

# **REBUILDING** 5F & H COMPRESSORS



#### 5F AND H LESSON GUIDE

This training lesson is intended to give the service person the background necessary to identify each compressor component and determine the proper procedure for servicing them.

In this lesson we will cover:

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seats. Internal Components; cylinder and unloader sleeves, unloader springs and pins, piston and connecting rod assemblies, shaft seal assembly, seal-end bearing, crankshaft, unloader power element assemblies, hydraulic relay, and capacity control valve.	59 - 139
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external component and connection port locations. 38 - 46

Handout material should include the 5F, H Installation, Start-up, and Service Instructions.

When rebuilding a 5F or H compressor, a bearing puller and jackscrew, and a sleeve puller are recommended. For more information, contact your local Carrier Parts Center or an air conditioning supply outlet that handles Robinar parts.

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1. How to rebuild Carrier's 5F and H open-drive, reciprocating compressors is the subject of this training lesson.

2. We will cover the procedures to follow when removing, servicing, and reinstalling the various compressor components. To make it easier to follow these procedures, we'll divide the compressor into three main sections -the lubrication system, which supplies oil to all the moving parts; the head and valve assemblies, which allow refrigerant to flow from the low- to the high-side; and the internal components. which work together to compress the refrigerant.

We will not cover how to troubleshoot a component failure in detail in this lesson. For this information, refer to the Installation, Start-up, and Service Instructions and Carrier's Service Training book - Why Compressors Fail (GTC2-101, 020-342).

3. Before we start to cover the procedures for rebuilding a 5F or H, let's cover some background information on these compressors.

They can be either belt- or direct-drive and can use Refrigerant 12, 22, 500, or 502. They are used in air conditioning, refrigeration, and process cooling applications.



4. The 5F is available in four capacity sizes, ranging from 5 to 26-1/2 tons. The exact capacity will depend on the type of refrigerant used and the speed at which the compressor is operating.

All 5F compressors have a 2-1/2" bore and a 2" stroke. The basic difference between these compressors is the number of cylinders; they will have: 2, 3, 4, or 6. The number following the 5F lets you know how many cylinders there are. For example, the compressor at the right is a 5F20. The number 2 after the 5F means it has two cylinders.

The 5F20 and 30 have one cylinder under each head; the 5F40 and 60 have two.



5. The 5H is available in eight

capacity sizes, ranging from 25 to 150 tons. These compressors will have 4, 6, 8, or 12 cylinders.

All 5H compressors have a 3-1/4" bore, with either a 2-3/4" standard stroke or a 3-7/16" extended stroke. The compressors with the extended stroke have a higher capacity rating than the standard stroke compressor with the same number of cylinders.

Like the 5F, the number after the 5H represents the number of cylinders. All 5H compressors have two cylinders under each head. To determine if the compressor has a standard or an extended stroke, check the last digit of the model number. For example, if it's a 5H40, the zero means it has the standard stroke; if it's a 5H46, the six means it's the extended stroke.

Now, let's cover the procedures to 6. follow when checking out and servicing a 5F or H compressor. We'll be using a 5H80 with a standard stroke. The service procedures for the other comare basically the same. pressors However, some of the component locations are different; for complete details, refer to the Installation, Start-up, and Service Instructions.

Keep the following points in mind when servicing:

Before opening the compressor for service, close the service valves, and bleed the charge remaining in the compressor.

Drain the oil, if servicing in the area of the crankcase.

After removing a component, clean it with solvent.\*

Also, label all moving components so that they are reinstalled in the same place that they were removed from. If you mix the components, they may not have the same wear pattern and they will not wear evenly.

\*Agitene or trichlorethylene is recommended.

7. When checking a component for wear, refer to the Wear Limits Chart in the Installation Instructions.

Before installing a component, coat it with compressor oil and inspect all gasket surfaces. Replace all gaskets with new ones, and lightly coat them with oil. Factory-made gaskets are recommended.

Tighten all bolts to the torque values in the Installation Instructions.

And, when you're done servicing, refill the crankcase if the oil was removed.



8. The compressor we'll be using in this lesson isn't new. It was returned as a field failure. As we tear down the compressor, you'll notice some of the parts are worn or damaged.

Here we can see (starting at the top left, going clockwise) wear on the connecting rod bearings and the crankshaft journals, and damage to the seal-end bearing and a suction valve.

Most of the wear or damage was due to flooded starts. This is when the

compressor starts with liquid refrigerant in the crankcase. At start-up, the refrigerant flashes from a liquid to a gas, causing restrictions in the oil passages and poor lubrication.

Flooded starts can also cause a slug of oil and liquid refrigerant, which cannot be compressed, to enter a cylinder causing damage to the compressor components. In this case it resulted in a broken suction valve.

So, when you're rebuilding a compressor, find out what caused it to fail and correct the problem. If you don't, you can count on another failure.

Because this compressor is not going back into the field again until it goes to a rebuild station, we'll be reinstalling some of the old components.

If this was an actual rebuild job, you would not normally reuse these parts. Also, some of the old gaskets will not be removed or be completely scraped off. This pump works with an oil pressure regulator, which we'll see later, to provide positive pressure lubrication.



10. Notice the tang on the rotor. It fits into a slot at the end of the crankshaft. This is how the pump is driven. If this tang is broken, the pump will not operate and the complete pump assembly will have to be replaced.



9. Now, before we start with the service procedure for the lubrication system, let's take a look at the oil pump.

It's a rotary type and (starting from the left) it consists of a rotor, an idler, and a cover.



11. To get to the pump, remove the pump-end cover.

With the cover removed, you can see the pump located on the pump-end bearing head.



12. On the oil pump cover, there are two arrows -- one is at the top and the other is at the bottom.

The arrow at the top must be pointing in the same direction that the motor rotates. If it isn't, the pump will not work. You'll have to rotate the pump cover 180°; it's a manually-reversible pump.\* Depending on how old the pump is, the arrows may not be exactly at the top or bottom.

On some compressors, like the 5H80, there's also a directional tag on the bearing head. It should also be turned to match the direction of rotation of the pump. This way the next mechanic that works on the compressor will know in what direction the pump is set up to rotate, without removing the pump-end cover.

\*Beginning in 1986, the 5H120 and 126 will have a pump that will reverse automatically.



13. Now, let's see how to check out the lubrication system. We'll start by checking the oil pump rotor for excessive end play or binding.

