19XL
Packaged Hermetic Centrifugal Liquid Chiller
Stop Major
Carrier Training Service

Familiarization • Disassembly • Reassembly

This program introduces the 19XL Centrifugal Chiller with several new design features including: impeller design, tunnel diffuser, compressor housing, factory-mounted starters and PIC controls. In this program you will learn how to disassemble the compressor for the 19XL Centrifugal Chiller. Topics covered are listed below in the Table of Contents.

Catalog No. 039-289

Contents

Located in the back of the book are the following graphics:

Familiarization

Click here for Figure 1 — Model 19XL Centrifugal Liquid Chiller

1. In this program, you will learn how to disassemble the compressor for the Model 19XL Centrifugal Liquid Chiller using refrigerant R-22. Included in this program will be:

- Familiarization
- Safety considerations
- Pre-Disassembly procedures
- Tools needed
- Disassembly procedures
- Inspecting the internal parts
- Recording clearances
- and Reassembly

The information will follow the procedures outlined in the Task Handbook. This program will cover a 19XL Series Stop Major.

This program will not cover installation, start-up and operation because this chiller is very similar to other 19 Series machines. If you need more information, refer to the Installation, Start-up and Service Instructions for the 19XL which is the model designation of this machine.

This centrifugal chiller will be introduced with a single-frame size of 300 to 500 tons.

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Click here for Figure 2 — The 19XL Heat Exchanger

2. This 19XL Heat Exchanger is made for ease of service. Overall, the 19XL machine is designed for the replacement or retrofit market. It can be broken down into three pieces; cooler, condenser, and compressor. The cooler and condenser are bolted together and can be separated to fit into tight places.

The cooler and condenser are equipped with feet that can be rotated and used to support the units when they're separated. A heavy steel bar is mounted on the motor end cover. It is used to protect the motor and starter when rigging with a three-point hitch. This bar can be removed after the chiller is installed; but be careful because it weighs 60 pounds.

Click here for Figure 3 — Compressor

3. The compressor is mounted on the cooler section and has lifting lugs for rigging, one on the motor and one on the compressor base. It also can be removed to make rigging into small spaces easier.

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Gasketted flanges and "O" rings make disassembly and reassembly easy, eliminating any cutting and welding.

Click here for Figure 4 — Compressor (Flanged Elbows)

4. The compressor has flanged elbows on both the suction and discharge for easy servicing. The 19XL is equipped with isolation valves; one valve between the condenser and the discharge elbow and another valve under the cooler.

These valves are used to isolate the refrigerant charge for service work. You can close the valve located at the discharge elbow and the refrigerant cooling isolation valve.

Click here for Figure 5 — Liquid Transfer

5. Then push the liquid refrigerant out of the cooler and into the condenser using the optional pumpout unit. When all the liquid refrigerant is transferred, the isolation valve under the cooler is closed, and the pumpout unit is used to evacuate the gas from the cooler and compressor. To speed up the transfer use the PIC controls. Go to the controls test function and use the pumpout feature. This starts the condenser water pump and the cooler pump. It also directs you through the entire pumpdown process and locks out the low pressure alarm and the compressor from being started. Run the pumpout unit until it reaches 22 inches mercury. Use the PIC display and the gauges to monitor the pressures. It is also possible to use the pumpout unit to transfer the charge into the cooler/compressor to service the condenser.

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Click here for Figure 6 — 19XL High Side Float

6. A high side float is used for refrigerant control. It is similar to a 19FA style refrigerant float that uncovers an orifice to maintain the proper liquid level. This is also flanged for easy service.

Click here for Figure 7 — Hot Gas By-Pass Option

7. An optional hot gas bypass is located on the bottom of the cooler. Hot condenser gas enters the cooler through a solenoid valve which is piped up into the condenser. This valve is controlled by the temperature difference or ΔT between the entering and leaving chilled water and the pressure differential between the cooler and condenser.

Click here for Figure 8 — 19XL Relief Valves

8. Each vessel, cooler and condenser, has two ASME-approved relief valves, so that the refrigerant may be safely isolated in either side of the machine. A pressure gauge is mounted on the condenser along side the relief valves.

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The cooler and condenser are available in 2 or 3 pass configurations. Inside the heat exchangers, the tubes are supported by two tube sheets and three support sheets.

The standard cooler tubes are high efficiency type with external nucleate boiling surface. The internal surface is spiral fin for maximum heat transfer. Standard condenser tubes are 43 fin, also with internal rifling.

The condenser has a baffle plate located under the compressor discharge ell to distribute the refrigerant over the condenser tubes. Remember, with R-22 we only have to move 20% as much refrigerant vapor CFM to get the same refrigerant effect as R-11. It also has a flash subcooler, similar to the 19DK machine, which subcools the refrigerant prior to entering the float chamber.

Diffuser

Click here for Figure 9 — Diffuser

9. Next is the conical diffuser. The technology for this diffuser was derived from aerospace technology used on Pratt & Whitney's jet aircraft engines. This diffuser is designed for high efficiency and to operate in a very stable manner over a wide range of conditions. This diffuser has built in surge protection and practically eliminates any need for a moveable diffuser wall or hot gas bypass.

Notice this area on the diffuser wall. This is machined into a scalloped shape with a shallow angle. The refrigerant leaving the impeller is channeled through this scalloped shape into the conical diffuser. The refrigerant then follows Bernoulli's basic law of physics where the refrigerant enters the conical channel at high velocity, low static and leaves at low velocity, high static. Just the right conditions for a centrifugal chiller.

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Impeller

Click here for Figure 10 — 19XL Impeller

10. Now let's look at the impeller. This is an entirely new design. The 19XL machine uses a single aluminum impeller. It is an open type impeller and the running speed is 16,000 RPM. Notice how the fins sweep back to increase stability and raise efficiency. And, notice the splitter blades; they make for more efficient compression with less chance of surge. The impeller is locked in place with a nose piece and a hex-head cap screw with a thread locking compound.

The impeller nose piece has a six-sided section for holding it while the cap screw is being tightened. The nose piece is not threaded and no attempt should be made to turn it. Two roll pins extend from the nose piece into the impeller shaft keyways.

The impeller is keyed to the high speed shaft with two keys which greatly reduces the force a single key would see. It must be heated to be installed.

Click here for Figure 11 — 19XL Impeller (Drilled Holes)

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11. There are four drilled holes through the impeller that are used to reduce thrust. These venting holes equalize the pressure on both sides of the impeller. Located in the back of the impeller is a Labyrinth seal. This is used to counteract the thrust with suction pressure.

Controls

Click here for Figure 12 — 19XL Controls

12. As for controls, the 19XL machine is equipped with a product integrated control or a PIC and will interface with the Carrier Comfort Network. Notice there are two boxes on this side of the machine. On the back side, on the condenser, is a mounting for an optional starter, either electromechanical or solid state.

Click here for Figure 13 — 19XL Power Panel

13. The box in front of the oil pump is called the Power Panel. Part of the circuitry is high voltage and contains contactors for the oil pump and oil heater. Also in the Power Panel are step-down transformers to supply the low voltage needed for the PIC control box.

Click here for Figure 14 — 19XL PIC Control Center

14. Here's the PIC control center. On the front we have a stop button, an alarm light, a video monitor and four function switches or softkeys.

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Inside the box we find a processor module known as the PSIO (Processor Sensor Input Output). There's room enough to add four optional modules for future requirements. To the left is a relay module. This entire box is low voltage and gets its power from the Power Panel.

These controls have built-in diagnostics.

The video monitor displays information both while the machine is running and during shutdown. Near the top, there are two system messages displaying the operation mode. To the top right is the time and date display and the compressor run time indicator. Under that we have nine blocks of information which concern:

- Entering chilled water temperature
- Leaving chilled water temperature
- Evaporator refrigerant temperature
- Condenser water inlet temperature
- Condenser water leaving temperature
- Condenser refrigerant temperature
- Oil pressure
- Oil sump temperature
- Motor current

Below, on the monitor, we find a display for each of the four softkeys. As we use these menu functions, the nomenclatures and function of these four keys will change.

Sensors feed information to the PIC controls. These sensors are new and have a quick release plug at the sensor for easy servicing.

There's one in the oil sump to monitor sump temperature, and also to control the oil heater.

There is one dual-element bearing sensor (one element is a spare). The terminal plate for the high speed bearing sensor is located on the compressor base near the oil pump.

There are two sensors for motor temperature embedded in the stator windings (one is a spare).

The motor sensor terminal plate is located on the side of the stator near the motor terminal box.

Click here for Figure 15 — 19XL Sensors (Compressor Discharge)

15. There are two sensors in the compressor discharge. One is a pressure switch that opens on high pressure. The other measures discharge gas temperature.

Click here for Figure 16 — 19XL Sensors

16. Sensors measure both entering and leaving chilled water. The condenser water circuit also has sensors on both the entering and leaving water connections.

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A temperature switch is embedded in the oil pump motor winding. It's terminals are on the oil pump motor terminal plate. To measure oil pressure, there's a transducer in the oil pump

discharge. There's a transducer on top of the evaporator to measure evaporator refrigerant pressure. There is another transducer on top of the condenser measuring pressure there. The combination of all these thermostats and transducers relay information to the PIC controls.

This unit is available with one of two factory-mounted optional starters. One option is a electromechanical style. The controls on this starter include a Starter Management Module or SMM to communicate with the PSIO in the PIC control box. The control panel is hinged and swings out of the way to service the starter contacts.

Click here for Figure 17 — Solid State Starter

17. The second starter is solid state. The solid state starter is new to Carrier centrifugals. This starter is optional and may or may not be on your machine. This starter also uses a Starter Management Module, or SMM, to communicate with the PSIO in the PIC control box. Amperage, voltage and operating information are relayed between the PSIO and the SMM. This operating information can be displayed on the video monitor by pushing the status function softkey. This will display three status screen tables: select status 01 to view sensors and control settings; select status 02 to view contacts and relay status; select status 03 to view the optional 8 input modules.

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Compressor

Click here for Figure 18 — Compressor

18. The 19XL compressor is a new design which utilizes the best of older designs and new technology. The suction guide vanes, used to control capacity, are chain driven, using a vane actuator motor.

Click here for Figure 19 — Motor Cooling

19. Motor cooling is accomplished by piping liquid refrigerant from the bottom of the condenser through a valve and a filter-dryer to the motor end bell. Notice the dry-eye on this line. To control the motor cooling process, there is a bypass line with a solenoid valve which will open to allow extra refrigerant into the motor during high load conditions. From there the refrigerant travels to a spray nozzle and is sprayed into the rotor and stator where it flashes and cools the motor. The refrigerant level is maintained in the motor shell and overflows through a drain on the side of the motor shell to a back pressure valve located at the flanged drain connection. This back pressure valve is a spring check type and maintains a 5 to 7 lb. differential between the motor cavity and the cooler.

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Click here for Figure 20 — Oil Recovery System

20. To recover oil an eductor system is used which is similar to the one used on the 19D Series machines.

High pressure gas piped from the compressor discharge is directed across an eductor. This creates a low pressure area at the eductor which, in turn, is connected to the suction housing. Oil is normally carried with the refrigerant into the suction housing. However, an additional line from the cooler to the suction housing ensures that oil travels into the housing. The refrigerant and oil are then transferred through a line and filter into the oil reservoir. The refrigerant flashes to a gas and returns to the system through the demister and vent line located between the transmission housing and suction elbow. This keeps the transmission at suction pressure. The vent at the transmission housing uses a demister pad similar to the 19D Series. The oil drops into the oil reservoir.

A check valve prevents the oil from flowing backward during shutdown.

During light load conditions, the guide vane actuator closes a switch which energizes two solenoids. Because of the low suction pressure, the eductor will now take suction directly from the cooler shell in order to return the oil.

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Click here for Figure 21 — Oil Pump

21. Notice how the oil pump is located in the transmission housing -- not directly under the motor, but offset to one side.

The oil pump motor is 3 PHASE and the pump is a positive displacement vane type. The 19XL machine has a 10 gallon oil capacity and uses a new synthetic oil.

The oil cooler is located outside of the oil pump housing and uses liquid refrigerant to cool the oil.

A thermostatic expansion valve controls the refrigerant flow and maintains the oil temperature.

The compressor housing is both the oil reservoir and sump. There are two sight glasses for the oil, and the operating oil level should be maintained between the two. The shutdown level should be somewhere between the top of the bottom glass and the middle of the upper glass. Typical oil pressure is 20 to 25 lbs differential pressure.

Click here for Figure 22 — Lubrication System

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22. Pressurized oil is supplied to compressor bearings and gears by an integrally mounted, electric motor driven, vane type pump, which is submerged in the oil reservoir.

Oil from the pump discharge passes through the oil pump motor and serves as a coolant. Oil pressure is regulated by a relief valve that is located internally. The valve relieves the pump discharge back into the oil sump, maintaining proper oil system pressure. Pressurized oil then passes from the pump motor housing and into the filter chamber via some external piping. After being filtered, the oil is piped to the external oil cooler. Notice the valving on the oil filter. These two valves enable the service technician to isolate the oil filter and change it without draining the entire oil sump or having to pull the refrigerant charge. A charging valve is located on the filter housing to drain the oil in the filter chamber and also to evacuate and recharge new oil.

The pressurized oil flows to the transmission assembly where it feeds two lines. The lower line supplies oil to the high speed thrust bearing assembly and lubricates the gears. The upper line supplies the low speed shaft bearings. From there the oil is channeled to the high speed shaft bearing nearest the pinion. The oil then drains to a sump at the base of the compressor housing.

Click here for Figure 23 — Oil Heater

23. The oil heater is a new design with 1200 Watts. The oil heater has a flanged terminal plate with a flat washer-type gasket. The oil heater is controlled by a thermistor with its sensor immersed in the oil sump. The oil temperature in the sump is maintained between 140 and 160°F depending upon what the evaporator refrigerant temperature is.

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Pre-Disassembly Procedures

Click here for Figure 24 — Disassembling the Compressor

24. In this section of the training program, you will learn how to disassemble the compressor for the 19XL Centrifugal Machine.

Before starting, make sure you have all the necessary safety gear, including proper safety glasses and gloves. Be sure that all your tools and equipment are sturdy and in good working order. And, for safety's sake, always lock and tag all disconnects.

If you have questions about safety procedures, read the Carrier Safety Guide before working on a centrifugal machine.

Some of the tools needed are:

- a Gantry, or adequate rigging
- 1 ton chain fall
- depth micrometer
- outside micrometers - up to 5"
- telescope gauge
- straight edge

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Some additional tools are listed in the Tool List at the back of this book.

Store all the bolts and parts in plastic storage bags and identify the contents of each bag.

Store all the parts in a dry, clean area, and keep them orderly so that the parts will not be lost and reassembly may be completed more rapidly and accurately.

Let's start by covering (pre-disassembly) procedures. Use the R-22 machine's pressure to leak test the entire unit. Look for unusual leaks that can be repaired while the compressor is being overhauled. After tagging all leaks, proceed to transfer the refrigerant.

Next, isolate the chilled and condenser water circuits by closing the valves. Be sure the main disconnect to the compressor motor and the control panel is locked open and tagged.

Opening the main disconnect will isolate the oil heater.

With the refrigerant transferred and the power off, drain the compressor oil.

It's important to leave 1 to 2 PSI positive cooler-compressor pressure. Do this by first evacuating the section, then adding dry nitrogen. Then break the refrigerant and tubing connections. This is to prevent excessive refrigerant loss, and to prevent excessive moisture from the air entering the machine.

And remember, while the unit is open, keep the refrigerant side as clean and dry as possible. Do this by taping all openings closed with plastic sheeting to prevent foreign materials from entering the machine.

Also, oil down all compressor parts to prevent rusting.

Before we disassemble the motor and compressor, let's look at the design.

The 19XL machine is designed for service. There should be no need to rig or slide the compressor base. Everything that needs to be serviced can be reached easily. The motor stator and transmission assembly can be rigged off the back of the compressor base.

On the suction end, the suction ell is flanged and can be removed. This gives access to the suction housing. Behind the suction housing are guide vanes, inlet venturi, impeller and the conical diffuser.

Let's work on the actual machine and concentrate on the compressor end. We'll first cover the things which must be done before you service the compressor. First disconnect the items which attach the compressor to the rest of the machine.

Remove the motor terminal box. Identify and disconnect the main power leads at the starter and pull them out of the starter toward the motor.

Now disconnect the items which connect the motor to the rest of the machine.

Disconnect all control wiring. Identify and tag all wires.

Disconnect the wiring at the vane actuator motor.

Click here for Figure 25 — Disconnecting the Oil Reclaim Lines

25. Disconnect the oil reclaim lines at the suction housing.

Disconnect the motor cooling drain line at the flange.

Remove the insulation and use a wrench to loosen the refrigerant motor cooling line flare nut. Then cut the line near the motor cooling solenoid.

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Click here for Figure 26 — Removing the Suction Ell

26. If you've disassembled a 19 Series machine before, you may know there are a few other things which must be removed in addition to the preceding operations.

Next remove the suction ell.

Unbolt the demister vent line flange bolts at the compressor base.

Remove the insulation material from the suction ell.

Set up the rigging on the suction ell and remove the flange bolts. Back them up with an end wrench.

Rig the suction ell to the floor and remove from the work area.

Click here for Figure 27 — Removing the Suction Housing Bolts

27. Set up your rigging on the suction housing lifting lug and put tension on the chains.

Remove the suction housing bolts.

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Separate the suction housing from the compressor housing. Notice the strainer for the eductor system. Use the rigging to lower the housing to the floor.

Click here for Figure 28 — Inspecting Vanes, Pulleys, and Cable

28. Notice that the vane assembly is bolted into the housing. Inspect the vanes, pulleys and cable for wear or damage.

Click here for Figure 29 — Disassembling the Shroud

29. Put an index mark on the shroud to make reassembly easier.

Unbolt the impeller shroud from the conical diffuser. Use jacking bolts to back the shroud out of the conical diffuser.

