TM 5-278

WAR DEPARTMENT TECHNICAL MANUAL

OUTBOARD MOTORS

WAR DEPARTMENT · 30 JUNE 1944

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This manual supersedes TM 5–8000, Outboard Motor (Model POLR–15), 25 November 1942; and TM 5–8010, Motor, Outboard, 50 HP, Model 8008, 5-inch Shaft Extension, Evinrude Motors, 4 February 1943.

OUTBOARD MOTORS

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United States Government Printing Office
Washington : 1944

WAR DEPARTMENT,
WASHINGTON 25, D. C., 30 June, 1944.

TM 5–278, Outboard Motors, is published for the information and guidance of all concerned.

[A.G. 300.7 (17 Dec 43)]

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For explanation of symbols, see FM 21–6.

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SECTION I

GENERAL

1. Purpose

This manual provides basic information on the operation, maintenance, and repair of outboard motors.

2. Scope

These instructions are published for the information and guidance of the personnel to whom this equipment is assigned. They contain information on the operation and maintenance of the equipment as well as descriptions of the major units and their functions in relation to the other components of the equipment. They apply only to the outboard motor, 55-hp, Evinrude model 8008 and the outboard motor, 22-hp, Johnson model POLR–15. The appendixes illustrate and name the parts of the models discussed.

SECTION II

DESCRIPTION OF OUTBOARD MOTORS

3. General Appearance and Nomenclature

a. An outboard motor is a power plant complete with engine, gasoline supply, and starting apparatus. It is easily installed and detached from the boat. All outboard motors have a powerhead, or engine, a drive shaft extending downward into the water to drive the propeller, and a propeller.

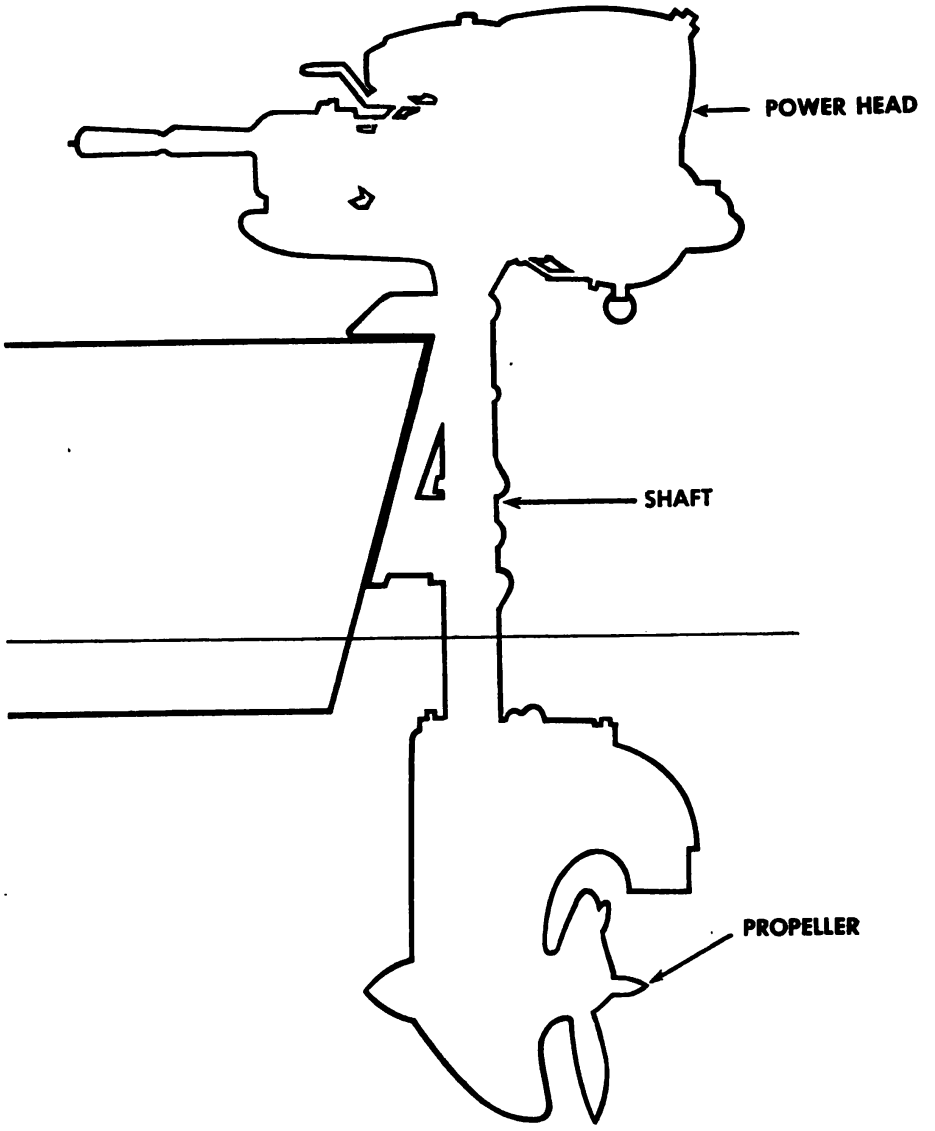
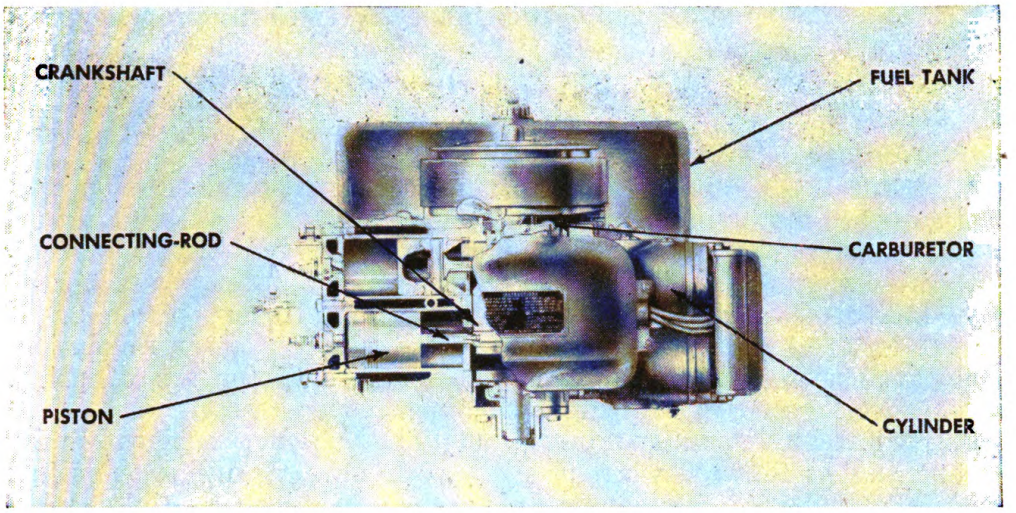
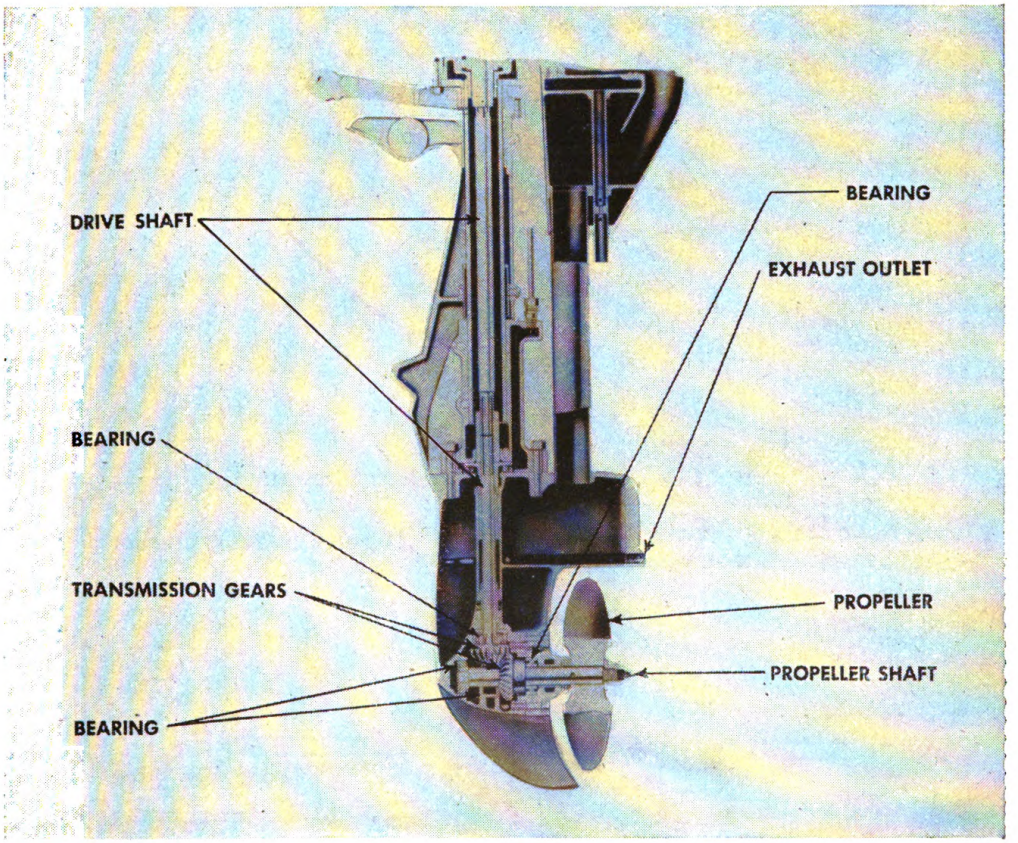


Figure 1. Simple diagram of outboard motor.



① *Powerhead.*



② *Lower unit.*

Figure 2. Diagram showing main parts of powerhead and lower unit.

b. The motors discussed in this manual have two major assemblies: the powerhead, mounted on the top, and the lower unit.

(1) The powerhead includes the cylinders, crankcase, crankshaft, pistons and connecting-rod assemblies, muffler, magneto system, carburetor, and fuel tank. It supplies the power to drive the propeller.

(2) The lower unit transmits the engine power to the propeller, and includes the transmission gears, drive and propeller shafts, bearings, water pump, exhaust outlet, propeller, and mounting bracket.

4. Mechanical Characteristics

a. General. The powerhead contains an internal-combustion engine. The outboard motors used by the army operate on the two-stroke-cycle principle, each cylinder having one port for intake and one for exhaust. Two-cycle engines are considerably lighter per unit of power output than four-cycle, since they have fewer parts and every piston has a power stroke at each revolution instead of at every other revolution. Light weight and compactness in an outboard motor are of prime importance for ease in carrying, attaching, and operating.

b. Two-stroke-cycle Principle. (1) The two-cycle engine (see fig. 3) operates as follows: when piston travels upward, a charge of fuel vapor in cylinder is being compressed; at the same time a partial vacuum is created in the crankcase. As piston progresses in its upward movement, intake port from carburetor is opened by rotary valve in crankshaft and fuel vapor is admitted to crankcase as in *A*, figure 3. At the end of upward or compression stroke of the piston, as illustrated in *B*, figure 3, a spark plug ignites compressed fuel vapor in cylinder and rapid gas expansion which follows, produces power by pushing piston on the downward or power stroke *C*, figure 3.

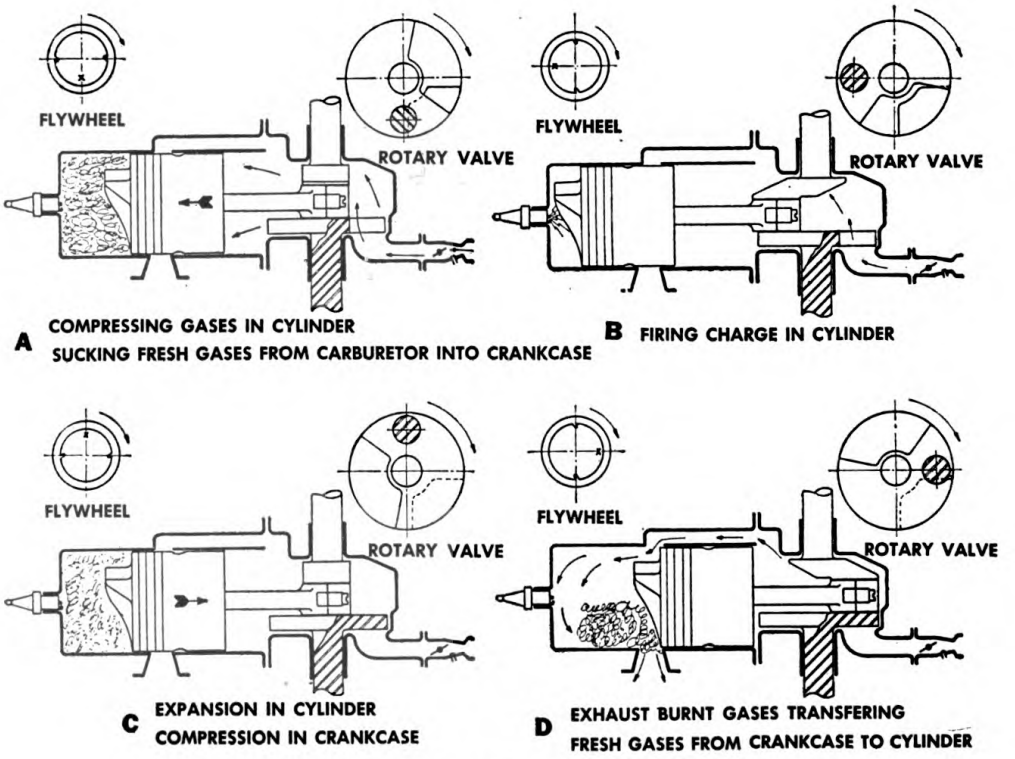


Figure 3. Two-stroke-cycle principle.

(2) As piston is moving downward on power stroke, it is at the same time compressing the fuel vapors which have been admitted to crankcase through the rotary valve. When piston reaches exhaust port, this

port is uncovered and burnt gases pass into expansion chamber or muffler and then out through underwater exhaust *D*, figure 3.

(3) After exhaust port opens, piston will uncover intake port and admit to cylinder compressed fuel vapors from crankcase through bypass from crankcase to cylinder intake port. Fuel vapors are directed upward by deflector on piston head, as shown in *D*, figure 3. The continuous succession of above cycles produces a constant, smooth flow of power.

c. LUBRICATION. (1) *The powerhead.* (*a*) The most practical method of lubricating the powerhead is by mixing lubricating oil with the gasoline. The fuel vapors are introduced first into the crankcase where the oil tends to separate from the gasoline vapor and lubricate the crankshaft bearings and cylinder walls. The remaining oil enters the cylinder with the precompressed fuel and oil mist, and lubricates the cylinder walls and the piston and piston rings.

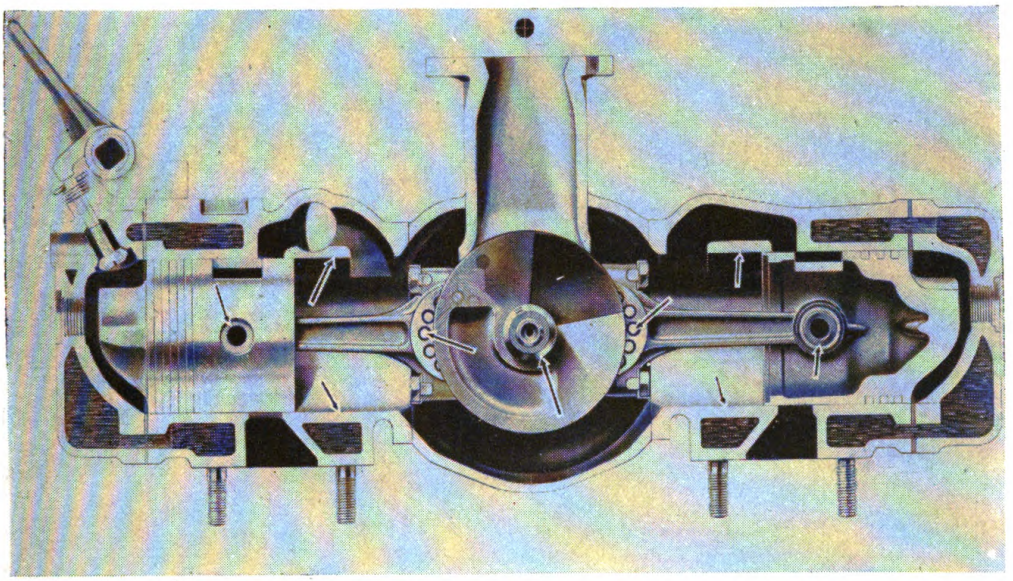


Figure 4. Engine surfaces lubricated by gasoline mixed with oil, indicated by arrows. (See table I.)

(*b*) To insure efficient engine operation, the proper grade and amount of oil must be mixed thoroughly with the gasoline. Too much oil or too heavy a grade results in fouled spark plugs, stuck rings, and loss of powers; too little oil or too light a grade causes excessive piston and bearing wear, and overheating or serious scoring of the motor. Detergent oils must not be used in two-cycle engines.

Table I. Correct gasoline and oil mixture

Motor	Fuel-tank capacity (pints)	Amount of oil per gallon of gasoline (pints)	Grade of oil
Storm boat	28	1	SAE–50
POLR–15	20	1	SAE–40

(*c*) The oil and gasoline must be measured accurately and mixed in a separate container. Never attempt to mix oil and gasoline in the

Figure 5. Pouring fuel into storm-boat motor gasoline tank.

fuel tank. Be sure fuel system is free of moisture by disconnecting the gas line below the carburetor to drain out dirt and water. Before putting fuel into gas tank eliminate dirt by pouring the fuel through a fine mesh strainer.

(2) *Lower unit.* (*a*) Waterproof grease in the gear case lubricates the gears, shafts, and bearings of the lower unit.

(*b*) The grease used for the lower unit of both motors grease, lubricating, mineral, gear case, outboard motor. It is furnished in two sizes, 13-ounce Federal Stock No. 14–4458.5–13 and 1-pound Federal Stock No. 14–4458.5–16. It will not become soft enough to leak past the bearings in warm weather; nor so hard and stiff that it fails to flow or prevents starting in extreme cold.

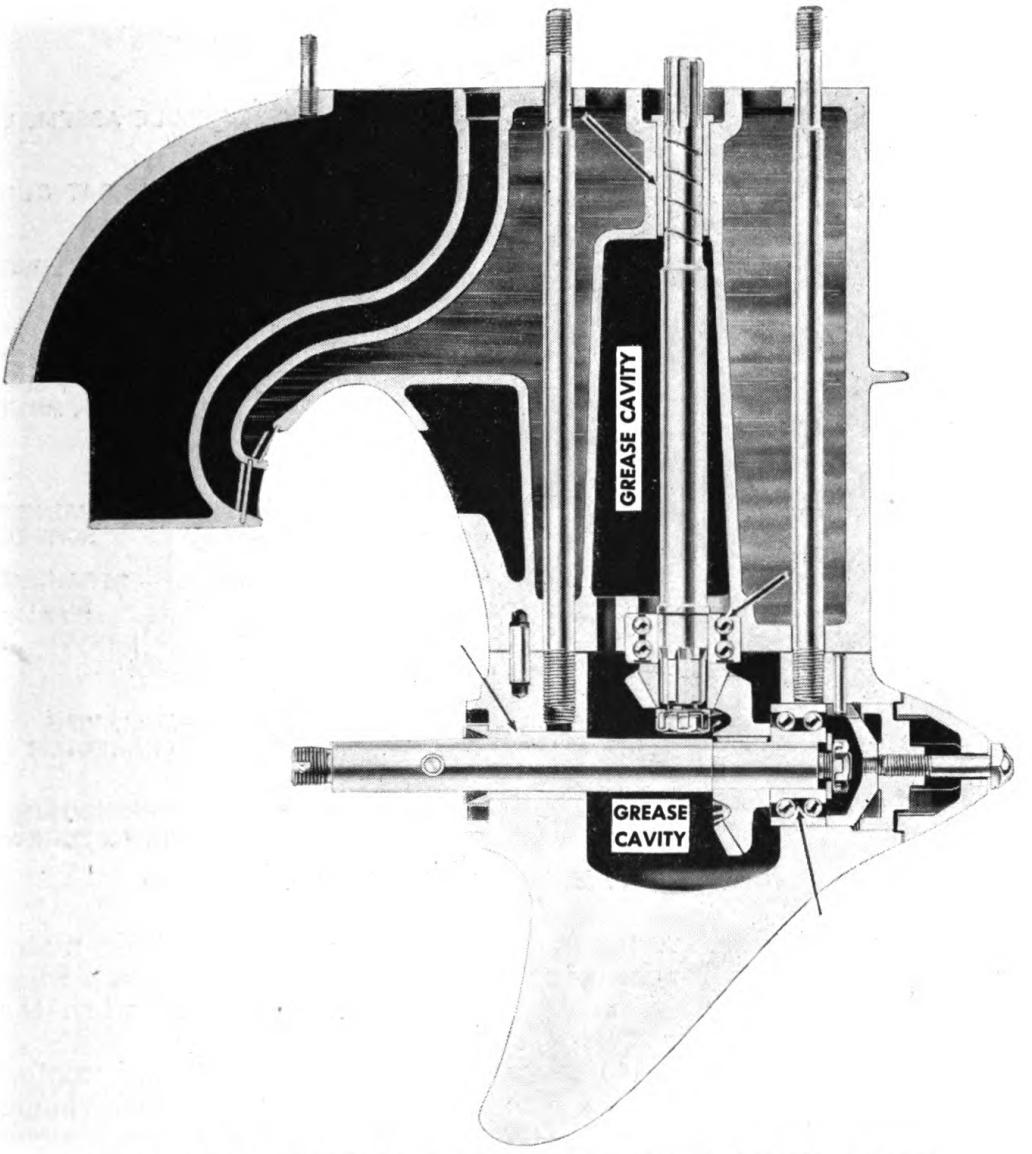


Figure 6. Surfaces lubricated by grease in gear case, indicated by arrows.

d. FUEL SYSTEM. (1) *Gas tank.* Oil is added to gasoline as explained in paragraph 4*c*(1). The fuel line from the gasoline tank connects to the bottom of the carburetor.

(2) *Carburetor.* (*a*) The carburetor mixes the gas-oil fuel and air in the proper proportion to form a combustible mixture and supplies this mixture to the crankcase each time the rotary valve opens. Proper carburetion is vital to the starting, lubrication, and efficient operation of the motor.

(*b*) The flow of gasoline into the carburetor float chamber is regulated by a float valve. When the piston travels upward a vacuum is created in the crankcase and air is drawn into the crankcase through the carburetor venturi tube. Projecting into this venturi tube are nozzles which supply liquid fuel through small jets. As the air passes these jets, the fuel is atomized to form a combustible mixture of small drops of fuel suspended in air.

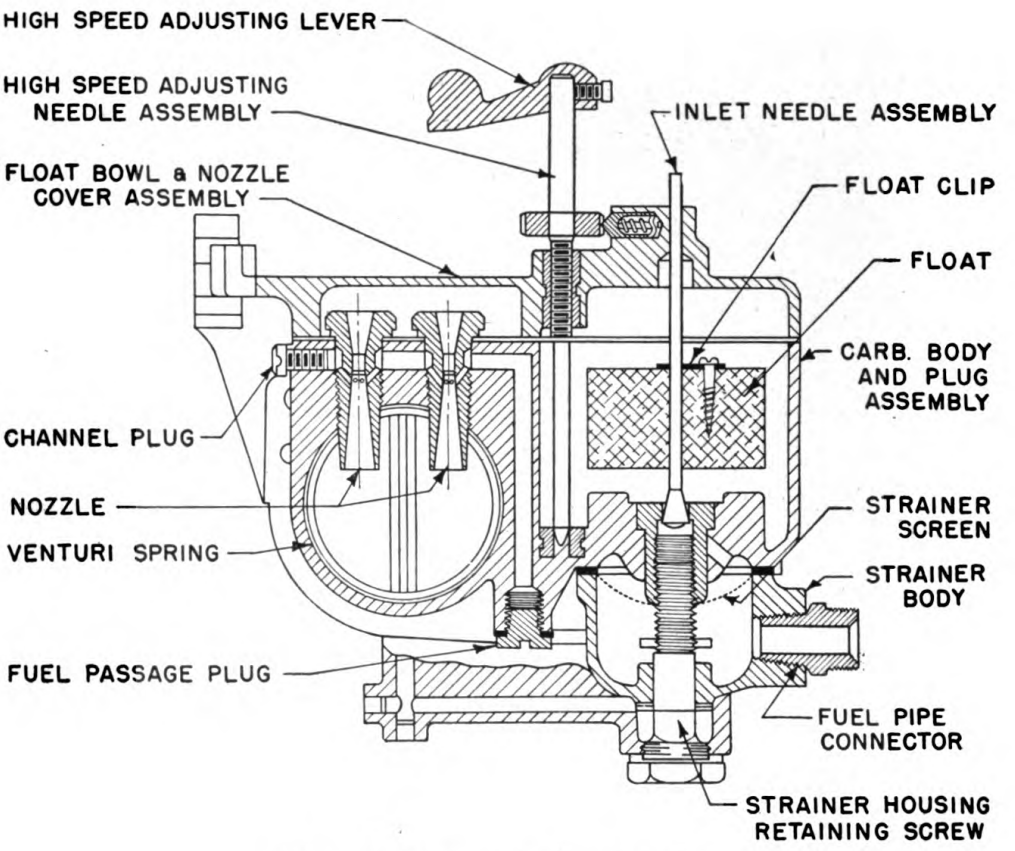


Figure 7. Main parts of carburetor.

(3) *Fuel mixtures.* A normal fuel mixture is one at which the motor performs properly throughout the speed range. A mixture is rich when the proportion of fuel to air is more than required; lean when the proportion of fuel to air is less than normal.

e. IGNITION SYSTEM. (1) *Magneto.* (*a*) In an outboard motor, electric current is generated by a magneto, and starting is done by hand. The magneto consists essentially of two parts; a permanent magnet to supply the field, and a winding in which the current is generated. On outboard motors this permanent magnet is built into the flywheel, and the ignition coil, condenser, and breaker points are mounted on an armature plate.

(*b*) The operation of the magneto is extremely simple. As the poles of the magnet pass over the heels of the coil, a magnetic field is built up within the coil core and current flows through the primary winding. At the proper time, the breaker points are separated by a cam, thus breaking the primary circuit and causing the magnetic field within the coil core to break down instantly. An electrical current of high voltage thus is induced in the fine secondary windings of the coil and is carried to the spark plug, where it jumps the gap between the points of the plug to ignite the compressed charge in the cylinder.

(2) *Spark plugs.* The outboard motors described in this manual usually operate at not less than 4,000 rpm to develop their rated horsepower. Because of this extremely high rate of speed, the demands on the spark plugs are severe. Spark plugs must be kept in the best possible condition. The electrodes must be adjusted to the proper gap

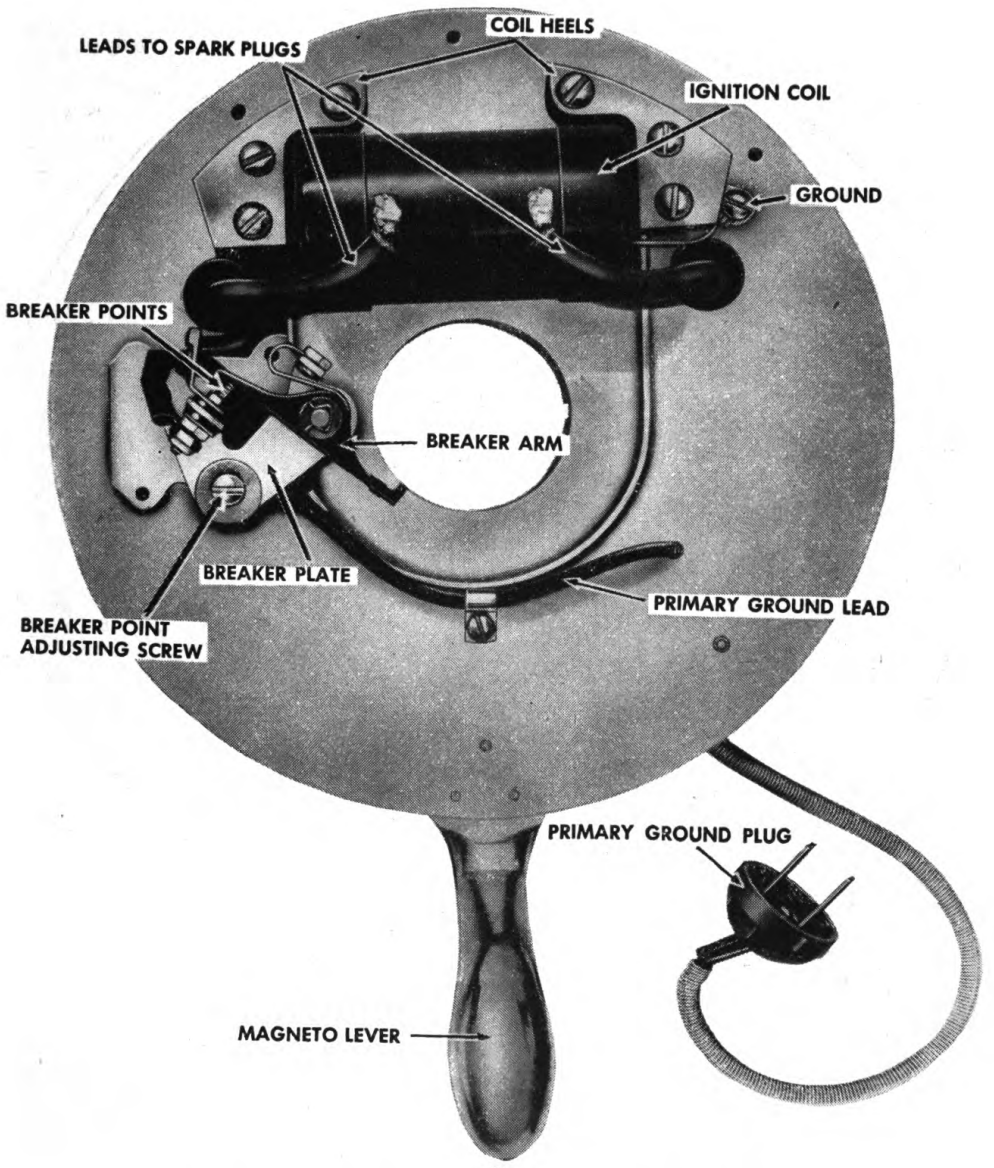
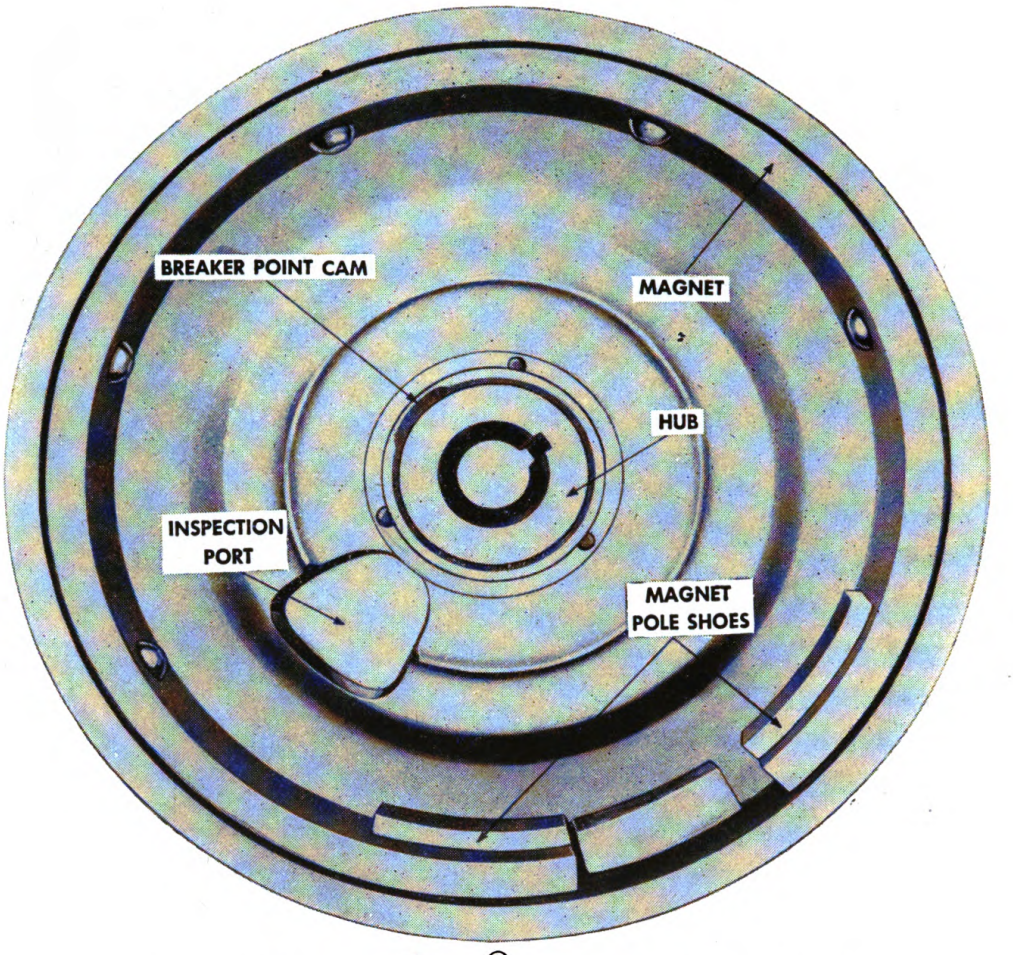


Figure 8. Main parts of magneto armature plate.

distance of .020 of an inch for the storm-boat motor and for the POLR–15 motor. Any tendency toward fouling is revealed by a black gummy deposit on the insulator inside the plug. Such fouling may result from operation of the motor at slow speeds for long periods, from the use of more oil in the gasoline than recommended, from using the wrong type of oil or the wrong type of spark plug. Champion R–7 plugs are recommended for both motors.

f. Cooling System. (1) The storm-boat motor and the POLR–15 have water-cooled engines. The cylinders have water jackets through which outside water is circulated to keep the cylinders cool. On the storm-boat motor a centrifugal pump forces water up from a submerged passage in the lower unit through the cylinder jackets. The cooling system of the POLR–15 operates on the pressure-vacuum principle. Water under pressure from the backs of the propeller blades is picked



②

Figure 8. Main parts of magneto armature plate—Continued.

up by a water scoop and forced through the water passages into the water jackets. The discharge is conducted through a second channel or pipe and emitted from the water-outlet scoop in the gear case. See figures 33 and 79 for location of water inlets and water scoop.

(2) At slow motor speeds, pressure of the water on the back of the propeller blades may not be great enough to force it through the channels and water jackets. Efficient cooling still is maintained, however, by the suction created by water discharging through the return channels. Since at slow speeds, cooling depends on both pressure and vacuum *it is important that immediately after starting, the motor be speeded up for an instant to fill water jackets.* Failure to do this may result in overheating and possibly scoring cylinder walls and pistons.

g. PISTONS, CONNECTING ROD, AND CRANKSHAFT. (1) *Piston.* (*a*) Outboard motor pistons are made of an aluminum alloy. On top of the piston is a deflector which directs the incoming fuel mixture upward into cylinder and away from exhaust port, as shown by figure 3.

(*b*) Grooves at the top of piston contain the piston rings. The rings hold the compression in the cylinder by eliminating or reducing the clearance between piston and cylinder walls. The fit on the sides of the rings and on the grooves must be accurate and conform to specification to insure efficient operation.

(2) *Connecting rod.* The piston contains two reamed holes in which

the wrist pin is fitted. The pin also passes through a hole in the end of the connecting rod and is fitted to allow the piston to move freely.

(3) *Crankshaft.* The larger end of the connecting rod fastens to the crankshaft by a roller bearing which permits crankshaft to rotate freely. The rotary motion is caused by the reciprocating, or up and down, motion of the piston.

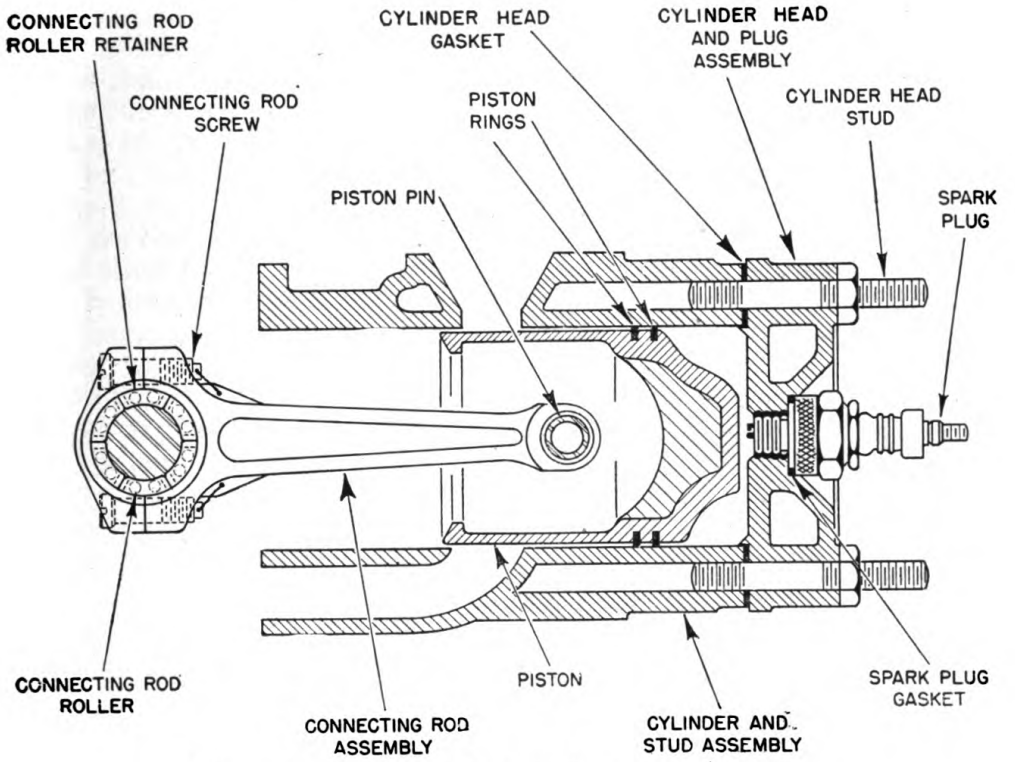


Figure 9. Main parts of storm-boat motor cylinder.

h. Rotary Valve. (1) *General.* The rotary valve which is a part of the crankshaft admits the fuel vapor mixture from the carburetor into the crankcase. This mixture from the carburetor is admitted to the rotary valve through a port in the crankcase. A passageway through the rotary valve continues the opening to a cutaway section of the crankshaft which provides the actual opening into the crankcase. Thus, for about half of each revolution the passageway to the crankcase is opened for the admission of fuel mixture. At all other times the passageway is closed due to rotary valve being closed.

(2) *Rotary valve openings for two- and four-cylinder two-cycle engines.* Only one opening in the valve is required for two-cylinder engines. For four-cylinder engines, one opening into the upper crankcase for the upper two cylinders and one opening into the lower crankcase for the other two are required. The center section of the crankshaft is so shaped as to serve as the rotary valve so one set of cylinders is taking fuel while the other is making the power stroke. The openings from the housing to the valve must be made so both sets of cylinders receive equal amounts of fuel.

i. Propellers. Diameter, pitch, and slip. Propellers have two or three blades, depending on the nature of the service they are to do. The size of a propeller is given in diameter and pitch.

(1) *Diameter* of a two-blade propeller is the distance from the tip of one blade to the tip of the other. The diameter of the two- or three-blade type is the diameter of the circle described by the tips of the blades.

(2) *Pitch* is the distance forward or back the propeller would travel in one revolution if the water were a solid. Thus, theoretically, a 12-inch-pitch propeller would advance 12 inches in one complete turn through a solid.

(3) *Slip* is the difference between the actual and theoretical pitch of the propeller caused by the fact that water, not being a solid, permits the propeller to slip. Slippage normally varies from 20 to 40 percent, depending upon the efficiency and speed of the propeller. In general, heavy boats or loads require propellers with greater diameter and blade area and less pitch than the propellers used on light, fast boats. A 12- by 14-inch propeller has a 12-inch diameter and a 14-inch pitch.

j. CAVITATION. The formation of a vacuum at the propeller is known as cavitation and occurs when a pocket of air has been sucked down by the propeller, causing it to spin in the air bubble and causing the engine to race. This action usually is caused by using a propeller of too great pitch, which keeps the motor from running at its most efficient speed and causes the water to be pushed aside faster than it flows in. This can be corrected by selection of a smaller-pitch propeller. Outboard motors have an anticavitation plate, as shown in figure 10, to

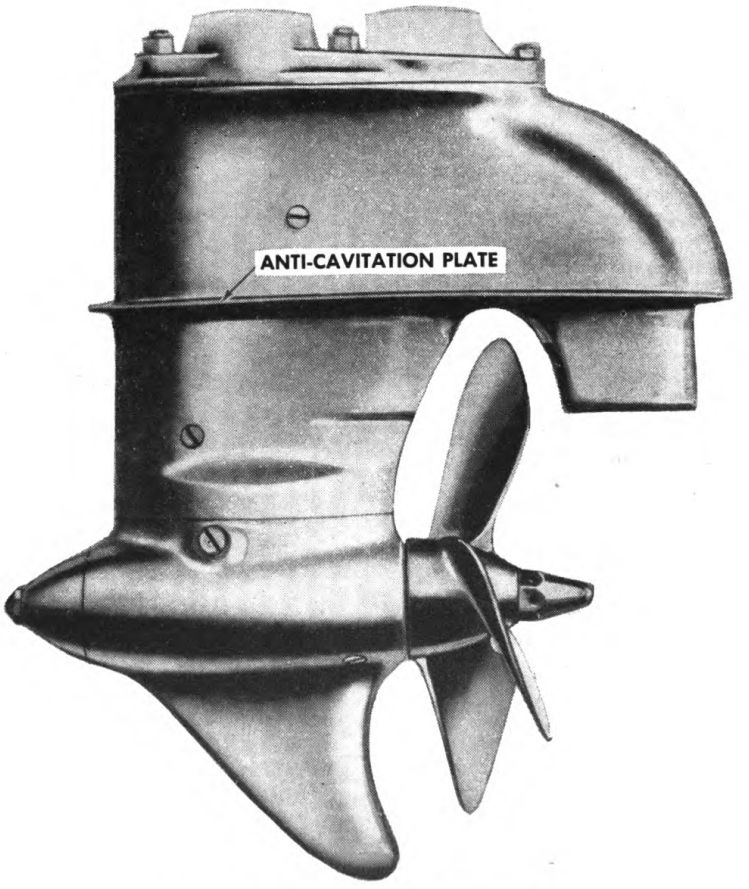


Figure 10. Anti-cavitation plate.

prevent such a downward suction of air. If the propeller is known to be correct, then cavitation is caused by the propeller operating too near the surface of the water, by air formations caused by the construction of the boat itself, or by weeds wrapped around the propeller or the lower unit.

k. Lower-unit Gears. The lower-unit gears or transmission consists essentially of a pair of bevel gears which transmit the power from the drive shaft to the propeller shaft. The pinion gear is keyed to the drive shaft and turns the horizontal gear which is keyed to the propeller shaft. The revolution reduction ratio of the drive shaft to the propeller shaft is set by this pair of gears.

SECTION III

TECHNICAL APPLICATION

5. Carrying, Installing, and Removing Storm-Boat Motor

a. CARRYING. Two combination carrying bars and paddles are provided for carrying the storm-boat motor. The bars are inserted through sockets in the hand grips on each side of the motor, with the circular paddles at the flywheel end of the motor which is carried as shown in figure 11.

b. INSTALLING ON BOAT. The motor can be used only on the storm boat. It is carried into the boat as shown in figure 13. The motor has a special stern bracket for mounting it on the boat. This bracket has two prongs which fit into motor-mount-plates on the floor of the boat

Figure 11. Carrying storm-boat motor.

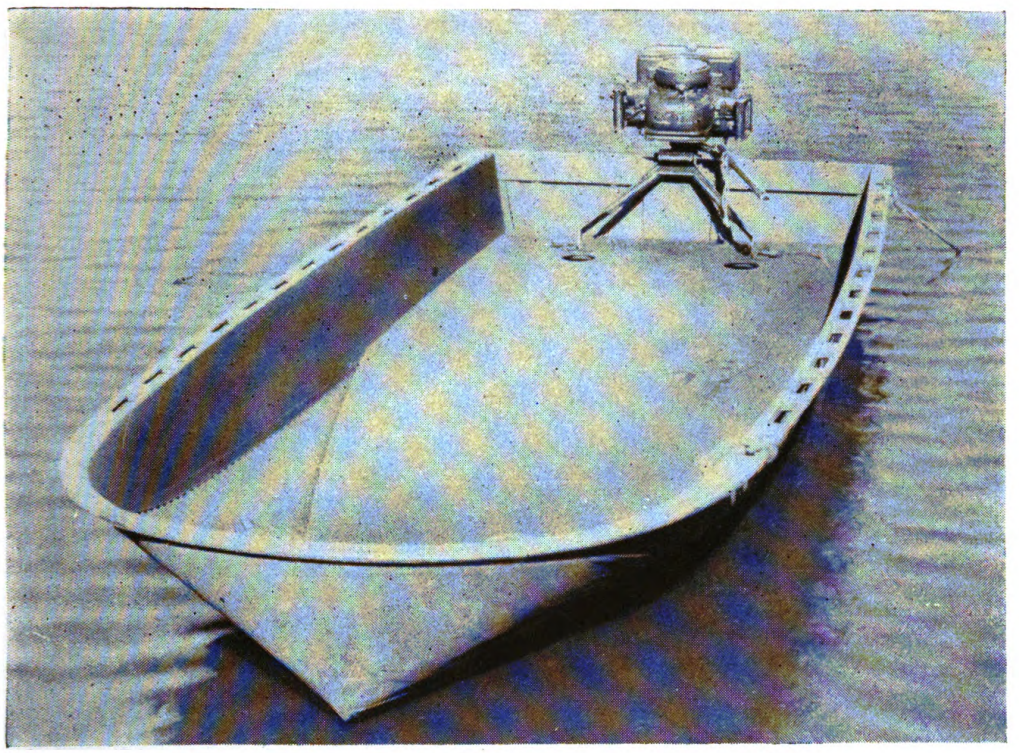


Figure 12. Storm boat with motor.

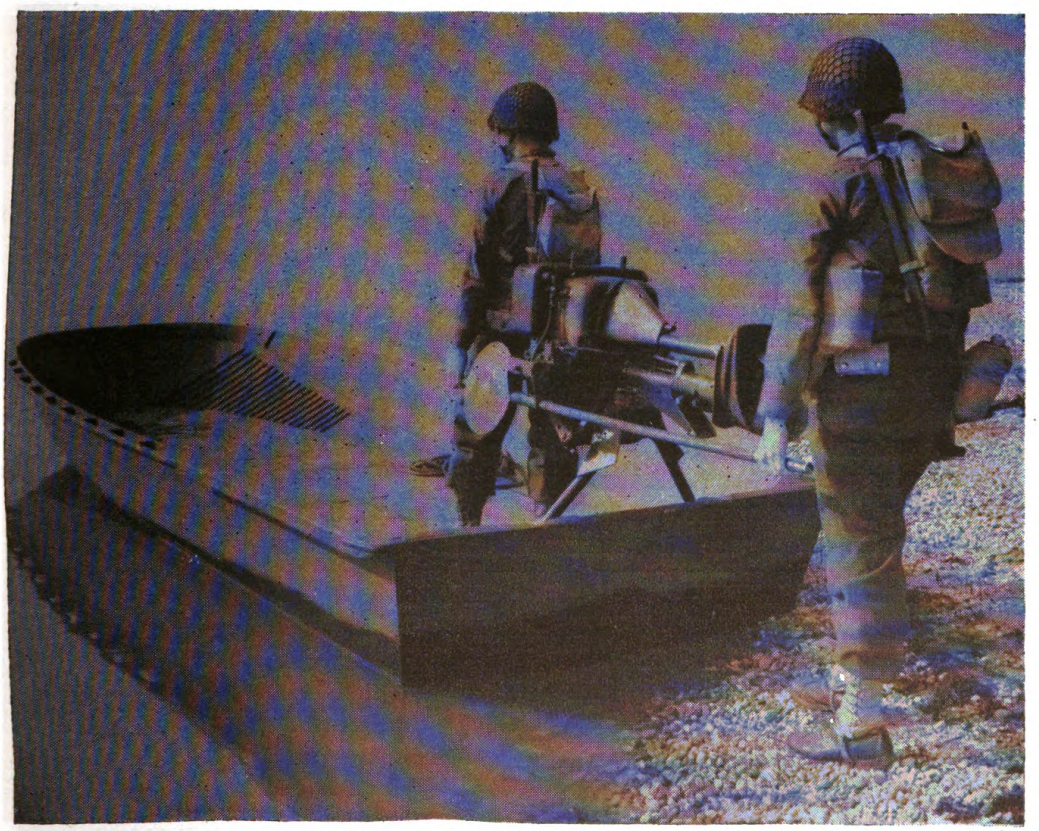


Figure 13. Carrying motor into boat.

Figure 14. Placing motor in boat.

and also has a thrust socket which fits into a slot cut in the back of the transom. The prongs of the bracket are locked into position with pins. These pins are inserted into the motor-mount-plates as illustrated in figures 15 and 16. The carrying bars are removed and the motor is laid down inboard as shown in figure 14. Prior to raising the motor make sure the boat is in water deep enough for ample propeller clearance. Raise the motor and move it slowly to position on the stern of the boat and lock the tilt-lock (see fig. 19).

c. REMOVING. (1) *Storm-boat motor from boat.* To remove the motor from the boat, shut the air vent in the cap of the gasoline tank and shut off the gasoline. (See figs. 35 and 36.) Pull the motor inboard as illustrated in figure 18 raising the tilt-lock as shown in figure 19. Before laying the motor down inboard let the water drain completely from the water system by holding the motor with the power head tilted up. Turn flywheel one turn to make sure. Remove the cotter pins and pull out the fulcrum pins. The carrying bars then are inserted and the motor is carried in the same position as illustrated in figure 11.

(2) *POLR–15 from boat.* To remove the motor, loosen the clamp screws and lifting the motor straight up hold it in a vertical position until all the water has drained from the water system. Never set the motor on the magneto or flywheel or carry it with the flywheel down as this may allow water to enter the powerhead.

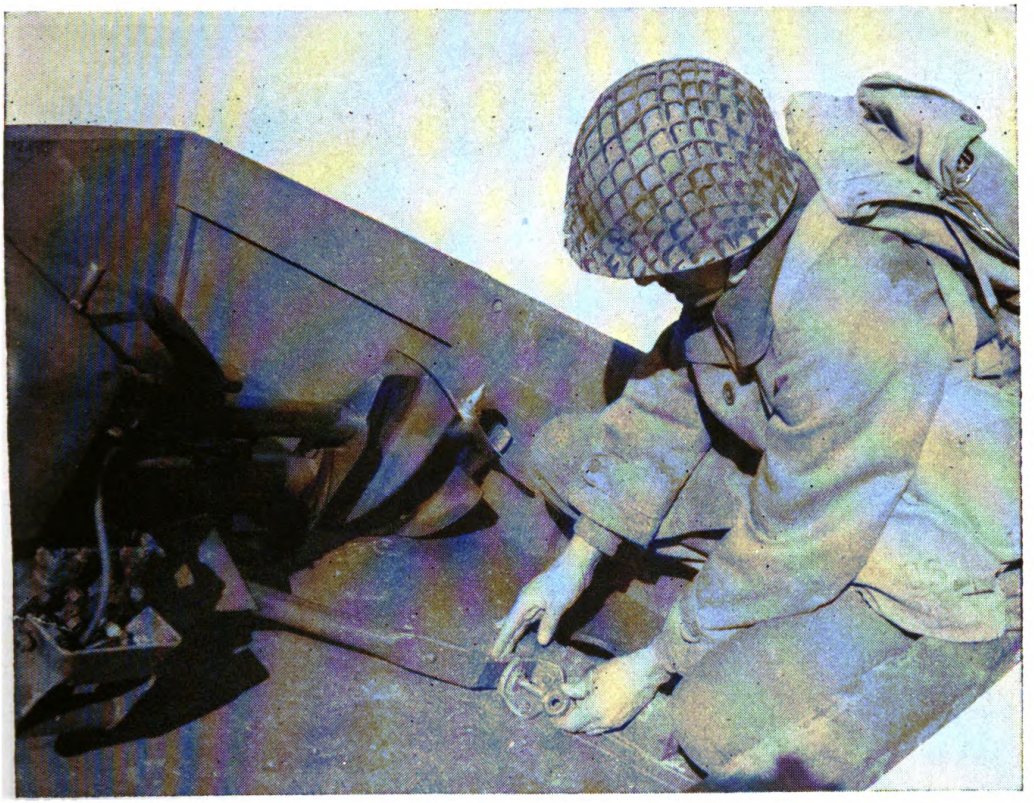


Figure 15. Attaching bipod by inserting fulcrum pins.

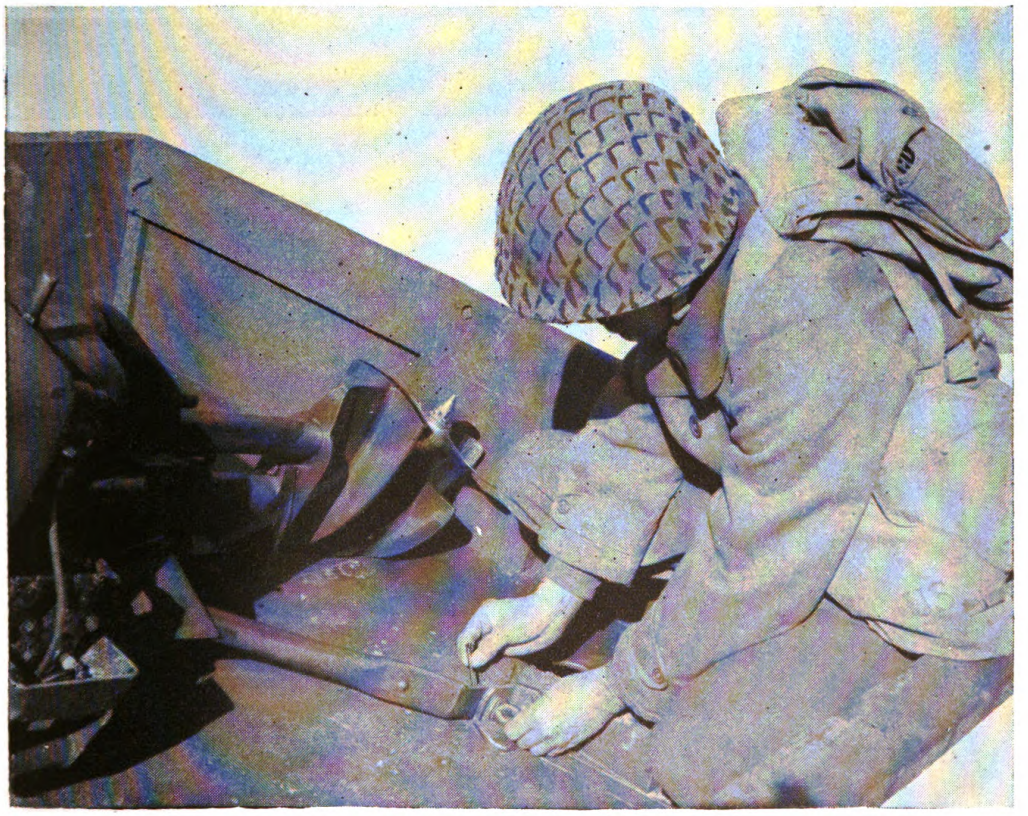


Figure 16. Inserting cotter pins.

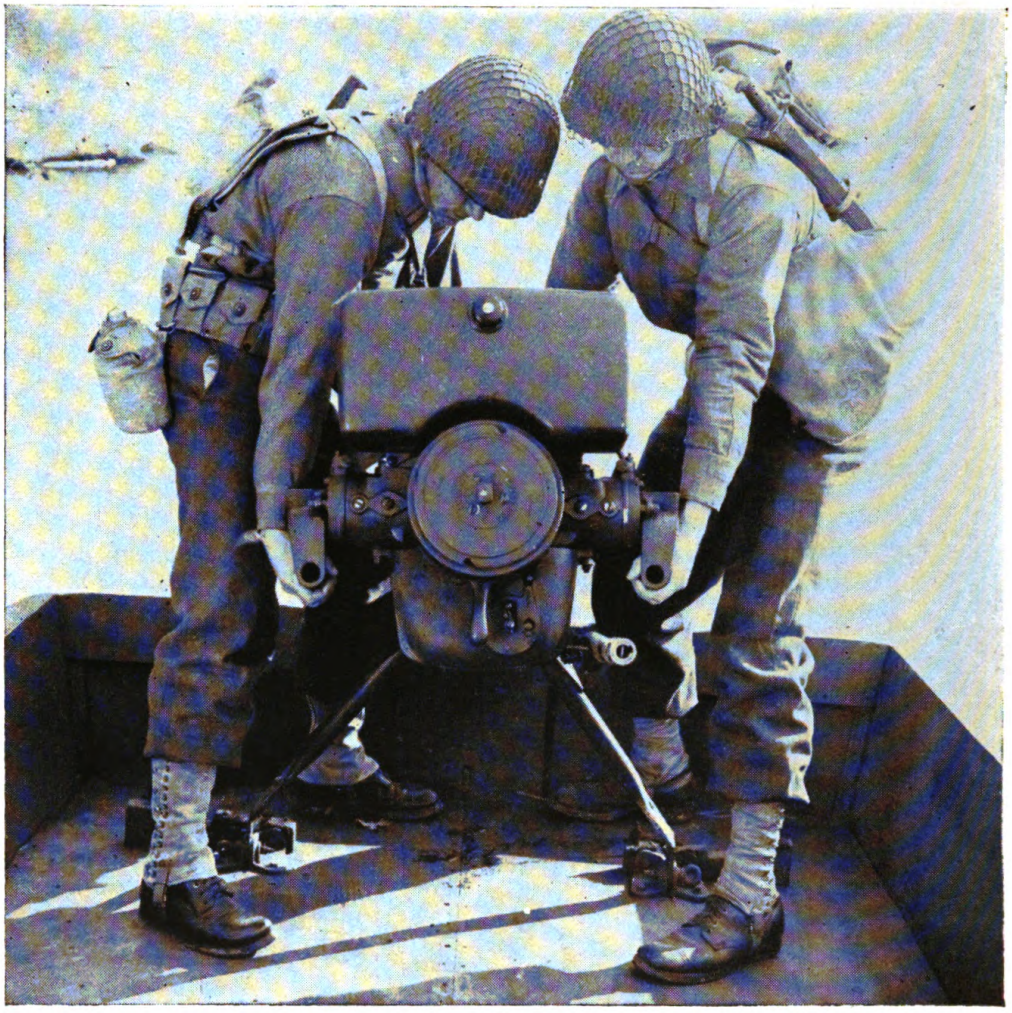


Figure 17. Placing motor on stern.

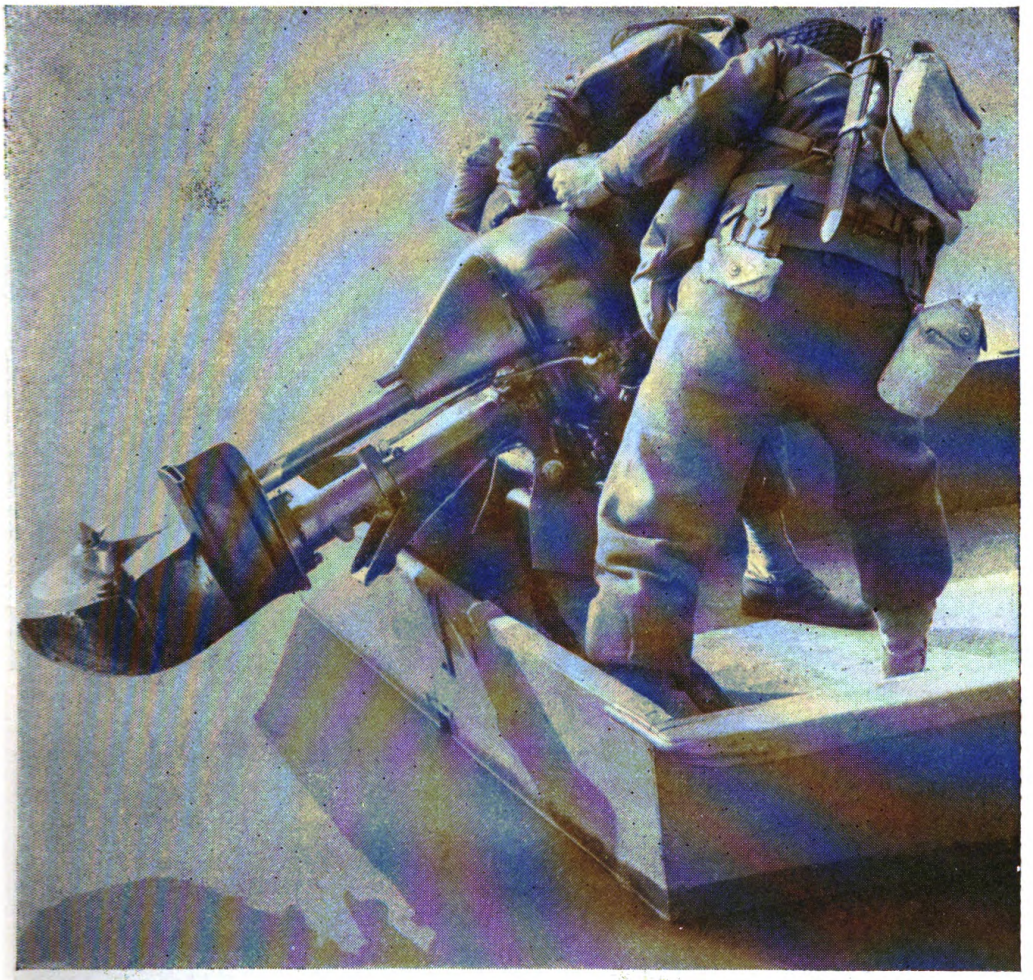
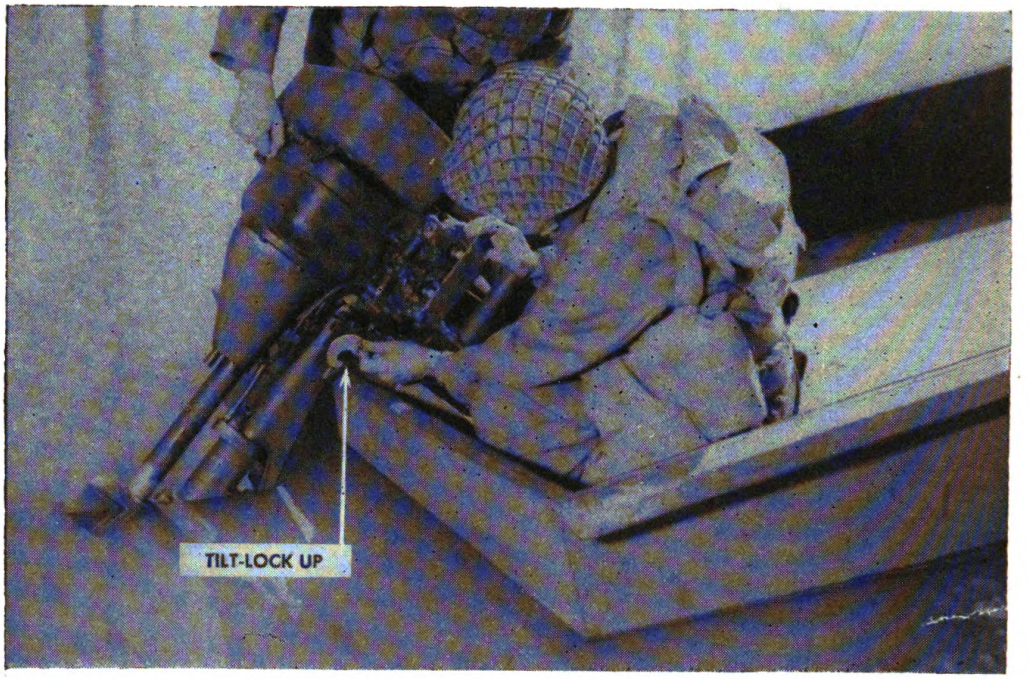
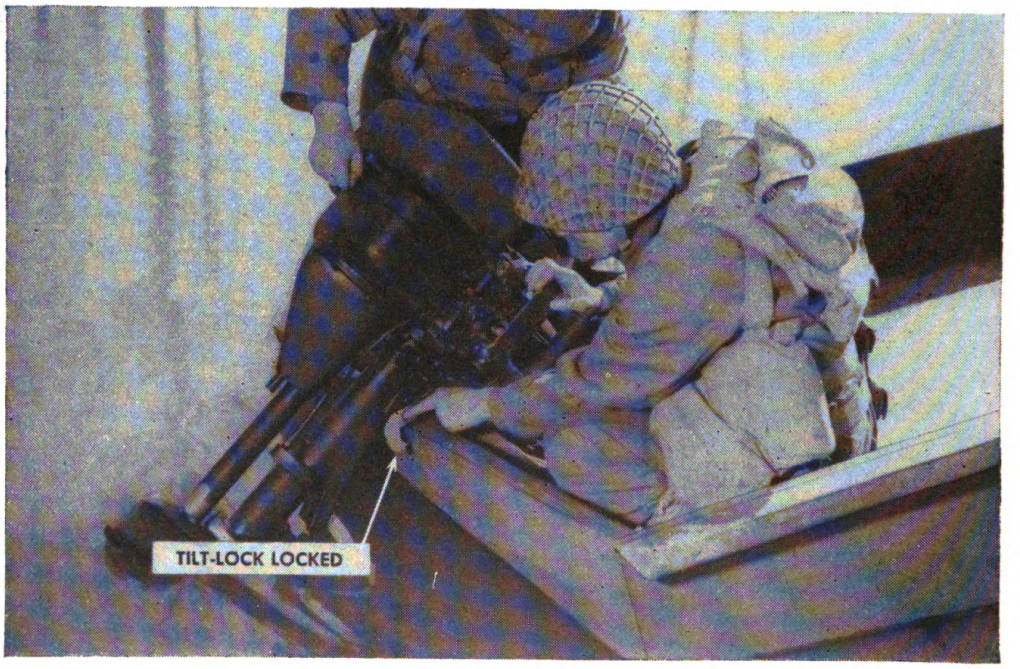


Figure 18. Pulling motor inboard.