To do this, remove the pump-end bearing head from the compressor.

Reach into the bearing head with needle nose pliers and grip the tang on the rotor. Move the rotor up and down and use a depth gauge to check the movement. The maximum allowable is .0025 inches; you'll see why a little later. If there's too much clearance, you'll have to reposition the oil pump bushing.



14. To check for binding, turn the rotor. If there's more than a slight drag, you may have to replace the oil pump assembly or the bearing head. The oil pump assembly includes the bushing.



15. Let's see how to reposition the bushing first.

Remove the oil pump and place a .001" circular shim on the rotor. Reinstall the rotor first; then the idler and oil pump cover together. Don't forget to install the oil pump cover gasket. If you don't, you won't get the correct clearance.



17. After repositioning the bushing, remove the pump and take out the shim that you placed on the rotor. Reinstall the pump and recheck the rotor end play.\*

\*Refer to the Wear Limits Chart in the Installation Instructions to determine the minimum and maximum tolerances for all compressor parts.



16. Drive the bushing toward the oil pump rotor, using a 1-1/4" pipe capped at one end and a 20 ounce or heavier ball peen hammer.\*

Although you can't see it here, a washer was brazed on the end of the pipe opposite the cap. This is to prevent the bushing from being damaged.

\*A bearing press can also be used.



18. Although we placed the shim between the rotor and the bushing to set the clearance, the actual operating clearance will be between the rotor and oil pump cover.

Too much clearance here will cause some of the oil to slip around the rotor instead of being compressed and forced out the discharge side of the pump. This will reduce the oil pressure and the amount of oil going to the parts that should be lubricated.



19. Now, here's how to determine if the oil pump and bushing, or the bearing head, should be replaced.

After removing the oil pump, check the bushing and oil pump rotor for scoring. This can include cuts, gouges, or burrs. Look at the surfaces shown here. These are the ones that are next to each other, when the bushing and rotor are in the pump head.

If the bushing or rotor is scored, you must replace the complete pump assembly, so that all the parts will wear evenly. In a minute, we'll see how to replace the bushing. you should check for scoring is the one that rotates next to the bearing head. If the rotor is scored in this area, this will also require that the complete pump assembly be replaced.

You'll also have to replace the bearing head, if it's scored.



21. Now, here's how to replace the bushing. To remove it, you must drive it out toward the inside of the bearing head, using the pipe and hammer. This is the only way it will come out.

Before you start, place the head on two pieces of wood so that it's completely off the surface that you're working on. This is necessary so that you don't damage the end of the pump-end main bearing or the locating dowel.



20. Another surface on the rotor that



22. Before installing the new bushing,

check the pump-end main bearing for wear or damage. Make sure it's within the tolerance specified in the Installation Instructions.



23. If the bearing is worn, remove the bronze bearing washer from the bearing head, if it's not already off.

Then, use a hacksaw blade and make at least three cuts in the bearing about an inch apart. To prevent damage to the bearing housing, DO NOT cut all the way through the bearing.



24. Next, use a tube collapsing tool\* like the one shown here.

Hit it with a hammer to pry up the bearing between the cuts. Because the collapsing tool has a round surface, it's less likely to dig into the housing. Once the bearing is pried up, you can pull it out with vice grips.

After you've removed the bearing, check the housing for burrs. If there are any, use a 120 grade sanding cloth to remove the high spots, so that you'll be able to install the new bearing.

\*Collapsing tools are available from Elliott through your Carrier Distributor.



25. The bearing should be lubricated and then installed so that the end with the larger chamfer enters the housing first. Make sure the hole in the bearing lines up with the oil port in the housing. To do this, the oil groove in the bearing must be at the top. This groove helps to distribute the oil evenly around the journal.



26. Press the new bearing into place using a bearing puller shoulder and jackscrew. Keep in mind that if the oil pump bushing is in place, you won't be able to do it this way. You'll probably have to have a machine shop do it. They'll use a bearing press.



27. The bearing should be positioned so that it's 3/32 of an inch above the bearing head.



28. Now, install the oil pump assembly and then the new bushing.

The oil pump idler and rotor should be installed through the inside of the bearing head. Make sure they are seated on the pump cover. If you install them with the oil pump cover from the outside, they will probably fall through because the bushing isn't in place to stop them.

To install the new bushing, we'll need a shim like we used to reposition it. After placing the .001" shim on the rotor, install the bushing so the lead end is toward the pump.

The lead end can be identified by the machined lines.

When you're driving in the bushing, place the bearing head on two pieces of wood so that the oil pump cover isn't damaged.

Once the bushing is in place, remove the shim.

After installing a new bushing or repositioning an old one, the next step is to install the bearing head.



29. The easiest way to do this is to leave the oil pump assembly off; then do the following:

Put a coat of oil on the bronze washer and place it in position in the bearing head. The coat of oil will hold it in place. Make sure the notch in the washer is around the dowel key.



31. Install the idler and oil pump cover together.

Remember, there are two arrows on the pump cover. Make sure the correct arrow is near the top. It must be the one that matches the rotation of the motor, when looking at the motor from the shaft end.



30. Install the bearing head so the magnetic oil plug is at the bottom. Then, insert the rotor so the tang fits into the slot at the end of the crankshaft.

If you try to install the bearing head with the oil pump assembly in place, it will take you more time to line up the tang; that's why we recommend installing the rotor separately. After installing the oil pump cover, install the pump-end cover.



32. Now, let's check out the oil regulator.

It's located near the drive end (or seal end) of the compressor. On the 5H80, it's on the right-hand side when facing the drive end.

The regulator, which is not adjustable, maintains the oil pressure necessary to

lubricate the compressor and operate the unloader system.

To remove the regulator, first take off the cap. Then, use an allen wrench to unscrew it.



33. To make sure the regulator is working properly, there are two checks you should make:

One, check the plunger. To do this, push it with a nail; it should move freely. If it doesn't, replace the regulator.

Early 5F and H compressors were equipped with adjustable regulators. If you have to replace one of these, use the nonadjustable type shown here.

The second check is to make sure the ports in the regulator are clean.

Later in this lesson, when we have the compressor apart, we'll see how the oil flows through the compressor and how the regulator actually works.



34. There are two more components in the lubrication system -- the oil return check valves and the oil filter screen.

To get to these components, remove the hand hole covers on both sides of the compressor.

