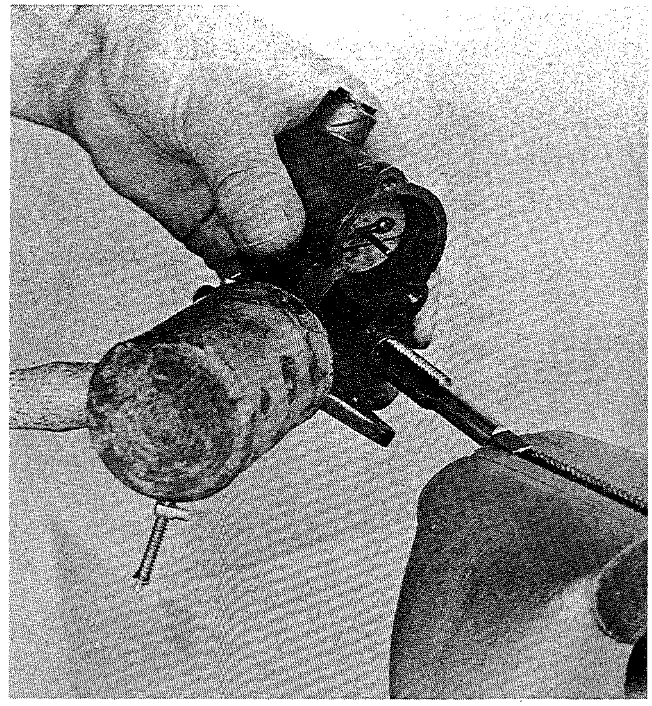
Gasoline gum may have collected on the check valve to render it inactive. In this event wash the assembly with alcohol. This gum is not soluble in gasoline, thus alcohol or a solvent is advised. The check valve must be free if the motor is expected to operate well at slow speeds. Since its function is to maintain proper fuel level at the slow speed intake in the crankcase, sluggish action will result in failure to obtain satisfactory slow speed adjustment and performance as well as to contribute towards hard starting.

Be sure the small gas line from the carburetor to the slow speed intake is also clean and free of obstruction.

The leather washers in the primer, if excessively worn or are not properly seated, should be replaced since loss of seal at this point prohibits the primer functioning as it should.



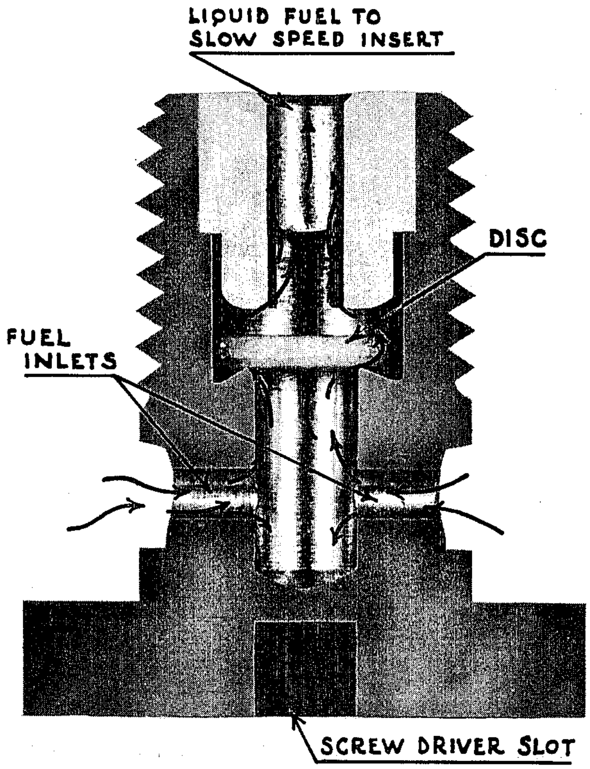
Remove the high speed needle and carburetor cover along with the primer plunger. The two brass and leather washers undoubtedly will remain in the cylinder. Place tool #301785 in vise in such a manner that it can be inserted in the primer cylinder. The small flare at the end of the tube can be directed through the hole in the washers and "hooked" behind them to make removal simply a matter of tapping lightly on the carburetor body as shown.



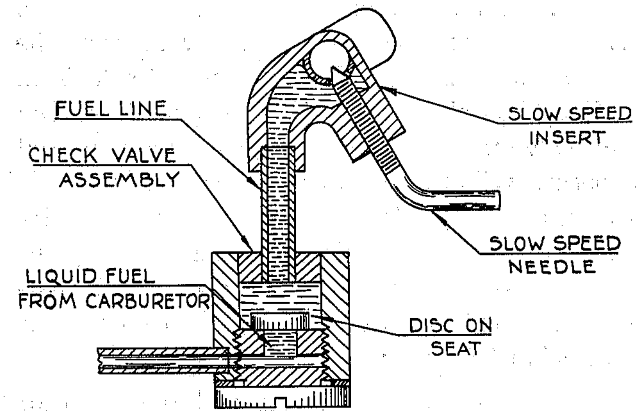
It frequently becomes necessary to replace the primer cylinder sleeve because of scoring to interfere with primer action. Run a 1/2″-13 tap part way down the sleeve—enough to grasp it firmly. Then place the tap in a vise and drive out by carefully tapping the carburetor body with a mallet, as illustrated. Be careful not to damage the body.

CHECK VALVE—CARBURETORS H, LS, LT AND T MODELS

Function of the check valve in the carburetor is to maintain proper fuel level at the slow speed mixing valve (Y insert in crankcase) since actual vaporizing of the fuel is performed at a considerably higher level than the mean level of the carburetor proper. Thus, each time the motor is turned over (cranked) for starting, liquid fuel from the carburetor is drawn up through the tube, leading from the carburetor to the mixing valve (insert), where it is mixed with air (vaporized) and conducted on into the crankcase by way of the slow speed rotary valve. This action takes place as result of suction or low pressure created in the crankcase on upward stroke of the piston. Fuel level, consequently, is maintained at the mixing valve only as long as low pressure (suction) exists in the crankcase unless some means are provided to hold the fuel in check as suction diminishes, which it does when the piston reaches the top of its upward stroke.



Sectional View of Check Valve



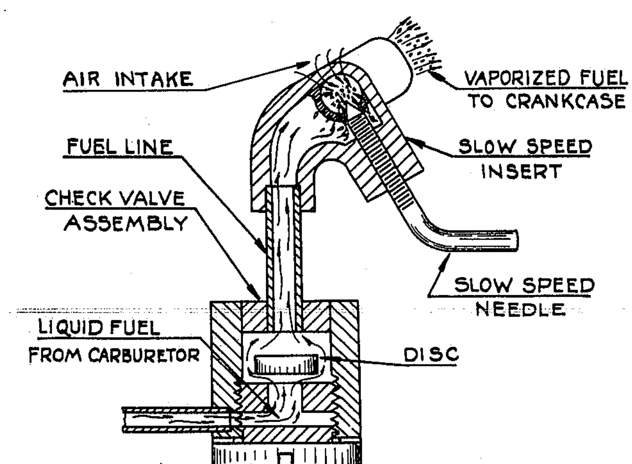
Schematic Drawing to Illustrate Function of the Check Valve. Note Disc Settled on its Seat Since there is no Suction (in Crankcase).

The result is a check valve built into the carburetor expressly for this purpose. It consists of a housing or body with openings at each end, between which is installed a small flat disc. The disc is free to be lifted off its seat when suction occurs to permit passage of liquid fuel and to seat to prevent return of the liquid above it when suction ceases.

Area of the disc and fuel passages above and below it are calibrated with respect to the volume of liquid fuel expected to flow through the check valve assembly—this, naturally, is governed by the rate of fuel consumption at the various engine speeds.

On cranking, the disc is lifted off its seat by suction created in the crankcase on upward stroke of the piston. This causes liquid fuel to flow around the disc (as illustrated) and on up through the fuel line to the mixing valve where it is vaporized and conducted into the crankcase. The fuel continues to flow in this manner as long as suction is built up in the crankcase as the piston travels upward. Suction ceases when the piston reaches top center and the fuel subsequently starts to drop down to seek normal level in the carburetor since no suction now exists to hold it at this high level. High level, nevertheless, is maintained, regardless—weight of the liquid in the fuel line above the disc (and the weight of the disc) causes the disc to normally come to rest on its seat, thereby preventing return flow of the liquid. The disc then alternately lifts from its seat when suction occurs to pass the liquid fuel and settles on the seat to prevent excessive drop in fuel level when no suction is present to otherwise maintain it.

If the check valve disc is prevented from acting freely either as result of accumulation of foreign matter or corrosion in the assembly, sufficient level



Schematic Drawing to Show Disc of Check Valve Raised off its Seat by Suction Created in the Crankcase on Upward Stroke of the Piston, to Permit Flow of Liquid Fuel.

of fuel in the slow speed arrangement cannot be maintained—thus, improper carburetion at slow speeds and faulty operation of the motor. The fuel level in this case is extremely important and must be maintained.

Prior to actually suspecting the check valve to be at fault, make certain all fuel lines and passages are clear and free of obstruction. Pay particular attention to the check valve screen—be sure it is clean.

It is a simple matter to determine whether or not the disc in the assembly is functioning as it should—place the open end in your mouth (wash it off first to guard against infection) and blow. If the disc is seating properly, it should be impossible to blow through the valve assembly. Now "suck" on the same end of the assembly—if the disc floats freely, it should be possible to **draw** air through it but not **blow** air through it. If there is any doubt as to its condition, replace the check valve assembly.

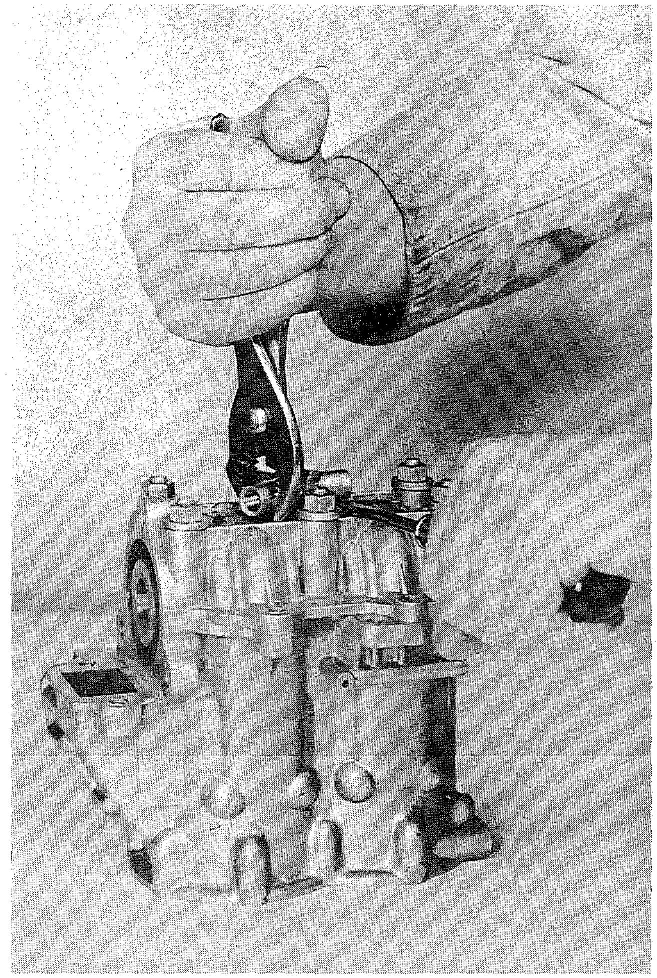
REMOVAL AND INSTALLATION OF SLOW SPEED INTAKE ON THE LS, LT, H AND T MODELS

There are times when it may seem impossible to obtain satisfactory slow speed adjustment on above models, even though the ignition system is in good working order, the power head in general is in good mechanical condition as well as the carburetor itself, spark is good, compression is good (no compression losses at slow speeds, resulting from faulty piston rings or excessive cylinder wear), carburetion is good at high, but not at slow, speeds.

In a situation of this nature, look to the slow speed insert on the crankcase—slow speed needle may be damaged or the slow speed needle seat in the insert may be damaged, or both.

Damage to the seat results from the motor operator screwing the slow speed needle down too tightly against the seat in his efforts to adjust the motor for slow speed performance. In doing so, the seat is frequently expanded or otherwise damaged which makes it impossible to obtain satisfactory slow speed adjustment thereafter.

Be sure the slow speed insert is clean and free of obstruction, however, and that the small check valve in the carburetor is clean. Open the slow speed needle several turns, then vigorously depress the primer button several times—this should force out any loose particles of obstruction. If gasoline is seen to spray into the opening in the insert, it is reasonable to assume there is no obstruction. If it is still impossible to adjust for slow speed operation, replace the insert and the slow speed needle. Proceed as follows:

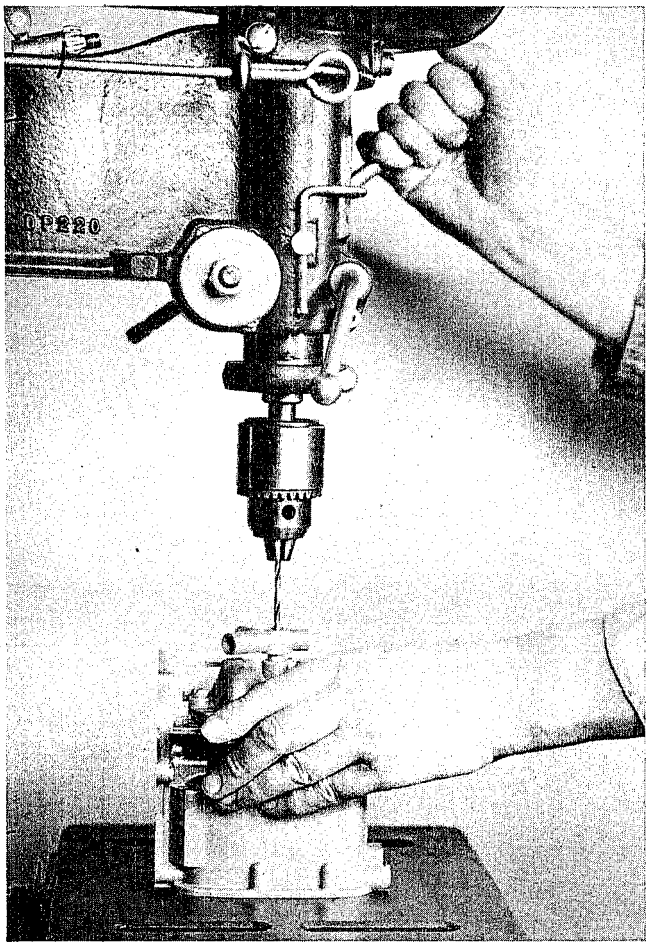


Remove the slow speed needle, packing nut and gas line to carburetor. Grasp the slow speed insert firmly with a pair of pliers, as shown in the illustration. Twist back and forth, at the same time pry upward with a screw driver placed between one of the ears of the insert and the crankcase. This is a press fit and not too difficult to remove as described.

Install new insert. Place a drop or two of oil on the boss which fits into the crankcase. Gently drive insert into place with a mallet, being sure it is properly aligned and does not cock when driving into position. Drive until the insert bottoms.

NOTE: On HS and HD models, a small lead seat (#43-298) must be inserted in the hole in the crankcase before the insert is installed. Push all the way down. **Small rib on seat must be down.** Rib must fit in corresponding recess at bottom of hole in the crankcase.

After having driven the insert "home," with lead seat in position, run a 5/32" drill through the hole in the insert and drill through the lead seat.

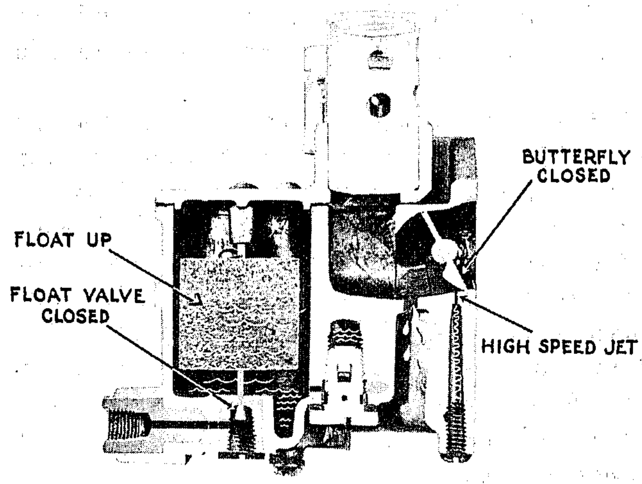


Drilling Lead Seat at Base of Slow Speed Insert
H Models Only

CARBURETOR—LT AND T SERIES (BUTTERFLY VALVE)

Quite often it appears that after having exhausted entire store of information regarding corrective measures for improvement of slow speed performance, an unsuspecting detail frequently comes to mind—for the time being, condition of the butterfly valve.

When removing the carburetor be sure to check the butterfly valve. Make certain it operates freely with no indication of binding whatever — that it is centered in the barrel and particularly that it closes when it should. Excessive leakage past the butterfly valve, when the magneto lever is set for slow speed operation, is one of the causes for your inability many times to obtain proper slow speed adjustment. At times one is apt to believe there is something wrong with the slow speed system or the magneto when actually it is right before us in condition of the butterfly valve.

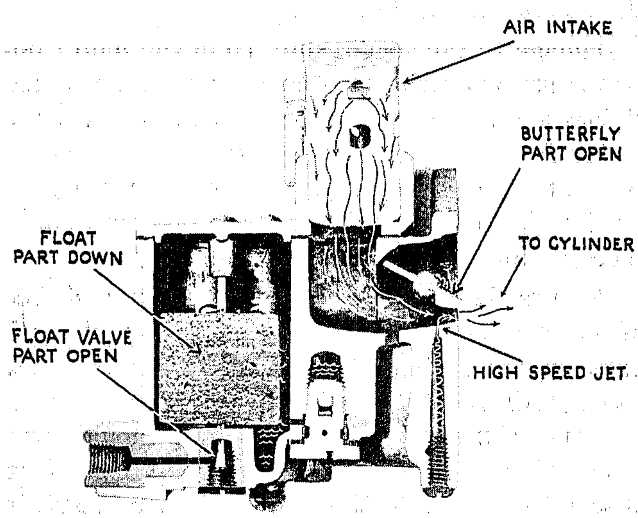


Butterfly Valve Closed

To check, set the butterfly valve in closed position (carburetor removed from motor) — blow through the barrel. If the butterfly is seating properly it should be practically impossible to blow by it. There will, of course, be some seepage but if it is felt that a great deal of air can be blown by, then try to find out what's wrong—the butterfly valve, when in closed position, should seat tightly.

The shaft should be free enough so that holding the butterfly valve closed is actually accomplished by tension of the spring on the small synchronizing shaft. If the valve can't be held closed by this tension, then it must be binding and should be made free.

In addition to this, note the small hole (high speed jet) drilled into the carburetor body just about where the bottom side of the valve closes. When the valve closes, this hole must be out of



Butterfly Valve Open

sight. If not, fuel will enter the mixture to interfere with properly setting the slow speed needle. BE SURE BUTTERFLY VALVE CLOSES FORWARD OF THE HIGH SPEED JET—DOES NOT CLOSE ON TOP OF THE JET.

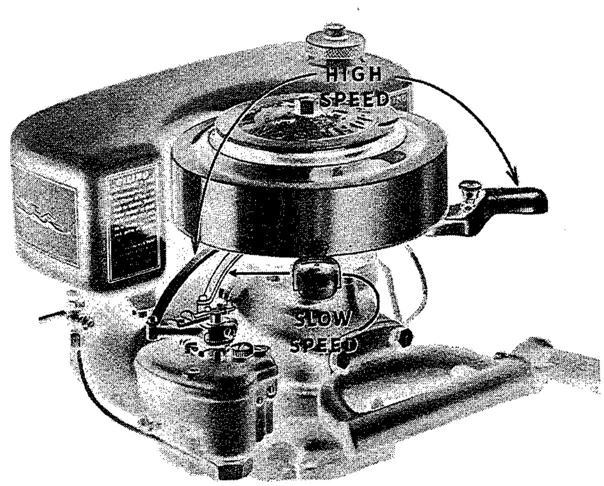
Actually, the way to properly check this setting is to close the butterfly, then indicate closed position in barrel of carburetor by running a scribe along the bottom outside edge of the butterfly. The barrel is thus scratched to show position of outside edge (lower) of the butterfly with relation to the high speed jet. If correctly adjusted, the distance between the scratch mark and near edge of the jet should be slightly greater than the thickness of the edge of the butterfly, so the butterfly does not close on top of the jet.

Keep above in mind when attempting to overcome a stubborn trolling condition in either of these two motors.

CARBURETION—K, KS, KD

Carburetors are of the full range type, that is, constructed with two jets to insure efficient carburetion throughout the entire speed range of the motor. The slow speed jet provides correct carburetion at slow and intermediate speeds; the high speed jet from intermediate to top speeds.

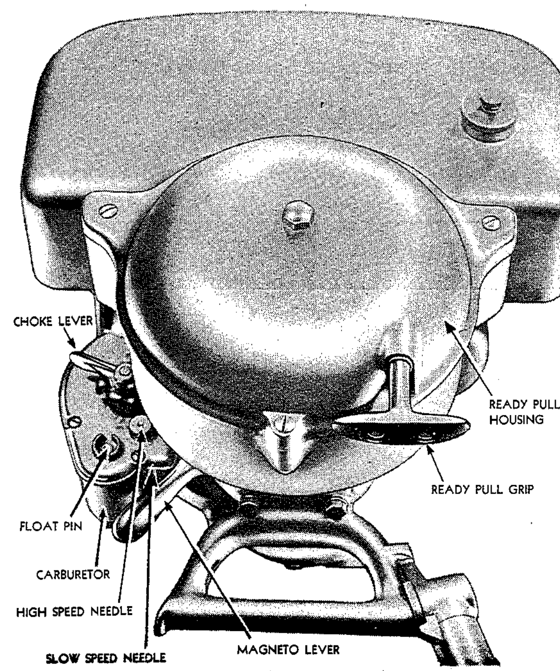
Two adjustments are thus necessary —slow and high speed needles.



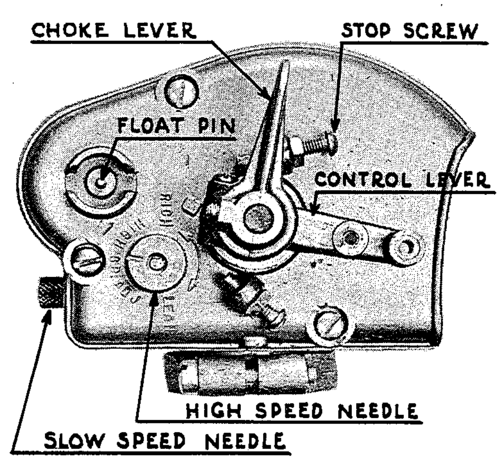
KS-KD Controls

TO ADJUST SLOW SPEED (slow speed adjustment should be made with retarded spark and at normal running temperature)—Close slow speed screw or needle (turn right until it rests gently on its seat). Open approximately ½ to ¾ turn (turn left). Start motor as instructed and operate at full throttle until it reaches normal temperature. Move magneto lever midway between center position and full retard. Turn slow speed needle to right or left as required to obtain smooth operation at slow speed.

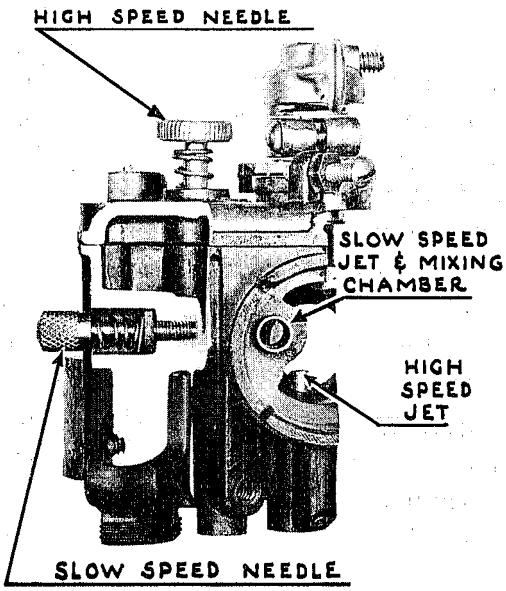
TO ADJUST HIGH SPEED—Start motor as instructed. Operate at full throttle and full spark advance until motor reaches normal operating temperature. Turn high speed needle to right or left as required to obtain maximum speed.



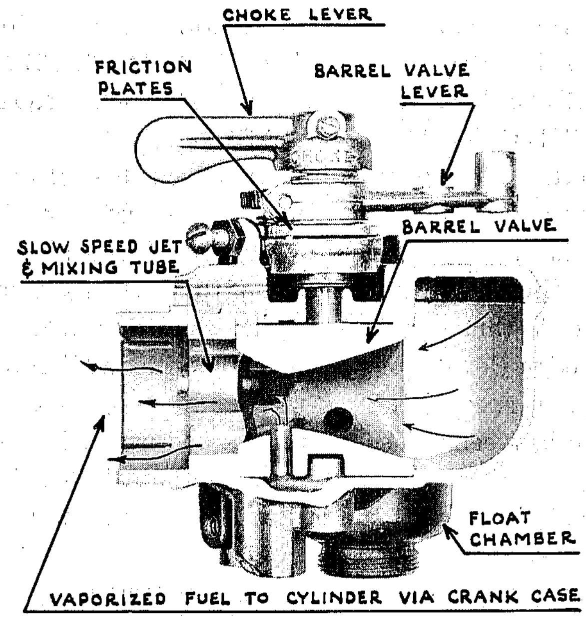
Showing Controls on Model KD(L)



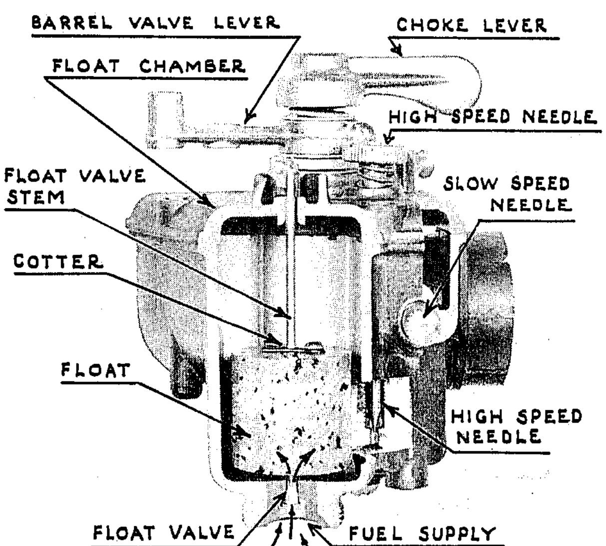
Showing Top View of Model KD Carburetor.



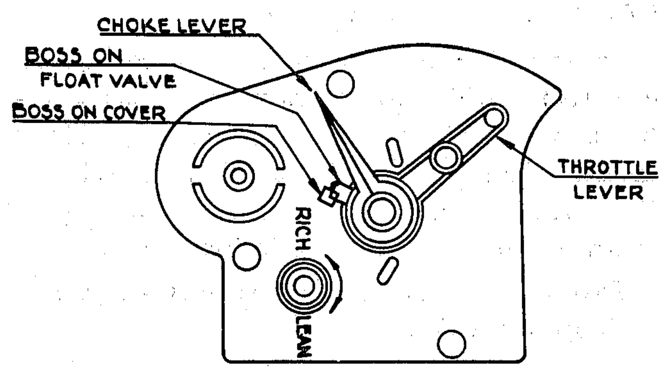
Sectional View Showing Part of Mixing Chamber, High and Slow Speed Needles



Sectional View of Mixing Chamber



Sectional View of Float Chamber



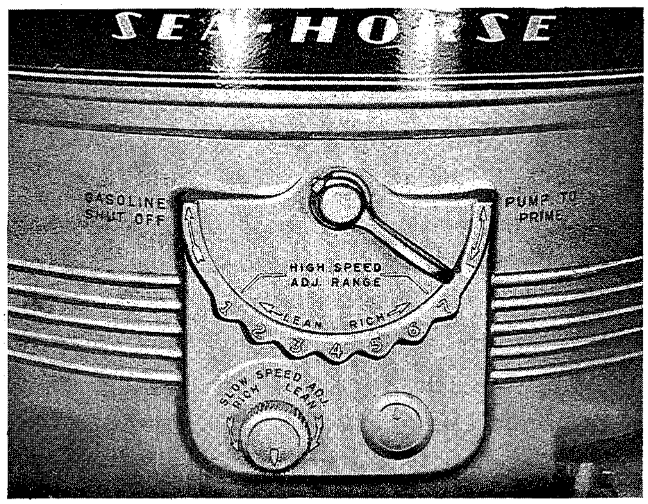
ADJUSTING SYNCHRO-CONTROL

After removing and disassembling the carburetor for repairs, some adjustment in the synchro-control mechanism is required on re-installing. Position of the barrel valve must be adjusted to function in relation to degree of spark advance—closed at spark **retard** and full open at spark **advance.**

Note that stem of the barrel valve is keyed to a small collar which drives against the control (throttle) lever through a friction plate, the purpose of which is to permit turning the barrel valve independently of movement of the magneto lever for choking when starting motor. Two small steel balls are inserted between the plates to assist in obtaining more positive drive when the lever is set for synchro-control. (Spring Loaded Ball Clutch.)

To adjust—install all parts of the carburetor arrangement, attach synchronizing lever to carburetor control lever, but do not tighten control lever clamp screw for the moment. Set spark lever at full advance. Note small boss on the collar (keyed to the barrel valve stem) and rise embossed on the carburetor cover. See illustration. Turn collar (and barrel valve) until the boss slightly overlaps the rise on the carburetor cover as shown. Tighten control lever clamp screw and replace choke lever.

CARBURETION—MODEL SD

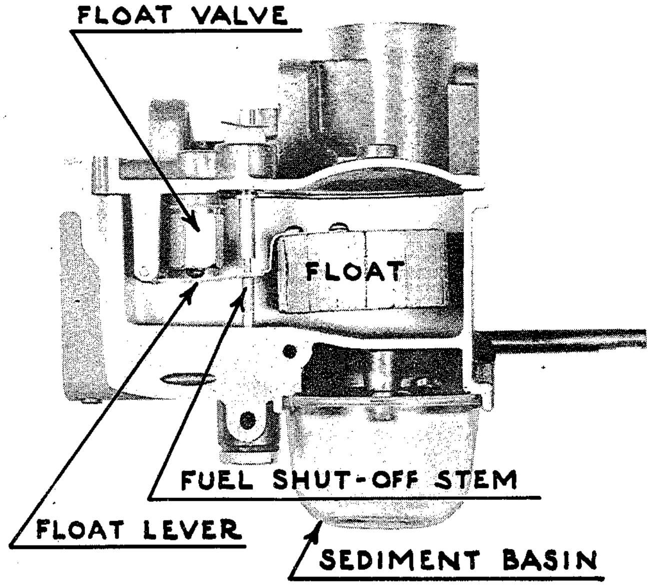


Model SD Carburetor Panel

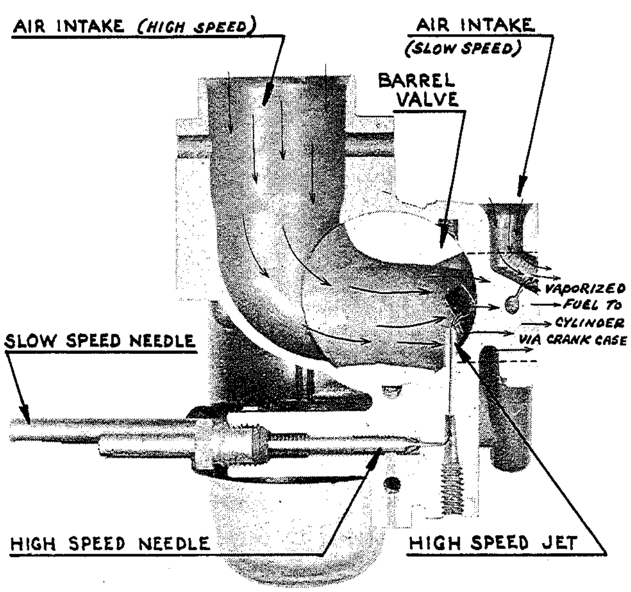
Model SD is of the two port rotary valve type, whereby fuel mixture enters the crankcase by way of two rotary valves built into the crankshaft, thus eliminating the third port in the cylinder wall. Action of carburetor control is such that only the small opening (rotary valve—slow speed) in the center journal of crankshaft functions to permit fuel mixture to enter the crankcase at slow speed. The area of this opening, being comparatively small, results in high velocity of fuel mixture so essential to maintaining proper fuel distribution in the slower speed range. From intermediate to full speed range, the large opening (rotary valve —high speed) in the cheek of the crank functions —this opening being of large area permits full charge entering the crankcase for maximum power.

High and slow speed needle valves (carburetor) are set at the factory for adjustment within a limited range—that is, providing an adjustment range of approximately 90 degrees on the high speed needle valve and 120 degrees on the slow speed needle valve.

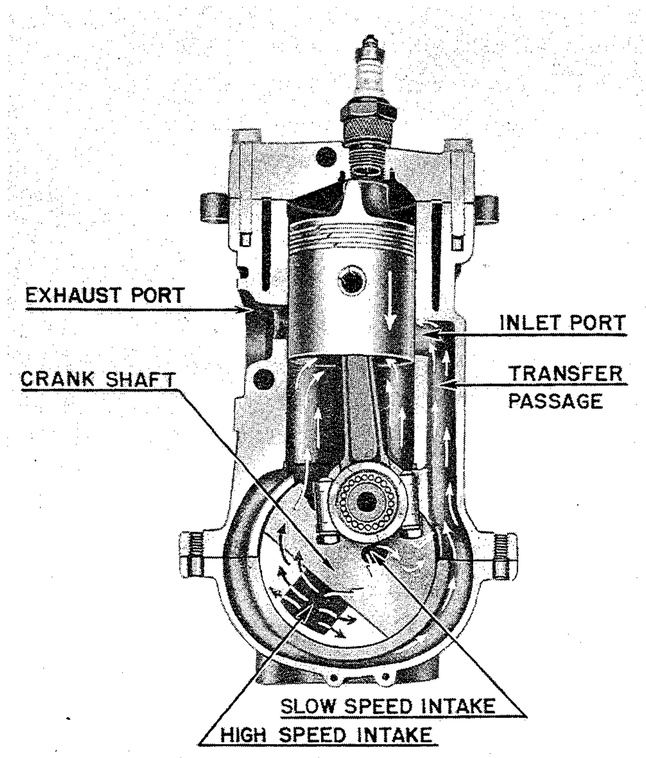
The purpose of the lever to which the high speed needle is attached is three-fold—namely, by moving it to the extreme left, it shuts off the fuel supply to the carburetor (fuel shut-off); by moving to the right, it increases the flow of fuel to provide a pro-



Sectional View of Float Chamber



Sectional View of Mixing Chamber



Top View of Power Head

portionately rich mixture (high speed needle adjustment)—the lever is linked to the primer thus, by moving it to the extreme right and upwards against spring pressure and permitting it to return to normal position, the primer discharges a spray of fuel into the crankcase by way of the slow speed intake to provide a rich mixture for easy starting (primer).

TO OBTAIN FINAL HIGH AND SLOW SPEED NEEDLE VALVE ADJUSTMENT, start motor as instructed and run until normal motor operating temperature is reached (two or three minutes is sufficient). Set spark lever to full advance and throttle control to full open. Move high speed needle lever to right or left as required to obtain maximum speed and best performance. (Lever moved to left results in lean mixture—to right, rich mixture. If mixture is too lean, motor will slow down—if too rich, motor will run sluggishly and smoke profusely). Note position of high speed needle lever when set at best running position for future operation.

To adjust slow speed needle valve, close throttle and retard spark to a position midway between full advance and full retard. If motor runs unevenly, turn slow speed knob to right or left as required to best running position (left for richer mixture—right for leaner mixture). Further retard spark and repeat as above until satisfactory slow speed operation is obtained. Once the slow speed needle valve has been correctly adjusted, it should require little or no attention thereafter.

Note: There is no vent in the gas tank filler cap—fuel in the tank is under slight pressure, built up in the crankcase to provide constant flow to the carburetor. The filler cap must be kept tight.

In the event the carburetor has been removed for cleaning purposes and both slow and high speed needles have been thrown completely out of adjustment, proceed as follows:

1. Open slow speed needle approximately ¾ turn from closed position.

2. Open high speed needle approximately ¼ turn from closed position.

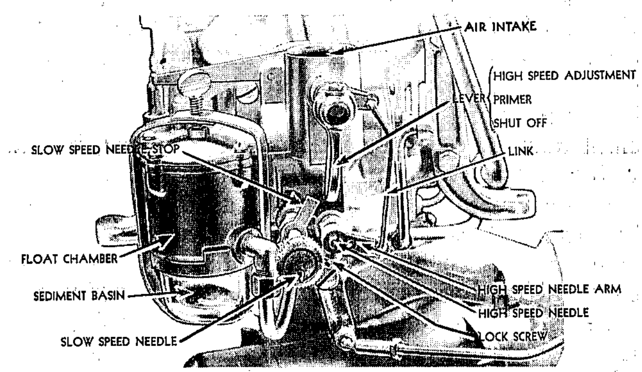
3. Start motor usual way—run until normal operating temperature is reached.

4. Retard spark lever to slow running position. Turn slow speed needle to right or left as required to obtain smooth slow speed operation.

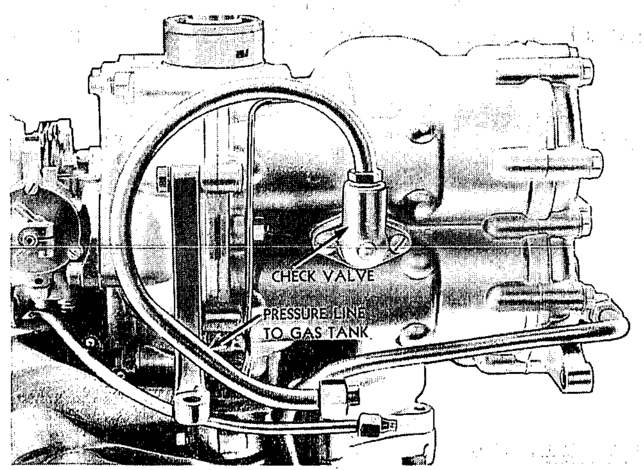
5. Set slow speed needle stop in vertical position so that it will rest on high speed needle when slow speed needle is turned to right—lock in position. (Note: Stop should not set on high speed needle packing nut—this will affect range of movement.)

6. Advance spark to fast running position—turn high speed needle right or left (with screw driver) as required to obtain best high speed setting.

7. Set high speed needle arm at horizontal position—tighten lock screw.



Model SD Carburetor (Panel Removed)

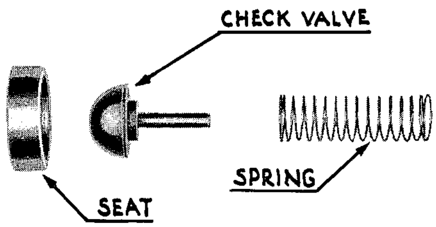


Model SD Pressure System to Gas Tank

8. Replace cover—attach slow speed needle knob and high speed lever. Final adjustment on both needles is thus provided by limited movement of the slow speed needle knob and high speed needle lever when the motor is operated on the boat.

Since fuel to the carburetor is fed under pressure, pressure built up in the crankcase is transferred to the gas tank by way of a simple check valve arrangement and tube leading directly to it as illustrated.

The valve mechanism is installed in the small housing attached to the side of the cylinder block



Check Valve

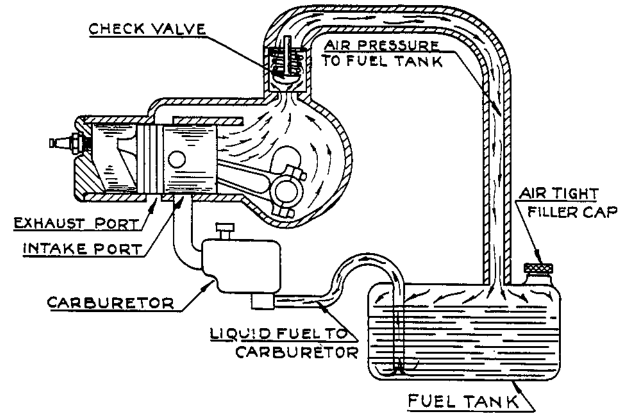
consisting of a seat, check valve, and spring. At period of high pressure (in crankcase) valve is forced off its seat to permit transfer to tank—at low pressure period, valve is forced back on the seat by the spring, to prevent pressure escape from the tank. Valve continues to function in this manner as long as the motor is running.

Two or three cranking efforts are all that is necessary to build up sufficient pressure in the tank for starting purposes. Upon having started, pressure is maintained by running of the motor.

The carburetor is provided with a sediment basin to gather foreign material and moisture which may be present in the fuel and may require cleaning from time to time. To clean, remove high speed needle valve lever and slow speed needle knob—remove cover to gain access to the carburetor. Sediment basin can then be removed for cleaning by loosening the screw at top of float chamber and swinging aside the bracket holding the basin in position. Reassemble in reverse order.

While the check valve functions with a minimum of attention, it must be free of minor irregularities which might otherwise interfere with its normal operation. The check must seat properly on its seat to prevent pressure escaping from the tank—the check valve spring must operate freely in the housing to prevent sluggish action and subsequent pressure escape. The spring, of course, must function freely. All air line connections must be tight.

In event the check valve becomes constantly fouled (fuel to carburetor stops flowing as result of pressure escape) with foreign matter, look for fracture in gas tank stand pipe as indicated by presence of liquid fuel in the pressure air line. It is possible under such conditions for foreign matter to accumulate on the check valve seat, causing liquid fuel to flood the crankcase.



Schematic Diagram to Illustrate Method of Building Up Pressure in the Fuel Tank

SPARK GROUND SWITCH

Practically all gasoline engines are stopped by grounding out the ignition system—grounding of the primary circuit renders the secondary circuit inoperative to cause the spark plugs to cease firing. Grounding in this respect is accomplished by a simple contract switch as illustrated below.

While of simple construction, the ground switch is at times troublesome and interferes with ignition as result of faulty insulation—ground leaks in the primary circuit. Look for faulty insulation here when running down obstinate spark difficulties.

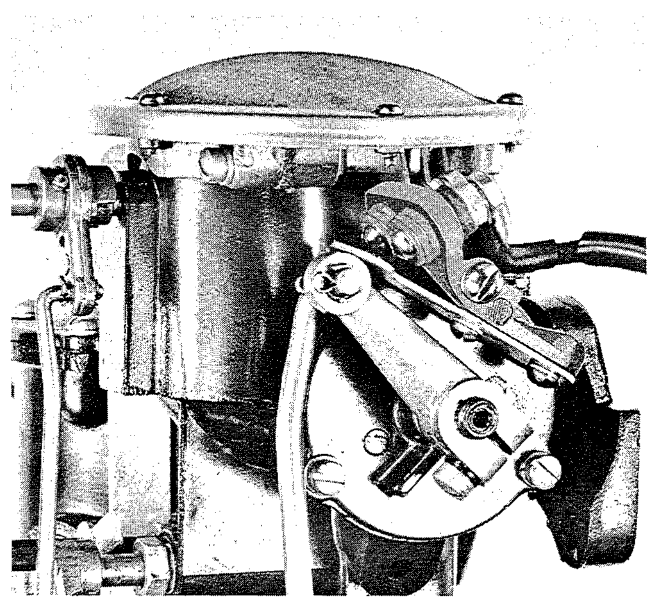
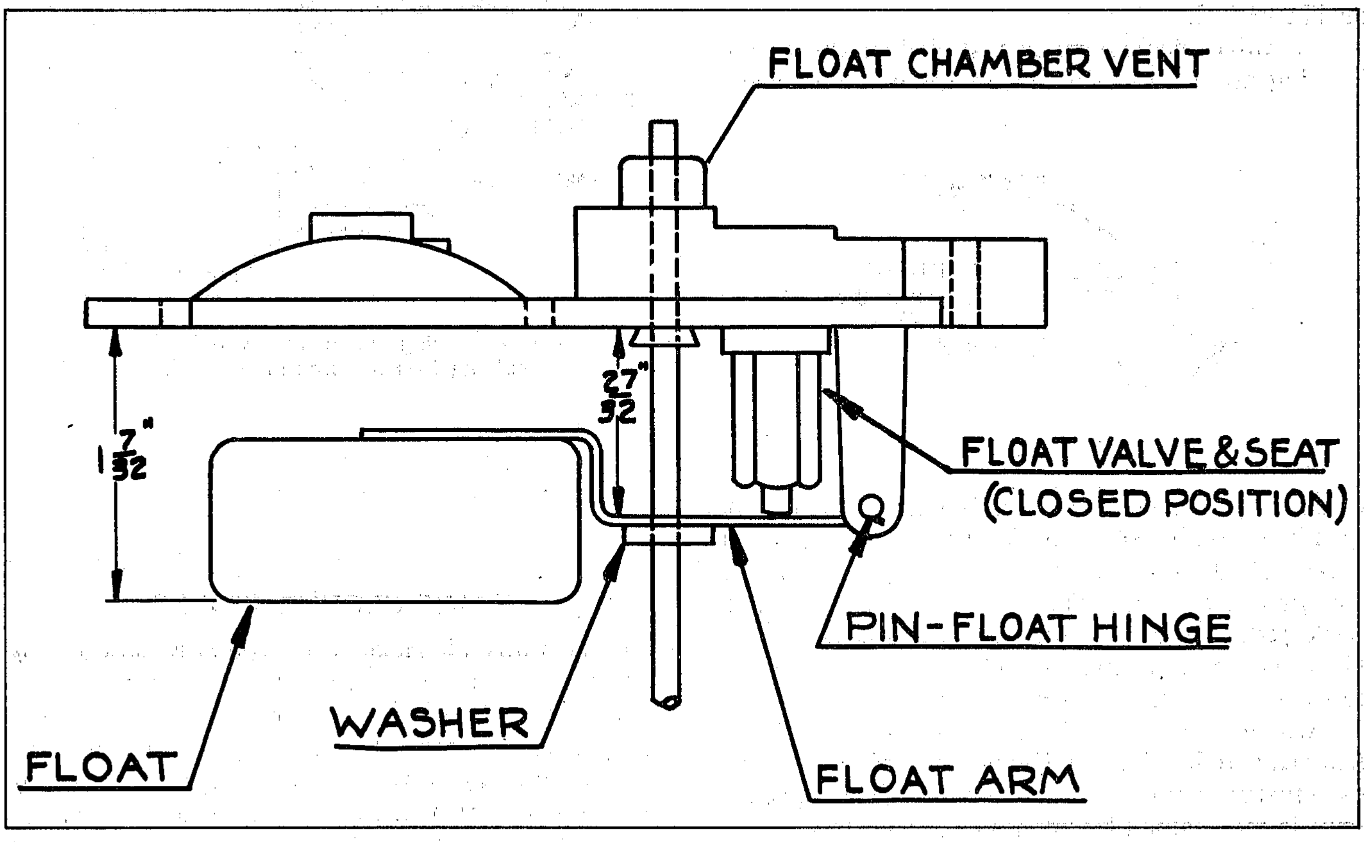


Illustration of SD Carburetor Showing Spark Cut-out

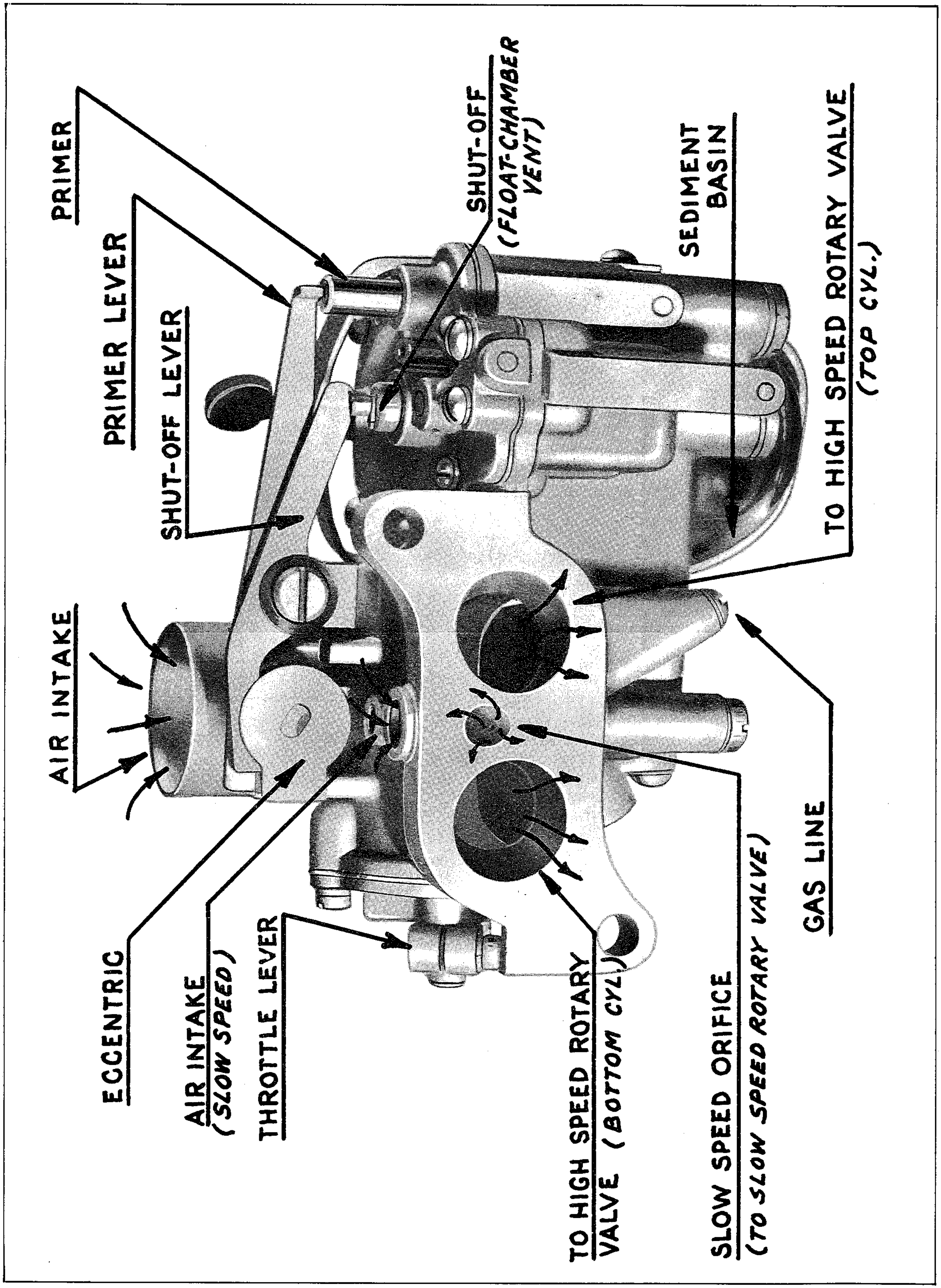
FLOAT SETTING—SD CARBURETOR



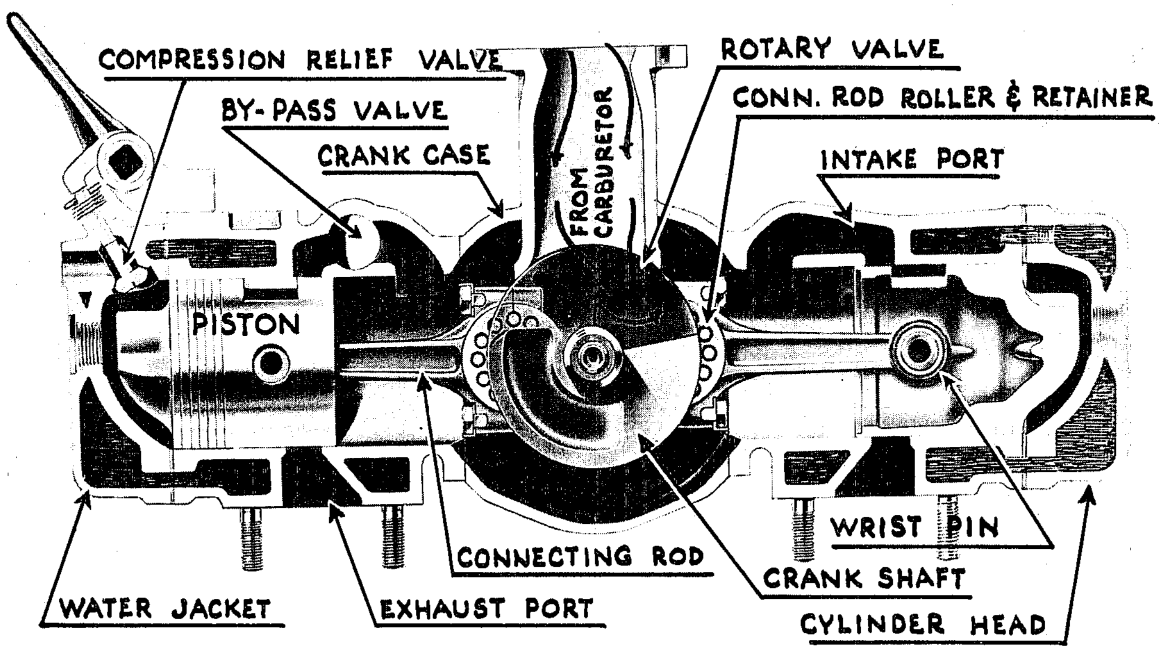
Float Arm and Float Setting

Above is sketch of the SD carburetor float and float valve arrangement, with correct measurements for adjusting float to proper level. This adjustment is accomplished by merely bending the float arm up or down as may be required to obtain correct setting. (Distances are all measured with the float valve closed.) Hold assembly in an inverted position when making adjustment.

NOTES


PRIMER
PRIMER LEVER
SHUT-OFF LEVER
SHUT-OFF (FLOAT-CHAMBER VENT)
SEDIMENT BASIN
TO HIGH SPEED ROTARY VALVE (TOP CYL.)
AIR INTAKE
ECCENTRIC
AIR INTAKE (SLOW SPEED)
THROTTLE LEVER
TO HIGH SPEED ROTARY VALVE (BOTTOM CYL.)
SLOW SPEED ORIFICE (TO SLOW SPEED ROTARY VALVE)
GAS LINE

CARBURETION—MODEL PO

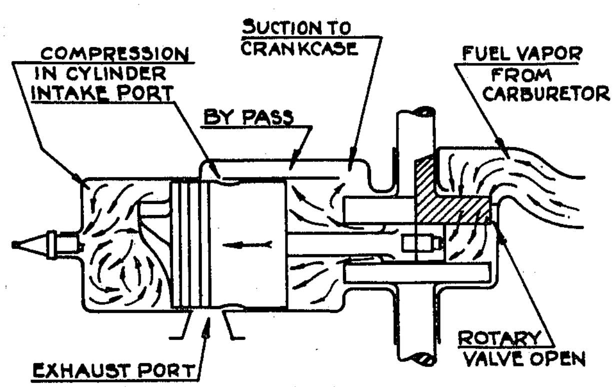


COMPRESSION RELEASE AND BY-PASS VALVE

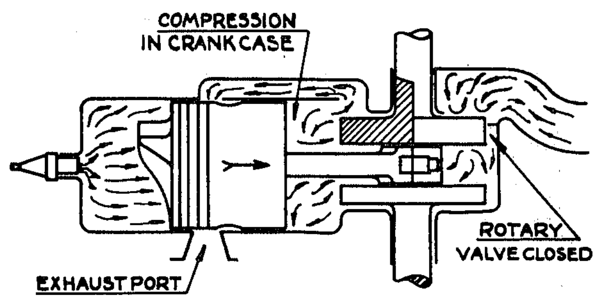
To obtain easy cranking and starting, a compression release and by-pass valve have been built into the port cylinder (left, back to motor).

The compression release consists of a small valve installed in the cylinder head — held closed by a spring and operated at will by movement of the compression release lever. Its function is to relieve compression pressure, when opened for starting purposes, thereby reducing cranking effort, since starting is accomplished on but one cylinder.

The by-pass valve, interlinked with compression release valve, is merely a gate in the by-pass chamber of the cylinder. Its purpose is to close off compression discharge to the port cylinder, resulting in the starboard cylinder (right, back to motor) receiving full compression discharge from crankcase to further facilitate easy starting.



Schematic Drawing to Illustrate Function of Rotary Valve (Built into Crankshaft—Model PO), Valve Open to Admit Crankcase Charge.



Schematic Drawing to Show Rotary Valve Closed

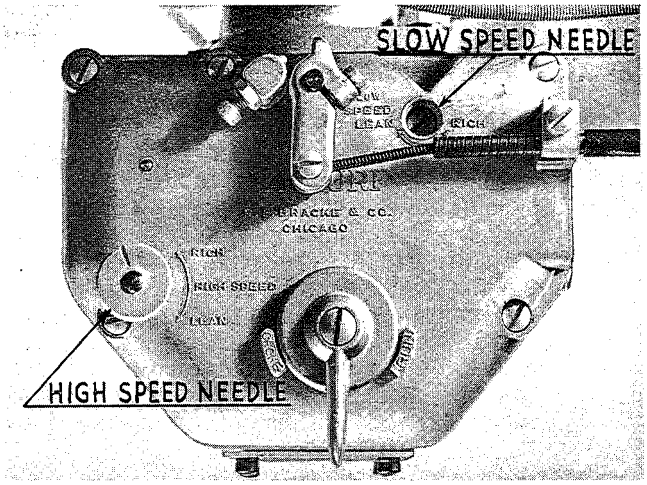
The compression release and by-pass valve operate in unison by movement of the compression release lever—lever moved to right (facing motor), compression release valve open, by-pass valve closed (starting position); if moved to left (facing motor) compression release valve is closed and by-pass valve open (running position).

CARBURETOR ADJUSTMENT

This carburetor is somewhat of a modification of the conventional two-jet carburetor in that a single jet as usual is provided for slow speed operation while two venturi type jets are installed for maximum vaporization at high speed. See illustration. Otherwise, the carburetor functions in the customary manner.

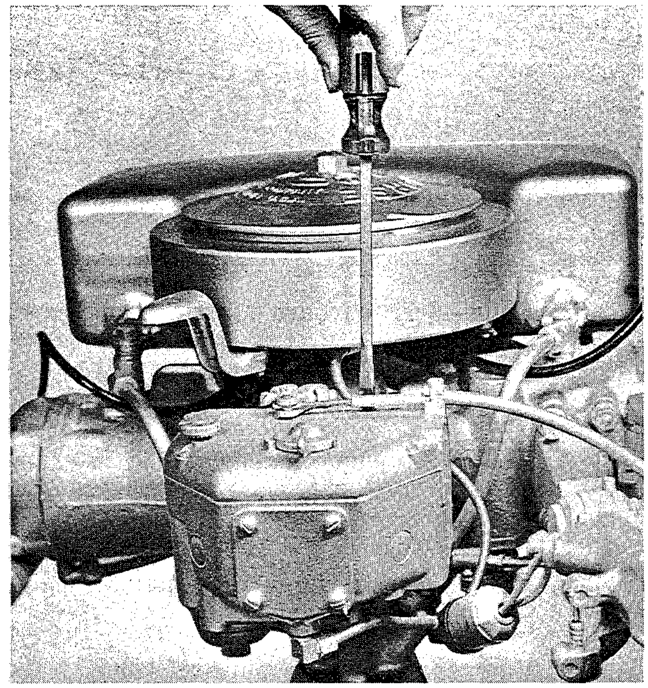
NOTE: Carburetors on the P models, while having a different appearance from those on the PO, basically are of identical construction with the only difference being in shape of the housing.

Carburetor is of the full range type, that is, constructed with two jets to insure efficient carburetion throughout the entire speed range of the motor. The slow speed jet provides correct carbu-



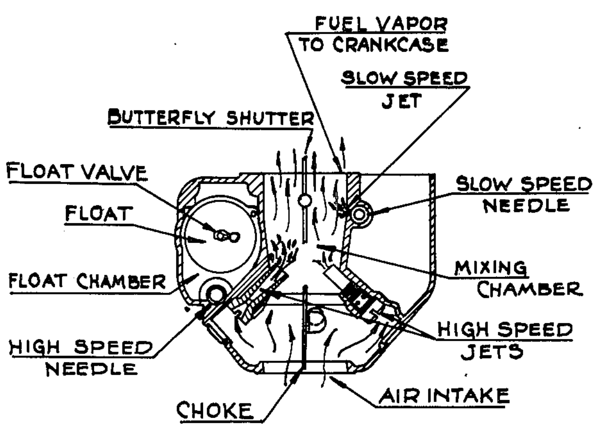
retion at slow and intermediate speeds; the high speed jet from intermediate to top speeds.

Two adjustments are thus necessary—slow and high speed needles.



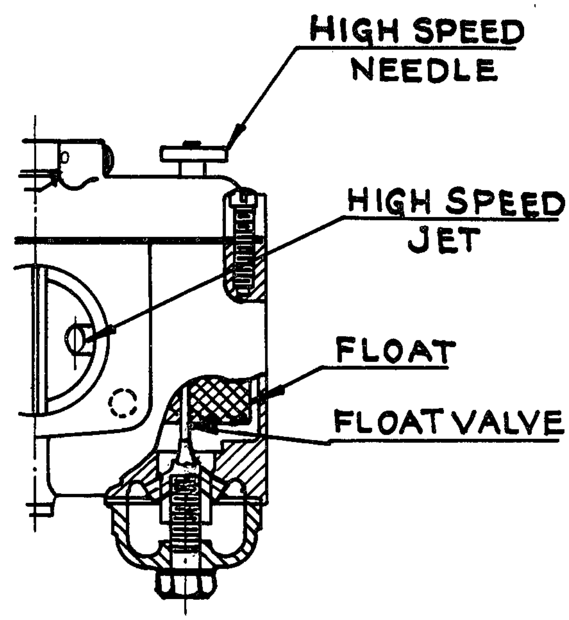
Adjusting Slow Speed Needle

TO ADJUST SLOW SPEED (slow speed adjustment should be made with retarded spark and at normal running temperature) — Close slow speed screw or needle (turn right until it rests gently on its seat). Open approximately ½ turn (turn left). Start motor as instructed and operate at full throttle until it reaches normal temperature. Move magneto lever midway between center position and full retard—close throttle. Turn slow speed needle to right or left as required to obtain smooth operation at slow speed.



Top Sectional View

TO ADJUST HIGH SPEED—Start motor as instructed. Operate at full throttle and full spark advance until motor reaches normal operating temperature. Turn high speed needle to right or left as required to obtain maximum speed.



Sectional View – Float Valve

CHECK CHART—CARBURETION (Common Difficulties)

1. **Fuel**
   A. Contains foreign matter to clog passages, screens, etc.
   B. Contains water to interfere with free flow.
   C. Stale—(causes hard starting and leaves gum deposits to clog screens, jets, passages, check valves, etc.)

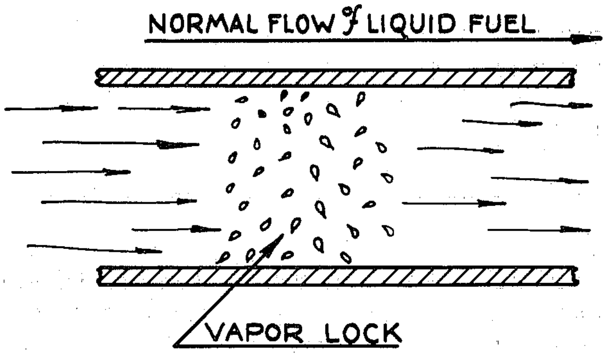
2. **Gas Tank**
   A. Closed air vent in filler cap to interfere with flow of fuel to carburetor. Exception, Model SD—since fuel is fed to carburetor under pressure, cap must be air tight.
   B. Contains water or foreign matter.
   C. Clogged screens.
   D. Clogged fuel line or shut-off valve.

3. **Carburetor**
   A. Water or foreign matter clogging passages, jets and screens. (Clean-out screws are provided for clearing passages in the carburetors.)
   B. Not mounted horizontally on crankcase (older models held in position by clamp) to cause either flooding with float bowl high or starving (lean mixture) with float bowl low.
   C. Float heavy (soaked with gasoline and oil) to cause constant flooding since float settles to bottom of chamber whereby the float valve remains open. Flooding is also caused by foreign matter lodged between the float valve and its seat.

   Flooding or starving for fuel can be caused by improper adjustment of fuel level—**too high** or **too low.** In the case of a cork float as used on most Johnson carburetors, fuel level is pre-set and governed by a groove on the float valve stem which should come to rest between the prongs of a cotter attached to top end of float.

   D. Float valve. Stem bent to cause sluggish action, either flooding or starving. Valve face or seat in carburetor damaged—not seated. (If not too badly pitted or damaged, it is possible to re-seat by simple lapping operation.)
   E. Faulty check valve—LS, H, LT and T series.
   F. Vapor lock. When gasoline is heated up to a certain point it begins to boil, so to speak, thus vaporizes and in a way creates a "void" (vapor lock) in the fuel system to interfere with carburetion by interrupting normal flow of the liquid.

   Faulty muffler or muffler assembly in some of the older models is frequently responsible for creating vapor lock. Exhaust leaks in the muffler assembly directly underneath the tank, result in hot gases heating the fuel contained to near critical boiling point—thus, as the fuel progresses toward the carburetor, heat normally radiated by the running motor and muffler is sufficient to raise the already pre-heated fuel to actual boiling point, causing it to

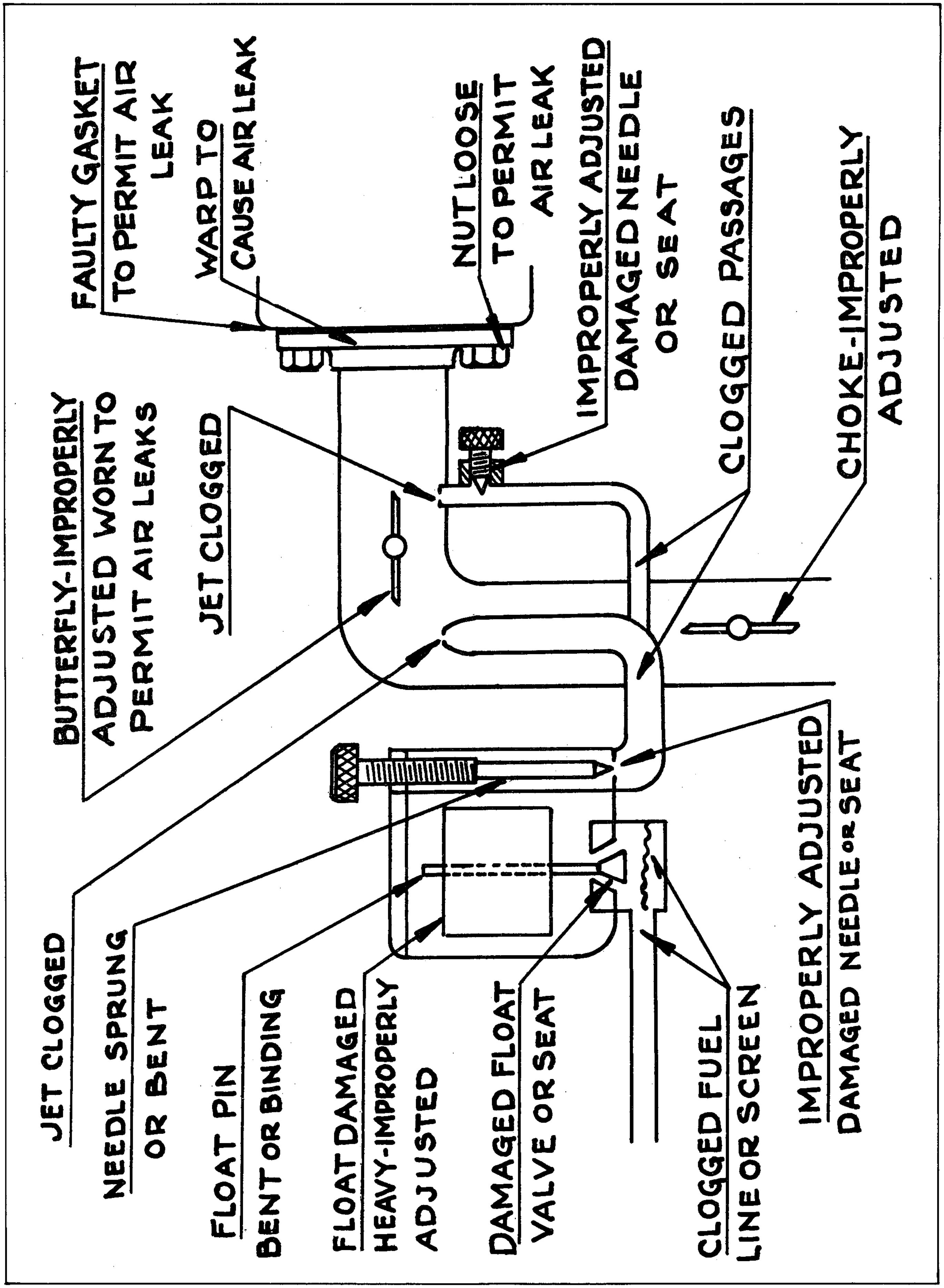


vaporize (boil) and ultimately form a vapor lock.

   Further—like conditions can be created if, when assembling mufflers for the older models, the inner shell is installed with the row of exhaust holes directed upward. This concentrates excessive heat on the top side of the muffler directly under the tank which causes pre-heating of the fuel. Likewise, if the gas line is accidentally bent or installed too near the hot exhaust castings, resulting absorption of heat will cause the liquid fuel in the line to boil and create a vapor lock.

   In event of a faulty cooling system (any model) the entire power head, including the carburetor, becomes excessively hot, thus, the liquid fuel vaporizes or boils immediately on entering to produce a vapor lock. The fuel must be liquid if it is to be properly vaporized for efficient carburetion.

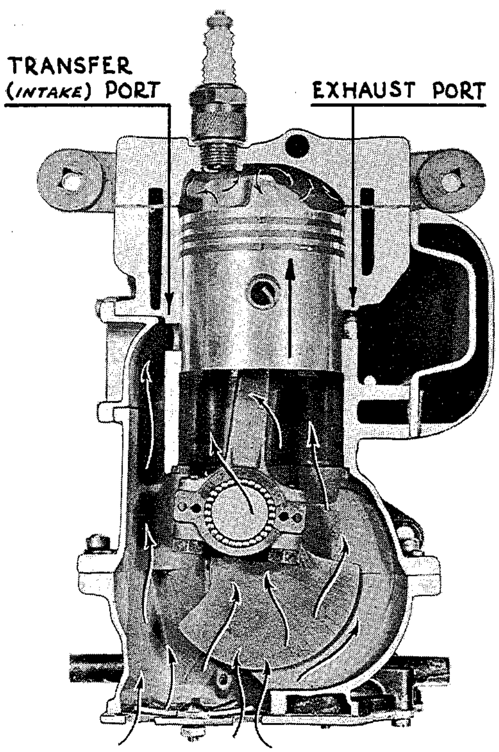
   G. Damaged needle valve seats — high and slow speed, to make proper adjustment difficult or impossible. This usually comes from turning the needles down too tightly on their seats. The seats then become spread or distorted while the face of the needle is grooved. Correction involves replacing affected parts — carburetor body or slow speed insert as the case may be.
   H. Improperly adjusted butterfly shutter.


FAULTY GASKET TO PERMIT AIR LEAK
WARP TO CAUSE AIR LEAK
NUT LOOSE TO PERMIT AIR LEAK
IMPROPERLY ADJUSTED DAMAGED NEEDLE OR SEAT
CLOGGED PASSAGES
CHOKE-IMPROPERLY ADJUSTED
BUTTERFLY-IMPROPERLY ADJUSTED WORN TO PERMIT AIR LEAKS
JET CLOGGED
JET CLOGGED
NEEDLE SPRUNG OR BENT
FLOAT PIN BENT OR BINDING
FLOAT DAMAGED HEAVY-IMPROPERLY ADJUSTED
DAMAGED FLOAT VALVE OR SEAT
CLOGGED FUEL LINE OR SCREEN
IMPROPERLY ADJUSTED DAMAGED NEEDLE OR SEAT

NOTES

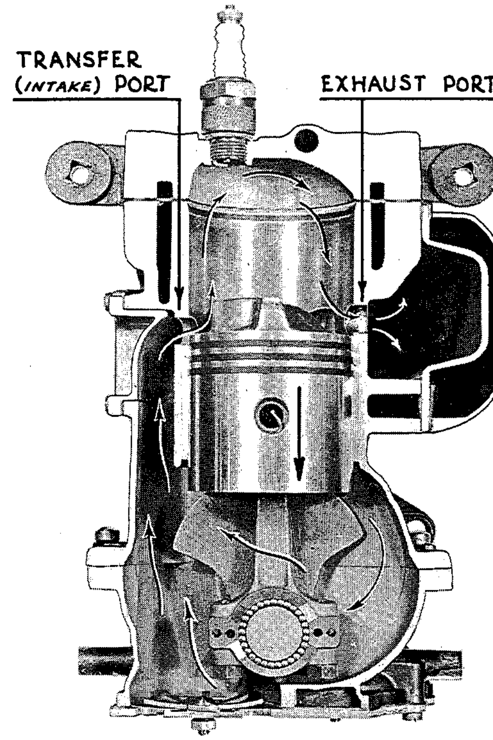
CARBURETION—MODEL QD

The Model QD is a two port, two (stroke) cycle engine, relying on the use of an automatic leaf valve for crankcase induction. As suction is created by upward movement of the piston to result in low crankcase pressure, the leaf valve is forced off its seat due to higher pressure without and comparatively low pressure within the crankcase. This causes an air stream to flow through the carburetor mixing chamber and the resultant fuel vapor to flow into the crankcase, thus charging the crankcase. Crankcase suction diminishes as the piston reaches the top of its stroke—the leaf valve then springs back against its seat to seal the crankcase. The charge in the crankcase is compressed on following downward movement of the piston—crankcase pressure builds up until head of the piston uncovers the transfer or intake port in the wall of the cylinder when the compressed vapor charge in the crankcase discharges into the cylinder. See pages 59 and 107.



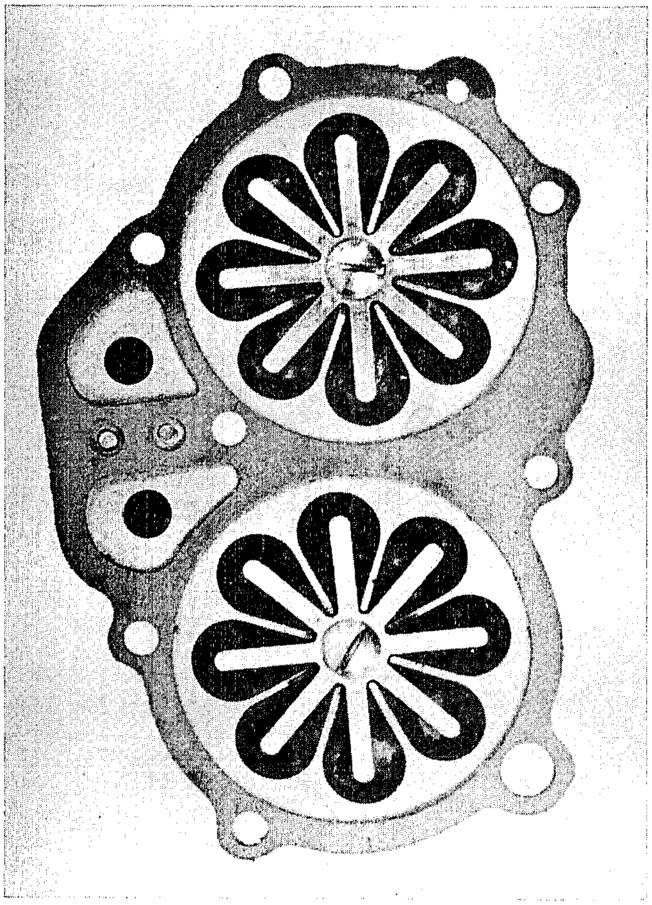
Sectional View Showing Piston Moving Upward, Vaporized Fuel from the Carburetor Being Drawn into the Crankcase by Way of the Automatic Leaf Valve and Compression of a Previous Charge in the Combustion Chamber. Note Intake, Transfer and Exhaust Ports Are Covered by the Piston.

Actually, the automatic leaf valve as employed in the Model QD consists of eight leaves or segments arranged in daisy petal fashion anchored in center position to a plate drilled with eight corresponding holes to complete the valve assembly—one assembly for each crankcase chamber. The plate, of course, must be flat and true to maintain a "tight" seal with like surface of the leaf. A guide is attached to the assembly to limit movement of each segment. Naturally, all eight leaves or segments lift from their respective seats simultaneously to admit fuel vapor into the crankcase when sufficient suction or low pressure is built up and close together as suction diminishes. The leaves open into the crankcase. Leaf plate is constructed of specially heat treated beryllium copper. Do not, under any circumstances, bend or flex leaves of the valve by hand—in such event they are rendered unfit for use and should be discarded.



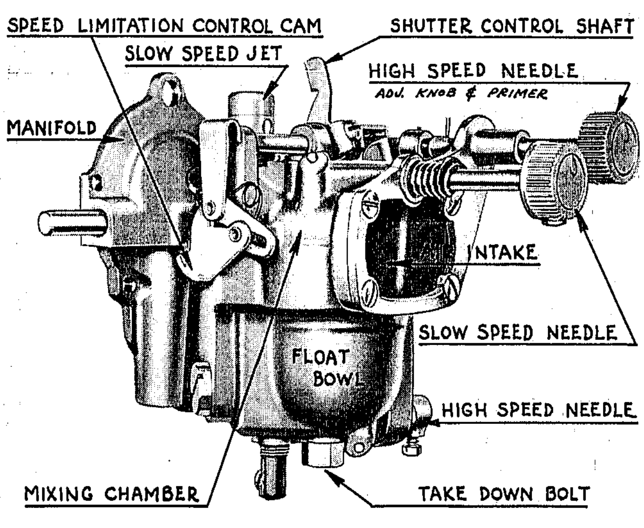
Sectional View Showing the Piston Moving Down, Intake (Transfer) and Exhaust Ports Open (Uncovered by Piston) Exhaust Gases Discharging into Exhaust Manifold, and Compressed Crankcase Charge Flowing into Cylinder, Later to be Compressed and Ignited.

The automatic leaf valve in this case replaces the third port or rotary valve employed in other models. It is automatic in that it does not open until sufficient low pressure is built up in the crankcase to overcome leaf tension pre-established by special heat treatment of the material of which it is constructed. The degree of leaf opening depends upon



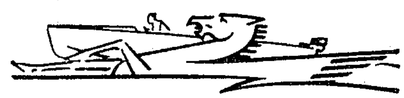
Leaf Plate Assembly—Side Opening into Crankcase

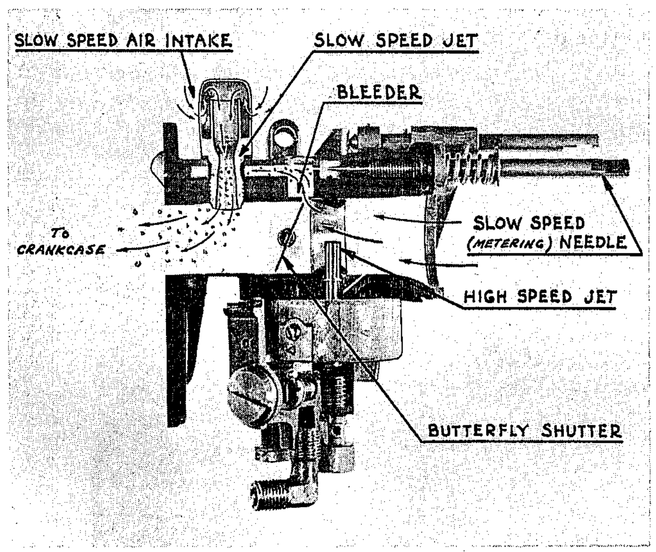
crankcase pressure which varies with the rate of speed at which the motor is operating. Such action results in more satisfactory performance throughout entire speed range of the motor. Both the third port and rotary valve open to same degree regardless of motor speed, while the automatic leaf valve only in proportion to demand created at various motor speeds, thus acting more efficiently.



Model QD Carburetor Only.

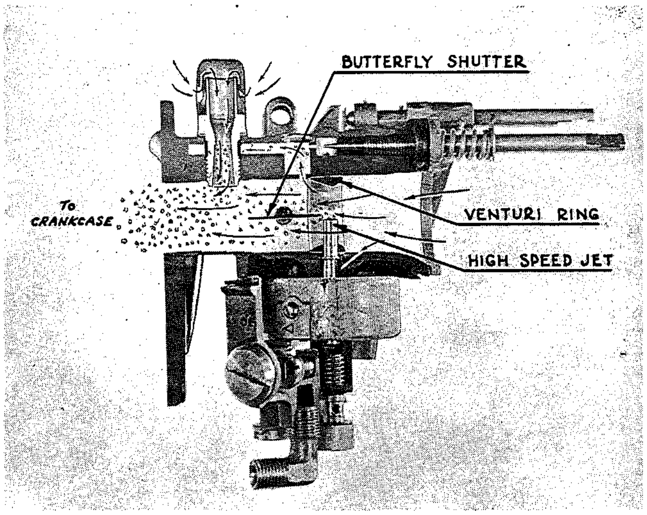
The carburetor is of the float feed two jet type consisting of a mixing chamber with integral intake manifold and conventional float chamber to which are added synchro and speed limitation control mechanisms (to be explained later) as required for gear shift. Two adjustments are provided, namely, for high and slow speed performance. See pages 62, 63 and 64.



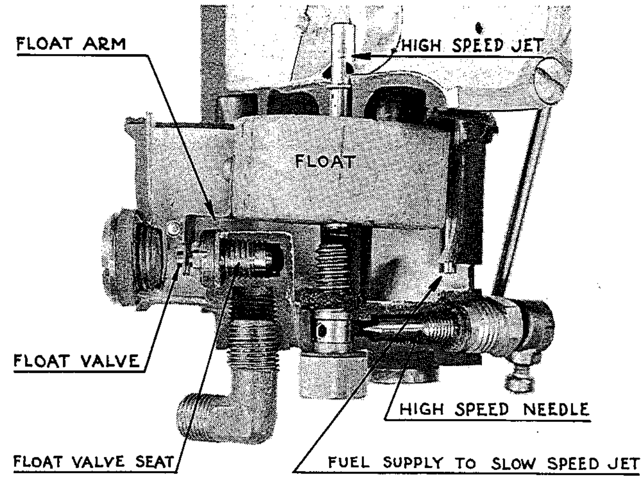


Sectionalized View of Mixing Chamber Showing Shutter Set for Slow Speed Operation. Note Maximum Fuel Vaporization at Slow Speed Jet.

Above illustrates action of carburetion during slow speed performance of the motor. Note that the butterfly shutter is closed to permit very little air flowing through the mixing chamber except for the small stream entering the bleeder orifice. High suction created in the crankcase at this time, causes air to enter through the slow speed jet at high velocity, since area of the jet is comparatively small. Air velocity is further increased by constriction of the area as can be seen in sectional view (known as venturi). This subsequently results in partially vaporized fuel (effect of air bleeder has previously caused the liquid fuel to break up) flowing through the several small orifices (holes) in the slow speed jet to mix with the high velocity air stream to produce the fuel vapor essential to combustion. See pages 62 to 64.



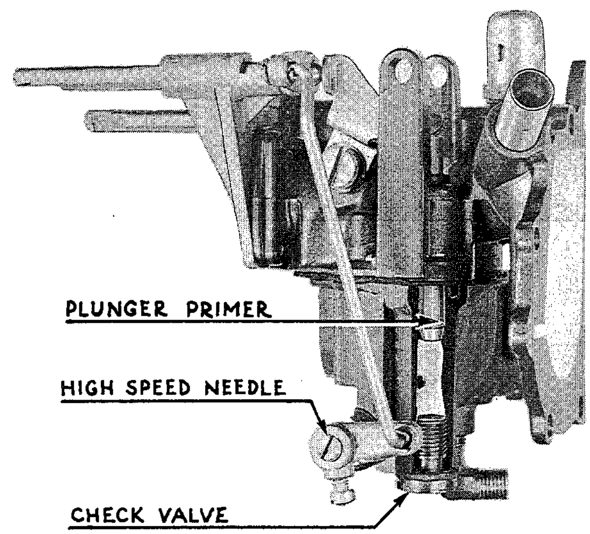
Sectionalized View of Mixing Chamber with Shutter Set for High Speed Performance. Note Maximum Fuel Vaporization at the High Speed Jet, also Effect of Restriction Caused by the Venturi Ring to Increase Air Velocity in Area of the High Speed Jet.



Sectionalized View of Float Chamber.

Sectional view above shows action of carburetion during top speed performance of the motor. Note that the butterfly shutter is full open to permit maximum flow of air through the mixing chamber. Velocity through the mixing chamber at this time is comparatively high but proportionately diminishes with closing of the butterfly shutter to reduce motor speed. To obtain maximum air velocity (required for maximum fuel vaporization) in area of the high speed jet, a venturi ring has been installed, as shown above. The ring actually consists of a constriction in the air stream (funnel like). Cross section of the venturi indicates a rather abrupt but curving constriction on the leading side—gradually tapering to full diameter on the trailing side to result in maximum air velocity in the jet area, thus maximum fuel vaporization.

High and slow speed jets do not function independently of each other, however, vaporization takes place only at the slow speed jet when the butterfly shutter is closed for slow speed motor operation. Vaporization at the slow speed jet decreases in proportion to butterfly shutter opening. Conversely, vaporization at the high speed jet proportionately increases until full open position of the butterfly shutter has been reached to result in maximum vaporization (at high speed jet) and a minimum of vaporization at the slow speed jet. The slow speed jet then functions in various degrees throughout the entire speed range of the motor—the high speed jet remaining idle when the butterfly shutter is closed for slow speed motor performance.



Sectional View of Float Chamber Showing Primer Plunger and Check Valve Assembly.

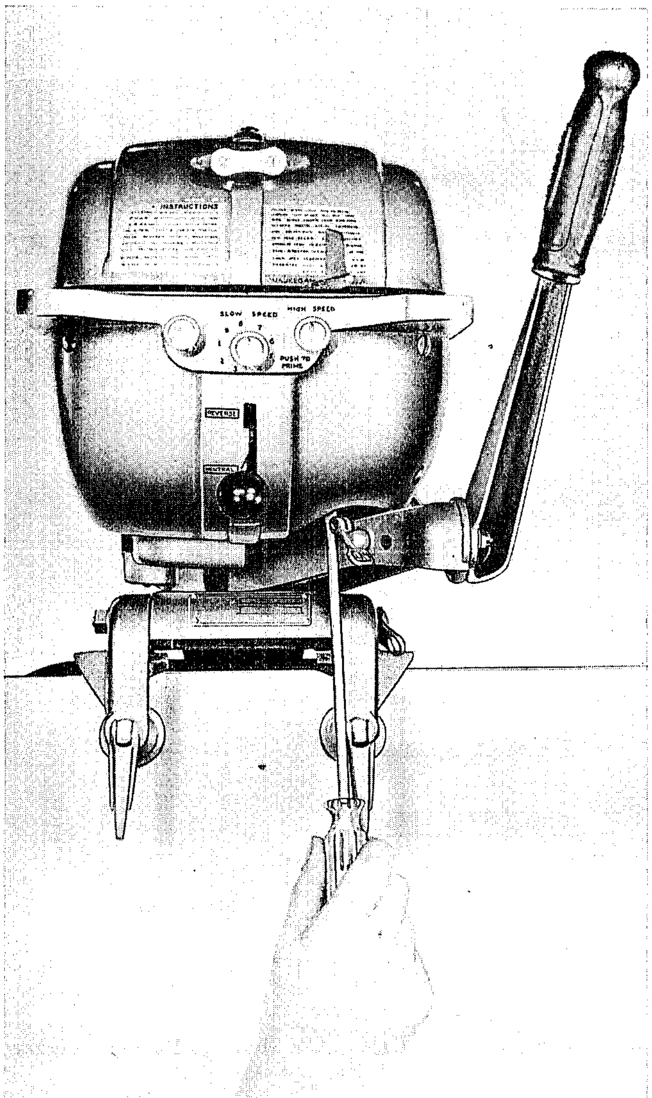
To Adjust High Speed Needle

Start motor, set shift lever to "forward" position and allow to run at top speed (move control lever to "fast" position) until normal operating temperature is reached. Turn "high speed" needle knob to right or left as required to obtain maximum performance. This adjustment should be performed only with control (speed) lever set for top speed—position "fast" (spark at full advance and carburetor shutter at full open).

The high speed needle is initially adjusted at the factory but provisions are made for limited adjustment to compensate for variations apt to be encountered during normal operation of the motor.

In event restricted range of adjustment is not sufficient to obtain proper high speed needle setting, proceed as follows:

Loosen screw holding small bell crank fast to the high speed needle—accessible under side cover as shown below.



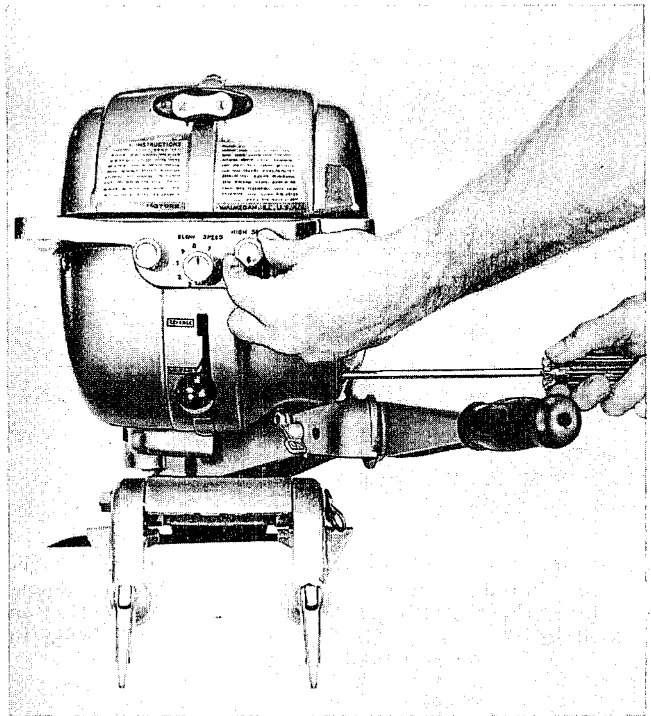
End of the high speed needle is slotted to accommodate screw driver bit.

Start and operate motor at "fast" speed until normal temperature is attained.

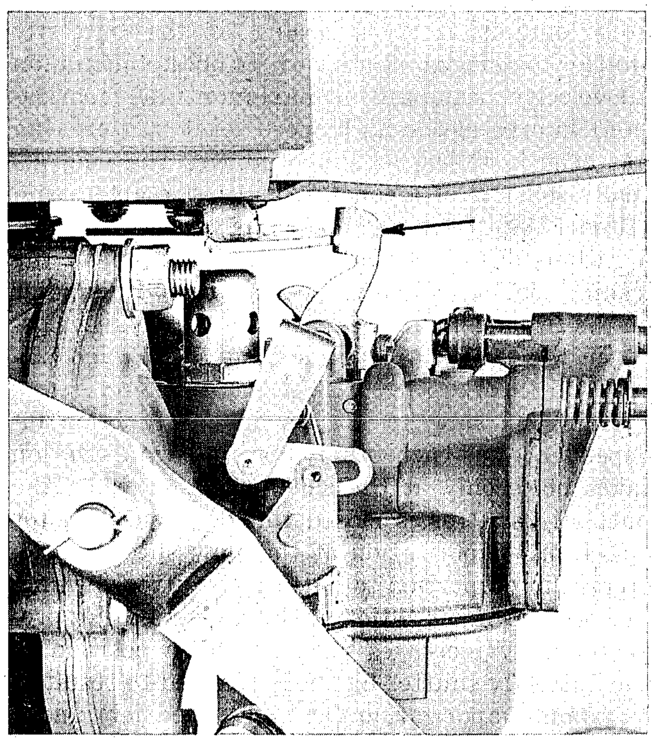
Set high speed (needle) adjusting knob to center position—arrow down, and hold in this position.

Insert screw driver through port in side cover to engage high speed needle.

Turn high speed needle to left or right as required to obtain maximum speed or best running position. (Left, to enrich mixture—right, to lean out).



While still holding high speed (needle) adjusting knob in center position, tighten screw in bell crank to secure.



Showing Carburetor Synchro-Control Lever Riding Against Cam Attached to the Armature Plate. In Following Contour of the Cam Plate as the Speed Control Lever Is Moved to Right or Left, the Carburetor Shutter (Butterfly) Opens or Closes in Proportion to Degree of Spark Advance (Speed of Motor).

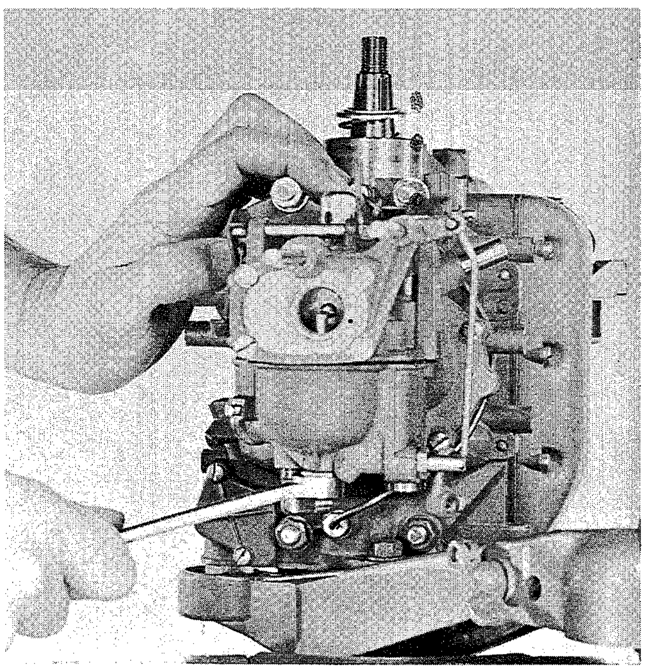
To Adjust Slow Speed Needle

Move control (speed) lever to "slow" range position. While operating within slow speed range, turn slow speed needle knob to right or left as required to obtain satisfactory slow speed performance. Move control lever farther to left to further retard motor speed. Reset slow speed needle as, and if, required to obtain smooth operation. (Note: Turning needle to left enriches the fuel mixture—that is, increases proportion of fuel to air. Turning the needle to right reduces proportion of fuel to air to result in lean mixture). An excessively rich mixture is indicated by "rough" running of the motor. "Spitting or coughing" in the carburetor is indicative of a lean mixture.

The high speed needle may require further attention (adjustment) on attaining final adjustment of the slow speed needle. Proceed as above in this event.

To Remove Carburetor

In event it becomes necessary to remove the carburetor, the float chamber must be first removed.

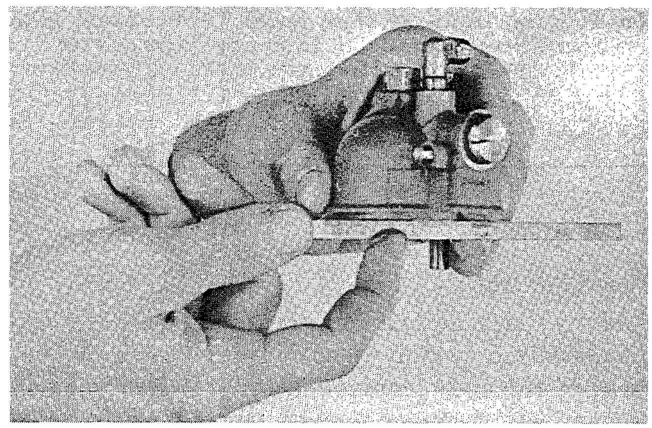


Removing Carburetor Float Bowl.

This operation is followed by removing the small screws holding the mixing chamber and integral manifold fast to the crankcase. One screw immediately back of the float bowl prohibits detaching the carburetor assembly without first removing the float bowl. Reassemble in reverse order, being careful to guard against damage to the gasket, float arm or primer spring. Careful assembly is not too difficult to accomplish.

To Adjust Float Level

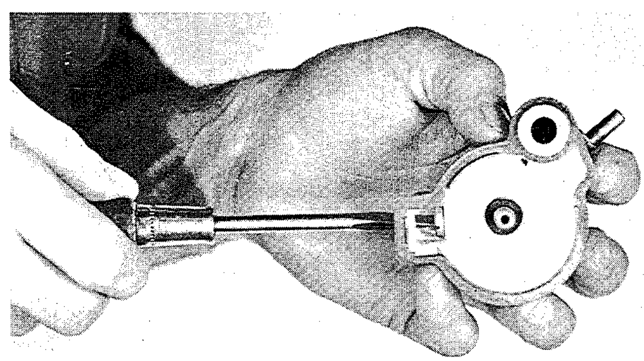
It may become necessary to adjust the float level, possibility resulting from attempting to install the float bowl to throw it slightly out of adjustment. Turn the float bowl assembly upside down—place a straight edge across edge of bowl. Float level is correct when top face of the cork float comes to rest flush with the edge of bowl. In event it falls below level of edge of bowl when in upside down position, fuel level will be too high causing float bowl to overflow and drip. (Dripping from the float bowl may also be caused by a loose fitting or otherwise impaired float valve and seat assembly. Make certain this assembly is secure in the float bowl).



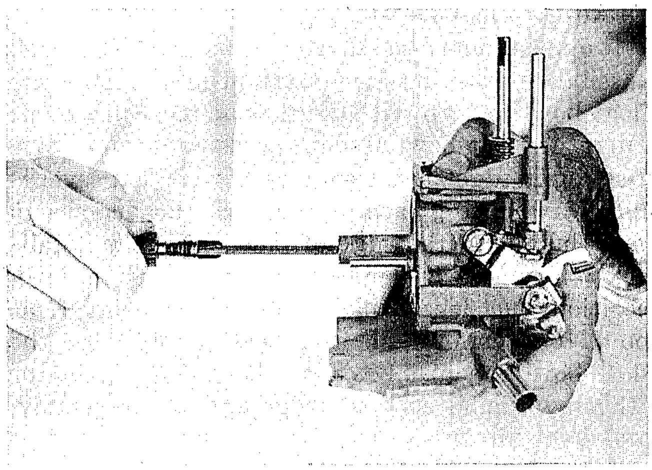
Method of Checking Float Level.

If top surface of the float fails to reach a position flush with the straight edge, fuel level will be too low to result in carburetor "starving" to interfere with motor performance particularly at high speed.

To correct float level, carefully bend float arm as required to obtain proper setting. Make sure no binding exists—the float must function freely to obtain maximum carburetor performance. See carburetor Check Chart, pages 90—91 and instructions regarding shutter, which apply equally to QD carburetor—faulty shutter closing affects slow speed operation.



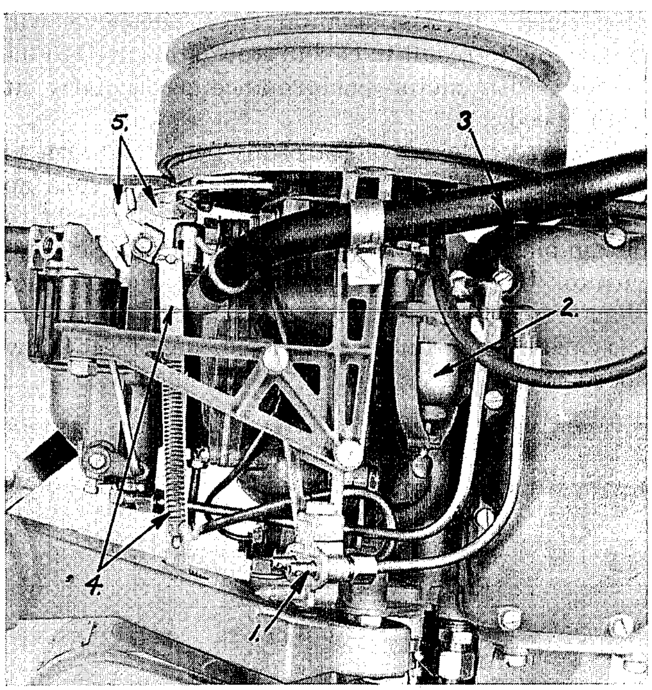
Removing or Installing Float Valve Seat.



Removing or Installing High Speed Needle–Loose High Speed Needle Can Result in Irregular Carburetor Performance.

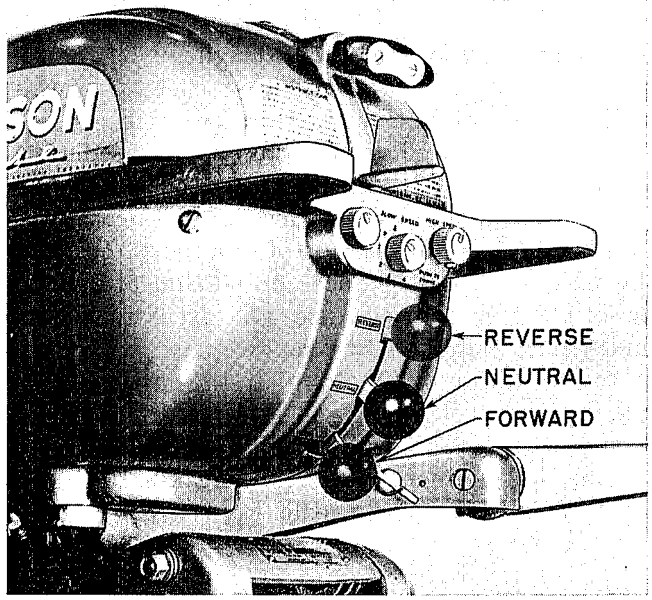
Speed Control

Since spark and carburetor shutter control are synchronized, motor speed is controlled by movement of the speed control (magneto) lever—slow, when to left (facing motor) and progressively gaining speed as the lever is moved to right.

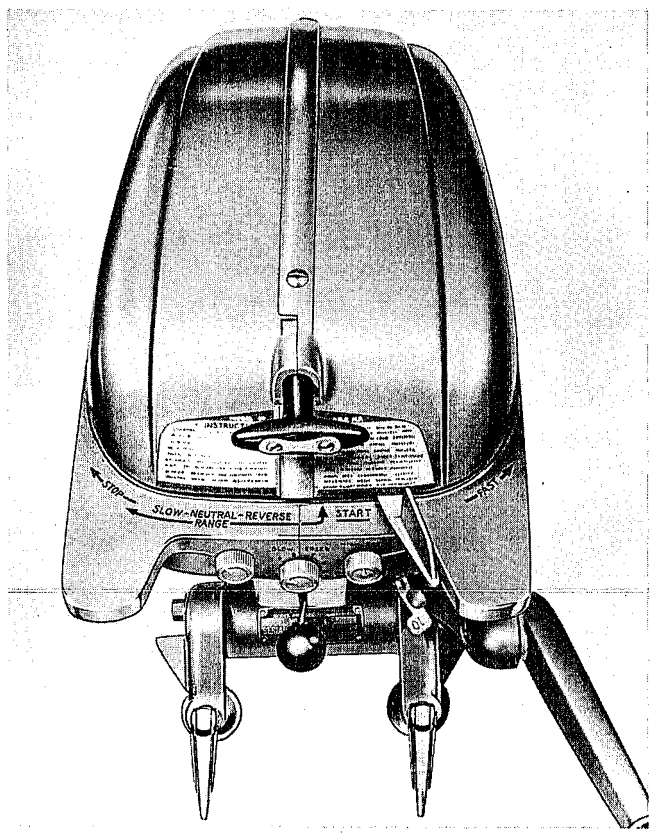


Showing (1) Fuel Line Connector, (2) Filter, (3) Leaf Valve Silencer Tube, (4) Spring and Lever Applying Tension on Carburetor Shutter Shaft and (5) Lever Riding Against Cam on Armature Plate–Synchro Control.

Gear Shift



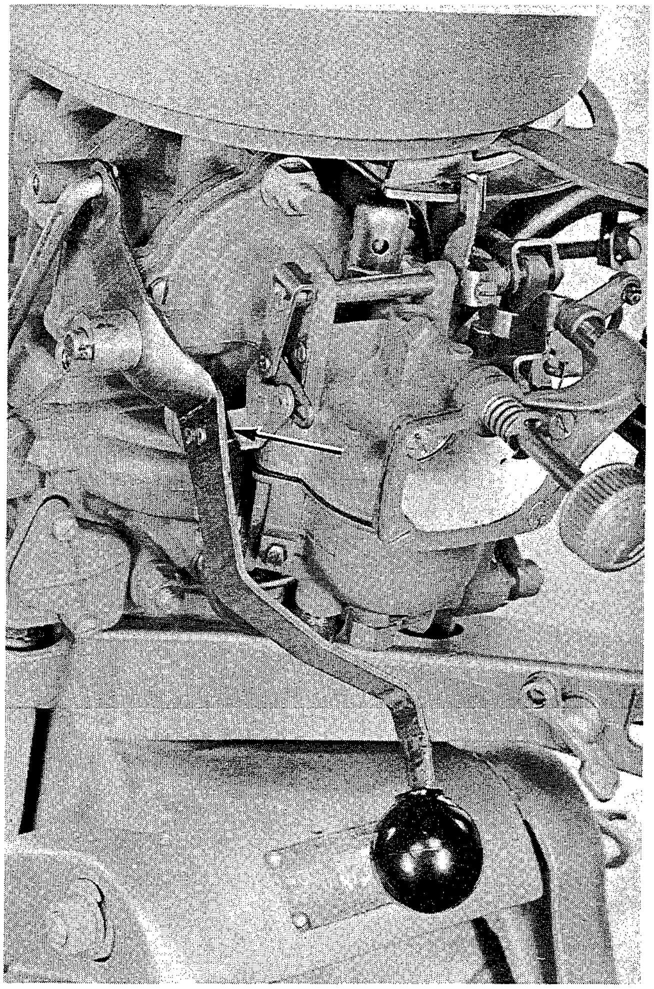
Showing Three Positions of the Shift Lever.



Showing Speed Control Lever on Panel.

FORWARD OPERATION. The shift lever can be moved into "forward" position regardless of control (speed) lever setting (Start, Slow, Fast, etc.) and while in this position, the motor functions in conventional manner.

NEUTRAL OPERATION. The shift lever can be moved into "neutral" position only when the control (speed) lever is set within "neutral" range (indicated on the motor rest bracket).

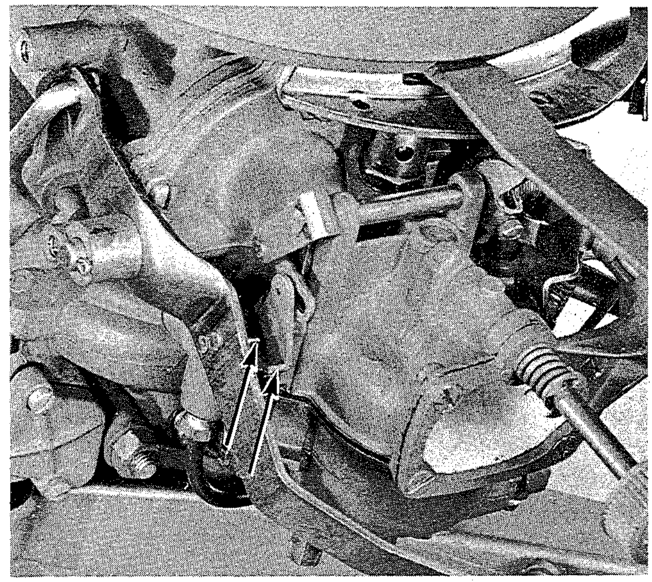


Showing Position of Speed Limitation Control Cam with Respect to Gear Shift Lever Set in "Forward" Position. When Set in This Position (Forward) the Motor May Be Operated at Any Desired Speed within the Limits of Its Capacity Since the Small Bracket on the Shift Lever Does Not Engage the Limitation Cam to Limit Opening of the Carburetor Shutter.

The control (speed) lever may be moved to any position with the gear shift lever in "neutral". However, it is not recommended that the motor be operated beyond range indicated for "neutral" or "reverse". It is possible, but not recommended, to shift into "forward" position with the control lever set beyond "neutral" or "reverse" range. The gear shift lever cannot be moved back into "neutral" once the control lever is moved beyond the "neutral-reverse" range.

The Control Lever Must Be Positioned Within the "Neutral-Reverse" Range Before Shifting Back to "Neutral." Do Not Force.

REVERSE OPERATION. The same speed restrictions apply to "reverse" as apply to "neutral" operation. The control (speed) lever must be set within "neutral-reverse" range prior to shifting into "reverse."



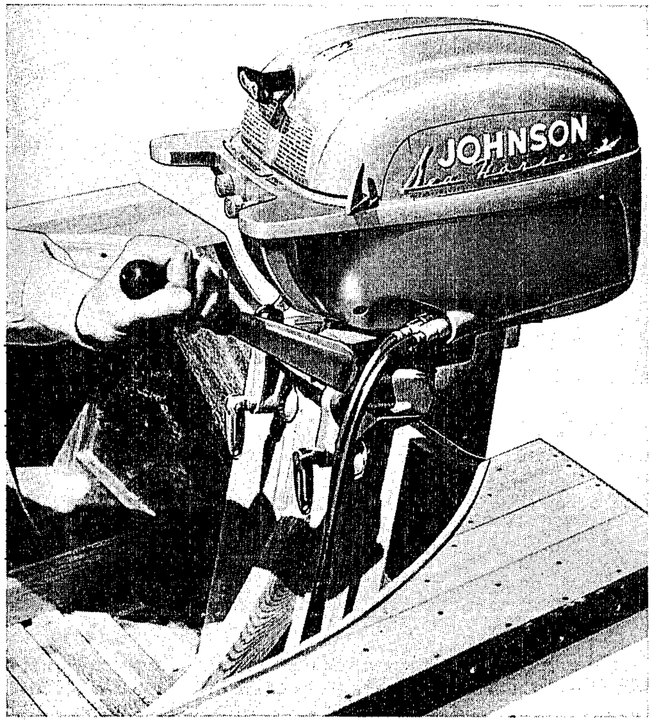
Showing Shift Lever Set at "Neutral" or "Reverse" Position. Note Position of Bracket on the Shift Lever with Respect to the Speed Limitation Cam on the Carburetor. In This Position the Small Bracket Engages the Cam to Restrict Its Degree of Travel and Subsequently Limiting Movement of the Carburetor Shutter to Prohibit Motor Speed Beyond a Narrow Range—Up to Approximately 2000 R.P.M.

Motor power and speed are automatically limited in reverse as a precaution against damaging the boat. The reversing feature is provided for maneuverability of the boat, though not efficient for pulling heavy loads.

Do Not Attempt to Force the Gear Shift Lever into "reverse" or "neutral." Move control (speed) lever within "neutral-reverse" range, then shift to "neutral" or "reverse" with ease.

Actually, little is gained when attempting to test a motor (after repairs) in a tank with the regular propeller installed — it starts hard, it doesn't turn up as it should, neither does it idle as it should. Further— it is impossible to obtain proper carburetor needle settings, not to mention the impossibility of conducting a satisfactory demonstration for the owner or prospective buyer. Test wheels are important and very necessary equipment for the well equipped and organized Johnson Service Shop.

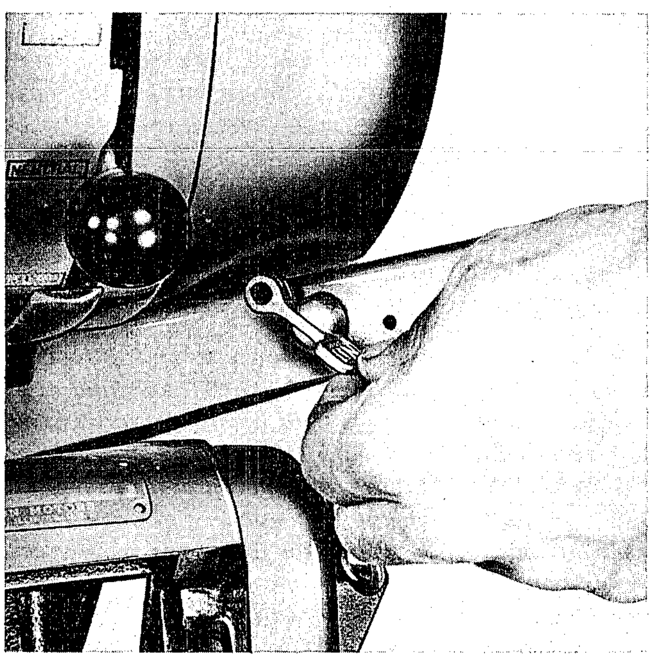
Occasions may arise when it is advisable to suddenly reduce motor speed at a moment's notice. This can be accomplished by simply raising or tilting the steering handle up as shown here—provid-



Tilting Steering Handle to Reduce Motor Speed.

ing the small lever on the steering handle bracket has been pre-set to position "ON" as shown below.

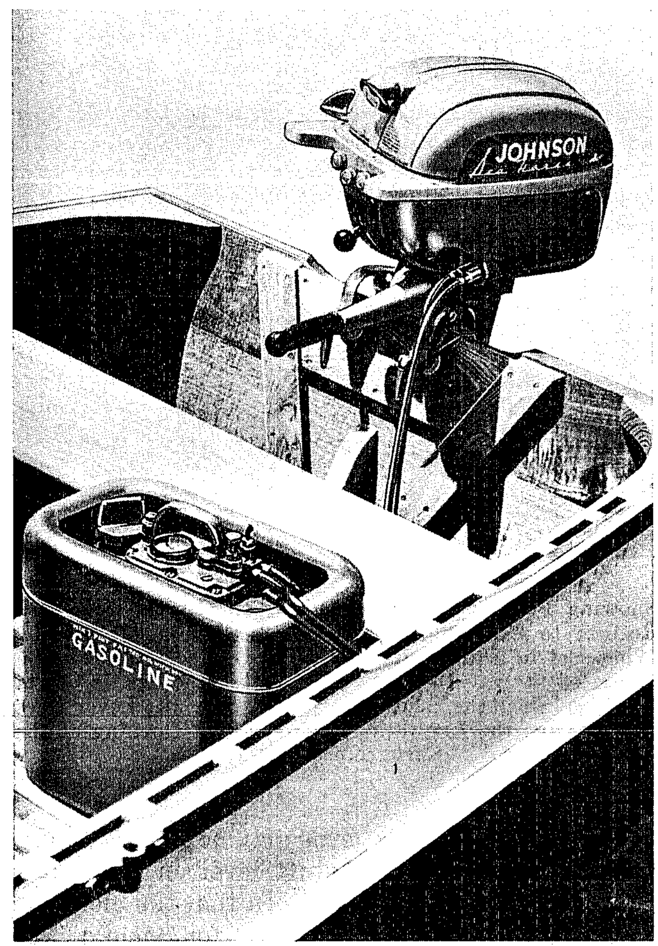
In event control action is not desired, set lever to "OFF" position and operate in conventional manner.



The motor will be found to run rather unevenly (sluggishly) when operating at reduced speed, as result of tilting the steering handle. To overcome this condition, move control (speed) lever to left—"slow" range. Resume speed by returning steering handle to original horizontal position and advancing speed control lever to desired position.

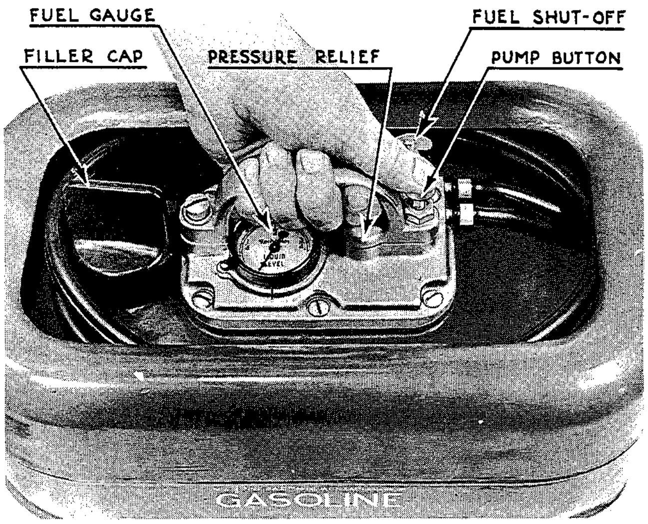
In situations where speed reduction is but momentarily required, it is not necessary to alter position of the speed control lever—resume normal "fast" speed by merely returning the steering handle to horizontal position.

THE MILE-MASTER FUEL TANK



Showing Application of the Mile-Master Tank.

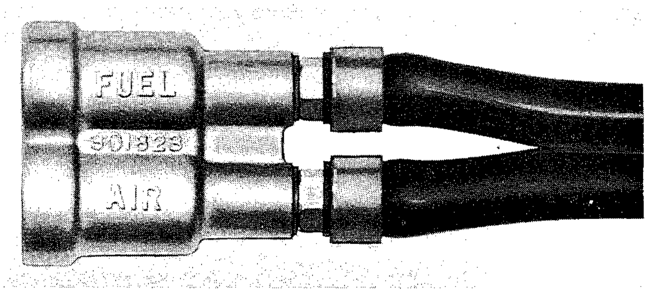
Pressure to lift and transport fuel from the tank to the motor (Model QD and SD-20) is built up in the crankcase of the motor. See illustration and description of this function on page 85. While mechanical details differ somewhat, principle of operation is identical.



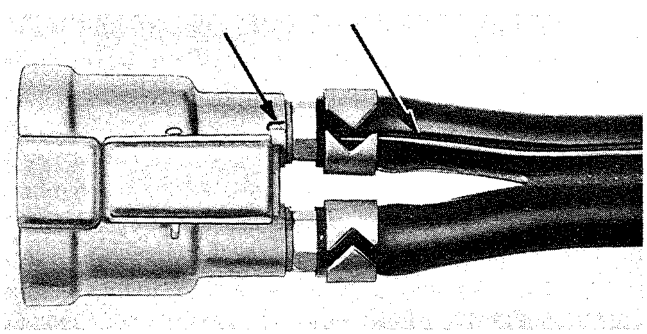
Top View of Mile-Master Tank.

Twin synthetic rubber tubes (two tubes fused together) are employed to conduct air pressure to and fuel from the tank to the motor. One end of the assembly is anchored to the tank (air and fuel line fittings)—the other is provided with a fitting (connector) to connect air and fuel lines to corresponding fittings on the power assembly from which a tube leads to the crankcase check valve and a second tube to the carburetor.

The connector is marked "air" and "fuel," as shown below, and must be properly assembled to the fuel line so air pressure and fuel lines are not crossed.



Top View of Fuel Line Connector.

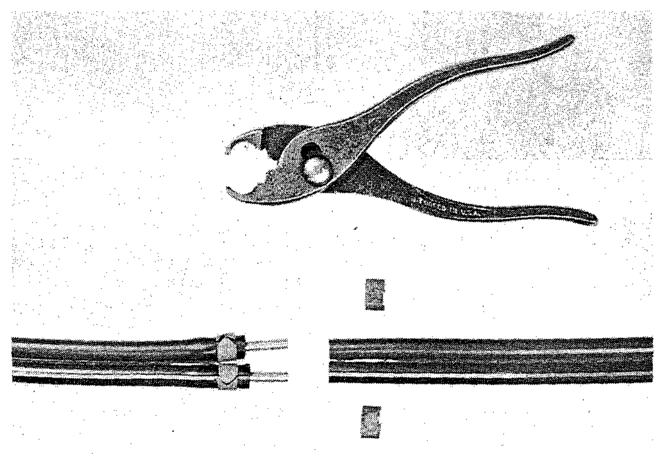


Bottom View of Connector–Arrows Directed to Embossing and Ridge on Air Line. Assembly Must Align Accordingly.

By turning the connector over, a small embossing will be noted on the "air" side and that the air line is ridged to correspond with the embossing. Should it become necessary to install a new connector or fuel line assembly, make certain the tubing provided with the identifying ridge lines up with embossing on air side of the connector.

The connector is provided with check valves to avoid fuel tank pressure release when disconnecting from the motor. Once pressure has been built up in the tank (normal 2 to 5 pounds), it is retained for a considerable time regardless of having detached the connector. Pressure is released only on removing the filler cap, and result of gradual seepage over periods of inactivity or because of irregularities in the assembly to cause air or fuel leaks.

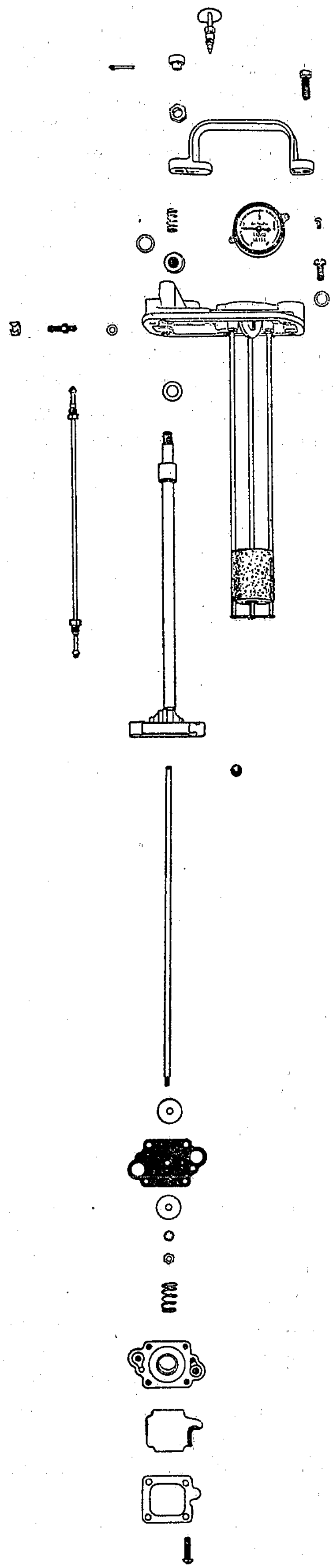
Broken fuel lines can be repaired by cutting ends square and inserting pieces of 3/16" copper tubing (about 2" long—one-half into each tube). Force the tubes together over the copper tubing, then secure with clips (#301822). Fuel line lengths can be extended as desired in like manner.



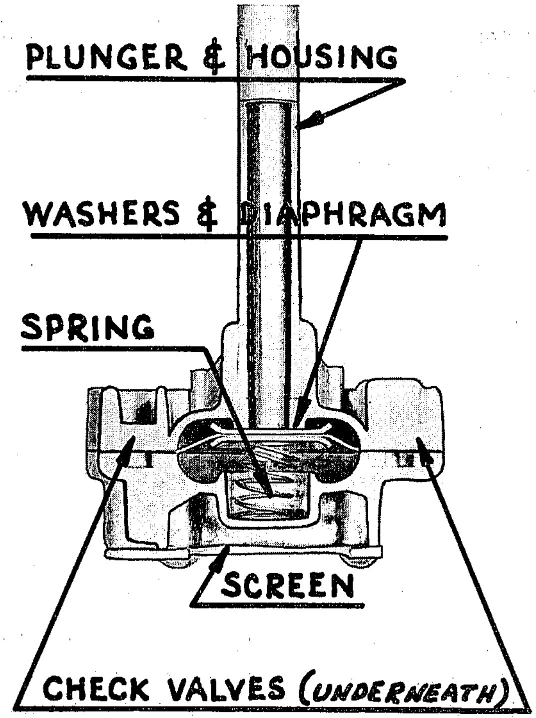
Illustrating Method of Splicing the Fuel Line and Specially Ground Pliers to Crimp Hose Clamps in Clips. An Inexpensive Pair of Pliers Can Easily Be Ground for the Purpose as Shown Above.

The fuel tank is of but simple and rugged construction—capacity 5 gallons. It contains the pump (for filling carburetor bowl), fuel level float and gauge, pressure relief valve, connections for fuel and air lines as well as a space into which the fuel line is coiled when not in use and a carry grip.

The pump employs the use of a diaphragm flexing in a small housing to pump fuel to the carburetor for starting purposes—necessary only when pressure has been released from the tank for refilling or as result of standing idle for some time. Two check valves are required—one for intake and another for discharge, as in any conventional pump. A screen is installed to avoid entrance of foreign matter.



Extended View of Tank Cover, Pump, Float, and Pressure Relief Assembly.



Sectional View of Pump.

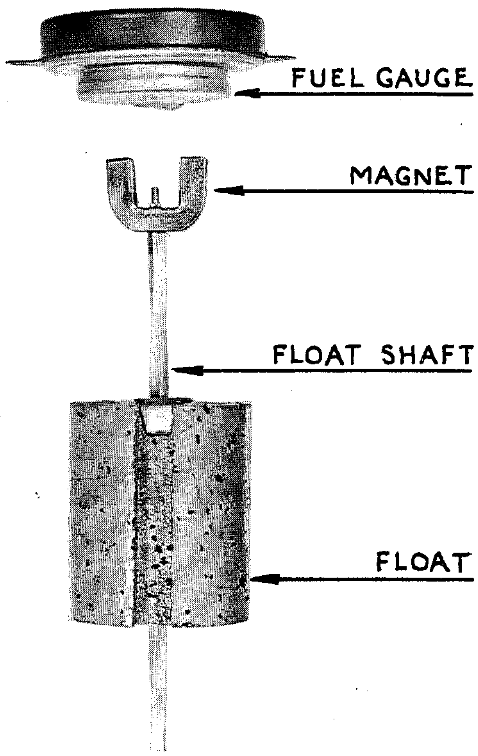
Failure to pump in most instances will be result of a punctured diaphragm which is easily installed. Like service operations on the power head or gear-case, they must be well performed, with care and same degree of carefulness.

Observe assembly prior to doing the job—dismantle and reassemble in reverse order. Install required new parts. Lap sections of the pump housing to insure flatness, if necessary.

When replacing the diaphragm, place a thin coat of hard drying cement on top side of curved washer, around the hole. Purpose is to eliminate possible seepage at this point. Note holes in diaphragm and corresponding holes in the pump housing— assemble so all line up. This is important. Do not neglect replacing the check valve discs and be careful they are not "cocked" and off their seats on assembly. Be careful not to wrinkle the diaphragm when bolting sections of the housing together (see that bolt holes line up and that diaphragm does not overlap). Result is failure of the pump to operate and leakage to interfere with functioning of the tank. Similarly, the gasket at top of the pump housing, next to cover, must be in place and in good condition to avoid possibility of air leaks.

The pump should be used only when the carburetor float bowl is empty—as indicated by little or no resistance when depressing the pump button except that set up by tension of the spring in the pump assembly. Float valve (in carburetor) closes as the bowl fills and closes entirely when filled to progressively build up resistance to pumping. Under no circumstances force the pump (depressing of pump button four to five times should be sufficient to fill the bowl)—the diaphragm is apt to be fractured.

Leaks in the pump assembly are indicated by failure of the pump and often fuel seepage around the tank cover. In some instances, the motor cannot be operated without necessity of constantly pumping fuel (fuel pump). In others, seepage may be slight, requiring manual pumping only at higher speeds.



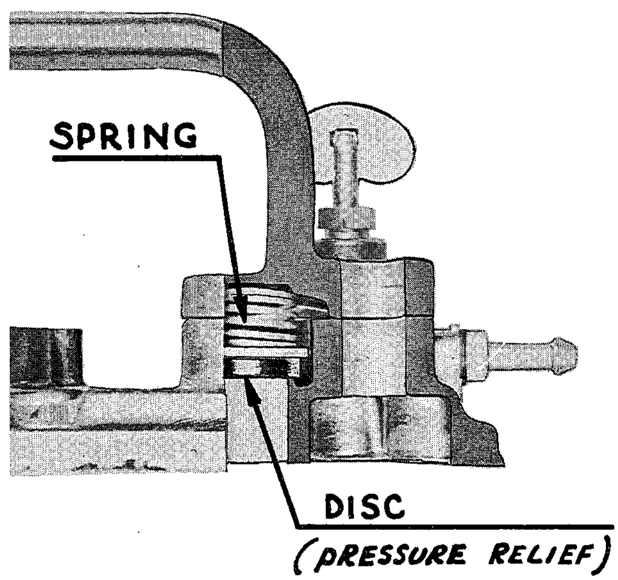
Illustrating Magnetic Control of Needle in the Fuel Gauge.

Since the fuel tank must be air tight, the gauge is magnetically operated. This is accomplished by attaching a small "U" shaped magnet to the end of the gauge needle shaft and a similar but larger magnet to the end of the float shaft. Thus, as result of magnetic attraction, the needle in the gauge is deflected with turning of the magnet on the float shaft to indicate quantity of fuel in the tank.

It will be noted from the illustration that the float shaft is constructed of square stock—twisted to cause it to turn as the float rises or falls. The float is grooved on one side into which fits one of the assembly supporting members and provided with a guide plate which straddles the support rod to prevent the float from twisting. A square hole is punched in the guide plate which slides on over the twisted float shaft in assembly. Inasmuch as the float is prevented from turning by the guide plate and support rod, the float shaft is caused to turn and proportionately deflect gauge needle with degree in rise or fall of the float.

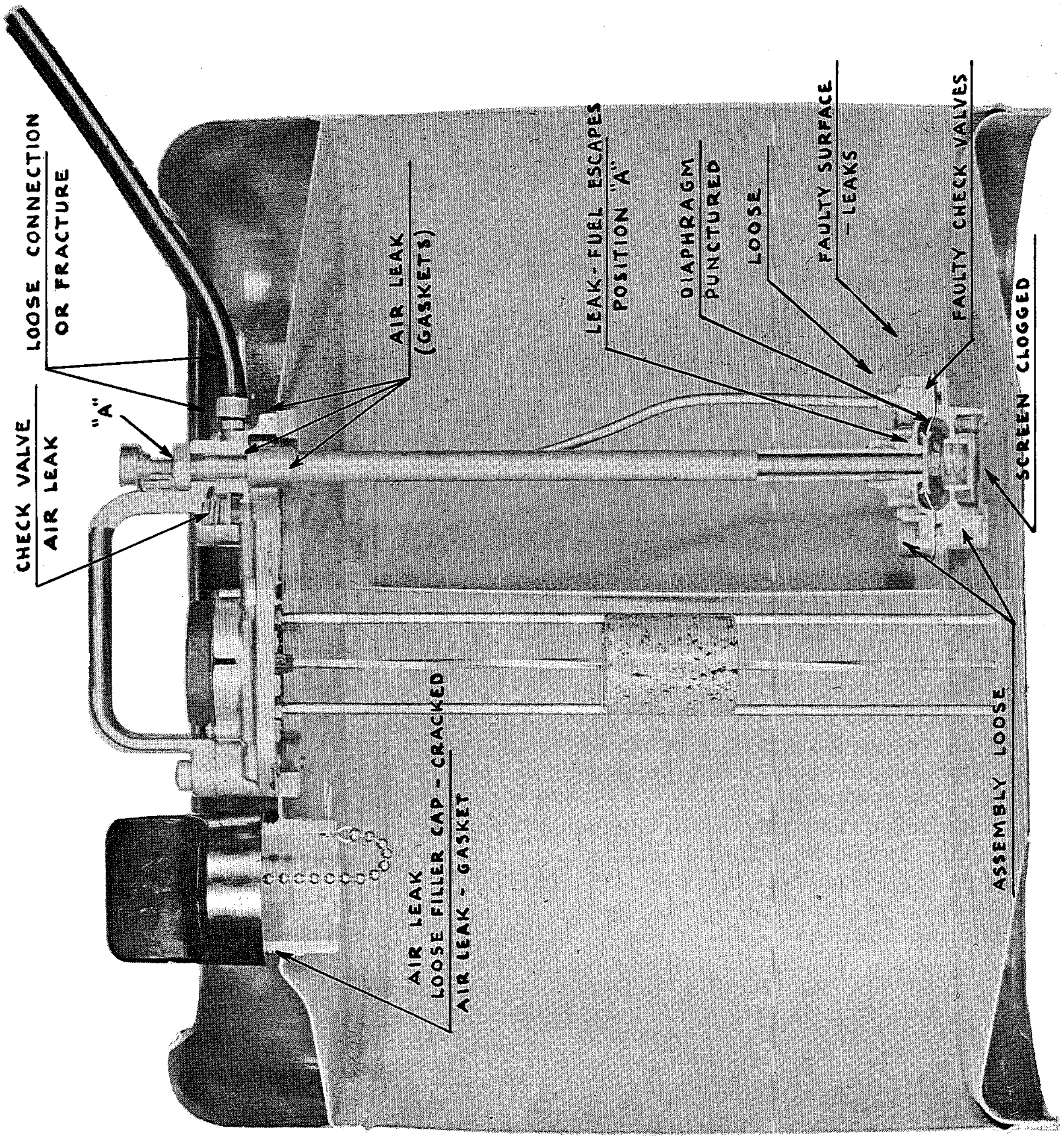
Very little difficulty can be expected with this assembly—barring accident—magnets are permanent and should require no alteration. Chief concern is to make certain the float operates freely with no indication of binding.

The cross member (float shaft support) is soldered to the support rods— to remove, simply heat with soldering iron and replace in line manner. The float shaft can be improperly installed—four different ways since there are four sides to the square shaft. Check with gauge, with float resting on bottom, needle should point to "empty." If otherwise, detach float from the shaft—turn shaft and magnet to correct position, then replace the float. Solder cross member to support rods.



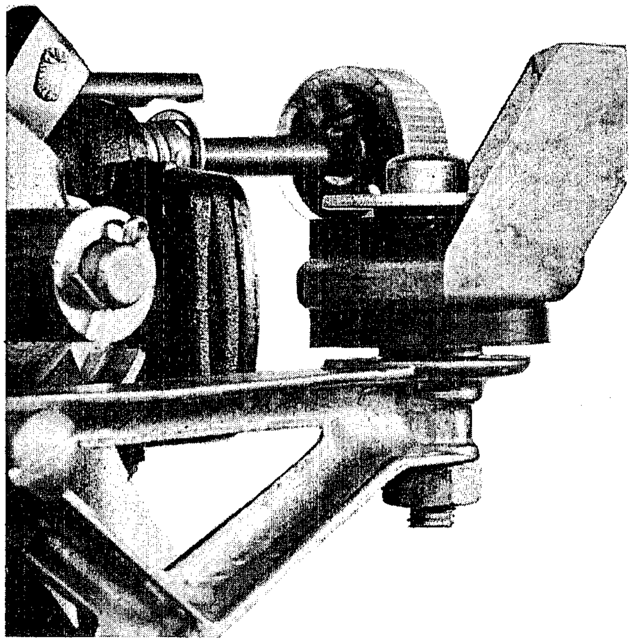
Sectional View of Tank Cover to Show Pressure Relief Valve Arrangement. Disc Is Forced Off Its Seat against Tension of the Spring When Tank Pressure Reaches Approximately Eight (8) Pounds. Check for Leaks if Tank Fails to Function.

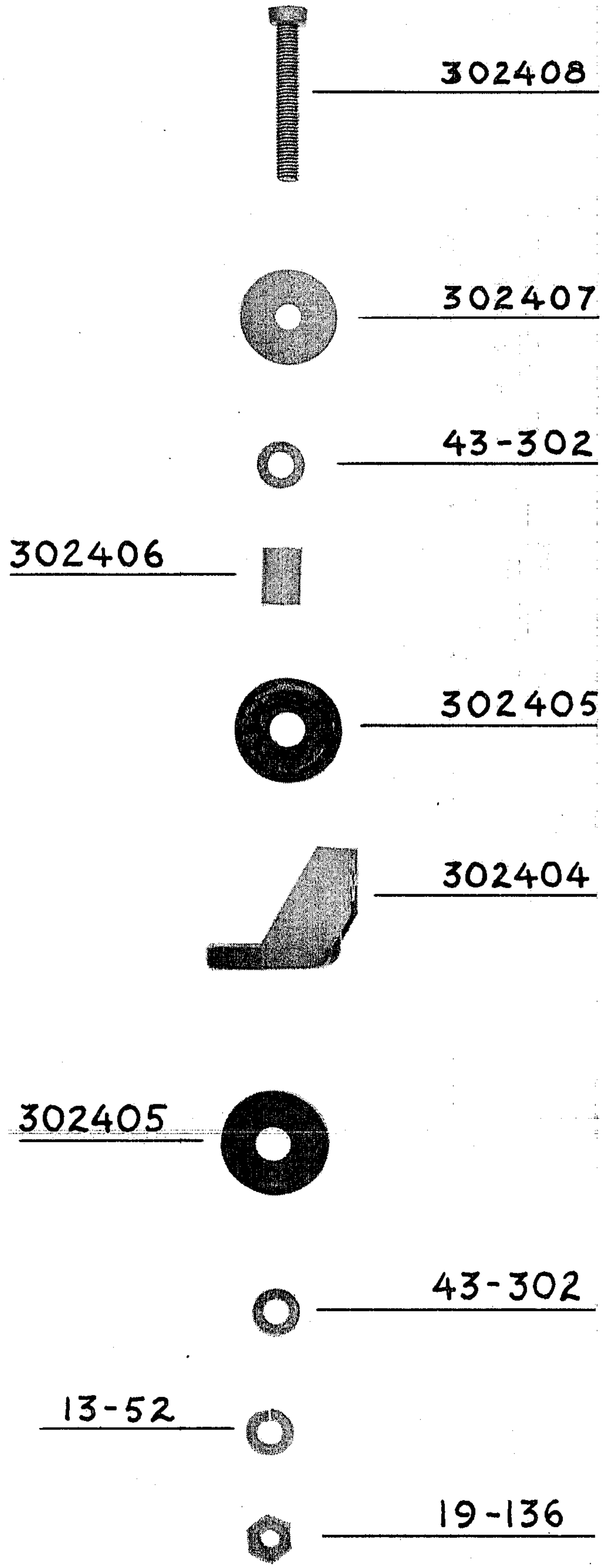
NOTES



CHECK CHART—MILE-MASTER TANK

SERVICE BULLETIN NO. 277—REPRINT



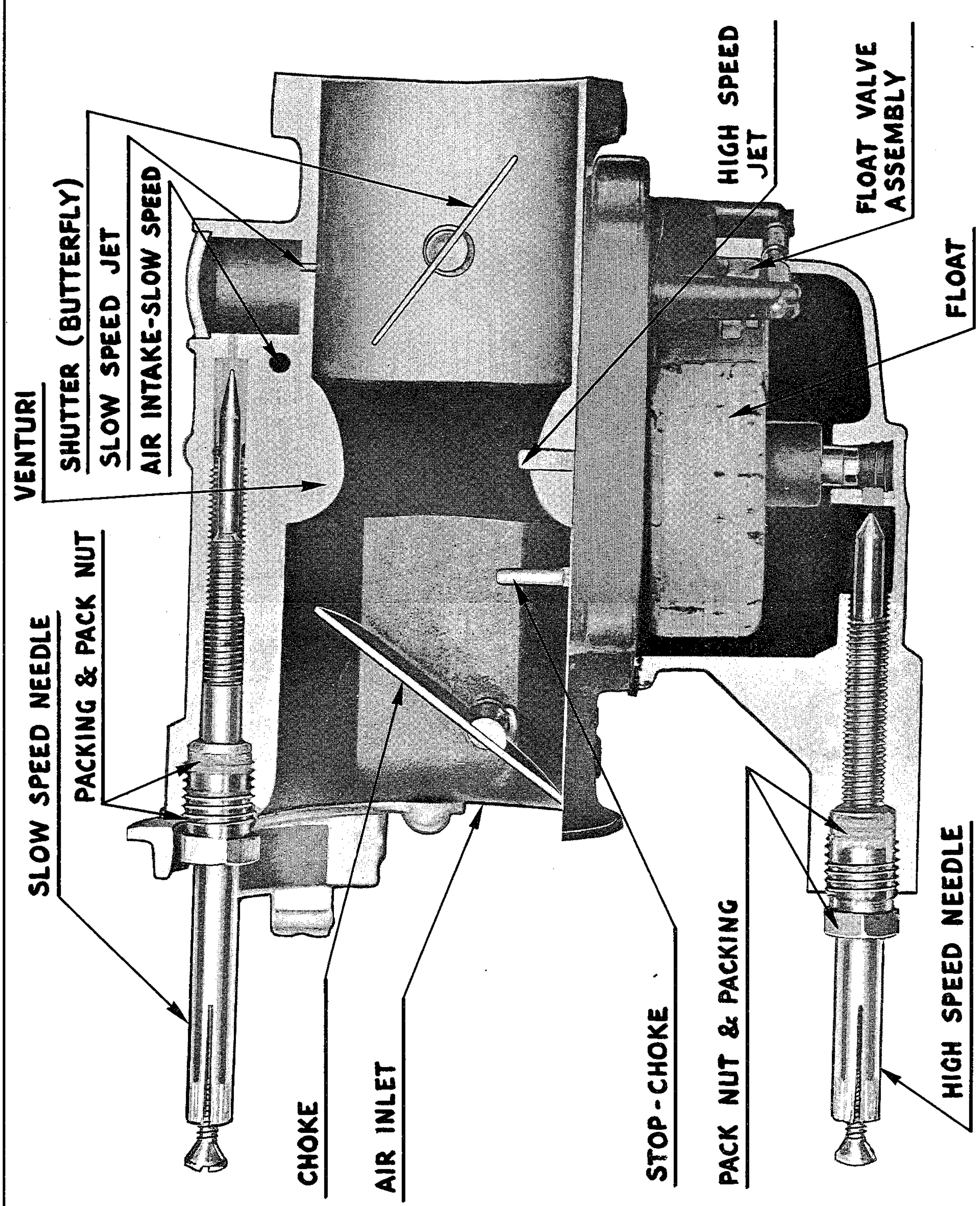


RUBBER MOUNT ASSEMBLY—QD—SD

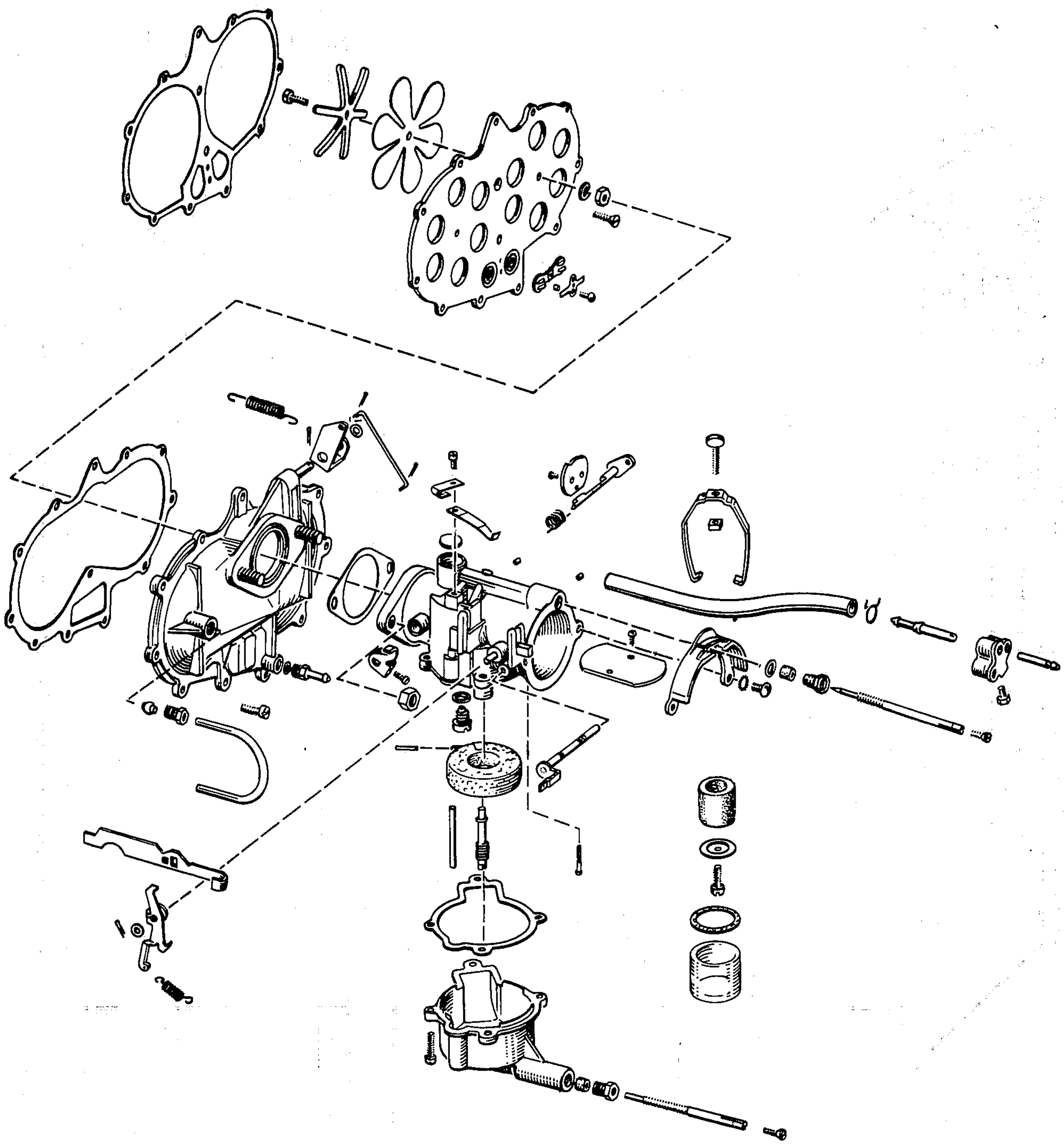
Illustrated here is the new Rubber Mount Assembly No. 375716, replacing the original Mount No. 302021 used to support the Shrouds on Models QD and SD. Four (4) of these new assemblies are used on the QD—two (2) only on the SD—two (2) of No. 302116 are still being retained as rear support of the Shrouds in this case.

Note order of assembly at right. It is important sequence of assembly be accomplished as illustrated (see illustration above).

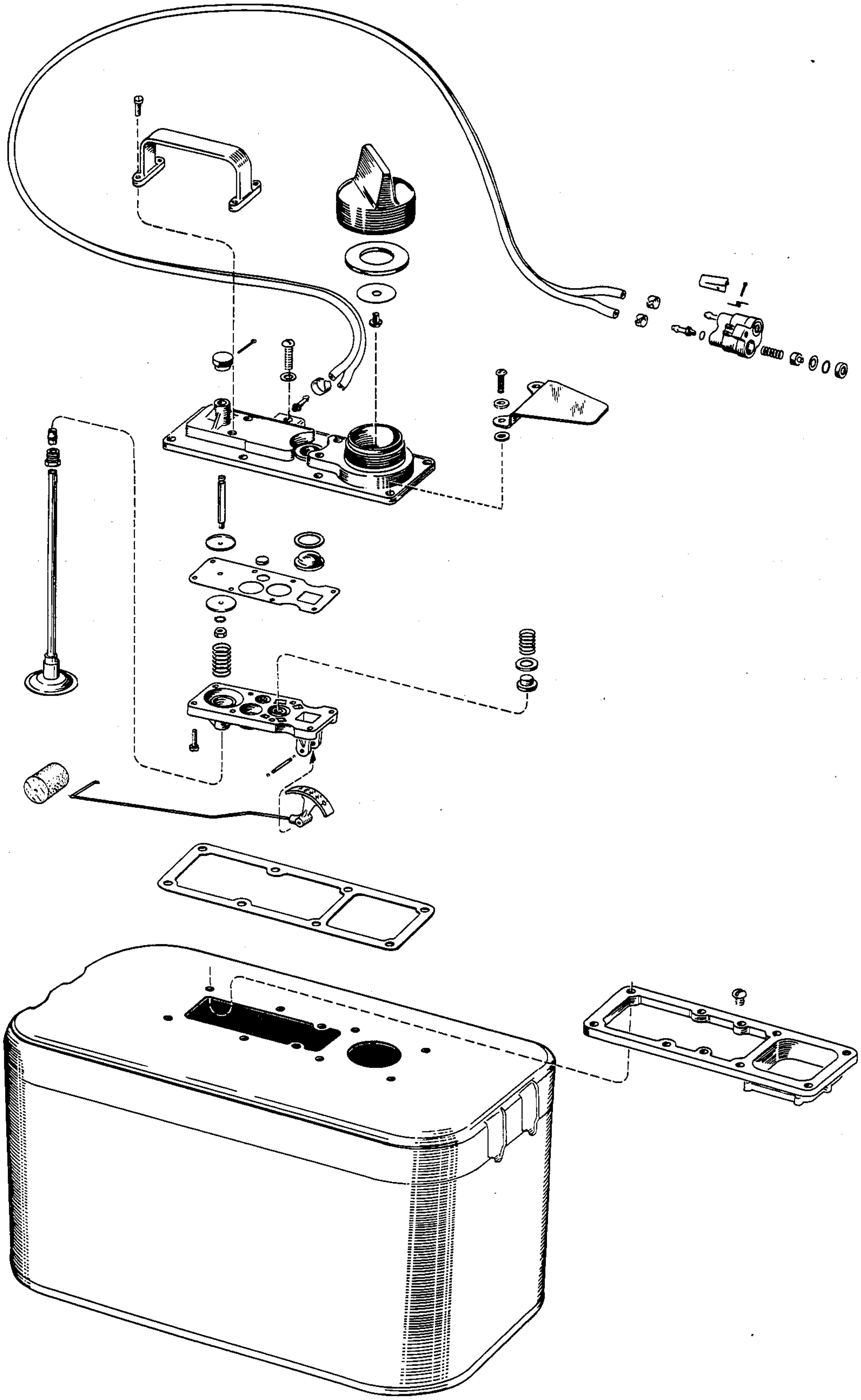
No. 302021 Mount is no longer available— as result of this change Bracket No. 302020 is likewise cancelled and no longer available—order No. 375-716 Mount Assembly when required. Order from your District Service Station.



Sectional View of Carburetor (Fuel Filter Not Shown)—Model RD



Assembly Layout—Carburetor and Automatic Intake Valve Group—Model RD

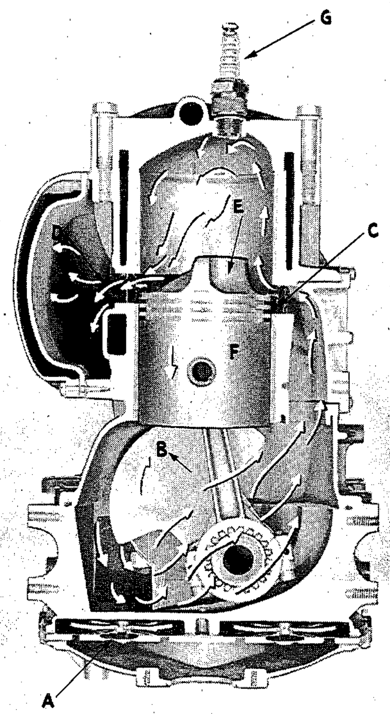


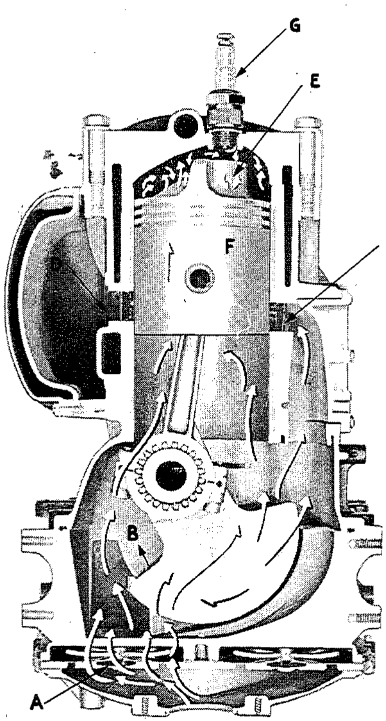
Assembly Layout—Mile-Master Fuel Tank—Models QD and RD

NOTES

THE CARBURETOR — MODEL RD

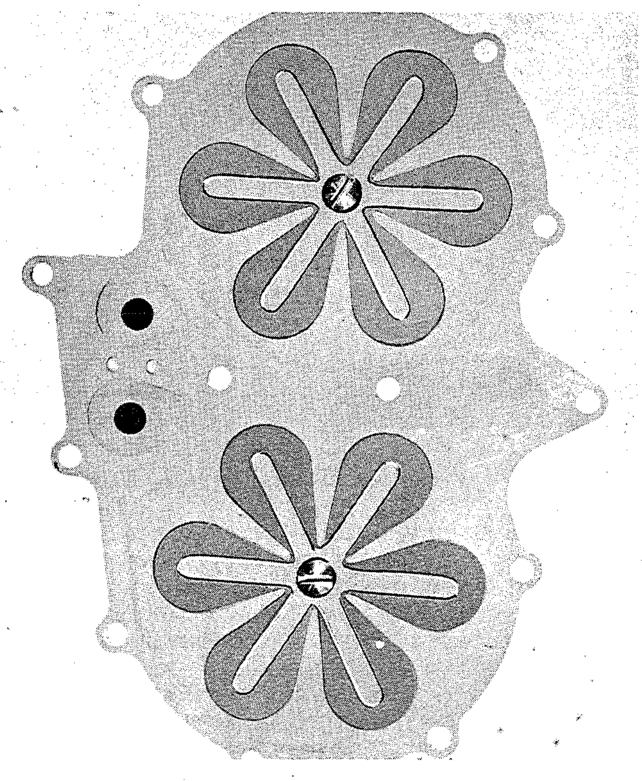
Carburetion: The motor is of a two port, two (stroke) cycle type, relying on the use of an automatic leaf valve for crankcase induction. As suction is created by upward movement of the piston to result in low crankcase pressure, the leaf valve is forced off its seat due to higher pressure without and comparatively low pressure within the crankcase. This causes an air stream to flow through the carburetor mixing chamber and the resultant fuel vapor to flow into the crankcase, thus charging the crankcase. Crankcase suction diminishes as the piston reaches the top of its stroke—the leaf valve then springs back against its seat to seal the crankcase. The charge in the crankcase is compressed on following downward movement of piston—crankcase pressure builds up until head of the piston uncovers the transfer or intake port in the wall of the cylinder when the compressed vapor charge in the crankcase discharges into the cylinder.





Actually, the automatic leaf valve as employed in the motor consists of six leaves or segments arranged in daisy petal fashion which are anchored in center position to a plate drilled with six corresponding holes to complete the valve assembly —one assembly for each crankcase chamber.

The plate, of course, must be flat and true to maintain a "tight" seal with like surface of the leaf. A guide is attached to the assembly to limit movement of each segment or leaf. Naturally, all six leaves or segments lift from their respective seats simultaneously to admit fuel vapor into the crankcase when sufficient suction or low pressure is built up and close together as suction diminishes. The leaves open into the crankcase. Leaf plate is constructed of specially heat treated beryllium copper. Do not, under any circumstances, bend or flex leaves of the valve by hand—in such event

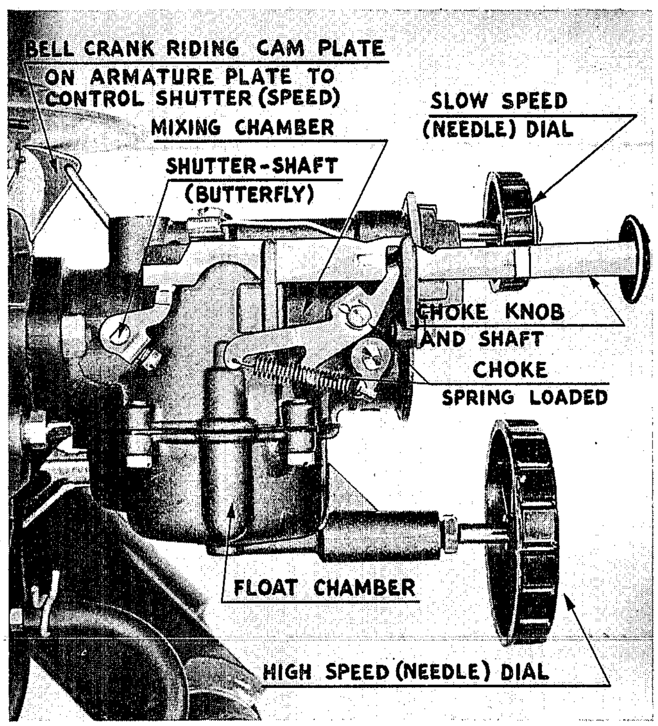


Leaf Plate (Automatic Intake Valve) Assembly Side Opening Into Crankcase.

they are rendered unfit for use and should be discarded.

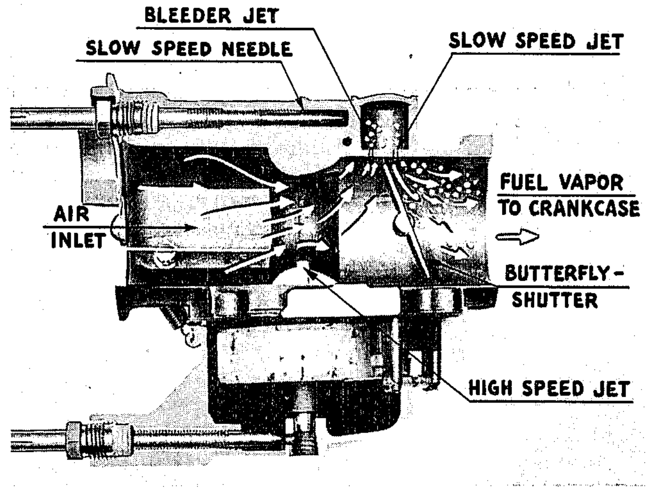
The automatic leaf valve in this case replaces the third port or rotary valve employed in other types of construction. It is automatic in that it does not open until sufficient low pressure is built up in the crankcase to overcome leaf tension, pre-established by special heat treatment of the material of which it is constructed. Degree of leaf opening depends upon crankcase pressure which varies with the rate of speed at which the motor is operating. Such action results in more satisfactory performance throughout entire speed range of the motor. Both the third port and rotary valve open to same degree regardless of motor speed, while the automatic leaf valve only in proportion to demand established at various motor speeds, thus acting more efficiently.

The carburetor is of the float feed two jet type, consisting of a mixing chamber and conventional float chamber to which are added synchro and speed limitation control mechanisms (to be explained later) as required for gear shift. Two adjustments are provided, namely, for high and slow speed performance.

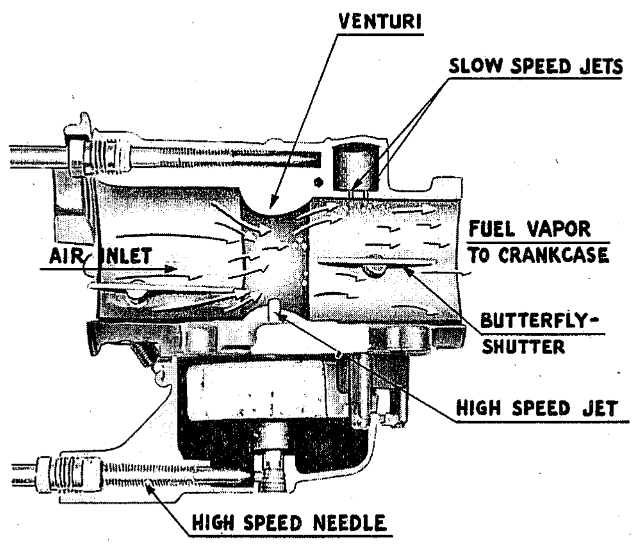


View of Carburetor as Attached to the Motor.

Below illustrates action of carburetion within the mixing chamber (carburetor) at period of slow speed motor performance. Note that the butterfly shutter is closed to permit very little air entering except that passing through the slow speed bleeder jet to partially vaporize the liquid fuel in the small pocket—later drawn into the mixing chamber and crankcase to be consumed as result of "suction" created by the upward moving piston. Since ultimate speed of the motor is dependent on volume of fuel vapor (air-fuel mixture) entering the crankcase, further opening of the butterfly shutter ad-



Sectionalized View of Mixing Chamber—Showing Butterfly Shutter Set for Slow Speed Operation (Closed). Note Maximum Fuel Vaporization at Slow Speed Jet—Vaporization at High Speed Jet is Nil.



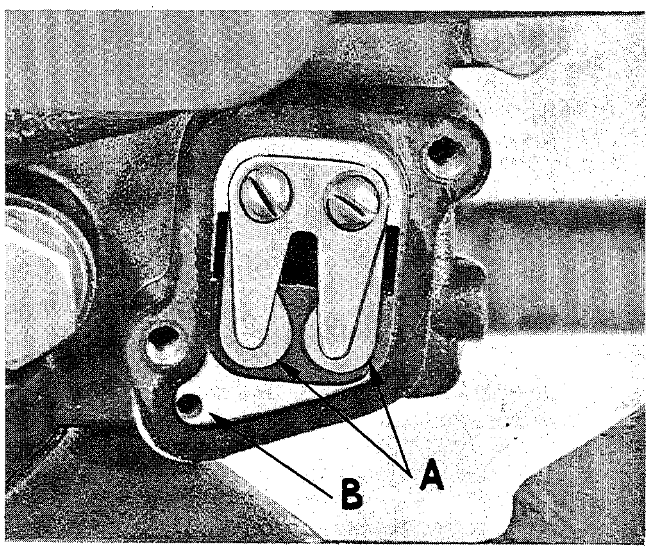
Sectionalized View of Mixing Chamber—Butterfly Shutter Full Open for High-Speed Performance. Note Maximum Fuel Vaporization at the High Speed Jet with a Minimum of Vaporization at the Slow Speed Jets. Also Effect of Restriction Caused by the Venturi Ring to Increase Air Velocity in Area of the High Speed Jet.

mits more air to be mixed with the liquid fuel (vaporized), thus a stronger or heavier charge to develop proportionately more power, etc.

Sectional view shows action of carburetion during top speed performance of the motor. Note that the butterfly shutter is full open to permit maximum flow of air through mixing chamber. Velocity through the mixing chamber at this time is comparatively high but proportionately diminishes with closing of the butterfly shutter to reduce motor speed. To obtain maximum air velocity (required for maximum fuel vaporization) in area of the high speed jet, a venturi ring has been installed, as shown above. The ring actually consists of a constriction in the air stream (funnel like). Cross section of the venturi indicates a rather abrupt but curving constriction on the leading side—gradually tapering to full diameter on the trailing side to result in maximum air velocity in area of the jet, thus maximum fuel vaporization.

High and slow speed jets do not function independently of each other, however, maximum vaporization takes place only at the slow speed jet when the butterfly shutter is closed for slow speed motor operation. Vaporization at the slow speed jet decreased in proportion to butterfly shutter opening. Conversely, vaporization at high speed jet proportionately increases until full open position of the butterfly shutter has been reached to result in maximum vaporization (at high speed jet) and a minimum of vaporization at the slow speed jet. The slow speed jet then functions in various degrees throughout entire speed range of the motor—the high speed jet remaining idle when the butterfly shutter is closed for slow speed motor performance.

The crankcase of a two (stroke) cycle engine has a tendency toward loading up with unburned fuel (liquid) when operating for any length of time at slow speed with result that it is "flooded" when accelerated for high speed performance. Flooding in this respect likewise affects slow speed operation. This is evidenced by profuse smoking of exhaust gases, faltering and erratic operation until accumulated fuel has been discharged. In extreme instances, stoppage occurs as result of spark plugs fouling. The situation is created by the heavy ends of the fuel vapor settling out or condensing during slow speed operation since velocity through the crankcase is not sufficient to hold them in suspension.



Bleeder Check Valve—Cover Removed.

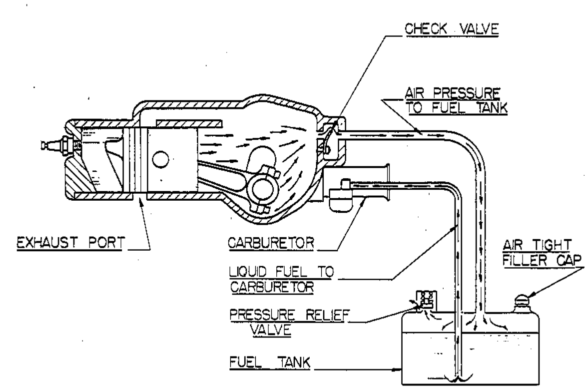
To overcome this situation, a bleeder arrangement is provided which functions automatically to discharge the resultant crankcase accumulation throughout entire speed range of the motor.

The arrangement consists of a small hole or channel leading from a pocket in each crankcase chamber to an automatic check valve located at the bottom of the power head as shown here. In operation, the fuel which settles out of the fuel mixture during periods of slow speed running, accumulates in the pocket provided for this purpose, fills the channel down to the check valve and there remains until the piston travels on its downward stroke. Subsequent crankcase compression (pressure) forces the check plate off its seat to permit liquid fuel escaping through outlet and on into the driveshaft casing where it is discharged with the exhaust gases. Note there are two check plates—one for each crankcase chamber. During upward stroke of the piston, there is no discharge since low pressure or suction exists in the crankcase—the check plate springs back on its seat to prevent air flow in opposite direction.

Action described above continues during entire period of motor operation with maximum bleeding of liquid fuel at slow speed performance and proportionately decreasing with increase in motor r.p.m. At top speed there is practically no discharge since the velocity through crankcase is sufficient to hold all particles (for practical purposes) of fuel in suspension to be later burned on compression and ignition in the combustion chamber.

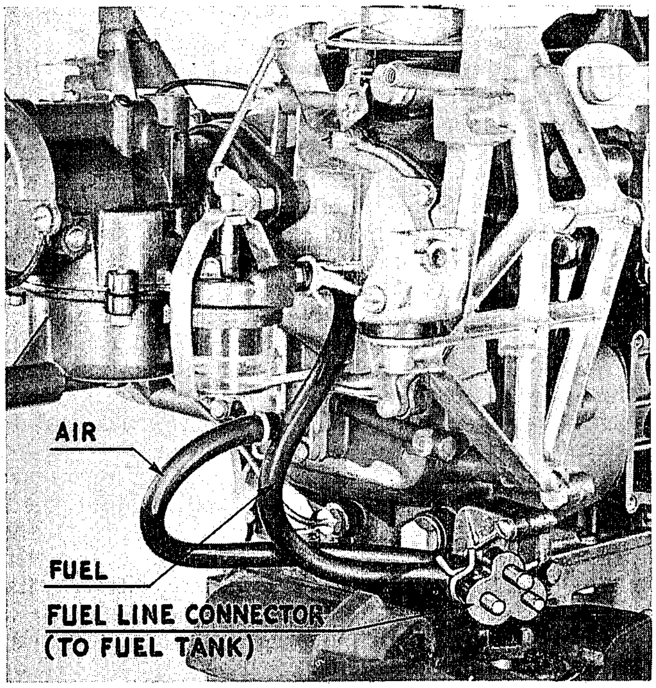
An oil "slick" may form on the surface of the water when operating for any length of time at slow speed—the result of crankcase bleeding as described.

FUEL PRESSURE SYSTEM



Carburetor-Drawing Showing Fuel Pressure System.

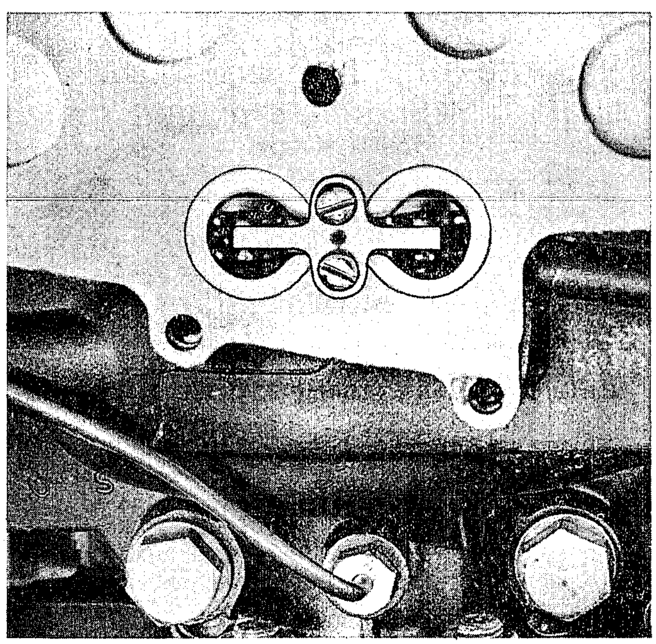
Since fuel supply to the carburetor is by means of a pressurized gas tank— a device is built into the motor assembly to permit a portion of pressure built up in the crankcase during operation, to escape by way of a flexible rubber tube into the tank. The fuel mixture then under pressure is conducted to the carburetor by a second flexible rubber tube. Both tubes, however, are molded together and provided with necessary connectors and terminal fittings for convenient handling.



Showing Arrangement of Air and Fuel Lines.

Attached to the aluminum valve or leaf plate, but not associated with functioning of the automatic intake, is the fuel pressure check valve assembly. This assembly consists of two small (connected) rubber discs held in position over two corresponding holes drilled into the plate, by a flat spring of predetermined tension to comprise a check for each crankcase chamber.

When pressure in the crankcase reaches a predetermined point (determined by tension of the spring) the disc is momentarily forced off its seat, permitting pressure thus escaping to be conducted by way of the air line to the fuel tank.

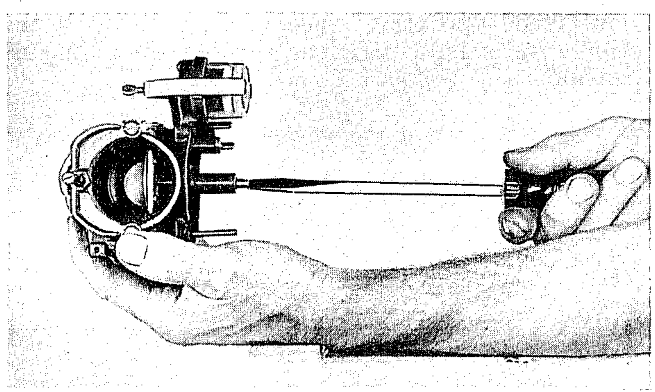


Showing Location of Fuel Pressure System Check Valves.

The checks function alternately as the cylinders fire—first one opens, then the other, to build up and maintain sufficient pressure in the tank to "feed" the carburetor. When pressure in the tank equals pressure built up in the crankcase, there is obviously no valve action in this respect. Degree of valve action depends on volume of fuel in the tank. As fuel level in the tank lowers, resulting increase in air "space" causes proportionately greater check valve activity. Normal fuel tank pressure is from 2 to 5 pounds, depending on motor speed and fuel level. An automatic pressure release is installed to relieve pressure above 8 pounds.

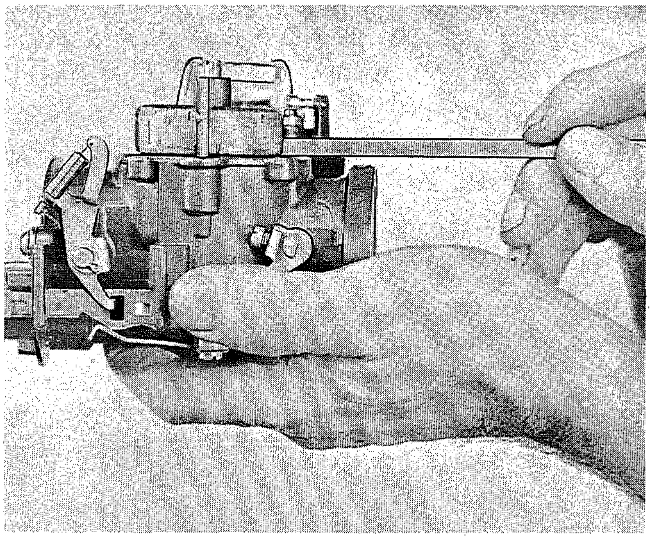
To clean filter element: loosen wing screw; remove bracket holding filter bowl in position; remove filter bowl, rinse out in clean gasoline; move screw holding filter element in position—lift the element free; rinse in container of gasoline to clean — replace if necessary — the elements frequently "clog" with a gummy substance after long periods of idleness, thus present a barrier to consistent flow of liquid fuel; replace filter bowl, making certain gasket is in good order to permit proper seating of the bowl; replace bracket and draw up wing screw to secure.

To check high speed jet: remove screws holding the float bowl fast to carburetor body; work bowl carefully off to make the float, float valve and seat assembly and high speed jet accessible for inspection and/or replacement; high speed needle is easily removed with screw driver as shown below —after inspection it can be similarly reinstalled or replaced if necessary, being careful to properly seat.



Illustrating Method of Removing and/or Installing High Speed Jet and Float Valve Seat.

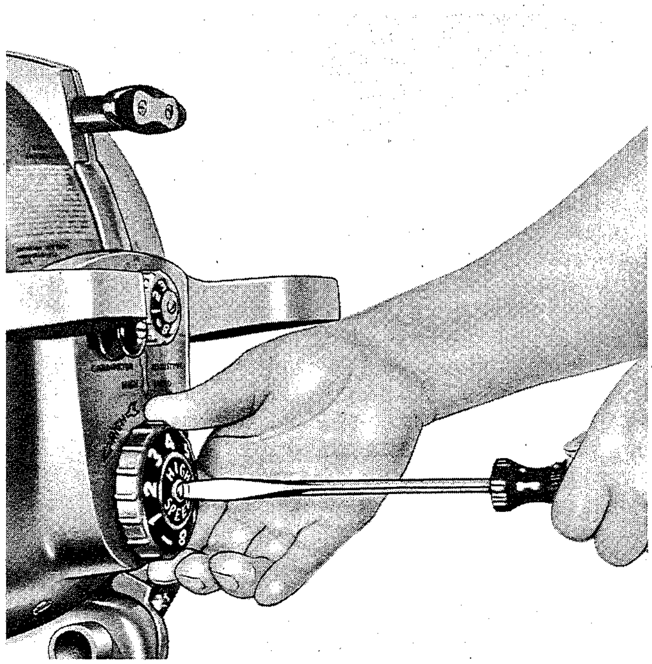
To check float, float level and float valve assembly: remove small pin, float and arm assembly from position on brackets provided in the carburetor body; lift float free and remove the float valve; remove float valve seat with screw driver; check float for defects, replace if necessary; rinse float valve and seat in gasoline to clean—be on lookout for sticky gum coating seat and valve point to cause sluggish float action after long periods of idleness; replace float valve and seat assembly—if tapered face of float valve appears badly "ringed" or grooved; turn float valve seat into carburetor body with screw driver tightly—insert float valve; replace float—check for correct "level"; top face of float should come to rest flush with face of carburetor body as shown—otherwise, carefully bend float arm up or down as required to gain proper level—float action should be free—check for binding; replace carburetor body—install new gasket if required.



Method of Checking Float Level.

To adjust high and slow speed needles after repairs, proceed with the operation prior to installing the motor covers— it is more easily accomplished in this manner.

On removing the carburetor needle dials, note "stops" or ribs on inside surfaces of both and corresponding "stops" cast on to the motor covers which permit approximately one turn of each needle after initial setting to compensate for variations frequently encountered during normal operation of the motor.

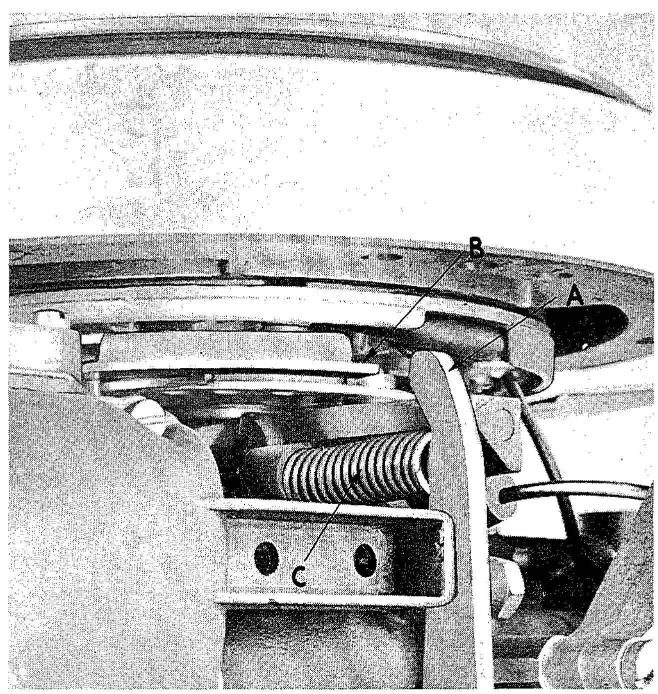


Loosening Dial Center Screw to Permit Adjusting on Carburetor Needle Shaft.

Dials are held fast to their respective needles by slotting and knurling a short distance on the end of each and by the installation of a counter sunk head screw which when screwed into the end of the needle causes expansion or binding to hold the dial fast. Thus to remove the dial, it is simply a matter of loosening the center screw to pull it free of the needle or to adjust its position as may be required.

Gently and carefully close both needles against their respective seats. Do not under any circumstances screw down tightly since doing so will only result in "ringing" the needle point face and distort the needle (valve) seat in the carburetor body to later make correct settings impossible. Damaged needle points and needle valve seats cannot be properly adjusted to obtain satisfactory motor performance.

After having loosened both needles, open slow speed needle approximately 1 turn; the high speed needle about 3/4 turn. Start the motor—let it run until normal operating temperature is reached. Adjust both needles to their best running position. Set speed control grip to position marked "slow," then adjust the slow speed needle (dial) to position marked "fast" to adjust the high speed needle (dial). Remove both dials in their respective positions with numeral 4 in each case directed "up" without having disturbed either needle setting. Allow sufficient clearance between the dial and covers to prevent rubbing. Secure in this position by drawing up on the screw on the end of each needle. It is advisable to check each needle packing nut to make sure sufficient "drag" is present to prevent "creeping" during operation of the motor —don't overdo it, though. Any variations required in needle valve settings after the motor has been

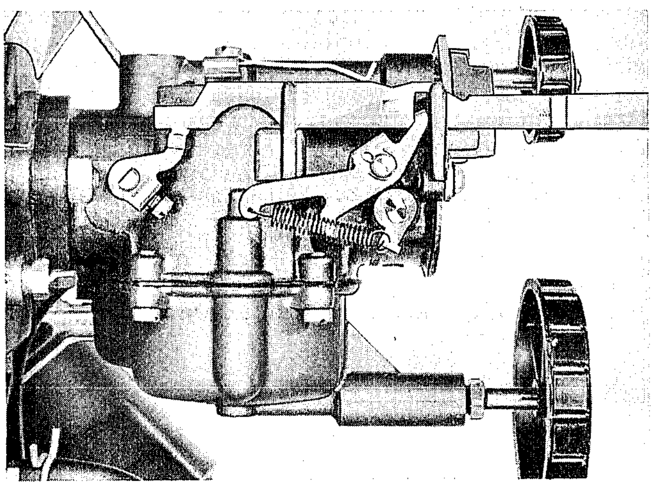


Showing Speed Control Limitation Lever "A" Engaging Stop "B" Attached to the Armature Plate, Acting Against Tension of Spring "C"—Speed Limited When Set For "Neutral" and "Reverse."

turned over to its operator can now easily be performed by the individual without throwing the carburetor too far out of adjustment, should he fail to understand the procedure. The dials can always be returned to "4" up and the motor made to perform, providing, of course, all other mechanical details are functioning as they should.

Speed limitation control is by means of a lever acting against a "stop" attached to underside of the magneto armature plate. The speed limiting lever is acted upon by an arm (an integral part of the shifting lever) in such manner that when set for neutral, limiting lever engages the "stop" under the armature plate to prevent further movement toward increasing speed.

Speed limitation occurs only when shifting lever is set at neutral to guard against excessive "racing" of the motor when shifting to forward or reverse as the case may be. Deeper recesses in notches (of the speed limiting lever) for reverse and forward prevent the lever from engaging the stop on the armature plate—thus, there is no limit to motor speed when in forward or reverse. Exercise *caution* when operating in reverse.



Carburetor—Showing Choke Lever Spring. Choke in Spring Loaded.

RD-12 Carburetor — Spring choke lever No. 302747. Tension on this spring was reduced to 12 ounces from the original 20 ounces to avoid possibility of over-choking when starting—the choke in this case being spring loaded. Arrow indicates spring in the illustration.

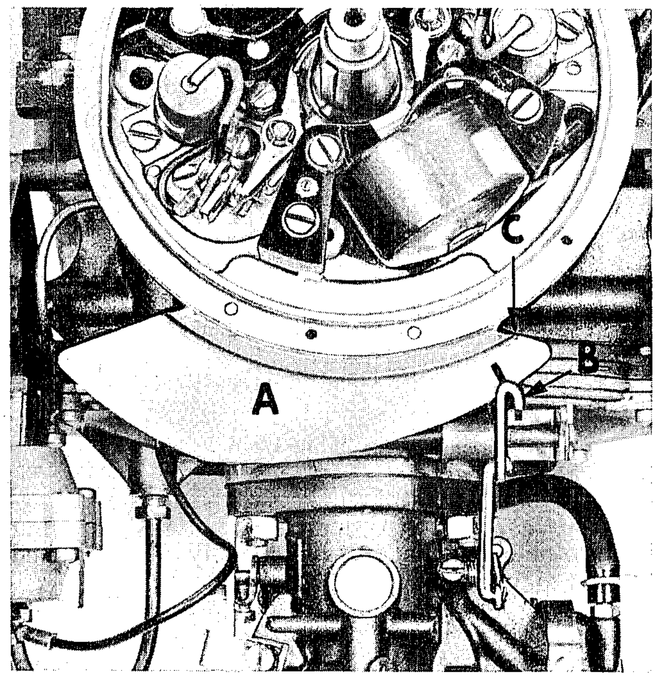
RD-12 Cutout Assembly No. 375843 removed entirely as not required due to minor changes in the carburetor butterfly valve and a slight change in the contour of the cam No. 302705 controlling the action. This accomplishes closing off all fuel vapor to the crankcase when turning the speed control grip to position "stop."

Carburetor—RD-10 & 11. Carburetor body No. 375867 (new part number) will be provided hereafter with the redesigned butterfly No. 302828 and the new cam No. 302830. When making the installation, remove the cam originally attached to the armature plate—replace it with new cam.

Similarly, carburetor complete No. 375868 (new part number) for the RD-10 & 11 comes with the new redesigned cam (No. 302830) and butterfly (No. 302828). When attaching carburetor in this case, remove and discard original cam attached to the armature plate—install new cam shipped with the carburetor.

RD-12 carburetor body No. 375932 (new part number) correct for model as is.

Part No. 375815 is part number assigned to the RD-12 carburetor complete—as ready to be installed.

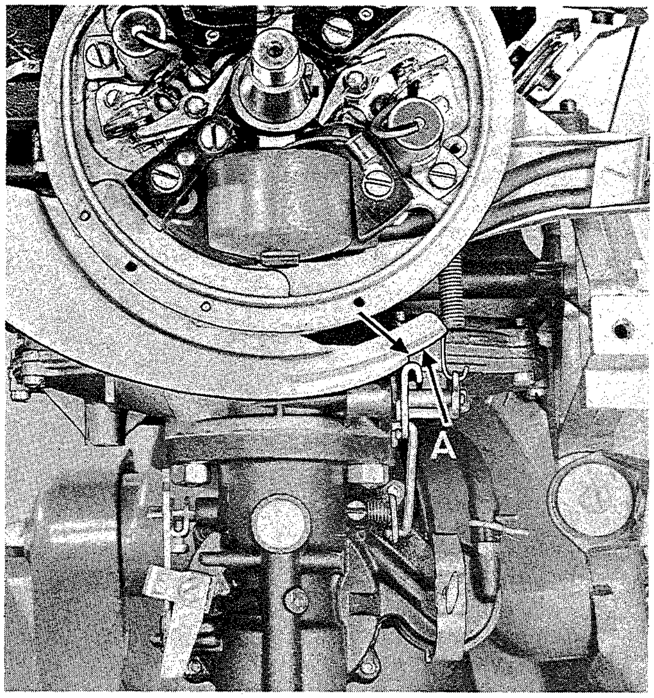


Showing Carburetor Control Cam "A" (Attached to Armature Plate—Synchro-Control) and Cam Follower "B." When Properly Adjusted, Cam Contour Edge Should Make Contact with Follower "B" at Point of Index "C." Models RD-10 and 11.

Cam follower "A" rides contour of cam "B," attached to the armature plate and through linkage with the carburetor shutter (butterfly) shaft acts to control speed of the motor as advance is toward high end of the cam. "Spark" and "gas" are thus synchronized to proportion opening of the shutter with respect to degree of spark advance. Carburetor shutter is full open for maximum speed with spark set at full advance—shutter closes to reduce motor speed with retard spark (cam follower riding low end of cam "B").

Cam "B" is adjustable for proper synchronization by means of slotted hole at "low" end. Low end of the cam can be shifted "in" or "out" to accomplish this adjustment. When correctly adjusted, the follower should make contact with contour edge of the cam when aligned with index mark "C" as shown here.

Models RD-12 & 13 make use of a similar arrangement to synchronize "spark" and "gas." Note —the index mark has been omitted from the cam in this case but that a depression has been provided at extreme end "A." Function of the depression is to cause "complete" closing of the carburetor shutter (butterfly) as the cam follower



Showing Method of Spark and Carburetor Control Installed on Models RD-12 and 13.

"drops" into position with maximum spark retard —speed control lever set to "stop."

FUEL TANK—PRESSURIZED

The fuel tank is of simple but rugged construction—capacity 5 gallons—plug oil content. It contains the pump (for filling carburetor bowl), fuel level float and gauge, pressure relief valve, connections for fuel and air lines as well as a bracket arrangement around which the fuel line is coiled when not in use and a carry grip.

The pump employs the use of a diaphragm flexing in a small housing to force fuel to the carburetor for starting purposes—necessary only when pressure has been released from the tank for refilling or as a result of standing idle for some time. Two check valves are required—one for intake and another for discharge as in any conventional pump. A screen is installed to avoid entrance of foreign matter.

Failure to pump in most instances will be the result of a fractured or improperly installed diaphragm which is easily replaced, or a "clogged" screen. Like service operations on the power head or gearcase, they must be well performed, with care and same degree of carefulness.

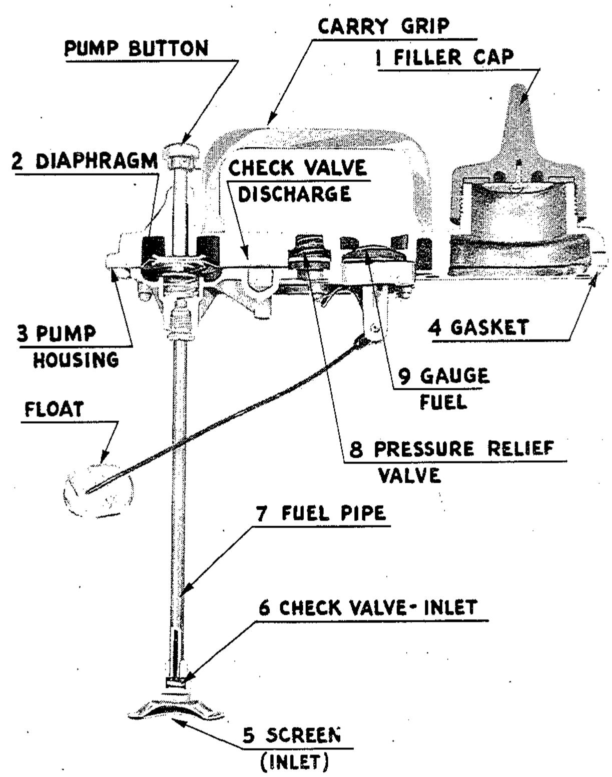
Observe assembly prior to doing the job— dismantle and reassemble in reverse order. Install required new parts. Lap sections of the pump housing to insure flatness, if necessary.

When replacing the diaphragm, apply a thin coat of hard drying cement (Sealer 1000) around the hole in both cupped washers—diaphragm contact side. Purpose is to eliminate possible seepage at this point. Note holes in diaphragm and corresponding holes in the pump housing—assemble so all line up. This is important. Do not neglect replacing the discharge check valve disc and be certain same is not "cocked" and off its seat on assembly. The intake disc is installed above the screen at lower end of the suction pipe as shown. Be careful not to wrinkle the diaphragm when bolting sections of the housing together (see that bolt holes line up and that diaphragm does not overlap). Result is failure of the pump to operate and leakage to interfere with functioning of the tank. Similarly, the gasket between the pump assembly and tank must be in place and in good condition to avoid possibility of air leaks.

The pump should be used only when the carburetor float bowl is empty—as indicated by little or no resistance when depressing the pump button, except that set up by tension of the spring in the assembly. Float valve (in carburetor) closes as the bowl fills and closes entirely when filled to progressively build up resistance to pumping. Under no circumstance force the pump (depressing of pump button four to five times should be sufficient to fill the bowl)—the diaphragm is apt to be fractured.

Leaks in the assembly are indicated by failure of the pump and often by fuel seepage around the tank cover. In some instances, the motor cannot be operated without necessity of constantly pumping fuel (fuel pump); in others, seepage may be slight, requiring manual pumping only at higher speeds. Seepage of fuel mixture around the pump shaft is evidence of an improperly installed or a faulty diaphragm.

FUEL TANK — CHECK CHART



Showing Pump Mechanism and Gauge as Attached to the Fuel Tank.

Since the fuel tank plays such an important part in over-all performance of the motor (models QD and RD), it is imperative that it be checked as to fitness when conducting motor repairs— the motor cannot be made to perform with a faulty tank —always consider the fuel tank as part of the motor assembly.

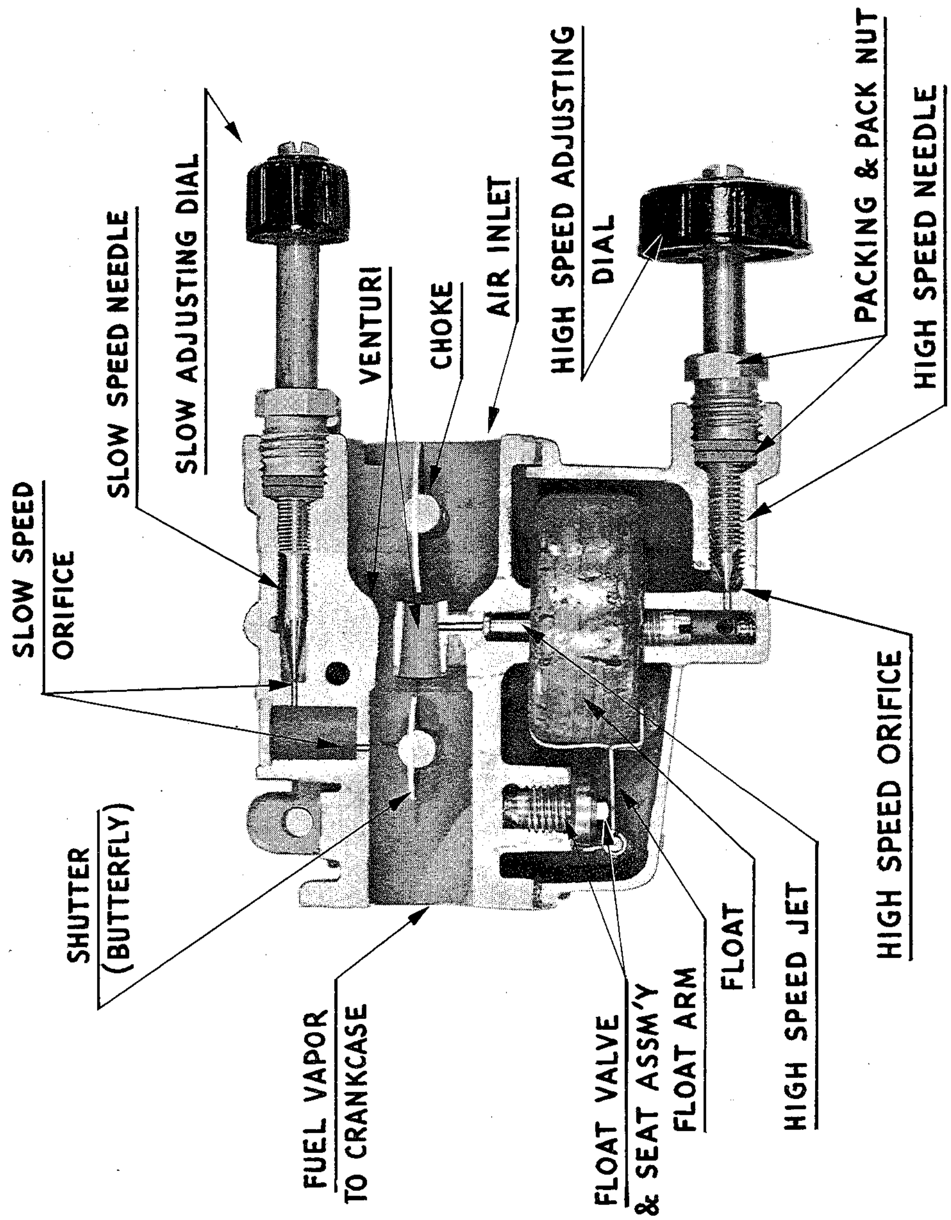
Major tank difficulties involve principally air or pressure leaks. See explanation of fuel system—page 85 Service Manual and Pressurized Fuel Tank on page 92-8.

Be guided by the following suggestions when diagnosing fuel tank irregularities and/or performing repairs on the tank.

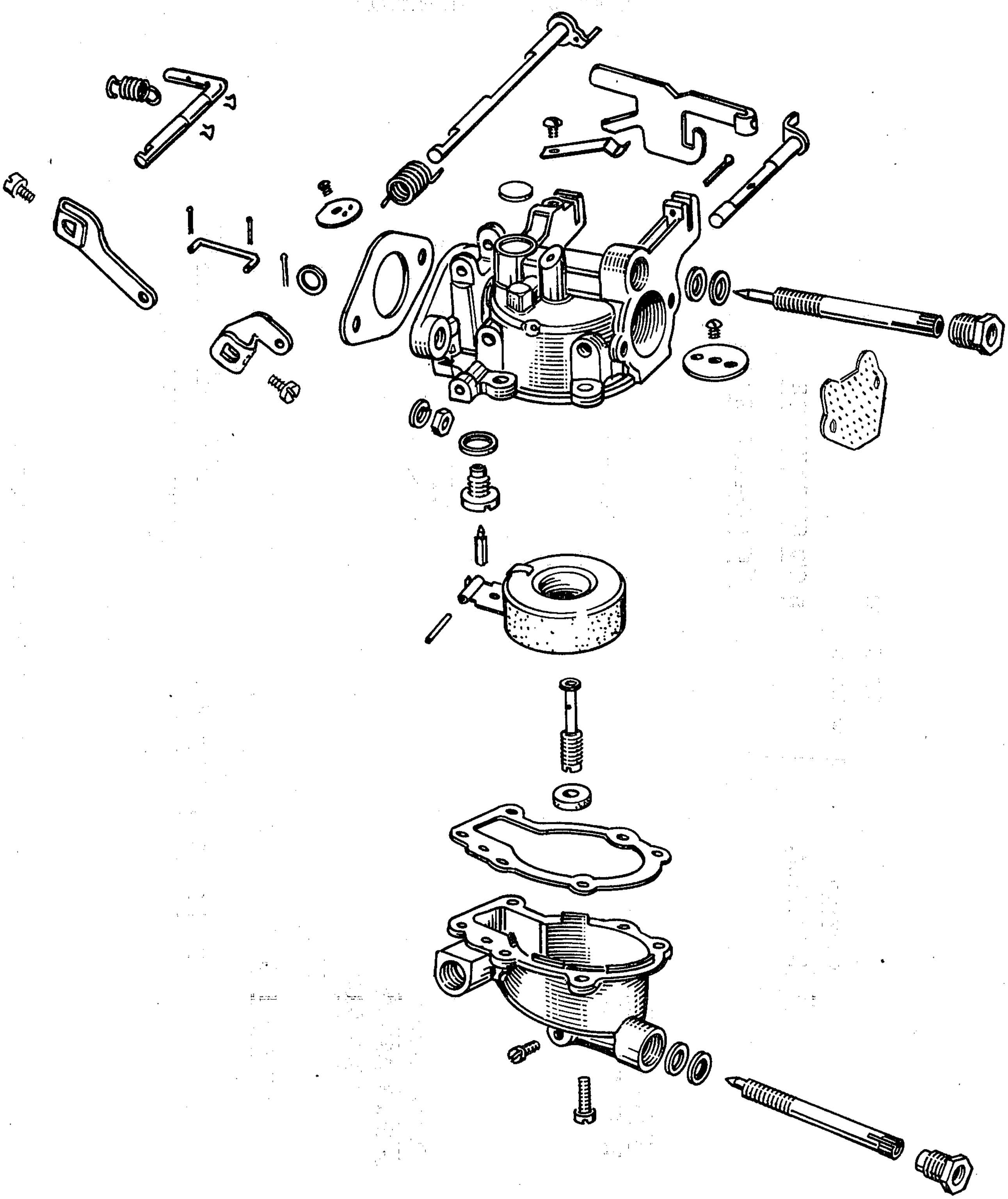
1. Filler cap and gasket
   (a) Loose or cracked
   (b) Faulty or improperly seated
   (c) Damaged gasket faces
2. Diaphragm—No. 302563
   (a) Punctured
   (b) Leaks—end of pump shaft—fuel escapes under pump button—nuts at the end of pump shaft loose or area around cup washers (No. 301800) not properly cemented
   (c) Not properly seated between pump housings
3. Pump housings—No. 302572 and No. 302555
   (a) Surfaces not flat to cause air seepage and resultant pressure drop
   (b) Not bolted together securely
4. Gasket—No. 302577
   (a) Damaged
   (b) Not secure to seal against pressure loss between pump assembly and tank proper
5. Screen
   (a) Clogged with foreign matter
6. Check disc valves No. 302802 and No. 375846 (assembly)
   (a) Sticking
   (b) Improperly seated
7. Fuel pipe
   (a) Loose in pump housing to cause pressure leak
8. Pressure release valve
   (a) Improperly seated to cause pressure leak
   (b) Sticking
9. Fuel gauge glass
   (a) Cracked
   (b) Improperly seated
10. Fuel tank
    (a) Punctured to cause pressure leaks
11. Fuel line and connectors
    (a) Faulty to permit pressure escape
    (b) Clogged

NOTES

MODEL JW CARBURETOR



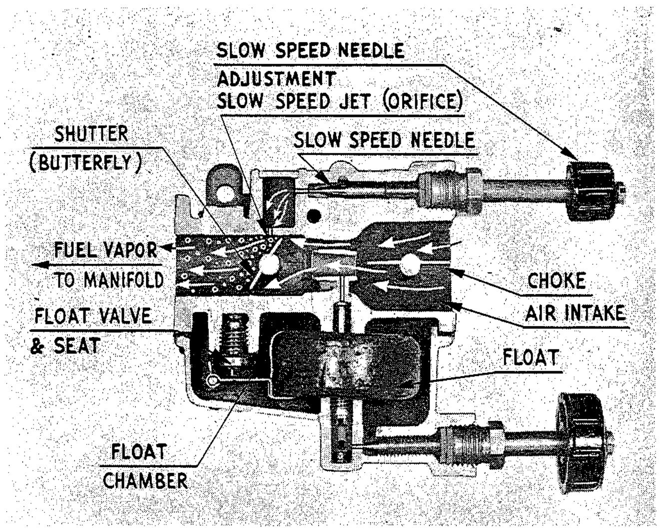
Sectionalized View of Carburetor—Model JW.



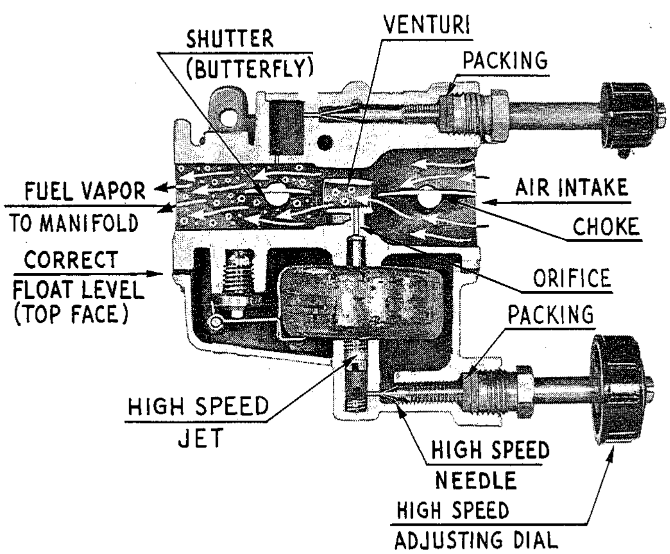
Assembly Layout — Carburetor Model JW.

CARBURETOR — MODEL JW

Carburetor on the Model JW is similar to that employed on other Models (QD, RD, etc.) in that it is of the float feed two-jet type, consisting of a mixing chamber and conventional float chamber. Two adjustments are provided, namely — for high and slow speed performance.

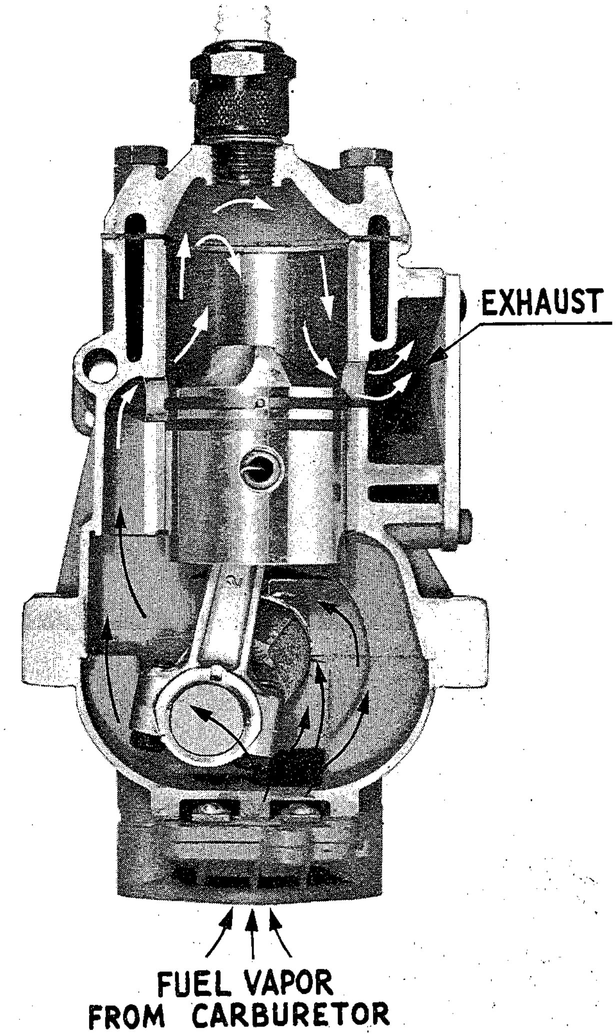


Sectionalized View of Carburetor (Float and Mixing Chambers) Showing Butterfly Shutter Set for Slow Speed Operation (Closed). Note Maximum Fuel Vaporization at Slow Speed Jet — Vaporization at High Speed Jet is Nil.



Sectionalized View of Carburetor (Float and Mixing Chambers)— Butterfly Shutter Full Open for High Speed Performance. Note Maximum Vaporization at High Speed Jet (Orifice) with a Minimum of Vaporization at the Slow Speed Jet; also, Effect of Restriction Caused by the Venturi Tube Built into the Mixing Chamber to Increase Air Velocity in Area of the High Speed Jet (Orifice). Note Position of Float when Adjusted to Correct Level—Top Face Flush with Face of Float Bowl. See Instructions Pertaining to Float Valve and Float on Page 92-22.

Induction to the crankcase similarly is by means of an automatic intake valve situated between the carburetor and crankcase which functions in accordance with changes in crankcase pressure as the pistons travel up and down to complete the cycle— see pages 92-19 to 92-21 inclusive for detail description.

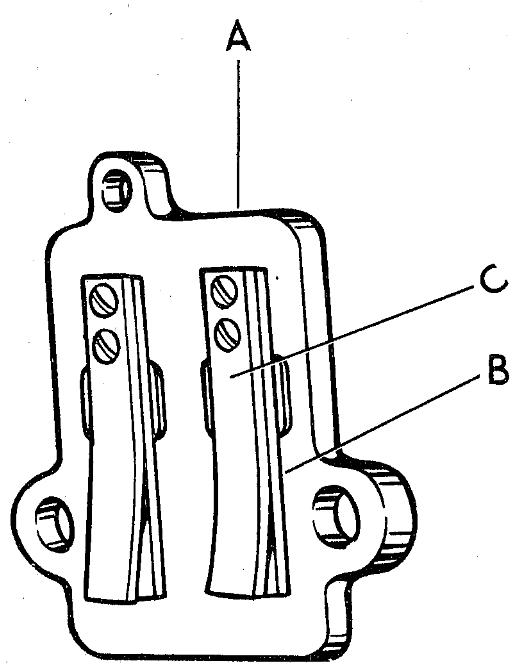


Arrows Indicate Path of Fuel Vapor as the Piston Progresses Through the Cycle. (Intake, Compression, Power and Exhaust).

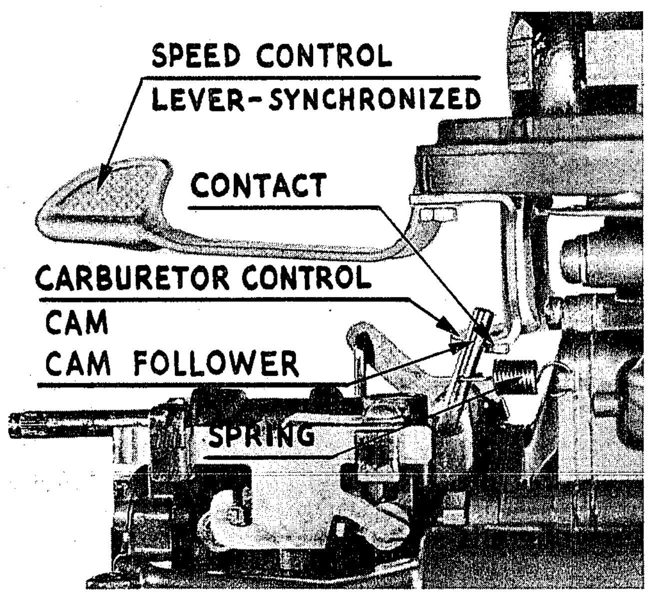
It will be noticed, however, that the automatic intake valve is not made up of several segments, as in the case of Models QD and RD, but of a single "strip"— one for each crankcase chamber as illustrated on following page.

CARBURETOR CONTROL (SPEED) ADJUSTMENT

Since gas and spark are synchronized to permit realizing consistent performance throughout entire speed range of the motor by correctly proportioning volume of fuel charge with respect to degree of spark advance, some adjustment is required to gain end results.

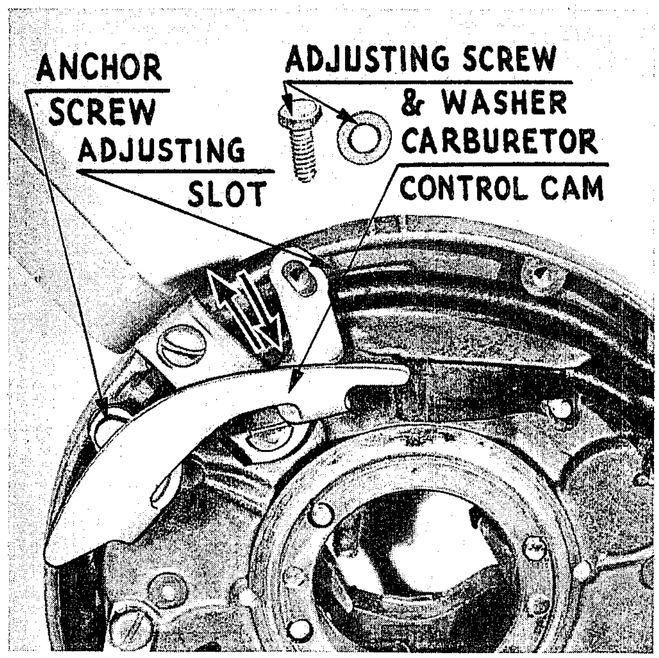


Illustrating the Model JW Automatic Valve Assembly Including (a) Valve Plate, (b) Automatic Valve, and (c) Automatic Valve Back-up Plate.

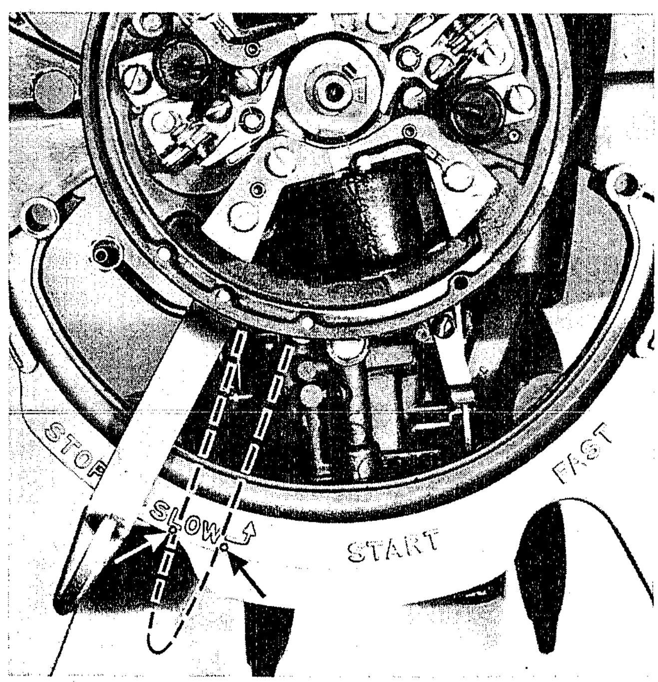


Illustrating Speed Control Synchronizing Mechanism, Namely — Speed Control Lever, Carburetor Control Cam and the Carburetor Control Cam Follower.

Synchronizing is accomplished by means of a cam, cam follower and linkage arrangement as shown here. The cam is attached to the armature plate and moves with it as the spark is advanced. At retard spark, the cam follower rides on the "low" end of the cam to result in but partial opening of the carburetor shutter (butterfly). With advance of spark (speed control level) the follower progresses toward "high" end of the cam — greater opening of the carburetor shutter to permit larger charge of fuel vapor and subsequent increase in power and speed.



Showing Slot in Free End of the Carburetor Control Cam to Permit Shifting In or Out as Required to Obtain Correct Synchronizing Adjustment.



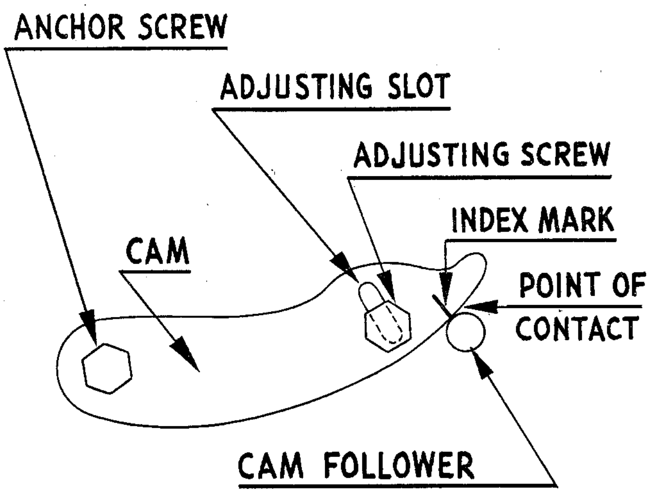
Showing Small "Embossings" on the Gas Tank Mounting Bracket to Locate Position of Speed Control Lever When Adjusting Carburetor Control Cam.

Some adjustment is required to properly synchronize — proceed as follows:

1. Loosen screws slightly at both ends of the

speed control cam (underside of armature plate).

2. Move speed control lever to position between embossings on the gas tank bracket as indicated by the dotted line in the illustration.
3. Note line stamped on top side of the control cam—with speed control lever set in position described above, move free end of the cam "out" until it makes contact with the cam follower (but only after slack in the linkage has been taken up) at point of index mark.
4. Draw up on both screws holding the cam to the armature plate to secure in this position.

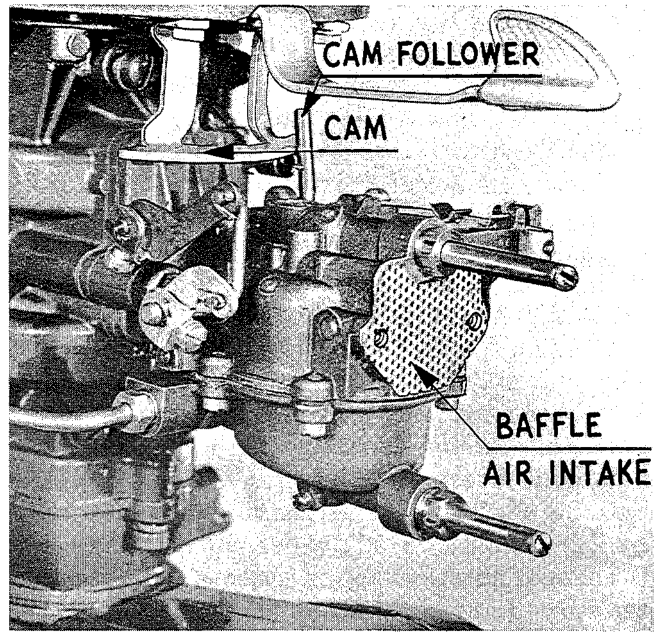


Schematic Drawing to Illustrate Cam and Cam Follower Adjustment.

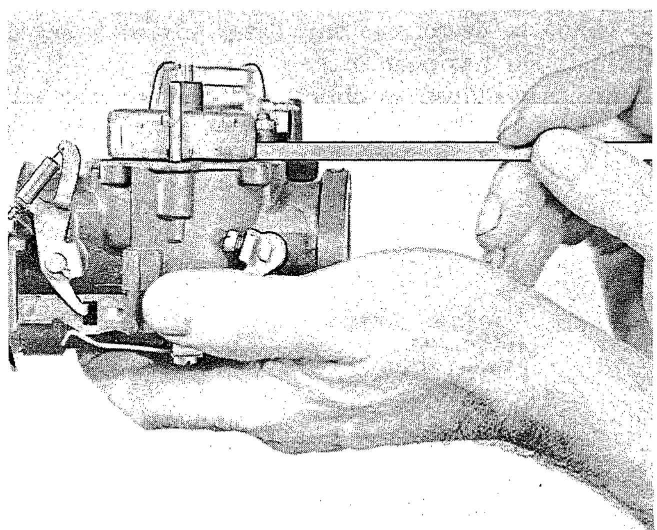
CARBURETOR ADJUSTMENT

The carburetor being of the two-jet (float feed) type, is designed for maximum, efficient carburetion at all speeds, two adjustments are thus required, namely: high and slow speed. Both high and slow speed needles are adjusted at the factory with provisions for limited variations to compensate for atmospheric conditions. However, if ultimate adjustment does not fall within the limited range or in case of repairs, proceed as follows:

Loosen, but do not remove screws in center of slow and high speed dials. (Dials are held firmly in position on their respective adjusting needle shaft by expansion of slotted serrated ends as a result of drawing up on the counter-sunk head screws.) Pull dials out until limiting stops on dial (back side) clear like stop cast onto the motor cover. Dial is now free to be turned beyond normal limited range: tighten center screws to secure to needle shafts.



Showing Screen or Baffle Attached to the Carburetor Intake — Function of which is to Counteract Effect of Surging Impulses Created by Action of the Automatic Intake Valve.



Method of Checking Float Level.

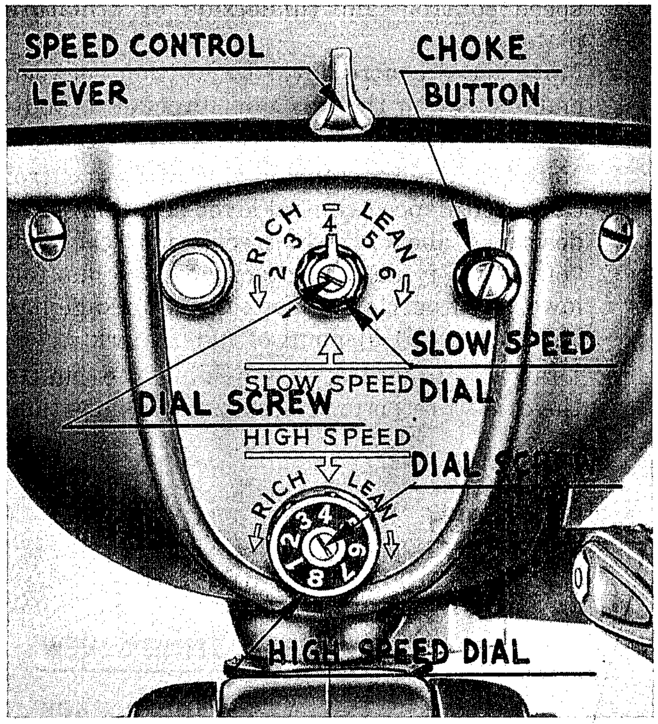
Carefully turn both dials to right, to position where adjusting needles come to rest gently on their seats. Be careful not to injure seats by turning down too tightly. Then back off (turn left) slow speed dial approximately one full turn — high speed dial about 3/4 turn.

SLOW SPEED ADJUSTMENT

Start motor as instructed — run at "Fast" speed until normal operating temperature has been reached. Throttle down to "slow speed range." Turn dial to right or left as required to obtain best setting for slow speed.

(Note: Turning needles to left enriches the fuel mixture — that is, increases proportion of fuel to air to result in rich mixture. An excessively rich mixture is indicated by "rough" running of the motor. "Spitting or coughing" in the carburetor is indicative of a lean mixture, caused by turning needle too far to right.)

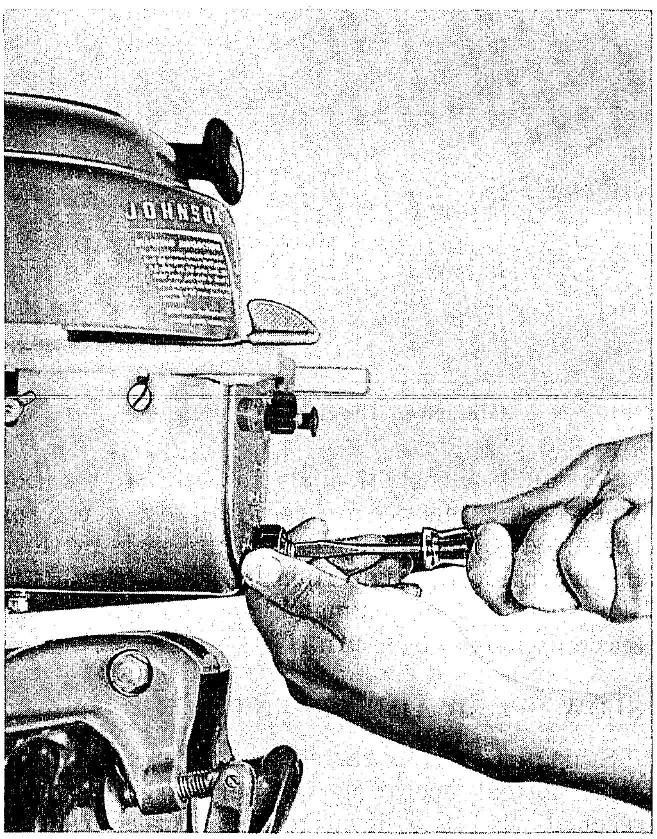
Loosen center screw to properly arrange dial, without disturbing position of the slow speed needle (this is IMPORTANT). Should dial tend towards binding on the needle shaft, it may become necessary to pull it free entirely to permit rearranging its position without affecting adjustment of the needle at this time. Arrange dial to position where pointer is directed to Numeral 4. Push dial back onto the shaft to distance clearing the motor cover by approximately 3/32", which should be sufficient to engage limitation stop on the cover. Tighten center screw to firmly secure dial. Atmospheric conditions may necessitate slight variation from time to time — limited range provided in this respect should be sufficient, nevertheless.



Showing Carburetor Control Panel.

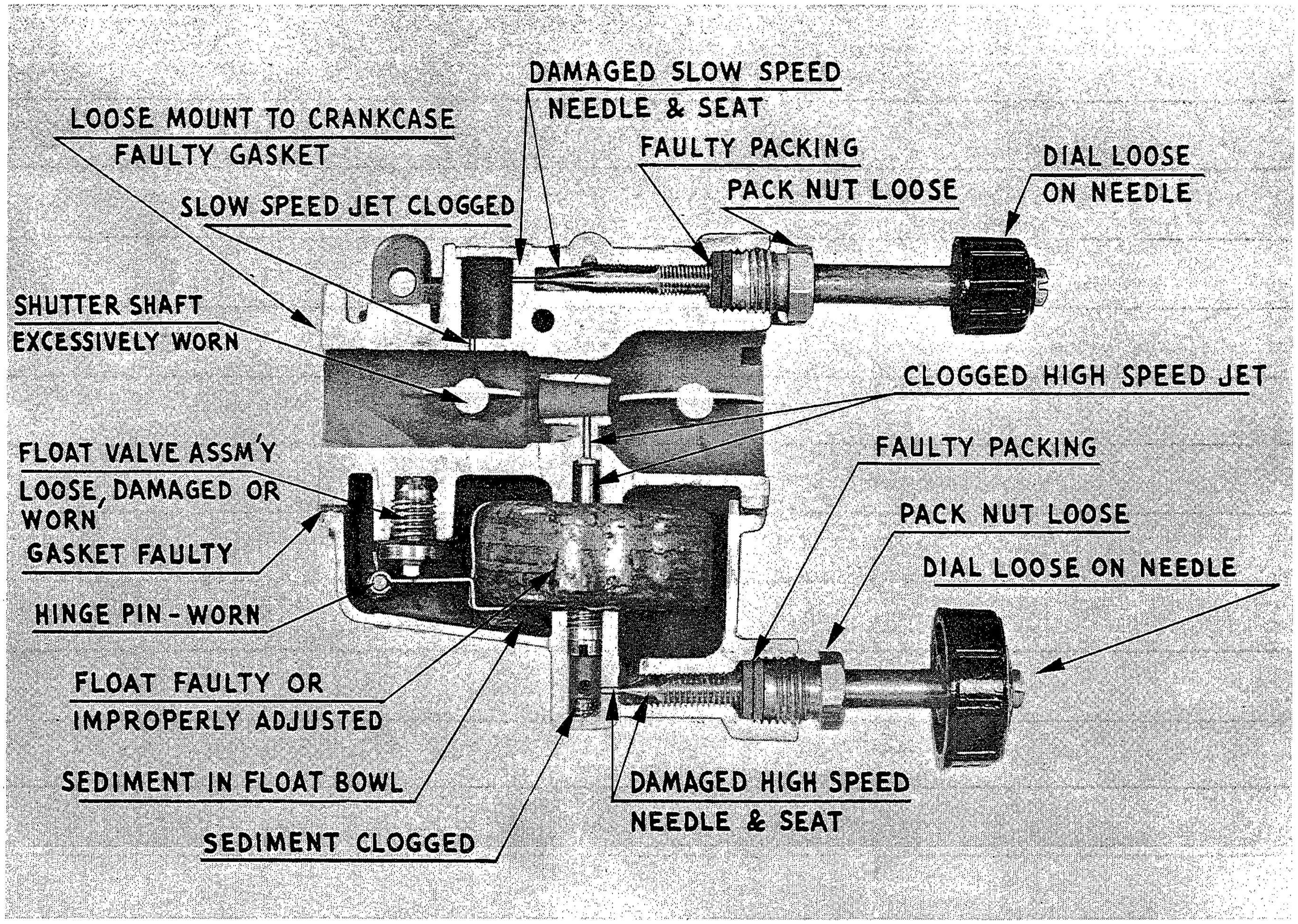
HIGH SPEED ADJUSTMENT

(Must be performed only after final slow speed adjustment has been made.) Turn dial to left or right as required to obtain best setting for top speed performance. Rearrange dial numbers as described above — Number 4 should be directed up as shown above.



Showing Method of Adjusting Position of Carburetor Needle Dials

NOTES

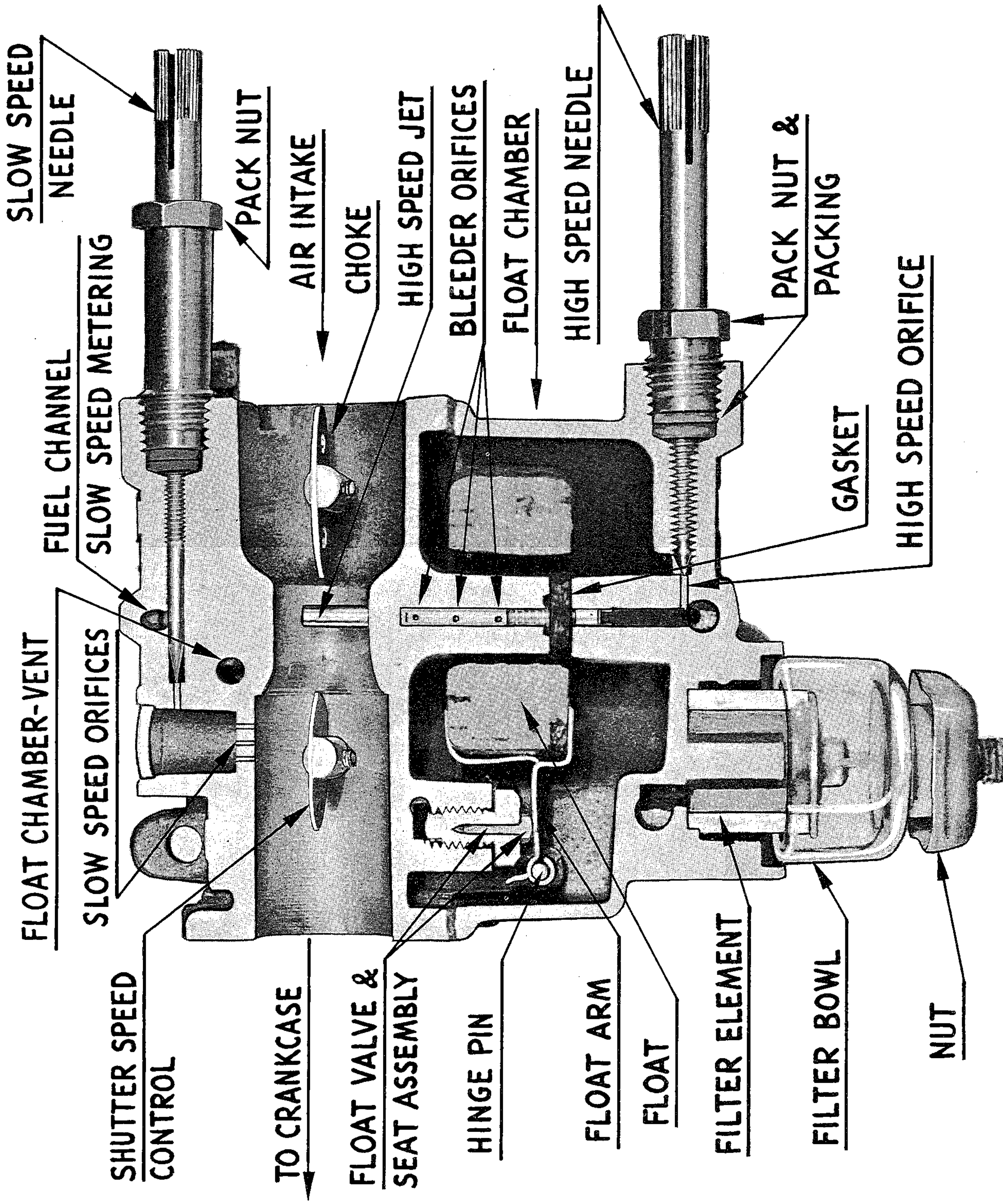


CARBURETOR CHECK CHART

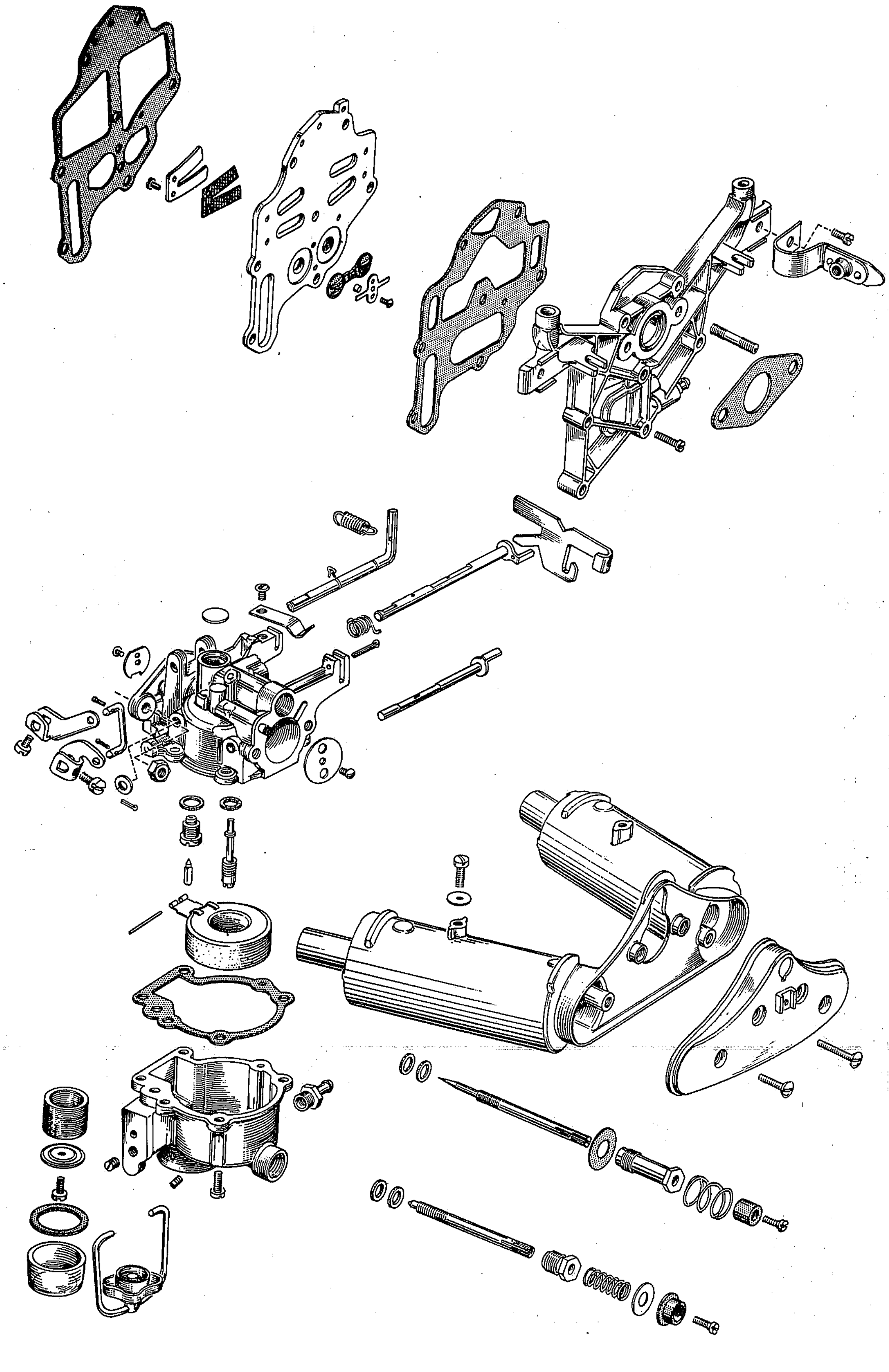
NOTES

NOTES

MODEL CD CARBURETOR



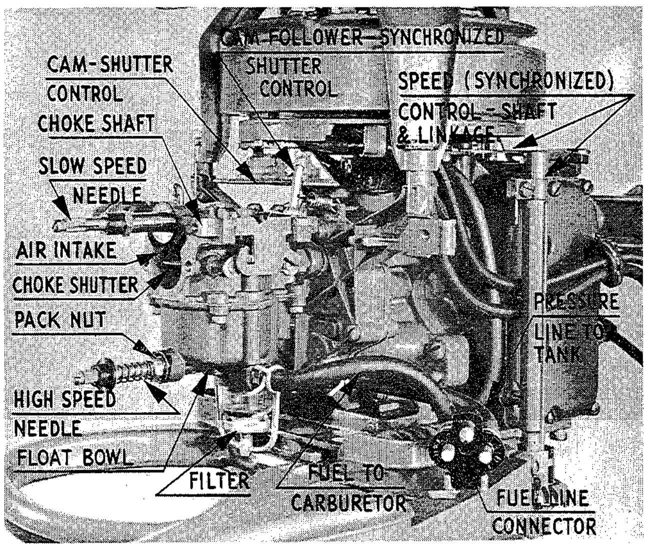
Sectionalized View of Model CD Carburetor.



Carburetor, Manifold, Valve and Silencer Group

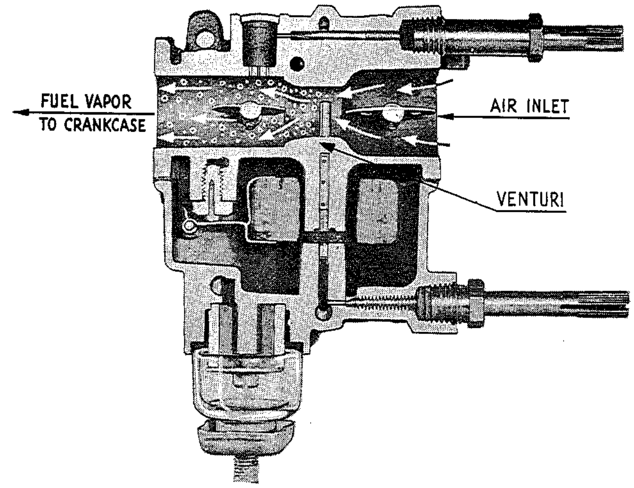
CARBURETOR — MODEL CD

Carburetion built into the Model CD assembly is identical in principle to that used in the JW, QD, and the RD. Except for minor details in construction, functioning is similar, employing two carburetor adjustments to achieve efficient carburetion throughout entire speed range of the motor (high and slow speed), reed type of fuel vapor intake valve to the crankcase, synchronized shutter control (spark-gas), manually operated choke and a fuel filter attached as an integral part of the carburetor float body casting. Fuel supply is by means of pressurizing the Mile Master Tank as described on page 92-21. See "Carburetion" on pages 62 and 92-1.

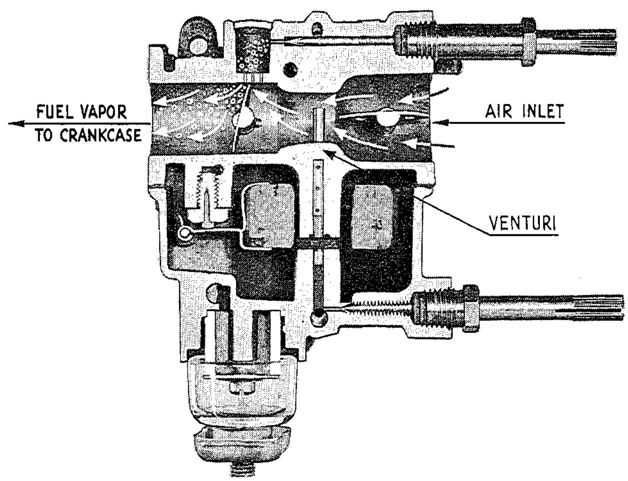


CARBURETOR INSTALLATION

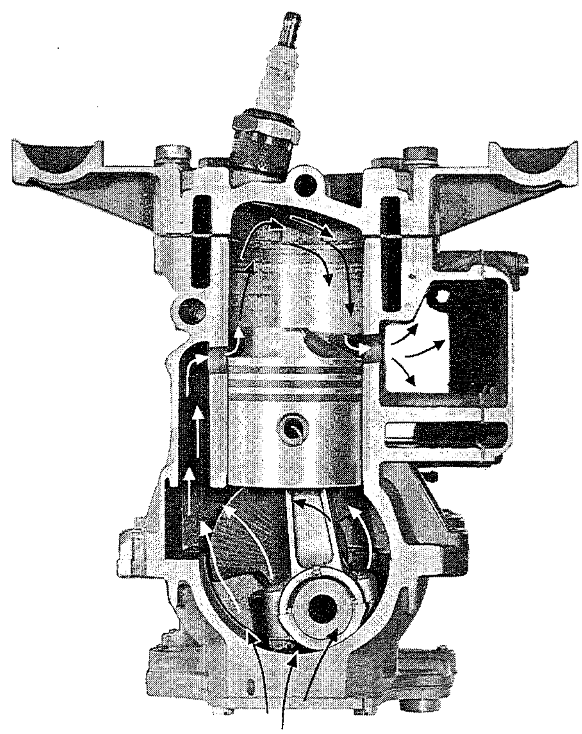
Shown above, carburetor and synchronizing control mechanism — Spark and fuel vapor (gas) are synchronized to obtain correct volume of fuel charge with relation to degree of spark advance to obtain maximum efficiency and over-all performance throughout speed range of the motor — slow, intermediate and high speeds, and during moments of rapid acceleration — deceleration.



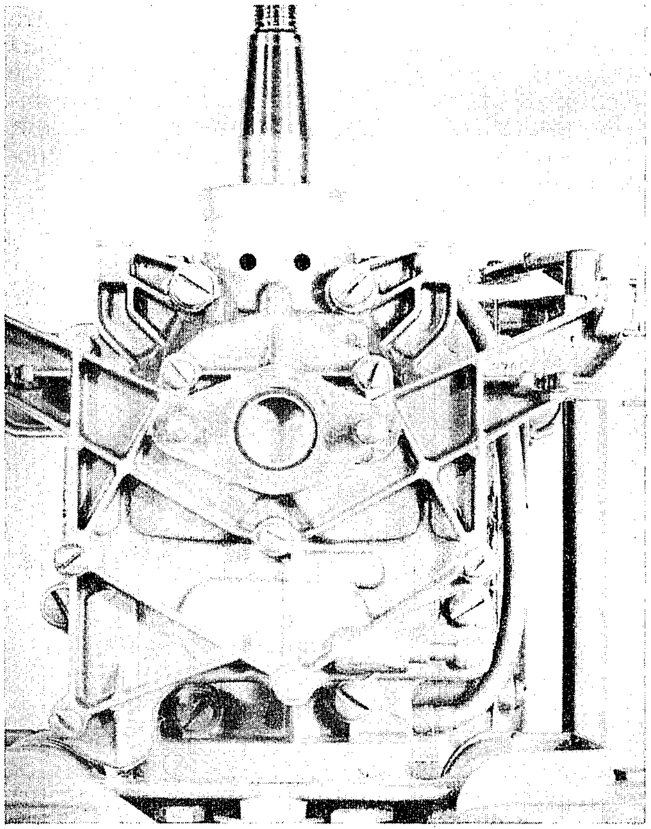
Sectionalized view of mixing chamber—butterfly shutter full open for high-speed performance. Note maximum fuel vaporization at the high speed jet with a minimum of vaporization at the slow speed jets. Also effect of restriction caused by the Venturi ring to increase air velocity in area of the high speed jet.



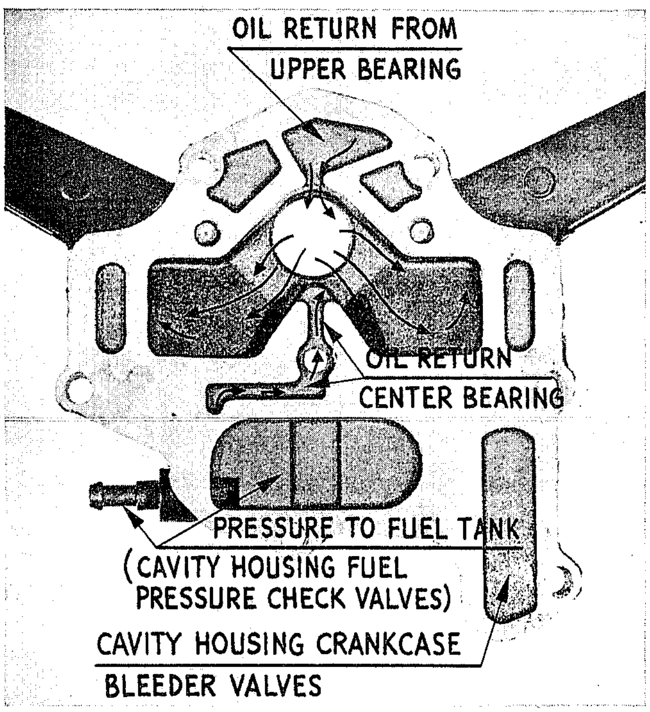
Sectionalized view of mixing chamber—showing butterfly shutter set for slow speed operation (closed). Note maximum fuel vaporization at slow speed jet—vaporization at high speed jet is nil.



Showing path of fuel vapor as it progresses through the powerhead during completion of its cycle.

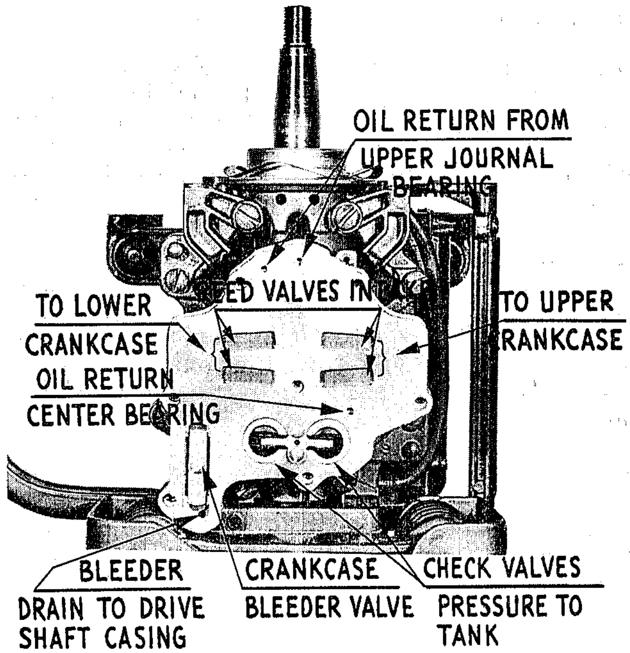


Carburetor removed to expose "Throat" in the intake manifold

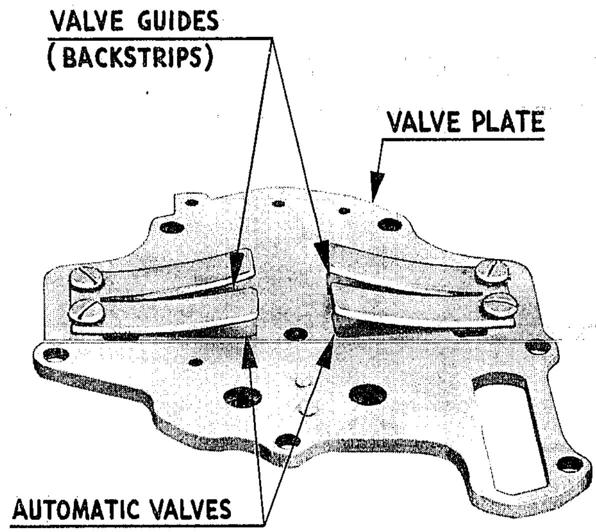


Illustrated above is back view of the intake manifold showing oil return channels leading into the manifold proper. Here, oil returning from the upper and center bearings enters the fuel-vapor stream to be conducted into crankcase chambers.

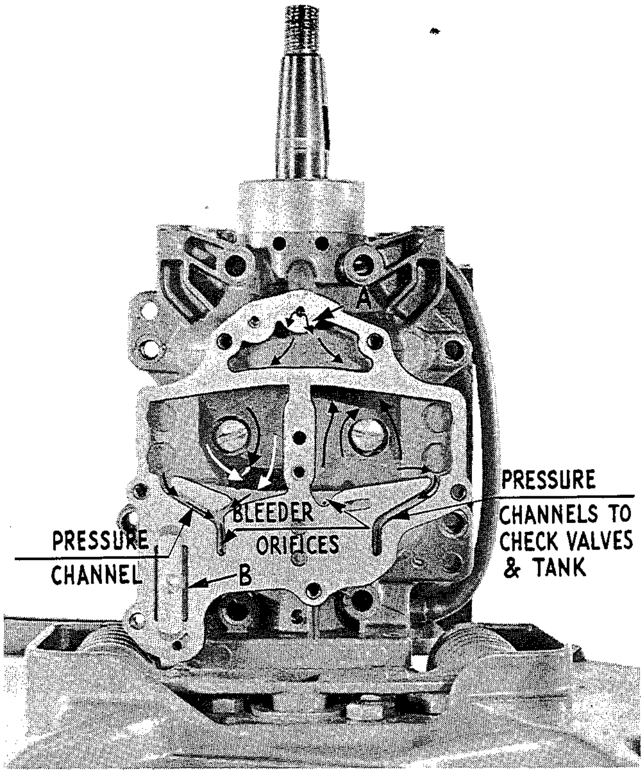
Shown also are cavities housing the fuel pressure check valves and crankcase bleeder valves.



