TM 5-2036

WAR DEPARTMENT TECHNICAL MANUAL

PUMP, CENTRIFUGAL

1½ DISCHARGE, 125 G.P.M.

300-FOOT HEAD

GASOLINE ENGINE DRIVEN

MODEL B-180, ECONOMY

NOTE. This is a reprint of TM 5-2036. No distribution will be made to personnel possessing the original publication.

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TM 5–2036, Pump, Centrifugal, 1½ Discharge, 125 G. P. M., 300-Foot Head, Gasoline Engine Driven, Model B–180, Economy, is published for the information and guidance of all concerned.

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BY ORDER OF THE SECRETARY OF WAR:

G. C. MARSHALL
Chief of Staff

OFFICIAL:
J. A. ULIO
Major General
The Adjutant General

Foreword

This manual has been published in the interest of those who operate, maintain and service the Economy Model B-180 portable pumping unit.

These units carry Economy serial numbers 95359 to 95458 inclusive, and were built for the Corps of Engineers, United States Army under War Department's Purchase Order 56579.

For convenience, manual is arranged into two major divisions with each division divided into three functional sections.

DIVISION I—PUMP

DIVISION II—ENGINE

ALPHABETICAL INDEX

DIVISION I—PUMPS

DIVISION II—ENGINE

ECONOMY MODEL B-180
PORTABLE PUMPING UNIT

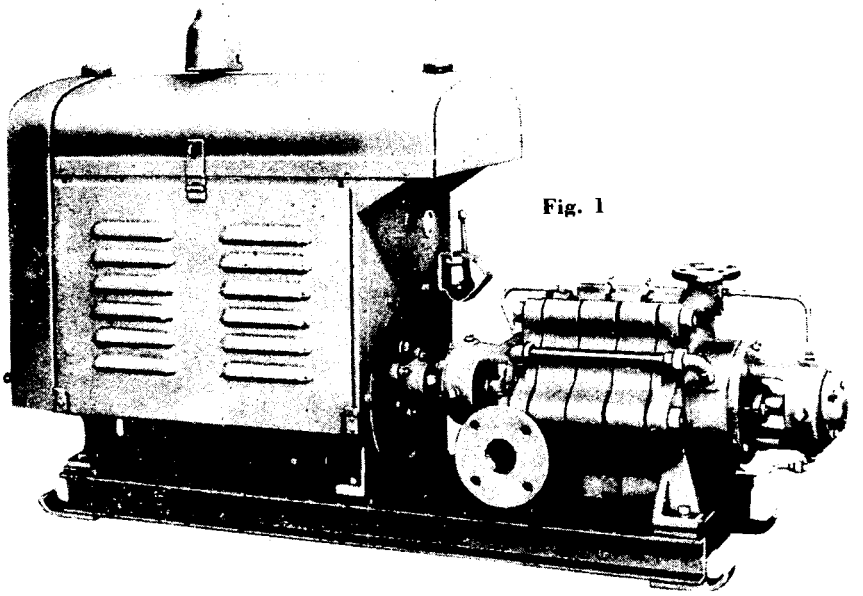


Fig. 1

OUTLINE DIMENSIONS FOR
ECONOMY MODEL B-180
PORTABLE PUMPING UNIT

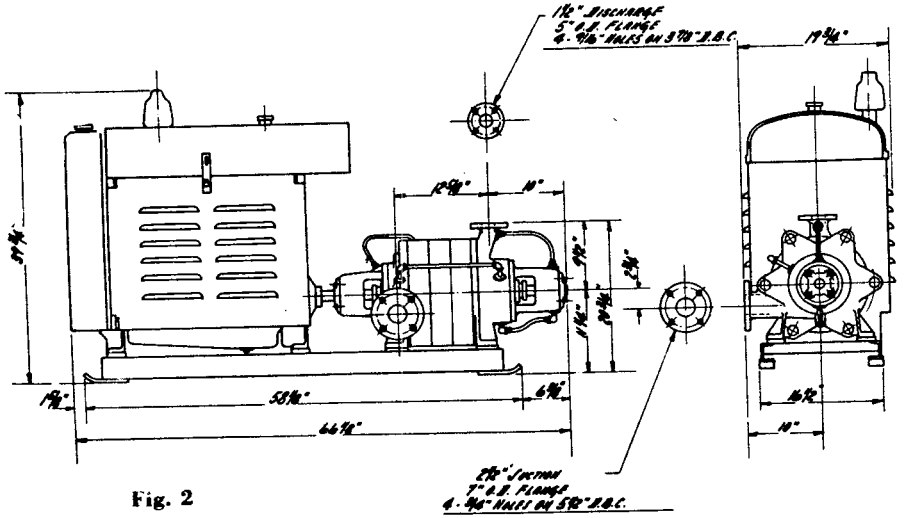
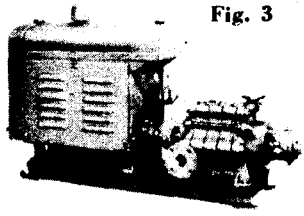


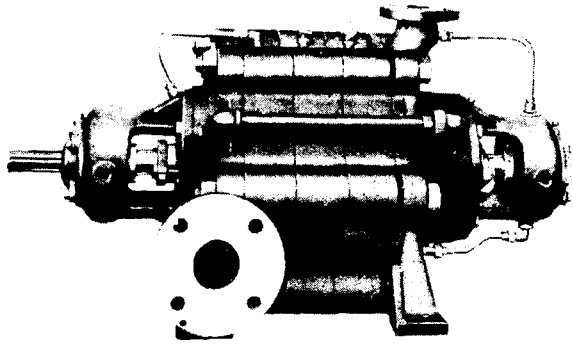
Fig. 2

Fig. 3



Economy B-180
Portable Pumping Unit

Fig. 4



Economy B-180 — 2½" x 1½" Type CS
Four Stage Centrifugal Pump

The Economy Model B-180 portable pumping unit as illustrated consists of two distinct pieces of machinery. The pump is an Economy 2½" x 1½" vertically split case multi-stage pump. Division I is devoted to this pump. The driving machine is a Le Roi Model D-133, water cooled gasoline engine. See Division II for engine data.

Engine is direct connected to pump by means of flexible coupling. Pump and engine are properly aligned and fastened to a welded structural steel skid.

The pump, although of sturdy and careful construction, will perform more efficiently and its operating life will be considerably increased if operator will familiarize himself with its construction, operation and maintenance. The few simple instructions as presented on the pages that follow will prepare the operator to properly care for his machine.

OPERATOR'S INSTRUCTIONS

STARTING PUMP AND ENGINE
(Condensed Instructions)

a — Always keep pump and engine level.

b — Tighten suction and discharge lines to pump.

c — See that pump is primed.

Examples:

1 — No priming required when pump is under positive suction pressure.

2 — With no suction pressure available attach foot valve to suction line and prime pump.

Pump

a — Lubricate radial and thrust bearings.

b — Check packing in packing boxes.
Do not pull glands too tightly.

c — Open pet cocks at top of stages to vent air, close after running two minutes.

Engine

a — Check gasoline in fuel tank.

b — Check water in radiator.

c — Check crankcase oil level.

d — Check fan pulley and water pump grease cups.

e — Check choke and engine throttle.

Note:

These are condensed instructions for starting the complete Economy Model B-180 Portable Pumping unit.

For precise instructions see page 14 for pump and pages 60, 61 and 62 for engine.

SPECIFICATIONS

Pump	Economy 2½" x 1½" Type CS Vertical Split Case Multi-Stage Pump
No. of Stages	Four
Size Discharge	1½" — 125# Std. Flange
Size Suction	2½" — 125# Std. Flange
Capacity	125 GPM
Head	300 Ft.
R.P.M.	1860
Case	C. I.
Fitted	Bronze
Impellers	9" Dia.
Shaft	SAE — 4140 — 1⅝" Dia.
Bearings	Radial and Thrust Ball Bearings

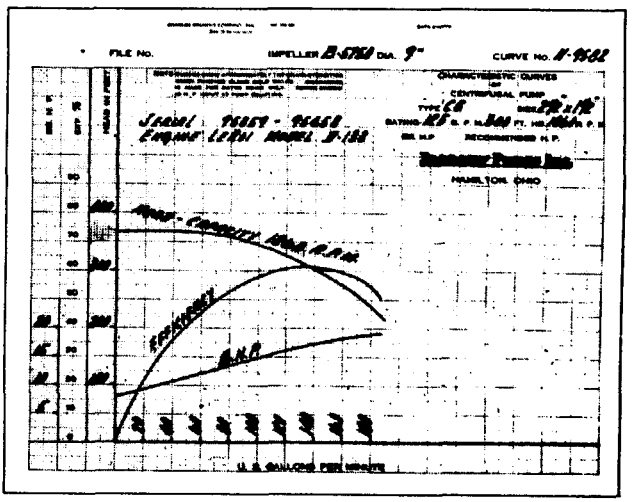


Fig. 5

Pump Performance Curve

OPERATOR'S INSTRUCTIONS

GENERAL INSTRUCTIONS

The operation of an Economy 2½" x 1½" Type CS vertically split multi-stage pump is simple and easy to understand. However, there are a number of things common to such a pump which a new operator ordinarily cannot learn except from experience.

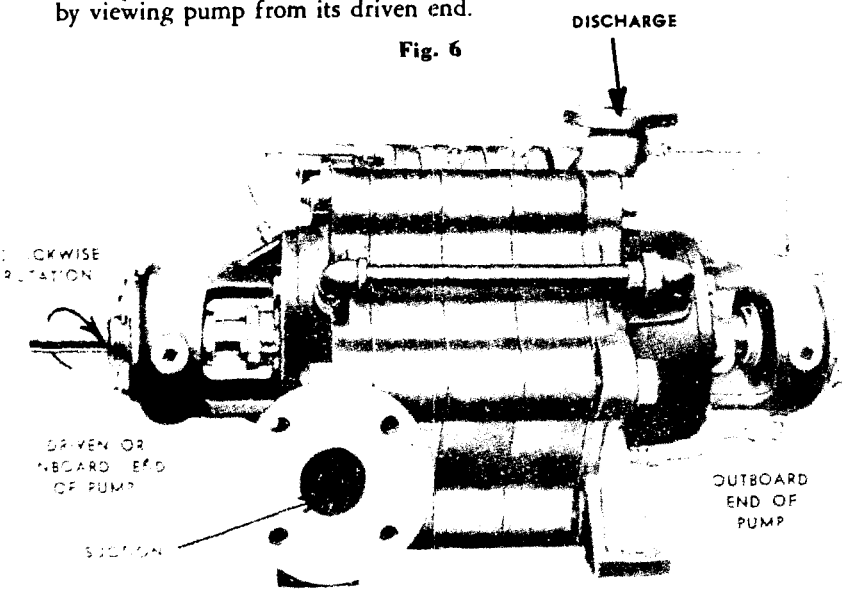
A—Since this particular pump is composed of four stages and the total head is 300 feet, each impeller delivers one-fourth of the total head or 75 feet of head.

$$\frac{\text{Total Head}}{\text{Number of Stages}} = \text{Delivered head per stage or impeller.}$$

B—The cycle of operation can easily be determined by viewing pump from the front side or, the side which places the coupling end of pump shaft to the left. The horizontal suction (2½" — 125# Std. Flange) is on the left or first stage, and the vertical discharge (1½" — 125# Std. Flange) is at the right, or, above the fourth or last stage. When pumping, water enters the suction and passes successfully to each stage until forced through discharge.

C—Operating rotation is clockwise. Correct rotation can be determined by viewing pump from its driven end.

Fig. 6



Front Side
2½" x 1½" Type CS Pump
Four Stages

GENERAL INSTRUCTIONS

D—The outboard bearing (a) is a double row radial and thrust ball bearing of adequate capacity to carry any hydraulic thrust built up by the pump. Housing for this bearing is jacketed, providing means to cool bearing by water circulation. Circulation is a component part of the pump operation. Water flows from discharge nozzle (b) through line (c) into housing jacket (d). From the jacket it is returned to pump through line (e) into balance chamber (f) from whence it is circulated through equalizer connection (g) back to suction chamber (h).

E—Inboard bearing (j) is a single row ball bearing of maximum capacity type. Housing for this bearing is not provided with water cooling.

F—Inboard packing box (k) is equipped with a lantern ring for water sealing. Water is forced from first stage of pump (1) into ring through line (m).

G—Outboard packing box (n) does not have water sealing arrangement.

H—To counteract pressure set up at last stage of pump an equalizer line (g) is provided. This line releases pressure from balance chamber (f) back to suction chamber (h).

I—Petcock type air vents (r) are provided at top of case for releasing entrapped air.

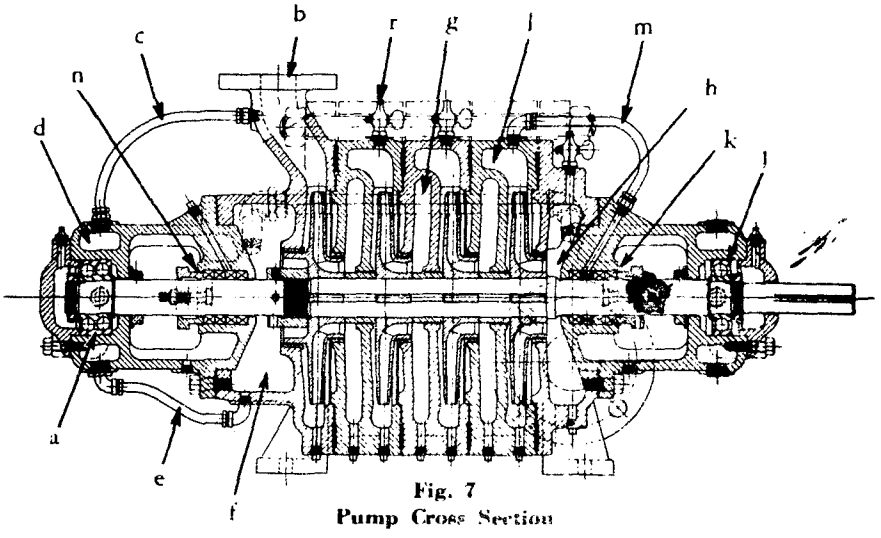


Fig. 7
Pump Cross Section

STARTING PUMP

Caution should be exercised by the operator when starting a pump. Operator's attention is directed to the following important instructions.

A — Important

Keep pump level while operating.

B — Lubrication

Be sure that radial ball bearing (left end of pump) and thrust ball bearing (right end) are properly lubricated. However, do not over lubricate as too much grease will cause bearing to overheat, result of which may be a damaged and idle pump. A new pump is properly lubricated at the factory. No attention is required until after approximately 500 hours of operation.

C — Packing Boxes

Check to see that packing is not overworn and that glands are pulled up properly. Do not adjust them too tightly. Compressing packing will score shaft and overload motor. A slight leakage is essential to efficient operation of the pump. Packing box is properly fitted and inspected before shipment, therefore requires no attention when starting a new pump.

D — Important Precaution

Before subjecting pump to any actual pumping job it is well to determine whether liquid to be pumped is injurious to pump parts. Unit is built to handle clear water or liquids and will not pass larger size solids. Whenever water contains excessive amounts of heavy silt or sand, a strainer should be used on suction line to the pump. This will prevent silt, sand or small solids from entering into the pump and causing serious wear and damage.

E — Priming

If unit is used where city water pressure is present, the pump will prime itself. This is also true whenever suction head is available. However, if unit operates under conditions where there is a suction lift, means must be provided to prime the pump. This can be done, simply, by using a foot valve at end of suction line and pouring water into case through the discharge of the pump, before discharge connection is made.

F — Air Vents

Keep pet-cocks at top of pump open when priming and do not shut them off until pump has been in operation for several minutes. Entrapped air in the case is thus released, the result being, quieter and more efficient operation.

STORING

When a pump is not to be used for a period of time it should be stored in a warm, dry, protected place. To leave equipment outside, exposed to the elements, will materially shorten its life.

These instructions should be followed whenever pump is placed in storage for periods exceeding thirty days.

A—Remove all water from the pump. Pipe plugs for draining purposes are provided at bottoms of casings, suction chamber, balance chamber, water jacket around thrust bearing housing and the packing box wells. Should pump be operated during temperatures of 32° or lower water should be drained every night unless unit is stored in a warm dry place.

B—Be sure that bearings are properly lubricated (not overlubricated) as grease will prevent bearing from rusting due to temperature changes, weather, etc.

C—Grease exposed portions of pump shaft.

D—If finish on pump has been injured, respot or repaint before placing in storage.

TROUBLES AND REMEDIES

1 — Noise, Loss of Efficiency

a) Air Binding	Entrapped air in cases should be released. Be sure water seal line for inboard packing box is clean and functioning properly.
b) Worn Impeller Wearing Rings	Should be replaced.
c) Worn Spacer Sleeves	Should be replaced.
d) Damaged Case	Repair if possible. Replace if necessary.

2 — Excessive Leakage

a) Packing Worn	Replace.
b) Scored Pump Shaft	Result of pulling packing gland too tight. If not serious, shaft should be refinished at points where it passes through stuffing box. If seriously scored old shaft should be replaced by a new one.

3 — Bearing Failure

a) Too much Lubrication	Overheats. Never over-lubricate bearings.
b) Lack of Lubrication	Bearings run dry. May cause serious damage and shut down. Keep bearings under constant surveilance.
c) Poor alignment between pump and motor	Whenever pump is removed from its mounting caution must be exercised in remounting so that proper alignment between pump and motor is attained. While coupling is flexible and can take a fair degree of misalignment it cannot withstand extraordinary acute misalignment. Correct alignment will add longer life to the bearings.
d) Overheating of Outboard (Thrust) Bearing	Poor cooling water circulation in lines. Keep clean and free from clogging.

TROUBLES AND REMEDIES

4 — Loss of Capacity

a) Worn Impellers	Replace if seriously worn.
b) Worn Impeller Wearing Rings	Replace.
c) Worn Impeller Spacer Sleeves	Replace.
d) Low R.P.M.	Check drive unit.
e) Damaged Case	Repair if possible. Replace if necessary.
f) Air Binding	See No. 1.
g) Clogging of Impellers or Casing	Remove for cleaning.

5 — Loss of Head

a) Worn Impellers	Replace if seriously worn.
b) Worn Impeller Wearing Rings	Replace.
c) Worn Impeller Spacer Sleeves	Replace.
d) Low R.P.M.	Check drive unit.
e) Damaged Case	Repair if possible. Replace if necessary.
f) Air Binding	See No. 1.

CASING ASSEMBLY

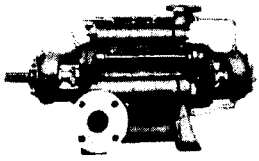


Fig. 8

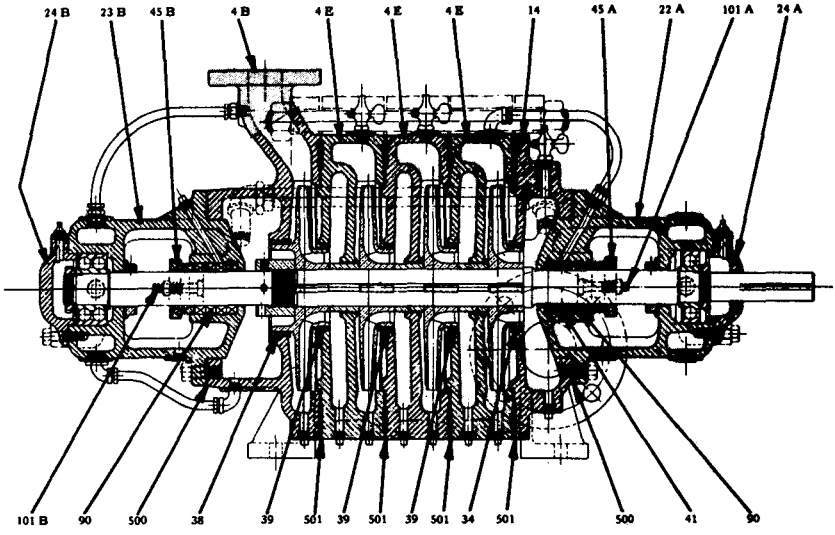


Fig. 9
Cross Section of Pump Showing Casing Assembly

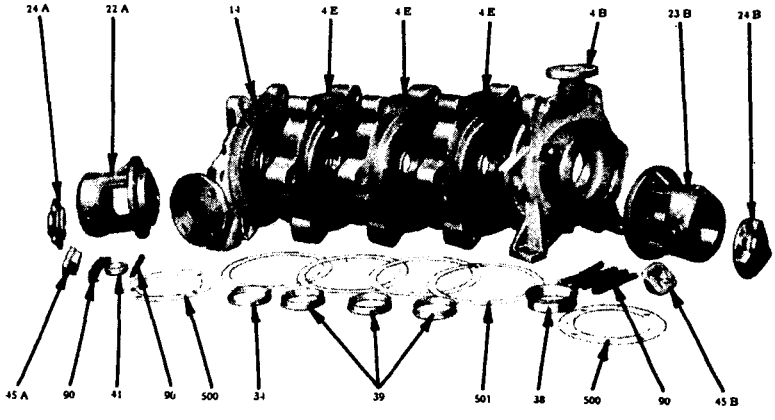


Fig. 10
Casing Assembly Parts

CASING

Figures 9 and 10 show the major component parts which make up the pump casing, exclusive of nuts, bolts, fittings and other minor parts. These illustrations are keyed with reference numbers coinciding with numbers as found in Parts List, Section 3. For minor parts refer to Misc. Parts — 4 in Parts List, Section 3.

To prevent rusting and maintain appearance of pump proper, casing should be inspected periodically for undue wear and chipping of finish. Whenever necessary chip spots or wear should be respotted or refinished. Surfaces to be refinished should be sanded sufficiently to remove any rust. A primer is then applied using a good grade of Gray Iron Filler such as Grand Rapids Varnish Company's No. 55-020 or equal. After properly preparing surface with filler, allowing it to dry thoroughly, finish can then be applied either by brushing or by spray gun. It is best to use the same finish that has been applied at the factory. The specifications are:

Paint — U. S. Army Spec. ES-680 Class No 4.
Ammendment Jan. 2, 1942.

Thinner — U. S. Army Spec. ES-370-B.
Ammendment Jan. 2, 1942.

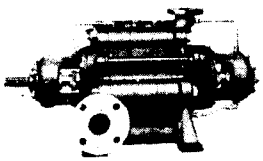


Fig. 8

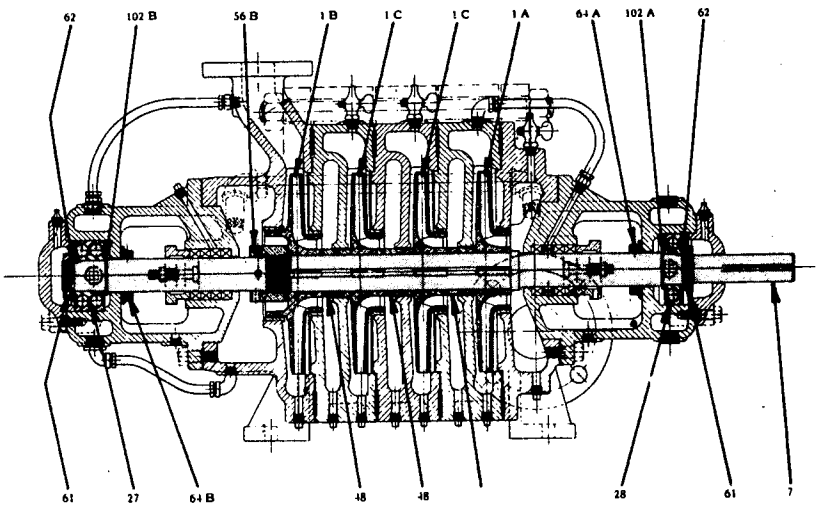


Fig. 11 Cross Section of Pump Showing Rotor Assembly

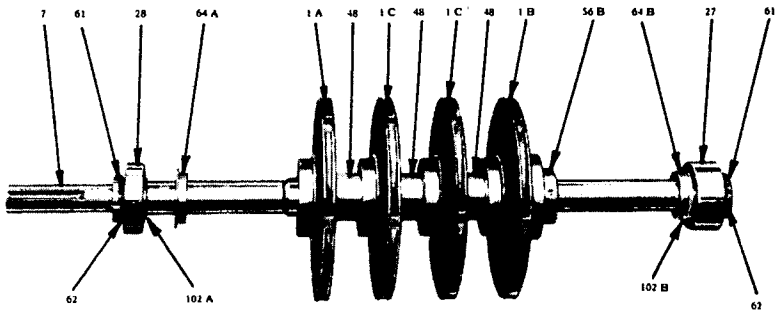


Fig. 12 Assembled Rotor

ROTOR

Figures 11 and 12 illustrate the major component parts of the pump rotor assembly. Impeller keys, set screws for the impeller nut and flingers are listed in Parts List — Section 3 under Misc. Parts 4.

Rotor assembly does not require special attention except when dismantling pump for inspection or repairs and when reassembling. The rotor is always the first assembly which must be completed before re-building a pump. This is explained in Assembling and Dismantling — 3 under Maintenance Instructions, this section.