Lift the shroud out of the diffuser being careful not to damage the impeller.

Click here for Figure 30 — Nose Cone Thrust Reading

30. This would be a good time to take a nose cone thrust reading. Compare this reading with the actual thrust reading that we will measure later in this program.

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Click here for Figure 31 — Removing the Impeller

31. Now we will remove the impeller. The impeller hold-down bolt has right hand threads, and must be turned counter clockwise to be removed.

The impeller nose piece has a six-sided section for holding it while the cap screw is being removed. Use a end wrench to hold it. The nose piece is not threaded and no attempt should be made to turn it.

Two roll pins extend from the nose piece into the impeller shaft keyways.

Index the impeller to the shaft using a felt tip pen.

Click here for Figure 32 — Installing the Impeller Wheel Puller

32. Install an impeller wheel puller. The impeller has threaded holes to accept the puller. The impeller is installed with a shrink fit approximately 1/2" long, from the base end of the bore. Adjust the puller so it fits snug against the high-speed shaft.

Slowly apply pressure to the puller until the impeller is removed.

Remove the impeller from the work area and set it on wood to prevent damage. Clean and inspect it for damage or cracks.

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Click here for Figure 33 — Removing the Impeller Keys

33. Next remove the impeller keys. Each of the two impeller keys should be indexed so that they can be reinstalled in their original position. Be sure these marks are distinguishable from each other. Remove the keys.

Remove the impeller shim. Using a micrometer, measure and record its thickness.

Remove the impeller spacer. Tape both the shims and spacer together.

Click here for Figure 34 — Snap Ring

34. Notice this special snap ring that locks the high-speed shaft into the hi-speed bearing assembly. Notice the labyrinth seal that lines up with the back of the impeller.

Remove the cap screws that secure both the laby seal and the hi-speed bearing.

Mark the top of the seal because it can only be installed one way.

Be careful. The "O" ring which seals the high speed labyrinth from the thrust housing may tear. To prevent this, loosen the labyrinth so the "O" ring is loose within its groove, and will not have the tendency to tear against the compressor base.

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Click here for Figure 35 — Removing the Laby Seal

35. Pull the laby seal straight out being careful not to damage the laby teeth. Notice the inner laby teeth that seal the high speed laby slinger. Also notice the "O" ring that seals the hi-speed bearing and laby. Remove this "O" ring.

Now you have an option. You can pull both the hi-speed bearing and shaft out together from this end, or you can leave them in place and rig them out with the motor rotor and transmission case. To leave them in place, we would replace the bearing bolts so the bearing is secured to the transmission case and is not damaged when rigging. For this program, we will go with the first option and pull the high-speed shaft out this end.

Screw bolts into the threaded jacking holes in the bearing. Use the bolts and the high-speed shaft to carefully work the assembly out.

Notice the small "O" ring that seals the laby gas passage.

Once out, move it to a bench where it can be disassembled further.

Click here for Figure 36 — Kingsbury-type Thrust with Tilting Pads

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36. Notice that this is a Kingsbury-type thrust with tilting pads. Looking at the assembly, we see

a bearing surface for the transmission end; an area with gear teeth that mesh with the bull gear... then the thrust assembly. The thrust generated by the gears is used to offset the aerodynamic thrust of the impeller.

The machined surface on the high speed shaft makes contact with the thrust surface.

Oil for the bearing is pumped in from the top and supplies both the journal and thrust. The journal surface has oil grooves. Inspect all these surfaces for wear or damage.

Click here for Figure 37— Removing the Conical Diffuser

37. Next is the conical diffuser. Bolts for the diffuser are recessed into the housing and will require a socket extension to reach them.

Notice that the conical diffuser is marked TOP for easy reassembly.

Remove the bolts and screw in guide bolts. Then use bolts in the jacking holes to push the diffuser out.

Get help to support the diffuser so it doesn't damage anything. Note the condition of the three "O" rings -- one on the outer edge, and two in the compressor housing. Lower the diffuser to the floor

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Click here for Figure 38 — Silencer

38. We want to bring your attention to the silencer. The silencer is made up of 4 pieces and is held in place with pins, a ring and springs. If the silencer is damaged or needs service, now is the time to do the work.

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Click here for Figure 39 — Inspecting the Motor and Transmission Assemblies

39. Now, to inspect the motor and transmission assemblies. Start by removing the motor end bell. Move the rigging into place for this procedure.

There is one copper refrigerant cooling line connected to the end bell. Remove the line now, if it is still in place.

The motor end bell has both threaded jacking bolt holes and regular bolt holes for threaded bar stock. Attach a lifting eye bolt and set up the rigging. Screw the threaded bar stock into these holes. The bar stock is used to guide the end bell straight out. Remove all the bolts from the end bell and use the jacking bolts to separate the end bell from the motor.

The end bell must be pulled straight back about one foot for the spray nozzle to clear. Remove the end bell from the work area.

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Removing Motor Assembly

Click here for Figure 40 — Removing the Motor Assembly

40. Next, remove the motor stator assembly. Use the motor lifting lug and set up sufficient rigging to support the motor shell and stator. Index the stator to make reassembly easier.

Disconnect the motor temperature sensors and the main motor leads if you haven't done so already.

Remove the motor shell bolts and screw in the jacking bolts and guide bolts. Tighten the jacking bolts to separate the stator shell from the transmission housing.

The motor shell can now be removed by guiding it straight back until the rotor shaft is cleared. Be careful not to damage the motor windings, then lower the stator to the floor.

Rig the motor so it is supported on the floor. Use wood blocks to prevent damage. Set up a 100 watt light bulb inside the stator and cover the open ends to help keep the motor dry during the overhaul.

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Removing Transmission Assembly

Click here for Figure 41 — Removing the Transmission Assembly

41. Before the transmission assembly can be removed, the bearing sensors must be disconnected.

Remove the cover from the terminal box. Then remove the bolts that secure the terminal plate. Pull the terminal plate out far enough to identify and remove the sensor wires.

Disconnect the oil supply lines. You do not have to cut the oil lines. Just undo the flare connections.

Click here for Figure 42 — Dial Indicator

42. Now to check the thrust clearance, set up a dial indicator. Position the button so it is in contact with a flat surface on the end of the rotor shaft. Push the rotor in and zero the dial indicator, then pull the rotor out. The movement on the indicator will be the thrust clearance. Be sure the shaft is moved fully in each direction, thrust and counter thrust.

Check the Operation and Maintenance instructions for the correct thrust clearance. If the clearance is not within tolerance, the bearings may have to be replaced.

Next remove the transmission assembly.

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Click here for Figure 43 — Rigging the Transmission Assembly

43. Screw an eye bolt into the transmission case mounting flange. Set up the rigging and put tension on the rigging.

Another option for rigging is to use a nylon sling between the motor and transmission case. Also the end of the rotor shaft has a threaded hole that can be used for rigging.

Remove the socket head cap screws that secure the transmission to the compressor housing. Then use bolts in the jacking holes to separate the sections. Raise up on the rigging so the transmission will clear the housing. It may be necessary to use a come-a-long to keep the transmission level. Slide the transmission outward until it is free of the compressor housing and can be lowered onto the floor, out of the way.

We find the demister assembly located inside the compressor housing. Unbolt the demister and check the condition of the foam pad. The demister bolts use thread locking compound.

Click here for Figure 44 — Hi-Speed Bearing

44. Place the rotor-transmission on a working area with supports to keep it horizontal.

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Let's pause and look at the components we have disassembled. A shroud covers the bull gear. This is used to prevent excessive oil foaming at start-up. The transmission uses a single helical bull gear to drive the high speed shaft. The bull gear is secured on the rotor with a hex head bolt and thread locking compound.

A laby pressurization line is used to provide gas at motor pressure to the laby to reduce oil loss. By taking the sealing gas from a relatively low pressure area, just slightly above transmission pressure, oil leakage is prevented, while very little compressed gas is wasted.

Located in the bottom of the housing is the hi-speed bearing. This bearing is secured with Allen head cap screws.

Click here for Figure 45 — Indexing the Laby Seal

45. Now index the laby seal to the transmission case. Unbolt the laby seal and remove the two halves.

Click here for Figure 46 — Inspecting the Laby and Seal Ring

46. Inspect the laby and laby teeth. Inspect the seal ring.

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Now let's disassemble these parts. First unbolt and remove the gear shroud that covers the bull gear. Notice the bull gear oil wiper. Lift the shroud off.

Click here for Figure 47 — Removing the Self-Locking Bolt

47. Remove the self-locking bolt that secures the bull gear on the rotor shaft.

Use the tapped holes in the bull gear to attach a puller. The bull gear does not need to be heated to be removed. Overheating this gear could cause the heat-treating process to fail.

Remove the bull gear from the work area and set it on wood to prevent damage.

Click here for Figure 48 — The Bull Gear

48. The bull gear has a machined surface that contacts the compressor bearing providing a counter thrust.

Next, remove the square keys, identify and store them away from the work area.

Click here for Figure 49 — Setting Up Rigging on the Rotor

49. Set up rigging on the rotor. Use a sling and the rigging bolt to support it. Move the rotor shaft out of the transmission case bearings. Be careful not to damage the shaft or bearings. Keep the parts aligned straight to prevent binding.

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Click here for Figure 50 — Inspecting the Bearing and Thrust Surfaces

50. Once out, set the rotor on supports to protect it. Inspect the bearing and thrust surfaces for wear or damage.

There's a thrust collar on the rotor shaft that contacts the babbitted surface of the drive end bearing.

Click here for Figure 51 — Bearings

51. There are two bearings that support the rotor and bull gear.

Notice the bearings have tapped jacking bolt holes to make bearing replacement easier. Also, the drive end bearing is notched on the bottom.

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Measuring Clearances

Click here for Figure 52 — Measuring the Rotor Bearing

52. Next, you should check and record all the clearances for this compressor.

To measure the rotor bearing, first use the micrometer to measure the outside diameter rotor journal.

Click here for Figure 53 — Measuring the Drive End Bearing

53. Then, use a telescope gauge to measure the inside diameter of the drive end bearing. Use the telescope gauge, then remove it, and measure it with the micrometer. Make several measurements 90 degrees apart, and get an average measurement.

To get the clearance, subtract the journal from the bearing measurement. Compare this reading with the clearance table in the Operation and Maintenance manual.

Repeat this procedure for the compressor end bearing.

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Click here for Figure 54 — Measuring the High-Speed Bearing and Shaft

54. Next, we'll measure the high-speed bearing and shaft. Use a telescope gauge to measure the inside diameter of the high-speed bearing; then remove it and measure it with a micrometer.

Click here for Figure 55 — Measuring the High-Speed Shaft Journal

55. Then measure the high-speed shaft journal with the micrometer. To get the clearance, subtract the journal from the bearing measurement.

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High Speed Assembly

Click here for Figure 56 — Checking the High Speed Assembly

56. Next, check the high speed assembly. Disassemble the high speed assembly. The special snap ring that locks the slinger and bearing to the shaft is an interlocking two-piece assembly. The high speed of the 19XL machine requires this type of snap ring be used. To release it, find the outer ring, put a screw driver blade in the slot and pry it off. Once the snap ring is off, remove the slinger. Notice the counter-thrust area on the journal bearing that makes contact with the slinger.

Click here for Figure 57 — Checking the High Speed Assembly (Continued)

57. Now turn the assembly over and match mark the parts, then remove the cap screws. With the cap screws removed, lift off the retaining ring.

Under the retaining ring is a seal ring; remove it. Next is a spacer ring. To remove the high speed shaft lift it straight up.

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Click here for Figure 58 — Thrust Shoes, Leveling Pads and Adjustment Pads

58. Now remove the thrust shoes, leveling pads, and adjustment pads.

Inspect the thrust shoes and high speed shaft, looking for wear or damage.

Click here for Figure 59 — Measuring the High Speed Main Journal Bearing Clearance

59. We also recommend measuring the high speed main journal bearing clearance using a telescope gauge and a micrometer. Measure the bearing with the telescope gauge. Measure at three points midway between the grooves, and record the measurement, then measure the high speed shaft using the micrometer. If the journal shows signs of wear, or is questionable, the high speed assembly must be replaced.

Click here for Figure 60 — Checking the Thrust Clearance of the High Speed Assembly

60. To check the thrust clearance of the high speed assembly, all the components -- thrust shoes, leveling pads, adjustment pads, slinger, and special snap ring -- must be in place.

Next, put the impeller spacer on the high speed assembly.

Contents

When checking the thrust clearance on a bench, a clamping fixture must be used. There are different sizes for the different machine models. The clamping fixture is used to simulate the impeller and take up any slack. Measuring the thrust without the fixture will cause a false thrust clearance reading. Install the clamping fixture and lock it in place with a bolt.

Now set up a dial indicator on the high speed assembly. Attach the dial indicator so the button is in contact with the center of the clamping fixture bolt. Set the dial indicator at zero.

Hold the bearing assembly and move the high speed shaft up and down. The movement on the indicator will be the thrust clearance. Be sure the shaft is moved fully in each direction, thrust and counter thrust.

Check the Operation and Maintenance Instructions for the correct thrust clearance. If the clearance is not correct, it must be adjusted.

Sample Thrust Adjustment Problem

Example 1:

If Measured Thrust Bearing Clearance Is Greater Than .014:

Step 1:

- Actual thrust clearance .016"

Step 2:

- Actual thrust clearance .016"
- Less desired thrust clearance -.011”
- Difference between desired and actual thrust clearance .005"

Steps 3 & 4:

- Disassemble the bearing and remove adjusting pads

Step 5:

- Pad Thickness .110”
- Pad Thickness .112”

Contents

- Pad Thickness .114”
- Pad Thickness .111”
- Pad Thickness .113”
- Pad Thickness .112”
- Total thickness .672"

Step 6:

- Total thickness 672"
- Divided by six pads ÷ 6
- Average pad thickness .112”

Step 7:

- Average thickness per pad plus difference between desired and actual thrust bearing clearance .112” +.005"
- New average adjusting pad thickness required to give overall thrust clearance of .011" .117"

Step 8:

- Select pads from kit

Contents

Answer:

- Four pads @.120" .480"
- Two pads @.110" .220"
- Total .700"

Average thickness per pad with this combination is .11666" (.700 ÷ 6 =.11666) and desired thickness from Step 7 is .117".

Steel or stainless steel shim stock can be added under the original shims to increase the thickness of each pad to the desired thickness determined in Step 7.

Example 2:

If Measured Thrust Bearing Clearance Is Less Than .008:

Step 1:

- Actual thrust clearance .006"

Step 2:

- Desired thrust clearance .011"
- Less actual thrust clearance -.006"
- Difference between desired and actual thrust clearance .005"

Contents

Steps 3 & 4:

- Disassemble the bearing and remove adjusting pads

Step 5:

• Pad Thickness	.112"
• Pad Thickness	.115"
• Pad Thickness	.102"
• Pad Thickness	.108"
• Pad Thickness	.105"
• Pad Thickness	.106"
• Total thickness	.648"

Step 6:

• Total thickness	.648"
• Divided by six pads	÷ 6
• Average pad thickness	.108"

Step 7:

• Average thickness per pad	.108"
• Less difference between desired and actual thrust bearing clearance	-.005"

- New average adjusting pad thickness
  required to give overall thrust clearance of .011" .103"

Step 8:

- Select pads from kit

Answer:

- Four pads @.100" .400"
- Two pads @.110" .220"

Total = .620"

Average pad thickness per pad with this combination is .10333"... (.620 ÷ 6 = .10333) and desired thickness from Step 7 is .103".

Compressor Reassembly

Click here for Figure 61 — Reassembling the Compressor

61. In this module, we'll cover compressor reassembly, including spacing the impeller.

First, all parts must be thoroughly cleaned and inspected for wear. Matching faces must be perfectly clean and new "O" rings should be used.

Clean all "O" ring grooves and mating surfaces and carefully look for irregularities in the surfaces. Then, clean everything with solvent.

To reassemble the transmission, first clean and blow out all oil channels and lines.

Wipe a light film of oil on the bearing and rotor journal surfaces including the hi-speed bearing surfaces.

Rig the rotor using a sling and the rigging bolt.

Make sure the seal ring is on the shaft before inserting it into the transmission case.

Align the rotor and transmission case. Be careful to keep the parts straight and not bind or force them.

Now bolt the motor shaft labyrinth into place. The notch on the seal ring is placed at 12 o'clock. The labyrinth seal will hold the rotor in place. Assemble the laby halves and start the bolts.

Contents

Tighten to the proper torque.

With the rotor in place, replace the bull gear. This gear should be heated in an oven or oil bath to 200°F. Do not use a torch, the uneven heating will damage the heat treatment of the gear! Replace the square keys. With both square keys in place, use heat resistant gloves and push the gear onto the motor shaft. Use the bolt to draw the bull gear into place.

After the bull gear cools down, remove the bolt. Apply a thread locking compound to the bolt and put it back in. Tighten to the proper torque.

Next, check the gear wear and tooth contact pattern.

Bolt the high speed assembly into the transmission housing using the high speed laby to lock it in place.

Rotate the gears several times. Inspect the gears. Look for wear, broken teeth or cracks.

Remove the high speed assembly and continue.

Click here for Figure 62 — Replacing the Bull Gear Shroud

62. Now replace the bull gear shroud. Bolt the bull gear shroud into place. Use thread locking compound on the bolts. Replace the oil wiper. Check the clearance of the wiper. It should be.020 to.030.

Contents

Replace the laby pressurization line. Tighten the flare nuts.

Attach a string or piece of wire to the bearing sensor wires. This will be used to guide the wires to the bearing terminal plate.

Use a new "O" ring in the transmission housing. Grease the "O" ring with silicone grease. Put the "O" ring into the groove.

Click here for Figure 63 — Rigging the Transmission Case

63. Rig the transmission case and move the assembly to the compressor housing. Stop when the transmission case is about one foot away from the compressor housing. Feed the string attached to bearing sensor wires to the terminal plate hole. Carefully work the transmission case into the compressor housing. Start the two cap screws and draw the transmission case into place. Tighten the bolts evenly. Use a torque wrench.

