

JOHNSON

JOHNSON MOTORS
2600 Pershing Rd.
Waukegan, Illinois

CONDENSED SERVICE DATA

Series Year Produced	KX	ND	RD	SD
1955.....	_____	RD-17	_____	_____
1956.....	_____	RD-18, RD-18	_____	_____
1957.....	_____	_____	RD-19, RD-19	_____
1958.....	_____	_____	RD-19C, RD-20	_____
1959.....	_____	_____	RD-21, RD-21	_____
1960.....	_____	_____	_____	RD-21, RD-21
1961.....	_____	_____	_____	RD-22, RD-22
1962.....	KX-10C	_____	_____	RD-24, RD-24
1963.....	_____	_____	_____	KX-24
1963.....	KX-21A	_____	_____	RD-25D, RD-25D
1963.....	_____	_____	_____	KX-25D
TUNE-UP				
Rp @ 1200.....	28 @ 4500	30 @ 4500	35 @ 4500	40 @ 4500
Bore—Inches.....	2 1/4	2 1/4	2 1/2	3 A
Stroke—Inches.....	2 1/4	2 1/4	2 1/4	2 1/4
Number of Cylinders.....	2	2	2	2
Displacement—Cu. In.....	35.7	35.7	40.5	43.8
Spark Plug				
Champion.....	14J	N7	N7	54J
AC.....	M42X	M44C	M44C	M42X
Auto-Lite.....	A21X	A3X	A3X	A31X
Electro Gap.....	0.030	0.030	0.030	0.030
Magneto Point Gap.....	0.020	0.020	0.020	0.020
Magneto Timing.....	_____	_____	See Text	_____
Carburetor Mixture.....	_____	_____	Own	_____
Carburetor Adjustment.....	_____	_____	See Text	_____
Fuel-Oil Ratio.....	24:1	20:1	24:1	24:1
SPES—CLEARANCES				
Piston Rings				
End Gap.....	_____	_____	0.007-0.017	_____
Side Clearance.....	0.005-0.0045	0.0045-0.007	0.005-0.0065	0.005-0.0065
Piston Skirt Clearance.....	0.0035-0.004	0.0025-0.004	0.0035-0.004	0.0035-0.004
Crankshaft Bearing Diameters				
All Main Bearings.....	_____	_____	2.995-1.000	_____
Crankpin.....	_____	_____	2.1825-1.1815	_____
Crankshaft Ring Clearances				
Driveshaft Bushing—Upper				
Clearance in Housing.....	_____	_____	_____	0.0008-0.0023
Clearance on Shaft.....	_____	_____	0.005-0.003	0.001-0.003
Piston Shaft Bearing				
Diametral Clearance.....	_____	_____	Roller Bearing	_____
Propeller Shaft Bearing				
Diametral Clearance.....	_____	_____	_____	_____
Propeller End.....	_____	_____	Ball Bearing	_____
Forward End.....	_____	_____	Tapered Roller	_____
TIGHTENING TORQUES				
(All Values in Inch-Pounds Unless Noted)				
Connecting Rod				
9/32-Inch Screws.....	_____	215-222	210-222	215-222
5/16-Inch Screws.....	248-272	_____	_____	248-272
Compressor Nuts				
Center Screws.....	145-168	105-108	102-108	162-167
Edge Center Screws.....	144-168	144-208	144-208	144-168
Cylinder Head.....	108-130	218-240	218-240	168-190
Inlet Manifold.....	24-30	24-30	24-30	24-30
Exhaust Manifold.....	60-84	60-84	60-84	60-84
Flywheel.....	100-100	750-790	720-790	100-100
Spark Plug.....	240-240	240-240	240-240	240-240

LUBRICATION

The power head is lubricated by oil mixed with the fuel. On motors produced before 1958, mix 16-pint outboard motor oil with each gallon of unleaded gasoline. On 1958 and later motors, use 16-pint oil with each gallon of fuel. If outboard motor oil is not available, use a good grade of regular "Type NM" SAE 30 motor oil. Regular gasoline may be substituted for unleaded gasoline, however the anti-knock components may shorten spark plug life. Mix gasoline and oil thoroughly, using a separate container, before pouring mixture into fuel tank.

The lower unit gears and bearings are lubricated by oil contained in the gearcase. Special Outboard Marine Corporation, Type "C" Lubricant should be used. This lubricant is supplied in a tube, and filling procedure is as follows: Remove lower plug from gearcase and attach tube. Remove upper (vent) plug from case and, with motor in upright position, fill gearcase until lubricant reaches level of upper (vent) plug hole. Reinstall vent plug; then remove lubricant tube and reinstall lower plug. Tighten both plugs securely, using new gaskets if necessary, to provide a water tight seal. If OMC Type C lubricant is not available, gearcase may be temporarily filled with outboard motor oil through vent (upper) plug opening. If outboard oil is used, drain and refill with OMC Type C lubricant as soon as possible. Lower gear lubricant should be maintained at level of vent plug, and drained and renewed after every 100 hours of operation.

FUEL SYSTEM

CARBURETOR. A float type carburetor is used on all models. Refer to Fig. 143 or 144. Normal initial setting for low speed mixture needle (20) is 1 turn open. On models so equipped, initial setting for high speed mixture adjustment needle (20) is 1/4 turn open. Final adjustment be made when motor is in operation, by turning knobs on control panels. Clockwise rotation of both needles leans the mixture. Low idle speed can be adjusted by turning screw shown in Fig. 143 or 144.

To set the carburetor float level, remove the shroud and control panel; then unhook and remove the carburetor. Remove the float chamber and level the carburetor body with float attached as shown in Fig. 142. The upper surface of float lower surface when assembly is levered) should be level and flush with gasket surface of carburetor body as shown. If it is not, carefully bend float lever; then check other assembly to be sure the float does not bind or rub.

Some models are equipped with an electrically operated choke which employs a carburetor mounted solenoid as shown in Fig. 144. To adjust the choke, loosen band (X) and pull out manual choke control until choke is fully closed. Push solenoid housing through band as indicated by arrow, until plunger bottoms in housing. Tighten band at this point; then check to see that choke operates properly.

Some forty horsepower (1950 and other) models are equipped with an automatic choke (93 through 106—Fig. 141). The coiled bimetal thermal unit is contained in cover unit (97) and is only available in the assembly. A water pocket is built into housing (98) and water at engine temperature passes around thermal unit through hoses (105 & 106) to control the choke opening. Cover unit (97) also houses a diaphragm (96), the

lower side of which is connected to manifold vacuum by means of hose (94). When the motor is not running, spring (93) operates through plunger on diaphragm (96) to close the choke. As soon as engine is started, manifold vacuum moves the diaphragm downward against spring pressure which will allow the choke to partially open against the lighter pressure of the coiled thermal unit spring. As motor warms up,

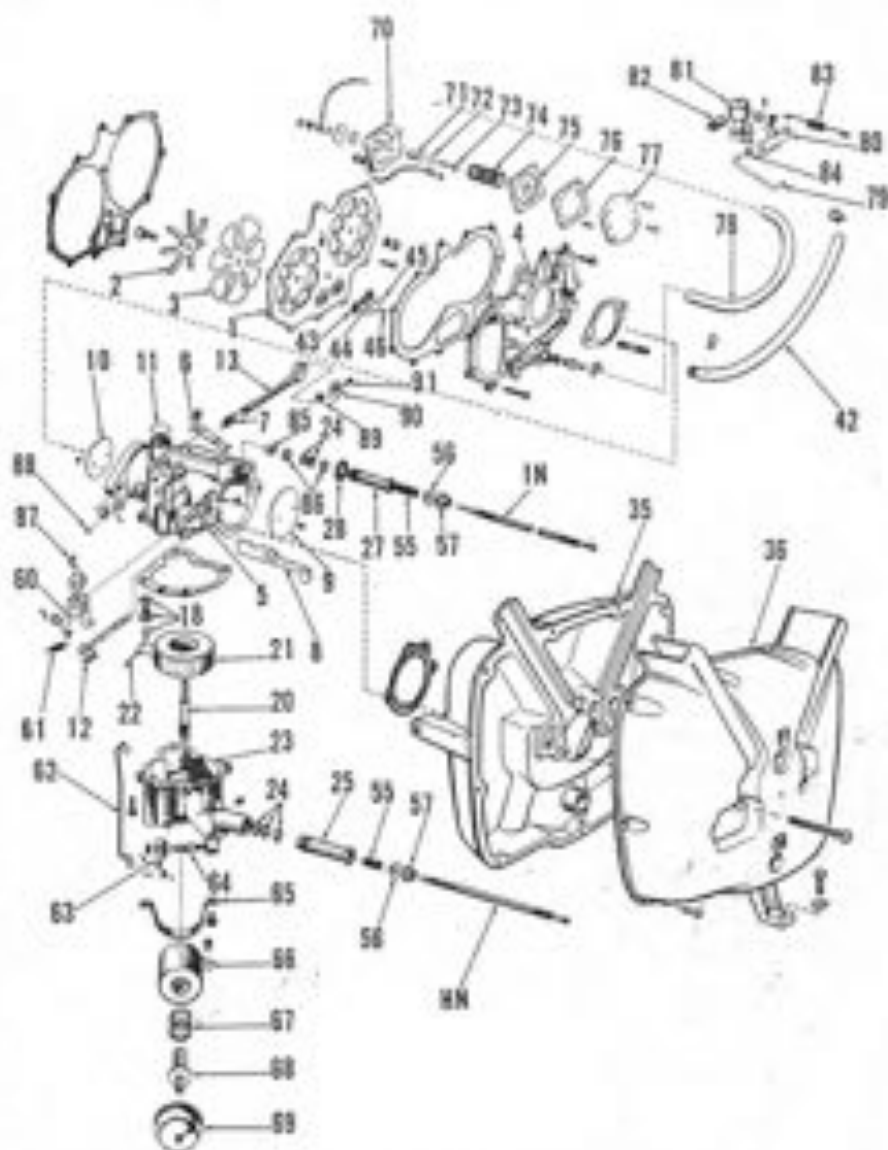


Fig. 142—Exploded view of carburetor and reed valves assembly used on EBE motors. EJE-19, EJE-19M and ESL-20 are similar. Carburetor for ED motors is similar except that solenoid actuated choke (142 through 193) is not included.

10. Low speed needle	36. Main needle	57. Grommet	75. Diaphragm
10M. High speed needle	37. Float	58. Bellcrank	76. Gasket
1. Reed plate	38. Float chamber	59. Spring	77. Adapter
2. Reed stop	39. Packing	60. Choke link	78. Shim
3. Reed pin	40. Packing nut	61. Lever	79. Throttle link
4. Solenoid assembly	41. Packing nut	62. First shaft	80. Throttle lever
5. Carburetor body	42. Washer	63. Clamp band	81. Cam follower
6. Spring	43. Air cleaner	64. Solenoid (body)	82. Spring
7. Retort spring	44. Cover	65. Spring	83. Spring
8. Choke rod	45. Fuel line	66. Plunger	84. Bushing
9. Choke valve	46. Check valve	67. Cover	85. Bushing
11. Plug	47. Spacer	68. Out-out switch	86. Washer
12. Choke shaft	48. Spring	69. Body	87. Lever
13. Throttle shaft	49. Screw	70. Topping	88. Out Plug
14. Jet needle & seat	50. Spring	71. Washer	89. Cam follower
	51. Washer	72. Screw	90. Clamp
	52. Washer	73. Spring	91. Screw

the best acts on the coiled thermal unit to relax spring tension and allow choke to fully open.