Shown here are carburetor and intake manifold detached to expose the valve plate, showing installation of the reed (automatic intake) valves, check valves — releasing crankcase pressure to the Mile Master Tank and crankcase bleeder valve arrangement employed for escape of "heavy" fuel vapor ends which settle out during slow speed running of the motor. See explanation on pages 92-21 and 164-9.

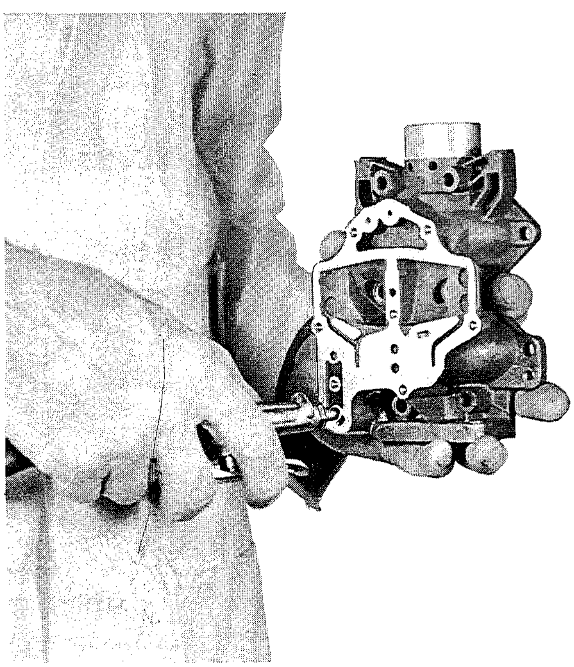


Back View of Valve Plate, Exposing the Automatic Valves and Guides (Back Strips).

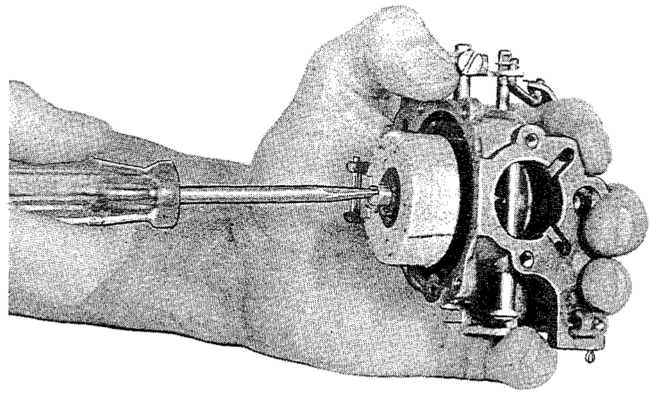


Above shows intake manifold and valve plate assembly removed to expose channels leading to upper and lower crank chambers — arrows indicate fuel-vapor entering each.

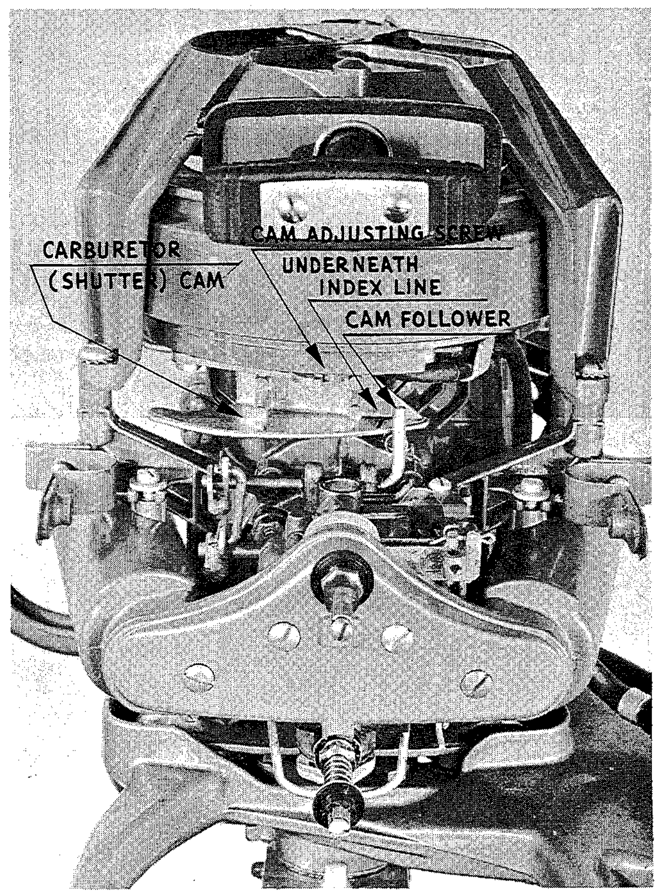
Small arrows A indicate oil return from the upper journal bearing where it flows through a corresponding hole in the valve plate to enter the fuel-vapor stream flowing through the intake manifold, re-entering the crankcase for further use. For explanation of check valves B, crankcase bleeder, see page 164-9.



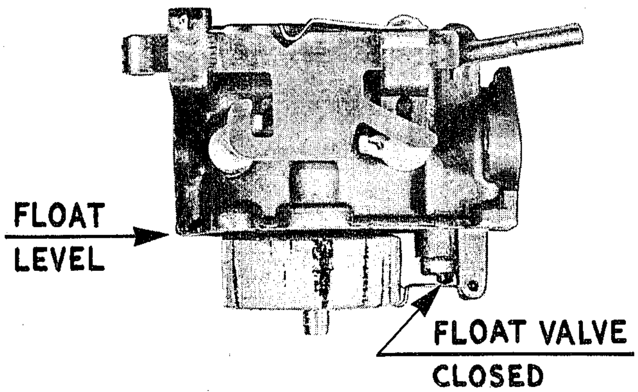
Blowing out the Oil Bleeder Orifices.



Removing the High Speed Jet



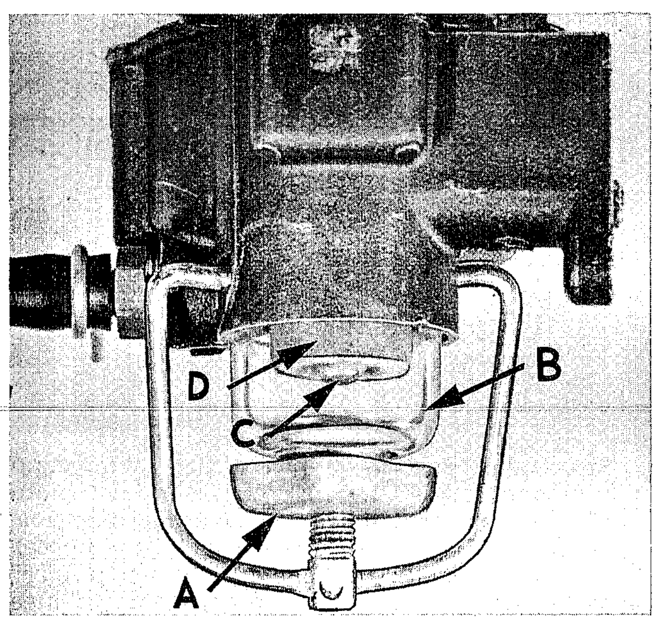
Spark and "gas" are synchronized by means of a cam and linkage arrangement for best motor performance shown above—some adjustment may be required. Note index line cast onto the cam and spring loaded cam follower. When properly adjusted, cam follower should "contact" or meet contour of the cam at point of the index line, but only after slack in linkage has been taken up with the carburetor shutter just on verge of opening. To adjust if necessary, loosen adjusting screw under the armature plate slightly (hole in cam is elongated), move "low" end of cam in or out as required to achieve correct indexing or contact of cam follower. Re-tighten adjusting screw. Carburetor shutter is closed when follower "rides" on low end of the cam—open at the "high" end for maximum top speed.



Maintaining correct fuel level in the float bowl is important to proper functioning of the carburetor throughout speed range of the motor. Since fuel level is controlled by the cork float acting on the float valve, some adjustment may be required in this respect. Fuel level is correct when top face of the float comes to rest "flush" with face of the carburetor body when turned up-side-down or as shown here.

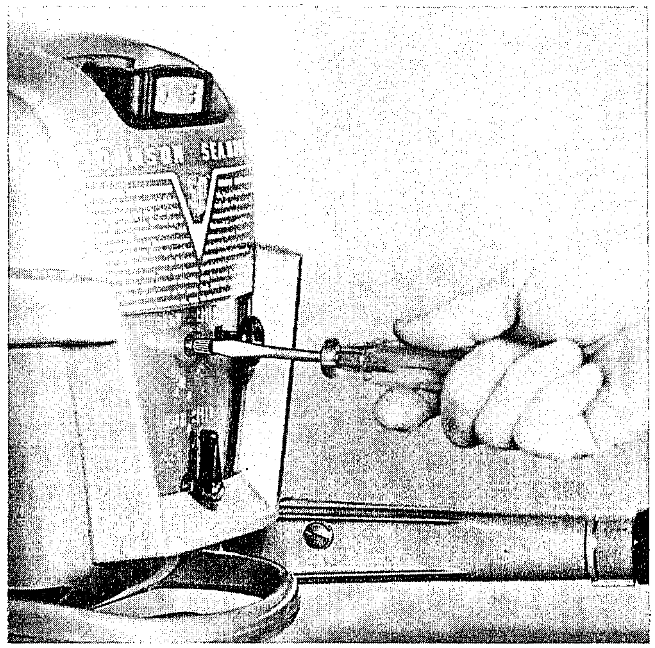
In event the float is too high or too low, carefully bend the float arm up or down as required to obtain position indicated by arrow — Float level too high causes overflowing, "dripping" of the carburetor and/or sluggish motor operation; level too low results in faulty operation — in extreme instance, "spitting" back through the carburetor.

In either case, carburetor needle adjustment appears to have little effect.

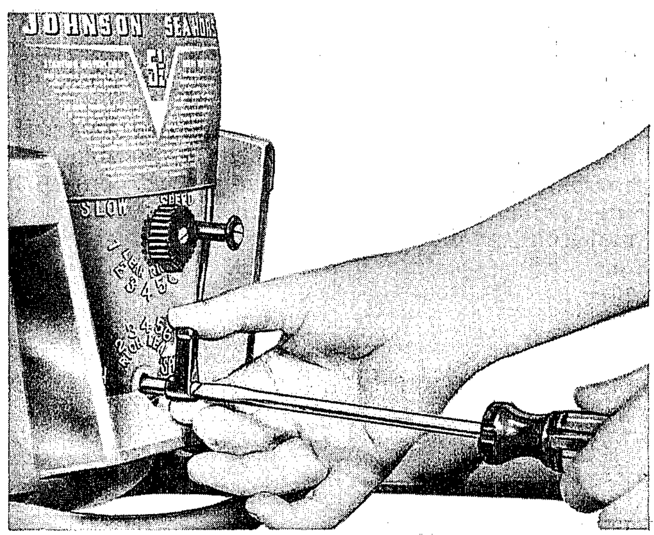


Showing above filter assembly attached to the carburetor float bowl — To clean, loosen nut A; swing supporting bracket aside to permit removing the filter bowl B; remove screw C to free filter element D for cleaning. Wash the filter element free of foreign accumulation in vessel of clean gasoline. Replace and complete assembly in order reverse of that described above. Check condition of filter bowl gasket at this time to insure against fuel seepage later on—install new gasket if in doubt.

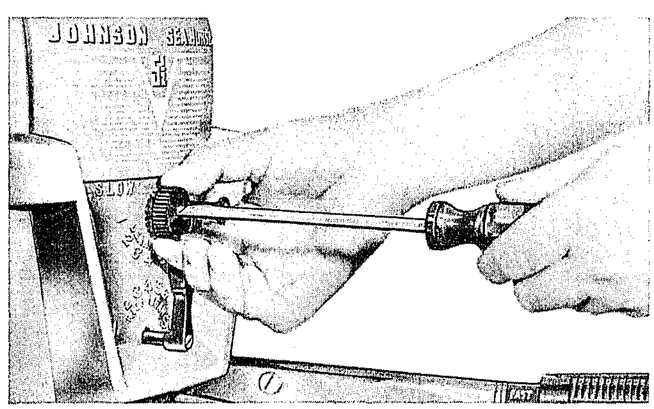
CARBURETOR ADJUSTMENT



Adjusting needle setting with screwdriver prior to final placing of the slow speed dial and high speed lever.



Adjusting Position of High Speed Lever



Adjusting Position of Slow Speed Dial

CARBURETOR ADJUSTMENT — SLOW AND HIGH SPEEDS

Both high and slow speed needles are adjusted at the factory on final assembly and testing, with a limited range for further adjustment provided the ultimate owner to compensate for local operating conditions such as temperature (atmospheric and water), atmospheric or barometric pressure (altitude), humidity, etc., which frequently require slight variations in needle settings. A boss or "stop" is cast on to the carburetor panel and a similar arrangement cast on to the back or inside of the slow speed adjusting knob which permits somewhat more than a half turn of the knob as and if required to achieve best performance—Note pointer on knob and numerals 1 to 7 on the control panel.

Similar provisions are made for compensating adjustment of the high speed needle for like reasons except that the limiting "stops" for the high speed adjusting lever are built into the cover—Note numerals 1 to 7 which limits adjusting to less than a half turn.

In event the carburetor has been "torn down" for cleaning and/or repairs, primary or initial adjustment will be required for both high and slow speed needles—best accomplished with the motor cover removed. Proceed as follows:

1. Note—that the slow speed knob and high speed lever are made fast to their respective needles by means of serrations on the slotted end of the needle as result of expansion when drawing up on the taper headed screw—remove both screws to gain access to slot at the extreme end of each needle.

2. Insert screw driver bit into slotted end of the high speed needle—turn right to close until the face of the pointed needle rests gently on its seat in the carburetor body (this is important, do not turn down tightly—to do so will cause the face of the needle to "ring" and the seat to expand or distort after which further adjustment becomes impossible due to damage caused). Then turn left or "unscrew" approximately 1/2 turn high speed.

3. Perform same function on the slow speed needle but open or "unscrew" about 1-1/8 turn.

4. Attach test wheel—start and run the motor in a test tank until normal running temperature has been attained.

5. Turn high speed needle (with screw driver) to right or left as required to obtain best setting for maximum performance.

6. Reduce motor speed towards idling position —turn slow speed needle to right or left as required to obtain smooth operation in the lower speed range. Further retard motor speed—adjust position in like manner for best performance. Repeat the operation until best setting for maximum slow speed running has been accomplished.

NOTE—rough or "jumpy" running of the motor denotes an excessively rich carburetor mixture (too much fuel—too little air) and as evidenced by a "smoky" exhaust. Spitting back or "coughing" through the carburetor is indication of a too lean mixture (too little fuel—too much air). Turning needle adjusting valve to right reduces flow of liquid fuel into the carburetor air stream thus "leaning out" the fuel vapor mixture; turning to left, increases the flow of liquid fuel to result in a correspondingly richer mixture.

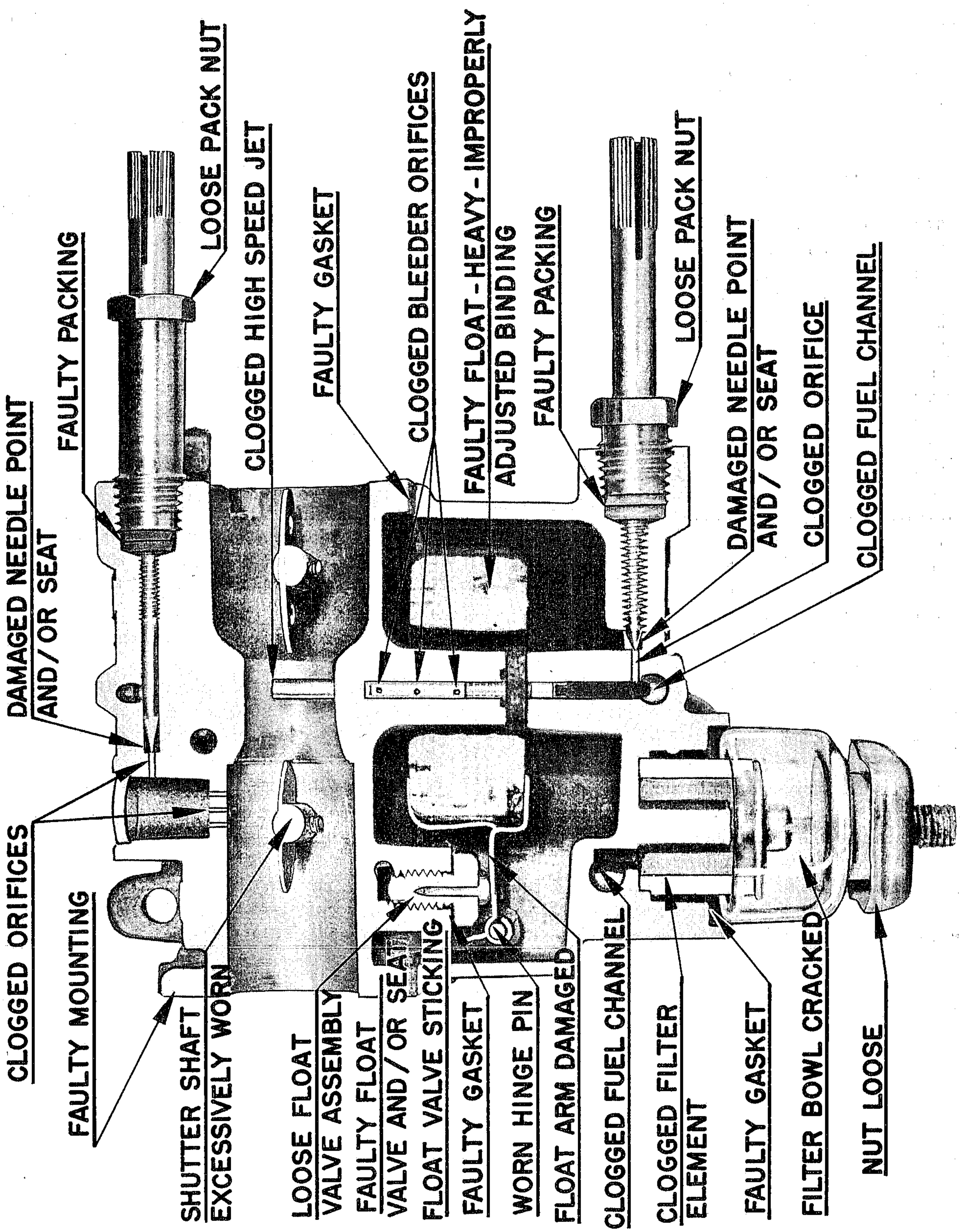
7. Re-check both needle settings to assure best performance.

8. Without disturbing position of the slow speed needle, install the slow speed knob over the protruding serrated end, with pointer directed towards numeral 4. Insert and draw up snugly on the taper headed screw provided for the purpose.

9. Locate position of the high speed needle lever as described above—lever directed towards the numeral 4

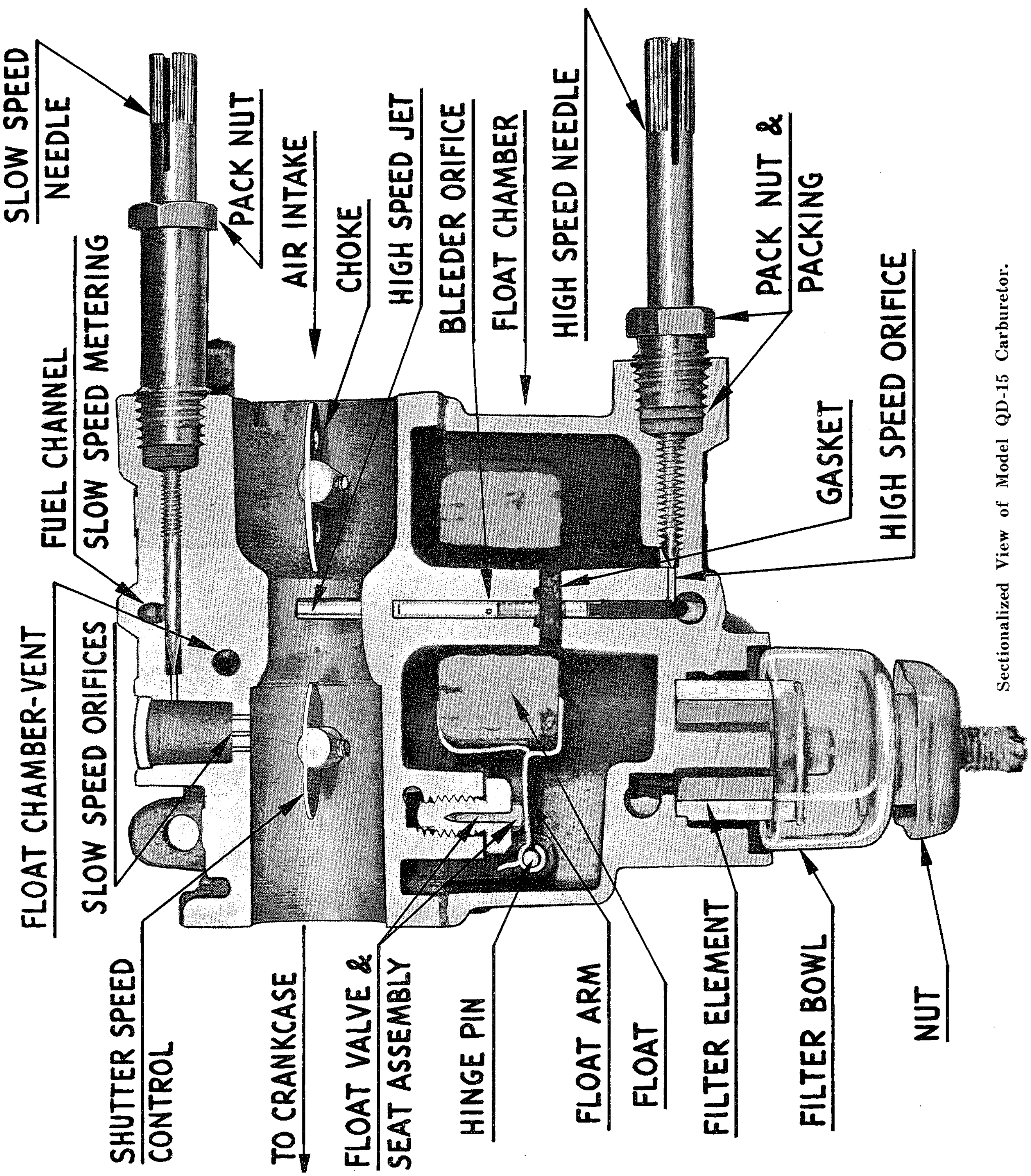
10. Make certain the taper headed screws are drawn up securely to hold the knob and lever fast on their respective needles.

NOTES

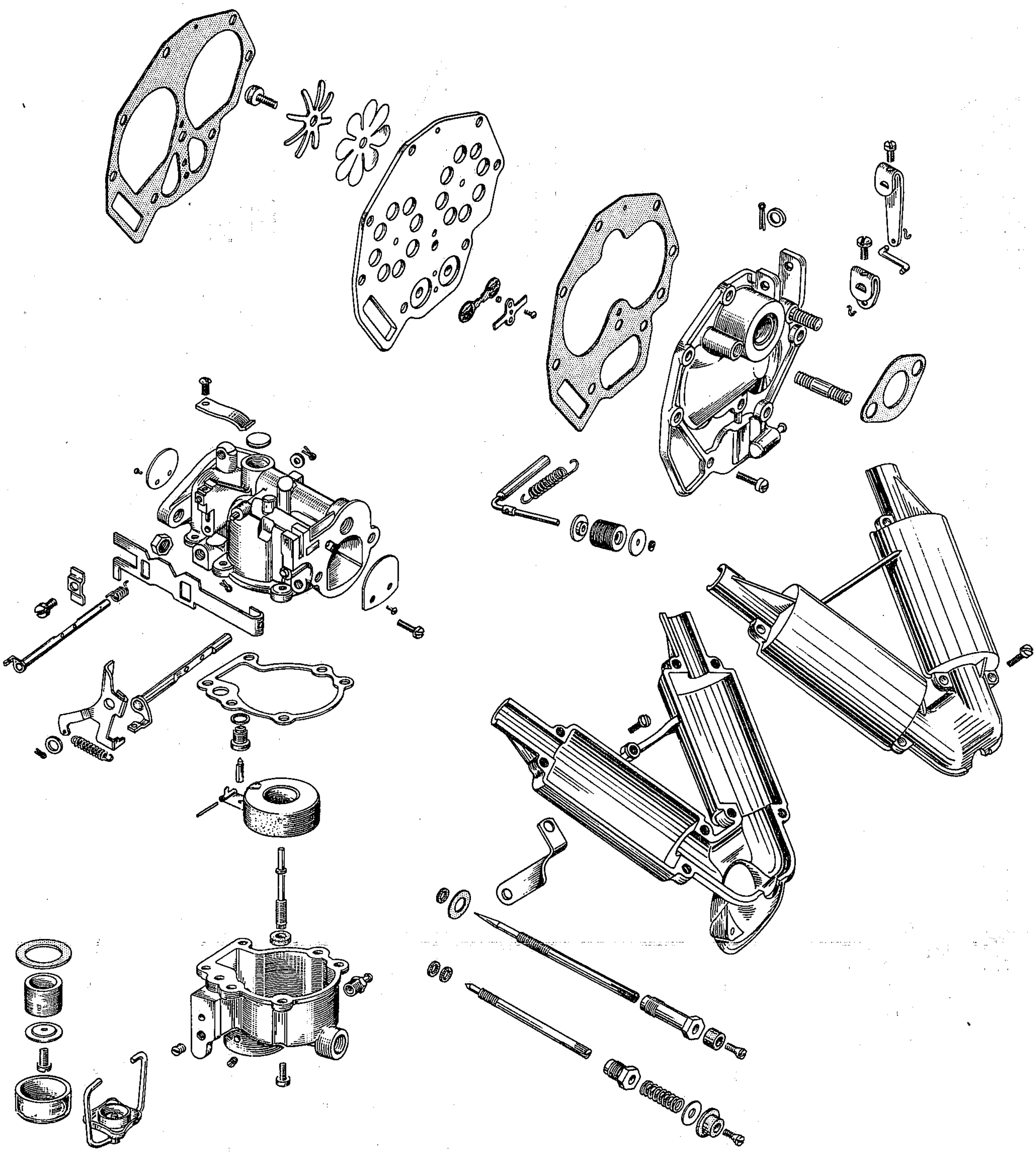


CHECK CHART MODEL CD

MODEL QD-15 CARBURETOR

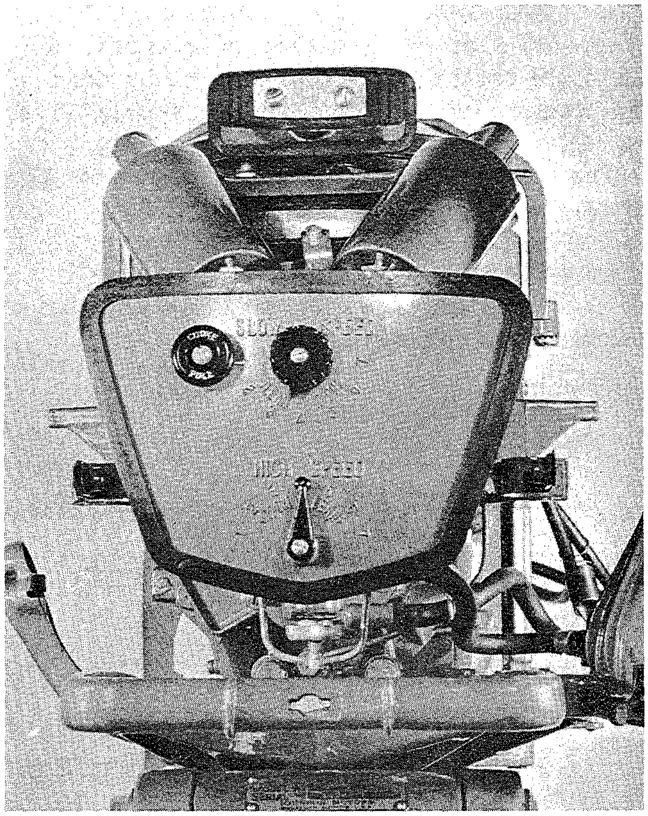


Sectionalized View of Model QD-15 Carburetor.

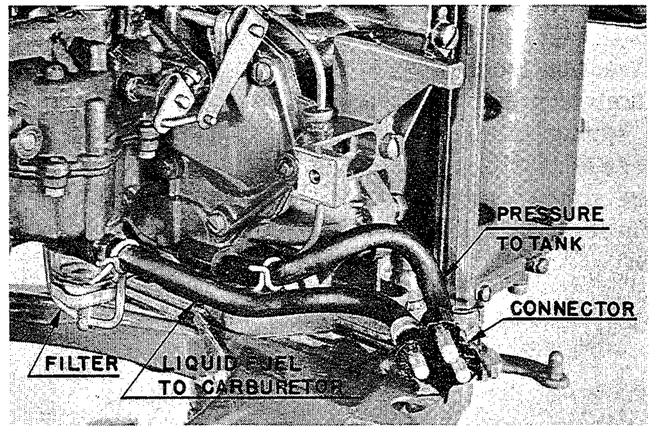


Carburetor, Manifold, Valve and Silencer Group.

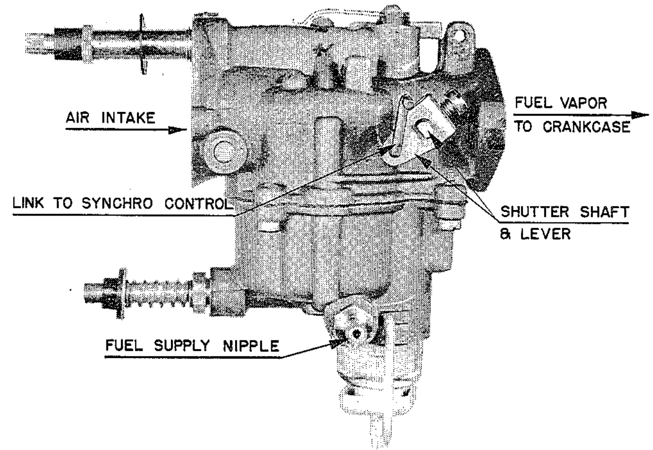
MODEL QD-15 CARBURETOR



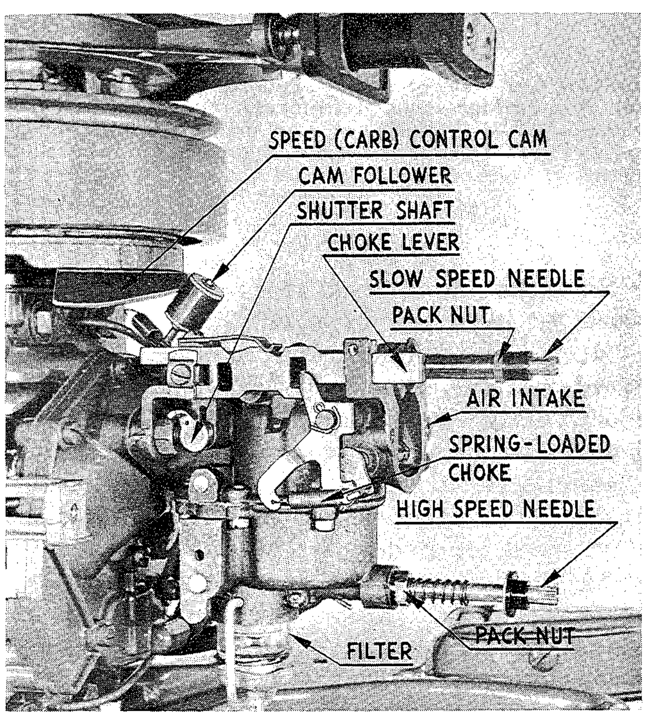
Front View of Carburetor Control Panel (Motor Cover Removed) Showing Position of the Choke Button, Slow Speed Adjusting Knob and High Speed Adjusting Lever.



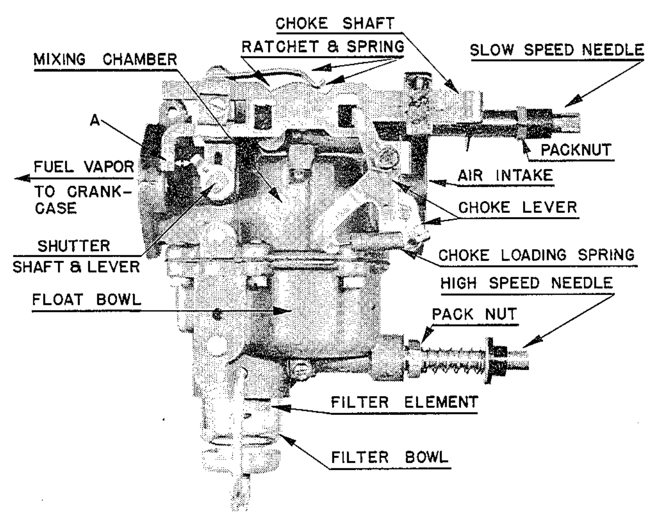
Showing Pressure Line to Tank, Fuel Line to Carburetor and Fuel Filter.



Port View of Carburetor Showing Shutter Shaft and Lever, Link to Synchro-Control Mechanism and Fuel Supply Nipple Attached to the Float Bowl.

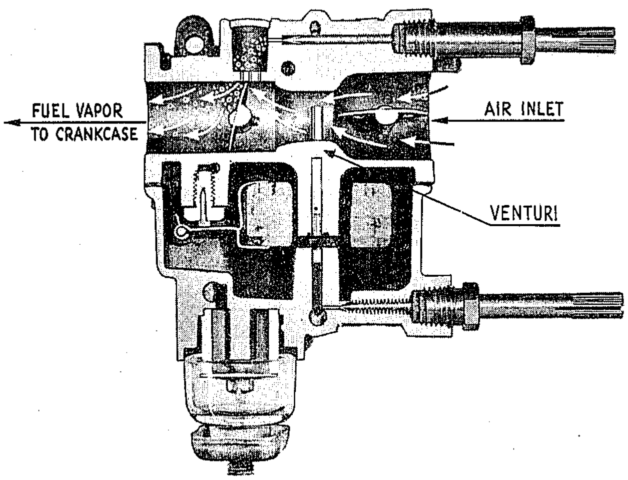


Carburetor Installation on Powerhead, Showing Cam and Cam Follower (Speed Control—Carburetor Shutter). Note that Choke Shutter is Spring Loaded to Avoid Excessive Choking During Movement of Starting.



Starboard View of Carburetor. Note that Choke Control is Spring Loaded to Guard Against Flooding Immediately After Starting and that Extreme End of Choke Shaft (A) is Arranged to Engage the Choke Shaft Lever to Permit Partial Opening (Cracking) of the Shutter at the Time of Starting—For Ease of Starting.

The carburetor employed in assembly of the Model QD-15 differs somewhat in design and construction from those of earlier models in that the familiar primer has been omitted and replaced with a spring loaded choke for simplification and for ease of starting. Otherwise principles of operation are similar, embodying slow and high speed carburetion. See illustrations below.



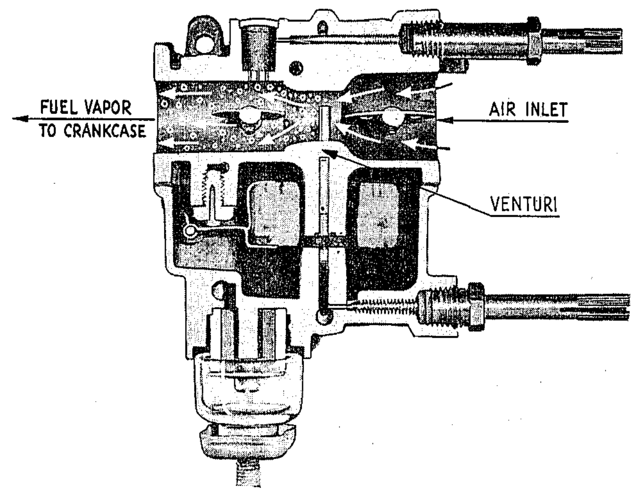
Sectionalized view of mixing chamber—showing butterfly shutter set for slow speed operation (closed). Note maximum fuel vaporization at slow speed jet—vaporization at high speed jet is nil.

Since a motor running in the slower speed range operates with the carburetor shutter closed or nearly closed, suction on the intake manifold side is sufficient to lift liquid fuel higher than the level normally maintained by the float in the float bowl, it reaches the slow speed "mixing" or vaporizing area on top side of the carburetor. Here the liquid fuel is metered by adjustment of the slow speed needle — to obtain a combustible vapor mixture as it enters the air stream.

With the existence of low pressure (suction) in the manifold during periods of "slow" operation, velocity of air rushing (squeezing) through the small gap on top side of the shutter is considerably increased, thus thoroughly vaporizes liquid fuel flowing from small orifices in the immediate area.

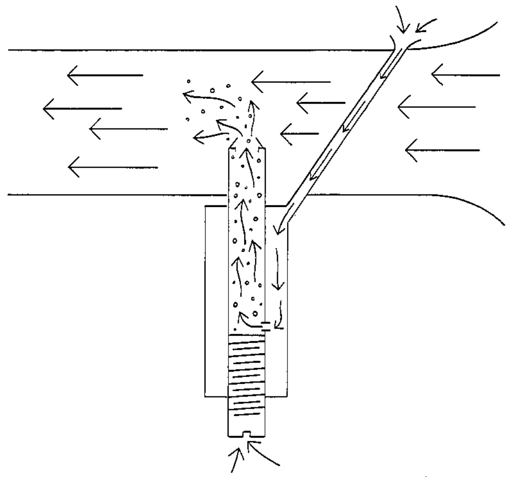
With speeding up as a result increasing degree of shutter opening suction in the manifold is progressively reduced while velocity and volume of air flowing through the carburetor throat is increased. At this stage vaporization at the slow speed orifices commences to diminish since manifold suction is not great enough to maintain the high fuel level required for vaporization in the "slow speed" area. However, velocity of air flowing through the carburetor at this time is considerably increased by the choking or restricting effect of the Venturi into which the high speed jet is inserted.

The resultant high velocity air stream flowing or passing over the high speed jet in the Venturi causes liquid fuel to raise to point of overflow when it mixes or vaporizes in the rapidly moving air to be conducted into the crankcase and combustion chamber as a combustible mixture.



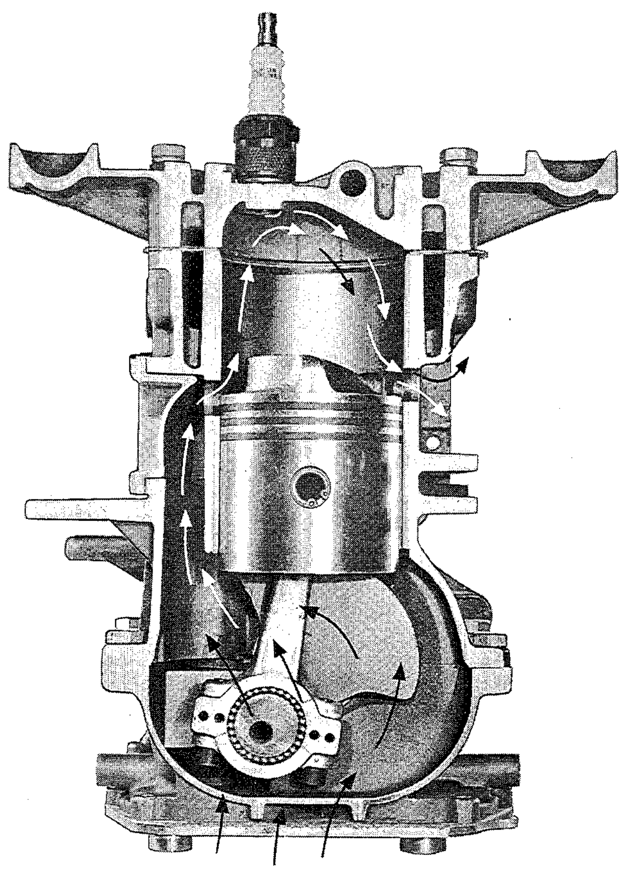
Sectionalized view of mixing chamber—butterfly shutter full open for high-speed performance. Note maximum fuel vaporization at the high speed jet with a minimum of vaporization at the slow speed jets. Also effect of restriction caused by the Venturi ring to increase air velocity in area of the high speed jet.

Since the rate of liquid fuel flow from the high speed jet increases out of proportion to increase of air velocity through the carburetor as motor speeds increase, some provisions must be taken to more nearly equalize or proportion the rate of liquid flow with respect to velocity of the air stream. This is usually accomplished by "bleeding"—that is, by means of injecting air into the high speed jet at desired levels to progressively reduce liquid flow as air velocity increases — see schematic sketch below and following sectional view of the carburetor. A decrease in motor speed obviously causes lower air velocity through the carburetor and subsequently lessens the effect of air bleeding to proportionately increase flow of liquid fuel and, therefore, maintain a more favorable balance in fuel-air ratio for best performance.



Schematic Drawing to Illustrate Principle of Carburetor Jet Bleeding.

Further, on reducing motor speed the shutter is closed to build up high suction in the manifold while simultaneously diminishing volume and air velocity through the carburetor. This increased suction or low pressure in the manifold causes fuel vaporization to be again resumed in the slow speed vaporizing area while vaporization at the high speed jet proportionately diminishes.



Showing Path of Fuel Vapor as it Progresses Through the Powerhead during Completion of its Cycle.

Both slow and high speed metering needles must be adjusted separately to realize maximum performance as instructed below.

The choke is spring loaded to avoid choking or flooding during initial period of starting. The choke remains closed for starting but as running commences, the choke is caused to open against tension of the spring applied to it, thus admitting sufficient air to maintain a combustible vapor mixture entering the crankcase and eventually the cylinder where it is ignited on ending of the compression stroke. Choking naturally ought to be released from closed position by pushing the choke button in as the motor gains speed.

Ordinarily the carburetor does not require a great deal of attention except for perhaps periodic cleaning and removal of gum deposits. Obviously all sludge or foreign matter should be removed—all channels, jets, orifices, etc., made free of it. If confronted with gum or "varnish" accumulation, it may be removed by immersion in one of the commercial gum solvents available for the purpose. However, before attempting to remove gum by this method remove first the cork float to avoid dissolving the coating applied to insure its buoyancy.

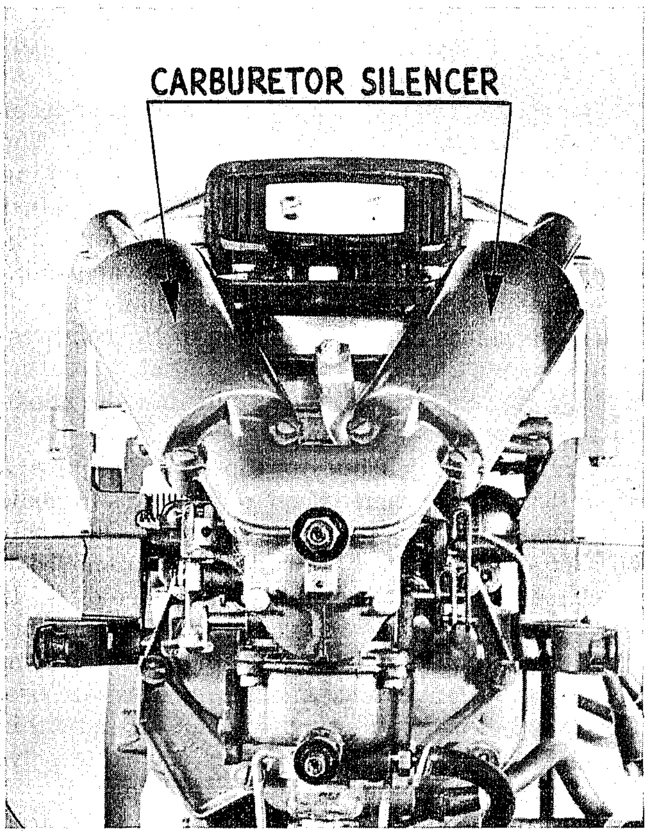
Constant flooding or overflowing can be traced to (1) improperly adjusted float level (see Page 92-22), (2) faulty float, (3) faulty float valve and its seat, and (4) float valve seat not made properly secure in the carburetor body — seepage past the threads in this case to by-pass the float valve assembly.

Under no circumstances should either the slow or high speed needles ever be turned (screwed) down "hard" against their respective needle point seats; in this event not only the pointed or metering end of needle becomes "ringed" or grooved but its seat in the carburetor becomes distorted or expanded after which further adjustment is impossible to obtain satisfactory motor performance thereafter. Adjusting needles can be replaced at but little cost but with "ruined" needle seats in the carburetor body, eventual necessary replacements become expensive.

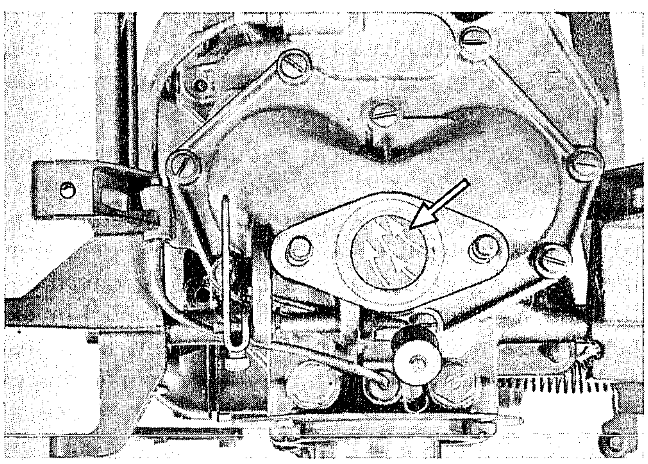
Naturally all screws should be tight, gaskets as employed in good condition and in place, and of considerable import, the carburetor should be securely mounted to the crankcase.

Look to the fuel lines, fuel line fittings and the fuel tank when normal attempt at correcting carburetor condition prove to no avail—assuming, of course, the ignition system is in good working order—See pages 92-25 and 26, Fuel Tank Check Chart.

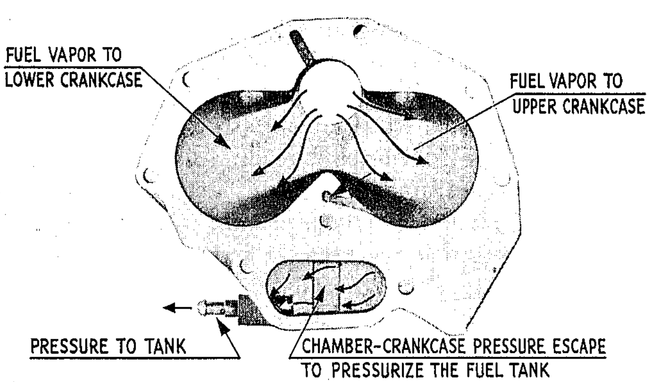
In extreme instances, look for excessive wear about the carburetor shutter shaft to permit unwanted air entering the vapor stream.



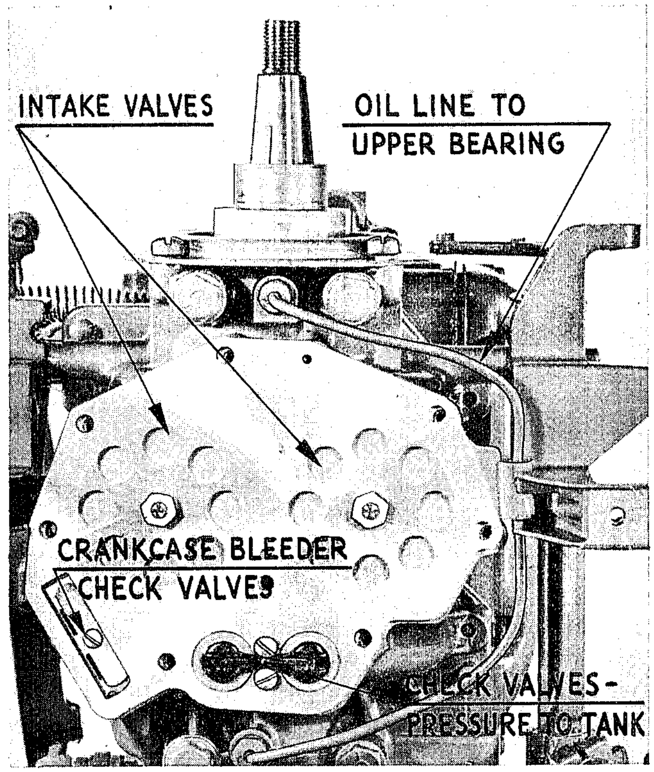
Front View of the Powerhead Showing Carburetor Silencer Attached to the Air Intake (Carburetor).



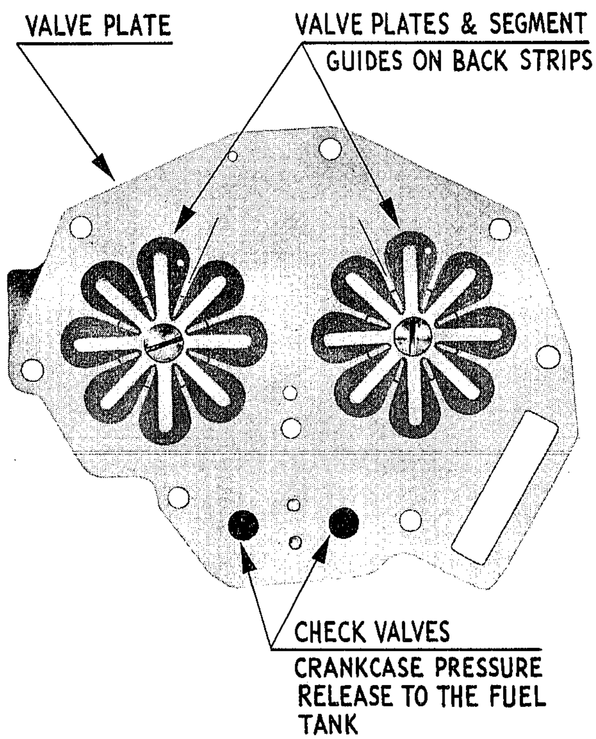
Carburetor Removed to Expose Intake Manifold Throat.



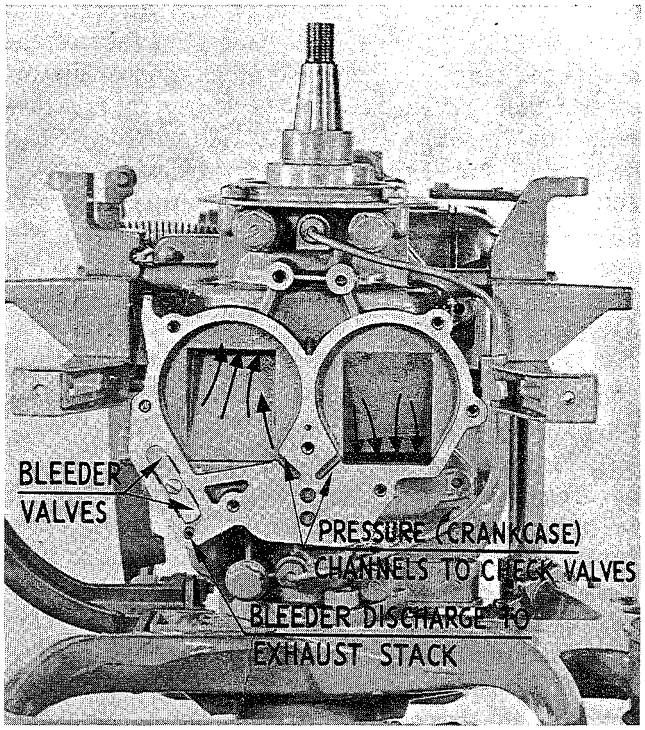
Inside or Back View of the Intake Manifold.



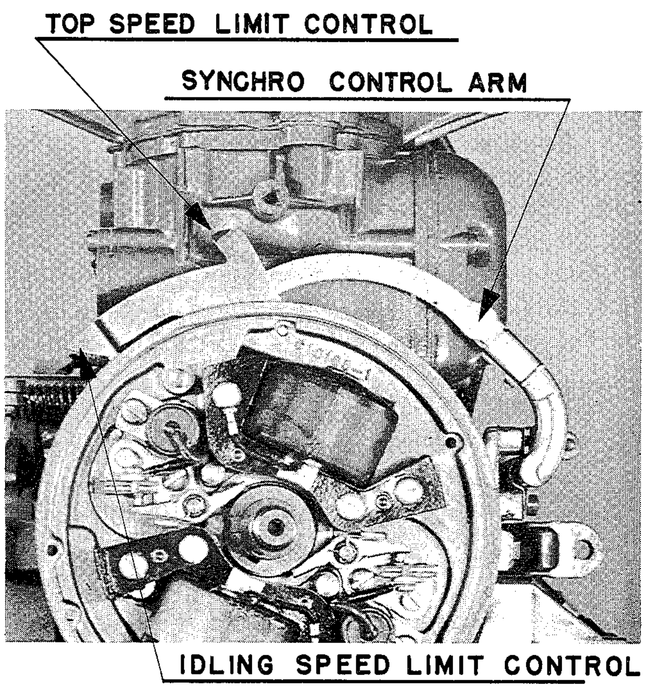
Intake Manifold Detached to Show Automatic Intake Valves (see page 92-19) Crankcase Pressure Release Valves to Pressurize the Tank, Crankcase Bleeder Valve (see pages 92-21 and 194-9) and Oil Returns.



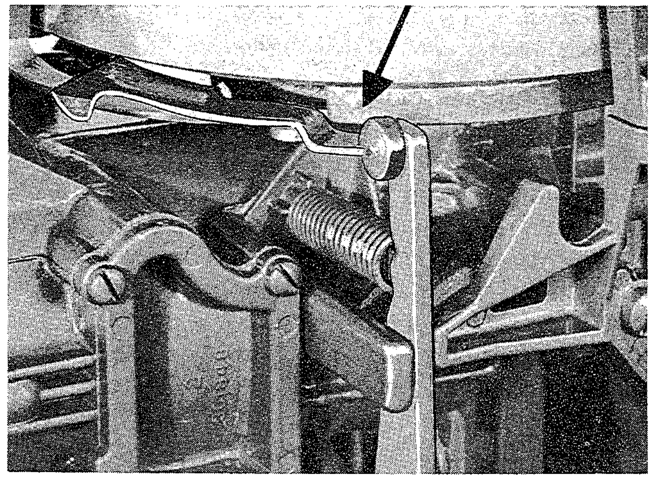
Back View of the Automatic Valve Plate Showing Valves and Back Plates (to Guide Each Segment) when Installing New Valve Plates, Include New Back Plates. Note "Ink" Dot on One of the Valve Segments which Should be Visible when Properly Installed—Also the Fine "Scratch" Line Equidistant Between Two of the Holes in the Valve Plate. On Securing Position of the Valve Plate, this Line Should Fall Midway Between Edges of the Corresponding Segments to Correctly Center.



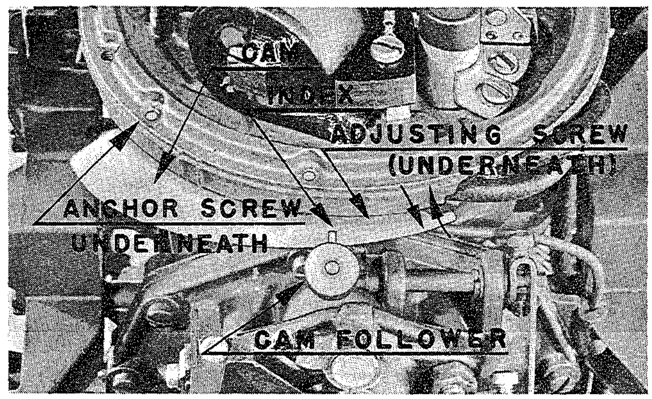
Valve Plate Removed to Expose Channels (Fuel-Vapor) to Upper and Lower Crankcase Chambers, Bleeder Check Valves, Pressure Channels (to Pressurize Tank), Oil Return and Bleeder Drain to the Exhaust Stack.



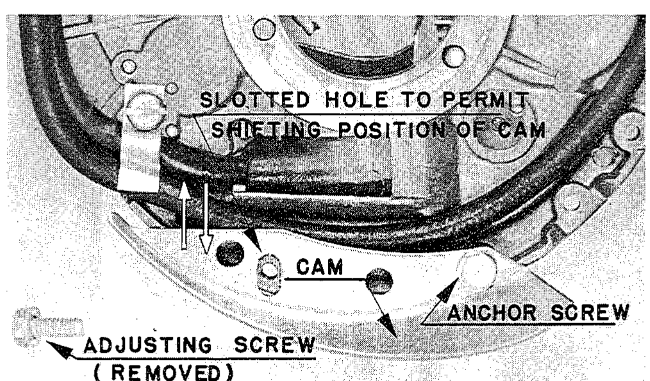
Showing synchro-control linkage with built in stops to limit idling and top speed running.



Speed Control Grip Set for Neutral Running—Note "Stop" Arrangement to Limit Idling on Neutral Running Speed.



Showing Synchro-Speed Control Arrangement and Adjusting Facilities, Note "Index" Mark on Cam which is Adjustable as Attached to the Lower Side of the Armature Plate and the Cam Follower. To properly Synchronize, (1) Loosen the Adjusting Screw which Seats in an Elongated or Slotted Hole in the Cam; Permitting "Low" End of the Cam Being Shifted "in" or "out" as Required (2) Adjust Position of Cam to Point where the Index (on cam) Aligns with Center of the Cam Follower, but only after all of the "Slack" in the Synchro-Control Linkage has been "Taken up" and the Carburetor Shutter is JUST on the Verge of Opening, (3) Tighten Adjusting Screw and if Necessary the Anchor Screw. Recheck Alignment since this Adjustment is of Extreme Importance to Achieve the Maximum in Performance.



Bottom View of the Armature Plate Showing Installation of the Carburetor Control Cam, Anchor Screw, Adjusting "Slot" and Corresponding Screw Removed for Purpose of Illustration.

CARBURETOR ADJUSTMENT — SLOW AND HIGH SPEEDS

Both high and slow speed needles are adjusted at the factory on final assembly and testing, with a limited range for further adjustment provided the ultimate owner to compensate for local operating conditions such as temperature (atmospheric and water), atmospheric or barometric pressure (altitude), humidity, etc., which frequently require slight variations in needle settings. A boss or "stop" is cast on to the carburetor panel and a similar arrangement cast on to the back or inside of the slow speed adjusting knob which permits somewhat more than a half turn of the knob as and if required to achieve best performance—Note pointer on knob and numerals 1 to 7 on the control panel.

Similar provisions are made for compensating adjustment of the high speed needle for like reasons except that the limiting "stops" for the high speed adjusting lever are built into the cover—Note numerals 1 to 7 which limits adjusting to less than a half turn.

In event the carburetor has been "torn down" for cleaning and/or repairs, primary or initial adjustment will be required for both high and slow speed needles—best accomplished with the motor cover removed. Proceed as follows:

1. Note—that the slow speed knob and high speed lever are made fast to their respective needles by means of serrations on the slotted end of the needle as result of expansion when drawing up on the taper headed screw—remove both screws to gain access to slot at the extreme end of each needle.

2. Insert screw driver bit into slotted end of the high speed needle—turn right to close until the face of the pointed needle rests gently on its seat in the carburetor body (this is important, do not turn down tightly—to do so will cause the face of the needle to "ring" and the seat to expand or distort after which further adjustment becomes impossible due to damage caused). Then turn left or "unscrew" approximately 1/2 turn high speed.

3. Perform same function on the slow speed needle but open or "unscrew" about 1-1/8 turn.

4. Attach test wheel—start and run the motor in a test tank until normal running temperature has been attained.

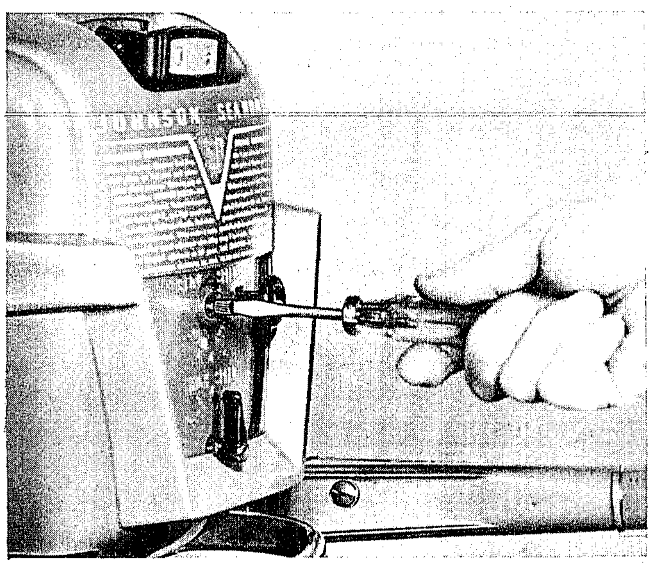
5. Turn high speed needle (with screw driver) to right or left as required to obtain best setting for maximum performance.

6. Reduce motor speed towards idling position —turn slow speed needle to right or left as required to obtain smooth operation in the lower speed range. Further retard motor speed—adjust position in like manner for best performance. Repeat the operation until best setting for maximum slow speed running has been accomplished.

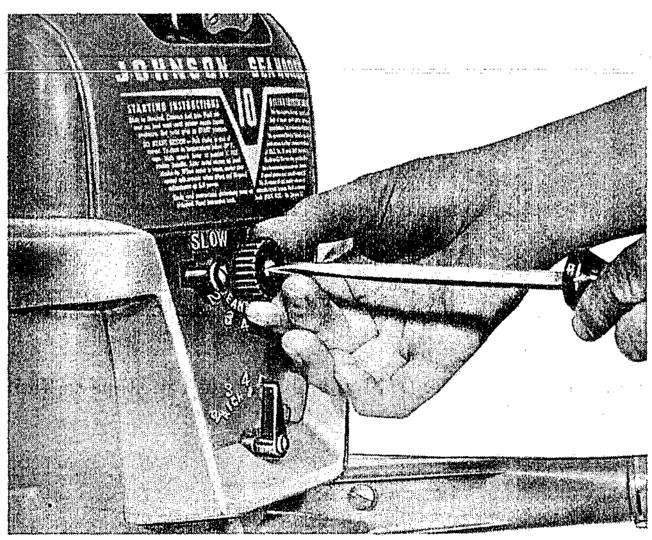
NOTE—rough or "jumpy" running of the motor denotes an excessively rich carburetor mixture (too much fuel—too little air) and as evidenced by a "smoky" exhaust. Spitting back or "coughing" through the carburetor is indication of a too lean mixture (too little fuel—too much air). Turning needle adjusting valve to right reduces flow of liquid fuel into the carburetor air stream thus "leaning out" the fuel vapor mixture; turning to left, increases the flow of liquid fuel to result in a correspondingly richer mixture.

7. Re-check both needle settings to assure best performance.

8. Without disturbing position of the slow speed needle, install the slow speed knob over the protruding serrated end, with pointer directed towards numeral 4. Insert and draw up snugly on the taper headed screw provided for the purpose.

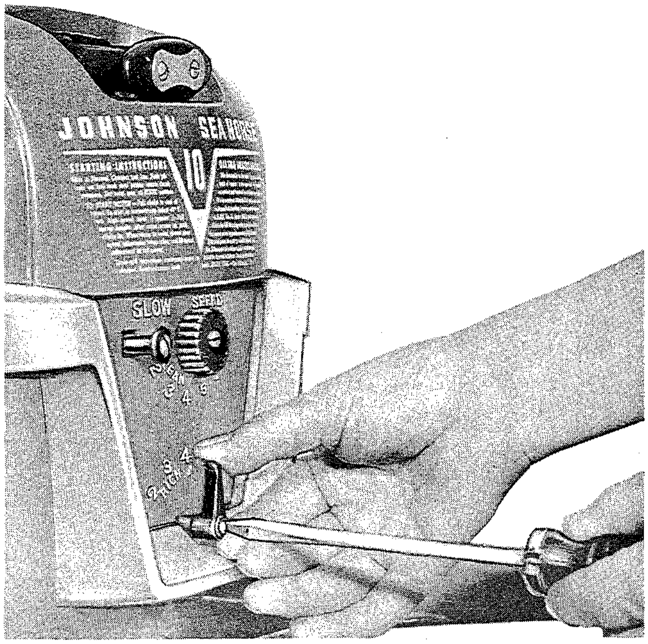


Adjusting needle setting with screwdriver prior to final placing of the slow speed dial and high speed lever.



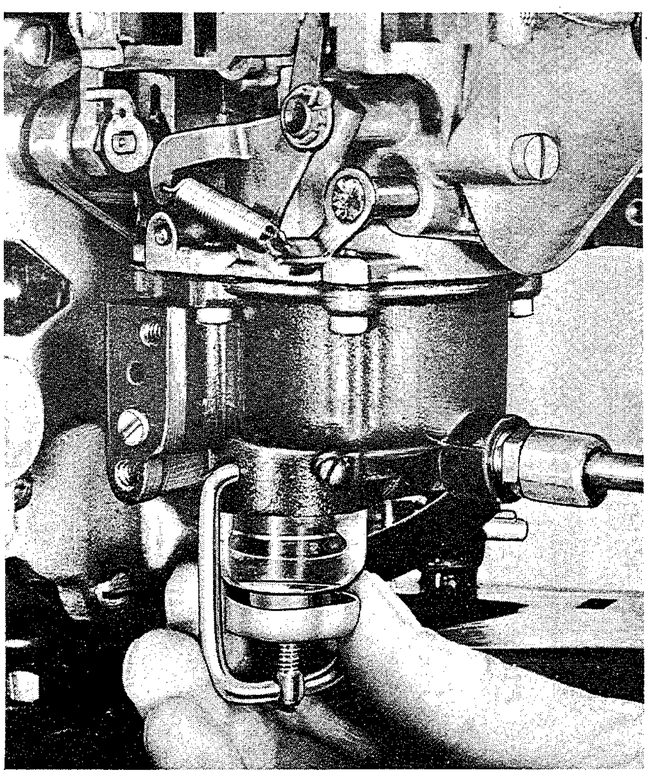
Locating Position of Knob on the Slow Speed Needle.

9. Locate position of the high speed needle lever as described above—lever directed towards the numeral 4 as shown below.



Locating Position of Lever on the High Speed Needle.

10. Make certain the taper headed screws are drawn up securely to hold the knob and lever fast on their respective needles.



Removing Filter Bowl to Gain Access to the Filter Element for Cleaning—Simply Remove and Rinse in Clean Gasoline.

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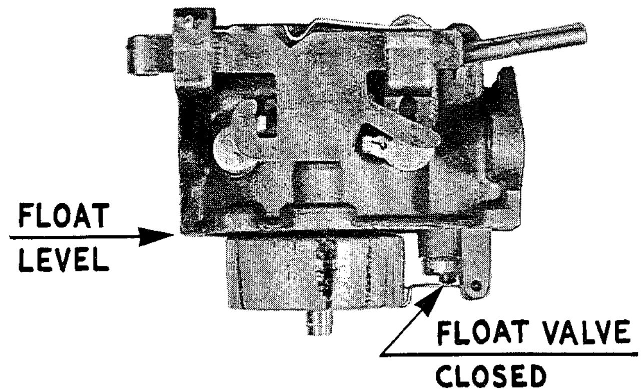
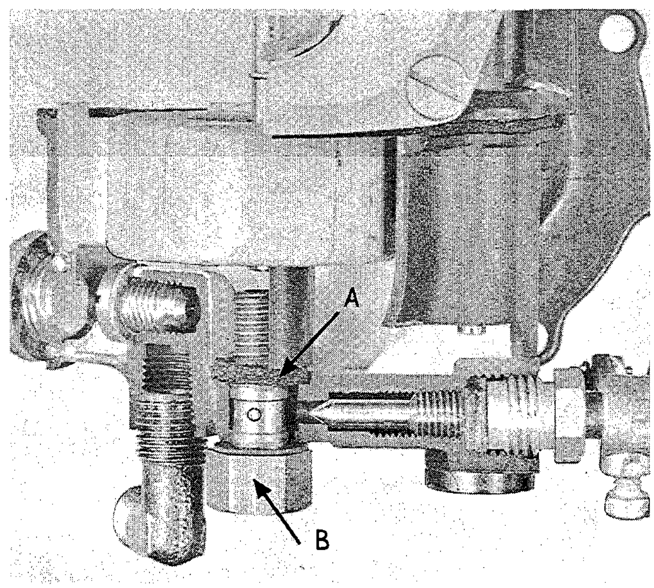
MODEL QD-10 THROUGH 14



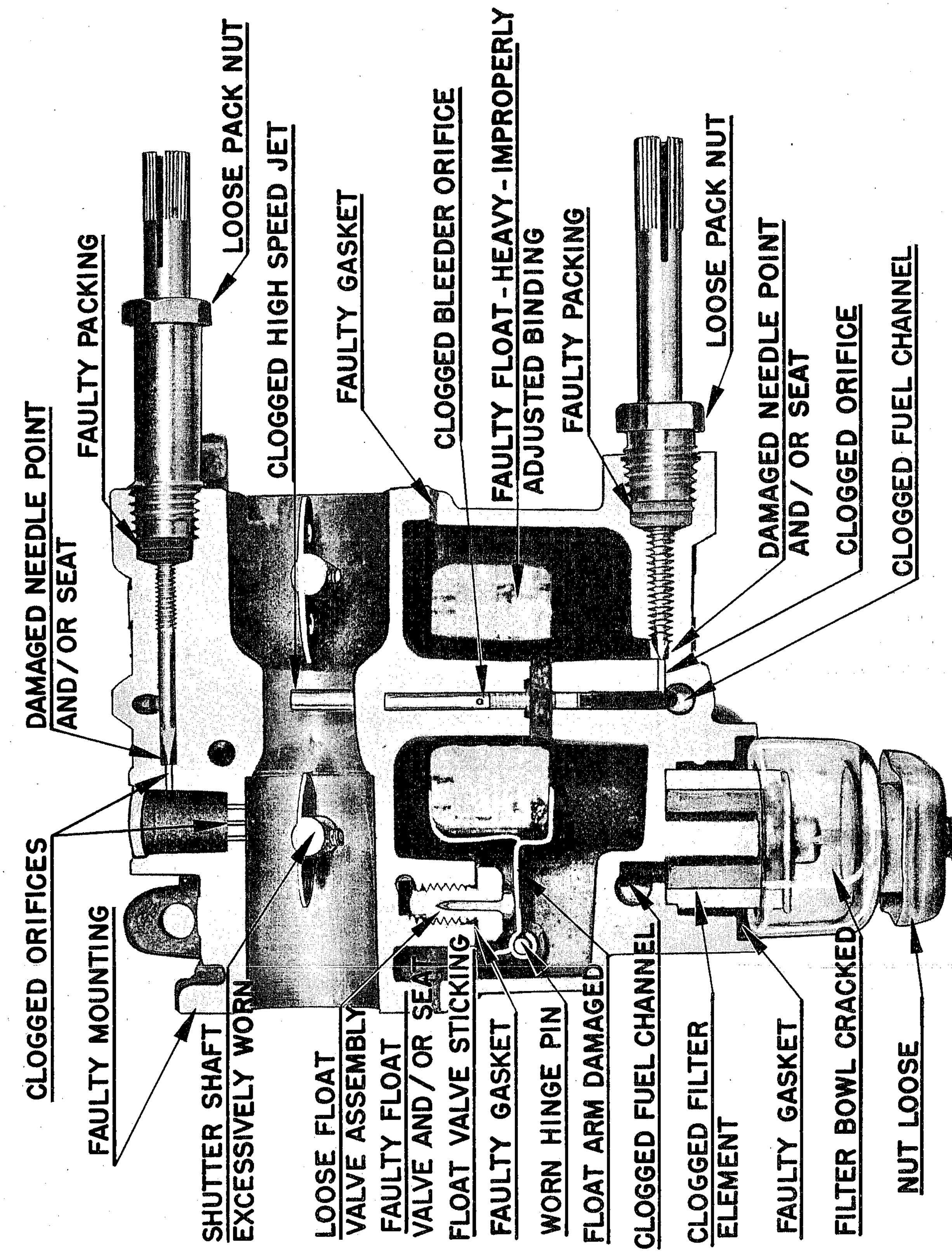
Showing position of float when properly adjusted. See Page 92-32.



There may be occasion when it Appears Impossible to Obtain Satisfactory Carburetor Adjustment (high speed) on Models QD-10 to 14 Inclusive or "Fair" Adjustment on the High Speed Needle but with a Tendency Toward "Rough" Running Due to What Seems to be an Excessively Rich Mixture Even Though the High Speed is Set or Adjusted Scarcely off its Seat. In the Extreme, the Motor may be Found to run with the High Speed Needle Closed Entirely.

If and when Encountering a Similar Situation, Look to Condition of Washer #301999, Indicated by Arrow in the Illustration, as the Distributing Factor. On Observing Location of the Washer, it can be Easily Seen that being Improperly Seated, Damaged, or Omitted, Liquid Fuel will bypass the High Speed Needle Seat to Enter the Jet Area Without Having been Metered (Fuel-Air Ratio.)

Corrective Measures in this instance can be Readily Accomplished by Removing Screw "B" to Detach the Carburetor Float Bowl. Insert Screw through Float Bowl, Install New Washer (on Screw—Inside Float Bowl) then Carefully Replace Float Bowl Assembly. Care Should be Exercised During Installation Procedure, Since Tension on the Primer (Plunger) Spring must be Overcome—See Page 92-3.



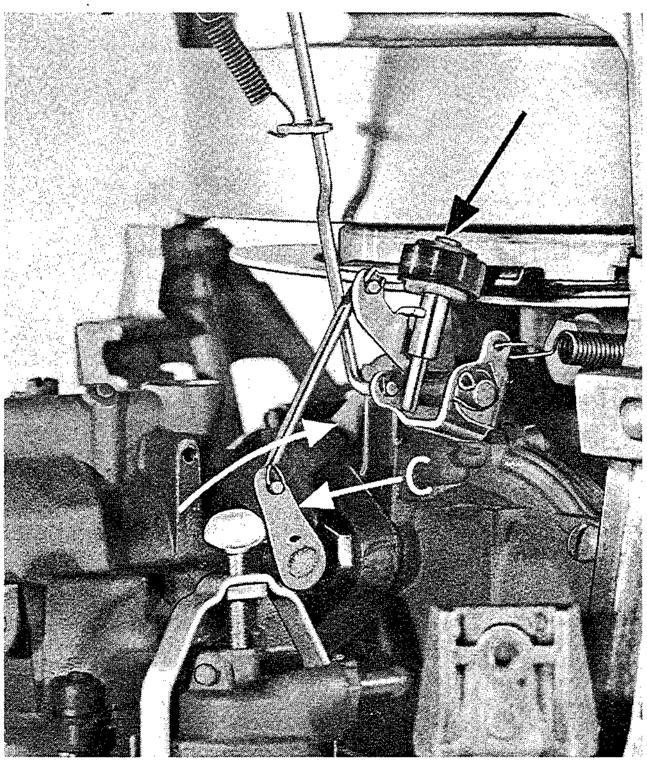
CHECK CHART MODEL QD

RD CARBURETOR CAM FOLLOWER — SPEED CONTROL, MODEL RD-14, 15

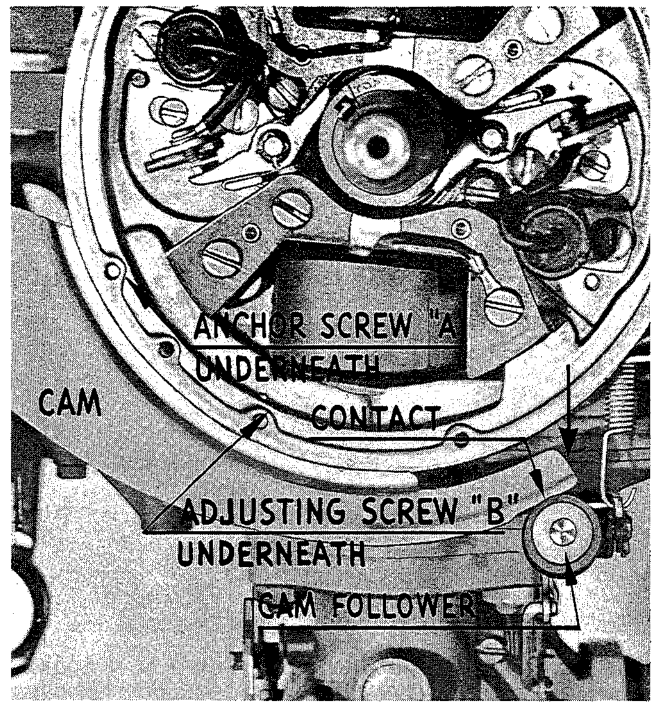
The "sliding" type of cam follower was replaced by one of "roller" construction commencing with the RD-14 to insure more precision in the synchronized linkage control by reducing wear at this point to a minimum.

Note step or depressed area at extreme (low) end of the carburetor control cam plate attached to the armature plate by two screws, one an anchor or pivot screw "A" and the other "B" adjusting screw. To adjust position of cam with respect to the cam follower (roller), proceed as follows:

1. Loosen anchor screw "A" slightly.
2. Loosen adjusting screw "B"—just enough to permit "pivoting" of the cam plate.
3. Set speed control grip to position indicated for "stop."
4. Exert pressure on lever "C" with thumb in direction indicated by long arrow to hold in closed position. The shutter (carburetor) must be fully closed during this moment of the operation to attain the proper synchronization.
5. With right forefinger, shift "free" end of cam plate to position of contact with the cam follower—roller.
6. Draw up on anchor and adjusting screws to secure position of the cam plate.



Exert Pressure with Thumb Against Lever "C" in Direction of Arrow.



Showing Cam Follower (Roller) Making Contact with "Depressed" Area at Far End of the Carburetor Control Cam as Required to Properly synchronize Shutter (Butterfly) Action with Relation to Cam Contour.

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Hard starting of the model RD may at times be laid to the automatic starter lock (latch) engaging too early — engaging too early to permit taking full advantage of top limit speed predetermined for starting as result of collar "A" (shown in illustration) being out of place or improperly adjusted.

To adjust position of locking "latch" "B," proceed as follows:

1. Set shift lever to "Neutral."
2. Loosen screw "C" securing collar "A" to shaft "D."
3. Turn speed control grip to top limit for starting as governed by limitation control mechanism built into the assembly.
4. Push collar "A" up against bracket on latch "B" just far enough to cause opposite end of latch "clearing" stop lugs on the starter pulley. Ultimate position can be determined by simultaneously pulling on the starting cord grip.
5. Draw up on screw "C" to hold collar "A" fast to control shaft "D."

The above adjustment is a simple one; however, in event latch "A" engages "stop" lugs too early, carburetor throttle and spark cannot be advanced far enough to accomplish "easy" starting.

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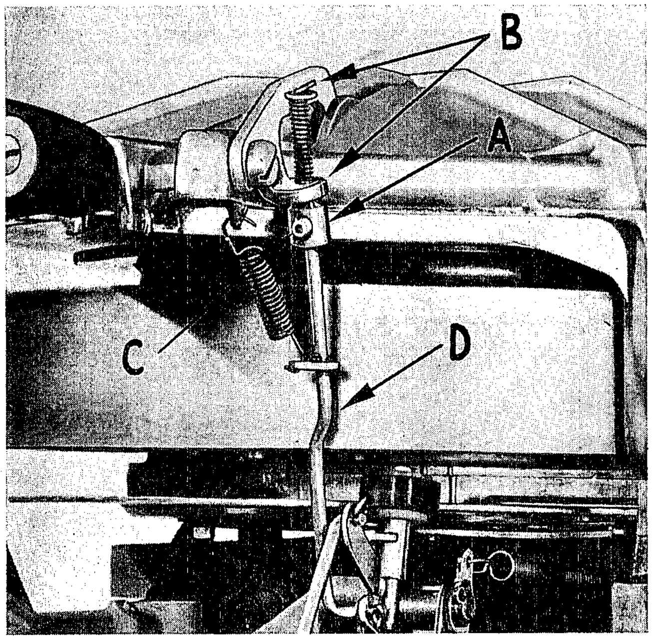

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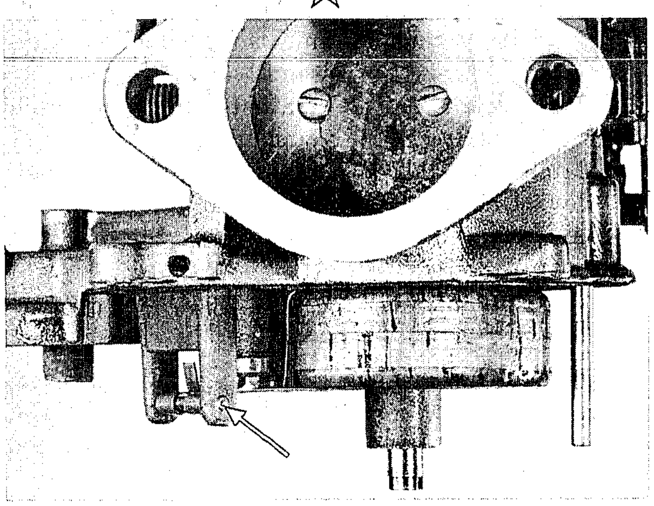

There may be Occasion when it is found Difficult to Obtain Satisfactory Float Level Adjustment on the Model RD Carburetor to Overcome Constant Flooding. (See Pages 92-22 and 23).

Investigation has Revealed this Situation to be Result of Excessive Wear on the Float Arm Hinge Pin (#302661) thus Establishing more than Normal Clearance (Play) between the Pin, its Supporting Bracket and Float Arm than can be Compensated for by Following Normal Procedure for Adjusting Float Level.

Installation of a new Hinge Pin (#302661) and Perhaps a bit of Careful "Crimping" of the loop on the Float Arm (around the pin) to obtain a Closer Fit, should take up enough "Slack" to Maintain Proper Fuel Level when Correctly Adjusted.

"Crimping" of the Float Arm Loop Around the Pin, if Necessary, should be Carefully Pursued with a pair of Pliers—Keeping in Mind that Clearance between the Loop and Hinge Pin ought to be just enough to Permit Free Movement without Possibility of Binding—but not a "Sloppy" Fit.

It is Advisable when Replacing the Hinge Pin to Install a New Float Valve and Seat Assembly #375978. And likewise a New Hinge Pin when Replacing the Float Valve and Seat Assembly.

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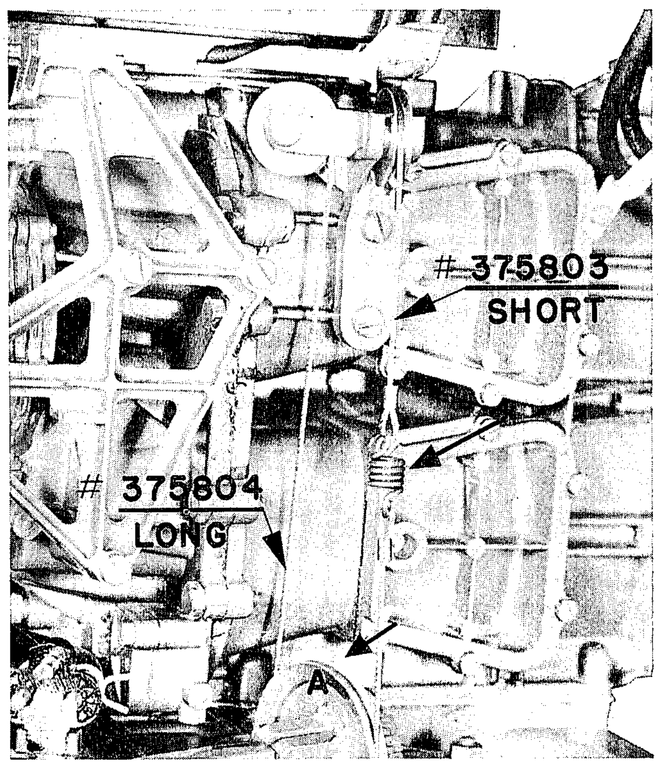


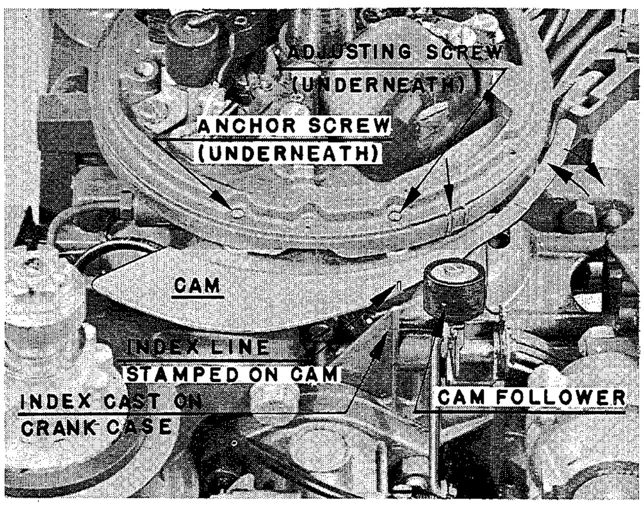
A Change in Assembly of #375804 Speed Control Cable (from Armature Plate to Pulley at Rear End of the Steering Arm), Involved but Relocation of the "Bead," which Locates Position of the Cable in Pulley "A" and which Requires Reversing Position of the Cable When Attaching to the Armature Plate. Under these Circumstances the "Take-up" Spring will Locate Outside (adjacent to the Motor Cover) Rather than on the "in" Side, Next to the Cylinder Block as Heretofore. To Accomplish the installation Simply Reverse Positions of the Long Cable #375804 and the Short Cable #375803 as Illustrated here. See Pages 56-11 to 56-13 Inclusive and 92-23.

Purpose of the Revised Arrangement is to Prevent the Spring (Connecting Cables) from Advancing the Armature Plate to Engage the Shift Lock. This Occurs after Shifting with the Speed Control Grip Set to Maximum for Starting, thereby, making it Impossible to Shift Back to Neutral Without First Retarding Motor Speed.

SYNCHRONIZING SPARK AND GAS MODELS RD-16 AND RDE

Quite frequently failure to obtain satisfactory motor performance for no seemingly known reason can be attributed to improper synchronization of spark and carburetor control — degree of spark advance out of proportion to degree of carburetor shutter opening.

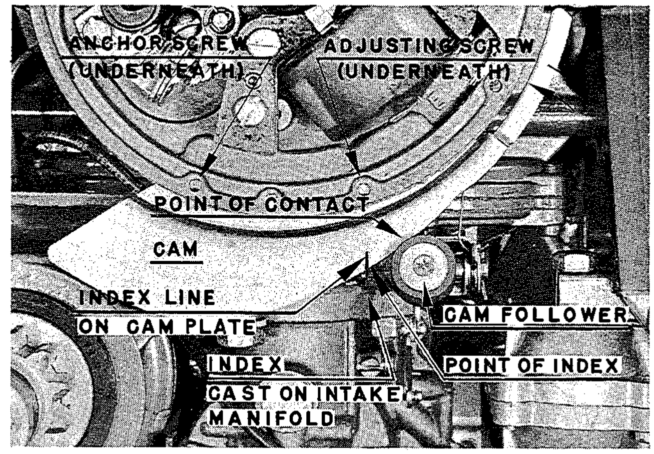
To achieve the maximum in performance, a definite relation has been established between degree of spark advance and shutter (butterfly valve) opening which must be maintained throughout entire speed range of the motor — accomplished by a roller acting on the carburetor shutter through an arrangement of linkage and following contour of a cam plate attached to the armature plate which has been carefully calibrated to correctly proportion volume of fuel charge with respect to degree of spark advance.



Showing speed control cam attached to armature plate, adjusting screws; index cast onto the intake manifold and cam follower (roller) acting on carburetor shutter through an arrangement of linkage. Note alignment of small ridge on edge of armature plate with center of cam follower.

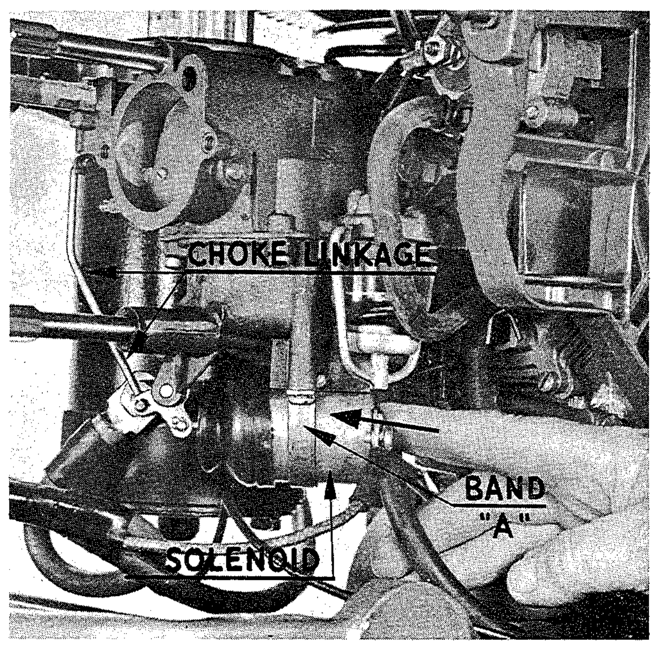
As may be observed from illustrations shown here, the control cam is rather long, slender and shallow at one end (slow speed range) and progressively increasing in width towards the opposite end (intermediate and high speed range). It will be noted that two screws are employed to hold the cam plate fast to the armature plate — one, an anchor or pivot screw, the other resting in a "slotted" hole to permit pivoting or shifting (in or out) as arrows indicate. Note, too, an index line stamped on top face of the cam plate and an index or "pointer" cast on to the intake manifold.

To synchronize — loosen anchor screw slightly, the adjusting screw a bit more, turn speed control grip to position where index line on the control cam comes to rest "flush" with straight side of the index (pointer). Exert light pressure against the roller to take up all "slack" in shutter linkage, with shutter *just* on the verge of opening as required to obtain best results. Hold in this position. Shift "free" end of cam out to make contact with the cam follower (roller). Cam follower contact with contour of the cam must occur when index line on face of the cam plate and index are in alignment. Draw up on anchor and adjusting screws to secure in this position.

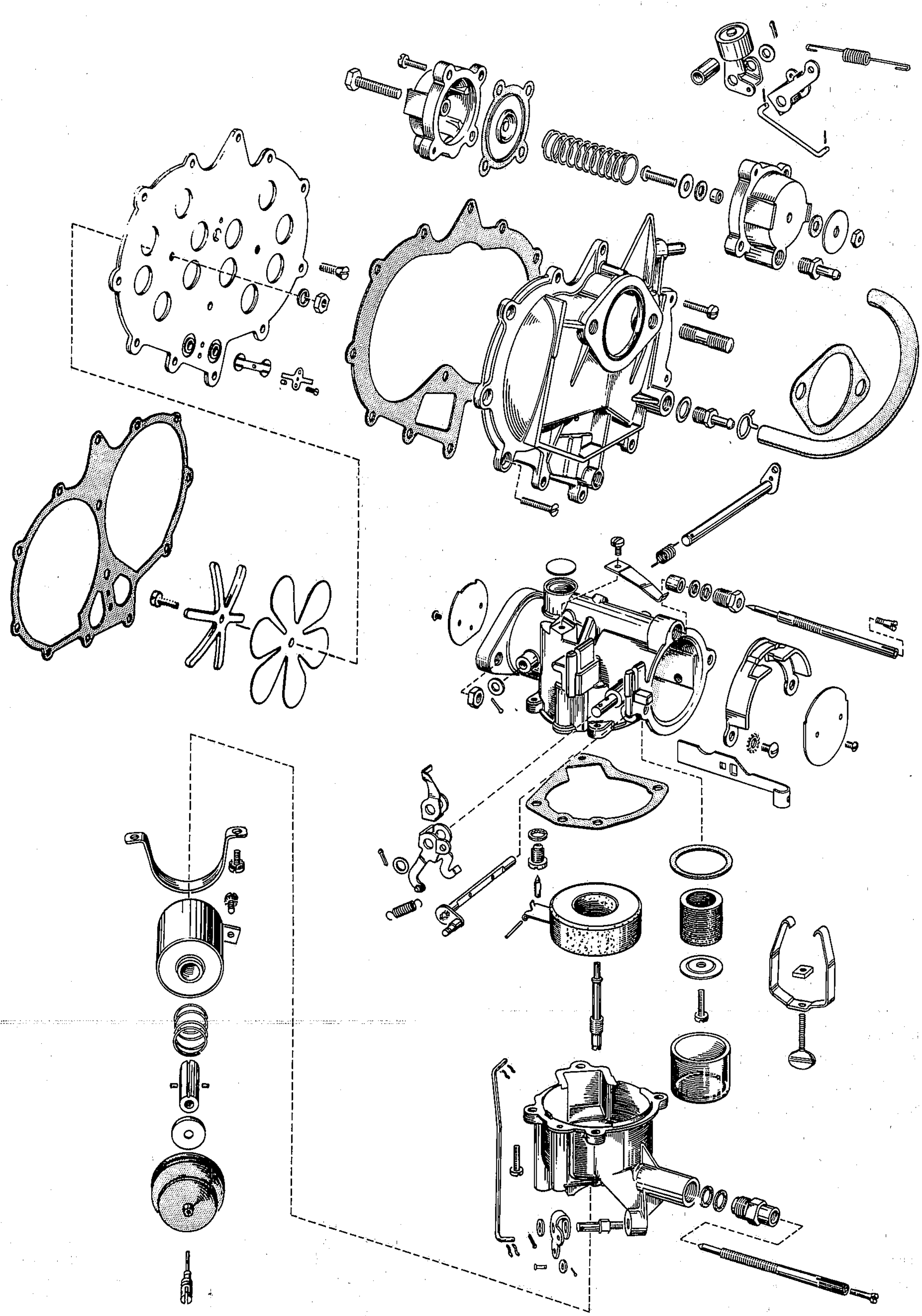


Showing position of cam follower (carburetor speed control) with relation to index and cam to obtain proper synchronization of spark and gas.

Turn the speed control lever back and forth several times — recheck to assure correct synchronizing as described and illustrated.



Showing location of electrically operated solenoid which acts on the choke through an arrangement of levers and linkage when depressing choke button on starting panel. Note—the solenoid is attached to a boss cast onto the carburetor float body and held fast with a band—when installing the solenoid, some alignment is required to properly locate. To adjust—pull choke button out to full choke, place solenoid in position with all connecting linkage attached—leaving band "A" slightly loose for the moment. Push solenoid forward—in direction of arrow—until plunger "bottoms" within the solenoid case and can be moved no further. Draw up on band screws to secure position of solenoid.

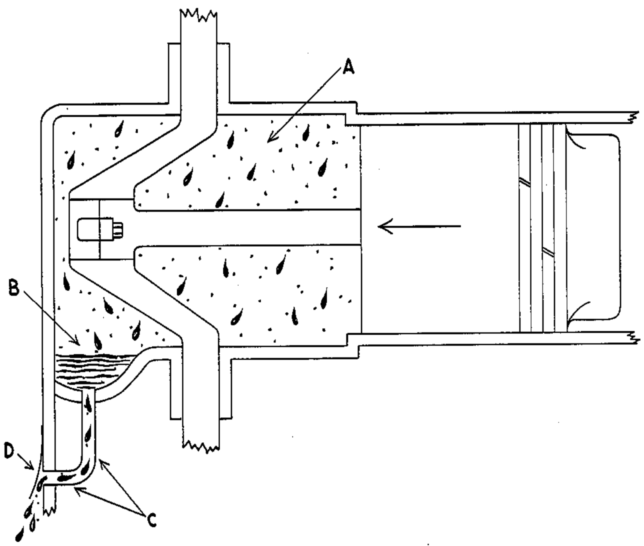


Model RDE carburetor, solenoid, intake manifold, valve plate, and automatic ignition cutout group layout.

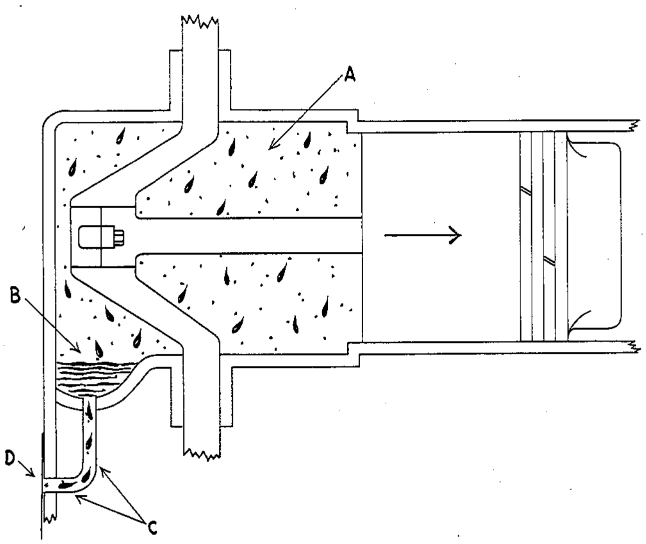
CRANKCASE BLEEDER (Models RD, QD, and CD)

Schematic drawings shown here are to illustrate crankcase bleeder action which becomes active with slow speed operation as when idling or trolling.

Maximum vaporization of the fuel mixture (after leaving the carburetor) is dependent upon degree of crankcase and manifold turbulence or "agitation" created by higher air velocities and the revolving crankshaft and movement of the piston. Constant or high velocity action is required to maintain suspension of all fuel particles for complete combustion and best performance.

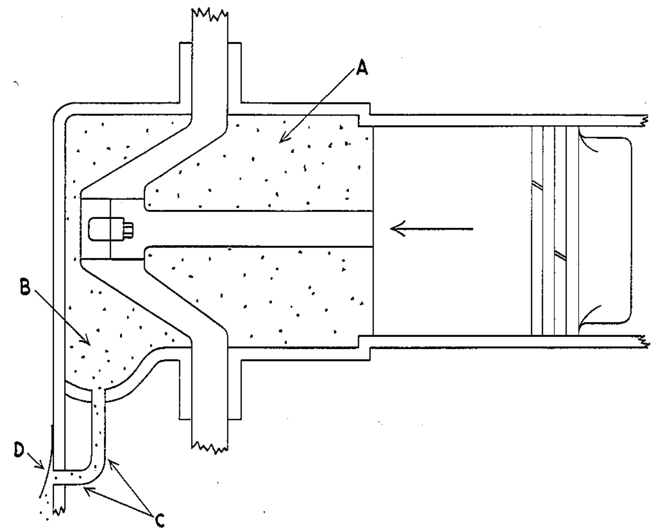


During periods of "slow" running, velocity or turbulence in the crankcase correspondingly diminishes to result in the heavier fuel particles "settling out" or condensing — characteristic of petroleum fuels. Eventually an accumulation of liquid fuel "pools" to slosh around in the crankcase and as such, contributes to faulty slow and intermediate speed operation, excessive carbon accumulation "smoky" exhaust and evidence of "choking" when accelerating unless means are provided for its dissipation.



On downward stroke of the piston, pressure is built up in the crankcase — bearing down on surface of the condensed pool "B" causes bleeder valve (flapper) "D" to be lifted from its seat, thus permitting a portion of the condensed fuel escaping.

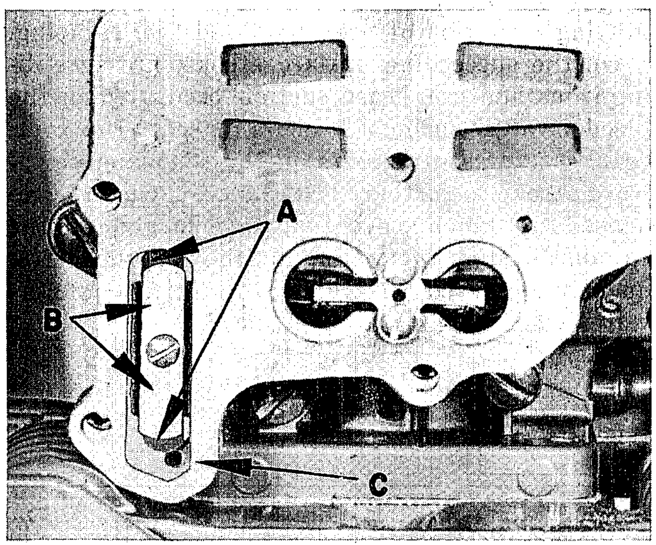
On the succeeding upward stroke, pressure diminishes and crankcase suction occurs when the bleeder valve "springs" back on its seat. However, crankcase pressure recurs on the following downward stroke to further clear the crankcase of condensed fuel which is eventually discharged into the exhaust system to account for the "oil slick" frequently observed as trailing on surface of the water when running at slow speed.



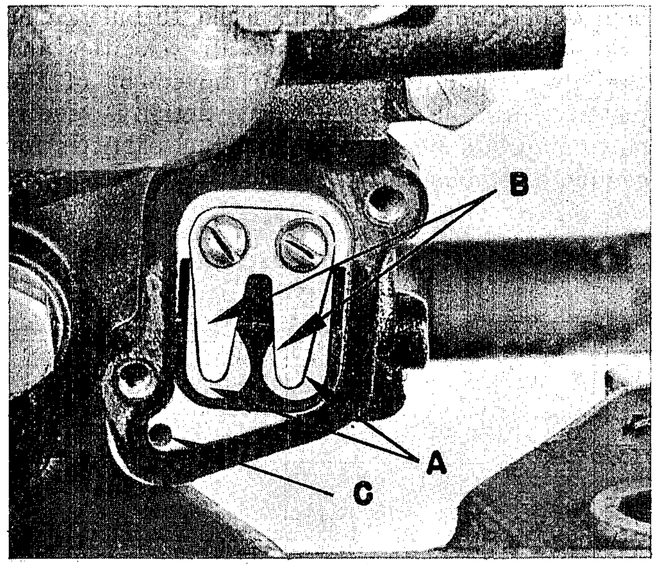
With increasing of motor speed (RPM's) turbulence or velocity in the crankcase is progressively increased to maintain suspension of a greater portion of the fuel particles (less condensation or settling out) — subsequently less bleeding of condensed fuel. The heavier fuel particles still continue to condense out but only to a point of where rate of turbulence (governed by motor speed) in the crankcase is sufficient to hold all particles of the fuel mixture in suspension at which time "bleeding" is reduced to practically nil, as sketch above indicates.

The bleeder valve arrangement as described functions at all times regardless and throughout entire speed range of the motor; when not bleeding liquid or condensed fuel (high speed) crankcase pressure loss (if any) is of little significance due to the extremely small bleeding orifice and rate of motor speed.

Ordinarily the bleeder system requires little or no attention except that when conducting major repairs, it is advisable to remove the bleeder valve and as precautionary measure "blow out" the bleeder channels or drains with high pressure air to insure against possible clogging later on. Should there be evidence of gum or varnishing within the crankcase, run a fine wire through the channels, being careful not to injure the bleeder valve seat. Make sure at this time that the bleeder valve comes to rest squarely on its seat when reassembling and that the supporting back strip is properly installed to permit function of the bleeder valve segments. Note—The Model CD bleeds only from the intake manifold chambers — top and bottom.



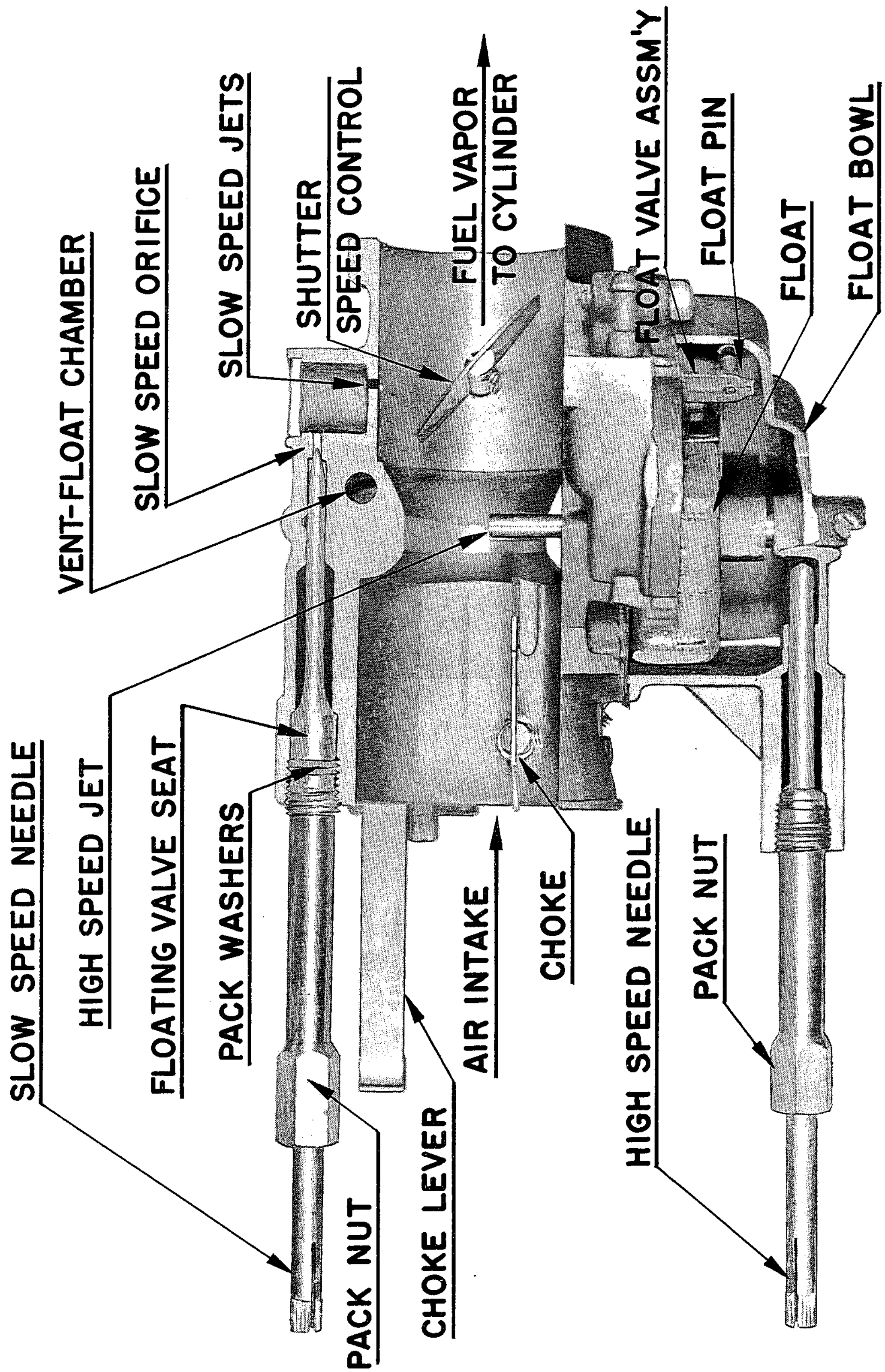
Showing arrangement of bleeder valve assembly as installed on the Model RD and QD previous to QD-15. "A"—bleeder valve segments; "B"—back strips to guide action of bleeder valves; "C"—bleeder discharge.



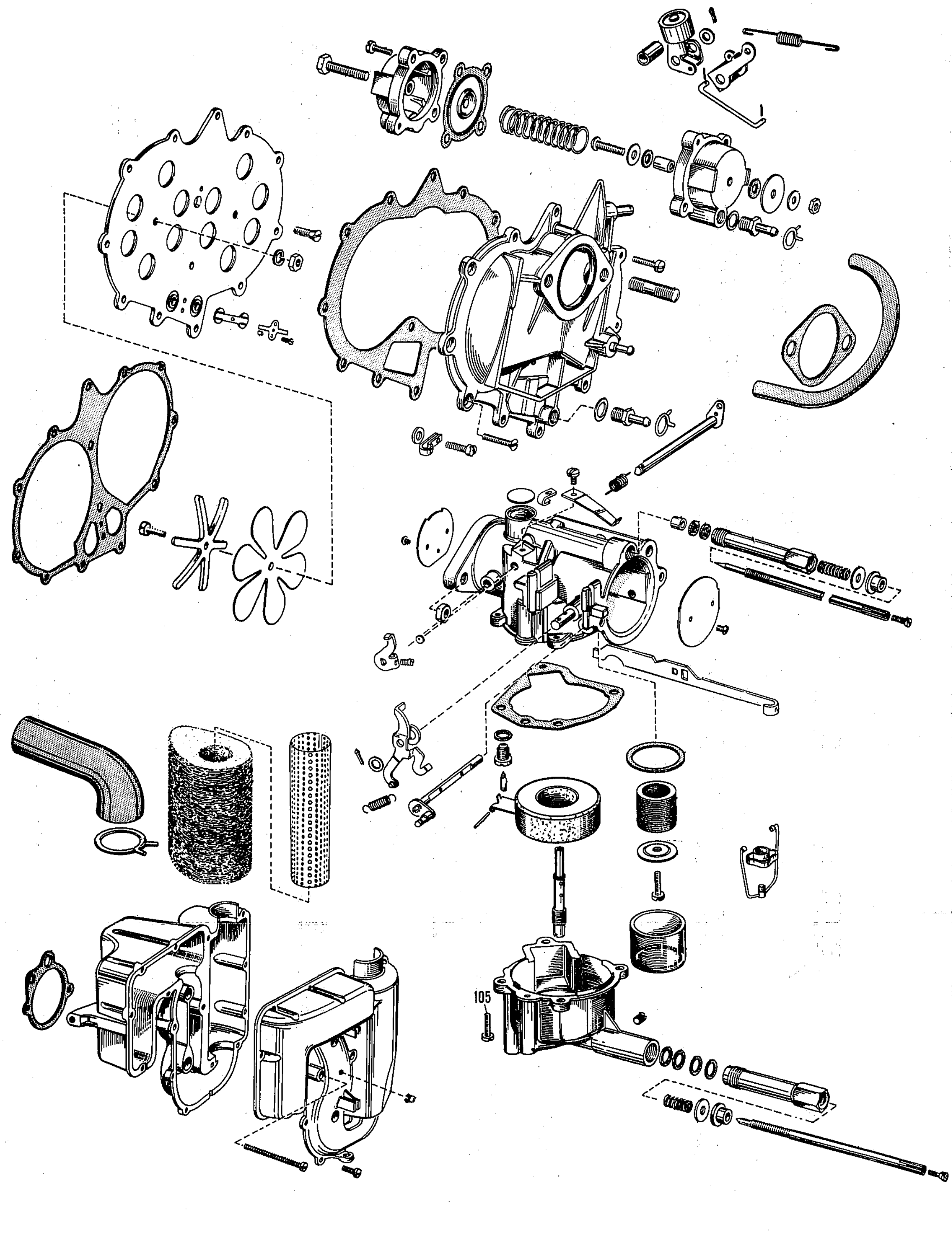
Illustrating arrangement of bleeder assembly as employed in construction of Model CD and QD-15. "A"—bleeder valve; "B"—back strip to guide movement of bleeder valve; "C"—bleeder discharge.

NOTES

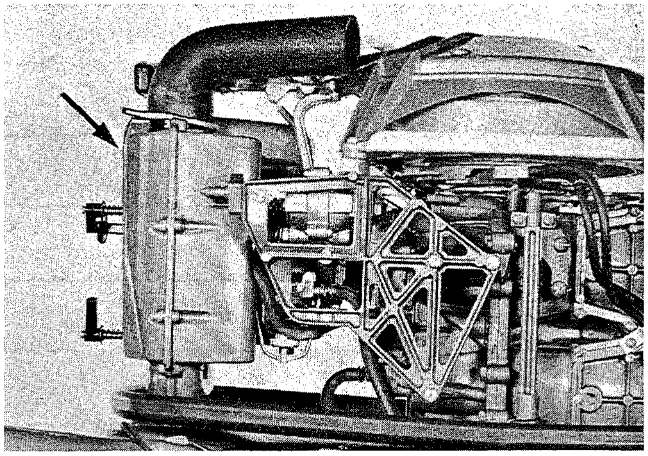
MODEL RD-17 CARBURETOR



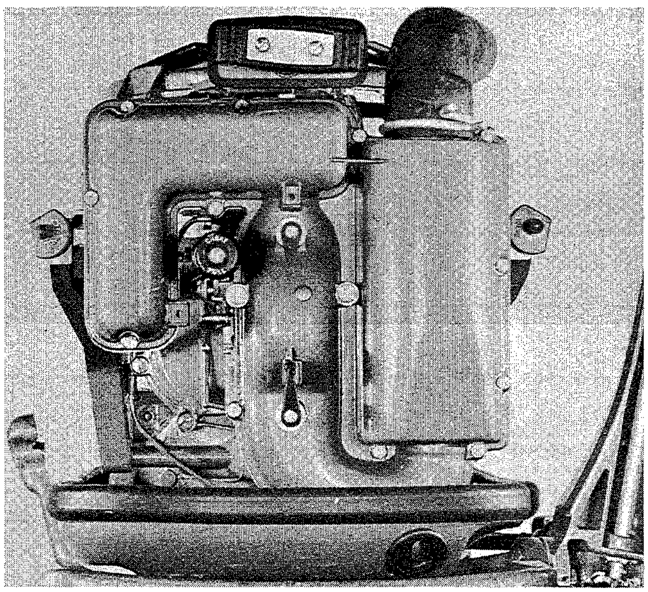
Basic construction and functional details of the Model RD-17 carburetor is similar to that of the RD-16 (Also JW—CD—QD Series)—see pages 92-19 through 92-25 and check chart on page 92-42.



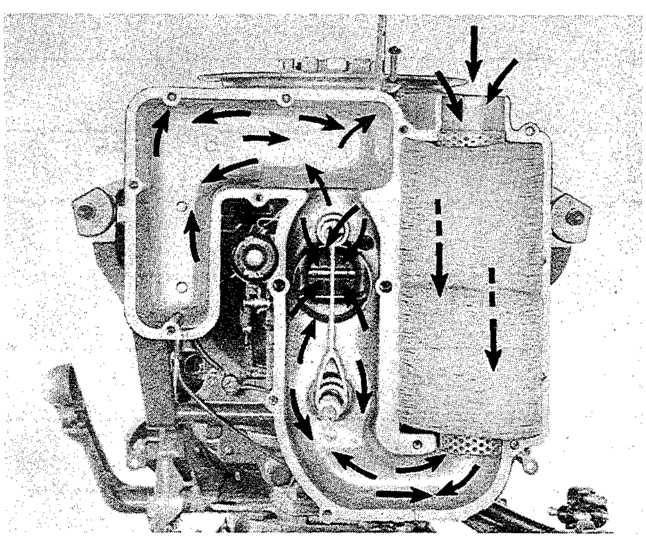
Extended view of the carburetor, valve plate—manifold and carburetor silencer group—Model RD-17.



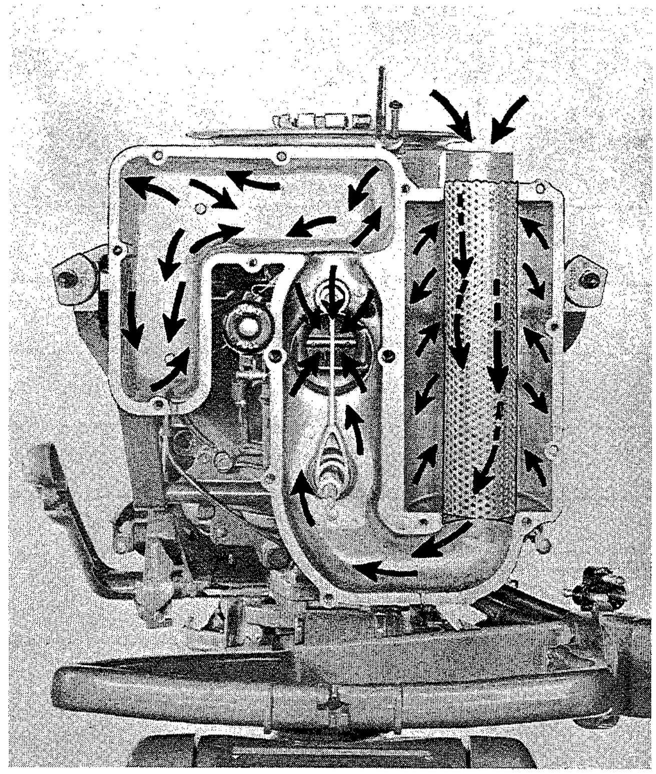
Side view (port) of the RD-17 Powerhead showing installation of the carburetor silencer.



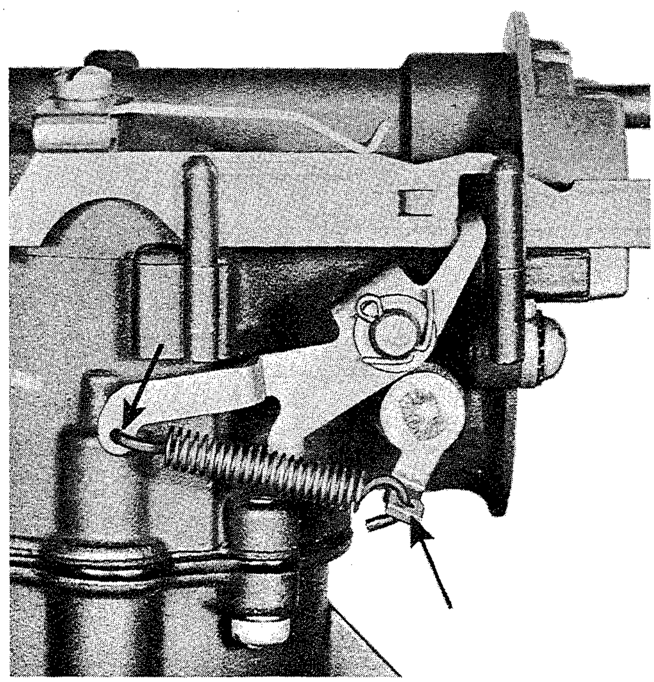
Front view of the RD-17 Powerhead showing the carburetor silencer installation.



Carburetor silencer with front (half) removed—showing spun glass wadding to assist in absorbing noises.



Carburetor silencer with front (half) removed to show perforated tube employed to support the glass wadding and further aid in absorbing motor noises through perforations.



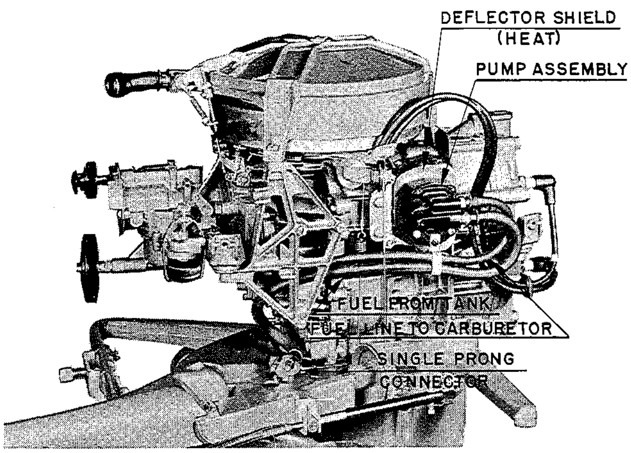
#302747 choke spring as installed on the Model RD carburetor (#375815)—RD-14 and earlier—has been cancelled and superseded by spring #376388.

It is actually the same spring, however, but provided with a short length of "spaghetti" tubing fitted over each end to achieve better anchoring and thus reduce loss of the spring to a minimum during operation of the motor.

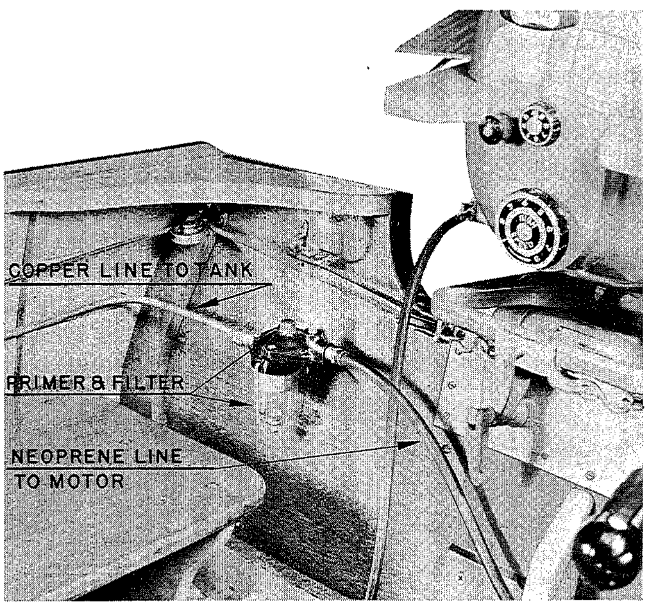
Installation of the new spring assembly is identical with that of the former except that it requires reaming or drilling out corresponding holes (indicated by arrows) in brackets

NOTES

FUEL MASTER PUMP



Showing installation of the fuel pump.



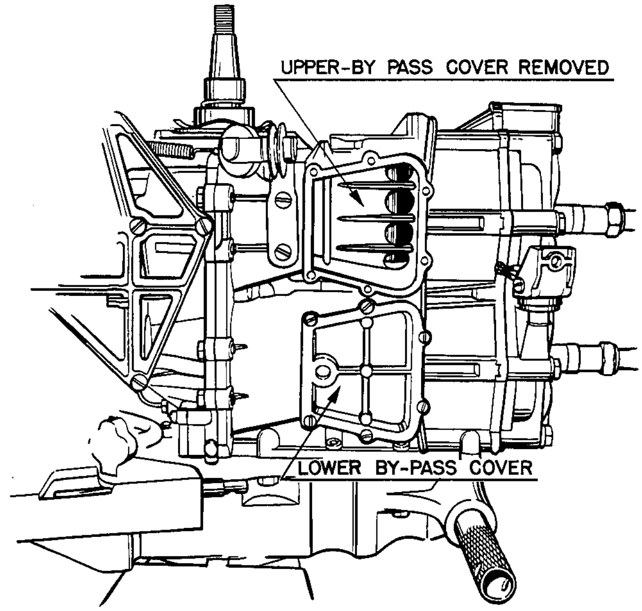
Showing installation of the primer-filter assembly as attached to transom of the boat, copper fuel line leading to the built-in tank and flexible neoprene fuel line to the motor (carburetor).

The cruising (Fuel Master) fuel system is put up in a kit and designed to replace the familiar six gallon pressurized tank with one of greater capacity (built-in) as required and desired for outboard cruiser and runabout purposes.

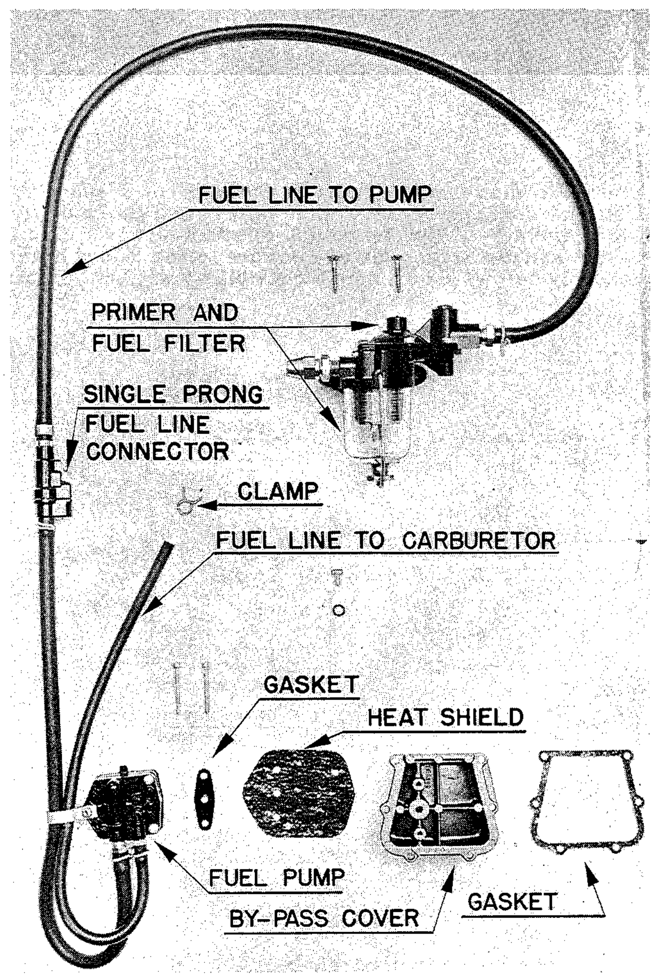
The kit consists of:

1. Pump Assembly
2. Filter-Primer Assembly
3. A single "pronged" fuel line connector (since pressure is not utilized in this case to convey liquid fuel from the tank to the carburetor).
4. A piece of flexible neoprene tubing with fittings for connecting between the Filter-Primer and motor.

The fuel tank is **not** included—this phase of the

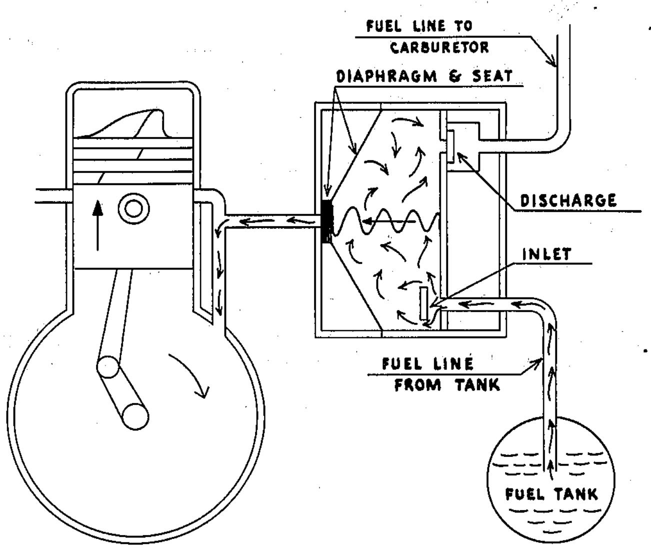


Showing upper by-pass cover removed prior to installing cover plate provided with the pump assembly.

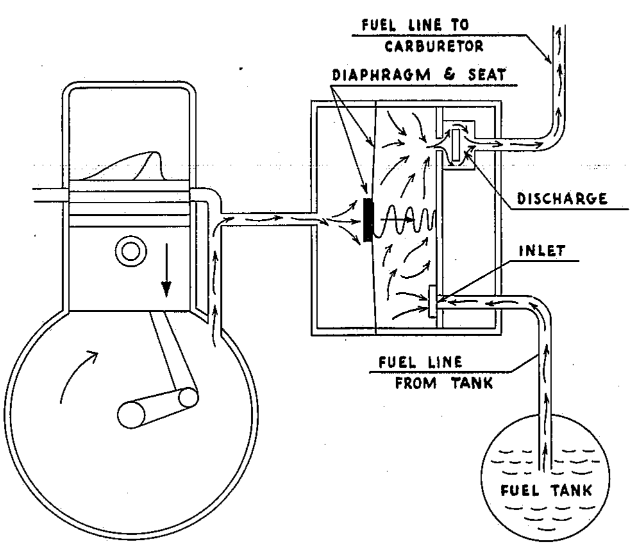


Showing parts that make up the pump kit.

installation (built into the boat) is left to the designer/builder of the craft or operator; however, its construction and all connecting fittings should conform to the current Fire Protection Standards for Motor Craft—by the National Fire Protection Association. Note: It is suggested the tank be fitted with a coarse screen at the outlet baffles and in the event a flat bottomed tank is used, a sump or trough be provided to "trap" part of the fuel at least when level is low to avoid running "dry" because of sloshing in a rolling sea.



Schematic drawing to illustrate position of diaphragm, inlet and discharge (valve) discs on upward stroke of the piston and flow of fuel from tank to pump—suction. (Note—Inlet and discharge (valve) discs are spring loaded in the assembly but not shown here for simplicity of illustration.)



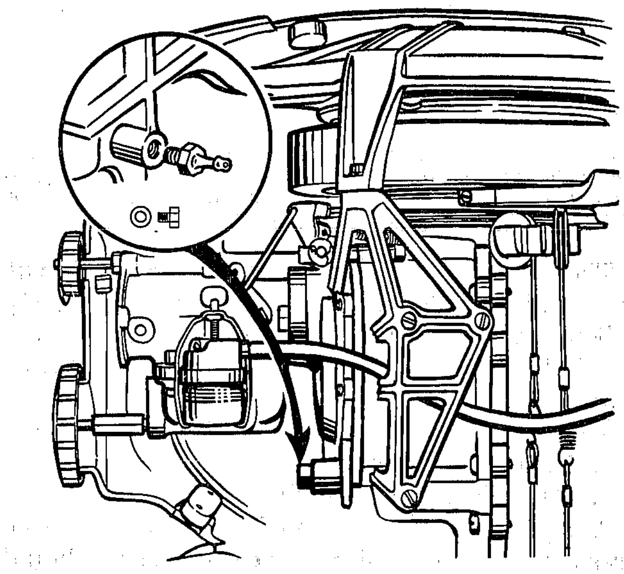
Schematic drawing to illustrate position of diaphragm, inlet and discharge (valve) discs on downward stroke of the piston and flow of fuel from pump to carburetor.

The pump is of the diaphragm displacement type—being operated by crankcase impulses since it is attached to the top cylinder bypass. In addition to the spring loaded diaphragm, the assembly includes two similarly spring load disc valves—inlet (suction) and outlet (discharge) and a small opening leading directly into the crankcase bypass. Alternate suction and compression in the crankcase, created by travel of the piston through its cycle causes the diaphragm to flex. On upward stroke of the piston, the diaphragm aided by spring loading is caused to flex inward thus displacing volume on its opposite side to create "suction" and subsequently liquid fuel to be "drawn" in by way of the inlet disc valve.

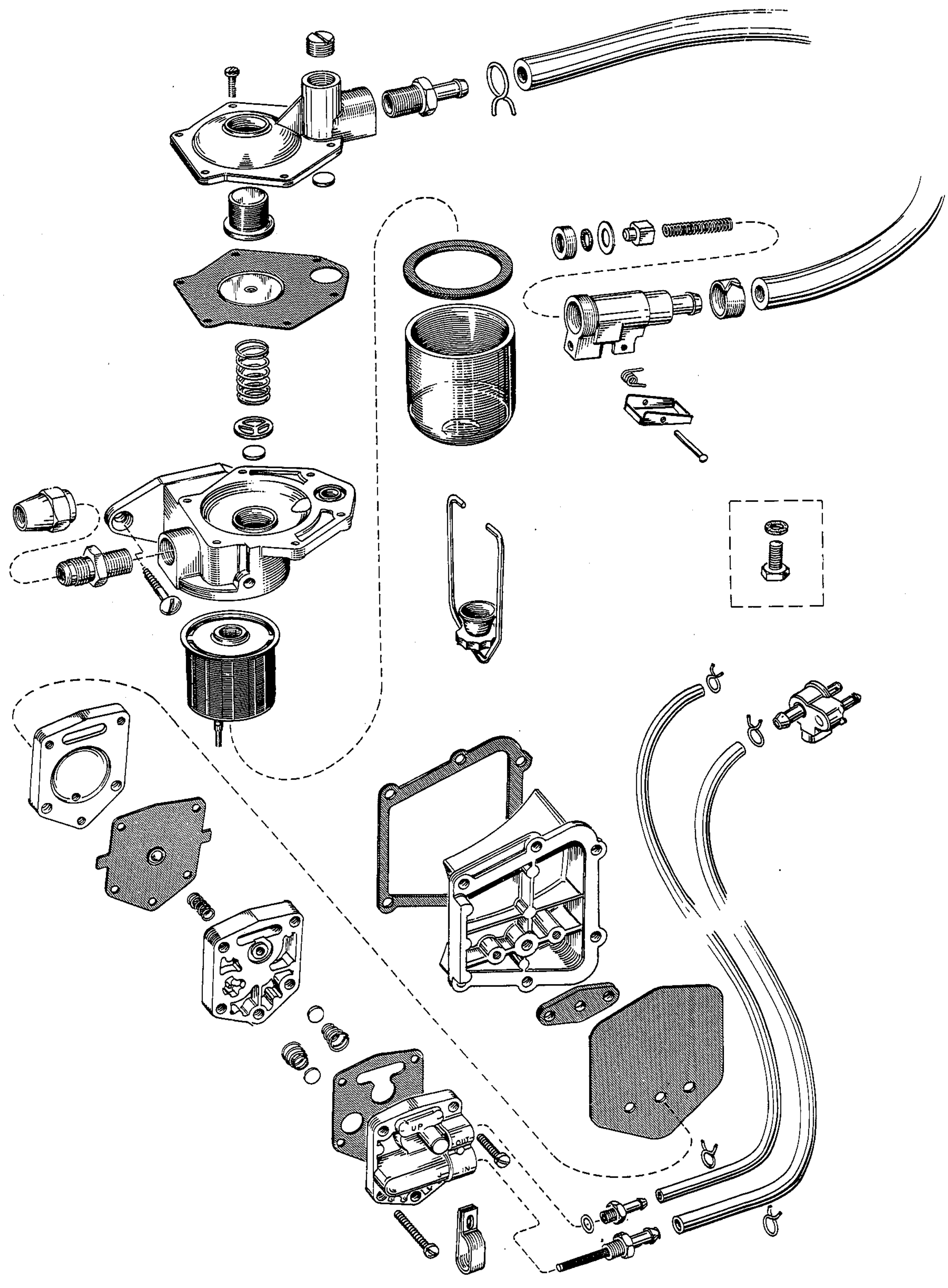
During downward stroke of the piston, resultant compression (in the crankcase) causes the diaphragm to flex in the opposite direction to force the fuel out by way of the discharge valve disc which has been lifted off its seat and on through to the carburetor. Constant action or pulsating of the diaphragm as described results in a steady flow of liquid fuel to the carburetor.

Volumetric capacity of the pump is five gallons per hour at four pounds pressure per square inch—will lift the fuel mixture two feet.

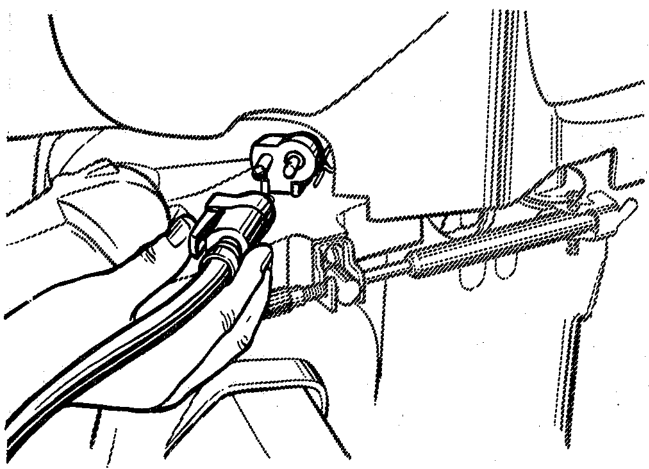
Little difficulty, if any, will be encountered, except perhaps for leaks in the "suction" lines—copper or the flexible neoprene tubing; a punctured diaphragm or air leaks between sections of the pump assembly and/or disc valves not properly seated.



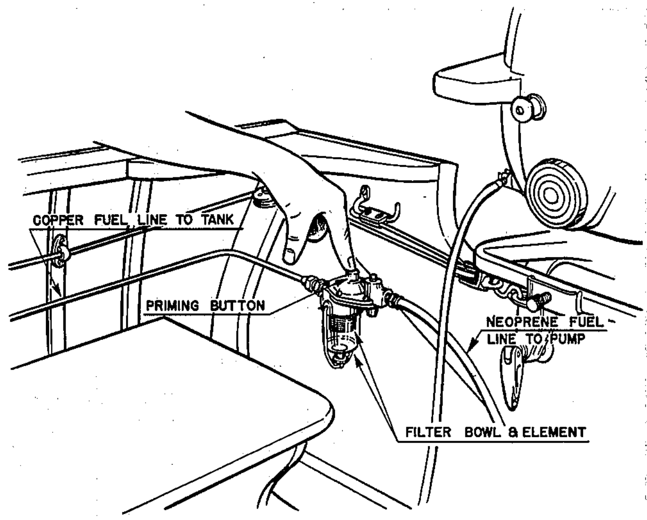
With installation of the fuel pump, it becomes necessary to remove and replace nipple #301820 with screw and washer #303639 and #301819 respectively as provided with kit. Single pressure line to the tank is not now required.



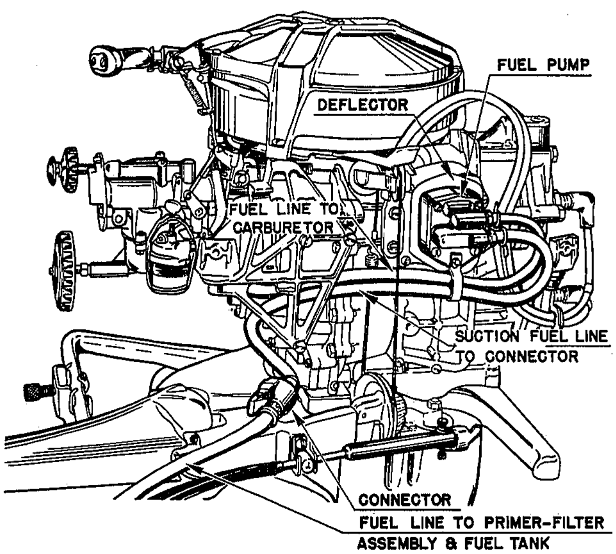
Detail layout of pump kit assembly.



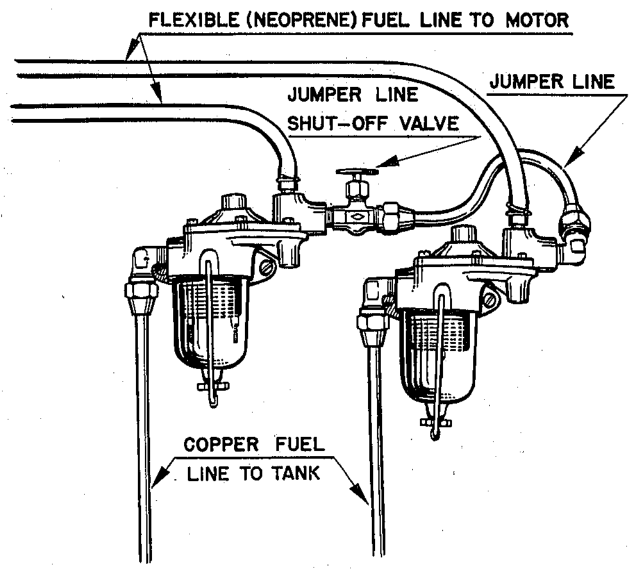
Attaching fuel line to single "pronged" connector.



Depressing primer button to fill the carburetor.



Line drawing to illustrate the pump installation.



Installation of Two Filter-Primer Assemblies
For twin tank—twin motor installation, see plans following. The jumper line is kept closed unless one of the tanks has run dry. In this event, close the fuel shut-off valve on line to the empty tank—then open the jumper line valve.

ATTACHING THE PUMP ASSEMBLY

1. Remove both motor covers.
2. Remove by-pass cover plate from top cylinder by-pass.
3. Install replacement by-pass cover plate followed by the gasket, deflector and pump assembly.
4. Remove original fuel and air lines from nipple fittings on carburetor and manifold—also remove fuel and air connector from steering handle bracket.
5. Install pressure fuel line—connecting pump assembly and carburetor.
6. Attach fuel line connector (supplied with kit) to the steering handle bracket.
7. Attach suction fuel line—connecting pump and fuel line connector.
8. Remove nipple fitting from manifold.
9. Replace nipple fitting with washer and plug (provided with kit). Make certain plug is tight to avoid crankcase compression seepage.
10. Replace motor covers.

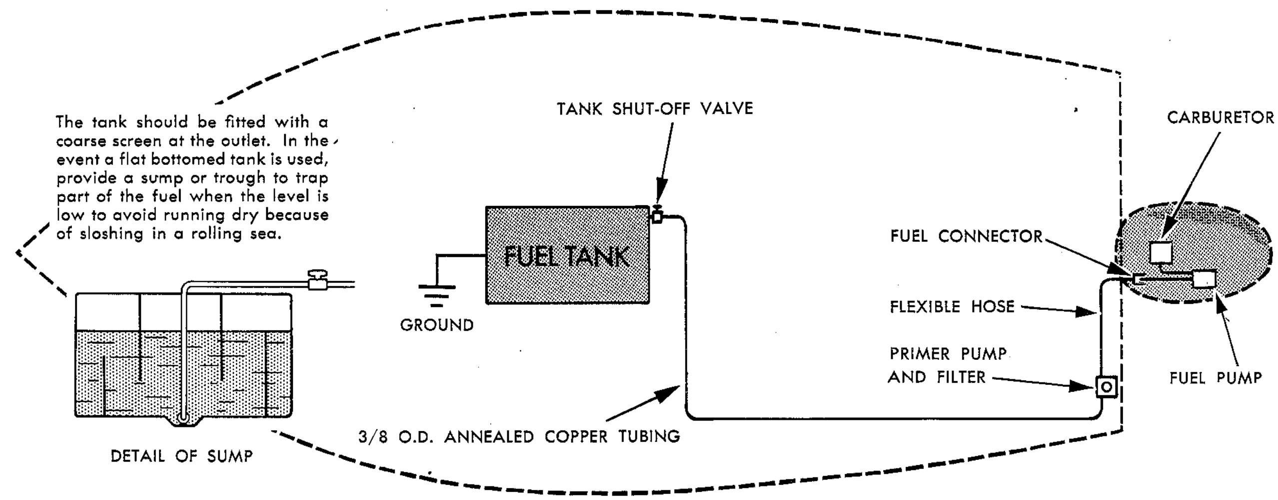
GENERAL INSTALLATION INSTRUCTIONS FOR FUEL SYSTEM

1. On all copper tubing connections, use flared type fittings.
2. All shut-off valves should be installed so as to be accessible in case of emergency.
3. All copper tubing should be clamped to permit a minimum of vibration. Clamps should have no sharp edges.
4. Mount fuel tank as low as possible in the boat and symmetrical with the keel.
5. Mount the priming pump and filter assembly so that its outlet is higher than the top of the fuel tank.
6. Cement all pipe thread connections with a gasoline resistant cement (Gasoila).
7. All flexible hose connections must be clamped securely.
8. Take precaution in locating the flexible hose, to eliminate possibility of cutting or crimping when engine is turned.
9. All copper tubing should be 3/8 O.D., annealed copper, and have a wall thickness of .049.
10. Locate the entire fuel line from the tank to the engine on an incline upward to the engine. Avoid loops and humps as much as possible.
11. Fuel tank filling spout should be located on the outside of the boat. (Not inside the cabin.) Ground the tank to metal strip on keel or ground plate attached exposed side of hull below water level. Ground filler cap to tank by means of chain (metal) etc.

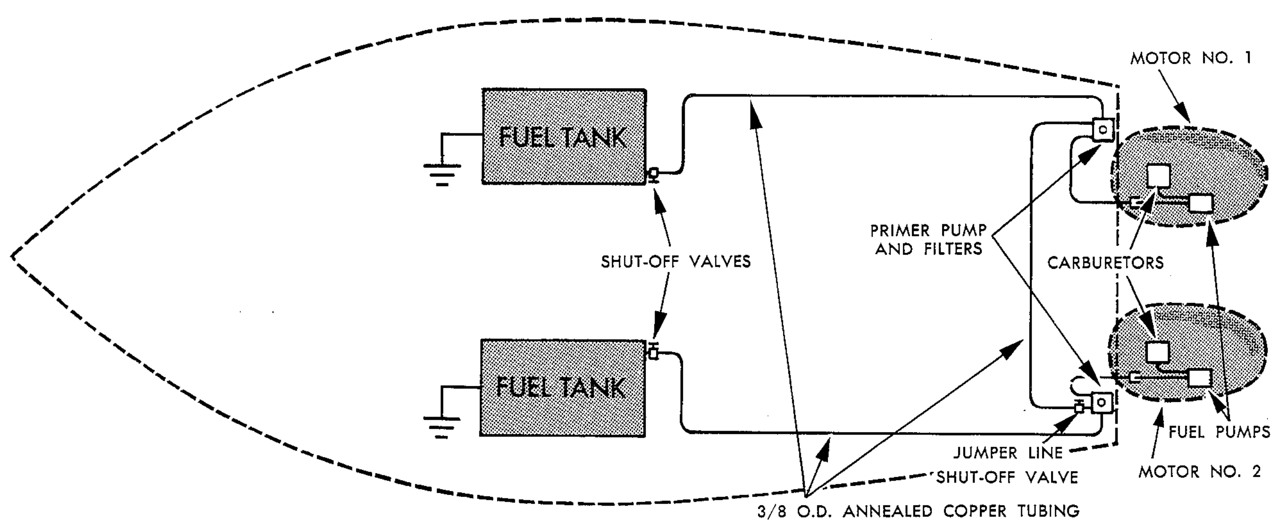
12. Fuel tank must be vented to the outside.
13. Locate Tank Shut-Off Valve at top of tank for easy accessibility and to minimize possibility of leakage through faulty valve.

NOTE: Flaring tools for preparation of copper tubing are ordinarily available through local automotive, marine hardware, oil burner or refrigeration supply houses.

SINGLE TANK...SINGLE MOTOR INSTALLATION



TWIN TANK...TWIN MOTOR INSTALLATION



NOTES

THE POWERHEAD

POWERHEAD

Section III

THE POWER HEAD

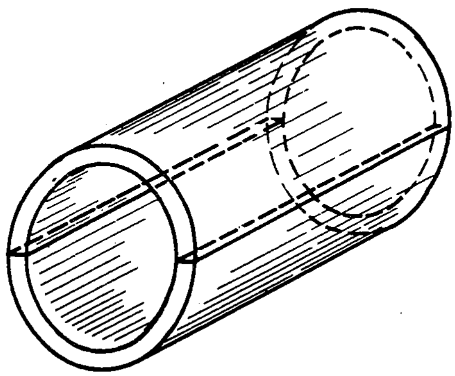
NOTES

THE POWER HEAD

BEARINGS

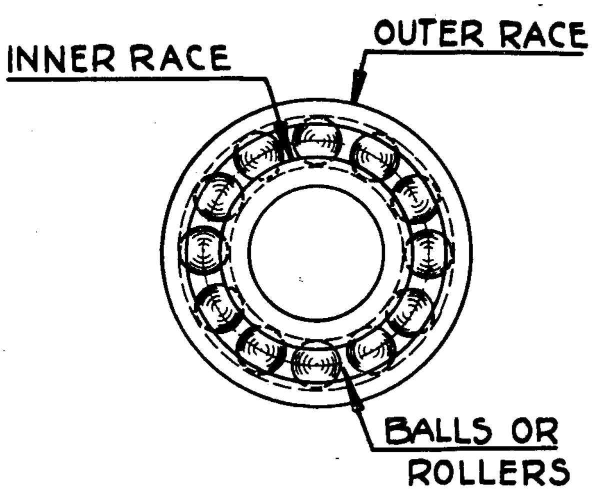
The purpose of bearings in any type of engine (reciprocating or otherwise) is to support the revolving or reciprocating parts such as crankshafts, connecting rods, pistons, etc. and in the outboard motor, driveshafts and propeller shafts.

Bearings generally are classified as either friction or non-friction. The friction type of bearing as employed in the outboard motor consists of a bushing or cylindrical sleeve of bronze, machined to size. It may be of solid construction or split as required for assembly and performance of its function.



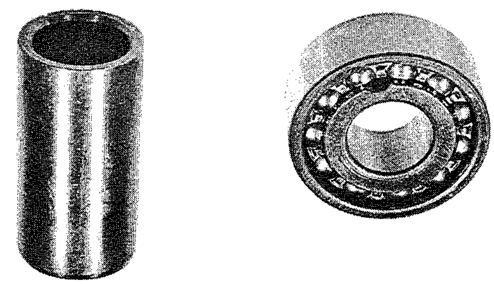
Schematic Drawing of Friction Type Bearing (Bushing)

While some of the bearings or bushings in the four (stroke) cycle engine are constructed of bronze, the principal friction type bearings (crankshaft mains and connecting rod) usually are of babbitt.



Schematic Drawing of Non-Friction Type Bearing (Roller or Ball)

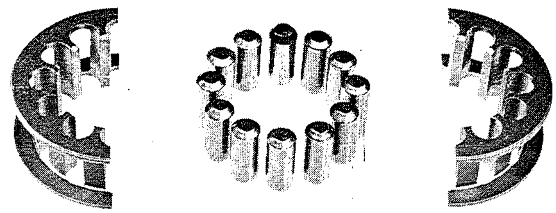
Non-friction bearings are normally constructed of an inner and outer race (steel) of proper dimensions to permit installing rows of steel balls or rollers—all elements being held together by a "cage" or retainer to make up a unit assembly.



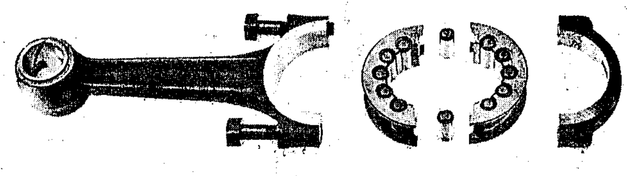
Bronze Bushing (Friction); Roller Bearing Assembly (Non-Friction)

Being of a solid one-piece unit assembly, this type of construction (in the outboard motor) is limited to installation on the top and bottom journals of the crankshaft, the driveshaft and propeller shaft. Other means are necessary to provide non-friction bearings for the center journal (if designed with more than two journals) and crankpin unless the crankshaft is of assembled construction to permit the installation.

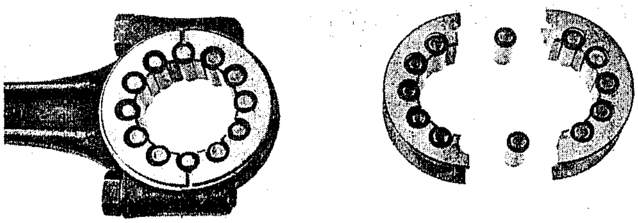
When non-friction bearings are installed on the crankpin, the connecting rod is generally constructed of steel, with the crankpin end of sufficient size to accommodate the necessary rollers. The inside faces of the rod and cap are hardened and accurately ground to size—thus, act as the outer race, while the hardened ground crankpin functions as the inner race. The rollers are set in a split "cage" or retainer—each half of the assembly then placed on the crankpin. This is followed by installing the connecting rod and cap which, when bolted together, makes up a non-friction bearing assembly.



Split Cage (Retainers) and Rollers.

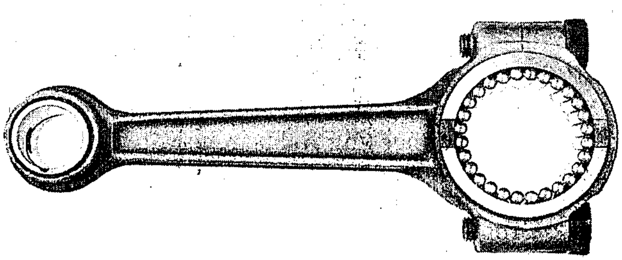


Rollers Placed in Split Cage Ready for Assembly. What Appears to be Free Rollers Actually Find Their Places in Assembly as the Cage or Retainer Sections are Clamped Together on Attaching and Securing of Connecting Rod Cap.

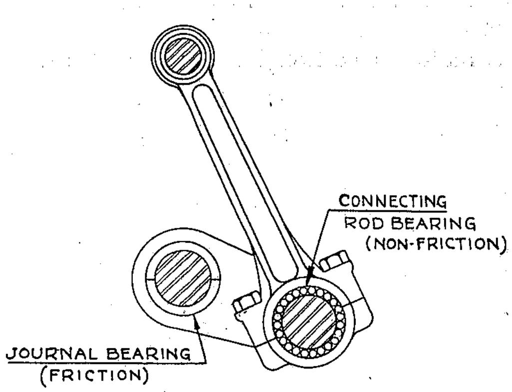


Showing How Split Cage (Retainers) with Rollers in Position is Finally Assembled in the Connecting Rod. Accurately Ground Hardened Surfaces of the Connecting Rod Act as the Outer Race While the Hardened, Machined Surface of the Crankpin (Crankshaft) Acts as the Inner Race to Make Up a Non-Friction Type Bearing Assembly.

Steel needles (needle bearings) are frequently installed on the crankpin, rather than the roller-retainer assembly but otherwise perform as a non-friction type of bearing—the connecting rod and crankpin acting as outer and inner races.

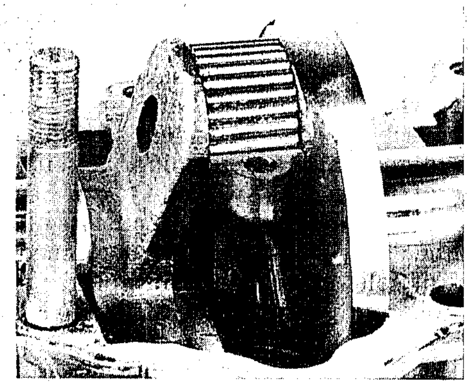


Steel Connecting Rod with Needle Bearings in Position Which, When Mounted on the Crankpin, Make Up a Non-Friction Type Bearing Assembly.



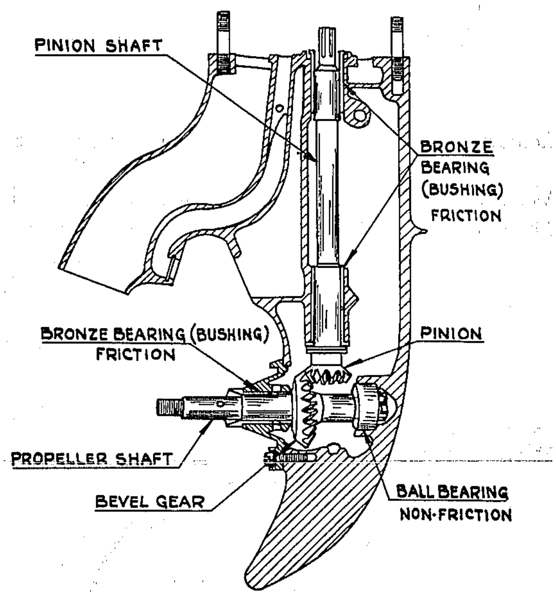
Drawing to Illustrate Common Application of Friction and Non-Friction Type Bearings.

Although most common practice is to provide friction type bearings for both the crankshaft journals and connecting rod, especially in the smaller models, a combination of the two is frequently employed in the larger motors; namely, friction on the crankshaft journals and non-friction on the crankpins as shown at bottom of preceding column.



Showing Position of Needles on Crankpin (Cap Excluded)

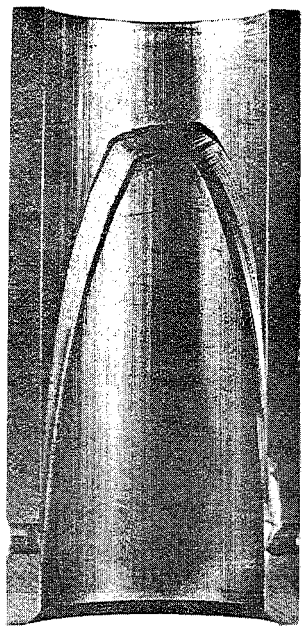
Friction type bearings (bushings) are most generally used for the drive and propeller shafts in motors of low horsepower range while both friction and non-friction types are employed in like positions in the higher powered models.



Drawing to Show Combination of Friction and Non-Friction Type Bearings as Frequently Employed in the Gearcase.

In some motors such as the racing type, non-friction bearings are used throughout—ball or roller bearing assemblies or needles on the crankshaft journals, rollers or needles on the crankpins, ball bearing assemblies on the drive or pinion shaft with ball bearings and needles on the propeller shaft—wrist pin bearings are most frequently of the friction type.

All bearings, regardless, must be fitted with a certain amount of clearance (space between the bearing surface and shaft, crankpin or journal or space between the balls, rollers, needles and races in the non-friction type) to provide ample "space" for lubrication and to allow for expansion as operating temperature rises. To further assist in obtaining efficient lubrication, grooves are cut in the

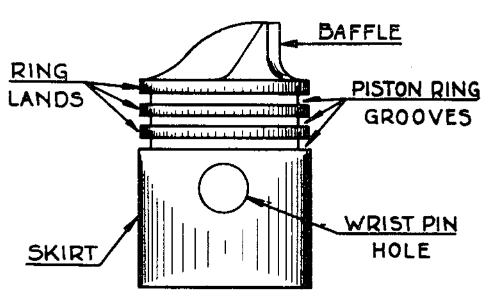


Sectionalized Bronze Bearing to Show Arrangement of Grooving for Oil Circulation.

bearing surfaces of friction type bearings, starting or ending at edge of the bearing or at holes drilled through the bearing wall and on through the bearing "boss" or support to the source of lubrication supply.

The grooves are arranged to circulate or spread the lubricant over the bearing surface—entering at one end of the groove and discharging at the other end to complete the circuit. Rotation of the shaft and spiral of the groove cause the lubricant to be spread over the bearing surfaces.

PISTON AND PISTON RINGS



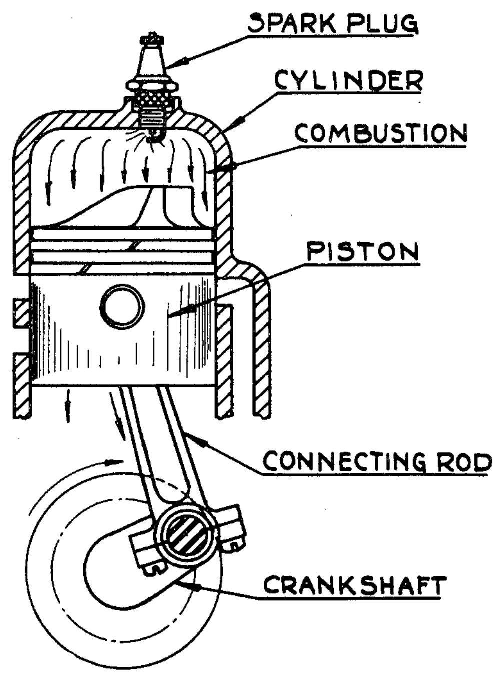
Drawing of Two (Stroke) Cycle Piston.

All Johnson pistons, except for some of the older models, are constructed of aluminum alloy. Cast gray iron pistons were used in models of early vintage.

Since the piston with piston rings installed, receives the force of combustion in the cylinder head (after vaporized fuel has been forced into the cylinder to be followed by compression and ignition), it is necessary that both the piston and piston rings be properly fitted and in good operating condition to seal this force or pressure above the piston head. Seepage past the piston rings and on down between the skirt of the piston and cylinder wall, results in loss of power—if excessive, interferes with operation of the motor, particularly at slow trolling speeds.

To retain maximum of power (pressure) within the cylinder above the piston head, the cylinder must of course be round and the piston rings correctly seated against the cylinder wall. Further, the rings must be properly seated in the ring grooves and the gap between the ends of the rings of sufficient width to prevent "butting" and ultimate warping of the rings to cause pressure loss in the cylinder.

The piston rings naturally cannot be expected to retain the force (power) of combustion if the pistons and cylinder walls are excessively worn or otherwise damaged (scored). In this instance, replacements are in order.



Drawing to Illustrate Function of the Piston.

Function of the piston in a two (stroke) cycle engine is two-fold—namely, to receive the force of combustion which is transferred by way of the connecting rod to the crankshaft in the form of power and to control the flow of fuel vapor and exhaust gases as it covers and uncovers the ports in the cylinder during its travel. The piston rings must be free (in the ring groove) to expand against the walls of the cylinder—any tightness or binding in this respect, will restrict normal activity of the ring to result in loss of compression and subsequently power. Seepage or escape of compression by way of the piston rings is frequently referred to as "blow-by" and is indicated by discoloration or carbon formation clinging to skirt of the piston.

Piston rings are caused to bind or seize in the ring grooves either by carbon accumulation piling

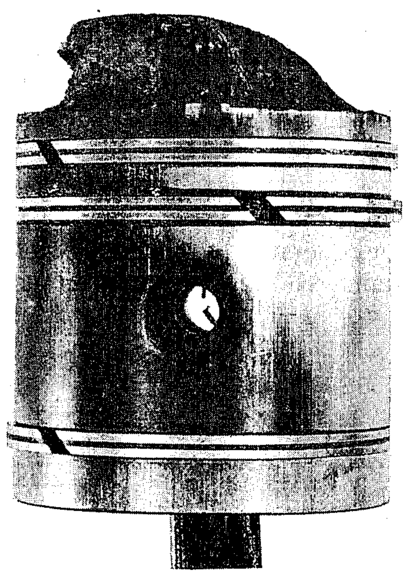
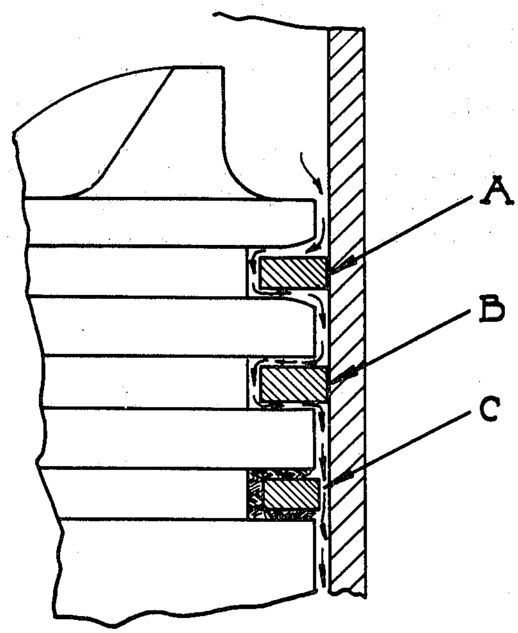


Illustration of Carbon Sooted Piston.

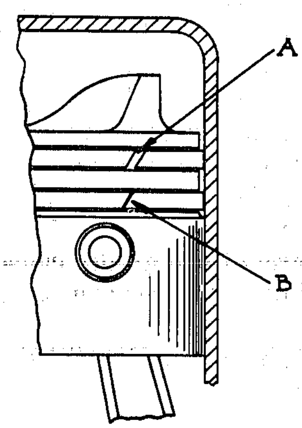
up back of the rings and gradually filling in above and below to render them inactive, or, by insufficient groove or gap clearances. The piston then operates in the cylinder without the benefit of the rings expanding against the cylinder wall to seal the force of compression and combustion. Naturally, the result is loss of power, unsatisfactory slow speed performance and hard starting, the degree of which is dependent upon actual restriction of ring activity under the circumstances.



A. Loss of Compression (Power) Result of Worn Ring Grooves.

B. Loss of Compression (Power) Due to Faulty Ring Seat. ("Wavy" Ring Groove in Piston or "Wavy" Piston Ring Side Walls.) Loss of Compression (Power) Result of Ring "Warpage" Due to Insufficient Gap between Ring Ends Causing Ends to "Butt" as Normal Engine Running Temperature is Reached. (Rings Elongate in Proportion to Temperature Rise, Thus "Gap" Must be Sufficient to Prevent "Butting.")

C. Rings Inactive as Result of Excessive Carbon Accumulation in Ring Groove to Cause "Blow-By" or Escape of Compression (Power).



A. Correct Ring Gap Permits Freedom of the Ring to Act against the Cylinder Wall, Thus Sealing the Compression (Power) above the Piston. Excessive Gap (Clearance) Results in Compression (Power) Loss Due to "Blow-By."

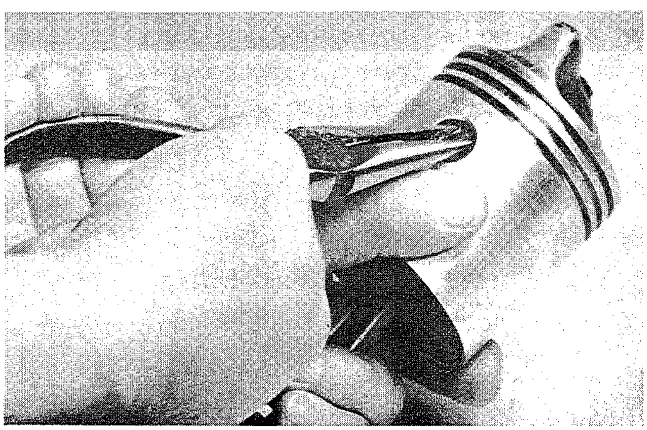
B. Insufficient Ring Gap Causes Ends of Ring to "Butt" to Result in Buckling and Ultimate Inactivity of the Ring.

Not all of the rings on the piston are affected to the same extent—usually the top ring (since the temperature is higher at the top of the piston) is first to become carbon clogged, followed by the second ring, etc., as temperature decreases in proceeding on down the land area and skirt of the piston to be ultimately dissipated via piston rings, piston skirt and as result of comparatively cool fuel vapor entering the crankcase and cylinder—thus absorbing a considerable degree of heat generated in the piston as it functions throughout the cycle.

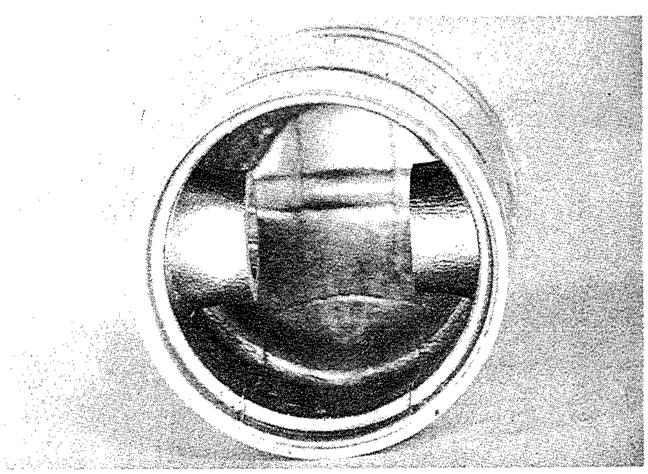
Excessively worn, scored or damaged pistons necessitate replacing which, in conjunction with other corrections, assists in restoring the motor to normal operating condition.

It is assumed that the piston and connecting rod assembly has been detached from the crankshaft and removed from the cylinder on disassembly of the motor for repair.

Remove carefully the wrist pin retaining clip (or other pin retaining device) in the piston at each end of the pin as illustrated below.

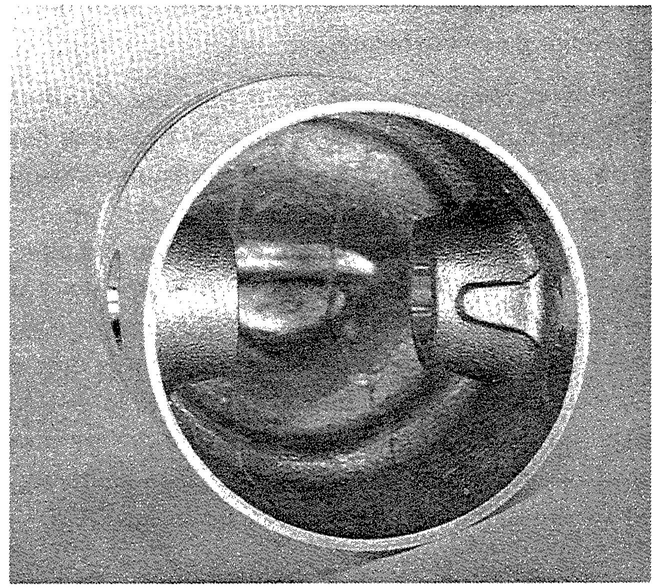


Removing—Installing Wrist Pin Clip (Retainer).



Rise on Boss to Indicate Slip-Fit (Wrist Pin).

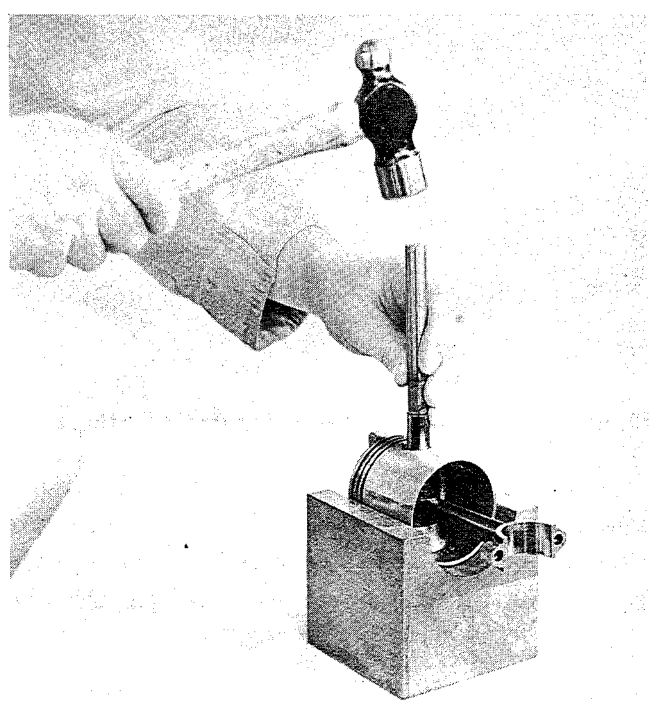
Observe wrist pin bosses inside of piston and note that a small rise is embossed on one wrist pin



Embossing to Indicate Slip-Fit (Wrist Pin).

support (boss) or in lieu of the rise, a prick punch mark.

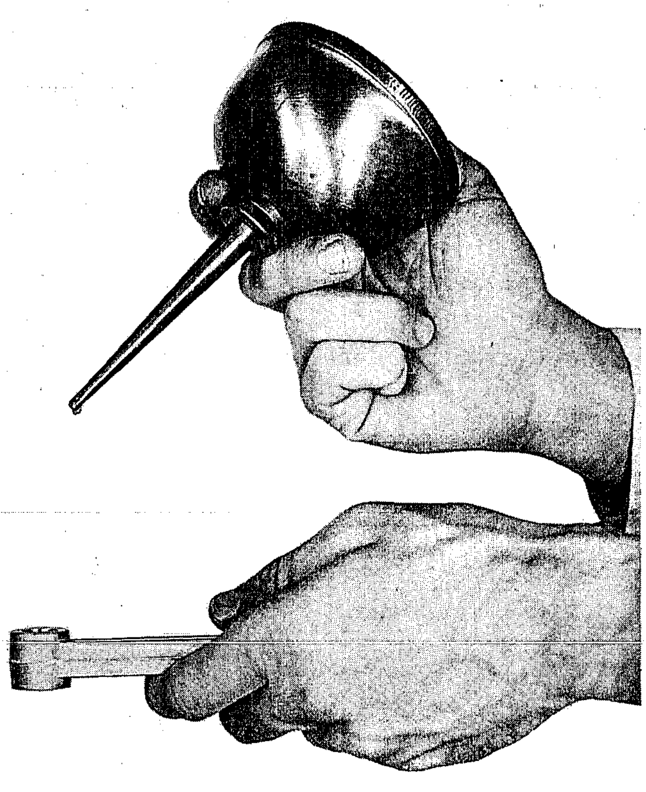
To prevent distortion of the piston as it expands on reaching normal running temperature of the motor, one of the bosses is bored for a slip-fit on wrist pin while the other for a press-fit. The **marked** boss contains the slip-fit bore, consequently, when driving the wrist pin out, in process of detaching



Driving Wrist Pin into Position.

the piston from the connecting rod, or when assembling, drive from the marked side, using a fixture, **as shown,** to guard against distortion or damage during the operation.

Note that many of the wrist pins are closed at one end and open on the other. In this case the wrist pin should be installed in the piston-connecting rod assembly in such a manner that when the assembly is ultimately installed in the cylinder, the closed end of the pin is directed **down** (except in case of the Model PO when one of the closed ends will be up, while the other is down. This is due to the manner employed in securing the pin in the wrist pin boss). Prior to finally driving the pin into position, determine how the piston is to be installed in the cylinder—see instructions, page 107.

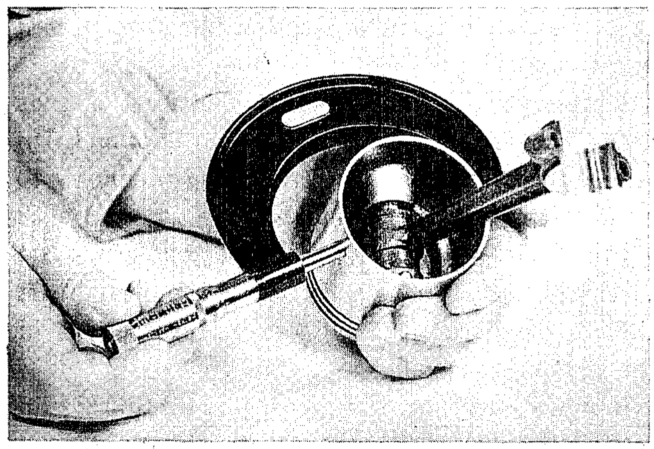


Place Drop of Oil on Wrist Pin Bearing (in Connecting Rod).

Attach new piston to connecting rod in similar manner—apply coat of oil to wrist pin—be sure surface is clean—also, a drop or two of oil in each pin hole in the **piston.** Insert wrist pin through slip-fit side. Oil wrist pin bearing in connecting rod.

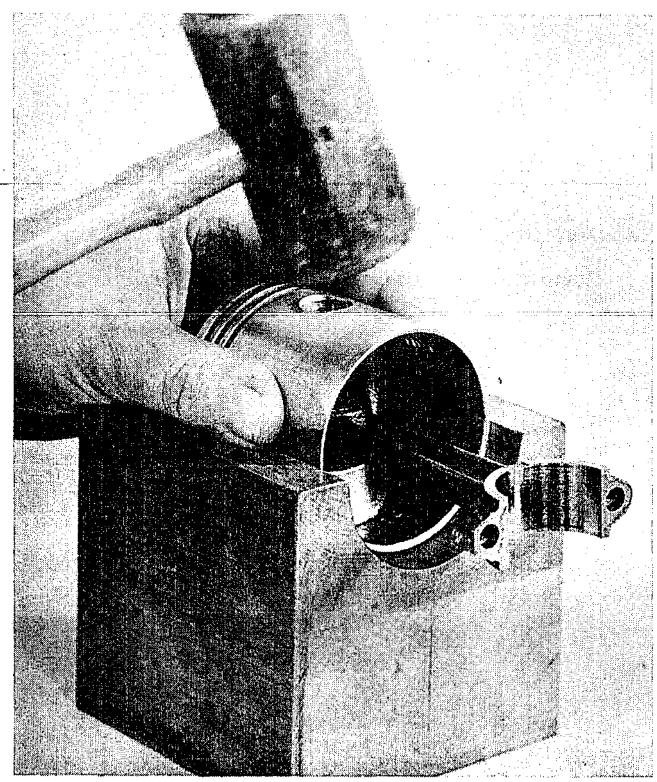
Place connecting rod in position, then proceed to drive the pin "home." (Note: This assembly can be accomplished with less difficulty if the piston is heated slightly to expand.) Replace retaining clips, making certain they come to rest securely in the groove provided for this purpose.

The piston may have been distorted during assembly procedure—check with micrometer to determine "roundness." If slightly out of round, place in fixture and tap high side with light mallet (do



Checking Piston for Roundness

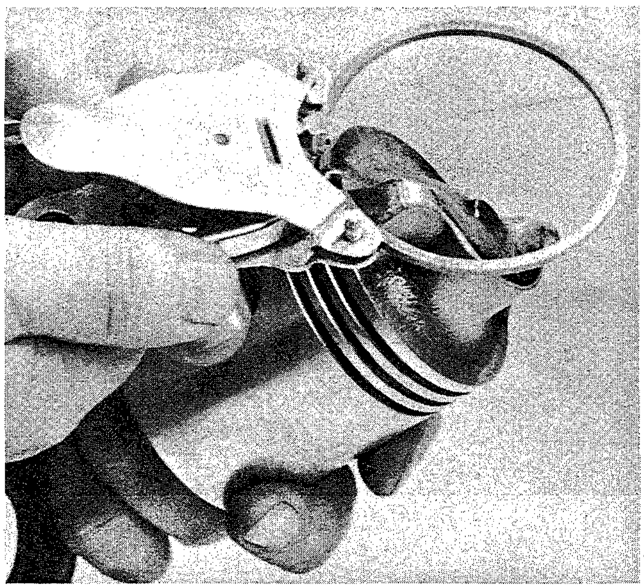
not use hammer) to restore original roundness. Proceed carefully in this respect and caliper frequently until the piston is "rounded" out. (Johnson pistons are not cam ground—oval.)



"Trueing" Piston After Installing Wrist Pin.

Extreme care should be exercised when removing the piston rings, particularly if they are partly "frozen" or binding in the ring grooves due to carbon accumulation, not so much in fear of breaking the rings as in all probability they should be replaced, but to guard against injury to the ring grooves.

When removing the rings, it is advisable to use one of the special ring expanders available for this purpose, as shown here.



Removing—Installing Piston Ring with Expander.

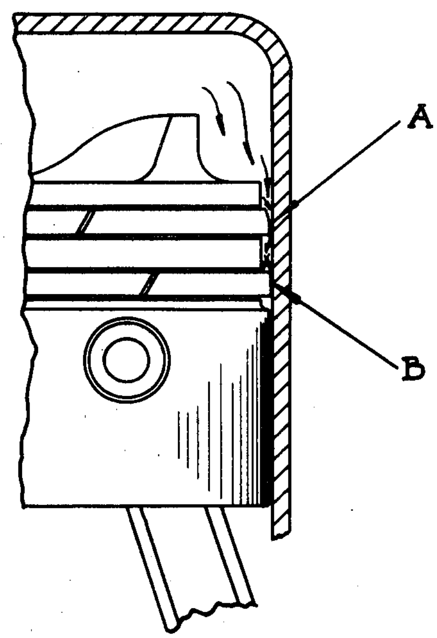
However, if the tool is not on hand for this operation, work the ring loose gradually in the ring groove, then expand sufficiently to remove it from the piston by spreading the ends of the ring with thumbs. This practice, nevertheless, is not encouraged since skin abrasion is apt to occur to be followed later by infection.

After having removed the rings, inspect the ring grooves for carbon accumulation, excessive wear or damage to the ring seats. Carefully scrape carbon from the ring grooves, if necessary—making certain that carbon clinging to the bottom and sides of the groove has been thoroughly removed without scratching or otherwise damaging the groove. Scratches or other damage to the ring seats of the groove results in loss of compression and power.

It may be possible that even though the piston rings are partially seized in the ring grooves because of carbon formation, they are still suitable for further service, requiring only freedom in the

Removing Carbon from Ring Grooves in Piston.

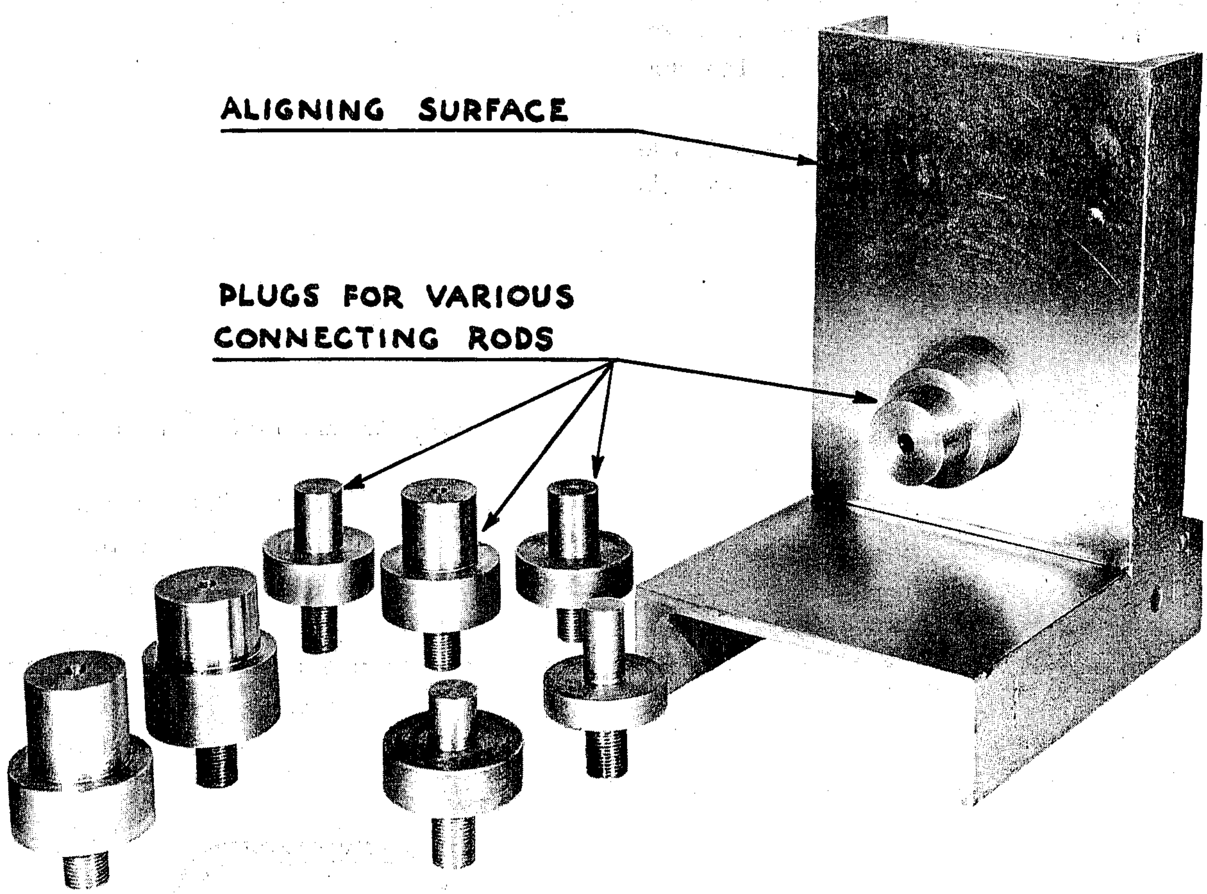
groove to function as they should. They are "worn," however, and should be replaced if the face of the ring is glass smooth—highly polished appearance or, if the edge of the ring is "rounded" off. The edges of the ring should be square, with the face not too smooth and rather dull in appearance if serviceable. If in doubt, install new rings.



A. Worn Ring—Rounded Edge and Smooth Polished Face Result in "Blow-By," Loss of Compression (Power) and Carbon Coated Piston Skirt.

B. Serviceable Ring—Square Edge and Dull (Appearing) Face Retain Force of Combustion to Deliver Maximum Available Power. Skirt of Piston Clean and Reasonably Free of Carbon.

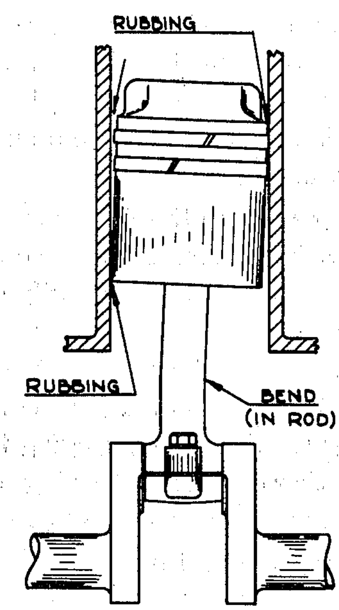
CHECKING PISTON—CONNECTING ROD ASSEMBLY FOR "SQUARENESS"



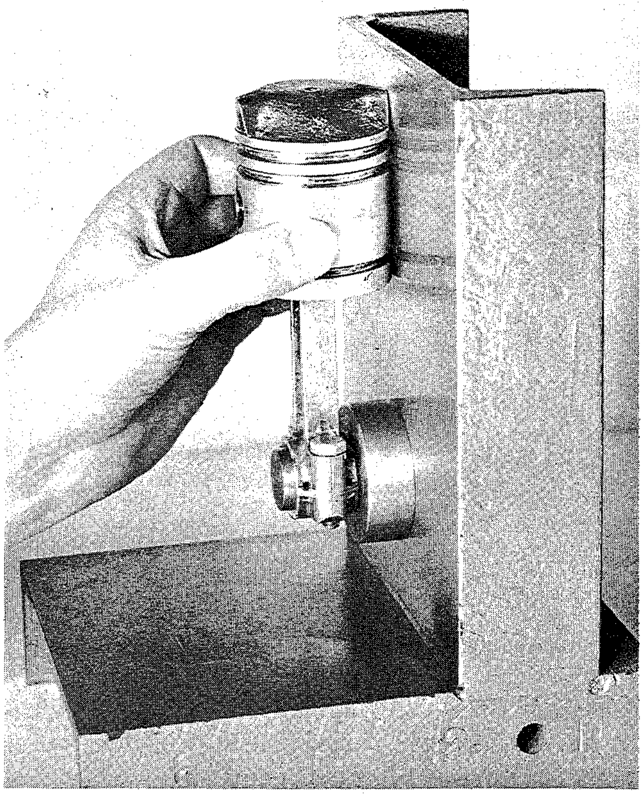
Connecting Rod Aligning Fixture.

Bent or twisted connecting rod-piston assemblies contribute considerably to faulty operation of any engine, to cause knocks and sluggish performance because of binding, which eventually produces overheating and attendant difficulties. Due to minor variations in the pistons and connecting rods or possibly because of accident, it is important to check alignment of this assembly for squareness or twist (in the rod) on an aligning fixture as shown here.

Check for squareness first by simply installing the assembly on the fixture, making certain the connecting rod is made secure on the protruding pin which simulates the crankpin on the crankshaft. Carefully adjust position of the piston so it comes to rest against the aligning face of the fixture, simulating the wall of the cylinder. Do not under any circumstances force the piston against this surface. If required to do so, investigate mounting of the rod on the fixture pin to ascertain first whether or not the rod is properly attached; then look for a bend or twist in the rod.

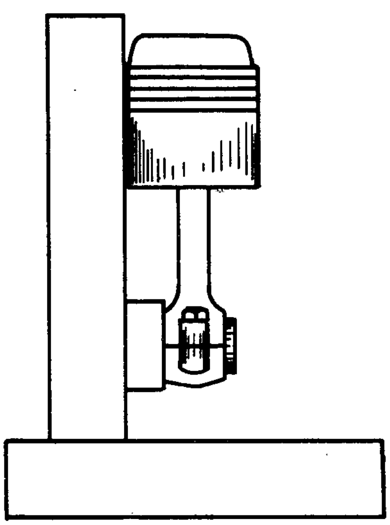


Schematic Drawing to Illustrate Conditions Created by a Bend or Twist in the Connecting Rod.

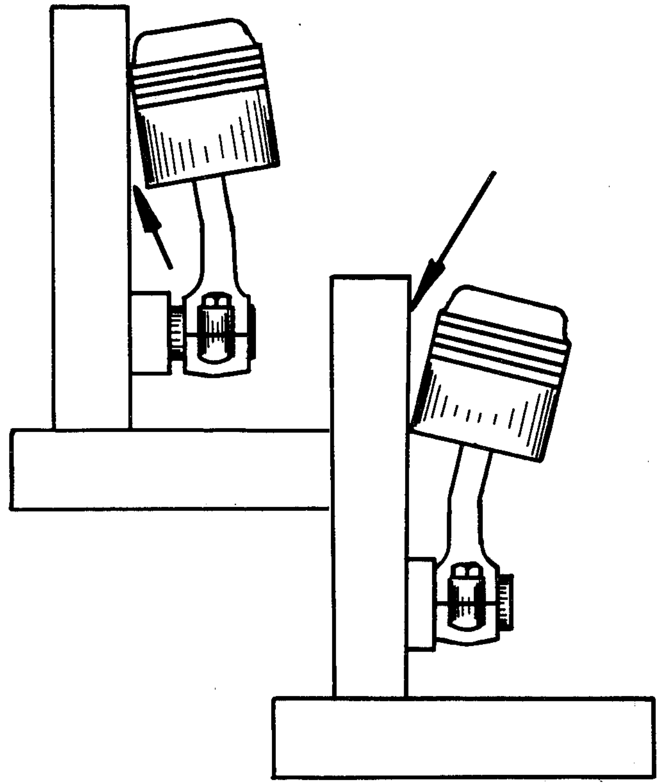


Checking Piston, Connecting Rod Assembly for Squareness.

To check for a bend in the rod, adjust piston to fit against the aligning face gently — do not use force since it is possible to "spring" the rod and thus obtain erroneous results. If the piston-rod assembly is "square" (straight connecting rod and straight piston) the skirt of the piston will be found to rest flatly against the aligning face. (No light visible between the skirt of the piston and fixture except at ring land area which is of slightly smaller diameter than the skirt.)

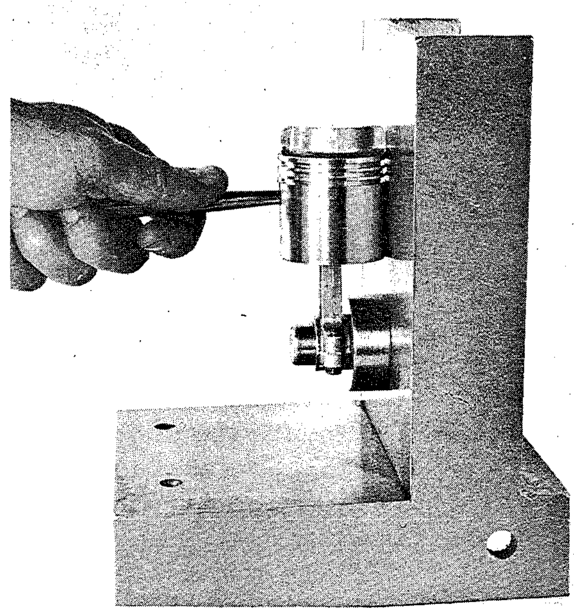


Drawing to Illustrate "Straight" Piston, Connecting Rod Assembly When Checked on Aligning Fixture.



Conditions Created by a Bend in the Connecting Rod When Checking Piston, Connecting Rod Assembly on Aligning Fixture.

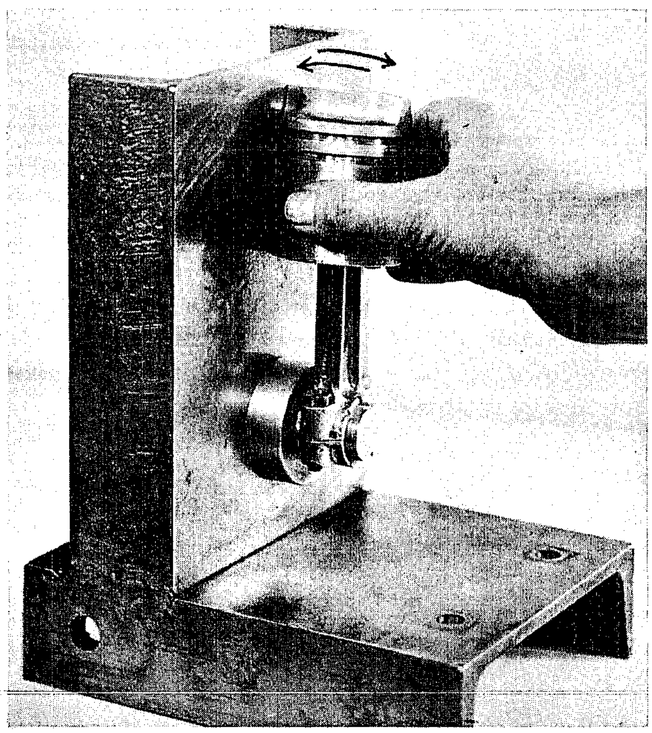
In event the assembly does not properly line up, insert small steel bar in wrist pin hole—lift up or bear down carefully as may be required to obtain alignment in this respect.



Straightening Connecting Rod.

Note—Some pistons are ground with a very slight taper on the skirt—that is, larger at the bottom of the skirt than diameter adjacent to bottom ring land. In this instance, check both sides of the piston—if a tapered piston is involved, a narrow streak of light will show between the aligning face and the top of the piston skirt, regardless. Split the difference so that light streak appears equal on both sides.

The fact that the connecting rod-piston assembly is "square" is no assurance that it is not "twisted." To determine if twist does exist, adjust assembly on the fixture to upright position (straight up and down) then without disturbing position of the connecting rod, rock the piston to right or left slowly —at the same time observe possibility of light streaks developing between the skirt of the piston and aligning face.

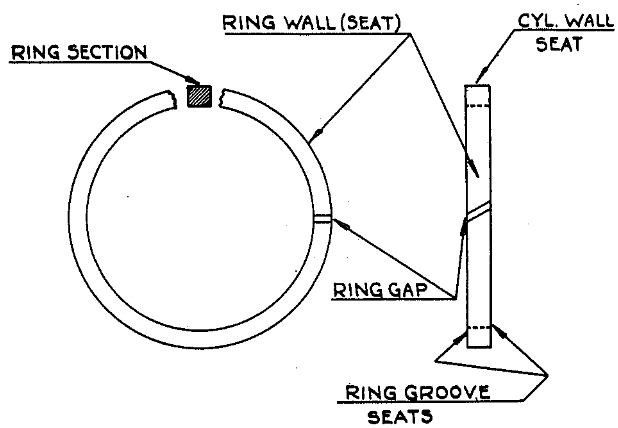


Rocking Piston to Check for Twist.

If a light streak appears at the top of the skirt when rocking piston one way and at the bottom when rocking the opposite direction, the connecting rod is twisted. Degree of "twist" is proportionate to width of visible light streak in this respect. Thus, to straighten, first determine direction of twist, then insert small steel bar in hole of wrist pin. Carefully twist rod in opposite direction until light streak disappears when "rocking" piston—(in event of a tapered piston, until light streak is equal on both sides of the piston at the top of the skirt.)

PISTON RINGS

Piston rings are constructed of high quality cast iron and in such a manner that, when installed on the piston operating in the cylinder, expand against the cylinder walls to form a seal.



Schematic Drawing of Conventional Piston Ring.

Sealing effect is accomplished by pre-establishing a slight strain in the original casting or by other means in process of manufacture, thus, after machining to correct dimensions and severing, ends of the ring "spring" apart. Space created by this action is referred to as the ring gap.

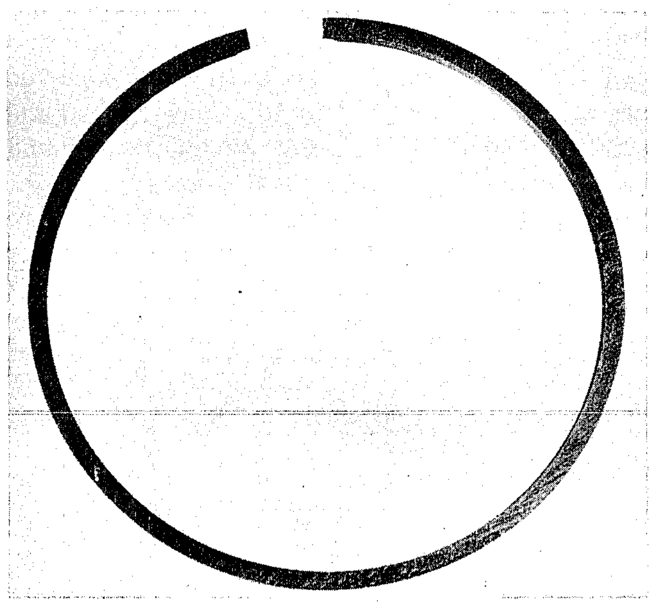
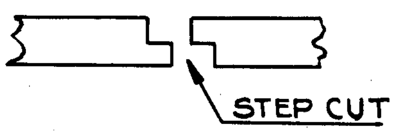


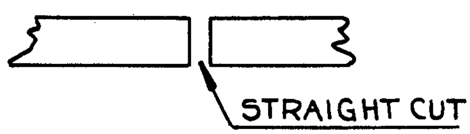
Illustration of Expanded Piston Ring Prior to Installing on Piston and Assembly in Cylinder.

Severing or cutting of the ring is required to provide flexibility of the ring wall (seat) to permit operating against the cylinder wall under slight tension (pressure). Tension in this respect must definitely be in relation to bore of the cylinder, width and depth of the ring.

Excessive pressure against the cylinder wall results in drag (stiffness or friction within the cylinder), creating high operating temperature to cause sluggish performance, abnormal ring, ring groove and cylinder wall wear, if not actual scoring. Insufficient ring wall tension results in "blow-by" to cause loss of power, over-heating, carbon formation on skirt of piston, etc.—faulty performance.

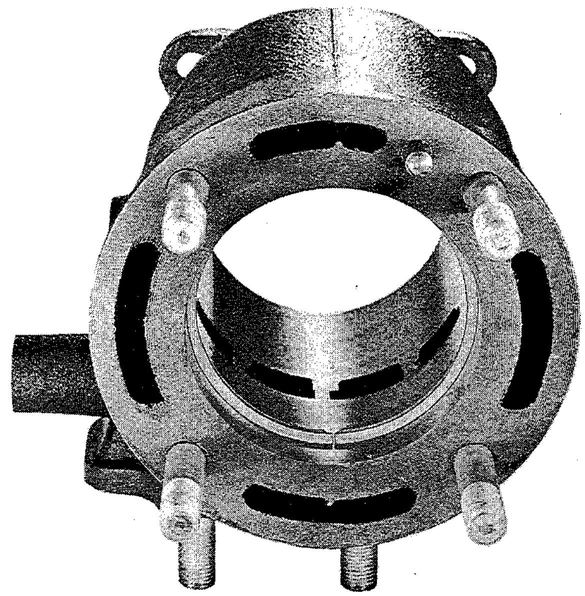
There are several methods of cutting (severing) the rings—namely, (1) Miter, (2) Step and (3) Straight.





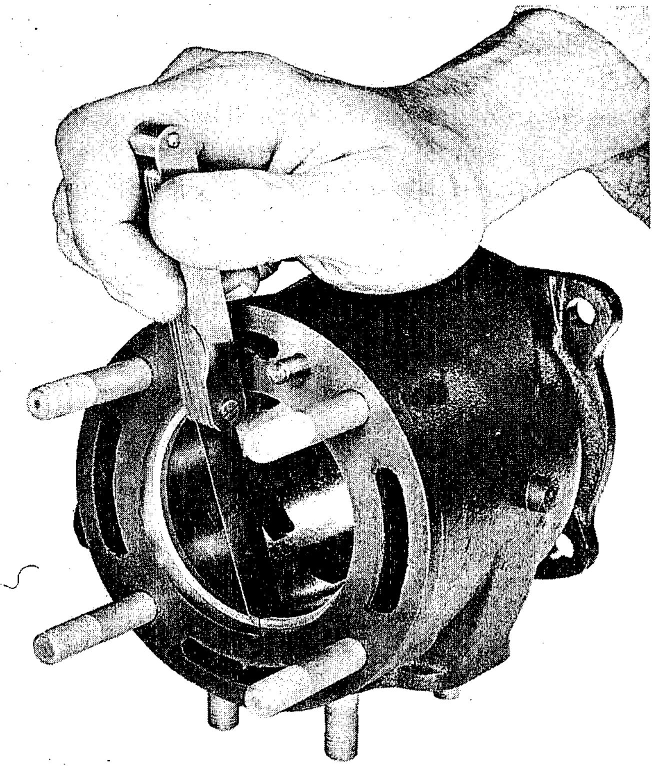
Piston rings are not true (round) until placed in the cylinder. Example—in process of manufacturing, the ring (solid) is turned to a definite O.D. (outside diameter) say, 2.5″ to fit a cylinder bore of 2.5″—curvature of the ring wall is then identical with curvature of the cylinder wall since both diameter of the solid ring and cylinder bore are equal (2.5″). After turning, the solid ring is "slotted" or cut to obtain flexibility with result that ends of the ring spring apart to create a gap. The O.D. subsequently becomes greater than the original 2.5″ actually turned—greater O.D. but not a perfect circle in contour. Although resulting variation in contour of the expanded ring could be measured only in "fractions of .001" of an inch, it nevertheless is not a true circle. True contour of the ring, however, can be restored by installing it in a cylinder of like diameter (2.5″).

The opposite is true if an attempt is made to fit an oversize ring in a cylinder of given standard size. Example—say the cylinder bore is 2.5″ but the O.D. turned size of the ring is 2.510″ (ten one-thousandths of an inch oversize.) Naturally, it is impossible to install an oversize ring in a standard bore of smaller diameter, without filing the ends of the ring. If the ends of the ring are filed or dressed down sufficiently to permit installation in the cylinder, actually, circumference or contour of the ring becomes out of round by "pinching" the ends together. The result is loss of power since the piston ring does not seat properly against the cylinder wall—the cylinder bore is round while circumference or contour of the ring is not.

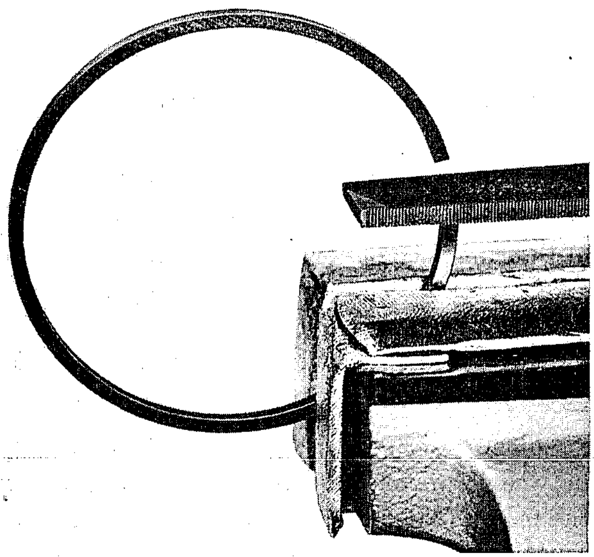


Illustrating Piston Ring Fit in Cylinder.

Sufficient clearance (gap) must be established between the ends of the ring prior to "fitting" in the piston for installation in the cylinder. The ring must be flexible to "follow" cylinder contour in operation of the motor with enough space allowed between the ends of the ring to prevent them from "butting" to create the effects of a solid "lifeless" ring. Further, the ring expands (elongates) as temperature rises during operation—consequently, the gap must be of sufficient width to permit a certain amount of expansion or elongation without "butting" to render the ring inactive. Proper width of ring gap depends on diameter of the piston ring, width, depth (thickness) and mean operating temperature of the engine. (See clearance chart).



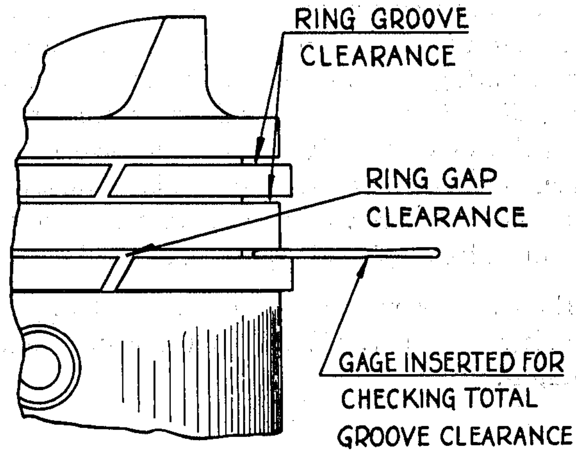
Checking Ring Gap with Feeler Gauge of Required Thickness.



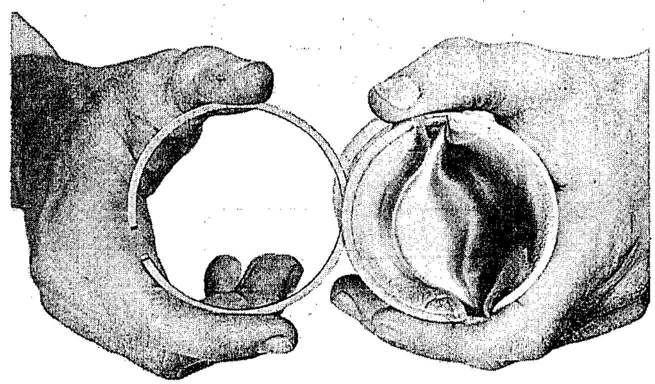
Dressing Down Ends of Piston Ring to Obtain Desired Ring Gap. This Operation Should be Carefully Carried Out—Guard against Damage to Ring by Using Copper or Aluminum Inserts in Vise.

Excessive gap clearance (width) is undesirable, too, in that it permits escape or seepage of compression to result in proportionate loss of power.

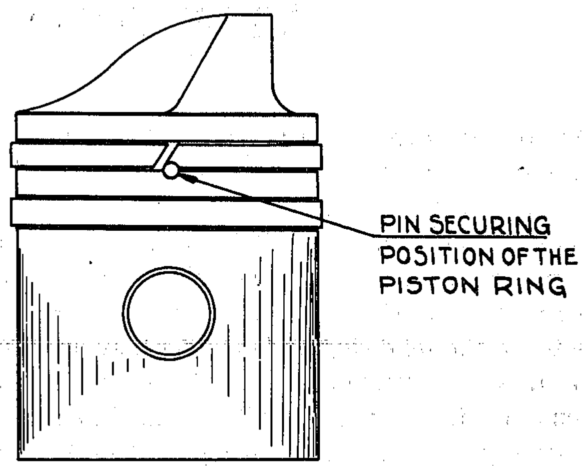
When installing piston rings, the ring gaps should be staggered to retard as much as possible the resulting slight compression loss ever present, regardless.



Drawing to Indicate Ring Gap and Ring Groove Clearance.



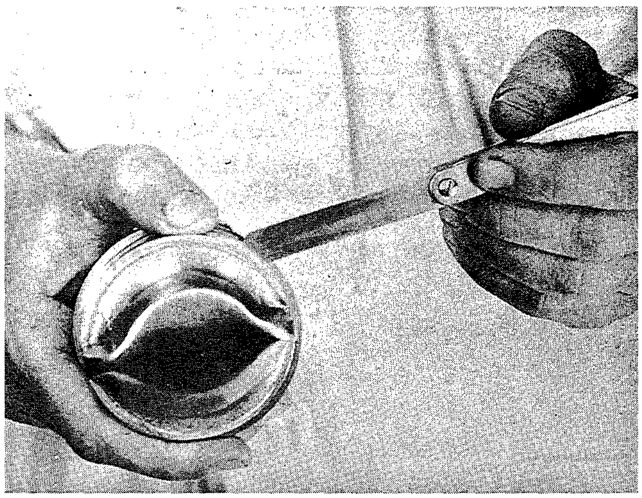
Check Piston Ring in Ring Groove (Piston) to Observe "Fit." Roll Ring in Groove around Piston—Check for Tight Spots and Binding as a Result of Burrs, etc.



Drawing to Indicate Position of Pin in Piston to Secure Position of Piston Ring in Ring Groove and Staggered Arrangement of Ring Gaps (2 Rings in this Case). Gap of Second Ring on Opposite Side of Piston.

The ring grooves in many Johnson pistons are pinned to secure position of the ring in the ring groove, not so much in view of staggering the ring gaps as to prevent ends of the ring "catching" on the edges of the ports (exhaust and intake) in the cylinder to cause breakage or excessive wear (ring) at this point.

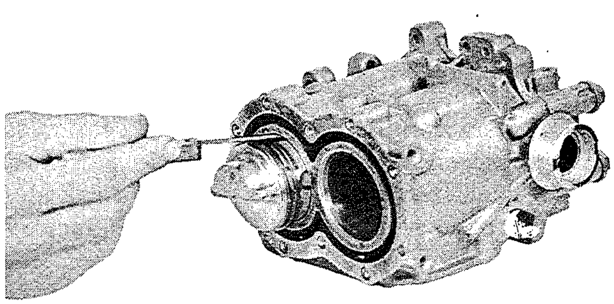
In addition to establishing proper gap clearance for the various size rings, it is equally important that clearance be provided between the ring and the ring groove to permit maximum flexibility. Like gap clearance—if excessive, the result is seepage (around the edges and back of the ring), while if insufficient, the ring is caused to bind in the groove to affect flexibility.



Checking Ring Groove Clearance with Feeler Gauge of Required Thickness.

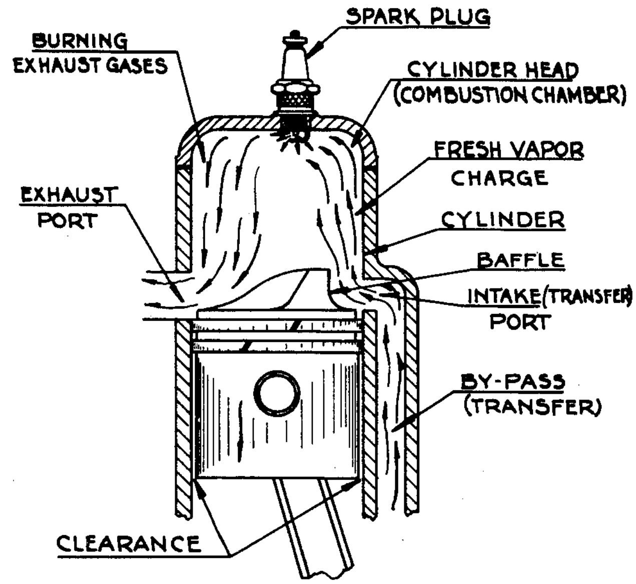
FITTING AND INSTALLING PISTON-RING ASSEMBLY

On having properly fitted the piston rings in the cylinder and in the ring groove, it is necessary that the piston be fitted in the cylinder with sufficient clearance to prevent binding to cause overheating and sluggish performance of the motor and at the same time providing ample space (clearance) between the piston and cylinder wall for lubrication and freedom of the piston to function as it should. Clearance at this point depends on diameter of the cylinder bore, material of which the piston is constructed, normal running temperature of the motor and the speed at which it operates. See table of clearances.



Checking Piston Clearance in Cylinder with Feeler Gauge of Required Thickness—Piston was Previously Checked for "Roundness."

Proceed by inserting the piston into the cylinder bore—check clearance with feeler gauge of thickness specified in "clearance chart" as proper clearance for the specific piston.



Schematic Drawing to Indicate Staggered Position of Piston Ring Gaps, Piston Clearance and Correct Position of Piston Baffle with Respect to the Intake (Transfer) Port—Straight Side of the Baffle Must be Directed toward the Intake (Transfer) Port to Insure Maximum Performance and Ease of Starting. This is Important.

Two (stroke) cycle pistons can be installed "backwards" which interferes considerably with starting and overall functioning of the motor. See drawing above and note that straight side of the piston baffle is placed adjacent to the intake (transfer) port in the cylinder. The purpose of this arrangement is to direct the incoming fresh vapor charge from the crankcase, upward along one side of the cylinder and in a manner, crowd the burning exhaust gases out through the exhaust port. Since width of the exhaust port is greater than that of the intake port, it is uncovered earlier by the downward moving piston to start exhaust gases moving out through the exhaust port, being directed in that direction by gradual decline of opposite side of the baffle and pressure existing in the cylinder at the moment.

Naturally, the process is not entirely efficient—not all of the "spent" gases are all discharged from the cylinder nor does all of the fresh vapor charge remain in the cylinder; some of the fresh charge escapes with the exhaust gases and some of exhaust gases remain in the cylinder to follow through in the subsequent cycle.

LAPPING PISTON RINGS

As stated earlier, three things are basically required to make any gasoline engine run, regardless of whether it be a two-stroke (outboard motor) or four-stroke cycle engine —they are, namely: 1. Spark. 2. A combustible ratio of air and gasoline, or in other words, "gas" and 3. Compression.

Spark must be of sufficient strength to jump the spark plug gap under compression in the cylinder and must be properly timed with relation to position of the piston.

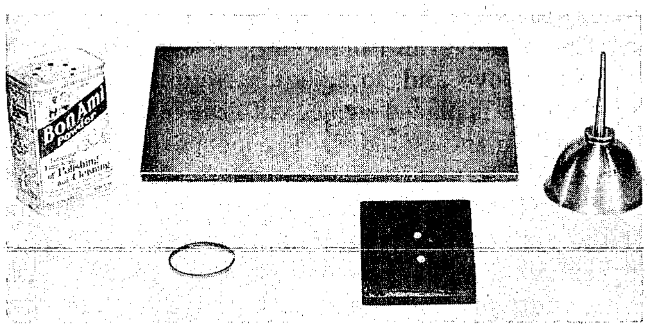
Gas must be of correct air-gasoline ratio—that is, if the mixture is too rich (too much gasoline) it will not ignite; also, if too lean (too little gasoline) it will not ignite. This is largely a matter of carburetor adjustment.

Compression must be good—the amount of compression depending on ability of the piston rings to prevent its escaping. Condition of the cylinder, piston ring grooves and the rings are naturally contributing factors.

An engine will run with some deficiency in either of the above but to get the most out of it, Spark, Gas and Compression must be good.

To obtain good compression, the cylinder must of course be round, the piston rings should seat on the cylinder walls and should also seat in the piston (ring grooves) to prevent compression escaping past the rings by way of the ring grooves.

The sides of the rings may not be flat, thus permitting loss of compression, which can be corrected by lapping. To lap, proceed as follows:



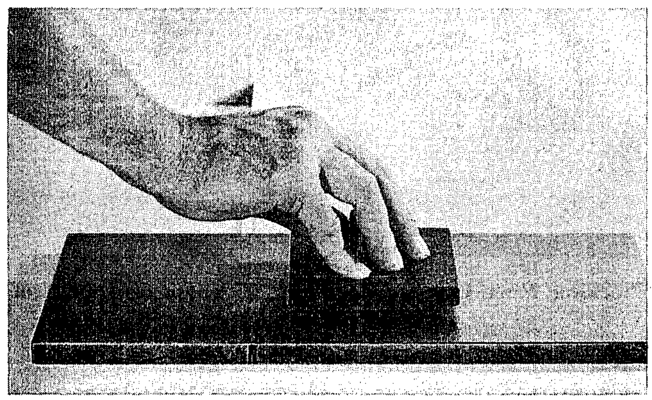
A. Obtain a small piece of plate glass—about 8" x 8".

Construct a lapping block, consisting of a flat piece of wood large enough to cover the average size ring. Glue a piece of felt to one face—attach a small drawer knob to the opposite side to enable lapping with equal pressure at all points of the ring.

Place a piece of No. 00 emery cloth on the plate glass—be sure it lies flat.

Place the ring to be lapped on the emery paper —place the lapping block on the ring. Grasp knob, bear down lightly and move slowly over the emery cloth in a figure 8 fashion.

Be careful not to remove too much of the ring stock but only enough to insure its flatness. This can very easily be determined by frequent observation—low spots will be dark. Cease when the entire surface is bright. Proceed in similar manner to rough lap other side. If too much stock must be removed to obtain flatness, discard ring.



B. To finish lap, sprinkle plate glass with powdered Bon-Ami. Mix with oil to form lapping compound (not too thick or not too thin).

Place ring on plate glass, lap with block in position as described above. Be sure to maintain equal pressure when both surfaces are bright throughout the entire circumference.

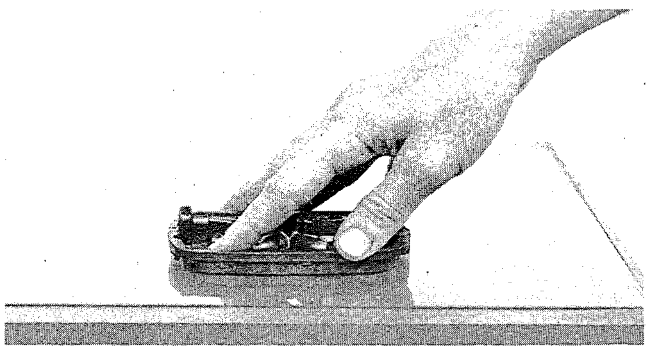
To lap piston ring grooves—apply mixture of Bon-Ami and oil to ring grooves, then install rings in their respective positions. Insert piston in cylinder, then push up and down with turning motion—a minute or two is sufficient.

Remove piston from cylinder and wash free of all traces of lapping compound. THIS IS IMPORTANT.

Minor discrepancies in the rings or ring grooves are not so noticeable at high speeds as at slow speeds for trolling purposes—unless the rings seat properly there is sufficient loss of compression to affect slow speed performance. Compression must be maintained in both the crankcase and cylinder in a two-stroke cycle engine to obtain satisfactory results.

LAPPING GASKET FACES

It is advisable to check all gasket faces for flatness—gaskets will perform their assigned function of containing liquid, oil, grease or compression only when bolted between flat surfaces. Under certain conditions, gasket faces are apt to warp or spring, rendering the gaskets useless to result in loss of liquids, oil, grease, compression, air leaks, etc. This is particularly true where comparatively thin sections or flanges are employed and subject to temperature changes—cylinder heads, carburetor flanges, manifolds, etc.



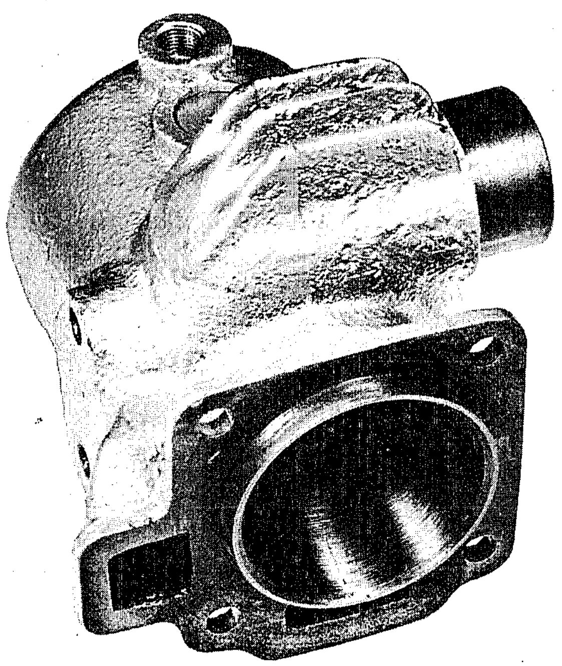
When checking for flatness, the operation should be performed on a lapping block or piece of plate glass. Lay a sheet of No. 0 or 00 emery cloth on the lapping block or plate glass—place the surface to be checked on the emery cloth and move slowly back and forth several times in a figure 8 motion simultaneously exerting light pressure evenly distributed. Lift part from lapping surface to observe results. In event the surface is actually warped or sprung, high spots making contact with the lapping surface will be found to have taken on a dull polish, while the low areas will be noted to have retained their original state. To insure flatness over the entire surface, continue with above operation until gasket surface has been polished to a dull luster. If resulting surface appears too rough, finer lap can be provided by smearing lapping compound evenly and thinly over the plate glass and by proceeding with the lapping operation.

Consider for possibility of lapping the cylinder head, carburetor flanges, manifolds, mufflers, etc.

NOTES

CYLINDER AND CYLINDER HEAD

Except for certain applications, cylinders generally (the bores at least) are constructed of high quality cast iron. Customary practice has been to cast the cylinder assembly, including the bore, water jacket, exhaust and intake ports, manifolds, cylinder head, etc., as one integral piece of gray iron to be machined to specifications as previously established. More modern procedure, however, is to die-cast the cylinder assemblies which involves the construction of rather elaborate dies to permit the use of cast iron cylinder bores, aluminum water jackets, bearing supports, bronze bearing inserts, and crankcase sections (where required). This method of casting assists considerably in reducing weight of assembly, increasing production capacity and uniformity in quality of cylinder blocks.



Cast Iron Cylinder Block.

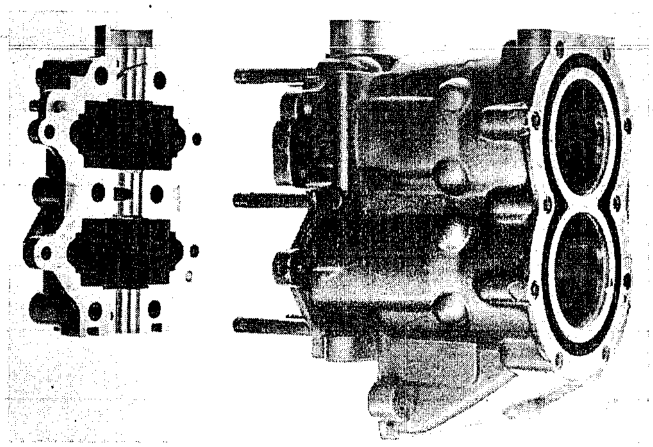
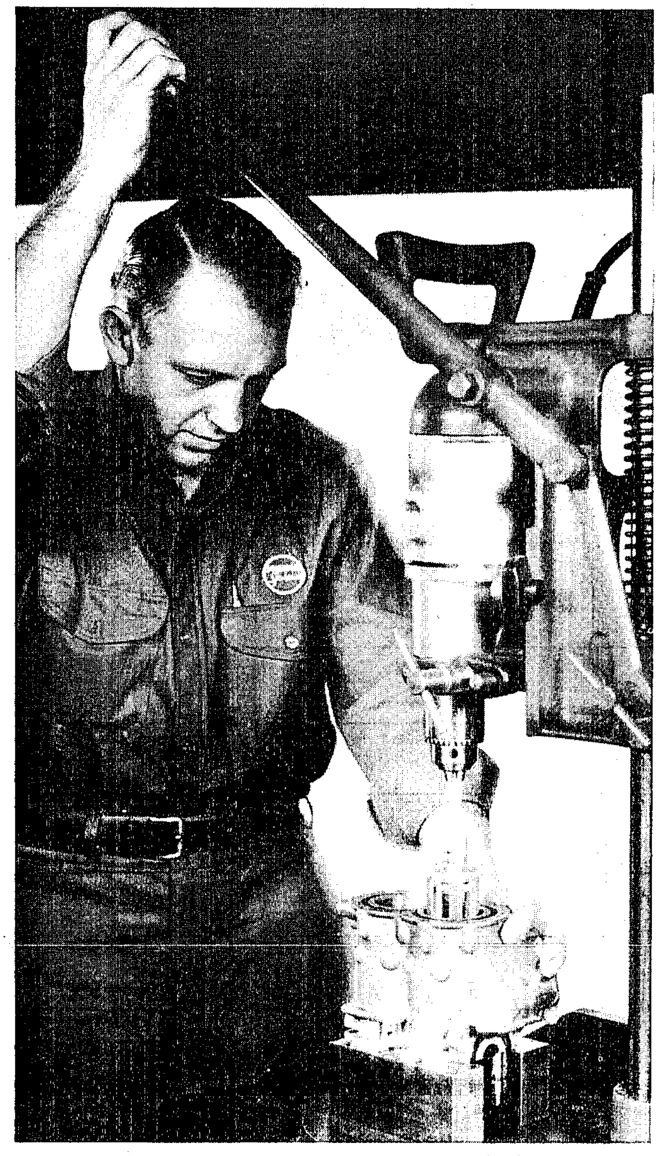


Illustration of Die-Cast Cylinder Block and Crankcase (Cast Iron Cylinder Sleeve and Bronze Bearing Inserts—Aluminum Water Jacket.)

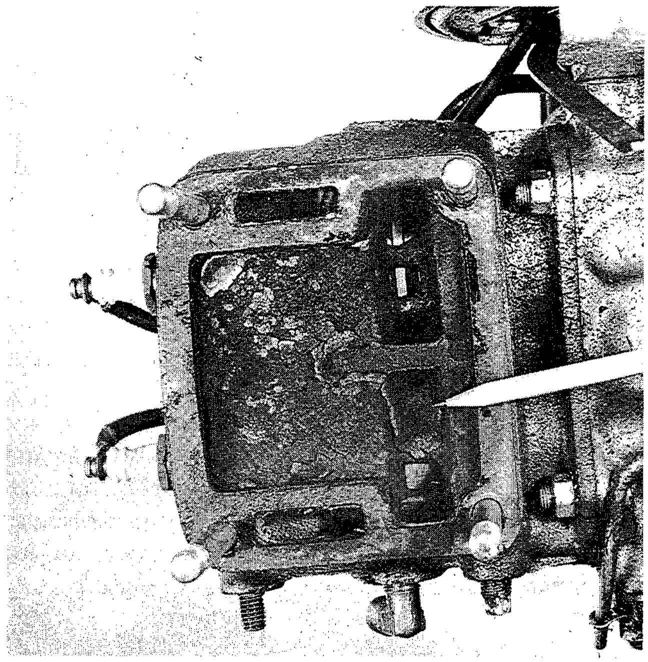
Naturally the cylinders must be round and straight to realize maximum power out-put of the motor. Cylinder bores normally wear with operation of the motor—degree of wear dependent on length of operation, efficiency of lubrication, general condition of complete unit (outboard motor), etc.

Excessive cylinder wear results in loose fitting pistons and rings to cause "blow-by", loss of compression, subsequently loss of power and inefficient performance. This condition can be overcome with a new block or by honing or reboring, followed by fitting and installing new pistons and rings.

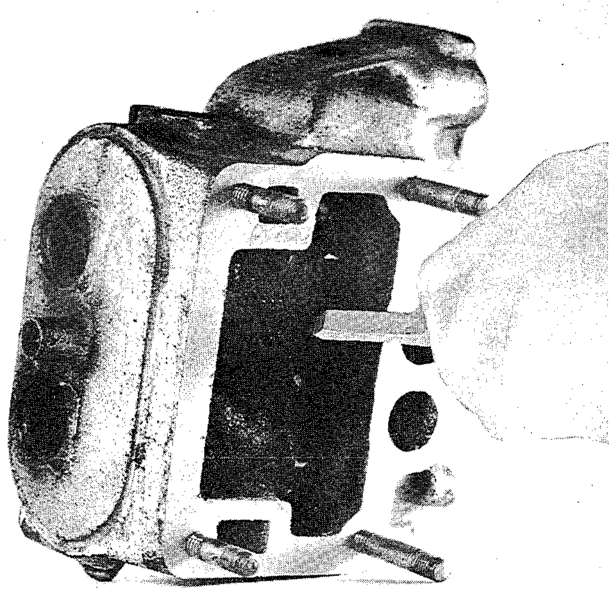


Illustrating Method of Re-Sizing Cylinder Bores by Use of a Cylinder Hone.

Ports in the cylinder walls, particularly the exhaust ports, occasionally become clogged with carbon to restrict the flow of exhaust gases thus, resulting in faulty performance. It is a simple matter to remove carbon accumulation of this nature to restore normal functioning of the port. Use a blunt instrument carefully for this operation.



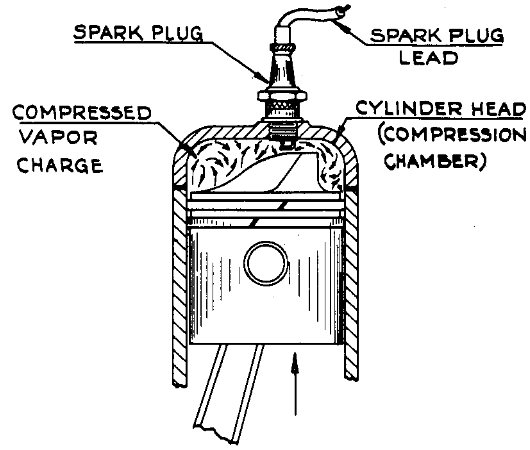
Illustrating an Example of Carbon Clogged Exhaust Ports (Cylinders) Causing Hard Starting, Sluggish Performance and Overheating.



Carefully Scrape Carbon Accumulation from Exhaust Ports with Scraper or Other Blunt Instrument. Walls of Exhaust Ports Must be Free of Carbon to Insure Maximum Performance.

The cylinder head, frequently referred to as the combustion chamber may be detachable or an integral part of the cylinder. It merely consists of a cavity placed at the top end of the cylinder, above the piston (when at top center) where the vapor charge transferred from crankcase to cylinder is compressed by upward stroke of the piston.

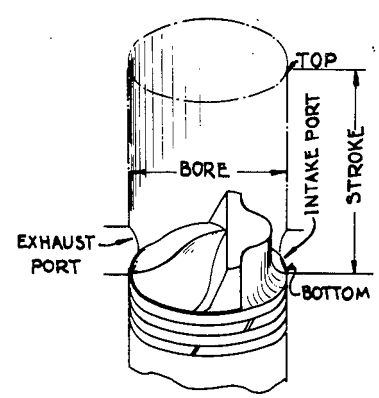
The spark plug is usually installed in the cylinder head and like the cylinder, the cylinder head is water jacketed for cooling purposes.



Drawing to Show Fuel Vapor Compressed in the Cylinder Head, Prior to Ignition and Combustion—Vapor Admitted into the Cylinder during Travel of the Piston from Top to Bottom of the Stroke.

When compression reaches maximum in the cylinder head, the compressed vapor charge is ignited (fired) by spark arcing across gap between points of the spark plug. The burning charge starts to expand rapidly to greatly increase pressure in the cylinder head (or cumbustion chamber). Resulting pressure acts on the piston to **drive** it downward, thus, delivering the power impulse.

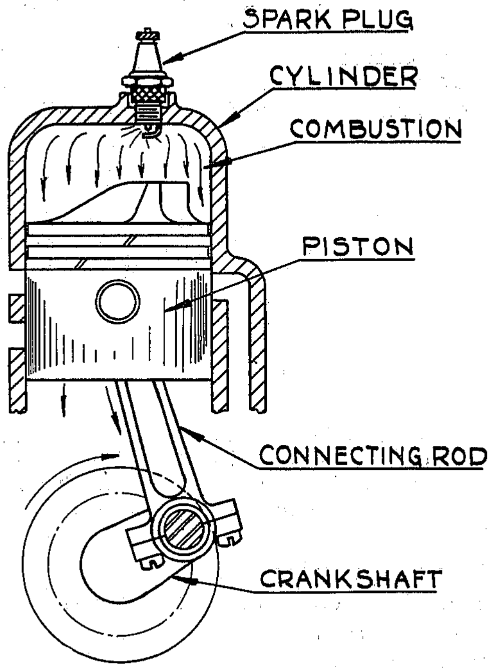
There is a definite relation between the volume of the combustion chamber (cylinder head) and volume created by downward movement of the piston, that is, from top center to bottom center. This volume is known as piston displacement. Consequently, if the volume of the combustion chamber is 20% that of the volume displaced by the piston on traveling entire length of its stroke, the compression ratio is 5 to 1.



Schematic Drawing to Indicate Volume Displaced (Created) by the Piston on its Downward Stroke—Piston Displacement, Area of Cylinder ($R^2 \times \pi$) x Length of Piston Stroke (Inches). Total Displacement Equals Number Cubic Inches Displaced by the Piston in One Cylinder Traveling from Top to Bottom of its Stroke Times the Number of Cylinders.

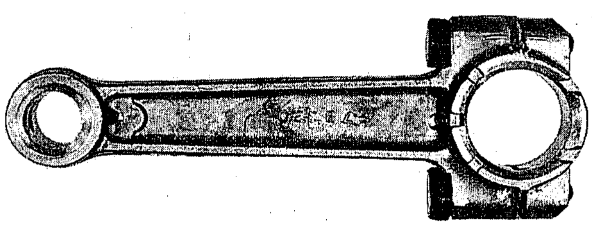
CONNECTING ROD & CRANKSHAFT

Purpose of the connecting rod is to provide linkage between the piston and the crankshaft—motion of the piston is reciprocative while that of the crankshaft is rotative.



Schematic Drawing to Show How Force Acting on the Downward Moving Piston is Converted to Power in Rotating Motion Through Linkage (Connecting Rod) with the Crankpin on the Crankshaft.

The force (power) of combustion being applied to the head of the piston in a downward thrust (straight line) is of no value for practical purposes unless it can be properly directed or gathered, so to speak, and applied where the resultant energy is required—to the propeller by way of the crankshaft, driveshaft, necessary gears and propeller shaft. Thus, energy originally directed in a straight line, is converted to rotating power (energy) through linkage (connecting rod) between the reciprocating piston and revolving crankshaft.



Conventional Connecting Rod Provided with Friction Type Bearing Surfaces.

Customary practice is to design and construct connecting rods of an "I" section with bearing bosses at either end—large at one end to accommodate the crankpin bearing and a smaller boss to support the wrist pin at the opposite end.

Connecting rods are constructed normally of aluminum alloy with bronze bearing inserts (top only) or from steel forgings, depending upon the type of bearing to be used—aluminum or bronze when arrangements are made for friction type bearings —steel for non-friction bearings (roller or needle) except in cases where steel rods were provided with bronze bearing inserts (friction).

Wrist pin bearings on small end of the rod are usually of bronze (friction) since degree of actual movement at this point is comparatively limited, being governed by angularity of the connecting rod. (Long rod, short stroke = s narrow angle; short rod, long stroke = s wide angle, etc.)

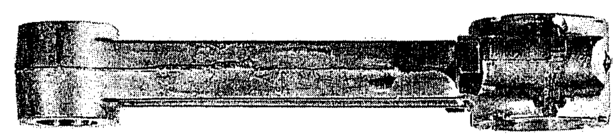
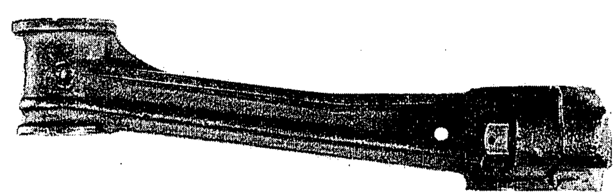
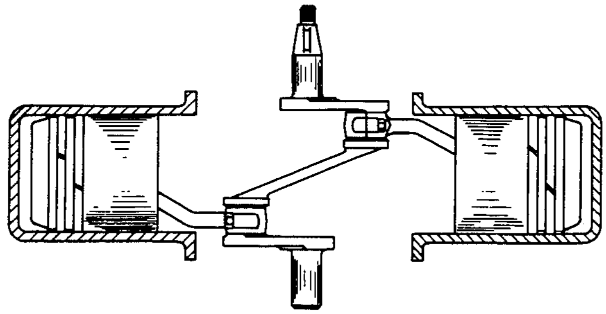


Illustration of Straight Connecting Rod.

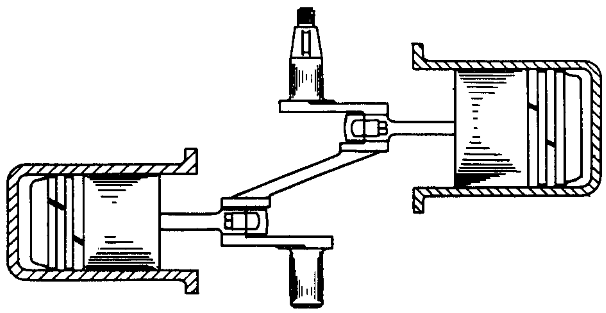


Illustrating the Offset Type of Connecting Rod.

Connecting rods are classified as straight or offset—straight rods being provided in opposed twins where the cylinders are offset as on the Model PO; offset rods, where the cylinders are in line (on the same plane) as on the 210 and many of the older models. Straight connecting rods are employed in all alternate firing twins.



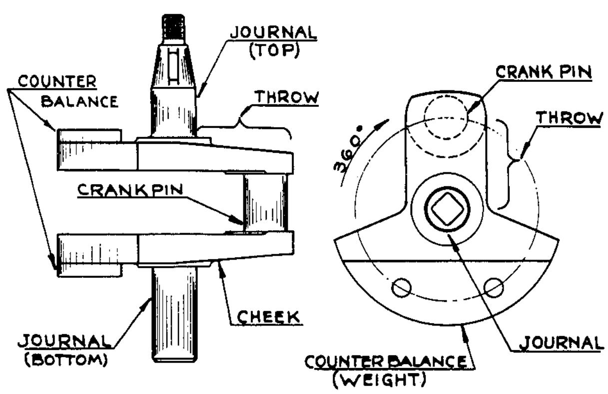
Schematic Drawing to Illustrate Application of Offset Connecting Rods Where Cylinders are in Line in the Same Plane.



Schematic Drawing to Illustrate Application of Straight Connecting Rods Where Cylinders Are Offset.

The crankshaft is generally made up of two or more journals, a crankpin (number dependent on number of cylinders and application) and a cheek or web to support the crankpin—one supporting each end.

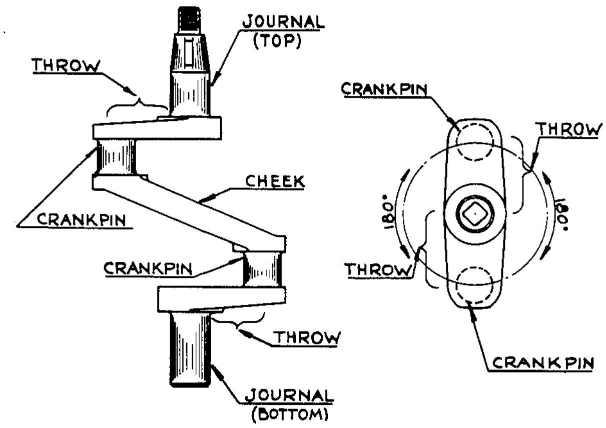
The cheek and crankpin together are referred to as a "throw." In event of but one crankpin, the crankshaft is classified as of "single throw" type.



Drawing of Single Throw Crankshaft—One Crankpin for One Cylinder.

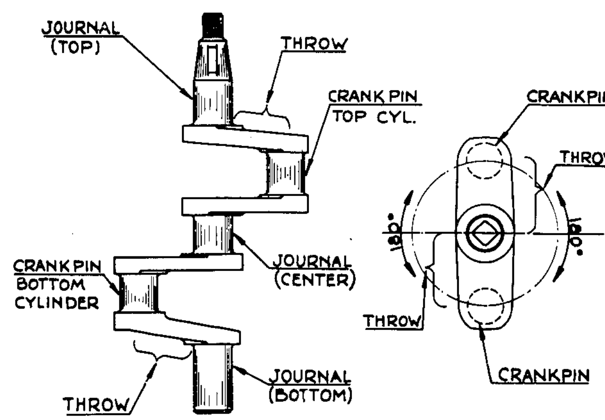
Single throw crankshafts are employed **only** in one cylinder outboard motors, however, are occasionally used in twin cylinder four (stroke) cycle engines. (Two crankpins in same plane.)

Single throw crankshafts must be counter-balanced to offset weight of the cheeks, crankpin and connecting rod to avoid excessive vibration.



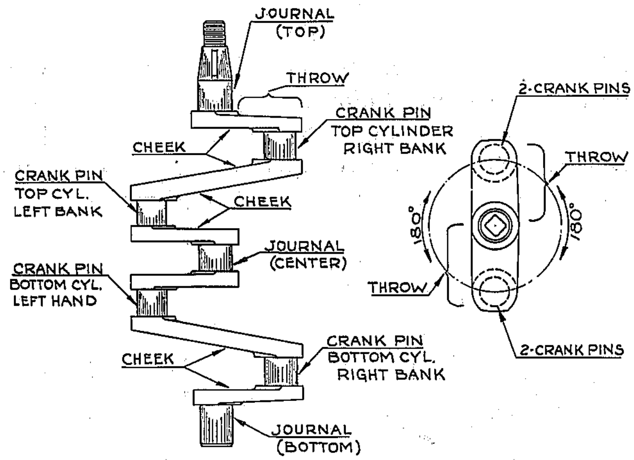
Drawing of Two-Throw Crankshaft (Two Crankpins Spaced 180° Apart) as Used in Twin Opposed Motor.

Two-throw crankshafts are used in construction of twin cylinder **opposed** and **alternate** firing motors also in four cylinder outboard motors except that two crankpins arranged in pairs, are spaced 180° apart.



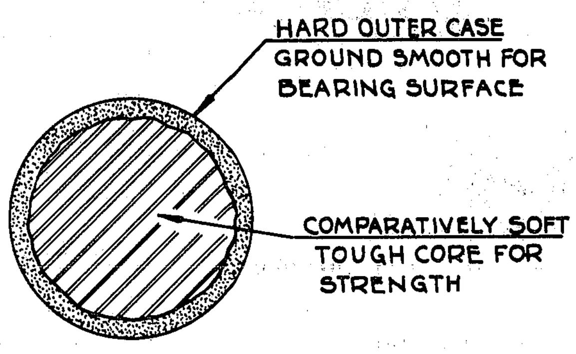
Drawing of the Two-Throw Crankshaft (Two Crankpins Spaced 180° Apart) as Employed in Alternate Firing Twins.

Crankshafts are machined from steel forgings —first turned to approximate dimension (journals and crankpins) followed by heat treating and final grind to finish size.



Drawing of Two-Throw Crankshaft (Two Pairs of Crankpins Spaced 180° Apart).

In preparation for heat treating, the cheeks or webs, threaded end of the crankshaft and a narrow area about the flywheel keyway are copperized. The crankshaft is then put to "soak" in a carburizing vat, that is, packed in a substance of high carbon content (charred bone or other substance, etc.). "Soaking" is accomplished under comparatively high temperature, during which time carbon emitted from the carburizing material penetrates or "soaks" into the uncoppered surfaces of the journals and crankpins. Depth of penetration is dependent on temperature and length of "soaking" period. On conclusion of pre-determined "soaking" period (time), the crankshaft is removed "red hot" from the vat and quenched to harden the carbon penetrated surfaces. This process of heat treatment is known as case hardening.



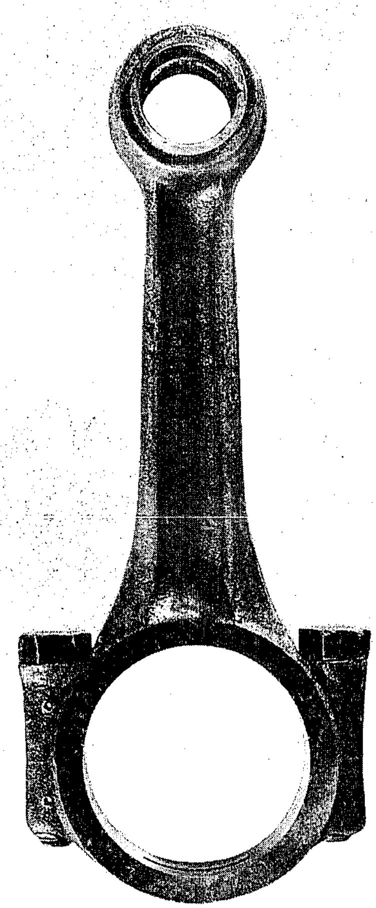
Schematic Drawing (Cross Section) to Show Character of Case Hardened Shaft.

The more modern method of case hardening for this purpose, however, employs the use of a carburizing oil, rather than charred bone, etc., to better control uniformity of carburization, depth of penetration and to reduce time of "soaking" period —a matter of importance in present day production. Carburizing in this instance is actually accomplished by soaking in vaporized carburizing oil.

As mentioned previously, only the bearing surfaces (journals and crankpins) require case hardening to withstand bearing loads. Since there is tendency towards brittleness in a hardened surface, remaining portions of the crankshaft are left comparatively soft and tough to carry the full load. This includes core of the journals and crankpin, cheeks or webs, threaded end of the crankshaft and a restricted area about the flywheel keyway, which are copper plated prior to carburizing. Carbon does not penetrate the copper plated areas during carburizing period, thus, are not materially affected (hardened) during quenching procedure but remain relatively soft and tough as required to withstand various degrees of distortion (bending-twisting) without cracking or breaking as result of effects caused by the power impulses and rate of rotation.

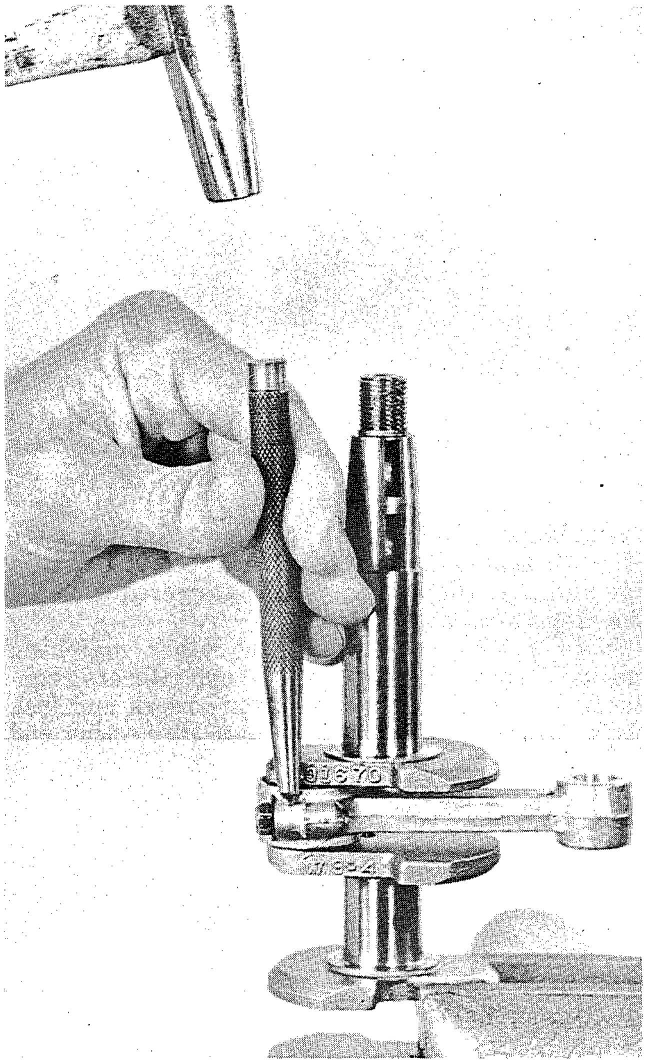
DETACHING CONNECTING ROD FROM CRANKPIN

When detaching the piston-connecting rod assembly from the crankshaft, it will be seen in many instances that the connecting rod and cap are marked or indexed with either a prick punch mark or a small elongated boss. The purpose of this marking is to indicate position of original assembly and to guide the repairman with respect to replacing the cap in its original position on the rod. (Index marks appear on one side only.)



Showing Index Marks on Connecting Rod and Cap. When Correctly Assembled Both Marks are in Alignment as Shown Above.