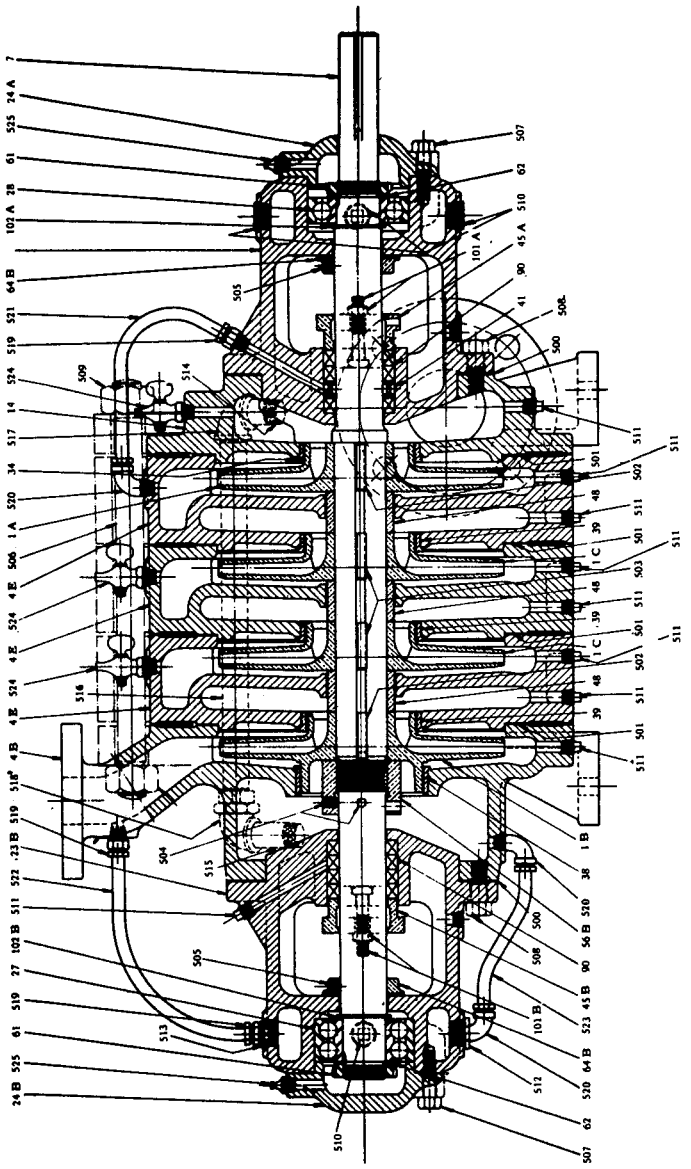


Figure 13
Cross Section of Pump Showing all Parts

ASSEMBLING

The best position for assembling the pump is in a vertical position. Illustration, Figure 14 describes the suggested equipment.

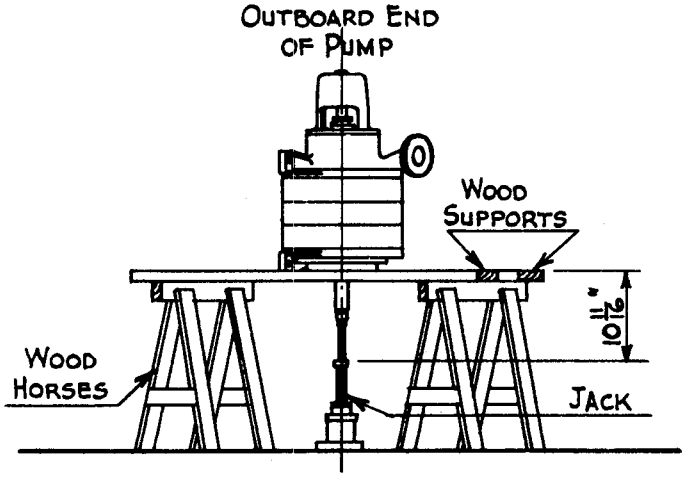


Fig. 14
Assembly Stand and Adjuster

Before proceeding with assembly of pump proper be sure to, first, assemble complete rotor. (See Figures 11 and 12 in Rotor Assembly 2 under Maintenance Instructions.) The reason for building up the rotor prior to pump assembly is very important by virtue of these reasons:

a) To see that all parts fit properly with one another.

b) So that complete rotor can be properly balanced. File or grind impeller shrouds until proper balance is achieved. One of the most efficient machines for balancing is a disc type balancing way.

c) To see that there are no burrs of any kind on impellers or shaft. File if necessary.

Upon assembly do not tighten Impeller Nut (56B) too tightly. When forced it may have a tendency to spring the shaft. It should be just tight enough so that Impeller (1 A), (1 B), (1 C) and Spacer Sleeves (48) are snugly tight against one another and not loose.

After Rotor Assembly has been properly balanced and inspected, disassemble completely. Assembly of pump is then begun in accordance to these subsequent instructions using Fig. 13 for guide.

1—Place Suction Cover (14) on stand with small end down and large end (Impeller side) up.

ASSEMBLING (Continued)

2—Shaft (7), Inboard Impeller (1A) and first Spacer Sleeve (48) are then assembled to one another and this partial rotor assembly is set into place. (When using jack, see Figure 14, place driving or inboard end of shaft directly on jack.)

3—Shellac gasket surface on Suction Cover (14) and place Gasket (501) evenly into place making sure bolt holes conform with Suction Cover.

4—Paint upper face of gasket with graphited oil.

5—Place case for first stage, Intermediate Volute (4E) into position.

6—Assemble second stage Intermediate Impeller (1C) and the second Spacer Sleeve (48) into position on shaft.

7—Shellac gasket surface on first stage Intermediate Volute (4E) and place Gasket (501).

8—Paint upper face of Gasket with graphited oil.

9—For successive stages repeat instructions 5, 6, 7 and 8, until last stage case is in place, ready to receive outboard volute (Discharge Case) (4B).

10—Assemble Outboard Impeller (1B) into position.

11—Screw Impeller Nut (56B) on shaft to lock Impeller and Spacer Sleeve assembly in place. Be sure not to tighten impeller nut too tightly. When forced too tight it may cause shaft to spring, which may result in excessive binding of rotor assembly or quickly worn impeller wearing rings and impeller hubs. These conditions along with excessive wear have a tendency to overload motor. Nut should be just tight enough to hold impellers and spacer sleeves snugly in place with no lateral movement. After nut is properly screwed in place, secure it with two set screws (504). See Figure 13 for set screws.

12—Shellac gasket surface on the last intermediate volute placed. Put Gasket (501) into place.

13—Paint upper face of Gasket with graphited oil.

14—Set outboard volute (4B) into place.

15—Next step is to lightly bolt together casing assembly with Studs (506) and Nuts (509). These are 6 Studs, each with two nuts. Tighten bolts lightly and only enough to hold casings together. *Do not make final tightening adjustments.*

16—Shellac gasket surface which receives Bearing Housing. Fit Gasket (500) into place.

ASSEMBLING (Continued)

17—Paint upper face of Gasket with graphited oil.

18—Next step is to assemble the water cooled Outboard Bearing Housing (23B) to the pump. Place it over shaft with small end up and lower into place just far enough to permit shaft to extend through stuffing box about 1½". Before allowing shaft to enter bearing chamber, slip Outboard Flinger (64B) over shaft. Now seat Bearing Housing and bolt lightly to Outboard Volute with 4 Cap Screws, Bearing Housing Bolts (508).

19—Slip Outboard Shoulder Ring (102B) over shaft and seat against shaft shoulder after which press Thrust Ball Bearing (27) into place against shoulder ring.

20—Lock bearing with Lockwasher (61) and Locknut (62).

21—Bolt Outboard Bearing Cap (24B) to bearing housing with 4 cap screws, Bearing Cap Bolts (507). After securing cap, check to see whether bearing is snugly held in place. Rotor assembly should now be in fixed position in relation to casing assembly and there must not be any movement of rotor, either up or down. Outboard bearing has been designed to allow no clearance between bearing and cap or bearing and housing shoulder or shaft shoulder ring.

22—Screw Greasing Connection (525) into position.

23—Grease pack bearing chamber with grease gun through greasing connection (525). *Do not overlubricate.* See Lubrication 8, in this section for greasing instructions.

24—Now level pump mounting legs and make final tightening adjustment on Studs (506) holding casing together. Level legs on Suction Cover (14) with legs on Outboard Volute (4B) by using an accurate steel straight edge. Tighten opposite nuts on studs and rotate this procedure with short turns until final adjustment has been attained. *Do not turn home each nut independently.*

25—Fasten Bearing Housing to Outboard Volute by tightening Bolts (508). Tighten opposite bolts with short turns, keeping rotation up until final adjustment.

26—While pump is still in vertical position, it is a convenient procedure to assemble all fittings to pump. The fittings which can be attached are:

A) 2—Plugs for Outboard Bearing Housing (510).

B) 8—Casing Plugs (511).

C) 1—Inlet line to bearing cooler water jacket consisting of:

a) 1—Inlet Bushing (513).

b) 2—Straight Compression Fittings (519).

c) 1—Inlet Tubing (522).

ASSEMBLING (Continued)

D) 1—Outlet line from bearing cooler water jacket consisting of:

a) 1—Outlet Bushing (512).

b) 2—Elbow Compression Fittings (520).

c) 1—Outlet Tubing (523).

E) 1—Equalizer line consisting of:

a) 1—Suction Chamber Nipple (514).

b) 1—Balance Chamber Nipple (515).

c) 1—Equalizer Line Nipple (516).

d) 1—Elbow (517).

e) 1—Elbow Union (518).

F) 3—Vent Petcocks (524).

27—All the assembling that can be done with pump in vertical position has now been completed. Remove pump from stand and place horizontally on a suitable and level surface for completing assembly of inboard parts.

28—Shellac bearing housing gasket surface on Suction Cover (14). Put Gasket (500) into place.

29—Paint upper surface of gasket with graphited oil.

30—Place Inboard Bearing Housing (22A) over inboard or driven end of shaft just far enough so that shaft protrudes through stuffing box by about 1½". Before allowing shaft to enter bearing chamber first place Water Seal Ring (41) on shaft and following it with the Inboard Flinger (64A). Now seat Bearing Housing and tighten it to suction cover by using 4 cap screws, Bearing Housing Bolts (508).

31—Slip Inboard Shoulder Ring (102A) over shaft and seat it against shaft shoulder.

32—Press Radial Bearing (28) into place. Must seat against shoulder ring.

33—Lock bearing to shaft with Lockwasher (61) and Locknut (62).

34—Slip Inboard Bearing Cap (24A) over shaft and secure it to bearing housing with 4 cap screws, Bearing Cap Bolt (507).

35—Screw Greasing Connection (525) into place on Inboard Bearing Cap.

36—Grease pack bearing chamber with grease gun through greasing connection (525). *Do not overlubricate.* See Lubrication 8, this section for greasing instructions.

ASSEMBLING (Continued)

37—At this time complete the assembly of the remaining fittings to inboard end of pump. The remaining fittings are:

a) 4 Plugs for Inboard Bearing Housing (510).

b) Water Seal line consisting of:

1—Straight Compression Fitting (519).

1—Elbow Compression Ftting (520).

1—Water Seal Line Tubing (521).

38—Set both Outboard and Inboard Flingers (64) and (64A) about 1/16" from face of bearing chambers and secure tightly to shaft with Set Screw (505). There is one set screw for each flinger.

39—Pack Outboard stuffing box with 4 rings of Packing (90) and compress slightly when assembling Outboard Stuffing Gland (45B) to pump with 2 Gland Bolts and Nuts (101B). Stuffing gland is split allowing for easy assembly and future packing operations. Stuffing Box is equipped with slotted ears to receive heads of Gland Bolts (101B). After bolts are in place compress packing in stuffing box by tightening on gland bolt against stuffing gland. Stuffiing gland should be pressured evenly by using like adjustment on both sides. *Never pull stuffing gland too tight.* See Replacing Worn Packing 7, this section, regarding packing.

40—Place one ring of Packing (90) into base of Inboard Stuffing box and adjacent to it place Water Seal Ring (41). Follow ring with 2 rows of Packing (90) and then assemble Inboard Stuffing Gland (45A) with 2 Gland Bolts and Nuts (101A) similar to assembly of Outboard group as described in 39.

41—Pump is now completely assembled and if every assembly step has been properly handled, rotor should move freely when shaft extension is turned by hand. There should be no friction, binding or drag. If rotor does not revolve smoothly and freely, pump should be dismantled step by step until cause has been found and eliminated.

IMPORTANT

While assembling the pump, oil should be used on Impeller Hubs and Impeller Wearing Rings (34), (38) and (39). Also oil exposed surfaces of Spacer Sleeves (48). A good grade of clean machine oil from an ordinary spouted oil can is recommended. This will give rotor free action when subjecting it to trial turnings.

After each step in the assembling operation, give rotor trial spins to make sure that parts are correctly placed and fit with one another thereby causing no friction, rubbing, bind or unbalanced condition.

ASSEMBLING (Continued)

Adjustments for free rotor rotation in relation to casing parts can be made by raising or lowering Adjuster. See Figure 14.

To seal casing against leaks, use white lead on threads of all bolts, and fittings. Likewise, use white lead on casing studs and bearing cap bolts to insure against loosening by vibration. White lead also preserves threads from rusting and deterioration caused by water or oxidization.

DISMANTLING OR TEARING DOWN PUMP

Reversing the step-by-step operations as outlined in the instructions is recommended for dismantling the pump.

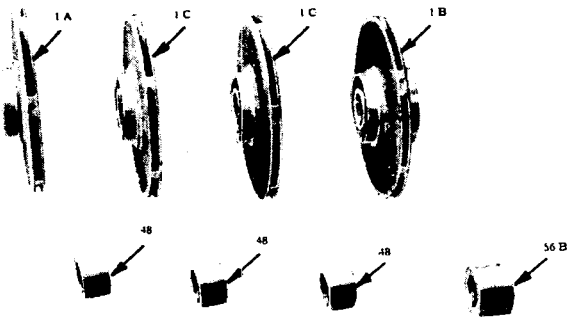


Fig. 15

REPLACING IMPELLERS AND SPACER SLEEVES

Whenever pump loses its efficiency in maintaining either the established discharge or head, it may be due to worn impellers. There are several reasons for worn impellers. Some of the more common are:

a) Pumping water containing sand, grit or small solids.
b) Pumping liquids other than for which pump was intended.
c) The rotor in relationship to the casing assembly can cause considerable damage by wear when parts do not properly fit one another.

To remove impellers which are to be replaced, dismantle pump step by step in accordance to Assembly and Dismantling Instructions 3, this section.

To remove an impeller which is seemingly frozen to shaft, tap impeller or shaft lightly and sharply with a wood or lead mallet, or, pry with suitable instrument between the shrouds of the impeller. Always pry close to a vane, never in space between the vanes for fear of damaging shrouds should impeller be suitable for use. Tapping impellers loose is recommended as the best procedure.

Replacement impellers are balanced and inspected at the factory, however, they should be checked to see that there are no burrs and have not been damaged while in transit or during stocking and handling. Blow out any dirt or metal particles from impellers before using.

When assembling impellers to shaft always be sure to face the eye or inlet of the impeller to the inboard or driven end of the shaft.

Oil impeller hubs before completing final assembly prior to placing pump into operation.

Spacer sleeves are easily removed by tapping them lightly and smartly with a wood or lead mallet to loosen them from the shaft. Sufficient clearance between sleeve and shaft will permit removal by hand.

In assembling spacer sleeve to shaft never force it into place. Ream to size with approximately .001″ to .0015″ clearance. Running clearance between spacer sleeve and case is from .007″ to .008″.

After properly assembled to shaft and prior to completing pump for actual operation, oil outside surfaces of sleeves.

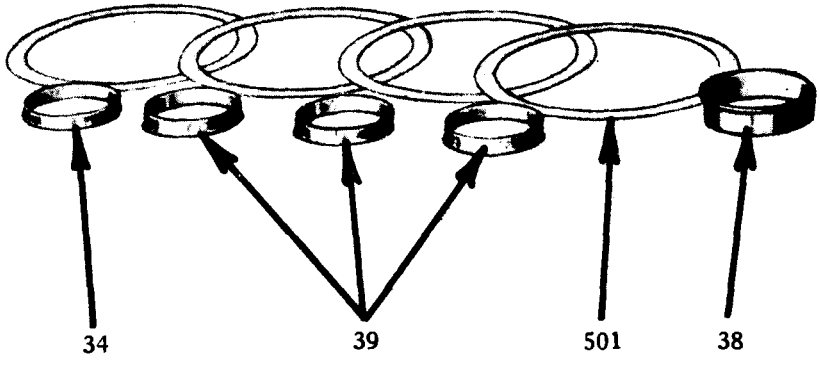


Fig. 16

REPLACING WEARING RINGS

Whenever Wearing Rings are worn, the pump efficiency is down. Sand, grit, and small solids can cause excessive wear with pressure loss resulting from it.

To remove a wearing ring use a keen edged tool between the case and the flange on the ring.

When assembling a new ring to the case use a block of wood to lightly tap or force ring into place. Never hit ring itself with hammer or other metallic instrument. All rings are press fit into case.

Running clearance of rings at impeller hubs is .010" to .012".

Oil inside surface of wearing rings when assembling.

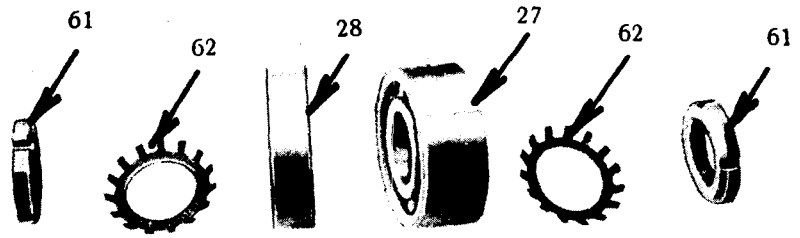


Fig. 17

REPLACING BEARINGS

Bearings are a vital part of the efficient operation of the pump. When bearings are worn through neglect or careless handling the pump will not perform satisfactorily.

Both the Outboard Thrust Ball Bearing and the Inboard Radial Ball Bearing are designed for push fit to the shaft and for light tap fit into their housings.

To remove bearings for replacement or inspection, remove bearing cap and pull bearing off shaft and out of housing with a hook instrument. If bearings are too tightly engaged, tap casing lightly with wood or lead hammer. *Under no circumstances use a hammer of any kind directly on the bearing itself.*

After removal of bearing flush all existing grease from bearing chamber with gasoline. Cover chamber with waste or cloth to prevent dirt from entering.

If bearing is to be re-used, clean it thoroughly in gasoline and when dry repack with fresh clean grease. New replacement bearings are shipped properly packed with grease.

Never leave bearings lie around exposed to dirt or harmful foreign matter. Always keep wrapped or covered and do not uncover until ready for installation.

After bearing has been installed with locknut and lockwasher in place securing bearing to shaft, replace bearing cap. Next add a sufficient amount of fresh clean grease to bearing chamber with gun through greasing connection. *Do not overlubricate.* See Lubrication 8, this section for correct lubrication instructions.

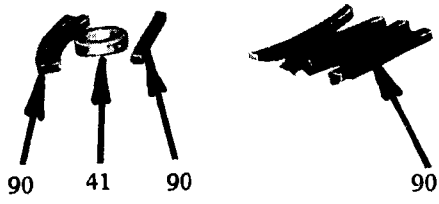


Fig. 18

REPLACING PACKING

To maintain the best possible pump efficiency and service, packing should be replaced when it becomes worn. Worn packing can be responsible for capacity and head losses.

To clean a stuffing box of old packing, first remove stuffing gland, then, remove packing. If packing is extremely worn and old, it may be necessary to use a knife. The water seal ring located in the Inboard stuffing box can be removed by inserting wires or pointed instrument into weep holes found on its face. After all packing has been removed, scrape and flush box clean with gasoline and let dry thoroughly.

When equipping boxes with new packing follow Instruction under Assemblying and Dismantling 3, this section.

Never pull stuffing gland too tight. A slight leakage at these points is essential to the most efficient operation of the pump. Further, packing that is compressed too tightly will score the shaft, cause the packing to become hot, burning itself to uselessness and overload the motor.

Graphite impregnated asbestos is the most serviceable type of packing. Hesters #350 or equal is recommended. The size is $\frac{3}{8}'' \times \frac{3}{8}''$ and each ring should be approximately $6\frac{1}{8}''$ long when laid out flat.

Pump Lubrication 8
Page 1/1

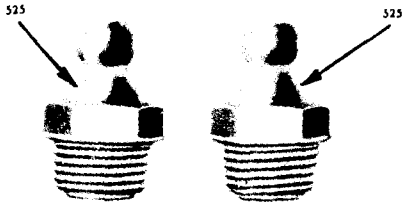


Fig. 19

LUBRICATION

There are only two lubricating points on this pump, one at the Thrust Ball Bearing (Outboard end of pump) and one at the Radial Ball Bearing (Inboard end of pump). Alemite greasing connections are provided in the Bearing Caps which protect the bearing housings. A suitable pressure grease gun should be used for supplying grease to bearing chambers through these connections.

At no time should bearing chambers be filled to more than ⅓ of their estimated capacity. Grease connections should be used only as a convenience for inserting grease and not to put pressure on bearing chambers. Over lubrication causes bearings to run hot as grease acts as an insulator, preventing dissipation of heat.

This list indicates the grease conforming to Army Specifications and symbols, which is recommended for use in lubricating the two ball bearings in the pump.

WB-2 Grease, general purpose, No. 2
U. S. Army Specification 2-108, May 1, 1942.

NUMERICAL PARTS LIST INDEX

Economy B-180 Pump

Ref. No.	Description	Weight*	Page
1-A	Impeller – Inboard	12½ #	49
1-B	Impeller – Outboard	11½ #	49
1-C	Impeller – Intermediate	12½ #	49
4-B	Volute – Outboard	72 #	47
4-E	Volute – Intermediate	74 #	47
7	Shaft	22¾ #	49
14	Suction Cover	72 #	47
22-A	Bearing Housing – Inboard	30 #	47
23-B	Water Cooled Brg. Hsg. – Outboard	30 #	47
24-A	Bearing Cap – Inboard	4 #	47
24-B	Bearing Cap – Outboard	4 #	47
27	Thrust Ball Bearing	2 #	49
28	Radial Ball Bearing	1¼ #	49
34	Suction Cover Wearing Ring	¼ #	47
38	Balance Chamber Wearing Ring	18 #	47
39	Intermediate Casing Ring	¼ #	47
41	Water Seal Ring	4 oz.	47
45-A	Split Stuffing Gland – Inboard	1¼ #	47
45-B	Split Stuffing Gland – Outboard	1¼ #	47
48	Impeller Spacer Sleeve	¾ #	49
56-B	Impeller Nut – Outboard	1¾ #	49
61	Ball Bearing Locknut	¼ #	49
62	Ball Bearing Lockwasher		49
64-A	Flinger – Inboard	½ #	49
64-B	Flinger – Outboard	½ #	49
90	Rings – Packing	2 oz.	47
101-A	Gland Bolt – Inboard	2 oz.	51
101-B	Gland Bolt – Outboard	2 oz.	51
102-A	Shoulder Ring – Inboard	1 oz.	49
102-B	Shoulder Ring – Outboard	1 oz.	49
500	Bearing Housing Gasket – 1/32"		47
501	Volute Gaskets – Paper		47
502	Chamfered Impeller Key	½ #	51
503	Straight Impeller Key	½ #	51
504	Impeller Nut Set Screw	1 oz.	51
505	Flinger Set Screw	1 oz.	51
506	Casing Stud	2½ #	51
507	Bearing Cap Bolt	1 oz.	51
508	Bearing Housing Bolt	2 oz.	51
509	Casing Stud Nut	¼ #	51
510	Bearing Housing Plug	1 oz.	51
511	Casing Plug	1 oz.	51
512	Water Jacket Outlet Bushing	1 oz.	52
513	Water Jacket Inlet Bushing	1 oz.	52
514	Suction Chamber Nipple		52
515	Balance Chamber Nipple	¼ #	52
516	Equalizer Line Nipple	¾ #	52
517	Equalizer Line Elbow	2 oz.	52
518	Equalizer Line Elbow Union	¼ #	52
519	Compression Fitting for Tubing	2 oz.	52
520	Compression Pitting for Tubing	2 oz.	52
521	Water Seal Line Tubing	¼ #	52
522	Bearing Cooler Inlet Tubing	3 oz.	52
523	Bearing Cooler Outlet Tubing	¼ #	52
524	Volute and Suction Cover bent Pet Cocks	¼ #	52
525	Ball Bearing Greasing Connections	1 oz.	54
526	Portable Structural Steel Skid	85 #	56
527	Pump Mounting Bolts	¼ #	56
528	Engine Mounting Bolts	¼ #	56

*NOTE: Parts with no weights shown weigh less than 8 oz.