Very little trouble is normally encountered with the automatic choke assembly. In cases of malfunction, first check the temperature control by malfunction of cooling system thermostat or plugging of coolant hoses (122 & 126) or water jacket in choke housing (96). A quick check which is usually effective is to feel of choke housing (96) after engine has been running a few minutes. If housing is unaccountably warm to the touch, temperature is probably satisfactory, and remainder of system should be checked. Any condition which interferes with the vacuum balance of the choke unit

Fig. J42—When carburetor body is inserted, flange should be even and flush with gasket surface as shown.

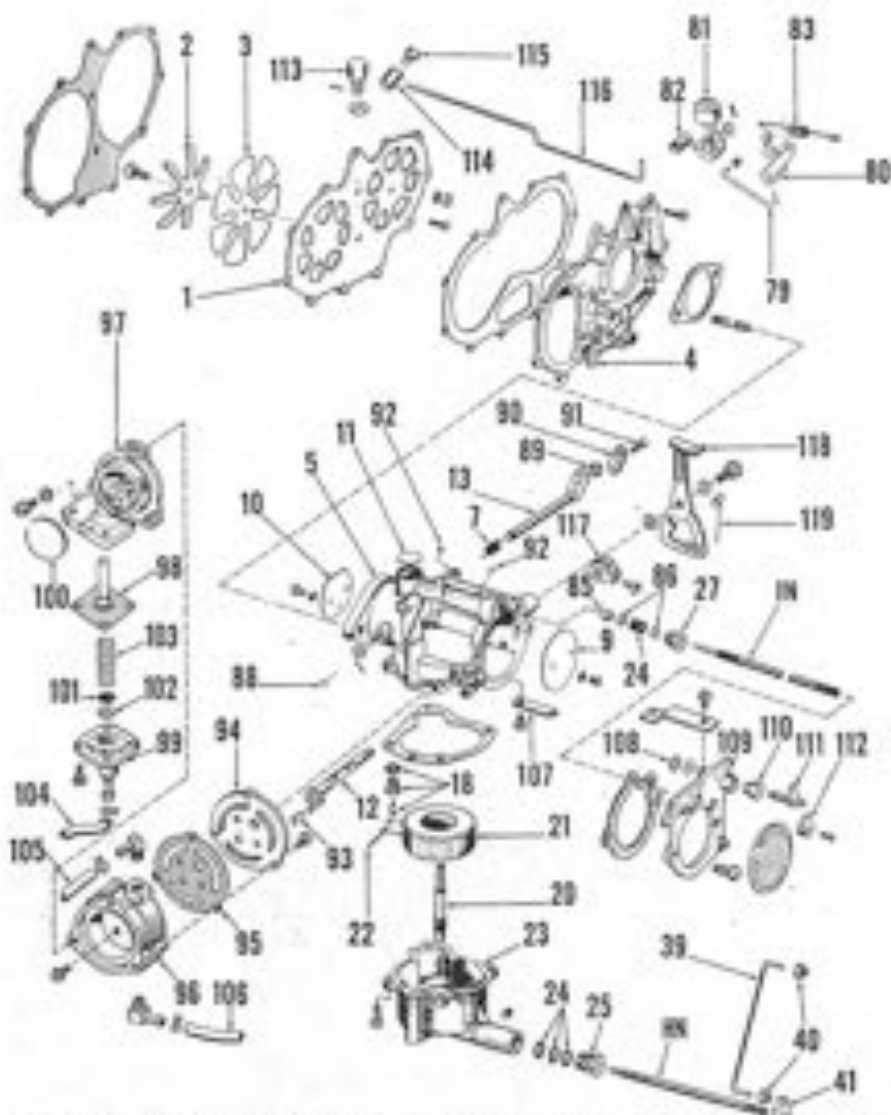
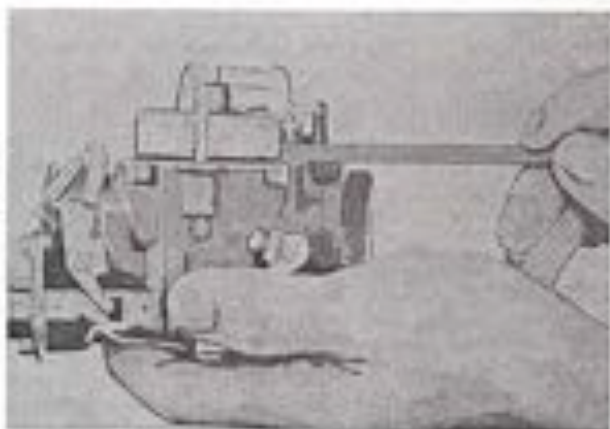


Fig. J41—Exploded view of RD5-22 and RD523C carburetor and reed valves. Late RD, RDS and RK carburetors use a fixed jet instead of high speed needle (HN). Model RK carburetor is similar except automatic choke is not used.

- | | | | |
|-------------------|-----------------------|--------------------------------|----------------|
| 88. Link rod | 97. Choke cover | 100. Outlet hose | 122. Pin |
| 89. Bushing | 98. Diaphragm | 101. Spring | 124. Collar |
| 91. Intake rack | 99. Diaphragm chamber | 102. Retaining ring | 125. Set screw |
| 92. Pin | 100. Expansion plate | 103. Control panel | 126. Link rod |
| 93. Sleeve | 101. Valve seal | 104. Bushing | 127. Choke arm |
| 94. Cover | 102. Valve | 105. High speed adjusting bush | 128. Lever |
| 95. Gasket | 103. Spring | 106. Low speed adjusting bush | 129. Spring |
| 96. Choke housing | 104. Yellow hose | | |
| | 105. Water hose | | |



Fig. J43—On all series RD motors before 1940, idle speed is adjusted by the stop screw shown. Screw is located on port side of motor.

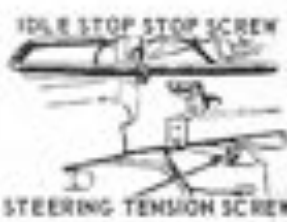


Fig. J44—View of idle speed stop screw on 1940 and later motors. Screw is on port side of motor.



Fig. J45—To adjust the choke solenoid on motors as equipped, loosen head (A), pull out manual choke linkage, and with choke fully closed, push solenoid housing in direction shown by arrow.

will allow diaphragm spring (128) to hold choke in closed position. Check for leaks in diaphragm (96), housing (98) or vacuum hose (94), or for kinks, collapses or plugging of hose. Grasp port side of choke lever (12) and check for binding by turning lever. Shaft should turn freely 45° in either direction. If the above checks fail to correct the malfunction, disassemble the automatic choke unit and/or renew cover assembly (37).

To disassemble or adjust the automatic choke unit, first scribe a line on cover (37) and housing (96) and loosen the three screws retaining cover to housing. If engine runs rich or floods when starting, turn cover slightly counter-clockwise; then retighten screws. If engine is hard to start because of insufficient choking, turn cover clockwise.

To check the operation of the automatic choke, start engine in normal manner, or by using the manual choke lever. Move manual lever to "Choke Off" position and allow engine to warm up; then adjust the high speed and slow speed carburetor adjustments. After engine is warm and carburetor is adjusted, move throttle to idle speed and move hand choke control to "Automatic" position. There should be no perceptible change in engine performance. Move hand choke control back to "Choke Off" position; then, while observing the visible end of choke shaft (12), move hand control back to "Automatic" position. Movement of the spring pin on choke arm (117) should not be more than 1/4-inch. If it is, "loosen" the choke by turning cover (37) counter-clockwise, or overhaul the unit as outlined above.

SPEED CONTROL LINKAGE. The carburetor throttle valve is synchronized to open as the ignition timing is advanced. It is very important that ignition timing and throttle valve opening be correctly synchronized to obtain satisfactory operation. Although operating principles are similar on all models, the method of adjustment has been changed. Refer to the appropriate following paragraphs for method of synchronization.

Models Before 1938 (Except 1937 Electric Start). Refer to Fig. 147. To synchronize the linkage, remove the shroud and slightly loosen the two screws (A) retaining the



Fig. 147—To synchronize throttle linkage on models before 1938, turn speed control grip until scribe line (5) is aligned with pointer (P). Loosen screws (A) securing cam (C) to armature plate. Hold throttle closed and move end of cam as shown by arrow until all slack is removed from linkage.

cam to the armature plate. Rotate the hand grip until index line (5) on cam and pointer (P) crankcase are aligned as shown. With index marks aligned, move the free end of cam out as shown by arrow, until throttle valve just begins to move from the closed position. Turn the speed control lever back and forth several times; then recheck to make sure adjustment is correct.

FUEL SAVER LINKAGE. Some 1937 and later models are equipped with a "Fuel Saver" (economizer) linkage that provides full advanced ignition timing with a cut-back carburetor throttle opening. To adjust the linkage, set speed control grip (or lever) at "fast" position. Hold the armature plate fully advanced (counter-clockwise) with the thumb and loosen the set screw on stop collar (17—Fig. 144). Move stop collar on throttle link (16) until it firmly contacts pivot (18); then tighten set screw in stop collar. Recheck to make sure that armature plate moves fully to "advanced" position when speed control grip is fully turned to fast position.

1937 Electric Start, and All 1938 and Later Models. The method of operation is similar to that of earlier models, but adjustment is accomplished differently. Refer to Fig. 148. Remove shroud and turn speed control grip (or lever) until index mark on cam and index pointer on crankcase are aligned as shown. Loosen anchor screw ("A"—lower) on throttle shaft lever and turn the eccentric bushing ("B") until all slack in linkage is taken up and throttle valve just begins to move from closed position. Tighten the anchor screw and move the speed control from slow to fast a few times; then recheck. On models equipped with "Fuel Saver," check and adjust the linkage as outlined in the previous paragraph.

REED VALVES. Two sets of reed valves (3—Fig. 140 or 141) are used. Reed valves are located between carburetor and power head crankcase, and should be checked every time the carburetor is removed for service. Reed petals should seat very lightly

against reed plate (1) throughout their entire length with the least possible tension. Check reed petal seating visually and/or by blowing and drawing air through ports with mouth. Renew petals (3) if broken, cracked, warped, rusted or bent. A broken reed petal is sometimes caused by a damaged, bent or mislocated reed stop. Sealing surface of reed plate (1) should be smooth and flat, and petals should be centered over ports. Reed stop (2) must rest over the petals of reed valve (3).

PRESURIZED FUEL TANK. Models before 1940 use a pressurized fuel tank. Pressure from the power head crankcase is conducted to the fuel tank through one of the passages in the dual passage hose. As air pressure is built up in the fuel tank, fuel is forced back through the other hose passage to the carburetor. Check valves (43) through 45—Fig. 140) are provided to prevent air pressure returning to the crankcase. A hand operated, diaphragm type fuel pump is used to provide starting fuel to the carburetor. Refer to Fig. 149 for an exploded view of the pressurized fuel tank.

Overhaul of the fuel system consists of renewal of the damaged or worn parts; however, the following items should be checked: The tank must maintain about 2 to 3 psi of air pressure to force fuel to the carburetor. Any leak in the air hose, fuel tank (around screws), tank cap gasket (43) or pressure relief valve (46) will release pressure. Also, failure of the check valves (43—Fig. 140) will prevent fuel reaching carburetor.

FUEL PUMP. Models after 1939 are equipped with a diaphragm type fuel pump as shown in Fig. 150. Pressure and vacuum pulsations in the upper crankcase is directed through a passage in the cylinder to one side of the pump diaphragm (78). Vacuum in the crankcase draws the diaphragm in as shown in view (A—Fig. 151). This diaphragm movement draws fuel past the inlet check valve (5) as shown by arrow. As piston moves downward in cylinder (view



Fig. 148—Speed control linkage used on models after 1937. Adjustment is made by loosening clamp screw (A—lower) and turning eccentric bushing (B). See text for details.

