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.

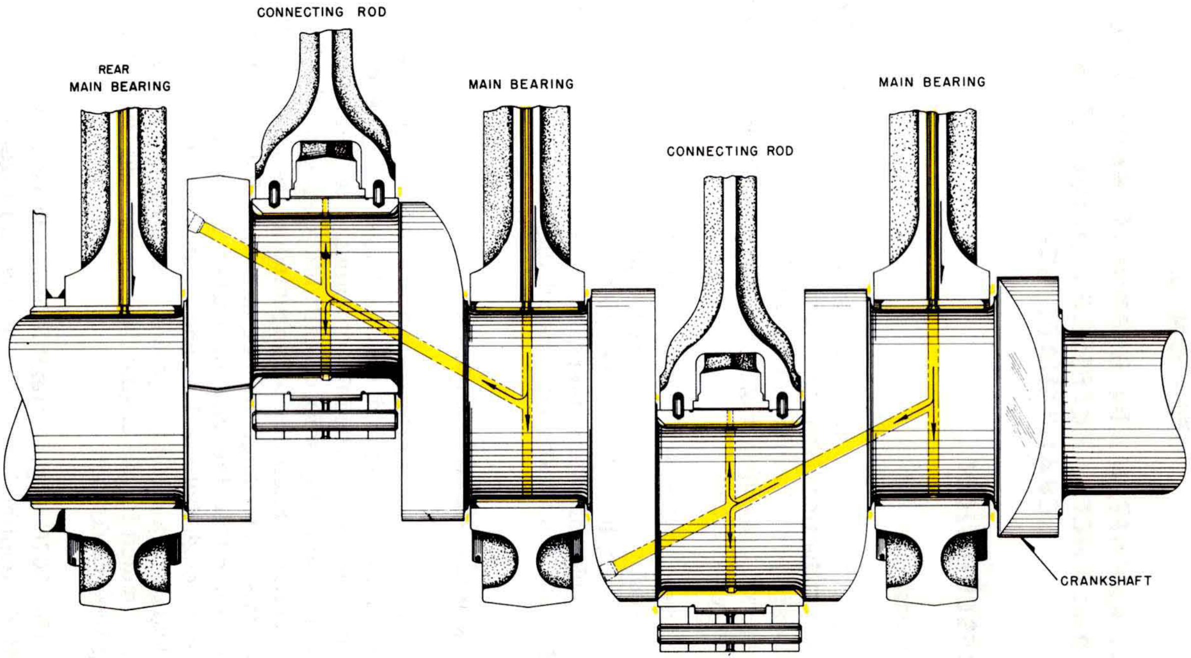
V

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.