PARTS LIST

Complete Parts Assembly 1
Page 1/1

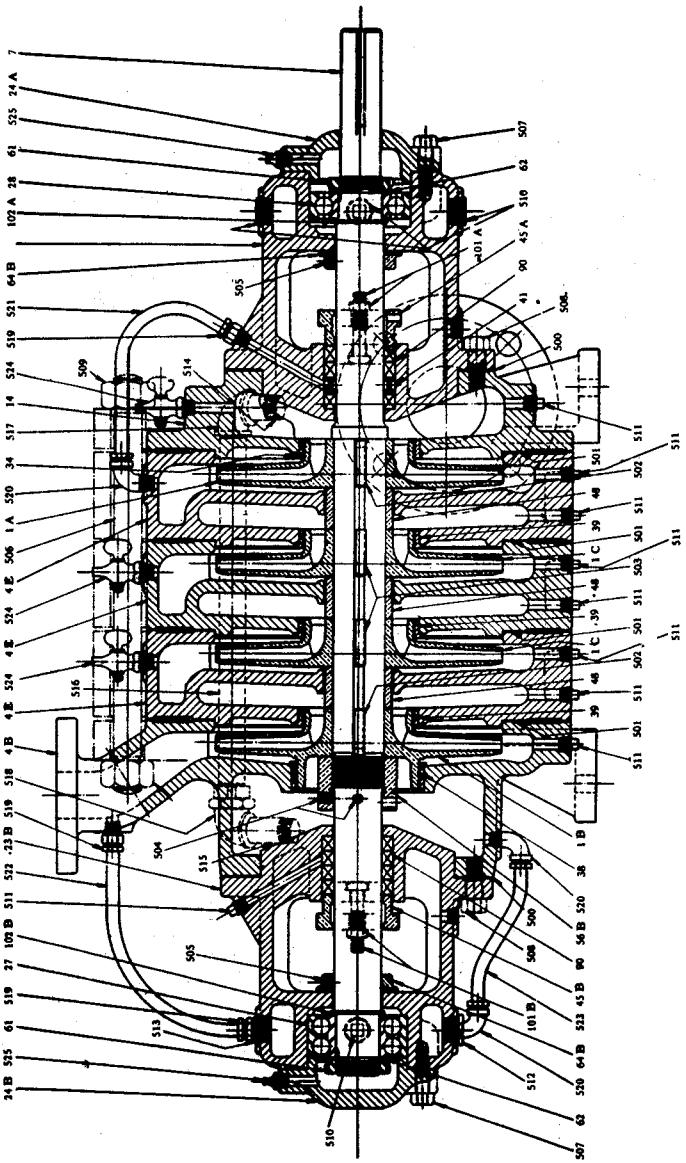


Fig. 13
Cross Section of Pump Showing all Parts

PARTS LIST

Casing Assembly 2
Page 1/2

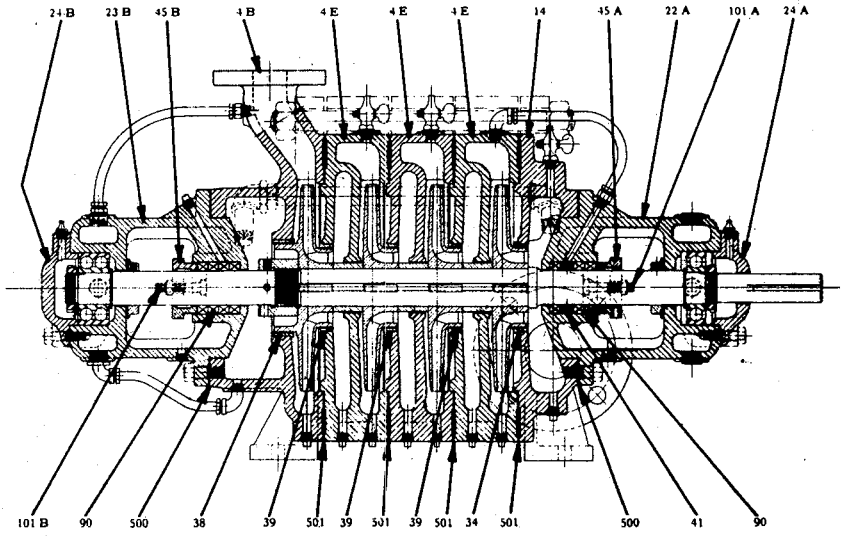


Fig. 20
Cross Section of Pump Showing Casing Parts

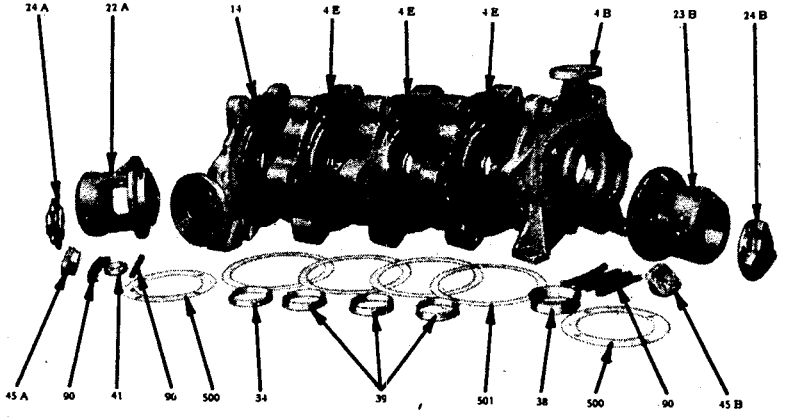


Fig. 21
Photo Illustration Showing Casing Parts

CASING ASSEMBLY

Figs. 20 and 21

Ref. No.	Economy Patt. or Part No.	No. Used	Description	Price Each*
4-B	C-2679	1	Volute—Outboard	$51.04
4-E	C-2678	3	Volute—Intermediate	39.92
14	B-5745	1	Suction Cover	40.24
22-A	B-5760-A	1	Bearing Housing—Inboard	20.38
23-B	B-5760-A	1	Water Cooled Brg. Hsg.—Outboard	20.38
24-A	B-3893-1	1	Bearing Cap—Inboard	1.90
24-B	B-3893	1	Bearing Cap—Outboard	1.90
34	E-4286	1	Suction Cover Wearing Ring	1.90
38	E-4303	1	Balance Chamber Wearing Ring	4.00
39	E-4286	3	Intermediate Casing Ring	1.90
41	E-4290	1	Water Seal Ring	1.80
45-A	E-4289 E-4289-1	1	Split Stuffing Gland—Inboard	2.08
45-B	E-4289 E-4289-1	1	Split Stuffing Gland—Outboard	2.08
90	3/8" x 3/8" 6 1/8" Lg.	7	Rings—Packing	.22
500	E-4331	2	Bearing Housing Gasket—1/32"	.10
501	E-4330	4	Volute Gaskets—Paper	.15

*All prices subject to change without notice. Prices shown are for Domestic Shipments. Add 10% to prices for Export Processing.

PARTS LIST

Rotor Assembly 3
Page 1/2

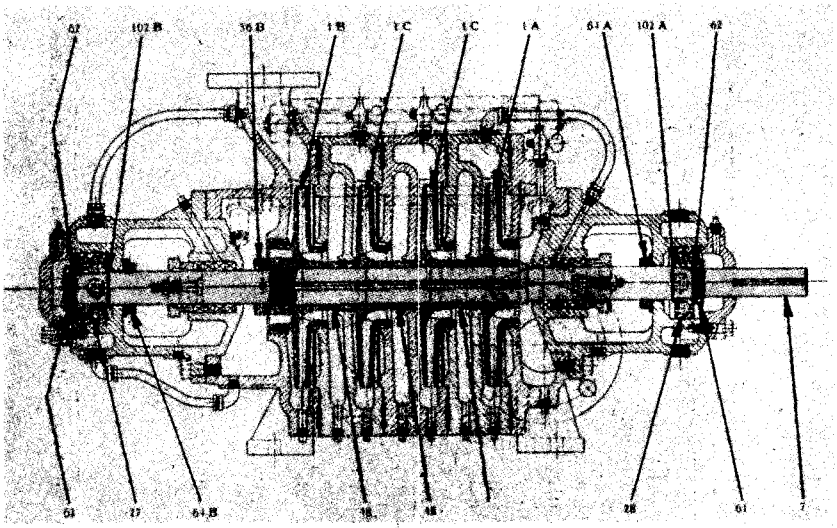


Fig. 22
Cross Section of Pump Showing Rotor Parts

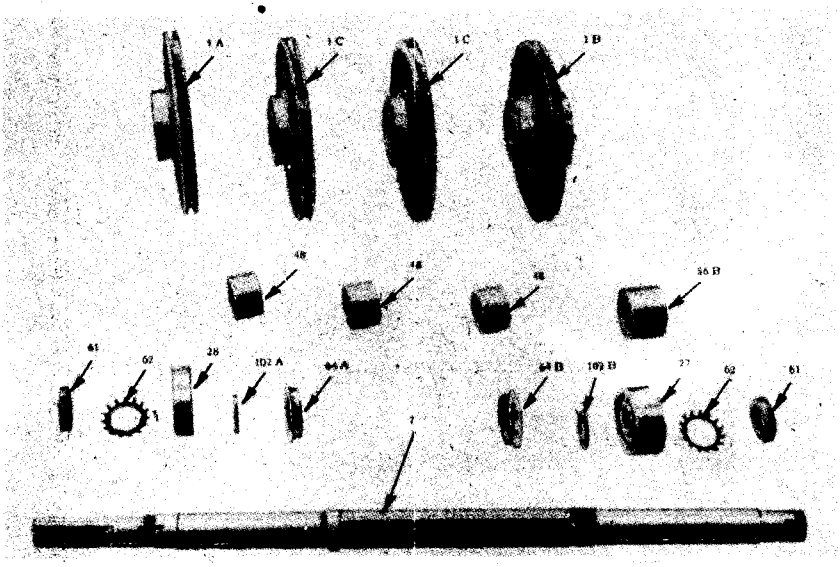


Fig. 23
Photo Illustration of Rotor Parts

ROTOR ASSEMBLY

Figs. 22 and 23

Ref. No.	Economy Patt. or Part No.	No. Used	Description	Price Each*
1-A	B-5750	1	Impeller—Inboard	$25.44
1-B	B-5750-A	1	Impeller—Outboard	29.19
1-C	B-5750	2	Impeller—Intermediate	25.44
7	B-5761-2	1	Shaft	35.60
27	MRC-5307	1	Thrust Ball Bearing	5.40
28	MRC-307-M	1	Radial Ball Bearing	3.14
48	E-4285	3	Impeller Spacer Sleeve	1.44
56-B	E-4301	1	Impeller Nut—Outboard	3.20
61	MRC-N-07	2	Ball Bearing Locknut	.28
62	MRC-W-07	2	Ball Bearing Lockwasher	
64-A	E-4300	1	Flinger—Inboard	2.52
64-B	E-4300	1	Flinger—Outboard	2.52
102-A	E-4302	1	Shoulder Ring—Inboard	.60
102-B	E-4302	1	Shoulder Ring—Outboard	.60

*All prices subject to change without notice. Prices shown are for Domestic Shipments. Add 10% to prices for Export Processing.

PARTS LIST

Misc. Parts 4
Page 1/3

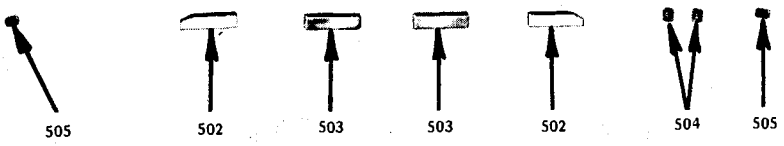


Fig. 24
Misc. Rotor Parts

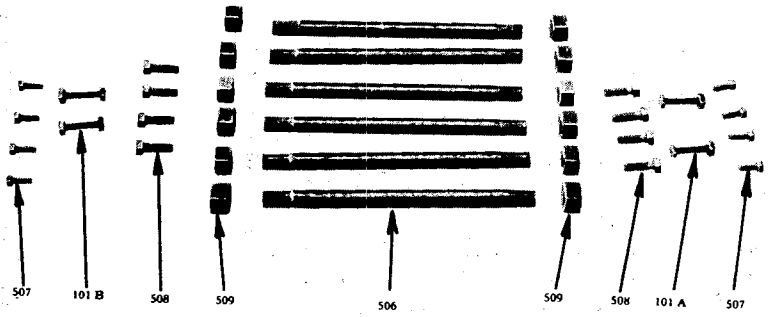


Fig. 25
Casing Bolts and Nuts

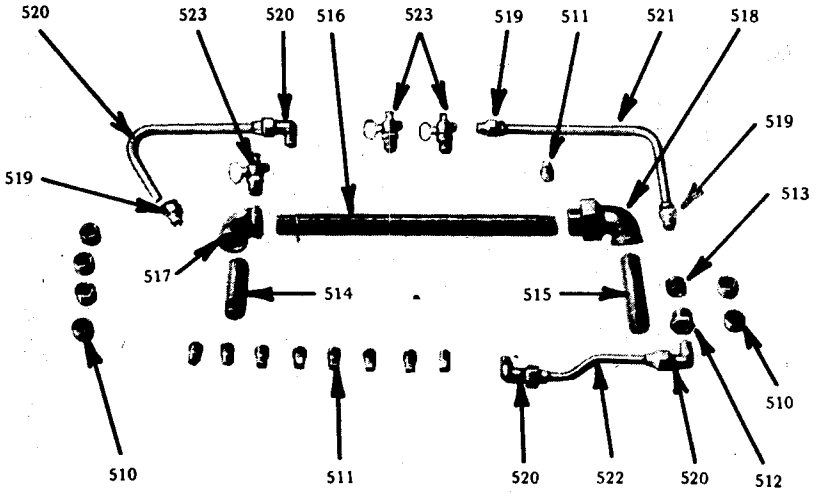


Fig. 26
Casing Fittings

PARTS LIST

Figs. 24, 25 and 26

Ref. No.	Economy Patt. or Part No.	No. Used	Description	Price Each*
502	5/16" x 5/16" x 1½"	2	Chamfered Impeller Key	$ .20
503	5/16" x 5/16" x 1½"	2	Straight Impeller Key	.15
504	5/16" x 5/16" Lg. Allen Head Cup Point	2	Impeller Nut Set Screw	.06
505	¼" x ⅜" Lg. Allen Head Cup Point	2	Flinger Set Screw	.08
506	E-4347	6	Casing Stud	.30
507	⅜" x 1" Lg. Hex. Cap Screw	8	Bearing Cap Bolt	.06
508	½" x 1½" Lg. Hex. Cap Screw	8	Bearing Housing Bolt	.08
509	⅞" U. S. S. Hex. Nut	12	Casing Stud Nut	.06
101-A	⅜" x 2" Lg. Sq. Hd. Mach. Bolt and Nut	2	Gland Bolt—Inboard	.08
101-B	⅜" x 2" Lg. Sq. Hd. Mach. Bolt and Nut	2	Gland Bolt—Outboard	.08
510	½" Ctsk.	6	Bearing Housing Plug	.08
511	¼" Sq. Hd. Pipe	9	Casing Plug	.06

*All prices subject to change without notice. Prices shown are for Domestic Shipments. Add 10% to prices for Export Processing.

PARTS LIST

Figs. 24, 25 and 26

Ref. No.	Economy Patt. or Part No.	No. Used	Description	Price Each*
512	1/2" to 1/4" Hex.	1	Water Jacket Outlet Bushing	$ .32
513	1/2" to 1/4" Face	1	Water Jacket Inlet Bushing	.28
514	1/2" x 2 1/2" Lg.	1	Suction Chamber Nipple	.10
515	1/2" x 3 1/2" Lg.	1	Balance Chamber Nipple	.12
516	1/2" x 11 1/4" Lg.	1	Equalizer Line Nipple	.21
517	1/2"-90° Std.	1	Equalizer Line Elbow	.44
518	1/2"-90° Female	1	Equalizer Line Elbow Union	.80
519	1/4" P. T. x 3/8" Tube Straight	3	Compression Fitting for Tubing	.24
520	1/4" P. T. x 3/8" Tube 90° Male Elbow	3	Compression Pitting for Tubing	.36
521	3/8" O. D.	1	Water Seal Line Tubing	.10
522	3/8" O. D.	1	Bearing Cooler Inlet Tubing	.12
523	3/8" O. D.	1	Bearing Cooler Outlet Tubing	.10
524	1/4" Straight	3	Volute and Suction Cover Vent Pet Cocks	.30

*All prices subject to change without notice. Prices shown are for Domestic Shipments. Add 10% to prices for Export Processing.

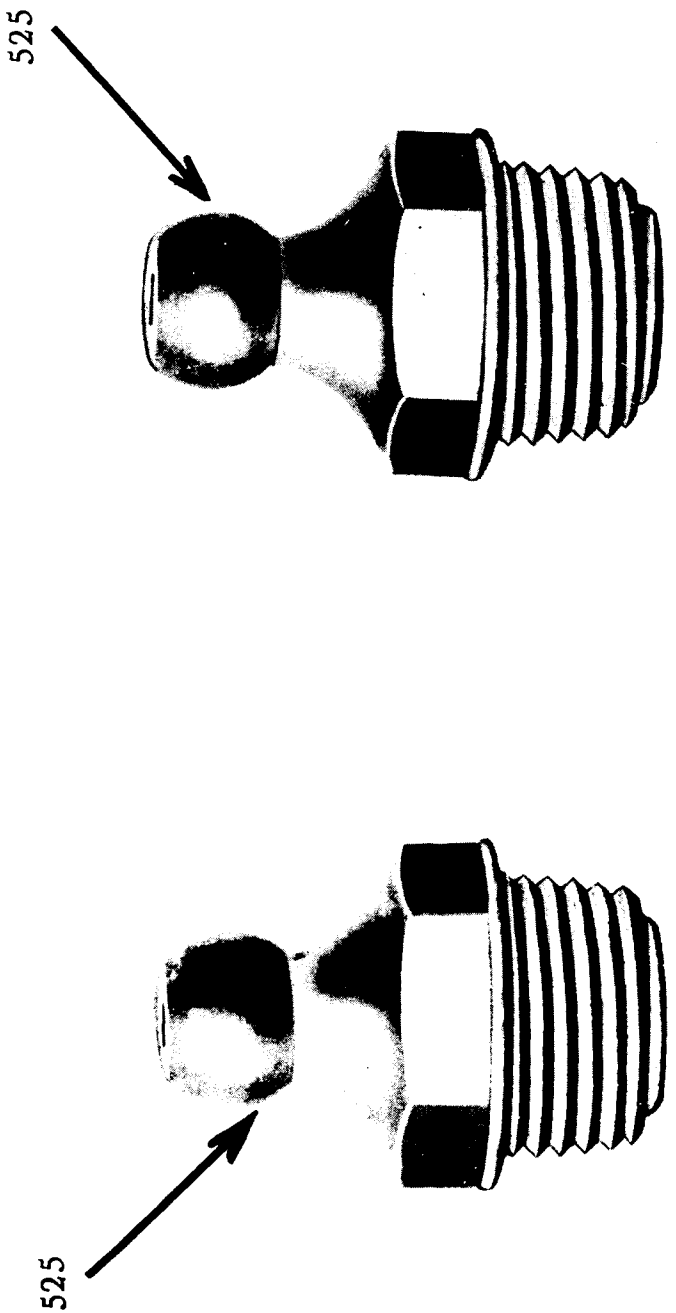


Fig. 27

PARTS LIST

Fig. 27

Ref. No.	Economy Patt. or Part No.	No. Used	Description	Each* Price
525	1610 Alemite Hydraulic	2	Ball Bearing Greasing Connections	$ .30

*All prices subject to change without notice. Prices shown are for Domestic Shipments. Add 10% to prices for Export Processing.

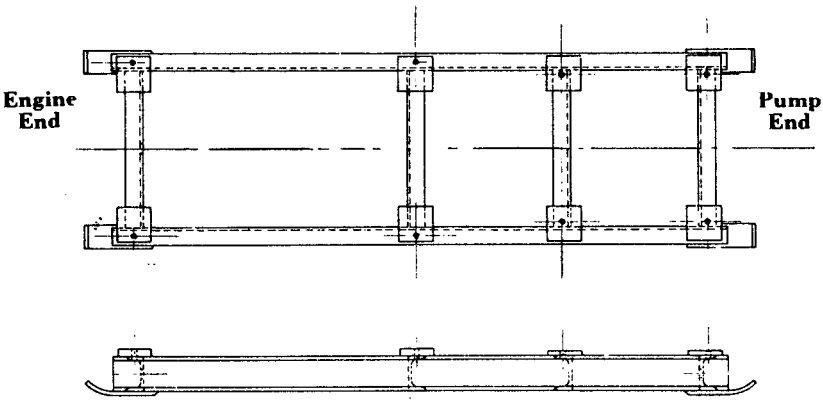


Fig. 28
Portable Skid — 526

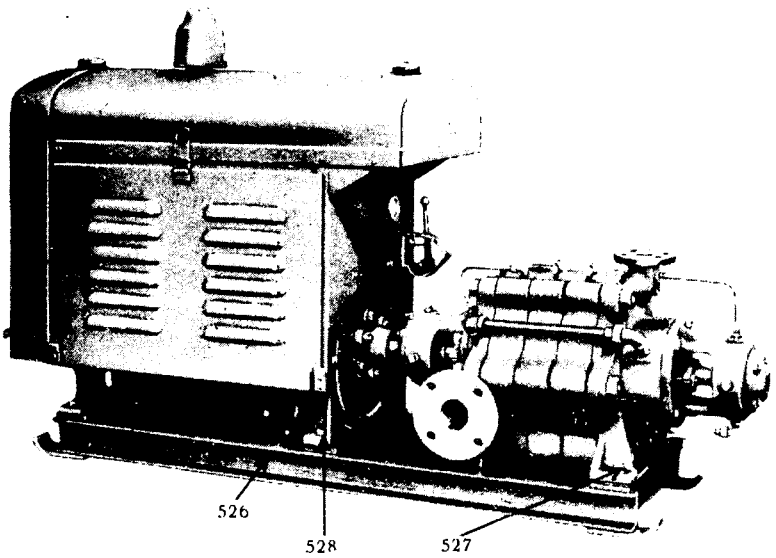


Fig. 29
Photo Illustration Showing Portable Skid Assembled with Pump and Engine

PARTS LIST

Figs. 28 and 29

Ref. No.	Economy Patt. or Part No.	No. Used	Description	Price Each*
526	B-5754-1	1	Portable Structural Steel Skid	$62.00
527	1/2" U. S. S. x 1 1/4" Lg.	4	Pump Mounting Bolts	.08
528	5/8" U. S. S. x 1 1/4" Lg.	4	Engine Mounting Bolts	.10

*All prices subject to change without notice. Prices shown are for Domestic Shipments. Add 10% to prices for Export Processing.

OPERATOR'S INSTRUCTIONS

LeRoi D-133 Engine

The standard LeRoi D-133 power unit is made up of the engine equipped with starting crank, bellhousing, flywheel, manifolds, exhaust pipe and muffler, governor with variable speed control, full pressure lubrication system with gear type pump and pressure gauge, water pump, fan, radiator, carburetor, screen type air cleaner, gasoline tank, gasoline filter, high tension magneto with impulse coupling, spark plugs, ignition cables and switch all enclosed in a heavy gauge sheet steel housing.

Engine is direct connected to pump by means of flexible coupling.

A thorough study of the simple instructions that follow will help operator to familiarize himself with the construction, operation and maintenance of his machine.

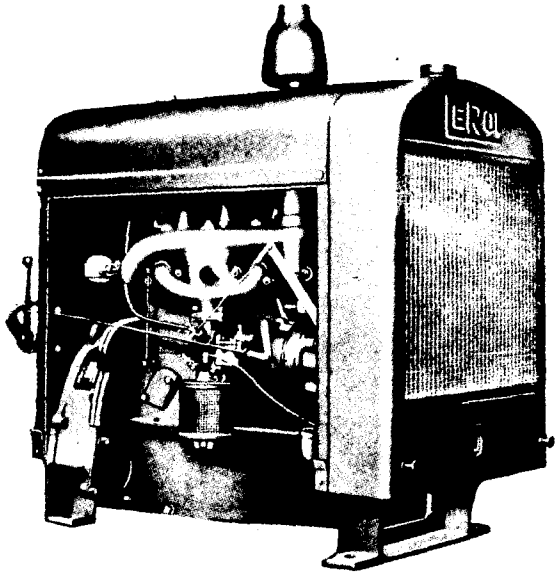


Fig. 30

ENGINE SPECIFICATIONS

Engine	LeRoi D-133
Cylinders	4
Bore	3¼"
Stroke	4"
Displacement (Cu. In.)	133
Engine Speed (Governed)	1860 R.P.M.
Magneto — WICO	Model C-4
Spark Plug Gap	.020" to .025"
Valve Clearance (Engine Hot)	.008" to .010"
Carburetor	⅞"
Fuel Tank	10 gals.
Water Cooling System	3½ gals.
Crankcase Pan	5 qts.

Coupling:

Flexible Type	6½"

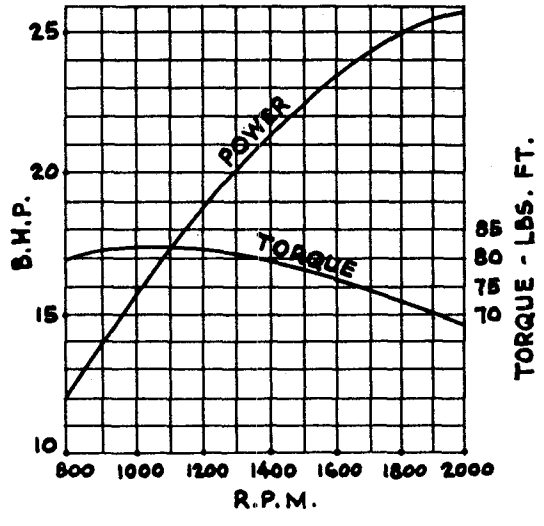


Fig. 31
Engine Performance Curve

GENERAL

The operation of a LeRoi engine is comparatively simple to understand when one realizes that the complete unit is in reality composed of various component and individual parts. There are, in accordance to illustration, Fig. 32, as follows:

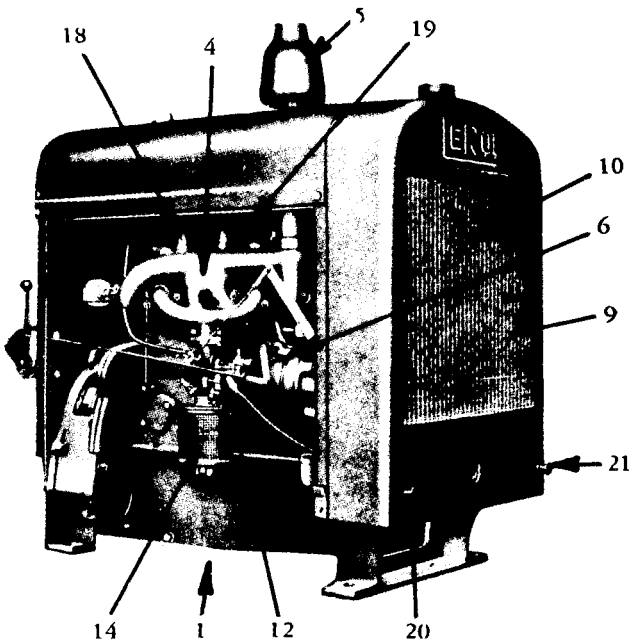


Fig. 32
LeRoi Engine D-133
Viewed from Crank End (Right End)
Showing Left Side of Engine

1—Engine
2—Bellhousing
3—Flywheel (Inside Housing-2)
4—Manifold
5—Exhaust Pipe and Muffler
6—Governor with Variable Speed Control
7—Pressure Lubrication System (in crankcase)
8—Oil Pressure Gauge
9—Radiator
10—Fan (Behind Radiator-9)
11—Water Pump (Behind Fan-10)
12—Carburetor
13—Throttle
14—Air Cleaner
15—Gasoline Tank (Under Housing)
16—Gasoline Filter
17—Magneto
18—Spark Plugs
19—Ignition Cables
20—Ignition Switch
21—Choke
22—Housing
23—Coupling

GENERAL (Continued)

The performance characteristics illustrated in curve, Fig. 31, apply to shown was obtained from laboratory tests on fully equipped engines. Engines will deliver approximately 10% power in excess to that shown on curve.

The ratings given are based on using gasoline with an octane number of 56 to 60 as a fuel. When fuels having higher octane numbers are used, there will be an increase in the amount of power developed and, conversely, when fuels having lower octane numbers are used, a decrease in the amount of power developed may be expected.

The performance characteristics illustrated are for operation at sea level. To obtain these characteristics at other altitudes deduct 3% from the figures shown for each 1,000 feet above sea level.

