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ENGINE

MAINTENANCE

MANUAL

NO. 252C

for

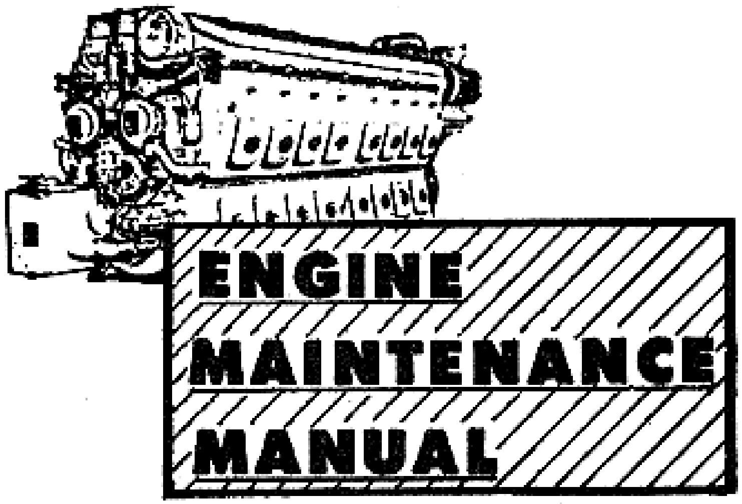
MODEL 567C ENGINES

3rd Edition

January, 1957

SECTION INDEX

MODEL 567C ENGINES



ELECTRO-MOTIVE DIVISION

General Motors Corporation

LA GRANGE, ILLINOIS, USA

Printed in U.S.A,

FORWORD

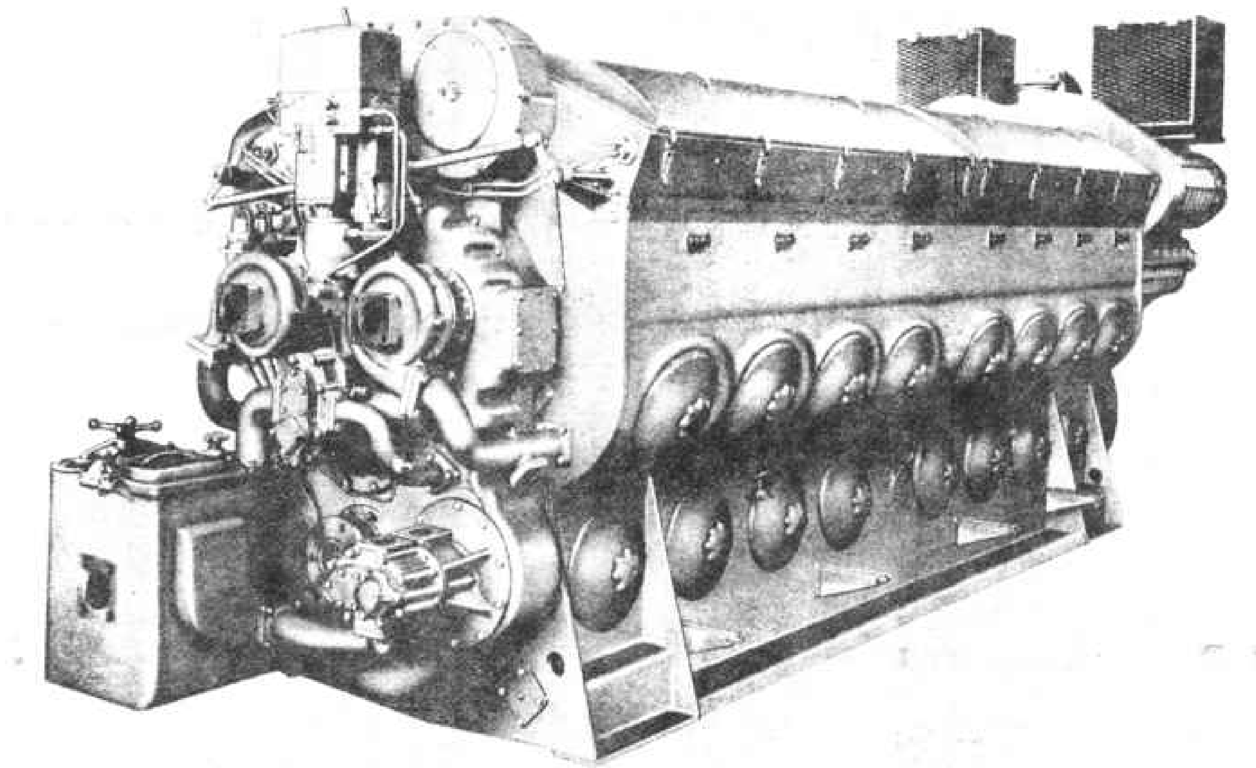
This manual is designed to cover all 6, 8, 12, and 16 cylinder Model 567C engines and attached accessories. Minor differences, between engines and the manual, due to slight refinements in specifications after the manual was sent to press may be encountered. Refinements in specifications of production engines generally are not reflected in engines already in service. Therefore, we feel it inadvisable to make revisions of manuals already distributed, except when major changes are recommended for engines already in service.

Each section of the manual consists of the Description, Operation, Maintenance, Specifications, and Equipment List on the component parts of the engine covered by that section.

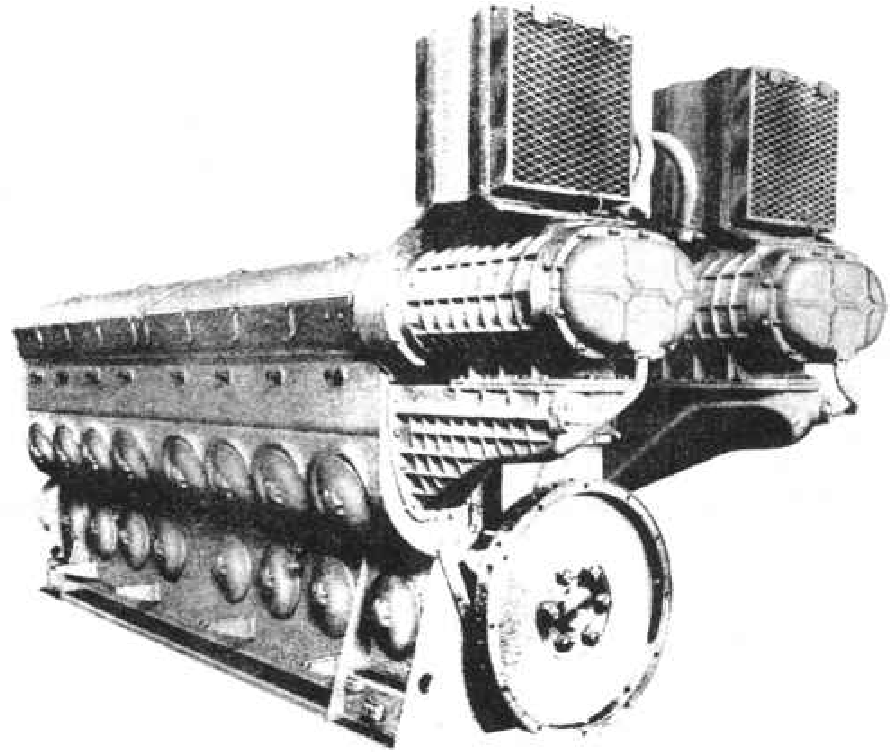
Wear limits are often given as diametric clearance. This means the total clearance on the diameter. Most diametric clearances can be measured by placing a feeler gauge on only one side of the object being checked. Other items may have to be checked by measuring the outside diameter of the shaft, using a micrometer, and subtracting this figure from the inside diameter of the bearing in which the shaft turns. A ball micrometer for measuring wall thickness of bearings, and a dial indicator for measuring diametric and longitudinal clearances will be found necessary. For measuring clearances such as piston to cylinder head, or oil pump gears to housing, the use of lead ribbon will be desirable. The lead ribbon is inserted between the parts, removed and measured to obtain the clearance.

Where radial clearance is specified it is because the nature of the part is such that diametric clearance cannot be measured. The radial clearance is always one-half of the diametric clearance.

Longitudinal or thrust clearances are listed throughout the manual with all of the clearances removed at one end of the part being measured. Where it is not convenient to take out all of the thrust at one end, the thrust at each end should be measured and added, to give the total longitudinal clearance.



Front Three-Quarter View Model 16-567C Engine
Fig. 0-1



Rear Three-Quarter View Model 16-567C Engine
Fig. 0-2

OPERATING DESCRIPTION

In a four-cycle engine, four strokes of the piston are required to complete one cycle of events; the in take stroke, compression stroke, power stroke an exhaust stroke. The crankshaft will make two revolutions per cylinder for each power stroke. During the intake and exhaust strokes the piston functions as a air compressor, which operation consumes power.

In a two-cycle engine, such as the model 567C only two strokes of the piston are required to complete the cycle of events. Intake and exhaust takes place during part of the power and compression stroke. Each downward (power) stroke of the piston deliver a power impulse to the crankshaft. Therefore, a two cycle engine has twice as many power impulses as four-cycle engine, with the same number of cylinder and operating at the same speed.

As tile piston in a two-cycle engine is not required to function as an air pump, an external mean of supplying air must be provided. A specially de signed blower, handling a large volume of air at lo pressure, is used for this purpose. The blower force air into the cylinder through ports in the cylinder line wall, thus expelling the exhaust gases and filling the cylinder with a fresh charge of air for combustion.

The cycle of events of the two-cycle engine an operation of the blower are graphically described o Fig. 0-3 and explained in the following paragraphs.

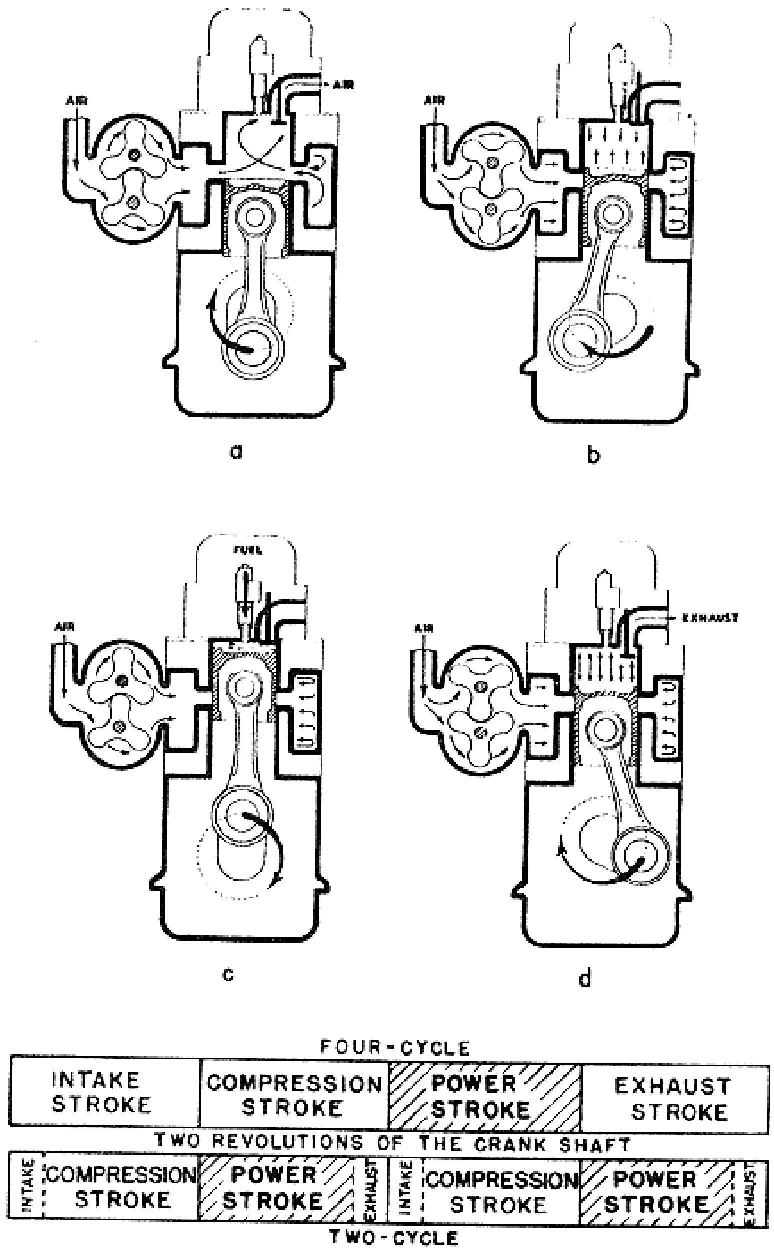


Fig. 0-3a. At the lower end of its downward

stroke the piston uncovers a row of ports in the cylinder liner admitting the scavenging air to the cylinder This flow of air through the ports and exhaust valve produces complete scavenging, leaving the cylinder fu of clean air when the piston covers the ports on it upward stroke.

Cycle Of Events of Engine
Fig. 0-3

Fig. 0-3b. As the piston continues on the upward stroke the exhaust valves close and the charge of air is compressed to about one-sixteenth of its initial volume, or about 600 pounds per square inch. Air, when compressed to this extent, increases in temperature to approximately 1000° F. This high compression ratio is maintained at all loads and speeds.

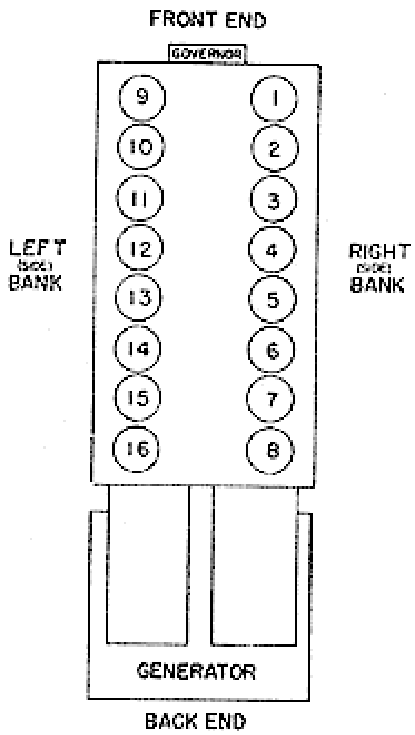
Fig. 0-3c. Shortly before the piston reaches the top dead center of its stroke, the fuel, atomized by high pressure is injected into the combustion chamber. The fuel is ignited by the high temperature of the air and continues to burn until the charge is consumed. The burning charge rapidly builds up a high pressure which acts upon the piston, forcing it downward on the power stroke.

GENERAL DESCRIPTION AND DATA

The Model 567C Diesel engine is a "V" type, two-cycle engine, incorporating the advantages of low weight per horsepower, fully scavenging air system, solid unit injection and high compression.

The accompanying sketch serves to identify the cylinder locations, ends and banks of the

Fig. 0-3d. just before the piston reaches the end of the power stroke, the exhaust valves open, releasing the gases to the atmosphere. The piston then uncovers the air inlet ports. By this time the exhaust gases have expanded to the point where the pressure is lower in the cylinder than in the air-box. The cycle is then repeated.



engine as referred to in this manual. The governor, water pumps and lube oil pumps are mounted at the "Front End." The blowers, oil separator and generator are at the "Back End."

GENERAL DATA

Bore	8-1/2"
Stroke	10"
Compression Ratio	16:1
Idling Speed	275 RPM
Starting Speed	75-100 RPM
Rotation (Facing Back End)	Counter-Clockwise
Angle Between Banks	45°

Weight (Approx.)

6-567C	15,660 Ibs.
8-567C	17,970 Ibs.
8-567CR	18,500 Ibs.
12-567C	24,660 Ibs.
16-567C	32,106 Ibs.

Rated Horsepower

Horsepower ratings for various applications of 567C engines are given in Table 'B," Section XI.

```
Firing Order
   6-567C                                    1-4-3-6-2-5
   8-567C                                1-5-3-7-2-6-4-8
   8-567CR                               1-5-3-7-4-8-2-6
  12-567C                     1-12-7-4-3-10-9-5-2-11-8-6
  16-567C    1-8-9-16-3-6-11-14-4-5-12-13-2-7-10-15

Displacement per Cylinder          567 cubic inches
Number of Exhaust Valves (per cylinder)            4
Crankpin Diameter                             6-1/2"
Crankshaft Journal Diameter                   7-1/2"
Number of Main Bearings
     6-567C                                        4
```


TORQUE VALUES FOR 567 SERIES ENGINES

	Foot Pounds
Cylinder Head Nuts	
"C" Engine type liners	200
Liners #1 and #2	290-300
Liner #3	200
Liner Stud Application (Min.)	50
Fork Rod Basket Capscrews (at serrations)	190-200
Fork Rod Basket Capscrews (at serrations)	
(checking ONLY, see Section 3)	175-185
Split Basket Bottom Bolts (1/21, x 20)	75
Main Bearing Nuts	500-800
Main Bearing Studs	250
Crab Stud Nuts	1800
Engine Flywheel Mounting Bolts	1200
Flywheel Coupling Bolts (3/4" x 16)	295
Injector Crab Nuts	50
Blower Timing Gear Cover Nuts	35-40
Oil Pan to Crankcase Mounting Bolts	450
Front and Rear 1/211 Mounting Capscrews	
Hardened (with mark on head)	85
Not Hardened (without any mark on head)	65
Aux. Gen. Drive Assy. 3/4" Mounting Bolts	175
Cylinder Head Frame Capscrews	30
Rocker Arm Shaft Nuts	300

8-567C	5
8-567CR	5
12-567C	7
16-567C	10

Injector Fuel Lines	40
Camshaft and Injector Shaft Capscrews	20-25
Fuel Manifold Blocks	25
Exhaust Manifold Capscrews (5/81, x 18)	130
Exhaust Manifold Stud Nuts (5/8" x 11)	90
Exhaust Manifold Connecting Clamp Bolt	70 in. Ibs.
Harmonic Balancer Capscrews (Mounting)	400
Accessory Drive Gear Capscrews (Mounting)	250
Cylinder Head Elbow Capscrews ("C" Engine)	30
Water Pump Impeller	80
Water Pump Gear	265
Water Manifold Strap Nuts	15

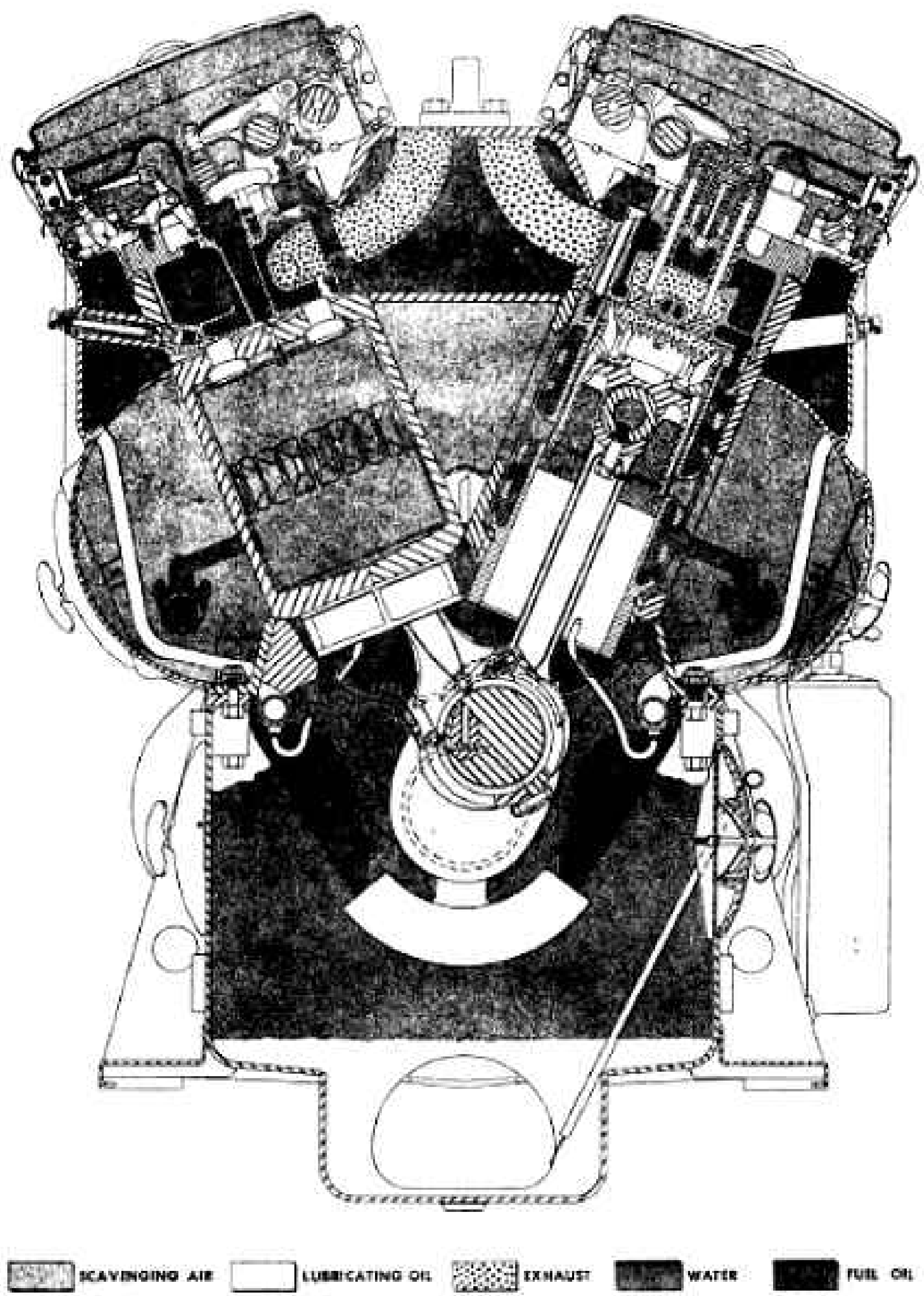
NOTE: All single values given may vary plus or minus five percent of the value.

Liner Water Inlet Tube Capscrews (in liner)	30
"Pee" Tubes	20
Bolted Crankshaft Counterweights	200
Engine Hold Down Bolts	450
Camshaft Stubshaft Bracket "CR" engine (5/8" dia. socket hd.)	130
Camshaft Stubshaft Bracket (1/2" dia. socket hd.)	75
Camshaft Bearing Blocks (3/8"-24)	27

TORQUE WRENCHES

	Part No.
Crab Nut Powerench (ratio 12:1)	8211089

Torque Wrench (25 ft. Ibs.) 1/2" Drive	8157122
Torque Wrench (100 ft. Ibs.) 1/2" Drive	8157120
Torque Wrench (300 ft. Ibs.) 3/4" Drive	8157121
Torque Wrench (200 ft. Ibs.) 3/4" Drive	8173332



SECTION 1

CRANKCASE AND OIL PAN

A. DESCRIPTION

1. Crankcase

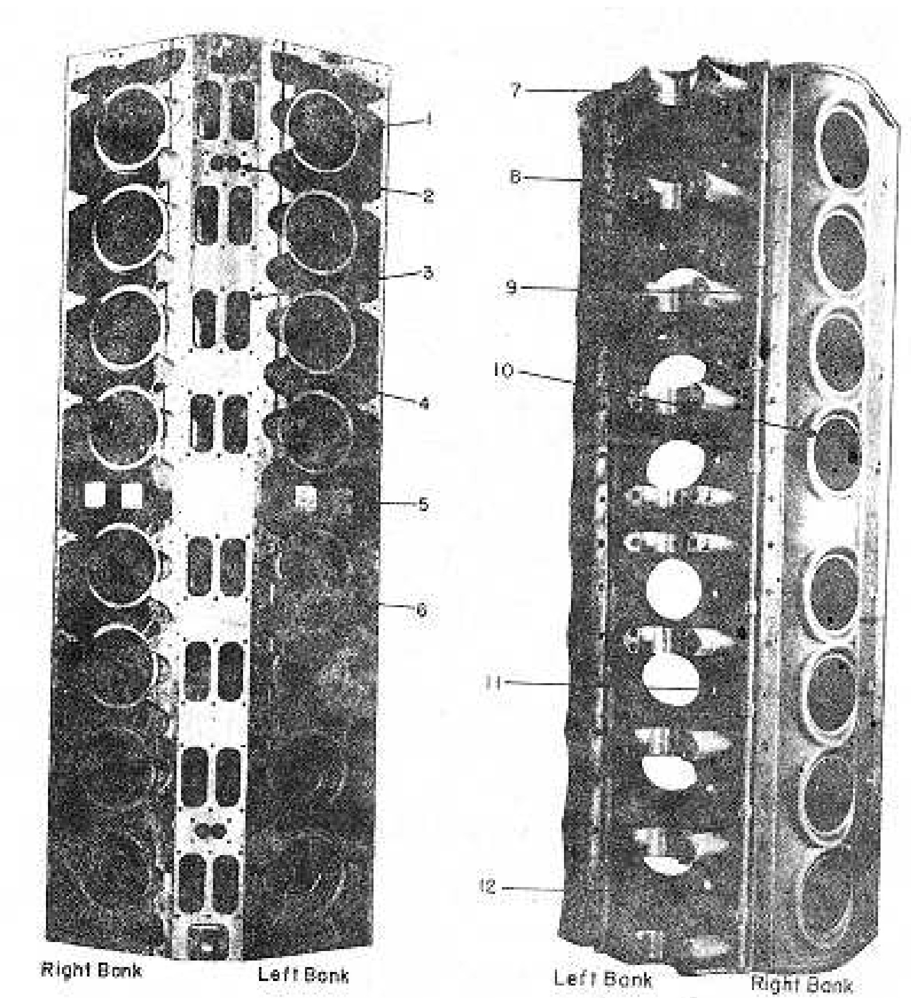
The crankcase is the main structural part of the engine, Fig. 1-1. It is a steel fabrication, forming a rigid self supporting assembly to accommodate the cylinder power assemblies and engine mounted accessories.

The major crankcase sections are the top deck, "A" frames, cylinder banks, side panels and end plates which enclose the assembly. The two cylinder banks left and right form the backbone of the crankcase. Each bank is formed by two steel channels welded together, with holes at top, bottom and sides at each cylinder location. Holes in top and bottom permit liner installation and accommodate replaceable lower liner pilot inserts and the holes in the sides or stress plate provide for liner port air supply and liner inspection. At each cylinder location on top of bank is a cylinder head retainer. Cylinder banks assembled in a crankcase form a "V" having a 45° angle.

The main bearing "All frames integrate the bottom of the crankcase being welded to the cylinder bank stress plates and base rail. The "A" frames are line bored, provided with main bearings and caps to support the underslung crankshaft.

The air box is the area surrounding the liners formed by the cylinder banks and enclosed by the crankcase end plates and side panels. Two air inlet holes in the rear end plate permit air supply to the air box from the engine blowers to provide air for the cylinder liners. Hand holes in the side panels provided with gasketed covers, Fig. 1-3, allow inspection of liners and pistons, cleaning of the air box, and access to mounting bolts.

CRANKCASE 252C-1-154



Top View   Bottom View

1. Cylinder head retainer
2. Engine water outlet
3. Cylinder exhaust passage
6. Camshaft bearing support
7. Main bearing "A" frame
8. Air box drain hole

252C-1-154 CRANKCASE

The upper deck of the cylinder banks separates the air box from the upper exposed part of the crankcase. Located on this deck are the cylinder head retainers of each bank joined at their inward side by the water discharge manifold. Exhaust elbows extend from each cylinder retainer through the water discharge manifold to the top deck of the crankcase. The forged camshaft supports with lined keyways are integral with the top deck which form a part of the water manifold. There is an individual discharge hole at each cylinder location for water discharge from the cylinder head. A tube extends from the outside of the crankcase into each retainer for application of the cylinder test valve. An oil drain channel rune the length of the crankcase adjacent to the outer side of the retainers, having drain pipes to empty return oil into the oil pan. These pipes serve also as ventilating tubes.

Two removable water inlet pipe manifolds, one on each aide of the crankcase for each cylinder bank, are located at the outer bottom of the air box. At the front of the crankcase on each side a machined hole is provided to insert the water manifold. Two of the blower support capscrews extend through the rear end plate and are screwed into the plugged end of the manifold to hold this end. The front end of the manifold extends slightly beyond the front end plate where it is held in a counterbore of the water inlet elbow when applied and sealed with an "O" ring. Openings in the manifold at each liner location provide for the application of liner water inlet tubes with saddle type connection. (See Section 9 for particulars on water system components.)

4. Cylinder head locating and water discharge opening
5. Center crab support
9. Piston cooling oil manifold
10. Air box inspection port
11. Liner pilot insert
12. Crab bolt seat

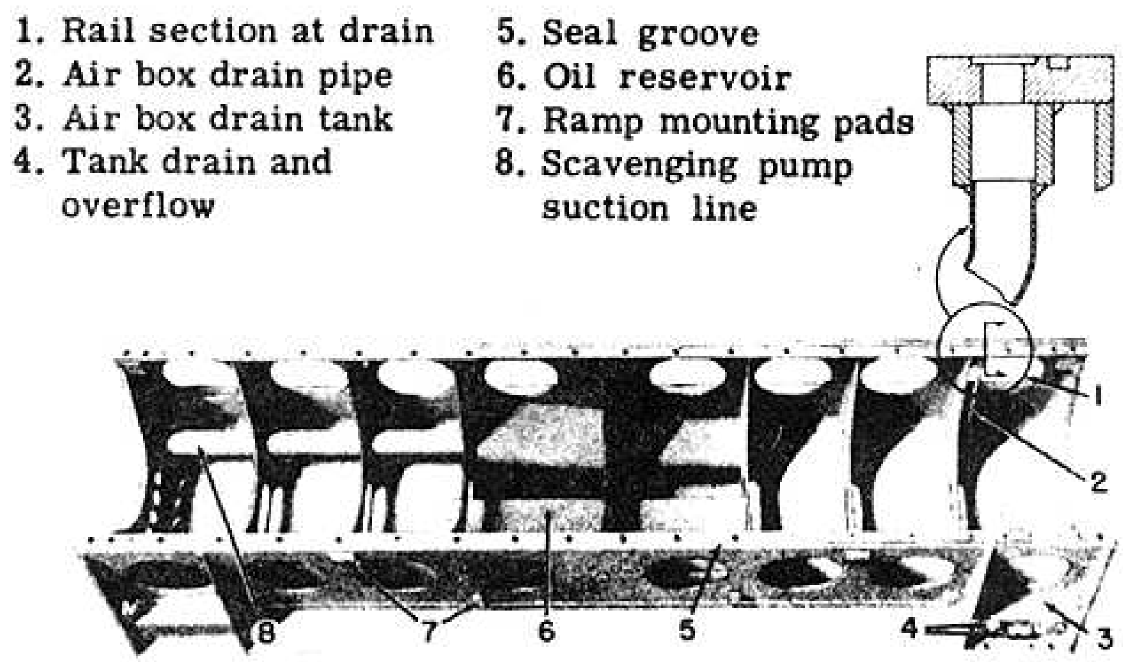
567C Engine Crankcase
Fig. 1-1

Lubricating and piston cooling oil manifolds are incorporated as a part of the crankcase. The lubricating oil manifold is formed by a plate across the "V"• junction of the inner stress. plates running the entire length of the crankcase. An opening in the front end plate admits oil to the manifold and an opening in the rear end plate permits oil supply to the camshaft gear train. Oil pipes

pressed into drilled passages through the main bearing "A" frames at their center, extend into the main lube oil manifold to supply each main bearing. Due to different length the 567C engine pipes cannot be used in other 567 series engines or vise-versa. The pipes extend above the bottom of the oil manifold to assure a clean oil supply. Piston cooling oil manifolds run parallel to the mounting rail at each side of crankcase. Piston cooling oil "Pee" pipe flanges are provided at each liner location.

Cylinder frames and covers are mounted on the crankcase to protect and enclose the operating mechanism. The cover frames are strongly fabricated and provide a flat seal surface on all top edges for the synthetic rubber seal in the light metal covers. Easily released latches hold the covers in place on the frame. Special hinges incorporated in the latches at the back of the covers permit covers to be removed, or raised without removal, to facilitate inspection. Cover support arms are provided to hold the cover open in selective positions.

NOTE:



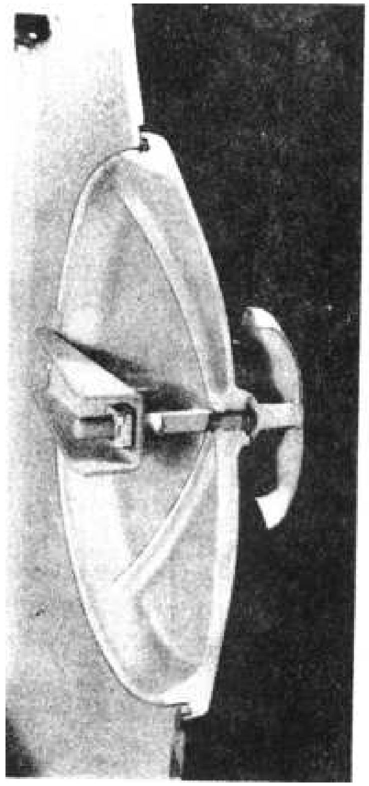
Oil Pan
Fig. 1-2

It should be noted that basic production model 567C engine crankcases have a different diameter upper liner pilot bore than some original pilot run models. All 567C engine crankcases starting serial #53-B-2 and engines starting serial #53-H-75 (16-567C) have an upper liner pilot bore diameter of 12.0911, nominal. 567C engines and crankcases` preceding these serial numbers (which have not been reworked) have upper liner pilot bore diameters of 12.061" nominal. Consequently, different size liners are used in crankcases having different bore diameters. See Section 4 for liner particulars.

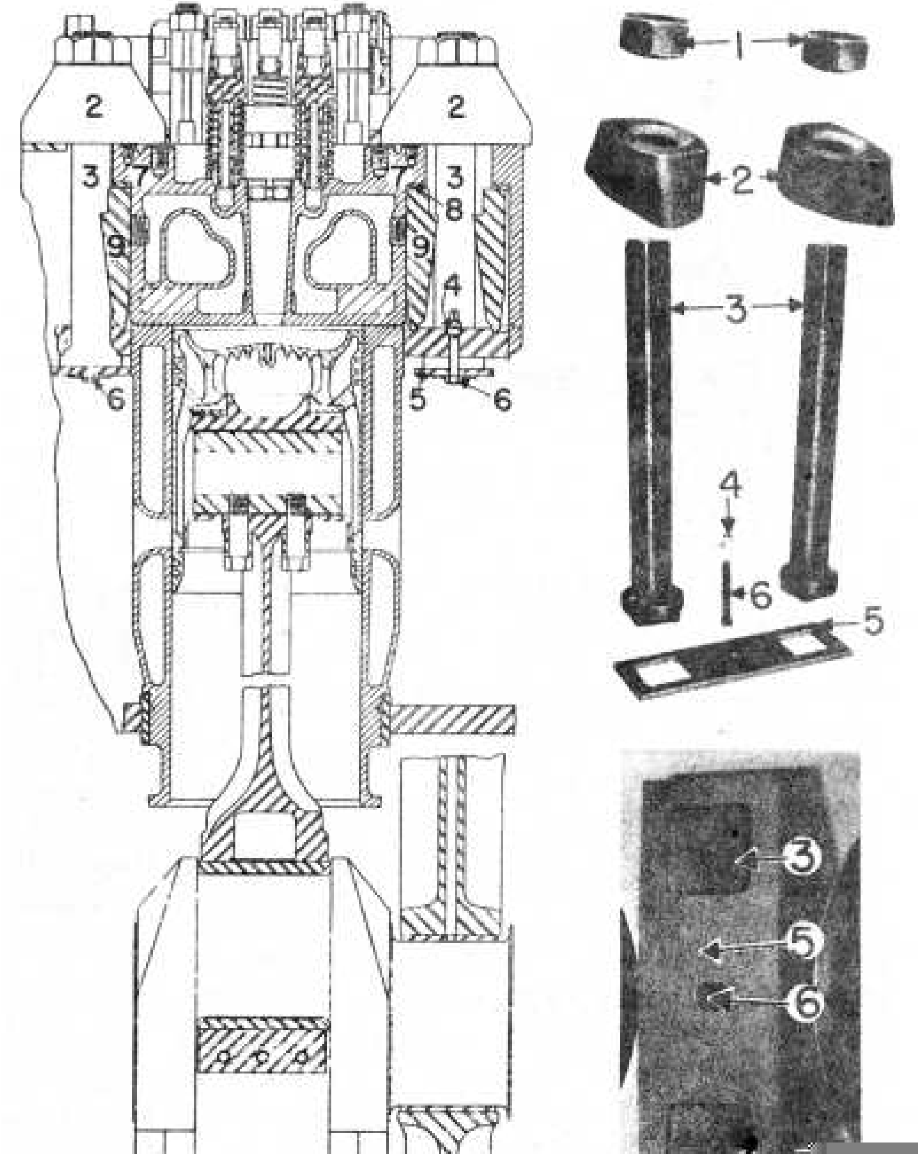
2. Oil Pan

The oil pan, Fig. 1-2, is a steel fabricated assembly. It supports the crankcase and serves as the engine base. Incorporated in the oil pan is the engine oil sump, located centrally in the pan, provided with oil drains.

An oil level bayonet gauge extends from side of the oil pan into the sump. A scavenging oil pump suction line is built into the oil pan extending from the sump to the front end plate. Openings in each end plate allow oil from the camshaft and accessory end housings to drain into the oil pan. Handholes at each cylinder location, provided with gasketed covers, Fig. 1-3, allow access to enclosed engine parts. Separate air box drain tanks in the oil pan receive any liquid accumulations from the air box through a drain pipe and passage through the oil pan and crankcase mounting rails. The seal arrangement between crankcase and oil pan mounting rails consists of a silicone rubber cord placed in