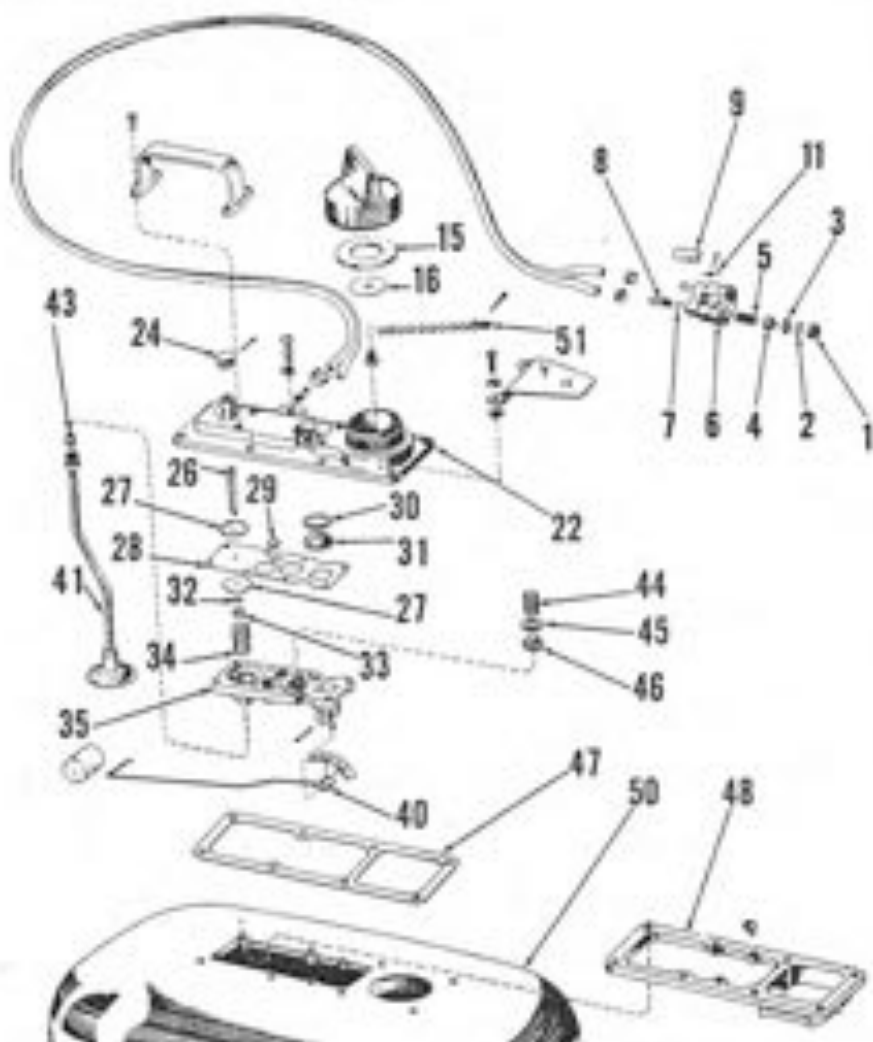


Fig. 349—Exploded view of pressurized fuel tank assembly.

- | | | | |
|--------------|-------------------|---------------------|-------------------|
| 1. Retainer | 8. Nut | 20. Push rod | 34. Spring |
| 2. 1/2" ring | 9. Lock | 21. Support washers | 35. Lower housing |
| 3. Washer | 10. Spring | 22. Pump diaphragm | 40. Fuel stage |
| 4. Valve | 11. Gasket | 23. Seal valve | 41. Inlet tube |
| 5. Spring | 12. Flare | 24. Seal | 42. Gland |
| 6. Connector | 13. Housing | 25. Gland | 43. Spring |
| 7. Washer | 14. Primer button | 26. Lockwasher | 44. Washer |
| | | 27. Nut | 45. Valve |

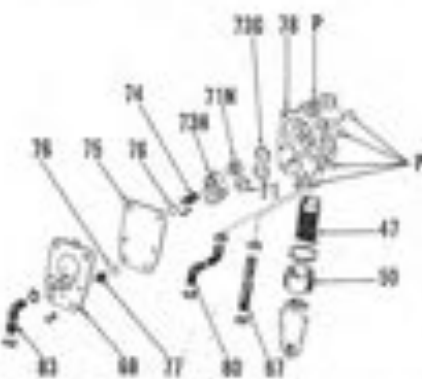


Fig. 350—Exploded view of fuel pump and strainer used on some late ED motors.

- | | |
|-------------------|-------------|
| 1. Ring | 100. Gasket |
| 2. Filter element | |
| 3. Nut | |
| 4. Fuel line | |
| 5. Pump cover | |
| 6. Outlet valve | |
| 7. Inlet valve | |
| 8. Gasket | |
| 9. Valve holder | |
| 10. Spring | |
| 11. Diaphragm | |
| 12. Support | |
| 13. Spring | |
| 14. Housing | |
| 15. Inlet hose | |
| 16. Hose | |

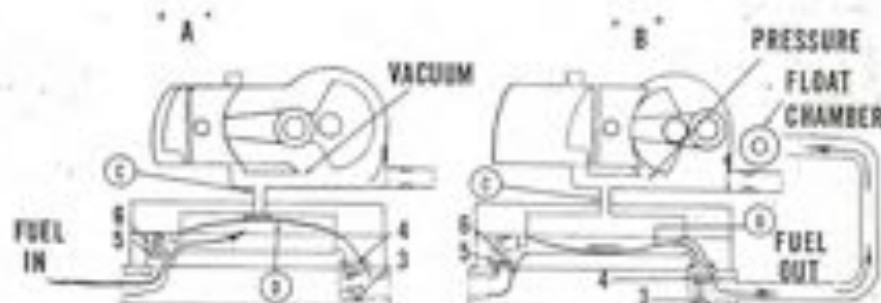


Fig. 351—Schematic view showing operation of the crankcase operated, diaphragm fuel pump. Pressure and vacuum positions from crankcase pass through connection (C) to rear of diaphragm (D) which induces a pumping action on fuel line as shown.

- | | |
|-----------------------|----------------------|
| 3. Valve spring | 6. Inlet check valve |
| 4. Outlet check valve | 5. Valve spring |

"B"), pressure is introduced to back side of diaphragm forcing fuel out past the outlet check valve (4) as shown.

All defective or questionable parts should be renewed. Diaphragm (7)—Fig. 350 should be renewed if air leaks or cracks are found, or if its condition is in any way questionable.

CRANKCASE BLEEDER VALVE. All models are equipped with a crankcase bleeder valve (21—Fig. 314) designed to remove any liquid fuel or oil which might build up in crankcase. The reed type bleeder valve thus provides smoother operation at all speeds and lessens the possibility of spark plug fouling during slow-speed operation. There is a small passage leading from the bottom of each crankcase to the bleeder valve location at bottom of power head. Any condensed liquid thus accumulates in the bleeder pocket and passage until the piston travels its downward stroke. The crankcase pressure caused by the downward stroke of piston forces the bleeder valve off its seat and blows the liquid out into the exhaust passage.

When engine is overhauled, bleeder passages should be blown out with compressed air. The bleeder valve reed should exert a slight pressure against the crankcase. Seating surface should be smooth and flat. Valve reed should be renewed if broken, cracked, warped, rusted or bent.

IGNITION

Breaker point gap should be 0.022, and can be adjusted through inspection opening in flywheel after recoil starter assembly is removed.

For a quick test of magneto condition, remove the spark plugs and hold spark plug wires about 1/4-inch away from cylinder head. Have someone spin the motor and note the condition of spark. Although spark may not be visible in bright daylight, a distinct snap will be noted as spark jumps the gap. If spark is weak or erratic, adjust the points as outlined above. Be sure to note point condition. If spark is weak, although points are in good condition and properly adjusted, remove the flywheel and examine the condition of points, condenser and coil wiring, and the insulation on the magneto coils. Look for broken or worn in-

valution or broken wires. Also check for loose or corroded connections. Disconnect the control or stop switch wiring to check for shorts or defective switch. Renew any parts which are damaged or in poor condition. Renew crankshaft upper seal whenever magneto is overhauled.

NOTE: When installing the flywheel on 40 horsepower (1944 and later) engines, follow the procedures outlined in subparagraph FLYWHEEL under the POWER HEAD section of this manual.

COOLING SYSTEM

WATER PUMP. All models are equipped with a rubber impeller type water pump. Impeller is mounted on and driven by the drive shaft in the lower unit. Refer to Fig. 351.

The main water scoop is located below the exhaust outlet, above and aft of the propeller. When cooling system problems are encountered, first check the water inlet for plugging or partial stoppage; then if not corrected, remove the lower unit or out-

board in the appropriate section and check the condition of the water pump, water passages, gaskets and sealing surfaces. On motors so equipped, also check the thermostat as outlined in the following paragraph.

THERMOSTAT. Model ED, EDC and EK motors after 1954 are equipped with a cooling system thermostat located at top of cylinder head as shown in Fig. 355. When thermostat is closed, coolant water is bypassed back to inlet side of water pump and recirculated until coolant temperature reaches the thermostat opening temperature of 130-150 degrees F. When motor reaches operating temperature, a sufficient quantity of coolant is discharged to maintain operating temperature.

POWER HEAD

BAR AND DISASSEMBLE. To overhaul the power head, clamp the motor on a stand or support and remove the shroud, control panel, intake silencer, and lower cover pan. Remove starter unit or units, flywheel, magneto armature plate, carburetor and inlet manifold. Refer to Fig. 354.

Remove armature plate support (11) and retainer (12), speed control lever (13) and outer and inner exhaust covers (20 & 28). Remove cylinder head (5) and put and starboard brackets (21 & 25); then unbolt and remove power head from lower unit.

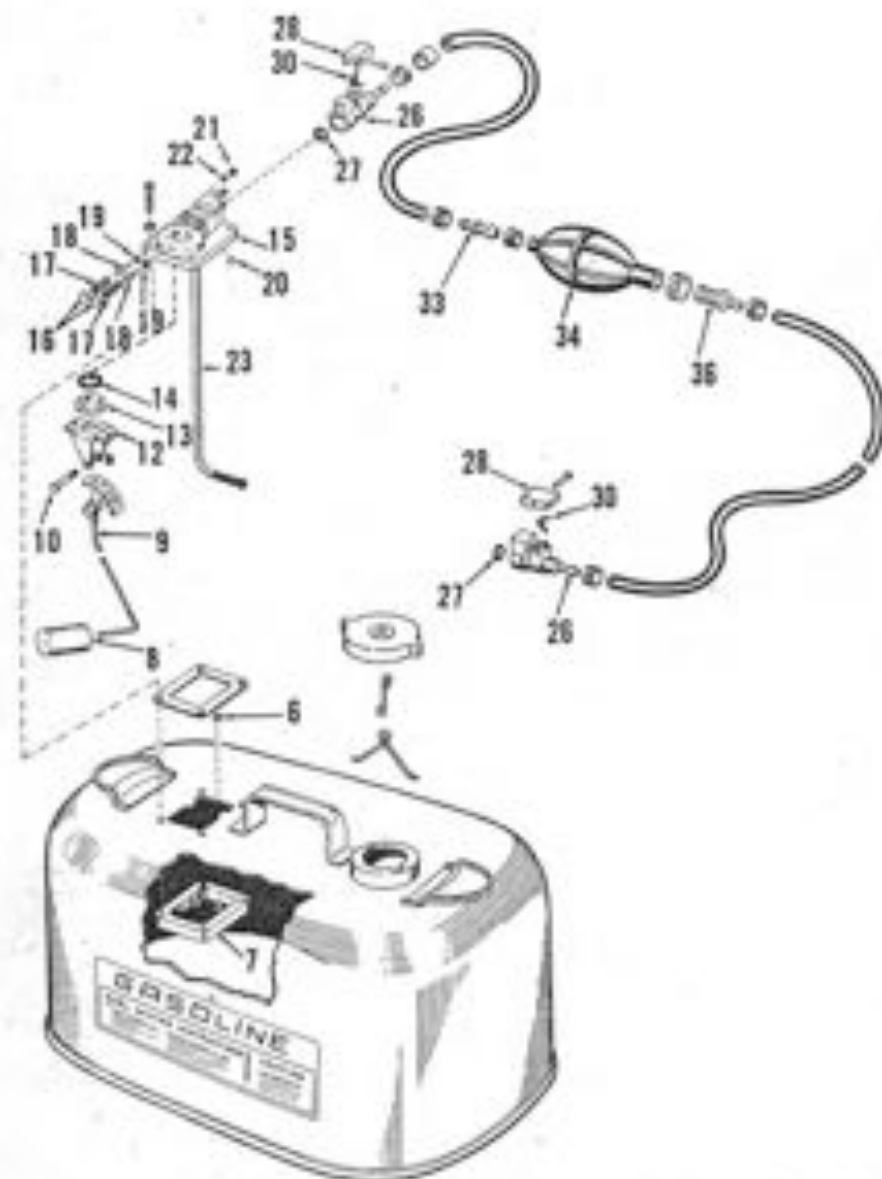


Fig. 352—Exploded view of fuel tank assembly used on motors with diaphragm type fuel pump.