Remember, in this training lesson we are working on a 5H80. The components and the procedures for removing them are slightly different on some of the other compressors. For complete details, refer to the Installation Instructions.



35. The 5H80 uses leaf-type check valves. They are located at the top center of the two hand hold cover openings, near the drive end of the compressor. These valves allow oil to return from the suction manifold to the crankcase. They are normally open. But they will close if the crankcase pressure goes above the suction pressure, as is the case in a flooded start. The valves close to prevent oil from "blowing" out of the compressor sump.

When checking these values, remove them and make sure the leaf is moving freely and isn't damaged.



36. The oil filter screen is at the bottom of the crankcase. Notice the wire that runs between the two bolts that attach the screen to the oil pump pick-up tube. This wire prevents the bolts from loosening up.

To check the screen, you'll have to cut the wire before unbolting it. Inspect the screen for holes; if there are any, replace it. If the screen is dirty, clean it with solvent. After reinstalling the screen, insert a new piece of wire through the bolts.



37. Next, let's check out a cylinder head and valve assembly.

After loosening the head bolts, tap the head with a dead blow or other softfaced hammer to free it.



38. Check the head for warping, cracks, and damage to the gasket surfaces. If there is any, replace the head.



39. Now, loosen but don't remove the three capscrews in the center of the valve guide on the valveplate. These screws hold the discharge valve inner seat in place, which you can't see here.

Remove the three screws from around the edge of the valve guide, which attaches it to the valveplate.

Notice the lockplate and lockwashers on the valve guide; they prevent the screws from vibrating loose.



40. After removing the valve guide, check the discharge valve outer seat (on the valveplate) for cracks or wear. If the seat is worn or cracked, replace the valveplate.



41. Next, remove the capscrews holding the discharge valve inner seat to the valve guide.

Check the inner seat and discharge valve for wear or damage and, if necessary, replace them.

Also, check the six discharge valve springs and spring holes in the guide. If the springs are damaged, replace them. If the holes are worn, replace the guide.

If the springs are the old style, replace them with new springs. The old style did not have the last coil larger than the rest of the spring. Under certain conditions, the springs could spin and cut a hole in the valve guide.



42. After checking the discharge valve

assemblies, remove the capscrews which hold the valveplate to the cylinder deck.

Check the valveplate and suction valves for cracking or excessive wear and, if necessary, replace them.

Notice there are six springs below each suction valve. Check these springs and holes also. If the holes are worn, replace the valveplate.

Like the discharge valve springs, if these springs are the old style, replace them.



43. Also, look at the suction valve seats on the cylinder sleeves. If they are worn, replace the sleeve. We'll see how to do this later. valveplate assembly.

First, place the large end of the suction valve springs in full contact with the bottom of the holes in the valveplate recesses.



45. Then, place the suction valve on the valve springs and press it into the valveplate recess. You'll have to use two retainer clips for each suction valve to hold it in place. These clips are available from Carrier.\*

To make it easier to remove the clips when you're done assembling the valveplate, install them so that the flat side is on the valve.

\*These clips are part of most service , replacement valveplate kits.



44. Now, let's

rea

reassemble



46. Locate the clips so they don't

the

cover the valve lifter pins when you install the valveplate. This will prevent the clips from getting caught between the suction valve and lifter pins.

The valve lifter pins are part of the unloader, which we'll cover later.



47. Also, make sure the pistons are below the cylinder sleeves before installing the valveplate. If they aren't, the valve clips will be caught between the valveplate and pistons and it may damage them.



48. Now, bolt the valveplate to the cylinder deck and remove the valve clips.



49. Next, place the discharge valve springs into the valve guide recess and install the discharge valve over the springs. Just like the suction valve springs, the large ends go in first.



50. Place the inner seat over the discharge valve and hand tighten the capscrews holding the seat to the valve guide.



51. Place the valve guide assembly on the valveplate and tighten all bolts. Also, don't forget to bend the tabs on the lockplates and washers so the screws don't vibrate loose. Although the old lockplates and washers can be reused if the tabs don't break, new ones are recommended.

After installing the valve guides, replace the cylinder head.

Now that we know the procedure for checking out and servicing the suction and discharge valve assemblies, let's see how the refrigerant flows through the compressor.



52. After the refrigerant enters the suction manifold, it flows through a suction strainer.

This strainer is located behind the suction manifold cover. If the strainer is dirty, clean it with solvent or replace it if it's broken or corroded.

The strainer protects the compressor from metal chips, copper oxide scale, and other contaminants that may have entered the refrigerant piping when it was installed in the field.



53. The refrigerant then flows through the suction passages in the compressor to the ports around the outer edge of the cylinder sleeves.

On the intake stroke, when the pressure in the cylinder drops below the suction pressure, the suction valve is pushed off its seat and refrigerant flows into the cylinder.

During the compression stroke, the combination of discharge pressure and the suction valve springs will seat the suction valve.



54. The pressure will continue to rise and when it is above the discharge pressure, the discharge valve will be pushed off its inner and outer seat.



56. As the cylinder goes through another intake stroke, the cylinder pressure drops below the discharge pressure and the valve guide springs will seat the discharge valve.





57. To prevent the possibility of an excessive pressure build-up in the system, the compressor has an internal pressure relief valve. It's located on the combination suction and discharge manifold cover.\*

The relief value allows the refrigerant in the compressor to vent from the high side back to the low side. It does that at a pressure differential of  $350 \pm 35$ psi.



55. This allows the refrigerant to flow past the discharge valve and through the slots around the bottom of the valve guide, shown on the left.

From here it flows through the discharge passage, shown on the right, and out the discharge manifold into the system. \*The 5F60 and all 5H compressors have a pressure relief valve. 5F60 relief valve has a pressure differential of 400  $\pm$  40 psi.

To do this, the cylinder heads, the valveplate assemblies, and the hand hole covers must be removed.



58. To check the relief valve, remove it from the cover and look for signs of overheating, which will be indicated by discoloration. If it has overheated, this means the valve has opened and should be replaced.

Also, if the seat is chipped or cracked, replace the valve. The seat is shown on the right; it's down inside the valve.



59. Next, we'll check out the compressor's internal components, starting with the cylinder sleeves, and the piston and connecting rod assemblies.



60. Then, reach in through the hand holes and loosen, but don't remove, the connecting rod lock nuts. They should be loosened enough so that they cover the threads at the end of the rod bolt.