In the event no index marks appear on the rod or cap, make it a point to provide the indexes before removing the cap—on either a new rod or prior to removing rod assembly from the motor.



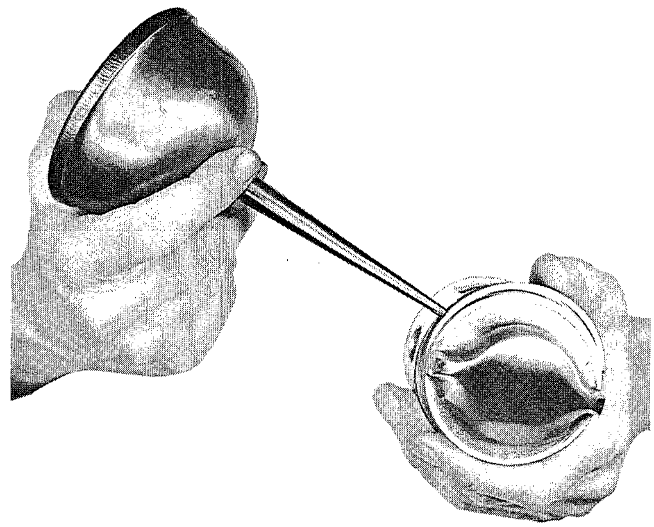
Crankshaft and Connecting Rod Only Mounted in Vise to Illustrate Procedure for Marking Connecting Rod and Cap.

This is important since the rod and cap are machined as a matched assembly and fit properly only when matched as to original assembly. Use a small prick punch to mark or index the rod and cap. Do not strike punch too hard—the rod and cap can be damaged.

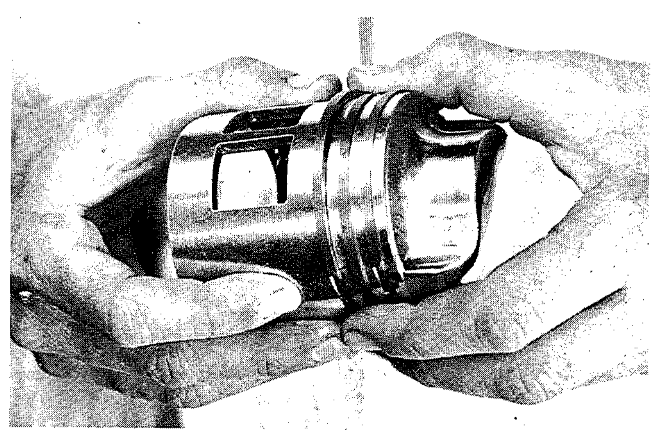
INSTALLING CONNECTING ROD-PISTON ASSEMBLY

Make certain that all parts involved in the assembly are clean—bearing surfaces, piston ring grooves and cylinder walls coated with oil to guard against abrasion or scuffing until normal lubrication takes place during operation of the motor.

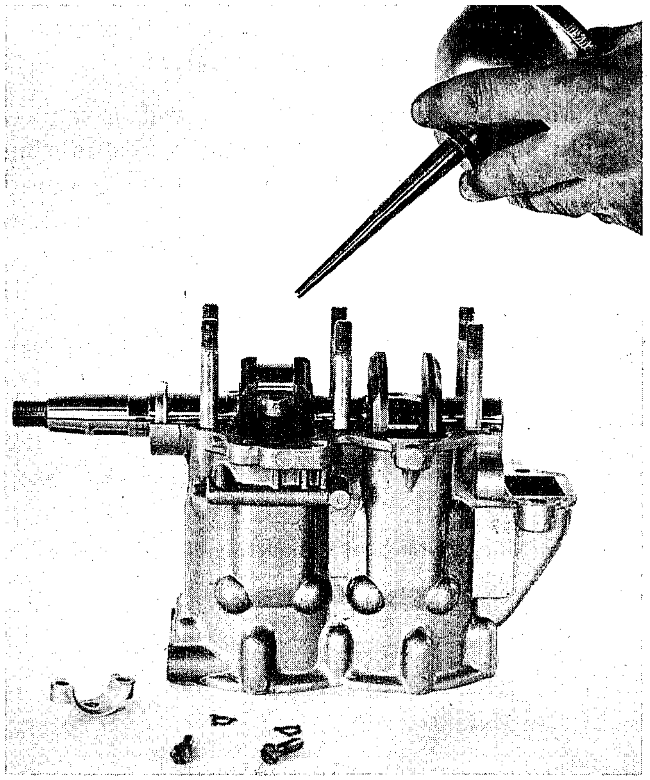
Piston Ring, Piston and Connecting Rod Assembly.



Coat Piston Rings and Ring Grooves Liberally With Oil.



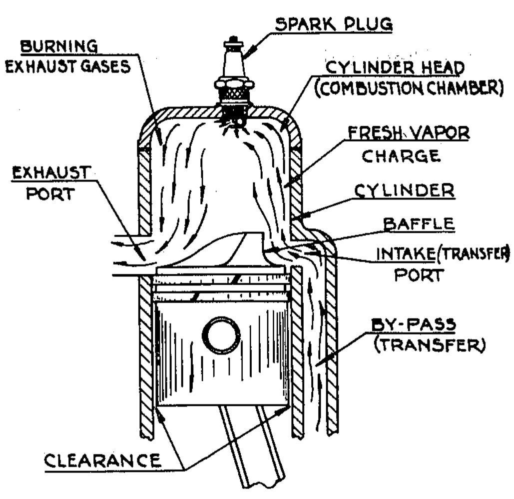
Spread Oil by Turning Rings back and Forth in Piston Ring Grooves.



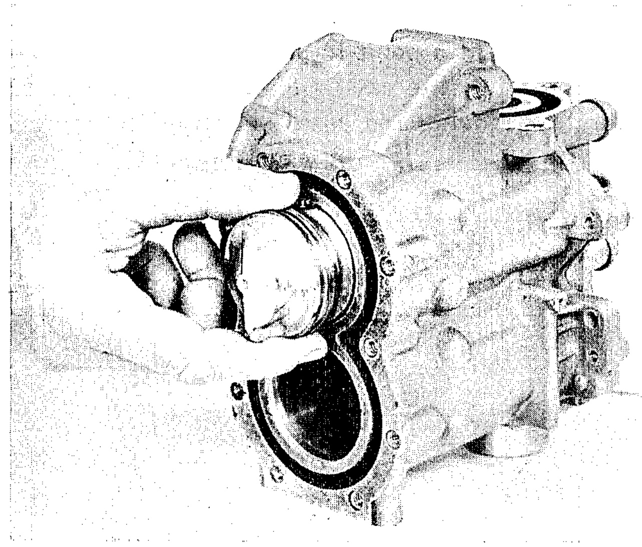
Oiling Crankpin and Connecting Rod Prior to Final Installation of the Rod. This is Important. Rod Should Not be Installed Dry.

See that the piston is arranged with relation to position of the intake (transfer) port — straight side of baffle adjacent to it. Insert piston into the cylinder accordingly, if cylinder block and upper half of crankcase are integral parts. Otherwise, note position of port and straight side of baffle and assemble later in like fashion.

The piston rings, of course, must be compressed before the piston assembly can be fully inserted in



Schematic Drawing to Indicate Staggered Position of Piston Ring Gaps, Piston Clearance and Correct Position of Piston Baffle with Respect to the Intake (Transfer) Port–Straight Side of the Baffle Must be Directed toward the Intake (Transfer) Port to Insure Maximum Performance and Ease of Starting. This is Important.

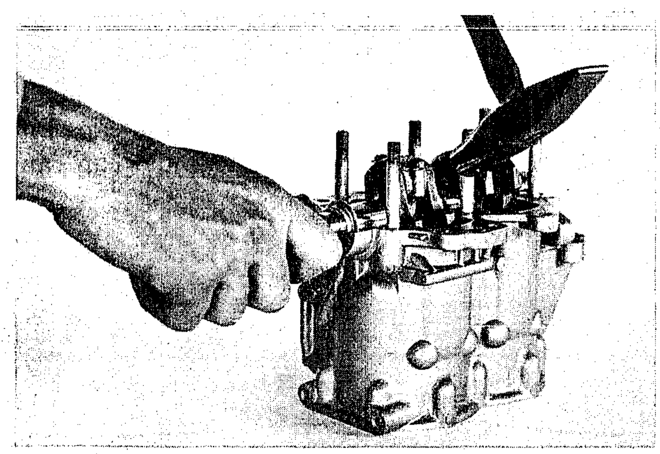


Direct Straight Side of Baffle (Piston) toward Intake Port When Installing Piston.

the cylinder. Be careful to see that the rings are properly seated in the ring grooves, to avoid breakage and that the ring gaps are staggered in event the rings are not "pinned."

Note prick punch marks or other matching marks on the connecting rod and cap. Observe condition of connecting rod bolts or screws and lock plates—replace if necessary. Place connecting rod carefully in position on the crankpin—install the cap, with match or index mark to match like marking on the rod. This is important to insure proper bearing surface.

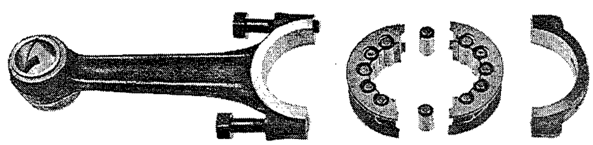
Place **new** lock plates on connecting rod screws, then bolt rod and cap together. Draw down snugly, being careful not to overdo to result in stripping of the threads. Strike sides of rod and cap lightly with small hammer if there is slight evidence of binding, to obtain final bearing seat. Do not strike aluminum rod too hard—if light tapping does not free it, look for other possible causes of binding—foreign particles on crankpin, etc.



Strike Side of Connecting Rod Lightly to Obtain Final Alignment of Rod and Cap.

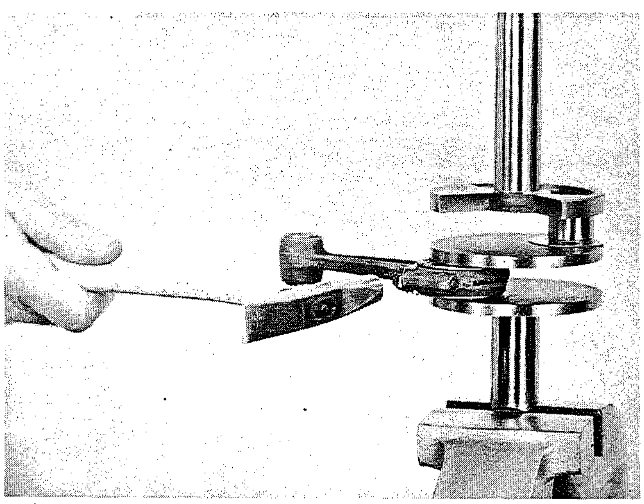
Check bolts or screws for tightness—bend two lugs of the lockplate down over the rod, the remaining one up firmly against the head of the bolt to prevent its turning. (Some instances require bending only one lug—up against the bolt.)

In event of roller bearings, proceed in like manner except that roller and retainer assemblies are installed on the crankpin prior to attaching the connecting rod cap.

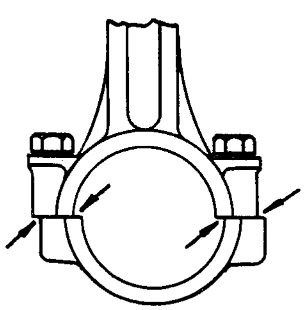


Connecting Rod and Roller Bearing Assembly.

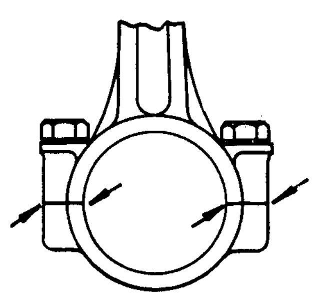
Arrange cap in position to permit match marks aligning (on same side of the rod). Install new lockplates on connecting rod screws and bolt cap firmly into position. Strike sides of the rod lightly with a hammer as shown here, to even up or align. Then draw pencil over edge surface (both sides of the rod) to make certain both rod and cap align at this juncture. If not aligned, offset edge can be felt in the pencil point.



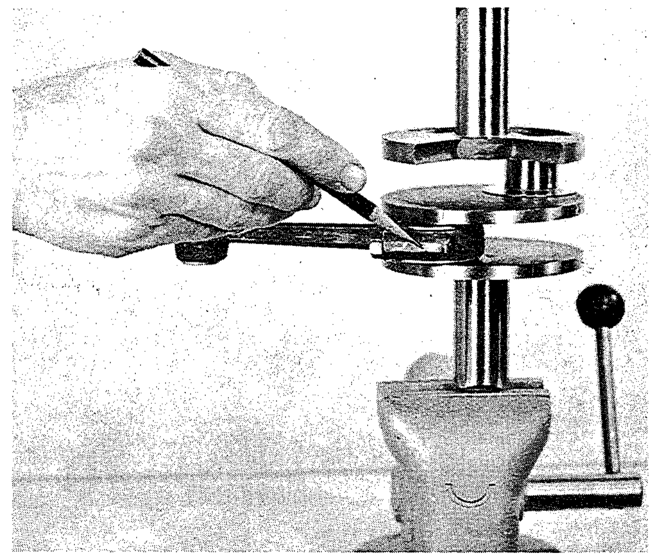
Crankshaft and Connecting Rod Only Mounted in Vise to Illustrate Method of Aligning Rod and Cap.



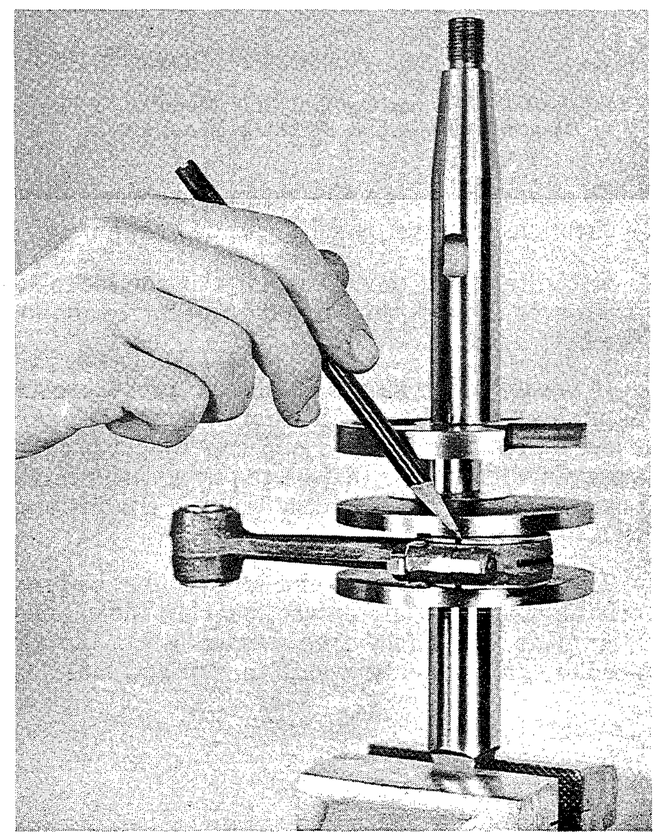
Incorrect.



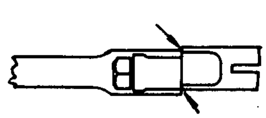
Correct.



Crankshaft and Connecting Rod Only Mounted in Vise to Illustrate Rod and Cap (Side) for Proper Alignment. See Drawing.



Crankshaft and Connecting Rod Only Mounted in Vise to Illustrate Checking of Rod and Cap for Alignment. See Drawing.



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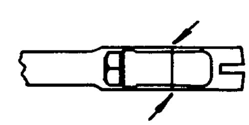
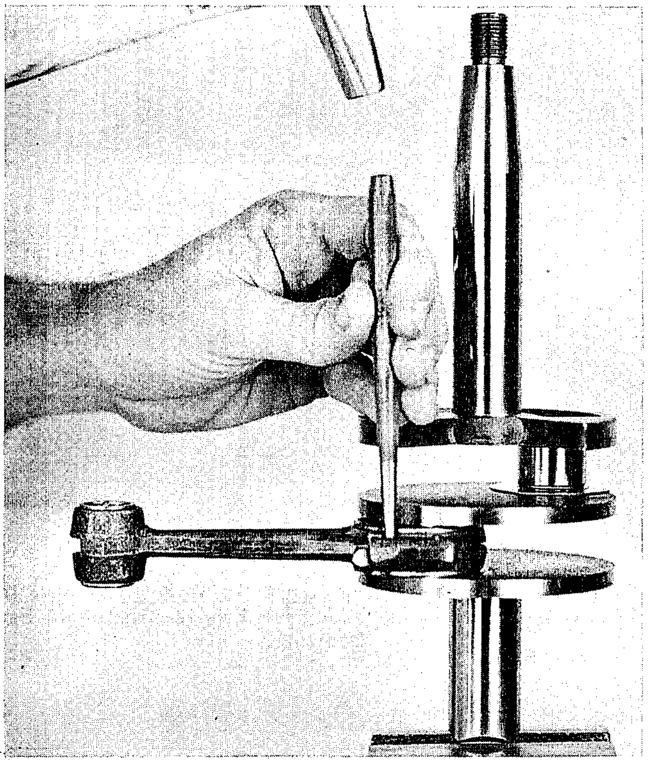


Correct.



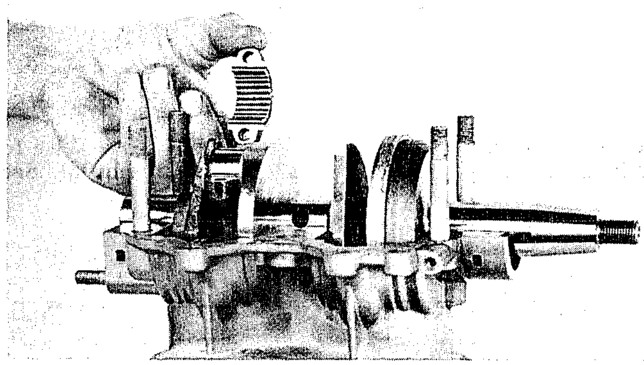
Crankshaft and Connecting Rod Only Mounted in Vise to Illustrate Method of Aligning Rod and Cap.

To align, drive high side down to properly align —check again with pencil to assure alignment.

Retighten bolts, bend two lugs of the lockplate down over the rod, the third lug up snugly against the bolt head.

If needle bearings are employed, procedure for assembly is identical with that where rollers are used, except that the rod and cap should both be smeared with grease (clean) to temporarily retain position of the needles while making the installation.

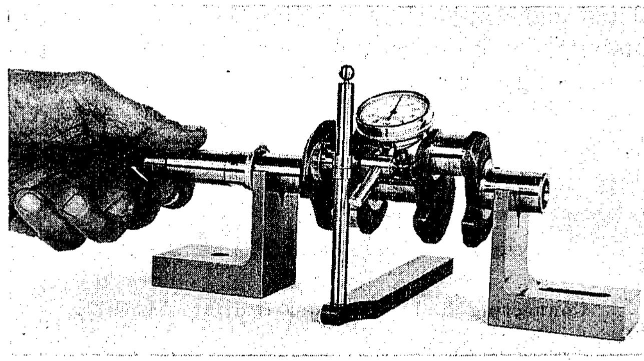
The rod and cap (sides and edges) must be properly aligned to assure correct bearing faces—misalignment will affect free normal action of the needles, and possibly result in damage later on.



Attaching Connecting Rod Cap to Rod. Needles Held in Place by a Thin Coating of Grease.

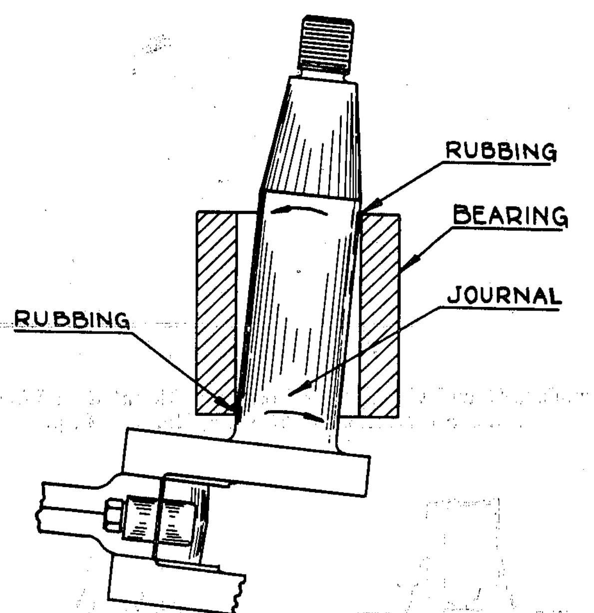
STRAIGHTENING THE CRANKSHAFT

Crankshafts have been known to be "sprung" (crooked) which requires an aligning or straightening operation to restore them to serviceable condition.



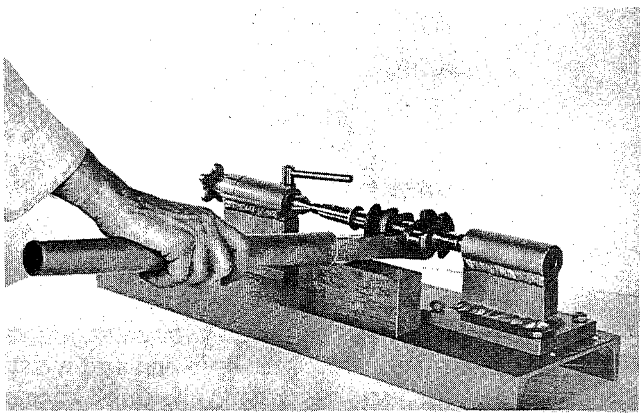
Checking Crankshaft for Straightness with Dial Gauge. Note—While All Crankshafts Are Provided with Centers, Some Are Centerless Ground Which Makes Checking on "V" Blocks Rather Than between Centers Imperative. Mark High Side with Chalk to Guide in Straightening.

It can be readily understood that a sprung or bent crankshaft cannot be properly aligned in the crankcase, with regard to journal bearing alignment. Bent or sprung crankshafts wobble in the bearings, to result in excessive drag by rubbing on the bearing wall, thus creating high bearing temperature and binding to interfere with normal motor operation.



Drawing to Illustrate Condition Created by a Bent or Sprung Crankshaft.

In this event, response to spark advance and throttle (butterfly-shutter) opening will be sluggish—top recommended r.p.m.'s falling off as temperature rises with running of the motor. If but slightly sprung, the motor can be started with no special difficulty and run at top speed but only until running temperature is reached when the crankshaft journals expand enough to rub against the bearing wall to cause slowing down. While running at reduced speed, temperature drops (motor cools off), and crankshaft journals "shrink" to free the bearings. The result is rapid acceleration of motor speed, lasting only until the motor "heats" up again to be followed by a repeat performance.



Straightening Sprung Crankshaft – Observe Position of Chalk Mark (High), Spring Crankshaft Slightly in Opposite Direction. Check with Dial Gauge (on "V" Blocks). Proceed in This Manner Until Proper Alignment is Achieved. Use Leather or Copper Strip Attached to Straightening Bar to Prevent Injury to Crankshaft Journals during Alignment Operation.

There is a limit, however, to extent of "straightening." If the crankshaft is bent or sprung through accident or otherwise, in excess of .015″ (indicated on dial gauge) no attempt should be made to straighten—discard and install new shaft. There is danger of creating small cracks, possibly resulting in breakage and serious damage later on.

SHOP CLEANLINESS — ORDERLINESS

A clean, orderly shop pays dividends — it makes an impression on the customer and good impressions on his part, which are frequently related to others by word of mouth, are indirectly profitable to operator. The customer expects his motor to be repaired with the same careful degree of "exactness" exhibited in a well arranged and orderly shop — shop conditions generally convey (to the customer) expressions of the shop keeper.

MOTOR TROUBLE SIMILARITIES

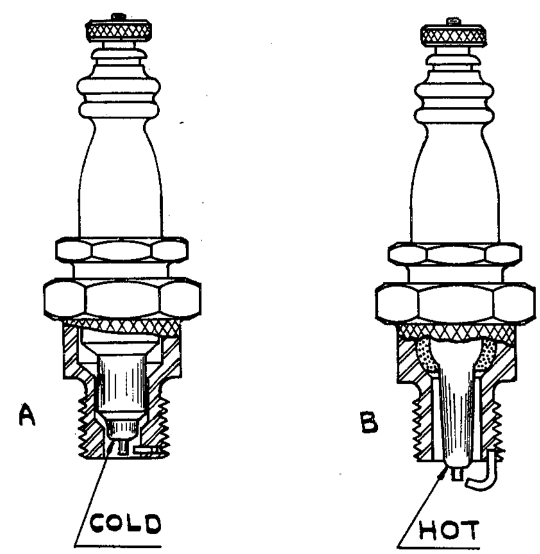
Four (4) irregularities (conditions) produce similar results in motor performance; namely,

1. Incorrect spark plug—too hot for the particular installation.
2. Vapor lock.
3. Insufficient clearance in bearings (slightly undersize), between piston and cylinder wall, piston ring gap or groove clearance and/or tight bearing fits (also gear mesh) in the gearcase.
4. Bent crankshaft—bent or twisted connecting rod.

Uneven running, that is, alternately **fast** and **slow** is or can be caused by any of the above singularly or in combination.

1. If the spark plug is "too hot" for the particular model, there is evidence of slowing down because of pre-ignition taking place as motor reaches running temperature.

Reduced r.p.m.'s, because of pre-ignition, cause temperature to fall—consequently, the plug cools off and functions normally again to permit motor "picking" up speed. However, with increased motor speed, temperature increases (the motor gets hotter) to cause the plug to overheat again. Result is repeat performance of pre-ignition and drop in r.p.m.'s. Solution: Install plug recommended for the model. If the plug is correct, "hunt" down possible causes for overheating.

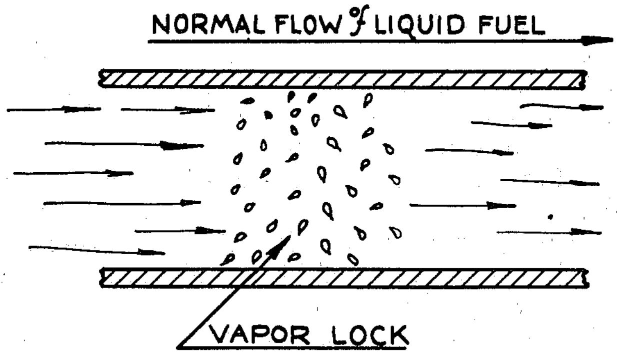


A–Cold Plug
Cold Plug–Low Insulator Seat Quickly Carries Heat from Core to Result in a Cold Plug.

B–Hot Plug
Hot Plug–High Insulator Seat Permits Core to Retain Maximum Amount of Heat to Result in a Hot Plug.

2. In event of fuel boiling (vapor lock) in the gas line or carburetor passages, the motor simply slows down for want of fuel (starved). During temporary reduction in motor speed (r.p.m.'s), operating temperature falls (the motor gets cooler), fuel stops boiling (vapor lock broken) and flows

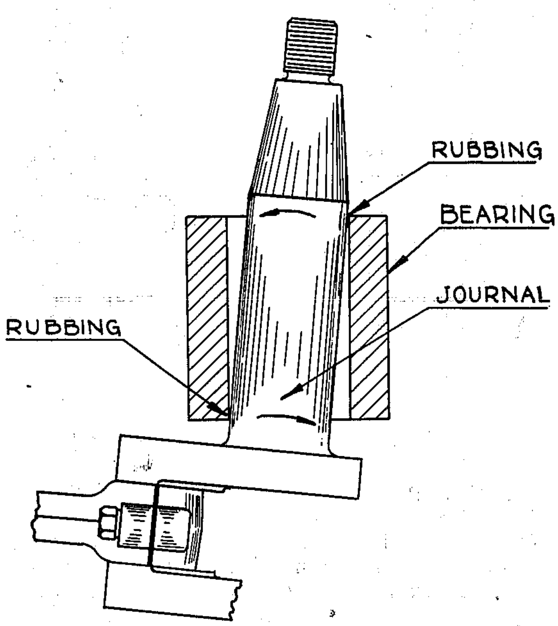
normally again to result in accelerated motor speed. As temperature rises with resulting increased r.p.m.'s, a repeat performance of the above condition appears—fuel boils to cause another vapor lock, and so on.



3. Every part of the motor assembly expands proportionately with degree of temperature rise—aluminum and bronze expanding more than cast iron or steel. As previously mentioned, the purpose of clearance between bearing surfaces is two-fold —(1) to make allowances for expansion and (2) to provide ample space for lubrication (oil film).

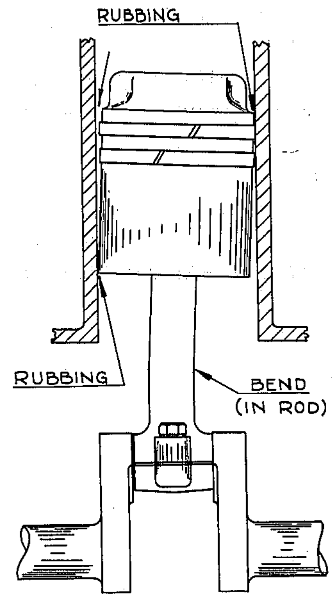
If clearance is insufficient, the oil, so to speak, is "squeezed" out and the bearing surfaces rub to create friction and subsequently heat. Added load, because of friction, causes motor r.p.m. to fall off.

4. Bent crankshafts, bent or twisted connecting rods produce like conditions even though bearing clearances are correct. Example: The journal of

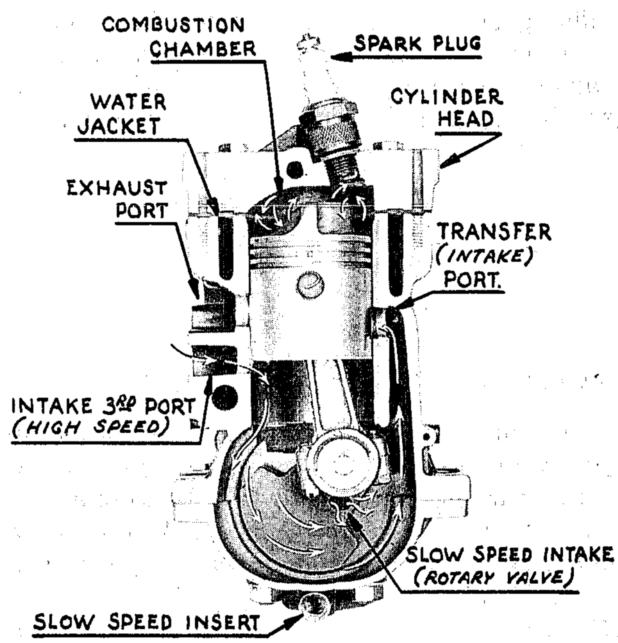


a bent crankshaft rubs on one side of the bottom edge of the bearing and on the opposite side of the top edge in a wobbling fashion, to create friction. Solution: Straighten or replace crankshaft.

Similar conditions are produced by a bent connecting rod.

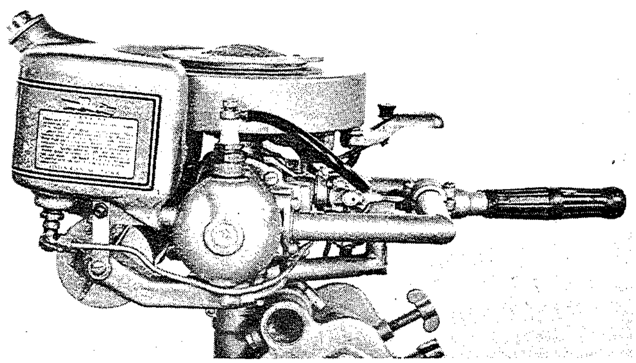


A twisted connecting rod (even though straight with relation to plane of the crankpin end and wrist pin) creates friction and results in "clicking" knock during operation of the motor. Actually the piston twists first in one direction (corkscrews), then the other as it travels up and down in the cylinder, producing a click at the bottom of the stroke on changing direction of twisting and another at the top of the stroke for like reason. (Under certain conditions, the crankshaft can be noted to "jump" up and down if the connecting rod is twisted, to likewise result in "knock," particularly at slow speeds.) Solution: Align rod or replace.



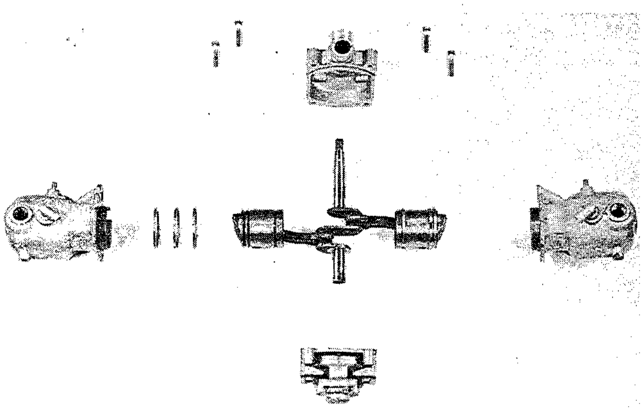
Top Sectional View of Power Head Showing Piston Up and Movement of Vapor Charge

OPPOSED FIRING TWINS AND EARLY MODEL SINGLES

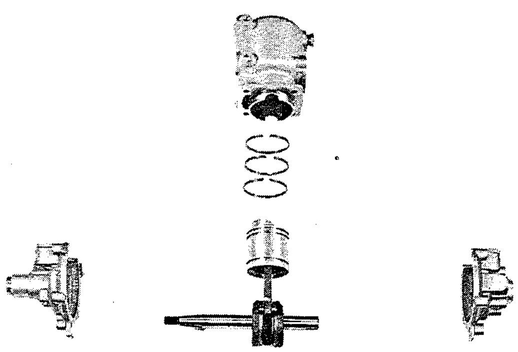


Light Twin—Opposed Firing—Power Head

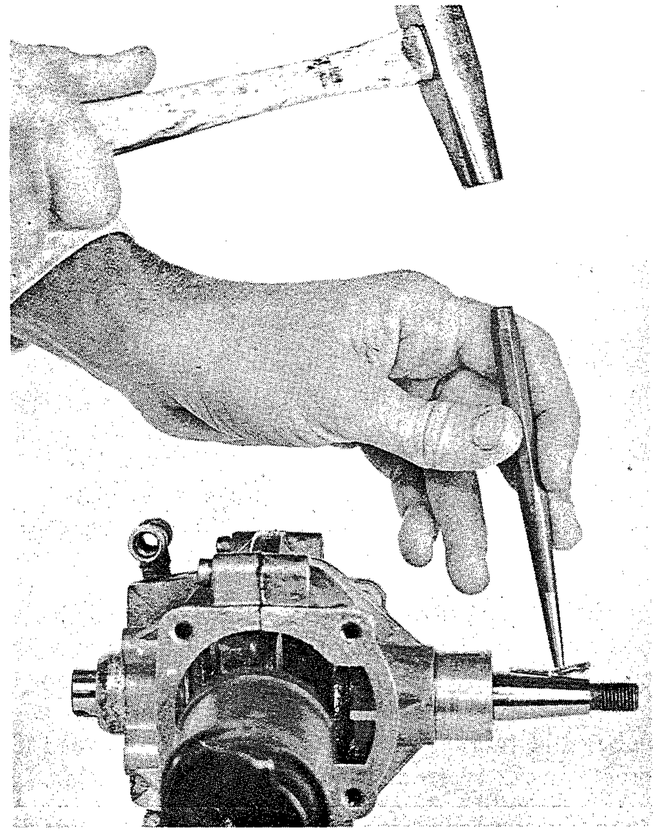
Since all of the older twin (opposed firing) power heads were practically alike in construction, the following instructions with respect to assembly and repair will be sufficient to cover basic detail of all—Models A, A-25-35-45, K-35-40-45, P-30-35-40-45, OA-55, 60-65, OK-55, 60-75, F-70-75, 200, 210 and the J and 100 series singles. In all instances, nevertheless, exercise extreme care in assembly. Make certain that all functional parts are in proper alignment and fitted with correct clearances.



General Layout of Opposed Firing Twin Parts —Gaskets Not Included

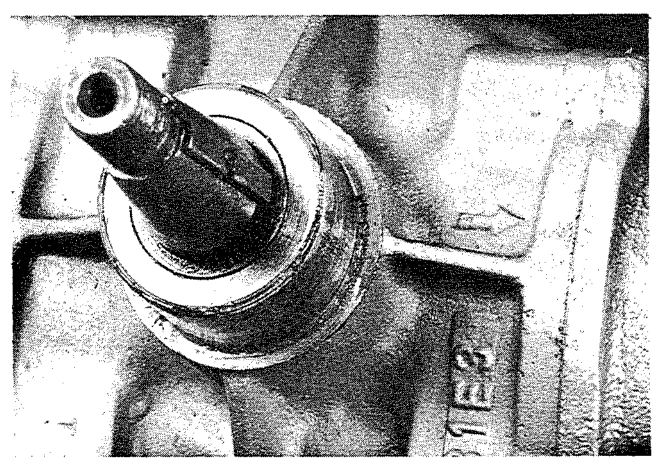


Illustrating Single Cylinder Assembly Layout —Gaskets Omitted



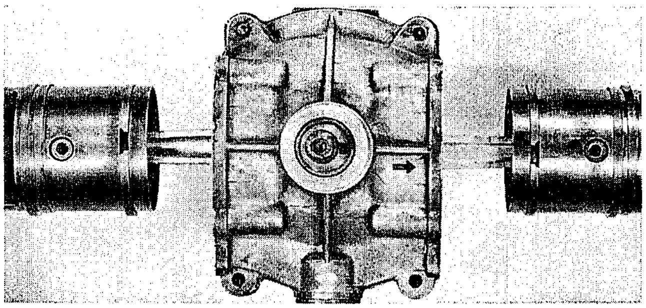
Illustrating Procedure for Driving out Crankshaft Keys—Support End of Shaft if Keys are Snugly Imbedded. Keys Must be Removed Prior to Disassembling the Crankcase.

When preparing to install crankshaft, piston and connecting rod assembly in the crankcase, note small "arrow" embossed on the top half, then arrange the assembly in such a manner that the pistons will extend outwardly (top dead center) when the keys in the taper of the crankshaft and the arrow on the crankcase line up.



Showing Flywheel Keys Imbedded in Keyway in Tapered End of the Crankshaft and Arrow Embossed on Crankcase

It is possible to make this assembly with the pistons set at the bottom of its stroke by simply swinging the piston-rod assembly around 180° from top center, but in this instance, position of the pistons is "out of time" with relation to spark —spark occurring then at the bottom of the stroke rather than at the top as it should. Pistons must

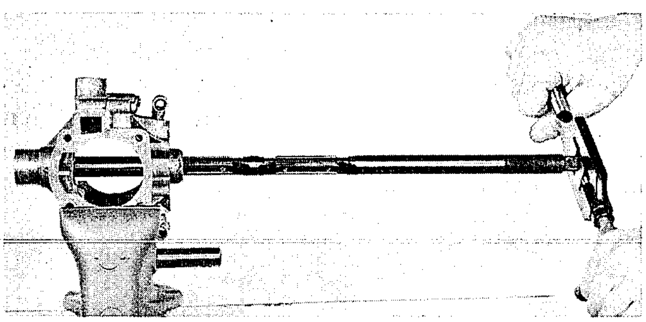


Illustrating Correct Position of Pistons (at top of stroke) with Respect to Arrow Embossed on the Crankcase and Position of the Keyway in the Crankshaft

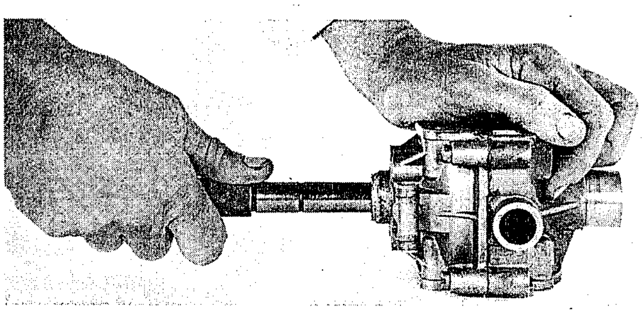
be out (at top center) when keys in the crankshaft and arrow on the crankcase align if the motor is to function at all. Breaker points are timed to open in vicinity of top dead center (allowances for advance and retard)—the motor cannot be started if points break when pistons are at bottom center.

Straight side of piston deflector must be directed toward the intake port in the cylinder — sloping side towards the exhaust port.

Avoid misalignments and misfits, both of which cause binding or stiffness of the power head to create excessive "drag" and faulty operation. Tight

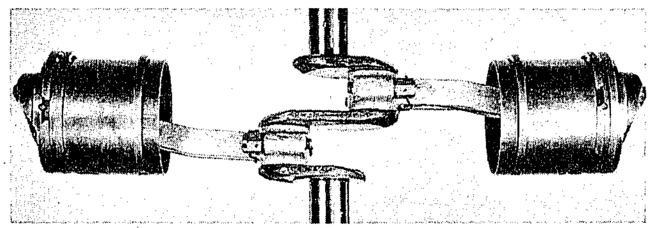


Illustrating Manner of Reaming Journal Bearings



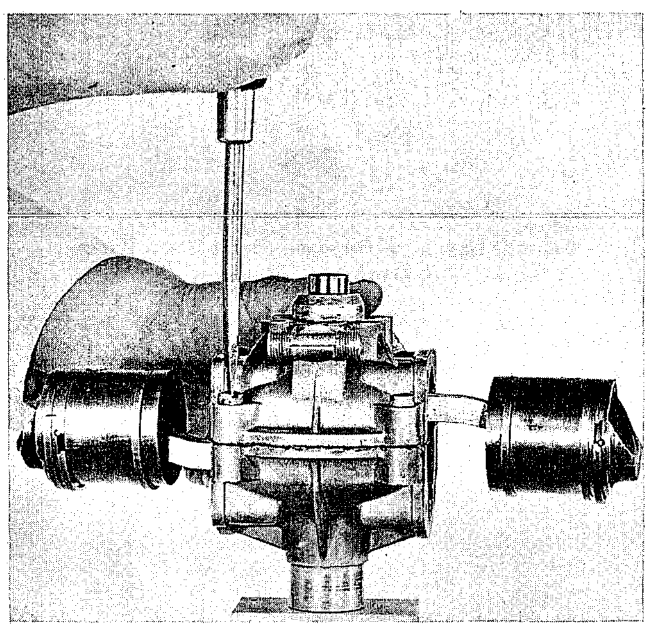
Checking Alignment of Journal Bearings After Reaming

fits or misalignments cannot be overcome by running the motor in — proper alignment and correct clearances must be established during assembly procedure. The power head assembly must be "free" with no indication of "tight" spots (misalignment) or "binding" (improper clearances) if it is to function as it should. The assembly should be free enough to rock against compression—there should be a reasonable amount of "free" end-play in the crankshaft in all positions, which can be determined by lifting up and down on the crankshaft. In event end-play is free in one position and tight in another, the cause invariably can be laid to bent or twisted connecting rods.

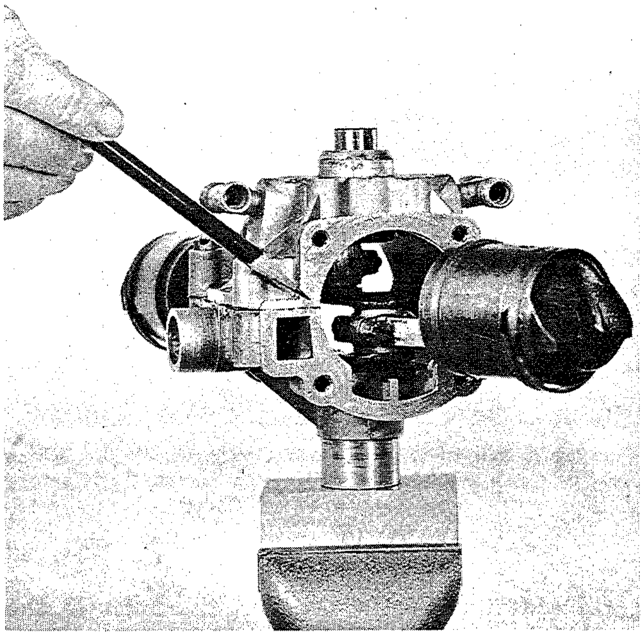


Opposed Firing Twin Crankshaft, Connecting Rod and Piston Assembly

If the crankshaft and connecting rods are straight (no binding — no twisting) and if the bearings, pistons and piston rings are fitted with correct clearances, the power head should be free of all binding or "drag" to permit maximum performance, providing the exhaust and intake ports (cylinder) and ring grooves are free of carbon as well as muffler outlets and that cylinders, pistons and piston rings are not excessively worn or scored.

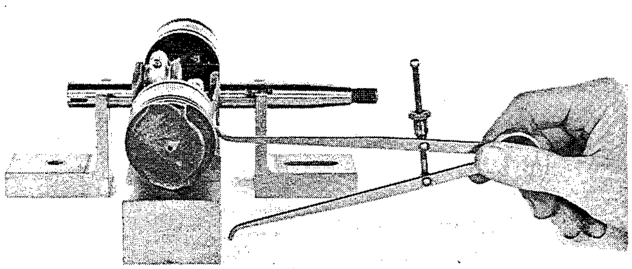


Drawing up Crankcase Screws Prior to Making Finally Secure. Check Cylinder Mounting Locations for Alignment as Illustrated Below.

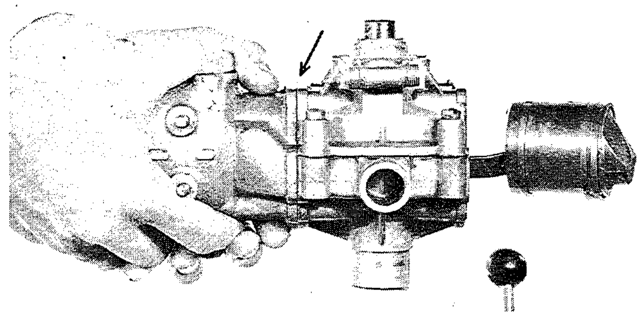


Checking Crankcase Halves (Cylinder Mounting Face) for Alignment with Pencil Point. Juncture at this Point Must be Flush. In Event One Side or the Other is High, Drive Down Carefully with Rawhide Mallet. When Flush, Drive Screws Down Securely. (Note—Gasket is Required Between Crankcase Sections)

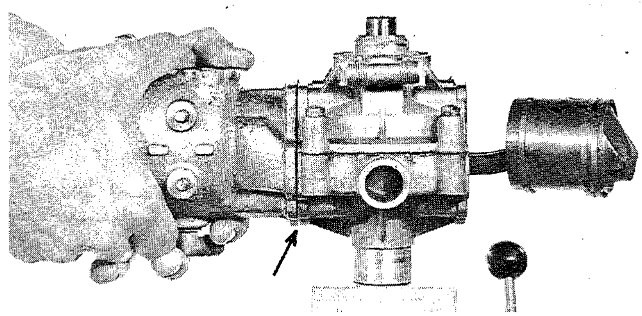
As mentioned earlier, excessively worn cylinder walls, pistons and piston rings contribute to loss of compression and subsequently, proportionate loss of power, hard starting and faulty operation. Carbon clogged ring grooves cause the piston rings to become partially inactive to result in "blow-by", loss of compression and power. The rings must be "free" in their respective ring grooves to properly seal.



To Check Connecting Rods for Twist—Place Crankshaft, Connecting Rod and Piston Assembly Between Centers in a Lathe or in V Blocks as Shown Above. Rest Pistons on Flat Surface in Such a Manner as to Permit Measuring Distance Between Wrist Pin Hole and Surface Plate with Inside Caliper. If the Connecting Rod is Straight (not twisted), Distance on Both Sides of the Piston will be Found to be Equal. Otherwise, if the Distance is Greater on One Side than the Other, a Twist Prevails. To Straighten, grasp the Connecting Rod I Beam Section Between the Jaws of a Wrench then Twist Either Way as Required to Straighten. Recheck with Caliper as Above.



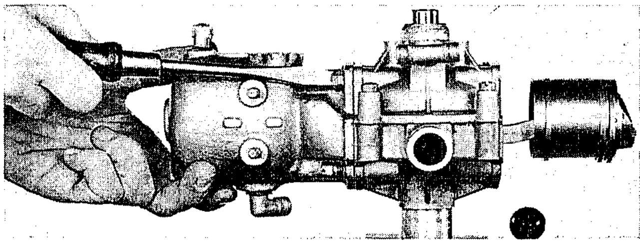
To Check Alignment of Connecting Rod (Piston Rings and Gaskets Removed), Install Cylinder as Shown, Hold Bottom of the Cylinder Base Firmly Against the Crankcase then Bear Down Lightly on the Cylinder with a "Cocking" Motion and Note Width of Gap thus Created Between Top of Cylinder Base and the Crankcase, Indicated by Arrow. See Following Illustration.



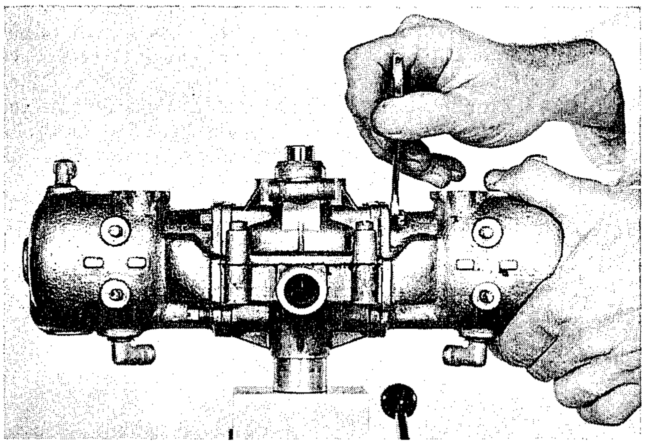
Proceed in Manner Similar to that Described Above, Except that Contact Should be Made Between the Top of the Cylinder Base and the Crankcase and that Pressure Should be Exerted Upward to Create a Gap Between the Bottom of the Cylinder Base and the Crankcase, Indicated by Arrow. Compare Width of Gap Created by Both Conditions. If Equal the Rod Can be Assumed to be Reasonably Straight and in Proper Alignment. If One Gap Created in this Manner is Greater than the other the Rod is Proportionately Out of Line and Should be Straightened. This can Easily be Accomplished by Bearing Down or Lifting up on the Cylinder as the Case May Require, thus Bending Rod One Way or the Other Until Gaps at Top and Bottom are Equal.

Cylinder walls wear in various degrees, depending on lubrication and generally conditions under which the motors are operated. Major portion of wear, regardless, is in the port area and area covered by ring travel in the cylinder to make the walls "bottle" shaped — hard starting and inefficient performance result.

Carbon accumulation on walls of the exhaust ports and muffler outlets restricts the flow of exhaust gases to have considerable effect on performance of the motor — restricted flow of exhaust gases limits the fresh fuel vapor charge to the cylinder to result in partial efficiency, hard starting, over-heating and otherwise sluggish performance. All exhaust passages must be made free of carbon deposits to obtain maximum performance.

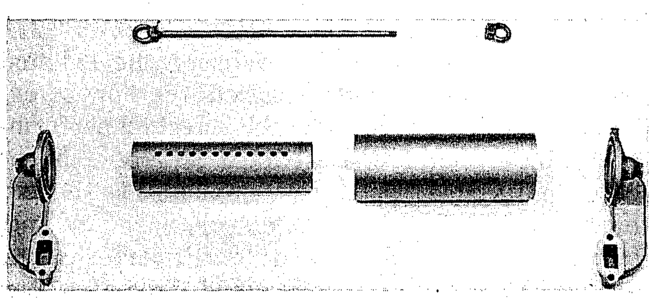


Installing Cylinder Base Screws

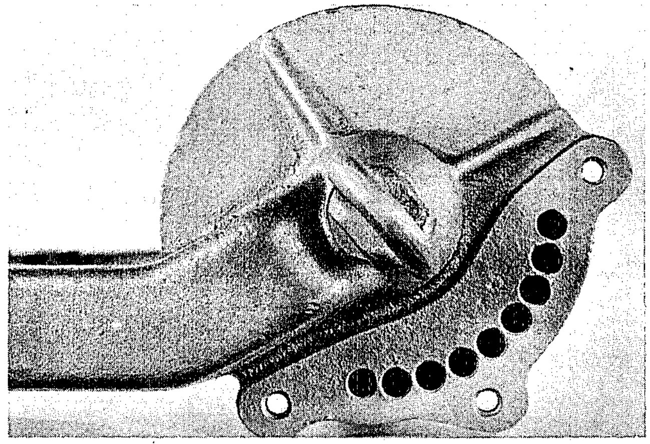


Drawing up Cylinder Base Screws After Having Complete Alignment of the Connecting Rods, Fitting and Installing Piston Rings and Necessary Gaskets

Many of the older mufflers were made up of two exhaust castings (bolted one to each cylinder) and an inner and outer shell — fitted and bolted together between the exhaust castings to make up an assembly. Purpose of the muffler is to control expansion rate of the hot gases as they leave the exhaust ports and thereby reduce the report (noise) of the rapidly expanding gases (hot) as they reach the atmosphere. The inner shell, of course, is cylindrical and includes a series of holes running the entire length of one side— the outer shell may be cylindrical or rectangular in shape, generally provided with no outlets, final exhaust being through a series of small holes drilled in one of the exhaust castings. All exhaust outlets (holes) must be free of carbon and inner walls of the exhaust castings, likewise free of carbon to guard against restriction in flow of the hot exhaust gases —the muffler assembly otherwise would function as a choke.

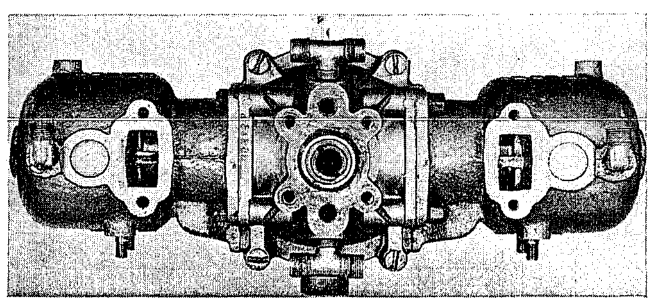


Layout of Muffler Parts



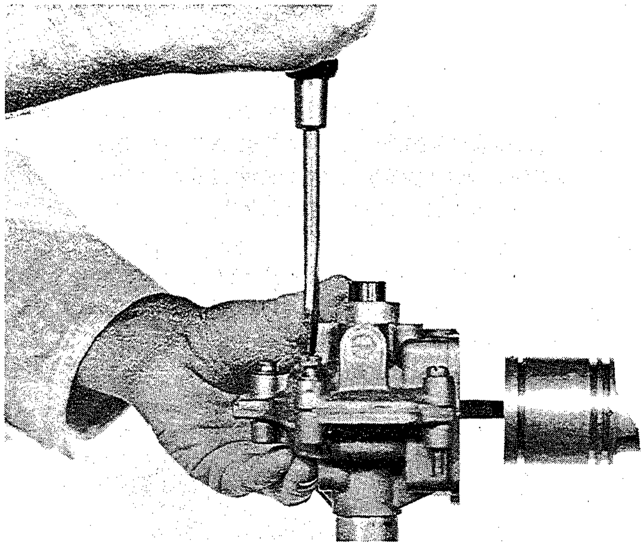
Showing Exhaust Outlet Holes in Casting of Muffler Which Must be Open and Free of Carbon to Realize Satisfactory Performance of the Motor

On assembly of the muffler, the holes in the wall of the inner shell must be directed down and away from the motor to obtain best results. If the inner shell is installed with the holes directed "upward", excessive heat is generated on the top side of the muffler, immediately under the "gas tank"—heat at this point causes the fuel in the tank to overheat and boil to result ultimately in vapor lock. Identical conditions are produced if the gas line is set too near the exhaust casting. Thus, to avoid vapor lock, make certain the holes in the inner shell are directed **down** and **away** from the motor and that there is no leakage (of exhaust gases) between the outer shell and exhaust castings to play upon the bottom side of the gas tank; also, keep gas line at a respectable distance from the hot exhaust casting.

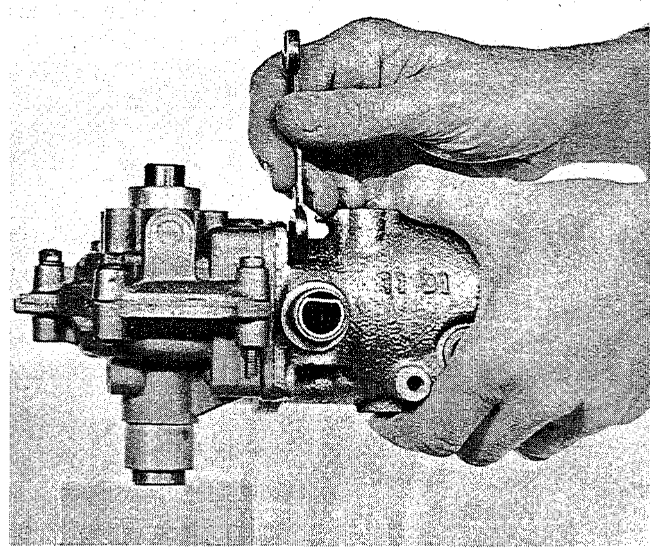


Showing Exhaust Ports in Cylinder and Muffler Mounting Locations

Portside is left with respect to direction of boat travel: starboard is right with respect to direction of boat travel. Port cylinder thus is left cylinder with operator facing direction of boat travel (operator's back to motor); star (board) cylinder is right from same position.



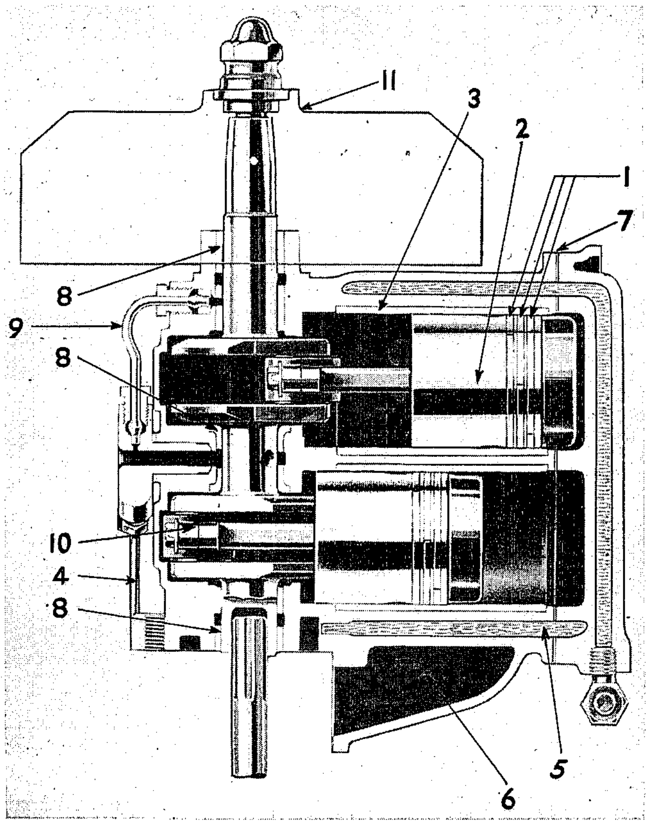
Drawing up or Removing Crankcase Screws, Screws Should Be Drawn up Evenly and Securely on Assembly with Gaskets Carefully Installed



Drawing up Cylinder Base Screws

NOTES

POWER HEAD H MODELS



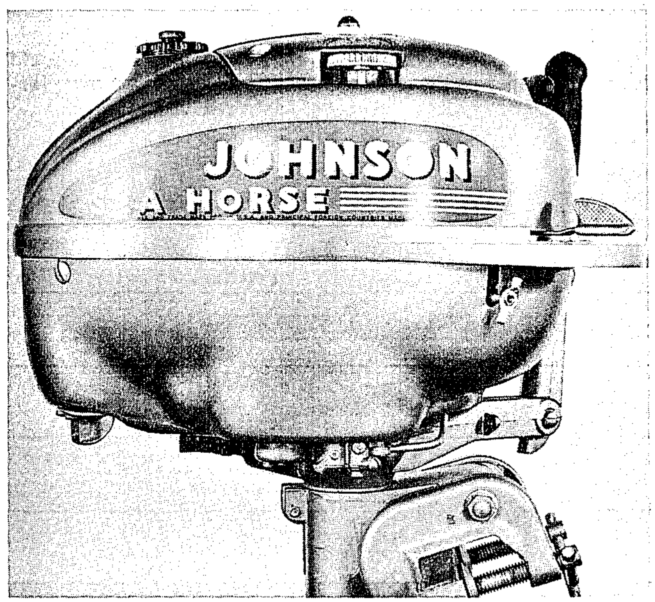
Power Head Assembly

POWER HEAD—SERVICE SUGGESTIONS

1. Piston rings—worn or fast in ring grooves, resulting in loss of compression. (Ring grooves may be clogged with carbon causing rings to stick.)
2. Piston—worn or scored.
3. Cylinder — worn or scored, causing loss of compression.
4. Low speed needle—improperly adjusted, needle and seat in low speed insert may be damaged beyond point where satisfactory adjustment can be obtained. This frequently results from screwing needle down too tightly on seat.
5. Water jacket—clogged with foreign matter, causing motor to overheat.
6. Exhaust passage—clogged with carbon to restrict flow of exhaust gases — will cause loss of power and motor to overheat.
7. Cylinder head gasket—leaking or blown out —cause water to enter or motor to overheat.
8. Journal bearings—excessively worn, causing loss of crankcase compression.

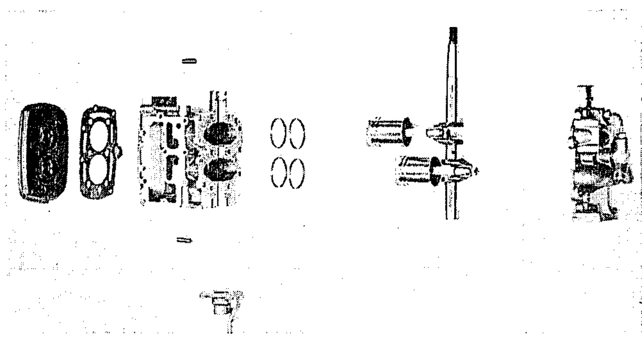
NOTE: Journal bearings are cast in the cylinder-crankcase assembly and, therefore, not replaceable. If bearings are worn to point where replacement is required, it is necessary to install a new cylinder-crankcase assembly. Crankshaft journals and bearings in cylinder-crankcase assembly are machined to such sizes as to permit bearing clearance of .001″ to .002″. Excessive journal bearing wear results in loss of crankcase compression and is indicated by oil smearing on magneto armature plate.

9. Oil return—clogged, causing excess oil to escape from bearing.
10. Connecting rod bearing—loose, causing motor to knock.
11. Flywheel—loose, causing motor to knock. Tighten flywheel nut.



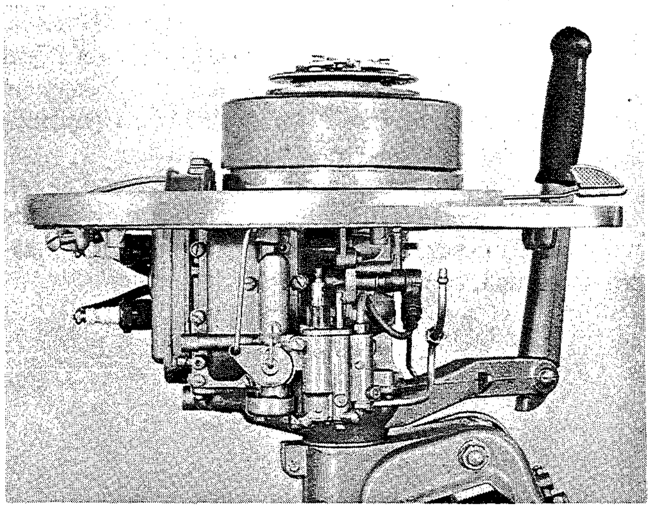
Model HD Power Head

Like service performed on any mechanical device, details of disassembly and final assembly (with necessary replacement parts installed) must be carefully thought out prior to actual procedure if the job is to be well done and with a minimum of



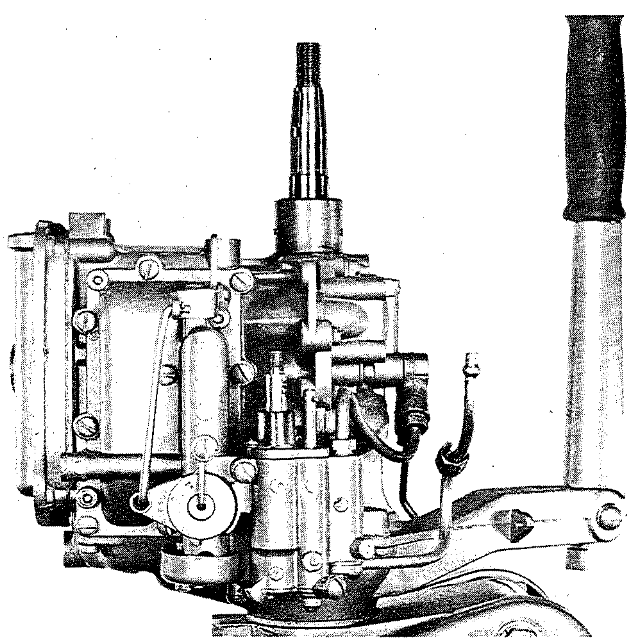
H Power Head Assembly Layout

effort. Observe first construction and assembly of the unit, then establish order of disassembly—provide ample space (on a bench) for parts to be removed and proceed with the operation. Start out with clean tools and a clean bench top—avoid possibility of mixing parts of one assembly with like parts of another. Use small trays or pans for removed parts.



Showing Ready-Pull, Gas Tank and Shroud Removed

In the case of Models H or M power heads—first, remove the ready-pull starter assembly (if provided) to be followed by removal of the shroud and gas tank. Remove next the flywheel (magnet rotor if provided) and armature plate, followed by removal of the carburetor and manifold assembly. Remove cylinder head carefully.



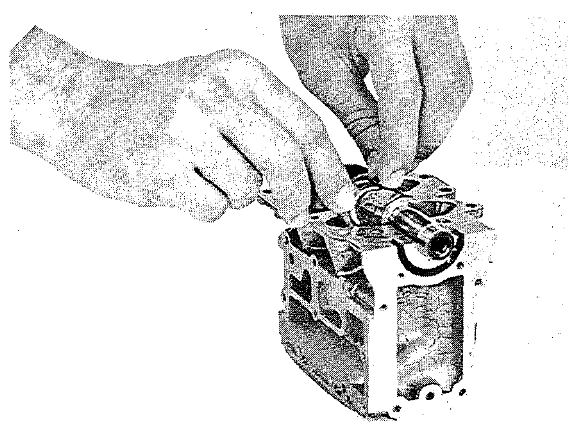
Showing Ready-Pull, Gas Tank, Tank Bracket, Shroud and Magneto Removed for Final Disassembly

Detach power head from the driveshaft casing—lift power head assembly from driveshaft casing and place on clean bench top. Remove screws holding crankcase fast to cylinder block. Drive out tapered pins aligning crank sections. The crankshaft and connecting rod assemblies are now accessible for removal.

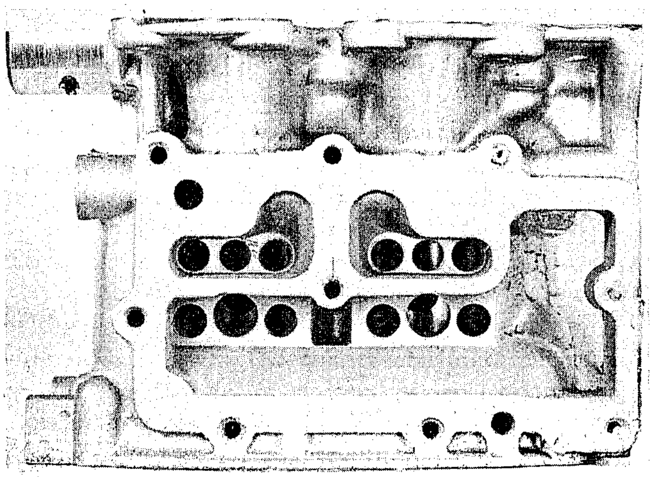
Bend small lug, resting against one side of the connecting rod to prevent its turning, away from screw head. Note markings on rod and cap—if no markings appear, carefully prick punch rod and cap (one side only) of each rod assembly to permit aligning on reassembly. Remove screws holding cap fast to rod—lift caps free of connecting rods, being careful not to mix caps or screws (caps and screws must later be reinstalled in original positions). Lift crankshaft from block assembly, then push rod and piston assemblies out of their respective cylinder bores, remembering which is top and bottom. Mark with pencil accordingly. Replace caps and screws (loosely) on their respective rods to avoid interchanging later on. Wash all parts of the assembly.

The power head is now completely disassembled for inspection of the functional parts to determine which are to be replaced or what otherwise is to be done to restore it to normal operating condition. The piston rings should be checked as to "freeness" in the ring grooves and for excessive wear (ring seats and ring grooves). The pistons and cylinder walls should be checked for excessive wear (see clearance chart) and arrangements made for installing new pistons, rings and cylinder block (or reconditioning) if necessary. Observe condition of walls of ports in the cylinders to make certain there is no obstruction as result of carbon accumulation—scrape free of port walls.

Check connecting rod wristpin and crankpin fits. Observe general condition of wristpins, crankpins and connecting rod bearings—if badly scored or worn, replace with new parts. To check for exces-

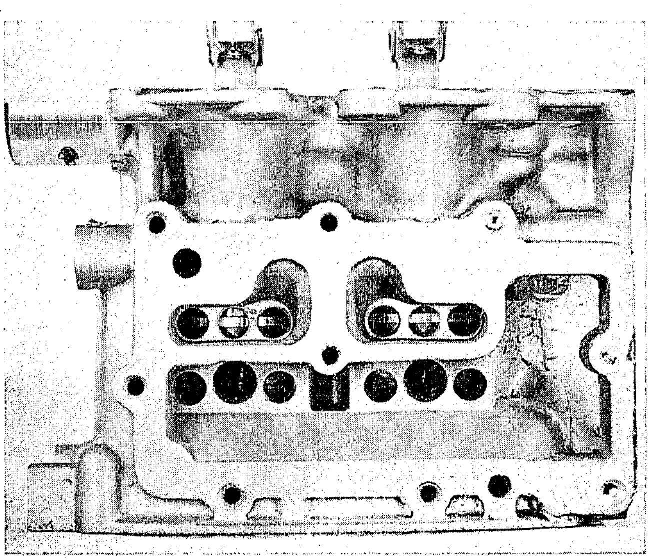


Checking Connecting Rod for Excessive Looseness on the Crankpin sive looseness of the connecting rod on the crankpin, first check to ascertain freeness of the rod on the pin which can be accomplished by exerting up and down motion on the rod at right angle to the crankpin. This operation should indicate normal clearance; however, if excessive clearance (or wear) is evident, it will be found possible to rock the rod from side to side on the pin in a "cocking" motion, as illustrated. Similar procedure can be carried out for wristpin fit. Check connecting rod for straightness. Clean out manifold assembly — check carburetor for functional defects as previously described.



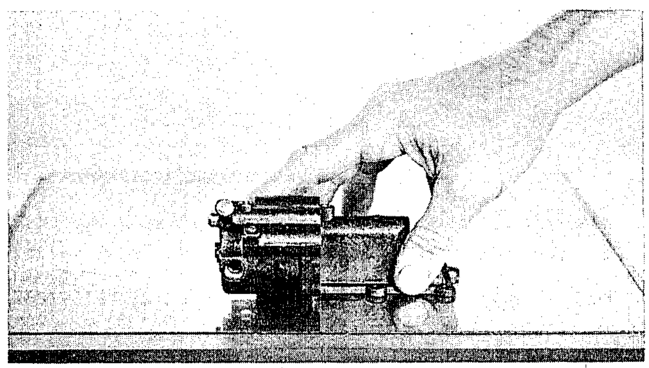
Cylinder Prepared and Ready for Assembly

After having completed inspection of parts to determine their fitness for further use or provided the necessary replacement parts, the power head is ready for assembly. Carefully assemble in order reverse of that described above—be sure all bearings "fit" with proper clearance, including pistons and rings. (Check pistons for roundness. First check for roundness is to insert the piston into its respective cylinder — if there is evidence of tightness or binding, the piston can be assumed to be out of round and should be "trued" up as previously described. Check with micrometer—otherwise if the piston slips into the cylinder freely, further check can be made by inserting a feeler gauge (.001" thick) between the piston and cylinder wall at several points in the circumference. Provide new gaskets but make certain gasket faces have first been cleaned off and are "flat" with no indication of warp. Use Perfect Seal No. 4 (cement —non-drying) on gasket faces.

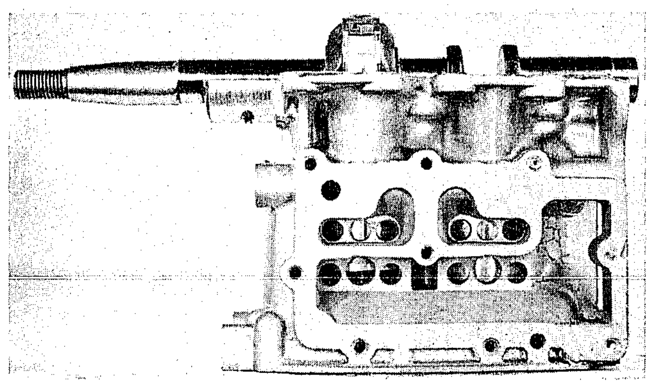


Cylinder Block with Piston and Connecting Rod Assemblies Installed

Work with clean tools, clean parts, a clean bench top and clean hands (free of grit, etc.)—an otherwise good job can be ruined by grit or foreign matter on hands, tools and parts.

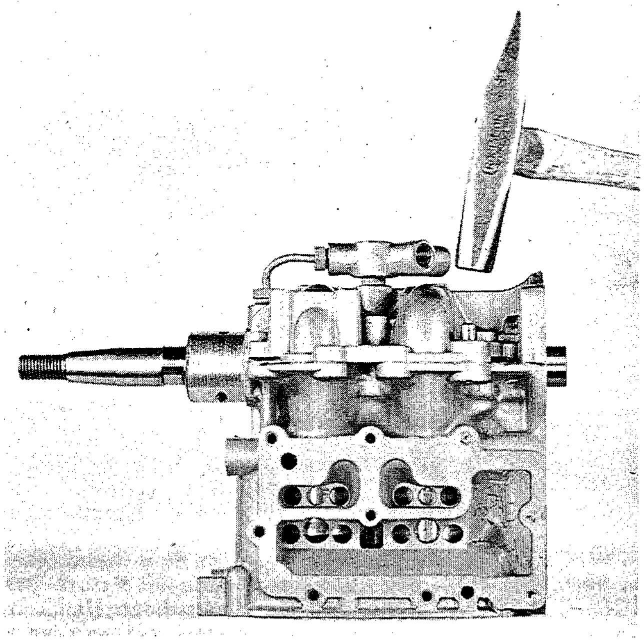


Lapping Manifold Face to Insure its Flatness



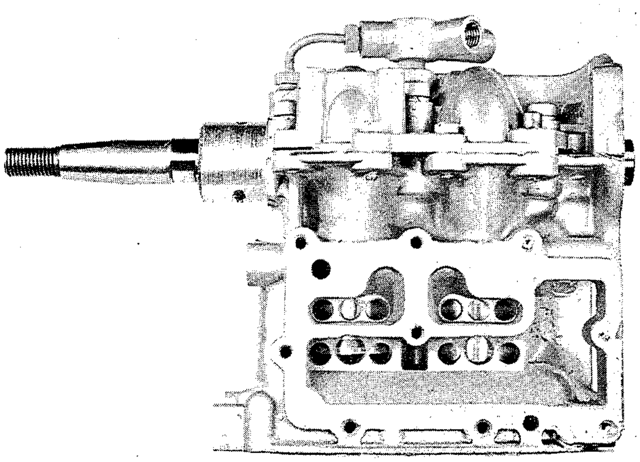
Showing Cylinder Block with Piston-Connecting Rod Assemblies and Crankshaft Installed

Coat all bearing surfaces liberally with clean oil prior to assembly—connecting rod and crankshaft bearings, cylinder walls, ring grooves, etc. Establish order of assembly and proceed accordingly—all assemblies must fit with no degree of tightness. Don't try to force fits—each piece has a definite place in the assembly and if properly installed, will satisfactorily perform its original function.



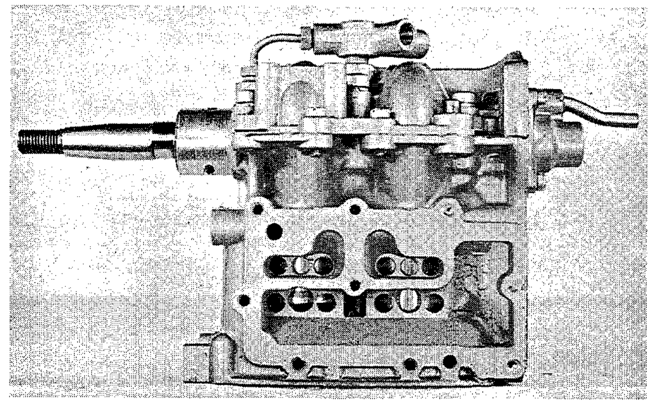
Driving in Tapered Pins to Properly Align Crankcase Section Prior to Bolting Down

Since there are no gaskets between the crankcase, it is extremely important that the top half of the crankcase be thinly coated with cement when assembling. The surfaces, though very accurately machined, must rely on a thin film of cement to guard against loss of crankcase compression. Be careful to guard against possibility of cement smearing on bearing surface under compression as crankcase screws are drawn up.



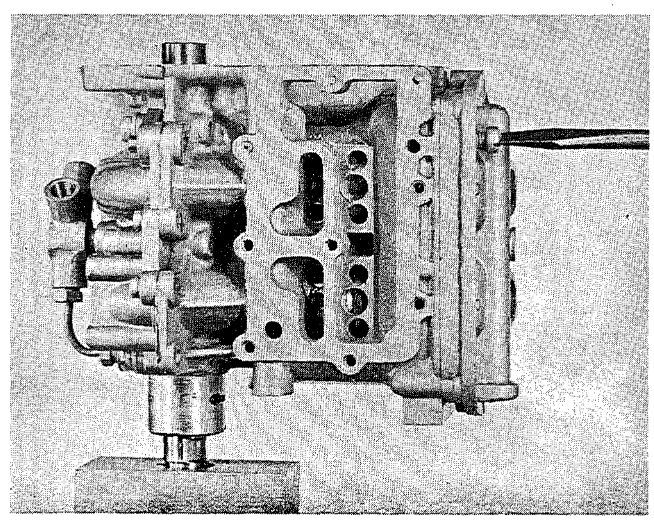
Showing Assembly with Crankcase Aligned and Properly Bolted Down

When assembling, be sure both surfaces are clean and that all traces of old cement have been removed. If the crankcase is assembled with the old cement still remaining and freshly coated with additional cement, bearing clearances are likely to be excessive — this will affect performance of the motor. Correct bearing clearance can be maintained only if, when assembling, the old cement is thoroughly removed and a thin coat of fresh cement applied to the surfaces. DO NOT USE THICK CEMENT. Apply only enough to cover the surfaces —be sure none of the oil passages are obstructed by an over abundance of cement.



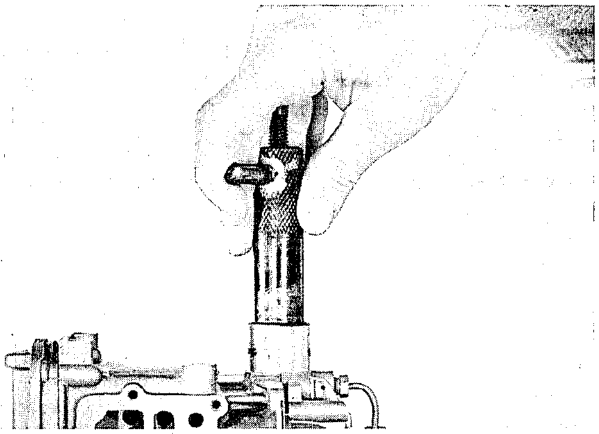
Power Head with Crankcase Cap and Water Outlet Attached

Some gasket cements dry quickly — everything should be in readiness to complete assembly immediately after applying the cement. If permitted to dry before assembling, bearing clearance will be greater than it would have been had the cement been in a fluid state at the time of tightening crankcase bolts.

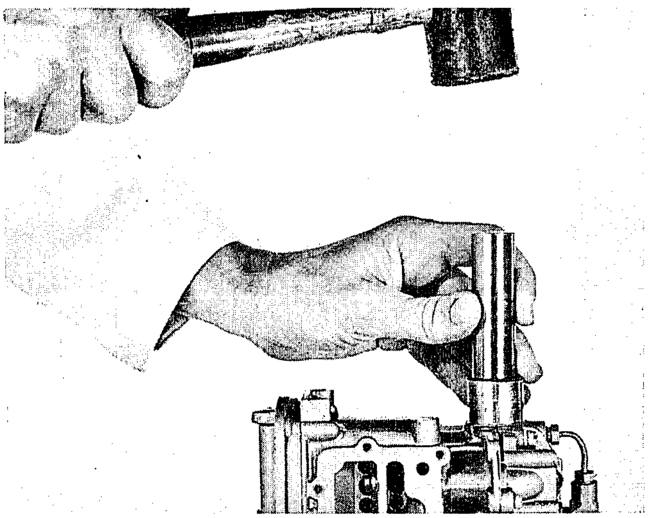


Removing or Installing Cylinder Head

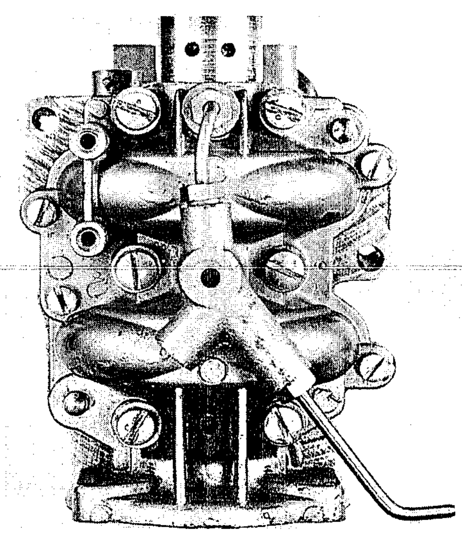
In event the cylinder is removed for inspection of the piston, rings, etc., it will be necessary when disassembling the crankcase to remove the old cement and to apply a fresh coat. Unless the original cement is removed and a fresh coat applied, there is danger of leakage between the halves of the crankcase.



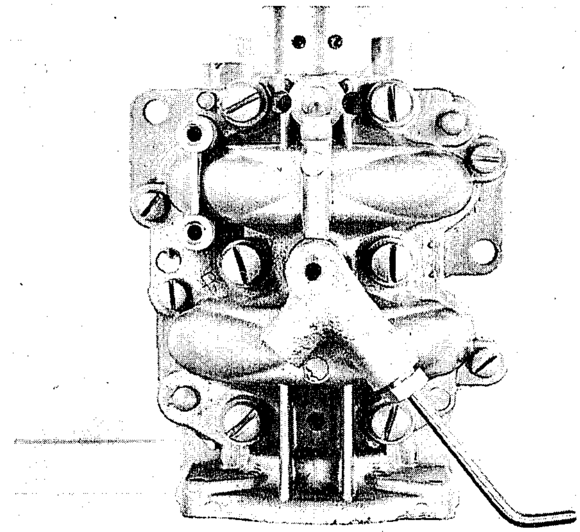
Removing Oil Slinger with Special Tool



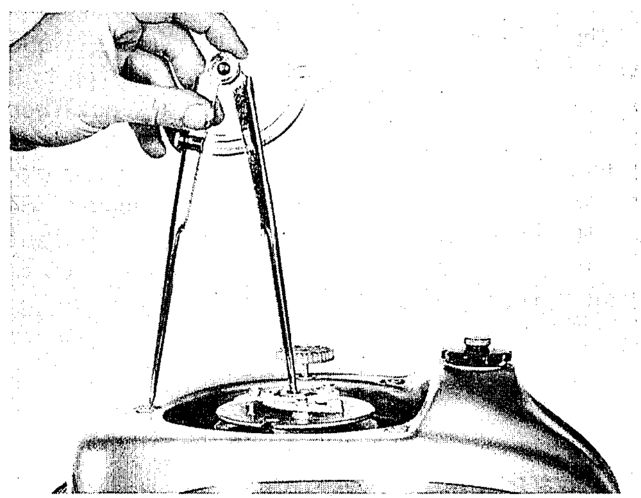
Installing Oil Slinger (Flange Section Down)



Many of the H Cylinder Block and Crankcase Assemblies were not Provided with an Oil Return, the Purpose of which is to Assist in Circulation of Oil Over Surface of the Top Journal Bearing. Oil on Reaching Top of the Bearing is Drawn Off by Suction Created by Action of the Slow Speed Insert, thus Returning Excess Oil to the Crankcase. Outside Piping was Employed to Accomplish this Purpose on Many of the Motors, However Later Production Makes Use of a Cast-in Passage to Perform the Same Function



It Will be Noted that Construction of the Slow Speed Insert is Somewhat Different where the Cast-in Oil Return Passage is Provided in that Outside Piping Connections are Omitted. The Insert Shown in the Assembly Above can be Installed Satisfactorily, However, in Motors of Earlier Production not Equipped with Oil Return

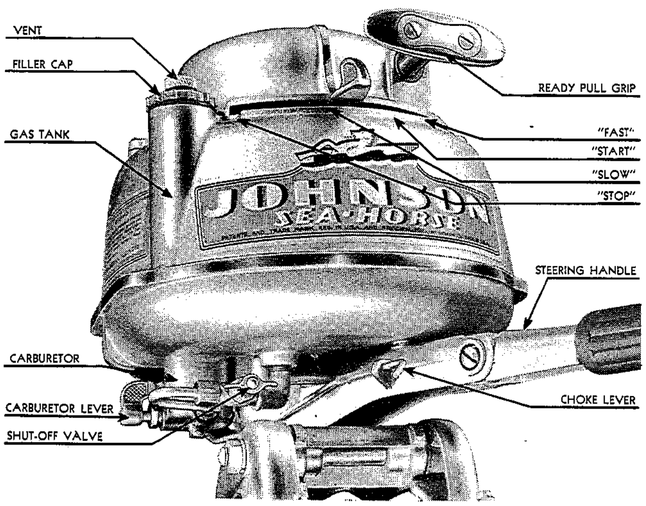


It is Extremely Important that the Gas Tank be Properly Lined up with Respect to the Center of the Crankshaft and Placed at the Correct Elevation to Prevent Mechanism in the Starter Head from Riding Against the Top of the Starter Pawl Plate on the Flywheel

To Check Alignment, Mount Tank in Place on the Bracket—Insert and Draw Up Snugly (not tightly) on the Mounting Screws. Check Position of the Starter Mount Holes in the Tank with Dividers as Shown Above. Holes (in the Tank) Should be Equidistant from the Center of the Crankshaft. In the Event the Tank is Slightly Out of Line, Tap Corresponding Side with Palm of Hand as Required to Obtain Correct Position. Tighten Mounting Screws. Install Starter Head and Check for Freedom of Action by Pulling on Starter Cord. If there are Indications of Rubbing Remove the Tank to Build up Elevation by Placing Flat, Thin Washers as Required Between the Tank and Mounting Bracket, then Proceed as Above Making Certain that the Starter Head Mounting Holes in the Tank are Spaced at Equal Distances from the Center of the Crankshaft. Finally Draw up Securely on Mounting Screws

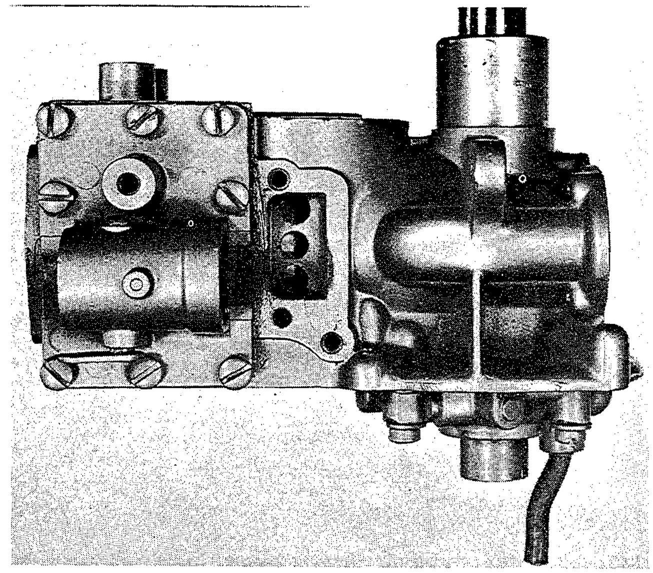
An Improperly Mounted Tank Will Eventually Result in Damage to Starter Parts in Addition to Being Noisy

Service procedure on the "M" power head (single cylinder) is conducted in a fashion similar to that described above—with the same care and degree of exactness, except that the crankcase is not split as can be seen from the following illustration. In this instance, the crankcase is provided with a detachable head which includes the lower journal bearing and water outlet and held fast to the crankcase proper by several screws (gasket between). On assembly, the crankshaft is inserted (tapered end through top journal) into the crankcase which is followed by installation of the crankcase head

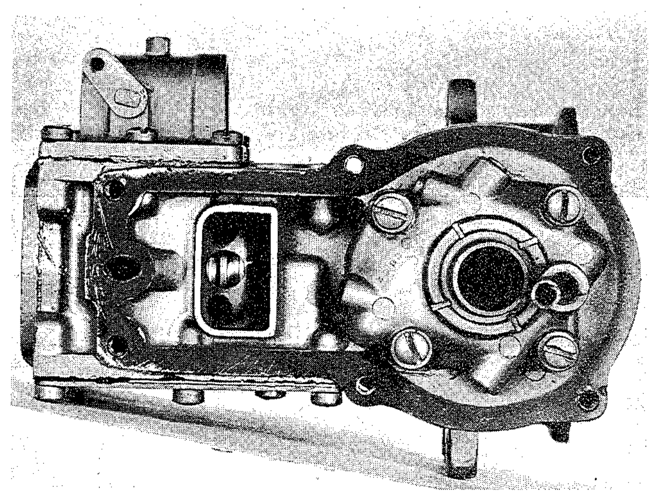


MD Power Head

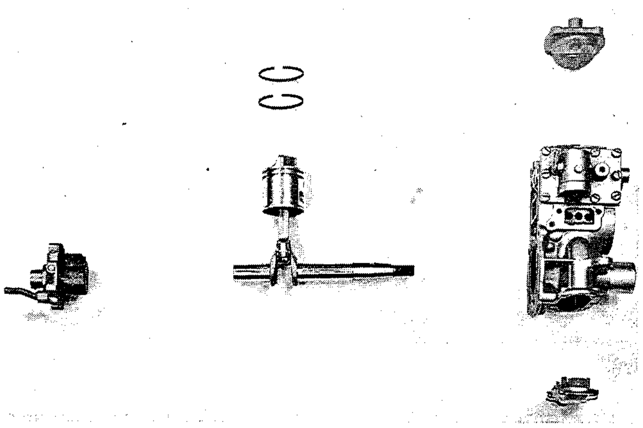
to support both ends of the crankshaft. NOTE: Gasket surfaces must be clean, smooth and flat at this point to prevent "cocking" of the bearing to result in drag on the journal—the gasket likewise must be free of foreign matter for the same reason and coated with cement (preferably Perfect Seal No. 4 or one of similar characteristics) to guard against crankcase leakage.



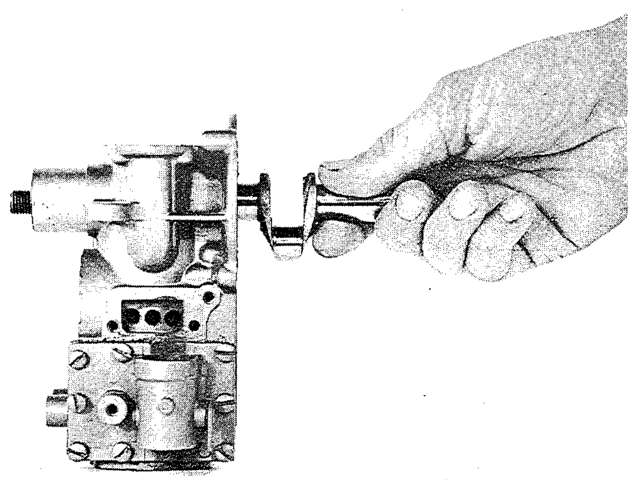
Showing Position of Third Port—Intake to Crankcase



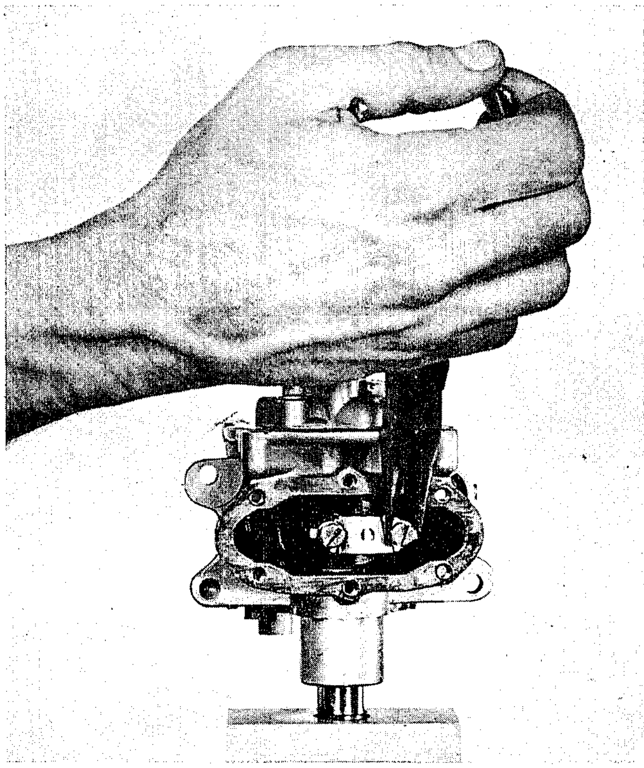
Showing Arrangement of the Exhaust Port



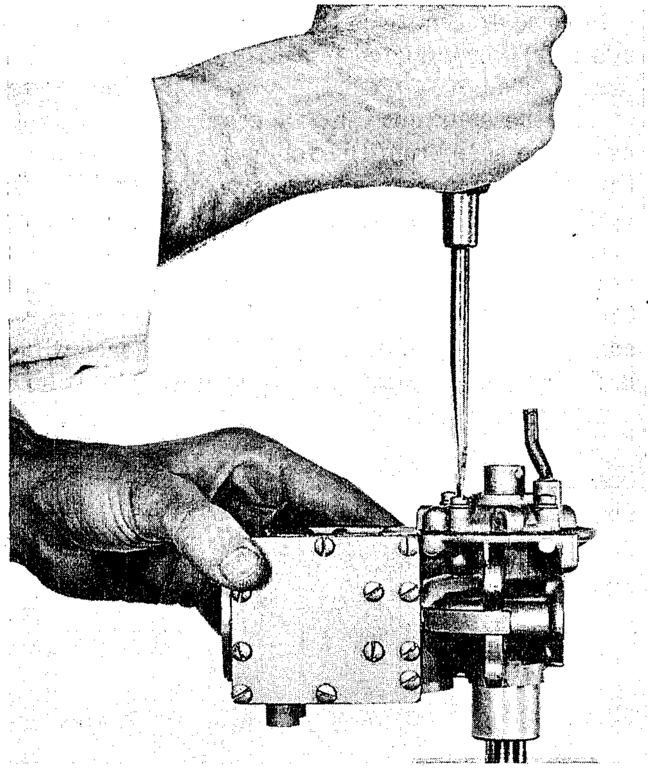
Showing Model M (Single Cylinder) Assembly Layout—Gaskets Omitted



Inserting Crankshaft



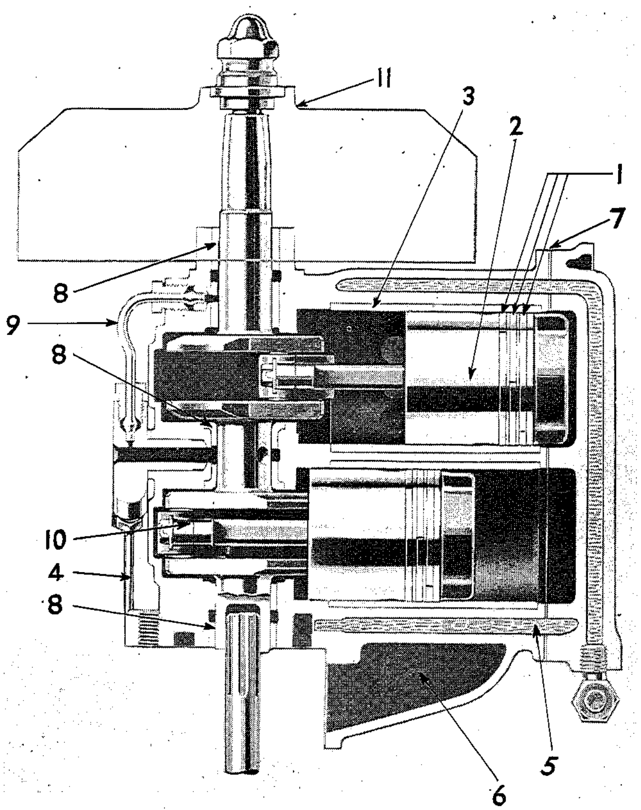
Bending Lug of Lockplate up Against the Head of the Connecting Rod Screw to Prevent its Turning and Becoming Loose



Installing the Crankcase Head

NOTES

POWER HEAD—LT, TS—TD



Power Head Assembly

POWER HEAD—SERVICE SUGGESTIONS

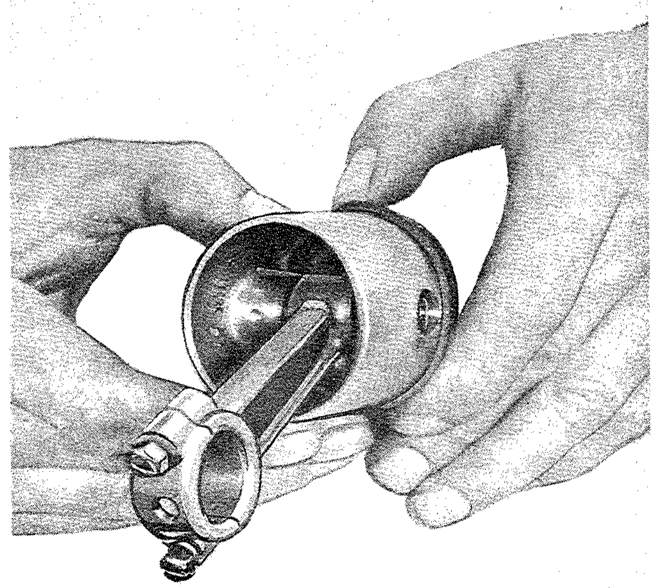
1. Piston rings—worn or fast in ring grooves, resulting in loss of compression. (Ring grooves may be clogged with carbon causing rings to stick.)
2. Piston—worn or scored.
3. Cylinder — worn or scored, causing loss of compression.
4. Low speed needle—improperly adjusted, needle and seat in low speed insert may be damaged beyond point where satisfactory adjustment can be obtained. This frequently results from screwing needle down too tightly on seat.
5. Water jacket—clogged with foreign matter, causing motor to overheat.
6. Exhaust passage—clogged with carbon to restrict flow of exhaust gases — will cause loss of power and motor to overheat.
7. Cylinder head gasket—leaking or blown out —cause water to enter or motor to overheat.
8. Journal bearings—excessively worn, causing loss of crankcase compression.

NOTE: Journal bearings are cast in the cylinder-crankcase assembly and, therefore, not replaceable. If bearings are worn to point where replacement is required, it is necessary to install a new cylinder-crankcase assembly. Crankshaft journals and bearings in cylinder-crankcase assembly are machined to such sizes as to permit bearing clearance of .001" to .002". Excessive journal bearing wear results in loss of crankcase compression and is indicated by oil smearing on magneto armature plate.

9. Oil return—clogged, causing excess oil to escape from bearing.
10. Connecting rod bearing—loose, causing motor to knock.
11. Flywheel—loose, causing motor to knock. Tighten flywheel nut.

TO REMOVE PISTON RINGS FROM PISTON

Expand rings by spreading with thumbs as illustrated, and slide over end of piston. There are three rings per each piston. Be careful not to spread too far, rings can be broken. Spread only far enough to permit slipping off piston.

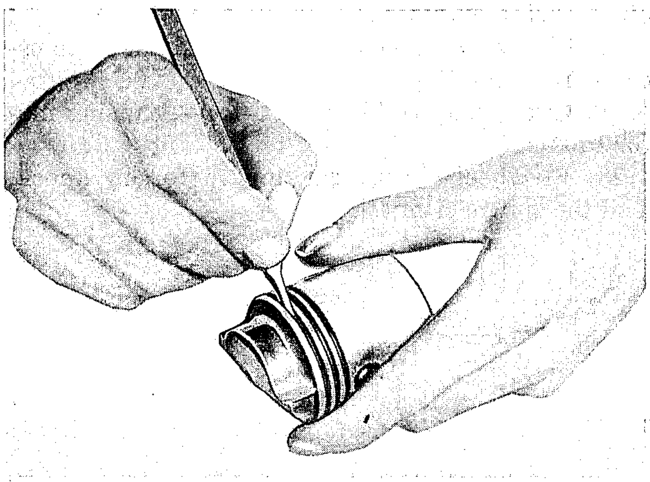


Removing Piston Rings

Rings are replaced in reverse order of that described above — spread enough by hand to slide over piston and into position in respective ring grooves.

TO CLEAN PISTON RING GROOVES

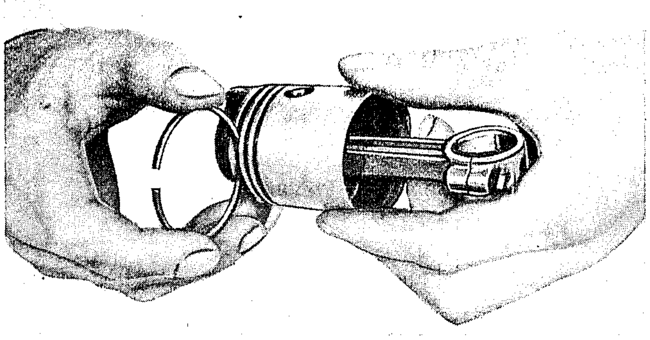
The piston ring grooves frequently become clogged with carbon after long periods of operation, which requires removal to prevent rings from sticking and becoming partially inoperative. This condition results in loss of compression and noticeable deterioration in power.



Cleaning Ring Grooves

It is a simple matter to remove carbon from the ring grooves by scraping as shown in illustration. A suitable scraper can be easily made from a discarded file or hack saw blade — make it slightly narrower than ring grooves in piston and sharp enough to scrape out accumulated carbon.

After removing carbon from ring grooves (piston) and prior to installing new rings, care should be exercised to make certain rings fit in piston grooves with no indication of tight spots or binding. This can be determined by rolling each ring, in their respective grooves, around the piston as illustrated. Resistance will be encountered where tight spots exist—this may be result of particles of carbon, burrs in piston ring grooves or high spots on edge of ring. Check grooves to see that all traces of carbon have been removed. If burrs exist, they usually can be removed with a sharp edge scraper.

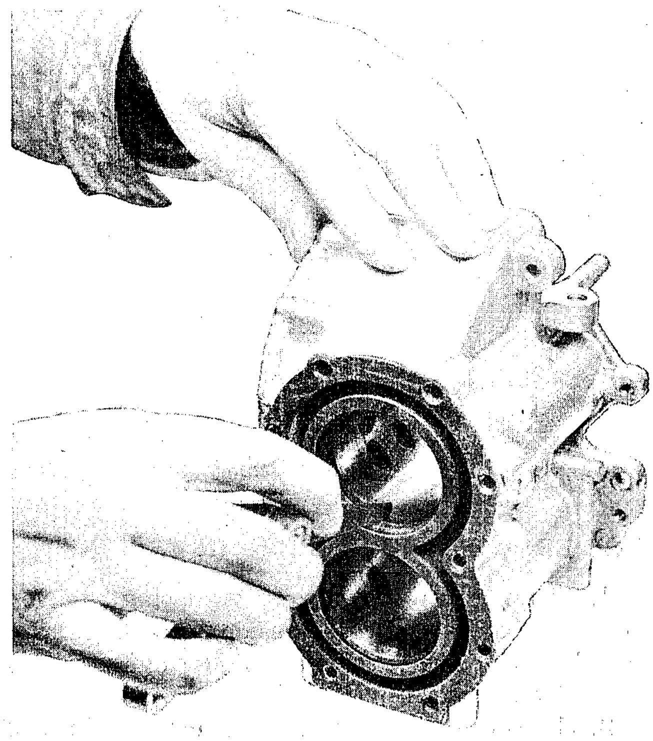


Checking Ring Grooves

Handle piston carefully. Burrs are the result of rough handling or dropping.

High spots on edges of rings are not frequent occurrences, but if such is the case, they can be dressed down by rubbing edge (side) of ring lightly over a piece of fine sandpaper or emery cloth placed on a flat surface.

NOTE: Rings must fit freely in piston ring grooves. Recommended clearance in piston grooves is .0015" to .0025". Piston rings and piston grooves are machined in correct sizes at factory and will fit properly, providing all carbon has been removed from piston grooves and no burrs are present.

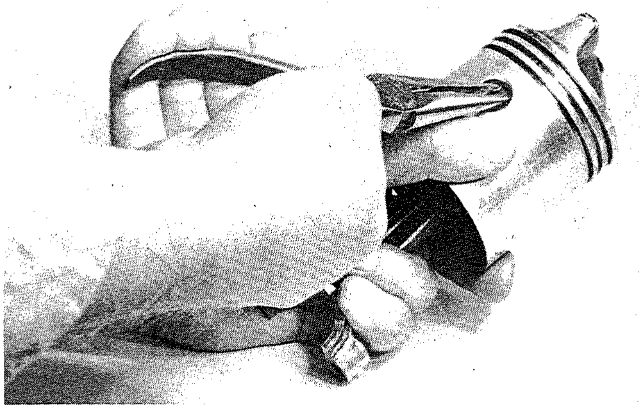


Checking Piston Ring Gap

Piston rings are ground to size at factory, but it is advisable to check gap clearance to make sure recommended .005" to .015" is maintained. Place each ring squarely in cylinder as illustrated. Insert feeler gauge between ends of ring (gap). Repeat same operation for each ring in respective cylinders. If noted clearance falls below .005", file end of ring carefully until desired gap is obtained. If clearance is considerably in excess of .010", cylinder is worn oversize and should be replaced.

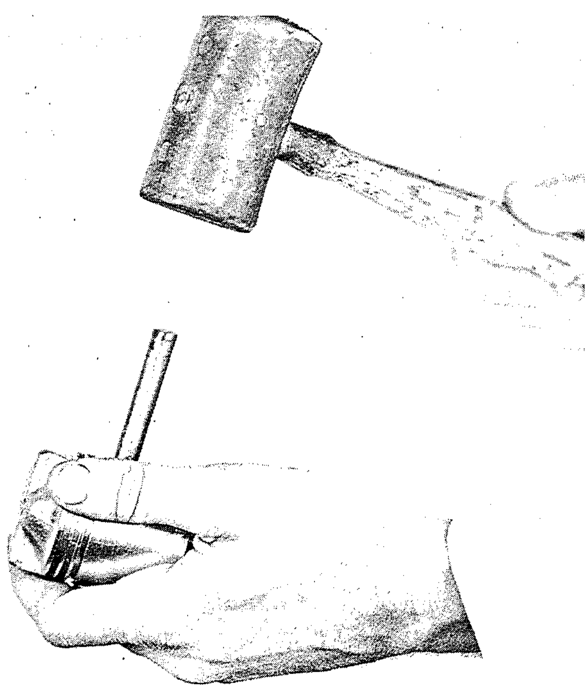
Cleanliness cannot be overemphasized—a good shop keeper is orderly about his personal appearance as well as that of his shop.

If found advisable to INSTALL A NEW PISTON, it must be detached from the connecting rod. First remove both lock rings from wrist pin hole as illustrated. Use long nose pliers, grasp protruding end of ring and pull out with twisting motion. The pin can then be driven out as shown. Use small flat end punch. If the fit appears a bit snug, hold piston in hot water for a few seconds to expand. Do not drive out wrist pin by laying piston on bench or hard surface—this will result in springing it out of round. Handle the piston assembly carefully.

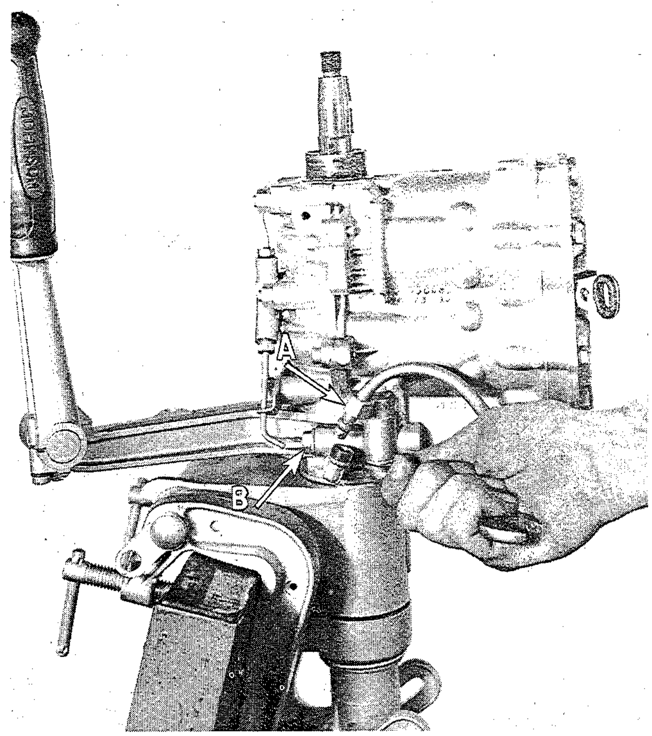


Removing Lock Ring

Attach new piston in reverse order of that described above. Note grooves in wrist pin hole for lock rings. Reinstall lock rings — grasp end of ring with long nose pliers, insert with twisting motion at the same time making certain ring comes to rest in groove provided for this purpose.



Removing Wrist Pin



Illustrating removal of powerhead from lower unit. Detach water tube connection A. Remove nut as shown and screw B. (Note—a similar nut and screw are located on reverse side which must also be removed). After removing nuts and screws, simply lift power head from lower unit.

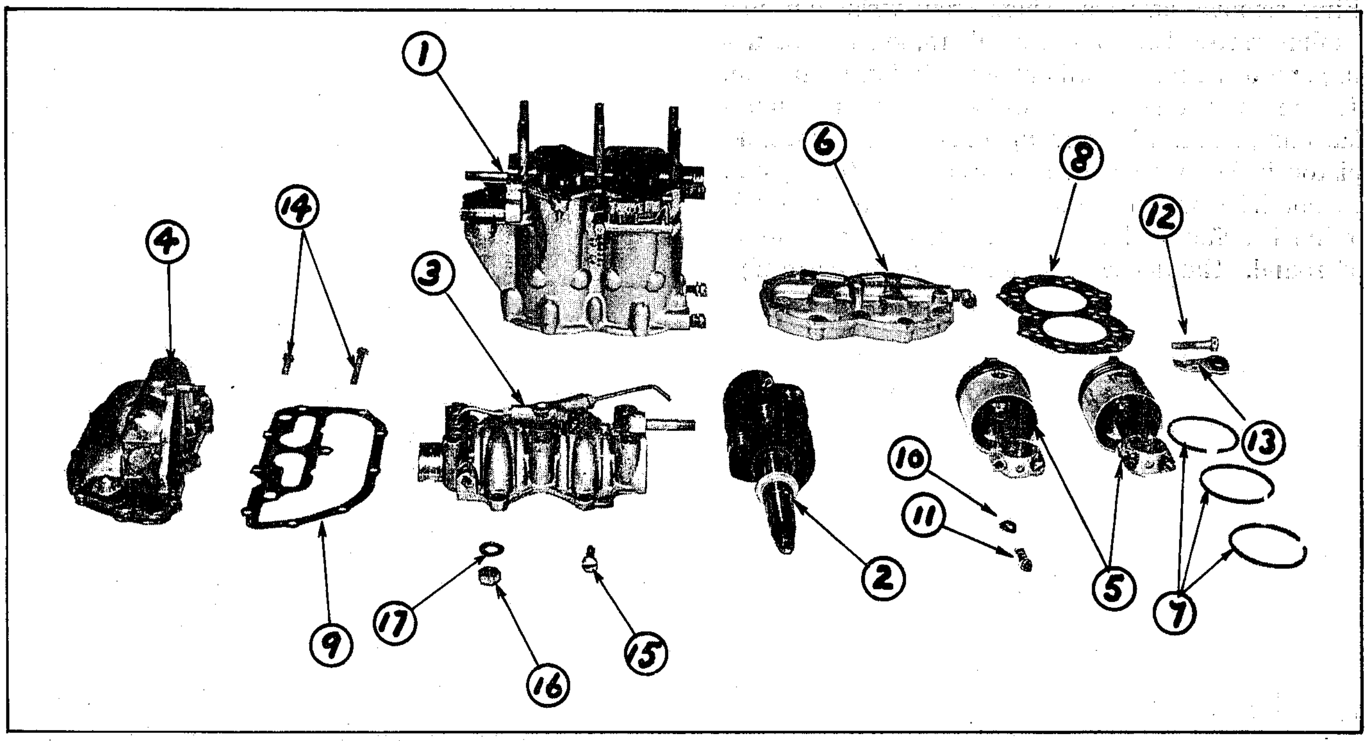
When installing the power head, use new gaskets and make certain gasket surfaces are clean and free of foreign matter—void of burrs or other irregularities apt to affect proper seal.

Install the mounting nuts and insert muffler screws (be sure gaskets are properly located). Draw up lightly first on nuts and muffler screws to position the power head, then tighten the nuts to secure the mounting. This should be followed by tightening the muffler screws.

Smear "glob" of grease on drive shaft and end of the crankshaft when assembling.

Avoid accumulation of oily rags about the shop or work bench—oily rags left lying about the shop are a hazard—a fire hazard and a threat to an otherwise promising business.

CORRECT PROCEDURE FOR ASSEMBLING POWER HEAD

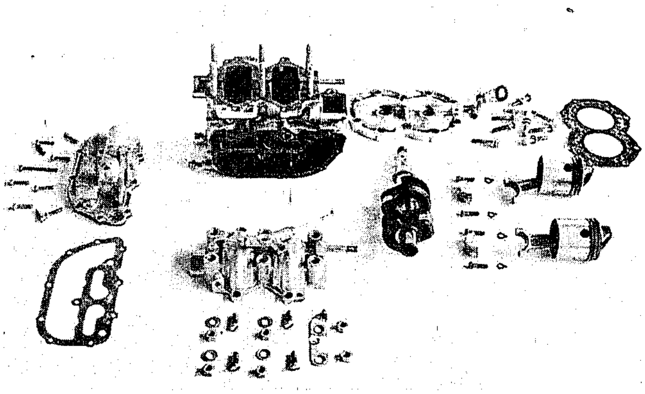


1. Cylinder
2. Crankshaft
3. Crankcase
4. Manifold
5. Piston and Connecting Rod
6. Cylinder Head
7. Piston Rings
8. Cylinder Head Gasket
9. Manifold Gasket
10. Lock Plate
11. Connecting Rod Screw
12. Cylinder Head Bolt (Screw)
13. Spark Plug Wire Support
14. Manifold Screws
15. Crankcase Screws
16. Crankcase Nut
17. Crankcase Washer

1. Make certain all parts have been thoroughly cleaned and that piston rings are properly fitted in piston ring grooves. Ring grooves must be free of carbon to prevent rings sticking. (Recommended gap clearance .005″ to .015″ — groove clearance .0015″ to .0025″.)

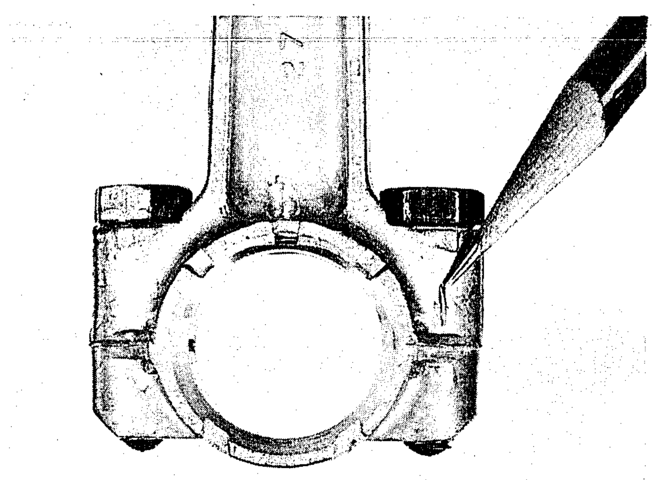
Remove all traces of gasket cement from face of both crankcase sections—this is important.

Lay all parts on a convenient assembly bench as illustrated.



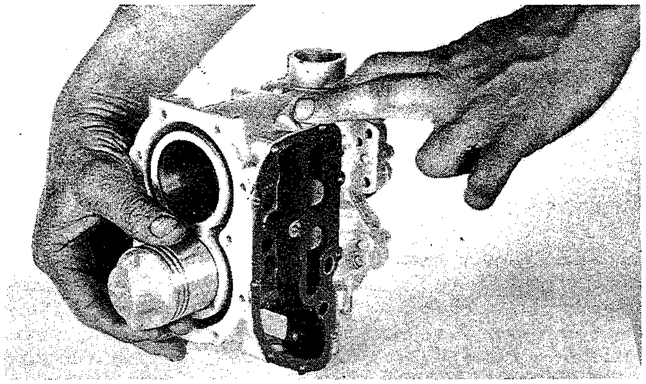
Parts to be Assembled

2. Place a few drops of oil on pistons and in ring grooves. Insert piston, ring and rod assemblies. Note deflector on piston, one side is abrupt while the other slopes gradually towards outer edge of piston. Piston should be installed with sloping side of deflector directed towards exhaust outlet as illustrated. Note compress rings with fingers.



Showing Index Marks on Connecting Rod

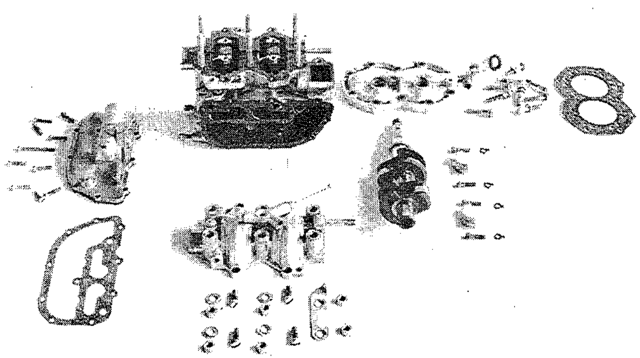
3. Place a drop or two of oil on each of the three bearings in the cylinder assembly — also a drop or two on each connecting rod bearing. Install crank-



Inserting Piston

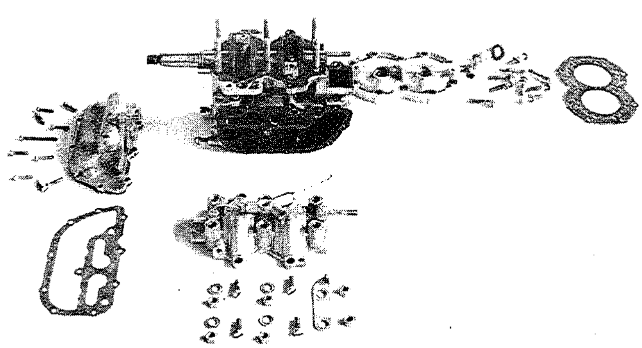
shaft. Attach connecting rods to crankpins. Do not neglect bending small lug on lock plate *up* to prevent connecting rod screw from turning.

4. Spread thin coat of gasket cement over face of the crankcase — (a light coat is essential — if too much is applied or if the cement is too thick, it will be impossible to maintain proper journal bearing clearance, .001" to .0025")—see crankcase assembly.



Showing Piston and Rods Installed

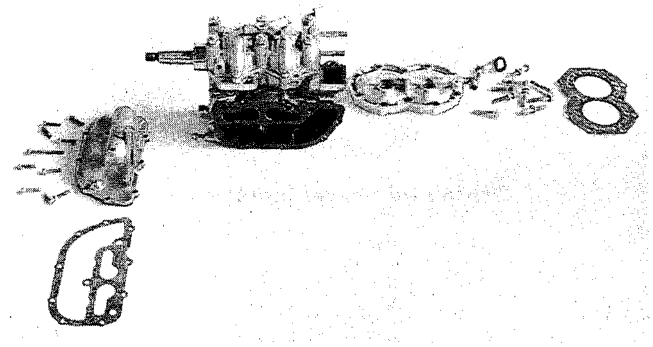
Place a drop or two of oil on each of the three bearings in crankcase section. Assemble necessary screws, nuts and washers — draw down evenly and securely.



Showing Pistons, Rods and Crankshaft Installed

CRANKCASE ASSEMBLY

Since there are no gaskets between the crankcase sections it is extremely important the surfaces be properly cemented when assembling. These surfaces are very accurately machined but must rely on a thin film of cement to guard against loss of crankcase compression.

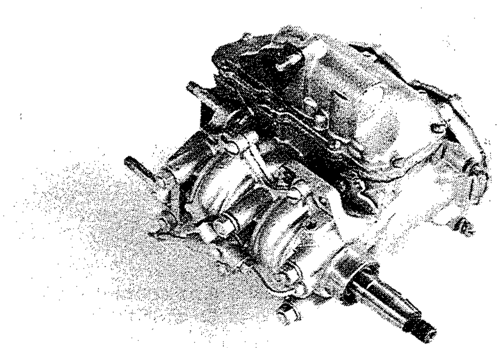


Showing Pistons, Rods, Crankshaft and Crankcase Installed

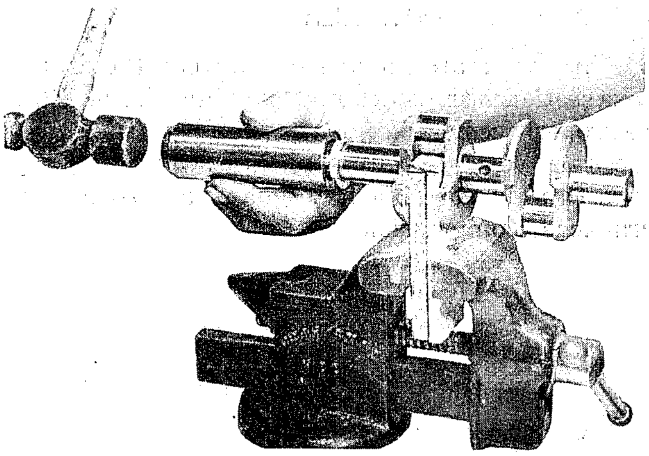
When assembling, be sure both surfaces are clean and that all traces of old cement have been removed. If the crankcase is assembled with the old cement still remaining and freshly coated with additional cement, bearing clearances are likely to be excessive — this will affect performance of the motor. Correct bearing clearance can be maintained only if, when assembling, the old cement is thoroughly removed and a thin coat of fresh cement applied to the surface. DO NOT USE THICK CEMENT. Apply only enough to cover the surfaces — be sure none of the oil passages are obstructed by an over abundance of cement.

Gasket cement dries quickly—everything should be in readiness to complete assembly immediately after applying the cement. If permitted to dry before assembling, bearing clearance will be greater than it would have been had the cement been in a fluid state at the time of tightening crankcase bolts.

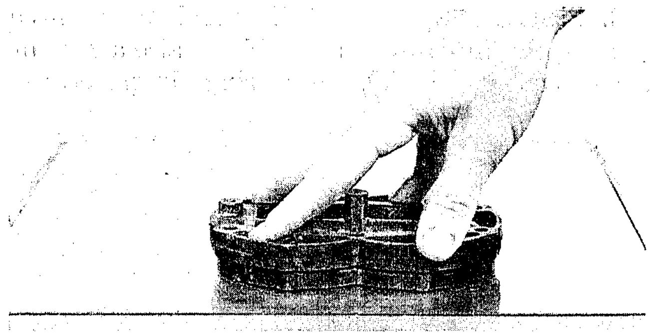
5. Complete assembly by installing gaskets, muffler-manifold assembly and cylinder head.



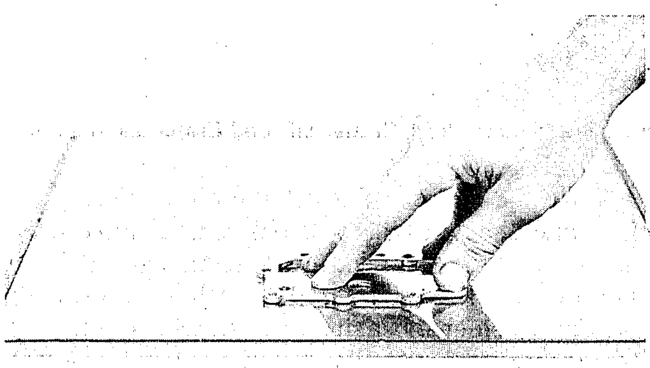
Complete Power Head Assembled



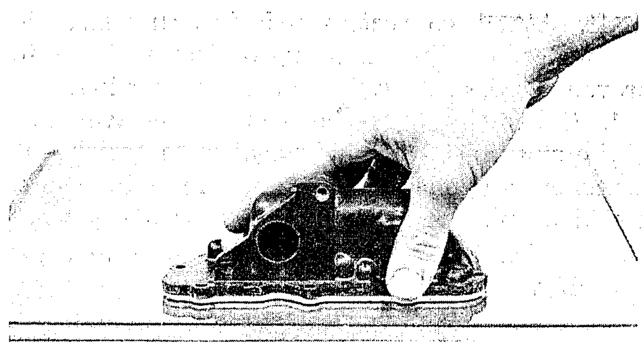
Driving Oil Slinger into Position



Lapping Cylinder Head to Insure its Flatness to Eliminate Possibility of Blown Gasket as the Result of Warpage. Lapping Operation Should be Accomplished on a Piece of Plate Glass or Other Flat Surface Covered with Lapping Compound or a Piece of No. 0 Emery Cloth. Move in a Figure Eight Motion to Properly Dress, Bearing Down Evenly on the Head

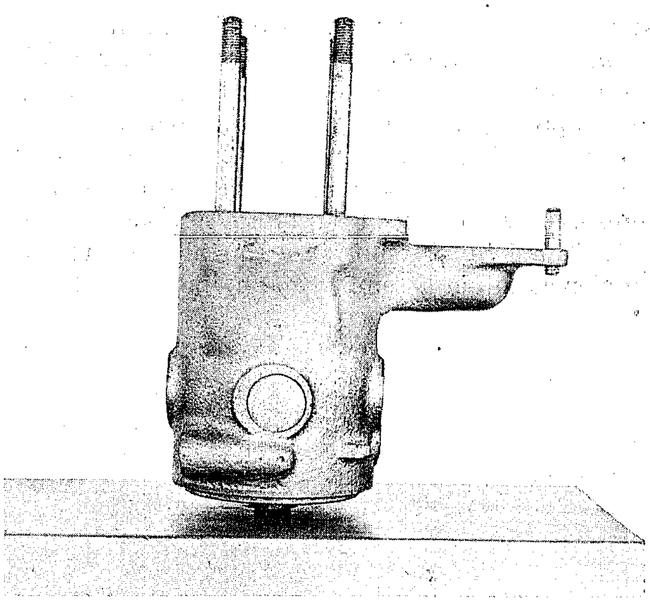


Lapping Manifold Plate to Insure Flatness

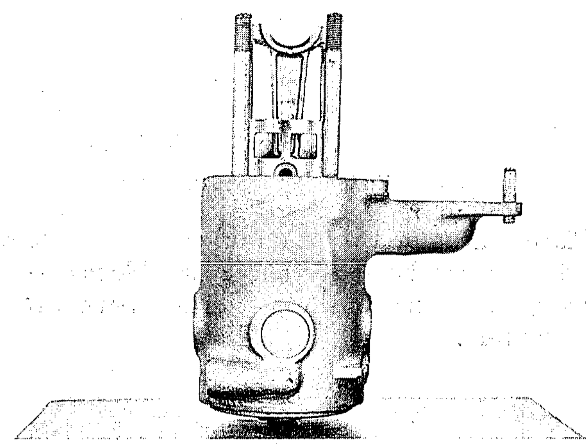


Lapping Manifold Assembly to Insure Flatness

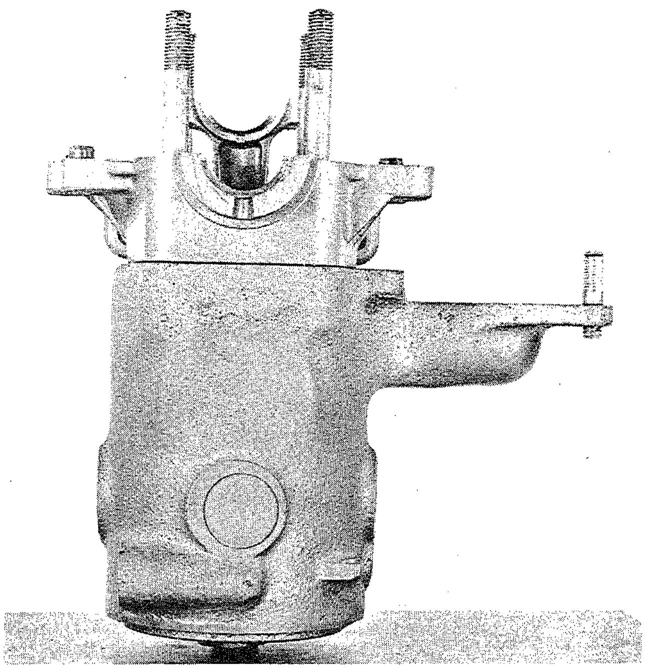
POWER HEAD ASSEMBLY—LS



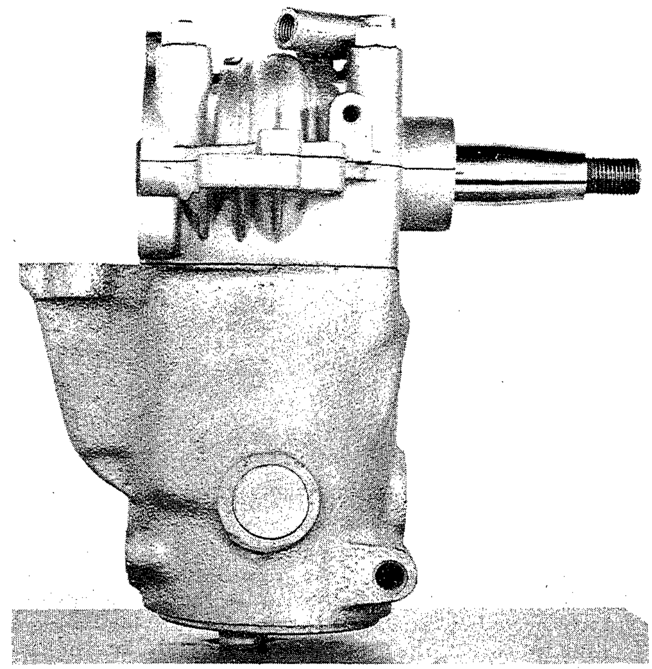
Place Cylinder on a Block of Wood Approximately 2 x 6 x 10 Inches in which a ¾-inch Hole is Drilled to Accommodate the Spark Plug Cover Boss Cast to the Cylinder Block. This Will Permit Standing the Cylinder on its End for Assembly Purposes



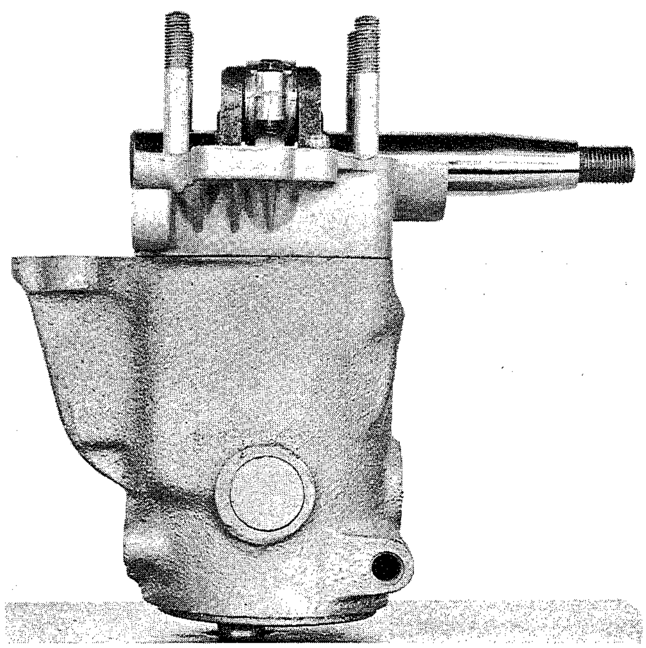
Carefully Install Piston Rings on Pistons, Making Certain that the Ring Grooves are Free from Carbon and that the Rings do not Bind in any Manner, also that the Rings are Properly Seated in the Ring Grooves after Having Checked the Ring Gaps (see Clearance Chart, Page 219). Install Piston and Connecting Rod Assemblies as Shown Above. Note Ports in the Skirt of Each Piston. Pistons Should be Installed in such a Manner that the Ports Align with the Corresponding Ports in the Cylinder Walls, Directly Opposite the Exhaust Ports. If the Pistons are Installed Accordingly, the Straight Side of the Deflector on the Head of the Piston will then be Adjacent to the Intake Port which is Proper



Make Certain that the Face of the Cylinder Base and the Top Face of the Crankcase are Both Clean and Flat. Apply a Thin Coat of Cement (preferably Perfect Seal No. 4). Insert Gasket and Place Top Half of the Crankcase in Position

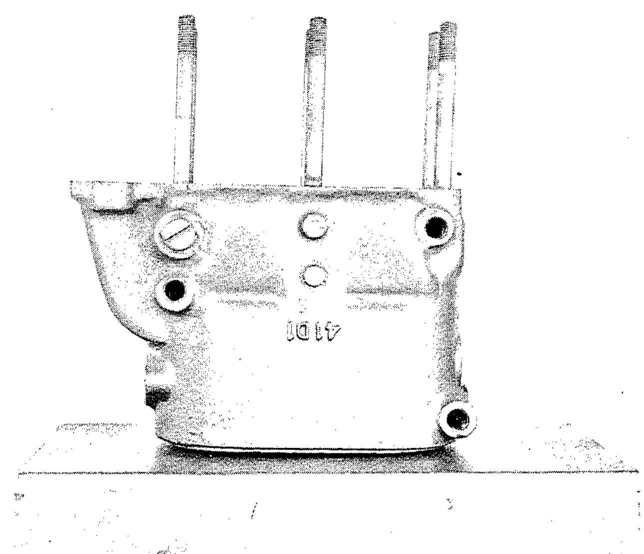


Prior to Assembling Upper Half of the Crankcase, Observe Condition of Mounting Face—Both Faces of Each Crankcase Section Must be Smooth, Flat and Clean to Avoid Possibility of Leakage on Assembly. Apply a Thin Coat of Cement to Each Surface. Guard Against Excessive Amount. Install and Bolt Upper Half of the Crankcase into Position. Draw Down Evenly and Tightly on All Nuts and Screws to Make Fast

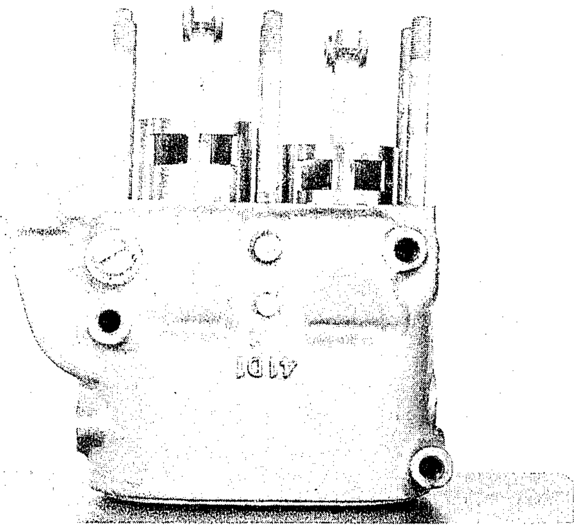


Remove Caps from the Connecting Rods—Push Piston and Connecting Rod Assembly Down Far Enough into the Cylinder to Permit Installing Crankshaft. Prior to Installing Crankshaft, Coat Journals and Crankpins Liberally with Clean Oil. Place Connecting Rods in Position on their Respective Crankpins. Replace Connecting Rod Caps in their Original Positions. Install Cap Screws (with new lock plates) to make the Cap Fast. On Having Drawn up on the Cap Screws, Tap Sides of the Rod Lightly with Small Hammer to Obtain Final Alignment of the Rod and Cap. Bend Lug of Lock Plate up Flatly Against One Wall of the Cap Screw Head to Prevent its Turning to Become Loose While the Motor is in Operation. This is Important—Use New Lockplates

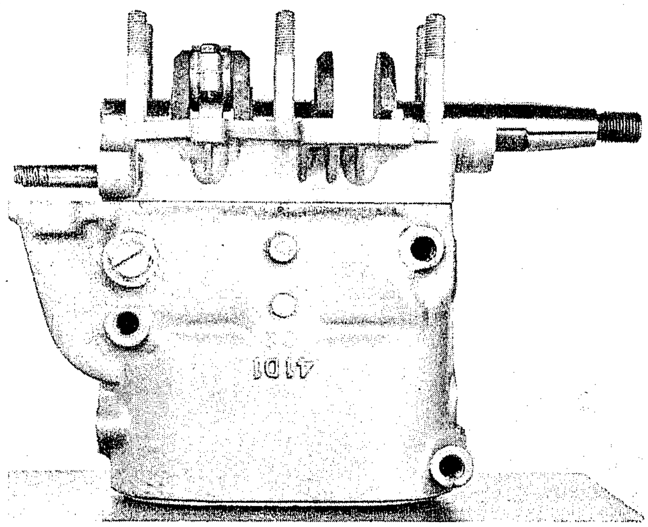
POWER HEAD ASSEMBLY—LT-37-38



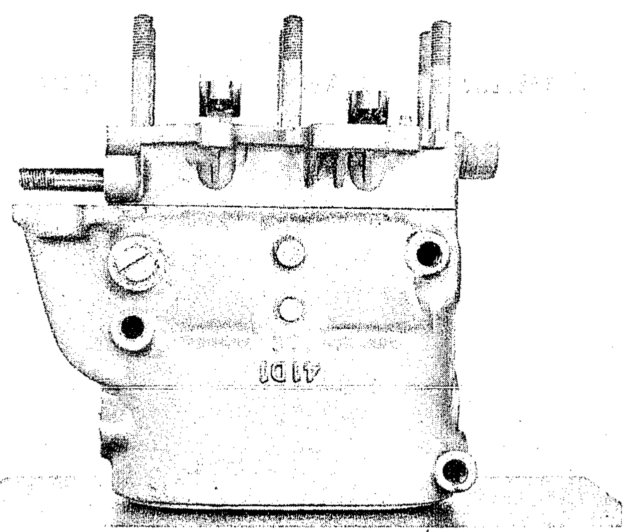
Place Cylinder on a Block of Wood Approximately 2 x 6 x 10 Inches in which a ¾-inch Hole is Drilled to Accommodate the Spark Plug Cover Boss Cast to the Cylinder Block. This Will Permit Standing the Cylinder on its End for Assembly Purposes



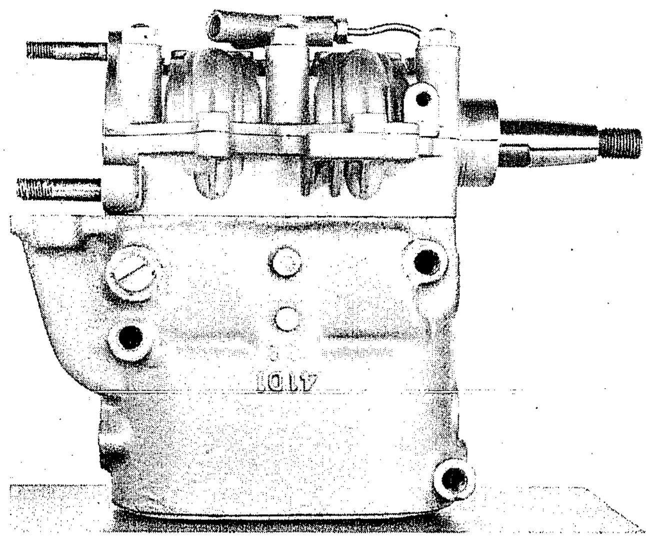
Carefully Install Piston Rings on Pistons, Making Certain that the Ring Grooves are Free from Carbon and that the Rings do not Bind in any Manner, also that the Rings are Properly Seated in the Ring Grooves after Having Checked the Ring Gaps (see Clearance Chart, Page 219). Install Piston and Connecting Rod Assemblies as Shown Above. Note Ports in the Skirt of Each Piston. Pistons Should be Installed in such a Manner that the Ports Align with the Corresponding Ports in the Cylinder Walls, Directly Opposite the Exhaust Ports. If the Pistons are Installed Accordingly, the Straight Side of the Deflector on the Head of the Piston will then be Adjacent to the Intake Port which is Proper



Remove Caps from the Connecting Rods—Push Piston and Connecting Rod Assembly Down Far Enough into the Cylinder to Permit Installing Crankshaft. Prior to Installing Crankshaft, Coat Journals and Crankpins Liberally with Clean Oil. Place Connecting Rods in Position on their Respective Crankpins. Replace Connecting Rod Caps in their Original Positions. Install Cap Screws (with new lock plates) to make the Cap Fast. On Having Drawn up on the Cap Screws, Tap Sides of the Rod Lightly with Small Hammer to Obtain Final Alignment of the Rod and Cap. Bend Lug of Lock Plate up Flatly Against One Wall of the Cap Screw Head to Prevent its Turning to Become Loose While the Motor is in Operation. This is Important—Use New Lockplates

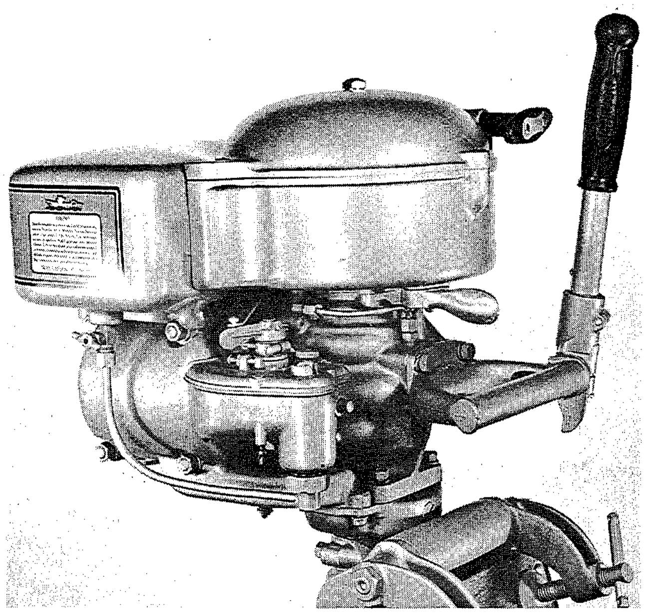


Make Certain that the Face of the Cylinder Base and the Top Face of the Crankcase are Both Clean and Flat. Apply a Thin Coat of Cement (preferably Perfect Seal No. 4). Insert Gasket and Place Top Half of the Crankcase in Position

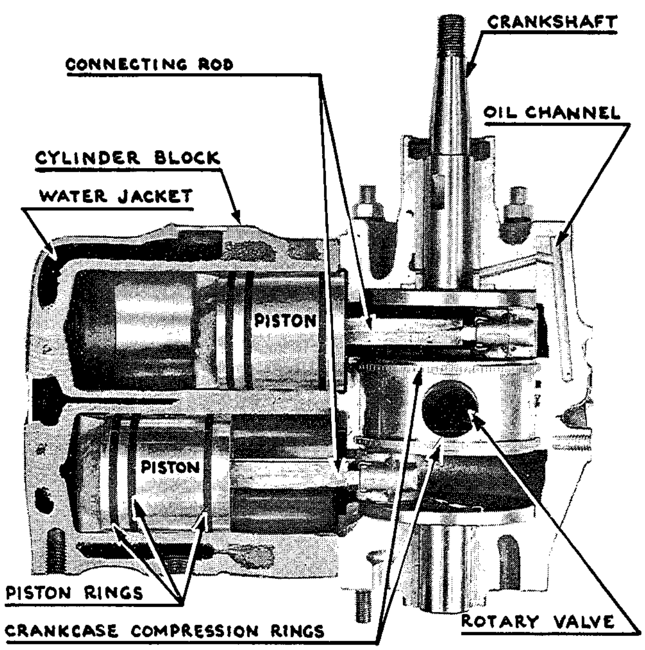


Prior to Assembling Upper Half of the Crankcase, Observe Condition of Mounting Face—Both Faces of Each Crankcase Section Must be Smooth, Flat and Clean to Avoid Possibility of Leakage on Assembly. Apply a Thin Coat of Cement to Each Surface. Guard Against Excessive Amount. Install and Bolt Upper Half of the Crankcase into Position. Draw Down Evenly and Tightly on All Nuts and Screws to Make Fast

POWER HEAD—K, KS AND KD

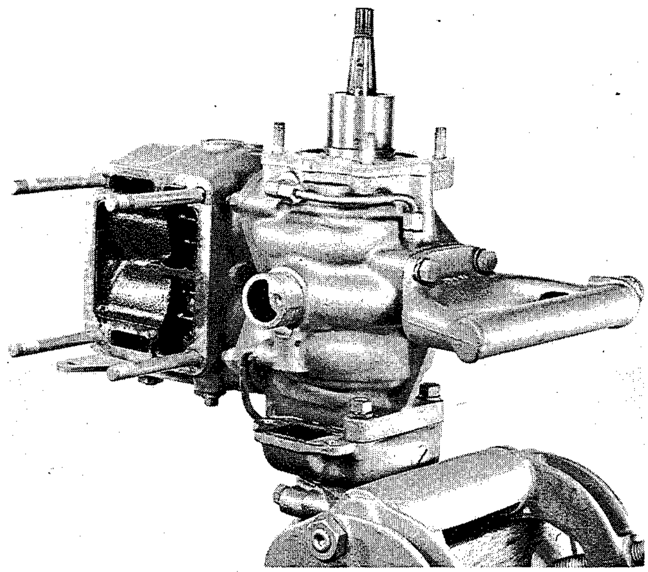


Model KD Power Head



Sectionalized Model K Power Head—Similar in Construction to that of the Model A and AA Power Head

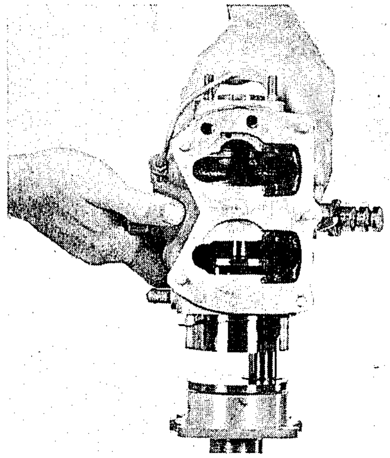
On disassembly of the motor for repairs on the power head, the gas tank, ready-pull (if provided), flywheel, armature plate, carburetor and muffler must be carefully removed and set aside for checking (or repairs) later on, prior to reinstallation after having completed required service operations. The power head should then be removed from the driveshaft casing, followed by removal of the flywheel keys (if the power head is to be completely dismantled).



Showing Ready-Pull Starter, Magneto, Gas Tank, Muffler and Carburetor Removed

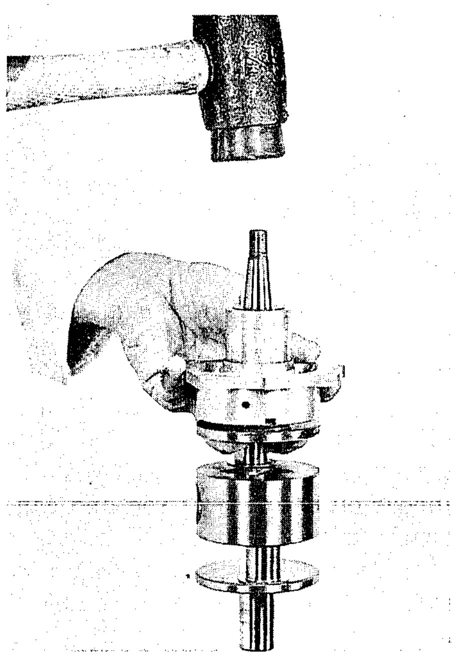
Lift power head from the driveshaft casing and support in vise (using power head support block securely gripped in vise), remove cylinder block, being careful not to bend or twist the connecting rods in doing so. Check connecting rod for looseness on the crankpin. Bend lock plate lug away from connecting rod screw head. Note if aligning marks appear on one side of rod and cap—if not, provide with prick punch. Indicate top and bottom rod for later reassembly. Loosen and remove cap screws. Detach piston-rod assembly from the crankpin. Replace cap (loosely) in original position to guard against interchanging with cap of the other rod. Check wrist pin for excessive looseness in the piston or top end of the rod. Note, also, condition of piston rings, ring grooves and general condition of the piston.

Remove piston rings from the piston—note condition of the cylinder bores (scores, scratches and excessive wear). Insert pistons in their respective cylinder bores to check for excessive clearance as result of wear in normal operation.



Showing Procedure for Removing or Installing Crankcase Head and Crankshaft

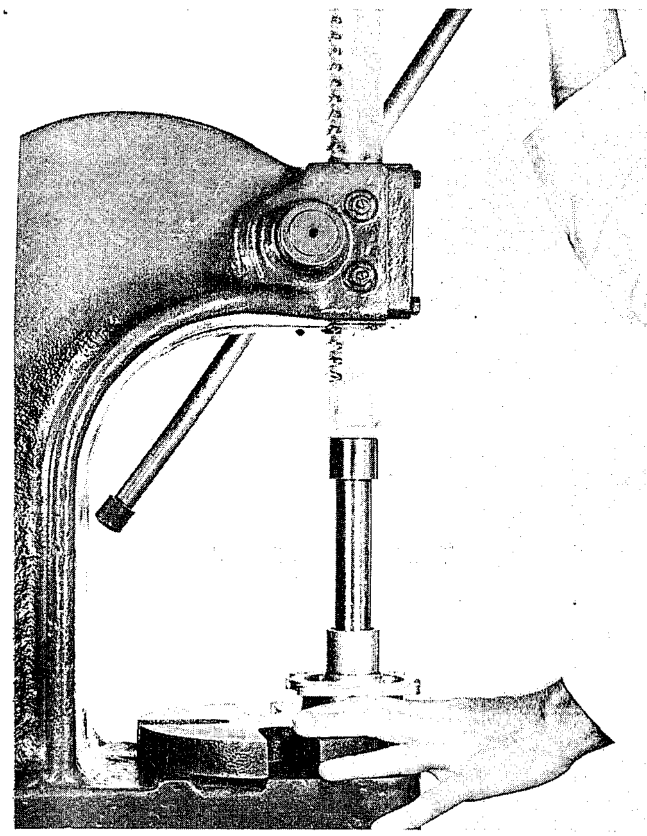
Remove crankcase head to permit withdrawal of the crankshaft for inspection of the journals and journal bearings. If bearings are excessively worn, arrange for replacement. Oil splattered about on the armature plate indicates abnormal journal bearing wear; however, in such case, check first for obstructed oil lines or passages.



Since the Oil Slinger Involves a Spring Fit Over the Top Journal of the Crankshaft, Slight Pressure is Required to Remove the Crankcase Head from the Crankshaft. Hold Assembly Securely with Hand as Shown Above, Tap Lightly on End of Crankshaft with Mallet to Drive Out

Note: Oil Slinger Should Always be Installed with Wide Wall "up"—This is Important. The Angular Slot Cut Into the Wall of the Oil Slinger Should be Directed in the Opposite Direction of the Crankshaft Rotation—if Otherwise, the Slot will act as a Scoop to Cause Oil from Bearing to Splatter over the Armature and Erroneously give Evidence of Excessive Journal Bearing Clearance

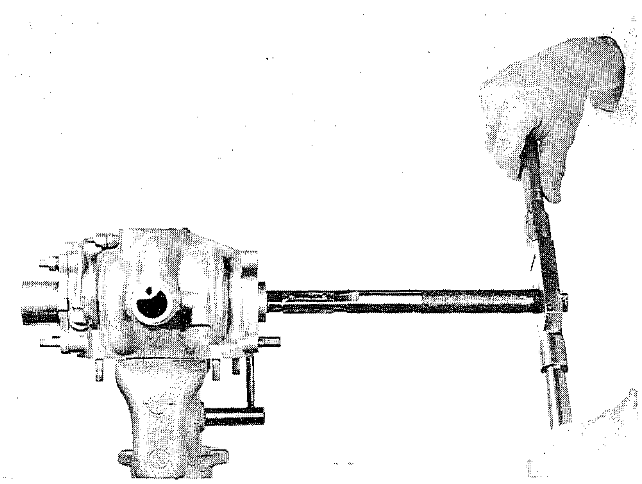
To install new journal bearings it is, of course, necessary to remove the originals which is easily accomplished on an arbor press. The operation, nevertheless, must be performed with extreme care to avoid possible injury to the bearing bosses. When arranging for installation of replacement bearings,



Installing or Removing Journal Bearing in Crankcase Head on Arbor Press

make certain the bearings are positioned in such a manner that the oil holes in the bearings align with corresponding oil holes in the crankcase (bearing bosses). Press gently but firmly into place — check to see that oil holes are properly aligned. Pay particular attention to installation of the top journal bearing — note narrow slot in outside wall which, when properly positioned, should locate on right side of the crankcase head (looking at inside surface) with small projection on the head up. See illustration. The purpose of this slot is to draw oil from the top of the bearing and return it to the crankcase; thus, if incorrectly positioned, oil circulation is obstructed, with possibility of overflow at top of the bearing to splatter over the armature plate.

On having installed the top and bottom journal bearings, the crankcase head should be attached to the crankcase proper (gasket omitted) and preparations made for reaming. Both surfaces should be clean and free of foreign matter which might otherwise throw the bearings out of line when reamed. The crankcase should be supported in a vise for this operation, taking care to guard against possibility of "springing" the assembly. Two reamers are required: namely, rough and finish line reamers, the former to remove excess bearing stock and the latter to finish line ream to proper diameter. Both reamers are piloted to insure correct alignment which could not be accomplished otherwise. NOTE: Bearings for some of the K series are machined undersize—too small in diameter to take the rough reamer pilot. In this case, ream out sufficiently with expansion reamer to clear. Attach handle to rough reamer (see list of reamers) — insert pilot through bottom bearing and commence reaming operation by turning in clockwise direction. Proceed in this manner until reamer blades have passed through the bearing. Withdraw reamer but still turning in clockwise direction. Under no circumstances pull the reamer straight out nor turn it "backwards" when removing to prevent injury to both the bearings and the reamer blades. Proceed in like fashion with the finish line reamer. If the reamer blades are correctly adjusted, clearance between the bearing wall and journal will be sufficient to provide for expansion and proper lubrication (see clearance chart).

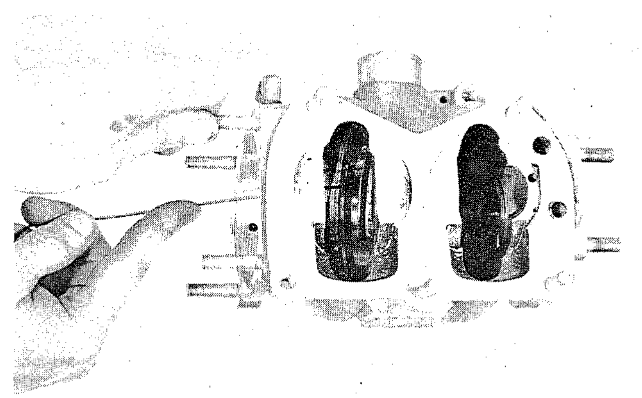


Reaming Journal Bearings

After having reamed the bearings, detach the crankcase head—wash or blow out inside of the crankcase to remove all trace of bearing chips which might have gathered during the process. Blow or wash out the crankcase head for like reason. Make certain all oil holes and passages in both the head and crankcase are clear and free of chips.

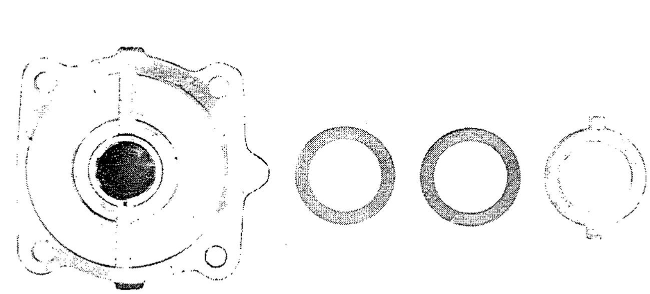
Check crankshaft for straightness as previously instructed and scores or flat spots on crankpins or journals. In event the crankshaft is sprung beyond reasonable straightening limits, the crankpins or journals excessively pitted, worn or scored, make arrangements for installation of a new crankshaft.

Prior to installing the crankshaft, observe condition of crankcase compression rings in the center journal bearing, like the piston rings—they must be free in the ring grooves (bronze center journal bearing insert) to properly seal, thus, to prevent crankcase compression from one chamber escaping to the other to cause irregular performance. Coat all bearing surfaces liberally with clean oil—bearings, crankpins and journals.



In Event the Crankcase Compression Rings Require Removal, Simply Bend the End of a Stiff Piece of Wire to Permit Insertion Between Ends of the Ring as Shown Above. Pry One End of the Ring Up and Over the Other to Compress and Lift Out. Compression Rings Should be Free in their Respective Grooves to Insure Functioning Properly. Purpose of the Rings in this Instance is to Prevent Compression Escapage from One Chamber of the Crankcase to the Other

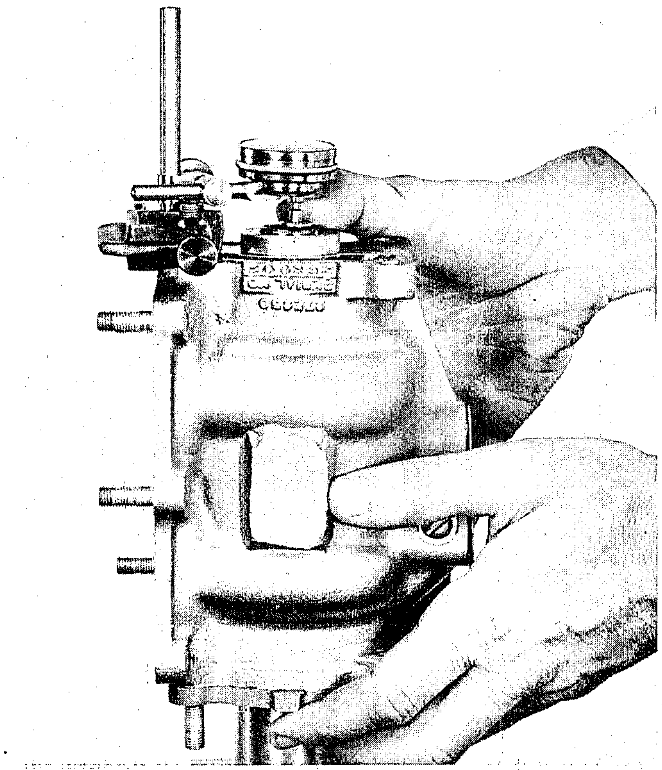
Carefully insert crankshaft — coat crankcase head gasket thinly with non-hardening gasket cement, just enough to cover the surface but guard against excessive coating to possibly plug oil passages later on. Note contour of crankcase head and that the gasket is cut to match—install gasket on the crankcase head in such a manner that its shape or contour matches contour of the crankcase head. Note bronze spacer and/or shims previously removed from the crankcase head on disassembly.



Showing Gearcase Head, Spacer and Shims

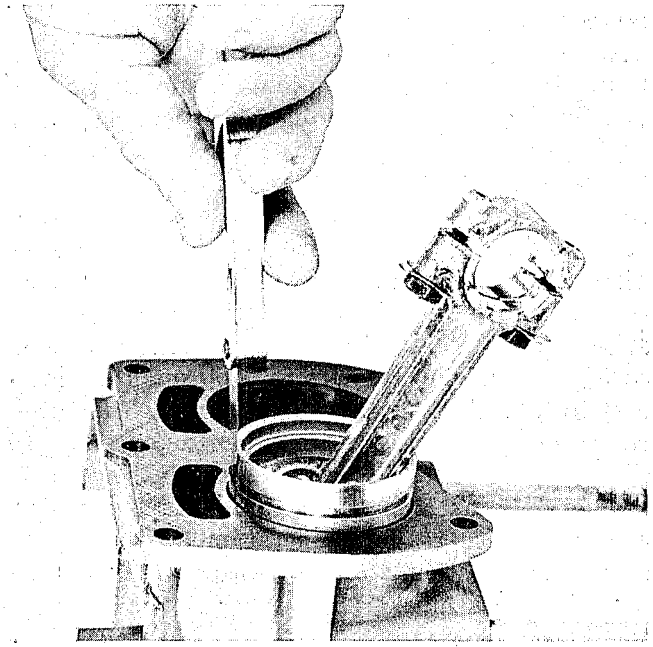
Install spacer in original position — install shim or shims adjacent to the spacer. Slip crankcase head carefully over the top journal of the crankshaft (keys removed from taper on the crankshaft). Align contour or shape of the crankcase head to match like contour of the crankcase. Gently force (by hand) into position on the crankcase. Replace washers and nuts. Tighten evenly to avoid possibility of "cocking" to bind the bearings. The crankshaft should be free in the crankcase with no indication of binding.

Check crankshaft for end play, using a dial gauge as illustrated. End play should check from .003″ to .005″. Proper adjustment in this respect is accomplished by the addition or subtraction of shims placed adjacent to the spacer. Shims are available .003″, .005″ and .010″ thick.



Checking Crankshaft End Play with Dial Gauge. With Dial Shaft Resting on End of Crankshaft, Lift Up and Down Gently on the Crankcase, Note Flexing of Needle

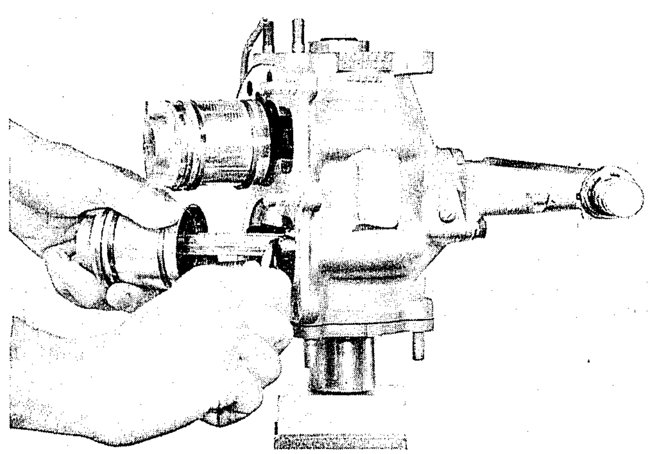
After having properly installed the crankshaft, consideration should be given to condition of the connecting rod, piston and ring assembly. As advised earlier in this Manual, the connecting rods should be fitted to the crankpins with proper clearance for expansion and lubrication (see clearance chart). They should be straight—no bending or twisting. See illustrations for checking and straightening connecting rod assemblies. If bent or twisted beyond limits of correcting or if bearing surfaces are excessively worn or scored, install new rods. Check wristpin fit during this procedure.



Checking Clearance Between Cylinder Walls and Piston by Inserting Gauge Strip of Proper Thickness—see Clearance Chart

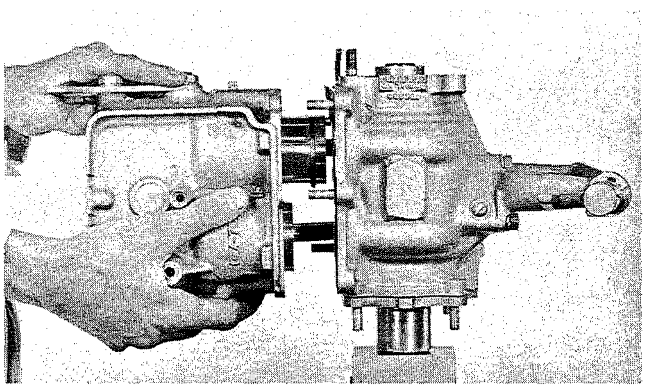
The pistons, piston rings and cylinder walls should be checked at this point for wear, scores, out of round, carbon clogged ring grooves, faulty rings and carbon clogged ports — see preceding comments regarding pistons, piston rings and cylinder walls. Replace or recondition as required.

Spread coat of oil on crankpin bearings (rod and cap), also some oil on the wristpin and bushing. Install piston-connecting rod assemblies in their respective original positions. Draw up firmly on connecting rod cap screws. Bend lug of lockplate up against side of the cap screw to prevent its turning. Always use new lockplates wherever used. Be sure that index marks on cap and rod align and that bearings are free with no indication of binding. Strike side of rod and cap lightly with hammer to finally seat bearing surfaces.



Installing Piston-Connecting Rod Assemblies

Clean mounting faces of the crankcase and cylinder—coat thinly with non-drying cement, install new gasket and prepare for installation of the cylinder. Make sure cylinder bores are in good condition (straight, round and clean). Do not overlook water jacket—it must be clear and free of obstruction. Coat cylinder walls, pistons and piston ring grooves with oil. Adjust position of piston



Removing or Installing Cylinder Block

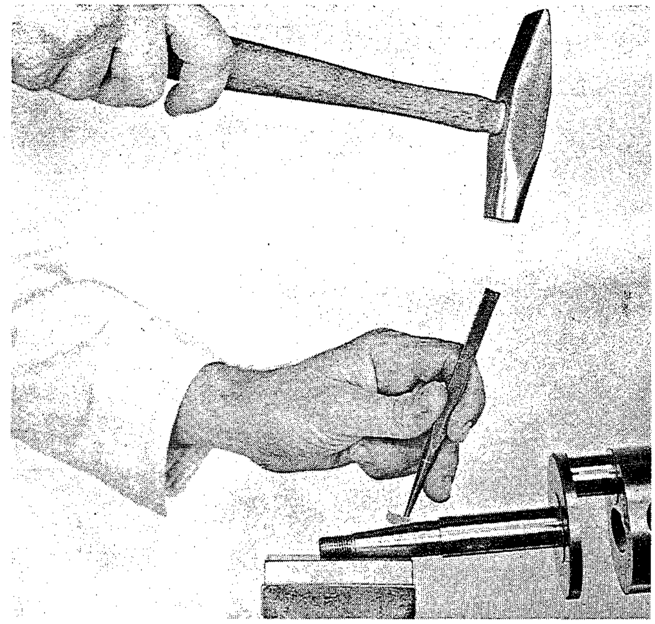
rings in ring grooves. Rotate crankshaft to bring one piston up—compress rings and carefully slip cylinder in position over the piston. Compress rings of second piston and slide cylinder into final mounting position. Install washers and nuts — tighten evenly to make cylinder fast to the crankcase. The crankshaft, piston and connecting rod assembly should now be free to function with no indication of binding or tight spots. However, if there is evidence of excessive tightness or binding, it is advisable to dismantle the job to locate and correct the source of difficulty prior to continuing with final assembly. The power head can then be attached to the driveshaft casing for installation of the carburetor, muffler, gas tank, magneto, ready-pull, etc., assuming each to have been previously checked as to their fitness for further service. Install new gaskets where used.

Note: When installing the flywheel, be careful to see that the keys are properly seated in the crankshaft keyway and that no burrs or sharp edges are present to prevent final seating of the flywheel on the taper of the crankshaft.

To facilitate easy starting and to maintain quiet operation of the KA, K-75, K-80, KS and KD, an exhaust cut-out was provided to relieve back pressure created by the under-water exhaust during time of starting.

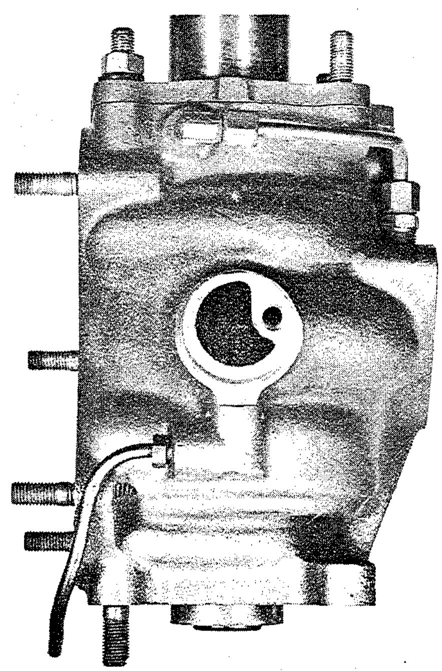
Located in the passage, conducting exhaust gases to the driveshaft housing, its operation is synchronized with movement of the magneto lever.

By an arrangement of linkage between the cut-out and magneto levers, the cut-out remains closed until the spark is retarded well beyond the center



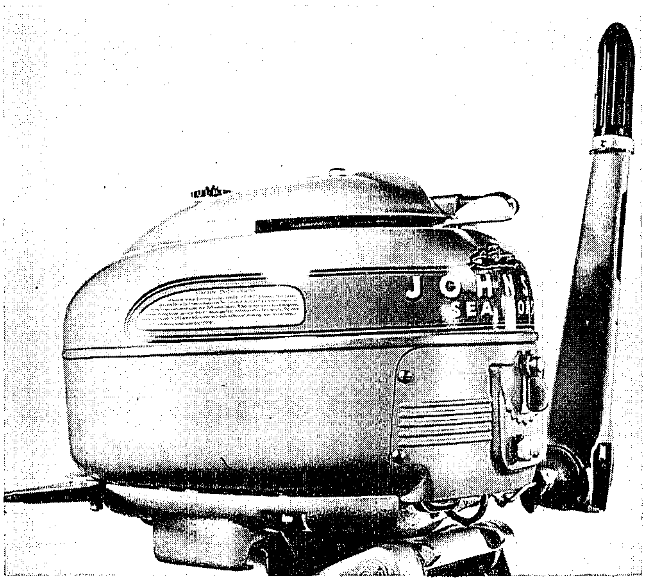
Illustrating Method of Driving Out Flywheel Keys in the Crankshaft. Note: This Operation is Generally Performed Prior to Removing and After Installing the Crankshaft to Guard against Injury to the Journal Bearing

position, to permit quiet operation at intermediate speeds. However, upon advancing from full retard, the cut-out does not close until the magneto lever is moved past center position (starting), thus, relieving back pressure for starting purposes only.

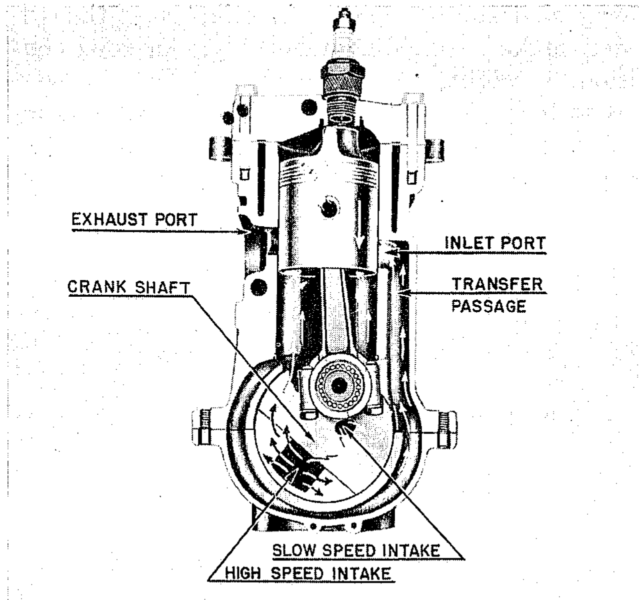


Crankcase Showing Overflow Line Provided for Draining Excess Fuel Mixture Accumulated in Manifold. Shown also is the Crankcase Spout to Which the Carburetor is Attached. Small Circular Opening Conducts Fuel Vapor to Crankcase During Slow Speed Operation—Large, Irregular Shaped Opening During Intermediate and Top Speeds (Full Throttle Opening)

POWER HEAD—MODEL SD

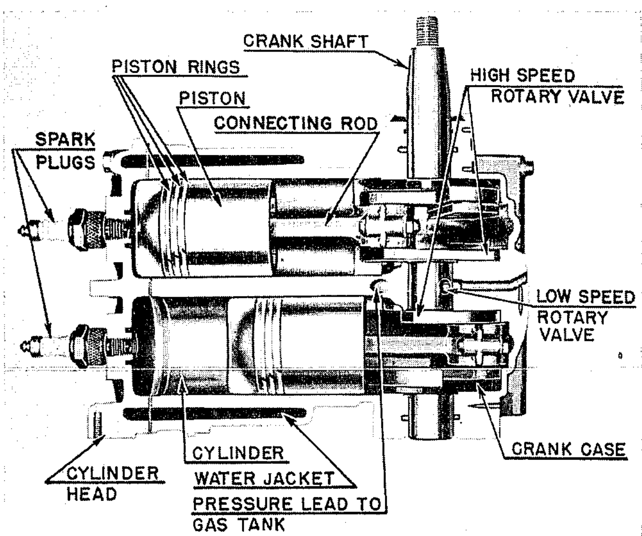


SD Power Head



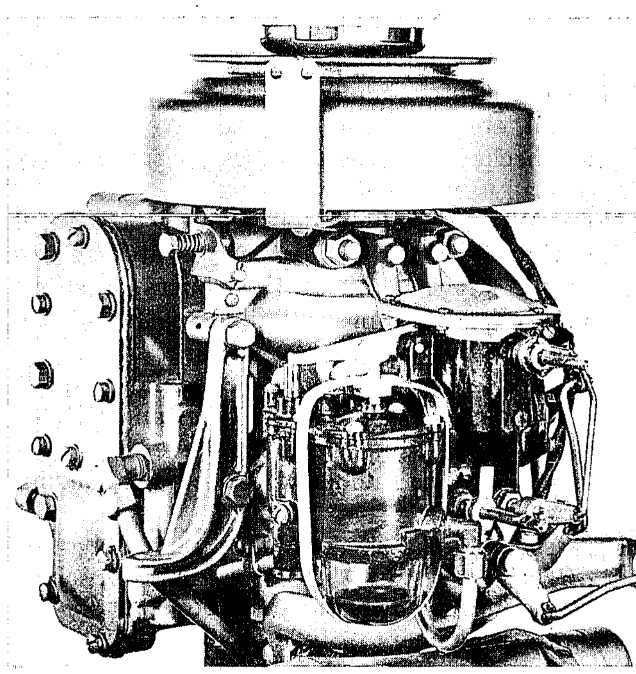
Sectionalized Top View of SD Power Head

Disassembly for repairs on the Model SD power head should be conducted in an orderly manner and since it is one of the larger motors, sufficient space should be provided about the work bench for temporary storage of the detached assemblies prior to actually dismantling.



Sectionalized View of Model SD Power Head Showing Functional Parts

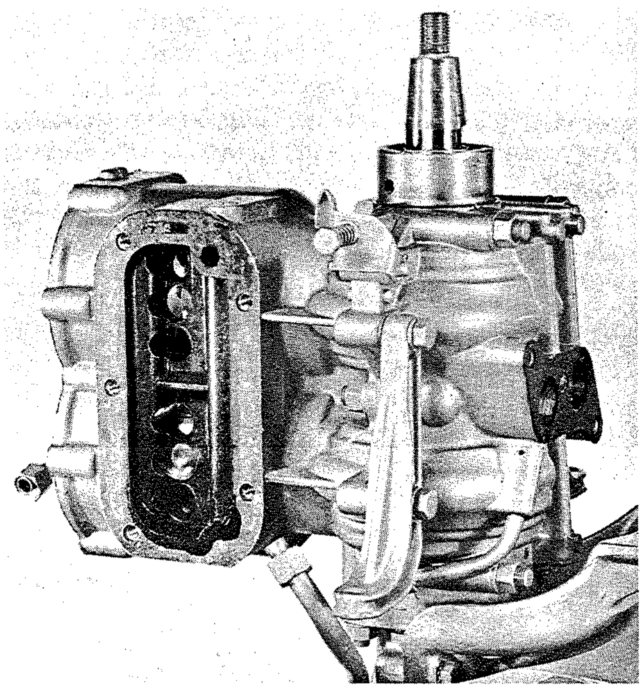
Remove first the starter (ready-pull) assembly and magneto lever, followed by the carburetor cover plate, shroud (disconnect the pressure and gas line) and gas tank. It will be noted that the gas tank is attached to the power head by means of two brackets, each of which are bolted to the crankcase and by means of two cap screws holding the tank fast to the cylinder head—the cylinder head is provided with brackets for this purpose. On removing the tank, pay particular attention to whether or not washers or spacers have been installed on either side of the mounting bracket—if so, wire same in position to simplify installation of the tank later on after repairs have been completed. Purpose of the washers is to obtain alignment of the tank with respect to ultimate position of the starter mechanism.



Showing Ready-Pull Starter and Gas Tank Removed

Carefully remove the flywheel and armature plate as previously instructed, using a flywheel puller and the necessary wrenches. This should be followed by detaching the carburetor control levers (from steering arm) and magneto ground leads prior to proceeding with finally detaching the carburetor from the crankcase — same being held in position by two cap screws.

Detach next the exhaust pipe. Remove carefully the cylinder head and manifold to be followed by removal of the gas tank brackets, ratchet and oil return line. The power head should then be detached from the driveshaft for final disassembly.

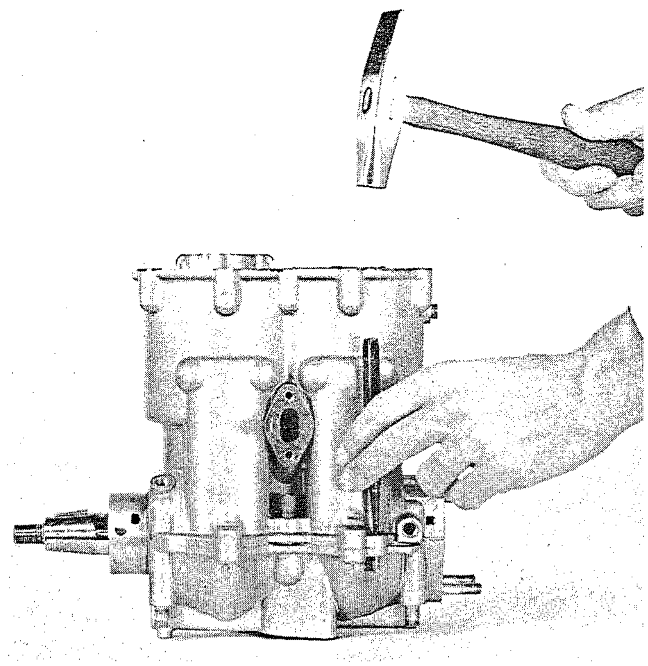


Showing Ready-Pull Starter, Gas Tank, Magneto, Carburetor and Manifold Removed

Remove the screws and nuts holding the crankcase fast to the cylinder block assembly, then drive out (from cylinder block side) the tapered crankcase aligning pins as illustrated. Purpose of the tapered pins is to properly align the crankcase section with respect to position of the journal bearings, one-half of each being cast respectively in the top and bottom halves of the crankcase.

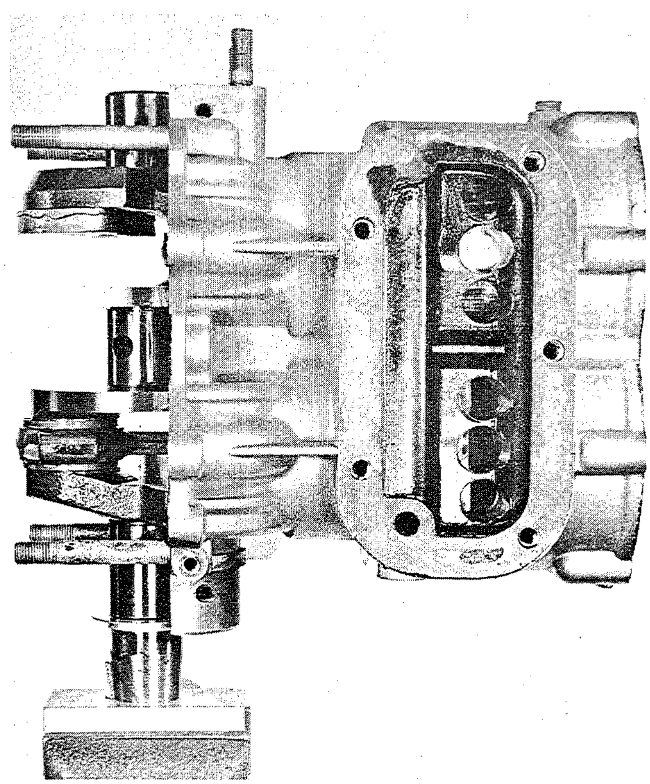
Prior to removing the piston-connecting rod assemblies, indicate respective positions in the cylinder block. This can be accomplished by marking the piston heads or connecting rods with chalk or pencil—numbers 1 and 11, etc.

Bend lugs away from screw head on connecting rod cap to permit removal of the cap screws. Lay cylinder block assembly on its side. Remove one connecting rod cap at a time, holding hand under the cap to catch the needle bearings as they fall



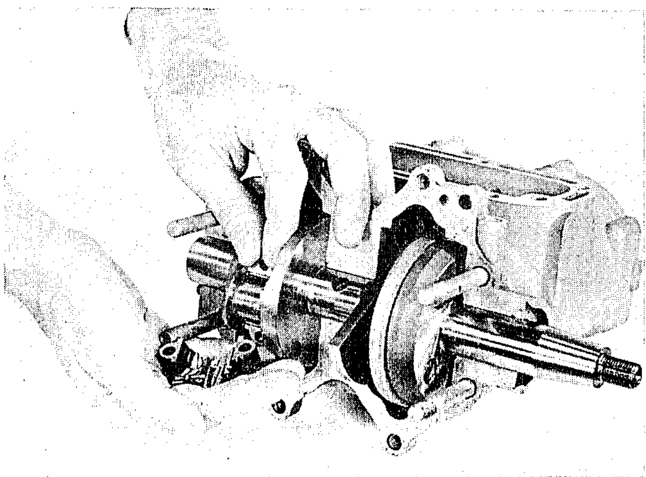
Driving Out Tapered Aligning Pin

from the crankpin. Push the connecting rod away from the crankpin to collect balance of the needle bearings. There should be 28 per each crankpin—count them. Place needles in clean paper or cloth bag, then push piston-rod assembly out of the cylinder. Note that rod and cap are prick-punched to



Power Head Mounted in Vice Block for Loosening Connecting Rod Screws

indicate original assembly. Replace cap and screws accordingly. Attach paper or cloth bag containing the needles to the connecting rod to prevent possibility of interchanging with needles of the other rod on reassembly.



Removing Connecting Rod Cap and Bearing Needles

Remove the other piston-rod assembly carefully and in like manner.

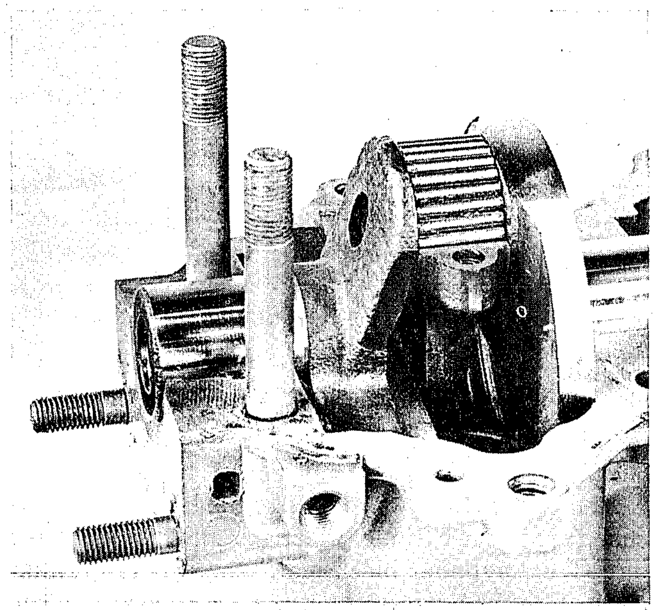
After having completed disassembly of the power head, the dismantled assemblies should be washed (made free of carbon, oil, grease or foreign matter) and the functional parts thoroughly examined and inspected as to their fitness for further service—discard unfit or otherwise excessively worn parts and replace with new, unless reconditioning makes it possible to restore former usefulness.

Examine condition of the cylinder bores, keeping in mind they must be round with straight walls—not excessively worn or scored. The appearance of a glass-like cylinder wall surface is indicative of wear which contributes to loss of compression (power) and faulty operation of the motor since a certain amount of minute roughness is required to provide an efficient seal in conjunction with performance of the piston ring. Oil retained in the microscopic grooves of a properly machined cylinder wall and piston ring face (seat) actually provides the seal against compression and power loss.

In event both the ring seat and cylinder walls have been worn smooth (to the extent of resulting in highly polished surfaces) it becomes increasingly difficult for the sealing oil film to retain its position (between the cylinder wall and piston ring) and subsequently, to carry on its normal function, the result of which is "blow-by" to cause diminishing power, overheating, loss of power, etc.

The fact that inspection reveals highly polished cylinder walls need not necessarily indicate excessive wear—the bores may still be round, straight and serviceable, requiring but a little "roughing" to restore original dull luster like appearance (caused by microscopic grooves in the surface). "Roughing" can be accomplished with a cylinder hone—just a few turns in the bore will do. "Roughing", however, should not be considered under any circumstances until it is first and definitely established that doing so will not result in creating excessive clearance between the piston and cylinder wall (see clearance chart) and that the bore is not "worn" beyond the point of reconditioning in this manner — resizing and fitting with oversize pistons and rings may be required.

The wrist pin fits should be checked for wear and looseness which can be accomplished by grasping the piston in one hand and attempting to move the rod up and down on the pin with the other, then by attempting to twist or rock the rod sidewise on the pin. In event of considerable looseness being noted in this respect, it will be advisable to remove the pin to check its fit in the wrist pin holes (piston) and bushing in the small end of the rod—see clearance chart. Replace parts as and if required.



Showing Needles in Position on the Crankpin

The pistons should be checked for roundness, excessive skirt wear, scores, etc.—carefully remove piston rings to permit examination of the ring grooves as to wear and carbon accumulation. Remove carbon if necessary, as previously instructed. If piston ring grooves are in suitable condition for further service and the piston otherwise serviceable, check piston fit in the cylinder, assuming, of course, the cylinder bores are round, straight and serviceable. Slip the piston into its respective bore — insert feeler gauge of proper thickness (see clearance chart) between the piston cylinder wall.

If gauge strip slides loosely between the skirt of the piston and the cylinder wall, insert the next thicker gauge strip, and so on, until one of the strips appears to bind slightly. Note thickness stamped on the strip, then consult clearance chart to determine course of procedure.

It is possible to check straightness of the cylinder walls in a like manner—check clearance between the piston skirt at the top of the bore, then advance the piston farther down in the bore and note "feel" between the cylinder wall and piston at this point. If free or loose, attempt inserting next thicker strip and so on until slight binding is noted. In event it is possible to insert a thicker strip of the feeler gauge near the center of the bore than at the top, the cylinder walls can be assumed to be "barrel or bottle" shaped. However, if the reverse is true and the thicker strip is required to take up the clearance between the piston and the top of the bore, the cylinder can be considered "wedge" shaped—larger at the top than at or near the bottom of the bore. Greatest cylinder wear, nevertheless, is generally found in area of the ring travel and in vicinity of the ports. The cylinder otherwise can be checked for wear and size by taking micrometer readings from a snap gauge adjusted to various positions in the cylinder bore as previously instructed.

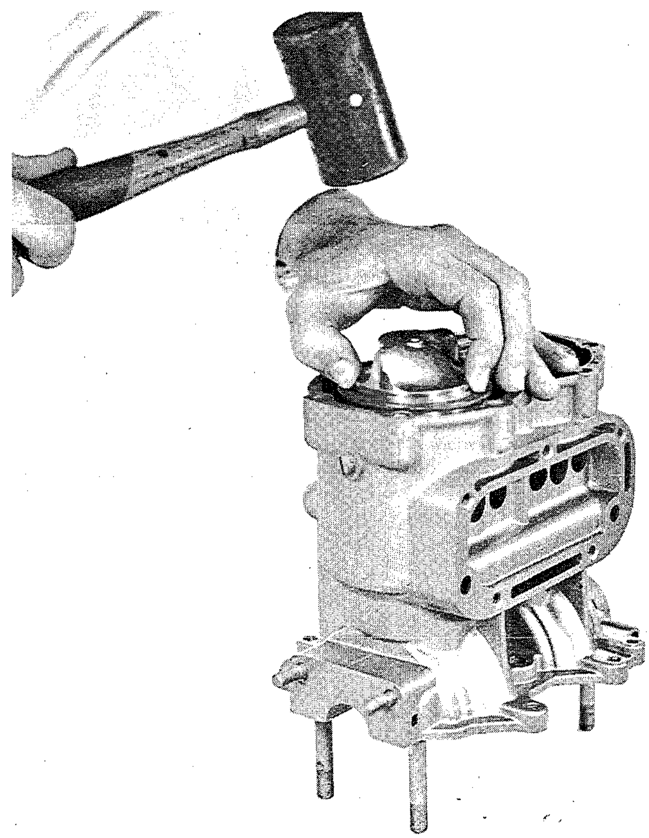
Check the piston-connecting rod assembly on aligning fixture for straightness — no bend, no twist, as previously instructed.

The piston rings should be checked for serviceability—discard if face or wall seat is worn to a high polish and if there are evidences of side wall wear or other irregularities to interfere with efficient ring performance. Place ring squarely in its respective cylinder bore—this can be done by first inserting the ring, then by using the bottom of the piston "square" it up in the bore; push the ring down in the bore slightly with the bottom of the piston. Check gap between ends of the ring — if greater than indicated on the clearance chart, discard and replace with new ring. Check each ring in their respective piston ring grooves for evidence of tightness or binding by rolling the ring around the piston in ring groove. Check for side clearance with feeler gauge—see clearance chart.

Don't waste time with doubtful rings—install new rings when in doubt but make certain they are properly fitted. Bear in mind, too, that it requires more running of the motor to properly seat a new ring in an old cylinder bore (not reconditioned).

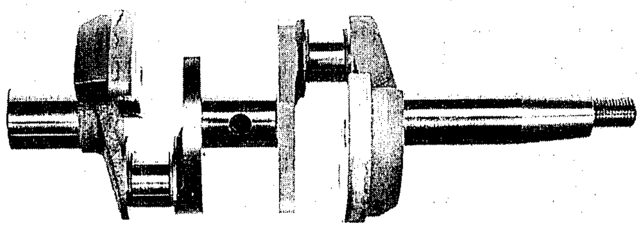
Carefully install rings in the piston ring grooves, being cautious not to "burr" the ring lands nor the side walls (ring grooves). Make certain they are free in the ring grooves—check after installing. Place several drops of oil in each ring groove (between ends of the ring)—turn rings in their grooves to spread the oil.

Assuming now that the cylinder bores are in serviceable condition (reconditioned or new) with ports clean and free of carbon and that the pistons, rings and connecting rods are in like condition, having been previously checked as to serviceability, preparations should be made for assembly. Spread a film of oil over entire surfaces of the cylinder walls, on the skirt of each piston and about the wrist pin and wrist pin bushing to avoid starting later on with dry surfaces in this respect. Make it a point to see that no foreign particles nor grit of any sort cling to the cylinder walls, skirts of the pistons or in the piston ring grooves, thus eliminating the possibility of scratching or scoring the smoothly finished surfaces from the start. It is important that assembly be performed with clean hands—free of grit and grime.



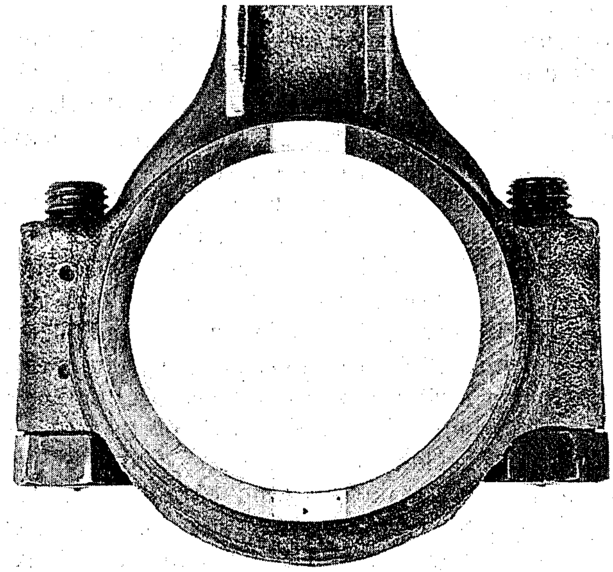
Compress Piston Rings with Fingers—Carefully and Lightly Tap on Head of Piston with Mallet to Position the Piston in the Cylinder. (Sloping Sides of the Piston Deflector Must be Directed Toward the Exhaust Ports).

Insert piston-connecting rod assemblies in their respective cylinder bores (each having been marked accordingly on disassembly) with straight side of the piston deflector directed towards the intake port. Arrange piston rings properly in the ring grooves in accordance with position of the small pin in each. Compress the bottom ring with fingers and tap lightly on the head of the piston with small rawhide mallet to drive piston in. This operation should be carefully and gently performed to prevent breaking of the rings—do not strike the head of the piston too vigorously, a light tap will do if the ring is properly compressed and located in the ring groove. Proceed in like manner until all three rings and the piston are fully inserted in the bore. Install second piston-connecting rod similarly.



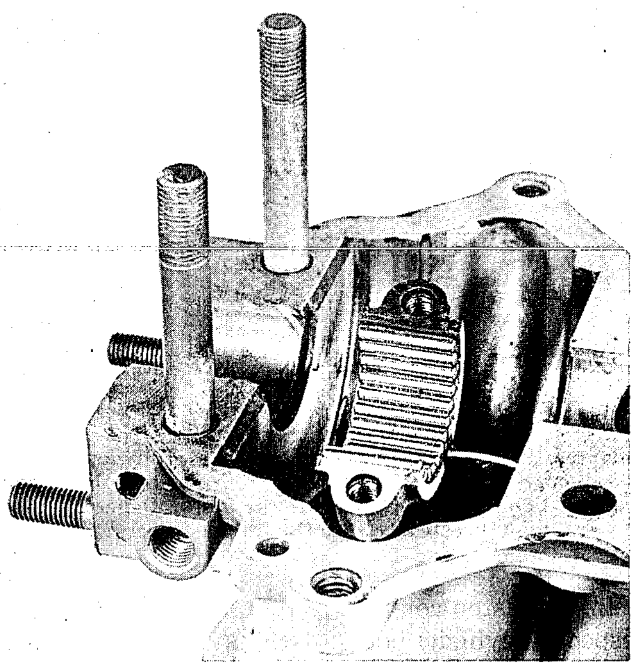
Model SD Crankshaft

Check the crankshaft for straightness as instructed earlier—check journals and crankpins for irregularities (rust, pitting, etc.)—also, see that the flywheel keys are correctly and snugly fitted in the keyway in the taper of the shaft. Observe condition of the threaded end. Make certain threads are fit for additional service to permit securely drawing up of the flywheel nut.

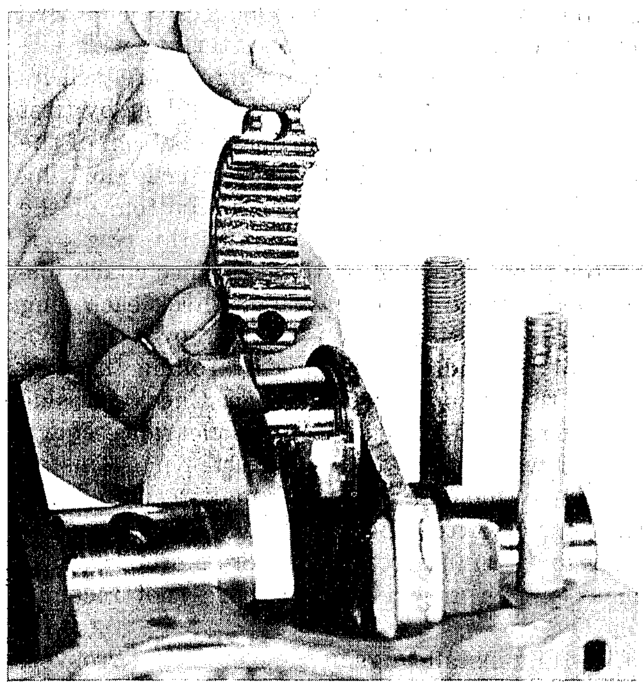


Showing Index Marks Prick-Punched on Connecting Rod and Cap

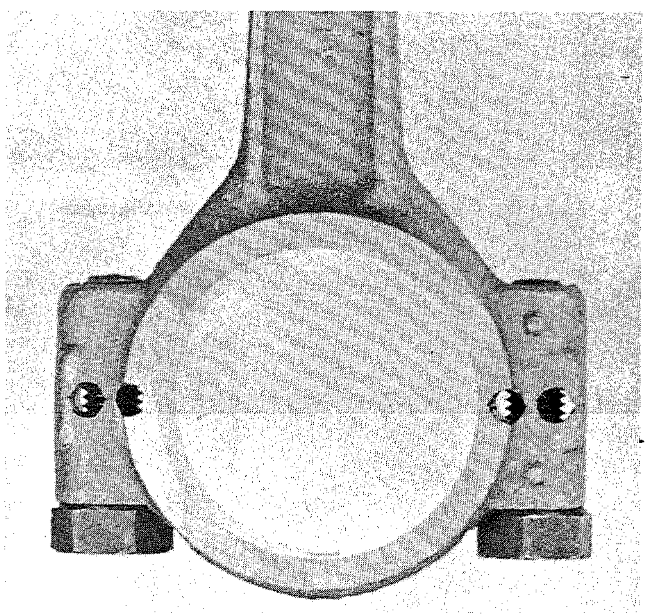
Smear clean, clear grease over bearing surface of each connecting rod and cap—place fourteen (14) needles in each (28 make up each bearing assembly). Purpose of the grease is to hold the needles in position during assembly. Note prick punch mark on both the rod and cap. Place a drop or two of oil on each journal bearing, then insert crankshaft at the same time, turning it over tc spread the oil and to check for freeness in the bearing halves—periodic tightness or binding at this



Showing Needles Placed in Connecting Rod

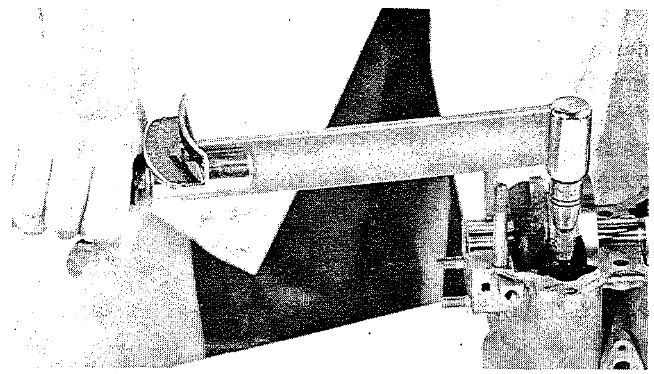


Placing Connecting Rod Cap and Needles in Position on the Connecting Rod time is indicative of a sprung crankshaft. Pull connecting rod (with needles inserted) up against the crankpin. Place cap, with needles inserted, in position on the rod in such a manner that mark on cap and rod align. Insert connecting rod screws with new lock plates. Draw up snugly on screws then bend two lugs of the lock plate down and over the rod. Check side and end surfaces of the rod and cap as previously instructed for assemblies of this nature. Check with pencil point to make certain side and end surfaces align. This is extremely important. After alignment, make final draw up on cap screw then bend the remaining lug of the lock plate up against the side of the screw head.



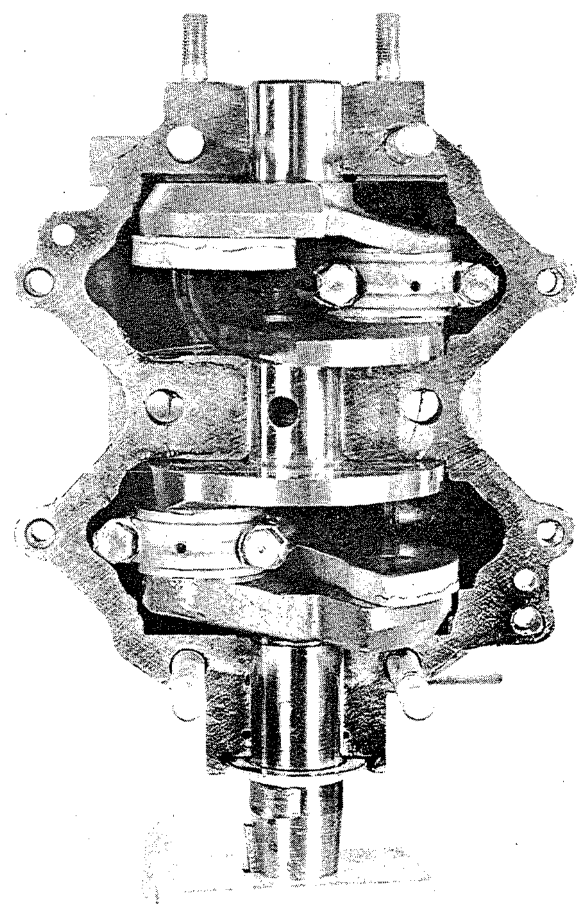
Crankpin End of SD Connecting Rod—"Split" Type Construction

Construction of the rod is somewhat different in those of later design Model SD's, commencing with Serial No. 684446, in that the rod and cap are machined as an integral unit, then broken (split) apart. This operation leaves both the rod and cap with a rough or serrated like surface, which, when replaced, provides correct alignment of the bearing surface and side faces. Care should be exercised when installing the cap. Note embossing of both rod and cap—arrange cap in such a manner that embossing aligns on the same side. Carefully adjust position of the cap or the rod (with needles in position) to insure jagged faces falling together in proper alignment. This is extremely important—if not correctly "matched," evidence will be indicated by offset alignment of the side faces (of the rod) and, of course, the bearing surface in which the needles float to later result in damage to the bearing assembly and possibly to the entire power head.



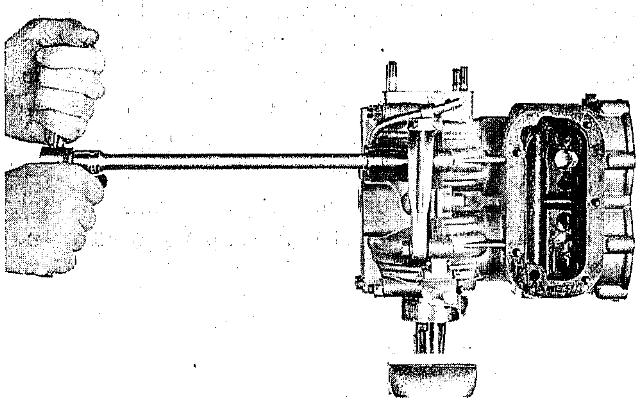
Showing Use of Torque Wrench on Connecting Rod Screws

It will be noted, too, that **no** lockplates are employed on the connecting rod screws—their security being maintained by tightening to proper tension. After having matched the cap and rod, insert and evenly tighten cap screws until drawn up snugly—finish operation with torque wrench (as illustrated) drawing up to 20 foot pounds, or, if the particular instrument is graduated to inch pounds, 240 inch pounds will properly secure the screws.



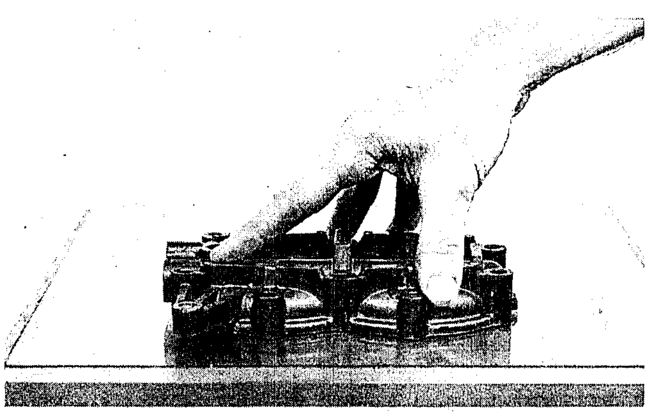
Showing Crankcase Assembly Mounted in Vice for Final Check of Connecting Rod, Cap Screws and Lock Plates Where Used

On completion of assembling and aligning the piston-connecting rod assemblies, check to make certain the crankcase surfaces are clean and free of particles, grit, etc. Apply thin coat of cement to crankcase faces of the top half only—guard against excessive coating. Place a drop or two of oil on each bearing insert in the bottom half of the crankcase but only after washing the surfaces clean and free of grit, etc. Attach bottom half of the crankcase to the cylinder block assembly—drive tapered pins into position to align crankcase sections. This is important. Draw up evenly and tightly on nuts holding crankcase sections together. Draw up and tighten evenly nuts on studs protruding from the crankcase (top and bottom) adjacent to the journal

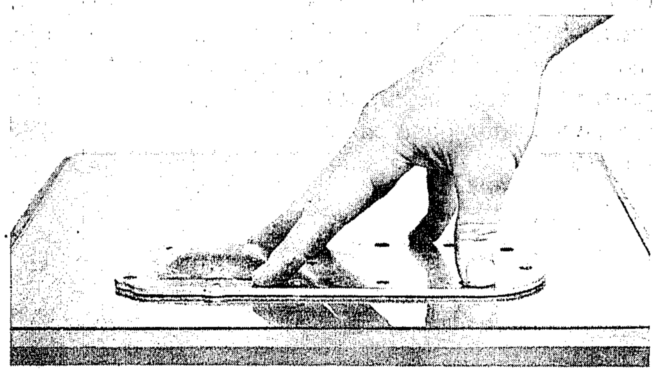


Power Head Mounted in Vice Block for Installation of Crankcase

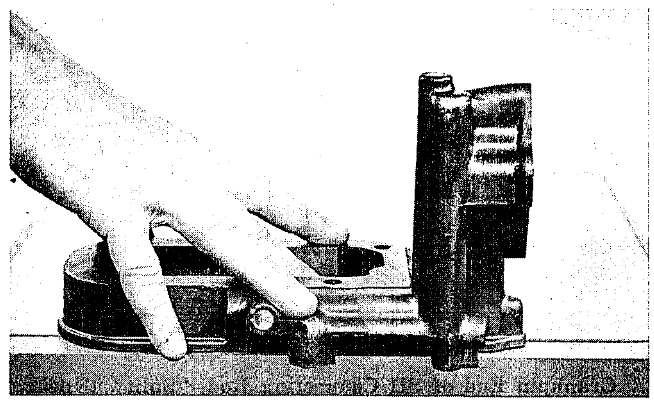
bearings. This operation should be followed by installation of the cylinder head and gasket after having checked "flatness" of the head face. Warpage of the cylinder head will eventually result in a blown gasket to interfere with performance of the motor. Place a sheet of No. 0 emery cloth on a piece of flat plate glass or other flat surface. Move cylinder head gently and under slight pressure back and forth several times over the emery cloth to determine if high and low spots actually exist to indicate a warped head. In case of a warped surface, continue to move the head back and forth over the emery cloth until entire surface has made contact with the flat piece of emery cloth. Remove emery cloth and spread lapping compound evenly over surface of the plate glass—finish lap by moving the head over the plate in figure 8 fashion until a smooth, flat surface has been obtained.



Lapping Cylinder Head to Insure Flatness



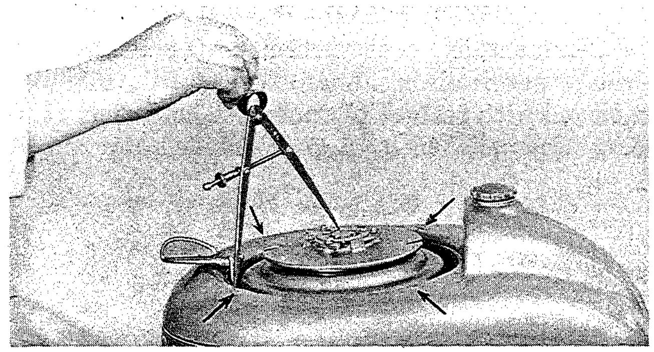
Lapping Manifold Cover Plate to Insure Flatness



Lapping Manifold to Insure Flatness

Check manifold and manifold plate for "flatness" as described above—lap accordingly if necessary. Install new gaskets and proceed with the installation. Attach power head to the driveshaft casing and exhaust pipe, using new gaskets. Install tank, brackets, oil return line, carburetor, magneto assembly, gas tank and ready-pull.

The gas tank must be correctly centered to permit starter pawls in the Ready-Pull head properly engaging the dogs or ratchet attached to the flywheel. Position of the tank with respect to center of the crankshaft can be checked with dividers as illustrated. When properly installed, holes (for mounting Ready-Pull head) in the tank should be equidistant from center of the crankshaft. Note that holes in the tank mounting brackets and in boss on the tank are either elongated or larger than diameter of the mounting screws—this to permit a certain amount of shifting of the tank for center-ing purposes prior to finally drawing up tightly on the screws to secure position of the tank. In event the tank comes to rest at a position too far down in the assembly, even though properly centered, further adjustment will be required to prevent mechanism in the starter head striking or rubbing on the ratchet attached to the flywheel. This can be accomplished by placing flat washers on top side of the mounting bracket (on the crankcase) to raise the front end of the tank slightly. Rear end can be raised by simply lifting up on the tank a bit prior to drawing up on the securing screws.

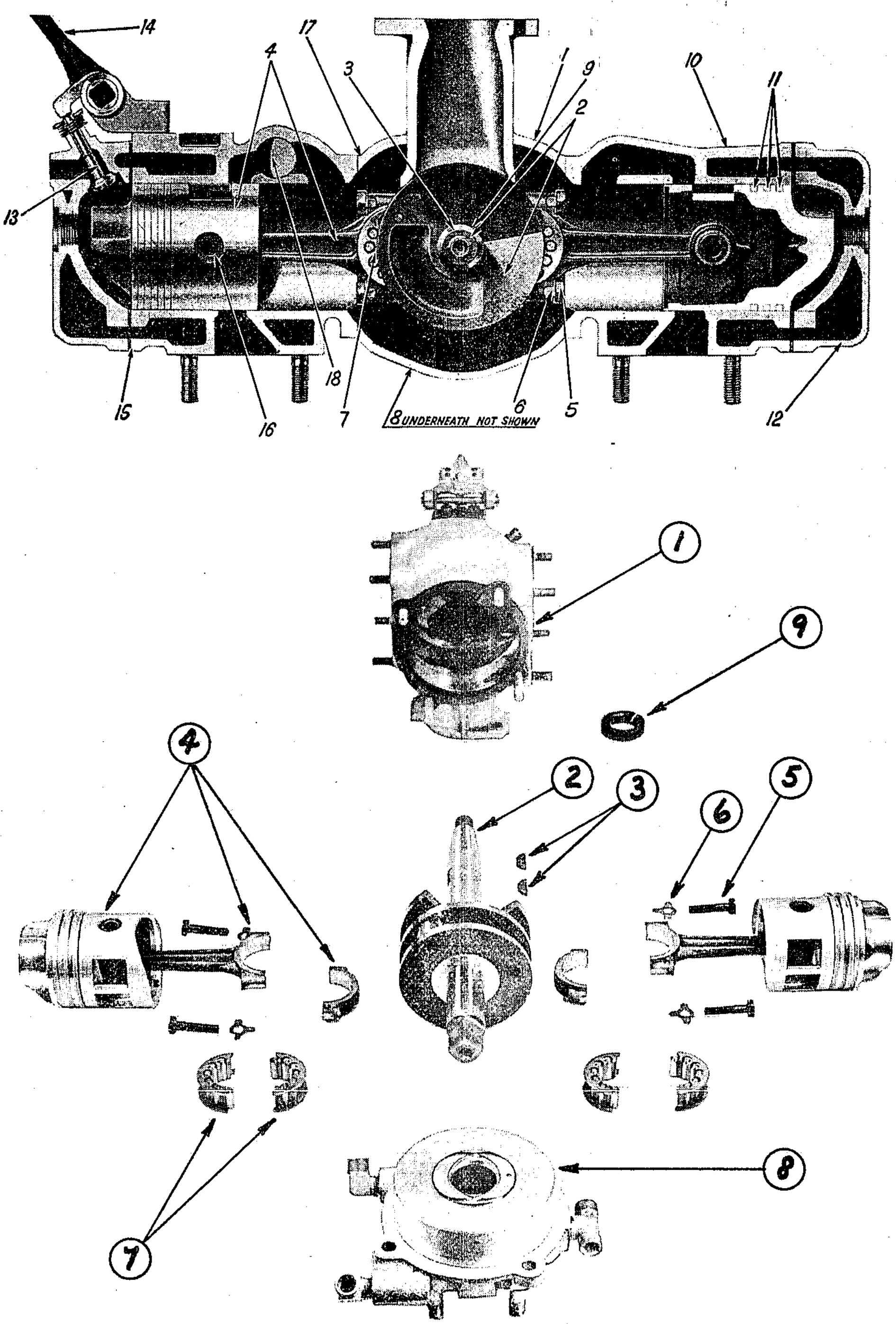


Checking Alignment of Gas Tank

NOTES

POWER HEAD—P AND PO

Fundamentally, construction of the P and PO series power heads is similar except for the method employed with respect to crankcase induction, this being accomplished by a gear driven rotor valve in the former while by way of a section machined out of the crankshaft cheek in the latter, thus, following instructions will suffice for both series. Repairs on the S and V series can also be carried on in like manner.



Powerhead Assembly Group—Less Cylinders and Cylinder Heads

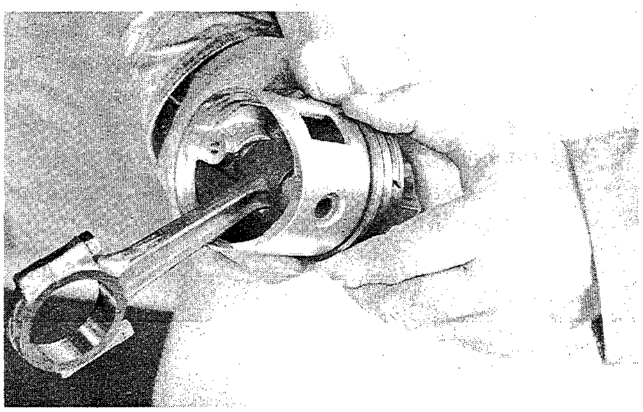
1. Crankcase
2. Crankshaft
3. Flywheel Keys
4. Piston and Connecting Rod Assembly
5. Connecting Rod Bolt
6. Connecting Rod Bolt Lock Plate
7. Roller Bearing Assembly
8. Crankcase Head
9. Oil Slinger
10. Cylinder
11. Piston Rings
12. Cylinder Head
13. Release Valve
14. Release Valve Lever
15. Cylinder Head Gasket
16. Wrist Pin
17. Cylinder Base Gasket
18. Bypass Valve

TO REMOVE PISTON RINGS FROM PISTON

Expand rings by spreading with thumbs as illustrated and slide over end of piston. There are three rings per each piston. Be careful not to spread too far, rings can be broken. Spread only far enough to permit slipping off piston.

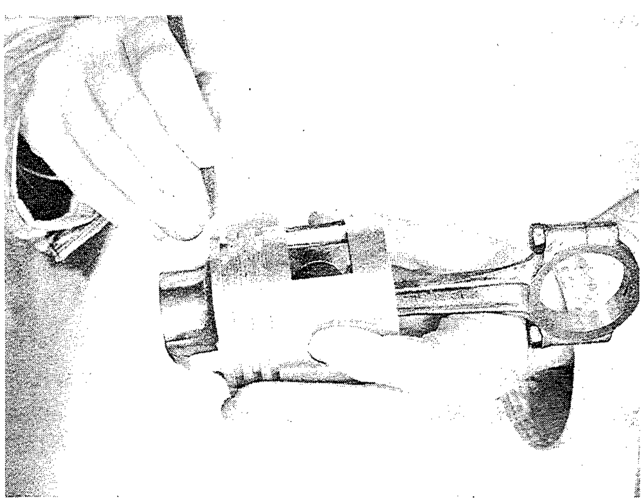
Rings are replaced in reverse order of that described above — spread enough by hand to slide over piston and into position in respective ring grooves.

The piston ring grooves frequently become clogged with carbon after long periods of operation, which requires removal to prevent rings from sticking and becoming partially inoperative. This condition results in loss of compression and noticeable deterioration in power.



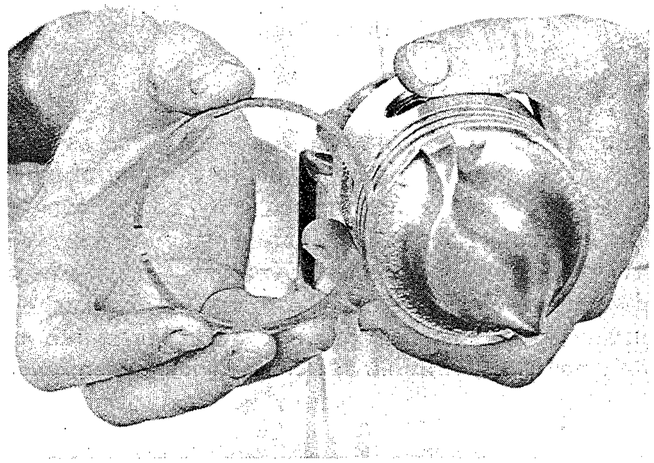
Removing Piston Rings

It is a simple matter to remove carbon from the ring grooves by scraping as shown in illustration. A suitable scraper can be easily made from a discarded file or hack saw blade — make it slightly narrower than ring grooves in piston and sharp enough to scrape out accumulated carbon.



Cleaning Ring Grooves

After removing carbon from ring grooves (piston) and prior to installing new rings, care should be exercised to make certain rings fit in piston grooves with no indication of tight spots or binding. This can be determined by rolling each ring, in their respective grooves, around the piston as illustrated. Resistance will be encountered where tight spots exist — this may be result of particles of carbon, burrs in piston ring grooves or high spots on edge of ring. Check grooves to see that all traces of carbon have been removed. If burrs exist, they usually can be removed with a sharp edge scraper.



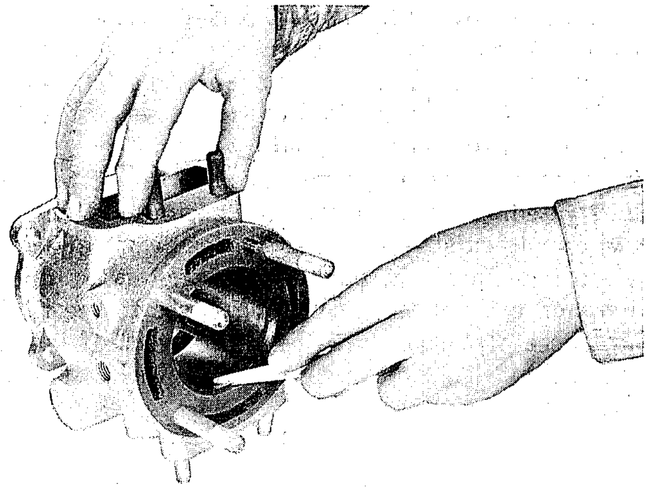
Checking Ring Grooves

Handle piston carefully — burrs are the result of rough handling or dropping.

High spots on edges of ring are not frequent occurrences, but if such is the case, they can be dressed down by rubbing edge (side) of ring lightly over a piece of fine sandpaper or emery cloth placed on a flat surface.

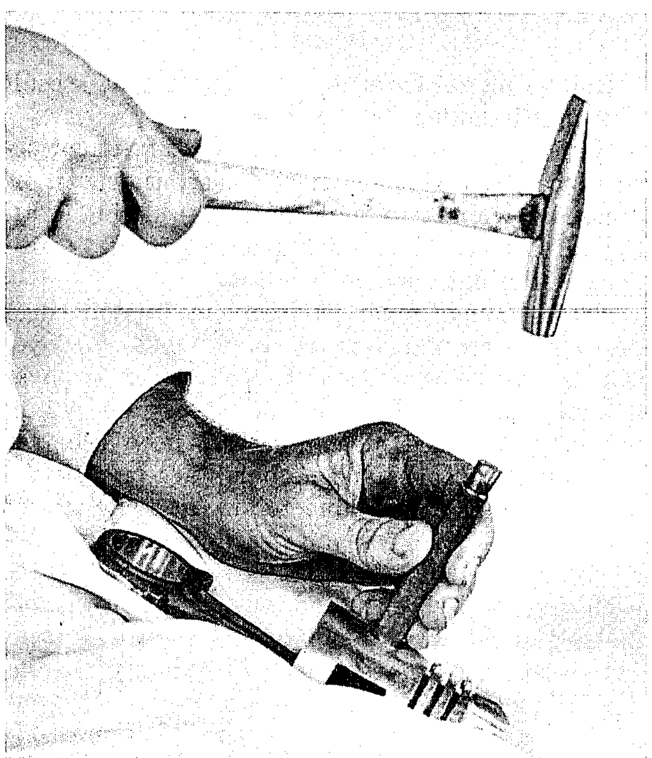
NOTE: Rings must fit freely in (piston ring) grooves. Recommended clearance in piston grooves is .0025″ to .0045″. Piston rings and piston grooves are machined to correct size at factory and will fit properly, provided all carbon has been removed from piston grooves and no burrs are present.

Piston rings are ground to size at factory, but it is advisable to check gap clearance to make sure recommended .005″ to .012″ is maintained. Place each ring squarely in cylinder as illustrated. Insert feeler gauge between ends of ring (gap). Repeat same operation for each ring in respective cylinders. If noted clearance falls below .005″, file end of ring carefully until desired gap is obtained. If clearance is considerably in excess of .012″, cylinder is worn oversize and should be replaced.



Checking Ring Gap

If found necessary to install a new piston, it must be removed from the connecting rod assembly. The wrist pin is held fast in the piston by a set screw which is made secure by a lock washer and lock nut. Loosen lock nut and remove set screw. The wrist pin can then be driven out — this is best done by placing assembly between the knees when in a seated position to prevent springing piston as driving force is applied. Drive from side of piston containing wrist pin set screw and lock nut. If fit appears a bit snug, hold piston in hot water to expand.

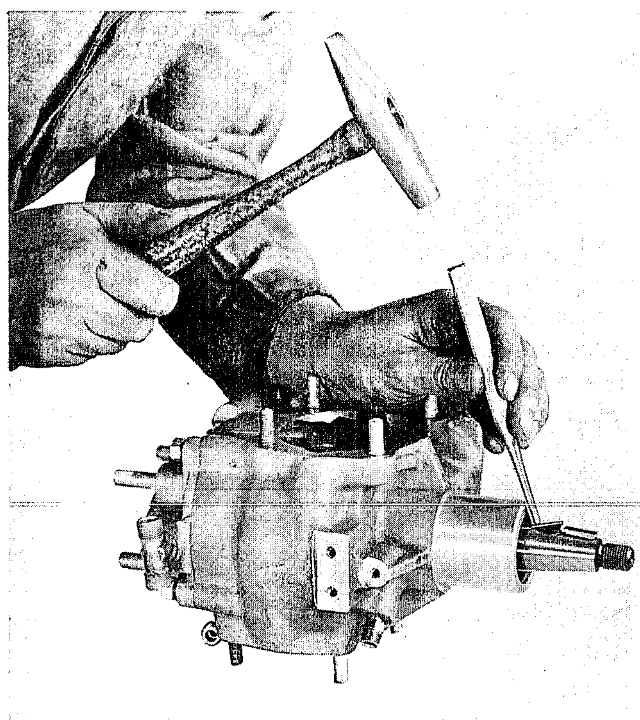


Removing Wrist Pin

Install new piston in reverse order of that above. NOTE: Hole in wrist pin and threaded hole in wrist pin boss (piston)—insert wrist pin through opposite hole in piston, end of pin with hole first. Drive pin home. Hole in wrist pin must line up with threaded hole in wrist pin boss (piston). Install wrist pin set screw—be sure end fits squarely into hole in wrist pin provided for this purpose. When set screw has been made tight in position, tighten lock nut, with lock washer in place, to properly secure set screw. This is important.

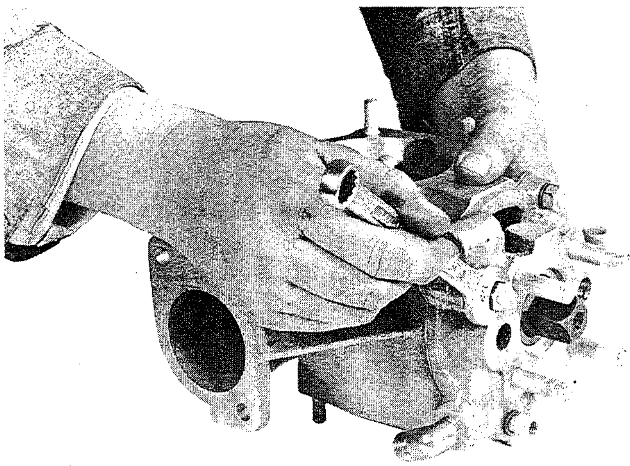
TO REMOVE CRANKSHAFT FROM THE CRANKCASE

The flywheel keys must first be dislodged as they protrude beyond inside diameter of bearing. Both keys can be easily driven out of keyways by using a small flat end punch as illustrated. Care should be taken in this operation not to nick or gouge the crankshaft taper. If accidentally nicked, simply dress down with file prior to withdrawing crankshaft from bearing. Removal of keys can also be performed before detaching crankcase assembly from the driveshaft casing.



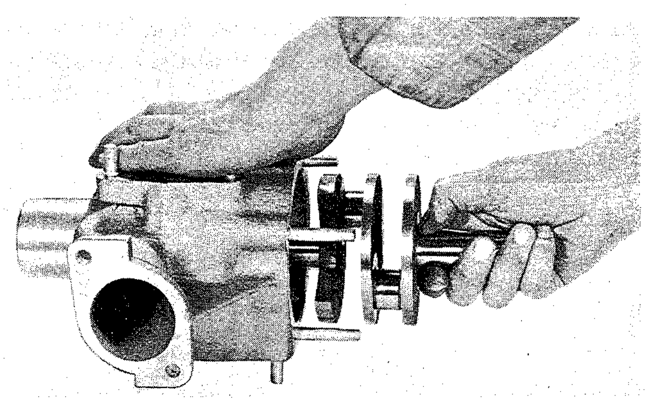
Removing Keys from Crankshaft

REMOVE CRANKCASE HEAD to permit withdrawing crankshaft as shown. Assemble in reverse order of that described above (be sure to install gasket between crankcase proper and crankcase head). Draw nuts, holding head in position, up tightly and evenly.



Removing Crankcase Head

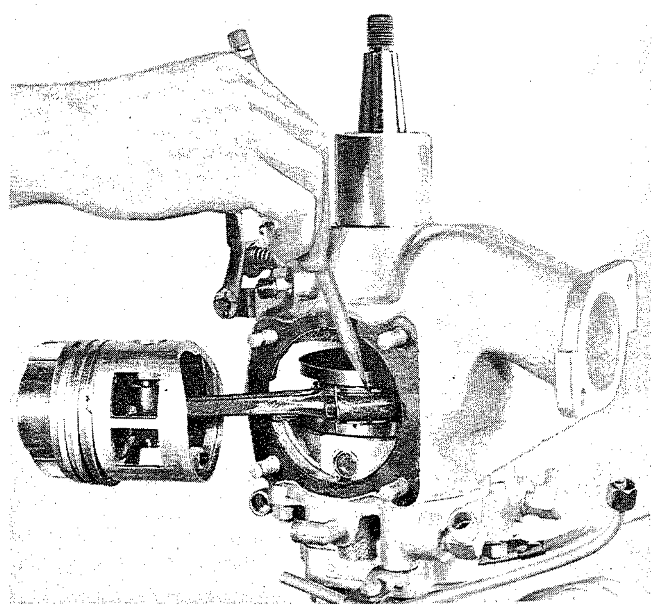
IMPORTANT—Spread coat of oil on crankshaft journals and on bearing surfaces before assembling.



Installing Crankshaft

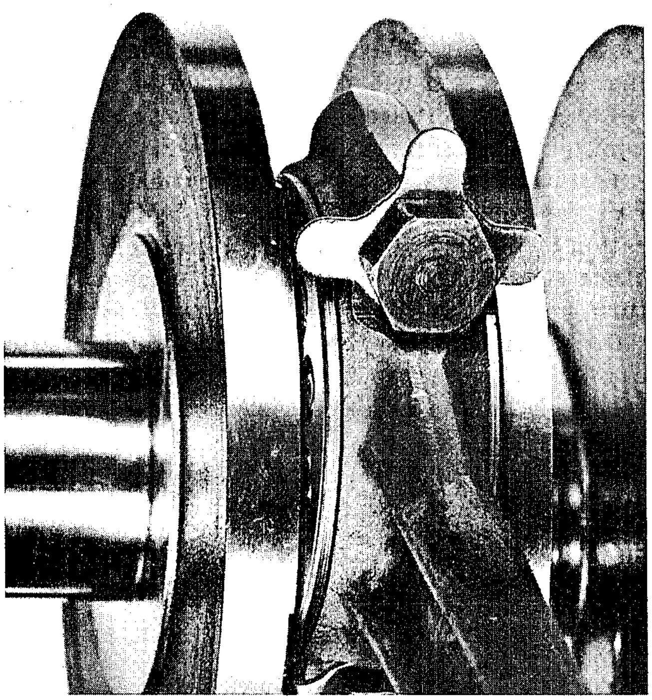
TO ASSEMBLE CRANKSHAFT, CRANKCASE, PISTONS AND CONNECTING RODS, proceed as follows:

1. Make certain all parts are in good mechanical condition, clean and free of foreign matter (dust, grit, etc.).
2. Spread thin coat of oil on crankshaft journals and crankpins — also a few drops in bearings of crankcase and crankcase head.
3. Insert crankshaft.
4. Install crankcase head (be sure gasket is in place) and bolt in position. Crankshaft should turn freely on completing this operation.
5. Slip oil slinger on over top of crankshaft—tap down lightly until it rests on top surface of journal bearing in crankcase. This should be followed by tapping both ends of the crankshaft lightly with a mallet or hammer to make sure clearance exists between oil slinger and top end of bearing. (Oil slinger should not ride or rub on bearing.) Note groove cut in outside wall of oil slinger, leaving a narrow and wide edge. Narrow edge should be directed downward — this is important to prevent oil escaping from the crankcase.
6. Piston rings should be properly fitted — correct gap clearance is .005" to .012", with no indication of binding at any point in the ring groove. Place several drops of oil in each ring groove—turn rings around in grooves to spread oil film.
7. Assemble roller bearings and retainers to crankpins. Note two free rollers, one fitting on each side of the crankpin and between ends of retainers.



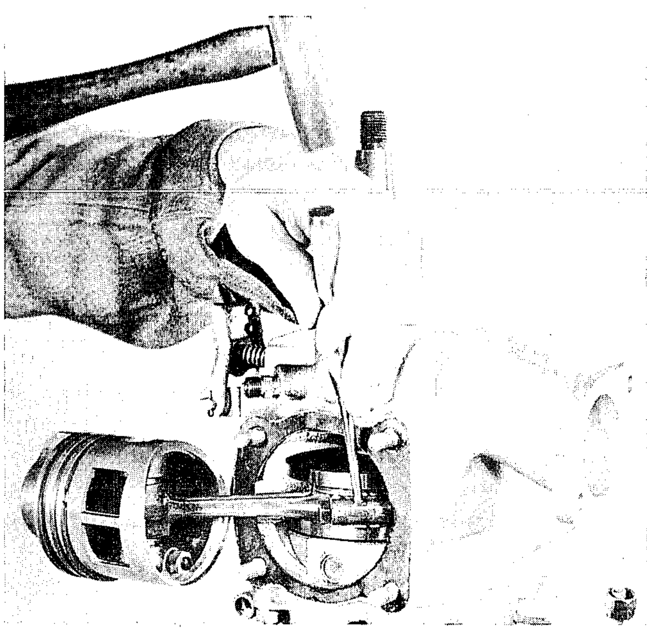
Checking Rod and Cap Alignment

8. Note large ports in wall of piston and punch marks on connecting rod and cap. When attaching connecting rod and piston assembly to crankpins, ports in piston should be directed towards carburetor side of crankcase; connecting rod and cap should be assembled with both marks on same side. This is important.
9. Turn crankshaft to bring crankpins to outer most position — slip connecting rod cap back of crankpin and around rollers. Place piston and rod assembly in position. Assemble lock plates and screws. (Be sure both marks are on same side.) Tighten connecting rod screws — bend two lugs on each lock plate protruding opposite each other down over connecting rod.
10. Connecting rod and cap must be properly aligned — that is, cap must line up perfectly with rod — sides of both must be flush. This can be accomplished by turning roller assembly so that gap



Showing Lockplate Installed Under Head of the Connecting Rod Screw

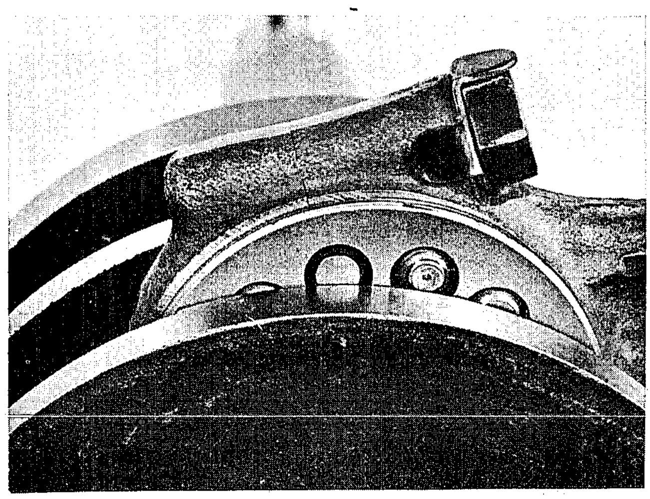
between retainers comes to rest over junction of cap and rod. By sliding a pencil over junction, as illustrated, it is a simple matter to determine whether or not surfaces are flush. In event one side or the other is high, drive high side down until flush with other. Check again with pencil. When surfaces are flush, tighten screw and bend remaining protruding lug up and against screw head to lock in position.



Align Rod and Cap

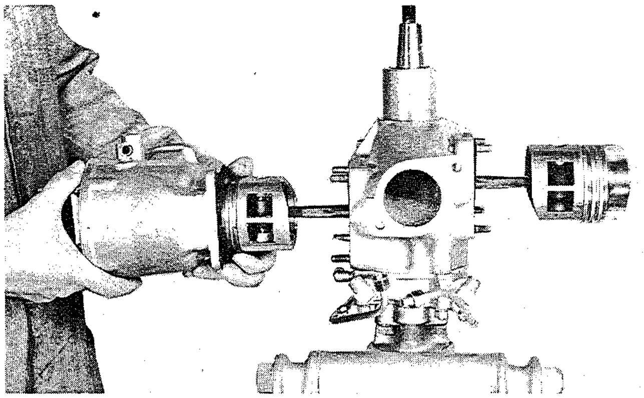
Construction of the rod is somewhat different in those of later design in that the rod and cap are machined as an integral unit, then broken (split) apart. This operation leaves both the rod and cap with a rough or serrated like surface, which, when replaced, provides correct alignment of the bearing surface and side faces. Care should be exercised when installing the cap. Note embossing of both rod and cap—arrange cap in such a manner that embossing aligns on the same side. Carefully adjust position of the cap or the rod (with roller assemblies) to insure jagged faces falling together in proper alignment. This is extremely important —if not correctly "matched" evidence will be indicated by offset alignment of the side faces (of the rod) and, of course, the bearing surface in which the rollers float to later result in damage to the bearing assembly and possibly to the entire power head.

It will be noted, too, that *no* lockplates are employed on the connecting rod screws—their security being maintained by tightening to proper tension. After having matched the cap and rod, insert and evenly tighten cap screws until drawn up snugly —finish operation with torque wrench, drawing up to 20 foot pounds, or, if the particular instrument is graduated to inch pounds, 240 inch pounds will properly secure the screws.

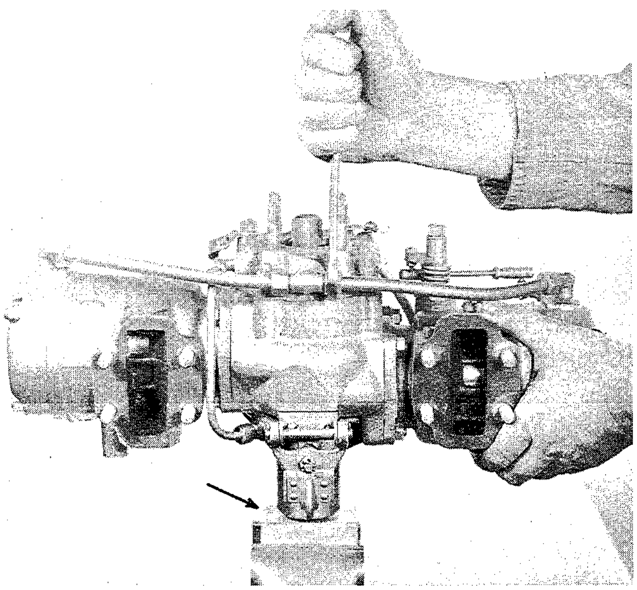


Showing Opposite Lugs of the Lockplate Bent Down Over the Rod While the Third Lug is Bent Up Against the Head of the Screw to Prevent Its Turning and Becoming Loose

TO ATTACH CYLINDERS—Be sure cylinder walls and pistons are clean. Spread film of oil on cylinder walls and skirt of piston. Install cylinder base gasket over studs on crankcase. (Not necessary to cement this gasket.) Compress piston rings with fingers. Slide cylinder over piston and up to crankcase — attach necessary washers and nuts and tighten to securely mount cylinder.



Attaching Cylinder

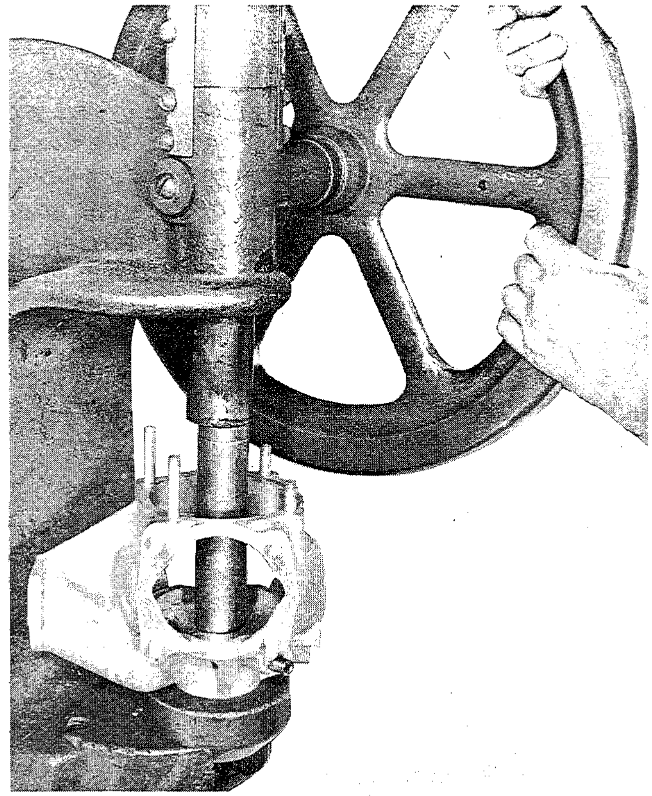


Showing Powerhead Mounted in Vice Block for Better Accessibility

TO INSTALL JOURNAL BEARINGS (Crankcase)

The journal bearings seldom require replacing; while appearing to be loose (when compared to similar bearings in automotive practice) they are originally fitted with considerable clearance at the factory to provide sufficient lubrication. There is no noticeable crankcase compression loss under these conditions and the bearings need only replacing when clearance has reached the point where oil from the crankcase begins to smear on the magneto armature plate.

TO INSTALL NEW CRANKSHAFT JOURNAL BEARINGS, the old bearings must, of course, be removed. This is accomplished on an arbor press as illustrated. Both top and bottom bearings are pressed out in a similar manner — use a round bar or mandrel slightly smaller than the bearing to permit driving all way through bearing bosses.



Driving Out Journal Bearing

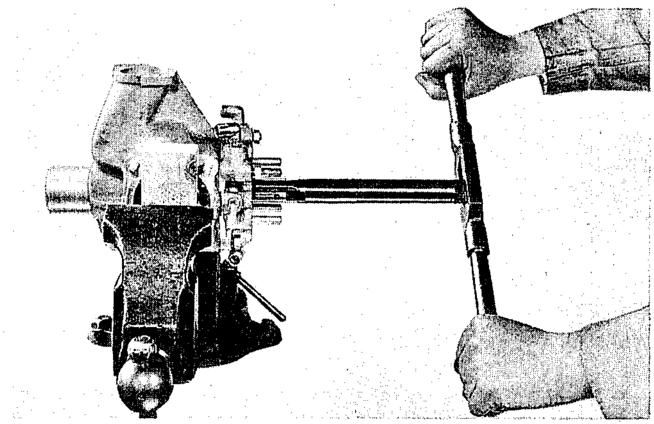
NOTE: Top bearing fits into crankcase proper, while the bottom bearing is pressed into the crankcase head (lower section of the crankcase).

On removal of old bearings, to install new top bearing, crankcase should be placed on the press table with bearing boss up. Bottom end of top bearing is machined to match contour of inside of crankcase. Line up bearing with respect to contour of crankcase (inside) and press into case until bottom of bearing is flush with inside of crankcase. It is advisable to note position of the old bearing before pressing out to install a new one.

TO INSTALL BOTTOM JOURNAL BEARING, place crankcase head on press table with inside surface up. Note oil holes in bearing and corresponding holes in crankcase head — align bearing accordingly and press in until thrust face of bearing comes to rest solidly against head.

TO REAM JOURNAL BEARINGS. After having installed new journal bearings, they must be reamed to size — top bearing 1.0015″, bottom bearing 1.0415″. This permits clearance of .003″ at top and bottom journals since they are ground to .999″ and 1.039″ respectively.

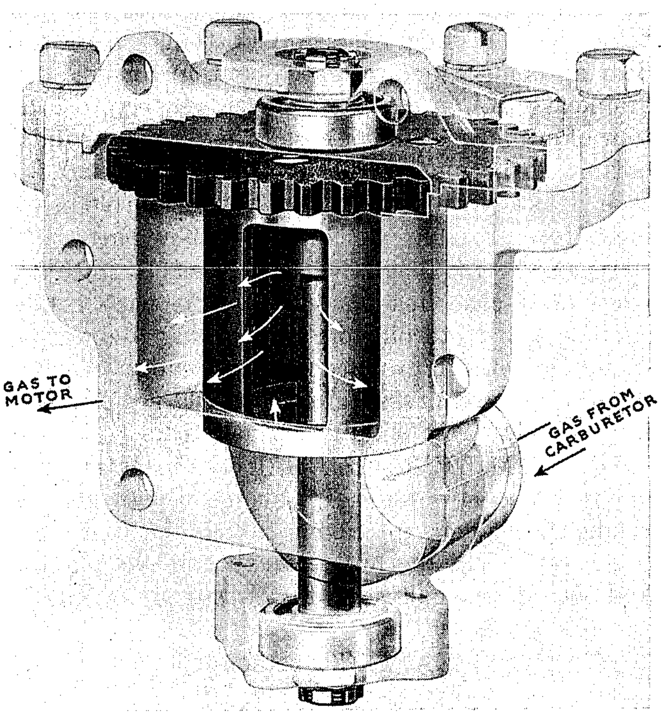
TO REAM BEARINGS, attach crankcase head —draw up tightly and evenly. Place crankcase assembly in vise as shown. Use wood blocks to prevent injury to studs. Two reamers are used in this operation, namely — the rough reamer No. S-86 and the finish line reamer No. S-83. Insert pilot of rough reamer through bottom journal bearing and on into top bearing while turning reamer in clockwise direction (facing bottom bearing). These reamers are provided with two cutters—one for each bearing since they are of different size. Continue turning reamer, at same time forcing it gently forward until cutters pass through bearing. Withdraw reamer slowly with same turning motion — clockwise. Insert finish line reamer and proceed in like manner. The bearings should now be reamed to correct size and ready for assembly of the motor.