Handhole Cover - Section
Fig. 1-3



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1. Crab Nut      4. Retainer Bolt Nut     7. Cylinder Head
2.Crab           5.Retainer Plate         8.Cylinder Head Seat Ring
```

a groove outside the bolt line the entire length of each oil pan mounting rail. A small "O" ring seal placed in a counterbore, seals the air box drain opening. Dowels hold the crankcase to oil pan alignment after original assembly and crankcase to oil pan bolts secure the assembly.

3. Crab Bolts

The cylinder head and liner are bolted together and are held after installation in their respective locations by 1- 3/4" - 12 crab bolts and upper crabs, Fig. 1-4. The crab bolts extend through the cylinder bank upper deck plate adjacent each cylinder retainer. The bottom bolt heads have a spherical seating surface which seat in a like surface, the bolts being held in position by a separate plate and capscrew for each pair of bolts. The square bolt heads fit a corresponding hole in the plate which prevents their turning when being torqued. Lower crabs are not used on the "C" crankcase. Upper crabs, each contacting two cylinder heads, except for end or center crabs on 16- cylinder engines, hold the power assemblies firmly in place. A top spherical surface of the crab receives a crab nut with a mating spherical seat.

4. Main Bearing Stud Bolts

The main bearing stud bolts are shown in Fig. 1-5. Each "A" frame has four 1-1/4" - 12 lubrized main bearing studs except the center "A" frames on 16 cylinder engines which have two each. They pass through tae "A" frame and main bearing caps with their lower end about 6-1/2" below the "A" frame serrations. Lockwire holes are provided at the lower end of the stud.

3.Crab Bolt 6.Retainer Bolt 9.Cylinder Head Retainer

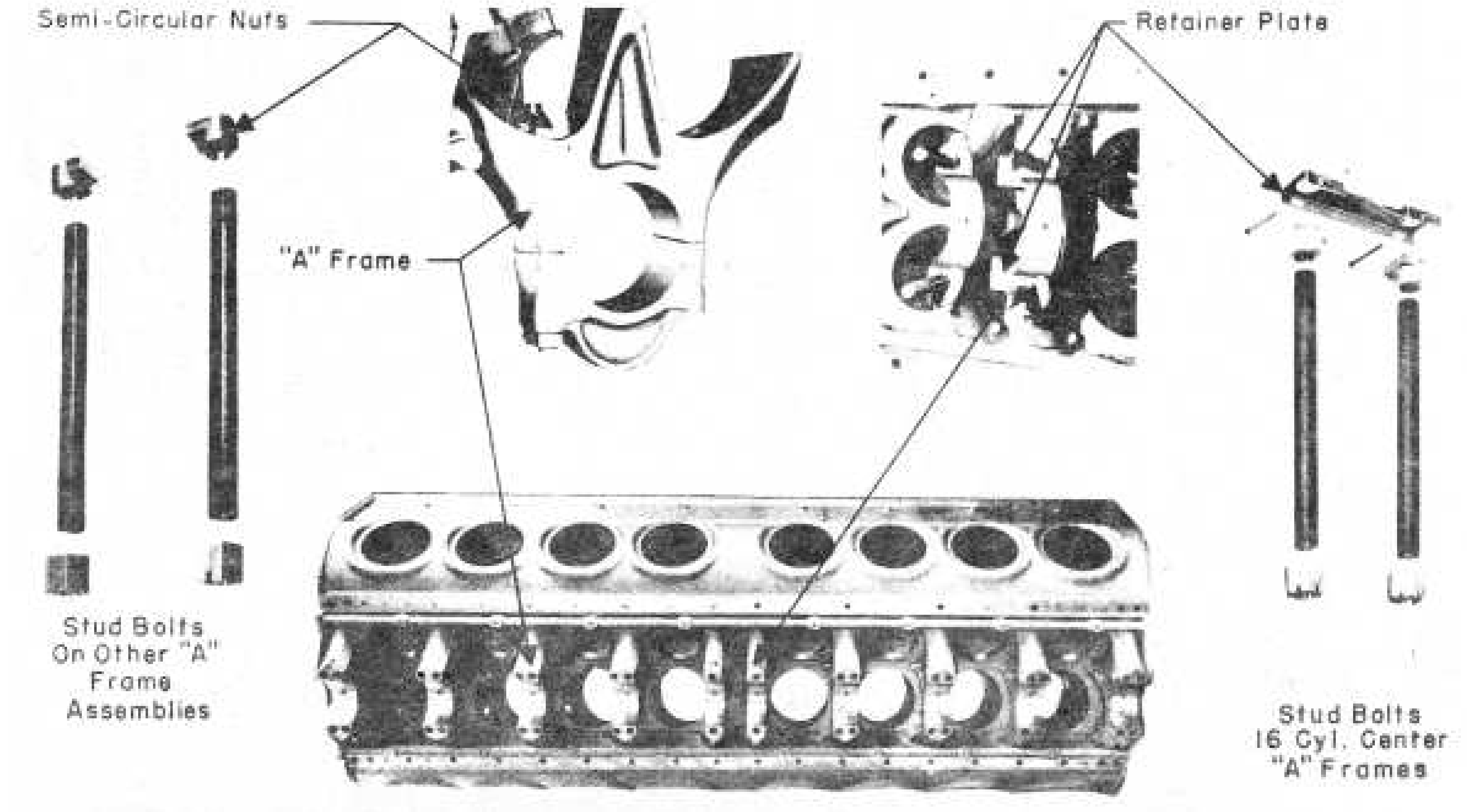
Crab Bolt Assembly
Fig. 1-4

- 105 -

A 5/16" transverse hole at the upper end of the stud accomodates a 1/4" bolt which passes through the stud and slots in the upper nut. Semi-circular or "D" shaped nuts are used at the upper end of the stud. The flats of adjacent nuts mating to prevent turning. The upper nuts have a spherical seating surface to

- 106 -

CRANKCASE 252C-1-1255



Main Bearing Stud Bolts
Fig. 1-5

match a similar surface in the "A" frame. Since the center "A" frames of the 16 cylinder engine are at a distance from each other, a retainer assembly is used to prevent the upper end nuts from turning. The retainer assembly is held in place over the nuts by the 1/4" bolts which pass through the nuts and studs. The lower main bearing nuts are conventional slotted hexagon nuts using lockwire to aid in securing the nuts.

Original main bearing stud "D" shaped nuts had a special insert to lock the stud. These have been superceded by the nuts described using pinning bolts. Also, the retainer described replaces the prior used retainer which was secured by 3/8" capscrews vertically run into the center bearing stud at the top. See item 2, under Maintenance for use of the new parts with old studs.

A serrated joint is used at the "All frame to cap parting line. Since the caps are applied to the "All frames and then line bored, each cap must be kept with its "A'• frame; they are not interchangeable. To identify matching "A" frame and its cap, both are stamped with corresponding bearing number.

5. Engine, Crankcase and Oil Pan Serial Numbers

Engine serial numbers are stamped on the identification plate, listing model of engine, located on the right side about six inches below the cylinder cover frame base between the center cylinders. Also, serial numbers axe stamped at front left corner of crankcase under cover frame base. The engine serial number consists of month and year of manufacture plus the consecutive engine of the month in which it was built. An alphabetical letter represents the month, as "A," 'B," "C" corresponding to "A" January, "B" February and so forth, except "I" which is not used. For example, 54-E-125, identifies the 125th engine built in May, 1954

Each month the letter is changed and numbers start again at 1, the year symbol corresponds to the last two figures of the current year. Crankcase serial numbers also have (like engines) the year, month of manufacture, and the consecutive crankcase number manufactured that month. For example, 54-E-98, identifies a crankcase, manufactured in May, 1954 and was the 98th crankcase built in May. Care should be taken when referring to the crankcase serial number that it include the number of the cylinders and the word "crankcase." Otherwise, there is a possibility of misinterpretation between crankcase and engine serial numbers. Oil pan serial numbers are located on the left side of the oil pan near the crankcase support base at the front or rear.

B. MAINTENANCE

1. Crankcase To Oil Pan Seal Application and Tightening

Before seal application inspect oil pan rails for nicks, burrs, or foreign material of any kind in seal grooves, and remove to provide a clean smooth surface. Any indentation in the seal grooves or base rails that would allow oil seepage must be filled with solder and finished flush with affected area.

Along outside edge of oil pan rail surface, apply one coat of Tite Seal #3, approximately 1/2" width and about .0151' thick, or thickness of ordinary playing card.

Install seals in grooves without twisting or stretching and without lubricant. The individual seals for each model engine are longer than required but do not cut off seal ends at this time.

Place crankcase over oil pan, and using line up pin guides in the four corner holes, lower crankcase on oil pan. Apply taper dowel bolts and tighten. Check crank- case to oil pan alignment, using care not to damage seal cord.

CAUTION: Do not pull or stretch the ends of seal cord.

Assemble all crankcase to oil pan bolts with washers and snug four corner bolts to about 100 ft. lbs., torque. Then torque all bolts to about 100 ft. lbs., in sequence as shown in Table 1 starting with #1 bolt. Repeat same sequence and tighten all bolts to 450 foot pounds. After all bolts have been tightened to 450 ft. lbs., cut seal cord ends to provide a seal protrusion from face of end plates of 3/32" ± 1/64": This seal protrusion will seal the three way joint of oil pan, crankcase and end housing.

All crankcase to oil pan bolts must be tightened at regular intervals, in accordance with mileage indicated in the Scheduled Maintenance Program.

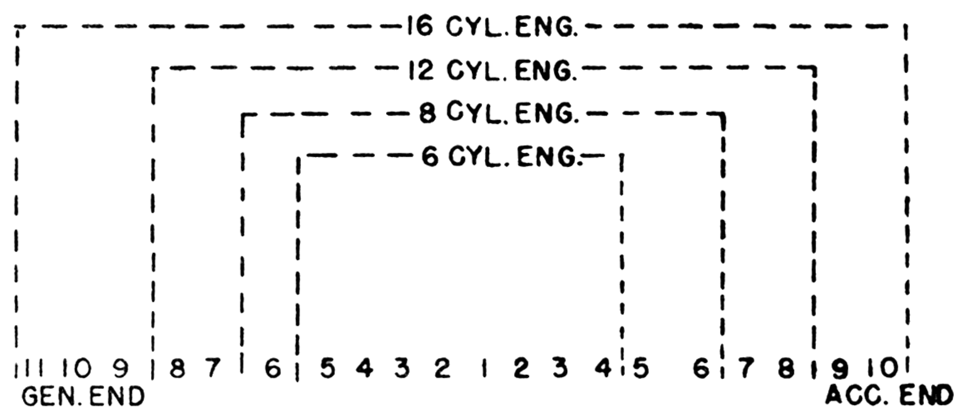


Table 1 - Crankcase To Oil Pan Bolt Tightening Diagram

2. Main Bearing Studs

Thread size at both ends of main bearing stud bolt is 1-1/4"- 12. To clean up threads, a 1-1/4"-12 thread die 8060349 can be used, while 1-1/4"-12 tap 8060387 can be used on the stud nuts. To aid in obtaining correct torque values the threads should be cleaned before parts application.

Upon application, each stud is inserted into its place in the "All frame and run into its nut until the 5/16" hole in the top of stud lines up with the bolt slot of the nut. The lockwire end of the stud should be 6-1/2" ± 1/16" from the serrations on the "A" frame when the stud is brought out with the spherical surface of the upper nut contacting its like surface in the "A" frame. This is to assure the lockwire passing through the slots of the lower stud nuts when the bearing cap is applied and the nuts tightened properly. The 1/4" bolt and self locking nut may then be applied to all the upper nut and stud assemblies except the center "A" frames on 16 cylinder engines. The upper nut flats contact each other when in place on all "A" frames except the center "A" frames on the 16 cylinder engines which are separated from each other. A retainer plate is used on the center "A" frame upper nuts to prevent them from turning. After the stud has been run into the nuts the proper amount the retainer which is like a channel is placed over the nuts. The 1/4" bolts are then applied which pass through the retainer and stud and across the nut slots. The bolt slots in the retainer are of different widths, one slot being larger to take the bolt nut head and prevent it from turning when tightened. The retainers may be a straight channel or cut away on one side to provide clearance for a stiffener plate between the center "A" frames on later 16 cylinder engines. The first crankcase having this stiffener has serial number 5513-21 in engine having serial number 55C-116.

Original main bearing studs do not have the 5/16" through hole at the top but have a 3/8"-24 tapped hole at the top of the stud which is used to secure the center bearing stud nut retainer originally used. Also the original stud nuts have a special insert in addition to the regular nut thread. These parts have been discontinued and replaced by the similar parts previously described. If a slotted nut and 1/4" bolt is to be used on an original design stud, the stud must have a 5/16" hole drilled through at a 14-13/16" dimension from the bottom or lockwire end of the stud. The threads should then be recleaned after drilling. If either a new nut or new retainer has to be applied on old style studs at the center "A" frames of a 16 cylinder engine, both studs must be drilled and both nuts and retainer must be of the new design.

In application of the original studs using insert type upper nuts, both studs are run in up to the insert, then each stud is run into the insert to maintain correct length from the "All frame serrations, 6-1/2" ± 1/16"; the retainer is secured by 3/8"-24 capscrews in the center "A" frame studs. Upon removal of these studs, both should be backed out of the insert before individual removal.

Main bearing caps are originally applied to the "A" frame and then are line bored; therefore, they are not interchangeable or available for replacement. They must be reapplied on the same "A" frame in the same original position as removed. Each cap and "A" frame is stamped on the right side with their bearing number, and in addition, all caps and the end "A" frame are stamped with the crankcase serial number. Before cap application, check serrations in cap and "A" frame and remove any burrs or foreign material to provide a good mating fit.

Torque value of the main bearing nuts is 500 to 800 ft. lbs. For correct assembly, the nuts should be

252C-1-1255 CRANKCASE

brought up to 500 ft. lbs. and then tightened further until line up of first lockwire hole is reached. This will assure torque value being within the 500-800 ft. lb. range.

For checking main bearing bore dimensions, a torque value of 650 ft. lbs. should be used. When nuts are torqued this amount the out-of-round limit of the main bearing bore is .003". Likewise, the main bearing bore dimensional limit- at this torque is minimum 8.249'• and maximum 8.252". These are the average of six (6) measurements, three (3) taken at each end of the bore.

Main bearing wrench set 8219512 similar to set 8155363 used on the other series of 567 engines may be obtained for use on the 567C engine. This wrench in use is supported in the oil pan inspection opening. Also, a 8191591 offset ratchet set is available for running up and loosening main bearing nuts. For information on these tools see the latest revision of toot catalog #91.

To facilitate measurement of crankcase "A" frame and cap distortion, serration measure gauge #8177167 may be used. This gauge is semi-circular to fit around the crankshaft and has serration prongs that fit "A" frame or cap serrations, one prong actuates a dial micrometer. Distortion is read directly from the dial micrometer. The maximum limit from the nominal "A" frame serration center line dimension is plus or minus .003" (±.003") which may be read directly from the gauge indicator. A separate master gauge is provided for checking the fixture prong distance. Crankcases having serrations exceeding the maximum limits should be returned for rebuild. (See Factory Rebuild Bulletin #109.)

3. Crab Bolts

After upper crab bolt nuts are removed the bolts maybe removed through the air box after removing crab bolt retainer plate capscrew and plate. Crab bolt threads may be cleaned up using 1-3/4" -12 thread die 8067409, and nut threads cleaned up using tap 1-3/4"-12 8050688. Whenever crab bolt threads are exposed, they should be protected with thread caps 8034600. Alt crab bolts now are 15-1/16" tong, compared to the original length of 16-1/16".

Torque value of the cylinder head crab nuts is 1800 ft. lbs. - 5%. A powerench #8211089 for tightening crab nuts is available through our Parts Department. This is a mechanical advantage wrench employing a standard torque wrench.

Before application or re-assembly of the crab, spherical washer or nut, examine for burrs, roughness or galling which would effect the true torque value. They should also be lubricated at time of assembly, using a lubricant having specifications similar to Texaco Stud Lube 921 or engine tube oil.

Crab bolt nuts should be tightened in two passes, half total torque at each pass, tightening the diagonally opposite nuts alternately to form a letter "X." This method applies whether tightening an entire bank or a single cylinder. After final cylinder assembly, bring engine water temperature to 170° F. and re-torque crab nuts and liner stud nuts to proper torque. Recheck at intervals specified in the Scheduled Maintenance Program.

> NOTE: When liner and crab nuts are being retightened, those that move at less than the specified torque values, should be tightened to proper value. Those which DO NOT MOVE, below or up to the proper values, should be checked by pulling up to a value not exceeding 10°% more than recommended torque.

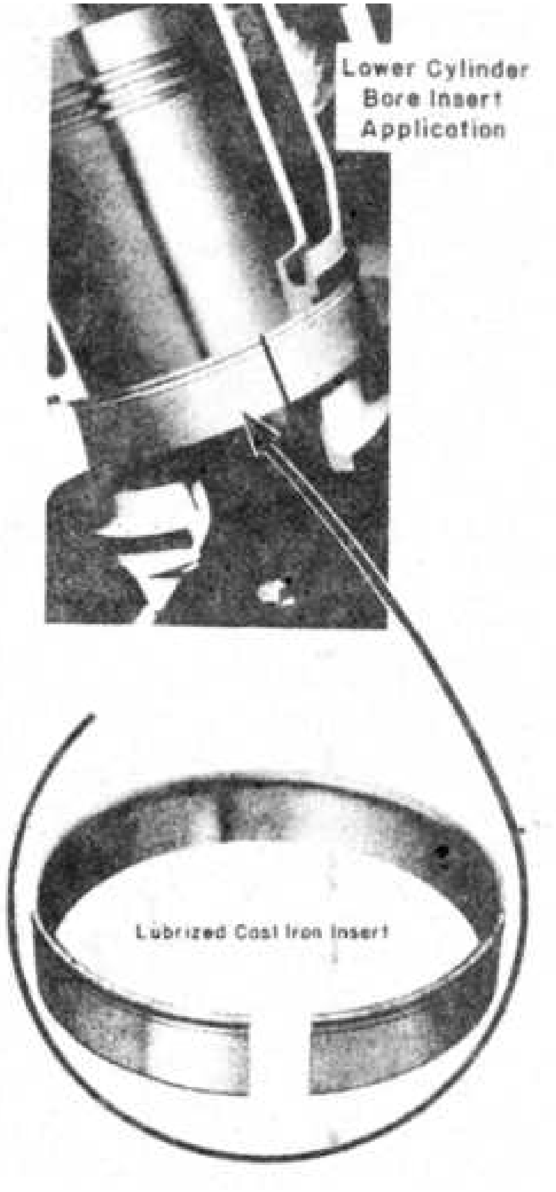
 252C-1-1255 CRANKCASE

4. Lower Cylinder Bore Insert

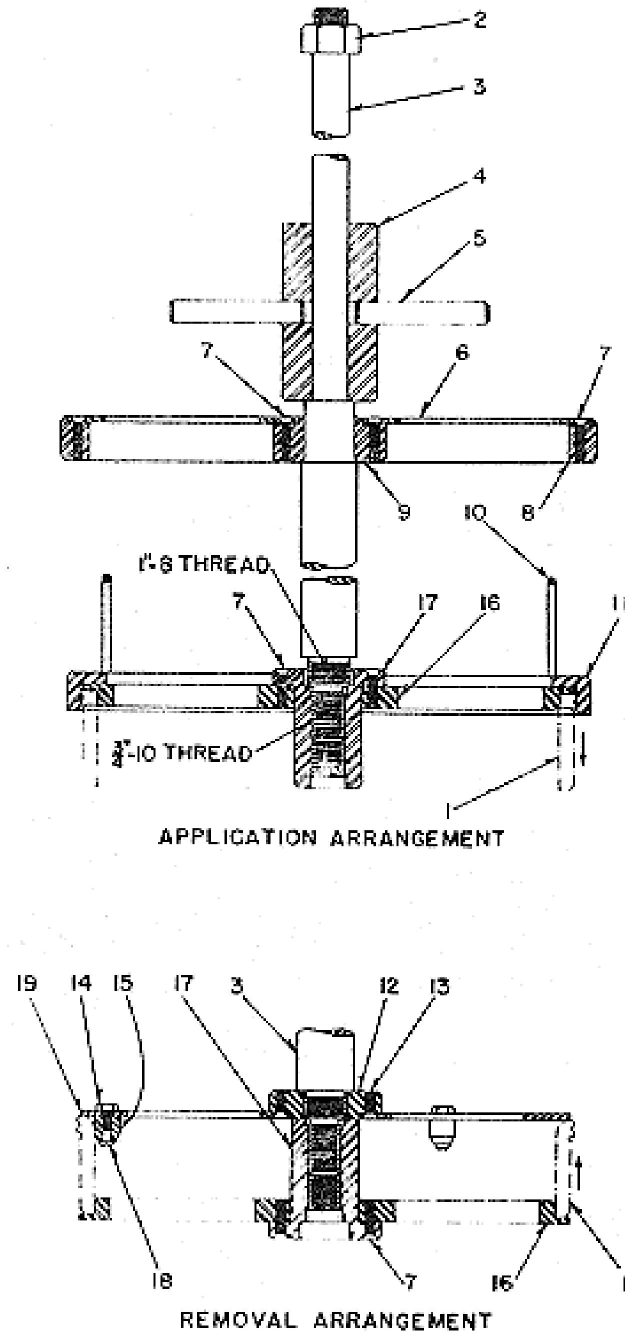
A replaceable, lubrized cast iron insert, Fig. 1-6, is used in the lower cylinder bore of the crankcase to provide a wear surface at the lower liner pilot. A seal held in a groove in the liner pilot prevents air passage between insert and liner. In addition a sealing compound is used at the insert split line. When the inside diameter of the insert reaches the maximum dimension of 10.386", the insert must be removed and a new insert installed.

Clearance between the lower liner pilot and insert must also be checked so as not to exceed an insert to liner pilot diametral clearance of .015", as shown on Fig. 4-7, Section 4. Sealing compound 8222724 (1 pint can) should be applied to one end of the crankcase insert before it is installed to eliminate possibility of air leaking from the air box into the oil pan. Thickness of the compound on the insert end should be 1/16" thick. After applying compound, allow at least two (2) hours drying time before installing the insert. Tool 8212763 is used to apply or remove the crankcase inserts.

Tool 8212764, insert compressing tool is used with tool 8212763. These tools are shown in Fig. 1-7.



Lower Cylinder Bore Insert
Fig. 1-6



1. Insert
2. 3/4"-10 Nut
3. Spindle
4. Striker
5. Dowel Handle
6. Center Plate
7. Screw
8. Center Ring
9. Center Bore
10. Handle
11. Holding Ring
12. Boss Nut
13. Screw
14. Nut
15. Bushing
16. Puller Plate
17. Boss Nut
18. Screw
19. Clamp Plate

Compressing Tool

Crankcase Insert Applying Or Removing Tool
Fig. 1-7

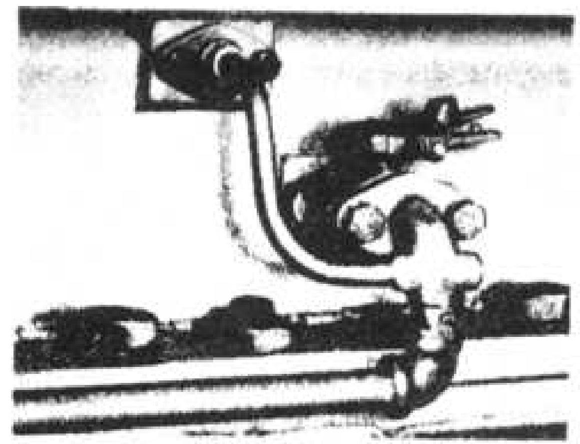
To use tool 8212763 in applying the insert, assemble parts at end of spindle as indicated in Fig. 1-7. Invert holding ring and place tool puller plate inside the holding ring. Using compressing tool 8212764 at bottom of insert, reduce insert diameter and install on the puller plate. Place holding ring around top outer edge of the insert and remove compressing tool. Apply assembly with insert to the shoulder of the bottom threads on the tool spindle, with top of insert toward the tool striker. Position tool with insert in the cylinder bore, and using striker drive insert all the way down into its bore.

To remove an insert, remove holding and puller plate from the end of the tool and apply clamp plate at upper threaded portion of the spindle end. Install tool assembly in the cylinder bore and position clamp plate on the insert. From the underside of the insert, apply puller plate to spindle end, inverted compared to insert installing position. Using striker against spindle top nut, drive insert from bore.

In the event that the preceding installing and removing tool, 8212763 and compressing tool 8212764 are not available, the insert should be applied or re- moved using a rawhide or wooden mallet and wooden drive blocks to prevent damage to the crankcase. To apply the insert, compress it to allow starting in the bore and tap it all the way down into its bore until the outer edge rests solidly in the counterbore. To remove, drive the insert from the bottom, working around the insert circumference until it is free from its bore.

When installing the insert, it should be applied so that the gap or insert ends are on the cylinder bank longitudinal centerline, with the gap toward either end of the engine. The bottom edge of the

5. Air Box Drains The engine air box accumulation settles in the two drain tanks incorporated one on each side at the rear of the oil pan. Valves are provided for drainage of these tanks by a syphon arrangement. The tanks should be drained at appropriate frequent intervals with attention given to the discharge noting if there is any water or excessive oil accumulation in the air box. If a discharge is noted from the drain pipe with the air box drains closed, the air box accumulation should be investigated.



Air Box Drain Valve
Fig. 1-8

6. Crankcase Inspection

Serious crankcase failures can be avoided and longer crankcase life obtained by careful periodic crankcase inspection. Careful inspection may disclose small discrepancies which, if they were allowed to progress, might result in major failure, loss of service, or loss of the crankcase. Inspection and early trouble detection and repair are most important, since major repair generally cannot be done in the field. In in- stances where major repair is involved requiring extensive welding, it is essential that the crankcase be stress relieved and remachined where necessary. This tends to shorten crankcase life, as there is a limit to number of times this can be done. In addition, when an engine insert has a 60° chamfer to aid application.

failure occurs due to breakdown of parts, a careful inspection is essential at

locations other than the immediate damaged area. (For example, an engine failure in which a connecting rod damages the liner pilot and plate.) A rod may also strike and nick the stress plates. It is most important in this event that the stress plate be inspected in the holes opposite the liner and if any nicks are found, they must be blended out. The stress plates are subject to shock loading and nicks may serve as a possible stress concentration that may lead to cracking. It is recommended that crankcase requiring rebuild or reconditioning be returned for the work.

7. Return of Engine Crankcases

It is essential that the crankcase, oil pan and cover frame be maintained the same length to assure proper assembly of end housings and parts. Therefore, when returning crankcases, the oil pan and cover frame should be returned, so that in the event the crankcase end plate requires machining, the oil pan and cover frame can be machined to match.

8. Cleaning Crankcase

The crankcase should be cleaned after any work has been done on the interior of the engine, to remove particles of metal or dirt. This can be done by using spray gun #8193041 and solvent. The equipment near the engine should be protected against the spray. After spraying the top deck (cylinder heads, rocker arms, etc.), wipe with towels saturated with solvent. Wipe up all solvent trapped in corners and pockets. Use only lintless, bound-edge towels.

Cleaning of the air box with a spray gun while liners are in place is not recommended practice, due to possibility of solvent entering liners at the

cleaning the air box with liners in place, use only bound edge towels and petroleum solvent.

At anytime cleaning is done on the crankcase, care should be given to oil passages, bearing surfaces, gears, etc., that gritty material will not be trapped. Cleaning information on the crankcase and other engine parts is contained in Maintenance Bulletin # 1706.

9. Engine Painting

If an engine is to be removed from service and completely overhauled and the interior repainted, the parts to be painted must be cleaned in a vat of caustic solution to remove old paint, grease and oil from the pores of the metal. The caustic solution must be thoroughly removed by washing the parts in clean hot water, and air dried with an air hose. (Aluminum parts must not be washed in the caustic solution). If caustic cleaning is not done before painting, the paint will peel off the interior of the engine and restrict the lube oil lines. Mask off parts not to be painted.

Use crankcase paint (5 gal. #8187782, 1 gal. #8187781) on the following: interior of crankcase, oil pan, blower supports, top deck, cylinder head cover frames, (except on seal surface), accessory and camshaft drive housings. Do not paint any machined surfaces, liners, heads or seal surfaces.

To refinish the exterior of the engine, remove all grease and oil, using an alkaline cleaner. Mask off water, fuel, and oil connections. If required, apply coat of primer, either number given above. Then apply a finish coat of Suede Gray, 5 gal. #8133054, 1 gal. #8122047. (Larger containers of all the preceding paint are available, if desired.)

ports. If

C. EQUIPMENT LIST

Name	Part No.
Spray gun	8193041
Bound-edge towels	8050752
Crankcase paint	
5 gallon	8187782
1 gallon	8187781
Suede gray paint (5 gallon)	8133054
Crab stud protector	8034600
Crab stud thread die 1-3/4"-12	8067409
Crab nut tap 1-3/4"-12	8050688
Main bearing bolt thread die 1-1/4"-12	8060349
Main bearing nut tap 1-1/4"-12	8060387
Powerench (crab nut)	8211089

Insert tool (Installing and removing)	8212763
Insert compressing tool (used with 8212763)	8212764
*Lower deck boring bar	8215546
Pliers (remove ring 8173805 "C" hand	
hole covers)	8228031

*Used to rebore repaired lower liner pilot or insert bore on 567 series engines.

D. SPECIFICATIONS

Main bearing bolts (length from		
serrations)	6-1/2"± 1/16	
Main bearing bores Min.	Min	Max.
**Diameter	8.249"	8.252
Out-of -round		.005

**Average of 6 readings, 3 at each end of bore, 60° apart, with main bearing nuts torqued to 650 foot pounds.

Liner Bore Dimensions	Limit
Upper liner pilot	

12.091" nominal bore	12.104
12.061" nominal bore (pilot models only)	12.070
Lower liner pilot (insert)	
10.377" nominal bore	10.387

SECTION II

CYLINDER HEAD ASSEMBLY

A. DESCRIPTION

1. Cylinder Heads

Cylinder heads are made of alloy cast iron and are clamped in the crankcase by the cylinder head crabs, Fig. 2- 1. A bronze cylinder head seat ring is used between the top of the retainer and cylinder head.

The cylinder head is located by line-up of the discharge water outlet elbow, Fig 2- 2, between the cylinder head and the crankcase. The 567C cylinder head is NOT interchangeable with other 567 series engine cylinder heads. The head is cast with cored water passages having drilled openings at the bottom, Fig. 2-3, to match the water outlet holes on top of the cylinder liner on which it seats. Exhaust passages in the cylinder head line up with mating elbows in the retainer, which conduct exhaust gases through the water discharge manifold to the exhaust manifold.

A well is located in the center of the cylinder head for application of the unit fuel injector. Injector locating dowel holes are provided for the standard and high output injectors. The standard injector dowel hole is on the cylinder head vertical centerline while the dowel hole for the high output injector is located off the vertical centerline. (For specific injector application, see Section XI.)

The cylinder head assembly includes three rocker arms, four exhaust valves and springs, valve bridges with springs, valve guides, overspeed trip pawl, fuel injector

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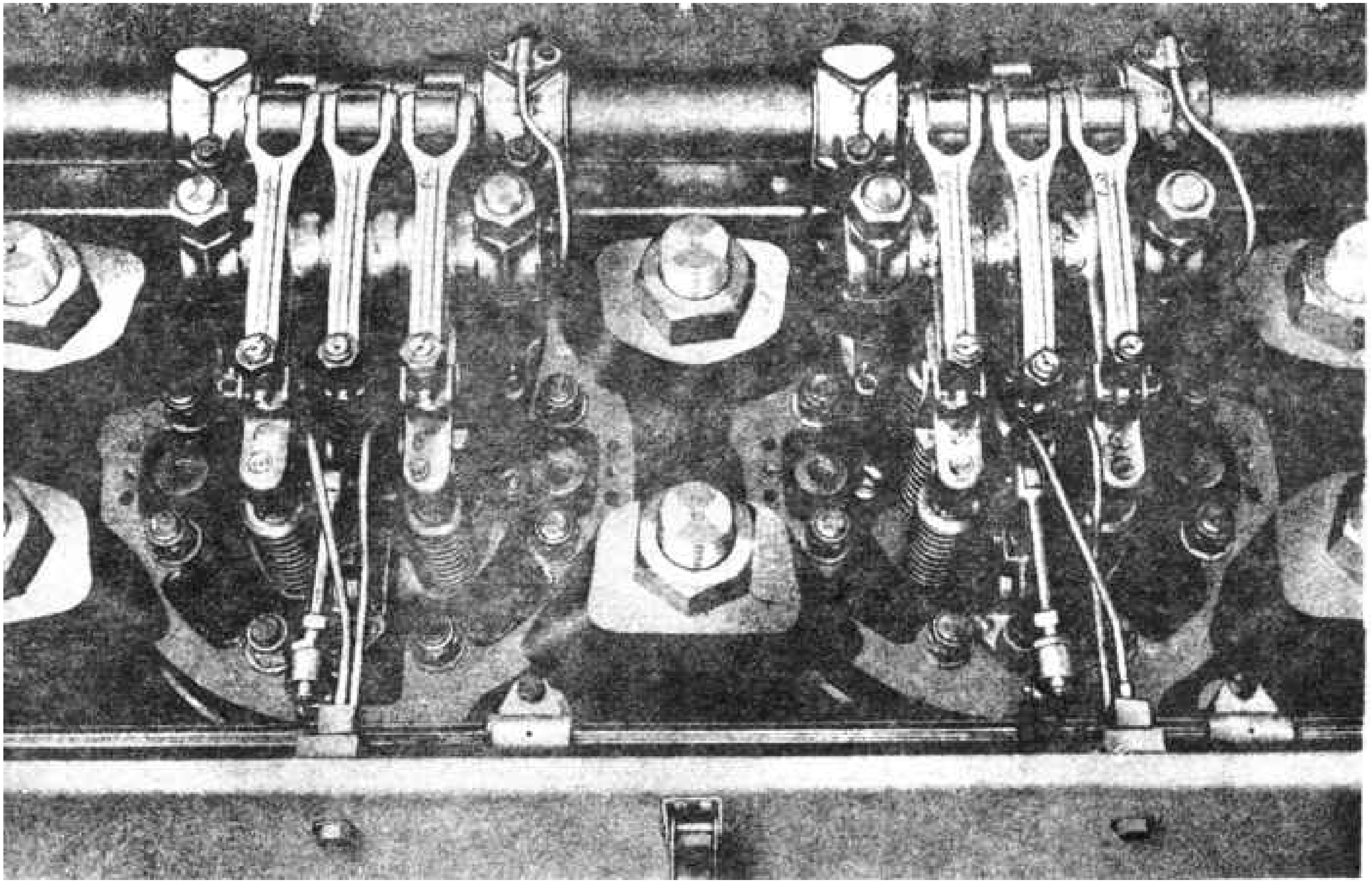
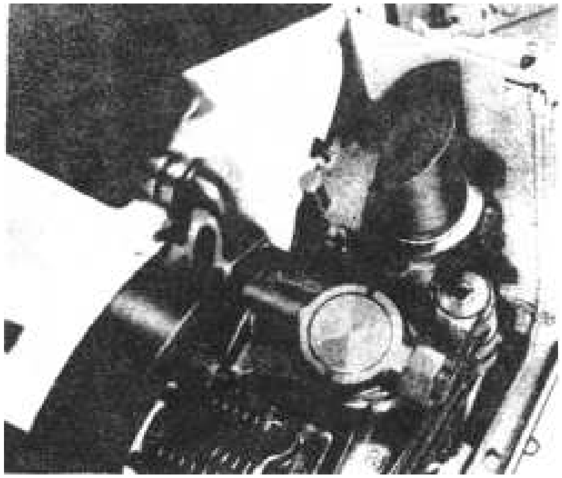


Top View Of Cylinder Heads
Fig. 2-1

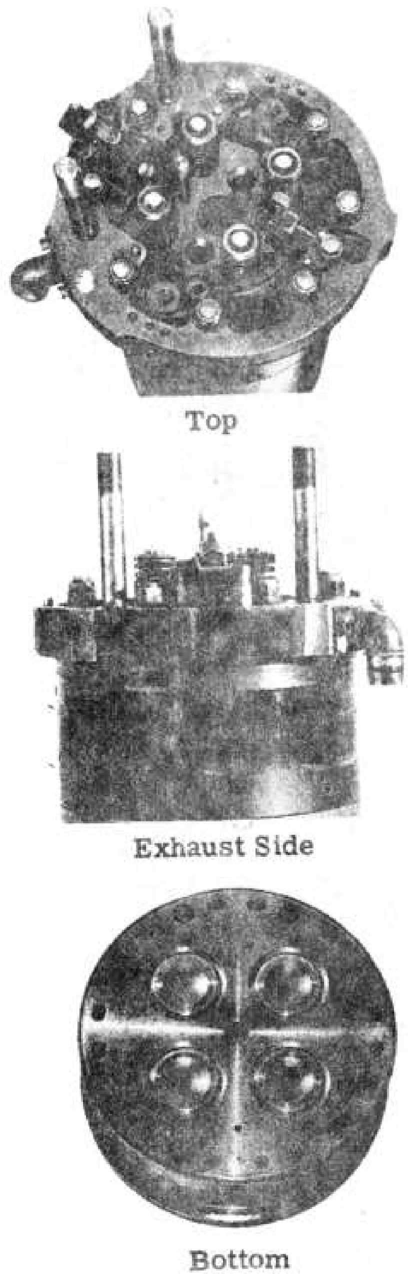
and injector control lever, as shown in the exploded view, Fig. 2-4. It is secured to the liner by eight cylinder head to liner nuts; a hardened washer is used under each nut. There are two designs of water discharge elbows, Fig. 2-5, used on 567C engine cylinder heads. Two elbows have long syphon tubes that extend down into the water discharge manifold with their end close to the bottom of the manifold. All other water discharge elbows used on the engine do not have the syphon tube. As their name implies, the long tube acts as a syphon. when the engine water is being drained. to empty water from the discharge manifold. It is important that the last cylinder head of the right bank and the first cylinder head of the left bank have a syphon tube discharge elbow. These cylinder heads position the syphon tube at the farthest ends of the manifold and provide for manifold drainage if the engine is not level.



Water Discharge Elbow Location
Fig. 2-2

2. Exhaust Valves

The exhaust valves are the long stem type, having metal faced valves 8206109. These valves are identical to valve 8082254 used in Fig. 2-2 other 567 series engines,

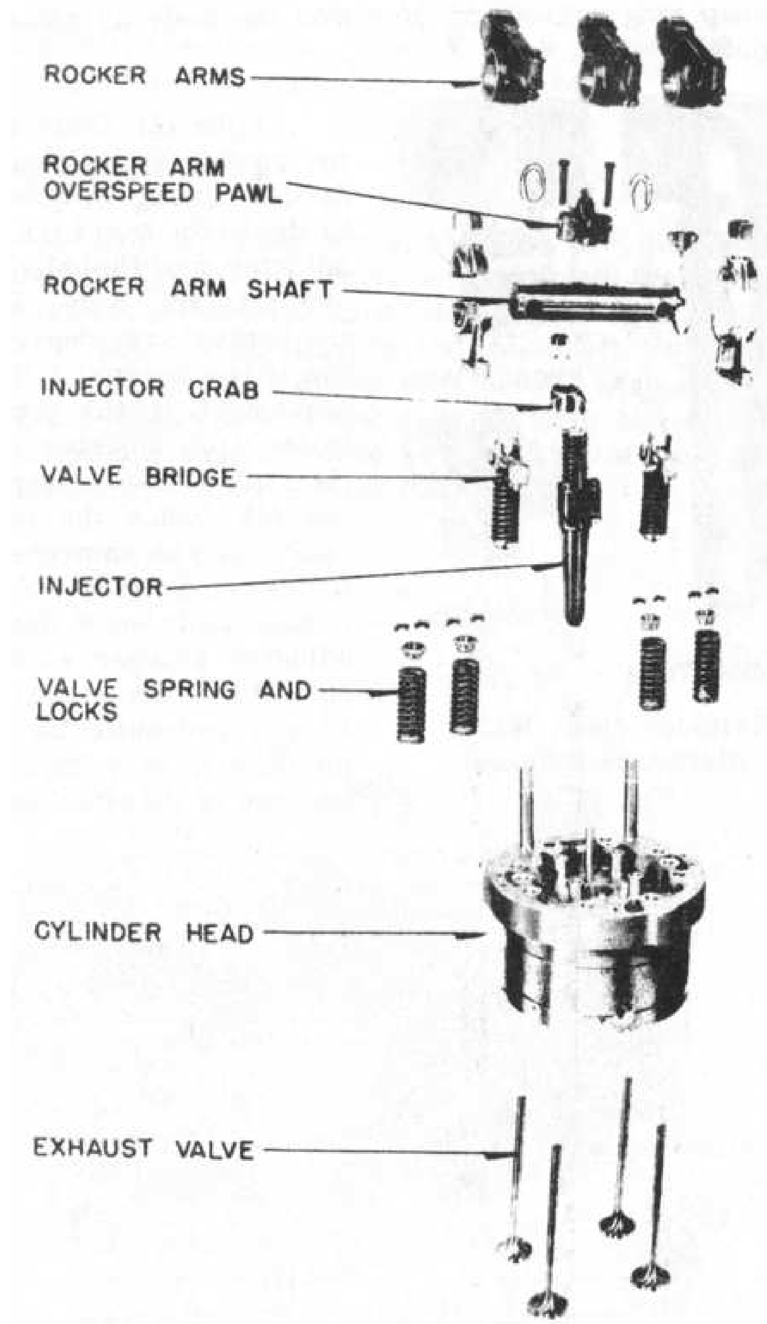


Cylinder Head Detail
Fig. 2-3

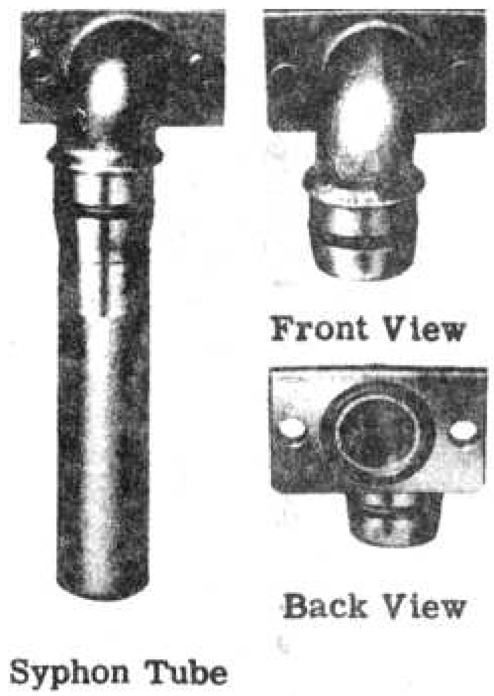
hardened and polished stem ends, held in the head by springs, tapered spring seats, valve keepers or locks tapered to fit the spring seat. The valve guides are precision type providing ample length for proper valve operation. Exhaust valves used in cylinder heads of the high output 16-567C, 1750 horsepower engine are Stellite except for the Stellite metal in the valve face. Valve 8206109 can be identified by a 1/32" groove, 5/32" from top of valve, between the top of valve and first loci groove. (Some of the firs Stellite faced valves uses did not have the 1/32' groove and can only be identified by the part number 8206109.)

3. Valve Bridges and Hydraulic Lash Adjuster

The valve bridge operates two exhaust valves from one rocker arm. return spring and sprint retainer having a ball seat are held on the valve bridge stem by a to c L ring. The ball seat rest; in a socket in the cylinder head and the springy applies pressure so that the valve bridges will staff in contact with the rocker arm. The hydraulic lash adjuster used on the 567C engine is of the long travel type. It maintains zero lash between valve stem end an the valve bridge. The assembly consists of a body plunger, spring, ball check and ball check retainer



Cylinder Head Assembly
Fig. 2-4

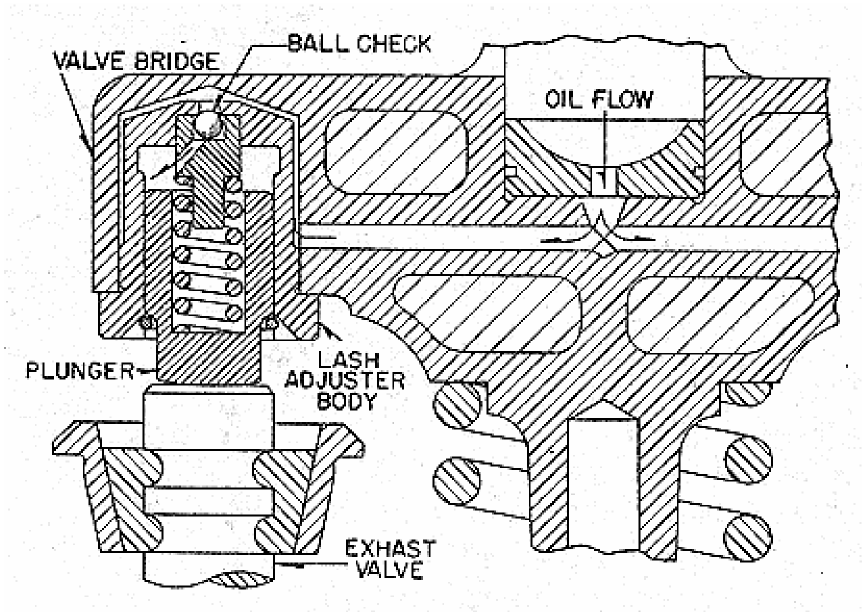


Cylinder Head Water Discharge Elbows
Fig. 2-5

A snap ring retains parts within the body as shown in Fig. 2- 6.

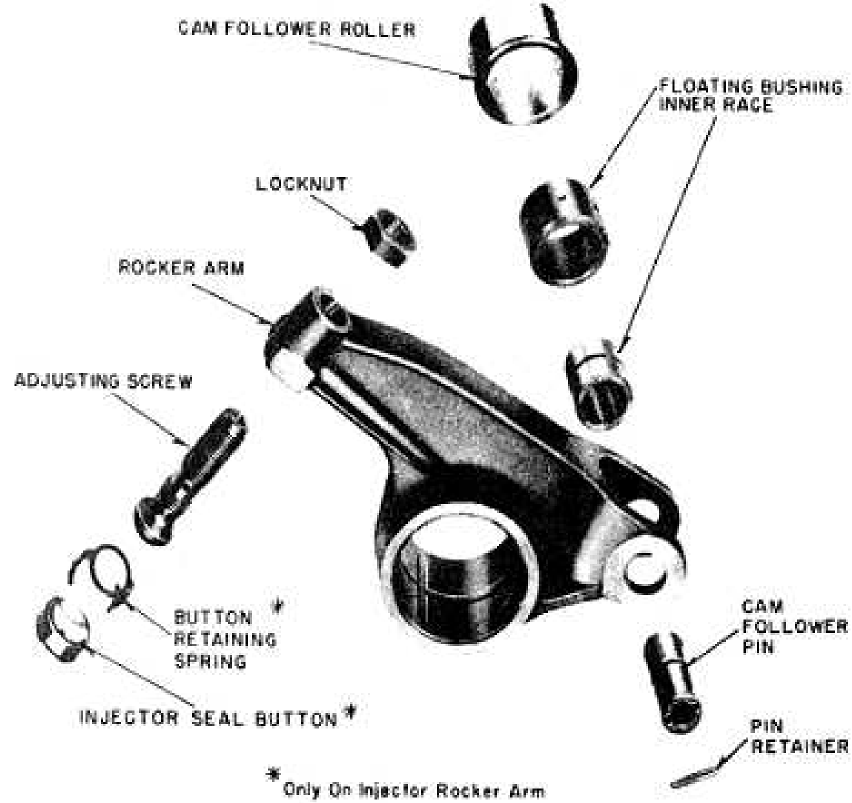
Lube oil flows from the rocker arm through a drilled passage in the valve bridge to the top of the lash adjuster, past the ball check and into the body. When the rocker arm depresses the valve bridge, a slight movement of the plunger in the lash adjuster seats the ball check, trapping the oil. Since the oil is practically incompressible, further movement of the rocker arm causes the lash Syphon Tube adjuster plunger to force open the exhaust valve. Proper hydraulic lash adjustment is very important because of its effect on the

the valve operation. (See Item 8 under Maintenance "Adjusting Hydraulic Lash Adjusters.") 4. Rocker Arms Three rocker arms, Fig. 2-?, are mounted on the cylinder head. Two rocker arms actuate the four exhaust valves, the third operates the injector. The rocker arms are operated directly by the camshaft through a cam follower mounted at the fork end of each rocker arm. The opposite end of each rocker arm has an adjusting screw and lockout for setting the injector timing and adjusting the hydraulic lash adjusters.



Hydraulic Lash Adjuster
Fig. 2-6

- 205 -



Exploded View of Rocker Arm Assembly
Fig. 2-7

- 206 -

CYLINDER HEAD 252C-2-955 252C-2-154 CYLINDER HEAD

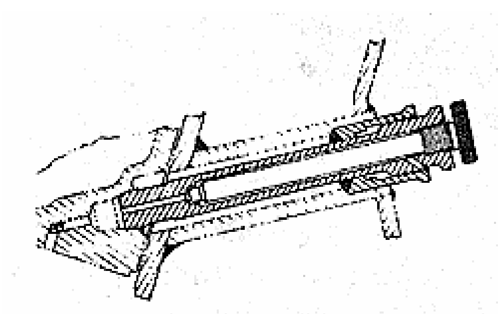
An oil jumper line from the camshaft bearing carries oil to the rocker arm through drilled passages in the rocker arm shaft, Fig. 2-1. The rocker arm is drilled to supply oil to the valve bridge and lash adjusters and to the cam follower.

5. Cylinder Test Valves

The cylinder test valve consists of a valve body, valve stem, packing nut and seal ring. This assembly is inserted in a housing within the crankcase and screwed in the cylinder head, Fig. 2-8. The purpose of the cylinder test valves is to relieve compression in the cylinders and to permit detection of water or oil in the combustion chamber before the engine is started by rotating the crankshaft, using the engine turning jack. A cylinder test valve wrench, Fig. 2-9, is used to open the valves 3 turns before rotation and to close the valves after inspection.

B. MAINTENANCE

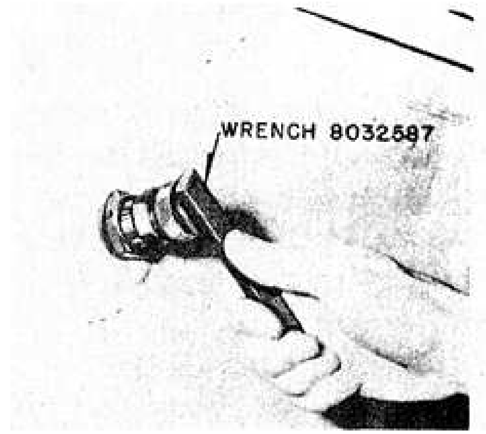
The maintenance procedures which follow consist of removing, cleaning, reconditioning, and installing the cylinder head and its component parts. For cylinder head Magnaflux inspection, see Maintenance Instruction 1754.



Cylinder Test Valve
Fig. 2-8

1. Cylinder Test Valves

The cylinder test valves should be opened 3 turns to test for liquid accumulations in the cylinder before starting the engine, if it has been dead a considerable length of time or to relieve the compression when servicing the engine. (Caution: Do not open test valves too far, as they may be forced out by pressure, possibly causing injury.)



Cylinder Test Valve Wrench
Fig. 2-9

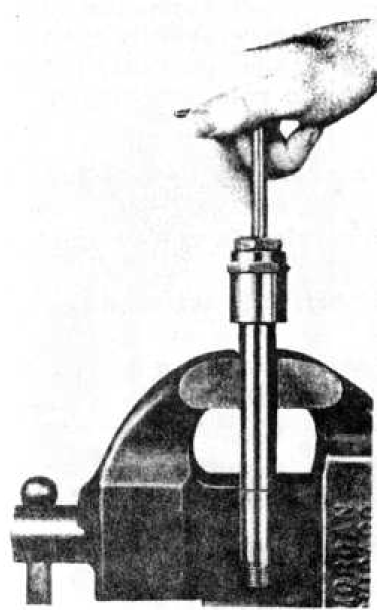
Rotate the crankshaft at least one turn with the test valves open, and observe test valves for discharge. If any liquid is expelled from any test valve, no attempt should be made to start the engine until liquid is removed and its cause corrected.

The crankshaft must be rotated by hand, using engine flywheel turning jack I or barring tool. The electrical "start" button must not be used when testing for cylinder liquid accumulation. Precaution must be taken to prevent the engine from being started, when the crankshaft is being rotated.

Test valve wrench X8032587, Fig. 2-9, is used to open and close the test valves. Care should be taken not to tighten valves too tight as to damage the valve seat.

It is possible for rain to enter the cylinder through the exhaust stack and open exhaust valves when a locomotive is left outside shut down in the rain. If

- 207 -



Reaming Test Valve Seat
Fig. 2-10

conditions warrant it, the exhaust stacks should be covered.

- 208 -

CYLINDER HEAD 252C-2-154 252C-2-1255 CYLINDER HEAD

If the cylinder test valves leak with normal tightening, the valve seat should be reamed, using reamer #8064804, Fig. 2-10. Valve seat diameter at top should not exceed 1/4".

If valve stem face is scored or damaged, it should be reground and rehardened to a case depth of .005" - .010". Minimum length of seat protrusion from stem is 1/4". When installing a cylinder test valve, apply a small amount of white lead or pipe thread compound to the threads. This will alleviate rusting and binding, to make removal easier. To remove test valves, loosen packing nut and remove assembly from cylinder head by unscrewing body nut.

2. Removing Cylinder Head

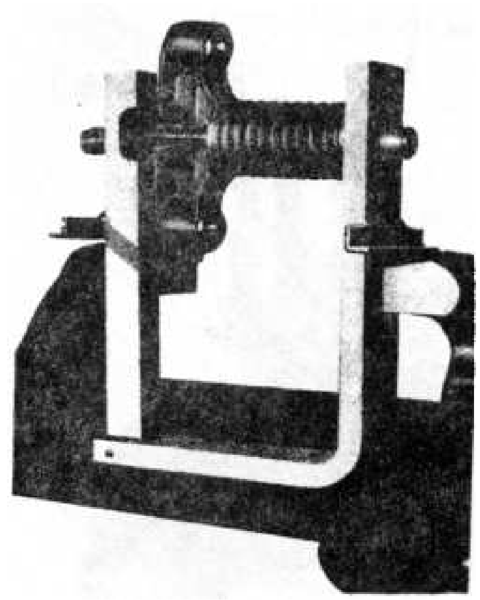
Removing Injector

- c. Remove cylinder liner stud nuts and washers.
- d. Remove crab nuts and crabs.
    1. Place protector tubes #8034600 over studs to protect threads.
- e. Remove cylinder head with use of head removing tool #8075894. Protect water outlet elbow. Place head into cylinder carrying basket #8060247, to protect machined gasket seat

The cylinder test valve must be removed and engine cooling water system drained before attempting to remove the cylinder head. If the cylinder liner is to be removed, remove piston cooling "pee" pipe assembly and water jumper line before starting to remove cylinder head.

- a. Remove rocker arms, rocker arm shaft, and valve bridges.
    1. Disconnect camshaft bearing to rocker arm oil Line.
    2. Remove rocker arm shaft cap nuts and remove caps.
    3. Remove rocker arm assembly, being careful not to let shaft fall from rocker arms.
    4. Remove valve bridges.
- b. Remove injector.
    1. Disconnect fuel oil lines from injector and fuel oil manifold.
    2. Remove adjustable injector link.
    3. Remove injector crab.
    4. Remove injector, using prybar #8041183, Fig. 2- 11. Protect injector from dirt and damage by using holding rack #8159228, or shipping container.

Fig. 2-11



Compressing Valve Bridge Spring
Fig. 2-12

surface from damage.

- f. Remove cylinder head seat ring and check for wear.

NOTE: Maintenance Fi1e 232 giving construction details on equipment for handling the cylinder head, liner, piston and rod assembly is available upon request.

3. Rocker Arms and Shaft

Inspect rocker arm bushings, cam followers, and rocker arm shaft, Fig. 2-7. Look for evidence of discoloration, excessive wear, shelling or scuffing due to lack of

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ubrication. Inspect for fatigue cracks. For wear limits, see specifications.

4. Valve Bridges and Lash Adjusters

Clean valve bridges using a solvent, inspect for wear or damage. Rework as in following paragraphs.

a. Removing and installing valve bridge springs or spring seats, Fig. 2-12.

(1) Mount valve bridge spring compressing tool #8070883 in vise. clamp valve bridge in vise removing lash adjuster, as shown in Fig. 2-13, using lash adjuster removing tool #8070866. Fuller arm #8154408 is used with this tool for removing long travel lash adjuster.

(2) To install lash adjuster assembly, use installing tool #8072927 shown in Fig. 2-14.

(3) Internal parts of the lash adjuster can be removed for cleaning or replacement and reinstalled without removing lash adjuster body from valve bridge. Use tool #8072927 with plug, to compress the lash adjuster plunger for removing the snap ring as shown on Fig. 2-15, using snap ring removing tool #8080632.

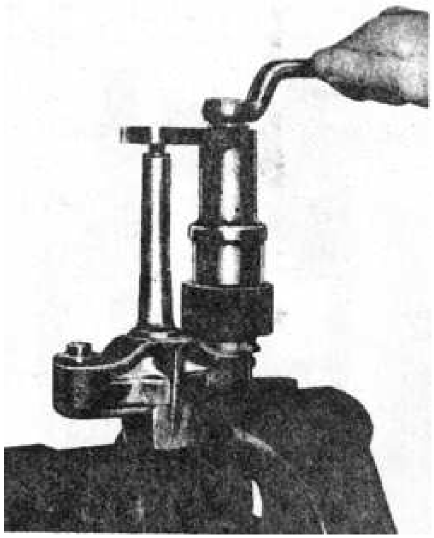
(2) Install valve bridge in compressing tool, compress spring, remove snap ring and remove spring.

(3) Install new spring or valve spring spherical seat as required, and replace snap ring using snap ring tool #8070903.

b. Removing and installing hydraulic lash adjuster.

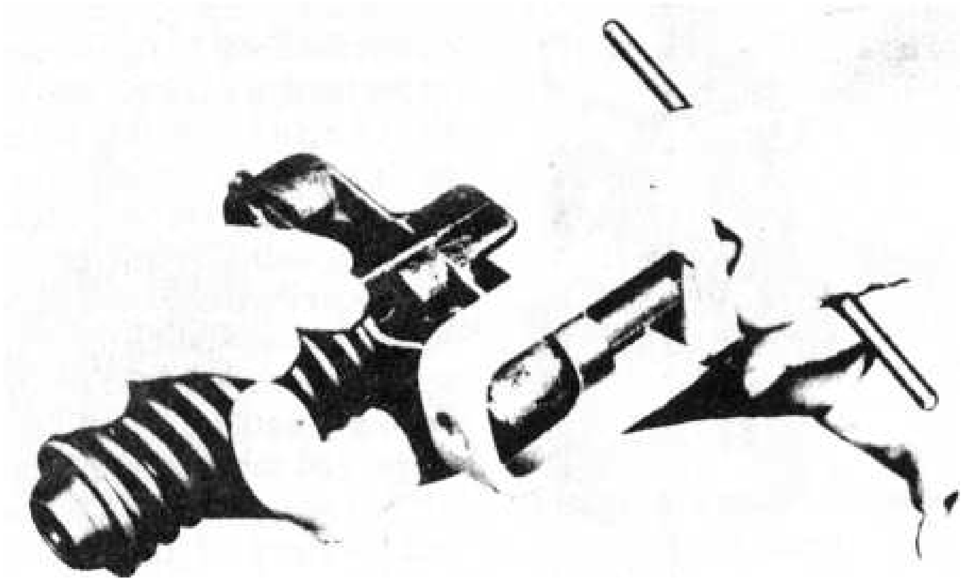
NOTE: Inoperative lash adjusters are noisy and can be located while engine is running at idle by their sharp tapping. (This may be noticed at t i m e s with good adjusters when first starting an engine, caused by cold oil). To correct this condition, remove lash adjuster and clean or replace parts, as necessary.

(1) To remove lash adjuster assembly



Removing Hydraulic Lash Adjuster
Fig. 2-13

- c. Cleaning Lash Adjuster Lash adjuster may be cleaned without removing body from valve bridge, as outlined above. Dirt in the lash adjuster will cause the lute oil to leak past the ball check. This can be tested by depressing plunger by hand. If the plunger can be rapidly depressed with the lash adjuster full



Installing Lash Adjuster
Fig. 2-14

of oil, the ball check is leaking. To correct this condition, disassemble the lash adjuster as outlined above and clean all parts thoroughly. A gummy deposit on the plunger can be cleaned by using alcohol or lacquer thinner. The lash adjuster should then be reassembled, the valve bridge filled with lube oil, tested as above, and replaced if defective.

5. Exhaust Valves and Guides

a. Removing valve springs. Compress spring using the compressor tool #8033783 and adapter #8034054 screwed to head, or use type of compressor tool that compresses all four springs #8239430, Fig. 2-16. Valve springs can be removed and replaced without removing the cylinder head from the engine, by using a special short adapter with tool #8033783.

Removing Lash Adjuster Snap Ring Fig. 2-15

If this is done, the piston must be at top center to prevent the valves from falling into the cyl inder when the valve locks are removed. Valve and valve bridge springs should be inspected for nicks or unusual wear when removed. Do not clean springs using hydro blast ing or grit blasting. Min imum free length of the spring is 3-31/32". The spring seats should be inspected for unusual wear o r damage. Minimum thickness of the spring seating surface is .145".

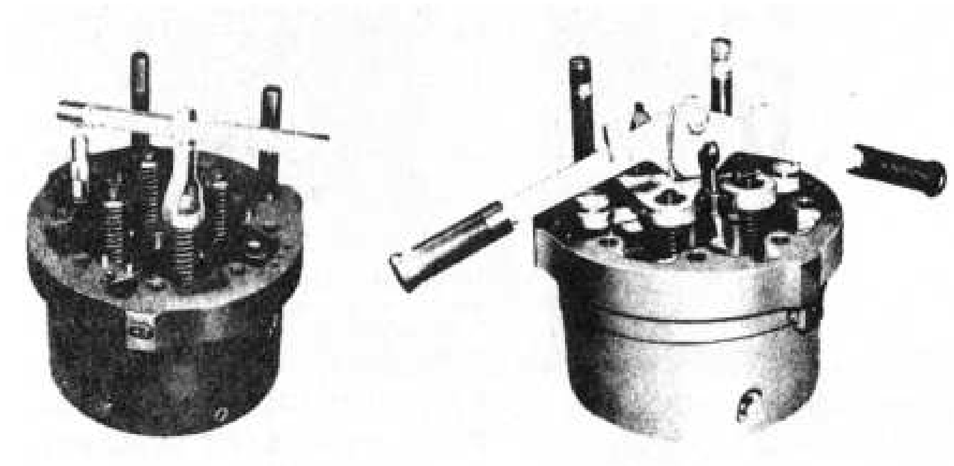
b. Mating Locks and Valve Stems

Before installing valves in head, check conical lock fit to valve stem. If lock fits loosely, try new lock. If new lock is loose, it will indicate that the valve stem grooves are worn. Discard valves or locks if either is worn. Check locks and spring seats together. Match to obtain rigid assembly, so no spring seat wobble is felt. Valve locks supplied under 8028122 may or may not have a groove on top. Care should be taken so that the two types are not mixed when installing on a valve. Both locks used on a valve must be identical types.

c. Reconditioning Valves

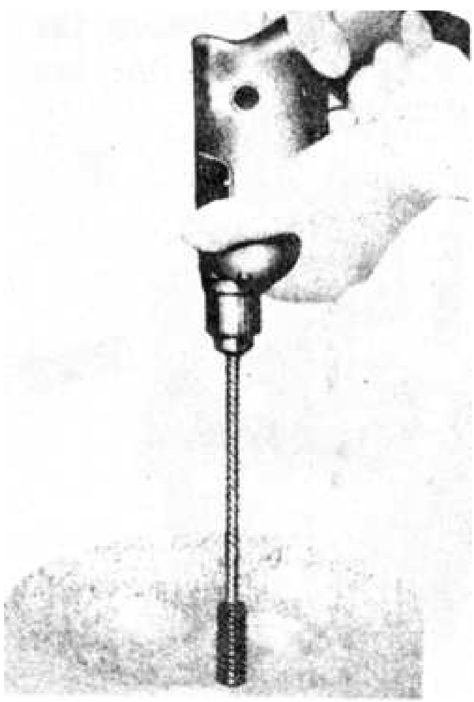
If there is any evidence of scuffing or galling on valve stem it must be completely removed by polishing or the valve replaced.

Examine valve heads for cracks and scuffing on the face by visual inspection with a magnifying lens and Zyglo inspection where available. Look for indications of failure on valve face, edge and bottom machined portion of the head and the weld junction on the stem.



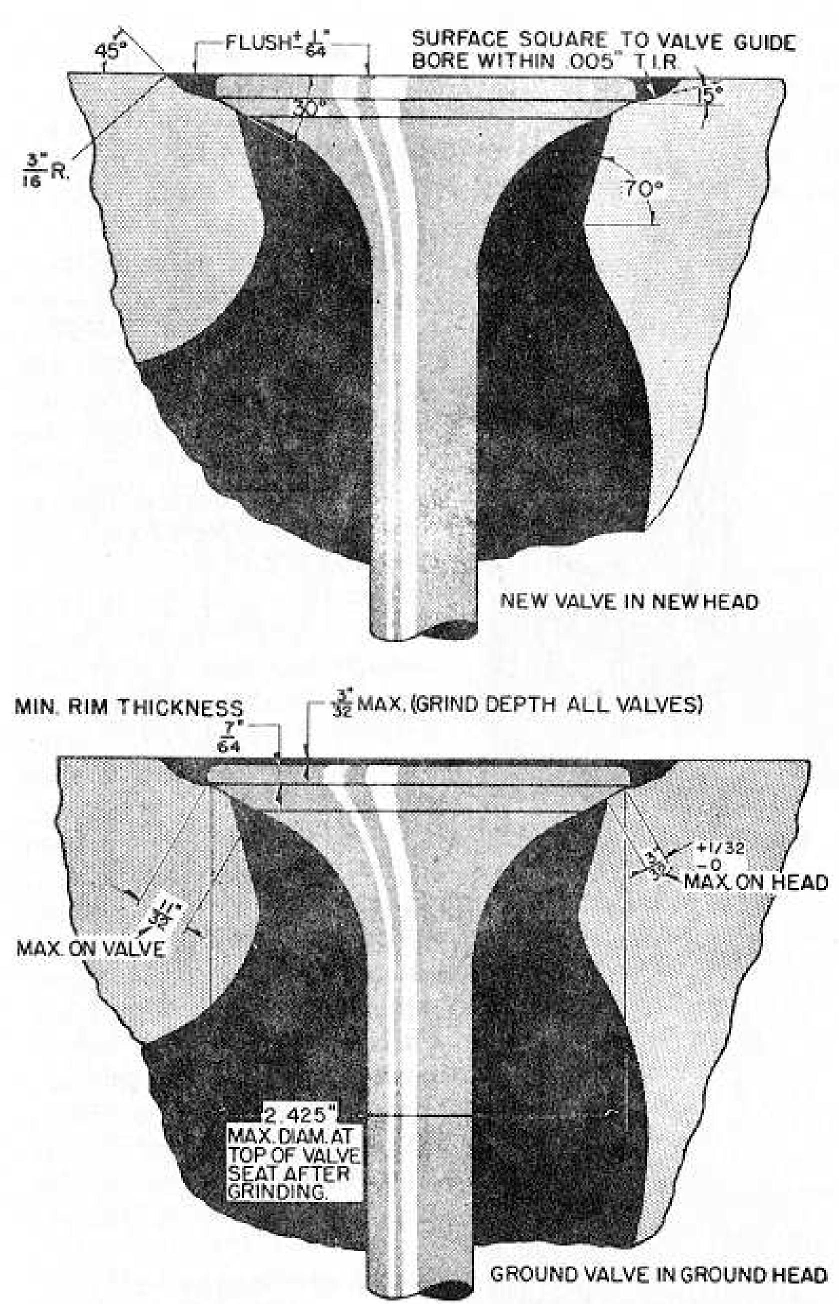
Compressing Valve Springs Fig. 2-16

For refacing valves follow instructions supplied with valve refacing machine 8137779, 110-volt, 8137780, 220-volt. Special grinding wheels are used for refacing Stellite faced exhaust valves, 8215388 is used with Black and Decker Grinder Universal #6, and 8035729 with Albertson Co. Sioux Model 663. See Tool Catalog for complete description of valve tools. d. Valve Guides The valve guides are a press fit in the cylinder head and can be pressed in or put using valve guide installing or removing tool 8224241, to prevent damage to the guide. Although the valve guides are precision guides and generally do not require reaming after assembly, it is recommended a .626" reamer or plug gauge be inserted after guide installation to assure a .626" minimum diameter. For precision valve guide limits, refer to Specifications under Valve Guides at the end of this Section.



6. Cylinder Heads

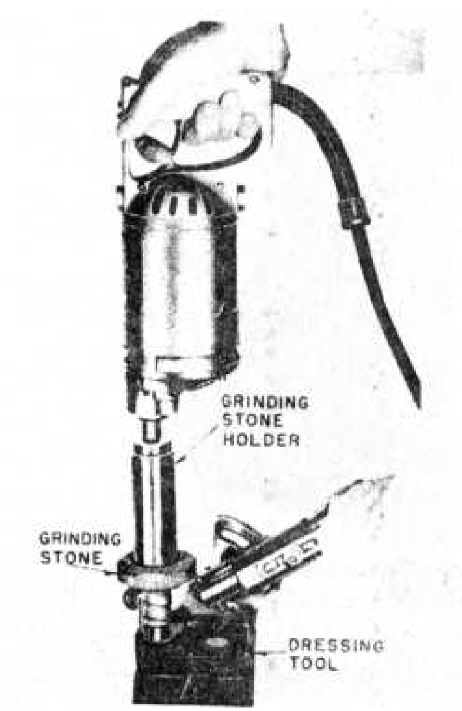
a. Cleaning and inspection Cylinder heads should be thoroughly cleaned af ter disassembling, as out- lined in Maintenance in struction 1706. When the head is removed f r o m cleaning tank, stud holes should be cleaned. A stud hole cleaning tool #8211907, Fig. 2-17, is available for this purpose. Clean cyl inder test valve threads in head with 1/2" standard pipe tap. When head is Stud Hole Cleaning Tool clean, inspect for cracks Fig. 2-17 and damage (See Maintenance



Exhaust Valve Clearance
Fig. 2-18

Instruction 2127 for cylinder head Magna- flux inspection), and if satisfactory, proceed with following service operation. b. Grinding valve seats Use valve seat recon ditioning set 8035775, 115 -volt o r 8041445, 220 -volt. Do not use grinding compound. See Fig. 2-18, for valve and valve seat dimen sions. Proceed as follows:

(1) Dress grinding wheel before using on each cylinder head. Mount as in - Fig. 2 -19. Wipe pilot with oil-soaked cloth for lubrication. Do not get oil on the grinding wheel.



Adjust the spiral sleeve on the dressing tool until the wheel touches the diamond. Make final adjustment with diamond adjust ing screw. Holder and grinding wheel are then revolved with the high speed drive. Hold the driver as straight as possible. Move the diamond steadily across the wheel, taking light cuts. Keep grinding wheel properly dressed to obtain the best results for fast grinding, accuracy, and a smooth f inish.

(2) Clean valve guides with cleaning tool 8141439 drill 8062140, 220-volt, or 8045450, 110 volt, shown in Fig. 2-20. Any evidence of galling inside of by reaming or the guide replaced. See Specifications for condemning limits.

(3) Select a tapered pilot which will bring the shoulder on the pilot above the valve guide. Press pilot firmly into guide, using pin. Wipe pilot with an oily cloth.

(4) Ream inside and outside of valve seat to conform to dimensions given on Fig. 2-18, Use reamer clamp $194884 with adapter 8192140 to apply an even, adjustable pressure to the reamer, Fig. 2-21. First, use reamer 8192191 to ream clearance inside of seat. (Cutting angle of this reamer has been changed from 75° to 70° to conform to current design cylinder heads.) The top outside of the valve seat is narrowed to proper width of 3/32« + 1/321, -0", using one of the following reamers. Cylinder heads serial 55A-2267 and after have a 3/16" radius at edge of valve recess to bottom of head; on these heads use reamer 8227358. Use reamer 8192190 on all cylinder heads prior to serial 55A-2267. After completion of reaming

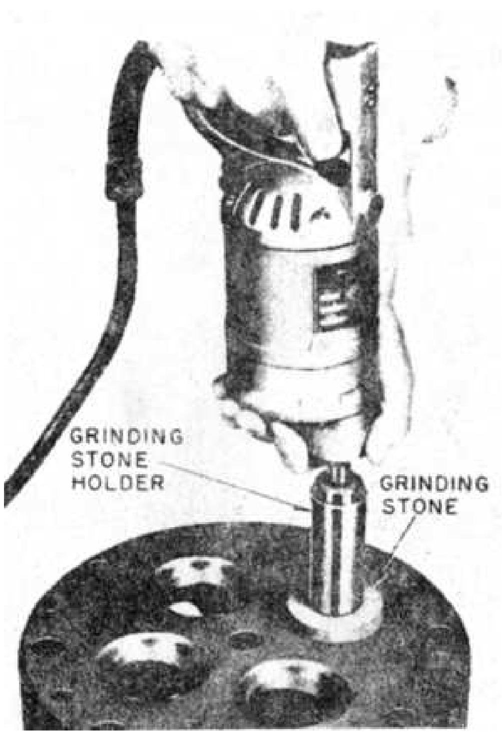
Cleaning Valve Guide
Fig. 2-20

Dressing Valve Seat Grinder
Fig. 2-19

guide must be entirely removed

operations, blow out cut- tings with air hose and wipe parts clean.

Reaming Valve Seat
Fig. 2-21



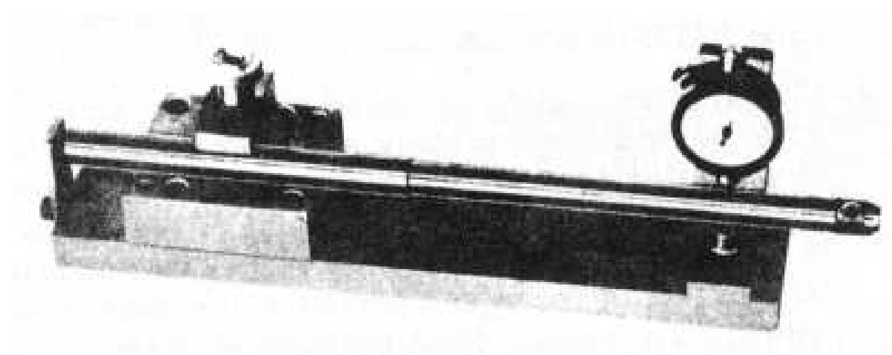
Grinding Valve Seat
Fig. 2-22

(5) Place holder with wheel over pilot. Insert abrasive cloth between grinding wheel and valve seat, and clean seat by turning holder by hand. Re- move abrasive cloth and proceed to grind with driving motor, as shown in Fig. 2-22. No pressure is required when grinding. Permit the driving motor to-run at top speed. Hold driving motor as straight as possible. Grind until valve seat is true. Raise grinding wheel off seat before stopping motor.