6. Flange
7. Plate
8. Float
9. Gage
10. Float
11. Bracket
12. Plug
13. Seal

15. Cover housing
16. Float
17. Spring
18. Valve
19. "U" ring
20. Plug
21. Retainer
22. "U" ring

23. Fuel line
24. Plug
25. "O" ring
26. Lock
27. Spring
28. Plug
29. Primer bulb
30. Plug



Fig. 353—Schematic view of the rubber impeller type water pump used on all models. Impeller mounts on lower unit drive shaft and rotates in upper pump housing. At slow speeds impeller blades follow the outline of housing. Water is drawn into pump (IN) as area between blades increases, and is forced into power head (OUT) as area narrows. At high speeds, blades remain curved as shown by broken lines (HS) and pump operates by centrifugal action.

Tap out the tapered crankcase sliding pins (7); then unlock and remove crankcase (2). NOTE: Two outer main bearing cap screws are accessible through the intake ports and must be removed.

Pistons, rods and crankshaft are now ac-

cessible for removal and overhaul as outlined in the appropriate following paragraphs.

Remove crankcase bleeder valve (23) and oil line (24) and blow out all lines and passages. Refer to CRANKCASE BLEEDER

VALVE paragraph in previous FUEL SYSTEM section for further information concerning bleeder valve.

ASSEMBLY. Because of the two-cycle design, crankcase and intake manifold must be completely sealed against both vacuum and pressure. The exhaust manifold and cylinder head must be sealed against water leakage and pressure. Mating surfaces of water intake and exhaust covers between power head and lower unit must form a tight seal.

Whenever power head is disassembled, it is recommended that all gasket surfaces and the mating surfaces of crankcase halves be carefully checked for nicks and burrs or warped surfaces which might interfere with a tight seal. The cylinder head, head end of cylinder block, or mating surfaces of manifolds and crankcase may be checked and lapped, if necessary, to provide a smooth surface. For lapping, use a regular lapping block or a sufficiently large piece of smooth plate glass. Lay a sheet of No. 10 emery paper on the lapping block; then place the surface to be lapped on the emery paper. Use very light pressure and a figure eight motion, checking frequently to determine progress. Do not remove any more metal than is necessary. Finish lap using lapping compound or wax emery paper. Thoroughly clean the parts with saw oil or a clean rag; then wash with hot soapuds and clean rags until all traces of loose metal and grit are removed. Mating surfaces of crankcase may be checked for smoothness on the lapping block, and high spots or nicks removed, but surface must not be lowered. If extreme care is used, a slightly damaged crankcase can be salvaged in this manner. In case of doubt, renew the crankcase assembly.

The crankcase halves are positively located during assembly by the use of two tapered dowel pins. Check to make sure that the dowel pins are not bent, skewed or distorted, and that dowel holes are clean and true. When installing dowel pins, make sure they are fully seated, but do not use excessive force.

When reassembling the crankcase, install the sealing strips (25—Fig. 254) and trim the ends to extend approximately 1/4-inch into bearing bores. Make sure mating surfaces of crankcase halves are completely clean and free from old cement or from nicks and burrs. Apply a bonding cement such as "Sealer 1000" (available from Mapes Corporation, P. O. Box 555, Sheboygan, Wisconsin) to cylinder half of crankcase only. Apply cement sparingly and evenly, making sure entire surface is covered. Immediately install the head half and position by installing the locating dowel pins. Install and tighten the crankcase screws and nuts to a torque of 250 inch-pounds.

When installing gaskets, check to make sure correct gasket is used and that ALL water passage holes are open and aligned. All gasket surfaces must be sealed, using a non-hardening type cement such as "Perfect Seal No. 4." Tightening torques are

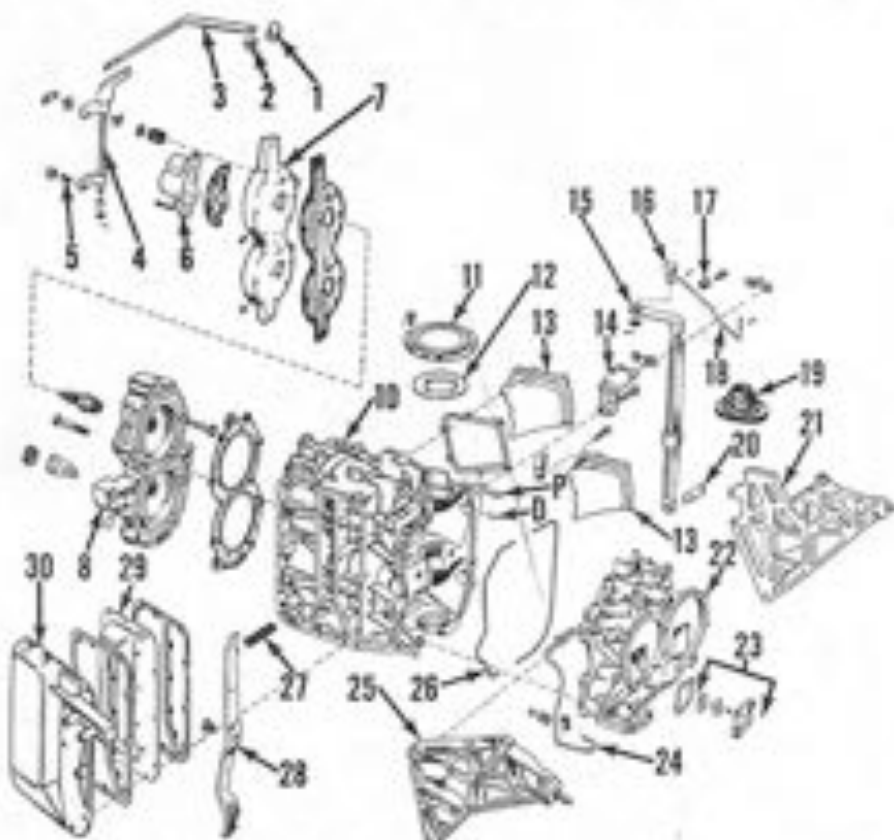


Fig. 254—Exploded view of power head used on 1957 motors. Other motors are similar except that compression release mechanism (1) through (7) is not used before 1957 or after 1961.

- | | | |
|--------------------|--------------------------|----------------------|
| 1. Dowel | 18. Cylinder & crankcase | 28. Pin |
| 2. Taper pin | 19. Support | 29. Sealstrip |
| 3. Gasket | 20. Ballast | 30. Crankcase half |
| 4. Follower | 21. Transfer port cover | 31. Bleeder valve |
| 5. Arm | 22. Sealstrip | 32. Oil line |
| 6. Lever | 23. Lever | 33. Sealstrip |
| 7. Adjusting screw | 24. Pin | 34. Head strip |
| 8. Upper chamber | 25. Snap | 35. Spring |
| 9. Lower chamber | 26. Limit | 36. Locknut lever |
| 10. Cylinder head | 27. Root | 37. Exhaust manifold |
| | | 38. Exhaust manifold |

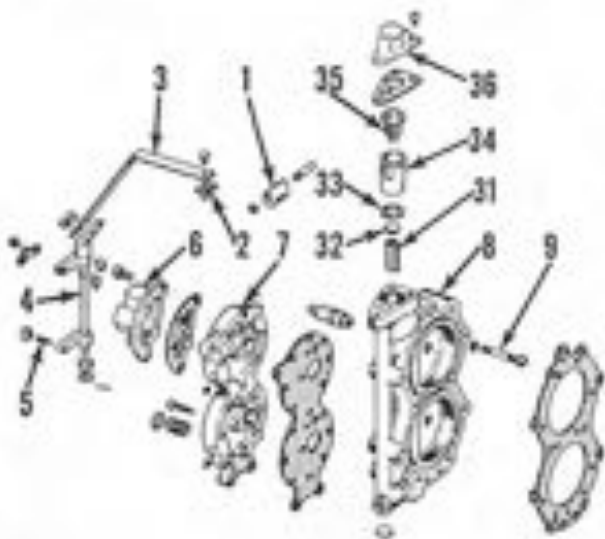


Fig. 255—Exploded view of cylinder head, compression release mechanism and thermostat used on 1958-1961 motors. Refer to Fig. 254 for legend except for the following.

- | |
|------------------|
| 1. Release valve |
| 2. Spring |
| 3. Valve |
| 4. Gasket |
| 5. Housing |
| 6. Thermostat |
| 7. Cover |

given in the CONDENSED SERVICE DATA table.

FLYWHEEL. When installing the flywheel on 40 horsepower motors (1955 and later), turn the key (K—Fig. 354) so that outer flat edge is parallel with center line of crankshaft as shown at (A). Improper installation of key may prevent tightening of flywheel on crankshaft taper, resulting in possible damage. Tighten the flywheel retaining nut to a torque of 100-105 ft.-lbs. on these models.

CYLINDER HEAD. On 1957 and later motors the cylinder head is equipped with a compression release chamber and valve as shown in Fig. 357. The purpose of the compression release mechanism is to lower the compression slightly for hand starting. The rocker arm (4) is actuated by a cam (See Fig. 356) on the top of the starter pulley to open the release valve (3)—Fig. 357 when the starter rope is pulled. Part of the compression pressure first passes through valve to enter the compression release chamber (2). When starting cord is released, valve (3) returns to its seat and the motor functions normally. After assembly, adjust the clearance between the adjusting screw on rocker arm (4) and the release valve (3) to 0.015-0.021, with starter pulley in the normal position.

Adjust the length of the starting cord unit, with starting handle in running position, a distance of 1-inch exists between point of cam and forward edge of cover opening as shown in Fig. 356.

PISTONS, PINS, RINGS AND CYLINDERS. Before detaching connecting rods from crankshaft, make certain that rod end cap

are properly marked for correct assembly to each other and in the correct cylinder.

Each aluminum piston is fitted with three identical rings which are interchangeable and may be installed either side up. Piston, pins and rings are available in standard size and oversize of 0.020 and 0.040. The recommended piston ring end gap is 0.007-0.017 for all motors. Ring to groove clearance is 0.0043-0.007 in 1955 and 1956 model engines only (30 hp), and 0.005-0.0065 in all other motors. Piston to cylinder wall clearance is 0.0025-0.004 for 1955 and 1956 (30 hp) engines and 0.0021-0.004 for other models. Renew pistons, rings and/or cylinder assembly if scored or otherwise damaged, or if clearance is excessive.