Rotation is clockwise when viewing engine from cranking end. (Right end—See Fig 32).

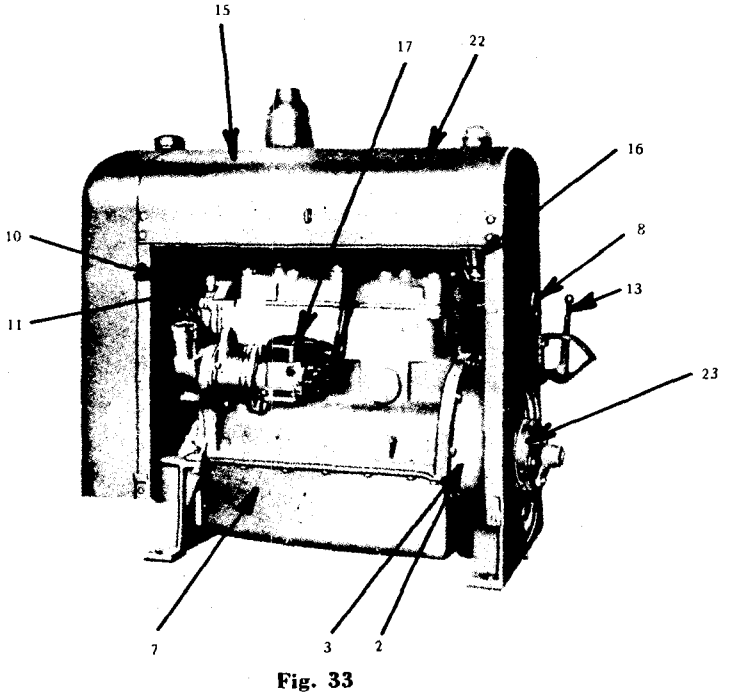


Fig. 33
LeRoi Engine D-133
Viewed from Coupling End (Left End)
Showing Right Side of Engine

ENGINE CONTROLS

Choke Rod

(G) Helps start the engine when the engine is cold. Pulling out the rod shuts off air to the carburetor, giving a rich mixture. After the first few revolutions of the engine, push the choke button in half way, or to a point where the engine runs without missing. Push the choke all the way in after the engine has started. Do not run the engine with the choke rod out. In hot weather it may not be necessary to choke the engine.

Ignition Switch

(H) Should be pulled out all the way for starting. In this position the switch is "on" and pushed in all the way is "off."

Oil Pressure Indicator

(J) Indicates the pressure in lbs. per sq. in. of the oil circulating through the engine. The indicator needle should be between 20 lbs. and 30 lbs., when the engine is running. If the needle is not in this position, stop the engine immediately and investigate the cause of the oil pressure failure.

Engine Throttle

(K) Controls the engine speed within the governor range.

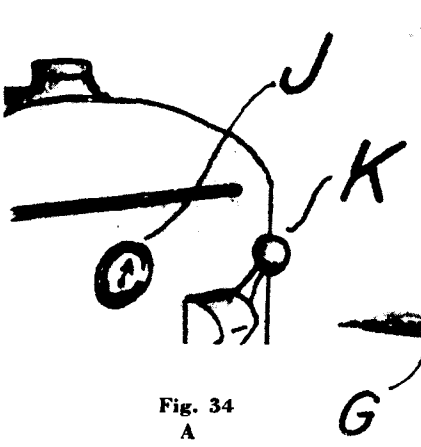


Fig. 34
A
Left or Drive End

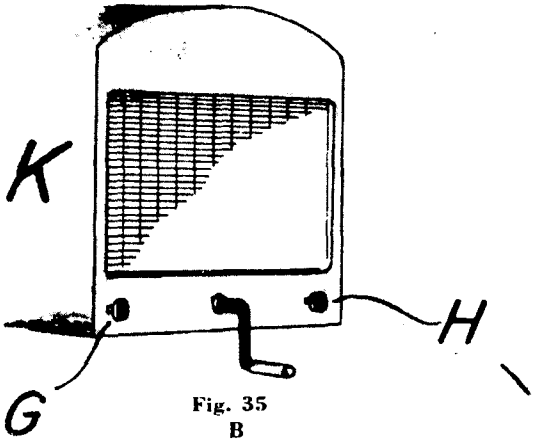


Fig. 35
B
Right or Crank End

BEFORE STARTING A NEW ENGINE

It is recommended that the operator follow the proceedure outlined below before starting or operating a new engine.

Lubrication

(1) Lubricate the entire engine, using the "Lubrication" 15, this section.

(2) Check the oil levels of the engine crankcase to see that it is filled to the correct level with the proper grade of oil for the prevailing temperature.

Engine Cooling System

(The water capacity of the engine is approximately 3½ gallons, U. S.) It is important to use clean, soft water in the cooling system. In some parts of the country where engines are required to operate, the only water available is that taken from alkali springs and this water deposits an insoluble scale on the walls of the water jacket and radiator and causes overheating of the engine. When it is necessary to clean the cooling system of these deposits this should be done by using acids under supervision of a competent mechanic.

The following table gives the proper percentage of alcohol to add to water at freezing temperatures. Alcohol must be added from time to time as its rate of evaporation is much faster than that of water.

Temperature	Amount of Alcohol	Hydrometer Reading
30°	0	1.00
20°	10%	.987
10°	20%	.975
Zero	28%	.965
– 10°	37%	.953
– 20°	45%	.943

Note

If no anti-feeze solution is used, the entire cooling system must be drained when engine is not being used when the temperature drops below 32° F. To accomplish this, open the drain cock in the bottom radiator connection and also the drain cock in the cylinder block. See Fig. 46, Page 78.

Important

Before filling the radiator in freezing weather, cover the entire radiator and then start the engine. Put the water in immediately after the engine has started. This prevents the water from freezing during the warm-up period.

Over Heating

The engine may over-heat because the radiator or water pipes are clogged; the fan belt slips; oil is insufficient or poor; carburetor out of adjustment; or faulty ignition.

To Clean Out Dirt and Sludge

(1) Drain the cooling system by removing the plug on the right hand side of the engine (see "Lubrication 15," Page 78) and remove the cap from the radiator drain pipe. Allow the system to drain and replace the plug.

(2) Fill the cooling system with a solution of 2 pounds of ordinary washing soda mixed with 3½ U. S. gallons of water (cooling system capacity).

(3) Leave the radiator filler cap off and run the engine until the water is hot, then, drain and flush the system with clean water.

Radiator Core

Overheating of the engine is often caused by bent or clogged radiator fins. If the spaces between the radiator fins become clogged, clean them with an air or water hose. When straightening bent fins be careful not to injure the tubes or break the bond between the fins and the tubes. Some operators apply a coating of vinegar to the entire radiator before starting the engine. Cement dust does not have a tendency to stick to parts which have been coated with vinegar.

Fuel System

The engine is designed to operate on regular commercial gasoline. Fill the fuel tank with CLEAN gasoline. The capacity of the tank is approximately 10 gallons U. S.

Safety First. Never fill the fuel tank when near an open flame, when smoking or when the engine is running. Keep the funnel in contact with metal of fuel tank when pouring in fuel to avoid the possibility of an electric spark igniting the gas. Do not light matches or use oil lanterns near gasoline as the air within a radius of several feet is permeated with a highly explosive vapor.

STARTING AND STOPPING ENGINES

Starting the Engine

Advance throttle (K) one or two notches. Pull the ignition switch (H) out all the way, pull the choke (G) out half way and then crank engine. As soon as the engine starts, the choke should be adjusted to a point where the engine runs without missing, and as the engine warms up, the choke should be gradually pushed in all the way. Do not use the choke to enrich the fuel mixture except when starting the engine. Never operate the engine with the choke rod partly out. Immediately after the engine starts, check the oil pressure indicator on dash to see if it is registering pressure. If it is not, stop engine and inspect the oil system to find the cause of failure.

Stopping Engine

Push ignition switch (H) in all the way.

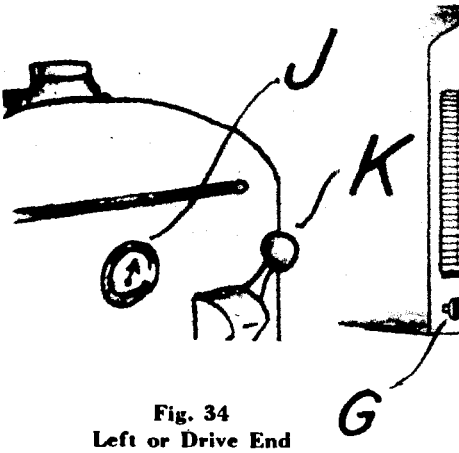


Fig. 34
Left or Drive End

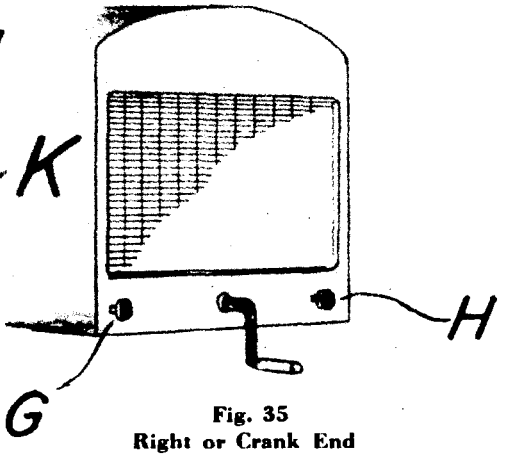


Fig. 35
Right or Crank End

STORING ENGINE

When an engine is not to be used for a period of time, it should be stored in a dry protected place. To leave equipment outdoors exposed to the elements, will result materially shortening the life of the machine. The following procedures should be followed when the engine is placed in storage for thirty days or more, and the lubrication precaution should be repeated every six months thereafter.

(1) Drain all water from the engine cooling system.

(2) After the engine has cooled, remove the spark plugs and pour ½teacup full of S.A.E. 50 lubricating oil of good grade into each cylinder. Crank the engine two or three times to distribute the oil over the cylinder walls. Cover up the exhaust pipe and air intake to prevent moisture from entering the engine.

(3) Drain the gasoline from the tank and carburetor and clean out the fuel strainer glass bowl. CAUTION: A gummy substance will form in the gasoline line if it is allowed to stand in the tanks, fuel line or carburetor. This gum accumulates in the carburetor jets and passages, causing serious trouble. These gum deposits can be completely dissolved with the mixture of one part alcohol and one part benzol, or with acetone.

STARTING ENGINES THAT HAVE BEEN IN STORAGE

(1) Remove the spark plugs and pour a mixture of one-half gasoline and one-half light lubricating oil into each cylinder (one tablespoon ful per cylinder is enough).

(2) Crank the engine rapidly until the excess oil has been blown out of the spark plug holes. This operation will loosen any tight piston rings and wash the old gummy oil from the valves and pistons.

(3) Fill the crankcase with the specified lubrication oil. (See Lubrication 15, this section.)

(4) Remove cover from exhaust pipe and carburetor.

(5) Install the spark plugs.

(6) Fill the water cooling system.

(7) Fill the fuel tank.

(8) Start engine and let run slowly; observe if any valves are sticking. If so, pour small quantity of penetrating oil on the valve stem until it is loose.

(9) Assemble the valve housing cover.

Caution

Do not accelerate the engine rapidly or operate at high speed immediately after starting.

Cold Weather Operations

If the engine is to be operated in temperature 32° F. or lower, observe the following precautions; (See "Before Starting New Engine 5," this section).

Engine Fuel System

Use only a high-test winter-grade gasoline for starting and keep your supply in a closed container so the more volatile portion does not evaporate.

Storage tanks should also be kept in a clean dry place away from grit and dirt.

Fill the fuel tank at the end of the day's run to prevent moisture from collecting in the tank.

Lubrication

Be sure to use the correct grade of lubricant in the engine crankcase, air cleaner and transmission as specified on the "Lubrication Chart," (see "Lubrication 15," this section).

COOLING SYSTEM

When the temperature is likely to be 32° F. or lower, there is danger of the water freezing in the cooling system. To overcome this, either drain the water from the cooling system at the end of each run, or follow the recommendations given in "New Engines 5," this section).

ENGINE TROUBLES AND REMEDIES

Failure to Start

No gasoline in carburetor.
Fuel valve closed.
Carburetor choked too much.
Magneto grounded.
Engine throttle not sufficiently advanced.

Irregular Speed

Governor sticking, out of adjustment, or worn.
Throttle shaft bent or out of alignment.

Lack of Power

Governor out of adjustment.
Exhaust pipe clogged.
Engine speed control lever not advanced.
Clutch slipping.
Air cleaner pipe clogged.

Overheating

Insufficient amount of water.
Fan belt slipping.
Excess load.
Inside of radiator and cylinder block limed up or clogged with dirt.
Outside of radiator covered with dirt or cement.
Excess carbon in the cylinders.
Carburetor improperly adjusted.

Missing and Backfiring

Water in the fuel.
Air leaks around the intake manifold.
Engine not warmed up.
Red-hot carbon deposits in cylinder.

Lack of Oil Pressure

Insufficient amount of oil.
Oil diluted or not as specified.
Oil filter clogged.
Dirt under the oil pressure regulating valve.
Broken oil pressure indicator.
Oil pump strainer clogged or pump not working.

ENGINE TROUBLES AND REMEDIES

Knocking

Excess carbon in the cylinders.
Sticky-valve or improperly adjusted valves.
Loose piston pin, connecting rod, camshaft or crankshaft bearings.
Broken piston rings or loose pistons.

Lack of Compression

Sticky, dirty, pitted or improperly adjusted valves.
Stuck, worn or broken piston rings.
Worn pistons.
Leaky cylinder head gasket.

Excess Fuel Consumption

Choke closed.
Air intake cap or air cleaner clogged.
Incorrect amount or improper grade of oil.
Leaky carburetor fuel valve.
Carburetor adjustment too rich.

Lack of Fuel

Fuel low in the tank.
Air vent hole in fuel tank filler cap plugged.
Fuel valve closed or only partially opened.
Clogged fuel strainer screen, fuel line or carburetor strainer.

Defective Ignition

Wrong kind, old, cracked, dirty or poorly set spark plugs.
Broken, loose or improperly connected wiring.
Dirty distributor block disk.
Stuck or broken distributor brush in magneto.
Dirty, pitted, or improperly set breaker points.
Breaker arm not free on its bearing or the breaker arm spring weak or broken.
Magneto not timed correctly with the engine.
Impulse coupling dirty, dry or lubricated with heavy oil.

ENGINE ELECTRICAL SYSTEM

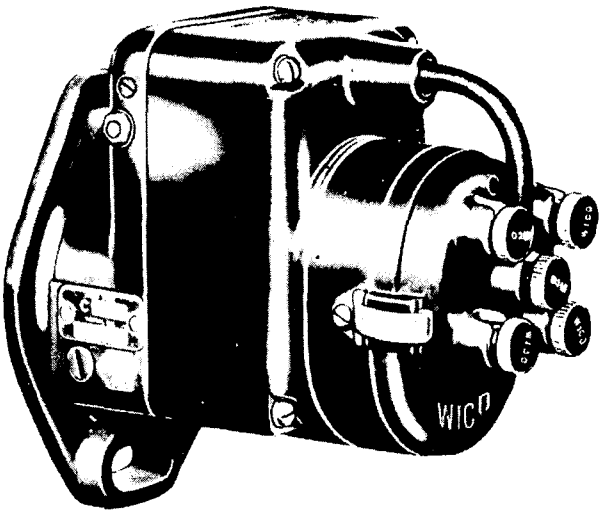


Fig. 36
WICO Model C 4 Magneto

MAGNETO

The engine is equipped with a Wico Model C-4 magneto.

Lubrication

The magneto is provided with two oilers, one on each side of the main housing, so that whichever way the magneto faces the engine, one oiler will always be convenient. Once every two hundred (200) hours of operation, these oilers should be filled to overflowing with WICO or S.A.E. oil. After every 1000 hours of service it is necessary to relubricate the cam oil pad. This is done by removing the pad and squeezing and working into it some stringy grease. A summer grade of automobile transmission grease will very closely resemble that used at the factory. Do not use ordinary grease.

Timing Magneto for Impulse Spark

When the impulse coupling is to be used in timing the magneto to the engine, and in the absence of other information from the engine manufacturer, first remove the distributor cap, then turn the magneto shaft over in the proper direction of rotation until the impulse coupling has just tripped. Note which tower of the distributor cap the distributor arm is nearest and the cylinder to which this tower is connected by the spark plug cable; turn the engine over to top dead center on this cylinder, on the compression stroke, and couple the magneto to the engine.

ENGINE ELECTRICAL SYSTEM (Continued)

Timing Magneto to Advance Spark

Where the engine flywheel is marked with the position of advance or running spark, usually designated by IGN, a different procedure is followed: Turn the shaft in a direction opposite to its ordinary rotation until the distributor arm is at the tower of the distributor cap to which is connected the spark plug cable leading to No. 1 cylinder. By means of a thin piece of paper between the points, the exact instant of breaker point opening can be determined. At this point, the magneto is in a position where a spark will be delivered to the No. 1 cylinder. Turn the engine over until the advance spark mark on the flywheel is correctly located on the compression stroke of No. 1 cylinder and couple the magneto to the engine.

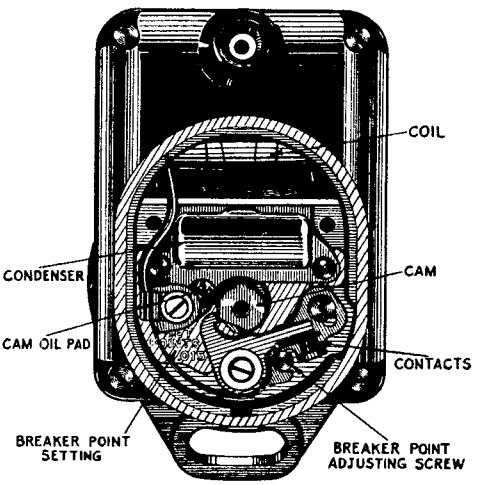
Removal of Distributor Cap, Gear Housing, and Distributor Arm

On models with Gear Housing, the distributor cap is removed by wedging out the distributor clips with a screw driver. The distributor arm may then be pulled off the shaft. When replacing the distributor arm, be sure the key lines up with the flat on the shaft, then push in place. When either arm or cap is replaced, be sure the arm does not hit the insert in the cap. The Gear Housing is removed from the machine by loosening the two screws which hold it in place. When replacing the Gear Housing, make certain the key in the gear shaft of the Gear Housing lines up with the slot in the rotor shaft, that the distributor arm is in the same quadrant as when removed, and that the rotor shaft has not turned. Make certain the distributor cap and Gear Housing Gaskets are in place.

Removal of Condenser

With the distributor cap removed, the condenser can be easily removed by first taking out the screw holding the breaker arm spring *(the breaker arm need not be disturbed)*. Then remove the two screws holding the condenser and slide the condenser up slightly and pull it out. (See Fig. 37.)

To replace the condenser, slip it in place under the breaker arm spring being careful to get the condenser gasket in place. Tighten down the condenser screws firmly as an electrical contact is made under one of them.



VIEW OF C BREAKER

Fig. 37

ENGINE ELECTRICAL SYSTEM (Continued)

Removal, Replacement and Adjustment of Breaker Points

The breaker point opening should be adjusted to .015", by means of the screw head eccentric acting on the fixed contact.

It is recommended that if points need replacing, both the fixed contact and the moving point be replaced at the same time.

The breaker arm is integral with the spring and spring terminal and the moving contact point. To remove it, take off the breaker arm clamp screw, lock washer and clamp washer and the breaker arm spring terminal screw and lock washer and pull the assembly off the breaker arm pivot.

In reassemblying, be sure that the steel breaker arm spacer is in place. With the breaker arm assembly off, the fixed contact plate may be taken off the breaker arm pivot, after the contact screw has been removed.

Removal of Cover

The cover, including the breaker assembly, may be removed by first loosening the breaker arm spring screw and pulling out the coil and ground lead terminals. Next, loosen the four fillister head screws one in each corner of the cover, until they are free, then pull the cover off.

Removal of Coil and Coil Core

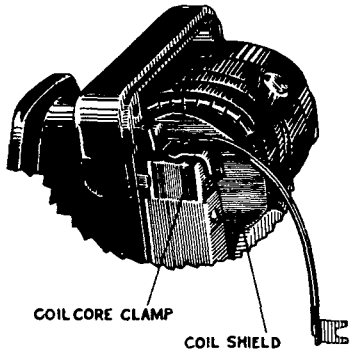
With the magneto cover off, remove the two fillister head screws holding the coil core clamps in place. Under one is found the ground end of the primary and secondary of the coil. Turn the rotor until the magnetism no longer grips the coil core to the main housing. Pull the coil and coil core free. (See Fig. 38.)

When replacing the coil and coil core on the magneto, be sure the ground surface of the core is against the laminated cores and the primary leads are properly located. When the coil is located, the coil terminal button should be up and toward the breaker plate. The surface must be clean. Be sure to place the ground wire under the core screw lock washer and not under the coil core clamp.

Removal and Replacement of Coil from Coil Cores

The coil is held to the coil core by two wedges, therefore, it will be necessary to press with considerable force to remove the coil core.

ENGINE ELECTRICAL SYSTEM (Continued)



C MAGNETO COIL MOUNTING PLATE 2

Fig. 38

Always be careful not to damage the coil windings.

When replacing a coil on the coil core, slide it on being sure that the finished side of the core is down and the high tension button is up. Then on the finished side of the core, press in the two wedges, one on each side, until they are flush with the primary coil winding. Slide the coil shields on, one on each side, and thread the primary leads through the slot provided for them. (See Fig. 38.)

Impulse Coupling

The impulse coupling is designed to give a spark of high intensity for starting. It automatically cuts out at about 200 R.P.M. The engine should not be run continuously below this speed, as this would cause an unnatural strain and wear on the impulse parts.

The impulse also provides a retarded spark for starting, automatically advancing it as the engine gets up to speed. Any advance from 5° to 12° beyond impulse spark can be obtained by shifting the position of the impulse stop ring.

Flushing of Impulse

If the impulse becomes clogged with dirt, the necessity for flushing it is evidenced by the trip arms failing to engage or disengage, or by sluggishness in the action of the impulse when it trips. The impulse should be flushed out thoroughly with kerosene, taking care, however, not to allow any of the kerosene to work its way into the magneto housing.

When a dust cover over the impulse is provided on the magneto, it must first be removed by loosening the clips at either side.

SPARK PLUGS AND CABLES

Spark Plugs

The spark plugs used were selected after careful tests as best suited for this engine.

The spark plugs should be removed after every 200 to 300 hours of operation or oftener if necessary, for cleaning and checking the gaps between electrodes. A gap of .020" to .025" should be maintained. When making this adjustment, always bend the outer electrode. Never bend the center electrode as it may damage the insulator. If the gap between the electrodes is too great, due to improper setting or burning off the ends, the engine will misfire and be hard to start.

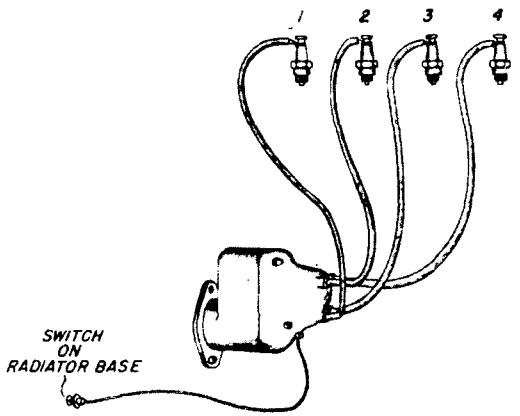


Fig. 39
Ignition Wiring

Special Spark Plugs

To remedy fouling or sooting, use a hotter (light service) spark plug. To remedy pre-ignition and burning of electrodes, use a colder (severe service) spark plug.

Cleaning Spark Plugs

The recommended method of cleaning spark plugs is sand blasting. Never scrape or clean the insulator with anything which will scratch and porcelain because scratched porcelain allows carbon and dirt to accumulate much faster.

Spark Plug Cables

If the spark plug cables are removed for any reason, note the position of each cable on the magneto.

There should be 1/4" minimum clearance between the spark plug cables and the cylinder head. By maintaining this clearance, shortening out the spark plug will be prevented, and the cable will be away from the extreme heat of the cylinder head. The heat of the engine would soon cause the rubber to become soft and the cable would be ruined.

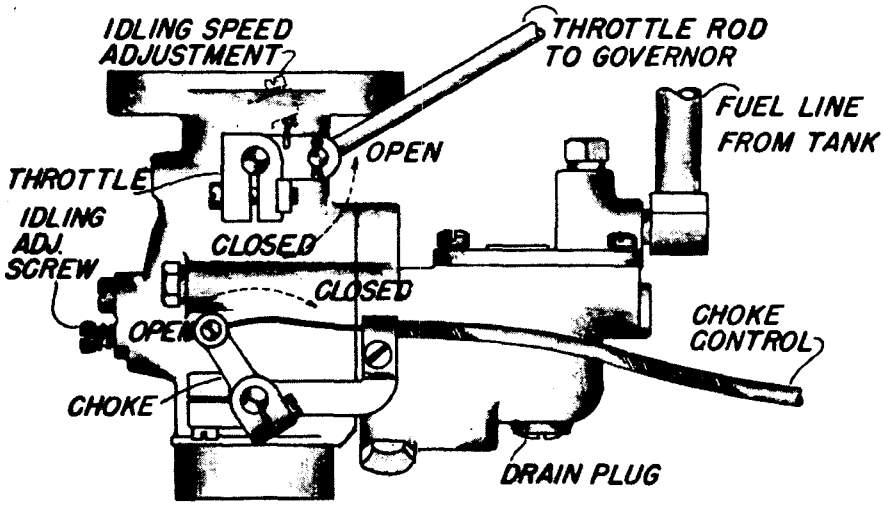


Fig. 40
Zenith Model TU 3½ KV
CARBURETOR

Care of the Carburetor

Occasionally, remove the fuel screen by unscrewing the fuel line fitting; clean the screen and replace it.

The flange nuts, which held the carburetor to the manifold, should be checked periodically for tightness.

Check the screws that fasten the fuel bowl to the fuel bowl cover occasionally. These screws should be kept tight to prevent any leakage of air past the fuel bowl cover gasket.