Click here for Figure 64 — Dial Indicator

64. Now, set up a dial indicator to check the thrust clearance. Position the button so it is in contact with a flat surface on the end of the rotor. Push the rotor in and zero the dial indicator, then pull the rotor out. The movement on the indicator will be the thrust clearance. Be sure the

Contents

shaft is moved fully in each direction, thrust and counter thrust.

Check the Operation and Maintenance instructions for the correct thrust clearance. If the clearance is not within tolerance, the bearings may have to be replaced.

Motor Assembly

Click here for Figure 65 — Installing the Stator and End Bell

65. Next, install the stator and end bell. Inspect the stator windings visually for any broken wires or insulation. Check the internal motor terminals for tightness.

Click here for Figure 66 — Transmission Housing

66. Grease the transmission housing to motor housing "O" ring, using the special silicone based "O" ring lube, and place it on the transmission housing. The grease will hold it in place.

EXERCISE CAUTION WHILE INSTALLING THE STATOR SO THAT THE WINDINGS DO NOT GET NICKED OR SCRATCHED.

Use an ohmmeter to check the sensor wires for continuity. With the stator in place, replace the bolts and tighten to the proper torque.

Motor End Bell

Click here for Figure 67 — Installing the Motor End Bell

67. Next, install the motor end bell. Inspect the refrigerant spray nozzle. Grease the motor end bell "O" ring and place it in the end bell groove. The grease will hold it in place.

Use the eye bolt, threaded bar stock and rigging to position the end bell. Push the end bell into place. When the end bell is in place, replace the bolts and tighten.

Click here for Figure 68 — Installing the High Speed Assembly

68. Next install the high speed assembly into the compressor. Replace the small "O" ring that seals the gas passage to the laby. Align the high speed bearing so the drain is at the bottom. Push the hi-speed assembly into place being careful to align the shaft in the rear hi-speed bearing.

When the assembly is in place, install a new high speed labyrinth "O" ring. Use grease to hold it in place.

Contents

Click here for Figure 69 — Installing the High Speed Labyrinth

69. Install the high speed labyrinth. Note that the labyrinth cap screws hold both the labyrinth and the high speed assembly in place. Tighten the cap screws to the proper torque.

Click here for Figure 70 — Replacing the Conical Diffuser

70. To replace the conical diffuser, grease each of the two "O" rings and put them into the grooves in the compressor housing. Put one additional "O" ring on the outer edge of the conical diffuser. Lift the diffuser into position. Line up the TOP at 12 o'clock and push it into place. Start a few bolts and replace the remaining bolts. Then tighten to the proper torque.

Impeller Spacing

Click here for Figure 71 — Impeller Spacing

71. Before impeller installation, impeller spacing must be checked to insure proper clearance. The impeller clearance to the shroud is determined by the shim thickness behind the impeller. The shim has 0.003" laminations which can be peeled off by using a knife.

First, take an impeller to hub counter bore measurement. We will call this step "B." Place the impeller in the shroud and center it. With a one-inch thick straight edge in place against the impeller, use a depth micrometer to make two measurements. Get an average of the two readings, and record the dimension. Then rotate the straight edge 90° and repeat the measurements.

Click here for Figure 72 — Shroud Mounting Surface Measurement

72. Now check the impeller to shroud mounting surface measurement. We will call this step "A." With the straight edge against the impeller, use the depth micrometer to make two measurements. Get an average of the readings and record the dimension.

Contents

Click here for Figure 73 — Diffuser to Spacer Measurement

73. Now check the diffuser-to-spacer measurement. We will call this step "C." Be sure the labyrinth and spacer are in place. Use the clamping fixture and lock it in place with a bolt. Be sure that the shaft is in the counter thrust position (toward the motor).

Place the straight edge in a vertical position. Adjust the straight edge, and take two readings. Take several additional readings at 3 and 9 o'clock. Reverse the straight edge, and take more readings. Average the readings, and record them.

Click here for Figure 74 — Impeller Spacing

74. Now subtract the thickness of the straight edge from the diffuser-to-spacer measurement.

The desired shim thickness can now be calculated. First subtract the average impeller-to-hub counter bore measurement "B" from the average shroud-to-impeller reading "A". Subtract the value of "A-B" from the diffuser-to-spacer measurement and find the total clearance. Now, subtract the actual thrust clearance. This gives us a new total. Finally subtract the desired impeller clearance, or air gap, which is given in the Operation and Maintenance booklet. The remainder is the required shim thickness.

Contents

Installing the Impeller

Click here for Figure 75 — Checking Shim Thickness

75. Before installing the impeller, make sure all necessary tools are on hand. If the impeller has been replaced, check the part number stamping on the impeller to be sure the correct impeller is being installed. Record the part number.

To install the impeller, check the shim thickness with a micrometer before installing it. One side of the shim is a solid ring, and the other side of it has.003" laminations which can be peeled off to obtain the required shim thickness. Adjust the shim to the proper thickness. Install the shim over the shaft, against the spacer with solid side toward the impeller.

Click here for Figure 76 — Impeller Keys

76. Next, place impeller keys in the impeller keyway to be sure they fit properly. Then place impeller keys in their proper shaft keyway slots, by using the index marks. The long edges of the keys are chamfered. One side of the key has a wide chamfer, and the other a narrow chamfer. The side of the key with the narrow chamfer goes into the shaft keyway slot.

Contents

Next, heat the impeller evenly with a Mapp or propane torch, using a 225 to 250°F heat stick to prevent damage or overheating.

Install the impeller as soon as the proper temperature is reached, forcing it home immediately. Be sure the impeller is fully inserted.

Click here for Figure 77 — Installing the Nose Piece

77. Install the nose piece and tighten the bolt to be sure the impeller sets against the shim. Use the six-sided section to hold the impeller to prevent damage during tightening. Check the tightness of the bolt periodically as the impeller cools on the shaft. When the impeller has cooled completely, remove the bolt and use a thread locking compound on the bolt. Tighten the impeller bolt to the specified torque of 44 to 46 ft. lb.

Click here for Figure 78 — Nose Cone Thrust Reading

78. Now take a nose cone thrust reading to prove the impeller is in place. It must equal the actual thrust setting. Also turn the compressor over by hand, to make sure it turns free.

Contents

Click here for Figure 79 — Placing the Impeller Shroud

79. Next, lift the impeller shroud into place. Be careful not to hit the impeller.

Start a bolt at 12 o'clock, then start the remaining bolts. Tighten the bolts to the proper torque.

Click here for Figure 80 — Suction Housing

80. Next is the suction housing. If service work was done on the guide vanes, the assembly would be mounted into the suction housing. Look at the casting. Find the raised letters "DP". These letters point out where the drive pulley is located and should be positioned toward the vane shaft. Bolt the assembly into the suction housing.

Put a new "O" ring on the suction housing. Use silicone grease to hold it in place.

Click here for Figure 81 — Setting Up the Rigging

81. Now, set up the rigging on the suction housing lifting lug and rig the housing into place.

Start a couple of bolts and replace the rest. Torque these bolts.

Contents

Replace the suction elbow using new flange gaskets.

Do not add new compressor oil until the oil pump is serviced and the oil filters have been changed.

Click here for Figure 82 — Compressor Overhaul

82. To complete the compressor overhaul, you must still:

- Connect all flanges, pipes, tubing, conduit and electrical connections.
- Change refrigerant filters.
- Perform leak testing and repair any leaks.
- Add new charge of compressor oil.
- Use a megohmmeter to check motor resistance.
- Perform "Machine Dehydration."
- Replace the insulation.
- Open the isolation valves then return the machine to normal operating conditions.

Click here for Figure 83 — 19XL Series Machine

83. Well, that does it. In this program we covered:

- Familiarization

Contents

- Safety considerations
- Tools needed
- Pre-disassembly procedures
- Disassembly procedures
- Inspecting the internal parts
- Recording clearances
- and Reassembly

We hope this program goes a long way to help you understand the 19XL Series machine, and how to service it.

19XL QUIZ

Familiarization

1. After isolating the refrigerant charge in preparation for servicing the compressor, the pumpout unit should be run until the cooler/compressor reaches _____ of vacuum.

2. The controls for the hot gas bypass valve sense:

a. pressure differential between compressor and cooler.

b. temperature differential between entering and leaving chilled water.

c. pressure differential between cooler and condenser.

d. temperature differential between compressor discharge gas and condenser liquid.

3. With R-22, the compressor needs to pump only _____ % as much refrigerant vapor CFM as with R-11.

4. The compressor diffuser has built-in surge protection and totally eliminates the need for hot gas bypass. T or F

5. The impeller nose piece six-sided section should never be turned, since it is not threaded. T or F

Contents

6. Amps, volts, and operating information are relayed between the PSIO and the _____.

7. High pressure gas directed across the _____ helps to return oil from the cooler to the oil sump.

a. diffuser

b. separator

c. eductor

d. demister

8. Lube oil pressure normally runs _____ to _____ psi above sump pressure.

9. Lube oil temperature in the sump is maintained at _____ to _____ °F.

Disassembly Procedures

10. Before transferring the refrigerant from the compressor, it is good practice to:

a. check for refrigerant leaks

b. close the transfer valves.

c. megger the motor.

d. go to lunch.

11. After evacuating the cooler/compressor section, you should leave _____ to _____ psi positive pressure in the section by adding _____ _____.

12. Because the impeller is a shrink fit on the shaft, a _____ _____ is necessary for its removal.

13. Before removing the high speed labyrinth seal, be sure to first loosen the seal so the "O" ring is free. T or F

14. When removing the diffuser, be sure to check the _____ to see if any service is necessary.

15. When removing the motor end bell, be sure to pull it straight back at least one foot in order to clear the _____ _____.

16. After the motor is removed, a 100 watt light bulb should be placed inside the stator for the purpose of:

a. ease of inspection.

b. keeping the stator clean.

c. keeping the stator dry.

d. good luck.

17. After removing the transmission, remove the _____ assembly and check the condition of the foam pad.

18. Gas at motor pressure is supplied to the transmission labyrinth seal for the purpose of:

a. cooling the seal.

b. equalizing the pressures across the seal.

c. venting the motor section.

d. reducing oil loss.

19. The transmission bull gear should not be heated during disassembly. T or F

Compressor Reassembly

20. During re-assembly, the transmission bull gear should be heated in an oven or oil bath only to _____ °F.

21. When re-assembling the motor stator, extreme caution is necessary to avoid damage to _____.

22. The impeller clearance to the shroud is determined by the thickness of a _____ located behind the impeller.

23. During re-assembly, the actual impeller-to-shroud clearance must be measured and calculated, then compared to the desired clearance, in order to determine the required shim thickness. T or F

24. The side of the impeller keys having the wide chamfer is the side that goes into the shaft keyway. T or F

25. For reassembly, the impeller wheel should be heated evenly to _____ to _____ °F.

Tool List

- a Gantry, or adequate rigging
- 1 ton chain fall
- guide bolts
- temperature stick -- 225-250°F
- special impeller puller
- allen wrenches
- depth micrometer
- dial indicator with a magnetic base
- snap ring pliers
- punch set
- outside micrometers--up to 5"
- telescope gauge
- torch
- plastic hammers
- set of open end wrenches
- torque wrench
- nylon slings
- teflon strips
- straight edge
- pry bar
- threaded bar stock

Additional materials needed include:

- insulation and glue
- clean lint-free rags
- refrigerant 22
- approved centrifugal compressor oil
- soldering material
- replacement spare parts, "O" rings, filters, etc.

19XL Quiz Answers

Paragraph

Familiarization

1. 22 inches 5

2. b and c 7

3. 20 8

4. F 9

5. T 10

6. SMM (starter management module) 17

7. c 20

8. 20, 25 21

9. 140, 160 23

Disassembly Procedure

10. a 24

11. 1, 2; dry nitrogen 24

12. impeller wheel puller 32

Contents

Paragraph

Disassembly Procedure (Continued)