1955 motors are fitted with a 0.0148 full floating piston pin which should have 0.0007-0.0014 clearance in connecting rod bushing and a slightly tighter, slip fit in piston bosses.

On motors made in 1956 and later, the piston end of connecting rod contains needle bearings. Piston pin is a press fit in one piston boss and a slip fit in opposite boss. The piston boss containing the slip fit may be identified by the word "LOOSE" embossed on the inside of the piston skirt. When disassembling piston from connecting rod, remove the retaining rings, then use an arbor press or wooden block inserted in piston pin at "LOOSE" side of piston. Install pin through loose side of piston and through the rod bearing; then press pin into tight piston boss and install retaining rings.

When reassembling, all engine parts should be well coated with engine oil. Piston should be installed in cylinder with long-tapered side of piston head toward seaward port side of cylinder.

CONNECTING RODS, BEARINGS & CRANKSHAFT. Before detaching connecting rods from crankshaft, make sure rod end cap are properly marked for correct assembly to each other and in the correct cylinder. Also notice alignment marks on rod and center main bearing cases.

Connecting rods are fitted with needle rollers installed in a two piece bearing caps on crankpin end. Motors after 1955 use a coped (overedge type) needle bearing at piston end of rod. At these main bearings one of the needle roller type. The top and bottom main bearings are of the carriage type and include the outer bearing race. The center bearing is fitted with 18 rollers positioned in a two-piece caps. Outer race

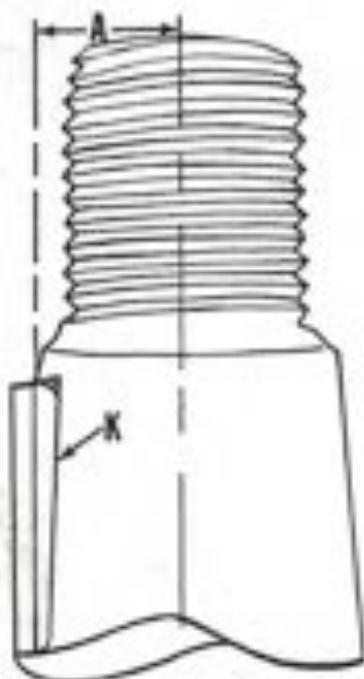


Fig. 354—When installing flywheel on 40 hp motors, make sure outer edge of key (K) is parallel with centerline of crankshaft as shown at (A).

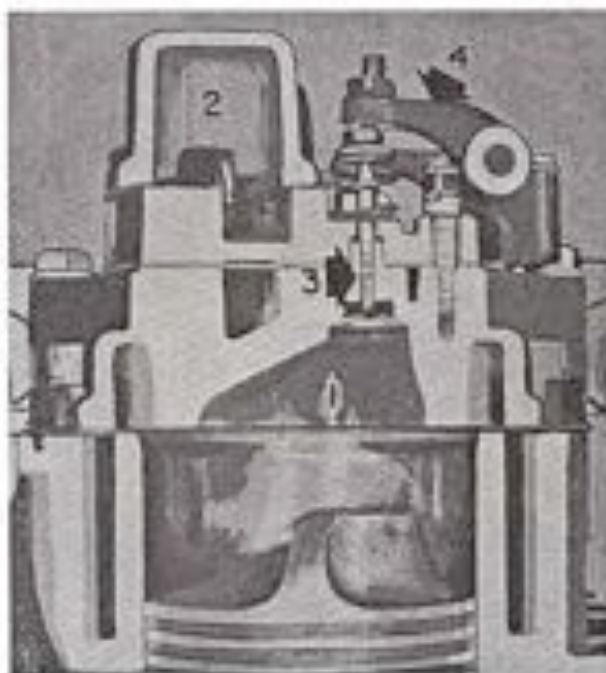


Fig. 357—Cutaway view of compression release mechanism. Poppet valve (2) is opened by lever (3) which is actuated by stator pulley. When starter rope is pulled, valve opens to admit part of cylinder compression into release chamber (2) making motor easier to crank.

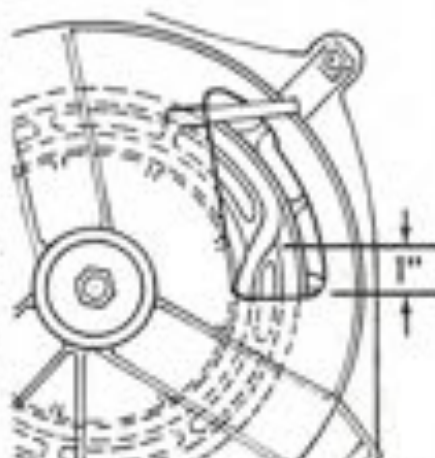


Fig. 358—Schematic view of compression release cam groove which is machined on top of starter pulley. Starter rope must be adjusted so that point of cam is 1 inch from edge of opening in housing as shown.

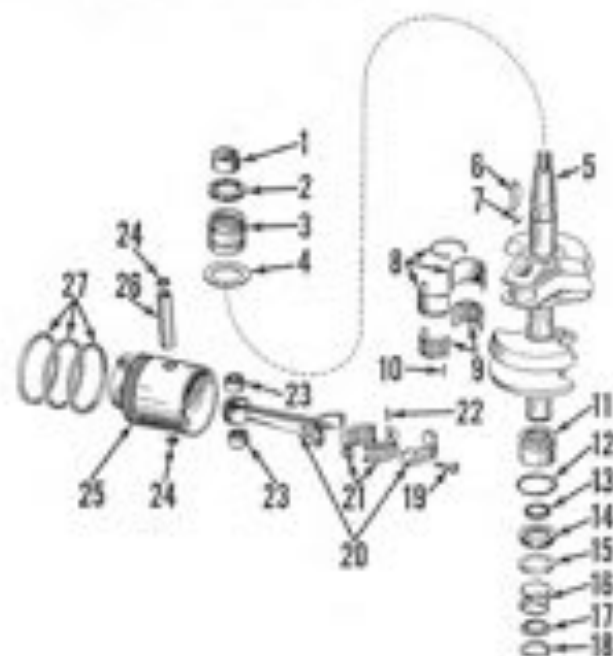


Fig. 319—Exploded view of crankshaft, piston and bearings of the type used.

1. Cap
2. Seal
3. Bearing assembly
4. Thrust washer
5. Crankshaft
6. Woodruff key
7. Dowel pin
8. Outer race
9. Outer cage
10. Bearing roller
11. Bearing assembly
12. "O" ring
13. Seal ring
14. Seal
15. Retaining washer
16. Spring
17. Retaining washer
18. Snap ring
19. Screw
20. Connecting rod
21. Outer cage
22. Bearing roller
23. Needle bearing
24. Retaining ring
25. Piston
26. Piston pin
27. Piston rings

is two-piece and is held together by a retaining ring (8—Fig. 319).

Rod is drilled and finished, then carefully tapered at points shown by arrows, Fig. 320. Parting line is not machined. When reassembled, the uneven edges of parting line fit together to properly align rod and cap. When assembling, align the index marks (C), then move cap back and forth slightly as rod screws are tightened until uneven fracture lines mesh. Test the alignment by scratching fingernail across parting line, which should be barely noticeable. The two-piece crankpin bearing caps is indexed by grinding off one corner of each rope flange. Place these index marks together when assembling.

Main bearing outer ropes are prevented from turning in crankcase by locating dowels (2—Fig. 319) in cylinder half of bearing box. Alignment dowel must fit in hole in bearing case. To remove the dowel, first center punch end of dowel then drill with a No. 18 drill. Tap the hole in dowel using a No. 10-24 thread tap and use a puller plate and jack screw to remove dowel.

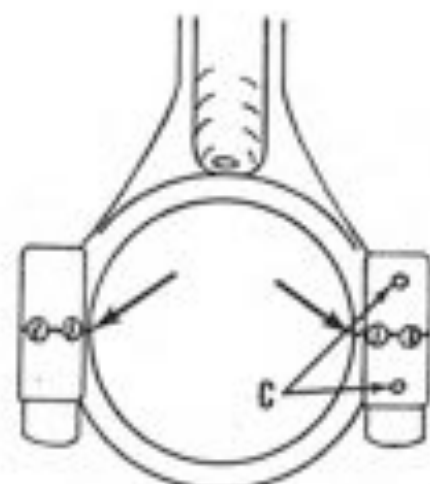
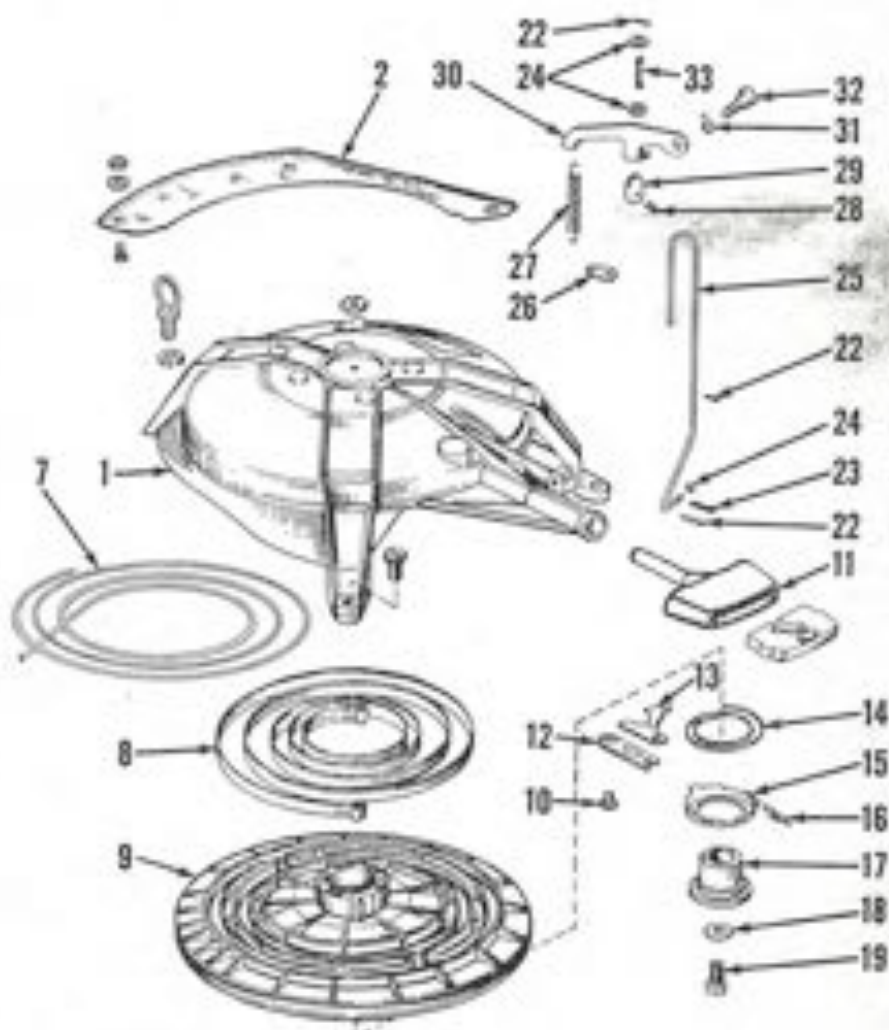


Fig. 320—Connecting rod is "fractured" at point of arrows. When installing cap make sure correlation marks (C) are together then work cap back and forth a slight amount until fracture lines mesh.