Adjusting the Carburetor

This carburetor was correctly set before it was shipped from the factory, but if the settings have been disturbed, the following procedure should be followed:

Before making any adjustment, close idling adjustment screw and reset the idling adjustment screw 1 to 1½ turns open.

FUEL STRAINER OR GAS FILTER

Cleaning the Fuel Strainer and Sediment Bowl

The fuel strainer should be cleaned at least once a month; to do this, proceed as follows:

(1) Close shut-off valve between tank and filter.

(2) Take the strainer apart by loosening the thumb wheel.

(3) Clean out the sediment bowl and clean the screen if necessary.

(4) When reassembling the strainer be sure the cork gasket between the bowl and the main body is in good condition and does not leak.

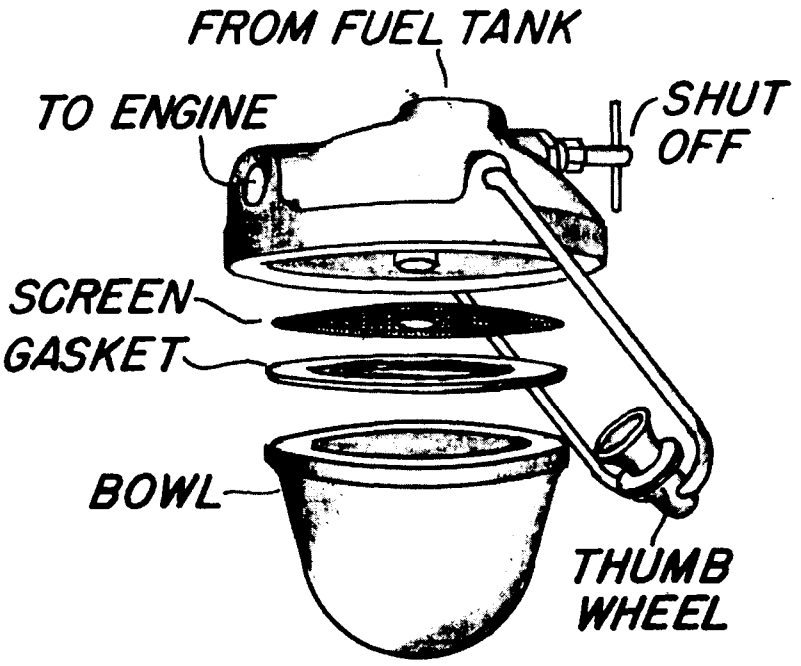


Fig. 41

Tillotson Gasoline Strainer

MINOR SERVICE OPERATIONS

Cylinder Head Gasket

The best method for tightening the cylinder head after installing the cylinder head gasket, is to tighten the nut in numerical order as shown in Fig. 42. Draw down the nut fairly snug, and then repeat the operation over the entire cylinder head until all unts are absolutely tight. Do not screw one nut down perfectly tight and then go to the next as you will not secure an even pressure on the gasket in this manner. After replacing the cylinder head, it is necessary to assure against leaks by tightening the stud nuts after engine has been run and the water jacket has become thoroughly heated.

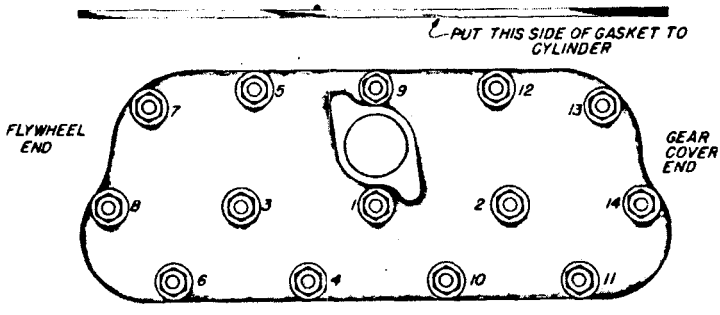


Fig. 42
Cylinder Head

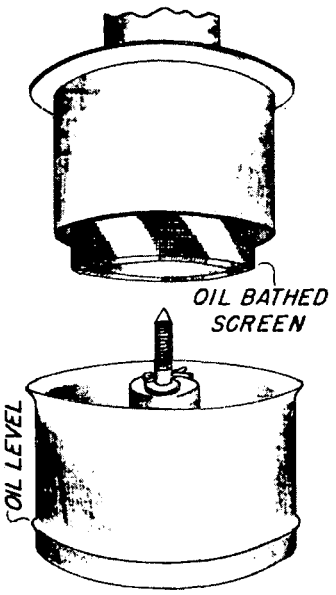


Fig. 43
Air Cleaner

CARBURETOR AIR CLEANER OR FILTER

The air filter is of the oil bath type which assures clean air for combustion if kept clean. The air first passes to the oil cup where it goes through a bath of oil. As the air rises to the intake manifold, it passes through a series of oil bathed screens, and all fine dust is removed. As the oil from the screens works back down, it carries the dirt with it and settles in the oil cup. The oil must be cleaned and refilled regularly with new oil. See Fig. 43.

Oil Cup

Clean and refill oil cup every day or even ten hours of operation. (More frequently when operating under dusty conditions.)

Before replacing the oil cup on the air cleaner, clean or wipe oil or grit from the top bead of the oil cup, oil cup retaining clamp and the surface under the clamp. See Fig. 43.

Washing the Cleaner

After every sixty hours of operation particularly in the case of an engine used where the atmosphere is heavily laden with dust, the air filter should be removed and cleaned. It should be then completely disassembled and each part washed thoroughly in oil or soluble fluid. After all the parts have been thoroughly cleaned, replace the oil to the proper level as described above and clamp the air filter back on the carburetor.

FAN BELT

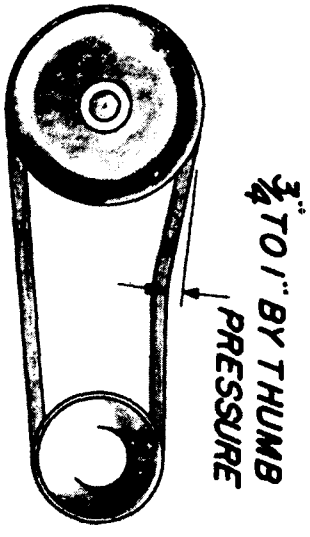


Fig. 44
Fan Belt

Fan Belt Tension

The slack of the fan belt should be checked frequently to assure maintenance of the correct tension. The tension is correct when the belt can be depressed without effort by the thumb, approximately ¾ to 1 inch midway between the two pulleys as shown in Fig. 44. If the slack is more than 1 inch, adjust belt as described below.

Removing the Fan Belt

See Fig. 45. To remove the fan belt, loosen the screws (A) in the flange on the fan pulley and unscrew the flange as far as possible. Start the belt over the outer flange of the lower pulley and pry it out with a light bar or rod. Slowly crank the engine at the same time and the belt will work off the pulley. After the belt is off the pulley, remove the starting crank. The belt can then be worked over the top of the fan blades.

Replacing Fan Belt

The fan belt should be replaced with a new one when it becomes soaked with grease, or when it is so badly worn that it does not drive the fan at the proper speed.

When replacing the belt, reverse the procedure outlined under "Removing Fan Belt," except that the belt can be started on the lower pulley by hand, and, by slowly cranking the engine, the belt will find the correct position.

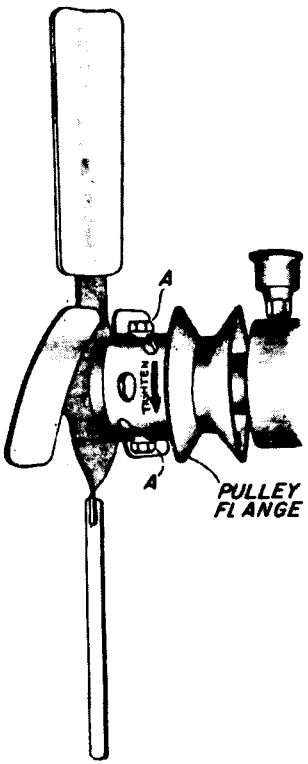


Fig. 45
Fan Belt Adjustment

Adjusting Fan Belt

Adjust the tension of the fan belt by changing the width of the groove in the fan pulley. To change the width of the pulley groove loosen the set screws (A) (Fig. 45) then screw the pulley flange in toward the belt to tighten it and out to loosen it. Retighten the set screws (A) after the correct tension is obtained.

After a new belt has been run approximately 50 hours, check the tension and adjust it again if necessary

The belt should at no time contact the bottom of the pulley groove because this will cause the belt to wear rapidly. Adjust the pulley for a narrower groove, if this is possible without increasing the tension more than allowable. Having "V" belts tighter than the tension specified, will result in rapid wear.

LUBRICATION

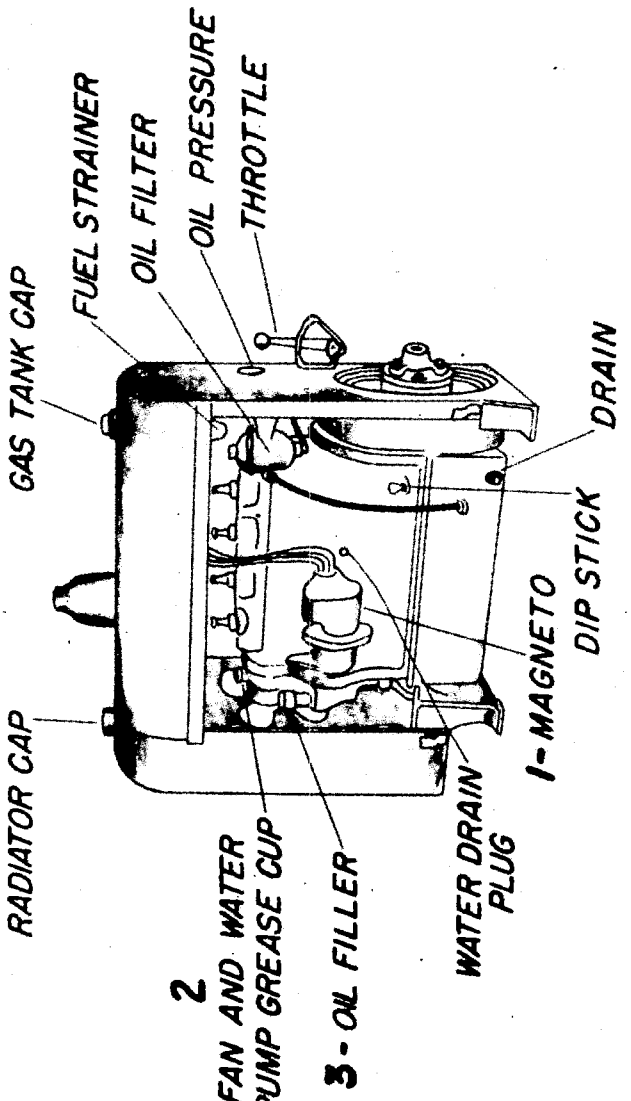


Fig. 46
Engine Lubrication Illustration

LUBRICATION

General Lubrication

The life of any machine depends on the care it is given. Proper lubrication increases the life of the machine. Recommended lubricants for the engine are given below:

Engine Lubrication

It is needless for you to experiment to find the proper grade of oil to use, as the following recommendations give the grade of oil which should be used in LeRoi engines. Care must be exercised to replenish the supply daily if necessary, and to drain it as advised in the paragraphs that follow.

Suitable oil is one of the most important items in the economical operation of the engine, yet it is the cheapest item of operating cost. Select the oil solely on quality and suitability — never on price — for no one thing is so sure to bring about unsatisfactory performance and unnecessary expense as inadequate lubrication.

High grade, highly refined oils, corresponding in body to the S.A.E. (Society of Automotive Engineers) viscosity numbers listed below, will prove economical and assure long engine life.

IMPORTANT: S.A.E. viscosity numbers classify oils in terms of body only without consideration to quality or character. Therefore, we list Mobiloil as a typical example of a lubricant possessing the qualities we believe desirable in oils for LeRoi engines. THIS DOES NOT MEAN, HOWEVER, THAT OTHER OILS OF THE PROPER BODY AND CHARACTER ARE TO BE AVOIDED.

The recommendations that follow are for new or well-maintained engines:

LUBRICATION

Oil Recommendations

Summer (Normal Temperature)
Army engine oil OE-30
U. S. Army Specification 2-104A, April 9, 1942.

*Winter (Below 32° F)
Army engine oil OE-10
U. S. Army Specification 2-104A, April 9, 1942.

*Follow summer recommendations if engine is being used in a warm building.

Oil System

This LeRoi engine employs force feed oil circulating system.

Force Feed System

The oil supply is contained in the oil pan and oil is fed to the moving parts of the engine by a gear-type pump. This pump draws oil out of the oil pan, through a fine mesh screen which prevents foreign material from being drawn into the lubricating system. The oil screen is located in the center of the oil pan.

An oil pressure relief valve is provided to prevent the oil pressure from building up to an excessive degree, and to hold it to between 20 and 30 lbs. with oil hot and engine at governed speed.

NOTE: Extreme temperatures, load conditions, or the use of improper grades of oil, may cause this pressure to vary.

Filling

The oil in the engine should be replenished daily, if necessary, in order to maintain the level to the FULL mark on the dipstick.

Never fill the oil pan while the engine is running. Before checking the oil level, allow the oil, which has accumulated in the engine, to drain back into the oil pan.

Never permit the oil in the oil pan to get below the HALF-FULL mark on the dipstick, or below the end of the dipstick when only a FULL mark is shown. Overfilling should also be avoided as this may permit the connecting rods to dip into the oil supply, thus splashing an excessive quantity of oil on the cylinder walls, causing smoking, oil pumping, waste of oil, excessive carbon deposit, fouled spark plugs and sticky valves.

Keep oil level to full mark and no more, if you want trouble-free performance from the engine.

Be sure the filler cap is replaced after refilling to prevent dirt from entering the engine.

LUBRICATION

Draining

It is essential that the oil pan be drained and refilled with new oil at various intervals. The oil gradually accumulates small particles of dust, grit and metal, which will cause wear, and it is also diluted by unburned fuel which passes by the pistons. The oil pan should be COMPLETELY drained when the engine is hot.

Do not flush with kerosene, as it dilutes the oil and impairs its lubricating qualities.

Draining the oil while hot will accomplish all that flushing with kerosene can do in the removal of sediment. Refill the oil pan to the proper level with new oil and replace filler cap.

Cleaning the Oil Pan

We recommend the practice of removing the oil pan at least once a season or after twelve hundred hours of service for inspection of the bearings, etc. At that time the oil pan should be washed thoroughly with gasoline and a stiff brush. Do not use cotton or wool waste, as fibres from it may stick to rough surfaces, ultimately causing stoppage of the screen and oil lines in the lubricating system.

Sludge

The formation of slude in the oil pan is due to oil contamination caused by exhaust gases which pass the pistons and come in contact with the oil to condense and form an acid. *This condition will be found more often and to a greater extent when an engine is operated at too low a temperature.* Sludge is very detrimental and if, when draining oil, it appears to be thick and congealed, the oil pan should be thoroughly cleaned of all sludge.

Key to Lubrication Recommendations

No. (1) *Magneto.* Every 200 hours of operation, fill magneto lubricating hole after first removing screw. Use light machine oil. After every 1,000 hours' service it is necessary to lubricate the cam oil pad. This is done by removing the pad and squeezing and working into it some stringy grease. A summer grade of automobile transmission grease will very closely resemble that used at the factory.

No. (2) *Fan Pulley and Water Pump Grease Cup.* The fan is provided with a grease cup on the fan bracket. Regular automotive type water pump grease must be used as this fitting supplies lubrication for the water pump shaft bushing Check every 60 hours of operation — replenish if necessary.

No. (3) *Crankcase Lubricant.* Fill the crankcase with the proper oil as recommended above. It should be checked daily with the bayonet gauge and the oil level maintained to the mark on the gauge. It is recommended that oil be changed after every 50 hours of operation.

COUPLING

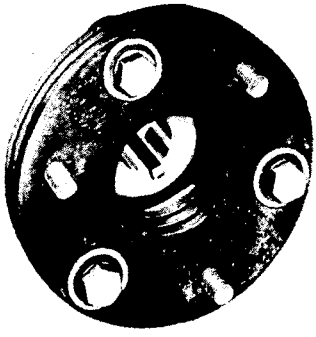


Fig. 47
Coupling—Fly Wheel End

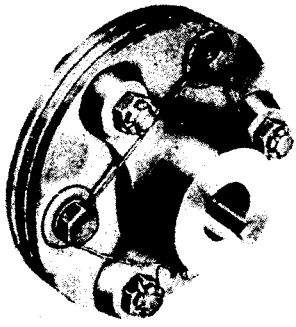


Fig. 48
Coupling—Pump Shaft End

LeROI MODEL 3C COUPLING

The LeRoi model 3C coupling is of the flexible type. It is bolted directly to power take off flywheel of engine and it has key seated hub for pump shaft.

Three fabricoid discs are used for inserts which absorb torque from the engine and pump and at the same time will allow for certain amount of misalignment between engine and pump.

Pumps and engine are properly aligned at the factory and no harmful coupling action should result unless either or both engine and pump are removed from the mounting and then not properly aligned when remounted.

Proper parallel and angular alignment can be secured through the use of a steel square as illustrated in Fig. 49.

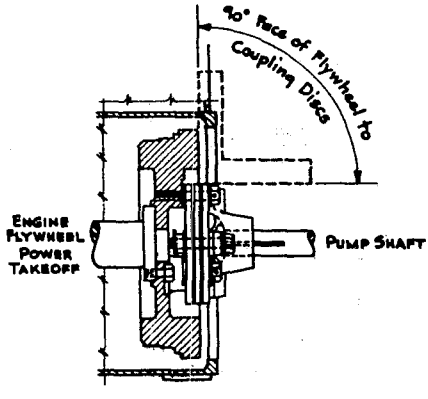


Fig. 49
Pump and Engine Alignment

GOVERNOR ADJUSTMENT

To increase the engine speed, loosen lock nut A and turn nut B to the right until desired speed is obtained. To decrease the engine speed, turn nut B to the left. Be sure to securely tighten lock nut A after adjustment. If the Governor adjustment does not seem accurate, remove pin C, turn yoke D until hole in yoke and hole in lever E are exactly in line when carburetor lever is in horizontal position when pointing toward the governor. Then replace pin C and lock yoke in place by tightening nut against the yoke.

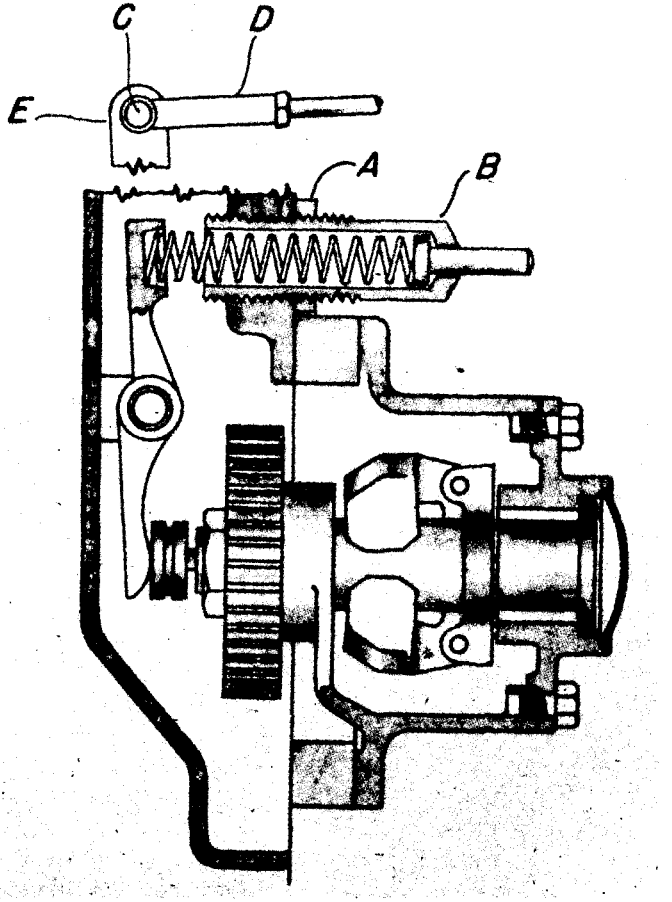


Fig. 50
Governor

CARBURETOR

Carburetor

Fig. 51 shows the construction of the Zenith Carburetor used with this engine.

The Venturi (1) is cast integrally with the carburetor and measures the volume of air which is passed through the carburetor. The Venturi size used is the smallest one which will permit full power development. The Venturi size is indicated by figures stamped on the face of the carburetor flange (2).

The main jet (3) and the well addition jet (7) are the principal fuel metering jets. The main jet fuel feeds through a channel into the metering well (4) controls the mixture characteristics at all speeds except idling. The holes in the side of the well influence the flow of fuel from the main jet at low speed. The diameter of the hole (5) in the metering well is selected to balance the main jet and Venturi sizes. It regulates the suction transmitted to the main jet and influences the mixture ratio at all speeds except idling. Best performance is usually obtained by using a metering well which permits the use of a main jet preferably one size smaller than the size of the Venturi.

The size of the high speed bleed (6) controls the rate of air flow into the metering well channels. This size is determined by test and, once determined, should not be altered. Increasing the size of this hole would cause a lean mixture at high engine speeds. Decreasing its size would cause a rich mixture at high engine speeds. The hole (13) provides additional air for atomization and is not part of the calibration.

The well addition jet (7) controls the rate of fuel flow into the well reservoir (7a) and provides a reserve which is available as an accelerating charge when the throttle is opened quickly. The size of the well addition jet also has an effect on the mixture ratio at part throttle slow speed operation—just above the idling range. Too large a jet would cause a richness and too small a jet would cause a leanness at this point. The idling system consists of the idling jet (8) which meters the fuel, the idling adjusting screw (9) which controls the air, and channels which carry the air and fuel to the edge of the Throttle Plate (10) at which point a high suction exists at idling speeds. This mixture of fuel and air for idling is discharged into the carburetor barrel through the priming hole (11). As the idling adjusting screw controls the admission of air, a richer mixture is obtained by turning

CARBURETOR

Carburetor (Continued)

the idling adjusting screw clockwise (toward its seat) and a leaner mixture is obtained by turning the idling adjusting screw counter-clockwise.

When these types of carburetors are used as standard equipment there will be little necessity for making changes in the calibration of the carburetor. The standard setting has been determined to give the best possible results under normal operating conditions. About the only care required by the carburetor is that it be kept clean and that worn parts be replaced when necessary.

A main jet adjustment may be used with the TU Series but a different fuel bowl cover is required.

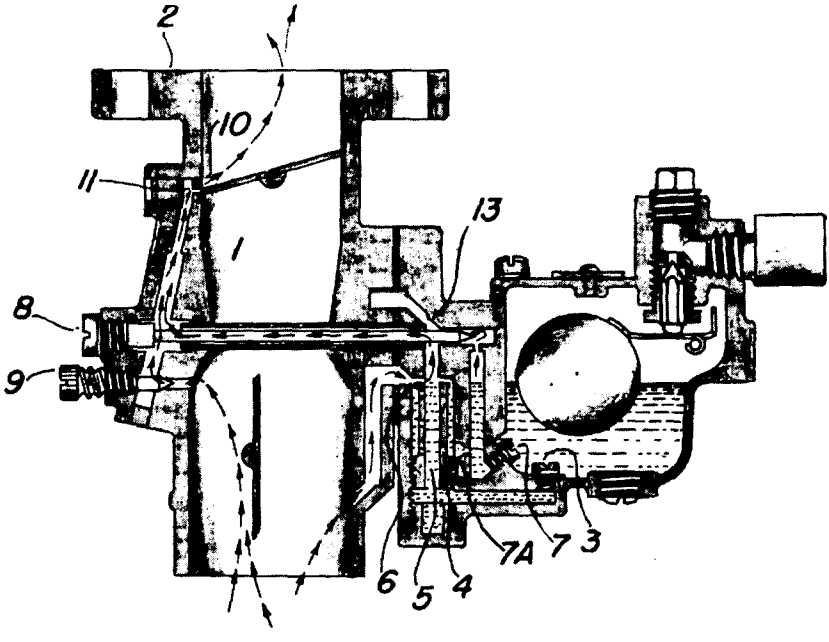


Fig. 51
Section of Carburetor

ELECTRICAL SYSTEM

Electrical System

The following recommendations are for average conditions, but should low grade fuels (62 to 68 octane) be used, knocking may occur under heavy loads in which case it will be necessary to retard the spark enough to eliminate the knock. If high grade gasoline (72 to 80 octane), butane or natural gas is used, it may be possible to advance the spark.

Ignition

Ignition or spark, to ignite the charge of fuel, is produced by the high tension magneto. The exact time the spark occurs in relation to the position of the piston in the cylinder is very important. If the spark occurs too soon, the engine will knock, may overheat and be dangerous to crank; whereas, if it occurs too late the engine will overheat and will not develop its full power.

Settings for Spark Plugs and Magneto Point Gap

Spark plug gaps .025 inch to .030 inch. Magneto breaker point gap .012 inch to .014 inch.

Ignition Timing

Dead center "D.C." and the timing marks, stamped on the flywheel of the engine, when lined up with the pointer or mark on the top or side of the flywheel housing, indicate when the spark should occur in relation to the position of the piston. When setting ignition timing, No. 1 piston should be on the compression stroke. To place the piston in this position, make sure the tappet clearance is properly set (see Fig. 52). Rotate the engine in its running direction until No. 4 exhaust valve just starts to close. Continue to rotate the engine slowly until the pointer or mark on the housing is midway between mark 15 and 20 on the flywheel indicating that No. 1 piston is 18 degrees before the top dead center.

VALVES

Removing Carbon and Grinding Valves

Incorrect adjustment of the carburetor resulting in too rich a mixture will cause carbon deposits in the combustion chamber and on the valve and piston heads; whereas, too lean a mixture will cause the valves to burn. Excessive carbon deposits will also be caused by the use of oil of incorrect body.

With the valve cover removed and the cylinder head off, the valves are easily accessible for removal. Before removing the valves, see that each valve is marked with a number corresponding to the number of the port in which it is located. Remove all carbon from the cylinder head, cylinder, exhaust valve pockets, valves and piston heads, taking care not to score the valve faces, seats or cylinders with the scraper.