Compressor Reassembly

Contents

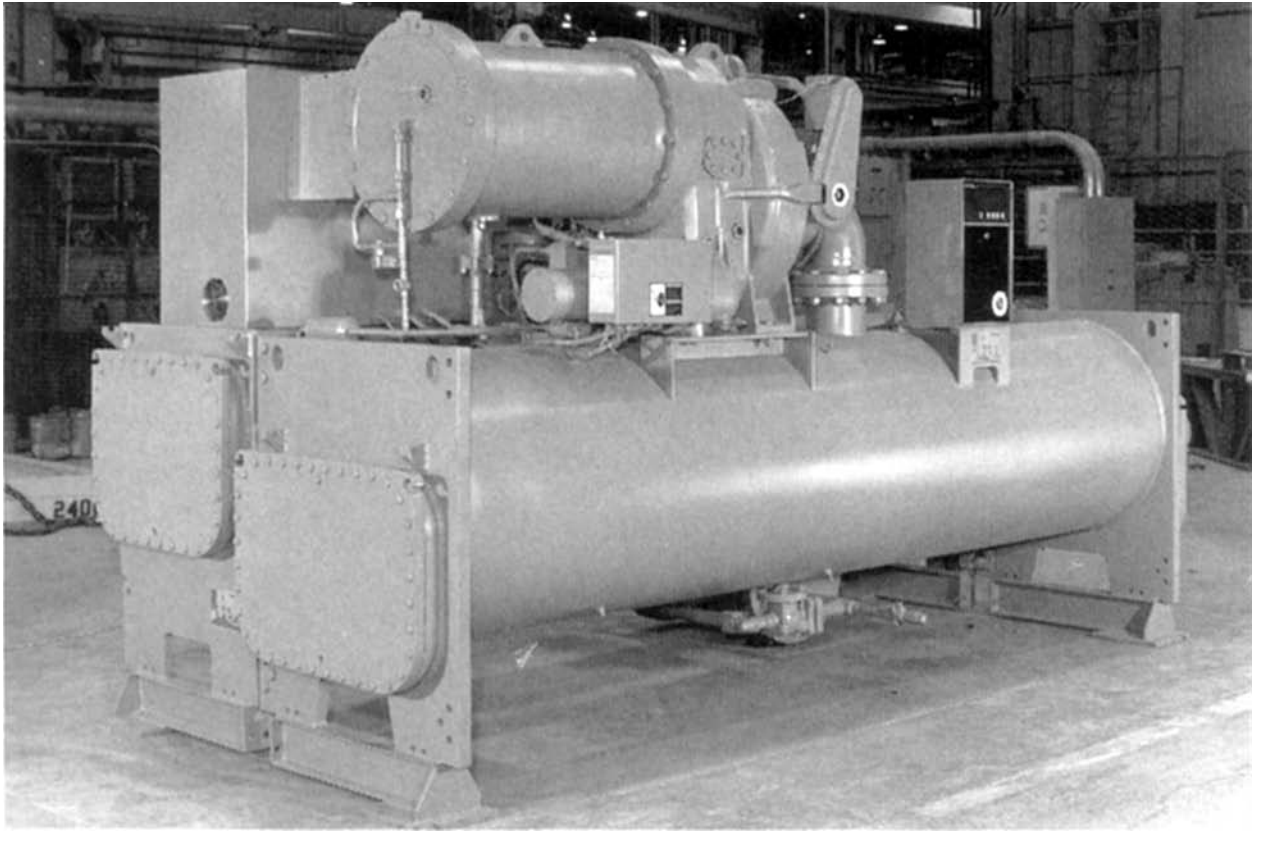

Figure 1 — Model 19XL Centrifugal Liquid Chiller

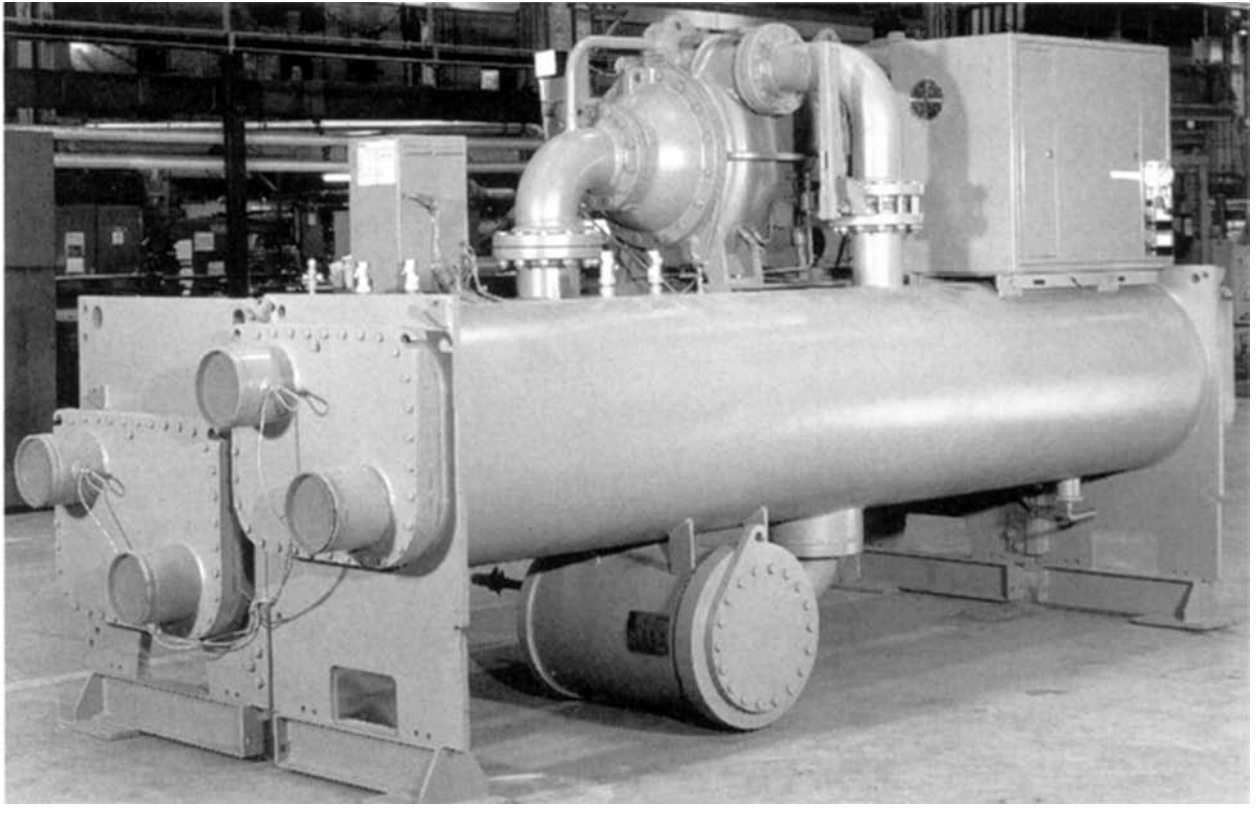

Figure 2 — The 19XL Heat Exchanger

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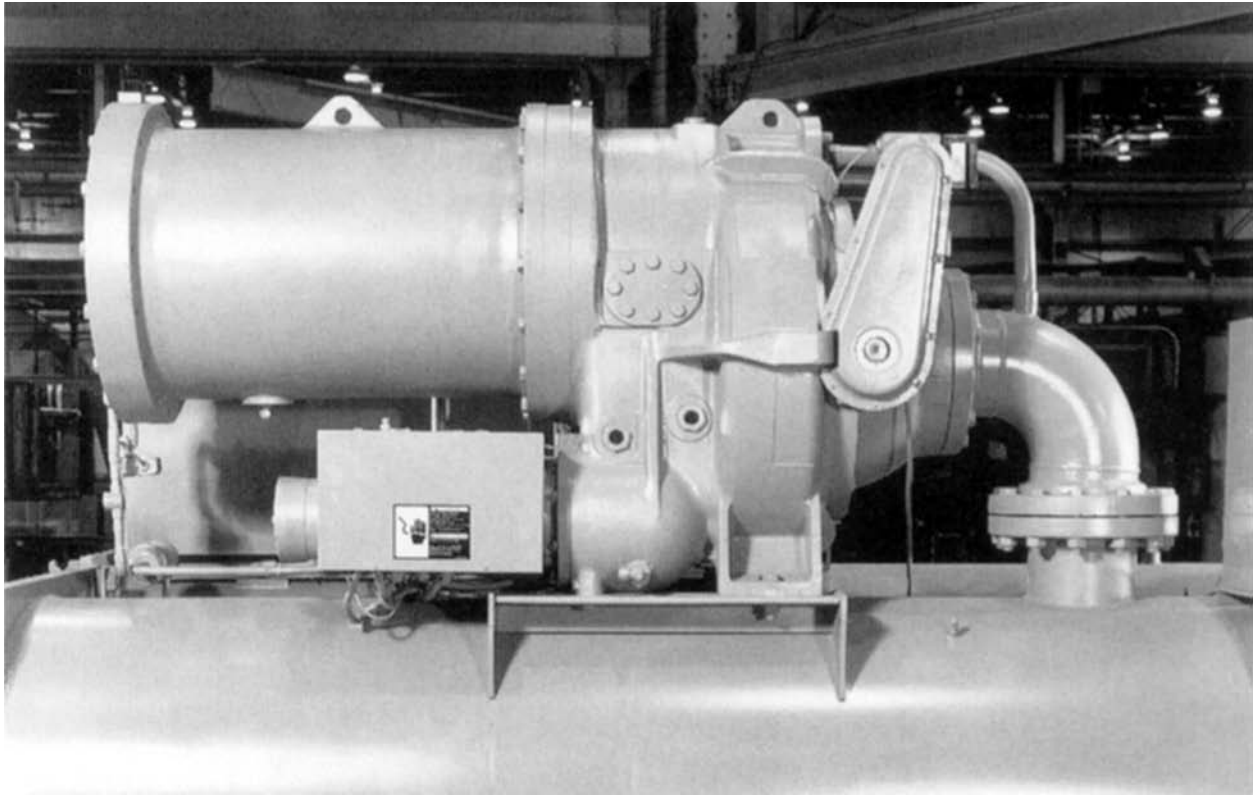

Figure 3 — Compressor

Figure 4 — Compressor (Flanged Elbows)

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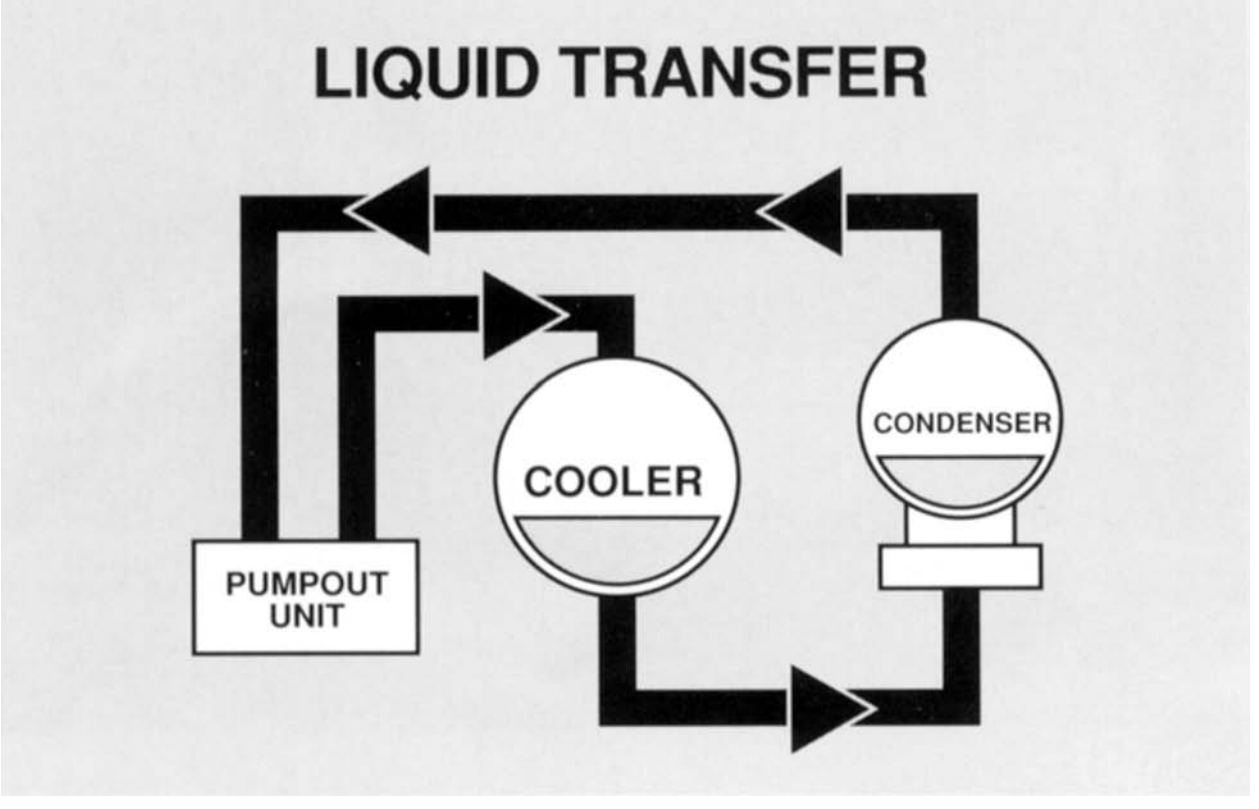

Figure 5 — Liquid Transfer

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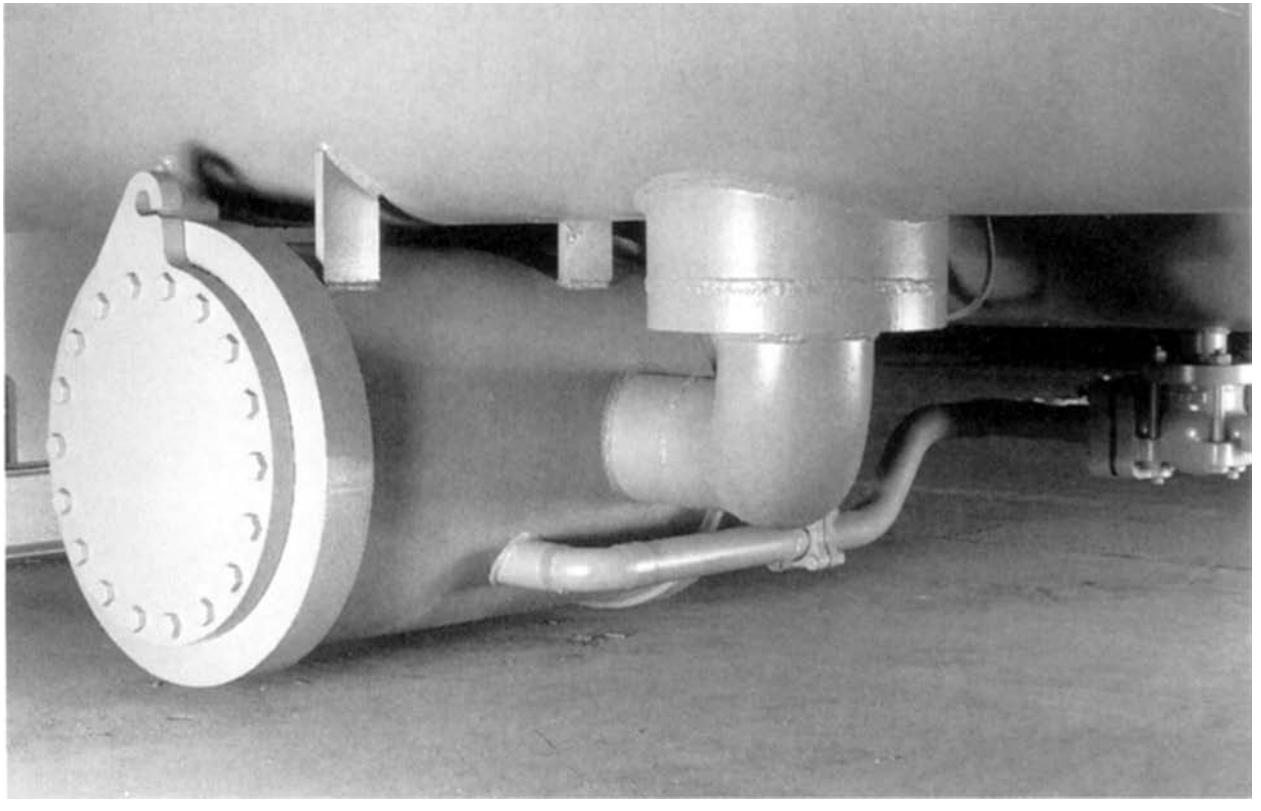

Figure 6 — 19XL High Side Float

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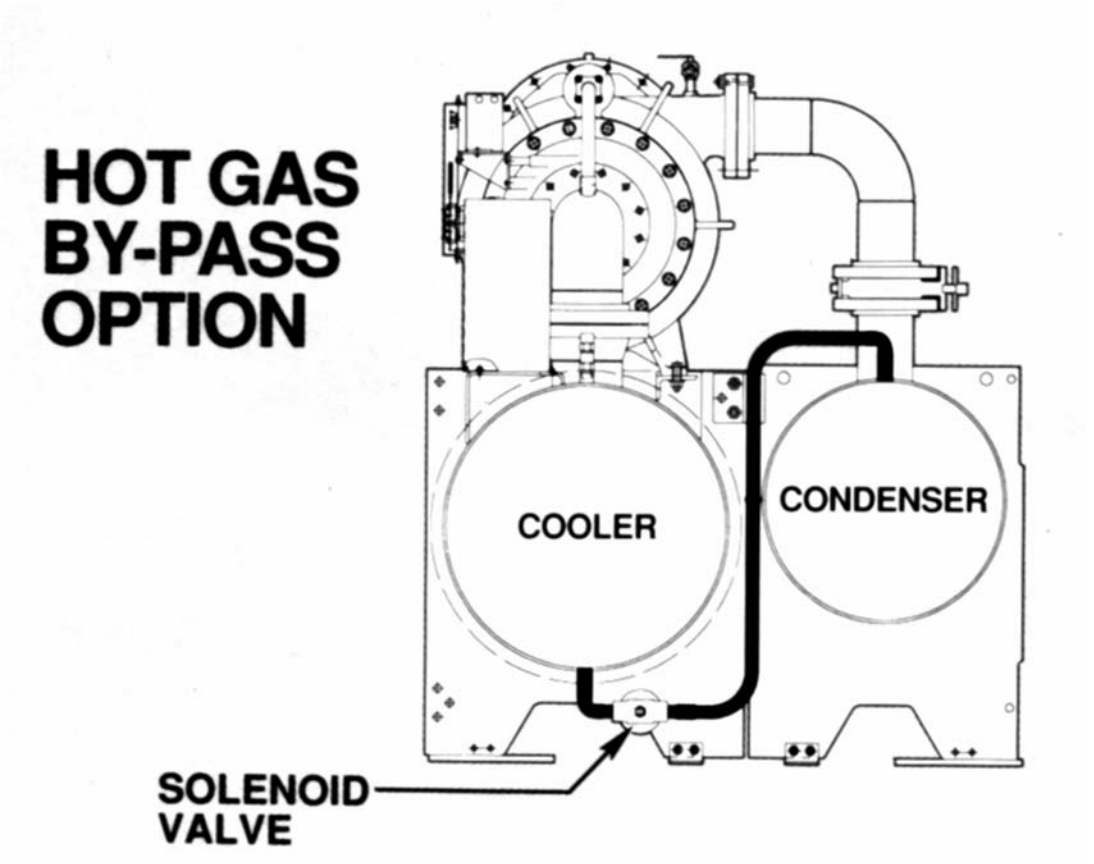

Figure 7 — Hot Gas By-Pass Option

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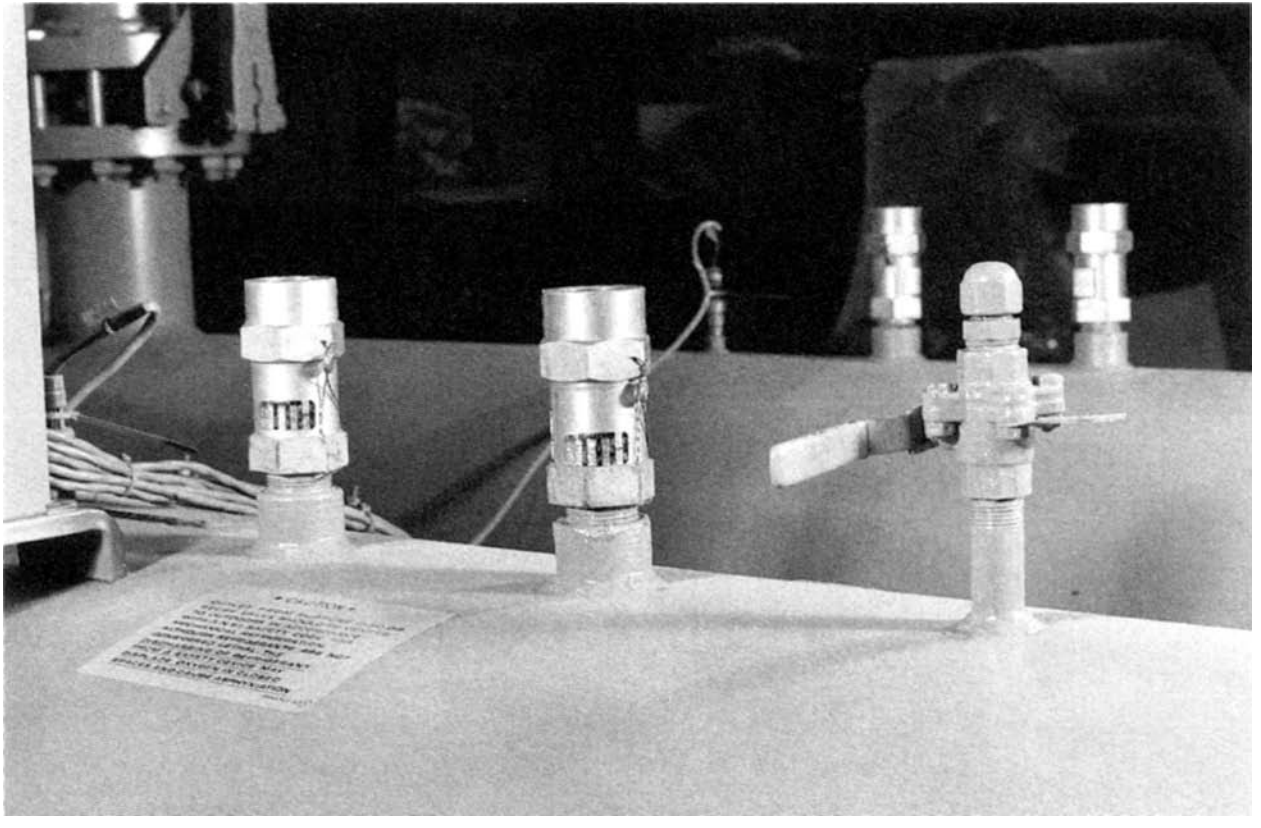