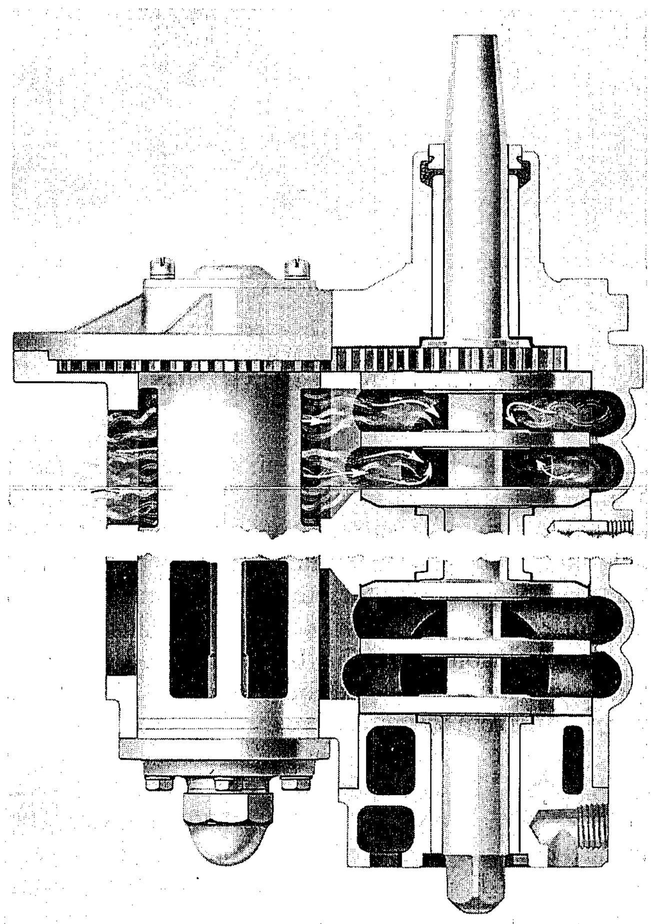
Reaming Journal Bearing

GEAR DRIVEN ROTOR VALVES

The S, P-50 up to and including the P-70 and V series motors were all provided with gear driven rotor valves for crankcase induction. The rotor assemblies consisted of a cylindrical rotor with cast-in or machined cavities to permit transfer of fuel vapor when aligned with corresponding openings in the housing in which the rotor revolves and the necessary gear arrangement to time opening and closing with respect to position of the piston in the cylinder. Models S and V-45 were geared 1:1 ratio —later models of the series 2:1.

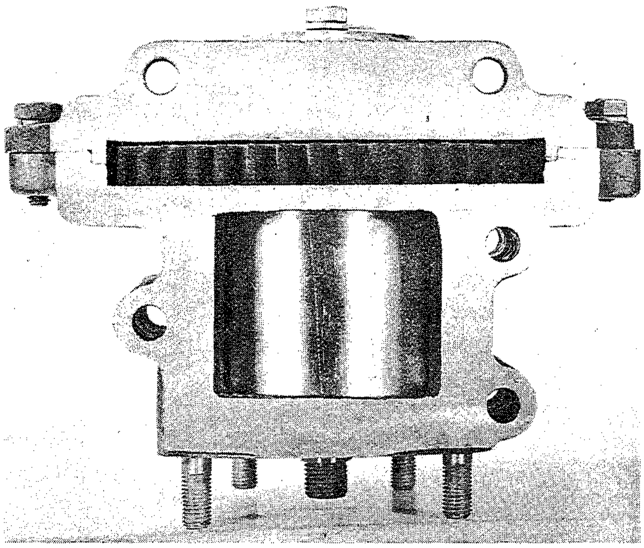


Illustrating Gear Driven Rotor Valve

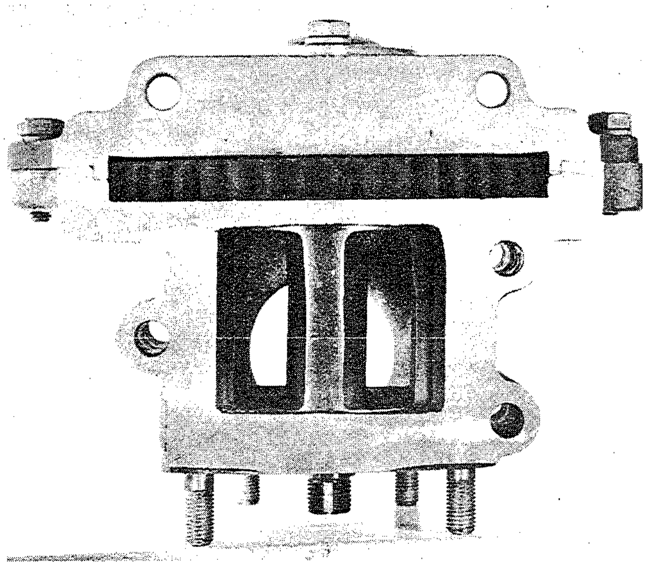


Views to Illustrate Open (Top) and Closed (Bottom) Position of Rotor Valve

Since the rotor assemblies are detachable from the crankcase, correct timing or meshing of the gears (one on the rotor shaft and one on the crankshaft) is required on reassembly to ultimately assure maximum fuel charge entering the crankcase —the rotor valve must open and close at the proper time to realize maximum performance of the motor.



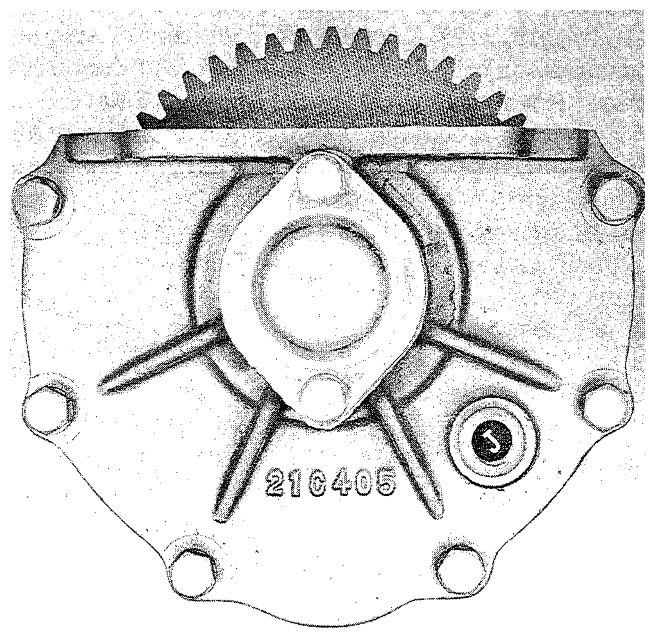
Showing Rotor Valve Closed



Showing Rotor Valve Open

To time—with spark plugs removed and ignition leads grounded, insert narrow scale into cylinder through spark plug hole (top cylinder or four cylinder V Models) until it comes to rest on the head of the piston. Turn flywheel slowly in direction of normal rotation (left to right) until piston comes to rest at top center. Note distance indicated on scale then continue rotation until the piston has advanced 1/2 inch below top center, keeping in mind rotation is from left to right. One-half (1/2) inch below top center is correct for service motors while 5/8" below top center is advised for the racing series.

Remove inspection screw from rotor housing cover—note letter "J" stamped on the rotor gear. Rotate gear until the letter "J" is visible in center of the timing port. Attach rotor assembly to crankcase in this position at the same time inserting proper gaskets (shims) to provide necessary gear clearance (mesh) — approximately .0015" backlash.



Showing Position of Letter "J" (Stamped on the Rotor Gear) When Rotor Valve is Properly Timed.

Make no "dry" assemblies—coat all bearing surfaces, cylinder walls, pistons and rings with oil prior to final assembly.

WHAT'S WRONG WITH IT? "Three-Fourths of the Cure is in Diagnosis of the Ailment"

What do you do first when a Johnson owner brings in his motor and says, "You make it run." Do you jump right into it or do you try to "dope" it out before laying a wrench to it?

The thing was built to run, so if it doesn't run or run **right** when you get it, it's best to look around a bit—investigate and ponder a little. Put the owner on the "pan" too—maybe it's not the motor at all—it could be him, you know. Possibly he doesn't understand it. Try to find out how he goes about starting and running it. He may be doing something wrong. In this case, give him a hand —spend a little time with him. He'll not only thank you for it but it's good for your business. It's building good will and he'll be back some day or probably send a friend in with some cash to spend. It's a good way to sell yourself. If he's sold on you, you're all set with him for the future.

Now, if the motor doesn't run at all or run as it should, remember THREE FUNDAMENTALS are basically required to make it perform—namely: (1) **"Spark,"** (2) A combustible mixture of air and gasoline—in other words, **"Gas"** and (3) **"Compression."** It's got to have Spark. It's got to have Gas —and, it's got to have Compression. Practically all motor difficulty results from deficiency in one or in a combination of all three fundamentals. Check **one at a time.**

For a preliminary "once-over," check the easiest things first. The simplest thing to do and which comes naturally, is to turn the flywheel to see if there is (3) Compression in each cylinder. You can tell from past experience whether or not compression is O.K. Next, take a look at the carburetor needles to make sure they are properly set and try to determine if there is fuel in the carburetor. Don't overlook the possibility of water in the fuel mixture or improperly mixed fuel, closed vent in filler cap, or clogged gas lines. This takes care of (2) Gas for the time being. Then—take a gander at the ignition system (1) **Spark.** Remove and check the spark plugs first. If they look O.K. (not wet) lay them aside for the moment. Hold one ignition lead approximately 1/8″ from the motor—ground the other (short to motor). Pull motor over to see if spark jumps this gap. It should if the magneto is O.K. Repeat same with other lead but be sure not to hold the wire too close to the spark plug hole—fuel vapor blown from cylinder may ignite to start a fire or maybe result in personal injury. Repeat the same operation with spark plugs attached to ignition leads, ground body of spark plugs to motor. If the plug is faulty it should now reveal its condition. Don't fuss with doubtful spark plugs—install new ones when necessary.

Now, after you have done all this (and you can do it in less time than it takes to write about it), you should have a pretty fair idea as to where the difficulty lies and it's time to really get down to business.

Suppose the ignition system was found to be out of sorts—(1) **Spark**—carefully check the following:

1. SPARK PLUG:
   - (a) Fouled
   - (b) Burned out
   - (c) Cracked porcelain
   - (d) Residue formed on porcelain to cause periodic shorts
   - (e) Wrong type for the motor (heat range)
2. IGNITION COIL:
   - (a) Weak
   - (b) Shorted
   - (c) Improperly mounted
   - (d) Loose wires
3. CONDENSER:
   - (a) Weak
   - (b) Shorted
   - (c) Improperly mounted
   - (d) Loose wires
4. BREAKER POINTS:
   - (a) Improperly adjusted
   - (b) Pitted or corroded
   - (c) Broken or weak spring
   - (d) Breaker point loose in its mounting
   - (e) Loose wires
   - (f) Breaker point arm binding on pivot post to cause sluggish action or plunger rod binding in the bracket
   - (g) Broken cam follower or plunger rod
   - (h) Timing marks (old models) must be lined up when points break
5. WIRING:
   - (a) Loose, corroded or poorly soldered connections
   - (b) Broken wires (broken under insulation)
   - (c) Oil soaked to cause leaks—leaky spark plug wires, too
   - (d) Faulty ground (stop button)
     - 1—Oil soaked to cause leaks
     - 2—Broken or cracked insulating washers and bushings to cause leaks
     - 3—Faulty spark suppressors (where used)
6. FLYWHEEL:
   - (a) Weak magnet
   - (b) Cracked magnet
   - (c) Improper clearance between magnet pole pieces and coil heels
   - (d) Magnet pole pieces striking or rubbing on coil heels

7. If it's NOT the coil—if it's NOT the condenser and if it's NOT the points, then check the wiring system carefully. Look for grounds caused by oily wires and insulating washers, broken insulation, broken or cracked insulation washers. Don't overlook possibility of broken wires under insulation, loose connections or open circuits because of corroded connections. Check every wire on the armature plate if necessary.
8. On the LT series magneto, look for grounds in the distributor block in the flywheel. Bakelite is sometimes carbon streaked to cause grounds. Scrape carbon off carefully. If too badly streaked, install new distributor block (be sure small spring is installed under distributor segment to make proper ground with flywheel). Also, check distributor brushes.

On the early H series magneto, check condition of brush holders and ground connections in like manner.

Maybe the carburetion system needs attention, (2)

Gas—look for:

1. Closed or clogged vent in tank filler cap
2. Water in the gas tank (this can cause no end of trouble for the motor owner)
3. Obstructed gas lines
4. Clogged screens
5. Foreign matter in the gas tank
6. Clogged screen and check valve in carburetor of the H & T series motors
7. Obstructed fuel passages in the carburetor
8. Damaged slow speed needle and seat in slow speed insert (H & T series) affecting slow speed adjustment
9. Damaged high speed needle and seat in carburetor body—this condition will affect high speed adjustment.
10. Damaged float valve and seat in carburetor body to result in flooding
11. Damaged or improperly adjusted float in the carburetor
12. Faulty carburetor body casting—cracked or porous
13. Faulty action of butterfly valve in carburetor of H & T series motors.

Finally, we get down to (3) **Compression.** If compression is weak, the power head will have to be disassembled to check for:

1. Faulty piston rings
   - (a) Stuck in carbon clogged piston ring grooves
   - (b) Worn
2. Carbon clogged exhaust ports
3. Excessively worn cylinder walls and pistons
4. Scored pistons and cylinder walls
5. Blown cylinder head gasket—where used

The above covers (1) **Spark,** (2) **Gas,** and (3) **Compression,** but occasionally there are other details which affect motor performance such as:

1. Failure of the cooling system
   - (a) Worn parts in water pump — where used
   - (b) Clogged water lines
   - (c) Clogged water jackets or corroded cylinders, particularly in salt water areas
   - (d) Faulty gaskets or other water connections
   - (e) Excessively worn propeller blade tips on motors with pressure-vacuum cooling
2. Water in the motor, caused by:
   - (a) Faulty gaskets
   - (b) Faulty assembly
   - (c) Cracked or porous castings
   - (d) Bad gasket surfaces — not flat and smooth
   - (e) Operator lifting lower unit of motor higher than level of the power head on removing it from the boat (before all water in the exhaust system has drained off)
   - (f) Water actually in gas tank

3. Tight or misaligned journal bearings or bent crankshaft results in drag or binding to interfere with starting and ultimate performance of the motor. Crankshaft should spin easily in the crankcase if properly assembled. It's folly to complete assembly of the motor if it doesn't—it just won't work right.

4. Tight connecting rod bearings, bent or twisted connecting rods produce a similar condition. Power head should be free with no indication of binding after assembly if the motor is to perform.

5. Improperly assembled lower unit, with tight or misaligned bearings, bent propeller shaft, bent driveshaft or sprung housings create excessive binding or drag to interfere with motor performance. Don't overlook this possibility. Also, if the gears mesh too close, like results can be expected.

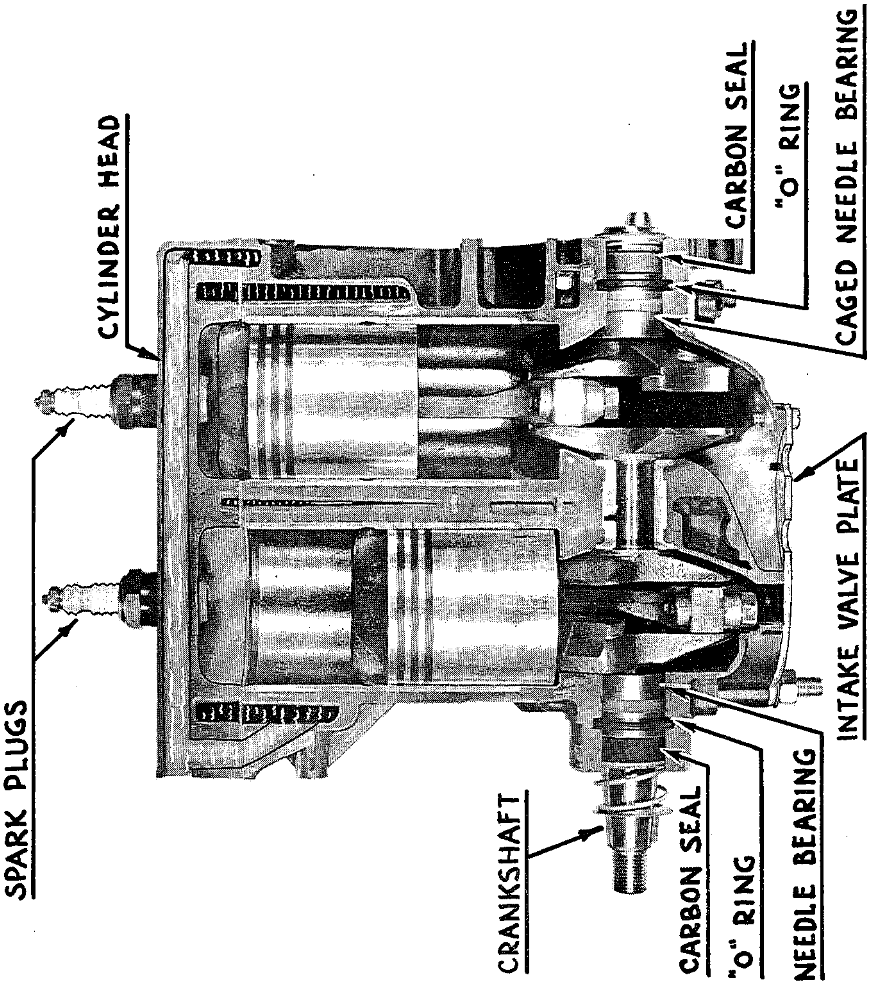
6. A lot of trouble (noise and vibration) can be caused by damaged propeller blades—blades broken or out of line.

It's as simple as all this (on paper) but sometimes it takes a lot of scratching to find out just where the difficulty lies. Keep the above suggestions in mind, nevertheless, when trying to run it down. This may be a lot of "old stuff" to many, but it's still a good procedure to carry out.

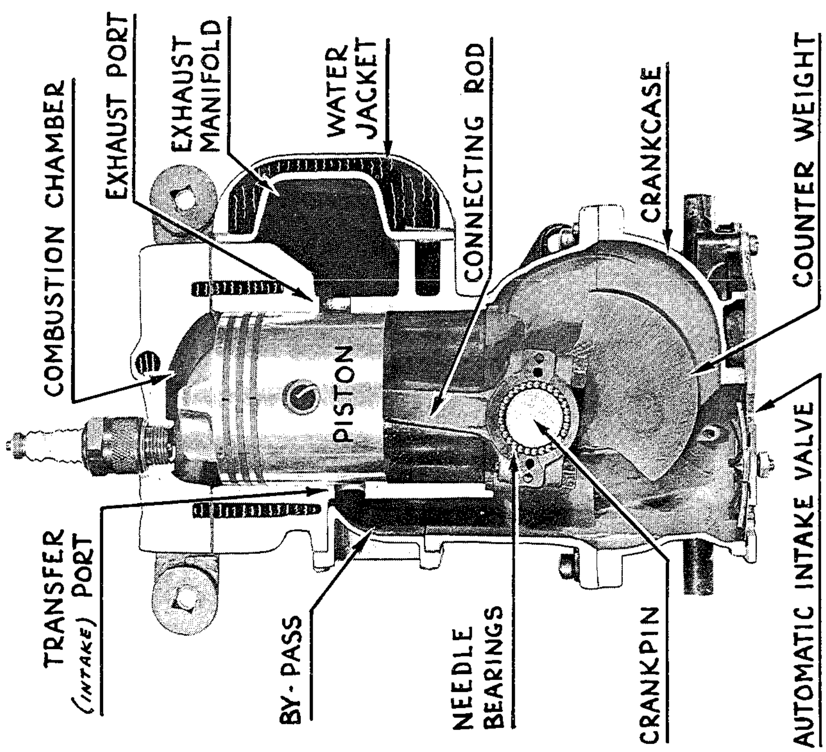
"THREE-FOURTHS OF THE CURE IS IN DIAGNOSIS OF THE AILMENT."

(Reprint from Service Bulletin No. 208)

NOTES



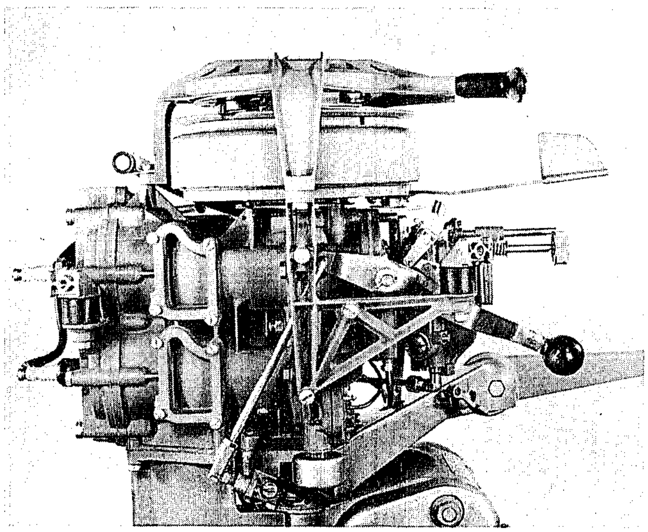
Vertical.



Horizontal

Sectional View of QD Power Head

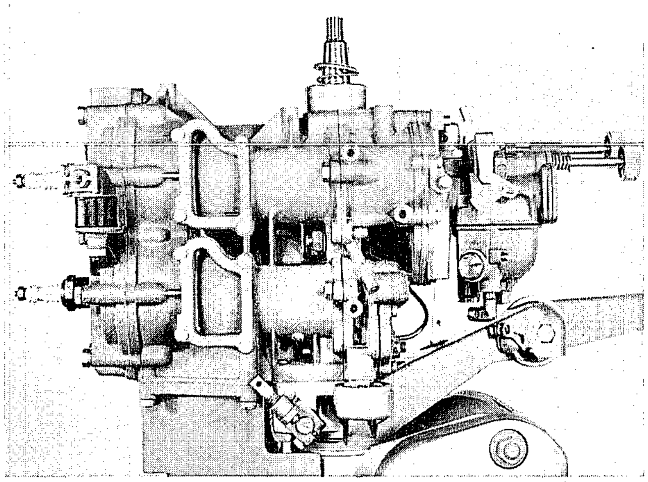
POWER HEAD — MODEL QD



Model QD Power Head—Ready Pull Starter Installed.

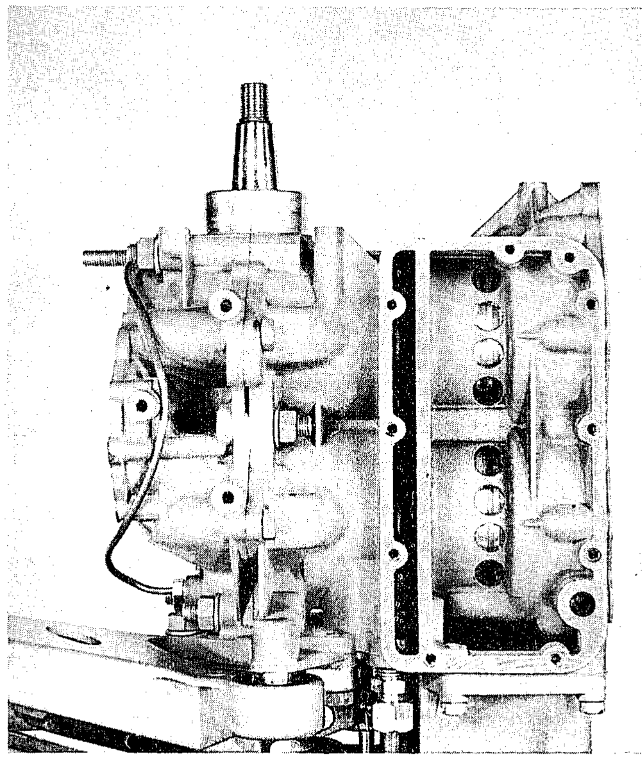
When major repairs on the power head such as installation of new piston rings, pistons or reconditioning of the cylinder bores, etc., are required, a disassembly operation becomes necessary which should be carefully performed in clean surroundings—on a clean and orderly bench top with sufficient space to temporarily store the various parts as removed.

First, remove the side covers, followed by disassembly of the Ready Pull starter, flywheel and armature plate as previously instructed.



Power Head with Side Covers, Ready Pull Starter, Flywheel, and Armature Plate Removed. Notice Spring and Washer on the Crankshaft—Used to Hold Carbon Seal in Position Against the Caged Needle Journal Bearing Assembly.

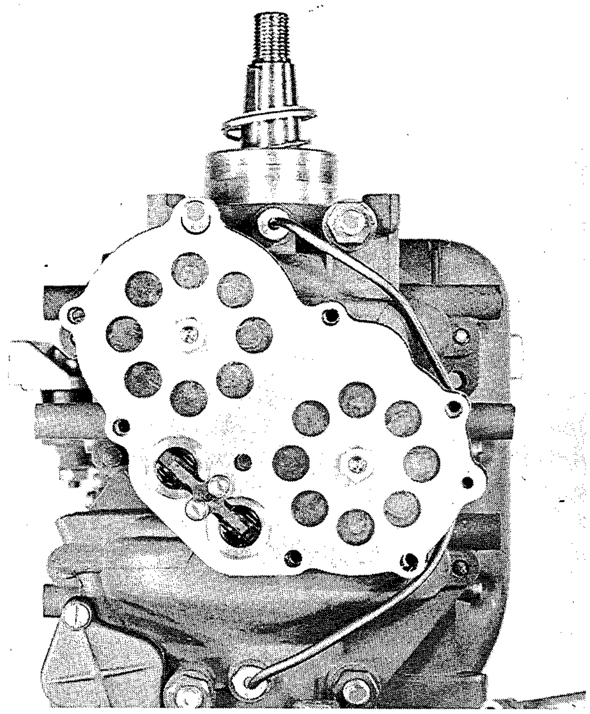
Detach carburetor assembly from crankcase (necessary to first remove carburetor bowl, then mixing chamber). Remove cylinder head and muffler. The muffler is water cooled and is made up of two pieces, namely: a die cast outer shell and a stamped inner shell. The inner shell being somewhat smaller than the outer shell, a space is created when the two are placed together and assembled to the cylinder block. The space thus created fills



Showing Carburetor, Cylinder Head and Muffler Removed. Exhaust Ports and Water Jacket Exposed.

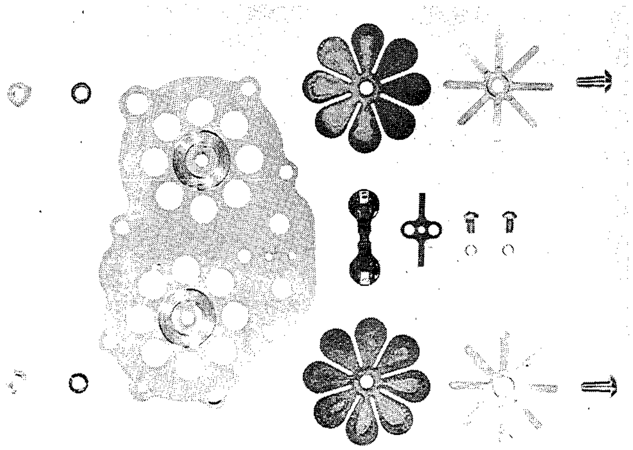
with water to assist in dissipating heat of exhaust gases during operation of the motor and becomes part of the water circulating system. As such, the muffler is sealed with two gaskets—one between the outer and inner shells and second between the inner shell and the cylinder, all of which are bolted to the cylinder block. The gaskets, of course, must be properly seated and in good condition at all times. Check at this time, possibility of warped gasket faces to guard against leaks, see pages 138 and 152. Lap surfaces if necessary.

Carefully detach the automatic intake valve assembly—set safely aside until required for reassembly or repairs. Place assembly in a clean wooden or small cardboard box during repairs on the power head or wrap in clean paper. Be careful not to per-



Carburetor Removed Exposing Automatic Leaf (Intake) Valve Plate Assembly, and Check Valves.

mit foreign matter scratching surfaces of the plate which must be flat and true to maintain crankcase compression. Likewise, when reassembling to the crankcase, make certain gasket faces are flat and clean and that no scores or scratches appear. Check gaskets to determine fitness for further service—replace if necessary. Use nondrying cement on gaskets for this installation—use sparingly.

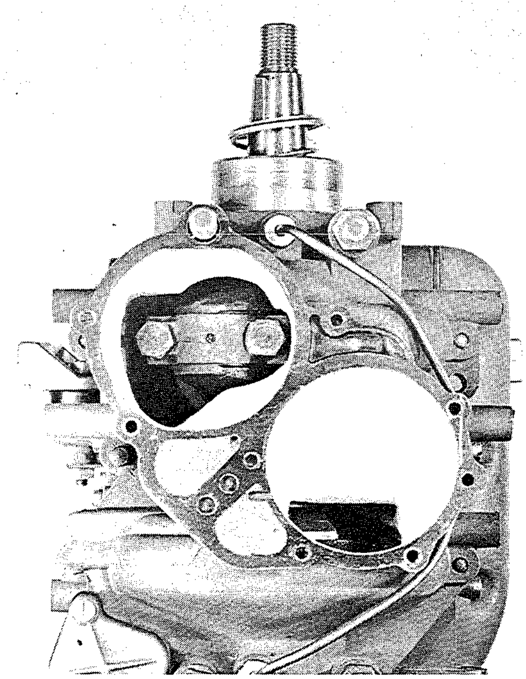


Disassembled Automatic (Leaf) Intake Valve Plate, Showing in Detail the Plate with Intake Ports, Leaf Plates, Leaf Guides, Pressure Check Valves (Controlling Pressure to Mile-Master Tank) and Minor Parts Incidental to Assembly.

The automatic intake valve assembly, as shown above, consists of an accurately machined aluminum plate with both faces true, flat and smooth. Holes (ports) are drilled into the plate to form part of the valve assembly. Two series of holes (ports) are employed to make up an intake assembly for each crankcase chamber. Attached to this plate are two valve plates, each provided with eight anchored discs or segments which, when properly assembled, come to rest over corresponding holes in the aluminum plate and thus comprise the valve assemblies. A guide with eight curved fingers is attached immediately back of the valve plate to limit degree of valve or disc opening. (Operation of the valve assembly is as described under "Carburetion").

Normally, this assembly requires little attention. Its performance can be affected only by foreign matter lodging between the disc or leaf plate and the aluminum plate to hold one or more of the segments off their seats to result in escape of crankcase compression. Likewise, if the plate is carelessly handled during power head repairs—becomes scratched or nicked, the result is crankcase compression loss to interfere with motor performance.

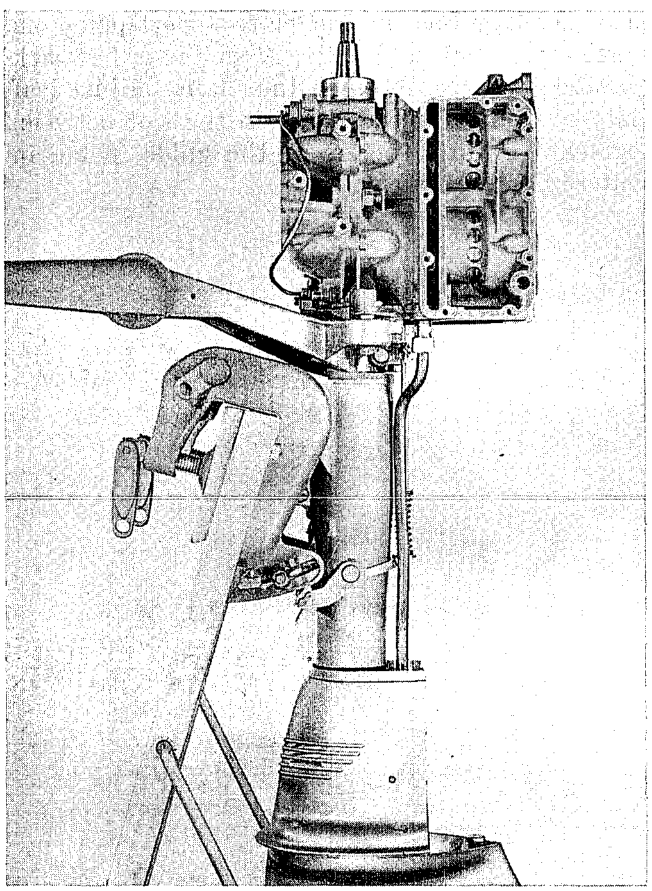
If there is occasion to install a new leaf plate, care must be exercised to see that each individual segment or leaf comes to rest squarely over the corresponding hole in the plate—overlapping an equal amount on each side. A small scribe mark (scratch) will be noted on the plate—adjust leaf plate so that it falls midway in the slot between segments. Adjust fingers of the guide to fall in center of each segment.



Crankcase with Automatic Intake Valve Assembly Removed—Showing Oil Line Connecting Top and Lower Journal Bearings.

Since the leaf plate is constructed of specially heat treated beryllium copper, do not, under any circumstances, flex or bend the segments by hand —to do so will render it unfit for further use (discard at once—replace with new one to avoid doing the job over again). This is IMPORTANT. The leaf plate should be stored between clean pieces of stiff cardboard to prevent bending—handle carefully. Heat treatment sets up a definite tension on each segment; if bent beyond critical point, tension "sets"—that is, the segment will no longer spring back to its normal position.

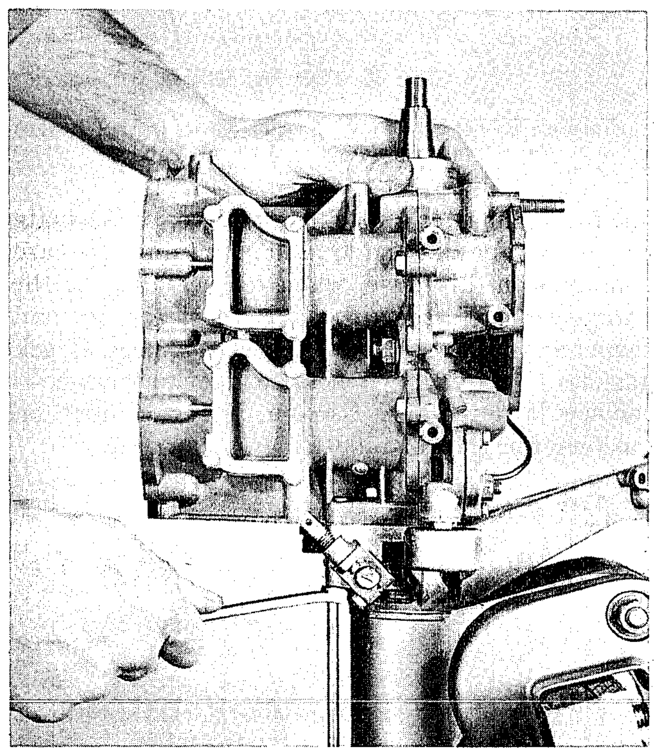
Attached to the aluminum valve plate also but not associated with functioning of the automatic intake valve, is the fuel pressure check valve assembly. This assembly consists of two small (connected) rubber discs or plates which are held in position over two corresponding holes drilled in the plate, by a flat spring of predetermined tension to comprise a check for each crankcase chamber. When pressure in the crankcase reaches a certain point (determined by tension of the spring) the rubber disc is momentarily forced off its seat, permitting pressure thus escaping to be conducted by way of the air line, into the Mile-Master Fuel Tank.



Power Head with Side Covers, Starter, Magneto, Carburetor, Muffler, Cylinder Head and Exhaust Tube Removed, Prior to Detaching from Lower Unit.

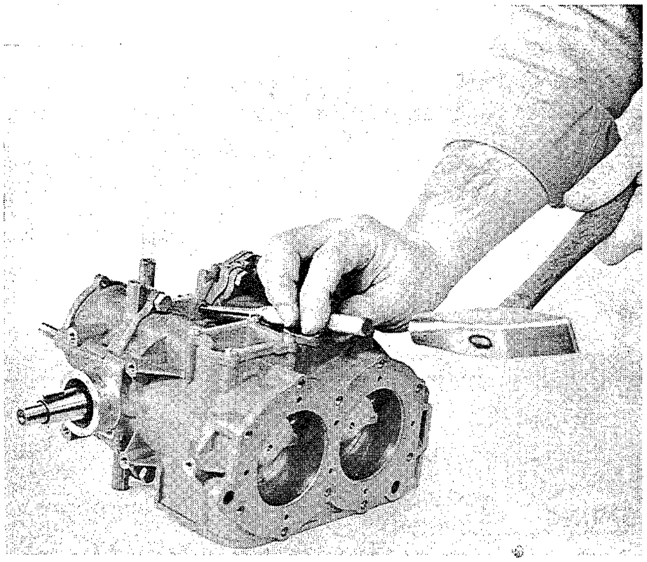
The checks function alternately as cylinders fire —first one opens, then the other, to build up and maintain sufficient pressure in the fuel tank to "feed" the carburetor. When pressure in the tank equals pressure built up in the crankcase, there is naturally no valve action in this respect. Degree of valve action depends on amount of fuel in the tank. As fuel level in the tank lowers, greater air space results to cause proportionately greater check valve activity. Normal fuel tank pressure is 2 to 5 lbs., depending on motor speed and fuel level.

To remove balance of the power head from the lower unit, it is necessary to first remove the exhaust tube (top and bottom sections as shown above), followed by disconnecting the water tube leading from the pump housing, then by removing the nuts holding the power head fast to the driveshaft casing. Carefully lift power head from lower unit.

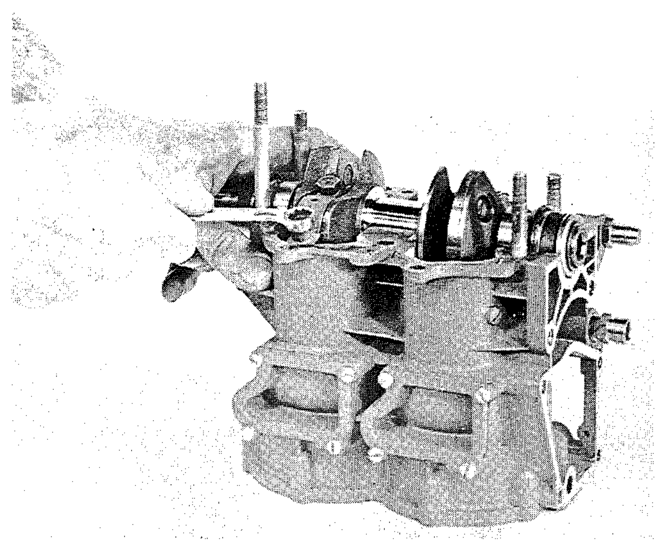


Detaching Power Head from Lower Unit.

It will be noted on removal of the power head that the driveshaft casing drops down approximately 1/4" but this need cause no concern since it was originally designed to do so under the circumstances. Observe also, at this time, the conical springs seated in arms of the steering bracket and attached to the power head by means of two large pins screwed into corresponding arms of the crankcase. Purpose of this arrangement is to absorb torque impulses between the power unit and steering bracket (arm).

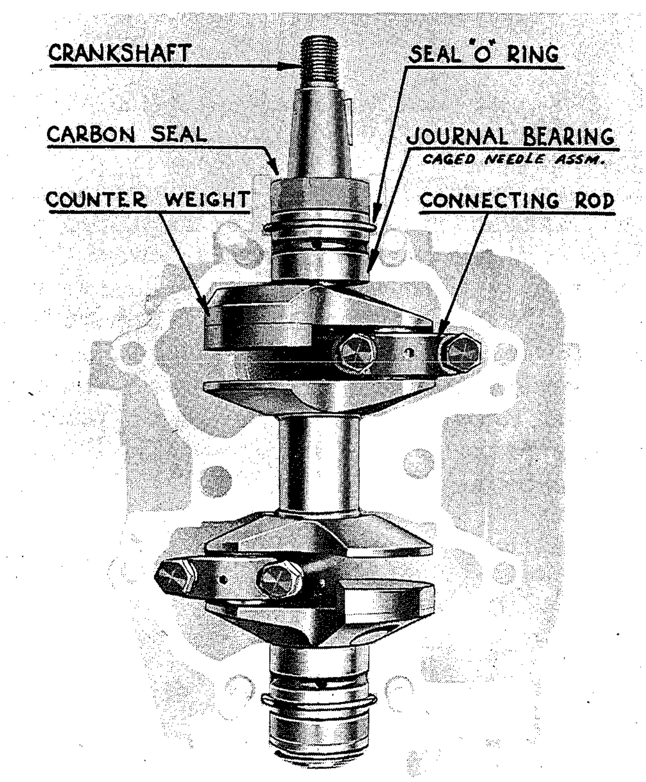


Driving Taper Aligning Pins from Crankcase.



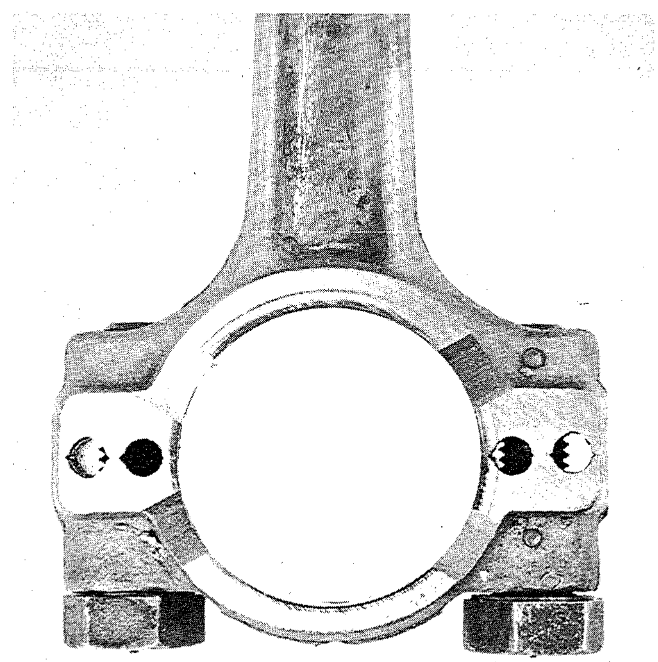
Removing Connecting Rod Screws.

Place power head on clean bench top to disassemble crankcase. Drive taper pins out with flat punch as shown here. Two are used—one on each side to obtain proper crankcase alignment. Remove nuts and screws holding crankcase fast to the block assembly, then carefully lift off. If found to be sticking to the cylinder block, tap crankcase lightly with a mallet to free.



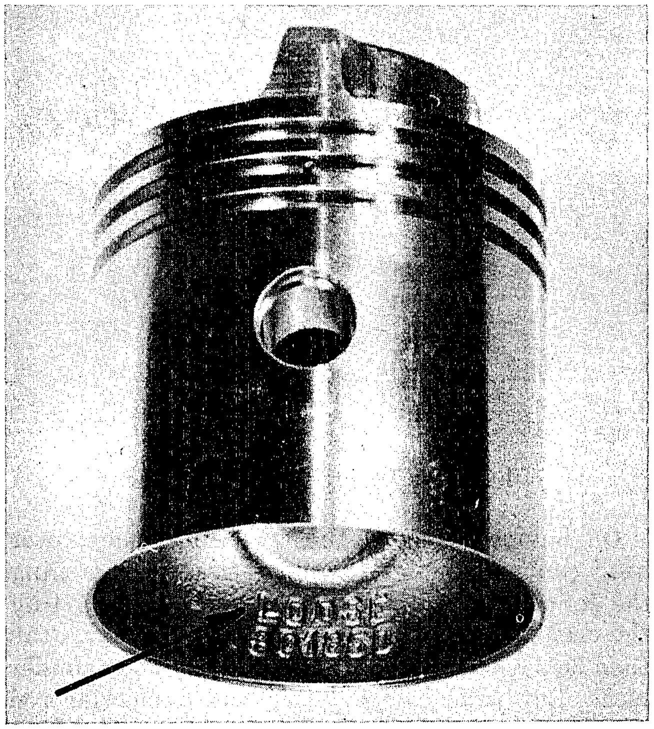
Crankcase Removed, Exposing Crankshaft, Connecting Rods, Caged Needle (Journal) Bearing Assemblies, and Crankcase Seals.

On having removed the crankcase, the power head can be completely dismantled by detaching the connecting rod cap screws and simply lifting the crankcase free. Piston and rod assemblies can then be pushed out through the top of the cylinder block. But, prior to doing this, the connecting rod caps should be marked with chalk or pencil, #1 top and #2 bottom. Mark the connecting rods and pistons accordingly if the same assemblies are to be reinstalled. Do not interchange the connecting rod caps. The rod and cap make up a matched assembly. See page 151.



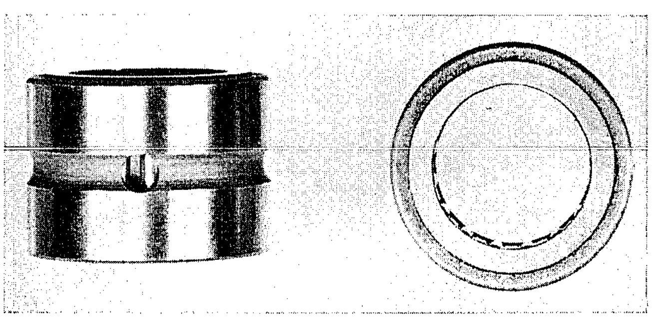
Showing Notch Marks on Connecting Rod and Cap. Cap Must Be Installed so that Marks Align on the Same Side.

See general instructions pertaining to cylinder bores, piston rings, pistons, connecting rods and crankshafts on pages 97 to 120 incl.



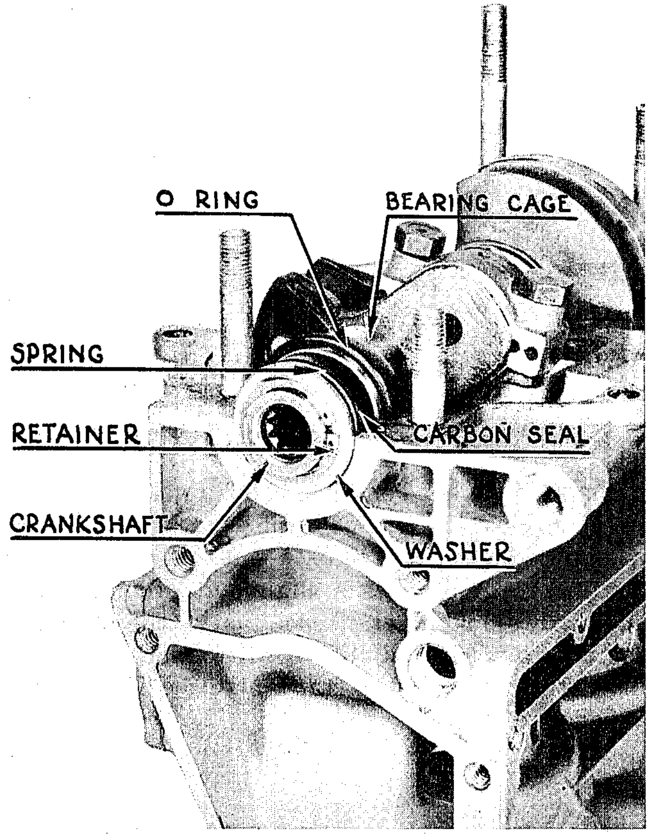
Note Wrist Pin Hole Bored for Slip Fit is Marked "Loose" Inside of Piston Skirt.

Johnson has employed for the first time caged needle bearings on top and bottom crankshaft journals in the Model QD whereas bearings in like position on other service models were of the friction type bronze bushings, reamed or fly-bored to specified size for proper journal bearing clearance.



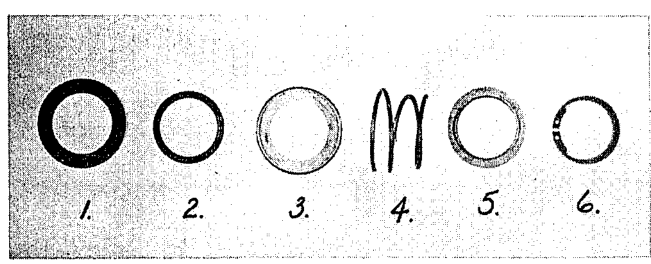
Caged Needle Bearing (Journal) Assembly—Side and End Views.

Since the caged needle bearing assemblies are not "air tight" and do not fit sufficiently tight in the crankcase bearing boss, some form of compression seal must be installed. This consists of a round rubber ring ("O" ring) fitted over the caged needle assembly and into a groove machined in the crankcase boss. Thus, on installation and assembly of the crankcase, the area between outer surface of the bearing cage and machined corresponding surface of bearing boss are sealed against crankcase losses by compression of the rubber "O" ring.

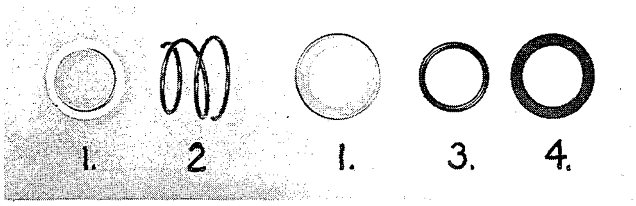


Showing Lower Bearing and Seal Assembly.

Compression loss between the bearing assembly and crankshaft is accomplished by installation of a carbon seal ring placed immediately forward of the bearing cage which is held tightly against thrust face of the cage by spring tension to prevent loss at this point. A second rubber "O" ring is installed in a groove machined on inside surface of the carbon seal; consequently, a seal is obtained by compression of the "O" ring when assembling the carbon seal on the crankshaft.

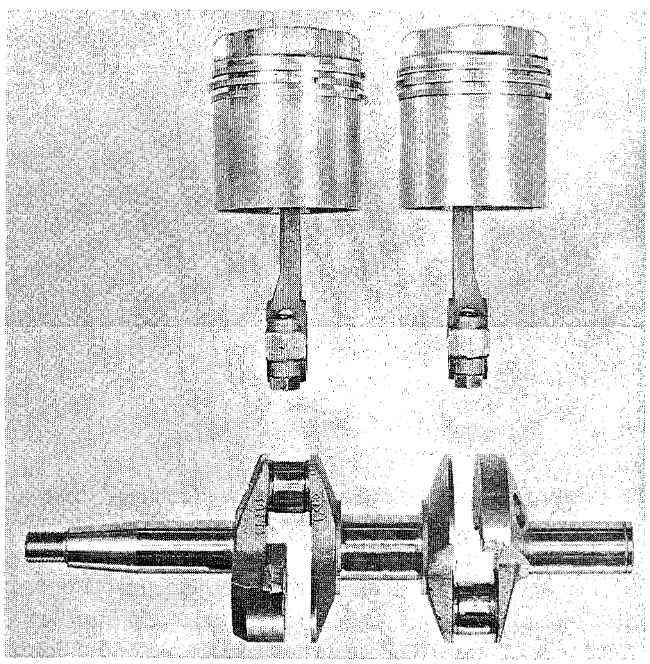


Details of Carbon Seal Assembly—Lower Journal: (1) Carbon Seal, (2) "O" Ring, (3) Washer, (4) Spring, (5) Washer, (6) Retaining Washer.



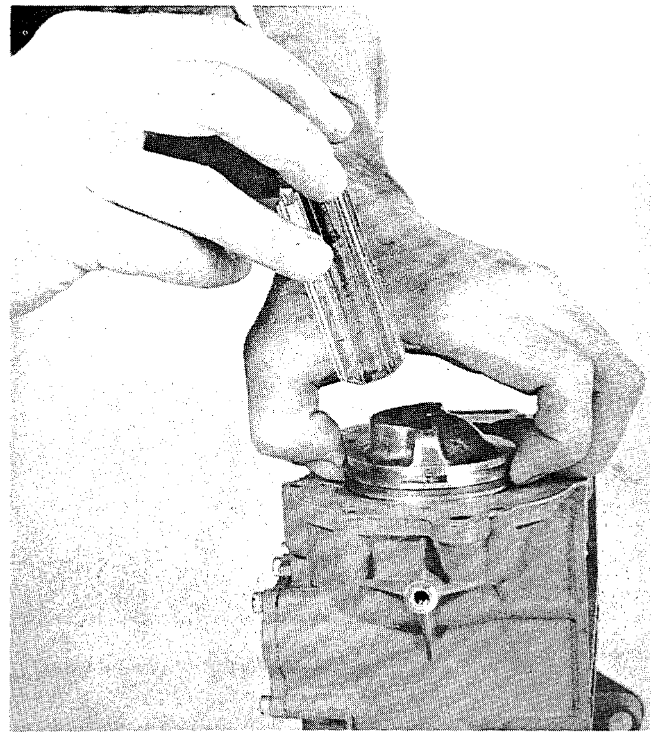
Carbon Seal Assembly of Top Journal: (1) Washers, (2) Spring, (3) "O" Ring and (4) Carbon Seal.

On completion of actual power head repairs, piston rings, pistons, cylinders, connecting rods, crankshaft, etc., reassembly becomes the order. See pages 162 and 163. Generally, reassembly is performed in reverse of disassembly and it is assumed that careful observation was maintained during "tear down" procedure.

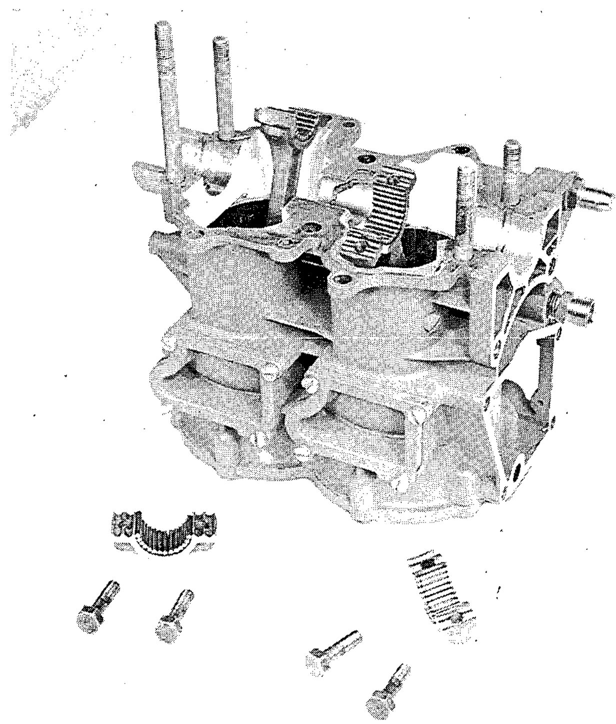


Illustrating Proper Assembly of Connecting Rods. Note Straight Sides of Rods Face Each Other to Facilitate Attaching to Crank Pins. Pistons Must be Correctly Installed on Connecting Rods to Permit Assembling Accordingly—Straight Sides of Piston Deflectors Should Align on Same Side.

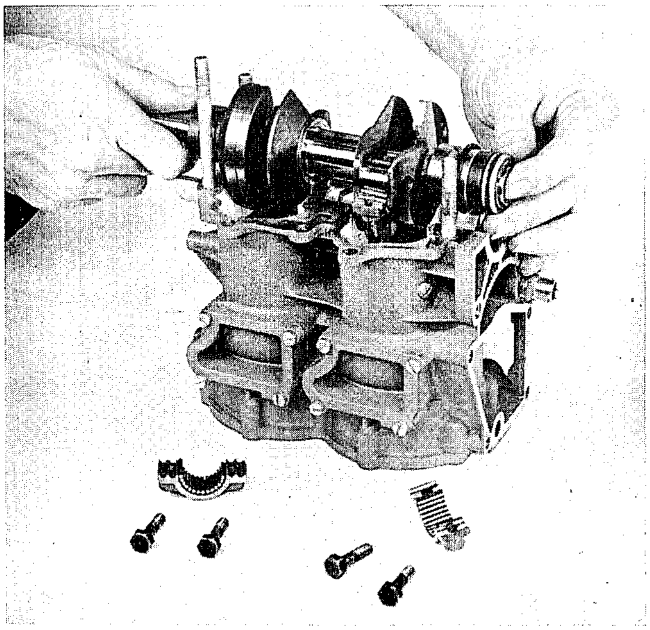
The piston and connecting rod assemblies are first to be installed—proceed slowly. Make no forced assemblies unless "press" fits are called for and make no "dry" assemblies. Be sure all parts to be assembled are clean and free of grit—severe damage and expense result from making "dirty" assemblies. Perfectly good cylinder walls, pistons and rings can be ruined in a few minutes of operation unless all forms of grit are removed before assembly. Work in clean surroundings and with reasonably clean hands. Coat all bearing surfaces, cylinder walls, etc., with clean oil preceding assembly.



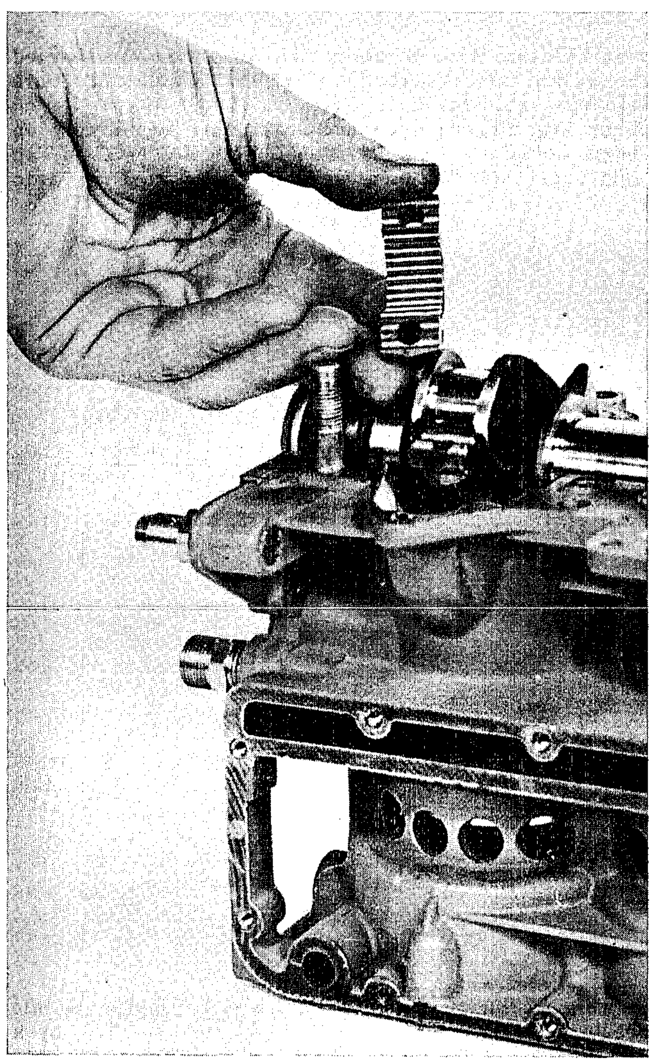
Install Piston With Straight Side of Deflector Directed Toward the Intake (Transfer) Port in Cylinder. (Be Sure Assembly is Installed in Proper Cylinder Bore). Piston Rings Are Pinned in Grooves, Arrange Accordingly on Piston. Compress Rings as Shown, With Finger Tips. Tap Lightly and Carefully on Head of Piston to Drive Into Cylinder.



Showing Piston and Connecting Rods Assembled—Needle Bearings Inserted in Rods and Caps [Held in Place by a Coating of Clean Grease—Twenty-Nine (29) Needles to Each Connecting Rod] in Preparation for Installing of the Crankshaft.

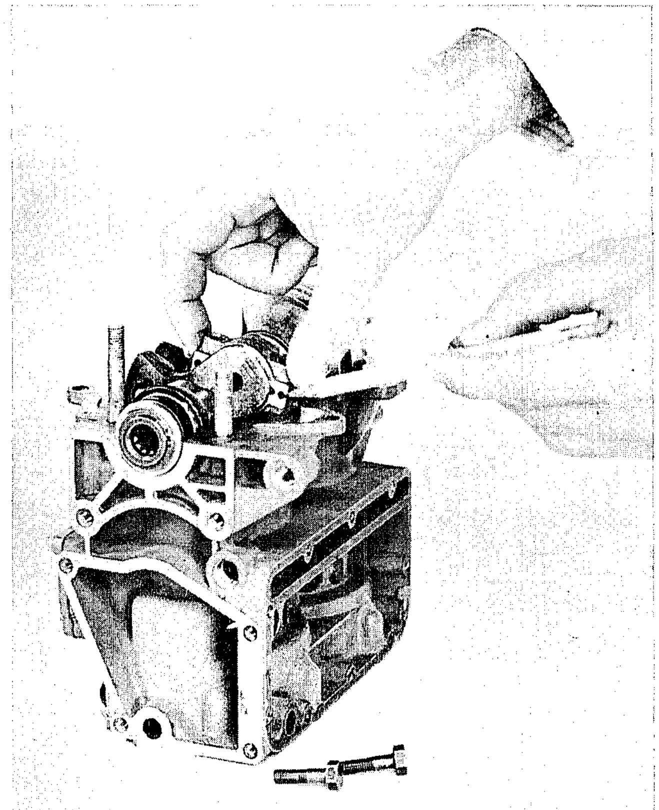


Installing Crankshaft.



Installing Connecting Rod Cap.

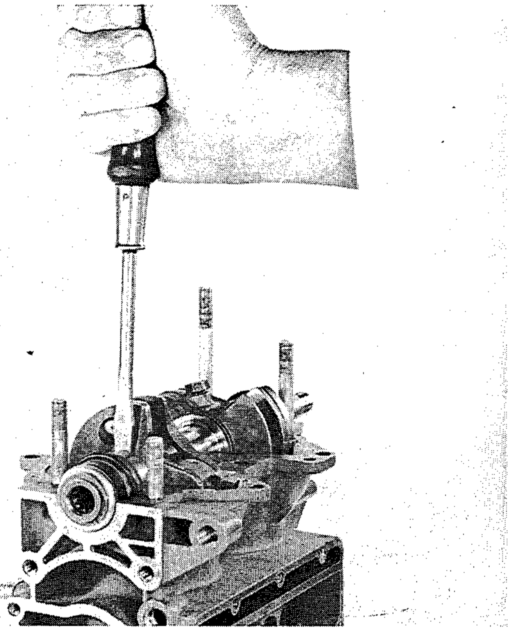
The Model QD connecting rod being of split type construction, makes it imperative that the rod and cap be assembled with index marks aligning on the same side since the broken surfaces (as result of splitting) must match when bolted together.



Checking Connecting Rod and Cap Alignment Prior to Bolting Together.

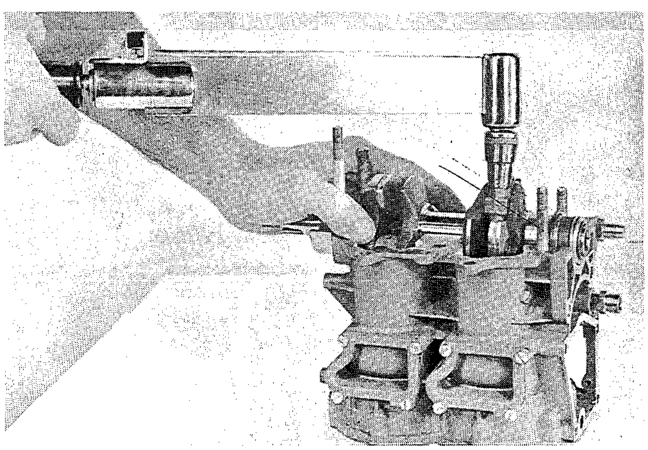
To be assured of this alignment, grasp the cap between the thumb and forefinger, rock back and forth slightly until the cap settles on the rod. Check parting line with pencil, surface must be "flush"—if not, rod and cap are out of line and should not be bolted together. Proceed in this fashion until both sides and end of the cap and rod "flush up." Bolt together snugly at this time but not too tightly, some adjustment on the caged needle bearing assemblies (crankshaft) is first necessary.

Note small pins protruding from crankcase boss (top half) and corresponding holes drilled in needle bearing cages. When placing the crankshaft in final position, the small pins must engage the holes in the bearing cages. The top bearing cage can easily be turned and adjusted to engage the pin, however, spring tension against the lower bearing must be overcome to engage the pin; this is readily done by carefully inserting a screw driver between the end of the bearing cage and cheek of the crankshaft and prying slightly until the pin and hole engage.



Prying Bearing Assembly Into Position in the Crankcase.

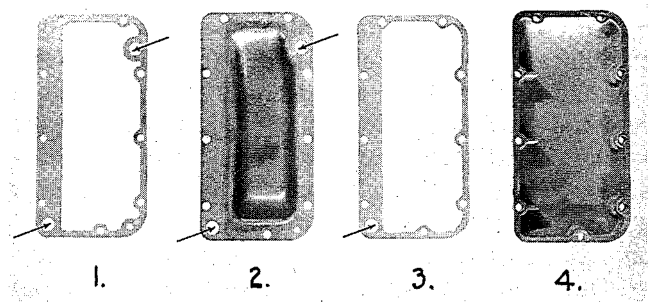
The connecting rod screws can now be finally adjusted with use of a torque wrench—draw up to 20 foot pounds. No lock plates are used for this installation.



Drawing Up Connecting Rod Screws With Torque Wrench —Twenty (20) Foot Pounds Tension.

After securing the connecting rod screws, apply a thin coat of hard drying cement, similar to Perma-Tex No. 1 to bottom crankcase faces—do not over cement; excess merely squeezes over to foul oil channels, etc. Place crankcase in position, replace tapered aligning pins. Replace nuts and screws—draw up tightly and evenly—be sure no foreign particles have been left on crankcase faces to cause seepage from the crankcase.

Install power head on lower unit—use new gaskets wherever required. Replace muffler, carburetor, magneto, starter, etc., and exhaust tube. Do not neglect spring, washers and carbon seal on top journal prior to installing the flywheel.

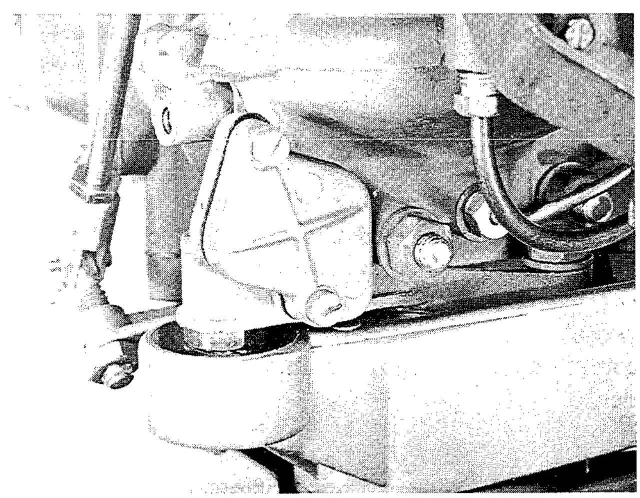


It is Extremely Important to Prevent Water Entering Cylinders, that the Exhaust Manifold (Muffler) Gaskets be Properly Installed when Attaching the Manifold. Gasket 1 Should be Placed Between Cylinder Block and Inner Shell (2) so that Water Openings (Indicated by Arrows) Align —Gasket 3, Between Inner Shell (2) and Outer Shell (4) Aligned in Like Manner with Respect to Water Openings.

Crankcase Bleeder

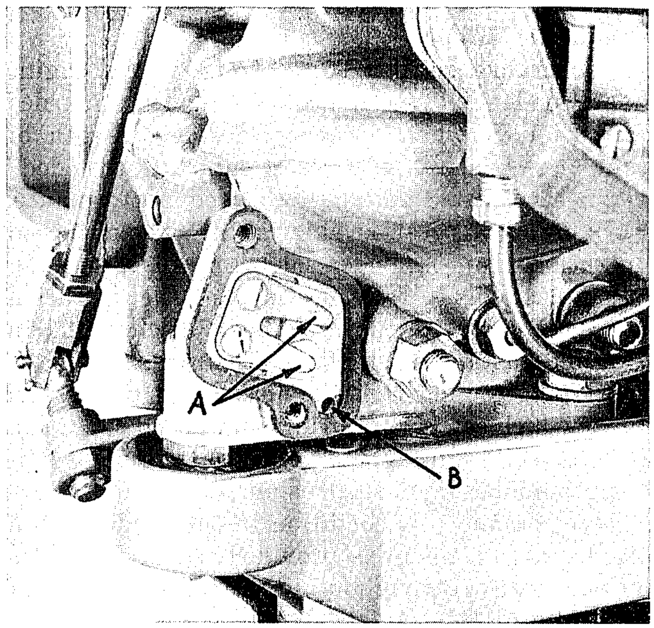
The crankcase in a two (stroke) cycle engine has a tendency towards loading up with unburned fuel (liquid) when operating for any length of time at slow speed with result that it is "flooded" when accelerated for higher speed performance. Flooding in this respect likewise affects slow speed operation. This is evidenced by profuse smoking of exhaust gases, faltering and erratic operation until accumulated fuel has been discharged. In extreme instances, stoppage occurs as result of spark plug fouling. It is the heavy ends of the fuel vapor which settle out during slow speed operation since velocity through the crankcase is not sufficient to hold them in suspension.

To overcome this condition in the Model QD, a bleeder arrangement is provided which functions automatically throughout entire speed range of the motor.



Showing Position of Crankcase Bleeder Valve.

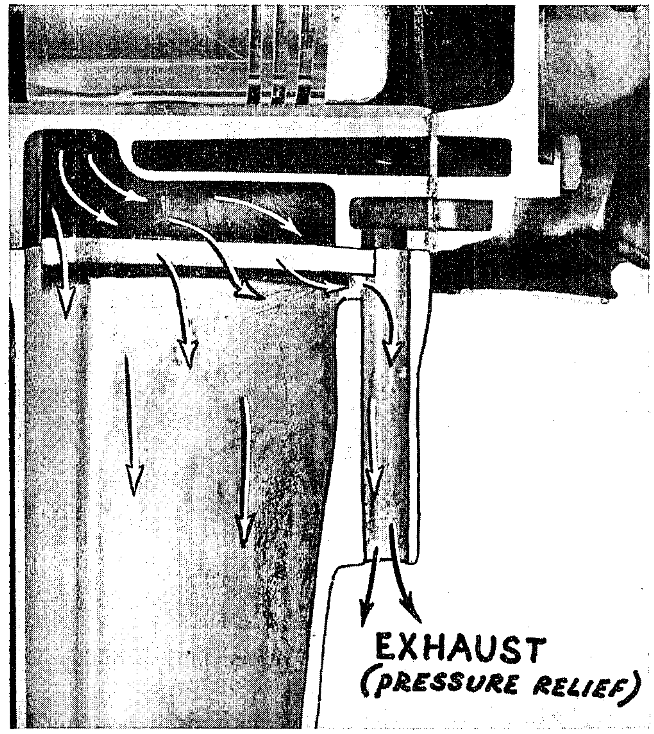
The arrangement consists of a small hole or channel leading from a pocket in each crankcase chamber to an automatic check valve located at the bottom of the power head as shown above. In operation, the fuel which settles out of the fuel mixture during periods of slow speed running, accumulates in the pocket provided for this purpose, fills the channel down to the check valve and there remains until the piston travels on its downward stroke. Resultant crankcase compression (pressure) forces the check plate (a) off its seat to permit liquid fuel escaping through outlet (b) and on into the driveshaft casing where it is discharged with the exhaust gases. Note there are two check plates—one for each crankcase chamber. During upward stroke of the piston, there is no discharge since low pressure or suction exists in the crankcase—the check plate springs back on its seat to prevent air flow in opposite direction.



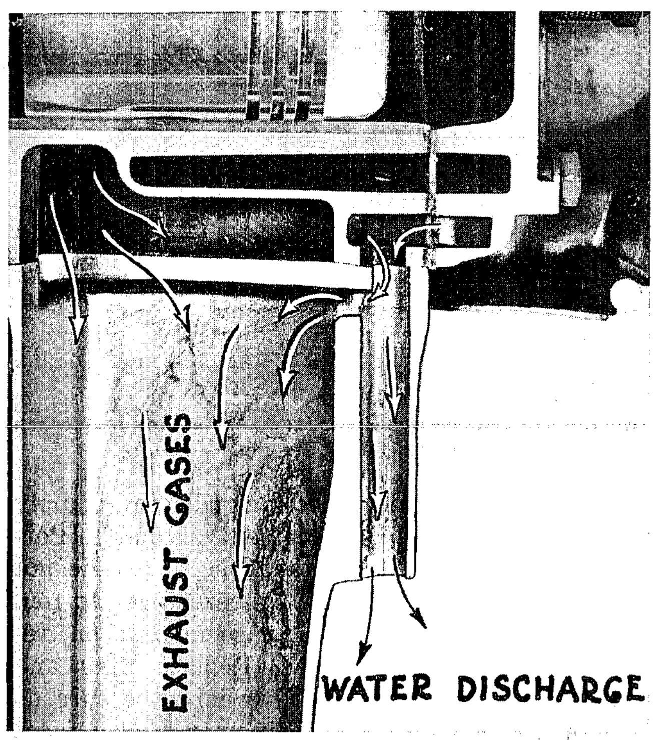
Bleeder Check Valve Showing Cover Removed.

Action described above continues during entire period of motor operation with maximum bleeding of liquid fuel at slow speed performance and proportionately decreasing with increase in motor r.p.m.'s. At top speed there is practically no discharge since velocity through the crankcase is sufficient to hold all particles (for practical purposes) of fuel in suspension to be burned later, on compression and ignition in the combustion chamber.

Do not be alarmed if an oil "slick" forms on the surface of the water when operating for any length of time at slow speed—it's the result of crankcase bleeding as described.



Illustrating Exhaust Relief for Starting Purposes. When Cranking to Start, Back Pressure Created by Underwater Exhaust is Relieved by Way of Opening into the Water Outlet as indicated by Arrows.



On Having Started the Motor, Water Starts Circulating Through the Cooling System Which Discharges Through the Water Outlet. This Action Results in Some of the Water Flowing Through the Exhaust Relief Opening and into the Exhaust Stream, Thus Obstructing or Closing the Relief Opening. Water Acts Also Towards Reducing Temperature of Exhaust Gases.

#27-10 BEARING—UPPER JOURNAL K-KD—REDESIGNED

Service Bulletin No. 256 (Reprint)

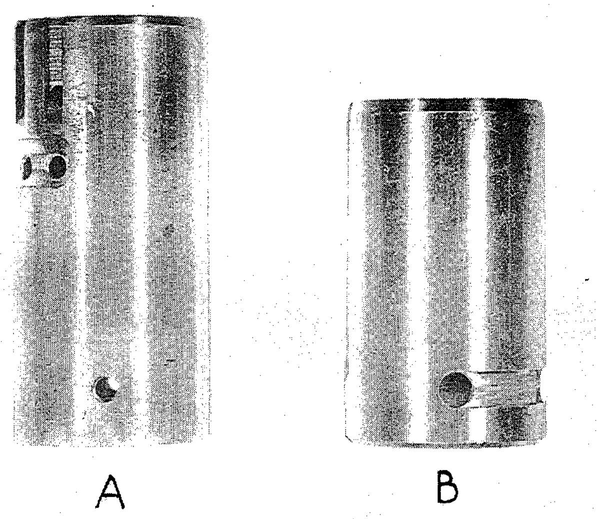


Fig. 1

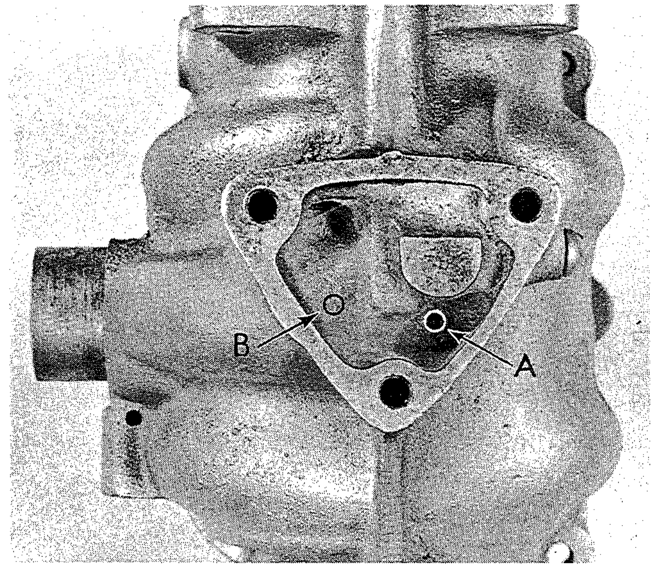


Fig. 2

Shown here are illustrations of the original (A) and redesigned (B) #27-10 upper journal bearing (crankshaft) for the K-KD models. Note that the redesigned bearing (B) is somewhat shorter than the original (A) and that some oil channeling has been omitted. The new bearing contains but one oil groove (inside surface) and one oil hole at the lower end. Reason—to improve lubrication of the top journal.

Construction of the new bearing and machining of the crankcase head, however, is such that installation CANNOT be made in the field—it must be done at the factory with special equipment. This will mean that the Dealer will send the crankcase head (#28-21) to the factory for bearing installation and boring operation for which a flat net charge of $3.00 will be made to the authorized Johnson Dealer. The District Service Station will not be involved in these. [Crankcase head (#28-21) with new bushing is finished to size and should NEVER be reamed.]

It may be well to purchase a new head (#28-21), list price $8.25, to hold in stock for replacement purposes to avoid delay in bearing installation. The old one can then be sent to the factory for installation and matching of new bushing (provided the head is in good usable condition) and used at a later date as the occasion presents itself.

The bottom journal bearing of the crankcase is reamed in the conventional manner, using the reprocessed crankcase head to pilot the reamer.

With installation of the redesigned bearing, a minor operation is required in the crankcase to relocate the oil return from the upper journal. This is easily accomplished by merely plugging hole (A) in the crankcase, Fig. 2, with aluminum plug #300739 (list price $.025 each) and drilling a 1/8″ hole through the manifold wall (B).

CEMENT CHART

(Recommended for Johnson Repairs)

CEMENT NAME AND SOURCE OF SUPPLY	MODEL	APPLICATION
Perfect Seal No. 4 Source: Johnson Motors	HD	Muffler Gaskets Takedown Gaskets Inner Casing Flange Gaskets
Part No. 301719 or	QD	Lower Unit Gaskets Muffler Gaskets
Local Automotive Supply House	SD	Gearcase to Pinion Case Gasket
	PO	Gearcase to Pinion Case Gasket
Sealer 1000	HD	Cylinder & Crankcase Halves
Source: Marine Products, Inc. 166 N. Main St. Oshkosh, Wis.	TN	Cylinder & Crankcase Halves
	SD	Cylinder & Crankcase Halves
	QD	Cylinder & Crankcase Halves
Aviation Form-A-Gasket No. 3	TN	Muffler Gaskets
Source: Local Automotive Supply House	SD	Driveshaft Casing to Pinion Case Gaskets Muffler Gaskets
	PO	Pinion Case to Driveshaft Casing Gasket Crankcase to Cylinder Gasket
		All Elbows & Tee Fittings All Motors
Permatex No. 1	HD	3 Muffler Screws (Muffler to Crankcase)
Source: Local Automotive Supply House or Perfect Seal No. 4	TN	2 Screws in Muffler
Perfect Seal No. 4		All Cylinder Head Gaskets

Date — 8/1/50

RECOMMENDED TORQUE TENSIONS FOR FOLLOWING NUTS AND SCREWS

MODEL HD

PART NUMBER	DESCRIPTION	FOOT POUNDS
43-189	Flywheel Nut	40 to 45
43-259	Cyl. Head Screw 10-24	2 to 3
21-167	Cyl. Head Screw 1/4-20	5 to 7
15-251	Crankcase Head Screw 1/4-20	5 to 7
43-147	Crankcase Head Screw 10-24	2 to 3
43-44	Conn. Rod Screw 12-24	5 to 8 (Varies depending on fit to crank)
300630	Upper to Lower Gearcase 1/4-20	5 to 7
300645	Clampscrew-Gearcase Upper 1/4-20	8 to 10
33-79	Gearcase Head Screw 10-24	3 to 4

MODEL TD

PART NUMBER	DESCRIPTION	FOOT POUNDS
41-32	Flywheel Nut	50 to 55
53-89	Cyl. Head Screw 1/4-20	5 to 7
21-167	Crankcase Screw 1/4-20	5 to 7
7-46	Crankcase Nut 5/16-24	12 to 14
41-44	Conn. Rod Screw 12-24	5 to 8 (Varies depending on fit to crank)
300631	Clampscrew Gearcase—Upper 5/16-18	14 to 16
300630	Upper to Lower Gearcase 1/4-20	5 to 7
39-176	Gearcase Head Screw 1/4-20	5 to 7

MODEL QD

PART NUMBER	DESCRIPTION	FOOT POUNDS
301473	Gearcase Head Screw 1/4-20	5 to 7
301989	Upper to Lower Pump Housing Screw 1/4-20	8 to 10
301966	Clampscrew Upper Pump Housing 1/4-20	8 to 10
25-238	Exhaust Pipe Screw 1/4-20	5 to 7
302009	Cyl. Head Screw 1/4-20	8 to 10
7-46	Crankcase Nut 5/16-24	10 to 12
51-135	Cyl. to Crankcase Screws 1/4-20	5 to 7
301649	Conn. Rod Screw 1/4-20	18 to 20
301988	Flywheel Nut	55 to 60

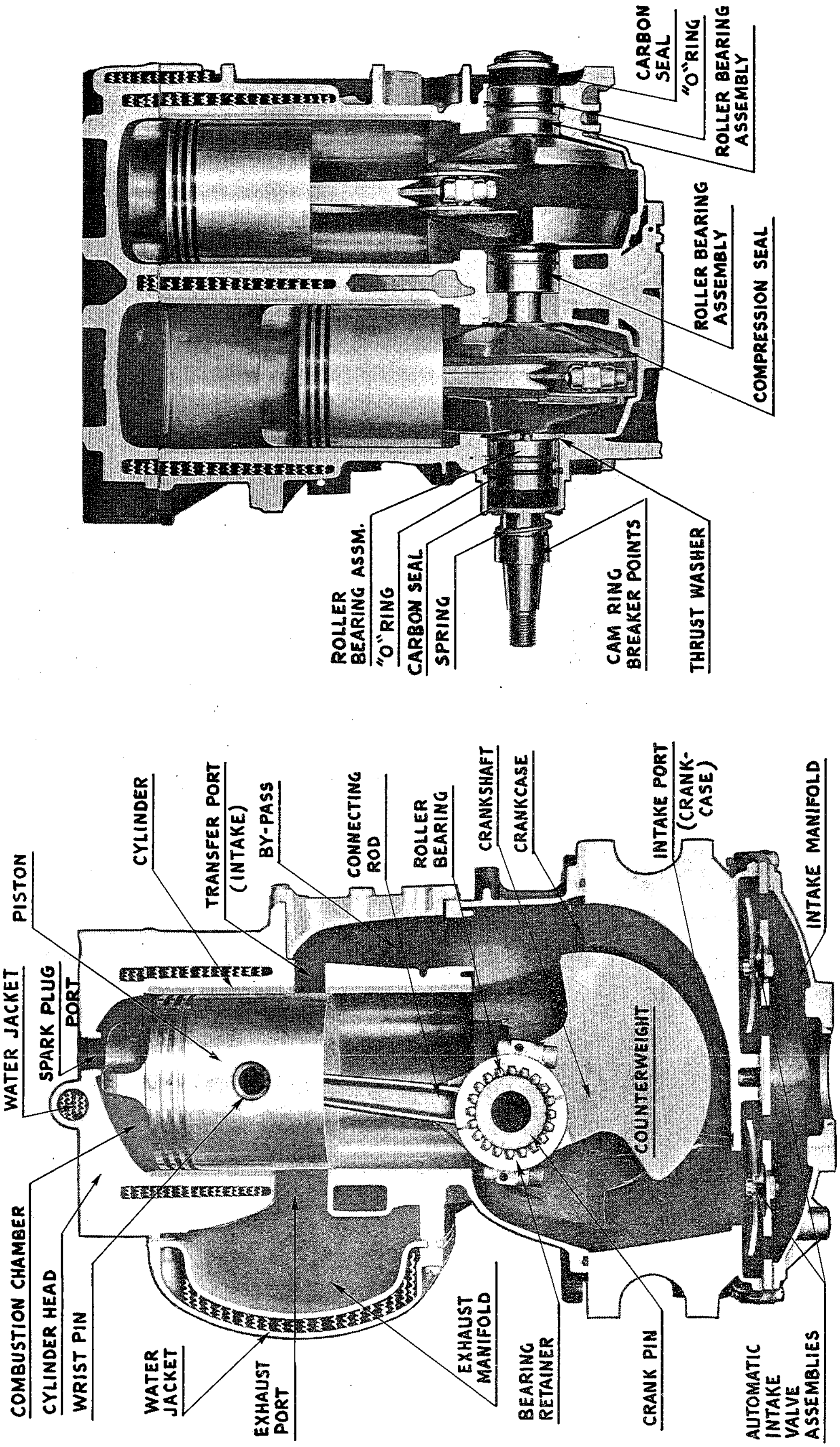
MODEL SD

PART NUMBER	DESCRIPTION	FOOT POUNDS
302270	Flywheel Nut	60 to 65
300260	Cyl. Head Screws—short 5/16-18 heat treated	18 to 20
300261	Cyl. Head Screws—long 5/16-18 heat treated	18 to 20
7-45	Crankcase Nuts 3/8-24	18 to 20
301649	Conn. Rod Screws 1/4-20 heat treated	18 to 20
300258	Gearcase Head Screws 1/4-20	5 to 7

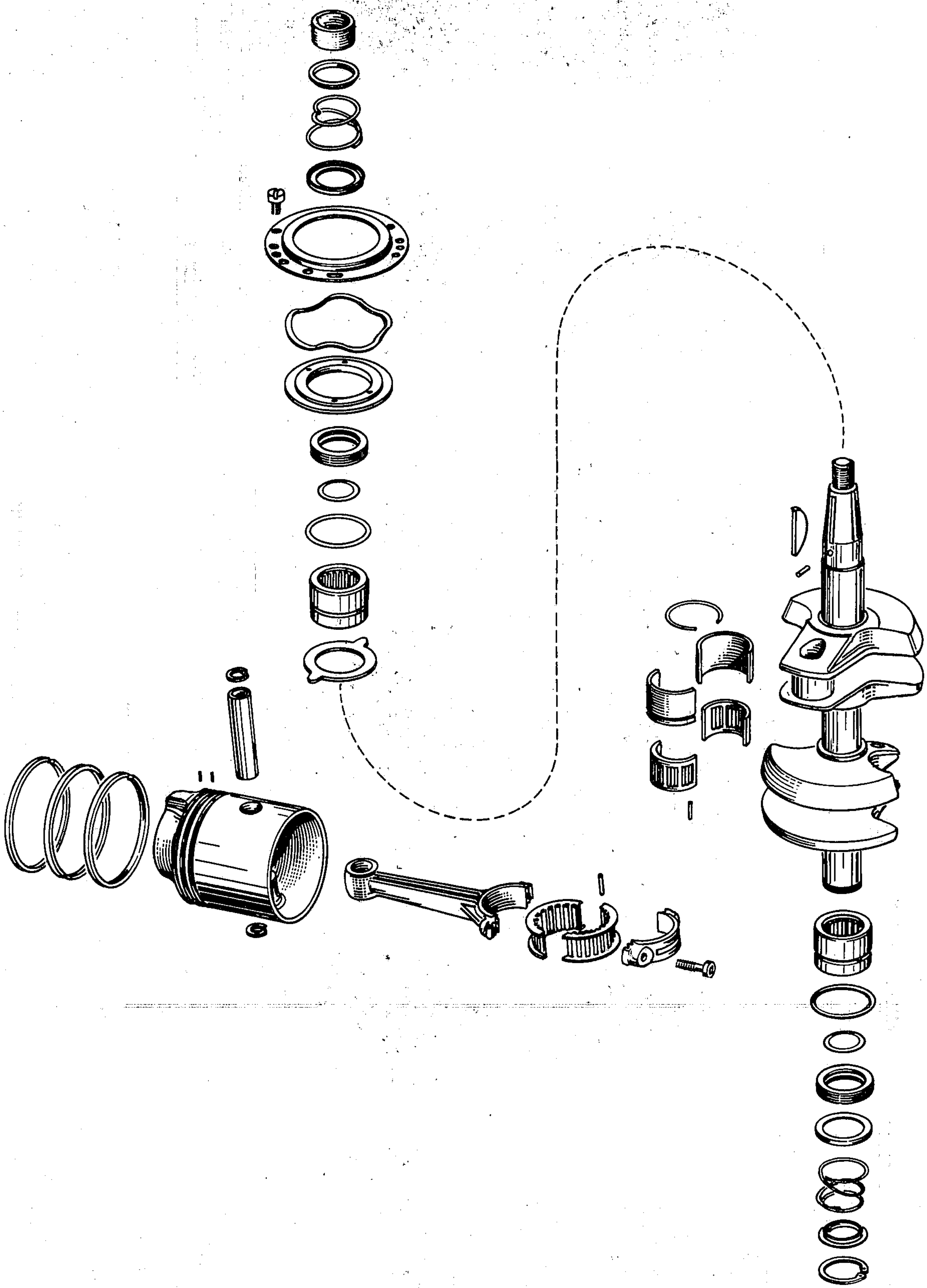
MODEL PO

PART NUMBER	DESCRIPTION	FOOT POUNDS
15-194	Flywheel Nut	65 to 70
7-46	Crankcase Head Nuts 5/16-24	12 to 14
7-45	Cyl. Head Nut	18 to 20
19-54	Gearcase Nuts 7/16-20	28 to 30
29-178	Conn. Rod Screw 1/4-20 heat treated	18 to 20

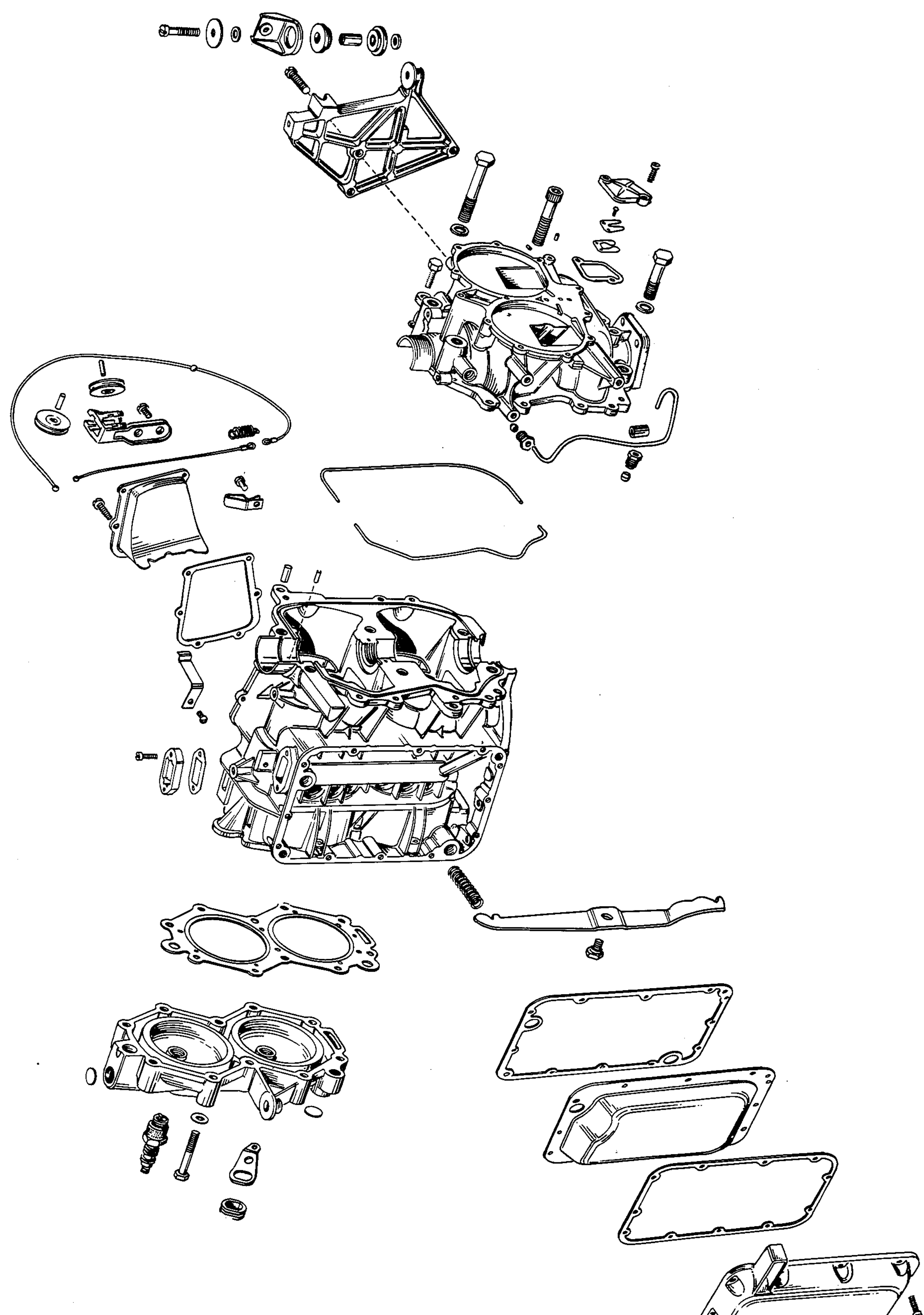
NOTE: If using torque wrench indicated in inch pounds, multiply above foot pounds by 12.



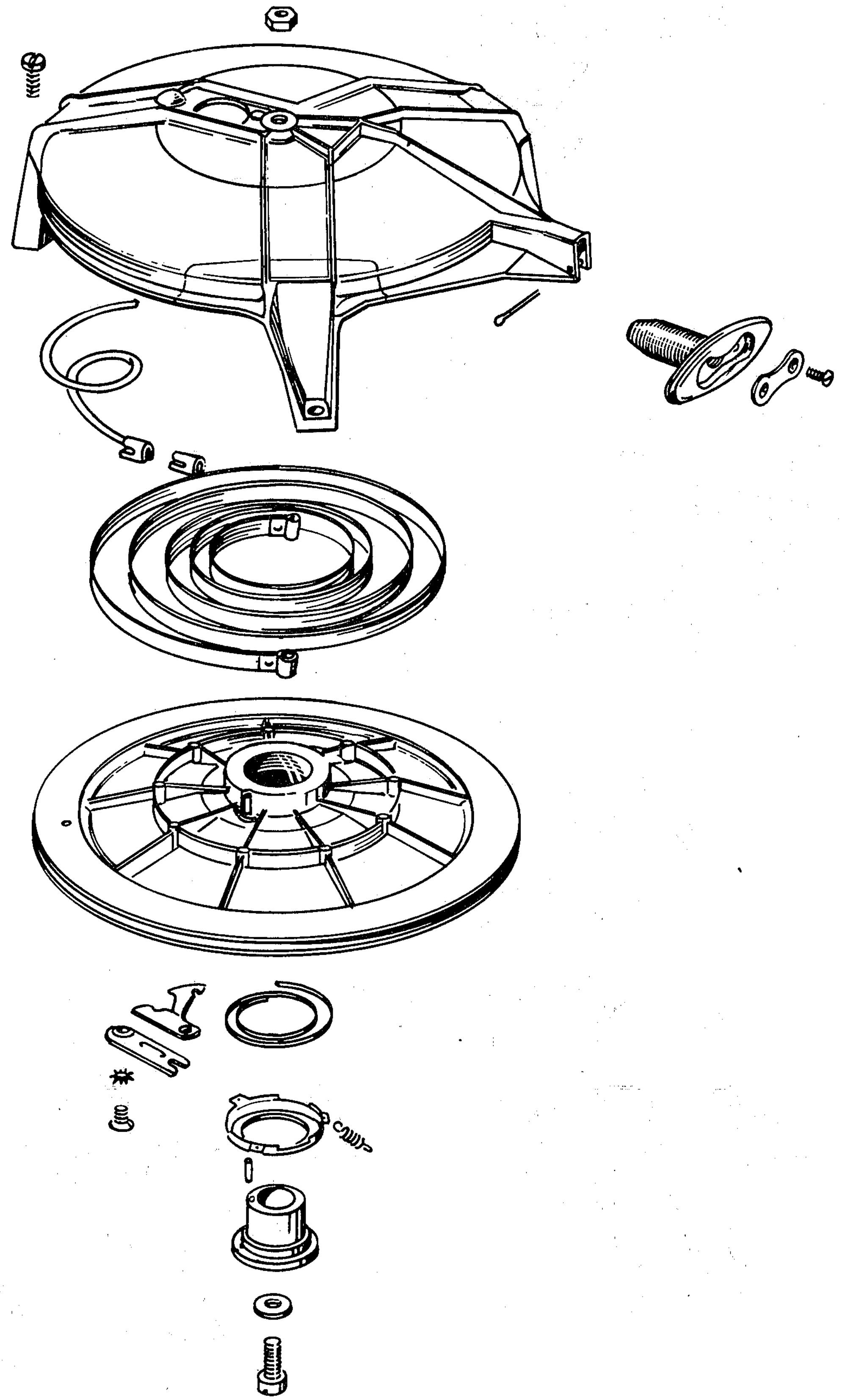
Sectional Views of Powerhead—Model RD



Assembly Layout—Piston, Connecting Rod and Crankshaft Group—Model RD

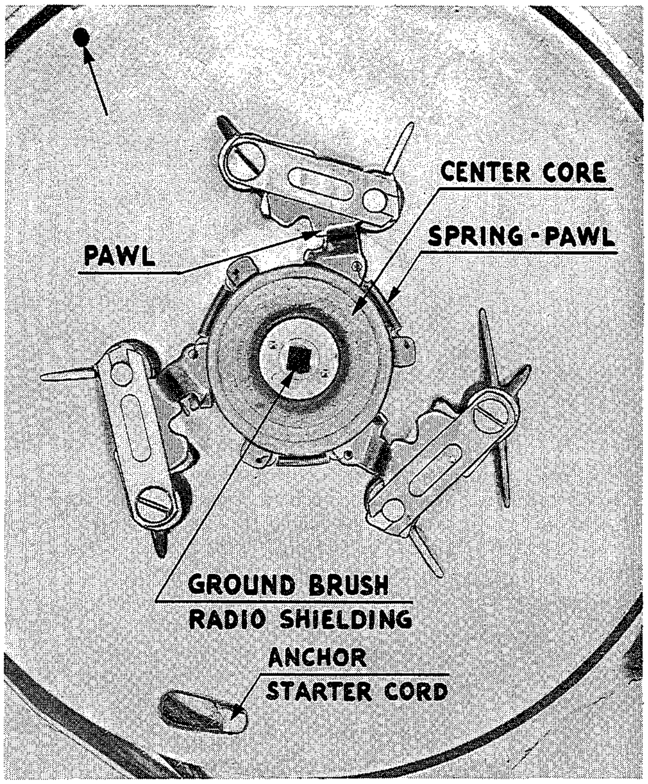


Assembly Layout—Cylinder Block Group

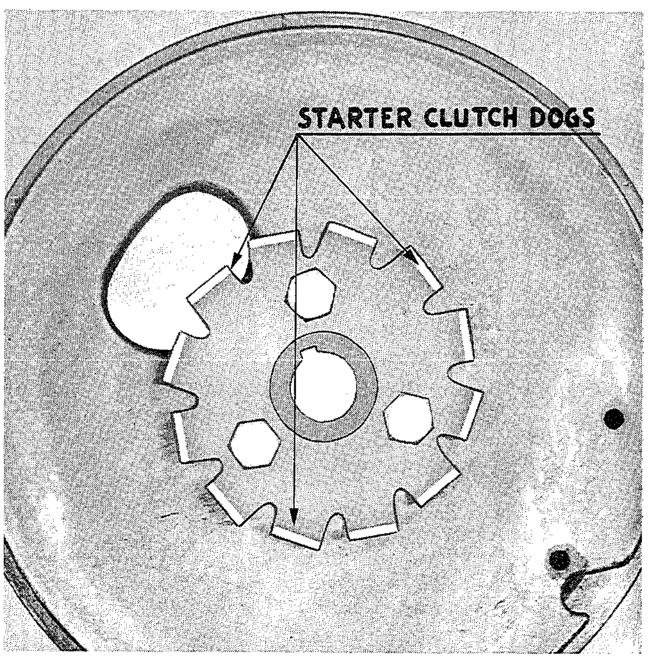


Assembly Layout—Starter Group

THE READY PULL STARTER—MODEL RD



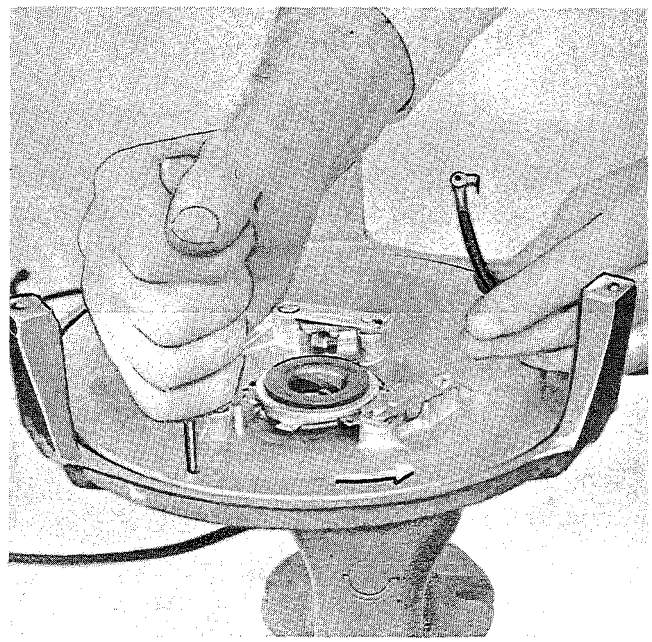
Starter Engaging Mechanism—Starter Head.



Starter Clutch "Dog" Bracket Attached to Flywheel.

The ready pull starter consists of a starting cord and grip, a rewind spring, an arrangement of pawls and corresponding clutch "dogs" and a housing required to contain the complete assembly. When pulling on the starter cord grip, the pawls automatically engage the clutch "dogs" attached to the flywheel to accomplish cranking for starting purposes.

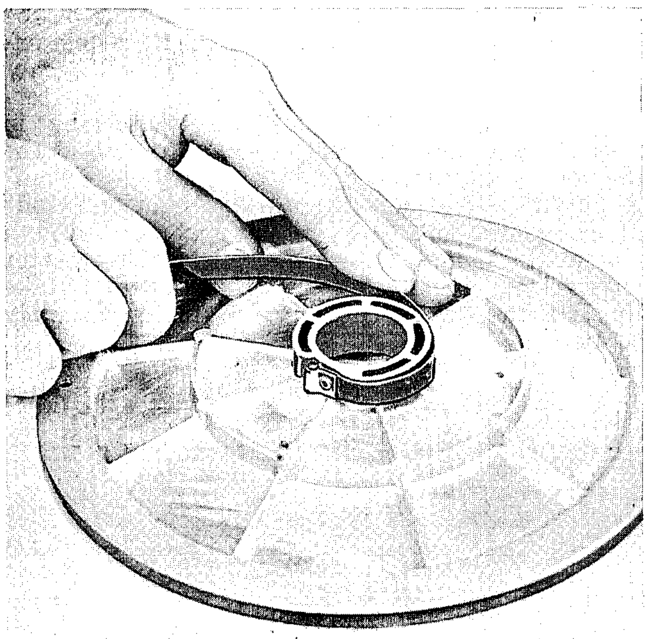
1. To install starter cord: remove starter assembly from the motor; detach grip from starter cord (remove screws and small plate—end of the grip); pull cord out to extreme limit; grasp starter pulley with hand to hold it fast; pull on anchor end of the cord to remove; gradually release tension of rewind spring; place starter assembly in vise to hold; insert straight punch in hole in the starter pulley provided for this purpose; "wind" spring up to full limit, then back off or "unwind" approximately one turn; thread new cord through slot in the pulley; attach opposite end to starter cord grip; gradually release spring tension to take up all of the starter cord; attach starter assembly to motor.



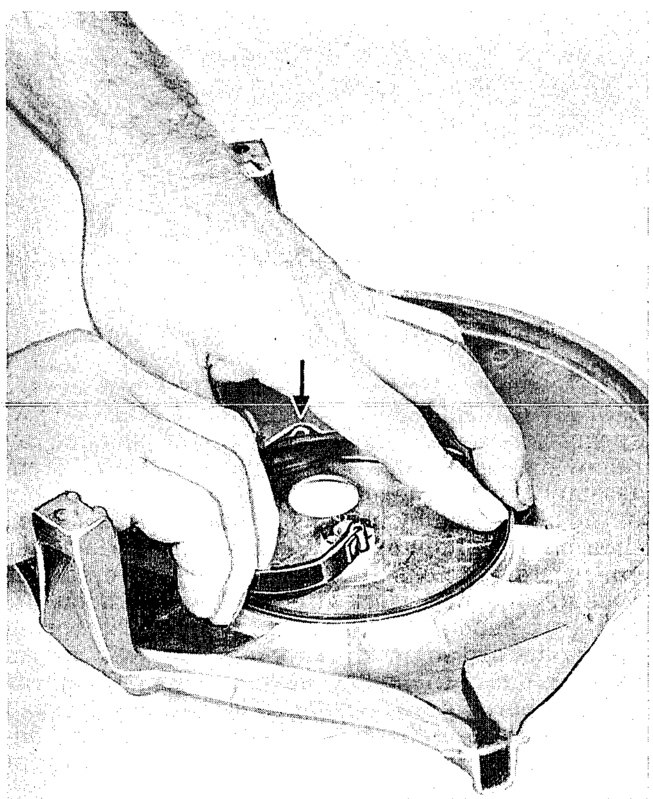
Winding Starter Spring and Inserting Cord.

2. To replace the rewind spring: remove starter cord as instructed above; detach the starter pawl springs; remove pulley from starter housing by removing center core bolt; lift center "core" from assembly, then the pulley; form a loop over pin in the pulley and by bending around boss as shown, then place loop on opposite end of the spring over pin in starter housing; "coil" spring into starter housing (counter-clockwise looking down on assembly); bend "looped" free end of coiled spring up or outward to permit slipping loop over corresponding pin in the pulley on final assembly; smear grease liberally over spring coils with small brush or finger; assemble pulley and housing (with coiled spring installed) as shown—being sure loop of free end of the spring is properly guided to "fit" over corresponding pin on the pulley; carefully replace center core with small spring correctly installed—wrapped clockwise looking down—avoid possibility of one loop riding on top of the other

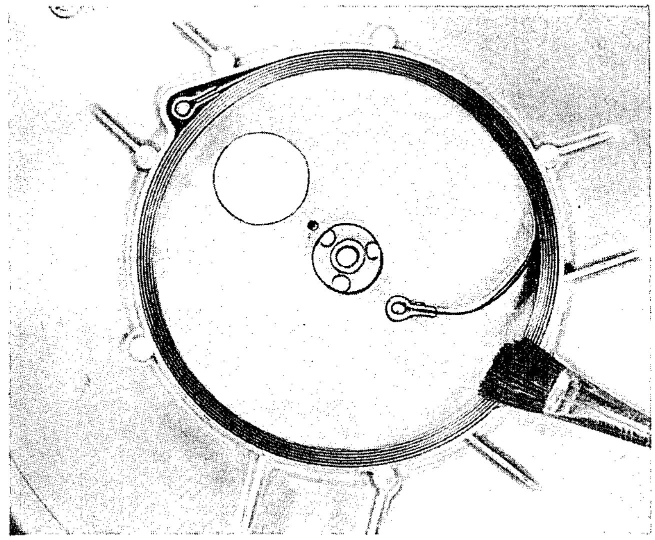
—note small hole in starter housing adjacent to boss and corresponding pin like boss on end of the center core—boss or pin must engage this hole to accomplish correct assembly in this respect; replace and secure center core; replace starter pawl springs; install starter cord as described above.



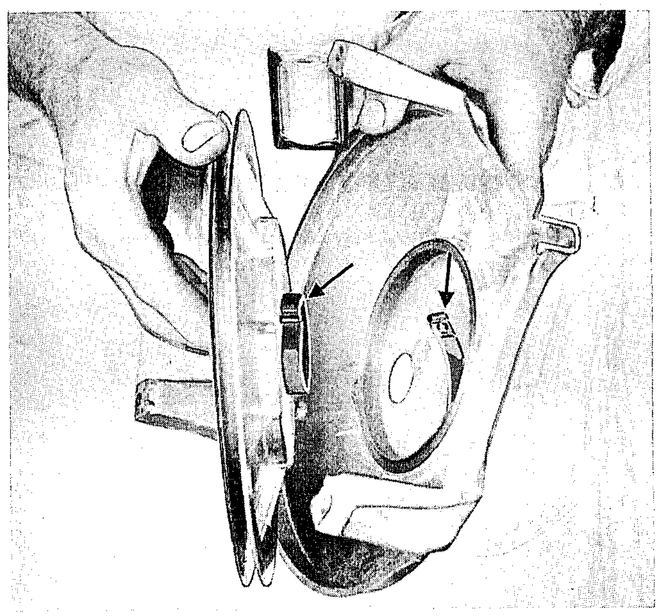
Forming Loop or "Hook" on End of Starter Spring.



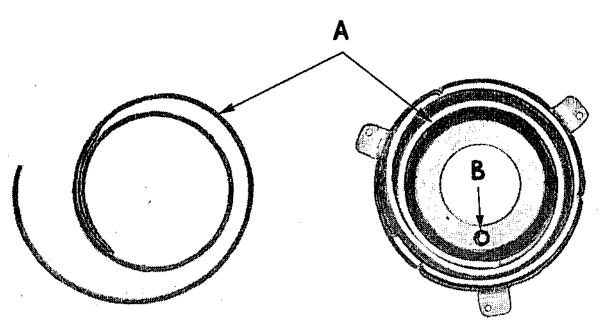
Coiling Spring into Starter Housing—One End Attached to Pin in Housing—Free End Bent Upward to Facilitate Final Assembly.



Showing Starter Spring Coiled into Housing—One End Anchored to Pin—Free End Attached to Pin in Starter Pulley —Applying Grease to Coils of Spring with Brush.

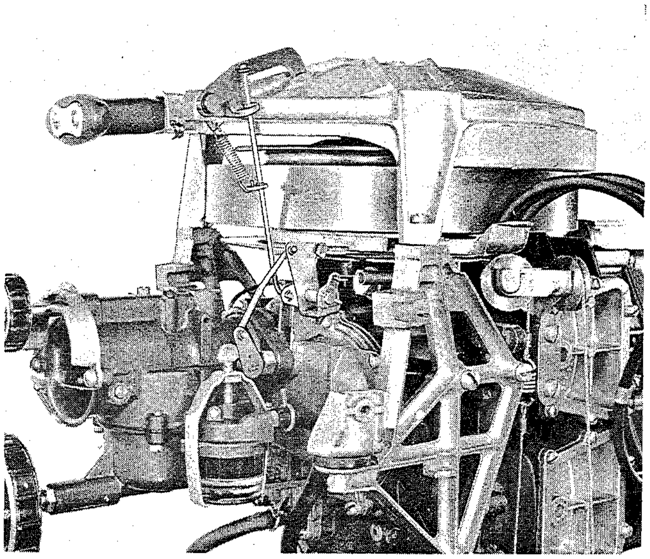


Assembling Starter Head and Pulley—"Loop" on End of Spring to Engage "Pin" in Pulley.

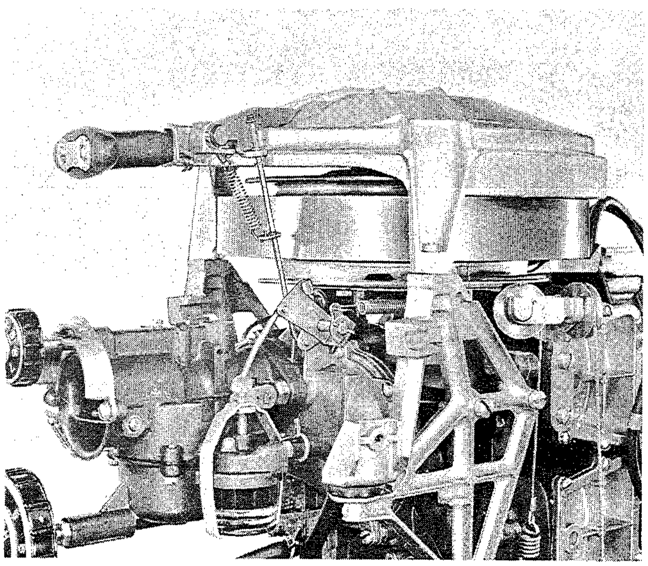


Showing Spring "A" Properly Installed in Starter Center Core—Also Pilot Boss "B" to Locate in Corresponding Hole in the Starter Housing.

STARTER LOCK—MODEL RD-13



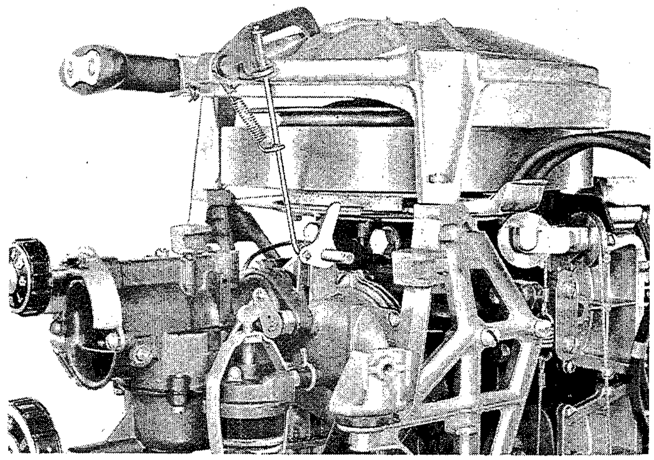
Showing Latch "Released" for Starting.



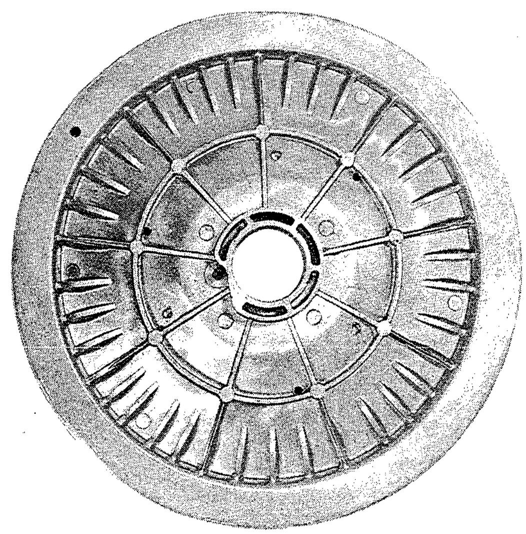
Showing Latch "Engaged" to Prohibit Starting in Gear at High Speed.

Shown here are several views of the starter "lock" as installed on the Model RD-13 to prevent starting in gear at high speed. The assembly is arranged in such a manner that through link, cam and spring action, the starter mechanism is automatically "locked" in event starting is attempted in gear at high speed—speed control grip set beyond position recommended for starting.

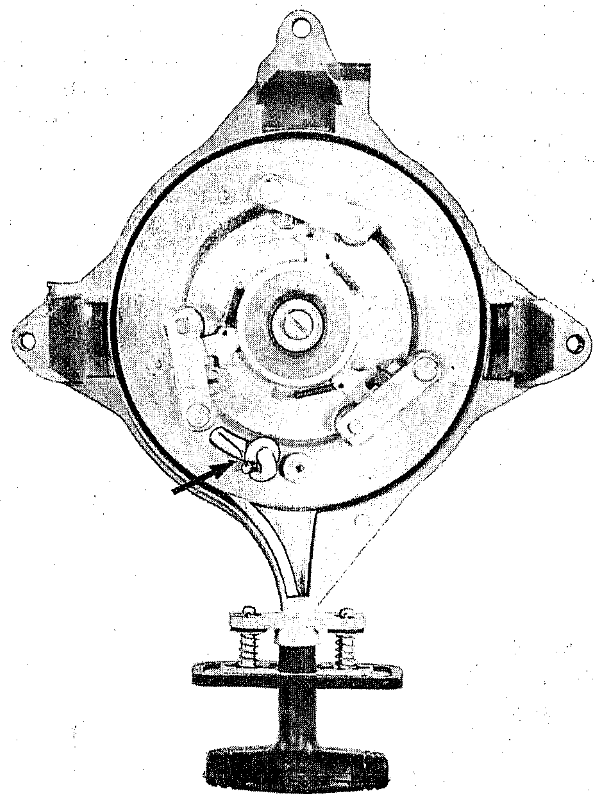
Action is extremely simple—as the speed control grip is advanced, the cam follower (illustration No. 3) riding against high contour of the carburetor control cam (attached to the armature plate), causes latch to engage one of the "blocks" cast on to the starter pulley to prohibit its turning. The starter is "locked" when in this position. With retarding of the speed control grip, the cam follower in riding low contour of the carburetor control cam causes the latch to "lift" thus releasing its hold on starter pulley to permit cranking.



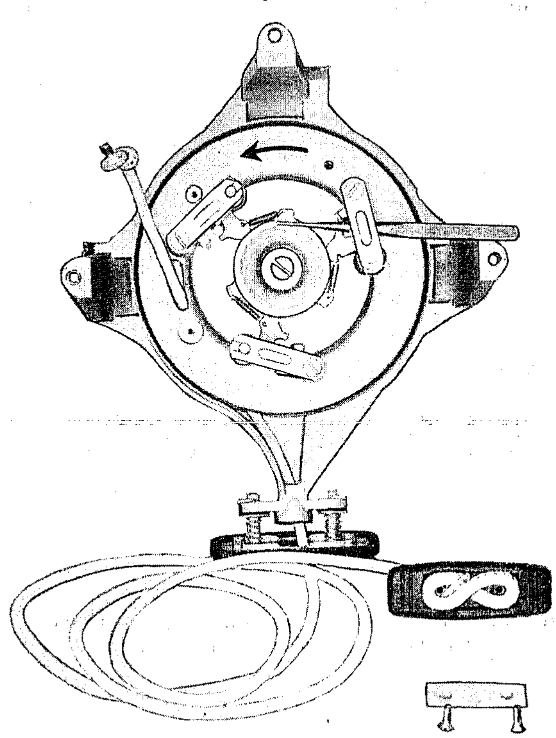
Showing Position of Starter Latch Cam Follower as it Rides Contour of the Carburetor Control Cam—Carburetor Control Mechanism Removed for Purpose of Illustration.



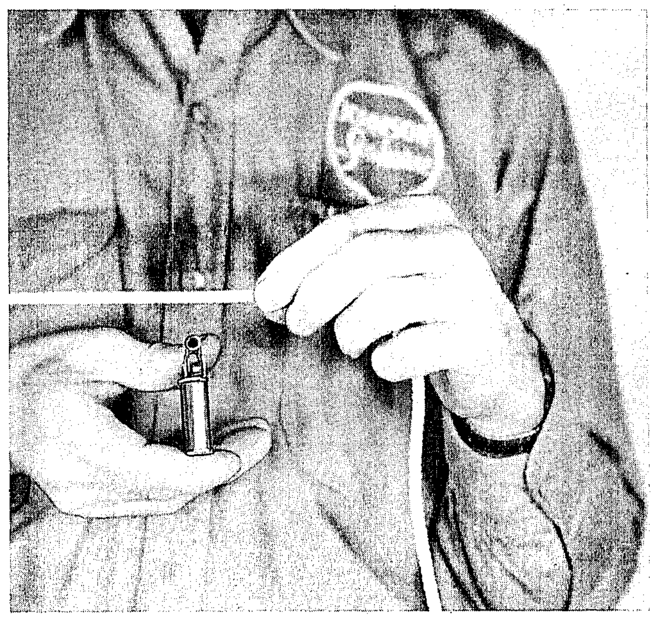
View of Starter Pulley—Topside—Showing Position of Cast—on "Blocks" to Engage the Latch.



It will be noted from the above starter assembly illustration that the familiar starter cord anchor has been replaced with a simple "knot" — made possible by the installation of a nylon cord.



Though the stranded core cord has been replaced by one of nylon, installation procedure remains basically the same. Take up all tension of the starter spring, then permit it to "release" approximately one turn — hold in this position with punch "wedged in" as shown here. Thread cord through the pulley, tie knot, attach opposite end of cord to the grip —looping the cord in a figure eight fashion to secure, then replace cover plate.



Singe area of the cord to be severed with match or cigaret lighter to slightly fuse strands together to prevent them from "unraveling."

NYLON STARTER CORD

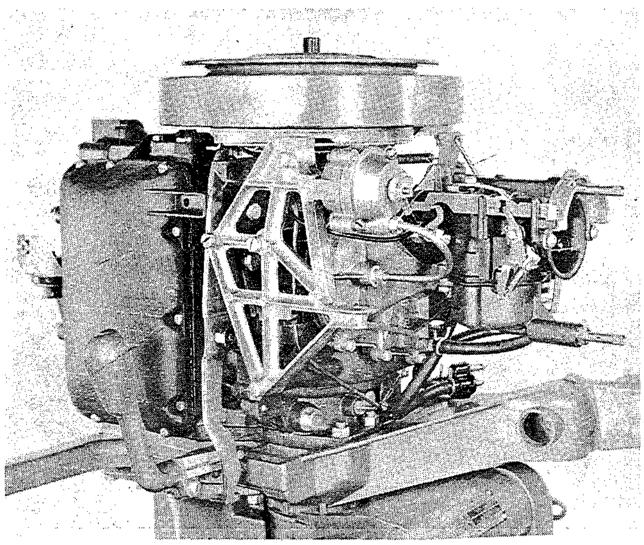
The starter cord on all 1955 models has been changed to one of nylon weave to withstand wear with a center core of dacron to minimize stretch—replacing the familiar one of stranded bronze core, cotton covered and anchor attached.

Models JW, CD, QD, RD and RDE prior to 1955 may be converted for the nylon cord by replacing the starter pulley.

NOTES

THE POWER HEAD — MODEL RD

When major repairs on the power head (engine) such as installation of new piston rings, pistons, connecting rods, crankshaft, etc. are required, a disassembly operation becomes necessary which should be carefully performed in clean surroundings—with clean tools and on a clean and orderly bench top with sufficient space to temporarily store the various parts as removed for inspection, corrective measures or replacement.

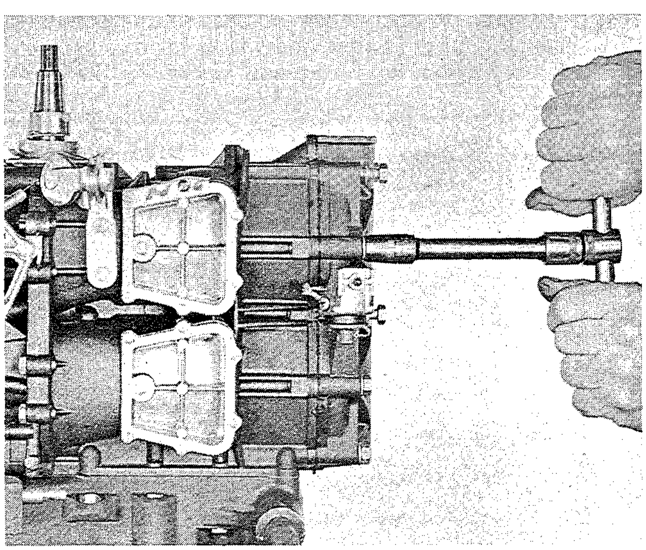


RD Powerhead.

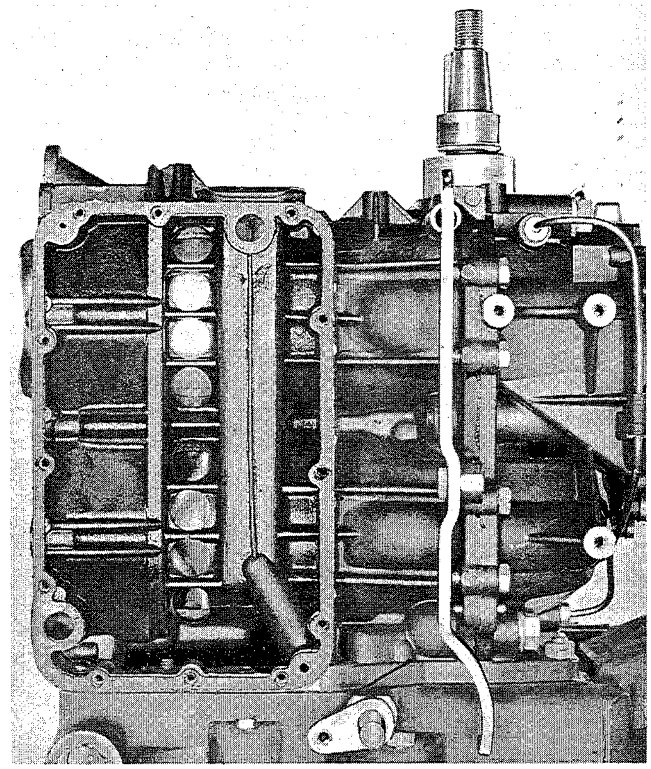
Remove first the motor covers followed by detaching the ready pull starter, flywheel and armature plate assembly as previously instructed.

Detach the fuel and air lines from the fuel filter and intake manifold followed by removing the carburetor.

Remove the intake manifold, cylinder head and muffler.

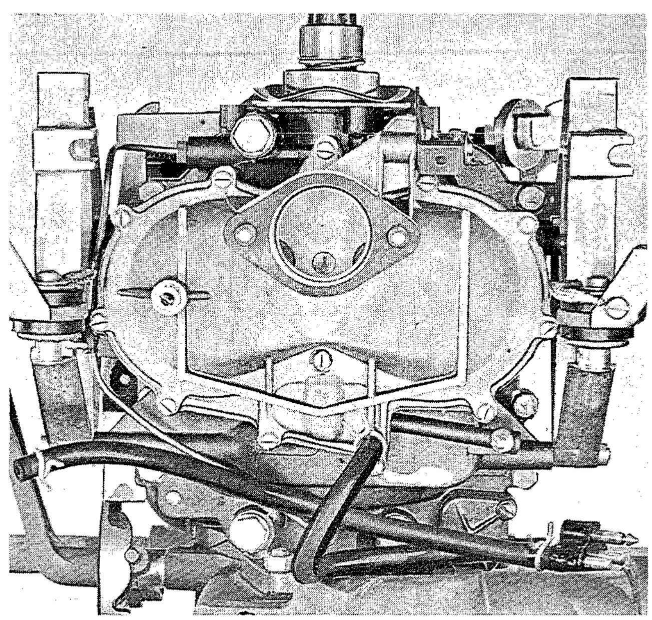


Removing Cylinder Head—Starter Head and Magneto Previously Removed.



Muffler Removed to Expose Exhaust Ports in Cylinder Block.

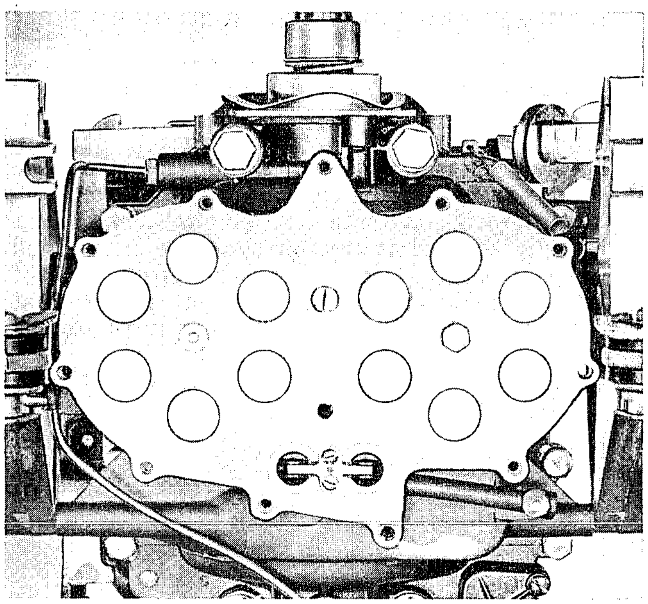
The muffler is water cooled and is of two-piece assembly, namely, a die cast aluminum outer shell and a stamped sheet steel inner shell. The inner shell being somewhat smaller than the outer shell provides space when assembled for circulation of water to assist in dissipating heat of exhaust gases during operation of the motor and becomes



Carburetor Removed to Expose Intake Manifold.

part of the water circulating system. As such, the muffler assembly is sealed with two gaskets—one between the outer and inner shells and a second between the inner shell and corresponding face of the cylinder block, when bolted together. The gaskets must be well seated and, of course, in good condition at all times to guard against water seepage. Faces of both the inner and outer shells must be flat to obtain water tight seat at this location —gaskets rarely hold against "warped" surfaces. Lap down to "true" if necessary—a piece of emery cloth placed on a square of plate glass or other flat surface will suffice for a lapping block. Move surface to be "lapped" carefully over lapping surface in figure eight motion until flat.

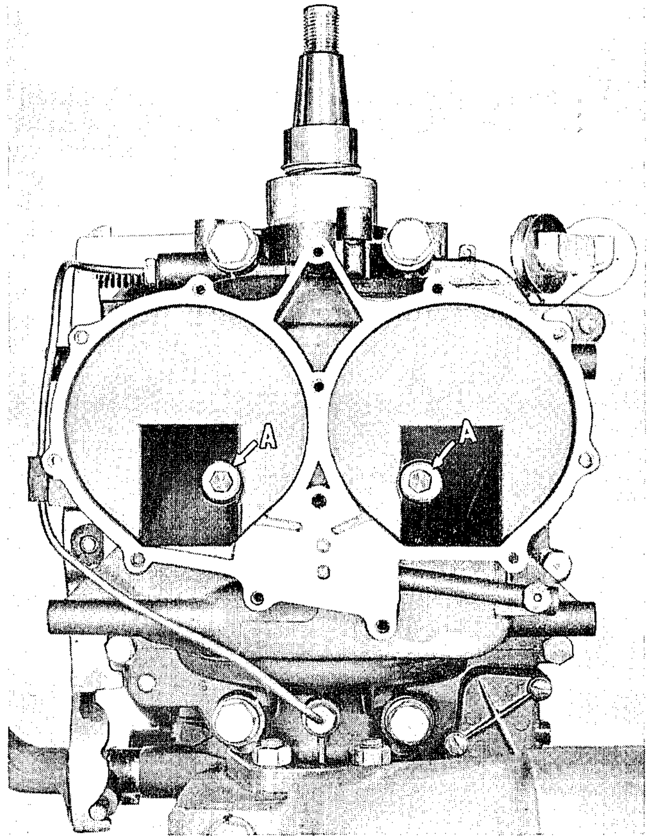
Carefully detach automatic intake valve assembly—place on clean surface, preferably in a small cardboard or wooden box or wrap in piece of clean paper until ready for inspection and repairs later during the process of overhaul. Do not permit foreign matter to scratch surfaces of the aluminum plate or enter the assembly in any manner—surfaces must be flat and smooth to maintain crankcase compression. Holes or ports drilled into the plate form a part of the valve arrangement against which segments of the valve or leaf plate come to rest—thus, surrounding surfaces must be free of scratches or not otherwise injured to prevent loss of crankcase compression.



Intake Manifold Removed to Expose the Automatic Intake Valve and Plate Assembly—Also, the Fuel Pressure Check Valves.

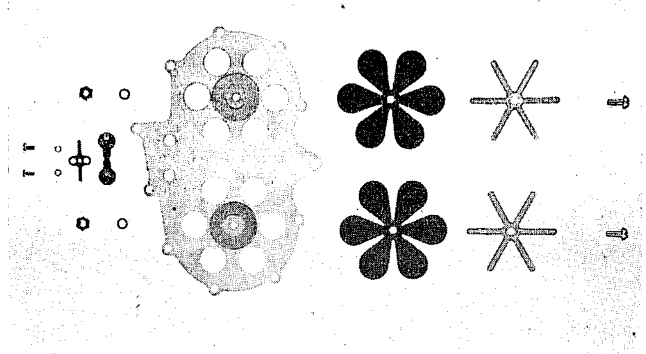
A guide with six corresponding curved fingers is attached immediately back of each valve plate to limit maximum degree of segment opening—operation of the valve is described under "carburetion."

In event there is occasion to install a new valve plate, care must be exercised to see that each segment is located squarely over corresponding holes in the valve plate—overlapping and equal distance on each side. Adjust fingers of the guide member to fall in center of segment. Since the leaf or valve

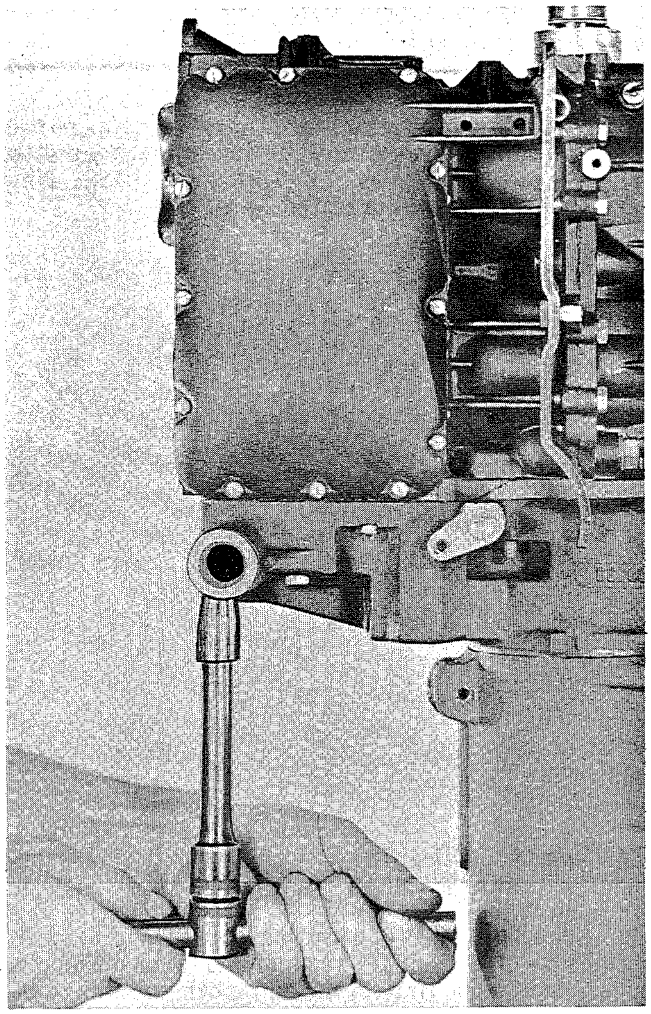


Valve Plate Assembly Removed to Expose Crankcase—Necessary to Remove Allen Head Screws for Complete Disassembly of the Cylinder Block.

plate is constructed of heat treated beryllium copper, do not under any circumstances, flex or bend the segments by hand—to do so will render it "unfit" for further service—discard and replace with new valve. In the process of heat treating a definite tension (spring) is provided each segment; if bent beyond critical point, tension "sets"—that is, the segment will no longer spring back to its normal flat position against the aluminum valve plate. Result is loss of crankcase compression to cause hard starting and faulty operation of the motor. Similarly a broken segment will result in like performance.

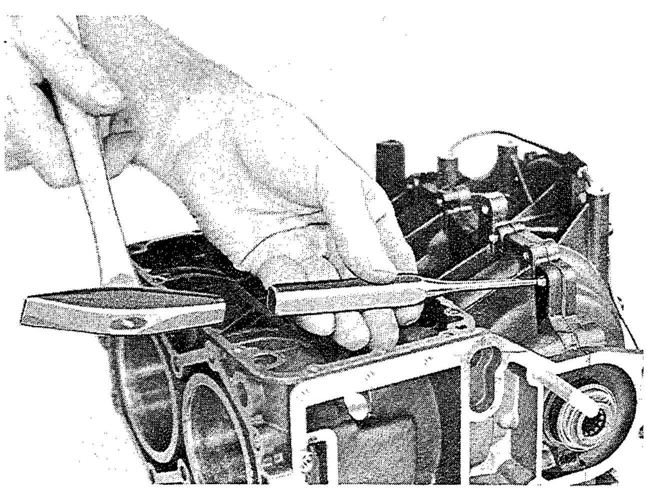


Automatic Valve Plate Assembly.



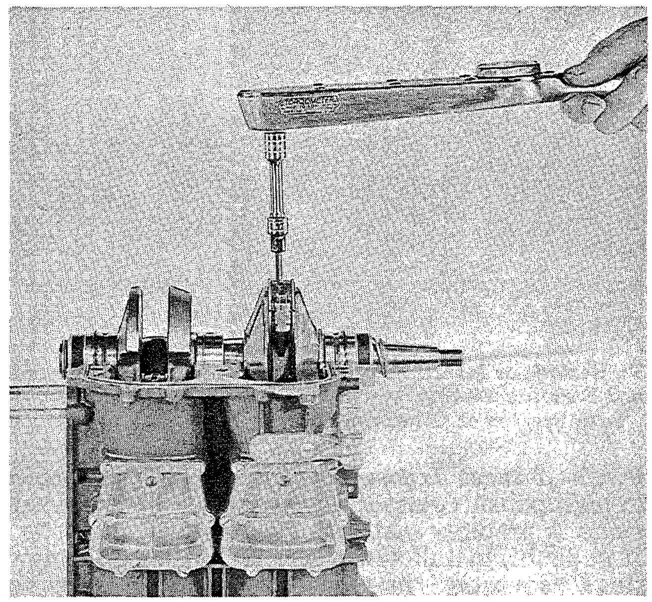
Removing Power Head from the Lower Unit.

To detach balance of the power head from the lower unit assembly, it requires removing all the screws holding it fast in this position. Carefully place power head on clean bench top for further disassembly. Note gasket placed between both assemblies to seal water transfer and exhaust gases at this location.



Driving Tapered Pin Out with Punch.

Tapered pins (2) are employed to attain proper alignment of the crankcase with respect to the cylinder block proper and crankshaft bearing locations. Drive pins out with flat punch as shown. Remove nuts and screws holding crankcase fast to the cylinder block. If necessary, tap the crankcase lightly with mallet to free — lift from position. (Note: Allen head screws in manifold areas—back of automatic intake assembly.)



Removing and/or Installing Connecting Rod Allen Head Screws.

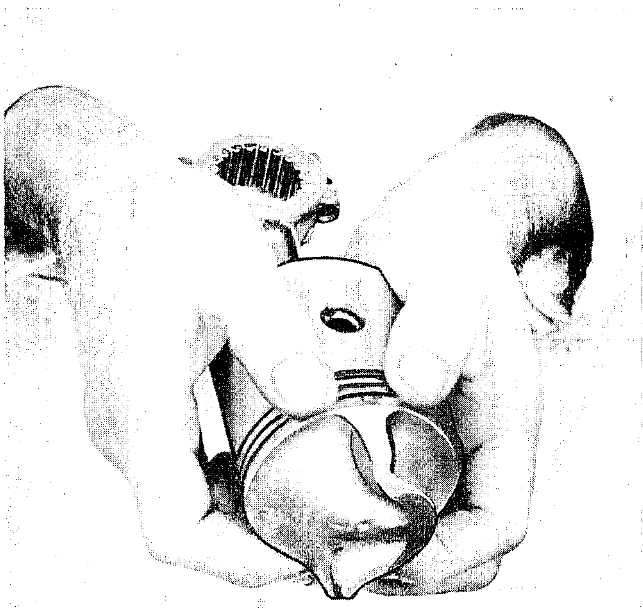
Crankshaft and connecting rod-piston assemblies are now accessible for inspection and removal. Connecting rods should be marked No. 1 (top) and No. 2 (bottom) with pencil or chalk to avoid interchanging on reassembly if same assemblies are again installed—also, at the time bear in mind to retain original position of roller bearing-retainer assemblies and connecting rod caps (connecting rod and caps are "matched" assemblies, do not attempt interchanging the connecting rod caps).

Piston and connecting rod assemblies may now be detached from the crankshaft. Remove Allen head connecting rod cap screws (use Allen head wrench) lift caps and bearing retainer assemblies from respective crankpins. Lay on clean bench top in positions like that removed to avoid interchanging later on.

Lift crankshaft assembly from the crankcase (upper half in cylinder block). Remove balance of connecting rod roller bearing-retainer assemblies —lay on bench next to corresponding caps to retain original position.

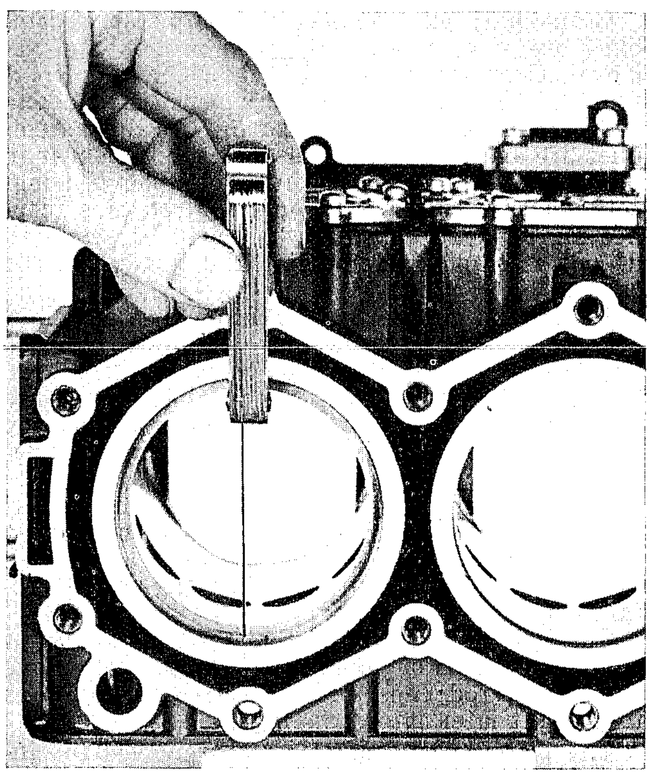
Push connecting rod-piston assemblies out of cylinder bores. For time being, replace respective connecting rod caps, bearing-retainers and caps to prevent later interchanging.

The piston rings may now be removed for inspection or replacement—spread between thumb and forefinger to slip off over head of the piston. Install in similar manner. Check piston rings for



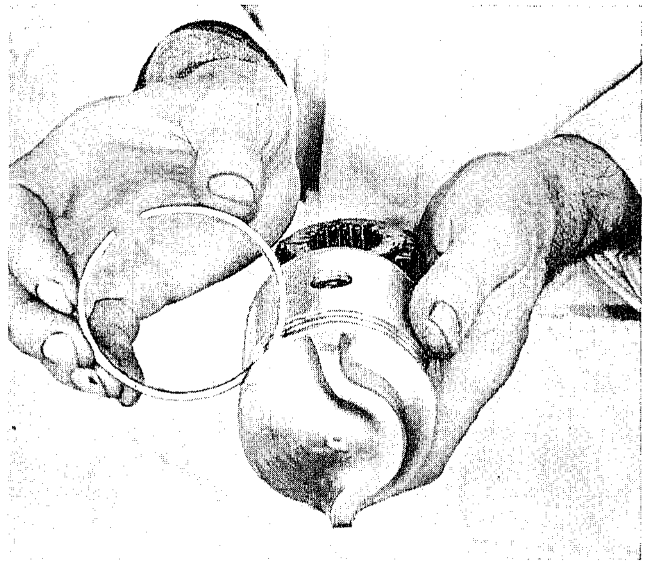
To Remove or Install Piston Rings, Spread Between Thumb and Forefinger—Slip Over End of Piston, Being Careful Not to Scratch or Otherwise Injure Piston Ring Lands.

wear—if faces exposed to cylinder wall are worn to high polish (glass-like appearance), replace the rings. A properly seated ring wears to a dull luster. If in doubt, install new piston rings. Place the new rings "squarely" in respective cylinder bores to check gap clearance between ends of ring-recommended .007" to .017", using feeler strip or gauge of corresponding thickness.



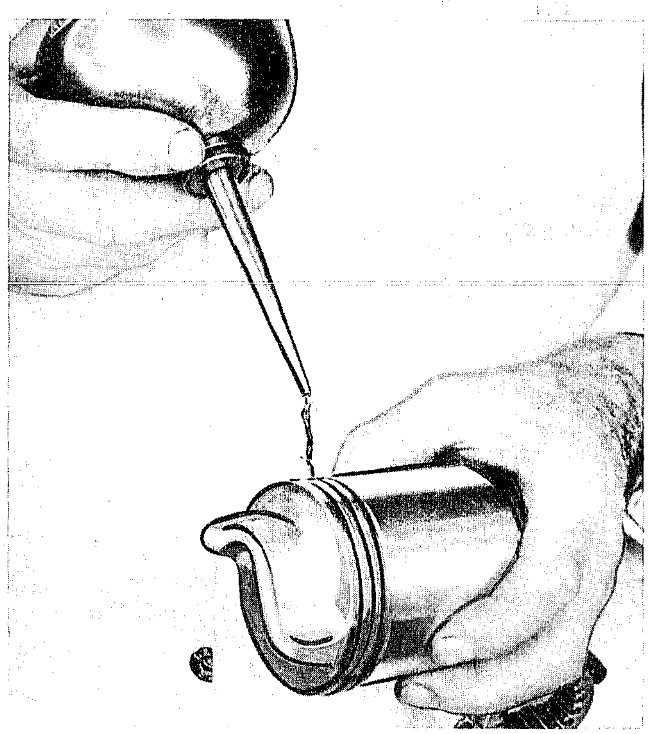
Checking the Piston "Gap" Clearance with Feeler Strip of Recommended Thickness.

Remove carbon from piston ring grooves to prevent rings sticking and becoming partially inactive—result is loss of compression. Operation may be easily performed with small narrow scraper being careful not to scratch or otherwise damage the groove walls. Check each ring in respective piston ring groove for possible "tightness." Roll ring around groove as illustrated here.



Checking Piston Ring Grooves for Burrs or Other Damage to Prevent Piston Ring Binding.

There should be no indication of sticking or binding—check ring grooves and side walls for possible causes (burrs, nicks, or other damage)—dress down high or tight areas.

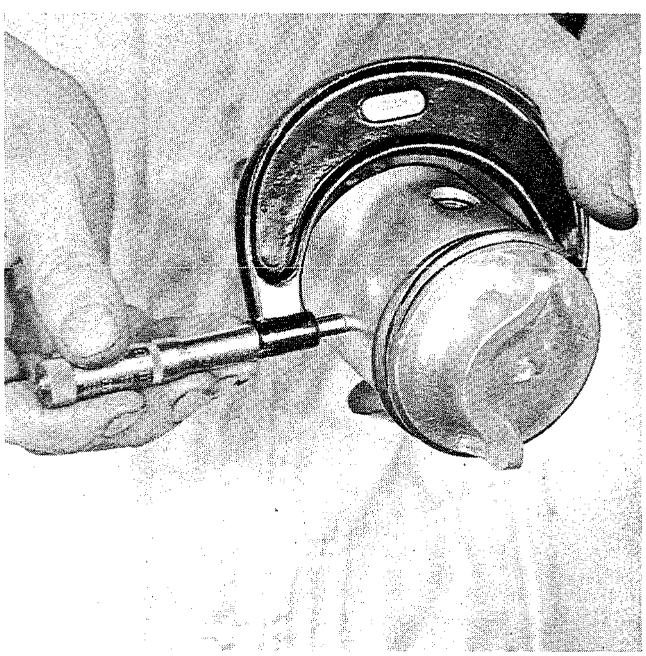


Oiling Piston Ring Grooves—Piston Rings Installed.

On having installed piston rings, apply oil to ring grooves as shown. Roll rings around piston to spread. Note pins in ring grooves to locate position of rings on piston—adjust rings so that gap locates over the pin.

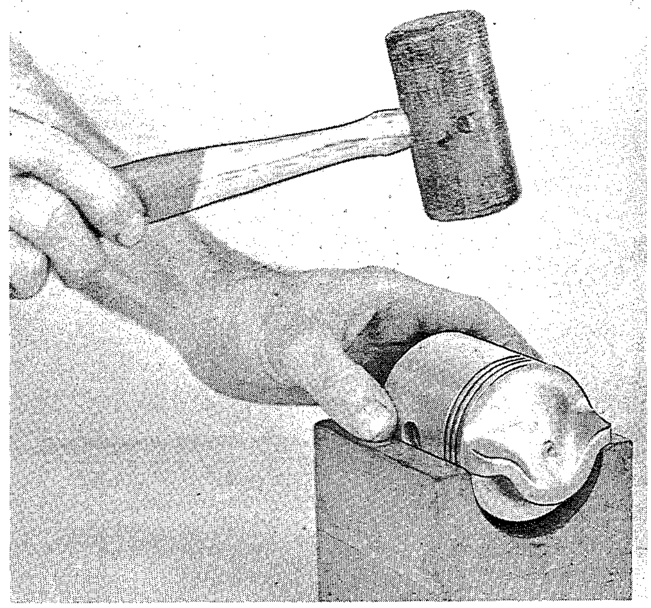
Piston (wrist) pin is full floating—free in the piston bosses as well as being free in connecting rod top end. To remove, simply remove the retainer ring with sharp long nose pliers—one on each side of the piston. It is then only a matter of pushing the pin out with thumb or finger. Reinstall in reverse order but apply oil to surfaces prior to doing so—make no dry assemblies where lubrication is involved.

Removing and/or Installing Wrist (Piston) Pin Retainer.

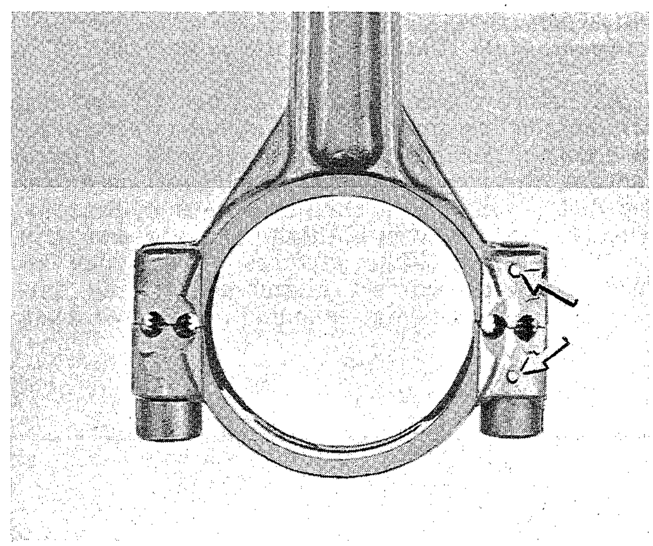


Checking "Roundness" of Piston with Caliper.

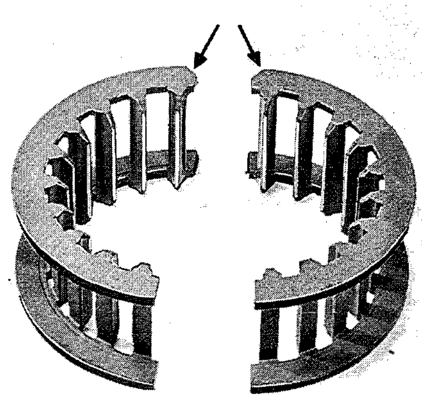
Check "roundness" of piston with caliper. If necessary "true up" by placing piston in hallowed block, strike lightly on high side with mallet.



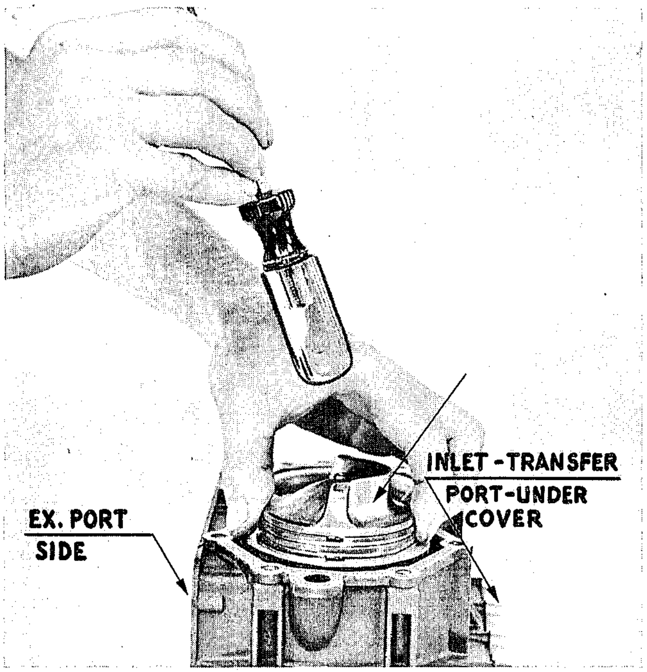
"Rounding" Piston.



Showing Match Marks on Connecting Rod and Cap.

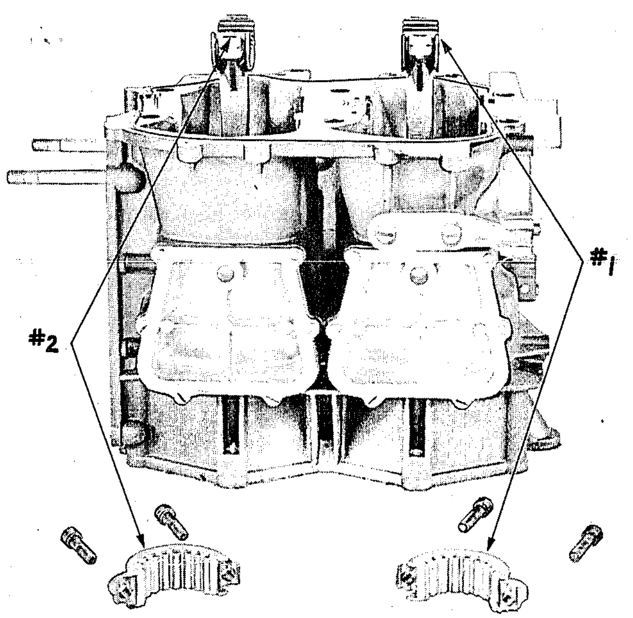


Showing Match Marks (Slants) on Connecting Rod Roller Bearing Retainers.

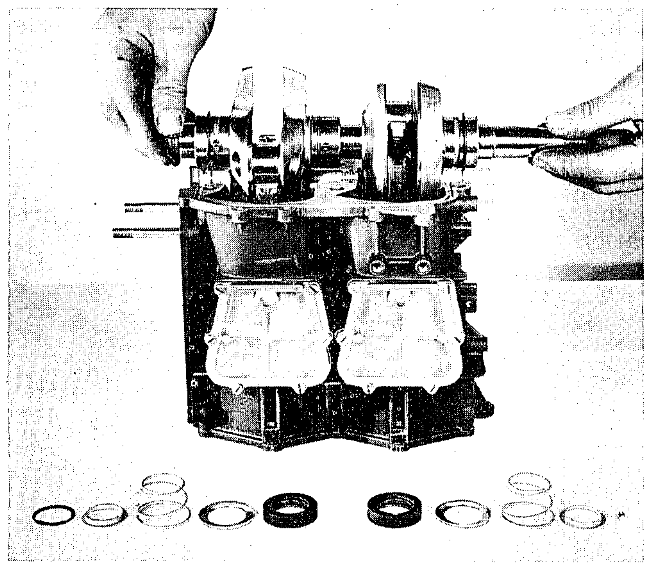


Showing Installation of Piston—Note the Straight Side of Piston Deflector Faces Side of Transfer or Intake Port—Opposite of the Exhaust Port. THIS IS IMPORTANT!

As before stated, the connecting rod and cap are matched assemblies—that is, not interchangeable with other like parts. In the process of manufacture, the rod and cap are machined as an integral or "solid" unit, then broken or split apart. This operation leaves both the rod and cap with rough or serrated-like surfaces which when replaced, provide correct alignment bearing surface and side walls. Care should be exercised when attaching the cap to assure its "falling" into place—rough areas "matching." To avoid turning the cap end for end—both rod and cap are marked to aid in matching.

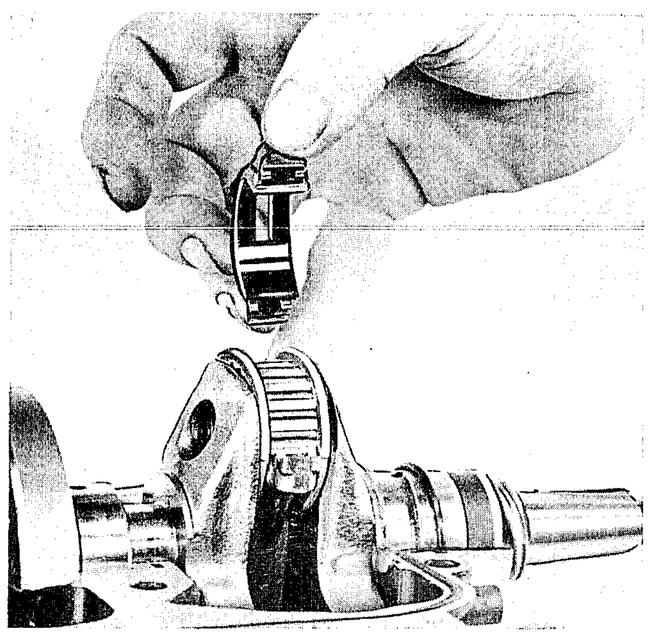


Piston-Connecting Rod Assemblies Installed Prior to Replacing the Crankshaft. Connecting Rod Caps and Bearing Retainers Laid Out as to Position of Assembly to Respective Connecting Rods.

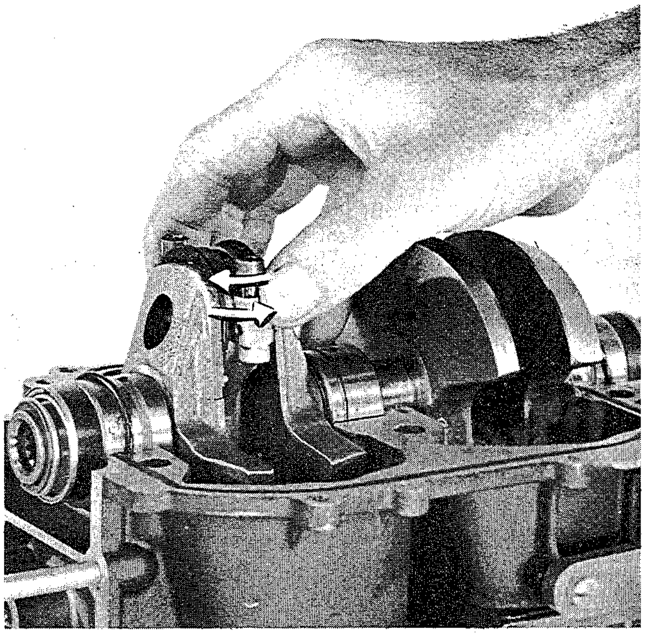


Installing Crankshaft—Prior to Replacing Connecting Rod Caps.

Connecting rod roller bearing retainers similarly machined as one piece later split by sawing to permit assembly on the crankpin, proper matching is required. The "halves" are not interchangeable and must at all times be kept together—wired or tied together in event there is possibility of "mixing" during repair procedure. Neither can they be placed or turned end for end on assembly. Note: "Slant" ground on matching ends or sides—always assemble accordingly.

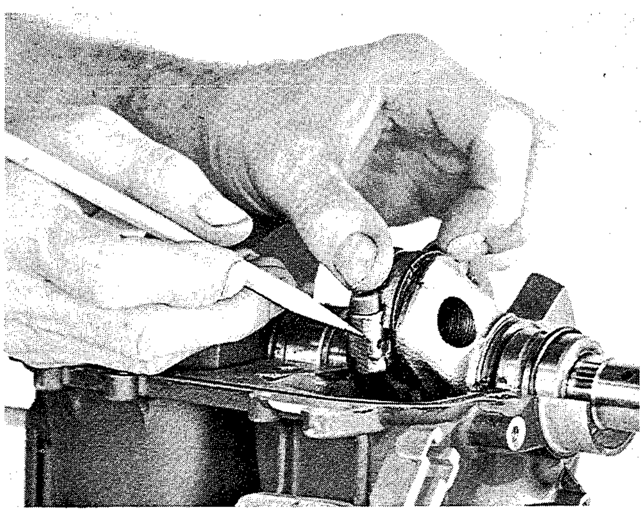


Showing Roller Bearing Assembly Installed on Crankpin and Replacing the Connecting Rod Cap—After Aligning Both Cap and Retainer with Respect to "Matching" Marks.

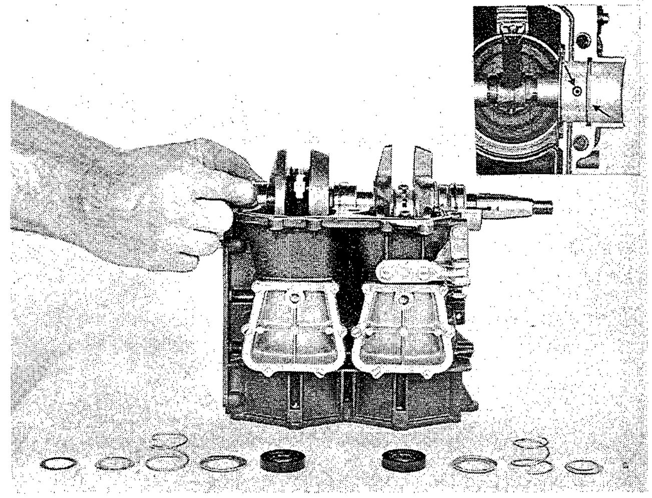


Rocking Connecting Rod Cap to Assure Proper Seating in Corresponding "Fractured" Surfaces of the Connecting Rod Prior to Drawing Up on Allen Head Screws.

Since all three of the "main" crankshaft bearings are of the caged needle or roller type, some provisions of necessity must be made to seal the crankcase compression—at both ends of the crankcase and the center journal or "main" between the two crankcase chambers. A carbon seal is arranged to ride under spring tension against the end of each roller bearing—top and bottom while a grooved bronze bushing is installed adjacent to the center roller bearing as shown. The crankcase being of "split" type requires sealing between the outer bearing assembly and crankcase support—thus the "O" ring as shown in the illustration. Constructed of rubber, it compresses between the bearing race and crankcase to seal off compression.



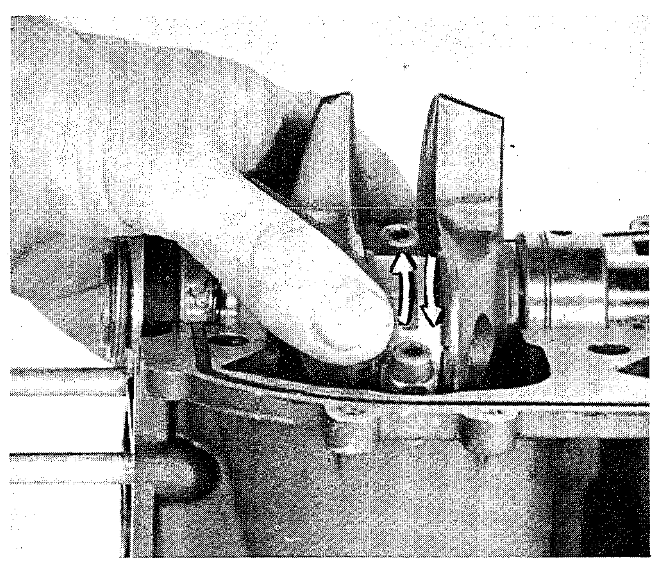
Checking Side Surfaces of Rod and Cap with Sharpened Pencil Point for "Flushness"—Neither Edge Should Overlap the Other. Flush Surface at this Point Indicates Proper Seating of Rod and Cap.



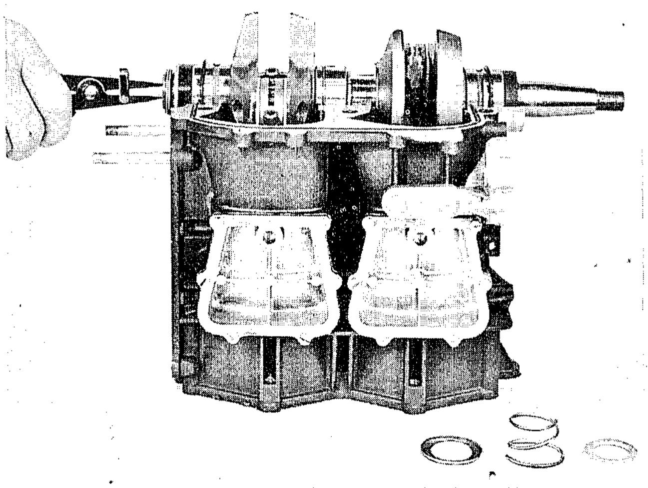
Aligning Journal Bearing Assemblies to Seat Over Pins in Crankcase Bearing Supports. Insert Shows Pin to Align Bearing in Support and Groove to Contain the "O" Ring. Carbon Seals and Attendant Parts to be Later Installed.

To install the piston and connecting rod assembly, note first that the straight side of the deflector on top of the piston must be directed toward the intake or by-pass port in the cylinder—opposite the exhaust port or muffler side of motor—this is IMPORTANT to assure proper functioning.

Insert piston-rod assembly in respective cylinder bore. Compress piston rings with fingers and carefully "tap" into bore with smooth end of screw driver or other object as shown. Gap between ends of the piston ring should ride over the pin in the piston ring groove. Turn assembly end for end—pull piston-rod assemblies out to limit. Insert connecting rod retainer with rollers installed—use clean light grease to retain position.



Checking "Freeness" of Roller Bearing Retainer After Assembly—Push Back and Forth with Thumb. Correct Assembly of Rod and Cap and Bearing Retainer Permits Free Movement in This Respect. "Binding" of Retainer Indicates Improper Assembly—Recheck as Instructed—Bearing-Retainer Assembly Should Revolve Freely on the Crankpin and Within the Connecting Rod.



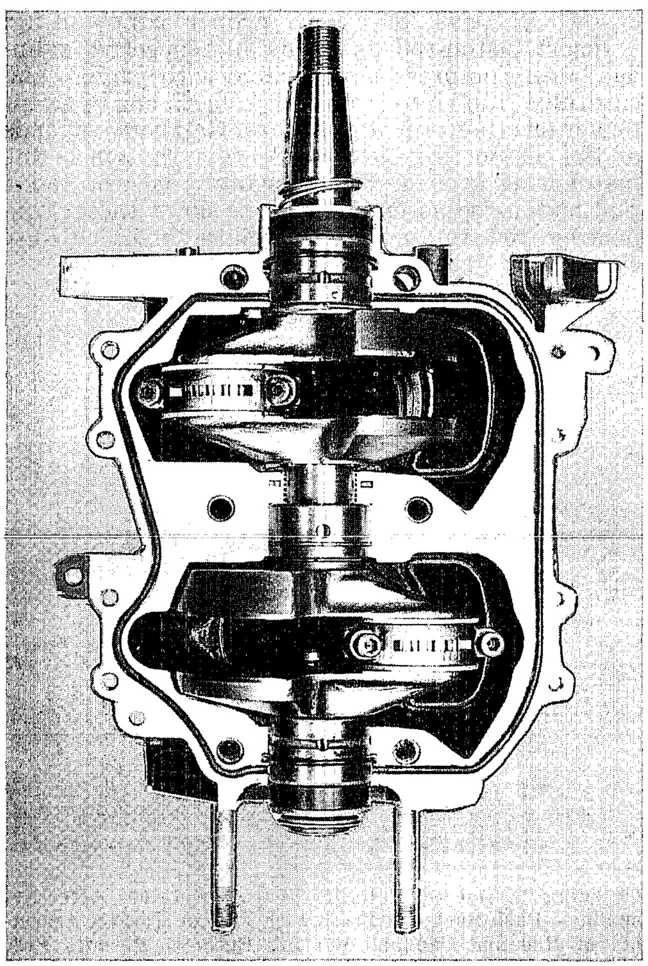
Final Assembly of Crankshaft—Installing Carbon Seals, Springs, Retainer Washers and Retainer Washer on Bottom Journal—Using Pointed Nose Pliers.

Rock cap on rod to make sure proper seating is obtained—accomplished by "feel." Replace Allen head cap screws—draw up but not tightly at this time. Check outside surfaces with sharp pencil point for "flushness." Tighten the Allen head cap screws with torque wrench to 20 foot lbs. tension —Note: In the event wrench is calibrated in inch pounds, multiply by 12.

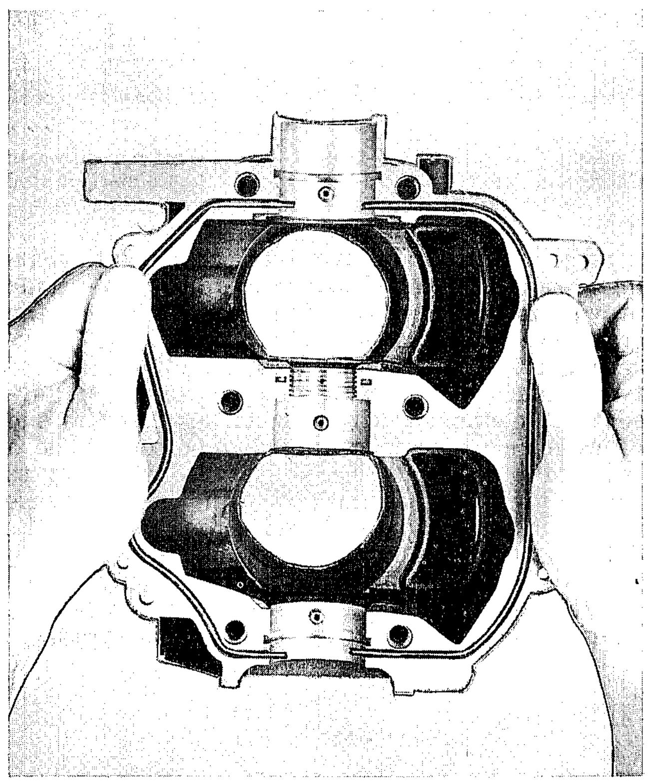
Seat entire assembly of crankshaft and connecting rod assemblies in the crankcase. Note pins in crankcase "main" bearing bosses and corresponding holes in crankshaft main bearing assembly outer cages. Align bearings to engage pins in the crankcase bearing supports.

Replace carbon seal washers, springs and the retaining washer on the bottom end. Assembly on top end is held fast by hub of the flywheel.

Note that rubber seal strips of round cross sections are employed to seal the crankcase — fitted into shallow grooves of the upper section (cylinder block) provided for this purpose to accomplish crankcase compression seal in conjunction with "O" rings installed on the top and bottom bearing cages when crankcase sections are bolted together.

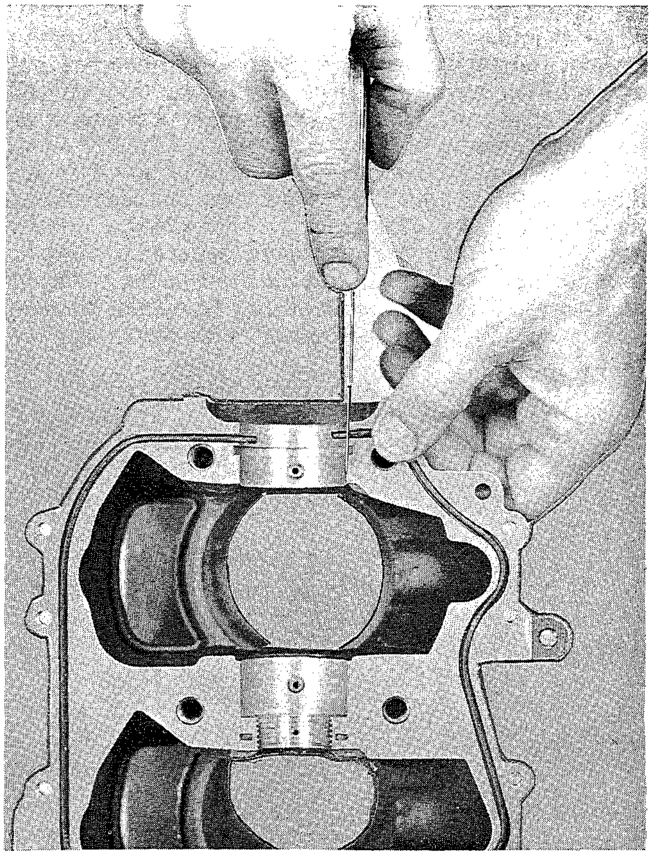


Showing Crankshaft Seated in Upper Crankcase and Seal Strip Installed.



Placing Seal Strip in Bottom.

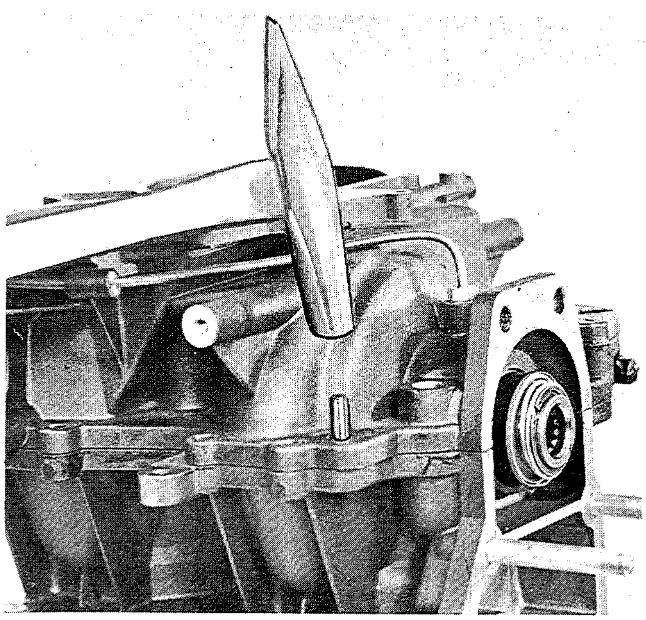
The seal strips, when obtained as service parts come just a bit too long for installation "as is"— this is to permit proper installation or adjustment in corresponding grooves. To install—remove all traces of cement on crankcase faces and grooves, if necessary. Apply Sealer 1000 (or similar hard drying cement) at several points along the grooves and particularly at the end of each groove. Place seal strip in position immediately (before the sealer dries) allowing each end to overhang slightly, then, before the sealer sets, guide the entire length of the strip towards outside edge of the groove in each case. Use thumbs of each hand to accomplish as illustrated. Trim ends with knife allowing ends to hang over just a "hair" to insure proper seal at the end of the strip.



Trimming Ends of Seal Strip.

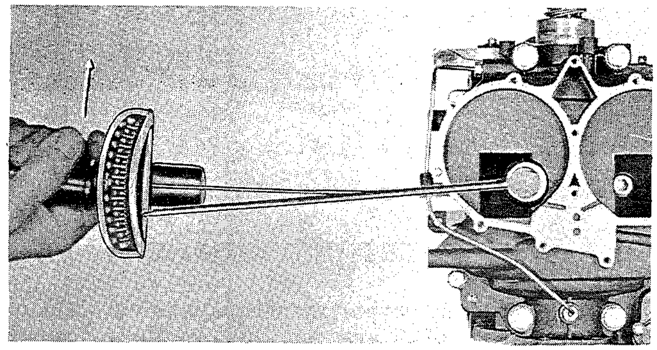
Apply thin coat of Sealer 1000 (or similar hard drying cement) to surfaces to be bolted together —be a bit more generous with sealer in areas at ends of the seal strips to insure a good "butt" seal.

Replace crankcase section — drive in aligning dowel pins. Replace and tighten the bolts and/or screws. Draw up Allen head screws in manifold area to 12 to 14 ft. lbs. tension with torque wrench.

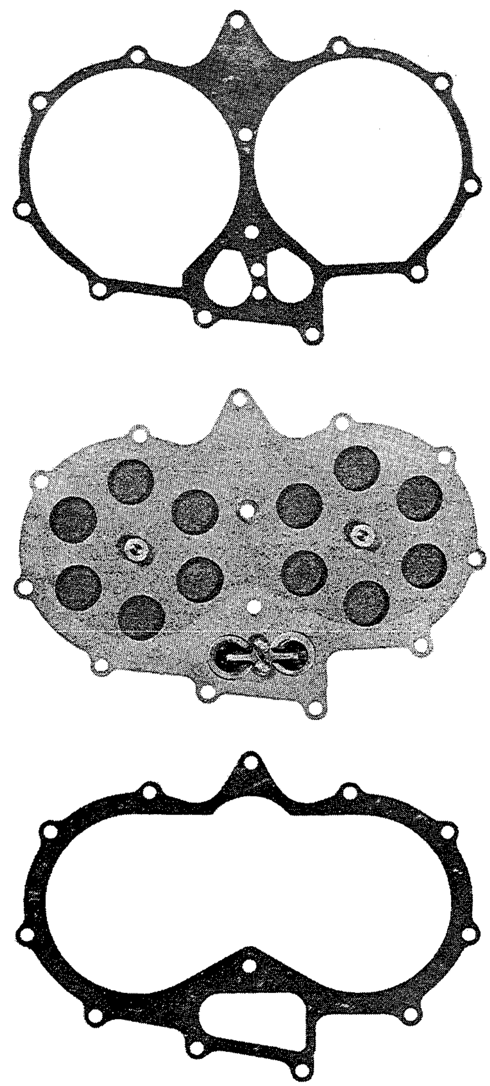


Driving Tapered Dowel Aligning Pins.

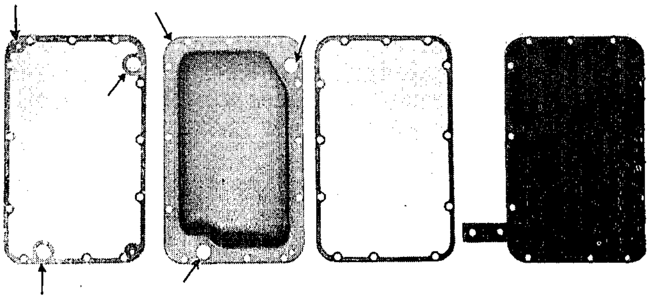
The power head is now ready for final assembly and attaching to the lower unit—followed by replacing the cylinder head, muffler, intake manifold, carburetor, magneto and ready pull starter. Make sure all gasket surfaces are clean, smooth, flat and undamaged—use new gaskets.



Drawing Up Allen Head Screws with Torque Wrench.



Showing Proper Arrangement of Gaskets and Valve Plate Assembly—Top Gasket Next to Crankcase, etc.



Showing Assembly Arrangement of Muffler and Gaskets.

RD GASKET INSTALLATION

It is extremely important that gaskets appearing somewhat alike are installed in their proper locations.

Intake Valve Assembly. Gasket No. 302606 should be installed next to the crankcase (between the automatic intake valve assembly and the crankcase).

Gasket No. 302605 should be installed next to the automatic intake valve assembly (between intake manifold and the automatic intake valve assembly).

Muffler Assembly. Gasket No. 302607 should be installed next to the crankcase (between the crankcase and inner muffler shell).

Note arrows directed to holes in the gasket and inner muffler shell. Make certain holes "match" —holes in the inner shell, holes in the gasket and corresponding holes in the crankcase.

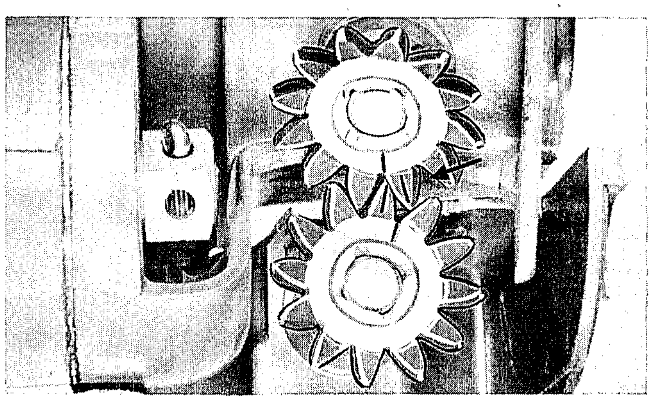
Gasket No. 302608 should be installed next to the muffler inner shell (between the inner shell and the outer shell).

When replacing the magneto armature plate, the cam attached to its under side should be adjusted to engage the carburetor shutter control follower at the point of recess. The cam is provided with slotted holes to accomplish this adjustment—it can be shifted in or out as required.

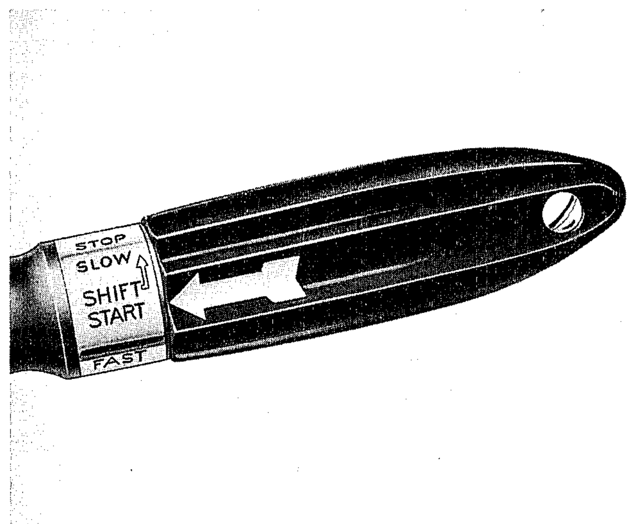
TO INSTALL STEERING HANDLE

Since spark and gas are synchronized and speed control is by the "twist grip" with provisions made for speed limitation when operating in Neutral, some "timing" is necessary when attaching the steering arm—this required to obtain correct position of the twist grip with respect to "markings" on the steering arm and synchronized speed control mechanism.

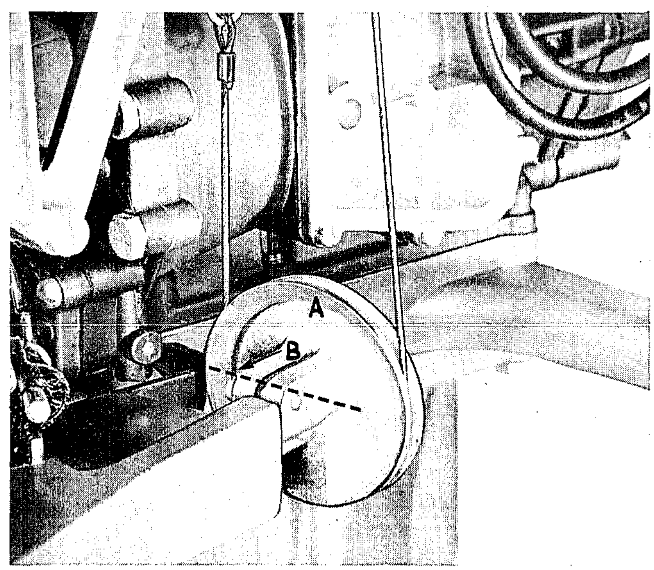
Timing can be easily accomplished—simply mesh teeth on coupling segments in accordance with markings provided for this purpose as shown here. Attach steering arm with segments meshed in this position. Install bolt and nut to hold arm in position—adjust nut as required to obtain the desired steering arm tilt—secure with *cotter pin* for safety.



Timing Marks on Coupling Segments.



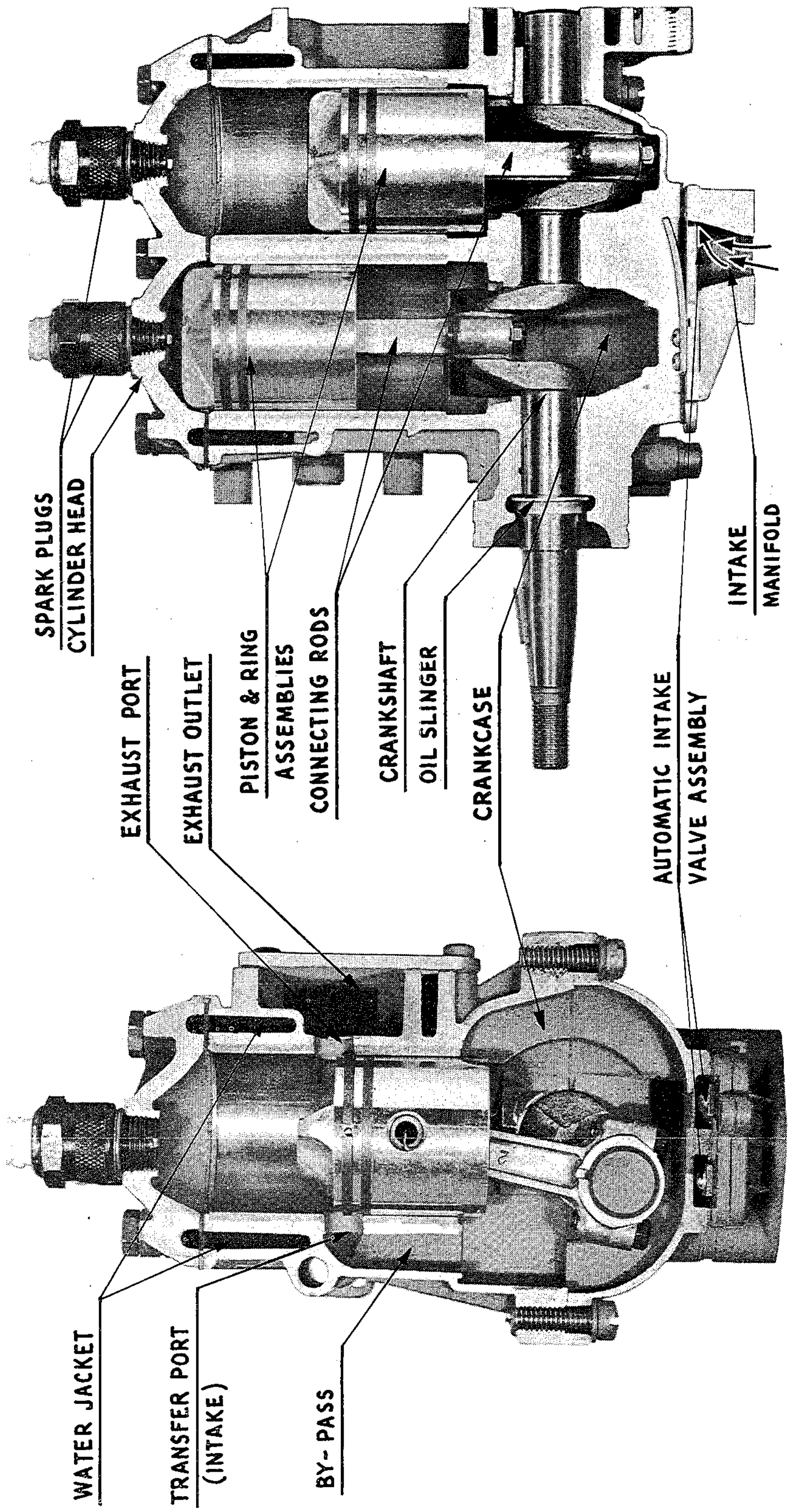
Speed Control Grip—Set to "Start" Position.



Showing Position of "Flat" Area on Pulley Boss when Control Coupling Segments are Properly Aligned with Respect to Setting of the Speed Control Grip.

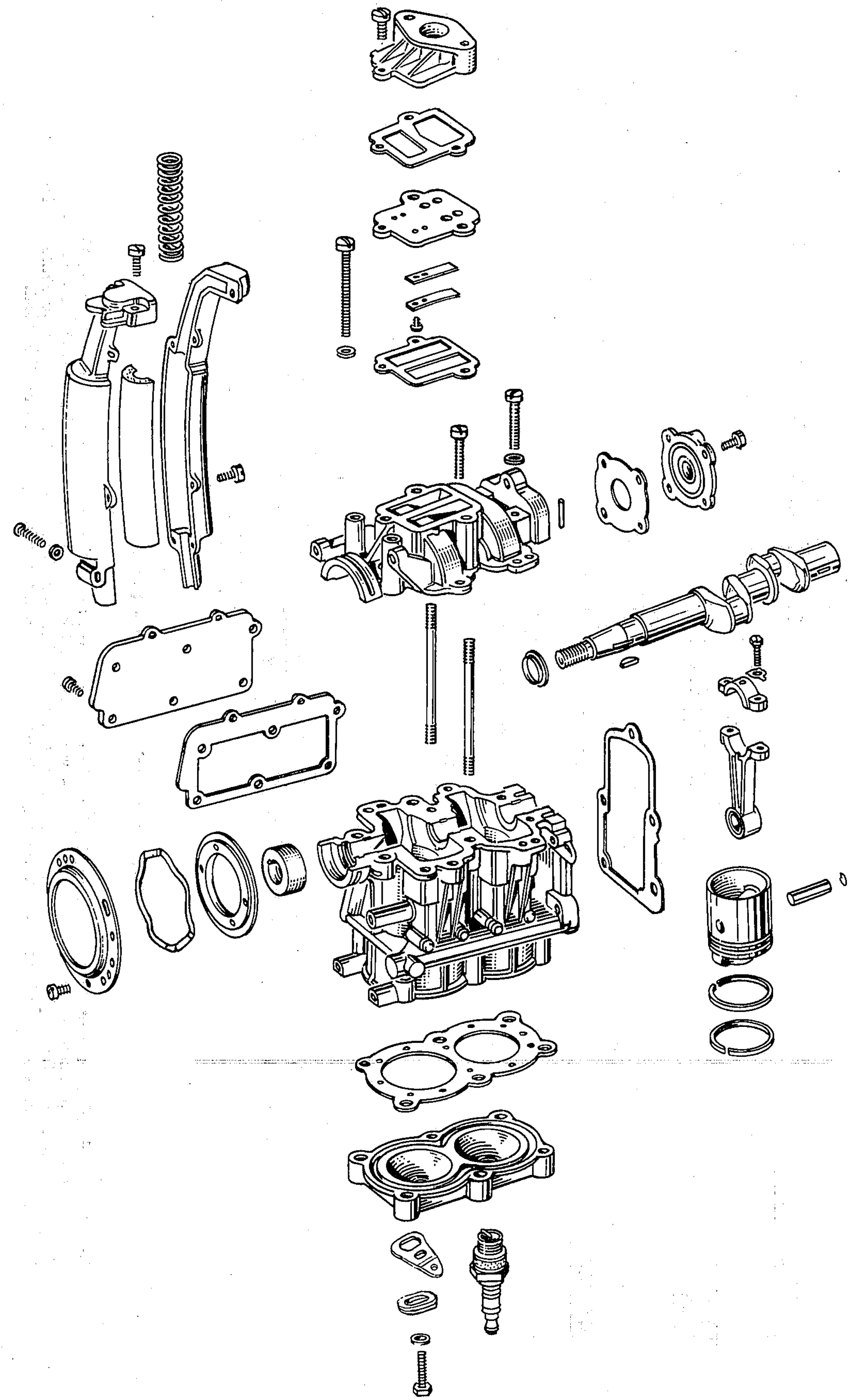
In event timing marks have become obliterated, set speed control grip to position marked "stop" —turn pulley "A" to position where flat area "B" on the pulley boss is horizontal as shown here; engage coupling segments.

MODEL JW POWER HEAD



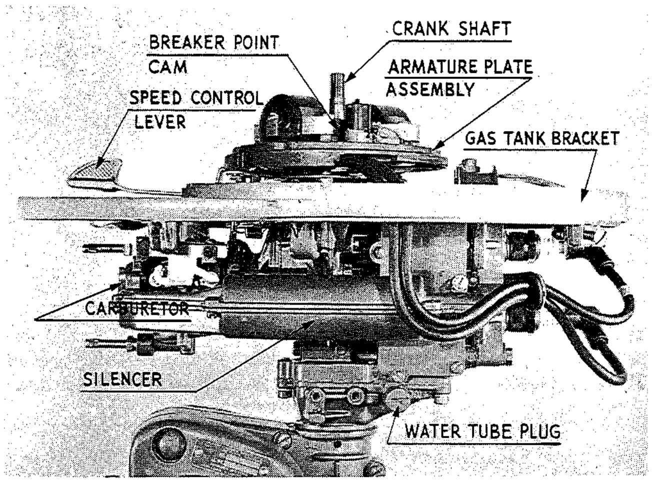
Sectional Views of the JW (3) Power Head.

Note that Fuel Induction is of the two-port Type (Transfer on Intake Port and Exhaust Port Built into the Cylinder Wall)— Employing in Conjunction an Automatic Intake Valve Arrangement to Charge the Crankcase. For Explanation of "Port" Action see Page 59 — for Explanation of Automatic Intake Valve Action, see Page 92-19. Automatic Valve Plate in the Model JW However, Consists of but a single Segment, Otherwise, Functional Service Operations are Identical.



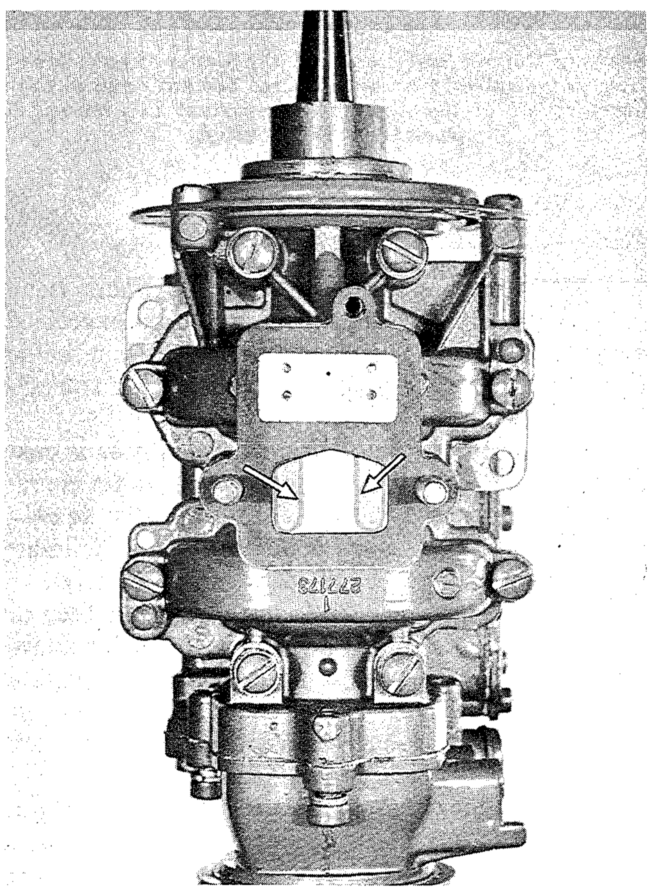
Model JW Power Head Group.

MODEL JW POWER HEAD

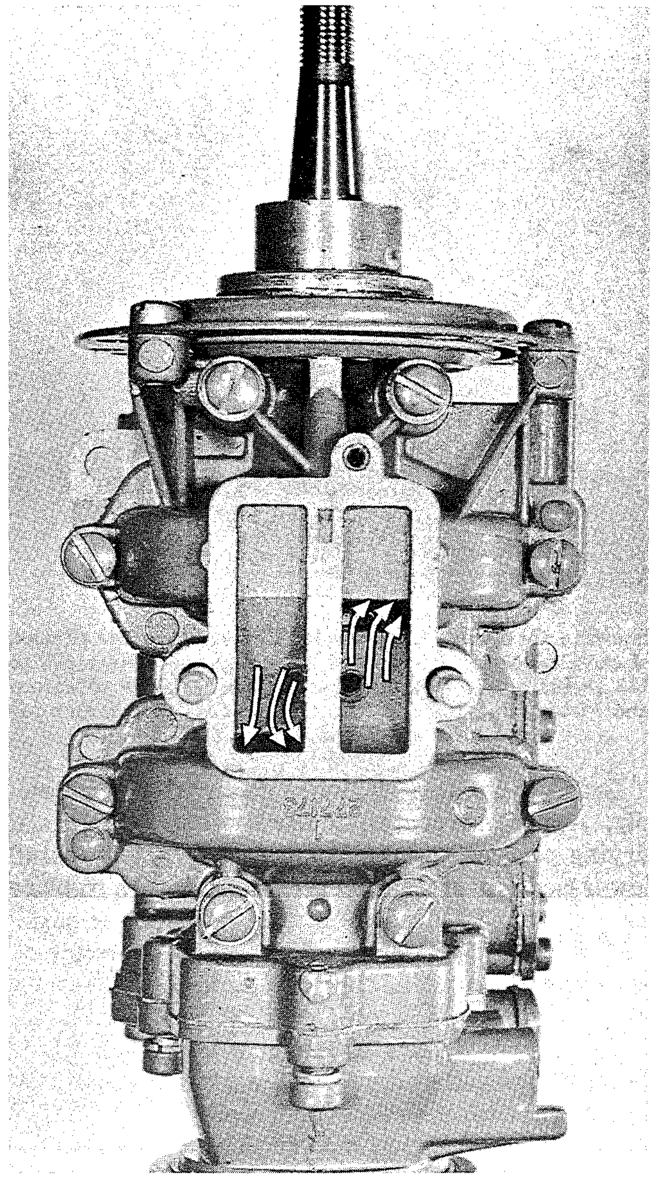


Powerhead Assembly with Gas Tank, Cover and Flywheel Removed.

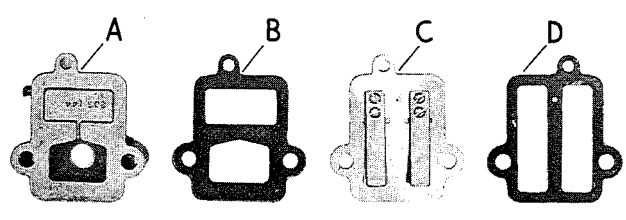
Procedure for disassembly, repair and assembly of the JW power head is similar to that accomplished in earlier models of small bore and corresponding horsepower as described on Pages 126 to 129 inclusive, and Page 134. Attention given bearing "fits" (connecting rod and crankshaft) should be exercised with the same care and degree of exactness.



Powerhead (Stripped) with Carburetor and Intake Manifold Removed to Expose Automatic Intake Valves — One for Each Crankcase Chamber is Indicated by Arrows.

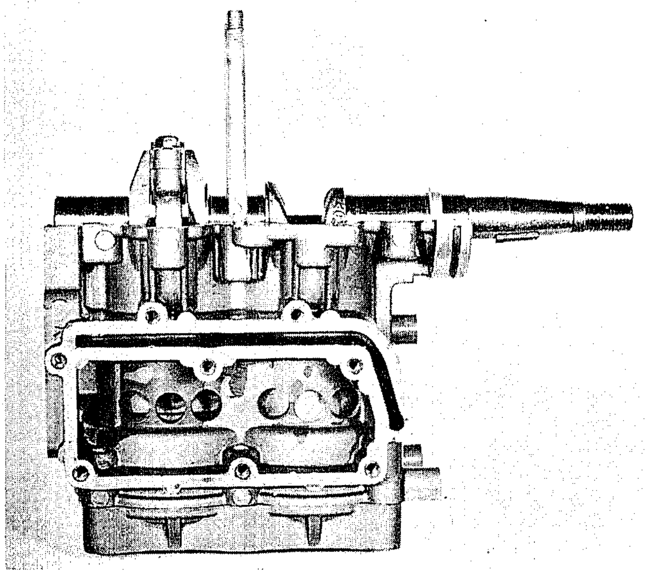


Powerhead (Stripped) with Carburetor, Intake Manifold and Automatic Valve Plate Assembly Removed to Expose Channels Directed to Each Crankcase Chamber as Indicated by Arrows.



Showing Manifold (A), Gaskets (B & D) and Automatic Valve Plate Assembly (C)

Make no "dry" assemblies — coat all functional moving parts (bearings, piston and cylinder walls and piston ring grooves) with a film of oil prior to installation assembly.

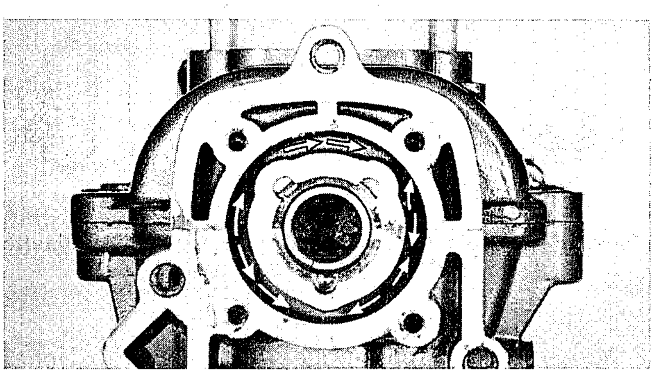


Showing Crankcase Removed for Removing or Installation of the Connecting Rod-Piston Assembly—see Pages 133 to 135 Inclusive for Detailed Instructions Relative to Piston and Piston Ring Installation. Correct Piston Ring Gap for the Model JW is .005" to .015."

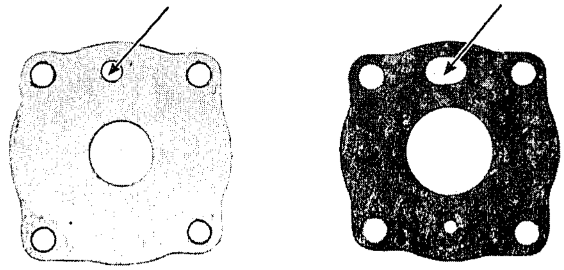
Crank case faces should be clean prior to assembly. Apply thin coat of Sealer 1000 or similar hard drying cement to upper crank case face — install lower section of crank case immediately, replace tapered pins to align crankcase sections, see pages 129 and 164-29, then draw up evenly and snugly on screws and nuts holding the assembly together. Torque crankcase screws to 5 to 7 foot pounds.

Some precaution is necessary when attaching the lower flange and gasket. Make certain holes in gasket align with corresponding holes in the flange mounting face. Open hole in the flange provides water discharge from the cooling system into the drive shaft casing and should be placed toward "front" side of the power head (carburetor side).

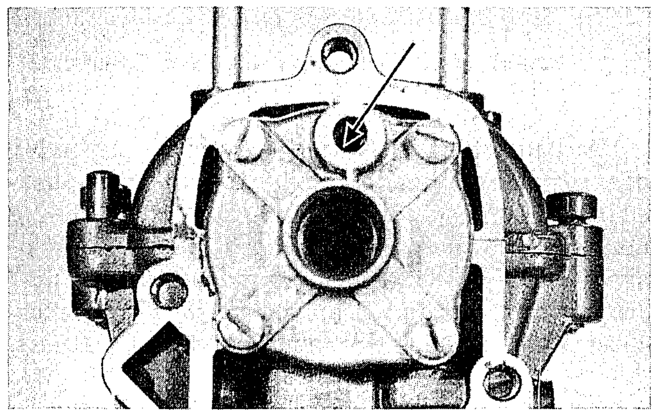
If placed in any other position, water through the cooling system will be obstructed to cause overheating.



Showing Water Channel Surrounding the Lower Journal Boss on Bottom End of the Powerhead Assembly to Permit Cooler Operation in Area of Bearing.



Holes in Gasket (shown above) must be Properly Aligned with Holes in the Crankcase Lower Flange — Elongated Hole in Gasket (right) Aligned with Hole in the Flange as Indicated by Arrows.



Showing Correct Installation of the Lower Crank Cover. Hole as Indicated by Arrow, Directed Toward Front or Carburetor Side of the Assembly. Important to Accomplish Open Circulating System.

CYLINDER HEAD AND GASKET INSTALLATION

Since it is possible to install the cylinder head and gasket end for end, care should be exercised when performing the operation to prevent baffle of the piston striking against inside wall of the cylinder head.

To aid in proper installation, a small boss is cast onto the top side of the cylinder block and a corresponding boss on top end of the cylinder head— when correctly installed, both boss on the cylinder head and cylinder block should "index" or align.

Carefully check the gasket face against face of the cylinder head to make certain ALL holes align. Carelessness in this respect will certainly lead to a great deal of difficulty later on. Head gaskets of later production are provided with a "tab" to match the boss on the cylinder block and cylinder head— in this case, simply align all three and "bolt" down. Torque (tighten) cylinder head screws at 5 to 7 foot pounds. Run the motor for several minutes then "re-torque" to compensate for whatever compression (in the gasket material) might have taken place.

Note this — head gaskets during early production of the JW included **no** "locating" tab to align with bosses on the cylinder head or cylinder blocks, so — make doubly sure that **all** holes in the gasket align with **all** holes in the cylinder head.

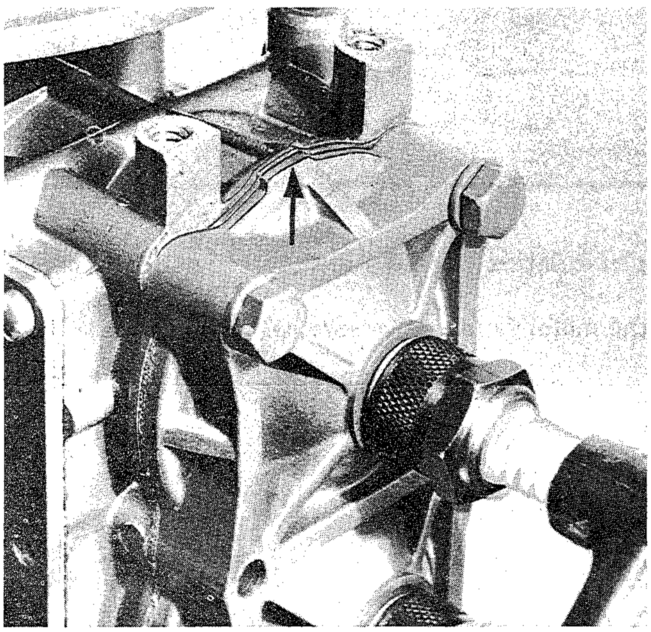
Observe too, that it is possible to line up the head screw holes — gasket and cylinder head, but at the same time, the holes "punched" out (gasket) for the pistons to clear do not align. In this case simply turn the gasket over on its other side.

Both head gaskets of early production and later, however, are identical in all other respects.

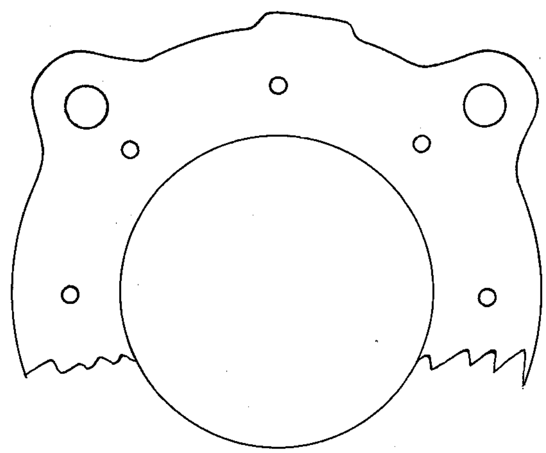
In case of doubt, note on observing contour of the combustion chamber (cylinder head) that one wall (side) "slopes" considerably more than the other. When correctly installed, the greater "sloping" side should be directed toward the exhaust (manifold) side of the cylinder to properly dispel exhaust gases and to prevent the baffle on the piston from striking.

Further, aligning bosses cast on to early production cylinder head and cylinder blocks are comparatively small — about the size of No. 5 or 6 shot while the boss cast during later production is wider —approximately 5/16″.

A persistently hard to "find" knock in the JW could be the result of the cylinder head being assembled end for end or the head gasket being improperly installed.



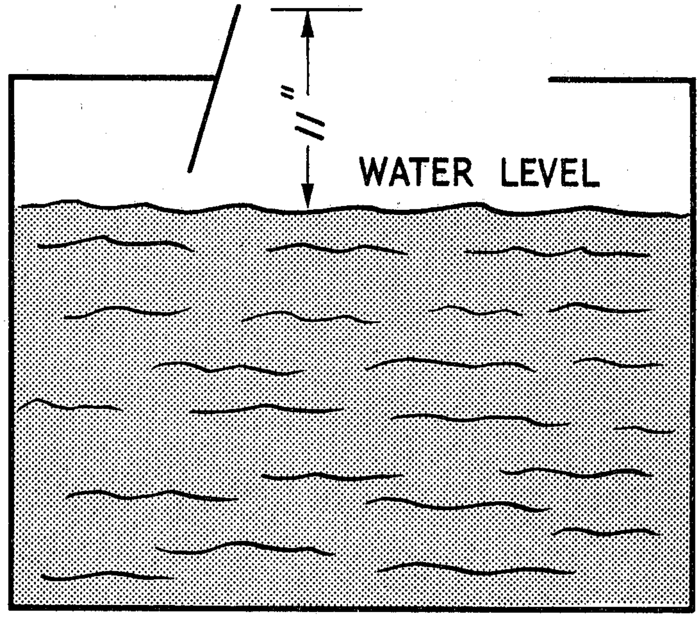
Showing "Embossing" on Cylinder Head and Cylinder Block —Both Should Index When Correctly Assembled.



Contour-Cylinder Head Gasket.

Wherever convenient and when the occasion presents itself, carefully remove the cylinder head for cleaning of carbon deposits—inside surface of the combustion chamber, head of piston, walls of ports and upper edges of cylinder bores and gasket. Loose bits of carbon frequently dislodge and often find their way between the points of the spark plug gap to cause fouling. Constant spark fouling for no apparent reason can usually be attributed to carbon accumulation. Replace cylinder head. Torque screws at 5 to 7 foot pounds—install new head gasket if necessary.

TEST TANK WATER LEVEL

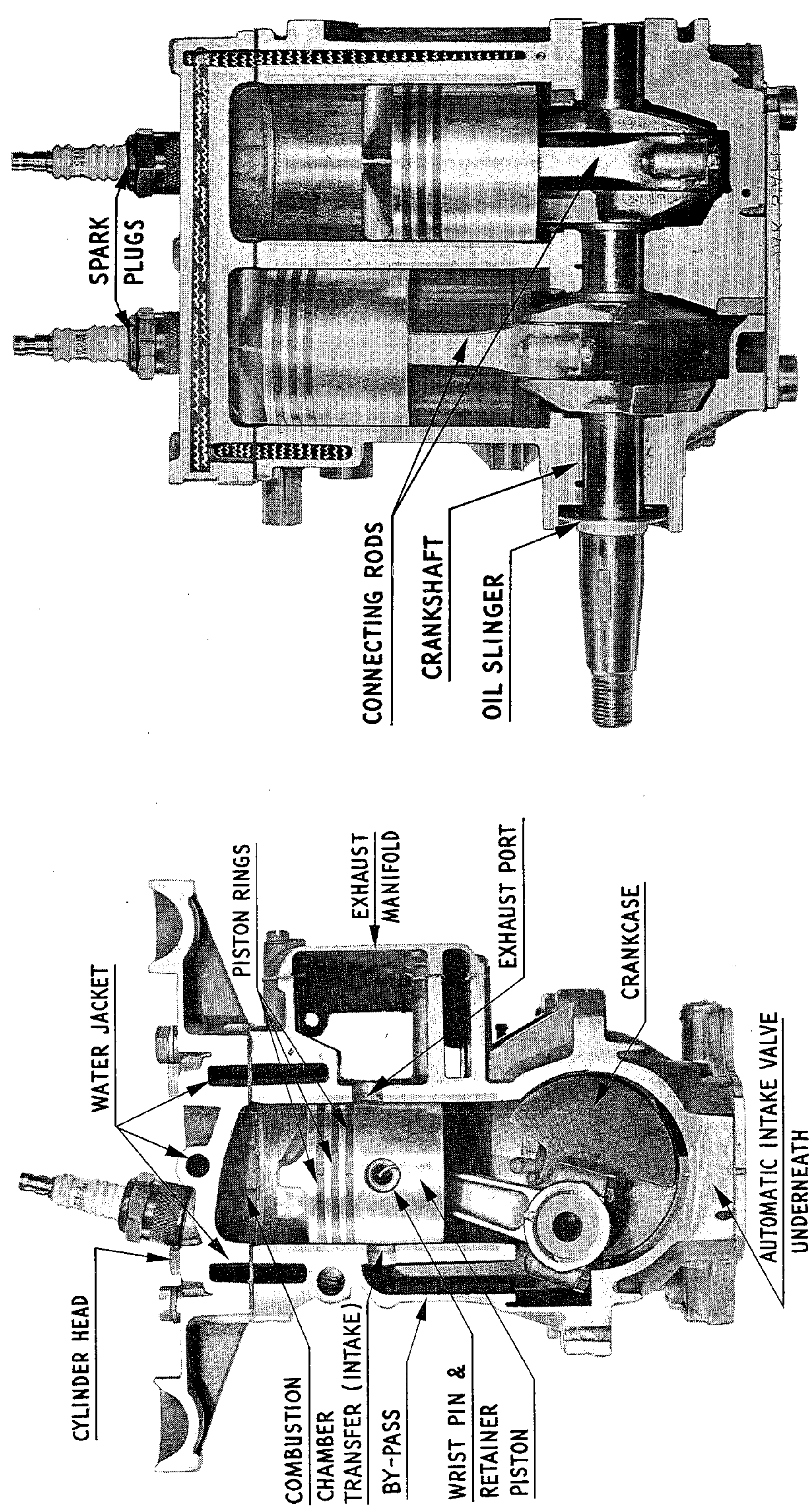


It is of extreme importance that depth of water in the test tank be maintained at level high enough to insure immediate water circulation upon having started the motor for testing after repairs, demonstrating or merely checking for minor adjustments—the pump housing of all models must be fully submerged—since the pump assembly is not primarily a suction pump and therefore will not "lift" water.

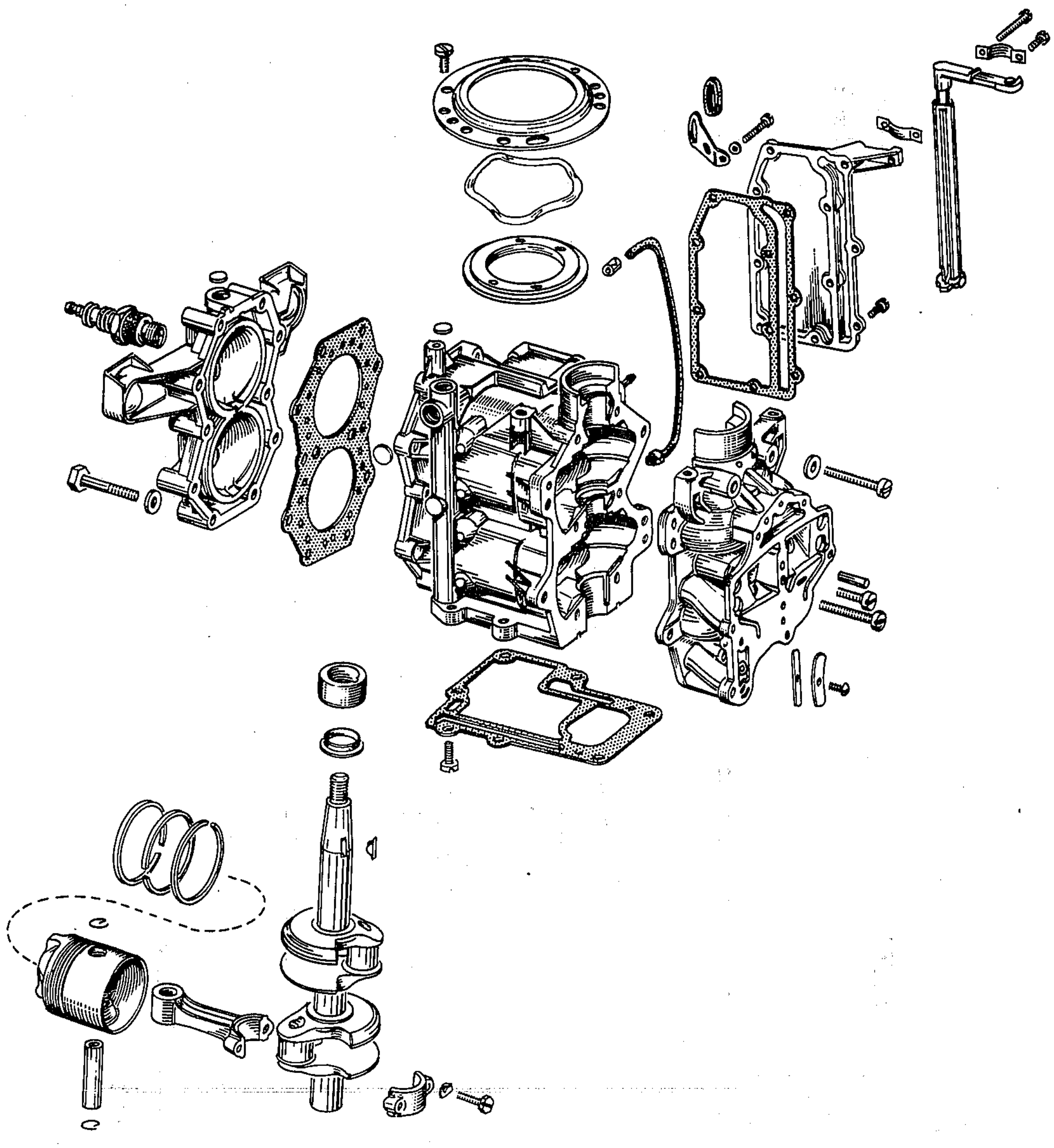
Running for any length of time without ample water circulation causes excessive impeller housing wear to interfere with efficient pumping later on when the motor is placed in service. Not only that, but overheating frequently results in damage to the cylinder head gasket installation which further aggravates interference with the circulating system to eventually result in major damage.

To be sure — check water level periodically (with rule) — distance between top face of tank mounting bracket and water level should be not more than eleven (11) inches. Keep the tank clean and fresh at all times.

MODEL CD POWER HEAD



Sectional views of the Model CD Power Head



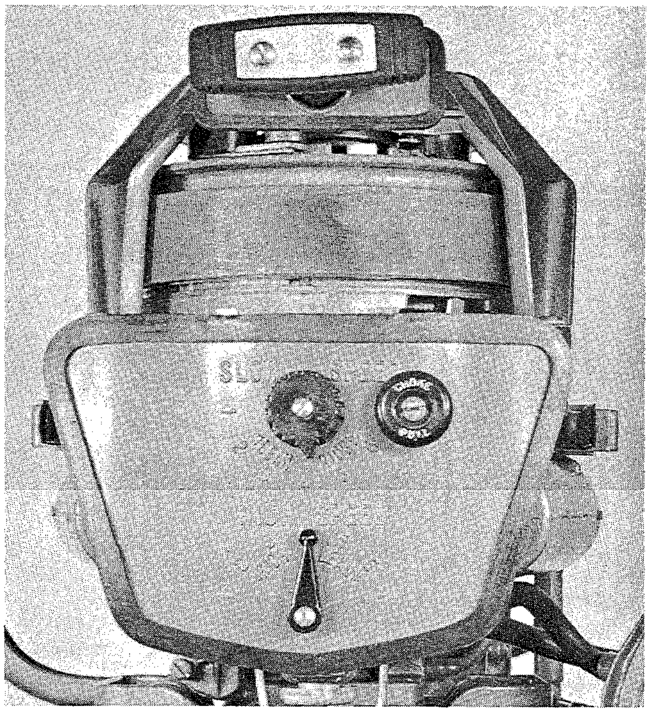
Model CD Power Head Group

MODEL CD POWER HEAD

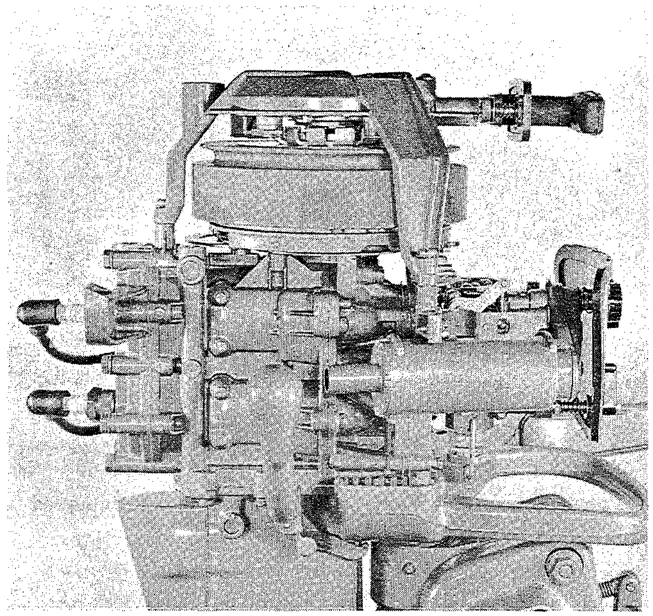
Repairs on the Model CD Power Head are conducted like those on earlier models of same horsepower range. Except for a difference in over-all design, service operations involving the functional parts are identical—each step exercised with precaution and exactness in clean surroundings. Treatment of the pistons, piston rings, connecting rods, crankshaft, and cylinder walls should be conducted as described on pages 97 to 127, inclusive.

A manifold bleeding arrangement has been installed for the first time in the lower horsepower range, to drain or bleed off heavy ends of the fuel mixture "puddling" in the manifold when running in the slower speed range for trolling, etc. See explanation of the manifold bleeder on pages 164-9 to 164-10, inclusive.

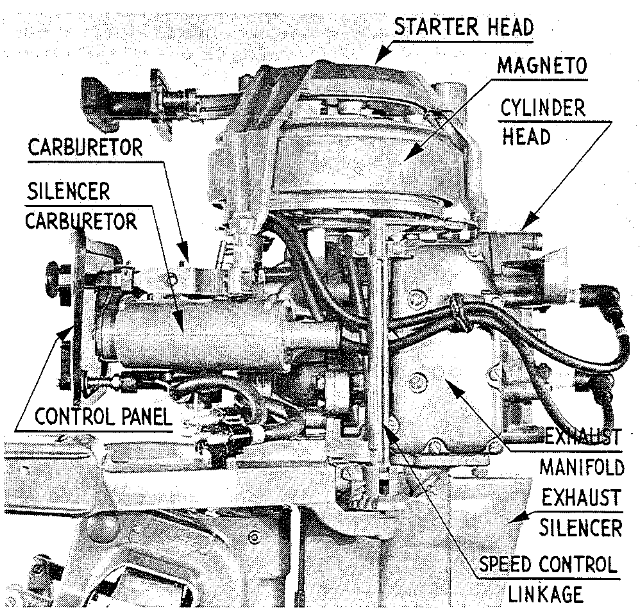
Fuel supply to the carburetor is by pressurizing the tank to require installation of pressure (crankcase) release valves as in the QD and RD series. See explanation of the pressurized fuel system on pages 92-21 and 92-25.



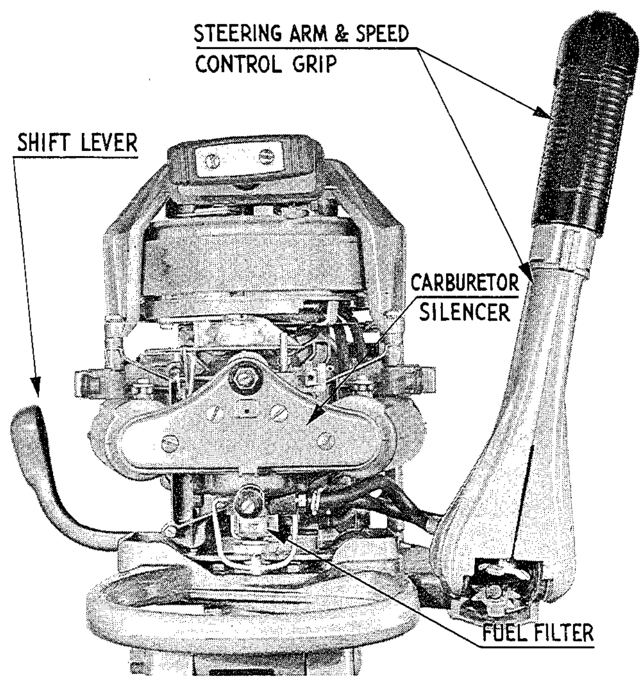
Showing Front View with Motor Cover Removed



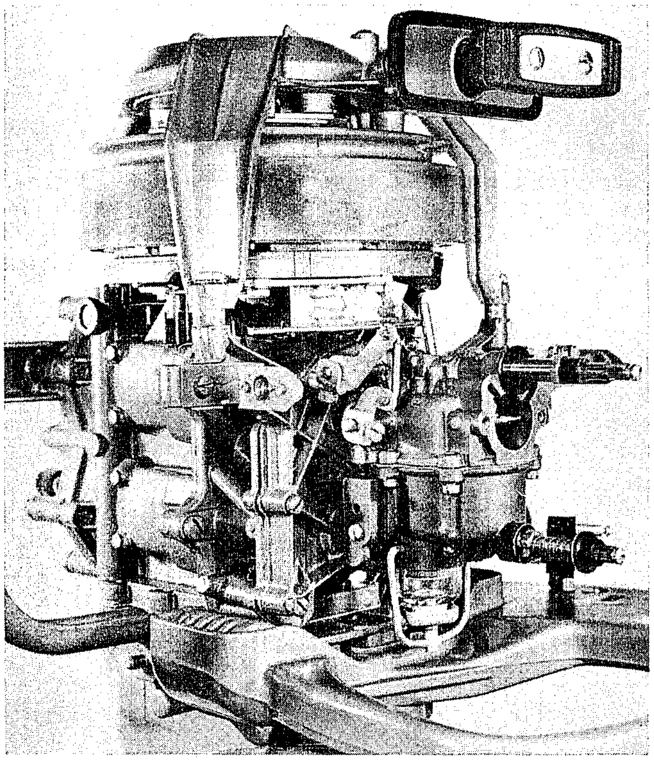
Side View of Power Head Cover Removed



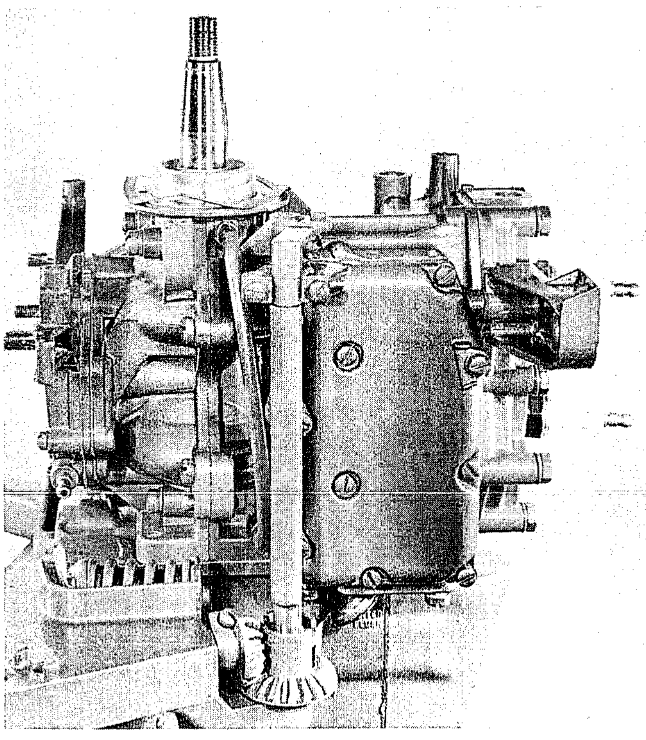
Side view of Power Head



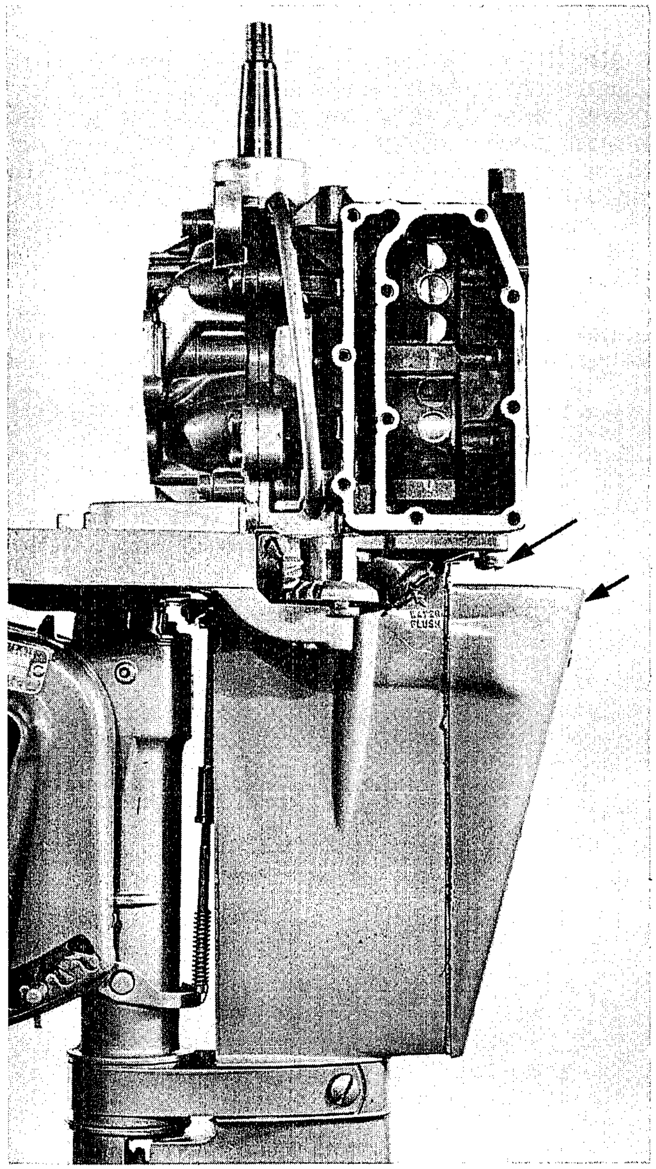
Front view of the Power Head



Power Head with Cover, Panel and Silencer Removed to Expose the Carburetor

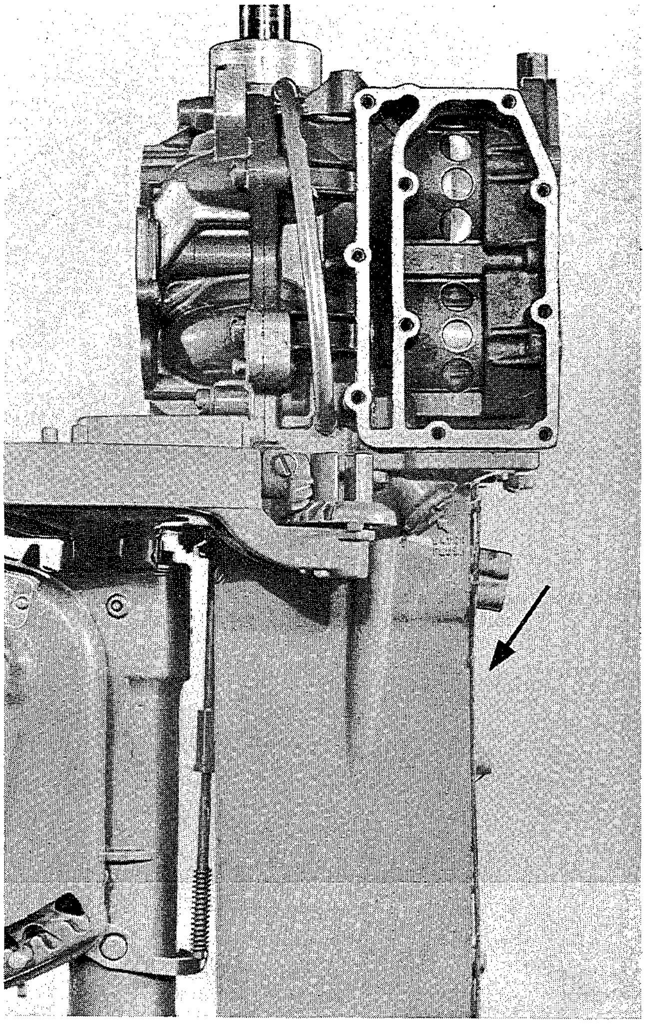


Power Head view showing starter head, magneto and carburetor head removed as attached to the lower unit assembly.

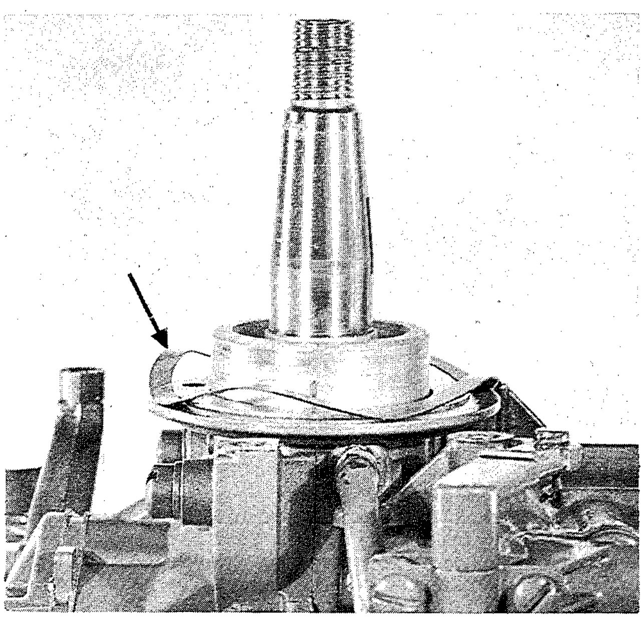


Power Head stripped prior to detaching from the lower unit — Note — the exhaust silencer (indicated by arrow) must be first removed to gain access to one of the screws holding the Power Head fast to the lower unit assembly.

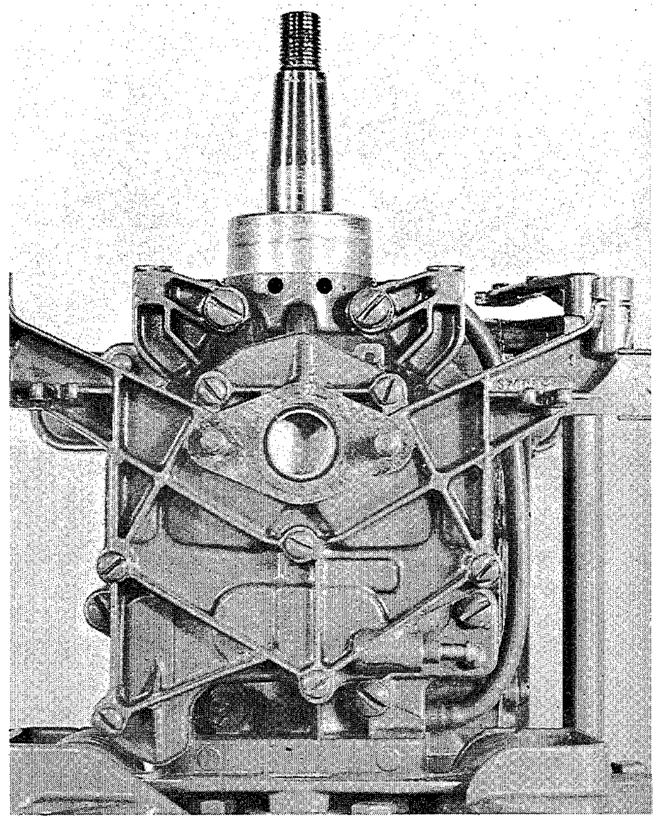
Avoid accumulation of oily rags about the shop or work bench. Oily rags left lying around the shop are a hazard—a fire hazard and a threat to an otherwise promising business with a future.



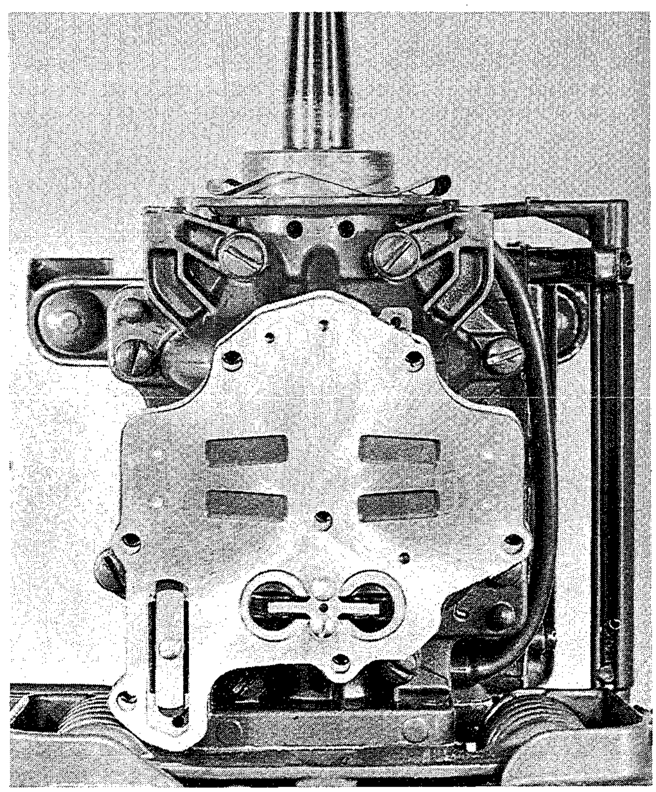
Exhaust Silencer Removed Prior to Detaching the Power Head



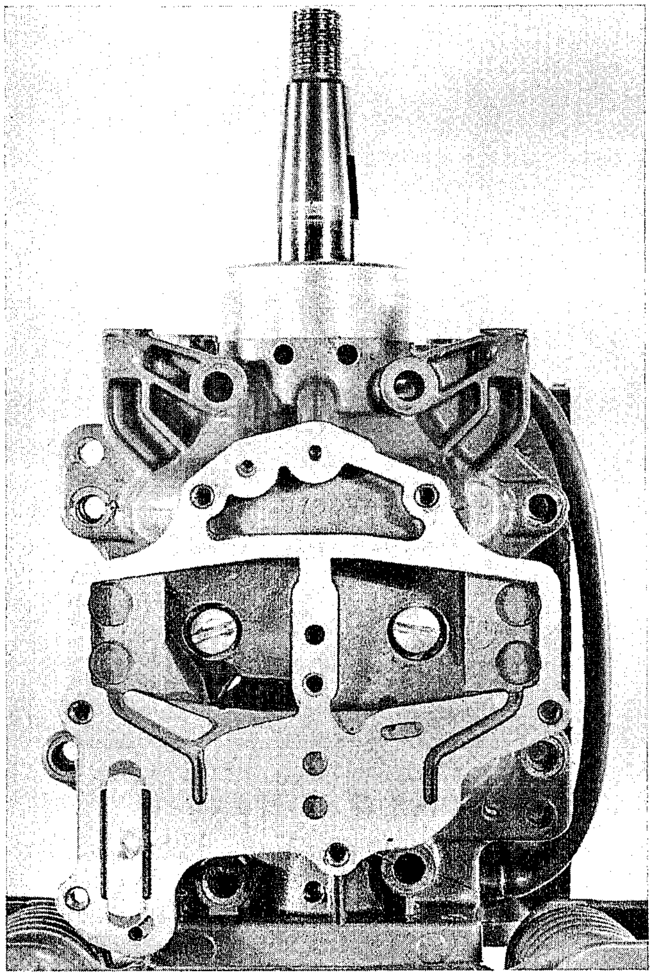
Showing magneto removed to expose wave washer against which the armature plate rides on the Model CD-10 but deleted from assembly of the CD-11.



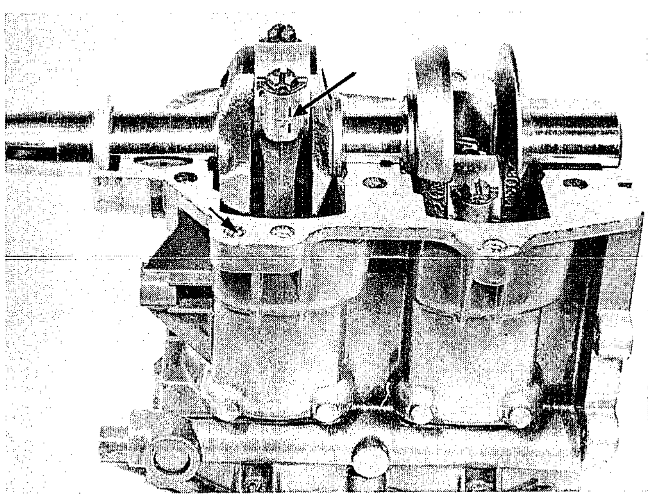
Power Head Magneto and Carburetor Removed



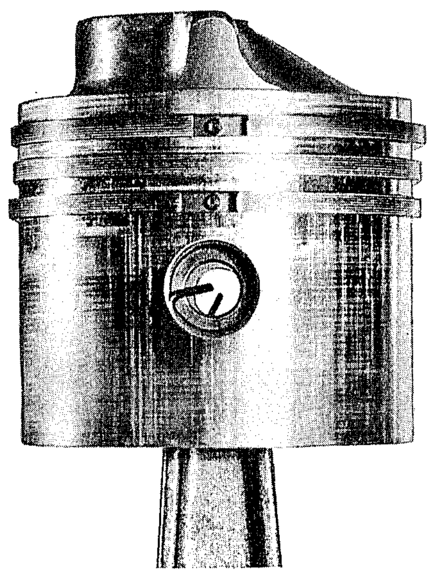
Front View of Carburetor Showing Intake Manifold Removed to Expose the Reed Valve, Fuel Pressure Valve and Manifold Discharge Valve Arrangements. See Explanation of Automatic Intake Valve on Page 92-19; Fuel Pressure System and Manifold Discharge or Bleeder on Page 92-21.



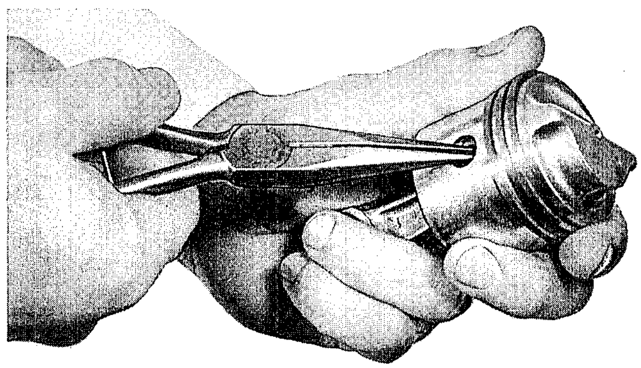
Valve plate removed to expose fuel vapor channels leading to upper and lower crankcase chambers. See explanation under Carburetion—CD



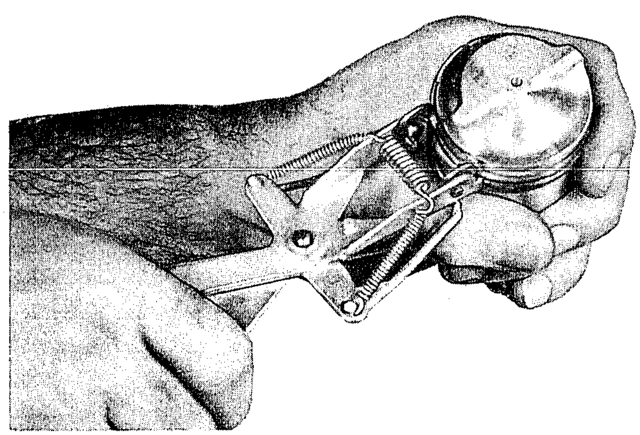
Crankcase removed to expose the crankshaft and connecting rod assemblies. When detaching connecting rod caps, first note index lines on each which must align if the rod is to be correctly assembled—Final assembly should be free with no indication of binding—it may be necessary to tap sides of the rod and cap lightly with hammer to line or free up—Torque screws at 5 to 8-foot pounds. Bend lug on retaining washer up against side of screw head to secure—Be sure hole for tapered pins (indicated by arrow) is scrupulously clean to avoid misalignment when bolting crankcase sections together.



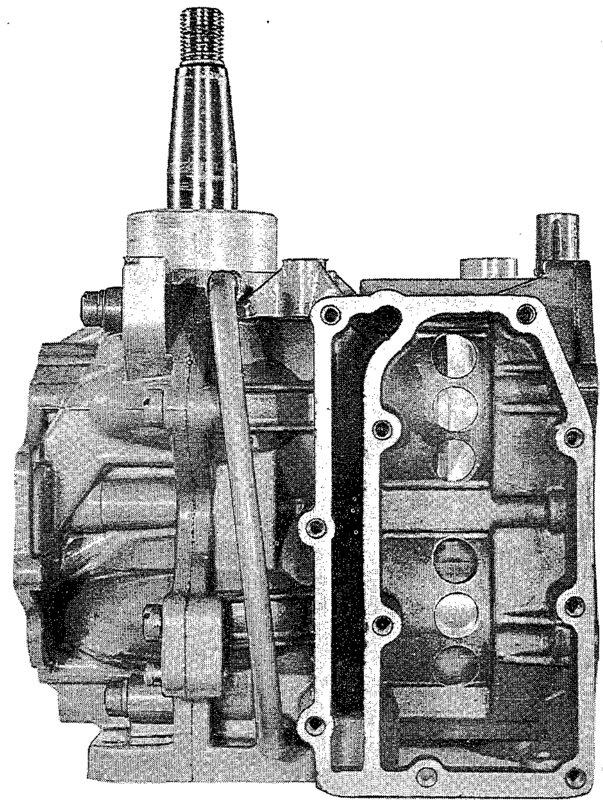
View of piston showing wrist pin retaining (lock) ring; note end protruding for removal.