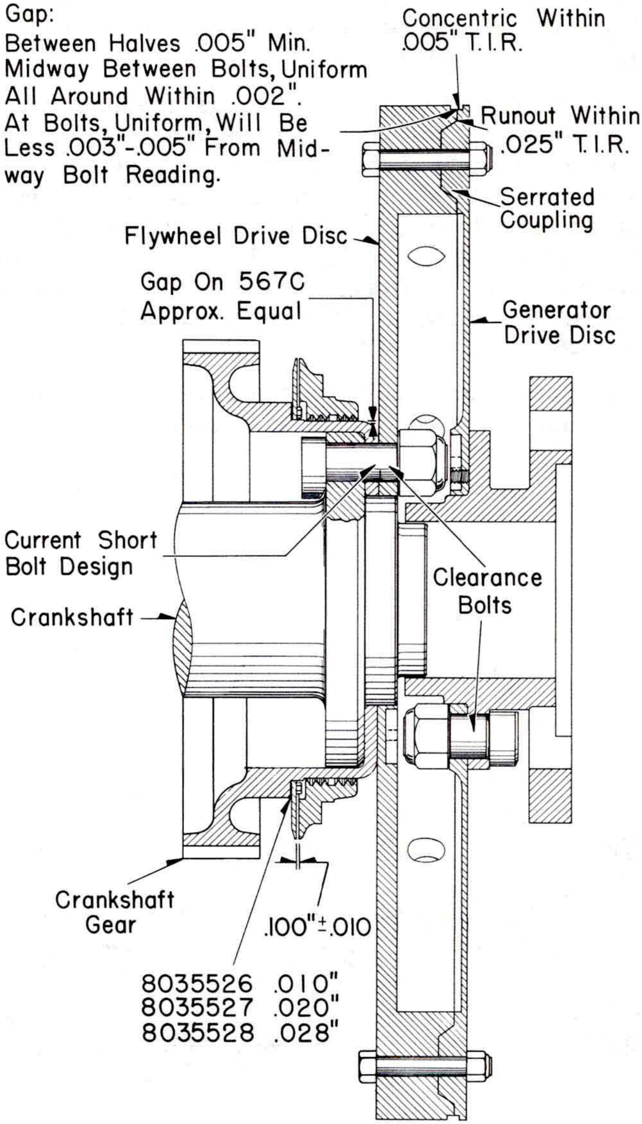
2. Flywheel — Flexible Coupling

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 coupling 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



Crankshaft Oil Passages
Fig. 5-1

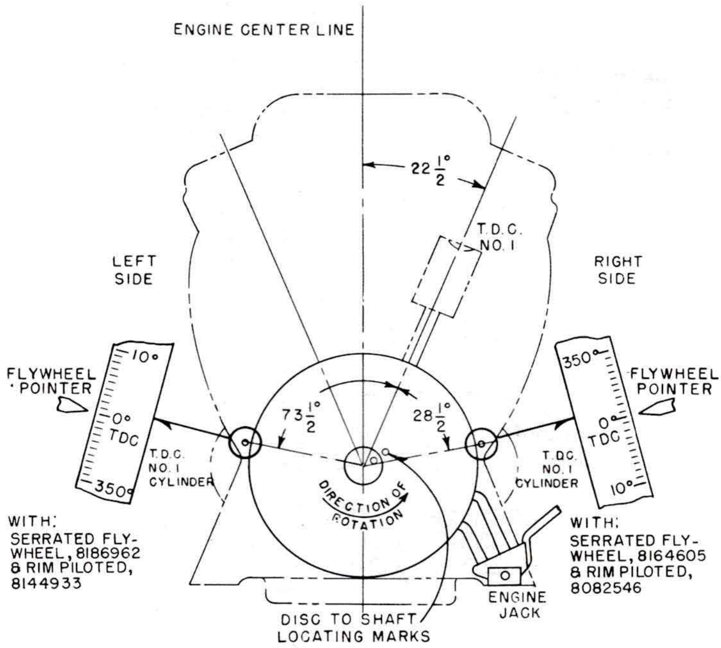


Crankshaft Rear End Details And Generator Coupling
Fig. 5-2

the generator disc rim. This design gives a self-centering unit, the serration acting as a guide when the coupling is assembled.

Two types of serrated couplings are used according to engine application, one having the 0^o 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 0^o 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 rim of the generator half disc.

NOTE: Some early 567C engines were equipped with non-serrated flexible couplings, or rim piloted



Flywheel Pointer Location
Fig. 5-3

two-piece type of coupling. These couplings have six reamed mounting hole bolts and one 3/4" - 16 x .8740" diameter bolt at the rim not used with the serrated coupling. Pointer location and 0° T.D.C. marking of these couplings are included in Fig. 5-3.

3. Main Bearings

The main bearing shells are precision type steel-backed 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 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.