You'll have to turn the crankshaft to position the lock nuts so that you can use a socket and ratchet. Use the bolt at the end of the crankshaft to do this.

Tap the lock nuts until the rod cap is loose. Then, remove the lock nuts and pull off the rod cap. You may have to use a screwdriver to pry the rod cap off the connecting rod. Be careful not to damage the mating surfaces.

When loosening and tapping the lock nuts on the connecting rods near the pump-end of the compressor, it's a good idea to remove the oil screen so you don't hit and damage it.



61. After removing the rod cap, push the connecting rod and piston assembly, and cylinder sleeve up through the cylinder deck.

You may have to use a sleeve puller to "break" the cylinder sleeve free. Before inserting the puller into the sleeve, turn the crankshaft until the piston is in mid-position. With the puller in the sleeve, tighten the nut on the top of the puller while holding the bolt. This will expand the puller. Then, turn the crankshaft again. This will cause the piston to push against the puller, forcing the sleeve out.

If you do it this way, you can remove the sleeve, and the piston and connecting rod assembly separately.



62. Let's check out the sleeve first.

If you pulled it out with the piston and connecting rod assembly, pull the piston out through the bottom of the sleeve.

Notice on this sleeve there's an unloader sleeve, and unloader pins and springs. These components, which are part of the unloader system, control the compressor's capacity. We'll see how this is done later.

Also, on the cylinder sleeve there is a snap ring which holds the unloader sleeve in place.



63. To remove the snap ring, use a ring expander. With the ring removed, you can slide off the unloader sleeve. This will allow the pins and springs to drop out of the holes around the edge of the cylinder sleeve.

Check and replace any pins and springs that are damaged. Also, check the holes that they were in; make sure the holes are clean.



64. With the unloader sleeve removed, take a look at the lip on it. If it's worn or damaged, replace the sleeve.

Keep in mind, if the lip, or the pins and springs are worn, the cylinder may not unload.\*

On this compressor only six of the eight cylinders have an unloader sleeve, and unloader pins and springs. The other two cylinders will not unload.

Later in this lesson, we'll cover the other components in the unloader system.

\*Refer to the Carrier Service Training book on Capacity Control (GTC1A-101, 020-300) for complete details on how the unloader system works. look at the inside surface. If it's worn or damaged, you'll need a new sleeve.

Now, reinstall the pins and springs, and the unloader sleeve on the cylinder sleeve.



66. Next, we'll check out the piston and connecting rod assembly. Remove the rings from the piston, using a ring expander.

After removing the rings, throw them away. Don't try to reuse them. If you do, they may not seat properly; this will cause oil to blow by the piston and a loss of compression.



65. When checking the cylinder sleeve,



67. Remove the piston from the connecting rod. To do this, pull out the lock rings on each side of the piston pin. Knock out the pin using a hammer and a brass rod or a socket and extension. If you're using a socket and extension, use a dead blow or other soft-faced hammer to prevent the extension from being damaged. If the pin is frozen, it will have to be pressed out.

Label the piston pin so that you put it back into the same piston when you're done.

Check the pin, the piston, and the connecting rod for wear and replace them, if necessary.



68. Don't forget to check the piston pin bushing in the connecting rod, shown on the left, and the connecting rod bearing inserts.

If the bushing is worn, don't try to remove it. Use a new connecting rod; it will already have the bushing installed.



69. Also, clean the oil hole at the top of the connecting rod. If it's dirty, there may not be enough oil getting between the piston pin and bushing. This can result in excessive wear and eventually the piston may slap against and damage the valveplate.



70. Now, reassemble the connecting rod and piston in the reverse order that they were disassembled.

When reinstalling the piston pin, it should be a tight fit through the piston. If it's not, recheck the pin and piston.

Also, install the lock rings so that their gap is at the 3 or 9 o'clock position.

Once the lock rings are in place, check each one to make sure it can't be moved by finger pressure; if it can, it will have to be replaced.



71. Before installing the new rings, check them first; don't assume they're OK.

Insert each ring separately in the cylinder sleeve approximately 3/8 of an inch from the top. Then, check the ring gap. If it's not within the tolerances shown in the Wear Limits Chart and the sleeve is OK, don't use that ring; get another new one.



72. There are four rings per piston; two compression and two oil.\* Use a ring expander when installing them. Install the rings starting at the bottom and work up. The oil rings go into the third and fourth grooves from the top, with either side up.

However, when installing the compression rings, which go into the top two grooves, the marked side goes toward the top of the piston.

\*The 5H extended stroke compressors have aluminum pistons and use only three rings -- two compression and one oil.



73. Make sure that you stagger the ring gaps around the piston so that you don't have oil blow-by and a loss of compression.

Measure the side clearance between the ring and piston; refer to the Wear Limits Chart for the clearance. If the ' clearance isn't within the limits and the piston checked out OK, replace the ring.

Also, check to make sure the rings move freely. If they don't, clean the piston grooves.



74. Any time new rings are installed with the old cylinder sleeves, break the hard, glazed surface of the sleeve to reduce the wearing-in period of the new rings. Use number 80 emery cloth and clean the sleeves thoroughly after breaking the glaze.



75. When installing the bearing inserts in the connecting rod and cap, make sure the knobs on the inserts fit into the notches on the rod and cap.



76. After you're done checking all the components in each of the cylinders, check the crankshaft journals. If they are worn, the crankshaft can be reground .010 or .020 below the factory tolerances listed in the Wear Limits Chart.

Because this compressor has a center main bearing, we'll have to remove the crankshaft to check it and the journal.

However, before you do, check the end play of the crankshaft.



77. To do this, first remove the bolt and washers and the drive key from the end of the crankshaft. Also, remove the shaft seal assembly, which includes the coverplate (shown in the center).

If the drive key is frozen on the shaft, use a chisel and hammer to knock it out. Replace the key if you damage it. When removing the seal assembly, you may have to use two screwdrivers to pry it loose. Place the screwdrivers 180° apart on the seal spring, not the crankshaft.



78. Now, check the end play with a dial indicator or feeler gauge.

If you use a dial indicator, set it to zero after you push the crankshaft as far forward toward the pump-end as possible. Then, pull back on the crankshaft as far as you can and take a reading. Do this at least twice to make sure your reading is correct.

If the end play exceeds the maximum listed in the Wear Limits Chart, replace the thrust washer and two bearing washers.