① *Raising tilt-lock.*



② *Tilt-lock locked.*
Figure 19.

6. Installing POLR–15 Motor

a. On Boat. (1) The motor is mounted on the stern of the boat so the line of the propeller drive shaft is parallel to the line of boat travel. Correction of the line of the propeller drive is made by adjusting the thrust socket.

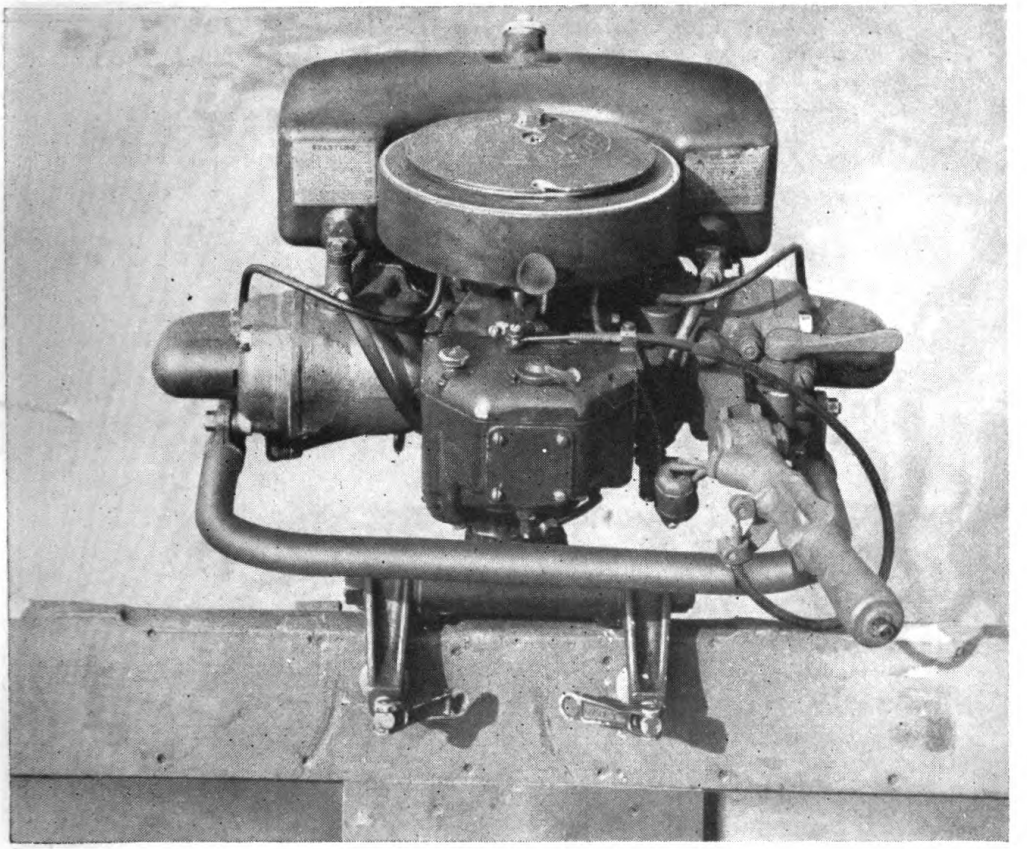


Figure 20. POLR–15 mounted on boat. Keep both clamps tight.

(2) Hang the motor on the stern of the boat and tighten the clamp screws by hand. Tilt the motor to the estimated angle and loosen the thrust-socket nut. Slide the thrust socket up on the quadrants until it rests firmly against the drive-shaft housing. Tighten the thrust-socket unit. Start the motor and operate at full throttle. If the boat has a tendency to ride with the bow high out of the water, the propeller is tilted too far away from the stern. The angle of drive, being directed downward, results in a downward thrust on the stern, thus raising the bow.

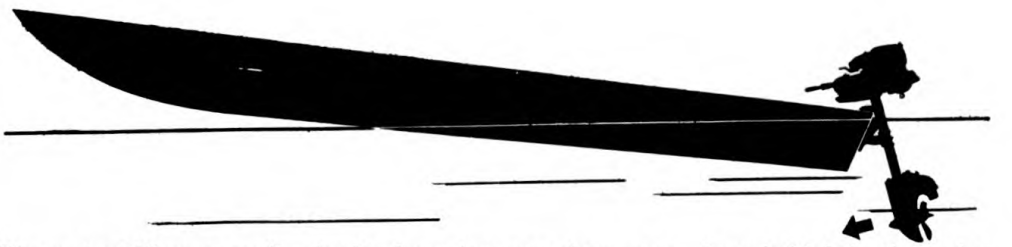


Figure 21. When propeller is tilted too far away from stern, bow is high in the water.

Figure 22. When propeller is tilted too close to stern, bow is low in the water.

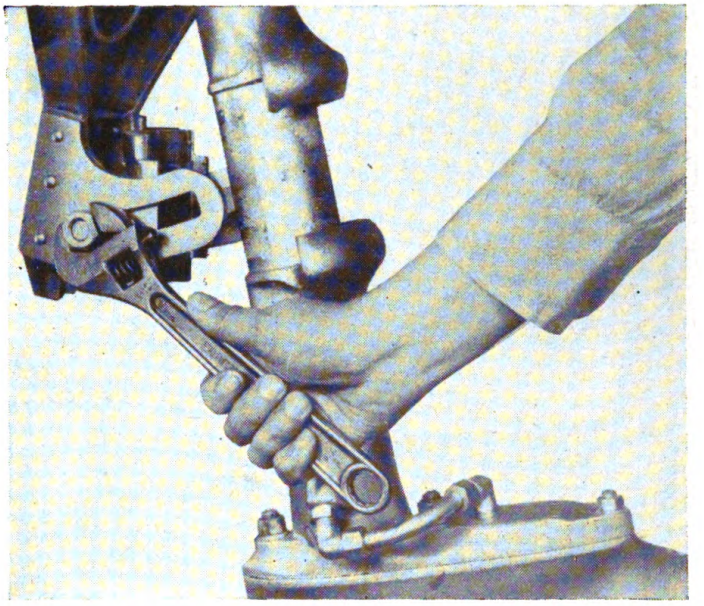


Figure 23. Tightening thrust-socket nut after line of propeller drive is adjusted correctly.

(3) If the propeller is tilted too close to the stern the boat is hard to control, as the bow will dig in or plow into the water. This is due to the upward thrust exerted on the stern. *With the load in the boat evenly distributed, the thrust socket should be adjusted so the line of the propeller drive is parallel to the surface of the water when the motor is at full throttle.*

(4) When the lower unit strikes an underwater obstruction, the motor tilts as shown in figure 24 to prevent damage to the boat and motor.

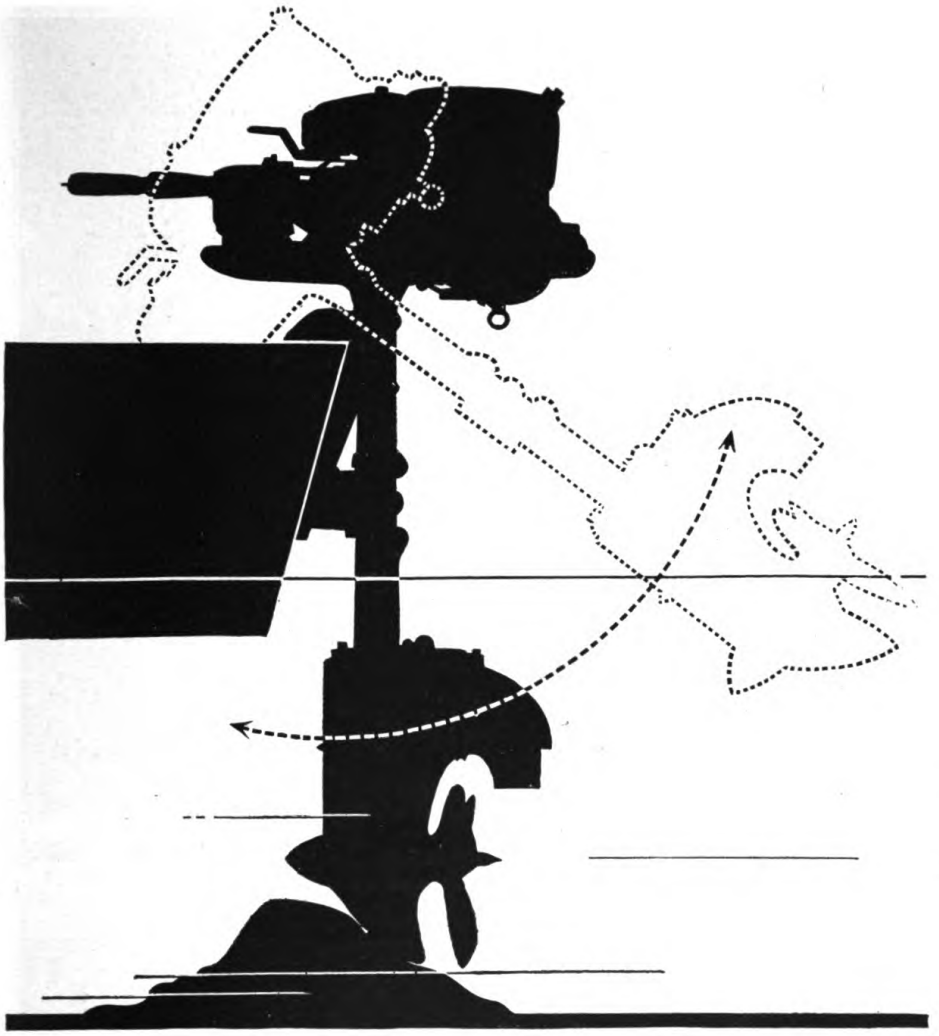


Figure 24. Action of motor upon hitting obstruction.

b. On Various Types of Floating Equipment. Figures 25 to 30 inclusive show how the POLR–15 is attached to—

Ten-ton ponton.
Twenty-five-ton ponton.
Assault boat M1.
Assault boat M2.
Treadway bridge float.
Infantry support raft.

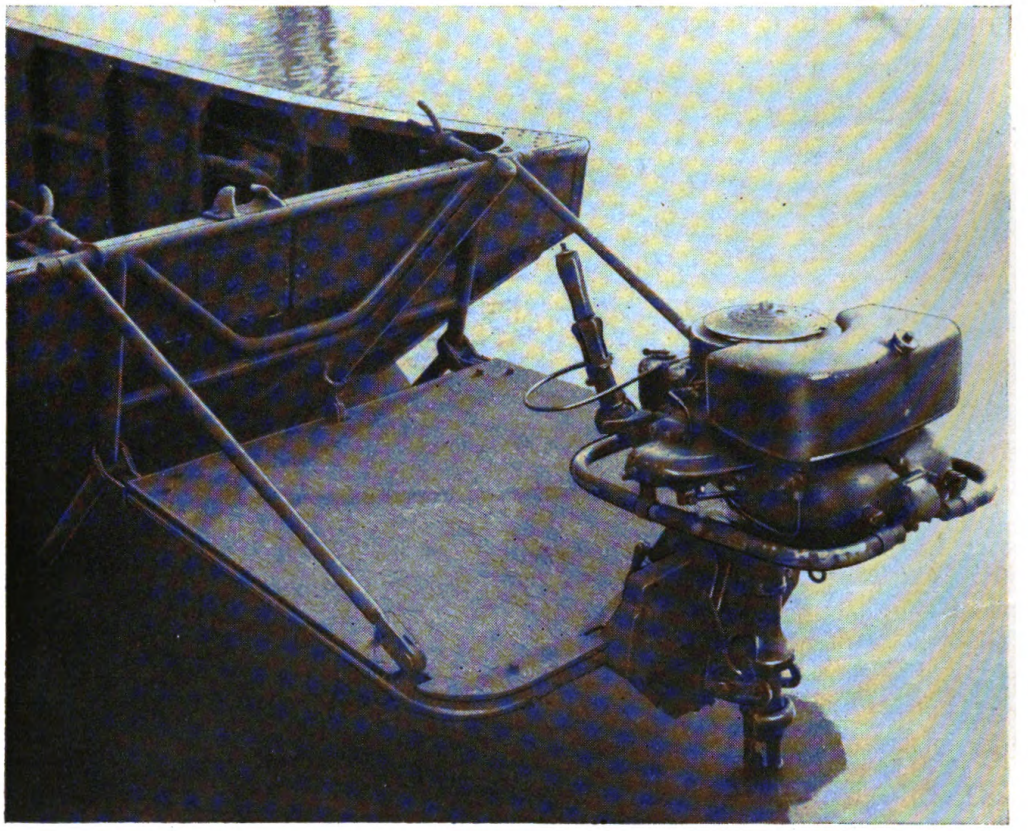


Figure 25. POLR–15 attached to 10-ton ponton with 10-ton ponton 22-hp outboard motor stern attachment bracket.

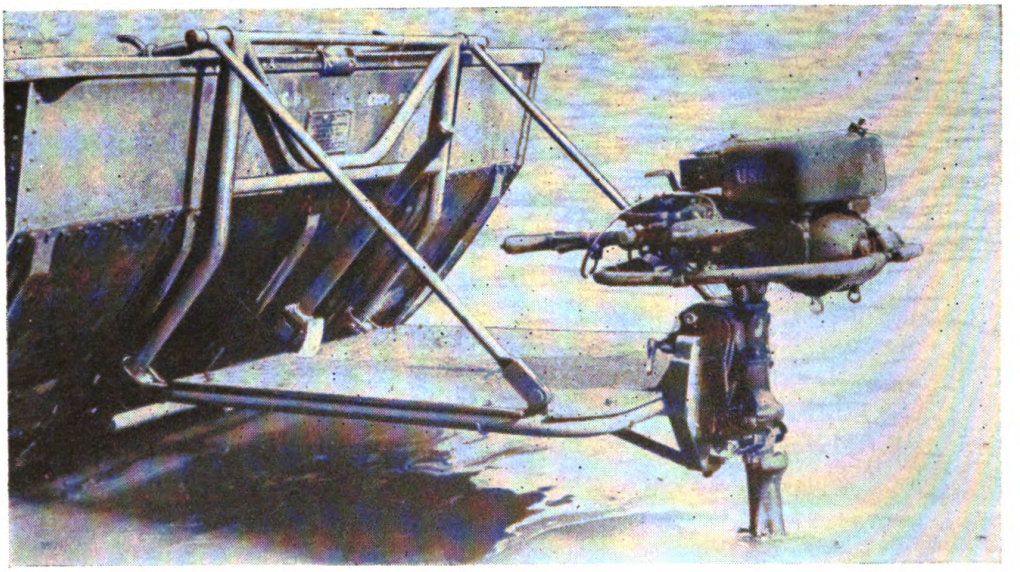


Figure 26. POLR–15 attached to 25-ton ponton with 25-ton ponton 22-hp outboard motor stern attachment bracket.

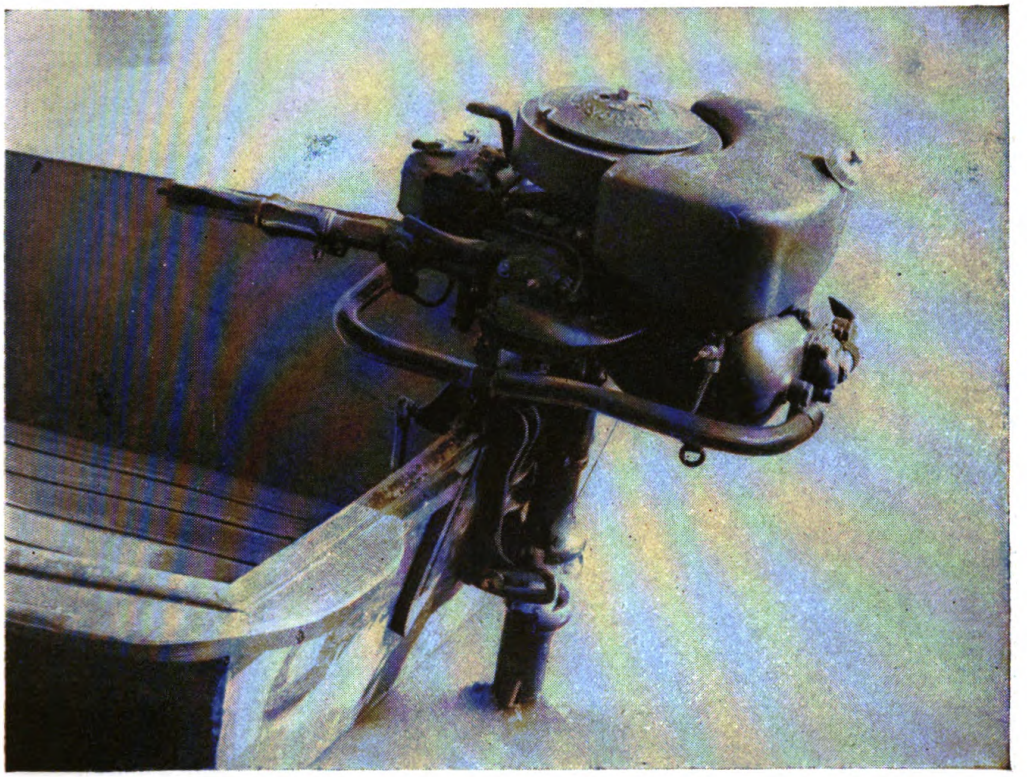


Figure 27. POLR–15 attached to M1 assault boat.

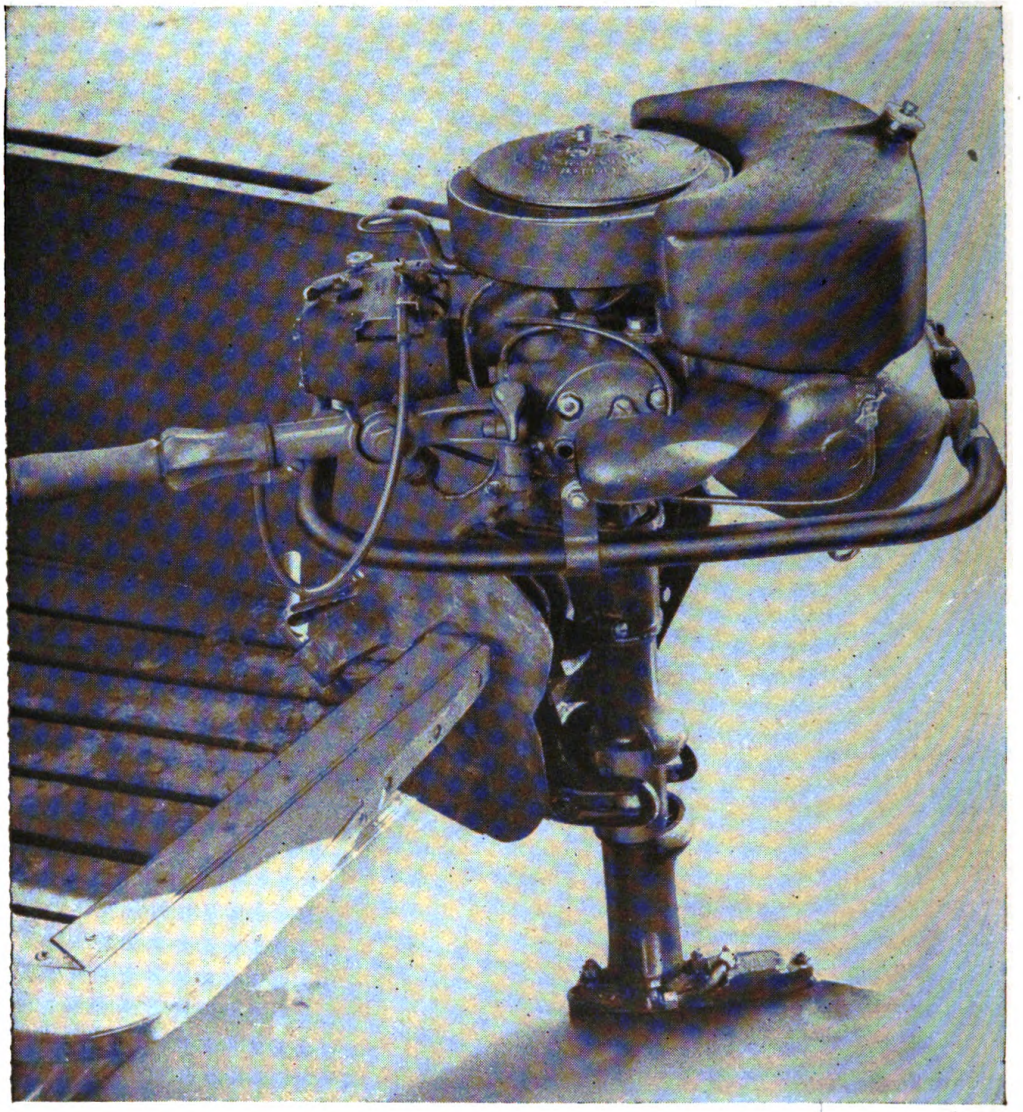


Figure 28. POLR–15 attached to M2 assault boat with M2 assault boat, 22-hp outboard motor stern attachment bracket.

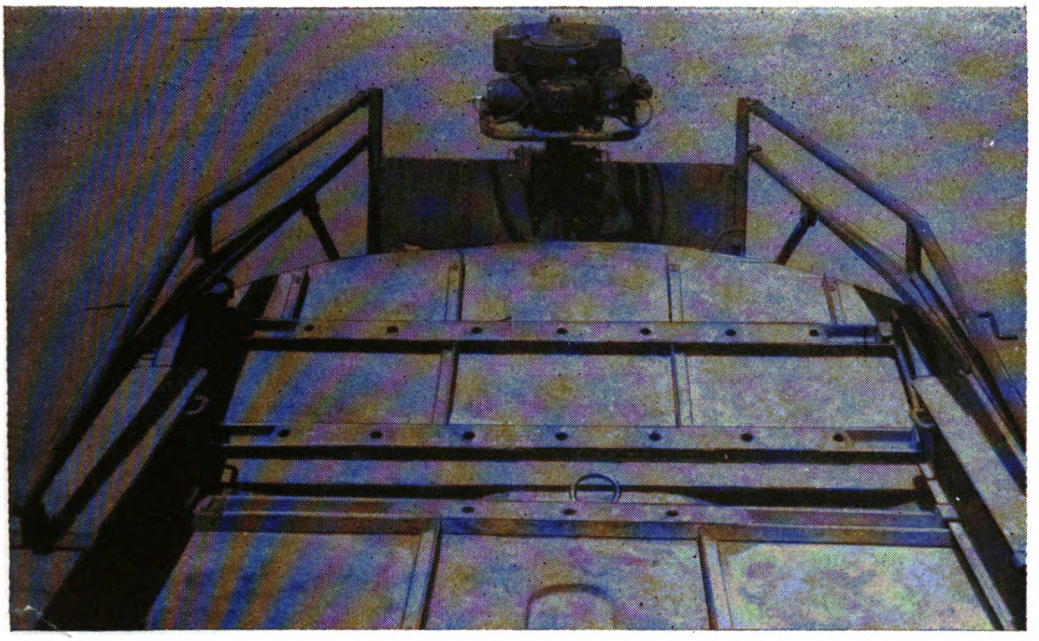


Figure 29. POLR–15 attached to treadway bridge float with M1 18-ton pneumatic float, 22-hp outboard motor stern attachment bracket.

Figure 30. Outboard motor attached to infantry raft using M2 assault-boat bracket.

7. Elementary Outboard Motor Operation

a. STEERING. Steering is done with the left hand. The operator faces the bow of the boat with the motor to his left as shown in figure 31. The craft is steered by moving the steering handle to the right or left. If the operator wishes to make the boat turn to the left, he moves the

Figure 31. Operator's position in storm boat. (Kneel on left knee, right foot forward, right hand on gunwale and left hand holding the throttle control on steering handle.)

handle toward him, or to the right. To make a right turn he moves the handle away from him, or to the left. The motor pivots so the direction of boat travel is governed by the propeller thrust. This gives the operator full control of the boat from the time the motor is started.

b. Docking. In docking, the boat is brought in parallel to the dock, if possible, heading into the wind or current, whichever has the greater effect on the boat's course. In docking where the landing room is limited, the boat is brought toward the dock at a right angle to it. A short distance from the dock a 90° turn into the wind or current is made and the motor shut off. The boat will drift broadside into the dock. The distance from the dock at which the turn is made depends on the type of boat and the speed it is making.

c. Reverse. The POLR–15 can be pivoted 360°. It is reversed by raising the steering handle and turning the motor 180° to reverse position. The speed of the motor should be reduced before pivoting the motor to reverse position. The motor does not tilt when in reverse, so particular care must be taken to avoid striking submerged obstructions.

d. Beaching Storm Boat. The boat may be beached at full throttle on banks having gentle slopes. The motor is stopped by the operator immediately before the skeg or the bow of the boat grounds. This depends on the depth of water near the bank. The boat is headed

Figure 32. Beaching storm boat under power. (Note position of passengers. The operator has moved out of the way of the motor which is tilting inboard.)

directly into the beach so the bow will ground squarely. If the boat slants as it grounds, it will swerve and possibly tilt over.

8. Where Used

Outboard motors are used to propel boats, pontons, and rafts on sheltered waterways. They can be used only in water deep enough to accommodate the propeller. Underwater obstructions may damage the propeller or shear pin, and entangled weeds may cut down the propeller's efficiency.

9. Preparation for Storage

a. Limited Storage, 30 Days or Less. Before the motor is placed in storage, do the following:

(1) Drain all fuel from gas tank, gas line, and carburetor.

(2) Remove and clean carburetor and gas-tank screens.

(3) Remove grease and drain plugs to allow water in the gear case and cooling system to drain off. Rock the motor from side to side while it is in an upright position to make sure all water has been drained. If the motor has been operated in salt water, flush the cooling system with fresh water.

(4) Refill gear case with Evinrude Super Grease or Johnson Sea-Horse Lubricant.

(5) Remove spark plugs. Pour about a tablespoon of clean oil through each spark-plug opening. Turn flywheel slowly to distribute oil on cylinder walls and replace spark plugs.

(6) The motor should be placed in an upright position in its motor chest or hung on a rack similar to the manner in which it is mounted on the boat.

b. Dead Storage. Refer to TM 5–9715, copies of which may be obtained from Engineer Field Maintenance Office, P. O. Box 1679, Columbus, Ohio.

10. Preparation for Shipment

a. By Rail or Truck. Follow the instructions contained in paragraph 9 above.

b. Export. Refer to TB 5–9711–1, copies of which may be obtained from Engineer Field Maintenance Office, P. O. Box 1679, Columbus, Ohio.

SECTION IV

STORM-BOAT MOTOR

11. Nomenclature

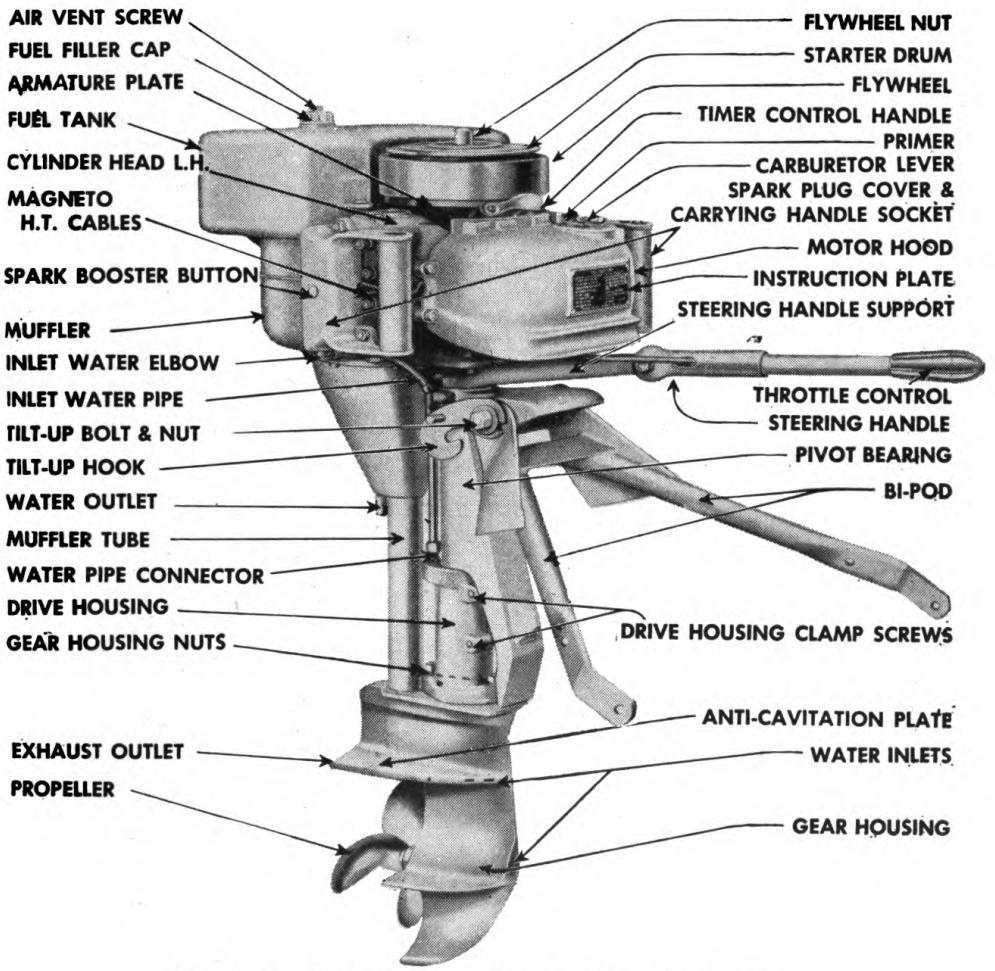


Figure 33. General nomenclature, storm-boat motor.

12. Specification Chart

Table II. Specification chart, storm-boat motor

Bore	2¾ in.
Stroke	2½ in.
Piston displacement	59.4 cu. in.
Horsepower	50 at 5,500 rpm.
Number of cylinders	4.
Bevel gear ratio: motor to propeller	15:21.
Propeller as supplied with motor:	
Number of blades	3.
Material	Bronze.
Diameter and pitch	10½ by 9 in.
Fuel-tank capacity	28 pints.
Make carburetor	Vacturi.
Cooling system	Centrifugal water pump.
Weight, net	198 lb.
Over-all dimensions, omitting steering handle	22½ by 24½ by 52 in.

13. Operating Kit and Motor Chest

a. Operating Kit. The operating kit that comes with each storm-boat motor contains tools for emergency repairs and adjustments and also an emergency set of spare parts. When the boat is in use the operating kit always is carried in it.

b. Motor Chest. Figure 34 illustrates how the motor, kit, spare parts, and carrying handles are packed for shipment or storage. The motor and equipment are fastened in the motor chest by thumb screws and straps. No tools are required to remove them.

14. Starting Instructions

When ready to start the motor, proceed with the operations listed on the motor instruction plate in the order shown below.

a. Mix one pint SAE No. 50 lubricating oil with each gallon of gasoline and fill tank.

b. Open vent screw on gas-tank cap (fig. 35).

c. Open gas cock under tank (fig. 36).

d. Set carburetor lever to "cold" (fig. 37).

e. Set timer lever to "start" (fig. 38).

f. Set steering grip to "start" (fig. 39).

g. Wrap rope on flywheel (fig. 40).

h. Push primer five times (fig. 41). If motor has been run and is hot, prime sparingly or not at all.

i. Spin flywheel with strong pull (fig. 42).

j. When started, move timer to "run" and turn steering grip toward "fast."

k. With throttle wide open adjust carburetor lever toward "warm" until motor runs smoothly.

l. Motor is stopped by moving timer handle to the position marked "stop" (all the way to left, as you face motor). (See fig. 43.)

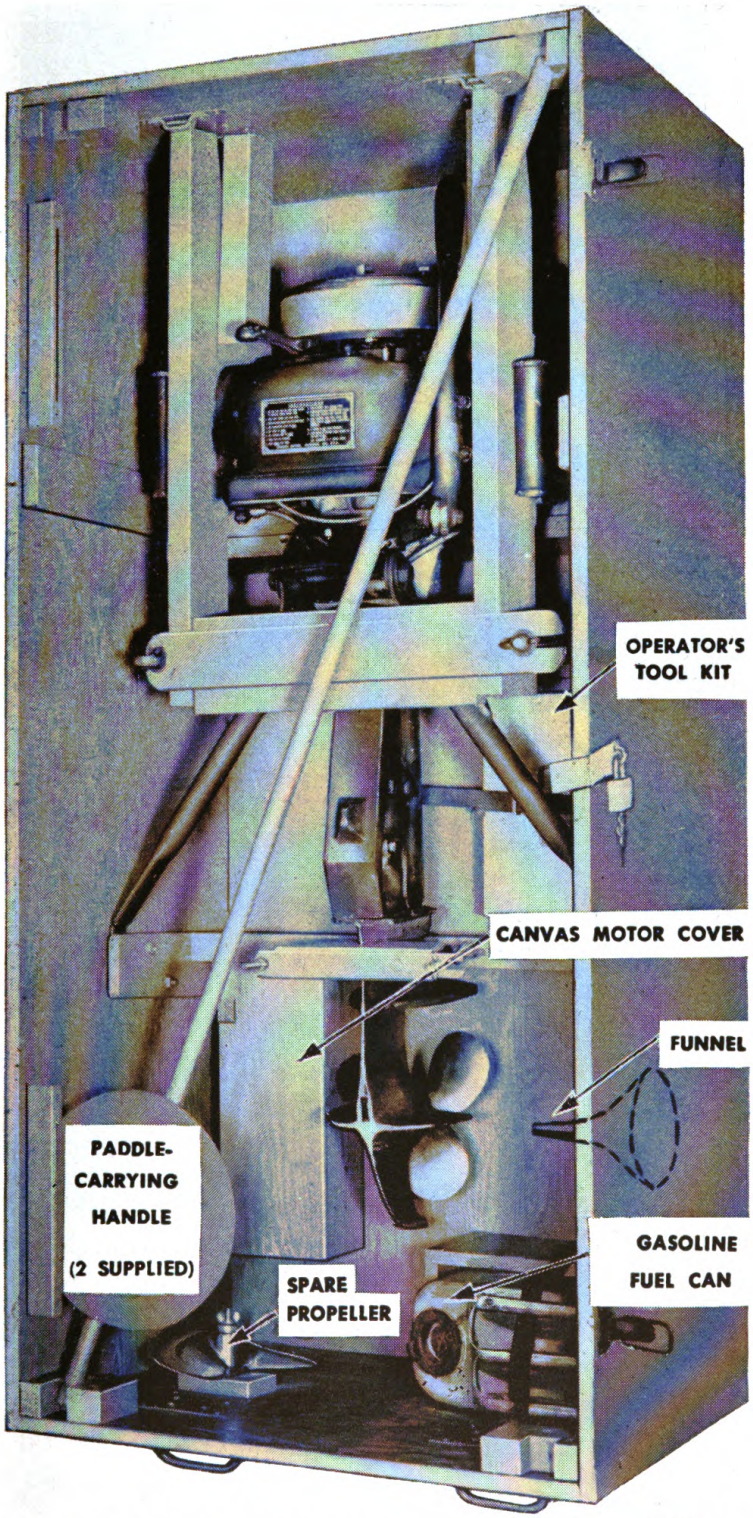


Figure 34. Storm-boat motor in motor chest. (Over-all dimensions of motor chest are 81 by 36 by 35 inches and total shipping weight of chest, motor, and accessories is 650 pounds.)

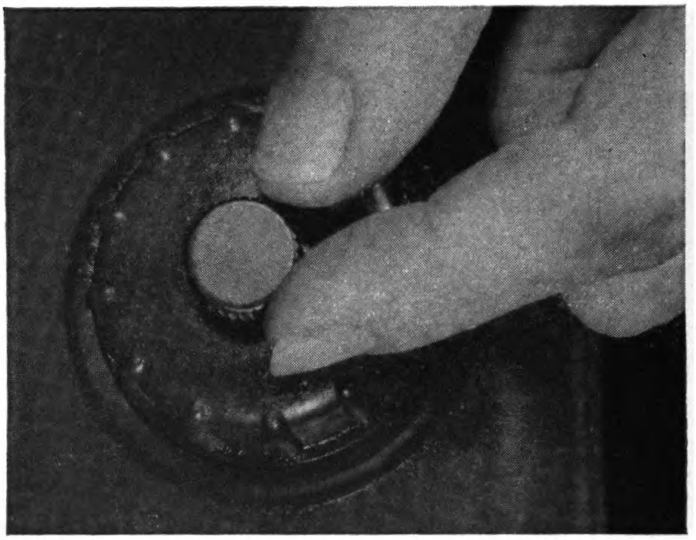
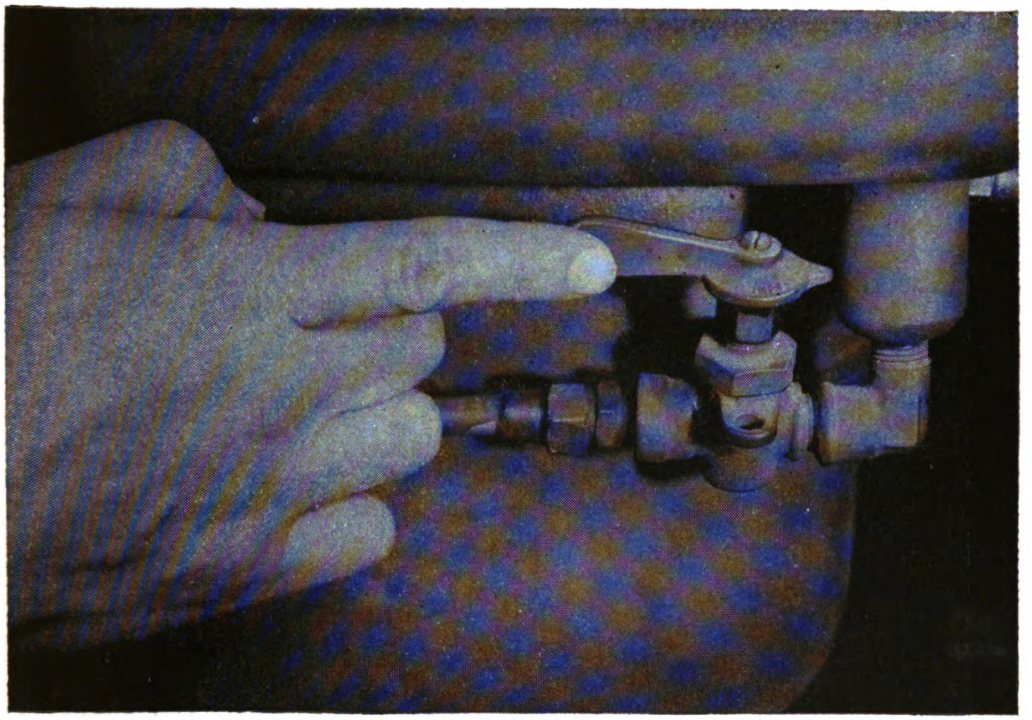
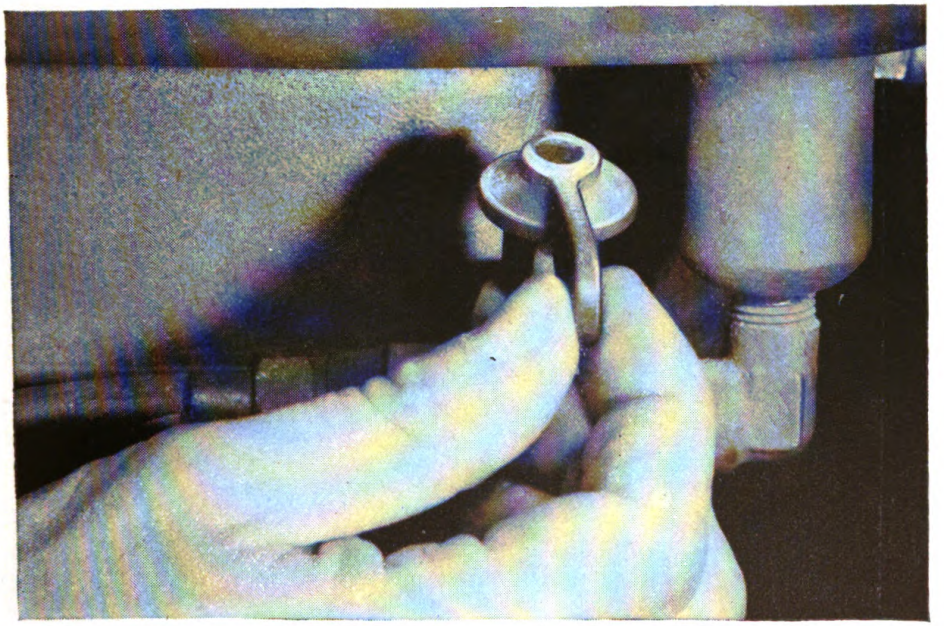


Figure 35. Open vent screw on gas-tank cap to allow air to enter tank permitting gasoline to flow from tank.



① *Closed position.*



② *Open position.*

Figure 36. Open gas cock under tank to permit gasoline to flow to carburetor.

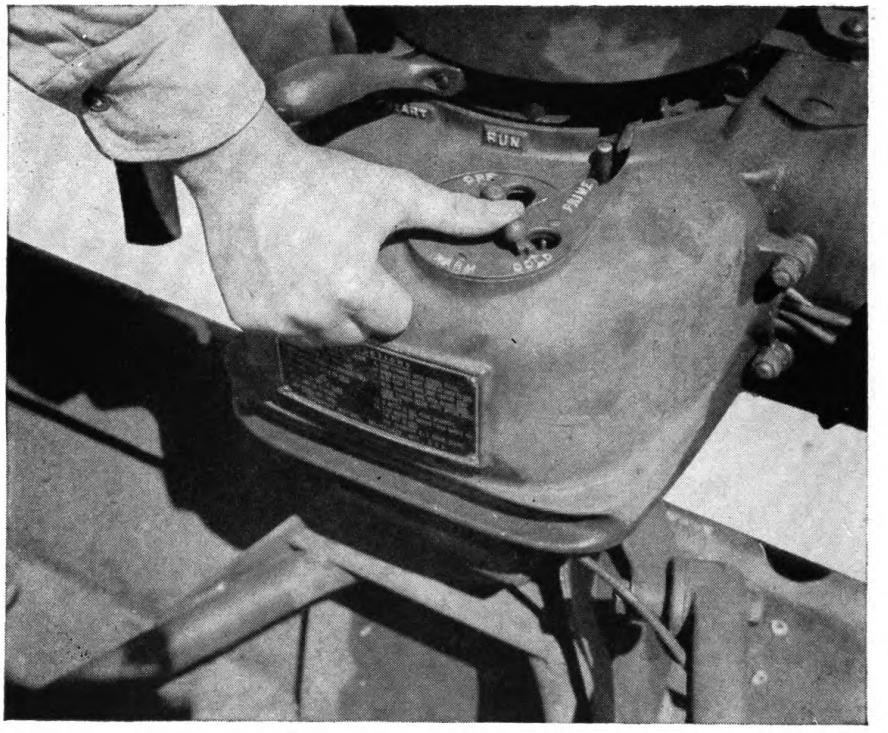


Figure 37. Set carburetor lever to "cold" to furnish a richer gasoline and air mixture for starting.

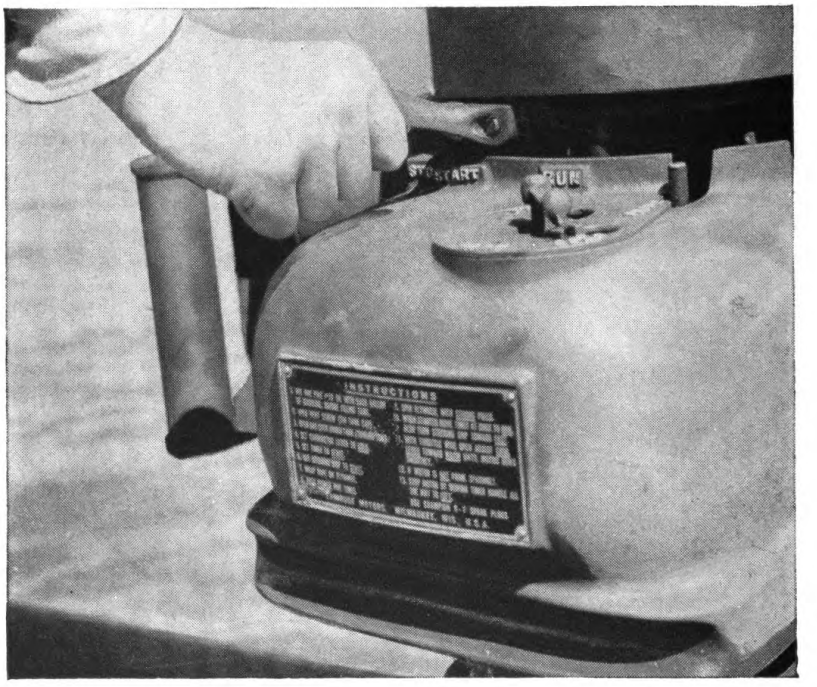


Figure 38. Set timer lever to "start" to retard spark and thus prevent back firing.

Figure 39. Set steering grip to "start" to give correct throttle adjustment for starting.

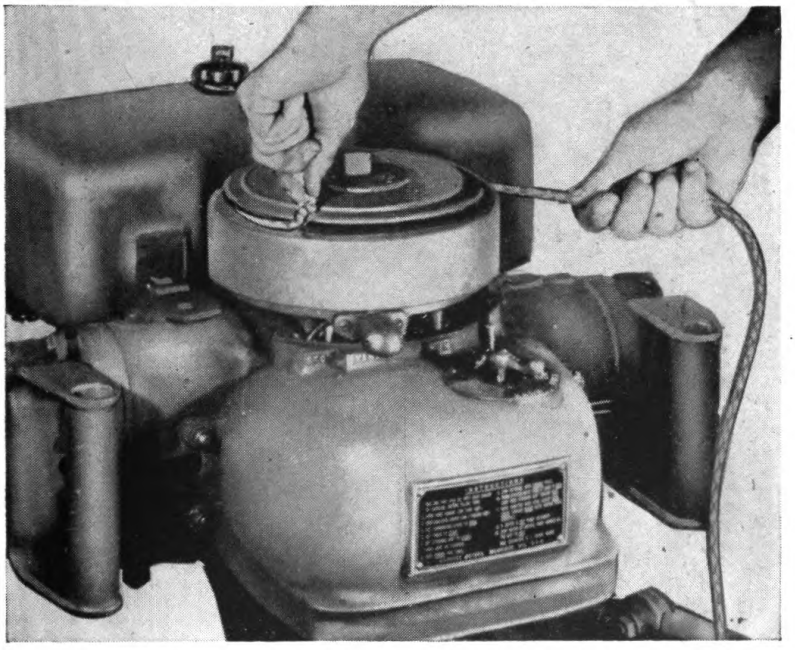


Figure 40. Wrap starting cord clockwise around starting drum placing knot of cord in notch of drum.

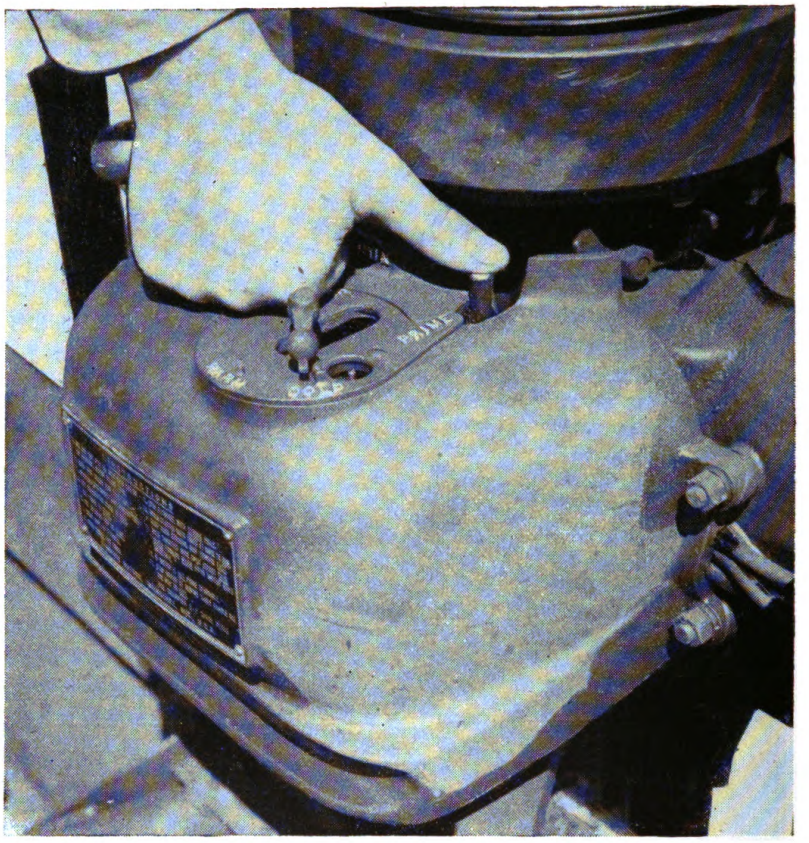


Figure 41. Push primer five times to inject a supply of fuel into crankcase for starting. (Don't prime a hot motor.)

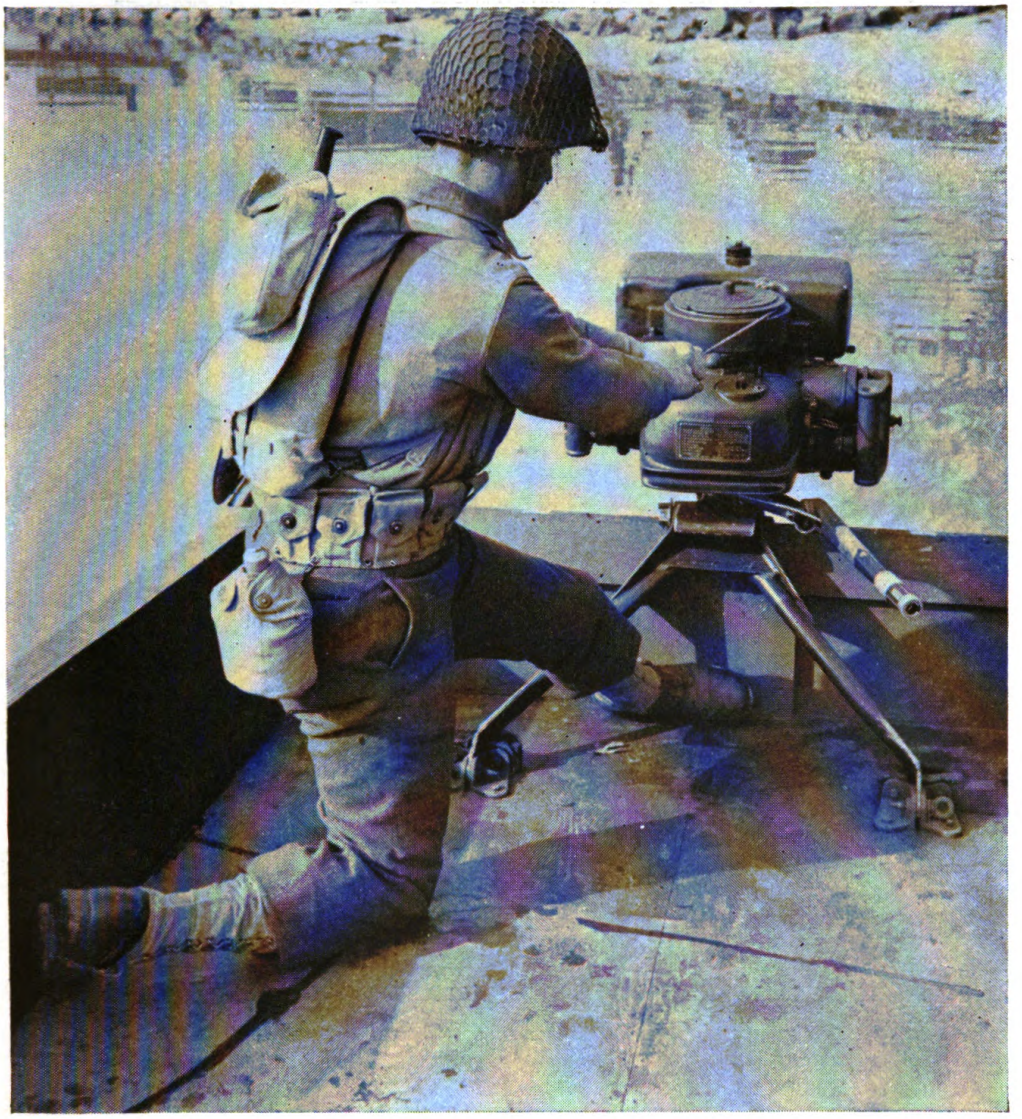


Figure 42. Spin flywheel. (Grasp starting cord as shown and spin flywheel with a sustained, strong pull. Do not jerk rope. Note operator's position.)

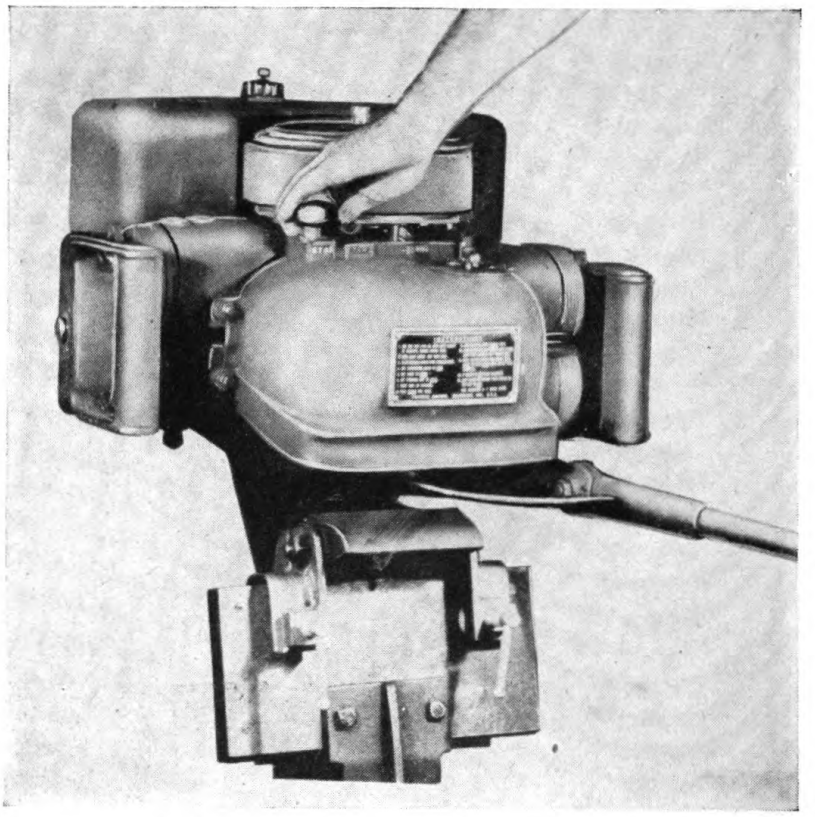


Figure 43. To stop motor, move timer handle to "stop."

15. Operating Instructions

a. (1) THREE FUNDAMENTALS OF OPERATION. There are three fundamentals in the operation of an outboard motor. Know what they mean and keep them in mind constantly. Learn how to find out whether and how well these fundamentals are fulfilled. They are:

(*a*) The proper mixture of gasoline-vapor and air in the cylinder.

(*b*) The compression of this mixture in the cylinder by the piston.

(*c*) A hot electric spark across the electrodes of the spark plug at the right time.

(2) Given a proper mixture, good compression, and hot spark, barring minor mechanical difficulties the motor will run and deliver power.

b. CARBURETOR ADJUSTMENT. After the motor has started and the timer advanced to "run" the carburetor needle lever is turned toward "warm" until the motor operates smoothly. This should be done when the throttle is wide open. The best adjustment is found by moving the carburetor needle lever toward "warm" until the speed starts to drop off, and toward "cold" until the motor begins to run unevenly. Select a position about halfway between these two extremes, but favor the rich or "cold" side.

c. TIMER-HANDLE SETTING. The motor has a maximum spark-advance stop which is set for the most common fuels. As some fuels do not permit an early spark setting, not retarding the spark may result in pre-ignition, overheating of the spark plugs, and burning of the pistons. When the engine has been brought to full speed by advancing the timer handle against the stop and opening the throttle fully, the timer handle is retarded as far as possible without reducing the speed.

The difference in timer setting due to difference in fuels usually falls in a range between full advance, against the stop, and two notches to the left of the stop.

d. IDLE FUEL ADJUSTMENT. The idle-speed jet may need adjustment due to varying atmospheric conditions. This is done by turning the idle-speed adjusting needle with a screw driver, as shown in figure 44. The needle is moved clockwise for a leaner mixture and counterclockwise for a richer mixture. These adjustments are made with the throttle closed. Turn the needle until the motor idles smoothly without stopping. Then open the throttle and check the speed of the motor. If the speed is less than before the adjustment, close the throttle and adjust the idle-speed needle again. Repeat until the motor runs smoothly with throttle closed, yet still retains its maximum speed at full throttle.

e. FLOODING. If the motor becomes flooded, move the carburetor high-speed needle to the "off" position and crank the motor until it starts. Immediately open the high-speed needle to the "run" position. If the motor starts and then dies, start it again by following the starting instructions.

f. SPARK BOOSTER. A spark booster is located on the left spark-plug cover. It is used if condensation or corrosion on the spark-plug points makes the motor hard to start. By *pulling the button out* and cranking

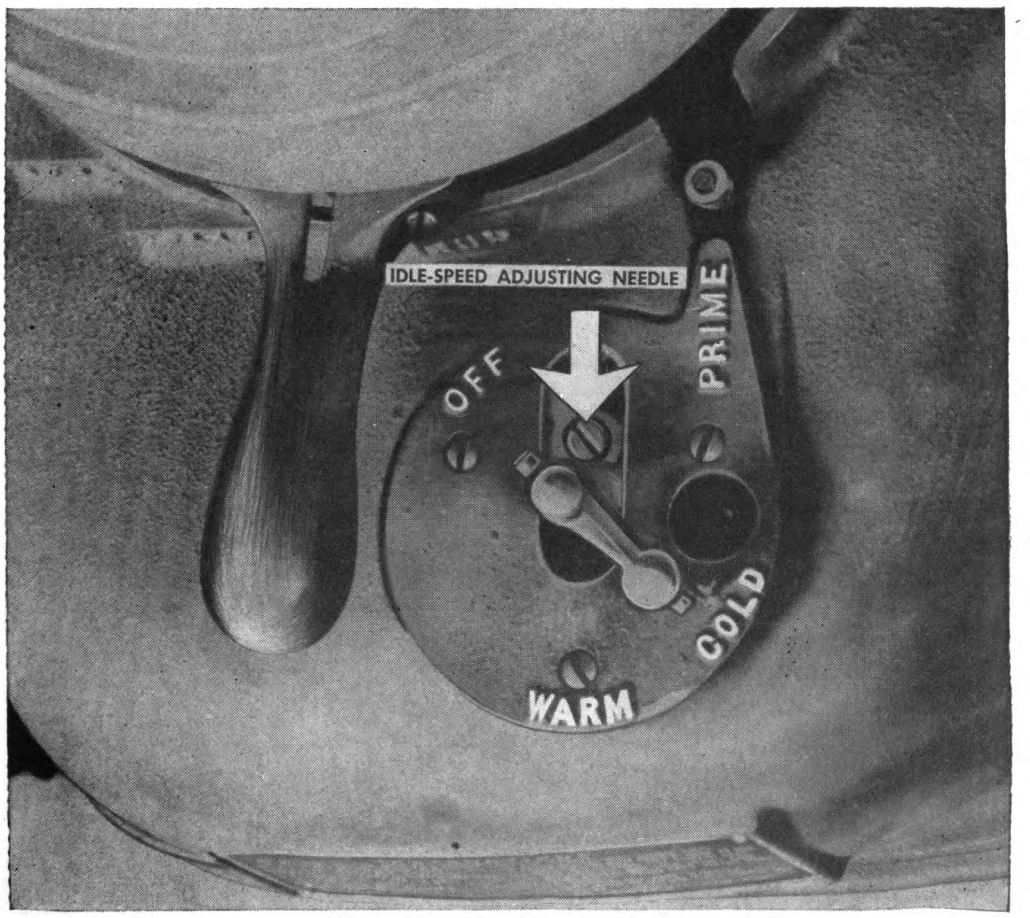


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Figure 44. Idle-speed adjustment. (Turn needle clockwise for leaner mixture; counterclockwise for richer mixture.)

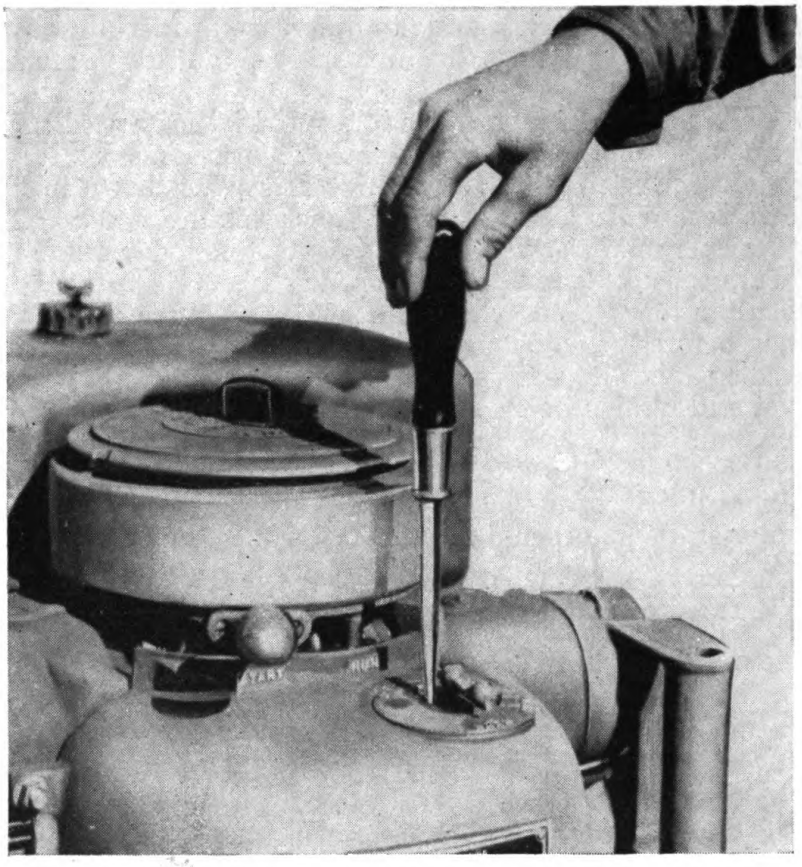


Figure 44. Idle-speed adjustment. (Turn needle clockwise for leaner mixture; counterclockwise for richer mixture.)—Continued.

the motor the entire magneto spark is sent to the two spark plugs on the opposite side of the motor. (See fig. 45.) Usually this will break through plug condensation or corrosion. Push the button in immediately after the motor starts. The use of this booster does not affect the other starting operations.

g. SAFETY SHEAR PIN. (1) One of the safety features of the motor is the shear pin in the propeller. This pin shears off whenever the propeller strikes an obstruction with sufficient force. When this occurs, the motor races and should be shut off immediately. A new pin is installed as follows:

(*a*) Close gasoline shut-off and vent screw.
(*b*) Pull motor inboard.
(*c*) Remove cotter pin.
(*d*) Remove propeller nut and washer.
(*e*) Remove propeller.
(*f*) Drive out old shear pin.