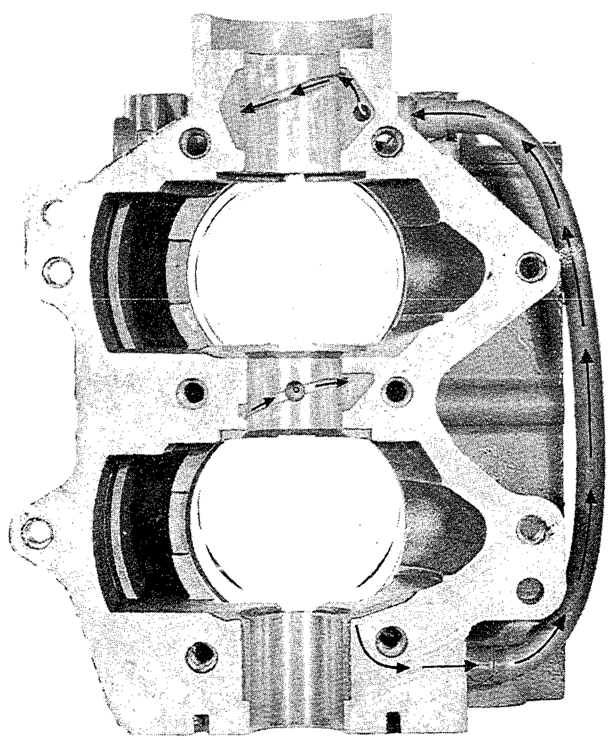
Removing wrist pin retainer—grasp protruding end of retainer (lock) ring with pair of long nose pliers—extract with twisting and slightly prying motion.



Installing and/or removing piston rings with ring expander shown here. This operation should be carefully performed, taking precaution against "nicking," scratching or otherwise damaging the piston ring grooves. After installing the rings make sure that each turns freely in its respective groove with no indication of tightness or binding. Apply oil to each ring groove, piston and cylinder walls on final assembly—see pages 97 to 108, inclusive. Correct ring groove clearance for the Model CD ring groove is .002" to .0035." Gap clearance .005" to .015."

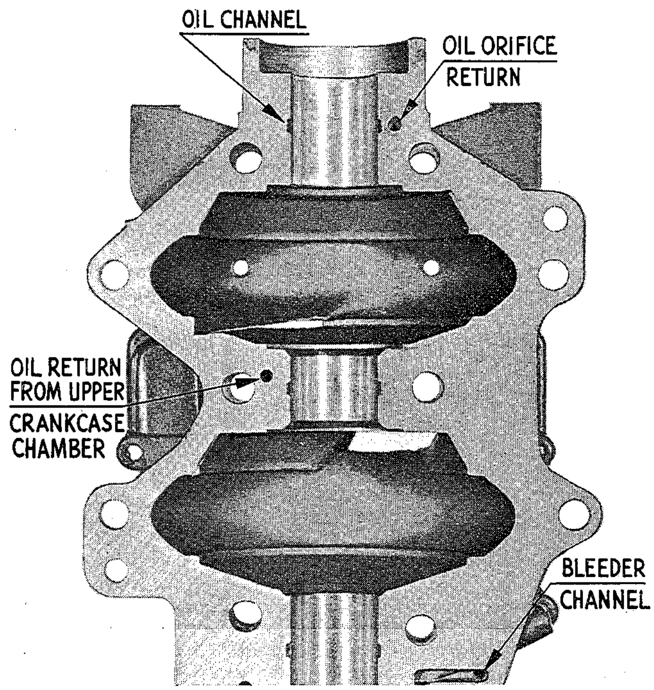


Power Head Detached from the Lower Unit for Further Disassembly — Note Flexible Oil Line Connecting Top and Bottom Journal Bearings. Oil is Fed from the Lower to Top Bearing Under Crank Pressure, Returned to Upper Crankcase Chamber by Suction as the Piston Travels on its Upward Stroke.

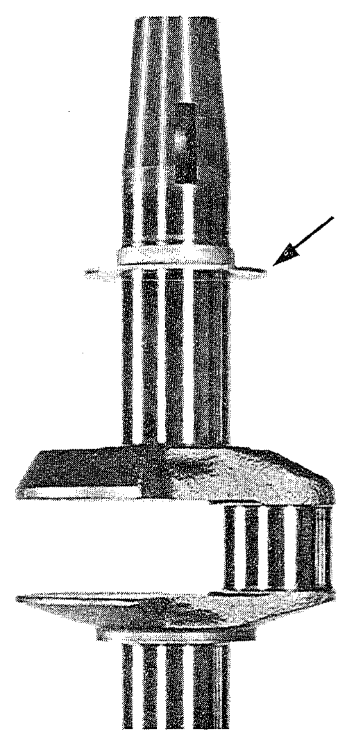


Oil pocketing in the lower crankcase chamber and under pressure as the piston progresses on its downward stroke, is conducted to the upper journal bearing by means of flexible tubing as shown above; here it enters the special groove to circulate around the journal. Bearing (half) in the lower crankcase is similarly "grooved" with a return channel leading to the intake manifold to complete the circuit.

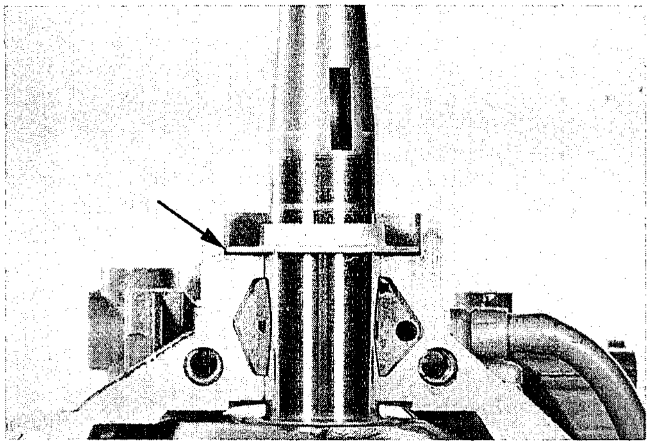
Oil is circulated through the center bearing in like manner but without the aid of tubing.



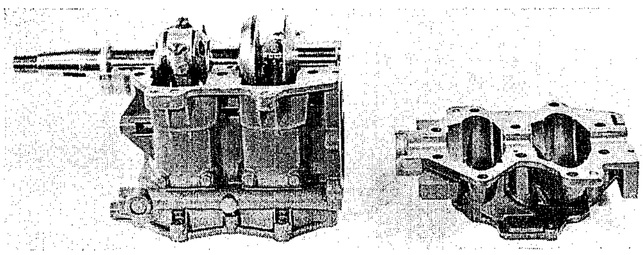
Showing Oil Channels in the Crankcase Section



Showing oil slinger installation on top journal of the crankshaft to prevent oil circling around the journal bearing from escaping and "spewing" over the armature plate.

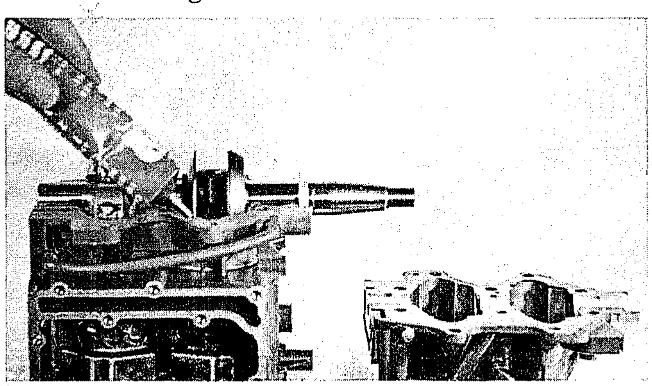


Showing oil slinger properly installed on the crankshaft. Care should be exercised when driving the oil slinger down and over the top journal—it must be driven down squarely and to a point where approximately 1/16″ clearance is maintained above the top journal bearing as indicated by arrow.

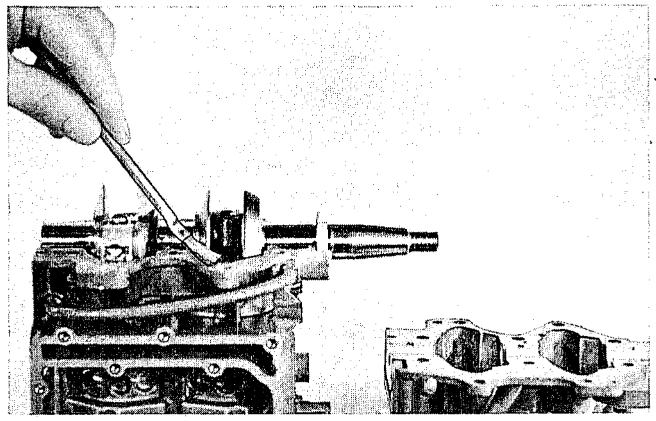


Showing Power Head with Crankcase Removed to Expose Crankshaft and Connecting Rod — When Replacing the Crankcase, all Surfaces must be made Clean and Free of "Old" Cement Used to Seal the Sections Originally. Have Everything in Readiness When Reassembling. Coat Face of Cylinder Block with Sealer 1000 or Other Similar Hard Drying Cement. Place Crankcase Immediately in Position; Drive Tapered Aligning Pins in Place to Obtain Crankcase Alignment. Install Screws — Torque to Tension Specified 5-7 Foot Pounds.

After cleaning both crankcase faces scrupulously free of "old" cement, or other foreign material and removing burrs or nicks which may have accumulated during repair, smear thin coat of hard drying cement, such as Sealer 1000, or other product of similar characteristics over cylinder block faces as shown above. It is of extreme importance that all traces of old cement be removed. A coating of cement spread "on top" of another will prevent correct mounting of the crankcase sections to cause excessive journal bearing clearance or misalignment.

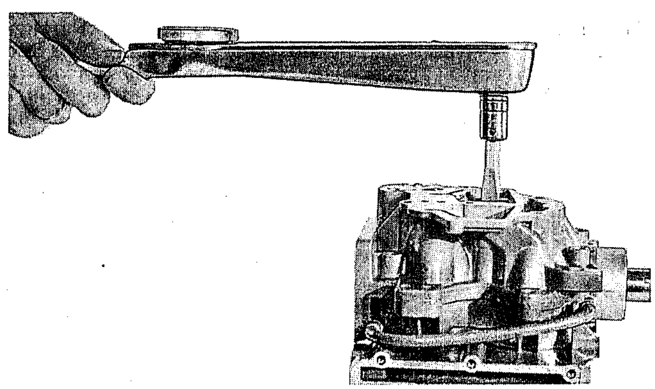


Applying Cement to Crankcase Face

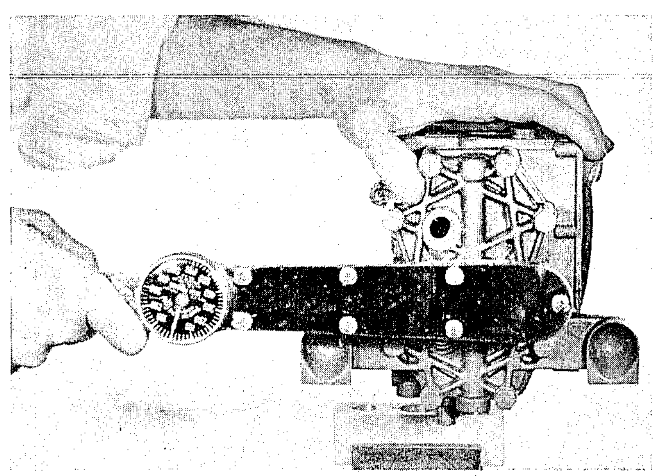


Spreading Cement With Brush

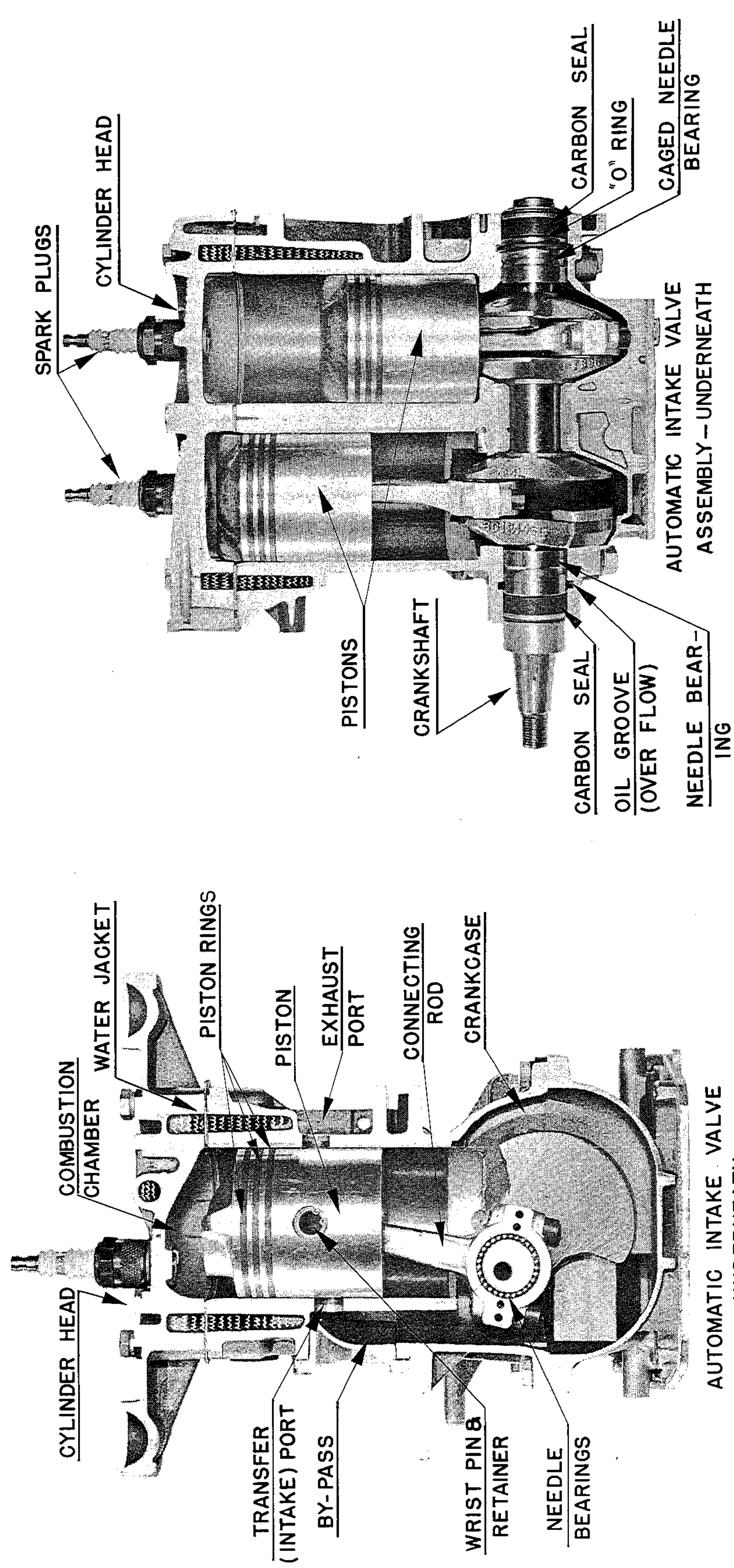
Tapered dowel pins are employed to align the crankcase sections. Precautions should be taken to make certain the corresponding holes are clean and free of burrs. Surfaces of the tapered pins similarly should be clean and free of burrs. Spread cement with brush as shown here—guard against excessive coating to prevent overabundance squeezing out to "plug" the oil channels on assembly. Install lower crankcase section with a minimum of delay to prevent cement hardening—Drive tapered pins home—Insert the crankcase screws.



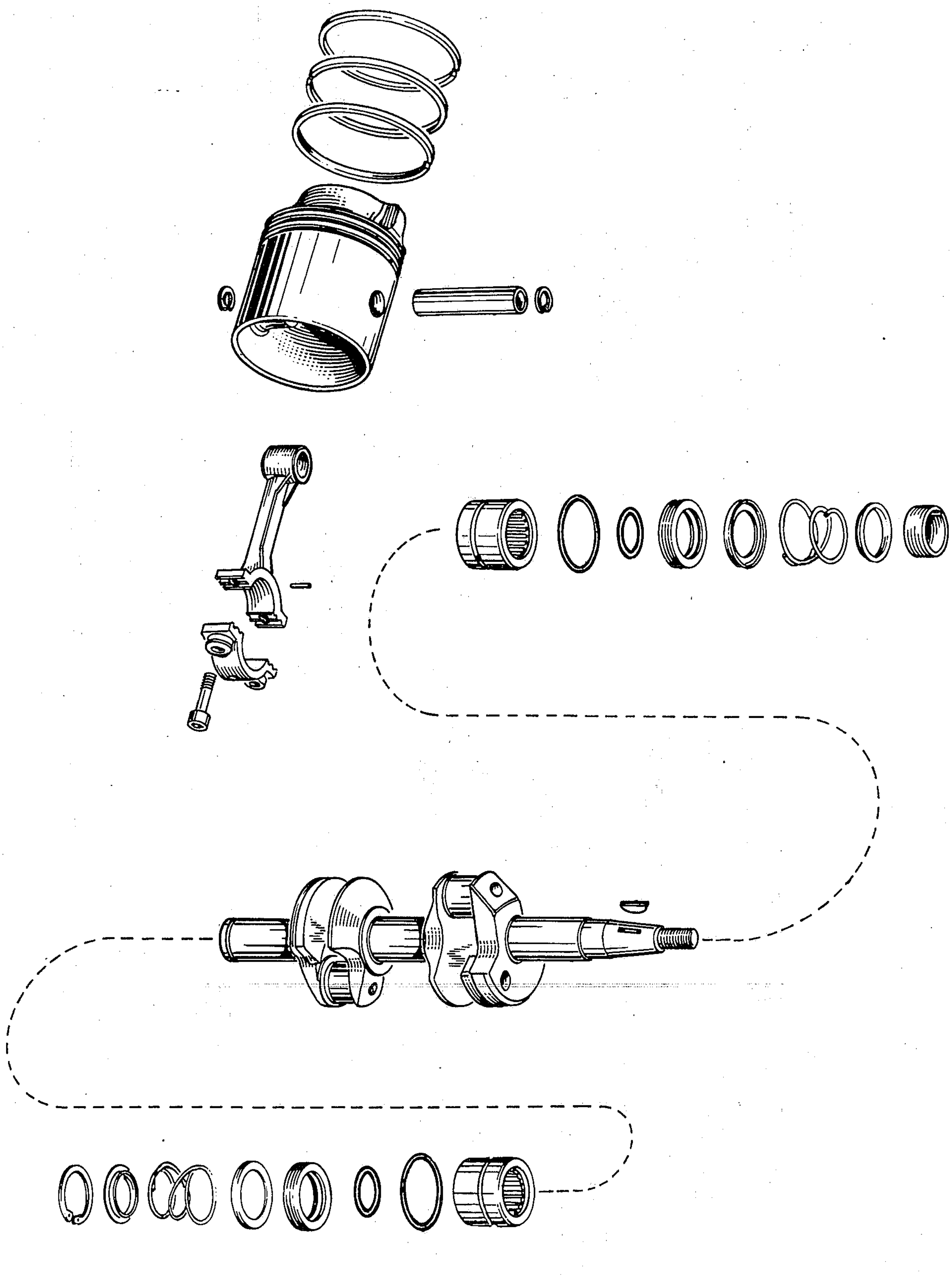
Torquing Crankcase Screws—Torque at 5 to 7-Foot Pounds



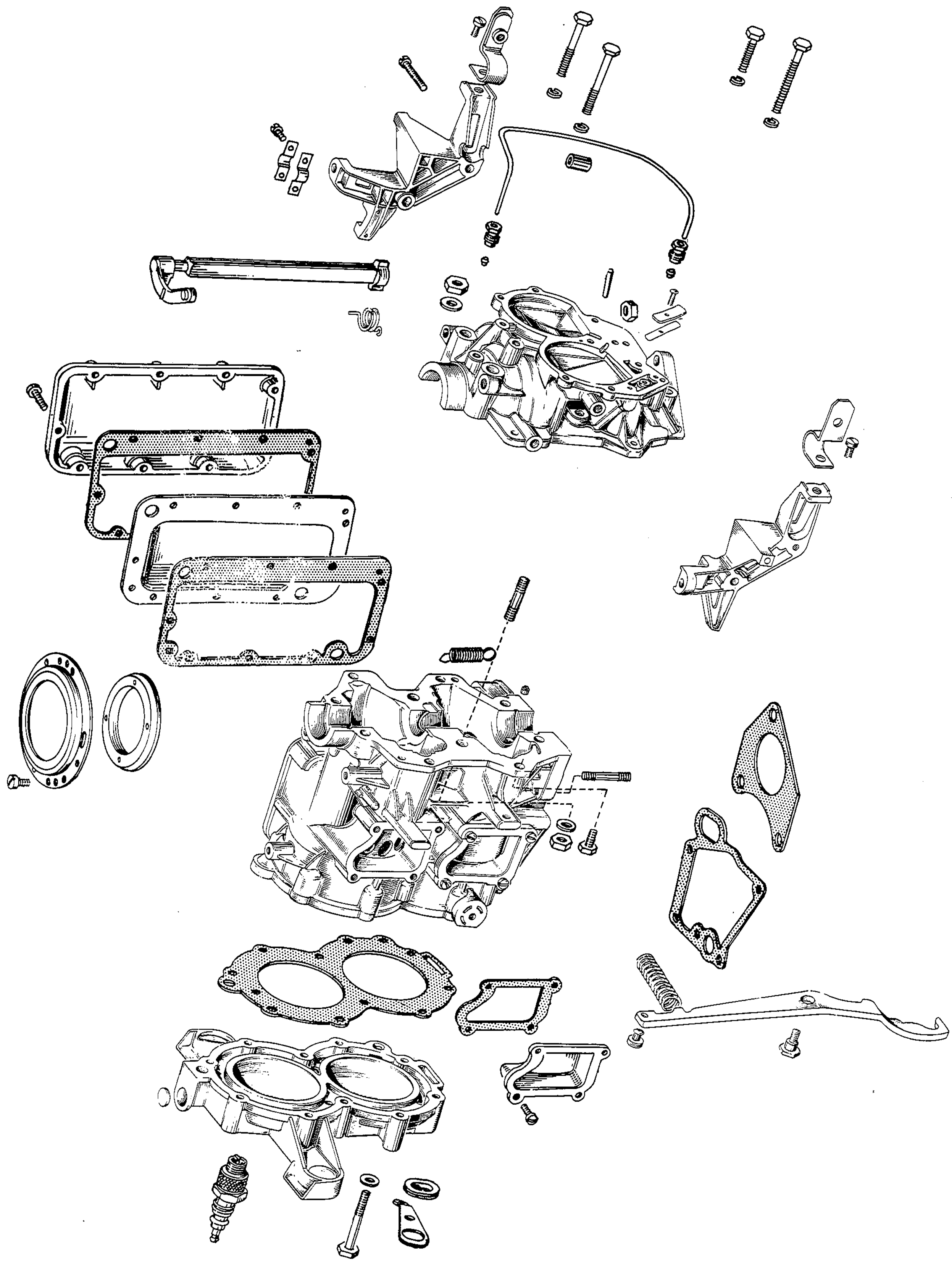
Extreme caution should be exercised when drawing up on the cylinder head bolts—should be drawn up evenly and torqued at 5 to 7-foot pounds—60 to 84-inch pounds if calibrated in inches as above.



Sectionalized Views of Model QD-15 Powerhead.



Crankshaft, Piston-Connecting Rod Group.



Cylinder Block Group.

MODEL QD-15 POWERHEAD

Design and construction of the Model QD-15 powerhead are basically like that of previous models, employing the use of roller bearings (top and bottom only) and carbon seals on the journal bearings (top and bottom), needle bearings on the crank pins (connecting rods), a crankcase bleeder system, pressure (to tank) check valves, automatic intake reed valves for fuel vapor induction to the crankcase, but using full floating wrist pins rather than anchored in the piston as in earlier production.

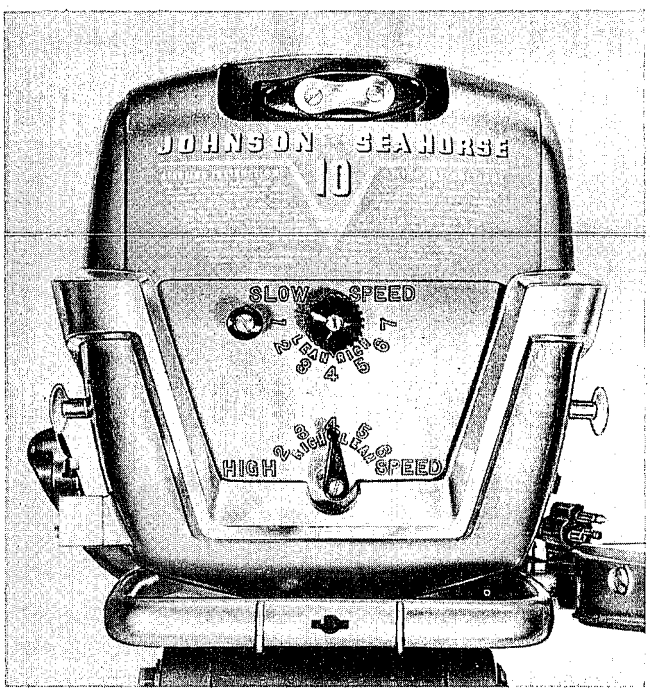
The cylinder head is a bit different in design though merely to support the "lift-off" cover, otherwise other details are alike.

The crankshaft-driveshaft "coupling" has been changed from the involute spline to a four fluted coupling to hold up better.

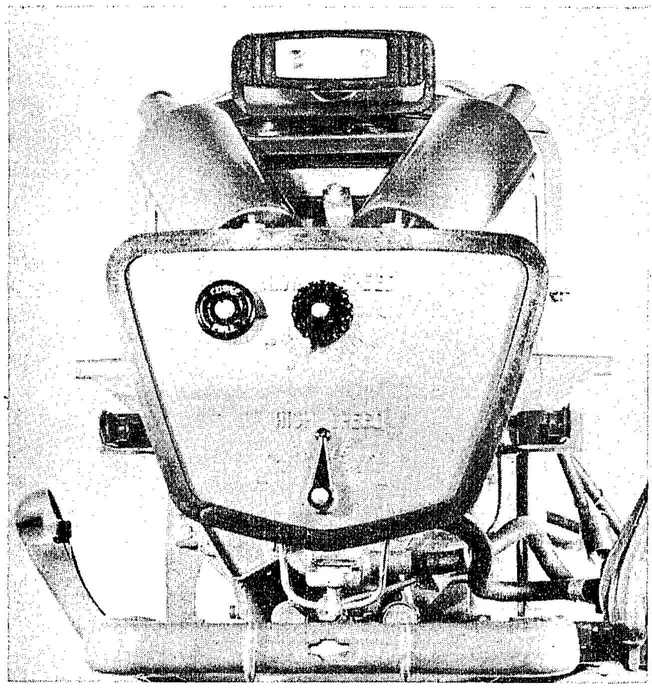
The familiar "O" ring on the top journal bearing cage has been deleted in favor of an oil return to the intake manifold where overflow (oil) "mixes" with fuel vapor from the carburetor and is subsequently returned to the crankcase chambers.

The automatic intake valves are now "side by side"—horizontally on the same plane whereas in design of earlier vintage the installation arrangement was staggered (one set of valves slightly above the other).

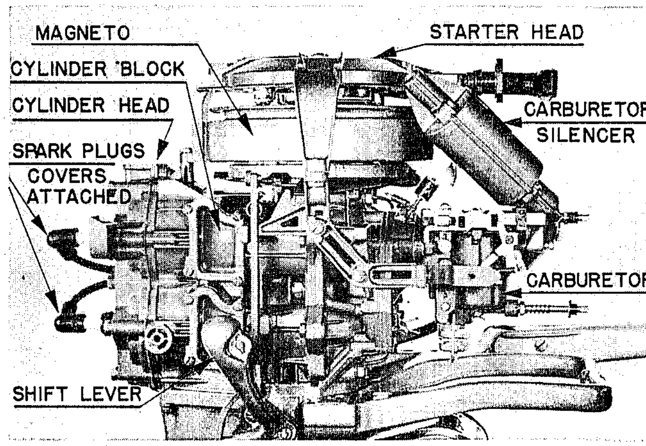
Service operations—treatment of the connecting rod—piston and ring assembly, crankshaft (bearings and seals), the cylinder block, cylinder head and gasket installation and automatic induction valve set-up are identical with those performed on QD Models—see pages 164-1 to 164-10 inclusive.



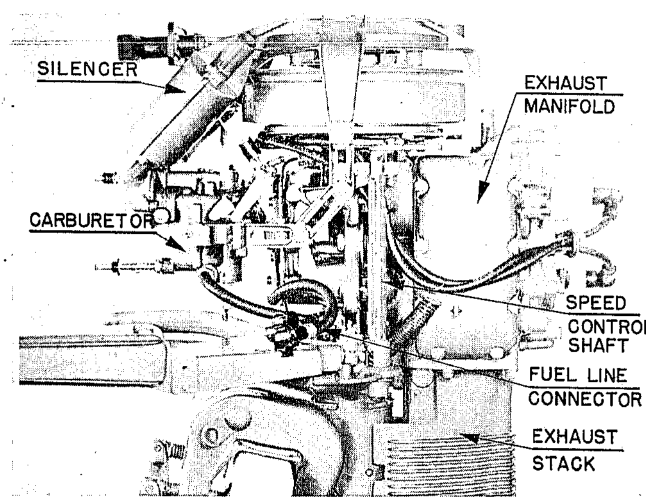
Front View of QD-15 Powerhead.



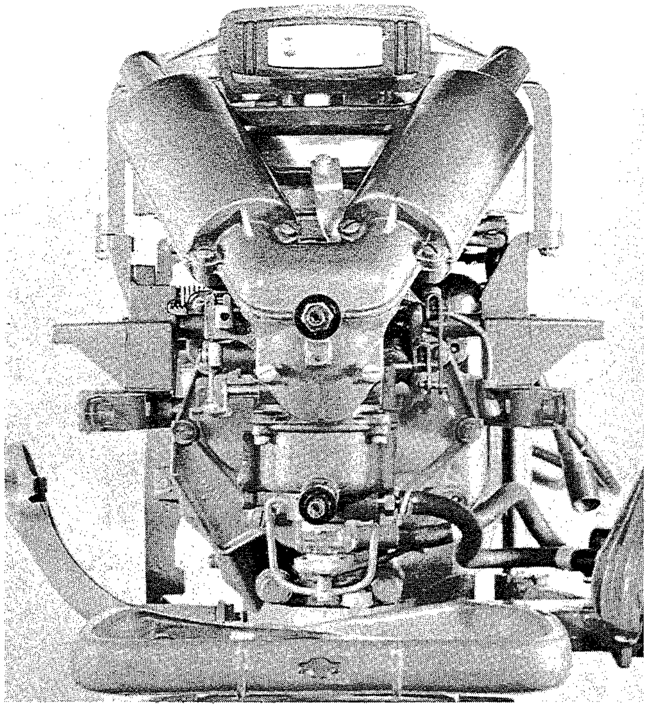
Front View of the Powerhead with "Lift-Off" Covers Removed.



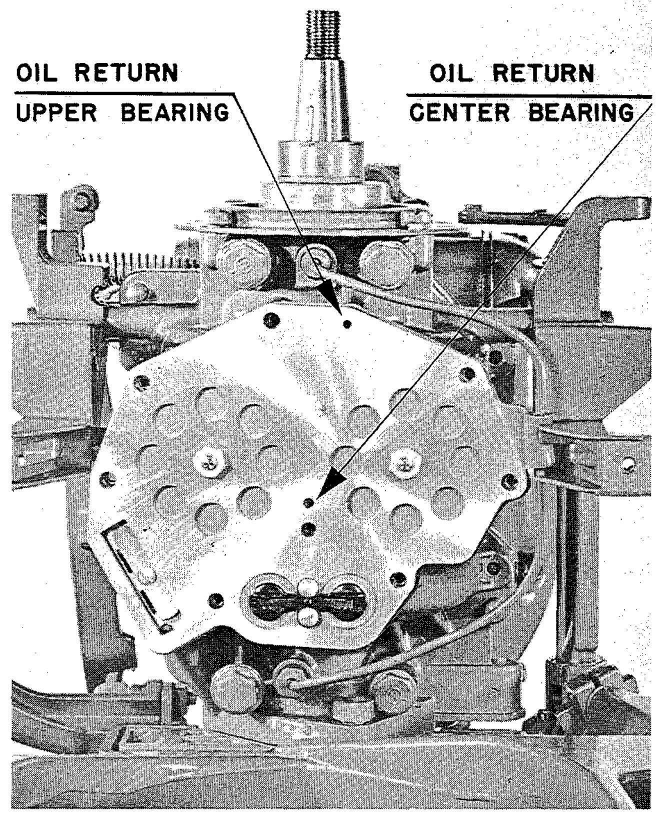
Starboard Side Powerhead Assembly.



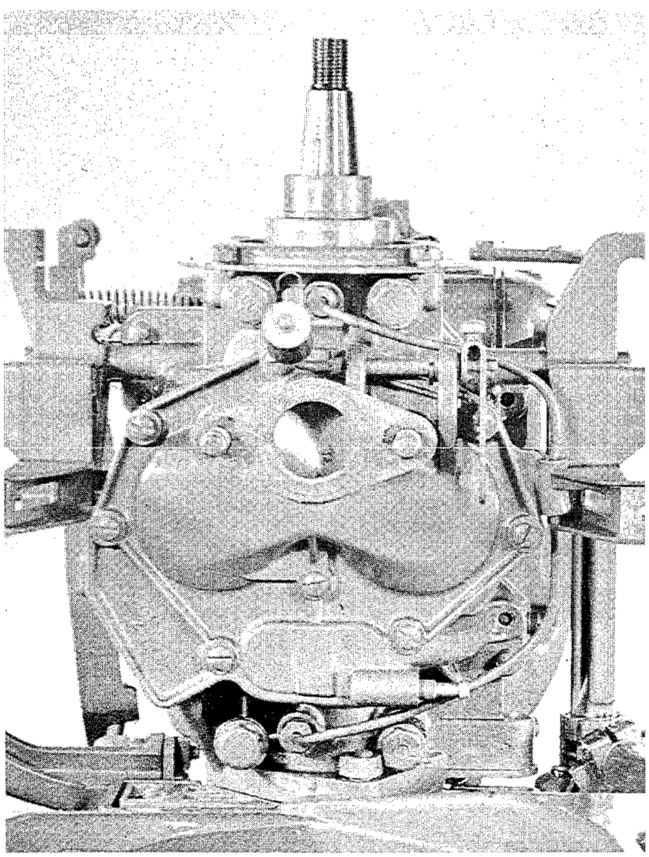
Powerhead Assembly Port Side.



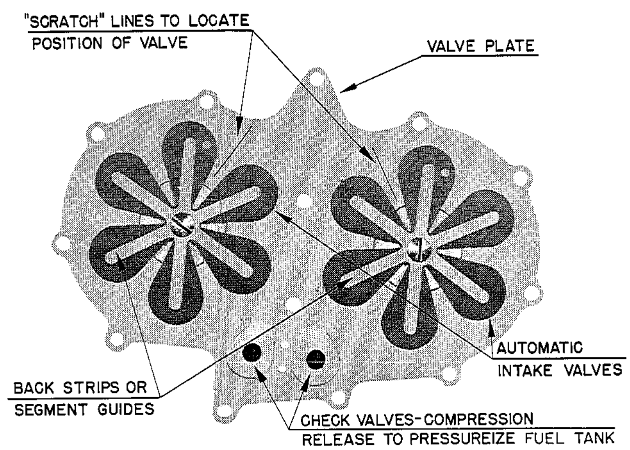
Front View of Powerhead with Carburetor Control Panel Removed to Expose the Carburetor and Silencer.



Showing Magneto, Carburetor Silencer, Carburetor and Intake Manifold Removed to Expose the Automatic Valve Plate, Bleeder and Pressure Check Valves.



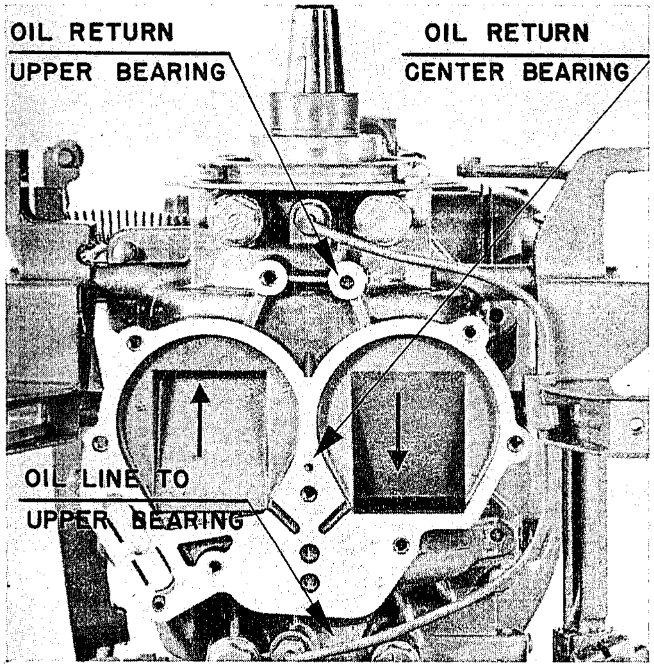
Front View of Powerhead with Starter, Magneto (see Instructions Under Universal Magneto of Preceding Pages), Silencer, and Carburetor Removed to Expose the Intake Manifold.



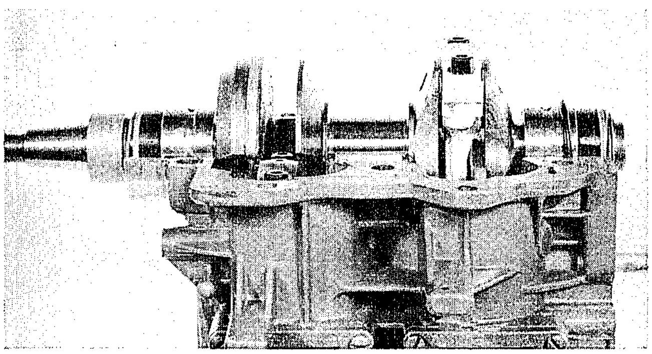
Back view of valve plate assembly showing installation of the automatic intake valve and back strip or segment guides and check valves employed to control compression release from the crankcase to pressurize the fuel tank. When required to replace the automatic valve because of a broken segment or for other reasons which may affect motor performance, it is advisable to install a new back strip (segment guide). Make certain locating surfaces are clean and free of burrs. "Cocking" or misalignment of the back strip for any reason will result in continued breaking of valve segments.

Note small ink spot on one of the valve segments—install with ink spot *out* as shown above to insure proper seating. Note also fine "scratch" lines on the valve plate—one for each valve. Prior to drawing the assembly together, space adjacent segments equidistant from scratch line as shown here to achieve full coverage and seating over corresponding ports (holes) in the valve plate.

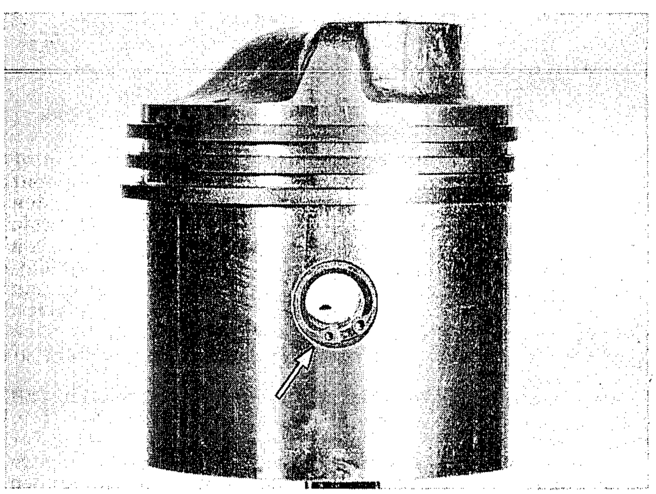
See pages 164-2 to 164-4, inclusive.



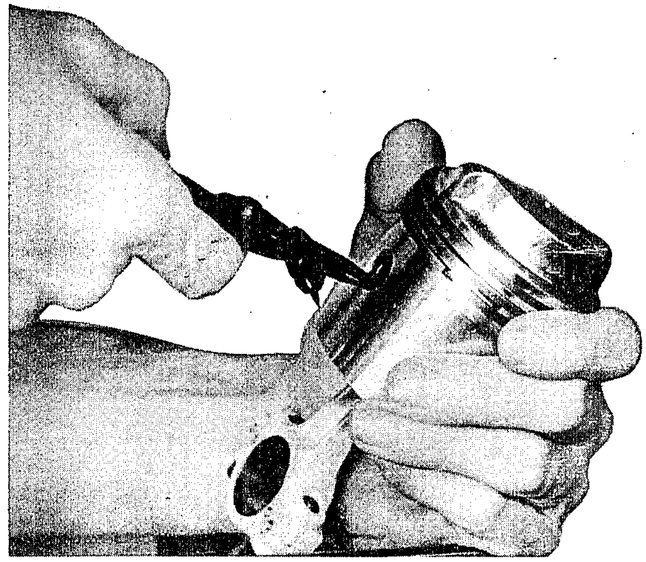
Front View of Powerhead Showing Starter, Magneto, Silencer, Carburetor Manifold and Valve Plate Removed to Expose Fuel Vapor Channels Leading to Top and Bottom Crankcase Chambers.



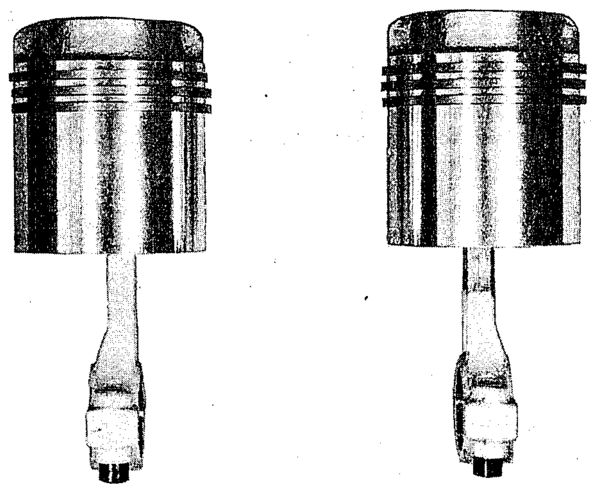
Showing the Crankcase Removed to Expose the Crankshaft and Crank Pin Ends of the Connecting Rods.
See Pages 164-5 to 164-9, Inclusive, for Treatment of Connecting Rod, Piston and Crankshaft Assemblies.



Showing Wrist Pin Retainer Installed to Retain Position of the Wrist Pin which "Floats" in Both the Piston and Connecting Rod.



Removing the Wrist Pin Retainer with Tru-Arc Pliers.

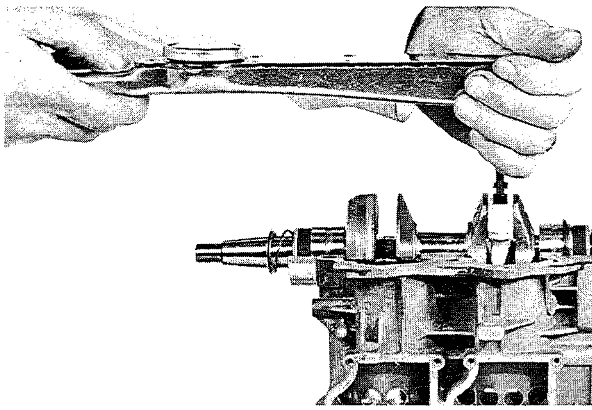


Illustrating proper assembly of connecting rods. Note straight side of rods face each other to facilitate attaching to crankpins. Pistons must be correctly installed on connecting rods to permit assembling accordingly—straight side of piston deflectors should align on same side.

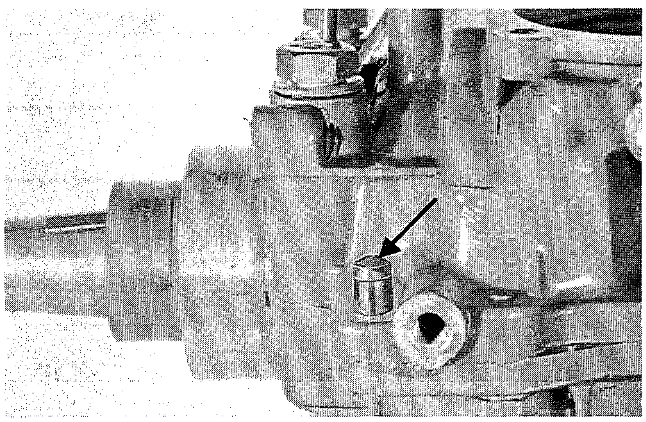
Commencing with the Model QD-14A, a change was made in the connecting rods and pistons to accommodate full floating wrist pins—floating in the connecting rod bushing and in wrist pin bosses of the piston. Resultant modification subsequently required some change in both the rod and piston. Wrist pin bosses (piston) were lengthened to gain increased bearing surface with the wrist pin end of the rod made narrower to maintain original overall dimension.

	Cancelled and Superseded by
Part #375591 Piston	#376202
Part #301788 Wrist Pin	#303711
Part #120325 Retainer	#303712
Part #375595 Connecting Rod	#376223
Part #375668 Piston and Rod Assembly (top)	#376224
Part #375730 Piston & Rod Assem. (bottom)	#376226

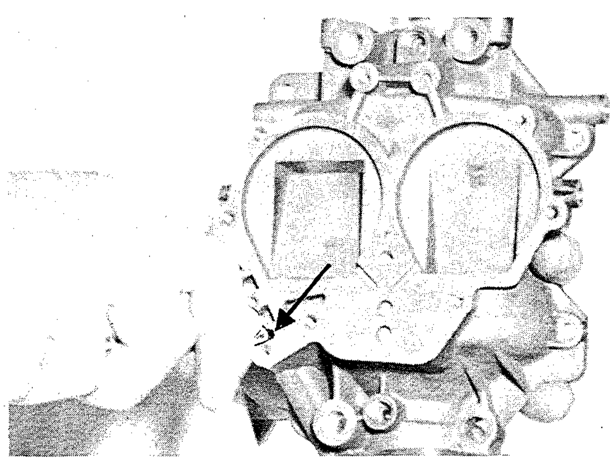
Any of the above superseding part numbers may be used in detail or assembly in repair of QD-14A and up; however, when like parts are required during repair of Model QD-14 and below (QD-13, 12, 11 and 10), assemblies #376224 and #376226 piston and rod assemblies top and bottom respectively must be installed since the original (cancelled) and redesigned parts are not interchangeable in detail.



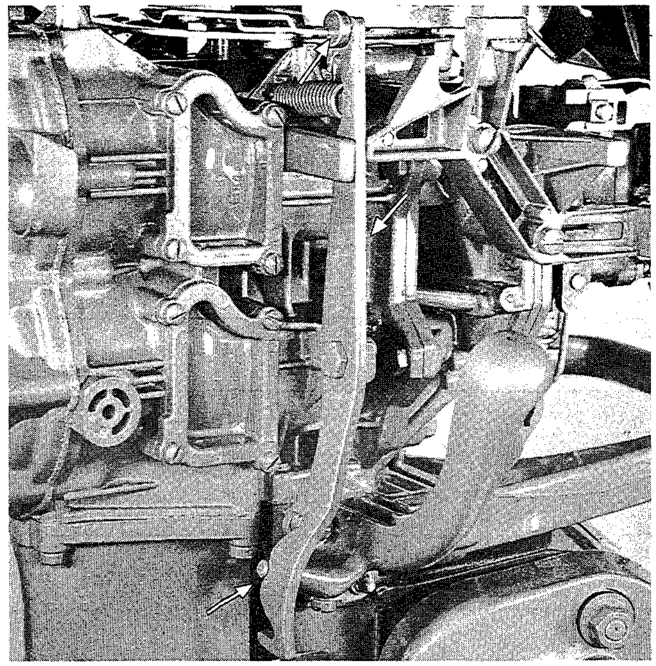
"Torquing" the Connecting Rod Screws at 15 to 17 Foot Pounds.



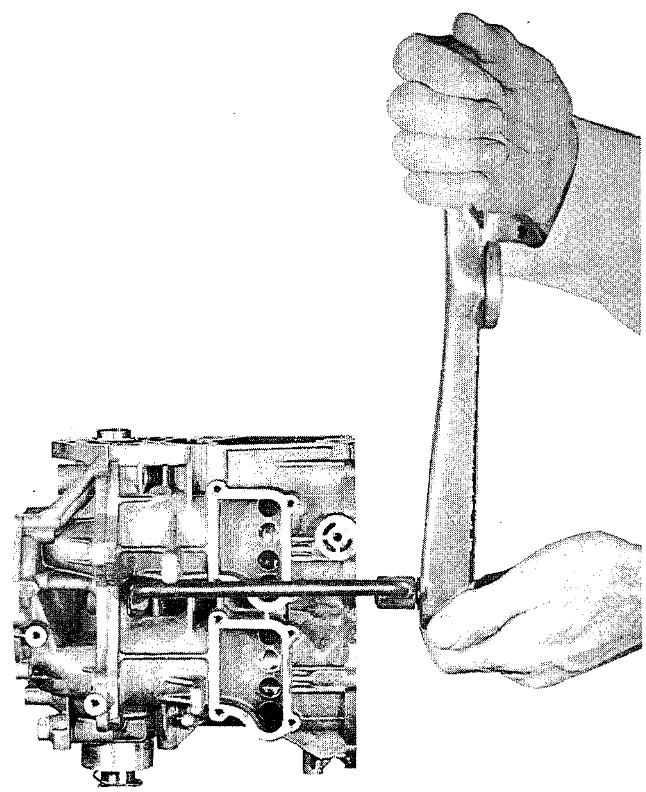
Showing Location of the Tapered (Dowel) Pin Employed to Achieve Correct Alignment of the Crankcase Sections—Two are Used. When Assembling, Make Certain Dowel Pin Holes in the Crankcase Sections are Scrupulously Clean, and Free of Burrs—Clean with Small Round Brush (Like an Electric Shaver Brush). Check Surfaces of Tapered Pins for Nicks, Burrs or Foreign Matter, Paint, Dry Cement, etc. Unless the Crankcase Holes are Clean, Free of Burrs, Paint or Dry Cement and/or the Pins are Similarly Clean and Smooth, the Crankcase Sections can be Thrown Off (Out of Line) when Driving the Pins "Home," Causing Mis-Alignment of the Crankshaft Journal Bearings and Resultant Faulty Operation for no Apparent Reason.



As a Precautionary Measure and Prior to Installing the Crankcase, Remove the Crankcase Bleeder Valve to Gain Access to the Bleeder Orifices—Blow Out with High Pressure Air Line to Avoid Possibility of Clogging Later on.



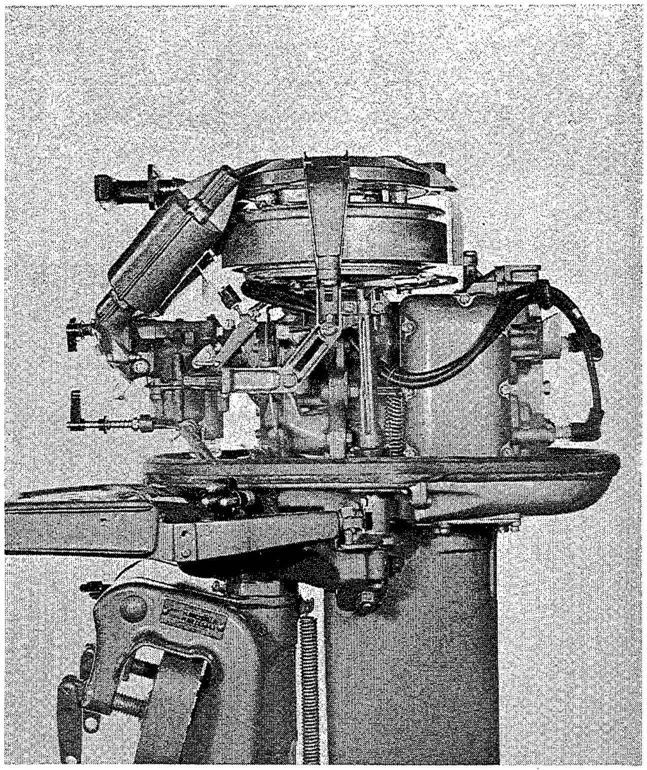
Powerhead Showing Location of the Shift Lever and Corresponding Speed Limit Control Mechanism — Top Idling or Neutral Running and Top Speed or Limit of Synchro-Control Advance.



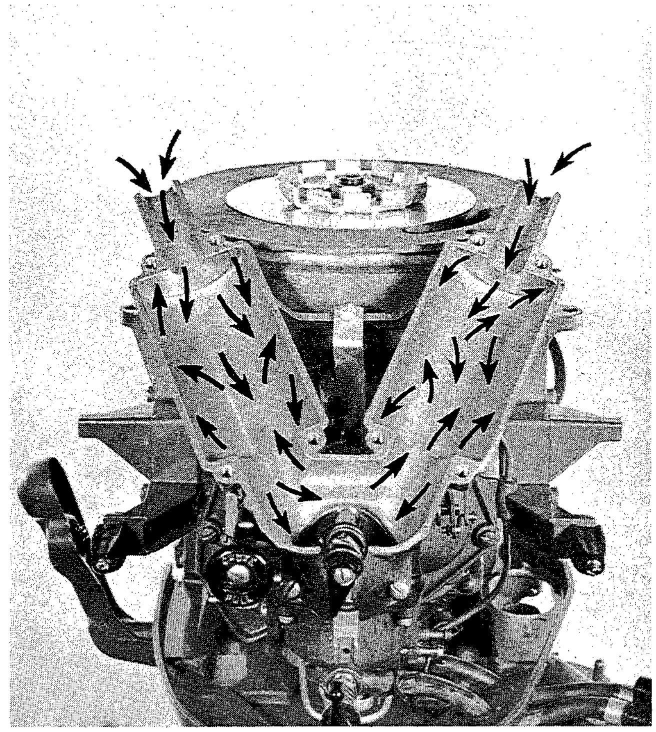
Make Sure Crankcase Faces Have Been Made Clean and Free of Traces of "Old" Cement. This is Important since "Piling" One Coating of Cement on Top of the Other Affects Journal Bearing (Center) Clearance and Seating of the Top and Bottom Journal Bearing Cages. Apply Coat of Sealer 1000 or Similar Hard Drying Cement on Crankcase Face (Cylinder Block). Spread Evenly with Small Stiff Brush. Attach the Crankcase Immediately (the Cement is Known to Dry Rapidly). Torque Crankcase Screws at 5 to 7 Foot Pounds — Nuts at 10 to 12 Foot Pounds.

NOTES

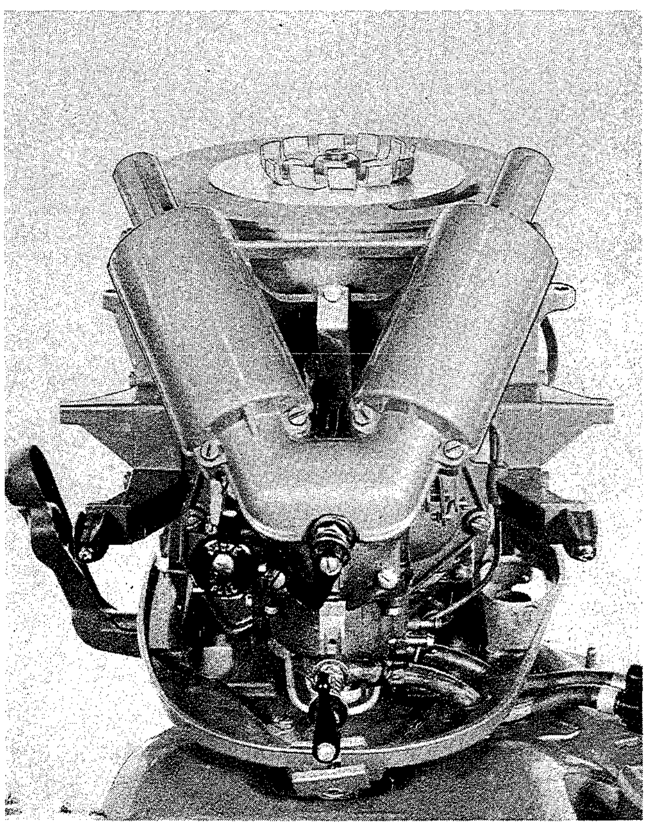
MODEL QD-16 POWERHEAD



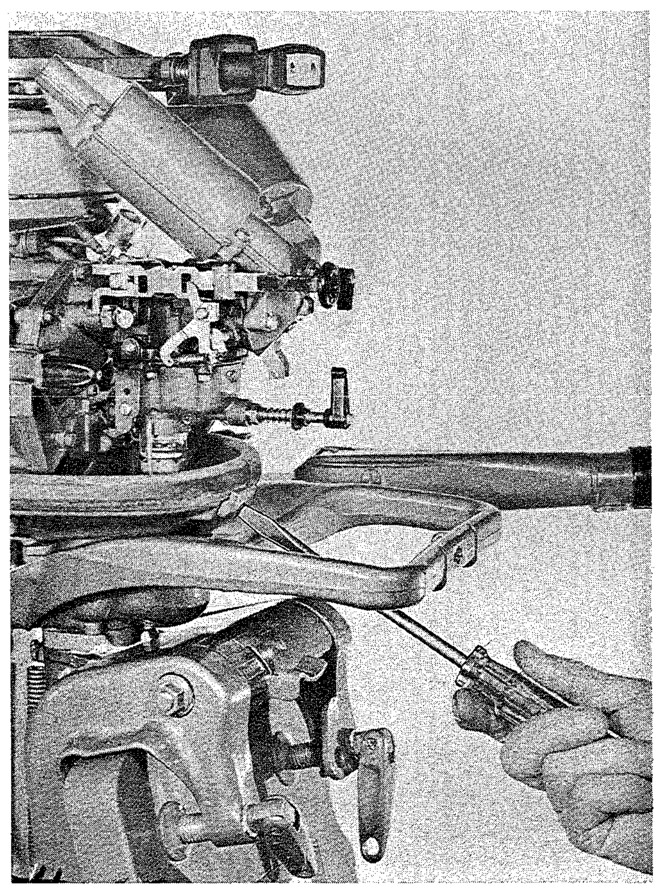
Since construction details of the Model QD-16 powerhead are basically like that of preceding models, refer to pages 164-1 to 164-10, inclusive and 164-45 through 164-51 for instructions pertaining to service procedure.



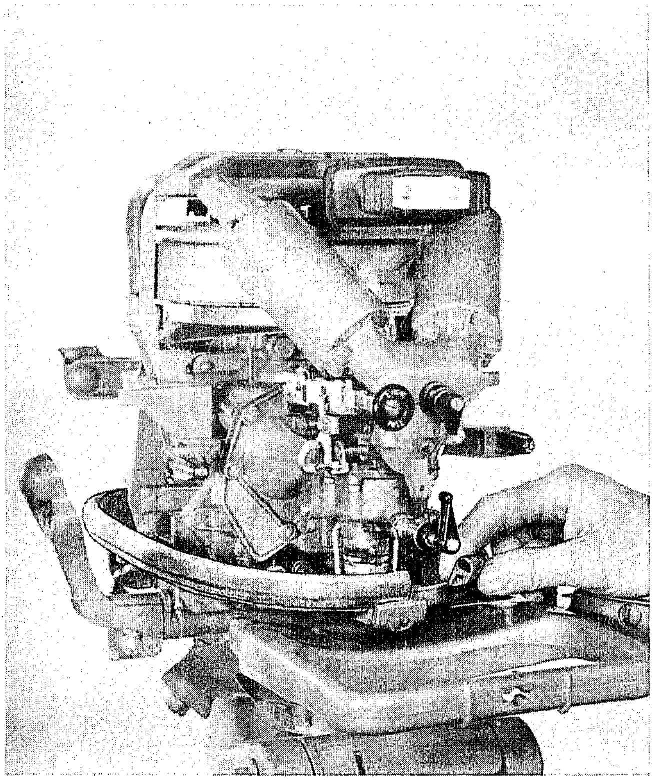
Carburetor silencer with top half removed.



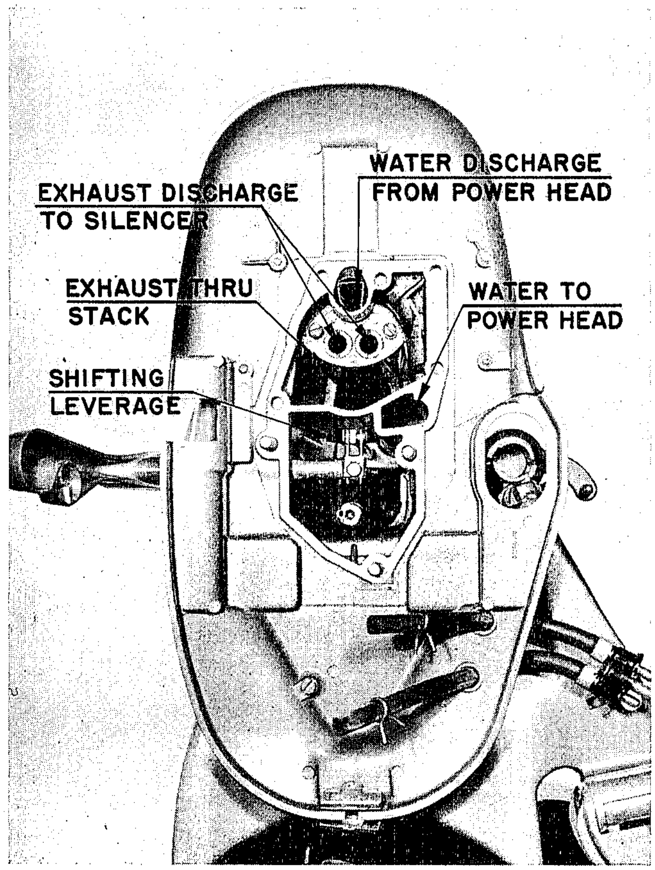
Front view of the QD-16 powerhead showing installation of the carburetor air silencer.



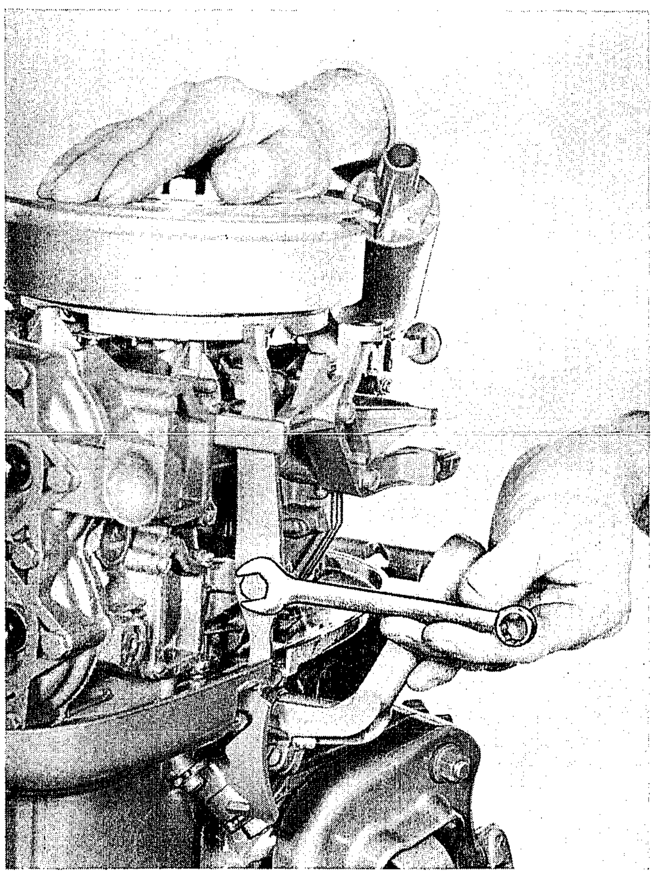
Releasing motor cover grommet.



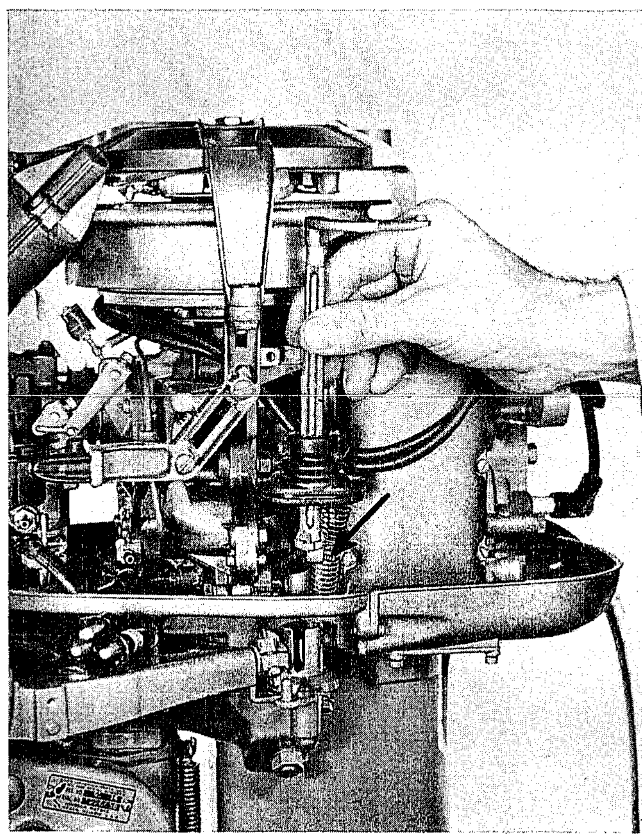
Removing or replacing the motor cover grommet—to assist in the installation, coat cover "pan" edges lightly with oil or liquid soap.



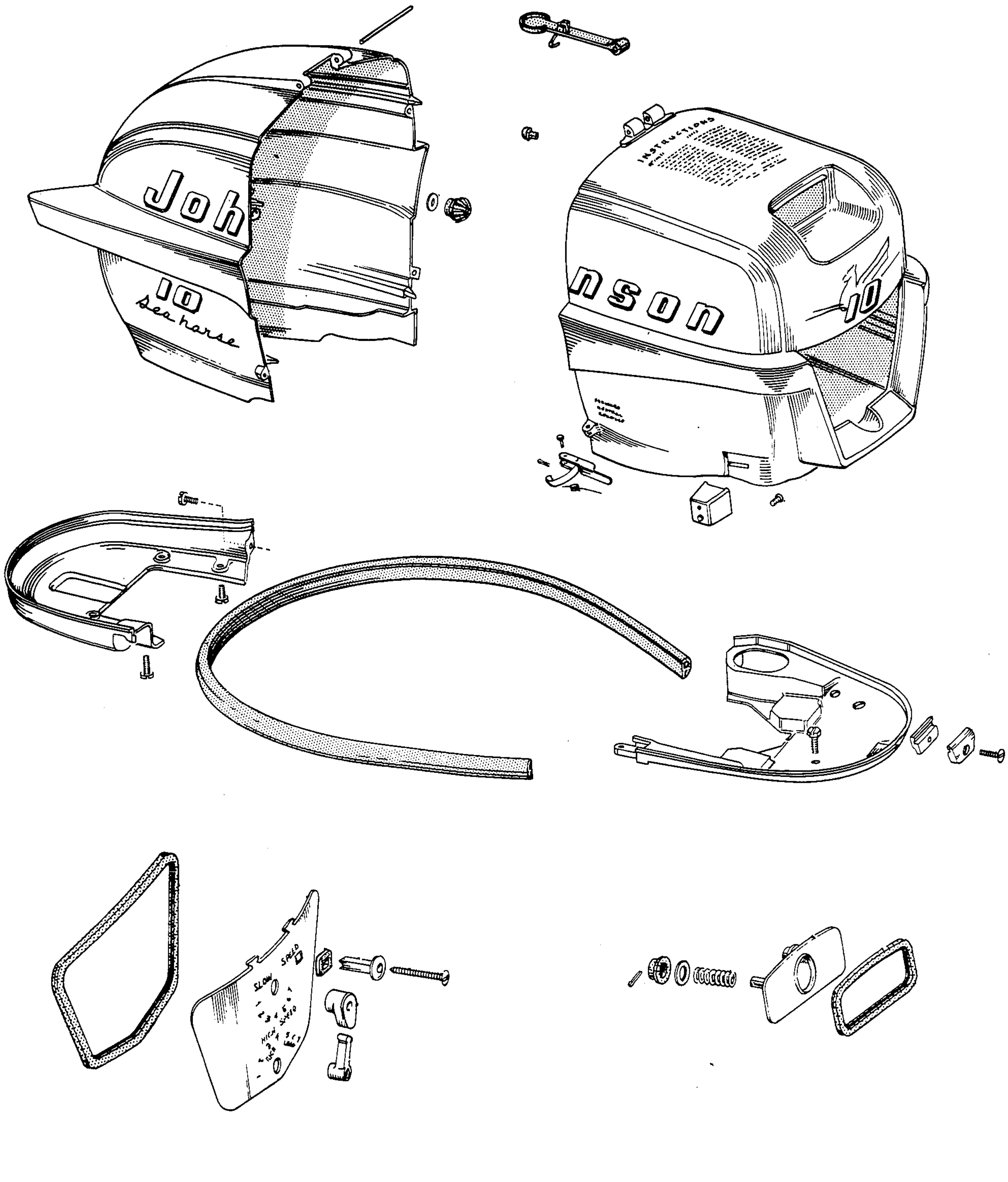
Powerhead detached from the lower unit—top view.



To finally accomplish removal of the powerhead, the speed limiting lever must be detached.



When replacing the speed control shaft, make sure the small spring shown above is in position.

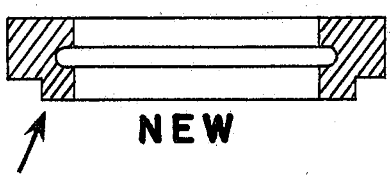


Showing motor cover, pan, grommet and carburetor control panel assembly.

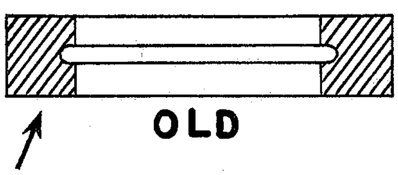
NO. 302036 CARBON SEAL — CRANKSHAFT (TOP) — MODEL QD

No. 302036 carbon seal for the top end of the Model QD crankshaft has been changed some in design — this to facilitate a better oil seal at the top face of bearing No. 302499, the purpose of which is to minimize possibility of oil laden crankcase vapor escaping and eventually accumulating on the breaker point contact faces to interfere with magneto performance.

Above change has consisted of machining a narrow face on the lower side of the seal where it "rides" on the top face of the bearing; the original seal was cut "straight across" to leave a much wider seal face, which doesn't "seal" as well as the narrower face.



NEW



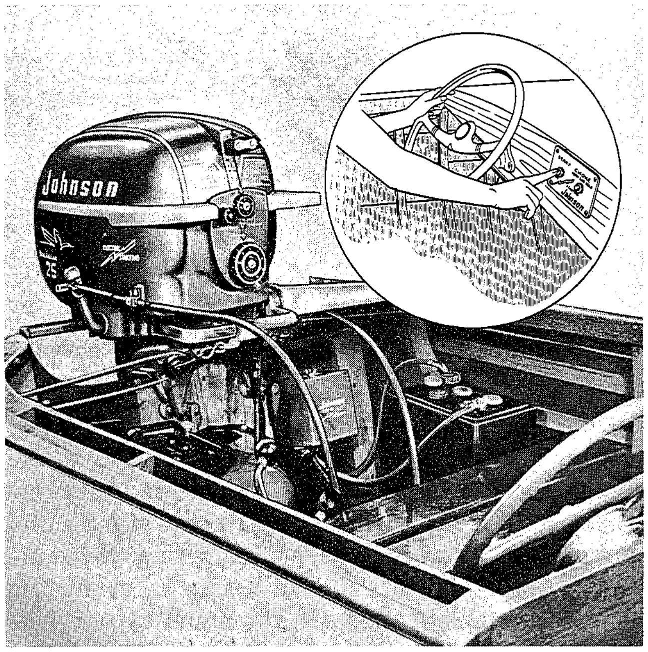
OLD

IMPORTANT — It is *important* that WHENEVER THE FLYWHEEL is removed or on other occasions when presented, the old seal be removed and one of the new design be installed as a safeguard against "oily" points and resultant faulty motor operation. Install with notches UP. Install also a NEW No. 301967 "O" ring.

The same seal (No. 302036), incidentally, is used on the bottom end of the crankshaft, too.

NOTES

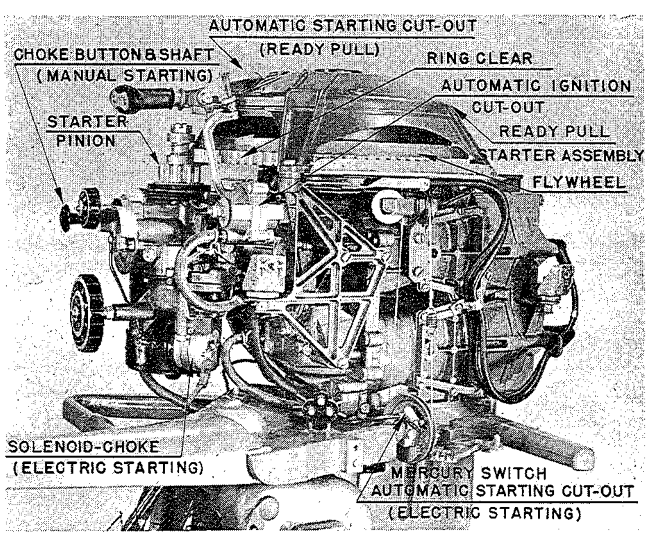
MODEL RDE — ELECTRIC STARTING 25



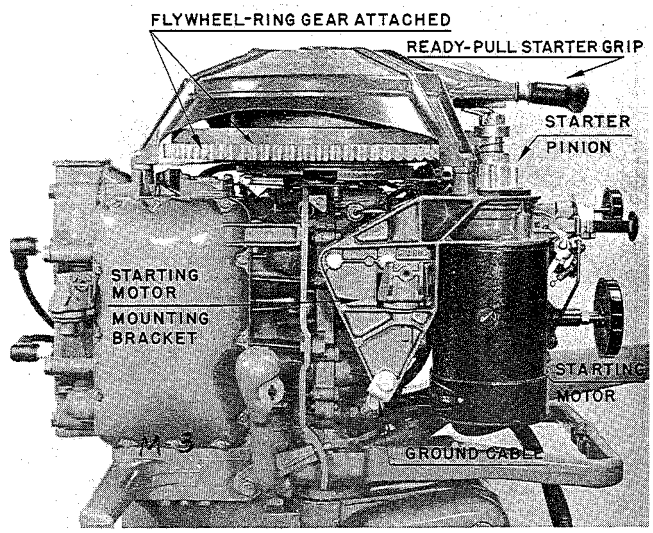
Model RDE Installation.

Basically, Models RD-16 and RDE-16 (electric starting) are alike in construction except for the built-in starting motor with pinion drive, a ring gear bolted to a flywheel of somewhat different design and a solenoid to act on the carburetor choke. Starting and choke is by remote control from the panel board at the driver's seat. Depressing of the starter button causes the relay (in junction box) to bridge the circuit between the battery and starting motor. Depressing the choke button causes the solenoid to close the choke at time of starting.

Like the Model RD, the motor cannot be started in gear with the grip control set for high speed. A mercury switch is employed to break the circuit



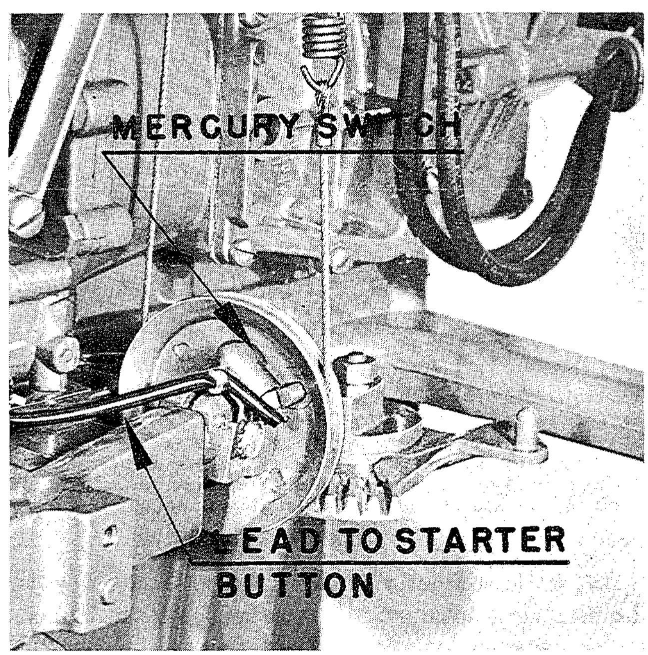
Model RDE powerhead assembly — port side.



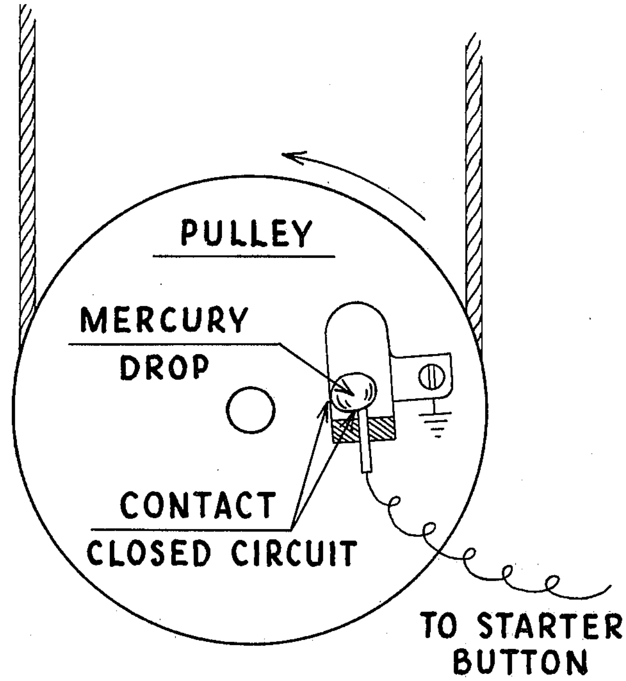
Model RDE powerhead—starboard side.

between the starting button and relay when set for high speed operation — likewise, the starter cannot be made to engage the flywheel unless the speed control grip is retarded to "starting range."

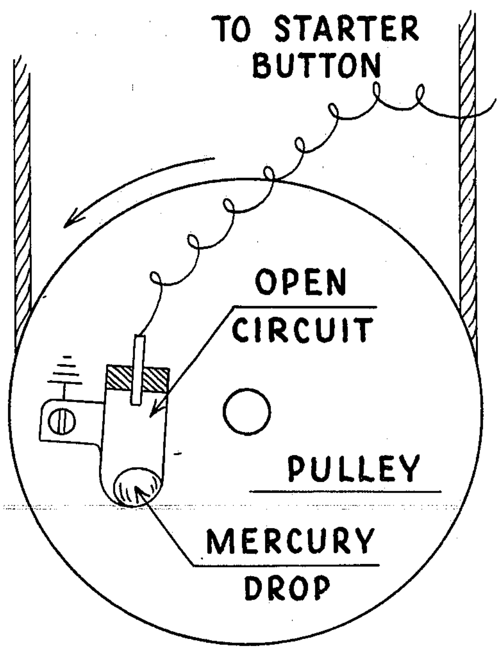
The mercury switch consists of a cartridge-like affair of stainless steel in which is sealed a single drop of mercury. The sealed end of the cartridge includes an insulated terminal leading to the remote starter button. Being attached to the speed control pulley, the cartridge is "up ended" when advancing from slow to fast speed and "tipped" oppositely on retarding towards slow speed range for starting. With this movement, the mercury drop is caused to flow from one end of the cartridge to the other, etc., making and breaking the circuit whichever the case may be.



Showing location of the mercury switch (automatic starting cut-out) on speed control pulley.

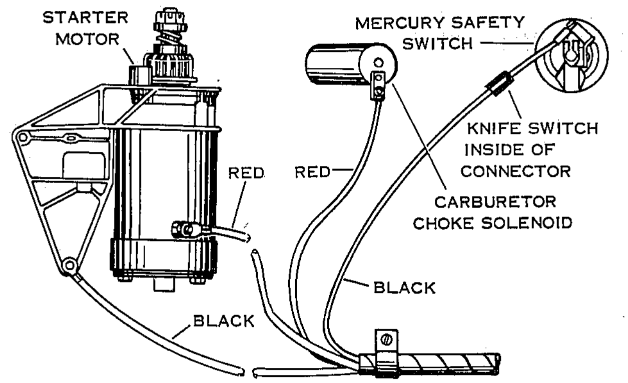


Schematic drawing to show position of mercury drop when speed control grip is set for starting. Note that contact has been established between the shell and insulated terminal lead to close the circuit to permit starting with remote button on the panel.



Schematic drawing to show position of mercury drop when the speed control grip is set for speeds above "starting" range. Note that on increasing speed, the switch has been up-ended with the mercury drop now resting on bottom end of the cartridge (full speed) thus breaking the circuit to result in no starter action when depressing the starter button.

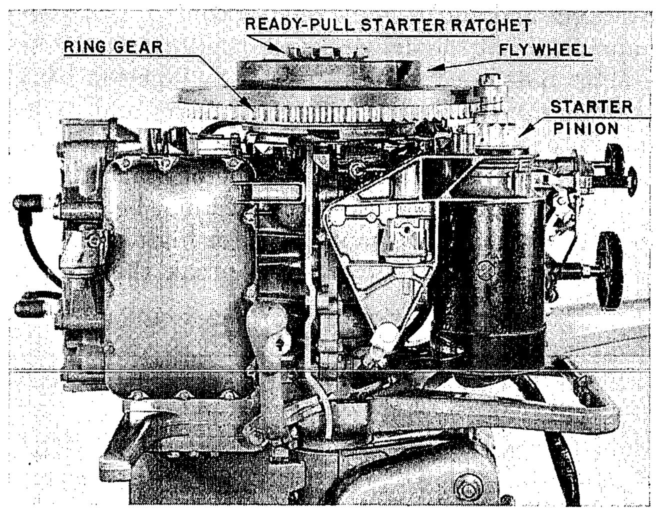
But little difficulty should be encountered with the electric starting unit; however, should the occasion require, look to the battery first. Make certain it is "up"; check terminal connections to assure their tightness and freedom from corrosion;



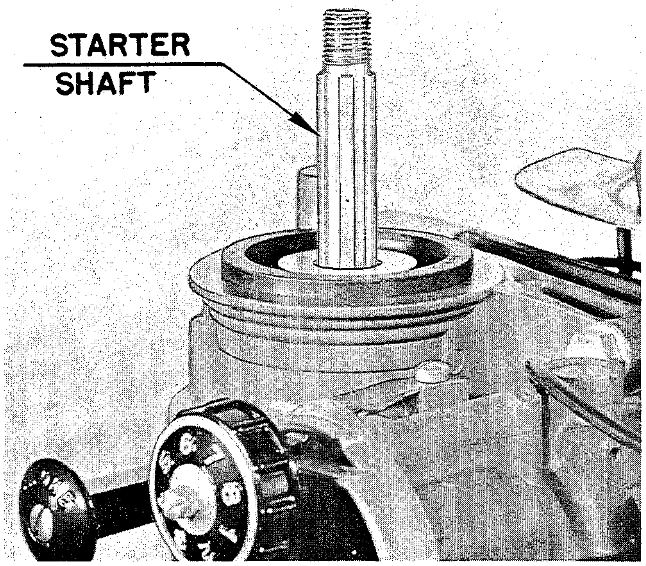
Schematic drawing showing the starter, choke solenoid and mercury switch arrangement.

investigate all terminal connections in the wiring system to determine their fitness, including the mercury switch; be on lookout for loose, broken or otherwise faulty wiring. Check remote starter and choke buttons on the panel — See wiring diagrams and assembly layouts shown here. In event the remote starter button fails, the small cap on bottom end of the starter relay may be removed to expose an auxiliary button — depress to start.

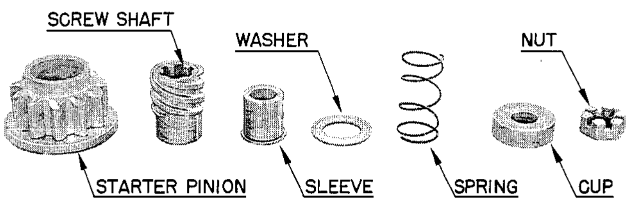
The pinion gear "screw" should be oiled periodically with motor oil or thinly coated with Lubriplate. Wash off occasionally with kerosene or gasoline if there is evidence of the pinion "sticking" (use sparingly) re-oil.



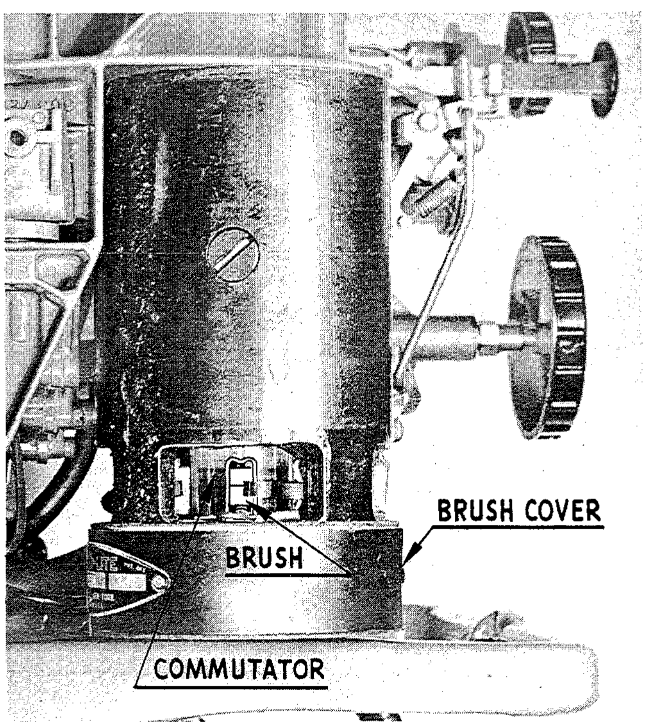
Model RDE powerhead—ready pull removed to expose the flywheel with ring gear attached and starter drive.



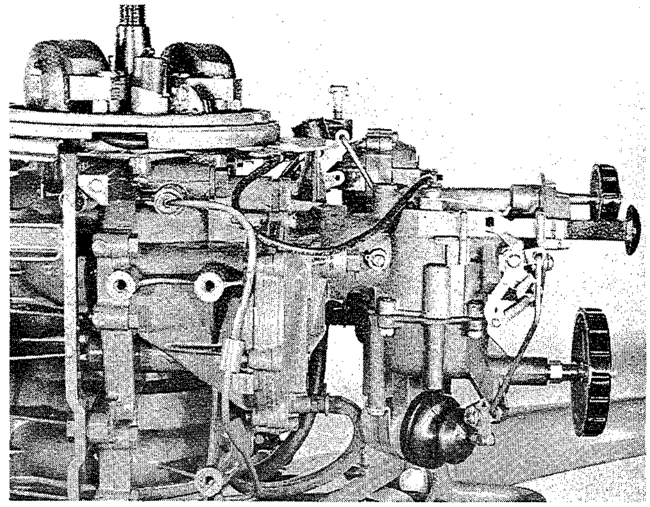
Showing starting motor with nut, spring, washer, screw, and gear removed for periodic cleaning. Rinse all parts of the assembly with gasoline to remove traces of scum and/or effects of salt water operation to avoid "sticking" of pinion gear. Lubricate with few drops of light oil.



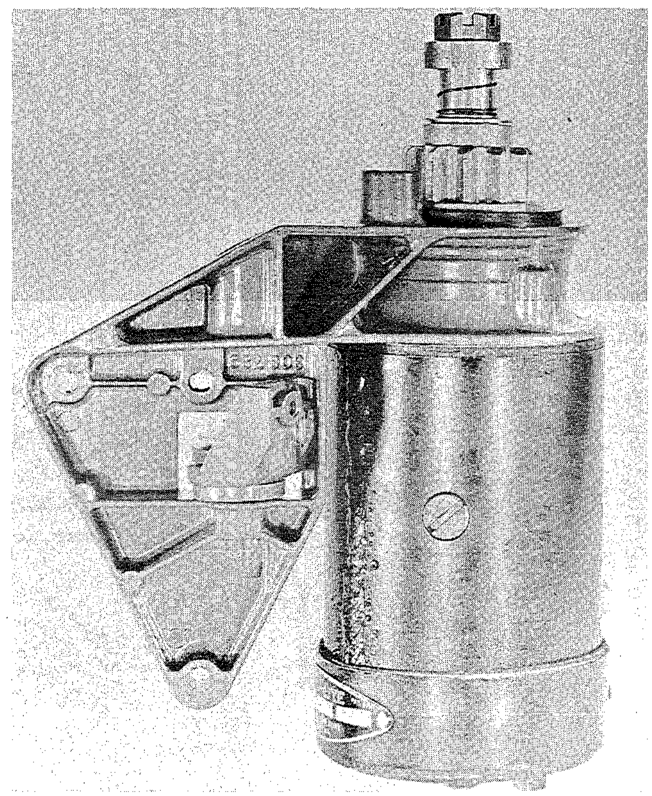
Layout of starter gear assembly. Note long shoulder on screw which must be directed downward on assembly.



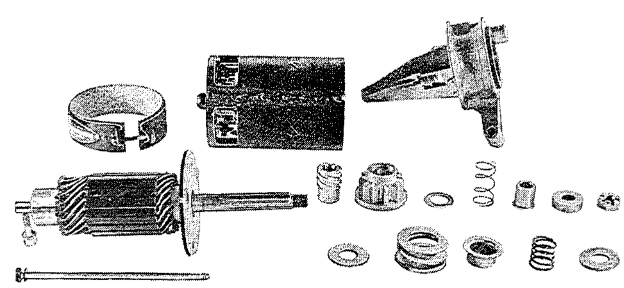
Brush cover removed for inspection of commutator segments and brushes.



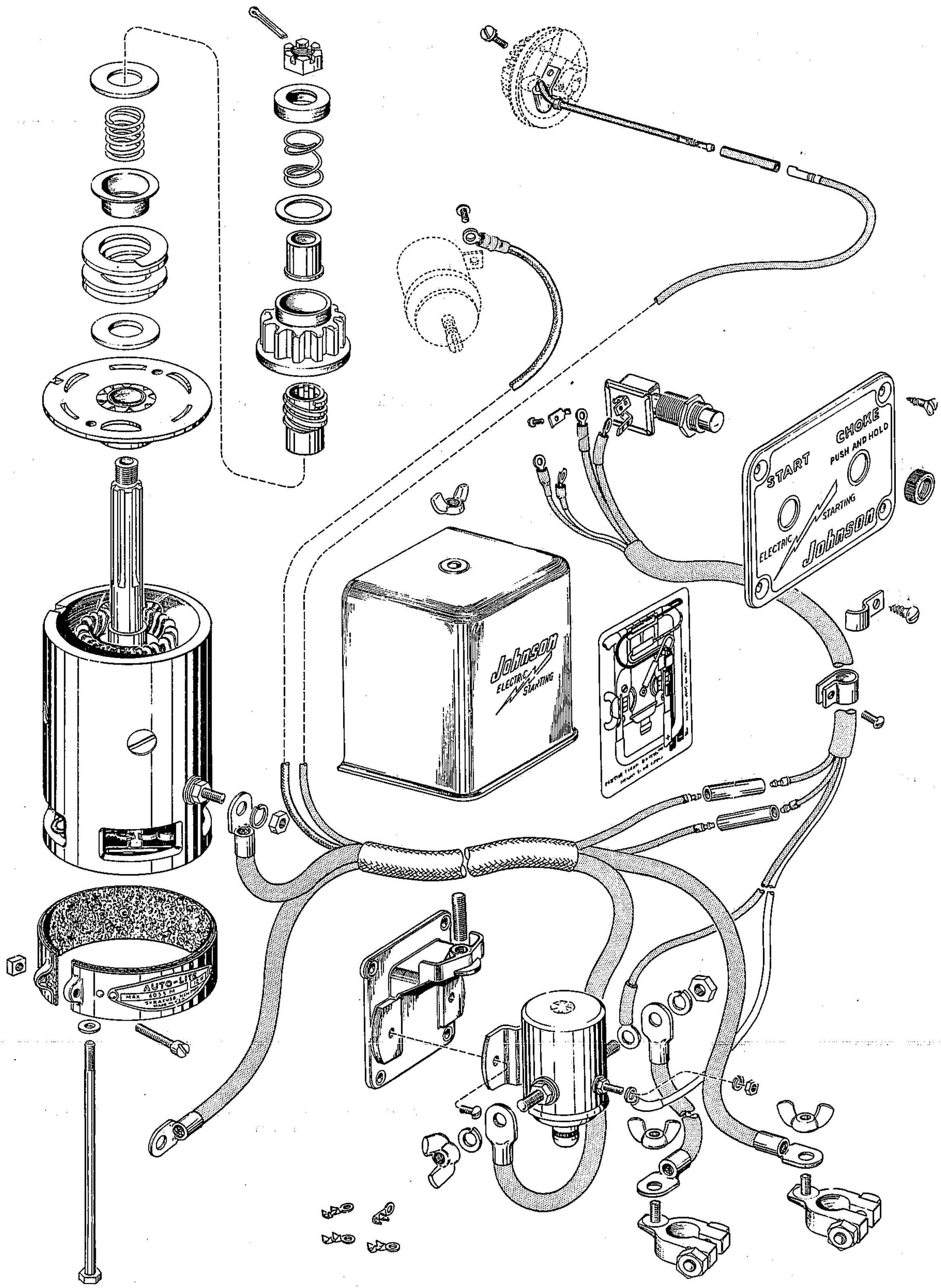
Power head with starter and mounting bracket assembly detached.



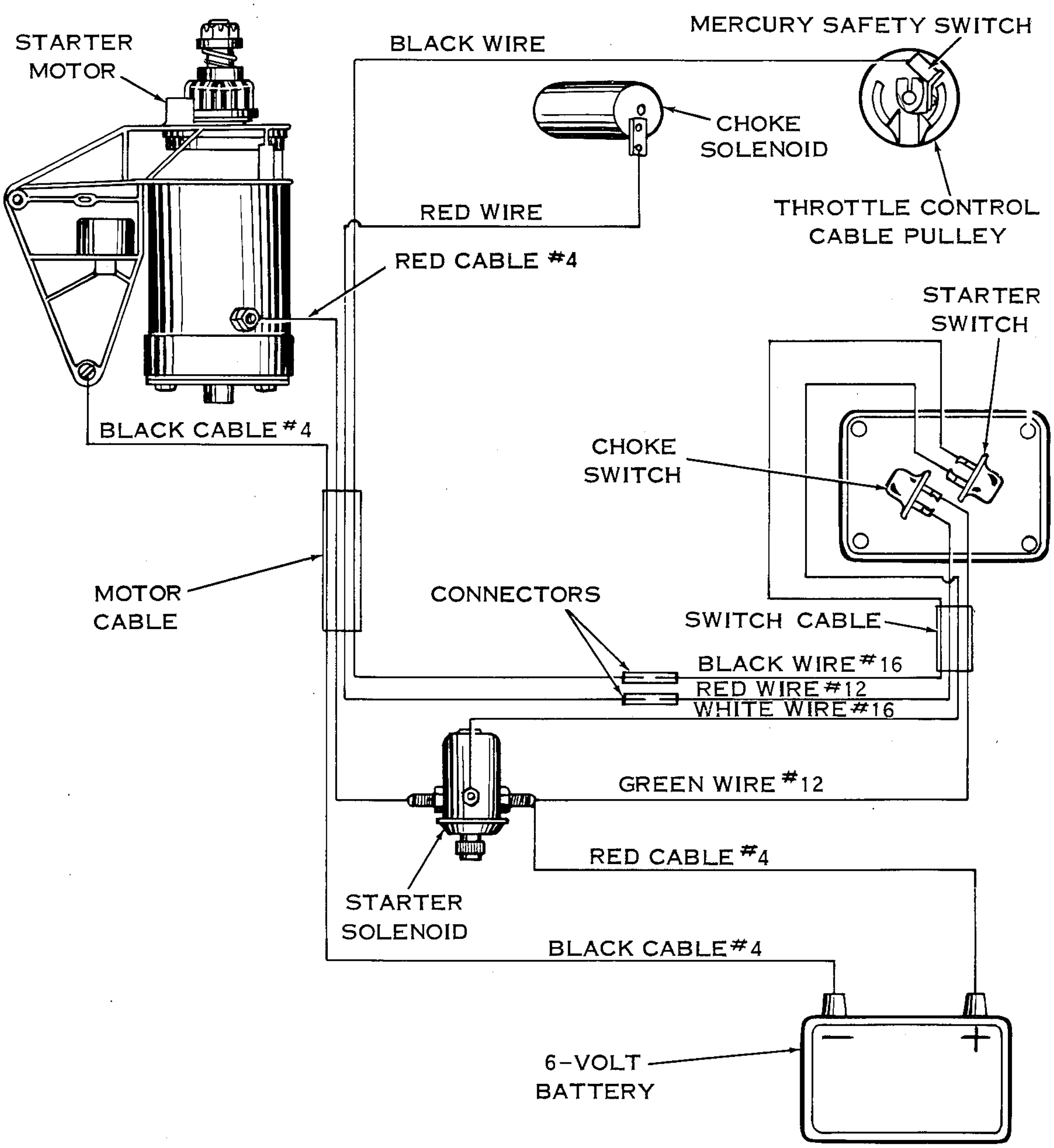
Showing the starter assembly and mounting bracket as removed from the motor.



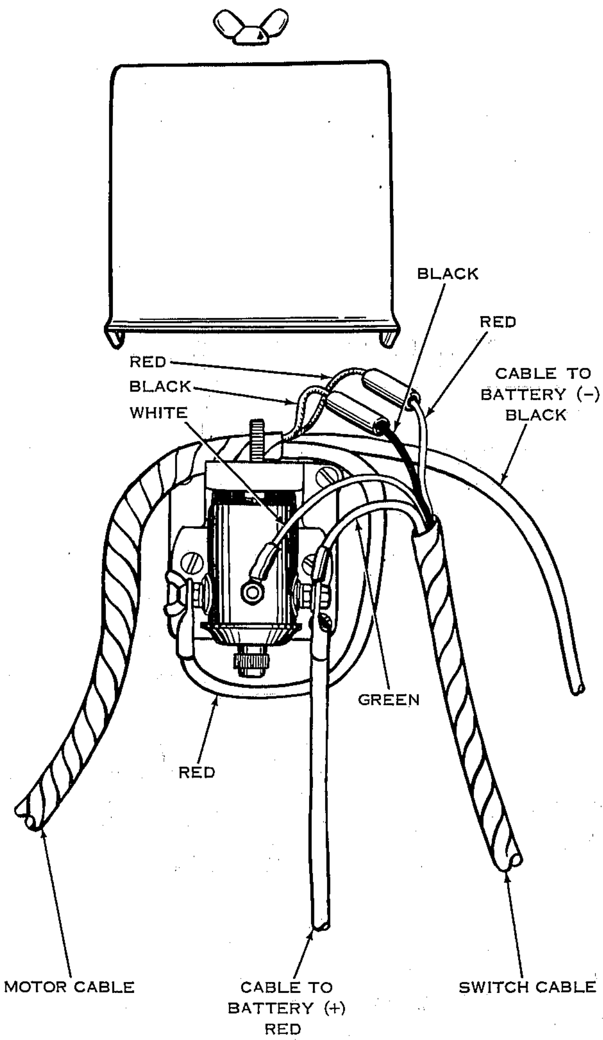
Break Down of Starter Assembly.



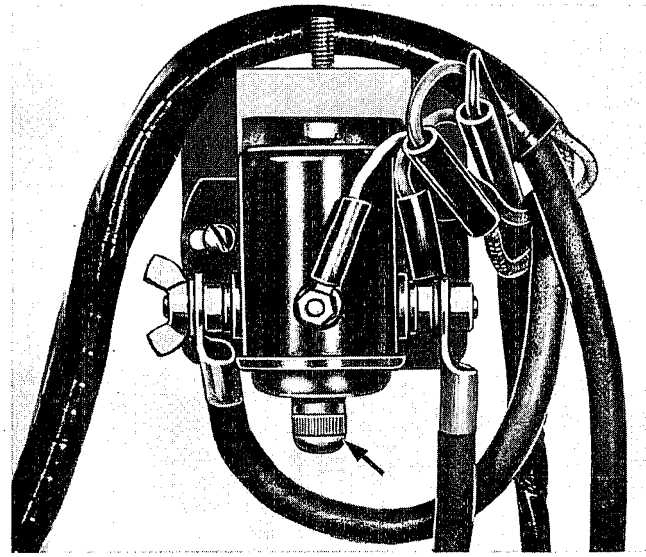
Model RDE electric starting group layout.



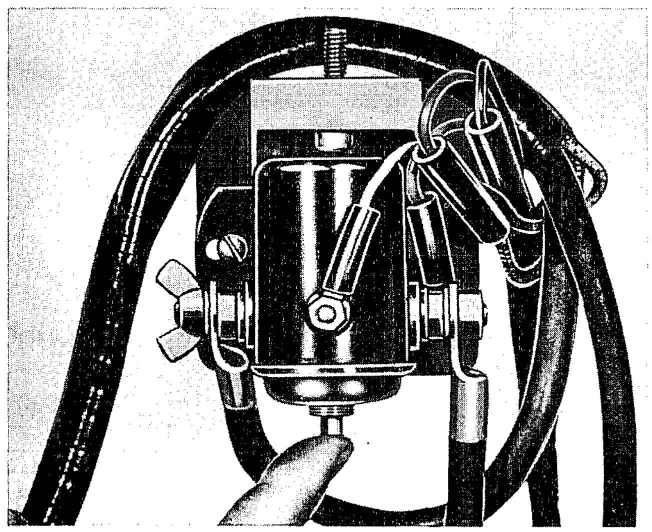
Wiring diagram.



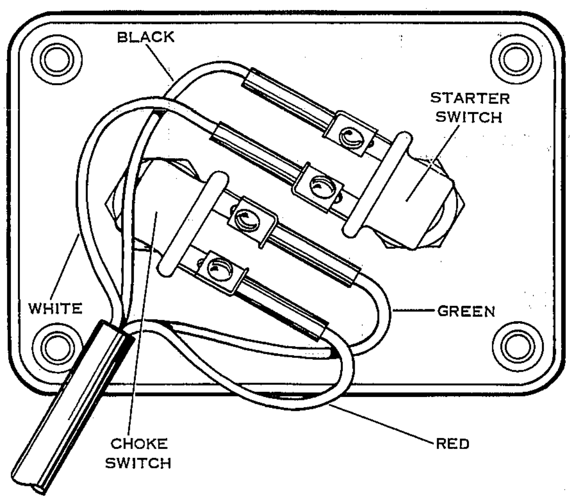
Junction box wiring diagram.



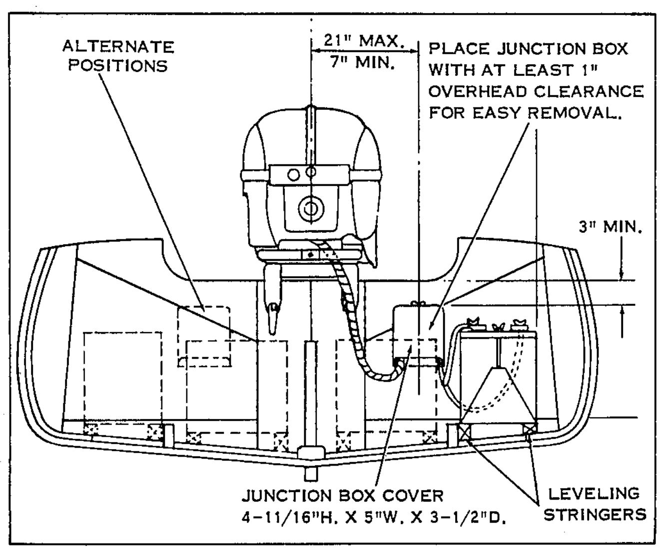
Showing starter relay and arrangement of wiring under the junction box. Note cap under relay indicated by arrow.



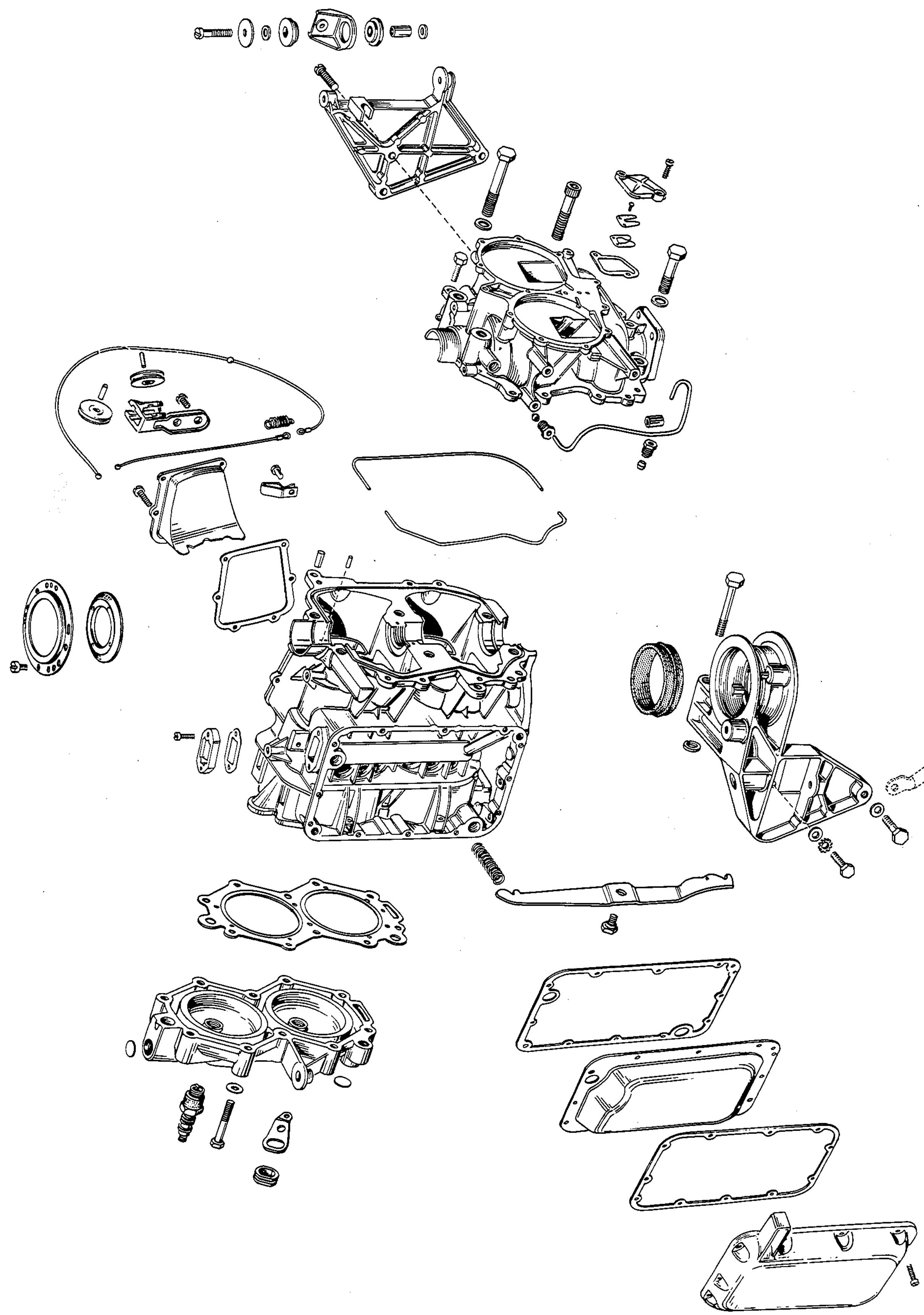
Showing relay cap removed, exposing the auxiliary starting button.



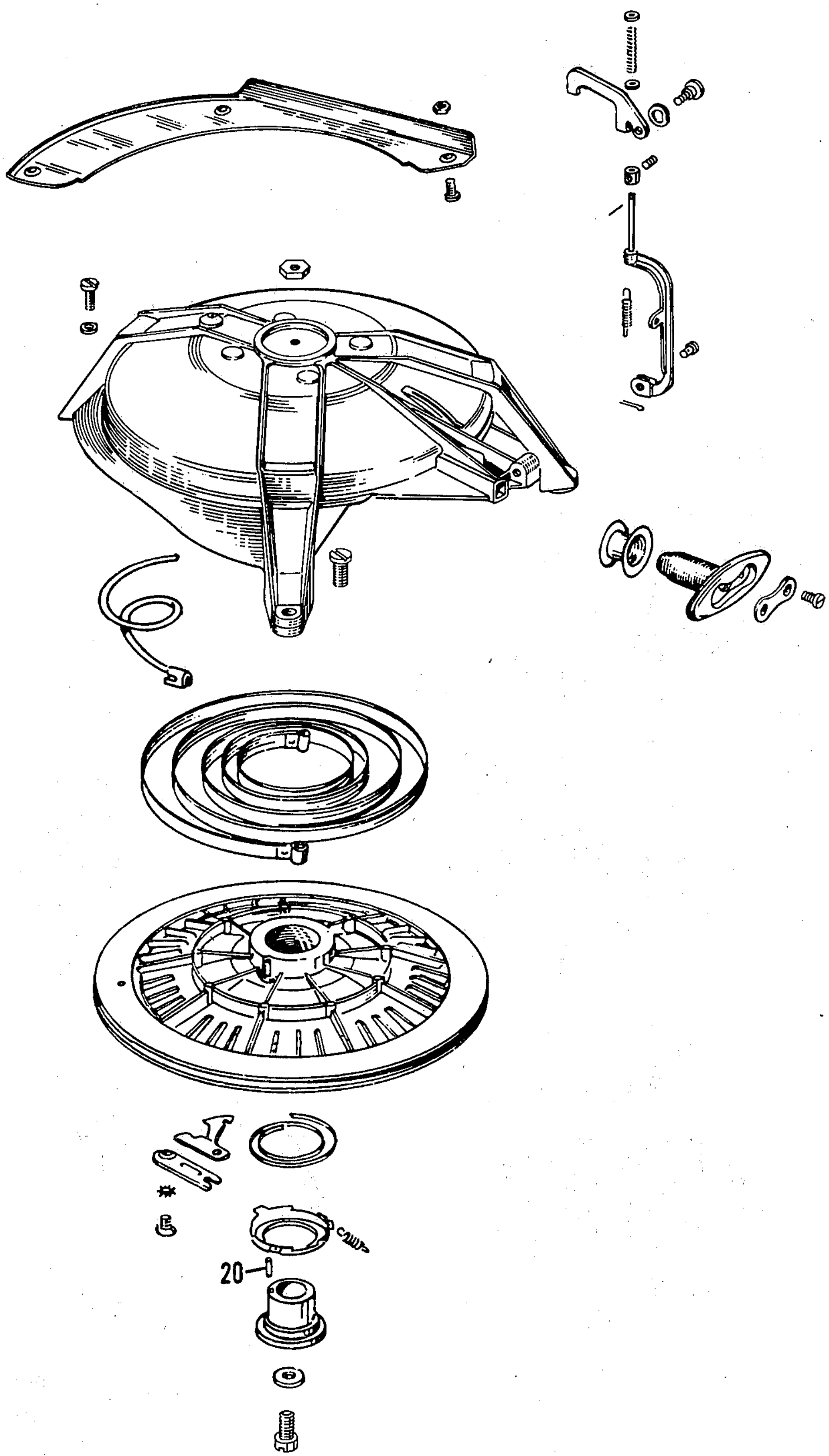
Wiring diagram—back of starter-choke switch panel.



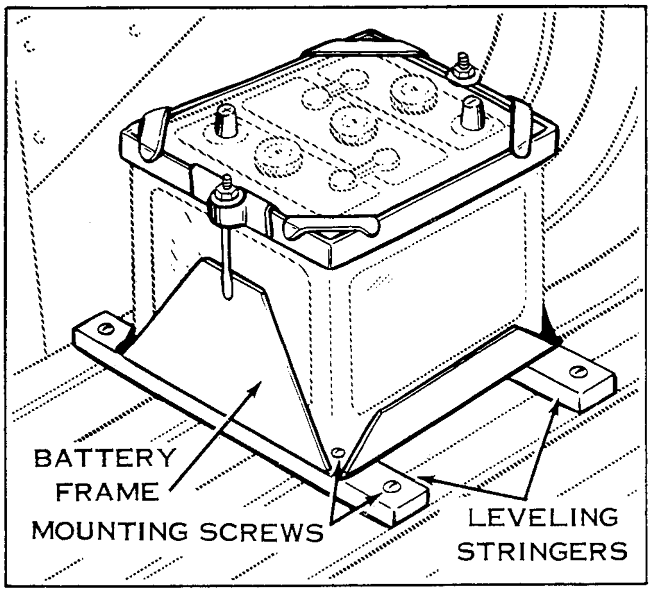
Motor installation plan.



Model RDE cylinder and starter mounting group layout.



Model RD and RDE—16 starter assembly layout—ready-pull (manual) starting.



Showing suggested battery installation.

CARE OF THE BATTERY

A fully charged battery should read 1285-1300 on a hydrometer or 2.125 volts on a sensitive voltmeter. The battery should be recharged when the hydrometer reaches 1200 or the voltmeter 2.020 for maximum battery life. Starts can be expected, however, until the hydrometer reaches 1150 or the voltmeter 1.990. We recommend checking every thirty days for average use, or oftener in cases of exceptionally heavy use. The use of lights and other electrical accessories will, of course, greatly reduce the time between chargings.

Do not recharge the battery by the "fast charge" method. This method does not restore the full charge and also shortens the life of the battery. Have the battery slow charged by the service station, or purchase a 3 to 10 ampere battery charger for convenient use at home. With these chargers you can expect to recharge the battery in from 8 to 24 hours.

GENERAL BATTERY INFORMATION

A. The specific gravity reading of a fully charged battery is 1285-1300.

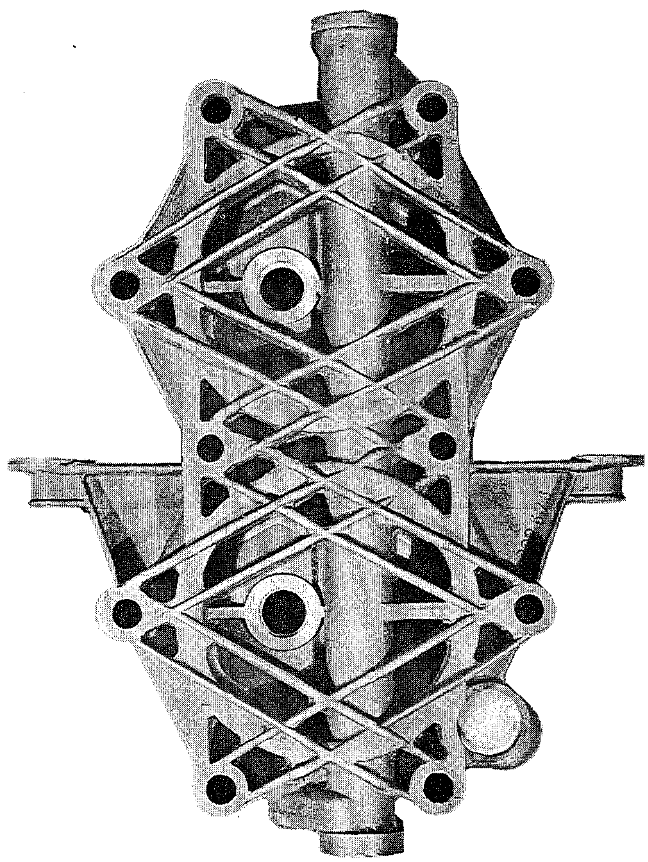
B. The voltage reading on a fully charged battery cell is 2.125.

C. The water in the battery should cover the plates 1/4 to 1/2 inch or enough water to fill a hydrometer.

D. A battery hydrometer reading is not accurate if water has been recently added. This is due to the fact that the water has not had a chance to mix with the electrolyte.

E. An idle battery should not be filled in freezing weather. The newly added water will not mix with the electrolyte immediately and may freeze.

F. Refer to instructions provided by battery manufacturer for additional information.



Illustrated above is the new reinforced cylinder head for the Model RD—Note that additional ribbing has been included but beyond this, depth of the head has been increased by approximately 1/4" which requires correspondingly longer head bolts (303783) to accomplish the installation. (Provided with the head.)

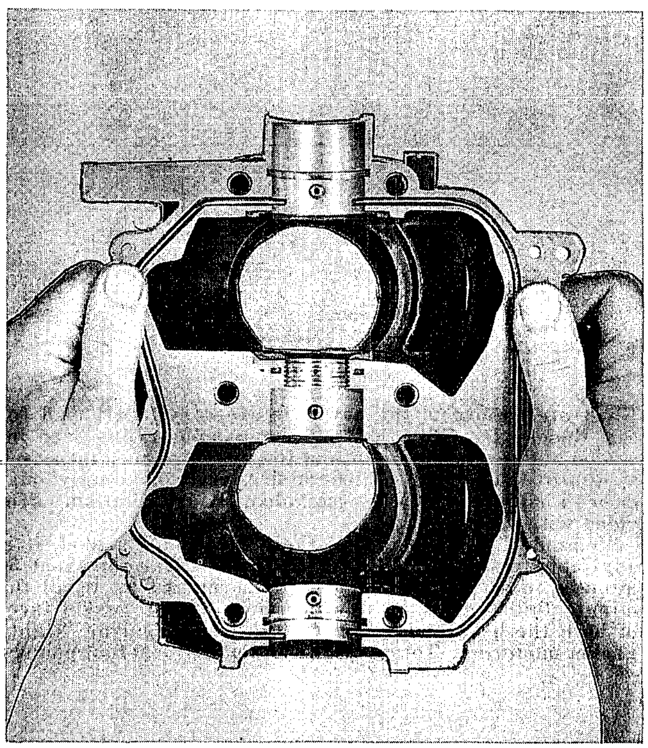
Reminder, when installing the RD cylinder gasket, it is advisable to submerge and soak it in kerosene for about 30 minutes to soften a bit. This will permit filling in all the minute "hills and valleys" which may exist in gasket faces of both the head and cylinder block, thus insuring "tight" gasket mounting. Torque head bolts at 18 to 20 foot pounds.

RD CRANKCASE ASSEMBLY — OIL SEALING

It is of extreme importance that the RD crankcase sections are properly sealed (cemented) on the repair assembly, particularly in regions where the rubber seal strip "butts" up against the top and bottom journal bearings. Note areas encircled and indicated by arrows in Figure 3 which should be given special attention in this respect. Oil escaping at top journal bearing installation finds its way up under the armature plate and eventually accumulates around and on the magneto breaker point faces to cause hard starting, faulty operation and other attendant difficulties associated with an oil drenched armature plate. Careful sealing and cementing at this point is of considerably more significance now that the "O" ring (#302537) has been removed from the top journal bearing to accommodate the oil return.

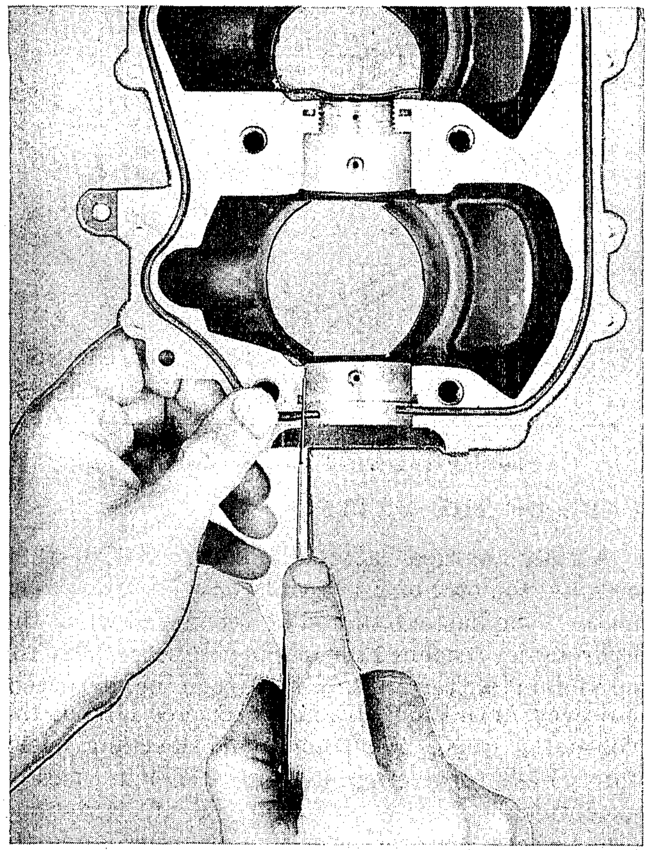
Do not excessively smear cement on areas adjacent to center bearing installation—a thin coat but well spread—surplus of cement here merely squeezes out inside the crankcase which is apt to clog the bleeder orifices to cause motor difficulty later on.

When reassembling always use new carbon seals (#302538) and carbon seal "O" rings (#302540). Install carbon seal with "notch" up.



Placing Seal Strip in position.

Note that rubber seal strips of round cross sections are employed to seal the crankcase — fitted into shallow grooves of the upper section (cylinder block) provided for this purpose to accomplish crankcase compression seal in conjunction with "O" ring installed on the top and bottom bearing cages (earlier models only) when crankcase sections are bolted together.

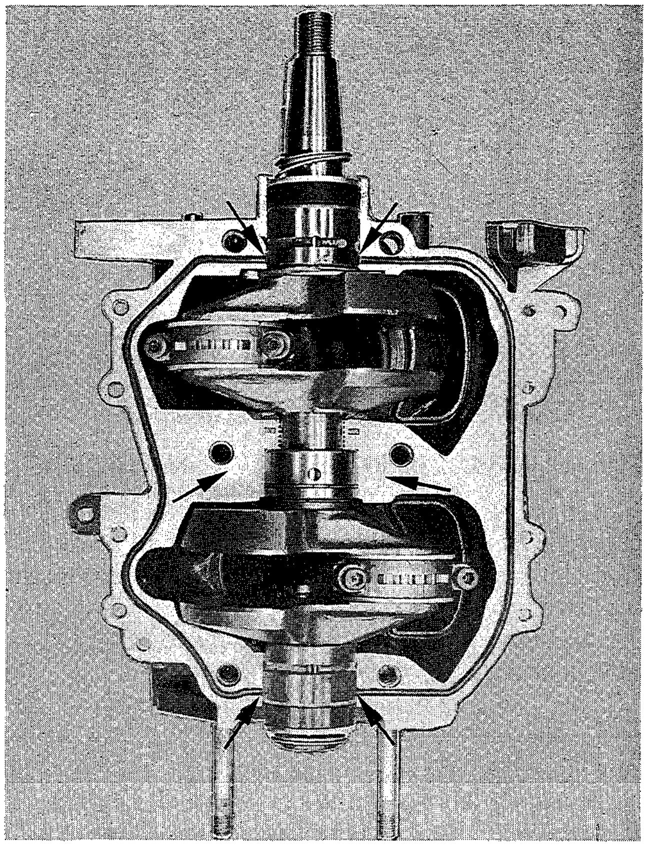


Trimming ends of Seal Strip.

The seal strips, when obtained as service parts come a bit too long for installation "as is"—this is to permit proper installation or adjustment in corresponding grooves. To install — remove all traces of cement on crankcase faces and grooves, if necessary. Apply Sealer 1000 (or similar hard drying cement) at several points along the grooves and particularly at the end of each groove. Place seal strip in position immediately (before the sealer dries) allowing each end to overhang slightly, then, before the sealer sets, guide the entire length of the strip towards outside edge of the groove in each case. Use thumbs of each hand to accomplish as illustrated. Trim ends with knife allowing ends to hang over about 1/16″ to accomplish a good compressed "butt" seal at the end of the strip.

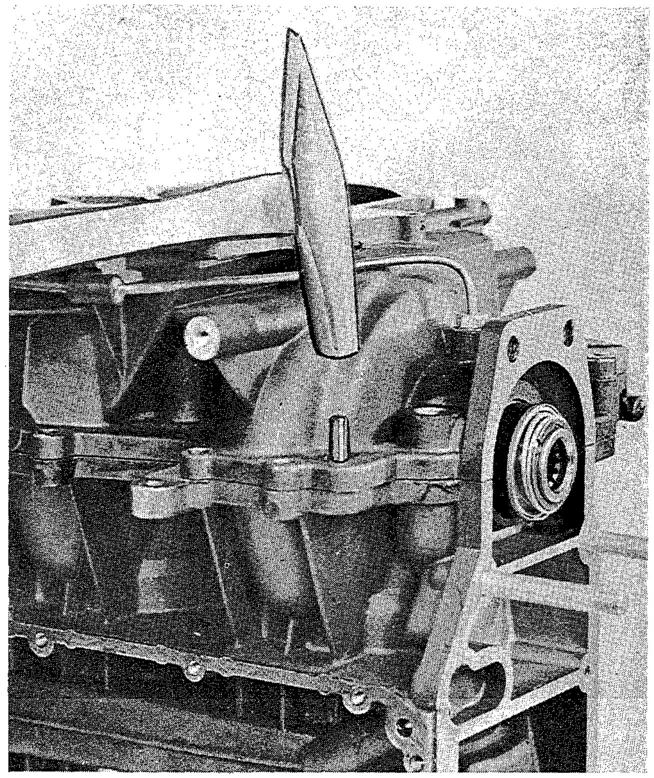
Apply thin coat of Sealer 1000 (or similar hard drying cement) to surfaces to be bolted together—be a bit more generous with sealer in areas at ends of the seal strips to insure a good "butt" seal.

Inspect dowel pins and dowel holes in the crankcase. It is important to remove burrs and traces of old cement, if any exist, to achieve proper alignment of crankcase sections. Make certain dowel pin holes in the crankcase are scrupulously clean with no indication of burrs or nicks on dowel pins.



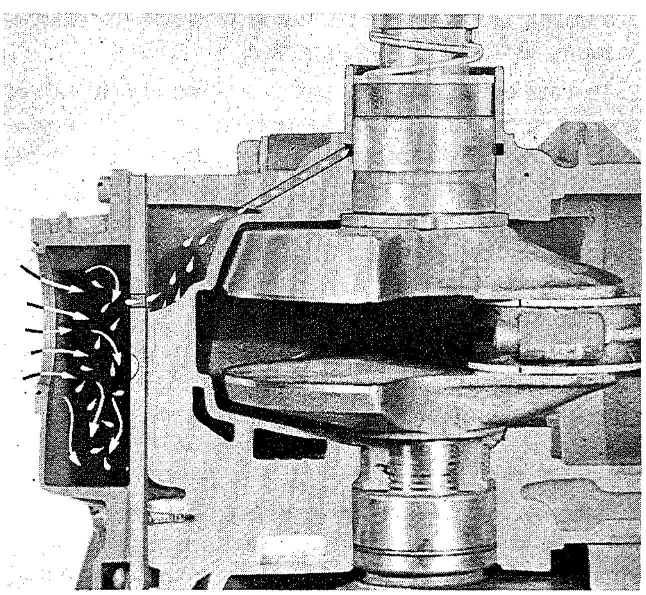
Showing crankshaft seated in upper crankcase and Seal Strip installed.

Replace crankcase section—drive in aligning dowel pins. Replace and tighten the bolts and/or screws. Draw up Allen head screws in manifold area and balance of crankcase screws to 12 to 14 ft. lbs. tension with torque wrench.



Driving tapered dowel aligning pins.

OIL RETURN—UPPER BEARING— "O" RING NO. 303537

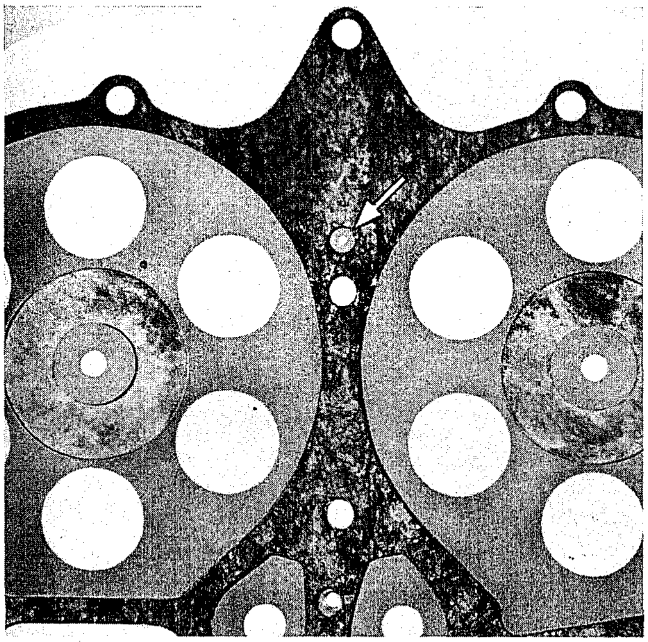


Schematic layout to illustrate oil return.

A change was made recently to provide an oil return from the top journal bearing in the Model RD which eliminated installation of "O" ring seal, #302537.

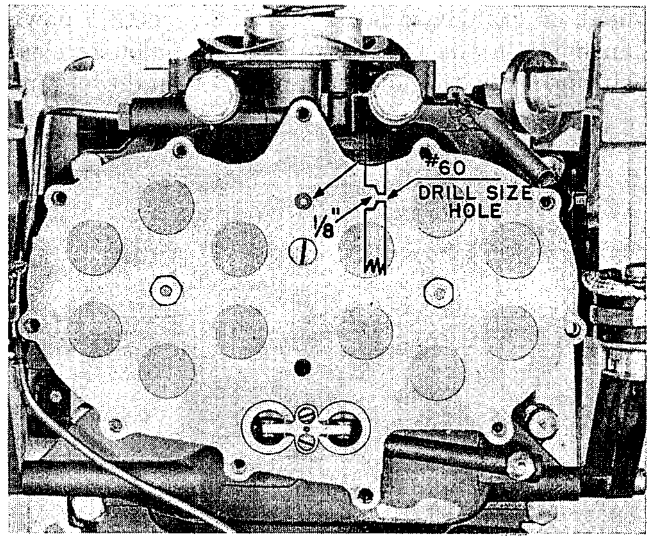
To accomplish, a small hole has been drilled in the crankcase groove formerly employed to locate the "O" ring—in the crankcase half. As may be observed from the illustration, overflow oil seeps into the small pocket back of the valve plate, where a corresponding hole permits its entering the fuel-vapor stream flowing through the manifold and on into the crankcase to complete the circuit.

When receiving and installing a new cylinder assembly during repair, exclude "O" ring #302537 from the assembly. Use gasket #302606 provided with the cylinder as a template laid on back side of the valve plate. It will be noted that all holes in the gasket will align with like holes in the valve plate, except one—indicated by arrow in the illustration. Scribe location of this hole on the valve



Arrow indicates hole to be scribed on the valve plate and later drilled as described here.

plate and drill through the plate with a No. 60 drill. Countersink with 1/8″ drill approximately half way

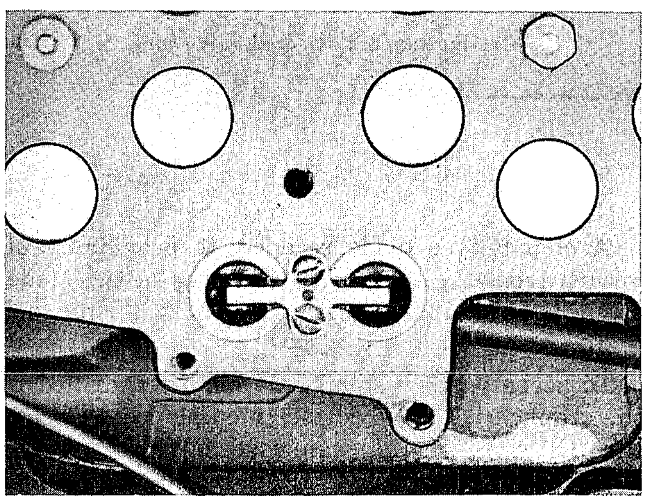


Sectional sketch to illustrate drilling of the valve plate to accommodate oil return.

through as shown in the cross sectional "sketch." Complete assembly thereafter in the customary manner.

The above operation applies only to RD-14, 14A and earlier.

CRANKCASE PRESSURE RELEASE CHECK SPRING NO. 302048



Pressure Check Valves and Spring.

There may be occasion when a falling off in performance of the Model RD (and other models with pressurized tanks) is noted for no apparent reason except that perhaps it might be contributed to fuel supply — not quite enough pressure for maximum performance.

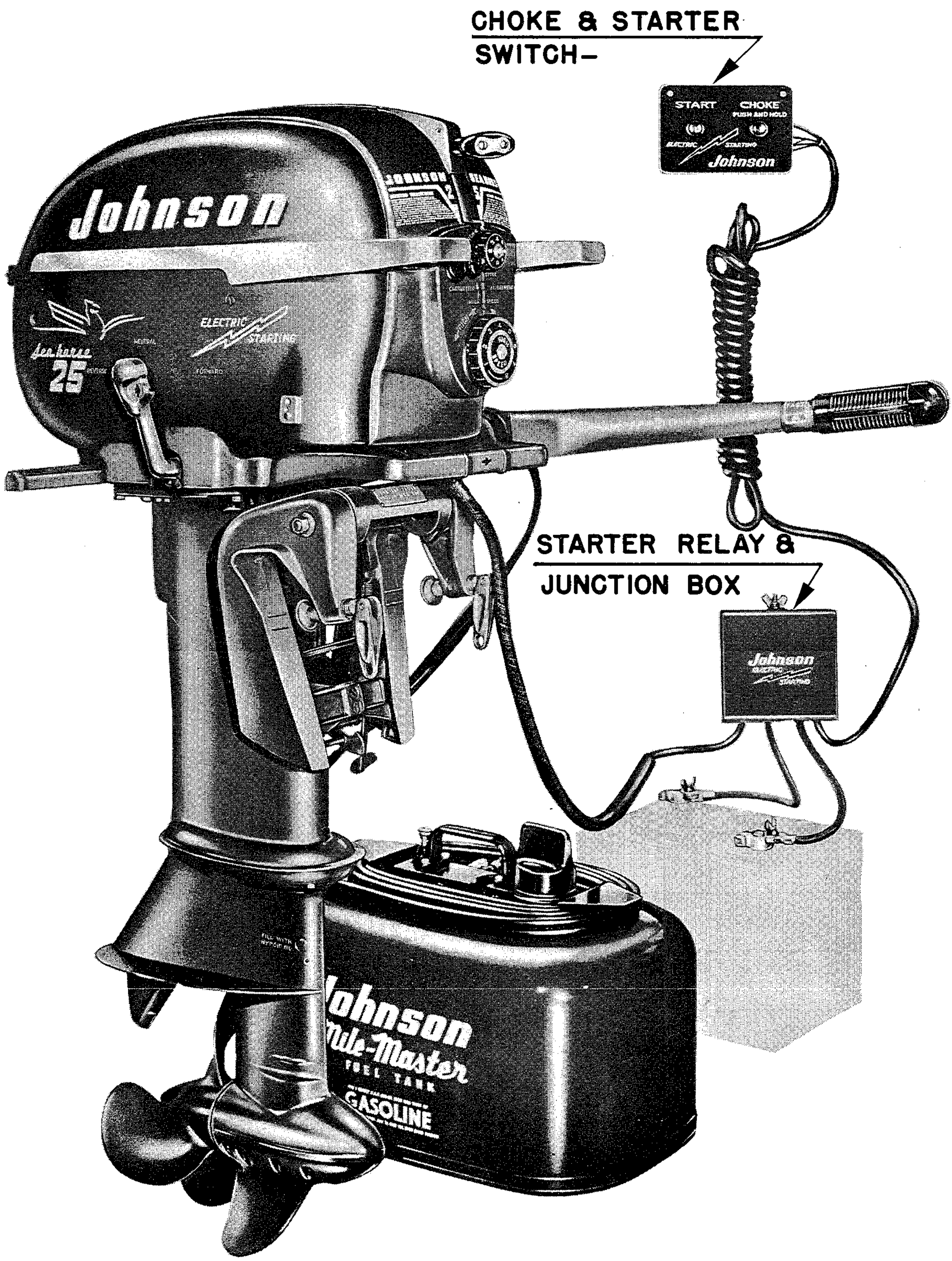
Ordinarily a situation of this sort could be traced to some irregularity in the fuel tank or fuel line assemblies — loss of pressure by way of faulty gaskets, fuel line fittings, punctured diaphragm, discrepancy in assembly, etc. (see Page 92-25 Service Manual) ; however, a temporary exchange of fuel tanks often fails to divulge any appreciable improvement.

Since instances have been reported where removal of the filter element has led to better top speed performance, it is reasonable to assume the fault lies in the pressure "pumping" mechanism, providing the element removed was not excessively clogged with foreign matter.

In this event, look to the pressure check valves and/or spring attached to the valve plate as possible disturbing factors. Any irregularity in seating of the "rubber" checks, insufficient spring tension or otherwise faulty assembly, will interfere with pressurizing of the tank for best performance.

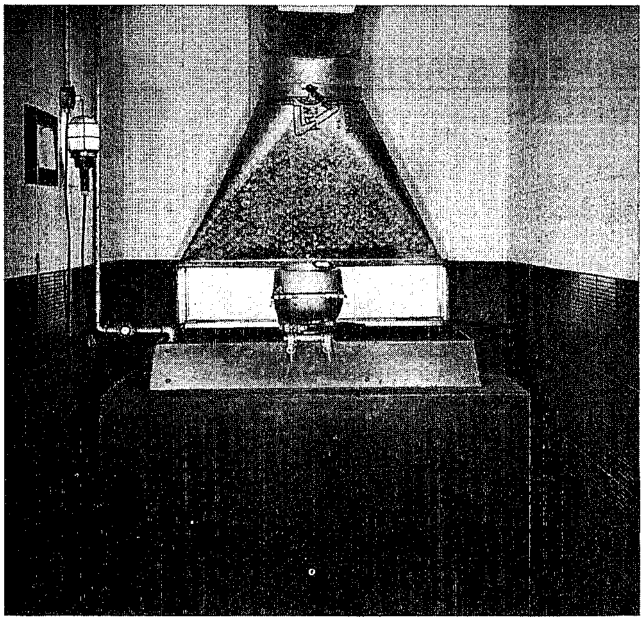
A change has recently been made in tension of spring #302048 — tension increased to exert added pressure on the checks and thus insure more efficient valve action to maintain normal tank pressure — 4 to 5 pounds. The new spring may be identified by its .008″ thickness — the original was .005.″

Keep in mind when diagnosing performance difficulties— install one of the new springs at every opportunity and a new rubber check valve #302042 as a precautionary measure. Make sure assembly is securely mounted.


CHOKE & STARTER SWITCH–
START
CHOKE
PUSH AND HOLD
Johnson
Johnson
ELECTRIC
STARTING
25
STARTER RELAY & JUNCTION BOX
Johnson
Johnson
Mile-Master
FUEL TANK
GASOLINE

Model RDE-16.

TANK TESTING



Showing typical test tank installation with exhaust stack.

Missing, uneven running and/or sluggish operation and the absence of response to throttle (speed) control for no apparent reason are frequently caused by exhaust fumes accumulating in the tank and finding their way on into the motor by way of air stream "rushing" through the carburetor.

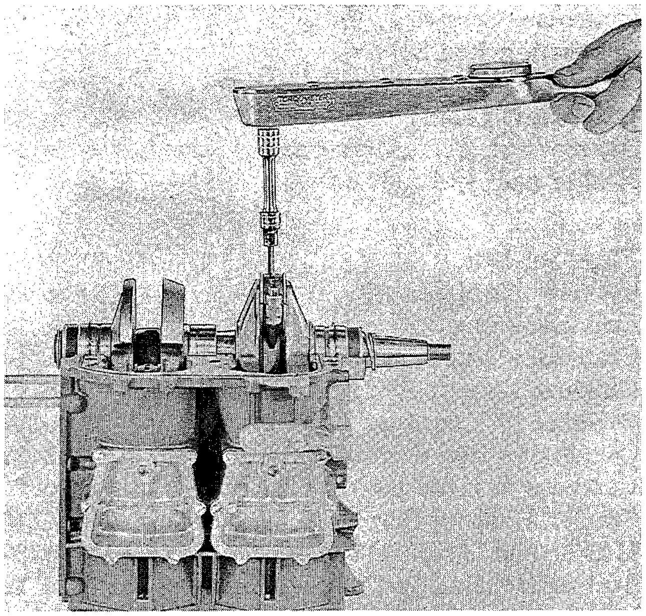
Exhaust, of course, should be "piped" from the tank but that's really not enough — it requires installation of a "fan" or blower in the system to completely rid the tank of detrimental exhaust fumes.

As is generally known, it's impossible to satisfactorily tank test a motor unless provisions have been made for dispelling the exhaust gases (fumes). Air entering the carburetor throat will support just so much. It's either a case of fuel vapor or "spent" exhaust fumes—it can't be a mixture of all three to accomplish good running, much less proper testing after repairs.

Unless the exhaust gases are dispelled from the tank when set up for testing, carburetor adjustment, or simply demonstration, the effort is of little or no avail. Resultant polluted mixture entering the crankcase lacks enough oxygen to upset combustion characteristics of the fuel vapor charge which makes it impossible to correctly set high and slow speed needle settings. Further the piston on its upward stroke displaces so many cubic inches of crankcase volume. Say that (for purpose of illustrating) half of the mixture by volume flowing into the crankcase consists of "spent" exhaust fumes and the remaining half vaporized fuel, ultimate results are easily recognized — no power and irregular running.

NOTES

TORQUE — TENSION TIGHTENING



Removing and/or Installing Connecting Rod Allen Head Screws.

All nuts, bolts and screws are drawn up or tightened by means of torque — a twisting motion exerted by wrench or screw driver, usually relying on the individual's personal judgment as to degree of tightening.

With modern application of advanced design and construction, specific torque tension (tightening) applied to each group of screws, bolts or nuts in the assembly becomes an important factor in the overall job — original assembly and/or repair.

All nuts, screws or bolts cannot be drawn up to the same degree of tightness for several reasons—but mainly because of application, material used in construction, the type of threads, etc. For example, one screw or bolt may be considerably larger than another, yet specified torque tension for tightening may be greater for the smaller diameter screw; it was designed for a definite purpose and all details surrounding its installation have been previously engineered. You know—the old days of "nuts and bolts simply being nuts and bolts" are fast disappearing which suggests a revised technique in handling—"torquing."

Torque is measured in foot pounds ordinarily, but frequently gauged in inch pounds, depending largely on circumstances involved. Just to remind you, one foot pound of torque tension is equal to resultant force of one pound placed one foot from a fulcrum or pivot (if gauged in inch pounds, 12 in. pounds.)

Torque wrenches are available and calibrated accordingly — either in foot or inch pounds as required.

Nothing is gained by drawing up beyond specified torque (tightness) recommended for the particular nut, screw or bolt. Excessive tightness merely results in additional strain — beyond that required to do the job, which only tends toward "stripping" — stretching of material and threads. Naturally torque tension recommended for a steel screw is greater than that specified for one of aluminum even though the former is considerably smaller in diameter. Torque recommendations similarly vary with application. A steel screw for aluminum application generally cannot be "torqued" as high as the same screw set up for steel installation dependent on length of screw engagement, thread pitch and other factors. Actually screws or nuts drawn up beyond the yield point of material and/or threads "weakens" the installation to result in eventual looseness.

OVERHEATING

Overheating naturally is result of some failure or discrepancy in the water-circulating system; in some instances, mounting of the motor on a boat transom too high for the specific model. For Johnson, the recommended transom height is 15″, for the L (long models) 5″ higher to insure ample water supply for satisfactory cooling.

Component parts of the pump assembly must, of course, be in "fit" condition: water tubes (where employed) should be made secure to guard against "seepage"; gasket and gasket faces in the circulating system must be in good condition and water tight; grommets, where used, must be properly installed—not allowed to "crimp" over the end of the water tube to restrict volume of water to the cooling system. Situations of this sort are easily overlooked. Be on the lookout and alert for any irregularities apt to interfere with "free" passage of water for cooling.

Of extreme importance, but frequently overlooked, is condition of the cylinder head gasket. The least amount of compression "seepage" into the **cylinder water jacket** is enough to build up sufficient pressure (in the cooling system) to retard or stop water circulation; inevitable result is **overheating** and eventually, complete "blowing" of the gasket. "Good" compression when cranking does not necessarily indicate a good or tight gasket mount; seepage may still exist between gasket faces. When in doubt, install a new cylinder head gasket; draw head screws up to recommended torque tensions as follows:

RECOMMENDED TORQUE (TENSION) TIGHTENING FOR THE FOLLOWING

JW

	Foot-Pounds
Flywheel Nut	40 to 45
Cylinder Head Screws	5 to 7
Crankcase Screws	5 to 7
Connecting Rod Screws (As needed)	5 to 8
Exhaust Housing to Cylinder Screws	5 to 7
Gearcase to Driveshaft Casing	5 to 7
Muffler Screws	2 to 3

CD

Flywheel Nut	40 to 45
Cylinder Head Screws	5 to 7
Crankcase Screws	5 to 7
Connecting Rod Screws	5 to 8
Exhaust Housing to Cylinder Screws	5 to 7
Gearcase to Driveshaft Casing	5 to 7
Muffler Screws	2 to 3

QD

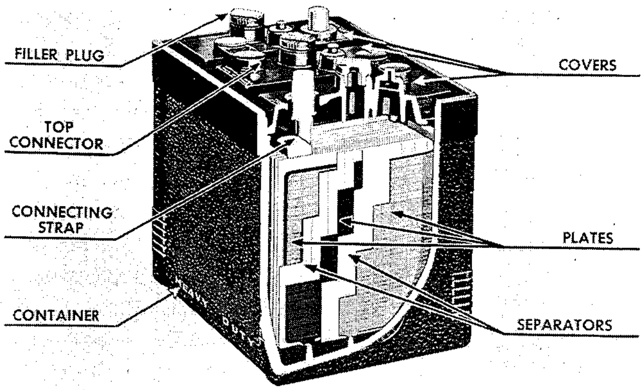
Flywheel Nut	40 to 45
Starter Housing Screws	5 to 7
Cylinder Head Screws	8 to 10
Crankcase Nuts	10 to 12
Crankcase Screws	5 to 7
Connecting Rod Screws	15 to 17
Exhaust Tube to Cylinder Screws	5 to 7
Driveshaft Casing to Cylinder Nuts	10 to 12
Gearcase to Driveshaft Casing Screws	8 to 10
Muffler and By-Pass Screws	2 to 3

RD

Flywheel Nut	60 to 65
Cylinder Head Screws	18 to 20
Crankcase Screws	12 to 14
Crankcase Nuts	12 to 14
Exhaust Tube to Cylinder Screws	5 to 7
Cylinder to Mounting Bracket Nuts	10 to 12
Connecting Rod Screws	15 to 17
Gearcase to Exhaust Tube Screws	5 to 7
Starter Housing Screws	8 to 10
Muffler and By-Pass Screws	2 to 3
Starter Housing to Cylinder Screws	8 to 10

NOTES

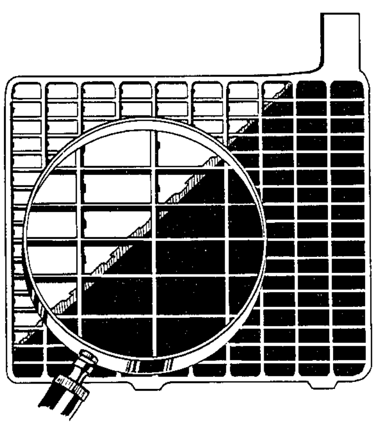
STORAGE BATTERY



Courtesy Willard Storage Battery Co., Cleveland, Ohio

Showing construction details of the Battery.

The storage battery as we know it is classified as a secondary chemical generator — an electrical current temporarily produced by chemical action on two dissimilar materials when submerged in an acid solution (electrolyte) but capable of being "revitalized" by reversal of current through it from an outside source.



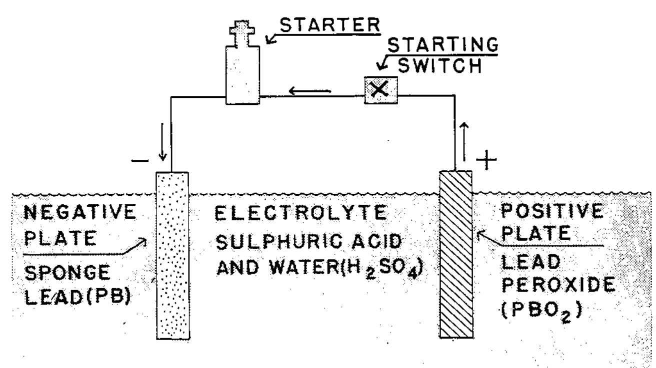
Positive plate with part of active material removed to show grid structure.

Its construction basically consists of a series of "skeletons" or grids composed of an alloy of lead and antimony on which are pressed and treated, masses of lead oxide—after initial charging, sponge lead (gray) for the negative plate and lead peroxide (brown) for the positive plate. Several of each are grouped and placed in a cell of hard rubber—number of positive plates determined by capacity specified for the particular assembly with one additional negative plate. The plates in assembly are alternated — negative, positive, negative, positive, negative, etc., and separated with sheets of corrugated wood or of special rubber construction. All positive plates are "bridged" to a common connector with a strap of lead across projections provided for this purpose — the negative plates are similarly "bridged" together and the entire assembly installed and sealed in a rubber container. This is followed by assembling three like assemblies in a "Master" rubber case—connected in series (positive to negative), sealed and finally filled with an electrolyte (sulphuric acid and water) to make up a 6-volt chemical generator (battery), after "charging" from an outside source. Six cells are employed in the assembly of a 12-volt battery.

Voltage (pressure) is predetermined by potential difference naturally existing between the chemical composition of sponge lead (negative) and peroxide of lead (positive) — established in average storage battery assembly at about 2.1 volts (per cell). Voltage is multiplied by the number of connecting individual cells in series (positive to negative) — thus 3 cells = 6 plus volts.

Amperage (rate of electrical current flow or quantity) is determined by battery plate area—size of plates and number included in the assembly —and nature of acid condition acting upon them.

Electrolyte (solution acting upon the battery plates) is "balanced" at a specific gravity of 1.260 or 1.280 as specified by the battery manufacturer —a mixture of water and sulphuric acid. Density or weight of water is established as 1.000; sulphuric acid for battery use, 1.400—meaning that the weight or density of the sulphuric acid is 1.4 times that of an equal volume of water. Or, in practice,



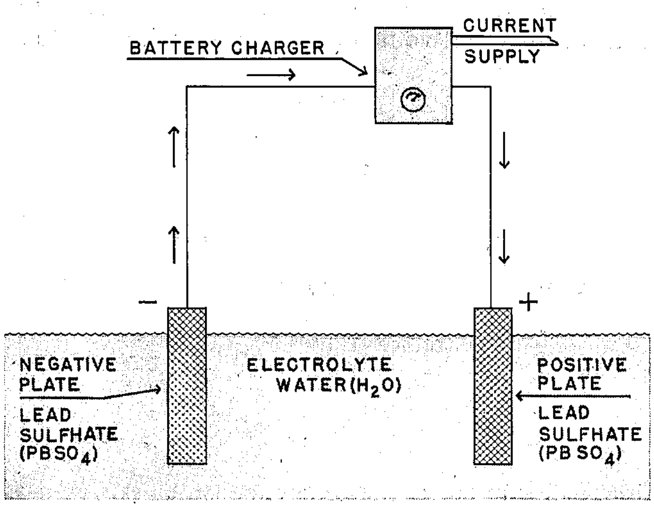
Schematic drawing to illustrate condition of battery in a fully charged state and showing current flow on discharge.

1. *Negative plate*—Sponge lead (PB) changing to lead sulfate ($PBSO_4$).
2. *Positive plate*—Lead peroxide (PBO_2) changing to lead sulfate ($PBSO_4$). O_2 uniting with liberated hydrogen (during process) to form water (H_2O).
3. *Electrolyte*—The sulfate of sulfuric acid unites with active material on plates leaving weaker acid solution — hydrogen of acid and oxygen of lead peroxide (positive plate) combine to form water, thus diluting the solution.

the density of a correctly prepared electrolyte is either 1.26 or 1.28 times the weight or density of water — as observed from floating a hydrometer "bulb" in a quantity of the solution.

On discharge of the battery as when electrically starting the RDE, current flows to turn the starting motor because of chemical action of the electrolyte acting on the positive (red) and negative (gray) plates. During this process, the SO_4 of the electrolyte (H_2SO_4) unites with the PB (lead) element of the negative plates, also with the PB (lead) element of the positive plate (PBO_2) to form lead sulphate ($PBSO_4$) on the baces of both. The O_2 of the positive plate (PBO_2) unites with hydrogen liberated during the procedure of discharging to form water (H_2O). In a sense, when lead sulphate accumulates on both plates to the extent that further acid penetration or contact with the lead and lead peroxide of either plate can no longer be maintained, the battery is said to be discharged—dead. Obviously, there are various interim stages or degrees of discharge to be considered.

Recharging—the restoration of normal battery activity as a chemical generator is accomplished by causing a specified current from an outside source to flow through it but in opposite direction (charging) — positive lead of the charging unit attached to positive post of the battery with negative lead to the negative post. Accepted practice is to start "charge" at approximately 7.4 volts and at the rate of one ampere per each positive plate in the battery. Example: a 15-plate battery contains 7 positive plates (8 negatives) — suggested charging rate, therefore, is 7 amperes.



Schematic drawing to illustrate condition of battery in a fully (theoretically) discharged state and showing current flow on charge.

1. *Negative plate* — Lead sulfate changes to sponge lead. Sulfate returns to electrolyte.
2. *Positive plate* — Lead sulfate changes to lead peroxide. Sulfate returns to electrolyte.
3. *Electrolyte*—Very dilute, made stronger by return of sulfate from the plates.

The function or purpose of recharging basically is to restore original battery consistency—convert the positive plates from lead sulphate ($PBSO_4$) to peroxide of lead (PBO_2), the negative plates from lead sulphate to sponge lead (PB) and to restore specific gravity of the electrolyte (H_2SO_4).

During the process of charging: (1) water (in the electrolyte) is "split" by electrolysis into hydrogen and oxygen gas — the components of its structure (H_2O); (2) the PB radical "leaves" the lead sulphate ($PBSO_4$) having accumulated on the surface of both the positive and negative plates and unites with liberated hydrogen to form sulphuric acid (H_2SO_4); (3) the liberated oxygen unites with the PB of the positive plate to form peroxide of lead (PBO_2); (4) the SO_4 having been liberated from the sulphated negative plate ($PBSO_4$), returns to the electrolyte as explained and leaving it sponge lead (PB). Thus, original state of the battery has been restored — sponge lead (negative plates), peroxide of lead (positive plates) and the electrolyte restored to specific gravity of 1.260 or 1.280 as the case may be.

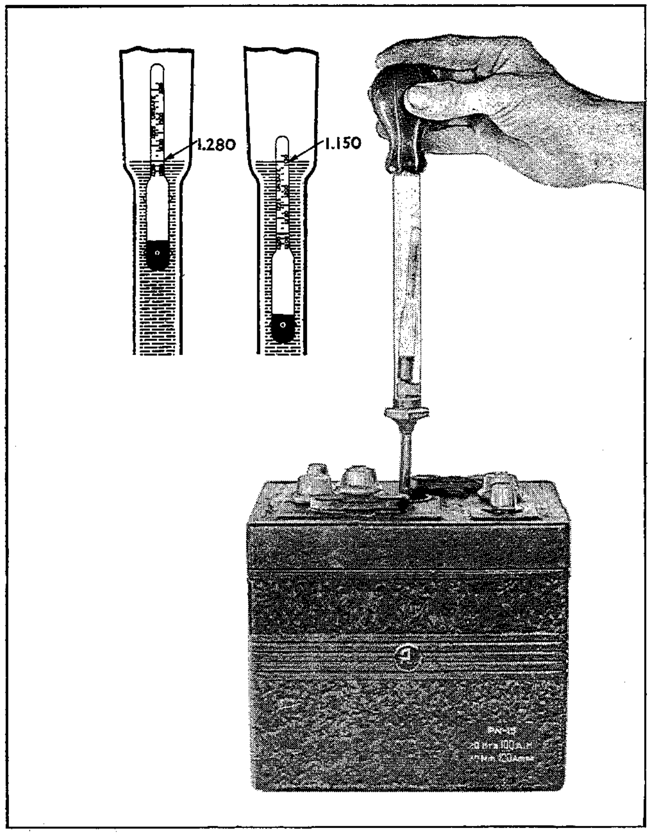
When charging the battery, it is advisable to follow instructions in this respect as provided by the battery manufacturers or builder of the charging unit.

Facts about storage batteries

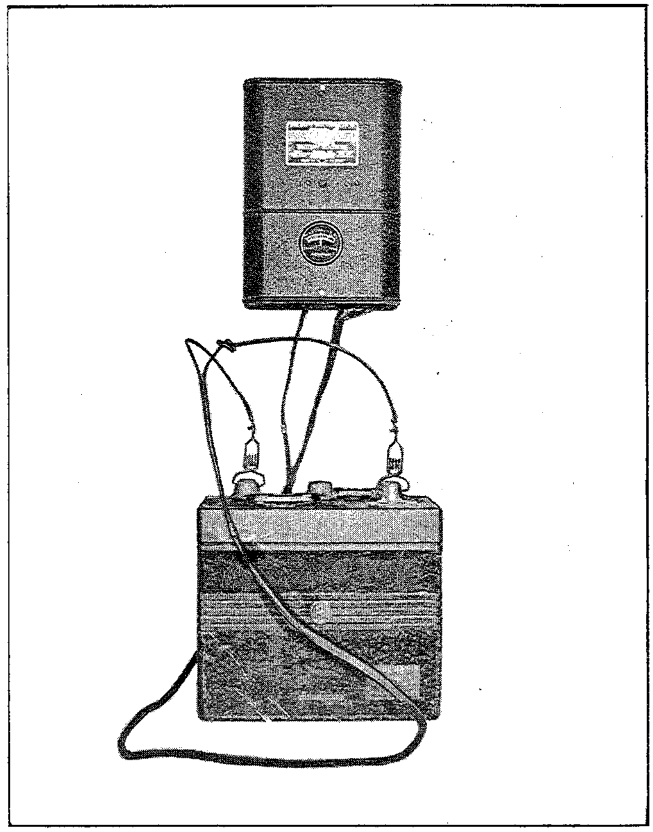
1. Battery liquid level should be retained at approximately 3/8" above top edge of cell plates to avoid damage caused by exposure and to retain originally specified ratio of sulphuric acid and water in the electrolyte—1.260 or 1.280 specific gravity. Add water (distilled) if necessary but never acid to obtain desired liquid level. In event of accidentally "spilled" battery solution, seek assistance of the local battery dealer or distributor to restore normal acid-water balance.

2. Specific gravity (hydrometer) reading will be in error—low—if taken immediately after adding water. Proceed with charging for an hour or so to achieve thorough "circulation" through battery solution prior to attempting hydrometer reading.

3. Specific gravity readings vary with existing temperature of the battery solution (electrolyte); when relatively high, gravity reading will indicate "low" on the hydrometer scale due to proportionate **expansion** of the liquid and conversely, "high" with falling temperature as result of contraction or shrinkage—a denser concentration. Accepted practice, therefore, is to correct "taken" specific gravity readings to 80° F. (battery solution)—correction factor being .004 (4 points) specific gravity for each 10° F. above or below established 80° F. added to or subtracted from the "taken" reading as the case may be.



"Taking" specific gravity reading of the battery solution (electrolyte) to determine state of charge.



Charging storage battery with one of the chargers available for the purpose

EXAMPLE "A"

Hydrometer Reading	1.255	
Battery Solution Temperature		100° F.
Correction—Add	.008	
Corrected Specific Gravity is	1.263	

EXAMPLE "B"

Hydrometer Reading	1.260	
Battery Solution Temperature		70° F.
Correction—Subtract	.004	
Corrected Specific Gravity is	1.256	

Battery solution density (specific gravity) should not be permitted to fall below 1.220 (corrected to 80°F.) when idle, as in storage, to avoid the harmful effects of excessive cell plate sulphation but placed on "charge" before reaching low state of discharge.

4. Original specific gravity (electrolyte) specifications vary under certain conditions as follows and as established by the battery manufacturers—

	Specific Gravity		Voltage Readings per Cell 1.260 Gravity	Voltage Readings per Cell 1.280 Gravity
*Fully Charged	1.260	1.280	2.10	2.12
¾ "	1.220	1.250	2.08	2.10
½ "	1.170	1.200	2.05	2.07
¼ "	1.120	1.150	2.02	2.04
Discharged	1.070	1.100	1.98	2.00

*Current trend in battery construction is to deviate from the familiar 1.280 specific gravity (battery solution) in favor of a 1.260 gravity specification for the better quality batteries. Batteries filled with 1.260 solution are identified as such by embossing on the cell connectors. "Plain" connectors indicate a 1.280 solution filled battery.

5. A fully charged battery is known to withstand temperatures as low as -90° F.; a dead battery will freeze at about +19° F. and perhaps cause bursting of both the cell and battery cases.

Specific Gravity (Corrected to 80°F.)	Freeze at
1.280	-90° F.
1.250	-60° F.
1.200	-16° F.
1.150	+ 5° F.
1.100	+19° F.

6. It's characteristic of lead plate batteries to "self discharge" (run-down) during periods of idleness, thus requiring periodic charging. During process of charging, a slight amount of antimony dissolves from the positive plate grids which deposits on the sponge lead of the negative plates where it sets up a localized chemical action, thus, slowly discharging the negative plates. Further, the presence of other impurities or foreign matter in minor quantities may also create a like effect. The degree of self discharge is in direct relation to existing atmospheric temperature; relatively fast where high temperatures are involved—progressively slower with falling temperature as will be noted from the following chart, revealing approximate safe lapse time between charging at temperatures given.

Temperature at	Approx. number of days safe lapse time between charging
100° F.	17 days
80° F.	42 days
70° F.	56 days
60° F.	70 days
44° F.	140 days
31° F.	180 days (6 mos.)

Be guided by above time lapse table to avoid the harmful effects caused by permitting the battery to remain idle for long when in a discharged state.

7. Hydrometer readings of the solution in each cell should be taken every 30 days throughout the life of the battery whether in use or not (storage). An open circuit voltmeter may be used to test the condition of each cell with a fully recharged battery; it should indicate 2.10 volts per cell.

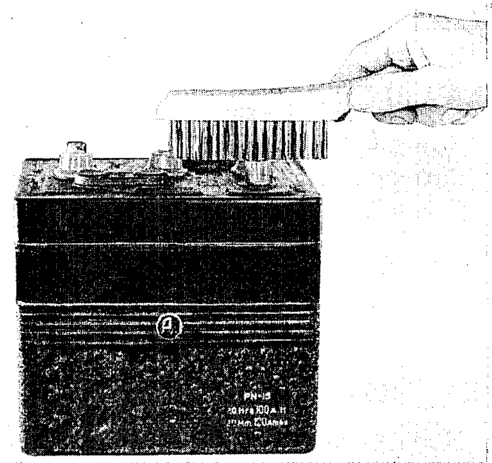
The battery should be placed on charge when the specific gravity (hydrometer) reading falls to 1.220. Note—do not attempt hydrometer reading immediately after adding water but proceed with charging for an hour or two to permit ample time for circulation throughout electrolyte solution. If an open circuit voltmeter is used the battery should be recharged when the voltage of each cell falls to 2.07 volts or less.

8. Avoid over-charging — over-charging causes excessive "gassing," harmfully high battery solution temperature, "mushing" or shedding of the lead peroxide active material on the cell plates and damage to the supporting grids, which eventually contributes to battery failure. Charge only until specific gravity of the electrolyte has been restored to either 1.260 or 1.280 as specified for the particular unit or, up to a point where three consecutive hydrometer readings taken hourly fail to reveal further rise or increase.

Hydrogen (gas) liberated from the battery cells on charge and to a considerably lesser degree when idle (off charge) is explosive and dangerous—keep open flame, sparks, etc. (cigarettes, cigars, pipes, electrical appliances) at prudent distance. Arrange for ample circulation of air about the batteries in storage—if in a room, it is essential that vents are provided for sufficient circulation to guard against mishap.

9. In event the battery is to be removed from the boat and "stored," it should be placed in a room where average temperature is not apt to fall below 32° F. or above 80° F., but preferably stored in the lower temperature bracket (cold). Batteries in storage should never be placed near steam pipes, boilers or other heating devices, on cement floors nor exposed to the direct rays of sunlight.

However, for those with the facilities and who may prefer not disturbing the battery installation, it is perfectly all right to arrange for "outside" storage (boat and motor) subject to normal winter temperatures, but providing the battery is fully charged and maintained in a fully or nearly full state of charge by periodic charging. Rate of self discharge is exceedingly slow in the lower temperature range. See chart.

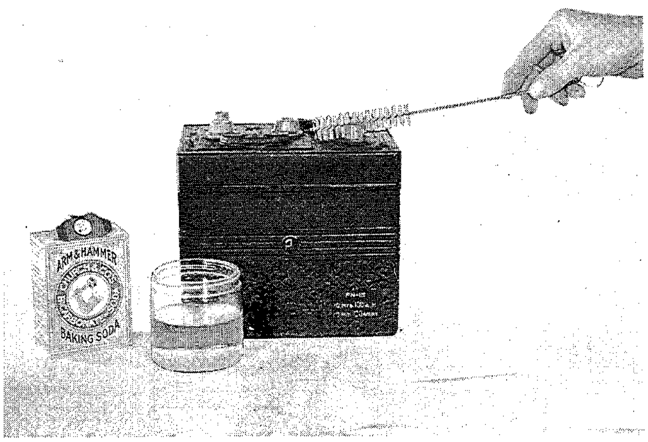


Removing evidence of corrosion from battery posts and connectors with wire brush.

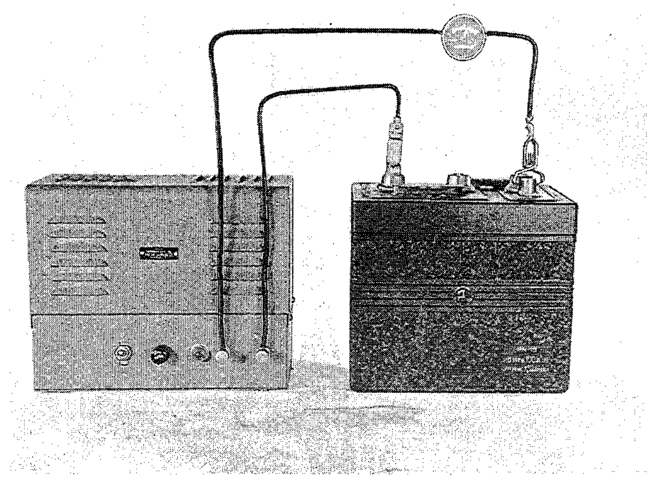
Corrosion, the "whitish" yellow substance often observed accumulating on the battery posts and connectors, is destructive and should be removed as it will damage the cable terminals, causing loose connections.

Remove evidence of corrosion from the battery posts and/or connectors by "swabbing or scrubbing" with a solution of household baking soda and water (mixed to ratio of about one tablespoon of baking soda to a quart of water). Scrub with stiff bristle brush if necessary, then smear "cleaned" surfaces with vaseline to prevent further corrosion. Be sure cell covers are in place when using the soda solution to avoid possibility of "spilling" into the battery electrolyte. Do not "slop" the soda solution around during this procedure. Finally, rinse off with fresh water.

When replacing the battery — come spring — make sure it is fully charged, all terminal connections made clean and on "connecting," apply a coat of vaseline to exposed areas of the battery posts and clamp connectors to avoid or at least retard accumulation of sulphation.

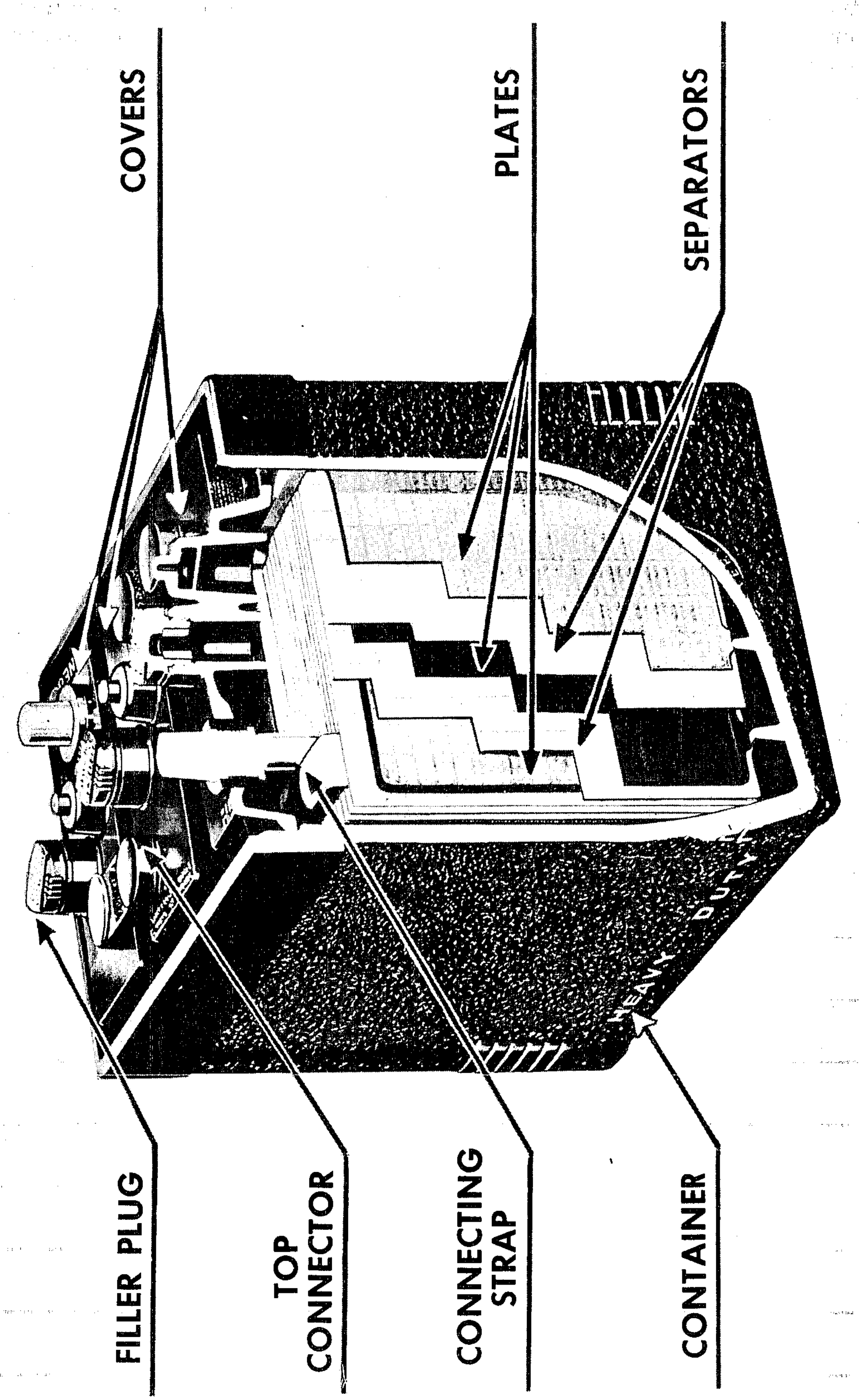


Swabbing battery posts and connectors with a solution of household baking soda and water to neutralize possible acid condition existing in the area. Rinse later with fresh water. Be careful not to "spill" soda solution into battery cells.



The Stevens Power Unit may be used in an emergency as a "slow" charger as illustrated here.

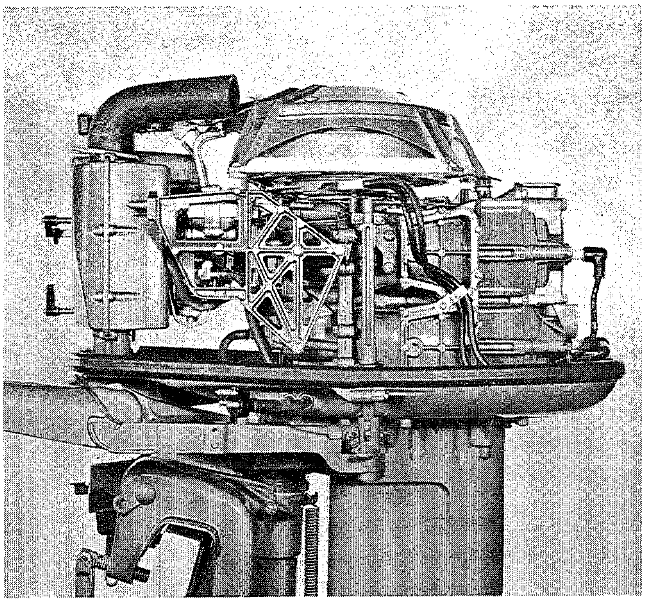
NOTES



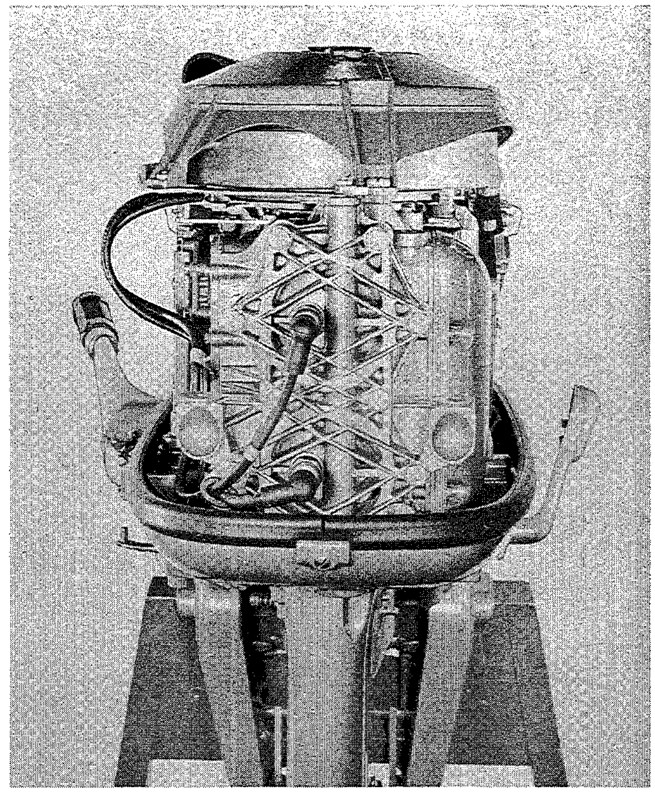
Courtesy Willard Storage Battery Co., Cleveland, Ohio

Showing construction details of the Battery.

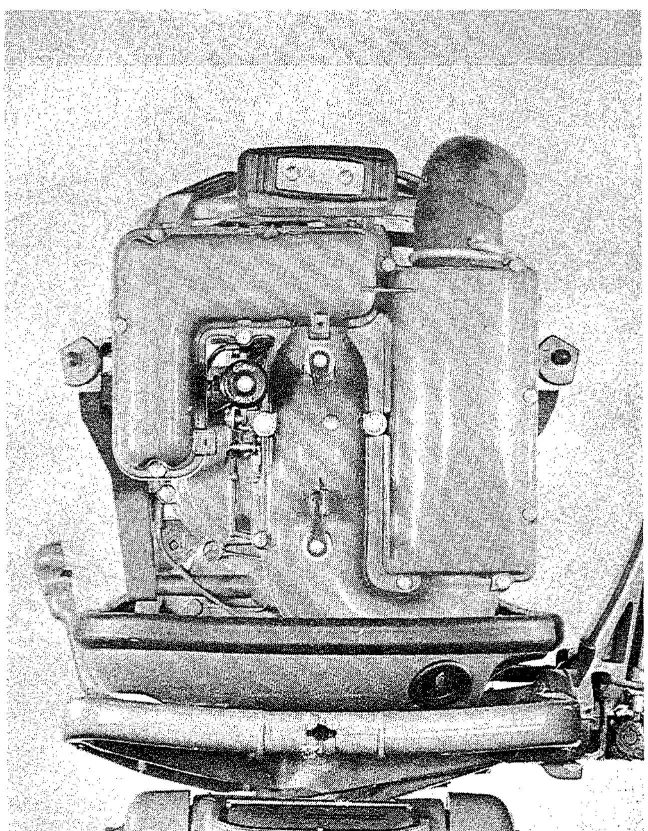
MODEL RD-17 POWERHEAD



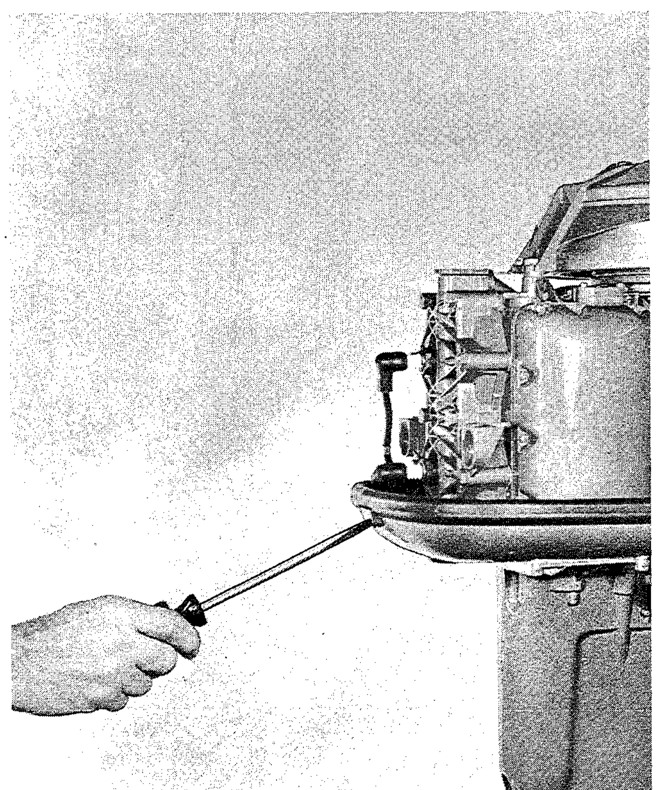
Since construction details of the RD-17 powerhead are fundamentally like those of the preceding models, the several service operations are to be performed in like manner. Refer to pages 164-21 to 164-30, inclusive and pages 164-53 through 164-64.



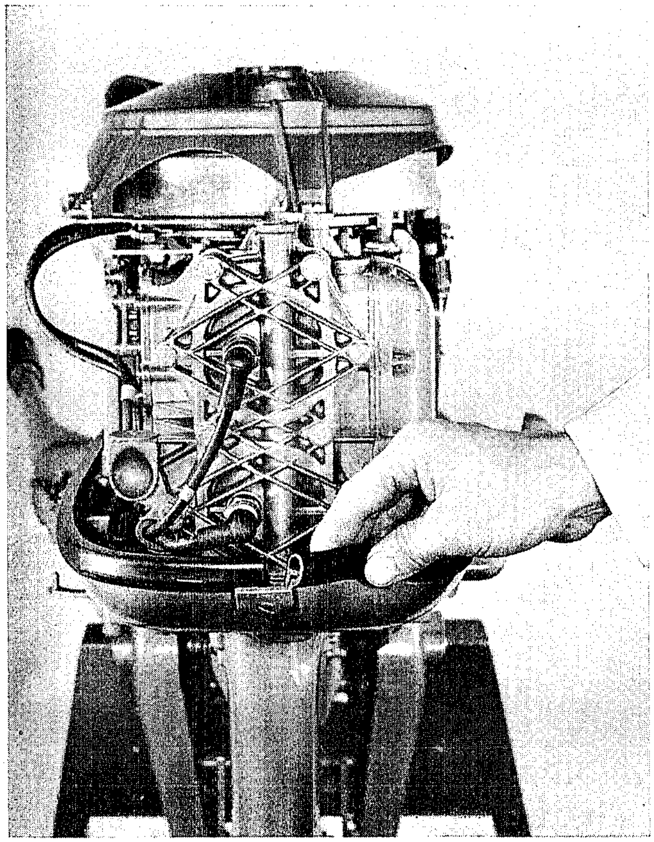
Rear view of powerhead showing installation of the motor cover pan grommet.



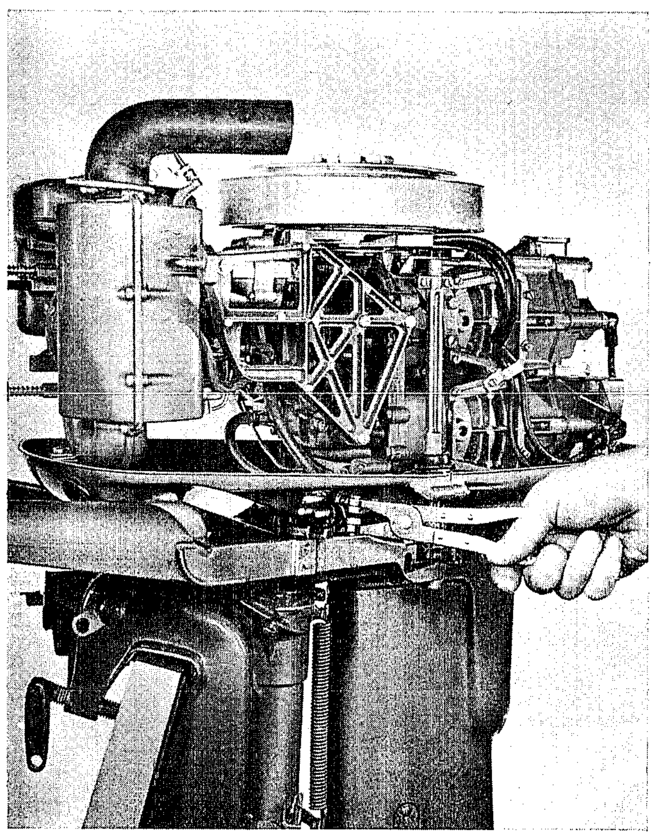
Front view of powerhead showing installation of the carburetor silencer.



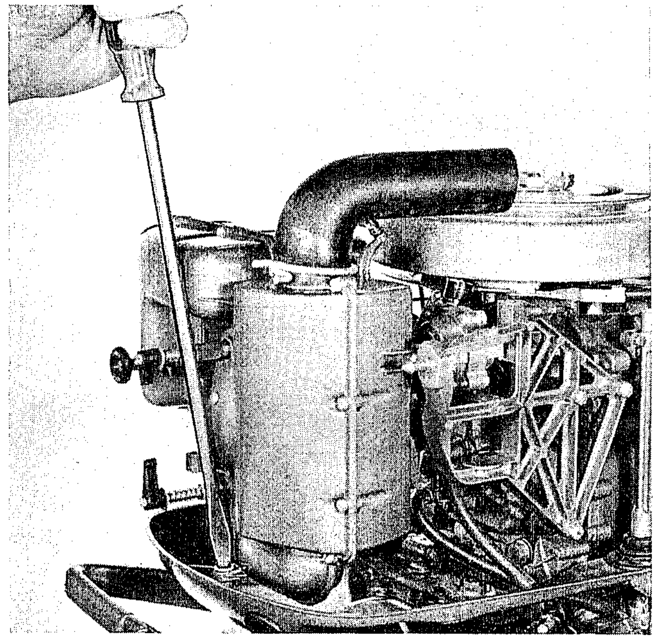
Releasing rubber grommet from the motor cover pan.



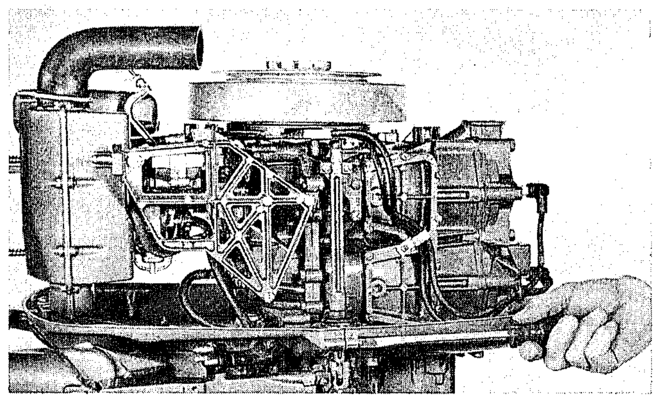
Removing and/or installing the motor pan grommet — to facilitate ease of installation, simply coat edges of the pan lightly with oil or liquid soap.



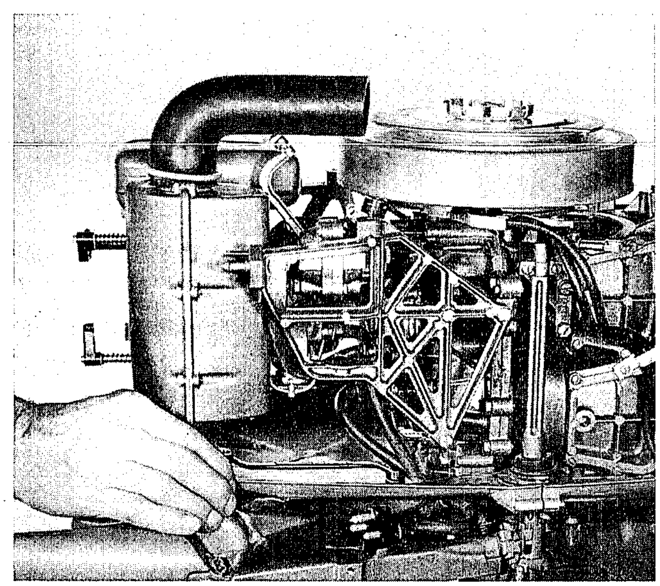
Detaching fuel and air pressure lines from the fuel connector to permit removing front section of the motor pan.



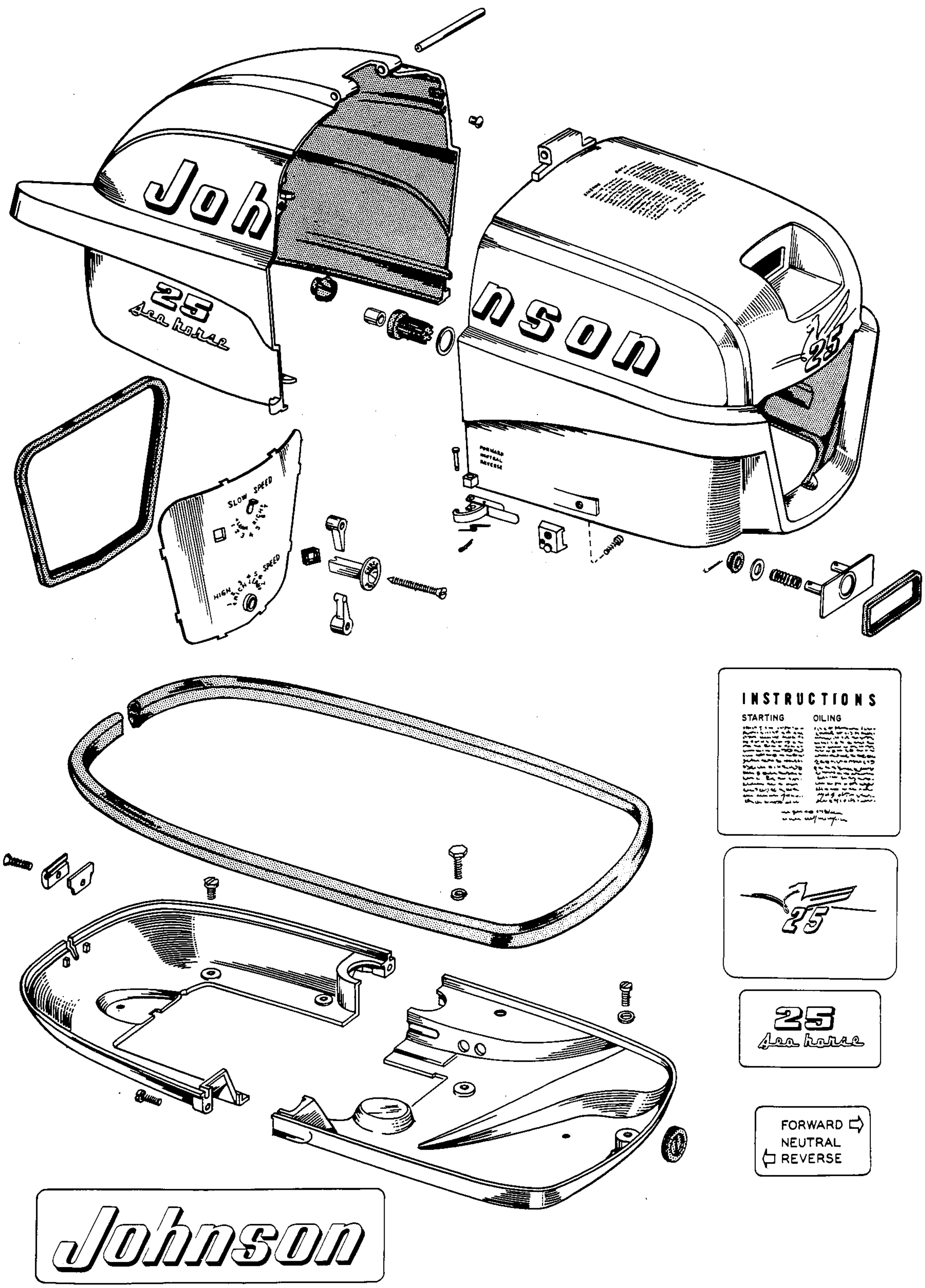
Releasing carburetor silencer from front section of the motor pan.



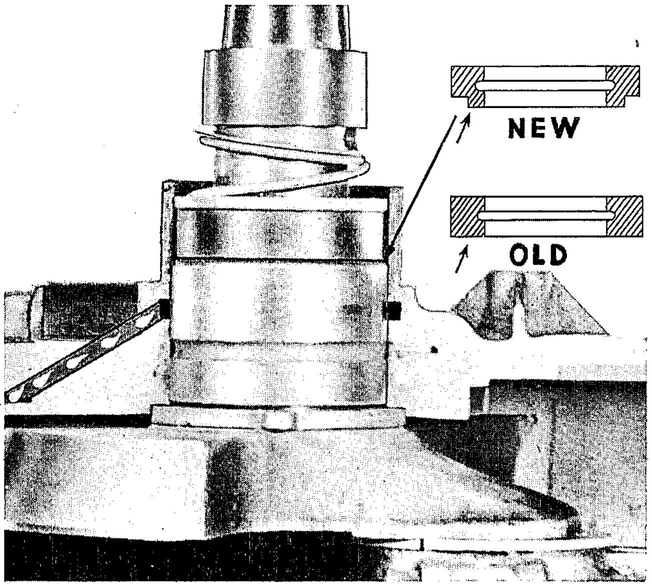
Releasing front section of the motor pan from the rear section.



To finally detach the front motor pan section, remove screw shown above to free it of the lower unit assembly.



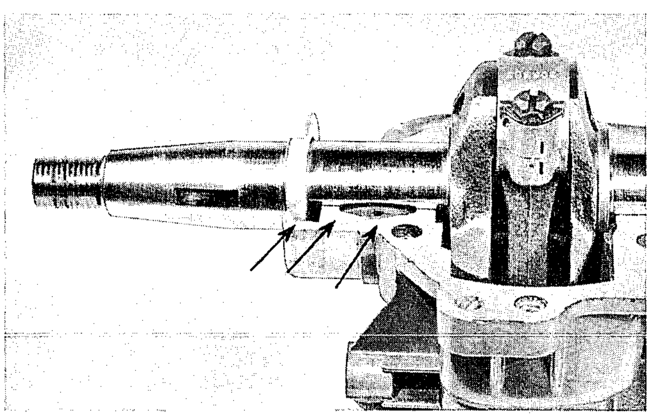
Motor cover, pan, grommet and carburetor panel assembly group.



#302538 carbon seal for the top end of the Model RD crankshaft has been changed some in design—this to facilitate a better oil seal at the top face of bearing #375763, the purpose of which is to minimize possibility oil laden crankcase vapor escaping and eventually accumulating on the breaker point contact faces to interfere with magneto performance.

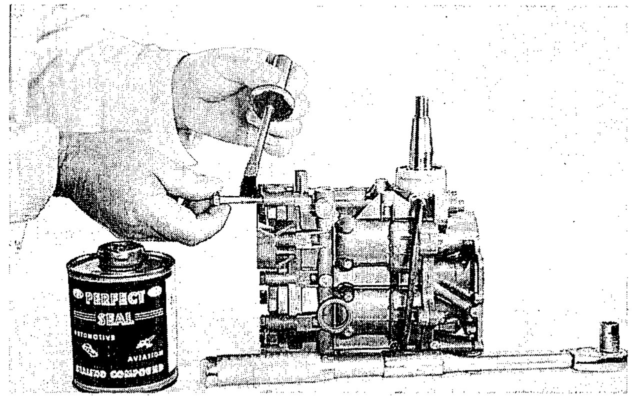
Above change has consisted of machining a narrow face on the lower side of the seal where it "rides" on the top face of the bearing; the original seal was cut "straight across" to leave a much wider seal face, which doesn't "seal" as well as the narrower face.

IMPORTANT—It is important that WHENEVER THE FLYWHEEL is removed or on other occasions when presented, the old seal (if installed) be removed and one of the new design be installed as a safeguard against "oily" points and resultant faulty motor operation. Install with notches UP. Install also a NEW #302540 "O" ring.



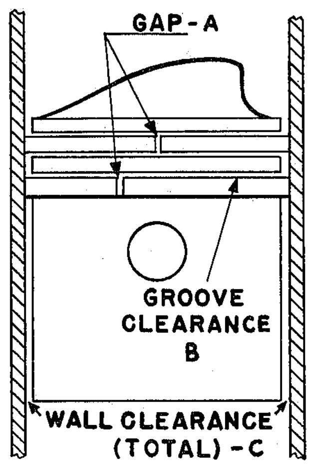
Function of the oil slinger (where installed) as attached to the crankshaft (shown here) is to prevent oil escaping from upper journal bearing "spewing" over the armature plate—escaping oil is subsequently returned to the crankcase by way of the intake manifold with following incoming vapor charges.

It is possible, however, for oil to find its way to top face of the armature plate in event "matched" surfaces of the crankcase and cylinder block in the area are not properly cemented on assembly. When installing the crankcase after motor repair or to overcome oil seepage in this respect, make certain regions indicated by arrows (both sides of the crankshaft) are well cemented with sealer 1000 or other similar hard drying cement — avoid an over abundance of cement which is apt to "clog" the oil return channel as it "squeezes" out when drawing up on the crankcase screws, but at the same time, assuring an "oil tight" assembly. Oil "spewing" over the armature plate contributes to early breaker point failure—keep the armature plate free of oil.



Spread thin coat of non-drying cement — Perfect Seal #4 (Factory #301719) or similar—on all threads prior to assembly particularly in salt water areas to avoid corrosive effects, stripped threads, broken studs, etc., on subsequent disassembly.

PISTON AND RING FITTING



Factors contributing to good motor performance are concerned a great deal with properly fitted pistons and piston rings, and of course, round bores among other details — but the pistons and piston rings must be correctly fitted with just the right amount of clearance or "leeway" to compensate for various degrees of expansion as result of operating temperatures encountered, as follows:

	HD	JW	TD
A.	.004 - .0014	.005 - .015	.005 - .015
B.	.001 - .0035	.001 - .0035	.001 - .0035
C.	.0010 - .0025	.0013 - .002	.0010 - .0025

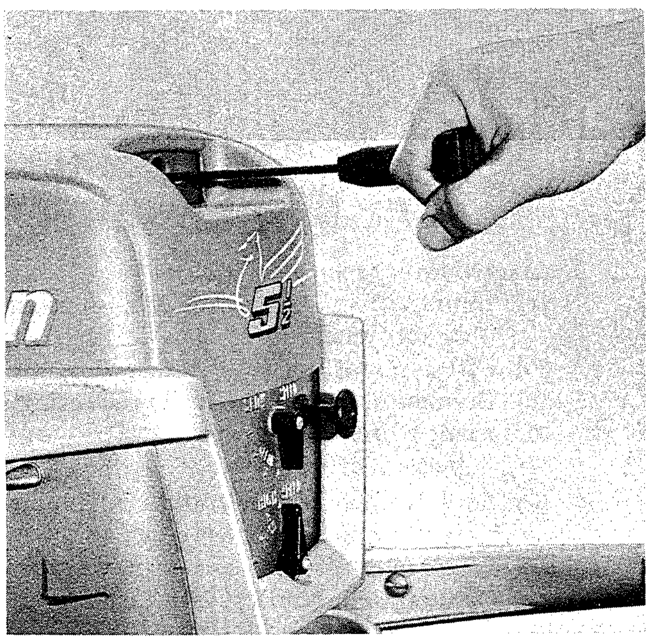
	TN	CD	QD
A.	.005 - .015	.005 - .015	.007 - .017
B.	.001 - .0035	.001 - .0035	.001 - .0035
C.	.0010 - .0025	.0013 - .0025	.002 - .0035

	SD	PO	RD
A.	.007 - .0017	.005 - .012	.007 - .017
B.	.001 - .0035	.0025 - .0045	.0045 - .007
C.	.002 - .0035	.005 - .0065	.0025 - .004

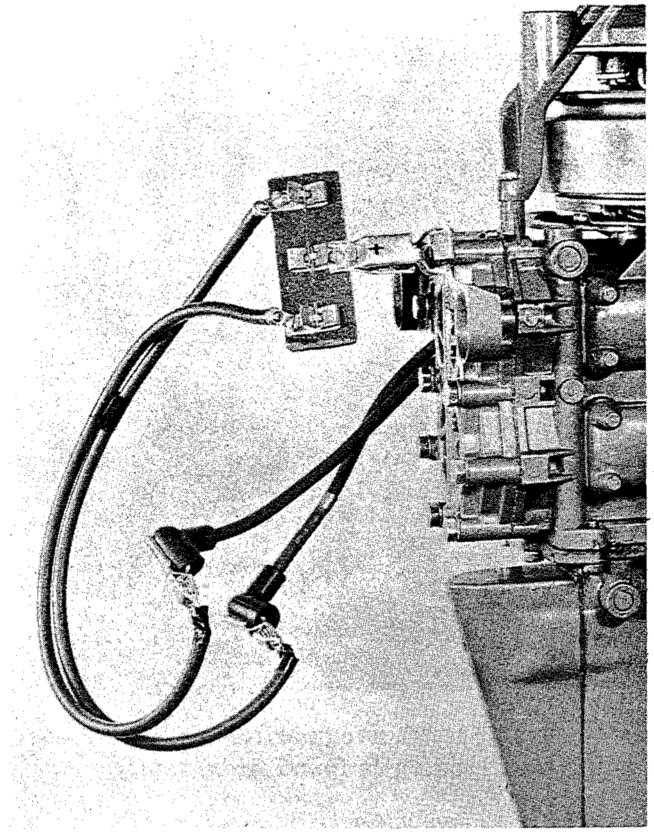
DIAGNOSIS

When attempting to "run down" or diagnose motor difficulties, bear in mind that three fundamentals are basically required to achieve performance, namely: (1) Spark, (2) A combustible mixture of gasoline and air — in other words GAS and (3) COMPRESSION. It's got to have SPARK — it's got to have GAS, and it's got to have COMPRESSION. Practically all motor difficulty can be laid to a deficiency in one or in a combination of deficiencies in all three. Check one at a time.

As a preliminary "once over" — probe the most accessible detail to get at first. The simplest thing to do and which comes naturally is to turn the flywheel to "see" if there is Compression (in each cylinder)—accomplished by merely pulling on the starting cord grip. A lively "bounce" when pulled over piston top dead center ought to indicate reasonably good Compression, the degree of which can be determined from past experience with the model.

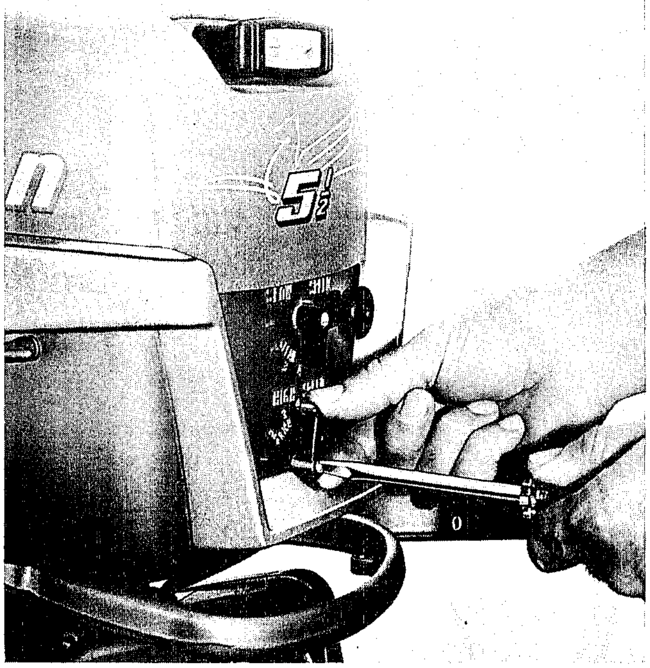


Next, divert attention to Spark. Remove and observe condition of spark plugs first; if appearance does not reveal wet or excessively coated insulators, badly eroded or misadjusted point gaps, lay them aside for the moment. Attach plug leads to spark gap fixture as shown here. Crank motor briskly. Good sparking is divulged by a strong "snap" at the gap—if visible, a "fat" spark; while presence of a less audible "snap" or hair line spark reveals weak or ineffective sparking. The effect of no spark is, of course, obvious. The spark plugs may then be attached to their respective



leads and checked in like manner—check one at a time; ground both plugs to frame of the motor (never let one "dangle" free without grounding at this time to avoid possible injury to the coil). A short length of wire with alligator clip attached to each end is more practical and serves better for grounding—clip to motor frame and "sparky" plug cover. A strong spark at the plug point gap ought to indicate good plugs; however, characteristics vary under compression when operating in the motor. Borderline "sparking" will break down under compression because of greater gap resistance introduced by the compressed atmosphere. Don't "fuss" with questionable plugs—install new plugs when in doubt. This should take care of "Spark" for the time being. Then—take a "gander" at the carburetion system. Observe if liquid fuel mixture is reaching the carburetor and check to ascertain correct position (adjustment) of carburetor needles as directed for each specific model. Don't overlook possibility of an empty fuel tank, water in the fuel mixture, clogged screens, fuel lines, loss of pressure if pressurized fuel tank is employed.

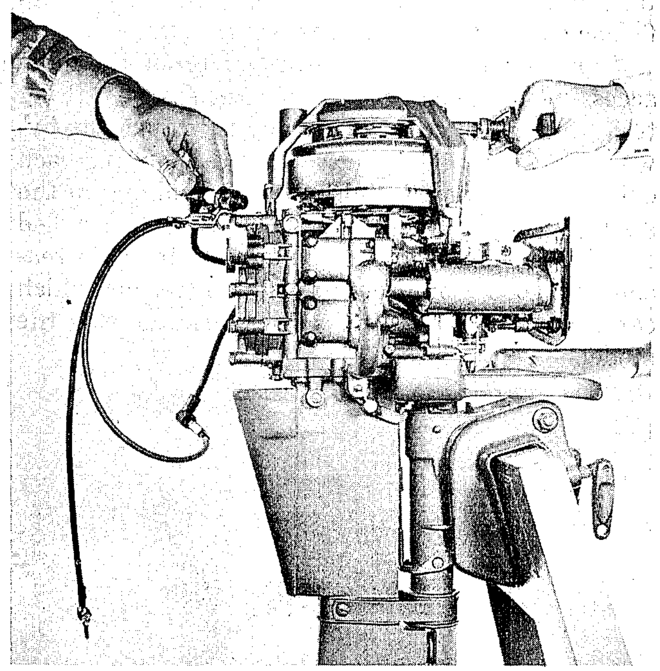
The above preliminary diagnosis may be accomplished in but a few moments and presumably by now, source of the difficulty has been traced to either (1) Spark, (2) Gas, or (3) Compression, or a combination of deficiencies in all three. To seek out corrective measures — proceed with checking



for ignition (Spark) irregularities as follows—assuming that ignition is found to be faulty.

SPARK

1. **Spark Plug** (see page 52)
   (a) Wrong type — too hot or too cold for the model.
   (b) Spark plug gasket faulty, incorrectly installed—leaking to cause abnormal rise in plug operating temperature.
   (c) Point gap too wide or too narrow — correct at .030″.
   (d) Electrodes (points) excessively eroded—"burned" away.
   (e) Fouled—wet or carbon clogged.
   (f) Cracked or broken insulator.
   (g) Residue coated insulator (exterior) to cause spark seepage and/or periodic "shorts" particularly in salt water areas.
   (h) Excessive carbon accumulation in the combustion chamber—loose bits of carbon breaking free and lodging in the plug gap to cause short circuiting (solution—remove carbon).
   (i) Possibility of a clogged crankcase bleeder system not to be overlooked at this time.
   (j) Deposits or coating (product of combustion) accumulating on surface of the insulator (interior) exposed to flame of combustion is often responsible for misfiring and/or failure at high speed because of current seepage. It is frequently characteristic of deposits of this sort to permit starting (firing) when cold but fail when hot.
   (k) Spark plug lead—faulty terminal connections at the coil or plug; broken wire; fractured or residue coated insulator to cause spark seepage or direct short circuit.



2. **Breaker Points** (see page 56-39)
   (a) Improperly adjusted, out of alignment or oil "smeared."
   (b) Pitted or corroded
   (c) Breaker surface loose in its mounting
   (d) Faulty breaker point insulation—stationary point
   (e) Loosely mounted or otherwise faulty rubbing block—worn down
   (f) Weak or broken breaker arm spring
   (g) Breaker arm binding on its pivot post to cause sluggish action
   (h) Broken, loose or corroded terminal connections
   (i) Cracked or "rough" breaker cam surface to cause rapid wear on face of the rubbing block, and its resultant effect on gap setting which should be maintained at .020″ full open.
3. **Condenser** (see page 56-41)
   (a) Weak
   (b) Shorted
   (c) Improperly mounted
   (d) Loose, broken or corroded terminal connections

(e) Faulty ground mount — corroded or broken loose on condenser case—ineffective ground mounting to armature plate.

4. **Coil** (see page 11)
   (a) Weak—partially shorted
   (b) Shorted—"dead"
   (c) Improperly mounted—coil heel to magnet pole shoe gap should be adjusted to .015″
   (d) Loose or corroded terminal connectors
   (e) Spark plug lead not properly installed
5. **Wiring** (see pages 13, 14 and 17)
   (a) Loose (poorly soldered) or corroded terminal connections
   (b) Broken stranded core
   (c) Fractured insulation ("pinching" of hold down clamps, etc.)
   (d) Oil soaked to cause current seepage
   (e) Cracked, oil soaked or otherwise faulty insulating washers where used (breaker point)
6. **Carbon Seal** (see page 164-52-4)
   (a) Faulty "O" ring installation
   (b) Cracked, broken or
   (c) Improperly installed to permit oil smearing armature plate and eventually affecting breaker point performance.
7. **Flywheel**
   (a) Loose on crankshaft
   (b) Magnets weak
   (c) Improperly adjusted clearance between flywheel magnet pole pieces and coil heels—see page 56-4

   See magneto check chart

Beyond ignition, look to carburetion.

GAS—Check for (see pages 92-1, 92-37 through 63)

1. Water in the fuel tank — improperly mixed fuel.
2. Clogged fuel lines, filters, screens, etc.
3. Aged (sour) fuel in tank.
4. Pressure seepage or absence of pressure if pressurized fuel tank is used.
5. Faulty fuel line connectors — seepage from pressure line.
6. Faulty crankcase pressure release to pressurized tank.
   (a) Obstructed pressure release orifices in crankcase.
   (b) Faulty or irregular compression release valve action—valves not seating — broken or faulty "flapper" valve spring (broken, bent out of shape).
7. Closed vent in gravity fuel tank, if used.
8. Broken segment automatic intake valve — power head.
9. Loose or poorly mounted valve and/or valve plate assemblies — power head (compression seepage around mounting screws to interfere with crankcase induction).
10. Carburetor (see page 62)
    (a) Adjusting needles (high and slow speeds) improperly "set" — damaged needle valve faces and their corresponding seats in the carburetor body.
    (b) Filter element, fuel passages and orifices obstructed with gasoline gum (varnish) or other foreign substance.
    (c) Improperly adjusted or faulty float affecting fuel level in the carburetor.
    (d) Faulty float valve action.
    (e) Faulty gasket installations.
    (f) Throttle shutter shaft excessively worn in the carburetor housing to admit a disturbing air stream, thereby upsetting fuel-air ratio.
    (g) Carburetor loosely mounted to crankcase.
    (h) Throttle shutter action not properly synchronized with spark timing—see carburetor check chart.

Finally, it's COMPRESSION.

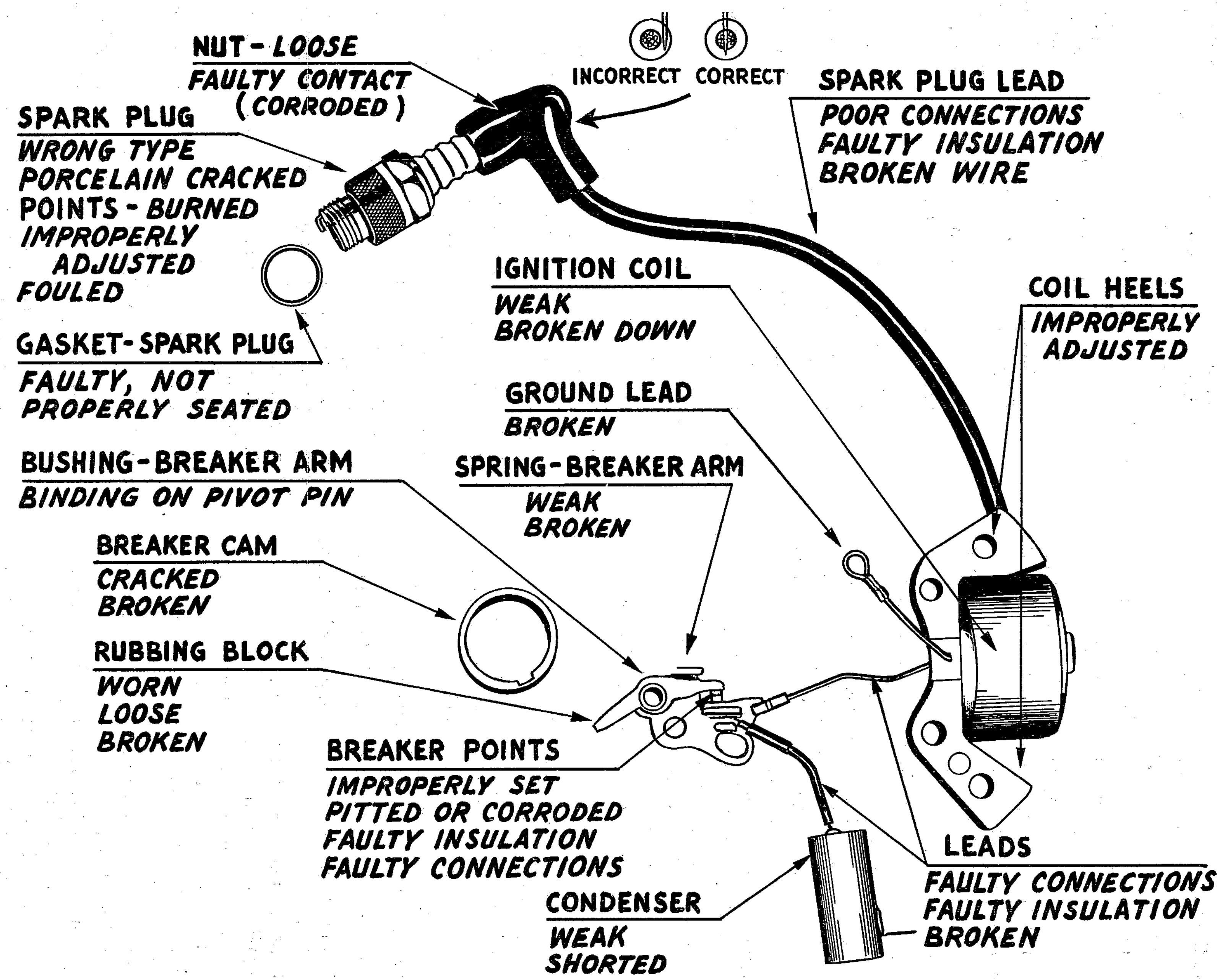
(See pages 97 through 101, 104 through 109)

Loss of compression (and power) may be attributed to:

1. "Blown" cylinder head gasket.
2. Faulty piston ring installation — excessively worn or carbon clogged in piston ring grooves.
3. Worn, glazed or scored cylinder walls to permit compression escape and subsequent loss of power as well as contributing to difficult starting.
4. Faulty carbon seals (crankshaft) where used.

Other factors contributing to faulty motor performance are:

1. Failure of the cooling system to cause overheating.
   (a) Worn pump assembly.
   (b) Clogged water tubes, passages and/or water jackets.
2. Water entering the power head.
   (a) Faulty gaskets or gasket installation.
   (b) Faulty carbon seals (crankshaft—bottom end) where used.
   (c) Cracked or porous castings.
   (d) Operator "lifting" lower unit higher than level of the power head on removing the motor from the boat without allowing ample time for water in



MAGNETO CHECK CHART

the cooling and exhaust system to drain off.

See power head check chart.

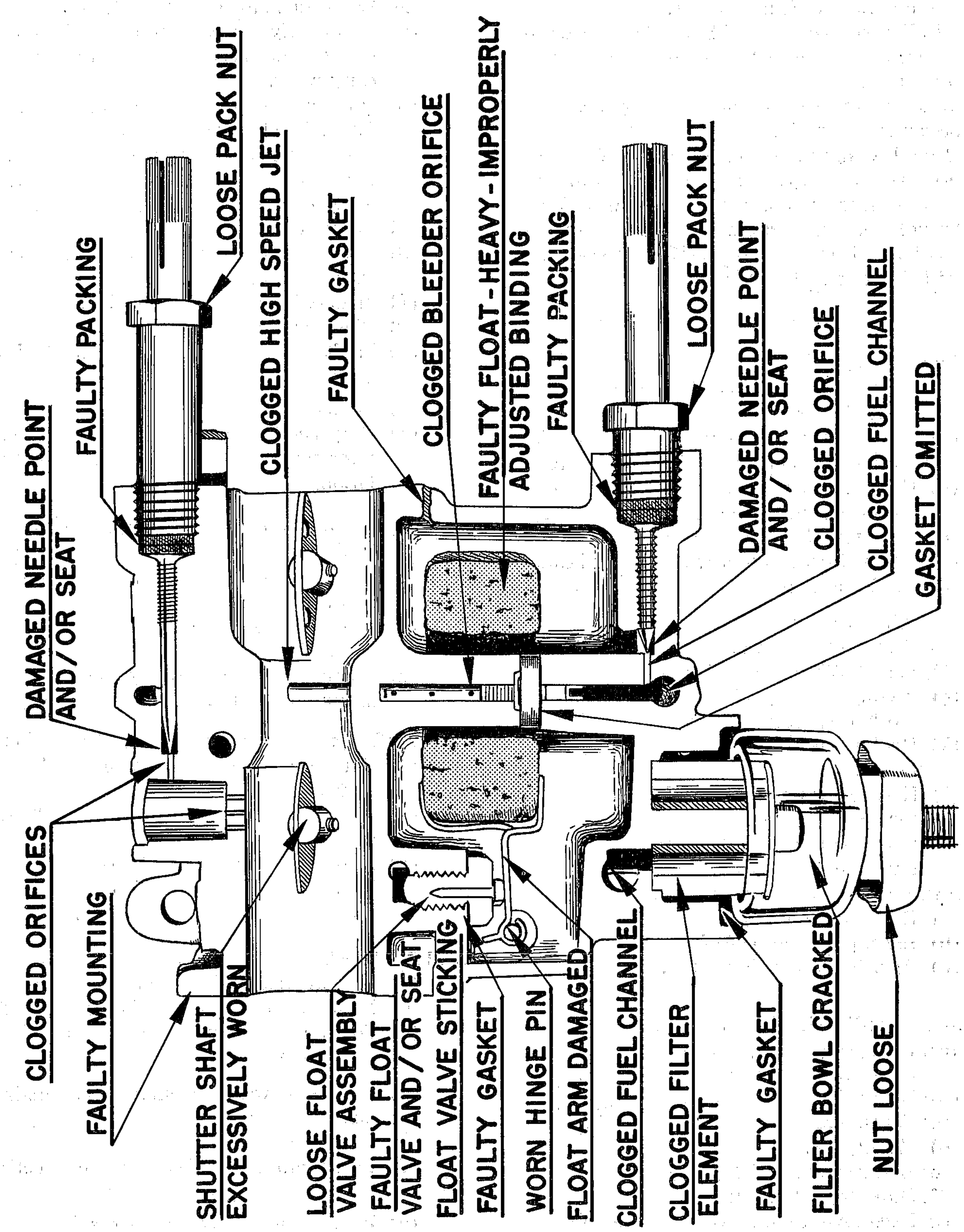
3. Misalignment on assembly of the crankcase to cause crankshaft "binding," ill fitted pistons, rings.
4. Misalignment of the lower unit by accident or faulty assembly.
5. Propeller damage — chipped or off pitch propeller blades, causing excessive vibration of the entire motor assembly—particularly "rough" or course running at slow and intermediate throttle, progressively increasing with higher motor speeds.

SYMPTOMS

1. Failure to start.
   - (a) Fuel tank empty—Moisture (condensation) in fuel tank.
   - (b) Primer not functioning—if a pressurized tank or vent closed if a gravity tank.
   - (c) Clogged fuel lines, screens, filter element, etc. (gum or other foreign matter).
   - (d) Faulty fuel line connectors.
   - (e) Water in fuel tank and/or power head.
   - (f) Faulty carburetor—see "Gas" above.
   - (g) Faulty ignition.
   - (h) Spark plugs fouled.
   - (i) Spark failure—see "Spark" above.
   - (j) "Blown" head gasket— see "Compression" above.
   - (k) Broken intake valve segment (power head).
   - (l) Electric starting—faulty battery or battery connections or starting unit. Faulty remote starting switch, on "dash" or relay switch in junction box.
2. Hard to start—usually caused by:
   - (a) Refer to items (a) through (l) above.
   - (b) Improperly mixed fuel.
   - (c) Aged (sour) fuel mixture.
3. Missing—ordinarily the result of:
   - (a) Faulty spark plugs or wrong type—too hot, too cold.
   - (b) Faulty broken points—gap.
   - (c) Faulty condenser.
   - (d) Faulty coil.
   - (e) Faulty wiring (Magneto).

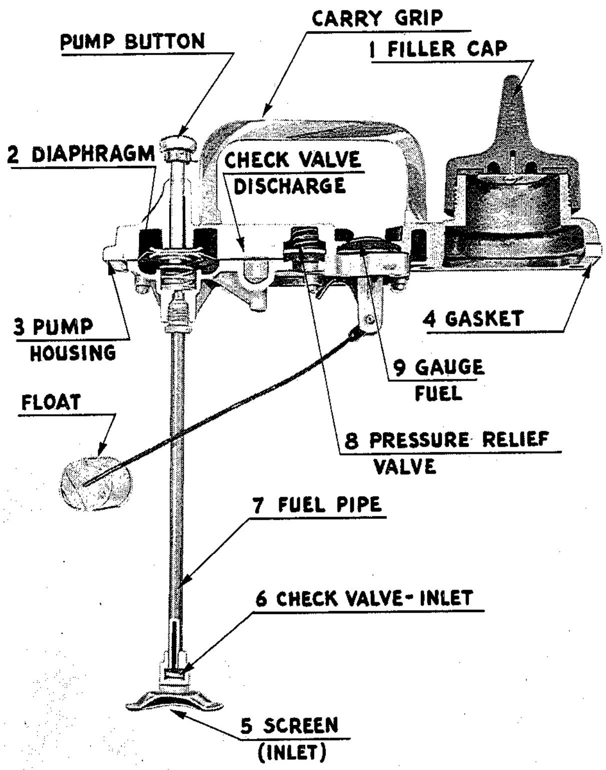
   (a)–(e): See "Spark" above
   - (f) Interrupted fuel supply.
   - (g) Excessive carbon—loose bits periodically "shorting" plugs.
4. Roughness or vibration.
   - (a) Loosely mounted on the boat.
   - (b) Propeller blades chipped or out of pitch.
   - (c) Flywheel loose on crank shaft (rarely)
5. Power fall-off—RPM's drop.

   Restricted fuel supply—(See "Gas" above)
   - (a) Improperly set carburetor needle—high speed, slow speed—foreign substance in carburetor.
   - (b) Pressure escaping from pressurized tank.
   - (c) Partially obstructed screens, filter elements, fuel line, carburetor orifices, air line if pressurized tank — vent closed in gravity tank.
   - (d) Faulty carburetor.
   - (e) Faulty pressure valving system — pressure to tank.
   - (f) "Leaky" cylinder head gasket.
   - (g) Blown cylinder head gasket.
   - (h) Faulty compression—see "Compression" above.
   - (i) Faulty cooling system.
   - (j) Propeller blades out of pitch—propeller pitch too great for the particular installation.
   - (k) Excessive carbon accumulation — (exhaust ports) to restrict flow of exhaust.
   - (l) Piston rings carbon "stuck" in ring groove.
   - (m) Worn and/or scored pistons and cylinder walls.
   - (n) Spark plug — too hot for the model or nature of service.
6. Irregular running—alternately fast and slow.
   - (a) Cavitation—see page 202. of the Service Manual.
   - (b) Intermittent fuel supply — see "Gas" above.
   - (c) Interrupted water circulation (cooling).
   - (d) Pistons — piston rings "fit" too snugly during repair—causes binding.
7. Motor knocks—
   - (a) Loosely mounted on boat.
   - (b) Flywheel loosely mounted on crankshaft.
   - (c) Coil heels striking magnet pole shoes (flywheel).
   - (d) Excessive wear—cylinder walls and/or piston.
   - (e) Loose wrist pin.
   - (f) Loose crank pin bearing — connecting rod.
   - (g) Bent or twisted connecting rod.
   - (h) Crank pin bearing too tight (if friction type), causing piston to "slap" as it passes over top and bottom "dead" centers.



CARBURETOR CHECK CHART

FUEL TANK — CHECK CHART



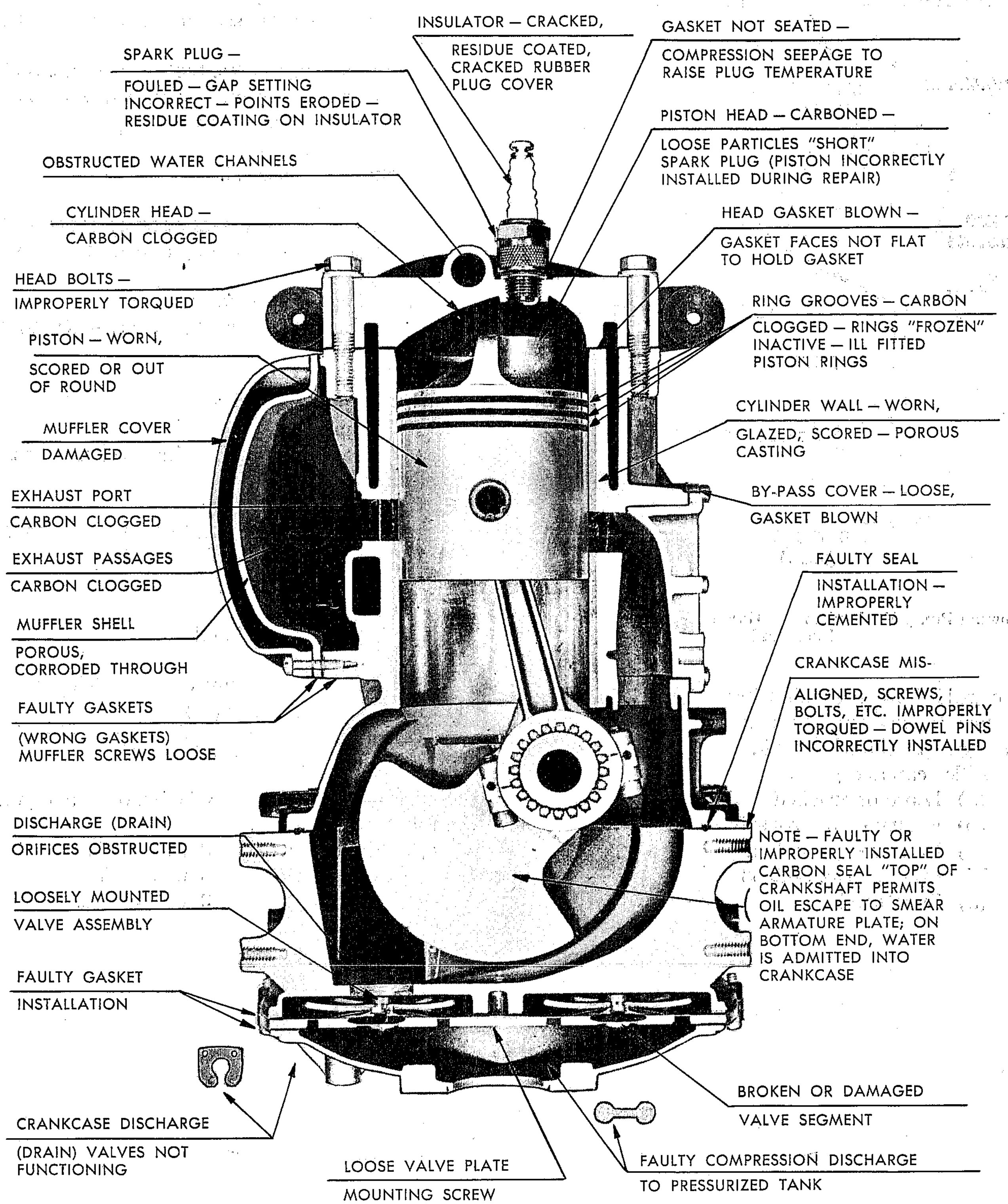
Showing Pump Mechanism and Gauge as Attached to the Fuel Tank.

Be guided by the following suggestions when diagnosing fuel tank irregularities and/or performing repairs on the tank.

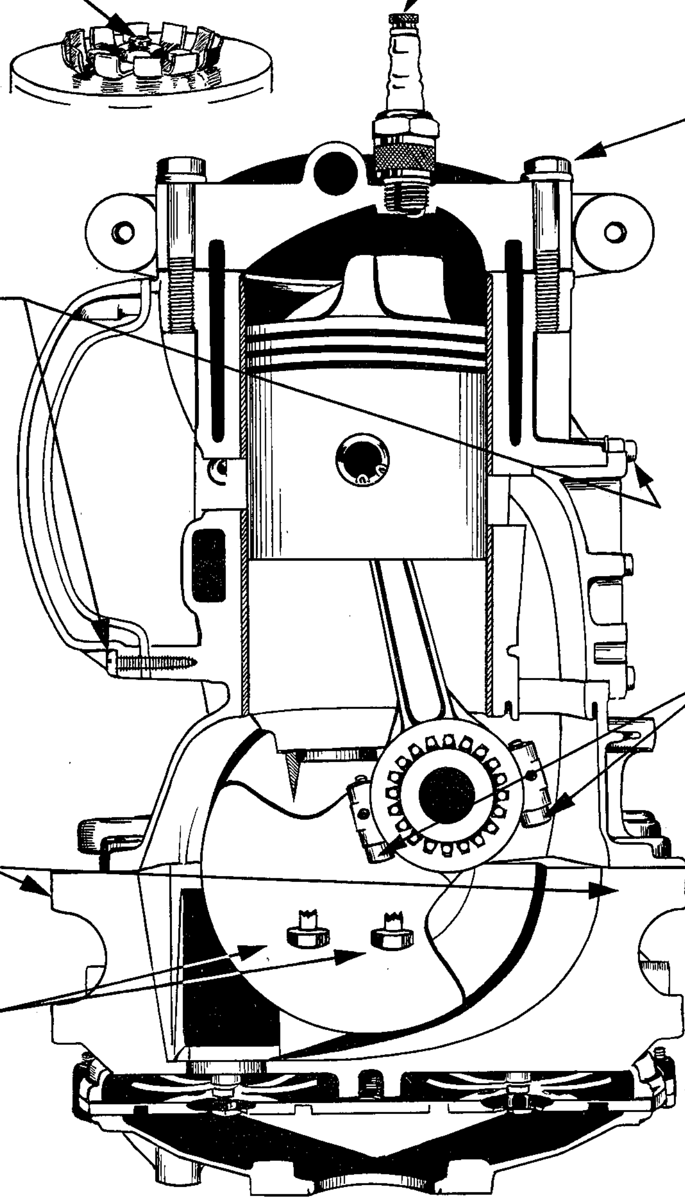
1. Filler cap and gasket
   (a) Loose or cracked
   (b) Faulty or improperly seated
   (c) Damaged gasket faces
2. Diaphragm—No. 302563
   (a) Punctured
   (b) Leaks—end of pump shaft—fuel escapes under pump button—nuts at the end of pump shaft loose or area around cup washers (No. 301800) not properly cemented
   (c) Not properly seated between pump housings
3. Pump housings—No. 302572 and No. 302555
   (a) Surfaces not flat to cause air seepage and resultant pressure drop
   (b) Not bolted together securely
4. Gasket—No. 302577
   (a) Damaged
   (b) Not secure to seal against pressure loss between pump assembly and tank proper
5. Screen
   (a) Clogged with foreign matter
6. Check disc valves No. 302802 and No. 375846 (assembly)
   (a) Sticking
   (b) Improperly seated
7. Fuel pipe
   (a) Loose in pump housing to cause pressure leak
8. Pressure release valve
   (a) Improperly seated to cause pressure leak
   (b) Sticking
9. Fuel gauge glass
   (a) Cracked
   (b) Improperly seated
10. Fuel tank
    (a) Punctured to cause pressure leaks
11. Fuel line and connectors
    (a) Faulty to permit pressure escape
    (b) Clogged

NOTE — Each tank should build up and retain the following pressures—

Model CD	3 to 4½ lbs.
Model QD	3 to 5 lbs.
Model RD	3 to 4½ lbs.



POWER HEAD CHECK CHART



FLYWHEEL NUT

Motor	Ft. Lbs.
JW	40 - 45
CD	40 - 45
QD	40 - 45
RD	60 - 65
HD	40 - 45
TD & TN	50 - 55
SD	60 - 65
PO	65 - 70

SPARK PLUG

Motor	Ft. Lbs.
All Models	20 - 20½

CYLINDER HEAD SCREW

Motor	Ft. Lbs.
JW	5 - 7
CD	5 - 7
QD	8 - 10
RD	18 - 20
HD	2 - 3
HD	5 - 7
TD & TN	5 - 7
SD	18 - 20
PO (Nut)	18 - 20

MUFFLER AND BY-PASS SCREW

Motor	Ft. Lbs.
JW	2 - 3
CD	2 - 3
QD	2 - 3
RD	2 - 3
HD	2 - 3
TD & TN	2 - 3
SD	10 - 12
PO	18 - 20

CONNECTING ROD SCREWS

Motor	Ft. Lbs.
JW	5 - 8
CD	5 - 5½
QD	15 - 15½
RD	15 - 15½
HD	5 - 7
TD & TN	5 - 7
SD	15 - 15½
PO	15 - 15½

CRANKCASE SCREWS

Motor	Ft. Lbs.
JW	5 - 7
CD	5 - 7
QD	5 - 7
RD	5 - 7
RD	12 - 14
RD (Center)	13½ - 14
HD	5 - 7
HD	2 - 3
TD & TN	5 - 7
TD (Nut)	12 - 14
SD	18 - 20
PO	12 - 14
QD	10 - 12

TORQUE CHART — POWERHEAD

TORQUE

Size	Torque Ft. Lbs.	Inch Lbs.
#10	2 - 3	24 - 36
#12	3 - 4	36 - 48
1/4	5 - 7	60 - 84
5/16	10 - 12	120 - 144
3/8	18 - 20	216 - 240
Spark Plug	20 - 20½	240 - 246
JW—Flywheel Nut	40 - 45	480 - 540
Cylinder Head Screws	5 - 7	60 - 84
Crankcase	5 - 7	60 - 84
Connecting Rod Screws (As needed)	5 - 8	60 - 96
Exhaust Housing to Cylinder Screws	5 - 7	60 - 84
Gearcase to Driveshaft Casing	5 - 7	60 - 84
Muffler Screws	2 - 3	24 - 36
Starter Housing	5 - 7	60 - 84
CD—Flywheel Nut	40 - 45	480 - 540
Cylinder Head Screws	5 - 7	60 - 84
Crankcase Screws	5 - 7	60 - 84
Connecting Rod Screws	5 - 5½	60 - 66
Exhaust Housing to Cylinder Screws	5 - 7	60 - 84
Gearcase to Exhaust Tube Screws	5 - 7	60 - 84
Muffler Screws	2 - 3	24 - 36
Starter Housing	8 - 10	96 - 120
Gearshift Clamp Screw	4 - 5	48 - 60
QD—Flywheel Nut	40 - 45	480 - 540
Starter Housing Screws	8 - 10	96 - 120
Cylinder Head Screws	8 - 10	96 - 120
Crankcase Nuts	10 - 12	120 - 144
Connecting Rod Screws	15 - 15½	180 - 186
Gearcase to Exhaust Tube Screws	5 - 7	60 - 84
Muffler and By-Pass Screws	2 - 3	24 - 36
Clam Shell Screw Side	14 - 16	168 - 192
Clam Shell Screw Front	12 - 14	144 - 168
Nut On Rubber Shock Absorber	12 - 14	144 - 168
RD—Flywheel Nut	60 - 65	720 - 780
Cylinder Head Screws	18 - 20	216 - 240
Crankcase Screws	12 - 14	144 - 168
Crankcase Screws (Center)	13½ - 14	162 - 168
Crankcase Nuts	12 - 14	144 - 168
Exhaust Tube to Cylinder Screws	5 - 7	60 - 84
Connecting Rod Screws	15 - 15½	180 - 186
Gearcase to Exhaust Tube Screws	5 - 7	60 - 84
Starter Housing Screws	8 - 10	96 - 120
Muffler and By-Pass Screws	2 - 3	24 - 36
Clam Shell Screw (Side)	14 - 16	168 - 192
Clam Shell Screw (Front)	12 - 14	144 - 168
Mounting Nut (Shock Absorber)	12 - 14	144 - 168
Gearshift Clamp Screw	4 - 5	48 - 60
Steering Bracket to Pilot Shaft	10 - 12	120 - 144

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THE LOWER UNIT

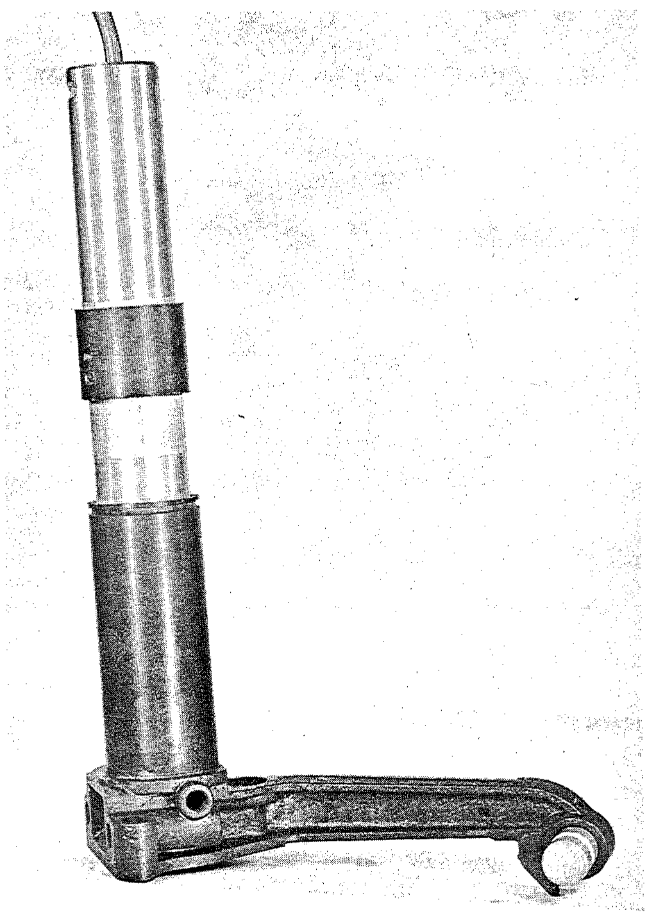
Section IV

THE LOWER UNIT

NOTES

THE LOWER UNIT

The lower unit is that part of the outboard motor assembly comprising the stern bracket, driveshaft casing, gearcase and of course, necessary shafting and gearing required to deliver power generated (by the power head) to the propeller which ultimately drives the boat. It also contains the water pump or water scoop, whichever the case may be, and piping for circulation of water through the cooling system.

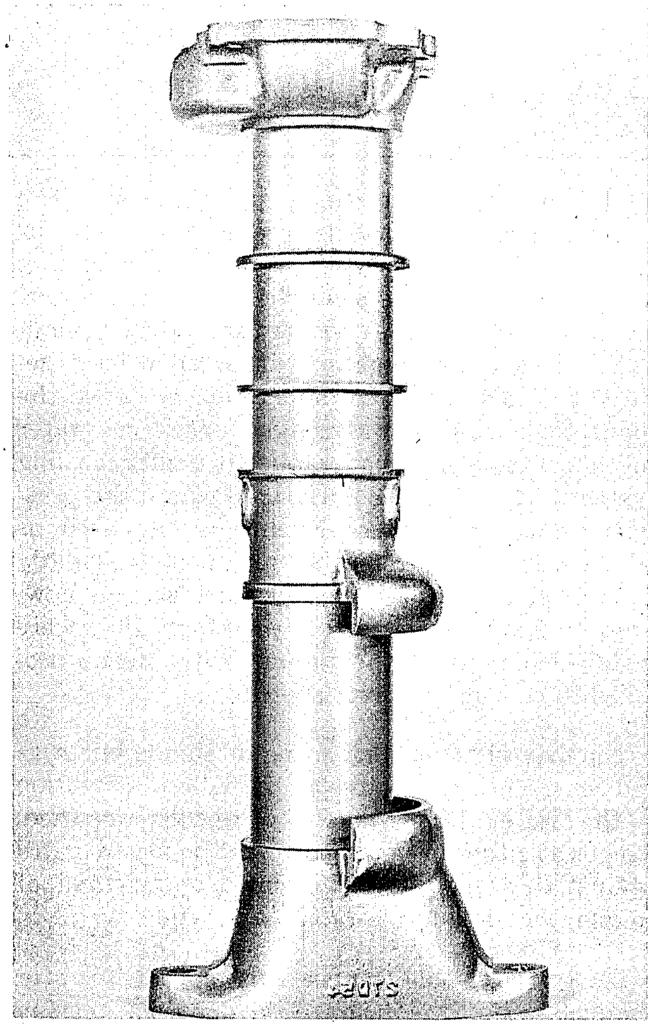


Tubular Constructed Driveshaft Casing

The driveshaft casing may be of tubular construction or of cast aluminum, provided with flanges at each end for mounting to the crankcase of the power head and upper part of the gearcase. In the case of tubular construction, generally some form of clamping arrangement is provided for attaching to the gearcase to make up a solid assembly of the driveshaft casing and gearcase. The driveshaft casing contains also, water tubing or cast-in channels for the purpose of conducting water to and from the power head for cooling purposes. The water tubes where used in cast aluminum driveshaft casings are either spun in or secured by means of a jam nut. In either event, the connections must be water tight since loose water tubes contribute considerably to faulty cooling systems. This is particularly true where the pressure-vacuum method of cooling is employed as later described. Water tubes are most frequently assembled inside of the driveshaft casing, however, on many models of early vintage, they were installed outside of the tubing, with means provided to permit full pivot steering.

The driveshaft casing, while of simple but rugged construction, requires a minimum of attention — the water tubes must be tightly mounted, flanges at either or both ends must be flat to guard against air seepage into the cooling system and, of course, they must be straight and true.

Leaky water tube connections or cast-in water channels permit the inside of the driveshaft casing to fill with water which eventually finds its way into the crankcase of the motor by way of the lower journal bearing to interfere with motor performance and subsequently injurious to functional parts. Water likewise finds its way into the gearcase to wash out the lubricant — look for water leaks if the gearcase requires an abnormal amount of grease. Further, if placed in storage over the winter months in this condition where temperature is apt to drop below freezing, expansion as result of water freezing in the driveshaft casing causes the water tubes to collapse to make them unfit for further service—this fact should be considered when attempting to run down possible causes of overheating. Water seepage may not necessarily be the result of leaking water tubes or water tube connections, but because of faulty gaskets or warped gasket faces. Take care to check gaskets (install new ones) and gasket faces. Make certain, too, that on assembly, holes or openings in the gasket align with like openings in the driveshaft casing flange, base of crankcase or top end of the gearcase. It is possible in some instances to obstruct the flow of water through the cooling system by improper installation of a gasket.

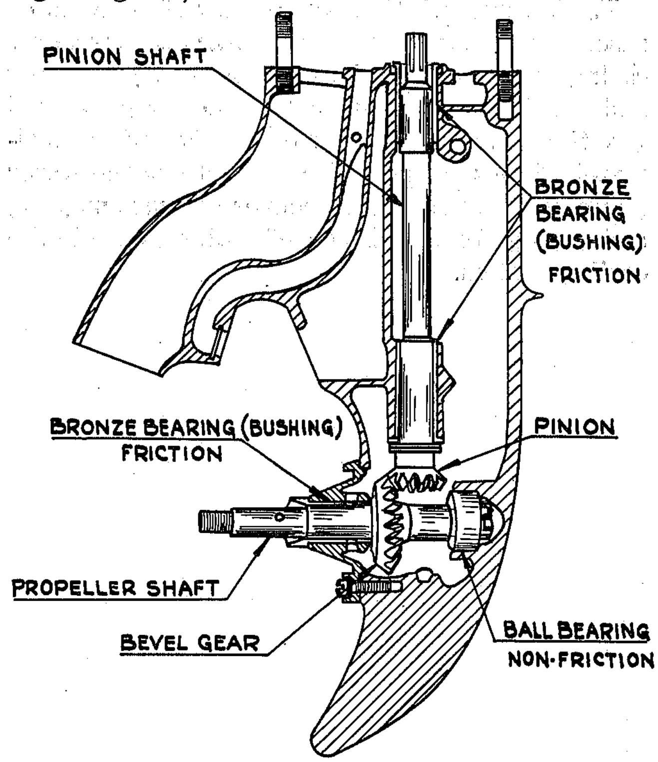


Cast Aluminum Type of Driveshaft Casing

The driveshaft casing must be straight and true —if bent or sprung, excessive driveshaft coupling wear can be expected, not to mention added load on the bearings in both the crankcase (lower) and gearcase to cause abnormal wear in this respect.

Except on some of the earlier models of Johnson motors, the gearcases are constructed of aluminum castings (die or sand casting, the former being of bronze to better withstand the ravages of salt water). Brass construction, however, made the motors considerably heavy and cumbersome to proportionately reduce their portability. Recent developments and improvements in aluminum castings, coupled with advanced manufacturing processes, have made aluminum the gearcase practical and well adapted for salt water service. The gearcase castings are given what is known as an Alrock treatment—a chemical process which retards the action of salt water on aluminum. In addition, the castings are sprayed with a salt water resistant prime coat, followed by a highly salt water resistant lacquer coat.

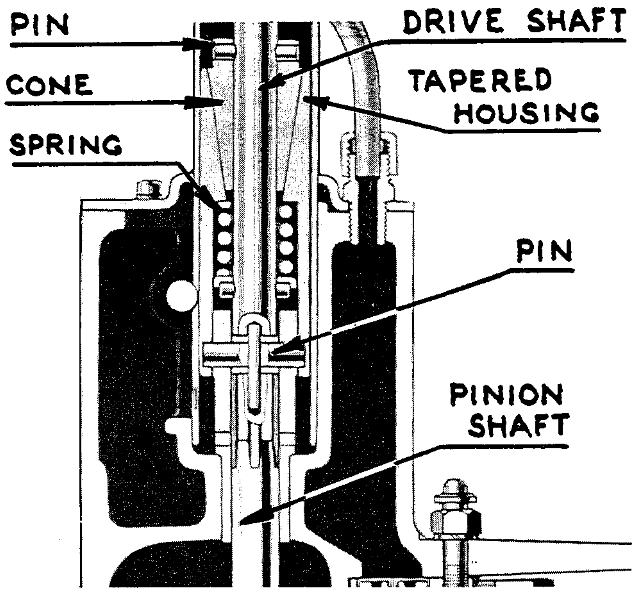
Most gearcase housing assemblies are made up of the gearcase proper and a gearcase head while some include a separate bottom and top gearcase section and, of course, the gearcase head as are necessary to contain the required bearings, shafting and gears, etc.



—(Drawing of gearcase here—as in front part of the book, power head section.)