If the valves and valve seats are badly pitted or warped, it is advisable to reface them.

To reface the valves and seats, the valves should be ground in a refacing machine, and the seats should also be ground. The angle for both the valves and seats should be 45°. The width of the seat should be 1/16".

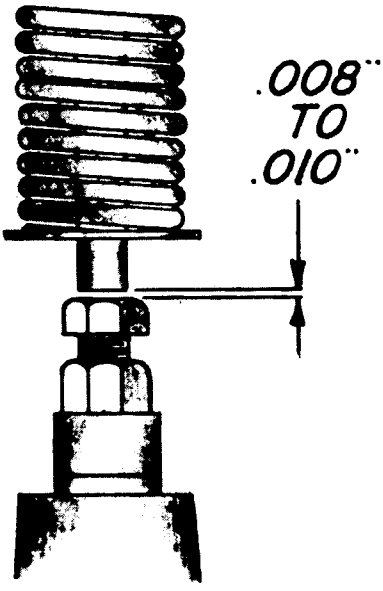


Fig. 52
Tappet Clearance

Valve Adjustment

Valve adjustment is provided by an adjusting screw in the tappet assembly. Each valve must be brought to the closed position before adjustment is made. The clearance between the valve tappet adjusting screw and the valve should be .008 inch to .010 inch when hot.

Firing Order

1 - 3 - 4 - 2.

VALVES

Valve Timing

If timing gears are removed, it is important that they be replaced correctly. Timing gears are properly marked and these markings should be observed when replacing the gears. For correct timing, mesh the camshaft and crankshaft gears as shown in Fig. 53.

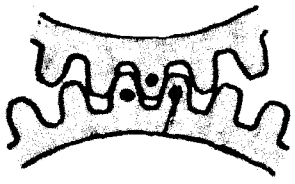


Fig. 53
Timing Marks

If timing gear marks are obliterated, or it is thought necessary to check the valve timing, the following table may be used. The columns 1 to 4 inclusive show the correct valve timing in degrees as indicated by the valve timing marks on the engine flywheel. After setting the valve clearance, rotate the engine in the direction it is to run until No. 1 piston is nearly at top center of the compression stroke and then continue to rotate slowly until the proper valve timing mark on the flywheel, as shown in column 1, lines up with the pointer on the flywheel housing. Then mesh the camshaft gear with the crankshaft gear. Continue to rotate the engine and check the valve action on No. 1 cylinder through the complete cycle, comparing the valve position, as shown in columns 2, 3, and 4, with the flywheel timing marks to make certain the setting is correct.

COLUMN No.

1	2	3	4	5
No. 1 Intake valve opens after top center	No. 1 Intake valve closes after bottom center	No. 1 Exhaust valve opens after bottom center	No. 1 Exhaust valve closes after top center	No. 1 Intake valve **should** open when piston is below top center as follows:
10°	30°	45°	5°	1/32"

Replacing the Cylinder Head

Before replacing the cylinder head, be sure that the surface of the cylinder block and head where the gasket rests are absolutely clean. It is important to securely tighten the cylinder head whenever it is replaced. This must be carefully done to prevent damage to the copper-asbestos gasket between the cylinder head and the cylinder block. When installing cylinder head gaskets, place the gasket on the cylinder block with the beaded side up.

Cylinder head nuts should be tightened as shown in Fig. 42.

PISTONS

Pistons

Before removing the pistons from the cylinders, mark each piston with the number of the cylinder from which it is to be removed, so that the pistons may be reassembled into the proper cylinder. Thoroughly wash the pistons in clean gasoline or kerosene, particularly the ring grooves and piston pin holes. Remove all abrasive matter from the pistons and cylinders.

Piston Rings

Test all piston rings for fit in the piston ring grooves and replace any rings that are worn. The rings should not be too loose in the ring grooves, but should be sufficiently free to move under their own weight when the piston is rotated.

Piston rings may be removed with the aid of a thin piece of steel. A thin flexible knife blade will prove effective in this operation. Be careful not to distort the piston rings when removing or reassembling. New piston rings must first be fitted in the cylinder bore for which they are intended. Allow a gap clearance of .007″ to .017″. With less clearance, expansion through heat may cause the ring ends to butt, resulting in warped rings or scored cylinders. Assemble the rings on the corresponding piston and make sure they are free in the ring grooves.

Piston Pin Fit

The piston pins are held in place by a setscrew in the piston pin boss. The piston pin holes should be reamed so that the piston pins are a handpush fit at the free end and slightly tighter fit at the setscrew end.

BEARINGS

Bearings

The crankshaft and connecting rods should have not less than .008", nor more than .020", end play in the bearing. We recommend a radial clearance of .002" to .0025" for connecting rod and main bearings. Connecting rod and crankshaft bearings are adjustable and are provided with shims for take-up.

Do not scrape thin shell bearings and do not file connecting rods or connecting rod cap parting faces.

While caps are off, see that the oil grooves are clean and free, and keep all internal parts of the engine free from dirt.

Replace the cap and turn the nuts down tightly. Try turning the engine over by hand, and make sure that the cap does not bind on the crank pin. The adjustment is correct when the nuts are tight, the bearings tight on the shims, and the crankshaft may be rotated by hand with the starting crank.

CRANKSHAFT AND CAMSHAFT

Crankshaft

To remove the engine crankshaft, it is necessary to dismount the engine from the pump. The flywheel should be removed. Then, the crank pan should be dropped and the caps of the main bearings removed and marked so that they may be replaced in their original places. This will permit the entire crankshaft assembly to be taken out including connecting rods and pistons. When replacing all parts, make sure that they are thoroughly cleaned, dried and oiled. Make sure that the oil retainer gaskets are in good condition when replacing the crankshaft.

Camshaft

The camshaft runs in three bronze bearings and is driven from the crankshaft through gears which are properly marked for checking valve timing, as described in Valves 4, this section.

WATER PUMP

Operation

A centrifugal water pump, driven from the fan shaft, circulates cooling water throughout the engine block and radiator. When the engine is operating, the pump takes the water from the bottom of the radiator, circulates it through the engine block and back to the top of the radiator to be circulated through the radiator for cooling. The water pump and fan assembly are on a common shaft running in sleeve bearings mounted in the water pump body.

To keep water from running through shaft bearings, it is essential that the grease cup cap be screwed down daily. Water pump grease should be used in grease cup. This should be checked every 60 hours of operation.

Manifold

Both intake and exhaust manifold are combined in one casting. Separate gaskets are used for each port. When replacing manifold, be sure all nuts are drawn up very tight as dirt may be drawn into the engine which would cause serious damage.

Oil Pump

The oil pump is of the gear type and is driven through a gear meshed with the crankshaft timing gear. It is of the positive type and takes its suction through a pipe connected with an oil screen mounted in the bottom of the crankcase. The oil is forced through drillings to all main, camshaft, and connecting rod bearings. The piston pins are provided with lubrication by splash. A pressure relief valve prevents the oil pressure from being built up to an excessive degree.

COUPLING

It is not likely that with proper care and with alignment maintained between pump and engine that coupling should ever have to be removed for disassembly.

If the fabricoid discs should become worn to such extent that coupling becomes inefficient, remove coupling. To do this remove bolts holding pump to skid, remove lock wire (A) and three flywheel bolts (B). Slide pump away from engine enough so that coupling can be removed from pump shaft. Remove the three disc bolts (C) and discs can then quickly be replaced. The disc bolts are equipped with castellated nuts which are locked by means of cotter pins. Do not misplace cotter pins unless new pins are available for reassembly of coupling.

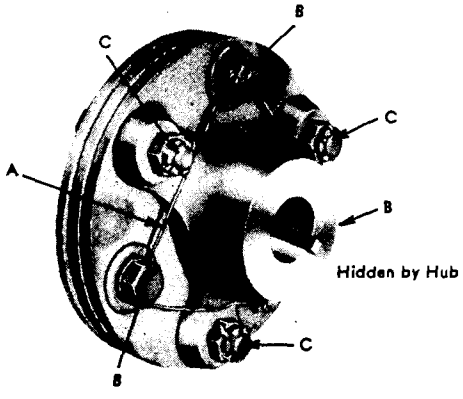


Fig. 54
Coupling Pump Shaft End

Upon assembly of new discs to coupling be sure to replace washers to same position between discs, coupling half, bolts, etc., as they were before disassembly.

For proper placement of coupling parts see Fig. 55.

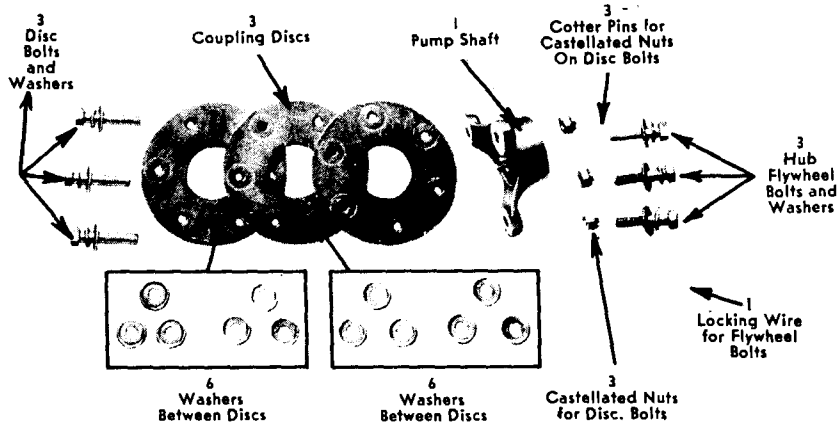


Fig. 55

After coupling has been reassembled and placed back upon pump shaft, slide pump back into position for flywheel bolts to be inserted for attaching coupling to flywheel. However, before tightening bolts be sure alignment between pump and engine has not been disturbed. If it has, re-shim pump properly and check alignment with steel square as described and illustrated in Operator's Instructions—Coupling 16.

NUMERICAL PARTS LIST INDEX

LeRoi D-133 Engine

*NOTE: Parts with no weights shown weigh less than 8 oz.

NUMERICAL PARTS LIST INDEX

LeRoi D-133 Engine

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NUMERICAL PARTS LIST INDEX

LeRoi D-133 Engine

Ref. No.	Description	Weight*	Page
	Water Pump Assembly (includes parts Ref. No. 701-712 inclusive)	14#–1 oz.	131
700	Water Pump Body	5#–10 oz.	131
701	Water Pump Body Bushing		131
702	Impeller Shaft	8 oz.	131
703	Fan Hub	8 oz.	131
704	Thrust Washer		131
705	Rubber Washer		131
706	Impeller	10 oz.	131
	Impeller Pin ⅛ dia. x ⅜ long		131
	Taper Pin No. 3 x 1¼		131
	Cover Gasket		131
707	Shaft Retainer		131
708	Retainer Spring		131
709	Water Pump Bracket	1#–6 oz.	131
	Body to Cover Cap Screw ¼–20 x 1¼		131
	Lock Washer ¼		131
	Grease Cup		131
710	Pulley to Fan Hub Cap Screw 5/16–18 x ¾		131
711	Lock Washer 5/16		131
712	Fan Pulley Assembly	1#	131
	Water Pump Body Gasket (round)		131
713	Water Pump Body Gasket		131
	Cap Screw for Body ⅜–16 x 2		131
	Lock Washer ⅜		131
	Fan Belt		131
714	Fan Blade	2#–7 oz.	131
730	Camshaft	5#	133
	Camshaft Thrust Screw ½–20 x 15/16		133
	Copper Asbestos Ring Gasket ½		133
731	Woodruff Key No. 6		133
	Camshaft Shim		133
732	Camshaft Gear	2#–2 oz.	133
733	Camshaft Gear Nut 1"–14		133
734	Washer		133
735	Idler Gear	1#–5 oz.	133
736	Idler Gear Bushing		133
737	Gear Pivot Bolt		133
	Lock Washer ⅝		133
738	Nut ⅝–18		133
	Ignition Drive Body	2#	133
	Assembly (includes parts Ref. No. 739-745 inclusive)		133
739	Ignition Drive Body	10 oz.	133
740	Magneto Shaft Bearing		133
741	Magneto Drive Shaft	7 oz.	133
	Magneto Coupling Key—Woodruff No. 6		133
742	Magneto Coupling	9 oz.	133

*NOTE: Parts with no weights shown weigh less than 8 oz.

NUMERICAL PARTS LIST INDEX

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LeRoi D-133 Engine

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PREPARATION

State **PERIOD** designation by use of one of the following terms:

(1) **"INITIAL"** – first requisition of authorized allowances.

(2) **"REPLENISHMENT"** – subsequent requisitions to maintain authorized allowances.

(3) **"SPECIAL"** – requisitions for necessary repairs not covered by allowances.

Emergency requisitions sent by telephone, telegraph, or radio must always be confirmed immediately with requisition marked: "Confirming (state identifying data)."

Prepare a separate requisition for each different machine.

Type "SPARE PARTS" in upper right hand corner of requisition form.

Give complete shiping instructions. Special instructions for packing, marking, routing, etc., should be given at the end of the requisition.

State proper nomenclature of machine, and make, model, serial number and registration number.

State basis or authority, and date delivery is required, immediately below description of machine.

State manufacturers' parts numbers and nomenclature descriptions accurately and completely. Do not use abbreviations.

Group parts required under group headings as shown in manufacturers' parts catalogs.

Double space between items.

Nonexpendable items must be accounted for.

WAR DEPARTMENT
O.M.C. Form No. 400
Revised Apr. 6, 1951

(S A M P L E)

SPARE PARTS

REQUISITION

To: Engineer Supply Officer, Columbus Quartermaster Depot, COLUMBUS, OHIO. No. of Sheets 1 Sheet No. 1

Requisition No. E-631-3-43 Date March 18, 1943 Period Special

SHIP TO Engineer Property Officer, Pine Camp, New York
MARKED FOR: Engineer Supply Officer, 802nd Engr. Battalion, Pine Camp, N. Y.

REQUISITIONED BY (show Signature, Rank, Organization, Destination. If different from "SHIP TO" include address):

Robert E. Roe
Robert E. Roe,
Major, C. E.,
Engineer Property Officer.

APPROVED FOR: The Commanding Officer:

John E. Doe
John E. Doe,
Col., C. E.,
Executive Officer

~~STOCK NO.~~ Mfg. No.	ARTICLES	UNIT	ON HAND AND DUE	CONSUMED	REQUIRED	APPROVED
	PARTS FOR GASOLINE ENGINE, LeROI MODEL D-133 USED AS DRIVE UNIT ON ECONOMY MODEL B-180 PORTABLE PUMPING UNIT, SERIAL NO. 95365, U. S. ARMY REQUISITION NO. 56579, REQ. NO. TM5-2036					
	Basis: Repair of Disabled Equipment.					
	Delivery is requested by August 20, 1943.					
	CARBURETOR GROUP (ZENITH MODEL TU-3½XV)					
C23-86	Throttle Shaft	ea	0	1	1	
	FAN AND WATER PUMP GROUP					
42-63-1	Fan Blade	ea	0	1	1	
02-18	Pulley to Fan Hub Cap Screw 5/16 - 18x¾	ea	0	4	4	
05-50	Lock Washer	ea	0	4	4	
	NONEXPENDABLE ARTICLES SHOWN HAVE BEEN PLACED ON I & I REPORT (REPORT OF SURVEY, ETC.)					

OF REQUISITIONS

A Sample requisition in the correct form for submission by the Engineer Property Officer is shown on the opposite page.

THIS SHALL BE FOLLOWED IN MAKING OUT REQUISITIONS

In order to eliminate duplication of work, Property Officers may authorize organizations to prepare requisitions in final form, leaving requisition number space blank for completion by Property Officer.

THE FOLLOWING RULES WILL BE OBSERVED CAREFULLY IN PREPARING REQUISITIONS FOR SPARE PARTS:

a. Prepare a separate requisition for each different machine.

b. Type "SPARE PARTS" in upper right hand corner of requisition form.

c. State PERIOD designation by use of one of the following terms:

(1) "INITIAL" – first requisition of authorized allowances.

(2) "REPLENISHMENT" – subsequent requisitions to maintain authorized allowances.

(3) "SPECIAL" – requisitions for necessary repairs not covered by allowances.

d. Give complete shipping instructions.

e. State proper nomenclature of machine, and make, model, serial number and registration number.

f. State basis or authority, and date delivery is required, immediately below description of machine.

g. Group parts required under group headings as shown in manufacturers' parts catalogs.

h. State manufacturers' parts numbers and nomenclature descriptions accurately and completely. Do not use abbreviations.

i. Double space between items.

j. Emergency requisitions sent by telephone, telegraph, or radio must always be confirmed immediately with requisition marked: *"Confirming* (state identifying data)."

k. Nonexpendable items must be accounted for.

CARBURETOR

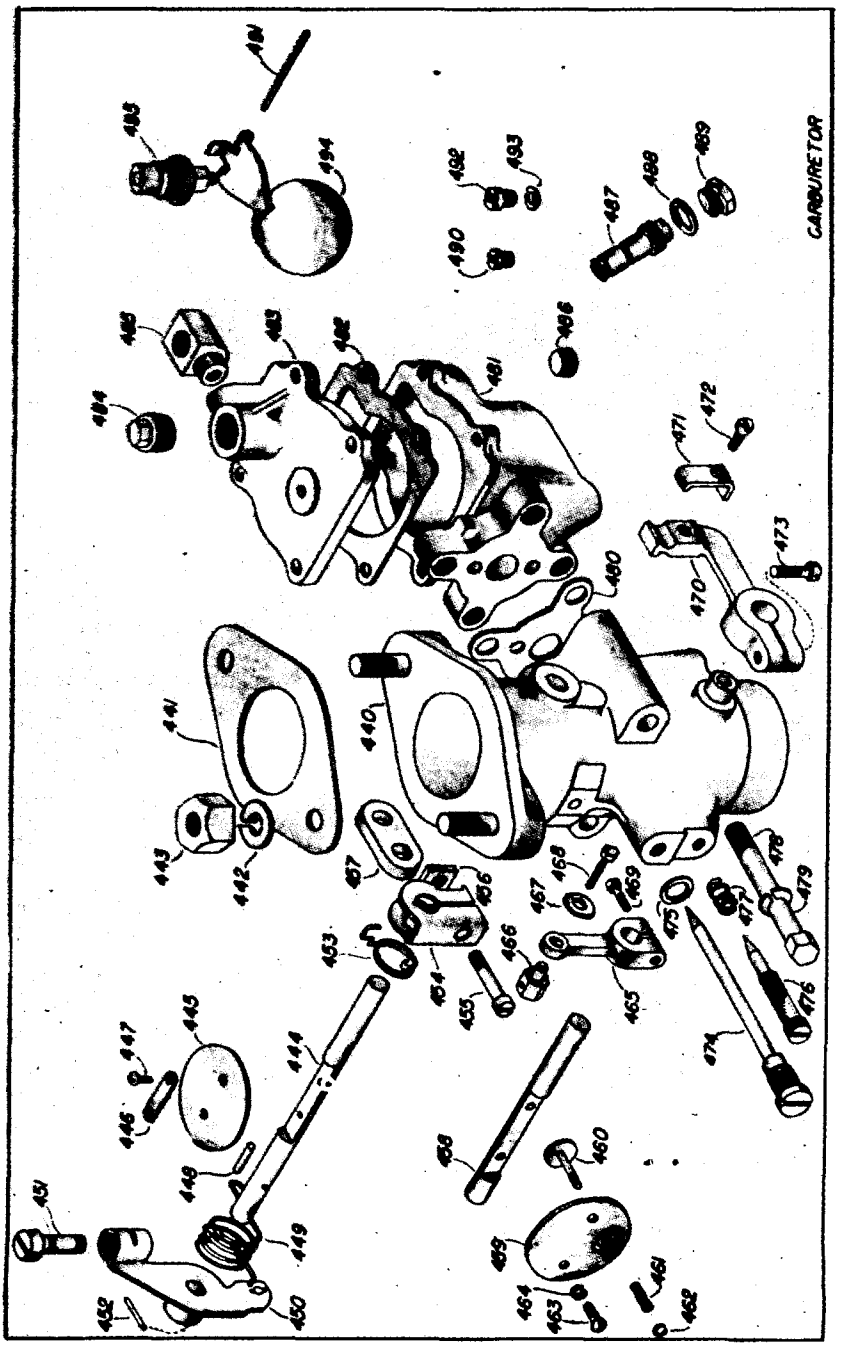

Fig. 56

CARBURETOR

Fig. 56

Ref. No.	Zenith Part No.	No. Used	Description	Price* Each
440	B2–4L	1	Throttle Body Assembly	$4.00
441		1	Gasket	**
442		2	1/2 Lock Washer	**
443		2	Hex Nut 1/4–20	**
444	C23–86	1	Throttle Shaft	.40
445	C21–3	1	Throttle Plate	.95
446	CR22–1	1	Throttle Plate Screw Lock Washer	.10
447	T15B5–3	2	Throttle Plate Screw	.05
448	CR121–11	1	Throttle Stop Pin	.10
449	D–2688	1	Spring	.10
450	CR28–7	1	Throttle Stop Lever	.65
451	T1S8–10	1	Throttle Stop Screw	.05
452	CT63–2	1	Stop Lever Taper Pin	.05
453	C117–8	1	Spring	.10
454	C25–14A	1	Floating Lever Stop	.30
455	T1S10–12	1	Lever Stop Clamp Screw	.05
456	T24S10	1	Clamp Screw Nut	.05
457	C25–18	1	Floating Lever (1 1/64" Drill on 3 3/64 C.)	.35
458	C105–4	1	Air Shutter Shaft	.40
459	C101–17	1	Air Shutter	.50
460		1	Not Serviced Separately See Ref. No. 459 for Ass'y	
461		1		
462		1		
463	T15B5–3	2	Air Shutter Plate Screw	.05
464	T41–5	2	Air Shutter Plate Screw Lock Washer	.05
465	C106–3	1	Air Shutter Lever Ass'y	.60
466	CR134–2	1	Swivel	.20
467	CT52–1	1	Swivel Washer	.05
468	T8S8–10	1	Swivel Screw	.05
469	T8S8–7	1	Lever Screw	.05
470	C109–3	1	Air Shutter Bracket	.35
471	C110–1	1	Clip	.05
472	T1S8–8	1	Screw	.05
473	T1S10–10	1	Screw	.05
474	C51–2	1	Idling Jet Size No. 11	.75
475	T56–48	1	Idling Jet Washer	.05
476	C46–25	1	Idling Adjusting Screw	.30
477	C111–9	1	Idling Adjusting Screw Spring	.10
478	T2S25–28	2	Bowl to Body Screw	.10
479	T43–25	2	Lock Washer	.05
480	C142–2	1	Gasket	.10
481	B3–30	1	Fuel Bowl Assembly	2.00
482	C144–1–1	1	Cover Gasket	.10
483	C6–3B	1	Bowl Cover	.75
484		1	Plug	**
485		1	Fitting	**
486	CT91–1	1	Pipe Plug	.10
487	C76–9	1	Metering Well Size No. 60	.75
488	T56–24	1	Metering Well Washer	.05
489	C138–23	1	Lower Plug	.35
490	C52–2	1	Compensator Size No. 17	.35
491	C121–14	1	Float Axle	.10
492	C52–1	1	Main Jet Size No. 20	.35
493	T56–4	1	Main Jet Washer	.05
494	C85–15	1	Float Assembly	.60
495	C81–2	1	Fuel Valve and Seat Assembly Size No. 35	.75

*All prices subject to change without notice. Prices shown are for Domestic Shipments. Add 10% to prices for Export Processing. **Not serviced.