(2) Replace the old pin with one of the spare pins found in the operating kit, and assemble the parts in reverse order. Replace the cotter pin.

h. PROPELLER. If the propeller blades are damaged or bent a new propeller should be installed. Bent propellers cause hard starting, vibration, and unnecessary wear on the bearings and gears of the lower unit. Propeller blades not damaged too badly may be straightened as described in paragraph 18*r*.

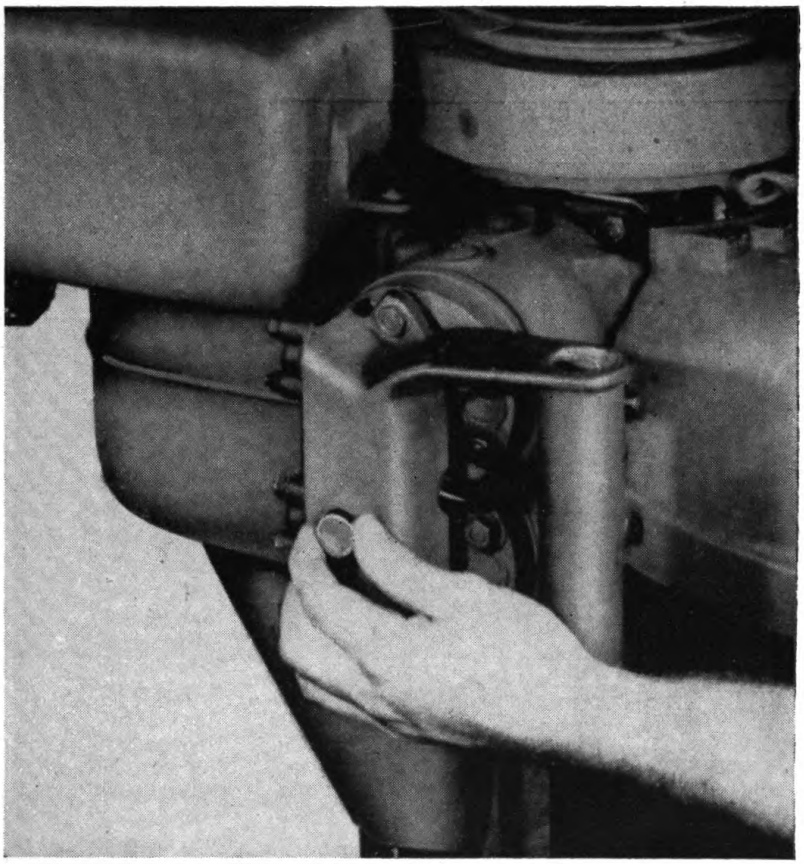


Figure 45. Spark booster. (Pull button out to send entire magneto spark to the two plugs on opposite side of motor to break through plug corrosion or condensation.

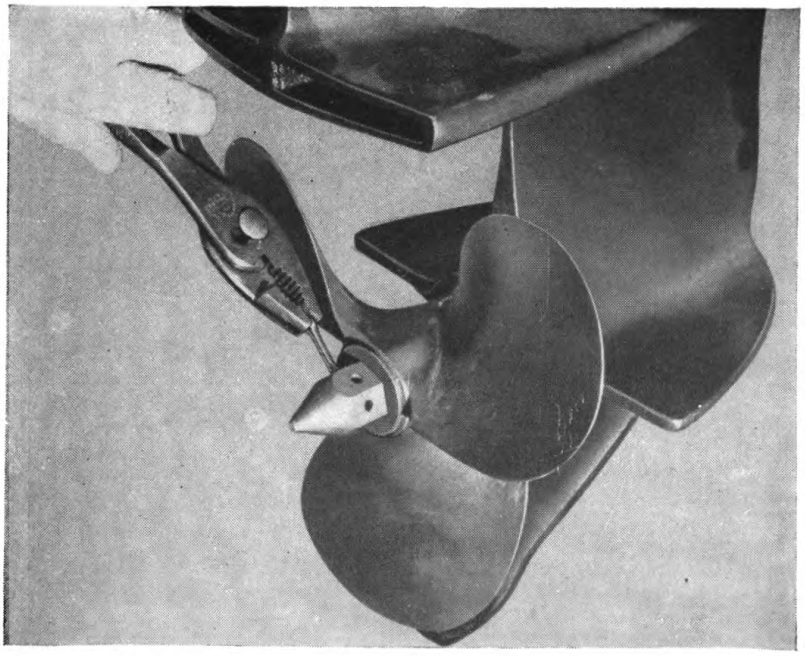


Figure 46. Remove cotter pin preparatory to detaching propeller.

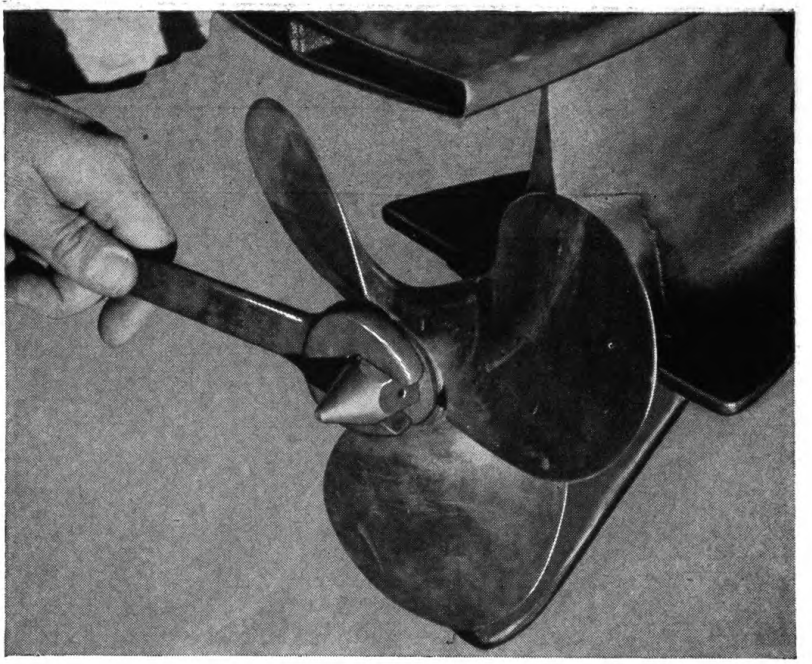


Figure 47. Remove propeller nut using open-end wrench.

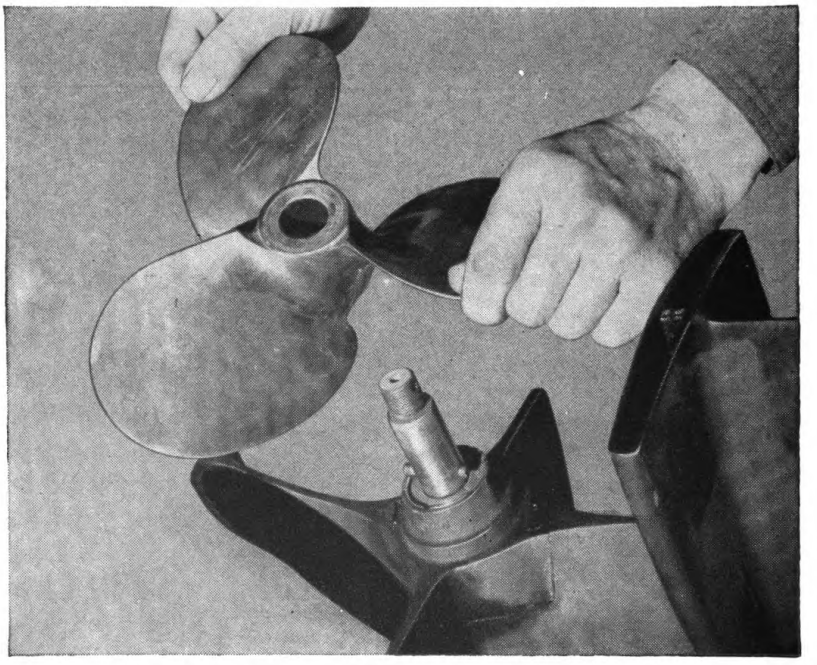


Figure 48. Remove propeller from propeller shaft

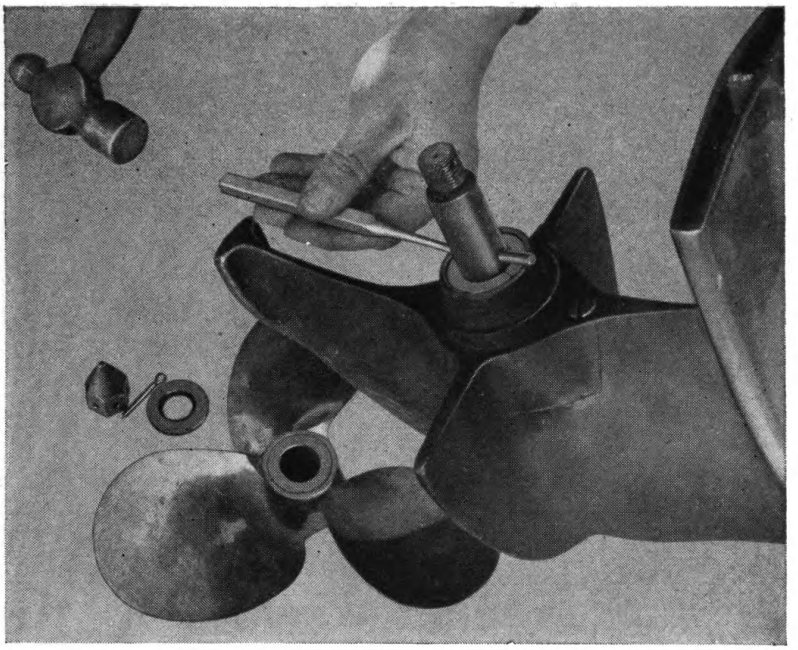


Figure 49. To drive out shear pin, use drift punch and hammer.

i. Faulty Spark Plugs. When the motor is receiving proper carburetion but still runs unevenly, check to see if all spark plugs are firing. This is determined by stopping the motor and feeling the base of each spark plug. If warm, the plug has been firing. If cold, it should be replaced with a clean plug. The carburetor requires high-speed readjusting when the motor is started again. Wiping the outside of spark-plug porcelains helps keep the plugs in good firing condition.

j. Motor Dropped Overboard. If a motor has been dropped overboard it should be recovered as soon as possible. Water left inside a motor for even a few hours damages the internal parts. Until it has been overhauled do not attempt to start a motor that has been submerged. How to remove the water, and clean the motor is described in paragraph 18*r*.

16. Demolition to Prevent Enemy Use

a. General. Each operator must know how to destroy these motors when their capture is imminent to prevent their use by the enemy. When there is not enough time to destroy the motor completely, give priority to essential parts most difficult to replace. The same parts are destroyed on all like units to prevent cannibalization. All spare parts carried for maintenance must be destroyed also.

b. Methods. The following methods may be used singly or in combination:

(1) *Mechanical.* Destroy auxiliary equipment with an ax, pick, sledge, or rifle butt. Make certain that the carburetor, starter drum, flywheel, and armature plate are damaged beyond repair. Heavy sledge blows on the cylinder head and the gear housing of the lower unit will make the motor inoperative.

(2) *Explosives.* Detonate a ½-pound charge placed between the cylinder head and the flywheel.

(3) *Weapons fire.* Use hand and rifle grenades, antitank rockets, or machine-gun fire.

(4) *Fire.* Puncture gasoline tank, pour other available fuel over motor, and ignite.

(5) *Water.* Drop motor in water deep enough to prevent recovery.

17. Operating Maintenance

a. General. The using arm personnel do first and second echelon maintenance. This maintenance includes lubrication, the making of minor repairs and adjustments, and the replacement of such parts as spark plugs, propellers, and shear pins. Pistons rings also may be replaced if the necessary tools and equipment are available.

b. Lubrication. (1) *Powerhead.* See paragraph 3*c*.

(2) *Lower unit.* (*a*) Check gear housing daily if motor is being used and put in more grease if needed. Place motor in upright position. Remove grease plug in upper opening and drain plug in lower opening. If grease does not flow from lower opening more is required. Place grease gun or tube in upper opening and force in lubricant until it flows from lower opening.

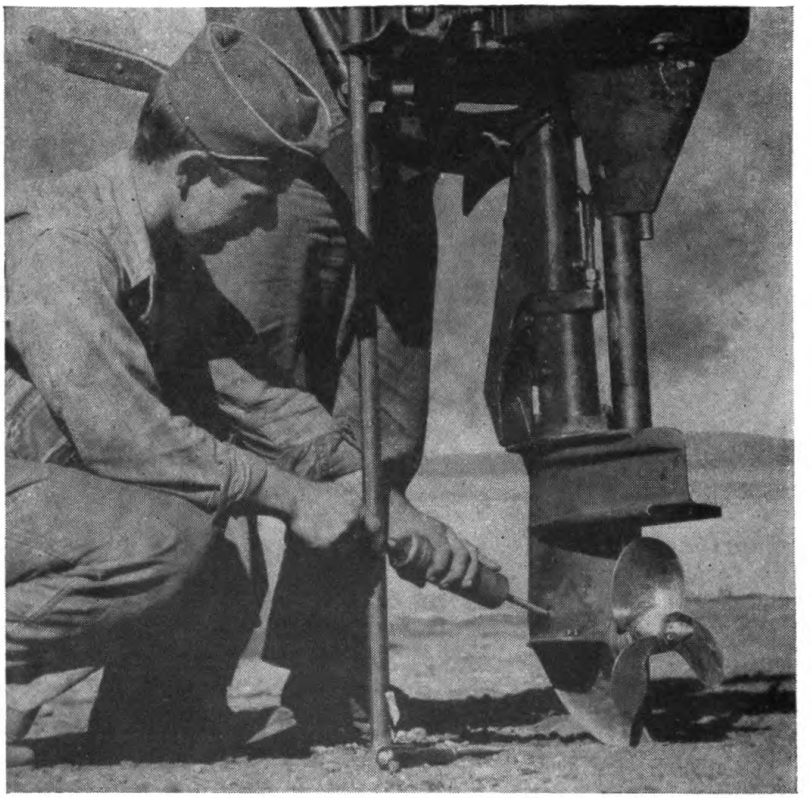


Figure 50. Lubricating gear housing using waterproof grease. (Fill until grease flows from drain opening.)

(*b*) Replace plugs, making certain they are tightened securely. Change the grease in gear housing every 50-hours of operation.

(*c*) Before storing or shipping the motor, remove drain and grease plugs to allow water in grease housing to drain off. This prevents bursting of gear housing from freezing and eliminates danger of corrosion.

c. Operator Maintenance. To insure dependable starting and performance the motor is checked after every operation. Minor repairs that might give trouble during the next period of motor operation are found and corrected. The motor must be ready for service at all times. After every operation—

(1) Drain motor thoroughly by keeping it upright until all water has drained from the cooling system, muffler, and driveshaft housing.

(2) Drain water from gear housing and fill with recommended waterproof gear grease. Remove propeller and inspect for damaged blades. Replace propeller if necessary. Inspect shear pin and, if damaged, replace with new pin.

(3) Clean gasoline filter screen in carburetor and gasoline tank. Occasionally disconnect gas line below carburetor to drain out dirt and water. Check for gasoline leaks.

(4) Remove, inspect, and clean spark plugs. Replace if necessary.

(5) (*a*) Test spark-plug wires. While spark plugs are out, ground all spark-plug wires except the one being tested. Hold this wire about ¼ inch from cylinder and rotate flywheel in the direction the motor runs, observing spark jumping from the wire to the cylinder. If the spark seems fairly strong it is sufficient to operate. Test each spark-plug wire the same way. Each wire should produce an equal spark.

(*b*) Make certain all spark-plug wire terminals are in good condition.

(*c*) Check plug ignition points for proper gap of .020 inches and adjust and clean if necessary. Points covered with oil produce a weak spark or none. Wipe the points with a clean cloth or clean with fine sandpaper to remove oil and carbon deposits.

(6) Replace spark plugs in cylinders.

(7) Tighten all bolts, nuts, and screws.

(8) Drain gasoline tank and carburetor.

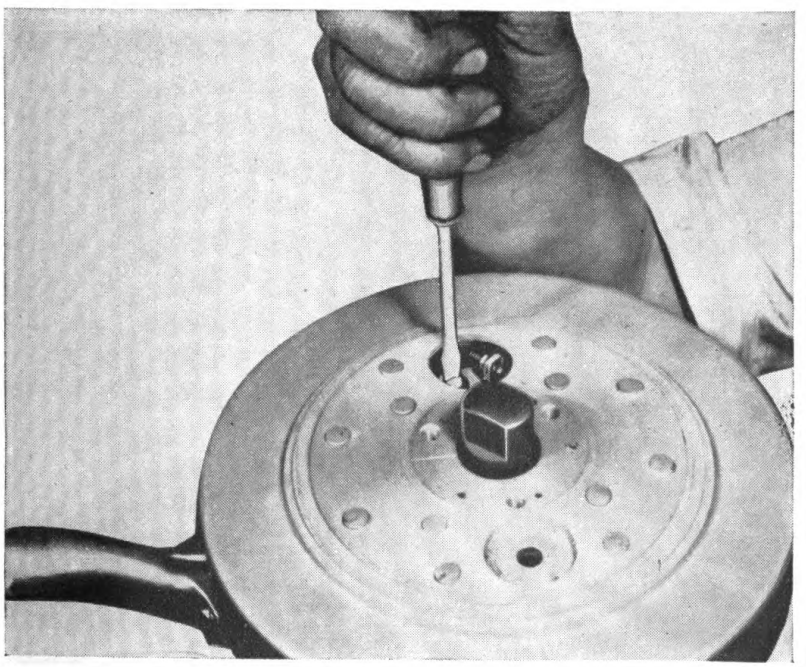
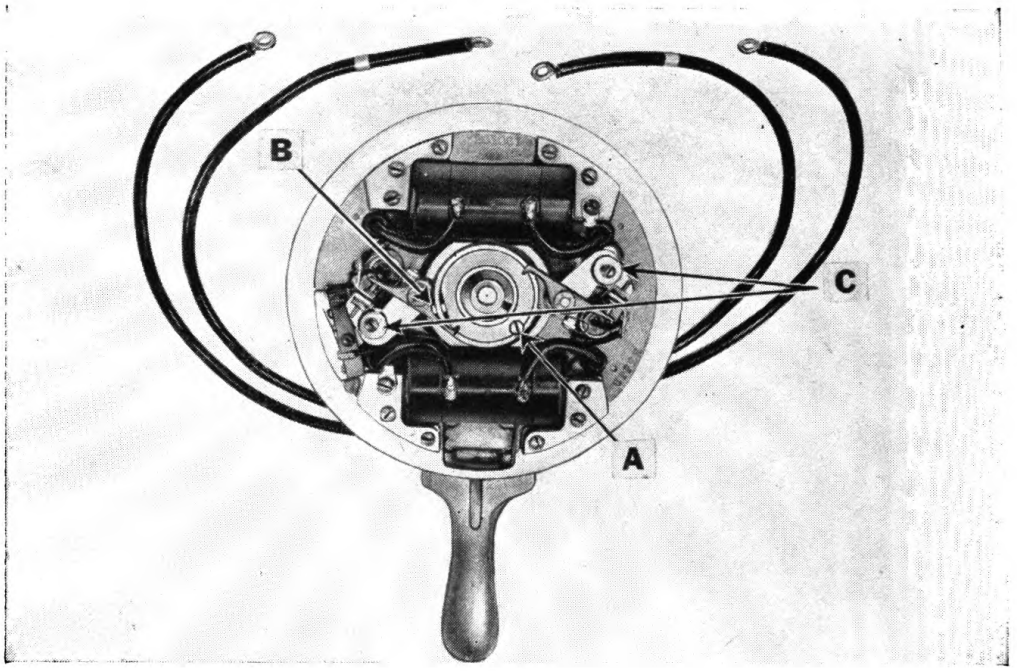


Figure 51. Using screw driver to adjust ignition points to .020 inch.



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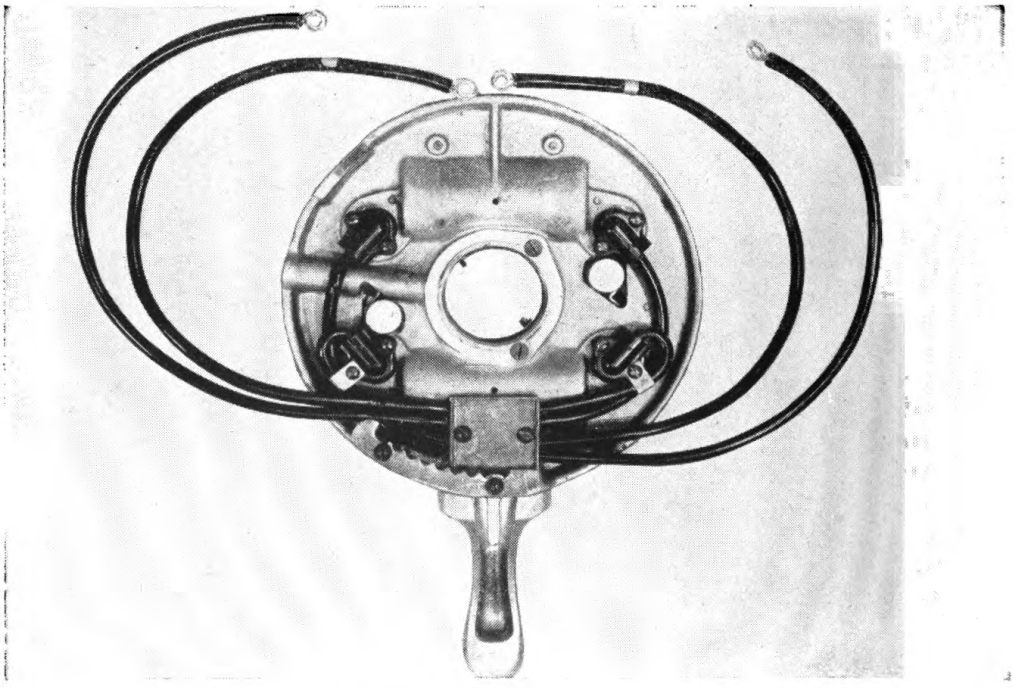

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Figure 52. Armature base.

(9) (*a*) At least once a week, if the motor is not being used, put it in a water-filled outboard motor testing tank. Run motor and check to see it is in perfect condition and that all cylinders are firing properly.

(*b*) If motor fails to start or to run properly check back on carburetion, ignition, crankcase, and pistons until the trouble is located and corrected.

(*c*) Check operating kit and replace all missing items.

(*d*) Report all necessary major repairs.

d. Salt Water Operations. When motor has been used in salt water, wash the outside of the lower unit with fresh water and wipe with an oiled cloth. Flush cooling system with fresh water from a tap or by running motor in a tank or a fresh-water stream.

e. Cleaning and Adjusting Breaker Points. (1) Examine points by removing starter-rope drum and inspecting points through inspection hole. Points should be clean and not pitted. Clean with a fine sandpaper (not emery). The flex-stone listed in first echelon spare parts may be used. Fold paper double and draw it back and forth between points. If points are in bad condition, replace them.

(2) No wrenches are needed for adjusting point gap. Points are set through inspection hole in flywheel. Adjust points with a screw driver (see fig. 51) by loosening screw on breaker plate (see *C*, fig. 52), then shifting plate until maximum clearance of .020 inch is reached. Gap gauge is furnished with operating kit. Use gauge as shown in figure 53. Replace starter-rope drum.

f. Trouble Shooting. See section V.

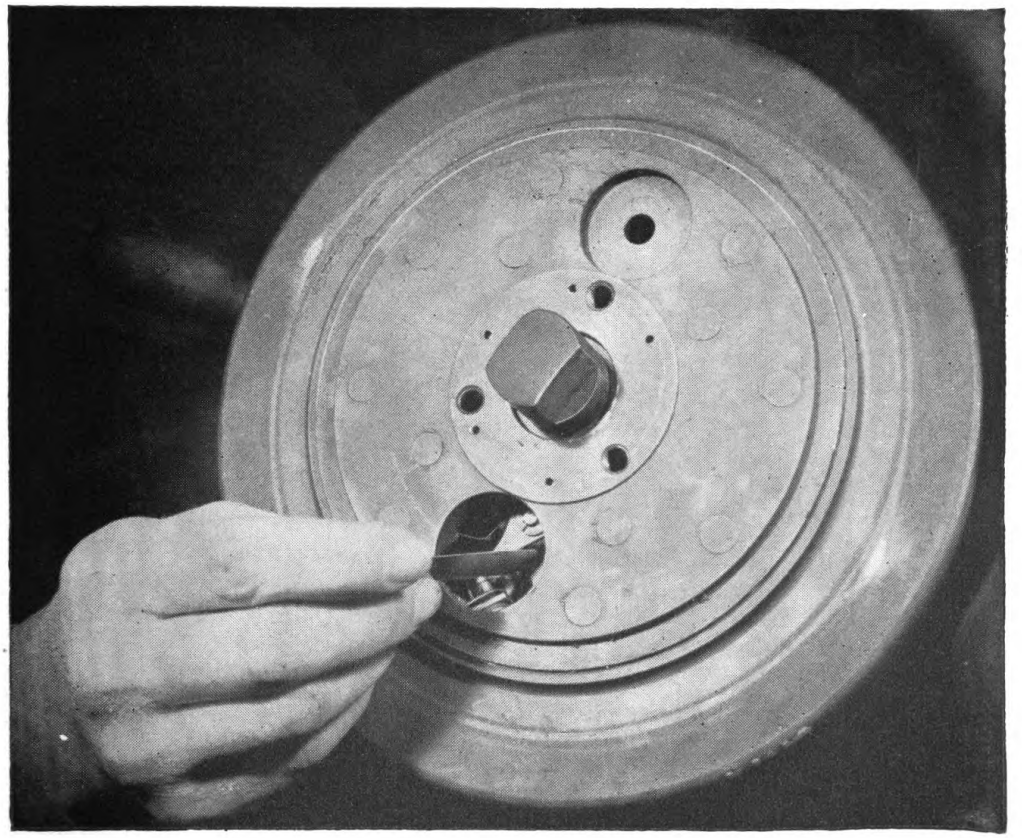


Figure 53. Checking ignition-point gap with gap gauge.

18. Repair Instructions for Third and Higher Echelons

a. GENERAL. This part of the manual contains detailed instructions on making the motor repairs and the replacement of parts that are done by third and higher echelons. These operations require the special tools and equipment listed in paragraph 25.

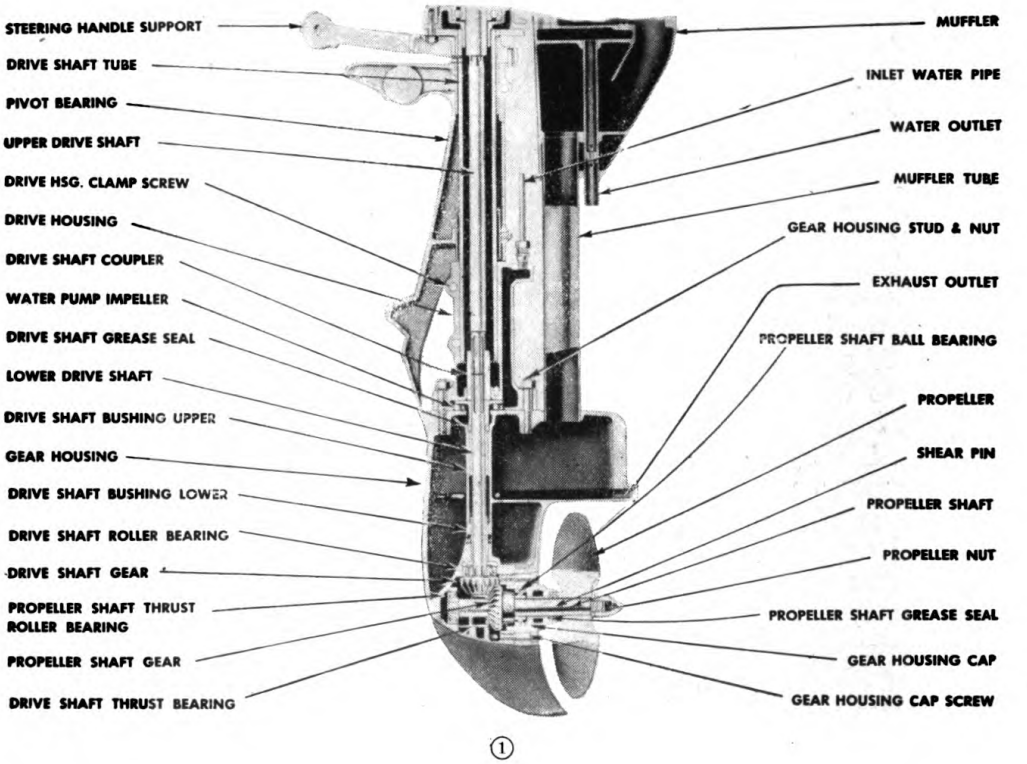


Figure 54. Powerhead and lower unit, storm-boat motor.

b. To Disassemble Motor. When overhauling the motor or installing some vital internal part, follow the procedure outlined below to save time and to do the task with the least effort. During the overhaul keep the parts in clean containers.

(1) Remove motor cover. This is held to motor by four nuts and lockwashers, two on each side of cover.

(2) Remove carrying handles at ends of cylinders. Four nuts hold each handle.

(3) Remove starter plate on flywheel.

(4) Remove flywheel nut. Tap wrench with hammer to loosen flywheel nut if necessary.

(5) Use flywheel puller to remove flywheel. See figure 55. Do *not* tap off the flywheel as this may injure the ball bearings in the crankcase.

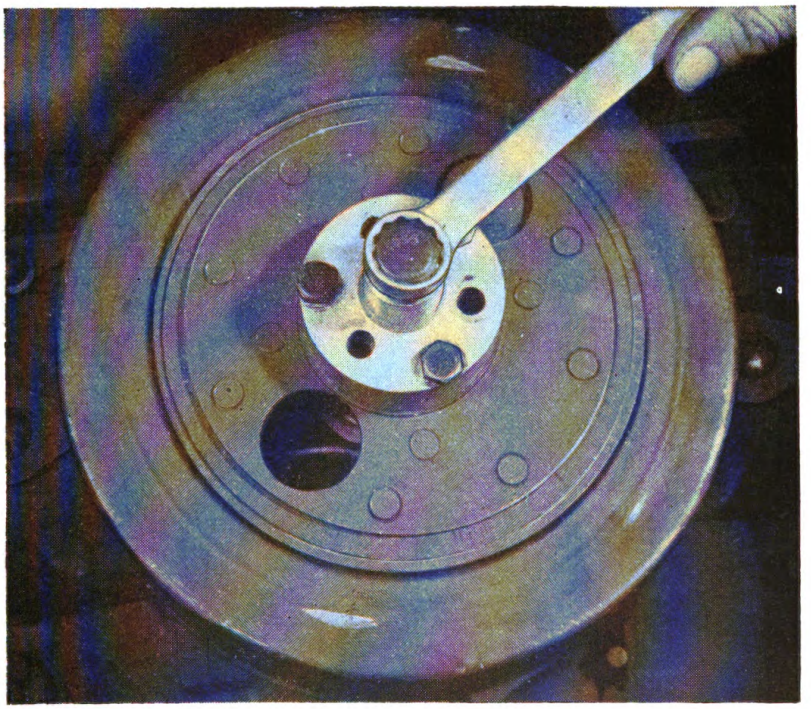


Figure 55. To remove flywheel, use flywheel puller and socket wrench.

(6) Remove armature plate completely. Check coils, condensers, cut-out switch and wires. Clean contact points. If points show wear or are badly pitted, they should be replaced. Usually this is due to weak condensers, which also should be replaced.

(7) Remove fuel line.

(8) Remove fuel tank by taking off two screws on upper part of muffler, two nuts on back of muffler, and fuel-line connection.

(9) Clean tank and fuel line with a noninflammable cleaning solvent. Dirt may have gotten into tank from careless filling.

(10) Remove carburetor by taking off two nuts and lock-washers. Primer body comes off with carburetor. Clean carburetor strainer bowl below carburetor. Do not remove primer from carburetor unless to replace rubber sleeve on primer inlet.

(11) Remove large hexagon nut at bottom of primer. Remove valve,

spring, and plunger. Clean with cleaning solvent. Check primer leather cups; if worn, replace with new cups.

(12) Remove gear housing and upper driveshaft by removing two stud nuts at water-pump housing.

(13) Remove muffler by removing six nuts and washers in rear of cylinders, and two bolts on front side of motor at center of cylinders close to crankcase. (See fig. 56.) Do not attempt to remove muffler before these bolts are located and removed. Check muffler for cracks or breaks. Check drain hole in muffler; this must be kept open to permit drainage when motor is tilted into boat.

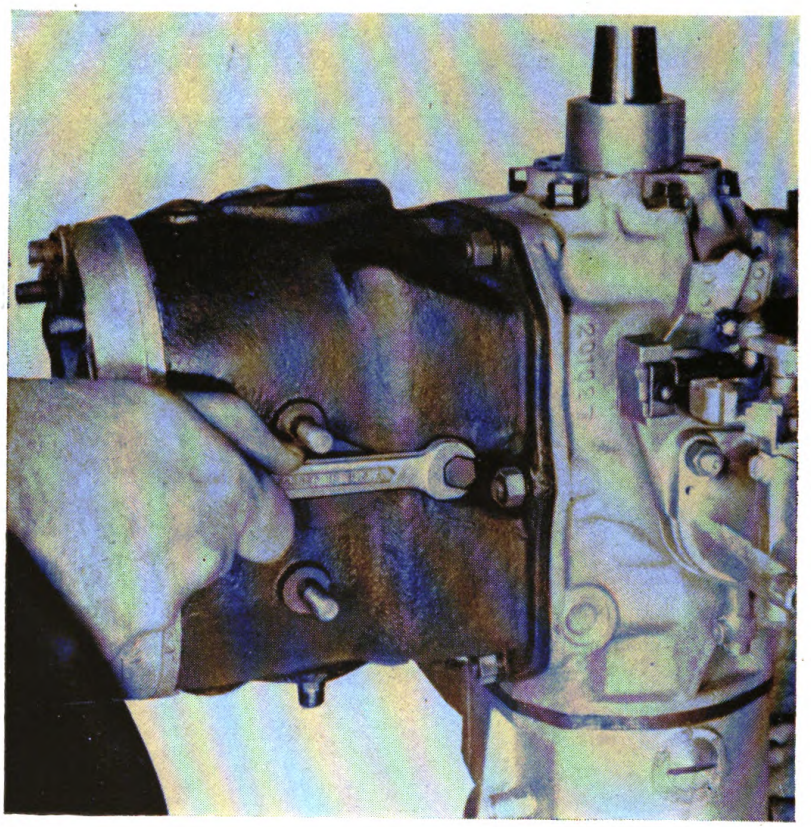


Figure 56. Removing muffler.

(14) (*a*) Remove cylinders by removing the six nuts and lockwashers on each block. Remove water pipe. Slide cylinder off carefully. Check cylinders for wear, scoring, or rust. Remove all carbon. If rusted, check for leaks in cylinder-head gaskets. To check, remove cylinder heads from cylinders by taking off nuts and four brass washers on each side of motor.

(*b*) Cylinder-head gaskets should not be re-used; replace them with new ones whenever cylinder heads are removed.

(*c*) Check cylinder heads for cracks, and check spark-plug-hole threads. Check drain hole in brass plug at base of cylinder. If clogged, remove obstruction, or cylinder will crack from freezing in cold weather.

(15) Remove pistons, marking them as follows: 1, upper left; 2, upper right; 3, lower left; 4, lower right.

(16) With a long-nosed pliers remove spring-lock rings in piston-pin hole.

(17) While supporting piston in one hand, tap out piston pin with a piston-pin punch. (See fig. 57.)

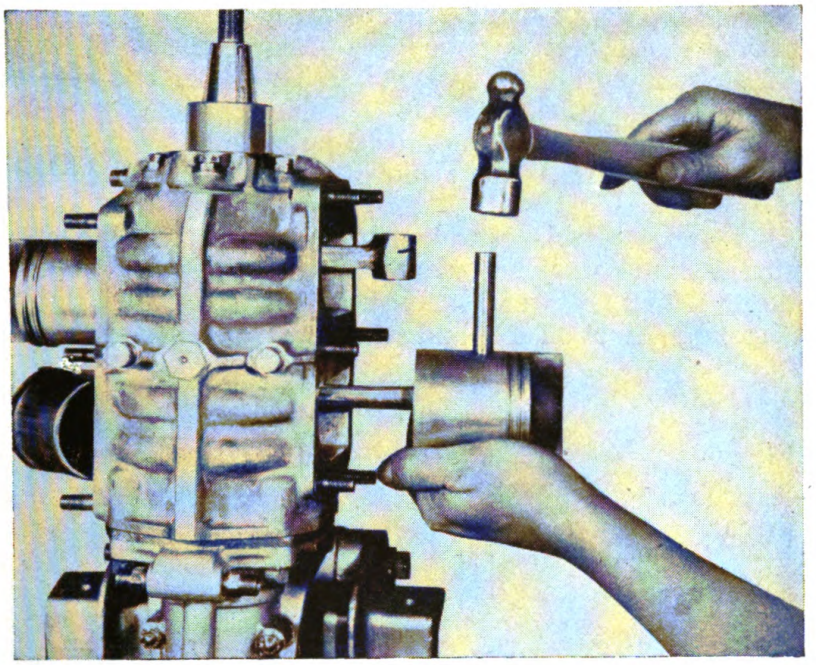


Figure 57. To remove piston pin, tap out pin with a piston-pin punch.

(18) Remove connecting rods and mark for identification. Cut wire holding screws in cap. Remove screws with a well-fitting bit and brace. These screws are fitted tightly and if slots are damaged are hard to remove. Keep rollers and retainers with their respective connecting rods. Check rods, retainers, and rollers carefully and replace all cracked, broken, or worn parts.

(19) (*a*) The crankshaft and center bearing never is removed except to replace or straighten crankshaft. This assembly "stays put" in normal service and cannot get out of adjustment except in cases of rod or crank breakage, burned-out crank pins, or damaged ball bearings. If necessary to remove, follow procedure below:

(*b*) Remove the four nuts under drive-housing flange and lift off crankcase.

(*c*) Remove lower brass bearing held by two flathead screws.

(*d*) Remove flywheel key from crankshaft keyway. (See fig. 58.)

(*e*) Remove 12 half-nuts on top of crankcase. These hold clamp ring for upper ball bearing.

(*f*) Remove center-bearing dowel screw in back of crankcase; then the bolt on each side of dowel screw.

(*g*) The crankshaft with center bearing and upper bearing now can be taken out by tapping shaft with a rawhide hammer, or by heating crankcase in hot water or center part of crankcase with a blow torch.

(20) To remove center bearing from crankshaft, remove two screws that hold the halves together. (See fig. 59.) Do not lose any of the 34 rollers of this bearing or split-bronze seal between them.

(21) To remove upper ball bearing, loosen lockwasher; then loosen left-hand locknut by driving with a flat-headed punch and hammer.

(22) Remove lower ball bearing by tapping crankshaft with a rawhide hammer.

(23) The upper driveshaft housing does not require much attention. If parts become broken or damaged they must be replaced or repaired. To remove driveshaft housing, remove set screw from side of lower drive housing. Next remove the two lock bolts. The lower one goes through part of drive-housing tube, and has to come all the way out. After both bolts are removed drive tube can be pulled out.

(24) To remove gear housing, remove nuts from studs located above water-pump inclosure.

(25) (*a*) To disassemble gear housing, remove propeller-nut cotter pin and nut. Remove propeller wheel, drive out propeller pin.

(*b*) Take out the two screws holding gear-housing cap to gear housing. (See fig. 60.) Slide off cap and withdraw propeller shaft and gear.

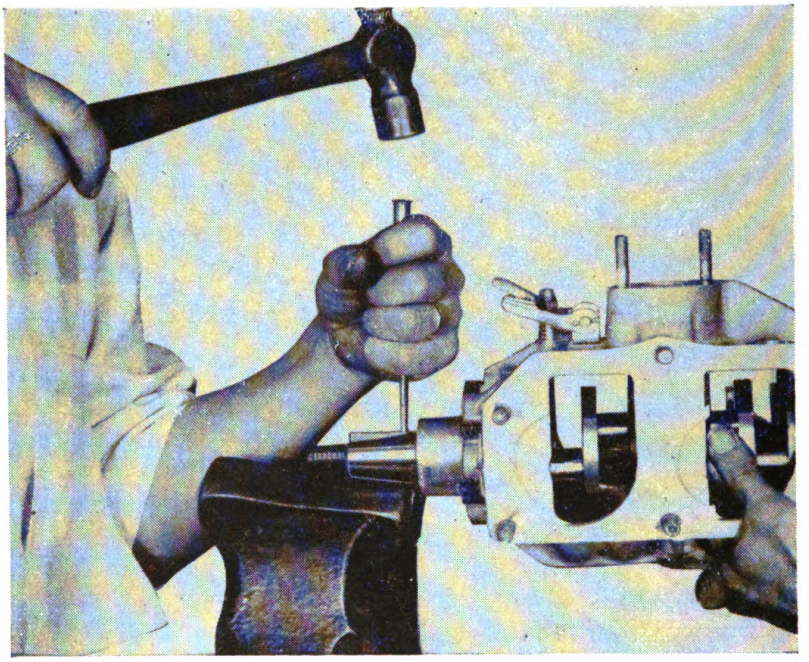


Figure 58. To remove flywheel key, use small flat-end punch.

(*c*) Next remove thrust bearing. Now propeller shaft roller bearing can be removed. (See fig. 61.) After driveshaft is pulled out, driveshaft gear and roller bearing will drop out. Remove both grease seals.

(26) Clean all parts in cleaning solvent. Check each piece minutely for wear or breakage. Check roller bearings for wear, rust marks, or pitted and rusted rollers. Bearings in such condition should be replaced with new parts.

(27) To remove roller-bearing cup from housing, housing is expanded by heating gently with a blow torch at point where bearing cup is fitted into housing. (See fig. 62.) Tapping heated housing with a rawhide hammer will cause cup to drop out.

(28) After all parts have been cleaned and inspected they are reassembled.

(29) Do not use old grease seals; replace them with new ones. After assembling and drawing up screws tightly and evenly, pack housing with new grease. See greasing instructions in paragraph 17*b*.

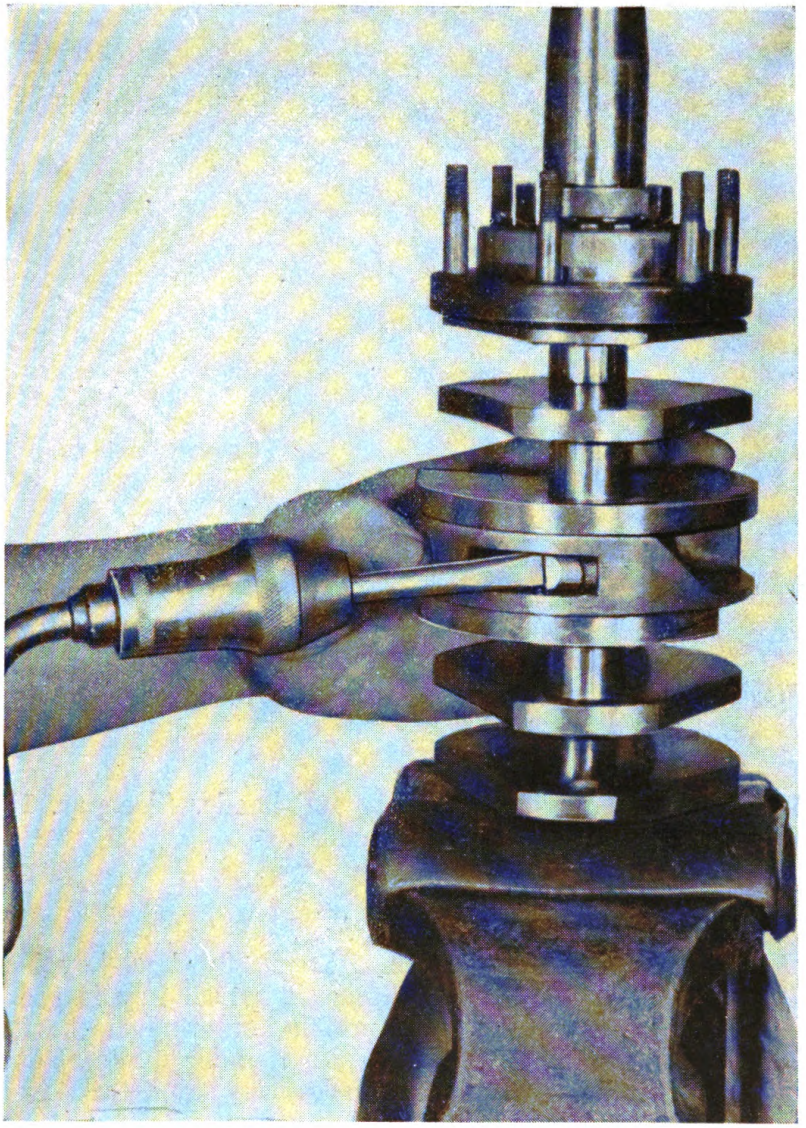


Figure 59. To remove center bearing, remove both screws holding halves of bearing together.

c. Order of Reassembling Motor. (1) Assemble crankshaft and center bearing into crankcase as described in paragraph 18*o*.

(2) Assemble connecting rods to crankshaft. Lock all connecting-rod screws with wire. (See par. 18*p*.)

(3) Assemble crankcase lower brass bearing held by two screws. (See par. 18*b* (19).)

(4) Assemble drive housing to pivot bearing.

(5) Assemble crankcase with connecting rods to drive housing, which is held by four nuts and washers.

(6) Assemble pistons to connecting rods. (See par. 18*q*.)

(7) Assemble cylinders and gaskets to crankcase. Line them up with muffler. Slide muffler onto cylinders without gaskets. Make sure muffler face is flat against cylinders. Hold this, and tighten up two nuts on each cylinder, then remove muffler. Add all nuts and washers. Draw up tightly.

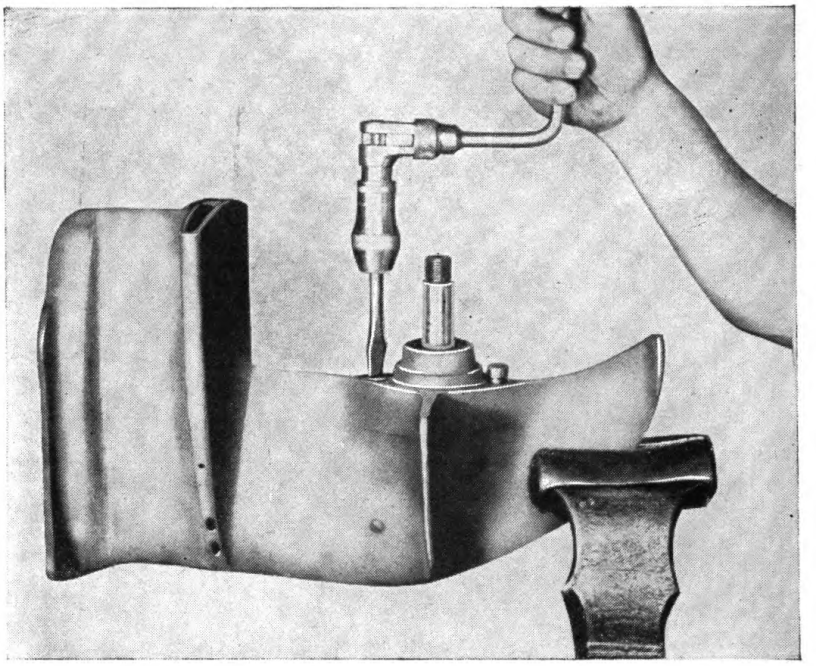


Figure 60. Unscrewing two screws preparatory to removing gear-housing cap.

(8) Assemble cylinder-head gaskets and heads. (See par. 18*q*.)
(9) Assemble muffler gaskets and muffler.
(10) Assemble water pipe.
(11) Assemble gas tank to motor.
(12) Assemble carburetor and gas line.
(13) Assemble magneto to motor. Be sure flywheel key is not too high. Check keyway. To check whether flywheel key is too high in crankshaft keyway, place flywheel in position on crankshaft with armature removed. Hold a sheet of white paper under flywheel at hub, in line with keyway. Look down through keyway from top. If paper is visible, key is in proper position, enabling flywheel to seat firmly on crankshaft taper.
(14) Assemble motor cover, held with four nuts.
(15) Assemble gear housing and muffler tube to motor.
(16) Assemble spark plugs and carrying handles.

d. Assembling Drive Housing and Pivot Bearing. To assemble drive housing and pivot bearing, assemble steering-handle support and rubber liners to drive housing. Slide drive housing and handle support into pivot bearing. Assemble upper pump body to bottom of drive tube. This is held by two lock screws and one set screw which is in side of pump body.

e. Replacing Flywheel. Install flywheel key, making sure taper on crankshaft and taper bore of flywheel are clean. Align flywheel keyway with key in crankshaft and set flywheel in position, making certain it is down all the way. Then replace flywheel nut and tighten it securely, using a hammer or mallet on wrench used for tightening. Replace starter drums and tighten the three screws securely.

f. Drive-shaft Spacing. (1) When installing new drive shaft or lower-unit parts, the clearance between upper end of drive shaft and

spacing bushing inside spline of crankshaft is most important. Proper clearance is shown at *B*, figure 63.

(2) If drive shaft is too long it exerts pressure on crankshaft and causes heating of the shaft and bearings, and breakage.

(3) Several methods can be employed in measuring this clearance. A simple one is to use a washer of known thickness, over .015 inches, and insert it between drive shaft and crankshaft spacer bushing at *B*, figure 63. Deducting thickness of feeler gauge from thickness of washer gives the clearance between shaft and bushing. Do not attempt to move bushing.

g. Removing Armature Base. (1) After removing flywheel disconnect all spark-plug wires from plugs. Loosen friction screw shown

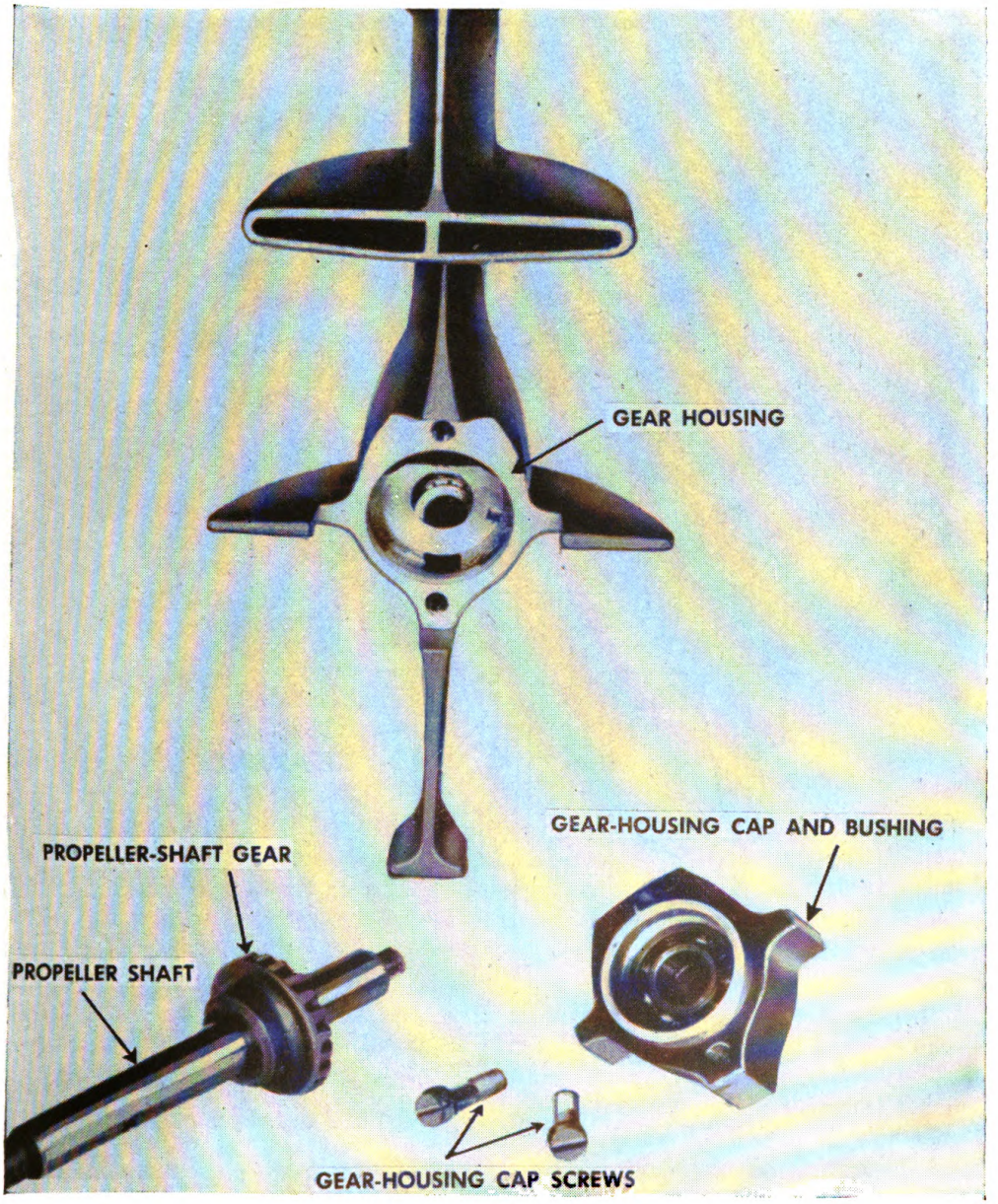


Figure 61. Disassembled gear housing.

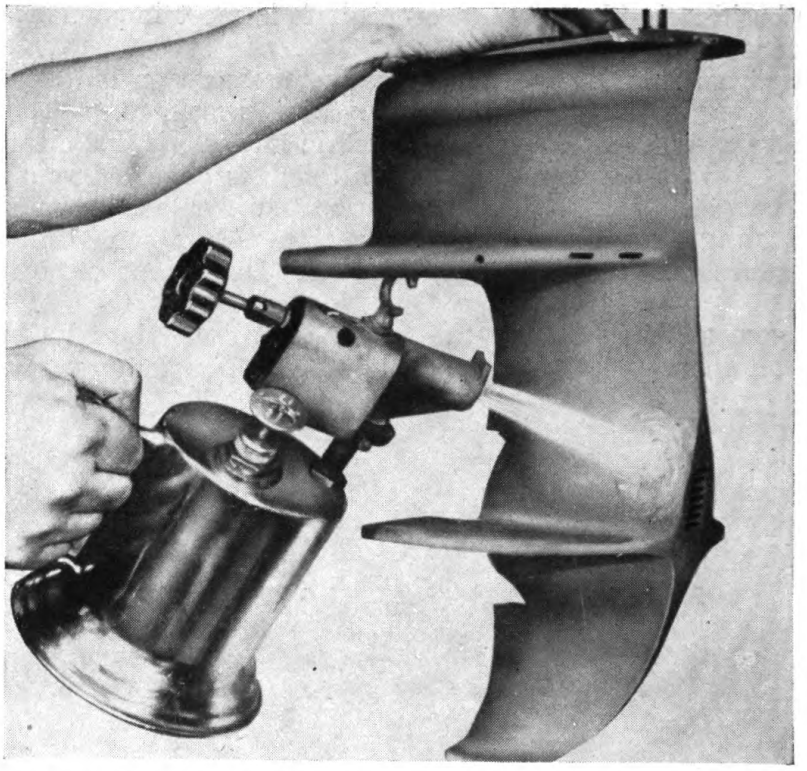
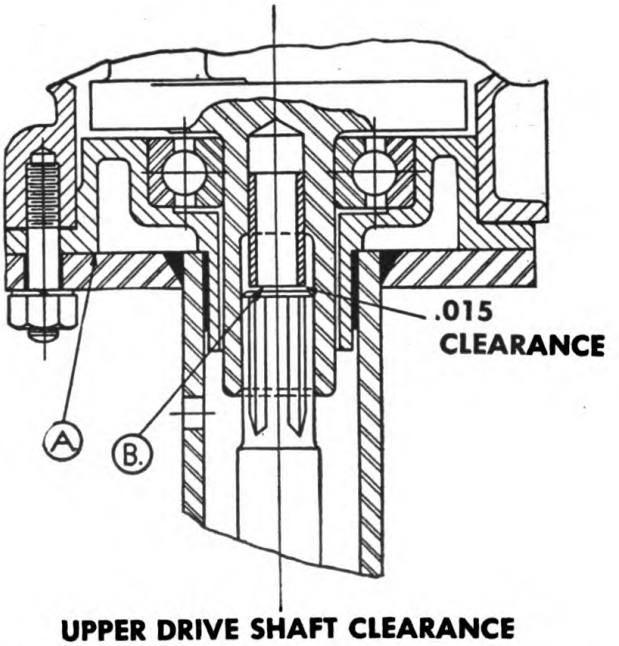


Figure 62. To remove roller-bearing cup, expand housing by heating with a blow torch.



UPPER DRIVE SHAFT CLEARANCE

Figure 63. Upper drive-shaft clearance to prevent overheating or breakage of shaft and bearings.

at *B*, figure 64. Remove hold-down screw on top of crankcase at center of armature base (see *A*, fig. 52) and armature may be removed.

(2) When replacing armature base, make sure hold-down screw is replaced before installing flywheel. Damage may result from omitting screw.

h. Installing New Breaker Points. (1) Loosen and remove nut holding breaker-arm spring fast to armature base. Remove small clip holding breaker arm on pivot post. Lift breaker-arm assembly from pivot post. Remove condenser and coil wires from breaker plate. Remove screw holding breaker plate to armature base, pivot post, and stationary point.

(2) Install new points. Flywheel must be replaced to readjust points. Follow adjusting directions in paragraph 17*e*.

i. Installing New Condenser. To install new condenser first unsolder condenser wire from breaker-point bracket and remove screw in condenser clip at *A*, figure 64. Install new condenser and solder lead wire to breaker-point bracket. Use only resin-core solder.

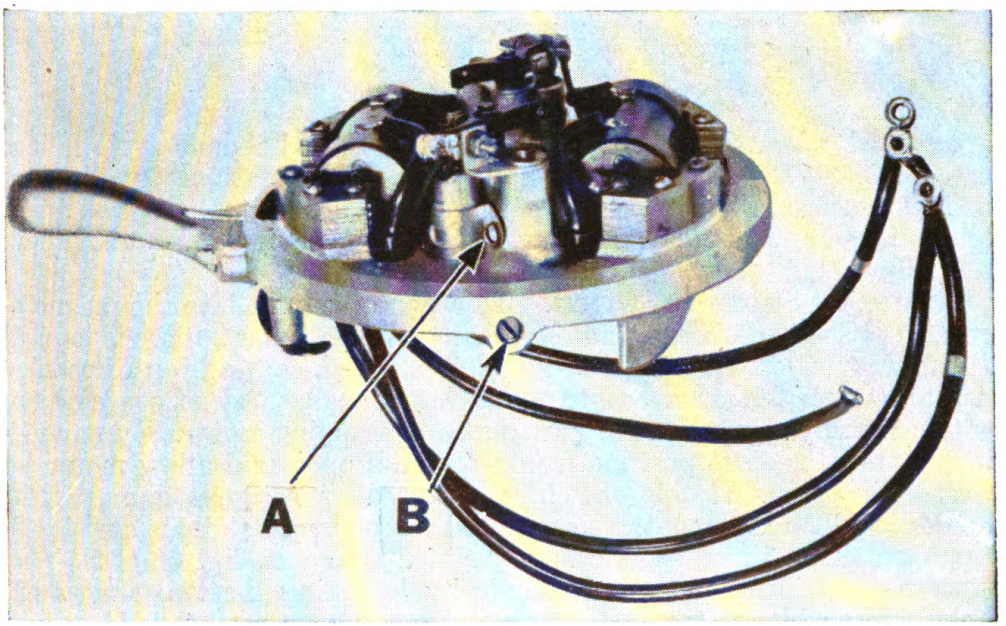


Figure 64. Armature base.

j. Installing New Ignition Coil. (1) Detach ground wire from armature base. Detach primary lead soldered to bracket on breaker plate. Detach spark-plug wires soldered to top of coil. Care must be taken not to use too much heat. Remove four screws which hold coil to base. Do not remove two screws shown at *A*, figure 65. Remove coil and heels together.

(2) New coils are furnished with semifinished coil heels, and it is necessary to turn them to proper diameter after installing coil to base. Coil heels are turned to same diameter as pads to which coils are attached on armature base. This operation should be performed by an experienced machinist.

(3) If no lathe is available, old coil heels may be removed and installed on new coil. (See *B*, fig. 65.) Coil heels must be made flush with pads on armature base to prevent striking pole shoes on magnet

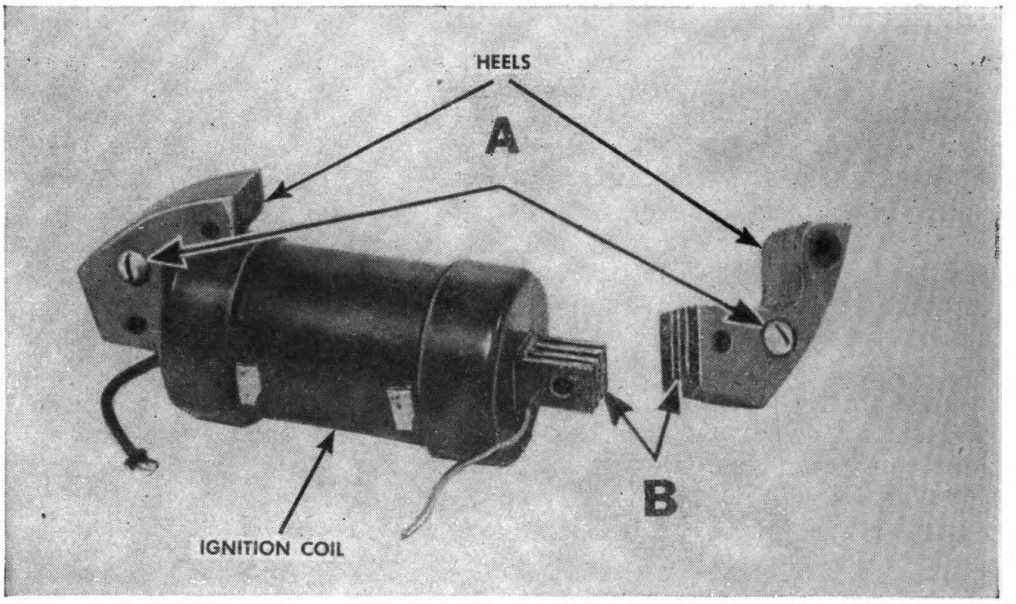


Figure 65. Coil and coil heels.

in flywheel when flywheel is rotated. This can be done by leaving screws slightly loose and then lining up heel laminations by tapping with hammer and setting to turned pads on armature base and then tightening screws. It may be necessary to file heels if uneven or if they strike flywheel.

k. IGNITION SHUT-OFF SWITCH. This switch is built into the magneto armature base and operates automatically. When timer handle is moved all the way to left over the word "stop" on hood, cam on top of crankcase allows switch push rod to move far enough to close contacts on switch, thereby short-circuiting current and stopping motor. By moving timer handle to start position, contact points open and allow motor to be started again. If this switch is removed or becomes damaged, it should be adjusted so contacts are closed when timer handle is at "stop," and open when timer handle is at "start." (See *B,* fig. 66.) *This is important.* Adjustment can be made by loosening the two screws on top of switch block (see *A,* fig. 66) and moving switch block in or out until proper setting is found. Always test by moving timer handle to make sure switch is working properly.

l. MUFFLER. This part requires practically no attention. If the casting is broken or cracked it can be welded. Keep drain hole open to permit drainage when motor is tilted and to prevent water from entering cylinders through the ports.

m. CARBURETOR. (1) To get at carburetor, hood must first be removed. To check and clean carburetor, remove fuel line at bottom of carburetor bowl. Loosen Bowden control wire from speed-control lever and slide wire out of socket.