(6) Check valve seat width. If over 1/8", ream with outside reamer, then grind lightly to remove any raised edge caused by reamer.

(7) Use indicator 8073108 included in the valve grinding set to measure trueness of valve seat.

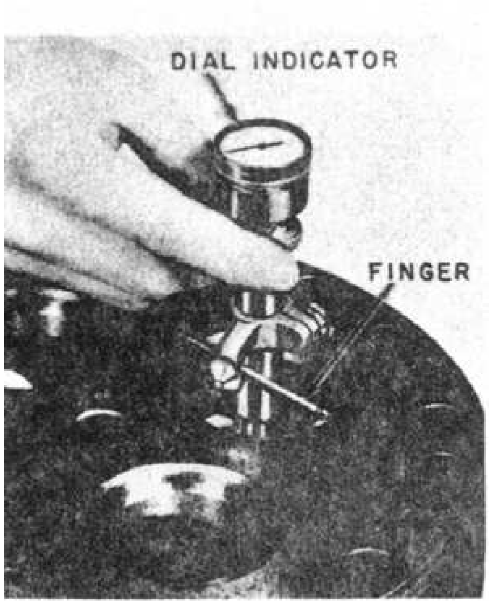
.002". An attempt should be made to obtain a perfect valve seat, since it is a very important factor in valve life. e . A fixture 8173996, Fig. 2-24, is available for checking valve grinding and seat testing arbors. To insure satisfactory results, the grinding arbors should not exceed .0005" run out.



Pilot Checking Fixture
Fig. 2-24

c. Testing valve seats To check seal of valves, assemble valves and springs to cylinder head and place head in an angular position resting on the rocker arm studs, with the valve seats up. Be sure that the bottom of the head is clean.

Vacuum cup lifter (4")



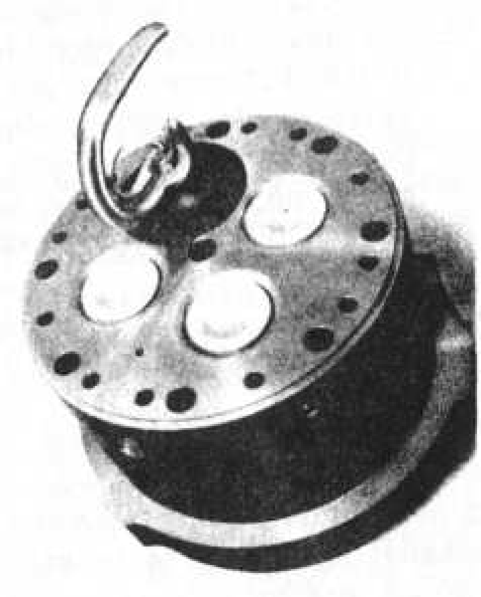
Checking Valve Seat Roundness
Fig. 2-23

Place indicator over pilot, Fig. 2-23, and adjust so indicator is depressed slightly and ball of valve seat rider is at the center of the valve seat. Rotate valve seat rider and observe indicator reading. Valve seat out of round will be indicated on dial Indicator reading must not exceed

- 219 -

8213518, Fig. 2-25, is used to test the valve seal. Apply soap or a suitable lubricant to the concave surface of the vacuum cup, and apply to the cylinder head, care- fully covering one valve. Be sure seal is not formed on the head of the valve, thereby testing the cup portion of the valve instead of the seat. Place

- 220 -



Vacuum Cup Lifter
Fig. 2-25

CYLINDER HEAD 252C-2-1255 252C-2-1255 CYLINDER HEAD

the valve tester with its handle in the 6 o'clock position, so tester will fall off readily when vacuum is depleted. If the tester falls off in less than three (3) minutes, the valve seating is defective and the head seat and/or valve face must be reworked. To remove the tester, open the trigger valve. Check the valve seat tester occasionally by applying it to a vertical piece of glass, because the release valve or rubber cup may become defective. New vacuum cups 8213519 are available.

d. Checking the height of valve stems

After reconditioning valves and valve seats, the height of the valve stem above the cylinder head must be checked. This is done with the use of the valve stem tram 8042773, as shown in Fig. 2-26. Clean off bottom feet of tram, and

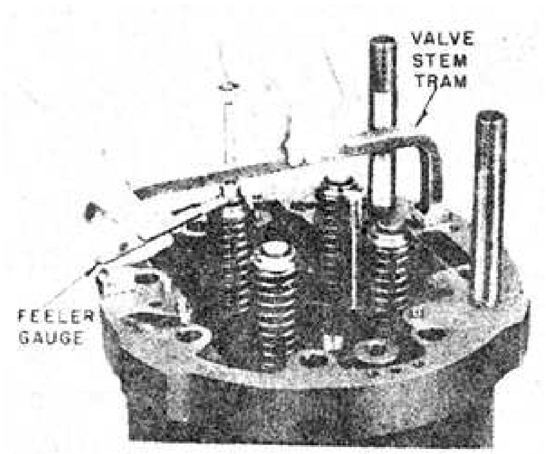
or scratches which would cause water seal or gasket leakage. Clean the liner stud holes using tool 8211907, Fig. 2-17. If this tool is not available, a wire brush can be used to remove rust, scale or dirt from these holes. It is recommended that just prior to installation of any cylinder head that a small quantity of green soap be applied to the bottom of all water and stud holes to help prevent possibility of dirt dropping on the water seals or cylinder head gasket surface during installation of the head.

Liner stud nuts should be examined and discarded when bottom of nut or threads are galled, or insert area cracked, torn, or frayed. Inspect cylinder head nut washers for damaged surface or warped condition, and replace if required.

portion of cylinder head on which tram rests. Hold tram down firmly on cylinder head and with use of feeler gauge and screw, determine the difference of valve stem height. The difference of this height between valve stems under the same bridge should not vary more than 1/16". If the difference varies more than 1/16", the high valve would have to be replaced or the low valve ground in, provided this does not exceed the limits given on Fig. 2-18. End of valve should not be ground off as tip is hardened.

7. Installing Cylinder Head

Before installing cyl inder head be sure the re tainer inner surface and exhaust is cleaned of loose carbon and oil. Examine the cylinder head that it is clean in ternally and in particular that the bottom surface is clean, free of dirt, nicks



Checking Height Of Valve Stems
Fig. 2-26

Copper clad steel shim liner to head gasket should be installed with notched holes on liner pilot stud and left adjacent stud. Examine counterbore in liner water holes to be sure these areas are free of dirt and nicks that would break the seal grommets.

Install new seal rings in clean grooves of water discharge elbow. Clean flange surface on cylinder head for the elbow and apply elbow to head. Torque value of elbow to head capscrews is 30 foot-pounds. The discharge water elbow also serves to position the cylinder head in the crankcase. The elbow may be removed to change seals if necessary and reapplied with the head installed after removal of the crab above it, otherwise the cylinder head installation need not be disturbed. A thin shim used between the elbow flange and cylinder head, to hold the seal in place, aids in elbow application when the cylinder head is in place. It is important that the last cylinder head of the right bank and the first cylinder head of the left bank have a syphon tube water discharge elbow to permit water drainage from the discharge manifold when draining the engine cooling water. This arrangement assures drainage in the event the engine is not level when drained.

When this preliminary work is completed, proceed with the installation of the cylinder head, as follows: a. Apply cylinder head seat ring to top of retainer. (See specifications for seat ring limits Lower head into position slowly. Line up water dis charge elbow with mating hole in crankcase.

b.Apply cylinder liner stud nuts and tighten snugly. Use lube oil or a lubricant having specifications similar to Texaco Stud Lube #921 on threads and bottom of nuts. At this initial tightening, apply only 75 foot- pounds torque.

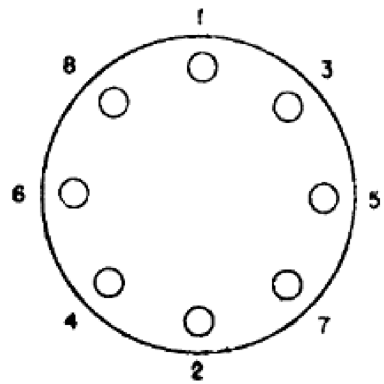


Fig. 2-27

c. Apply crabs and crab nuts. Use a lubricant similar to "b" above on the threads. Pull crab nuts down snugly.

d. Tighten liner stud nuts to proper torque of 200 foot- pounds, as indicated in the sketch, Fig. 2-27, making several rounds.

e. Tighten crab nuts. Crab nuts should be tightened alternately, forming the letter "X," and in two passes, half torque each pass. Powerench #8211089 may be used, which has a mechanical ratio of 12-1. Socket #8065580, box wrench #8034085, used with 60" extension, can also be used. Torque value for the crab nuts is 1800 ± 5% foot-pounds.

f. Install injector. Connect fuel oil lines and adjustable link. Injector crab nut- torque value is 40-50 foot-pounds. (Time, as given in Section X).

g. Install valve bridges (with protruding boss toward camshaft for uniform assembly) rocker arms and lube oil lines. Set valves per item 8 below.

h. Install cylinder test valves.

applying "pee" pipe, clean it with cleaning tool #8087086; after applying, check alignment in piston carrier with tool #8071720.

j. After assembly is installed and everything tightened properly, adjustments set and engine is ready to run, start engine and raise water temperature to 170° F. Recheck torque on crabs and liner stud nuts. Inspect assemblies for condition after running.

> NOTE: When liner and crab nuts are being retightened, those which move at LESS than the specified torque values, should be tightened to the proper torque value. Those nuts which do not move below or up to the proper values, should be CHECKED by pulling up to a value not exceeding 10% more than the recommended torque values. Special offset box socket wrenches #8166890 and #8166891 used with a standard torque wrench are available to tighten inaccessible cylinder head nuts under installed rocker arms.

8. Adjusting Hydraulic Lash Adjusters

Application of properly operating lash adjusters, correct setting and subsequent inspection at regular maintenance intervals is very important in valve operation. Improperly set or defective lash adjusters cause the valve to be subjected to increased stress which leads to ultimate failure with resulting damage to the engine.

After complete cylinder head assembly has been installed, the lash adjusters must be set.

a. Rotate crankshaft so that piston is at or near top center of the cylinder being set.

b. Loosen rocker arm adjusting screw locknuts.

c. Turn rocker arm adjusting screw down until the last valve touches the hydraulic lash adjuster plunger, and then turn one and one-half (1-1/2) turns further down.

i. Apply liner water inlet line and piston cooling oil pipe if these items were removed. Before

252C-2-1255 CYLINDER HEAD

d. Check valve bridge spherical seat to be sure that it is spring loaded against the cylinder head spherical seat. If the bridge spring spherical seat is not spring loaded against the cylinder head spherical seat (any looseness evident), turn down the rocker arm adjusting screw until no looseness is felt, and then turn it one-quarter (1/4) turn further down.

e. Tighten rocker arm adjusting screw locknut. f. After running the engine for two or three minutes, or after pumping oil out of lash adjuster by forcing down the rocker arm, check the clearance between lash adjuster bodies and the end of the valve stems with piston near top center. If the clearance is less than one-sixteenth (1/16") the cylinder head should be removed for reconditioning or rejection. Use minimum extension gauge #8107788, as shown in Fig. 2-28, to gauge lash adjuster plunger minimum extension. This gauge is 1/16" thick and it should fit between lash adjuster body and valve stem top, to assure the 1/16" clearance.

9. Tracing A Defective or Noisy Cylinder

A cylinder that is not firing properly will have a cooler exhaust stack, com pared to one that is firing properly (engine at idle). This is caused by

f. Excessive ring blow-by.

g. Cracked piston.

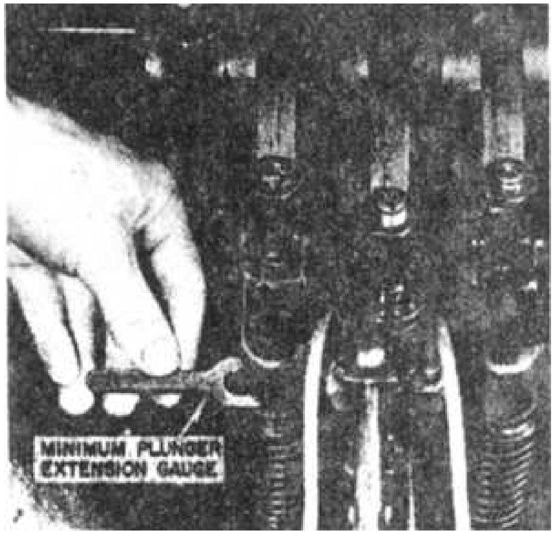
To determine if injector is at fault, disconnect injector adjustment link on the suspected cylinder and, with engine running at idle, push control rack open slowly and return to idle position as soon as observation has been made. If injector is operating properly a pronounced laboring of the cylinder will have been detected.

An exhaust valve leak can be detected when standing outside of locomotive by a pronounced blow at the exhaust stack, with engine idling.

To locate the leaking cylinder (engine shut down) install cylinder test adapter #8070872 in place of cylinder test valve, connect air hose to adapter, rotate engine until piston of cylinder to be tested is at top center and turn on air pressure. If valves are leaking, blow will be heard at exhaust stack. This method can also be used for checking excessive ring blow-by. In this case, blow will be heard in air box. If piston is cracked, blow will be detected at oil pan.

10. Repair of Damaged Seating Surfaces

It is permissible to rework cylinder heads which have damaged seating surfaces to the limits shown on Fig. 2-29.



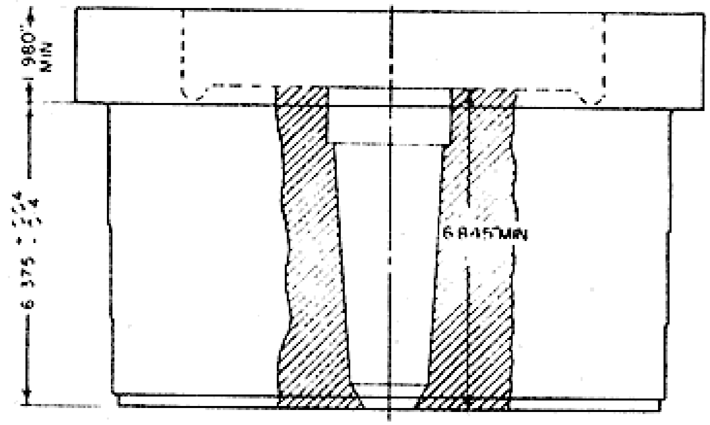
Minimum Plunger Check
Fig. 2-28

a. Badly leaking exhaust valves.

b. Defective injector. c. Improper injector timing or control rack setting.

d. Dirty injector filter.

e. Air bound injector.



Cylinder Head Dimensions
Fig. 2-29

C. SPECIFICATIONS

Exhaust Valves	
Diameter of stem (new)	.6215" - .6225"
Valve stem diameter	Min. .620"
Diameter of head	2-1/2"

C. SPECIFICATIONS (Cont'd)

Valve stem to guide clearance	Limit .010"
Press f it in head	.0005" - .0020"
Cylinder Head Seat Ring	
Thickness (new) standard	.192" ± .002"
Minimum thickness	.184"

Valve seat angle	300
Lift	.686"
Number per cylinder	4

Valve Springs

Free length (approximately) (new)	4-1/8"
Free length	Min. 3-31/32"
Length - valve open	2-11/16"
Length - valve closed	3-3/8"
Pressure with valve open	213 lbs. to
	225 lbs. (new)
2-11/16" length 175	lbs. low limit

Valve bridge spring - same as valve spring. Spring must not show any set after being compressed with coils touching.

Valve spring seat thickness	Min. .145"

Rocker Arm

Rocker arm shaft diameter	Min. 2.246"
Rocker arm lever bushing inside diameter	Max. 2.254"
Press-bushing to rocker arm	.002" - .004"
Uniform thickness within	.002"

D. EQUIPMENT LIST

	Part No.
Valve Seal Tester	8213518
Vacuum Cup (spare for 8213518)	8213519
Test Valve Wrench	8032587
Snap Ring Removing Tool - Lash Adjuster	8080632
Cylinder Head Removing Tool	8075894
Cylinder Head Carrying Basket	8060247
Valve Bridge Spring Compressing Tool	8070883
Valve Bridge Snap Ring Installing Tool	8070903
Hydraulic Lash Adjuster Puller	8070866
Lash Adjuster Installing Tool	8072927
Exhaust Valve Spring Compressing Tool	8033783
Adapter (for above)	8034054
4-Spring Compressing Tool	8239430
Valve Refacing Machine 110 Volt	8137779
Valve Refacing Machine 220 Volt	8137780
Valve Seat Reconditioning Set 115 Volt	8035775
Driver (for above) 115 Volt	8200893

Inner race outside diameter	Min. 1.048"
Floating bushing inside diameter	Max. 1.055"-
Floating bushing outside diameter	Min. 1.4435"
Cam follower inside diameter	Max. 1.4505"

Valve Guide

Inside diameter (New-not installed)	.627" - .629"
(installed in head)	Min. .626"
Limit (at bottom)	.632"
Limit (1/2" from bottom and top)	.630" -

Valve Seat Reconditioning Set 220 Volt	8041445
Driver (for above) 220 Volt	8200894
Valve Guide Cleaning Tool	8141439
Guide Installing and Removing Tool	8224241
Valve Seat Reamer (inside)	8192191
Valve Seat Reamer (outside) see text	8192190
Valve Seat Reamer (outside) see text	8227358
Pressure Arm - Valve Seat Reamer	8194884
Taper Pilot Checking Fixture	8173996
Cylinder Test Valve Seat Reamer	8064804
Valve Stem Tram	8042773

D. EQUIPMENT LIST

Cylinder Head Stud Hole Cleaning Tool	8211907
Crab Nut Socket	8065580
Box Socket Wrench	8034085

Crab Nut Box Wrench Handle - 60"	8084091
Lash Adjuster Minimum Plunger Extension Gauge	8107788
Cylinder Test Valve Adapter (air test)	8070872
Crab Nut Powerench (12-1 ratio)	8211089
"Pee" Pipe Cleaning Tool	8087086
Cylinder Assembly Lift (Eccentric type)	**8212009**

(8212009 is for 567C engines only)

SECTION III

PISTON AND CONNECTING ROD ASSEMBLIES AND CONNECTING ROD BEARINGS

A. DESCRIPTION

1. Piston Assembly The cast iron alloy pistons used in 567C production engines are two piece or "floating" pistons, consisting of an integral body and a piston carrier designated as the "trunnion type" shown in Fig. 3-1. The carrier sup- ports the piston body at an internal piston platform and is held in place by an internal snap ring in the piston body. A thrust washer is used between the carrier platform and piston

platform. This design allows the piston body freedom to rotate during engine operation. Three compression rings and two double hook oil control rings are used. Oil taken up by the oil rings passes through drilled holes behind the rings.

The carrier used in the trunnion piston assembly has a circular boss located centrally on its upper platform which pilots in a bore in the center of the piston platform, and is also piloted in the piston at the carrier bottom outside diameter. No piston pin bushings are used in the carrier, since the piston pin bearing area extends the diameter of the carrier and is formed to the contour of the piston pin. Pin bearing area in the carrier is honed and polished. The bearing surface of the pin oscillates in the carrier. The piston pin is inserted in the carrier pin bore, then rigidly bolted to the upper end of the connecting rod.

Internal parts of the piston are lubricated and cooled by the piston cooling oil. Cooling oil is directed through a drilled passage in the piston carrier, circulates about the piston crown area, lubricates the piston pin and drains through two 5/8" holes in the carrier at right angles to the pin.

252C-3-1255 PISTONS AND RODS

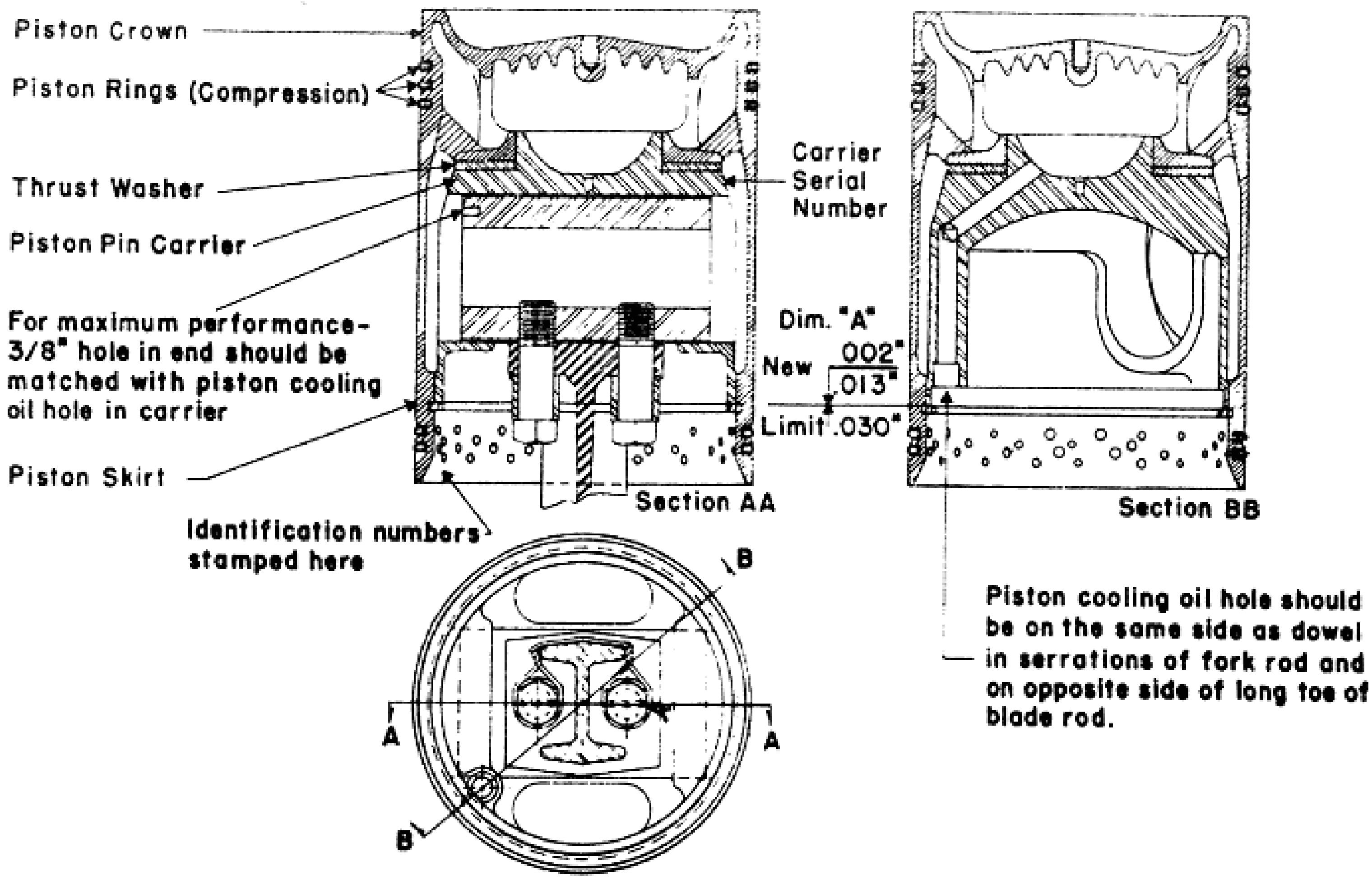
Some early 567C pilot engines are equipped with conventional floating pistons. These pistons are easily distinguished from the trunnion type by the carrier with bushings used with connecting rods having pin bores and bushings. Conventional floating pistons have rim piloted upper platforms and thrust washers of smaller diameter and thickness compared to trunnion thrust washers. Both trunnion type and conventional floating pistons and connecting rod assemblies can be used together in any 567 series engine. However, parts of the two assemblies are not interchangeable. Description and maintenance of conventional floating pistons and connecting rod assemblies is contained in Section 3 of the 252E Engine Manual.

Pistons are given Parco Lubrite treatment to aid skirt lubrication. This process etches the surface to a dark dense porosity, which gives better oil retention. Information on field relubrite treatment is contained in Maintenance Instruction 1758.

2. Piston Pin

The steel alloy piston pin is mounted directly on the circular contour at the top of the connecting rod. Two 7/8" bolts, each provided with a non-removable spacer, pass through the upper end of the rod and screw into the piston pin. A torque value of 450 foot pounds is used to tighten these bolts, after which they are lockwired.

Because the piston pin is bolted to the connecting rod, it is forced to oscillate in the carrier bore. The top surface of the pin, which is the bearing area, is provided with grooves to aid in the distribution of lubricating oil. Silver bearing material about .015" thick is provided all over the outer pin surface. In addition, to aid "run in" the pin surface is given a thin flash coat of pure lead.



Floating Piston Assembly
Fig. 3-1

3. Connecting Rod Assembly

The connecting rods are interlocking, blade and fork construction. The blade rod moves back and forth on the back of the upper crankpin bearing and is held in place by a counter-bore in the fork rod. See Fig. 3-2 and Fig. 3-3.

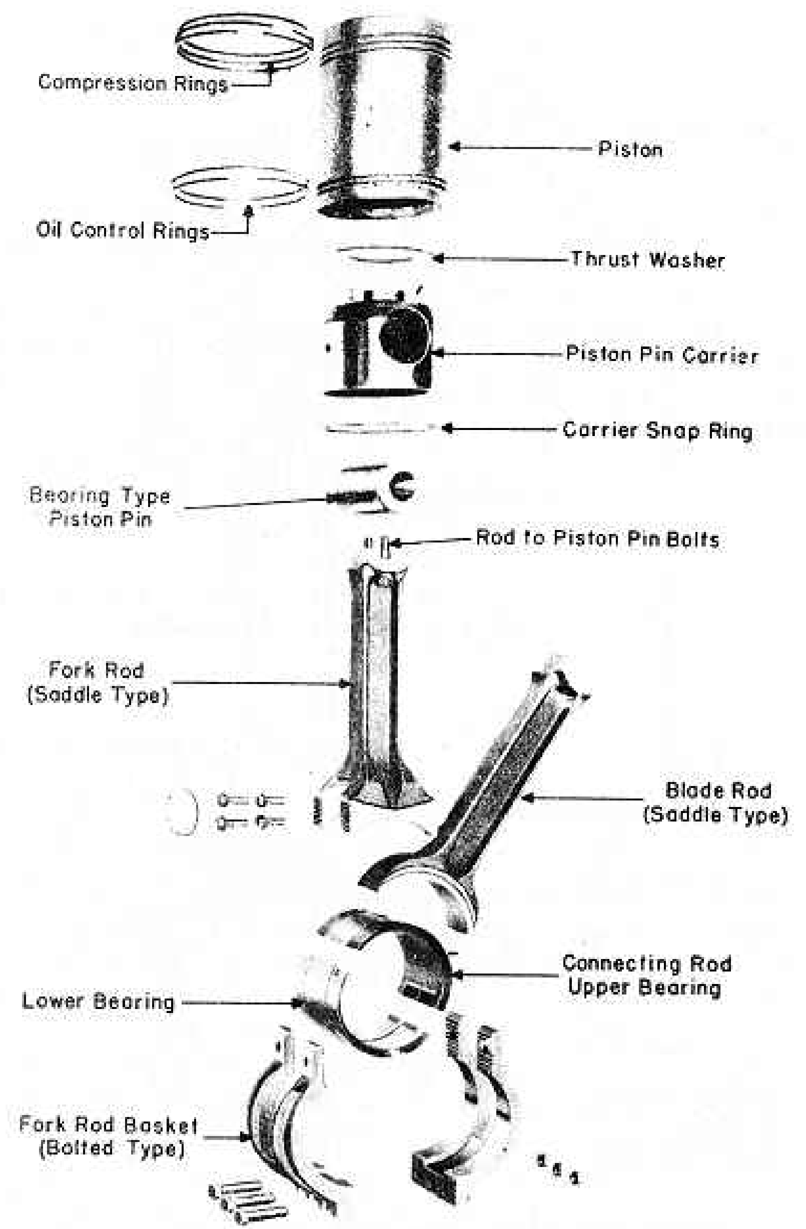
One side of the blade rod bearing surface is longer than the other and is known as the "long toe. The blade rods are installed in the right bank of the engine, with the long toe toward the center of the engine.

The fork rods are installed in the left bank of the engine. Serrations on the bottom sides of the rod match similar serrations on the bearing basket. The bearing basket consists of two halves, bolted together at the bottom by three bolts having self locking nuts. The fork rod and basket are fastened together at the serrations by means of a dowel and capscrews. Fork rods and baskets are not interchangeable since they are line bored as an assembly. Both the fork rod and basket are stamped with an identical assembly serial number for purposes of matching and identification.

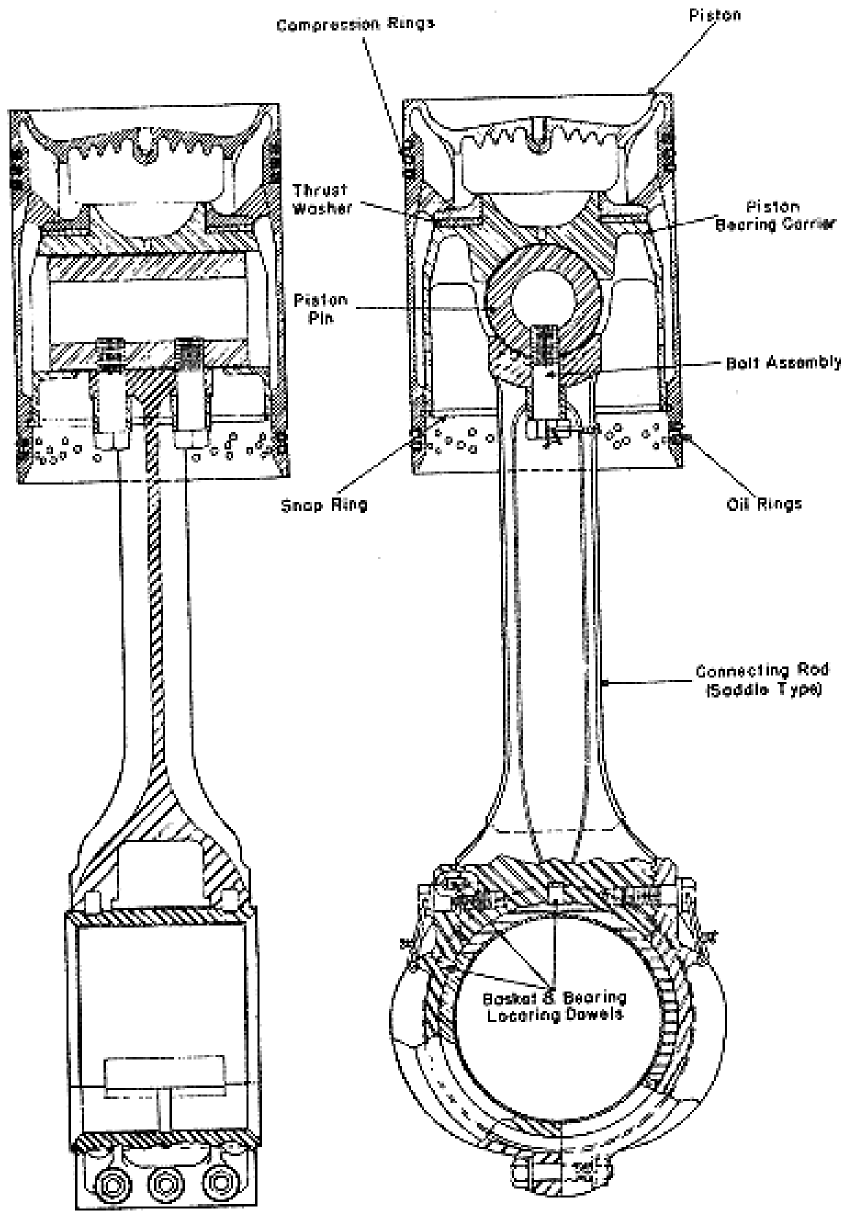
The top of each rod is machined to a contour of the piston pin. Piston pins are held to the connecting rod by two capscrews, provided with non-removable spacers.

4. Connecting Rod Bearings

Connecting rod bearings consist of upper and lower shells, Fig. 3-2. They are semi-circular steel, having a layer of bronze covered by a lead tin coating on the inside diameter. The upper bearing also has a bearing surface in the center of the outer diameter consisting of a layer of bronze without lead tin overlay. This provides a bearing surface for the slipper of the blade connecting rod.



Piston And Connecting Rod Assembly
Fig. 3-2



Piston and Connecting Rod (Cross Section)
Fig.3-3

Dowels in the fork rod and bearing basket hold the shells in proper position. Two dowels in the fork rod hold the upper shell and the lower shell is located by a dowel in the basket.

No adjustment of connecting rod bearings is provided. When bearing clearance exceeds the limit given in the specification, replace the bearings. After bearing shells are once used on a crankpin, they must not be used on any other crankpin.

Lubricating oil is supplied the crankpin bearing from an adjacent main bearing, fed through a drilled passage in the crankshaft. An oil groove at the center of the lower bearing supplies oil to a drilled passage in the upper bearing for the blade rod bearing surface. Oil is distributed over this surface by a "fishback" or oil groove down the bearing center having grooves at right angles along its length.

B. MAINTENANCE

1. Piston and Connecting Rod Inspection

While Installed Piston and Connecting rod assemblies can be inspected while installed in an engine with the engine shut down and the air box and oil pan inspection covers removed.

Precautions should be taken before proceeding to prevent the engine from being started.

Open all cylinder test valves to facilitate rotation of the crankshaft using the turning jack

a. Air box inspection

(1) Rotate crankshaft so piston of cylinder being inspected is at bottom center.

(2) Inspect cylinder wall and top of piston. Check for scoring of cylinder walls and inspect for water leaks.

(3) Rotate crankshaft so rings may be inspected through liner ports. Observe for blow-by indicated by vertical brown streaks caused by stuck or broken rings. Do not use bar or piece of wood to see if rings are free. Rings in good condition will be bright and free in grooves with ferrox grooves visible. Rings with ferrox gone in any part or with vertical brown blow-by streaks should be replaced.

(4) Inspect piston skirt for scoring or scuffing.

(5) Inspect air box for foreign material or signs of water indicating leaks.

b. Oil Pan Inspection

(1) Inspect back of upper connecting rod bearing for cutting or signs of over heating.

(2) Inspect bearing surface of piston pin by feeling along pin checking for any evidence of roughness or scuffing.

(3) With piston at top center, inspect lower liner walls for scoring.

(4) Inspect oil pan for foreign matter.

To check thrust washer wear, measure clearance between piston and snap ring. Excessive clearance indicates worn parts. See specifications for limits.

2. Pulling Piston and Rod Assembly

2) Remove piston cooling oil pipe.

(3) Remove cylinder head as outlined in Section II.

(4) Apply piston pulling eyebolt #8040413 in tapped hole in piston crown.

b. Fork Rod Removal

(1) Remove fork rod basket bolts and capscrews. Remove basket halves and lower bearing shell.

(2) Pull piston and rod assembly holding rod as it clears crankshaft to prevent it striking piston skirt or liner. Apply fork rod boot #8062034 and complete removal of piston and rod assembly.

c. Blade Rod Removal

(1) If opposite fork rod and piston are not to be removed then it is essential that this assembly be held out of the way using holding tool #8052958. This is done by removing basket and lower bearing then placing fork rod piston at top center. Holding tool is then applied to outboard side of fork rod using two basket capscrews. Rotate crankshaft in normal direction so holding tool will rest in oil pan. Protect upper bearing and continue rotation to position blade rod for removal.

(2) Raise piston and blade rod assembly and carefully remove upper bearing shell. Prevent rod from striking piston skirt or liner.

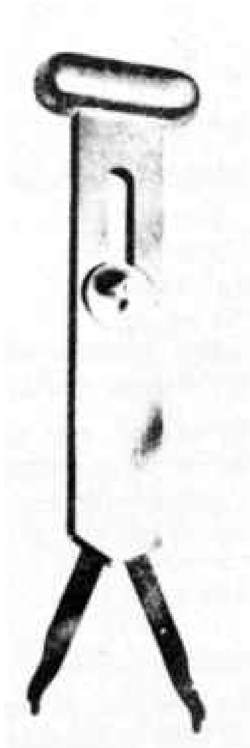
(3) Apply boot #8062033 and complete removal of blade rod assembly.

3. Disassembly of Piston and Rod

a. Preliminary Steps

(1) Remove cylinder test valve assembly:

a. Place piston and rod assembly on wooden topped work bench and remove piston snap ring, using



Piston Snap Ring Removal Pliers
Fig. 3-4

snap ring pliers 8171633, Fig. 3-4. Care should be taken in handling piston assembly t o avoid knocks or scraping of the piston skirt.

b. Place rod and carrier in holding fixture 8236589. If fixture is unavailable, a vice may be used having copper protected jaws. Place pin close to vice so pin bolts may be removed with exerted force in a vertical plane.

c. Remove pin from carrier.

4. Cleaning Pistons

To clean piston and rod assembly, follow procedure given in Maintenance Instruction 1706.

Maintenance Instruction 1754 covers connecting Rod Magnaflux inspections.

(3) Check fork rod bore by fastening basket securely in place using 175 foot-pounds torque on basket cap screws. (Normal basket capscrew torque is 190-200 foot-pounds on assembly). Torque value of lower basket bolts is 75 foot-pounds. Measure bore at points 60° apart as indicated in Fig. 3-5. The average of these dimensions must not exceed 7.626". If bore is beyond this dimension, the rod and basket should be reworked. For information on connecting rod rework see Factory Rebuild Service Bulletin #305.

(4) Fork rod rework will be required for any of the following conditions:

(a) Average of three 60° measurements across fork rod and basket bore exceeding 7.626".

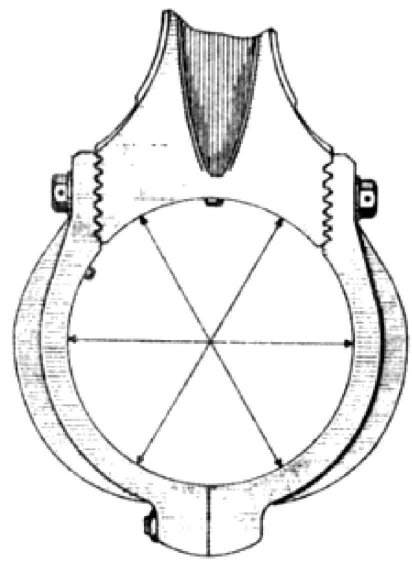
(b) Nicks, burrs or fretting on fork and basket serrations.

5. Connecting Rod Inspection

a. Fork Rod

(1) After all parts are clean, check tapped capscrew holes in the fork rod. If needed, they may be cleaned up using a 5/8"-18 tap. The basket capscrews should be inspected any time they are removed. They should be replaced if they appear bent, nicked, have worn threads, or if they cannot be run into the rod with the fingers.

(2) Fork rod serrations should be checked for nicks or burrs and cleanliness. Check tightness of upper bearing locating dowels. Step dowels are available in the event oversize dowels are required. Both visual and Magnaflux inspect for cracks in serrations and rod



Checking Fork Rod
Fig. 3-5

(c) Damaged threads in capscrew holes; loose dowels.

(d) Damaged or distorted basket.

(e) Twist exceeding .006" across length of saddle.

(f) Out of parallel in excess of .003" limit across saddle length.

(g) Length of rod between bore centers less than the minimum of 22.990".

(h) Fork counterbore exceeding.400" maximum depth.

(5) Fork Rod assembly to be scrapped if any one or more of the following conditions exist:

(a) Fatigue cracks through basket serrations and rejectable Magnaflux indications outlined in Maintenance Instruction 1754.

(b) Heat discoloration in basket or fork.

(c) Rod bent or damaged beyond repair.

(d) Twist exceeding .006" along saddle length.

(e) Out of parallel exceeding.003'1 along saddle length.

(f) Length between bore centers below minimum allowable length of 22.990".

(3) Blade rod should be scrapped if any one or more of the following conditions exist.

(a) Rejectable Magnaflux indications as outlined in Maintenance Instruction 1754 (b) Heat discoloration on slipper surface.

(d) Length between bore centers below 22.979". b. Blade Rod

(1) The blade rod is checked on a 7.692" diameter mandrel to observe slipper surface for "open" or "closed" ends. See "Checking Rod Length, Twist and Bore Parallel" following. Blade surface should be bright, shiny and smooth. Rod should be scrapped if this surface shows heat discolorations.

> NOTE: During the flame hardening process, a blueblack color results on the shoe of the blade rod. This discoloration is normal and has not been caused by poor operation. The slipper surface however should show no discoloration.

(2) Blade rod rework will be required for any of the following conditions.

(a) Scarred, pitted or deeply rust etched slipper surface.

(b) Ends of slipper closed in beyond .007" limit.

(c) End of slipper opened beyond .003" limit.

(c) Below .335" minimum flange thickness on slipper shoulder.

(d) Twist, out-of-parallel or damage beyond repair.

(e) Length between bore centers below 22.979".

> NOTE: Refer also to Factory Rebuild Service Bulletin #305 for return and rework of connecting rods.

6. Checking Rod Length, Twist and Bore Parallel The connecting rod checking fixture shown in Fig. 3-6 can be constructed for checking rods. The construction of this fixture is outlined in blueprint M-248, obtained from the Service Department Product Installation Section. (Blueprint M-248 gives part details to construct this fixture for use with bolted piston pin rods or with rods having piston pin eye. When fixture is used to check bolted pin rods, a 1" spacer block is used under the indicator assembly block and the 1.4136" indicator gauge block is used.)

With 1" spacer block applied under indicator assembly when using fixture outlined in blueprint M-248 for checking saddle end connecting rods, place the 1.4136" indicator gauge block on fixture permanent gauge block and with indicator button on the 1.4136" block

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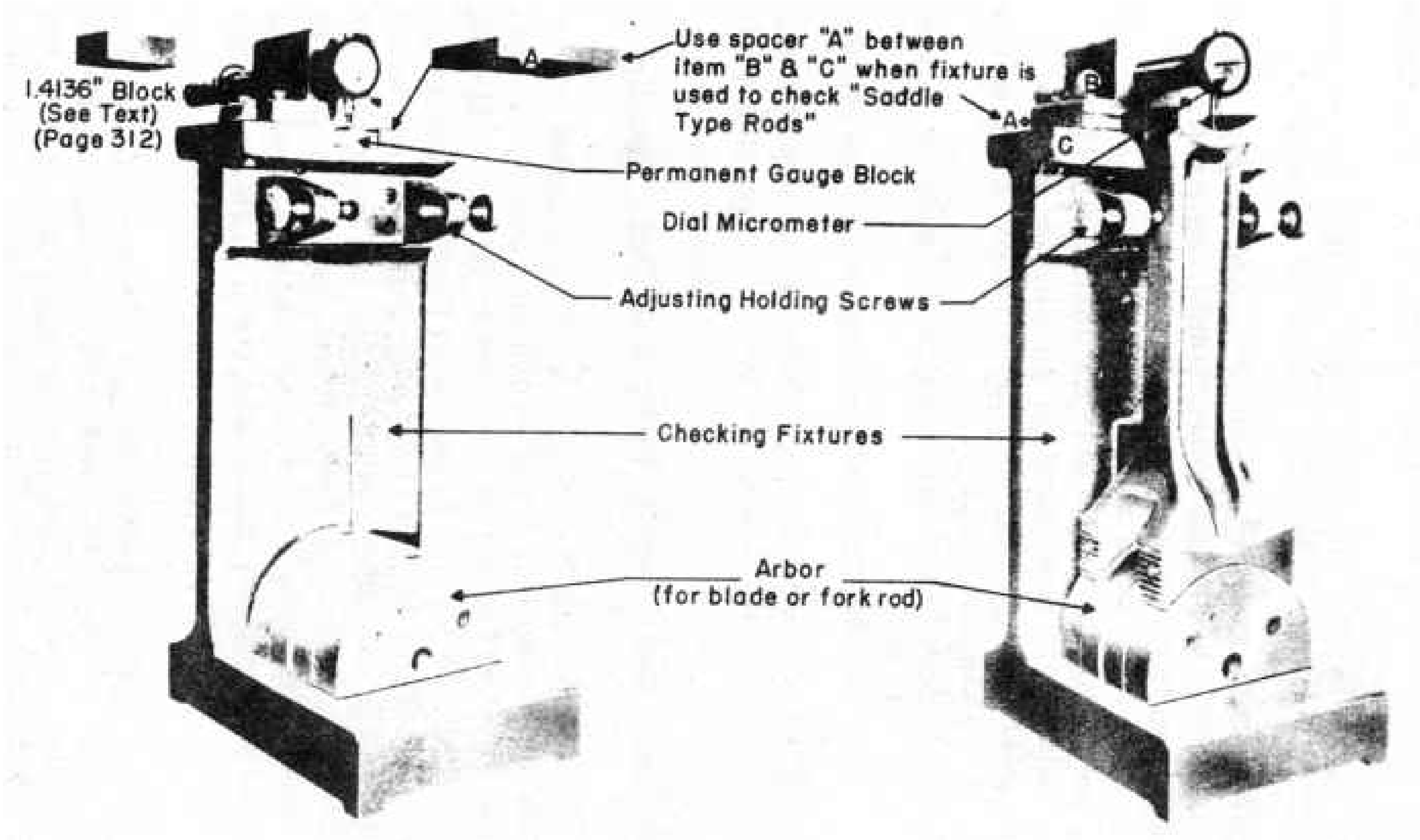


1.4136" Block (See Text) (Page 312)
Use spacer "A" between item "B" & "C" when fixture is used to check "Saddle Type Rods"
A
B
C
Permanent Gauge Block
Dial Micrometer
Adjusting Holding Screws
Checking Fixtures
Arbor (for blade or fork rod)

252C-3-1256

set indicator to "0." Place rod on fixture and place indicator button at bottom of contour, or by checking at each top edge of contour, adjust screws to bring rod to vertical position and tighten screws.

Check for open ends of slipper surface by trying a .003" feeler gauge at each toe end, between slipper surface and arbor. Blade rods with open end slipper surfaces may be used providing a .003" feeler gauge cannot be inserted more than two (2) inches from each end of slipper when mounted on the 7.692" arbor. Close-in of the slipper surface is evidenced by ends having no clearance and slipper surface open. Rods may be used having closed-in slipper surface, providing a clearance no greater than .007" is obtained when measured any place between ends of slipper on 7.692" arbor.

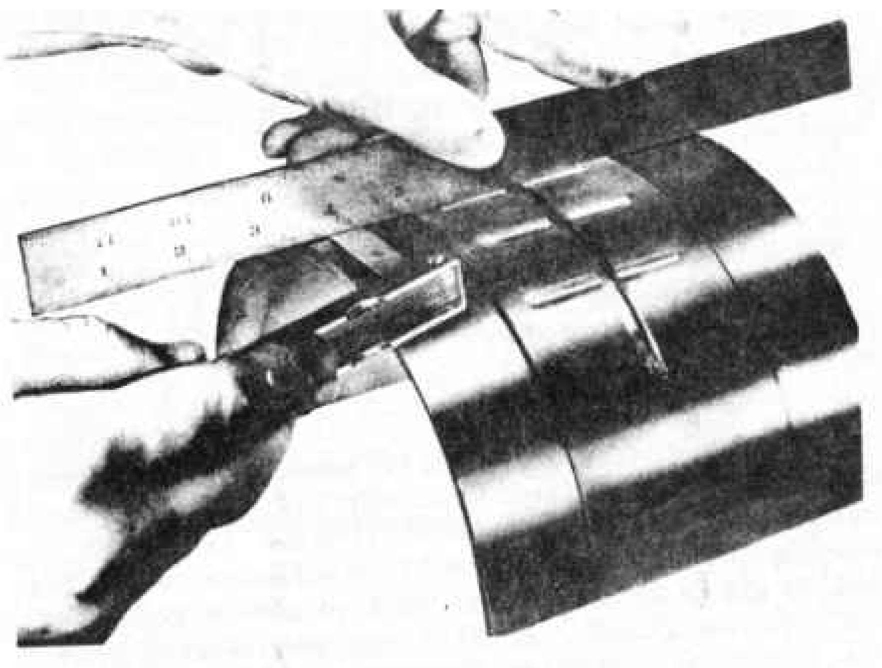
After adjusting indicator and placing rod in vertical position, set indicator button at top inside edge of saddle, and run indicator along length of saddle. Indicator deflection shows rod twist. Twist should not exceed .006".

Place indicator at bottom of saddle, note indicator reading. Check along length of saddle bottom, circumventing bolt holes, to check out of parallel. Indicator must not show more than .003" deflection along length of saddle.

Replace indicator on 1.4136"gauge block and check indicator dial "0" setting. Slide indicator button off block to bottom of saddle and note deflection. Deflection or reading must not exceed .010" to allow re-use of the rod, to give a generated rod bore centerline dimension not less than 22.990". A .021" indicator reading shows the rod bore centerline dimension of 22.979", which scraps the rod.

7. Checking Connecting Rod Bearings

The connecting rod bearings should be checked for out-of- round whenever the piston and rod assembly is removed from the engine. To make this check, apply bearings to fork rod and basket in which they are to be used. Tighten basket capscrews to 175 foot- pounds torque and measure across the bearing bore at points 60° apart This is similar to the procedure used on checking fork rod basket bore, Fig. 3-5. The average of ,these three readings must not be less than is necessary to insure a clearance between crankpin journal and bearing of at least. 006", or a maximum of .015". A maximum out-of-round of .0061, must not be exceeded. It is permissible to tap the basket with a soft mallet in order to maintain the out-of-round limit. After operation, rod bearings may give indication of being tight across the split line when loose on the crankpin. However, rod bearings in



Checking Upper Connecting Rod Bearing Shell
Fig. 3-7

tended for use should be mounted in the fork rod and then checked. Note: After bearings have once been used, they should not be used on any other journal.

Check upper bearing step thickness as shown in Fig. 3-7. This will indicate blade rod bearing surface wear. Step thickness should not be less than .027".

Bearing shells showing indication of scoring must be replaced.

8. Piston Pin and Carrier Limits, Inspection and Cleaning

Piston pins used in trunnion design piston and rod assemblies originally had thirteen oil grooves and a helical groove. Current design piston pins have six oil grooves and no helical groove. Either pin can be used providing they are within the recommendations.

A piston pin should be retained with its original carrier as long as possible. The carrier pin bore to platform dimension is the limiting factor in determining reusability of a carrier, and .010" more wear is permissible if the original pin and carrier are used together in the same relative position. See condemning limits and examples on page 317.

> NOTE: The 3/8" hole in the end of the piston pin is matched with the piston cooling oil inlet hole in the carrier as a convenient means of keeping the pin and carrier in the same position.

It is recommended that the piston pin and carrier be cleaned using a high flash point petroleum solvent, such as Stoddard Solvent 105° flash point or equal. These parts should never be washed using an alkaline or caustic water solution.

No abrasive material of any kind should be used in the carrier pin bore or on the piston pin. Also, the trunnion pin bore must be protected against rust at all times. The oil grooves in the piston pin should be cleaned using a wooden stick, pointed to fit the grooves.

The piston pin minimum diameter is 3.678". Piston pins should be replaced on condition 'as well as wear. Particular attention should be given bearing grooves. Sharp edges on the grooves must be blended. Pins with smeared silver should not be reused. Corrosion does not impair pin bearing surface, unless there has been considerable loss of surface area. Examine the 7/8" -14 pin bolt threads for condition. Clean by retapping. If threads show damage replace the pin.

Condemning limits of the trunnion design piston pin carrier are as follows. (Measurement of carrier bore wear is to be made by measuring distance from top of carrier bore to platform face, each side.)

carrier - top pilot diameter	Min. 3.556"
Carrier - bottom pilot diameter	Min. 7.479"
Carrier height (platform to bottom)	Min. 5.990"
*Top of pin bore to platform	
a. When re-using same pin	Min. .690"
b. When interchanging pins or using new pin	Min. .700"
Top of pin bore not parallel to platform face	Max. .003"

Top of pin bore to platform

One side .691"

Opposite side .693"

Pin bore to platform out of parallel .0021,

In this case the carrier height of 5.997", indicates no wear on platform, so no correction need be made to the .691" or .693" dimension. The difference between the pin bore to platform measurements (.002") is less than the maximum of .003" allowed. The .691" measurement is above the minimum (.690") dimension between top of pin bore and platform. Carrier can be re-used only if same pin is re-used.

Example #2 - When using new pin.

Carrier height 5.994"

Top of pin bore to platform

One side .6981'

Opposite side .698"

Pin bore to platform out of parallel .000"

In this case the carrier height of 5.994", indicates .003" wear on the platform, so .003" can be subtracted j from the .700" limit, resulting in .697". There is no out of parallel condition and the .698" measurement is .001" above the low limit (.697" compensated) for the carrier pin bore when using a new pin.

For carrier Magnaflux instructions see Maintenance Instruction 1754.

*These limits assume no wear on carrier platform. If carrier height (5.997" New) indicates platform wear, the amount of wear can be subtracted from the .690" or .700" dimension accordingly. For example:

Example #1 - When re-using old pin. Carrier height 5.997"

For other piston carrier dimensions and limits see Specifications at end of this section.

9. Removing and Installing Piston Rings

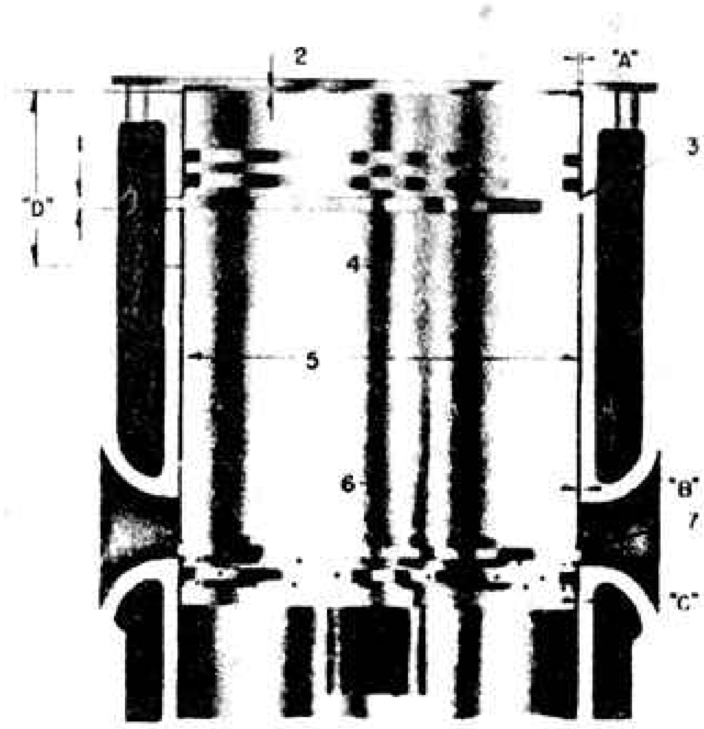
Use piston ring expander 8194036 when removing or installing rings. See Fig. 3-8. This tool prevents twisting or over expanding which distorts the ring. New

Removing Piston Rings
Fig. 3-8

rings should be used on each piston installation, to insure quick seating and avoid difficulties caused by damaged rings. Used rings once disturbed may not "seat-in." After new rings are applied, engines should be worked. hard to aid ring seating.

10. Piston Inspection

Limits are listed un der specifications at end of section.



1. Compression and oil ring groove width	New	.251" - .254"
Wear step on ring groove lower face		
not to exceed:		
#1 compression ring		.006"
02, d3 compression and oil rings		.005"
Compression ring groove may be recut		
to Maximum #1 ring		
Standard		max. .280"
1/32" Overwidth ring	Max. .282"	w .003" - .000"
"2. Piston to head clearance	Minimum	.028"
	Maximum	.068"
3. Compression ring to	Standard Width	Narrow width Rings
land clearance	Ring 8166641	8235401 - ••8235299
New	.04" - .008"	.008" - .012"
Limit 41	.014"	.018"
Limit N2	.010"	.014"
4. Compression ring gap (new ring in		
8.500" liner)	New	Min. .040"

See Fig. 3-9 for Piston and Ring Clearances.

Pistons that have been found dimensionally and structurally satisfactory for re-use, should also have the heat dam area thoroughly cleaned of undercrown deposits. Undercrown deposit cleaning should be accomplished using a sand or grit blast cleaning in conjunction with liquid cleaning. Maintenance Instruction 2174 outlines a recommended procedure and details of construction of a fixture for the grit blast cleaning of pistons.

a. Check piston for cracks. For Magnaflux in structions, see Maintenance Instruction 1754.

b. Measure piston diameter 211 below the compression ring grooves and below the oil ring grooves. Take two readings at each location 90e to each other.

c. Measure thrust washer thickness.

d. Check clearance of carrier retainer snap ring to piston carrier.

e. Check ring groove wear step.

- 319 -

	Condemn ring when	worn In bottom of
	Ferrox groove al any	point.
.5. piston diameter	New	8.488" - 8.490"
	Limit (interchangeable)	8.485"
	(.005" out-of-round	permissible)
	Wear limit	8.482"
6. Oil ring gap (new ring in 8.500" liner)	New	.015" - .025"
	Limit	.070"
7. Oil ring to land clearance	New	.002" - .006"
	Limit	.010"
Piston to liner clearance of "A"	New	.0485" - .0525'•
Piston to liner clearance of "B"and"C"	New	.0095" - .0135"
	Limit	.020'.
Piston taper "0" (from top of crow''		
to 1-1 4" below bottom compression		
ring groove)		
" An increase in compression clearance	of .030" from the assembly value at	

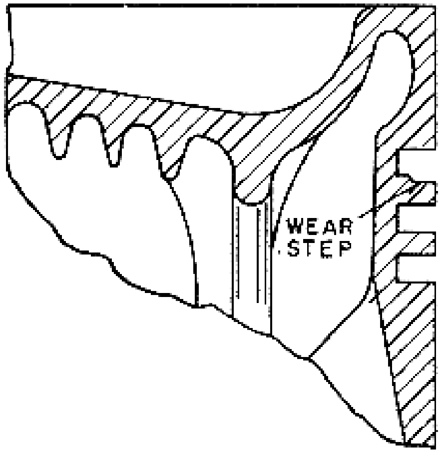
the time of installation condemns the assembly. Any sudden increase should

he immediately investigated.

•• Chrome faced ring (standard on 8 and 12 cylinder engines).

Pistons and Ring Clearance
Fig. 3-9

NOTE: Reworked ring grooves should have 1/32" top and 'bottom radii and 45° x .015" chamfer on land edges.

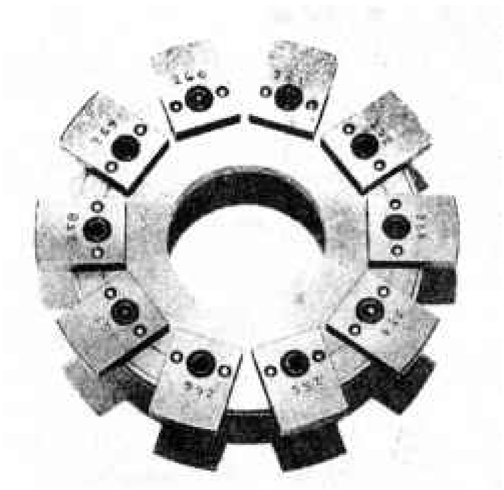


Piston Ring Groove Wear Step
Fig. 3-10

largest block that will enter groove up to the wear step. By subtracting the smaller block dimension from the largest one to enter, the wear step is determined.

When step wear greater than .006" is found on the lower face of the top compression ring groove, the groove may be recut to remove the wear step, provided the finished width does not exceed .260" when finished for use with a standard ring.

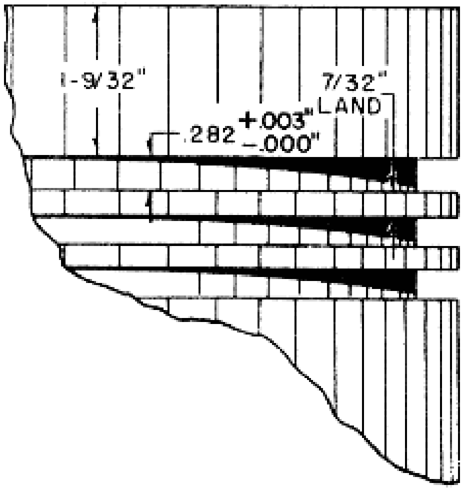
If the ring groove is worn beyond a width of .260" it is possible to machine the top ring groove to use a 1/32" oversize ring. For dimensions, see Fig. 3-12.



Wear Step Measure Gauge
Fig. 3-11

Check wear step on ring groove lower face. See Fig. 3-10. Top ring breakage is usually the result of excessive wear step. The maximum wear step is: #1 compression ring .006", #2 and #3 compression rings and oil rings .005".

Wear step gauges standard 8225256, Fig. 3-11, and oversize 8225257, are available to make this measurement. Each gauge consists of a number of separate width indicators precise to .001 ". Gauge 8225256 has indicators from .2511' through .260".



Ring Groove Oversize Dimension
Fig. 3-12

When performing either of the preceding operations, care must be taken to keep the ring groove faces parallel to each other and at right angles to the center line of the piston. The surface finish must be smooth to avoid excessive wear.

Pistons and ring oversizes are available. For details see the Parts Catalog. For return of pistons for reconditioning, consult Factory Rebuild Service Bulletin #308.

Gauge 8225257 is similar to 8225256 but has 1/32" oversize indicators for use on oversize ring grooves.

To measure wear step, it is first necessary to determine the original ring groove width, because it may vary from .251" to .254". By trial, insert gauge blocks in ring groove to determine which one enters its full depth. This will show the original width to be the dimension of that particular gauge block. Then insert

11. Assembling Piston and Rod

Assemble connecting rod, piston pin and carrier. Examine all surfaces for smoothness and cleanliness. Oil pin and carrier pin surface before placing pin in carrier. (Note: Install trunnion piston pin so 3/8" hole in pin end is matched with piston cooling oil inlet hole in carrier.) Insert piston pin in carrier and mount pin to rod. Place assembly in holding fixture 8236589 to

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torque bolts. (If fixture is not available, place rod in vise with pin close to vise and torque in vertical plane.) Torque value of rod to pin bolts is 400-450 foot-pounds. To torque saddle rod pin bolts, a 300 foot-pound torque wrench 8157121 is used with an extension 8210136. One end of extension with plug and socket fits bolt head and 3/4" torque wrench drive is inserted at other end. To torque bolts to 450 foot-pounds, a torque reading of 300 foot-pounds is required using the extension. When lockwiring bolts after assembly, lockwire is twisted at bolt head, but not where wire passes over the rod. Use lockwire 8116933 (200 foot roll) which is approximately .07211 in diameter. Pin bolts now have three lockwire holes to facilitate assembly.

When assembling rod and carrier, the piston cooling oil hole in the carrier must be on the same side as the dowel pin in the serrations of the fork rod and on the opposite side to the "long toe" of the blade rod. This will assure proper position of the hole when assembly is installed in the engine.