- | | |
|---------------------|-----------------|
| 1. Housing | 19. Screw |
| 2. Guard | 20. Pin |
| 3. Ring | 21. Outer pin |
| 4. Spring | 22. Washer |
| 5. Pulley | 23. Seal |
| 6. Screw | 24. Anchor |
| 7. Blade | 25. Spring |
| 8. Retainer | 26. Set screw |
| 9. Pin | 27. Collar |
| 10. Friction spring | 28. Lock |
| 11. Cap | 29. Snap washer |
| 12. Spring | 30. Screw |
| 13. Rotor | 31. Spring |
| 14. Washer | |

Fig. 321—Exploded view of stator of the type used on models equipped with compression release mechanism. Other models are similar. Starter lock (30) enters notches in outer rim of pulley (5) to prevent stator being pulled when throttle is set for high speed.

Always carefully renew all crankshaft seals whenever motor is disassembled.

MANUAL STARTER

Fig. 31 shows starter typical of the one used. When installing a new starter cord or spring, insert the removed starter assembly in a vice and wind the spring by turning the starter pulley counter-clockwise until spring is completely wound. Reverse the pulley one turn and install the cord.

On motors equipped with compression release (1957-1961), release mechanism must be used by adjusting the length of starter cord as outlined in CYLINDER HEAD paragraph of POWER HEAD section.

All models are equipped with a starter latch which is mechanically linked to carburetor follower cam to prevent starting the motor when throttle is set for high speed. To adjust the starter latch, set shift lever in neutral position and speed control to the fast link recommended for starting. Loosen the set screw in stop collar (A—Fig. 32) and adjust collar up or down on link until inner end of latch (B) just clears the cam lugs on the starter pulley. Tighten set screw with collar in this position.

LOWER UNIT

PROPELLER AND DRIVE PIN. Protection for the propeller and drive unit is built into a cushioning slip clutch in the propeller hub. Only a propeller especially designed for the motor should be used.

Propeller clutch slippage can be checked using a torque wrench and suitable holding fixture and adapter. Slippage should occur at a torque of 150-210 ft.-lbs. If slippage occurs at a lower figure, renew the propeller.

REMOVE AND REINSTALL. Most service on the lower unit can be performed by detaching the gearcase housing from drive shaft and exhaust housing. When servicing lower unit, pay particular attention to water pump and water tubes with respect to oil or water leaks. Leaky connections may interfere with proper cooling of the motor. Water leaks may also permit the inside of drive shaft casing to fill with water which can eventually find its way into motor crankcase through the lower bearing and/or into



Fig. 32—To adjust the starter latch, first set speed control grip at the fast speed recommended for starting, loosen stop collar (A) and adjust latch (B) until it just clears starter pulley lugs.

Model	Propeller			Drive Pin			
	Dia.	Pitch	Blades	Dia.	Length	Material	Part No.
All 1955-56	1 1/4	1 1/4	3	1/4	1 1/2	Stainless Steel	304273
All 1957 & later	1 1/4	1 1/4	3	1/4	1 1/4	Brass	303168
				1/4	1 1/2	Stainless Steel	304273

*Used on some early models with original equipment propeller.

the gearcase where it washes out the lubricant. Look for water leaks if the gearcase requires an abnormal amount of lubricant.

Use appropriate exploded views (Fig. 33 or 34) as a guide when overhauling the

lower unit, together with the special precautions listed below. Refer to the separate ELECTROMATIC MODELS paragraphs for service procedures on motors with electric shift. All contact surfaces must be smooth.

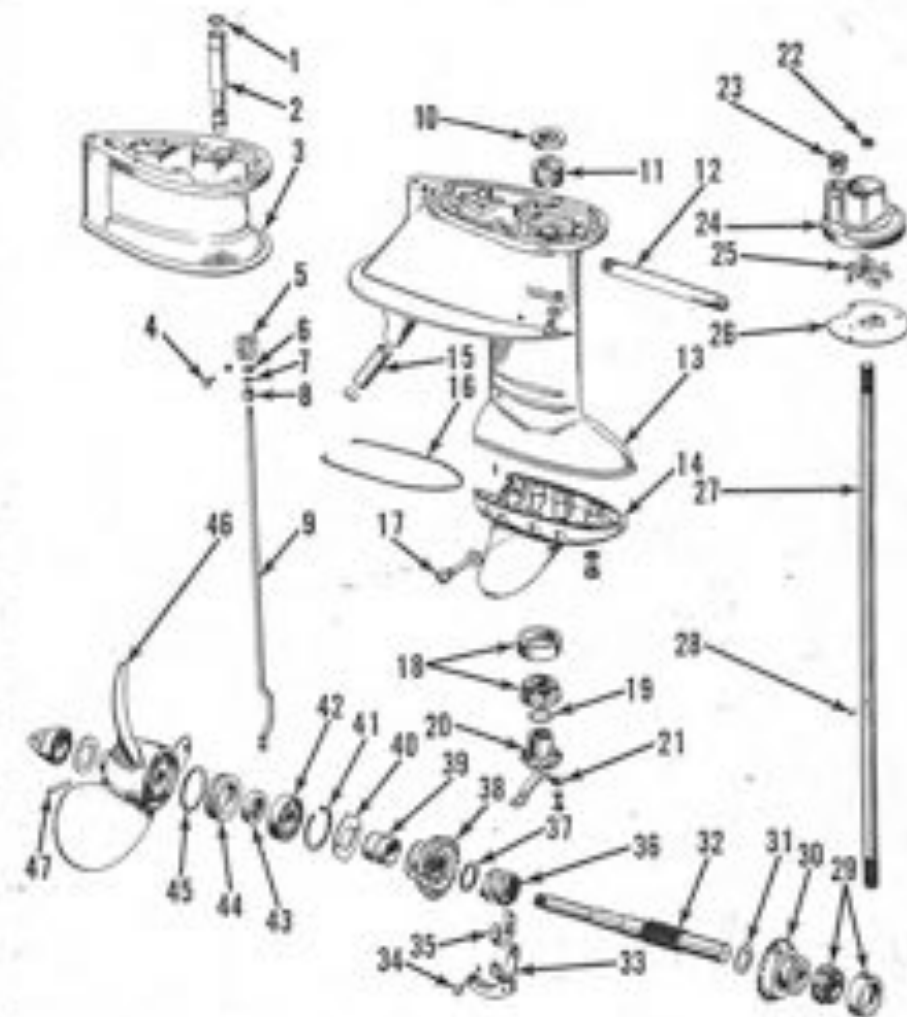


Fig. 34—Exploded view of lower unit gearcase, water pump and associated parts used on early models. Parts (1, 2 & 3) are only used with "Long" models.

1. "O" ring	12. Gearcase housing	25. Impeller	38. Clutch dog
2. Adapter	13. Lower gearcase	26. Plate	39. Thrust washer
3. Extension	14. Screw	27. Shaft	40. Reverse gear
4. Lock screw	15. Seal strip	28. Pin	41. Gear housing
5. Connector	16. Thrust pin	29. Bearing	42. Thrust washer
6. Gasket	17. First pin	30. Forward gear	43. Snap ring
7. "O" ring	18. Shim	31. Thrust washer	44. Bearing
8. Bearing	19. Drive pinion	32. Propeller shaft	45. Oil seal
9. Shift rod	20. Support	33. Shift lever	46. Housing
10. Oil seal	21. "O" ring	34. Pin	47. "O" ring
11. Washer	22. Gasket	35. Cradle	48. Propeller
12. Cover	23. Shim		49. Drive pin

free from nicks and burrs, and assembled using a non-hardening type sealer such as Fenwax No. 1 or Perfect Seal No. 4. All joints without gaskets must be smooth and free from nicks and burrs and old cement and sealed with a hardening sealer such as "Sealer 1000" available from Marpac Corporation, P. O. Box 955, Sheboygan, Wisconsin. Refer to CONDENSED SERVICE DATA table for repair specifications and recommended tightening torques.

The propeller shaft (31—Fig. 363 or 39—Fig. 364) and drive gears (30 & 36—Fig. 363 or 37 & 46—Fig. 364) can be removed after first draining lubricant from gear compartment, removing pinion screw (17), and unlubing and removing gearcase lower bearing (34). To remove pinion (30—Fig. 363 or 37—Fig. 364) it is necessary to remove retainer strap (21—Fig. 363 or 24—Fig. 364).

To separate gear case from the exhaust and drive shaft housing, it is necessary to remove cover (18—Fig. 363 or 32 & 18—Fig. 364) and loosen clamp bracket screw (4—Fig. 363 or 3—Fig. 364). Gear case can then be unlubed and separated from exhaust housing.

On motors after 1958, observe the following. Pinion thrust bearing races (19 & 21—Fig. 364) are of different sizes. Bearing race (21) has a 1/4-inch diameter inner hole and should be installed on pinion first. Race (19) has a 1/2-inch diameter hole and fits more snugly in gear case. When reassembling, install a new sealing strip (16) and trim the ends to extend 1/8-inch from ends of seal grooves.

The shifting linkage must be adjusted to provide full engagement of the shifter collar with the forward and reverse gears. On models before 1955, loosen the two clamp screws (2—Fig. 365) on shift lever (A) and move lever until detent (21) is located in lower notch of speed control arm. Reach behind shift lever hub and rotate ball cock (2) clockwise as far as possible. NOTE: Turn propeller shaft to make sure that forward gear is completely engaged, and not loading up on top of clutch dogs. Hold ball cock in forward engaged position and tighten clamp screws (2).

On later models, refer to Fig. 368. While turning propeller, carefully move shift lever (A) and note position of lockout pin (P) as clutch dogs engage. Forward and reverse clutch dogs should engage on high points of shifter lock (2) on equal distance from the neutral detent. To adjust, loosen the clamp screw (A) and move lever on shaft. NOTE: Shift lever should be in vertical position when neutral detent is engaged as shown.

Steering tension on all models can be adjusted by turning screw (7—Fig. 365 or 36) until motor is easy to steer but will maintain a set course. Screw is on port side of lower unit.

1. Exhauster
2. Lock screw
3. Clamp
4. Shift rod
5. Gasket
6. "O" ring
7. Sealing
8. Oil seal
9. Sealing
10. Cover
11. Gasket
12. Gearcase housing
13. Lower gearcase
14. Seal strip
15. Flange pin
16. Sealing
17. Upper nut
18. Thrust bearing
19. Lower race
20. Bearing
21. Drive pinion
22. Support
23. Water tube
24. Gasket
25. Cap
26. "O" ring
27. "O" ring
28. Seal
29. Sealing
30. Insulator
31. Plate
32. Shaft
33. Woodruff key
34. Bearing
35. Forward gear
36. Thrust washer
37. Propeller shaft
38. High lever
39. Pin
40. Drive
41. Clutch dog
42. Thrust washer
43. Gear housing
44. Drive gear
45. Thrust washer
46. Snap ring
47. Bearing
48. Oil seal
49. Housing
50. "O" ring
51. Propeller
52. Drive pin

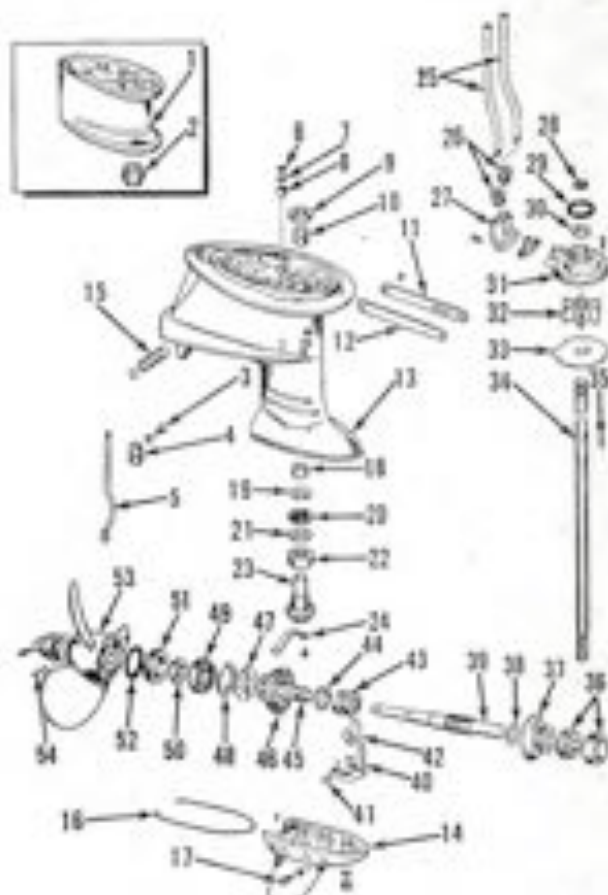


Fig. 364—Exploded view of lower unit gearcase and associated parts used on late models. Parts in least are used on "Long" models only.