Bearing installation may be of friction or non-friction type or a combination of both as shown above. Friction type bearings may be pressed in or cast-in as in the case of later models, especially where die castings are employed. Die cast-in bearings are not replaceable, therefore, when excessive wear occurs, the entire housing must be replaced. Pressed-in bearings (bushings) are replaceable when wear is prevalent by simply driving out the old and pressing in the new bearing (bushing)—this followed by a careful line reaming operation. See list of line reamers. Non-friction bearing assemblies are easily replaced when necessary—merely a matter of removal from the shaft-gear assembly and installation in reverse order.

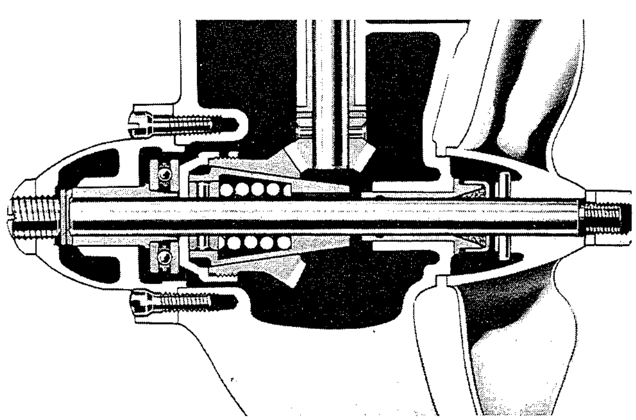
In addition to containing the final driving gear, the gearcase housing on many models of comparatively early vintage included a slip clutch or shock absorber (installed on the propeller shaft) to reduce shearing of propeller pins to a minimum or possible injury to motor parts as result of the propeller striking underwater obstructions and on all models, a water pump or necessary water scoop and water outlet. See cooling.



Illustrating Cone Type Clutch (Shock Absorber) Built into the Driveshaft Assembly

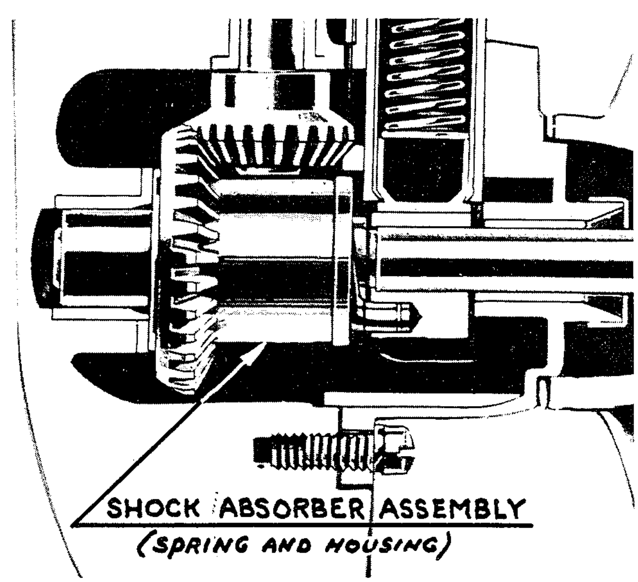
An early type of slip clutch consists of a cone and cone shaped housing, each mounted independently on a shaft and held in contact by a strong spring to function as a unit until the propeller makes contact with an underwater obstruction when the cone slips or turns in the tapered housing in a clutch-like fashion. On diminishing of resistance as the obstruction is passed over, contact is resumed between the cone and the housing to continue propeller drive. The unit of this description was mounted originally on the driveshaft in the driveshaft casing.

An adaption of the above unit was later applied to the propeller shaft. While principle of operation is identical, the cone is keyed or pinned to the propeller shaft, with the cone shaped housing an integral part of the bevel gear floating on the propeller shaft; contact (friction) between the cone and housing is accomplished by a similarly strong spring bearing against the shoulder of the cone and inside face of the housing cap, screwed firmly into position. Propeller drive is thus through the bevel pinion, bevel gear and by way of friction, through the housing and cone pinned to the propeller shaft. Contact with an underwater obstruction likewise causes the cone to slip in the housing since the bevel gear is merely turning on the propeller shaft under such condition.



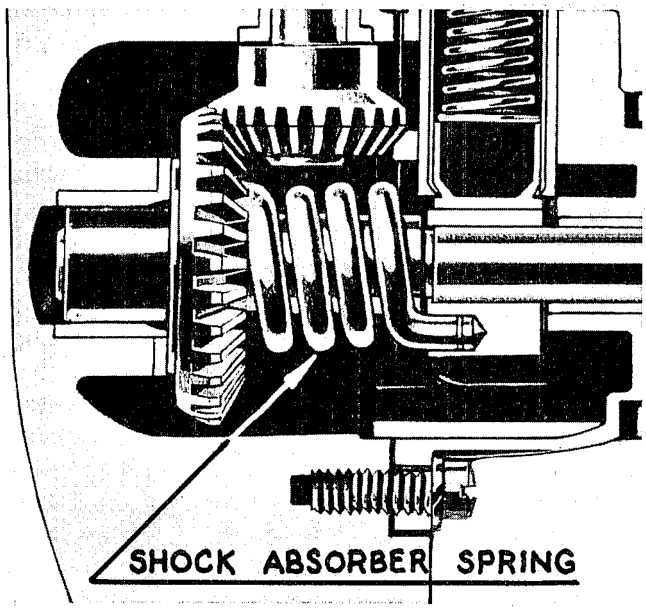
Illustrating Application of Cone Type Clutch (Shock Absorber) on the Propeller Shaft

The slip clutch or shock absorber installed in the gearcase of the LT-38-39 and 10 and the LS series, performed the same function but in a somewhat different manner. The unit consists of an accurately ground (internal) sleeve, into which is coiled a spring constructed of square cross section stock without side surface ground to several thousandths of an inch larger in diameter than that of the sleeve. The spring is then coiled into the sleeve so that difference in diameter creates tension or friction between the sleeve and the spring. The spring is pinned to the water pump eccentric which in turn is keyed to the propeller shaft—the bevel gear floats on the propeller shaft, however, is pinned to the one end of the sleeve. Final propeller drive is thus provided by way of friction existing between the sleeve and inserted spring. Consequently, on the propeller striking an underwater obstruction, the spring winds up or coils in the sleeve which causes a slight reduction in outside diameter of the spring to permit movement between the sleeve and coiled spring (slippage). Immediately on release of resistance caused by propeller contact with the obstruction, the spring unwinds, so to speak, and normal O.D. is restored to result likewise in restoration of normal drive through friction between the sleeve and spring.



Showing Installation of Spring and Sleeve (Shock Absorber) Assembly

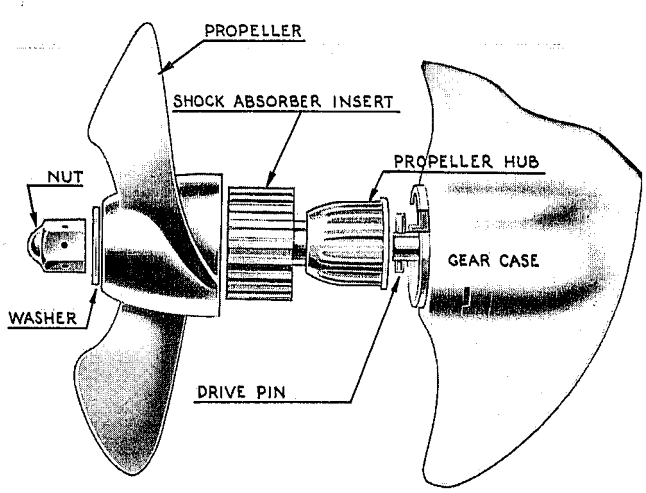
A rather simple shock absorber arrangement was employed in the LS and LT-37 series involving the use of a spring, one end of which was pinned to the bevel gear and the other to the pump eccentric. It merely absorbed shock between the propeller shaft and bevel gear.



Illustrating Application of the Shock Absorber Spring

Occasionally clutches of this type slip when they are not supposed to, to result in "racing" of the motor with little or no boat movement in extreme cases (not to be confused with propeller cavitation). Performance of this nature is frequently caused by a weak spring or improperly seated clutch faces. Solution is to replace the spring if it lies with the spring or lap in the clutch faces to obtain required contact between both surfaces.

Recent development in the shock absorber has been to simplify construction and maintenance in



Illustrating Rubber Shock Absorber Drive Assembly

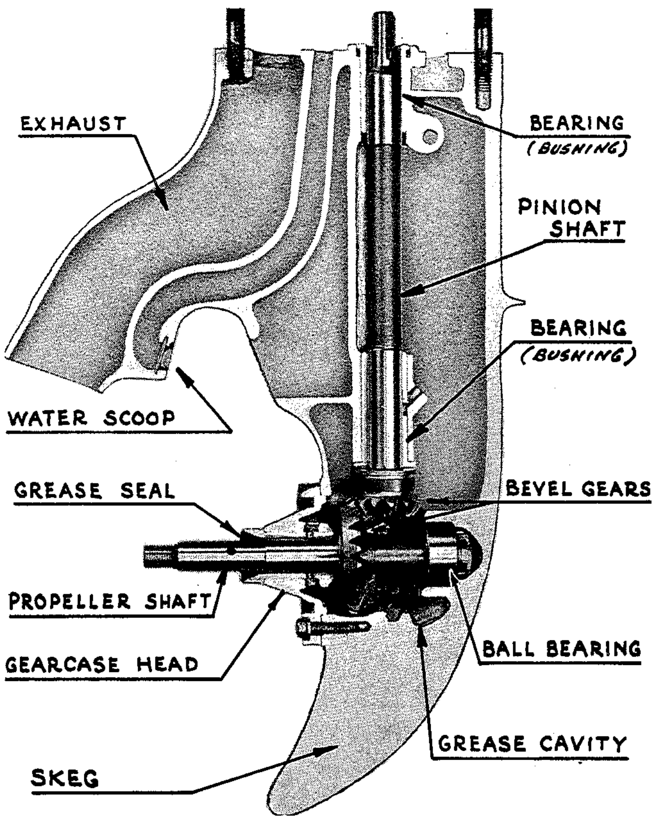
that shock is absorbed by a rubber cushion inserted between the propeller and the propeller shaft, as shown here. Drive is through the propeller shaft to the propeller hub (driven by the drive pin) through the serrated rubber insert which comes to rest in a like serrated section in the propeller. Inside of the rubber insert (cushion) is serrated or slotted to fit over corresponding slots machined on the propeller hub.

On striking underwater obstructions, the rubber insert "gives" or slips in the propeller to absorb shock which might otherwise shear the drive pin, causing damage to the propeller or other functional parts of the motor. On release of the propeller, the rubber insert resumes its normal position to continue driving the propeller, having engaged slots or serrations in the propeller and on the hub provided for this purpose.

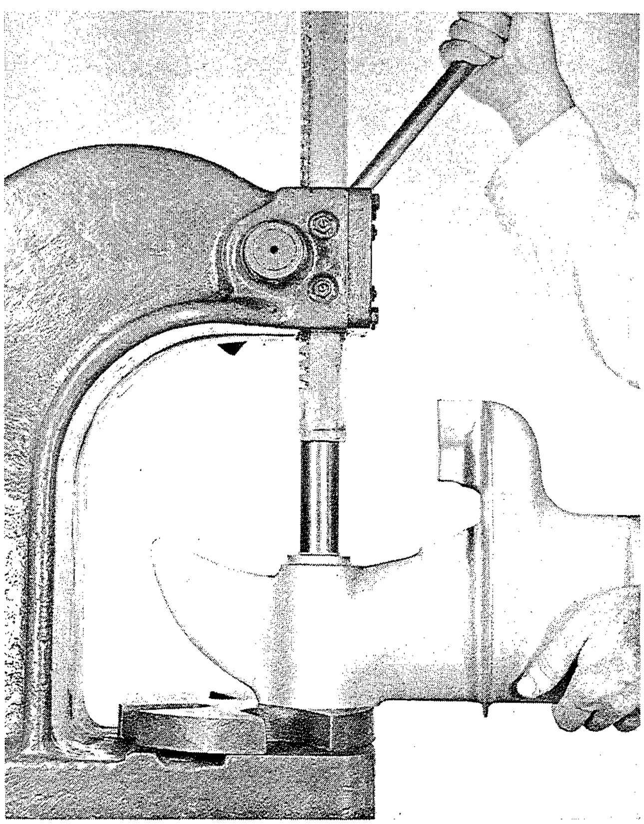
BEARING INSTALLATION

Bearings, shafts and gears wear normally as result of normal operation— excessive as result of insufficient or improper lubrication. In either case, replacement of like parts becomes the order at various intervals, dependent on amount of service and efficiency of lubrication. Lubrication, to be efficient, must be of proper quality and consistency to permit circulation throughout the entire gearcase, including bearings, gears, shafts, etc. On this depends lapse of time between intervals of repair, water entering the gearcase by way of faulty gaskets, water connections, faulty grease seals (where used) and as result of excessive propeller shaft bearing wear because of faulty lubrication, hastens the necessity of expensive repairs.

While the gearcase assemblies generally are of simple but rugged construction, repairs should be thoroughly and carefully conducted in reasonably clean and tidy surroundings. Assemblies to be repaired should be washed and made free of all foreign matter prior to conducting inspection with regard to determining extent of necessary repairs. This is important to avoid possibility of over-looking some major defect hidden by grease or other matter. Examine condition of gears, propeller and driveshafts and bearings—prepare for installation of new parts as required. Pay particular attention to condition of the propeller shaft and driveshaft bearings — excessive wear of the bearings naturally requires replacement of like parts together with the propeller shaft and driveshaft since excessive wear likewise affects same. In event the bearings (bushings) are of the removable type, they can be driven out and preparations made for installation of new bearings and final line reamings, otherwise, if cast-in, new casings will be required.

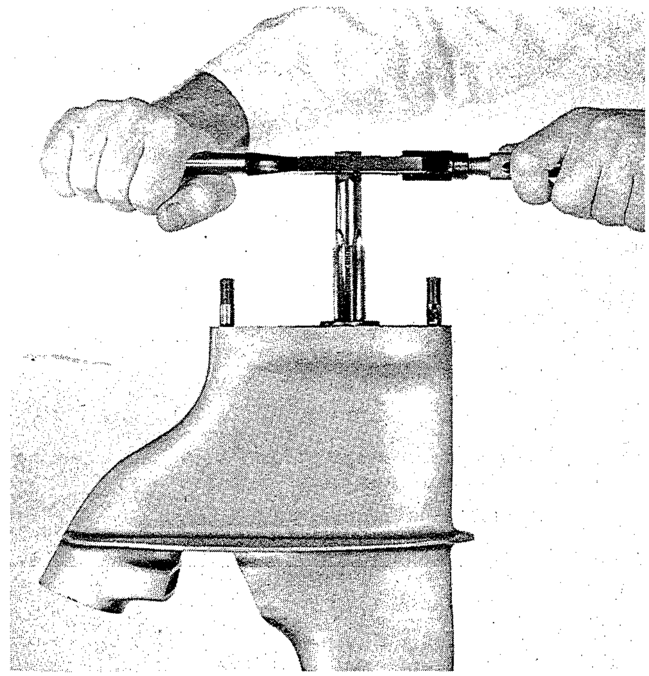


Sectional View of Model KS-KD Gearcase (Conventional Type of Construction)



Installing Propeller Shaft Bearing (Bushing)

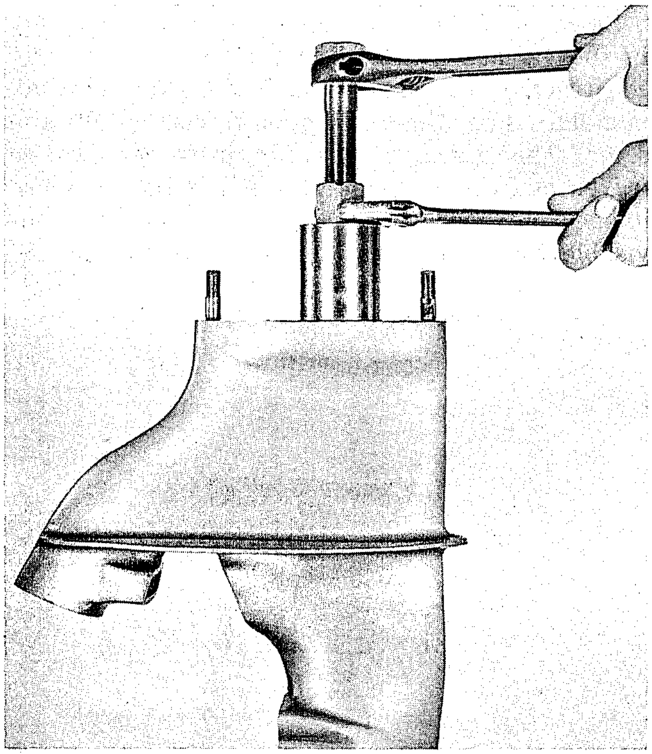
Since all of the replaceable bearings (bushings) in the various gearcase assemblies are similarly constructed and installed, procedure for removal, installation and line reaming is fundamentally the same. The bearings in many instances can be driven out with a mandrel, holding the gearcase in one's lap, however, an arbor press is deemed advisable for both operations of removing and re-



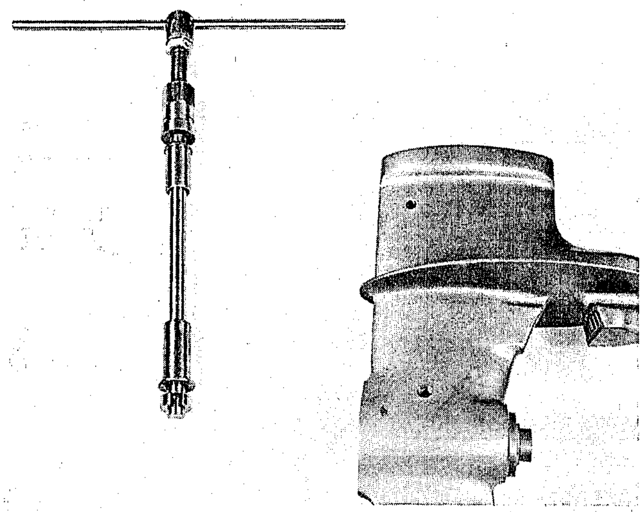
Tapping Top Pinion Shaft Bearing (Bushing) Prior to Extracting

placing the bearings with the aid of mandrels as illustrated. Care should be exercised when driving the bearings out as well as when installing, making certain walls of the bearing boss are not scored nor scratched by the mandrel (being oversized or containing sharp edges) during the procedure to ultimately result in loss of gear lubricant.

In instances where both the top and bottom pinion shaft bearings are of bronze, installed in a one piece gearcase (less gearcase head), the top bearing will, of necessity, have to be removed in a somewhat different manner. The operation consists of first cutting a thread in the bearing with the aid of a tap, as shown here — size of tap depending on bore of the bearing. Removal is thus performed by the use of a special tool (puller) which consists of a bolt, threaded approximately its entire length (pitch and size of thread equal to that of the tap), a nut of same size screwed to top end of thread and a bushing, closed at one end and provided with a hole to accommodate the bolt.



Showing Method of Extracting Top Pinion Shaft Bearing (Bushing) from Gearcase



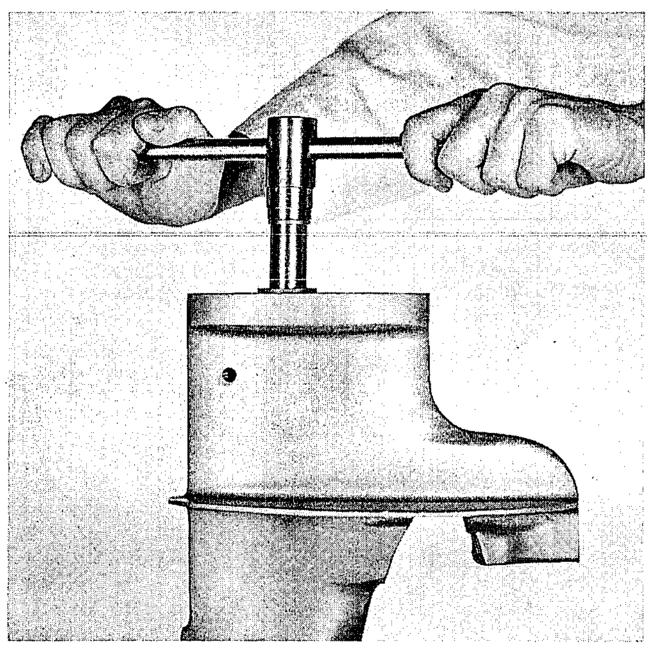
Illustrating Tool Designed to Draw Top and Bottom Pinion Shaft Bearings (Bushings) into Position—Gearcase K-KD and Models of Similar Construction

The entire assembly is placed over the bearing to be removed, bolt screwed into the already tapped bearing and the nut screwed down against the top of the bushing, as illustrated.

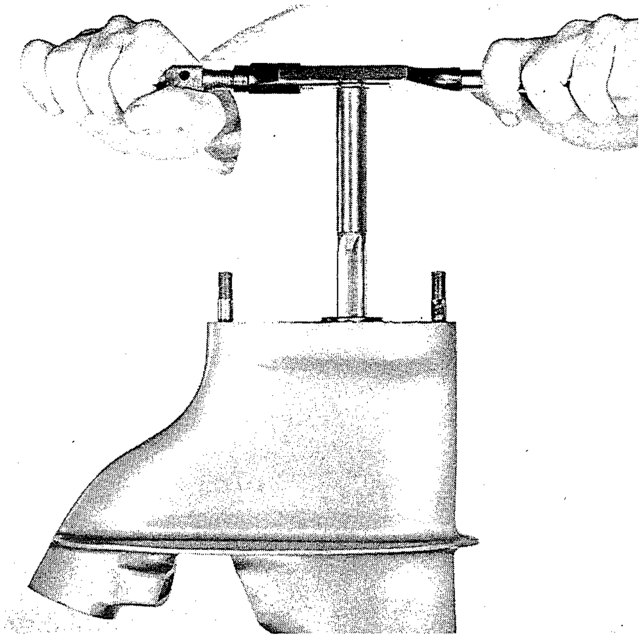
As the nut is advanced down against the bushing, the bearing in the gearcase commences to move out. On removal of the top bearing, the lower bearing can be easily driven out with a mandrel.

Installation of new bearings (bushings) should be carefully performed—paying particular attention to alignment to prevent possibility of "cocking" which not only ruins the bearing but in many instances, the gearcase. Note any holes which might have been drilled in the bearing walls (for lubrication purposes) and like holes in the bearing boss—they should be in alignment after the bearing has been driven "home."

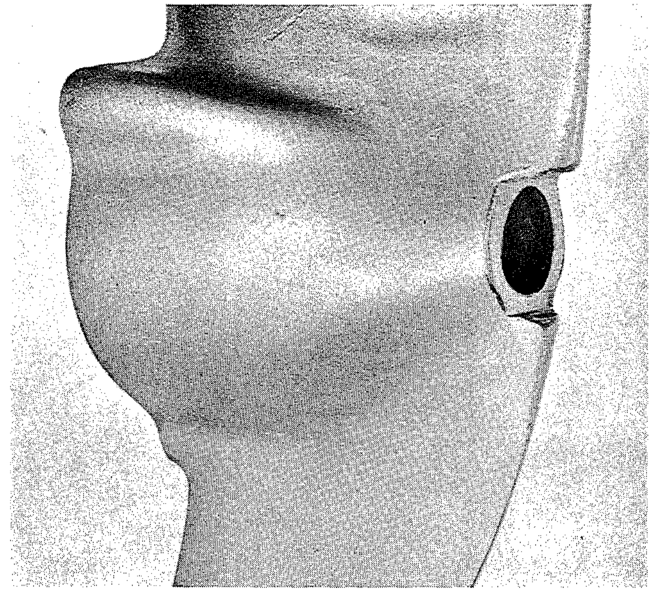
While many gearcase bearings (bushings) can be installed by a simple arbor press operation, installation of the top and lower pinion shaft bearings is performed in a somewhat different manner with the aid of special equipment, consisting of a fairly long threaded bolt with nut and compression plate and a removable head plate, as illustrated. During installation procedure, bearings are properly aligned in the gearcase (top and bottom), the head of the bolt drawn out of its slot and removed for the moment. This is followed by inserting the bolt down through both bearings (head end first), inserting the head plate in its respective slot, then by slowly and carefully drawing up on the nut to draw the bearings into position. The bearings are thus ready for the required line reaming operation. After having completed line reaming operations, make certain all chips have been removed and inside of the gearcase washed out thoroughly to guard against damage to gears and other parts by remaining solid particles to wedge between the teeth of the gears or lodge in the water pumping mechanism as is possible in many instances.



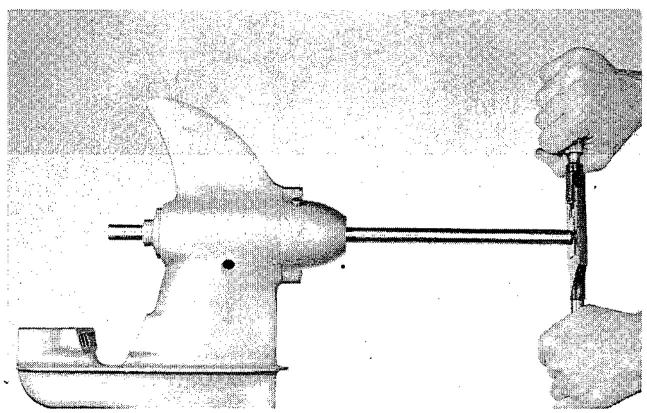
Illustrating Use of Tool Described Above—Drawing Bearings (Bushings) into Position in the Gearcase



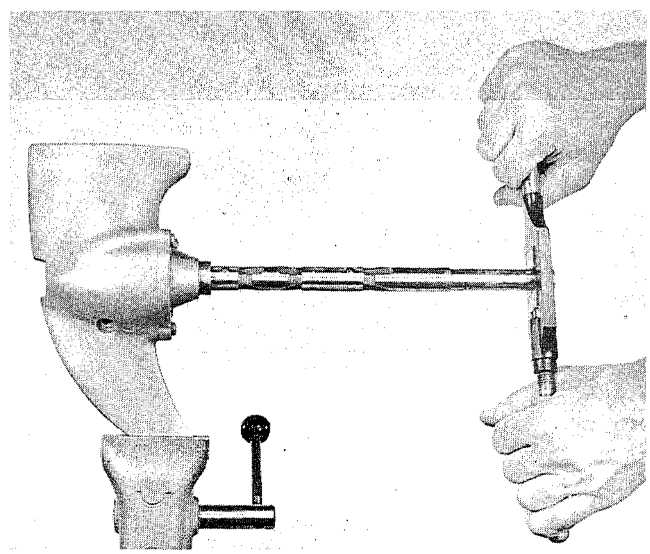
Reaming Top Pinion Shaft Bearing (Bushing) in Gearcase



Showing Hole Drilled Through Gearcase to Provide Pilot for Reaming Bearing (Bushing) in the Gearcase Head. This Fixture can be Constructed from a Discarded Gearcase—KS-KD Series. Construct Brass Bushing to Fit Ball Bearing Seat to Actually Pilot Reamer



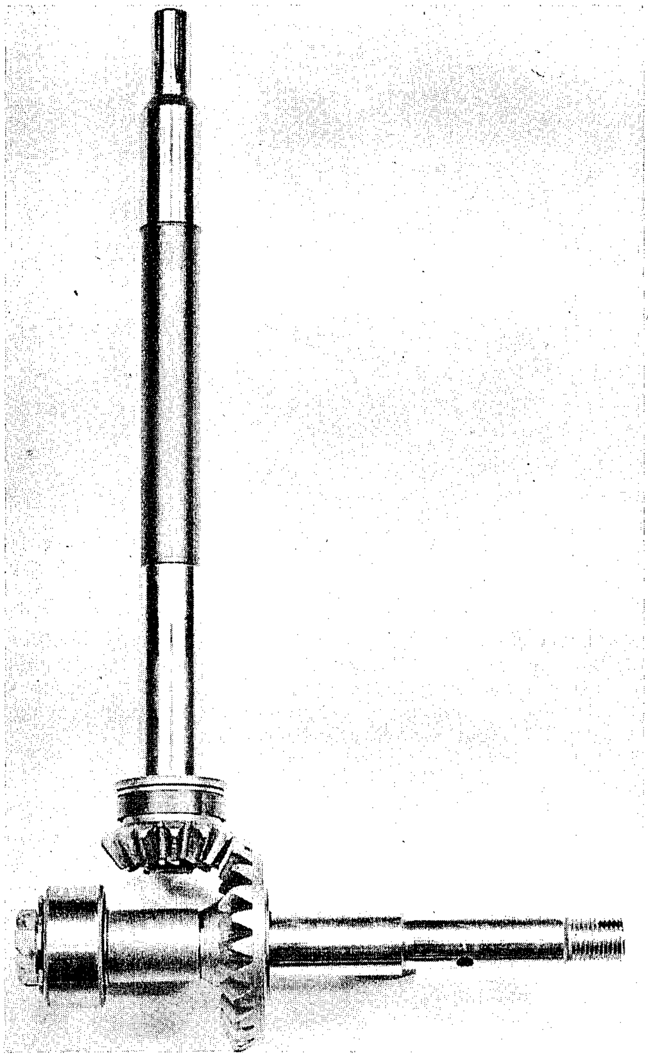
Reaming Propeller Shaft Bearing in Gearcase. Models Prior to K-75 and Other Models of Similar Construction



Reaming Gearcase Head Bearings (Bushings) Using Fixture Described Above

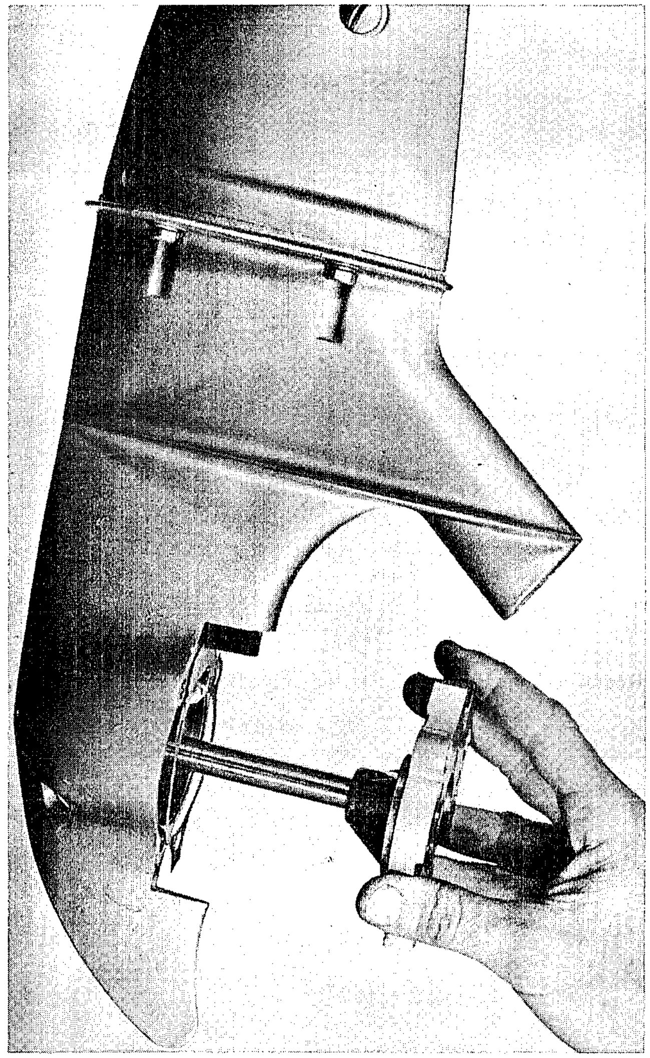
Reassemble the gearcase carefully with necessary new parts, using new gaskets, coated with non-drying cement. Check for free movement of the entire assembly — binding or excessive drag is the result of insufficient bearing clearance (see clearance chart), misalignment of the bearings or improperly meshed gears (or by attempting to mesh an old and worn gear with a new gear—always replace both gears in this case). Adjust gear mesh with adjusting screw or nut as provided in many instances — draw up until gears actually bind then back off approximately one-half (½) turn on the adjusting screw or nut. Tap end of the propeller shaft lightly with a rawhide mallet to drive assembly back. Check for "feel" of mesh, turn propeller shaft to make sure no binding occurs at any point. Lock adjusting screw or nut in position. Tightly meshed gears cause them to "growl" in operation and in extreme cases affect performance of the motor.

Gear mesh in many models is not adjustable, in a sense, in that proper mesh is provided in original manufacture by accurately pinning the bevel gear to the propeller shaft and maintaining close tolerances with respect to bearing locations and thrust faces—same close tolerances being upheld in manufacture of replacement parts to make any and all like parts interchangeable.



Showing Conventional Arrangement of Gears, Ball Bearing, Pinion Shaft and Propeller Shaft in Gearcase

Many gearcases employ the use of seals on the propeller and driveshafts to assist in retaining gear lubricant, otherwise where not provided, lubricant is actually retained only by "fit" of the propeller and driveshafts in their respective bearings. In the case of a sealed gearcase, it is possible to use a lighter lubricant for better circulation—Sea Horse No. 2, while a heavier lubricant is necessary in the unsealed gearcase—Sea Horse No. 1.

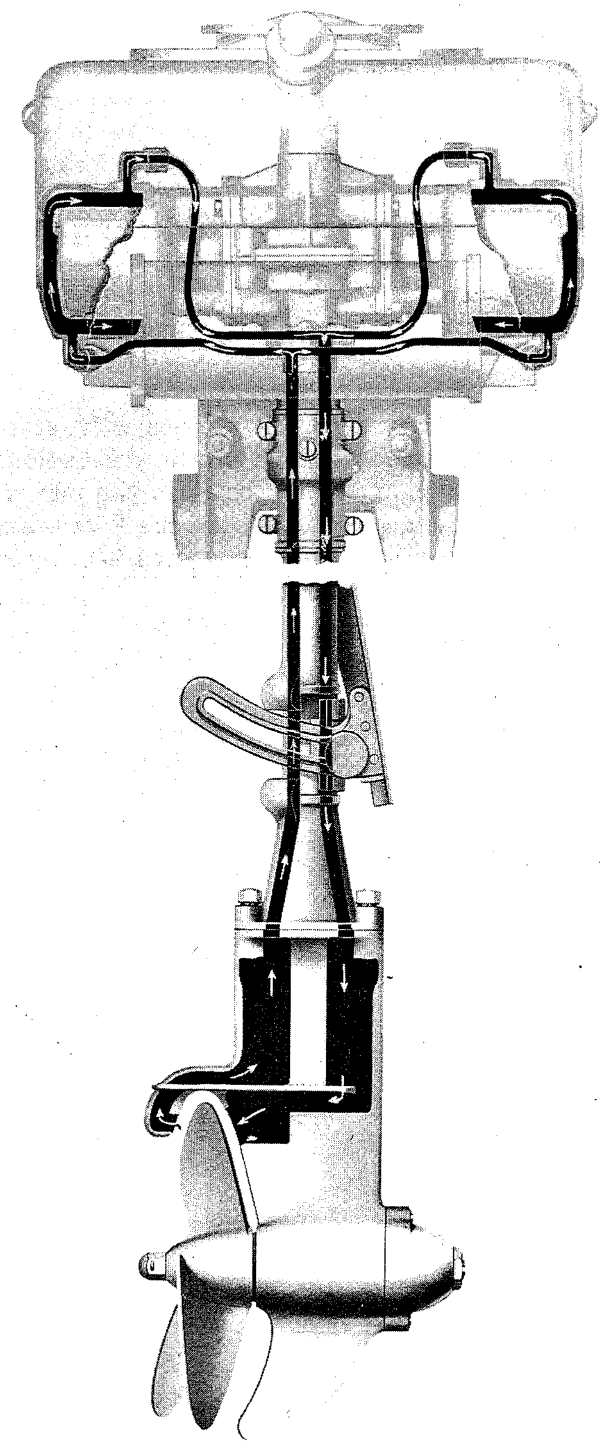


Showing Procedure for Installing Gearcase Head on HD and TD Models. Guard Against Injury to the Grease Seal by "Screwing" the Assembly on over Threaded End of the Propeller. Proceed Cautiously. Do Not Force on Over the Thread

The seals (where used) should be installed with care to guard against possible injury to the seating surface to render them unfit for sealing purposes. When required to install over threads as in the case of the HD and T models, carefully "screw" the seal over the threaded end of the propeller shaft.

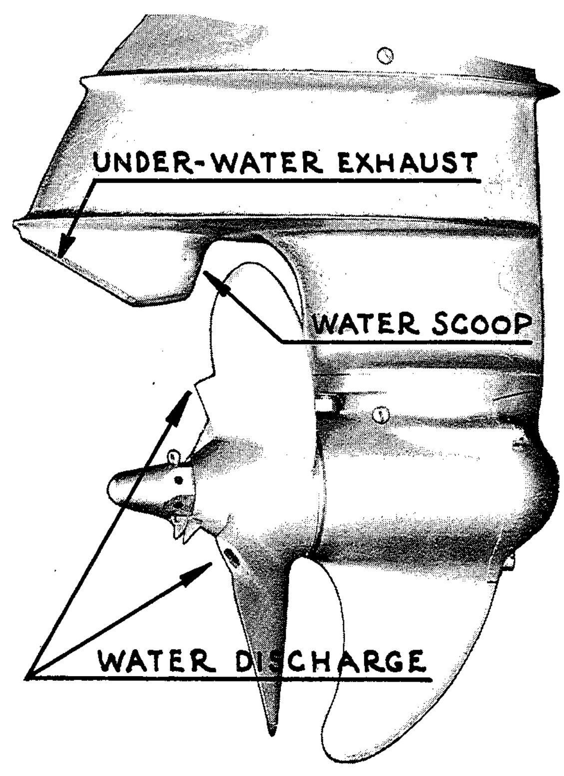
COOLING

Cooling medium in Johnson motors is naturally water, circulated through water jackets about the cylinders and in the cylinder heads—circulation being provided by the pressure-vacuum method or by means of positive pump action.



Illustrating Pressure-Vacuum Water Circulation for Cooling Purposes

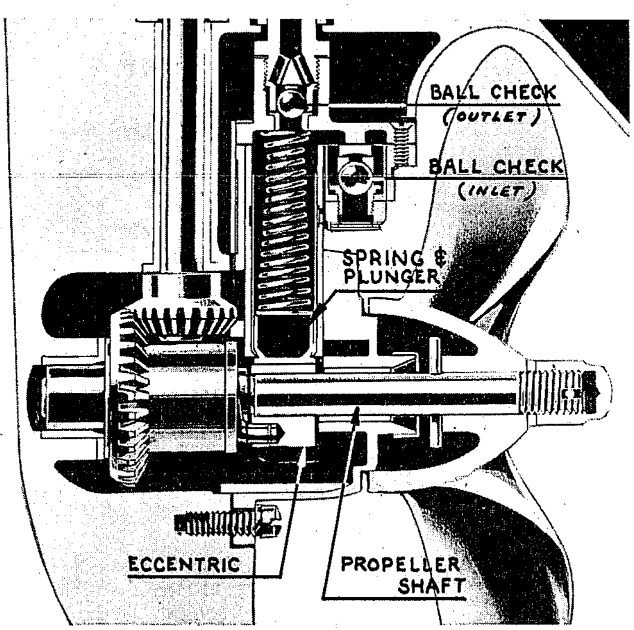
Where the pressure-vacuum method of circulation is employed, water thrown from tips of the propeller blades is picked up or gathered by a scoop in the gearcase just back of the propeller, forced through the water channels or tubing in gear and driveshaft casings and on into the water jackets to absorb and carry off excess heat generated within the cylinders as result of combustion. Discharge is by way of a second channel or by means of water tubing leading to an outlet in the gearcase immediately forward of the propeller, thus action of the propeller and forward motion of the boat aid in circulation. At slow or trolling speeds, pressure of water thrown from tips of the propeller may not be great enough to force it through the cooling system. Efficient cooling is still maintained, however, by suction as result of water flowing through the return or discharge channels (siphon). Since circulation for cooling purposes is dependent on both pressure and vacuum at slow speeds, it is important that the motor be speeded up for an instant immediately after starting, to fill the channels and water jackets with water. Overheating may be the result of having failed to perform this operation. Water circulation through the cooling system of the Model SD series is accomplished in a similar manner except that discharge is aided by providing louvers in the propeller blades as shown here to cause a centrifugal effect.



In view of there being no actual moving parts employed in this method of cooling unless the propeller is considered, the system will function so long as the water channels and water jackets remain open and are free of obstruction. All water connections in the system (gasket or otherwise) must be air tight, not so much from the standpoint of performance at high speeds but when considering slow speed operation—vacuum must be maintained if circulation is to continue for cooling purposes at slow speeds at a time when pressure created by the turning propeller and resultant slow motion of the boat are not sufficient to provide ample circulation. Loose or defective water connections permit air seepage into the cooling system to break the seal or destroy siphoning effect. Water flowing through the return channels results in continual circulation, providing ultimate discharge is slightly lower than the inlet and that slight aid is abetted by action of the propeller — air seepage into the cooling system at this time breaks the seal (siphon) and causes water to stop flowing — result is overheating.

Excessively worn propeller blades are frequently the cause of overheating at slow and intermediate speeds simply because overall diameter of the propeller is reduced to proportionately affect performance of the water scoop in that tips of the propeller blades are now further distant from the water scoop to result in lower pressure.

Water jackets clogged with the effects of salt water corrosion, water channels clogged with mud (from resting motor on muddy beach) and marine growth are also factors contributing to faulty water circulation and subsequent overheating.



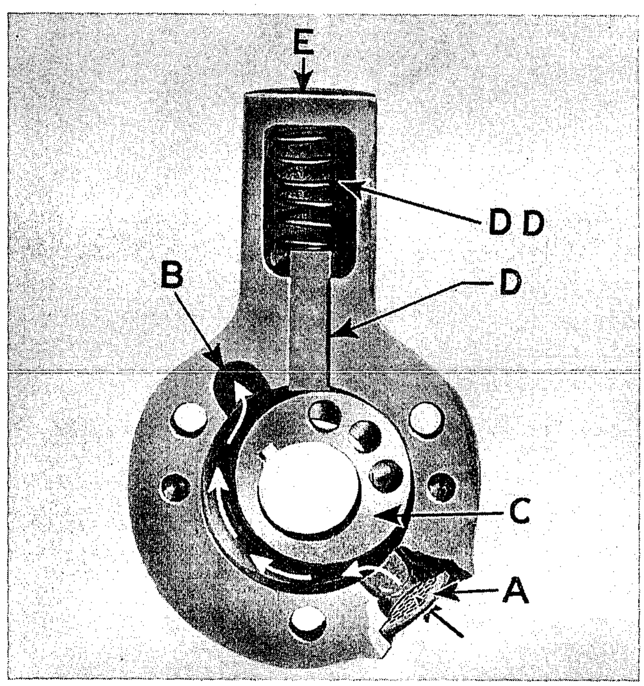
Sectional View of the Plunger Type of Water Pump

Positive pressure for water circulation is accomplished by means of a plunger pump, eccentric and vane assembly or by action of a rubber rotor operating on an eccentric within a housing attached to the gearcase.

The plunger type of pump consists of a cylinder in which a plunger is installed and operated by means of an eccentric on the propeller shaft—contact between the plunger and face of the eccentric being maintained by action of a spring. Two check valves (one inlet and one outlet) are installed in the head of the pump assembly to control flow of water. Check valves on many of the older models were of the poppet type while those on motors of later vintage were of the ball check type.

Failure of the pump to perform satisfactorily could be the result of one or a combination of the following:

1. Obstructed inlet screen.
2. Excessively worn cylinder, plunger or eccentric.
3. Weak or broken spring.
4. Faulty check valves and their respective seats.
5. Loose or otherwise faulty water connections.
6. Gear lubricant seeping between the plunger and cylinder walls to foul the check valves or excessive pressure in the gearcase to interfere with plunger action as result of over supply of gear lubricant.



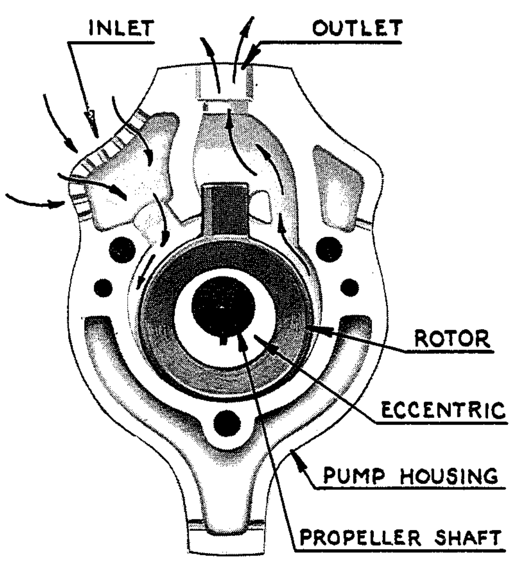
Sectional View of Sliding Vane Type of Water Pump
A—Water Inlet (Suction)
B—Water Outlet (Pressure)
C—Cam (Eccentric)
D—Sliding Vane
DD—Spring
E—Pump Housing

The sliding vane type of pump includes an eccentric or cam keyed to the propeller shaft and a vane fitted into the pump housing which constantly follows contour of the cam as it revolves—contact being maintained constantly by a small spring installed in the housing and bearing against the top end of the vane. Pumping action is created by simply displacing the volume or void immediately forward of the high side of cam as it rotates with the propeller shaft. Suction occurs after the high side of the cam has uncovered inlet "A" and continues until high side of the cam uncovers outlet "B" (leading eventually to the cylinder water jackets by means of copper or aluminum tubing) after which water thus accumulated is forced through outlet "B" as the cam continues to rotate with operation of the motor.

Failure of the pump to function efficiently can be attributed to one or a combination of the following:

1. Clogged inlet screen.
2. Weak spring.
3. Excessively worn or scored cam (eccentric) or housing.
4. Excessively worn vane (side faces) or housing at this point.
5. Excessive clearance between cam and pump housing.
6. Sheared key on propeller shaft.
7. Faulty water tube connections, obstructed or clogged cylinder water jackets.

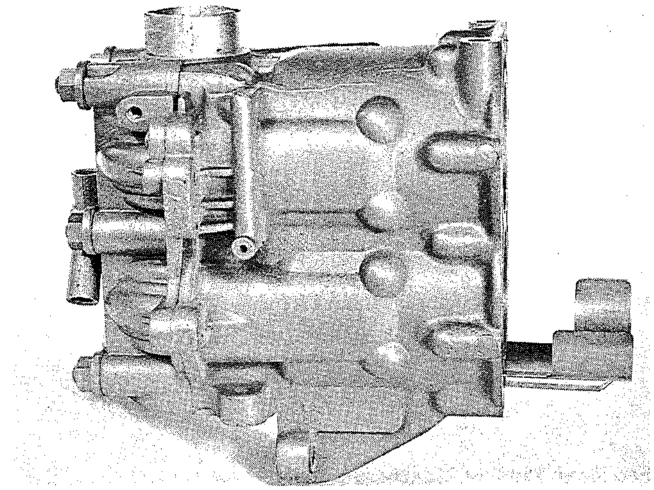
The rotor type of pump employed to circulate water through the cooling system actually functions in a manner like that described above though it differs somewhat in details of construction. As can be seen from the illustration, it consists of a housing and rubber rotor operating on a cam or eccentric pinned to the propeller shaft. The rubber rotor is so constructed as to function as both the eccentric and sliding vane.



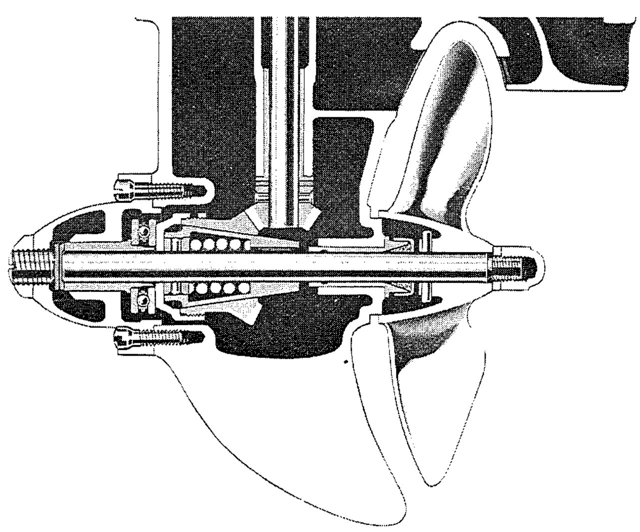
View of Rubber Rotor Pump (Removed from Gearcase)

Failure of the pump assembly to perform can be laid to one or a combination of the following:

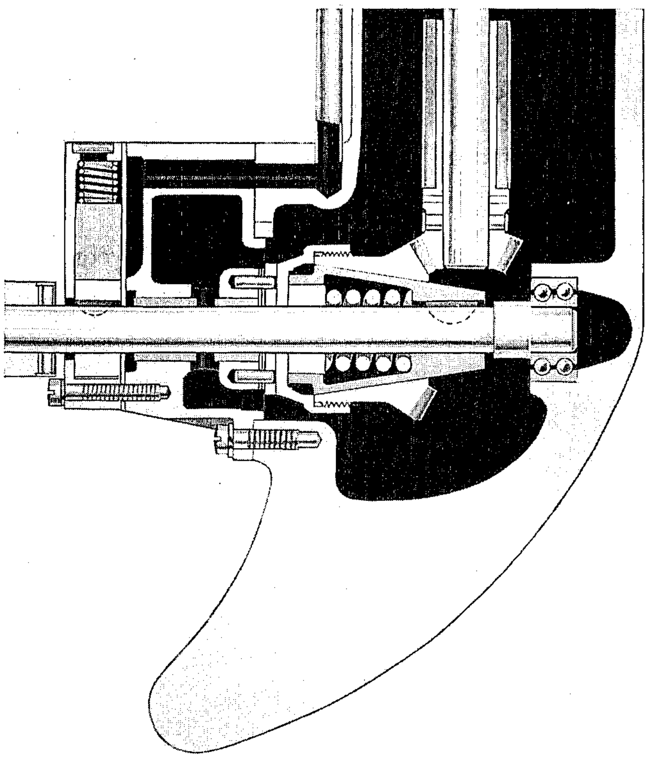
1. Clogged inlet.
2. Excessively worn rotor or housing or both.
3. Faulty water tube connections.
4. Excessive clearance or wear between side wall of the rotor and pump housing.
5. Pump housing loose on the gearcase.



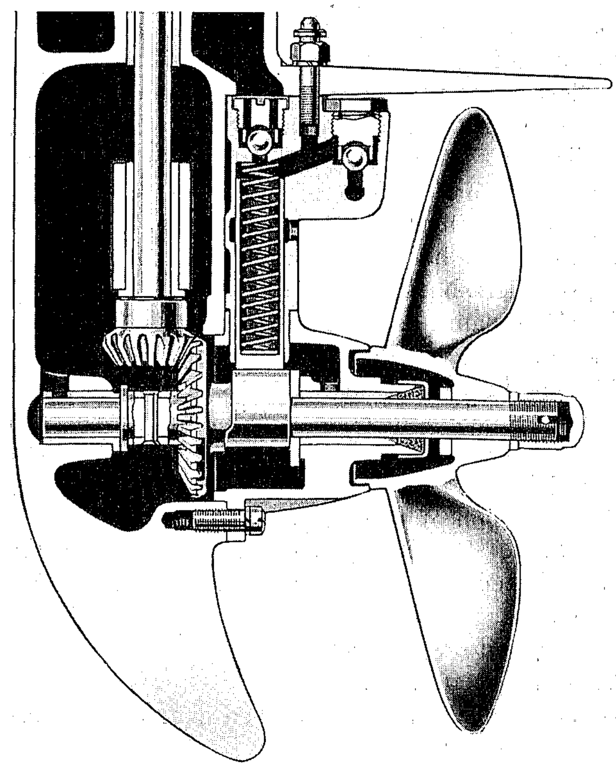
Showing Water Deflector Insert as Installed in the Water Jacket of the Model TD Cylinder Block—(Partially Removed Here for Purpose of Illustration). Function of Deflector is to Prevent Cold Water from Striking the Bottom Side of the Lower Cylinder Wall thus Avoiding Creation of a "Cold Spot." Result is that Cold Water Coming from the Pump is More Evenly Distributed to Better Balance Temperature in the Water Jacket.



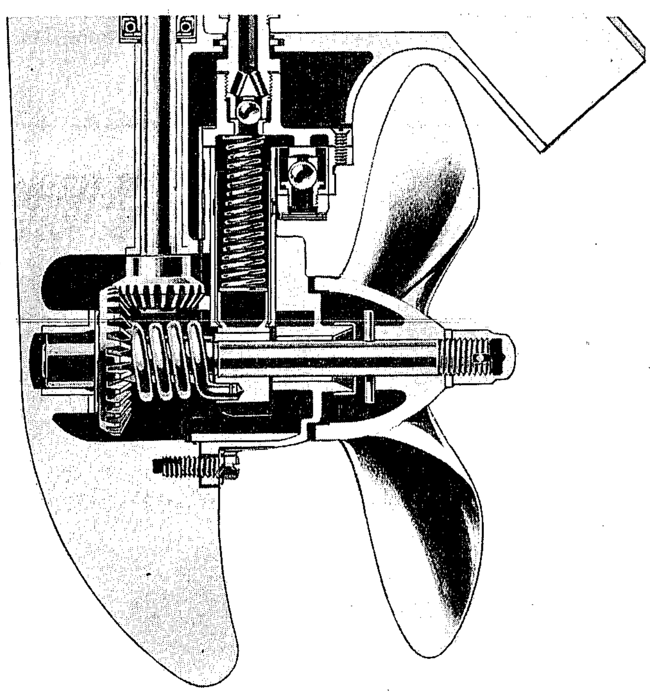
Illustrating Type of Gearcase Used in Models A-35-45, K-35-40, KR-40, K-45, K and A-50-65, AA-37, K-75-80, P-30-35-40-45, Employing Installation of Cone Clutch (Shock Absorber) Attached to the Propeller Shaft. Pressure-Vacuum Cooling



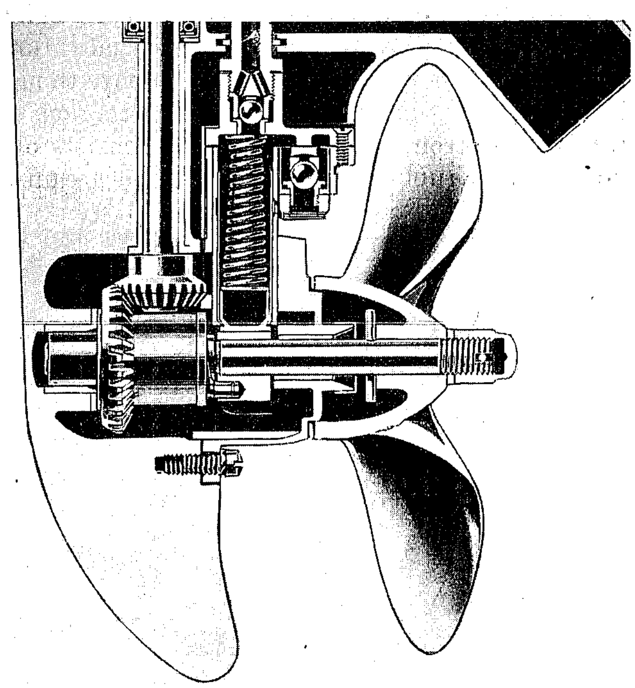
Sectional View of Gearcase Construction Installed on Models OA and OK-55-60, OK-75, Employing the Use of a Sliding Vane Water Pump and Cone Clutch (Shock Absorber) Attached to the Propeller Shaft. Note Combination of Friction and Non-Friction Bearings



View of Gearcase Assembly Used on Models J-75, F-75 and 300, Employing the Use of the Plunger Type Water Pump and Cone Clutch (Shock Absorber) Attached to the Driveshaft

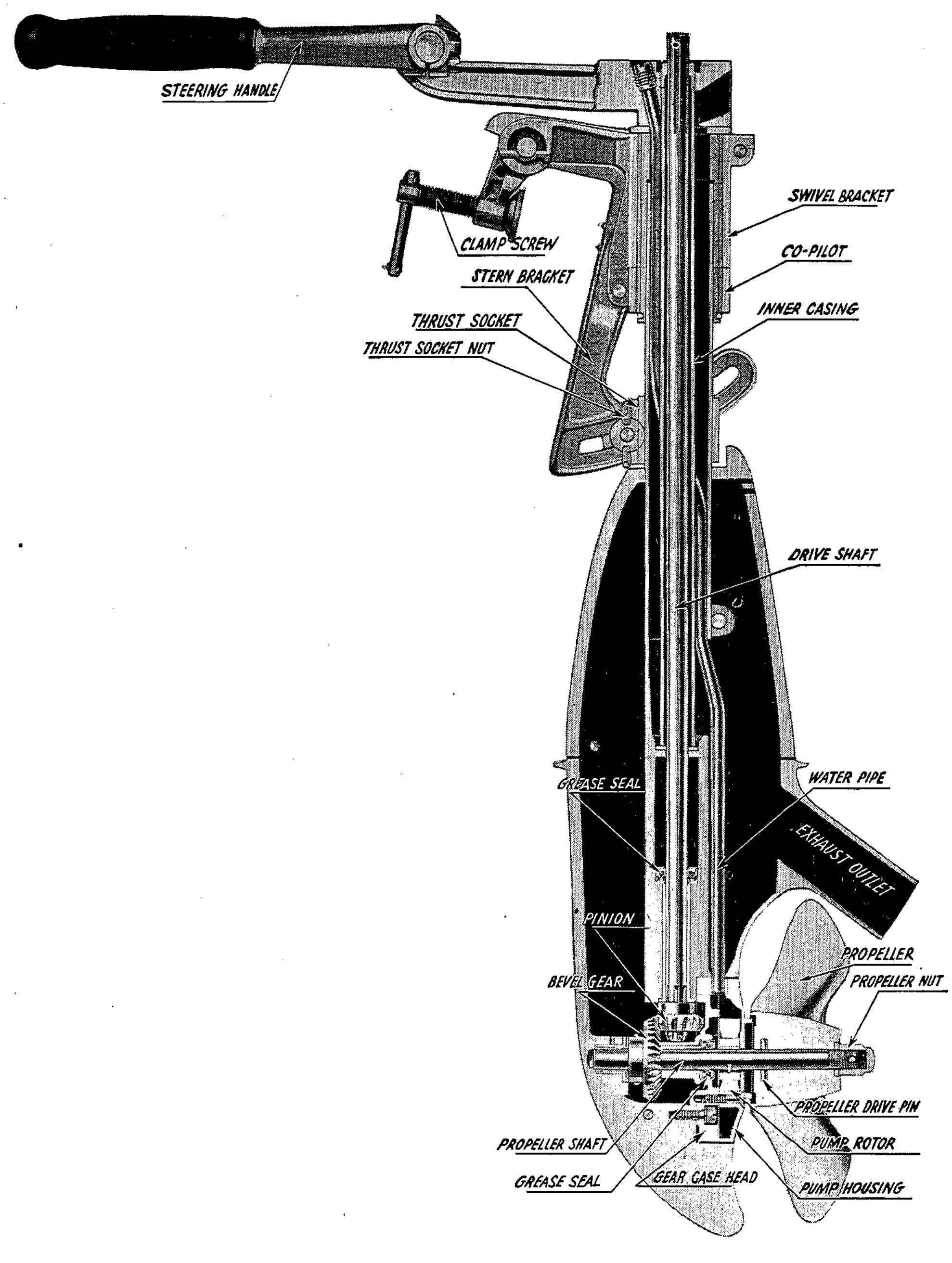


Sectional View of Gearcase Used in the Assembly of Models LS and LT-37 Employing Plunger Water Pump, Spring Type Shock Absorber, Grease Seals and Under-Water Exhaust



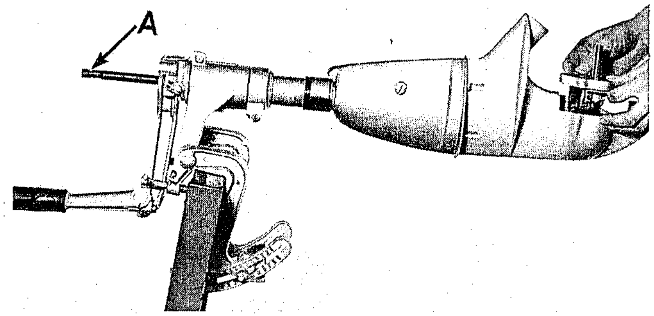
Sectional View of Gearcase Assembly Used in Models LS-38, LT-38-39, and 10, Similar to Earlier Models of Like Construction Except that a Spring and Housing Shock Absorber Assembly Replaces the Simple Spring for this Purpose

LOWER UNIT ASSEMBLY (MODELS HS, HD, TS, TD)



To remove propeller shaft, gears and drive shaft from lower unit, proceed as follows:

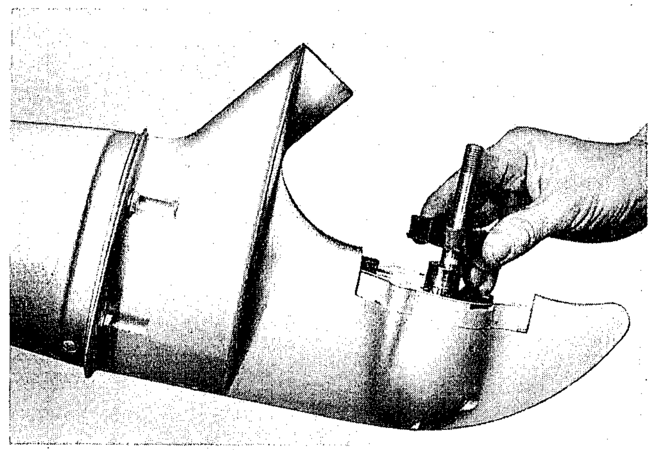
1. Partially withdraw drive shaft as shown here.



Showing Removal of Gearcase Head from Lower Unit

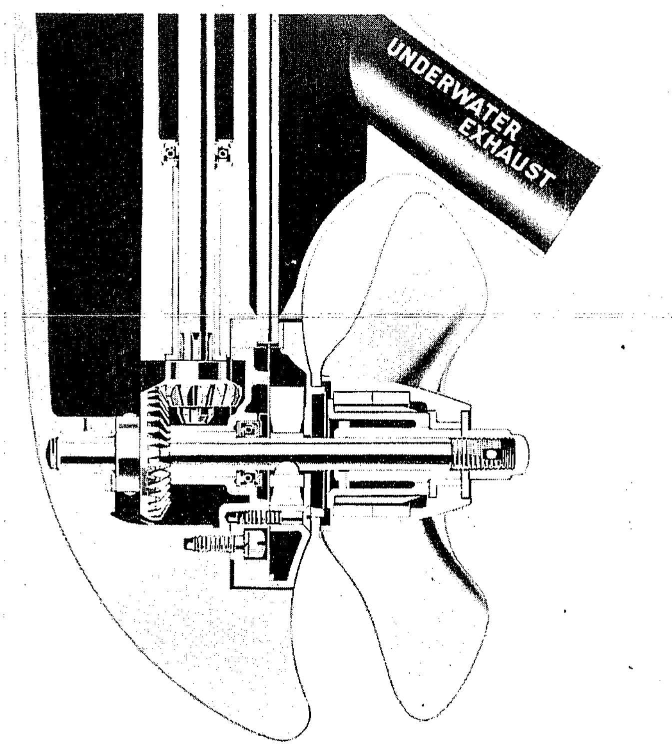
2. Remove pump housing and gear case head—each held in position by three screws.
3. Lift out propeller shaft, gear assembly and pinion. (Gear case houses only propeller shaft, bevel gear and pinion.)
4. Reassemble in reverse order of that described above—installing whatever new parts may be necessary. Note: Bearings in gear case and gear case head are cast in, consequently when found to be excessively worn are not replaceable—a new gear case and gear case head are required under these circumstances. Drive shaft, propeller shaft and bearing are machined to such sizes to permit clearance of .0015″ on propeller bearing and .0025″ on drive shaft bearing. When necessary to install new gear case and gear case head, it is advisable to include new drive shaft and propeller shaft assembly.
5. Refill with fresh gear lubricant as instructed.

In event of excessive overheating of motor, source of difficulty may lie in the pump rotor, which probably will necessitate replacing. To install new pump rotor, proceed as follows:

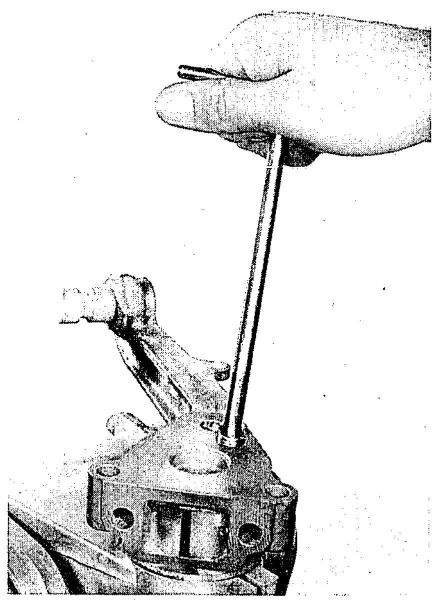


Showing Installation of New Pump Rotor

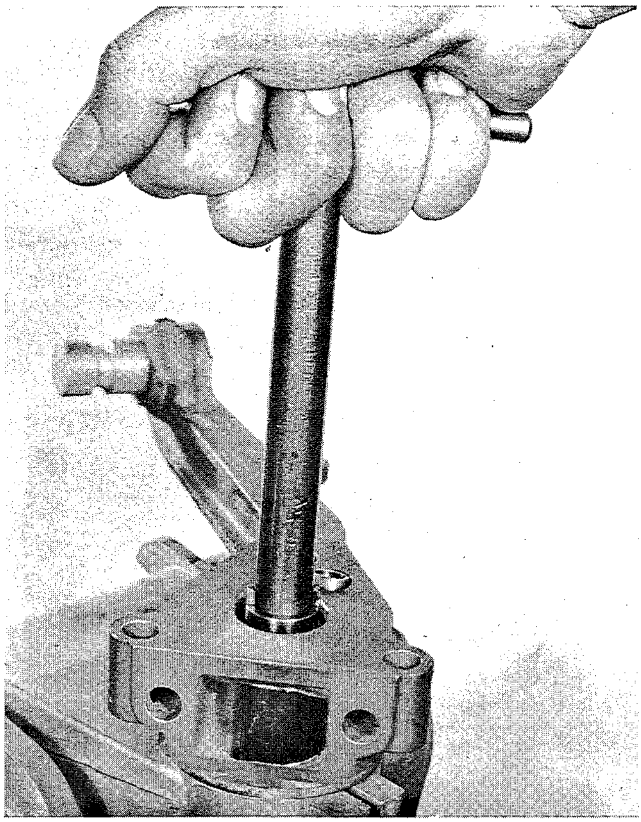
1. Remove propeller nut cotter pin.
2. Remove propeller nut.
3. Remove propeller.
4. Remove water pump housing (held in position by three screws).
5. Lift old rotor from eccentric.
6. Install new rotor — slip over pump eccentric.
7. Reassemble all parts in reverse order of above.



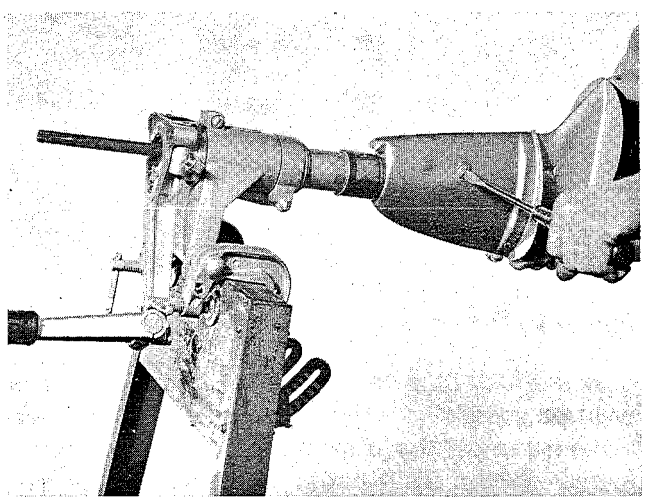
Gearcase (Models HS, HD, TS, TD)



Removing Water Tube from the Driveshaft Casing



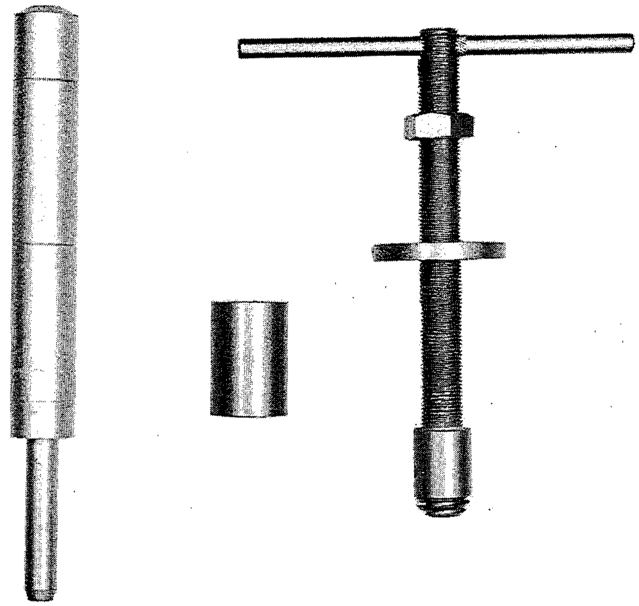
Illustrating Use of Tool No. S-261 for Removing Inner Tube from Driveshaft Casing



If it becomes necessary to remove the gear case housing from drive shaft casing, simply loosen large screws and pull in twisting motion as shown above. Assemble in reverse order.

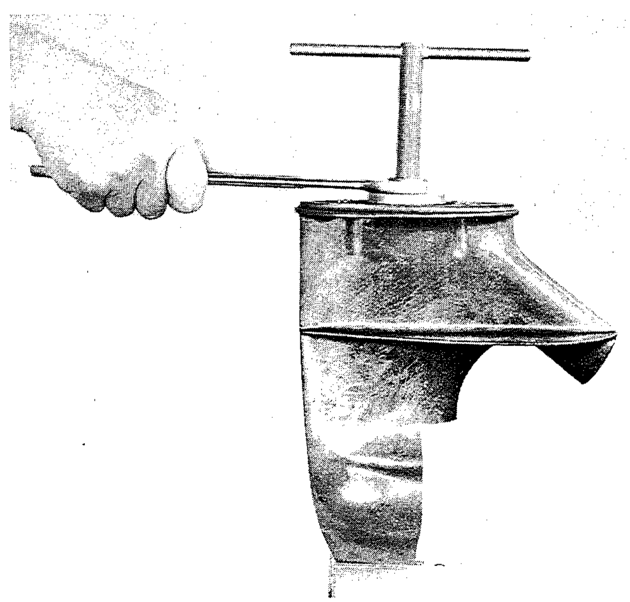
GREASE SEALS

Removal and installation of grease seals (Nos. 41-62) as employed in the gear cam and gearcase head of Models TS-TD, LS-LT, can easily be accomplished with aid of special tool illustrated below.



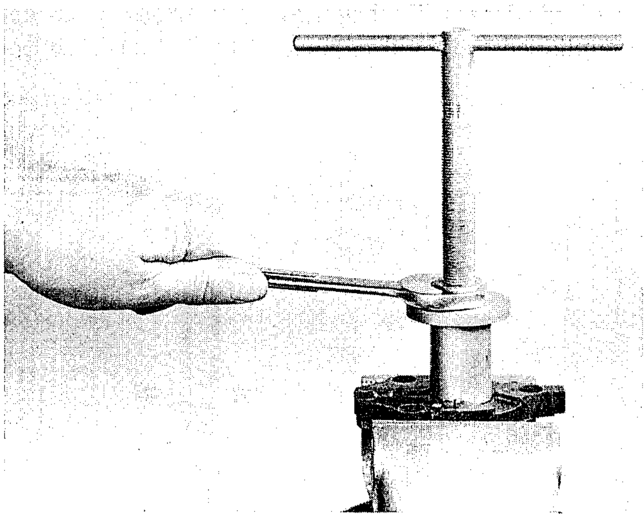
Seal Drive, Bushing and Seal Extractor

To remove the seal from the driveshaft casing, simply insert extractor into the gearcase head, then turn extractor screw into the seal to obtain a firm grip. Turn nut on the bolt down against the plate provided for this purpose — continue turning until the seal is withdrawn from its seat.



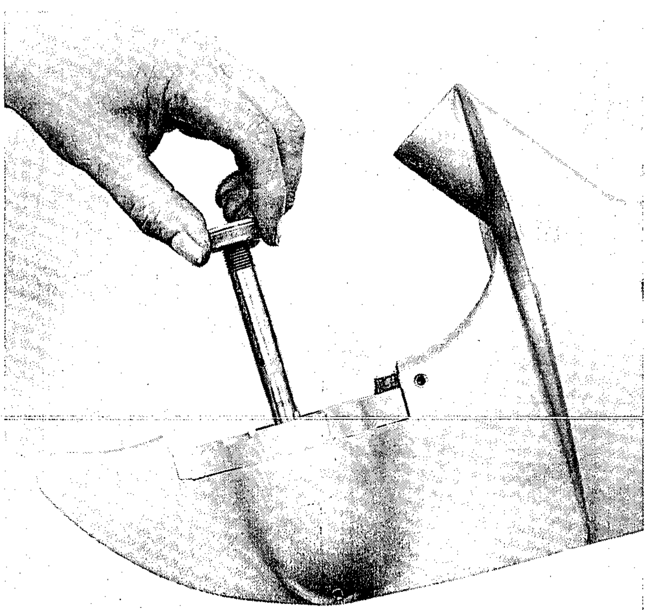
Removing Seal from the Gearcase

To remove seal from the gearcase head, proceed in like manner, using the bushing to pull against the head.



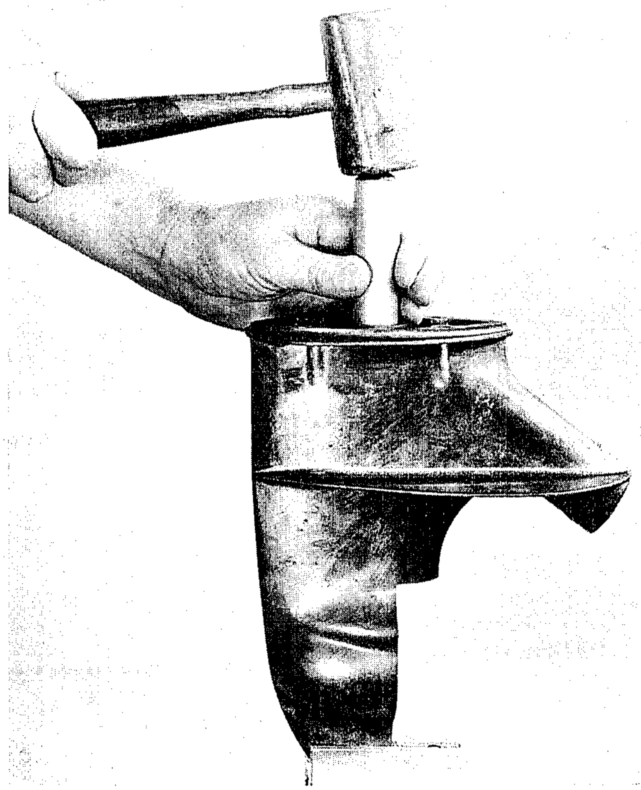
Removing Seal from Gearcase Head

Check seal seats in the housings for burrs, scores, or other damage which are apt to permit grease escaping around the seal even though the seal proper functions as it should. The seals must be properly seated in their respective housings.



It May Be Preferable in Some Instances after Removing the Grease Seal in the Gearcase Head to Attach the Seal to the Gearcase Prior to Installing a New Seal—the Propeller Shaft, in this Instance Acting as a Pilot. However, on Installing the Seal, Extreme Precaution Should be Taken when Assembling on the Propeller Shaft to Avoid Injury to the Seal Surface. Turn the Seal Down on the Threads as Shown Here. Do Not Force over the Threads. After Passing the Threaded End, Slide the Seal into Position for Seating. Carefully Drive Home to Seat—Do Not Crush the Seal

To install a new seal, place the seal in position on the pilot of the tool—stamped end of seal up. This is important. Grease will continue to discharge from the gearcase if the seal is installed upside down. Insert tool with seal attached—pilot located in the driveshaft bearing. Drive the seal into position—lower guide line on the driver flush with top of the gearcase. In case of Models LS-LT, drive to the upper guide line. Extreme caution should be exercised during this operation since it is possible to crush the seal by driving beyond points indicated.

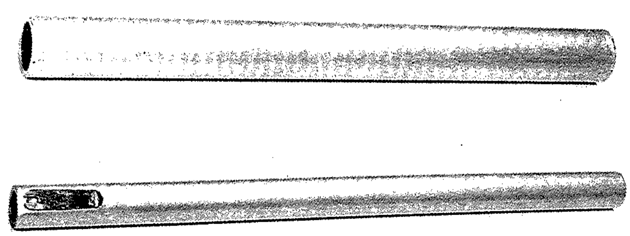


Driving Grease Seal into Position

When installing the gearcase head with seal in position, carefully "screw" the assembly down over threaded end of the propeller shaft to guard against damage to the seal—under no circumstances push the seal down over the threads.

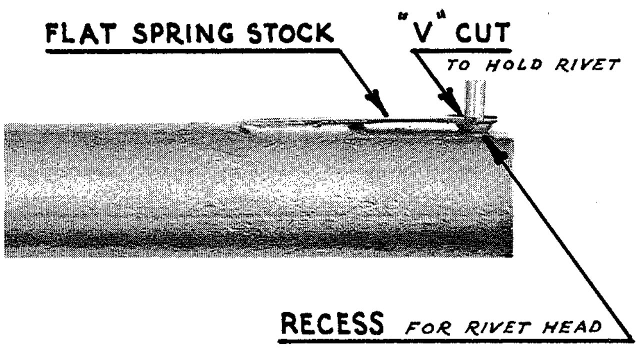
INSTALL THRUST SOCKET LINING ON DRIVESHAFT CASING

When necessary to install thrust socket lining on the driveshaft casing, Models HS-HD—TS-TD, a very simple arrangement can be constructed for



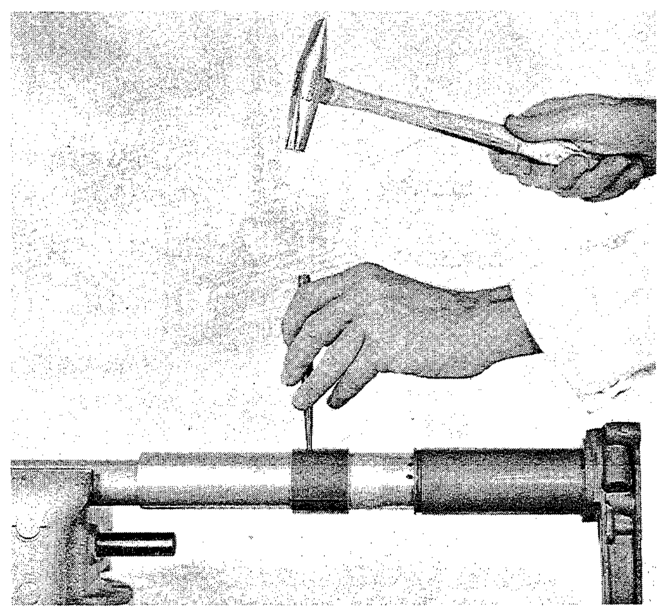
Tools for Installing Rivets in Driveshaft Casing

this purpose—using an 18″ length of ½″ and 1″ gas pipe. Grind a short flat space on one end of the ½″ pipe and about ½″ from the end of the pipe. On the flat, drill a recess deep enough to fit the head of the rivet. Sweat a narrow piece of spring stock (provided with a "V" at opposite end for holding the rivet) to the flat on the pipe, as shown here.



End View of Tool Inserting Rivet

To accomplish the installation, first place liner in position on the driveshaft casing then insert rivet (end of small pipe) as shown above. Insert ½″ pipe, with rivet installed, into the driveshaft casing to guide rivet through hole in the driveshaft casing and the nole in the liner. "Cock" liner slightly to hold rivet in place—install second rivet in like manner. Place the large pipe in a vise—carefully slide the driveshaft casing, with liner and rivets in place, over the pipe. Upset rivet with punch as shown below. Upset just enough to secure the rivet.

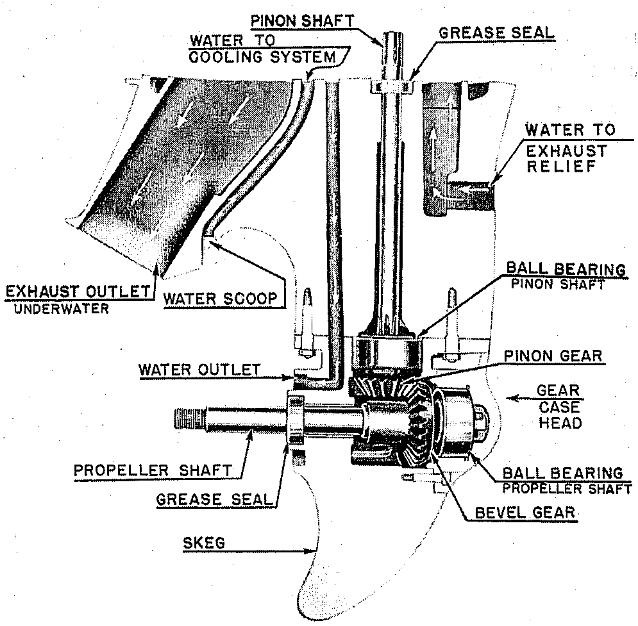


Riveting Lining into Position

NOTES

LOWER UNIT ASSEMBLY—MODEL SD

Like all other service operations, assembly of the lower unit should be carefully performed, following the same general procedure described earlier in this Manual, but paying heed to differences in construction.



A combination of friction and non-friction bearings is employed as can be seen from the sectionalized view of the gearcase assembly—non-friction bearings being installed in positions of maximum load, immediately back of the gears. The propeller and pinion shafts are provided with grease seals.

The gearcase assembly is built up of the gearcase and the upper or pinion shaft casing, bolted together with a gasket inserted to retain the gear lubricant. Disassembly can be accomplished by first removing the gearcase head, followed by removing nuts on the studs provided for this purpose. It is a simple matter then to drive the pinion shaft, gear and ball bearing assembly out of the upper case. The propeller shaft, bevel gear and ball bearing assembly are easily removed from the gearcase.

Note a slight press fit provided for installation of the pinion shaft ball bearing and that the bearing is pressed onto a shoulder or boss on the gear. To remove, grasp the bearing in one hand and tap exposed end of the gear shoulder lightly with small brass hammer or piece of soft metal to drive the gear out. It is advisable to perform this operation over a bench top to guard against the gear falling on the floor.

To assemble the gear and ball bearing, make certain that face of the gear shoulder or boss and inside face of the ball bearing retainer are clean and coated lightly with oil. Set the bearing flatly on the shoulder of the gear to avoid "cocking"—this is important. Carefully press the bearing into position.

The ball bearing on the propeller shaft is removed by straightening the lock plate lug, followed by removing the nut holding the assembly together. The bearing, gear and sleeve can then be removed from the propeller shaft. Purpose of the bushing is to hold the pinion shaft in position, thus, the end of the pinion shaft "rides" on the bushing during operation of the motor. To reassemble, proceed in order reverse of that described above, making certain that all parts are in good mechanical condition and free of foreign matter. Keep hands and bench clean. Install new lock plate —bend lug up against the nut to secure its position.

Grease seal on the upper casing can be removed in a manner similar to that described for like operation on the gearcase of Models TS-TD. The propeller shaft seal can easily be "picked" out with a blunt instrument. New seals can be installed by carefully driving into position — flat with machined surfaces on the upper case and gearcase head. Stamped end of the seal UP. Small diameter of the seal should be directed down to retain the gear lubricant.

Prior to assembly of the unit, it is advisable to "spin" the ball bearings to check for possibility of grit having found its way into the bearing assemblies. In this event, rinse the bearings out in clean gasoline, kerosene or other grease solvents. Spin bearings to further check for presence of grit. Rinse, if necessary, to remove all possible traces of grit. Place several drops of oil in each bearing —spin to spread. Foreign material remaining in the bearing assemblies may result in serious damage later on and subsequently expensive repairs.

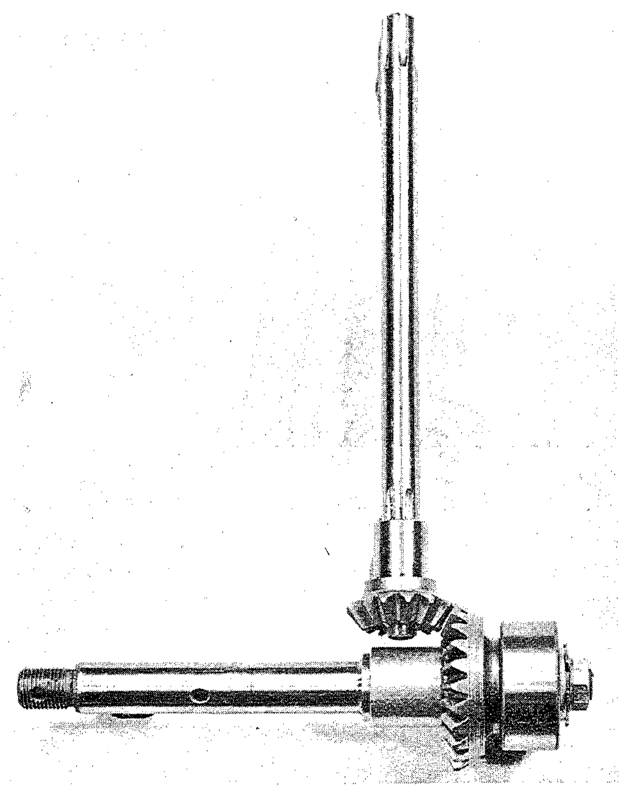
Wash out grease cavities in both the gearcase and upper casing thoroughly and carefully to ascertain that no foreign matter remains. This is IMPORTANT.

Spread thin coat of oil on upper end of pinion shaft. Carefully insert pinion shaft, gear and bearing assembly into the upper casing to avoid possible injury to the grease seal.

In event the grease seal is to be replaced, installation of the new seal can be withheld until after completing assembly of the entire gearcase

(gearcase and upper casing). It is then a simple matter to guide the seal on over the pinion shaft and to drive "home" with a bushing of proper size. Be careful not to crush the seal—drive only until it bottoms in its seat.

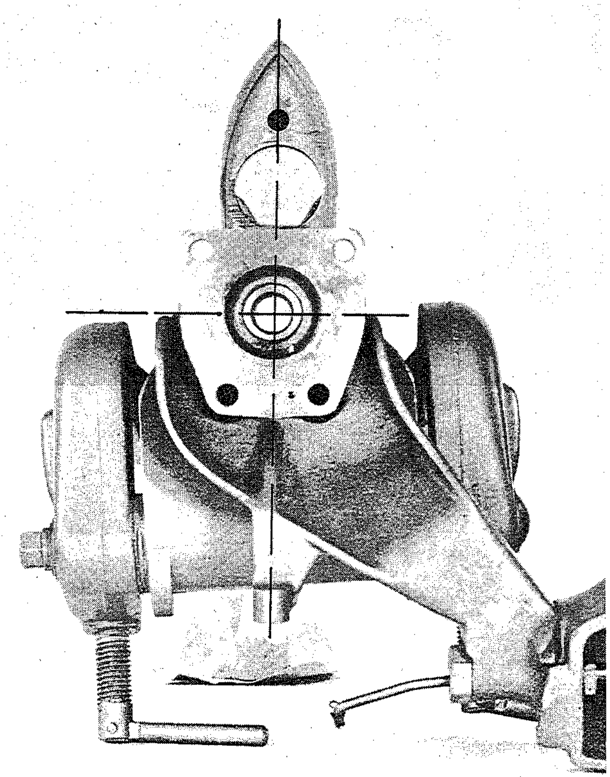
If the propeller shaft seal is to be replaced, the operation can likewise be delayed until completion of the gearcase assembly and the seal later installed in a similar manner to that described above. However, if the original seal is suitable for further service and need not be replaced, carefully proceed with assembly of the gearcase.



Proper Gear Mesh is Provided for in Holding Close Tolerances During Manufacturing Process. Gears are Correctly Meshed if the Bearing Seats are Free of Foreign Matter, Burrs or Otherwise Damaged to Prevent Ball Thrust Bearings from Properly Seating

Install new gasket, thinly coated with non-drying cement, on base of the upper casing, making sure hole provided for water circulation lines up with like passages in the upper casing and gearcase. Bolt upper casing and gearcase firmly together, with pinion shaft, gear and bearing assembly in position. Place a drop or two of oil on the propeller shaft—spread. Insert the propeller shaft, bushing, gear and bearing assembly into the gearcase. Install new gasket on the gearcase head, thinly coated with non-drying cement. Place gearcase head in position over the ball thrust bearing, being careful to avoid cocking. (Tap lightly on the gearcase head, if necessary). Install bolts holding the gearcase head fast to the gearcase. Draw up evenly and tightly. Fill gearcase with gear lubricant, simultaneously turning the propeller shaft to insure distribution.

Provide new gaskets (two)—one for each side of the plate inserted between the gearcase assembly and the driveshaft casing. Coat thinly with non-drying cement. Place one gasket on each side of the plate, making certain that holes in gasket align or match with like openings in the plate, gearcase assembly and the driveshaft casing. Bolt firmly together.

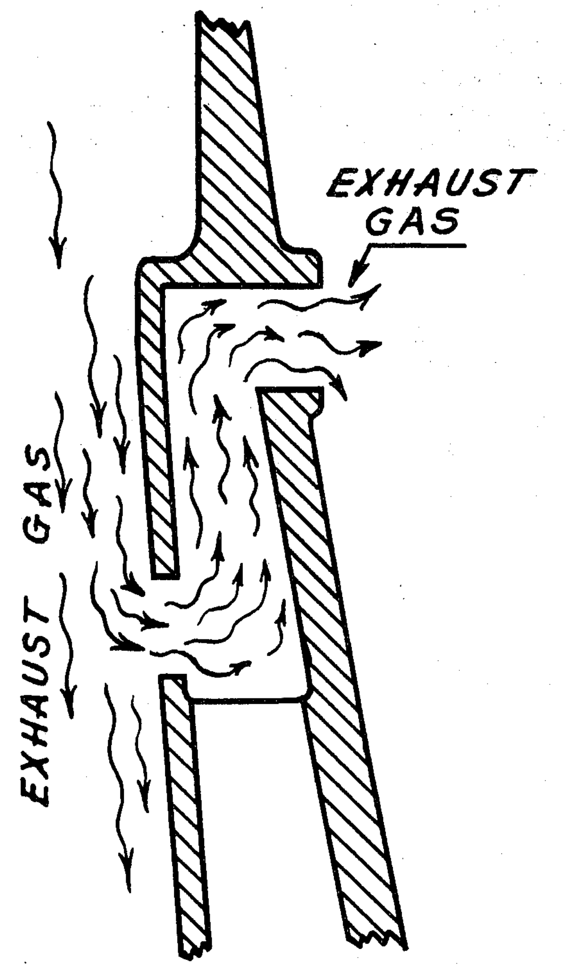


When Assembling the Stern Bracket and Driveshaft Casing, Care Should be Exercised with Respect to Obtaining Proper Alignment. Note Cross Lines and Arrows in Illustration. The Driveshaft Casing Must be Square with the Stern Bracket to Properly Align the Power Head on Assembly. Improper Alignment Will Interfere with Carburetor Control—that is, Affect Range of Barrel Valve Operation

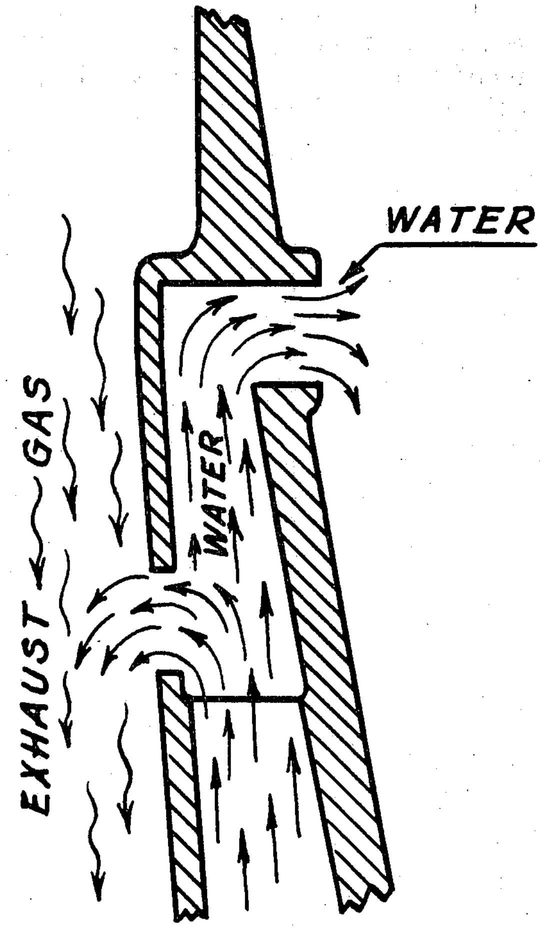
Since a rubber cushion is provided between the driveshaft casing and the steering arm to reduce transmission of torque impulses, care must be exercised when assembling the swivel bracket and driveshaft casing. The driveshaft casing must be installed in such a manner that a line drawn through its center will "square up" with center of the small boss on the steering arm as indicated by arrow in illustration above.

Purpose of this operation is to maintain original degree of carburetor barrel valve action. With the carburetor attached to the power head, which in turn is attached to the driveshaft casing, and the small bell crank in the carburetor control linkage attached to the boss on the steering arm, any deviation in original alignment will affect degree of barrel valve opening. This alignment must be maintained.

EXHAUST CUTOUT



Open

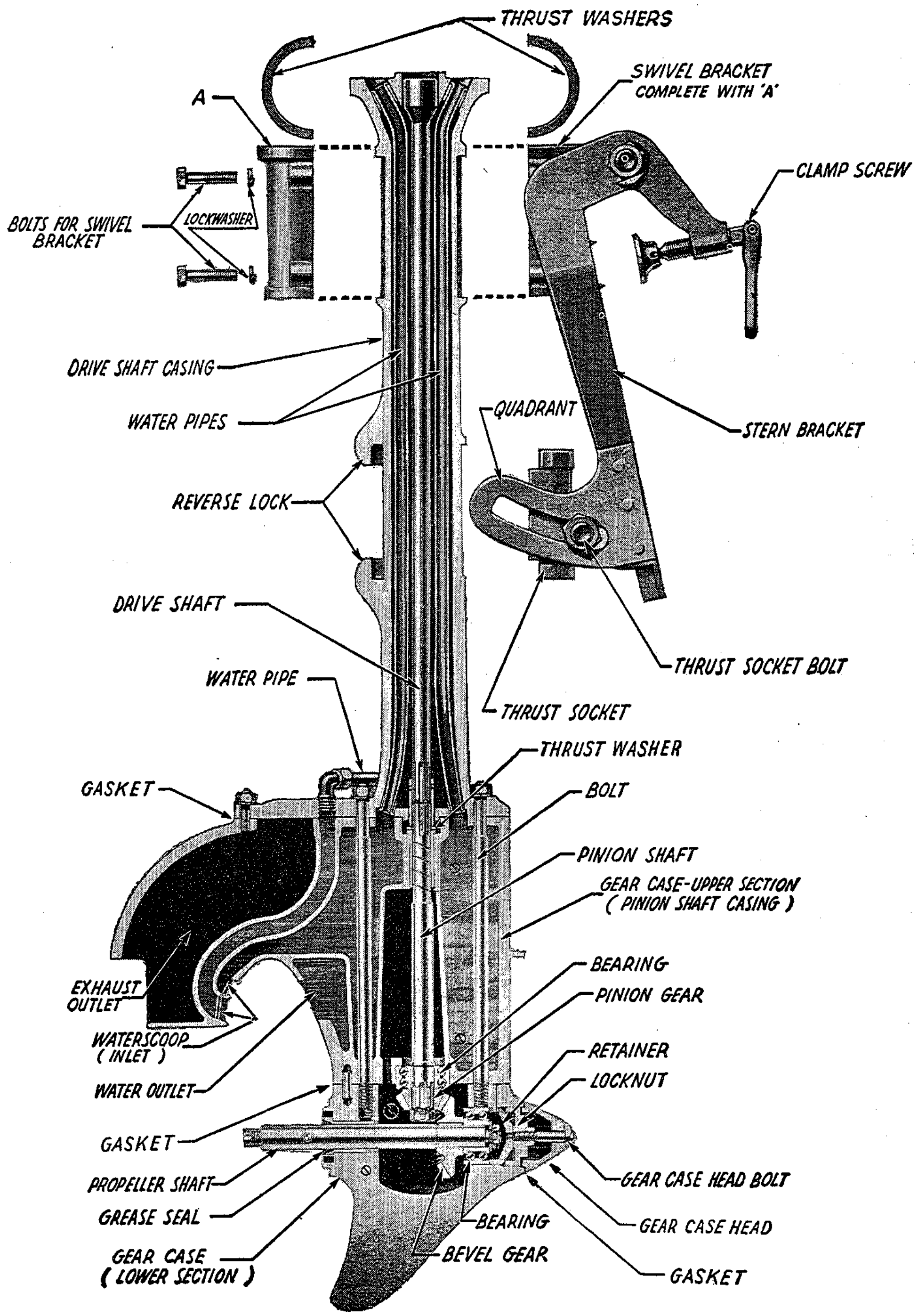


Closed

An Exhaust Cutout is Built into the Exhaust Pipe to Relieve Exhaust Pressure for Starting Purposes and Operation at Low Speeds. Its Action is Entirely Automatic and Requires no Attention, Consisting Merely of a Water Pocket Built into the Exhaust Pipe with an Opening in the Exhaust Pipe Proper, an Overflow and a Channel Leading to the Front Edge of the Gearcase

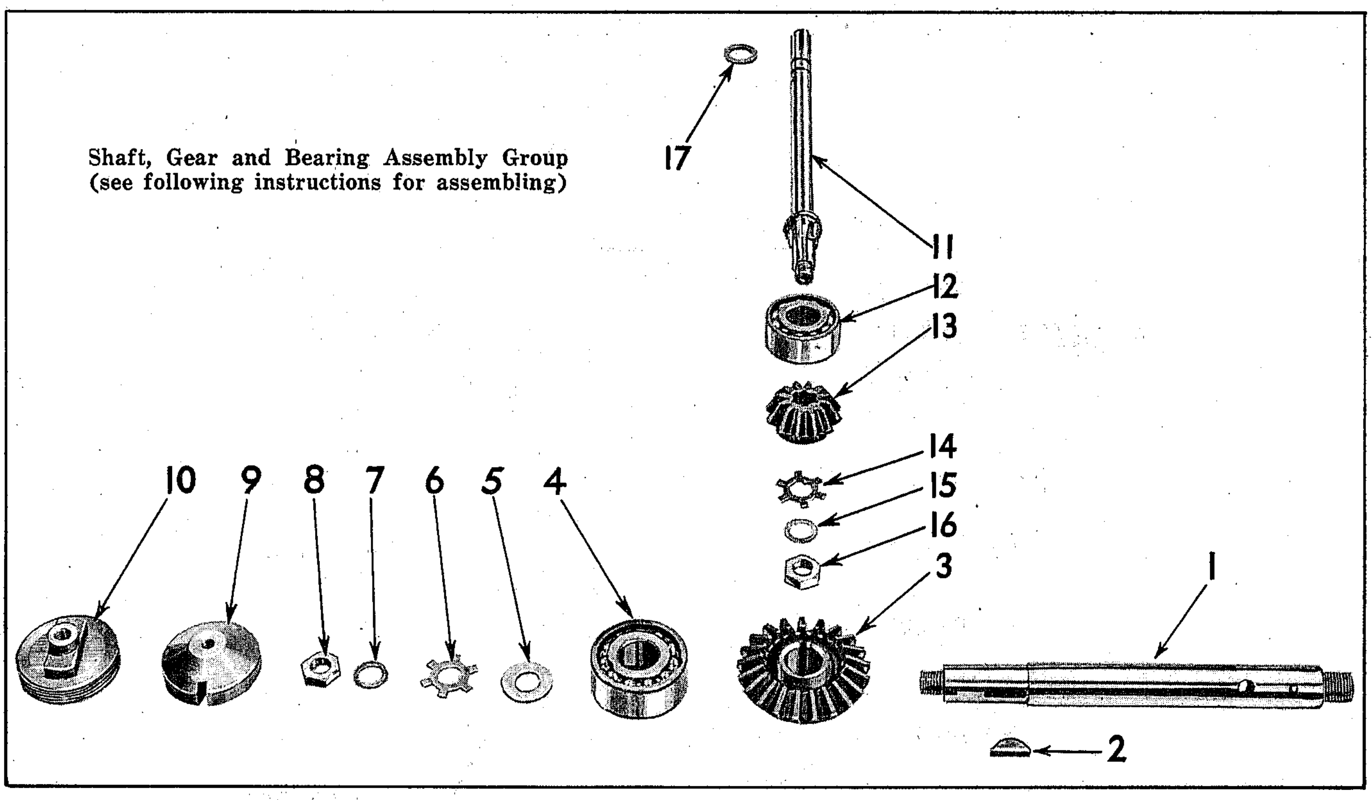
When the Motor is Idle, the Pocket is Empty of Water, thus Exhaust Gases are Free to Escape into the Atmosphere to Relieve Pressure when Cranking to Start. As the Motor is Started and the Boat Picks up Speed, Water is Forced Through the Opening in the Leading Edge of the Gearcase and is Conducted to the Pocket in the Exhaust Pipe. On Filling of this Pocket with Water, Exhaust Gases are Prevented from Escaping Above Water Level to Close Exhaust Cutout. Consequently, Water Will be Seen to Discharge from the Opening in the Exhaust Pipe While the Unit is in Operation

LOWER UNIT ASSEMBLY—(PO)



Lower Unit Assembly—(Similar to Model PO)

GEAR CASE ASSEMBLY—(MODEL PO)



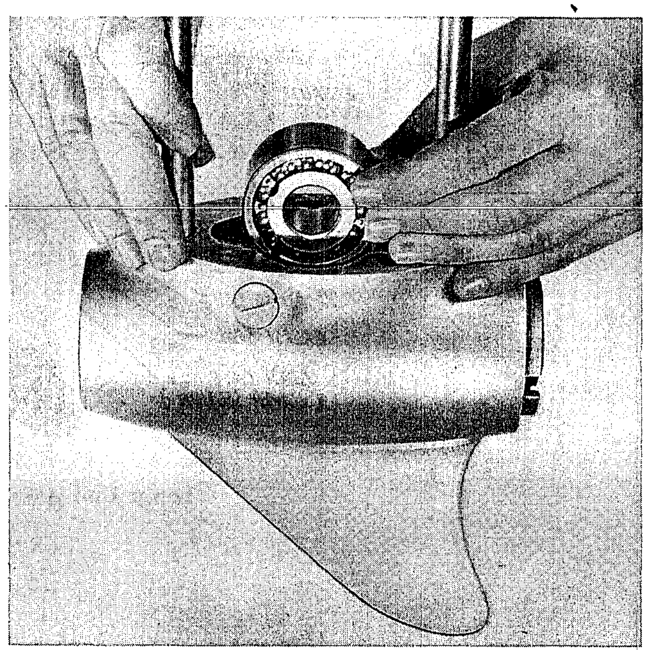
1. Propeller Shaft
2. Propeller Shaft Key
3. Bevel Gear
4. Ball (thrust) Bearing
5. Washer
6. Lockwasher
7. Washer
8. Nut
9. Retainer
10. Lock Nut
11. Pinion Shaft
12. Ball (thrust) Bearing
13. Pinion Gear
14. Lockwasher
15. Washer
16. Nut
17. Thrust Washer

TO ASSEMBLE GEAR CASE, PROCEED AS FOLLOWS:

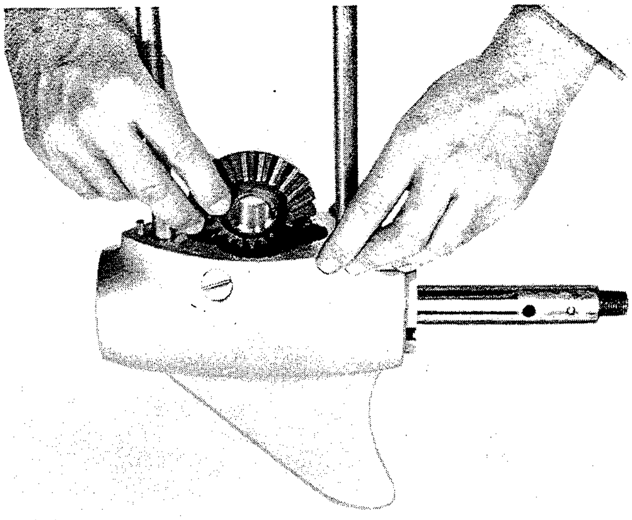
1. Insert ball bearing through top opening in gear case. Note location (seat) machined for bearing. Turn bearing around and press into seat as far as possible with fingers. Bearing cannot be seated unless square with seat. To square bearing, insert propeller shaft through both bearings to line them up, tap ball bearing in place by tapping end of propeller shaft with a mallet.

2. Withdraw propeller shaft until it is on the verge of coming out of the bearing on propeller end. Insert bevel gear as shown, turn gear around, when in gear case, to permit sliding propeller shaft through hole (in gear).

3. Install Woodruff Key in propeller shaft keyway provided for this purpose. Key must be installed when end of propeller shaft has been inserted in gear case, propeller shaft cannot be pushed through bearing in gear case with key installed.



Installing Ball Bearing

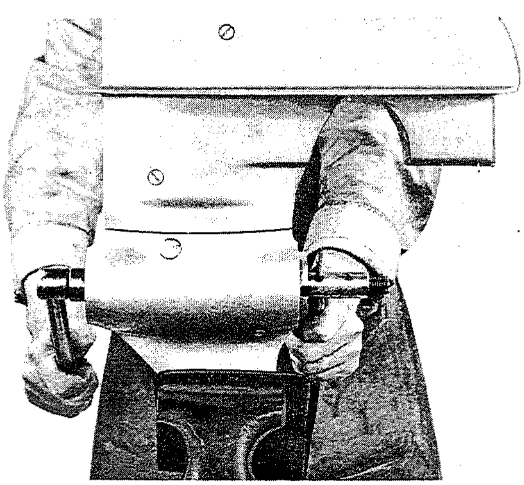


Inserting Bevel Gear

4. Key must line up with keyway in gear. Push propeller shaft through gear until gear is up against the shoulder on the shaft. Continue pushing propeller shaft until it enters hole in ball bearing, then tap lightly on end of propeller shaft to force bearing down in seat and gear up to the shoulder of shaft. Note small pin protruding at end of bearing seat inside gear case—drive propeller shaft, gear and bearing assembly in until bearing comes to rest against this pin.

5. Install large washer, lock washer, small washer and nut in order as laid out. Tighten nut with fingers for time being.

6. Slip ball bearing over end of pinion shaft, this followed by the gear, lock washer, plain washer and nut in order as laid out. Draw up tightly on nut to make certain assembly is secure on pinion shaft. Bend all six lugs on lock washer up and against sides of nut to prevent its turning and becoming loose.



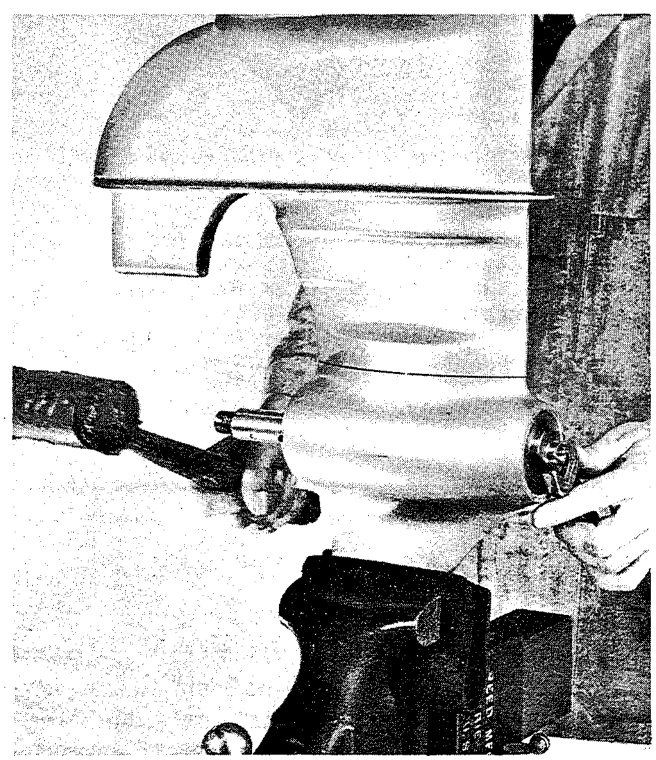
Drawing Up Propeller Shaft Assembly

7. Insert pinion shaft, bearing and gear assembly in upper section of gear case — install gear case gasket. Attach upper gear case section to gear case by sliding over long studs provided for this purpose. Install spacers on long studs, attach nuts and draw down tightly.

8. Place gear case assembly in vise to tighten propeller shaft nut. Insert punch through propeller pin hole to prevent turning when tightening nut as illustrated. When nut has been drawn up sufficiently, lock in place by bending at least three lugs of the lock washer up and against side of nut.

9. Install bearing retainer (note slot provided for pin in gear case — both of which must line up). Screw bearing lock nut in gear case to prepare for adjusting gears.

10. TO ADJUST GEARS—Draw up tightly on bearing lock nut, that is, until there is no clearance between bevel gear and pinion in gear case. Unscrew lock nut approximately $\frac{1}{4}$ turn. Strike end of propeller shaft with mallet to drive propeller shaft and gear assembly away from pinion to obtain necessary clearance between teeth of gears. Turn propeller shaft with fingers to note if gears bind in any position. If binding occurs, unscrew lock nut slightly and drive propeller shaft back again. When proper gear mesh has been attained, there will be no binding between gears when turning propeller or pinion shafts — a small amount of back lash should be noted.

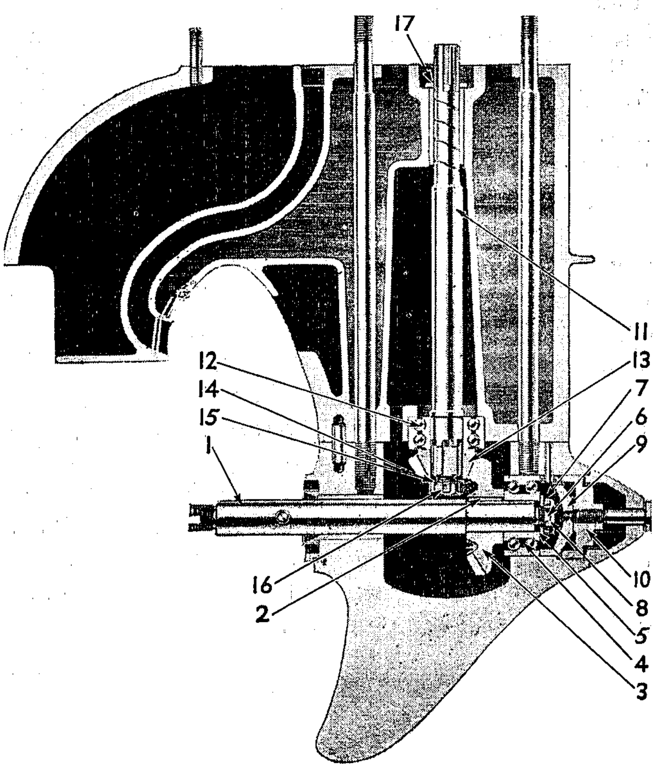


Adjusting Gear Mesh

11. Install gasket, gear case head and gear case head bolt.

12. Remove spacers, install gasket and thrust washer. Attach gear case assembly to motor—be sure all nuts are tight. Fill gear case with gear lubricant as instructed.

TO DISASSEMBLE GEAR CASE, proceed in reverse order of that described above. Wash gear lubricant off parts and out of gear case to make all parts accessible for inspection.

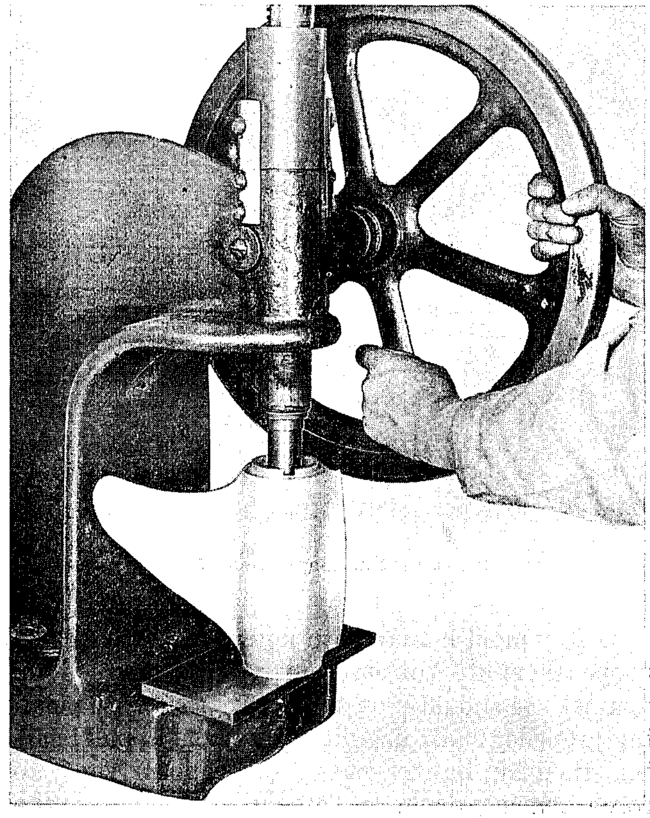


Gear Case Assembly (Completed)—(Model PO)

1. Propeller Shaft
2. Propeller Shaft Key
3. Bevel Gear
4. Ball (thrust) Bearing
5. Washer
6. Lockwasher
7. Washer
8. Nut
9. Retainer
10. Lock Nut (Bearing)
11. Pinion Shaft
12. Ball (thrust) Bearing
13. Pinion Gear
14. Lockwasher
15. Washer
16. Nut
17. Thrust Washer

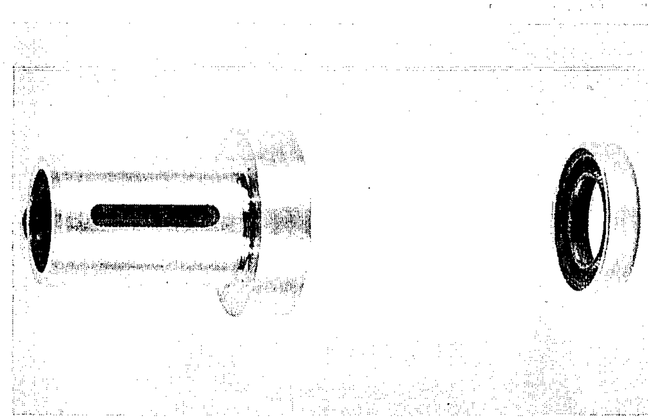
TO INSTALL NEW BUSHING (BEARING) IN GEAR CASE—(MODEL PO)

Since the gear case is provided with one bushing (propeller shaft bearing) and one ball bearing (propeller shaft thrust bearing), only one reaming operation is required when replacing propeller shaft bearing (bushing)—the ball bearing is removed and replaced as a unit.

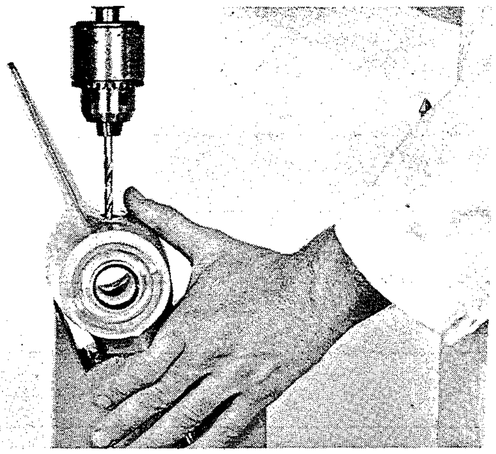


Installing Propeller Shaft Bearing

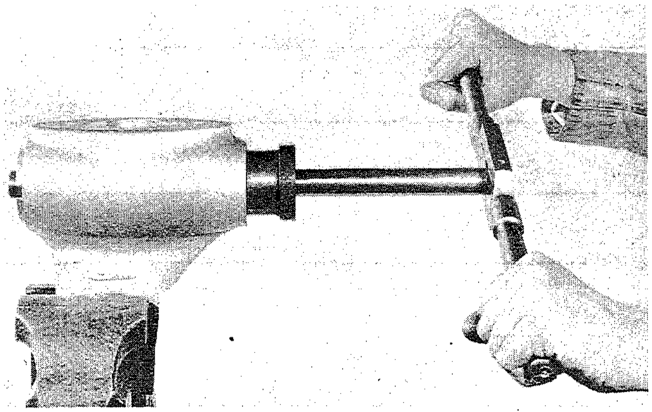
When it becomes necessary to install a new propeller shaft bearing (bushing) the old one must be removed — this can be accomplished by driving out an arbor press in manner similar to removing journal bearings, previously described. Place gear case on table of press with bushing downward. Use round bar or mandrel slightly smaller than bushing to permit driving all way out. Install new bushing. Drive bushing (bearing) down until shoulder rests firmly against gear case.



Propeller Shaft Bearing (Bushing) and Grease Seal—PO—Replacing Original Bushing and Cork or Leather Seal. Seal is Similar to That Installed in the Gearcase of Models TS and TD. The Bearing (Bushing) is Machined to Accommodate the Seal



Drilling the Gearcase to Accommodate Installation of the Propeller Shaft Bearing (Bushing) Where Same has not Previously been Drilled. Purpose is to Provide Lubrication. Drill Size, ¼ inch

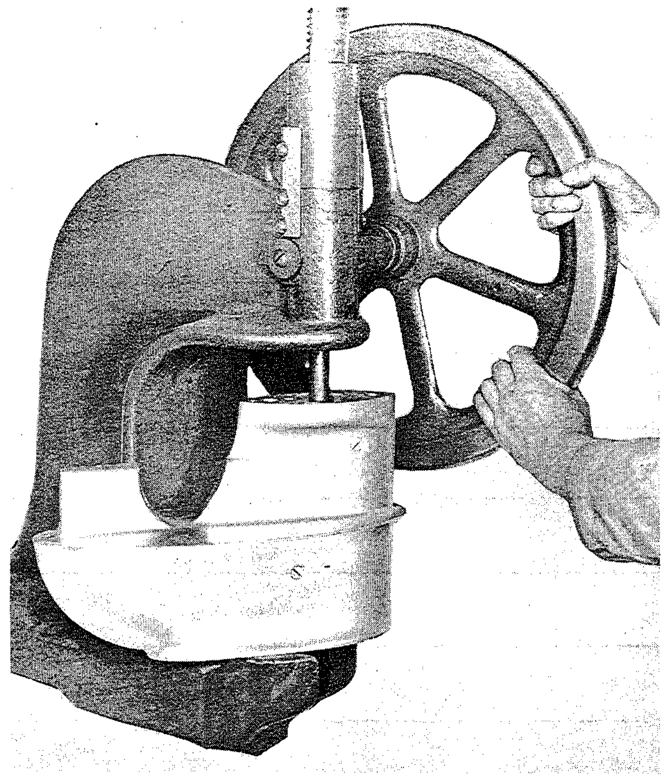


Reaming Propeller Shaft Bearing

Ream bearing to size .875″. Use reamer No. S-94. Place gear case in vise (note large pilot right side of gear case). Insert reamer, pilot on reamer proper in propeller shaft bearing (bushing) and large pilot fitting over reamer shaft into the gear case to obtain correct alignment when reaming. Turn reamer in clockwise direction (facing back of gear case) at the same time forcing gently forward until cutter passes through bearing. Withdraw reamer slowly with same turning motion.

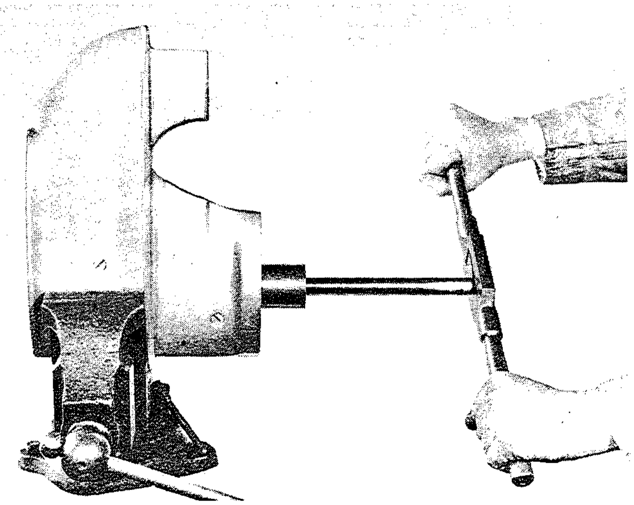
TO INSTALL NEW BEARING (BUSHING) IN PINION SHAFT CASING—(MODEL PO)

The pinion shaft casing, like the gear case, is provided with one bushing (top) and one ball bearing (thrust-bottom), consequently, only one reaming operation is necessary to install new bearing (bushing). To install a new bushing the old one must be driven out and a new one pressed in, while the ball bearing is removed and replaced as a unit.



Driving Out Pinion Shaft Bearing

To drive out top bushing, place pinion shaft case on table of press as shown. Insert round bar or mandrel slightly smaller than bushing to permit driving all way out. To install new bushing, place case on table of press with bushing location up. Press new bushing (bearing) in until thrust face rests solidly against casing.

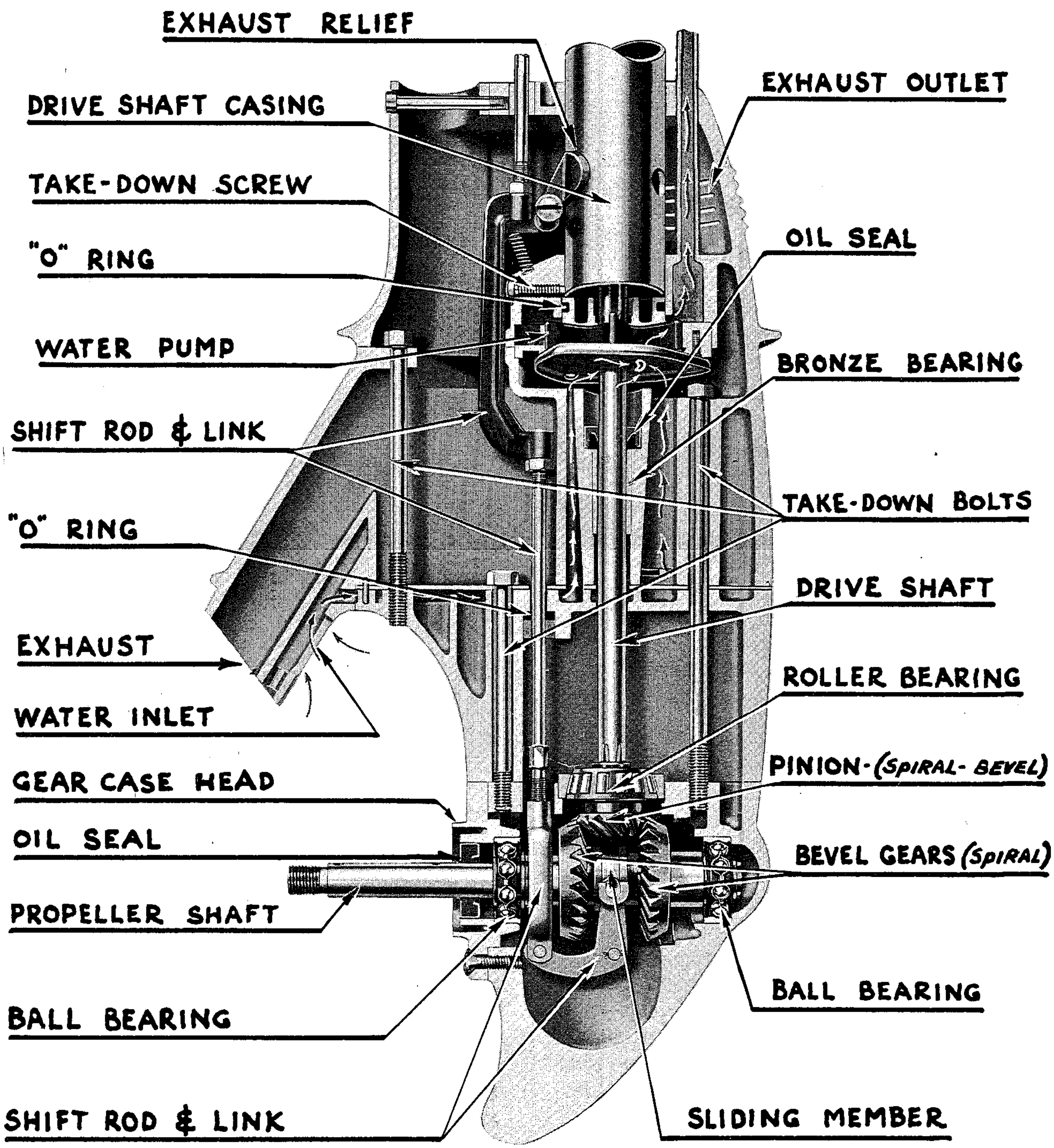


Reaming Pinion Shaft Bearing

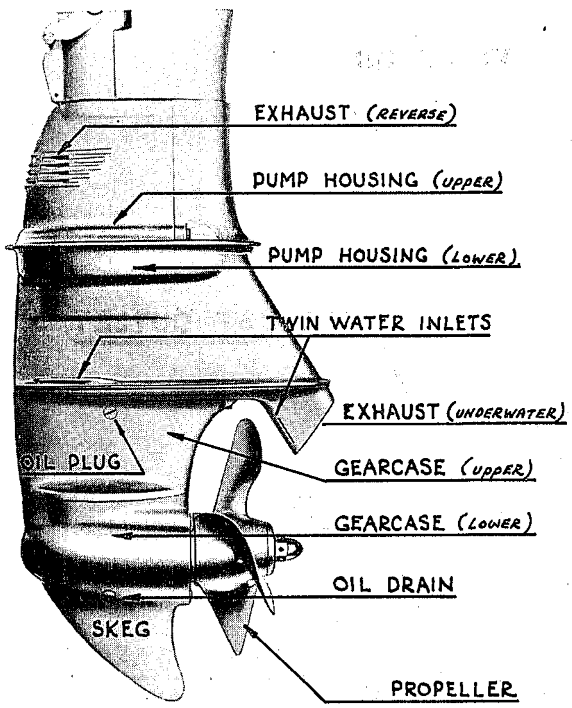
Place casing in vise to ream bearing as illustrated. Ream to size .625″ with reamer No. S-95, in manner similar to reaming propeller shaft bearing (bushing) described above.

NOTES

LOWER UNIT ASSEMBLY — MODEL QD



Sectional View of Gearcase Assembly—Model QD.

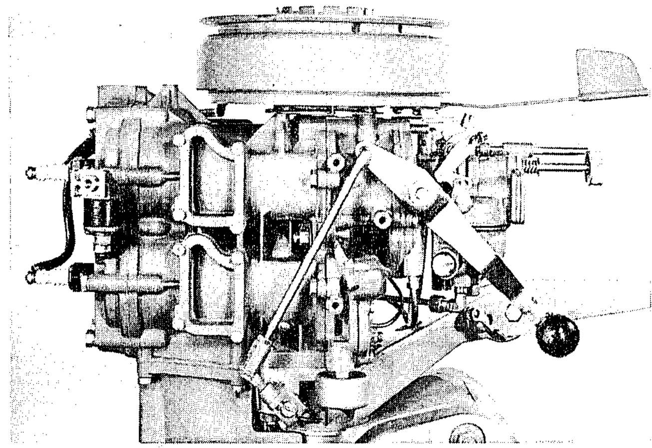


Gearcase Assembly.

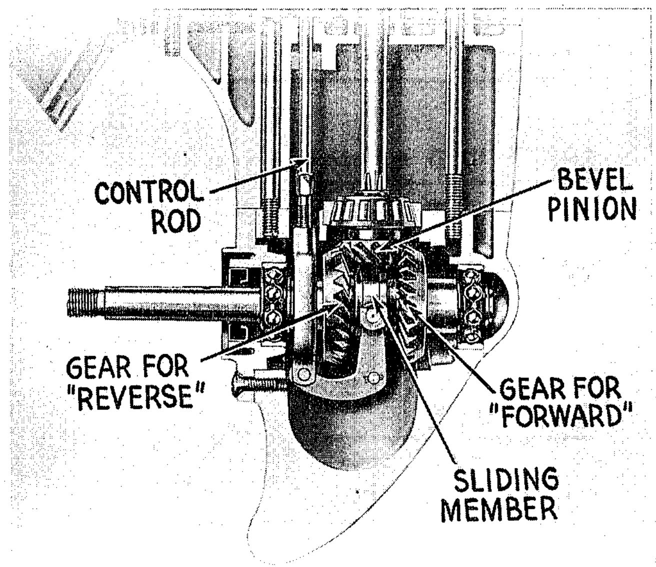
Disassembly and repairs on the QD lower unit are not too difficult to perform if procedure and instructions below are closely followed.

Inasmuch as all but one of the bearings are of non-friction type and the only bronze bushing employed is "cast in" and machined to size, no reaming operations are required. Ball and roller bearings are replaced as units and rest in properly machined seats—(clearances established in original manufacture) while the bronze bushing can be replaced only, if necessary, by installation of a new lower pump housing. Possibly a new driveshaft may be required in event bronze bearing wear is excessive. As can be seen from the foregoing illustration, an oil seal is installed on the driveshaft above the bronze bearing and another on the propeller shaft immediately back of the propeller. Ball bearings are installed to support the propeller shaft with a taper roller bearing supporting the pinion and bottom end of the driveshaft—in this case to carry the load of gear thrust.

The gearcase housing assembly is built up of several sections, namely: the upper pump housing, lower pump housing, upper gearcase and lower gearcase and includes the water pump, driveshaft, propeller shaft, required gears and gear shifting mechanism.



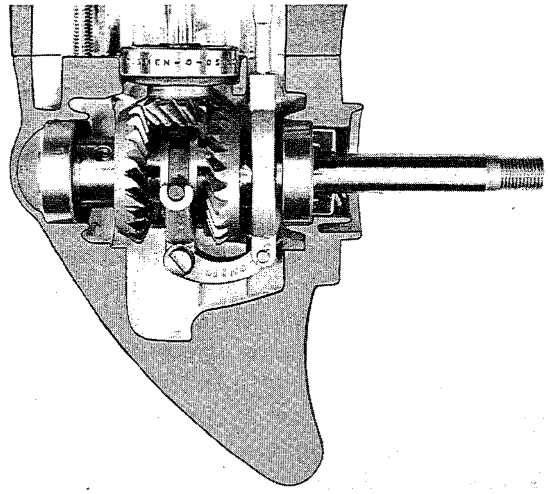
Motor Side Covers Removed to Show Shift Lever and Linkage.



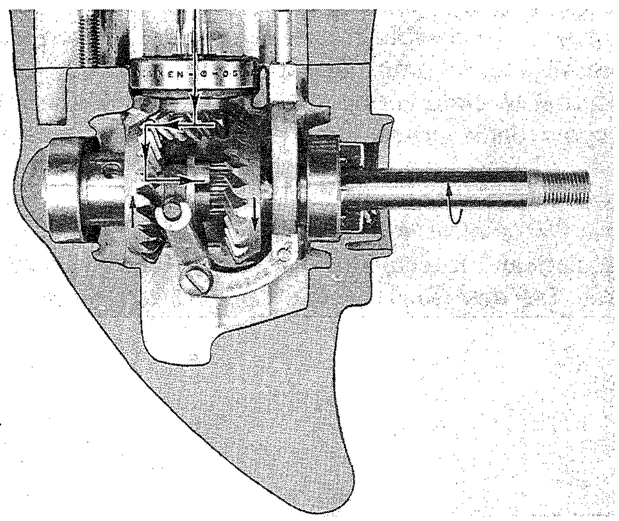
Sectional View of the Gearcase, Showing Gear and Gearshift Arrangement.

Gear Shift

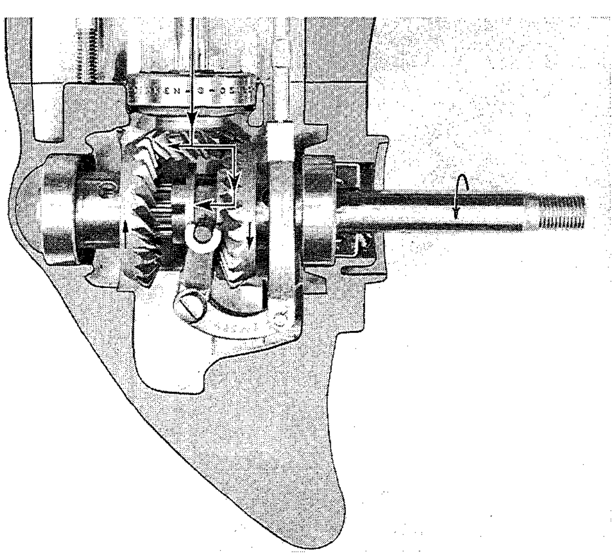
To accomplish "forward," "neutral" and "reverse," three gears, a sliding member and shifting mechanism are required. The pinion (gear) is splined to the driveshaft and rotates constantly with operation of the motor. The bevel gears (one forward and one aft) float on the propeller shaft and like the pinion, rotate with operation of the motor—one in one direction and one in the other. The sliding member is keyed or splined to the propeller shaft and remains motionless as does the propeller shaft and propeller (neutral) during operation of the motor, until the "dogs" of the sliding member engage like "dogs" on either gear—(forward or reverse, depending upon which gear is engaged).



Showing Gear in "Neutral"—Bevel Gears Floating on the Propeller Shaft Which is Motionless.

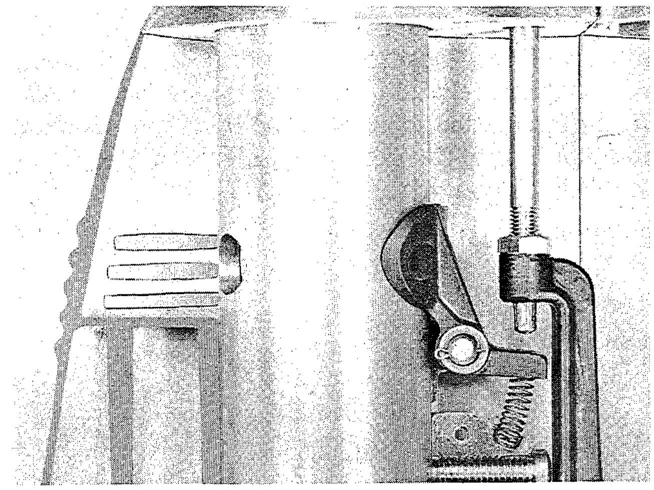


Showing Gear in "Forward"—Sliding Member Engaging Forward Gear. Note Line of Drive. Gear For Reverse is Now Floating on the Propeller Shaft.



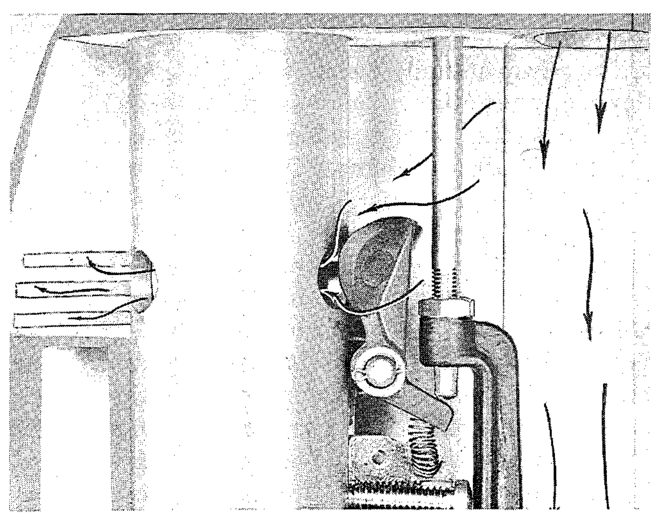
Showing Gear in "Reverse"—Sliding Member Engaging Reverse Gear. Note Line of Drive. Gear for Forward is Now Floating on the Propeller Shaft.

Exhaust Relief



Showing Exhaust Relief Valve Closed—"Neutral" and "Forward."

Exhaust gases are conducted down through the exhaust tube, upper pump housing, lower pump housing and discharge under water, through the exhaust outlet during "neutral" and "forward" operation. However, when in "reverse," water backing up into the normal exhaust outlet, creates excessive back pressure (against exhaust gases) which would interfere with functioning of the motor unless means were provided for relief in this respect. This has been accomplished in the Model QD by drilling holes in the driveshaft casing, installing a valve and providing louvers in the upper pump housing.

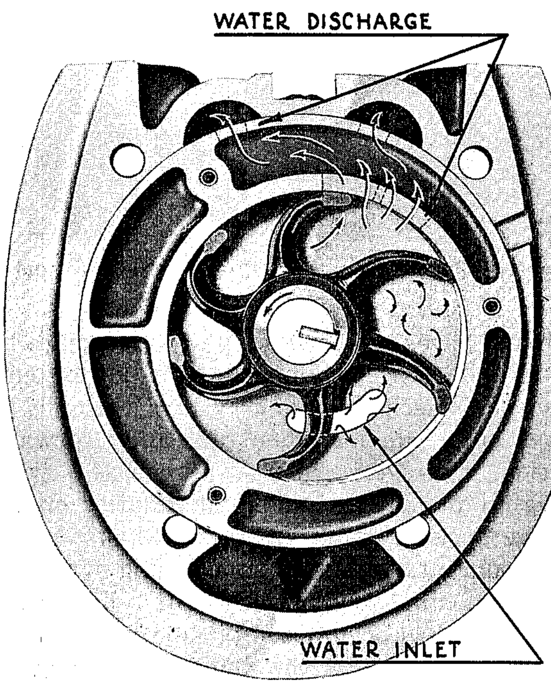


Showing Exhaust Relief Valve Open—"Reverse."

During neutral and forward operation, the valve remains closed, being held in position by a small spring. When shifting to "reverse," shifting mechanism is arranged to open the valve, as shown above. Exhaust gases subsequently "by pass" through the driveshaft casing and into the atmosphere by way of louvers in the upper pump housing.

The Water Pump

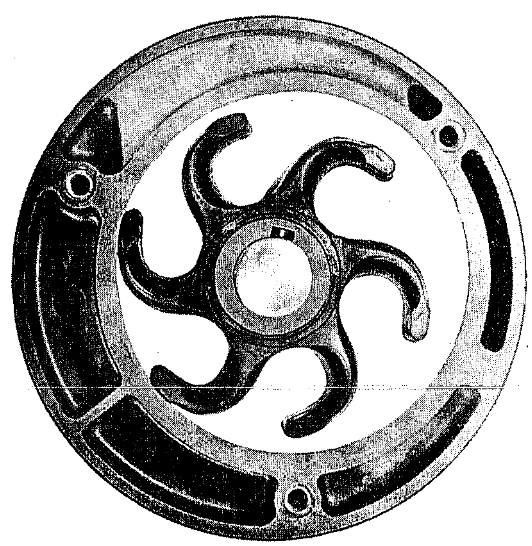
Cooling, of course, is provided by water circulating through jackets surrounding the cylinders, exhaust manifold and cast into the cylinder head. Water circulation is maintained by a Vari-Volume pump built into the gearcase assembly and operated by the driveshaft.



Illustrating Action of the Vari-Volume Pump—Pump Cover Removed to Expose the Impeller.

The pump actually consists of an impeller (with flexible synthetic rubber vanes or blades) rotating in an aluminum housing into which are cast ports for water discharge. Open end of the housing is closed by installation of a stainless steel plate including an elongated slot to serve as the water inlet. It will be noted from the illustration that the driveshaft does not center in the impeller or pump housing—the impeller thus offset to one side. This causes the impeller blades to flex or bend as they rotate in the housing—curved more while traveling through area of the narrow side than on the opposite wider side at which little curvature occurs. It can readily be seen that the volume or space between the individual blades varies with impeller rotation—volume in this respect is considerably constricted on the narrow side of the impeller housing but expands (grows) as the blades progress towards the wide side where little constriction exists.

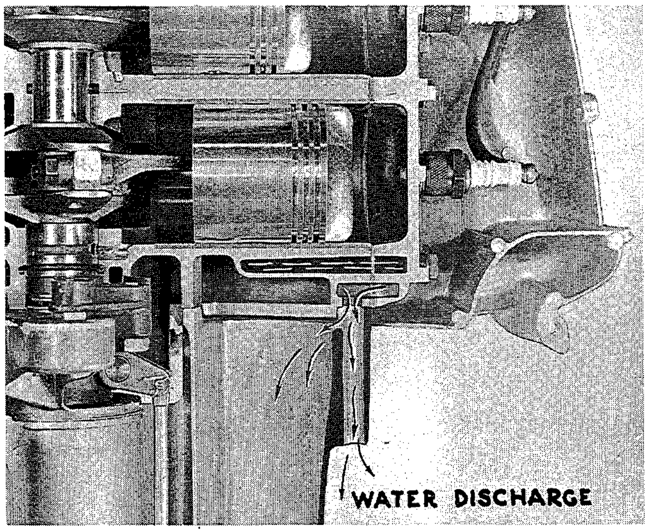
It is this flexing or bending of the impeller blades which makes it a displacement pump (at slow speeds). Note position of water inlet and discharge. Inlet slot in the cover plate is so spaced as to create an opening between the impeller blades at a point just after maximum constriction occurs and when the blades commence to straighten out. Resultant gradual increase in volume (between the blades) as the impeller rotates, causes water to be drawn in (suction) to fill up the space or volume thus created. At the proper moment of volume expansion, top edge of the impeller blade passes end of the slot— water stops flowing into this particular space. The water now trapped between the blades is carried around with the impeller until the blades start to flex or bend again on approaching the narrow side. Volume between the impeller blades now commences to constrict (grow smaller) to create pressure. The tip of the leading blade, however, at this time uncovers a slot (discharge) in the impeller housing which causes the trapped water to be discharged as the space it originally occupied constricts. Discharge continues in proportion to diminishing volume until tip of the following blade passes over (closes) the discharge slot. Identical action takes place in the space between each of the impeller blades to provide a constant stream of water, when operating the motor at slow and intermediate speeds. Creation of suction (as described) permits installing the water pump above water level.



Showing Position of Impeller Blades During Operation in Higher Speed Range.

At high operating speeds, water resistance within the impeller housing is sufficient to prevent the impeller blades stretching out, so to speak, to maintain contact with the impeller housing—simple impeller action results. The impeller acts now merely as a circulator, relying on pressure created by the revolving propeller and forward motion of the boat to provide sufficient water through the twin inlets in the gearcase for cooling purposes.

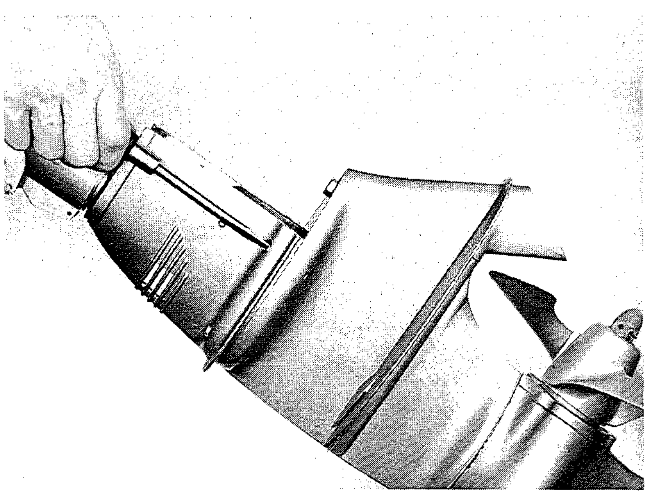
Water discharge is through the outlet in the exhaust tube immediately below the cylinder block.



Sectional View of Power Head to Show Position of Water Discharge.

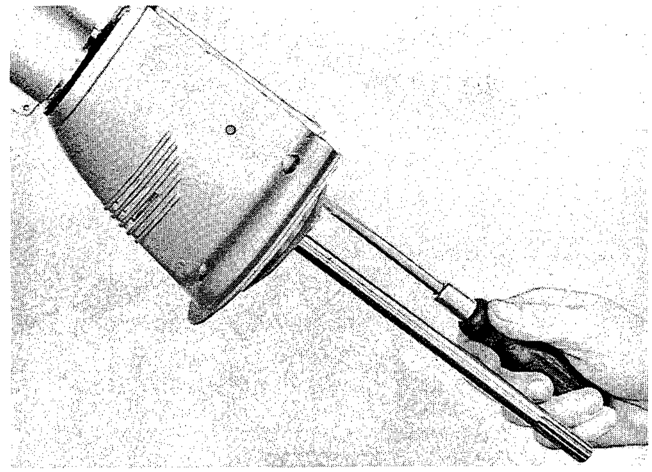
On decreasing motor speed, resistance within the impeller housing diminishes to permit the impeller blades resuming normal position, thus functioning again as a displacement pump. It's the flexing or bending of the impeller blades that causes pumping action as result of the volume or space between the blades alternately diminishing and increasing with rotation. If the impeller was centered in the housing, it would simply perform as a conventional impeller and not as a displacement pump to force water circulation at neutral, slow and intermediate speeds.

After having disconnected and unscrewed the (upper) shift rod (detached from the link), the gearcase is disassembled by first detaching it from the upper pump housing, as shown below.



Removing Gearcase Assembly From Upper Pump Housing.

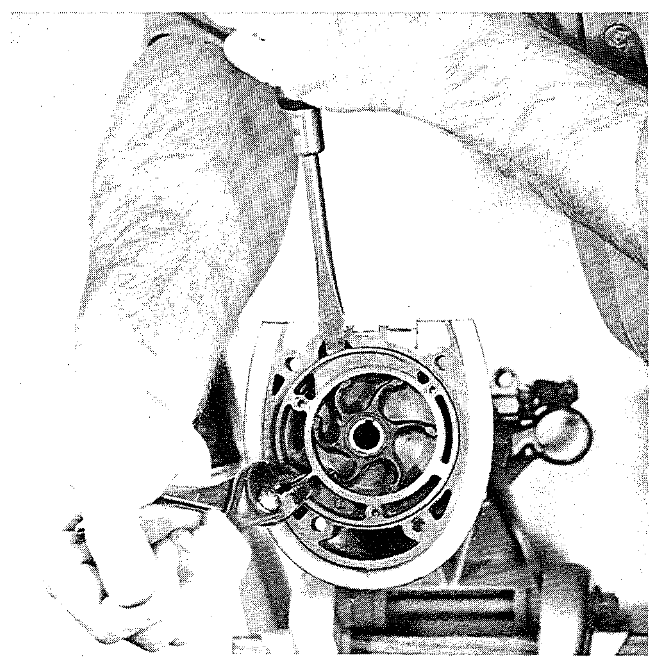
Since the impeller, housing and driveshaft assembly are attached to the upper pump housing by three screws, the screws must be removed to detach it. The impeller is keyed to the driveshaft by a small pin. Thus, on removing the impeller plate, the driveshaft can be withdrawn from the assembly. The impeller merely lifts out. In some



Removing the Impeller Plate.

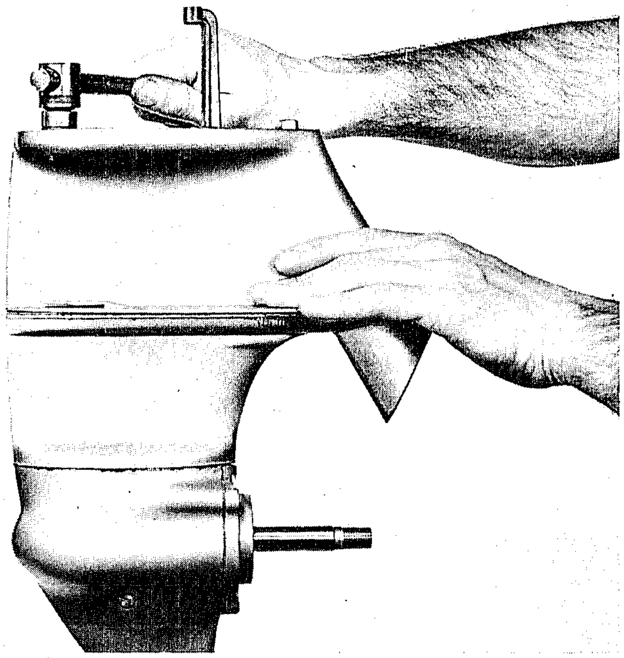
instances, the entire pump assembly may be removed as a unit by simply pulling on the driveshaft but most likely, the rubber "O" (seal) ring adheres sufficiently to prevent entire assembly removal in one operation.

To remove the impeller housing from the upper pump housing, gently grasp one of the webs in the housing with a pair of pliers and insert screw driver between the impeller housing and pump housing, as shown below. Carefully and evenly pull on

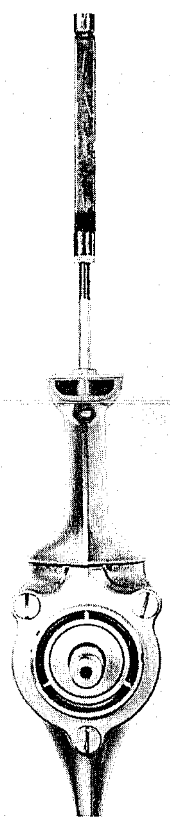


Removing the Impeller Housing.

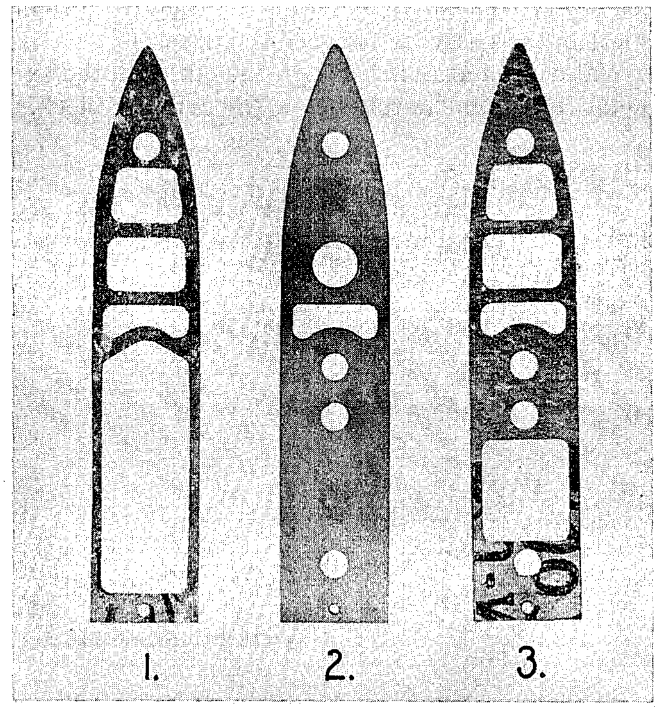
the pliers and pry on the screw driver. Exercise caution during this operation. Do not force too hard and be careful not to "cock" the housings to cause unnecessary strain.



Removing the Upper Pump Housing.

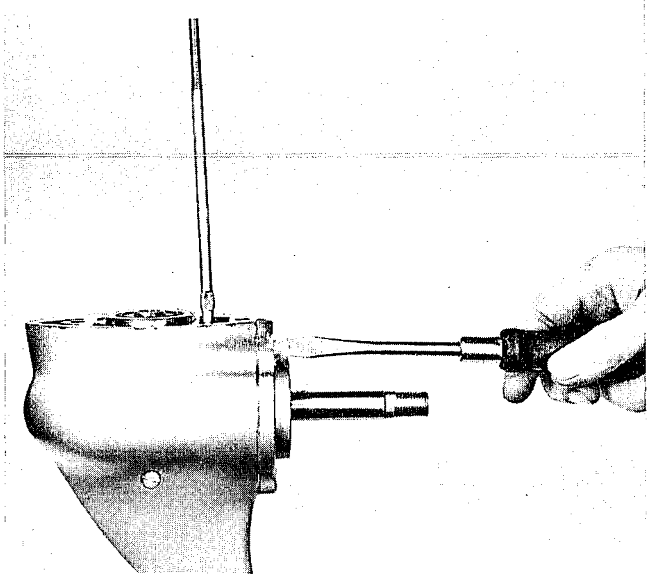


Showing Lower Pump Housing Removed. Link and Lower Shifting Rod Exposed.



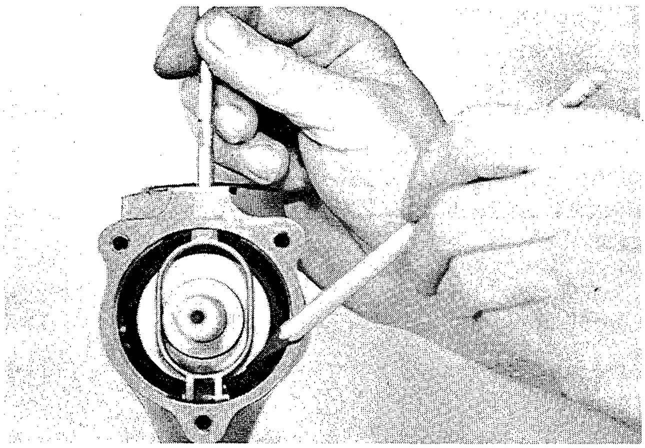
Showing (1) Gasket Top, (2) Aluminum Plate and (3) Gasket Bottom, All of Which Are Installed Between The Lower Pump Housing and the Upper Gearcase Section in the Order Given. This is Important. Gasket Surfaces Should be Coated with Nondrying Cement on Assembly.

On removal of the lower pump housing, detach the link (offset in shifting mechanism to accommodate the exhaust valve) then remove screws holding the upper gearcase section fast to the lower gearcase proper.

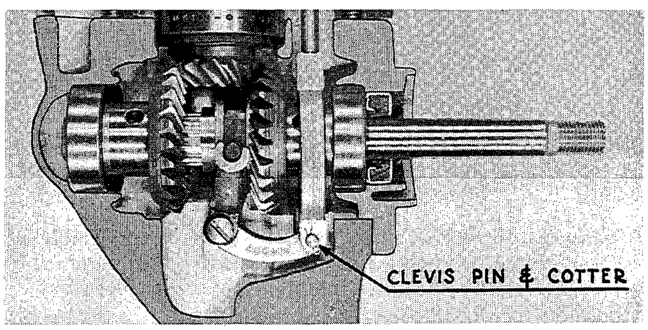


Removing the Gearcase Head.

After detaching the gearcase head, the lower rod and shifting yoke must be disconnected to permit withdrawing the propeller shaft and gear assembly. The yoke is pinned to the small shifting lever in the gearcase and the pin secured with a cotter, as shown below.



Showing Position of Clevis Pin.

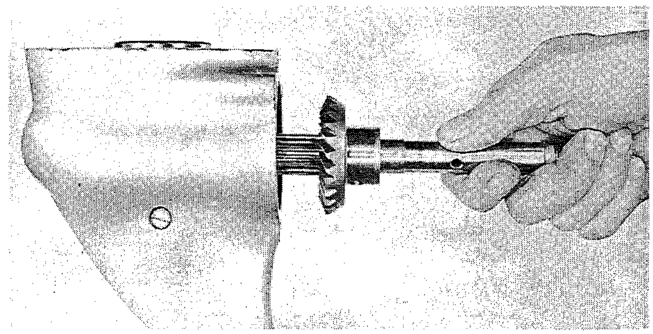


Sectional View Showing Clevis Pin and Cotter to be Removed.

Straighten ends of the cotter and remove the clevis pin with long nose pliers. Make certain the pin is removed, not dropped into the gearcase where it could cause damage later on. Discard the old cotter—always use new one on reassembly.

In like manner, carefully remove the clevis pin with long nose pliers. Detach shifting rod from shifting yoke, then carefully withdraw propeller shaft and gear (reverse). The shifting or sliding member and "forward" gear will fall off end of the propeller shaft and into the gearcase—simply lift out. Tap gearcase lightly on block of wood to jar front ball bearing free. Front and back ball bearings can be installed either way. Note there are two flat washers—one each installed next to each gear (between the gear and the shifting member). The shifting arm need not be removed at this time unless it is desired to do so. It is held in position by a long screw which incidentally must not be confused with the "oil drain" screw. The pinion and roller bearing assembly can then be pushed out of position easily by hand.

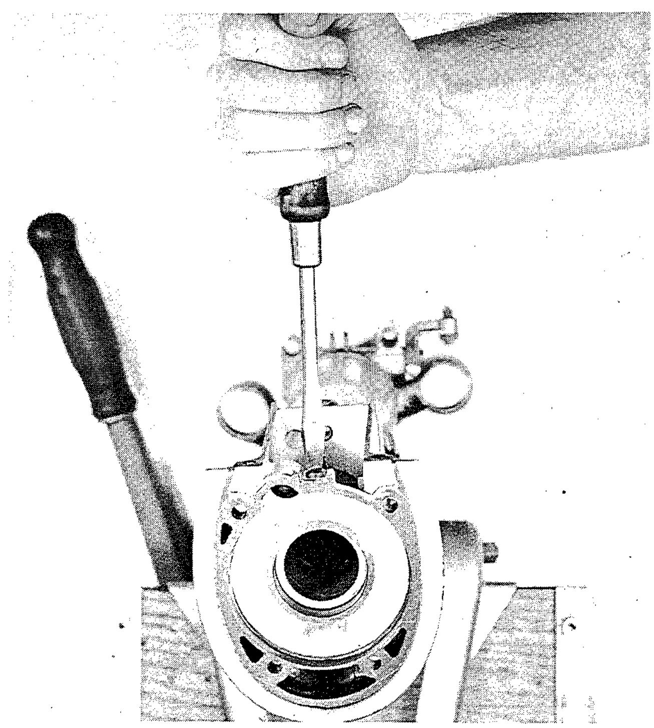
Assembly of the gearcase is in reverse of that described above—easily accomplished by exercising a bit of care. Make certain all parts are clean and thinly coated with oil and that no foreign particles remain in the gearcase. Replace parts as required. Do not install one new gear to operate with two old ones—the result is inevitably a noisy gearcase and possible damage later on. Be sure the bearings are clean and free of grit. Spin in hand to note presence of grit.



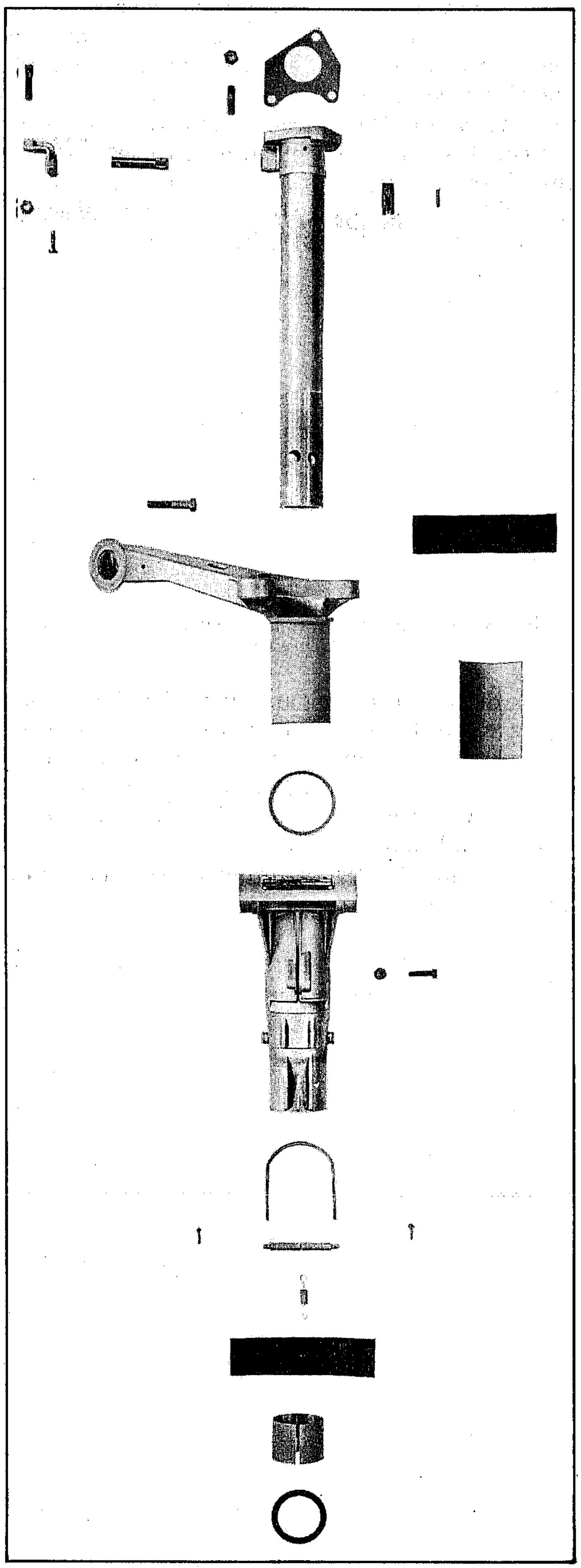
Removing Propeller Shaft and Bevel Gear from the Gearcase.

The driveshaft casing and swivel bracket assembly is easily taken apart by removing the large screw holding the upper pump housing fast to the driveshaft casing and carefully driving it off. The swivel bracket assembly and driveshaft can then be easily taken apart.

Reassemble in reverse order of that described above.

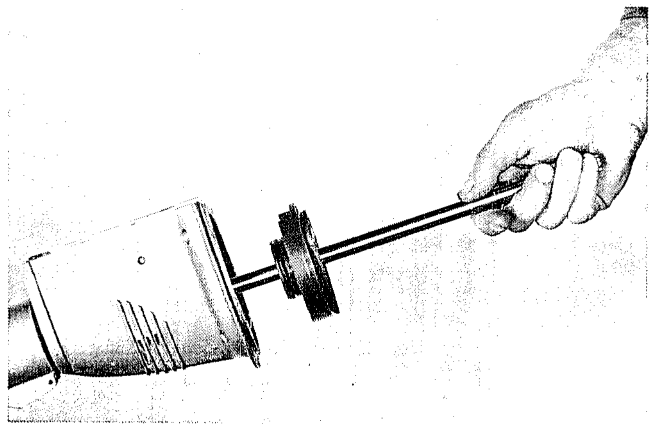


Detaching Upper Pump Housing from the Driveshaft Casing.

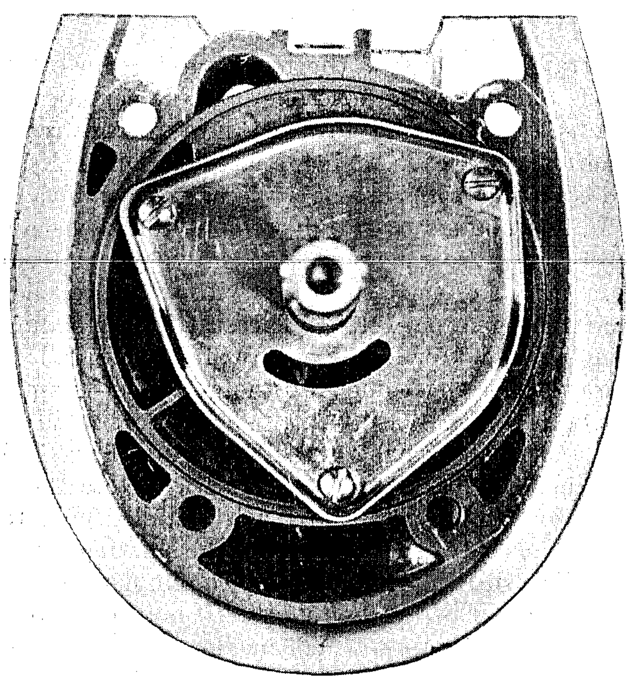


Extended View of the Swivel Bracket, Steering Arm and Driveshaft Casing Assembly.

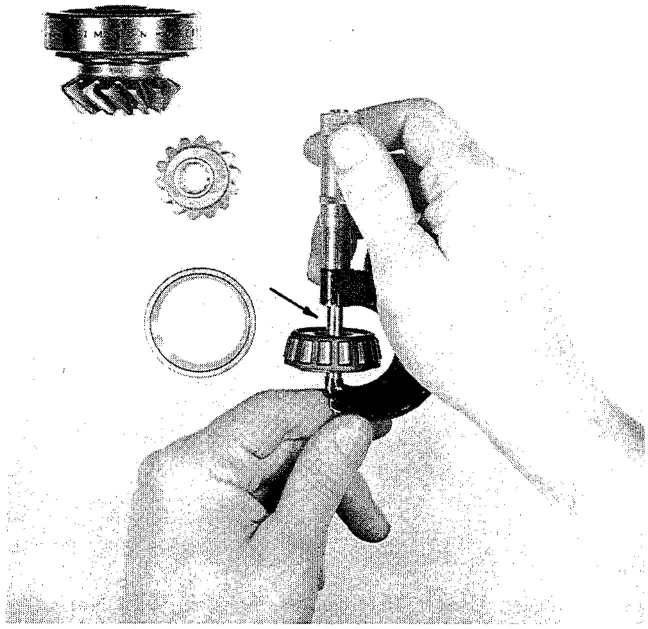
Make certain that all parts to be assembled are in good operation condition—that none of the housings are cracked or otherwise damaged to interfere with their performance in the assembly. See that all gasket faces are flat and true to avoid water or oil leaks. Lap faces if necessary; however, if in doubt as to their condition, replace with new parts. Check condition of bearing seats, oil seals, "O" (seal) rings, ball and roller bearing assemblies, gears, gear shifting mechanism, propeller and driveshafts and the bronze bushing in the lower pump housing to ascertain their fitness for use. Replace as required. Use nondrying cement on all gaskets.



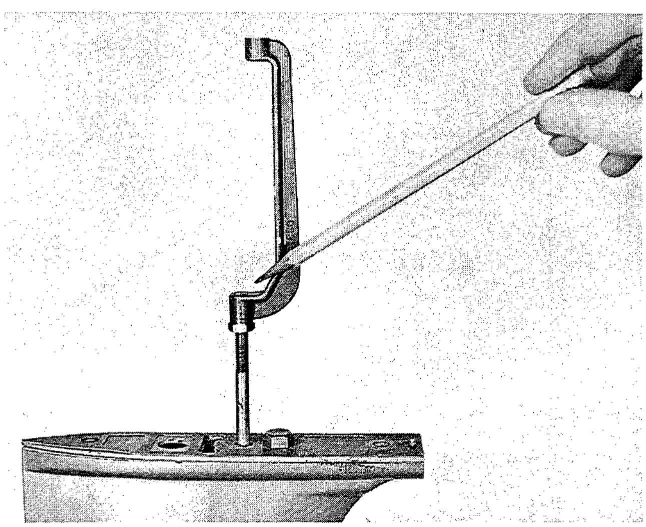
Prior to installing the Water Pump Assembly—Assemble to the Driveshaft as Shown Above. Do Not Neglect Replacing "O" Ring on the Housing—Install New One if Necessary.



The Pump Assembly Can be Installed in One Position Only as Illustrated Above.

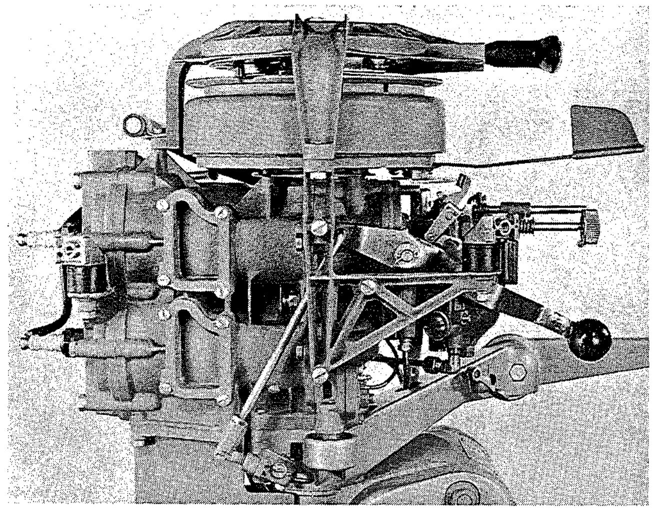


Showing Pinion and Taper Roller Bearing Assembly (Upper Left) and Method of Calipering Width of Bearing Race to Determine Correct Thickness of Spacer (Shim) to Install Between the Bearing Race and Gear on Assembly. The Bearing and Pinion are Provided by the Factory as an Assembly; However, in Event Assembly is Performed in the Field, the Operation is a Critical One and Must be Performed with Extreme Care. Since All Bearing Seats Are Machined to Close Limits to Obtain Proper Gear Mesh, Existing Variations in Width of Roller Bearing Race (Inner) Must be Compensated For by Addition of a Spacer or Shim Between Bearing Race and Face of Gear. Spacers or Shims Are Available in Thicknesses of .005″ (#301932), .006″ (#301933), .007″ (#301934), .008″ (#301935), and .009″ (#301936). Correct Dimensions as Indicated by Arrow Are .578″ to .580″. This is Important to Provide Correct Gear Mesh. Install Shim or Combination of Several Shims to Build up Accordingly. Carefully Press Bearing and Required Shim or Shims on the Gear. Coat Gear Boss with Clean Oil to Facilitate Assembly—Do Not "Cock" When Pressing Into Position.



Showing Link Properly Attached to the Lower Shift Rod. The End of the Rod Should Be Screwed Into the Link—Flush With Inside of the Boss, as Shown. Lock Nut Should be Turned Tightly Against the Link to Anchor.

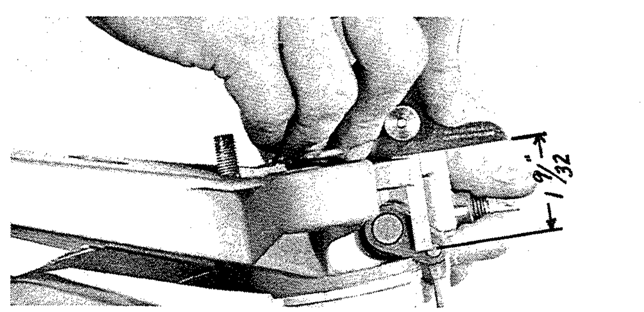
Gear Shift Adjustment



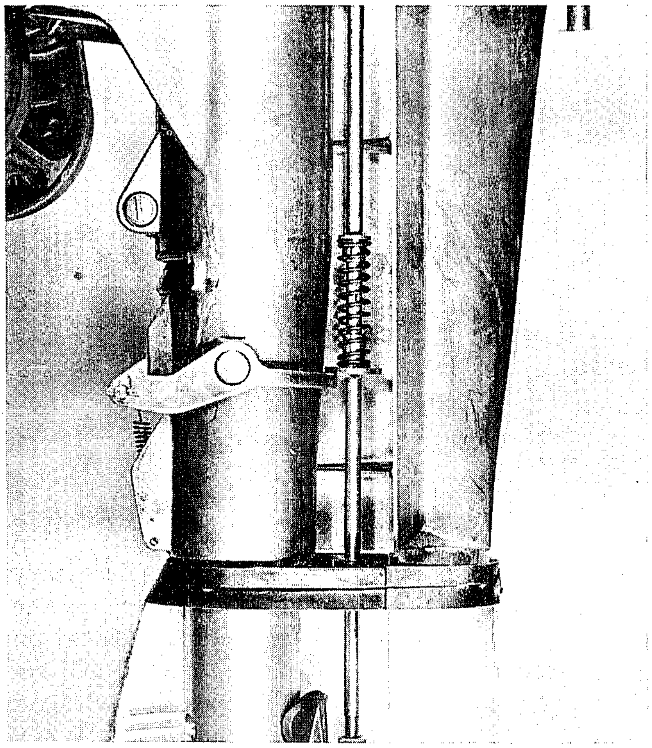
On completion of assembly, it becomes necessary to adjust the gear shift rod, that is, adjust the length of the rod to permit the sliding member on the propeller shaft engaging the forward and reverse gear and to take a neutral position with respect to position of shifting (hand) lever. When lever is set to either forward or reverse, the sliding member must fully engage either gear as the case may be and to assume a neutral position (midway between both gears) when the shifting lever is set in neutral.

The upper shift rod should be screwed into the top of the link to a point where the threads "flush" with bottom of the boss.

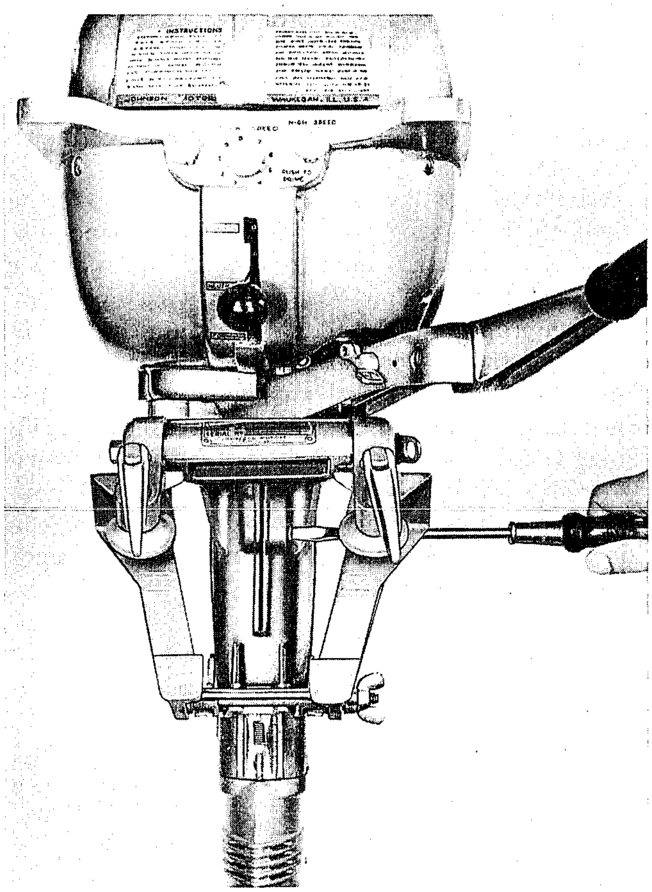
Attach other end of the rod to lever at top of the driveshaft casing by inserting pin to retain momentarily. Set a depth gauge to 1-9/32″—press lever down, as shown below—as far as it can possibly go. Turn propeller shaft to make certain the sliding member in the gearcase properly engages the gear. The rod is adjusted to proper length when the distance between the top face of the driveshaft casing flange and the center of the pin is 1-9/32″, as shown here. This adjustment is accomplished by removing the pin and turning the rod into or out of the link as required. When final setting has been reached, secure pin with cotter.



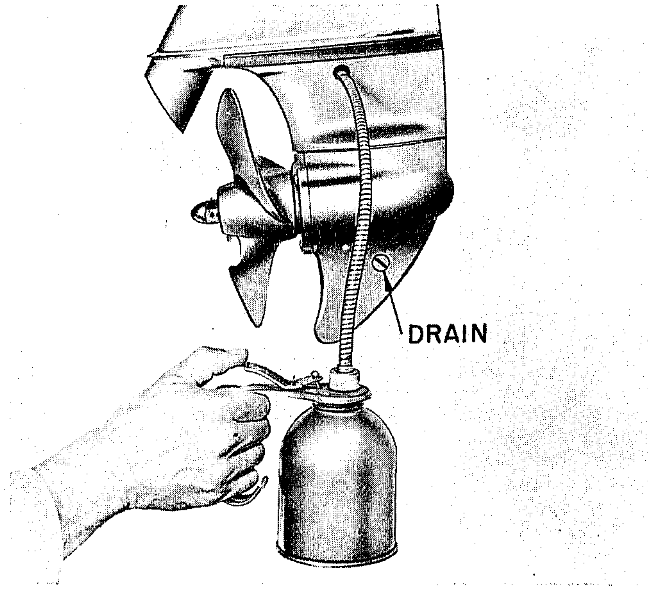
Checking Distance Between Driveshaft Casing Flange and Center of Clevis Pin. Driveshaft Casing Must be Lifted "Up" When Taking This Measurement.



Showing Reverse Lock Mechanism.



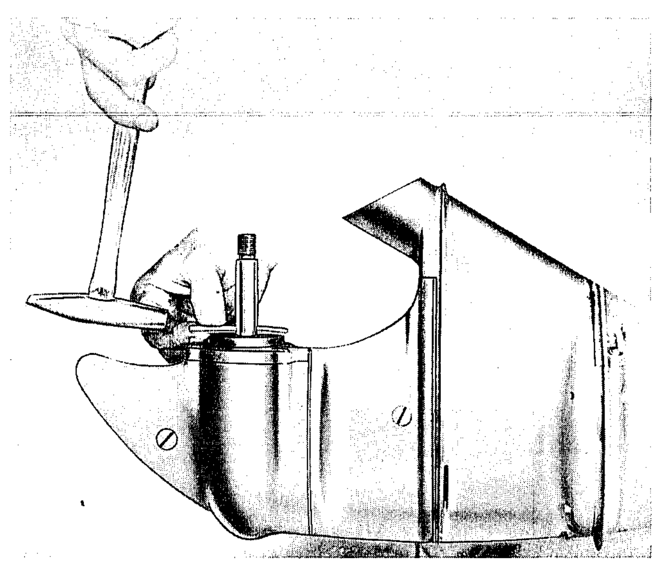
Steering Friction May be Adjusted to Individual Requirements by Simply Loosening or Tightening the Screw in the Swivel Bracket Provided For This Purpose. Tilt Motor From the Thrust Socket to Gain Accessibility to the Screw.



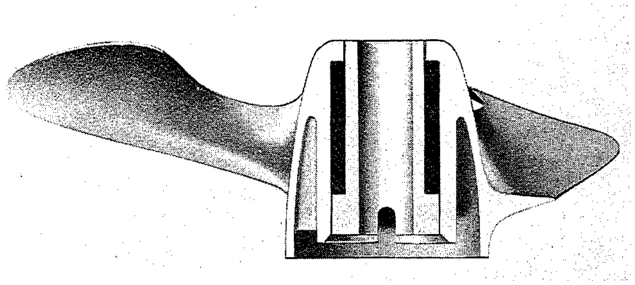
The Gearcase Uses a Different Lubricant Than Normally Used in Outboard Motors Prior to This Time. Mobilub GX90 is Recommended For Best Operation. In the Event This Lubricant is Not Obtainable, Use Any Good Grade of SAE 90 Gear Oil (Suitable For Automotive Hypoid Gears). In Case of an Emergency Where Neither is Available, it is Permissible to Use an SAE 40 Oil, But Only Until Such Time as the Proper Lubricant Can Be Obtained.

Where a Complete Change of Lubricant is Required, Vent and Drain Plugs Should Both be Removed. Drain Out All of the Oil, Water or Residue; Replace the Drain Plug Then Fill the Gearcase Through the Vent Plug With a Pump Type Oil Can as Shown. Fill to Level of the Vent and Replace Screw. Capacity 10 Fluid Ounces (5/8 Pint).

When Checking for Water in the Gearcase it is Necessary to: First, Remove the Vent Screw; Second, Loosen the Drain Screw Partly to Allow Enough of the Lubricant to Run Out to Determine Whether or Not Water is Present. If There is No Water, the Drain Screw May be Retightened without an Excessive Loss of Lubricant. The Gearcase Should Then be Filled to the Vent Screw Level and the Vent Screw Replaced. Check Condition of Gasket on Both Screws to Avoid Possibility of Leaks. Replace if Necessary.



Installing Propeller Drive Pin.

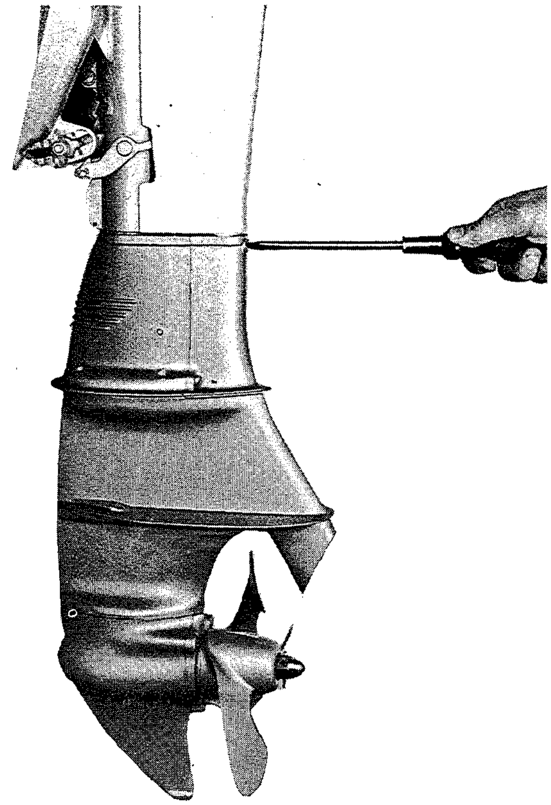


A Rubber Cushion Has Been Installed Between the Propeller Hub and Propeller for the Purpose of Absorbing "Shock" in Event the Propeller Blades Strike an Underwater Obstruction During Operation of the Boat. Shearing of Propeller Drive Pins and Possibility of Otherwise Damaging the Motor are Thus Considerably Minimized.

The Rubber Cushion Performs an Additional Function in the Case of the Model QD in that it Acts to Reduce Impact Load on the Reversing Mechanism.

Under no Consideration Substitute Propellers Not Provided With the Rubber Shock Absorber, to Avoid Causing Rapid Wear of Reverse Mechanism.

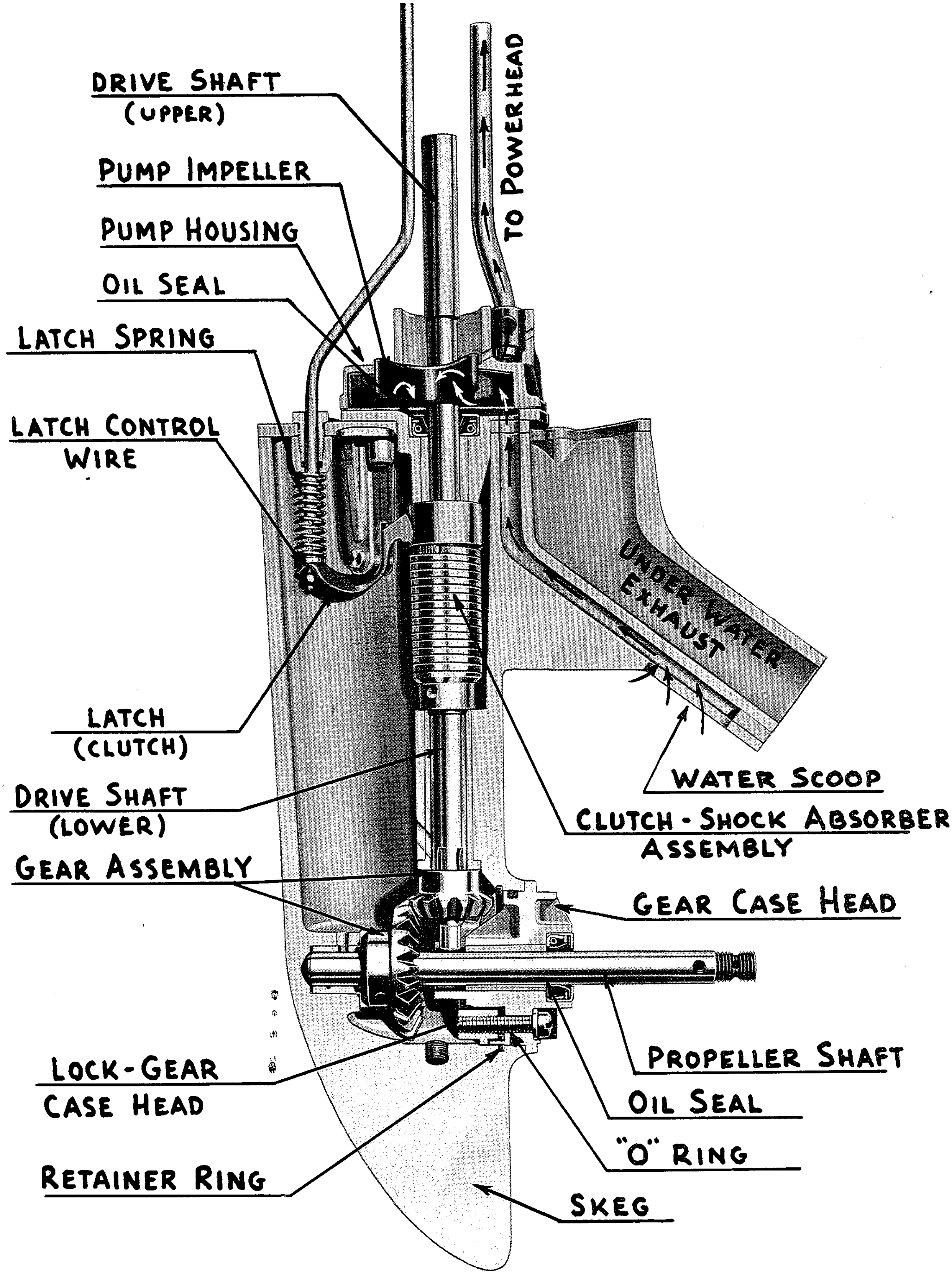
On testing the motor in a motor test tank after final assembly, be sure all exhaust gases are drawn off the tank. This is important since they accumulate under the shroud (motor cover) to interfere with carburetion, thus causing the motor to operate erratically for no apparent reason. Same holds true for tank testing of all outboard motors.



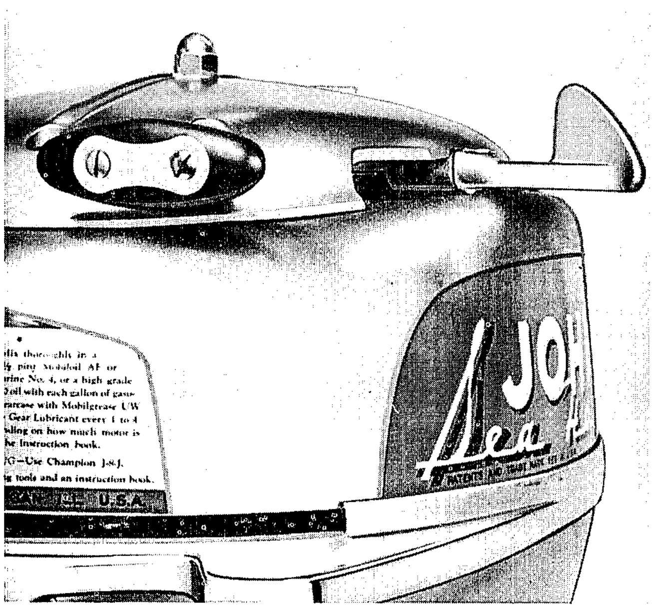
It is Extremely Important that the Screw at the Base of the Exhaust Tube is Made Secure—Be Sure it is Tight. Excessive Vibration Results from this Screw Being Loose or Dislodged.

NOTES

LOWER UNIT ASSEMBLY — MODEL TN

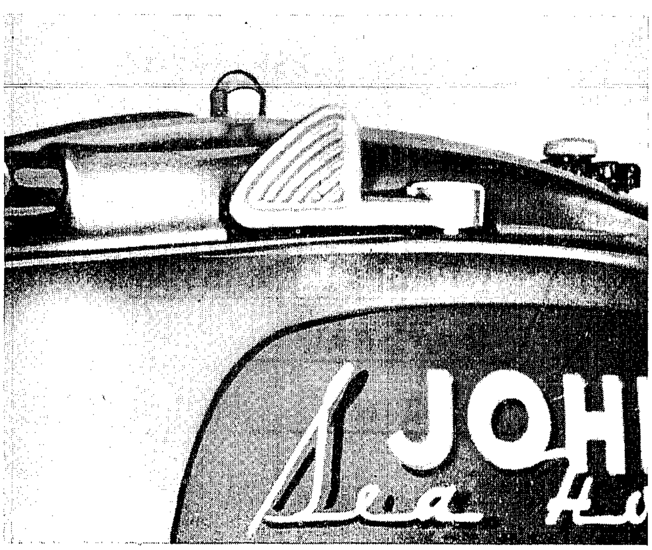


Design and construction of the Model TN lower unit, while it includes a neutral clutch and shock absorber, are such that disassembly and repair are not too difficult to accomplish with a bit of care and on careful observation during the procedure. All service operations, nevertheless, must be performed with care and in reasonably clean surroundings —clean bench, tools, etc. Cleanliness plays a most important part in repairs of all sorts—the gearcase of an outboard motor being no exception.



Showing Control Lever Set to "Neutral" Position

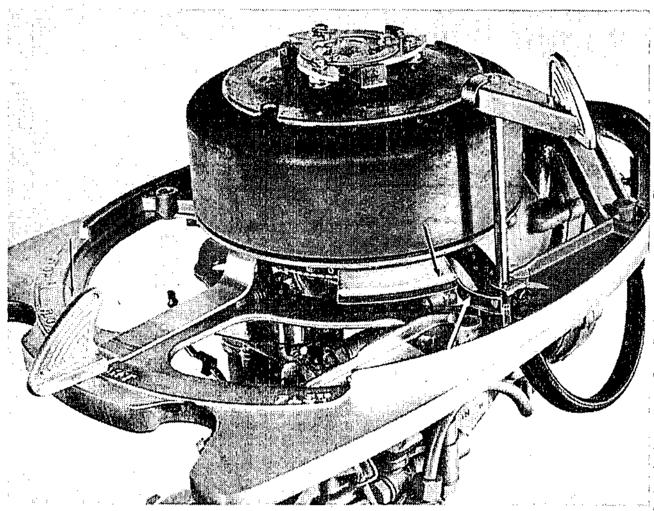
A "Neutral" arrangement is provided to permit starting the motor "out of gear"—the motor may be started at the dock and operated at idle speed until warmed up or until ready for power application. A clutch mechanism controlled manually, is built into the gearcase for this purpose. Control is accomplished by movement of the small lever installed adjacent to the Ready Pull starter—"in gear" when lever is set flush with contour of the fuel tank—"in neutral" when lever is extended.



Showing Control Lever in "Run" Position

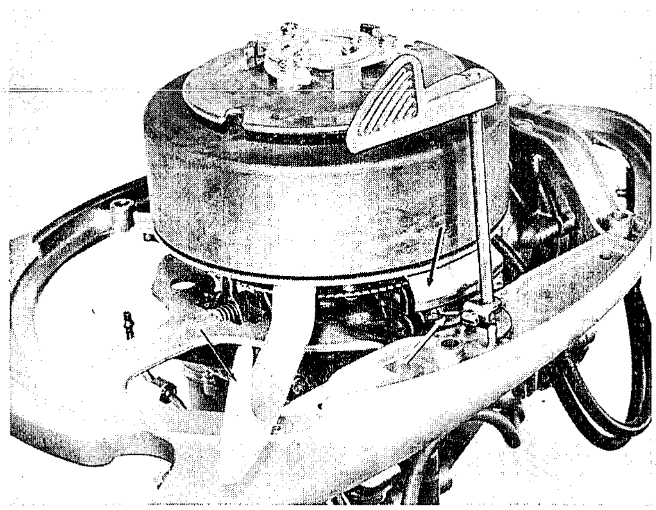
Note—The neutral control lever cannot be shifted with speed control (magneto) lever advanced beyond "start" position—required to prevent "racing" of the motor when in neutral. To accomplish shifting, the speed control lever must be retarded to "start" position or within the slow speed operating range. No attempt should otherwise be made to shift the neutral control lever.

Speed limitation control for "shifting" is obtained by installing a cam on the armature plate and a quadrant on the neutral control shift rod as illustrated here.



Arrows Indicate Position of Speed Limitation Control Mechanism when Control Lever is Set to "Neutral" Position—Speed Control Lever Set at "Start" Position

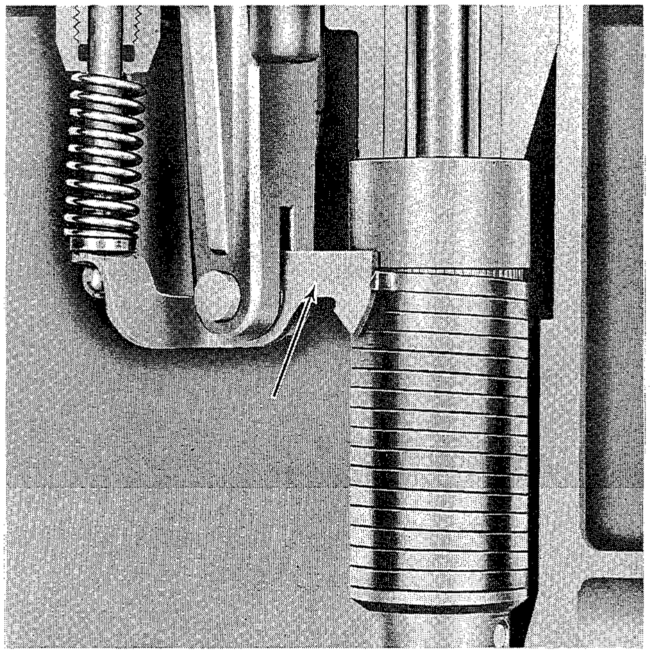
In operation, the quadrant attached to the control rod, engages the cam on the armature plate to prevent advancing the speed control lever beyond the "start" position, when set in "neutral." When



Arrows Indicate Position of Speed Control Mechanism when Control Lever is Set to "Run" Position — Speed Control Lever Advanced for High Speed Performance set for "running," the quadrant clears the cam to permit free movement of the speed control lever—the motor in this case, may be operated throughout its entire speed range.

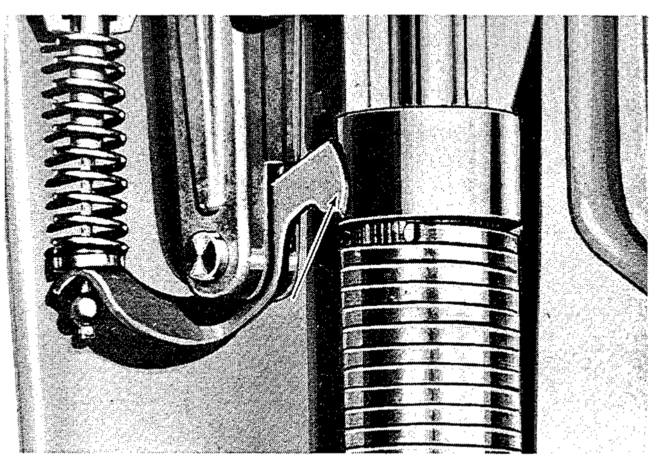
The neutral clutch consists of steel bushing keyed to the lower driveshaft, an accurately ground steel sleeve driven by the upper driveshaft and a spring which is coiled around both the steel sleeve and the bushing.

Propeller drive is thus accomplished by gripping effect of the clutch spring on the sleeve and bushing created during operation of the motor.



View of Clutch Assembly—Latch Down—"Neutral"

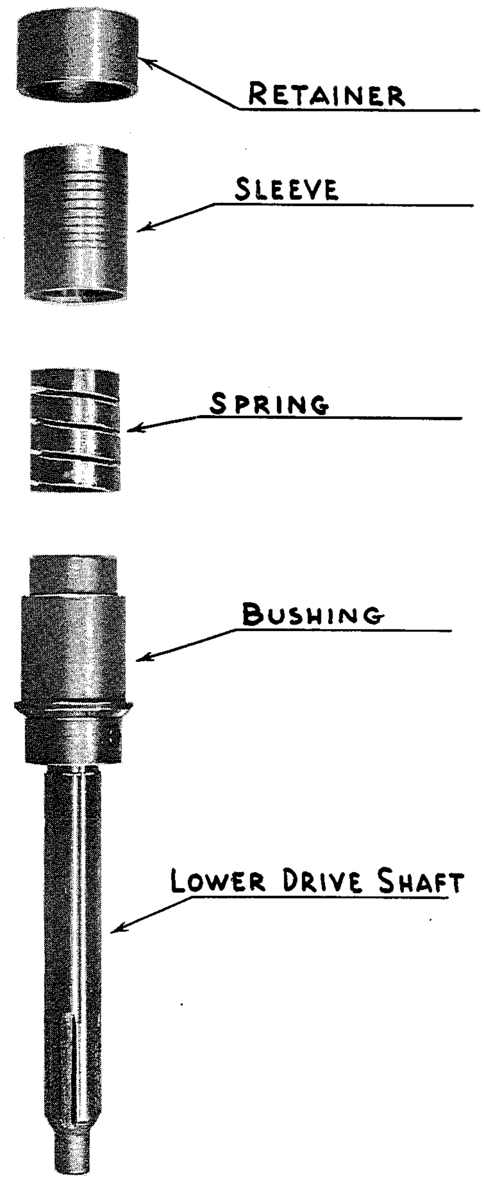
When set for neutral operation, the latch is lowered by movement of the neutral control lever to obstruct rotation of the clutch spring. This action causes the spring to unwind and to subsequently release its grip on the steel sleeve and bushing to permit "slippage" between the upper and lower driveshafts—neutral. When operating "in gear,"



View of Clutch Assembly Showing Latch Up—Running

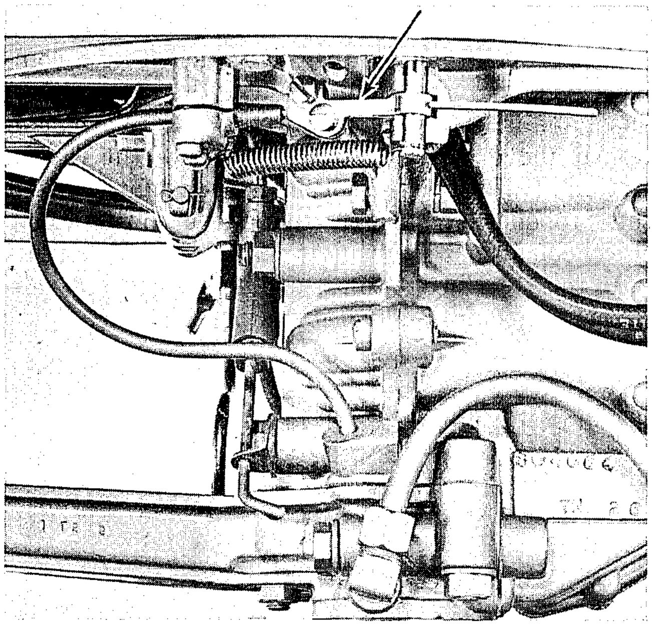
the latch is lifted by moving the neutral control lever to running position to resume rotation of the clutch spring and its grip on both the steel sleeve and bushing. Rotation causes the spring to "wind up" to increase its grip as motor speeds up.

The propeller shock absorber consists of a comparatively strong spring keyed to the upper driveshaft and inserted tightly into the steel sleeve mentioned above which is actually part of the clutch. Action of the shock absorber is such that in event the propeller strikes an underwater obstruction, the shock absorber spring is caused to "coil" slightly in the steel sleeve to release its grip thereby absorbing shock of sudden impact.

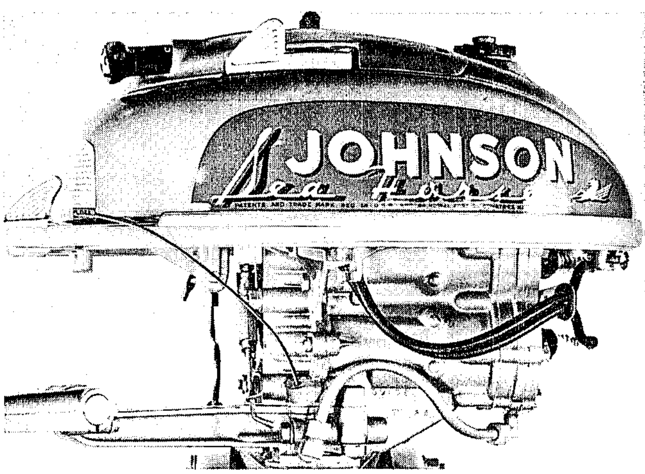


Showing Details of the Shock Absorber Assembly

In event it becomes necessary to detach the lower unit from the power head, the neutral clutch cable must be made free of its anchor. Simply loosen the two screws holding the anchor fast to the cable. Remove the cable guide tube, then the nuts and screws securing the power head and lower unit.

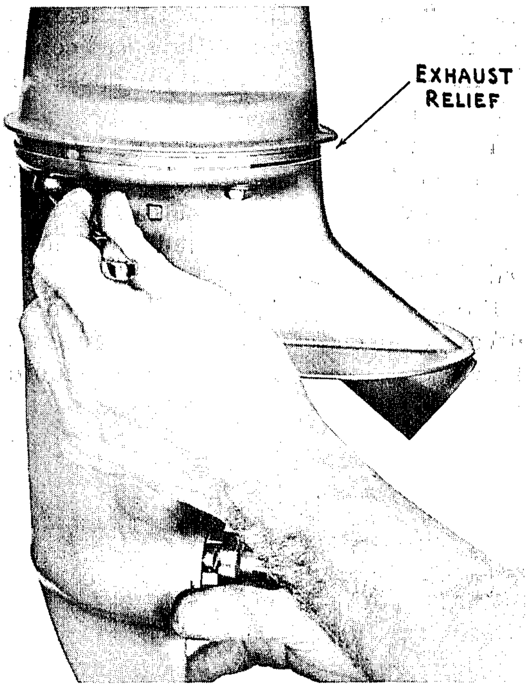


Showing Method of Anchoring the Clutch Control Cable

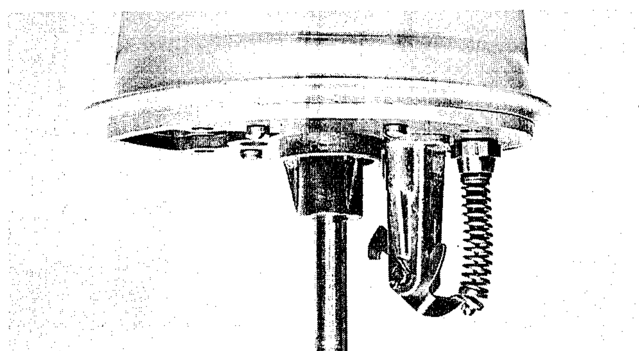


Showing Clutch Cable Detached from Anchor and Guide Tube Removed, Prior to Detaching Power Head from the Lower Unit

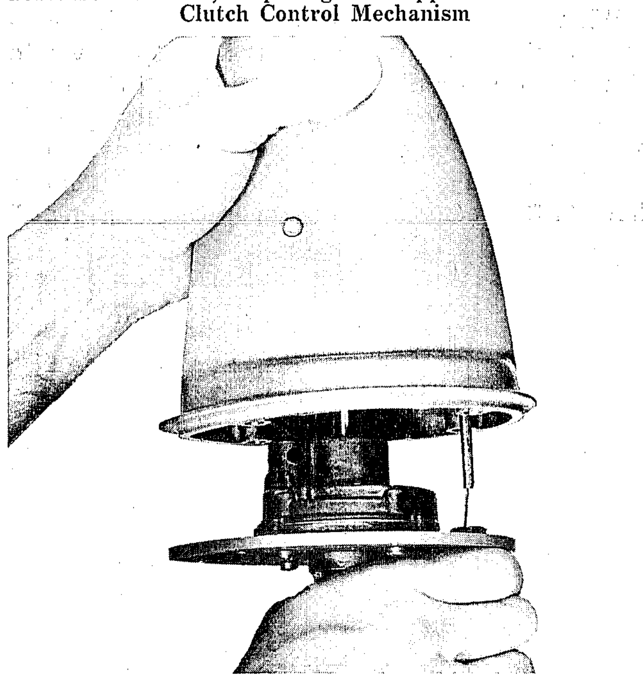
To remove the gearcase proper from the upper gearcase housing, it is necessary merely to remove the screws holding the assembly fast. The gearcase and upper section are easily separated. Note narrow "open slot" between the two sections above the exhaust outlet. Purpose—to provide exhaust relief for starting and slow speed operation.



Removing Gearcase from Lower Unit Assembly

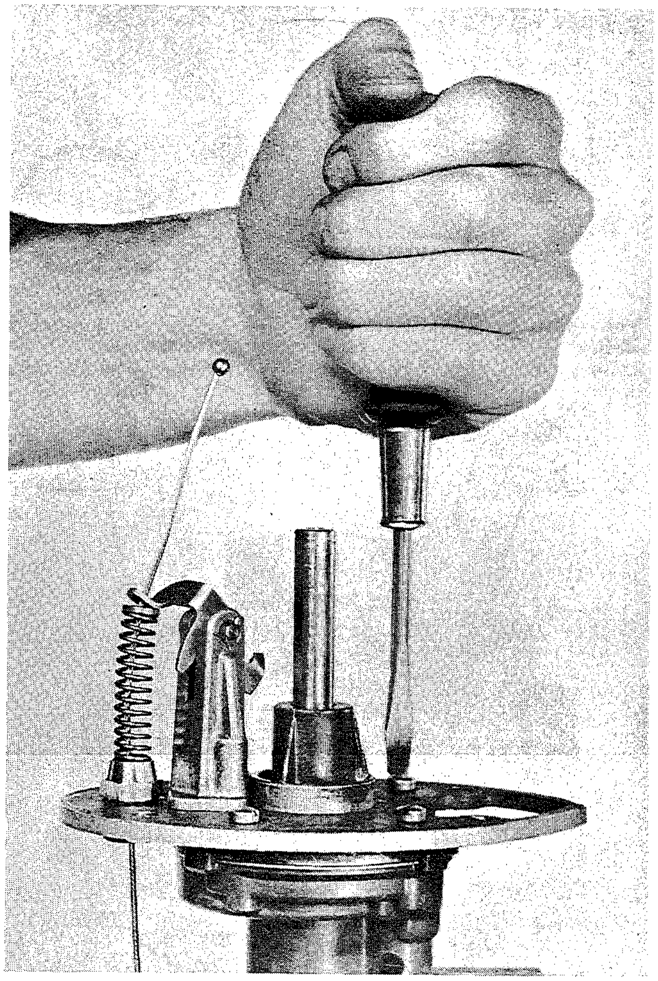


Gearcase Removed, Exposing the Upper Driveshaft and Clutch Control Mechanism

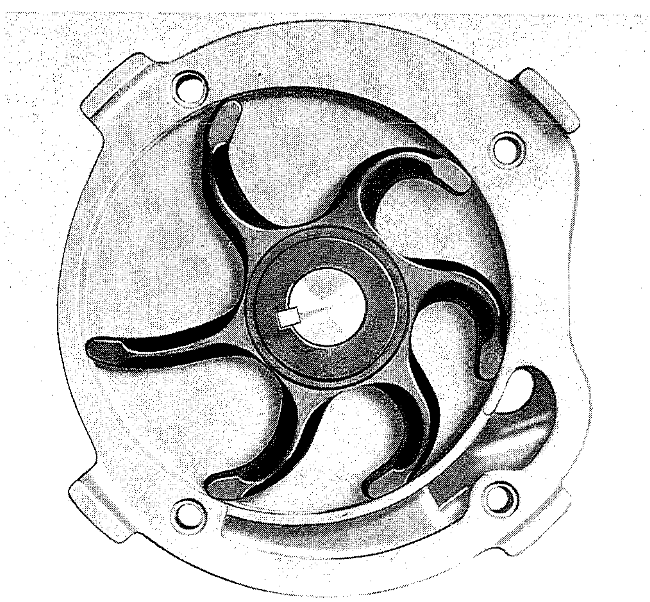


Removing Pump Assembly, Clutch Control Mechanism and Bearing Support from the Lower Unit Assembly

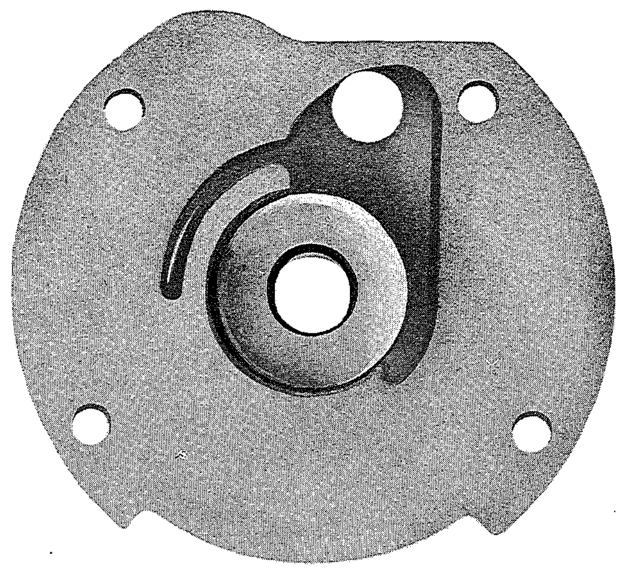
The water pump assembly is installed in the upper gearcase section and is made accessible for inspection or repair on removal from the bearing support plate as shown below.



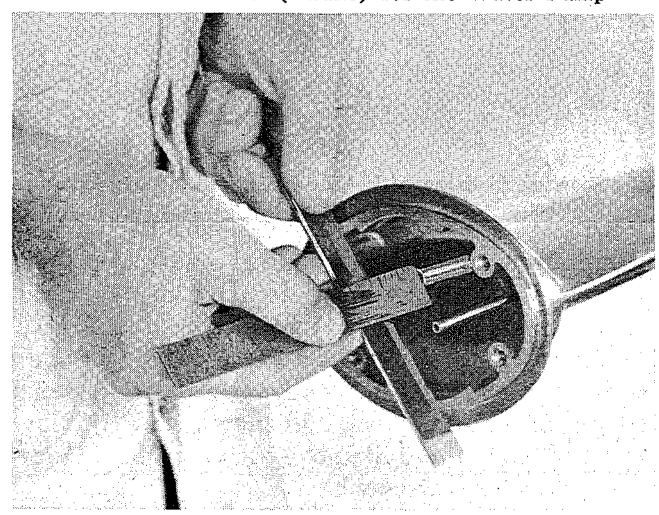
Detaching Bearing Support and Clutch Control Mechanism from the Water Pump Assembly



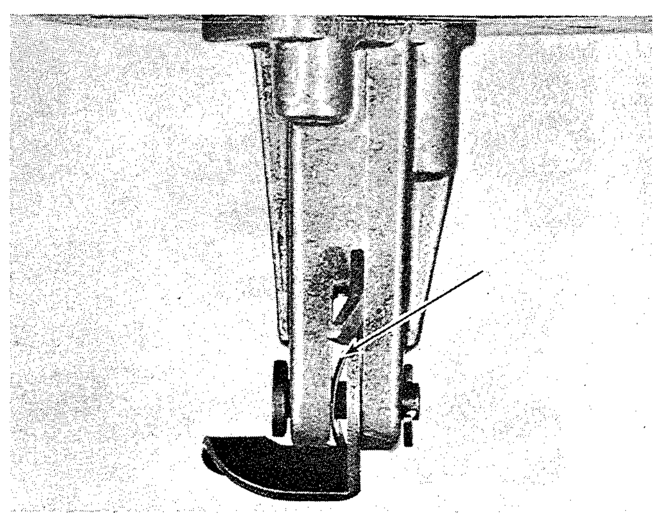
Showing Position of Impeller in the Water Pump Housing —for Further Explanation of the Pump, see Page 192-4



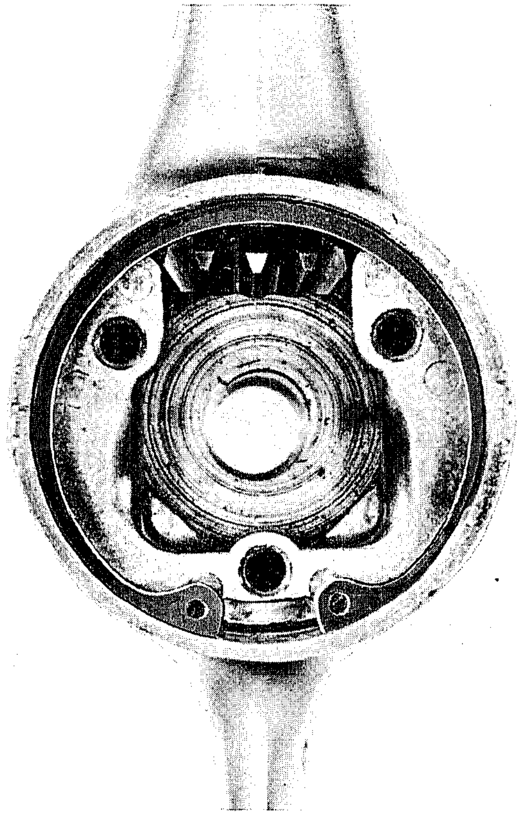
Top Side of Bearing Support Plate Showing the Oil Seal and Water Channel (Intake) for the Water Pump



Correct Procedure for Checking Position of the Water Tube (to Cooling System)—End of the Tube Should Locate 7/8" Below Surface of the Housing as Illustrated—IMPORTANT: End of Control Cable Tube Should Protrude 7/8"

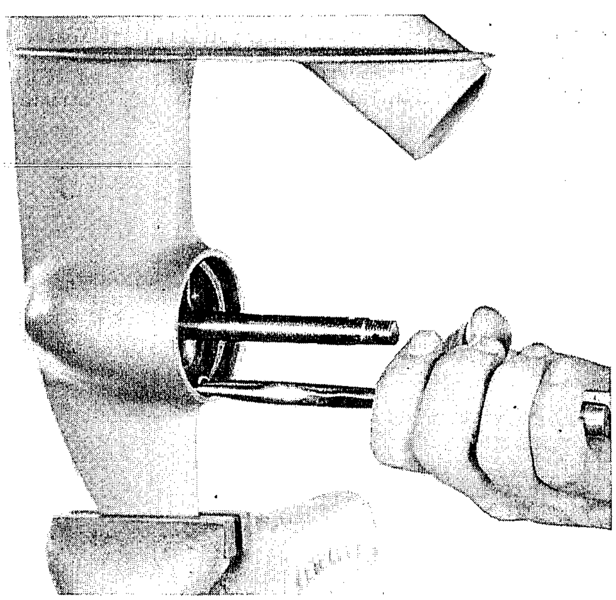


Note Correct Position of Spring Washer in Assembly of the Clutch Control Mechanism



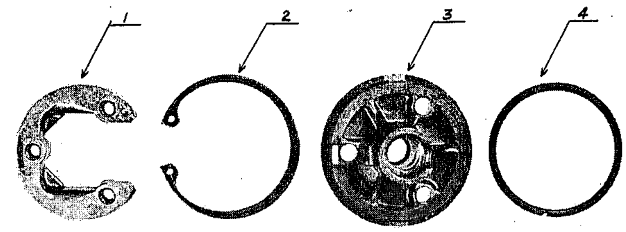
Showing Position of Retainer Ring in the Gear Case

To gain access to the gear assembly, remove three screws holding the gearcase head fast to the gearcase—withdraw the gearcase head. Final disassembly is accomplished by compressing the lockplate retainer ring with a pair of pointed nose pliers as shown here. Turn the gearcase upside-down to permit the clutch-shock absorber assembly falling out in palm of hand. Remove the lockplate and propeller shaft-gear assembly.

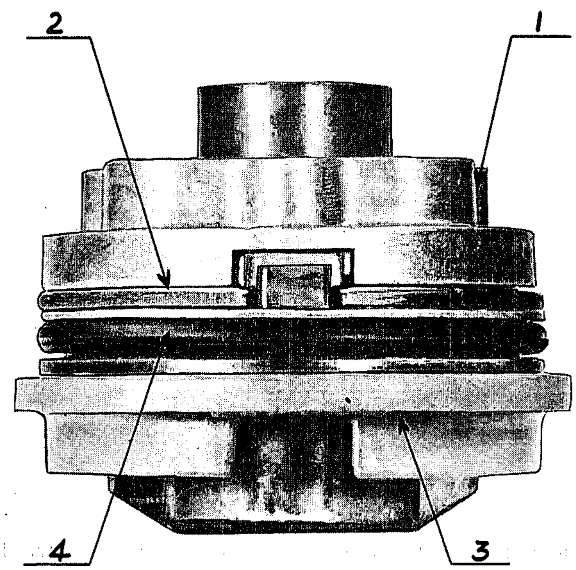


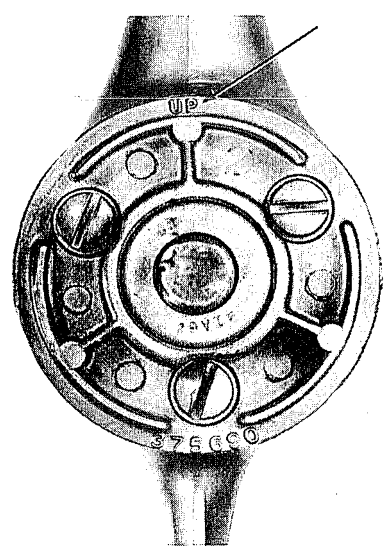
Illustrating Procedure for Removal of the Retainer Ring with Pointed Nose Pliers to Accomplish Final Disassembly of the Gearcase

All parts of the lower unit assembly should now be available for inspection or replacement as required. Bearings are cast in. Reassembly should be carefully performed in order reversed of that explained above.

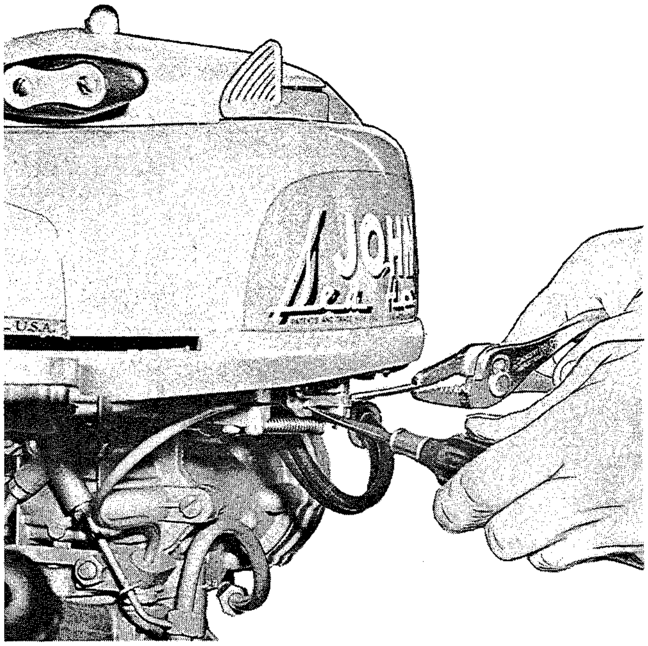


Top—Illustrating Details of the Gearcase Head Assembly: Below—Gearcase Head Assembly. (1) Lockplate, (2) Retainer, (3) Gearcase Head (Including Bearing and Oil Seal, (4) "O" Ring

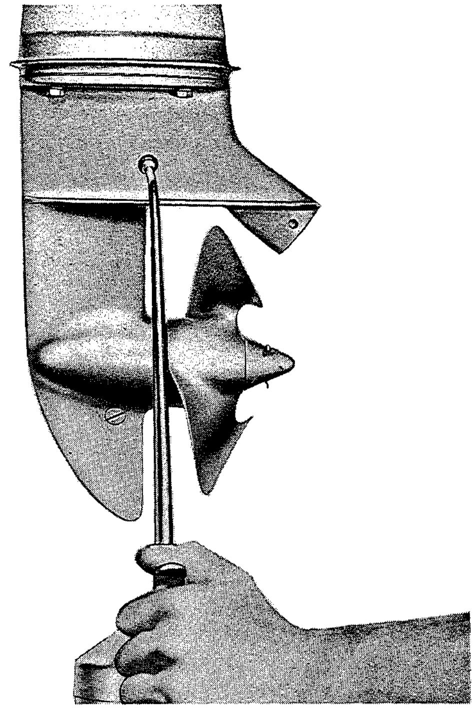




Illustrating Correct Position of the Gearcase Head when Attached to the Gearcase



Illustrating Procedure for Correct Anchoring of the Clutch Cable on Completion of Assembly. Note—Neutral Control Lever in "Run" Position. Grasp Protruding End of Control Cable with Pliers, as Illustrated—Pull to Take up Slack (to a Point Beyond Where Spring Tension is Felt). Draw up Snugly on Clamp Screws



The Gearcase is Lubricated with Hypoid Gear Lubricant. Oil Seals are Provided for the Propeller Shaft and Driveshaft. See Page 180 for Details of Oil Seal Installation

NOTE: The inner driveshaft casing is not built into the lower unit assembly in case of the Model TN—same being replaced by a carbon seal, "O" ring, washer and a spring which bears against the carbon seal from below to insure contact with the end of the crankshaft. The "O" ring seals the space between the outside wall of seal and recess (which contains the above parts) in upper end of driveshaft casing.

NOTES

INSTALLATION INSTRUCTIONS FOR PART NO. 376311 SEAL ASSEMBLY KIT—UPPER DRIVESHAFT CASING TO DRIVESHAFT— MODELS TN-27 AND TN-28

The following parts are included in this kit:

1	303894	Retainer
1	303347	O-Ring
1	303391	Seal
1	303357	Spring
1	303327	Washer
1	303261	Drive Pin
1	303904	Instruction Sheet

Installation Instructions for Model TN-27

A. Disassemble driveshaft casing assembly (#375727) and driveshaft (#302469) from motor and machine through the driveshaft casing flange 15/16″ diameter. (Ream or drill).

B. Apply a thin coat of lubricant on the outside of the retainer (#303894) and press retainer down in driveshaft casing flange so that the top of retainer is 1/8″ below top of driveshaft casing flange. See drawing on reverse side (TN-27) for proper position of retainer.

C. Drill .097 - .095 diameter through driveshaft. Location of hole being 2-11/16″ from top of driveshaft to center hole. Insert drive pin (#303261).

D. Place washer (#303327), spring (#303357), seal (#303391) and O-ring (#303347) in position and reassemble motor using new gaskets #302355 and #41-36 (if necessary) between the powerhead and lower unit.

E. It may be necessary to **slightly** bend the water and neutral clutch cable tubes for proper clearance of the seal assembly.

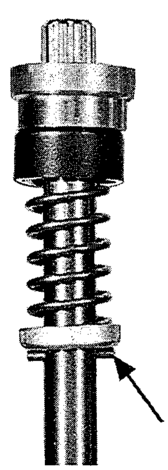
Installation Instructions for Model TN-28

A. Disassemble driveshaft casing (#375943) and driveshaft assembly (#375939) from motor. Apply a thin coat of lubricant on the outside of the retainer (#303894) and press retainer down in the driveshaft casing flange (#375943) so that top of retainer is 1/8″ below top of driveshaft casing flange.

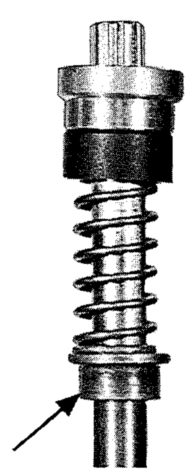
B. Press collar (#303031) down on driveshaft so that top face of collar is 2-5/8″ from top of driveshaft. Place spring (#303357), seal (#303391), and O-ring (#303347) in position — see drawing on reverse side (TN-28)—and reassemble motor using new gaskets #302355 and #41-36 (if necessary) between powerhead and lower unit.

C. It may be necessary to **slightly** bend the water and neutral clutch cable tubes for proper clearance of the seal assembly.

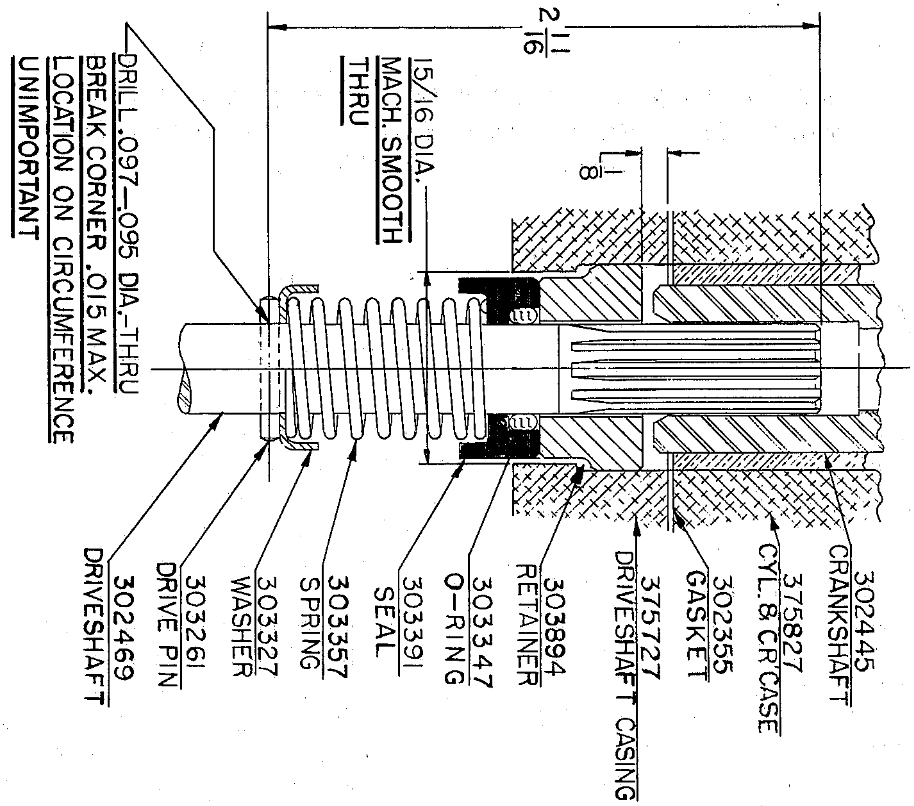
D. Part #303261 drive pin and #303327 washer not required for installation of seal assembly on Model TN-28, UNLESS collar #303031 on driveshaft breaks when pressing to proper position. If collar breaks, remove same from driveshaft and install #303261 drive pin and #303327 washer—see instructions — paragraph "C" and "D" for Model **TN-27**.



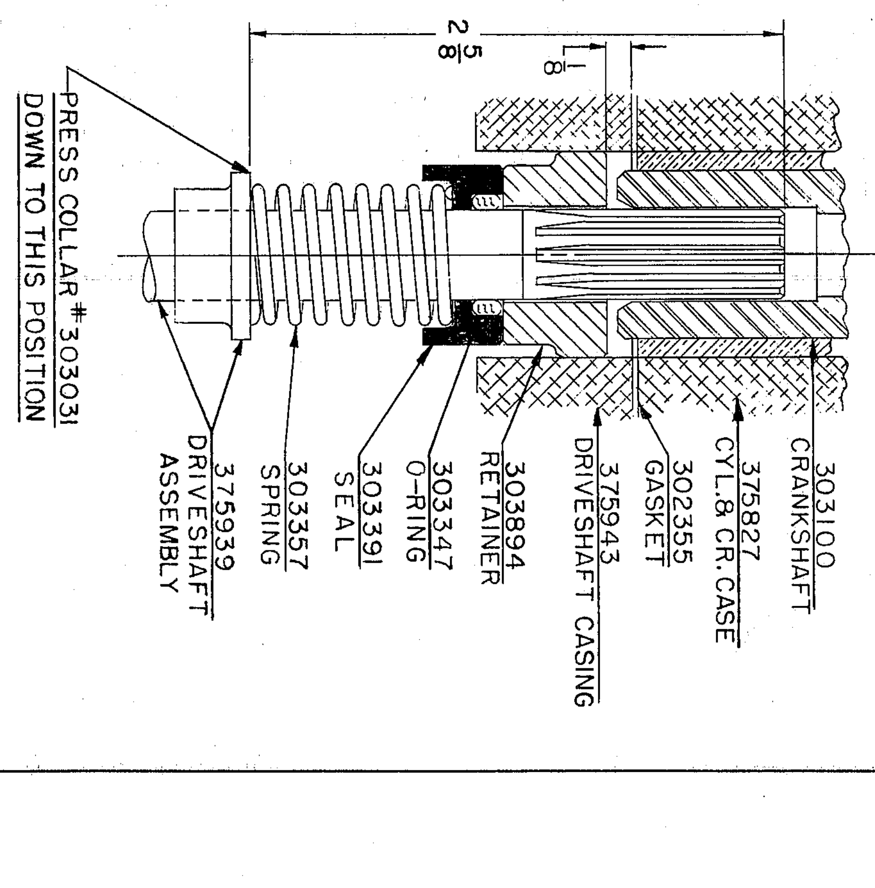
Carbon seal assembly—Model TN-27.



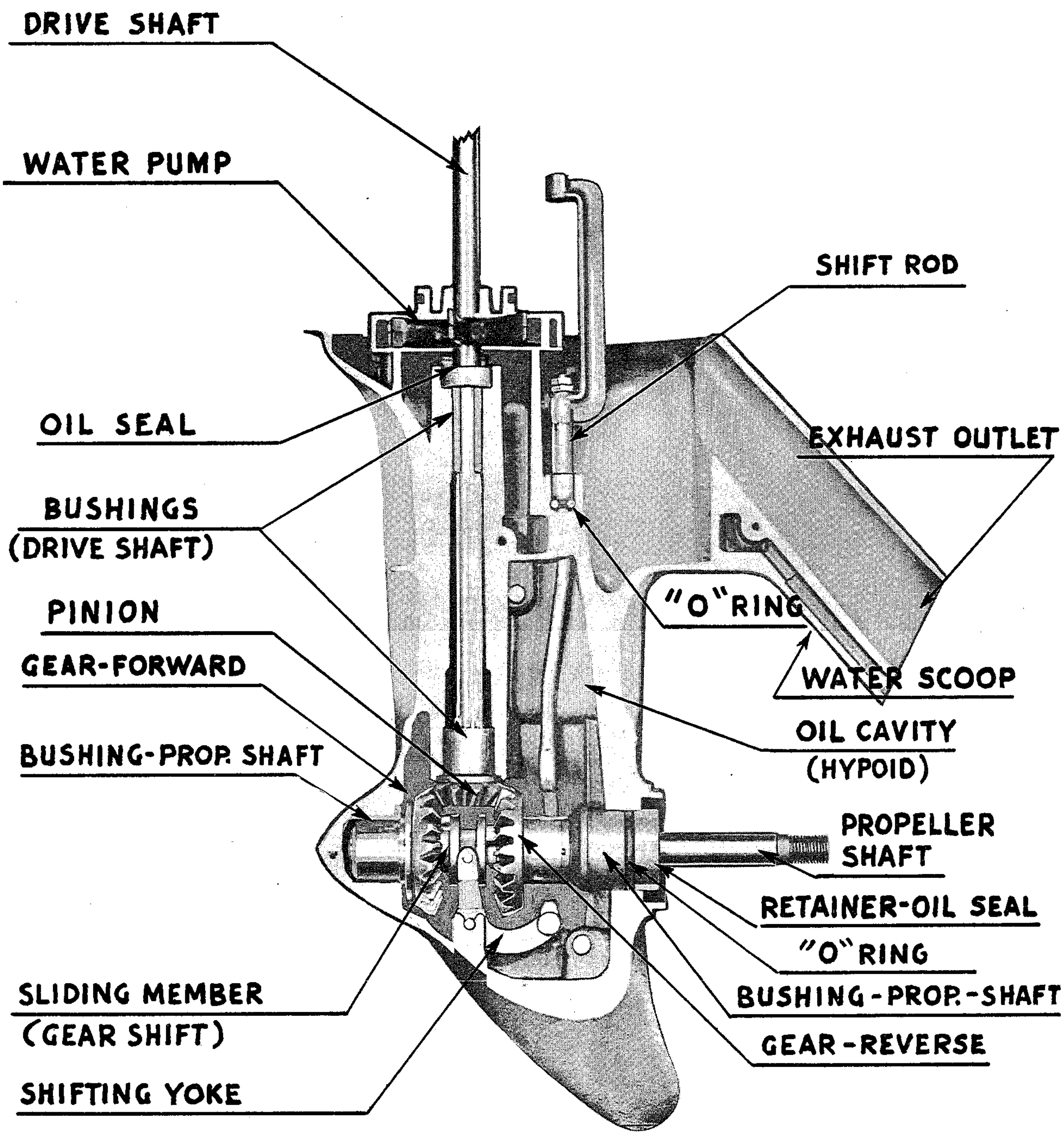
Carbon seal assembly—Model TN-28.


2 11/16
1/8
15/16 DIA.
MACH. SMOOTH
THRU
DRILL .097-.095 DIA.-THRU
BREAK CORNER .015 MAX.
LOCATION ON CIRCUMFERENCE
UNIMPORTANT
302445
CRANKSHAFT
375827
CYL.& CR.CASE
302355
GASKET
375727
DRIVESHAFT CASING
303894
RETAINER
303347
O-RING
303391
SEAL
303357
SPRING
303327
WASHER
303261
DRIVE PIN
302469
DRIVESHAFT

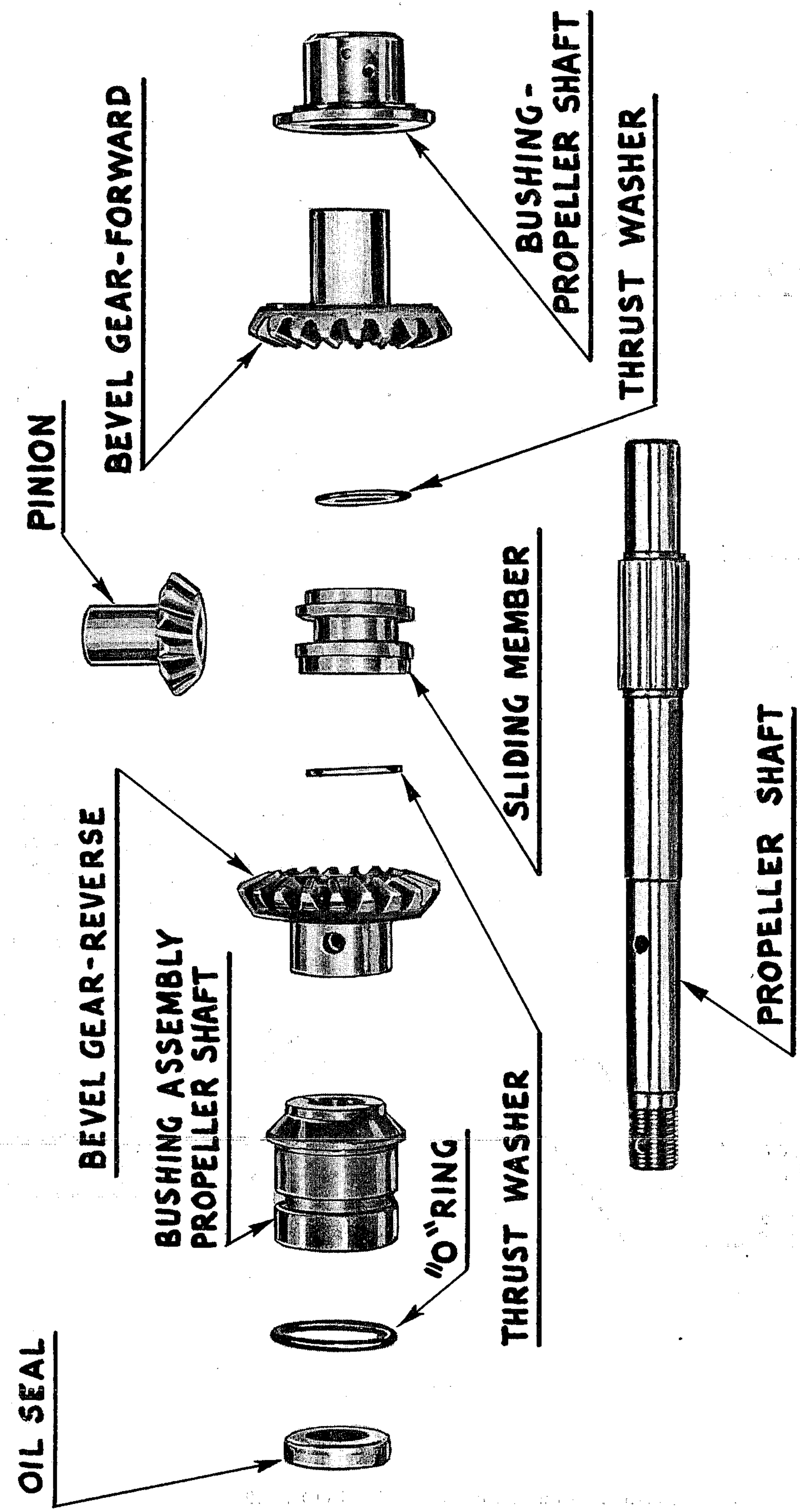
TN 27


2 5/8
1/8
PRESS COLLAR # 303031
DOWN TO THIS POSITION
303100
CRANKSHAFT
375827
CYL.& CR.CASE
302355
GASKET
375943
DRIVESHAFT CASING
303894
RETAINER
303347
O-RING
303391
SEAL
303357
SPRING
375939
DRIVESHAFT
ASSEMBLY

TN 28

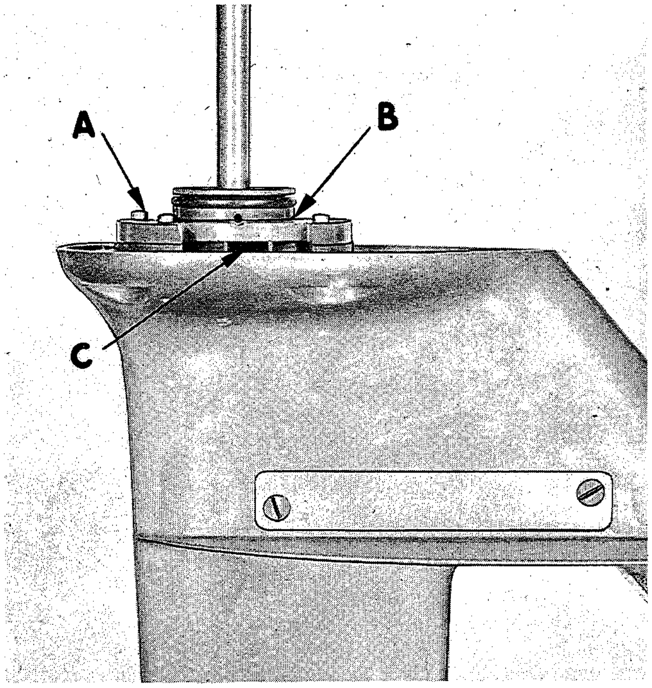


Sectional View of Gearcase—Model QD 11-12



Assembly Layout—Propeller Shaft, Gears and Bushings (Bearings)—Model QD 11-12

WATER PUMP ASSEMBLY — QD-11 AND 12



Showing Pump Assembly "B" Attached to the Gear Case and Position of Water Discharge "C."

Access to the water pump assembly ("B" shown above) in this case is gained obviously by detaching the gearcase from the driveshaft casing—remove screws holding gearcase fast to the driveshaft casing.

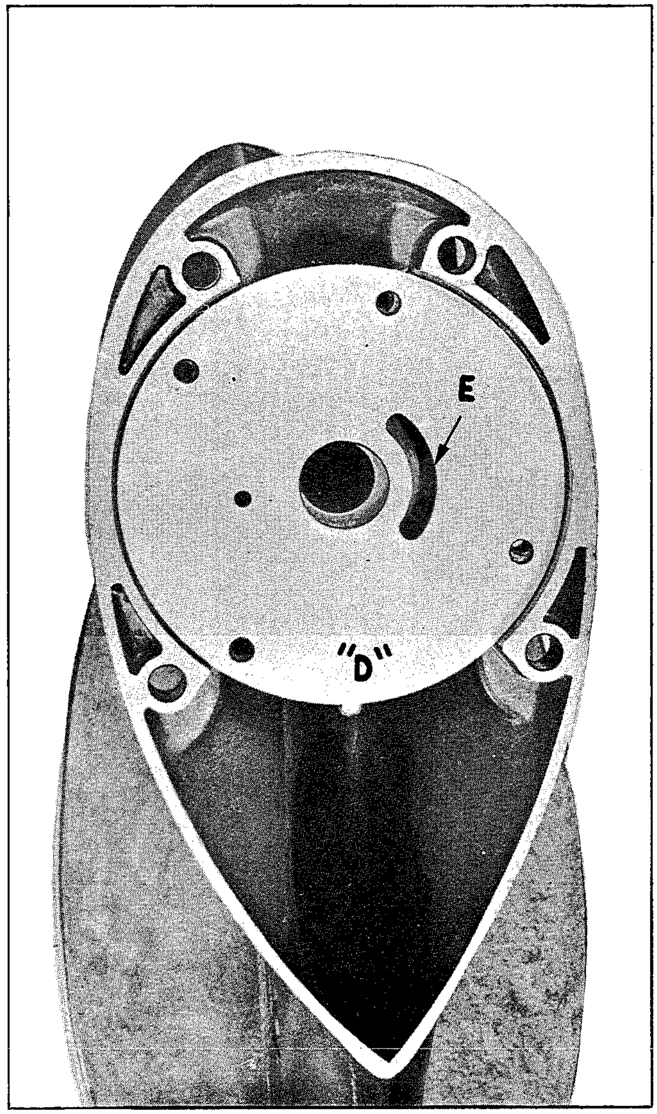
The pump housing, impeller cover plate make up the assembly — keyed (impeller) to the driveshaft and attached to the gearcase by screws "A" as shown above.

To detach the pump assembly, remove screws "A"—carefully lift or pry (if necessary) from the gearcase. In all probability cover plate "D," shown below, will remain in the gearcase. Pay particular attention to position of water inlet "E" at this time.

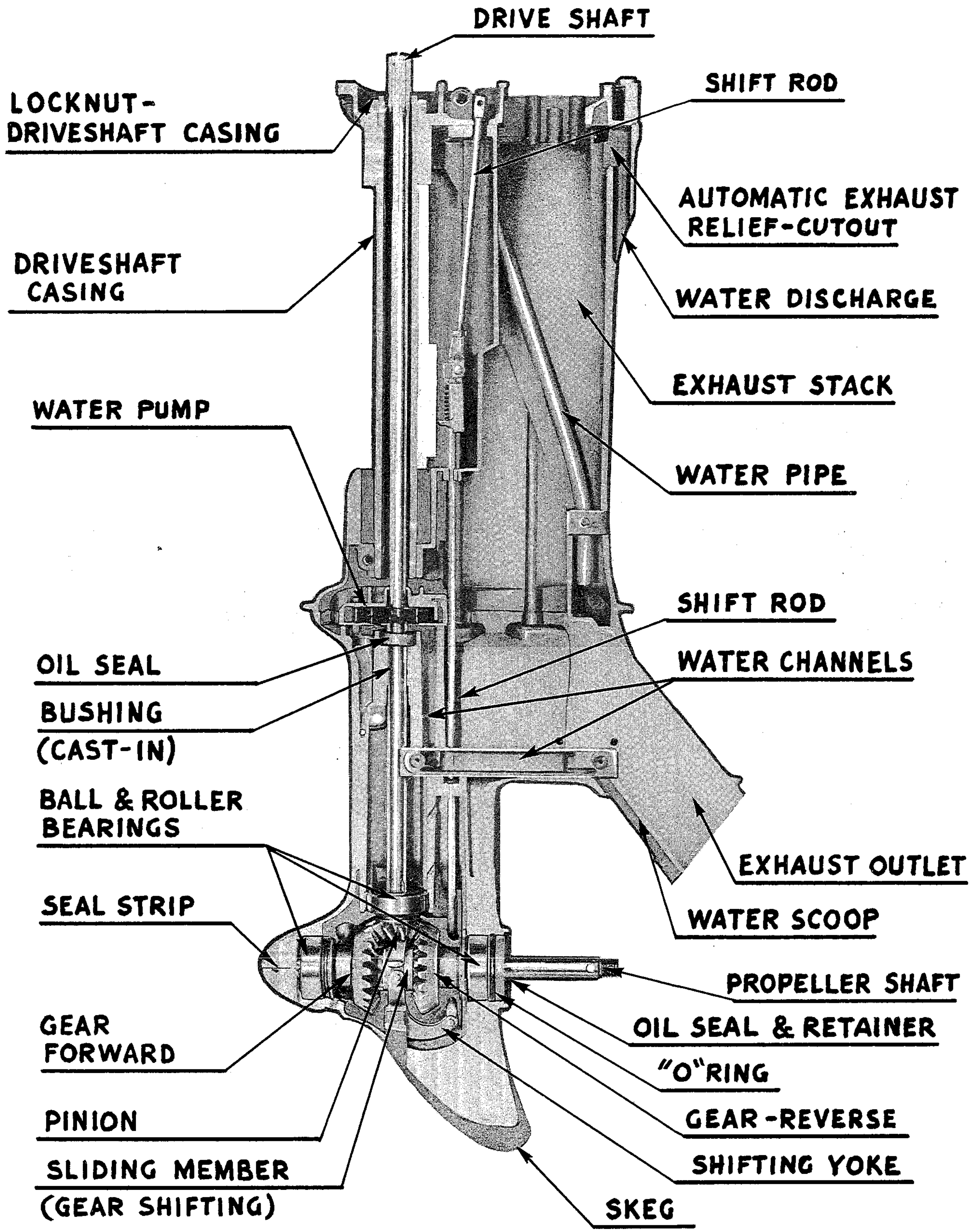
Repair and assembly of the water pump is extremely simple—replace parts indicating excessive wear—but, it is possible to install cover plate "D" incorrectly. Note position of water pump discharge "C" and water inlet "E" (cover plate).