Figure 8 — 19XL Relief Valves

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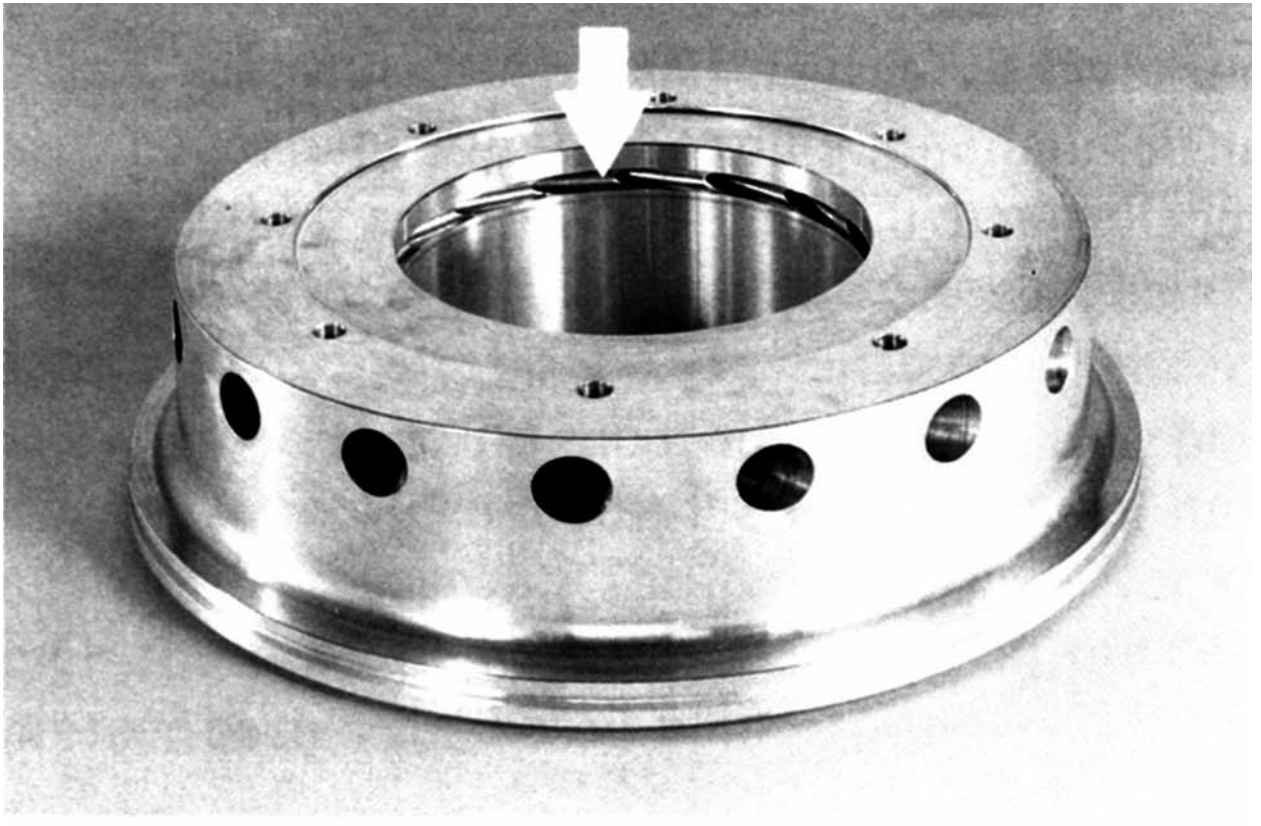

Figure 9 — Diffuser

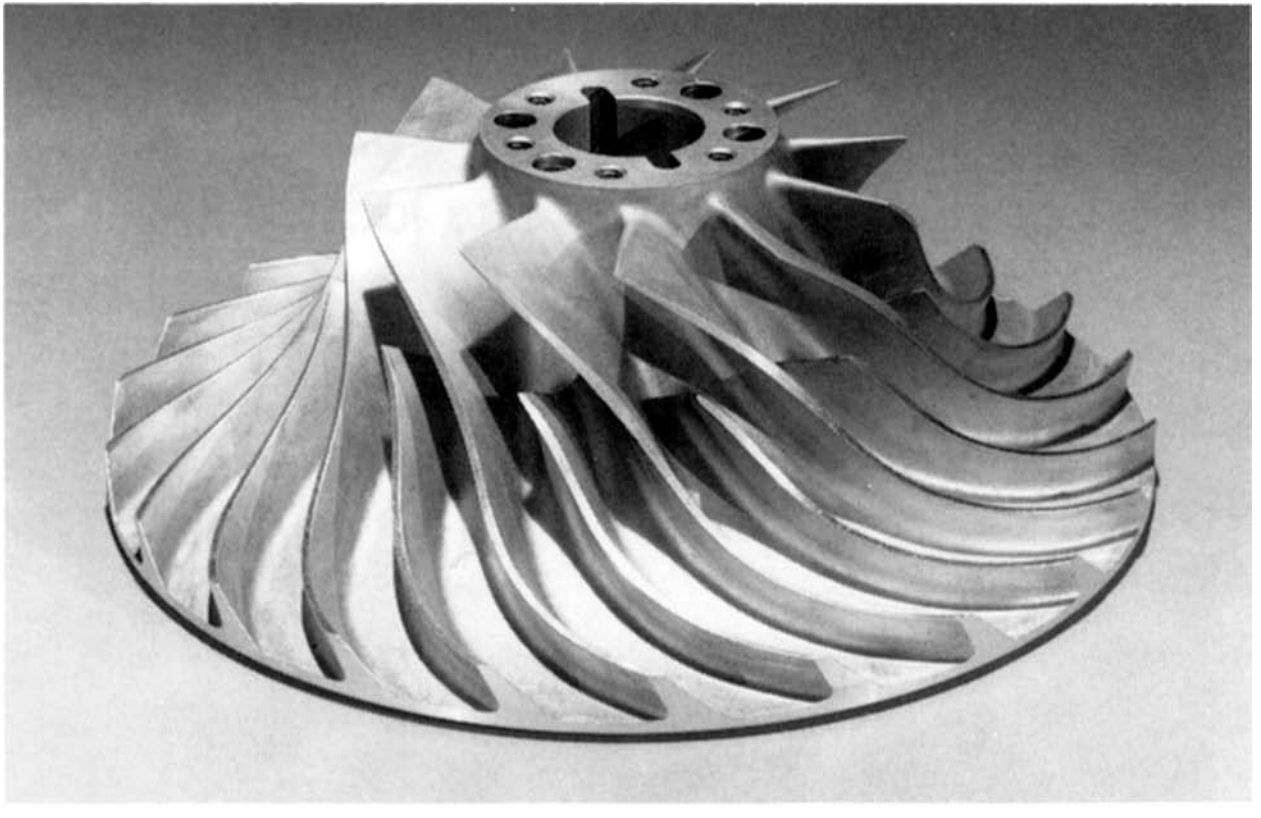

Figure 10 — 19XL Impeller

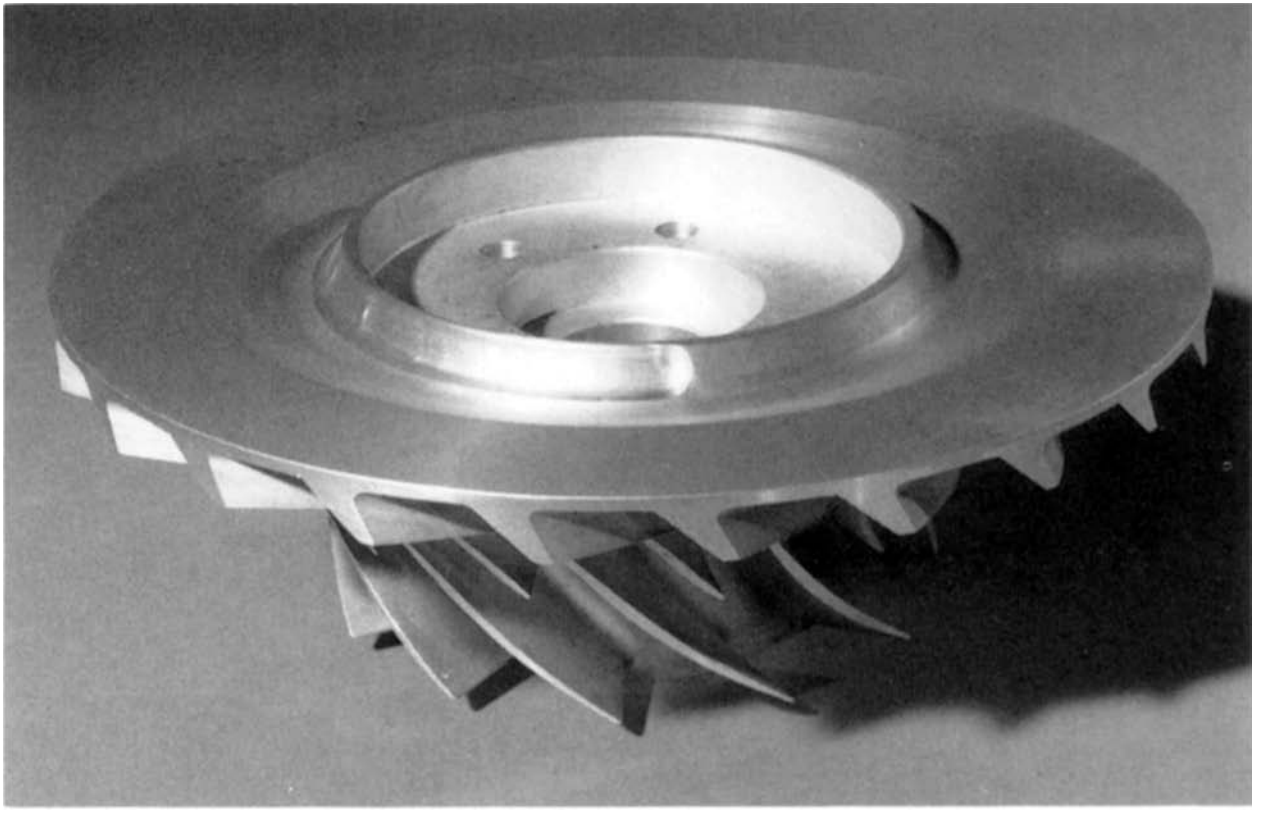

Figure 11 — 19XL Impeller (Drilled Holes)

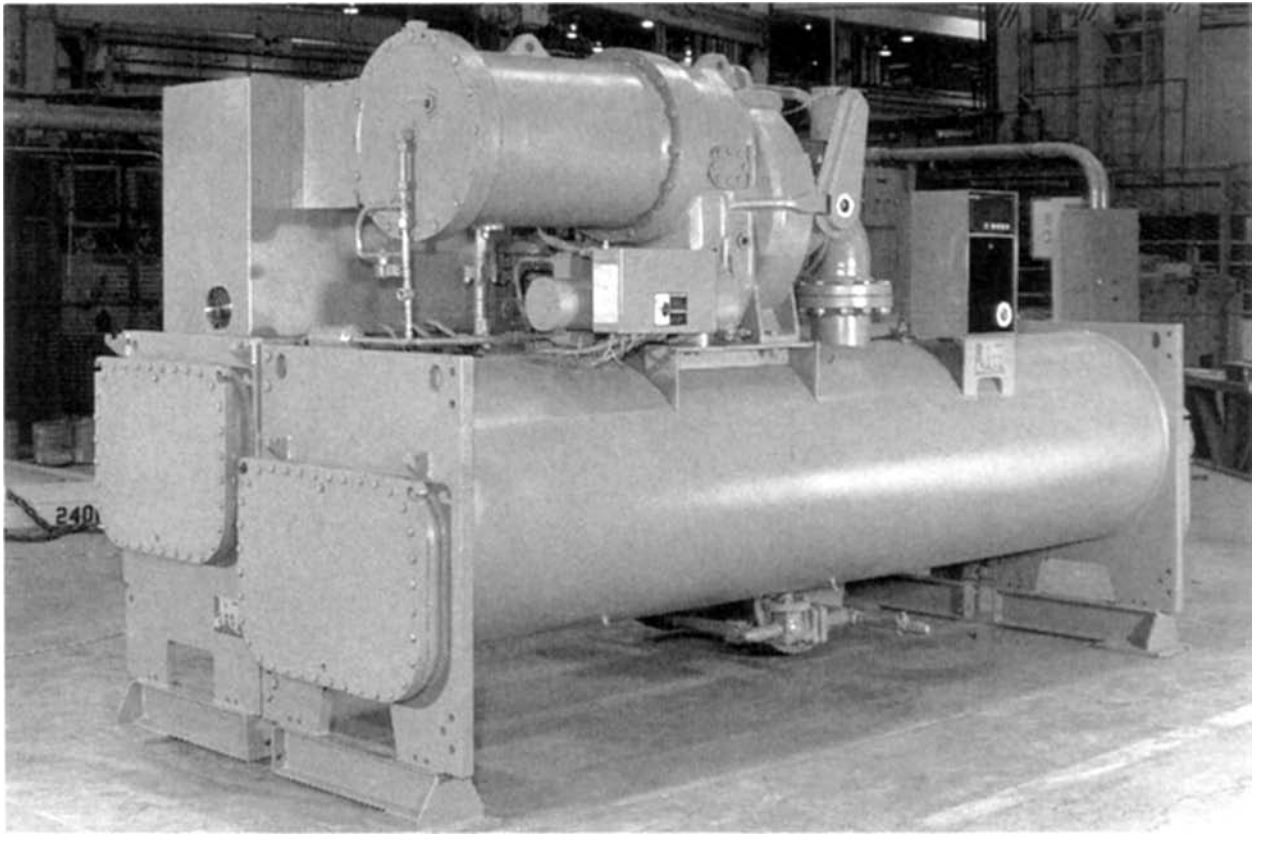

Figure 12 — 19XL Controls

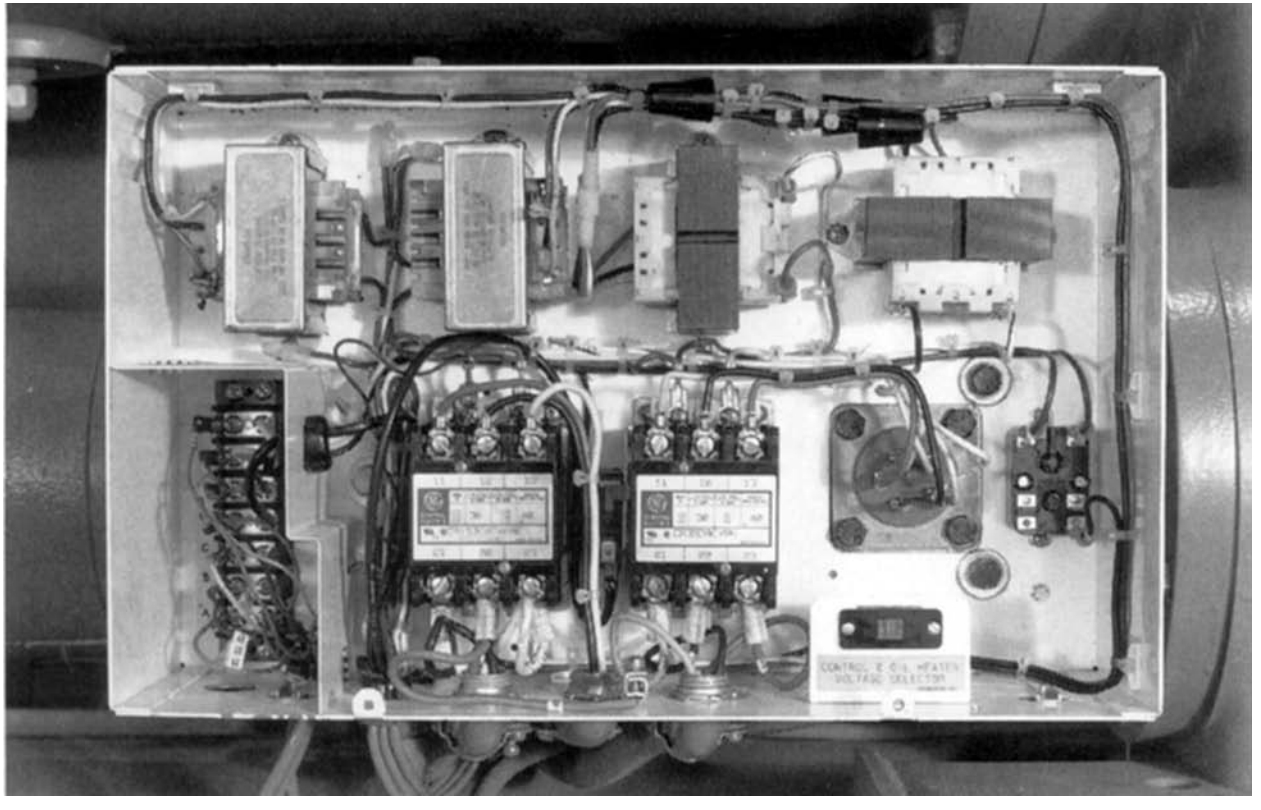

Figure 13 — 19XL Power Panel

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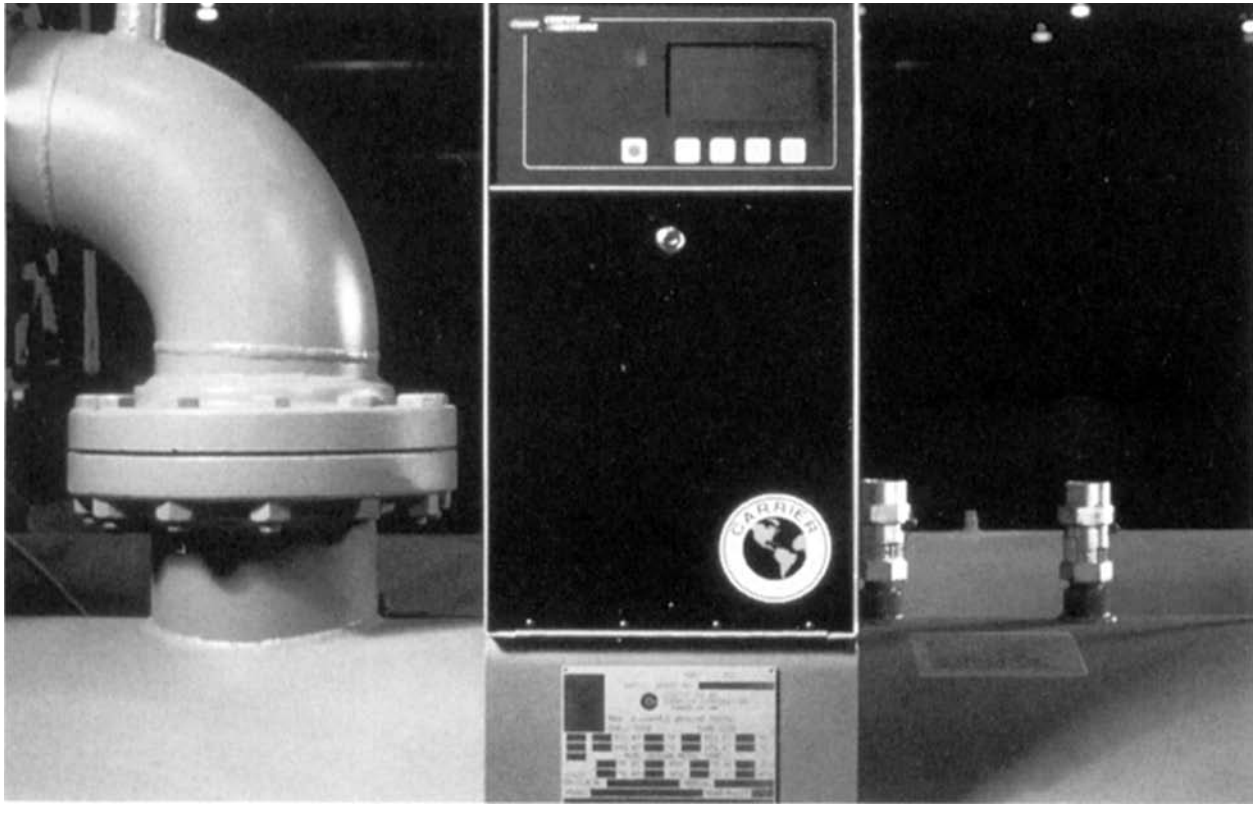