MAGNETO

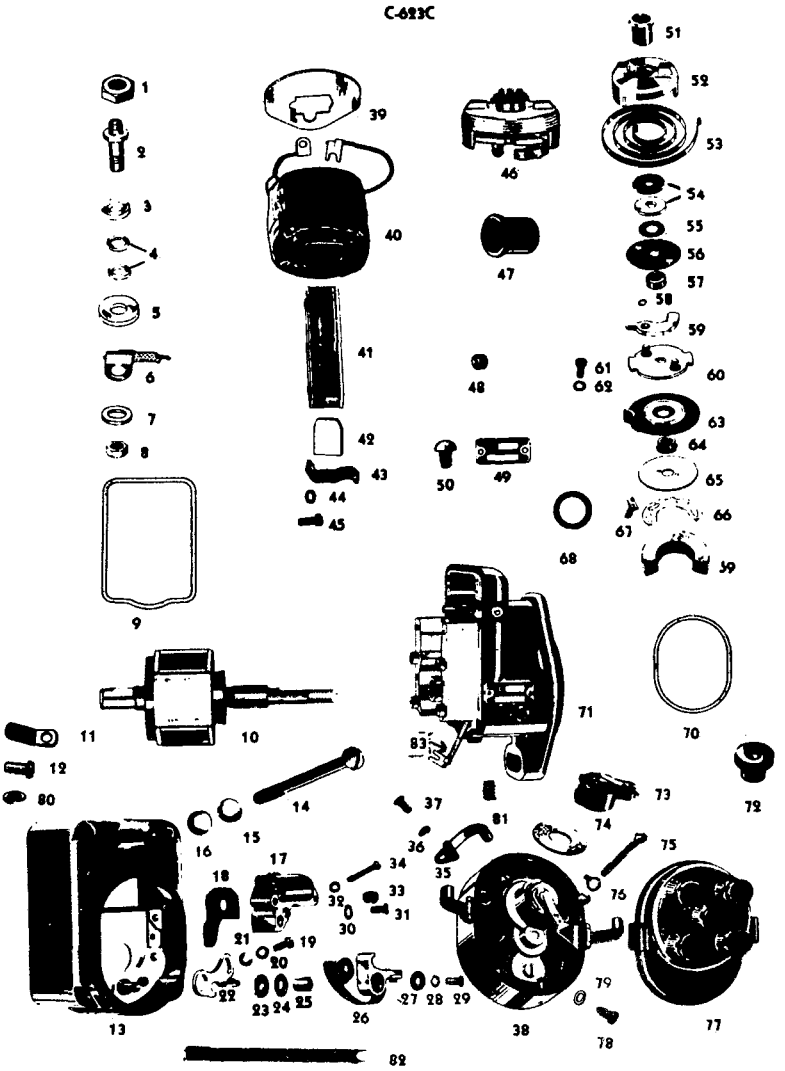

Fig. 57

MAGNETO
Fig. 57

Ref. No.	WICO Part No.	No. Used	Description	Price* Each
1	3230	2	Ground Stud Nut (Outside)	$ .05
2	3431	2	Ground Stud	.10
3	M-35X	2	Ground Stud Insulating Washer (Outside)	.05
4	M-34X	4	Ground Stud Insulating Bushing	.05
5	IXA-862	2	Ground Stud Insulating Washer	.05
6	X4760	1	Ground Stud Lead Group	.15
7	M-33X	2	Ground Stud Washer	.05
8	M-72X	2	Ground Stud Nut	.05
9	2504	1	Cover Gasket	.05
10	X2716	1	Rotor Assembly	6.60
11	1397	1	Coil Contact	.05
12	1404	1	Terminal Screw	.05
13	X2798	1	Cover Group (Horizontal Term.) (Multicyl.) Includes items 16, 12, 11, 14, 15, 80	2.20
14	2538	4	Cover Screw	.05
15	IXA-256	4	Cover Screw Washer (Steel)	.05
16	1118	4	Cover Screw Washer (Leather)	.05
17	X1413	1	Condenser Group	1.20
18	1533	1	Condenser Case Gasket	.05
19	M31X	1	Fixed Contact Screw	.05
20	M-55XA	1	Fixed Contact Screw L.W.	.05
21	IXA-256	1	Fixed Contact Screw Washer	.05
22	1196	1	Fixed Contact	.50
23	1197	1	Breaker Arm Spacing Washer (3/64" thick)	.05
24	1197T	1	Breaker Arm Spacing Washer (Use with 1197 when required to remove excessive play of breaker arm)	$ .05
25	1418	1	Breaker Arm Spacer	.05
26	X1408	1	Breaker Arm Group	1.25
27	1207	1	Breaker Arm Clamp Washer	.05
28	M-55XA	1	Breaker Arm Clamp Screw L. W.	.05
29	16-738	1	Breaker Arm Clamp Screw	.05
30	2573	1	Breaker Arm Spring Screw L. W.	.05
31	16-738	1	Breaker Arm Spring Screw	.05
32	M-90X	2	Condenser Screw L. W.	.05
33	1194	1	Cam Oil Pad	.05
34	1383	2	Condenser Clamp Screw	.05
35	X1503	1	Distributor Clip Assembly	.25
36	M-55XA	2	Distributor Clip Screw L.W.	.05
37	16-738	2	Distributor Clip Screw	.05
38	X2732	1	Gear Housing Assembly (Includes items 75, 76)	4.95
39	1760	2	Coil Gasket	.05
40	X2766	1	Coil Group	2.75
41	X2706	1	Coil Core Group	.55
42	3497B	2	Coil Wedge	.15
43	2503	2	Coil Core Clamp	.05
44	M-55XA	2	Coil Core Clamp Screw L.W.	.05
45	M-126XB	2	Coil Core Clamp Screw	.05

*All prices subject to change without notice. Prices shown are for Domestic Shipments. Add 10% to prices for Export Processing.

MAGNETO

Fig. 57

Ref. No.	WICO Part No.	No. Used	Description	Price* Each
46	X2775	1	Impulse Coupling Unit (Includes items 52, 57, 60, 56, 53, 51, 54, 59, 58, 55)	$3.30
47	2495	2	Rotor Bushing	.20
48	IXA-345	1	Main Housing, Oil Plug	.05
49	2506	2	Identification Plate	.20
50	1248	4	Identification Plate Screw	.05
51	2076	1	Impulse Lock Nut	.35
52	1806B	1	Drive Cup	2.00
53	15-186	1	Drive Spring	.55
54	IVA-583	1	Drive Cup Spacing Washer (Steel)	.10
54	IVA-583	1	Drive Cup Spacing Washer (Steel)	.10
55	M-42XA	1	Driven Flange Spacer Washer	.05
56	2288	1	Drive Spring Retainer	.05
57	2122	1	Driven Flange Spacer	.10
58	A-243X	2	Snap Ring	.05
59	A-179X	2	Trip Arm	.25
60	X2286	1	Driven Flange Group (CW)	.50
61	2641	1	Impulse Stop Screw	.05
62	2749	1	Impulse Stop Screw L.W.	.05
63	X2719	1	Impulse Stop Group	.85
64	2121	1	Impulse Spacer	.05
65	2745	1	Oiling Disc	.05
66	2505	1	Oil Pad Spring Plate	.05
67	X1487	1	Oil Scraper Assembly	.25
68	2496	1	Impulse Stop Gasket	$ .05
69	1379	1	Main Oil Pad	.10
70	2497	1	Gear Housing Gasket (Same as Distributor Cap Gasket)	.05
70	2497	1	Distributor Cap Gasket (Same as Gear Housing Gasket)	.05
71	X5089	1	Main Housing Assembly (Multicyl.) (Flange Mounting) (Includes items 50, 9, 49, 6, 1, 2, 83, 5, 7, 4, 3, 8)	6.70
72	16-463	5	Distributor Cap Terminal Nut	.10
73	16-X477B	1	Distributor Arm Group	.45
74	16-561B	1	Gear Housing Dust Washer	.05
75	2537	2	Gear Housing Screw	.05
76	2635	2	Gear Housing Screw L. W.	.05
77	X2704	1	Distributor Cap Group (4 cyl.) (Push type terminal)	1.90
78	16-449	1	Oil Plug, Gear Housing	.05
79	M-39XA	1	Oil Plug Washer (For Gear Housing)	.05
80	M-55XA	1	Terminal Screw Lock Washer	.05
81	16-539	1	Distributor Grounding Spring	.05
82	X2725	1	Secondary Interlead Group	.35
83	X3447	1	Ground Stud Interlead Group	.10
*84	X2747	1	Oiling Disc Unit (Includes items 64, 65)	.10

*All prices subject to change without notice. Prices shown are for Domestic Shipments. Add 10% to prices for Export Processing.

PARTS LIST

ENGINE BLOCK

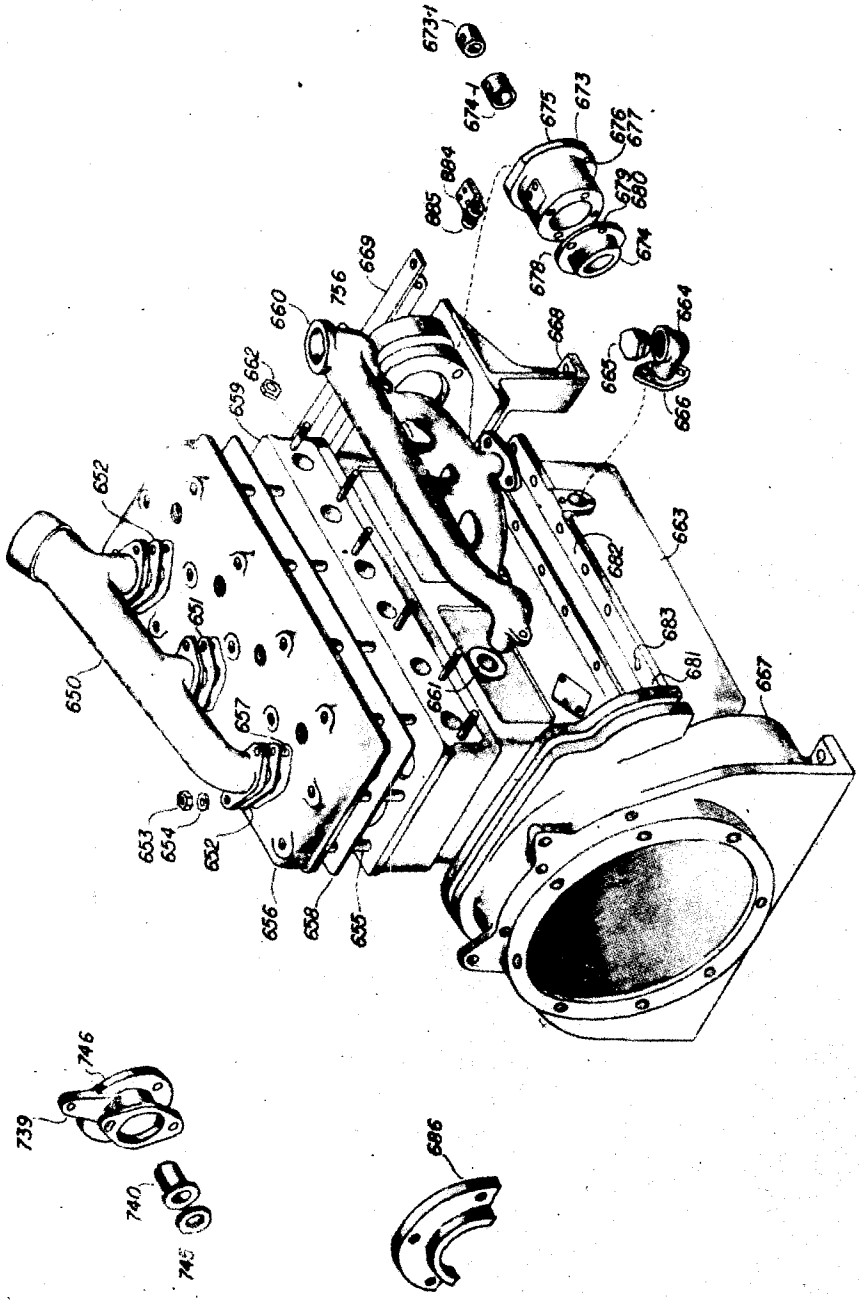

Fig. 58

ENGINE BLOCK

Fig. 58

Ref. No.	LeRoi Part No.	No. Used	Description	Price* Each
650	65–611	1	Water Outlet Connection	$1.68
651	16–9	1	Center Gasket	.02
652	16–531	2	End Gasket	.04
653	53–29	6	Hex Nut	.02
654	05–50	6	5/16 Lock Washer	.01
655	105–4	14	Cylinder Head Stud	.08
656	A2–249	1	Cylinder Head	15.60
657			Includes 657 – Water Connection Studs	12.50
658	16–724	1	Cylinder Head Gasket	.80
659	1A1–270	1	Cylinder Assembly – includes the following parts	72.00
	1–270	1	Cylinder Block	**
	4–109	1	Front Main Bearing Cap	2.00
	4–110	1	Rear Main Bearing Cap	2.20
	105–195	4	Main Bearing Stud 5/8 x 3 3/8 long	.18
	04–856	4	Nut for Stud 5/8	.06
	55–2–15	2	Oil Feed Tube	.12
	019–17	3	Welsh Plug 1 1/8	.04
	21–295	1	Front Cam Shaft Brg.	1.40
	21–261	1	Center Cam Shaft Brg.	.70
	21–271	1	Rear Cam Shaft Brg.	.90
	22–126	2	Front Main Brg. Shim	.08
	22–125	2	Rear Main Brg. Shim	.08
	11–2	4	Intake Valve Stem Guide Bushing	.32
	11–2	4	Exhaust Valve Stem Guide Bushing	.32
	19–13	4	Pipe Plug 1/8	.02
	019–34	1	Welsh Plug – Water Inlet Hole 2 1/4	.10
	105–6	2	Valve Cover Plate Stud	.08
	019–29	1	Rear Cam Brg. Welsh Plug	.08
	19–59	1	Cup Type Plug for dipstick hole	.08
	105–196	6	Manifold Stud 5/16 x 3 1/8	.08
	38–71	1	Fuel Pump Plate	.20
	16–229	1	Fuel Pump Plate Gasket	.04
	02–18	2	Fuel Pump Plate Cap Screw 5/16–18 x 3/4	.04
	05–50	2	Lock Washer 5/16	.01
	04–104	14	Cylinder Head Stud Nut 7/16–14	.02
	04–1001	2	Wing Nut for Valve Cover 5/16–18	.04
	07–25		Cotter Pin for Main Bearing Stud	.01
	52–1	1	Drain Cock	.28
	14–106	2	Valve Cover	.36
	16–673	2	Valve Cover Gasket (cork)	.06
	16–13	2	Valve Cover Gasket (lead)	.02
	06–3	2	Washer 5/16	.01
	16–24	1	Water Inlet Connection Gasket	.02
660	10–309	1	Intake and Exhaust Manifold	8.00
661	16–572	6	Intake and Exhaust Manifold Gasket	.06

*All prices subject to change without notice. Prices shown are for Domestic Shipments. Add 10% to prices for Export Processing. **Not serviced.

ENGINE BLOCK

Fig. 58

Ref. No.	LeRoi Part No.	No. Used	Description	Price* Each
662	53–149	6	Intake and Exhaust Manifold Stud Nut $\frac{5}{16}$	.04
663	A3–183	1	Oil Pan – includes the following parts	16.00
	3–183	1	Oil Pan	14.00
	02–20	2	Cap Screw $\frac{5}{16}$–18 x 1	.04
	05–50	2	Lock Washer	.01
664	13–375	1	Oil Filler Body	.90
665	4–142	1	Oil Filler Body Cap	.80
	16–776	1	Oil Filler Cap Gasket	.02
666	16–12	1	Oil Filler Body Gasket	.02
667	37–168	1	Bell Housing	20.00
	02–36	5	Bell Housing Cap Screws $\frac{3}{8}$–16 x 1	.04
	05–51	5	Lock Washers $\frac{3}{8}$	.01
	010–98	2	Bell Housing to Cylinder Taper Pin 1" long	.08
668	39–867	1	Front Engine Support	6.50
	02–36	4	Front Engine Support Cap Screws	.04
	05–51	4	Lock Washers $\frac{3}{8}$	.01
669	39–958	1	Radiator Support	2.60
	02–38	2	Radiator Support Cap Screws $\frac{3}{8}$–16 x $1\frac{1}{2}$	.04
	05–51	2	Lock Washers $\frac{3}{8}$	.01
	A60–43–49	1	Oil Gauge Dipstick	.50
673	13–236–1	1	Governor Body	5.50
673–1	11–182	1	Governor Body Bushing	.28
674	14–499	1	Governor Body Cover	2.00
674–1	21–30	1	Rear Governor Bearing	.30
	019–27	1	Welsh Plug $1\frac{3}{4}$	.04

*All prices subject to change without notice. Prices shown are for Domestic Shipments. Add 10% to prices for Export Processing.

ENGINE BLOCK

Fig. 58

Ref. No.	LeRoi Part No.	No. Used	Description	Price* Each
675	16–573	1	Governor Body Gasket	.06
676	02–18	3	Cap Screw $\frac{5}{16}$–18 x $\frac{3}{4}$	.04
677	05–50	3	Lock Washer $\frac{5}{16}$	.01
678	16–543	1	Governor Cover Gasket	.04
679	02–3	4	Cap Screws $\frac{1}{4}$–20 x $\frac{5}{8}$	.04
680	05–49	4	Lock Washer $\frac{1}{4}$	.01
681	16–551	1	Oil Pan Gasket – Rear	.08
682	16–671	2	Oil Pan Flange Gasket	.10
683	02–18	12	Oil Pan Flange Cap Screw $\frac{5}{16}$–18 x $\frac{3}{4}$	.04
	05–50	12	Lock Washers $\frac{5}{16}$	.01
	011–4	3	Pipe Plug $\frac{1}{2}$	.02
	02–20	2	Cap Screw $\frac{5}{16}$–18 x 1	.04
	05–50	2	Lock Washer $\frac{5}{16}$	.01
684	02–18	2	Cap Screws $\frac{5}{16}$–18 x $\frac{3}{4}$	.04
685	40–977	1	Governor Control Bracket	.70
686	31–297	1	Upper Rear Oil Retainer	2.50
	02–6	3	Cap Screws $\frac{1}{4}$–20 x 1	.04
	05–49	3	Lock Washer $\frac{1}{4}$	.01
	74–63–1	2	Oil Retainer Packing	.30
	16–553	2	Cork Retainer Gasket	.04
	16–554	1	Upper Oil Retainer Gasket	.06

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PARTS LIST

FAN AND WATER PUMP

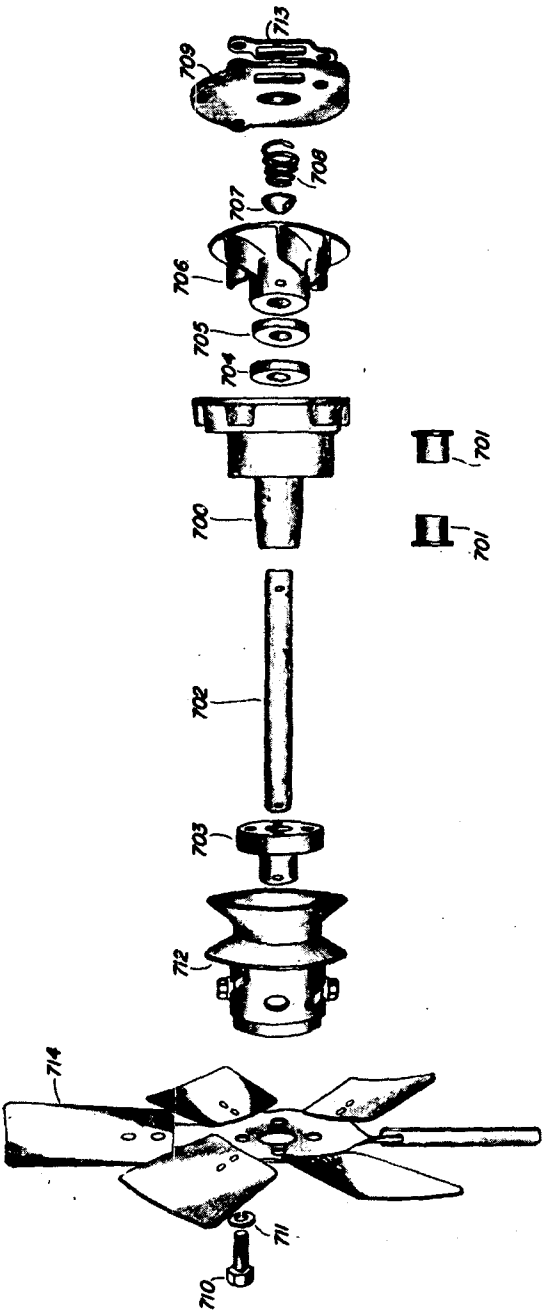

Fig. 59

FAN AND WATER PUMP

Fig. 59

Ref. No.	LeRoi Part No.	No. Used	Description	Price* Each
	1A81–171	1	Water Pump Assembly (includes parts Ref. No. 701 – 712 inclusive)	$16.00
700	81–171	1	Water Pump Body	
701	11–127	2	Water Pump Body Bushing	.15
702	27–1094	1	Impeller Shaft	1.00
703	132–70	1	Fan Hub	.80
704	20–235	1	Thrust Washer	.14
705	20–236	1	Rubber Washer	.04
706	101–19	1	Impeller	4.00
	17–16	1	Impeller Pin 1/8 dia. x 3/8 long	.05
	010–42	2	Taper Pin No. 3 x 1 1/4	.02
	16–773	1	Cover Gasket	.04
707	31–312	1	Shaft Retainer	.12
708	24–210	1	Retainer Spring	.12
709	40–1105	1	Water Pump Bracket	2.60
	02–7	2	Body to Cover Cap Screw 1/4–20 x 1 1/4	.04
	05–49	2	Lock Washer 1/4	.01
	017–11	1	Grease Cup	.12
710	02–18	4	Pulley to Fan Hub Cap Screw 5/16–18 x 3/4	.04
711	05–50	4	Lock Washer 5/16	.01
712	1A36–234	1	Fan Pulley Assembly	1.20
	16–774	1	Water Pump Body Gasket (round)	.02
713	16–775	1	Water Pump Body Gasket	.03
	02–40	3	Cap Screw for Body 3/8–16 x 2	.04
	05–51	3	Lock Washer 3/8	.01
	41–113	1	Fan Belt	1.30
714	42–63–1	1	Fan Blade	3.30

*All prices subject to change without notice. Prices shown are for Domestic Shipments. Add 10% to prices for Export Processing.

PARTS LIST

CAMSHAFT AND TIMING GEARS

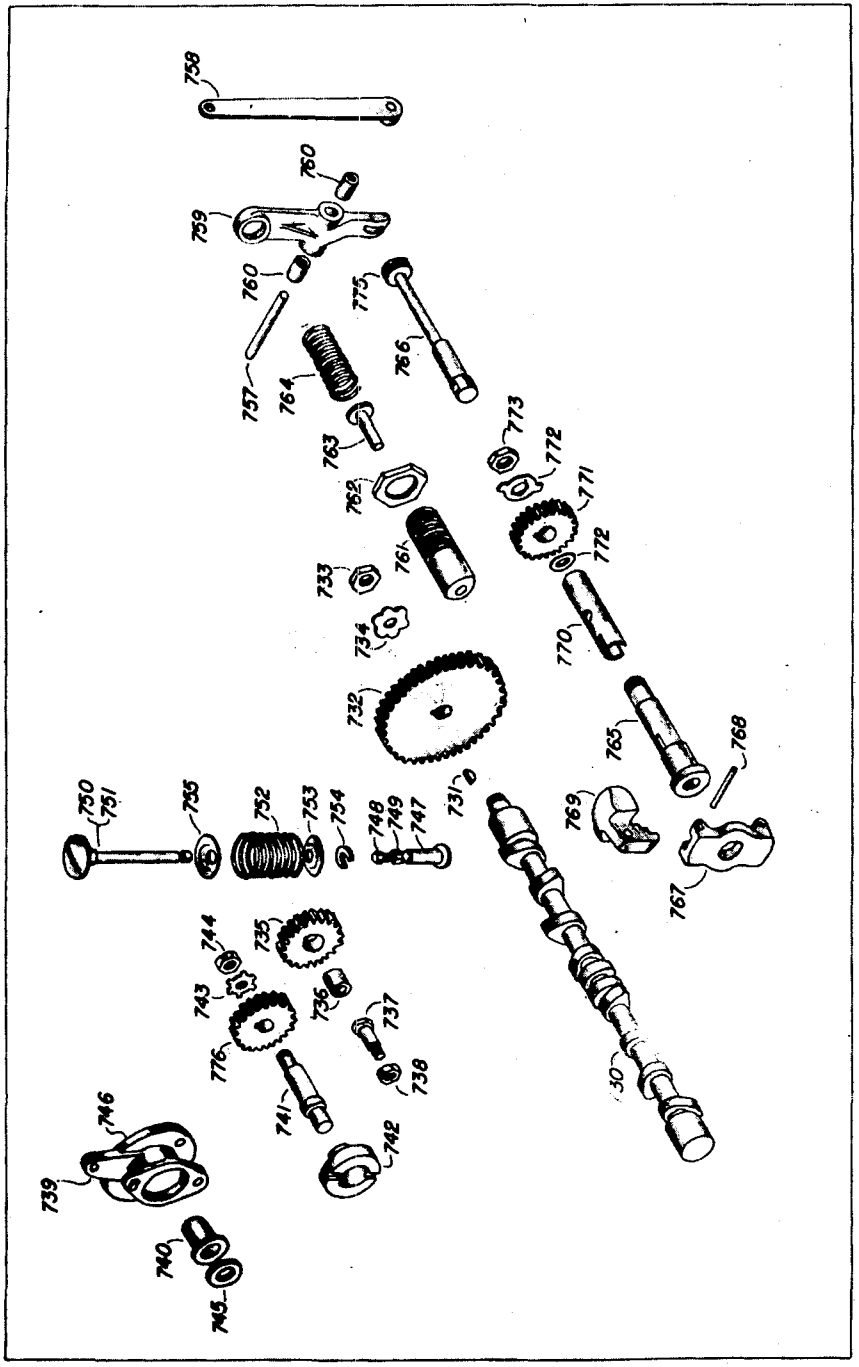

Fig. 60

CAMSHAFT AND TIMING GEARS

Fig. 60

Ref. No.	LeRoi Part No.	No. Used	Description	Price* Each
730	6–25–5	1	Camshaft	$14.00
	106–210	1	Camshaft Thrust Screw 1/2–20 x 1 5/8	.34
	16–740	1	Copper Asbestos Ring Gasket 1/2	.06
731	09–6	1	Woodruff Key No. 6	.02
	22–11	1	Camshaft Shim	.04
732	26–4	1	Camshaft Gear	2.40
733	53–193	1	Camshaft Gear Nut 1"–14	.10
734	20–47	1	Washer	.04
735	26–304	1	Idler Gear	2.20
736	21–223	1	Idler Gear Bushing	.30
737	34–109	1	Gear Pivot Bolt	1.50
	05–55	1	Lock Washer 5/8	.02
738	04–957	1	Nut 5/8–18	.06
	1A13–271	1	Ignition Drive Body Assembly (includes parts Ref. No. 739–745 inclusive)	12.00
739	13–271	1	Ignition Drive Body	5.20
740	21–225	1	Magneto Shaft Bearing	.50
741	27–798	1	Magneto Drive Shaft	2.50
	09–6	1	Magneto Coupling Key Woodruff No. 6	.02
742	28–154	1	Magneto Coupling	.75
	09–3	1	Magneto Gear Key Woodruff No. 3	.02
743	20–147	1	Lock Washer	.04
744	04–955	1	Shaft Nut 1/2–20	.02
745	125–27	1	Oil Retainer	1.00
746	16–574	1	Magneto Drive Body Gasket	.06
	02–18	3	Cap Screws for Body 5/16–18 x 3/4	.04
	05–50	3	Lock Washer 5/16	.01
	02–37	2	Cap Screws for Body 3/8–16 x 1 1/4	.04
	06–5	2	Plain Washer 3/8	.01
	A23–1	8	Valve Tappet Assembly (includes part Ref. No. 747, 748, 749)	.72
747	23–1	8	Valve Tappet	.60
748	106–35	8	Valve Tappet Adjusting Screw 1/4–28 x 1	.04
749	53–55	8	Valve Tappet Adjusting Screw Nut	.02
750	15–2	4	Intake Valves	.44
751	15–182	4	Exhaust Valves	.76
752	24–1	8	Valve Springs	.08
753	20–1	8	Valve Spring Retainer Washer (lower)	.04
754	20–2	8	Valve Spring Retainer Washer (horse shoe)	.02
755	20–12	8	Valve Spring Retainer Washer (upper)	.04
	5A14–689	1	Gear Cover Assembly (includes parts Ref. No. 756 – 760 inclusive)	15.00
756	14–689	1	Gear Cover	8.50
757	27–1025	1	Governor Lever Shaft	.30

*All prices subject to change without notice. Prices shown are for Domestic Shipments. Add 10% to prices for Export Processing.