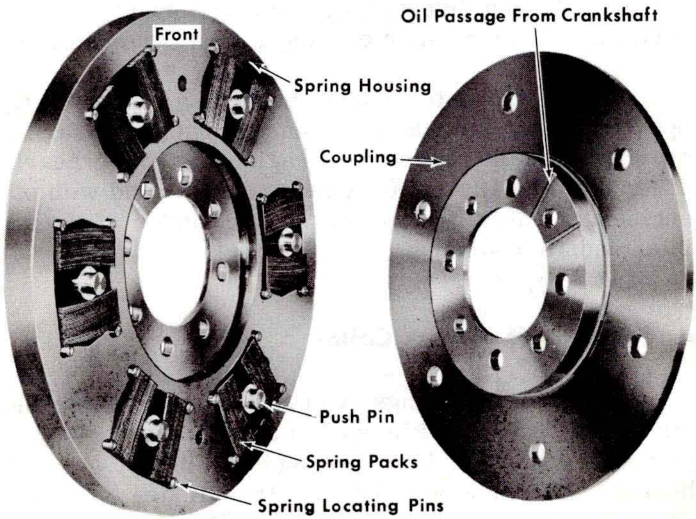
4. Crankshaft Thrust Collar

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.

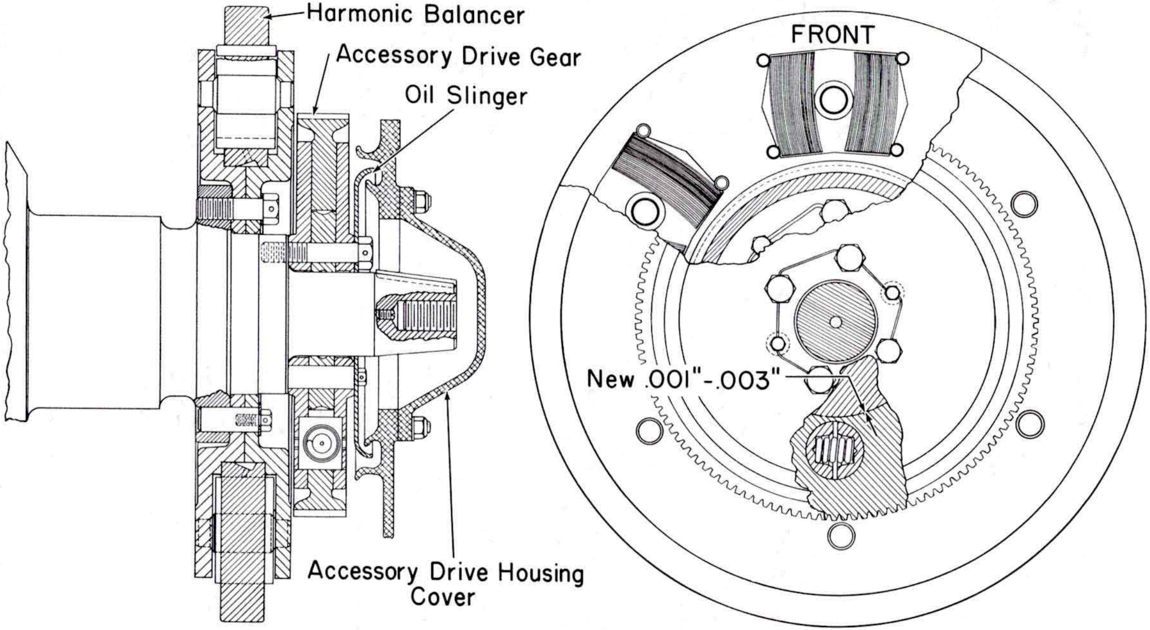
The thrust surfaces are lubricated by main bearing leak-off oil and are installed with their "thumb print" oil depression away from the "A" frame in which they are placed.

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 balancer receive oil through radial passages in the spring housing supplied through the crankshaft.