(2) Take off two nuts that hold carburetor and primer to crankcase. Remove carburetor.

(3) To clean carburetor bowl remove the five screws and washers that fasten top of carburetor to body. Screw out high-speed needle valve and remove cover. Clean out bowl with cleaning solvent. Make sure no sediment or foreign substance clings to walls.

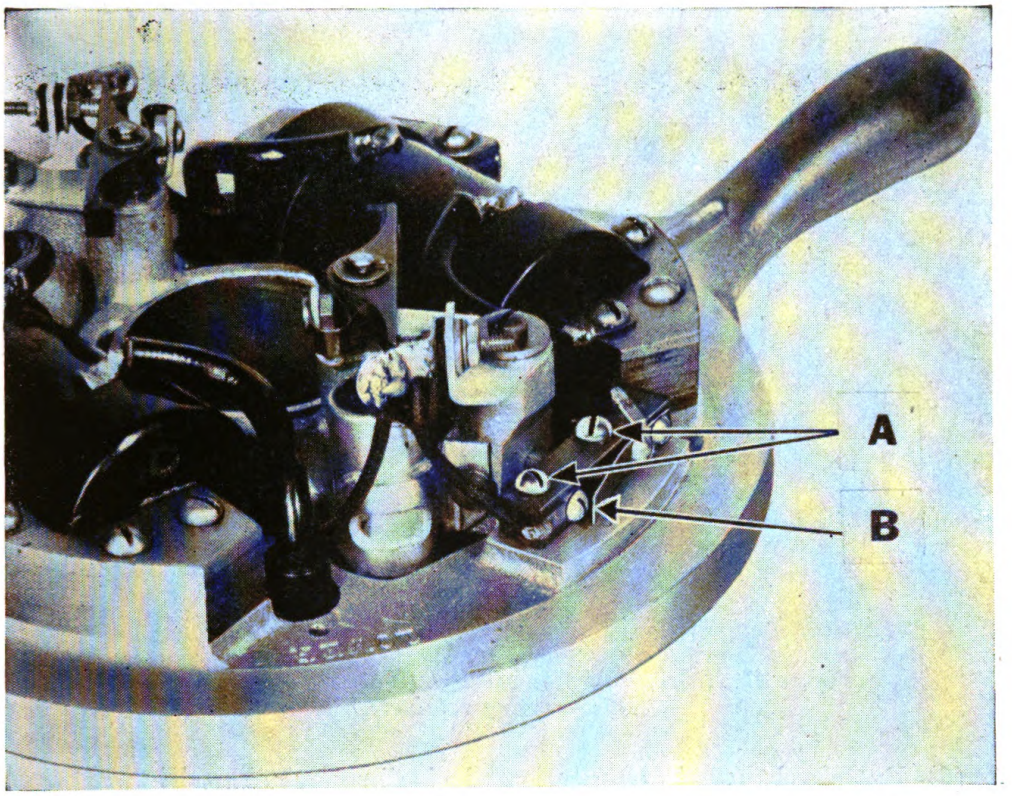


Figure 66. Ignition shut-off switch. (When timer handle is moved to "stop" position, the contacts on switch are closed.

(4) Remove strainer body. Take out screw that holds float needle to float which then can be pushed down through inlet hole in carburetor bowl. Check float needle for wear. Clean needle and needle seat thoroughly.

(5) In reassembling float and needle, before replacing cover be sure spring clip that holds float in position is in notch cut in float-valve needle. See that cover gasket is in place when cover is put on. Fasten all screws firmly and evenly.

n. CARBURETOR PRIMER. If primer gasket leaks, replace with new gasket. Assembly can be repaired without removing primer with carburetor. Remove screw plug at bottom of primer, allowing spring and plunger to slide out. Check plunger leather caps; replace if worn. In reassembling, draw screw plug up tightly.

o. INSTALLING CRANKSHAFT IN CRANKCASE. (1) Clean all parts with cleaning solvent so they are free from chips, grit, and dirt. If new parts are used, remove all burrs and sharp edges.

(2) Put ball bearings in a pan of cleaning solvent. Keep them there until needed.

(3) Assemble center-bearing retainers to center bearing, making sure marked half-pairs are assembled together properly.

(4) Now place roller retainer into center bearing. Assemble center-bearing seal as shown in figure 67. The halves should come together at ends marked with a punch.

(5) Add more heavy oil and assemble rollers into the halves' center-bearing retainer, or race. There are 34 rollers in this assembly.

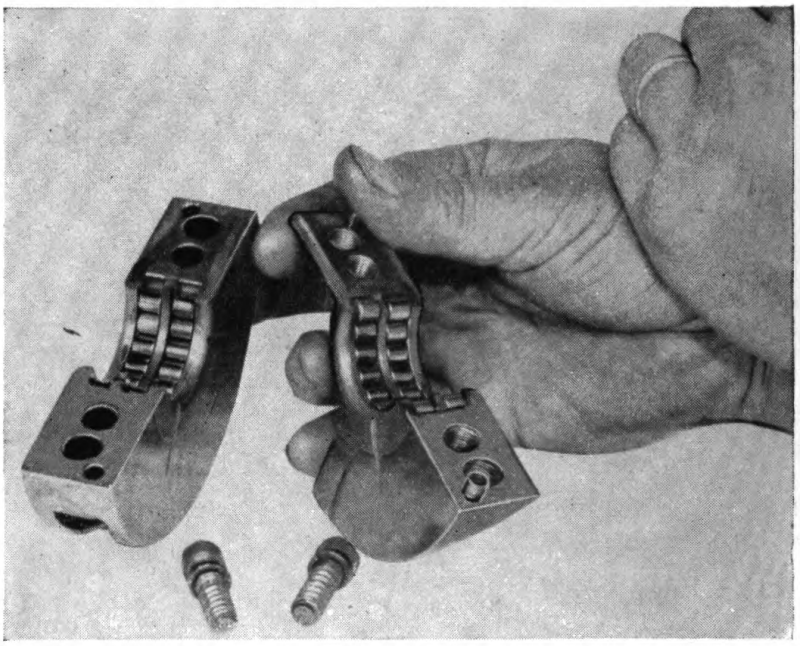


Figure 67. Halves of center bearing. (Note roller bearing in center-bearing retainers.)

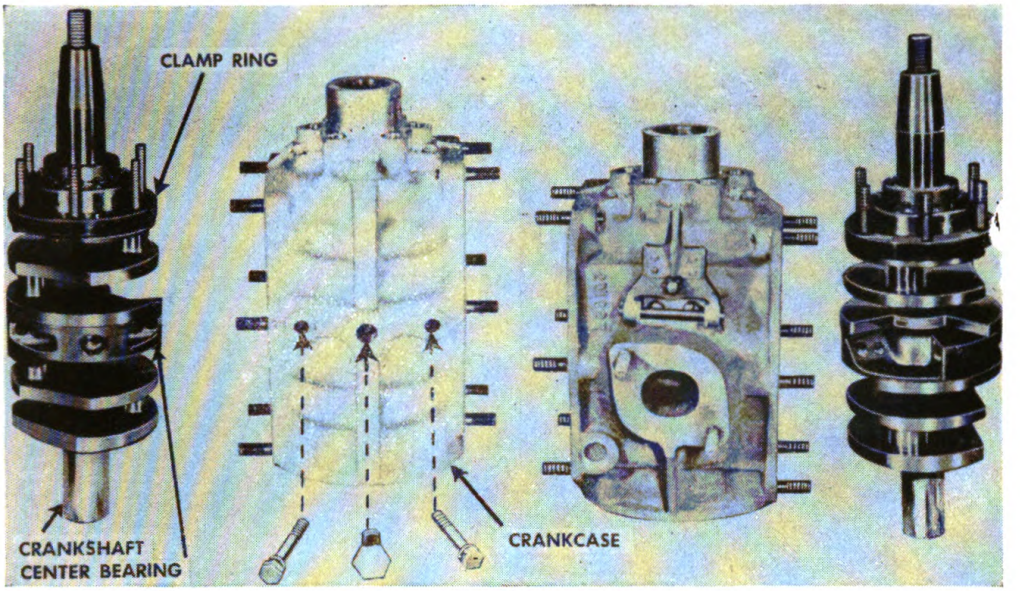
(6) Put crankshaft in copper-jawed vise in vertical position. If used crankshaft is being assembled, be sure it has been straightened and checked. Slide both halves of bearing race, with rollers, into position around center journal of crankshaft, making sure rollers are in position. While holding halves together with one hand, put screws in place. With a brace and bit pull screws up tightly. Rotate bearing to make sure it is free.

(7) Place clamp ring—the ring with six studs—over upper, tapered, end of crankshaft, studs pointing upward. (See fig. 68.) Clean and dry upper ball bearing with air hose, making sure all grit and dirt is removed under balls. Slide ball bearing over the threaded end of crankshaft. Follow with lockwasher and nut, which has a left-hand thread. Bend all prongs of lockwasher into slots of locknut or against side of nut. Now this assembly can be put in crankcase.

(8) Slide crankshaft into crankcase. (See fig. 69.) Center-bearing dowel pins and screw holes must match holes in crankcase. Because of the close fit, assembly is easier if crankcase first is expanded by heating gently with blow torch or with hot water. If impractical to do this, tap crankshaft into position with a rawhide or lead hammer.

(9) When, and not before, holes line up perfectly, assemble the large dowel screw. If holes do not line up exactly it usually results in damage to thread in center bearing or to dowel screw. After large dowel screw is in place, assemble two center-bearing screws and washers. Draw up these three screws tightly. (See fig. 68.)

(10) Now loosen the six adjusting screws at upper part of crankcase so they are about three threads above the machined surface. Assemble the six washers to clamp-ring studs. Screw one-half nut on each stud. Pull these up equally tight. Now turn down adjusting screws which raise or lower crankshaft assembly in crankcase until they touch the bearing. Next, loosen clamp-ring nuts about four turns each. Mark



Muffler side. Carburetor side.

Figure 68. Crankshaft, clamp ring, center bearing, crankcase.

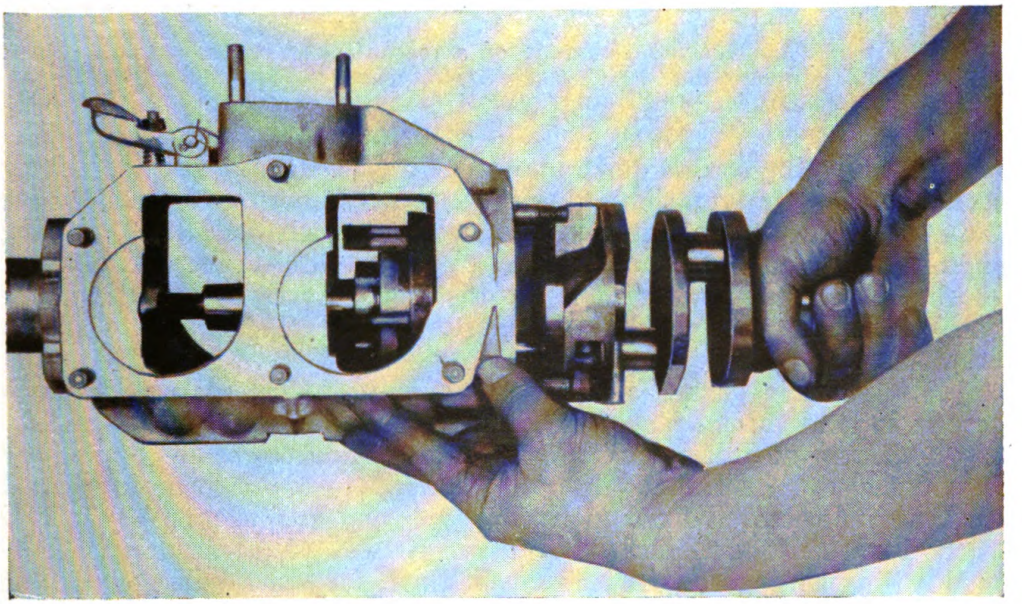


Figure 69. Assembling crankshaft and center bearing to crankcase.

crankcase with a pencil in line with screw slots, thus providing a starting point for adjusting clearance between crankshaft and center bearing.

(11) Turn adjusting screws to the right a three-quarter turn each. Be careful all screws are turned the same amount, or ball bearing will not line up. Now draw down the six nuts that hold the clamp ring. With feelers, check clearance between crankshaft and center bearing. Clearance on top of center bearing should be 0.001 to 0.0002 more than on the bottom of center bearing. (See fig. 70.)

(12) If shaft is too high, rub off pencil mark on crankcase and mark again at screw slots. Start from that point, loosening locknuts and

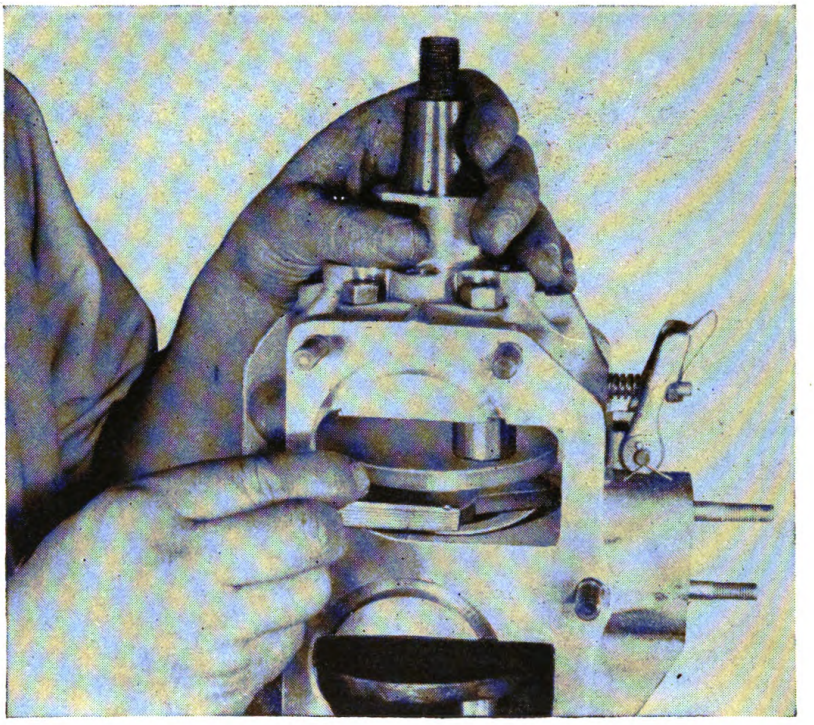


Figure 70. Checking clearance of crankshaft and centerbearing. (Clearance should be 1.1809 to 1.1813 inches for top and bottom of centerbearing.)

turning adjusting screws down about one-eighth turn at a time, locking locknuts each time and checking until top and bottom clearances are even. After crankshaft is adjusted, add other six half nuts, locking these tightly against lower half nuts. Again check clearance. If position of shaft has not changed and it turns freely lower ball bearing now can be slid into position on crankshaft. This bearing is a "tap" fit on crankshaft.

(13) Assemble gasket and lower crankcase bearing, using the two screws to hold this in place. Again try shaft for freeness.

(14) Using an oilcan, put a few drops of lubricating oil into upper bearing, center bearing, and lower bearing, to keep them lubricated until they receive oil from fuel mixture during operation.

p. Assembling Connecting Rods to Shaft. (1) Wash rods thoroughly in cleaning solvent and check them for score marks and heat discolorations. If too badly scored, or if color is dark, replace with new rods.

(2) Check piston-pin bushings. These should have about .002-inch clearance on the piston pins. Piston-pin fit is never a tight fit and the pin should slide through piston-pin bushing freely. If bushing shows wear or discoloration, replace it. If motor went overboard while running, rods probably are crooked and must be checked and replaced if damaged. After rods have been inspected and found in good condition, or replaced, clean roller-bearing retainers thoroughly in cleaning solvent. There are six retainers to each rod. Check each piece carefully for breaks or cracks. Replace all that are even slightly defective. Remove all sharp edges and burrs with a fine stone.

(3) When installing new connecting-rod-roller retainers they should

be used in sets of six, which are enclosed in sealed envelopes. These sets have proper spacing for connecting rod. Single retainers may be used for replacement only when end clearance has been checked. This clearance must total .010 to .014 inches. (See fig. 71.) A feeler gauge is used for spacing.

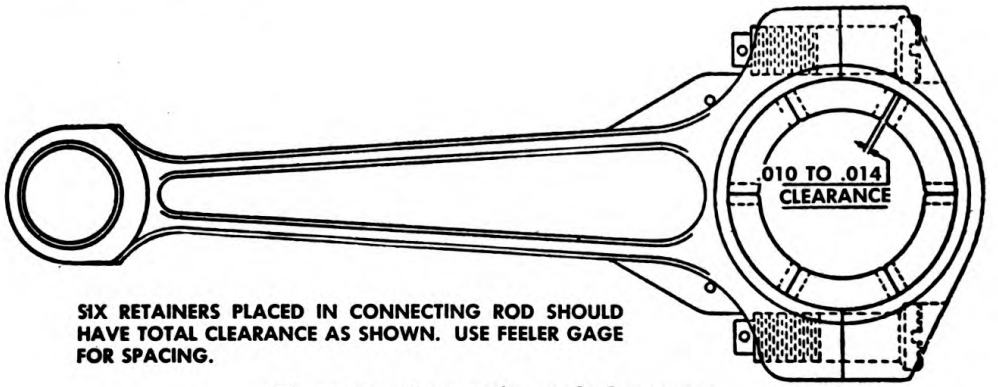


Figure 71. Connecting-rod clearances.

(4) After all parts have been cleaned and made ready for reassembling, place a set of retainers on a clean bench and drop rollers into retainers. A few drops of No. 70 oil will keep them in place. *Do not use grease.*

(5) Place crankcase and crankshaft assembly in a vise in horizontal position, and proceed with rod No. 1, upper left. Place three retainers with their rollers on upper part of rod. Bring rod up to crank pin. (See replacing No. 2 rod, fig. 72.) Then take remaining three retainers with rollers and place them on crank pin. Drop rod-bearing cap over the retainers. See that cap is in proper position by checking markings on cap and rod.

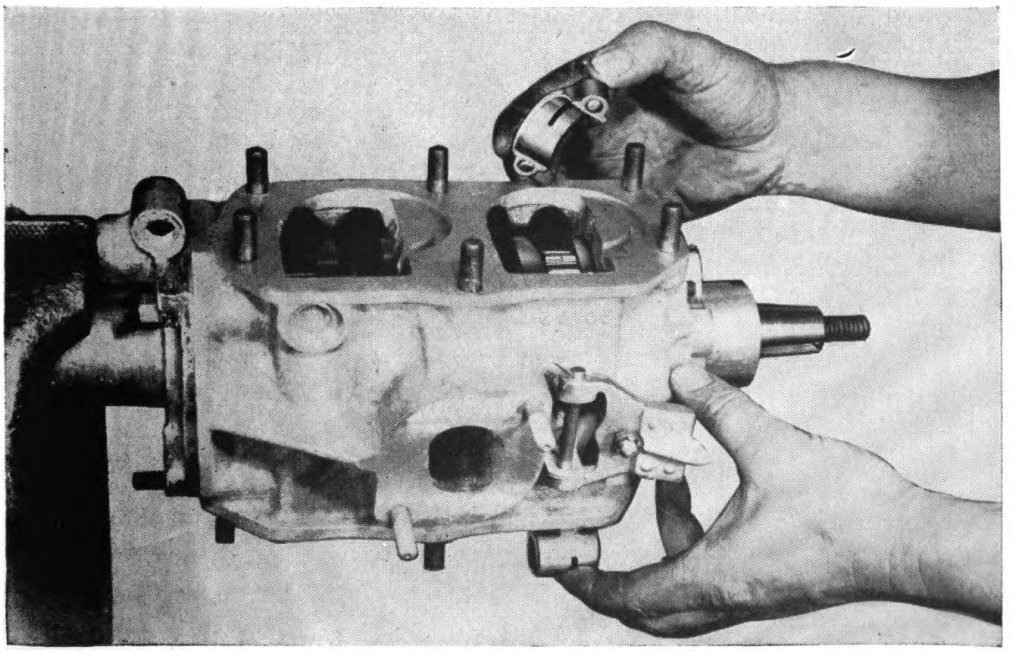


Figure 72. Assembling connecting rods.

(6) Put in connecting-rod screws and draw up evenly. In like manner assemble other rods and bearings. No. 1 rod is upper left; No. 2, upper right; No. 3, lower left; No. 4, lower right. Tighten all rod screws with brace and screw-driver bit. Grasping piston end of rod, allowable up-and-down movement at piston-pin end of rod is about 1/32 inch. (See fig. 73.)

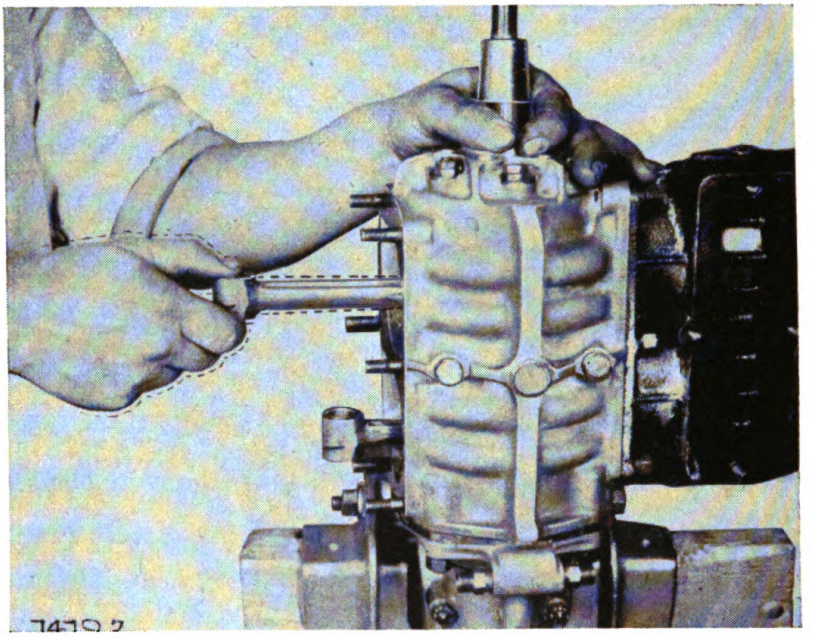


Figure 73. Up-and-down movement of rod should be about 1/32 inch.

(7) If original rollers were used, and rod has a tight spot during rotation, cap may have been put on incorrectly. Recheck markings on cap and rod.

q. Pistons and Piston Rings. (1) Check pistons carefully for score marks and stuck piston rings. Badly scored or burned pistons should be replaced.

(2) Clean out carbon from ring grooves. To do this grind or file square end of about one-third of broken piston ring, using this as a tool with which to clean carbon out of ring grooves. (See fig. 74.)

(3) After grooves are cleaned thoroughly, new rings may be assembled. Clean piston and ring in cleaning solvent and blow dry with compressed air or wipe dry with clean cloth. Rings should fit freely in grooves.

(4) When all rings have been installed properly and all parts are cleaned thoroughly, they are assembled to connecting rods.

(5) Put one spring ring into position in groove in bottom of piston-pin hole. (See fig. 75.) Place piston in position on rod with short, intake side of piston deflector toward the front, carburetor side of motor. (See fig. 76.) Slide piston pin into position from top downward through connecting-rod bushing. Install other spring ring in top of piston pin. *This is of utmost importance.* Be sure all original pistons are placed in same positions as before disassembling according to center-punch markings.

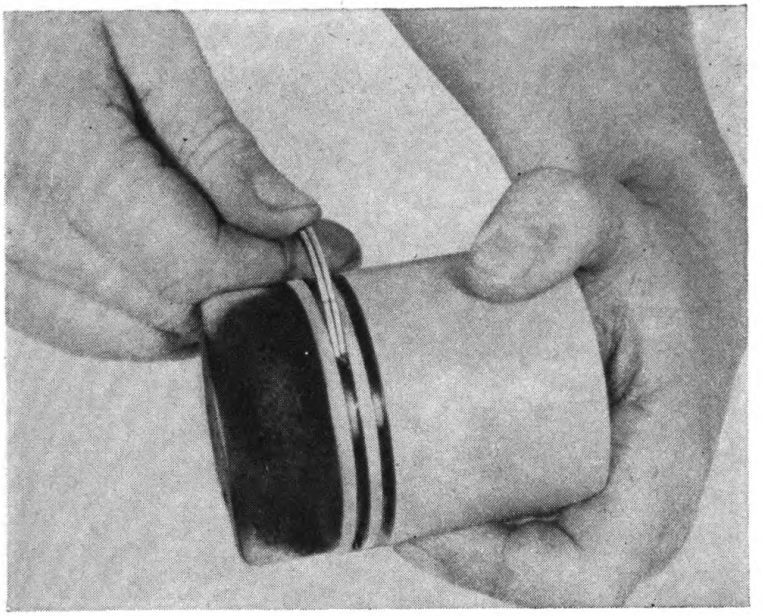


Figure 74. Cleaning carbon from piston grooves with piece of broken piston ring.

(6) Now assemble cylinder to crankcase. Put one cylinder gasket in place. Old gasket should not be used. Apply lubricating oil to pistons and rings with oil can. Do not spread oil with gritty fingers. Be sure piston rings are in proper position with regard to stop pins that keep them from rotating in ring grooves. If piston rings are not lined up with stop pins, the cylinder cannot go on. Be careful to avoid grit or dirt from workbench or fingers getting in parts. This job requires extreme cleanliness, as grit easily can score pistons and cylinders.

(7) (*a*) Slide cylinder into position with water-outlet holes on top. (See fig. 77.) Put on lock washers and nuts to hold cylinder to crankcase, leaving nuts partly loose. Then use muffler for squaring both cylinders. Remove muffler and draw up all nuts securely.

(*b*) Piston-ring specifications for the storm-boat motor are:

Number of rings per piston	2
Diameter of ring	2.750 inches
Width of ring	0.125 inch
Pounds of compression recommended when compressed	90 psi.
Gap clearance	0.010 inch

r. Miscellaneous Repairs. (1) *Straightening bent propeller.* Propellers not damaged too severely can be straightened. Best results are obtained by using a propeller pitch block on which the propeller is mounted and the dents and bends pounded out with a hammer. Bronze or brass propellers are more ductile than aluminum and stand better the strain of bending and straightening.

(2) *Motor dropped overboard.* If a motor has been submerged, it should be recovered as quickly as possible and promptly taken apart and cleaned. If the motor cannot be overhauled immediately, do the following:

Figure 75. Installing bottom piston-pin spring ring. (Note position of hands.)

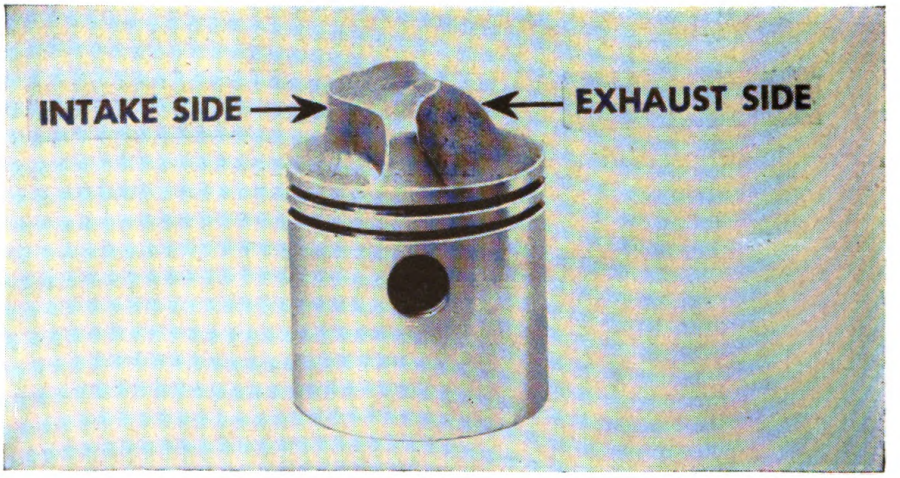


Figure 76. Aluminum alloy piston. (Note two ring grooves, piston-pin hole, and unusual shape of piston's top.)

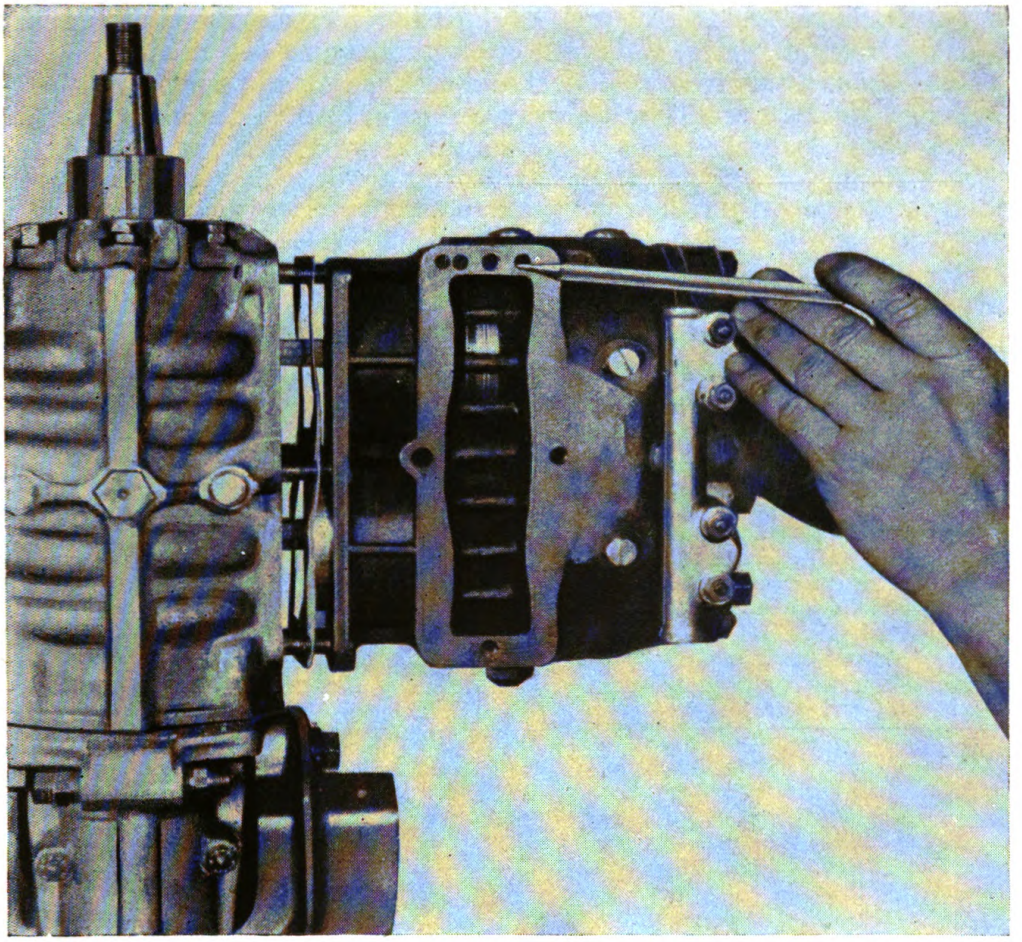


Figure 77. Two water-outlet holes at top of cylinder.

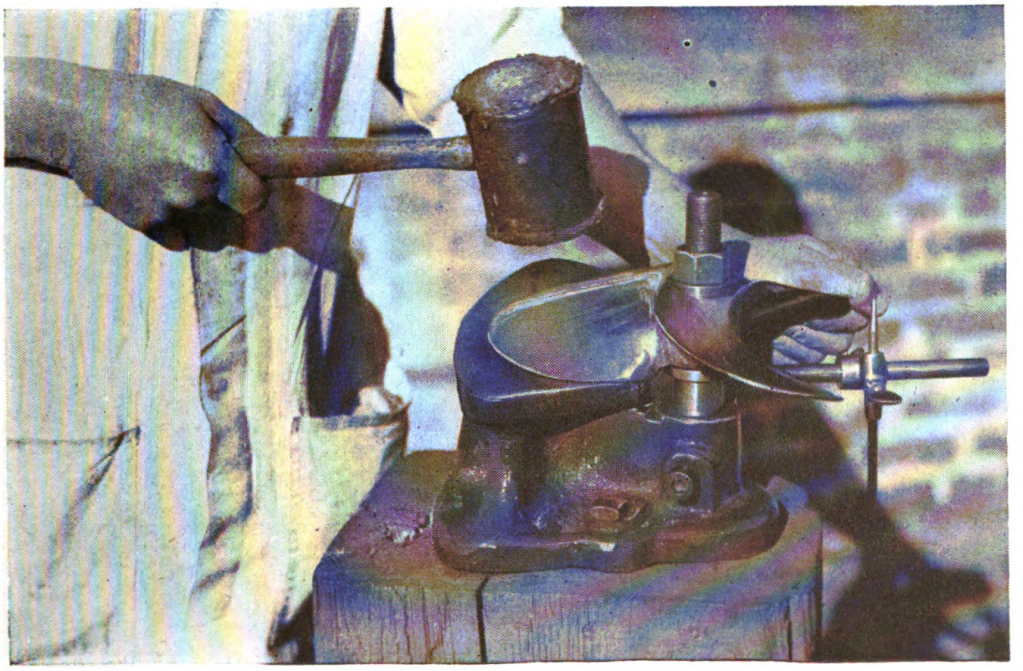


Figure 78. Straightening propeller on propeller pitch block. (Mallet is used to straighten bends and dents in propeller blades.)

(*a*) Remove fuel tank, fuel line, carburetor, magneto, and spark plugs. Drain all water, and wash out with cleaning solvent.

(*b*) Drain water from cylinders and crankcase and pour oil into each cylinder, rotating crankshaft slowly a turn or two to distribute the oil.

(*c*) Clean armature plate thoroughly and wipe with dry cloth.

(*d*) Replace spark plugs, place motor in a warm, dry spot, and overhaul it as soon as possible.

(3) *Care after salt-water operation.* The corrosive effects of salt water on the exposed motor parts makes additional care of the motor necessary. (See par. 17.)

Table III. Table of limits storm-boat motor

Cylinder diameter	2.750 to 2.751 inches.
Piston limits	
Piston diameter	2.7425 to 2.7415 inches.
Skirt clearance	0.0075 to 0.0095 inch.
Taper to skirt clearance	0.0015 to 0.0135 inch.
Piston ring	
Clearance in groove	0.005 inch.
Crankshaft limits	
Top journal	1.24975 to 1.25025 inches.
Center journal	1.1809 to 1.1813 inches.
Bottom journal	1.1809 to 1.1813 inches.
Connecting-rod pin	0.9995 to 1.0000 inch.

SECTION V

TROUBLE CHART

POWERHEAD

Motor Fails to Start

Ignition	Defective spark plugs	Wrong type.
		Fouled or cracked porcelain.
		Gap incorrect.
	Defective magneto	Broken wires.
		Loose connections.
		Shorted ground wire.
		Breaker points out of adjustment.
		Breaker points pitted.
		Condenser defective.
		Insulation broken down.
		Ignition coil defective.
		Weak or cracked magnet.
Fuel	Defective fuel supply	Fuel improperly mixed.
		Fuel line obstructed.
		Screens clogged.
		Water in fuel.
	Defective carburetion	Float valve stuck.
		Fuel jet clogged.
		Needle valve not adjusted.
		Needle-valve seat clogged.
		Air leak—crankcase spout broken.
		Carburetor flooded; crankcase flooded.
		Carburetor float-valve seat leaking.
		Water in crankcase.
Assembly	Pistons and cylinders	Worn excessively.
		Cylinder gasket defective.
	Journal bearings	Reamed too close.
		Out of line.
	Crank shaft	Sprung.
		Twisted.
	Connecting rods	Not straight.
		Twisted.
		Fitted too close.
Motor binding	Pistons	Fitted too close.
		Out of round.
		Galled, burned, or scored.
	Piston rings	Gap too close.
	Crank case	Sprung.
		Porous casting causing leak.
	Cylinder	Not squarely mounted.
	Rotary valve	Binding.
Gearcase binding	Gears	Meshed too close—binding.
		Broken.
	Propeller and pinion shafts	Sprung—corroded.
	Bearings	Reamed too close or out of line.
Fuel mixture—Oil content		Too rich.
		Too lean.
Fuel supply—Partially obstructed		Fuel line.
		Screen.
		Carburetor nozzle.
		Float valve.
		Needle valve.
Carburetor—		Loose connections.

Faulty Operation and Missing

Ignition	Spark plug	Wrong type.
	Breaker points	Pitted.
		Weak spring.
		Arm binding on post.
		Loose in mounting.
	Condenser	Weak.
		Loose connections.
	Moisture underneath insulating material.	
	Coil	Loose connections.
		Weak.
	Magnet	Weak.
		Cracked.
	Insulation worn off wires.	
Assembly	Bearings	Fitted too close.
		Out of line.
	Crank shaft and connecting rod	Sprung.
		Twisted.
		Out of true.
		Worn.
	Piston	Worn.
		Out of round.
		Fitted too close.
	Piston rings	Worn.
		Bound in ring groove.
		Incorrect gap adjust.
	Crankcase	Sprung.
		Porous casting.
Water entering crankcase up through lower journal bearing.		

Motor Hard to Start

Spark plug	Wrong type.
	Gap set too close, too wide.
	Fouled.
	Cracked porcelain.
Magneto	Loose connections—primary.
	Shorted wires.
	Breaker points pitted.
	Breaker points loose in mounting.
	Breaker-points gap incorrect.
	Breaker points not adjusted with relation to position of cam.
	Breaker arm binding on post.
	Weak condenser.
	Soldered connections loose—condenser.
	Moisture collected underneath coil and insulation.
	Weak coil.
Fuel	Excessive oil content.
	Improperly mixed.
	Water in fuel.
Fuel line	Air vent closed—gas tank.
	Screens clogged.
	Fuel line obstructed.
Carburetor	Fouled jets.
	Air leak—broken crankcase spout.
	Needle valve improperly adjusted or closed.
	Over or under choked.
Motor binding	Bearings fitted too close or out of line.
	Crankshaft, connecting rods, sprung or twisted.
	Crankcase sprung.
	Drive-shaft case sprung.
	Flywheel binding on armature.
Cylinder	Excessively worn, scored.
	Exhaust ports clogged with carbon.

Motor Hard to Start—*Contd.*

Piston	Excessively worn.
	Scored.
	Ring grooves filled with carbon.
	Installed inverted position.
Piston ring	Excessively worn.
	Gap too close or too wide.
	Stuck in ring groove.
Muffler	Clogged with carbon. Holes stopped up.
	Exhaust cut-out closed.
Rotor valve	Binding.
	Incorrectly timed.
Water entering crankcase up through lower journal bearing.	

Overheating

Water pump	Check valves	Bound.
	Tubes	Leaking.
		Filled with sand.
	Housing	Worn.
		Out of true.
	Inlet	Clogged.
Tubes and fittings	Broken.	
	Corroded.	
	Clogged.	
Over supply of grease in gear case.		
Fuel mixture	Insufficient amount of oil.	
Cylinder	Exhaust ports clogged with carbon.	
	Excessively worn.	
	Water jackets corroded—hole leading into cylinder.	
Piston	Excessively worn.	
	Ring grooves filled with carbon.	
	Piston rings bound in ring groove.	
	Piston ring worn—insufficient gap clearance.	
Bearings	Out of line.	
	Fitted too close.	
Crankshaft and connecting rods	Sprung.	
	Twisted.	
Muffler	Clogged with carbon.	
	Assembled incorrectly.	
	Water jacket porous—leaking.	
Armature plate	Clamp screw too tight.	
	Heels striking poles of magnet.	

Motor Knocking

Carburetor	Set too rich at needle adjustment.
Bearings	Loose.
	Out of line.
Crankshaft	Worn.
	Sprung.
	Excess end play.
Connecting rods	Bent.
	Twisted.
	Bearing surface worn.
Flywheel	Loose. Cracked hub. Worn keyway.
	Striking heels of coil. Loose rivets.

Spark Plug Difficulties

Spark plug	Wrong type—too hot.
Plug fouls	Fuel mixture too rich—oil content.
	Carburetor set too rich.
	Wrong type—too cool.
	Water entering crankcase.
Plug burns out	Wrong type—too hot.
	Water in crankcase.
	Fuel mixture too lean—oil content.
	Carburetor set too lean.
Motor knocks	Plug too hot.

Erratic Motor Operation (Speed varies)

Spark plug	Too hot.
Bearings	Binding.
Propeller	Pitch too great (cavitation, racing).
Transom of boat	Too high.
Gears—gearcase	Meshed too close.
Cavitation	Transom too high.
	Keel interferes.
	Grass, weeds collected on gear case.

GEARCASE

Gear Difficulty

Gears	Improperly adjusted.
Bearings	Worn.
	Reamed oversize.
	Out of line.
Water in gearcase	Propeller shaft bearing—Worn. Reamed oversize.
	Loose inspection or grease plugs.
	Leaking water tubes or connections (driveshaft).
	Propeller shaft out of true.
	Grease seal — Leather washer won't slide on shaft.
	Spring binding or corroded.
	Injured retainers.
	Injured gaskets.

Water in drive-shaft casing (leaking water tubes or connections (corrosion)).

SECTION VI

POLR–15

19. Nomenclature POLR–15

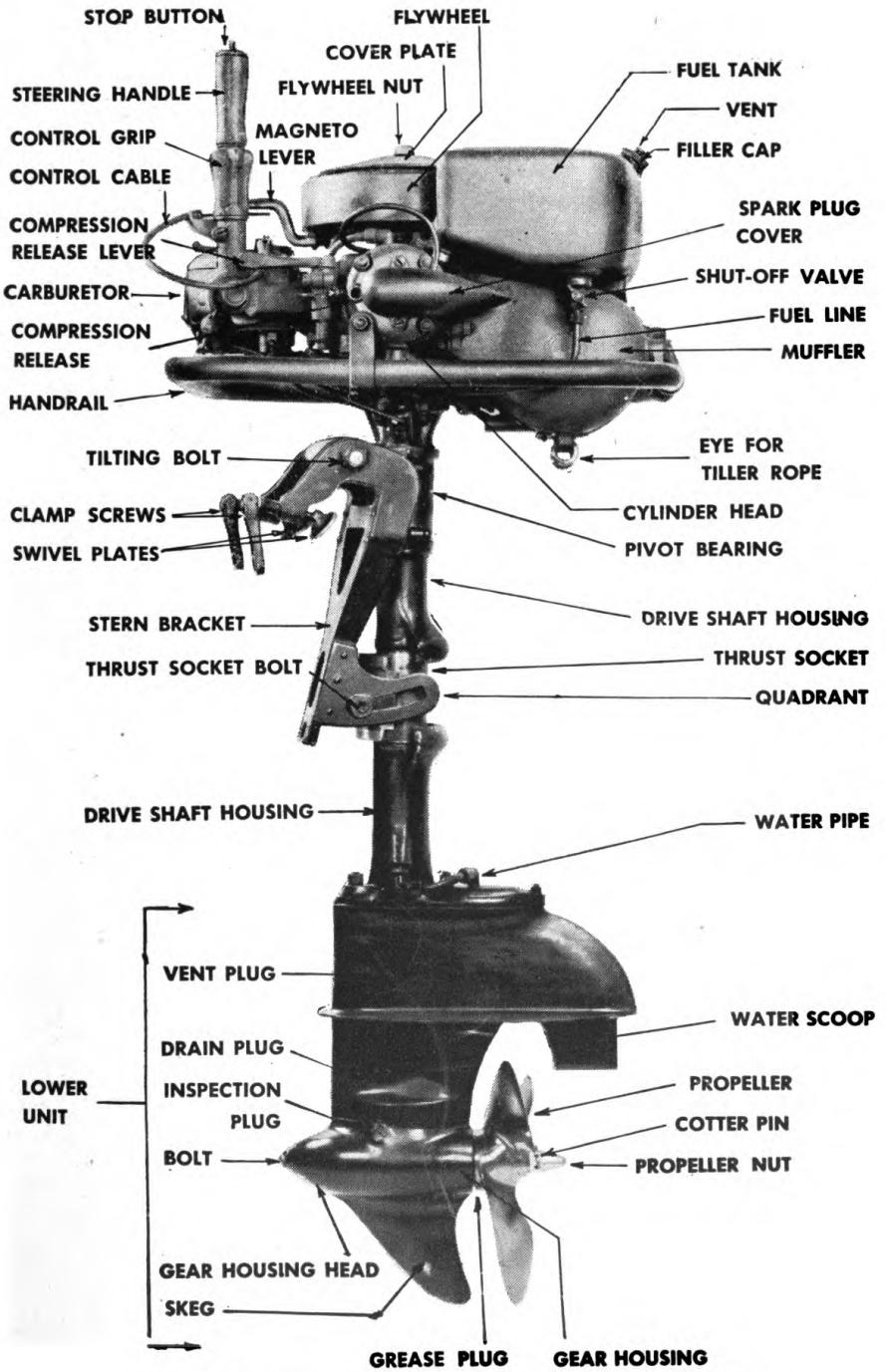


Figure 79. General nomenclature, POLR–15 motor.

20. Specification Chart

See table IV.

Table IV. Specification chart POLR-15

Mechanical specifications	*POLR-15*
Powerhead	Two-port rotary valve opposed cylinders.
Bore and stroke	2¾- by 2.52-in.
Number of cylinders	2.
N.O.A. certified	22.0.
Brake hp at rpm	4,000.
Piston displacement	29.92 cu. in.
Weight	126 lb.
Propeller-diameter pitch	12- by 10-in., 3-blade.
Fuel-tank capacity	2½ gallons.
Starting	Rope.
Ignition	Magneto.
Make carburetor	Vacturi.
Gear ratio	12–21.
Type of exhaust	Open.
Cooling system	Pressure vacuum.
Steering	Full pivot.
Reverse	Yes.
Stern height (maximum)	20 in.

21. Starting Instructions

To start the motor, follow the instructions shown in figures 80 to 89 inclusive. Mix 1 pint SAE No. 40 lubricating oil with each gallon of gasoline and fill tank.

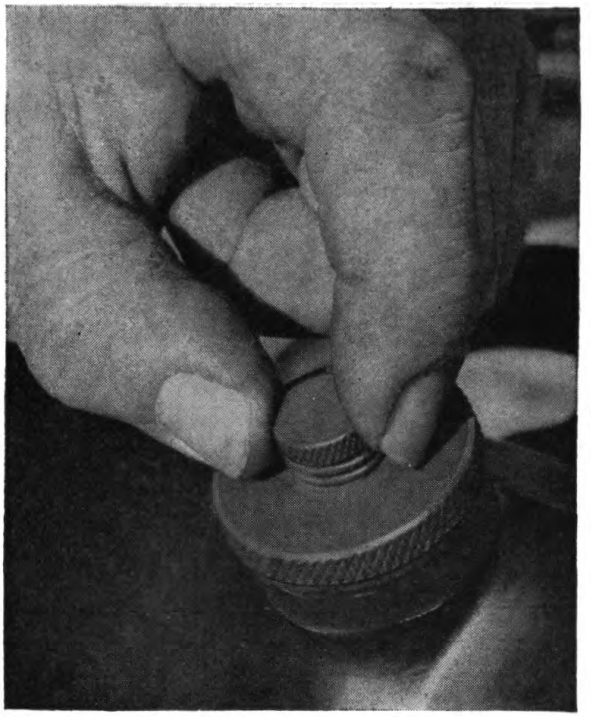


Figure 80. Open air vent in gas-tank filler cap to allow air to enter tank permitting gasoline to flow from tank.

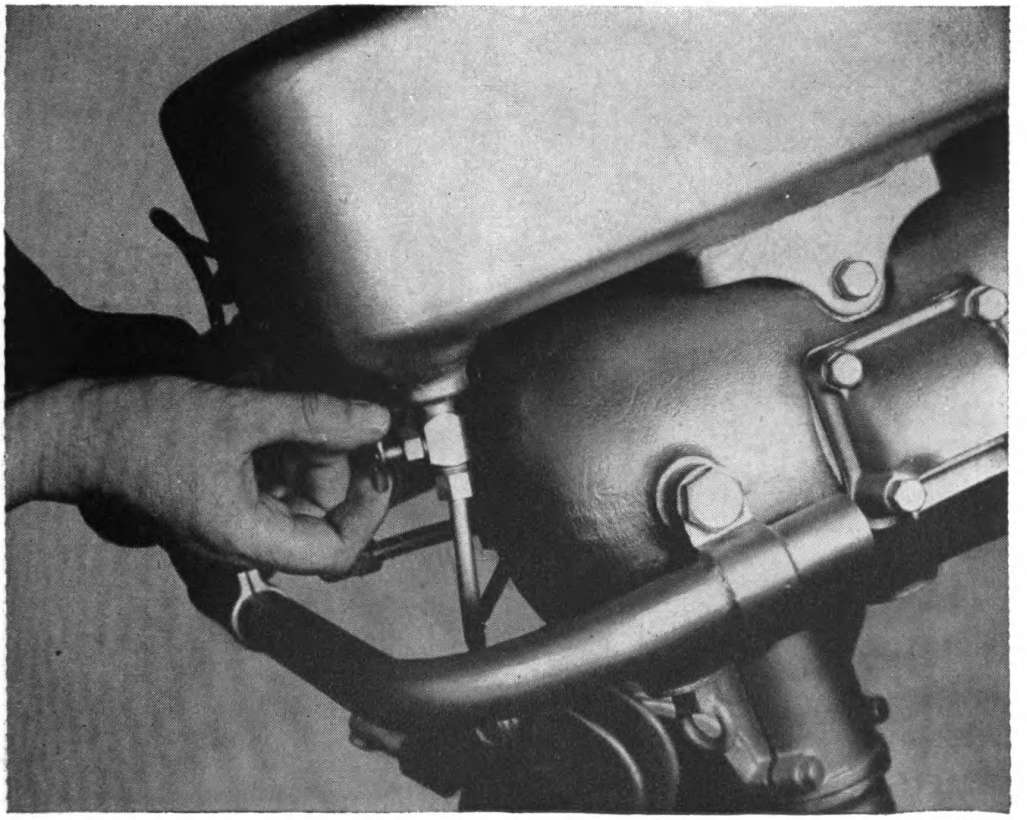


Figure 81. Open gas tank shut-off valve to permit gasoline to flow to carburetor.

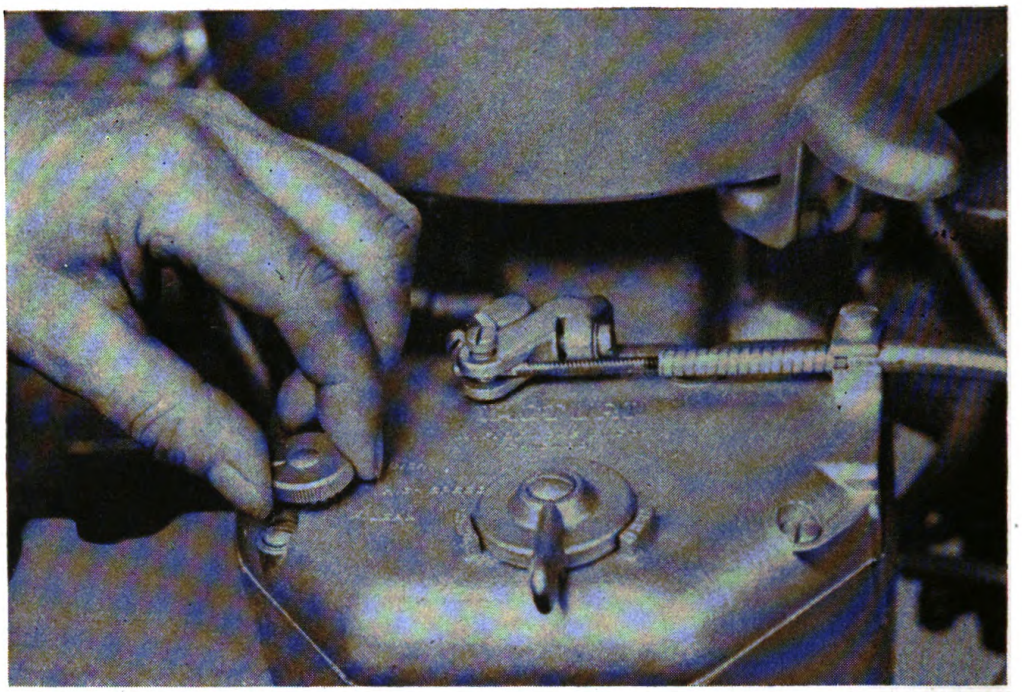


Figure 82. Set high-speed needle one turn from closed position for correct carburetion for starting. (Be sure needle is adjusted properly. If in doubt, turn needle clockwise to close, then open one turn from closed position.)

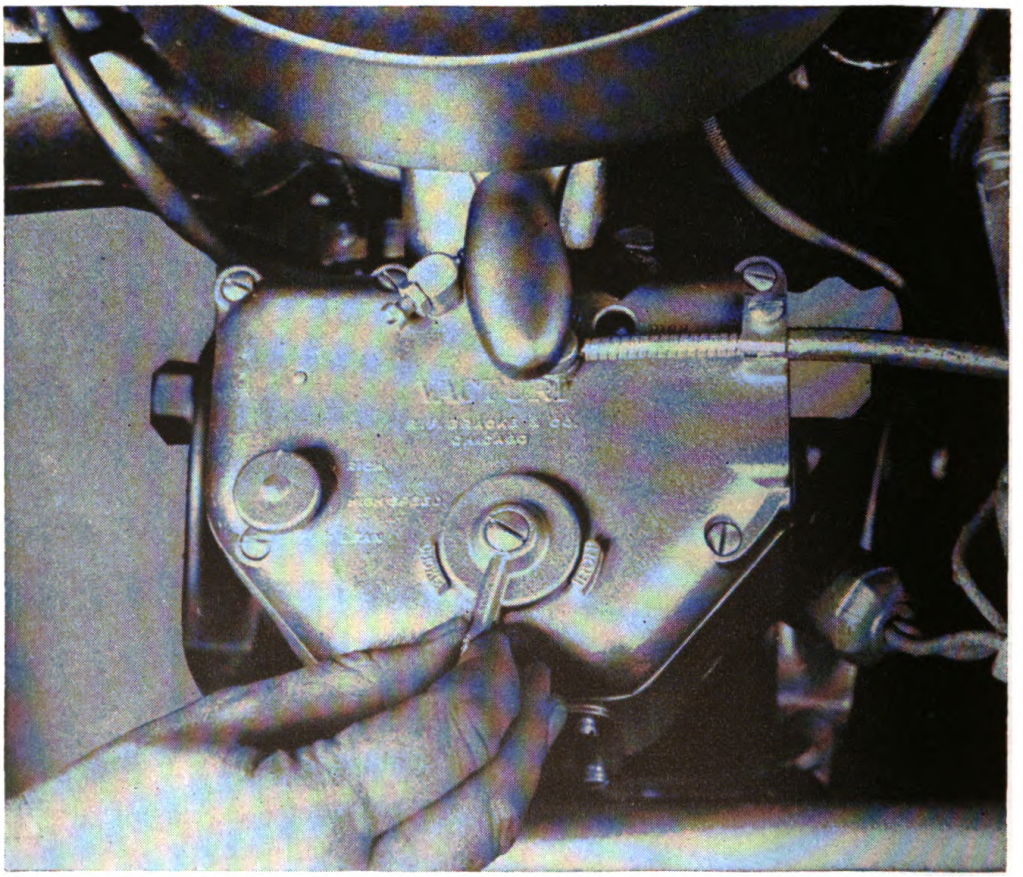


Figure 83. Set choke lever to "choke" position. (Move choke lever to position marked "choke." Do not use choke to start when motor is warm unless necessary.)

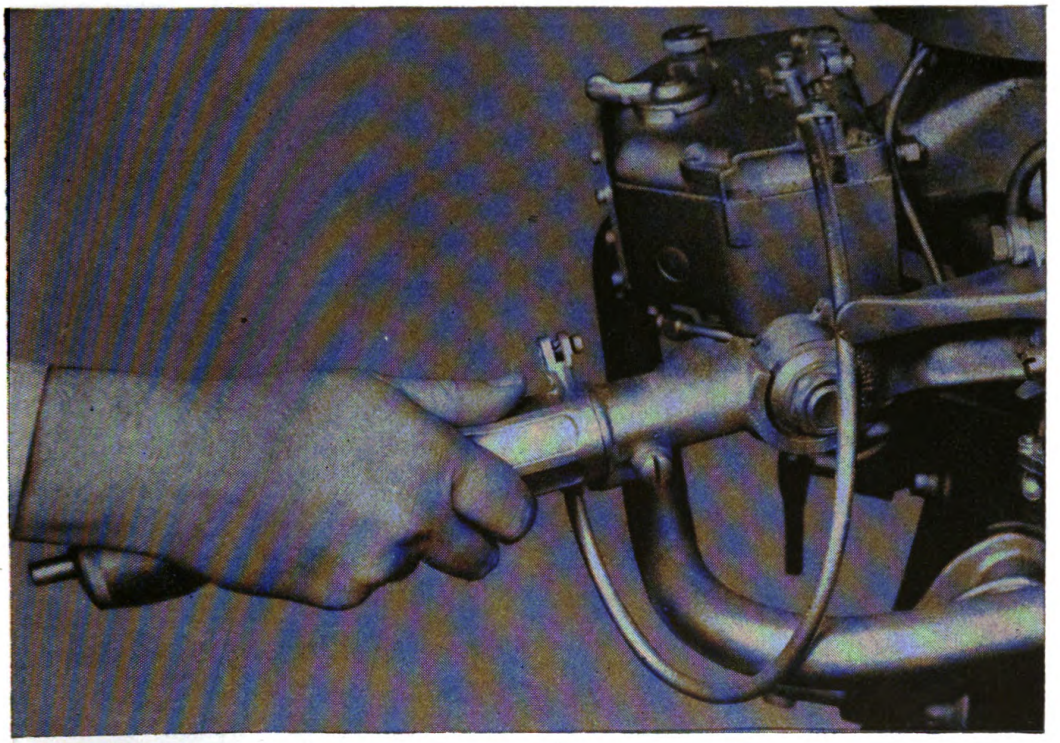


Figure 84. Set throttle one-third open to give correct throttle adjustment for starting. Set throttle approximately one-third open. Turn control grip clockwise from closed position.

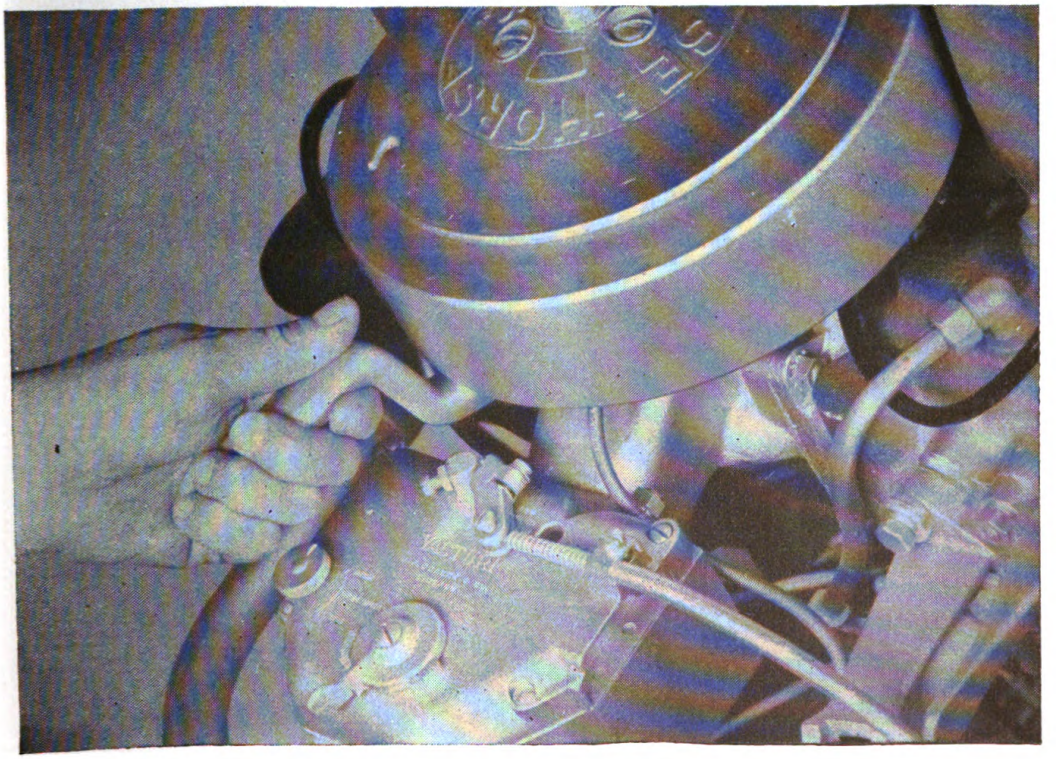


Figure 85. Set magneto lever to center position.

Figure 86. Wrap starting cord clockwise around starting pulley placing knot of cord in notch of drum.

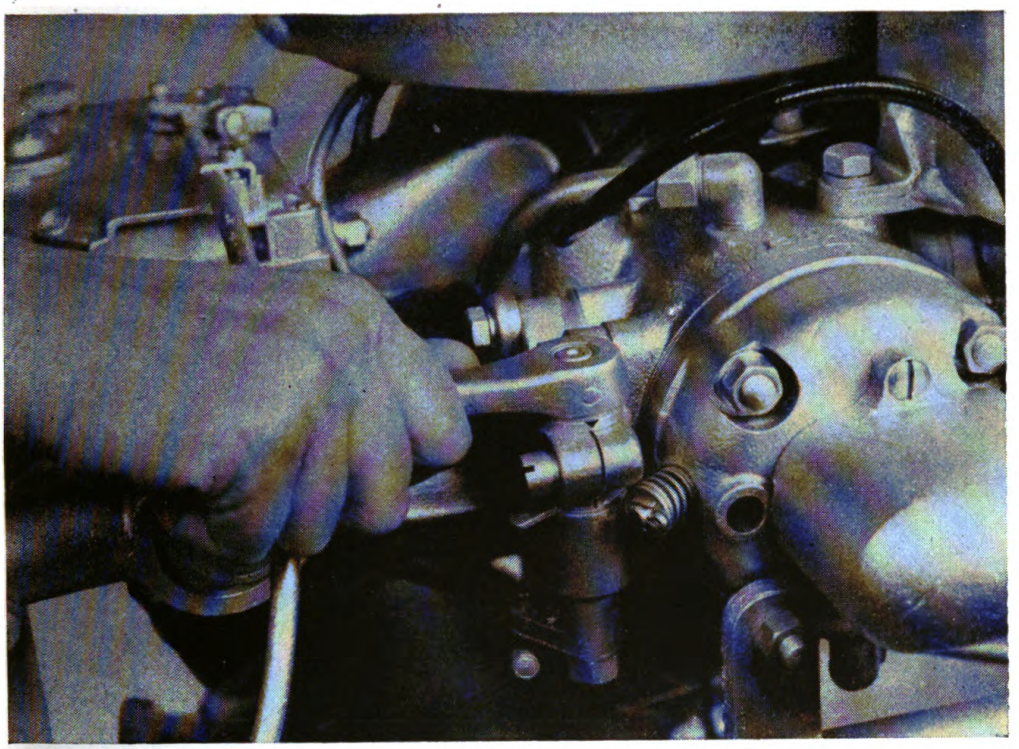


Figure 87. Move compression release lever to extreme right (facing motor) to reduce cranking effort.