One of the bearing washers that we've seen before is in the pump-end bearing head, shown here in the middle.

The other bearing washer and the thrust washer are in front of the seal-end bearing housing, shown on the right, next to the drive end of the compressor. We'll have a better look at these two washers when the crankshaft is removed.



79. Here's how to measure the clearance with a feeler gauge.

At the pump end, you can check the clearance between the bearing washer and the counterweight, while pulling back on the crankshaft. Or, at the seal end, you can check between the bearing washer and thrust washer, while pushing the crankshaft forward.



80. If there's too much end play, the crankshaft journals, the connecting rods and bearing inserts, the pistons, and cylinder sleeves will wear quicker.



81. After checking the end play, here's what you have to do to remove the crankshaft. Starting at the top left, going clockwise:

Remove the pump-end cover and bearing head and loosen the center main bearing housing. To loosen this housing, remove the bearing housing plug on the compressor casing, and the lockscrew and setscrew beneath it.\* Then, slide out the crankshaft through the pump-end opening.

\*On a 5H86, 120, and 126; remove the oil line to the center main bearing.



82. With the crankshaft removed, disassemble the bearing housing. You'll have to cut the wires that run from the bolts to the housing. These wires, like the ones on the oil filter screen, prevent the bolts from loosening up.

After removing the bolts and taking apart the housing, check the bearing inserts, and replace them if necessary.

Also, check the journal for the center main bearing.



83. Now, remove the crankshaft plugs and check the oil passages. If the passages are dirty, clean them. Use compressed air or refrigerant. Don't forget to reinstall the plugs when you're done. If you don't, oil will flow out of these holes and the compressor may lose all oil pressure.

Also, check and clean all the oil feed, tubes in the crankcase and replace any that are broken. Replacement tubes are available from Carrier.\*

\*Contact your Carrier Distributor for instructions on how to field fabricate the tools needed to replace the tubes.



84. Here are the other two washers that you'll have to replace with new ones if the end play of the crankshaft is too much.

One is the thrust washer.\* It's located on the crankshaft and is shown on the left.

The other is the seal-end bearing washer, which you can see when looking through the hand hole cover toward the drive end of the compressor. It's located on the front of the seal-end main bearing housing.

\*Not all models have thrust washers.



85. Next, check the seal-end bearing for wear or damage, and replace it if necessary.

Shown on the right is a closer look at the one that was removed previously. It was the most severely damaged of all the bearings in the compressor. This may have been the result of a combination of poor lubrication, as described previously, and misalignment between the compressor and motor.\*

\*For complete details on the causes of poor lubrication and how to align the compressor and motor, refer to the 5F, H Installation Instructions and the Carrier Service Training book - Why Compressors Fail (GTC2-101, 020-342).



86. Keep in mind, when this bearing or any bearing is worn, it will not do the job it was designed to do - support and align a moving part. And, if it's not doing its job, it will also affect the wear of the other parts in the compressor.

For example, a worn seal-end bearing can cause misalignment of the crankshaft. This in turn will cause the connecting rod bearings and crankshaft journals to wear.

So, any time you're checking a bearing, make sure you check all of them and the parts that they support.



87. To remove or install the seal-end bearing, use a puller shoulder and jackscrew.

Whether you're removing or installing it, the puller and jackscrew will be positioned as shown here. The direction of pull will be the same in both cases.



89. Then, (starting at the top left, going clockwise) position the bearing so that the chamfered edge enters the housing first. Make sure the oil hole in the bearing and regulator housing line up. To do this, the bearing relief groove must be at the top. This groove, like the one in the pump-end bearing, distributes the oil evenly around the journal. Now, press the bearing into place with the puller and jackscrew.



88. Before installing the new bearing, blow out the oil groove in the bearing housing and the oil line to it.



90. The bearing must be installed so that it is 1/32 of an inch below the outside face of the bearing washer.

After it's installed, look through the regulator housing to make sure the hole in the bearing and housing are lined up. You'll have to remove the regulator to do this.



91. Now that we've checked out the piston and connecting rod assemblies, the bearing inserts, the crankshaft, and the pump and seal-end bearings, let's see how the oil flows to these components.

Starting at 1, the oil flows through the oil screen to the oil pump, at 2. From the pump the oil flows in two directions. One is through the crankshaft, at 3, to the first two connecting rod journals and the center main bearing journal. The second direction is through a tube, at 4, in the crankcase to the seal-end bearing housing. From here the oil flows to the regulator, at 5, which we'll take a closer look at in a moment; and through the crankshaft to the second two connecting rod journals.



92. Now, let's take a closer look at

the oil pressure regulator, which maintains the oil pressure between 45 to 55 psi. Here's how it works.

Notice the cavity that the regulator is screwed into. It's always at crankcase or suction pressure. The suction pressure enters this cavity through the same passages that the oil flows through to get back to the crankcase; we'll cover these oil passages next.



93. The hole shown here, at 1, on the regulator allows the suction pressure to enter behind the plunger.



94. When the oil pressure is 45 to 55 psi above suction pressure, the plunger is pushed back and the oil flows through the holes on the regulator near the front end of the plunger, at 2.



95. From the regulator, the oil flows through a passage, at 1, to the shaft seal assembly.

The area around the shaft seal fills with oil to prevent the bellows and carbon seal from cracking.\* When this area fills with oil, the oil will then flow through a passage, at 2, back to the crankcase.

\*The oil temperature should also be kept below 160°F, to prevent premature seal failures. An oil cooler may be required to do this.



96. In the crankcase there is an oil mist and oil squirting out from between the rod bearings and journals which lubricates the cylinder walls, pistons, piston pins, and rings. The oil flow we've just covered is for a 5H80. It's basically the same for the other compressors, except for some slight variations due to the number of cylinders and crankshaft design.\*

\*Also, if the compressor is equipped with an oil filter or cooler, the flow will be different.



97. Now, let's cover the unloader system, which is operated by oil pres-sure.

(Starting at the top left, going clockwise), it consists of a capacity control valve; a hydraulic relay\*; the unloader power element assemblies; and the unloader sleeves, pins, and springs.

On a 5H80, which is the compressor we are "tearing" down, there are six cylinders that can unload. So, there will be six unloader power elements and six unloader sleeves; each sleeve will have six pins and springs.

\*The capacity control valve and hydraulic relay are in the pump-end cover on the 5H40-88, the pump-end bearing head on the 5H120 and 126, and the hand hole cover on the 5F40 and 60.