Inlet "E" should be placed to side opposite discharge "C" prior to securing the pump assembly as shown here. Inlet (cover plate) and discharge (pump housing) must be arranged directly opposite if the assembly is to function—extreme caution should be taken at this stage of assembly.

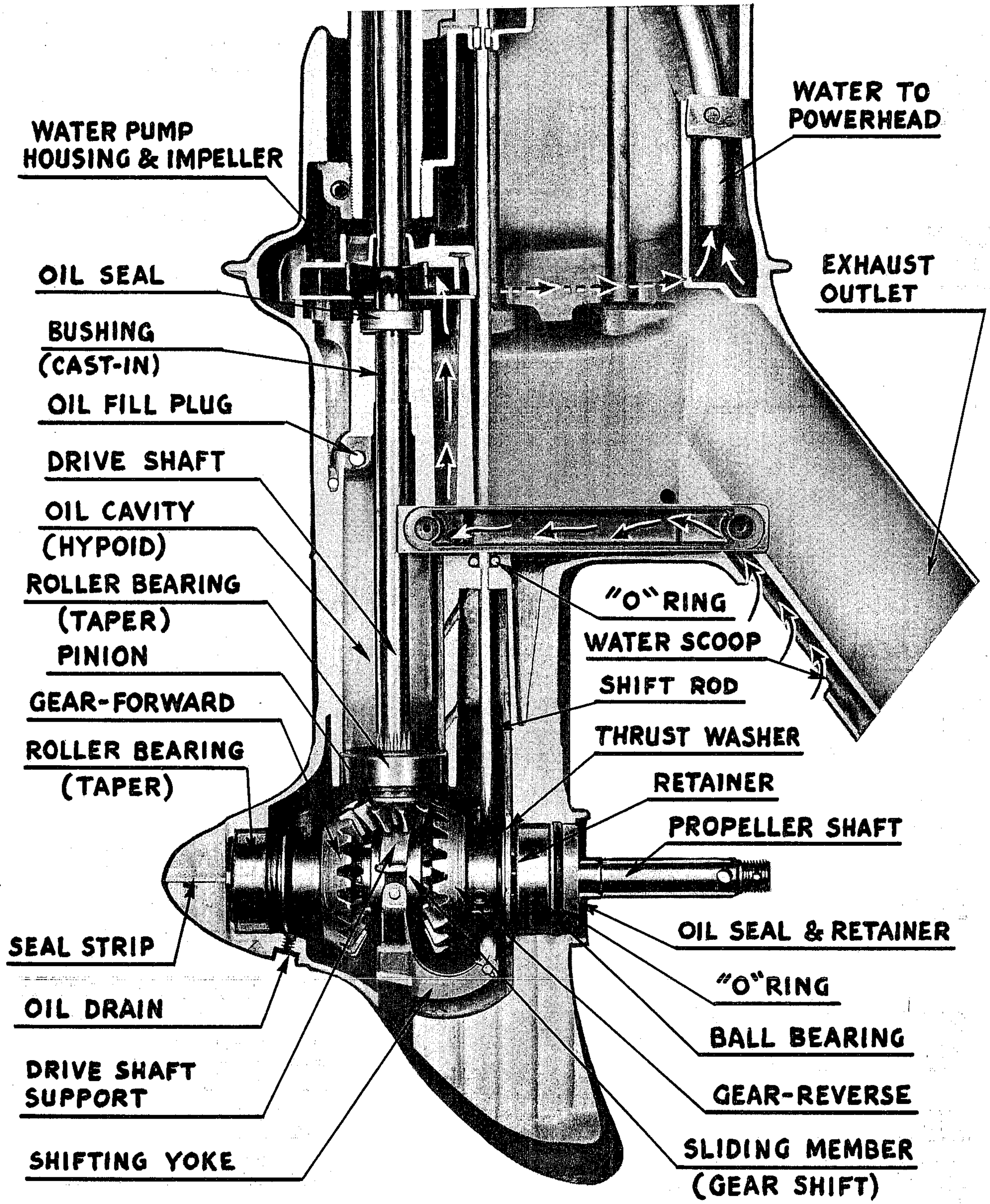
See page 192-4 regarding details of operation.



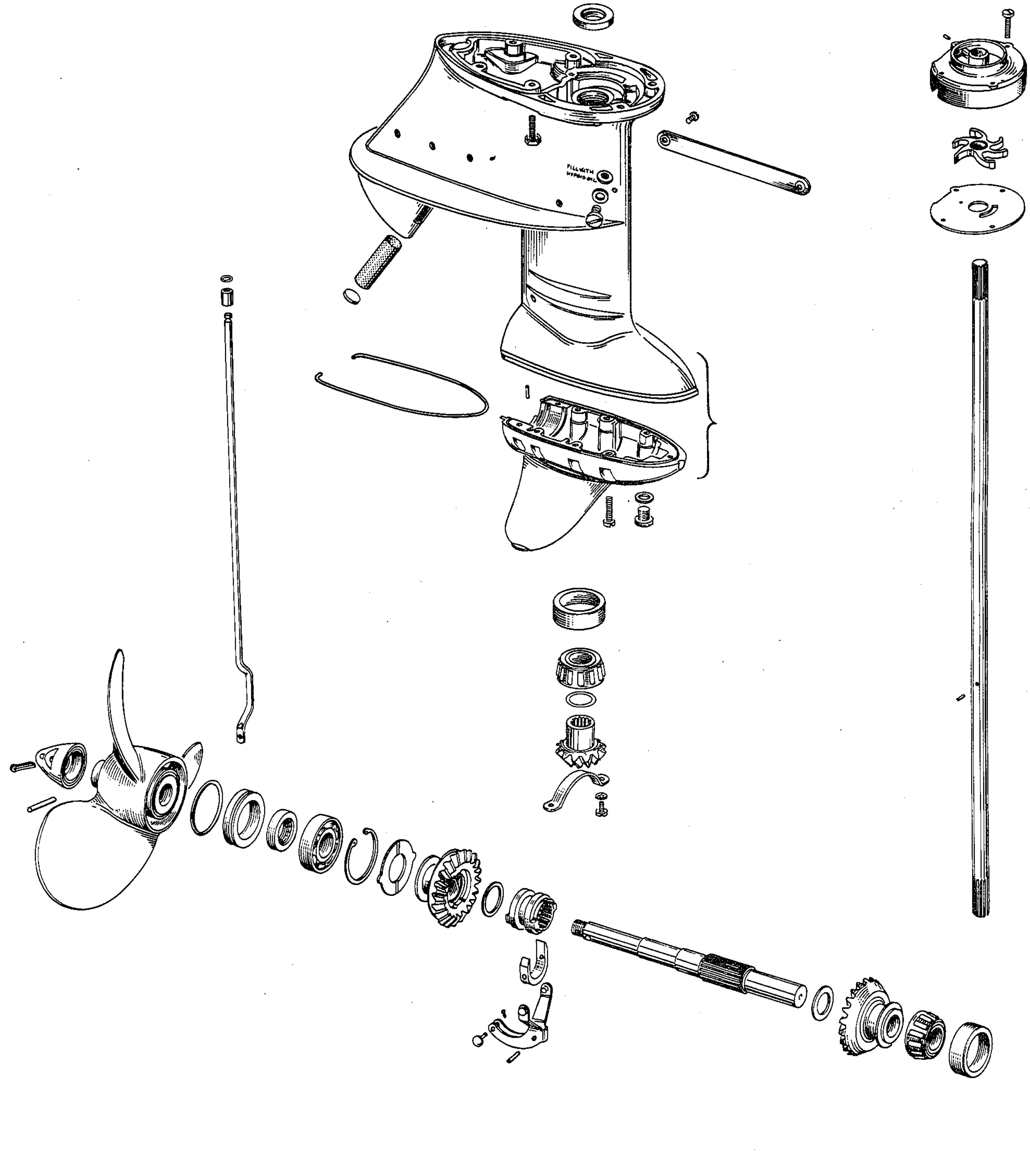
Showing Position of Cover Plate "D" when Correctly Positioned in the Gear Case.



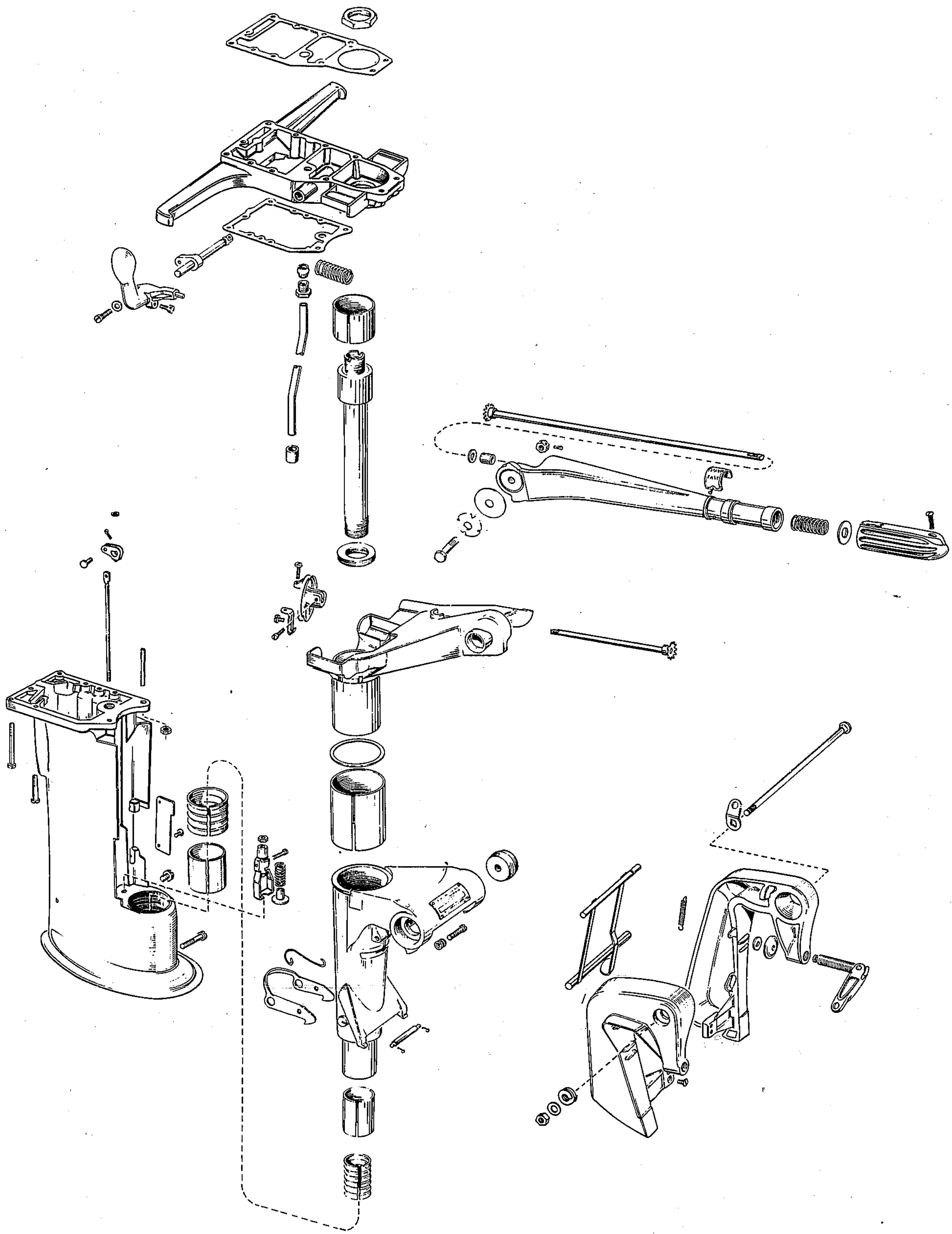
Sectional View of Lower Unit—Model RD



Sectional View of Gearcase—Model RD



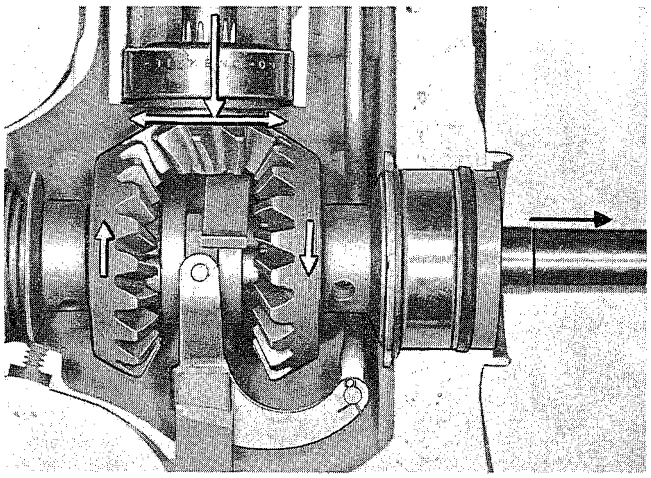
Assembly Layout of Gearcase Group—Model RD



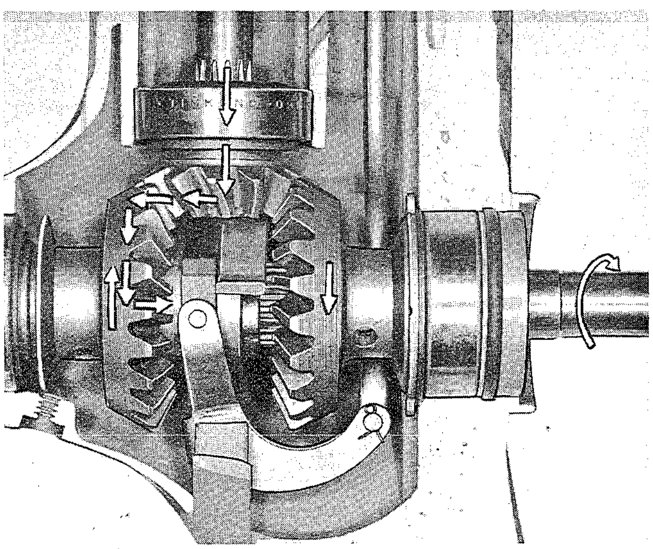
Assembly Layout—Swivel Bracket, Drive Shaft,
Stern Bracket and Steering Arm Group

THE LOWER UNIT

The lower unit as can be seen from the sectionalized view contains: (a) the driving gear (forward, neutral and reverse), (b) driveshaft, (c) the gear shifting, exhaust control and reverse locking mechanisms, (d) the water pump, (e) driveshaft casing, (f) swivel bracket and (g) stern brackets.

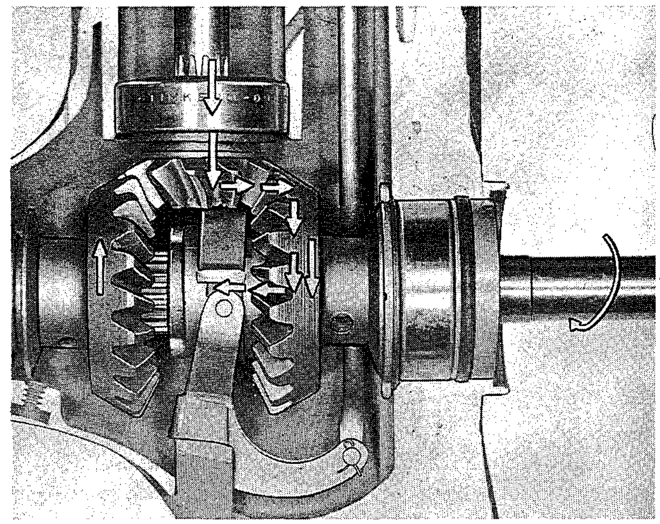


Gear Shift "Neutral"—Bevel Gears Floating Idle on the Propeller Shaft Which Remains Motionless.



Gear Shift "Forward"—Sliding Member Engaging the Forward Gear. Note Line of Drive. Gear for Reverse Is Now Floating Idle on the Propeller Shaft.

Gear shifting: To accomplish "forward," "neutral" and "reverse," three gears, a sliding member and shifting levers properly supported are required. The pinion (gear) is splined to the driveshaft and rotates constantly with operation of the motor. The bevel gears (one forward and one aft of the pinion) float or ride "free" on the propeller shaft—one in one direction and the other in the opposite direction. The sliding member is keyed or splined to the propeller shaft and remains motionless as does the propeller shaft and propeller

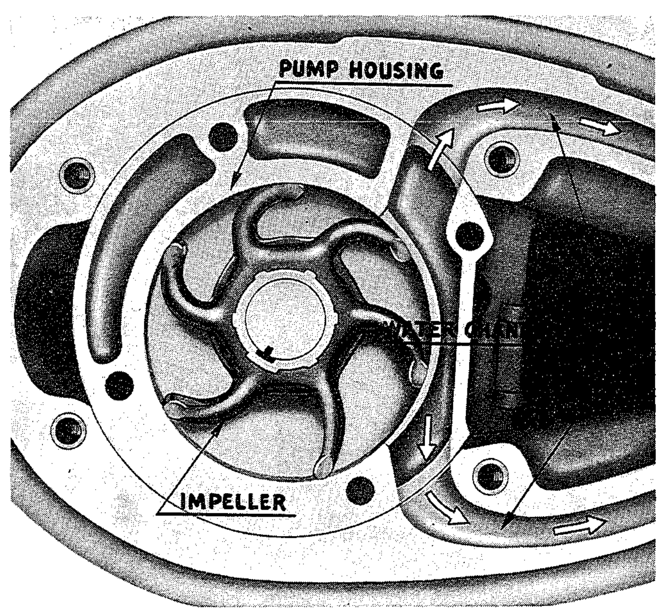


Gear Shift "Reverse"—Sliding Member Engaging the Reverse Gear. Note Line of Drive. Gear for Forward Is Now Floating Idle on the Propeller Shaft.

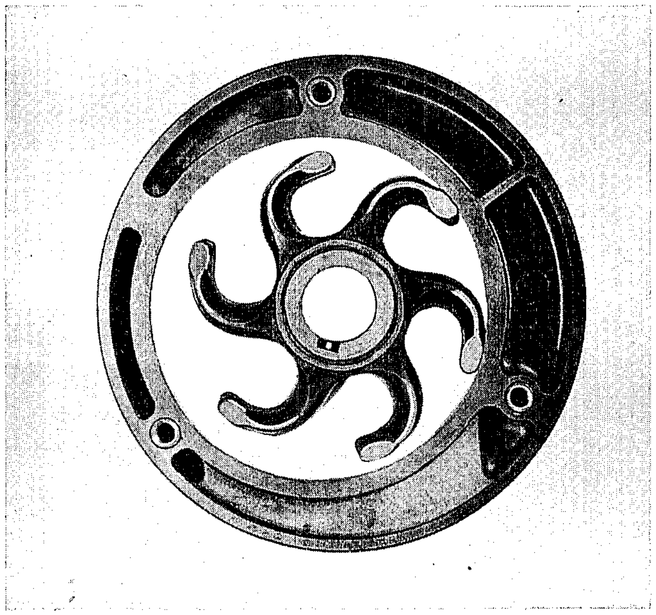
(neutral) during operation of the motor, until the "dogs" of the sliding member engage like "dogs" on either gear (forward or reverse, depending upon which gear is engaged).

The water pump provided for circulating water through the water jackets to dissipate heat consists of an impeller (with flexible synthetic rubber vanes or blades) driven by the driveshaft and rotating in an aluminum housing into which are cast ports for water discharge. Open end of the housing is closed by installation of a steel plate with elongated slot to act on the water inlet.

It will be noted from the illustration that the driveshaft does not center in the impeller or pump housing—the impeller is thus offset to one side. This fact causes the impeller blades to flex with

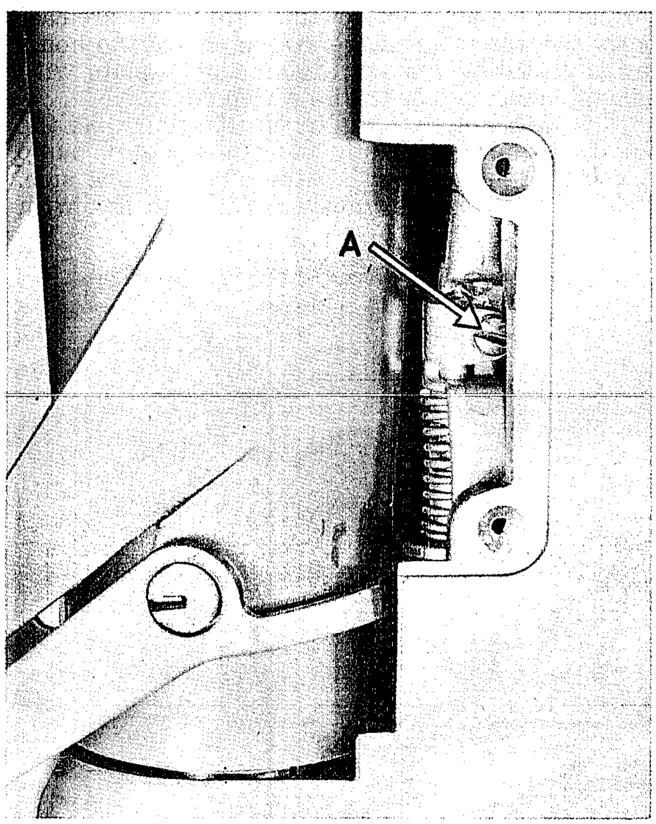


Pump Assembly.



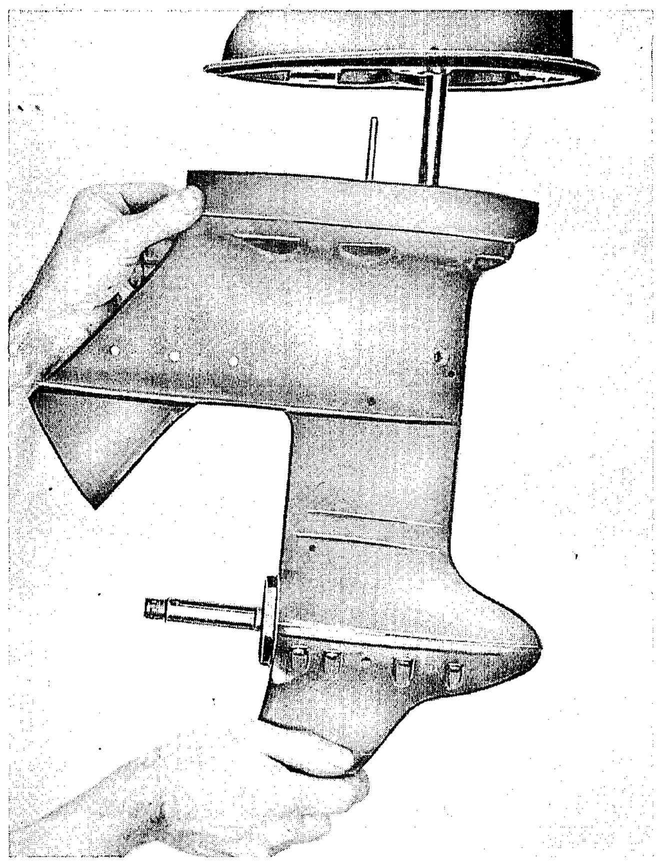
Showing Position of Impeller Blades during Operation in Higher Speed Range.

rotation — subsequently varying volume between the blades to make it a displacement type of pump when acting at low r.p.m. As motor speed increases, resistance within the pump housing increases to cause all of the blades to flex or bend in such manner it performs merely as an impeller to maintain water circulation.

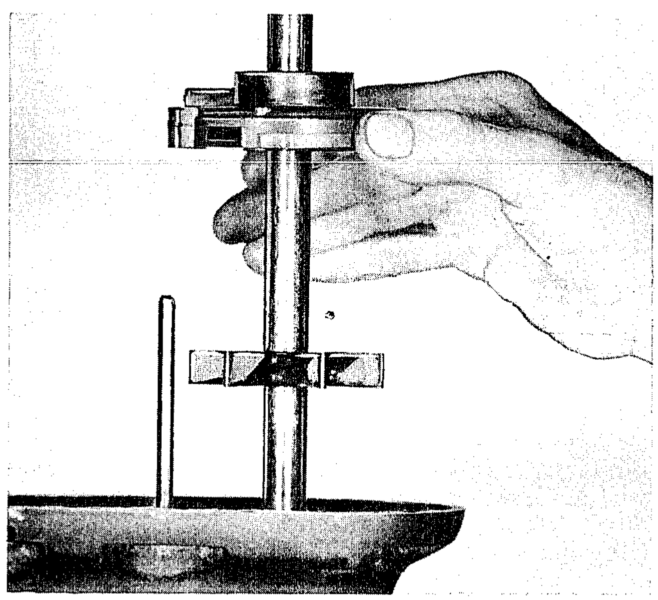


Showing Position of Screw "A" in Bracket, Connecting Upper and Lower Shift Rods.

To remove the gearcase for inspection and/or repair, remove small plate in upper housing—loosen exposed screw "A" shown below—see page 192-21—to free lower end of shift rod. Loosen and remove bolts holding gearcase fast to the upper housing—pull from assembly as shown here. Install in reverse order.



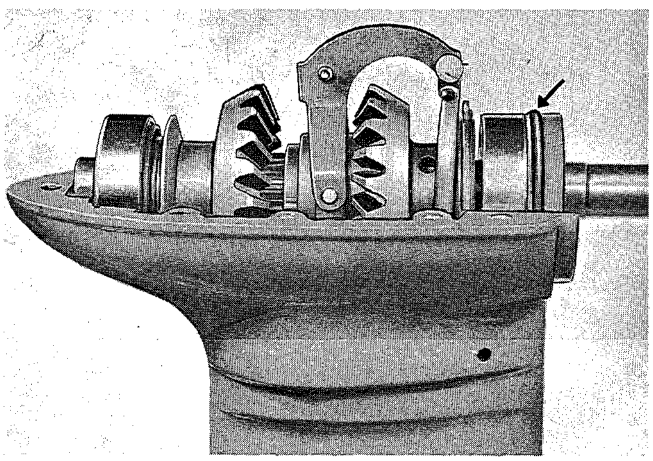
Removing Gear Case Assembly to Detach from Upper Housing.



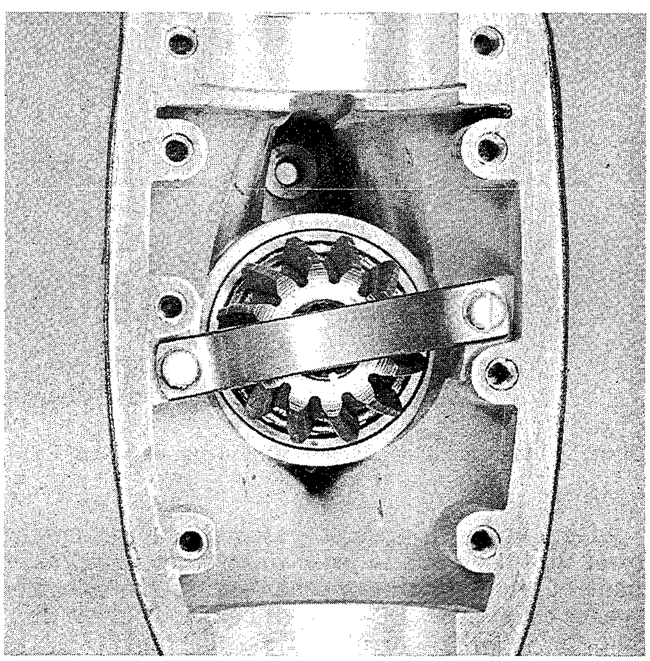
Removing Pump Housing and Impeller from the Gear Case. Pump Housing Held Fast to Gear Case by Four Screws.

To remove and disassemble the water pump, loosen and remove screws holding it to upper part of the gearcase—the pump housing, impeller and cover plate may then be separated and removed with the driveshaft.

To remove gearcase lower cover (skeg) for inspection and/or replacement of parts, remove screws holding it fast to the gearcase proper. It may adhere strongly—in this event, strike the skeg lightly with mallet to jar loose. Removal exposes running gear assembly and shifting mechanism for removal. Remove pin attaching shifting member to shifting shaft—lift shifting member off—lift propeller shaft, bearing and gear assembly from its "bed" in the gearcase. The propeller oil seal-retainer can be taken off over the end of the shaft—Note "O" ring to accomplish "seal" between the propeller shaft oil seal retainer and sections of the gearcase.



Skeg Removed to Expose Gear Case Mechanism for Inspection and/or Repair.

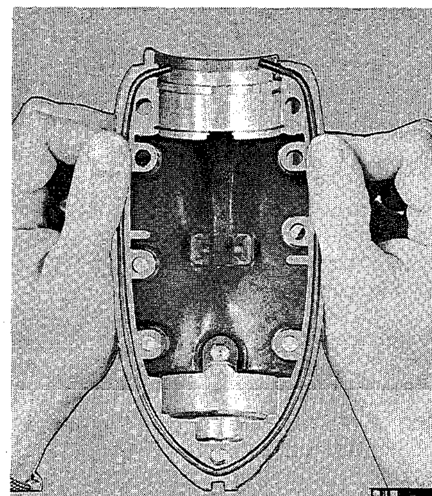


Showing Installation of "Bridge" Piece to Support Driveshaft and Gear.

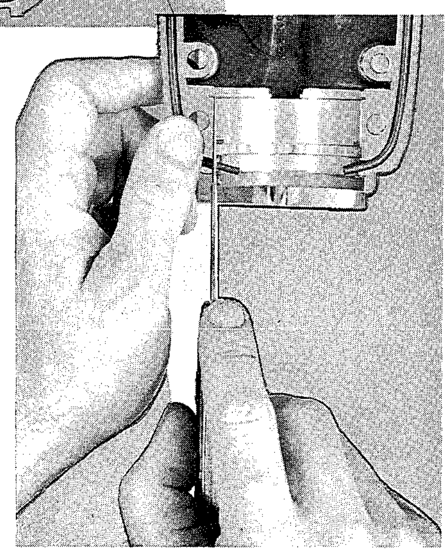
Pinion (gear) bearing assembly and driveshaft are supported in the gearcase by a small "bridge" held fast by two screws—to remove the gear and bearing assembly, simply detach the bridging piece. Gear and bearing are available as an assembly only.

Reassemble gearcase in reverse order of this, described with necessary new parts. Replace lower gearcase section (skeg).

The seal strip, when purchased as a service part, comes just a bit too long for installation "as is"—this is to permit proper installation or adjustment in corresponding grooves—gearcase. To install—remove all traces of cement on gearcase faces and grooves, if necessary. Apply Sealer 1000 (or similar hard drying cement) at several points along the grooves and particularly at the end of each groove. Place seal strip in position immediately



Installing Seal Strip.



Trimming Seal Strip.

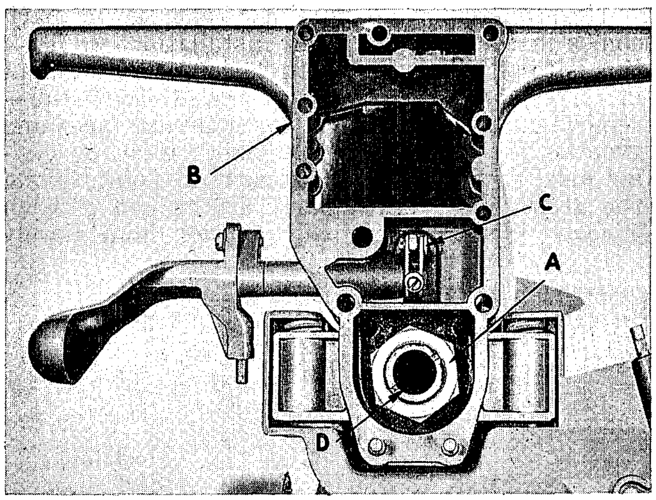
(before the sealer dries) allowing each end to overhang slightly, then, before the sealer sets, guide the entire length of the strip towards outside edge of the groove in each case. Use thumbs of each hand to accomplish as illustrated. Trim ends with knife as shown—ends hanging over just a bit to insure proper seal at the end of the strip.

Apply thin coat of Sealer 1000 to surfaces to be bolted together—be somewhat more generous with sealer in areas at ends of the seal strip to insure a good "butt" seal.

Apply Sealer 1000 (or similar hard drying cement) to threads of bolts holding sections together. The threaded areas must be "oil tight" too.

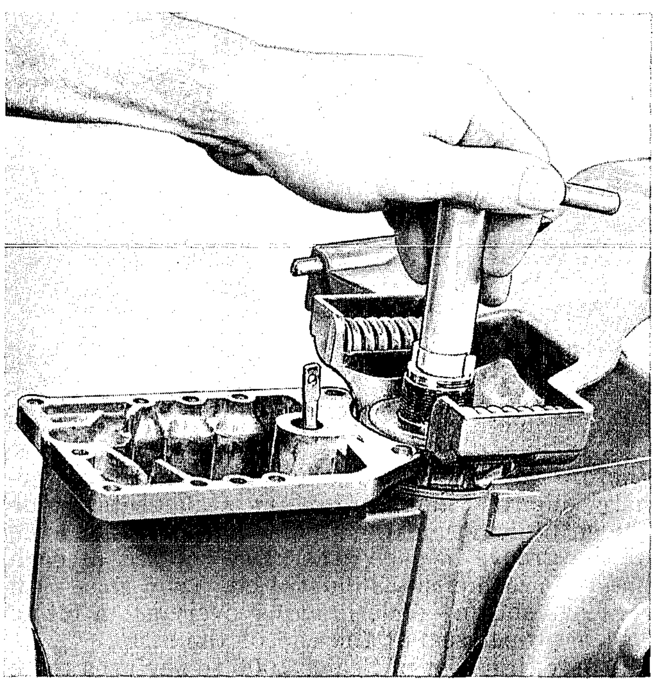
Refill with hypoid gear oil as instructed.

To disassemble the upper lower unit section, for replacement of the swivel bracket, it is, of course, necessary to detach the power head.

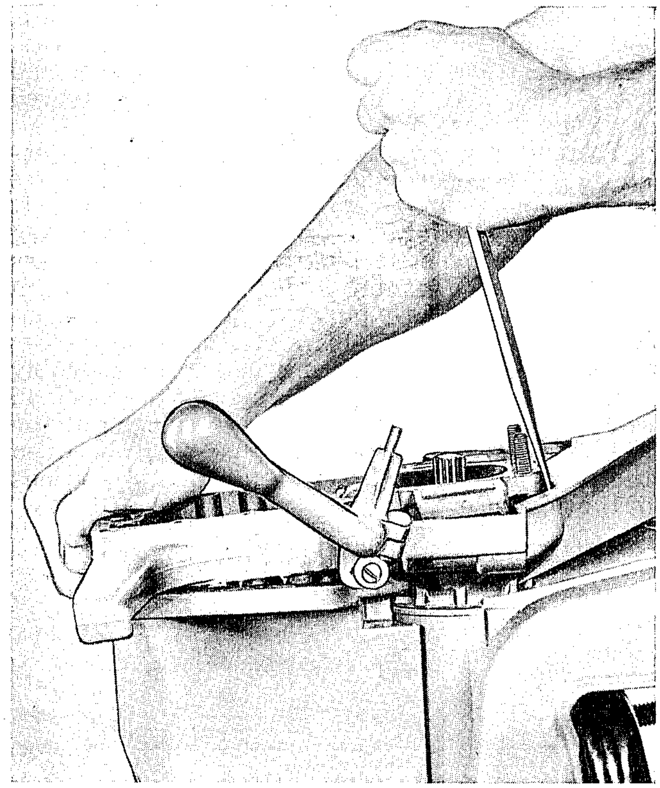


Power Head Removed to Expose Details of Lower Unit Assembly—Upper Section.

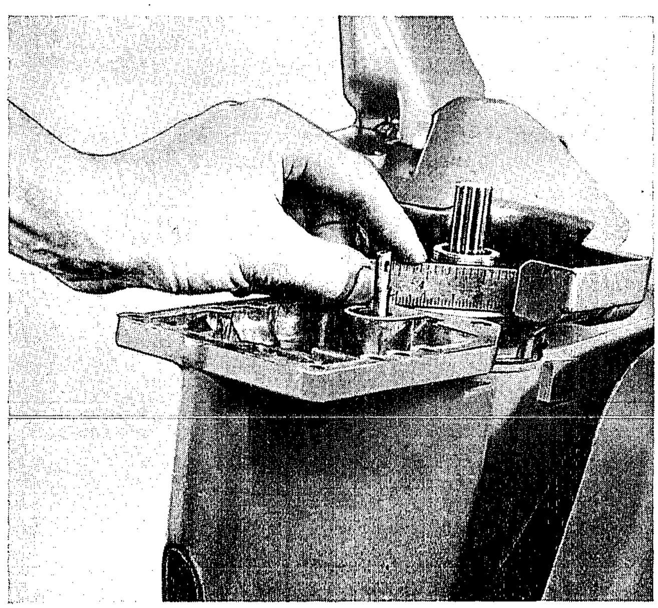
Remove nut "A" shown above and pin "C." Carefully pry adaptor "B" from its position. Remove driveshaft casing "D." Lift swivel bracket from its position; replace if required and reassemble in reverse order. Note collar on top end of the driveshaft casing. Turn driveshaft casing down until top surface is "flush" with top face of the exhaust stack. This is **Important** to avoid strain of misalignment.



Showing Method of Removing the Driveshaft Casing with Special Tool.

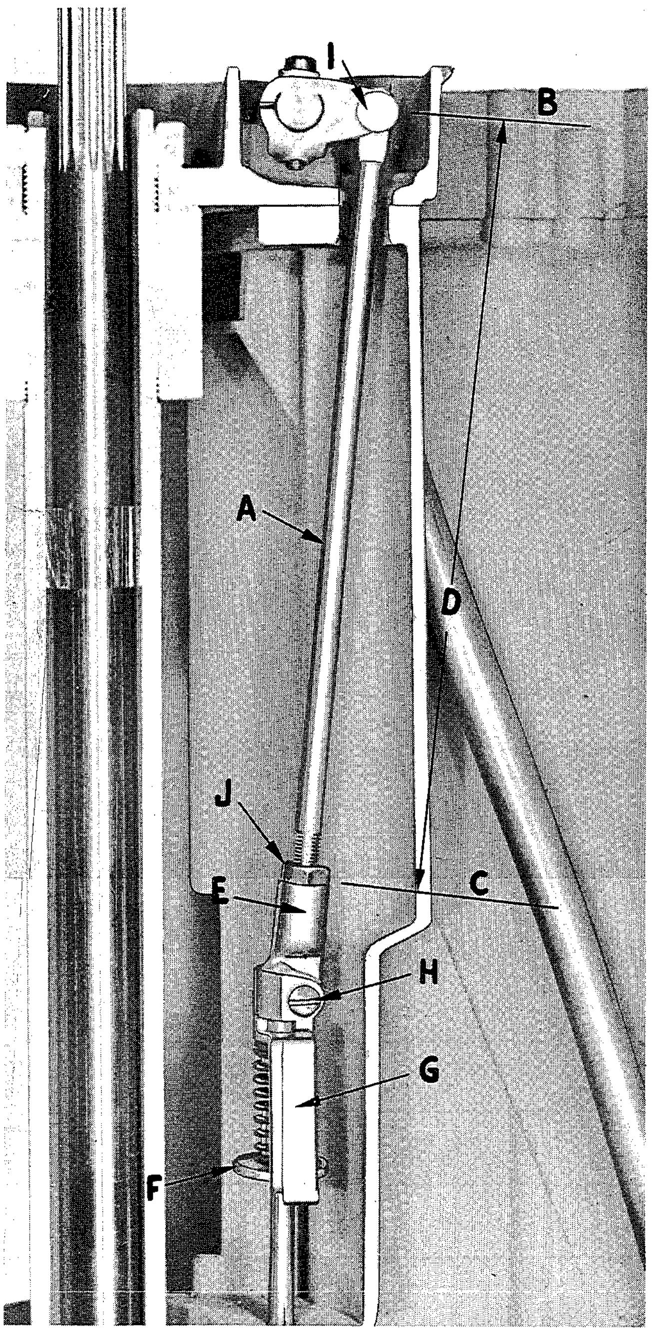


Illustrating Method of Replacing Adaptor "B"—Carefully Applying Pressure against Torque Springs to Properly Locate.



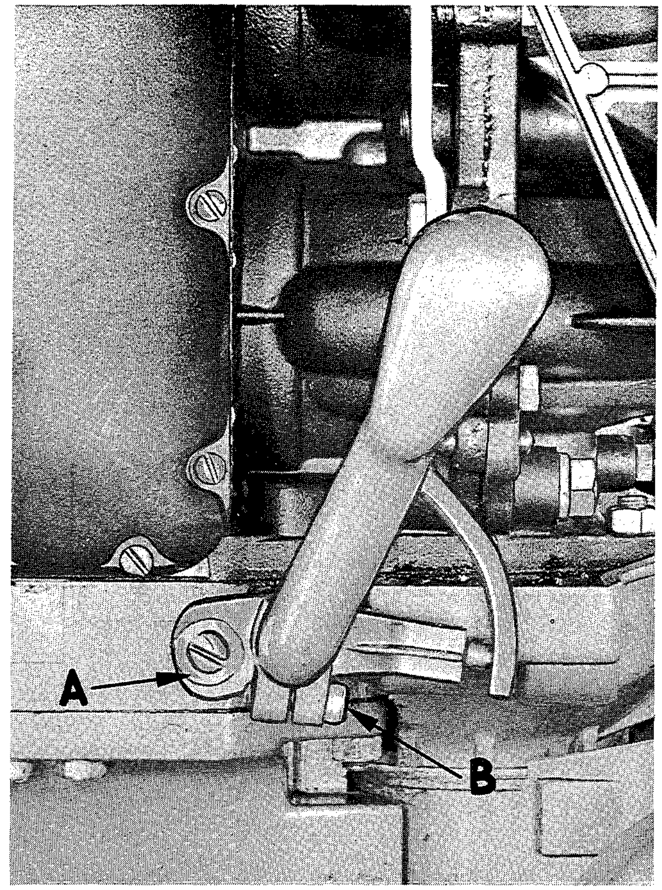
Checking Alignment of Driveshaft Casing and Top Face of Adaptor.

After having completed assembly of the upper lower unit section and prior to attempting adjustment of gear shifting mechanism, it is advisable to check distance "D"—shown below. Correct distance between "B" (center of pin "I") and "C" (top face of bracket "E") is 7 1/8″—obtained by turning shaft "A" into or out of bracket "E" as required and locking to position with nut "J."

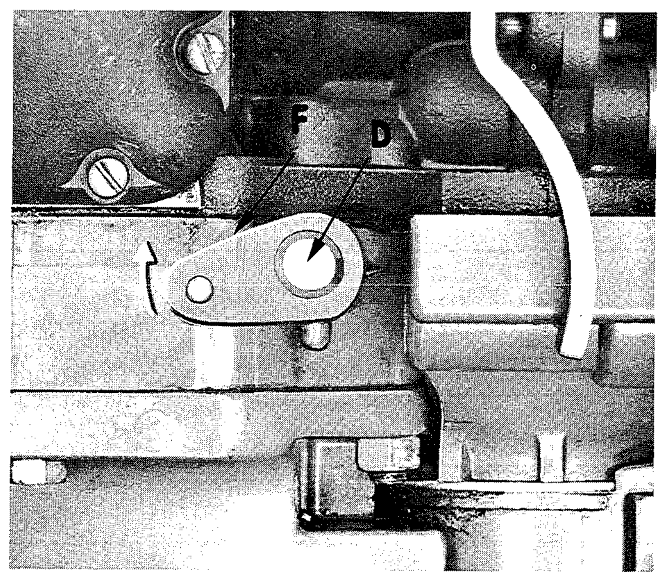


Sectional View to Show Upper View of Shifting Mechanism —"A," Upper Shift Rod; "E" and "G," Connecting Bracket; Washer "F" to Act on the Reverse Lock.

To adjust gear shifting mechanism: (1) loosen screws "A" and "B" (shown below) to permit free movement of the shift arm; (2) with screws "A" and "B" loose, move the shifting lever to FORWARD running position; reach back of the shift lever—move bell crank "F" up to extreme limit of its travel, then release slightly (just a "hair") to relieve pressure of sliding member in the gearcase against the "forward" gear; (3) rock the propeller back and forth to make certain sliding member properly engages the forward gear (does not "butt" against the gear without engaging); (4) draw up on screws "A" and "B" to secure in this position.

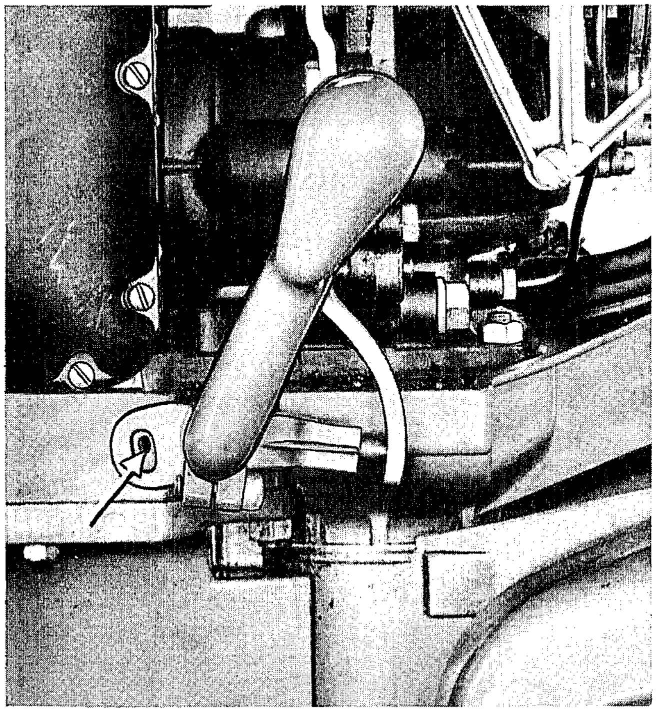


Illustrates Position of Shifting Arm when in Forward. Note "Pin" on Shifting Arm Comes to Rest in Lower Notch of Speed Limitation Control Arm.

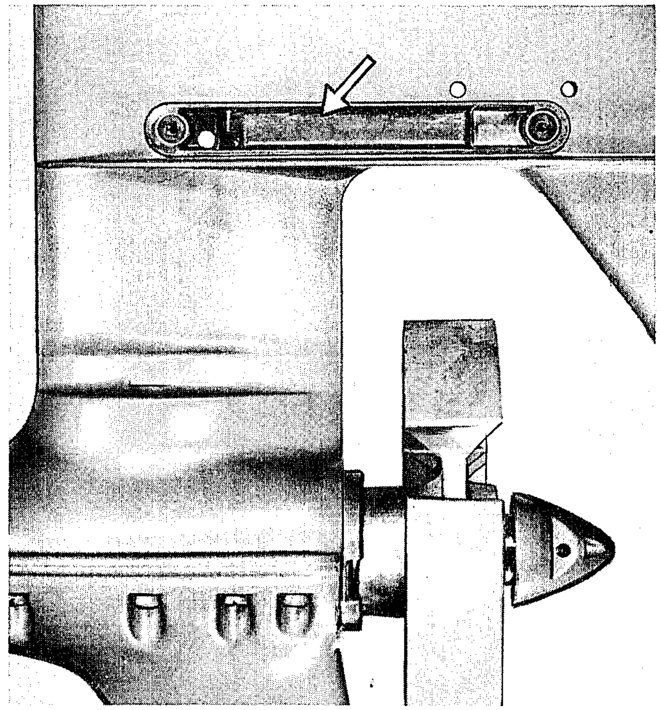


(Shift Lever Removed) Illustrates Forward Position of the Bell Crank Attached to Shaft "D" Resting Back of the Shifting Lever.

When tank testing the Model RD, it is advisable to remove the strip plate above the anti-cavitation plate as indicated by arrow below—to assure sufficient water for cooling. Make sure it is restored on completion of tank test.

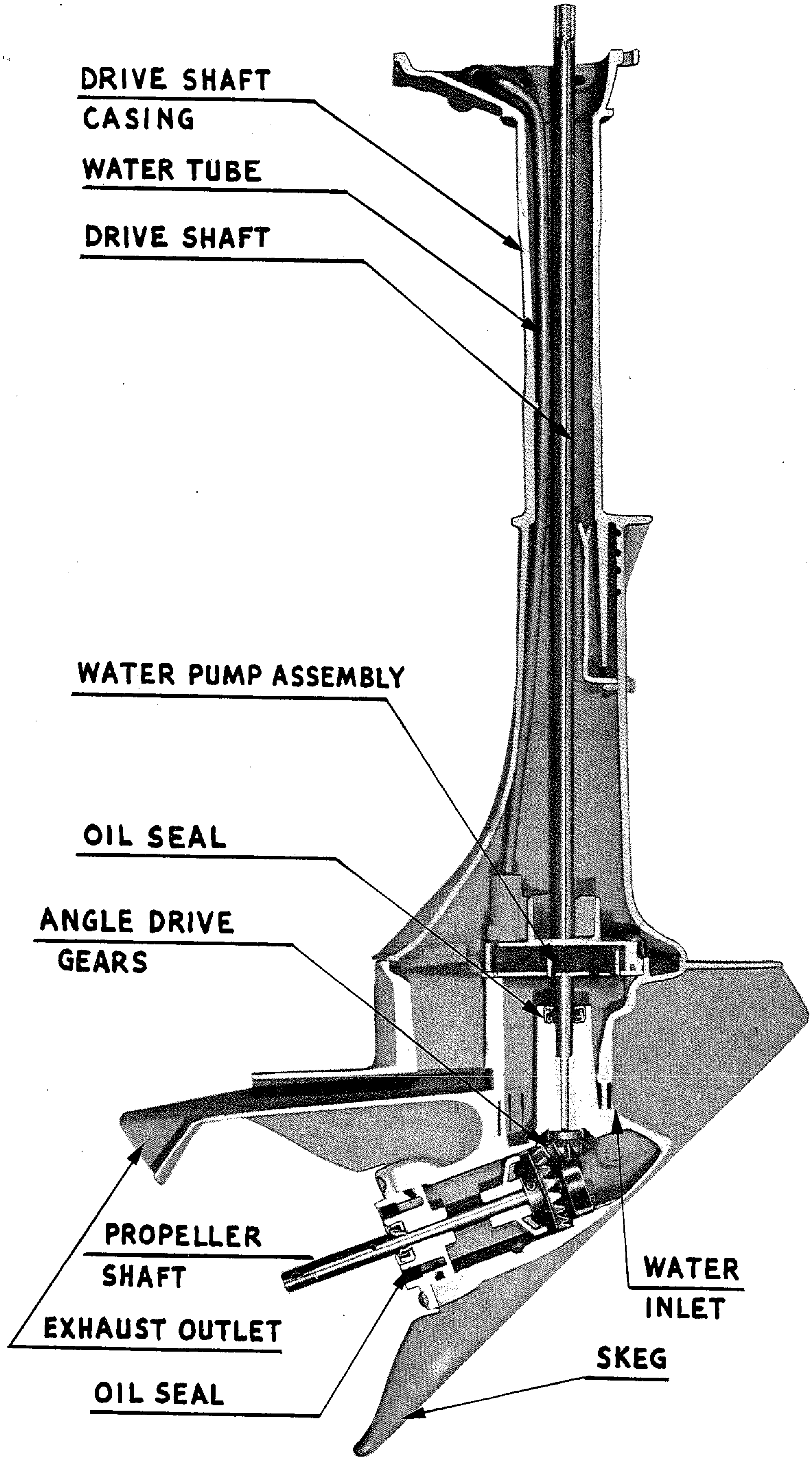


Illustrates Slot in Small Quadrant on the Shifting Lever to Permit Adjustment with Respect to Position of Bell Crank "F."

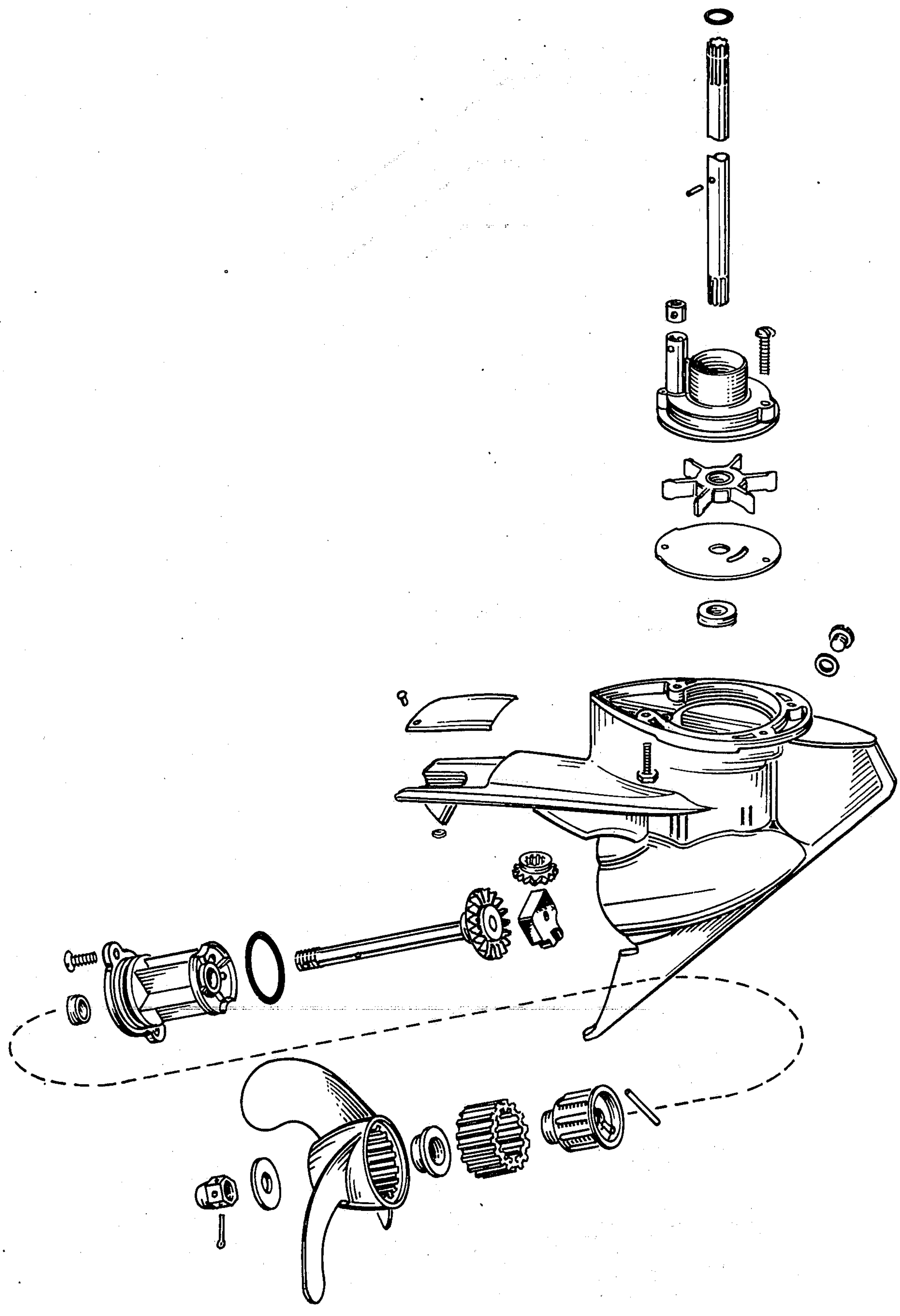


Showing Test Wheel Installed and "Strip" Removed for Tank Testing.

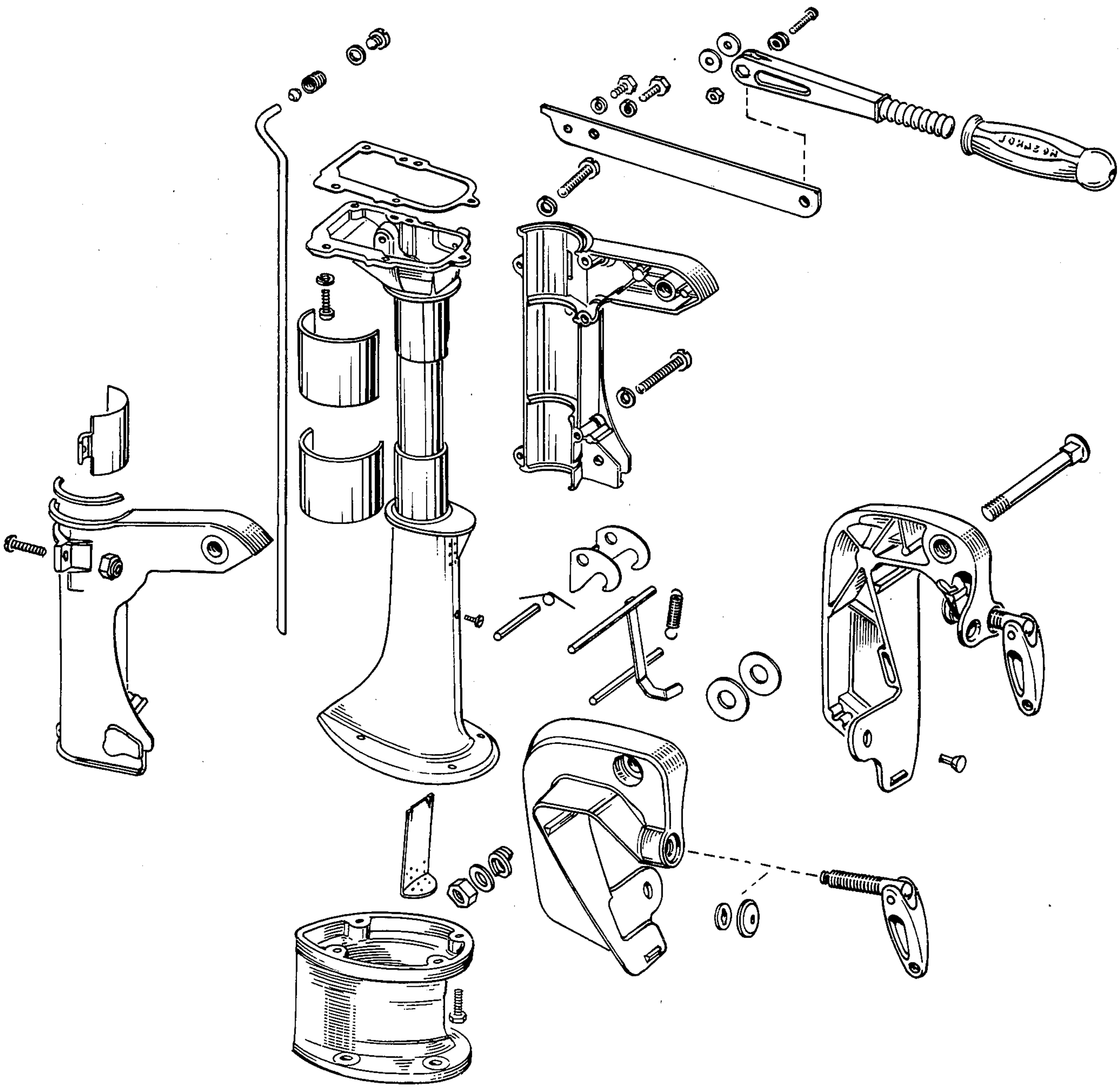
NOTES



Sectionalized View of Lower Unit — Model JW



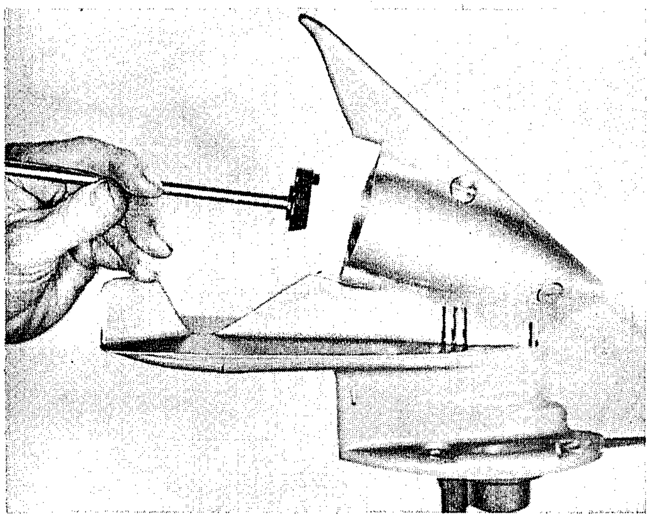
Assembly Layout — Gear Case Group.



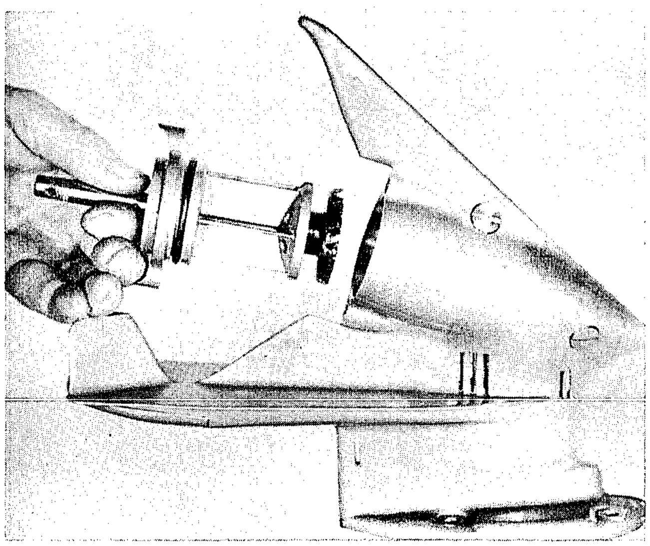
Assembly Layout — Driveshaft Casing.

LOWER UNIT — MODEL JW

The lower unit on the Model JW is of conventional design and construction, except that a weedless type of gear case is employed which includes a propeller shaft driven at 30° "off" horizontal to permit operation in shallow water. Exhaust is under water. The water pump is driven by the drive shaft, as has been established practice for the past several years, see Page 192-4.



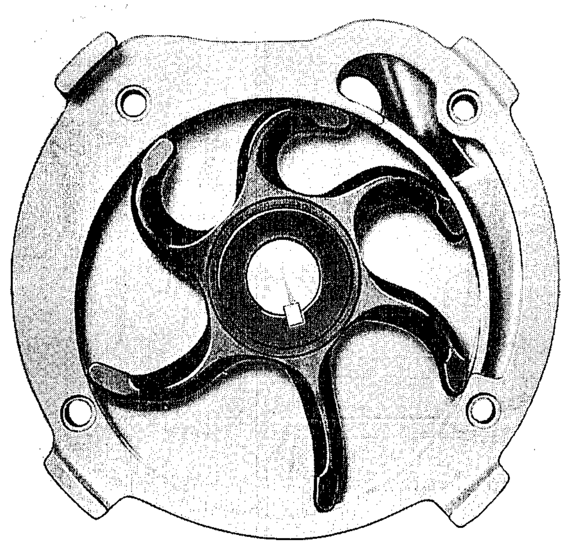
Illustrating Method of Installing the Thrust Block — Note Locating Pins in the Gear Case and Corresponding Notches in the Thrust Block. Align to Accomplish Proper Seating.



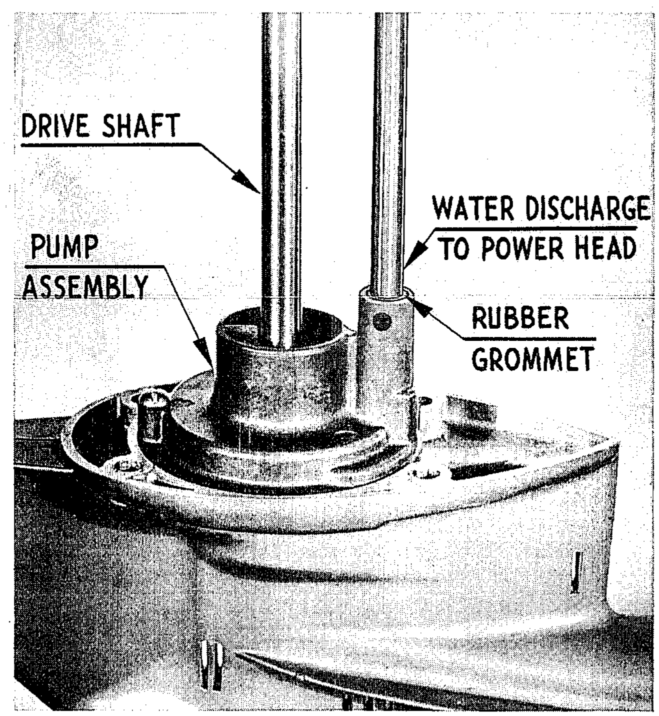
Installing Propeller Shaft-Gear and Gear Case Head and Bushing Assembly.

Assembly procedure (see assembly lay-out illustrations).

1. Insert drive shaft into gear case. 2. Install pinion on lower end of the drive shaft. 3. Insert thrust block. 4. Install propeller shaft bevel gear assembly into the gear case head — see that large "O" ring is in its correct position. 5. Coat mounting face of gear case head with thin film of Sealer 1000 or similar hard drying cement. 6. Insert assembly into the gear case head — make secure with screws provided for the purpose. 7. Install water pump cover plate. 8. Insert pin (to drive the impeller) into hole in the drive shaft. 9. Assemble pump housing — secure position of assembly with impeller screws provided for the purpose (coat threads of screws with Perfect Seal No. 4 to permit easy removal at a later date — of extreme importance in salt water areas).

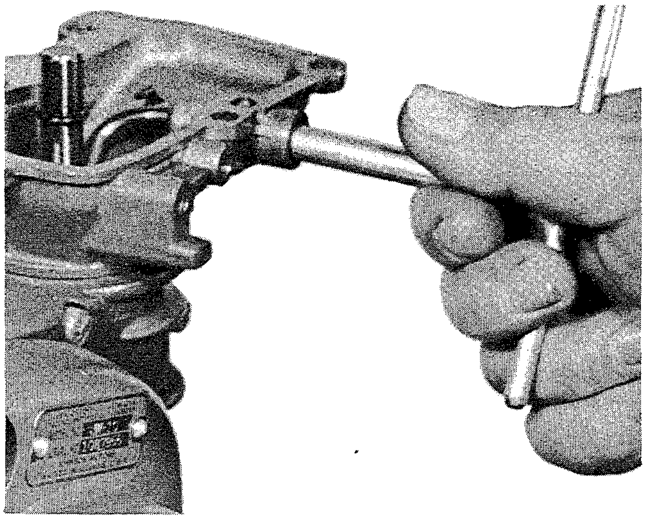


Showing Impeller Installed in the Pump Housing.

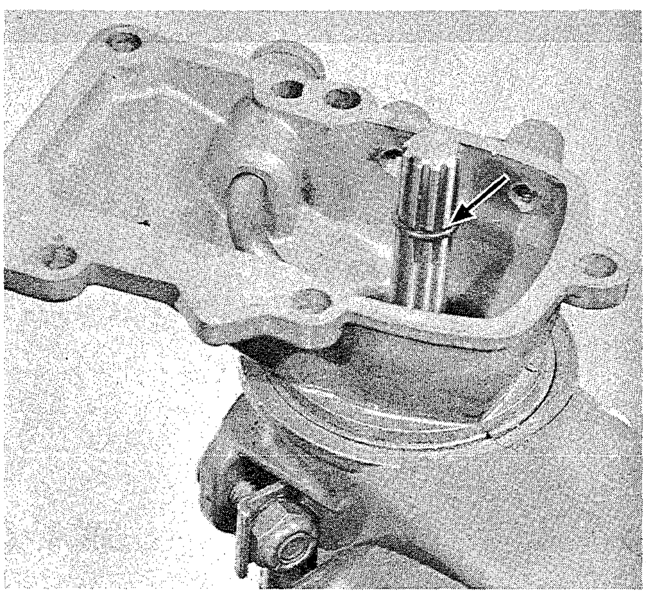


Showing Water Pump Assembly Attached to Top End of the Gear Case.

10. Install water tube grommet (rubber). 11. Attach drive shaft casing with water tube installed—make certain the water tube is properly directed into the rubber grommet. 12. Bolt drive shaft casing to the gear case and later attach to power head to complete repair.



Showing Installation and/or Removal of the Water Tube in the Driveshaft Casing.

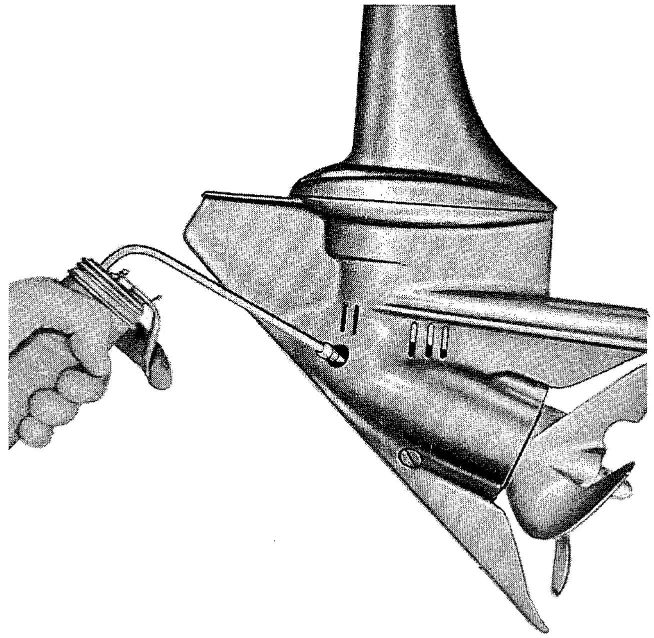


Upper Ends of the Driveshafts in Models JW, QD, and RD are Grooved and provided with an "O" Ring as Illustrated here (Model JW).

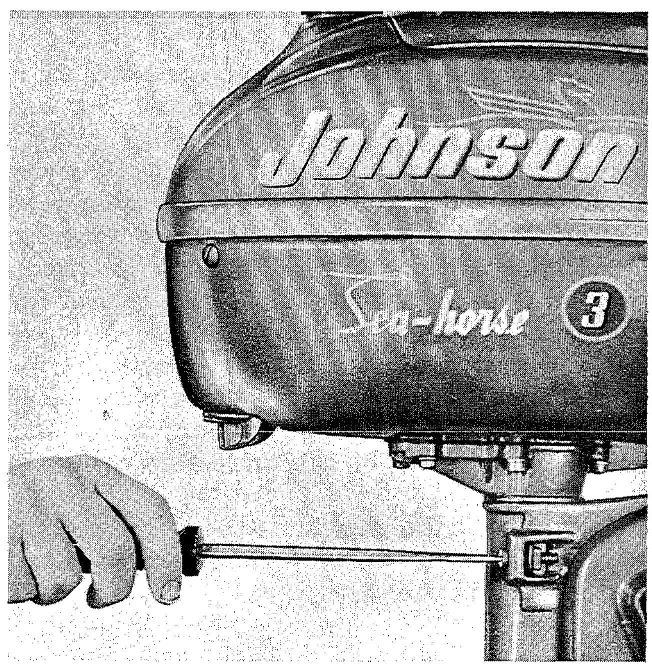
Purpose of the Installation is to Prevent Water and/or Salt Spray from Actually Reaching the Splined Areas (Crankshaft—Driveshaft).

Splined Surfaces should be Coated with Water Resistant Grease when Attaching the Power Head in each case. Do not "Pack" the Crankshaft Spline excessively with Grease (too full). Insert Just enough to Cover the Splined Surfaces. Over-Greasing here will merely act to force the "O" on the Driveshaft out of Position when Assembling to the Lower Unit and thus Void its Purpose since there is no Pressure Relief except by Forcing the "O" Ring out of Position.

The propeller is provided with shock absorber drive as illustrated in assembly lay-out — see page 170 for explanation.



Inserting Gear Lubricant — Hypoid Oil.

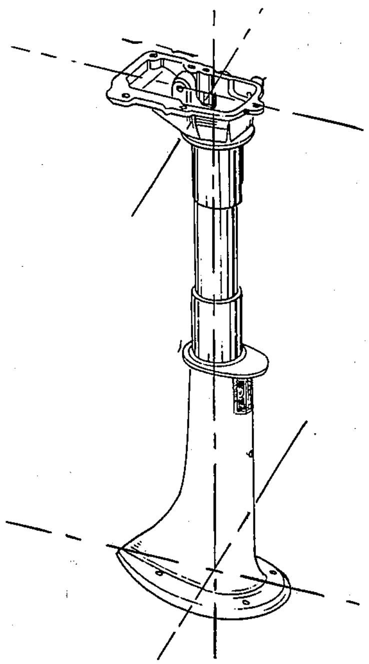


Adjusting Swivel Bracket Tension (Steering).

•

Avoid accumulation of oily rags about the shop or work bench. Oily rags left lying around the shop are a hazard—a fire hazard and a threat to an otherwise promising business with a future.

DRIVESHAFT CASING INSTALLATION



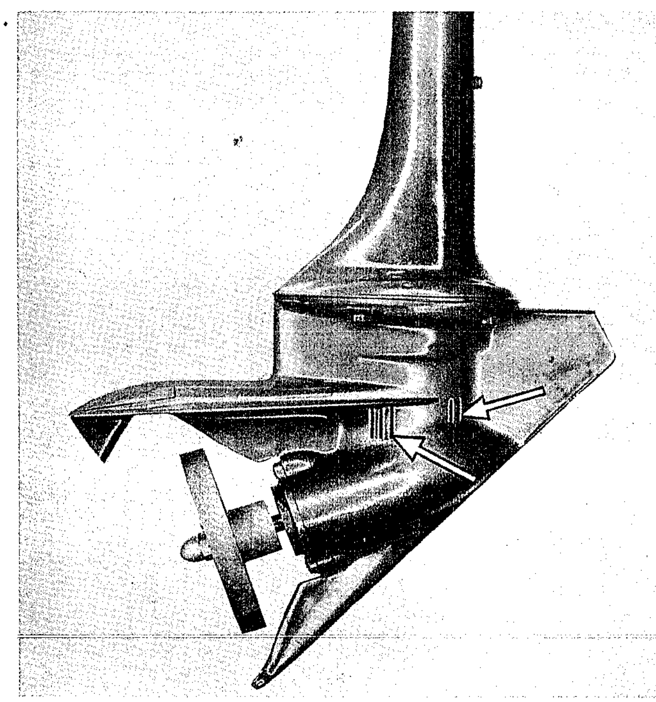
During process of servicing the Model JW from time to time, it may require removing the powerhead from the lower unit. Doing so provides an opportunity for checking alignment of the driveshaft casing with respect to attachment to the powerhead as it might affect wear on the driveshaft and crankshaft spline.

With the assembly in proper alignment, little if any action takes place in the splined coupling — it serves merely as a connection (driving member) between the crankshaft and driveshaft. However, misalignment of the driveshaft casing, perhaps as result of accident to cause bending or twisting, throws the driveshaft out of line with the crankshaft to result in "flexing" and rapid wear of the "splines" (driveshaft and crankshaft). It is extremely important the driveshaft casing be in proper alignment to avoid excessive spline "wear." Top and bottom flanges must be "square" with a line through the center of the driveshaft casing as shown here.

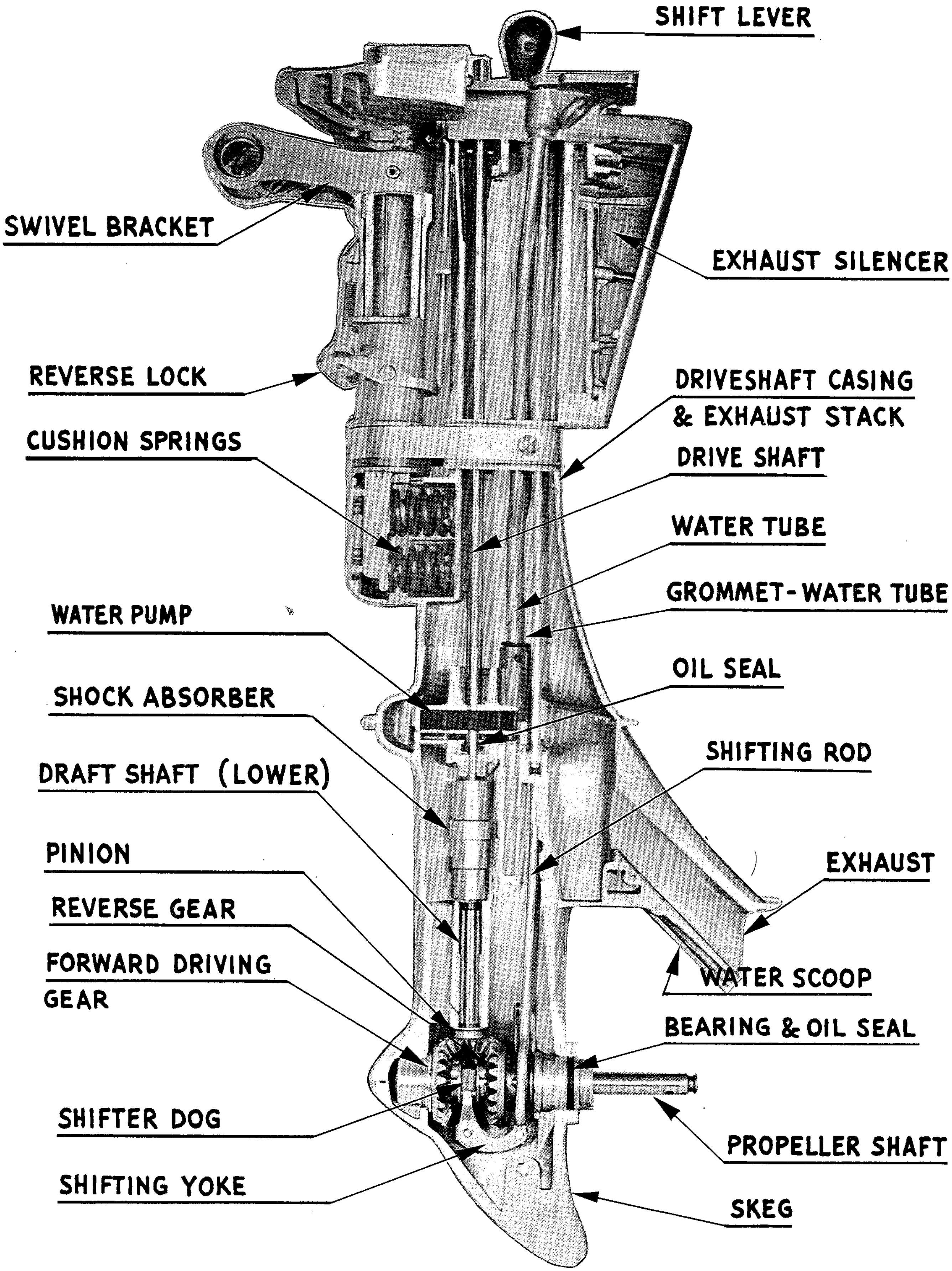
In event of misalignment, it becomes necessary to install a new assembly — **misalignment cannot** be corrected in the casting.

When reassembling, smear the splines with water resistant grease and make certain "O" ring No. 202893 is in proper position on the driveshaft since it acts to prevent water discharging from the cooling system attacking the splined areas — of extreme importance in salt water regions. Use the grease sparingly — enough to cover the splined surfaces; excessive application will cause the "O" ring to be forced from its seat on the driveshaft when attaching the powerhead. This incidentally, holds true for all splined couplings where the "O" ring is employed on the driveshaft — there is just so much "room" (volume) in the crankshaft spline for grease. An overabundance is forced out when assembling only to dislodge the "O" ring and subsequently destroy the seal provided for this purpose.

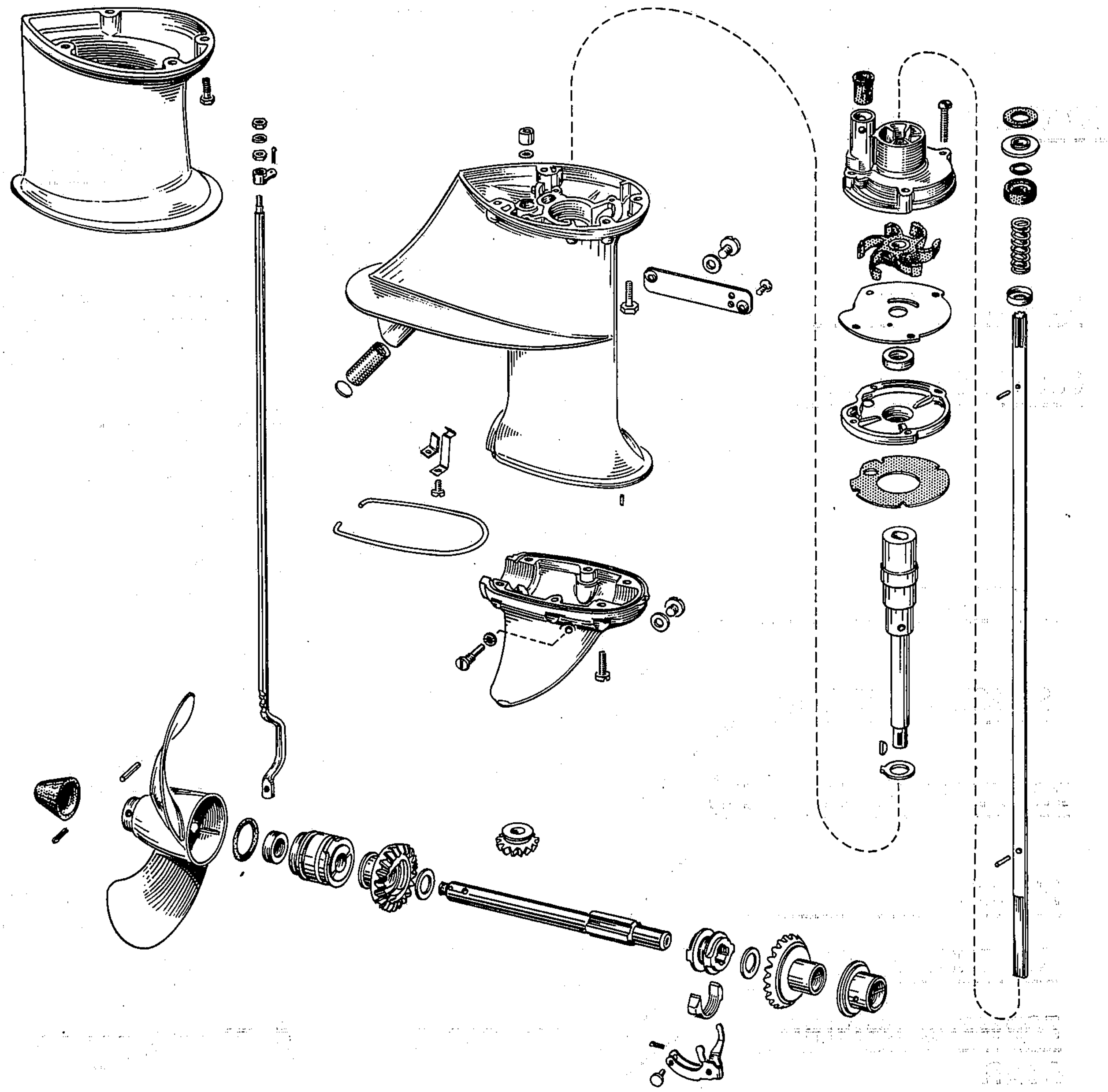
Further, any misalignment (bending or twisting) in the driveshaft casing, regardless of model motor, is the chief factor in premature and rapid spline wear.



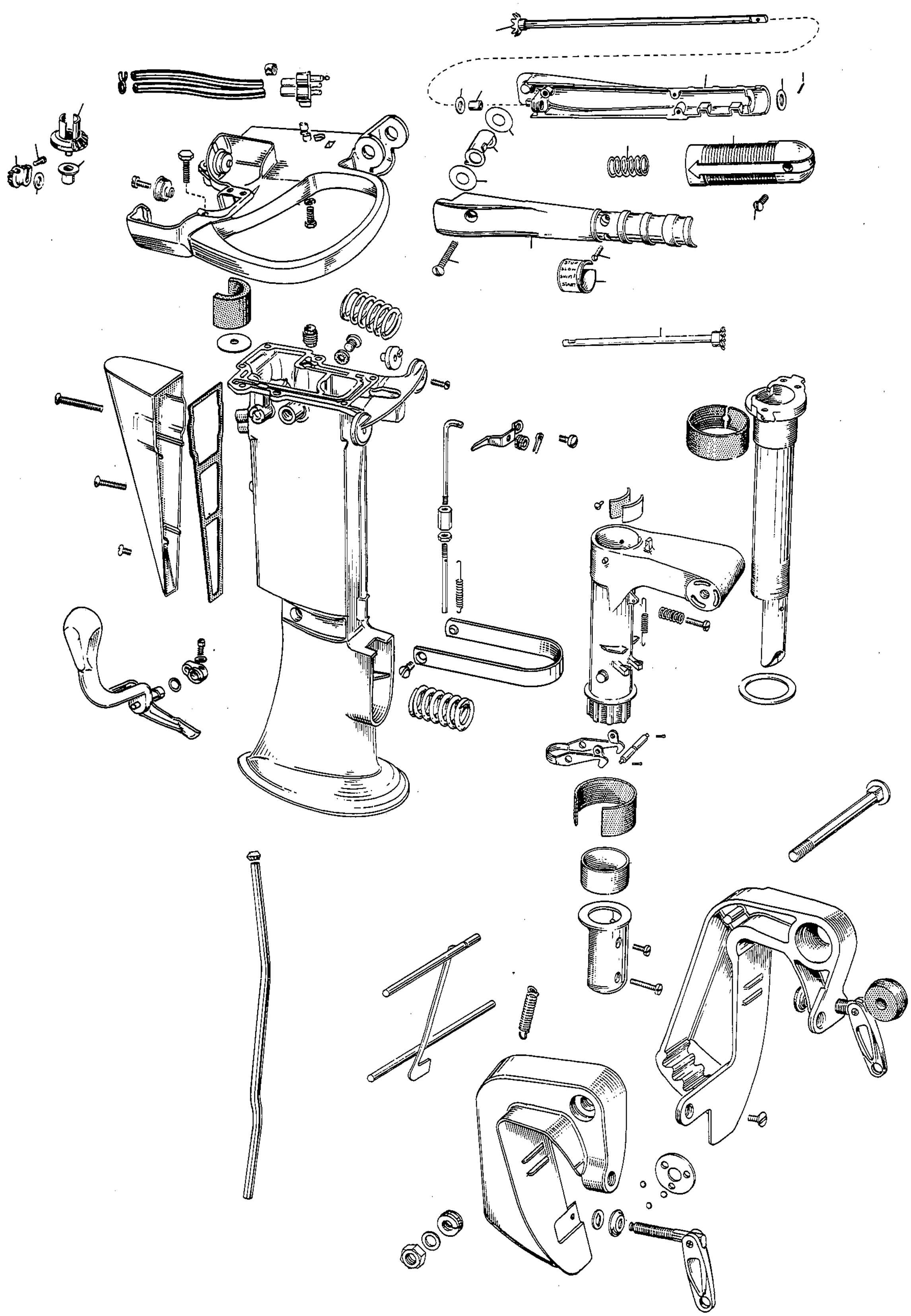
Gear Case with Test Wheel Installed. Arrows Indicate Water Inlet.



Sectionalized view of the Lower Unit

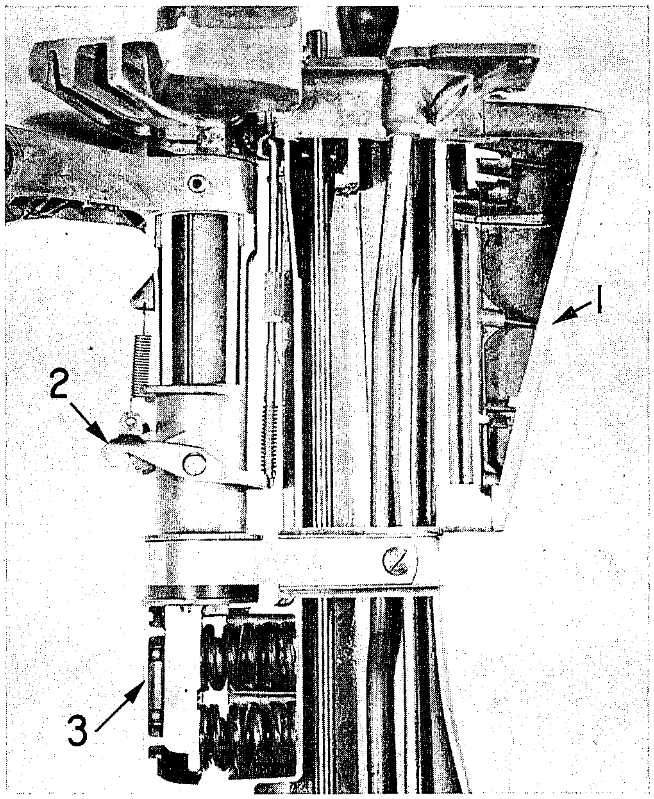


Model CD Gearcase Group

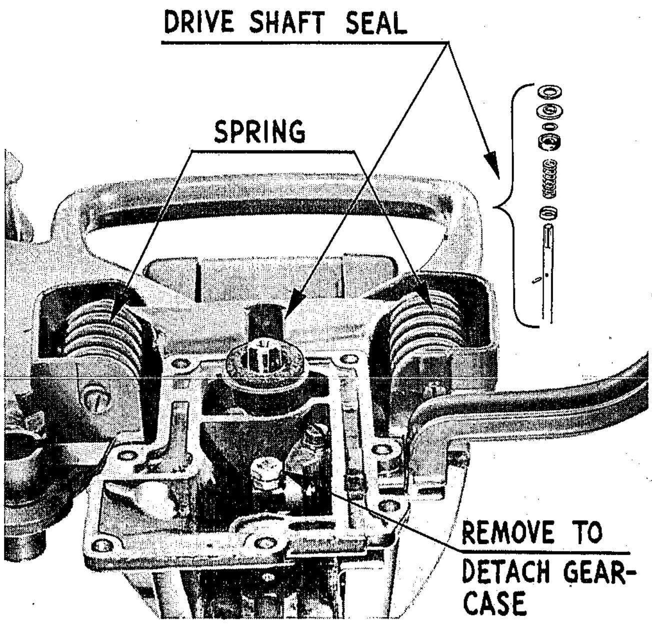


Model CD Stern Bracket, Exhaust Stack and Steering.

CD LOWER UNIT



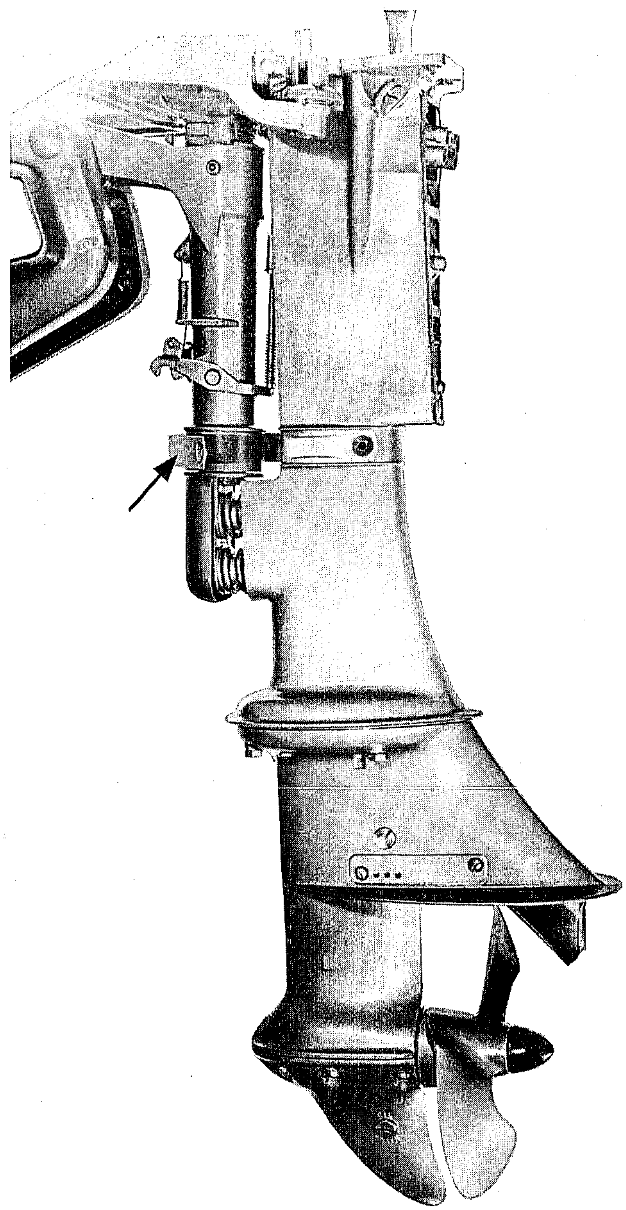
Upper section (sectionalized) of the lower unit showing (1) the muffler silencer, (2) the reverse lock and (3) cushion mount springs, which absorb shock of power impulses.



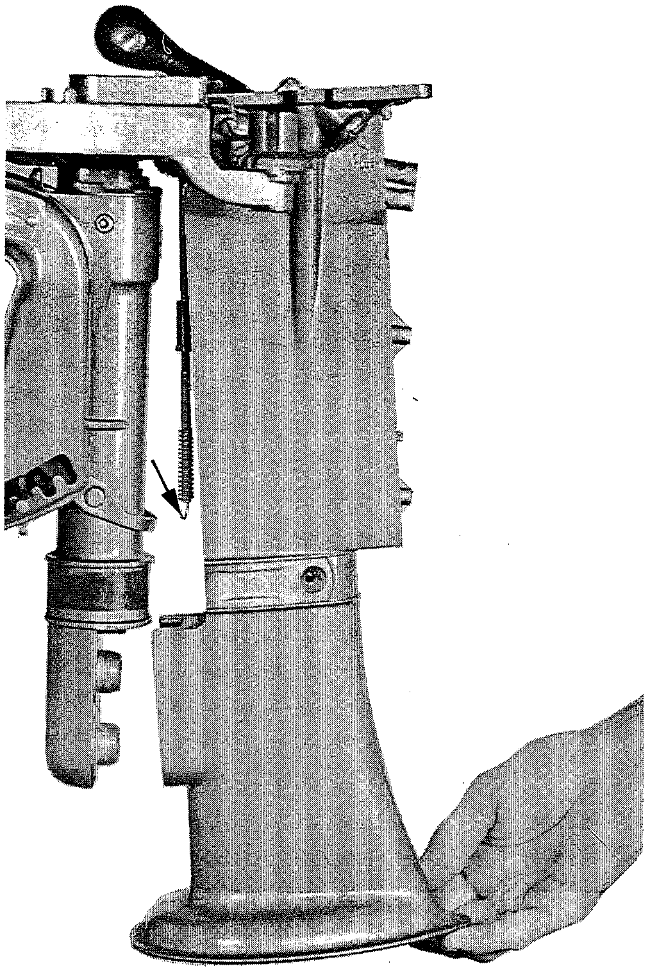
Showing top end of the lower unit, exposing the driveshaft and seal assembly, the shift rod lever and securing nuts and the cushion mount springs. Arrow indicates position of seal on the driveshaft and assembly lay-out to the right. To detach the shift rod as required when removing the gear-case, remove both nuts holding rod fast to the shifting lever swivel. Replace in reverse order. Springs are employed to absorb torque impulses created by the Power Head. Note—Always install a new cork washer (No. 303355)—top of crankshaft seal assembly when removing and prior to re-placing the Power Head.

The Model CD lower unit is of simple but sturdy construction and built along conventional lines as employed in other models, except that cushion mounting and an exhaust expansion or silencing chamber — attached to the exhaust stack — have been included to reduce audible operating noises to a minimum. Cushion mounting minimizes sounding board effect of the transom to which the motor is attached while the exhaust silencer acts to reduce the staccato effect of exhaust discharge.

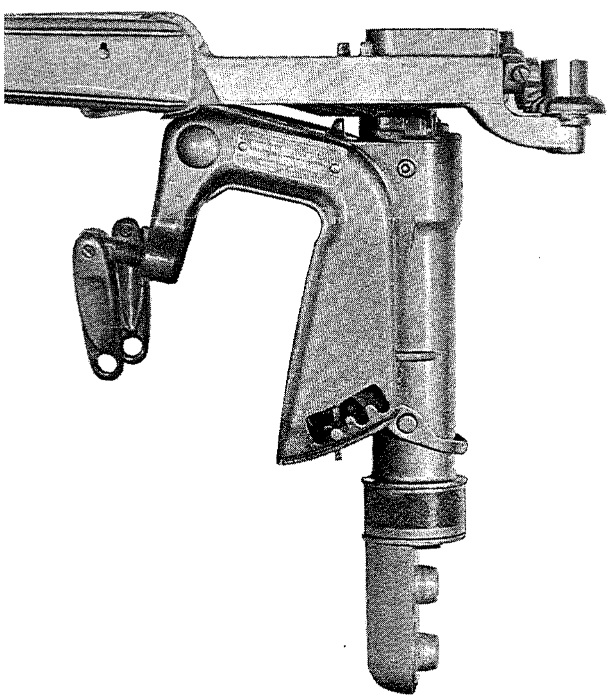
A gear shifting arrangement—forward, neutral and reverse is provided. See page 192-3 and a Vari-volume pump for cooling purposes. See page 192-4. A propeller shock absorber is built into the drive-shaft assembly—Maintenance and assembly oper-ations are not difficult to perform—Note details of construction as they appear in sectionalized view of the lower unit assembly on page 192-37.



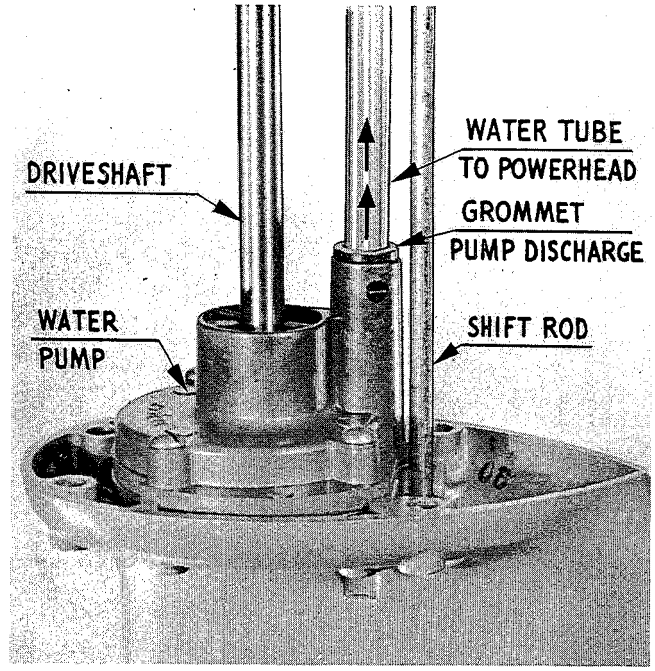
To detach gearcase-driveshaft casing assembly from the swivel bracket, remove band indicated by the arrow.



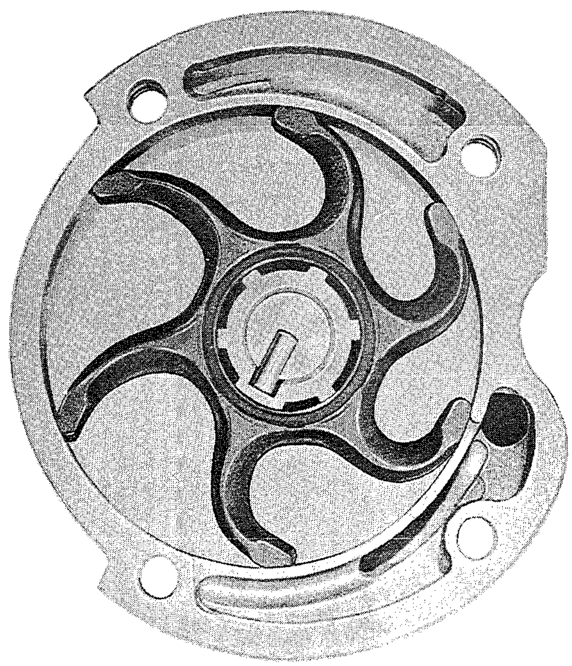
To detach driveshaft casing-exhaust stack from the swivel bracket, tilt with hand as shown, then lift up with "twisting" motion to free it from the torque springs on top end after disconnecting the reverse lock.



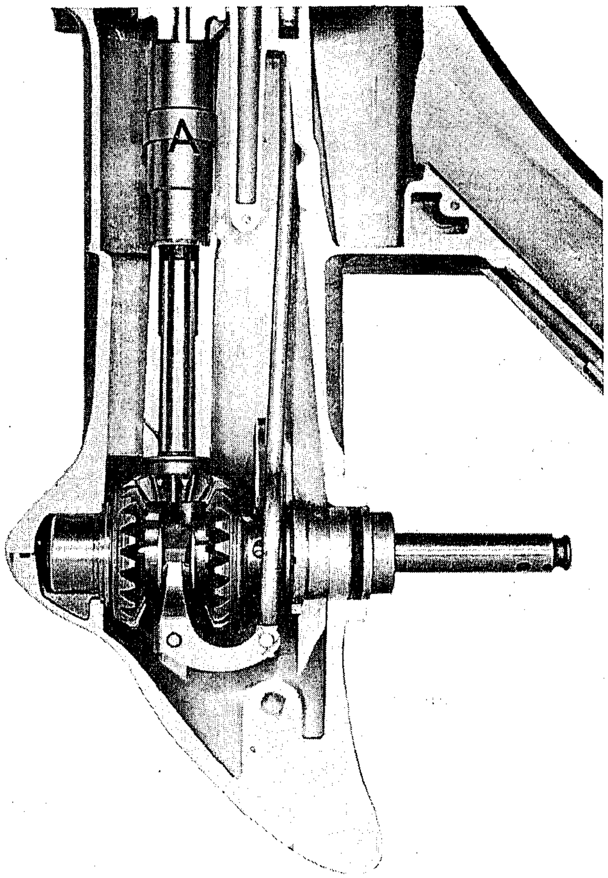
Showing stern and swivel bracket assembly after detaching the driveshaft casing and gearcase



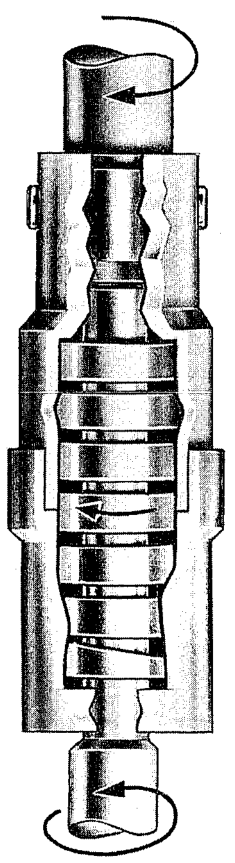
Showing location of the Water Pump



Showing the pump assembly — driveshaft, impeller and pump housing. See explanation of the Vari-Volume pump on page 192-25-1.

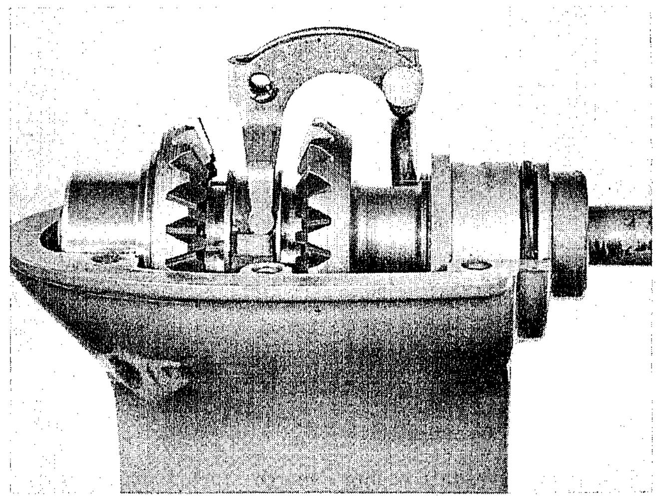


Sectionalized view of the gearcase showing gearshifting mechanism and the shock absorber "A"

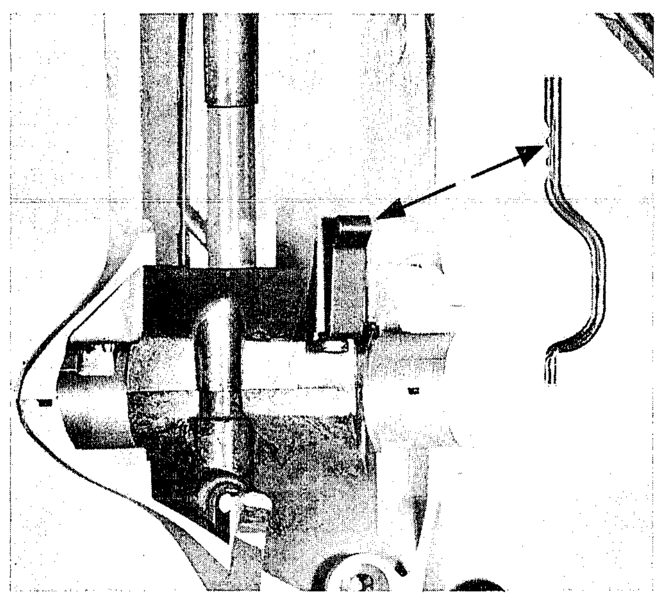


Sectionalized view of the Shock Absorber Assembly

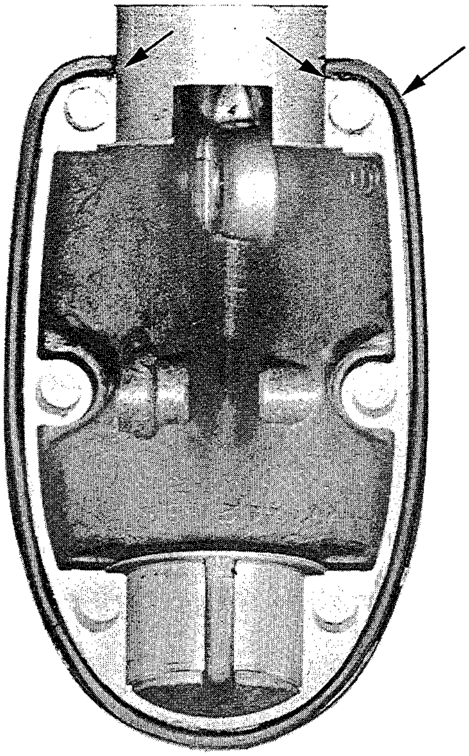
The shock absorber consists of two sleeves "riding" together, one keyed to the upper driveshaft, the other keyed to the lower driveshaft. As will be seen in the illustration, a spring of predetermined tension is inserted within the sleeves with tension bearing against the inner walls. Under ordinary operating conditions, the assembly turns as a unit to drive the propeller. However, on striking an underwater obstruction, the spring is caused to "coil" slightly; in doing so, outside diameter of the spring is reduced just enough to permit "slippage" between the spring and sleeves. On release of obstruction the spring returns to normal diameter and "drives" against inner walls of both sleeves to resume turning as a unit. The shock absorber requires no attention—replacement only in the event of failure.



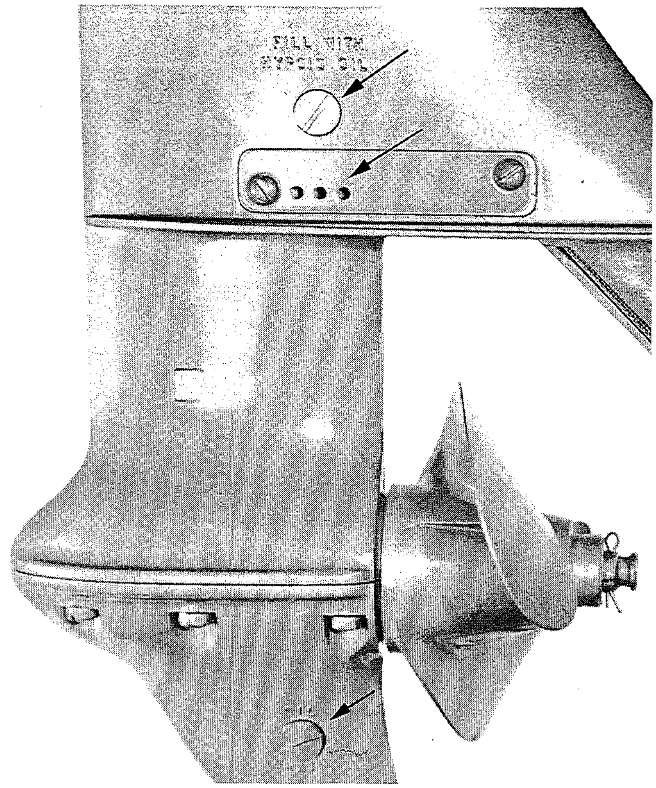
Skeg removed exposing Gear Shifting Mechanism



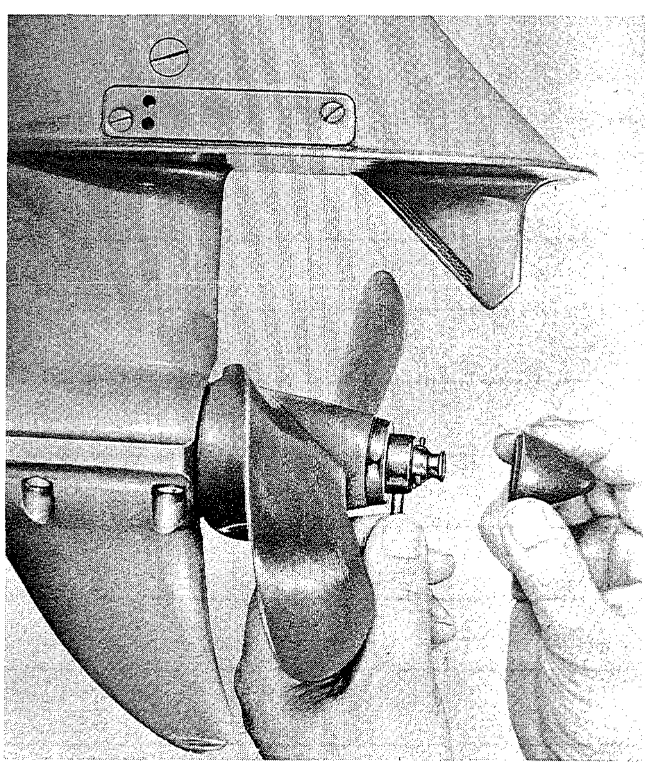
Sectionalized view of the gearcase showing spring ratchet which engages detents in the shifting rod to assure position of the shifter dog when engaged at forward, neutral, or reverse, as the case may be.



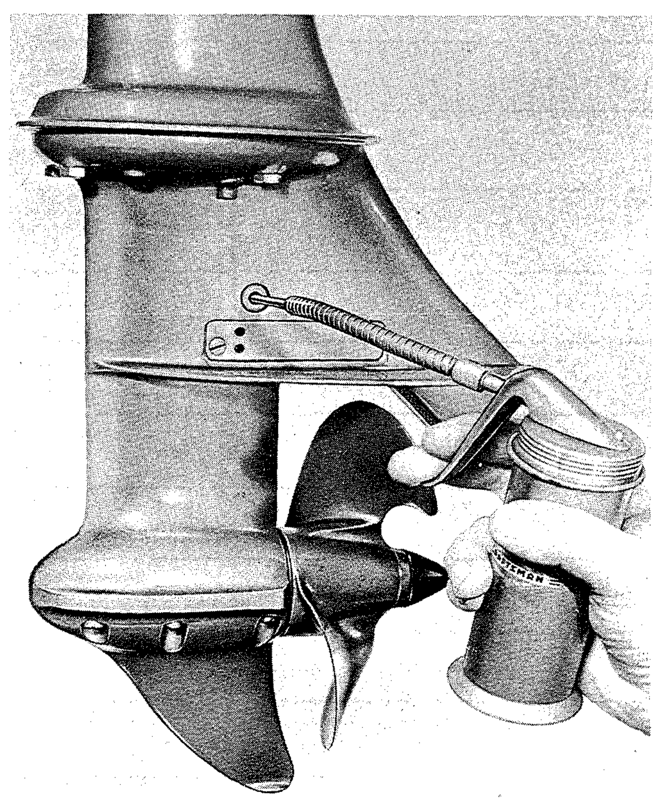
Top face of the gearcase skeg showing installation of seal strip. See explanation and installation instructions, page 192-27.



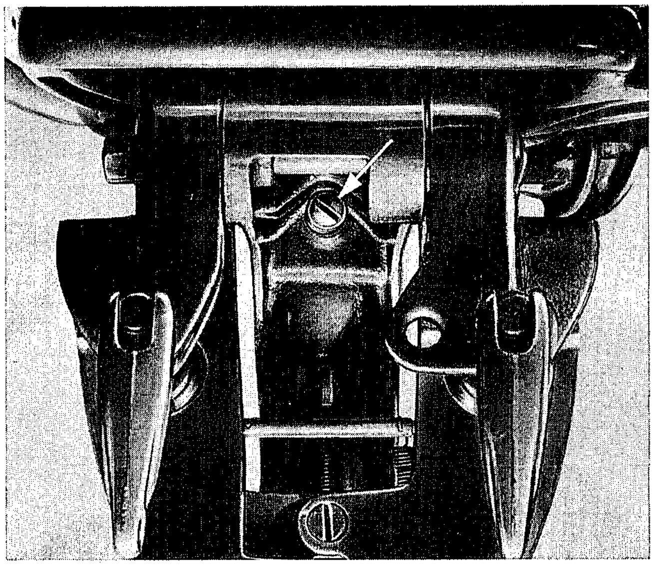
Holes in the rectangular plate attached to the gearcase are provided to insure ample water entrance for cooling when operating in reverse. Shown also are the drain and fill plugs (hypoid gear oil) in the gearcase.



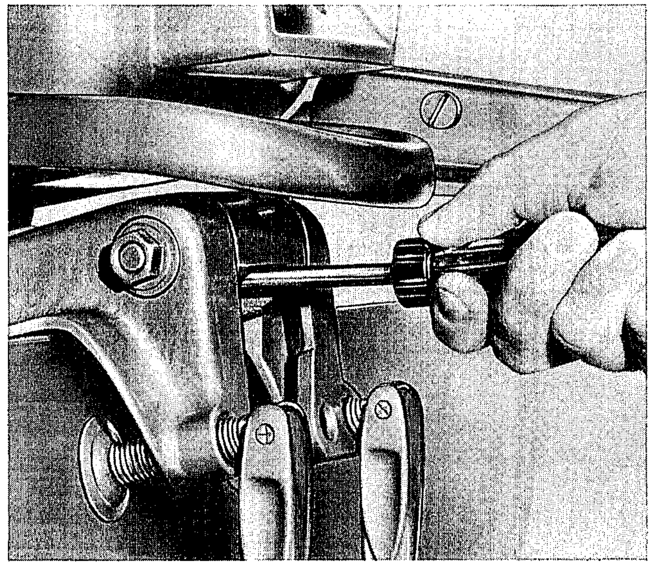
Removing and/or replacing the Propeller Drive Pin



Inserting Hypoid Gear Oil—Fill to Point of Overflow



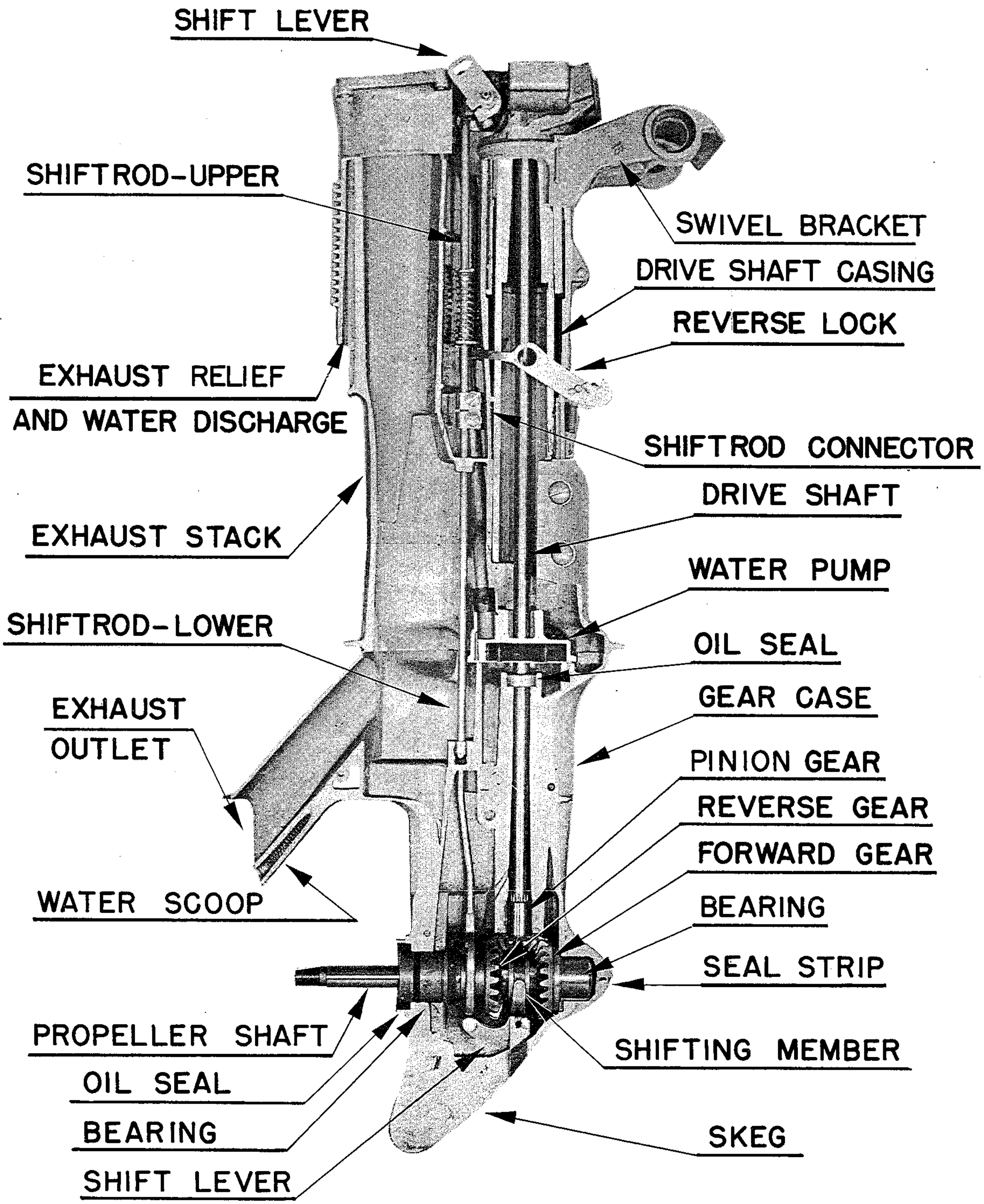
Arrow indicates Screw for Adjusting Tension of Steering



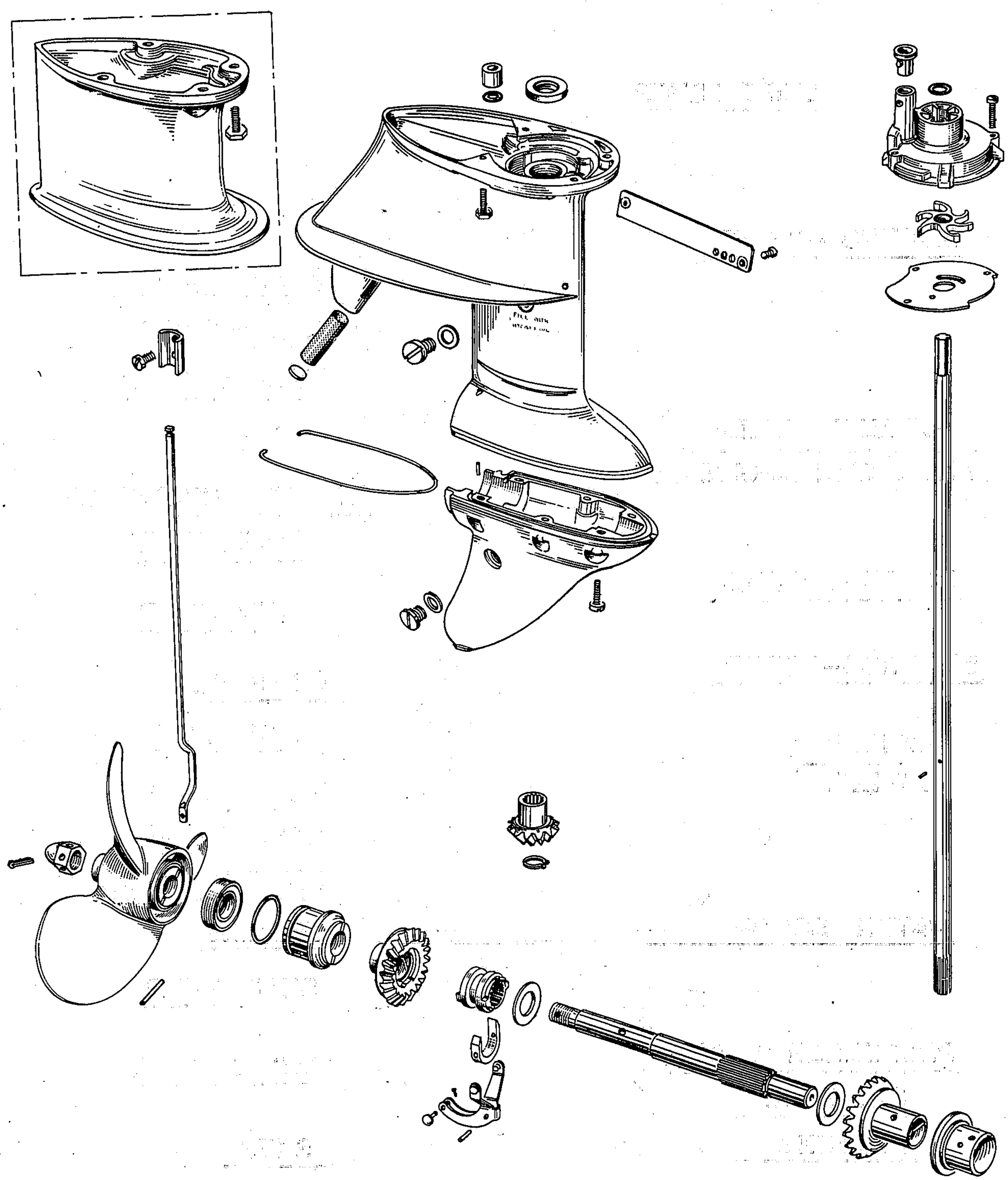
Adjusting Tension of Steering

NOTES

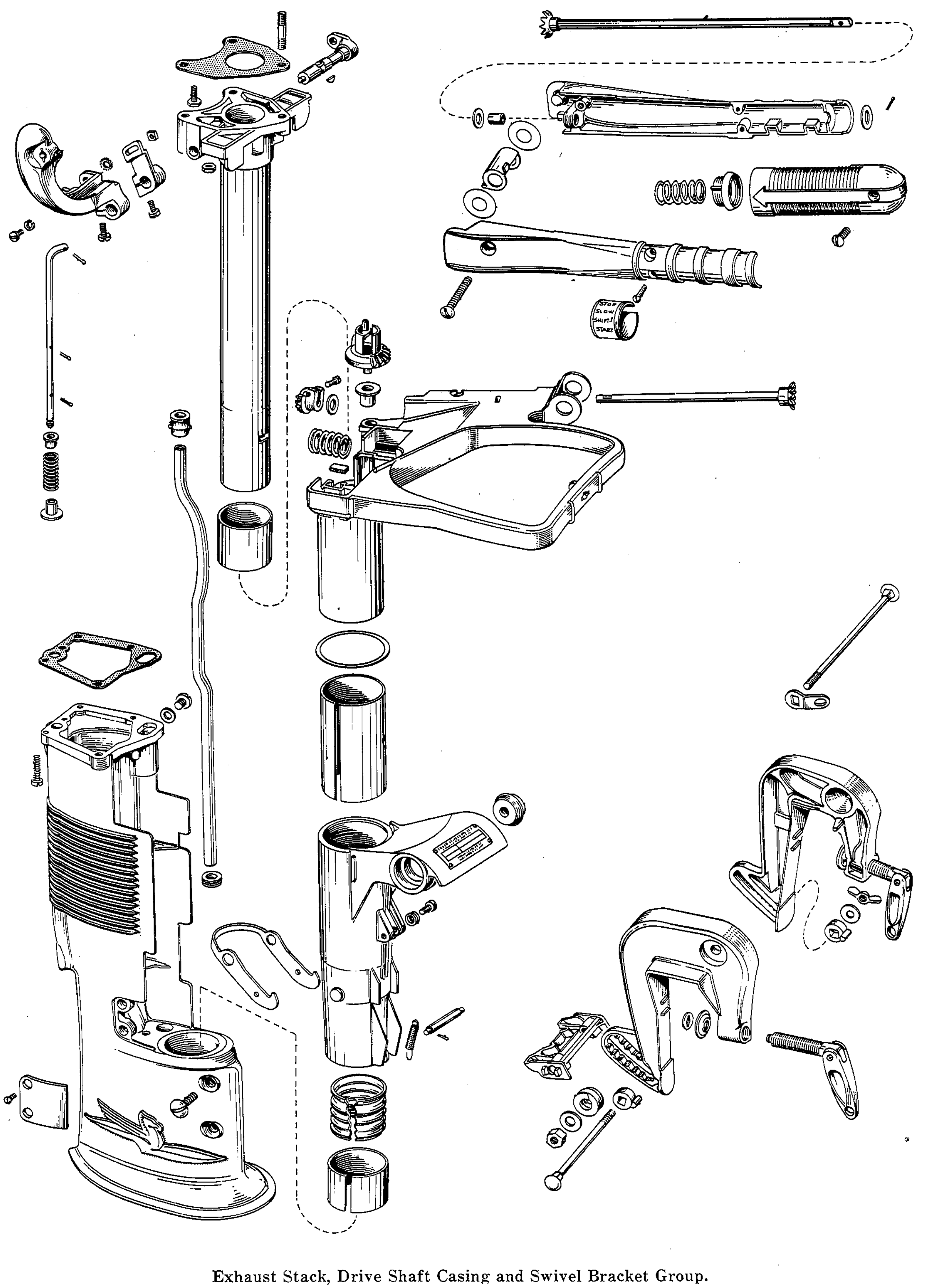
MODEL QD-15 LOWER UNIT



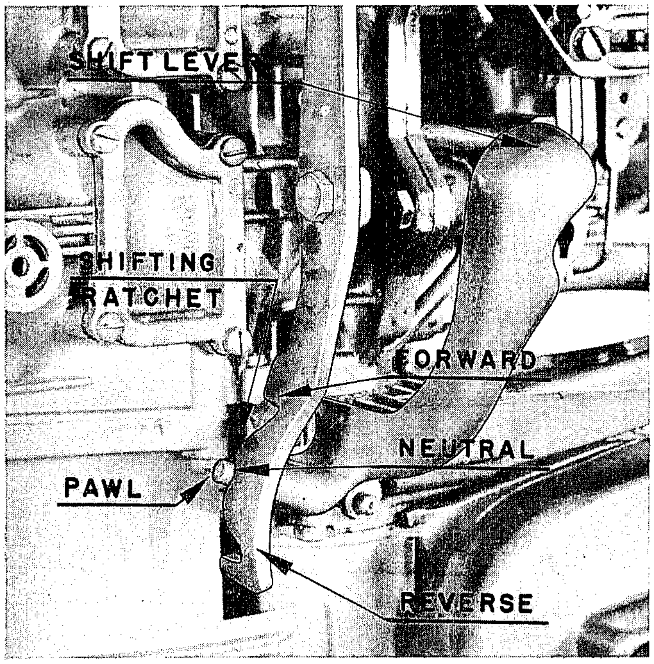
Sectional view of Model QD-15 lower unit.



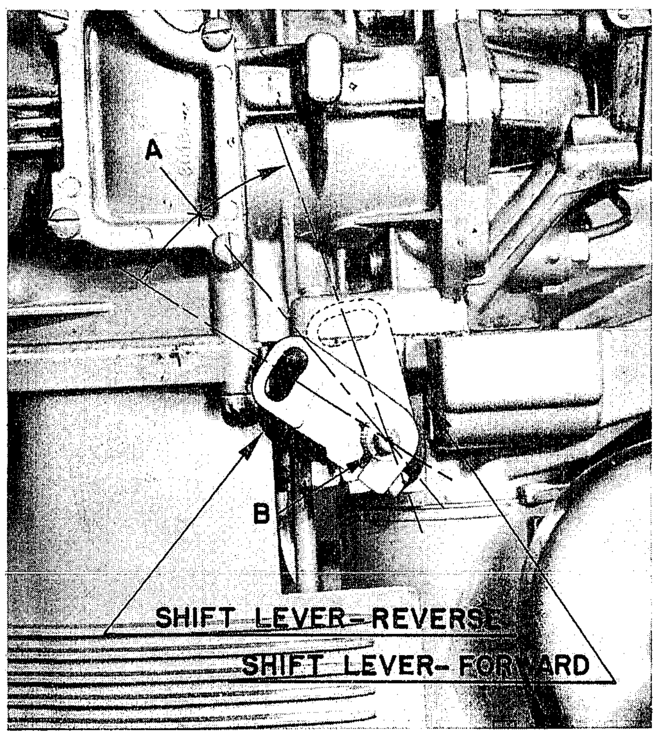
Gearcase Group.



Exhaust Stack, Drive Shaft Casing and Swivel Bracket Group.

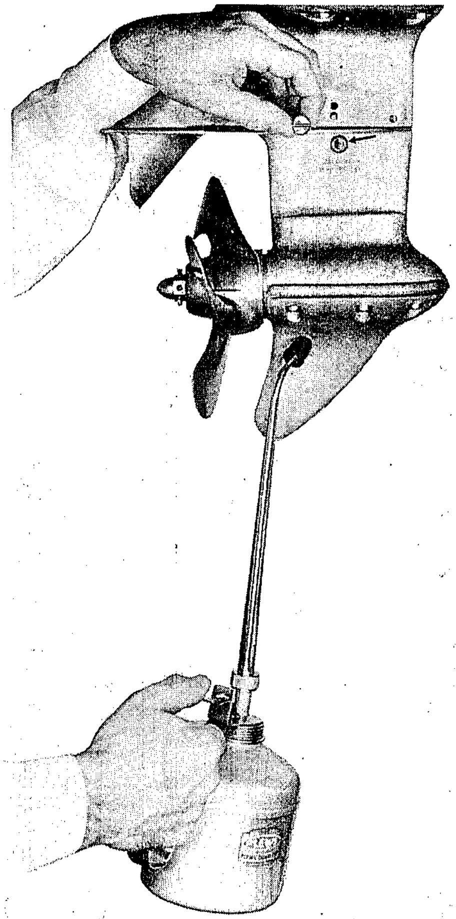


Showing location of shift lever and shifting ratchet—forward, neutral, and reverse.



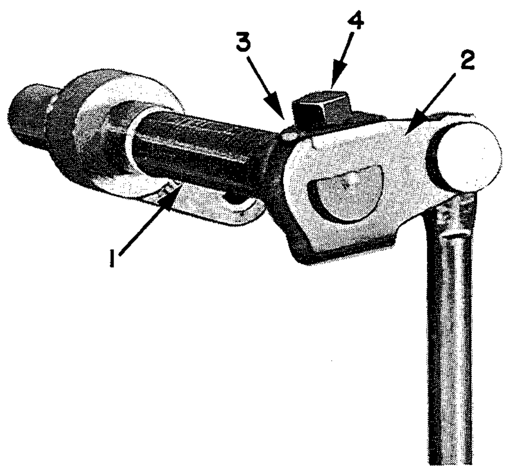
Showing positions of shift lever when in reverse and forward (phantom view). Arc and center line indicates midway position between forward and reverse. When attaching hand shifting lever, it becomes of extreme importance to first set shift lever midway between forward and reverse positions as indicated by center line "A" above. Note that hand shifting lever is made fast on shifting shaft "B" by an arrangement of serrations and a clamping device. Install hand shifting lever with pawl in neutral position of the ratchet. Place "star" washer between shift lever and pad provided on the hand shifting lever for this purpose—insert screw, install nut and "bolt" securely together.

The above described operation *must* be carefully adhered to and carried out to gain "full" engagement of shifter dog (in gearcase) with forward and reverse running gears.

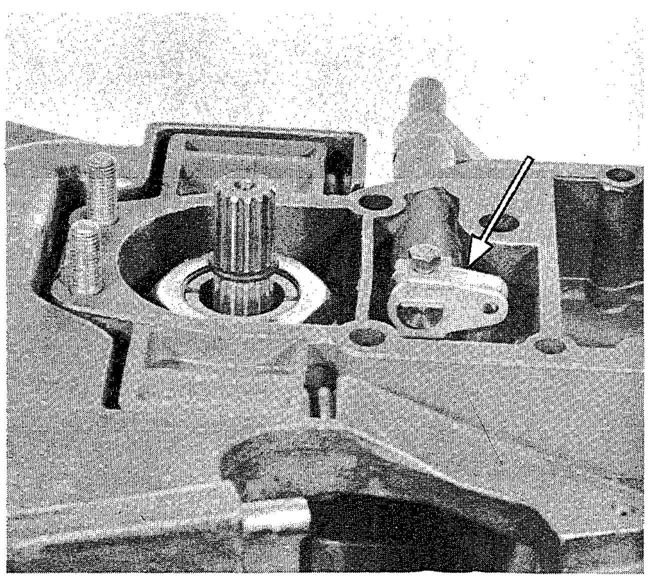


To simplify filling of the gearcase, remove the drain plug (bottom), remove fill (vent) plug at top end. Allow oil to drain in pan or other container. Install a rubber snubber on end of oil can spout as shown above (pump type oil can). Have fill plug in readiness—insert spout in drain hole. Pump oil to level of fill plug. Install "fill" plug—remove spout from drain, then install "drain" plug, since the gearcase becomes "air bound" on installing the fill plug, but little oil is lost when withdrawing the oil can spout. Make certain "plugs" and gasket washers are in good condition—install new washers whenever possible. Cement in position to avoid seepage and subsequent damage. Fill with Hypoid GX-90 oil.

RD—LOWER UNIT



(1) 376198 Shift Lever and Shaft Assembly
(2) 303720 Lever
(3) 303721 Lock Clip
(4) 303722 Screw

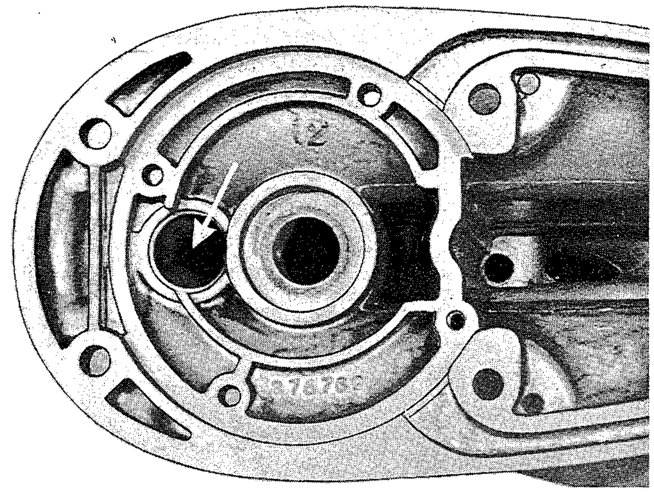


A change was put through affecting interchangeability of certain parts in the Model RD series — which resulted in setting up the Model RD-15A to distinguish it from earlier production. Parts affected which are not interchangeable include those that make up shift linkage in top end of the lower unit assembly as illustrated here. All parts illustrated can and should be installed on RD's brought into the shop and on every opportunity presented — but must be installed as a group on RD's earlier than RD-15A.

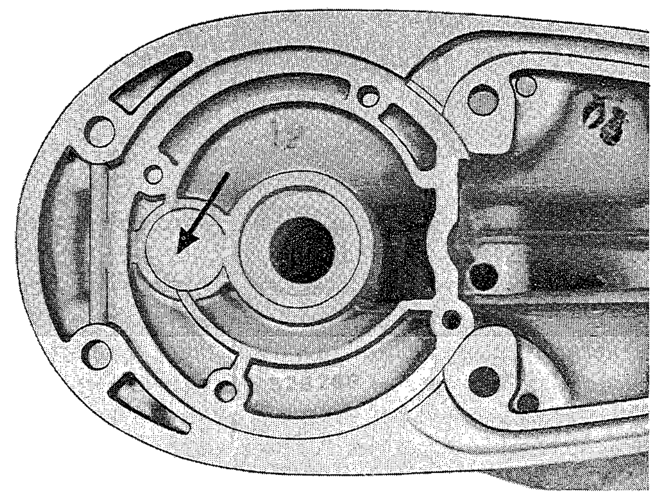
Reason for change in design and construction of this group of parts is to avoid possibility of lever #302644 working loose on shaft assembly #376198 and thus insure positive action of clutch dog (375783) in the gearcase — The parts are of more sturdy construction as will be noted and once properly installed will hold.

To install—

1. Insert shaft assembly (1)
2. Attach lever (2)
3. Place lock clip (3)
4. Install and draw up snugly screw (4). Shaft (1) is threaded to receive the screw.
5. Bend small lip or lap on lock clip (3) up against head of screw (4) to secure position.
6. Complete balance of assembly.



Arrow location for Core Plug Installation.



Showing Core Plug Installation.

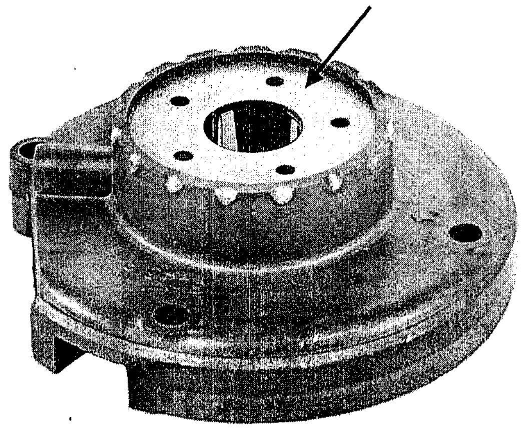
Illustrated here are two top views of the Model RD gearcase — observe that round hole indicated by arrow is open in the top view and closed in the lower view — by a core plug installation.

A cavity is cast into the gearcase with a drain hole at its bottom end to permit water escaping when the motor is removed from the boat. The drain hole is located just above the anti-cavitation plate — under certain conditions, it is possible that air enters the "suction" side of the cooling system to break the seal to cause irregular functioning of the pump.

To overcome and guard against possibility of "air" entering the "suction" side of the pump, the round hole observed in the top view has been sealed with core plug #13-426.

To install the core plug, clean wall around the hole, smear sealer 1000 around edges; place core plug in position — convex side (hump) up; drive core plug into position — use a mandrel of 3/4" round bar stock, "squared" off at the end; strike opposite end with hammer to expand and secure the core plug.

A change was made some time ago in design and construction of the RD pump housing to facilitate better pumping qualities in the higher speed ranges.

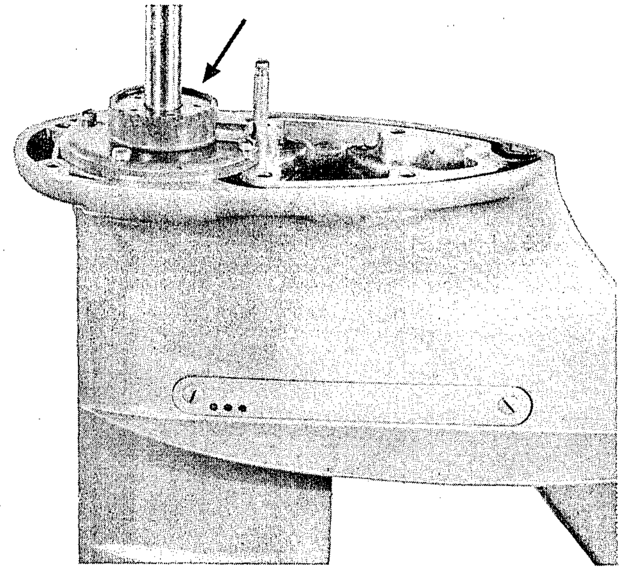


Improved Pump Housing.

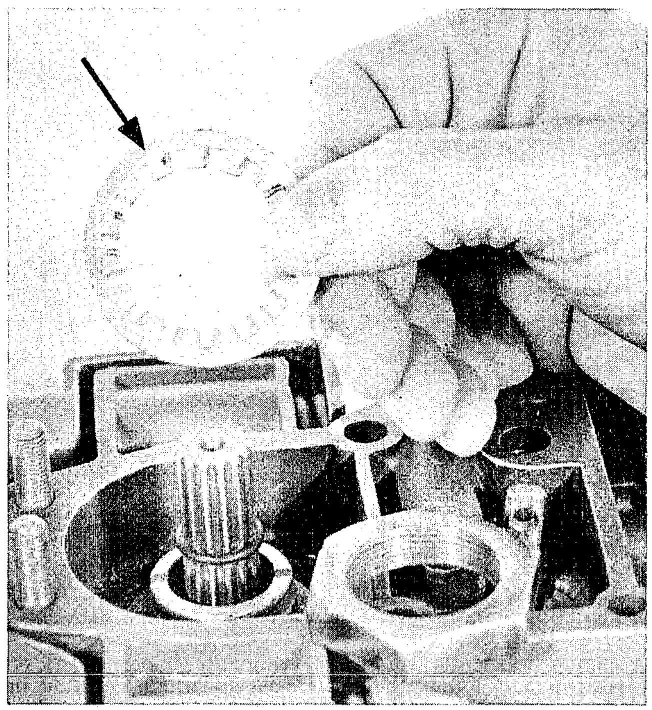
The old and new pump housings are alike in all respects except with relation to the top side, where baffles covered by a stainless steel plate have been introduced (as shown here) to obtain a more satisfactory water seal during high speed operation. Otherwise, there was a tendency for air to seep into the circulating system by way of the driveshaft; this possibility has been further eliminated by reducing clearance between the revolving driveshaft and pump housing.

To accomplish "sealing" at this juncture, some water is permitted to escape from the pump proper which is channeled into the newly created seal pocket—top side. The baffles prevent forming of a "whirlpool" within the seal pocket thus avoiding the entrance of air at its vortex about the driveshaft. A more "solid" body of water is subsequently maintained in the sealing area.

Some additional "sealing" of the pump is obtained by establishing slight convexity top (inner) side of the pump housing cover plate — scarcely noticeable on casual observation since but .010" to .020" of convexity is involved. The resultant "hump" is sufficient to bear against the impeller hub to cause a better seal on the bottom side too.



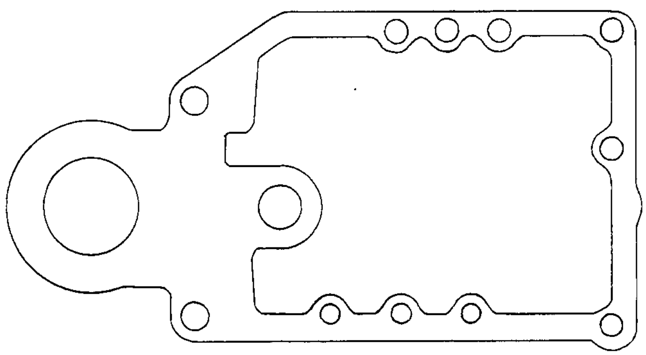
Showing location of the water pump as attached to the gearcase.



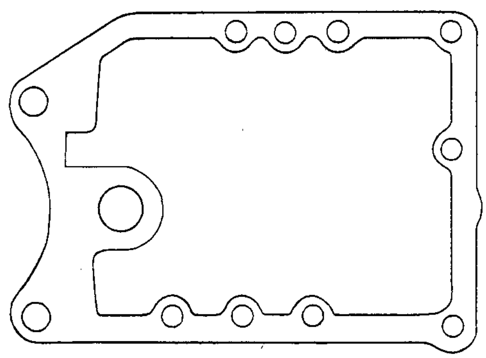
To better secure position of nut #302642 installed on the top end of the driveshaft casing — lower unit Model RD, a lockwasher #303755 has been added, as illustrated here. Installation is a simple procedure after having detached the powerhead — remove the nut, place washer in position over the driveshaft casing, then replace and draw up tightly on the larger nut. Use a 1-11/16" socket. Draw up to 65 foot pounds.

#302821 GASKET REDESIGNED FOR UPPER END OF MODEL RD-10 THROUGH 15a SERIES LOWER UNITS

Shown here are outlines of the current and former gasket #302821. The current gasket should be installed when making lower unit repairs on all Model RD-10 through RD-15a.



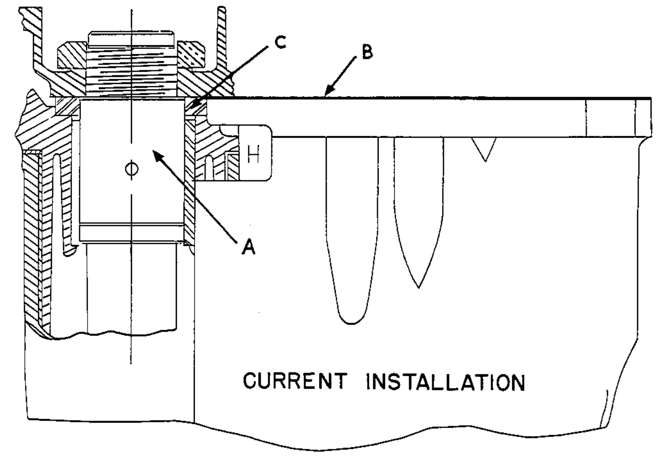
Outline of Former Gasket.



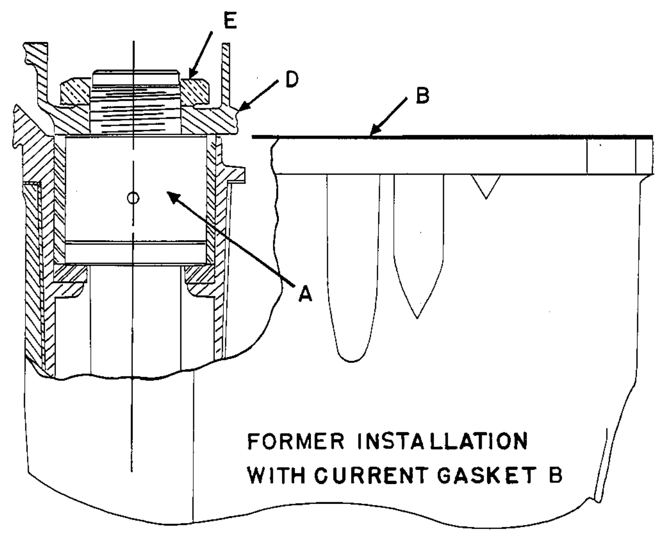
Outline of Current Gasket.

Reason for redesigning outline of the original gasket resulted from the fact that it was being damaged between the narrow shoulder on the driveshaft casing sleeve "A" and adapter "D" causing the driveshaft casing nut to work loose. Metal to metal contact is achieved on installation of the current gasket to better secure position of the nut with aid of lock washer #303755, torque nut to 65 foot pounds.

Some alignment of the driveshaft casing (tube) is required with installation of the gasket — top of sleeve "A" flush with top of gasket face "B." Important to avoid strain of misalignment. See page 192-28.

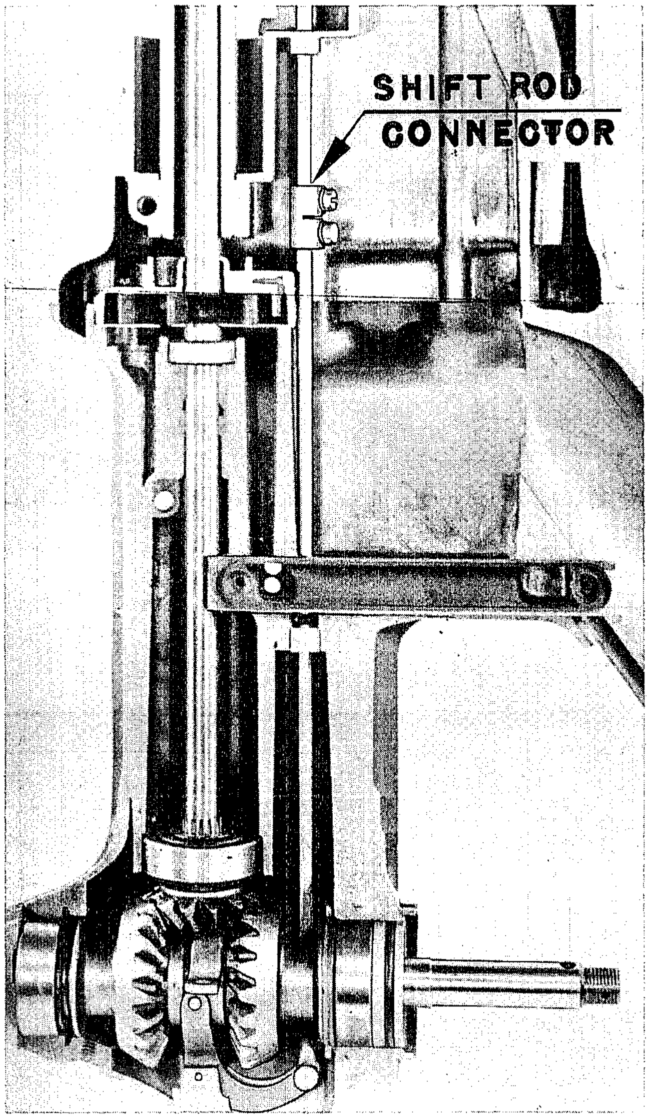


Adjusting, Removing and/or Installing Driveshaft Casing.

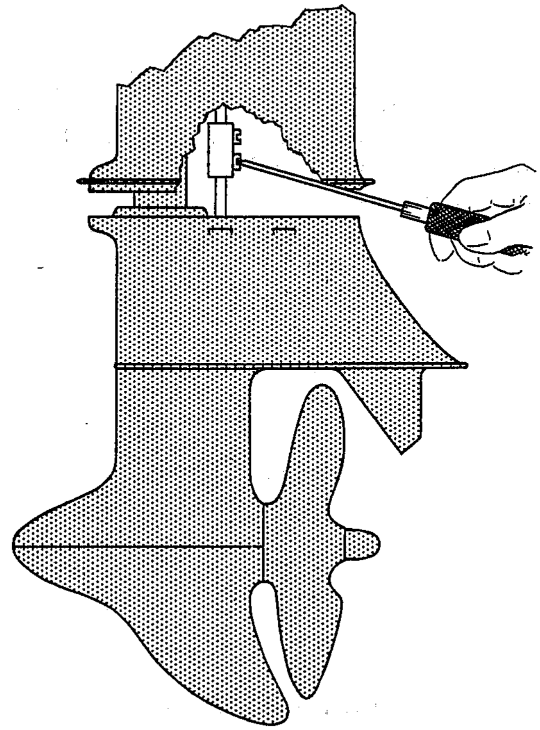


Checking Alignment Top Face of Sleeve A—Flush with Top Face of Gasket B.

When assembling RD-10 to 13, inclusive, apply thin coat of Sealer 1000, or similar hard drying cement, to top face of sleeve "A" prior to installing adapter "D" and driveshaft casing nut "E." Cementing operation not necessary on RD-14 and up since rubber washer "C" acts to seal in this case. However, its chief function is to absorb shock at this point.



Showing installation of the shiftrod (upper and lower) connector which must be disconnected to permit removal of the gearcase for repair or replacement of the waterpump.



Commencing with the RD-15 series, changes were made in the upper and lower shifting rods to accommodate a redesigned connector; upper shift rod #302641 was replaced with rod #303471 (RD-15), lower shift rod #302627 was replaced with #303472 (RD-15) and clamp (connector) #302628 was replaced with connector #303794 (RD-15).

Resultant change in position of the connector has required a different approach to gain access for disassembly. To accomplish, remove all screws holding the gearcase fast to the exhaust stack which permits "dropping" the gearcase approximately 1/2" to expose the connector screws for removal.

When replacing, make certain mounting faces are "flat" and smooth — coat threads of screws with Perfect Seal #4 (#301719) or similar non-drying cement to assure "easy" removal or subsequent repairs.

#375861 GEAR ASSEMBLY

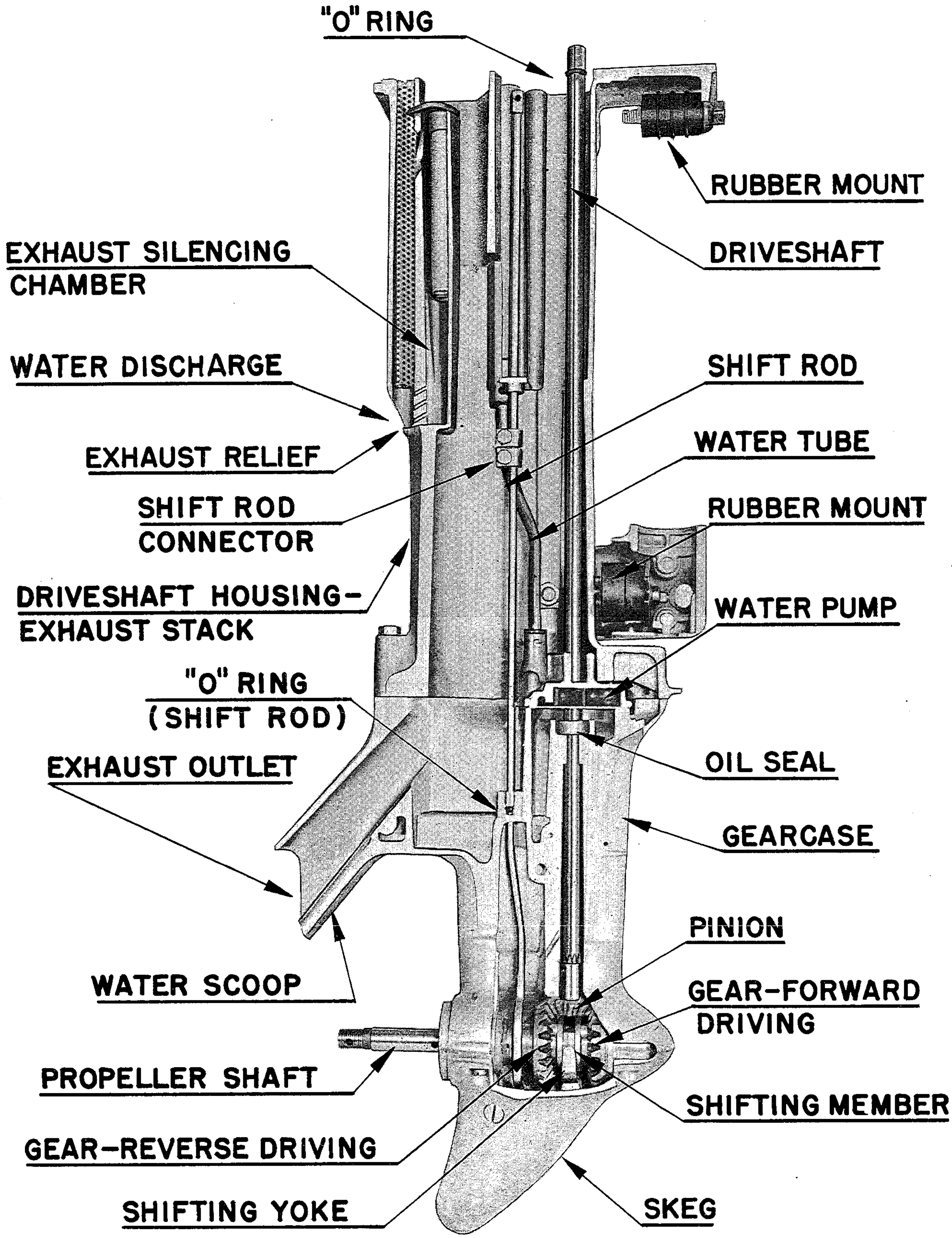
A change in design of gear assembly #375861 was made to accommodate a floating or "slip fit" bushing in the reverse gear to result in the assembly consisting of—

1 #375759 Gear and Bushing Assembly—Forward driving
1 #302517 Gear—Reverse driving
1 #303690 Bushing for Gear #302517
1 #375835 Pinion, Shim and Bearing Assembly

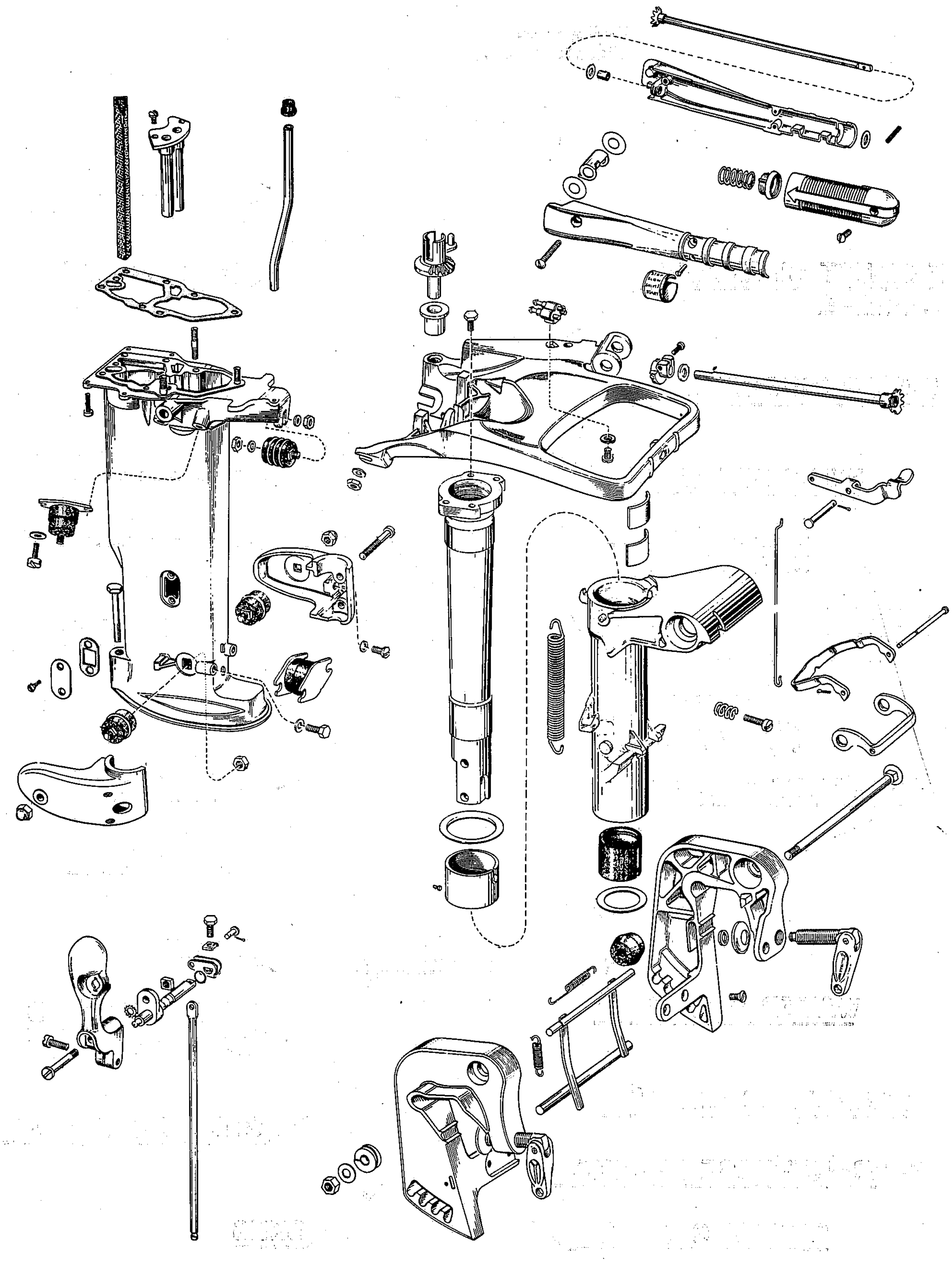
Some "scuffing" was known to take place on the bushing face during operation of the motor. Thus, the floating bushing to improve bearing performance and to facilitate corrective measures as and when required.

The new bushing is machined to "slip" fit into the reverse gear after removal of the bushing originally "pressed in." The old bushing should be carefully pushed out — on an arbor press, using the propeller shaft as a mandrel. Make certain inside surface of the gear is cleared of foreign matter, burrs, etc., coat with thin film of oil then "slip" new bushing (#303690) into position with thumb. The new bushing will be found to "float" in the gear.

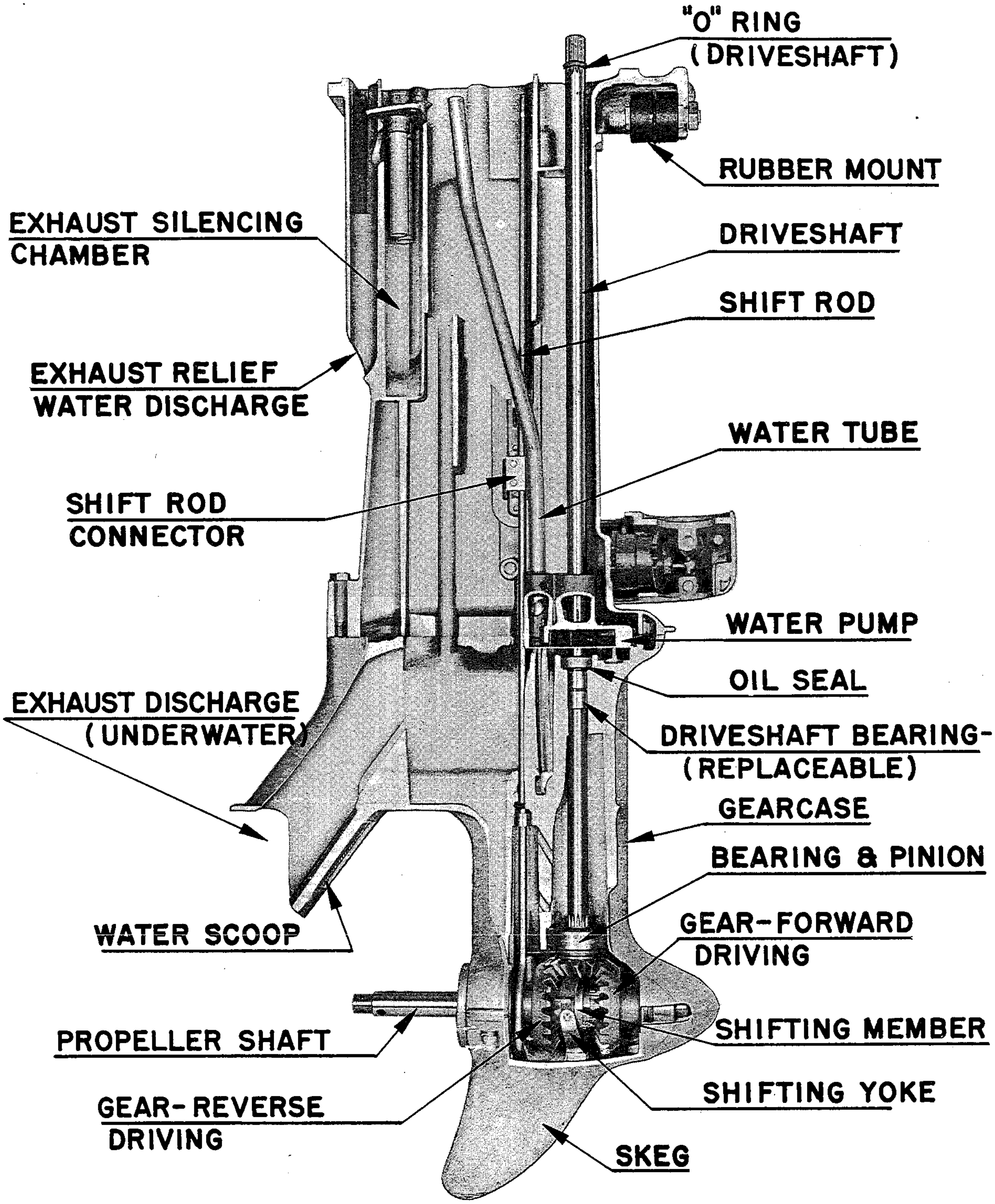
LOWER UNIT—MODELS QD, RD, AND RDE



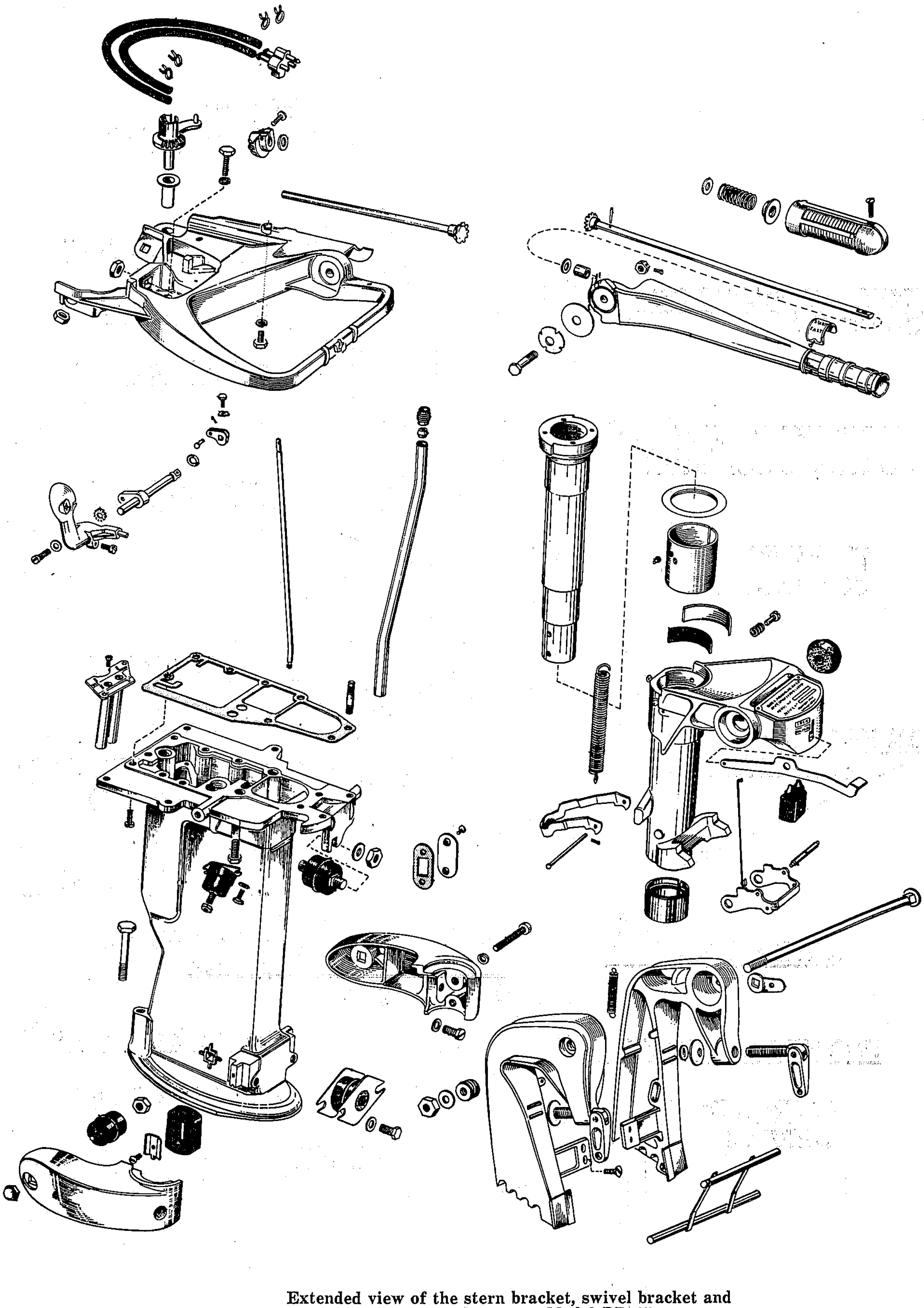
Sectional view QD-16 lower unit.



Extended view of the stern bracket, swivel bracket and exhaust stack group—Model QD-16.



Sectional view RD-17 lower unit.



Extended view of the stern bracket, swivel bracket and exhaust stack group—Model RD-17.

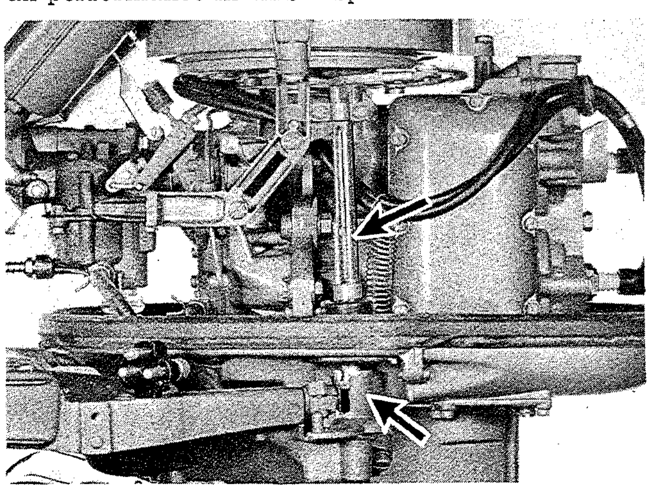
LOWER UNIT — MODELS QD, RD, AND RDE

In addition to installing air silencers on the carburetor intake (Models QD-16 and RD, RDE-17) and with silencing chambers built into the exhaust stacks to reduce motor noise, the power unit complete is isolated in a manner from the boat by means of rubber mounting (cushion) to further achieve quiet performance. Shock of motor vibration is absorbed or taken up by the mountings rather than being transmitted directly to the transom and side walls of the boat, which otherwise act as a "sounding board" to amplify motor noises. Mounts observed on side walls of the exhaust stack (top and bottom) "cushion" the shock of motor torque while those on center line—forward (top and bottom) absorb or cushion the shock of thrust —"soften" the effect of power or thrust impulses transmitted to the propeller.

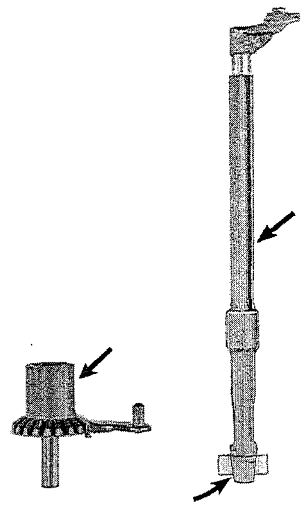
The swivel bracket—exhaust stack assembly in both the QD and RD are fundamentally alike, thus service operations are accomplished in like manner. Gearcase assemblies in each case are however of somewhat different design and construction —see pages 192-19 and 192-45 QD; 192-22 RD.

SPEED CONTROL LEVER — GEAR AND PIN ASSEMBLY — MODELS QD-16 AND RD-17 SERIES

With rubber mounting of the QD more wear than anticipated has been encountered between the bottom end of the speed control shaft (upright) and its corresponding socket in the control gear. To overcome the situation, a "pin" of nylon construction has been provided for installation at the point of wear—indicated by arrow. It's possible to achieve better wearing qualities with nylon—particularly when dry. This, in addition to maintaining closer tolerances and establishing smoother "rubbing" surfaces, leads to better overall performance in this respect.



Model QD



All Model QD, QDL-16's after serial #1227814, all Model RD, RDL-17's after serial #1228732, and all Model RDE, RDEL-17's after serial #1219876 have been assembled with the nylon pin installation as described above.

When requiring either the control shaft (upright) or the gear on QD-16 and RD-17 series prior to the above given serial number—

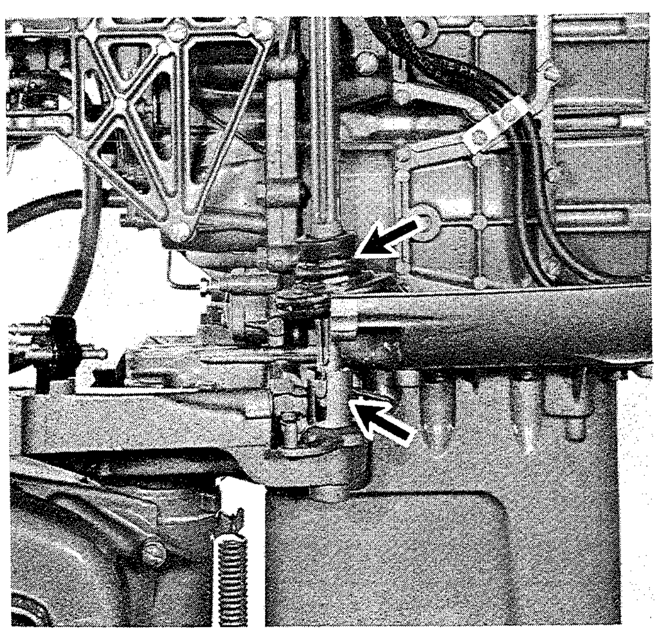
for the QD order assembly #376430, consisting of:

1 #304155 Pin (Nylon)
1 #304157 Gear
1 #304159 Shaft (lever—upright)

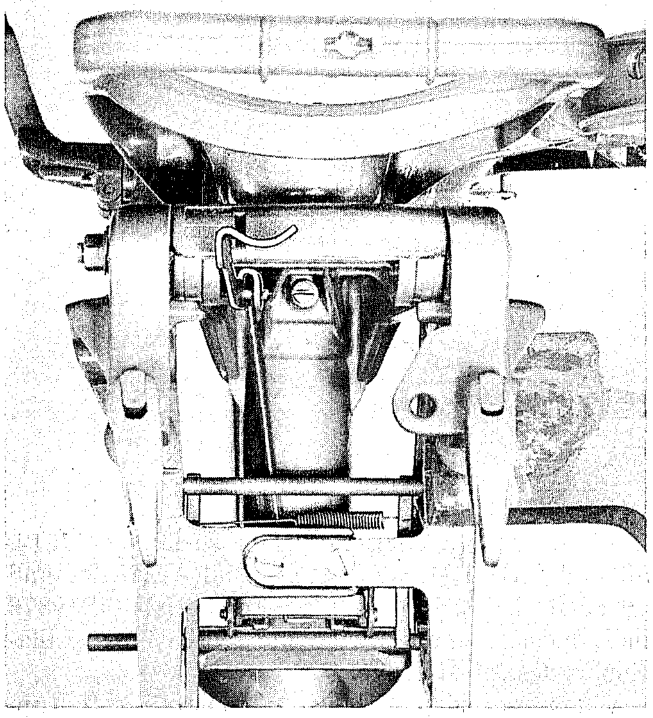
for the RD order assembly #376429, consisting of:

1 #304155 Pin (Nylon)
1 #304156 Shaft (lever—upright)
1 #304157 Gear

Always lubricate the assembly after installation with water-resistant lubricant.



Model RD



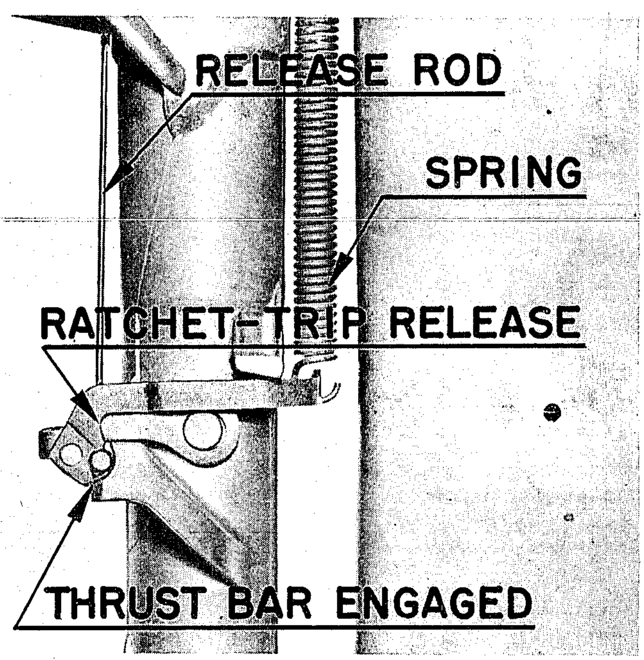
TILTING LOCK

A trip release (spring loaded) arrangement of sufficient tension is made part of the tilting lock. The tilting lock prevents tilting when suddenly decelerating, yet permits tilt of the motor on shock of impact when striking underwater obstruction.

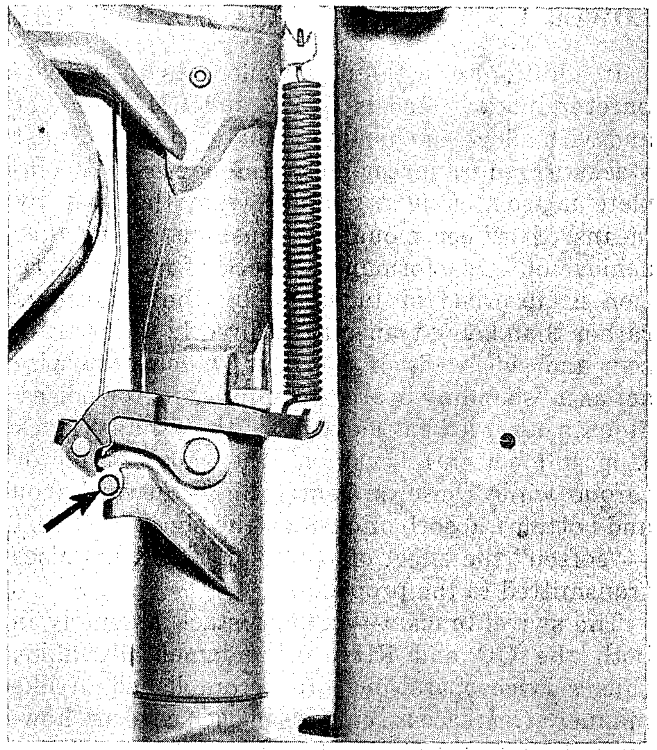
Normally operated by means of lever and linkage, the tilting lock may be released when desired by depressing lever and shifting slightly to left and restored by returning to normal running position.

It is advisable to tilt the gearcase out of the water when not in use—set lever to release position, then tilt; set at running position when submerging the gearcase for operation.

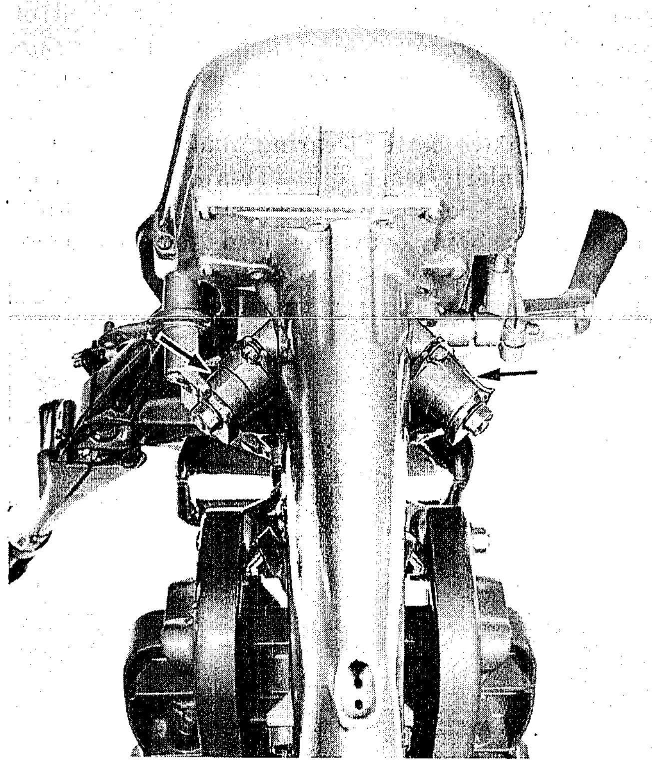
The motor does not tilt when operating in reverse.



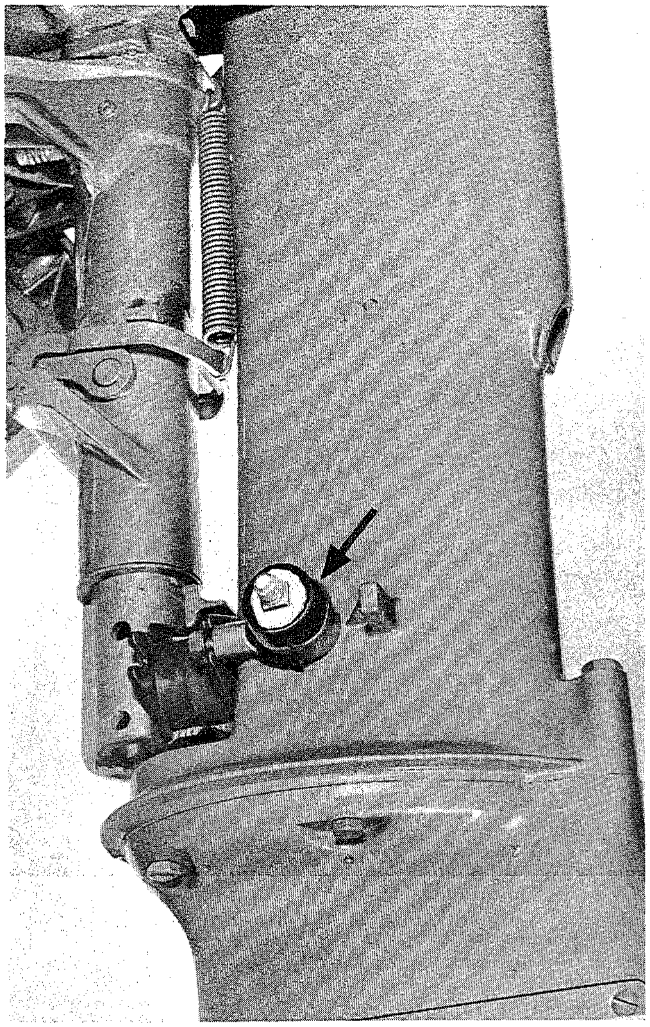
Showing the spring loaded tilt lock (thrust bar) engaged—during normal forward and reverse driving.



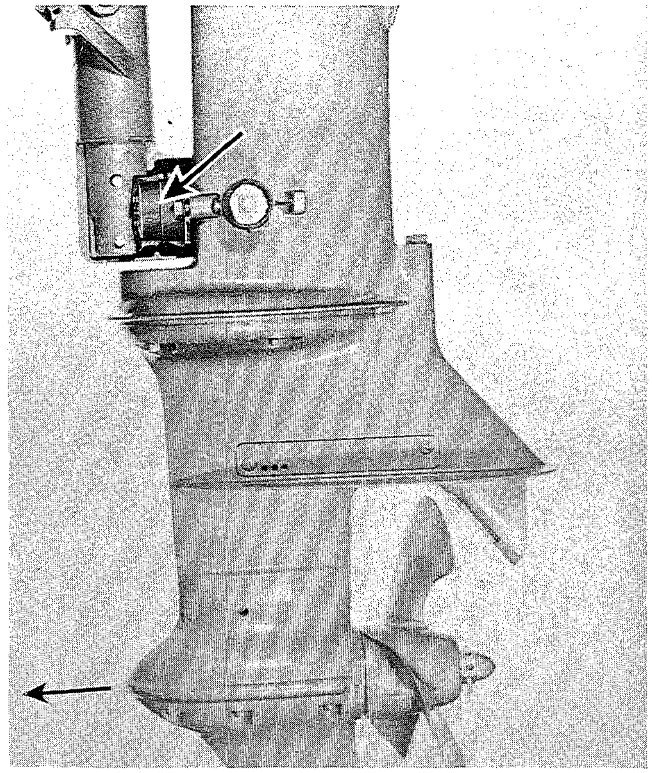
Illustrating the spring loaded tilt lock (thrust bar) released as occurs when striking an underwater obstruction.



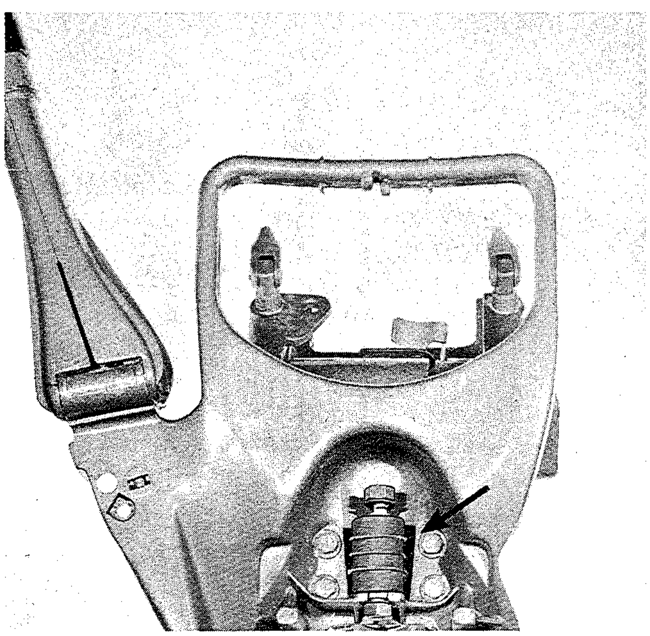
Rubber mounts (upper) to absorb effects of torsional shock.



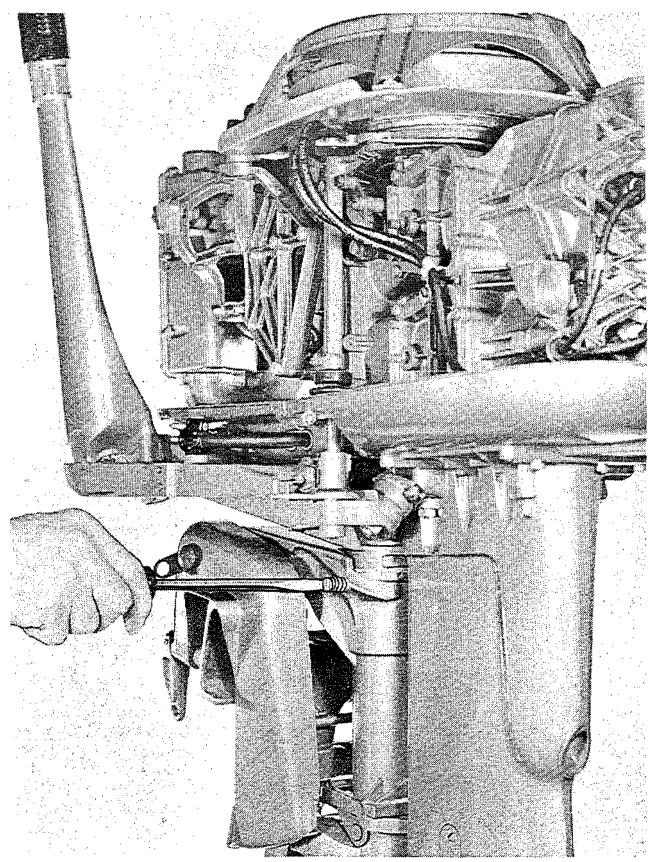
Showing location of rubber mounts—lower—to absorb effects of torsional shock.



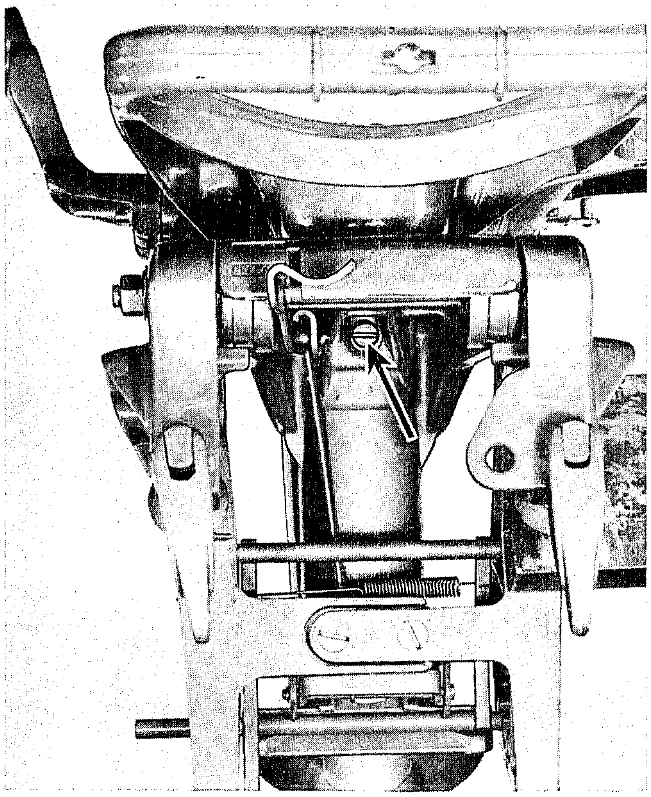
Lower rubber mount to absorb the effects of power thrust applied to the propeller.



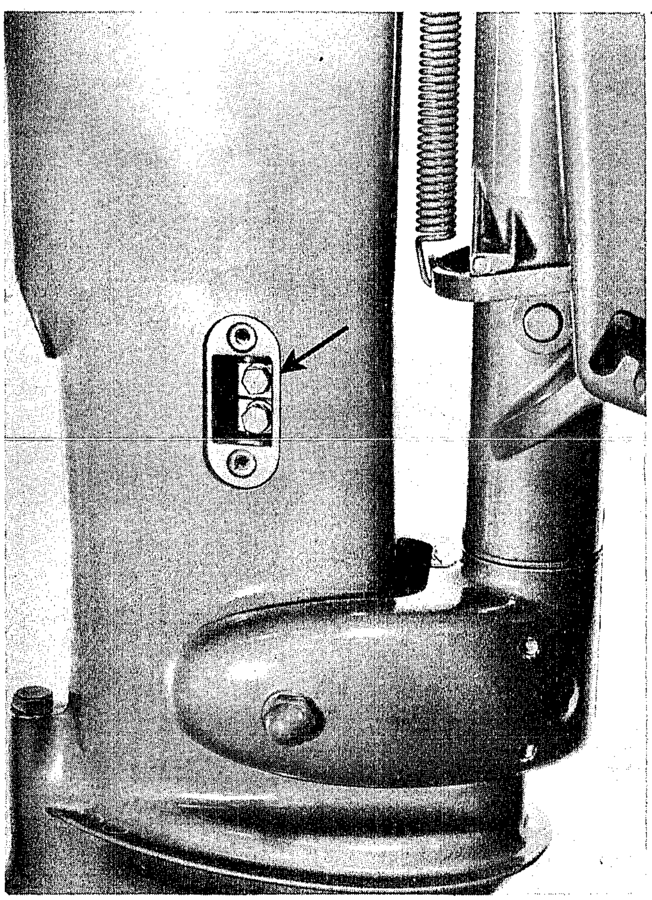
Showing location of rubber mount—upper—to absorb shock of power thrust as applied to the propeller.



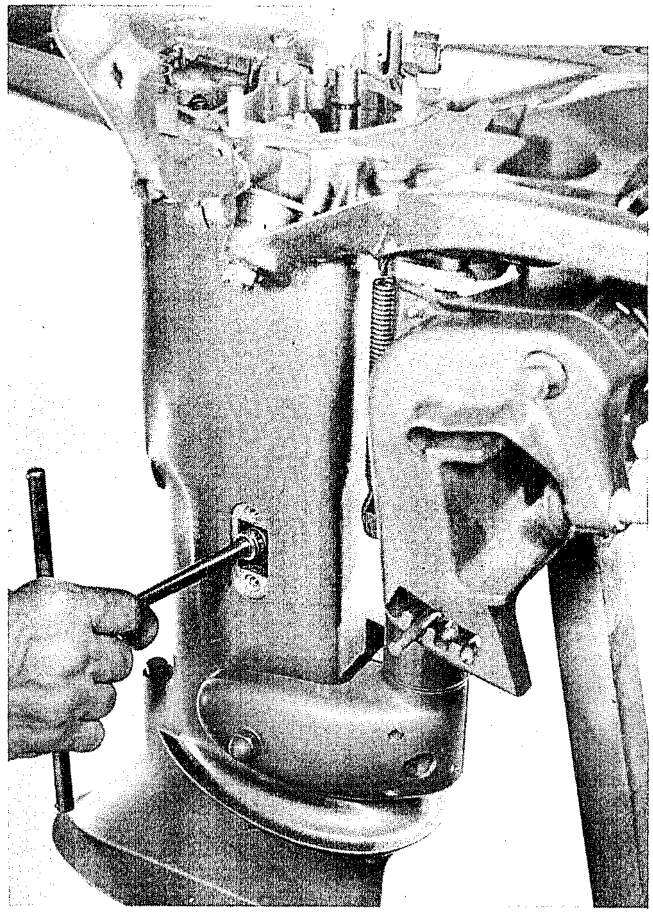
Adjusting tension of steering—Model RD-17.



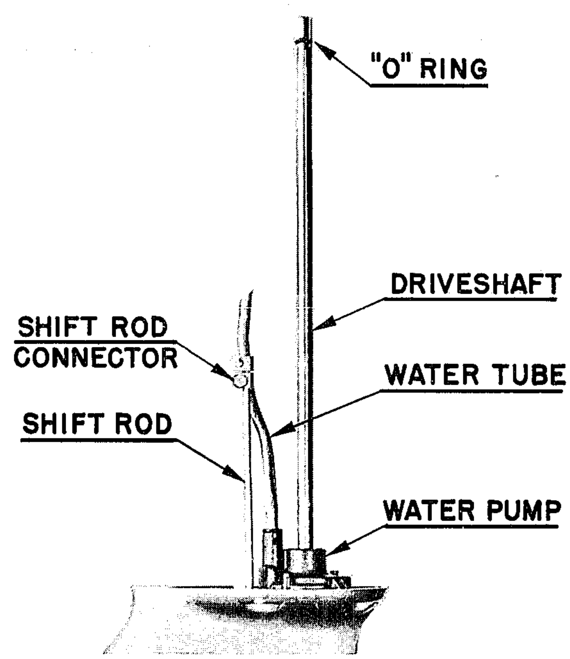
Showing location of steering tension adjusting screw—Model QD-16.



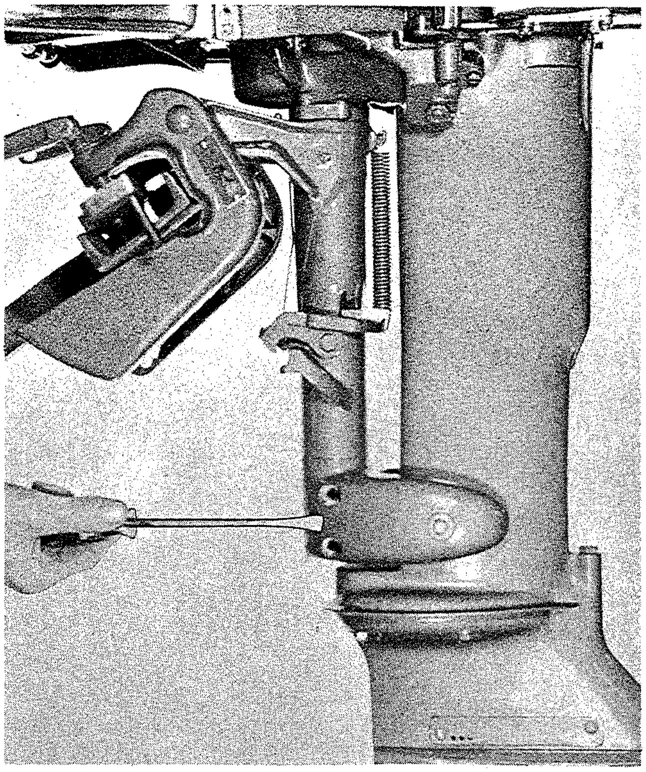
Showing cover removed to expose shift rod connector.



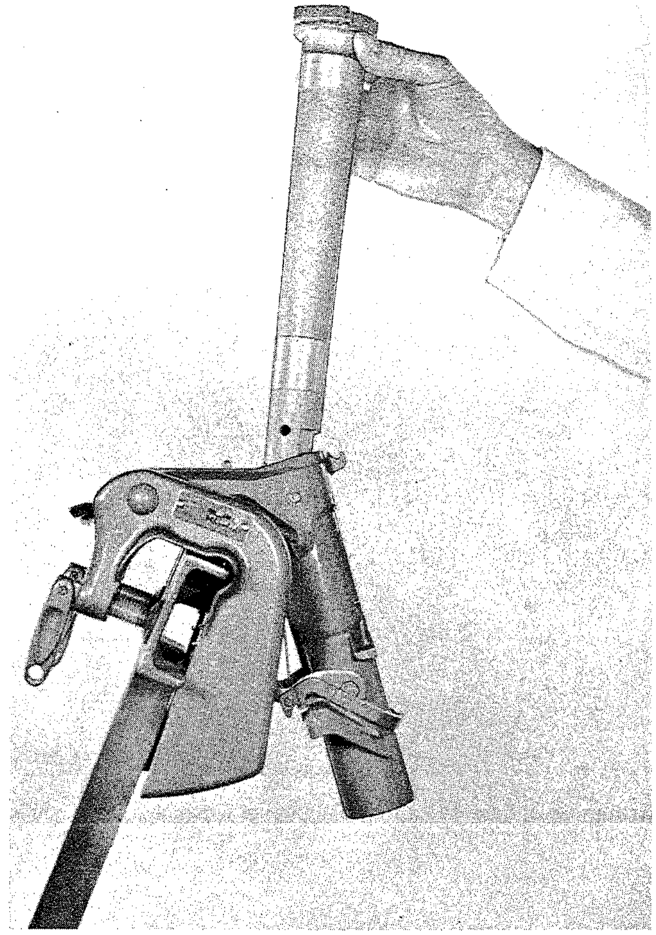
Removing the shift rod connector screw—remove the upper screw for ease of assembly later on.



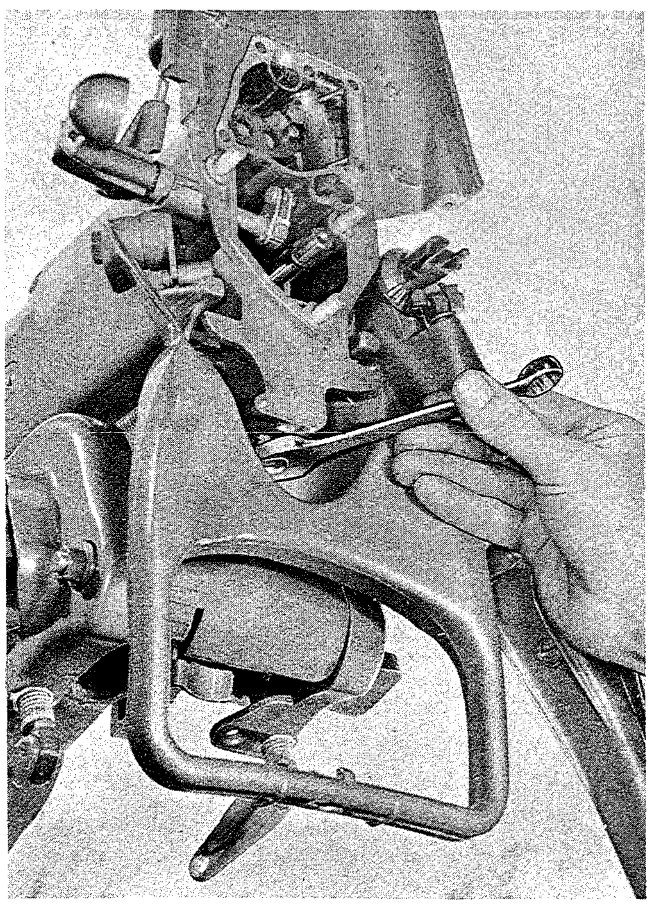
When attaching the gearcase assembly (shown above) to the exhaust stack, the operation may be simplified if the water tube is attached to the pump housing and the shift rod connector attached to the lower shift rod. Coat exposed end of the water tube with oil or liquid soap for ease of installation.



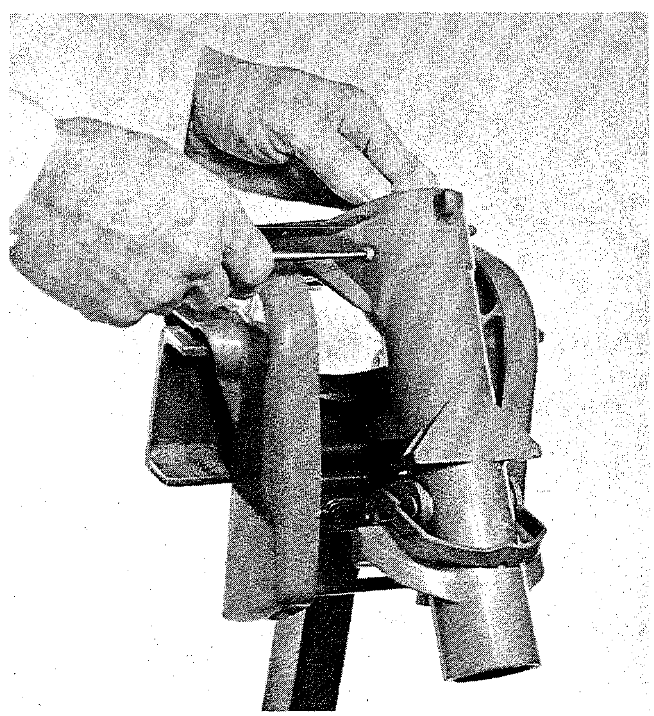
Removing rubber mount cover to provide accessibility to mounts for disassembly and/or repair.



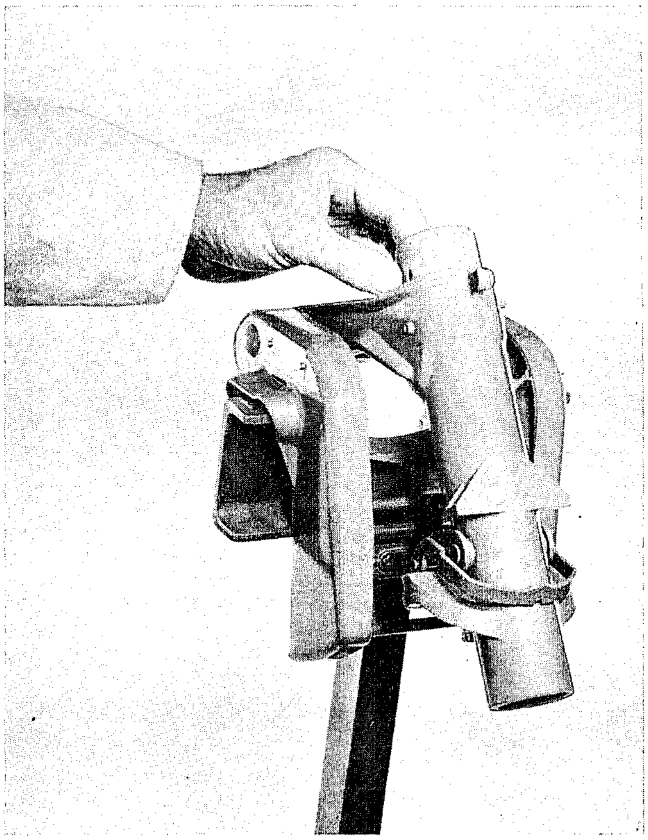
Removing pilot shaft from the swivel bracket.



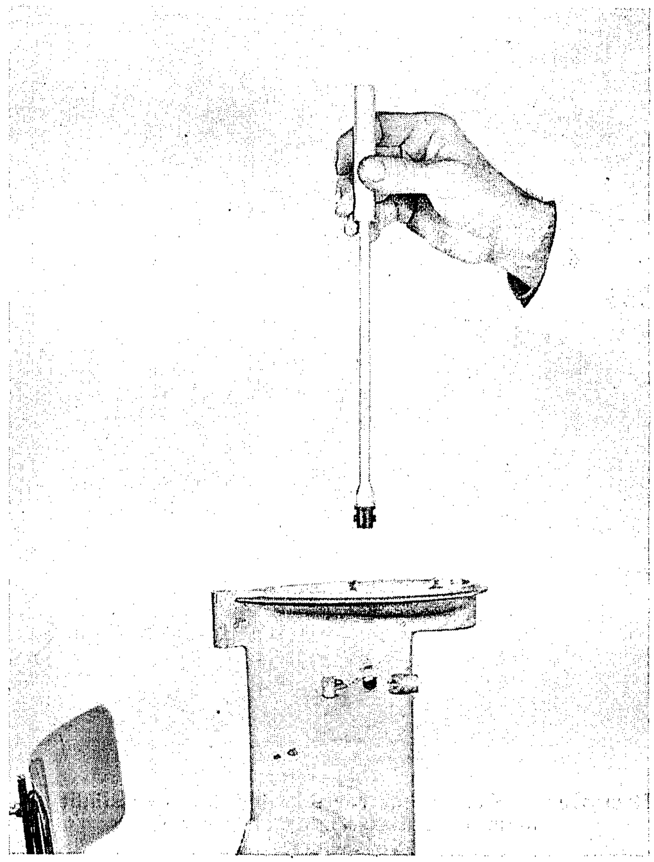
Detaching upper mount from the swivel bracket assembly.



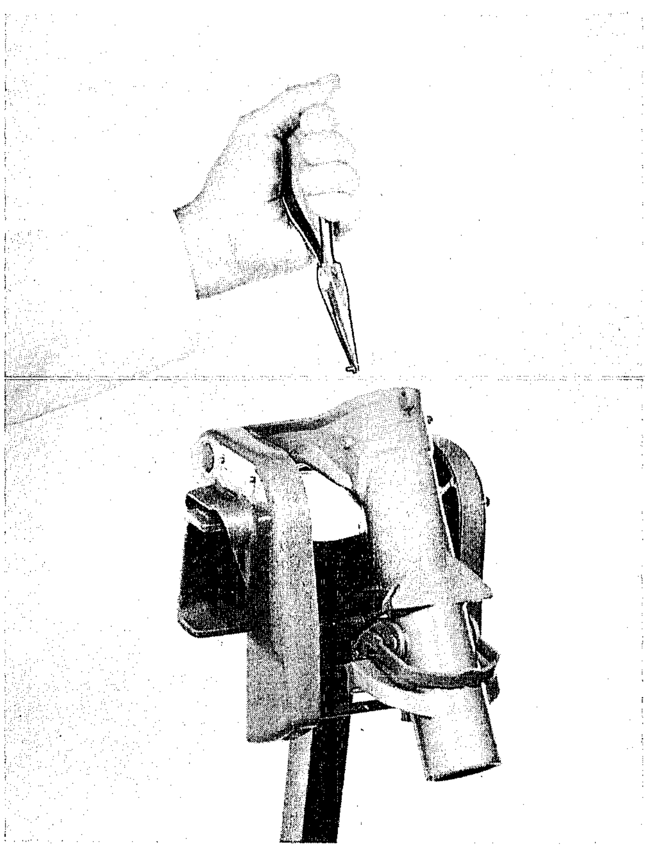
Pushing rivet free of the swivel bracket liner.



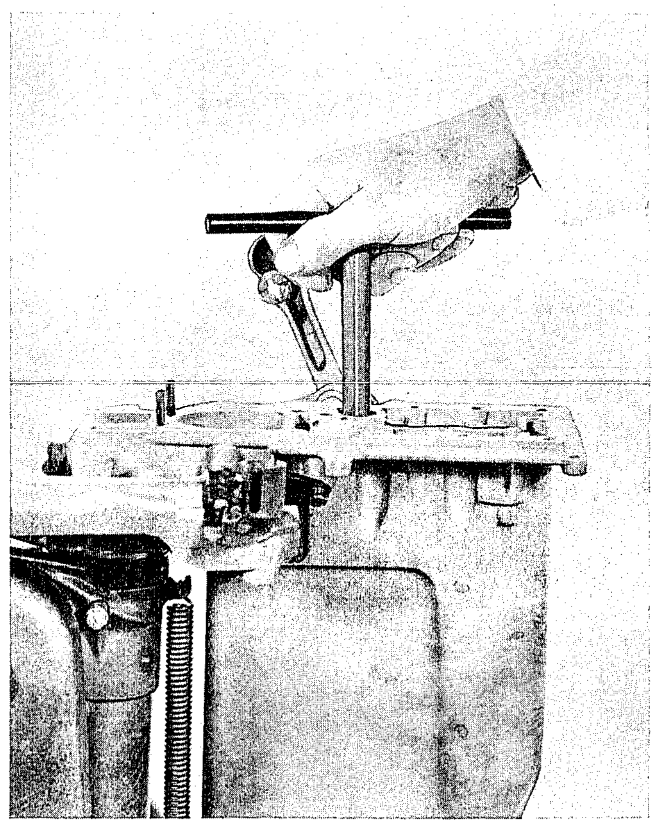
Removing and/or installing the swivel bracket liner—when installing, coat liberally with water resisting lubricant — Mobil Outboard Grease.



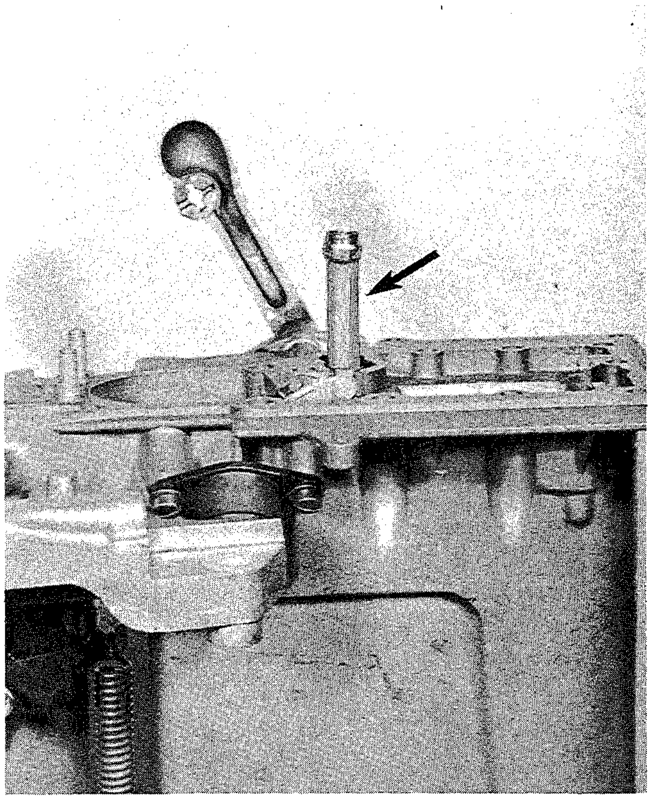
Inserting water tube grommet in the Model QD driveshaft casing and exhaust stock assembly.



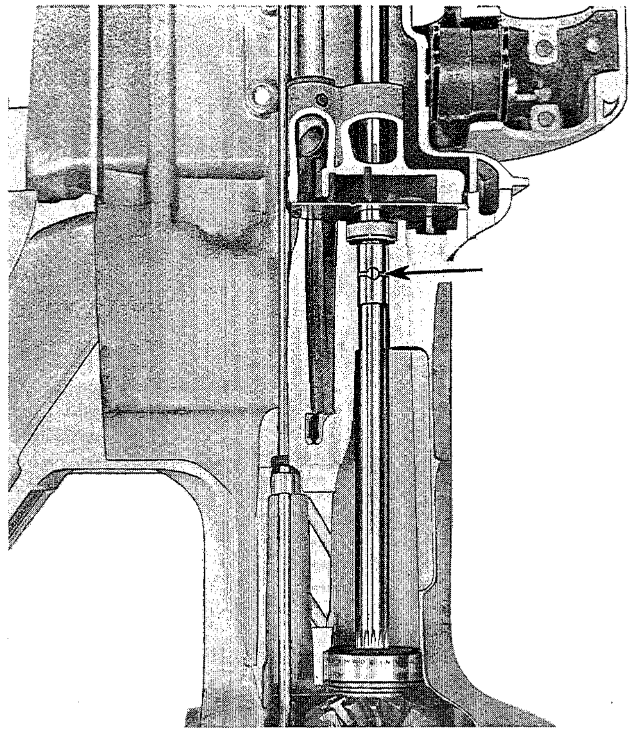
Installing rivet to hold the swivel bracket liner in position.



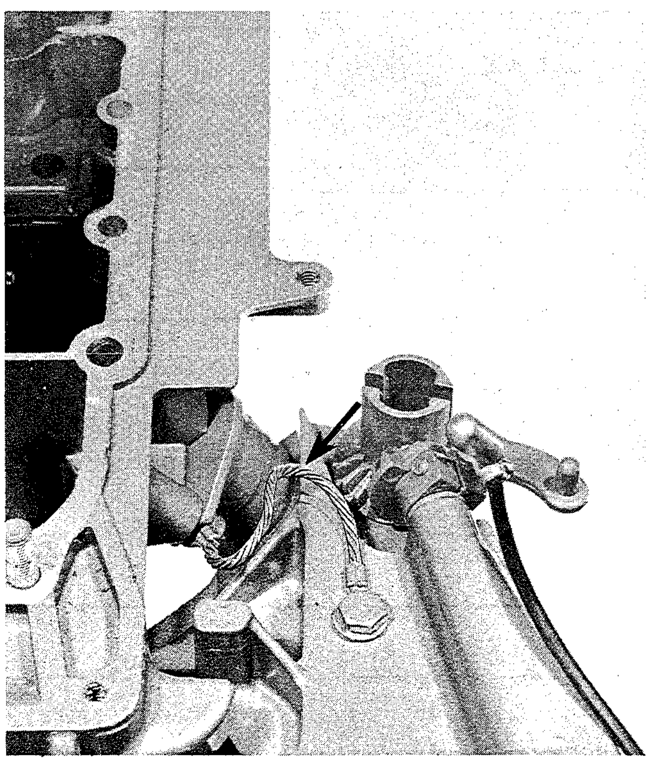
Removing and installing the water tube gland nut—Model RD-17 series.



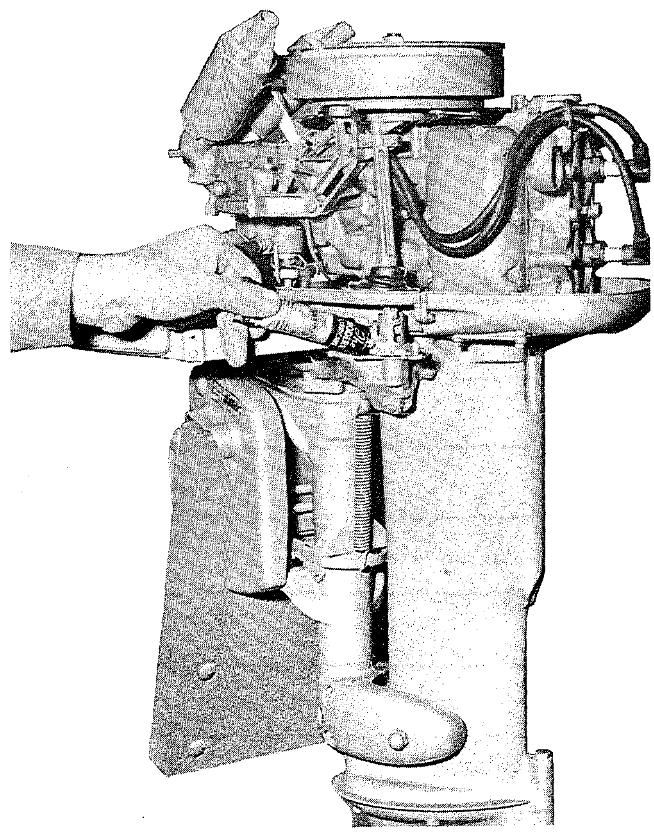
The installed gland prevents removal of the water tube. To remove water tube for replacing, cut off in area indicated by the arrow — discard original water tube later to be replaced with a new one.



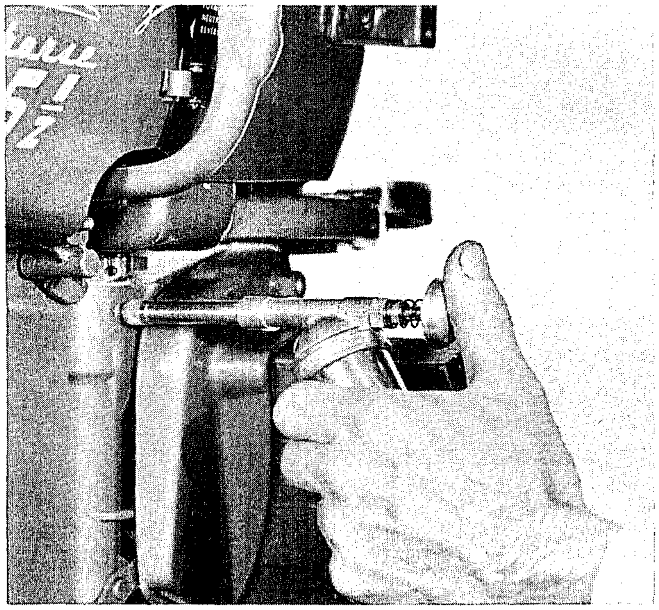
Showing location of upper Driveshaft Bushing — Floating (Model RD).



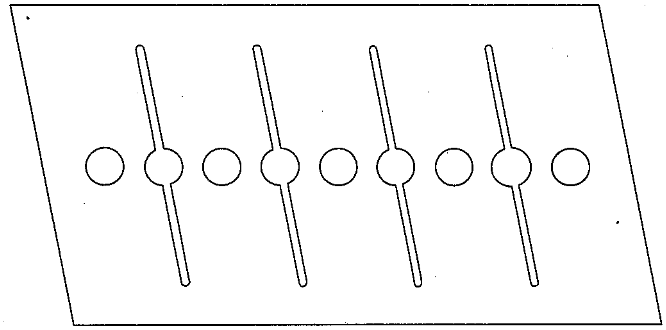
Showing installation of the safety switch (mercury) ground on lower unit of Model RDE-17—required because of rubber mounts "insulating" the power unit from the stern bracket assembly — make certain the ground lead is in place and properly attached.



Lubricate all moving control mechanisms liberally with water resistant grease.



Lubricating the swivel bracket with water resistant grease to avoid seizure—particularly in salt water regions.



Swivel bracket liner #302638 (shown as Item 28 on page 16 of the RD-16 parts catalog) for Models RD-10 to and including RD, RDE-16 and 16A was cancelled and superseded by #304133 shown here. The new liner is of molded or extruded nylon and much better suited for the purpose than #302638 which was of asbestos composition. The new nylon liner will eliminate, or at least reduce to a minimum, possible seizure of the swivel bracket when used in salt water regions.

No change in installation procedure is required except that Mobilgrease Outboard is recommended as lubricant. Apply lubricant when installing—holes and slots are provided in the liner to hold and spread the lubricant. Grease periodically thereafter as further insurance against seizure.

NOTES

PROPELLERS—OFF PITCH OR DAMAGED BLADES

Not to be overlooked when in process of diagnosing motor difficulties is condition of the propeller. Excessive vibration, faulty or irregular operation for no apparent reason may often be attributed to damaged or "off" pitch propeller blades as result of striking underwater obstructions.

When confronted with a situation of this sort, look to the propeller as the possible disturbing factor prior to going too far into the motor assembly for corrective measures.

As off pitch propeller blade frequently reveals symptoms of motor performance ordinarily associated with faulty ignition and/or carburetion—rough or "ragged" running throughout intermediate ranges with increasing roughness and vibration at top and near top speeds.

Casual observation generally will not divulge off pitch propeller blades, unless badly bent, thus the only assurance of true pitch is checking and correcting, if necessary, on a "pitch block" (propeller straightening fixture.)

#376106 Fixture (propeller #375790) RD
#376104 Fixture (propeller #375605) QD
#376103 Fixture (propeller #375689) TN
#376108 Fixture (propeller #376072) CD

Checking and Correcting Propeller Blade Pitch

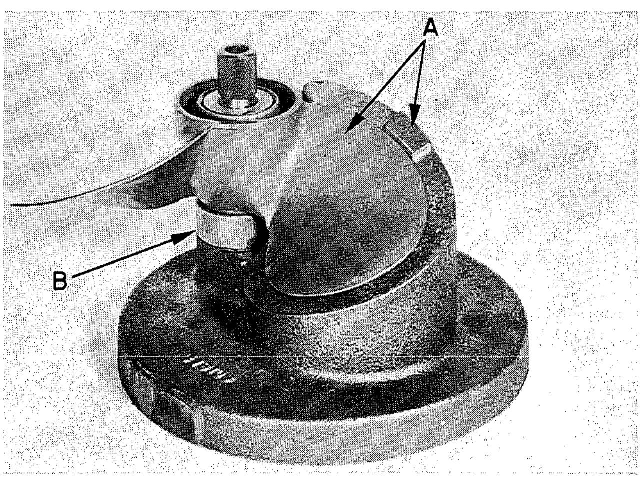


Figure 1.

Contour face of the propeller straightening fixture (pitch block) represents true pitch of each propeller blade, thus, if propeller pitch is correct, each blade will lie "flat" against the pitch face.

To check and correct propeller pitch, proceed as follows:

1. Install propeller on fixture as shown Fig. 1. Make sure propeller hub seats at base of spindle (B) and that leading edge of the propeller blade rests firmly against guide as indicated by arrows "A." Any variation or "off pitch" will be in evidence where blade area does not conform to pitch face of fixture. (An adapter or bushing is used to locate the propeller on some fixtures—do not fail to insert where provided.)

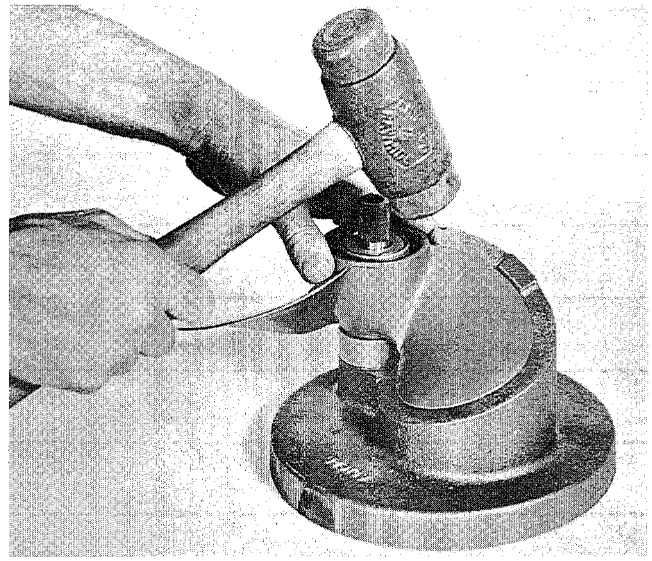


Figure 2.

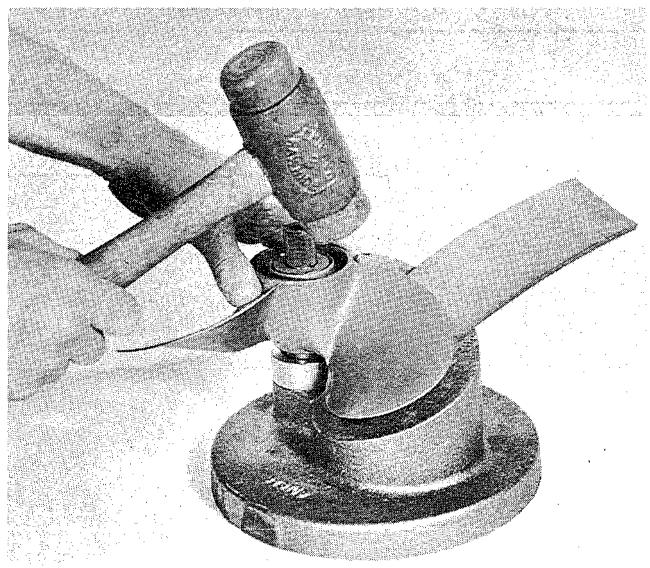


Figure 3.

2. Carefully strike "high" area of blade with rawhide or lead mallet to flatten against pitch face.
3. In event the blade cannot be "flattened" by this procedure—place a leather pad (about 3 inches wide and 1/8 inch thick) under low area as shown Fig. 3. Strike high blade area carefully with mallet to drive against pitch face.
4. Remove leather pad and recheck as shown Figure 1.
5. Repeat procedure until blade lies flat against the pitch face.
6. Perform same operations for each propeller blade.

NOTES

MISCELLANEOUS

Section V

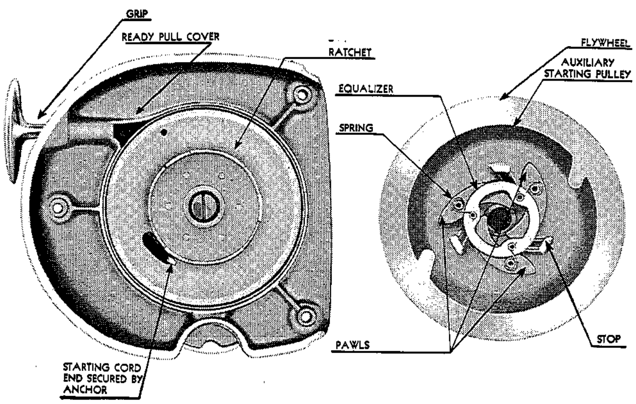
MISCELLANEOUS

NOTES

MISCELLANEOUS

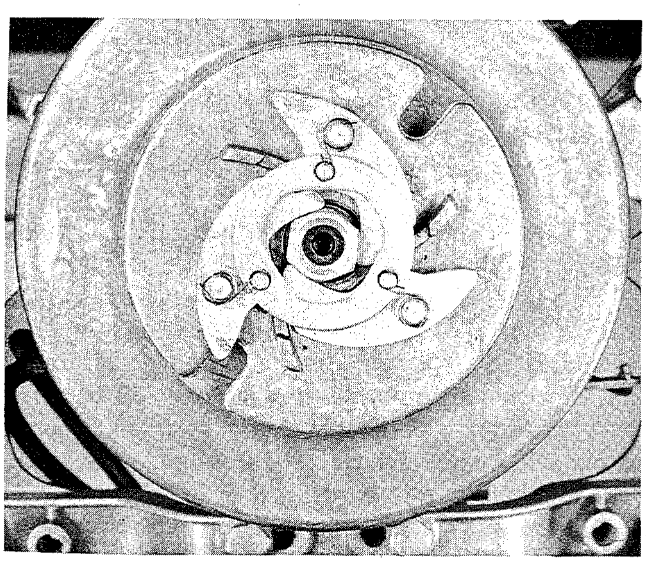
THE READY PULL—HD, TD

This simple device is built into the motor for the express purpose of eliminating the necessity of manually wrapping the cord around the starting pulley for cranking. It consists of a ratchet plate about which are coiled a return spring, the starting cord and a pawl arrangement mounted on top of the magneto flywheel.



Ready Pull Assembly

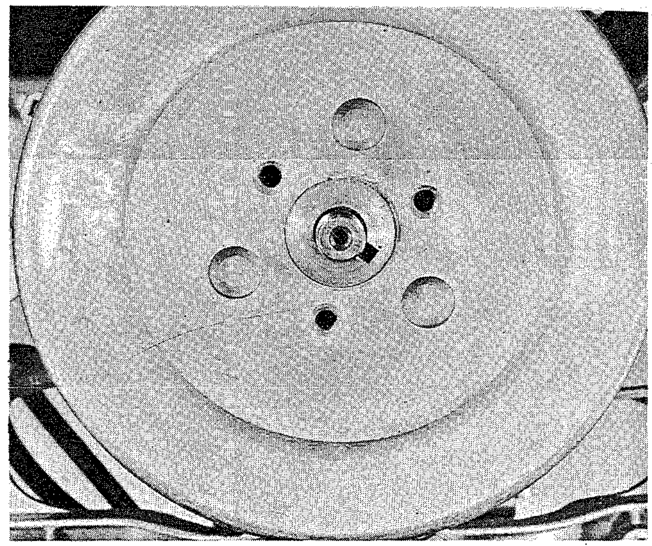
When at rest, the pawls are held in an extended position by small springs, making a positive connection with the ratchet — thus when pulling on the starting cord grip, cranking effort is applied directly to the flywheel.



Showing Pawl and Spring Arrangement on Flywheel

Upon having started the motor, the pawls disengage the ratchet automatically due to centrifugal force created by rotation of the flywheel. Once having started, "Ready Pull" mechanism remains idle, consequently since there is no action while the motor is in operation, there can be no wear on any of the parts. It is for this reason very little attention is necessary.

Immediately upon stopping the motor, centrifugal forces cease to act, causing the spring to extend the pawls to engage with the ratchet — the "Ready Pull" is then again in position for cranking. Its action is automatic — simply pull on the cord to crank.



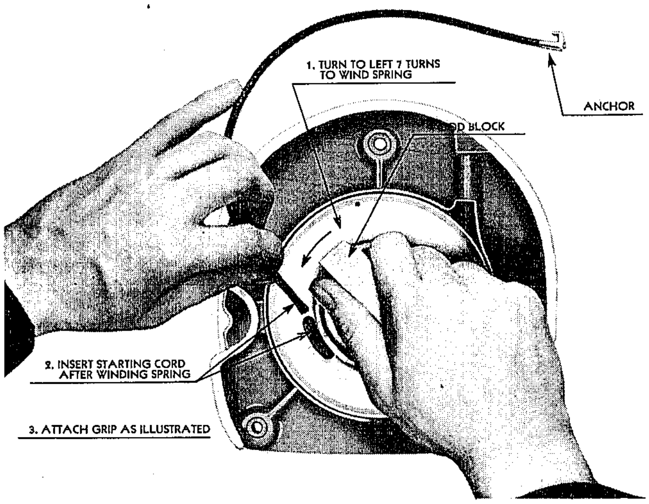
Showing Recesses on Model H Flywheel to Accommodate the Starter Pulley. Care Should be Exercised when attaching the Pulley to make certain corresponding lugs on Bottom Side Properly Engage the Flywheel

Care of the "Ready Pull"—Under no circumstances let the starting grip "snap" back into position after cranking by letting go. Retain hold of the grip until the cord has returned to normal position. Care should be exercised in this respect to prevent possible injury to the "Ready Pull" cover and starting cord.

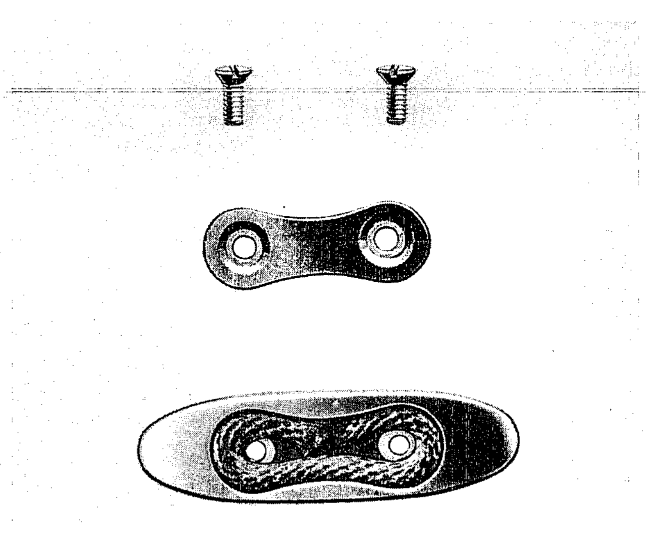
In event the starting cord should break, the "Ready Pull" may be removed and the motor cranked in conventional manner, by wrapping the cord around the auxiliary starting plate on the flywheel.

TO INSTALL NEW STARTING CORD proceed as follows:

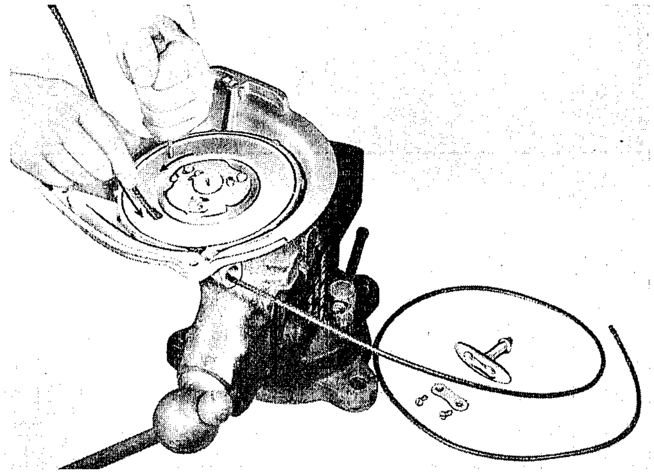
1. Remove "Ready Pull."
2. Remove fragments of broken starting cord.
3. Obtain new cord. Attach grip as shown. Use only the special cord provided by Johnson Motors.
4. Cut a small piece of wood to fit in ratchet as shown.
5. Turn in anticlockwise direction (right to left) 7 turns, using marker as indicated. (Be sure to turn right to left—to do otherwise will damage the recoil spring.)
6. Insert starting cord as illustrated.
7. Attach grip as shown.
8. Gradually release until all of cord has been taken up.
9. Attach "Ready Pull" to motor.



Installing New Cord

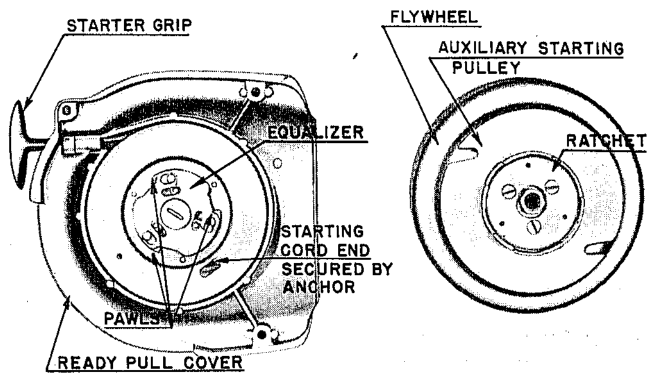


Cord Grip



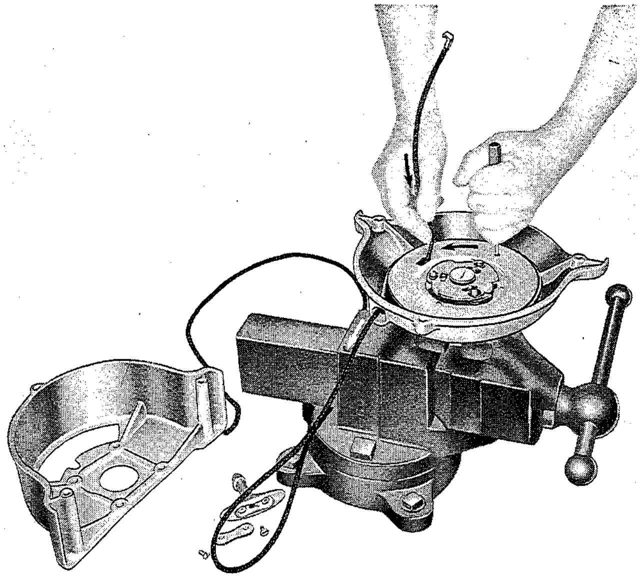
Where the Starter Pulley is Provided with a Hole as Above, It is a Simple Matter to take up Spring Tension prior to Inserting the Cord. Insert Punch and Turn in Direction of Arrow until all Tension is Taken Up—Then Release One Turn. Insert Cord as Illustrated, Install Starter Cord Grip and Release Tension on Spring to Take Up the Cord

TO INSTALL NEW STARTING CORD, PROCEED AS FOLLOWS (MODELS KD, SD):



Starter Assembly (Model SD)

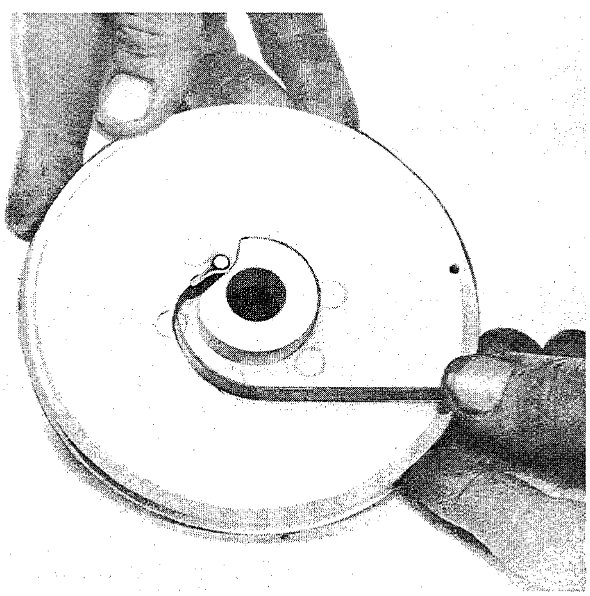
1. Remove "Ready Pull" from motor.
2. Place in vise as illustrated (assembly can be held fast by placing nut on top of "Ready Pull" between jaws of vise).
3. Remove fragments of broken or damaged cord.
4. Obtain new cord—use only special cord provided by Johnson Motors.
5. Insert punch in hole in pulley provided for this purpose. Turn pulley against tension of spring, as indicated by arrow until all of tension is taken up, then permit pulley to unwind one (1) turn.
6. Insert new cord as illustrated. (End opposite anchor on cord through slot in pulley.)
7. Attach grip to cord.
8. Gradually release tension on pulley until all of cord is taken up.
9. Attach "Ready Pull" to motor.



Installing New Cord

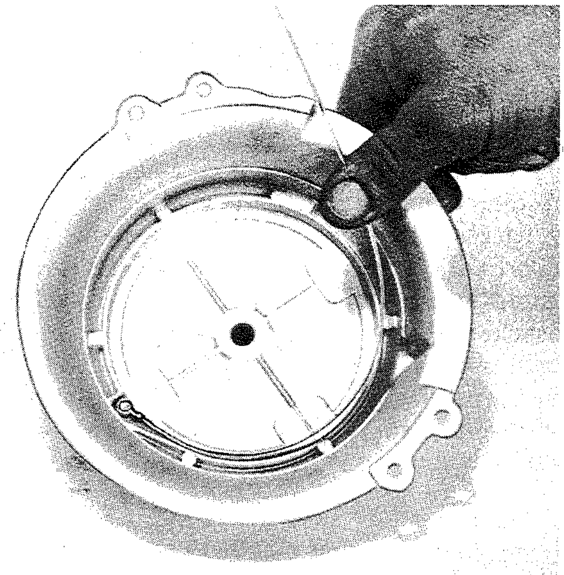
INSTALLATION OF NEW READY PULL STARTING SPRING

1. Place the rivet head towards the outside of pulley; with it in this position, place the loop over the pin on the pulley. Bend the spring around the hub, half way to form.



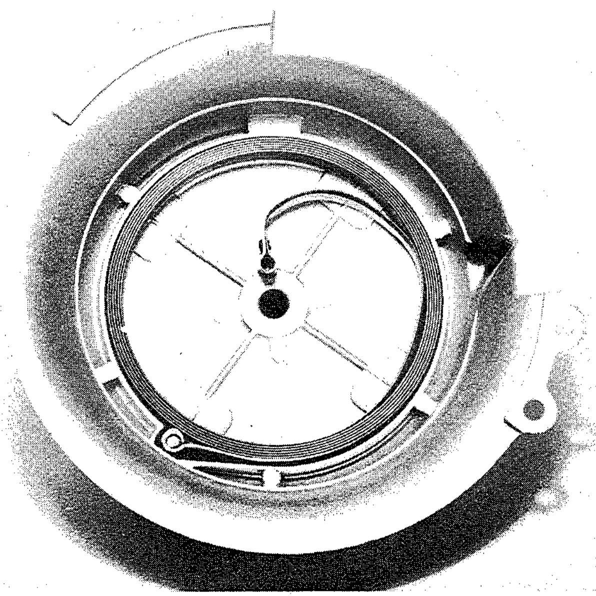
Attaching Spring to Pulley

2. Place the opposite end of the spring in position in the housing as shown below.



Installing Spring

3. Work the spring around in counterclockwise direction as shown above until entire length of the spring has been consumed. Bend inside end of the spring to permit loop coming to rest as shown below. Place pulley in position and bolt together.

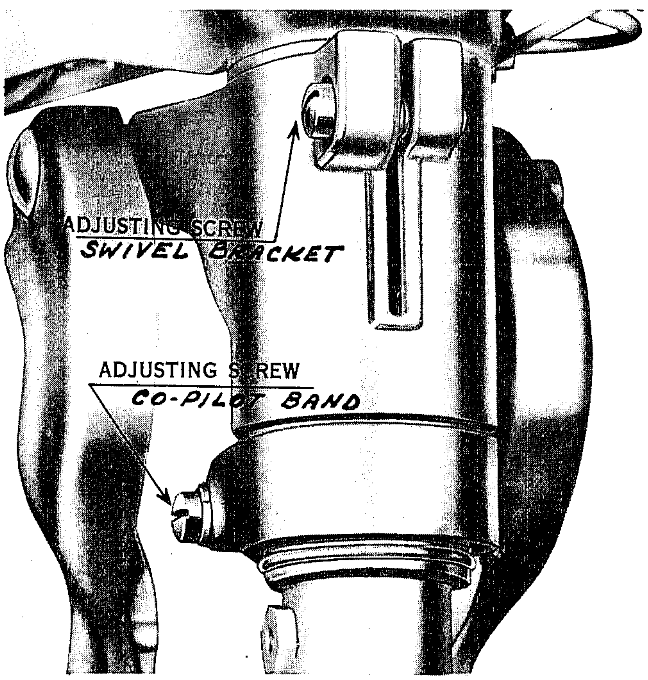


Spring Installed

THE CO-PILOT

The Co-Pilot is an automatic mechanical device to assist in maintaining a true course of the boat whenever the steering handle is left free. This permits moving about in the boat without slowing down or stopping the motor to prevent its swerving to one side or the other. It also is of value when trolling or casting from the boat.

Its construction is simple—consisting of a brake (Co-Pilot) band attached to the driveshaft casing immediately below the swivel bracket. The swivel bracket is provided with a small lug which protrudes between the ends of the Co-Pilot band. A comparatively stiff spring is mounted on each side of the lug and ends of the band as shown below, with a bolt or screw provided for adjusting tension.



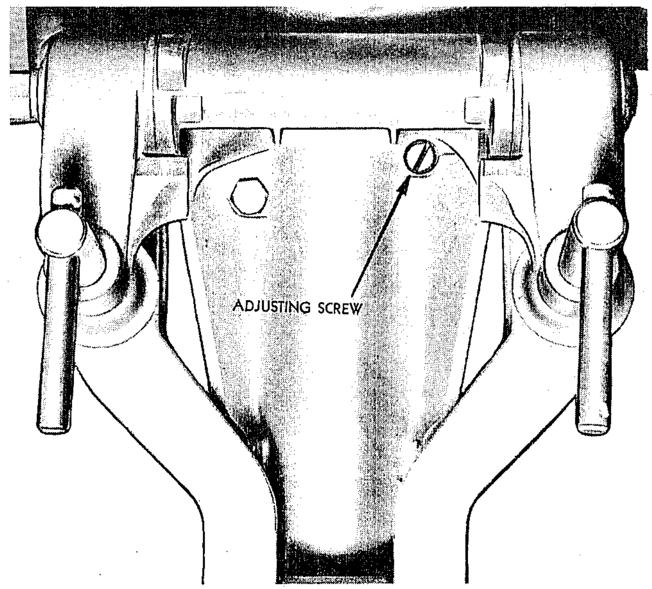
Co-Pilot Construction Models M, H, LS, LT & T Series

CARE AND ADJUSTMENT OF CO-PILOT

If for any reason steering is found to be too free or too stiff, adjustment can be obtained by either tightening or loosening the Co-Pilot band screw.

Since the Co-Pilot functions constantly during operation of the motor, periodic attention is required. Place a drop or two of oil on lining of the band occasionally and check tension on the springs.

In addition to being of assistance with respect to maintaining true course of boat travel under certain conditions of operation, it absorbs considerable shock of torque impulses which otherwise



Showing Co-Pilot Adjusting Screw Model SD (Rubber Insert)

are transmitted to the steering handle to the discomfort of the operator. Identical results, however, are frequently obtained by somewhat different construction, which consists of inserting a tube of synthetic rubber between the driveshaft casing and swivel bracket to absorb shock. A stainless steel sleeve is employed in this case between the driveshaft casing and rubber insert to provide the necessary bearing surface. Model SD employs the use of rubber inserts to accomplish this purpose.