Oil surfaces, place thrust washer on piston platform, and apply carrier and rod assembly. Install piston snap ring and rotate carrier in piston to check freeness. Check snap ring to piston carrier clearance.

c. Suspend piston and rod assembly and prepare connecting rod bearing for application. Oil inside and outside of bearing shells and install upper bearing in position on crankpin. d. Lower blade rod to rest on upper bearing. Remove eye bolt from piston and apply to fork rod piston. Apply boot to fork rod and lower rod to bearing. Check fork rod dowels that they enter bearing dowel holes without binding. Remove piston eye bolt. e. Apply lower bearing to doweled basket half and install basket half to fork rod, tightening basket to fork rod capscrews just sufficient to mesh the serration and hold the bearing in place. Then apply other basket half to fork rod, tightening rod capscrews to mesh the serrations. f. Apply the three 1/2" lower basket bolts and self- locking nuts. Torque value of these bolts is 75 foot- pounds.

12. Installing Piston and Rod

Before installing piston and rod, the liner should be serviced as outlined in Section 4.

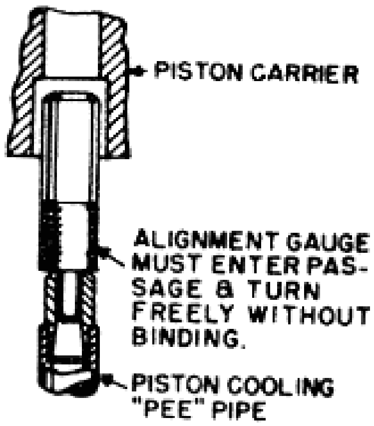
a. Set piston ring compressor and guide 8034087 standard size (8065452 - .030', O.S., 8065453 .060" O.S.) in place on cylinder liner. Oil cylinder wall, ring compressor and piston. Place crankpin on bottom center.

b. Apply connecting rod boot, then lower assembly into liner, using eye bolt in piston crown. Be sure piston cooling oil hole is positioned to outboard side of engine, on same side as short toe on blade rod and dowel in serration of fork rod.

g. Complete basket to fork rod capscrew application by tightening to 190-200 foot-pounds torque, and apply lockwire. Retighten assembly according to they scheduled maintenance program.

h. Install cylinder head as outlined in Section 2.

i. Install piston cooling oil pipe and check alignment. U s e piston cooling pipe gauge 8071720, Fig. 3-13.



" Pee" Pipe Alignment
Fig. 3-13

Insert small end of gauge in "Pee" pipe. Turn crankshaft slowly to bring piston to its lowest position. At same time rotate gauge by hand to make sure it does not bind in hole. If gauge indicates misalignment, replace pipe assembly. Do not use gauge to align pipe. Piston cooling "Pee" pipes should be checked before application, with cleaning tool 8087086.

13. Piston to Cylinder Head Clearance

The piston to cylinder head clearance governs to a great extent the efficiency of the engine and should be maintained within specified limits for best operation. In addition, if regular inspections are made, piston to head clearance may be used as an indication of wear in the parts of the piston and connecting rod assembly. Recorded or charted clearance readings will aid in the prevention of serious trouble from excessive wear of parts, as their condition will be indicated by comparing the successive piston to head clearance.

The engine records that are furnished include piston to head clearance readings taken at the time of manufacture. Such readings are listed for each cylinder and should be checked against subsequent readings that are taken to determine condition of the assembly. By recording the original and each successive reading in its proper place on a chart, a definite condition of the parts will be shown. Readings of the piston to head clearance may also be started on reinstalled piston and rod assemblies, by taking the clearance of the newly installed assembly.

It is recommended that compression lead readings be taken on all cylinders at intervals specified in the Scheduled Maintenance Program. More frequent inspections should be made on assemblies which show excessive or dangerous rates of increase in the clearance.

The following method is recommended to obtain the piston to head clearance. Rotate the crankshaft to place the piston to be checked at bottom dead center. Place a 1/8" soft lead or solder wire shaped to the con- tour of the piston crown, with the ends of the wire not over 8-1/4" apart, on top of the piston, through the liner ports. Position the lead wire directly above the piston pin parallel to the engine crankshaft. The engine is then

barred over one revolution and the wire removed and both ends measured with a micrometer. The clearance reading will be the average of the two measurements taken. If the difference between the two ends of the wire is more than .005", the clearance should be rechecked as the wire may have rotated on the piston to be at right angles to the piston pin.

The time necessary for taking readings on an engine may be lessened considerably with a saving of of wire by using wire holder 8243220 and wire as listed in the Equipment List. Also, observing the location of various pistons as crankshaft is rotated, will enable all readings to be taken in two revolutions of the crankshaft.

The limits of piston to head clearance on a new engine are .026" minimum and .068" maximum: with the readings on the average engine about .040" to .055". The condemning limits of piston to head clearance is .030" over the original assembly piston to head clearance. This limit also applies to cylinder assemblies applied in the field and leaded as outlined. When a gain of .030" is reached, the parts of the assembly should be removed and checked, replacing the worn parts. However, any sudden increase in lead reading should be investigated. The condemning limits of various individual parts of the assembly govern their respective replacement. These limits may be found under Specifications of this Section.

In conjunction with the piston to head clearance, the snap ring clearance should also be checked. If it is found that the piston to head clearance is within the .030" limit, but the snap ring clearance is at, or sufficiently near, the condemning limit, the piston assembly should be removed and the piston thrust washer checked.

C. SPECIFICATIONS

Connecting Rod:

Fork rod and basket bore New 7.624" - 7.625" Max. - See Text

252C-3-1255 PISTONS AND RODS

Bearing seat diameter of blade rod	New 7.692" - 7.693"
Clearance between shoulder on blade rod and counter-bore in fork rod (This measured by placing feeler gauge between the blade rod and top of upper bearing.)	New .008" - .012" Max. .025"
Depth of counterbore from bearing bore to counterbore	New .385" - .3865" Max. .400 400", provided the above . 02 5 " max. clearance is held.
Thickness of shoulder on blade rod	New. **.3445" - .346"** Min. .335", provided the above .025" max. clearance is held.

Piston (trunnion design)

Number of compression rings	3
Number of oil control rings	2
Piston and ring wear	See Fig. 3-9
Piston skirt diameter	New 8.488" - 8.490" Min. 8.482"
Piston platform bore (upper pilot for carrier - check 2 places 90° to each other)	New 3.565" - 3.567" Max. dia. 3.570"
Piston inside diameter (lower pilot for carrier - check 2 places 90° to each other)	New 7.487" - 7.490" Max. dia. 7.4961,
Clearance - piston to carrier pilot (upper and lower)	New .003" - .007" max. .014"
Piston platform to bottom of snap ring groove	New 6.376" - 6.380" Max. 6.387"

Carrier (trunnion design)

Carrier height (top at platform	to New 5.99711

Connecting Rod Bearings:

Bearing inside diameter (Average of three 60° measurements)	New 6.5066" - 6.510"
Bearing to crankpin clearance	New .007" - .011"
	Max. .015"
Bearing shell step height	New .030" - .031"
	Min. .027"
Bearing shell thickness	New .5587" - .5595"
Minimum wall thickness	Standard - .5530"
	Undersize 1/32" - .5686"
	Undersize 1/16" - .5843"
	Undersize 3/32" - .5999"
	Undersize 1/8" - .6155"

bottom of carrier)	Min. 5.990"
Carrier top pilot diameter	New 3.560" - 3.562"
	Min. 3.556"
Carrier bottom pilot diameter	New 7.483" - 7.484"
	Min. 7. 479"
Carrier pin bore condemning limit	See Maintenance item 8 in Text
Clearance - carrier to piston snap ring	New .002" - .0121,
	Max. .030"
Piston pin (trunnion design)	
Piston pin diameter	New 3.681" - 3.682"
	Min. 3 .678"
Thrust Washer (trunnion assembly)	
Thickness	New .18511 - .188"
	Min. .170"
Thickness variation	Max. .003"

PISTONS AND RODS 252C-3-1256 252C-3-1255 CYLINDER LINERS

D. EQUIPMENT LIST

	Part No.
Piston pulling eye bolt	8040413
Fork rod boot	8062034
Fork rod holding tool	8052958
Blade rod boot	80662033
Snap ring pliers	8171633
Motor driven flexible shaft buffer 115 V.	8084282
Motor driven flexible shaft buffer 230 V.	8084283
Piston ring expander	8194036
Piston ring guide (standard size)	8034087
(.030" oversize)	8065452
(.060" oversize)	8065453
Piston cooling "Fee" pipe alignment gauge	8071720
Piston cooling "Pee" pipe cleaning tool	8087086
Connecting rod checking fixture (print)	M248
Piston wear step gauge (.251" - .260")	8225256
Piston wear step gauge (for 1/32" oversize	
rings)	8225257
Extension (used with torque wrench 8157121)	8210136

Carrier, pin-rod, assembly and disassembly fixture	8236589
Wire holder (has contour of piston crown to hold small lengths of lead wire for piston to head clearance	8243220
Wire (lead, 1/8" dia., used with holder 8243220 or alone 5 lb. spool)	8243661
Wire (lead, 1/8" dia. part number covers any pound quantities as specified over 5 Ibs.	8136471

SECTION V

CRANKSHAFT, MAIN BEARINGS, HARMONIC BALANCER, ACCESSORY DRIVE GEAR, CRANKSHAFT GEAR

A. DESCRIPTION

1. Crankshaft

The crankshaft is drop forged carbon steel with journals induction hardened. Drilled passages in the crankshaft provide lubricating oil flow to main and connecting rod bearings, Fig. 5-1. Each crankshaft is dynamically balanced.

Sixteen-cylinder engine crankshafts are made up of two sections, front and rear, joined by a coupling. All other engines have one piece crankshafts. Like engine crankshafts are interchangeable; except 8-567CR and 8- 567C which are not interchangeable.

2. Flywheel -Flexible Coupling

The main generator armature is in effect the flywheel for the engine and is joined to the engine crankshaft by means of a flexible coupling, Fig. 5-2. An engine half disc and generator half disc comprise the flexible coupling. Each disc is mounted at its center to the respective part flange by six mounting bolts, and both halves joined at the rim or outer circumference by twelve through bolts. The engine disc support or rim has degree markings around its circumference and holes provided for an engine jack or turning bar for rotating the crankshaft.

The 567C engine flexible coup1ing is termed a serrated coupling because of the arrangement at the junction of the two discs. A "V" channel is provided in the engine disc rim, while a "V" serration is located at

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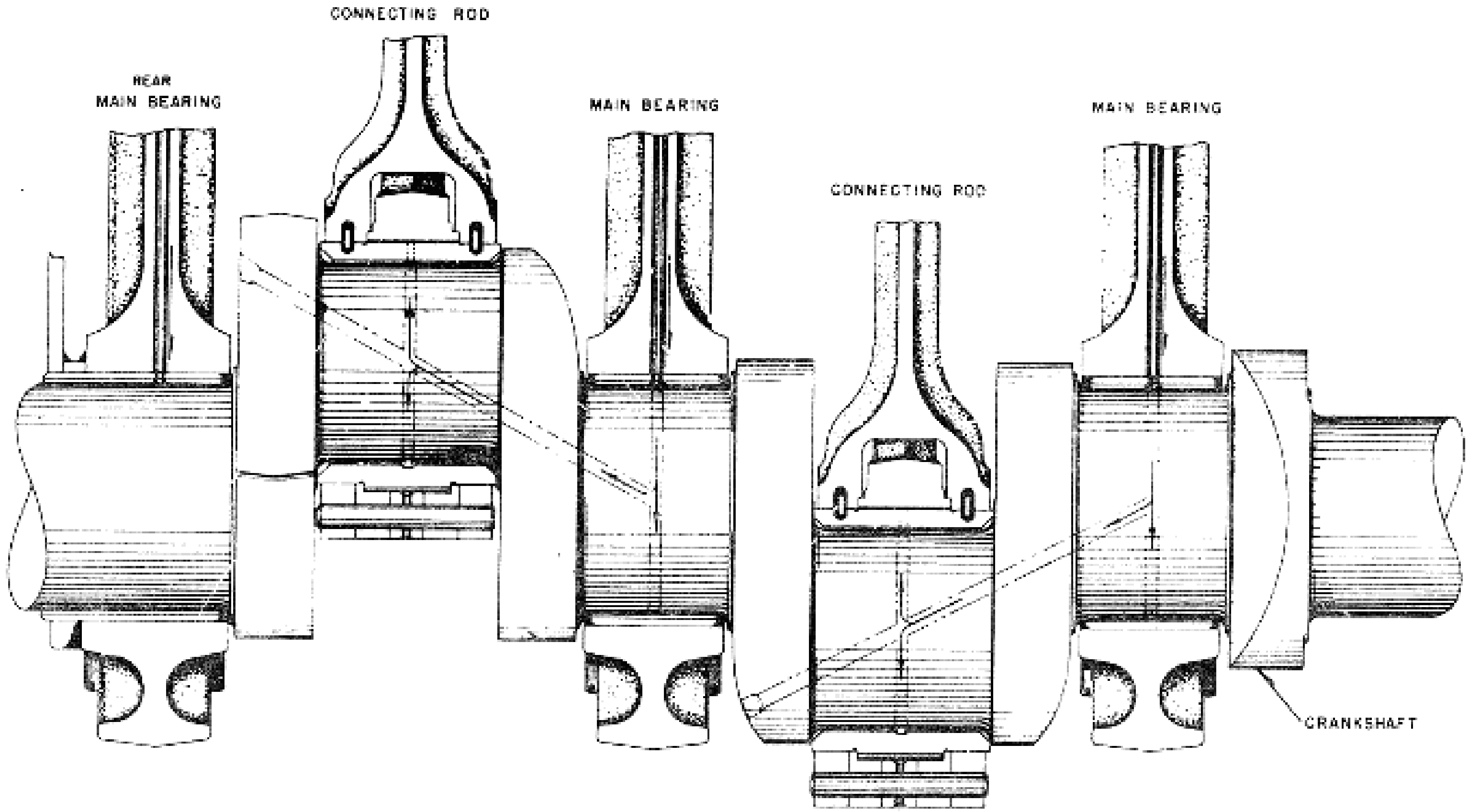
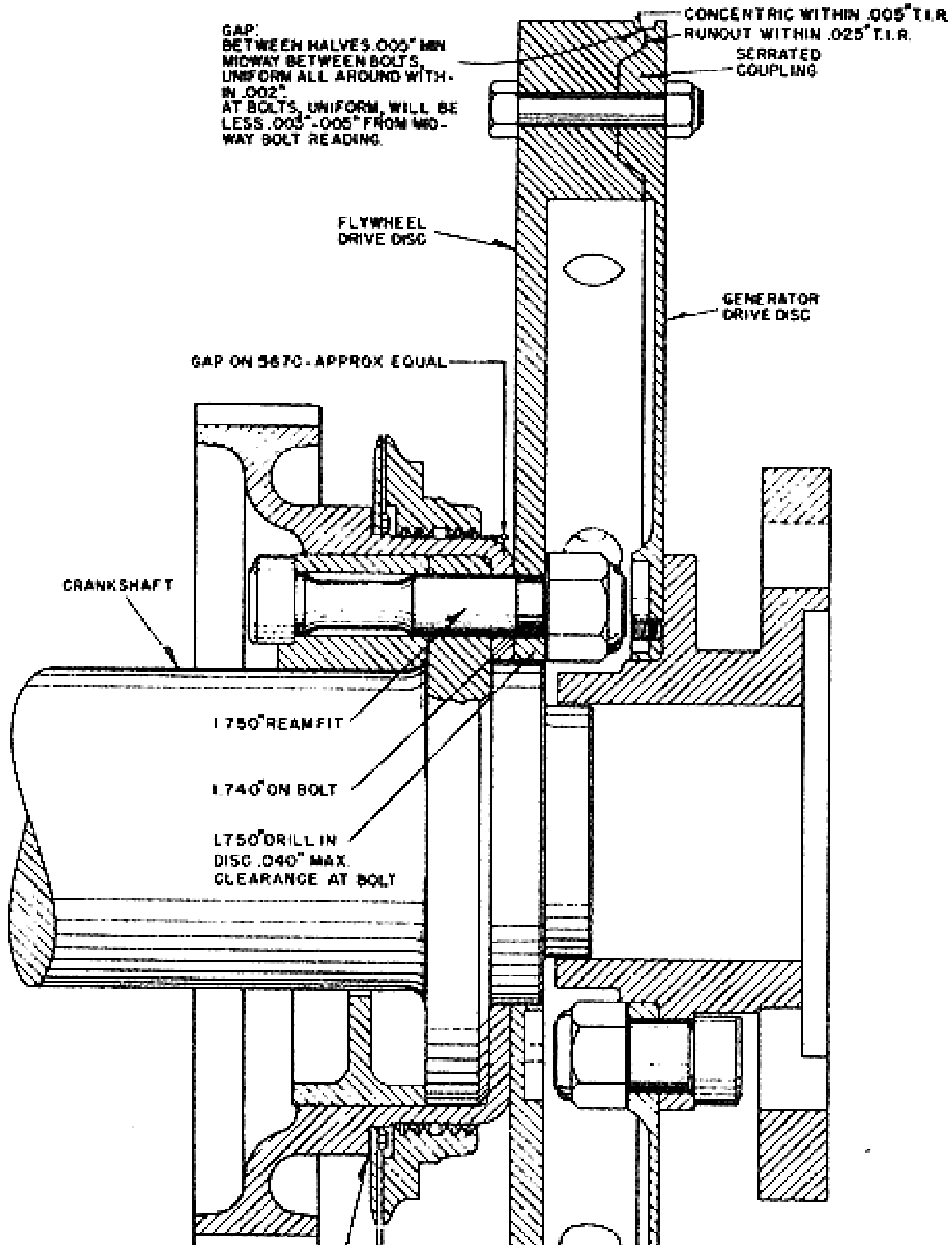
CRANKSHAFT

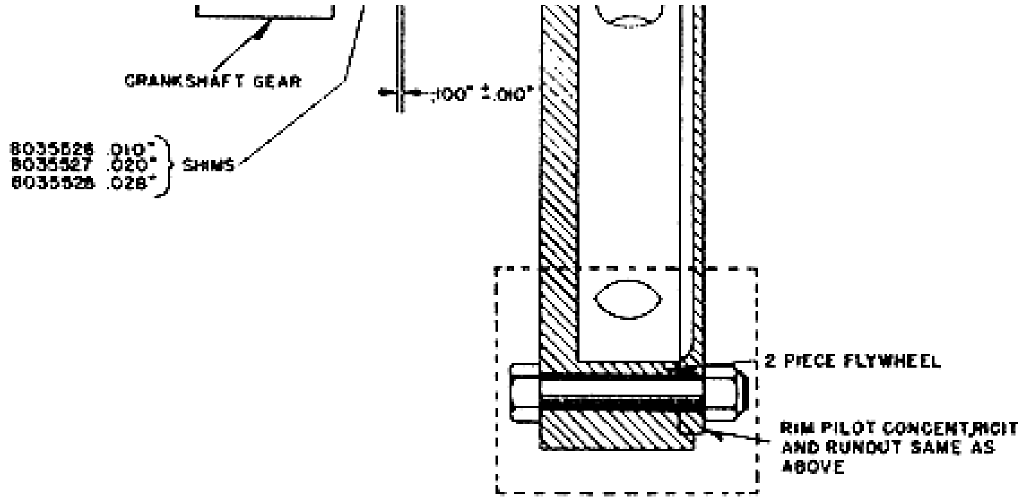
252C-5-154



Crankshaft Oil Passages
Fig. 5-1

252C-5-154 CRANKSHAFT



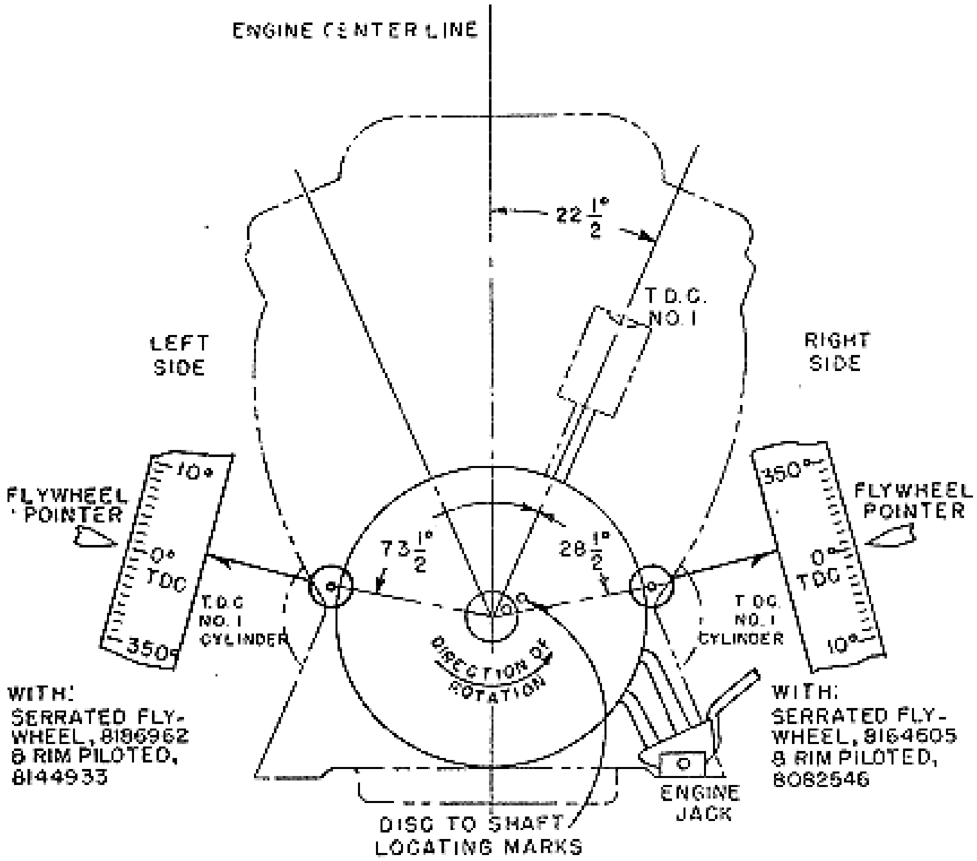


Crankshaft Rear End Details And Generator Coupling
Fig. 5-2

the generator disc rim. This design gives a self-centering unit, the serration a c t i n g as a guide when the coupling is assembled. Two types of serrated couplings are used according to engine application, one having the 00 T.D.C. mark located to the right of the engine center line to coincide with pointer with #1 piston on top dead center and the other coupling having 00 T.D.C. mark to the left of the center line as shown in Fig. 5-3. Therefore, flywheel pointer location is different depending on coupling used. If a separate generator fan is required, it is secured by capscrews to the r ins of the generator half disc. NOTE: Some early 567C engines were equipped with non-serrated flexible couplings, or rim piloted two-piece type of coupling. These couplings have six reamed m o u n t i n g hole bolts and one 3/4" 16 x .8740" diameter bolt at the rim not used with the serrated coupling. Pointer location and 00 T.D.C. marking of these couplings are included in Fig. 5-3.

3. Main Bearings

The main bearing shells are precision type steelbacked lead bronze, lined with a lead tin overlay. Tangs in the bearings locate them in the proper axial position and prevent bearing turning. Upper and lower half bearing shells are not



Flywheel Pointer Location
Fig. 5-3

interchangeable.

Lower main bearing shells have two tangs on each side which fit into the main bearing cap. Upper main bearing shells have one tang which fits a groove on the right side of the "A" frame bore. Upper shells can be rotated out, in a direction opposite to normal crankshaft rotation, when the lower bearing and cap are removed.

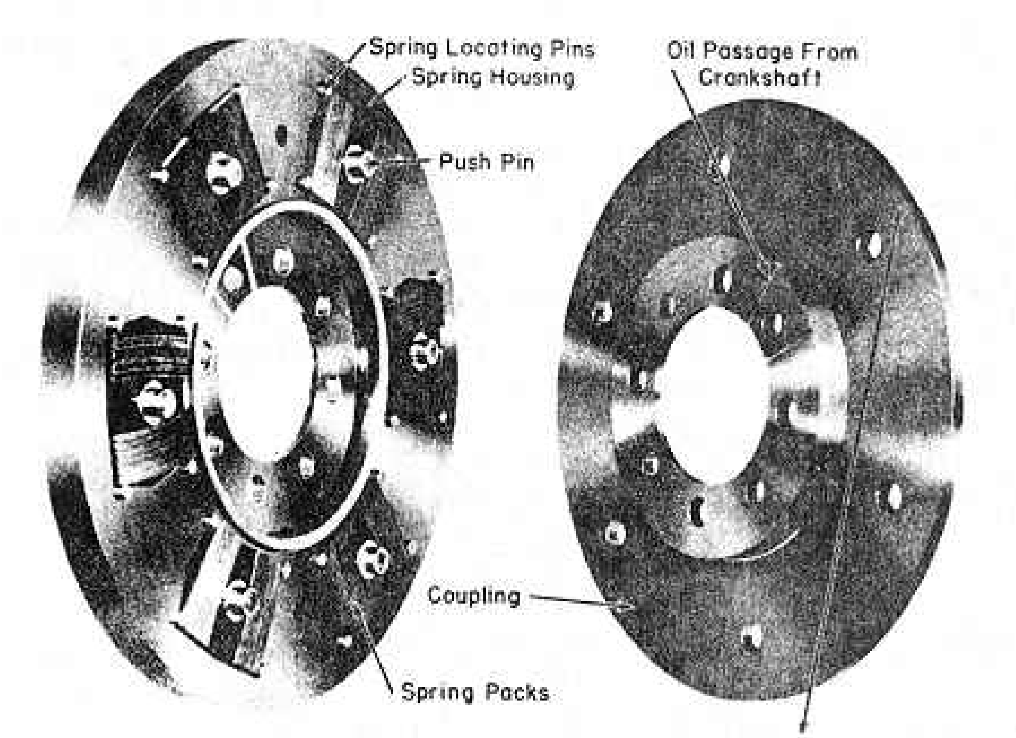
Front and intermediate bearings of each type, upper or lower, are the same on all engines. Rear main bearings are the same on all engines. Center bearings differ between 12 and 16-cylinder engines and with other engines. Center bearings on 8-cylinder engines are intermediate bearings.

4. Crankshaft Thrust Collar

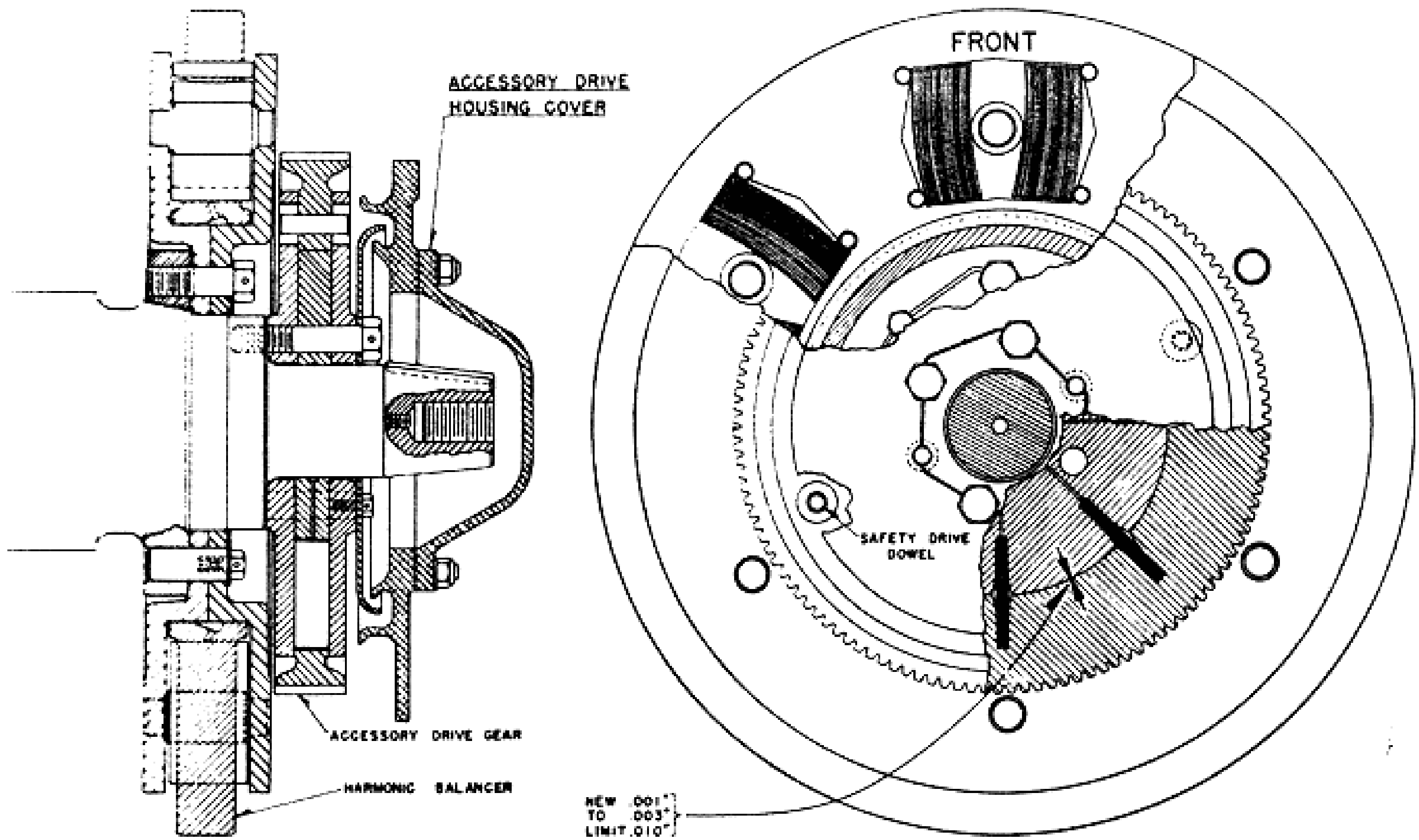
The thrust bearings are solid bronze, of rectangular cross-section and formed in a half-circle. They are placed in a counter-bore seat on each side of the center bearing "A" frame on 8, 12, and 16-cylinder engines and on each side of the #3 main bearing "A" frame on 6-cylinder engines. They are held in position by the bearing cap. Their purpose is to absorb the thrust or endwise movement of the crankshaft, by reason of the designed clearance between the face of the thrust bearing and machined surface of the shaft. The thrust surfaces are lubricated by main bearing leak-off oil and are installed with their "thumb print" oil depression away from the "A" frame in which they are placed.

5. Harmonic Balancer

The harmonic balancer is used on the 12, 16-567C engines and the 8-567CR engines. The function of the harmonic balancer is to dampen torsional vibration in the crankshaft. Construction and parts of the harmonic balancer are shown in Fig. 5-4. The springs of the harmonic baiancer receive oil through radial passages in the spring housing supplied through the crankshaft.



Exploded View - Harmonic Balancer Fig. 5-4



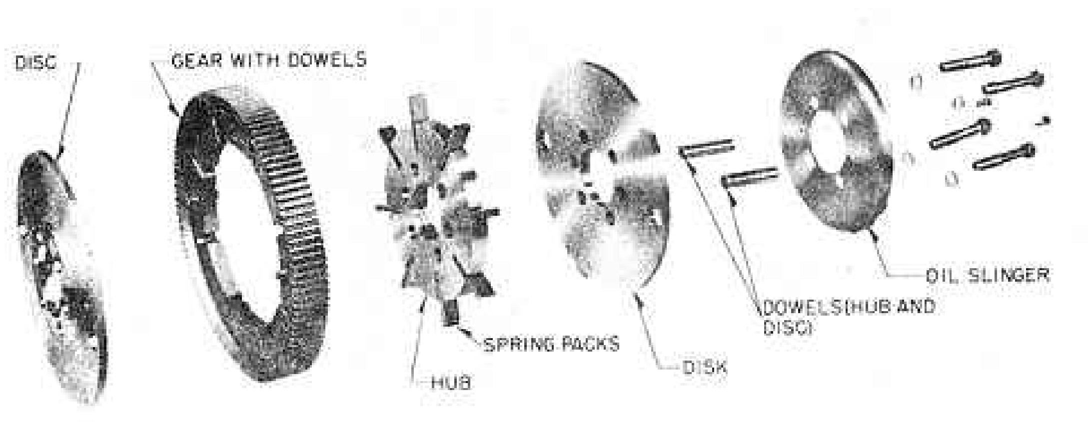
Harmonic Balancer And Accessory Drive Gear
Fig. 5-5

6. Accessory Drive Gear

The flexible accessory drive gear, Fig. 5-5, is mounted on the crankshaft in front of the harmonic balancer. Parts of the gear are shown in Fig. 5-6. This gear transmits driving force from the crankshaft to the pump gears and governor drive gear at the front of the engine. The gear hub is assembled in the gear with spring packs in each of the eight mating spring slots in both pieces. This construction alleviates transmission of torsional vibrations. The gear, spring packs and hub are confined between two discs, and two dowels through hub and discs secure the assembly.

Two safety dowels are app1ied through the gear web which extend into enlarged holes in each disc. In the event of complete spring pack failure, the safety dowels contact the discs to keep the gear turning. The engine should be shut down as soon as conditions permit, in the event of spring pack failure, for proper repair.

Lubricating oil is supplied the spring packs from the crankshaft, through radial passages in the hub. An oil slinger mounted on the outer side of the accessory drive gear prevents oil leakage at the crankshaft.



Exploded View - Accessory Drive Gear
Fig. 5-6

B. MAINTENANCE

1. Crankshaft Inspection

Whenever main or connecting rod bearings are removed, the crankshaft journals should be inspected. Check for scoring and cracks, and signs of distress, as will generally be evidenced first in the bearings. When the crankshaft is removed from the engine, it should be dimensionally inspected, visually inspected, and given a Magnaflux inspection, if possible. (See Maintenance Instruction 1754 for crankshaft Magnaflux inspection.)

The journals of the crankshaft are induction-hardened. When subjected to excessive heat, from lack of lubrication or other reasons, thermal cracks result in most cases.

Before any crankshaft or half-crankshaft of a 16cylinder engine is returned, it should be Magnaflux inspected for cracks. A crankshaft cannot be reconditioned if there is a crack over one inch long and more than one- sixteenth inch (1/16") deep in either the surface of a main bearing or crankpin bearing journal, or any journal fillet.

The depth of a crack may be determined by grinding with a high speed machine fitted with a fine conicalshaped stone. If, after examination, it appears that a shaft might be salvaged, it may be returned to LaGrange for reconditioning. For details on crankshaft return and reconditioning, see Factory Rebuild Service Bulletin #303.

Attempts to grind 567 engine crankshafts in the field have proven unsuccessful because during the process of regrinding, the induction-hardened depth should be checked, and when necessary rehardened. This requires special induction hardening equipment. Therefore, it is recommended that the crankshaft be returned for grinding.

To aid identification, reconditioned crankshafts having journals undersize or requiring oversize thrust bearings, have this information stamped on the same cheek as the serial number.

2. Main Bearing Removal and Installation

All upper main bearings, except the rear bearings on 6, 8, and 12-cylinder engines, and the two center bearings on 16-cylinder engines, are removed by inserting the upper main bearing removing tool #8055837 into the journal oil passage and rotating the crankshaft opposite to normal rotation. Upper bearings on journals without oil holes can be removed by using a small piece of brass to push out the bearing while rototing the crankshaft. When installing upper bearings, they should be rotated into position by hand. This will insure proper alignment of bearing tang. Do not install with removing tool.

3. Scheduled Main Bearing Renewal

Lower main bearings should be replaced at the intervals specified in the scheduled maintenance program for the particular installation. This renewal should be made in complete engine sets. Steel-backed upper main bearings have a life expectancy of approximately two times the loaded lower half. Upper half main bearings should not be removed at scheduled maintenance intervals for lower bearings, unless a lower half being removed shows signs of distress, in which case the upper

material, evidence of the latter being found in the lube oil filters, screens or engine oil pan. When such a situation arises, all the lower main bearings should be inspected.

This should be a visual inspection made by dropping the cap and bearing. The lead tin overlay on the bearing is primarily provided for "break in" purposes. The fact that part, or all, of this coating may have worn away should cause no concern, as long as all bearing shells have the same relative appearance. DO NOT UNDER ANY CIRCUMSTANCES REVERSE THE BEARING IN THE CAP.

Replacement of an individual bearing in distress should only be made if, after inspection, all other lower main bearings still have evidence of some lead-tin over- lay remaining in the loaded areas. If one or more of the other lower main bearings has all the lead-tin overlay worn off the loaded area, then ALL lower main bearings must be renewed to insure proper crankshaft alignment. If upon such an inspection any lower main bearing shows definite signs of distress, the upper main bearing should also be examined. Used bearings should positively not be re-installed on any crankshaft journal other than the journal from which it was removed. Used bearings reapplied must be installed in their original position relative to shaft rotation.

5. Limits

half should be removed for inspection. However, upper half main bearings should be inspected at major overhaul periods and, if dimensionally satisfactory, should be cleaned up and re-used.

4. Main Bearing Inspection

Interim inspection of main bearings should only be necessary when abnormal conditions are observed in the engine, such as contamination of lube oil due to dilution with fuel or water, or any other foreign

When engines are torn down for purposes other than main bearing troubles, it will be necessary to outline a condemning limit, and in these cases, we recommend the following rules be followed for both upper and lower main bearings.

a. Minimum wall thickness of any main bearing measured with ball micrometer should be: standard - .368'; undersize 1/32" - .3835", 1/16" - .3990", 3/32" - .415", 1/8" - .4305"

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b. Maximum wall thickness variation between adjacent main bearings which have a crankpin between them should be .002".

c. Maximum allowable wall thickness variation between center main bearings on a 16-cylinder engine, that is, with no crankpin between them, should be .0015". 6. Undersize Main Bearing Main bearing shells are available in 1/32", 1/16", 3/32", and 1/8" undersizes.

7. Harmonic Balancer

The harmonic balancer should be inspected at intervals specified in the scheduled maintenance program. The balancer should be disassembled, spring leaves or packs replaced and push pin dowels rotated to present a new contact surface to the springs. On disassembly, support the balancer slightly above wooden top of work bench by use of supports around the outer periphery of the spring housing. Using a brass or other soft metal drift, slightly less in diameter than top of push pins, drive push pins from top of coupling. Drive push pins alternately 1800, making sufficient rounds of light driving on each pin until top coupling is free. After top coupling is free, repeat driving procedure, after supporting spring housing, to

be identified by the marking "DB" (Dynamic Balanced) stamp adjacent the "Front" marking on the housing. It is important that the "short length" thrust pins be used with the wide shoulder spring housing. These short pins can be identified by a 1/16" deep groove around the pin 1/2" from end of pin. Short pins having grooves can be used in prior narrow shoulder spring housing balancer 8028659, but long ungrooved pins should not be used in wide shoulder spring housings. Otherwise assembly of both balancers is the same.

Examine components of the balancer, smooth up any roughness or burrs, particularly on spring housing thrust pin ends and push pins. Replace thrust pins having flats exceeding 1/8" wide, loose in spring housing or galled on the ends. Check thrust pin equal height above each side of spring housing. Oversize thrust pin and mounting dowels are available, but oversize push pins are not available.

Check 1/2" thrust pin impressions in the coupling inner face. Replace couplings having impressions exceeding .020" in depth. All impressions within allowable depth must be blended. (This should not occur with harmonic balancer 8194330.)

Check surfaces of spring cells nearest circumference of spring housing drive push pins from spring packs and housing. Repeat procedure on bottom coupling. Couplings should be identified to hold reamed parts together.

Harmonic balancer 8194330 used on all production engines provides that spring housing thrust be taken at the housing hub shoulder, instead of the spring pocket thrust pins. The spring housing hub shoulder is wider on this balancer, compared to prior used balancer, 8028659, and the thrust pins have been shortened. Harmonic balancer spring housings having the wide shoulder can

for non-uniform wear, due to centrifugal force and flexing of the spring. Replace spring housing if this wear exceeds .050" in depth. Replace all outer spring leaves. If inner spring leaves of spring packs are galled, replace with new packs throughout.

Clean oil passages in coupling and drilled oil passages in spring housing.

In preparation for reassembly, lightly file coupling contact surfaces which have the two oil passages, to remove any burrs or roughness. Place the coupling on

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a wooden top bench and drive push pins in place, being sure previously worn surfaces will not be in a position to contact springs. Use white lead or other suitable lubricant on push pin ends.

Place spring housing on the coupling, with side marked "Front" up. Apply spring packs to each side of push pins. About 82 to 84 spring leaves are required for each pack and their weight is about 4 lbs. 5-1/4 ozs. Stack leaves before applying and remove any over length, short length or over width leaves as compared with the majority of other leaves. The leaves do vary in thickness. Space springs to obtain same clearance on both sides in relation to thrust pin ends. Apply packs with several leaves less than normally required, as it is much better to add leaves when checking, than attempt leaf removal once assembled. Leaves can be added by starting one corner of the leaf and tapping into pack working along top of leaf, using a light steel hammer.

After all packs of about right quantity have been applied, each

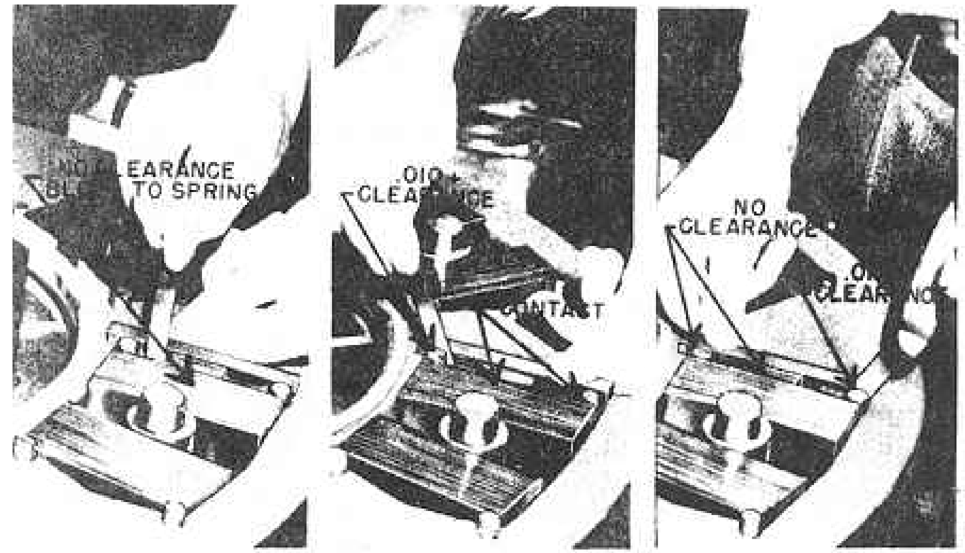
should be maintained, in most cases it will exceed the .010" due to varying thickness of added leaves.

Follow the preceding gauging sequence on pairs of spring packs diametrically opposite starting packs. Repeat sequence on adjacent packs until all packs have been gauged and proper quantity of spring leaves added. Re-check all spring packs.

Upon completion of spring pack assembly, place remaining coupling over the assembly so oil passages are matched. Clean up any burrs or roughness on hub. Using a rawhide mallet or press, force lubricated top ends of push pins in their respective holes in the coupling. Drive coupling down evenly to contact the shoulder of the push pins. Mark location of oil passages on coupling hub to aid installation of balancer to crankshaft, so oil passage lineup will match oil hole in crankshaft.

Raise the assembled coupling clear of the bench using a sling in the mounting holes. Check for any clearance between the mounting flanges with a .0015" pack should be gauged using deflection gauge 8080197, Fig. 5-7. Apply gauge as shown in Fig. 5 - 7a, and check for clearance between springs and gauge block. With gauge in position (a) there should not be any clearance between gauge block and springs.

However, due to applying packs minus several spring leaves, on first check there likely will be clearance. Make this check on each pack. 1f one pack indicates more clearance than opposite side, insert leaf inside having least clearance. If clearance still exists, add leaves to each pack until there is no clearance between gauge block and springs when pushed in position shown in Fig. 5-7a, and the gauge bar ends just clear the thrust pins. When gauge is held so center block contacts the springs and one end of the bar contacts a thrust pin as shown in Fig. 5-7b or (c), there should be at least .010" clearance between the opposite bar end and thrust pin. This clearance should also be obtained with gauge bar contact reversed. Although the .010" clearance



Block To Spring 5-7a | Bar To Pin L.S. 5-7b | Bar To Pin R.S. 5-7c

Fig. 5-7 - Spring Gauging

feeler. A .0015" feeler shou1d not enter between the mounting flanges. If it does, foreign particles or burrs are present on the flange surface which will require disassembly of the balancer to clean.

Also, with the balancer suspended as in the preceding paragraph, check clearance between top of spring pack and coupling. A .010" feeler should pass between coupling and spring pack. If feeler does not pass, tap the coupling lightly above the pack, using a rawhide mallet, at same time checking with the feeler. This procedure will provide the necessary clearance. By taking care during assembly to assure equal height of thrust pins, above each side of spring housing, it will not be necessary to check thrust pin end to coupling clearance.

Accessory drive gear hubs may also be used providing flat spots in spring slots do not exceed 3/8'" in length. Hubs may also be reversed as the gear.

The hardened discs used on the accessory drive gear should not require maintenance other than cleaning and possible surface smoothing of the disc face.

At each rebuilding, the accessory drive gear spring packs should be replaced. No attempt should be made to assemble packs from used spring leaves, as spring pack to slot clearance is very important and is

Prior to installing the harmonic balancer, clean, using air blast to remove any foreign particles, and oil springs with engine oil. Install on crankshaft with "FRONT" stamping facing you. Apply washers 8174659 under mounting bolts. Torque value for mounting bolts is 400 foot- pounds.

8. Accessory Drive Gear Assembly

The accessory drive gear should be inspected at intervals specified in the Scheduled Maintenance Program, or at a time of complete engine overhaul.

Check gear teeth for cracks, rough, scuffed or scored surface. See Maintenance Instruction 1754 for Magnaflux of engine gears. Examine spring slot condition. The gear need not be replaced for spring slot condition until flat spot on driven side exceeds 3/8" in length. The gear may be reversed to carry the load on the opposite side. Therefore, it is not necessary to replace gear until wear has occurred on both sides of the spring slot.

controlled by factory assembly of the spring pack. Clearance should be .003" - .009^. However, clearance cannot be measured in assembly because spring pack thickness must be determined in a clamping fixture with springs not oiled.

When assembling accessory drive gear, check gear to hub clearance. Maximum clearance is .010". Be sure assembly dowels fit snug, if not, ream for oversize dowels. Be sure all parts are clean and well oiled. When installing gear, use hardened washers 8140912 under mounting bolt heads to eliminate scoring of the oil Slinger, and assure better torque tightening. Torque value of accessory drive gear to crankshaft mounting bolts is 250 foot-pounds.

9. Flexible Coupling and Crankshaft Gear

The following instructions should be used for line up of the serrated type couplings, 8164605, and 8186962. Main .generator alignment is given in the generator maintenance instruction. The gap between engine and generator coupling halves should not be less than .005". Gap as measured midway between bolts must be uniform within .002"

around the coupling joint. Gap at the bolts must also be uniform, but w i 11 be .003" - .005" less than between bolts. Care should be taken to tighten all bolts uniformly to avoid cocking coupling at serration. Torque value for 3/4" - 16 coupling rim bolts is 295 foot-pounds.

Engine discs of the serrated coupling are interchangeable, providing top dead center pointer location on the engines are the same; also, engine half couplings can be aligned to different generators equipped with serrated coupling discs. There are no reamed body bound bolt fits in the serrated coupling used on the 567C engine. All rim bolts are the same size; no oversize bolt or hole is used in the rim. Line up of #1

diameter bolt is used. The 1.7817' diameter coupling mounting hole would only be reached generally to fit the coupling disc to the largest oversize coupling mounting bolts used on an engine. Therefore, when used with any other mounting bolt, the maximum clearance would not be obtained A reamed or body bound fit between coupling and bolt is not required in any engine disc; however, a reamed fit is required at the crankshaft flange, crankshaft gear and mounting bolts.

The coupling disc to engine bolt, 8208429, is the standard size, and is available in .005" increments up to .030" on the diameter which passes through the crankshaft flange and gear, not on the coupling disc center mounting bolt hole to #1 crankshaft bolt, positions degree markings on rim to align with pointer at 00 T.D.C. when #1 piston is at top dead center. Also, small" 0" marks on crankshaft coupling, position the coupling disc on the crankshaft.

Upon installation of coup1ing disc to crankshaft, face run out and rim concentricity should be checked. Eccentricity of rim taken at the machined groove should not exceed .005" T.LR., and run out on rim face should not exceed .025" T.I.R. (When taking rim run out, care should be taken to position crankshaft to avoid thrust interference.)

Coupling to crankshaft mounting bolts are ground at original assemb1y to provide a dowel fit of 1.750' through reamed holes in the crankshaft gear and flange to prevent oil 1eakage along the bolts, but where the bolt passes through the coupling disc, the bolt diameter is 1.740". With the 1.750" drilled hole in the coupling flange, this gives .010" difference between bolt diameter at the disc and the mounting hole in the disc. The mounting hole diameter allowed in the coupling disc is 1.780' or a maximum clearance of .040" when a 1.740"

diameter. They can be used with all 567 series engine coupling discs. Torque value of the coupling bolt nuts is 1200 foot-pounds.

It should be noted that engines or generators returned on Unit Exchange should have the coupling discs removed. All unit exchange engines and generators will be provided with current design coupling bolts.

Details of the crankshaft gear are given in Fig. 5-2. The crankshaft gear assembly is reamed at original assembly to assure a snug fit. Upon re-installation at any time, the snug fit should be maintained between coupling bolt, crankshaft gear and crankshaft flange, or be reamed for oversize bolts. All parts of the assembly should be carefully examined for burrs. Holes and bolts are numbered to aid in reassembly. Backlash between crankshaft gear and first idler shou1d be .007" - .014", limit .030". Also, the crankshaft gear teeth pitch diameter and bell portion of gear should be concentric with crankshaft journal within .004" T.I.R.

C. SPECIFICATIONS

Crankshaft

Diameter - main journal	New 7.498" - 7.5001'
	Limit 7.4965"
Diameter - crankpin journal	New 6.498" - 6.500"

Thrust bearing collar thickness:

6, 8 and 16 cylinder New .368"	- .369"
12 cylinder New .869"	- .870"

Limit 6.4965"

Main Bearings

Diameter (inside) installed - (Average of 3 - 600 measurements) New 7.5065" - 7.5095"

Clearance (diametric) main bearing to crankshaft New .007" - .011"

Limit .015"

Crankpin bearing to crank-shaft New .007" - .011"

Limit .015"

Minimum main bearing thickness - standard .368"

Undersize: 1/32" - .3835",1/16" - .3990",

3/32" - .415" ,1/8" - .4305".

Number of main bearings:

6 cylinder -	4
8 cylinder -	5
12 cylinder -	7
16 cylinder -	10

Harmonic balancer:

Number of leaves per spring pack (approx.) - 84

Clearances see text

Accessory drive gear:

Thickness of each spring pack .373" - .375"

Clearance - hub to gear New .001" - .003"

Limit - .010"

Accessory end gear train:	No. of teeth	Ratio to Crankshaft
Governor drive gear	113	1:1
Water pump gear	37	3.05:1
Lube oil pump gear	80	1.412:1
Scavenging oil pump gear	80	1.412:1
Accessory drive gear	113	1:1

Backlash accessory drive gears (all) New .008" .016"

Limit - .030"

D. EQUIPMENT LIST

Thrust bearing clearance:

6 cylinder	New .010" - .017"
	Limit - .030"
8 cylinder	New .008" - .015"
	Limit - .030"
12 cylinder	New .008" - .015"
	Limit - .030"
16 cylinder	New .008" - .018"
	Limit - .030"

	Part No.
Upper main bearing removing tool (see text)	8055837
Harmonic balancer dowel puller	8225989
Spring pack deflection gauge (Harmonic balancer)	8080197

(For additional engine tools, see Tool Catalog 91)

SECTION VI

CAMSHAFT GEAR TRAIN, CAMSHAFT ASSEMBLIES, TIMING AND OVERSPEED TRIP

A. DESCRIPTION

1. Camshaft Drive Gear Train

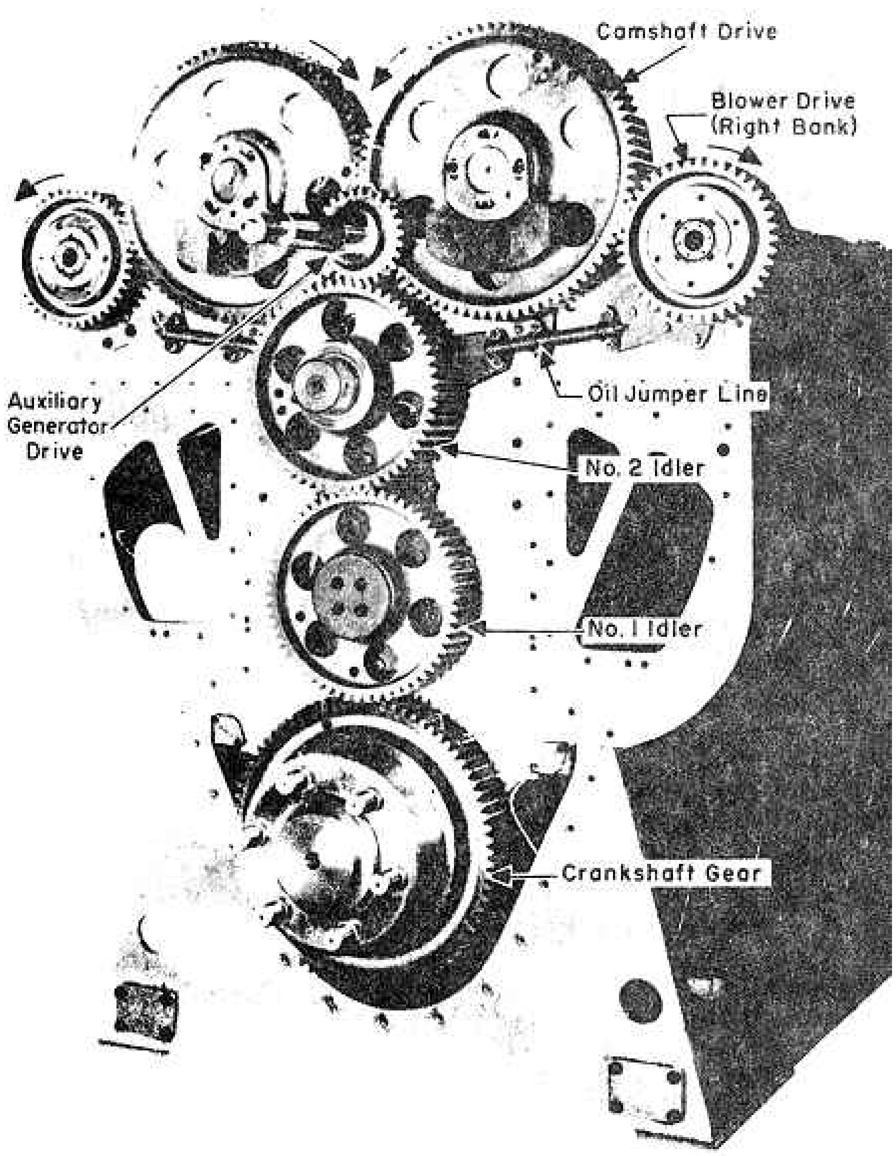
Power necessary to drive the camshaft and engine blowers is supplied from the crankshaft through the gear train at the rear of the engine. Fig. 6-1 shows the gear arrangement and Fig. 6-2 a cross-section of the gear train.

As shown in Fig. 6-1, the gear train consists of spur tooth gears, a crankshaft gear mounted on the crankshaft, two idlers, left and right bank camshaft drive gears and blower drive gears. The second idler gear has increased tooth length to accommodate the auxiliary drive gear. Rotation of the camshaft drive gears is inboard of the engine and at the same speed as the crankshaft. Blower drive gear rotation is out-board; speed depending on gear size, which differs, being smaller on 8 and 16 cylinder engines, compared to 6 and 12 cylinder engines. Hence, blower speed is faster on 8 and 16 cylinder engine. Only one blower drive gear is used on 6 and 8 cylinder engines.

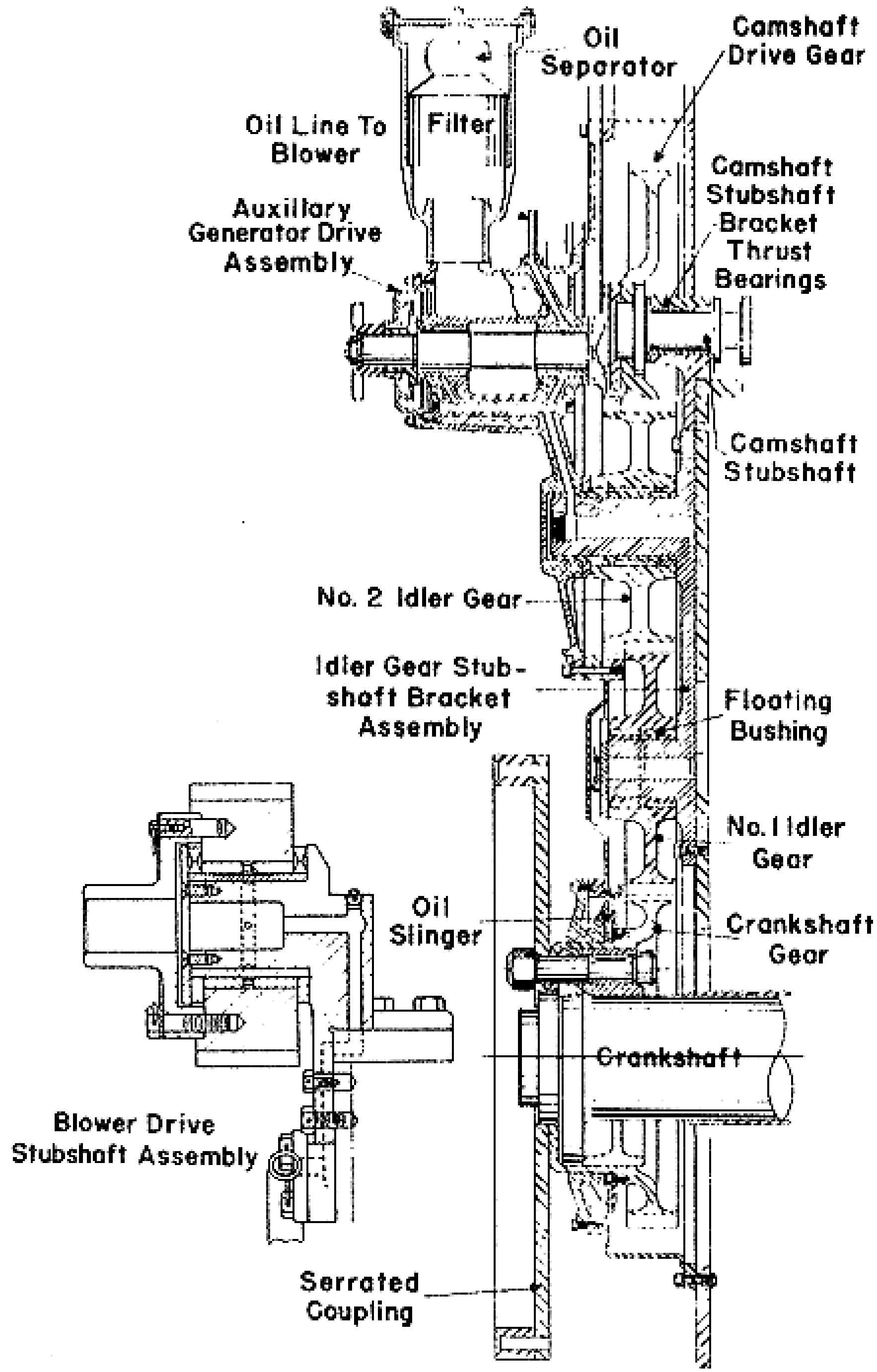
The idler gears and blower drive gears rotate on stubshafts mounted on the end plate which are equipped with floating bushings and thrust bearings. The stubshaft brackets have cast oil passages and connecting cast oil passage jumpers for lubrication and camshaft oil supply from the main lube oil manifold. The camshaft drive housing enclosing the gear train is wider on 6 and 12 cylinder engines than on 8 and 16 cylinder due to blower drive gear size.

2. Camshafts

Camshaft assemblies consist of flanged segments, end stubshafts, and on 12 and 16 cylinder engine camshafts a spacer is used between the center segments. Each segment spars several cylinders, 3 on 6 and 12,



Camshaft Gear Train



Cross-Section of 567C at Camshaft Drive End

Fig. 6-1

- 601 -

Fig. 6-2

-602 -

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and 4 on 16 cylinder engines; 8 cylinder engines have individual cylinder segments. At each cylinder locator on the camshaft there are two bearing journals, two exhaust valves cams, and one fuel injector cam, Fig. 6-3.

The segments are marked on each flange, °'A" or one and "H" on the other to aid in correct assembly, a: shown in Figs, 6-5 and 6-6. Also, one of the four hole. in each flange is small to assure relative positioning o1 the segments. Two bearing blocks at each cylinder location support the segments. Flanged stubshafts mounted at each end of the camshaft are supported it stubshaft bearing brackets. The camshaft drive gear and counterweight assembly is bolted and doweled to the rear stubshafts. A counter- weight is bolted on the front left bank stubshaft and the counter- weight and overspeed trip assembly is mounted on the right bank front stubshaft. Camshaft thrust bearings are provides in the rear stubshaft brackets.

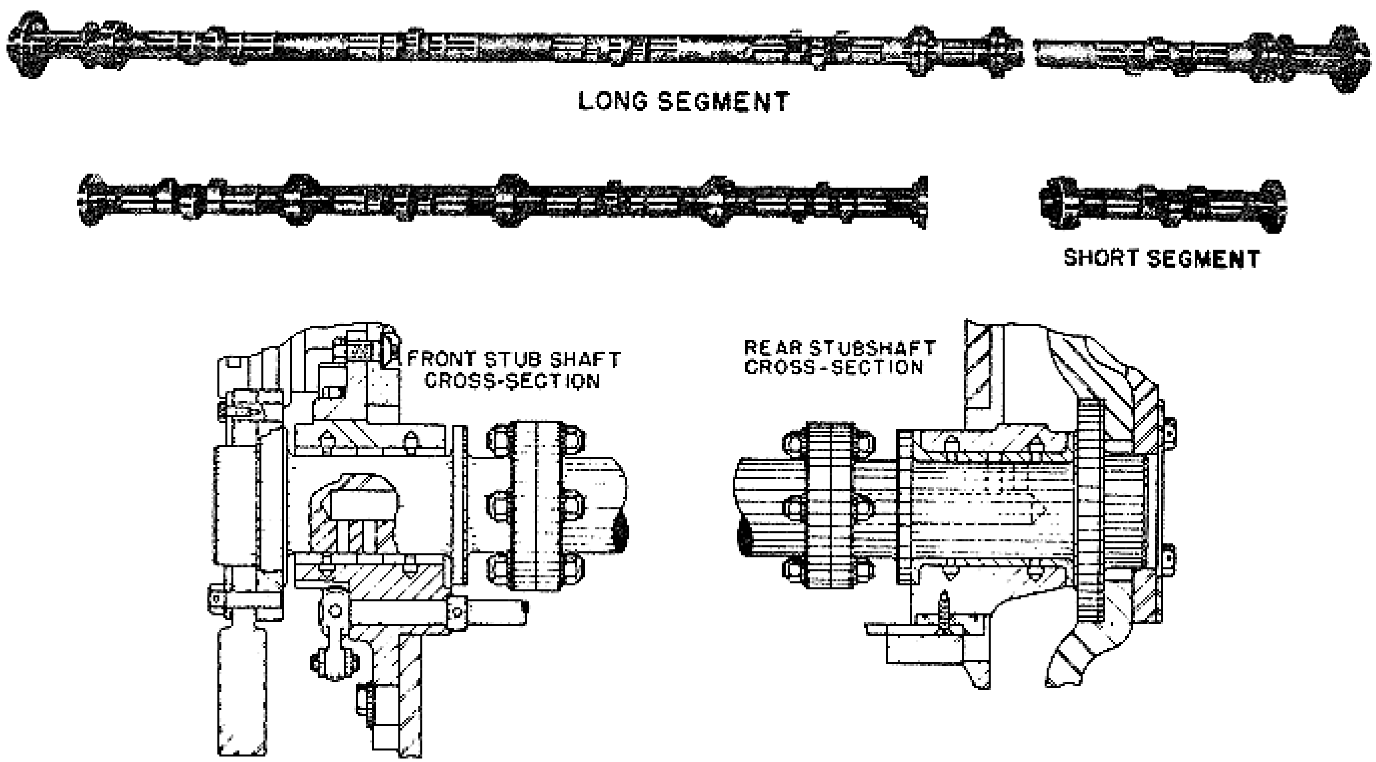
Camshaft oil supply from the main lube oil manifold gear train oil lines is received at the rear stubshaft bearings through drilled passages in each stubshaft. Each camshaft segment bearing is supplied oil from the camshaft center bore. One segment bearing cap at each cylinder location is flanged for an oil line to the rocker arm shaft.

3. Overspeed Trip

An overspeed mechanism is provided as a safety feature to stop the injection of fuel into the cylinder: should the engine speed become excessive.

If the engine speed should increase to approximately 900 RPM, the overspeed mechanism will shut down the engine. Fig. 6-4 shows the overspeed mechanism in both the normal latched position and the tripped position.

A trip shaft extending the length of the engine banks under each camshaft is provided at each cylinder



Camshaft Assemblies
Fig. 6-3

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with a cam, which when rotated contacts a spring loaded catch pawl mounted on each cylinder head, located directly under each injector rocker arm. In the overspeed trip housing on the front of the engine, the trip shafts are connected to spring operated links and lever mechanism, A reset lever on a spring lever arm shaft when rotated counterclockwise puts a tension on an actuating spring; tension being held by a trip lever engaging a notch in the reset lever arm shaft. This is the normal running position, in which the cams on the trip shaft are held away from the rocker arm catch pawls.

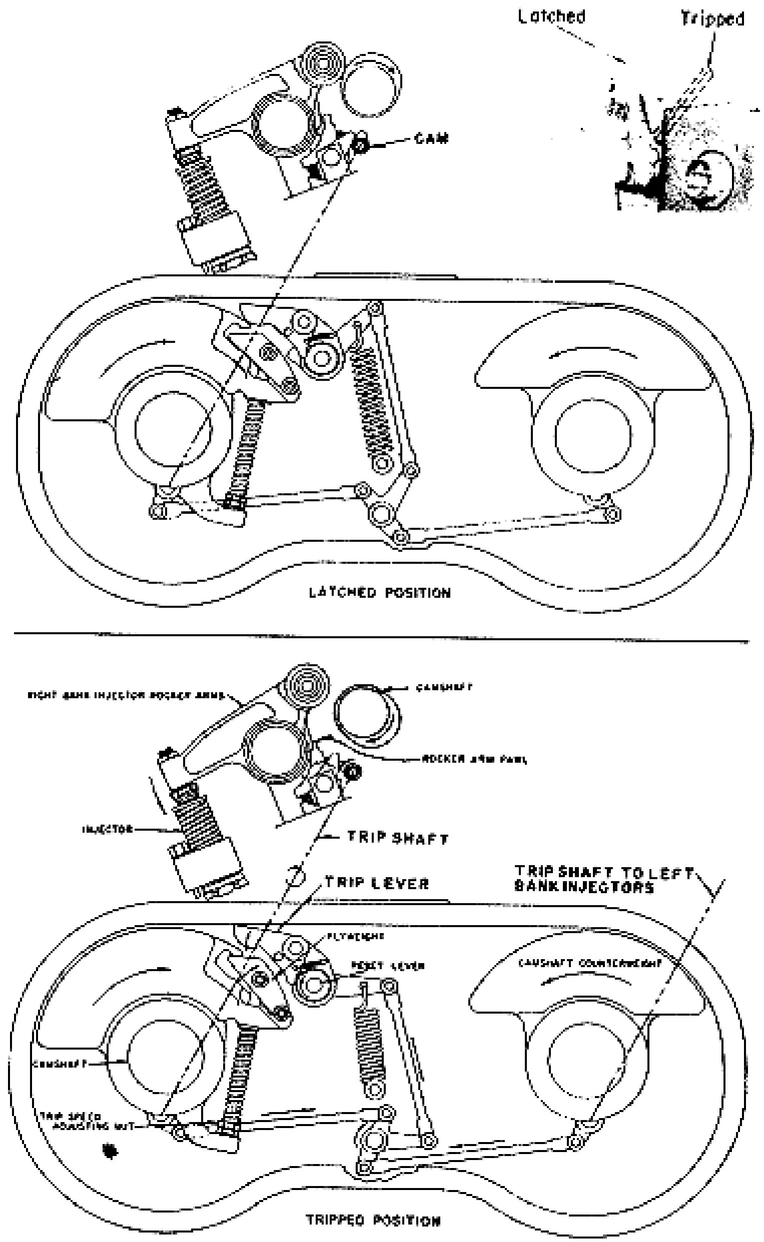
Incorporated in the right bank front camshaft counter- weight is the overspeed trip release mechanism. It consists of a flyweight held by an adjustable tension spring. When engine speed exceeds the safe limit, the set tension of the spring is overcome by the centrifugal force acting on the flyweight, causing the flyweight to move outward to contact the trip lever. This allows the actuating spring acting through connecting links to rotate the trip shafts. Consequently, the trip shaft cams contact and raise the injector rocker arm pawls preventing full effective injector rocker arm roller contact on its cam. This prevents fuel injection and stops the engine.

Upon resetting, by counter-clockwise movement of the reset lever, the trip shaft cams release the injector rocker arm catches. Rotation of the camshafts on starting the engine lift the rocker arms slightly allowing the catch pawls to resume unlatched position, releasing the injector rocker arm for normal operation.

B. MAINTENANCE

1. Camshaft Gear Train

Gear teeth should be inspected for fatigue indications, cracks, pits, or other evidence of failure. Whereever possible, inspection by Magnaflux methods are recommended. For Magnaflux inspection of engine gears,



Overspeed Trip
Fig. 6-4

see Maintenance Instruction 2132. Gears should also be inspected for excessive backlash by inserting a feeler gauge the entire length between teeth, or by other methods. Excesive backlash will result in improper valve operation anti injection periods as well as poor gear operation. Limiting backlash clearance is given under specifications at the end of this section. Clearances between gear stubsbaft and gear bushings and thrust clearances must also be maintained within specified limits. It should be noted that blower thrust washer (bronze) 8069139 is used "outboard," while washer (cast iron) 8166495 is used "inboard" on blower drive gear stubshaft. All production 8 and 16 cylinder 567C engines have 30 tooth blower drive gears except a few pilot models which used 31 tooth gears similar to earlier 567 series engines of the same size. The blower drive gears for 6 and 12 cylinder 567C engines have 41 teeth, the same as used on earlier 567 series engines of the same size. Export 6 and 12 cylinder 567C engines however use a 40 tooth blower drive gear.