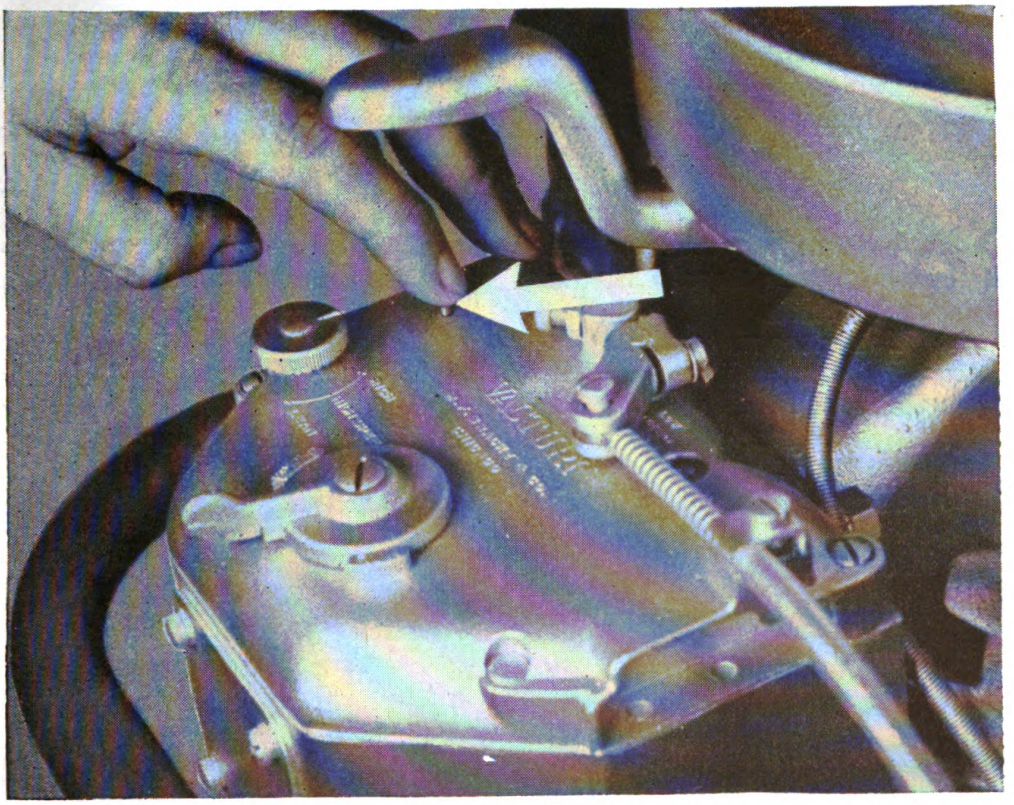


Figure 88. Depress float pin for 1 or 2 seconds to flush carburetor. Stop when gasoline flows from float-pin hole. Depress float pin for 1 or 2 seconds to flush carburetor. The float chamber is filled with fuel-oil mixture when float pin is up; chamber is empty when float pin is down.

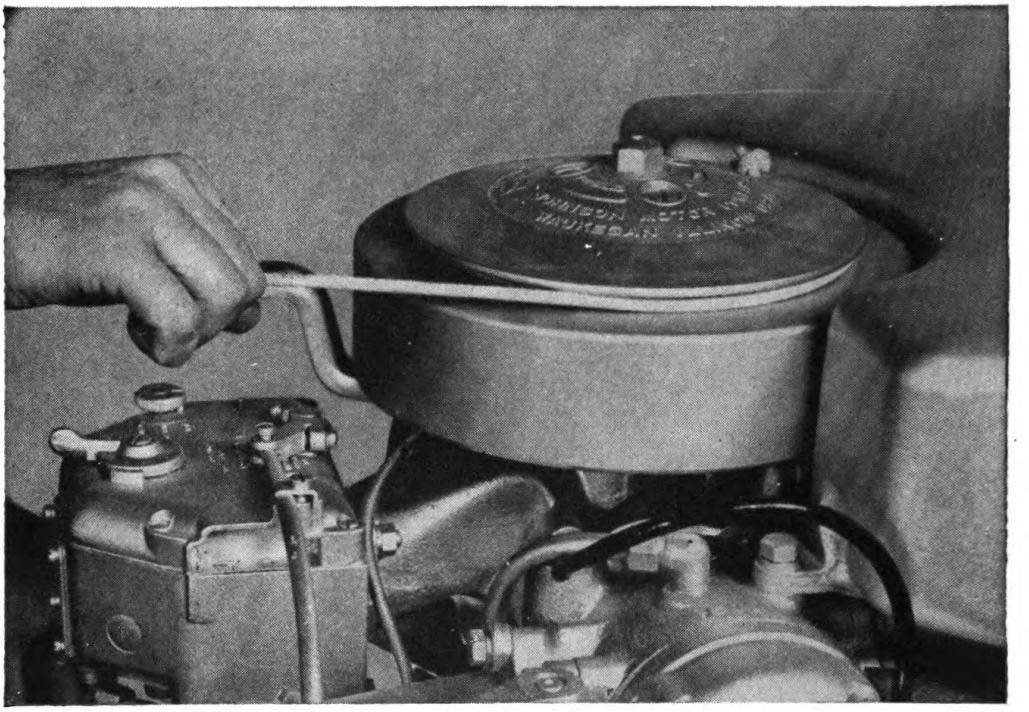


Figure 89. Pull starting cord. Grasp starting cord as shown and spin flywheel with a sustained, strong pull. Do not jerk rope.

22. Operating Instructions

a. Having started the motor, proceed as follows:

(1) Advance spark by moving magneto lever to right (facing motor).

(2) Move choke lever to "open" position.

(3) Move compression-release lever to extreme left (facing motor).

(4) Open throttle on control grip as desired.

(5) Turn high-speed needle right or left as required to obtain maximum speed. High-speed needle is adjusted correctly when maximum speed is attained.

(6) To reduce motor speed, close throttle and retard spark by moving magneto lever to left (facing motor). Turn control grip to right to open throttle, to left to close throttle.

(7) (*a*) To stop motor, depress stop button. Hold until motor stops running.

(*b*) If motor is flooded by overchocking and cannot be started, close high-speed needle. Crank motor to start, and allow to run until excess fuel in crankcase is consumed. Open high-speed needle and follow instructions in paragraph 21.

b. To attach motor to boat, see paragraph 6.

c. Compression Release and Bypass Valve. (1) To obtain easy cranking and starting a compression release and a bypass valve have been built into port cylinder (left, back to motor—see fig. 91).

(2) The compression release consists of a small valve installed in cylinder head and held closed by a spring, and operated at will by movement of compression-release lever. It relieves compression pressure and, when opened for starting purposes, reduces cranking effort, since starting is accomplished on but one cylinder.

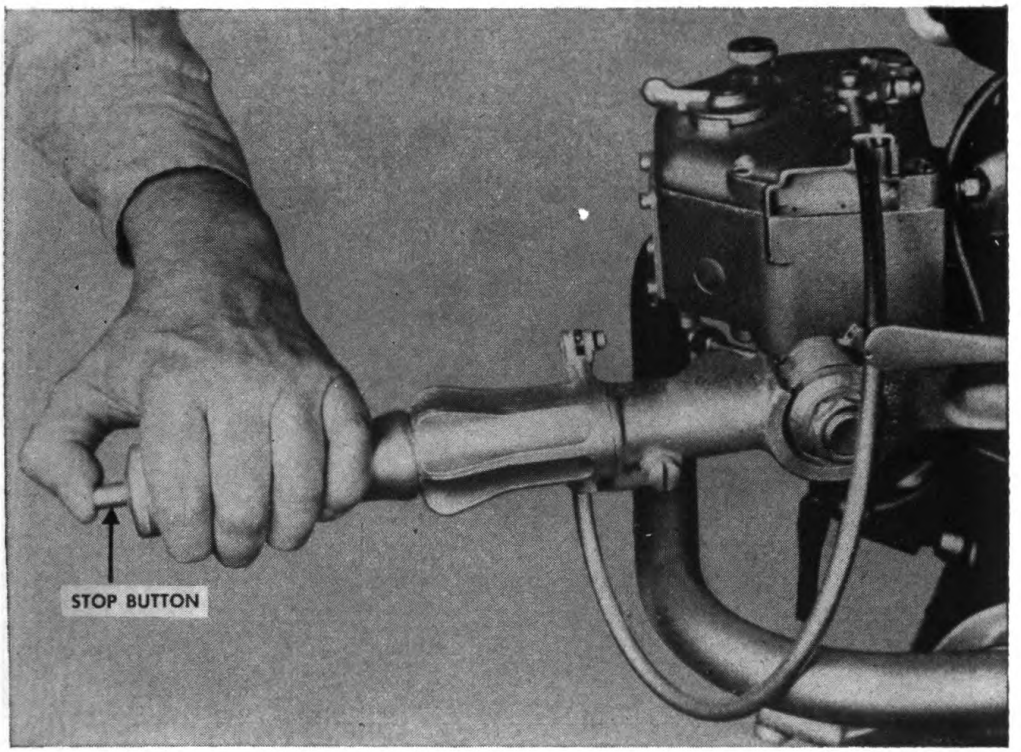


Figure 90. Push in stop button to stop motor.

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

(4) Compression release and bypass valves operate in unison by moving the compression-release lever to right (facing motor), which leaves compression-release valve open and bypass valve closed for the starting

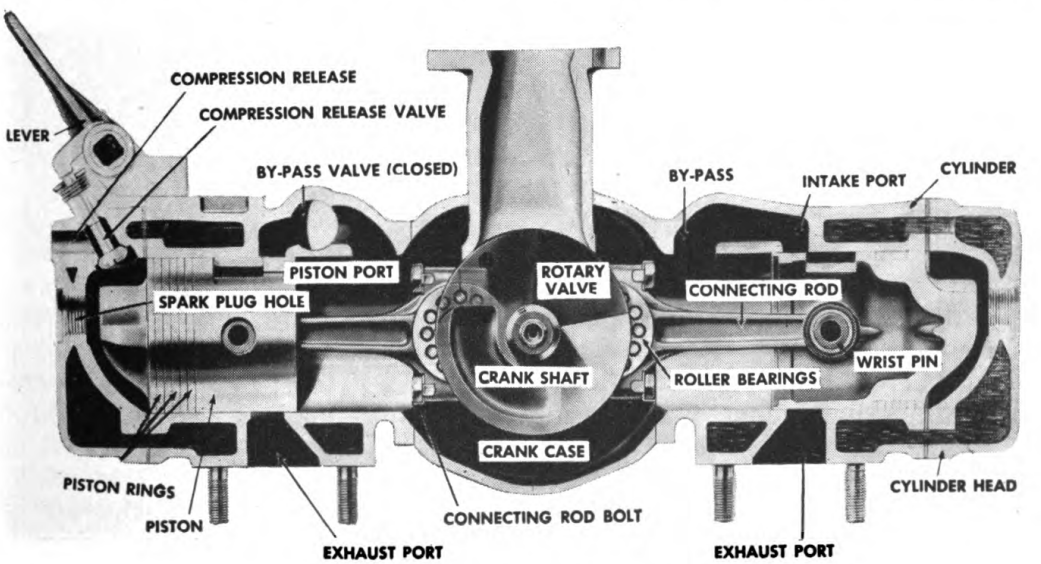


Figure 91. Compression release.

position. If compression-release lever is moved to left (facing motor) compression-release valve is closed and bypass valve open in running position. Move compression-release lever to the left immediately after starting motor.

d. CARBURETOR ADJUSTMENT. The carburetor has two jets to insure efficient carburetion throughout entire speed-range of motor. The slow-speed jet provides correct carburetion at slow and intermediate speeds, high-speed jet from intermediate to top speeds. Two adjustments are necessary—slow- and high-speed needles. (See fig. 92.)

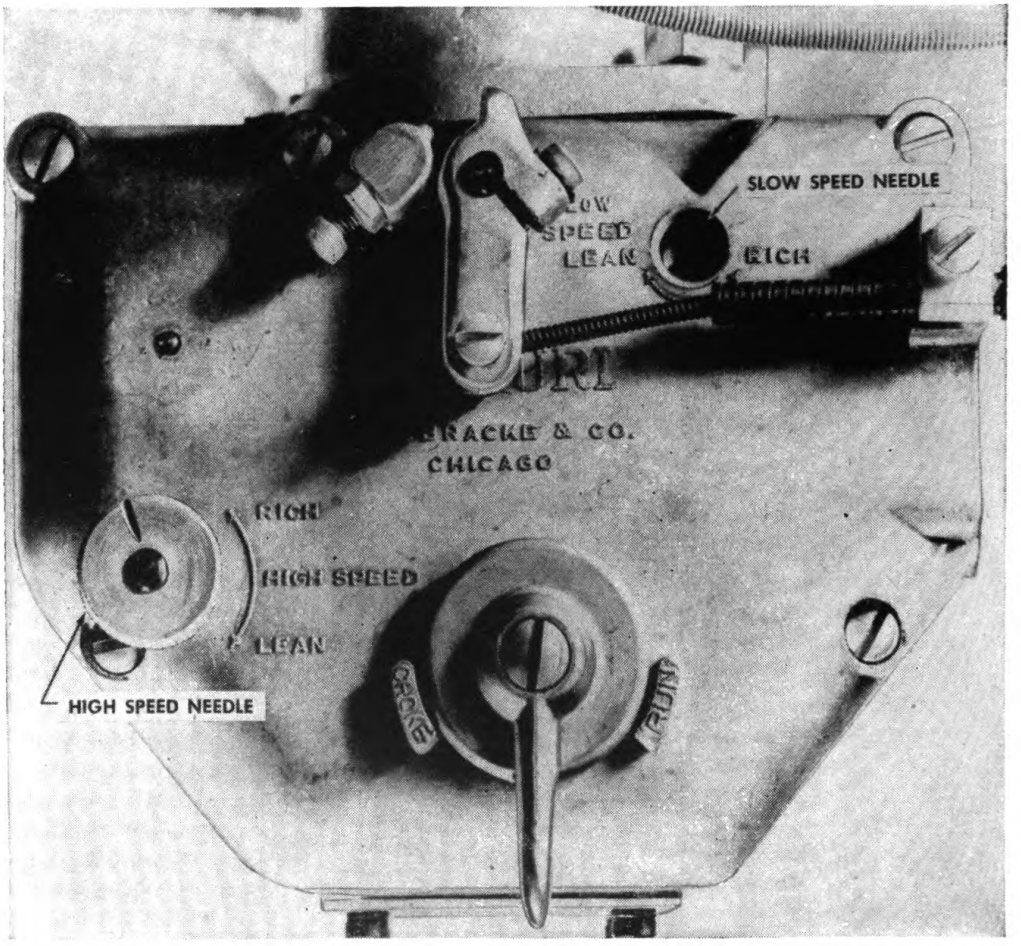


Figure 92. Carburetor needle controls.

(1) *To adjust slow speed.* Slow-speed adjustment is made with retarded spark and at normal running temperature. Close slow-speed screw or needle and open approximately one-half turn. Start motor as instructed, and operate at full throttle until it reaches normal temperature. Move magneto lever midway between center position and full retard, and close throttle. Turn slow-speed needle to right or left as required to obtain smooth operation at slow speed.

(2) *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.

e. Steering and Reverse. See paragraph 7.

f. Magneto. See paragraph 4*e*, and figure 8.

g. To Install Propeller Drive Pin (Safety Shear Pin). To install a new drive pin, withdraw propeller-nut cotter pin. Remove nut, propeller, and fragments of sheared pin. Install new pin. Replace propeller and nut. Draw up on propeller nut just enough to make certain propeller hub rests firmly against drive pin. If drawn up too tightly, it may shear new pin. Insert cotter pin and lock in position.

h. Cooling System. See paragraph 4*b*.

i. Cavitation. See paragraph 4*j*.

j. Motor Dropped Overboard. See paragraph 15*j*.

k. Demolition to Prevent Enemy Use. See paragraph 16.

l. Preparation for Storage. See paragraph 9.

m. Preparation for Shipment. See paragraph 10.

23. Operating Maintenance

a. Operator Maintenance. Follow procedure listed in paragraph 17*c*.

b. Lubrication of Gear Case. (1) Since gear case is submerged when in use it is important that gears and bearings be lubricated properly at all times. Gear case is lubricated at intervals of 10 to 12 hours of operation.

(2) Inspection of gear case is necessary at regular intervals to drain accumulation of water which may be present. Remove vent and grease plugs. Water in the gear case is injurious if allowed to remain, particularly if the motor is placed in storage, and causes gears, bearings, propeller and pinion shafts to rust and become pitted.

(3) To refill with gear lubricant, place motor in an upright position. Remove lower grease plug and upper vent plug. Fill with Evinrude Super Grease UW or Sea Horse Lubricant, using a grease gun or tube inserted through lower opening. Insert lubricant until it flows from vent opening. Replace plugs, making certain they are secure.

(4) Prior to storage remove all drain, vent, and grease plugs to allow water present in gear case and water channels to drain off. This prevents freezing and bursting of gear case, drive-shaft housing, water tubes, and cylinder blocks if motor is exposed to freezing temperatures, and eliminates danger of rusting.

c. Clean and Adjust Breaker Points. (See fig. 8.) (1) Remove flywheel cover plate held in position by three screws. A port or opening in flywheel makes points accessible for inspection, cleaning, and adjusting. (See fig. 94.) Spread breaker points with blunt instrument to observe their condition. If pitted or corroded, place a narrow strip of No. 00 sandpaper between points, folded so both points can be dressed down simultaneously by drawing sandpaper back and forth between them. The flex-stone listed in first echelon spare parts also may be used. Do not use emery cloth.

(2) Upon completing this operation, check the gap between points by turning flywheel slowly until points are wide apart. Insert feeler gauge between points as shown in figure 94. Correct setting is .020 inch. Note breaker arm, breaker plate, breaker-point adjusting screw, and breaker-point cam in flywheel in figure 8. If necessary to reset breaker points, loosen breaker-point adjusting screw. Note arm is free to move slightly. Since breaker points actually are operated by cam in flywheel,

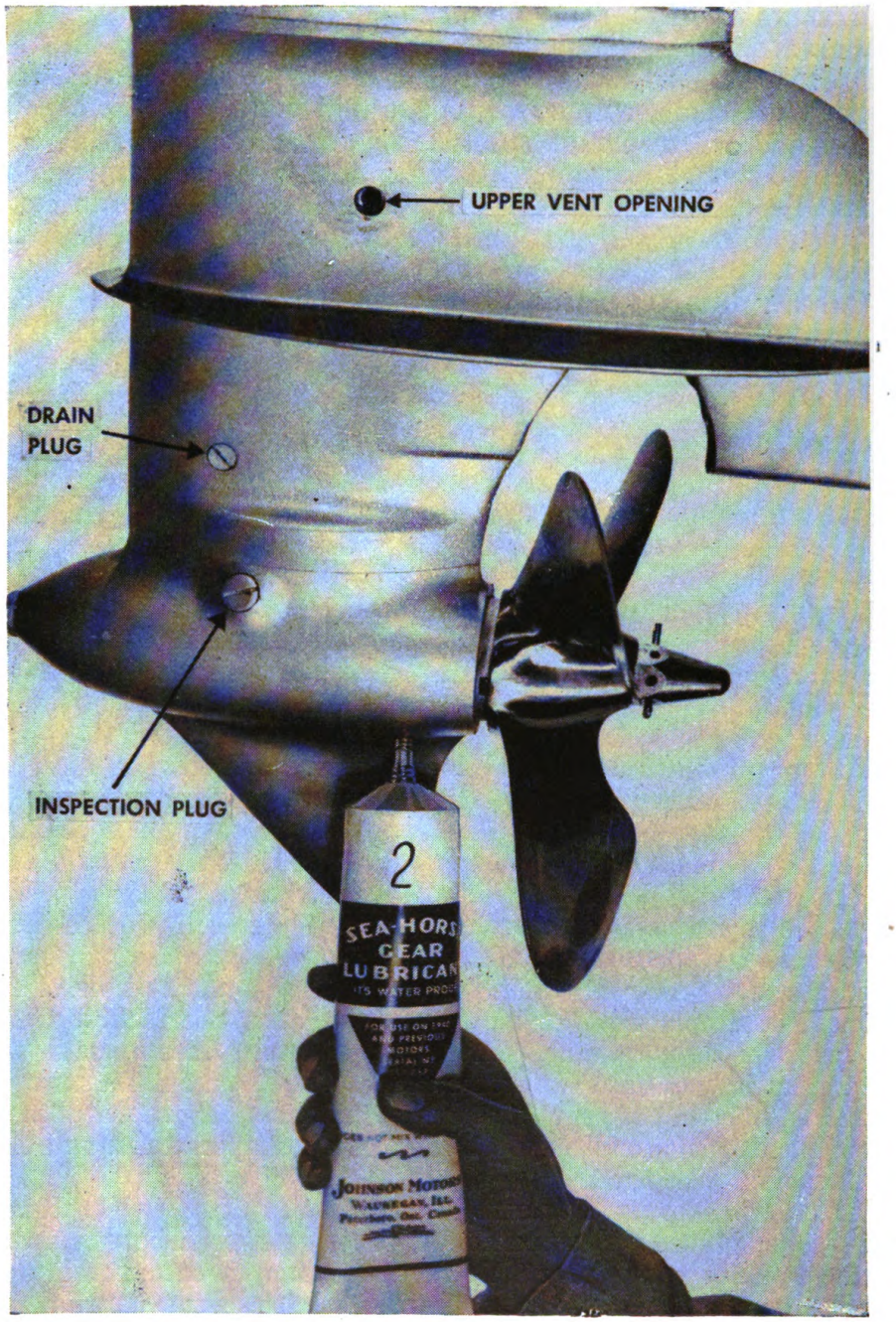


Figure 93. Lubricating gear case. (Insert waterproof gear lubricant, Evinrude Super Grease or Johnson Sea-Horse Lubricant. until grease flows from upper opening.)

breaker plate must be adjusted to a definite position with respect to cam to obtain proper gap setting at points. Insert screw driver or other blunt instrument through port in flywheel and shift position of breaker plate as required to attain gap of .020 inch. To increase gap, shift breaker plate and arm assembly towards cam center of flywheel; to decrease gap, shift from cam. Tighten setscrew to lock in position at proper gap setting.

(3) Note mark on rim of flywheel and similar mark on underside of

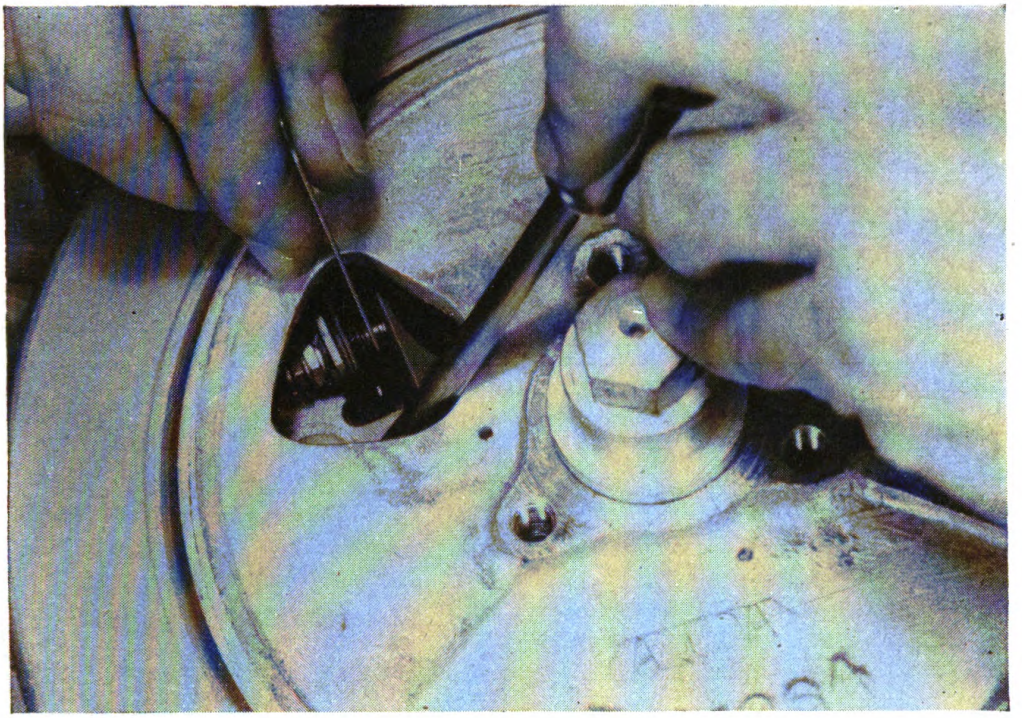


Figure 94. Checking breaker points through inspection port in flywheel.

armature plate. Points should be on verge of opening when two marks index. Replace flywheel cover plate.

d. Trouble Shooting. See section V.

24. Repair Instructions (see par. 16.)

a. To Remove Flywheel. The flywheel nut and cover plate act in combination as a puller when the flywheel nut is unscrewed. The nut has a shoulder that bears against under side of cover plate. Unscrew flywheel nut until it tightens against cover plate. Strike handle of wrench sharp blow with hammer or mallet as shown in figure 95. Two or three blows should be sufficient to jar flywheel loose from taper on the crankshaft. Lift flywheel from crankshaft.

b. To Install Flywheel. Remove cover plate from flywheel. Make certain keys are in position on crankshaft. Place flywheel over taper on crankshaft, at same time aligning keys and keyway in flywheel hub. Attach flywheel nut, and screw down tightly. Strike handle of wrench several sharp blows with hammer or mallet to tighten. Replace cover plate. Start and run motor 10 to 15 minutes. Retighten nut as described above. Newly installed flywheel will settle slightly on taper of crankshaft after a few minutes operation and unless tightened, is likely to cause serious damage both to flywheel hub and to crankshaft taper. Be sure flywheel nut is tight. Repeated shearing of propeller pins for no apparent reason is result of loose flywheel.

c. To Install New Breaker Points. 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. (See fig. 96.) Install new points, stationary point,

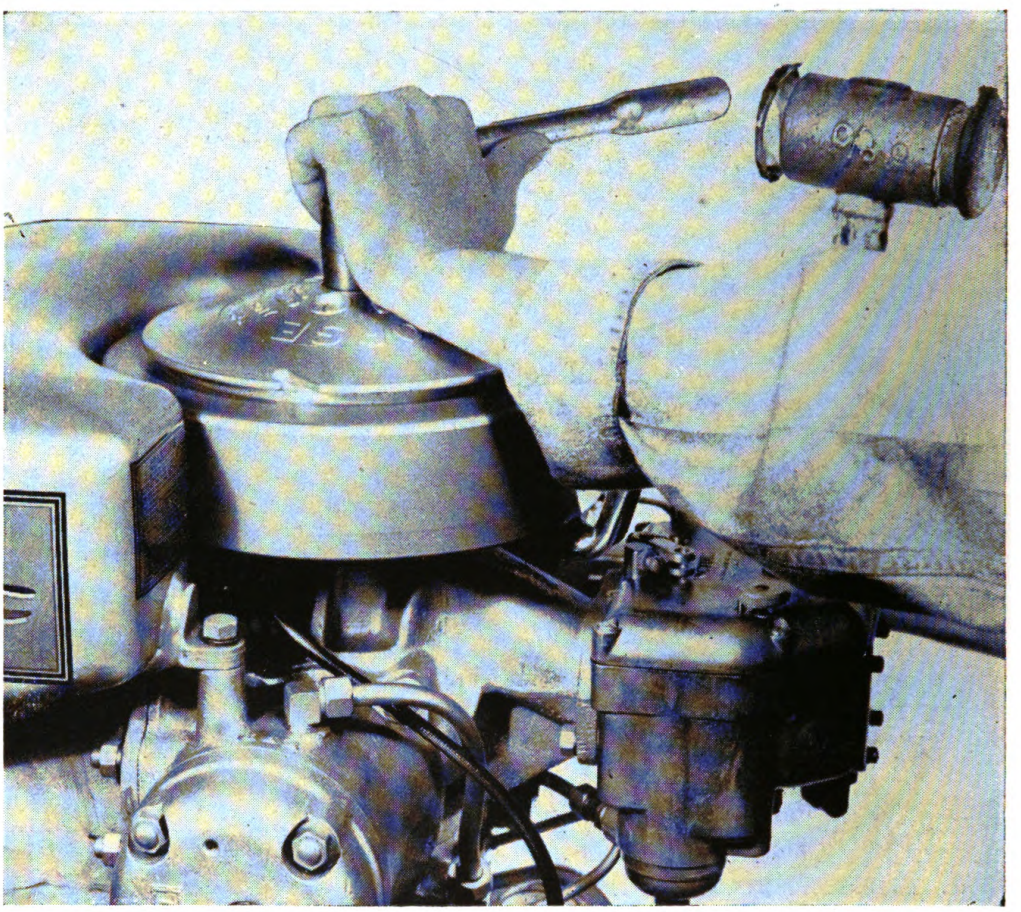


Figure 95. Using wrench on flywheel nut. (Strike wrench with hammer or mallet to loosen flywheel from crankshaft.)

and breaker-arm assembly in reverse order. Be sure breaker arm operates freely on pivot post and that all nuts and washers are drawn up securely. Adjust points. Since breaker-point cam is attached to hub of flywheel, flywheel must be mounted to crankshaft prior to attempting adjustment of points.

d. To Install Condenser. Condenser is fastened to under side of armature plate. (See fig. 8.) Remove screws, detach condenser leads which is soldered to bracket on breaker plate. Lift condenser from cavity in plate. When attaching new condenser, thread small wire through hole in armature plate provided for this purpose. Solder lead to bracket. Set condenser in cavity and replace screws to hold it fast.

e. To Install Ignition Coil. (1) Detach ground wire from armature plate. Detach primary lead soldered to bracket on breaker plate. Detach high-tension leads and 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, holding coil heels and coil to plate. Lift coil and heel assembly from armature plate. Middle screw *A*, figure 65, on each heel holds plates of heel assembly together. Do not remove this screw, merely loosen. Pry heels gently from coil. Simply pull off by hand. (See fig. 98.)

(2) To attach coil heels to new coil, place coil and heel assembly in position on armature plate. Insert and tighten screws holding assem-

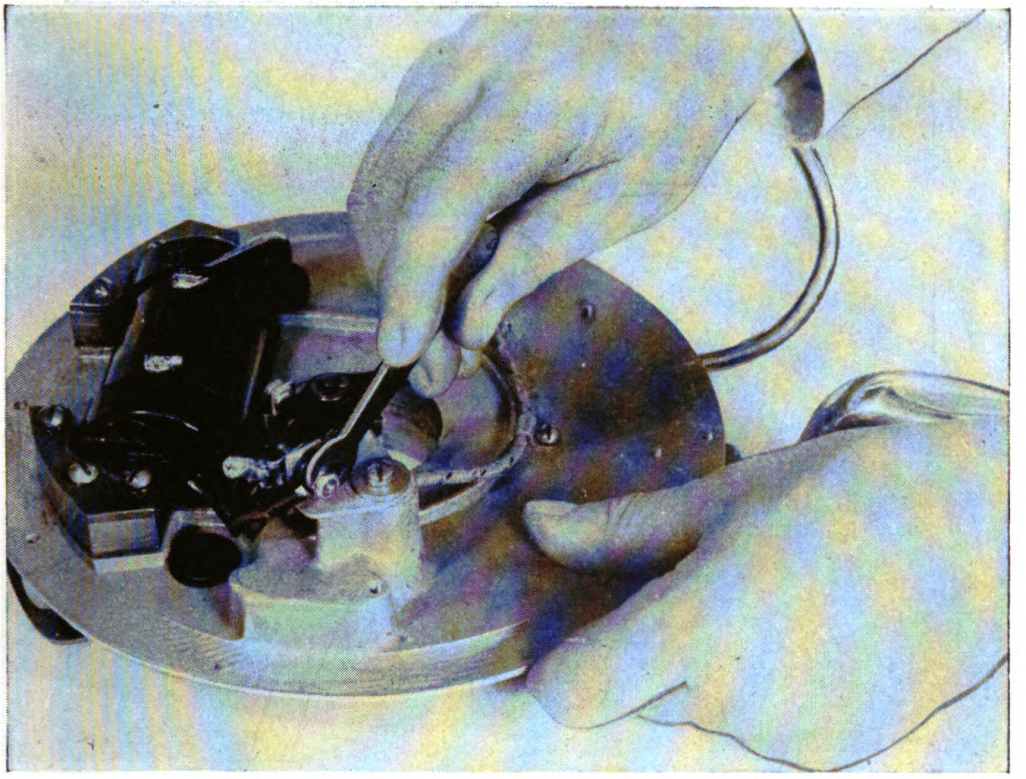


Figure 96. Removing nuts on breaker plate.

bly to plate. Solder high-tension leads and spark-plug wires to coil in their respective positions. Use soldering paste or rosin flux. Do not, under any circumstances, use acid flux. Use just enough heat, solder, and flux to obtain a good substantial connection. Excessive heat is likely to burn off small secondary lead from coil. Overuse of solder or flux results in short circuits and renders coil inoperative.

(3) Coil heels must be made flush with boss armature plate (figs. *A*, 99 and 100) to prevent striking pole shoes of magnet in the flywheel when motor is in operation. This is done by tapping heel assemblies with hammer as illustrated (fig. 99) or, if a lathe is available, by mounting armature plate assembly on a mandrel between centers and turning heel surfaces down until flush with boss on armature plate. (See *A*, fig. 100.) Having completed this operation, draw down farther on all screws in heel assembly to make certain coil is mounted securely.

f. To Remove Piston Rings from Piston. (1) Expand rings by spreading with thumbs as illustrated in figure 102, and slide over end of piston. There are three rings for each piston. Be careful to spread only far enough to permit slipping off piston, as rings can be broken.

(2) Rings are placed in reverse order. Spread enough by hand to slide over piston and into position in respective ring grooves.

(3) After long periods of operation the piston-ring grooves frequently become clogged with carbon which requires removal to prevent rings from sticking. This condition results in loss of compression and lack of power.

(4) It is simple to remove carbon from ring grooves by scraping, as shown in figure 103. A suitable scraper can be made easily from a discarded file or hacksaw blade. Make it slightly narrower than ring

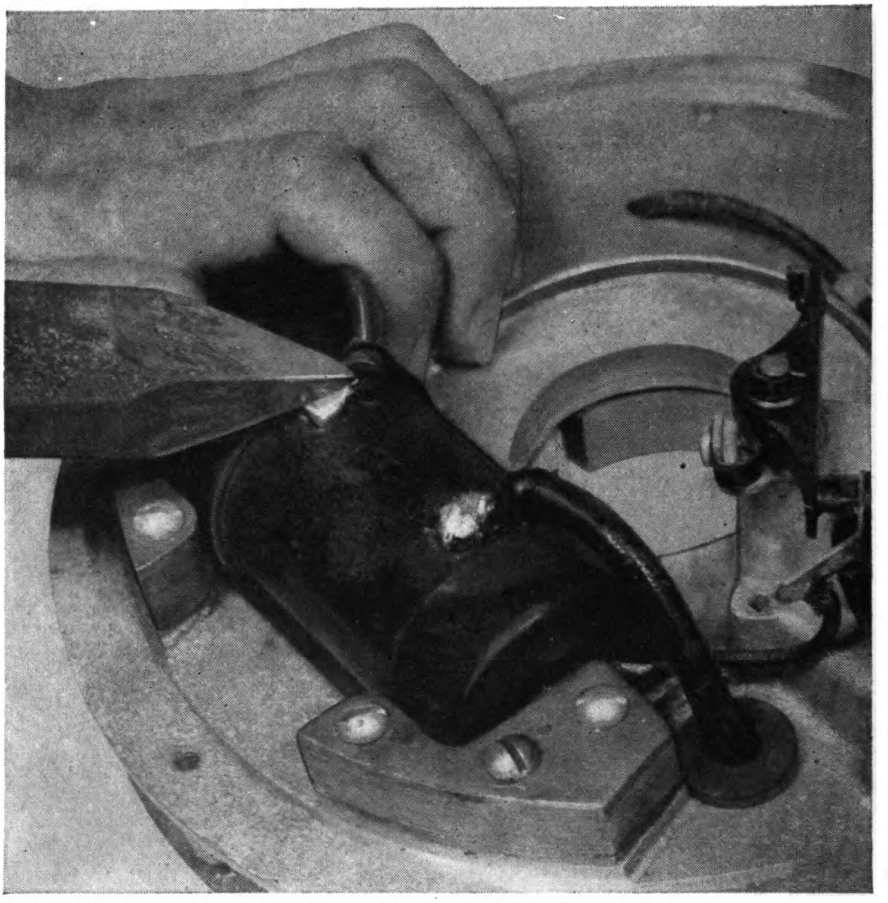


Figure 97. Detaching wires from coil.

grooves in piston, and sharp enough to scrape out accumulated carbon.

(5) After removing carbon from piston-ring grooves and before installing new rings, make certain rings fit in piston grooves with no indication of tight spots or binding. This can be determined by rolling each ring around the piston in its respective groove as illustrated in figure 104. Resistance is encountered where tight spots exist. This may result from particles of carbon, burs in piston-ring grooves, or high spots on edge of ring. Check grooves to see all carbon has been removed. Burs usually can be removed with a sharp-edge scraper.

(6) Handle piston carefully, as burs are result of rough handling or dropping.

(7) High spots on edges of rings can be dressed down by rubbing edge of ring lightly over fine sandpaper or emery cloth placed on a flat surface.

(8) Rings must fit freely in piston-ring grooves. Recommended clearance in piston grooves is .0015 to .0025 inch. Piston rings and piston grooves are machined to correct size at factory and fit properly provided all carbon has been removed from piston grooves and there are no burs.

(9) Piston rings are ground to size at factory, but it is advisable to check gap clearance to make sure recommended gap of .005 to .010 inch is maintained. Place each ring squarely in cylinder as illustrated in figure 105. Insert feeler gauge between ends of ring. Repeat same

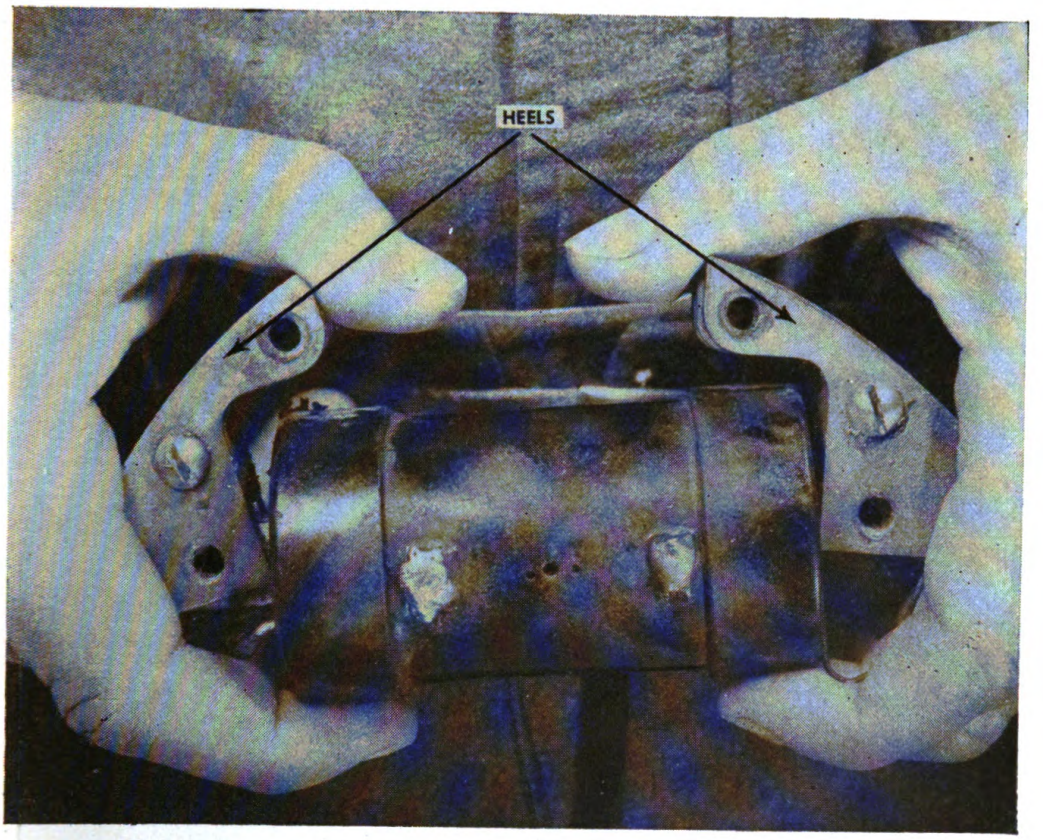


Figure 98. Detaching heels from coil.

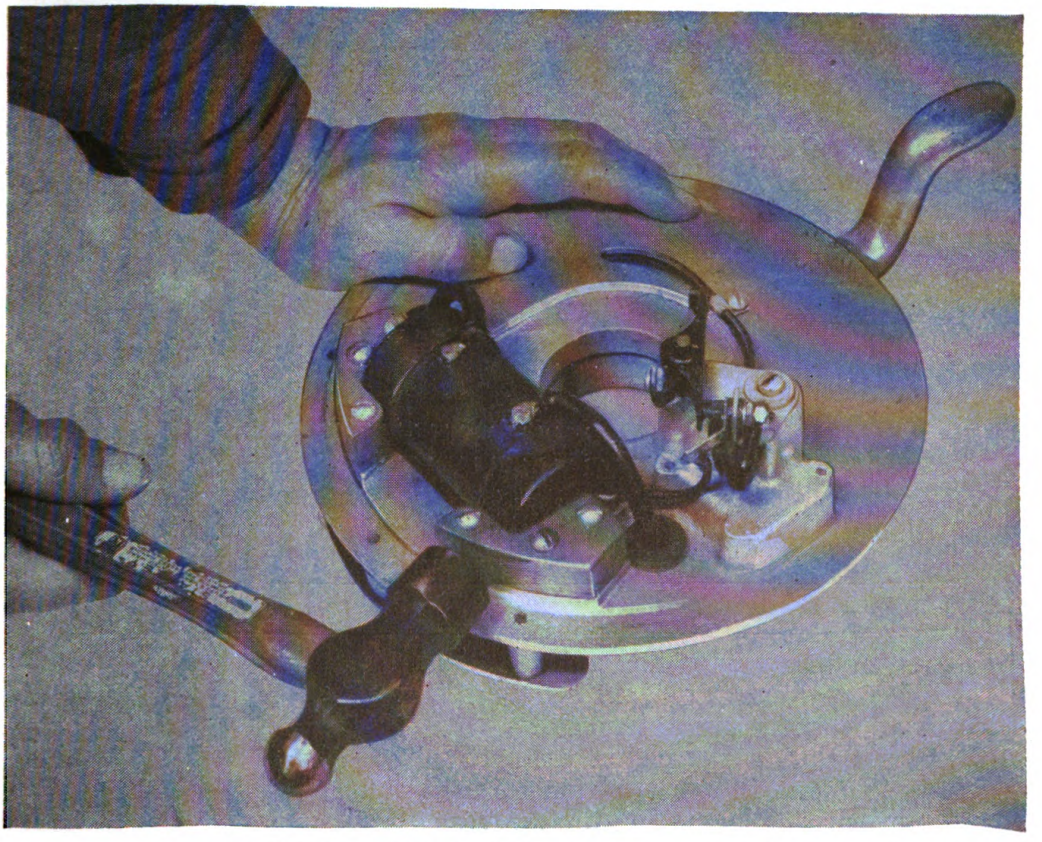


Figure 99. Setting coil heels flush with boss on armature plate.

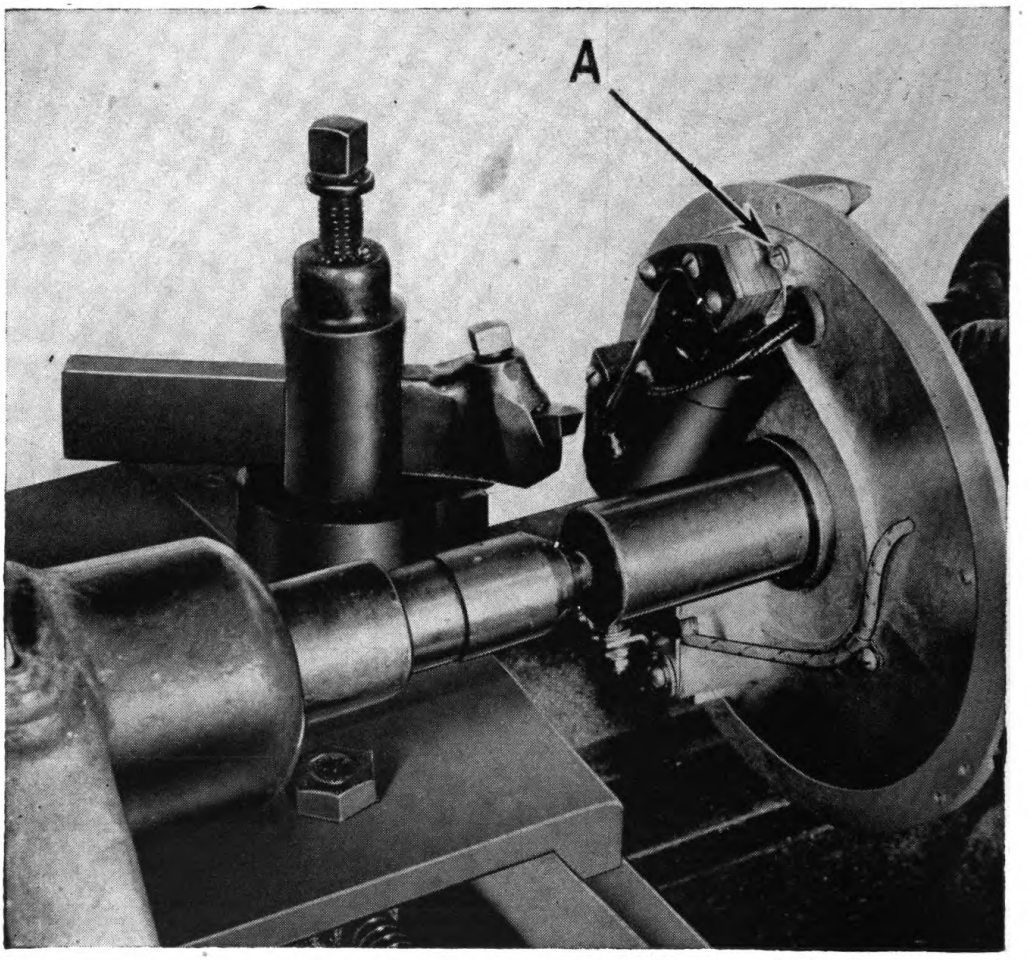


Figure 100. Turning down heel assemblies.

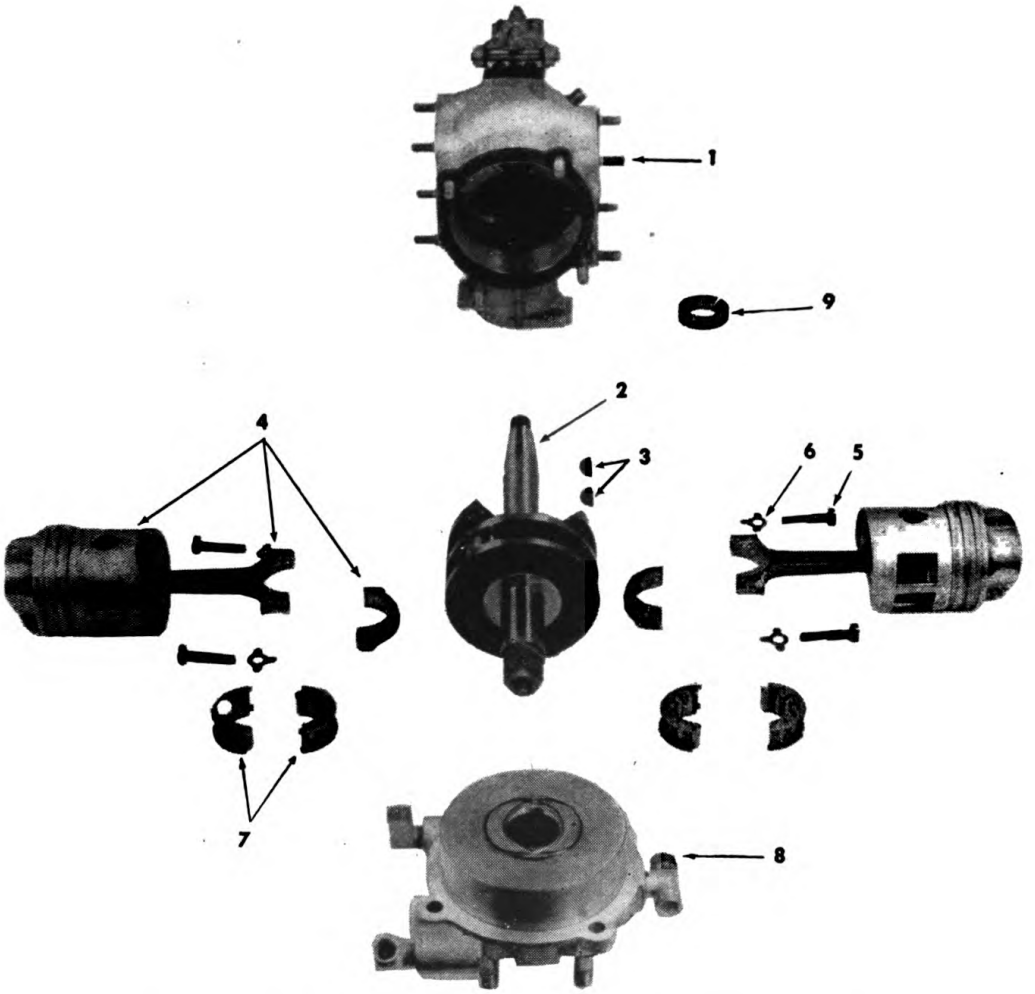
operation for each ring in respective cylinders. If clearance falls below .005 inch, file end of ring carefully until desired gap is obtained. If clearance is considerably in excess of .010 inch, cylinder is worn oversize and should be replaced.

(10) Piston-ring specifications for the POLR–15 are:

Number of rings per piston	3.
Diameter of ring	2.750 inches.
Width of ring	0.125 inch.
Pounds of compression	4 pounds.
Gap clearance	0.005 to 0.010 inch.

(11) If necessary to install a new piston it must be removed from the connecting-rod assembly. The wrist pin is held fast in piston by a setscrew made secure by a lock washer and lock nut. Loosen lock nut and remove setscrew. Wrist pin then can be driven out. This is done by placing assembly between the knees when sitting to prevent springing piston as driving force is applied. (See fig. 106.) Drive from side of piston containing wrist-pin setscrew and lock nut. If fit is snug, hold piston in hot water to expand.

(12) In installing new piston, note hole in wrist pin and threaded hole in wrist-pin boss. Insert wrist pin through opposite hole in piston, the end of pin with hole entering first. Drive pin home. Hole in wrist pin



1	CRANKCASE	6	CON. ROD BOLT LOCK PLATE
2	CRANKSHAFT	7	ROLLER BEARING ASSEMBLY
3	FLYWHEEL KEYS	8	CRANKCASE HEAD
4	PISTON & CON. ROD ASSEMBLY	9	OIL SLINGER
5	CONNECTING ROD BOLT		

Figure 101. Powerhead assembly group.

must line up with threaded hole in wrist-pin boss. Install wrist-pin setscrew. Be sure end fits squarely into hole in wrist pin provided for this purpose. When setscrew has been tightened, tighten lock nut with locker washer in place, to secure setscrew properly.

g. To Remove Crankshaft from Crankcase. (1) The flywheel keys first must be dislodged, as they protrude beyond inside diameter of bearing. Both keys can easily be driven out of keyways by a small, flat-end punch as illustrated in figure 107, taking care not to nick or gouge the crankshaft taper. If accidentally nicked, simply dress down with file prior to withdrawing crankshaft from bearing. Keys can be removed before detaching crankcase assembly from drive-shaft casing.

(2) Remove crankcase head (fig. 108) to permit withdrawing crankshaft as shown in figure 109. Assemble in reverse of order described

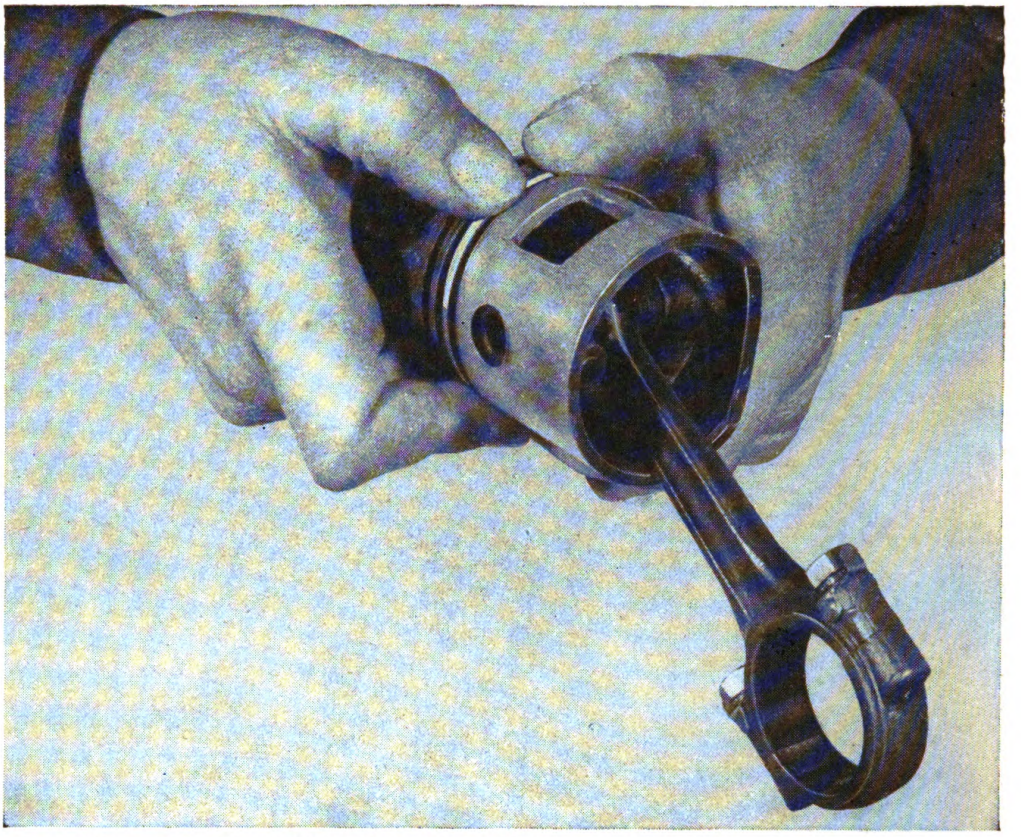


Figure 102. Expanding piston rings to remove them from piston grooves.

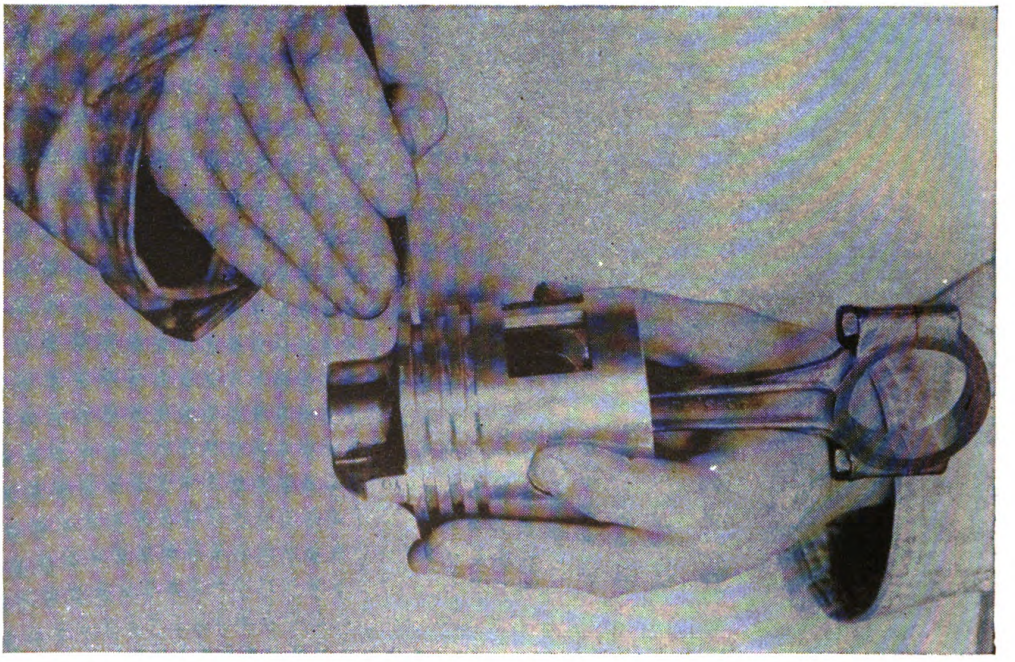


Figure 103. Scraping carbon from piston grooves.

above, being sure to install gasket between crankcase proper and crankcase head. Draw nuts up tightly and evenly holding head in position. Spread coat of oil on crankshaft journals and on bearing surfaces before assembling.

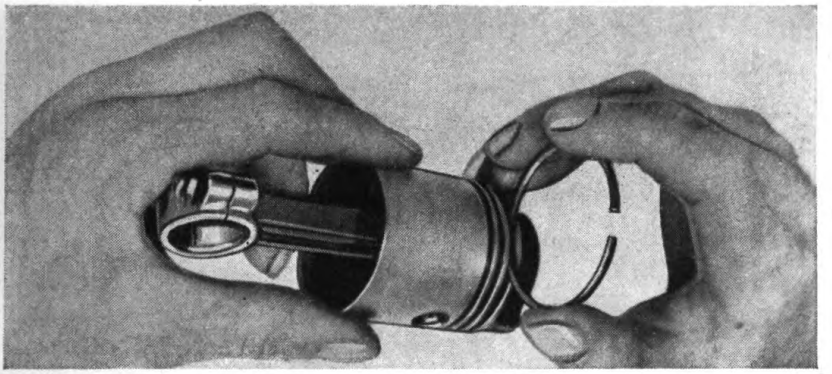


Figure 104. Testing fit of ring in piston groove.

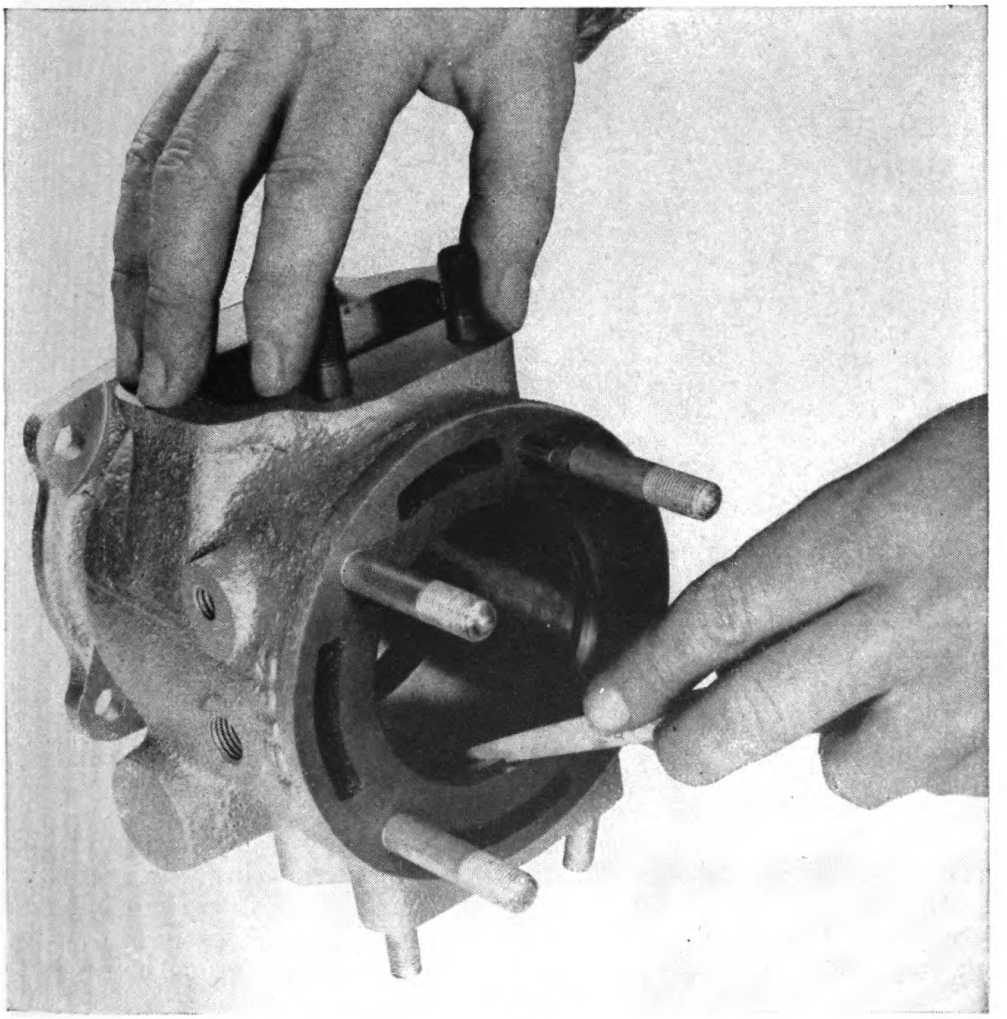


Figure 105. Testing fit of ring in cylinder.

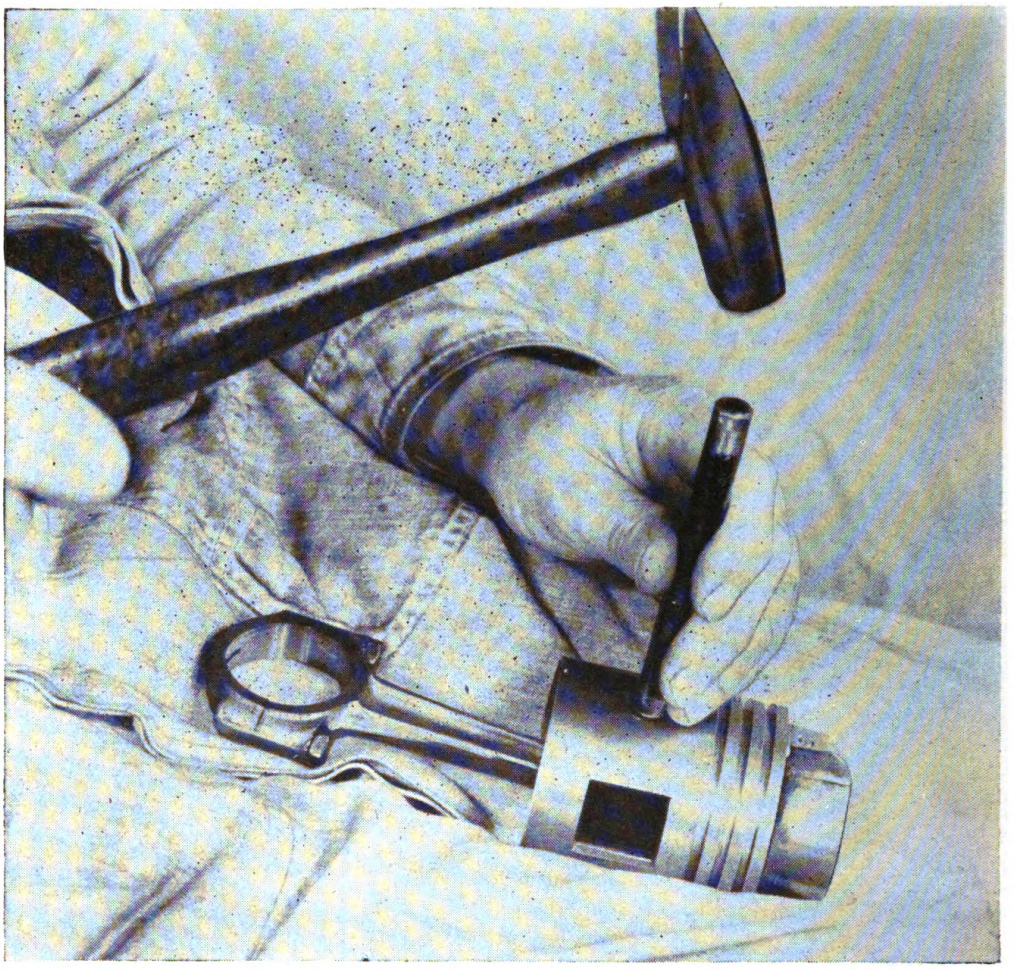


Figure 108. Removing wrist pin from piston, using drive punch and hammer.

h. Assemble Crankshaft, Crankcase, Pistons, and Connecting Rods.

(1) Make certain all parts are clean and in good mechanical condition.

(2) Spread thin coat of oil on crankshaft journals and crank pins, and a few drops in bearings of crankcase and crankcase head.

(3) Insert crankshaft. (See fig. 109.)