- A. Adjusting screws
- V. Adjusting screw
1. Shifting bracket
2. Lever
3. Shaft
4. Shift lever
5. Housing
6. Shift rod
7. Exhauster tube
8. Gasket
9. Saffle plate
10. Gasket
11. Exhauster housing
12. Rubber mount
13. Rubber mount
14. Housing
15. Housing
16. Rubber mount
17. Ground lead
18. Cover plate
19. Housing
20. Rubber mount
21. Water tube
22. Sealing
23. Gear
24. Pinion
25. Memory switch
26. Cover
27. Control knob
28. Thrust washer
29. Lever
30. Plate
31. Rolling
32. Locking lever
33. Thrust washer
34. Lever
35. Insulator
36. Lock
37. Lever
38. Rolling
39. Thrust bracket
40. Lever
41. Clamp screw
42. Thrust bracket

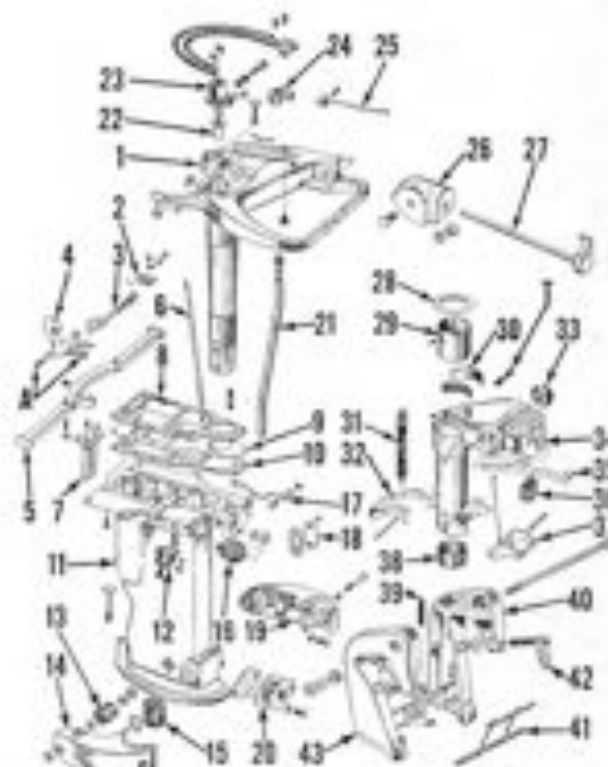


Fig. 365—Exploded view of stern bracket, drive shaft housing, exhaust housing and associated parts used on early models.

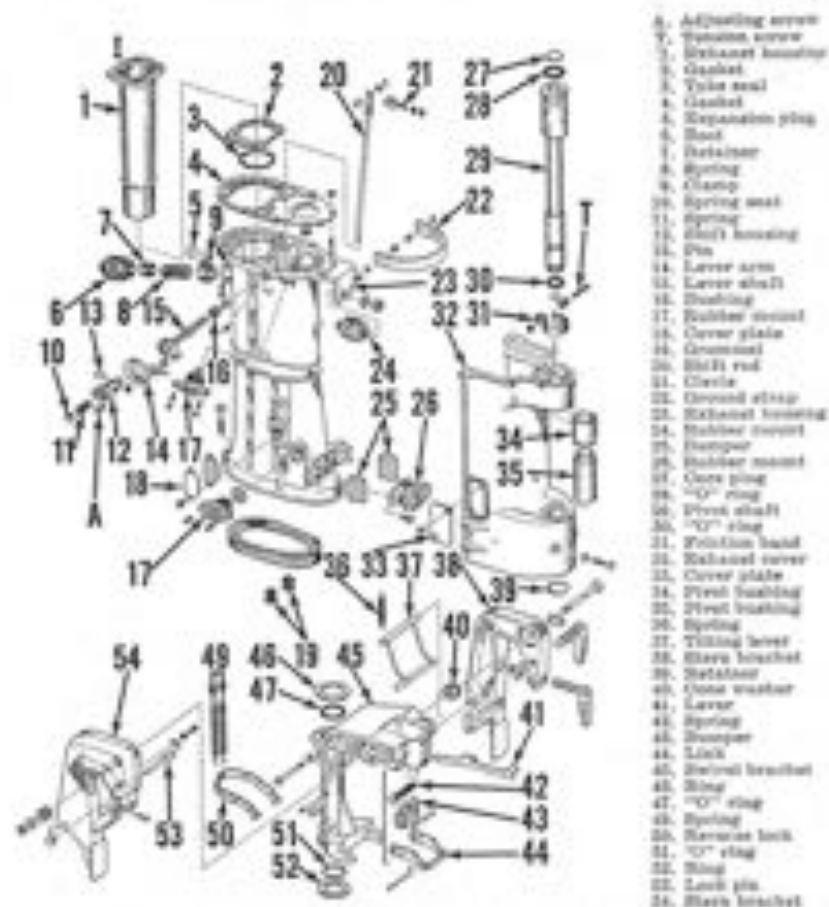


Fig. 246—Exploded view of late model driveshaft housing, swivel bracket and stern bracket assembly.

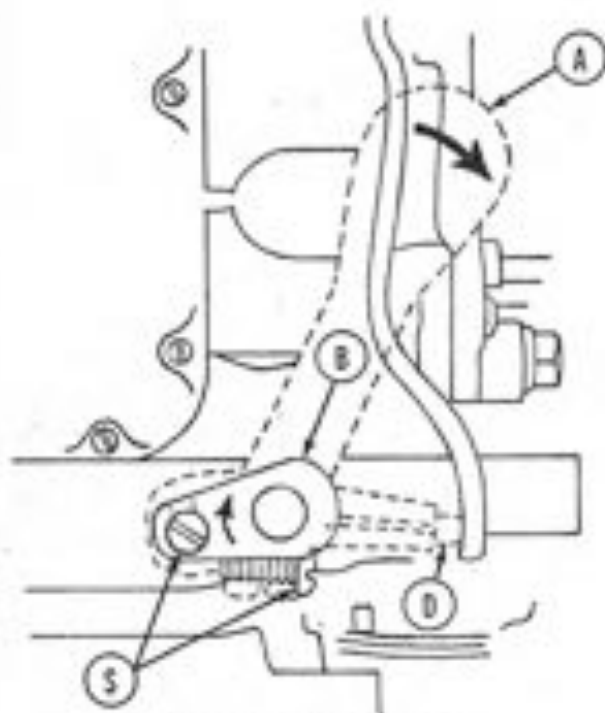


Fig. 247—Schematic view showing method of adjusting shift linkage on early models. See text for details.

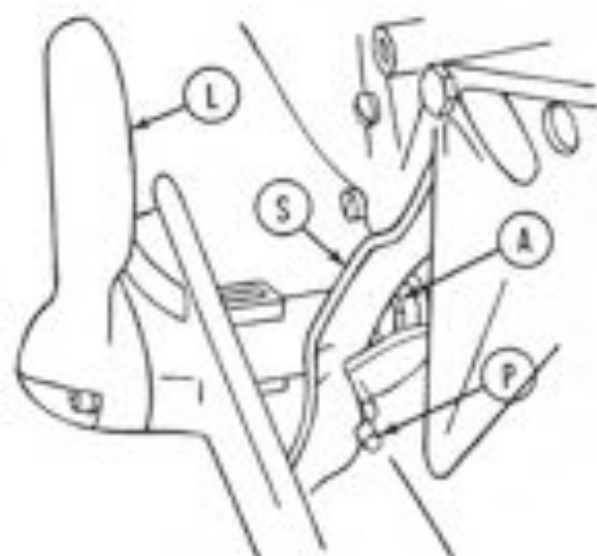


Fig. 248—Shift lever adjustment mechanism on late models. Refer to text.

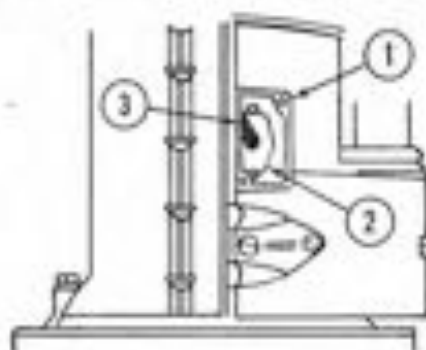


Fig. J72 — Before lower unit can be removed, upper cable must be disconnected as shown. Refer to text.

1. Cover opening
2. Cable support
3. Shift cable

ELECTRAMATIC MODELS. The driving mechanism of "Electramatic" models consists of two driven gears which turn freely on the propeller shaft, two clutch coils, two clutch hubs splined to propeller shaft; and a forward drive and reverse drive electromagnet to activate the clutches.

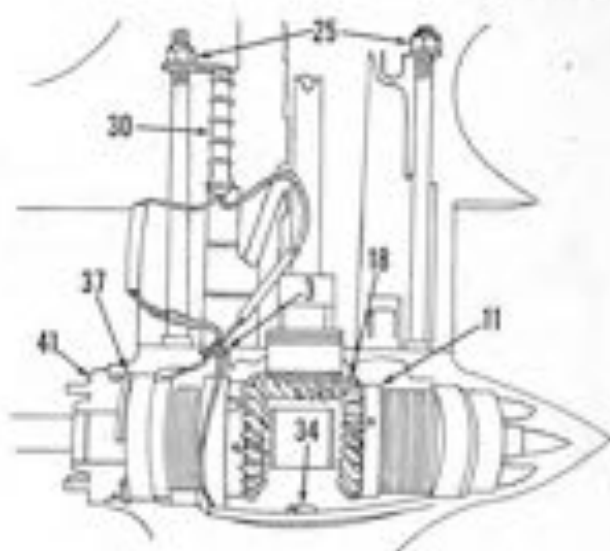
The clutch coils are anchored to their respective driven gears by three headless Allen set screws, and the gear and clutch assembly secured to the splined clutch hub by a snap ring. Activation of either of the electromagnets attracts the free end of clutch coil, causing it to drop on friction surface of splined hub. The resultant friction causes the coil to wrap around hub, gripping it firmly and locking propeller shaft to the selected drive gear. When the magnetic attraction is broken, the grip of the coil is released and both drive gears again turn independently of propeller shaft.

Malfunction of the unit could result in clutch slippage in one or both directions of travel; complete loss of ability to engage in either or both of the gears; failure to release in one of the gears; or complete lock-up, in which drive shaft or propeller shaft could not be turned. Malfunction could be either electrical or mechanical in nature, and the cause should be determined as nearly as possible before disassembly is attempted.