Although no wear should occur at the oil slinger, the .100" plus or minus .010" dimensions between crankshaft gear oil slinger and housing cover should be checked on assembly. This measurement is obtained by laying a straight edge across the camshaft drive housing flange, with crankshaft positioned toward the generator and measuring the distance to face of oil slinger. Then determine the protrusion of slinger mating surface on lower housing cover from its flange. The difference between these measurements equals the clearance. If required add or remove shims to obtain proper clearance.

2. Camshafts

Camshaft assemblies installed in an engine must conform to segment sequence and location for left and right bank as shown in Figs. 6-5, 6-6 and 6-7 on respective engines. (Figures 6-5, 6-6 and 6-7 show short camshaft segments part numbers in addition to the long segment numbers and location on the 567C engine to

provide association of these parts for customers having earlier 567 series engines.)

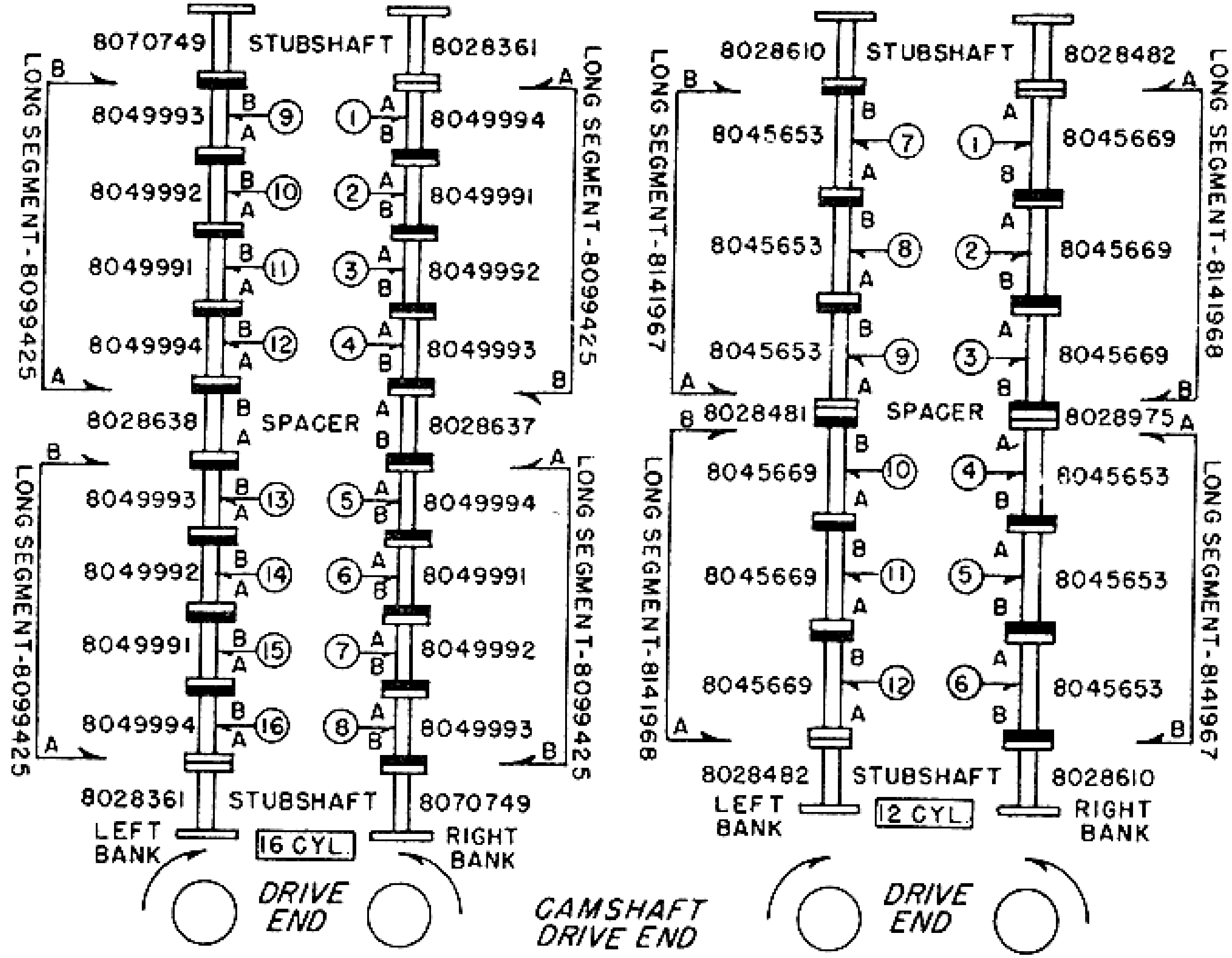
One dowel bolt hole in each segment flange is smaller than the others to assure correct segment angular position. On right bank camshafts, the "A" marking on each flange is toward the front of the engine. On left bank camshafts, the 'B" marking on the flange must be toward the front of the engine. (Except Fig. 6-7 arrangement.)

Check segment journal to bearing clearance and thrust clearance at rear stubstafts. Limits are given at end of section. Clearance measurement can be obtained with feeler gauges.

Camshaft Removal

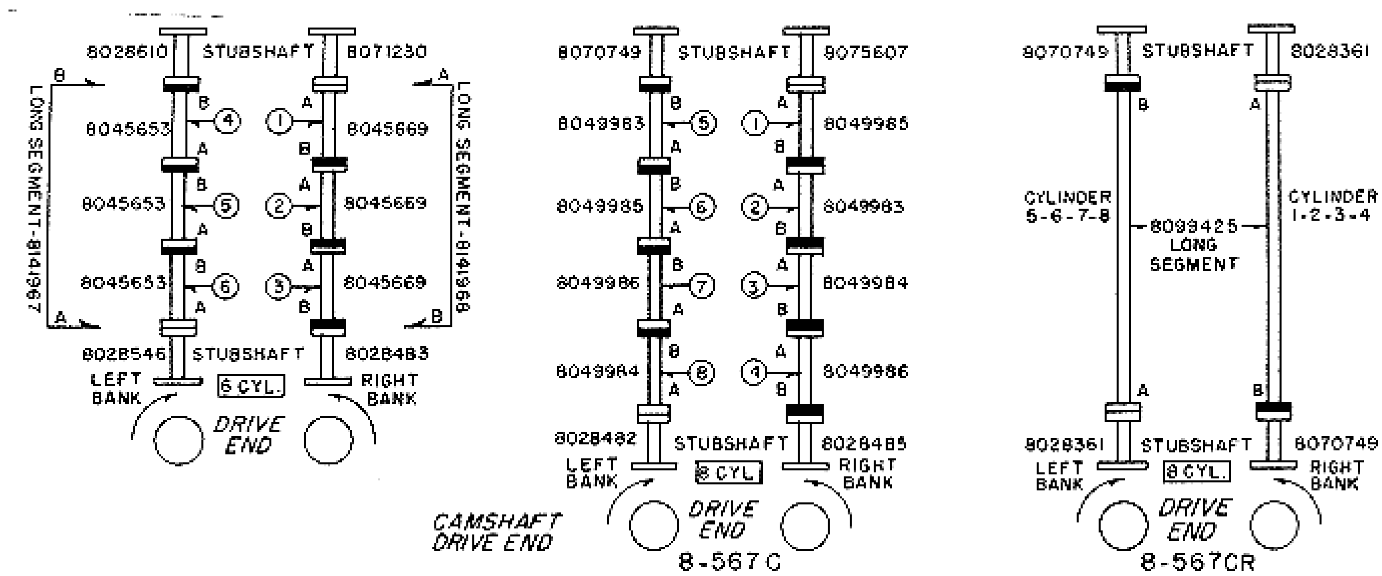
The camshaft may be removed without disturbing the stubshafts by removing the dowel bolts connecting the segment flange and stubshaft flange, removing oil lines from segment bearing blocks to rocker arms and removing rocker arms. Remove segment bearing block caps to allow camshaft removal. If the camshaft is removed for other reasons than bearing replacement an attempt should be made to retain relative position of the bearing bushings on re-installation of the camshaft. This may be accomplished by immediately replacing caps after camshaft removal, or if the entire block is removed, re-insert block bolts and wire the free ends of the bolts.

Upon installation or replacement of the camshaft, lubricate freely all moving parts, place the assembly in proper aligned position after replacing blocks and bearings as removed. Rotate camshaft to check for binding. Apply flange dowel bolts and reassemble rocker arms and associated parts. Check valve timing of at least one cylinder to check segment positioning and then make other adjustments such as exhaust valve setting and injector timing.

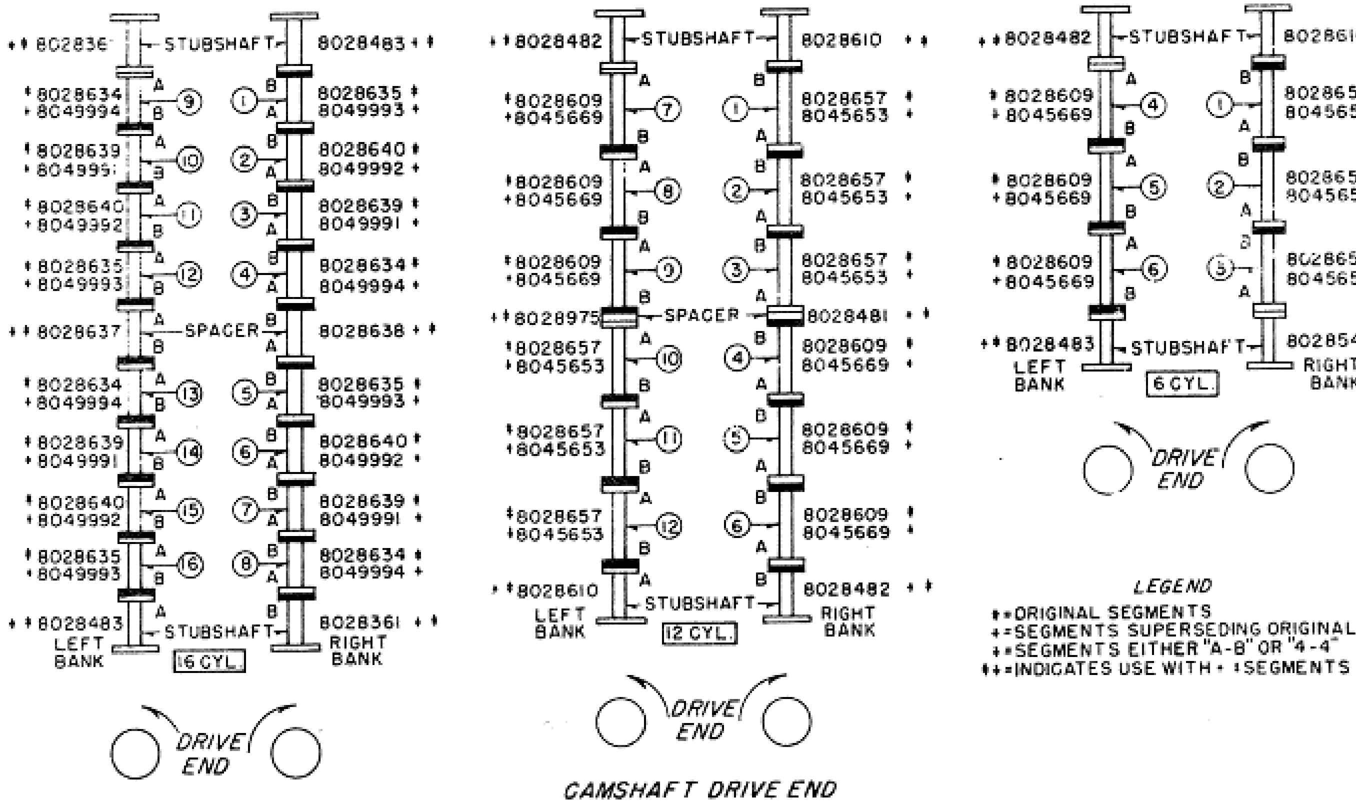


Long and Short Camshaft Assembles - 12, 16 Cylinder 567A, B, and C Engines
Fig. 6-5

252C-6-1256 CAMSHAFT



Long and Short Camshaft Assembles - 6, 8 Cylinder 567A, B, and C Engines and 8-567CR Engines
Fig. 6-6



Camshaft Assemblies -- Early 567 Cast And Fabricated Top Deck Engines
Fig. 6-7

252C-6-1256 CAMSHAFT

Camshaft Segment Removal

Individual segments comprise the entire camshaft on 6 cylinder engines, and are removed as previously given. It is also necessary to remove the entire camshaft to remove a segment of 12-cylinder engine camshafts due to center segment flange and spacer arrangement. The bolt heads held in the spacer and covered by adjacent segment flange prevent removal. Individual segments however may be removed from the 8 and 16 cylinder camshafts by removal of flange connecting dowel bolts.

Camshaft Inspection

After removal of camshaft, dismantle, wash and remove all dirt from oil passages. Visually inspect stubshafts and segments paying particular attention to cam lobes and journals for pitting, chipping, excessive scoring and heat discoloration. Journals and cams with light pit marks, minute flat spots and light score marks may be reused after blending and removal of sharp edges by hand polishing. Check inside of dowel bolt holes for burrs and remove.

Camshaft segments and stubshafts that show heat discoloration should be Magnaflux inspected and hardness tested. See Maintenance Instruction 1754 for this information. Discoloration on the unfinished portion of the camshaft should be disregarded as it results from production process as may be seen on a new camshaft.

After assembly of camshaft and stubshaft check for concentricity between journals. Concentricity should be within .002" T.I.R. Support the camshaft on precision rollers at journals 1, 7, 10 and 16 on 16 cylinder; 1, 6, 7 and 12 on 12 cylinder; 2 and 7 on 8 cylinder and 2 and 5 on 6 cylinder. For further limits see specifications.

---

3. Firing Order and Top Dead Center

Column A - Firing Order

Column B - Position of flywheel in degrees when piston is at top dead center.

6 Cylinder	8 Cylinder		12 Cylinder		16 Cylinder	
A B	A	B	A	B	A	B
	* 8-56 7 CR					

1	0 deg.	1	0 deg.	1	0 deg.	1	0 deg.
4	45	5	45	12	19	8	22-1/2
3	120	3	90	7	45	9	45
6	165	7	135	4	94	16	. 67-1/2
2	240	4	180	3	120	3	90
5	285	8	225	10	139	6	112-1/2
		2	270	9	165	11	135
		6	315	5	214	14	157-1/2
		8-567C		2	240	4	180
				11	259	5	202-1/2
		1	0 deg.	8	285	12	225
		5	45	6	334	13	247-1/2
		3	90				
		7	135			2	270
		Z	180			7	292-1/2
		6	225			10	315
		4	270			15	337-1/2
		8	315				

*NOTE: 8-567CR and 8-567C crankshafts are not interchangable.

4. Locating Top Dead Center

If it should become necessary to check the position of the flywheel or the flywheel pointer for top dead center, proceed as follows: a. Remove injector from No. 1 cylinder. b. Turn crankshaft in normal direction of rotation until piston is just before top center.' c. Insert threaded rod 8051833 through injector

d. Attach dial indicator 8039138 to a bolt screwed into threaded lifter hole in cylinder head, Fig. 6-8. Place indicator as shown, and depress a few thousandths of an inch.

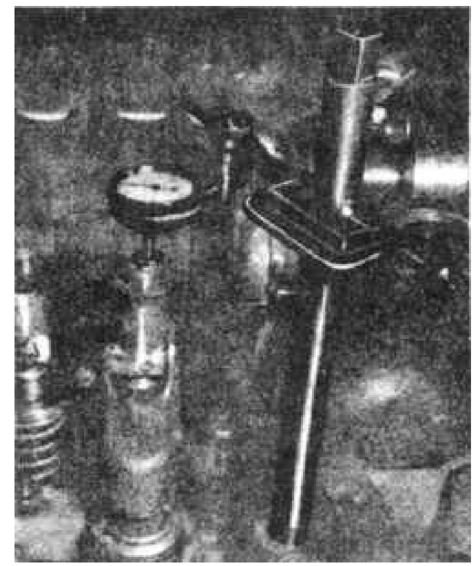
e. Set indicator at zero and mark flywheel at pointer. Turn crankshaft in normal direction until piston moves up to and past top dead center and indicator returns to zero.

NOTE: The distance the piston travels after the indicator is attached should be within the range of the indicator.

f. Continue turning crankshaft until piston moves approximately .010" past zero, then turn crankshaft in opposite direction until indicator returns to zero. This will compensate for clearance in bearings and piston assembly.

g. Mark flywheel again at pointer. Divide distance between the two marks. This point will be top dead center for No. 1 piston.

Locating Top Dead Center
Fig. 6-8



Timing Exhaust Valves
Fig. 6-9

hole and screw into piston puller hole in crown of piston.

252C-6-1255 CAMSHAFT

5. Checking Exhaust Valve Timing

To check timing, place a dial indicator on the rocker arm adjusting screw as shown in Fig. 6-9. Valve end of rocker arm must be in its highest position, so that the exhaust valves are closed. Press indicator down approximately .100" and set dial to zero.

Turn crankshaft in normal direction of rotation until flywheel is at 1060 A.T.D. C. of cylinder being checked. If timing is correct, the valve bridge will have moved down .014". Timing must not be later than 1100 or earlier than 1040 A.T. D.C. of cylinder being checked.

6. Timing Exhaust Valves

When blowers, oil separator, camshaft drive housing covers are removed for replacement of camshaft assembly, stubshafts or gears, the exhaust valves are timed as follows:

a. Remove or loosen all rocker arms except the one on which the dial indicator is resting. Each camshaft must be timed to the crankshaft. Checking timing of any one cylinder of each bank is usually sufficient.

b. Locate top dead center for the cylinder to be checked (see page 613). Remove the dowels and bolts from the camshaft drive gear and remove. gear. The camshaft can be rotated by placing a socket and wrench on flange bolt nuts.

c. Rotate the camshaft in its normal direction of rotation until the exhaust valve being checked opens .014".

d. Turn the crankshaft in the normal rotation until flywheel pointer reads 104° after top dead center of the cylinder being checked. If a new gear train has been installed, the timing may be as

early as 104° but not later than 106`. Unless a new gear train has been installed, it is preferable to set timing as nearly to the 106° mark as possible. With flywheel at 104° A.T.D.C. of the cylinder being checked, the dowel holes in the camshaft drive gear applied and dowel holes in the camshaft stubshaft should be in line or approximately in line with each other. If by turning the crankshaft from 104° to 106° A.T.D.C., the dowel holes can be made to line up, then the bolts should be tightened. If the dowel holes do not line up within this tolerance remove the camshaft gear from its stubshaft. Turn the gear 180° and replace on stubshaft or move the gear one tooth and replace on the stubshaft. The dowel holes should then line up.

e. If it is not possible to line up the dowel holes perfectly, they may be reamed oversize and oversize dowels installed. This will eliminate the necessity of redrilling the gear and stubshaft. Secure gear to its stubshaft.

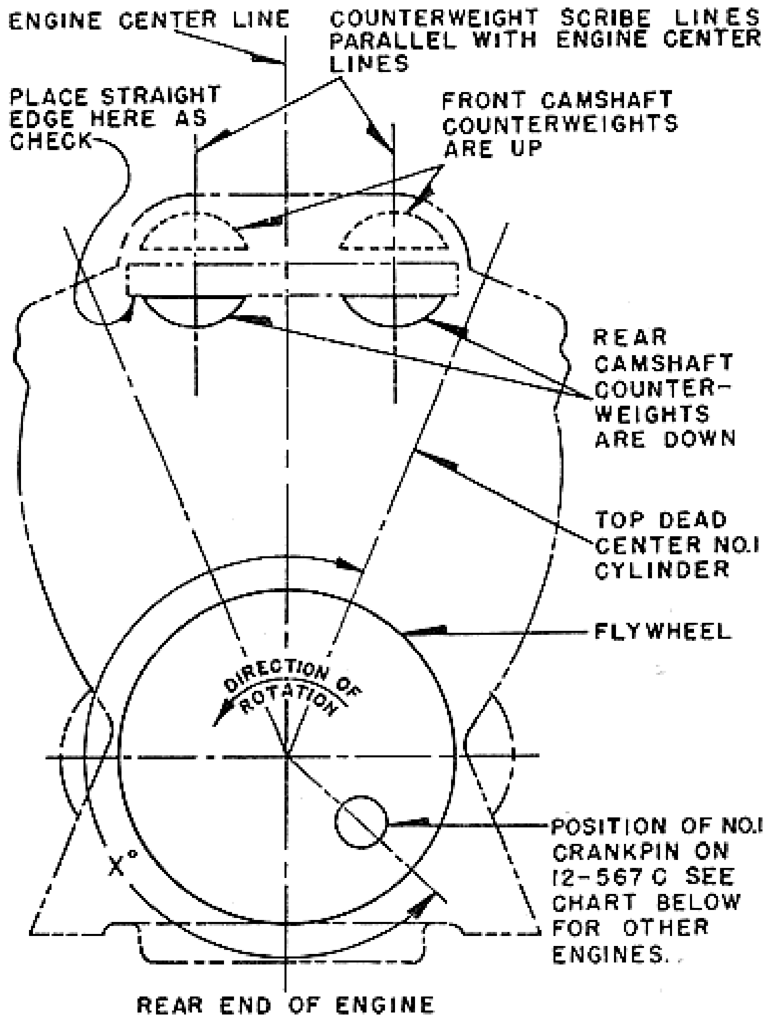
f. The crankshaft should now be rotated in its normal direction and the timing checked so that the exhaust valve being checked is open .014" when the crankshaft flywheel and timing pointer are between 104° - 106° A.T.D.C.

7. Counterweights

Counterweight replacement is rarely necessary. When applying counter-weights be sure they are in- stalled in proper position as indicated in Fig. 6-10.

8. Adjusting Overspeed Trip

To adjust the overspeed trip, shut engine down, re move the cover from right side of overspeed trip housing and turn adjusting nut to increase or decrease spring



X = DEGREES AFTER T.D.C. OF NO.I CYLINDER. TO GET THE CRANKSHAFT IN THIS POSITION, TURN THE FLYWHEEL UNTIL THIS NUMBER IS AT THE POINTER.

ENGINE MODEL	X EQUALS
6 - 567 C	172½°
8 - 567 C	247½°
8 - 567 CR	184°
[illegible]	[illegible]

ension as required. To increase engine speed at which overspeed trip operates, increase spring tension. After the adjusting nut has been moved, the locknut must be tightened and the engine run to test speed at which trip operates. The speed rise of the engine from idle to trip should be made in 20 to 30 seconds. Several adjustments may be required before final setting of 900-910 RPM tripping speed is reached.

When setting the overspeed trip, engine speed should not exceed 930 RPM, to limit centrifugal force on the generator commutator. More stabilized over- speed trip operation is obtained by using recently improved cupped spring washer and cylindrical end spring guide in the overspeed trip.

See Scheduled Maintenance Program for frequency of checking the overspeed trip.

C. SPECIFICATIONS

Gear Ratio to Crankshaft

Gear	No. of Teeth	Ratio to Crankshaft RPM
Crankshaft	79	1:1
Idlers	58	1.362:1
Camshaft Drive	79	1:1
Blower (6 and 12)	41	1.925:1
Blower (12 Cylinder Export)	40	1.975:1
Blower (8 and 16)	30	2.633:1

12 – 567C	249½°
16 – 567C	105°

Counterweight Timing
Fig. 6-10

Aux. Gen. Drive	26	3.037:1

Gear Backlash

Crankshaft gear to 1st idler	New .007"	- .014"
1st idler to 2nd idler	New .007"	- .014"
2nd idler to camshaft drive	New .007"	- .016"

252C-6-1255 CAMSHAFT

Camshaft drive to camshaft drive	New .007" - .022"
Camshaft drive to blower drive	New .007" - .016"
Aux. drive to 2nd idler	;New .007" -.016"
Limit (all gears) ;	.030"

Camshaft Drive Gear Clearances Limit

Idler gears (bushing to stubshaft)	New .005" - .008" .016"
Bushing to gear ;	New .008" - .010" .018"
Thrust Clearance No. 1 idler	New .009" - .017" .025"
Thrust Clearance No. 2 idler	New .050" - .068" .080"
Blower drive gears - diametric clearance-bushing to stubshaft ;	New .003" - .005" .016"
Bushing to gear ;	New .007" - .009" .018"

Stubshaft journal diameter **New 2.497 "-2.498" 2.495"**

Diametric clearance-journal to bushing	New .0035"-.0075" .010"
Stubshaft thrust clearance	New .010"- .018" .025"

Dimension between thrust faces Max. 4.195"

Camshaft Timing

Ideal Timing Setting .	106 deg. A.T.D.C. valve open .014"
Timing of new gear train not earlier than 2 deg. Max. (or 104	deg. A.T.D.C. at

Thrust Clearance ;New .009" - .017" .025"

Auxiliary Generator Drive

Diameter of journal New 2.499"-2.500"

Diametric clearance

driveshaft to bushing New .0025"-.0045" .0085"

End Clearance ; New .0105"-.0235" .035"

Camshaft and Stubshaft

Camshaft journal diameter New 2.496"-2.498" 2.495"

Diametric clearance -

segment journal to

bushing ; New .002"- .006" .010"

Taper length of journal ; . 001"

Runout (journal) T.I.R. ; .002"

Runout (base circle relative to journal) .003 "

Mounting flange (not convex) flat within* .0005"

Mounting flange square with longitudinal

center line within, T.I.R.* ; .001"

*(Correct by grinding faces)

.014" valve open)

Limit of lag - camshaft be-

hind crankshaft - due to

worn gears 4 deg. Max. (or 110

deg. A.T.D.C. at

.014" lift.

Flywheel Pointer setting 0 deg. T.D.C. of

No. 1 Cyl.

Overspeed Trip

Clearance-trip latch to fly-

weight .010" Min.

Trip setting. **900 - 910 R.P.M**

Part No.

D. EQUIPMENT LIST

Rod for locating top dead center **8051833**

Dial Indicator **8039138**

SECTION VII

BLOWER

A. DESCRIPTION

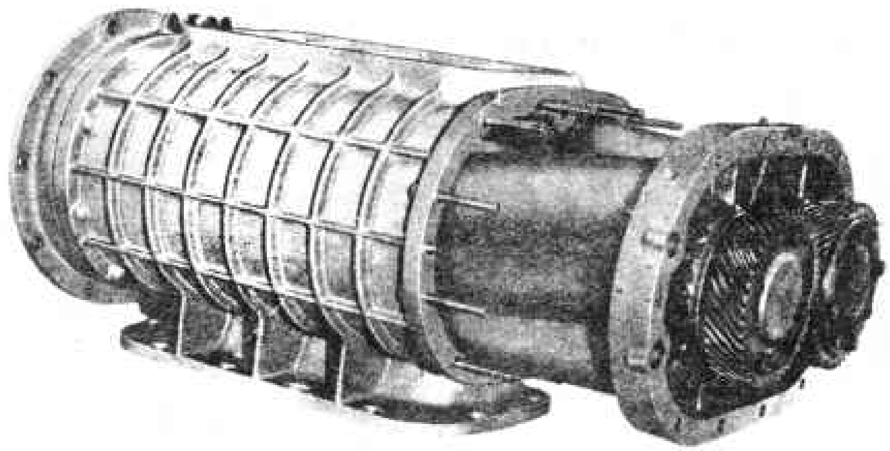
1. Blower

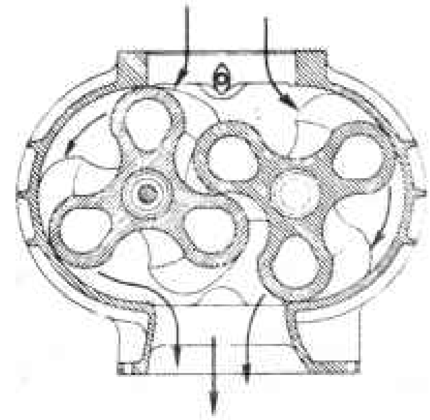
The blower, Fig. 7-1, consists of a pair of helical three-lobed rotors, which revolve in a close fitting aluminum housing. This design insures a large volume of air at low pressure, proportional to engine speed. A cross-section view of the blower is shown in Fig. 7-3. Two blowers are used on 12 and 16 cylinder engines; one on 6 and 8 cylinder engines on the right bank.

Each rotor is pressed on a tubular steel shaft. The engine end of these shafts are journals supported in the rear end plate bearing blocks. The front, or gear ends of the shafts, are serrated. Flanged hubs having ser- rated bores are pressed onto the serrated tubular shaft ends and serve as bearing journals and drive flanges for a matched pair of helical rotor gears. Thrust bearings are included in the front end bearing blocks.

Blower rotor bearings are pressure lubricated by engine oil supplied from the auxiliary generator drive housing. Oil is supplied to the bearings by drilled pas- sages in the end plates; both end plates being connected by an oil passage in the top center of the housing. Rotor gears are bath lubricated by running in oil. The oil level is maintained by a standpipe which is part of the blower oil drain line. Oil seals are provided in each end plate around each rotor shaft to prevent oil leakage into the rotor housing.

Gaskets are not used between the end plates and blower housing. A fine silk thread around the housing end, inside the stud line, together with a thin coating of gasket compound, provide an air-tight seal.





Blower Operation

Blower
Fig. 7-1

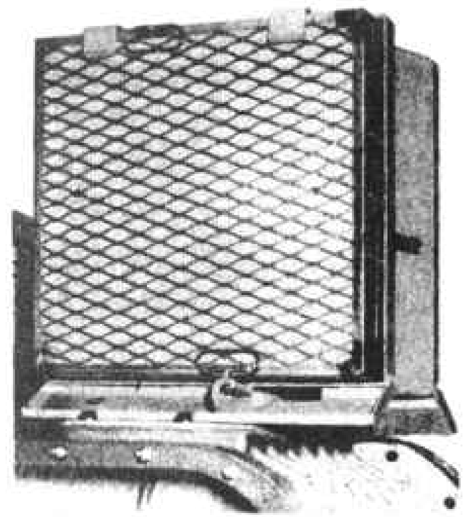
2. Blower Drive

Each blower is driven by a blower drive gear in the camshaft gear train. A flange with a serrated hub is bolted to the drive gear. A quill shaft having a flanged end bolted to a rotor gear, and a serrated end, extends through the outer rotor shaft. When the blower is in place, the serrated end of the quill shaft enters the serrated hub of the drive flange.

Engine blower drive gears on 8 and 16 cylinder engines are smaller than those used on 6 and 12 cylinder engines. Consequently, blower rotor speed is faster and capacity is proportionally greater on 8 and 16 cylinder engines. See Section VI, for additional information on the engine gear train.

3. Engine Air Filters

Air is cleaned before entering the blower by passing through the engine air filters and air intake silencer assemblies. Different arrangements and types of these assemblies are used depending on the engine installation and customer specification.

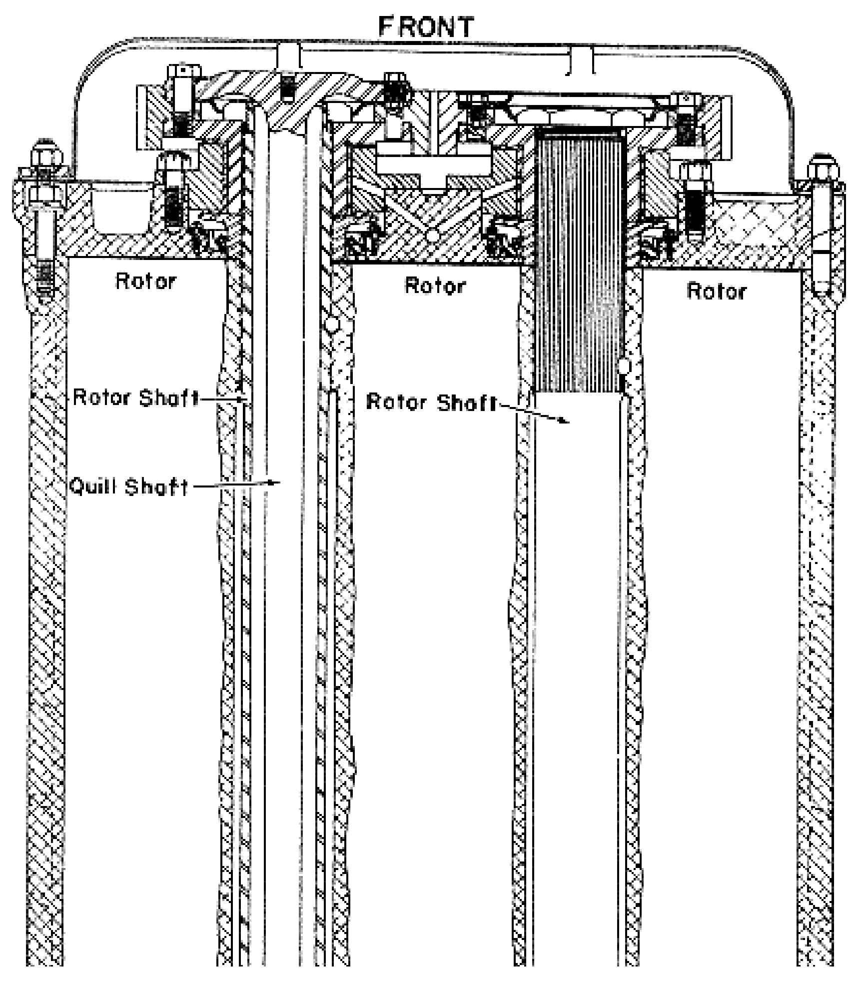


Engine Air Filters
Fig. 7-2

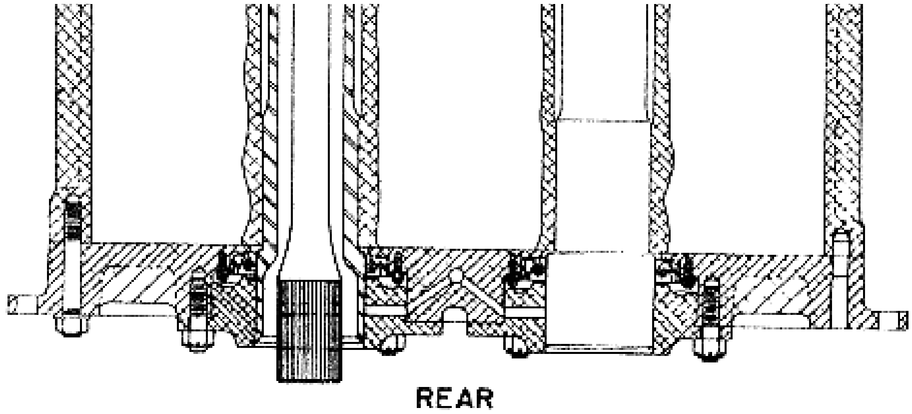
A representative air filter - silencer assembly is shown in Fig. 7-2.

It is very important that air supplied by the engine be clean to minimize wear of parts caused by air borne abrasive particles and to pre- vent contamination in the engine. Therefore, whatever the type of air filter used, it should be maintained to oper ate efficiently. Cleaning in- formation covering the engine filters is given in Maintenance Instruction 1706.

B. MAINTENANCE 1. Servicing Blower Blowers in need of rebuilding should be returned to the factory. For blower rebuild information see Factory Rebuild Service Bulletin #301. 2. Blower Inspection It is recommended that blowers be inspected at intervals specified in the Scheduled Maintenance Program. H blower bearings become worn enough for rotor interference, aluminum dust will appear in the blower support housing and in the air box. A blower in this condition must be replaced at once. A leak at the blower oil seals will show an excessive amount of oil running down the blower support and into the air box, and excessive oil on rotors and end plates. NOTE: Air pressure should not be used to test blower seals. . ` When inspecting blower rotors, a clean strip on the crown radius or high part of the lobes, running the entire length of the lobes, may be seen on some rotors. The strip appears to be flat, but actually is hand



worked to conform to the housing bore. The hand working oper- ation is done to match pairs of rotors for close clear- ance, and the width of the strip will vary on different rotors. The strip on the lobes is the closest point of rotor contact and therefore is usually cleaner than other lobe areas. Scratches may appear on the strip due to dirt particles finding their way into the blower, but generally they are of no consequence. Accordingly, the clean strip or evidence of scratches on it should not be interpreted as an indication of rotor to rotor or rotor to housing contact. -703



Engine Blower Cross-Section
Fig. 7-3

- 704 -

BLOWER 252C-7-1255 252C-7-1255 BLOWER

Upon inspection of the current design engine blowers, it will be noted that some parts, although similar to previously used parts are lighter in weight. The blower housing end plates and rotor lobes have been lightened, and the cast iron rear end plate bearing housing and bushing assembly has been replaced by an integral one piece aluminum bearing. Cast iron housings are rebushed, however, when blowers are rebuilt at the factory.

3. Blower Removal

General removal procedure is as follows:

a. Remove oil separator tines to blower.

b. Remove blower lube oil supply and drain lines; apply blank flange or otherwise cover openings.

c. Remove air filter element, element housing, and blower adapter (if used).

d. Remove stud nuts and capscrews securing blower to support and camshaft drive housing. (Special wrench 8177166 facilitates removal of hard to reach bottom nuts.)

e. Slide blower straight back from the engine until splined shaft clears spline drive on blower drive gear.

5. Blower Changeover

Blowers used on 567C engines are similar to blowers used on other 567 series engines. Blowers used on the same bank may be exchanged from 567A, 567B to 567C without alteration. To change over a 567 (cast or fabricated) engine blower to same bank on 567A, 567B or 567C engine, the drive quill shaft must be changed from the inside blower rotor gear to the outside gear, or vice versa from 567A, 567E or 567C to 567 engine blower.

Installation of blowers is the same, with wide mounting base flange inward of the engine.

To change a 567 blower to same bank on 567C, 567B or 567A or vice versa:

a. Remove blower end cover, quill shaft and gear cover on opposite gear from quill shaft.

b. Drill and ream two dowel holes in gear opposite original quill shaft location, and dowel quill shaft to gear

c. Replace gear cover on opposite gear and replace blower end cover. (Cover nut torque values are 35- 40 foot-pounds.)

C. SPECIFICATIONS

Blower	6 & 12 cyl.	8 & 16 cyl
Blower speed (engine speed 800 RPM)	1540 RPM	2040 RPM

f. With the aid of a chain hoist or equally safe means, carefully raise and remove the blower from its support.

4. Installing Blower

To install a blower, reverse the procedure outlined in Item 3. Grease the blower to blower support gasket, so blower can be moved in place without moving or tearing the gasket. Line up spline drive and slide blower straight into position.

Blower speed (engine speed		
835 RPM)	1650 RPM	2200 RPM
Blower capacity (per blower at		
7-1/2" Hg. approx.) 800 RPM	2000 CFM	2700 CFM
835 RPM	2150 CFM	2900 CFM
Blower pressure (approx.) 800 RPM 6"		to 8.511 Hg
at engine RPM 835 RPM 7"		to 9*' Hg.

C. SPECIFICATIONS (Con't)

	New Limit
*Clearance - rotor to rear end	
plate (away from gears)	.012"•- .023" .025"
*Clearance - rotor to front end	
plate (near blower gears)	.0085" - .0195" .022"
"Clearance - housing to rotor	.012" - .014" .017"
Clearance - rotor to rotor	.008" - .012" .015"
Clearance - diametric -	
rear rotor bearing	
aluminum	.0025" - .004" .005"
cast iron and sleeve	.002" .. .0041" .007"
Clearance - diametric - front	
rotor bearing	.002" - .0045" .007"
Clearance - thrust - front	
rotor bearing	.002" - .004" .006"

Backlash - synchronizing gears	.000" - .0025" .004"
Runout - synchronizing gear face (total indicator reading)	.002"
Runout - quill shaft (after assembly total indicator reading)	.025"
Blower base - twist or warp	.006"

*Rotor to be pushed toward the end on which clearance is being measured.

**Check clearance with blower inverted.

D. EQUIPMENT LIST

Name	Part No.
Blower Lifting Plate	8072929
Feeler gauges (1/21, x 12" - .008" - .020")	8049132
Feeler gauges (1/21, x 36" - .010" - .02011)	8049131
Feeler gauges (.0015° - .200" short)	8067337
Blower Nut Ratchet Wrench	8177166

For additional blower tools see Catalog 91B.

SECTION VIII

LUBRICATING OIL SYSTEM

A. GENERAL DESCRIPTION

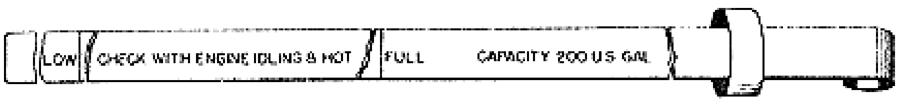
The engine lubricating system is a combination of three separate systems. The engine lubricating oil system, piston cooling oil system and scavenging oil system. The engine lubricating system supplies oil for lubrication of the various moving parts of the engine. The piston cooling system supplies oil for the cooling of the pistons and lubrication of the piston pin bearing surfaces. The scavenging oil system serves the purpose of supplying the other two systems with cooled and filtered oil, by taking the oil drained into the oil pan sump and forcing it through the filter and coolers from where it flows to the suction strainer housing supplying the lubricating and piston cooling oil pumps. Parts of the lubricating system mounted on the front of the engine are shown in Fig. 8-1.

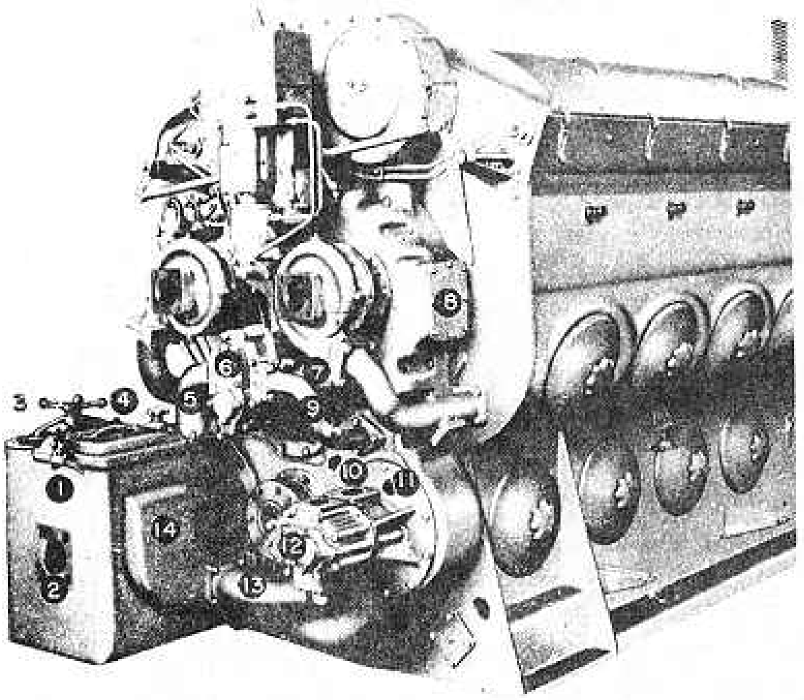
B. UNIT DESCRIPTION

1. Oil Pan

The oil pan, Fig. 1-2, serves as the support for the crankcase and enclosure for the lower parts of the engine. It is rectangular in shape, having handholes on each side for inspection and servicing. It serves as a sump for the engine lubricating oil. When the engine is stopped, oil not trapped in filter, cooler or lines, drains into the sump. The scavenging oil pump suction line is built into the oil pan. It extends from the sump to the front of the engine, to line up with the scavenging oil inlet to the strainer housing, Fig. 1-2, Item 8.

OIL SYSTEM 252C-8-154 252C-8-1255 OIL SYSTEM





Lubricating System Components
Fig. 8-1

1.Strainer Housing.

2.Cooler Oil Inlet to Housing.

3.Lube Strainers Hold Down Crab.

4.Filler Opening Cover.

5.Lube Oil Suction to Lube and Piston Cooling Pumps.

6.Lube and Piston Cooling Pumps.

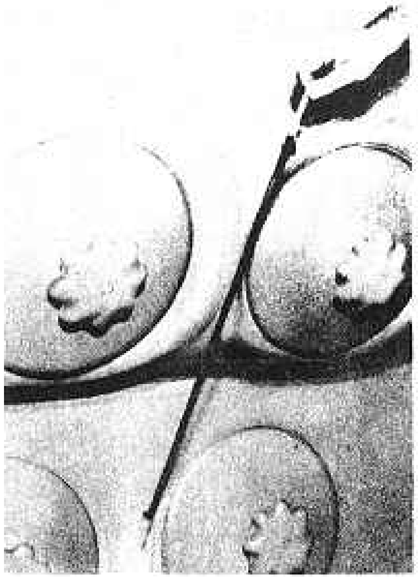
7.Lube Oil Discharge.

8.Oil Manifold Relief Valve Cover.

A bayonet type oil level gauge at the side of the oil pan, Fig. 8-2, is marked to show oil capacity, low and full levels and has a part number identifying its use in a particular engine.

2. Oil Strainer Housing

The oil strainer housing is a large box-shaped cast aluminum housing mounted on the front right side of the engine on the accessory drive cover, Fig. 8-1, Item 1. It contains Gauge independent strainers for the main oil pump supply and scavenging oil pump. Each pumps strainers have a separate oil inlet and discharge. There are two finemesh strainers for the main lube pump oil and one coarse screen for scavenging pump oil.



Lube Oil Level
Fig. 8-2

9. Piston Cooling Discharge.

10. Strainer Seal Oil Supply Line.

11. Scavenging Pump Outlet.

12. Scavenging Oil Pump.

13. Scavenging Oil Pump Suction Line From Strainer Housing.

14. Scavenging Suction Strainer Oil Outlet Channel.

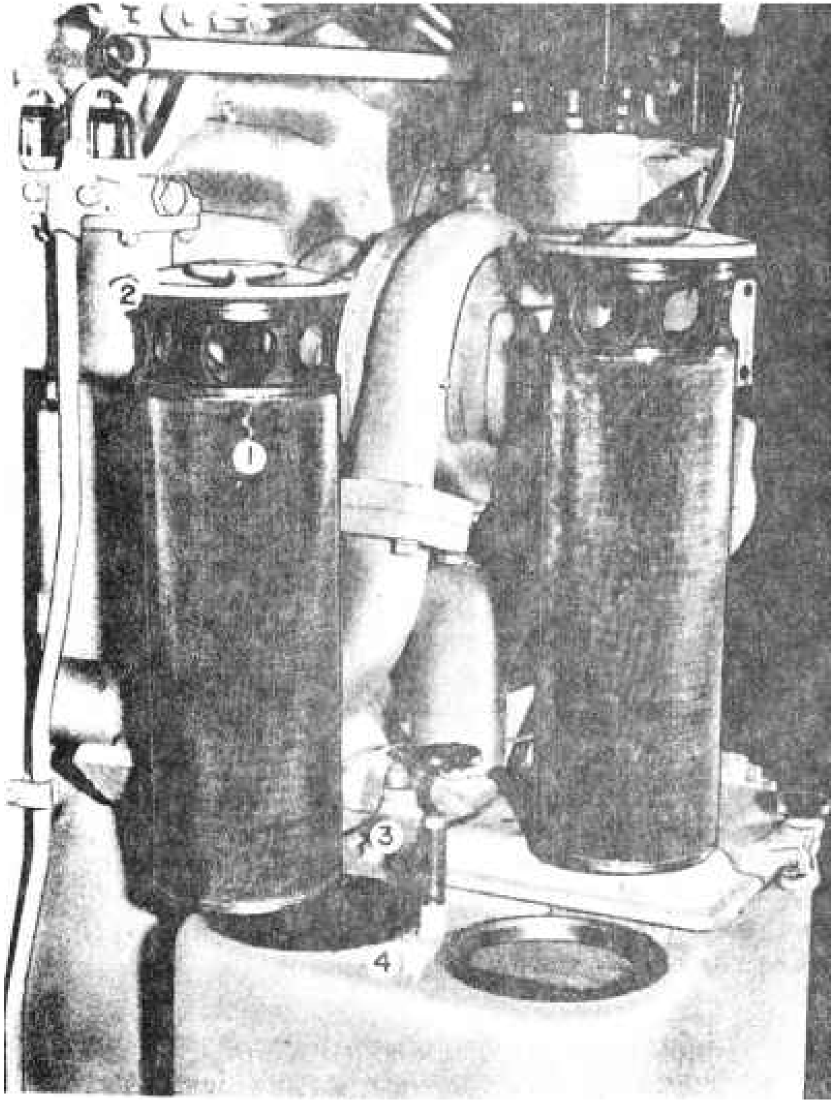
Fig. 8-3 shows the main oil pump strainers removed from the housing. When in place they are held by a crab and hand-wheel on the stud between the holes. Each strainer is sealed at the top by a seal ring. Also, oil under pump pressure is admitted to a groove around each strainer, just below the seal, to prevent air entry in event of a leaky seal. A partition adjacent to the strainers, open at the bottom, separates them from the oil inlet area of the housing. Oil enters the strainers at the partition bottom and is taken up by the pump through a cast passage in the housing.

The coarse scavenging oil pump suction screen is shown removed in Fig. 8-4. When the screen is in place its area is closed by a flange and gasket at the top of the screen and held by 3 studs and nuts, located under the large square oil filler opening cover. The inlet and outlet openings to the scavenging oil screen are shown in Fig. 8-5. An oil level is maintained in the strainer housing up to the bottom of oil overflow opening, Fig. 8-5.

Excess oil overflows into the accessory drive housing when it returns to the sump. When the engine oil is drained, oil in the strainer housing drains into the oil pan sump through the scavenging pump suction line, Fig. 8-6. A spring loaded valve is located in a cast passage between the oil storage area and scavenging suction which must be kept closed except when draining housing. The valve handle is located under the square filler opening cover.

3. Scavenging Oil Pump

The scavenging oil pump, Fig. 8-1, Item 12, is mounted on the accessory



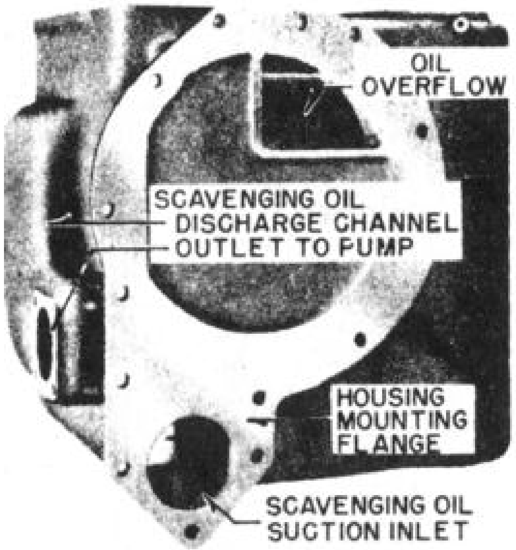
1. Strainer
2. Ring Seal
3. Filler Cover
4. Oil Passage

Pressure Pump Strainers
Fig. 8-3

- 803 -

Scavenging Pump Strainer
Fig. 8-4

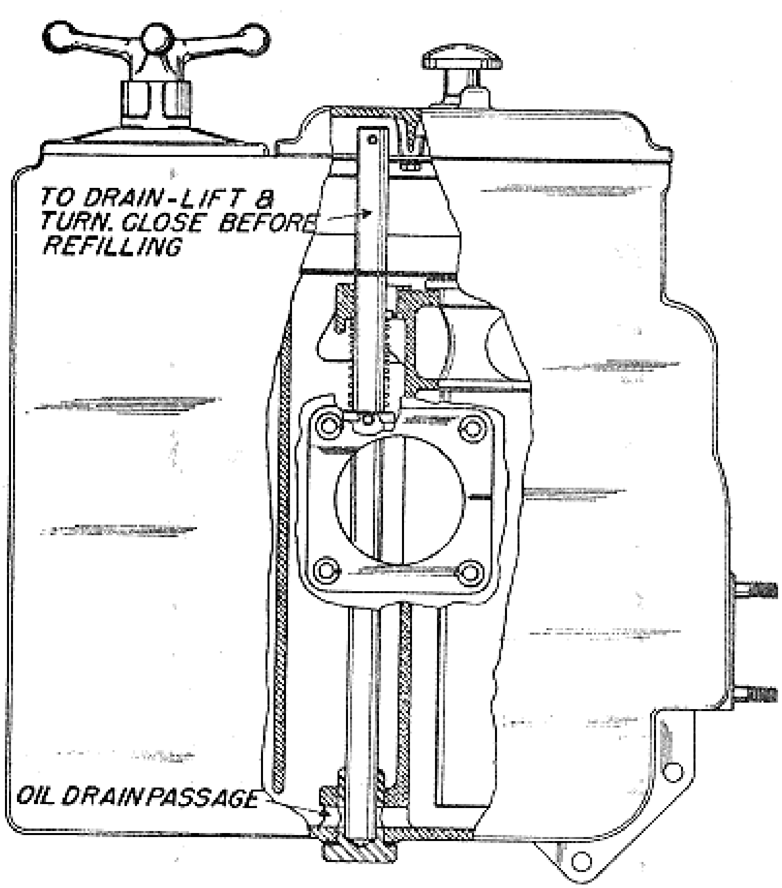
- 801 -



Back Of Strainer Housing
Fig. 8-5

gear cover in line with and to the left of the crankshaft and is driven by the accessory drive gear.

The scavenging oil pump, Figs. 8-7 and 8-8, is a positive displacement, helical gear type pump, and self priming. The pump housing, which is split transversely for ease of maintenance, houses a double set of mated pumping gears. The driving gears are retained on the pump drive gear shaft by Woodruff keys. The idler shaft is held stationary in the housing by a lock screw, and driven pump gears rotate on this shaft on bushings pressed into the gear shaft bore. The drive shaft turn. in bushings pressed into the pump housing. These bushings are made with thrust collars which protrude slightly above the pump body and absorb the thrust of the drive gears

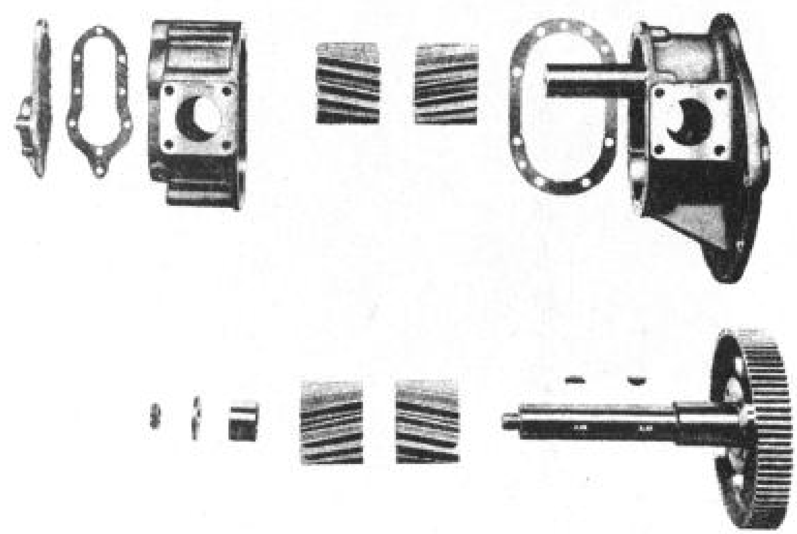


4. Lube Oil and Piston Cooling Pressure Pump

The lube oil and piston cooling oil pumps are contained in one housing, Fig. 8-9 and Fig. 8-10. The two pumps are separated by a division plate between the sections of the pump housing. Each has its individual oil inlet and discharge opening. The piston cooling pump at the outer end has narrower gears than the lube oil pump. Pump construction otherwise is similar to the scavenging oil pump. The lube oil and piston cooling oil pump is mounted at the accessory drive housing center, Fig. 8-1, Item 6, and is driven by the accessory drive gear.

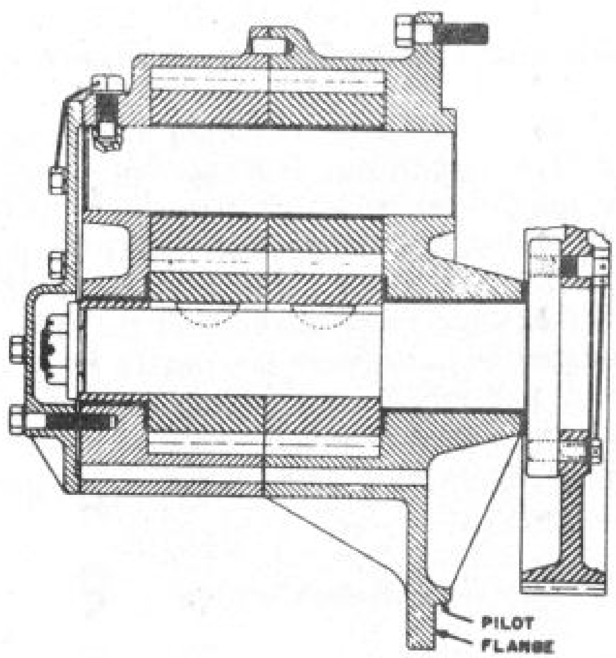
5. Lube Oil Pressure Relief Valve

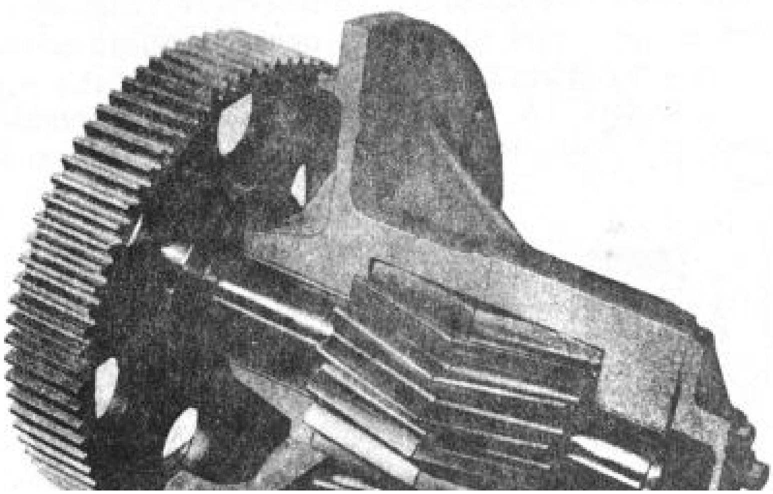
The lube oil pressure relief valve, Fig. 8-11, is mounted on the lube oil cross-over manifold under the accessory gear train cover on the left side of the engine, Fig. 8-1, Item 8. A cover plate, easily removable, is provided for access to the valve for inspection and adjustment.

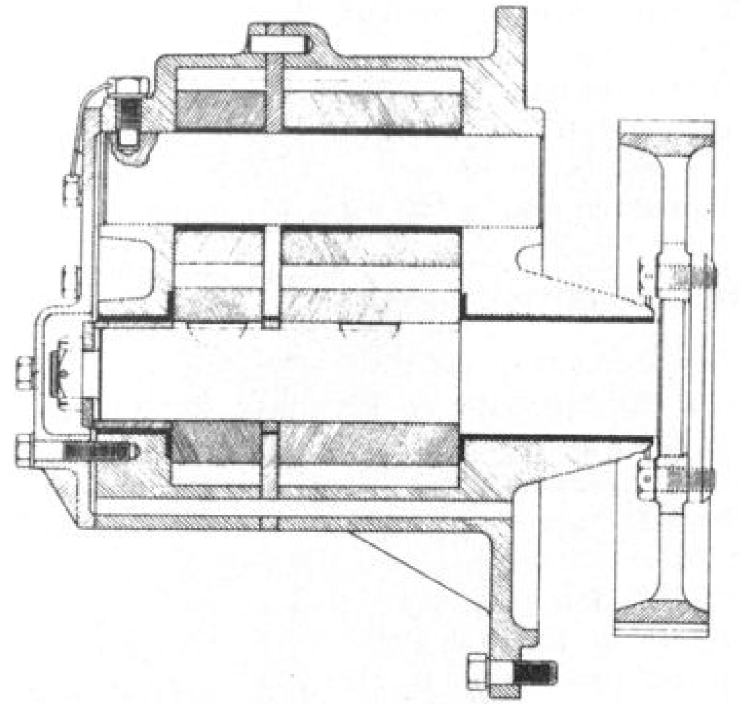


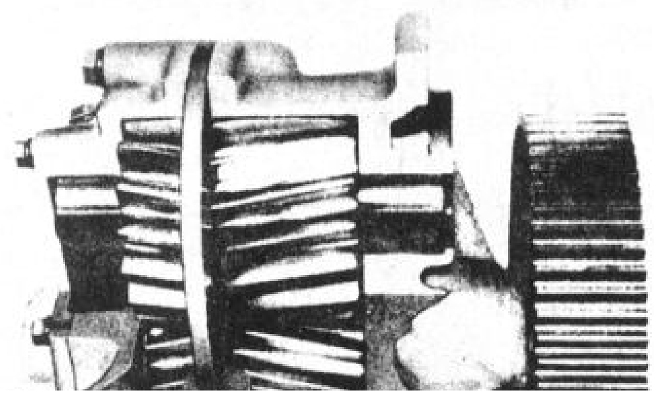
Scavenging Pump Exploded
Fig. 8-7

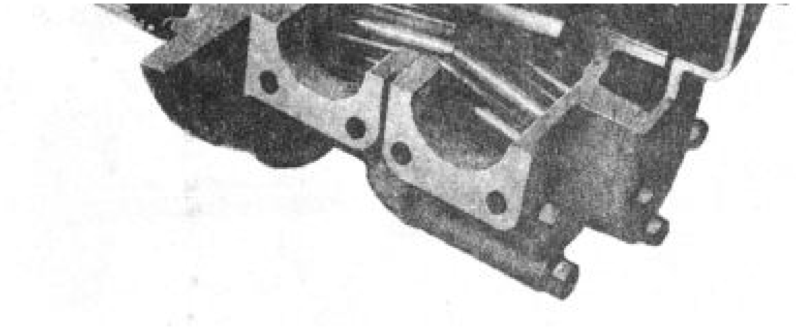
Strainer Housing - Internal Drain
Fig. 8-6





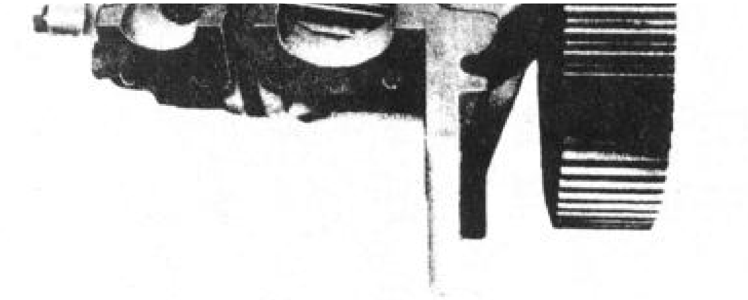






Scavenging Pump
Fig. 8-8

- 807 -



Lubricating and Piston Cooling Pump
Fig. 8-9

- 808 -

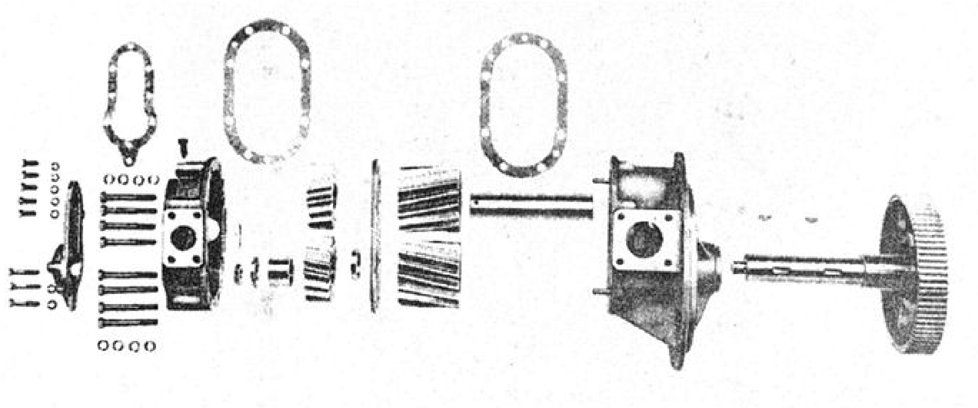
The purpose of the valve is to limit the maximum pressure of the lube oil entering the engine lube oil system. When the pump pressure exceeds the spring tension on the valve it will lift the valve off its seat and relieve the excess pressure. This oil drains into the accessory housing and to the oil pan sump.

6. Lube and Piston Cooling Oil Manifold

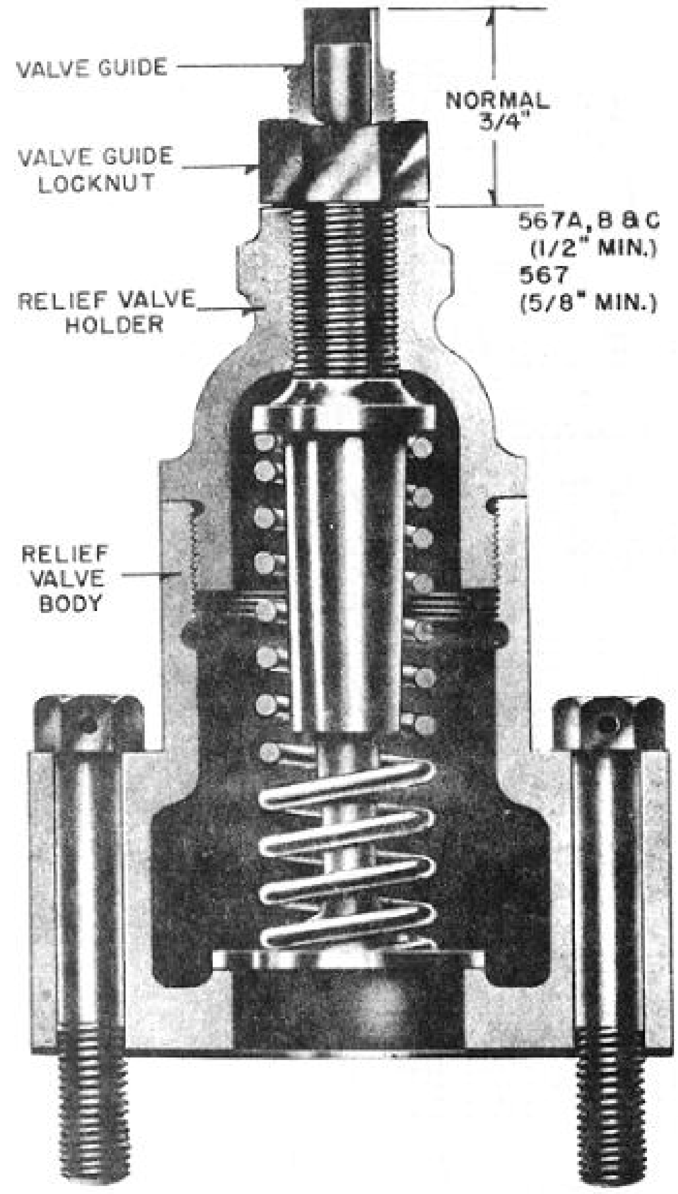
The lubricating and piston cooling oil manifold is a one piece casting with cored passages, Fig. 8-12. The manifold is mounted and doweled in the front endplate under the accessory drive cover. Connecting tubes passing through the accessory drive cover, protected against leakage by seal rings, connect the manifold to the discharge of the lube oil and piston cooling pressure pumps. The purpose of the manifold is to transfer the oil supplied by the lube oil and piston cooling pumps to the main bearing oil header in the center of the engine and to the piston cooling oil header pipes on each side of the crankcase just inside the oil pan mounting flange.

7. Lube Oil Separator

The oil separator, Fig. 8-13, is mounted on top the auxiliary generator drive housing. It is a cylindrical housing containing a securely held mesh screen element.

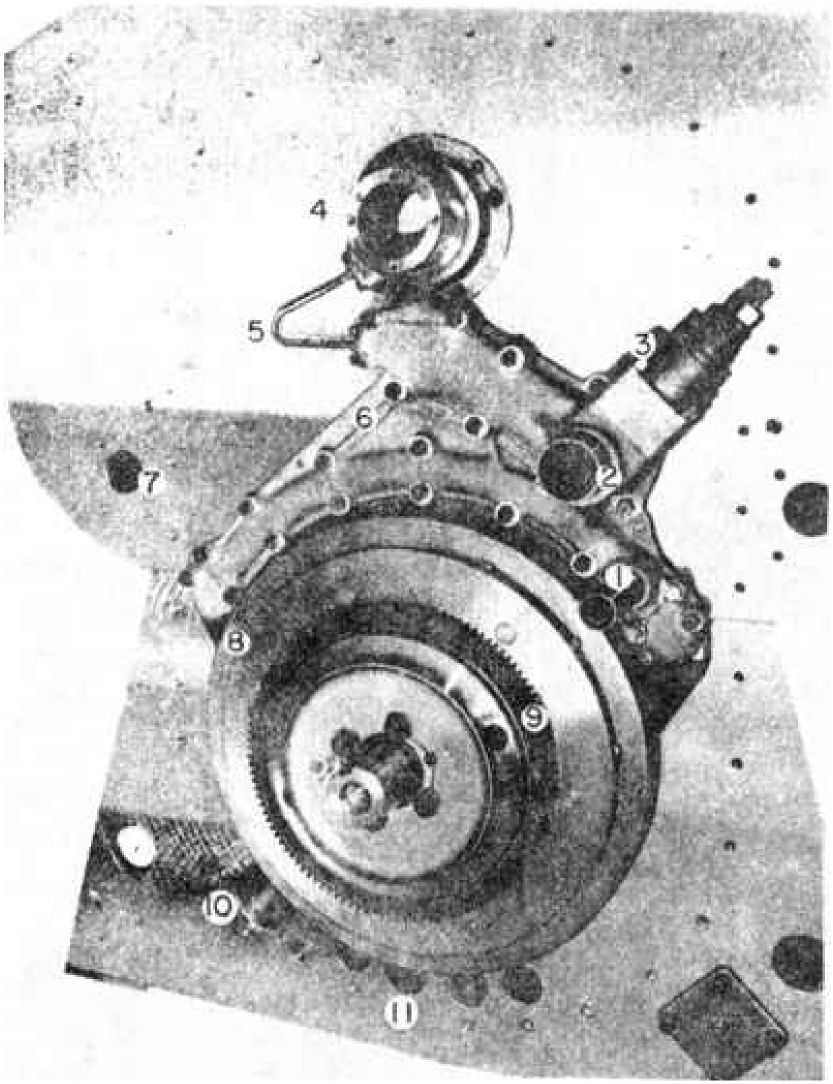


Exploded View Of Lube And Piston Cooling Pump
Fig. 8-10



Engine Oil Pressure Relief Valve
Fig. 8-11

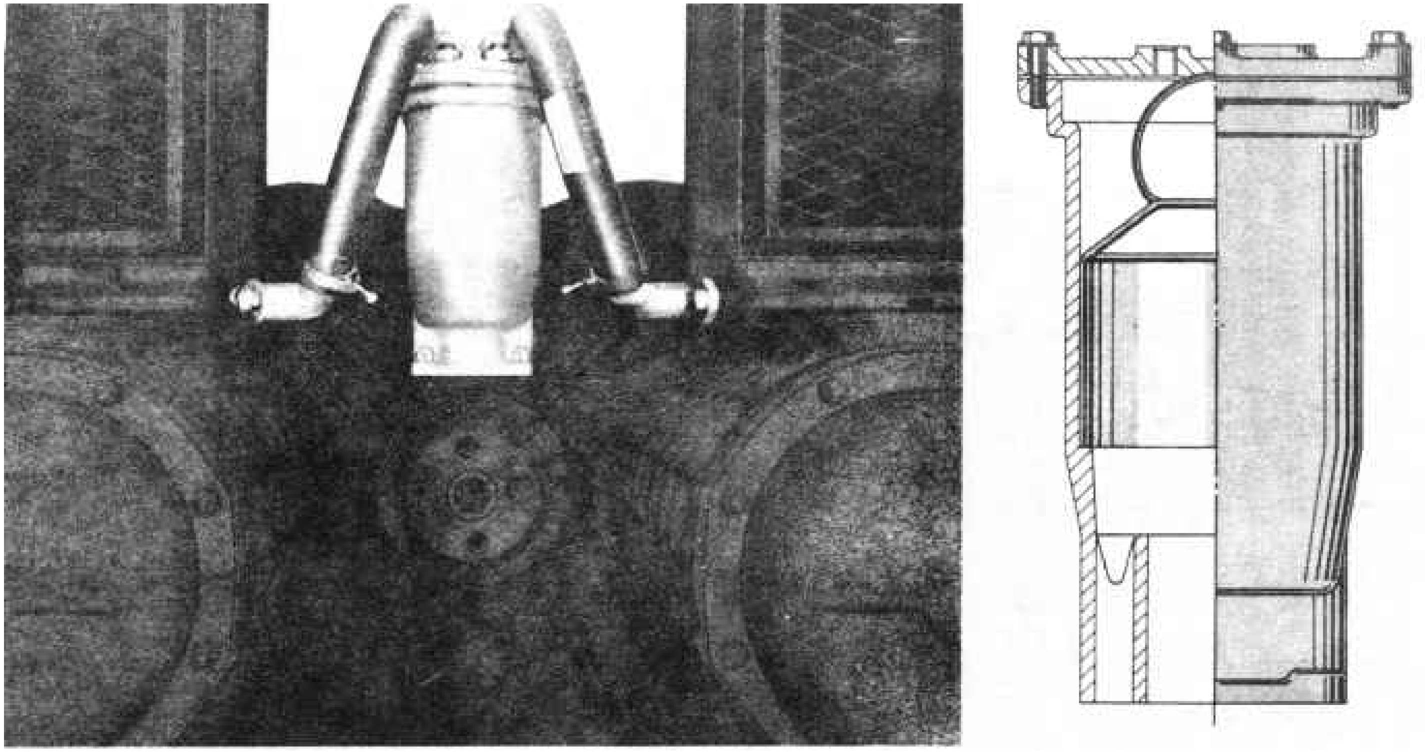
OIL SYSTEM 252C-8-154



1. Piston Cooing Oil Inlet
2. Lubricating Oil Inlet
3. Lubricating Oil Relief Valve

4.	Governor Drive Gear Stubshaft
5.	Stubshaft Oil Line
6.	Lubricating and Piston Cooling Oil Manifold
7.	Right Bank Water Inlet
8.	Harmonic Balancer
9.	Accessory Drive Gear
10.	Scavenging Oil Suction Line Outlet
11.	Oil Pan Return Oil Opening

Lubricating And Piston Cooling Oil Manifold
Fig 8-12



Oil Separator
Fig. 8-13

The housing cover has two openings on top to connect hoses leading to the suction side of each blower.

Blower suction draws the hot oily vapor from the oil pan through the rear gear train housing into the oil separator. The oily vapor collects as oil on the mesh screen of the separator element, drains to a trough at the separator bottom and flows into the gear train returning to the oil pan.

C. OPERATION

compression ring section of the piston skirt and lubricates the piston pin and bearing, then drains out of the piston through holes in the carrier.

The lube oil manifold delivers the oil from the lube oil pressure pump to the main "V" shaped oil header running throughout the length of the crankcase. An oil line taken off the pressure oil manifold extends to the governor drive gear stubshaft. Pressure oil in the "V" shaped header flows down the main bearing "A" frame oil tubes to lubricate the main bearings and then through drilled passages in the crankshaft to the connecting rod bearings. Leak-off oil

1. Scavenging Oil System

The scavenging oil pump draws oil from the oil pan sump or reservoir, through the scavenging oil strainer, and forces the oil through the oil cleaner (filter or seprifuge) and oil cooler to supply the lube oil and piston cooling oil pump. Provision is made to assure an oil supply to these pumps if oil from the scavenging oil pump is restricted by unusual conditions in either the filter or cooler.

2. Lube Oil and Piston Cooling Oil System

The lube oil and piston cooling oil pressure pumps draw the cleaned and cooled oil through the two fine mesh strainers in the oil strainer housing through a common suction elbow from the top of the strainer housing and discharges it under pressure through separate piston cooling oil pump and lube oil pressure pump discharge elbows to the manifold connections on the accessory gear cover.

The piston cooling oil manifold delivers oil to the two piston cooling header pipes. The oil is forced out of the headers through the piston cooling oil "pee" pipes which direct a stream of oil into a hole in each piston pin carrier. This oil cools the piston pin crown, the

from the adjacent main bearing will lubricate the thrust bearings. The harmonic balancer and accessory drive gear are lubricated by oil flowing forward under pressure from the #1 main bearing journal through radial drillings in the crankshaft which align with similar drilling in the harmonic balancer hub and accessory drive gear allowing pressure lubrication of spring packs and rim to hub bearing surface.

The oil flowing from the rear end of the "V" shaped main bearing oil header lubricates the gear bearings in the camshaft and blower drive and passes into the camshafts. The camshaft bearings are lubricated by radial holes in each segment bearing. From one bearing cap of each camshaft segment oil flows through a line to the rocker arm shaft bushings and through drilled passages in the rocker arm to the cam follower roller bushings and hydraulic lash adjusters. Leak-off from the camshaft and rocker arms flows across the tops of the cylinder heads into a drain channel extending the length of the engine. Vertical drain pipes from this channel allow the oil to drain to the oil pan.

Oil from the upper idler gear stubshaft lubricates the auxiliary generator drive bushings and then flows through the blower oil lines to the bearings and blower rotor gears.

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3. Lubricating Oil Pressure

Adequate lubricating oil pressure must be maintained at all times when the engine is running. Upon starting and idling an engine it will be noted that the oil pressure builds up almost immediately. In the event of cold oil the pressure may rise to the relief valve setting which will be approximately 50 pounds.

Lubricating oil pressure is not adjustable. The operating pressure range is determined by such things as manufacturing tolerances, oil temperature, oil dilution and of course, engine speed. Thus no specific operating pressures can be given. Generally however, the lubricating oil pressure will be between 16 to 25 pounds at idle speed of 275 RPM and 30 to 50 pounds at full speed of 800 to 835 RPM.

the low oil pressure and high lube oil suction shutdown as a part of the governor. Under either condition of low oil pressure or high suction the governor will act to shut down the engine. It allows a short time delay of about forty seconds at idle engine speed to allow engine starting and time to determine cause of trouble. However, repeated restarting of the engine after shutdown to locate trouble should not be attempted. The time delay is voided at 425 RPM engine speed and over, at which speed shutdown will occur in about two seconds. Details of the shutdown arrangement are outlined in the governor section. Oil pressure is measured at the rear of the engine with a connection being made at this point to the governor.

The minimum pressure at idle is 6 pounds and at full speed is 20 pounds. Operation at pressures above these minimums is entirely satisfactory. In the event of insufficient oil pressure, a shutdown feature built into the governor will automatically protect the engine by causing it to stop.

4. Piston Cooling Oil Pressure

No gauge for piston cooling oil pressure is provided. Piston cooling oil pressure can be determined by connecting a gauge at the 3/4" plugged opening at. the pump discharge elbow. Pressure of the piston cooling oil will be governed by oil viscosity, speed of engine, temperature of oil and wear of pump parts. The minimum piston cooling oil pressure at idle engine speed (275 RPM) is 3 p.s.i. and at full speed 15 p.s.i.

5. Low Oil Pressure and High Lube Oil Suction Shutdown

Engines are equipped with electro-hydraulic or pneumatic-hydraulic speed control governors which have

6. Possible Lubrication Troubles

a. Absence of Oil in Strainer Chamber This may be caused by inoperative scavenging system or open drain valve. Failure of scavenging system may be due to a broken or loose oil line connection causing an air leak, a faulty scavenging pump or clogged suction screen, or low oil level.

b. Low Lubricating Oil Pressure This may be due to stuck oil relief valve or foreign material on valve seat holding valve open, broken oil lines, clogged suction strainers, excessive bearing wear, low oil viscosity, faulty pump or diluted oil, or insufficient oil in strainer housing.

c. Failure of Oil Pump This may be due to sheared pump gear keys, broken housing or damaged gears.

d. Dilution It is possible for fuel oil to get into the lubricating oil if a fuel line connecting the injector to the fuel manifold is loose or broken or an injector is defective. If such a condition has

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existed the lube oil viscosity should be checked. The lube oil may also be contaminated by water. This can be checked visually on top cylinder heads or oil pan, also by taking test sample of oil.

e. Excessive Oil Consumption This may be caused by oil leaks, broken or stuck piston rings, worn cylinder liners, dam- aged blower oil seals, clogged oil separator screen, improper grade of oil or clogged oil drain holes under oil control rings of piston.

f. Little or No Lube Oil Consumption This may be due to water or fuel leaking into the oil.

D. MAINTENANCE

1. Oil Change

strainers, screens and filter containers, as recommended in cleaning bulletin, Mainte nance Instruction 1706.

(3) Wash down top deck, oil pan and filter hous ings using fuel oil or kerosene. Drain off all cleaning fluid and wipe areas free of excess cleaning liquid using bound edge ab sorbent towels.

(4) Replace pipe plugs in drain lines, where required, and close valves. Where neces sary renew gaskets.

(5) Install clean strainers, screens and filter containers with new elements. Prepare system to receive new oil.

(6) Recharge engine with lube oil within speci fications given in Maintenance Instruction 1607 (latest revision). Add oil through square filler opening at

Engine lube oil should be drained, filters replaced, suction strainers and screens cleaned at intervals out- lined in Maintenance Instruction 1704, Scheduled Maintenance Program. Before the oil is drained, its viscosity should be checked for indications of fuel dilution, indicating leaks, or contamination to allow their correction before adding new oil.

a. General Procedure

1. Provide container or run-off line for draining oil. Shut down engine. Open valve in strainer housing, allowing oil to drain into oil pan sump. Remove plug at end of drain line and open drain valve. Allow all oil to drain out of oil pan.
2. Remove pump suction strainers, screens, filter containers and cartridges. Clean

strainer housing. (Note: Be sure strainer housing internal drain valve is closed.) Sufficient oil will be retained in the housing to supply lube and piston cooling oil pumps on starting. Engine oil capacity may be found on the oil gauge and is given in the specifications at end of this section. Pour a liberal quantity of oil over cylinder mechanism before starting.

(7) Inspect engine prior to starting, then start engine. Check oil level with engine at idle speed. If oil level is not to "full" mark on gauge, add oil to bring level to 'full" mark, with engine at idle.

2. Checking Oil Viscosity

Oil viscosity should be checked at intervals as specified in the Scheduled Maintenance Program. By

comparing the oil. viscosity at different intervals taken at the same temperature or compensated to the oil viscosity when the oil was new, a close check can be kept on the oil to assure its replacement before its condition is rendered unusable and dangerous, within the recommended oil drain period.

Oil having viscosity changed to a great extent will, if not renewed, result in oil cooler clogging, strainer clogging, insufficient oil supply, carbon build-up on vulnerable places such as rings, grooves and small clearances with resulting damage. Therefore, to provide protection to the engine, the oil and system components should be carefully observed for proper functioning.

3. Oil Pressure Relief Valve

Disassemble the relief valve and inspect its parts at intervals given in Maintenance Instruction 1704.

guide, position the top of the valve guide 3/4" above top of valve holder and tighten locknut.

With the relief valve set to 3/4" dimension it will allow a maximum lube oil pressure at the pump of about 60 p.s.i. and provide sufficient valve lift under cold oil conditions.

Under some conditions such as weakening of the spring, it may be necessary to increase the spring tension. However, under no condition should the top of the valve guide be less than 1/2" from the top of the valve holder.

Lube oil manifold pressure or pressure at the valve may be determined by applying a pressure gauge at the pump discharge elbow.

4. Piston Cooling "Pee" Pipe Alignment

The alignment of the piston cooling oil "pee" pipe to the inlet hole of the piston carrier is checked. with alignment gauge, 8071720, shown in Fig. 8-14.

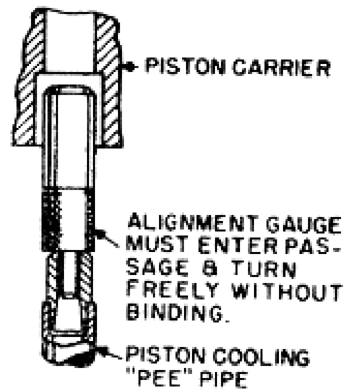
The small end of the gauge fits into the nozzle of the "pee"pipe and by