Figure 14 — 19XL PIC Control Center

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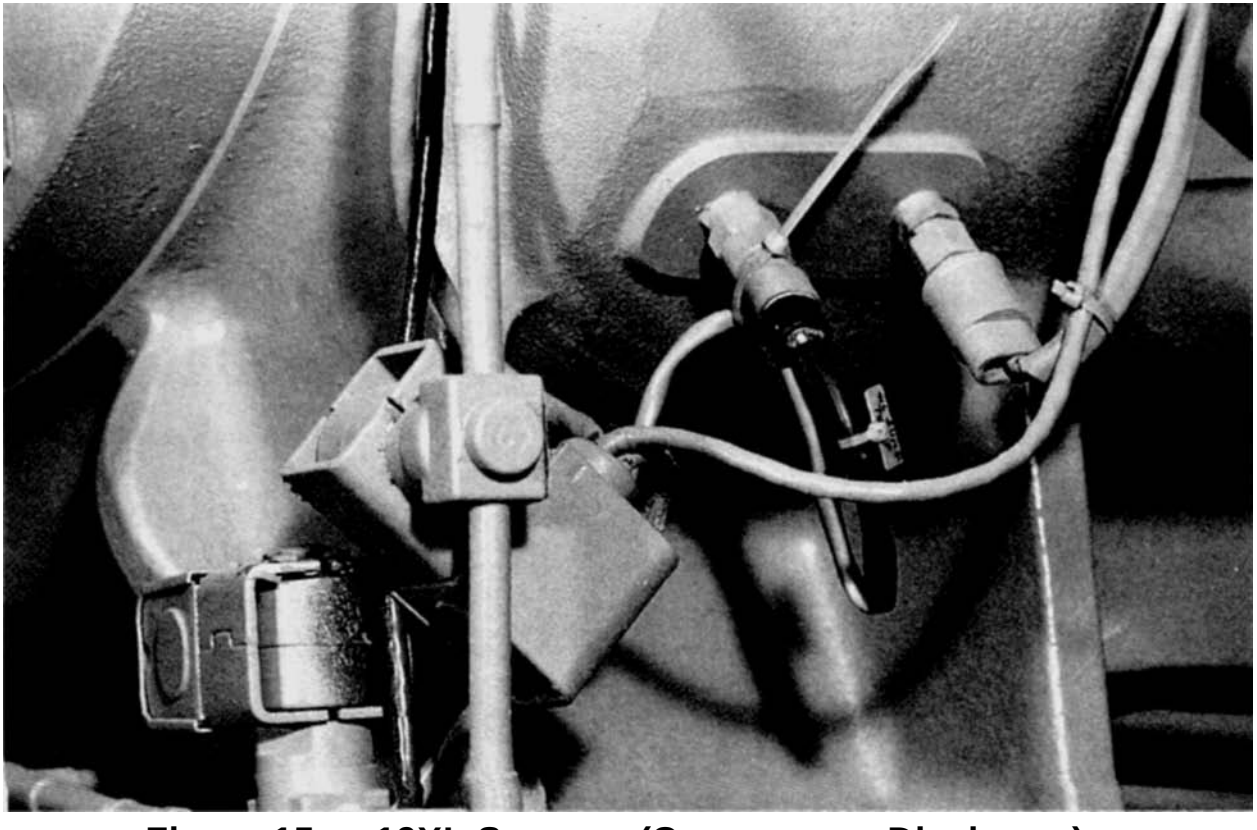

Figure 15 — 19XL Sensors (Compressor Discharge)

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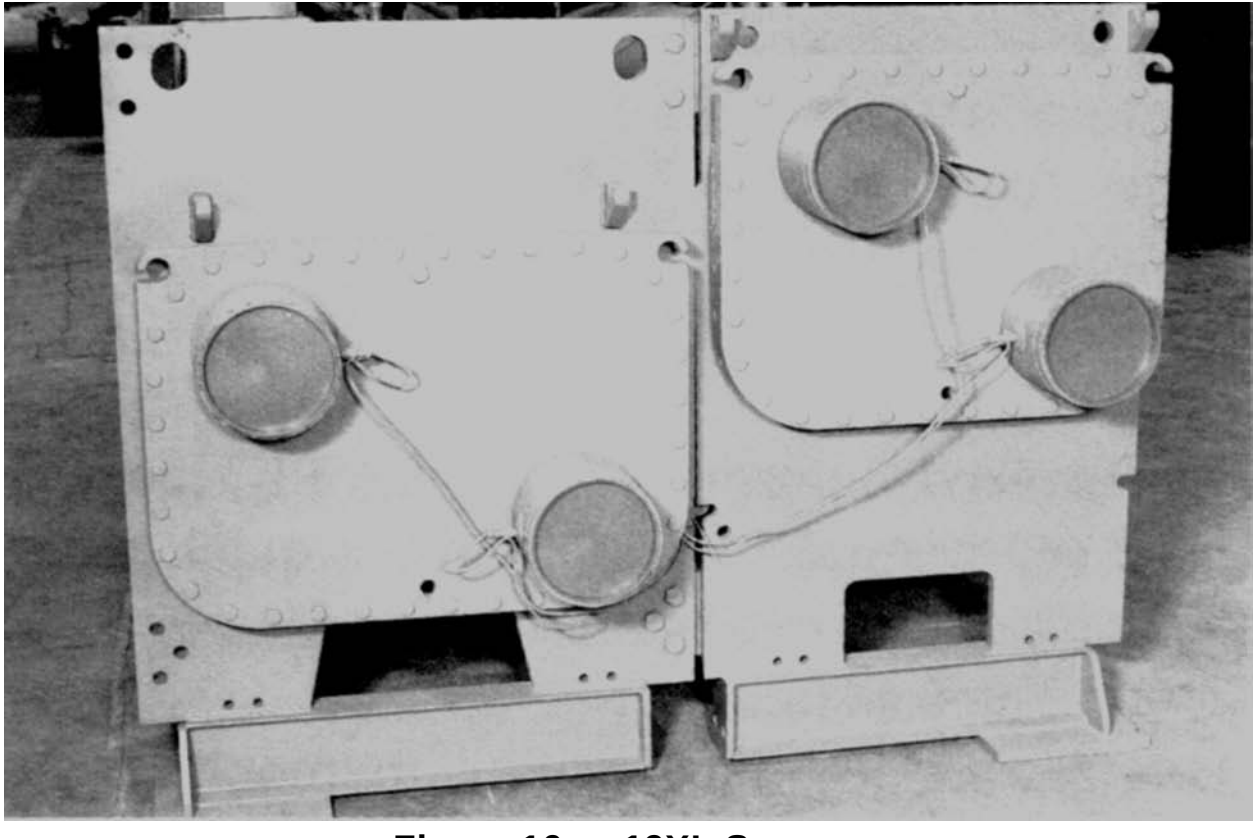

Figure 16 — 19XL Sensors

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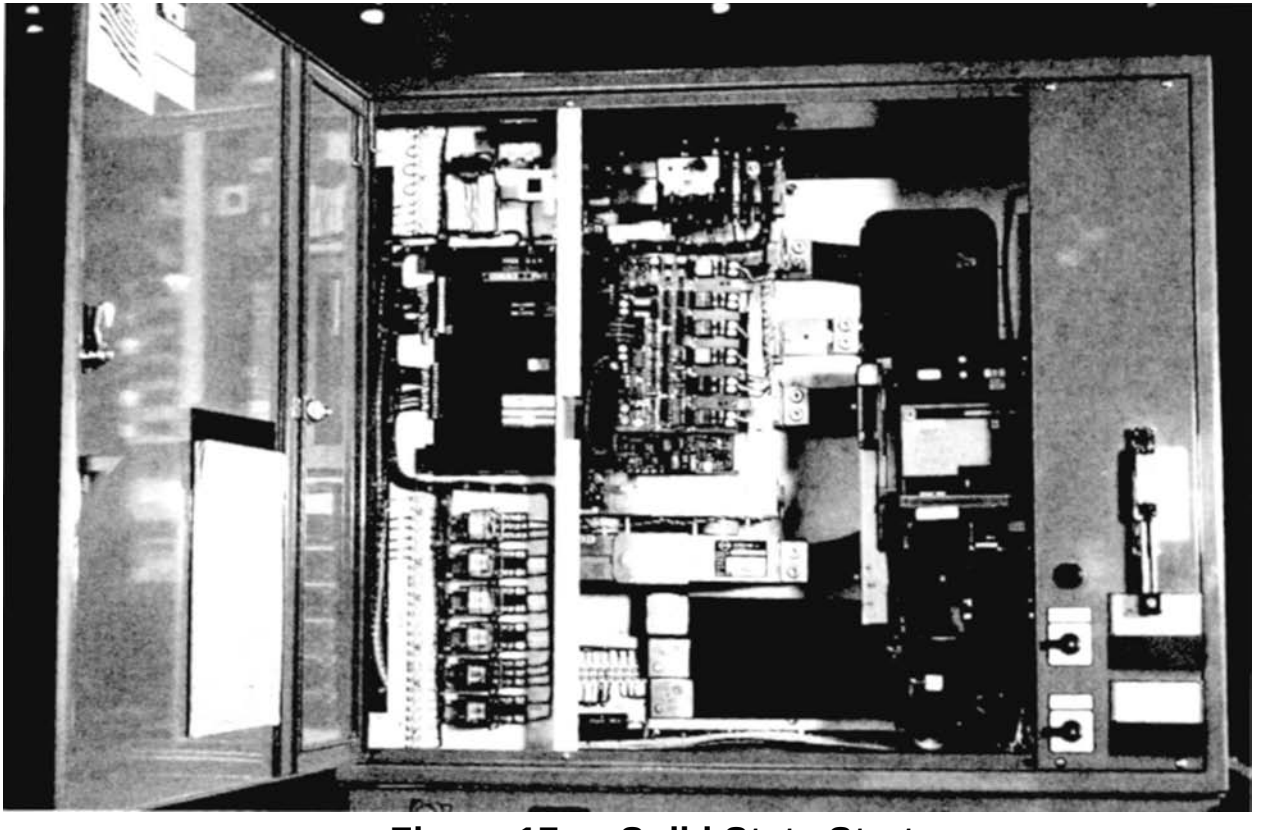

Figure 17 — Solid State Starter

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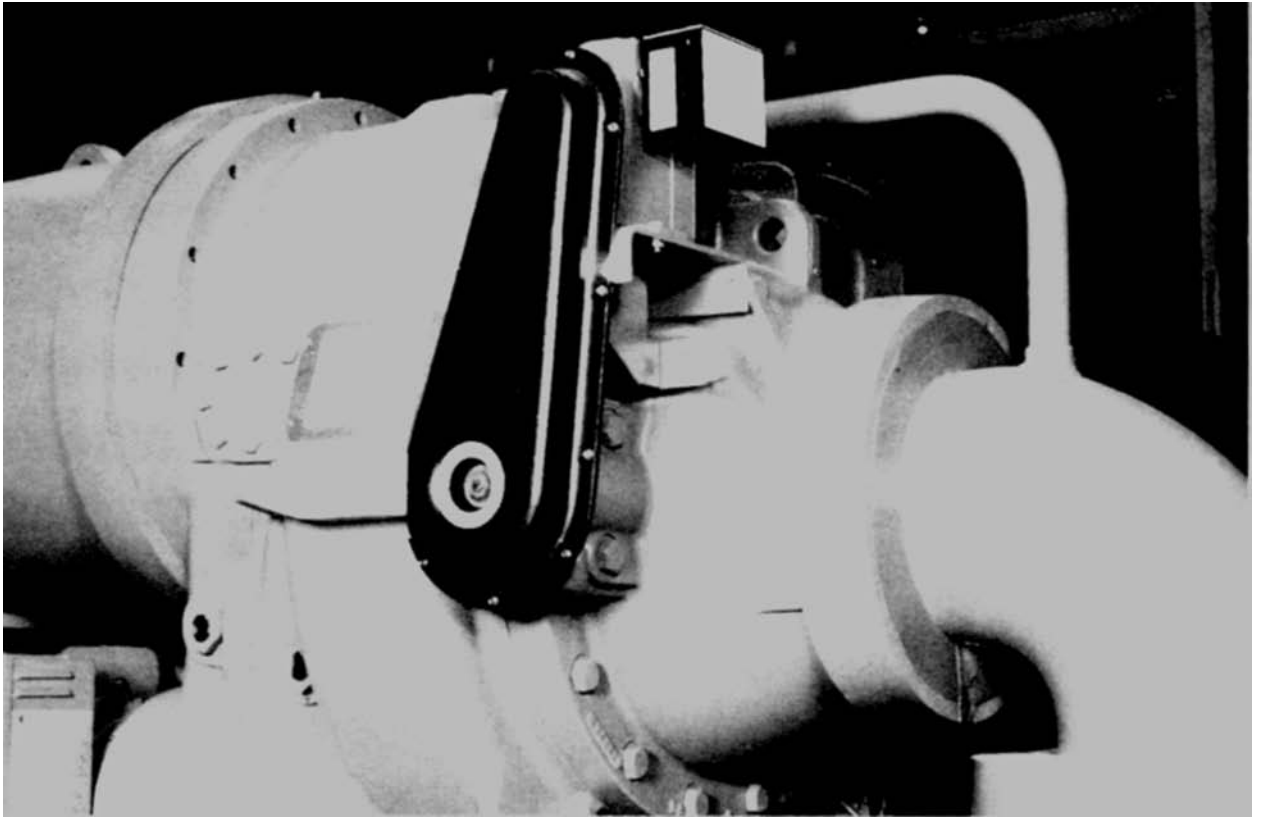