Exploded View - Harmonic Balancer
Fig. 5-4



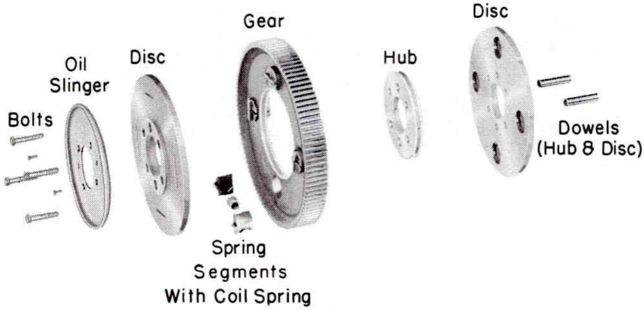
Harmonic Balancer And Accessory Drive Gear
Fig. 5-5

6. Accessory Drive Gear

The coil spring design accessory drive gear, Figs. 5-5 and 5-6, has replaced the prior used spring pack design shown in Fig. 5-8. The purpose of the gear is to alleviate transmission of crankshaft torsional vibrations when driving the accessories at the front of the engine.

As shown in Fig. 5-6, this gear consists of two discs, hub, gear, four coil springs, eight spring segments and two dowels with mounting bolts. The oil slinger is applied, as shown in Fig. 5-5, when the gear is installed on the crankshaft. Each coil spring is contained within two spring segments and then placed at 90° locations in the gear and discs, being located by tabs at the front of the segments. The hub serves as a pilot for the gear and spacer for the discs. Mounted on the crankshaft, force is transmitted through the disc, spring segments and coil spring to the gear.

Lubrication for the gear is supplied through the crankshaft into the hub. Drilled holes in the hub permit passage of oil between the hub and gear. The interlocking of the segments with the gear and discs, provide a positive drive to the engine accessories.



Exploded View - Coil Spring 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 16-cylinder 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 conical-shaped 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 rotating 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 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 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 overlay 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 re-applied must be installed in their original position relative to shaft rotation.

5. Limits

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".

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

c. Maximum allowable wall thickness variation between center lower main bearings on a 16 cylinder engine, that is, with no crankpin between them is .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 180°, 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 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 is now provided with different couplings and spring housing than was originally supplied. Originally, the spring housing had a wide shoulder at the inside hub diameter to take end thrust. This shoulder is removed on the present spring housing as shown in Figs. 5-4 and 5-5, but the shoulder is added to the hub of the new coupling. Although the shoulder location is changed, the function of the shoulder remains the same. Care must be taken so that the spring housing and couplings of the respective assemblies be kept together, for the parts are not interchangeable.

The spring housing of harmonic balancer 8194330 uses the "short" spring pin which is also a replacement for any earlier harmonic balancers using long pins. The "short" pin is identified by a 1/16" groove, 1/2" from the pin end. (If a long pin(s) require replacement on earlier harmonic balancer assemblies, all "short" pins should be used; long and short pins should not be mixed.)

Examine parts of the balancer, smooth up any roughness or burrs, particularly on spring housing spring pin ends and push pins. Rotate spring pins having 1/8" flats or more. Replace spring pins galled on the end and replace loose spring pins with oversize pins. (See Parts Catalog for available oversizes.) Check spring pins for equal height on each side of the spring housing.

Check 1/2" spring 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 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 leaves as required.

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 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.

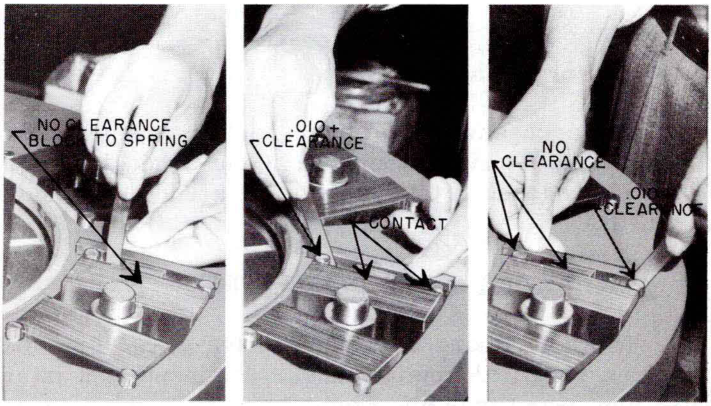
After all packs of about right quantity have been applied, each pack should be gauged using deflection gauge 8080197, Fig. 5-7. Apply gauge as shown in Fig. 5-7a, and check for clearance between springs and gauge block. With gauge in position (a) there should not be any clearance between gauge block 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. If one pack indicates more clearance than opposite side, insert leaf in side 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 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"



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 should 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.