When relief valve is disassembled, examine valve stem and guide for any roughness or galling. 1f valve stem appears good, check its diameter. Minimum valve stem diameter is .4925". Check squareness of valve face to stem; should not exceed .002" total indicator reading. Using a telescoping gauge, check valve guide inside diameter. Maximum inside diameter should not exceed .5025". Load test valve spring; to compress spring to 3-3/8" should require at least 200 pounds. Replace parts as required.

The setting of the oil relief valve connected to the lube oil manifold determines the maximum pressure at the lube oil pump. It is not set by pressure gauges, but by specific dimension from the top of the valve guide to the top of the valve holder.

To set the relief valve, Fig. 8-11, shut down the engine and remove relief valve cover, Fig. 8-1. Loosen locknut. Applying a wrench to the flats on the valve

bringing the piston to bottom center it should enter the inlet hole in the piston carrier and turn freely in this position. This gauge is not to be used for bending the "pee" pipe in case of misalignment. If the gauge will not freely enter the carrier hole, the "pee" pipe should be removed and replaced with a new one of correct alignment.



"Pee" Pipe Alignment
Fig. 8-14

The piston cooling "pee" pipe is a very important part of the engine and should be inspected carefully not only for misalignment, but also the condition of the nozz1e should be examined for ragged edges that might cause the oil to spray out instead of shoot out in a stream.

A cleaning tool for the "pee" pipe may be obtained under part #8087086.

5. Oil Pumps

a. Removal and Disassembly

1. Disconnect oil line from discharge elbow and remove discharge and suction elbows Remove pump mounting bolts, allowing pump to be removed. Clean outer area of pump before disassembly.
2. Remove capscrews securing outermost small cover, to allow access to the main driveshaft holding nut. Remove cotter pin, shaft nut and

6. Lube Oil Strainers

Lube oil strainers should be removed at each oil change and cleaned as outlined in Maintenance Instruction 1706.

As described under "Unit Description", engine lube oil strainers have an oil seal in addition to the seal rings. The oil under pressure will leak out under the strainer flanges if the seal rings are not seated properly or are damaged.' When strainers are replaced, care should be taken to see that the sealing surfaces are free from nicks and scratches and seal rings are in good condition. Also, that the oil passages to the seals are open and clear.

The oil seal may be checked, with the engine at idle speed, by loosening slightly the large wing nut holding the strainers in place. Carefully raise the washer. Remove capscrew which holds pump idler shaft stationary.

3. Removal of other pump housing bolts permits entire housing disassembly for removal of pump gears and pump drive gear. Do not p press driveshaft from pump housing as Woodruff keys may damage inner driveshaft bearing. (Drive gear is on pump side of driveshaft flange on lube oil pump, outside on scavenging oil pump.)

b. Inspection and Repair Clean all parts and examine for signs of failure on gear teeth, key ways and inside pump surfaces. Check clearances as given in specifications. Replace parts as inspection or clearances indicate.

c. Pump Assembly To assemble pump reverse general procedure outlined in Item "all above. On replacement of internal pump gears, they must be replaced in mated pairs.

strainer furthest from the engine. Oil should leak out around the strainer flange. If no oil appears, the engine should be shut down and the oil supply passages inspected and cleaned.

Any air which might enter system at this location will be discharged with the lubricating oil and may cause damage, even though normal oil pressure is indicated.

7. Lube Oil Separator

The oil separator screen should be cleaned at intervals given in Maintenance Instruction 1704.

Oil separator screens are removed after first shutting the engine down, then removing suction hose at the cover. After cover is taken off, the screen is removed. The element is cleaned as recommended in Maintenance Instruction 1706.

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8. Prelubrication of Engines

The prelubrication of newly installed overhauled engines or engines having been in storage a considerable length of time, before their initial running is a necessary and important practice. This procedure alleviates engine loading of unlubricated parts during the interval until normal lube oil pump operation starts. Also, it offers protection in seeing that oil distribution in the engine is satisfactory. The oil supply from an external pump should be warm. Oil pressure need not exceed 35 p.s.i: A piping diagram for pressure pretest of the

9. Oil System Information

Additional information on the oil system and components is given in the latest revisions of Maintenance Instruction bulletins. These instructions cover important items such as the Scheduled Maintenance Program which outlines maintenance intervals, flushing instructions, cleaning information and lubrication specifications.

E. SPECIFICATIONS

Lube Oil Lubricating oil to be used in the engine should be an S.A.E. #40 oil corresponding to specifications given in the latest revision of Maintenance Instruction 1607.

	New	Limit

lube oil, fuel oil and cooling system may be obtained by requesting blue print, File 294.

At the time of pumping the oil through the engine, inspection should be made at the rocker arms, camshaft bearings and main bearings to see that oil is reaching these parts. The crankshaft should be rotated at least one revolution so as to distribute oil over various moving parts. Sufficient oil should be pumped to assure oil reaching all parts of the engine.

Before starting the engine, pour a liberal quantity of oil over the cylinder mechanism of each bank. This applies also on new engines.

Inasmuch as new engines have been filled and run with oil before leaving the factory, prelubrication of such engines is considered unnecessary.

NOTE: When an engine is replaced due to mechanical breakdown, it is important that the entire oil system, such as oil coolers, filters and so forth, be thoroughly cleaned before a replacement engine or the reconditioned engine is put in service. A recurrence of trouble may be evident in the clean engine, if other system components are neglected.

Lubricating Oil Pumps

Clearance-Drive Shaft to bushing	.0015"	- .0045"	.007"
Clearance-Idler Gear Shaft to gear bushing	.0015"	- .0051"	.007"
*Clearance-Gears to separator plate	.002"	- .018")	Should not Wear
Clearance - Gear to housing - endwise	.018"	- .022•')	)
"Clearance - Gear to thrust bearing	.005"	- .016"	.022"
**Clearance - Gear to thrust bearing	.008"	- .016"	.022"
Protrusion - Thrust bearing from housing	.001"	- .007"	Flush

*Lubricating oil pump only. **Scavenging oil pump only.

OIL SYSTEM 252C-8-1256

New		Limit
Backlash - Pump gears .012"	- .016"	.030"
Backlash - Drive gears .00811	- .016"	.030"
Clearance - Pump gears to		
housing (radial)		.010"
Bushing diameter		
Outer pump body		2.379"
Inner pump body		2.504"
Driven gear		2.004"
Face runout - drive gear -		
total indicator reading		.003"
Pump flange face runout		
total indicator reading		.005"
Concentricity - pump flange pilot -		
total indicator reading		.002"

Pump Capacity (Approx. GPM)

800 RPM	6 cyl.	8 cyl.	12 cyl.	16 cyl.
Scavenging	124	124	182	248
Piston Cooling	31	31	43	59
Lube Oil	59	71	103	140

835 RPM

Scavenging	130	130	190	260
Piston Cooling	33	33	45	61
Lube Oil	62	74	108	146

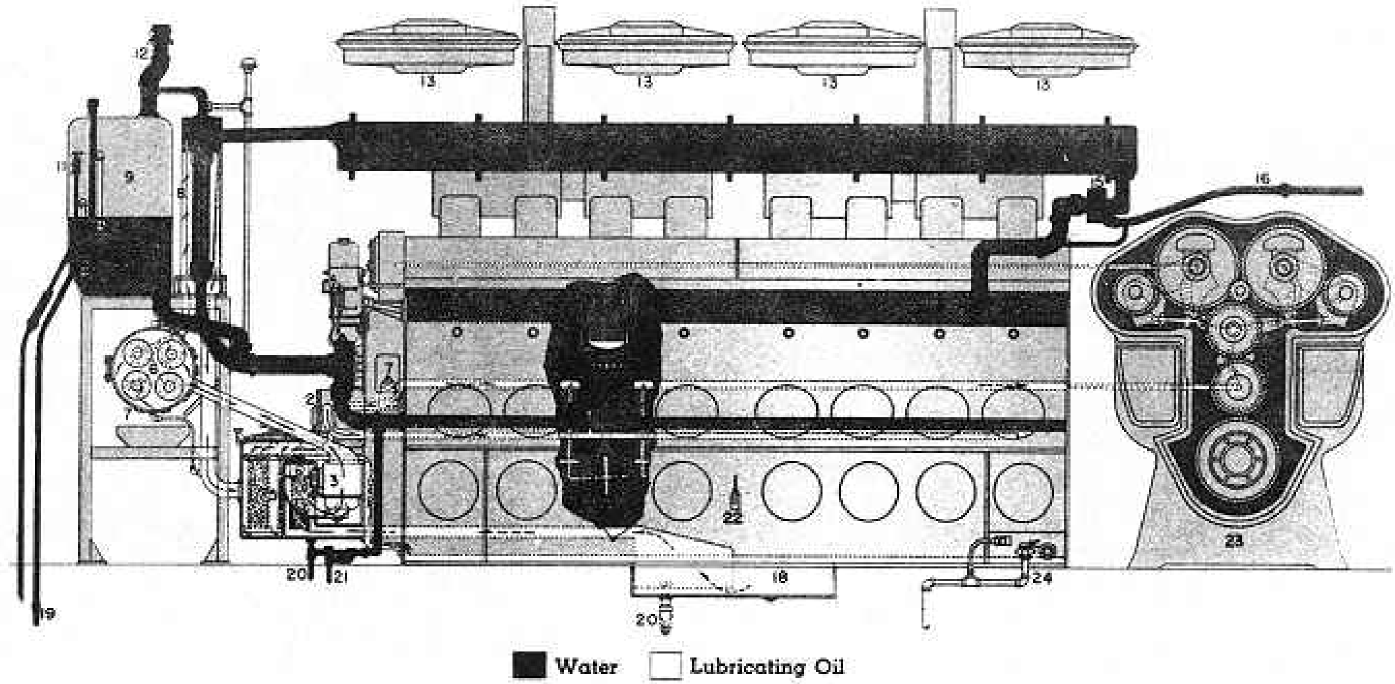
Oil Capacity

6 cyl. - 120 gal. (U.S.)	12 cyl.- 165 gal. (U.S.)
8 cyl. - 130 gal. (U.S.)	16 cyl.- 200 gal. (U.S.)

F. EQUIPMENT LIST

Name	Part No.
Spray gun	8193041
Gauge - piston cooling pipe alignment	8071720
Testing device - lube oil suction	File 110
Lube oil system - pretest diagram (includes diagram for fuel and water system)	File 294

For additional tools, see Tool Catalog 91B.


12
13
13
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8
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6
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2
3
22
23
20
21
18
24
19
20
Water
Lubricating Oil

SECTION IX

COOLING SYSTEM

A. GENERAL DESCRIPTION

The cooling system of the engine consists of engine driven centrifugal water pumps, replaceable inlet water manifolds with individual jumper line to each liner, cylinder head discharge elbows and outlet manifold, through which cooling water is circulated. The centrifugal water pumps are mounted on the accessory drive housing and driven by the governor drive gear.

Water temperature gauges, level gauges, connecting piping, and fill and drain lines complete the cooling system. A representative schematic of the cooling system is shown in Section 8.

The heated discharge water from the engine is cooled by either of two different methods depending on the individual installation.

1. Air Cooling

The engine discharge water is cooled in banks of tube and fin type radiators which are force ventilated by means of fans either driven mechanically by the engine or by separate electric motors. Water thus cooled leaves the radiators and flows through the lube oil cooler and then continues on to the water pump inlet where it is then recirculated through the engine.

Cooling air admission to the radiators is controlled by automatically operated shutters according to the water temperature. Electrically driven cooling fans also function automatically by thermostatic control, according to the water temperature. Some of the mechanically driven fans are constantly driven at

speeds directly proportional to engine speeds while others use eddy-current coupling arrangements to vary the fan speed according to the engine water temperature.

2. Water Cooling

If a sufficient supply of raw water is available a heat exchanger may be used on applicable installations. Engine water temperature on these applications is controlled by an automatic thermostat valve arrangement.

a shoulder on the shaft. The inner bearing is held in place by a retainer and snap ring to absorb any thrust in the shaft.

The pump drive gear is keyed to the pump shaft abutting the inner bearing and is held by a washer and nut on the shaft. A stationary bushing fits over the pump shaft at the impeller end and is mounted on the main housing. This bushing provides a smooth flat surface for the carbon seal which is between the bushing and the impeller. The impeller is keyed to the pump shaft and is held by washer and nut. It is enclosed by the impeller housing, which is mounted by studs and nuts to the main pump housing. Plugged drain holes are provided in the impeller

B. DESCRIPTION

1. Pumps

The engine cooling water pumps are of the centrifugal type and rotate counter-clockwise. Two pumps are used on the 12 and 16 cylinder engines and only one pump on the 6 and 8 cylinder engines. The pumps are carried under two part numbers to identify the right or the left bank pumps. The difference in the bank designation is only because of the position of the impeller housing to enable line up to the pump discharge pipe. The impeller housing position on either pump may be changed to permit use on either engine bank.

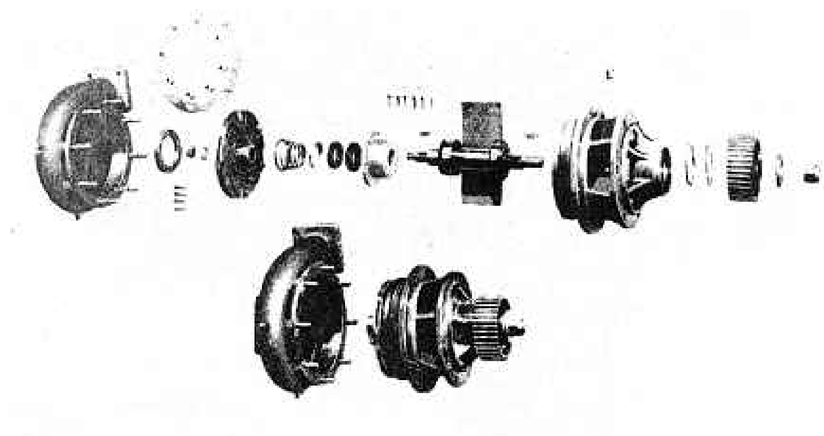
The various parts of the water pump are shown in Fig. 9- 1. The main parts are: impeller, impeller housing, drive shaft, drive shaft housing, bearing, seal assemblies and drive gear. A cross-section of the pump is shown in Fig. 9-2.

The pump drive shaft is supported in the main pump housing by two ball bearings separated by a steel spacer. The spacer is covered by a felt pad which receives the bearing lubricating oil from the oil cup in the housing. The outer bearing abuts a water slinger against

housing and a tell-tale drain is provided in the main pump housing to dispose of any water leak past the seal.

2. Engine Water

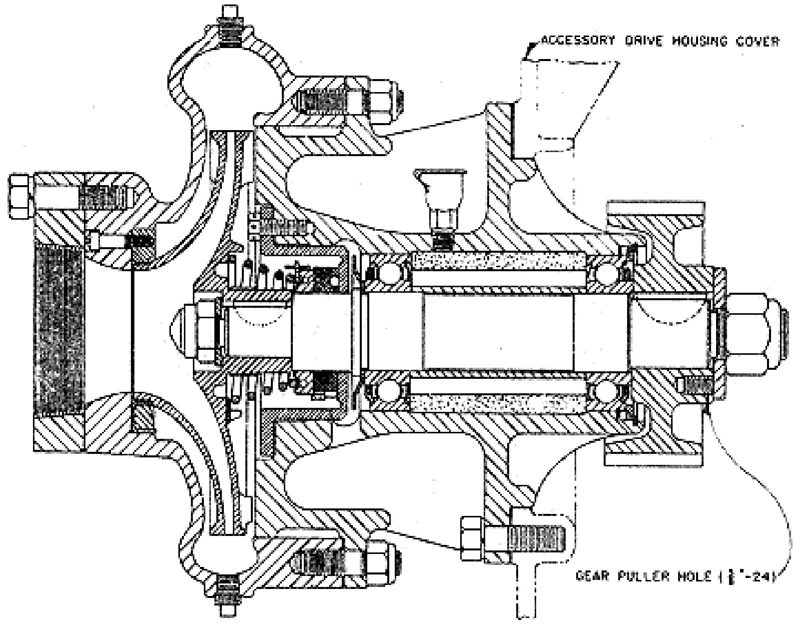
Passages Pump discharge elbows conduct water from the pumps to the removable water inlet manifolds, extending



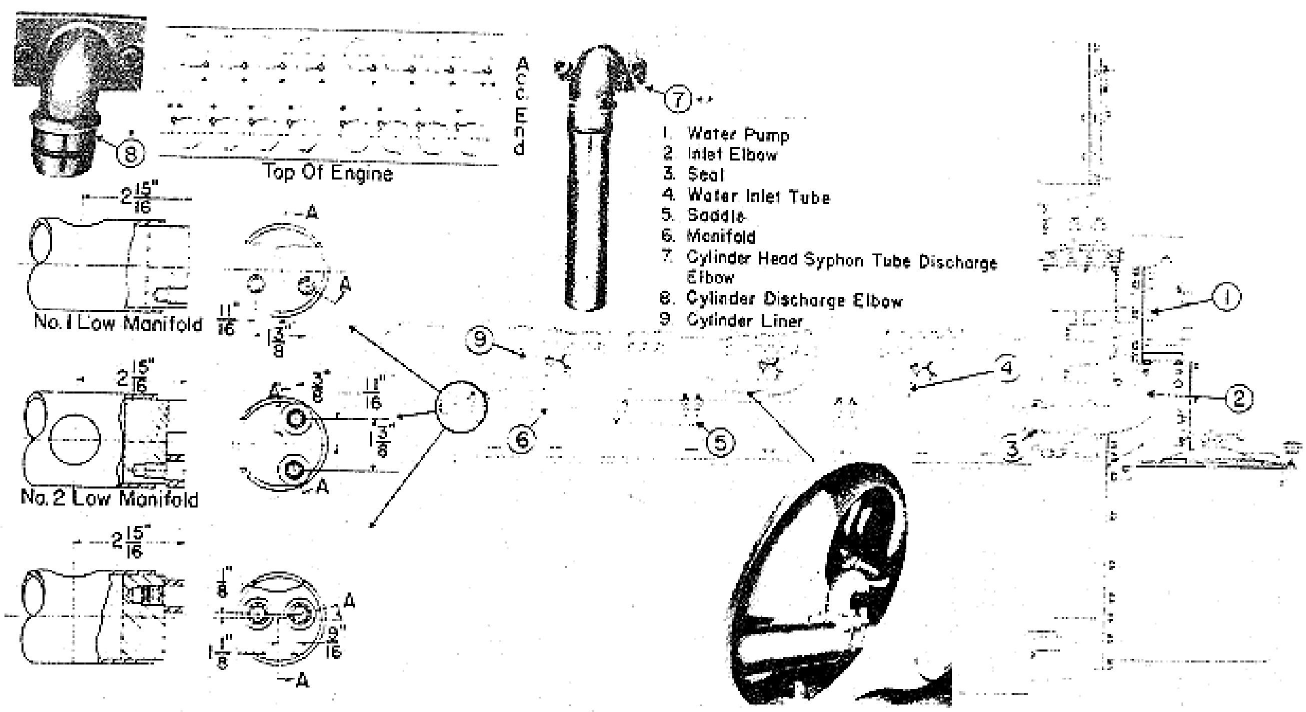
Water Pump - Exploded View
Fig. 9-1

the length of the crankcase, located in each air box, Fig. 9-3. Each manifold is supported at the rear end plate by two capscrews extending through the blower support and end plate into the plugged end of the pipe. Locating dowels at the rear end of the pipe extend into counterbores in the rear end plate to assure proper position of the pipe. At the front end plate the manifold protrudes and is held in a counter-bore in the connecting pump discharge elbow. A seal ring, in a chamfer in the discharge elbow, fits around the pipe to make the junction of pipe, discharge elbow and front end plate water-tight.

Each liner is individually supplied from the water manifold through a water inlet tube assembly. The inlet tube is connected to the manifold by saddle strap assemblies around the manifold and bolted to the liner. A gasket is used at the saddle connection while a synthetic



Water Pump Cross-Section
Fig. 9-2



rubber seal ring is used at the liner. A deflector is used at each liner water inlet (shown in Section 4), turning the water to prevent direct impingement on inner liner wall. Water enters the cylinder head through twelve discharge holes at the top of the liner. A counterbore around each hole accomodates a water seal ring. A single water discharge elbow, Fig. 9-3, bolted to each cylinder head provides water passage to the water discharge manifold extending along the top of the crankcase. The cylinder head water discharge elbows are applied to each cylinder head before installation, and act to properly position each cylinder head. Seal rings are used at the elbow connections. The seals maybe replaced if required, by removing the elbow, after first removing the crab above it, without disturbing the cylinder head. There are two designs of discharge elbows; siphon tube elbows, two of which are used in an engine, and elbows without siphon tubes. The siphon tube extends down into the discharge manifold, its end close to the bottom to drain the manifold when engine water is drained. It is important that the last cylinder head of the right bank and the first cylinder head of the left bank have a siphon tube water discharge elbow. This will provide for engine cooling water draining in the event the engine is not level.

3. Engine Water Temperature

Temperature gauges are provided in the cooling system for visual indication of engine water temperature and as a guide to engine water operating temperature in the recommended range. The recommended operating range is a water discharge temperature between 160° F. and 180° F. The minimum water temperature at which the engine should be loaded is 120° F. Automatic engine water temperature controls (where used) are set to maintain the water discharge temperature within approximately the 150° F. - 180° F. range.

A hot engine alarm (where used) indicates dangerous water discharge temperature. Hot engine water would result due to improper water, faulty water cooling equipment or loss of water. Engine load should be removed and speed reduced, not stopped, to obtain normal temperature in event of a hot engine alarm. Before resuming operation, the cause of the hot engine water should be found and corrected.

For the applicable instruction covering hot engine and engine temperature control settings, refer to the Service Publications Index.

4. Engine Cooling Water

The water used in the engine cooling system should be controlled so that its hardness will not exceed 10 grains per gallon and the chloride content less than 10 grains per gallon to prevent precipitation of solids in the engine when heated to operating temperature.

In addition, the water should be treated to prevent rust or corrosion of metal parts of the engine by a suitable inhibitor which is not detrimental to engine seals or cooling system hose. The pH value of the treated water should be within 8.5 to 9.7.

Experience has led to the conclusion that the Borate type water inhibitors are satisfactory in every way for use in the engine cooling water, such as National Aluminate Corporation, Nalco #39 or Dearborn Chemical Company, Dearborn #527 or their equivalent. These compounds should be added to the treated water in proportion of 0.75 ounces per gallon.

This conclusion has been reached after evaluating the types of inhibitors previously used in the cooling system such as, soluble oil and chromate types. Soluble oil is detrimental to engine seals and cooling system

hose, while chromate types lend themselves to personal safety risk through careless handling and/or negligent personal hygienic procedure.

It is important that the proper concentration of treatment be maintained in the cooling water at all times. A most satisfactory tray of maintaining this concentration is to have all stations where water is added to the system equipped with a supply tank in which good water having the proper amount of treatment is always available.

Proper water and attention to the cooling system cannot be too highly emphasized. Failure to recognize their value will most likely result in increased maintenance, replacement and repair of parts and damage to the engine and cooling system. Necessity for flushing of the cooling system also will be increased. Information on cleaning

Separate oil heaters or electric immersion type heaters may be applied to heat the engine water. The number and type of units, frequency of need for heat, availability of external heat supply and other factors, will influence the selection of equipment.

C. MAINTENANCE

1. Cooling System Piping Installation

Water inlet manifold assemblies, liner water inlet tubes and water pump discharge elbows in the present production 567C engines differ from a few original pilot model 567C engines. The reason for the difference is that present engine inlet water manifolds are raised?/8" compared to original engines.

and flushing the cooling system is contained in Maintenance Instruction 1706 which is the general cleaning bulletin.

2. Engine Water Heating

To prevent freezing of the engine water during cold weather when the engine is temporarily inactive, some means of heating the water must be provided. Methods for this protection are live steam admission to the cooling system, separate small water heaters, either oil-burning of electric, or by running the engine at idle.

Each engine cooling system is equipped with a steam admission line with a check valve allowing steam supply from an external source or from a steam generator on units so equipped. If steam is supplied for heating, the pressure must not exceed 50 p.s.i. and any overflow valve in the cooling system should be opened to permit condensation to drain and maintain the desired water level. A disadvantage in steam heating .the water is loss of inhibitor resulting in a weak solution.

On engines after serial number 53-J-99, the manifold end capscrews pass through the blower support flange at the bottom outer two bolts, while on low manifold engines, these bolts are below the blower support. Consequently, these bolts are longer on present engines, also they are of greater diameter, being 1/2"-20 x 2-1/4", compared to the 3/8"-24 x 1-1/41, used with the low manifold. Since one blower is used on 6 and 8 cylinder engines, the manifold holding bolts opposite the blower are shorter, 1/211-20 x 21: Torque value of the manifold holding bolts is 75-80 foot-pounds.

The low and high manifolds may also be identified by the locating dowels as shown in Fig. 9-3. The center line of the dowels of the present high manifold are 1/8" above the pipe centerline, 90° to vertical centerline through a water discharge hole and are 1-1/8" apart, while low manifold dowels are 3/ 8" below the centerline and 1-3/8" apart. (A few low manifolds did not have locating dowels.)

Liner water inlet tubes and pump discharge elbows on all engines are the same regarding construction but

high manifold parts are shorter, consequently not interchangeable.

Before tightening the liner water inlet tube capscrews or the saddle strap nuts, the cylinder head to liner nuts must be tightened and the water manifold must first be properly positioned by application of its rear end holding bolts through the blower support flange and/or end plate.

The locating dowels must be in their counterbore in the end plate. Apply liner water inlet tube seal (this seal is used also at cylinder head discharge elbow) and apply tube to liner, leaving capscrews loose. Apply saddle strap and tighten strap nuts finger tight, leaving sufficient space between pipe and saddle for gasket. Bend the gasket slightly to conform to pipe and place gasket under the saddle with long side across the pipe. Tighten liner capscrews to 30 foot-pounds and then tighten saddle strap nuts to 15 foot-pounds.

Apply seal over end of manifold and apply water pump discharge elbow. It is important that the last cylinder head of the right bank and first cylinder head of the left bank have a siphon tube discharge elbow to permit draining the water discharge manifold when the engine is drained. All other cylinder heads have discharge elbows without siphon tubes.

Seals and gaskets are identical in both low and high manifold engines. For respective part numbers of these and other system parts see Parts Catalog #90.

2. Pump

a. Removing Pump

(3) Remove suction line and disconnect pump discharge flange connection.
(4) Remove pump mounting capscrews allowing pump to be removed from the engine.

b. Removing Impeller

1. Remove nuts holding impeller housing and remove the housing. The impeller housing can be more easily removed if the pump is held suspended slightly above the work bench by hoist or other means, impeller end down, and by tapping on the housing with a rawhide or wooden mallet.
2. Remove impeller shaft nut and washer and apply impeller puller #8067245 to remove the impeller as shown in Fig. 9-4. The thrust

1. Drain cooling system
2. Mark flanges on bellows suction tube so it can be re-installed in its original position. This tube is not flexible enough to be bent, twisted or stretched too far without damage.

Removing Impeller
Fig. 9-4

cup which is part of the puller is placed over the end of the shaft to protect the shaft threads. Remove holding key.

c. Replacing Shaft Seal and Stationary Bushing

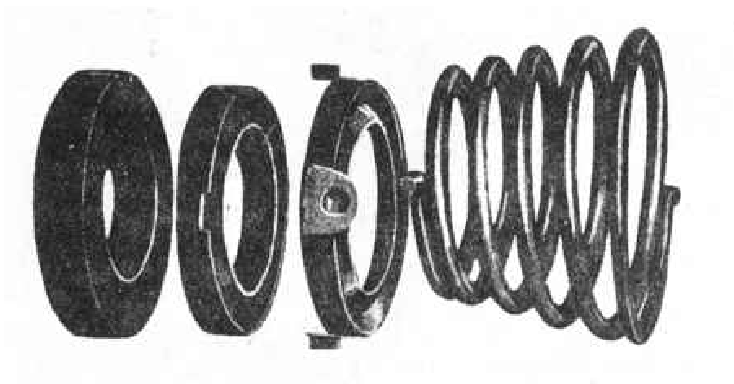
1. Remove impeller as outlined in Item "b."
2. Remove seal spring and seal assembly. Use care to prevent damage to the stationary bushing seal surface. Some seal assemblies offer little resistance to removal but some are quite firm on the shaft. Seal assemblies tight on the shaft may be removed with the stationary bushing.
3. Remove brass lockwire from capscrews of stationary bushing. Removal of the bushing may require force. In this event, insert 3/8" x 2" capscrews in the puller holes provided in the bushing, Fig. 9-6, and force the bushing out from the housing. The bushing may sometimes be loosened by tapping on the bushing flange with a rawhide mallet, allowing removal without force.
4. Clean the stationary bushing and pump shaft.

   CAUTION: The sealing surface of the stationary bushing must be absolutely smooth and flat to prevent wear of the carbon washer. A stationary bushing having a rough surface must be refinished or be replaced with a new bushing.

(5) Before applying the stationary bushing, be sure the bushing and mounting surfaces are clean. Any foreign material would cause the bushing to cock and interfere with effective sealing. Also, be sure that the smooth and flat carbon seal surface of the bushing is clean and dry.

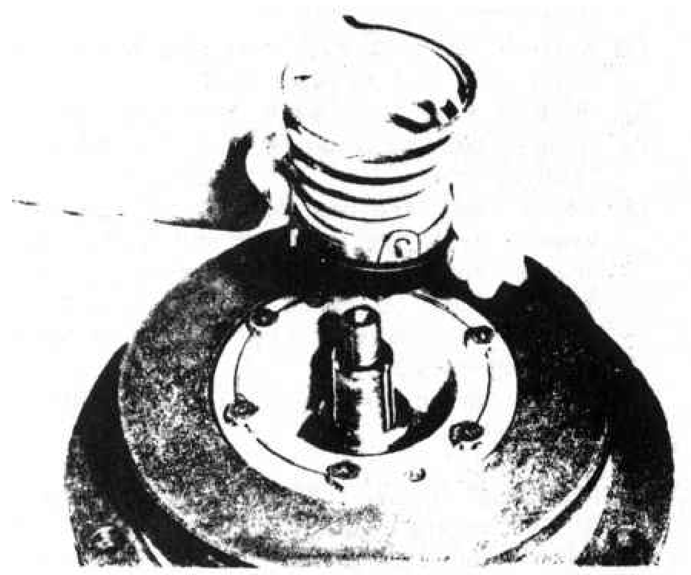
Apply new stationary bushing gasket and bushing. Tighten the capscrews evenly and lockwire using brass lockwire. Torque value of 5/16"-18 capscrews is 65-75 inch pounds.

After applying the stationary bushing, check runout of the carbon seal surface using an indicator mounted on the end of the pump shaft. Runout should not exceed .001" total



Water Pump Seal Assembly - Exploded
Fig. 9-5

- 911 -



Installing Pump Seal Assembly
Fig. 9-6

- 912 -

indicator reading. If .001" is exceeded, reposition bushing 180° and/or scrape off foreign material in area of high reading, on mounting surface.

(6) Install new seal assembly, shown in Fig. 9-5. Apply carbon washer (inner seal), narrow end contacting the stationary bushing. Check carbon face for cleanliness. Apply outer seal (synthetic rubber) to shell, and apply to carbon washer so ears of shell fit into the slots in the carbon washer. One end of the drive spring fits into the shell while the other end must be fitted into a slot at the bottom of the impeller when it is assembled.

d. Removing Pump Shaft And Bearings

1. Remove impeller housing, impeller, shaft seal, and stationary bushing, as outlined in Items "b" and "c."
2. Remove nut and gear retaining washer from drive gear end of pump shaft.
3. Remove gear using gear puller set #8068025.
4. Remove bearing retainer snap ring and bearing retainer ring.
5. Press shaft and bearing assembly out of the housing from the impeller end, using copper or other soft metal block protecting the threads of the shaft. Unscrew oil cup several turns to assure tip end will not protrude and restrict pressing operation.
6. Press bearing assembly off the shaft from the gear end.

   NOTE: Pump shaft puller #8219743 and gear puller #8219744may be used for disassembly and assembly of these parts if a press is not available. File print #536 shows application of these tools.

Bearings with seals or shields on both sides should not be washed but wiped clean. Inspect bearings for excessive end play, roughness, seizing, galled, worn or abraded surfaces, broken or bent seals or shields, fractured ring or rusted or discolored balls and raceways.

Pump shaft seal contact surfaces must be smooth. See Specifications for condemning limits.

e. Pump Assembly

1. Assemble water slinger, outer bearing, spacer, and inner bearing to the pump shaft, making sure that the rear bearing with the retainer ring is positioned correctly with the retaining ring to the outside. These parts are assembled, first with the slinger next to the shoulder on the shaft, concave side toward the impeller end, followed by the outer bearing (without retainer), spacer and inner bearing, abutting each other snugly. The seal sides of the bearings go toward the outer ends of the assembly, being distinguished by the seal side of the bearing protruding slightly beyond the outer race.
2. To apply the shaft and bearing assembly to the support housing, place the impeller end on the inlet flange of the impeller housing or provide a wooden block having a center bore to allow the shaft end to extend down.
3. Start the assembly in the housing, tapping lightly with a wooden mallet. Wrap the oil soaked felt pad around the spacer when the first bearing clears the housing boss, and continue down with the assembly, until the outer bearing rests on the housing boss.

(7) Clean and inspect parts for defects and replace damaged parts.

NOTE: If the felt pad feels gritty or is dirty, replace with a new oil soaked pad.

(4) First apply the bearing retainer and then the snap ring back of the rear bearing.

(5) Apply drive gear to shaft, puller taps outside. Check shaft key and way fit. Pump shaft diameter to gear bore fit is .001" loose, maximum. Inspect gear nut insert, that it is free of tears or disintegration. Nuts may be reused if fibre collar torque is 92 inch pounds. Gear nut (1"-14) torque is 265 foot pounds.

(6) Apply stationary bushing and gasket to housing and replace seal assembly as given in Item "c."

f. Installing Impeller

(1) Fig. 9-7 shows the impeller pressing on tool #8052959 in use. The threaded bushing of the tool is screwed on pump shaft threads. Then

Installing Pump Impeller
Fig. 9-7

by turning outer portion of the tool, the impeller is pressed into position. Care must be taken to start the impeller straight on the shaft and to see that the key and way are aligned.

When installing the impeller, engage seal spring end in slot under the impeller. Check insert of impeller to shaft nut that it is free from tears or disintegration. Nuts may be re-used if fibre collar torque is 32 inch pounds. Torque value of the impeller shaft nut (5/8"-18) is 80 foot pounds.

(2) Apply impeller retaining washer, nut and impeller housing using new gasket between housings.

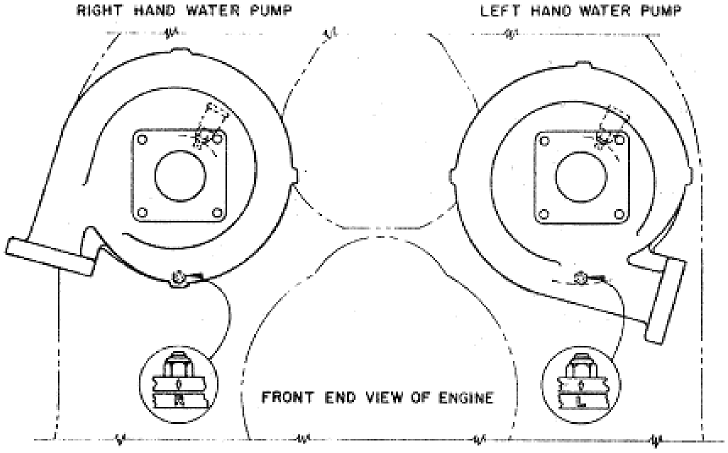
g. Installing Pump

The impeller housing is positioned differently on pumps used on the right and left bank of the engine. Before installation of the pump, determine whether the pump is to be used on the right or left bank. The relative position of the impeller housing with relation to the oil cup on the pump housing is shown in Fig. 9-8.

An arrow is cast in the edge of the flange on the bottom of the pump. The flange of the impeller housing has letter "R" (right) and "L" (left). For a right hand pump, assemble the impeller housing so that "R" is opposite the arrow, or for a left hand pump, the "L" should be opposite the arrow.

3. Water Leaks

If loss of water in the cooling system is noticed, check for leaks in piping, pump seals, jumper tube



Position Of Impeller Housing
Fig. 9-8

connections, cylinder head outlet elbow, junction head to liner, or possible cracked liner or cylinder head.

Unless very obvious, the location of a crack in the cylinder head or liner is very difficult to find, and requires careful examination. Any indication of a water leak on the head or liner surfaces requires their removal. Inspect cylinder interior through liner ports.

The only place where water might leak and enter the lube oil is at the cylinder head outlet elbow seals. These seals can be replaced without disturbing the cylinder head after a crab nut and crab are removed. Lubricating oil contamination by water will necessitate draining the oil and flushing the system, as outlined in Maintenance Instruction 1757, before the oil is renewed.

Lube oil contamination is best determined by laboratory analysis, but in the absence of such means, a

method of checking for water in the oil is as follows: Draw or dip a gallon of lube oil from the bottom of the engine lube oil sump. Let it stand for about ten (10) minutes, then spill about three-fourths (3/4) of the oil from the container. Place the remaining one-fourth (1/4) in a glass bottle and allow sample to stand another ten minutes. If any water is indicated in the bottom of the bottle, it is suggested that the lube oil system be drained and flushed. Replace with new oil after source of contamination is eliminated.

4. Additional Cooling System Information

Due to prohibitive length required to cover completely all details of the cooling system, separate maintenance instructions have been written. A listing of these instructions are in the Service Publication. Index for convenient reference.

D. SPECIFICATIONS

Water pump speed

(800 RPM Engine Speed) 2440 RPM

(835 RPM Engine Speed) 2546 RPM

Pump Capacity:

Actual pump capacity is 240 g.p.m. with 26 p.s.i. discharge pressure. The resistance of the various cooling systems affect the capacity and are varied.

Pump drive gear backlash New .008" - .016" - Limit .030"

Dimensional Limits

Diametric Condemning Limit

Min. Max.

Bearing bores in support

housing may be oversize

or bearing outer diameter

undersize. Fit must be .0001" tight to .002511 loose

Pump shaft, bearing mounting diameters to bearing bore.	No wear allowed.
Fit must be .000911	tight to .0001" loose
Pump shaft, drive gear mounting diameters to gear bore. Fit must be .0005"	tight to .001" loose
Pump shaft impeller mounting diameters to impeller .0005"	tight to .0025" tight

E. EQUIPMENT LIST

Name	Part No.
Impeller puller	8067245
Impeller pressing-on tool	8052959
Gear puller set (general use)	8068025
Water pump shaft and gear puller assembly	8219743
Water pump gear puller assembly	8219744
Engine cooling system water test (schematic piping diagram)	File 292

For additional tools see Tool Catalog 91B.

FUEL SECTION X

FUEL SYSTEM

A. GENERAL DESCRIPTION

The most important part of the fuel system is the unit injector, which is a high pressure fuel metering pump and spray valve combined in one housing. The injectors (one per cylinder) are supplied with a continuous flow of low pressure fuel delivered by a separate pump. A fuel supply tank, strainers, filters, fuel manifold, supply and return fuel lines complete the system.

B. DESCRIPTION

1. Injectors

A cross-section of the unit injector and names of the various parts is shown in Fig. 10-1. It is located and seated in a tapered hole in the center of the cylinder head, with the spray tip protruding slightly below the bottom of the head. It is positioned in the head by a dowel and held in place by an injector hold down crab and nut.

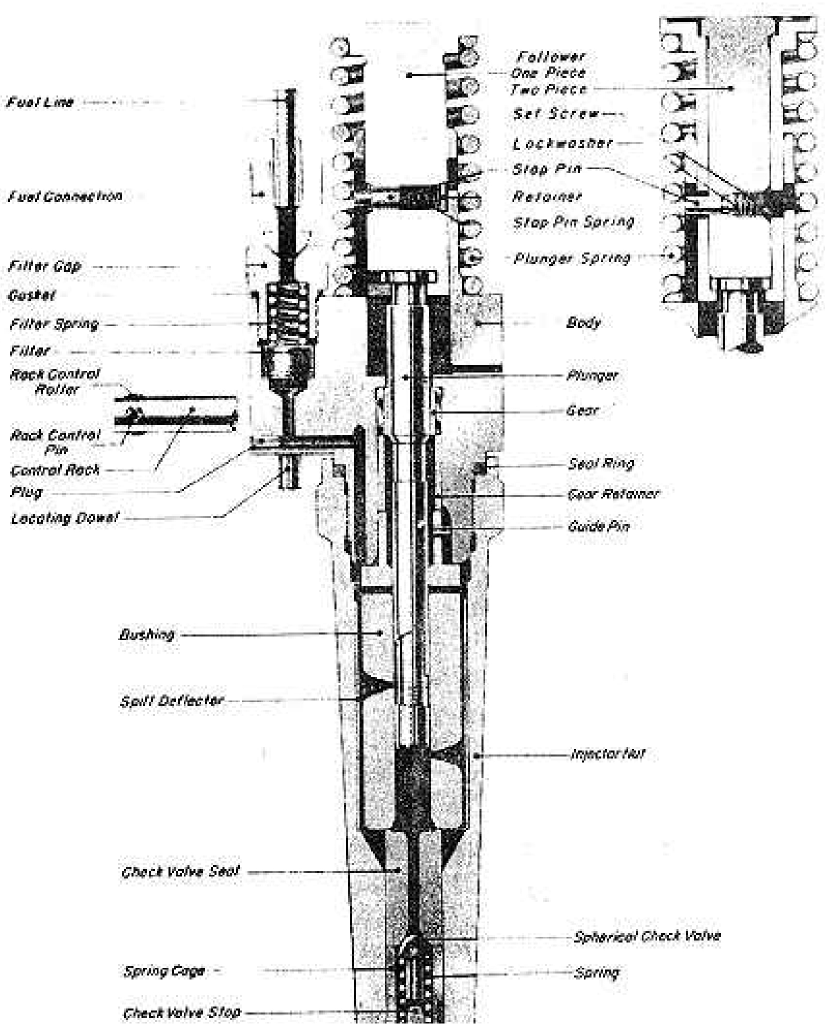
The external working parts of the injector are lubricated by oil from the end of the injector rocker arm adjusting screw. The internal working parts are lubricated and cooled by the flow of fuel oil through the injector.

The main working parts of the injector are: rack, gear, plunger, follower, spring and spherical check valve.

The plunger is given a constant stroke

reciprocating motion by the injector cam acting through the rocker arm and plunger follower. The timing of the

252C-10-1255 FUEL



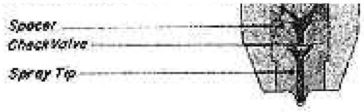
injection period during the plunger stroke is set by an adjusting screw at the end of rocker arm. Fig. 10-2 shows flow of fuel through injector during one downward stroke.

Rotation of the plunger by means of the rack and gear controls the quantity of fuel injected into the cylinder during each stroke. Rack position is controlled by the governor through the injector layshaft and linkage. The gear is keyed with a sliding fit to the plunger to allow plunger vertical movement. Injector rack setting adjustments are given in Section XII of this manual.

The helices near the bottom of the plunger control the opening and closing of both fuel ports of the plunger bushing. Rotation of the plunger regulates the time that both ports are closed during the downward stroke, thus controlling the quantity of fuel injected into the cylinder as shown in Fig. 10-3. As the plunger is rotated from idling position to full load position, the pumping part of the stroke is lengthened, injection is started earlier, and more fuel is injected.

Proper atomization of the fuel is maintained by the high pressure created by the downward stroke of the plunger, which forces fuel past the spherical valve and out through the six spray holes in the tip of the injector. The spherical valve prevents fuel leakage out the tip. The flat check valve under the lower spacer excludes combustion gases from the injector.

The injector has filters at the fuel inlet and outlet connections to protect the working parts.



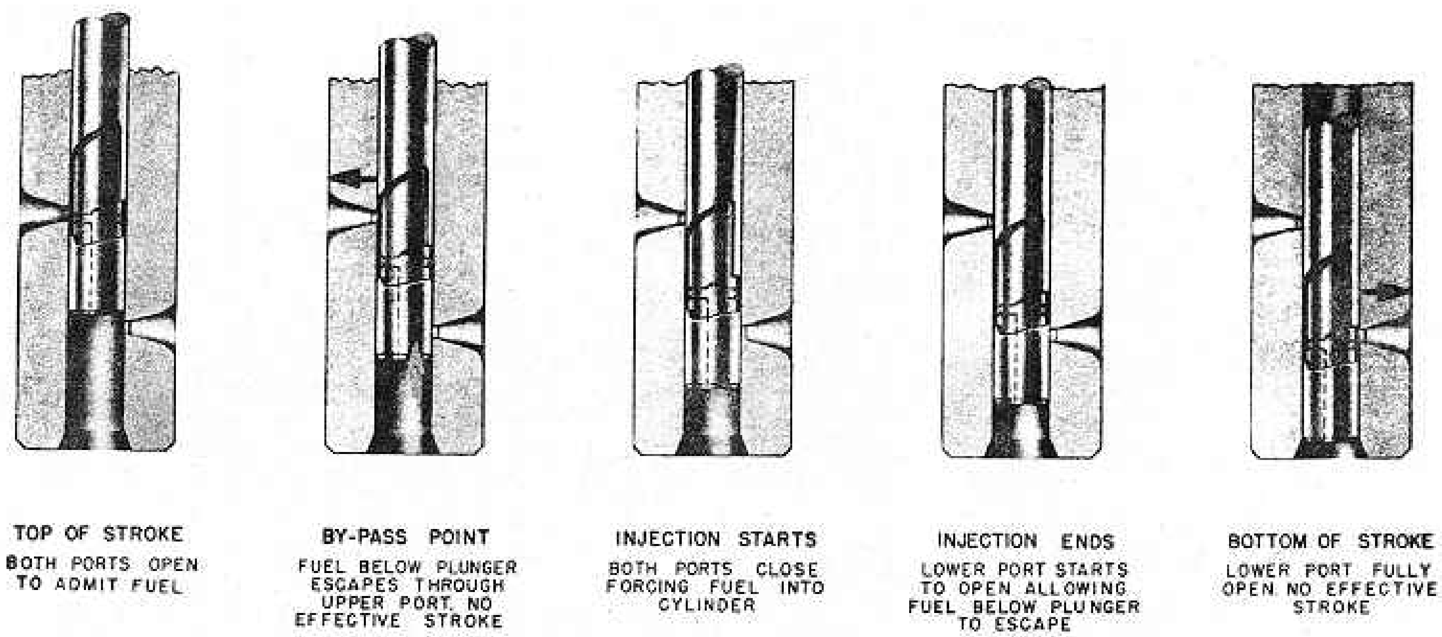
Cross-Section of Unit Injector
Fig. 10-1

- 1001 -

Two designs of fuel injectors are used in 567C engines, a high output injector 5228230 and a standard injector 5227852. The application of these injectors is given in Table B, Section XI, according to engine horsepower and full load injector rack length.

- 1002 -

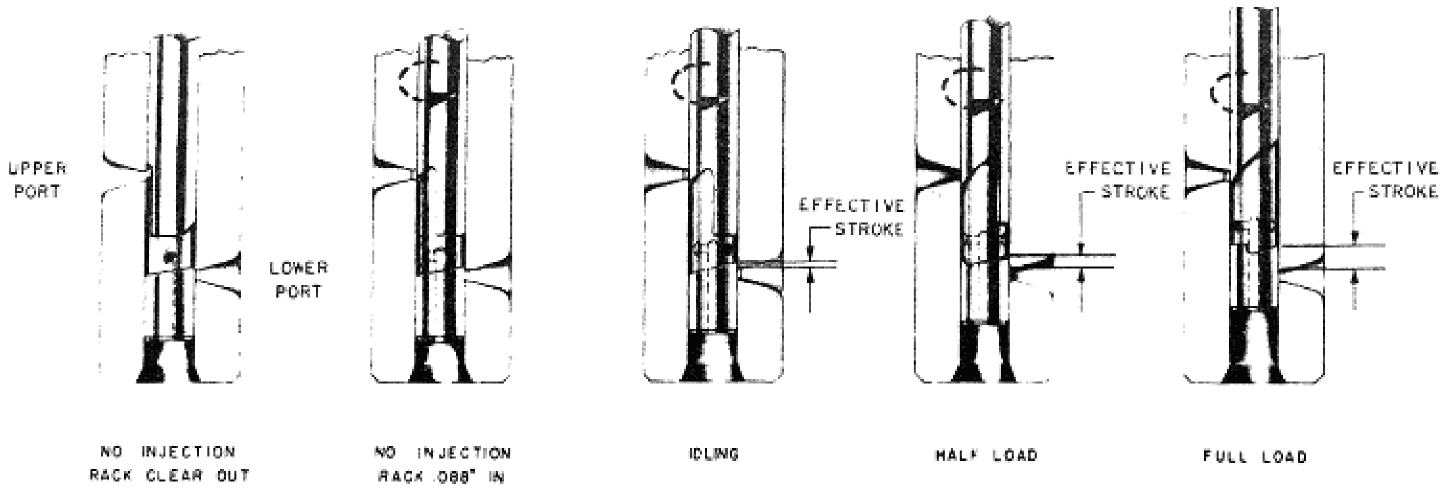
FUEL 252C-10-1255



One complete down stroke of plunger at "half load" position

Pumping Action of Injector Plunger
Fig. 10-2

- 1003 -



Quantity of Fuel Injected Is Controlled by Rotating Plunger with Control Rack

Fuel Control By Plunger Rotation
Fig. 10-3

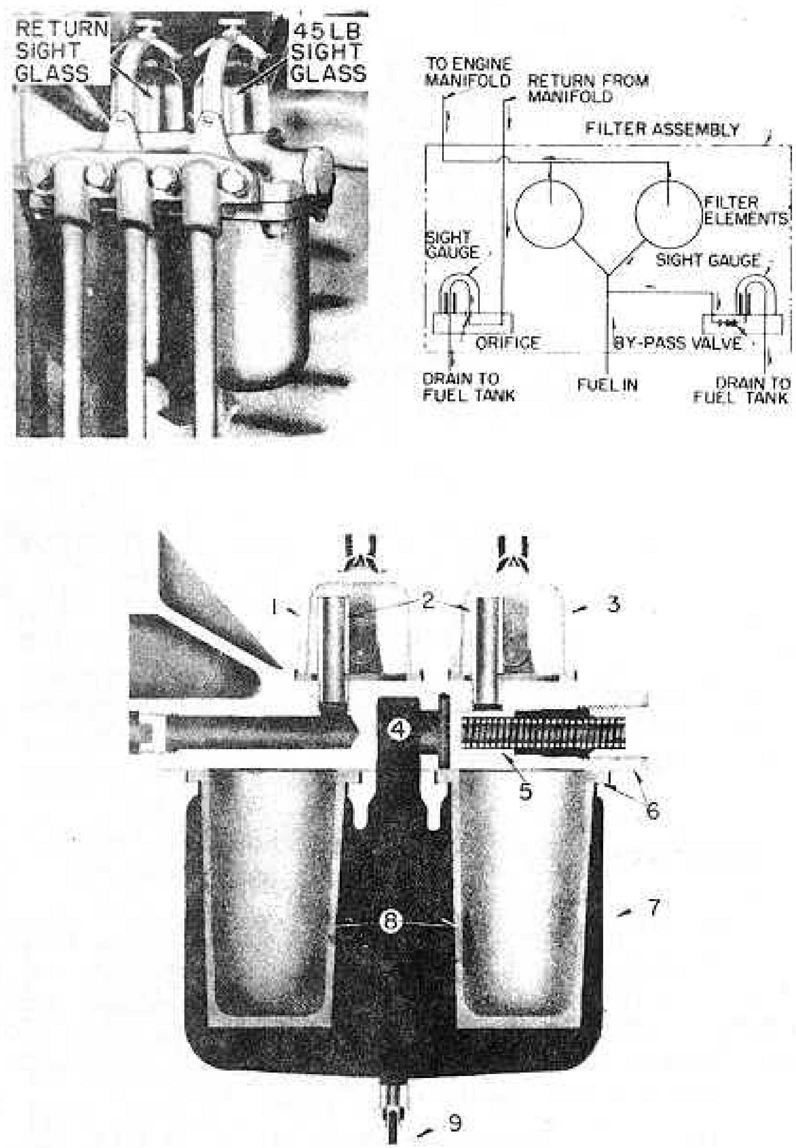
Injector 5228230 is similar to the .421" diameter plunger injector 5227852, but plunger helices are changed to give a greater effective fuel injection stroke. Externally the high output injector can be identified, in addition to its part number, by a vertical groove in the body, opposite the injector rack. Also, the locating dowels, used when installing the injectors in the cylinder head, differ in position. The locating dowel of injector 5227852 is on the body centerline, to line up with a corresponding hole in the cylinder head, but the locating dowel in injector 5228230 is positioned further out and to the left of the centerline to correspond with its locating hole in the cylinder head. Internally, the plunger bushing has a larger upper dowel to prevent installation in a 5227852 injector body, and its plunger can be identified by the number "7" stamped on it.

2. Filters

The only fuel filter mounted on the engine is the sintered bronze filter, shown in Fig. 10-4. However, other filters, not a part of the engine, are used in the fuel system, which vary in design, depending on the engine installation. See the Service Publications Index for the maintenance instruction of the particular filter used.

The engine mounted fuel filter is located at the right front of the engine. Sight glasses are provided on top of the filter housing to allow a visual indication of the condition of the fuel system.

Fuel returning from the injectors passes through the "return fuel" sight glass nearest the engine and returns to the fuel tank. Under normal operation this glass is full of fuel. An orifice inlet to the return sight glass causes a fuel back pressure on the injectors of about 5 pounds per square inch, to improve operation. An additional orifice is used in the return sight glass standpipe of this filter used on 8 and 12 cylinder engines.



1. Return sight glass-5 lb.
2. Stand pipe
3. By-pass sight glass
4. Fuel inlet passage
5. Relief valve
6. Gaskets
7. Case
8. Elements
9. Drain

Sintered Bronze Fuel Filter
Fig.10-4

Under normal operation the "by-pass" sight glass furthest from the engine should be empty of fuel. As the elements of the filter become dirty, the fuel pressure in the filter will increase. When fuel pressure in the element housing exceeds 45 p.s.i., the relief valve in the filter will be opened and fuel will enter and fill the by-pass sight glass, returning to the fuel tank and starving the engine of fuel. A small trickle of fuel purposely allowed to leak around the relief valve may be noticed entering the glass, however, this is normal and does not indicate clogged elements.

Air or gas in the fuel system will appear in the "return" sight glass as bubbles. Air entering the fuel at any place in the suction line may cause the engine to misfire or stop. Bubbles in the return sight glass with the fuel pump running and the engine stopped, indicates air entering the suction side of the fuel pump. If bubbles appear only when the engine is running it indicates leaky valves in the fuel injectors, allowing combustion gases to get into the fuel. Little or no fuel in the return sight glass with the by-pass sight glass empty indicates insufficient fuel supply to the engine.

C. OPERATION

Fuel from the fuel tank sump is drawn by the fuel pump through the suction strainer and discharges the fuel to the discharge filters. It then passes through the elements to the fuel manifold supply line from where it flows through a jumper line at each cylinder into the injector through the injector inlet filter. A small portion of this supply fuel to each injector is pumped into the cylinder, at a very high pressure, through the spherical check valve and spray tip of the injector. The quantity of fuel depends upon the rotative position of the plunger as set by the rack and governor. The excess fuel not used by the injector, flows through the injector, serving to lubricate and cool the working parts.

The fuel then leaves the injector through the return fuel filter. This filter is to protect the injector in the event of a backward flow of fuel into the injector from the return fuel line. From the return fuel filter in the injector the excess fuel returns through the fuel return line in the manifold to the orifice inlet of the return sight glass. This orifice restricts the return fuel to the extent of maintaining a back pressure of approximately 5 pounds. The fuel continues into the return sight glass filling the glass and down through the standpipe under the glass through return line to the fuel supply tank.

D. MAINTENANCE

1. Injectors

a. Installation

When installing an injector in an engine, make sure it is the correct one for the specific application, per identification given under "Description" in this section.

Install as follows:

1. See that injector body and tapered hole in cylinder head are clean.
2. Install injector and apply injector hold down crab, spherical washer and nut. Torque nut to 40-50 foot-pounds.
3. Connect injector rack to adjusting micro- linkage.
4. Install and tighten fuel supply and return lines to injector and engine fuel manifold.
5. Install rocker arm shaft and rocker arms. Loosen injector rocker arm lock nut and back off on adjusting screw before tightening rocker arm shaft nuts. Injector is now ready for timing.

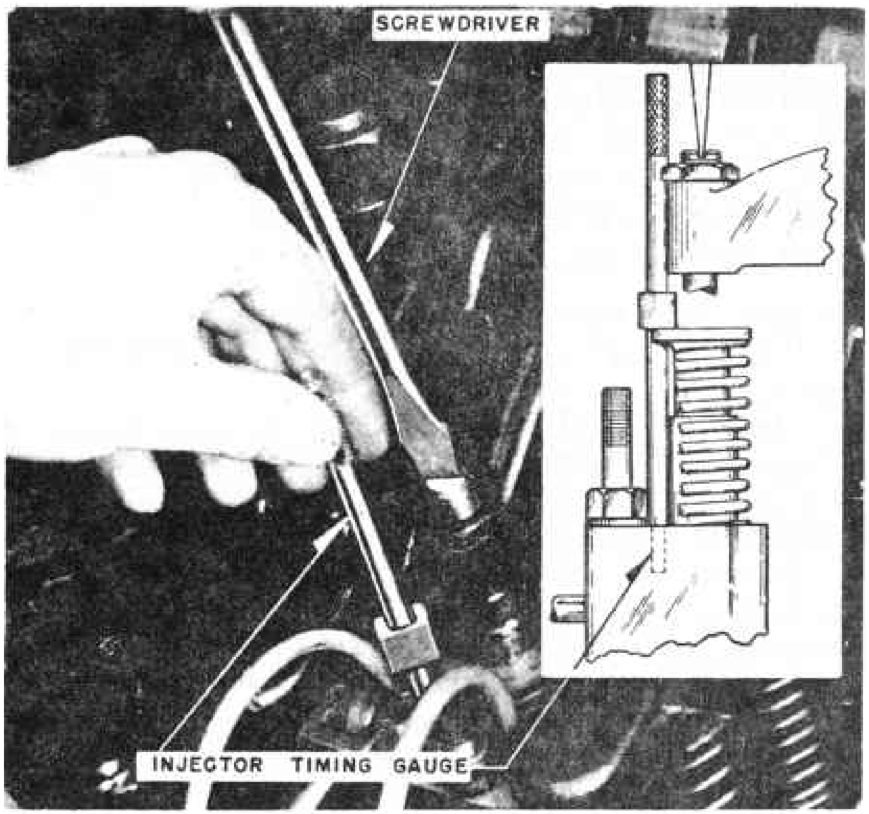
b. Timing

With the injector installed, make timing adjustment as follows:

(1) Set the flywheel at 4° before top dead center of the cylinder being timed. (See Section VI for firing order.)

(2) Insert gauge 8034638 into the hole provided for it in the injector body, Fig. 10-5.

(3) Turn the rocker arm adjusting screw until the shoulder of the gauge just passes over the injector follower guide.



Timing Injector
Fig. 10-5

NOTE: Injector rocker arms must be released by rotating the crankshaft at least one revolution after resetting the overspeed trip, in the event it has tripped, before timing the injectors.

(4) Tighten adjusting screw locknut, holding adjusting screw in position with a screwdriver.

(5) Recheck setting.

c. Injector Sticking