The shift wiring consists of a hot wire leading from "A" terminal on starting switch to the remote control unit; the control switches; connecting wires leading from switches to the electromagnets; the electromagnets; and the ground running back through motor housings to the battery. Malfunction of an electrical nature usually results in failure of one or both clutch units to engage. Failure to disengage could be caused by malfunction of the control switch. Similar troubles could also be of a mechanical nature.

To check the electrical system, remove the motor cover and disconnect the shift

Fig. J71 — Cross section of the assembled ELECTRAMATIC gearcase and associated parts. Refer to Fig. J72 for legend.



cable leads of the quick-disconnect terminals on port side of power head. **NOTE:** The shift wires are color coded light green (reverse) and light blue (forward), and are secured to lower transfer port cover by a wiring clamp.

Attach one lead of an ohmmeter to a suitable ground and test the resistance of each of the lower shift leads in turn. Resistance should be 7-8 ohms for each of the leads if system is in good condition. A zero ohmmeter reading indicates a short circuit, while an infinity reading is an indication of an open circuit. An extremely high reading could indicate a broken wire or loose or corroded connections. In case of an unsatisfactory reading, the lower unit must be removed for further checking.

If a satisfactory reading was obtained, use a voltmeter to check continuity of circuits and available current, if remote control unit and a battery are connected. Current should flow on battery voltage from the proper shift wire to a suitable ground, when "Start" switch is in "On" position and the proper control switch is activated. There should be no current when "Start" switch is in "Off" position or when the other control switch is activated.

To remove the lower unit, first remove engine cover, disconnect shift cable leads and detach cable clamp from lower transfer cover. Remove rear exhaust cover, and cover plate from opening (1)—Fig. J72 on starboard side of boat exhaust cover. Pull upper end of shift cable (2) through the exposed opening, then unbolt and remove cable support (2). Be careful not to damage the cable insulation. Lubricating cable is an aid in disassembly and assembly.

After upper cable is free, remove propeller then unbolt upper gearcase assembly from exhaust housing. Remove gearcase while leading cable through cable support opening. When installing, note that two series of ridges are moulded into cable cover about 1/2 inches apart. When lower

shaft unit is installed, engage support in upper set of ridges. Engage support in lower ridges on short shaft models, pulling slack into upper exhaust housing. The series of ridges form an exhaust gas seal.

To disassemble the gearcase, unbolt and remove the water pump and drive shaft, then remove and discard the two stud nuts (25)—Fig. J72, retaining lower gearcase to upper housing. New self-locking nuts should be used when reassembling.

Insert the assembly and separate lower gearcase (30) from upper case (27). Tap lower gearcase lightly with a soft hammer. If necessary, to free lower case from its doweled position. Separate the housings 2-3 inches, then disconnect the two coil leads from upper shift cable (2). The connectors are covered by an insulating rubber sleeve which must first be pushed up the cable wires. After wiring is disconnected, the lower gearcase may be withdrawn.

Remove the four screws from rear surface of gearcase head (41). Thread puller legs into the threaded holes and remove gearcase head, using a suitable puller. Remove snap ring (37), clamp screw (3) and coil wire retaining clamp (4). Insert a small punch into drive pin hole in propeller shaft and tap lightly on side of punch, pulling propeller shaft out of gearcase enough to dislodge the reverse electromagnet (11); then remove the electromagnet, being careful not to damage the coil lead.

Withdraw propeller shaft (26) with the reverse gear and hub assembly remaining on shaft. Tilt the piston gear (32) toward the rear and withdraw through rear opening of gearcase; then, tilt the gearcase and remove forward gear and hub assembly.

Reach down through drive piston opening with a screwdriver and remove the screw (34) which retains the forward coil lead shield to bottom of gearcase. Refer to Fig. J71. Also the screw is removed, insert an internal expanding gear puller like bear-

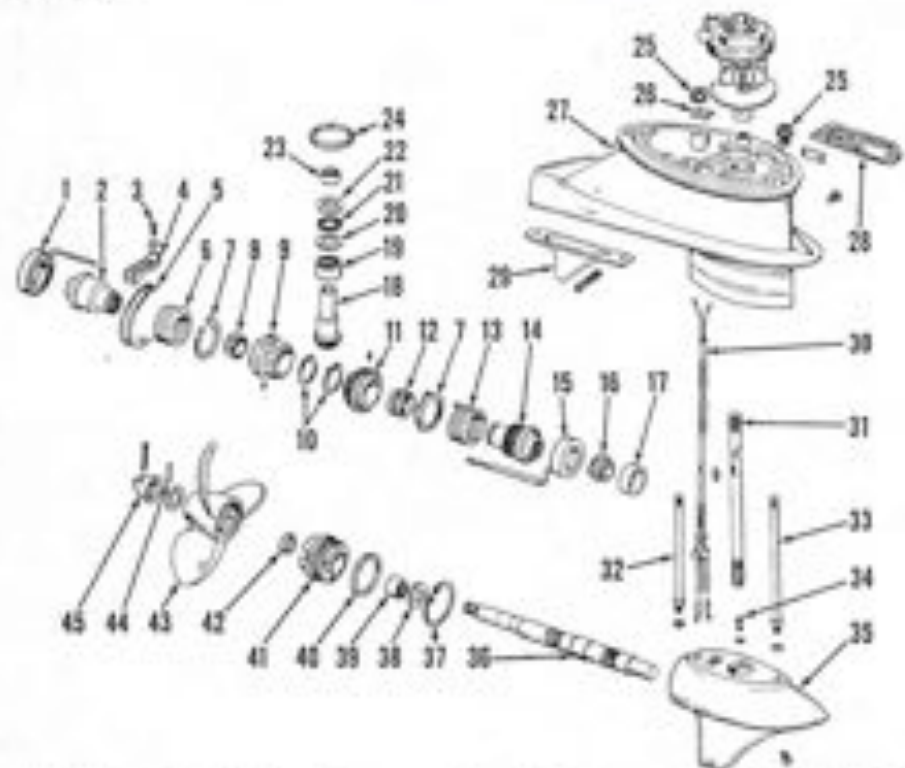


Fig. J72 — Exploded view of gearcase and associated parts used on ELECTRAMATIC models.

- | | | | |
|---------------------------|----------------------------|----------------------|---------------------|
| 1. Reverse electro-magnet | 21. Forward housing | 35. Needle bearing | 41. Lower gearcase |
| 2. Reverse hub | 22. Clutch coil | 36. "O" ring | 42. Propeller shaft |
| 3. Cover | 23. Forward hub | 37. Self-locking nut | 43. Snap ring |
| 4. Sealator | 24. Forward electro-magnet | 38. Clip | 44. Thrust washer |
| 5. Wire guard | 25. Bearing cone | 39. Upper bearing | 45. Needle bearing |
| 6. Clutch coil | 26. Bearing cup | 40. Water inlet | 46. "O" ring |
| 7. Spacer | 27. Drive pinion | 41. Water inlet | 47. Gearcase head |
| 8. Needle bearing | 28. Needle bearing | 42. Upper wiring | 48. Seal |
| 9. Reverse gear | 29. Washer | 43. Drive shaft | 49. Propeller |
| 10. Snap ring | 30. Thrust bearing | 44. Stud | 50. Inboard pin |
| 11. Forward gear | 31. Washer | 45. Stud | 51. Propeller nut |
| | 32. Washer | 46. Clamp screw | |

ing cone (26—Fig. J72), and pull the bearing cone and forward electromagnet (15). Bearing cup (17) can be removed, with an internal expanding puller and slide hammer, or by heating the gearcase (35) to approximately 200° F. and jacking cup from housing.

Forward and reverse drive gears (8 and 11) are identical, but should not be interchanged once they have been used. Clutch coils (6 and 12) and spacers (7) are also identical for forward and reverse drive units. The forward clutch hub (14) differs from the reverse hub (2) by being knurled on the friction surface. These two hubs must not be interchanged. The reverse driving gear (9) is fitted with a needle roller bearing (8), while forward gear contains a bushing (12). These must also be installed in the indicated positions.

The spacers (7) are wedge-shaped, and designed to fill up the space between the last winding of clutch coil and the pocket of the driving gear. The projecting legs of coil and spacer are placed side by side to completely fill the driving slot of gear. Apply one drop of Grease "D" LOCTITE to the threads of the retaining set screws and

tighten the screws to a torque of 15-20 inch-pounds, using a torque wrench and suitable adapter. Forward bushing (12) should have a diametral clearance of 0.0005-0.0011 on the hub (14) and in the bore of driving gear (11). Because of the close clearance, extreme care must be used in assembly. Make sure parts are absolutely clean, and do not use force. Perfect alignment is required when assembling the gear and hub unit. Use a light oil as a lubricant when assembling the forward gear and bushing assembly; and needle bearing assembly grease or equivalent, when assembling the reverse gear. If clutch coil tends to bind, turn gear counter-clockwise while applying gentle pressure until gear is fully installed on hub. Install snap ring (10) with the sharp edge to the outside.

Assemble by reversing the disassembly procedure, making sure that the lead for forward electromagnet (15) properly fits in groove in bottom of gearcase and is secured with the retaining screw (34). Fit the guard (5) over tail of forward lead after gear units are installed. Use new self-locking stud nuts (33) and tighten to a torque of 10-20 ft.-lb.

ELECTRICAL UNITS

Some motors are equipped with an electrical starting system, with or without generator. Refer to Fig. J73 for wiring diagram, and to ELECTRICAL SYSTEM at end of JOHNSON section for overhead data.

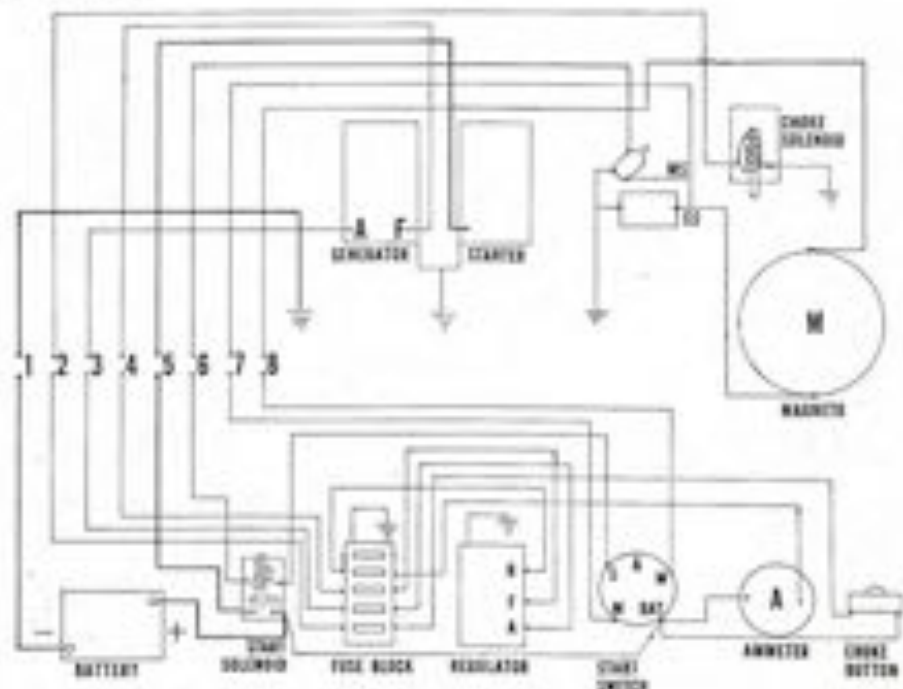


Fig. J73 — Wiring diagram used on electric starting models with generator. Color code is as follows:

- | | | | |
|----------|-----------|----------|----------|
| 1. Black | 3. Yellow | 5. Red | 7. Black |
| 2. Red | 4. Blue | 6. White | 8. Black |