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

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

Coil Spring Design 8250286

The coil spring accessory drive gear, Fig. 5-6, requires very little maintenance. At inspection intervals, the gear assembly should be disassembled to examine the parts. It is suggested that the coil springs be replaced at this time as well as any parts which show obvious damage.

The gear portion should be inspected for rough or scored surfaces on the gear teeth and given a Magnaflux inspection as outlined in Maintenance Instruction 1754.

To assemble the drive gear, be sure all parts are clean and well lubricated. Place the slotted disc, slots face down, and apply the gear over the disc. Align the holes in the gear and disc. Place the coil spring into two segments, and with the tabs down, and slightly pressed together, start the assembly into the hole in the gear. Drive the assembly all the way down, using a rawhide mallet, so that the tabs enter the slots in the disc. Repeat this for the remaining three spring assemblies. After the spring assemblies are in place, install the hub in the gear bore, and apply the top disc, locating the spring segments in the disc holes. Line up the dowel holes in both discs and hub and apply the dowels. Dowels should fit snug, if not, ream and apply oversize dowels. If the assembly is to await installation on the crankshaft, apply a holding bolt through the assembly.

When applying the assembly to the crankshaft, apply the oil slinger, dowel capscrews, hardened washers and mounting bolts. Torque the mounting bolts to 250 foot-pounds and lockwire.

Spring Pack Design 8084764

The spring pack type accessory drive gear, Fig. 5-8, has been replaced by the preceding coil spring design. The spring pack type requires the following maintenance.

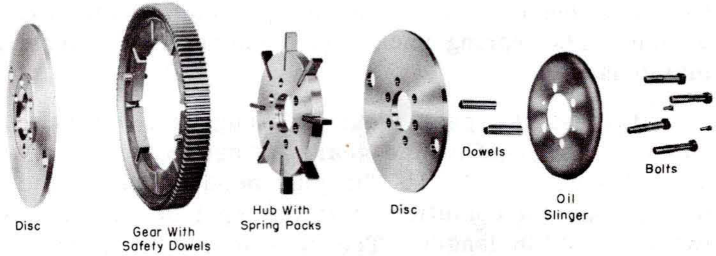
Inspect the gear teeth for roughness or scored surfaces. Magnaflux the gears as outlined in Maintenance Instruction 1754. The gear need not be replaced for spring slot condition until flat spot on driven side exceeds 3/8" in length. The gear may be reversed to carry the load on the opposite side. Therefore, the gear need not be replaced until wear has occurred on both sides of the spring slot.

Examine the hubs also, for flat spots in the spring slots, as with the gear. The hub may also be reversed to permit wear on both sides until flat spots exceed the 3/8" limit.

Smooth up any roughness on the hardened discs' surfaces.

The spring packs should be replaced at each inspection. No attempt should be made to make spring packs from used spring leaves, as spring slot clearance is very important and is controlled by factory assembly of the spring packs. Clearance should be .003"-.009", however, clearance cannot be measured in assembly because spring pack thickness must be determined in a clamping fixture, with the springs not oiled.

Check all the gear parts to see that they are clean and well lubricated before assembly. Place one disc, flat side up and place gear on the disc, lining up the safety dowels in the disc holes. Place the hub in the gear bore and check clearance, which should not exceed .010". Apply spring packs in hub and gear slots, and place other disc over the gear and hub. Line up dowel holes in the discs and hub and apply the dowels. Dowel fit should be snug, if not, ream for use of oversize dowels. When the assembly is installed on the crankshaft, apply the oil slinger, dowel cap screws, hardened washers and mounting bolts. Torque mounting bolts to 250 foot-pounds torque and lockwire.