(4) Install crankcase head, being sure gasket is in place and bolt in position. Crankshaft should turn freely on completing this operation.

(5) Slip oil slinger over top of crankshaft. Tap down lightly, until it rests on top surface of journal bearing in crankcase. Follow by tapping both ends of 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 edge and a wide edge. Narrow edge should be directed downward. This is important to prevent oil escaping from crankcase.

(6) Piston rings should be fitted properly. Correct gap clearance is .005 to .010 inch, 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.

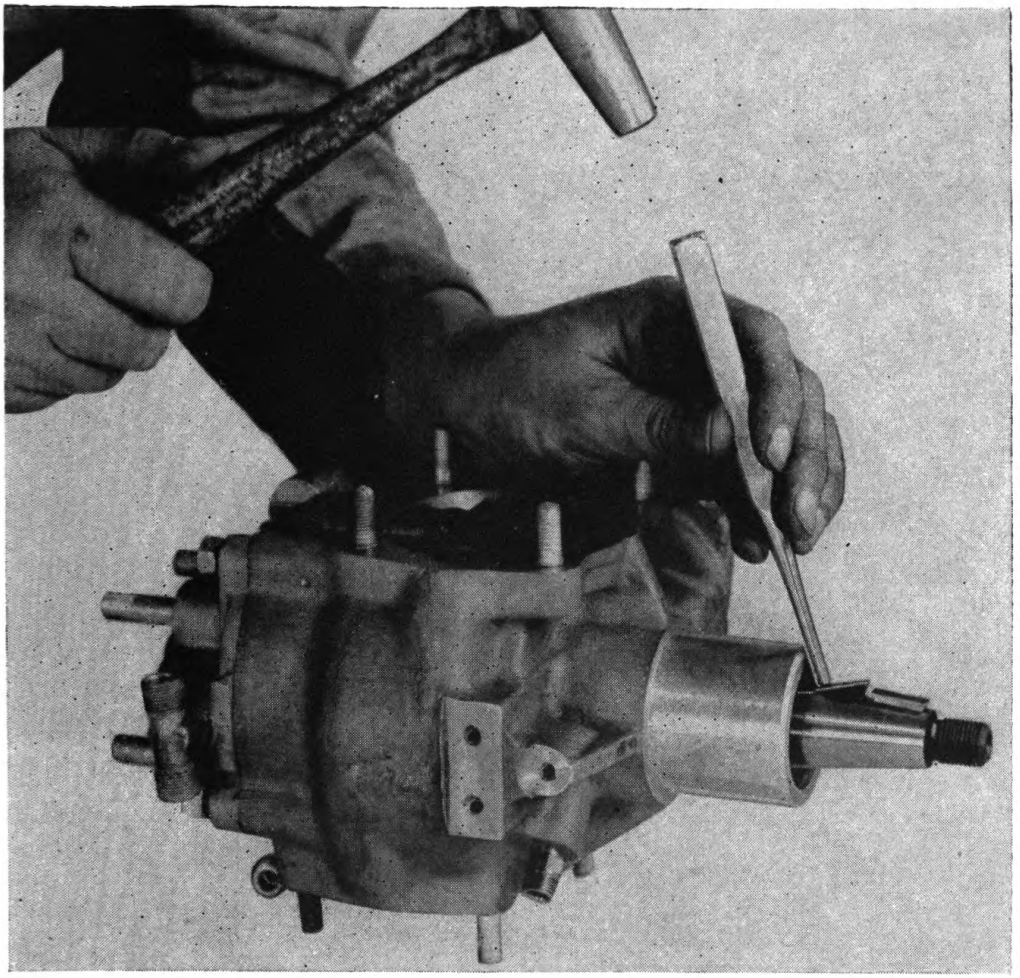


Figure 107. Removing flywheel keys with small flat-end punch and hammer.

(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.

(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. (See fig. 110.) Connecting rod and cap should be assembled with both marks on same side.

(9) Turn crankshaft to bring crankpins to outermost position. Slip connecting-rod cap back of crankpin and around rollers. Place piston and rod assembly in position. Assemble lock plates and screws, making sure both marks are on same side. Tighten connecting-rod screws. Bend two lugs protruding opposite each other on each lock plate down over connecting rod.

(10) (*a*) Connecting rod and cap must be aligned properly. That is, cap must line up perfectly with rod, and both sides must be flush. This is done by turning roller assembly so gap between retainers comes to rest over junction of cap and rod. By sliding a pencil over junction, as shown in figure 111, it is simple to determine whether or not surfaces are flush. If one side or other is high, drive high side down until flush with other as shown in figure 112. Check again with pencil. When

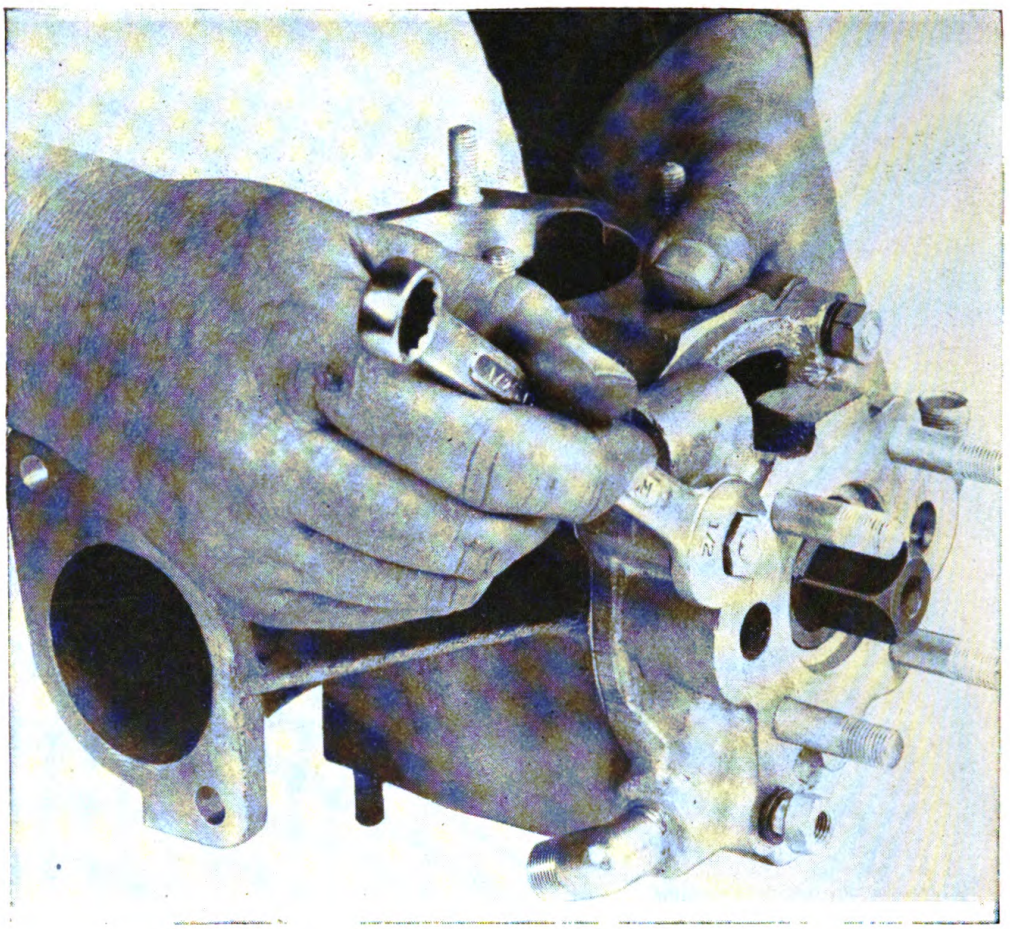


Figure 108. Removing crankcase head.

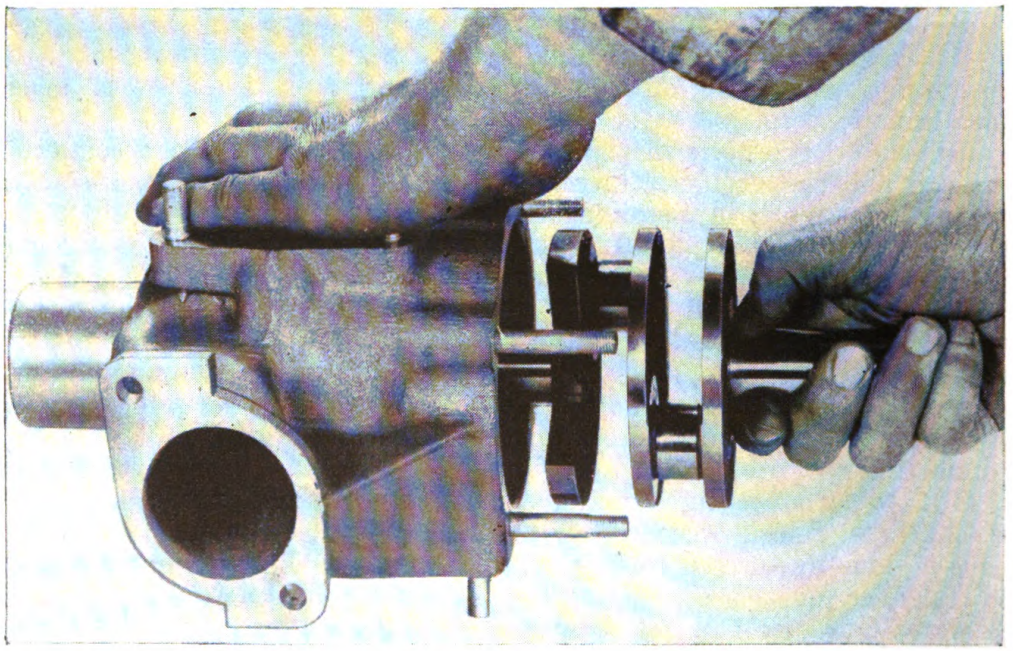


Figure 109. Withdrawing crankshaft.

surfaces are flush, tighten screw and bend remaining protruding lug up and against screw head to lock in position.

(*b*) 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. It is not necessary to cement this gasket. Compress piston rings with fingers as shown in figure 110. Slide cylinder over piston and up to crankcase. To mount cylinder securely, attach necessary washers and nuts and tighten. (See fig. 101.)

i. ASSEMBLE GEAR CASE. (1) Insert ball bearing through top opening in gear case as shown in figure 114. 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 verge of coming out of bearing on propeller end. Insert bevel gear as shown in figure 115. Turn gear around in gear case to permit sliding propeller shaft through hole.

(3) Install Woodruff key in propeller-shaft keyway. 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.

(4) Key must line up with keyway in gear. Push propeller shaft through gear until gear is up against 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 shoulder of shaft. Note small pin protruding at end of bearing seat inside gear case. Drive in propeller shaft, gear, and bearing assembly until bearing comes to rest against this pin.

(5) Install large washer, lock washer, small washer, and nut in order as laid out in figure 113. Tighten nut with fingers for time being.

(6) Slip ball bearing over end of pinion shaft followed by gear, lock washer, plain washer, and nut as shown in figure 113. 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.

(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. (See fig. 116.) Install spacers on long studs; attach nuts and draw down tightly.

(8) Place gear-case assembly in vice (fig. 116) 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 one-fourth turn. Strike end of propeller shaft with mallet (fig. 117) 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

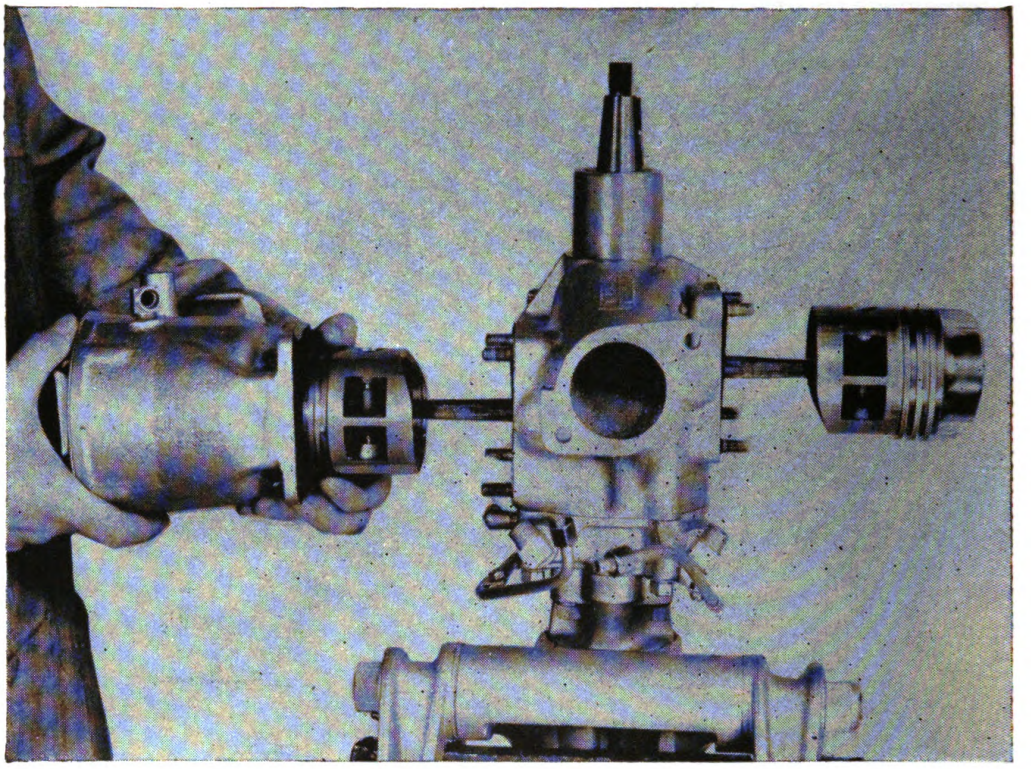


Figure 110. Attaching cylinders to crankcase.

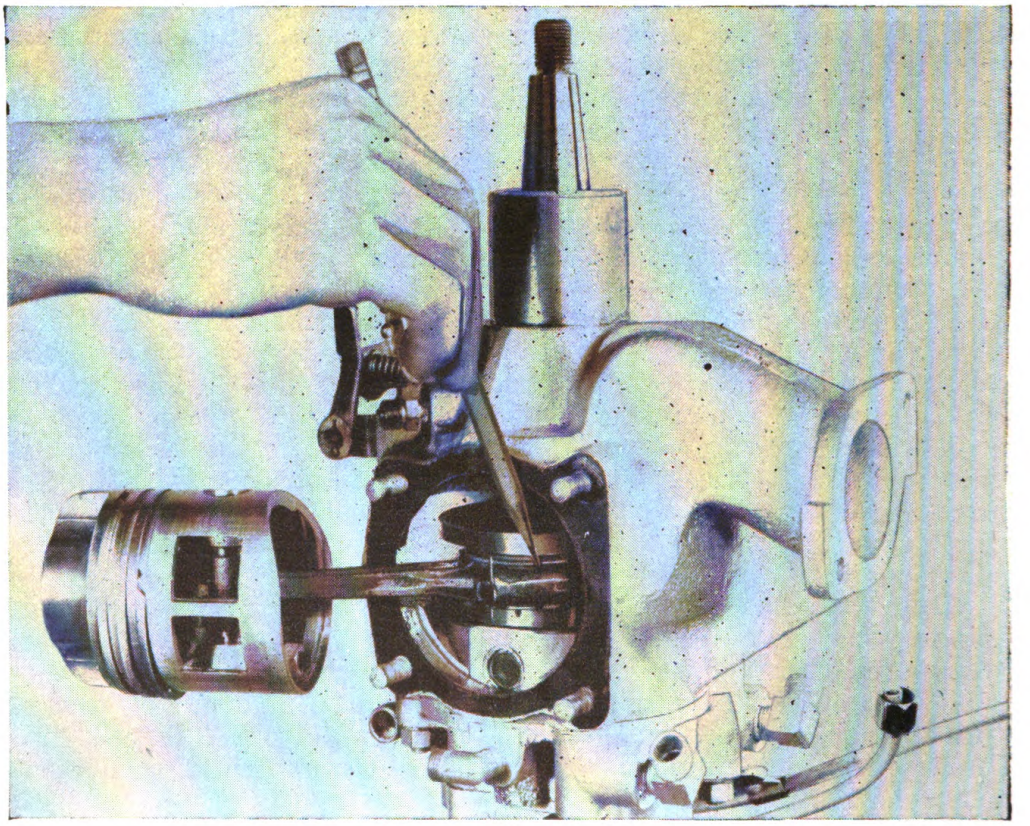


Figure 111. Testing rod and cap alignment to determine that surfaces are flush.

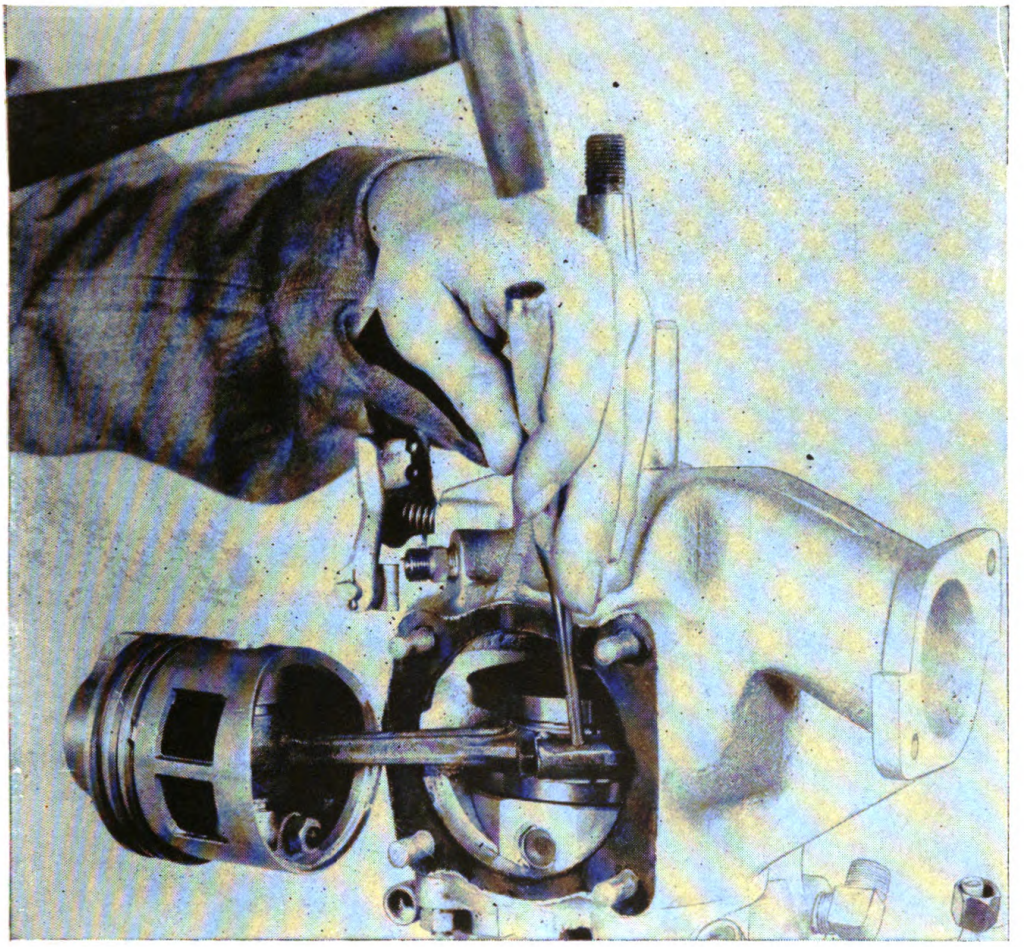


Figure 112. Aligning rod and cap by forcing high side down until flush with other side.

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.

(11) Install gasket, gearcase head, and gearcase head bolt. (See fig. 119.)

(12) (*a*) Remove spacers, install gasket and thrust washer (fig. 118). Attach gearcase assembly to motor. Be sure all nuts are tight. Fill gearcase with gear lubricant.

(*b*) To disassemble gearcase, proceed in reverse order of that described above. Wash gear lubricant from parts and from gearcase to inspect them.

j. Install Journal Bearings. (1) The journal bearings on model POLR–15 seldom require replacing. While appearing to be loose when compared to similar bearings in automotive use, they are fitted with considerable clearance at factory to provide sufficient lubrication. No noticeable crankcase compression is lost under these conditions and bearings need replacing only when clearance has reached point where oil from crankcase begins to smear on magneto armature plate.

(2) To install new crankshaft journal bearings, old bearings must be removed. This is done on an arbor press, as illustrated in figure 120.

1	PROPELLER SHAFT	10	LOCK NUT (BEARING)
2	PROPELLER SHAFT KEY	11	PINION SHAFT
3	BEVEL GEAR	12	BALL (THRUST) BEARING
4	BALL (THRUST) BEARING	13	PINION GEAR
5	WASHER	14	LOCKWASHER
6	LOCKWASHER	15	WASHER
7	WASHER	16	NUT
8	NUT	17	THRUST WASHER
9	RETAINER		

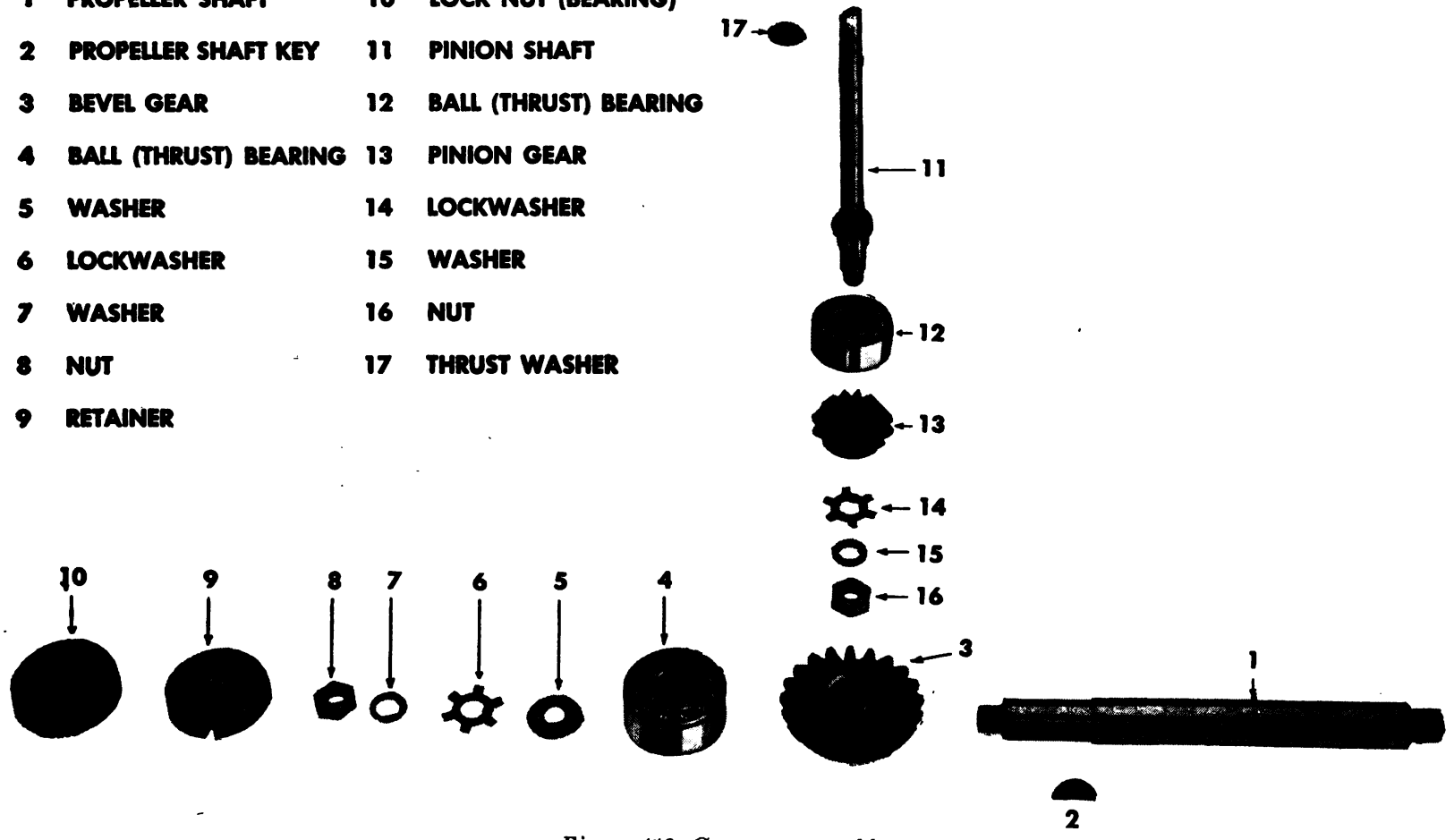


Figure 113. Gearcase assembly.

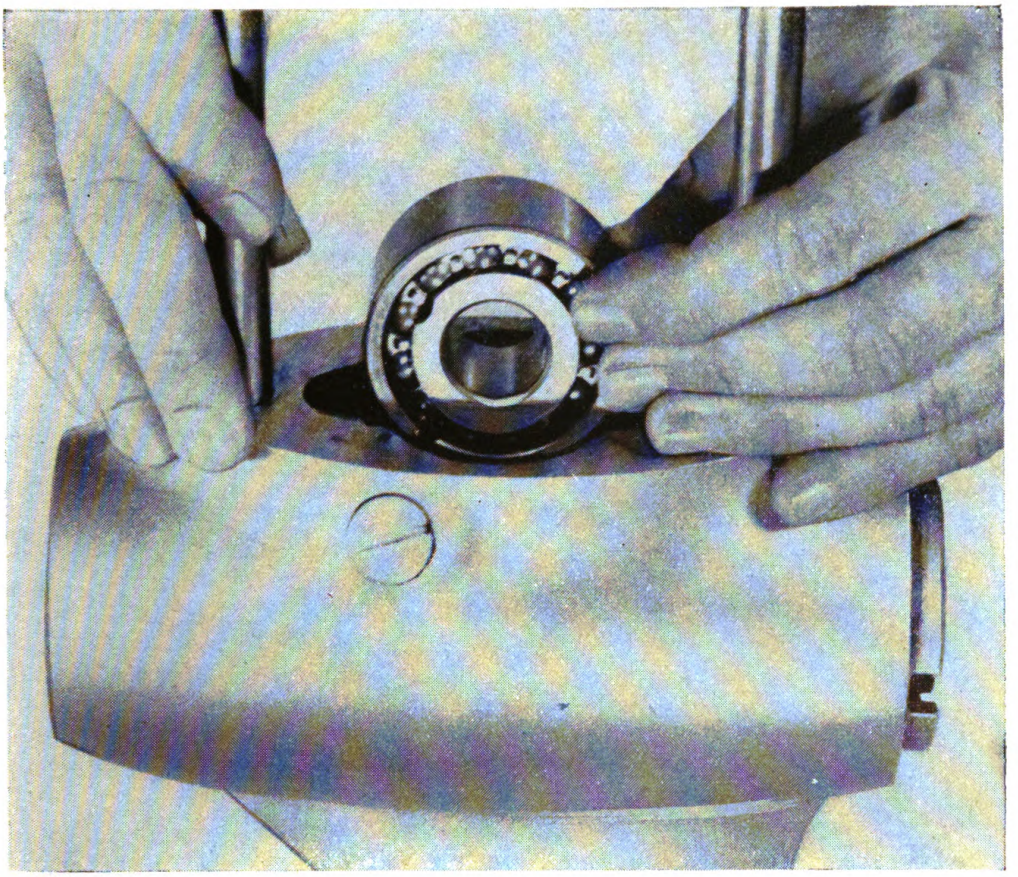


Figure 114. Inserting ball bearing in gearcase.

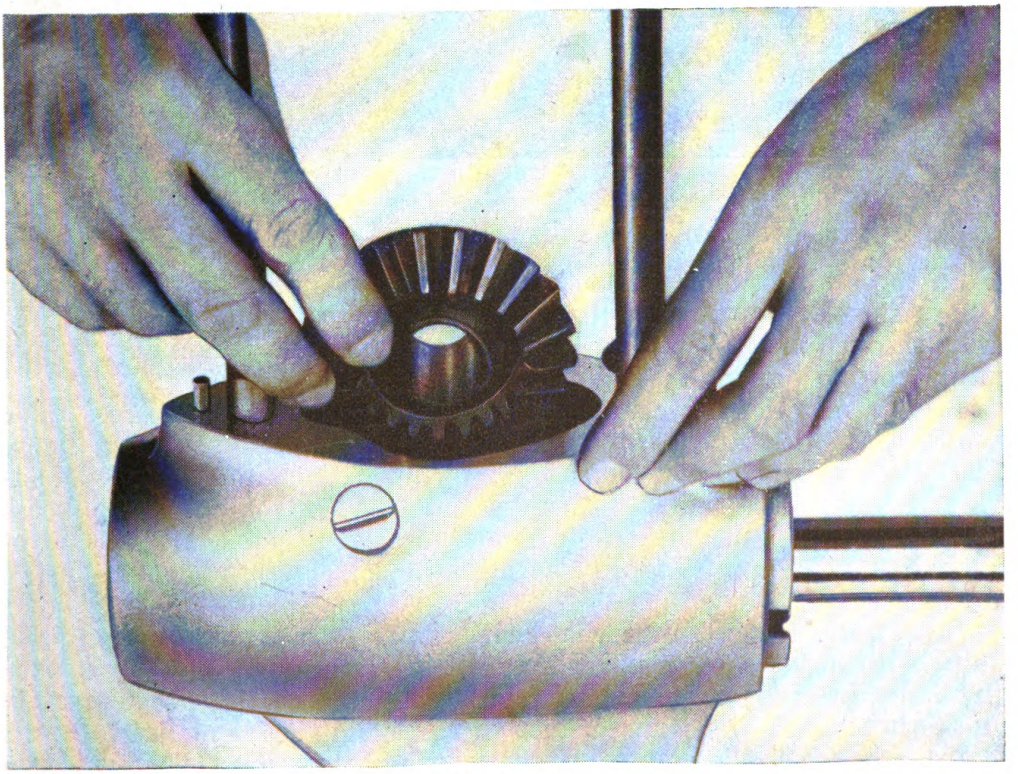


Figure 115. Inserting bevel gear in gearcase.

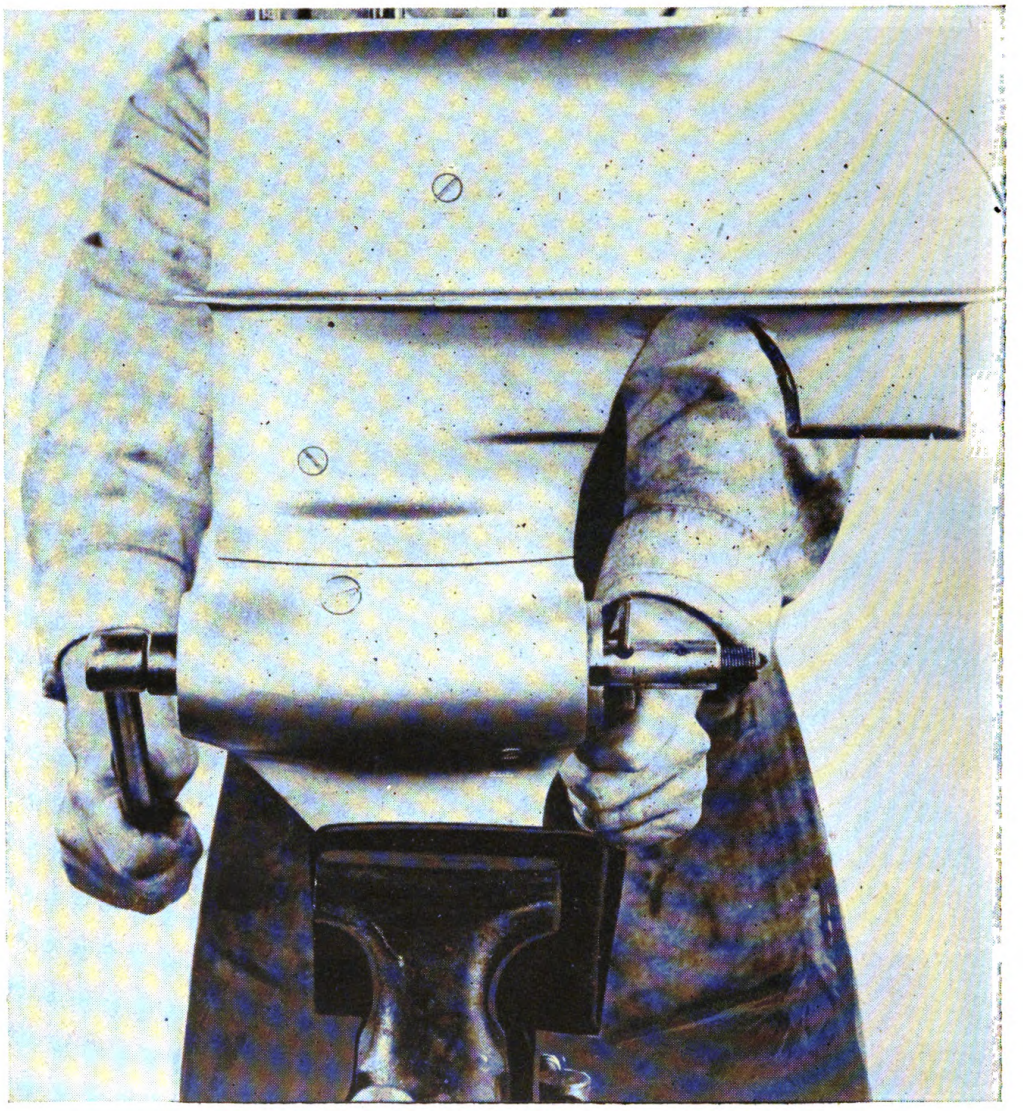


Figure 116. Gearcase assembly held in vice when tightening propeller-shaft nut.

Both top and bottom bearings are pressed out similarly. Use a round bar or mandrel slightly smaller than bearing to permit driving all the way through bearing bosses. Top bearing fits into crankcase proper while bottom bearing is pressed into the crankcase head.

(3) To install new top, bearing crankcase is placed on press table with bearing boss up in opposite position from that shown in figure 120. Bottom end of top bearing is machined to match contour of inside of crankcase. Line up bearing with respect to contour of crankcase and press into case until bottom of bearing is flush with inside of crankcase. Note position of old bearing before pressing it out to install a new one.

(4) 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.

(5) After installing new journal bearings they must be reamed to

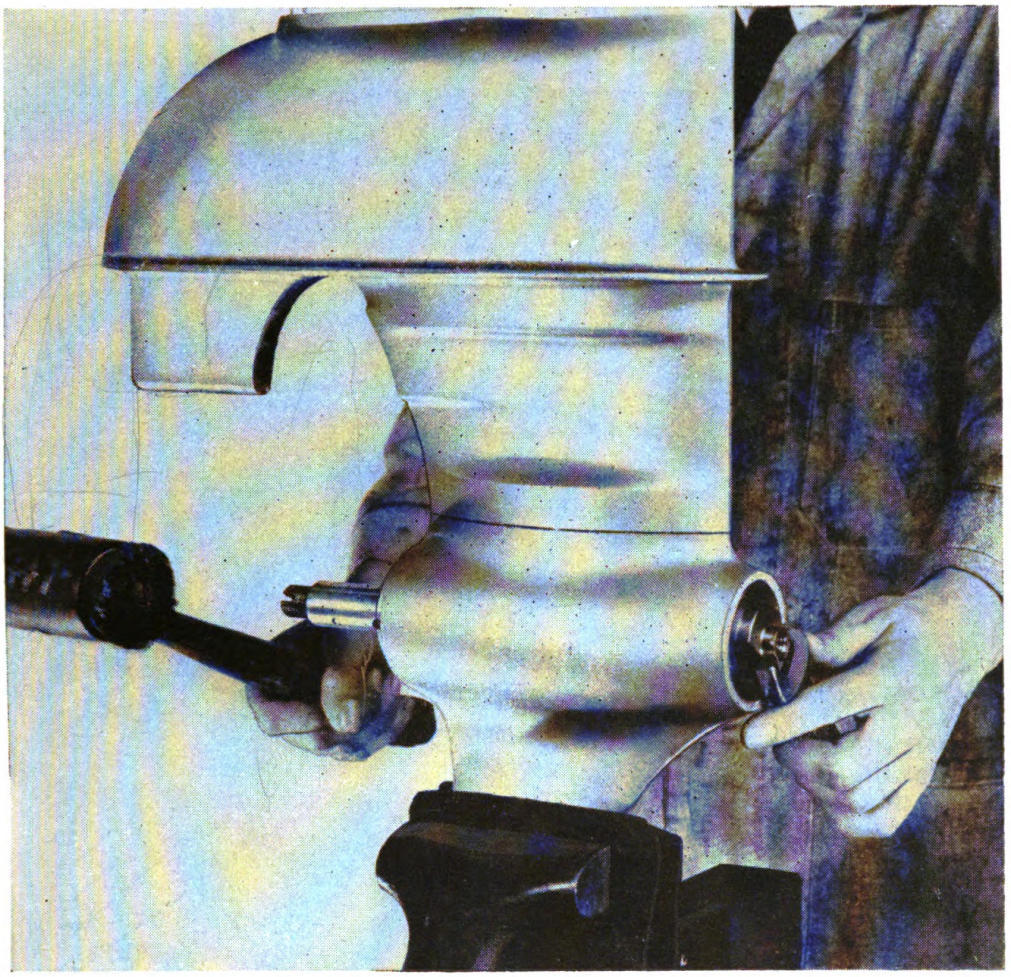
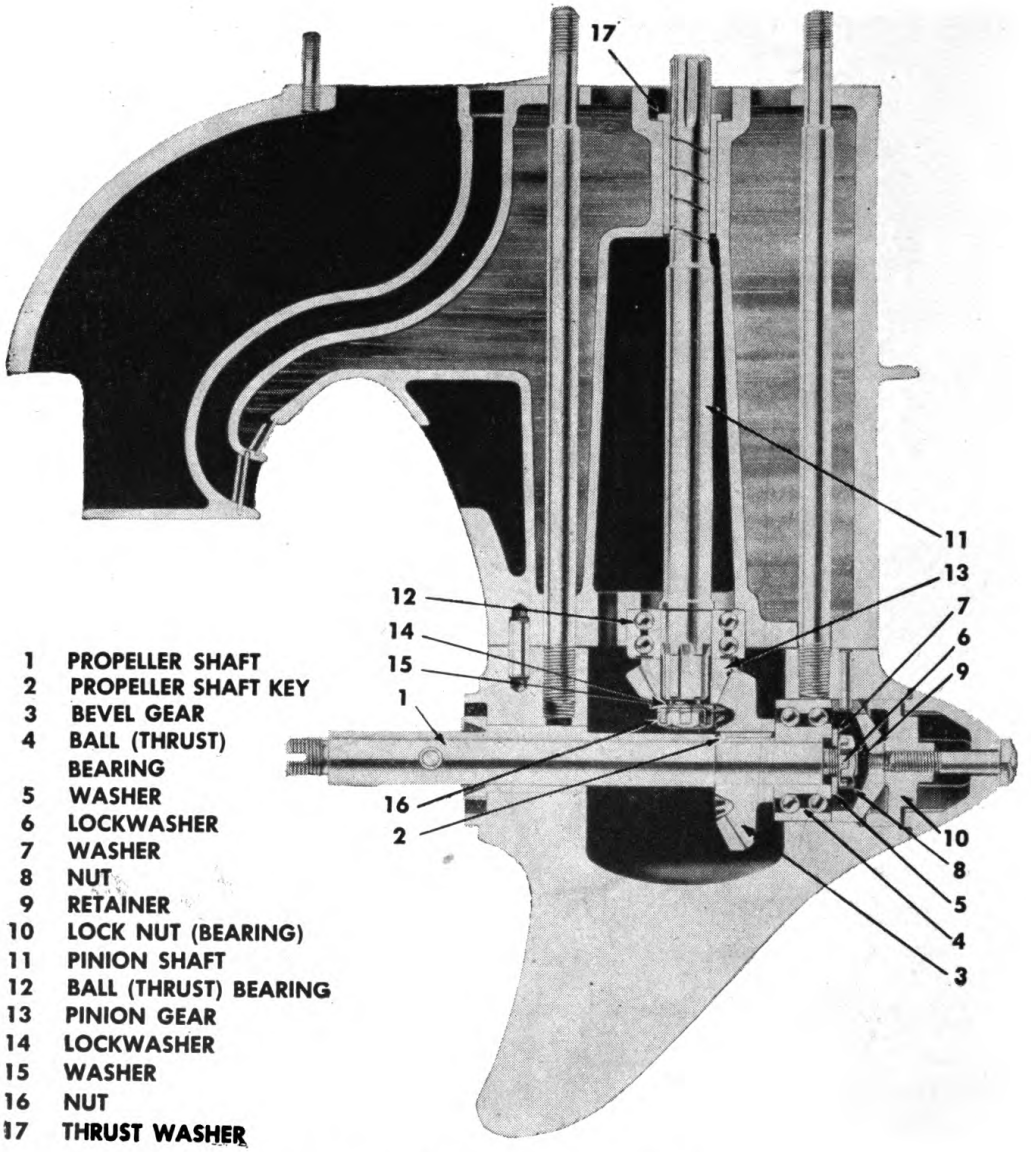


Figure 117. Driving out end of propeller shaft to obtain necessary clearance.

size; top bearing 1.002 inches, bottom bearing 1.042 inches. This permits clearance of .003 inch at top and bottom journals, since they are ground to .999 inch and 1.039 inches, respectively.

(6) To ream bearings, attach crankcase head. Place crankcase assembly in vice as shown in figure 121. Use wood blocks to prevent injury to studs. Two reamers are used in this operation, 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 clockwise, facing bottom bearing. (See fig. 121.) Reamers are provided with two cutters, one for each bearing. Turn reamer, at same time forcing it gently forward until cutters pass through bearing. Withdraw reamer slowly with clockwise turning motion. Insert finish line reamer and proceed in like manner. The bearing now should be reamed to correct size and ready for assembly of the motor.



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

Figure 118. Gearcase assembly.

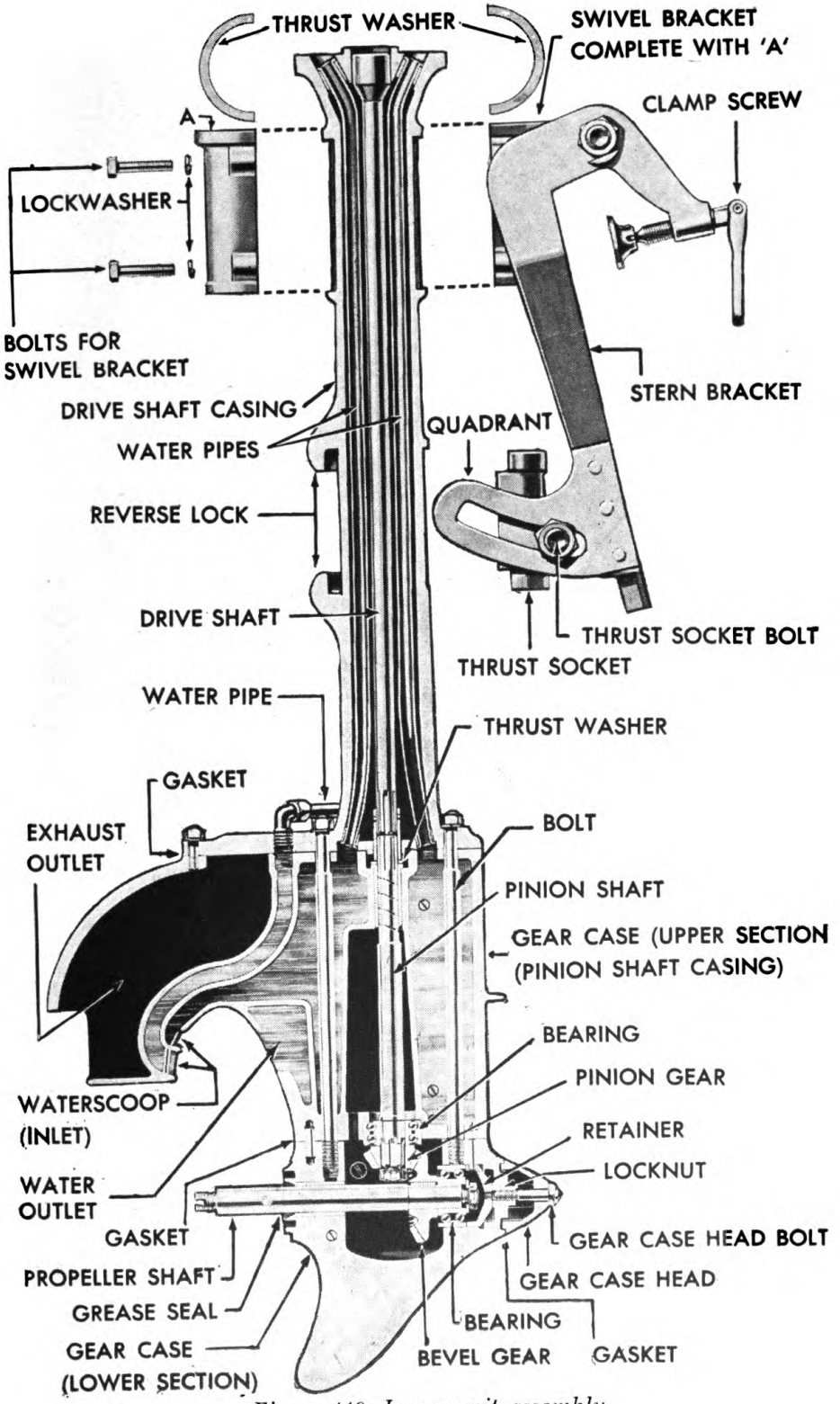


Figure 119. Lower-unit assembly.

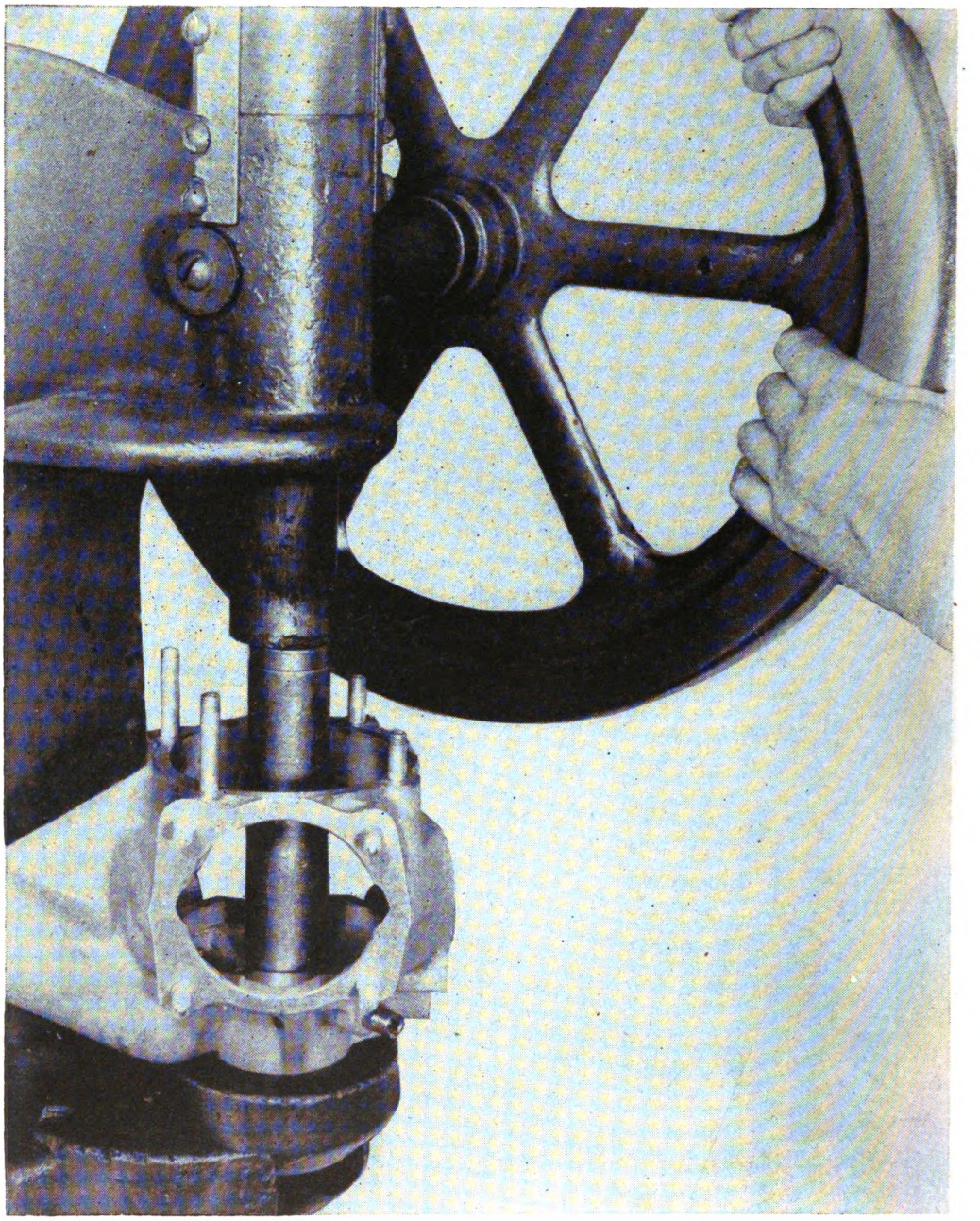


Figure 120. Pressing out bearing.

k. INSTALL BUSHING IN GEAR CASE. (1) Since the gear case has one bushing (propeller-shaft bearing) and one ball bearing (propeller-shaft thrust bearing), only one reaming operation is required when replacing propeller-shaft bearing. The ball bearing is removed and replaced as a unit. (See figs. 113 and 118.)

(2) To install a new propeller-shaft bearing or bushing the old one must be removed. This can be done by driving it out on an arbor press as in removing journal bearings. Place gear case on table of press with bushing downward, opposite from position shown in figure 122. Use round bar or mandrel slightly smaller than bushing to permit driving

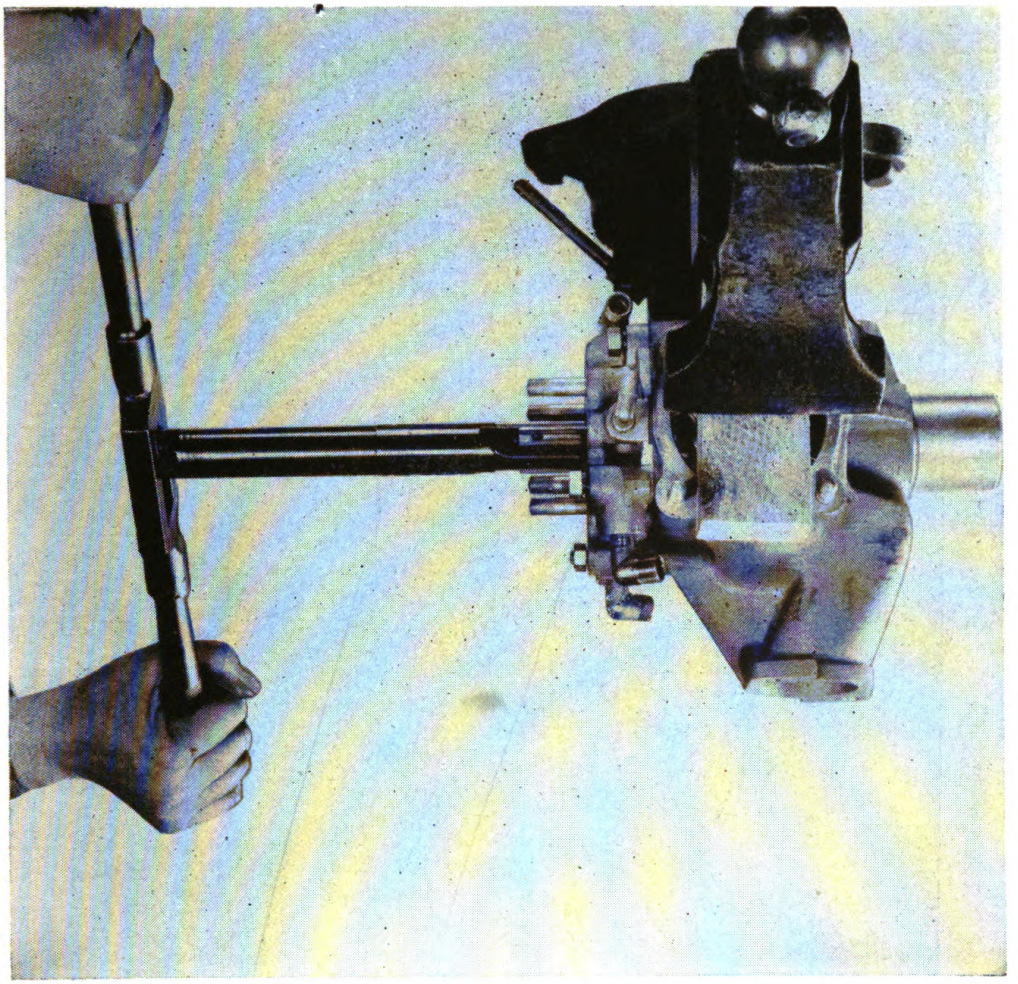


Figure 121. Reaming bearing.

all the way out. Install new bushing. Drive bushing down until shoulder rests firmly against gear case.

(3) Ream bearing to size .875 inch as shown in figure 123. Use reamer No. S–94. Place gear case in vice. Note large pilot on right side of gear case. Insert reamer, pilot on reamer in propeller-shaft bearing, 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 same time forcing gently forward until cutter passes through bearing. Withdraw reamer slowly with same turning motion.

l. Install Bearing in Pinion-shaft Casing. (1) The pinion-shaft casing, like the gear case, has one bushing and one ball bearing. Consequently, only one reaming operation is necessary to install new bearing. 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. (See figs. 113 and 118.)

(2) To drive out top bushing, place pinion-shaft case on table of press as shown in figure 124. 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 side up. Press in new bushing until thrust face rests solidly against casing.

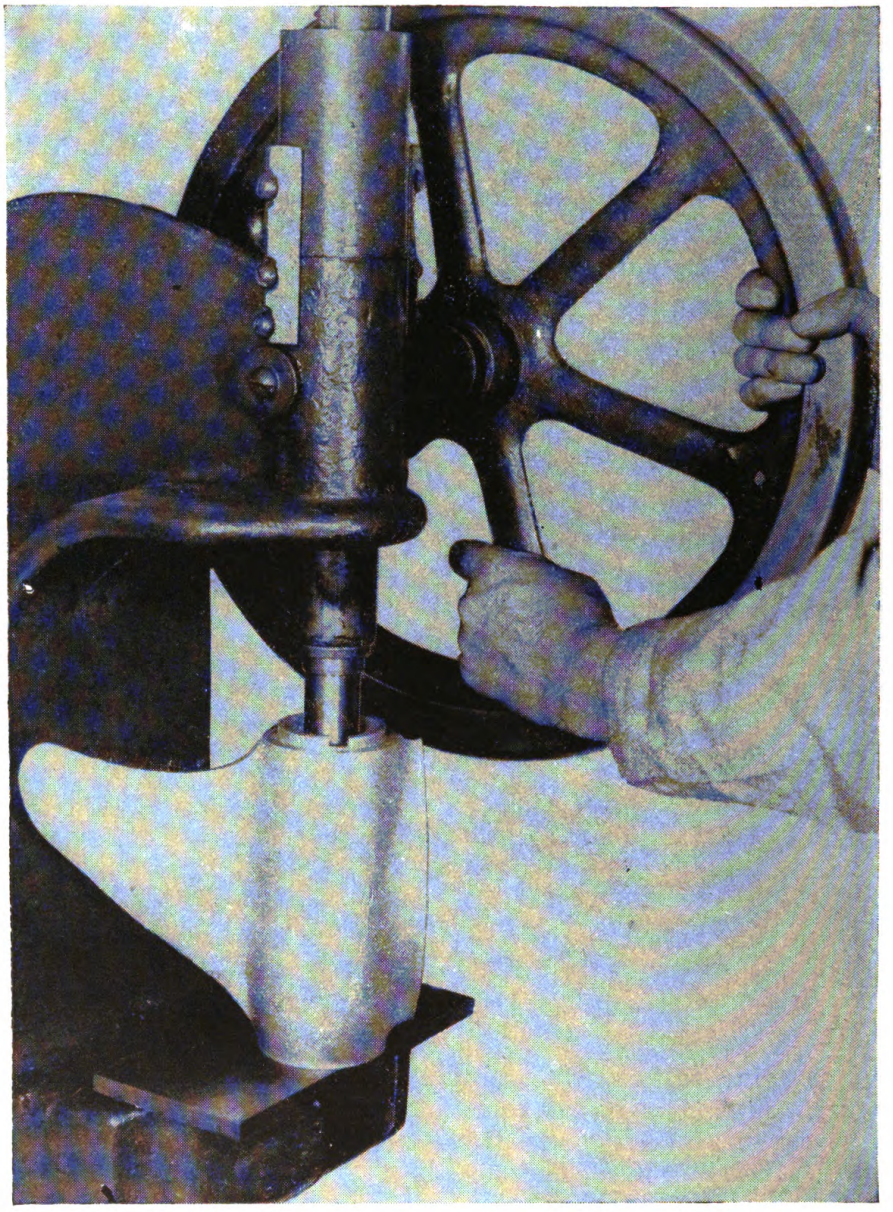


Figure 122. Installing bushing in gearcase.

(3) Place casing in vice to ream bearing as illustrated in figure 125. Ream to size .625 inch with reamer No. S–95, in manner similar to reaming propeller-shaft bearing.

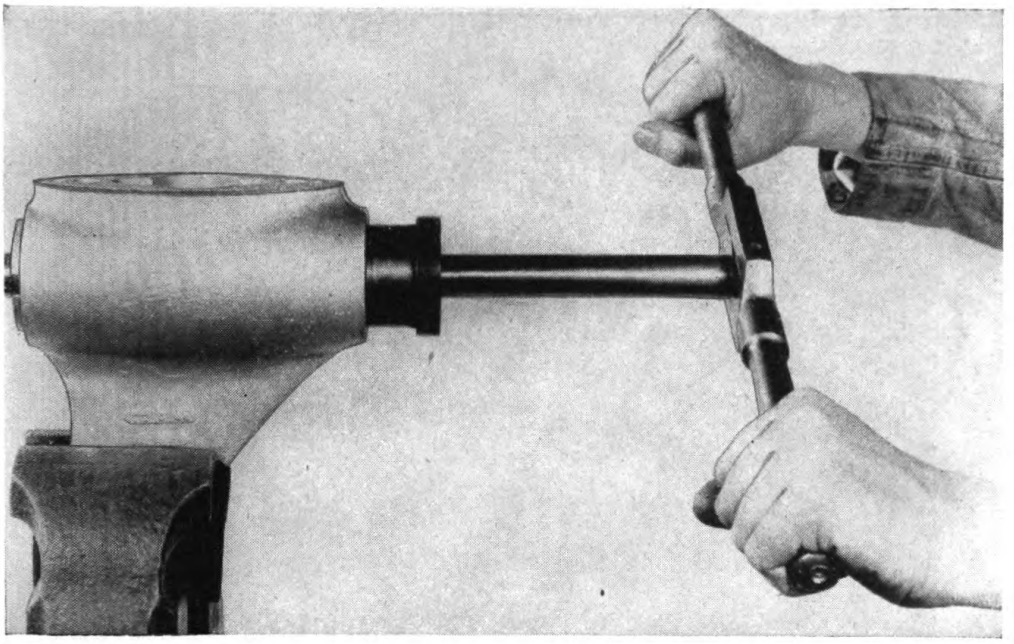


Figure 123. Reaming gearcase bearing.

25. Recommended Tools

2 screw drivers, one 8-inch and one 10-inch.
1 riveting hammer, medium size. ¾-pound.
2 pin punches, 5/32–6/32.
1 plier, 6-inch.
1 needle-nose plier, 6-inch.
1 tee-handle screw driver, large.
1 speed handle for sockets, ½-inch shank.
1 L-handle, ½-inch shank.
1 7/16-inch socket, ½-inch shank opening.
1 ½-inch socket, ½-inch shank opening.
1 9/16-inch socket, ½-inch shank opening.
1 ¾-inch socket, ½-inch shank opening.
1 adjustable (10-inch crescent) wrench.
1 open-end wrench, ½- by 9/16-inch.
1 open-end wrench, ⅜- by 7/16-inch.
1 open-end wrench, 7/16- by 7/16-inch, box on one end.
1 open-end wrench, 9/16-inch at 45°; other end 9/16-inch at 90°.
1 open-end wrench, ⅝-inch; one end box, ⅝-inch.
1 large rawhide hammer.
1 small rawhide mallet.
1 ½-inch brass rod 8 inches long, for removing propeller shaft.

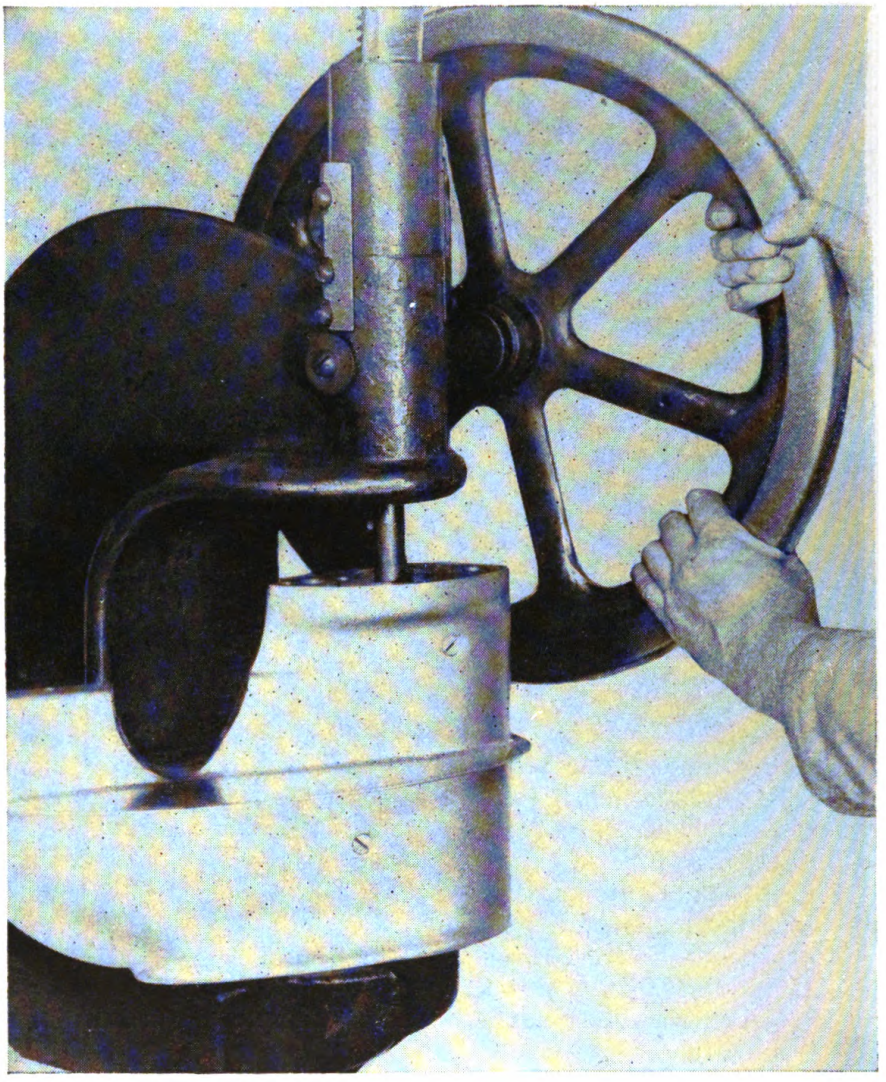


Figure 124. Driving out bearing in pinion-shaft casing.

Table V. Table of tolerances POLR–15

	Inches	*Tolerances in inches*
Cylinder diameter	2.750	Plus .0005; minus .0005.
Clearance in cylinder at top	.0115	
Clearance in cylinder at bottom	.0055	
Piston tolerances		
Piston diameter at top land	2.7385	Plus .0000; minus .0005.
Piston diameter at bottom land	2.7445	Plus .0000; minus .0005.
Piston ring		
Piston-ring diameter	2.750	
Width of ring	.125	Plus .0000; minus .0005.
Crankshaft tolerances		
Top journal	.999	Plus .0000; minus .0005.
Bottom journal	1.039	Plus .0000; minus .0005.
Connecting-rod pin	.9985	Plus .0000; minus .0005.