Engines may encounter injector sticking difficulties due to fuel, lube oil, or filter maintenance conditions. Since these conditions very often are momentary, injector removal may be minimized by utilizing alcohol to free up injectors in place. Ordinary commercial methanol can be applied to the injectors through a hole opposite the timing tool hole, and "popping" the injector or motoring the engine. This sticking condition usually occurs on injectors which are held with the plungers down when the engine is stopped. Should injector racks show signs of sticking, they should be checked for gum or varnish deposits. If they are present, the rack should be cleaned with alcohol and rechecked. If after these remedies, sticking persists, the injectors should be removed and replaced with injectors in proper working order. In no case should injectors be crutched out or cut out and the engine operated. If injectors operating unsatisfactorily cannot be remedied or replaced, the engine should be shut down until corrective measures to overcome the trouble have been carried out.

d. Servicing Injectors

When servicing the injectors, clean conditions must be maintained. Dust or dirt in any form is the most common cause of injector failure. When an injector is in an engine it is protected against dirt, dust and other foreign materials by the various filters employed. When an injector is in storage it is protected against harmful material by the filters which seal the body openings, these in turn are protected by shipping blocks.

However, an entirely different set of conditions is encountered when it becomes necessary to disassemble an injector for repair or overhaul. These conditions necessitate provision of special shops, equipment and trained personnel. These items are expensive, and in most cases the customer would not be warranted in the expense. Electro-Motive maintains this service for our customers and recommends the injector be returned to the nearest factory branch for rebuild or unit exchange. For particulars on this service see Factory Rebuild Bulletin No. 302.

2. Use of Injector Test Stand

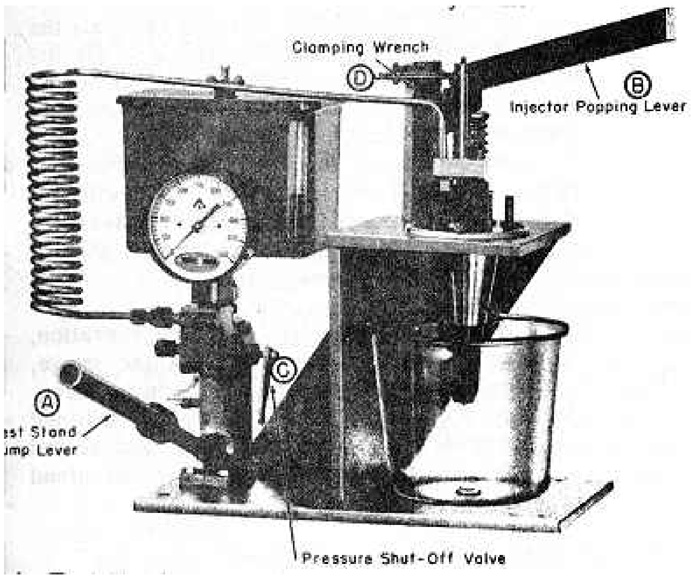
In order to insure satisfactory engine performance, injectors should be tested whenever removed from an engine regardless of the reason for removal. In addition, it would be well to set up a program for testing all injectors in an engine during each annual inspection in order to insure qualifications of injectors in complete engine sets. It is recommended that injectors be tested with the same oil as used for their rust prevention, given under "Storing Injectors."

It is important that the individual doing the testing understands the basic principals of injector operation and testing procedures in order to prevent qualification of defective injectors and condemning of good ones. Instructions in the use of the injector test stand and an outline of each separate test procedure along with a basic explanation of operation follows. These instructions cover the testing of all 567 injectors through use of test stand part 8202944, Fig.

10-6, or revised test stand 8171779, but are not applicable to other types of testing equipment since injector leak-off rates vary greatly in proportion to the volume of fuel contained in the high pressure portion of the test stand.

a. Testing of Injector Test Stand

Basically, the stand consists of a fuel reservoir, filter, high pressure pump, pressure gauge, and necessary connecting lines and fittings to supply fuel to the injector under test. On placing the test stand in operation, it should be set up as instructed by the manufacturer. Inspect carefully for dirt or foreign material in the tank and lines. Fill the tank with fuel and operate the pump to purge all free air from the system.



A. Test Stand Pump Lever C. Pressure Shut-Off Valve
B. Injector Popping Lever D. Clamping Wrench

Injector Testing Stand

Fig. 10-6

Investigation has shown that the viscosity of the fuel oil used in the test stand has a marked effect on the test results obtained. Regular fuel oil may be used provided the viscosity is not less than 32 S.S.U. at 100° F. Do not re-use fuel oil pumped through injectors into the plastic bowl.

(1) Test the stand for leaks

Install the test block in place of an injector on the stand and pump the pressure to 2000 pounds, as indicated by the stand gauge. This pressure should not drop below 1975 pounds in 5 minutes. Release the block and recheck at 500 and 1000 p.s.i. These pressures should hold 1 minute with no apparent gauge drop. These tests are to be made with the pressure shut-off valve (Fig. 10-6, Item C) open all the way. If the tests are satisfactory, all injector tests may be made without using the shut-off valve. If the preceding tests indicate leakage in the stand, repeat the tests, closing the shut-off valve before timing the leakoff rates. If the tests are satisfactory with the shut-off valve closed, it will be necessary to use the shut-off valve when making the injector holding pressure test.

(When placing a new test stand in operation, or after removing and replacing the gauge, fuel tank, filter, or pump, for any reason, the test block should be installed as outlined and pressure raised to 2500 p.s.i. and vented at least six times before testing the stand for leaks.) b. Operation of Injector Test Stand In using the test stand, the operator must consider it as an instrument, rather than a tool. Effort should be made to make the manual operation

of repeated tests the same. The following general procedures are listed to help in obtaining uniform operation:

1. When operating the pump, use a rate of 60 strokes per minute. This gives enough fuel rate to operate the check valve smoothly and circulate fuel within the injector.
2. When using the popping lever, do not use such force as to damage either the injector or the lever. Do not permit the lever to fly up freely.
3. In making holding tests, do not pump the stand above 2500 p.s.i.
4. Test stands regularly in use should be checked daily for leaks, using the test blocks.
5. Fuel oil used for testing should not be re-used.

3. Injector Testing

a. Rack Freeness Test

(1) Explanation

The rack engages with a small pinion on the injector plunger and serves to rotate the plunger with respect to two ports in the injector bushing, thus regulating the amount of fuel injected per stroke of the plunger. Binding of the rack is generally caused by damaged gear teeth, scored plunger and bushing, or galling of rack itself. In an engine, a binding rack may cause sluggish or erratic speed changes and overspeed trip action.

(2) Test

To be considered satisfactory, the rack must fall in and out through full travel by its own weight when injector is held horizontally and rotated about its axis.

b. Binding Plunger Test

(1) Explanation

Failure of the injector plunger, to move up and down freely indicates scoring of the plunger and bushing or weak or broken spring. In an engine, a binding plunger will cause erratic cylinder firing and, in extreme cases, overspeed trip action

(2) Test

Place injector in test stand but do not attach the fuel line. Place rack in the full fuel position and pump all the fuel out of the injector with injector popping lever, Fig. 10-6, Item B. When all of the fuel has been exhausted, depress the injector plunger to the extent of its full travel and release popping lever. Plunger should return to the top of its stroke with a definite snap action. Repeat this test with the rack in the half fuel and no fuel positions. Care should be used in the test to prevent the plunger from snapping back so violently that the plunger stop pin becomes broken.

c. Spray Tip Orifice Test

(1) Explanation

The six small holes in the injector spray tip serve to control injection pressure, fuel penetration and fuel atomization. Plugging of one or more of the holes may change injection characteristics enough to cause a smoky exhaust and in extreme cases, the pressure buildup in the injector body might lead to broken spray tips and injector rocker arms.

(2) Test

Attach the test stand fuel line to the injector, being careful to bleed all air from the system. This is best accomplished by holding the fuel line on the left-hand injector filter cap or oil inlet hole and slowly pumping the test stand pump lever, Fig. 10-6, Item A, until clear fuel flows from the outlet side of the injector. Slip the clamp bar over the injector stud and tighten the clamping wrench, Item D. Operate the test stand pump lever at the rate of sixty full strokes per minute and observe the spray at injector tip. Fuel should discharge from each orifice. Distribution and angle of the spray should be uniform.

CAUTION: Do not put hands near spray tip as the high pressure fuel is capable of penetrating the skin and entering into the blood stream, causing severe injury.

d. Valve Opening Pressure Test

(1) Explanation

The spherical check valve in the injector tip serves only to prevent the flow of fuel into the cylinder during the time when injection is not taking place. It does not control injection characteristics. In a new injector, this valve will open at a pressure of from 1000 to 1400 pounds per square inch. The nature of the valve spring, however, is such that it takes a slight "set" in the first several hundred hours of operation causing the opening pressure to drop 100 to 150 p.s.i. below the reading taken when new, prior to use in an engine. Any additional drop in pressure is the result of normal wear of the working parts of the valve.

When the valve opening pressure drops to a point below 600 p.s.i., valve action is likely to become erratic due to cocking of the valve stem through lack of spring pressure and excessive wear. The valve is then prone to leak which can result in smoky exhaust and possibly a scored liner and piston.

(2) Test

Test is to be made with the injector installed in the test stand as outlined in the preceding test. Place injector rack in the full fuel position. Operate pump lever at least twenty full strokes to insure that any observed leakage is not due to dirt or a cocked valve. Give pump lever one additional full stroke and immediately note pressure at which test stand-gauge settles out. This is valve closing pressure but since there is very little differential between valve opening and valve closing pressures, the two can be considered as identical for the purpose of this test. If this pressure is less than 600 p.s.i., the injector should be rejected.

e. Body Pressure Test

(1) Explanation

No external fuel leakage at the injector body seal, body plugs, or filter cap gaskets is permitted. Such leakage would cause fuel dilution of the engine lube oil which, if not caught in time, could result in serious engine damage.

(2) Test

With injector installed in test stand, as outlined in preceeding tests, depress popping lever and, at same time, slowly operate test stand

pump lever. When the injector plunger has been depressed to a point where the ports in the bushing are covered, the pressure within the injector body will rise above the valve opening pressure. Hold popping lever in this position and operate pump lever until the body pressure builds up to about 2000 p.s.i. Injector should be rejected if leakage is observed at the body nut seal, body plugs or filter cap gaskets. Leakage at the rack should be disregarded for the purpose of this test, as this is covered in the following section.

During this test, observe the tops of the filter caps for any sign of leakage between the ball seats on the fuel supply line and the filter caps. If such leakage is suspected, blow the fuel oil accumulation off with compressed air and repeat the test. If leakage is evident, loosen the fuel line from the injector, retighten, and test again before changing filter cap or rejecting injector.

f. Holding Pressure Test

(1) Explanation

All injectors lose pressure due to leakage at one of several points, but this leakage must be controlled to a satisfactory degree during injector manufacture in order to prevent excessive engine lube oil dilution and, at the same time, achieve dependable injector operation. The Holding Pressure Test will qualify injectors having specified leak-off rates providing this leakage is at the proper point and is satisfactorily controlled as outlined below:

(a) No leakage is permitted at the nut to body seal, filter gaskets, or body plugs, as outlined in Body Pressure Test "e."

(b) Leakage at the injector tip is of no consequence providing the injector passes the following "hold" pressure test. (If leakage at the tip is observed, the injector should be "popped" hard several times to insure that leakage is not due to a "cocked" valve.)

(c) Leakage occurring other than as indicated in (a) and (b) above will show as fuel at the injector rack. This will be due to leakage past the ground joint between the injector body and the injector bushing, or leakage at top of plunger and bushing lapped fit.

The leakage at the injector rack is controlled by timing the interval required for the pressure in the injector body to leak off from 1000 p.s.i., or valve opening pressure (if less than 1000 p.s.i.) to 400 p.s.i. A fast leak-off rate usually indicates excessive wear between the plunger and the bushing since the ground joint between the injector body and the bushing seldom leaks unless disturbed. The amount of fuel leakage noted at the rack during this test is not indicative of the amount which will leak into the oil when the injector is operating in an engine at normal pressure of 20 to 40 p.s.i.

(2) Test

With injector installed in test stand as in preceding tests, pop injector smartly with the test stand pump lever 15 to 20 strokes. With a suitable stop watch, time the interval required for the pressure to drop from 1000 p.s.i. (or valve opening pressure, whichever is lower) to 400 p.s.i. If this interval is less than 35 seconds, repeat the test, but close the pressure shut-off valve, Fig. 10-6, Item C,

immediately after popping the injector. If the interval is still less than 35 seconds, the injector should be rejected.

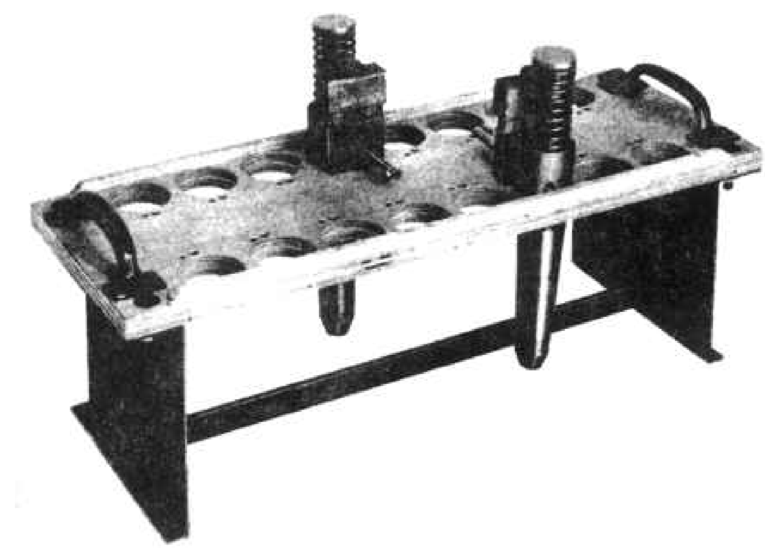
Any injector failing to pass any one of the tests outlined above should be returned to one of the Electro-Motive Factory Branches for remanufacturing.

4. Replacing Injector

Filters Injector filters should not be disturbed or removed except during injector reconditioning (when all parts are completely washed), or in the event of fuel stoppage to the injector.

5. Storing Injectors

When injectors are not to be used for a considerable length of time, they should be protected against



Injector Holding Rack
Fig. 10-7

rust by using oil 8203258 (50 gal.). This is a stable, non- corrosive straight-run petroleum distillate in the kerosene volatility range. It is also recommended that injectors be tested using this oil. If this is done, treatment will be taken care of at time of injector test.

After treatment, the injectors should be stored in a protective container until needed. A drawing, file 207, giving details of construction of an injector storage box, may be obtained on request. This box will accommodate an injector holding rack 8159228 (holding 16 injectors) similar to that shown in Fig. 10-7.

6. Diesel Fuel Recommendations

For information on fuel oil specifications, see Maintenance Instruction 1750 for Railroad 567 engines, or 1751 for Industrial 567 series engines.

7. Fuel System Components

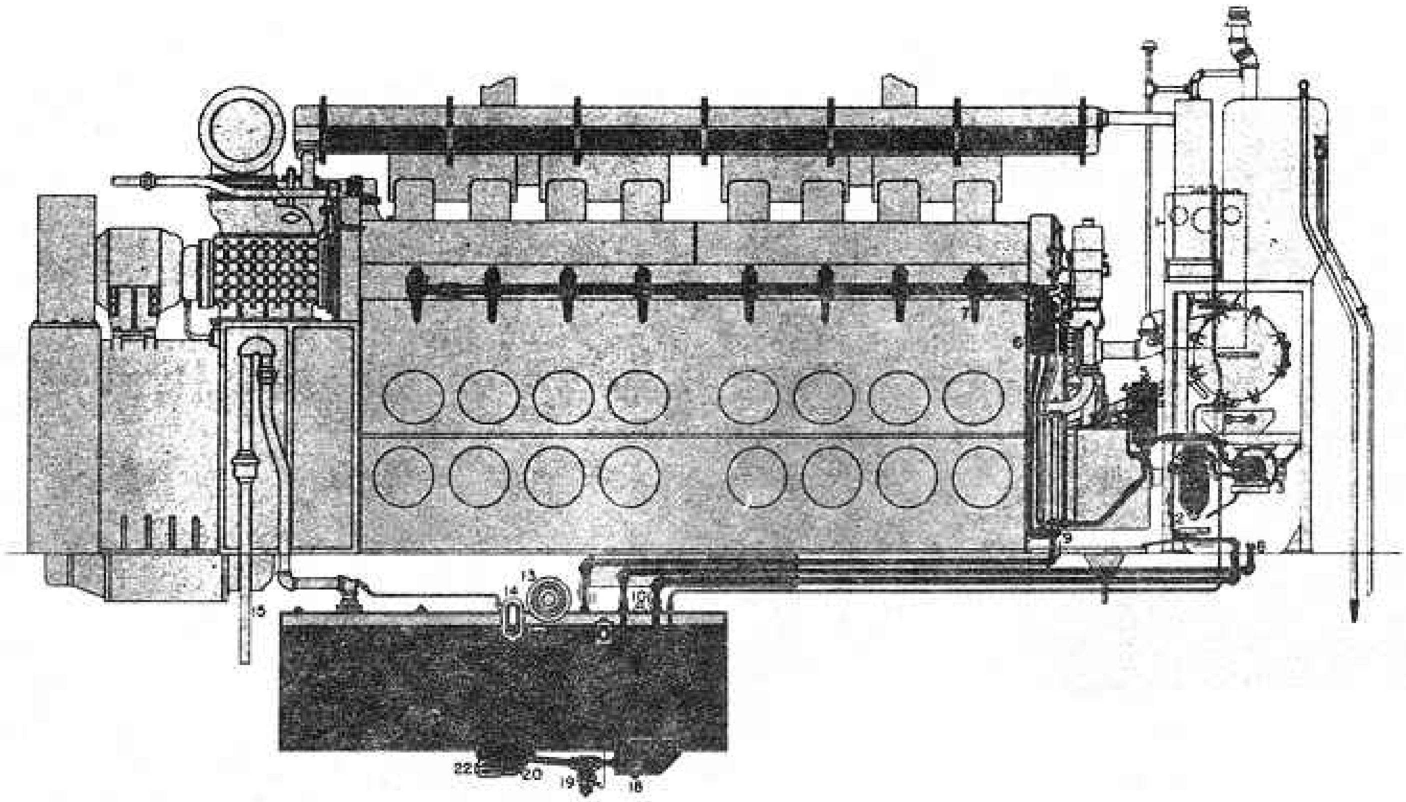
Varying types and designs of fuel system components are used on different engine installations which are more adequately covered by separate maintenance instructions. These instructions are listed in the Service Publications Index.

E. EQUIPMENT LIST

Name	Part No.
Injector holding rack (16 injectors)	8159228
Injector Prybar	8041183
Injector Timing Gauge	8034638
Injector test stand (complete)	8202944
Injector storage box (drawing)	File 207
Fuel system - pre-test (including water and oil system piping, for checking systems)	**Drwg. 294**
Remote fuel gauge test kit (consists of "U" gauges and valves for test system construction)	**8186329**
Oil (injector test, storage, and rust prevention - **50-gallon drum)**	**8203258**

Plastic spray cup (extra - used with 8202944 8171780

252C-10-1255 FUEL



1. Engine Control and Instrument Panel
2. Suction Filter
3. Fuel Pump and Motor
4. Fulflo Filter
5. Filter By-Pass Relief Valve
6. Sintered Bronze Filter and Sight Glass Assembly
8. Steam Gen. Fuel Supply
9. Steam Gen. Fuel Return
10. Fuel Supply to Engine
11. Fuel Return from Engine
12. Emergency Fuel Cutoff Pull Ring
13. Fuel Filler
15. Vent and Flame Arrestor
16. Fuel Tank
17. Fuel Supply sump
18. Fuel Drain Plug
19. Emergency Fuel Cutoff Valve
20. Fuel Drain Plug

7. Injector

14. Sight Gauge

21. Fuel Tank Sump

22. Fuel Tank Water

Fig. 10-8 -- Schematic of Fuel Oil System

SECTION XI

GOVERNOR, ENGINE SPEED CONTROL

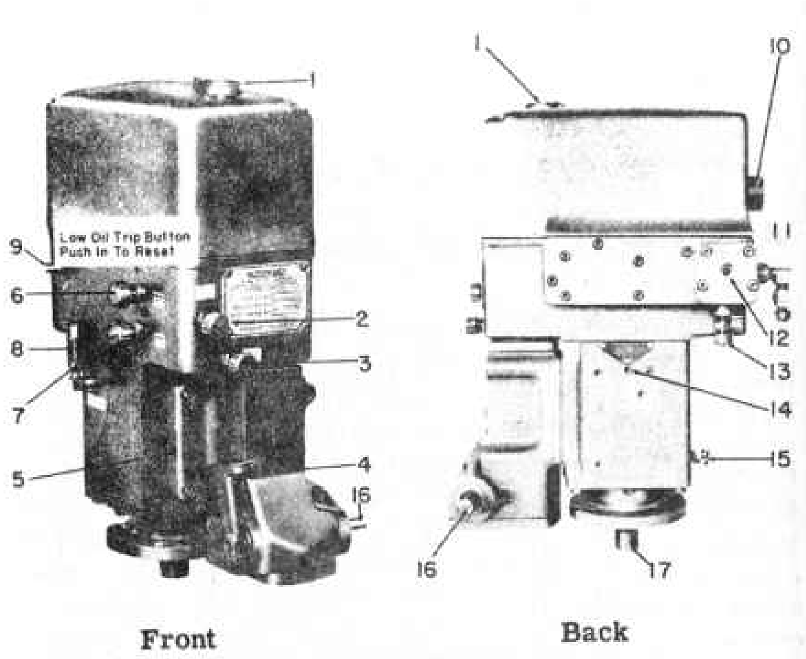
A. GENERAL DESCRIPTION

The governor maintains the speed of the engine at a setting determined by the engine operator. Governors, Fig. 11-1, used on the 567C engines are Woodward PG type, having either electro-hydraulic or pneumatic-hydraulic speed control. Each governor is identified by a separate part number. Numbers 8216206 and 8195017 are electro-hydraulic governors while 8200426 is a pneumatic-hydraulic speed control governor. Each governor may be set to maintain the engine speed desired for 800 RPM or 835 RPM full speed. To aid in correct governor installation, separate inserts (see Table B, page 1119) are applied to each governor name plate which identifies the speed setting of the governor and the proper full load injector rack length. Fig. 11- 2, shows a cross-section of the electro-hydraulic speed control governor.

Main parts of the governor are: a speed arrangement (speeder spring and flyweights), fuel adjustment control (power piston), compensating mechanism (compensating land integral on power piston pilot valve, buffer piston and springs), and an independent oil system (oil sump, oil pump, accumulators and connecting passages).

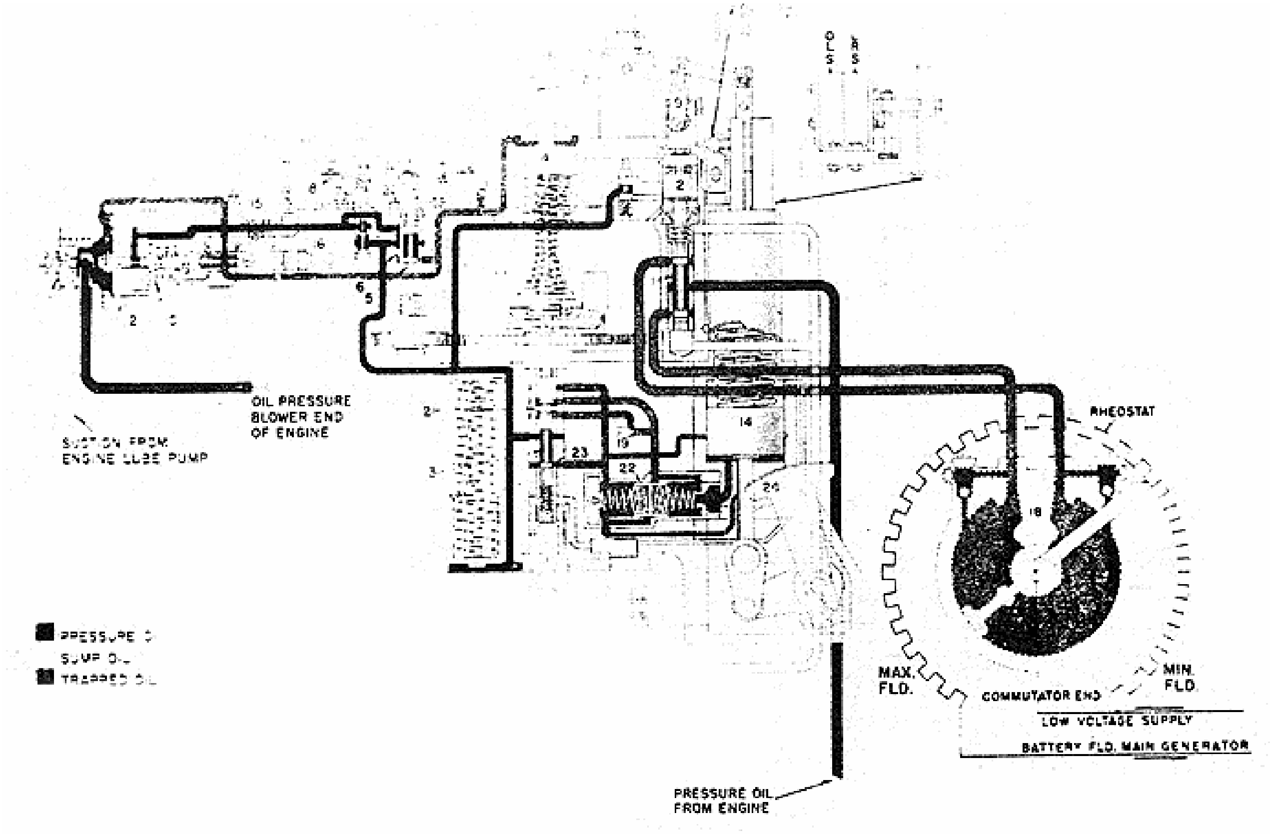
Engine auxiliary devices are a part of the governor, such as: load regulator pilot valve, ORS solenoid used with load regulator pilot valve over-riding piston, LRS and OLS switches, engine low oil pressure and high lube oil pump suction shutdown, as shown in Fig. 11-2.

GOVERNOR 252C-11-1255



1. 0il filler opening
2. Pilot valve engine oil supply
3. Pilot valve oil drain
4. Injector rack length scale quadrant
5. Compensating adjusting screw location
6. Vane motor oil line connection; decrease exitation
7. Vane motor oil line connection; increase exitation
8. Governor oil level sight glass
9. Low oil pressure and *high suction* shutdown rod
10. Electrical plug receptacle
11. Engine oil pressure connection
12. Engine oil pump *high suction* plunger
13. Engine oil pump suction connection
14. Vent plug location
15. Governor oil drain
16. Rotary terminal shaft, fuel control
17. Governor drive shaft

Rotary Shaft Electro-Hydraulic Governor
Fig. 11-1



Schematic of Rotary Shaft PG Governor with Electro-Hydraulic Speed Control
Fig. 11-2

GOVERNOR 252C-11-1255

B. DESCRIPTION

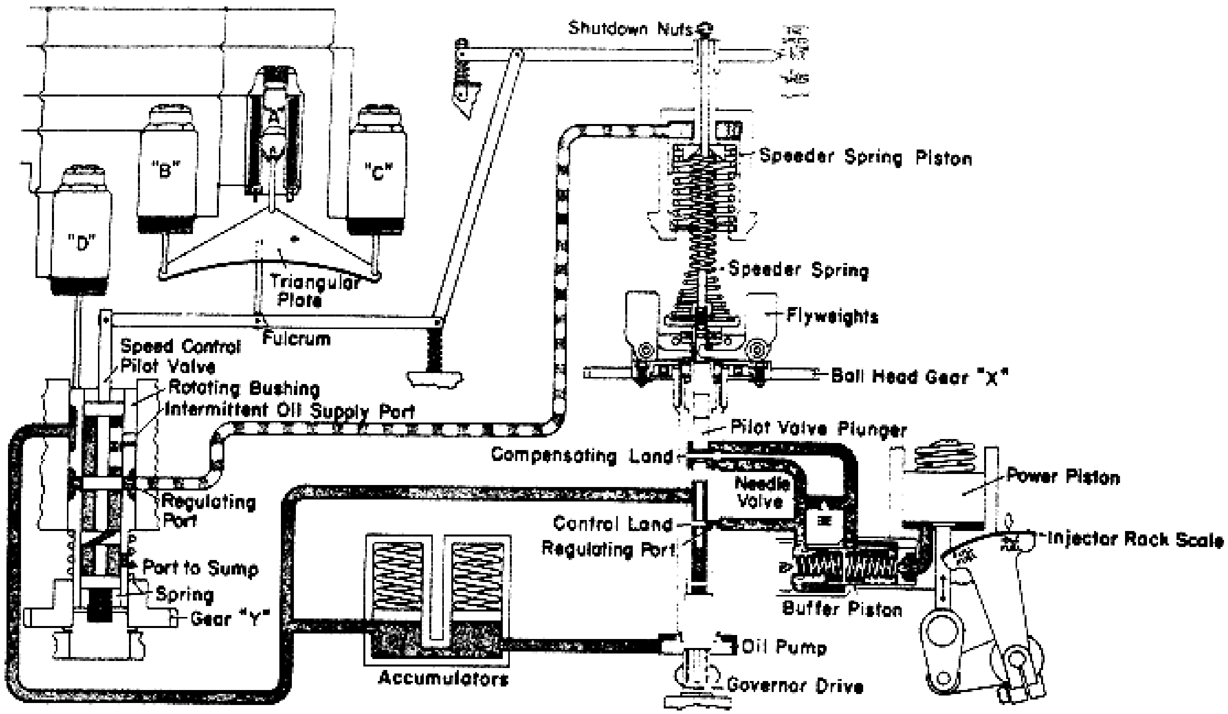
1. Electro-Hydraulic Speed Control

Speed setting with the electro-hydraulic governor is accomplished in steps by energizing different combinations of four solenoids "A " "B " "C " and "D" shown in Fig. 11-2 and in the schematic operating diagram, Fig. 11-3. Solenoids "A," "B" and "C" have plungers bearing on a triangular fulcrum plate at varying distances from a set fulcrum point. The triangular plate fulcrum bears on a lever which is connected to the speed control pilot valve inside a rotating bushing. The "D" solenoid plunger bears on the rotating bushing through its cap and bearing.

To increase engine speed, the speeder spring must be compressed; or compression lessened to decrease speed. The speeder spring piston position must be changed to satisfy these conditions. This is accomplished by admitting or releasing governor oil above the speeder spring piston. Admission or release of oil to or from the speeder spring piston is controlled by the solenoids through the speed control pilot valve and rotating bushing.

When a solenoid or different combinations of "A," "B" or "C" solenoids are energized, the triangular plate is forced down a distance depending on the solenoids energized. This causes the speed control pilot valve to go down a certain amount. The regulating port in the rotating bushing is uncovered, permitting governor oil under pressure to force the speeder spring piston down and compress the speeder spring. As the speeder spring piston moves downward, the linkage raises the speed control pilot valve to again close the regulating port when the desired piston position has been reached.

Compression of the speeder spring forces the flyweights in, allowing the governor pilot valve plunger



Schematic Operating Diagram Electro-Hydraulic Governor
Fig. 11-3

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to lower and permit oil to raise the power piston to increase fuel to the engine. Unbalanced oil pressure on the compensating land of the pilot valve plunger closes the regulating port when the power piston has been raised enough for the desired speed. When the new engine speed is reached the flyweights will return to balance position against speeder spring pressure.

When a solenoid or a combination of "A," "B" or "C" solenoids are de-energized, the triangular plate will rise, and the speed control pilot valve will also be moved upward. Since the pilot valve is raised, oil above the speeder spring piston drains through the regulating port to the oil sump. The speeder spring piston is raised by its spring. As the piston moves up, the connecting linkage causes the speed control pilot valve to move down and close the regulating port when the desired piston position is reached.

Note that oil enters the speed control rotating bushing through an intermittant supply port. This port is of such size to allow the speeder spring piston to move full stroke in a specified time. Consequently, speed increase is controlled under all conditions of operation.

2. Pneumatic-Hydraulic Speed Control

Speed control with the pneumatic-hydraulic governor consists of a transmitter and a receiver which, through linkage, raises or lowers the speed control pilot valve which is identical in operation as used in the electro-hydraulic governor.

The transmitter, Fig. 11-4, is located at the control station. It is actuated through the throttle lever, shaft, and cam. As shown, it consists of a spring loaded diaphragm and

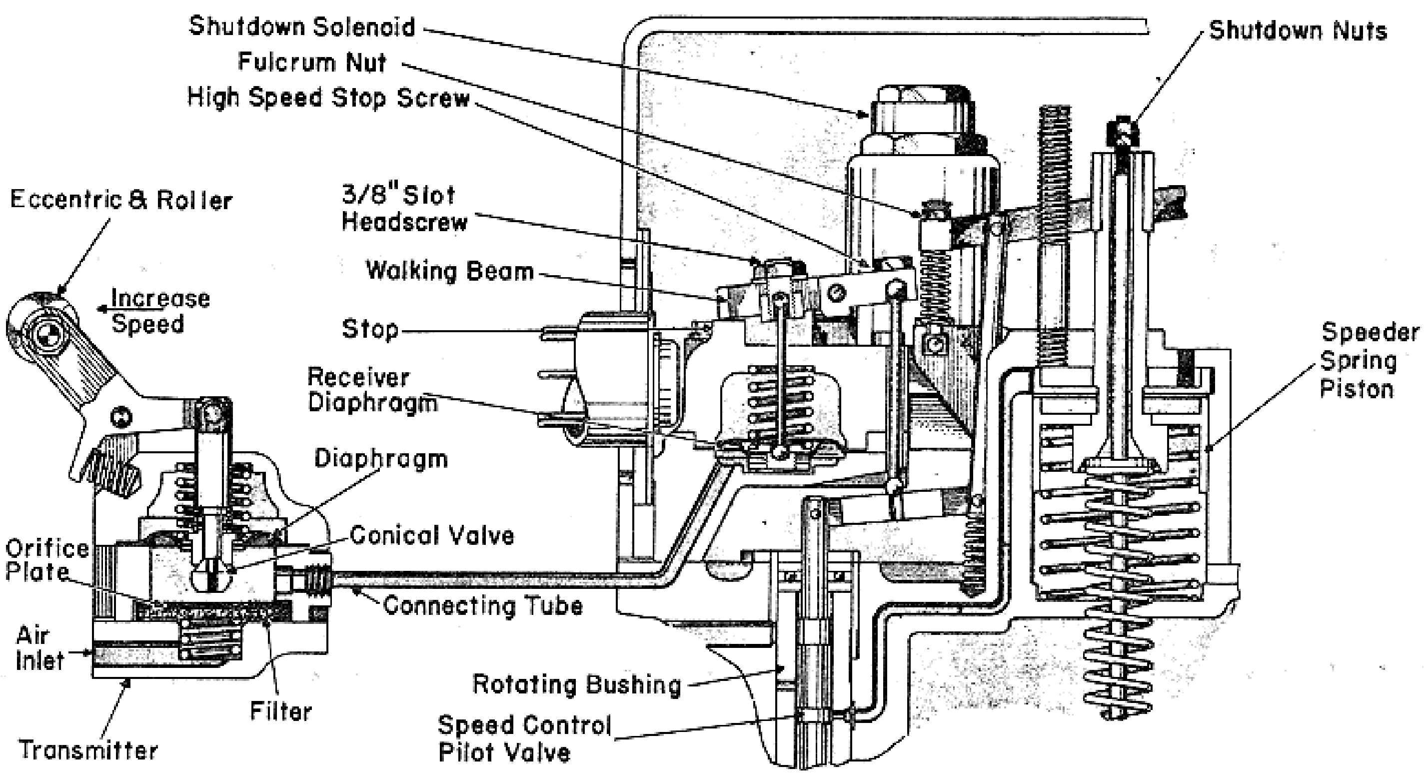
Since the speeder spring piston was raised, speeder spring compression is lessened. The flyweights will move outward under centrifugal force to lift the governor pilot valve. Oil will then be released from under the power piston and it will move downward to decrease fuel supply and engine speed.

Energizing the "D" solenoid in combination with other solenoids lessens their effect on engine speed, since the "D" solenoid pushes down the rotating bushing and lowers the regulating port. When only the "D" solenoid is energized it opens the regulating port in the rotating bushing to sump, permitting oil above the speeder spring piston to be released. The piston then raises and its extension lifts the shutdown nuts and rod, causing the governor to shut off the engine fuel supply.

tapered seat valve. Inlet air is supplied the transmitter through a sintered filter and inlet orifice to give a constant supply of air.

The air supplied through the orifice causes the pressure to raise until the air pressure against the diaphragm balances spring tension, at which time the conical valve is unseated and the air bleeds off to maintain constant pressure. There should be a continuous discharge of air around the transmitter stem except during an increase in speed. Varying the diaphragm spring tension, through the throttle and cam, varies the air pressure in the transmitter.

The transmitter air pressure is piped directly to the receiver, located in the governor, Fig. 11-4, and exerts its pressure against the receiver diaphragm. As the air pressure is varied in the transmitter, it is also varied in the receiver.



Pneumatic-Hydraulic Speed Control
Fig.11-4

The diaphragm responds to the varied pressure and moves the speed control pilot valve linkage to raise or lower the speed control pilot valve, operation of of which is identical as in the electro-hydraulic governor.

3. Governor Controls

a. Oil Supply

The governors have a self-contained oil system, consisting of storage sump, rotary gear pump and accumulators. The oil lubricates the moving parts and provides force necessary to operate various parts of the governor.

b. Speed Control Column

To vary the speed of the engine with throttle changes, or to maintain a constant engine speed with load changes, the amount of fuel injected into the cylinders must be varied. This is determined by the position of the power piston. See Fig. 11-5. To move the power piston, the tension on the speeder spring is varied. Whether the throttle changes or the engine speed changes (due to a load change), the flyweights will move. This changes the position of the pilot valve plunger and controls the supply of oil to the power piston.

c. Power Piston

The power piston supplies the energy to move the injector control rack through the governor rotary shaft and injector linkage. The upward motion of the power piston results from oil pressure, controlled by the power piston pilot valve plunger raising the piston against the pressure of the power piston spring.

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d. Compensating Mechanism

The compensating mechanism prevents the engine from racing or hunting by arresting the movement of the power piston after it has traveled a sufficient amount to give the desired speed. The compensating mechanism includes the integral compensating receiving piston, buffer piston and springs, and compensating needle valve on PG type governors, Fig. 11-5.

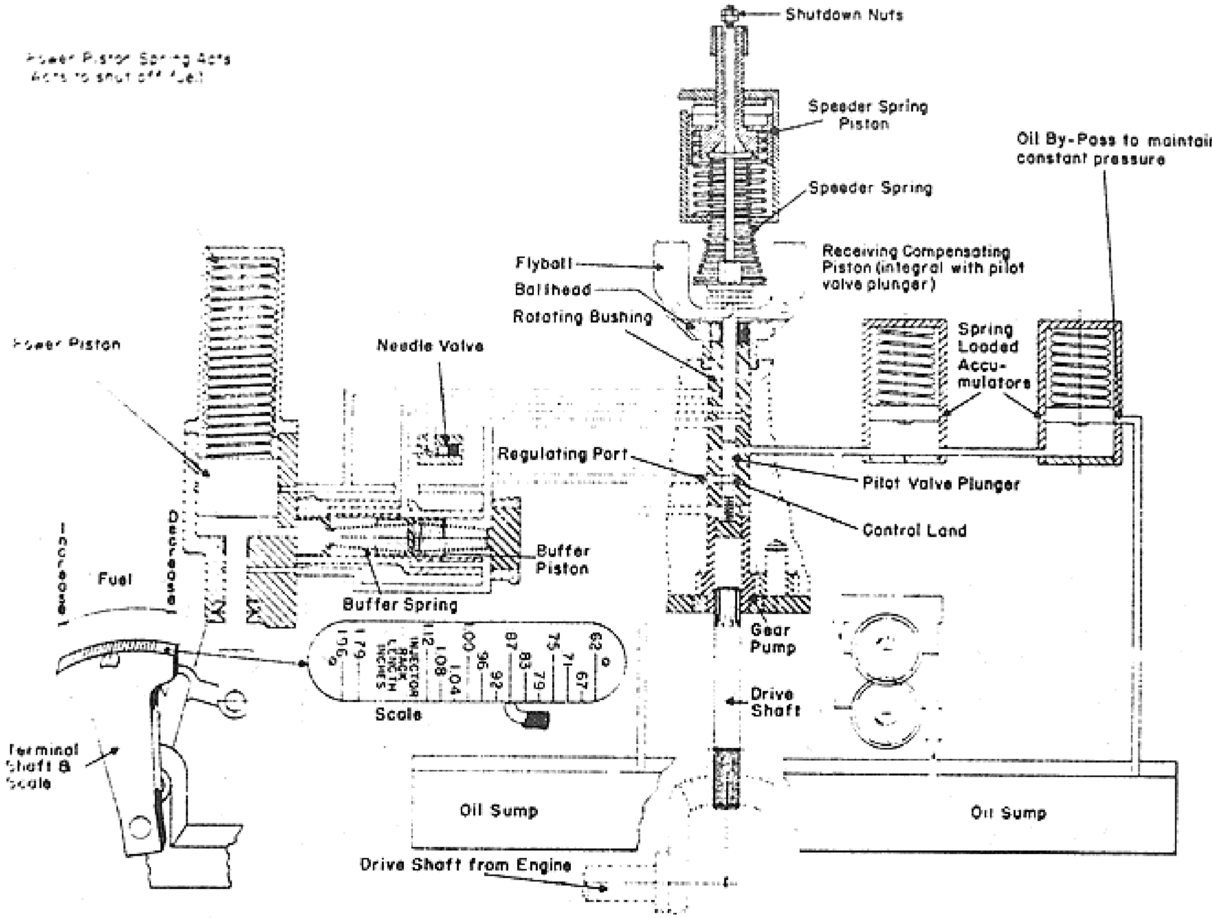
e. Fuel Control

Fig. 11-5 illustrates the operation of the fuel control portion of the PG governor. The power piston spring acts to shut off fuel to the engine. Oil pressure is used only to increase the supply of fuel to the engine.

The governor drive shaft, pump, rotating bushing and flyballs rotate together. Two accumulators are provided for governor pressure oil storage capacity; the maximum pressure of governor oil is regulated by a by-pass in one of them. A . buffer piston centered by springs is in the hydraulic circuit between the pilot valve plunger and the power piston. It is by-passed by the needle valve, and also by passages which are uncovered when it moves more than a certain distance away from its central position. The small difference in oil pressure on the two sides of the buffer piston is transmitted to the receiving compensating piston on the pilot valve plunger.

(1) Load Decreased or Throttle Decreased

As shown in Schematic diagram, Fig. 11-5, the engine is running normally under steady load and at constant speed. The flyballs, pilot valve plunger and buffer piston are in normal positions. The control land on pilot valve plunger covers the regulating port holes in the rotating bushing. The power piston is stationary.



Schematic Diagram PG Governor
Fig. 11-5

Assume that the engine load is decreased, thus increasing the speed. As the speed increases, the flyballs move out, raising the control land of the pilot valve plunger and uncovering the regulating ports in the rotating bushing. Uncovering the regulating ports in this direction permits oil to escape from the area right of the buffer piston; it moves to the right, and the power piston moves down. It is apparant that since this compresses the right-hand buffer spring, the oil pressure on the left of the buffer piston is a little higher than that on the right. These pressures are connected to the areas above and below the receiving compensating piston on the pilot valve plunger, and since the higher pressure is above this piston, it is forced downward, so that the land of the pilot valve plunger starts to close the ports and stop the power piston movement. The governor is so designed that this action will stop the movement of the power piston when it has moved far enough to correct for the load change that started the action.

Oil leaking through the needle valve then allows the buffer piston to return to center, which gradually releases the force on top of the receiving compensating piston. This force is no longer needed to hold the pilot valve plunger in its central position, because during this time the engine speed has been returning to normal, and the outward force of the flyballs has been reduced until it is balanced by the speeder spring.

It is apparent that the compensating mechanism described above produces stable operation by permitting the governor to move rapidly in response to a speed change, and then wait for the speed to return to normal.

(2) Load Increased or Throttle Increased

As before, all parts of the governor are centered, and there is no power piston movement. Assume that the engine load is increased, resulting in a decrease in speed. The governor will go .through a cycle of operations just the reverse of those described above, as follows: The decrease in speed will cause the fly-balls to move inward, which lowers the pilot valve plunger and opens the port. Oil from the accumulators passes through the pilot valve, forces the buffer piston to the left, and moves the power piston upward to give the engine more fuel. The compression of the left-hand buffer spring results in a higher pressure on the right- hand side of the buffer plunger and on the under side of the receiving compensating piston. This pressure moves the pilot valve plunger upward and stops the movement of the power piston when it has moved far enough to correct for the load change that started the action.

Oil leaking through the needle valve gradually releases the force under the receiving compensating piston, allowing the buffer piston to return to center. This force is no longer needed to hold the pilot valve plunger in its central position, because during this time the engine speed has been returning to normal.

In the foregoing description, speed changes as a result of load changes have been considered. Similar governor movements occur when a difference between actual governor speed and governor speed setting is produced by changing speeder spring tension through the speed adjusting control particular to the type of speed control used on the governor. With large speed

changes the buffer piston travel is much greater, to the left or right, depending on increase or decrease in speed, opening a passage for the flow of oil to or from the power piston. 4. Engine Shutdown (Adjustments Given Under Maintenance)

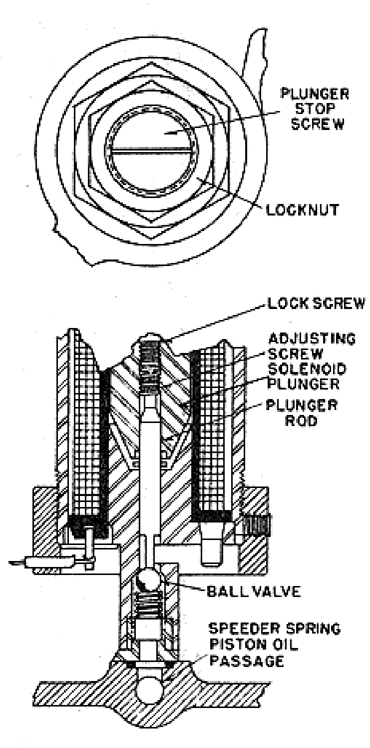
b. Pneumatic-Hydraulic Governor

On engines equipped with pneumatic-hydraulic governors, shutdown of the engine is accomplished by releasing the throttle to "Stop" position, which action completes a circuit to the shutdown solenoid shown in Fig. 11-6. Energizing the shutdown solenoid moves its plunger downward to open a valve in the oil line from the speeder spring piston, to the governor sump. The oil released above the speeder spring piston allows the piston to move upward, its extension contacting the shutdown nuts, Fig. 11-4, and bringing about engine shutdown as with the electro-hydraulic governor.

5. Low Oil Pressure and High Oil Pump Suction Shutdown

The electro-hydraulic and pneumatic-hydraulic governors have as a part of each governor

a. Electro-Hydraulic Governor Engine shutdown can normally be accomplished by depressing the "STOP" button or by placing the throttle in the "STOP" position. Either action will energize the "D" solenoid. This action de- presses the speed control rotating bushing so its port is below t h e land of the speed control pilot valve. This allows the trapped oil above the gov ernor speeder spring pis ton to drain. The spring under the piston forces the speeder spring piston upward and the piston ex- tension contacts the shut- down nuts on the shutdown rod, lifting the power pis- - ton pilot valve up, which action drains the oil from under the governor power piston, causing the power piston to turn the rotary shaft and bring the injectors to "no fuel" position.



Shutdown Solenoid Pneumatic-Hydraulic Governor
Fig. 11-6

an oil failure alarm system which in the event of low oil pressure or high oil pump suction, shuts the engine down and operates the low oil pressure alarm switch. Do not start engine until trouble is corrected, if engine dies on start after resetting governor shutdown rod. See Section 8, Possible Lube Oil Troubles.

As shown in Fig. 11-7, this feature consists of oil pump suction diaphragm, with adjusting screw, lube oil diaphragm and plunger, shutdown piston, two ball check valves, shutdown alarm rod and alarm circuit switch.

The area to the right of the suction diaphragm is connected to the lube oil pump suction. Oil pressure from the blower oil supply is admitted to the left of the lube oil diaphragm. On the right side of the lube oil diaphragm is oil under pressure from the governor speeder spring piston. Governor oil following through a milled passage in the outer circumference of the speed control rotating bushing, every revolution of the bushing, operates the shutdown piston in the event of low oil pressure or high pump suction when the engine is at idle. This oil admittance is adjustable through the speed control rotating bushing ports, by rotating the port sleeve, to give greater or less admittance of oil, thus regulating the time interval until sufficient oil is available to operate the shutdown piston. This gives the time delay necessary for building up oil pressure when starting the engine and is adjusted to operate after approximately 40 seconds with engine at idle position. At the third throttle position or higher, a time delay by-pass is opened to nullify the delay period and the engine will shut down in two seconds, should engine oil pressure fail or high tube oil pump suction exist. This safety feature differs in the electro-hydraulic and pneumatic-hydraulic governors only in the actuation of the time delay by-pass and its setting. The operation is identical for both governors.

6. Overriding Solenoid

The overriding solenoid "O" Fig. 11-2, is employed on the electro-hydraulic and pneumatic-hydraulic governors (if used) to position the load regulator in the minimum field position. The solenoid is energized by external circuits which may be determined by consulting the specific wiring diagram covering the particular governor application. When the over-riding solenoid is energized, it moves a small cylindrical valve downward, permitting governor accumulator oil pressure to flow under the overriding cylinder piston, Item 2. This piston moves up carrying the load regulator pilot valve plunger with it. When the solenoid is de-energized, a spring

moves the pilot valve back to normal position. Adjustment of the ORS solenoid is given under Maintenance, Item 7.

7. LRS and OLS Switches

The twelve point electrical receptacle used on the 567C engine governors, provide for separate cir- cuits to accommodate the LRS (when used) and OLS switches, as well as the low oil pressure switch and governor solenoids. Both the L RS and OLS

speed depending on application. Corresponding speeds for each throttle position are shown in Table A, "Engine Governor Speed Setting." (Some conversion engines are set at 300 RPM idle speed and throttle step speeds vary from those shown. Speed settings on these engines are outlined separately under 1-b.)

A system of identification is used on the governors, since their use and settings vary. The type of governor and its part number are located on the name plate. The part number identifies the type of load control pilot valve bushing in the governor as well as the speed control. Governors 8195017 electro-hydraulic and 8200426 pneumatic-hydraulic have a five port wide slot pilot valve bushing, whereas governor 8216206, electro-hydraulic has the conventional five port narrow slot bushing which gives different load regulator timing. (See * under Table B).

In addition each governor has an insert, Fig. 11-8, applied to the name plate. Marked on the insert is the full speed which the governor is set to maintain and the full load injector rack length of the engine on which the governor is to be used. There is one of these inserts for each full load injector rack setting and full engine speed which may be used. If governor is applied switches are contained in a bracket mounted on the electrical equipment base near the ORS solenoid and adjacent the power piston tailrod, Fig. 11-12.

Both switches protect against overload and are actuated by a. bar with adjusting screw, attached to the upper end of the power piston tailrod. When the injector rack length is one scale dimension (± 1/2 division) less than the full load rack setting of the engine the LRS switch is closed. Closing of the LRS switch voids supplemental circuits used in conjunction with the load regulator, permitting full load regulator control. If the injector rack length reaches .67", the OIS switch is closed, which energizes the ORS solenoid, causing the load regulator to move toward minimum field to reduce load on the engine. Setting of these switches is given under Maintenance, Item 6.

C. MAINTENANCE

1. Setting Governor for Engine Speeds

The 567C engine governors, electro-hydraulic or pneumatic-hydraulic, are set for 275 RPM idle engine speed and either 800 RPM or 835 RPM full engine

to another engine installation and reset to a different full speed or to one which has a

TABLE A

ENGINE GOVERNOR SPEED SETTINGS

Throttle Position	Governor Speed RPM		Solenoid Energized				Governor Speed RPM		Adjustment	
Stop	Min	Max	A	B	C	D	Min	Max	Solenoid	Sequence
Idle	275	283				*	275	283	"C"	5
1	275	283					275	283		
2	344	374	*				338	369		
3	424	454			*		414	444		
4	515	523	*		*		500	508	"B"	4
5	584	614		*	*	*	564	594		
6	675	683	*	*	*	*	650	658	Fulcrum Nut	1
7	755	763		*	*		725	733	"A"	3
8	835	843	*	*	*		800	808	"D"	2

TABLE B

567C Engine Governor Applications

Loco.	Engine HP 0	Full Engine R.P.M.	Full Load Mi. Rack	Current Gov. No. E-H	P-H	Name Plate Insert	Type Pilot Valve	Fuel - Injector	Replaces Governor
F9	1750	835	.968216206			8218698	NS	HO	8206333
									8195017

FP9	1750	835	.968216206	8218698	NS	HO	8206333
							8195017
GP9	1750	835	.968216206	8218698	NS	HO	8206333
							8195017
SD9	1750	835	.968195017	8218698	WS	HO	8206333
E9	1200	800	.838216206	8211843	NS	STD	8208845
							8195017
SW1200	1200	800	.83 8200426	8211843	WS	STD	
SW1200-MU	1200	800	.838195017	8211843	WS	STD	8208845
SW900	900	835	.92 8200426	8211840	WS	HO	8206334
UM	900	835	.928195017	8211840	WS	HO	8206333
SW600	600	800	.83 8200426	8211843	WS	STD	
SW600-MU	600	800	.838195017	8211843	WS	STD	8208845
Conv.	1750	835	.968216206	8218698	NS	HO	
Conv.	1600	835	1.008216206	8219317	NS	HO	
Cnnv.	1500	800	.878216206	8211841	NS	STD	
Conv.	1500	835	,928216206	8211840	NS	STD	
Conv.	660	800	1.008200426	8211842	WS	STD	
LWT12	**1200**	835	.878216206	8232688	NS	STD	

Replacement 567C Engines or Governors
Operating at Replaced Engine Horsepower

SW	600	800	.83 8200426	8211843	WS	STD
SW-MU	600	800	.838195017	8211843	WS	STD
SW	1000	800	1.00 8200426	8211842	WS	STD
SW-MU	1000	800	1.008195017	8211842	WS	STD
Pass.	1000	800	1.008216206	8211842	NS	STD

TABLE B (Cont'd)

Export 567C Engines

Engine H.P. o	Full Engine R.P.M.	Full Load Inj. Rack / Current Gov. E-H P-H	Name Plate No. Insert	Type' Pilot Valve	Fuel - Injector	Main Gen.
650	835	.928195017	8211840	WS	HO	D15
875	835	.928216206	8211840	NS	HO	D15
1125	800	.878216206	8211841	NS	STD	D15
1225	835	1.048240871	8219318	NS	HO	D15
1310	835	.928240871	8211840	NS	HO	D12
15110	8110	.878216206	8211841	NS	STD	D12
1500	835	1.048216206	8219318	NS	HO	D12
1600	835	1.008216206	8219317	NS	HO	D12
1750	835	.9282162066	8211840	NS	HO	D12

d - represents engine horsepower into the main generator 567C type electro-hydraulic governors ordered separately are set for 835 RPM and .96" injector rack setting and pneumatic-hydraulic governors are set for 800 RPM and .83" injector rack setling unless the purchase order specifically requests a different setting.

*NS - represents pilot valve plunger 08113805 and bushing #8146495 five port (narrow slot) which permits load regulator timing of 23 to 33 seconds from minimum field position to maximum field position and 6 to 10 seconds from maximum to minimum field position.

WS -represents pilot valve plunger #8188851 and bushing #8191874 ive port (Wide slot) which permits load regulator timing 6 to 10 seconds from minimum field position to maximum field position, and 23 to 33 seconds from maximum to minimum; and approximately 6 seconds from maximum to minimum field position when ORS solenoid is energized.

**HO -represents high output injector #5228230.

STD- represents standard injector #5227852.

Pass.	1125	800	.878	216206	8211841	NS	STD
SW	1200	800	.83	8200426	8211843	WS	STD
SW-MU	1200	800	.838	195017	8211843	WS	STD
Fri.	1350	800	1.00	8216206	8211842	NS	STD
Frt.-Pass.	1500	800	.878	216206	8211841	NS	STD
BL	1500	800	.87	8200426	8211841	WS	STD
SD7	1500	800	.878	195017	8211844	WS	STD

different full load injector rack length, the insert having the correct information should be applied to the governor. Application of the governors and the respective insert used is shown in Table B.

a. Electro-Hydraulic Governor

Due to the difference in expansion between the metals in the governor, no attempt should be made to accurately set the engine speeds until the temperature of the metal has equalized. Use a tachometer applied either to governor drive or front camshaft. A special solenoid adjustment