Figure 18 — Compressor

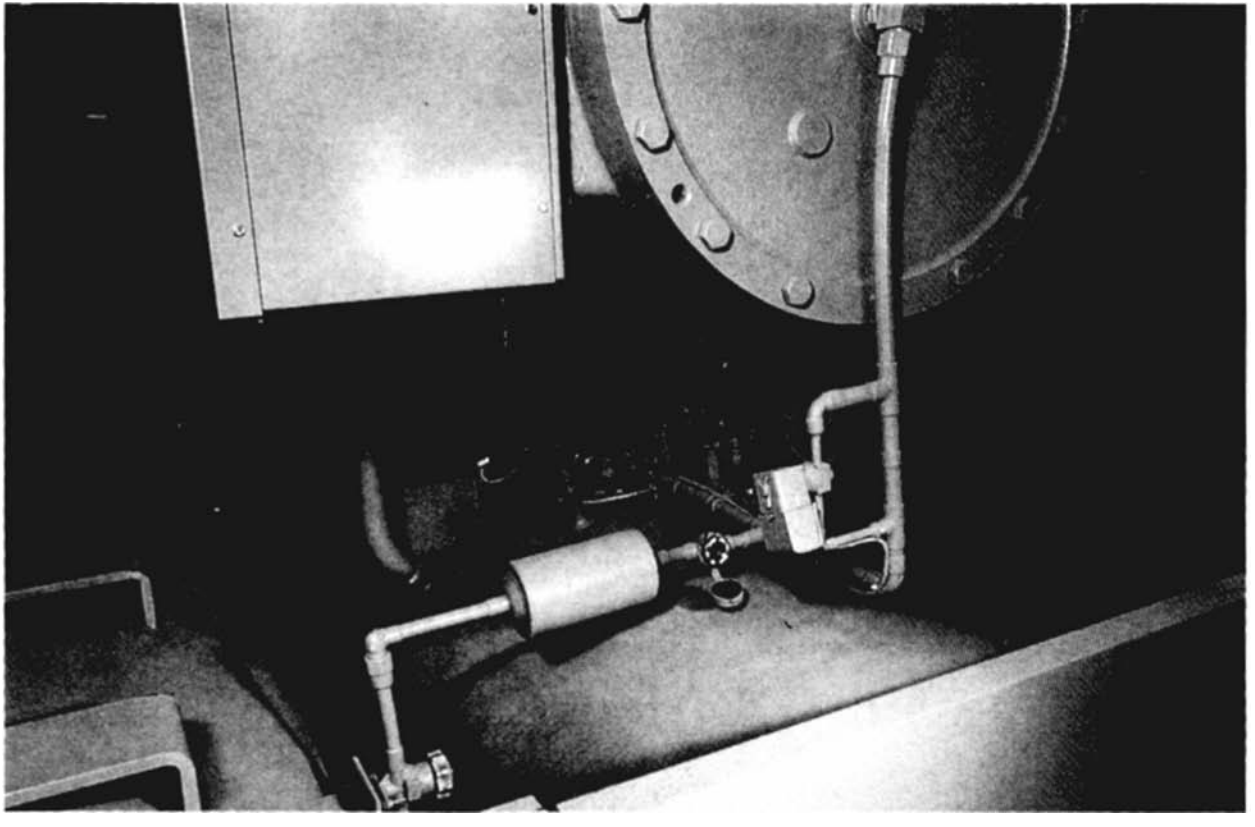

Figure 19 — Motor Cooling

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OIL RECOVERY EDUCTOR SYSTEM

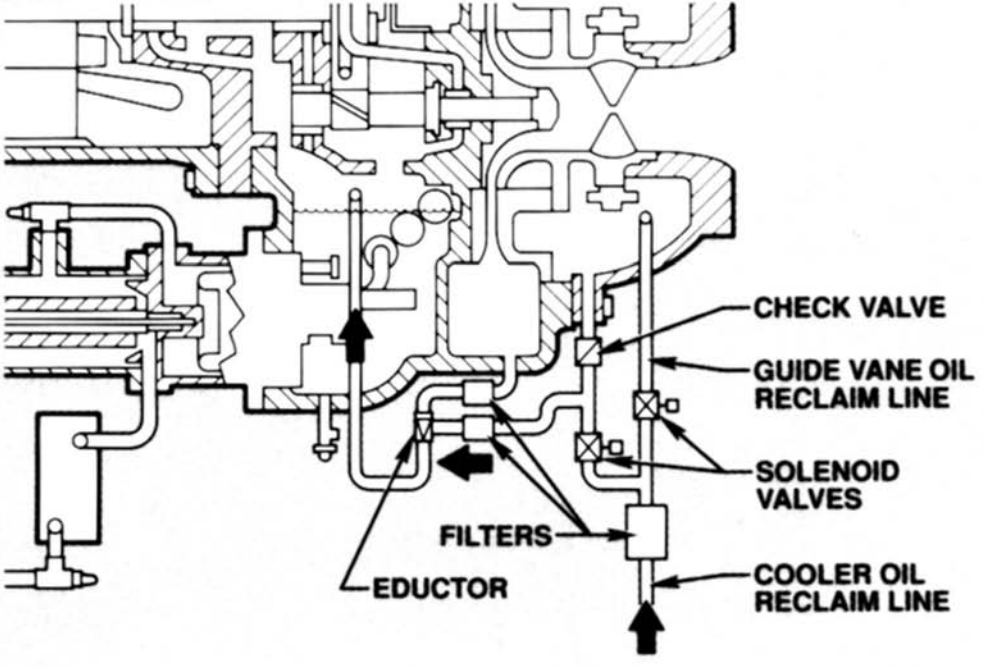


Figure 20 — Oil Recovery System

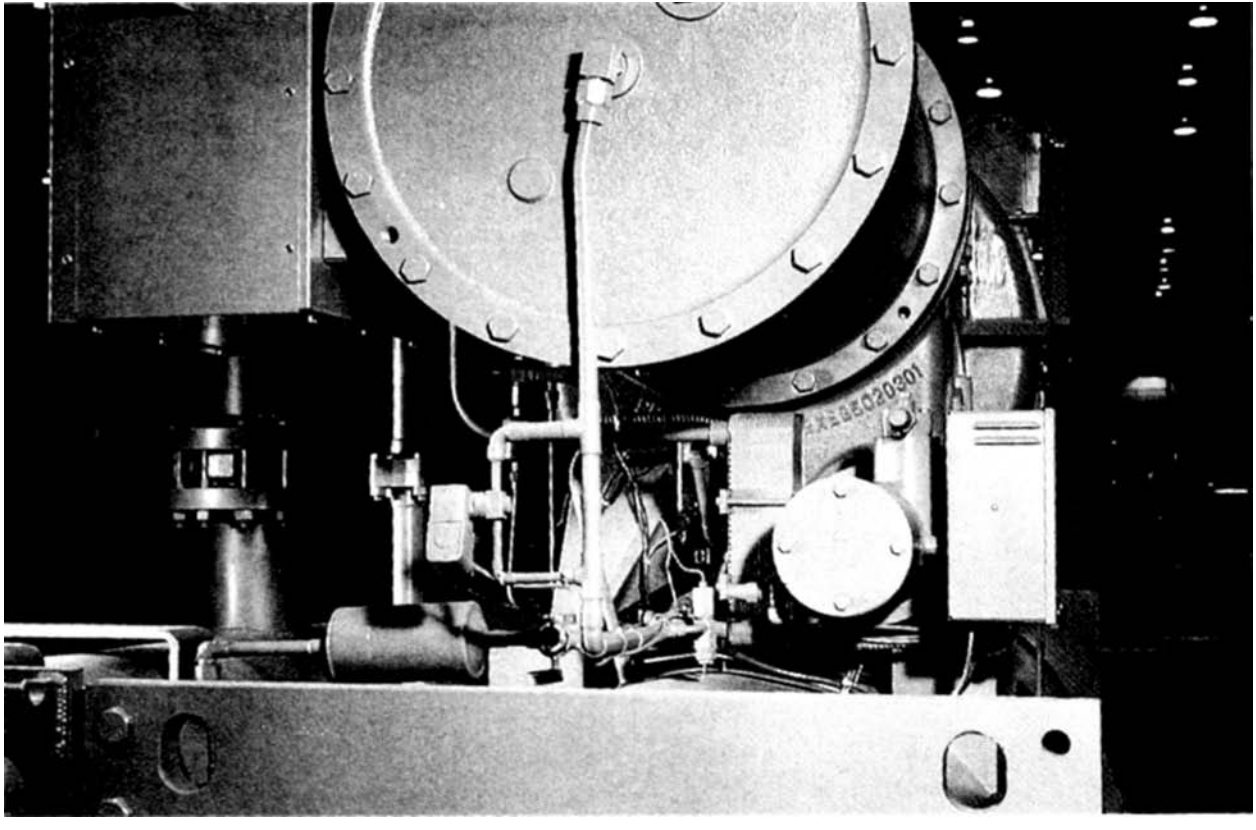
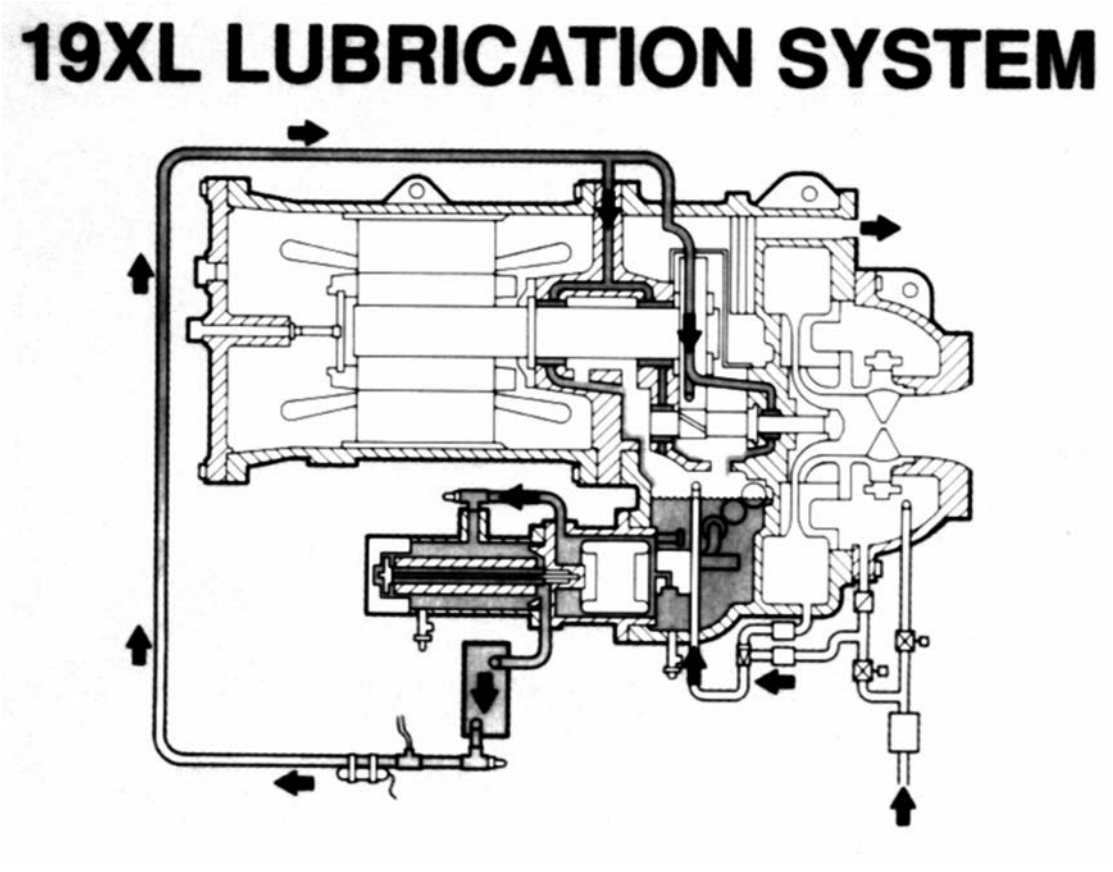


Figure 21 — Oil Pump



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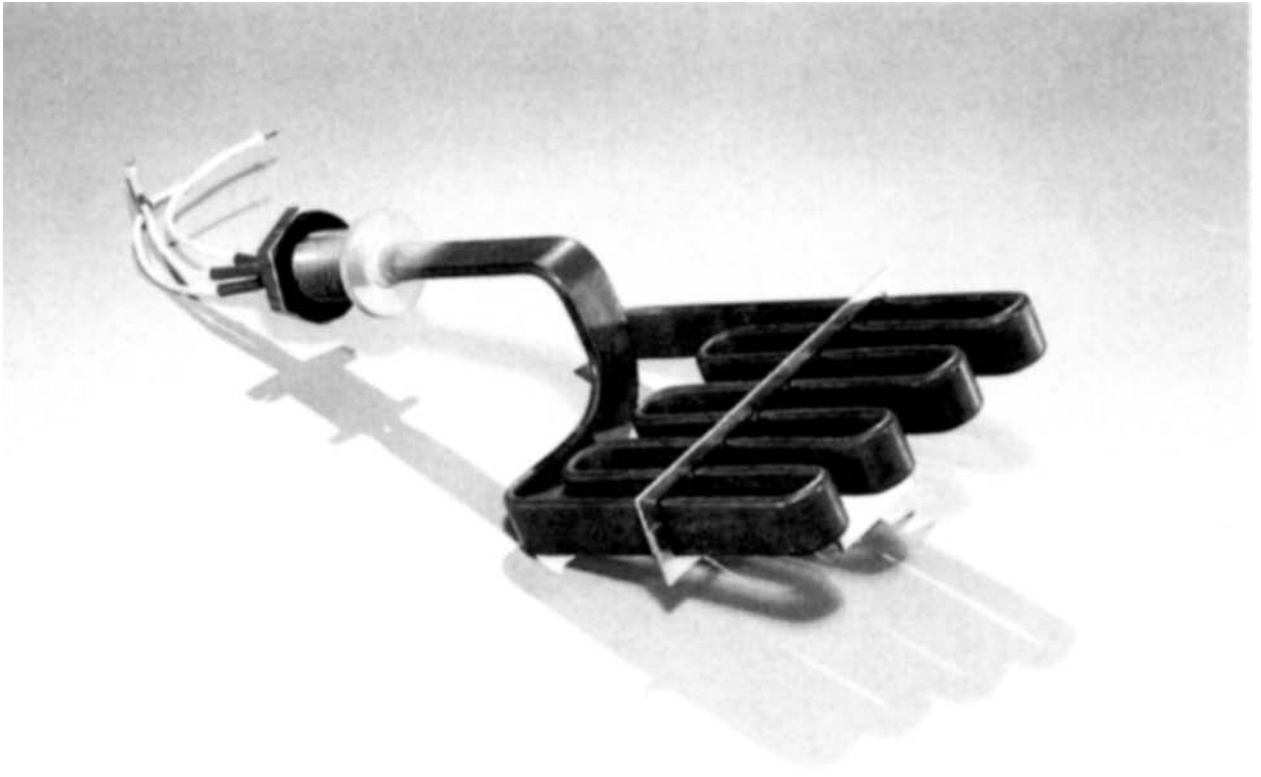

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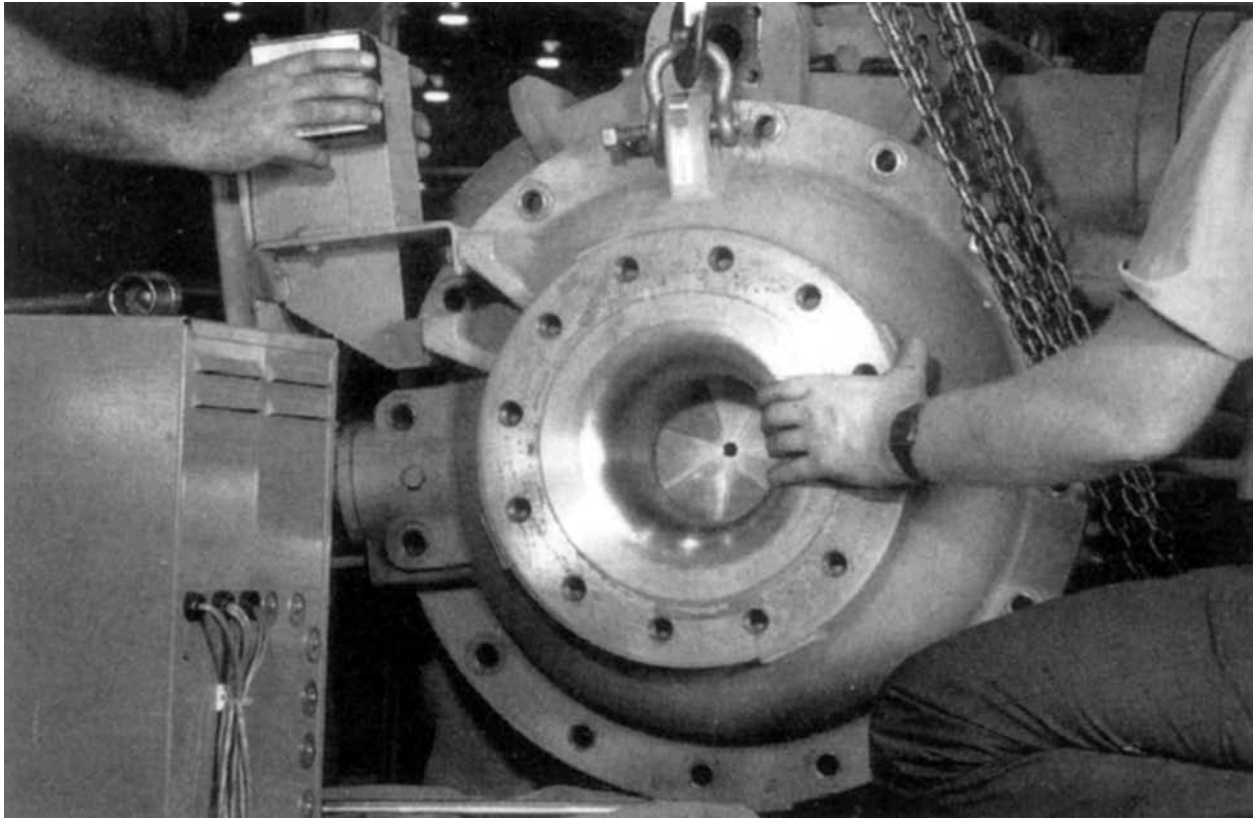

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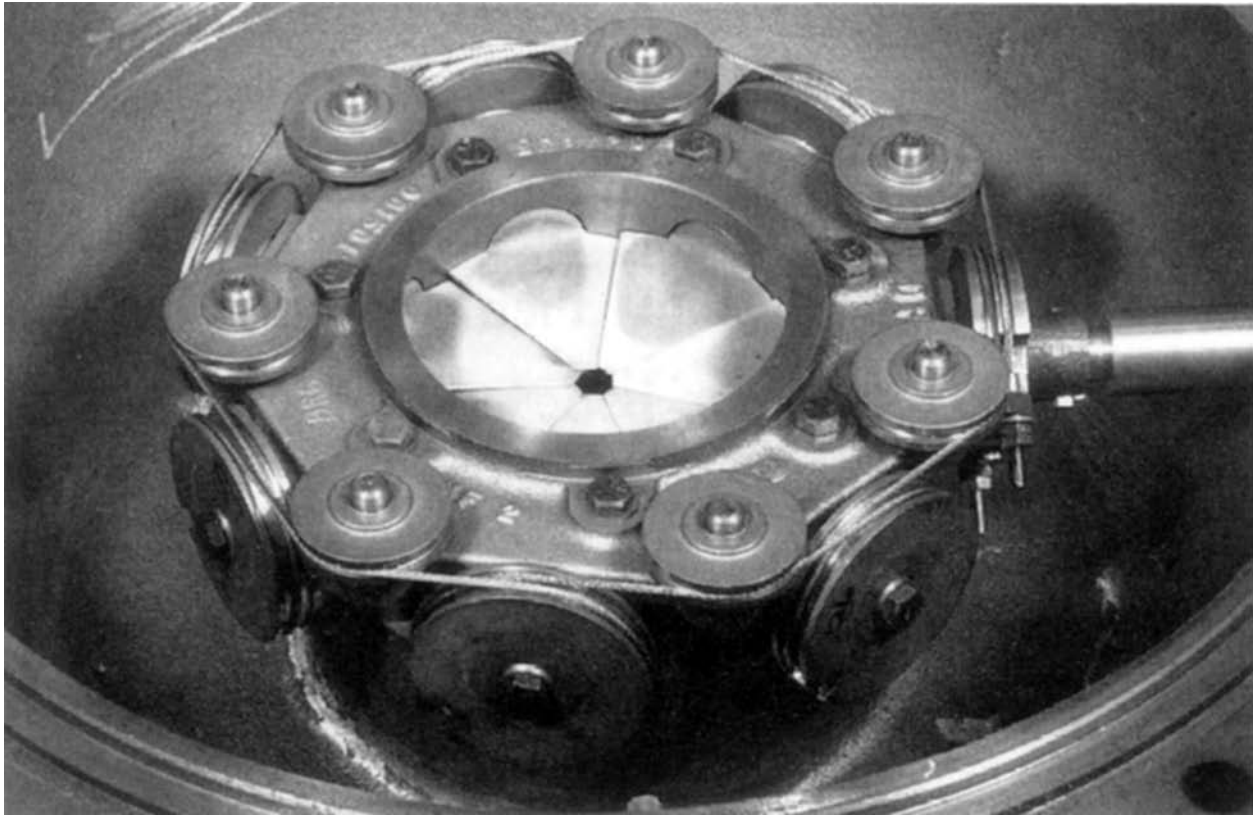