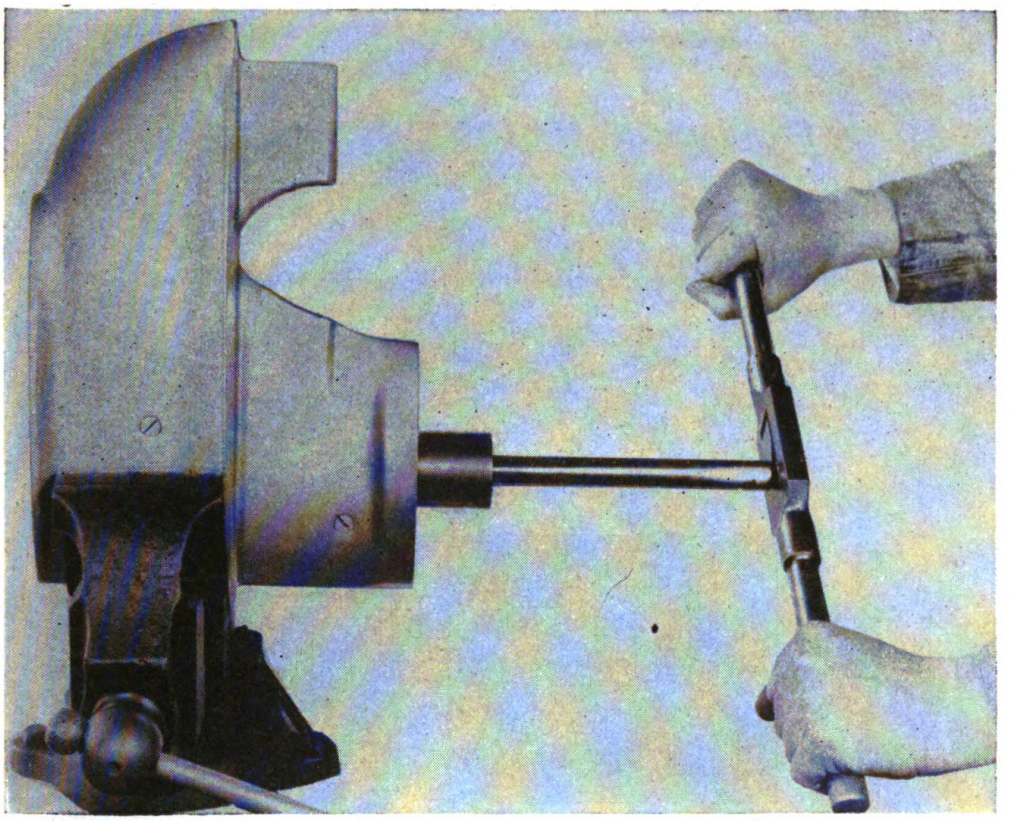


Figure 125. Reaming pinion-shaft bearing.

APPENDIX I

STORM-BOAT MOTOR ILLUSTRATIONS

(Evinrude Model 8008)

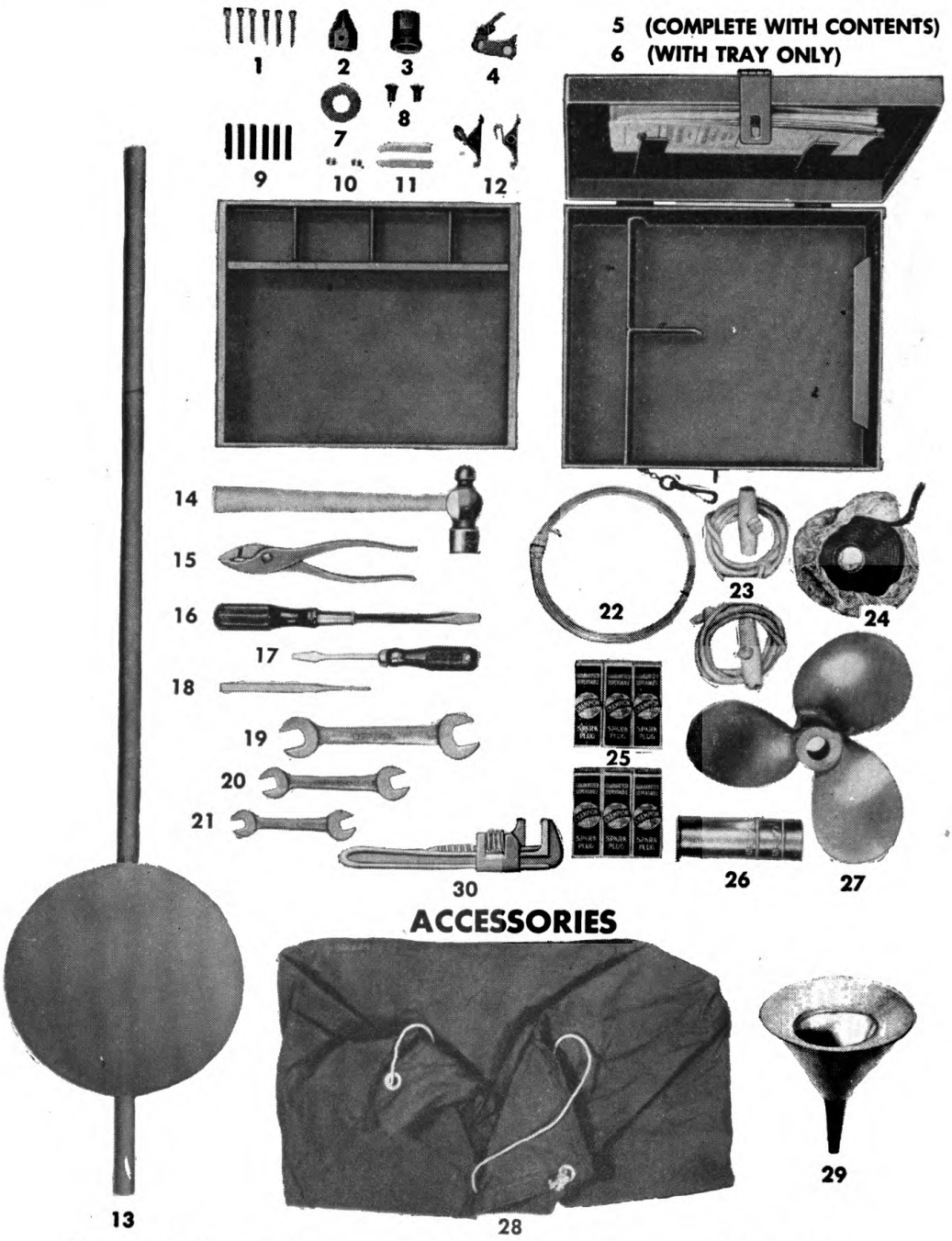


Figure 126. Operator's emergency kit. (Tools and accessories are listed at end of parts section.)

Key to figure 126.

No.	*Part No.*	*Nomenclature*
1	120,223	Propeller nut cotterpin.
2	130,295	Propeller nut.
3	201,043	Crankshaft nut.
4	275,786	Breaker plate assembly.
5	275,800	Operator's emergency kit, complete with contents.
6	275,801	Operator's emergency kit, with tray only.
7	201,131	Propeller nut washer.
8	201,036	Starter drum screw.
9	131,133	Propeller shear pin.
10	130,314	Grease plug.
11	201,236	Feeler gauge.
12	275,785	Breaker arm.
13	275,803	Carrying handle and paddle.
14	275,778	Ball peen hammer, 1 pound.
15	275,776	Pliers, 8-inch.
16	275,777	Screw driver, 10-inch.
17	194,046	Screw driver, 3½-inch.
18	201,111	Drift punch, $\frac{3}{16}$-inch.
19	160,153	Open-end wrench, ¾- by 1-inch.
20	160,152	Open-end wrench, $\frac{9}{16}$- by ⅝-inch.
21	160,151	Open-end wrench, $\frac{7}{16}$- by ½-inch.
22	201,113	Coil No. 16 galvanized steel wire.
23	275,655	Starter-rope assembly.
24	201,112	Roll friction tape, ¾-inch.
25	275,875	Spark plug, Champion, R7.
26	200,258	Oil measuring cup.
27	201,157	Propeller.
28	275,811	Canvas motor cover.
29	275,851	Filtering funnel.
30	190,154	Monkey wrench.

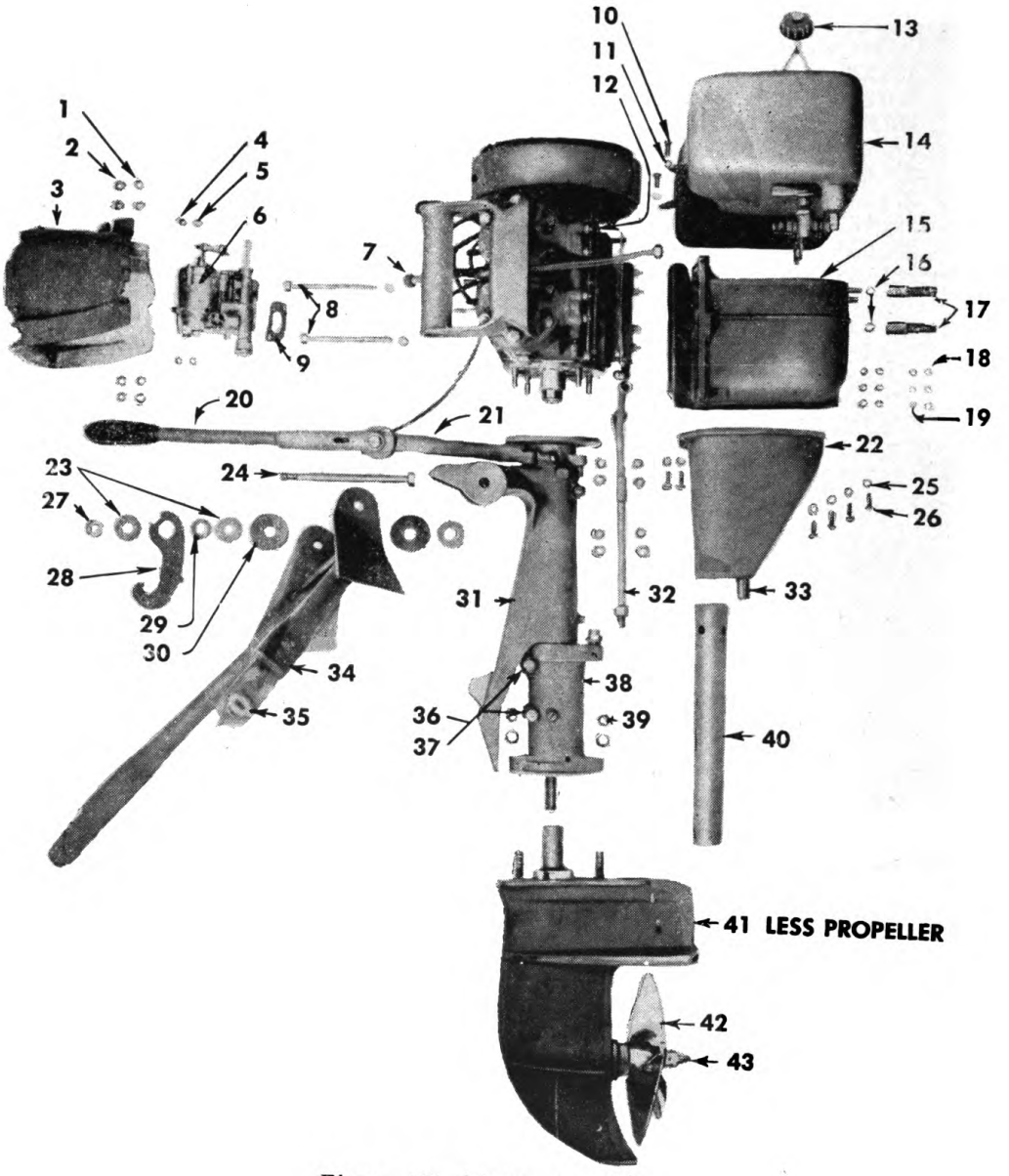


Figure 127. Motor assembly.

Key to figure 127.

No.	*Part No.*	*Nomenclature*
1	120,177	Lockwasher, ⅜ ID by ⅛ W by $\frac{5}{32}$-inch Th.
2	130,202	Nut, ⅜-inch.
3	275,802	Motor cover assembly.
4	130,162	Nut, $\frac{5}{16}$-inch.
5	120,255	Lockwasher, $\frac{5}{16}$ ID by $\frac{3}{32}$ W by $\frac{3}{32}$ Th.
6	275,726	Carburetor assembly.
7	275,798	Gasoline-pipe assembly.
8	275,885	Muffler stud and nut assembly.
9	201,047	Carburetor gasket.
10	131,254	Gasoline-tank screw, $\frac{5}{16}$-inch.
11	120,255	Lockwasher, $\frac{5}{16}$ ID by $\frac{3}{32}$ W by $\frac{3}{32}$ Th.
12	201,044	Muffler gasket.
13	275,475	Filler-cap assembly.
14	275,723	Gas-tank assembly.
15	275,781	Muffler and plug assembly, upper.
16	120,061	Lockwasher, ⅜ ID by ⅛ W by $\frac{1}{16}$ Th.
17	132,832	Muffler-extension stud.
18	130,162	Nut, $\frac{5}{16}$-inch.
19	120,255	Lockwasher, $\frac{5}{16}$ ID by $\frac{3}{32}$ W by $\frac{3}{32}$ Th.
20	275,788	Steering-handle assembly.
21	275,824	Steering-handle-support assembly.
22	275,782	Muffler and plug assembly, lower.
23	120,908	Tilting-bolt washer, ⅝-inch.
24	201,155	Tilting bolt.
25	120,255	Lockwasher, $\frac{5}{16}$ ID by $\frac{3}{32}$ W by $\frac{3}{32}$ Th.
26	131,424	Muffler screw, $\frac{5}{16}$-inch.
27	130,084	Tilting-bolt nut.
28	275,830	Tilt-up hook assembly.
29	201,191	Tilt-up hook washer.
30	201,156	Pivot-bearing friction washer.
31	275,819	Pivot-bearing assembly.
32	275,797	Water-pipe assembly.
33	275,722	Muffler overflow pipe assembly.
34	275,826	Bipod assembly complete.
35	201,160	Fulcrum pin.
36	131,981	Drive-shaft housing clamp screw.
37	120,574	Washer.
38	275,825	Drive-shaft housing assembly.
39	131,484	Gear housing flange stud nut.
40	201,142	Muffler tube.
41	275,822	Gear-housing assembly.
42	201,157	Propeller.
43	130,295	Propeller nut.

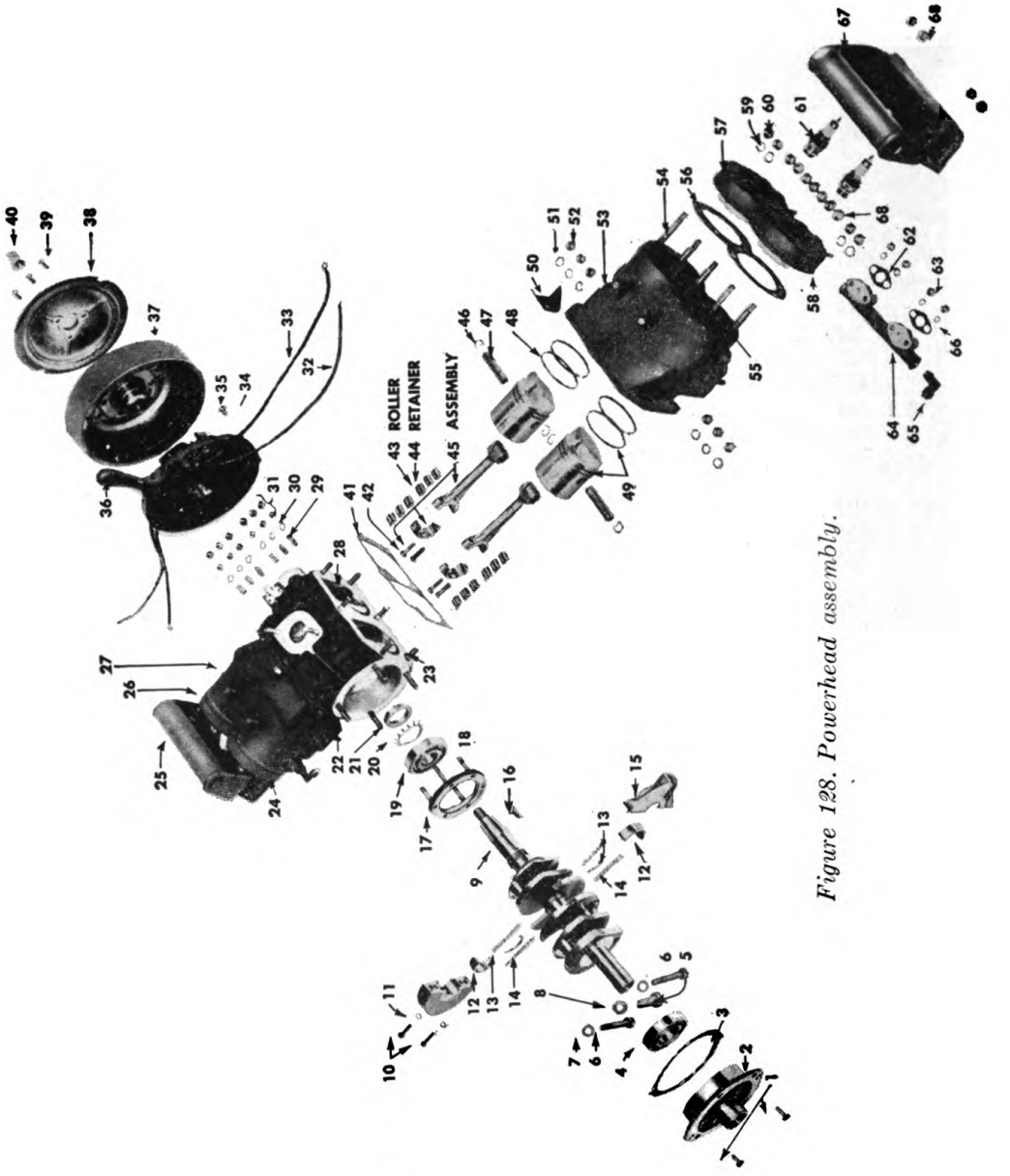


Figure 128. Powerhead assembly.

Key to figure 128.

No.	*Part No.*	*Nomenclature*
1	130,524	Crankcase lower bearing screw.
2	100,680	Crankshaft bearing, lower.
3	170,418	Crankcase gasket, $\frac{1}{64}$-inch.
4	191,446	Crankshaft ball bearing assembly, lower.
5	201,030	Center bearing locating dowel screw.
6	201,029	Center-bearing screw.
7	120,061	Lockwasher, ¼ ID by $\frac{5}{64}$ W by $\frac{1}{16}$ Th.
8	170,753	Center bearing locating dowel screw gasket.
9	275,709	Crankshaft and bushing.
10	131,888	Center-bearing screw.
11	120,042	Center-bearing-screw lockwasher.
12	201,196	Center bearing roller bearing retainer.
13	101,897	Center-bearing seal.
14	132,803	Center-bearing roller.
15	275,850	Crankshaft center bearing assembly.
16	120,658	Flywheel key.

Key to figure 128—Continued.

No.	*Part No.*	*Nomenclature*
17	191,449	Crankshaft ball bearing clamp ring and stud assembly.
18	131,919	Crankshaft clamp ring stud.
19	192,632	Crankshaft ball bearing assembly, upper.
20	120,579	Crankshaft lock nut lockwasher.
21	131,868	Crankshaft lock nut.
22	130,791	Driveshaft tube flange stud.
23	130,282	Cylinder stud.
24	275,718	Cylinder head and plug assembly.
25	275,884	Spark plug cover and carrying handle socket assembly, L. H.
26	275,719	Cylinder head and plug assembly, L. H. upper or R. H. lower.
27	275,716	Cylinder and stud assembly, L. H.
28	275,827	Crankcase and stud assembly.
29	131,869	Crankshaft ball bearing adjusting screw.
30	120,265	Crankshaft clamp ring stud nut washer.
31	130,690	Crankshaft clamp ring stud.
32	275,745	High-tension cable, short.
33	275,744	High-tension cable, long.
34	275,743	Armature base complete.
35	133,453	Armature hold-down screw.
36	201,062	Armature handle.
37	275,742	Flywheel assembly.
38	201,082	Starter drum.
39	201,036	Starter-drum screw.
40	201,043	Crankshaft nut.
41	170,755	Cylinder gasket.
42	130,790	Connecting-rod screw.
43	131,300	Connecting-rod roller.
44	120,582	Connecting-rod-roller retainer.
45	194,480	Connecting-rod assembly.
46	120,011	Piston-pin spring ring.
47	130,789	Piston pin.
48	100,801	Piston ring.
49	275,747	Piston and rings.
50	201,077	Armature-base stop.
51	120,177	Lockwasher, $\frac{3}{8}$ ID by $\frac{1}{8}$ W by $\frac{3}{32}$ Th.
52	130,202	Nut, $\frac{3}{8}$-inch.
53	275,714	Cylinder and stud assembly, R. H.
54	201,032	Cylinder-head stud, long.
55	132,565	Cylinder-head stud, short.
56	171,102	Cylinder-head gasket.
57	275,718	Cylinder head and plug assembly, R. H. upper or L. H. lower.
58	275,719	Cylinder head and plug assembly, L. H. upper or R. H. lower.
59	120,025	Cylinder-head stud-nut washer.
60	130,202	Nut, $\frac{3}{8}$-inch.
61	275,875	Spark plug, Champion, R7.
62	171,109	Inlet water manifold gasket.
63	130,201	Inlet water manifold stud nut.
64	201,081	Inlet water manifold, L. H.
65	101,160	Inlet water elbow.
66	120,054	Lockwasher, $\frac{1}{4}$ ID by $\frac{5}{64}$ W by $\frac{1}{16}$ Th.
67	201,084	Spark-plug cover and carrying-handle socket, R. H.
68	130,202	Nut, $\frac{3}{8}$-inch.

MAGNETO—ARMATURE PLATE

(TOP VIEW)

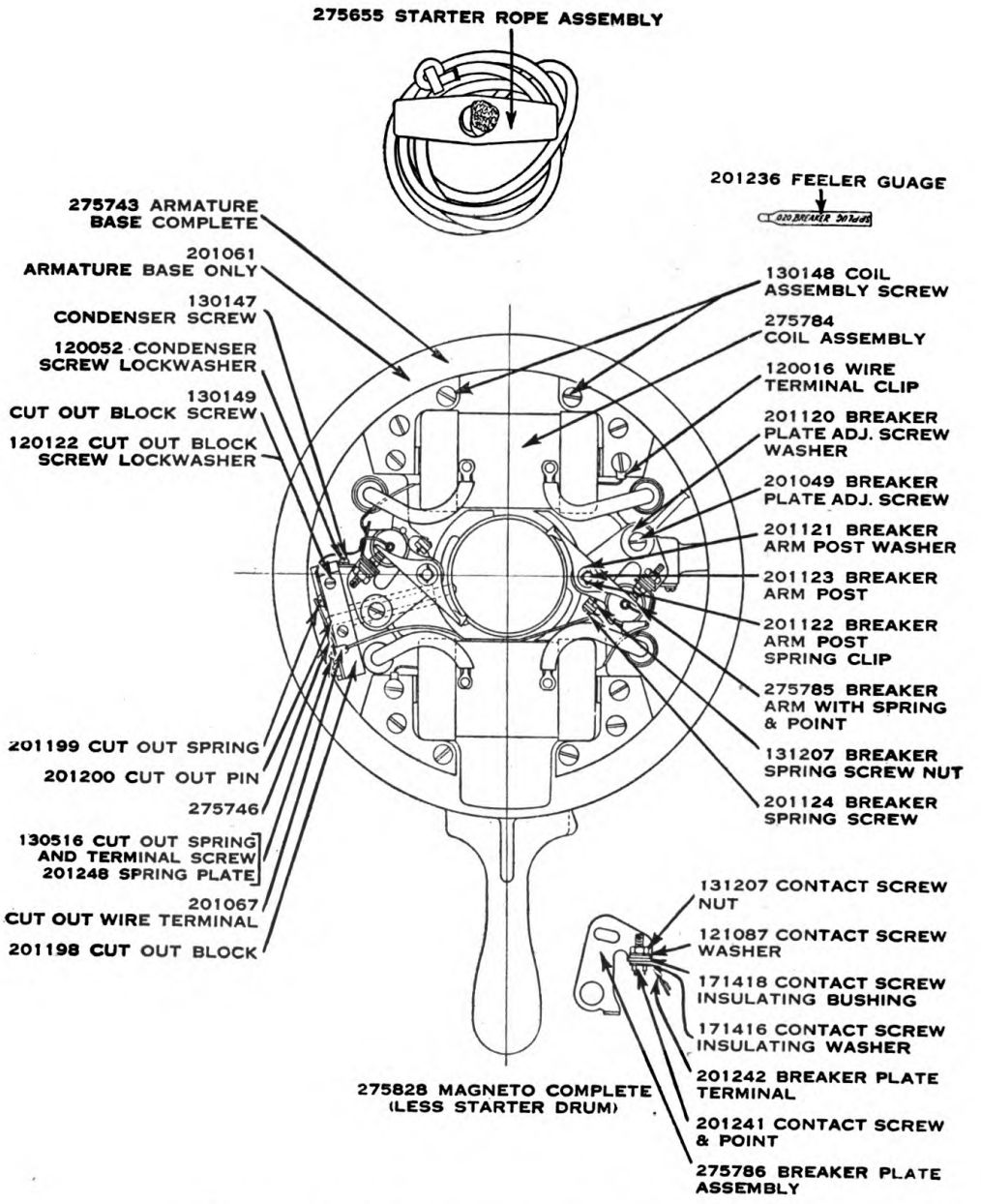


Figure 129. Magneto, armature plate—top view.

MAGNETO—ARMATURE PLATE

(BOTTOM VIEW)

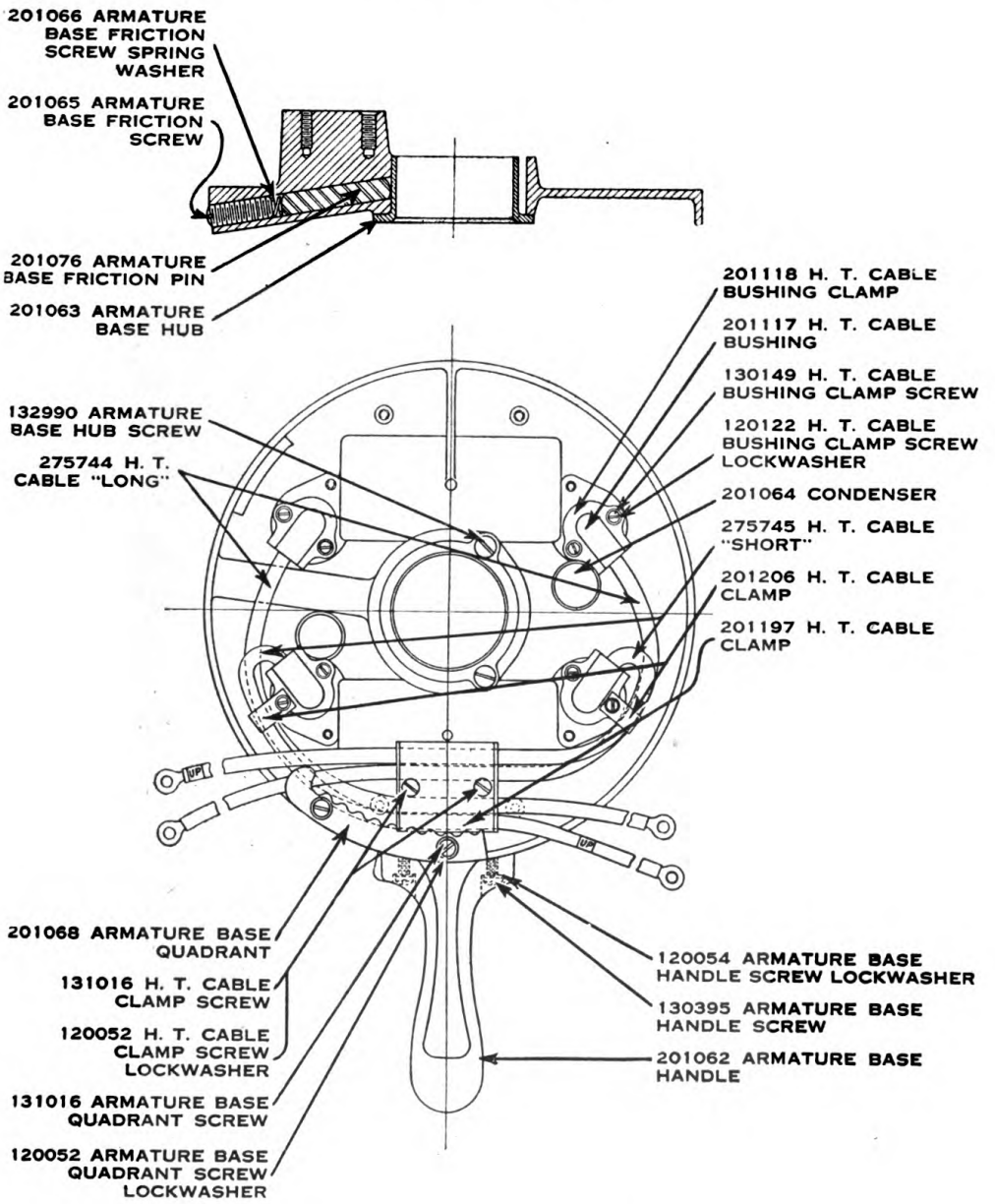


Figure 130. Magneto, armature plate—bottom view.

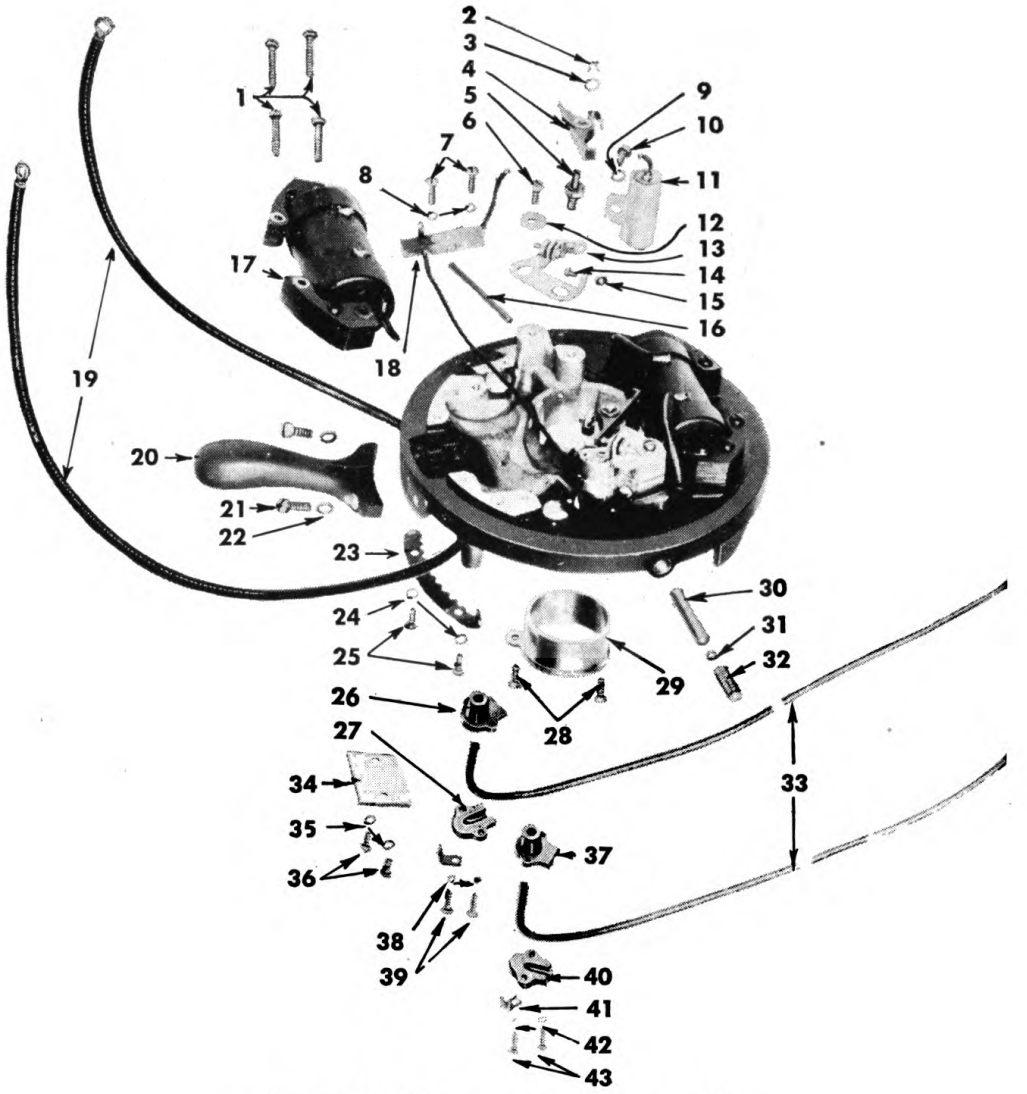


Figure 131. Magneto, armature assembly.

Key to figure 131.

No.	*Part No.*	*Nomenclature*
1	130,148	Condenser-assembly screw.
2	201,122	Breaker arm post spring clip.
3	201,121	Breaker arm post washer.
4	275,785	Breaker arm with spring and point.
5	201,123	Breaker arm.
6	201,049	Breaker plate adjusting screw.
7	130,149	Screw 8–32–¾-inch.
8	120,122	Lockwasher, 8 by $\frac{3}{64}$ W by $\frac{3}{64}$ Th.
9	120,052	Lockwasher, $\frac{3}{16}$ ID by $\frac{1}{16}$ W by $\frac{3}{64}$ Th.
10	130,147	Condenser screw.
11	201,064	Condenser.
12	201,120	Breaker plate adjusting screw washer.
13	275,786	Breaker-plate assembly.
14	201,124	Breaker spring screw.
15	131,207	Nut, 6–32 hexagon.
16	201,200	Cut-out pin.
17	275,784	Coil assembly.
18	275,746	Cut-out assembly.
19	275,744	High-tension cable, long.
20	201,062	Armature handle.
21	130,395	Armature-handle screw.
22	120,054	Lockwasher, ¼ ID by $\frac{5}{64}$ W by $\frac{1}{16}$ Th.
23	201,068	Armature-base quadrant.
24	120,052	Lockwasher.
25	131,016	Screw, 10–24–½-inch long.
26	201,117	High-tension-cable bushing.
27	201,118	High-tension-cable bushing clamp.
28	132,990	Screw, 10–24–⅝-inch long.
29	201,063	Armature-base hub.
30	201,076	Armature-base friction pin.
31	201,066	Armature-base friction screw spring washer.
32	201,065	Armature-base friction screw.
33	275,745	High-tension cable, short.
34	201,197	High-tension cable clamp.
35	120,052	Lockwasher, $\frac{3}{16}$ ID by $\frac{1}{16}$ W by $\frac{3}{64}$ Th.
36	131,016	Screw, 10–24–½-inch long.
37	201,117	High-tension-cable bushing.
38	120,122	Lockwasher, 8 by $\frac{3}{64}$ W by $\frac{3}{64}$ Th.
39	130,149	Screw, 8–32–¾-inch long.
40	201,118	High-tension cable bushing clamp.
41	201,206	High-tension cable clamp.
42	120,122	Lockwasher.
43	130,149	Screw.

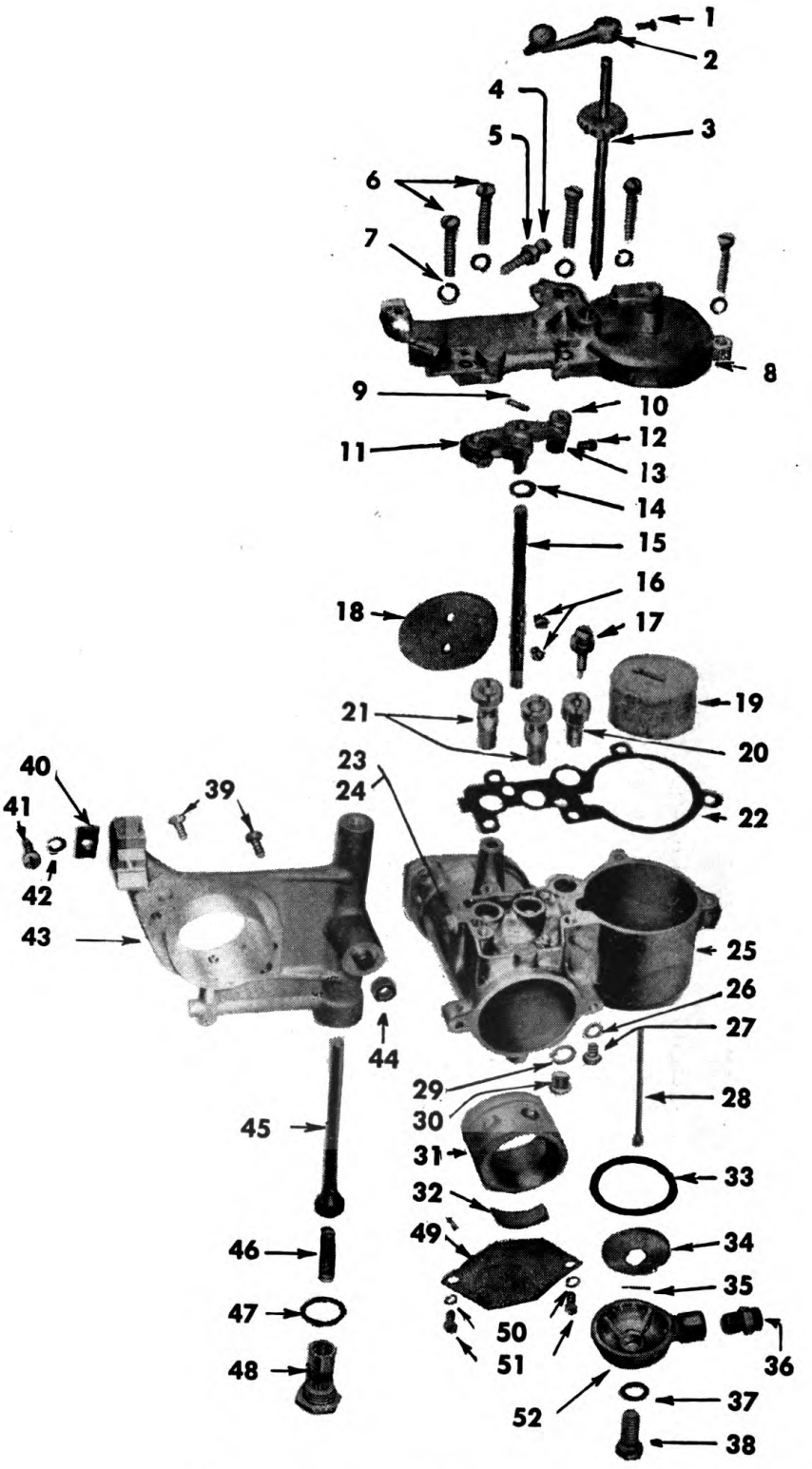


Figure 132. Carburetor assembly.

Key to figure 132.

No.	*Part No.*	*Nomenclature*
1	132,645	High-speed needle valve lever setscrew.
2	102,015	Carburetor-adjusting lever.
3	275,818	High-speed needle valve.
4	132,627	Throttle-adjusting screw.
5	130,625	Throttle-adjusting screw lock nut.
6	132,629	Float-bowl and nozzle-cover screw.
7	120,314	Lockwasher, No. 12, $\frac{1}{16}$ by $\frac{1}{16}$ Th.
8	194,187	Float-bowl and nozzle-cover assembly.
9	130,584	Throttle-lever pin.
10	121,038	Control-wire-connection washer.
11	101,798	Throttle lever.
12	130,760	Control wire connection setscrew.
13	201,051	Control-wire connection.
14	120,338	Thrust washer.
15	132,670	Throttle shaft.
16	132,626	Throttle-shutter screw.
17	132,621	Idle-adjustment needle.
18	120,885	Throttle shutter.
19	171,104	Float.
20	132,622	Idle adjustment needle seat.
21	132,625	Nozzle.
22	171,103	Float bowl and nozzle cover gasket.
23	132,693	Channel plug.
24	171,117	Channel-plug gasket.
25	275,849	Carburetor body and plug assembly.
26	171,108	Fuel-passage-screw gasket.
27	131,109	Screw, 12–24–$\frac{3}{8}$-inch long.
28	194,101	Inlet-needle assembly.
29	170,279	Fuel-passage-plug gasket.
30	132,624	Fuel-passage plug.
31	201,203	Venturi.
32	120,887	Venturi spring.
33	171,105	Strainer-body gasket.
34	120,886	Strainer screen.
35	120,356	Strainer housing retaining screw cotter pin.
36	100,282	Gasoline-pipe connector.
37	170,280	Strainer-body-screw gasket.
38	132,623	Strainer-body screw.
39	132,990	Screw, 10–24–$\frac{5}{8}$-inch long.
40	201,166	Control-wire clamp.
41	132,606	Control-wire casing clamp screw.
42	120,314	Lockwasher, No. 12, $\frac{1}{16}$ by $\frac{1}{16}$ Th.
43	275.739	Carburetor primer body and nozzle assembly.
44	201,059	Primer-body seal.
45	275,740	Primer plunger assembly.
46	201,114	Primer spring.
47	170.191	Primer-check-valve gasket.
48	275,741	Primer-check-valve assembly.
49	201,050	Flame-arrester screen.
50	120,314	Lockwasher.
51	131,109	Screw, 12–24–$\frac{3}{8}$-inches long.
52	101,745	Strainer body.

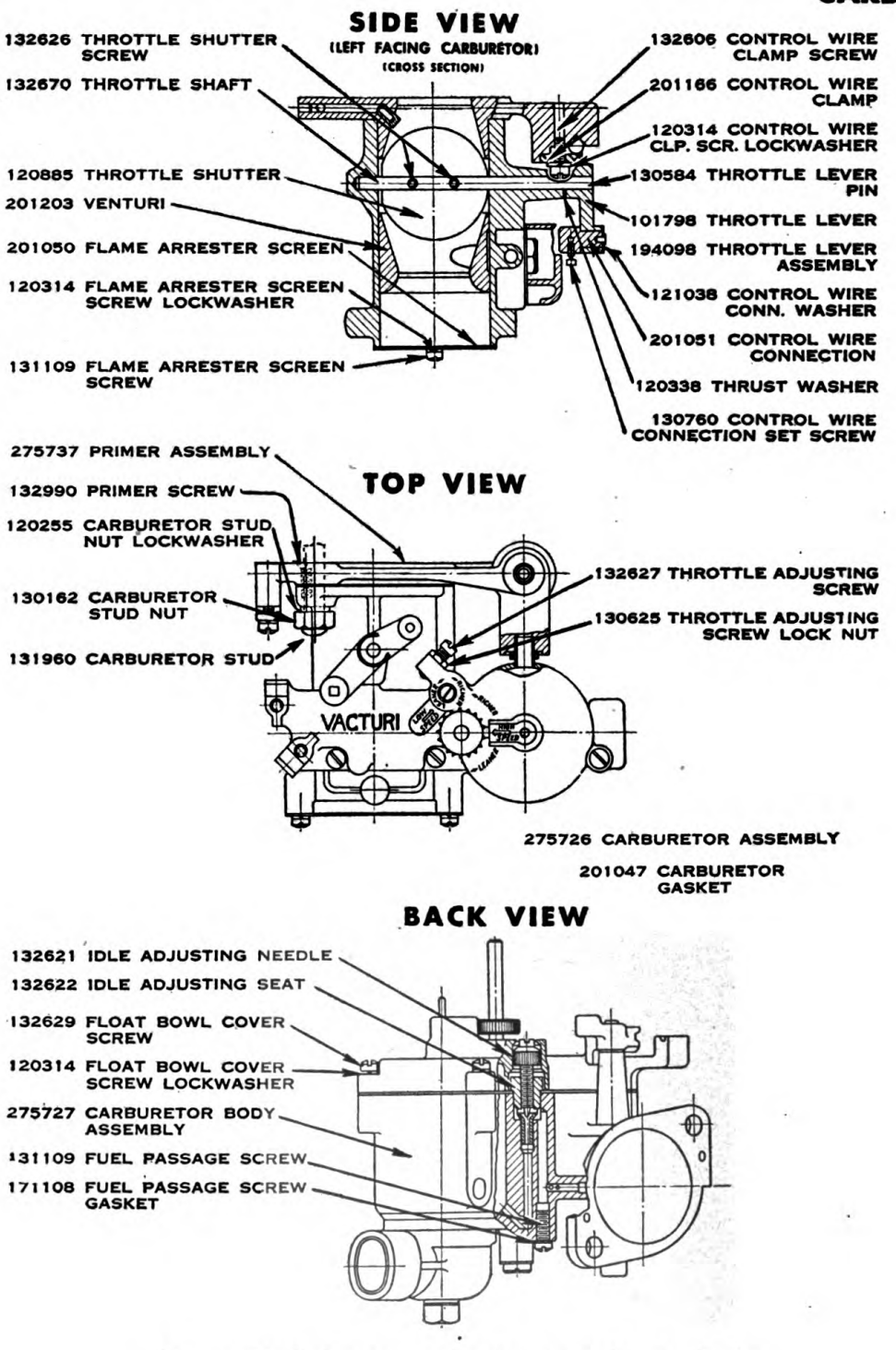


Figure 133. Carburetor—side view, top view, back view.

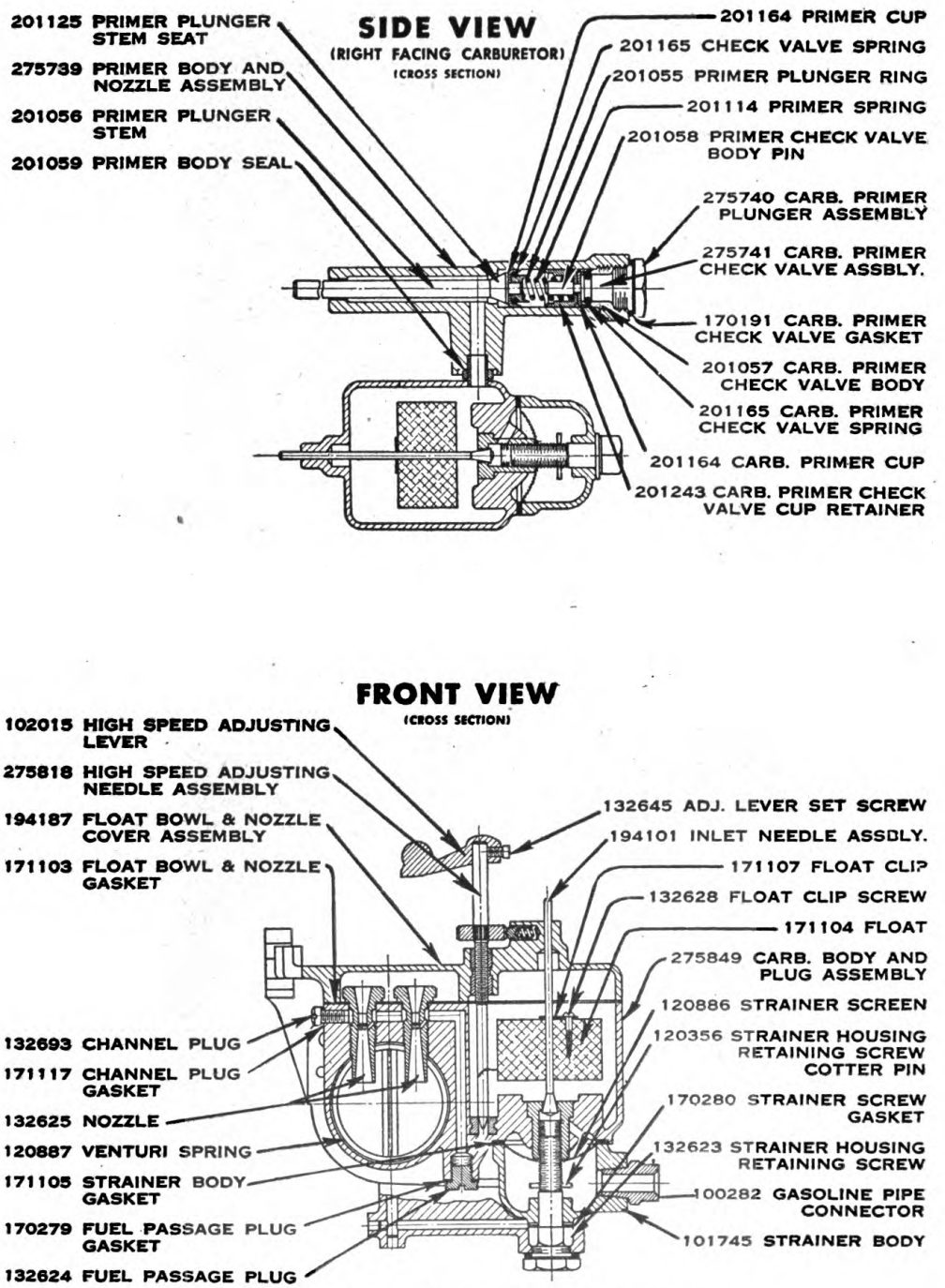


Figure 134. Carburetor—side view, front view.

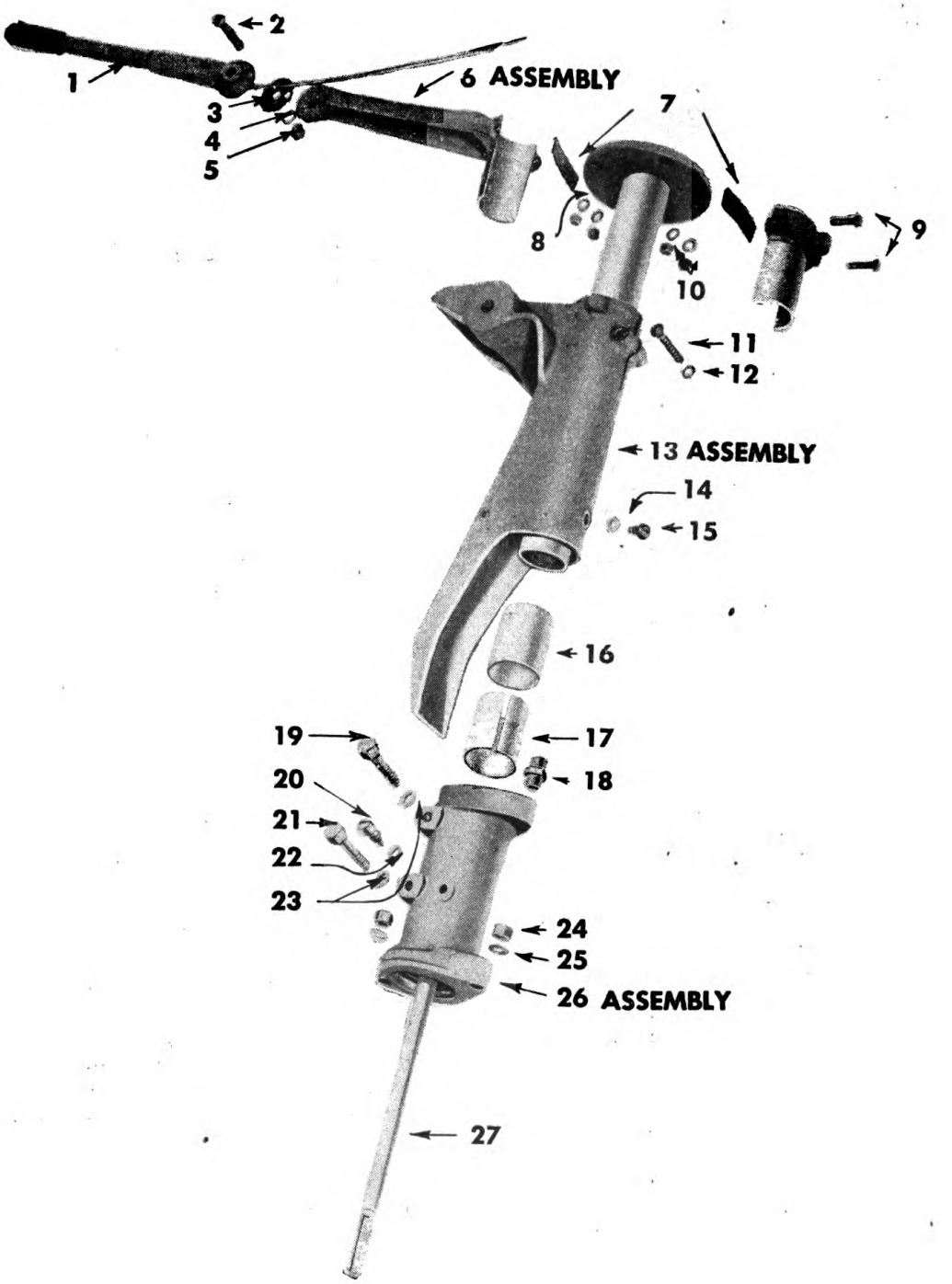


Figure 135. Drive-housing assembly.

Key to figure 135.

No.	*Part No.*	*Nomenclature*
1	275,788	Sterring-handle assembly.
2	200,930	Steering-handle screw.
3	200,929	Steering handle friction washer.
4	120,574	Washer.
5	130,541	Nut.
6	275,824	Steering-handle-support assembly.
7	171,187	Steering-handle-support rubber.
8	120,177	Lockwasher, ⅜ ID by ⅛ W by $\frac{3}{32}$ Th.
9	133,128	Steering-handle-support screw.
10	130,202	Nut, ⅜–24–$\frac{21}{64}$ Th.
11	131,678	Pivot-bearing clampscrew.
12	120,177	Lockwasher.
13	275,819	Pivot-bearing assembly.
14	120,177	Lockwasher.
15	201,149	Pivot-bearing bushing retainer screw.
16	201,150	Pivot-bearing bushing retainer.
17	201,151	Pivot-bearing bushing.
18	130,738	Water-pipe connector.
19	131,981	Driveshaft housing clamp screw.
20	201,214	Driveshaft tube screw.
21	131,981	Driveshaft housing clamp screw.
22	120,195	Driveshaft tube screw lockwasher.
23	120,574	Washer.
24	131,484	Gear-housing flange stud nut.
25	120,574	Washer.
26	275,825	Driveshaft-housing assembly.
27	201,141	Driveshaft, upper.

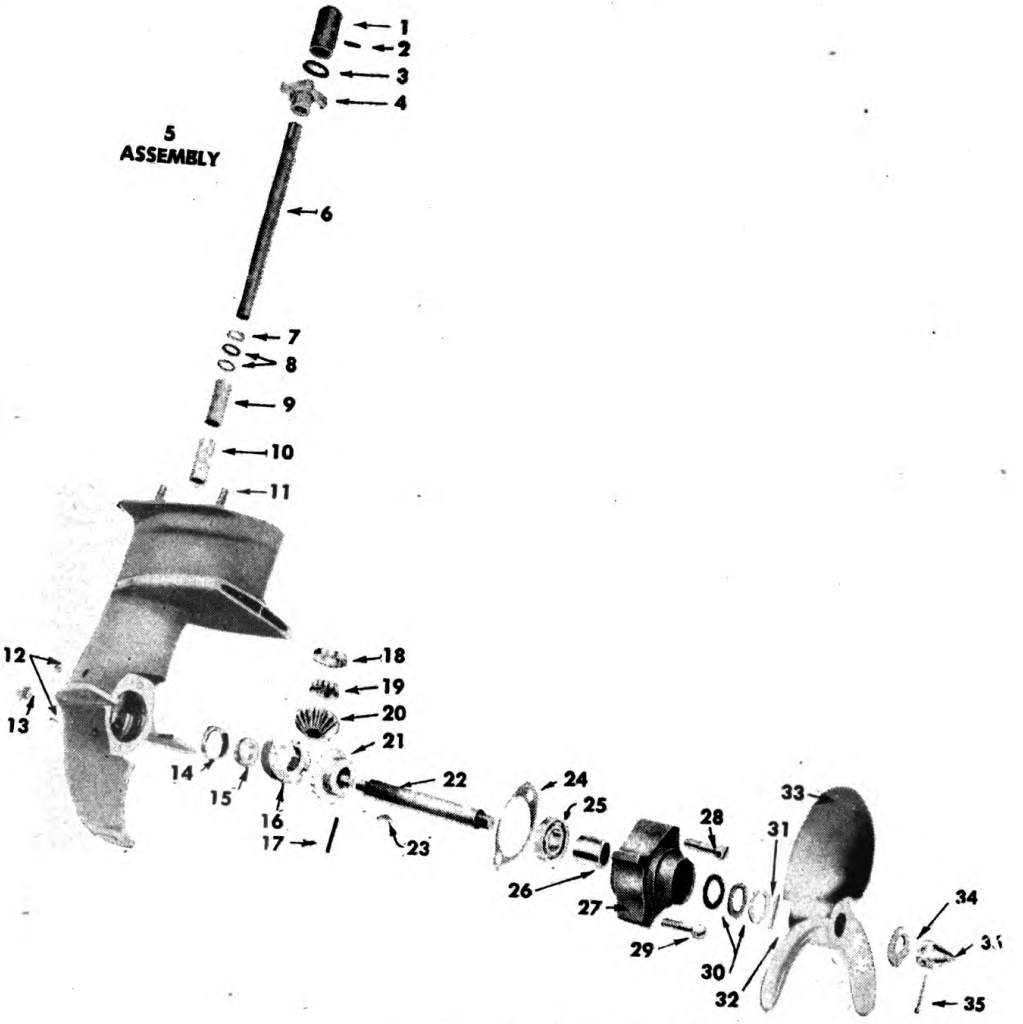


Figure 136. Gear-housing assembly.

Key to figure 136.

No.	*Part No.*	*Nomenclature*
1	131,452	Driveshaft coupler.
2	131,075	Driveshaft-coupler pin.
3	200,834	Impeller water seal.
4	100,885	Pump impeller.
5	275,594	Driveshaft and impeller assembly, lower.
6	132,379	Driveshaft, lower.
7	120,827	Driveshaft sealing washer retainer.
8	200,580	Driveshaft grease seal.
9	170,792	Driveshaft bushing, upper.
10	102,384	Driveshaft bushing lower.
11	201,134	Gear-housing-flange stud.
12	130,314	Grease plug.
13	201,135	Gear-housing plug.
14	120,073	Roller-bearing cup.
15	190,286	Propeller shaft thrust roller bearing cone assembly.
16	200,924	Driveshaft thrust bearing.
17	201,138	Propeller-shaft gear pin.
18	120,073	Roller-bearing cup.
19	190,285	Driveshaft roller bearing cone assembly.
20	131,450	Driveshaft gear.
21	200,919	Propeller-shaft gear.
22	201,137	Propeller shaft.
23	200,416	Propeller-shaft-gear key.
24	200,922	Gear-housing-cap gasket.
25	191,535	Propeller-shaft ball bearing assembly.
26	200,920	Gear-housing-cover bushing.
27	275,820	Gear-housing cap and bushing.
28	201,136	Gear-housing-cap screw.
29	201,136	Gear-housing-cap screw.
30	200,923	Propeller-shaft grease seal.
31	201,140	Propeller-shaft sealing washer retainer
32	131,133	Propeller shear pin.
33	201,157	Propeller.
34	201,131	Propeller-nut washer.
35	120,223	Propeller-nut cotter pin.
36	130,295	Propeller nut.

BI-POD

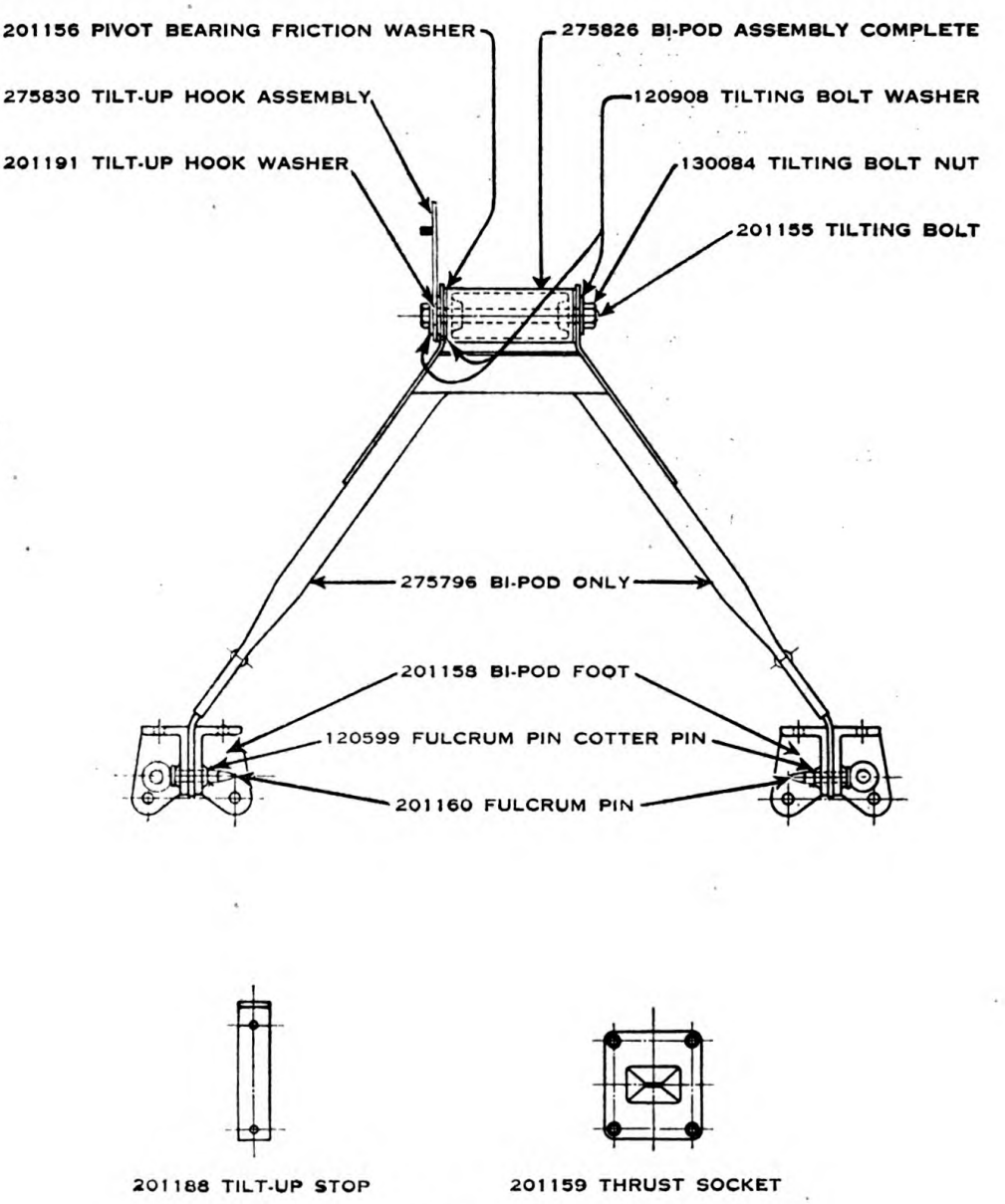


Figure 137. Bipod assembly.