wrench 8174868 is available to facilitate speed setting. This tool provides for holding the solenoid case while making locknut and stop screw adjustments.

Portable engine speed controller 8227463 with plug adapter #8210256 can be used to set engine speeds. This controller can be located close to the governor and current supply taken from a low voltage outlet receptacle. Adapter 8210256 must be used since the 567C engine governor has a 12 point plug, whereas the controller has an 8 point plug. (When a 567C engine is replaced by a 567B engine, permanent governor adapter #8210938

s used to connect the governor to the locomotive governor plug.)

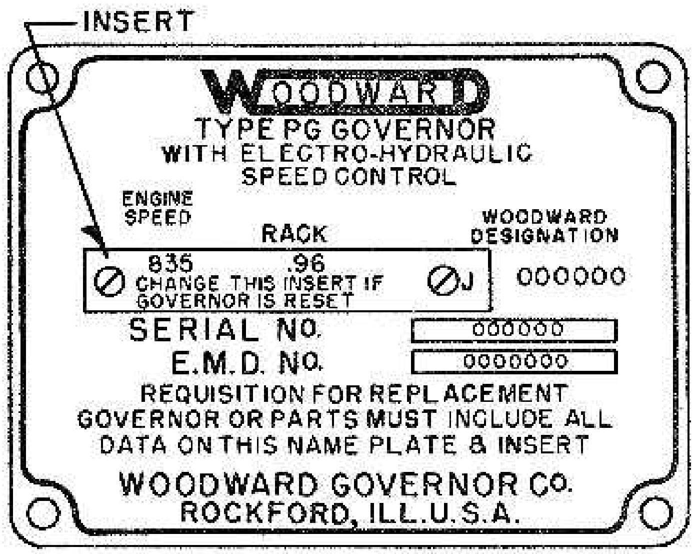
The speeds given in the following Items 2 through 6 cover governors set for full speed of 835-843 RPM. The same procedure is used to set the governor for 800-808 full speed engines except speeds should be, 650-658, 800-808, 725-733, 500-508 and 275-283 RPM for throttle positions #6, 8, 7, 4 and 1 respectively. Speed settings for 300 RPM idle speed engines are given under b, Special Engine Speed Settings.

(2) Set the throttle in #6 position and bring engine speed to 675-683 RPM by adjusting fulcrum nut, Fig. 11-9, Item 2, at the end of the linkage. Raising the fulcrum nut increases speed.

(3) Set the throttle to #8 position and bring engine speed to 835-843 RPM by adjusting the "D" solenoid stop screw, Item 1. Back off stop screw to increase speed.

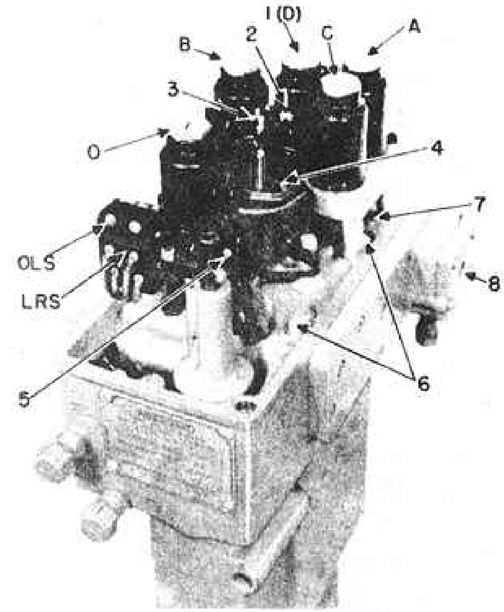
(4) With the throttle in #7 position, adjust the "A" solenoid stop screw for 755-763 RPM. Turn stop screw in to increase speed.

(1) Be sure necessary precautions are taken so the generator on the unit being worked on will not supply power. The portable controller 8227463 above can be connected directly to the governor, however, if the throttle is used on a multiple engine consist then the isolation switches on the other units must be placed in the "Start" position while the unit worked on is in the "Run" position.



Governor Name Plate Insert
Fig. 11-8

- 1121 -



I.	**D VALVE**	6.	**CONTROL COLUMN HOLDING BOLTS**
2.	**FULCRUM NUT**	7.	**TIME DELAY ADJUSTMENT POINTER**
3.	**SHUTDOWN NUTS**	8.	**HIGH LUKE OIL SUCTION**
4.	**SPEEDER SPRING PISTON STOP**	A.	**A VALVE**
	SCREW	B.	*B* **VALVE**
5.	**POWER PISTON TO FLOATING LINK**	C.	**C VALVE**
	PIN	D.	**D VALVE**

0.OVERRIDING SOLENOID

Speed Control - Electro-Hydraulic Governors
Fig. 11-9

- 1122 -

(5) Set throttle in #4 position and bring engine speed to 515-523 RPM by adjusting "B" solenoid stop screw. Turning in increases engine speed.

(6) With throttle at idle adjust "C" solenoid to give 275- 283 RPM engine speed. Turn screw in to increase speed.

(7) Check above settings and, if correct, all other speeds will be within limits, with all solenoids set. Check engine speed at all throttle positions. Speeds at intermediate throttle positions must be within limits as shown in speed chart.

(8) Also, the speed pointer should be observed to register at correct speed on the. speed scale when setting engine speeds at idle and full speed. If not, scale must be, relocated or remarked so pointer and scale correspond at idle and full speed. (H speed scale is altered, check pilot valve setting.)

b. Special Engine Speed Settings

Some 567C engines in repowered locomotives other than original EMD manufacture, are set to run at 300 RPM idle speed. Also, these engines operate at different speeds for corresponding throttle positions compared to other engines. For identification the wiring diagrams of these locomotives list their specific speeds.

To set speeds on these engines the same general procedure is followed as outlined under a, Items (1) through (8). However, the speeds for each throttle adjustment position should be: #6-660 RPM, #8-835 RPM, #7-775 RPM, #4-520 RPM and #1 or idle speed 300 RPM. These settings should give the following speeds in revolutions per minute at corresponding throttle positions: #1-300, #2-360, #3-460, #4-520, #5-600, #6-660, #7-775 and #8-835 RPM

c. Pneumatic-Hydraulic Governor

On engines equipped with pneumatic-hydraulic governors, the engine is adjusted for idle speed and full speed as follows:

(1) Release the throttle from "Stop" position to "Idle" position.

(2) Connect air pressure gauge in air line from transmitter in the control stand to receiver of the governor. (The gauge may be fitted so as to be connected between the air line and the governor, at the governor.) At Control Stand

(3) With throttle in idle, adjust eccentric on transmitter, Fig. 11-4, to give 14 p.s.i. on air gauge.

(4) With throttle in full speed position check air pressure on gauge. The air pressure should be greater than 28 p.s.i. At The Governor

(5) Start the engine, controlling speed with the layshaft lever. No air pressure is necessary. Set engine speed at 275-283 RPM by adjusting fulcrum nut, Item 6, Fig. 11-10. (Be sure shutdown solenoid is not bottomed, see adjusting solenoids for shutdown.)

The end of the walking beam should rest against its stop on the top of the receiver, Fig. 11-11, under the walking beam, directly behind the control cable plug. (The walking beam is the 1- 3/16" x 2" rectangular plate on the receiver with two 10-32 Allen screws and one 3/8" slot head screw and lock-nut.)

(6) Establish 15 p.s.i. on air gauge by opening throttle. Loosen 3/8" locknut on top of the walking beam and adjust 3/8"-24 screw so as to give a .001" - .002" clearance between bottom of walking beam and its stop on the receiver. Tighten locknut.

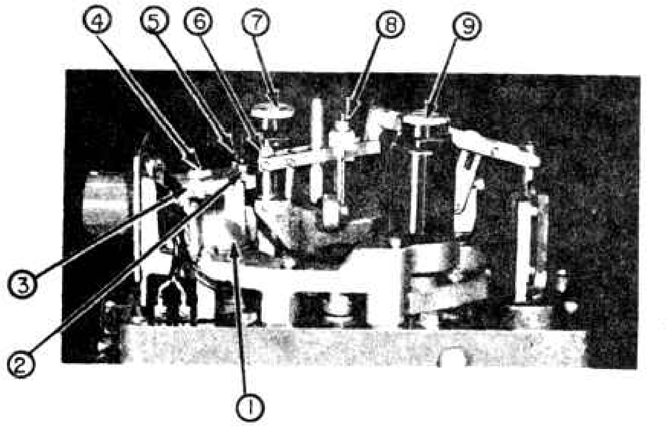
(7) Back off the high speed stop screw in the walking beam so as not to limit travel of the beam. Open the throttle to establish air pressure on the air gauge for the required full speed of engine as follows:

Air Pressure	Engine Speed

beam. Loosen the set screw and 3/8" screw and locknut and move sliding block "in" to

28 - 29 p.s.i	800 - 808 RPM
29.5 - 30.5 p.s.i	835 - 843 RPM

If engine speed is not correct at these pressures, adjust the movable block in the walking



1.	Governor Receiver	5.	Low Oil Time Delay By-Pass Adjusting Screw
2.	High Speed Stop Screw	6.	Fulcrum Nut
3.	Walking Beam	7.	Shutdown Solenoid
4.	3/8" Slot Head Screw	8.	Overriding Solenoid

Speed Control - Pneumatic-Hydraulic Governor
Fig. 11-10

increase speed, or move block "out" to decrease speed.

NOTE: Each time the sliding block is moved, return to item 6 and re- adjust the 3/8" screw.

(8) With throttle at full open position, adjust the high speed stop screw on the walking beam to obtain correct full engine speed according to the governor and engine.

2. Adjusting Speeder Spring Piston Stop

The speeder spring piston stop is the Allen head set screw shown as Item 4, Fig. 11-9. The location of the stop is the same on the pneumatic-hydraulic governor and is set as follows: With the engine at 275-283 RPM, run the set screw down until it contacts the top of the speeder spring piston, then back off on the screw 1-1/2 turns and lock. This prevents the piston from hitting top of the cylinder.

3. Adjusting Shutdown Nuts, Electro-Hydraulic and Pneumatic-Hydraulic Governor

Fig. 11-9, Item 3 shows the shutdown nuts on the electro- hydraulic governor and Fig. 11-10, Item 8 on the pneumatic- hydraulic governor. The shutdown nuts on the PG governor should be adjusted at idle engine speed, so there is 1/32" slack or clearance between the bottom of the lower shutdown nut and the top of the speed setting piston extension. (When the rod is released this clearance will not be apparent, since the shutdown rod will drop down.) A special wrench #8208398 is available to facilitate this adjustment. Tool #8208398 has 1/32" gauge wrench for PG governors and 3/32" gauge portion for SI Model governors.

4. Adjusting Solenoids for Shutdown

a. Electro-Hydraulic Governors

The "D" shutdown solenoid is adjusted at the time of engine speed adjustment.

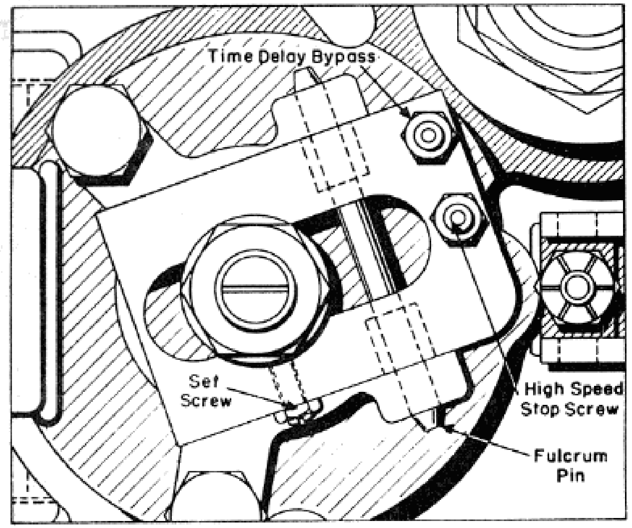
b. Pneumatic-Hydraulic Governors

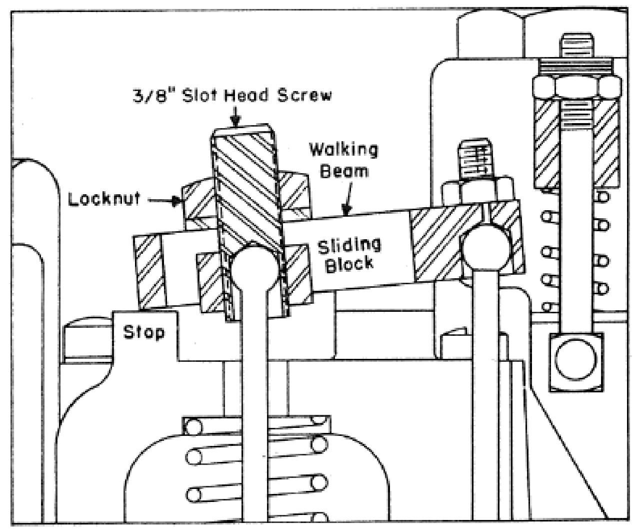
The shutdown solenoid of pneumatic-hydraulic governors used on 567C engines is shown in Fig. 11-6. The solenoid plunger is drilled and partially tapped for application of two 1/8" Allen head screws. The lower one serves as an adjustment screw while the upper screw serves as a lock to hold the adjusting screw in place.

The adjustment is made with engine dead, solenoid de-energized, as follows:

(1) Remove solenoid plunger stop screw and large lock nut, making solenoid plunger accessible.

(2) Insert small width rule in solenoid case so as to just rest on top of solenoid plunger. Observe dimension from top of plunger to top of case. Using rule push solenoid plunger down as far as it will go and observe reading on rule at top of case. The plunger travel should be .060" or approximately 1/16". If plunger travel is over .060" back off on adjusting screw, and if under .060" run adjusting screw down. (The plunger may be removed by using a 1/4"-28 bolt as a lifter). Remove plunger if adjustment is to be made and remove lock screw. Make necessary adjustment of lower screw until .060" plunger travel is obtained, then replace upper lock screw in plunger. Replace plunger and solenoid stop screw and run down until plunger bottoms, then back off 2-1/2 turns and lock with locknut. Observe shutdown





Slotted Walking Beam Detail
Fig. 11-11

valve during operation of governor. There should be no leakage at the valve.

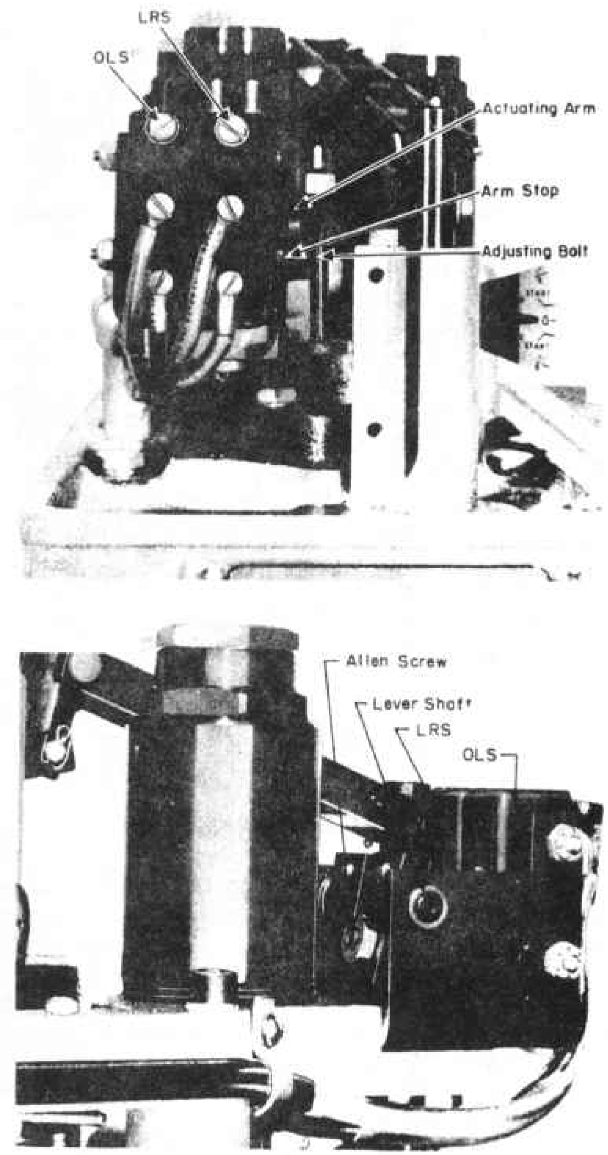
5. Adjusting Compensation

When the engine is started for the first time after installation of a new or reconditioned governor, it is important to adjust compensation. Open the compensating needle valve, located near the power cylinder, Fig. 11-1, six turns. Also, the vent plug (on rear of governor, identified by a triangular plate) should be loosened (not removed) and the engine allowed to surge by hand operating the layshaft lever for about 30 seconds, to work air out of the governor. After the engine has surged sufficiently to remove air from the system, tighten vent plug. Then close compensating needle valve gradually until surging is just eliminated. The proper setting depends on the characteristics of the engine. Keep the needle valve as far open as possible to prevent sluggishness.

After compensating has been adjusted correctly for the engine, it should not be necessary to change it, except for a large permanent temperature change affecting the viscosity of the governor oil. The needle valve setting will vary from 1/8 to 2 turns open.

6. Adjustment of OLS and LRS

The governor is equipped with an OIS switch and a LRS switch which are mounted adjacent to the power piston tailrod under the governor cover, Fig. 11-12. The OLS switch acts to prevent engine overload by completing a circuit to ORS. The LRS serves to cut out fast starting, returning full load control to the load regulator. These switches are set as follows:



OLS and LRS Switch Application
Fig. 11-12

The LRS switch is set to close one terminal shaft scale division, Fig. 11-5, plus or minus one half division (1 ± 1/2 division) lower than the full load injector rack length of the particular engine on which the governor is used. For example, if the full load injector rack length of the engine is .96'1, the LRS switch would be set to close at .92 ± 1/2 division, or if the full load rack length is 83'1 the LRS switch would be set to close at .79" ± 1/2 division. (See Table B, page 1119 for full load injector rack length of the various engines.) To set the IRS switch, raise the power piston tail rod, using the governor tailrod jack, until the correct setting dimension on the governor quadrant scale is opposite the scale pointer on the governor. Then adjust the knurled bolt through the extension bar to contact the switch actuating arm and close the LRS switch.

To adjust the OLS switch, raise the power piston tailrod, using governor jack, so pointer on the governor is opposite the .67" (± 1/2 division) mark on the terminal shaft scale. Loosen locknut on Allen screw on OLS lever, Fig. 11-12, and adjust Allen screw to cause ORS (overriding solenoid) to be energized. The OLS switch lever is behind the LRS lever about 5°.

7. Overriding Solenoid Adjustment

When the overriding solenoid is energized, it opens a valve permitting governor oil flow to,,, the load control pilot valve and lift the overriding piston. This positions the load control pilot valve plunger to reduce main generator excitation. When the overriding solenoid is de-energized, oil flow is stopped and a spring returns the load control pilot valve to normal operating condition. The overriding solenoid travel is adjusted as follows:

a. Loosen the locknut on the "0" solenoid and run the screw down until the load control pilot valve raises.

b. Carefully back off the screw until the pilot valve starts down. Then back off the screw a full quarter turn more and lock it.

Improper adjustment of the overriding solenoid may result in a loss of governor accumulator oil pressure. This is caused by the overriding solenoid adjusting screw being backed off too far, allowing its valve to open the supply port, per mitting governor oil pressure to be by-passed directly back to the governor oil sump.

In cases where the engine dies in the lower throttle positions, the adjustment of the overriding solenoid should be checked among other checks. The operation of the pilot valve is covered in Section XII of this manual.

8. Rushing Governor

It is not recommended to flush the governor as a regular maintenance item. Instead, the governor should be disassembled and cleaned if operation is impaired due to dirt or other foreign particles in the governor.

Although in cases of necessity where the governor is suspected of being dirty and it would not be practical to remove the governor from the engine, it may be flushed on the engine as follows:

The engine should be shut down and the drain plug removed from the governor case or petcock opened. Close valve or replace plug and add two pints of filtered kerosene to governor and start engine. By using layshaft manual control lever, vary the speed of the engine from 400 to 500 RPM, for about five minutes. Shut the engine down and drain kerosene from the governor. Repeat this operation several

times until the kerosene drained from the governor appears clean. Add two pints of recommended oil to the governor (as given in Item 9 following) and repeat the above procedure and drain. This will remove any kerosene trapped in the governor. Fill governor with recommended oil to proper level and start the engine. Vary speed of engine for several minutes to work air out of the system. The oil level should then be checked and oil added, if necessary.

9. Governor Oil Supply

The oil capacity of the governor is 3 pints. Use new oil of the type used in the engine or SAE #20 turbine type oil having rust and oxidation protection. The oil level should be maintained between the marks on the sight glass. The vent at the top of the sight glass

11. Adjusting Low Oil Pressure and High Oil Pump Suction Shutdown

a. Low oil Pressure Shut-Down - Electro-Hydraulic and Pneumatic-Hydraulic Governors

The low oil pressure time delay shutdown period with the engine at idle may be checked by shutting off the oil supply to the lube oil diaphragm by pressing in on the #10 Allen stop screw, Fig. 11-7, of the high pump suction diaphragm. Regulate the time delay period by adjusting the time delay pointer, Fig. 11-7.

As explained previously, the delay should be regulated at 40 plus or minus 10 seconds, by rotation of the manual time delay pointer, Fig. 11-9, Item 7, located under the "A" and "C" solenoids on electro- hydraulic and under shutdown solenoid on pneumatic- hydraulic must be open to assure correct readings. It is recommended that the governor oil be changed twice a year, using care that the oil and its containers are clean.

10. Governor Storage

In the event the governor is to be stored for a considerable length of time, it should be protected against rust. Governors using SAE #20 turbine type oil having rust and oxidation protection require no further protection. However, if other oil is used lacking these properties, the oil should be drained and the governor flushed with kerosene and drained. The governor should then be filled with oil providing protection against rust. After filling with this oil, the governor should be run several minutes if possible. When the governor is again put in service the recommended governor oil should be used.

governors. Rotation of the pointer counterclockwise increases the time delay period. A very slight change in pointer position is very effective.

(1) Time delay by-pass adjustment - electro-hydraulic governor

The time delay by-pass adjustment on the electro- hydraulic governor is made by regulating the clearance between the 3/32" Allen set screw located centrally, down between the "A," "C" and "D" solenoids and screwed into the triangular fulcrum plate, and the time delay by-pass extension, Fig. 11-7. The clearance at idle should be .010" to .015". It may be set by backing off on the screw several turns, placing the throttle in #3 position with the engine running, screw down carefully until, pressing on the #10 Allen stop screw of the high suction diaphragm will give a shut down

in about two seconds. Then turn the screw 1/4 turn further down and lock.

(2) Time delay by-pass adjustment - pneumatic- hydraulic governor

The time delay by-pass is checked in the pneumatic- hydraulic governor the same as with the electro- hydraulic governor, by pressing in on the #10 Allen set screw on the high suction diaphragm. The adjustment is made as follows: With the throttle at idle, put a 1/32" shim between the idle stop (control plug end of the receiver) and the walking beam of the receiver. Set the by- pass valve screw, Fig. 11-10, Item 5, which is next to the high speed stop screw and bears on the spring loaded by-pass extension, to just push the valve off its seat. Check the setting by pressing in on the #10 Allen set screw of the high suction diaphragm with the engine operating at the third (3) throttle position. The shutdown tripping time when the engine is operating in the third throttle position or higher should be no greater than two (2) seconds.

b. High Suction Shutdown - Electro-Hydraulic And Pneumatic-Hydraulic Governors

The high suction shutdown should operate at 16 to 20 inches of vacuum to initiate the shutdown feature.

The adjustment is made with the #10 Allen stop screw shown in Fig. 11-7. Screwing the set screw in decreases the suction tripping pressure. The setting adjustment may be made by disconnecting the suction line connection at the governor and attaching a device capable of creating a vacuum in the diaphragm chamber of 16" to 20" vacuum, and adjusting the set screw to operate under this

suction. Vacuum should be increased slowly, as rapid increase will give inaccurate setting.

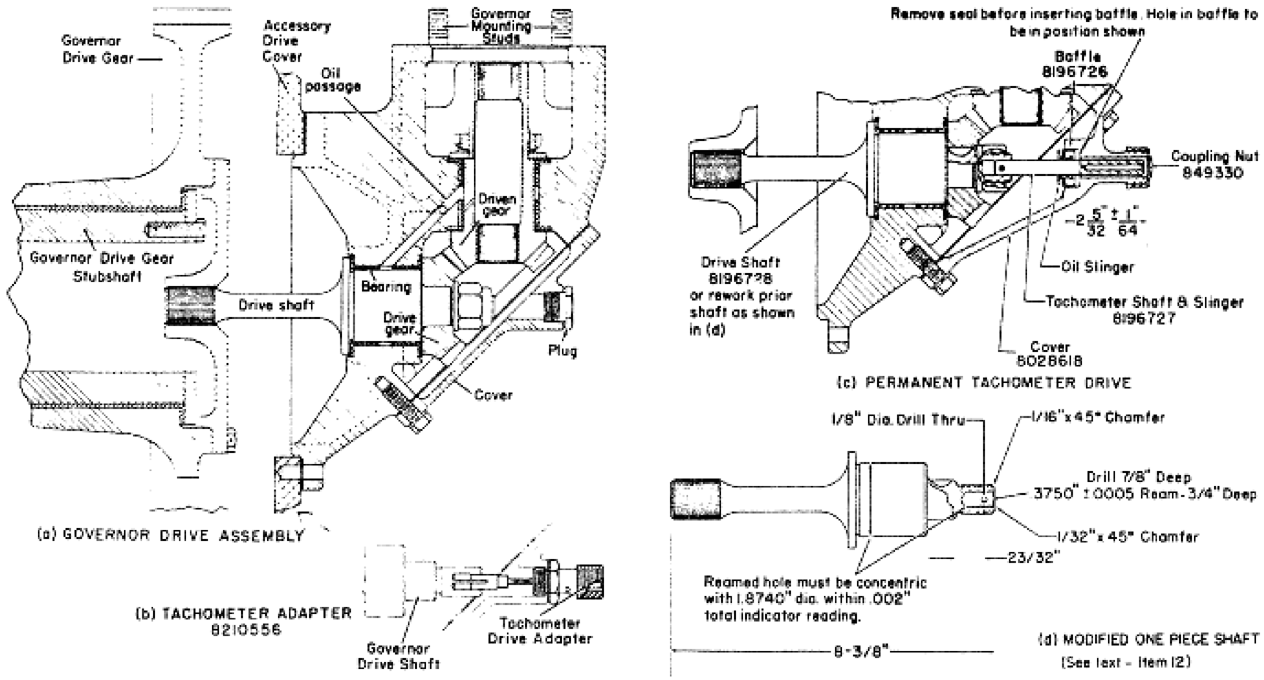
One suitable instrument for this purpose can be made from information in Maintenance Instruction 5503 which gives details of construction from ordinary available parts.

The operation of the suction alarm may be checked manually by pressing in on the #10 set screw. The engine should shut down in about 2 seconds when this screw is held in as far as it will go, when the engine is operating in the third throttle position or higher. In the event a suction diaphragm is broken a small amount of air will be drawn into the lube oil system. The diaphragm may be checked under external oil pressure not greater than 10 p.s. i. to check for leaks.

12. Governor Drive Assembly

The governor drive assembly, Fig. 11-13 (a), is mounted at the front of the engine on the accessory drive cover adjacent the water pumps. The governor is mounted on the housing and driven through the 90° bevel gear drive. The serrated end of the drive shaft is mated into a drive plate of the governor drive gear in the accessory gear train. Lubrication of the governor drive bearings and gears is provided through drilled passages in its housing.

A cover is provided on the housing having a removable plug, so that the tachometer adapter 8210556, Fig. 11-13 (b), can be inserted in the drive shaft end. The adapter end is inserted into a reamed hole in the end of the governor drive shaft and has a friction fit. A permanent electric tachometer drive application may be applied to the governor drive shaft as shown in Fig. 11- 13 (c). The permanent



Governor Drive Application
Fig. 11-13

tachometer drive is inserted into the hole in the end of the drive shaft and is pinned to the shaft. (One piece governor drive shafts 8028492 or 8024772 used in early 567 series engines can be modified as shown in Fig. 11-13 (d), to fit the 567C engine governor drive.)

The governor drive assembly normally does not require servicing except at the time of general engine overhaul or reconditioning. At this time or when conditions warrant, the governor drive assembly should be removed and the parts inspected and checked. After removal of the governor, the governor drive assembly can be easily removed. A mounting dowel correctly positions the governor drive housing on the accessory drive cover.

After the governor drive assembly has been removed and disassembled, visually inspect the bushing bores and thrust faces for flaking, imbedded dirt, chipping or scoring. Chipped, flaked or bushings having large quantities of imbedded dirt should be replaced with new bushings. Check oil passages in the housing to be sure they are free of restrictions. Inspect bevel gears for nicks, pitting or visible wear on the loaded tooth faces. Nicks, burrs or any high spots should be stoned out or the gears replaced. If it is necessary to replace a gear, it is recommended that both gears be replaced as a set. Check individual parts and assembly to be within limits as given under Specifications at end of this section.

D. GOVERNOR TROUBLES

1. If Engine Pails to Start

a. Check overspeed trip lever.

b. Check fuel supply and return in sight glass.

c. Check governor speed indicator pointer to see that it comes to the idle position (while engine is cranking, or running at idle speed - by manual layshaft control).

d. Check shutdown plunger, must be "in" (no red showing).

e. Start engine and hold 1.79" mark on terminal shaft scale opposite pointer on governor until engine lube oil pressure gauge reaches minimum of 3 to 5 pounds per square inch, then release. H engine will not continue to run and above items are O.K., the power piston probably is not getting oil due to internal governor defect.

2. If Engine Stops Under Load

a. Check shutdown plunger (kicks out and stops engine for low oil pressure or high suction).

b. Check overspeed trip lever.

c. Check fuel supply and return.

d. Restart and check lube oil pressure - minimum 3 - 5 p.s.i. at idle and 14 - 16 p.s.i. at 800 RPM or 14 - 17 p.s.i. at 835 RPM. If below these figures, shutdown plunger will pop out.

e. If pressure is satisfactory and plunger pops out, check suction head on lube oil pumps.

c. Check vane motor to see that it moves from minimum field position. If not, check operation of overriding solenoid to see if its hydraulic valve is operative (will move pilot valve up or down). Also, check overriding solenoid plunger operation to see that it moves downward when energized.

5. Engine Running Consistantly Over Or Unloaded

a. Check engine speed and speed indicating scale (inside governor), pilot valve scale, and rack length pointer scale, for accuracy under running, loaded conditions. If speed or pilot valve scales are off location for full load operation, reset and pin in place. Then reset pilot valve linkage. (In the "no fuel" position with the engine shut down the governor pointer should be opposite the 1.96 position on the terminal shaft scale of rotary shaft governors.)

6. Engine "Hunting"

NOTE: This can be caused by three systems. They are (1) Governor; (2) Pilot Valve and Injector Linkage; and (3) Load Regulation.

a. Check oil level in governor, must be between 2 lines on sight glass when running and under normal running temperature.

b. Check injector linkage for binding.

This must be less than 16 inches vacuum. If it is greater than 16 inches vacuum, clean suction screens. Shutdown plunger should not pop out below 16 inches Mercury vacuum.

3. Improper Speed Settings

a. Check idle and full speed setting at transmitter and receiver or speed setting solenoids.

4. Engine Not Loading Properly

a. Check pilot valve linkage adjustment.

b. See that engine is operative; i.e., has fuel, air.

c. Check load regulator vane motor travel timing. If hunting under load, remove load and check at same speed. If regulator timing is off and causing hunting, unloading the engine should stop the hunting. (The hunting can be greatly helped by steadying the engine speed with the layshaft lever.)

d. If all other checks above are O.K. then reset compensating needle of speed governor as necessary.

e. Flush the governor to remove dirt in the system.

7. Governor Overflows with Oil

a. Defective pilot valve oil seal (not to be confused with foaming due to overfilling).

b. Broken "lube oil pressure" diaphragm.

E. SPECIFICATIONS

Governor

Ratio governor speed to engine speed	1.09:1
Governor oil	
	New oil as used in the engine or SAE #20 turbine type oil having rust and oxidation protection.
Governor oil capacity	3 Pints
Governor Drive Assembly Bushing bore diameter (as assembled in housing)	Max. 1.8795"
Distance between bushing thrust faces	Min. 1.867"

F. EQUIPMENT LIST

Name	**Part No.**
Rotary shaft bearing - removing and	
installing tools (punch **and knock out**	
pins .685" and .810" dia.)	**8225658**
Rotary shaft seal removing tools (hook	**8225659**
tool and driving punch)	**8225660**
Tachometer **drive adapter**	**8210556**
Portable speed controller	**8227463**
Adapter plug used with **8182320**	
12 point "C" governor	**8210256**
Solenoid adjustment wrench	**8174868**

Diameter of drive shaft journal	Min. 1.8715"
Diametric clearance drive shaft and driven gear to bushings	Max. .008"
Governor drive shaft thrust face to shoulder	Min. 1.879"
Governor drive shaft end thrust	Max. .014"
Driven gear thrust face to shoulder	Min. 1.881"
Driven gear-end thrust	Max. .016"
Bevel gear backlash	Max. .013"

Tachometer - engine **speed (Hand)**	**8107967**
Power piston **jack - Extra (1 furnished** with the governor)	**8113650**
Speed jack - nut - Extra (1 furnished with governor)	**8113925**
Shutdown nut **adjustment wrench** (Sl - 3/32", PG - 1/32")	**8208398**

SECTION XII

PILOT VALVE, PILOT VALVE LINKAGE, SETTING INJECTOR RACK AND LINKAGE

A. DESCRIPTION

1. Pilot Valve

The pilot valve is a device for controlling the flow of oil to the vane motor of the load regulator.

Electro-hydraulic and pneumatic-hydraulic governors have the pilot valve embodied in the governor housing as shown in partial governor section, Fig. 12-1. The normal operation of the pilot valve depends on the action of the governor. If fuel supply is correct for engine speed, the pilot valve is balanced and prevents oil flow to the load regulator. If there is an unbalance in fuel supply and speed setting, the pilot valve permits oil flow to the load regulator so a generator load correction may be made to resume speed and fuel balance. However, when the ORS solenoid is energized the pilot valve is raised, making the load regulator move to minimum field position.

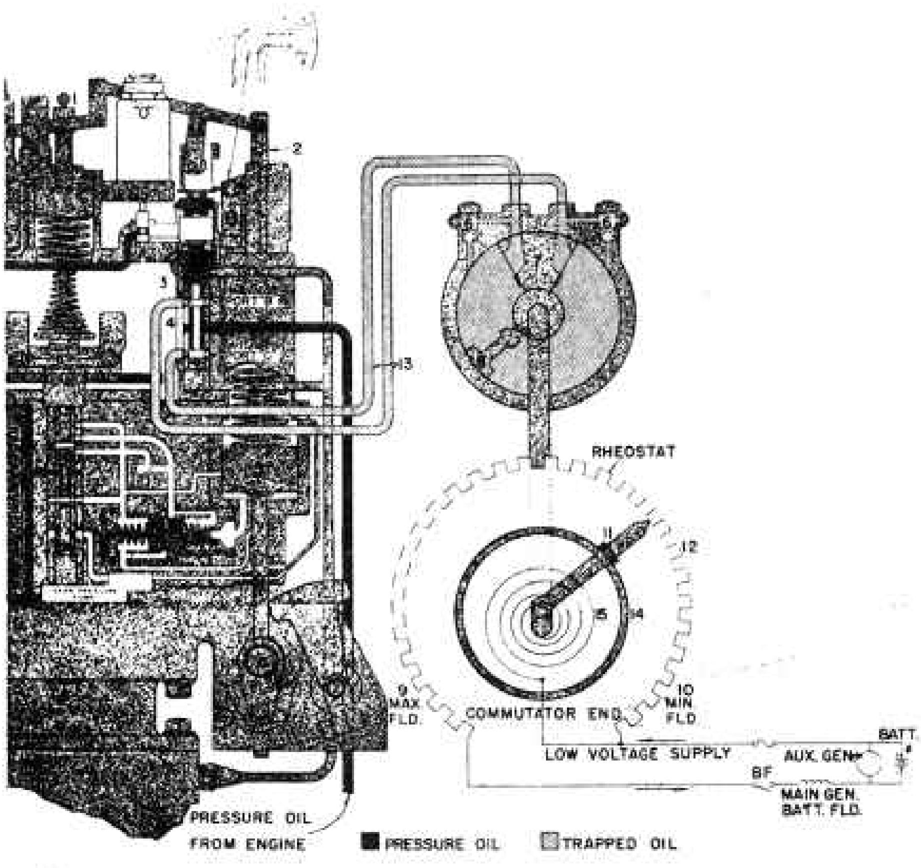
2. Pilot Valve Linkage

The pilot valve linkage is the same on the electro-hydraulic and pneumatic-hydraulic governors. It consists of a horizontal floating link, Fig. 12-4, vertical slide link, eccentric adjustment, clevis and holding screw, which connects the pilot valve plunger to the floating link.

3. Injector Linkage

The injector linkage; Fig. 12-2, consists of the mechanical arrangement which permits all injector racks

PILOT VALVE 252C-12-154 252C-12-1256 PILOT VALVE



to be positioned simultaneously by the governor fuel control lever. Parts of this linkage are: two injector control rods, one of which is adjustable and connecting fuel lever on governor to the injector control shafts. The injector control shafts, one for each bank, extend the length of the cylinder bank under the cylinder head cover frame. At each cylinder location a lever is pinned to the control shaft. A micrometer adjustable link connects the control shaft lever to a bracketed lever mounted on each cylinder head, one end of which saddles the ball at the end of the injector rack. As the governor fuel lever is moved, each injector rack is also moved proportionally.

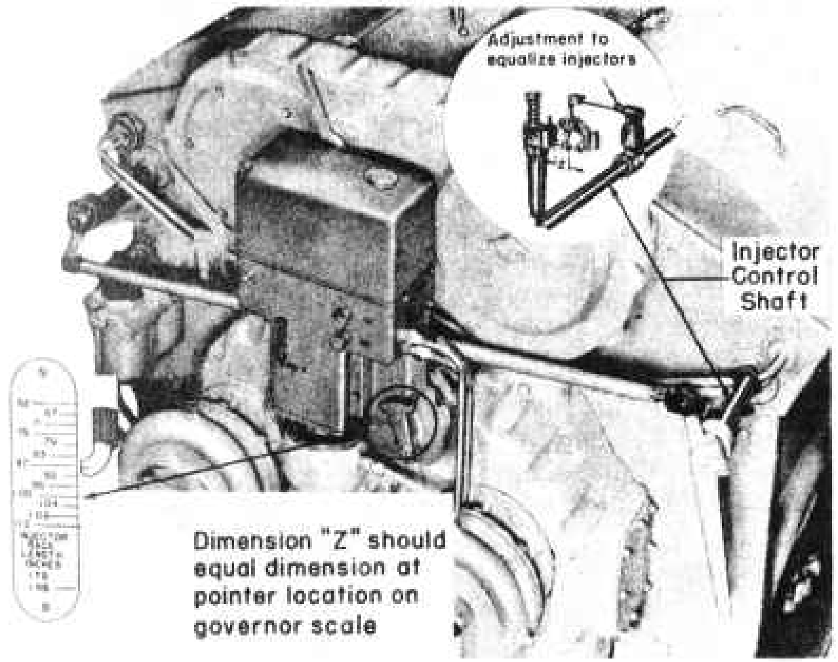
LEGEND

1. Speeder Spring Piston Extension	9. 8 O'clock Position
	10. 4 O'clock Position
2. Power Piston Tailrod	11. Brushholder And Arm
3. Pilot Valve Plunger	12. Load Regulator Resistance

4. Pilot Valve Bushing
5. Power Piston
6. Internal Check Valve
7. Vane Stop
8. Vane
13. Oil Lines
14. Slip Ring
15. Spring Shunt Overriding Solenoid

Fig. 12-1 - Schematic Load Regulator and Pilot Valve Arrangement

- 1201 -



Injector Linkage Fig. 12-2

- 1202 -

B. OPERATION

1. Pilot Valve

The pilot valve in conjunction with the load regulator requires each cylinder to assume a predetermined load for each throttle position, within the limits of the load regulator range of action, by controlling the loading of the main generator through the battery field.

Fig. 12-1 shows a partial governor section through the pilot valve and associated parts. When engine output is correct for a certain throttle position, the lands of the pilot valve plunger close ports "B" and "C" in the pilot valve bushing. In this position of the plunger no oil can flow through the ports to

generator output by increasing the electrical resistance of the battery field circuit. As the vane rotates it pushes oil ahead of it through the oil line port "C" of the pilot valve and thence to the engine oil sump. As the load on the engine is reduced, the power piston and pilot valve plunger move downward to normal position. The pilot valve plunger again closes both ports "B" and "C ."

The operation of the pilot valve for an underload on the engine is opposite that given for an overload, again adjusting generator load to permit the engine to assume its proper load for a certain throttle position, within the range of action of the load regulator.

The movement or timing of the vane or brushholder of the load regulator is or from the load regulator vane motor. This position is the balanced position of the pilot valve. As shown in Fig. 12-1, lubricating oil under pressure enters the valve at a point between the lands of the plunger and is trapped when the pilot valve is balanced.

When the horsepower demand on the engine is greater or less than the engine is set to develop at a given throttle position, a change will be made in the position of the governor power piston to meet the changed horsepower demand. Since the throttle position has not changed, the pilot valve plunger will either be raised or lowered, through the movement of the power piston and linkage. This action unbalances the pilot valve and the oil thus permitted to flow causes the load regulator to adjust the generator load to the desired engine output.

If the engine is overloaded, the power piston will move upward to increase fuel. This action raises the pilot valve plunger, opening port "B" with its upper land. Oil under pressure can then flow through port "B" to the vane motor of the load regulator. This causes the load regulator movement to reduce main

automatically controlled by orifices and slots in port "C," or lower port of the pilot valve bushings, as oil from the regulator must return through port "C" when oil to regulator leaves through port "B" or when oil to regulator passes through port "C." The slot and orifices in the pilot valve bushing lower port are designed to provide for a definite load regulator movement or timing. (See Table A, Section XI for the timing of the currently used pilot valve bushings.)

The pilot valve may be set either for maximum or minimum field starting. In maximum field, port "C" is open to operating pressure when starting; in minimum field, port "B" is open to oil pressure when starting. An additional setting is used on all current locomotives, known as modified maximum field start. With modified maximum field start, the pilot valve is set for maximum field, but through the action of the over-riding solenoid when energized, the pilot valve is positioned in minimum field position. Immediately after de-energizing of the over-riding; solenoid, the pilot valve assumes the position as originally set, maximum field. See "OverRiding Solenoid," Section XI. Provision is also made to allow oil to circulate through the system with the

engine in idle. This keeps warm oil in the system, improving the operation of the mechanism.

With the pilot valve set for minimum field position an unbalanced condition exists for the first several throttle positions, until the greater proportional movement of the speeder spring piston to the power piston allows the pilot valve plunger to assume balanced position. With maximum field start, the greater movement of the power piston in the first throttle position will lift the plunger to the balanced position.

C. MAINTENANCE

1. Setting Injector Rack

Before attempting to set injector racks, all racks and linkage should be

c. Rack setting gauge 8244899 is used to set the injector fuel rack. (This gauge replaces prior used injector rack setting gauge 8195904.)

Gauge 8244899 is made up of a body, indicator plate, multiplying lever-pointer and handle. Application of the gauge is shown in Fig. 12-3. In use, the injector fuel rack enters the gauge body and contacts the lever-pointer end, while the gauge is held against the injector. The injector link adjusting nut, Fig. 12-3, is turned to move the injector rack and position the gauge pointer at the center mark, which indicates that the injector rack is out of the injector one inch (1"). Calibration block 8244900 is - inserted fully into the gauge body in place of the injector rack to check pointer accuracy. Pointer position is correct if at the center mark with the calibration block in place in checked for binding, sticking or wear which would affect operation of the parts. To test injector racks of both banks, operate the injector control shaft hand lever. To check each bank separately, remove clevis pins from end of injector control rod ends. Each bank control shaft may then be checked. If required, each individual injector rack may be isolated from its control shaft for checking. (See Section X for remedy for sticking injectors.) Properly reassemble after checking.

The injector racks on the 567C engine are set as follows:

a. Injector racks on 567C engines should be set at a rack length of 1.00" with the governor pointer opposite the 1.00" mark on the governor terminal shaft scale.

b. Using governor tailrod jack, Fig. 12-4, raise tailrod until the 1.00" mark on scale is opposite the pointer on the governor. Do not force tailrod excessively as it may be broken in tension.

the gauge.

d. Using two 7/8" open end wrenches, hold the injector micrometer adjusting nut and loosen the locknut, Fig. 12-3.

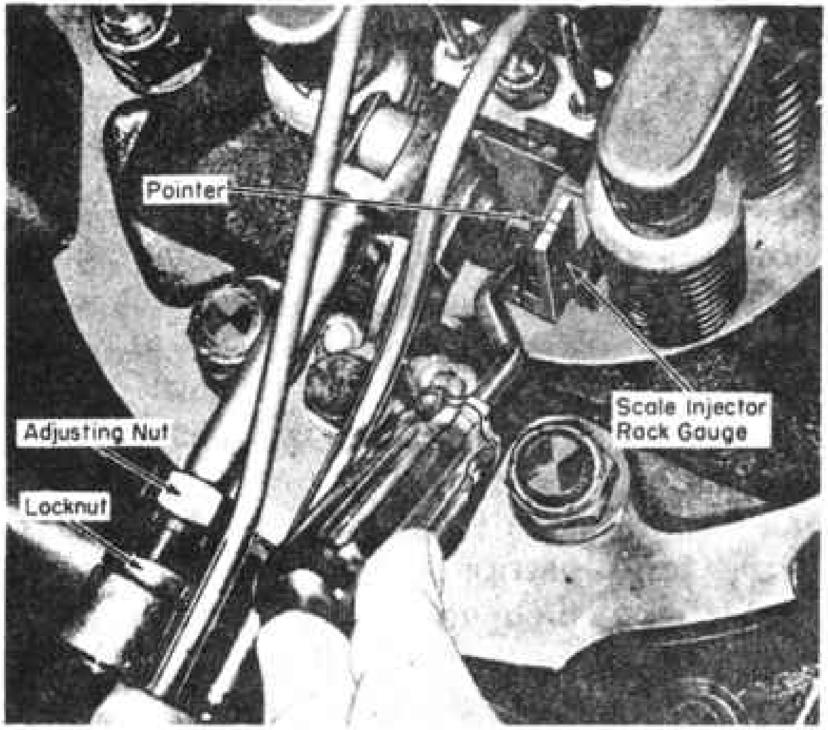
Place the injector rack setting gauge 8244899 over the injector rack and hold the gauge firmly against the injector body and check gauge pointer position. If pointer is on 'ILI' side of gauge, the rack is out too far. Move micrometer adjusting nut to place pointer on the "S" side of scale, then bring rack out so pointer mark and scale mark line up at the center position. Hold this position and tighten the micrometer adjustment locknut. By bringing the pointer to the "S" side of scale, then lining up pointer, when adjusting all racks, will assure the rack backlash is taken up in the same direction. Set and check all injectors using this procedure.

NOTE: In the event injector rack setting gauge 8244899 is not available, the injector racks may be set by positioning governor pointer opposite 1.00" mark on terminal shaft scale and adjusting the injector rack so that 1.00" scribe mark on the rack is just visible, or rack gauge 8107751 if available may be used. Replaced gauge 8195904 also had its pointer checked using a 1" gauge block and its pointer reset if required. However, this gauge is held to the injector by a magnet. Rack length was set by moving the fuel rack until gauge pointer was at the center mark of this gauge.

2. Setting Pilot Valve Linkage Before setting the pilot valve, the injector linkage, injector racks and engine speeds should be properly set. The governor engine speed scale must agree with the engine speed at idle and full speed positions or be re-set or re-marked to agree. If any change is made in the engine speed setting at anytime, the pilot valve should be checked for correct setting.

Also, the pilot valve scale should be checked that balance position agrees with actual pilot valve balance. Release the end of the floating link, and with the engine running, raise the floating link to position the pilot valve plunger so load regulator brush arm does not move when it is between maximum and minimum field positions. In this position of the pilot valve plunger, the pilot valve scale should indicate "0" or balance position. If the scale does not correspond with actual balance, the scale must be relocated or re-marked or pilot valve disc relocated to be correct.

Once the pilot valve is properly set, it should not be changed to correct



Injector Rack Gauge Application
Fig. 12-3

engine output until all other conditions are investigated. A partial list of probable causes of low output are:

Engine:

- Inoperative injectors
- Insufficient fuel
- Incorrect injector timing
- Incorrect speed setting

Electrical:

- Power contactors not energized
- Broken or loose connections
- Interlocks not making contact

The pilot valve linkage is the same on electro- hydraulic and pneumatic-hydraulic governors. It consists of a horizontal adjustable floating link and a vertical slide with an eccentric for adjustment as shown in Fig. 12-4. Changing the location of the movable block (dimension "A") varies the total travel of the pilot valve

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plunger, while changing the eccentric raises or lowers the plunger.

The pilot valve is set by making the following adjustments with the engine shut down:

a1. Check terminal shaft scale, with engine dead and governor power piston all the way down, that pointer indicates 1.96.

a2. Set dimension "A" of the floating link, Fig. 12-4, for the specific engine speed and full load injector rack length as given in Table "A" for the engine being set. Dimension "A" is approximately 45/64" for maximum field start for a 16-567C engine having .96 full load injector rack length and full speed of 835 RPM.

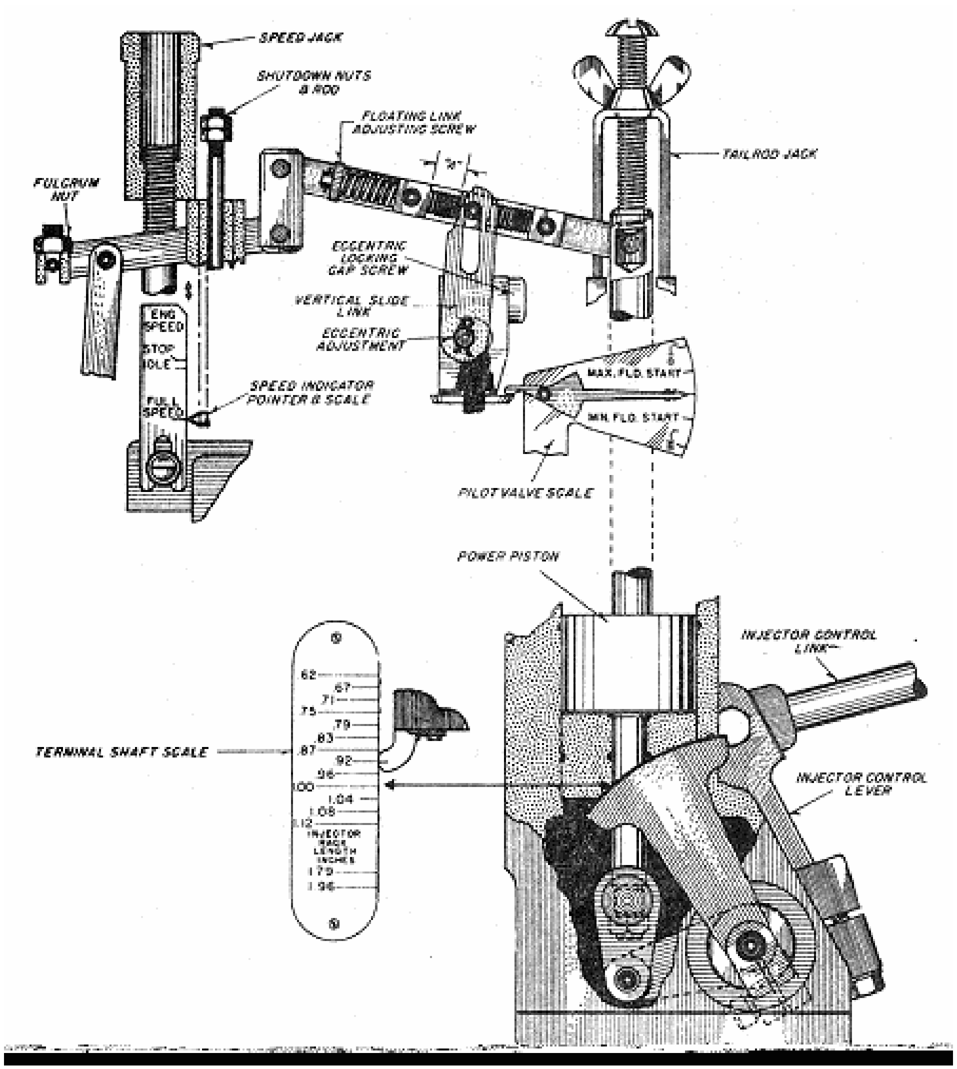
NOTE: Maximum field start setting (modified maximum field start with ORS energized or other) is standard on all locomotives; except Models E3, 6, 7, FT and F2.

b1.Position terminal shaft scale, using tailrod jack, until pointer is opposite full load rack length of engine being set.

b2.Using governor speed jack, position pointer on speed scale to full engine speed.

TABLE "A"

Full Load Injector Rack Setting	Full Engine Speed RPM	Type Of Idle Start	Pilot Valve Unbalance Direction	Amount	Dimension "A" (Approx.)
.83	800	Max. Fld.	Below	.040"	31/64"
•.83	800	Min. Fld.	Above	.040"	17/641,
.87	800	Max. Fld.	Below	.040"	17/32"
•.87	800	Min. Fld.	Above	.040"	5/16"



Schematic Pilot Valve Linkage 567C Engine Governor
Fig. 12-4

.87	835	Max. Fld. Below .040"	9/16"
.92	835	Max. Fld. Below .040"	21/32"
.96	835	Max. Fld. Below .040"	45/64"
1.00	800	Max. Fld. Below .040"	47/641,
•1.00	800	Min. Fld. Above .040"	15/32"
1.00	835	Max. Fld. Below .040"	49/64"
1.04	835	Max. Fld Below .0401,	13/161,

*Comparable full load injector rack lengths of 567C engines replacing other 567 series engines operating at 800 RPM, using injector 5227852 are as follows:

.83 full load injectorrack length = 5/16', power piston gap

.87 full load injectorrack length = 11/32" power piston gap

1.00 full load injectorrack length = 7/16" power piston gap

PILOT VALVE 252C-12-1255

b3. Pointer on pilot valve scale must show balance with b1 and b2 settings. If not, loosen eccentric lock screw and adjust eccentric to bring pilot valve plunger scale pointer to "0" balance position and re-lock. (The pilot valve must be positioned at "0" or balance at full load and speed on all engines.)

c1. Position governor speed scale pointer to idle speed, and terminal shaft pointer opposite 1.79. Pilot valve scale pointer should indicate maximum field start (or minimum field) depending on the dimension "A" setting; maximum field start with dimension given under a2.

NOTE: Some early governors have 1.70 mark on the terminal shaft scale, which should be re-marked 1.79. Mark location is correct.

c2. If pilot valve scale pointer is "below" the "maximum or minimum" field mark, dimension "A" should be lengthened; if "above" the respective mark, dimension "A" should be shortened. On this correction adjust dimension "A" one half (1/2) required, then return to full speed and full load rack length and adjust pilot valve pointer to "0" or balance position with eccentric (b1, 2 and 3 adjustments).

Recheck settings at idle engine speed and 1.79 rack length and if further adjustment is required, repeat above procedure until pilot valve scale pointer indicates correctly at idle speed and 1.79 settings and "0" or balance at full speed and full load injector rack length.