CAMSHAFT AND TIMING GEARS

Fig. 60

Ref. No.	LeRoi Part No.	No. Used	Description	Price* Each
758	48–51	1	Governor Lever	.30
759	48–247	1	Governor Speed Adjusting Lever	.60
	010–2	1	Taper Pin No. 00 x 3/4	.02
	106–19	2	Set Screw for Screen Hole	.04
	106–162	1	Oil Pressure Relief Screw	.20
	25–16	1	Oil Pressure Relief Plunger	.12
	24–99	1	Oil Pressure Relief Spring	.08
	53–57	1	Oil Pressure Relief Lock Nut	.08
760	11–144	2	Bushings	.16
761	53–148	1	Governor Spring Adj. Nut	.90
762	53–77	1	Governor Spring Adj. Lock Nut	.12
763	25–52	1	Governor Spring Plunger	.60
	16–555	1	Gear Cover to Cylinder Gasket	.12
	02–23	8	Gear Cover Cap Screw 5/16–18 x 1 3/4	.04
	02–22	1	Gear Cover Cap Screw 5/16–18 x 1 1/2	.04
	05–50	9	Lock Washer 5/16	.01
	182–16	1	Straight Fitting 3/8 Tube x 1/4 Pipe Thd.	.16
	182–5	1	Nut for Straight Fitting	.08
	31–341	1	Oil Seal	.16
	31–340	1	Oil Retainer	.20
	03–366	4	Oil Seal Screws No. 10–24 x 3/16	.01
	05–25	4	Lock Washer No. 10	.01
764	24–138	1	Governor Spring	.12
	49–50	1	Breather Tube	.75
	43–3	1	Breather Screen	.12
	A4–28–1	1	Breather Cover Assembly	1.00
765	27–797	1	Governor Shaft	4.00
766	25–59	1	Governor Operating Plunger	.30
	91–7	1	Governor Weight Yoke Key	.08
	1A45–14	1	Governor Yoke Assembly (includes parts Ref. No. 767, 768, 769)	2.20
767	45–14	1	Governor Yoke	.30
768	17–46	2	Governor Yoke Pin	.08
769	44–15	2	Governor Weight	.80
770	63–32	1	Governor Shaft Sleeve	.80
	09–6	1	Governor Gear Key – Woodruff No. 6	.02
771	26–2–4	1	Governor Drive Gear	1.70
772	20–23	1	Lock Washer	.02
773	53–57	1	Lock Nut	.08
774	22–113	1	Governor Gear Spacing Shim	.08
775	181–5	1	Thrust Bearing	1.50
776	26–2–16	1	Magneto Drive Gear	1.50

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CRANKSHAFT — PISTONS — OIL PUMP

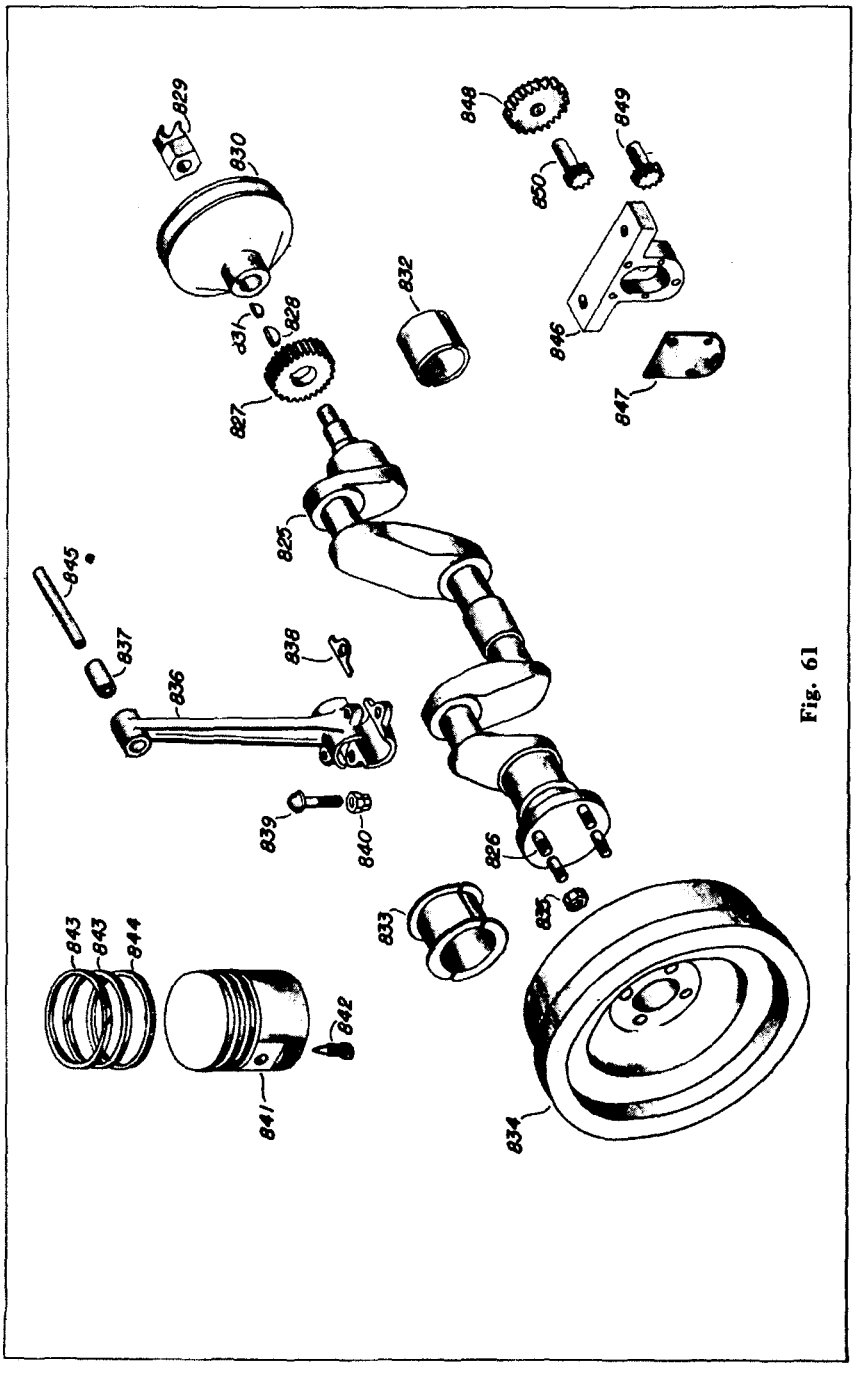

Fig. 61

CRANKSHAFT — PISTONS — OIL PUMP

Fig. 61

Ref. No.	LeRoi Part No.	No. Used	Description	Price* Each
	A5–271	1	Crankshaft Assembly (includes parts up to 011–101 inclusive)	$34.00
825	5–271	1	Crankshaft	**
826	105–16	4	Crankshaft Flange Stud	.08
	011–101	6	Pipe Plug	.02
827	26–2	1	Crankshaft Gear	1.50
828	09–6	1	Woodruff Key No. 6	.02
829	53–14	1	Starting Jaw Nut	1.10
830	36–399	1	Crankshaft Pulley	6.00
831	09–6	1	Woodruff Key No. 6	.02
832	21–220	2	Front Main Bearing	.80
833	21–221	2	Rear Main Bearing	1.40
834	9–361	1	Flywheel	21.00
835	04–805	4	Hex Nut 1/2–20	.04
	07–41	4	Cotter Pin 1/8 x 1 1/4 lg.	.01
	A7–21–3	4	Connecting Rod Assembly (includes parts up to Ref. No. 840 inclusive)	6.00
836	7–21–3	4	Connecting Rod	5.30
837	21–11	4	Piston Pin Bearing	.40
838	22–105	8	Connecting Rod Shim	.30
839	35–3	8	Connecting Rod Bolt	.20
	07–21	8	Cotter Pin	.01
840	53–31	8	Nut 7/16–20 Castle	.08
	A8–226–1	4	Piston Assembly (includes parts up to Ref. No. 842 inclusive)	2.50
841	8–226–1	4	Piston	2.40
	05–50	4	Lock Washer 5/16	.01
842	106–31	4	Piston Pin Screw	.06
843	18–267	8	Piston Ring PC No. 70 .007 – .017 Gap	.30
844	18–268	4	Piston Ring PC85 .007 – .015 Gap	.50
845	17–2	4	Piston Pin	.60
	A13–281	1	Oil Pump Assembly (incluudes parts up to 16–549 inclusive)	11.00

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CRANKSHAFT — PISTONS — OIL PUMP

Fig. 61

No.	Part No.	Used	Description	Each
846	13–281	1	Oil Pump Body	4.50
847	14–503	1	Oil Pump Body Cover	.10
848	26–308	1	Drive Gear	2.00
849	26–307	1	Pump Cover	1.80
850	26–306	1	Pump Gear	1.80
	03–369	5	Round Hd. Mach. Scr. No. 10–24 x 3/8 long	.01
	05–25	5	Lock Washer No. 10	.01
	010–203	1	Taper Pin No. 000 x 1 long	.04
	16–549	1	Gasket for Oil Pump Cover	.04
	02–37	2	Oil Pump to Main Brg. Cap Screws 5/16–18 x 2 3/4 lg.	.01
	05–50	2	Lock Washer 5/16	.16
	182–14	1	Straight Fitting to Pump 5/16 tube 1/8 P. Thd.	.16
	182–14	1	Straight Fitting to Cylinder Flange 5/16 tube 1/8 P. Thd.	.08
	55–2–31	1	Tube from Pump to Cylinder 5/16 x 4 3/8 long	.12
	182–35	1	Elbow Fitting for Pump 5/16 tube 1/8 P. Thd.	.08
	182–4	3	Nut for Elbow and Straight Fitting 5/16 tube	.08
	43–84	1	Oil Strainer	2.20
	02–16	1	Oil Strainer Cap Screw 5/16–18 x 1/2 long	.04
	05–50	1	Lockwasher 5/16	.01
	02–2	1	Oil Strainer to Pan Cap Screw 1/4–20 x 1/2 lg.	.02
	05–49	1	Lock Washer 1/4	.01

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PARTS LIST

ENGINE HOOD — GAS TANK

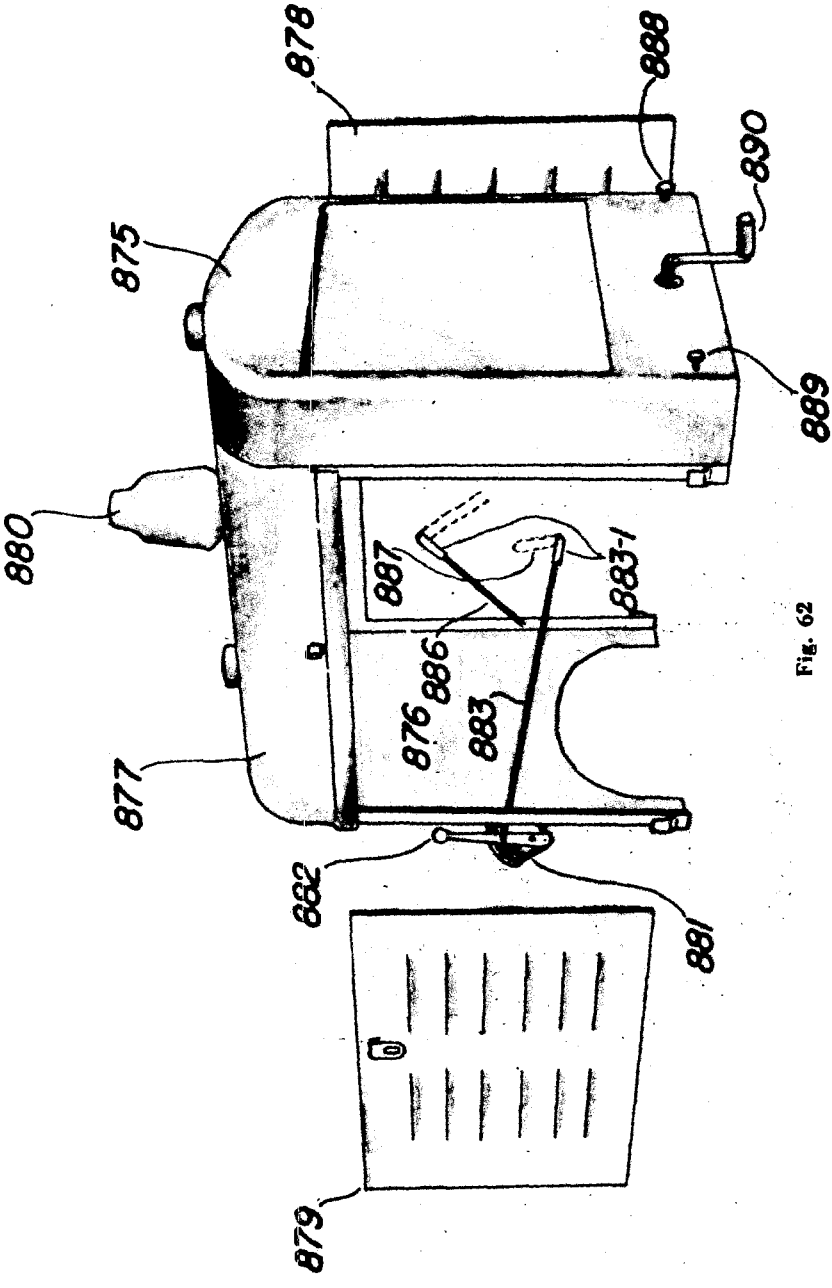

Fig. 62

ENGINE HOOD — GAS TANK

Fig. 62

Ref. No.	LeRoi Part No.	No. Used	Description	Price* Each
875	A71–305–32	1	Radiator with Cap	$47.00
	73–26–5	1	Hose 1½ x 6½ long	.20
	79–35	4	Hose Clamp	.04
	79–34	8	Hose Clamp End	.04
	04–13	4	Hose Clamp Nut No. 10–24	.01
	03–96	4	Hose Clamp Screw No. 10–24 x 1 lg.	.01
	02–36	2	Radiator Supp. to Eng. Supp. Cap Screw ⅜–16 x 1 long	.04
	05–51	2	Lock Washer ⅜	.01
	74–50	1	Packing Between Hood and Radiator	.20
	74–49	2	Rubber Packing for Radiator	.16
	A52–7	1	Water Drain Cock Assem.	1.00
	04–803	2	Hex Nut ⅜–24	.02
	07–23	2	Cotter Pin 3/32 x 1 long	.01
	73–26–2	1	Hose 1½ dia. x 2 lg.	.10
	73–26–18	1	Hose 1½ dia. x 3 lg.	.12
	79–35	4	Hose Clamp	.04
	79–34	8	Hose Clamp End	.04
	03–96	4	Hose Clamp Screw No. 10–34 x 1	.01
	04–13	4	Hose Clamp Nut No. 10–24	.01
	116–74	1	Thermostat – Dole – Model PAN	3.75
	182–176	1	Straight Fitting ⅜ P. Thd. – ⅜ Tube	.34
	182–37	1	Elbow Fitting ¼ P. Thd. ⅜ Tube	.18
	182–5	2	Nut for Straight Elbow Fitting ⅜ Tube	.08
	55–48–53	1	Tube ⅜ x 5¾ long	.16
876	39–1059–1	1	Housing Support	3.60
	02–32	4	Housing Support Cap Screw ⅜–16 x ½	.04
	05–51	4	Lock Washer ⅜	.01
	A68–548	1	Hood Top Assembly includes the following	14.00
877	68–548	1	Hood Top	6.00
	03–623	3	Screw for Gas Tank ¼–20 x 1¼ rd. lid.	.02
	04–101	3	Hex Nut ¼–20	.01
	A69–180	1	Gasoline Tank with Cap 4–12	9.00
878	68–549	1	R. H. Hood Side	3.50
879	68–549	1	L. H. Hood Side	3.50
	03–619	5	Hood Top to Radiator Screw ¼–20 x ½ rd. hd.	.01
	04–101	5	Hex Nut ¼–20	.01
	05–49	5	Lock Washer ¼	.01
880	1A78–51	1	Muffler Body Assembly includes the following	2.50
	78–51	1	Muffler Body	**
	55–580	2	Tube Half	.24

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ENGINE HOOD — GAS TANK

Fig. 62

Ref. No.	LeRoi Part No.	No. Used	Description	Price* Each
	011–5	1	Pipe Plug 3/4	.04
	013–180	1	Exhaust Pipe 1 1/4 x 10 lg.	.34
881	40–977	1	Governor Control Bracket	.70
	02–18	2	Governor Control Bracket Cap Screw 5/16–18 x 3/4	.04
	04–102	2	Hex Nut 5/16–18	.02
	05–50	2	Lock Washer 5/16	.01
882	48–399	1	Governor Control Lever	1.60
	06–69	2	Washer 3/8	.01
	07–5	2	Cotter Pin 1/16 x 3/4 lg.	.01
	A47–401	1	Governor Control Rod Assem. includes the following	.90
883	47–401	1	Governor Control Rod	.45
	031–61	1	Governor Control Rod Pin	.04
	04–27	1	Hex Nut No. 10–32	.01
	07–3	1	Cotter Pin 1/16 x 1/2 lg.	.01
883–1	031–1	1	Yoke	.20
	031–61	1	Rod End Pin	.04
	07–3	1	Cotter Pin 1/16 x 1/2 lg.	.01
	1A40–978	1	Control Bracket Assem. includes the following	4.00
885	40–978	1	Control Bracket	1.00
	27–1018	1	Control Shaft	.14
	48–398	1	Lever	.70
	010–2	2	Taper Pin	.02
887	48–382	1	Control Rod Lever	1.30
884	02–3	2	Control Bracket to Gov. Body Cap Screw 1/4–20 x 5/8	.04
	05–49	2	Lock Washer 1/4	.01
	27–1020	1	Governor Control Bracket Shaft	.30
	24–104	1	Governor Control Spring	.20
890	50–23	1	Starting Crank	1.00
	60–33	1	Oil Pressure Gauge U.S.	1.50
	A73–257	1	Flexible Oil Line 1/8 I.D. x 11 long	1.80
	A77–206	1	Oil Filter – Purolator N1540	2.50
	02–18	4	Oil Filter Cap Screw 5/16–18 x 3/4 long	.04
	06–3	4	Plain Washer 5/16	.01
	05–50	4	Lock Washer 5/16	.01
	04–102	4	Hex Nut 5/16–18	.02
	013–1	1	Close Nipple 1/8	.20
	013–601	1	Tee 1/8	.16
	A73–253–2	1	Flex. Oil Line – Filter to Eng.	2.00
	A73–257–1	1	Flex. Oil Line to Oil Gauge	1.80
	182–33	2	Elbow Fitting 1/8 P. Thd. 1/4 tube	.25

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ENGINE HOOD — GAS TANK

Fig. 62

Ref. No.	LeRoi Part No.	No. Used	Description	Price* Each
	182–3	2	Nut for Elbow Fitting 1/4 tube	.05
886	47–392	1	Governor Operating Rod	.90
	031–61	1	Governor Operating Rod Pin	.04
	04–27	1	Nut No. 10–32 Hex	.01
	07–3	1	Cotter Pin 1/16 x 1/2 lg.	.01
883–1	031–1	1	Rod Yoke	.20
	031–61	1	Rod End Pin	.04
	07–3	2	Cotter Pin 1/2 long	.01
	86–9	4	Spark Plug	.60
	2A61–1–37	2	includes the following Ignition Wire Assem.	
	61–1–37	2	Ignition Wire Assem. No. 7 MM x 20 long	.35
	121–35	2	Terminals	.10
			Terminals	.04
	121–62	2	Ignition Wire Assem.	
	3A61–1–6	2	includes the following	
	61–1–6	2	Ignition Wire Assem. No. 7 MM x 22 1/2 long	.40
	121–35	2	Terminals	.10
	121–62	2	Terminals	.04
	62–36	1	Wire Name Plate No. 1	.04
	62–36–1	1	Wire Name Plate No. 2	.04
	62–36–2	1	Wire Name Plate No. 3	.04
	62–36–3	1	Wire Name Plate No. 4	.04
888	A76–42	1	Ignition Switch Clum No. 16946	.90
	150–1	1	Rubber Grommet	.04
	39–1255	1	Rubber Grommet Bracket	.10
	40–1160	2	Ignition Wire Bracket	.05
	03–619	2	Mach. Scr. 1/4–20 x 1/2	.01
	05–49	2	Lock Washer 1/4	.01
	A77–22	1	Gasoline Filter	.90
	013–1	1	Close Nipple 1/8	.20
	A73–253–11	1	Flex. Hose Assem. 1/4 x 23	1.80
889	A120–2	1	Choke – Clum No. 8974	.80
	A77–187	1	Air Cleaner – Air Maze Oil Bath – No. 1B–OBNH	4.50
	4–132	1	Air Cleaner Connection Cap	1.50
	73–26–4	1	Hose 1 1/2 x 4 long	.25
	182–37	1	Elbow Fitting 1/4 P. Thd. 3/8 tube	.18
	55–48–31	1	Tube 3/8 x 15 long	.20
	182–16	1	Straight Fitting 1/4 P. Thd. 3/8 tube	.16
	182–5	2	Nut for Elbow and Str. Fitting 3/8 tube	.08
	40–1044	1	Air Cleaner Bracket	.70
	16–838	1	Air Cleaner Gasket	.06
	02–18	2	Cap Screw 5/16–18 x 3/4	.04
	05–50	2	Lock Washer 5/16	.01

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ENGINE HOOD — GAS TANK

Fig. 62

Ref. No.	LeRoi Part No.	No. Used	Description	Price* Each
	04–102	2	Nut $\frac{5}{16}$–18	.02
	79–34	4	Hose Clamps	.04
	79–35	8	Hose Clamp End	.04
	03–96	4	Hose Clamp Screw No. 10–24 x 1 long	.01
	04–13	4	Hose Clamp Nut No. 10–24	.01
	10–A88–13	1	Tool Kit Assembly includes the following	2.20
	88–2	2	Tappet Wrench	.20
	88–10	1	Valve Tappet, Spark Plug, and Mag. Point Gauge	.40
	88–13	1	Tool Container	.45
	88–85	1	Open End Wrench $\frac{11}{16}$ x $\frac{15}{16}$	.25
	88–12	1	Socket Wrench Handle	.35
	88–8	1	Connecting Rod Bolt Nut Socket Wrench	.25
	88–11	1	Open End Wrench $\frac{3}{8}$ x $\frac{7}{16}$	.15
	88–9	1	Open End Wrench $\frac{1}{2}$ x $\frac{9}{16}$	.15

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COUPLING

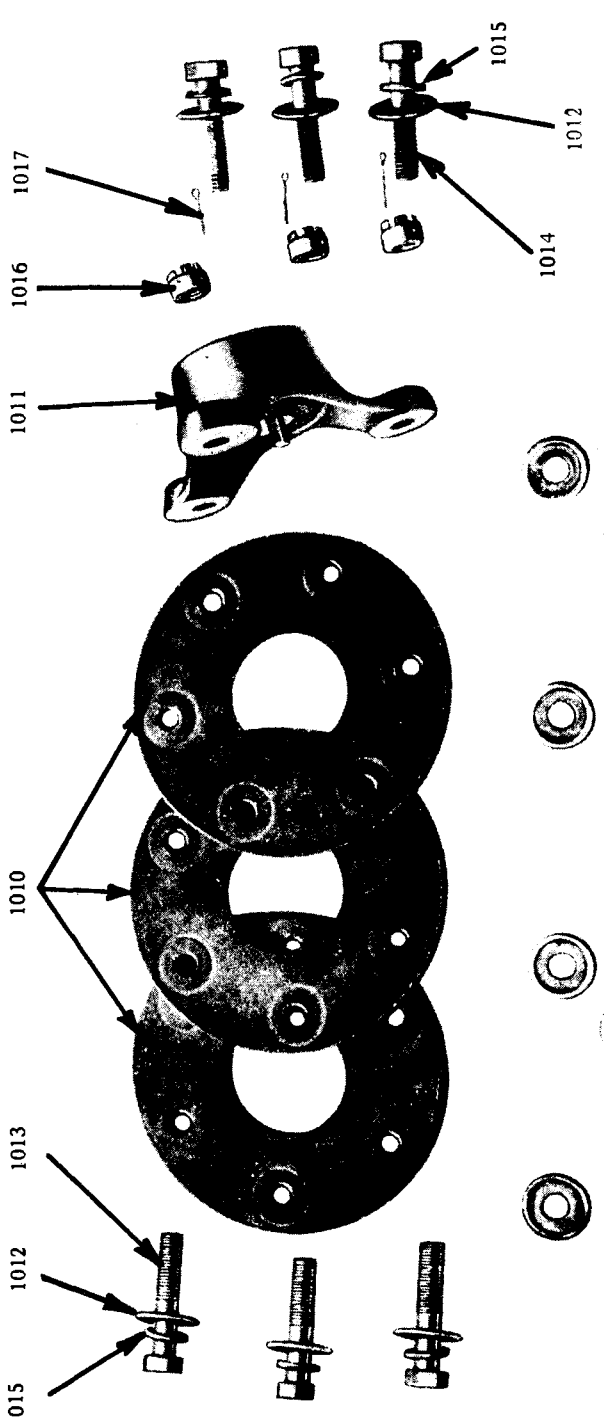

Fig. 63

COUPLING

Fig. 63

Ref. No.	LeRoi. Part No.	No. Used	Description	Price* Each
	35A-28-30	1	Flexible Coupling (Complete)	$8.50
1010	28-30	3	Coupling Discs	1.50
1011	80-32-11	1	Flexible Coupling Spider	6.00
1012	20-35	18	Flexible Coupling DiscWashers	
1013	106-42	3	Flexible Coupling Disc Cap Screw ½" x 2½" long	.16
1014	106-185	3	Flexible Coupling to Flywheel Cap Screw—½" x 2¼" long	.16
1015	06-71	6	Plain Washer—½"	.02
1016	04-805	3	Nuts—½" SAE Castellated	.04
1017	07-23	3	Cotter Pin—3/32" Dia. x 1" long	.01

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