APPENDIX II

POLR MOTOR ILLUSTRATIONS

(Johnson Model POLR-15)

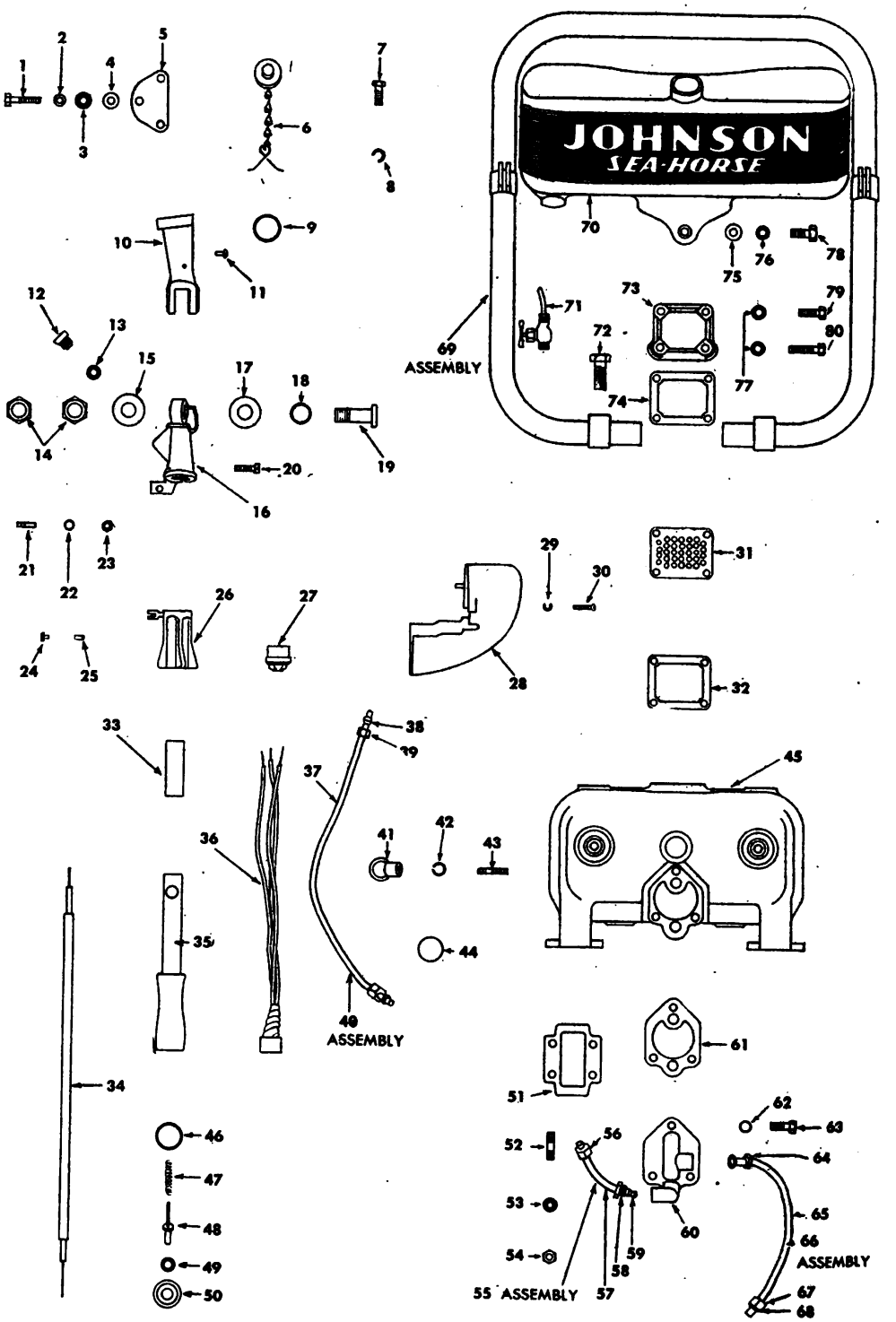


Figure 138. Powerhead parts.

Key to figure 138.

No.	*Part No.*	*Nomenclature*
1	21–601	Screw, steering handle to cylinder.
2	7–227	Lockwasher, $\frac{1}{32}$-inch.
3	37–109	Rubber washer, steering handle to cylinder.
4	37–108	Retainer washer, steering handle to cylinder.
5	29–179	Rubber base, steering handle.
6	34–19	Filler cap—gas tank.
7	71–1311	Screw, gas-tank support.
8	7–47	Lockwasher, lower unit and muffler to power head, gas-tank screws.
9	5–48	Gasket, filler cap.
10	21–33	Bracket, steering handle.
11	71–765	Screw, quadrant, magneto, and ground wire to steering handle.
12	71–870	Plug, insulator for cut-out wire.
13	71–872	Packing washer for cut-out-wire plug.
14	21–38	Nut, hinge pin, steering handle.
15	21–381	Thrust washer, hinge pin.
16	29–169	Hinge, steering handle.
17	21–381	Thrust washer, hinge pin.
18	21–39	Washer, hinge-pin nut.
19	21–376	Hinge pin, steering handle.
20	21–152	Screw, bracket and steering handle hinge and relief valve bracket.
21	29–168	Clampscrew, Bowdin cable.
22	19–124	Lockwasher, clamp screw control cable.
23	19–136	Nut, clamp screw control cable and wrist-pin lockscrew.
24	15–249	Clamp screw, swivel nut.
25	71–1,308	Swivel nut, control cable.
26	21–377	Control handle, steering handle.
27	21–428	Attachment—plug body.
28	300,134	Spark-plug cover.
29	43–300	Lock-ring spark plug cover screw.
30	41–37	Screw, spark-plug cover.
31	300,821	Plate, exhaust outlet.
32	21–102	Gasket, muffler outlet and plate.
33	21–391	Tube, steering handle.
34	30–113	Control cable, carburetor.
35	22–143	Grip and tube assembly, steering handle.
36	22–142	Contact block and lead, steering handle.
37	29–69	Gas line only.
38	17–131	Gland, gasoline line.
39	17–132	Nut, gasoline line.
40	30–63	Gas-line assembly.
41	17–30	Eyenut, muffler.
42	7–47	Lockwasher, lower unit and muffler to power head, gas-tank screw.
43	21–118	Stud, muffler eyenut.
44	21–230	Core plug, muffler.
45	30–124	Muffler assembly.
46	21–380	Washer, steering-handle cap.
47	21–373	Spring, stop switch.
48	22–140	Push button, steering-handle cap.
49	21–379	Washer, stop button.
50	21–374	Cap, steering handle.
51	21–97	Gasket, muffler to cylinder.
52	21–98	Stud, muffler.
53	7–47	Lockwasher, lower unit and muffler to power head, gas-tank screws.
54	7–45	Nut, $\frac{3}{8}$-inch.
55	375,319	Water-tube assembly, inlet.
56	17–139	Nut, water tube.
57	300,826	Water pipe, inlet.
58	300,828	Screw gland, muffler plate.
59	7–261	Gland, water tube.
60	375,322	Muffler-cover assembly.
61	21–99	Gasket, muffler cover.

Key to figure 138—Continued.

No.	*Part No.*	*Nomenclature*
62	7–227	Lockwasher.
63	7–116	Screw, muffler to muffler cover.
64	300,828	Screw gland, muffler plate.
65	300,825	Water pipe, outlet.
66	375,320	Water-tube assembly, outlet.
67	17–139	Nut, water tube.
68	7–261	Gland, water tube.
80	21–486	Screw, exhaust outlet, long.
69	375,318	Hand-rail assembly.
70	30–121	Gas tank.
71	22–44	Shut-off valve, gas tank.
72	300,824	Cap screw, handrail to muffler.
73	300,819	Outlet, exhaust.
74	21–102	Gasket, muffler outlet and plate.
75	17–218	Spacer, gas-tank support.
76	7–47	Lockwasher.
77	7–227	Lockwasher.
78	21–202	Screw, gas tank to cylinder.
79	53–81	Screw, exhaust outlet, short.

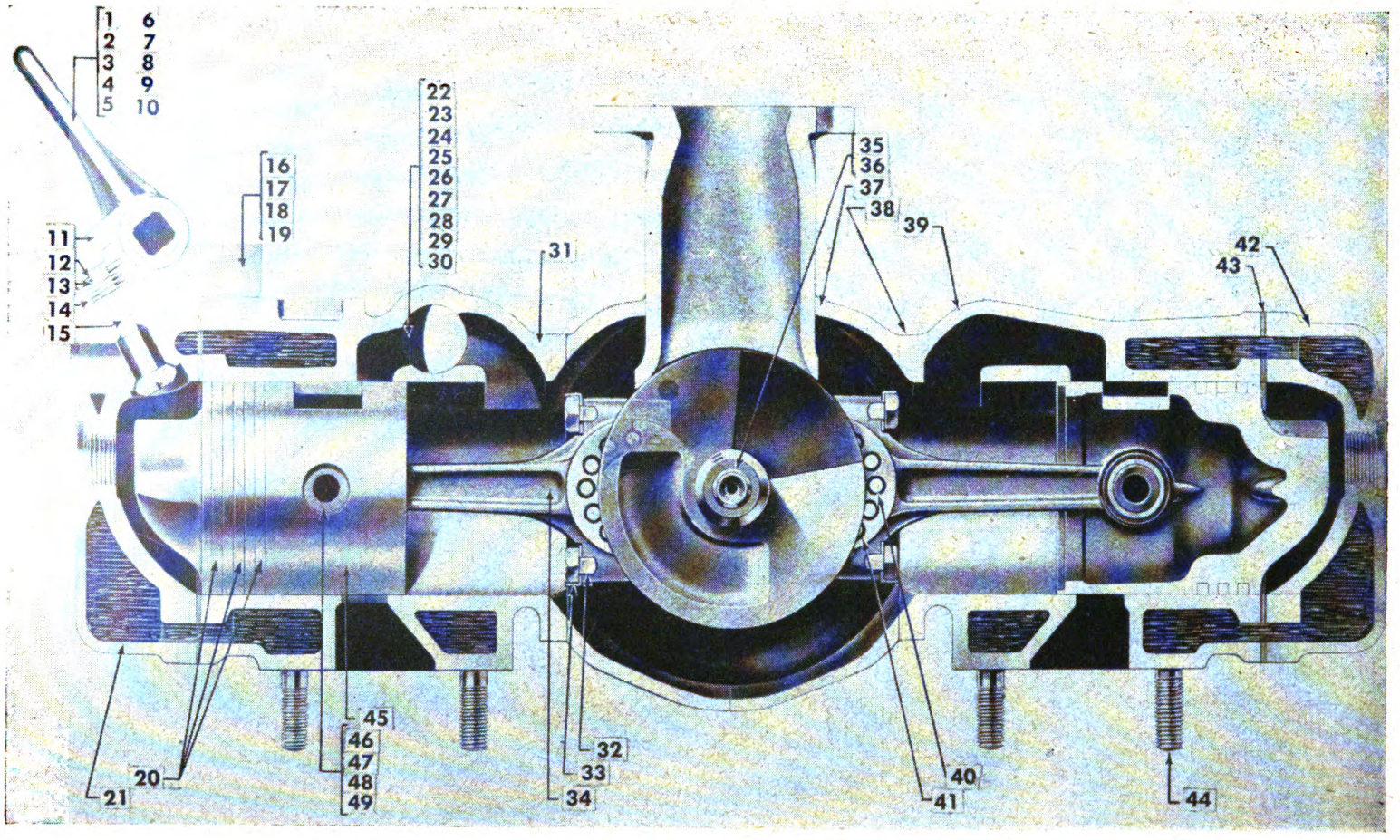


Figure 139. Powerhead.

Key to figure 139.

No.	*Part No.*	*Nomenclature*
1	22–137	Relief-valve lever and shaft.
2	21–114	Spring, relief valve.
3	21–110	Bushing, relief valve.
4	21–113	Lever, bypass and relief valve.
5	13–481	Lockwasher, $\frac{13}{32}$-inch.
6	7–45	Nut.
7	85–64	Locknut, throttle-adjusting screw.
8	15–197	Ball joint, bypass to relief valve.
9	85–64	Locknut.
10	29–21	Rod, bypass valve to relief valve.
11	21–108	Lever, relief valve.
12	15–213	Cotter pin, relief valve.
13	21–165	Washer, relief valve.
14	21–222	Spring, relief valve.
15	29–16	Relief valve.
16	21–352	Bracket, relief valve.
17	21–152	Clamp screw, relief-valve bracket.
18	7–227	Lockwasher, $\frac{11}{32}$-inch.
19	7–46	Nut.
20	29–10	Piston ring.
21	29–158	Cylinder head, port.
22	29–13	Bypass valve.
23	21–190	Gasket, bypass valve.
24	21–116	Bearing, bypass valve.
25	21–212	Spring, bypass valve.
26	21–213	Washer, bypass valve.
27	21–113	Washer.
28	13–481	Lockwasher, $\frac{13}{32}$-inch.
29	7–45	Nut.
30	19–139	Key, bypass valve lever and relief valve shaft No. 2.
31	30–24	Cylinder, port.
32	21–294	Lockplates, connecting rod.
33	29–178	Screw, connecting rod.
34	30–118	Connecting rod with lockplate.
35	30–123	Crankshaft.
36	21–198	Key, crankshaft No. 9.
37	30–122	Crankcase complete with bearings.
38	29–15	Gasket, cylinder base.
39	30–23	Cylinder, starboard.
40	29–155	Rollers, connecting rod.
41	29–156	Retainers, connecting rod.
42	29–157	Cylinder head, starboard.
43	29–51	Gasket, cylinder head.
44	21–98	Stud, muffler.
45	29–154	Piston.
46	21–44	Lockscrew, wristpin.
47	19–136	Nut, wristpin.
48	19–137	Lockwasher.
49	29–11	Wristpin, piston.

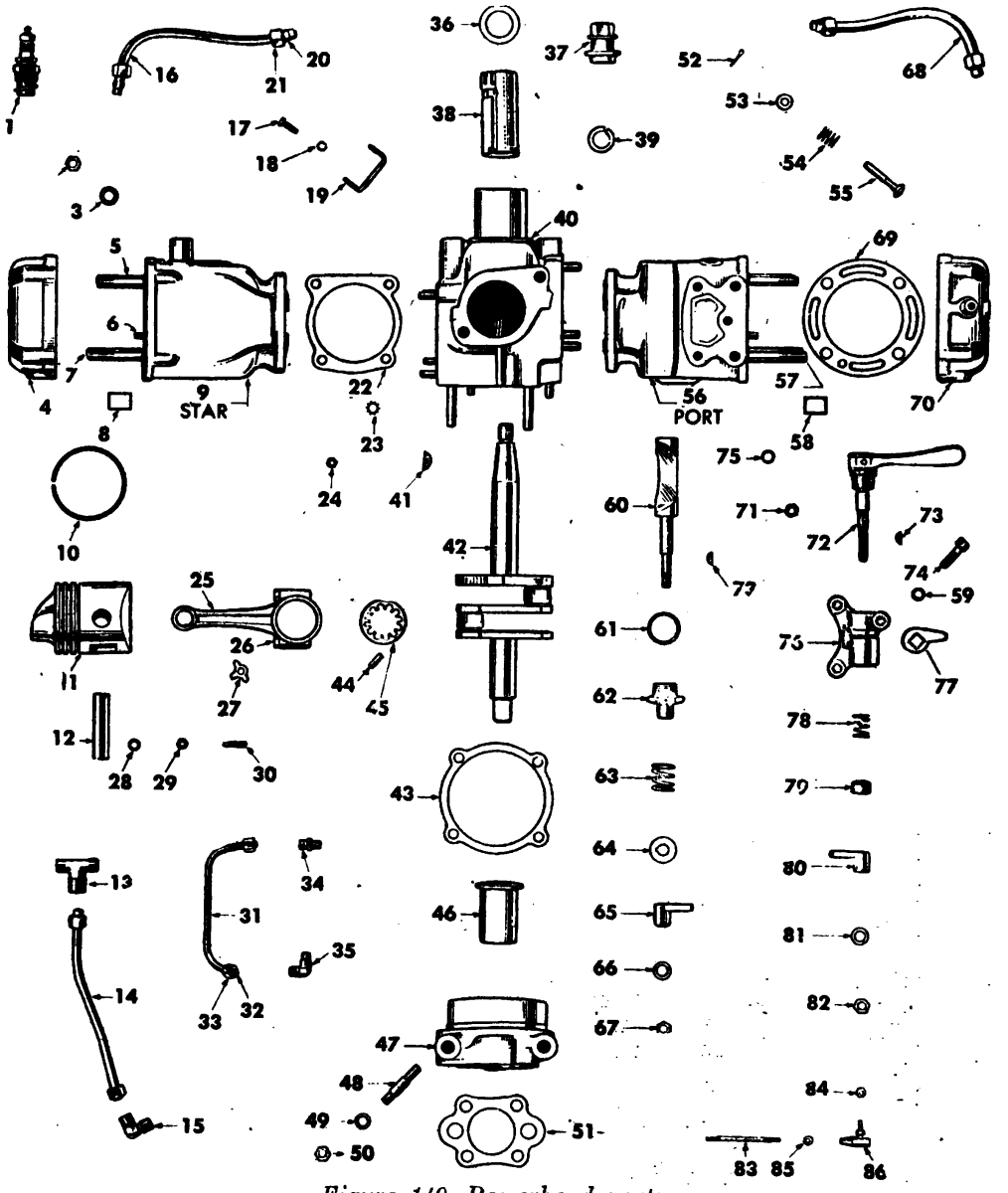


Figure 140. Powerhead parts.

Key to figure 140.

No.	*Part No.*	*Nomenclature*
1	76–131	Spark plug.
2	7–45	Nut, ⅜-inch.
3	21–154	Washer, cylinder-head stud.
4	29–157	Cylinder head, starboard.
5	21–153	Stud, cylinder head.
6	21–191	Dowel pin, cylinder head.
7	300,823	Stud, cylinder head, port and starboard.
8	300,830	Spacer, handrail.
9	30–23	Cylinder, starboard.
10	29–10	Piston rings.
11	29–154	Piston.
12	29–11	Wrist pin, piston.
13	7–258	Tee, crankcase head.
14	30–18	Water tube, inlet.
15	17–138	Elbow, water tube.
16	22–92	Water tube, outlet, starboard.
17	51–47	Screw, ratchet-lever bracket.
18	13–52	Lockwasher.
19	21–396	Bracket, ratchet lever.

Key to figure 140—Continued.

No.	Part No.	Nomenclature
20	7–261	Gland, water tube.
21	17–139	Nut, water tube.
22	29–15	Gasket, cylinder base.
23	51–115	Washer, cylinder-base studs.
24	7–46	Nut.
25	30–118	Connecting rod with lockplate.
26	29–178	Screw, connecting rod.
27	21–294	Lockplate, connecting-rod screw.
28	19–137	Lockwasher, wrist-pin lockscrew.
29	19–136	Nut.
30	21–44	Lockscrew, wrist pin.
31	30–131	Oil-line assembly.
32	13–304	Gland, drain tube and oil line.
33	13–305	Nut, drain tube and oil line.
34	13–365	Straight connection.
35	13–364	Elbow, carburetor drain and oil line.
36	21–434	Oil slinger, crankshaft.
37	15–194	Nut, flywheel.
38	29–159	Journal bearing, upper.
39	15–34	Lockwasher, flywheel nut.
40	30–122	Crankcase complete with bearing.
41	21–198	Key, crankshaft.
42	30–123	Crankshaft.
43	21–29	Gasket, crankcase head to crankcase.
44	29–155	Rollers, connecting-rod bearing.
45	29–156	Retainers, connecting-rod bearing.
46	21–431	Journal bearing, lower.
47	22–375, 119	Crankcase head and bearing.
48	21–189	Stud, powerhead to lower unit.
49	7–47	Lockwasher.
50	7–45	Nut, ⅜-inch.
51	21–28	Gasket, crankcase to lower unit.
52	15–213	Cotter pin, relief valve.
53	21–165	Washer, relief valve.
54	21–222	Spring, relief valve.
55	29–16	Relief valve.
56	30–24	Cylinder, port.
57	300,823	Stud, cylinder head.
58	300,830	Spacer, hand rail.
59	7–227	Lockwasher.
60	29–13	Bypass valve.
61	21–190	Gasket, bypass valve.
62	21–116	Bearing, relief valve.
63	21–212	Spring, bypass valve.
64	21–213	Washer, bypass valve.
65	21–113	Lever, relief and bypass valve.
66	13–481	Lockwasher.
67	7–45	Nut, ⅜-inch.
68	22–93	Water tube, outlet, port.
69	29–51	Gasket, cylinder head.
70	29–158	Cylinder head, port.
71	7–46	Nut.
72	22–137	Relief-valve lever and shaft.
73	19–139	Key.
74	21–152	Screw.
75	7–227	Lockwasher.
76	21–352	Bracket, relief valve.
77	21–108	Lever, relief valve.
78	21–114	Spring, relief valve.
79	21–110	Bushing, relief valve.
80	21–113	Lever, relief and bypass valve.
81	13–481	Lockwasher.
82	7–45	Nut, ⅜-inch.
83	29–21	Rod, bypass valve to relief valve.
84	85–64	Locknut, throttle-adjusting screw.
85	85–64	Locknut, throttle-adjusting screw.
86	15–197	Ball joint, bypass to relief valve.

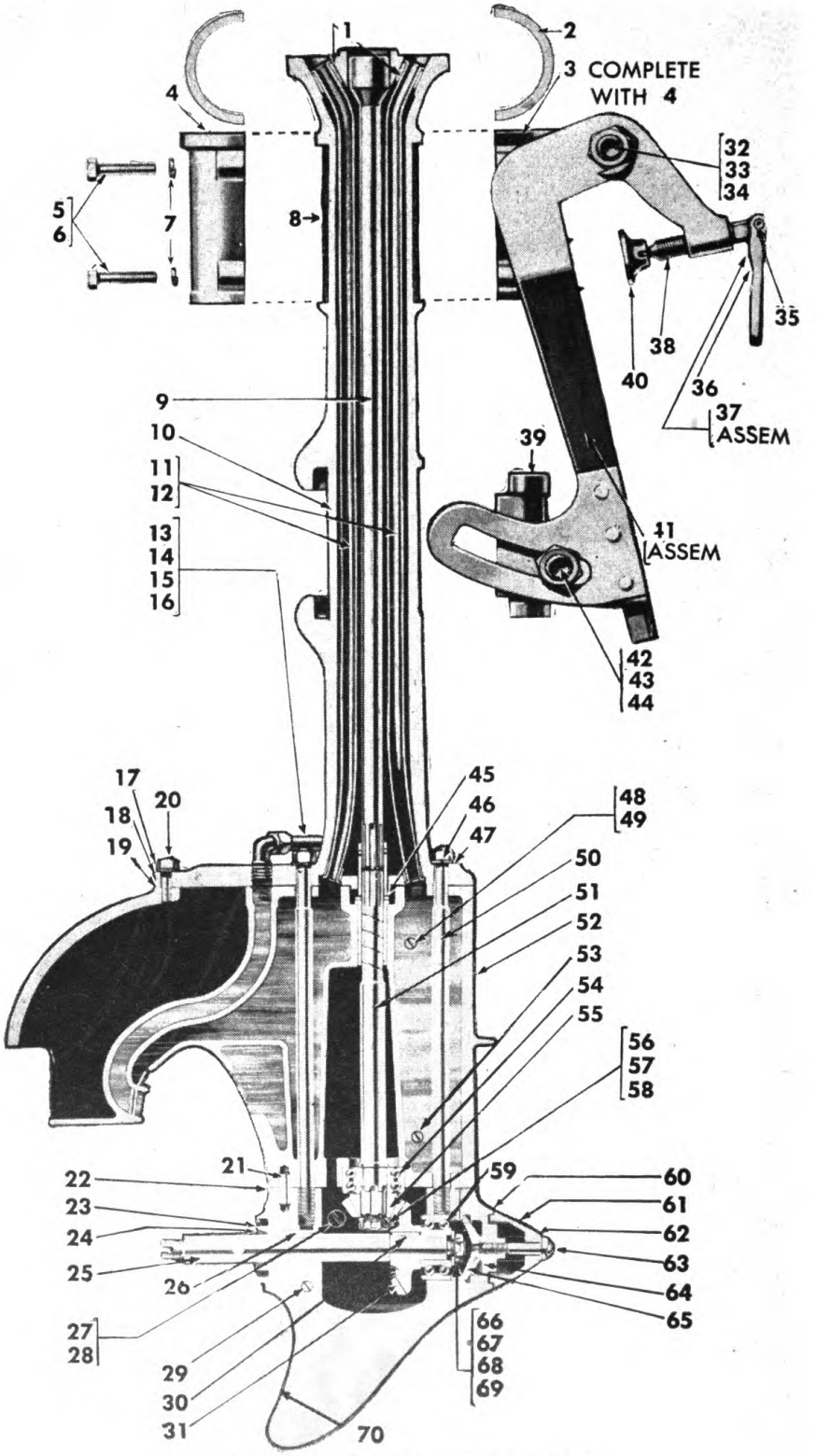


Figure 141. Lower unit assembly.

Key to figure 141.

No.	*Part No.*	*Nomenclature*
1	17–95	Ferrule—driveshaft-casing water tube.
2	17–22	Thrust washer—swivel bracket.
3	22–78	Swivel bracket.
4		Cap—swivel bracket, part of 22–78.
5	21–601	Screw—swivel bracket—steering handle to cylinder, $\frac{5}{16}$-inch-18 by 1½-inch.
6	7–31	Screw—swivel bracket, $\frac{5}{16}$-inch-18 by 1¼-inch.
7	7–227	Lockwasher—muffler cover, cut-out plate and steering handle, crankcase head to crankcase relief-valve bracket screw and carburetor to crankcase, swivel-bracket screw, and driveshaft casing to pinion casing, $\frac{1}{32}$-inch.
8	17–14	Bushing—swivel bracket.
9	22–40	Driveshaft.
10	375,321	Driveshaft casing and water tube.
11	21–161	Water tube—driveshaft casing.
12	300,818	Water tube—driveshaft casing.
13	375,323	Water-tube assembly—inlet—driveshaft casing.
14	300,829	Gasket—drive-shaft-casing water tube.
15	300,831	Screw—gland—driveshaft-casing elbow.
16	17–138	Elbow—water tube.
17	21–475	Nut—driveshaft casing to pinion-shaft casing, $\frac{5}{16}$-inch-24.
18	7–227	Lockwasher, $\frac{1}{32}$-inch.
19	21–65	Gasket—pinion-shaft casing to driveshaft casing.
20	21–68	Stud—pinion-shaft casing to driveshaft casing.
21	21–59	Dowel pin—gearcase to pinion casing.
22	23–58	Gasket—gearcase to pinion-shaft casing.
23	23–283	Cap—propeller-shaft bearing.
24	23–282	Cork packing—propeller-shaft bearing.
25	30–139	Propeller shaft.
26	23–284	Bearing—propeller shaft—propeller end.
27	21–64	Inspection plug—gearcase.
28	21–121	Washer—inspection plug, $\frac{33}{64}$-inch.
29	21–63	Plugs—driveshaft and pinion-shaft casings.
30	23–172	Key—bevel gear—No. 11.
31	23–43	Gear—bevel—propeller shaft.
32	22–165	Tilting shaft.
33	21–448	Thrust washer—swivel bracket to stern bracket.
34	21–344	Nut—tilting shaft.
35	21–46	Pin—clampscrew handle.
36	21–349	Handle—stern-bracket clamp screw.
37	22–139	Clampscrew and handle assembly—stern bracket.
38	21–92	Clampscrew only—stern bracket.
39	375,324	Thrust-socket assembly.
40	7–88	Swivel plate—stern-bracket clampscrew.
41	22–65	Stern bracket with quadrants only.
42	22–375,003	Thrust-socket bolt.
43	7–104	Washer—thrust-socket bolt.
44	7–105	Nut—thrust-socket bolt, $\frac{9}{16}$-inch-12.
45	21–62	Thrust washer—pinion shaft.
46	19–54	Nut—pinion-shaft to driveshaft-casing stud, $\frac{7}{16}$-inch-20.
47	5–58	Lock washer—driveshaft casing to pinion-shaft-casing stud, $\frac{15}{32}$-inch.
48	21–63	Plug—driveshaft casing.
49	21–122	Washer—driveshaft casing and pinion shaft casing plug, $\frac{21}{64}$-inch.
50	23–57	Stud—gearcase to driveshaft casing.
51	23–46	Pinion shaft.
52	23–77	Pinion-shaft casing less bearing.
53	21–63	Plug—pinion-shaft casing.
54	24–52	Ball bearing—pinion shaft.
55	23–42	Gear—pinion.
56	19–161	Nut—pinion and propeller shaft, ½-inch-20.
57	21–592	Washer—pinion-shaft nut $\frac{33}{64}$-inch.
58	21–120	Lockwasher—pinion and propeller-shaft nut.
59	29–300,316	Ball-thrust bearing—propeller shaft.

Key to figure 141—Continued.

No.	*Part No.*	*Nomenclature*
60	29–300,359	Gasket—gearcase cap.
61	29–300,352	Gearcase cap.
62	21–55	Washer—gearcase-head bolt.
63	21–51	Bolt—gearcase head.
64	29–300,354	Locknut—bearing.
65	29–300,353	Retainer, propeller-thrust bearing.
66	19–161	Nut—pinion and propeller shaft, ½-inch-20.
67	19–95	Washer—plain—propeller shaft, $\frac{17}{32}$-inch.
68	21–120	Lockwasher—pinion and propeller-shaft nut.
69	21–592	Washer—pinion-shaft nut, $\frac{33}{64}$-inch.
70	29–300,315	Gearcase only—less bearing.

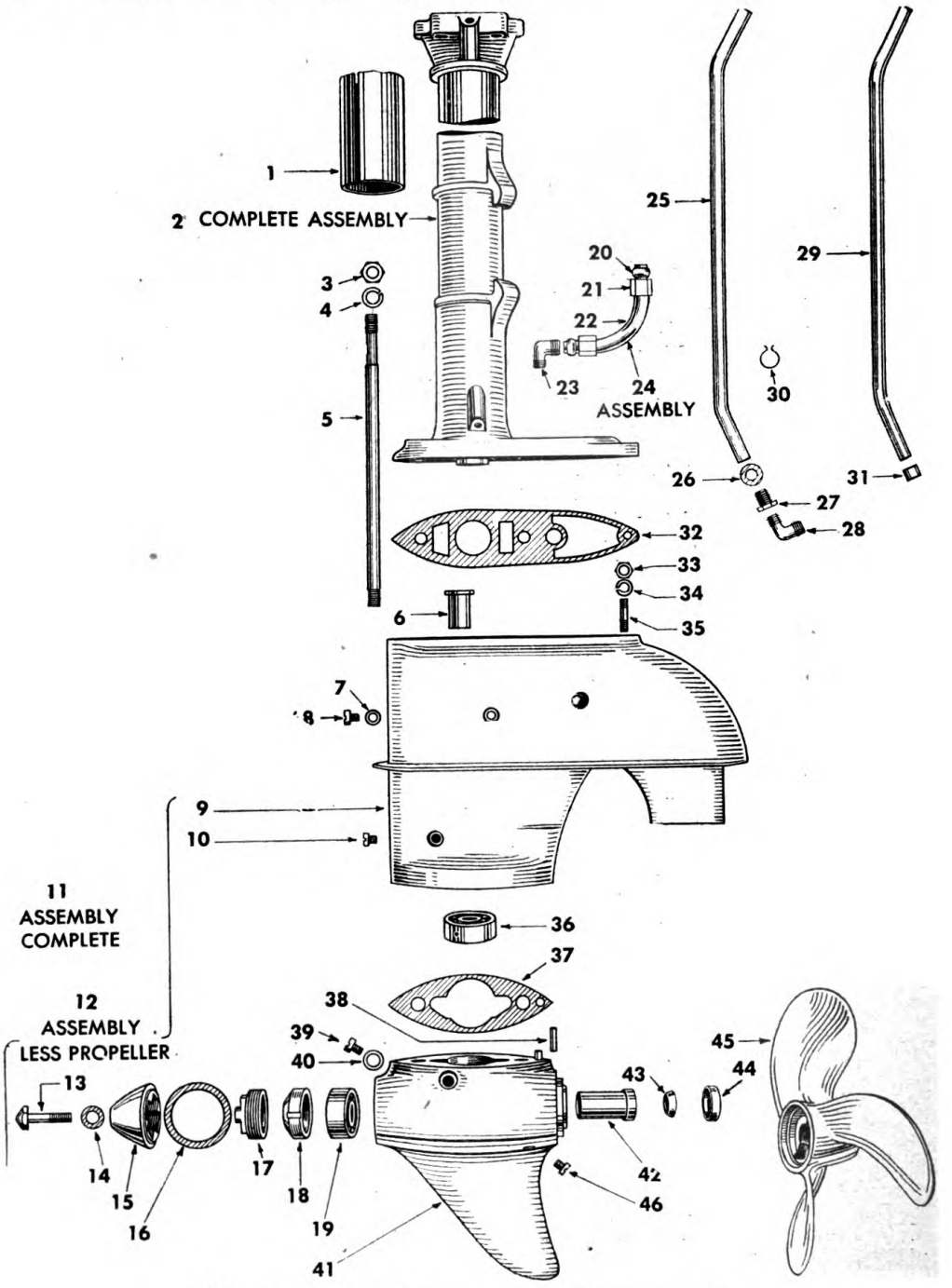


Figure 142. Housing group of lower-unit parts.

Key to figure 142.

No.	*Part No.*	*Nomenclature*
1	17–14	Bushing, swivel bracket.
2	375,321	Driveshaft casing and water-tube assembly.
3	19–54	Nut, pinion shaft casing to driveshaft casing.
4	5–58	Lockwasher.
5	23–57	Stud.
6	23–61	Bearing, pinion-shaft casing, upper.
7	21–122	Washer.
8	21–63	Plug.
9	23–77	Pinion-shaft casing.
10	21–63	Plug.
11	24–135	Gearcase.
12	24–207	Gearcase assembly, housings only.
13	21–51	Bolt, gearcase head.
14	21–55	Washer.
15	29–300,352	Gearcase cap.
16	29–300,359	Gasket, gearcase cap.
17	29–300,354	Locknut, bearing.
18	29–300,353	Retainer, propeller-thrust bearing.
19	29–300,316	Ball thrust bearing.
20	7–261	Gland, water tube.
21	17–139	Nut, water tube.
22	300,835	Water pipe, muffler.
23	17–138	Elbow, water-tube.
24	375,323	Water-tube assembly.
25	300,818	Water tube, driveshaft casing.
26	300,829	Gasket, driveshaft casing water tube.
27	300,831	Screw, gland.
28	17–138	Elbow, water tube.
29	21–161	Water tube, driveshaft casing.
30	300,827	Spring, water-pipe.
31	17–95	Ferrule, driveshaft casing water tube.
32	21–65	Gasket.
33	21–475	Nut.
34	7–227	Lockwasher.
35	21–68	Stud.
36	24–52	Ball bearing, pinion-shaft.
37	23–58	Gasket.
38	21–59	Dowel pin.
39	21–64	Inspection plug, gearcase.
40	21–121	Washer, inspection-plug.
41	29–300,315	Gear case only, less bearing.
42	23–284	Bearing, propeller-shaft.
43	23–282	Cork packing.
44	23–283	Cap propeller shaft bearing packing.
45	23–126	Propeller, 12 by 10.
46	21–63	Plug.

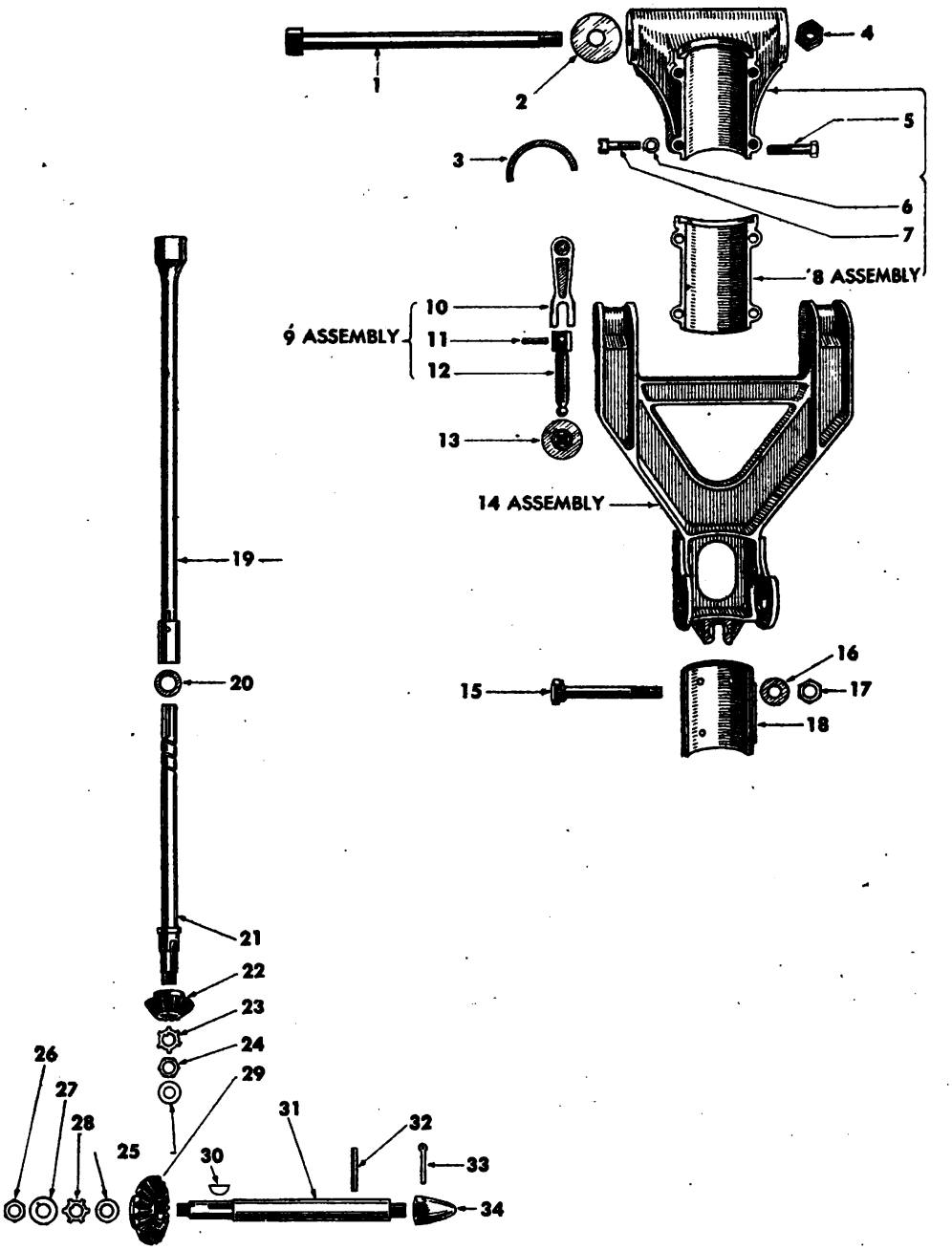


Figure 143. Gear shaft and bracket group of lower-unit parts.

Key to figure 143.

No.	*Part No.*	*Nomenclature*
1	22–165	Tilting shaft.
2	21–448	Thrust washer.
3	17–22	Thrust washer, swivel bracket.
4	21–344	Nut, tilting shaft.
5	21–601	Screw, swivel bracket.
6	7–227	Lockwasher, swivel-bracket screw.
7	7–31	Screw, swivel-bracket.
8	22–78	Swivel bracket.
9	22–139	Clamp screw and handle assembly.
10	21–349	Handle, stern bracket clamp screw.
11	21–46	Pin, clamp screw handle.
12	21–92	Clamp screw only, stern bracket.
13	7–88	Swivel plate.
14	22–65	Stern bracket with quadrants only.
15	22–375,003	Bolt, thrust socket.
16	7–104	Washer, thrust-socket bolt.
17	7–105	Nut, thrust-socket bolt.
18	375,324	Thrust-socket assembly.
19	22–40	Driveshaft.
20	21–62	Thrust washer, pinion-shaft.
21	23–46	Pinion shaft.
22	23–42	Gear, pinion.
23	21–120	Lockwasher.
24	19–161	Nut, pinion and propeller-shaft.
25	21–592	Washer, pinion-shaft nut.
26	19–161	Nut, pinion and propeller-shaft.
27	19–95	Washer, propeller-shaft.
28	21–120	Lock washer.
29	23–43	Gear, bevel, propeller-shaft.
30	23–172	Key, bevel gear No. 11.
31	30–139	Propeller shaft.
32	19–102	Drive pin, propeller.
33	19–84	Cotterpin, propeller-nut.
34	23–53	Nut, propeller.

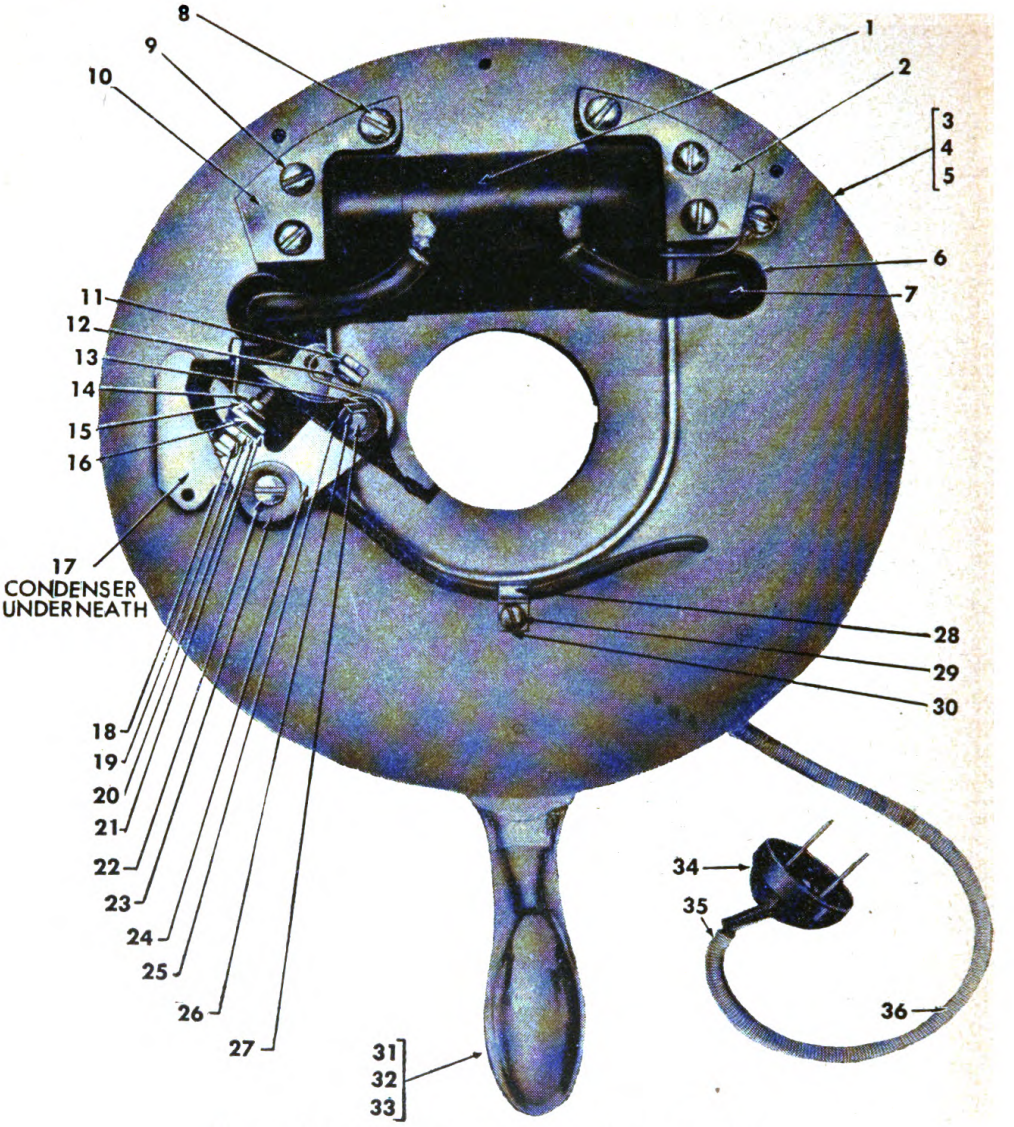


Figure 144. Magneto armature plate assembly.

Key to figure 144.

No.	*Part No.*	*Nomenclature*
1	72–852	Coil assembly, less heels.
2	72–856	Heel assembly, left-hand.
3	72–858	Armature plate and clampscrew.
4	5–136	Lockwasher, armature-plate clampscrew.
5	71–1235	Screw for armature-plate clamp No. 12.
6	71–1420	Grommet for ignition lead.
7	72–375,098	High-tension leads.
8	71–939	Screw for mounting coil to plate No. 10.
9	71–940	Screw for heels No. 10.
10	72–855	Heel assembly, right-hand.
11	71–471	Nut for screw No. 71–45 and contact screw.
12	71–45	Screw, spring mounting.
13	71–1048	Washer for breaker post.
14	71–1146	Contact point and screw.
15	71–1240	Terminal, for breaker.
16	71–66	Insulation washer for contact screw.
17	72–864	Condenser complete.
18	71–1274	Locknut for contact screw.
19	71–471	Nut.
20	71–1148	Insulation bushing.
21	71–49	Washer for contact screw.
22	71–31	Screw for mounting breaker No. 10.
23	71–610	Washer for breaker mounting screw.
24	71–1147	Breaker plate.
25	72–736	Breaker arm and spring assembly.
26	71–1052	Clip spring for breaker post.
27	71–1128	Breaker post.
28	71–1268	Clip for cut-out lead armor.
29	1–20	Screw for condenser mounting.
30	3–27	Lockwasher.
31	71–1139	Timer-lever casting.
32	3–27	Lockwasher.
33	5–114	Screw, timing lever and high-tension lead mounting.
34	71–1244	Plug for cut-out lead.
35	72–883	Cut-out lead assembly.
36	71–1249	Armor for cut-out lead.

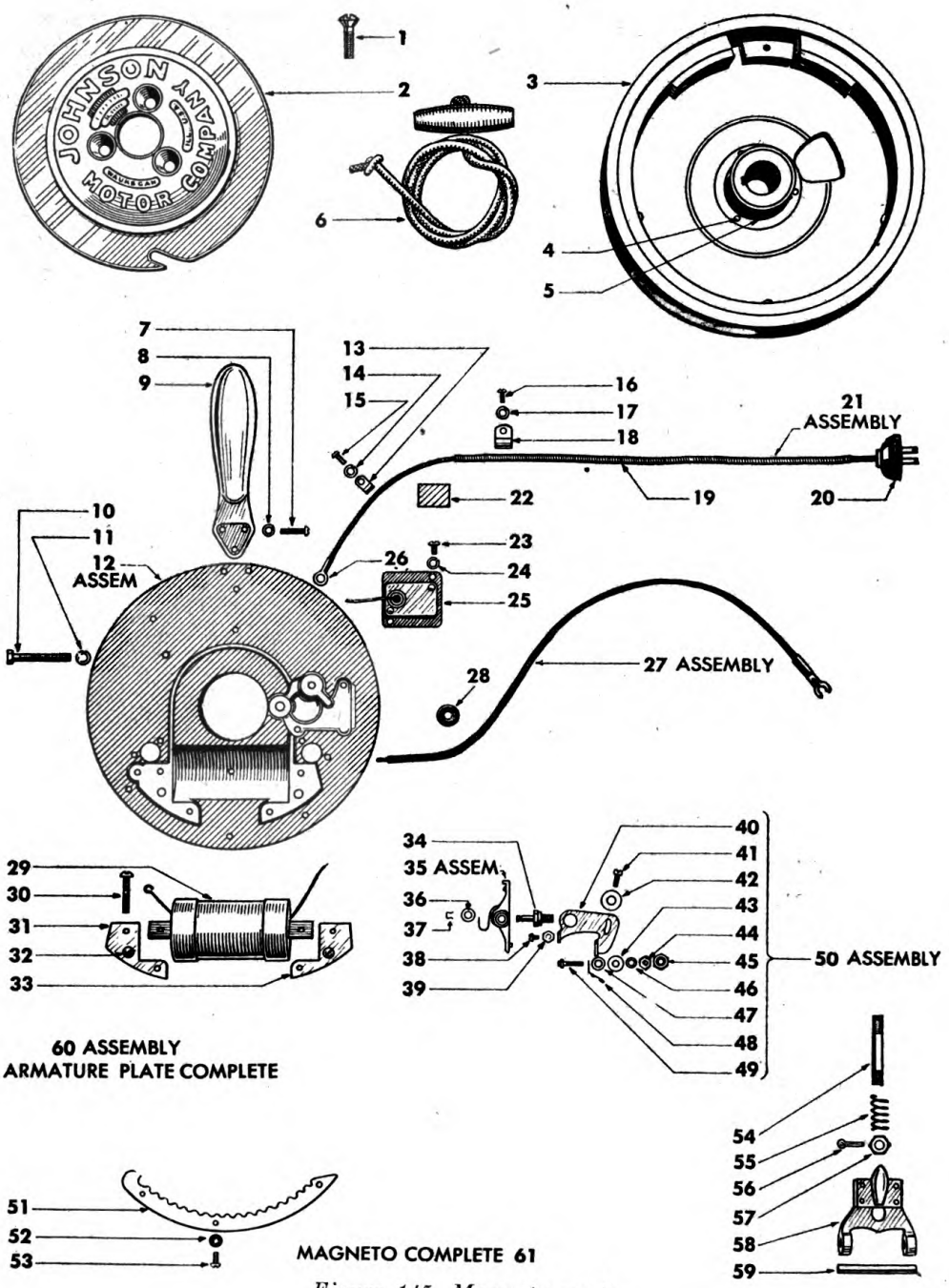


Figure 145. Magneto parts.

Key to figure 145.

No.	*Part No.*	*Nomenclature*
1	21–45	Screw, flywheel cover plate.
2	21–435	Cover plate, flywheel.
3	72–861	Dome, assembly.
4	71–1,054	Drive screw for mounting cam No. 4.
5	71–1,126	Cam.
6	16–19	Starting rope.
7	5–114	Screw, timing lever and high-tension lead mounting.
8	3–27	Lockwasher.
9	71–1,139	Timing-lever casting.
10	71–1,235	Screw for armature-plate clamp No. 12.
11	5–136	Lockwasher, armature-plate clamp screw.
12	72–858	Armature plate and clamp screw.
13	71–1,261	Clip for cut-out lead.
14	3–27	Lockwasher.
15	1–20	Screw for condenser mounting.
16	1–20	Screw for condenser mounting.
17	3–27	Lockwasher.
18	71–1,268	Clip for cut-out lead armor.
19	71–1,249	Armor for cut-out lead.
20	71–1,244	Plug for cut-out lead.
21	72–883	Cut-out lead assembly.
22	71–1,369	Felt pad for condenser pocket.
23	1–20	Screw.
24	3–27	Lockwasher.
25	72–864	Condenser complete.
26	71–60	Terminal for cut-cut lead.
27	72–375,098	High-tension leads.
28	71–1,420	Grommet for ignition lead.
29	72–852	Coil assembly, less heels.
30	71–939	Screw for mounting coil to plate No. 10.
31	72–856	Heel assembly, left hand.
32	71–940	Screw for heels No. 10.
33	72–855	Heel assembly, right-hand.
34	71–1,128	Breaker post.
35	72–736	Breaker arm and spring assembly.
36	71–1,048	Washer for breaker post.
37	71–1,052	Clip spring for breaker post.
38	71–45	Screw, spring mounting.
39	71–471	Nut for screw No. 71–45 and contact screw.
40	71–1,147	Breaker plate.
41	71–31	Screw, mounting breaker No. 10.
42	71–610	Washer for breaker mounting screw.
43	71–49	Washer for contact screw.
44	71–471	Nut.
45	71–1,274	Locknut for contact screw.
46	71–1,148	Insulation bushing.
47	71–66	Insulation washer for contact screw.
48	71–1,240	Terminal, for breaker.
49	71–1,146	Contact point and screw.
50	72–781	Breaker plate and point assembly.
51	71–1,223	Quadrant.
52	3–28	Lockwasher, quadrant screw.
53	71–765	Screw for quadrant, magneto.
54	21–397	Stud, ratchet lever.
55	21–178	Spring, ratchet lever.
56	21–163	Cotter pin, ratchet-lever stud.
57	21–398	Nut, ratchet-lever stud.
58	22–145	Ratchet lever for armature plate
59	21–177	Pin, ratchet lever.
60	72–859	Armature plate complete.
61	72–860	Magneto complete.

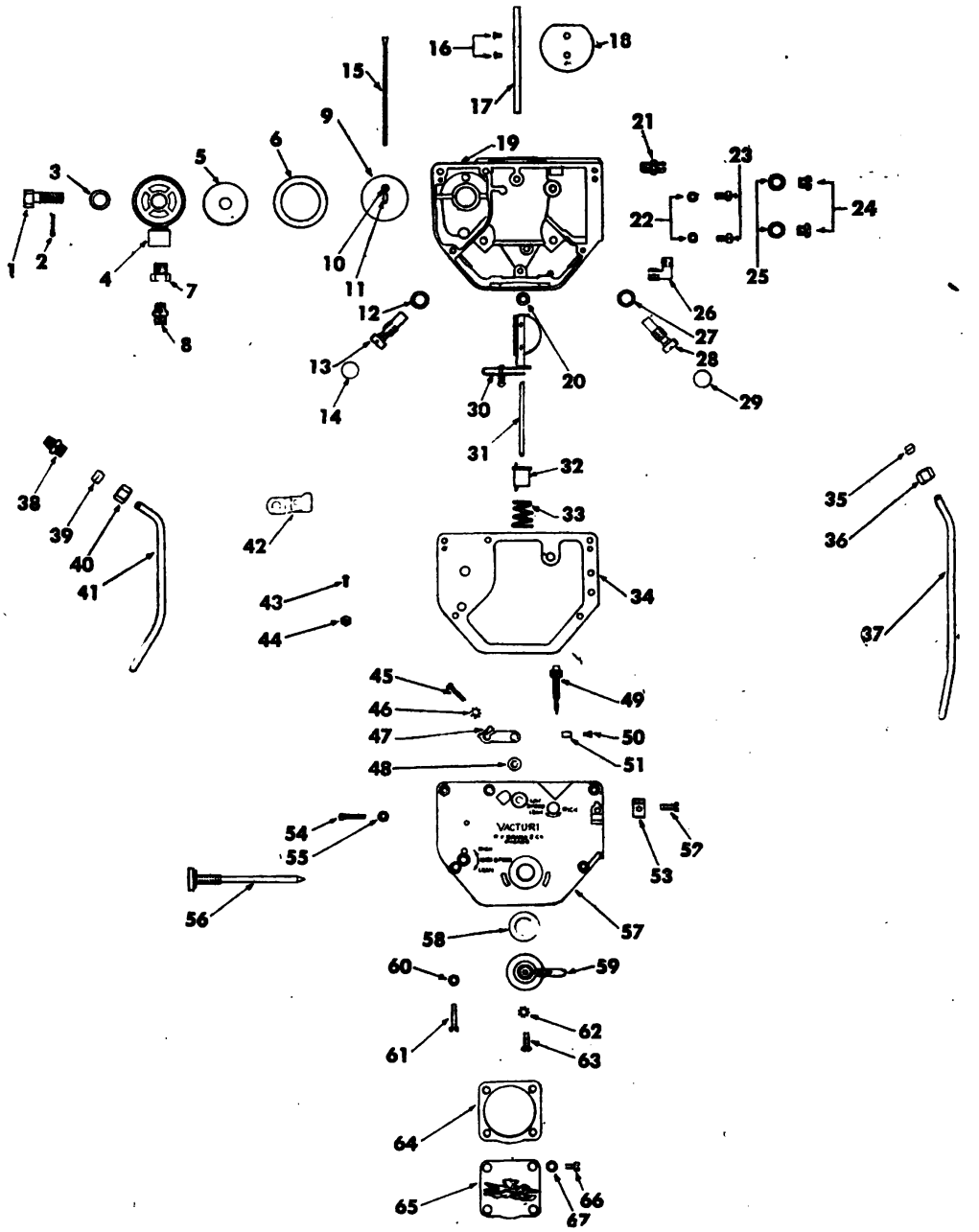


Figure 146. Carburetor parts.

Key to figure 146.

No.	*Part No.*	*Nomenclature*
1	35–101	Retainer screw, strainer housing.
2	21–163	Cotter pin, 1/16- by 5/8-inch.
3	35–103	Gasket, strainer screw.
4	35–99	Strainer housing.
5	35–100	Strainer-screen assembly.
6	35–102	Gasket, strainer.
7	13–136	Bushing, straight connection to carburetor.
8	13–365	Straight connection.
9	35–97	Float.
10	3–34	Screw, float clip No. 4.
11	35–110	Float clip.

Key to figure 146—Continued.

No.	Part No.	Nomenclature
12	29–300,802	Gasket, Venturi tube.
13	29–300,794	Venturi tube.
14	29–300,808	Expansion plug.
15	29–300,800	Float valve.
16	71–45	Screw, throttle plate.
17	29–300,791	Shaft, throttle.
18	29–300,805	Plate, throttle.
19	29–196	Carburetor body.
20	29–300,803	Thrust washer, choke.
21	21–553	Straight connection, gas line to carburetor.
22	23–194	Gasket, fuel-passage screw.
23	23–232	Screw, fuel-passage.
24	35–104	Plug, fuel-passage.
25	35–108	Gasket, fuel-passage plug.
26	13–364	Elbow, carburetor drain.
27	29–300,802	Gasket, venturi tube.
28	29–300,794	Venturi tube.
29	29–300,808	Expansion plug.
30	29–300,795	Plate assembly, choke.
31	29–300,799	Shaft, choke.
32	29–300,798	Pivot plug, choke lever.
33	29–300,804	Spring, choke lever.
34	29–300,793	Gasket, cover.
35	13–304	Gland.
36	13–305	Nut.
37	29–300,783	Drainpipe, air passage.
38	13–365	Straight connection.
39	13–304	Gland.
40	13–305	Nut.
41	29–300,782	Drainpipe intake passage.
42	21–457	Clamp.
43	13–100	Screw, No. 10.
44	71–1102	Nut, No. 10.
45	29–300,810	Screw, throttle-lever clamp.
46	71–915	Lockwasher, lever clampscrew No. 10.
47	29–300,790	Lever throttle.
48	35–107	Thrust washer.
49	29–300,796	Needle valve, slow-speed.
50	15–249	Screw, swivel nut No. 10.
51	71–1,308	Swivel nut, control cable.
52	21–491	Screw, carburetor control cable clip.
53	21–484	Clamp, carburetor control cable.
54	29–300,811	Screw, throttle-adjustment.
55	85–64	Locknut, throttle-adjustment screw.
56	29–300,797	Needle valve, high-speed.
57	29–300,789	Cover, carburetor.
58	29–300,801	Gasket, choke-lever.
59	29–300,792	Lever, choke.
60	13–52	Lockwasher, cover-screw.
61	35–114	Screw, cover.
62	35–116	Lockwasher, choke-lever screw.
63	29–300,809	Screw, choke-lever.
64	29–170	Gasket, carburetor-panel.
65	29–167	Panel, carburetor.
66	21–283	Screw, carburetor panel No. 10.
67	3–28	Lockwasher, panel screw.

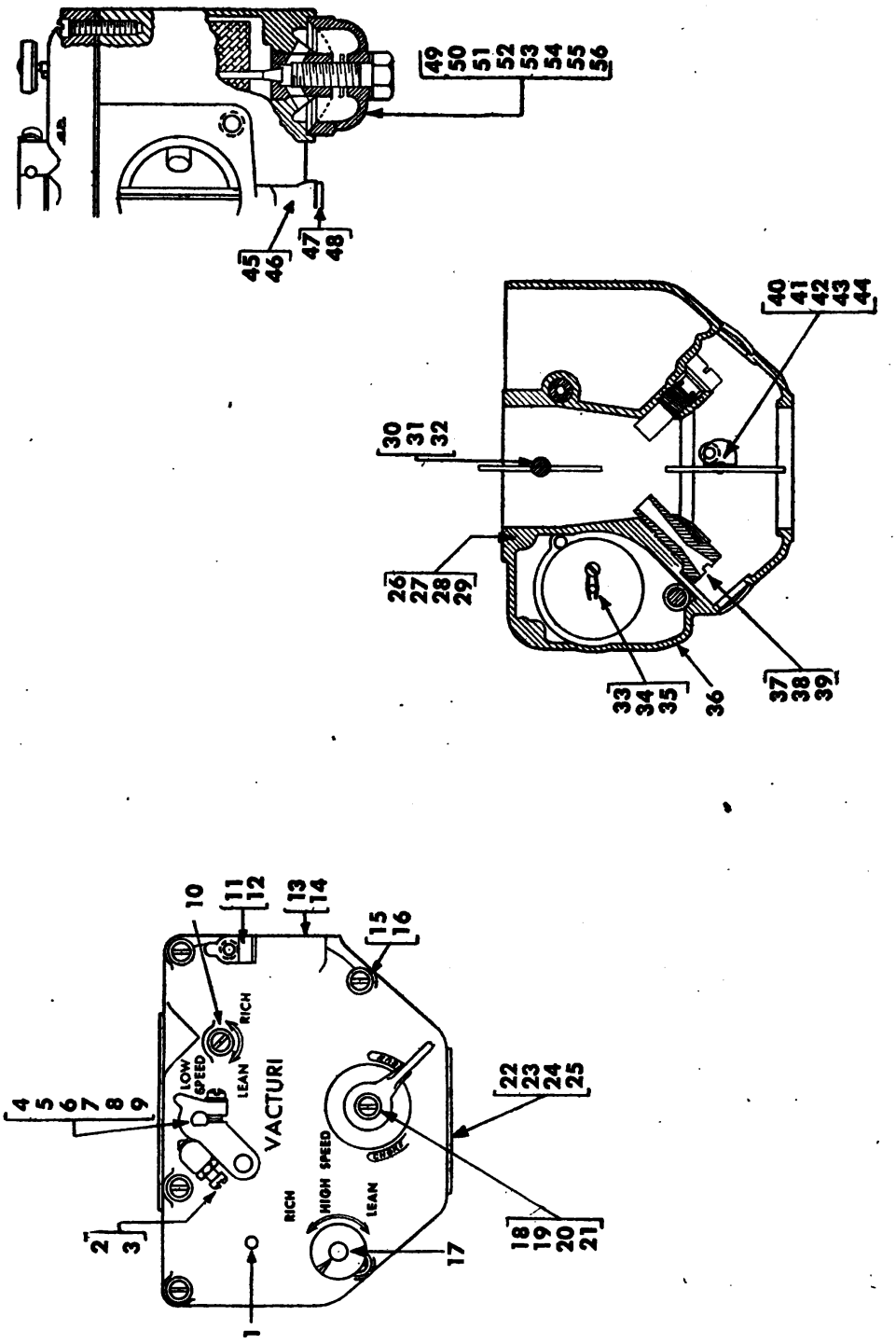


Figure 147. Carburetor parts.

Key to figure 147.

No.	*Part No.*	*Nomenclature*
1	29–300,800	Float valve.
2	29–300,811	Screw, throttle-adjustment.
3	85–64	Locknut, throttle-adjustment screw.
4	29–300,790	Lever, throttle.
5	29–300,810	Screw, throttle-lever clamp.
6	71–915	Lockwasher, lever clampscrew No. 10.
7	35–107	Thrust washer.
8	71–1,308	Swivel nut, control cable.
9	15–249	Screw, swivel nut No. 10.
10	29–300,796	Needle valve, slow-speed.
11	21–484	Clamp, carburetor control cable.
12	21–491	Screw, carburetor control cable clip.
13	29–300,789	Cover, carburetor.
14	29–300,793	Gasket, cover.
15	35–114	Screw, cover.
16	13–52	Lockwasher, cover-screw.
17	29–300.797	Needle valve, high-speed.
18	29–300,792	Lever, choke.
19	29–300,801	Gasket, choke lever.
20	29–300,809	Screw, choke lever.
21	35–116	Lockwasher, choke-lever screw.
22	29–167	Panel, carburetor.
23	29–170	Gasket, carburetor panel.
24	21–283	Screw, carburetor panel No. 10.
25	3–28	Lockwasher, panel screw.
26	29–162	Gasket, carburetor to crankcase.
27	25–28	Stud, carburetor to crankcase.
28	7–227	Lockwasher, carburetor to crankcase stud.
29	7–56	Nut, carburetor to crankcase stud.
30	29–300,805	Plate, throttle.
31	29–300,791	Shaft, throttle.
32	71–45	Screw, throttle plate.
33	35–97	Float.
34	35–110	Float clip.
35	3–34	Screw, float clip No. 4.
36	29–196	Carburetor body.
37	29–300,794	Venturi tube.
38	29–300,802	Gasket, Venturi tube.
39	29–300,808	Expansion plug.
40	29–300.795	Plate assembly, choke.
41	29–300.799	Shaft, choke.
42	29–300,798	Pivot plug, choke lever.
43	29–300,804	Spring, choke lever.
44	29–300,803	Thrust washer, choke.
45	29–232	Screw, fuel-passage.
46	23–194	Gasket, fuel-passage screw.
47	35–104	Plug, fuel-passage.
48	35–108	Gasket, fuel-passage plug.
49	35–99	Strainer housing.
50	35–100	Strainer-screen assembly.
51	35–101	Retaining screw, strainer-housing.
52	35–102	Gasket, strainer.
53	35–103	Gasket, strainer-screen.
54	21–163	Cotter pin, 1/16- by 5/8-inch.
55	13–136	Bushing, straight connection to carburetor.
56	21–553	Straight connection, gas line to carburetor.

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