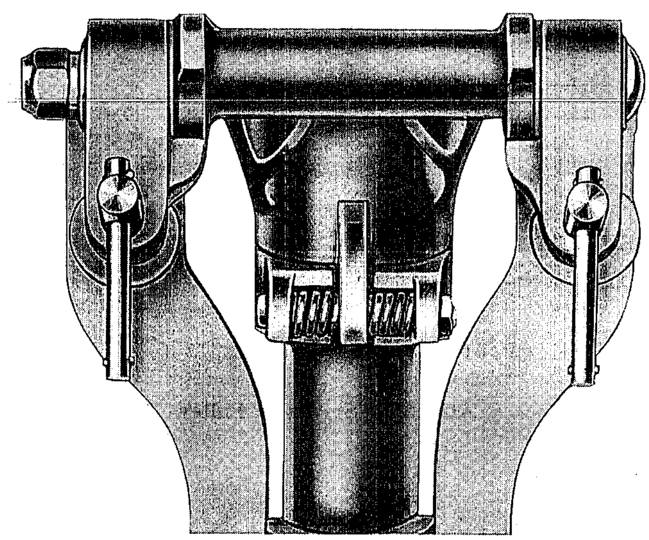


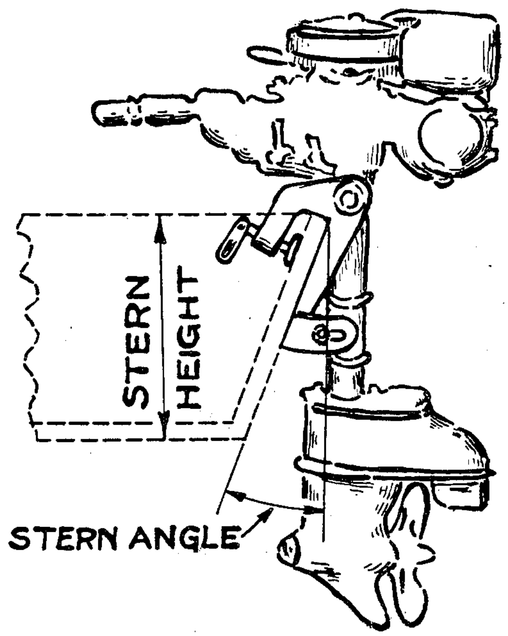
Illustration Application of Co-Pilot

MOUNTING THE OUTBOARD MOTOR ON THE BOAT

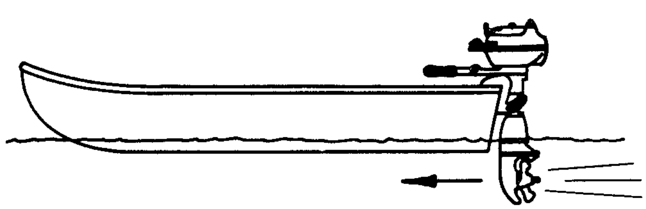
It is essential that the motor be properly mounted on the stern of the boat to obtain results. The object is to be sure that the propeller operates at correct depth below the surface of the water and that the line of propeller drive is horizontal or parallel to the line of boat travel.

Height of the stern governs the depth at which the propeller operates—the angle of propeller drive being determined by adjustment of the thrust socket.

For maximum efficiency, see recommended stern heights.



To obtain maximum efficiency, the driveshaft casing of the motor should be PERPENDICULAR or at Right Angle to the line of boat travel at full throttle, or, in other words, the line of propeller thrust parallel to the line of boat travel.



Motor Properly Mounted—Boat Riding on Even Keel

All motors are provided with an ADJUSTABLE thrust socket to permit adjustment of the angle of drive, with relation to the type of boat, the motor, the load carried, speed and character of service.

Size up the transom (stern)—how high is it, at what angle does it set, is it a square or sheer type stern?

The bottom of the hull should also be taken into consideration—is it a flat bottom, with excessive sheer (rocking chair effect), round or straight, a "V" or modified "V" bottom?

All these are IMPORTANT factors to bear in mind when making the installation, or when determining the size of motor best suited for a specific boat.

Should the stern be too low, a proportionately large section of the gearcase is submerged below the surface of the water to create excessive drag, resulting in unsatisfactory boat performance; while on the other hand, should it be too high, the propeller will operate too near the surface in highly disturbed water, resulting in cavitation (motor spinning), little or no boat speed and inefficient cooling due to air entering the water circulating system.

Average stern angle is approximately 12 degrees. Greater angle can be compensated for by the adjustable thrust socket. No angle at all will result in downward thrust of the propeller, causing the stern to "dig-in" and the bow to "rare-up" — finally resulting in the boat "squatting" and pushing the water before it or "galloping" (bow bobbing up and down), if the larger motor is involved, rather than gliding over the surface as it should.

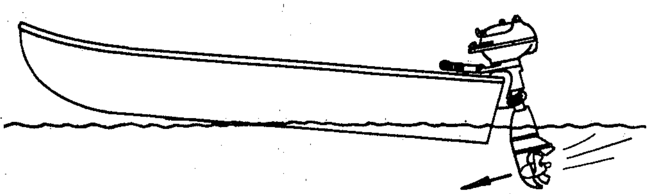
A flat bottom boat with excessive sheer, or a round bottom, with a great deal of stern sheer, will probably necessitate adjusting the thrust socket to permit the propeller to "pitch" slightly under the boat. The slightly "under" position of the propeller in this instance results in a lifting or raising effect on the stern, thus permitting the boat to operate on a fairly even keel when under way.

When loading a boat of this type, it is advisable to load forward to overcome the "rocking chair" effect. The boat should ride practically on even keel—bow slightly higher than stern.

Do not OVERPOWER a highly sheered boat (conventional row boat)—a small motor, properly adjusted, will invariably outperform the larger motor on a boat of this type by providing sufficient power to propel the boat without causing it to "squat" or PUSH the water before it.

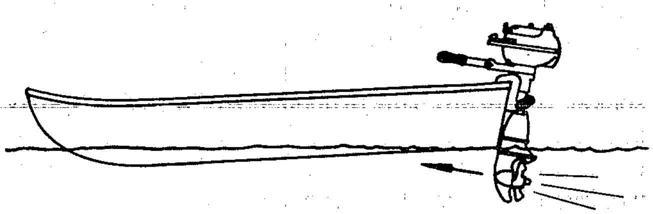
It appears that the square stern, round, V or modified V bottomed hulls have proven most satisfactory for average outboard motor service. Angle of drive, nevertheless, must be adjusted individually in all cases to realize maximum performance.

If the motor is mounted with the propeller tilted too far from the stern, thrust will be directed downward, causing the boat to "squat" (low stern—high bow). A longer than usual run will be required to reach planing position, and under certain conditions, the boat will be found to "gallop" with the bow slapping up and down on the surface of the water at frequent intervals.



Improperly Adjusted Thrust Socket – Gearcase Extended Too Far from Stern of the Boat. Propeller Thrust Directed Downward Causes Bow to Lift High Out of Water

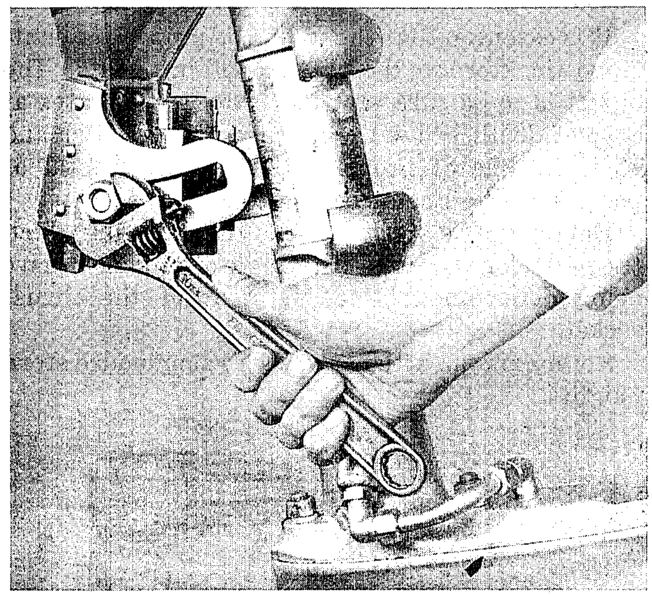
Adjusted to the opposite extreme (propeller tilted too near the stern) propeller thrust will be directed upward with a tendency toward raising the stern, causing the bow to "plow" into the water (high stern — low bow). The result is a zig-zag course and "tricky" handling, especially at higher speeds with the larger motors.



Thrust Socket Adjustment Permitting Gearcase to Operate Too Near Stern of Boat. Upward Propeller Thrust Lifts the Stern to Cause the Bow to Dig or Plow into the Water

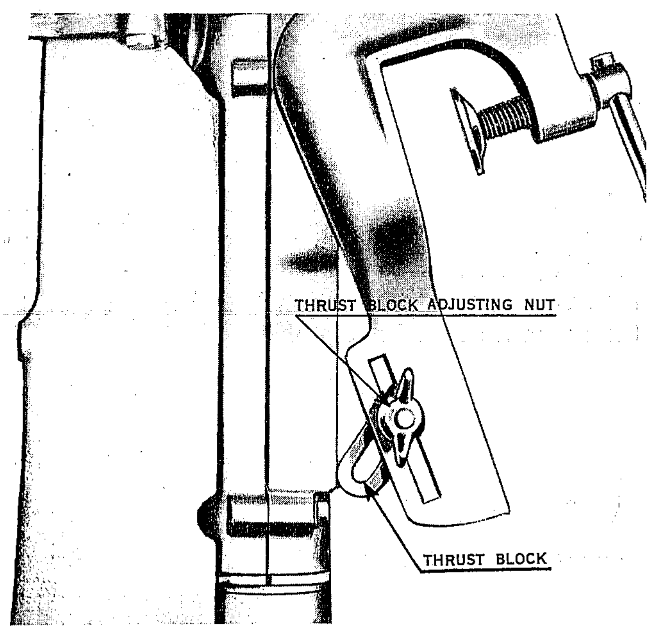
It is well at this time to observe construction of the keel—it should be tapered to a feather edge, commencing approximately 12″ to 18″ from the stern. The purpose of this operation is to avoid possibility of turbulence, often created by a square end keel, affecting propeller efficiency.

THRUST SOCKET ADJUSTMENT
(Angle of Drive)



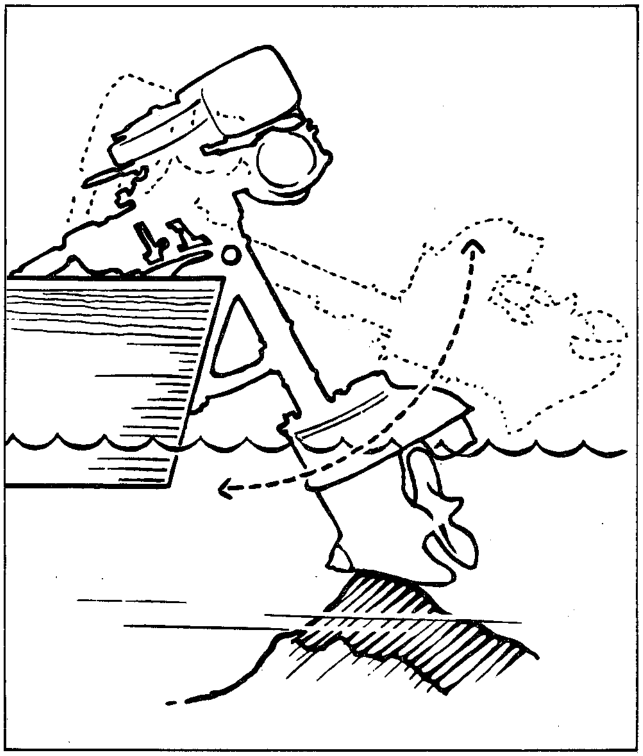
Attach motor to stern of the boat. Be sure to tighten clamp screws to prevent the motor from going overboard on sharp turns. This is IMPORTANT. (Do not use a wrench.) Tilt motor to estimated angle, loosen thrust socket nut, slide thrust socket up on quadrants until it rests firmly against driveshaft housing. Tighten thrust socket nut.

Start motor and operate at full throttle.



Model SD(L) Employs the use of a Thrust Block as Shown Above. This Block is Anchored at One End and Held Fast in Desired Position by the Thrust Block Bolt. To Adjust, Loosen Wing Nut on Bolt, Raise or Lower Free End of Block as Required to Obtain Correct Angle–Tighten Wing Nut Securely

Observe performance (as described above) — readjust position of thrust socket as and if required to obtain desired results commensurate with the motor and boat at hand.



Illustrating Tilting Action When Encountering Underwater Obstructions

CORRECT STERN HEIGHTS

The correct stern height of a boat is an important factor in operation of an outboard motor. The stern should be of such height as to allow the propeller to operate with no cavitation and with the greatest possible forward speed of the boat.

The stern height of a boat is measured from top to bottom of the boat—outside measurement.

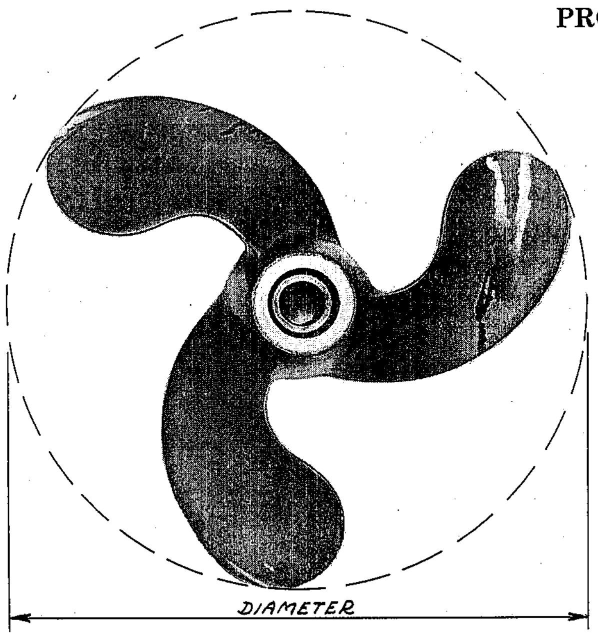
The following is a table of the correct heights of sterns for various Johnson Outboard Motors:

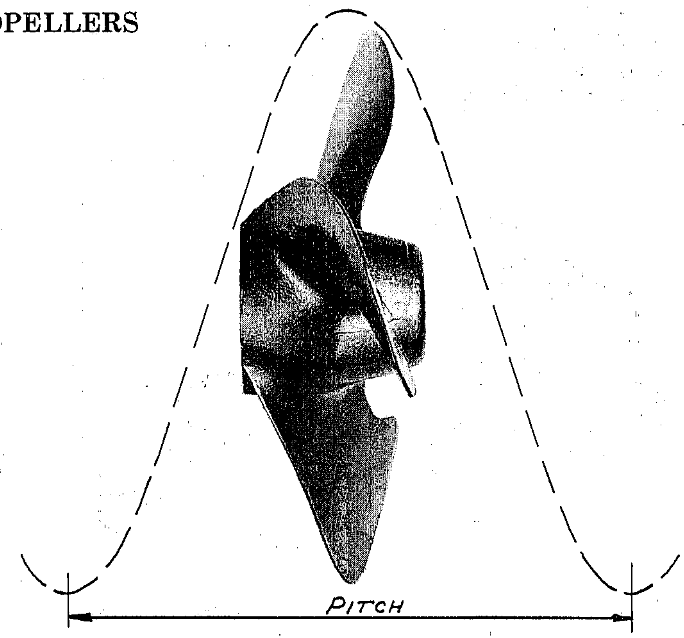
Model	Stern Height
J-75 & 80	15 inches
F-75	15 "
AA-37	14 "
75 & 80	15 "
KA-37, KA-38, KA-39 & 10, KS & KD-15	15 "
P-70, 75, 80, PO-37, 38 & 39, PO-10 & 15	15 "
300	15 "
100, 110	15 "
200, 210	15 "
LS-37 & 38, DS-37 & 38	15 "
LT-37, 38, 39 & 10, DT-37, 38, 39 & 10	15 "
MS-38, 39, 10, 15 & 20, MD-38, 39, 10, 15 & 20	15 "
HS-39, 10, 15 & 20, HA-39, 10 & 15, HD-39, 10, 15, 20 & 25	15 "
TS & TD-15-20	15 "
SD-10-15	15 "

Motors having extra long driveshaft, stern height is 5 inches higher than the standard motor.

NOTES

PROPELLERS





The size of the propeller is usually given in two dimensions — the DIAMETER and the PITCH. They are constructed with two or three blades, depending upon the nature of the service.

DIAMETER is the distance from the extreme tip of one blade to the tip of the other—two-blade type — or the diameter of the circle described by the periphery of the blades—three-blade type.

PITCH is the distance the propeller would advance in one revolution, if operating in a semi-solid substance, no slippage being evident.

FOR EXAMPLE — A 10″ x 12″ propeller will have a ten-inch diameter and a twelve-inch pitch—theoretically, advancing twelve inches per revolution.

But NO propeller is 100% efficient — certain losses prevail under all circumstances. The percentage of loss or slippage frequently runs as low as 10%, on extremely light racing hulls—and upwards of 40 to 60% on the heavier or cruising types.

EFFICIENCY of the propeller depends, to a great extent, upon the shape and weight of the hull. The light weight HYDRO-PLANE type possibly offers the least resistance to forward motion, therefore, high propeller efficiency. The heavier SQUARE STERN types offer the greater resistance, especially if the power applied is insufficient and incapable of planing the boat—resulting in low propeller efficiency.

Keel interference — angle of propeller thrust, with relation to the line of forward motion—depth, at which the propeller operates—marine growth, below the water line—and, of course, the load carried are also factors affecting propeller efficiency.

Johnson propellers are designed especially for Johnson Outboard Motors by Johnson engineers to meet the specific requirements of each model. For maximum propeller efficiency, install standard Johnson replacement propellers.

CAVITATION

Cavitation should not be confused with a sheered propeller pin.

Cavitation is a condition created whereby the propeller is forced to operate in turbulent or greatly disturbed water. Consequently, air is drawn from the surface into the propeller stream, which, naturally, lessens the load on the propeller, resulting in the propeller being turned at a high rate of speed. However, since the propeller is acting largely on air and turbulent water, its effectiveness is reduced considerably in that the propeller is merely churning the water rather than propelling the boat.

In most instances, cavitation is brought about by the propeller operating too near the surface of the water or to interferences created by the stern being too high. (See recommended stern heights.) A wide keel, extended to the stern of the boat, is often responsible for such interference and can be corrected by tapering to a feather edge — commencing approximately two feet forward of the stern.

Collection of grass and weeds on the gearcase also causes cavitation.

Bent or damaged propeller blades frequently result in excessive vibration and loss in propeller efficiency as well as to contribute towards causing cavitation.

CARE OF THE MOTOR

The service obtained from any motor is dependent largely upon the care it is given. The following suggestions will assist in properly maintaining the motor:

Remove screen from carburetor periodically to free screen and sediment basin of any foreign substance which might have accumulated. Remove and clean screen in tank.

Inspect spark plugs occasionally. Clean and, if necessary, adjust gap. (Correct setting of gap, .030″.) Wipe off insulator or porcelain of plug and ignition leads with a dry cloth to remove residue.

Check breaker points as instructed.

Be sure flywheel nut is secure.

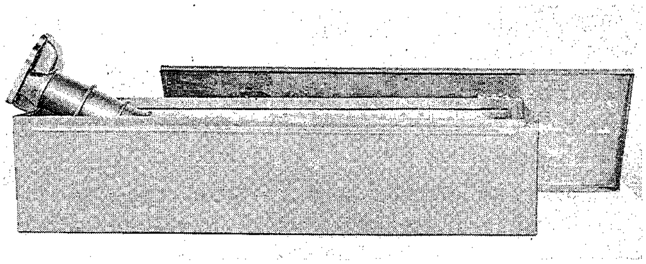
Draw up on all nuts and screws at least once each season.

Remove drain and vent plugs from gearcase at frequent intervals to drain off water. Refill with MOBILGREASE "UW" OR SEAHORSE GEAR LUBRICANT as instructed.

Wipe off motor regularly with a damp cloth. A clean motor is readily accessible for inspection and less apt to foul.

Remove propeller periodically to inspect drive pin. Observe condition of propeller blades. (A spare propeller is a good investment.)

Remove carbon from muffler outlets and exhaust ports each season, also from the exhaust passage in the driveshaft housing on the KS(L) and KD(L) Alternate Firing Twin. (Excessive carbon accumulation results in loss of power and hard starting.)



Driveshaft Casing (Alternate Firing A & K Series) Submerged in a Container of Carbon Solvent to Remove Carbon from Exhaust Passages. Note: For Purpose of Illustration, the Driveshaft Casing is Shown as but Partially Submerged—It Should be Fully Submerged in the Carbon Solvent

Grease thrust socket and reverse lock, oil swivel bracket and Co-Pilot at regular intervals. Note—Model PO(L) is not equipped with the Co-Pilot.

Always store motor in an upright position.

CAUTION—**After removing the motor from the boat it should not be laid down in such a manner that the Lower Unit will be higher elevation than the Power Head as any water remaining in the Exhaust Pipe may run into the Lower Cylinders to cause serious damage. It is further advisable to drain the cooling system prior to transporting motor.**

ADDITIONAL CARE OF THE MOTOR WHEN OPERATED IN SALT WATER

Operation in salt water presents certain conditions, not common to fresh water operation, due to the corrosive effects of salt water on the exposed motor parts.

The suggestions below will assist in reducing the corrosive effects to a minimum:

Remove motor from the boat immediately after salt water operation. If the motor cannot be conveniently removed, tilt gearcase out of water — rinse bright parts off with fresh water. (Never allow the gearcase to remain in the water, when not in use.)

Flush cooling system with fresh water, either by attaching a hose to the water scoop or by operating in a barrel of fresh water for several minutes. This is IMPORTANT.

Rinse motor off with fresh water. Go over all lower unit parts with an oily cloth.

The ignition leads and spark plug insulators or porcelains should be wiped frequently with a dry cloth to remove residue.

HARD STARTING IS CAUSED BY:

Failure to open vent in gas tank filler cap. [SD (L) does not have vent.]

Clogged fuel line, screens (carburetor and tank) and sediment basin.

Water in carburetor.

Needle valve not properly adjusted.

Failure to flush carburetor.

Fouled or defective spark plugs. (Residue collected on insulator, especially if operated in salt water.)

Loose electrical connections.

Corroded breaker points.

Cut-out closed. [KS(L), KD(L) and PO(L)].

Accumulation of carbon (after long periods of operation) in muffler outlets, exhaust passages [driveshaft housing KS(L) and KD(L)] exhaust ports and piston ring grooves.

FAILURE TO START

Vent in gas tank filler cap closed. [SD(L) does not have vent.]

Fuel valve closed.

Tank empty.

Needle valve not properly adjusted.

Water in fuel.

Clogged fuel line, screens and sediment basin.

Improperly mixed fuel.

Fouled or defective spark plugs.

Breaker points corroded and pitted.

Spark plug leads disconnected.

Excessive accumulation of carbon (after long periods of operation) in muffler outlets, exhaust passages, exhaust ports and piston ring grooves, causing rings to stick.

IF MOTOR IS DROPPED OVERBOARD

Recover motor from water immediately, if possible.

Remove fuel tank, fuel line, carburetor, magneto and spark plugs. Drain all water that may remain. Wash with gasoline.

Work as much water as possible out of the cylinders and crankcase by turning motor slowly in upright and inverted positions.

Pour a small amount of oil into each cylinder; turn crankshaft to distribute oil.

Blow off armature plate with air pressure, if available; wipe with dry cloth. Place in warm dry place, be sure it is thoroughly dried and that no water remains about the coil.

Replace all parts previously removed. Clean and fill tank with fresh fuel mixture. (Make certain no water remains in tank.)

Start motor as instructed and allow to run until you are reasonably sure no water remains.

CAUTION—Do not under any circumstances attempt to start the motor until the armature plate has been thoroughly dried. Remaining drops of water are likely to set up a short circuit which may result in extensive repairs.

If the motor cannot be started, it should be disassembled at once to remove all traces of water clinging to the inside walls and motor parts. Each part should be dried and coated liberally with oil to prevent rusting. This is IMPORTANT, the motor should be attended to immediately. Consult your local Johnson Dealer or Service Station.

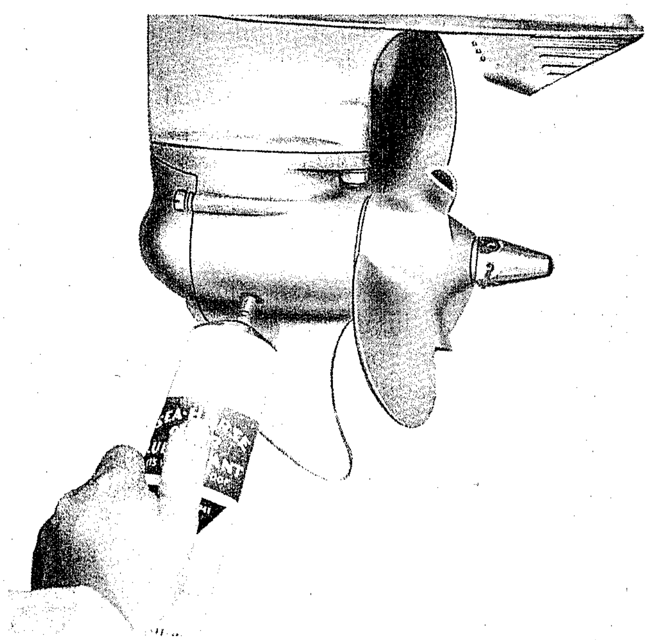
PREPARATIONS FOR STORAGE

No Outboard Motor should be placed in storage, especially winter storage, without considering the necessary precautions.

Most IMPORTANT — Remove all plugs in the gearcase and driveshaft housing, marked "drain" and "grease," to allow accumulative water in the gearcase and water remaining in the cooling system to drain off. Failure to take this precaution will result in bursted cylinder blocks, gearcase and possible injury to water channels and water tubes, due to freezing during the cold winter months. To make certain all water has been drained, rock motor from side to side.

If operated in salt water, flush cooling system with fresh water.

Refill gearcase with MOBILGREASE "UW" OR SEAHORSE GEAR LUBRICANT.



Inserting Gear Lubricant

Remove spark plugs—pour about a tablespoon of clean oil through each spark plug opening. Turn flywheel slowly to distribute oil on cylinder walls. Replace spark plugs.

Drain all fuel from gas tank, gas line and carburetor. Remove and clean carburetor and gas tank screens.

Under no circumstances should the motor be stored in an inverted position. It should be hung on a rack similar to the manner in which it is mounted on the boat.

PREPARATION FOR SPRING OPERATION

Remove spark plugs, attach ignition leads to some part of motor to prevent injury to the coil. Spin motor with rope to blow out excess oil. Clean and replace spark plugs. Install new plugs if necessary.

Tighten all nuts and screws. MAKE SURE FLYWHEEL NUT IS TIGHT.

Fill gas tank with properly mixed fuel.

OILING SPECIFICATIONS

QUANTITY OF OIL PER GALLON OF GASOLINE	MODEL
½ Pint S.A.E. #40	**Single Cylinder**—J-25, 65, 70, 80, 100, 110, LS-37, DS-37, J-75, MS-38, MD-38, MS-39, MD-39, MS-15, MD-15, MS, MD-20. **Light Twins**—A, BN, A-25, 35, 45, OA-55, 60, 65, F-70, 75, 200, 210. **Alternate Firing Light Twins**—A-50, 65, 70, 75, 80, AA-37, LT-37, DT-37, LT-38, DT-38, LT-39, AT-39, DT-39, LT-10, AT-10, DT-10, HS, HA, HD-39 & 10, TS-15, TD-15, HS-20, HD-20, Model 300. **Standard Twin**—K-35.
¾ Pint S.A.E. #40	**Standard Twins**—K-40, 45, OK-55, 60, 75. **Alternate Firing Twins**—K-50, 65 & 70. **Big Twins**—P-30 & 35.
1 Pint S.A.E. #40	**Alternate Firing Twins**—K-75, 80, KA-37, KA-38, KA-39, KA-10, KS-15, KD-15, SD-10. **Big Twins**—P-40 & 45. **Sea Horse**—S-45, 50, 65, 70, SE & SA-50, P-50, 65, 70, 75, 80, PE & PA-50, & PO-37, 38, 39, 10 & 15, V-45, 50, 65, 70, VE & VA-50. **Giant Twin**—TR-40.
1½ Pints S.A.E. #50	**All KR Racing Models**
2 Pints S.A.E. #50	**All SR, PR, VR & XR Racing Models**

ABOUT GAS AND OIL AND SPARK PLUGS

(Reprint from Johnson Jottings, February 5, 1948)

OIL

You remember the hullabaloo about Detergent Oil some time ago? It was even stated that detergents would "ruin" outboard motors. We made tests that indicated clearly that detergent oils—at least those tested—would not harm a motor; but might to some extent shorten spark plug life.

We have consequently recommended oils, such as Mobiloil, that are used for automobiles, are obtainable at regular auto filling stations, and do contain a detergent additive. There are some brands of detergent oil available, although not always generally available, which **will** shorten spark plug life. And we believe that some cases of plug trouble in our motors can be traced to use of such oils.

How can detergent oils be identified? Many of the oil companies have a "premium oil," a top grade which sells at a higher price, the best they know how to make for automobile use. These are usually detergent oils. The next lower grade or price oils—known sometimes as "regular"—usually do not contain detergents. Some oil companies may have a third grade.

No harm will result from the use of the "regular" or low priced oils and in doing so the owner may avoid spark plug trouble which might result from the "premium" grades. Remember, the oil in an outboard motor is **used only once**—an automobile uses the same oil over and over.

There are several "outboard" oils available. We haven't tested many of them but in general they are non-detergent and should be perfectly O.K. in Johnson motors (Mobil Outboard Special we have tested and it is O.K.). But we believe that these outboard specials will be little different, so far as spark plug trouble is concerned, from the "regular" oils.

GASOLINE

The most harmful ingredient of present day gasolines, from the standpoint of spark plug trouble, is lead which is added to increase the "octane rating."

There is some misconception about this "octane rating." It is ONLY a knock rating—nothing more or less. It has nothing whatever to do with volatility (ease of evaporation) nor easy starting. It means only that a gasoline with a high octane rating doesn't "ping" in an automobile (or truck, tractor, or airplane) engine. Lead is added only for this purpose. The more lead, the higher the anti-knock rating. Anti-knock characteristics are relatively unimportant in outboard motor fuel.

How much lead is added to a gasoline is determined by two things: The knock characteristics of the gas stock—and what octane rating it is to be adjusted to.

A "regular" or even a "low grade" gasoline at the filling station pump may contain as much as 2 or even 3 cubic centimeters of tetra-ethyl-lead per gallon although usually it is only "Ethyl" grades that contain more than 1 cc.

More than about 1 cc. of lead per gallon will shorten spark plug life in an outboard motor.

How can you tell? There isn't any way; the gas salesman himself usually doesn't know. And the amount today in this batch of gas may not be the same as that received tomorrow or next week.

IF A JOHNSON USER is having more than ordinary spark plug trouble, have him (1) use "white gasoline" if it is readily obtainable, or (2) switch to some other brand of "regular" gasoline than he is now using. He may have to switch two or three times to find the best.

GASOLINE GUM can cause spark plug trouble too—and clogging of gas line, screen, carburetor passages. This is frequently found in "old" gasoline. The user should not leave gasoline in his outboard motor tank—he should drain after using, refill from fresh supply when he goes out again.

Some old stored gasoline was dumped on the market after the war as surplus. Some of that gave gum trouble. Some brands of gasoline contain more gum, so here again, if trouble is experienced, switch brands.

CLEANLINESS. To avoid gas and oil trouble, containers — both gas and oil — should be kept CLEAN. Dirty gas or oil is no good!

GENERAL COMMENT: We can't test all the hundreds of brands of oil on the market. Even if we could, any one of them might be changed the next day. The same applies to gasoline.

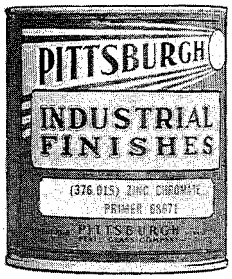
Use lower grades (not "premium") oil.

Use lower grades (not "Ethyl") gasoline.

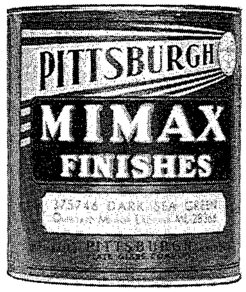
In case of spark plug trouble, switch to other brands of oil and gas.

NOTES

REFINISHING OF JOHNSON MOTORS

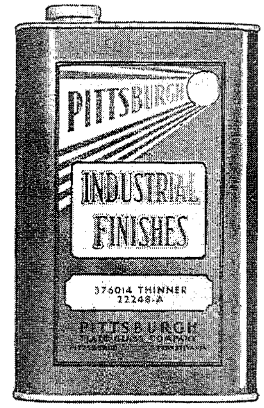


Zinc Chromate Primer
Part No. 376015



Dark Green
Part No. 375746

Thinner (for dark green)
Part No. 375563



Zinc Chromate Thinner
Part No. 376014

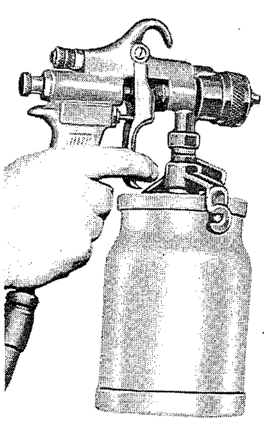
No major repair job has really been completed if the motor is turned over to its owner without first refinishing it. The motor owner expects and has a right to expect the best possible repair job; to accept an unpainted motor after paying good, cold cash for repairs, is quite depressing regardless of quality of repairs. Make an impression on the owner by handing him a nicely refinished motor. Do it the Johnson way — refinish all major repairs — it will add to your prestige and repay you many, many times over.

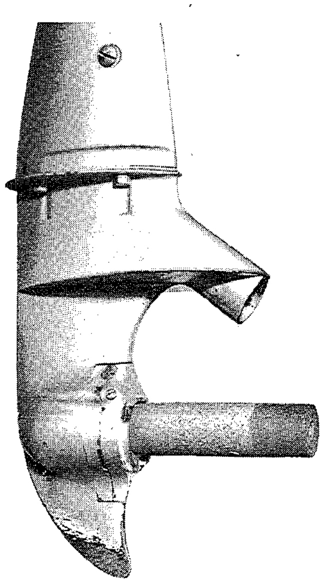
Do you have paint spraying equipment? If not, see your local hardware or auto supply house — it's not too expensive. (DeVilbis, Binks, etc.)

1. **Cleaning** — most important, all parts to be refinished must be scrupulously clean. That means no traces of dirt, oil or grease to result in peeling of the finish just when the fellow hangs his motor on the boat. Nothing "sticks" to grease and grime but more grease and grime.

Wash surfaces of motor to be refinished with commercial solvents available for the purpose. Wherever wiping is done, extreme care should be taken to see that only clean rags are used, otherwise the grease and dirt are not removed but merely rubbed onto the areas which would otherwise be clean.

After cleaning, be careful not to handle surfaces to be refinished with the bare hands — body acids are corrosive and detrimental to ultimate quality of the finish. Use clean cotton gloves for best results.





2. Install new transfer on tank if necessary or use old transfer if in good condition. In either case, mask transfer prior to spraying. This is accomplished by carefully lightly coating transfer only with grease, making certain that only the transfer is covered. This will prevent sprayed finish from adhering to the transfer.

3. Lightly spray bare metal parts (if any) with Zinc Chromate Primer No. 376015. Primer will air dry in fifteen minutes to one hour, depending on drying conditions — atmosphere, etc.

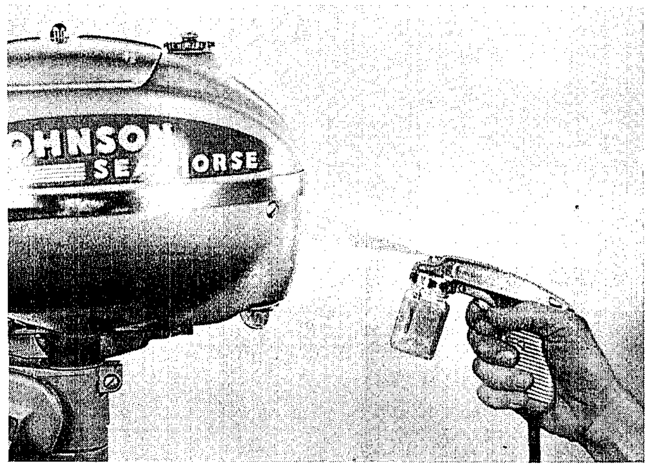
4. Follow priming (if required) by final spray coat — Dark Green, Part No. 375746. A full wet coat should be provided — experience in this respect will guide you. Several hours or overnight drying should be permitted for film to harden — considerably longer is required for complete setting of film.

5. Wash protective grease coating from surface of transfer.

There are several satisfactory cleaning devices on the market. To name a few:

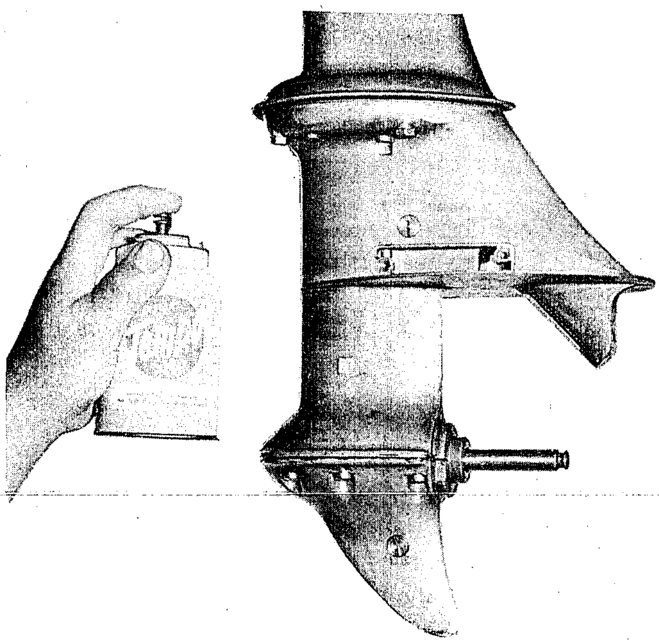
1. Kleer-Flow—Practical Products Co., 2632 Nicollet Ave., Minneapolis, Minn.
2. Park Chemical Co., 8074 Military Ave., Detroit 4, Mich.
3. K-Jax (Quick-Kleen), Box 3044, Dallas 1, Texas.
4. Clayton Manufacturing Co., Alhambra, California—Kerrick Kleaner.
5. Railway Supply Co., 418 S. Market Street, Chicago 7, Illinois.

Write to any of the above for their literature and prices.



The Smaller Inexpensive Type of Spray Gun as Shown Here is Well Suited for Minor "Touch-up"

NOTE—Zinc Chromate Primer, Green, Red, Chrome-Sheen-Bright Aluminum and Dull Aluminum are available in pressurized cans on order from the Johnson Parts Distributor.



To avoid possible clogging of the small spray nozzle or jet on top of the can, simply turn the can upside down as shown here, after each use — hold for a second or two — then, just a touch on the spray button will permit just enough of the liquid vehicle escaping to flush the jet — making it ready for subsequent spraying.

INSTRUCTIONS FOR INSTALLING TRANSFERS

1. Remove old transfers. This can be easily accomplished by liberally brushing thinner over the surface of transfer, letting it soak for awhile, after which apply another coat. When transfer has been softened, wipe or carefully scrape off.

If any of the commercial solvents are used in the shop, merely soak entire tank in the solvent, but only long enough to remove the transfer and original finish.

2. Be sure surface to be transferred is perfectly clean—no trace of grease, oil, etc.

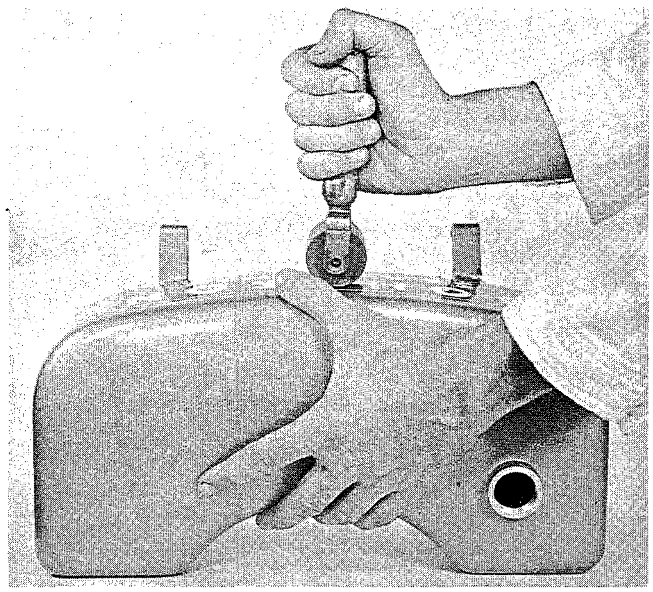
3. Coat back side of transfer evenly with transfer cement (#76-141)—not too thick a film, spread evenly and thinly. Let experience be your guide in this respect.

If transfer cement becomes too thick, thin out with thinner (#375-563) to satisfactory brushing consistency.

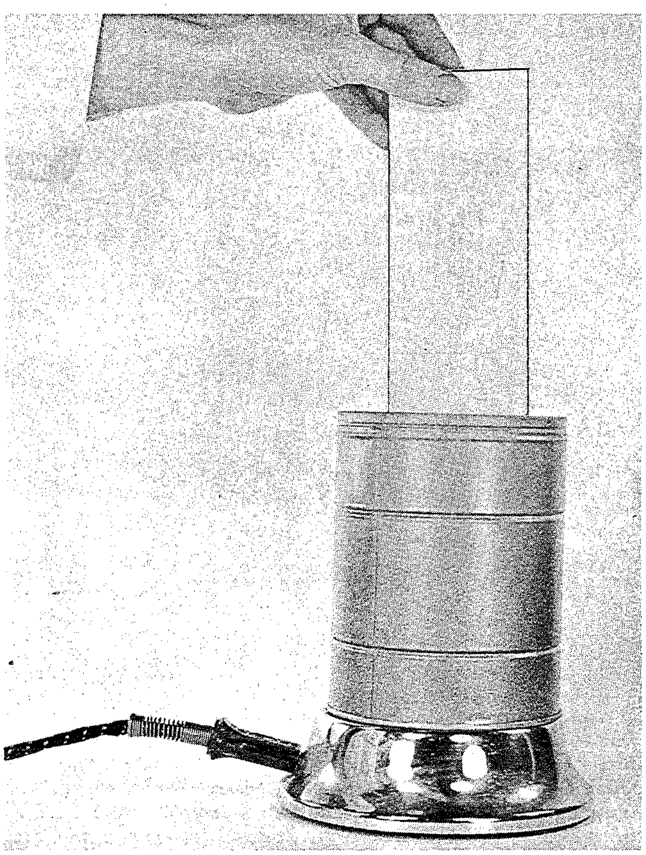
4. Allow cement on transfer to dry. Note—If transfer is one of the thicker kind, permit cement to dry until almost dry but still slightly "tacky." On the thinner type of transfer, permit cement to dry.

5. Submerge transfer in pan of warm water (approximately 120 degrees F) for a second or two, then immediately place in position on the tank. Carefully slide paper off transfer.

Roll transfer out with rubber roller. (Avoid wrinkles by careful handling of transfer.)



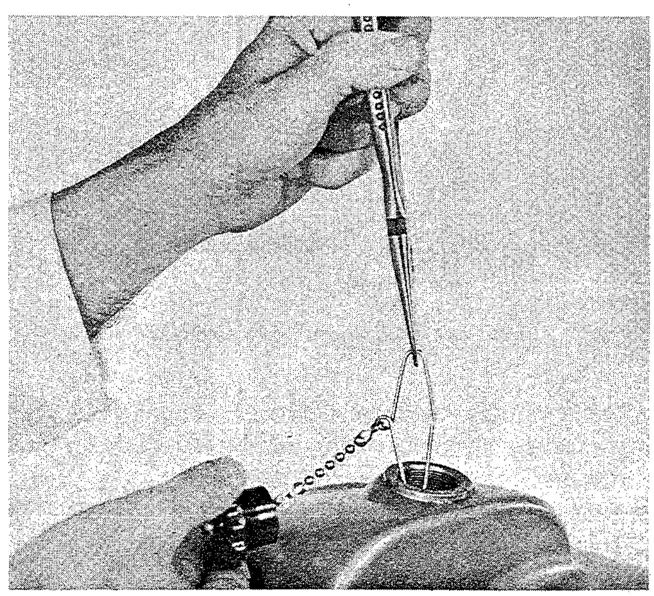
Method of Rolling Transfer Out on the Tank



Submerging Transfer (Decalcomania) in Warm Water—Water Heated on Small Electric Plate or Otherwise

6. Allow transfer to completely dry, then apply thin coat of clear varnish.

A little experience is all that is necessary to tell you how thick the film of cement should be, how long to submerge transfer in warm water, how to slide paper off transfer and how to evenly roll out the transfer.

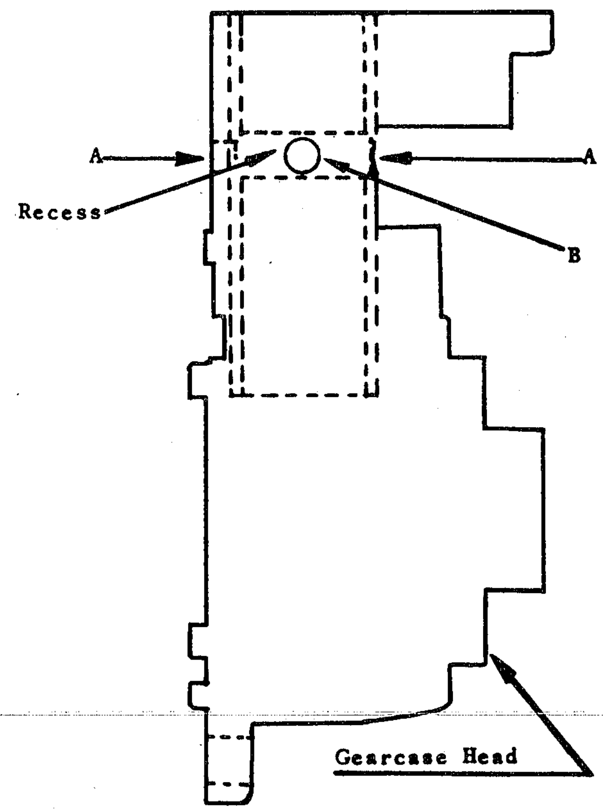


Illustrating Correct Procedure for Removing or Installing Filler Cap Chain, Exercising Extreme Care not to Inflict Injury to Threads in the Filler Spout

GEARCASE HEADS—M, H & LT SERIES—1939, '40

During early production of Models M, H & LT (1939-40) some difficulty was experienced with water pump failure which was later found to be the result of excessive pressure building up in the gearcase during operation of the motor. Resulting pressure interferred with normal functioning of the pump plunger to retard flow of water through the cooling system.

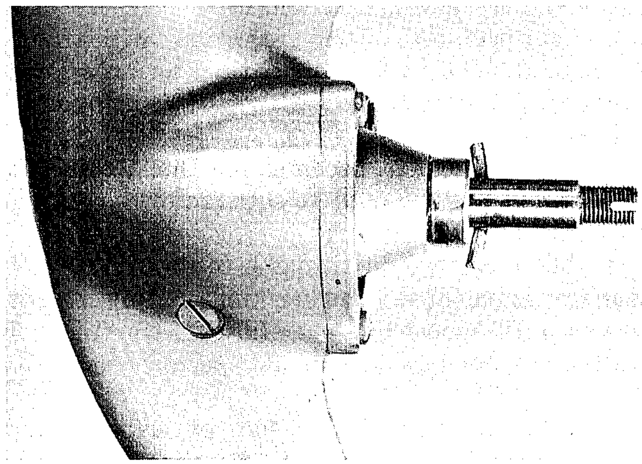
Pump failure was further aggravated by gear lubricant being forced past the plunger to ultimately accumulate about the ball checks and subsequently render them partially inactive. In extreme instances of high gearcase pressure, lubricant was forced past the driveshaft grease seal to eventually fill up the driveshaft casing.



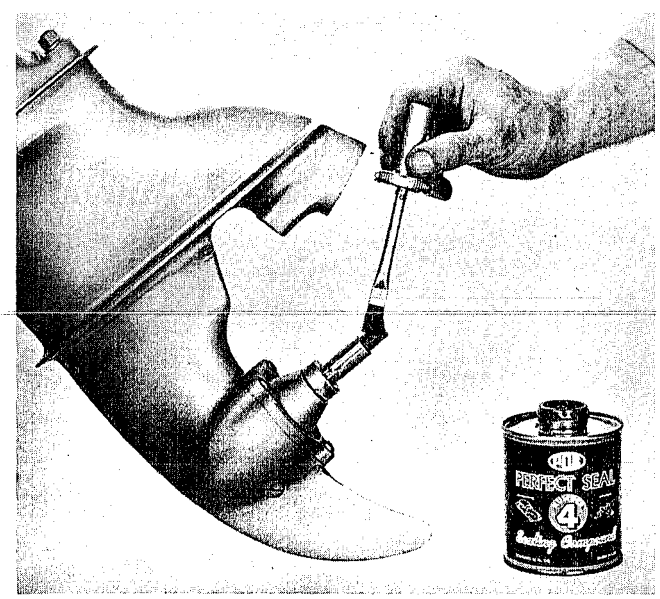
Removing Seal from Gearcase Head

This condition whenever necessary can be easily overcome by simply drilling additional holes in the pump housing to relieve the pressure.

1. Remove gearcase head from gearcase.
2. Remove pump plunger and spring.
3. Remove inlet screen and seat.
4. Note hole drilled in pump housing immediately below pump inlet screen—(LT series are drilled 3/16" and M and H series are drilled 5/32").
5. Run a drill straight through the housing as indicated by "A" on the above sketch.
6. On the same plane, but at 90° from the first hole, drill a second hole "B" through the housing
7. Clean out chips and reassemble.

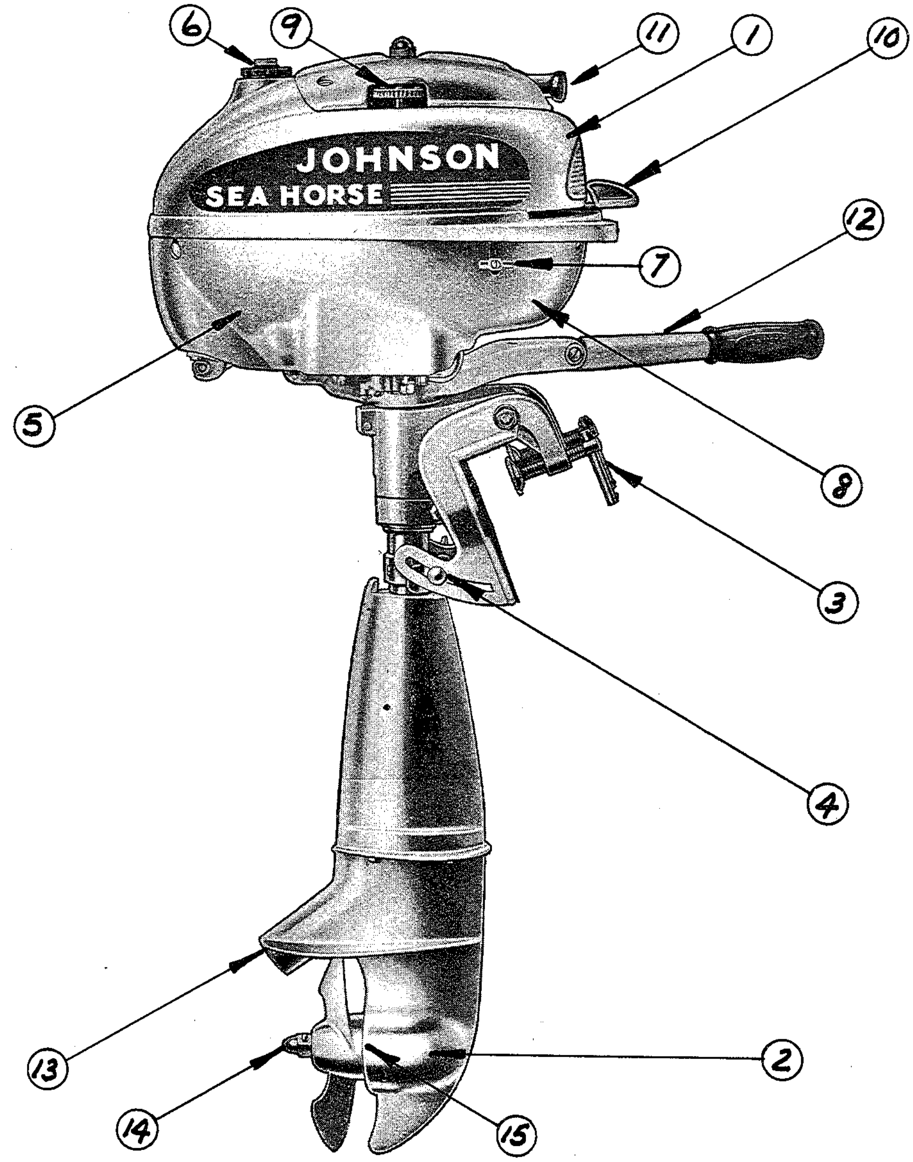


Illustrating Effect of Drawing Up Too Tightly on the Propeller Nut—Pin Partially Sheered in this Instance During Installation Procedure



Perfect Seal (#301719) When Thinly Coated on the Propeller Shaft and Propeller Nut Threads, Minimizes Effort Required to Remove the Propeller Especially in Salt Water Areas. Applied to All Threads (Nuts and Studs Exposed to Salt Air and Salt Water Spray) During Repairs as a Protection Against Corrosion, Aids Considerably in Performing Subsequent Service Operations

CHECK CHART



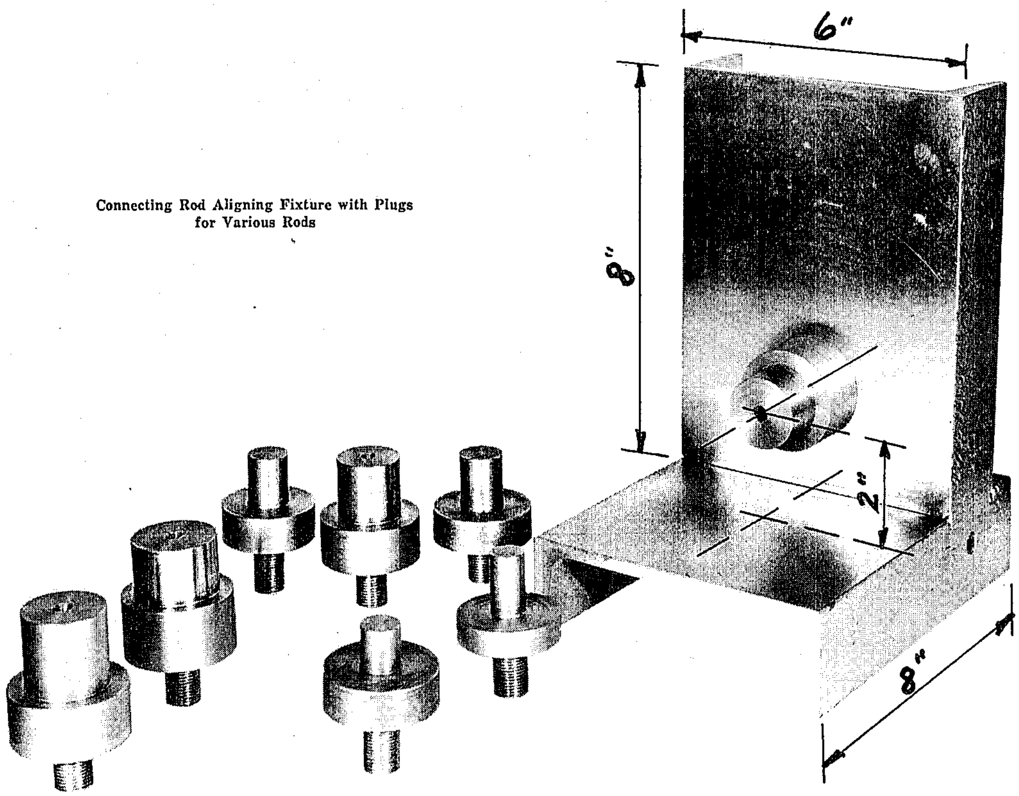
Dealer's instructions to the new Motor Owner should include the following, prior to making delivery:

1. Proper mixing of oil and gasoline.
2. Correct lubrication of the gearcase.
3. Proper use of stern bracket clamp screw.
4. Adjustment of thrust socket.
5. Install or change spark plugs.
6. Use of vent in filler cap.
7. Fuel shut-off valve.
8. Correct adjustment of slow speed needle.
9. Proper adjustment of high speed needle.
10. Function of the magneto lever (speed control).
11. Correct use of Ready Pull.
12. Steering and reverse. (Do not bear down on steering to tilt motor out of water.)
13. Underwater exhaust.
14. Change propeller, propeller pin or shock absorber rings.
15. Operation of water pump.

Dealer should check to see that—

A. There is lubricant in the gearcase.
B. Both high and low speed needles are properly adjusted.
C. Spark is O.K. (Spark Plugs O.K.)
D. The motor runs properly at both high and low speeds.
E. There are no fuel leaks.
F. There are no water leaks in water tubing or fittings.
G. The motor in general is in perfect condition.

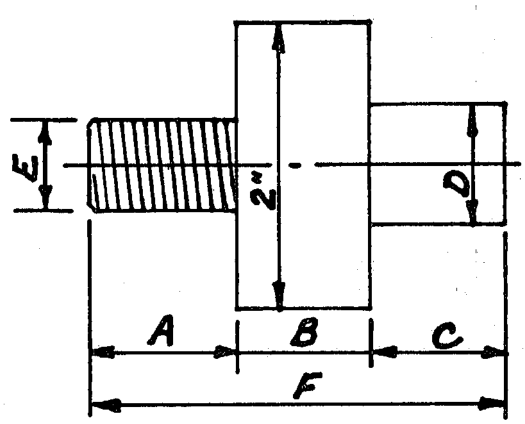
SUGGESTIONS FOR BUILDING A CONNECTING ROD ALIGNING FIXTURE



Connecting Rod Aligning Fixture with Plugs for Various Rods

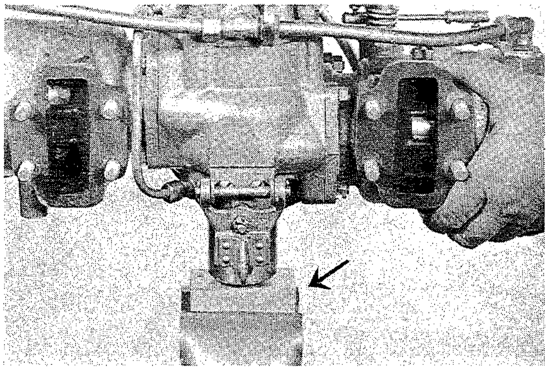
Above shown connecting rod aligning fixture is easily constructed of two pieces of channel iron 6" wide by 8" long—properly machined and welded together and several plugs to mount the various connecting rod assemblies. To build, proceed as follows:

1. Chuck piece of channel iron to be used for the upright in a lathe—take a cut across its face to make it smooth. (This operation can also be performed on a shaper or surface grinder, whichever is available.)
2. Be sure the surface is flat and smooth. Lap down on lapping block to smoothen, if necessary.
3. Drill a 41/64" hole in the piece to be used for the upright, 2" from one end and of course in center with respect to width. (This is where the plug for the various rods is attached). Hold plug in position with washer and 5/8" nut.
4. Square off ends of upright piece. Set on base piece and weld in position. Weld only at the ends as indicated in illustration to prevent buckling or warping.
5. Machine connecting rod plugs as per dimensions below.

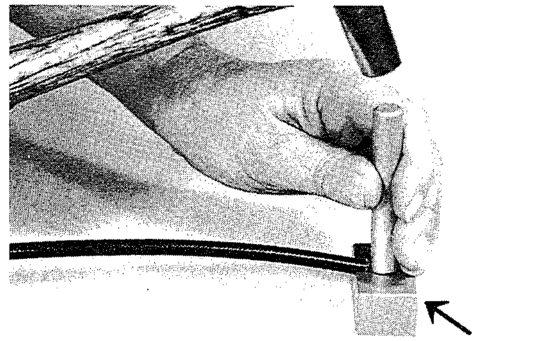


Model	A"	B"	C"	D"	E"	F"
M-H	1	7/16	1	.6267	5/8x18	2-1/2
T	1	21/32	27/32	.8115	5/8x18	2-1/2
A	1	11/16	13/16	.686	5/8x18	2-1/2
K	1	21/32	27/32	.8745	5/8x18	2-1/2
SD	1	27/32	1-5/32	1.2475	5/8x18	3
S45	1	7/8	1-1/8	1.375	5/8x18	3
P50	1	1-1/16	15/16	1.375	5/8x18	3
PO	1	1-1/16	15/16	1.500	5/8x18	3

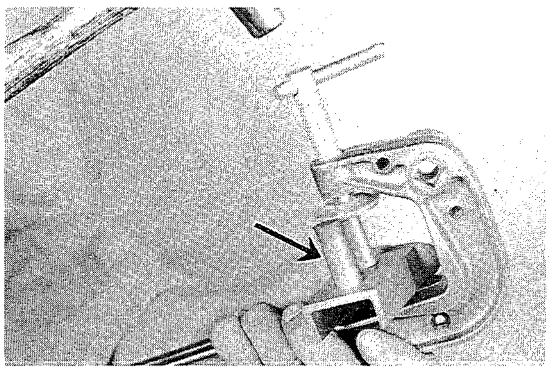
SPECIAL TOOLS



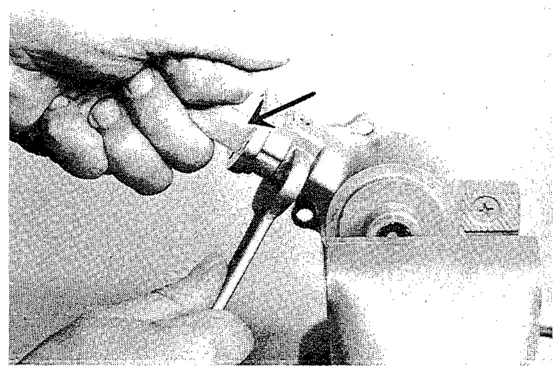
1—Blocks for holding Power Heads in vises (set of three) #301952



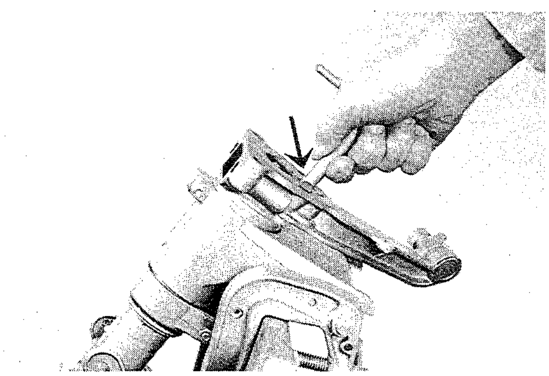
2—Tool for crimping Ignition Terminal #301579



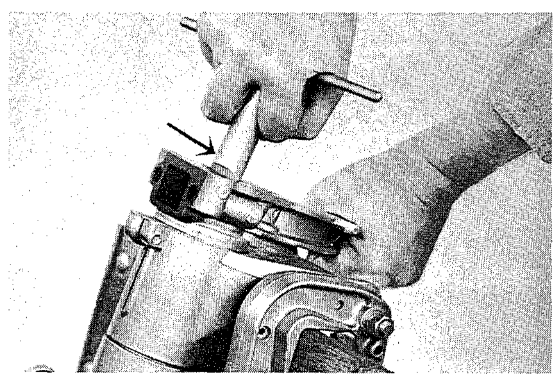
3—Tool for installing Swivel Plate #301584



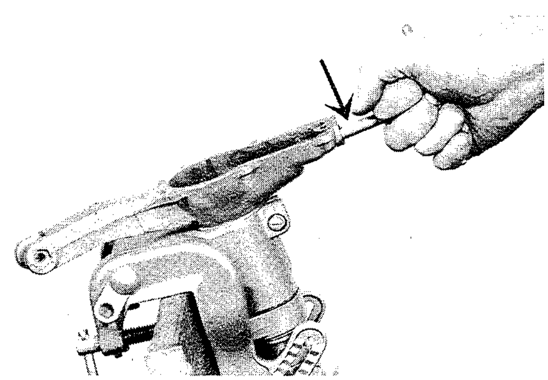
4—Tool for installing Water Intake Seat, LT, AT and DT (Water Pump) #301583



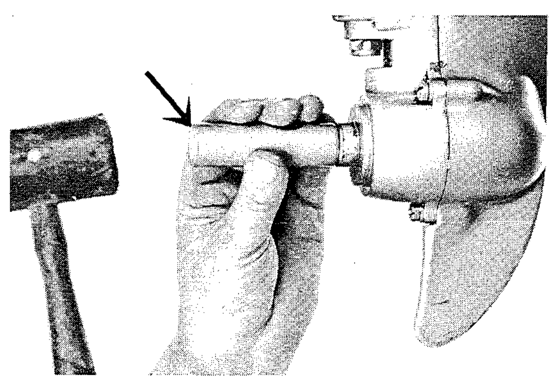
5—Tool for installing Water Tubes, LS, LT and TS-TD #301580



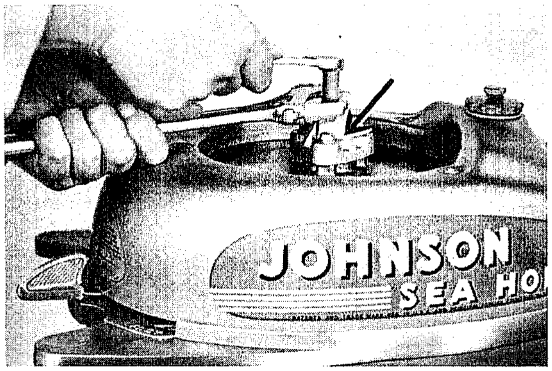
6—Tool for installing Inner Casting, LS, LT and TS-TD #301582



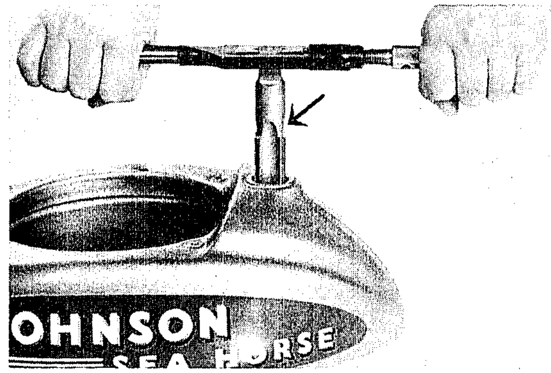
7—Tool for installing Water Pipes, M and H #301586



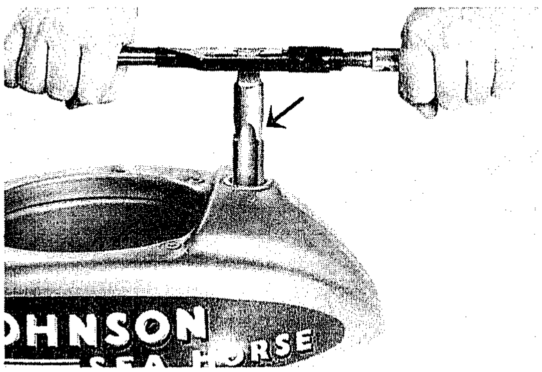
8—Tool for installing Seal (Propeller Shaft), M, HS and LT #301585



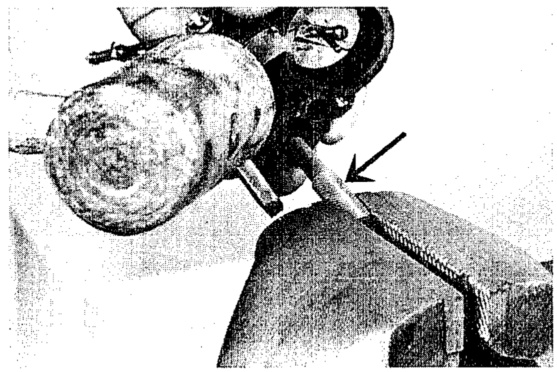
9—Flywheel Puller #375432



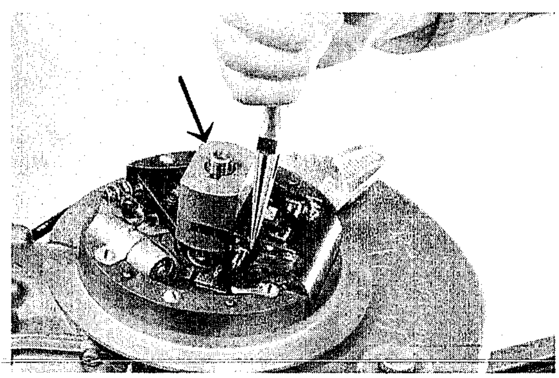
10—1"–20 Tap for Gas Tank Filler Neck #301784



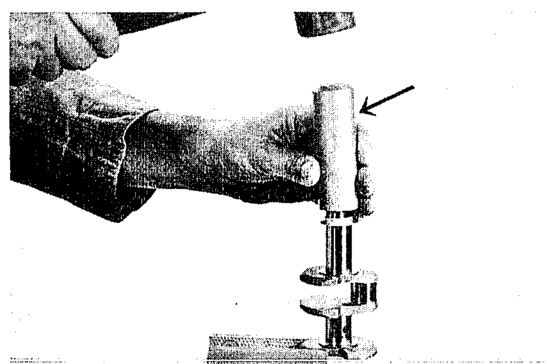
11—1 1/8"–20 Tap for Gas Tank Filler Neck #301783



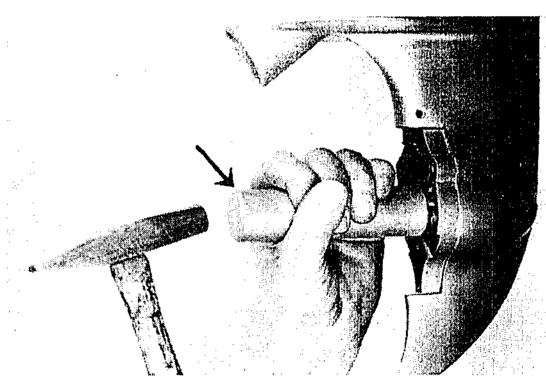
12—Tool for removing leathers on Carburetors, HD and TD-Primer #301785



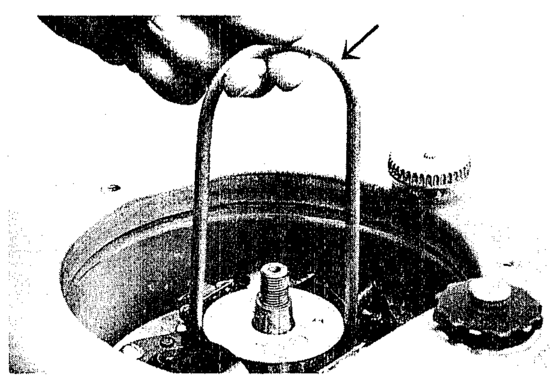
13—Tool for adjusting Brushes (Magneto), LT, AT and DT #301578



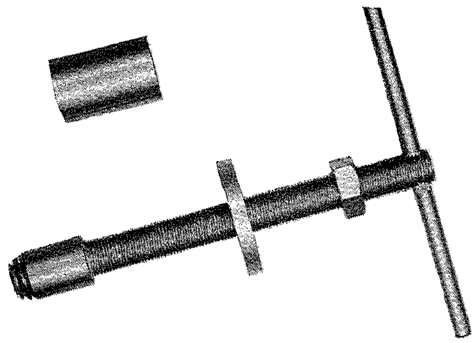
14—Tool for driving on Oil Slinger, LT and TS-TD #301581



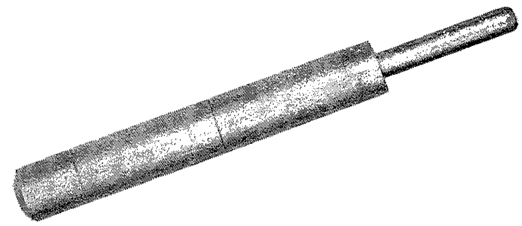
15—Tool for installing Seal (Propeller Shaft) TS and TD-15-20 #301683



16—Tool for removing Magnet Rotors # 301969

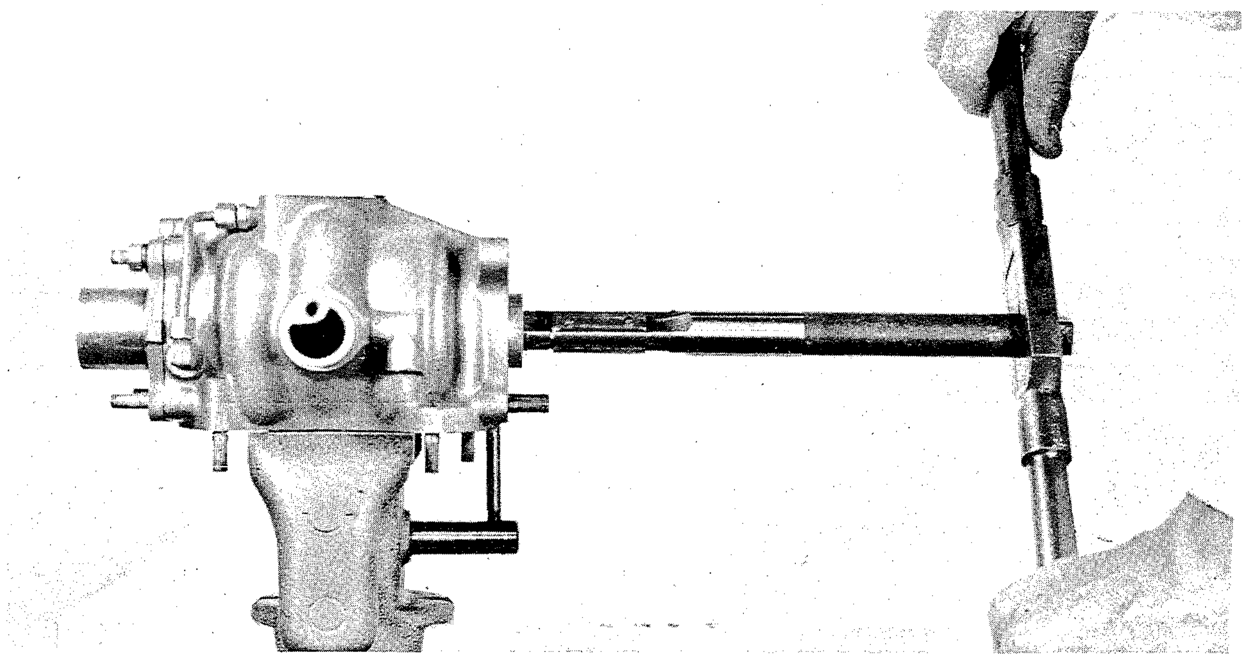


Grease Seal Extractor No. 301867



Grease Seal Driver No. 301868

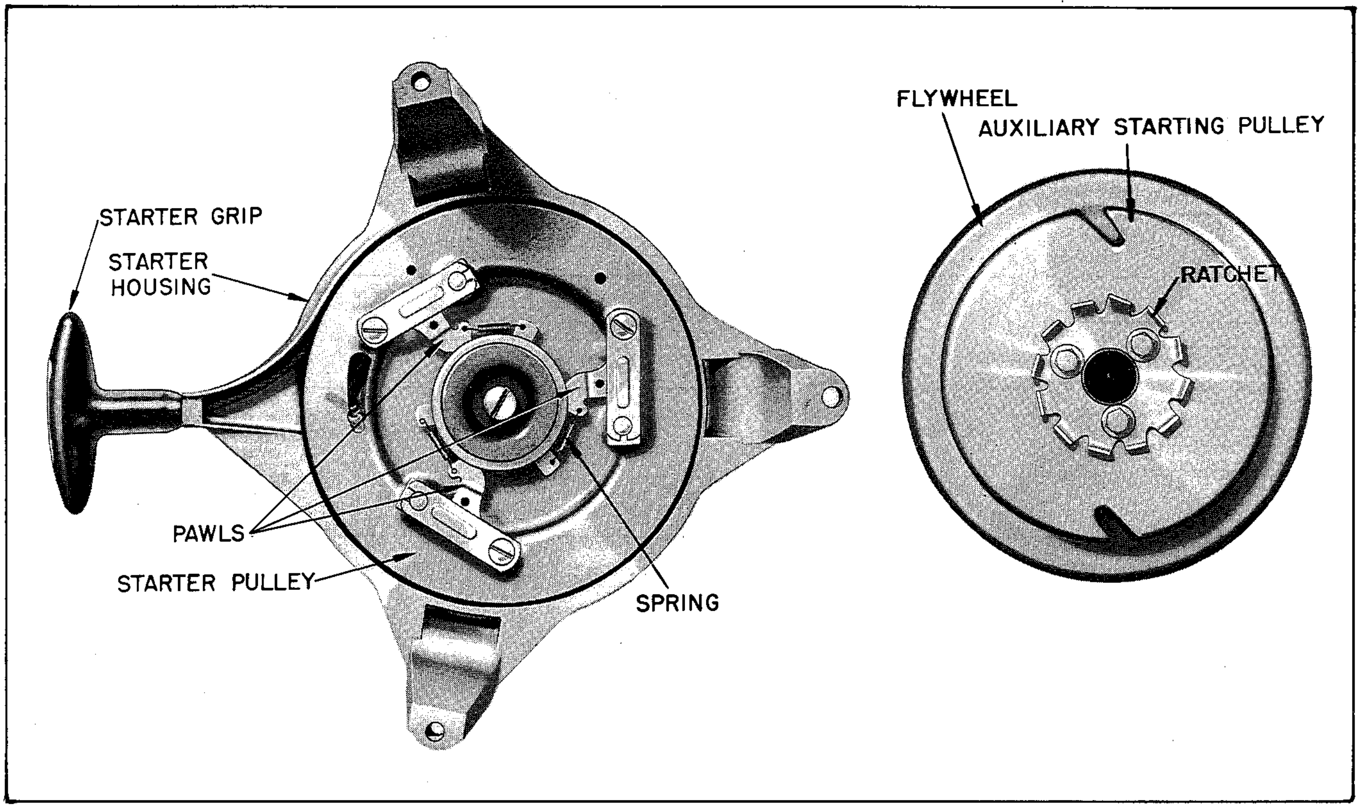
SPECIAL JOHNSON REAMERS



Part Number	Description
301742	Reamer—Crankcase: A-25 to and incl. A-45; OA-55 to and incl. OA-65; J-25 to and incl. J-80, 100, 110.
301743	Reamer—Propeller Shaft: A-25, J-25 to and incl. J-80, F-70-75, 300.
301744	Reamer—Pinion Shaft: A-25, J-25 to and incl. J-80, F-70-75, 300.
301745	Reamer — Pinion Shaft: Top Bearing: A-35-45, A-50 to and incl. AA-37, OA-55 to and incl. OA-65.
301746	Reamer—Pinion Shaft: Lower Bearing: A-35-45, A-50 to and incl. AA-37, OA-55 to and incl. OA-65.
301747	Reamer—Propeller Shaft: A-35-45, A-50 to and incl. AA-37.
301748	Line Reamer (Finish) Crankcase: P-50 to and incl. PO-15.
301749	Line Reamer (Rough) Crankcase: P-50 to and incl. PO-15.
301750	Line Reamer—Propeller—Lower: P-50 to and incl. PO-15.
301751	Reamer—Pinion Shaft: P-50 to and incl. PO-15.
301752	Line Reamer (Rough) Crankcase: K-50 to and incl. KA-10, KS and KD.
301753	Line Reamer (Finish) Crankcase: K-50 to and incl. KA-10, KS and KD.
301754	Line Reamer (Rough) Crankcase: A-50 to and incl. AA-37.
301755	Line Reamer (Finish) Crankcase: A-50 to and incl. AA-37.
301756	Line Reamer (Rough) Crankcase: 200-210, F-70-75, 300.
301757	Line Reamer (Finish) Crankcase: 200-210, F-70-75, 300.
301758	Reamer—Pinion Shaft—Upper Bearing: KA-37 to and incl. KA-10, KS and KD.
301759	Reamer—Pinion Shaft—Lower Bearing: KA-37 to and incl. KA-10, KS and KD.

NOTES

READY PULL STARTER — MODELS QD-10, SD-20



Ready Pull Starter—Models QD-10, SD-20

To Install New Starting Cord:

1. Remove "Ready Pull" from motor.

2. Place in vise as illustrated (assembly can be held fast by placing nut on top of "Ready Pull" between jaws of vise).

3. Remove fragments of broken or damaged cord.

4. Obtain new cord — use only special cord provided by manufacturer.

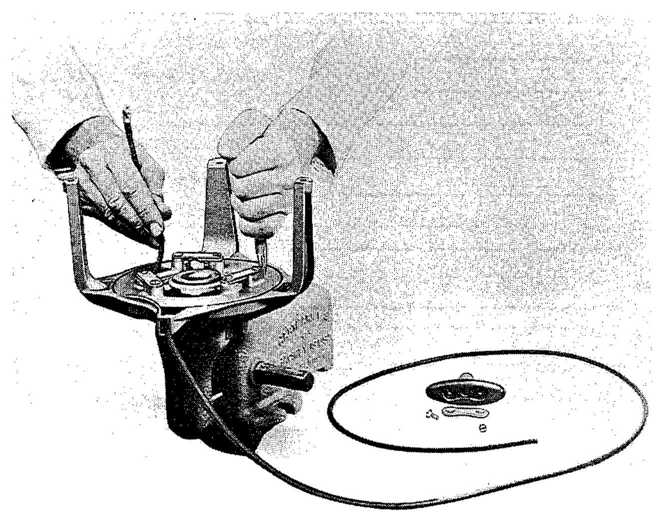
5. Insert punch in hole of pulley provided for this purpose. Turn pulley against tension of spring, as indicated by arrow until all of tension is taken up, then permit pulley to unwind one (1) turn.

6. Insert new cord as illustrated. (End opposite anchor on cord through slot in pulley).

7. Attach grip to cord.

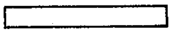
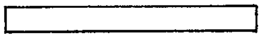
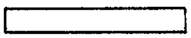
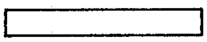
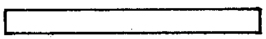
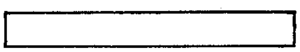
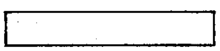
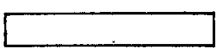
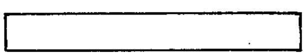
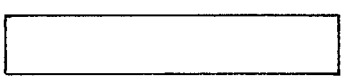
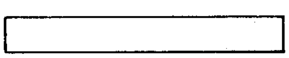
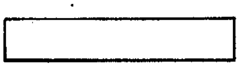
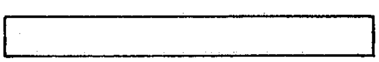
8. Gradually release tension on pulley until all of cord is taken up.

9. Attach "Ready Pull" to motor.



DRIVE PIN CHART

(NOTE—If in doubt, simply place the pin in question on the profile. Profile is actual size. If it fits, it's the pin you want.)

DRIVE PIN		MODELS USED IN
	No. 43-72, MONEL	MS-38, MD-38, MS-39, MD-39, HS-39, HD-39, HA-39. MS-15, MD-15, HS-15, HD-15, HA-15, MS-20, MD-20, HS-20, HD-20, HD-25.
	No. 13-40, BRASS	J-25, J-65, A, BN, A-25, AB-25, A-35, A-45, A-50, A-65, A-70, AA-37, LS-37, DS-37, LT-37, DT-37, LS-38, DS-38, LT-38, DT-38.
	No. 31-54, BRASS No. 41-300,592, MONEL	OA-55, OA-60, J-70, J-75, J-80, F-70, F-75, 100, 200, 110, 210, 300. TS-15, TD-15, TD-20.
	No. 31-148, BRASS	OA-65.
	No. 25-286, MONEL	A-75, A-80, LT-39, DT-39, AT-39, LT-10, DT-10, AT-10.
	No. 15-102, BRASS	K-35, K-40, KR-40, K-45, K-50, K-65, K-70, K-75, K-80, KA-37, KA-38, KA-39, KA-10.
	No. 33-54, BRASS	OK-55, OK-60, OK-75.
	No. 27-156, STEEL	KR-55, KR-65, KR-70, KR-80, KR-39, KR.
	No. 7-72, BRASS	P-30, P-35, P-40, P-45, S-45, SE-50, S-65, S-70.
	No. 19-102, BRASS	TR-40, P-50, PE-50, P-65, P-70, P-75, P-80, PO-37, V-45, VE-50, VA-50, V-65, V-70, PO-38, PO-39, PO-10, PO-15.
	No. 7-92, STEEL	PR-40, SR-45, SR-50, SR-55, PR-50, PR-55, VR-45, VR-50, VR-55, XR-55.
	No. 29-110, STEEL	SR-60, SR-65, SR-70, SR-80, PR-60, PR-65, SR-38, SR-39, SR.
	No. 45-300,079, BRASS	SD-10, SD-15, SD-20.
	No. 301923, MONEL	QD-10.

INSTRUCTION NO.1
TO REPLACE CONTROL WIRES

1. CUT WIRE TO APPROXIMATE LENGTH AS FOLLOWS:
   - 7' CABLES - 7'6"
   - 9' CABLES - 9'6"
   - 12' CABLES - 12'6"
   - 15' CABLES - 15'6"
   - 17' CABLES - 17'6"
2. ROUND ENDS OF WIRE WITH FILE TO PREVENT CUTTING OF CABLE SEAL.
3. COAT WIRE LIBERALLY WITH LUBRIPLATE GREASE AND INSTALL IN CABLE
4. SET CONTROL WIRE FLUSH WITH END OF RACK TIGHTEN SET SCREWS AS SHOWN (C)(I)
5. PLACE SHIFT LEVER ON REMOTE CONTROL UNIT IN NEUTRAL POSITION (D), WITH RACK CENTERED IN SLIDE, CUT WIRE TO LENGTH SHOWN IN FIG. A
6. PLACE THROTTLE LEVER IN (FULL) FAST POSITION WITH RACK ENGAGED AS SHOWN.(J) CUT WIRE TO LENGTH SHOWN IN FIG. B
7. ADJUST SHIFT AND THROTTLE CONTROLS PER INSTRUCTIONS NO. 2 AND NO. 3

INSTRUCTION NO.2
TO ADJUST SHIFT CONTROL

1. SET CONTROL WIRE FLUSH WITH END OF RACK.(C) TIGHTEN SET SCREWS AS SHOWN.
2. PLACE SHIFT LEVER ON REMOTE CONTROL UNIT IN NEUTRAL POSITION (D), WITH RACK CENTERED IN SLIDE.
3. SET SHIFT LEVER ON MOTOR IN NEUTRAL POSITION.(E)
4. ENGAGE SHIFT CONTROL CABLE IN LOCK MOUNTED ON STARBOARD SHROUD.(F)
5. INSERT LOCK PIN IN SHIFT LEVER WITH CONTROL WIRE, LOOSE IN CASING GUIDE.(G)
6. TIGHTEN ONE CLAMP SCREW UNTIL IT TOUCHES CONTROL WIRE, THEN GIVE ONE MORE COMPLETE TURN. TIGHTEN CLAMP SCREW ON OPPOSITE SIDE TO INSURE FIRM GRIP ON CONTROL WIRE. (H)

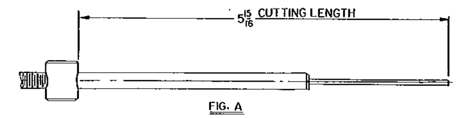
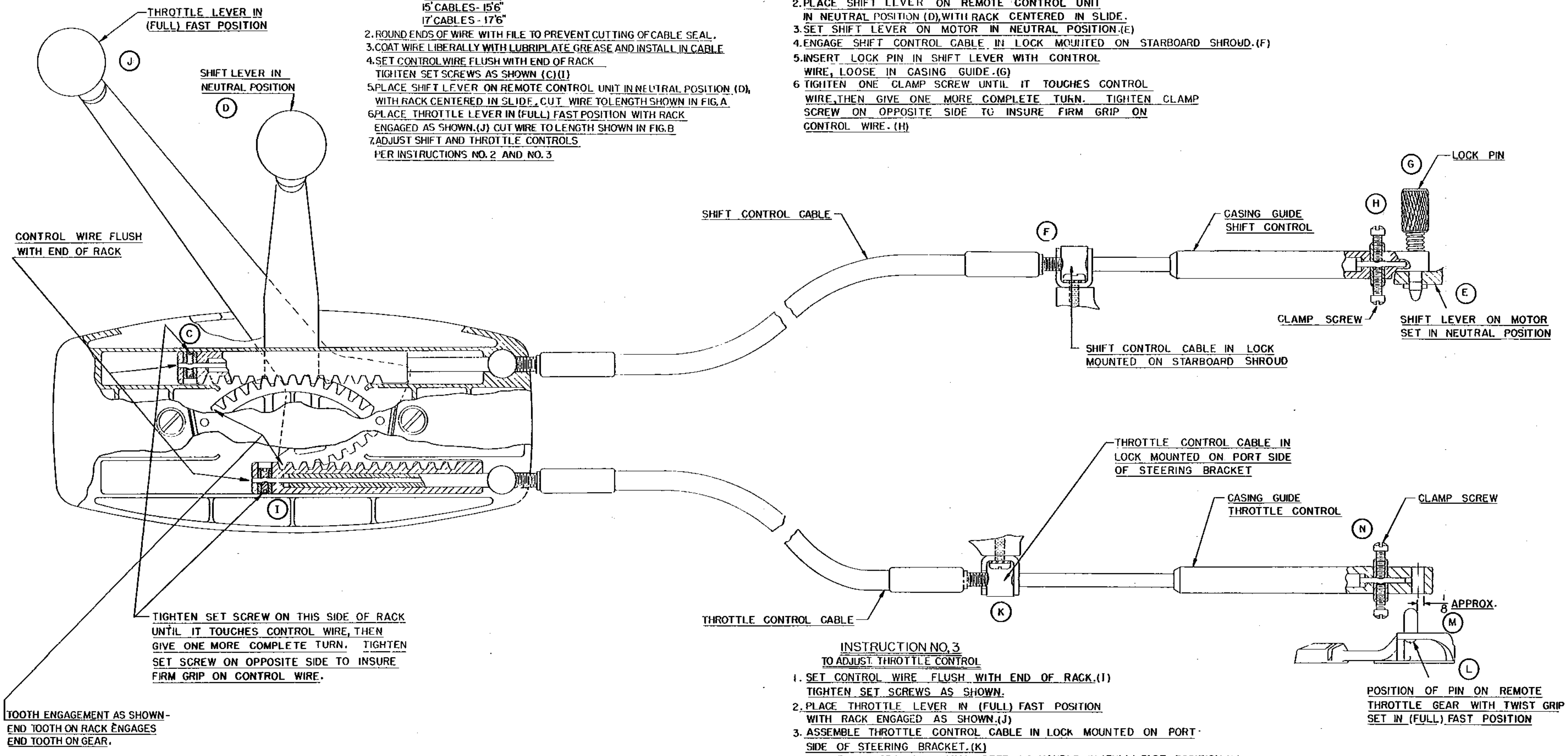


FIG. A



INSTRUCTION NO.3
TO ADJUST THROTTLE CONTROL

1. SET CONTROL WIRE FLUSH WITH END OF RACK.(I) TIGHTEN SET SCREWS AS SHOWN.
2. PLACE THROTTLE LEVER IN (FULL) FAST POSITION WITH RACK ENGAGED AS SHOWN.(J)
3. ASSEMBLE THROTTLE CONTROL CABLE IN LOCK MOUNTED ON PORT SIDE OF STEERING BRACKET.(K)
4. SET TWIST GRIP ON MOTOR STEERING HANDLE IN (FULL) FAST POSITION.(L)
5. WITH CONTROL WIRE LOOSE IN CASING GUIDE, PLACE GUIDE IN POSITION SHOWN - EDGE OF HOLE IN GUIDE APPROX. 1/8 INCH TO REAR OF MOUNTING PIN. (M)
6. TIGHTEN ONE CLAMP SCREW UNTIL IT TOUCHES CONTROL WIRE, THEN GIVE ONE MORE COMPLETE TURN. TIGHEN CLAMP SCREW ON OPPOSITE SIDE TO INSURE FIRM GRIP ON CONTROL WIRE. (N)
7. CASING GUIDE CAN NOW BE CONNECTED TO REMOTE THROTTLE GEAR.

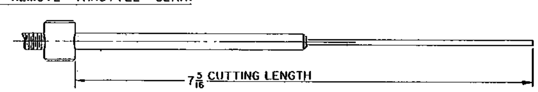


FIG. B

NOTES

CLEARANCES

CLEARANCES

Section VI

BEARING CLEARANCES AND SPECIFICATIONS

NOTES

GREASE CAPACITY OF GEARCASES

Model Motor	Grease Necessary
J-25-65	3 oz.
A	3 oz.
A-25	3 oz.
A-35	7½ oz.
A-45	7½ oz.
A-50-65	7½ oz.
OA-55-60-65	9 oz.
K-35	9 oz.
K-40	9 oz.
KR-40	9 oz.
K-45	9 oz.
K-50-65	9 oz.
OK-55-60	12 oz.
P-30	15 oz.
P-35	13 oz.
P-40	13 oz.
PR-40	13 oz.
P-45	13 oz.

Model Motor	Grease Necessary
TR-40	11 oz.
S-45-65	12 oz.
V-45-65	15 oz.
P-50-65	15 oz.
KR-55	5 oz.
SR-45	9 oz.
SR-50	9 oz.
SR-55	9 oz.
PR-55	10 oz.
VR-45	10 oz.
VR-50	10 oz.
VR-55	10 oz.
XR-55	10 oz.
SE-50	12 oz.
PE-50	15 oz.
VE-50	15 oz.
OA-60-65	9 oz.
OK-60	12 oz.

Model Motor	Grease Necessary
J-70	3 oz.
J-75-80	4 oz.
F-70	3 oz.
F-75	4 oz.
A-70-75-80, AA-37	7½ oz.
K-70-75-80, KA-37-38	9 oz.
S-70	12 oz.
P-70-75-80, PO-37-38	15 oz.
V-70	15 oz.
KR-70-80	5 oz.
SR-70-80	9 oz.
OK-75	12 oz.
100-110	3½ oz.
200-210	3½ oz.
300	4 oz.

Model Motor	Grease Necessary
LT, DT-37-38	3 oz.
LS, DS-37-38	3 oz.
MS, MD-38	1½ oz.
LT, AT, DT-39-10	3 oz.
MS, MD-38-39	1½ oz.
KA-38-39-10	9 oz.
PO-38-39-10-15	15 oz.
HS, HA, HD-10	1½ oz.
MS, MD-10-15-20	1½ oz.
HS, HD-15-20-25	1½ oz.
TS, TD-15-20	3 oz.
KS, KD-15	9 oz.
SD-10-15	10 oz.

PISTON RING SPECIFICATIONS

Model Motor	Ring Pt. No.	Diameter Of Ring	Width	(Approx.) lbs. Comp. Aimed At	Gap Clearance
J-25-65	5-194	2.000	.1245	4	.005 — .012
A	5-194	2.000	.1245	4	.005 — .012
A-25	5-194	2.000	.1245	4	.005 — .012
A-35	5-194	2.000	.1245	4	.005 — .012
A-45	5-194	2.000	.1245	4	.005 — .012
A-50-65	25-25	1.875	.1245	2½	.005 — .010
OA-55-60-65	5-194	2.000	.1245	4	.005 — .012
K-35	15-17	2.3125	.1545	4	.004 — .012
K-40	15-148	2.375	.1545	4	.005 — .012
KR-40	15-148	2.375	.1545	4	.005 — .012
K-45	15-148	2.375	.1545	4	.005 — .012
K-50-65	27-25	2.125	.1245	2¾	.005 — .012
OK-55-60	15-148	2.375	.1545	4	.005 — .012
P-30	7-91	2.875	.186	5	.006 — .012
P-35	17-48	2.6875	.186	4¾	.006 — .012
P-40	17-187	2.6875	.1245	3.16	.006 — .012
PR-40	17-187	2.6875	.1245	3.16	.006 — .012
P-45	17-187	2.6875	.1245	3.16	.006 — .012
TR-40	19-17	3.000	.140	5	.006 — .012
S-45-65	21-10	2.375	.1245	3½	.005 — .012
V-45	21-10	2.375	.1245	3½	.005 — .012
P-50-65	29-10	2.750	.1245	4	.005 — .012
KR-55-65-70	27-141	2.125	.1245	4½	.009 — .013
SR-45	21-10	2.375	.1245	3½	.005 — .012
SR-50	21-519	2.375	.1245	3½	.012 — .016
SR-55-60-65-70	21-546	2.375	.1245	5	.012 — .016
PR-50	29-35	2.750	.1245	4	.012 — .016
PR-55-60-65	29-60	2.750	.1245	5½	.012 — .016

PISTON RING SPECIFICATIONS (Continued)

Model Motor	Ring Pt. No.	Diameter Of Ring	Width	(Approx.) lbs. Comp. Aimed At	Gap Clearance
VR-45	21-10	2.375	.1245	3½	.008 — .012
VR-50	21-519	2.375	.1245	3½	.012 — .016
VR-55	21-546	2.375	.1245	5	.012 — .016
XR-55	35-4	2.656	.1245	5½	.012 — .016
SE-50-65	21-10	2.375	.1245	3½	.005 — .012
PE-50-65	29-10	2.750	.1245	4	.005 — .012
VE-50-65	21-10	2.375	.1245	3½	.005 — .012
V-65	21-10	2.375	.1245	3½	.005 — .012
J-70-75-80	5-194	2.000	.1245	4	.005 — .012
F-70-75	5-194	2.000	.1245	4	.005 — .012
A-70-75-80	25-25	1.875	.1245	2½	.005 — .010
K-70-75-80	27-25	2.125	.1245	2¾	.005 — .012
S-70	21-10	2.375	.1245	3½	.005 — .012
P-70-75-80	29-10	2.750	.1245	4	.005 — .012
V-70	21-10	2.375	.1245	3½	.005 — .012
KR-80-38	27-273	2.125	.1245	5½	.005 — .015
SR-80-38	21-605	2.375	.1245	8	.010 — .015
100	5-194	2.000	.1245	4	.005 — .012
200	5-194	2.000	.1245	4	.005 — .012
300	25-25	1.875	.1245	2½	.005 — .012
LT, DT-37-38	25-25	1.875	.1245	2½	.005 — .010
LS, DS-37-38	25-25	1.875	.1245	2½	.005 — .010
PO-37	29-10	2.750	.1245	4	.005 — .012
KA-37	27-25	2.125	.1245	2.75	.005 — .012
AA-37	25-25	1.875	.1245	2½	.005 — .010
OK-75	15-148	2.375	.1545	4	.005 — .012
110	5-194	2.000	.1245	4	.005 — .012
210	5-194	2.000	.1245	4	.005 — .012
LT, AT, DT-39-10	41-333	1.9375	.0935	2 7/8	.005 — .010
MS, MD-38-39	43-78	1.375	.09325	1½	.004 — .009
KA-38-39-10	27-25	2.125	.1245	3½	.005 — .012
PO-38-39-10-15	29-10	2.750	.1245	4	.005 — .012
HS, HA, HD-10	43-78	1.375	.09325	1½	.004 — .009
TS, TD-15-20	41-333	1.9375	.09325	3	.005 — .015
MS, MD-15-20	300211	1.500	.09325	2½	.004 — .014
KS, KD-15	27-25	2.125	.1245	4½	.005 — .015
HS, HD-15-20-25	43-78	1.375	.09325	2½	.004 — .014
SD-15	45-300050	2.500	.09325	4	.007 — .017

PISTON RING GROOVE (SIDE) CLEARANCE

Ring Width	Clearance
3/32″	.001 — .0035
1/8″	.0025 — .0045
5/32″	.003 — .005
3/16″	.003 — .005

TABLE OF CYLINDER BORE AND PISTON CLEARANCES

Model Motor	Cylinder Bore	Piston	Piston Clearance
J-25-65	2.0	1.996	.003 — .005
A	2.0	1.998	.001 — .003
A-25	2.0	1.998	.001 — .003
A-35	2.0	1.998	.001 — .003
A-45	2.0	1.998	.001 — .003
A-50-65	1.875	1.8725	.002 — .0035
OA-55	2.0	1.998	.001 — .003
K-35	2.3125	2.310	.0015 — .0035
K-40	2.375	2.370	.004 — .006
KR-40	2.375	2.367	.007 — .009
K-45	2.375	2.370	.004 — .006
K-50-65	2.125	2.122	.00225— .00375
OK-55	2.375	2.370	.004 — .006
P-30	2.875	2.872	.002 — .004
P-35	2.6875	2.6845	.002 — .004
P-40	2.6875	2.6775	.009 — .011
PR-40	2.6875	2.6775	.009 — .011
P-45	2.6875	2.6775	.009 — .011
TR-40	3.0	2.988	.011 — .013
S-45	2.375	2.370	.0045 — .006
V-45	2.375	2.370	.0045 — .006
P-50-65	2.750	2.7445	.005 — .0065
KR-55-65	2.125	2.120	.004 — .0055
SR-45	2.375	2.369	.0055 — .007
SR-50	2.375	2.369	.0055 — .007
SR-55	2.375	2.369	.0055 — .007
PR-50	2.750	2.743	.0065 — .008
PR-55	2.750	2.743	.0065 — .008
VR-45	2.375	2.369	.0055 — .007
VR-50	2.375	2.369	.0055 — .007
VR-55	2.375	2.369	.0055 — .007
XR-55	2.6562	2.649	.0067 — .0082
SE-50	2.375	2.3705	.004 — .0055
S-65	2.375	2.3705	.004 — .0055
PE-50	2.750	2.7445	.005 — .0065
VE-50	2.375	2.3705	.004 — .0055
V-65	2.375	2.3705	.004 — .0055
OA-60-65	2.0	1.998	.001 — .003
OK-60	2.375	2.370	.004 — .006
PR-65	2.750	2.746	.004 — .007
J-70-75-80	2.0	1.996	.003 — .005
F-70-75	2.0	1.998	.0015 — .0025
A-70-75-80	1.875	1.8725	.002 — .0035
K-70-75-80	2.125	2.122	.00225— .00375
S-70	2.375	2.3705	.004 — .0055
P-70-75-80	2.75	2.7445	.005 — .0065
V-70	2.375	2.3705	.004 — .0055
KR-80-38	2.125	2.120	.004 — .0055
SR-80-38	2.375	2.369	.0055 — .007
100	2.0	1.997	.00225— .00375
200	2.0	1.998	.001 — .003
300	1.875	1.8725	.002 — .0035
LT, DT-37-38	1.8750	1.8735	.001 — .002
LS, DS-37-38	1.8750	1.8735	.001 — .002
PO-37	2.750	2.7445	.005 — .0065
KA-37	2.125	2.122	.00225— .00375
AA-37	1.875	1.8725	.002 — .0035
OK-75	2.375	2.370	.004 — .006
110	2.000	1.997	.00225— .00375
210	2.000	1.998	.001 — .003
LT, DT, AT-39-10	1.9375	1.9360	.0010 — .0020
MS, MD-38-39	1.3750	1.3735	.0010 — .0020
KA-38-39-10	2.125	2.1223	.0022 — .0037
PO-38-39-10-15	2.750	2.7445	.005 — .0065
HS, HA, HD-10	1.3750	1.3735	.0010 — .0020
MS, MD-15-20	1.5000	1.4985	.0010 — .0020
HS, HD-15-20-25	1.3755	1.3735	.0010 — .0025
TS, TD-15-20	1.9380	1.9360	.0010 — .0025
KS, KD-15	2.1255	2.1225	.0020 — .0035
SD-15	2.5005	2.4975	.0020 — .0035

CRANKSHAFT SIZES

Model Motor	Top Journal	Center Journal	Bottom Journal
J-25-65	.686	None	.686
A	.686	None	.686
A-25	.686	None	.686
A-35	.686	None	.686
A-45	.686	None	.686
A-50-65	.7485	None	.8105

CRANKSHAFT SIZES (Continued)

Model Motor	Top Journal	Center Journal	Bottom Journal
OA-55-60-65	.686	None	.686
K-35	.999	None	.999
K-40	.999	None	.999
KR-40	.999	None	.999
K-45	.999	None	.999
K-50-65	.873	None	.904
OK-55	1.004	None	.999
P-30	1.124	None	1.124
P-35	1.124	None	1.124
P-40	1.124	None	1.124
PR-40	1.124	None	1.124
P-45	1.124	None	1.124
TR-40	1.249	None	1.374
S-45	.999	None	1.039
V-45	.999	1.019	1.039
P-50-65	.999	None	1.039
KR-55-65	.8745	None	.8745
SR-45	.999	None	1.039
SR-50	.999	None	1.039
SR-55-60-65	1.000	None	1.000
PR-50	.999	None	1.039
PR-55	1.000	None	1.000
PR-60-65	1.256	None	1.000
VR-45	.999	1.019	1.039
VR-50	.999	1.019	1.039
VR-55	1.000	1.000	1.000
XR-55	1.000	1.000	1.000
SE-50	.999	None	1.039
PE-50	.999	None	1.039
VE-50-V-65	.999	1.019	1.039
OA-60-65	.686	None	.686
OK-60	1.004	None	.999
J-70-75-80	.686	None	.686
F-70-75	.686	None	.717
A-70-75-80, AA-37	.7485	2.278 Rotor	.8105
K-70-75-80, KA-37	.873	3.057 Rotor	.904
S-70	.999	None	1.039
P-70-75-80, PO-37	.999	None	1.039
V-70	.999	1.019 Rotor	1.039
KR-70-80	.8745	3.058 Rotor	.8745
SR-70-80	1.000	None	1.000
300	.686	None	.717
100-110	.686	None	.686
200-210	.686	None	.717
LT, DT-37-38	.8105	.8105	.8105
LS, DS-37-38	.8105	None	.8105
OK-75	1.004	None	.999
LT, AT, DT-39-10	.8085	.8085	.8080
MS, MD-38-39	.6877	None	.6877
KA-38-39-10	.873	3.057 Rotor	.904
PO-38-39-10-15	.999	None	1.039
HS, HA, HD-10	.6852	.6857	.6857
TS, TD-15-20	.8085	.8085	.8080
MS, MD-15-20	.6877	None	.6877
KS, KD-15	.873	3.057	.904
HS, HD-15	.6852	.6857	.6857
HS, HD-20-25	.6857	.6857	.6857
SD-15	1.1220	1.1220	1.1220

JOURNAL BEARING REAM SIZE

Model Motor	Top Journal Bearing	Center Journal Bearing	Bottom Journal Bearing
J-25-65	.6875	None	.6875
A	.6875	None	.6875
A-25	.6875	None	.6875
A-35	.6875	None	.6875
A-45	.6875	None	.6875
A-50-65	.750	None	.8125
OA-55	.6875	None	.6875
K-35	1.001	None	1.001
K-40	1.001	None	1.001
KR-40	1.002	None	1.002
K-45	1.001	None	1.001
K-50-65	.8755	None	.906
OK-55	1.006	None	1.001
P-30	1.1265	None	1.1265
P-35	1.1265	None	1.1265
P-40	1.1265	None	1.1265
PR-40	1.129	None	1.129
P-45	1.1265	None	1.1265
TR-40	1.1254	None	1.379
S-45	1.0015	None	1.0415
V-45	1.0015	1.021	1.0415
P-50-65	1.0015	None	1.0415
KR-55-65	Roll. Brg.	None	Roll. Brg.
SR-45	1.003	None	1.043
SR-50	1.003	None	1.043
SR-55-60-65	Roll. Brg.	None	Roll. Brg.
PR-50	1.003	None	1.043
PR-55	Roll. Brg.	None	Roll. Brg.
VR-45	1.003	1.023	1.043
VR-50	1.003	1.023	1.043
VR-55	Roll. Brg.	Roll. Brg.	Roll. Brg.
XR-55	Roll. Brg.	Roll. Brg.	Roll. Brg.

JOURNAL BEARING REAM SIZE (Continued)

Model Motor	Top Journal Bearing	Center Journal Bearing	Bottom Journal Bearing
SE-50, S-65	1.0015	None	1.0415
PE-50	1.0015	None	1.0415
VE-50, V-65	1.0015	1.021	1.0415
OA-60-65	.6875	None	.6875
OK-60	1.006	None	1.001
J-70-75-80	.6875	None	.6875
F-70-75	.6875	None	.7185
A-70-75-80, AA-37	.750	2.282 Rotor	.8125
K-70-75-80, KA-37	.8755	3.0615 Rotor	.907
S-70	1.0015	None	1.0415
P-70-75-80, PO-37	1.0015	None	1.0415
V-70	1.0015	1.021 Rotor	1.0415
KR-70-80	Roll. Brg.	3.0625	Roll. Brg.
SR-70-80	Roll. Brg.	None	Roll. Brg.
300	.6875	None	.7185
100-110	.6875	None	.6875
200-210	.6875	None	.7185
LT, DT-37-38	.8125	.8125	.8125
LS, DS-37-38	.8125	None	.8125
OK-75	1.006	None	1.001
LT, AT, DT-39-10	.8100	.8100	.8100
MS, MD-38-39	.6897	None	.6897
KA-38-39-10	.8755	3.0615 Rotor	.907
PO-38-39-10-15	1.0015	None	1.0415
HS, HA, HD-10	.6872	.6872	.6872
TS, TD-15-20	.8100	.8100	.8100
MS, MD-15-20	.6897	None	.6897
KS, KD-15	.8755	3.0615	.9075
HS, HD-15	.6872	.6872	.6872
HS, HD-20-25	.6872	.6872	.6872
SD-15	1.1250	1.1250	1.1250

JOURNAL BEARING CLEARANCE

Model Motor	Upper	Center	Lower
J-25-65	.00125	None	.00125
	.00225		.00225
A	.00125	None	.00125
	.00225		.00225
A-25	.00125	None	.00125
	.00225		.00225
A-35	.00125	None	.00125
	.00225		.00225
A-45	.00125	None	.00125
	.00225		.00225
K-45	.0015	None	.0015
	.0025		.0025
K-50-65	.00425	None	.00225
	.00525		.00325
OK-55	.00175	None	.0015
	.00275		.0025
P-30	.00225	None	.00225
	.00325		.00325
P-35	.00225	None	.00225
	.00325		.00325
P-40	.00225	None	.00225
	.00325		.00325
PR-40	.0045	None	.0045
	.006		.006
P-45	.00225	None	.00225
	.00325		.00325
TR-40	.0045	None	.0045
	.006		.006

Motor Model	Upper	Center	Lower
S-45	.00225	None	.00225
	.00325		.00325
V-45	.00225	.002	.00225
	.00325	.003	.00325
P-50-65	.0025	None	.00225
	.0035		.00325
KR-55-65	Roll. Brg.	None	Roll. Brg.
SR-45	.00375	None	.00375
	.00475		.00475
A-50-65	.00125	None	.0015
	.00225		.0025
OA-55	.00125	None	.00125
	.00225		.00225
K-35	.0015	None	.0015
	.0025		.0025
K-40	.0015	None	.0015
	.0025		.0025
KR-40	.0025	None	.0025
	.0035		.0035
SR-50	.004	None	.00375
	.005		.00475
SR-55	Roll. Brg.		Roll. Brg.
PR-50	.004	None	.00375
	.005		.00475
PR-55-60-65	Roll. Brg.	None	Roll. Brg.
VR-45	.00375	.004	.00375
	.00475	.005	.00475
VR-50	.004	.004	.00375
	.005	.005	.00475

JOURNAL BEARING CLEARANCE (Continued)

Model Motor	Upper	Center	Lower
VR-55	Roll. Brg.	Roll. Brg.	Roll. Brg.
XR-55	Roll. Brg.	Roll. Brg.	Roll. Brg.
SE-50	.0025	None	.00225
S-65	.0035		.00325
PE-50	.0025	None	.00225
P-65	.0035		.00325
VE-50	.0025	.002	.00225
V-65	.0035	.003	.00325
OA-50	.00125	None	.00125
	.00225		.00225
OK-60	.00175	None	.0015
	.00275		.0025
J-70-75-80	.00125	None	.00125
	.00225		.00225
F-70-75	.00125	None	.00125
	.00225		.00225
A-70-75-80, AA-37	.00125	.0035	.0015
	.00225	.0045 Rotor	.0025
K-70-75-80, KA-37	.0023	.0040	.00275
	.0033	.0050 Rotor	.00375
S-70	.0025	None	.00225
	.0035		.00325
P-70-75-80, PO-37	.0025	None	.00225
	.0035		.00325
V-70	.0025	.002	.00225
	.0035	.003	.00325
KR-70-80-38	Roll. Brg.	None	Roll. Brg.
SR-70-80-38	Roll. Brg.	None	Roll. Brg.
300	.00125	None	.00125
	.00225		.00225
100-110	.00125	None	.00125
	.00225		.00225
200-210	.00125	None	.00125
	.00225		.00225
LT, DT-37-38	.0015	.0015	.0015
	.0025	.0025	.0025
LS, DS-37-38	.0015	None	.0015
	.0025		.0025
OK-75	.00175	None	.0015
	.00275		.0025
LT, AT, DT-39-10	.0010	.0010	.0015
	.0020	.0020	.0025
MS, MD-38-39	.0015	None	.0015
	.0025		.0025
KA-38-39-10	.0023	.0040	.00275
	.0033	.0050 Rotor	.00375
PO-38-39-10-15	.0025	None	.00225
	.0035		.00325
HS, HA, HD-10	.0015	.0010	.0010
	.0025	.0025	.0025
TS, TD-15, TD-20	.0010	.0010	.0015
	.0020	.0020	.0025
MS, MD-15-20	.0015	None	.0015
	.0025		.0025
KS, KD-15	.0023	.004	.00275
	.0033	.005	.00375
HS, HD-15	.0015	.0010	.0010
	.0025	.0020	.0020
HS, HD-20-25	.0010	.0010	.0010
	.0020	.0020	.0020
SD-15	.0025	.0025	.0025
	.0035	.0035	.0035

CRANKSHAFT END CLEARANCE

Model	Clearance
A-50-65-70-75, AA-37	.0025 — .0035
K-50-65-70-75-80	.0025 — .0035
KA-37-38-39-10, KS, KD-15	.0025 — .0035
KR-55-70-38	.0025 — .0035
300	.0025 — .0035
P-75-80, PO-37-38-39-10-15	.005 — .007
P-50-65-70	.010 — .012
V-45-70	.010 — .012
VR-45-50-55	.010 — .012
S-45-65-70	.010 — .012
SE-50	.010 — .012
SR-45-70-38	.010 — .012

CRANK PIN SIZES, CONNECTING ROD REAM SIZES AND CLEARANCES

Model Motor	Crankshaft Crank Pins	Connecting Rod Ream Size	Clearance
J-25-65	.624	.625	.00075 — .00225
A	.624	.625	.00075 — .00225
A-25	.624	.625	.00075 — .00225
A-35	.624	.625	.00075 — .00225
A-45	.624	.625	.00075 — .00225
A-50-65	.686	.6875	.00125 — .00225
OA-55	.624	.625	.00075 — .00225
K-35	.873	.875	.00175 — .00325
K-40	.873	.875	.00175 — .00325
KR-40	.873	.875	.00175 — .00325
K-45	.873	.875	.00175 — .00325
K-50-65	.873	.876	.003 — .004
OK-55	.873	.875	.00175 — .00325
P-30	.998	1.000	.00175 — .00325
P-35	.996	1.000	.00375 — .00525
P-40	.996	1.000	.00375 — .00525
PR-40	.996	1.000	.00375 — .00525
P-45	.8745	Roller Brg.	
TR-40	1.120	1.124	.00375 — .00525
S-45	.8745	Roller Brg.	
V-45	.8745	Roller Brg.	
P-50-65	.8745	Roller Brg.	
KR-55-65	.815	Roller Brg.	
SR-45	.8745	Roller Brg.	
SR-50	.8745	Roller Brg.	
SR-55-60-65	.8745	Roller Brg.	
PR-50	.8745	Roller Brg.	
PR-55	.8745	Roller Brg.	
PR-60-65	.999	Roller Brg.	
VR-45	.8745	Roller Brg.	
VR-50	.8745	Roller Brg.	
VR-55	.8745	Roller Brg.	
XR-55	.8745	Roller Brg.	
SE-50	.8745	Roller Brg.	
PE-50	.8745	Roller Brg.	
VE-50	.8745	Roller Brg.	
OA-60-65	.624	.625	.00075 — .00225
OK-60	.873	.875	.00175 — .00325
J-70-75-80	.624	.625	.00075 — .00225
F-70-75	.624	.625	.00075 — .00225
A-70-75-80, AA-37	.686	.6875	.00125 — .00225
K-70-75-80, KA-37	.873	.876	.003 — .0045
S-70	.8745	Roller Brg.	
P-70	.8745	Roller Brg.	
P-75-80-PO-37	.998	Roller Brg.	
V-70	.8745	Roller Brg.	
KR-70-80	.815	Needle Brg.	
SR-70-80	.8745	Roller Brg.	
300	.686	.6875	.00125 — .00225
100-110	.624	.625	.00075 — .00225

CRANK PIN SIZES, CONNECTING ROD REAM SIZES AND CLEARANCES (Continued)

Model Motor	Crankshaft Crank Pins	Connecting Rod Ream Size	Clearance
200-210	.624	.625	.00075 — .00225
LT, DT-37, LS, DS-37	.8100	.8125	.0015 — .002
OK-75	.873	.875	.00175 — .0025
LT, DT-38	.8105	.8115	.0005 — .0015
LT, AT, DT-39-10	.8105	.8115	.0005 — .0015
MS, MD-38-39	.6255	.6267	.0007 — .0017
KA-38-39-10	.873	.8745	.001 — .002
PO-38-39-10-15	.998	Roller Brg.	
HS, HA, HD-10	.6260	.6267	.0007 — .0017
TS, TD-15-20	.8105	.8115	.0005 — .0015
MS, MD-15-20	.6255	.6267	.0007 — .0017
KS, KD-15	.873	.8745	.0010 — .0020
HS, HD-15-20	.6260	.6267	.0002 — .0012
HS, HD-25	.6255	.6267	.0007 — .0017
SD-15	.9960	Roller Brg.	

WRIST PIN SIZES, WRIST PIN BEARING REAM SIZES AND CLEARANCES

Model Motor	Wrist Pin Size	Bearing Ream Size	Bearing Clearance
J-25-65	.365	.3655	.000 — .001
A	.365	.3655	.000 — .001
A-25	.365	.3655	.000 — .001
A-35	.365	.3655	.000 — .001
A-45	.365	.3655	.000 — .001
A-50-65	.437	.4375	.000 — .001
OA-55	.365	.3655	.000 — .001
K-35	.562	.5625	.000 — .001
K-40	.562	.5625	.000 — .001
KR-40	.562	.5625	.000 — .001
K-45	.562	.5625	.000 — .001
K-50-65	.4995	.500	.000 — .001
OK-55	.562	.5625	.000 — .001
P-30	.6245	.625	.000 — .001
P-35	.6244	.625	.0001 — .0011
P-40	.6244	.625	.0001 — .0011
PR-40	.6244	.625	.0001 — .0011
P-45	.6244	.625	.0001 — .0011
TR-40	.7495	.750	.000 — .001
S-45	.562	.5625	.000 — .001
V-45	.562	.5625	.000 — .001
OA-60-65	.365	.3655	.000 — .001
OK-60	.562	.5625	.000 — .001
P-50-65	.625	.6255	.000 — .001
KR-55-65	.4995	.500	.000 — .001
SR-45	.562	.5625	.000 — .001
SR-50	.562	.5625	.000 — .001
SR-55	.562	.5625	.000 — .001
PR-50	.625	.6255	.000 — .001
PR-55	.625	.6255	.000 — .001

WRIST PIN SIZES, WRIST PIN BEARING REAM SIZES AND CLEARANCES (Continued)

Model Motor	Wrist Pin Size	Bearing Ream Size	Bearing Clearance
VR-45	.562	.5625	.000 — .001
VR-50	.562	.5625	.000 — .001
VR-55	.562	.5625	.000 — .001
XR-55	.625	.6255	.000 — .001
SE-50, S-65	.562	.5625	.000 — .001
PE-50	.625	.6255	.000 — .001
VE-50, V-65	.562	.5625	.000 — .001
J-70-75-80	.365	.3655	.00025 — .001
F-70-75	.365	.3655	.00025 — .00075
A-70-75-80, AA-37	.437	.4375	.00025 — .00075
K-70-75-80, KA-37	.4995	.500	.0000 — .00075
S-70	.562	.563	.0005 — .00125
P-70-75-80, PO-37	.625	.6265	.001 — .00175
V-70	.562	.563	.0005 — .00125
KR-70-80-38	.4995	.500	.0000 — .00075
SR-70-80-38	.562	.563	.0005 — .00125
300	.4995	.500	.0000 — .00075
100-110	.365	.3655	.00025 — .001
200-210	.365	.3655	.00025 — .001
LT, DT, LS, DS-37-38	.437	.4375	.0000 — .00075
OK-75	.562	.5625	.000 — .001
LT, AT, DT-39-10	.437	.43775	.00000 — .00075
MS, MD-38-39	.3749	.376	.0004 — .0011
KA-38-39-10	.4995	.50025	.00005 — .00075
PO-38-39-10-15	.625	.6265	.00100 — .00175
HS, HA, HD-10	.3750	.375	.0004 — .0011
TS, TD-15-20	.4372	.438	.0003 — .0010
MS, MD-15-20	.3751	.376	.0004 — .0011
KS, KD-15	.4997	.5005	.0003 — .0010
HS, HD-15-20-25	.3751	.376	.0004 — .0011
SD-15	.56375	.5646	.00035 — .0011

PISTON WRIST PIN HOLE REAM SIZES

Model Motor	Slip-Fit Side	Drive-Fit Side	Heat Fit Both Sides Reamed Same
J-25-65	.3656	.3647	
A	.3656	.3647	
A-25	.3656	.3647	
A-35	.3656	.3647	
A-45	.3656	.3647	
A-50-65			.437
OA-55	.3656	.3647	
K-35	.5626	.5617	
K-40	.5626	.5617	
KR-40	.5626	.5617	
K-45	.5626	.5617	
K-50-65			.4995
OK-55	.5626	.5617	
P-30	.625	.62425	
P-35	.625	.62425	
P-40	.625	.62425	
PR-40	.625	.62425	
P-45	.625	.62425	
TR-40			.7495
S-45			.562
V-45			.562
OA-60	.3656	.3647	
OA-65	.3656	.3647	
OK-60	.5626	.5617	
P-50-65			.625
KR-55-65			.4995
SR-45			.562
SR-50			.562

PISTON WRIST PIN HOLE REAM SIZES (Continued)

Model Motor	Slip-Fit Side	Drive-Fit Side	Heat Fit Both Sides Reamed Same
SR-55			.562
SR-65			.562
PR-50			.625
PR-55			.625
PR-65			.625
VR-45			.562
VR-50			.562
VR-55			.562
XR-55			.625
SE-50			.562
S-65			.562
PE-50			.625
VE-50			.562
V-65			.562
J-70-75	.3656	.3647	
J-80	.3656	.3647	
F-70-75	.3656	.3647	
A-70-75-80			.437
K-70-75-80			.4995
S-70			.562
P-70			.625
P-75-80	.625	.625	
V-70			.562
KR-70			.4995
KR-80-38			.562
SR-70			.562
SR-80-38			.562
LT, DT-37			.4370
LS, DS-37-38			.4370
PO-37			.625
KA-37			.4995
AA-37			.437
OK-75	.5626	.5617	
100-110	.3656	.3647	
200-210	.3656	.3647	
300			.4995
LT, DT-38	.4372	.4360	
LT, DT, AT-39-10	.4372	.4360	
MS, MD-38-39	.3750	.3746	
KA-38-39-10	.4997	.498	
PO-38-39-10-15	.625	.625	
HS, HA, HD-10	.3750	.3746	
TS, TD-15-20	.4372	.4360	
MS, MD-15-20	.3751	.3746	
KS, KD-15	.4997	.4985	
HS, HD-15-20-25	.3751	.3746	
SD-15	.56425	.5625	

PROPELLER SHAFT FINISH GRIND SIZES FOR BEARINGS

Model Motor	Propeller End	Thrust Brg. End
J-25-65	.500	.500
A	.500	.500
A-25	.500	.500
A-35	.500	.499
A-45	.500	.499
A-50-65	.500	.499
OA-55	.500	.4724
K-35	.625	.624
K-40	.625	.624
KR-40	.625	.624
K-45	.625	.624
K-50-65	.625	.624
OK-55	.625	.5906
P-30	.750	.750
P-35	.750	.750
P-40	.750	.750
PR-40	.750	.750
P-45	.750	.750
TR-40	.874	.874
S-45	.750	.6685
V-45	.874	.787
P-50-65	.874	.787
KR-55-65	.582	.590
SR-45	.750	.6685
SR-50	.750	.6685
SR-55	.750	.6685
PR-50	.750	.6685
PR-55	.750	.6685
VR-45	.750	.6685
VR-50	.750	.6685
VR-55	.750	.6685
XR-55	.750	.6685
SE-50, S-65	.750	.6685
PE-50	.874	.787
VE-50, V-65	.874	.787
OA-60	.500	.4724
OA-65	.500	.500
OK-60	.625	.5906
SR-60-65	.755	.6685
PR-60-65	.755	.6685
J-70-75-80	.500	.500
F-70-75	.500	.500
A-70-75-80, AA-37	.500	.499
K-70-75-80	.625	.624

PROPELLER SHAFT FINISH GRIND SIZES FOR BEARINGS (Continued)

Model Motor	Propeller	Thrust Brg. End
S-70	.750	.6685
P-70-75-80-PO-37	.874	.787
V-70	.874	.787
KR-70-80	.591	.590
SR-70-80	.755	.6685
300	.500	.500
100-110	.500	.4885
200-210	.500	.4885
LT, DT-37	.5000	.5000
LS, DS-37-38	.5000	.5000
KA-37	.738	.590
OK-75	.625	.5906
LT, DT-38	.5000	.5000
AT, LT, DT-39-10	.5000	.5000
MS, MD-38-39	.4375	.4375
KA-38-39-10	.738	Roll. Brg.
PO-38-39-10-15	.874	Roll. Brg.
HS, HA, HD-10	.4375	.4375
TS, TD-15-20	.4883	.4883
MS, MD-15	.4375	.4375
MS, MD-20	.4258	.4258
KS, KD-15	.7385	Roll. Brg.
HS, HD-15	.4375	.4375
HS, HD-20-25	.4258	.4258
SD-10-15	.7485	Roll. Brg.

PROPELLER SHAFT BEARING REAM SIZES

Model Motor	Propeller End	Thrust Brg. End
J-25-65	.502	.502
A	.502	.502
A-25	.502	.502
A-35	.502	.502
A-45	.502	.502
A-50-65	.502	.502
OA-55	.502	Ball Brg.
K-35	.6277	.6277
K-40	.6277	.6277
KR-40	.6277	.6277
K-45	.6277	.6277
K-50-65	.6277	.6277
P-30	.751	.751
P-35	.751	.751
P-40	.751	.751
PR-40	.751	.751
P-45	.751	.751
OK-55	.6277	Ball Brg.
TR-40	.875	.875
S-45	.751	Ball Brg.
V-45	.875	Ball Brg.
P-50-65	.875	Ball Brg.
KR-55-65	Ball Brg.	Ball Brg.
SR-45	.751	Ball Brg.
SR-50	.751	Ball Brg.
SR-55	.751	Ball Brg.
PR-50	.751	Ball Brg.
PR-55	.751	Ball Brg.
VR-45	.751	Ball Brg.
VR-50	.751	Ball Brg.
VR-55	.751	Ball Brg.
XR-55	.751	Ball Brg.
SE-50	.751	Ball Brg.
PE-50	.875	Ball Brg.
VE-50	.875	Ball Brg.
OA-60	.502	Ball Brg.
OK-60	.6277	Ball Brg.
OA-65	.502	.502
SR-60-65	Needle Brg.	Ball Brg.
PR-60-65	Needle Brg.	Ball Brg.
J-70-75-80	.501	.501
F-70-75	.501	.501
A-70-75-80, AA-37	.502	.502
K-70-75-80	.6277	.6277
S-70	.751	Ball Brg.
P-70-75-80, PO-37	.875	Ball Brg.
V-70	.875	Ball Brg.
KR-70-80	Ball Brg.	Ball Brg.
SR-70-80	Needle Brg.	Ball Brg.
300	.501	.501
100, 110	.501 Gear	.4905
200, 210	.501 Gear	.4905
LT, DT-37	.5015	.750 Gear
LS, DS-37-38	.5015	.750 Gear
KA-37	.740	Ball Brg.
OK-75	.6277	Ball Brg.
LT, DT-38	.5010	.750
LT, DT, AT-39-10	.5010	.750
MS, MD-38-39	.4395	.4395
KA-38-39-10	.740	Roll. Brg.
PO-38-39-10-15	.875	Roll. Brg.
HS, HA, HD-10	.4395	.4395
TS, TD-15-20	.4895	.490
MS, MD-15	.4395	.4395
MS, MD-20	.4270	.4275
KS, KD-15	.740	Roll. Brg.
HS, HD-15	.4395	.4395
HS, HD-20-25	.4270	.4275
SD-10-15	.750	Roll. Brg.

PROPELLER SHAFT BEARING CLEARANCES

Model Motor	Propeller End	Thrust Brg. End
J-25-65	.0013 —.0022	.0013 —.0022
A	.0013 —.0022	.0013 —.0022
A-25	.0013 —.0022	.0013 —.0022
A-35	.0013 —.0022	.0028 —.0037
A-45	.0013 —.0022	.0028 —.0037
A-50-65	.0013 —.0022	.0028 —.0037
OA-55	.0013 —.0022	Ball Brg.
K-35	.0017 —.0033	.0032 —.0048
K-40	.0017 —.0033	.0032 —.0048
KR-40	.0017 —.0033	.0032 —.0048
K-45	.0017 —.0033	.0032 —.0048
K-50-65	.0017 —.0033	.0032 —.0048
OK-55	.0017 —.0033	Ball Brg.
P-30	.001 —.002	.001 —.002
P-35	.001 —.002	.001 —.002
P-40	.001 —.002	.001 —.002
PR-40	.001 —.002	.001 —.002
P-45	.001 —.002	.001 —.002
TR-40	.00075 —.00175	.00075 —.00175
S-45	.00075 —.00175	Ball Brg.
V-45	.00075 —.00175	Ball Brg.
P-50-65	.00075 —.00175	Ball Brg.
KR-55-65	Ball Brg.	Ball Brg.
SR-45	.00075 —.00175	Ball Brg.
SR-50	.00075 —.00175	Ball Brg.
SR-55	.00075 —.00175	Ball Brg.
PR-50	.00075 —.00175	Ball Brg.
PR-55	.00075 —.00175	Ball Brg.
VR-45	.00075 —.00175	Ball Brg.
VR-50	.00075 —.00175	Ball Brg.
VR-55	.00075 —.00175	Ball Brg.
XR-55	.00075 —.00175	Ball Brg.
SE-50, S-65	.00075 —.00175	Ball Brg.
PE-50	.00075 —.00175	Ball Brg.
VE-50, V-65	.00075 —.00175	Ball Brg.
OA-60	.0013 —.0022	Ball Brg.
OK-60	.0017 —.0033	Ball Brg.
OA-65	.002 —.003	.002 —.003
J-70-75-80	.0005 —.0015	.0005 —.0015
F-70-75	.0005 —.0015	.0005 —.0015
A-70-75-80, AA-37	.0013 —.0022	.0028 —.0037
K-70-75-80	.0017 —.0032	.0032 —.0047
S-70	.0005 —.002	Ball Brg.
P-70-75-80, PO-37	.00075 —.00175	Ball Brg.
V-70	.00075 —.00175	Ball Brg.
KR-70-80	Ball Brg.	Ball Brg.
SR-70-80	Needle Brg.	Ball Brg.
300	.0005 —.0015	.0005 —.0015
100, 110	.00075 —.00175 Gear	.0015 —.003
200, 210	.00075 —.00175 Gear	.0015 —.003
LT, DT-37	.0005 —.0015	.2490 —.2505 Gear

PROPELLER SHAFT BEARING CLEARANCES (Continued)

Model Motor	Propeller End	Thrust Brg. End
LS, DS-37-38	.0005 —.0015	.2490 —.2505 Gear
KA-37	.001 —.0025	Ball Brg.
OK-75	.00195—.00225	Ball Brg.
LT, DT-38	.0005 —.0015	.0015 —.0030
LT, DT, AT-39-10	.0005 —.0015	.0015 —.0030
MS, MD-38-39	.0015 —.0030	.0015 —.0030
KA-38-39-10	.0013 —.0022	Roll. Brg.
PO-38-39-10-15	.00075—.00175	Roll. Brg.
HS, HA, HD-10	.0015 —.0030	.0015 —.0030
TS, TD-15-20	.0007 —.0015	.0007 —.0020
MS, MD-15	.0015 —.0030	.0015 —.0030
MS, MD-20	.0007 —.0015	.0007 —.0020
KS, KD-15	.0013 —.0022	Roll. Brg.
HS, HD-15	.0015 —.0030	.0015 —.0030
HS, HD-20-25	.0007 —.0015	.0007 —.0020
SD-10-15	.0005 —.0020	Roll. Brg.

LOWER DRIVESHAFT (PINION SHAFT) SIZES

Model Motor	Top Grind Size for Brg.	Bottom Grind Size for Brg.
J-25-65	.4885	.4885
A	.426	.426
A-25	.4885	.4885
A-35	.4885	.4885
A-45	.4885	.4885
A-50-65	.4885	.4885
OA-55	.4885	.4885
K-35	.605	.605
K-40	.605	.605
KR-40	.605	.605
K-45	.605	.605
K-50-65	.605	.605
OK-55	.610	.605
P-30	.9375	.9375
P-35	.9375	.9375
P-40	.9375	.9375
PR-40	.9375	.9375
P-45	.9375	.7872
TR-40	.8266	.787
S-45	.6235	.669
V-45	.6235	.787
P-50-65	.6235	.787
KR-55-65	.4865	.591
SR-45	.6235	.669
SR-50	.6235	.669
SR-55	.6235	.669
PR-50	.6235	.669
PR-55	.6235	.669
VR-45	.6235	.669
VR-50	.6235	.669
VR-55	.6235	.669
XR-55	.6235	.669
SE-50	.6235	.669
S-65	.6235	.669
PE-50	.6235	.787
VE-50	.6235	.787
V-65	.6235	.787
OA-60-65	.4885	.4885
OK-60	.610	.605
SR-60-65	.6688	.6692
PR-60-65	.6688	.6692
J-70	.4885	.4885
J-75-80	.4885	.4885
F-70	.4885	.4885
F-75	.4885	.4885
A-70-75-80, AA-37	.4885	.4885
K-70-75-80	.605	.605
S-70	.6235	.669
P-70-75-80, PO-37	.6235	.787
V-70	.6235	.787
KR-70-80	.4865	.590
SR-70-80	.6688	.6690
300	.4885	.4885
100-110		.4885
200-210		.4885
LT-37, DT-37		.4885
LS, DS-37-38		.4885
KA-37	.738	.738
OK-75	.610	.605
LT, DT-38		.4885

LOWER DRIVESHAFT (PINION SHAFT) SIZES (Continued)

Model Motor	Top Grind Size for Brg.	Bottom Grind Size for Brg.
LT, DT, AT-39-10		.4885
MS, MD-38-39-15		.375
KA-38-39-10	.738	.738
PO-38-39-10-15	.6235	Roll. Brg.
HS, HA, HD-10-15		.375
TS, TD-15-20	.4885	.4885
MS, MD-20	.374	.375
KS, KD-15	.738	.738
HS, HD-20-25	.374	.375
SD-10-15	.5500	Roll. Brg.

PINION SHAFT BEARING REAM SIZES

Model Motor	Top Bearing	Bottom Bearing
J-25-65	.4905	.4905
A	.4275	.4275
A-25	.4905	.4905
A-35	.4905	.4905
A-45	.4905	.4905
A-50-65	.4905	.4905
OA-55	.4905	.4905
K-35	.607	.607
K-40	.607	.607
KR-40	.607	.607
K-45	.607	.607
K-50-65	.607	.607
OK-55	.6115	.607
P-30	.939	.939
P-35	.939	.939
P-40	.939	.939
PR-40	.939	.939
P-45	.939	Ball Brg.
TR-40	.8281	Ball Brg.
S-45	.625	Ball Brg.
V-45	.625	Ball Brg.
P-50-65	.625	Ball Brg.
KR-55-65	.490	Ball Brg.
SR-45	.625	Ball Brg.
SR-50	.625	Ball Brg.
SR-55	.625	Ball Brg.
PR-50	.625	Ball Brg.
PR-55	.625	Ball Brg.
VR-45	.625	Ball Brg.
VR-50	.625	Ball Brg.
VR-55	.625	Ball Brg.
XR-55	.625	Ball Brg.
SE-50, S-65	.625	Ball Brg.
PE-50	.625	Ball Brg.
VE-50, V-65	.625	Ball Brg.
OA-60-65	.4905	.4905
OK-60	.6115	.607
SR-60-65	Ball Brg.	Ball Brg.
PR-60-65	Ball Brg.	Ball Brg.
J-70-75-80	.4895	.4895
F-70-75	.4895	.4895
A-70-75-80, AA-37	.4905	.4905
K-70-75-80	.607	.607
S-70	.625	Ball Brg.
P-70-75-80, PO-37	.625	Ball Brg.
V-70	.625	Ball Brg.
KR-70-80	.490	Ball Brg.
SR-70-80	Ball Brg.	Ball Brg.
300	.4895	.4895
100-110		.4905
200-210		.4905
LT, DT-37		.4905
LS, DS-37		.4905
KA-37	.740	.740
OK-75	.6115	.607
LT, DT-38		.4905
LT, DT, AT-39-10		.4905
MS, MD-38-39-15		.377
KA-38-39-10	.7405	.740
PO-38-39-10-15	.625	Roll. Brg.
HS, HA, HD-10		.377
TS, TD-15-20	.4905	.490
MS, MD-20	.376	.3765
KS, KD-15	.7415	.7405
HS, HD-15	.376	.377
HS, HD-20-25	.376	.3765
SD-10-15	.5520	Roll. Brg.

PINION SHAFT BEARING CLEARANCES

Model Motor	Top Bearing	Bottom Bearing
J-25-65	.0018 — .0027	.0018 — .0027
A	.0012 — .0022	.0013 — .0022
A-25	.0018 — .0027	.0018 — .0027
A-35	.0018 — .0027	.0018 — .0027

PINION SHAFT BEARING CLEARANCES (Continued)

Model Motor	Top Bearing	Bottom Bearing
A-45	.0018 — .0027	.0018 — .0027
A-50-65	.0018 — .0027	.0018 — .0026
OA-55	.0018 — .0027	.0018 — .0027
K-35	.0018 — .0026	.0018 — .0026
K-40	.0018 — .0026	.0018 — .0026
KR-40	.0018 — .0026	.0018 — .0026
K-45	.0018 — .0026	.0018 — .0026
K-50-65	.0018 — .0026	.0018 — .0026
OK-55	.00125 — .00225	.0018 — .0026
P-30	.001 — .00225	.001 — .00225
P-35	.001 — .00225	.001 — .00225
P-40	.001 — .00225	.001 — .00225
PR-40	.001 — .00225	.001 — .00225
P-45	.001 — .00225	Ball Brg.
TR-40	.00075 — .00235	Ball Brg.
S-45	.00125 — .00225	Ball Brg.
V-45	.00125 — .00225	Ball Brg.
P-50-65	.00125 — .00225	Ball Brg.
KR-55-65	.003 — .004	Ball Brg.
SR-45	.00125 — .00225	Ball Brg.
SR-50	.00125 — .00225	Ball Brg.
SR-55	.00125 — .00225	Ball Brg.
PR-50	.00125 — .00225	Ball Brg.
PR-55	.00125 — .00225	Ball Brg.
VR-45	.00125 — .00225	Ball Brg.
VR-50	.00125 — .00225	Ball Brg.
VR-55	.00125 — .00225	Ball Brg.
XR-55	.00125 — .00225	Ball Brg.
SE-50, S-65	.00125 — .00225	Ball Brg.
PE-50	.00125 — .00225	Ball Brg.
VE-50, V-65	.00125 — .00225	Ball Brg.
OA-60	.0018 — .0027	.0018 — .0027
OK-60	.00125 — .00225	.0018 — .0026
OA-65	.002 — .003	.002 — .003
J-70	.0009 — .0017	.0007 — .0017
J-75-80	.0007 — .0017	.0007 — .0017
F-70	.0009 — .0017	.0007 — .0017
F-75	.0007 — .0017	.0007 — .0017
A-70-75-80, AA-37	.0018 — .0027	.0018 — .0027
K-70-75-80	.0018 — .0027	.0018 — .0027
S-70	.00125 — .00225	Ball Brg.
P-70-75-80, PO-37	.00125 — .00225	Ball Brg.
V-70	.00125 — .00225	Ball Brg.
KR-70-80	.003 — .004	Ball Brg.
SR-70-80	Ball Brg.	Ball Brg.
300	.0007 — .0017	.0007 — .0017
100, 110		.0015 — .003
200-210		.0015 — .003
LT-37-DT-37		.0015 — .003
LS, DS-37-38		.0015 — .003
KA-37	.0015 — .003	.0015 — .003

PINION SHAFT BEARING CLEARANCES (Continued)

Model Motor	Top Bearing	Bottom Bearing
OK-75	.00125 — .00225	.0018 — .0027
LT, DT-38		.0015 — .003
LT, DT, AT-39-10		.0015 — .003
MS, MD-38-39-15		.001 — .002
KA-38-39-10	.0025 — .0040	.0015 — .0030
PO-38-39-10-15	.00125 — .0025	Roll. Brg.
HS, HA, HD-10-15		.001 — .002
TS, TD-15-20	.0015 — .003	.0015 — .003
MS, MD-20	.001 — .002	.001 — .002
KS, KD-15	.0025 — .0040	.0015 — .0030
HS, HD-20-25	.001 — .002	.001 — .002
SD-10-15	.0015 — .0025	Ball Brg.

JW SPECIFICATIONS

Grease Capacity (Gearcase) — 2-3/4 fluid ounces

Piston Ring Specification:	A. Diameter of Ring	1.563
	B. Width	.093
	C. Approx. Lbs. Comp. aimed at	2 to 3-1/2 lbs.
	D. Gap Clearance	.005 — .015
Piston Ring Groove (Side) Clearance:		.001 — .0035
Cylinder Bore and Piston Clearance:	A. Cylinder Bore	1.5636
	B. Piston	1.562
	C. Piston Clearance	.0013 — .002
Crankshaft Size:	A. Top Journal	.6854
	B. Center Journal	.6854
	C. Bottom Journal	.6854
Journal Bearing Ream Size:	A. Top Journal	.6869
	B. Center Journal	.6869
	C. Bottom Journal	.6869
Journal Bearing Clearance:	A. Top Journal	.001 — .002
	B. Center Journal	.001 — .002
	C. Bottom Journal	.001 — .002
Crank Pin Size, Conn. Rod Ream Size and Clearance:	A. Crankshaft Crank Pin	.6252
	B. Conn. Rod Ream Size	.6264
	C. Clearance	.0007 — .0017
Wrist Pin Size, Wrist Pin Bearing Ream Size and Clearance:	A. Wrist Pin Size	.3649
	B. Bearing Ream Size	.3656
	C. Bearing Clearance	.0004 — .0011
Piston Wrist Pin Hole Ream Size:	A. Slip Fit Side	.3652
	B. Drive Fit Side	.3635
Propeller Shaft Finish Grind Size for Both Bearings in Gearcase Head:		.4271
Propeller Shaft Bearing Ream Size for Both Bearings in Gearcase Head:		.4271
Propeller Shaft Bearing Clearance:		.001 — .002
Lower Driveshaft Grind Size for Bearing:		.4275
Lower Driveshaft Bearing Ream Size:		.4305
Lower Driveshaft Bearing Clearance:		.002 — .004

TN SPECIFICATIONS

Grease Capacity (Gearcase) — 7 fluid ounces

Piston Ring Specification:	A. Diameter of Ring	1.9375
	B. Width	.0935
	C. Approx. Lbs. Comp. Aimed at	3 pounds
	D. Gap Clearance	.005 — .015
Piston Ring Groove (Side) Clearance:		.001 — .0035
Cylinder Bore and Piston Clearance:	A. Cylinder Bore	1.9380
	B. Piston	1.9360
	C. Piston Clearance	.0010 — .0025
Crankshaft Size:	A. Top Journal	.8085
	B. Center Journal	.8085
	C. Bottom Journal	.8080
Journal Bearing Ream Size:	A. Top Journal	.8100
	B. Center Journal	.8100
	C. Bottom Journal	.8100
Journal Bearing Clearance:	A. Top Journal	.0010 — .0020
	B. Center Journal	.0010 — .0020
	C. Bottom Journal	.0015 — .0025
Crank Pin Size, Conn. Rod Ream Size and Clearance:	A. Crankshaft Crank Pin	.8105
	B. Conn. Rod Ream Size	.8115
	C. Clearance	.0005 — .0015
Wrist Pin Size, Wrist Pin Bearing Ream Size and Clearance:	A. Wrist Pin Size	.4372
	B. Bearing Ream Size	.438
	C. Bearing Clearance	.0003 — .0010
Piston Wrist Pin Hole Ream Size:	A. Slip Fit Side	.4372
	B. Drive Fit Side	.4360
Upper Driveshaft Grind Size for Bearing:		.4375 — .4365
Upper Driveshaft Bearing Ream Size:		.4395 — .4390
Upper Driveshaft Bearing Clearance:		.0015 — .003
Lower Driveshaft Grind Size for Bearing:		.485 — .486
Lower Driveshaft Bearing Ream Size:		.490 — .491
Lower Driveshaft Bearing Clearance:		.0004 — .0006
Propeller Shaft Finish Grind Size for Both Bearings in Gearcase Head:		.4880 — .4883
Propeller Shaft Bearing Ream Size for Bearings in Gearcase Head:	A. Propeller End	.4890 — .4895
	B. Thrust End	.4900
Propeller Shaft Bearing Clearance:	A. Propeller End	.0007 — .0015
	B. Thrust End	.0007 — .0020

CD SPECIFICATIONS

Grease Capacity (Gearcase) — 9 fluid ounces

Piston Ring Specification:	A. Diameter of Ring	1.9375
	B. Width	.093
	C. Approx. Lbs. Comp. Aimed at	2 to 4 lbs.
	D. Gap Clearance	.005 — .015
Piston Ring Groove (Side) Clearance:		.001 — .0035
Cylinder Bore and Piston Clearance:	A. Cylinder Bore	1.938 — 1.9373
	B. Piston	1.936 — 1.9355
	C. Piston Clearance	.0013 — .0025
Crankshaft Size:	A. Top Journal	.8085 — .8080
	B. Center Journal	.8085 — .8080
	C. Bottom Journal	.8085 — .8080
Journal Bearing Ream Size:	A. Top Journal	.810 — .8095
	B. Center Journal	.810 — .8095
	C. Bottom Journal	.810 — .8095
Journal Bearing Clearance:	A. Top Journal	.001 — .002
	B. Center Journal	.001 — .002
	C. Bottom Journal	.001 — .002
Crank Pin Size, Conn. Rod Ream Size and Clearance:	A. Crankshaft Crank Pin	.8105 — .810
	B. Conn. Rod Ream Size	.8110 — .8115
	C. Clearance	.0005 — .0015
Wrist Pin Size, Wrist Pin Bearing Ream Size and Clearance:	A. Wrist Pin Size	.4272 — .4270
	B. Bearing Ream Size	.4280 — .4275
	C. Bearing Clearance	.0003 — .001
Piston Wrist Pin Hole Ream Size:	A. Slip Fit Sides	.4277 — .4272
	B. Drive Side	.4260 — .4255
Upper Driveshaft Grind Size for Bearing:		.428 — .427
Upper Driveshaft Bearing Ream Size:		.4305 — .4295
Upper Driveshaft Bearing Clearance:		.0015 — .0035
Lower Driveshaft Grind Size for Bearing:		.5500 — .5505
Lower Driveshaft Bearing Ream Size:	A. Bearing	.5525 — .5515
Lower Driveshaft Bearing Clearance:		.001 — .0025
Propeller Shaft Finish Grind Size for Bearing:	A. Propeller End	.554 — .5535
	B. Thrust Bearing End	.554 — .5535
Propeller Shaft Bearing Ream Size:	A. Propeller End	.5555 — .5550
	B. Thrust Bearing End	.555 — .5545
Propeller Shaft Bearing Clearance:	A. Propeller End	.001 — .002
	B. Thrust Bearing End	.0005 — .0015

QD-10 SPECIFICATIONS

Grease Capacity (Gearcase)—10 fluid ounces (5/8 pt.)

Piston Ring Specification:	A. Diameter of Ring	2.375
	B. Width	3/32
	C. Approx. Lbs. Comp. aimed at	4 lbs.
	D. Gap Clearance	.007 to .017
Piston Ring Groove (Side) Clearance:		.001 to .0035
Cylinder Bore and Piston Clearance:	A. Cylinder Bore	2.375
	B. Piston	2.3720
	C. Piston Clearance	.002 to .0035
Crankshaft Size:	A. Top Journal	.8150
	B. Center Journal	1.000
	C. Bottom Journal	.8150
Journal Bearing Ream Size:	A. Top Journal	Cage Needle Brg.
	B. Center Journal	1.0025
	C. Bottom Journal	Cage Needle Brg.
Journal Bearing Clearance:	A. Top Journal	Cage Needle Brg.
	B. Center Journal	.002 to .003
	C. Bottom Journal	Cage Needle Brg.
Crank Pin Size, Conn. Rod Ream Size and Clearance:		
	A. Crankshaft Crank Pin	.8150
	B. Conn. Rod Ream Size	Cage Needle Brg.
	C. Clearance	Cage Needle Brg.
Wrist Pin Size, Wrist Pin Bearing Ream Size and Clearance:		
	A. Wrist Pin Size	.4900
	B. Bearing Ream Size	.4903
	C. Bearing Clearance	.0003 to .001
Piston Wrist Pin Hole Ream Size:	A. Slip Fit Side	.4905
	B. Drive Fit Side	.4883
	C. Heat Fit Both Sides	Reamed Same
Propeller Shaft Finish Grind Size for Bearing:		
	A. Propeller End	.6255
	B. Thrust Bearing End	.6688
Propeller Shaft Bearing Ream Size:	A. Propeller End	Ball Bearing
	B. Thrust Bearing End	Ball Bearing
Propeller Shaft Bearing Clearance:	A. Propeller End	Ball Bearing
	B. Thrust Bearing End	Ball Bearing
Lower Driveshaft (Pinion Shaft) Size:	A. Top Grind Size for Brg.	.500
	B. Bottom Grind Size for Brg.	Roller Bearing
Pinion Shaft Bearing Ream Size:	A. Top Bearing	.5025
	B. Bottom Bearing	Roller Bearing
Pinion Shaft Bearing Clearance:	A. Top Bearing	.002 to .0035
	B. Bottom Bearing	Roller Bearing

QD-14, 14A & 15 SPECIFICATIONS

Grease Capacity (Gearcase) — 6 fluid ounces

Piston Ring Specification:	A. Diameter of Ring	2.375
	B. Width	3/32
	C. Approx. Lbs. Comp. aimed at	4 lbs.
	D. Gap Clearance	.007 to .017
Piston Ring Groove (Side) Clearance:		.001 to .0035
Cylinder Bore and Piston Clearance:	A. Cylinder Bore	2.375
	B. Piston	2.3720
	C. Piston Clearance	.002 to .0035
Crankshaft Size:	A. Top Journal	.8150
	B. Center Journal	1.000
	C. Bottom Journal	.8150
Journal Bearing Ream Size:	A. Top Journal	Cage Needle Brg.
	B. Center Journal	1.0025
	C. Bottom Journal	Cage Needle Brg.
Journal Bearing Clearance:	A. Top Journal	Cage Needle Brg.
	B. Center Journal	.002 to .003
	C. Bottom Journal	Cage Needle Brg.
Crank Pin Size, Conn. Rod Ream Size and Clearance:		
	A. Crankshaft Crank Pin	.8150
	B. Conn. Rod Ream Size	Needle Brg. Brg.
	C. Clearance	Needle Brg. Brg.
Wrist Pin Size, Wrist Pin Bearing Ream Size and Clearance:		
	A. Wrist Pin Size	.4900 to .4898
	B. Bearing Ream Size	.4907 to .4912
	C. Bearing Clearance	.0007 to .0014
Piston Wrist Pin Hole Ream Size:	A. Slip Fit Side	.4900 to .4903
Propeller Shaft Finish Grind Size for Bearing:		
	A. Propeller End	.6255
	B. Thrust Bearing End	.6688
Propeller Shaft Bearing Ream Size:	A. Propeller End	Ball Bearing
	B. Thrust Bearing End	Ball Bearing
Propeller Shaft Bearing Clearance:	A. Propeller End	Ball Bearing
	B. Thrust Bearing End	Ball Bearing
Lower Driveshaft (Pinion Shaft) Size:	A. Top Grind Size for Brg.	.500
	B. Bottom Grind Size for Brg.	Roller Bearing
Pinion Shaft Bearing Ream Size:	A. Top Bearing	.5025
	B. Bottom Bearing	Roller Bearing
Pinion Shaft Bearing Clearance:	A. Top Bearing	.002 to .0035
	B. Bottom Bearing	Roller Bearing

RD & RDE SPECIFICATIONS

Grease Capacity (Gearcase) — 11 fluid ounces

Piston Ring Specification:	A. Diameter of Ring	2.875
	B. Width	.093
	C. Approx. Lbs. Comp. Aimed at	4 to 6 lbs.
	D. Gap Clearance	.007 — .017
Piston Ring Groove (Side) Clearance:		.0045 — .007
Cylinder Bore and Piston Clearance:	A. Cylinder Bore	2.875
	B. Piston	2.8717
	C. Piston Clearance	.0025 — .004
Crankshaft Size:	A. Top Journal	1.000
	B. Center Journal	1.000
	C. Bottom Journal	1.000
Journal Bearing Ream Size:	A. Top Journal	Cage Needle Brg.
	B. Center Journal	Cage Needle Brg.
	C. Bottom Journal	Cage Needle Brg.
Journal Bearing Clearance:	A. Top Journal	Cage Needle Brg.
	B. Center Journal	Cage Needle Brg.
	C. Bottom Journal	Cage Needle Brg.
Crank Pin Size, Conn. Rod Ream Size and Clearance:	A. Crankshaft Crank Pin	1.182
	B. Conn. Rod Ream Size	Cage Needle Brg.
	C. Clearance	Cage Needle Brg.
Wrist Pin Size, Wrist Pin Bearing Ream Size and Clearance:	A. Wrist Pin Size	.6149
	B. Bearing Ream Size	.6159
	C. Bearing Clearance	.0007 — .0014
Piston Wrist Pin Hole Ream Size:	A. Slip Fit Both Sides	.6151
	B.	
	C.	
Propeller Shaft Finish Grind Size for Bearing:	A. Propeller End	.7866
	B. Thrust Bearing End	.812
Propeller Shaft Bearing Ream Size:	A. Propeller End	Ball Bearing
	B. Thrust Bearing End	Tapered Bearing
Propeller Shaft Bearing Clearance:	A. Propeller End	Ball Bearing
	B. Thrust Bearing End	Tapered Bearing
Lower Driveshaft (Pinion Shaft) Size:	A. Top Grind Size for Brg.	.6245
	B. Bottom Grind Size for Brg.	Tapered Bearing
Pinion Shaft Bearing Ream Size:	A. Top Bearing	.6277
	B. Bottom Bearing	Tapered Bearing
Pinion Shaft Bearing Clearance:	A. Top Bearing	.002 — .0035
	B. Bottom Bearing	Tapered Bearing

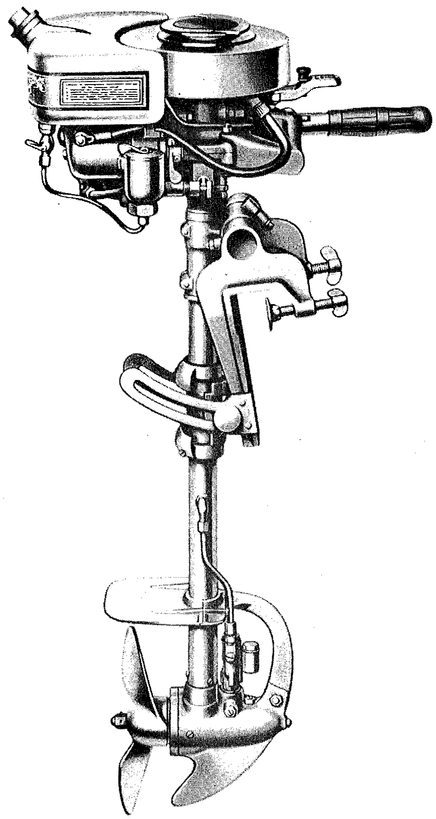
BASIC MODELS

BASIC MODELS

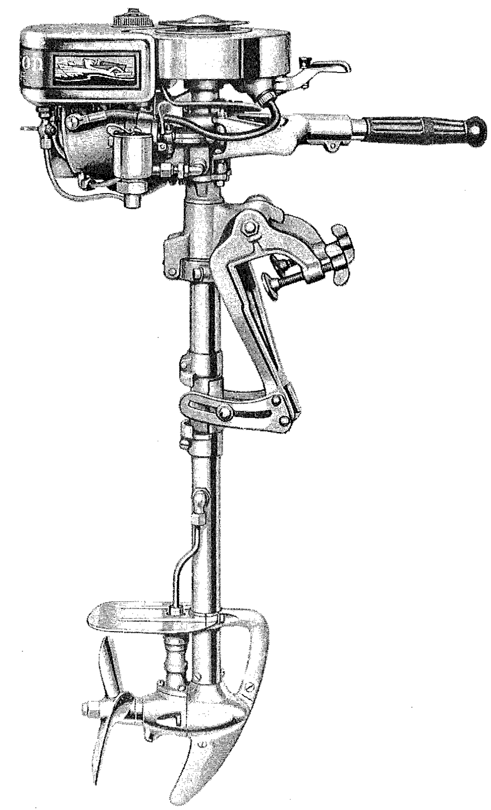
Section VII

BASIC MODELS

NOTES



Model J-25



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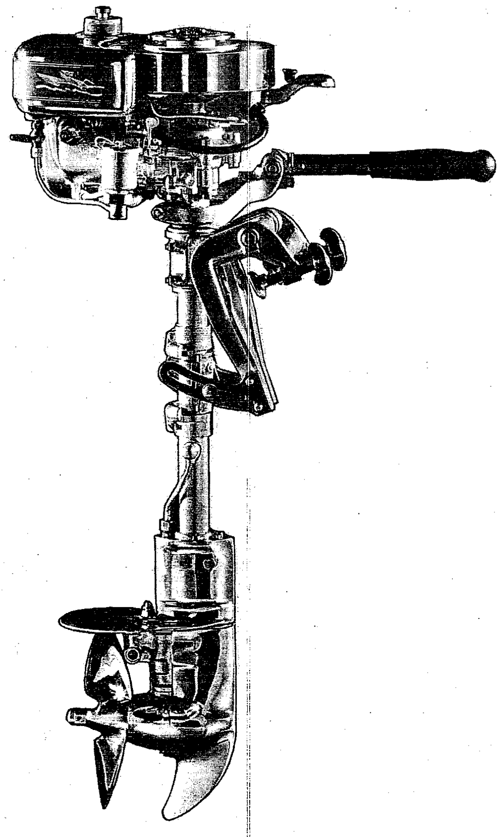
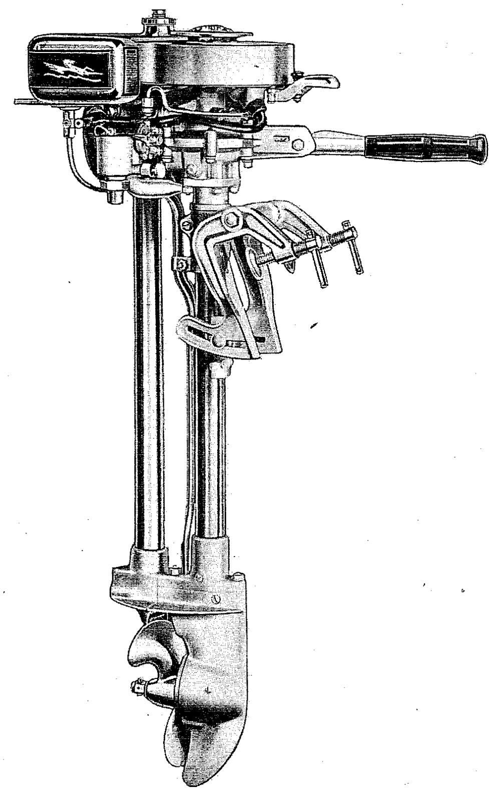
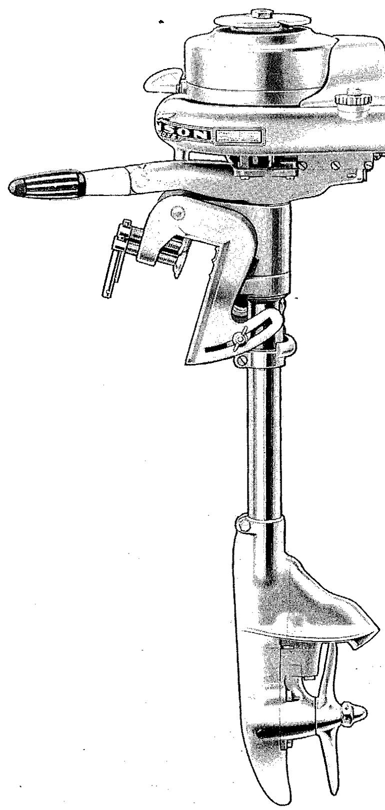


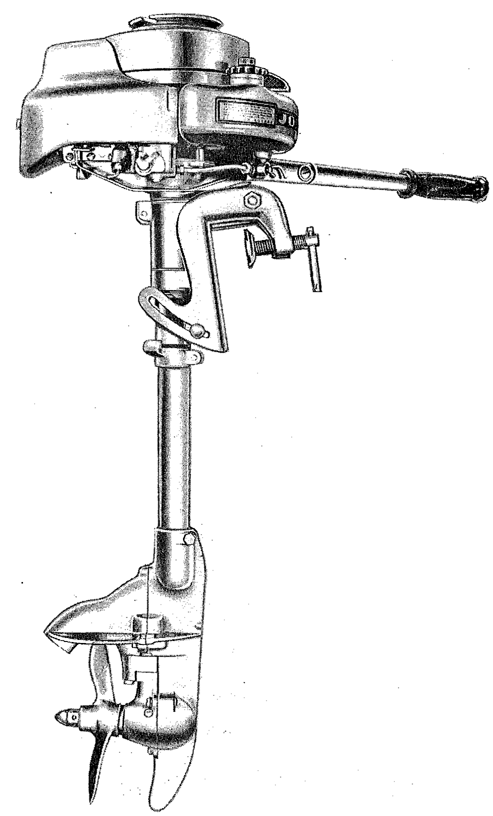
Model J-75



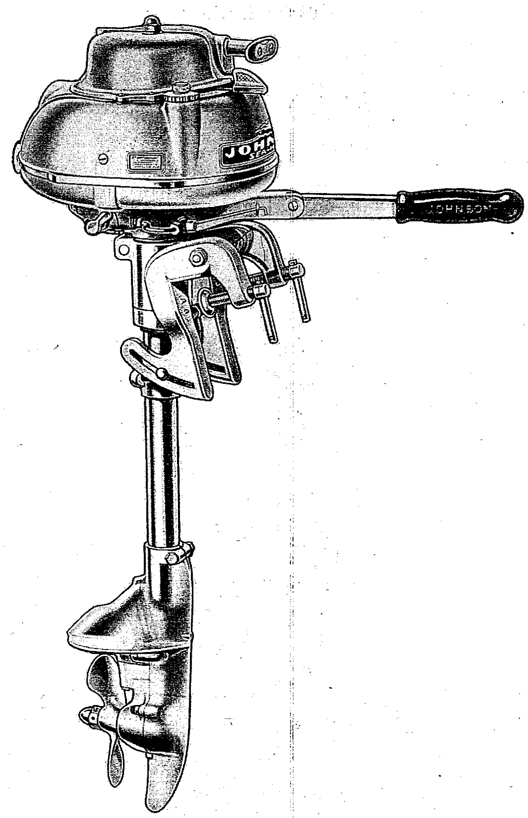
Models 100-110



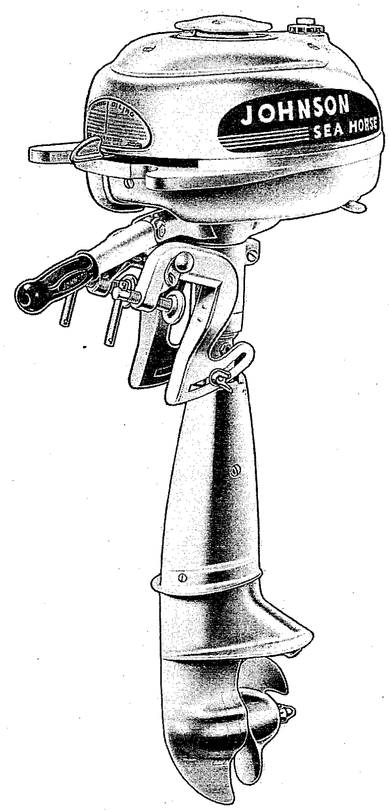
Models MS-38-39



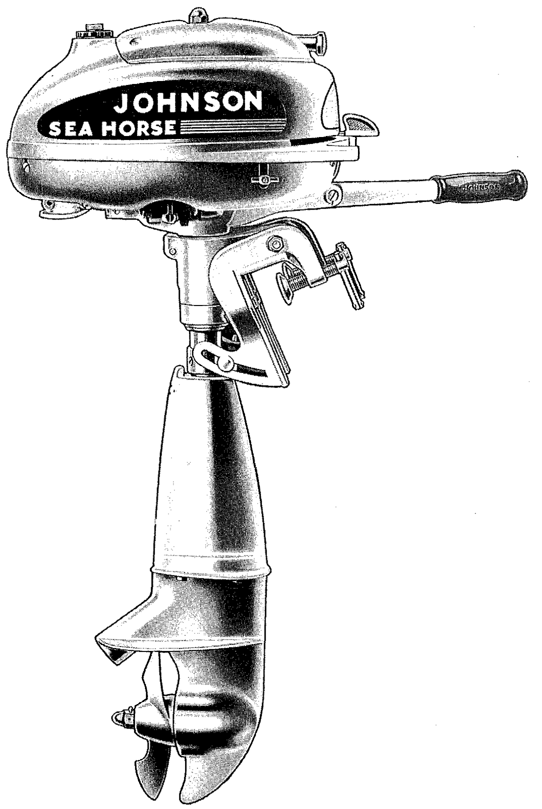
Model MS-15



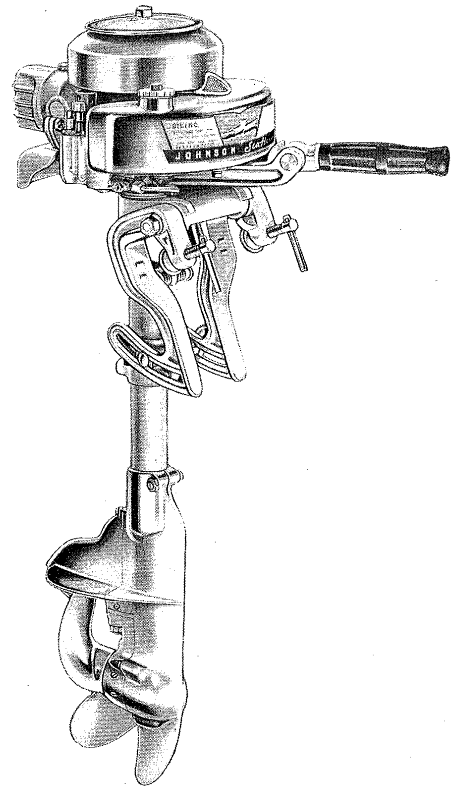
Model MD-38-39-15



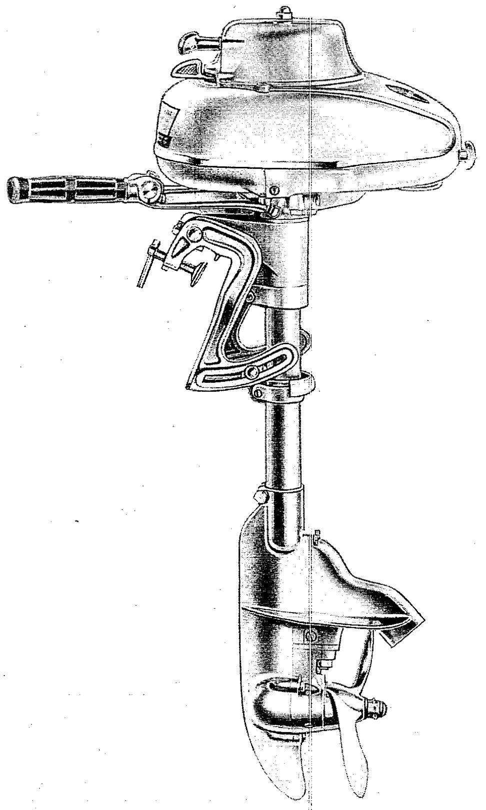
Model MS-20



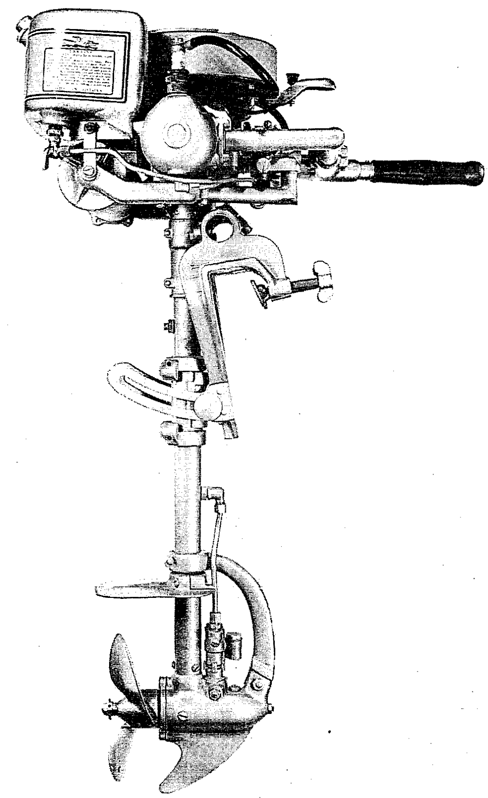
Model MD-20



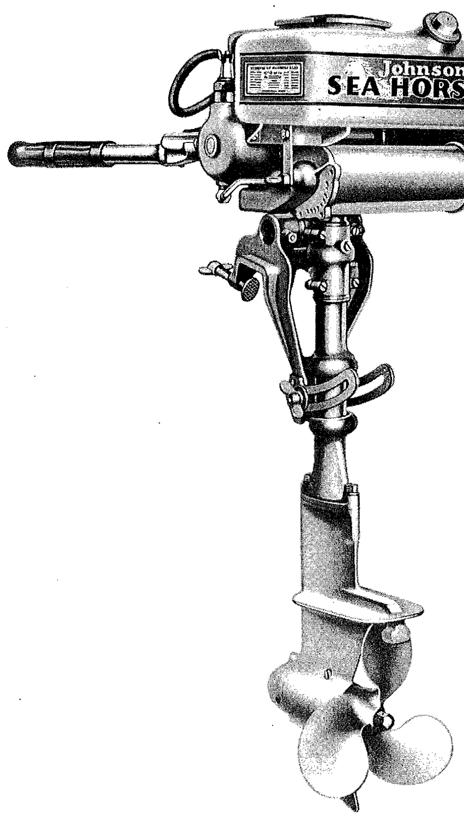
Models LS-37-38



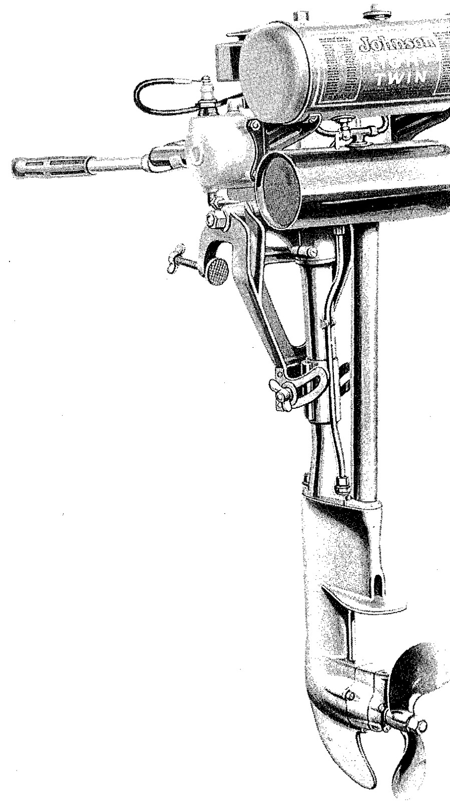
Models DS-37-38



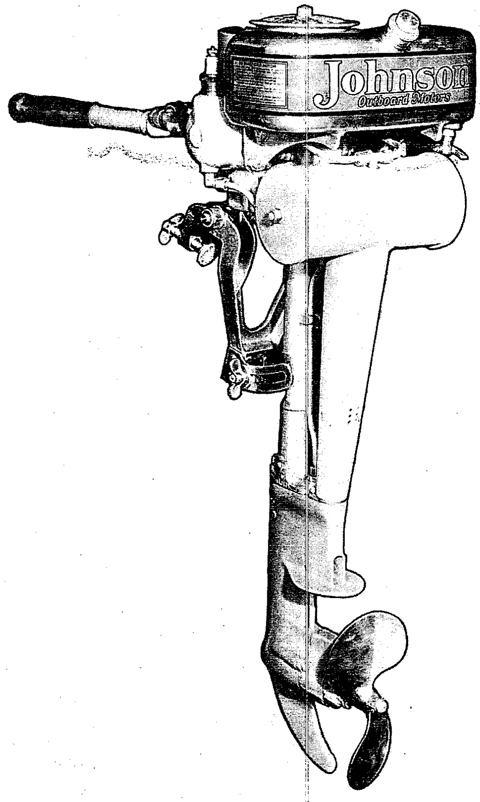
Models A, A-25



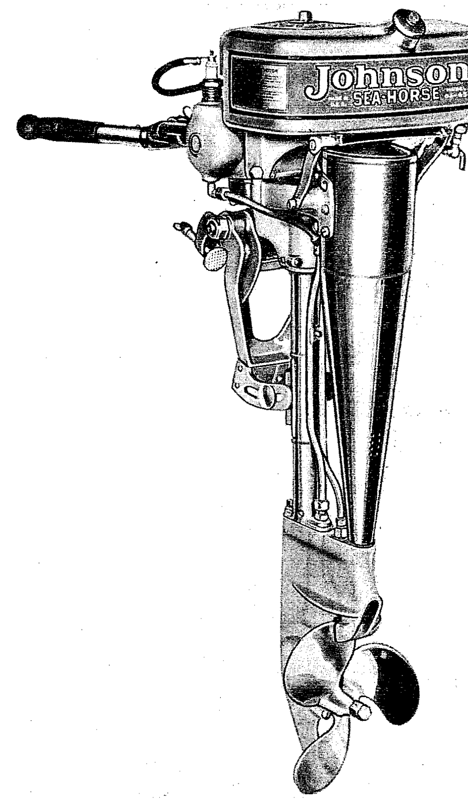
Models A-35-45



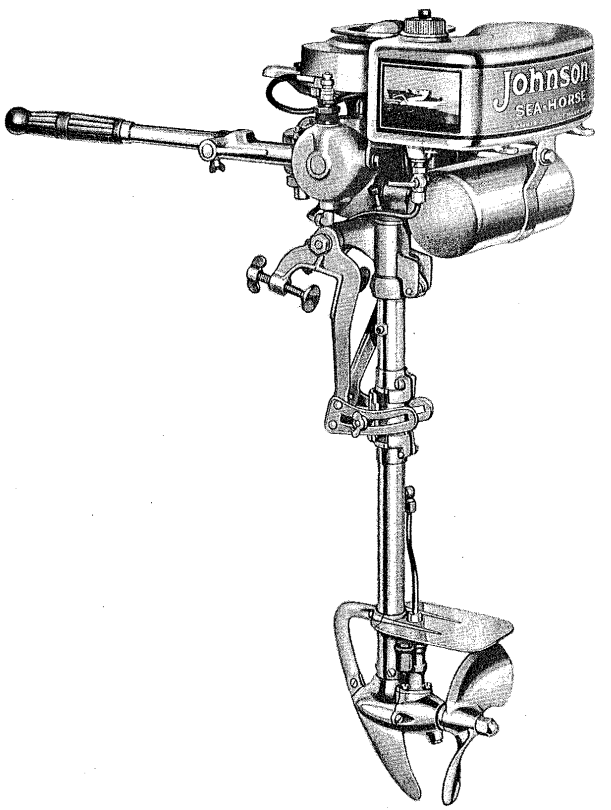
Model OA-55



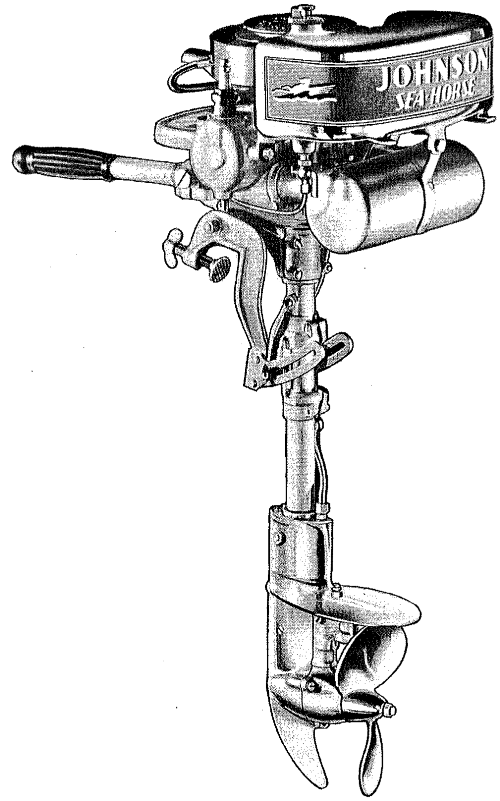
Model OA-60



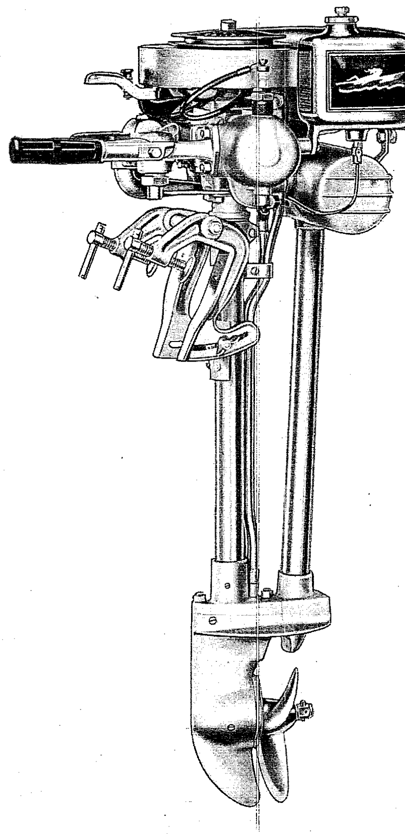
Model OA-65



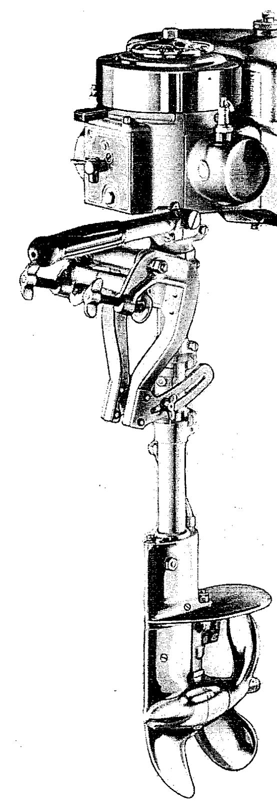
Model F-70



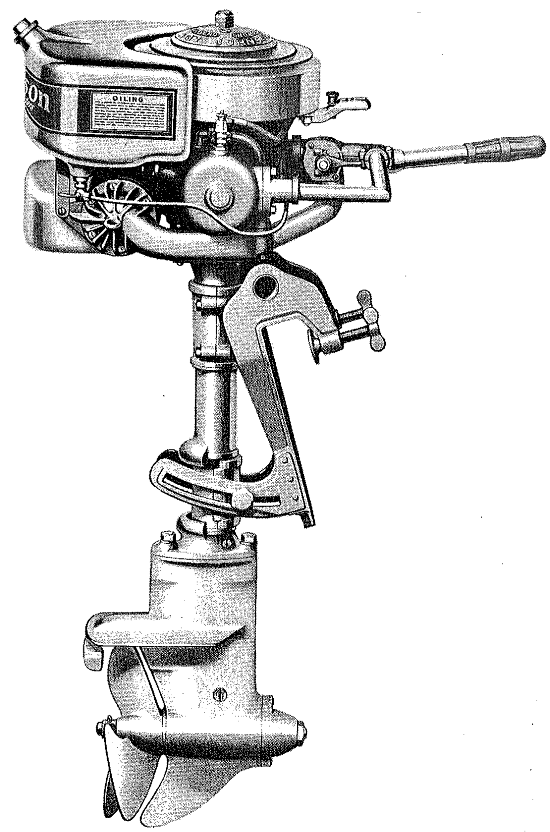
Model F-75



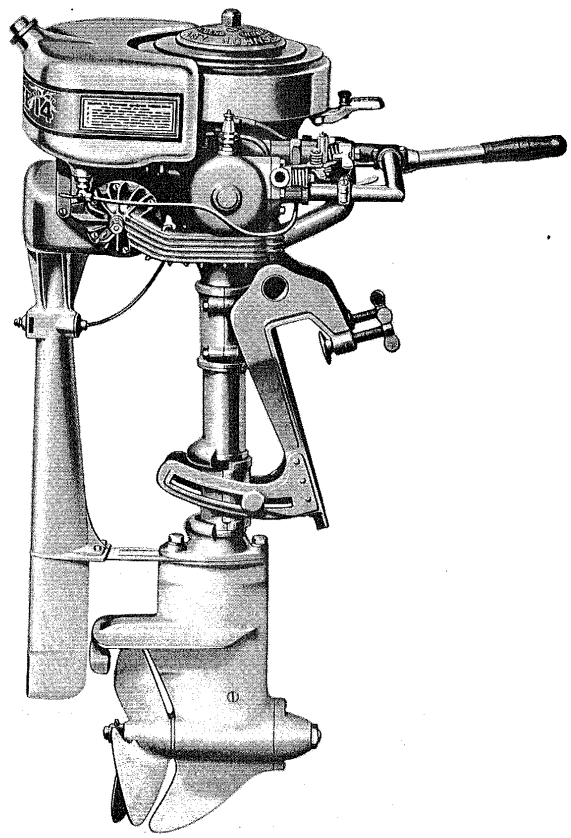
Models 200-210



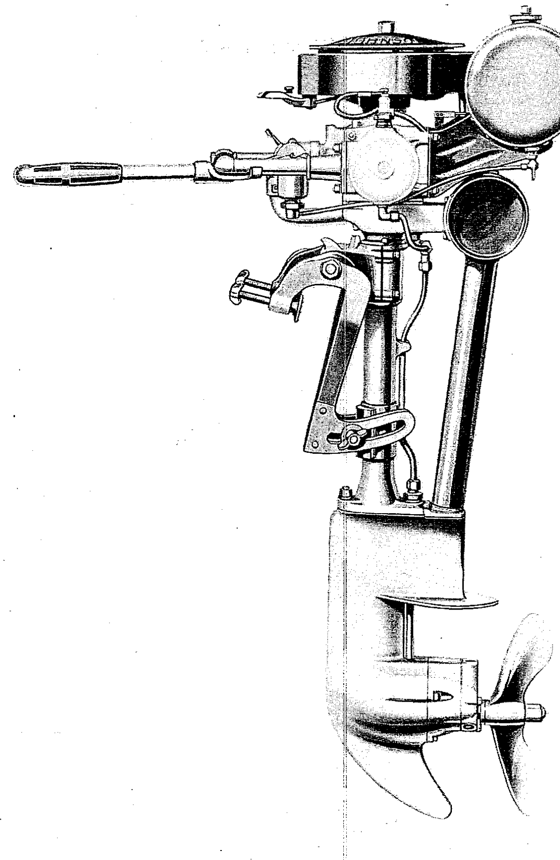
Model 300



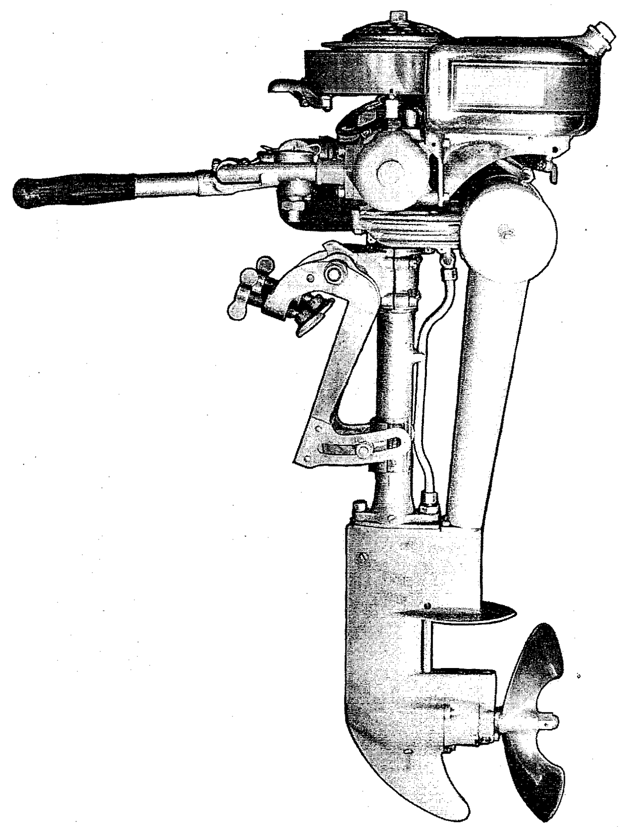
Models K-35-40, P-35-40



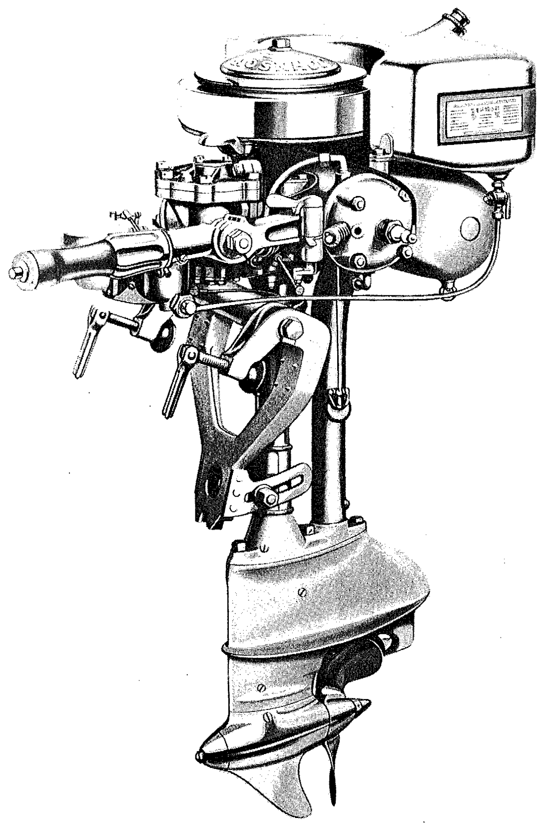
Models K-45, P-45



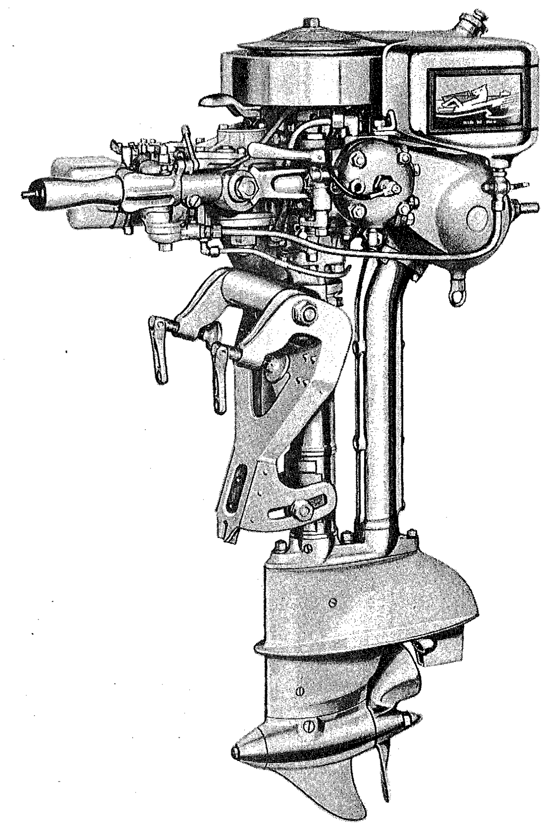
Model OK-55



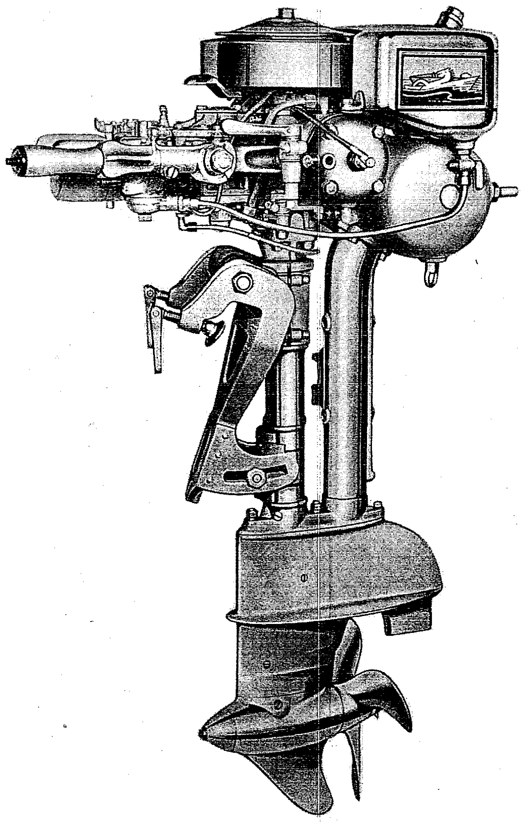
Models OK-60-75



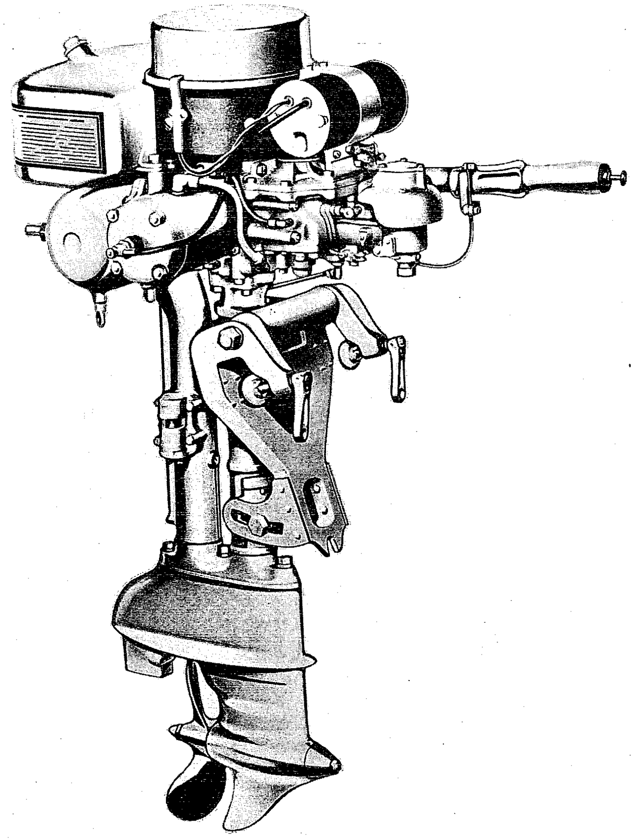
Model S-45



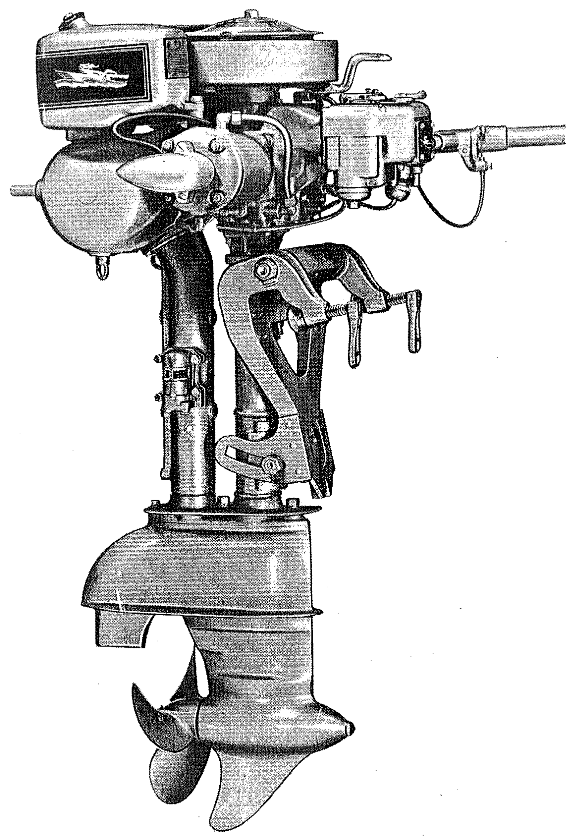
Models S-65-70



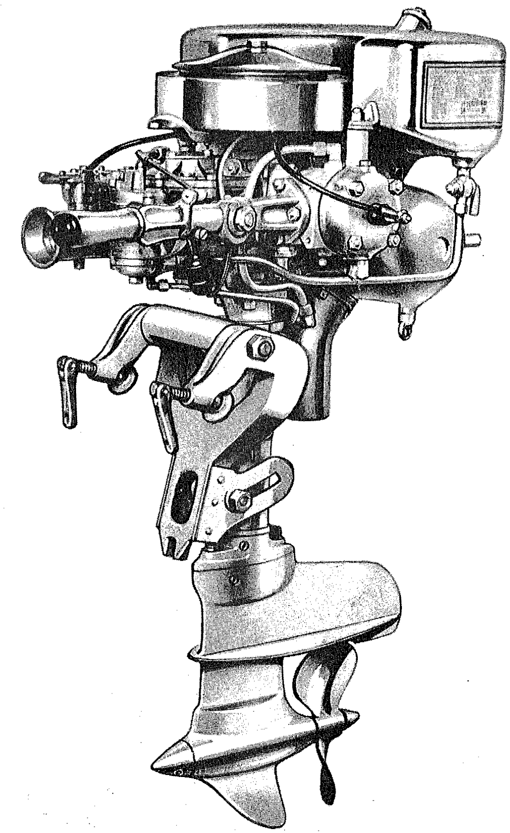
Models P-50-65-70



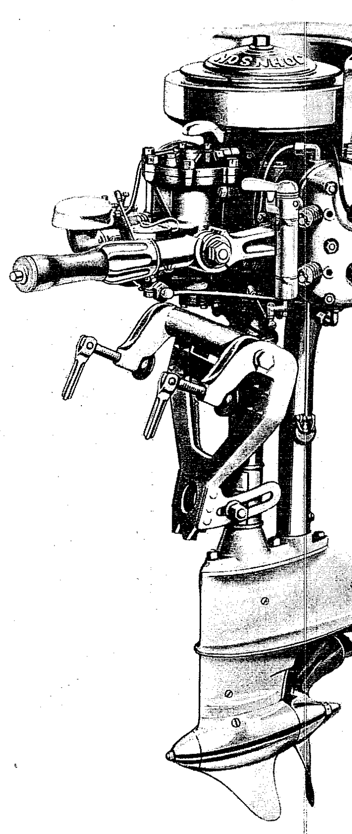
Models SE-50, PE-50



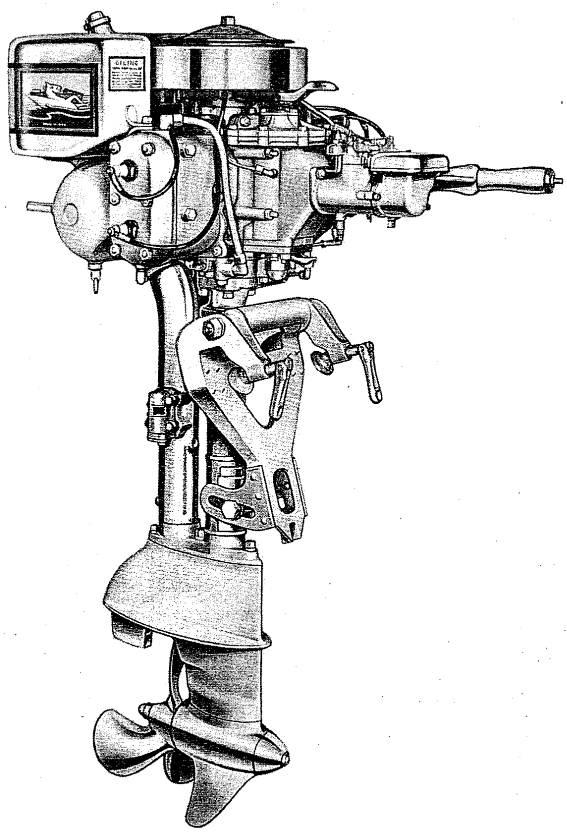
Models P-75, PO-15



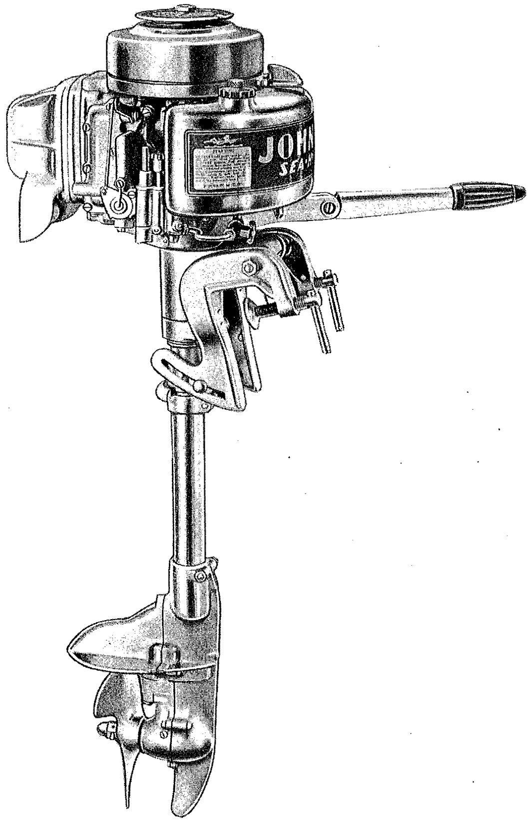
Models SR-PR (Racing)



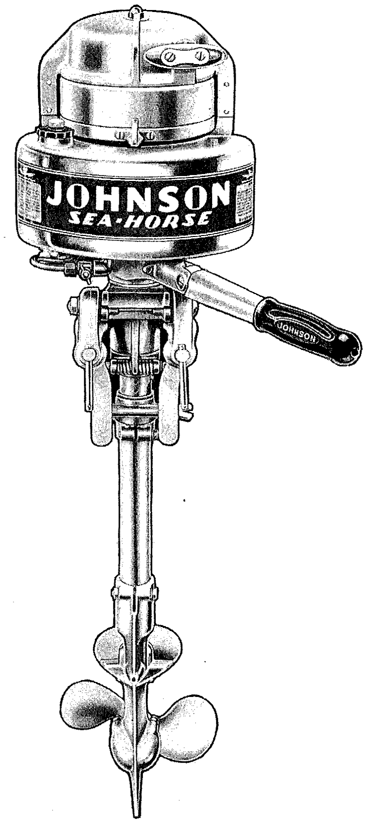
Model V-45



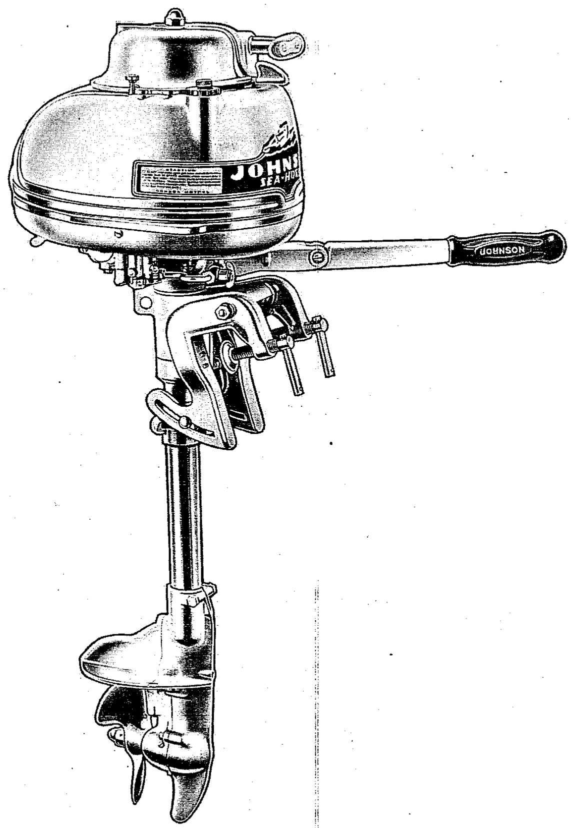
Models V-65-70



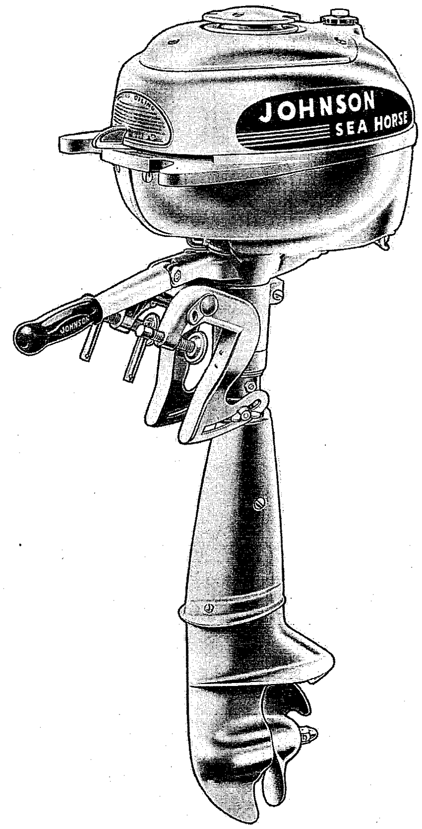
Model HS-39-10-15



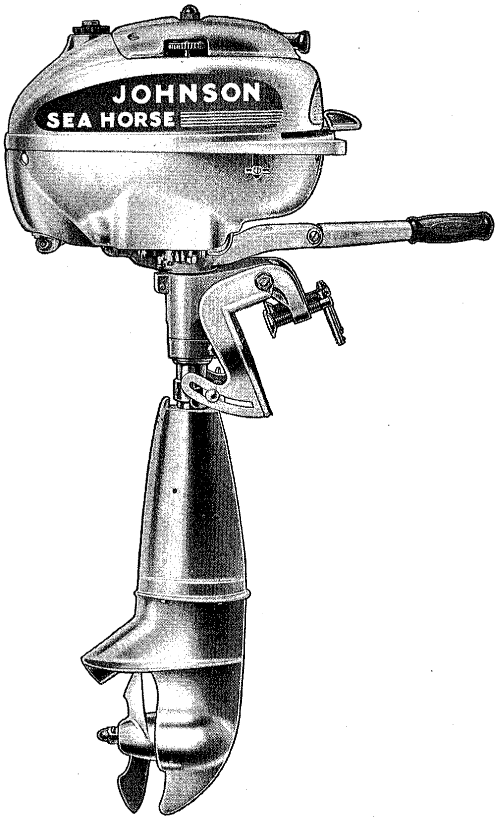
Model HA-39-10-15



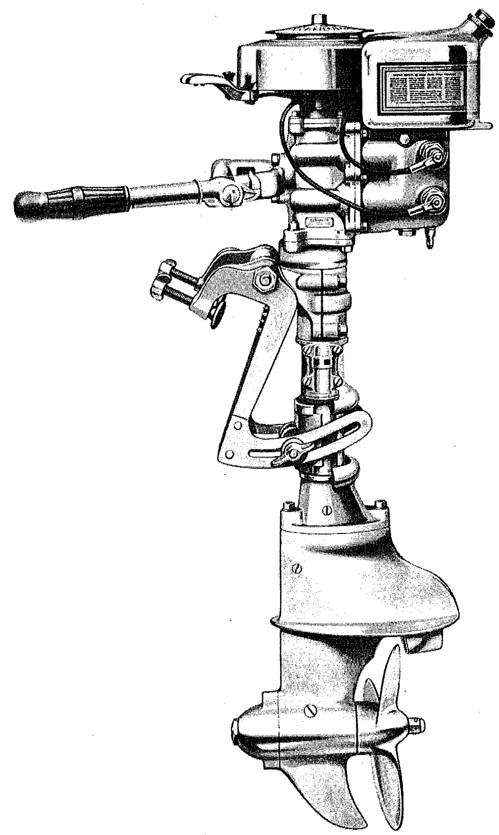
Model HD-39-10-15



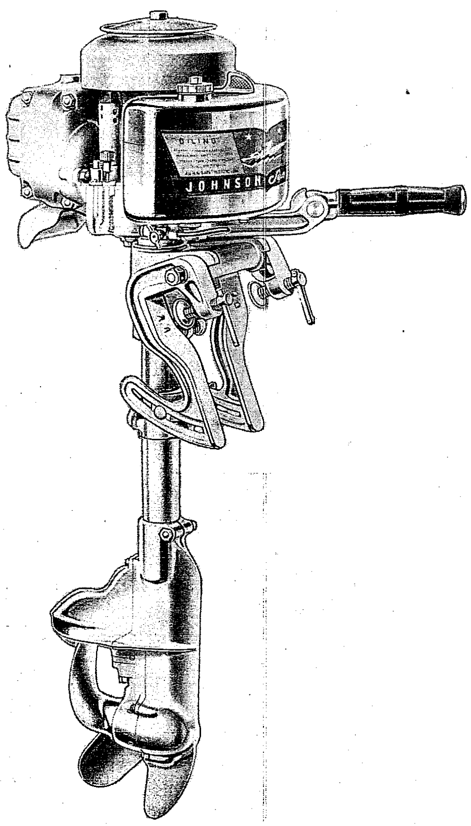
Model HS-20



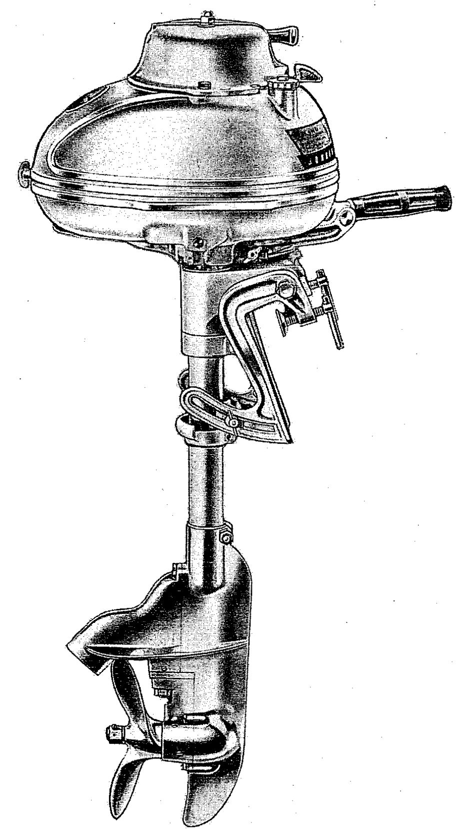
Models HD-20-25



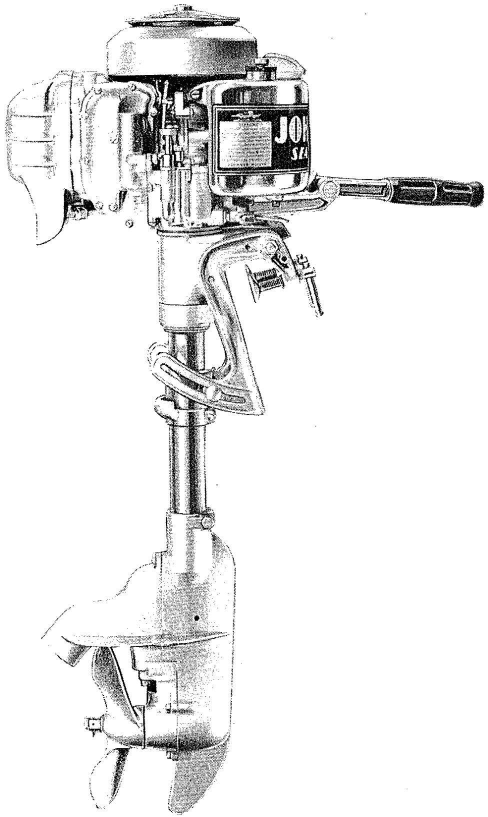
Models A-50-65-70—80, AA-37, K-50-65-70-80



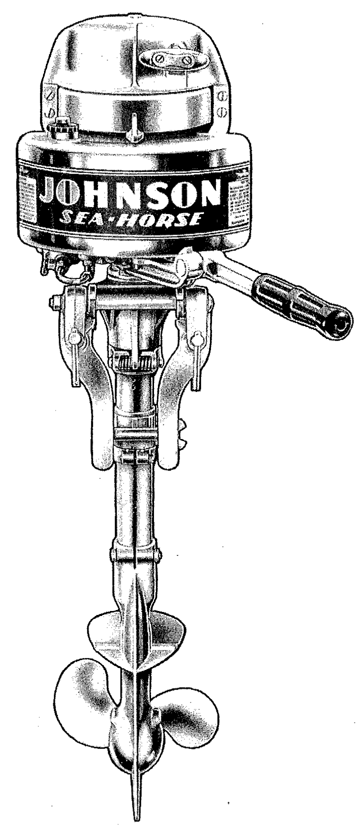
Models LT-37-38



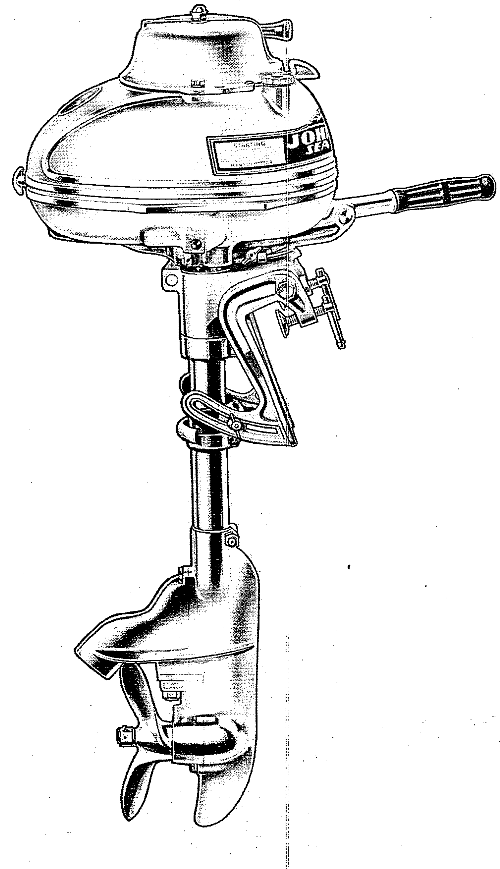
Models DT-37-38



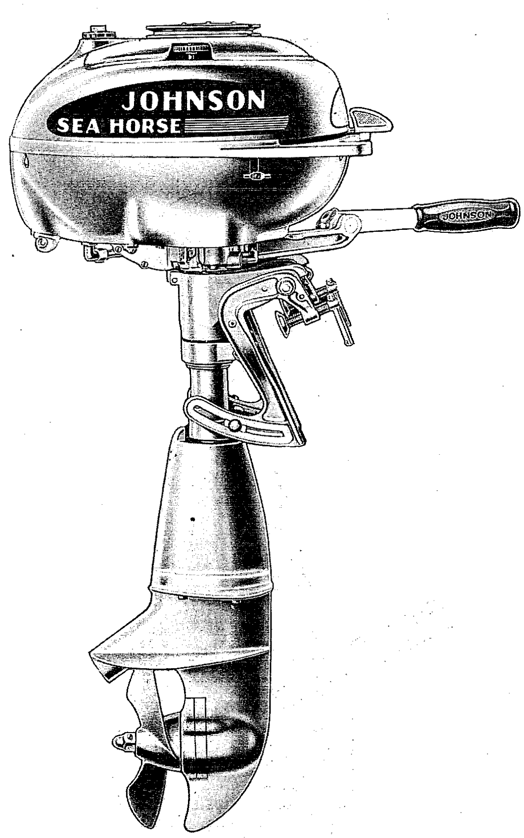
Models LT-39-10



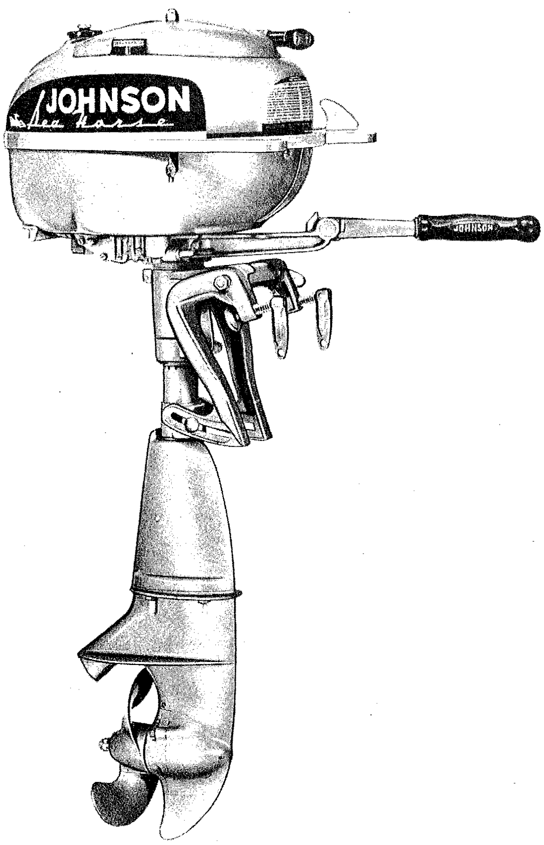
Models AT-39-10



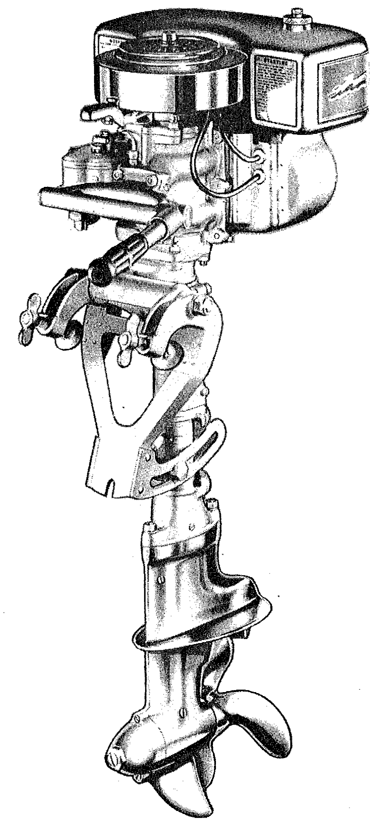
Models DT-39-10



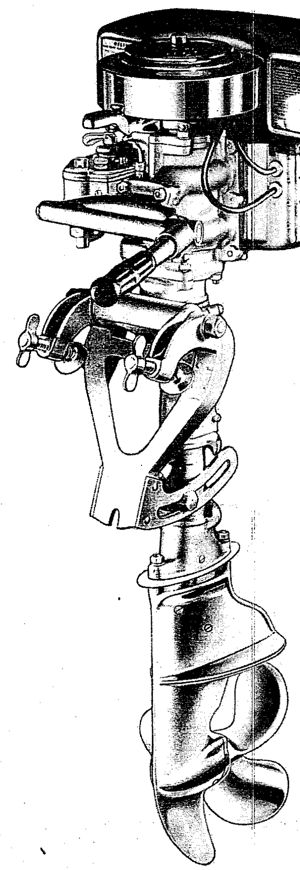
Models TS-15-20



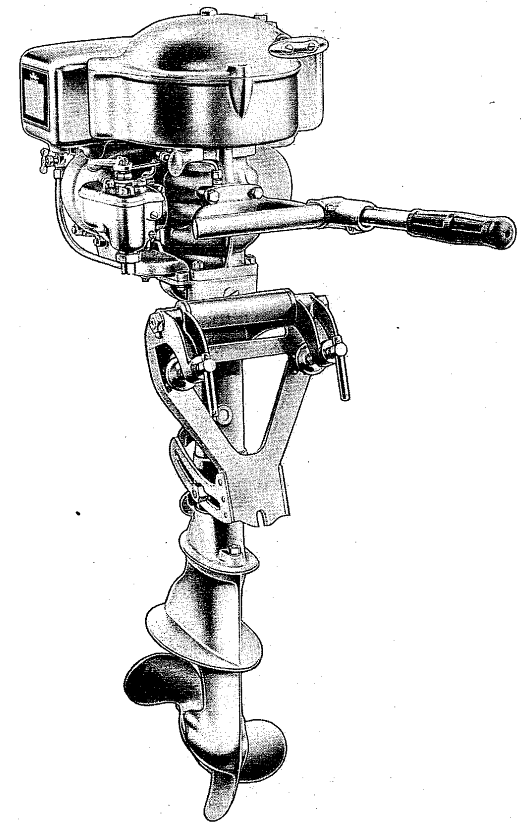
Models TD-15-20



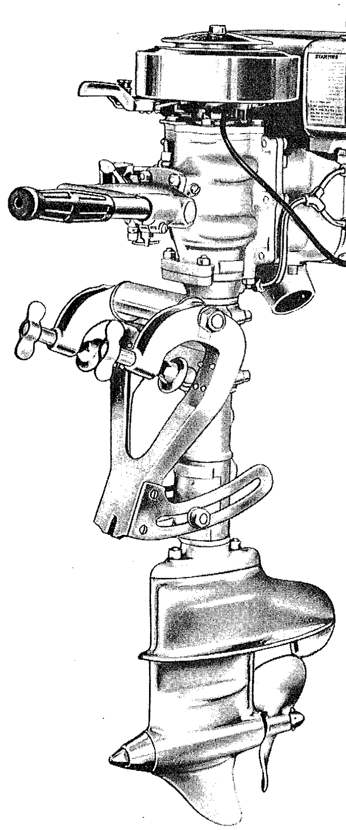
Models K-75, A-75



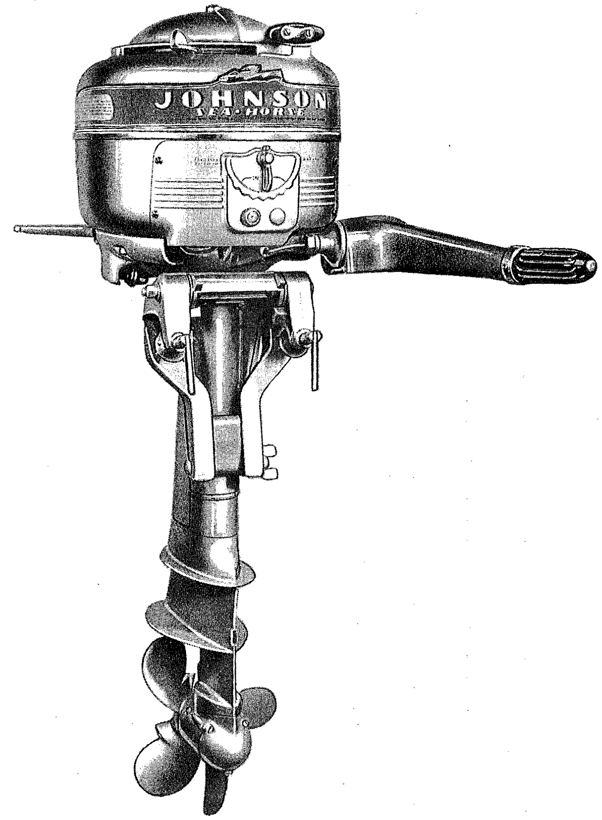
Models KA-37 to KS-15



Model KD-15

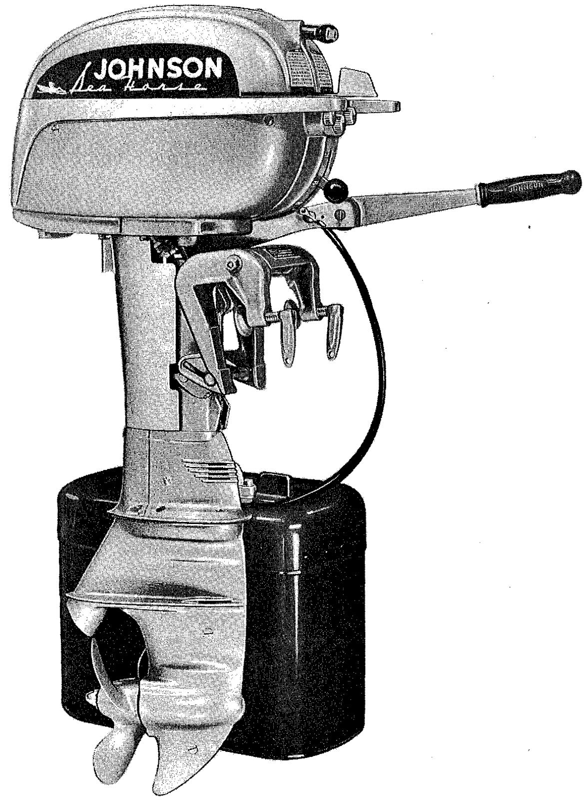


Model KR (Racing)

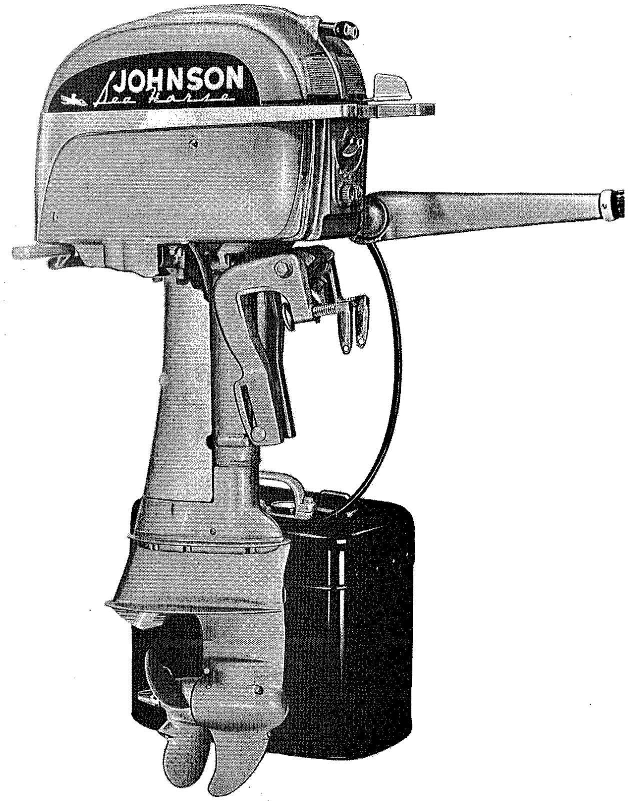


Models SD-10-15

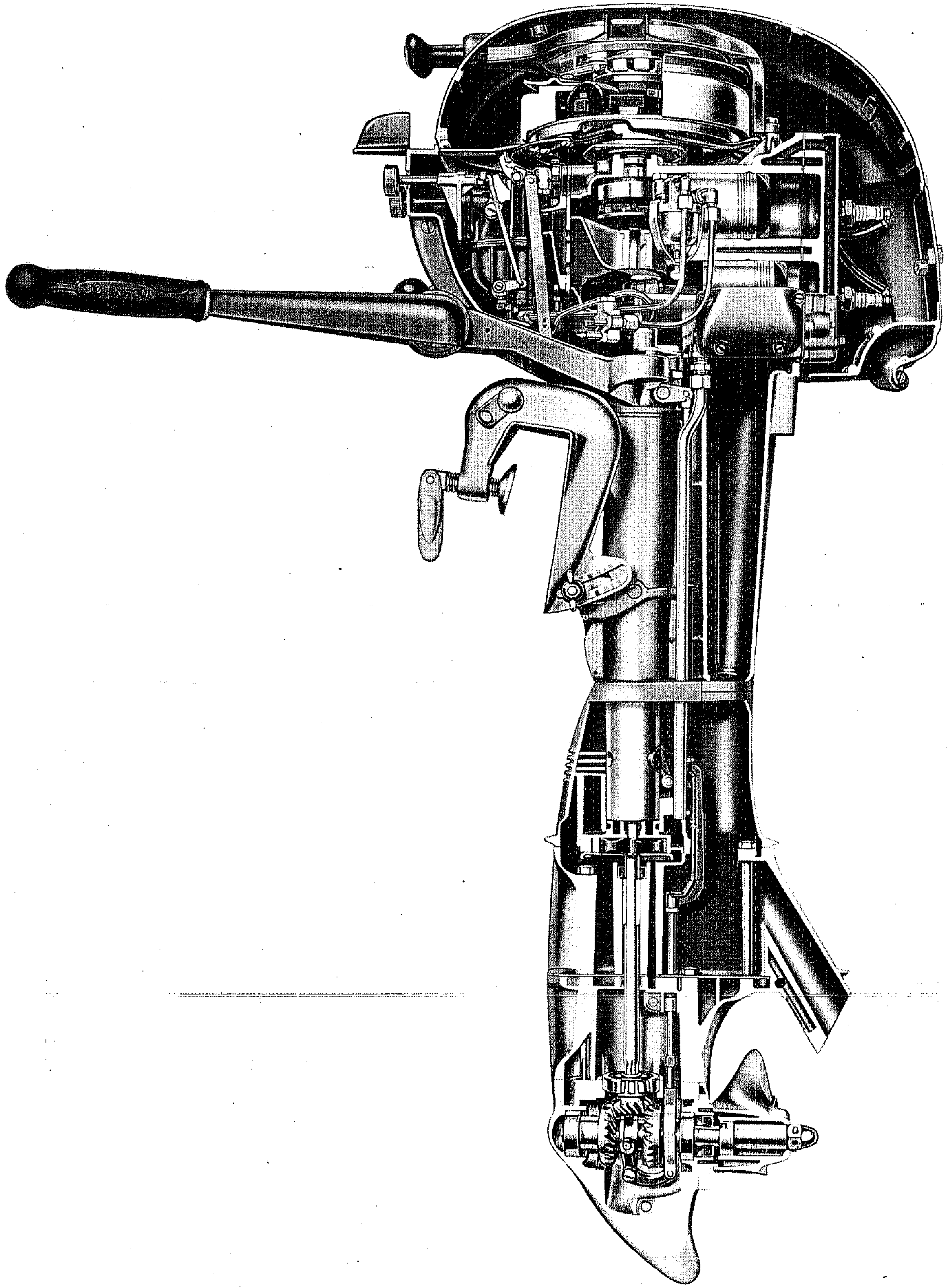
NOTES



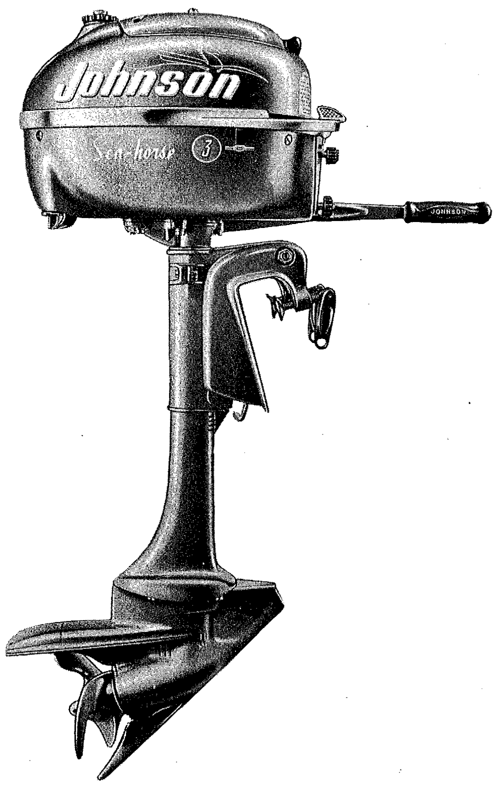
Model QD-10



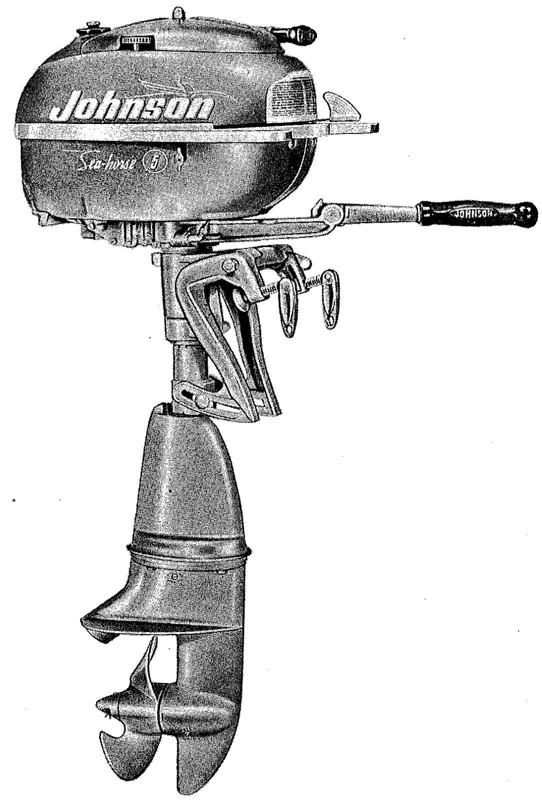
Model SD-20



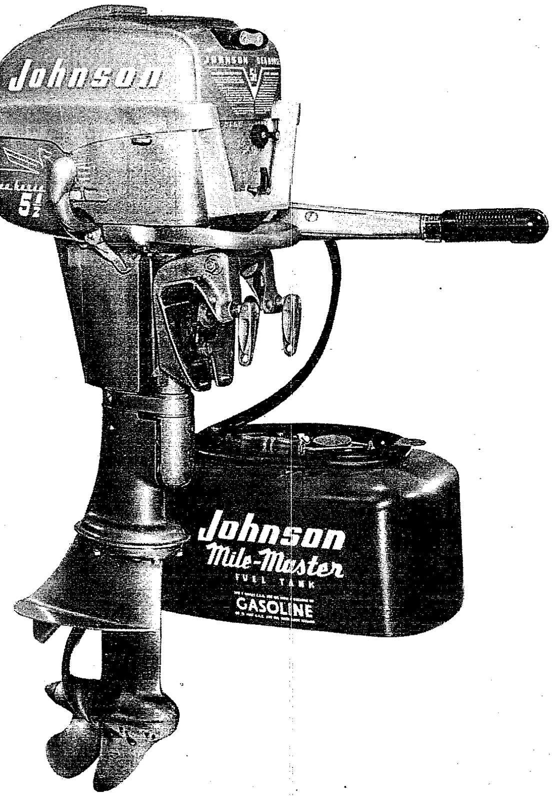
Model QD-10 (Sectionalized)



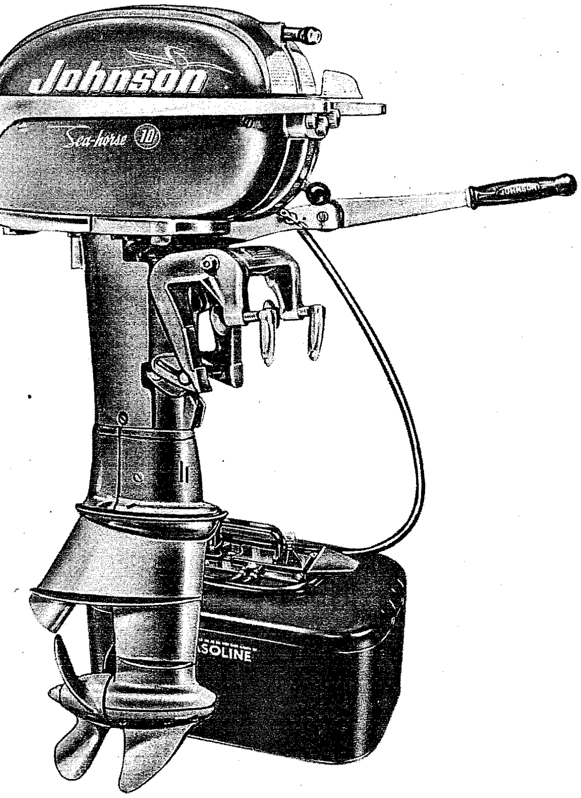
Model JW



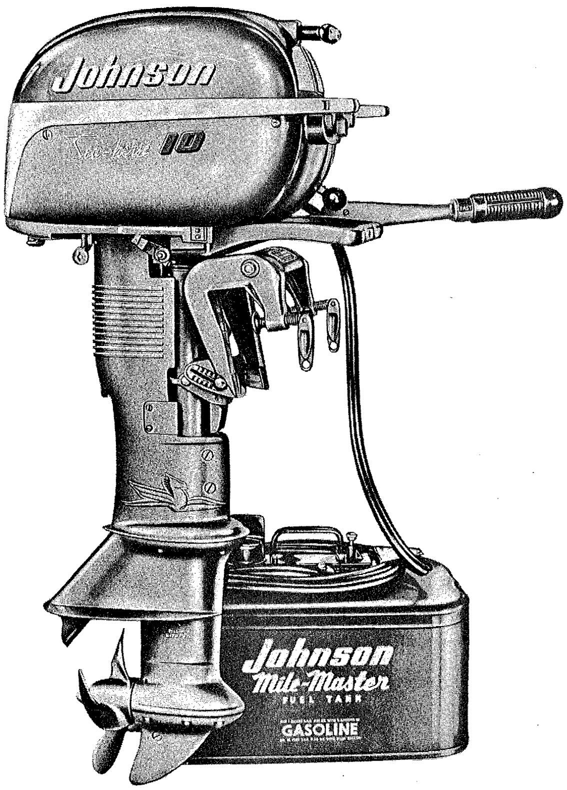
Model TN



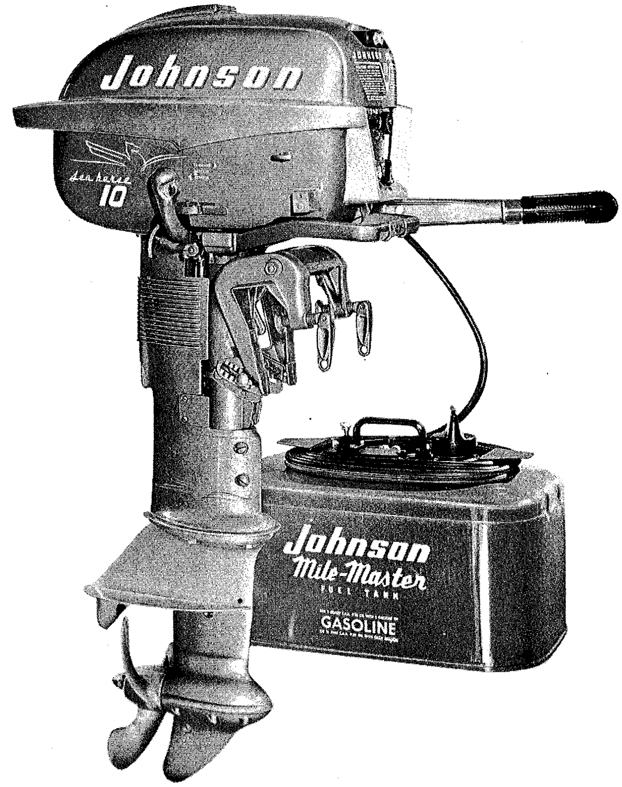
Model CD



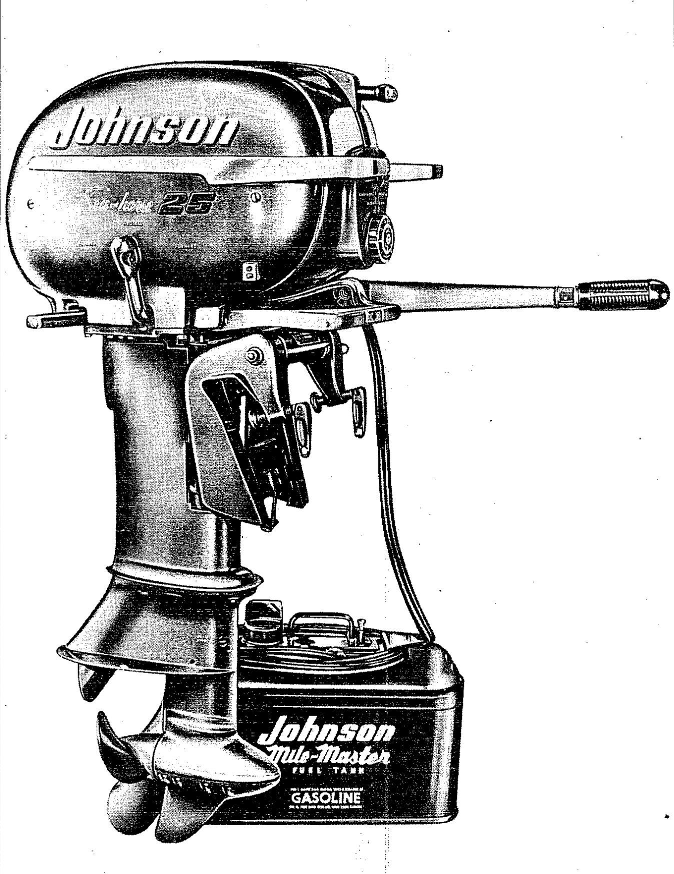
Model QD-12-13



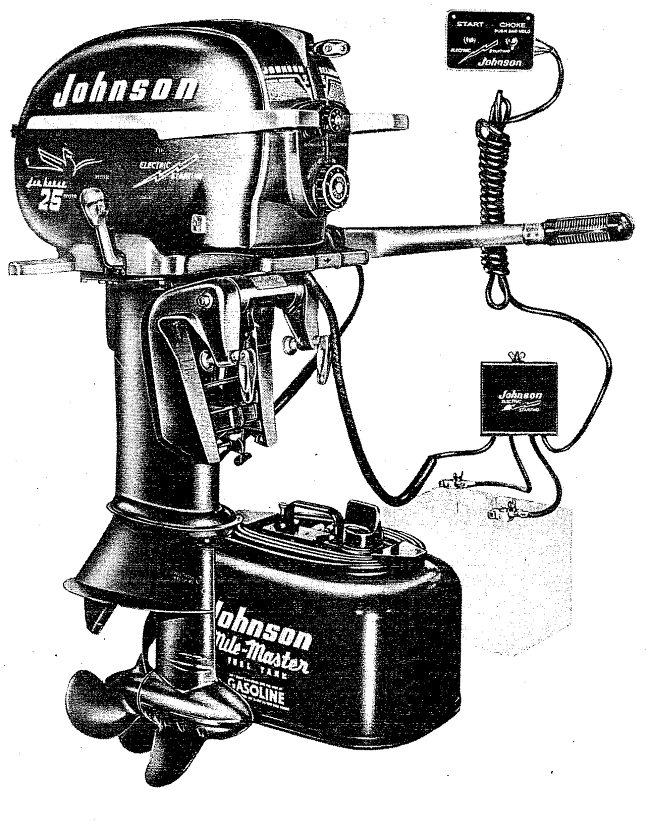
Model QD-14



Model QD-15

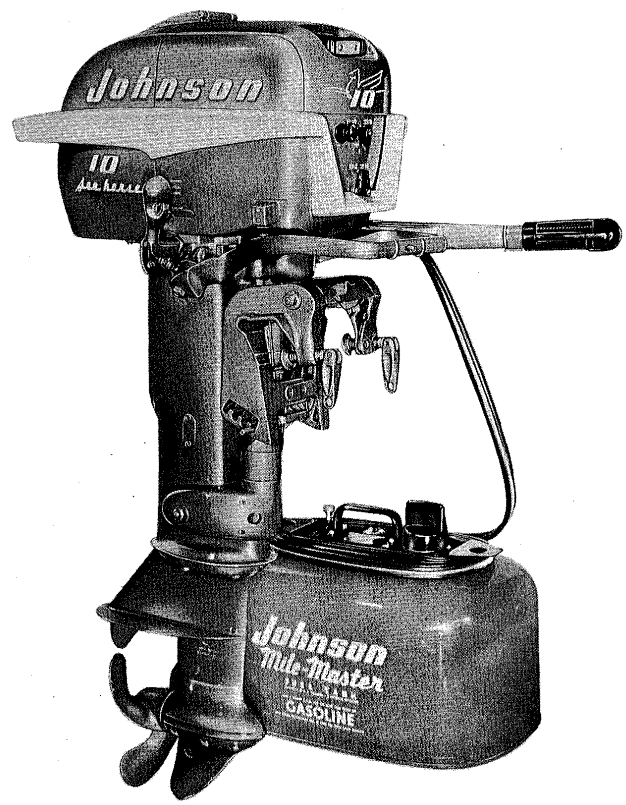


Model RD

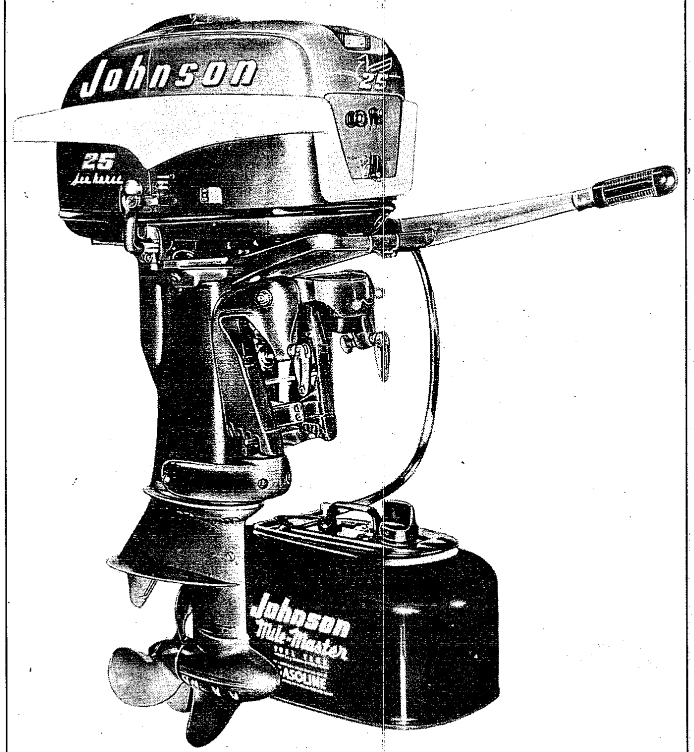


Model RDE

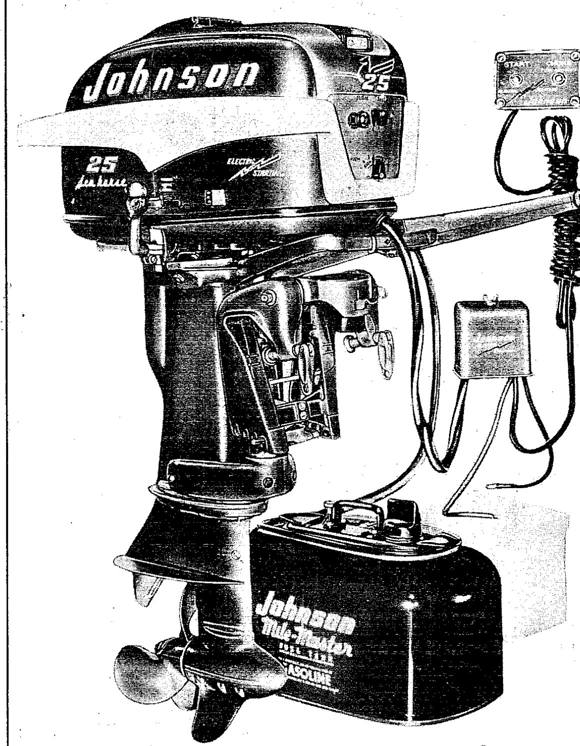
Model CD-12



Model QD-16



Model RD-17



Model RDE-17