98. Next, let's see how the unloader system works.

We will not cover in detail the operation of the internal parts of the control valve, the hydraulic relay, and the power element assembly. Also, we will not cover how to adjust the control valve. For this information, refer to the Carrier Service Training book -Capacity Control (GTC1A-101, 020-300).

Notice the port here, at 1, on the pump-end bearing head. It supplies oil from the pump to a port, at 2, in the pump-end cover. The oil then flows through a tube, at 3, to the hydraulic relay. From the relay, the oil flows through the control oil pressure line, at 4, to the control valve.



99. When the suction pressure rises

above the control valve setting, the control valve closes. This reduces the amount of oil draining out of it, at 1, to the crankcase.

The control valve senses suction pressure through a tube, at 2, connected to the crankcase. This tube runs through a surge chamber, at 3, to dampen out any fluctuations in suction pressure, which could affect the operation of the unloader system.

The setting of the control value is field adjustable by turning its value stem (not shown here) on the outside of the pump-end cover.



100. As the amount of oil draining from the control valve is reduced, the oil pressure will build up in the hydraulic relay, at 1. When this happens, a piston in the relay will move and open the ports which allow oil to flow through one or more of the tubes, at 2, that supply the oil to the power elements.

How many tubes the piston allows the oil to flow through will be determined by how much the control valve closes.



101. The oil then flows through the ports in the pump-end cover, at 1, and the pump-end bearing head, at 2.



102. From the bearing head, the oil enters the tubes in the crankcase connected to the power elements.



103. As the oil flows into each unloader power element assembly, there's a piston and rod inside of it which is pushed up, causing the unloader fork to pivot down. This allows the unloader sleeve, and the unloader springs and pins to drop, and the suction valve to seat. The cylinder is now loaded.



104. Now, here's what happens when the suction pressure drops below the control valve setting. Starting at the top left, going clockwise:

The control valve opens, allowing oil to drain out.

This reduces the oil pressure on the hydraulic relay piston. A spring in the relay then moves the piston to close off the ports, stopping the flow of oil to one or more of the power element assemblies. How many ports are closed is determined by how much the control valve opens.

When the flow of oil stops, there are springs inside the unloader power element assembly which push the unloader piston and rod down, causing the unloader fork to pivot up. This allows the unloader sleeve, pins and springs, and the suction valve to rise. The cylinder is now unloaded.

Also, when the unloader piston is pushed down, the oil is forced out of a drain on the power element and hydraulic relay.



105. Next, we'll cover how to check out the unloader system.

We'll start with the control valve. Starting at the top left, going clockwise:

Backseat its adjusting stem. Then, remove the control oil line from the valve and hydraulic relay. Notice that the line is soldered to a cover on the relay. To remove the line here, unbolt the cover. This line also connects to the pump-end cover. But don't try to remove it at this point; it's pressed in.



106. Move the line out of the way so that you can apply refrigerant or air pressure to the valve. Be careful not to kink the line. Here we are using a flare reducer fitting to connect the hose to the valve.

With pressure applied, check for flow at the oil drain on the valve. There should be none. However, as you frontseat the adjusting stem, there should be flow and it should increase. If the valve isn't operating properly, replace it.



107. With the cover still off the hydraulic relay, check the movement of its piston by pushing on it. It should move freely. If the piston isn't moving freely, you'll have to replace the pumpend cover. The hydraulic relay cannot be ordered separately, except on a 5H120 and 126. After you're done checking out the control valve and hydraulic relay, don't reconnect the control oil line yet. You've still got to clean out all the tubing in the pump-end cover that supplies oil to the unloader system.



108. But before you do, you should check out the control oil strainer and orifice assembly.\* The strainer helps to prevent the tubing from getting plugged by any metal filings or other particles in the oil. It's located in the pump-end cover passage which supplies oil to the unloader system.

To get to the strainer and orifice, you'll have to remove a plug and setscrew. Then, remove the strainer with a piece of wire, or paper clip like we've done here. If the strainer is torn, replace it; if it's dirty, clean it with solvent. After you're done checking the strainer, reinstall it.

Although the strainer protects the tubing, there is still a chance that something may get by. So, any time you're checking out the unloader components, you should clean out the tubing.

\* On the 5F20 and 30, and the 5H120 and 126, the strainer and orifice are separate. Refer to the Installation Instructions for their location.



109. To clean out the tubing in the pump-end cover, here's what you should do:

First, make sure the control oil line is removed.

Then, apply pressure to each of the oil ports in the pump-end cover and also the ones in the pump-end bearing head, which match up with them.

It is very unlikely that any of the tubes in the unloader system will be plugged. But if they are, applying pressure will clean them out.\*

\*If all the components in the unloader system check out OK, but the compressor doesn't load or unload properly, refer to the Troubleshooting Guide in the Installation Instructions.



110. Now, let's check out the unloader power element assemblies and the tubes connected to them.

Apply pressure to each of these tubes at the ports on the compressor shell. The unloader forks should drop when pressure is applied and then rise when pressure is removed.



111. If they don't, remove the power element. To do this, you'll have to reach in through the hand hole and remove the two allen head screws that attach it to the internal suction manifold.

With the power element removed, apply pressure again to make sure the tube is clean. You should feel flow at the suction manifold from where the power element was removed. If you don't, apply pressure in the direction opposite normal oil flow.



112. Then, take apart the power element and clean it, and replace any damaged parts. Also, make sure that you check the unloader fork height. If it's not within the limits specified in the Installation Instructions, replace the fork. If you don't, the cylinder may not unload.

After checking out the power element, reinstall it and apply pressure to make sure it's operating properly. If it's not, replace the complete power element assembly.

When checking out and servicing only the unloader system, it's not necessary to remove the crankshaft, like we did here.



113. However, you'll still have to remove the cylinder sleeves, and the piston and connecting rod assemblies. When removing these components, try to pull them out together. If the sleeve is removed from the piston, you'll have to install new rings and break the glaze in the sleeve. If you try to reuse the old rings, they may not seat properly.



114. Now, let's reassemble the compressor. (Starting at the top left, going clockwise.)

First, place the center main bearing housing on the crankshaft. As the crankshaft is being installed, line up the setscrew hole in the bearing housing with the hole in the compressor shell. Once the bearing housing is in place in the compressor, you may have to tap the housing up or down to line up the holes. You can use a hammer and brass rod to do this. Then, install the pump-end bearing head and cover. Next, insert the setscrew and tighten it while rotating the crankshaft. After tightening the setscrew, install the lockscrew and plug.