Spring Pack Type - Accessory Drive Gear Parts
Fig. 5-8

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 Maintenance Instruction 1753.

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 will 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 center mounting bolt hole to #1 crankshaft bolt, positions degree markings on rim to align with pointer at 0^{o} 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.

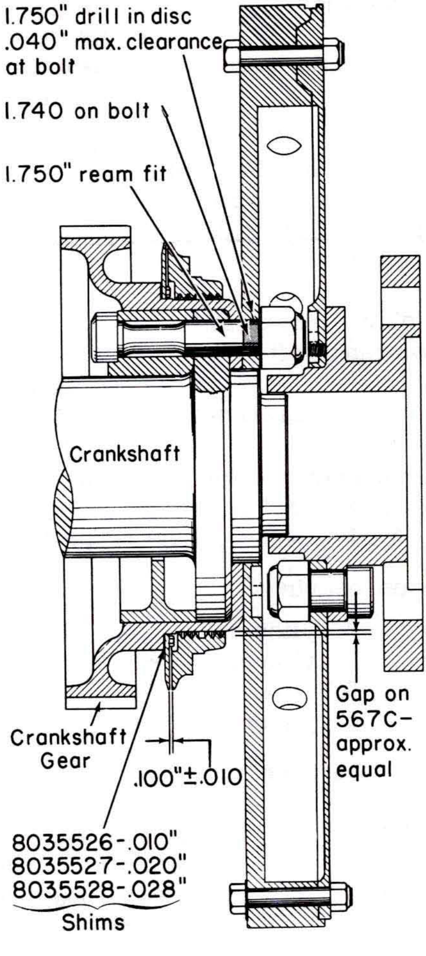
Upon installation of coupling disc to crankshaft, face run out and rim concentricity should be checked. Eccentricity of rim taken at the machined groove should not exceed .005" T.I.R., and run out on rim face should not exceed .025" T.I.R. (When taking rim run out, care should be taken to position crankshaft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

The short design coupling bolt as shown in Fig. 5-2, has replaced the prior used long bolt and lock ring shown in Fig. 5-9. The long bolt requires a ream fit at the crankshaft flange and crankshaft gear to maintain an oil seal. With the use of the short bolt no reaming is required as it has a loose fit at the crankshaft flange, crankshaft gear and engine coupling. The short bolt head is designed to seal against the inside surface of the crankshaft flange and is applied with the 3/8" chamfer of the bolt head toward the crankshaft flange radius.

Long bolts and lock ring parts are available. However, in using the long bolt a reamed fit must be maintained, either standard or oversize, at the crankshaft flange and gear as indicated in Fig. 5-9, although there is a clearance between the bolt and generator coupling.

Torque value for the engine to coupling bolt nuts is 1200 foot-pounds.

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



Long Reamed Coupling Bolt Application
Fig. 5-9

C. SPECIFICATIONS

Crankshaft

Diameter - main journal	New 7.498"-7.500"
	Limit 7.4965"
Diameter - crankpin journal	New 6.498"-6.500"
	Limit 6.4965"

Main Bearings

Diameter (inside) installed, with main bearing nuts torqued to 650 foot-pounds - average of 3 - 60° measurements	New 7.5065"-7.5095"
	Min. 7.505"
Clearance (diametric) main bearing to crankshaft	New .007"-.011"
	Limit .015"
Crankpin bearing to crankshaft	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

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"

Thrust bearing collar thickness:

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

Harmonic balancer:

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

Accessory drive gear (spring pack design):

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 .025"

Governor drive gear:

Diametral clearance
bushing to stubshaft .... New .007"-.014"
Max. .020"
Thrust clearance .... New .003"-.006"
Max. .008"

D. EQUIPMENT LIST

	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)