Do not take a chance with the old one. It's hard to tell whether or not the bellows or carbon ring, or the seat on the coverplate, were damaged when the assembly was removed. If any of them were damaged, refrigerant and oil could leak out of the compressor.



116. To make it easier to follow the steps for installing the seal assembly, we've removed the crankshaft from the compressor.

Make sure the drive end of the crankshaft is clean and free of rust. Polish it with crocus cloth, if necessary.

Apply compressor oil to the seal assembly bellows, carbon ring, and coverplate. Also, lubricate the shaft at the drive end.



115. With the crankshaft in place, install a new shaft seal assembly. This includes (starting from the left) the coverplate, the carbon ring, and the bellows assembly.



117. Before sliding the bellows assembly on the shaft, make sure its driving band lugs are positioned in the seal retainer slots.

Slide the assembly onto the shaft until the bellows just starts to grab; then stop.



118. Using the old seal coverplate and carbon ring, continue pushing the bellows assembly on until its spring guide is tight against the shoulder of the shaft.

With the bellows assembly in place, install the new carbon ring in the seal retainer. Make sure the grooves in the carbon ring line up with the knobs in the retainer. install the drive key, and the bolt and washers at the drive end of the crankshaft.

When installing this compressor or a replacement back into the system, make sure the motor and compressor are aligned properly. If they aren't, the seal assembly may be damaged.



120. Now, install the pistons in the cylinder sleeves. Remember, this also includes the unloader sleeves, and the unloader sleeves and pins for those cylinders set up for unloading.

Make sure the ring gaps are staggered around the piston. If they are lined up with one another, oil will blow by the piston and there will be a lack of compression.



119. Then, install the new coverplate and tighten the coverplate bolts. Tighten the bolts down evenly to prevent damage to the carbon ring. Also,



121. Lubricate the piston rings and the beveled surface at the lower edge of the

#### cylinder sleeve with refrigerant oil.

Place the cylinder sleeve upside down on a bench or other surface and push the piston down into the sleeve, while compressing the rings with your fingers. piston and connecting rod assembly, make sure the chamfered side of the connecting rod is facing the radius of the crankpin (or journal). Don't install the rod caps yet.



122. Next, install the cylinder sleeve, and the connecting rod and piston all together into the cylinder.

Don't allow the piston to come through the top of the cylinder sleeve. If you do, you won't be able to push the piston back down because the rings will spring out. And, you can't push the piston all the way through because the bottom of the connecting rod will not fit through the sleeve. So, you'll have to remove the rings that go above the sleeve and slide the piston out the bottom. Then, reinstall the rings.





124. After seating the cylinder sleeves for the cylinders that unload, rotate them so that any two valve lifter pins, opposite one another, are an equal distance from an imaginary line drawn horizontally through the center of the cylinders.



125. In this position the lifter pins will line up with the suction valve springs when the valveplate is installed. If they aren't lined up, the suction valve will warp.



126. Now, install the rod caps so that their chamfered side is also facing the radius of the crankpin.

installing each piston and After connecting rod assembly, check for binding. To do this, hold the cylinder sleeve in place with washers and bolts, shown here. Then rotate the as If there's binding, crankshaft. the chamfered side on the rod or rod cap isn't facing the crankpin radius. So you'll have to remove it and reinstall it in the right direction.



127. Next, install the valveplate assemblies, the cylinder heads, and the hand hole covers. And, don't forget to remove the suction valve clips from the valveplates.

- REFILL CRANKCASE
- IF STORED:
  - 1. EVACUATE
  - 2. ADD HOLDING CHARGE
  - 3. RAISE FRONT SO OIL
  - FILLS SHAFT SEAL HOUSING
- - -MOTOR ALIGNMENT
  - -START-UP
  - OTAIL O
- FIND & CORRECT PROBLEM THAT CAUSED FAILURE

128. After the compressor is back together, refill the crankcase with the correct amount and type of oil listed in the Installation Instructions.

If the compressor is going to be stored for future use, evacuate and add a refrigerant holding charge. Also, raise the front of the compressor so it's high enough for oil to fill the shaft seal housing. This will prevent the seals from drying out and cracking or tearing.

If you're going to reinstall the compressor, refer to the Installation Instructions for details on mounting, wiring, charging, motor alignment, and start-up.

Whether the compressor is going to be stored or installed, make sure you find and correct the problem that caused the failure. If you don't you'll probably be rebuilding another compressor.

129. This completes our training lesson on how to rebuild Carrier's 5F and H compressors.

The information in this training lesson, along with the Installation, Start-up, and Service Instructions, will give the service person the background necessary to identify all the compressor components and determine the proper procedure for servicing them.

This program was produced in Syracuse, New York, by the Carrier Factory Service Training Department.

### 5F20-Pump End

- 1 Oil Pump Pressure (Hi-Side Oil Pressure Switch Either Location)
- 2 Oil Fill Lo-Side (Oil Pressure Switch)
- 3 11/8" ODF Suction Service Valve
- 4 7/8" ODF Discharge Service Valve
- 5 Oil Pump Rotation Arrow
- 6 Crankcase Heater Casing
- 7 Oil Drain Plug



#### 5F20-Drive End

- 1 Low Pressure Control Connection
- 2 High Pressure Control Connection
- 3 Manifold Cover (Access to Suction Strainer)
- 4 Oil Pressure Regulator
- 5 Oil Level Sight Glass



### 5F30-Pump End

- 1 Oil Pump Pressure (Hi-Side Oil Pressure Switch Either Location)
- 2 Oil Fill (Lo-Side Oil Pressure Switch)
- 3 15%" ODF Suction Service Valve (Remove Valve for Access to Suction Strainer)
- 4 Low Pressure Control Connection (Hidden Under Valve Stem)
- 5 Oil Pump Rotation Arrow
- 6 Crankcase Heater Casing
- 7 Oil Drain Plug



#### 5F30-Drive End

- 1 High Pressure Control Connection
- 2 1%" ODF Discharge Service Valve
- 3 Oil Pressure Regulator
- 4 Oil Level Sight Glass



#### 5F40-Pump End

- 1 Capacity Control Valve
- 2 Capacity Control Oil Pressure
- 3 Pneumatic Control Connection
- 4 Oil Pressure Regulator
- 5 Oil Pump Pressure (Hi-Side Oil Pressure Switch Either Connection)
- 6 Oil Fill (Lo-Side Oil Pressure Switch)
- 7 1%" ODF Discharge Service Valve
- 8 15%" ODF Suction Service Valve
- 9 Low Pressure Control Connection
- 10 Oil Pump Rotation Arrow
- 11 Oil Drain Plug

#### 5F40-Drive End

- 1 Oil Level Sight Glass
- 2 High Pressure Control Connection
- 3 Suction Manifold Cover Plate (Remove for Access to Suction Strainer)
- 4 Crankcase Heater Casing





#### 5F60-Pump End

- 1 Capacity Control Valve
- 2 Capacity Control Oil Pressure
- 3 Pneumatic Control Connection
- 4 Oil Pump Pressure (Hi-Side Oil Pressure Switch Either Connection)
- 5 Oil Fill (Lo-Side Oil Pressure Switch)
- 6 Suction Manifold (Remove for Access to Suction Strainer)
- 7 Oil Pump Rotation Arrow
- 8 Oil Drain Plug



#### 5F60-Drive End

- 1 Oil Level Sight Glass
- 2 Low Pressure Control Connection
- 3 High Pressure Control Connection
- 4 21/8" ODF Suction Service Valve
- 5 1%" ODF Discharge Service Valve
- 6 Crankcase Heater Casing



#### 5H40 thru 5H86 Typical Left Side Pump End Connection

- 1 Connection to Oil Cooler (Sleeve Location)
- 2 Oil Pump Pressure (Both Locations) use either for High-Side Oil Pressure Switch Connection
- 3 Opening to Crankcase (Low-Side Oil Pressure Switch Connection)



#### 5H40 thru 5H86 Typical Right Side Pump End Connection

- 1 Pneumatic Control Connection
- 2 Capacity Control Valve
- 3 Oil Pump Rotation Arrow
- 4 Capacity Control Oil Pressure
- 5 Oil Fill Plug



#### 5H40-Pump End

- 1 Oil Pump Pressure also Connection at 9:00 on Periphery of Bearing Head (Hi-Side Oil Pressure Switch Connection)
- 2 Capacity Control Valve
- 3 Pneumatic Control Connection
- 4 Opening to Crankcase (Lo-Side Oil Pressure Switch Connection)
- 5 (Not Visible Here) 10:00 on Periphery of Bearing Head—Connection to Oil Cooler (Sleeve Location)
- 6 Hi-Side Control Connection
- 7 21/8" ODF Discharge Service Valve
- 8 Low Side Control Connection
- 9 Oil Pump Rotation Arrow
- 10 Oil Fill Plug
- 11 Capacity Control Oil Pressure
- 12 Oil Level Sight Glass

#### 5H40-Drive End

- Suction/Discharge Manifold Cover (Remove for Access to Suction Strainer and High Pressure Relief Valve)
- 2 Oil Pressure Regulator
- 3 Crankcase Heater Casing





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#### 5H60-Pump End

- 1 Oil Pump Pressure also Connection at 9:00 on Periphery of Bearing Head (Hi-Side Oil Pressure Switch Connection)
- 2 Capacity Control Valve
- 3 Pneumatic Control Connection
- 4 Opening to Crankcase (Lo-Side Oil Pressure Switch Connection)
- 5 (Not Visible Here) 10:00 on Periphery of Bearing Head—Connection to Oil Cooler (Sleeve Location)
- 6 31/8" ODF Suction Service Valve
- 7 31/8" ODF Discharge Service Valve
- 8 Suction Manifold (Remove for Access to Suction Strainer and High Pressure Relief Valve)
- 9 Low Side Control Connection
- 10 Oil Fill Plug
- 11 Oil Pump Rotation Arrow
- 12 Capacity Control Oil Pressure
- 13 Oil Level Sight Glass
- 14 Oil Drain Plug

#### 5H60-Drive End

- 1 High Side Control Connection
- 2 Oil Pressure Regulator
- 3 Crankcase Heater Casing



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#### 5H80-Pump End

- 1 Oil Pump Pressure also Connection at 9:00 on Periphery of Bearing Head (Hi-Side Oil Pressure Switch Connection)
- 2 Capacity Control Valve
- 3 Pneumatic Control Connection
- 4 Opening to Crankcase (Lo-Side Oil Pressure Switch Connection)
- 5 (Not Visible Here) 10:00 on Periphery of Bearing Head—Connection to Oil Cooler (Sleeve Location)
- 6 Remove for Access to Suction Strainer
- 7 31/8" ODF Suction Service Valve
- 8 31/8" ODF Discharge Service Valve
- 9 High Side Control Connection
- 10 Low Side Control Connection
- 11 Access to Center Main Bearing Retaining Screw
- 12 Oil Fill Plug
- 13 Oil Pump Rotation Arrow
- 14 Oil Level Sight Glass
- 15 Capacity Control Oil Pressure
- 16 Oil Drain Plug

#### 5H80-Drive End

- 1 Remove for Access to High Pressure Relief Valve
- 2 Oil Pressure Regulator
- 3 (2) Crankcase Heater Casings





#### 5H120 Pump End

- 1 Oil Pump Pressure After Filter
- 2 Oil Filter
- 3 Oil Pump Pressure Before Filter
- 4 Gas Equalization Connection
- 5 Oil Equalization Connection
- 6 41/8" ODF Discharge Service Valve
- 7 High Pressure Relief Valve
- 8 41/8" ODF Suction Service Valve
- 9 Suction Manifold Cover Plate (Remove for Access to Suction Strainer)
- 10 Oil Fill Plug (Lo-Side Oil Pressure Switch Connection)
- 11 Pneumatic Control Connection (Above Capacity Control Valve, but Not Visible)
- 12 Capacity Control Valve
- 13 Oil Pump Rotation Arrow (on Cover Plate)
- 14 Capacity Control Oil Pressure
- 15 Oil Drain Plug

#### 5H120 Drive End

- 1 (2) Crankcase Heater Casings
- 2 Access to Center Main Bearing Retaining Screw
- 3 Oil Level Sight Glass
- 4 Oil Pressure Regulator
- 5 Oil Pump Pressure (Hi-Side Oil Pressure Switch Connection)