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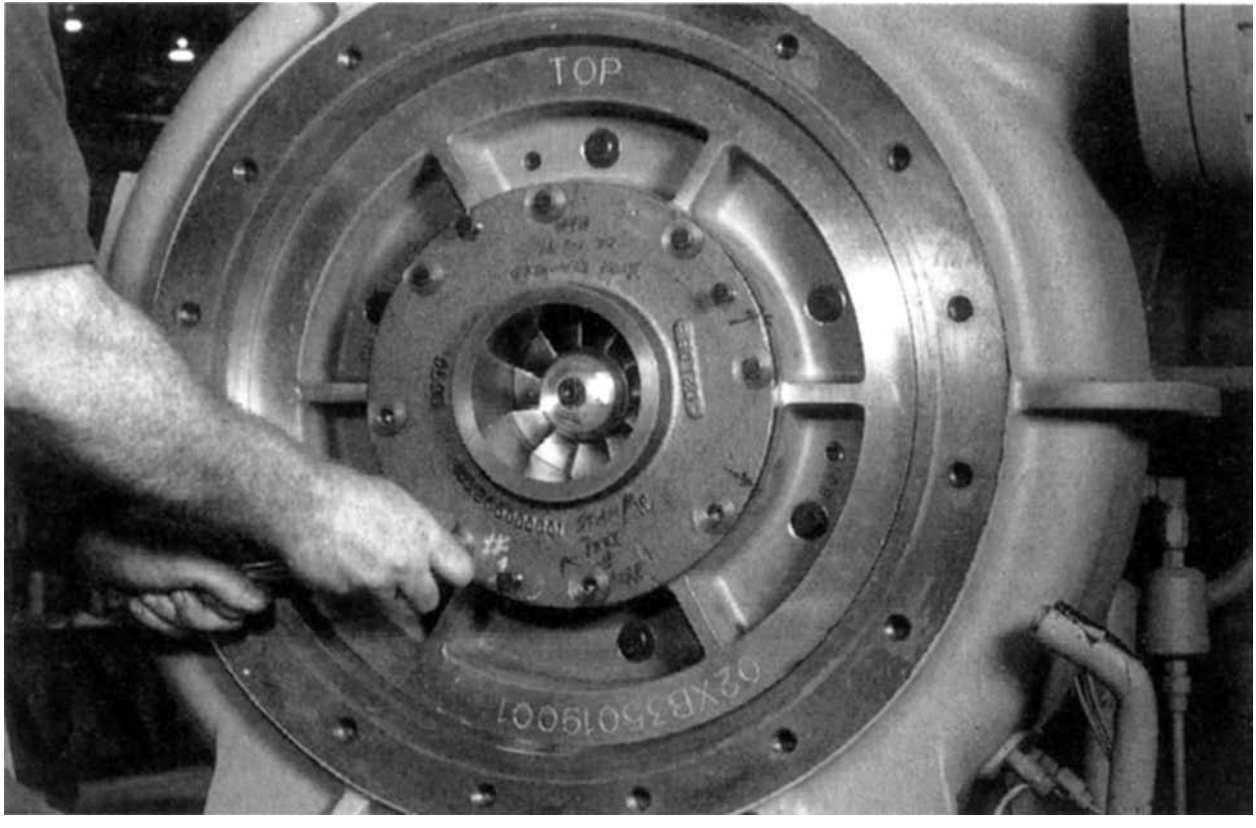

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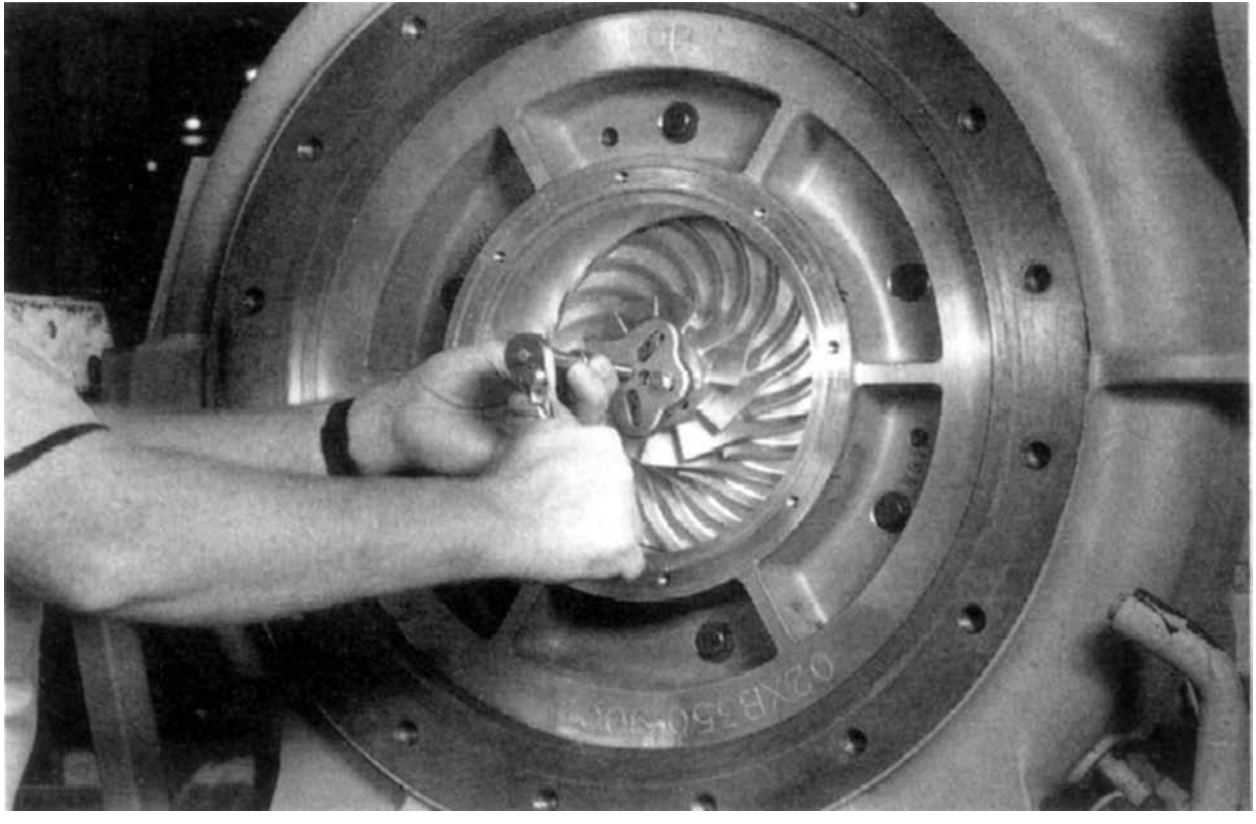

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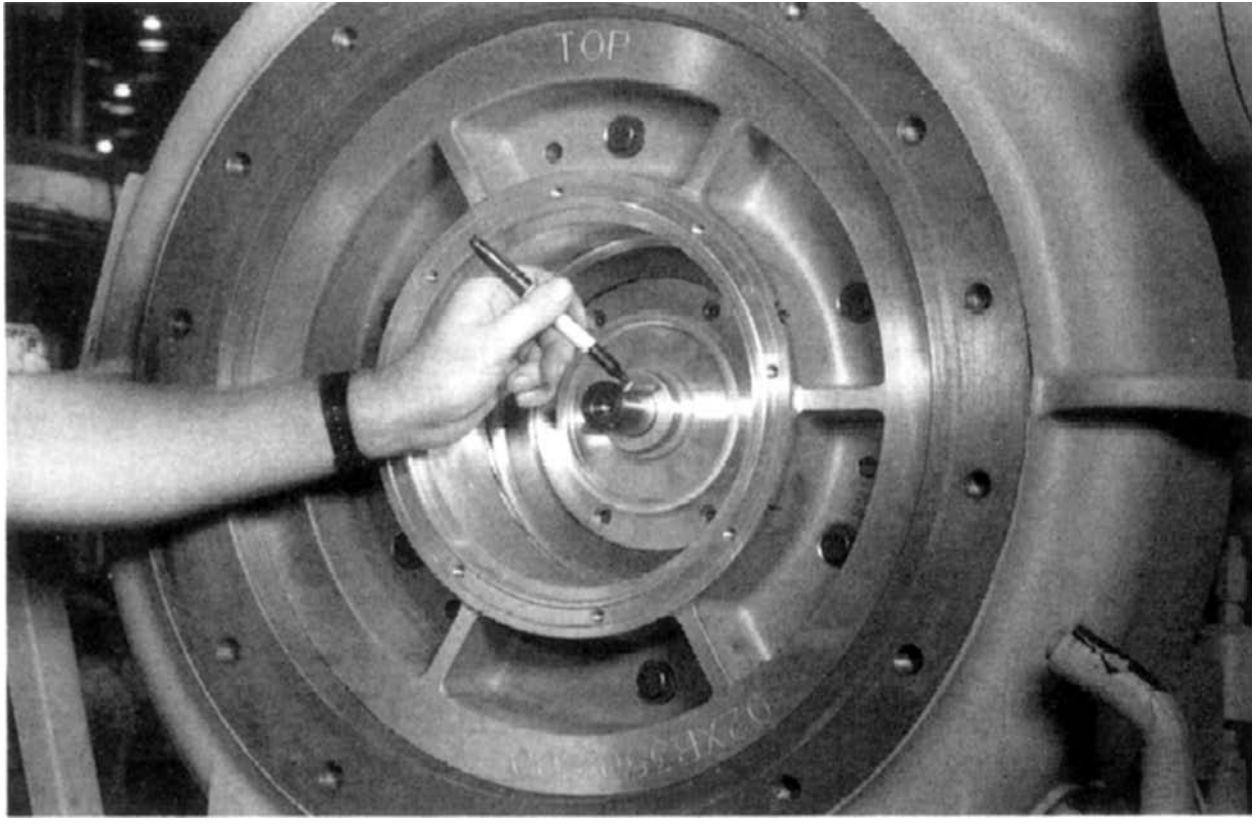

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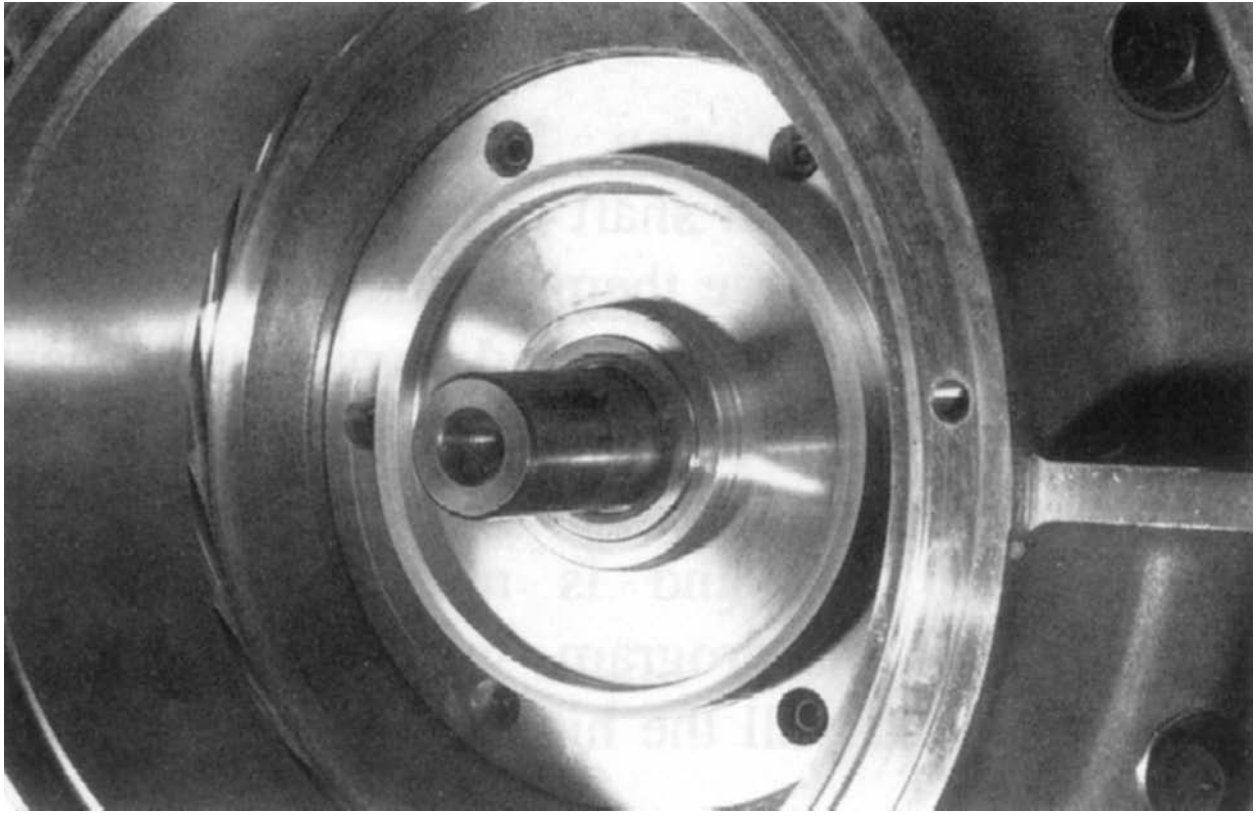

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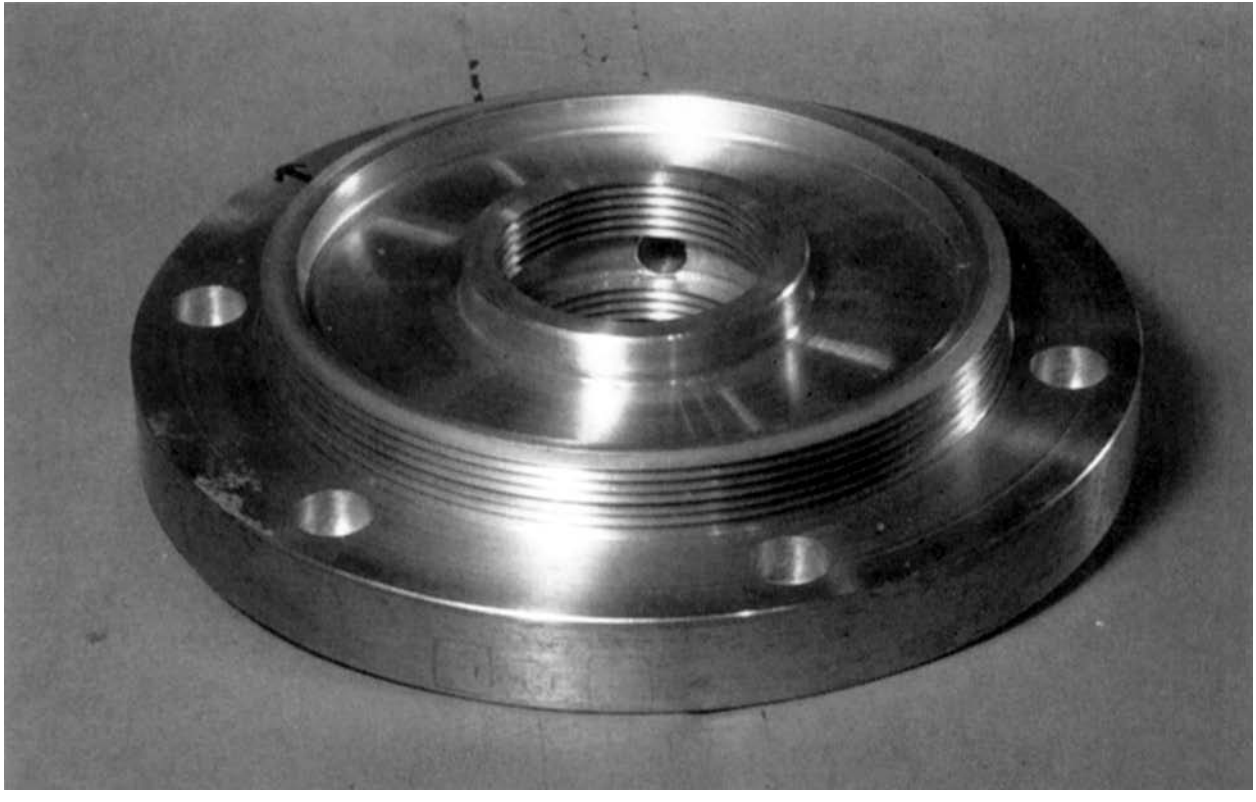

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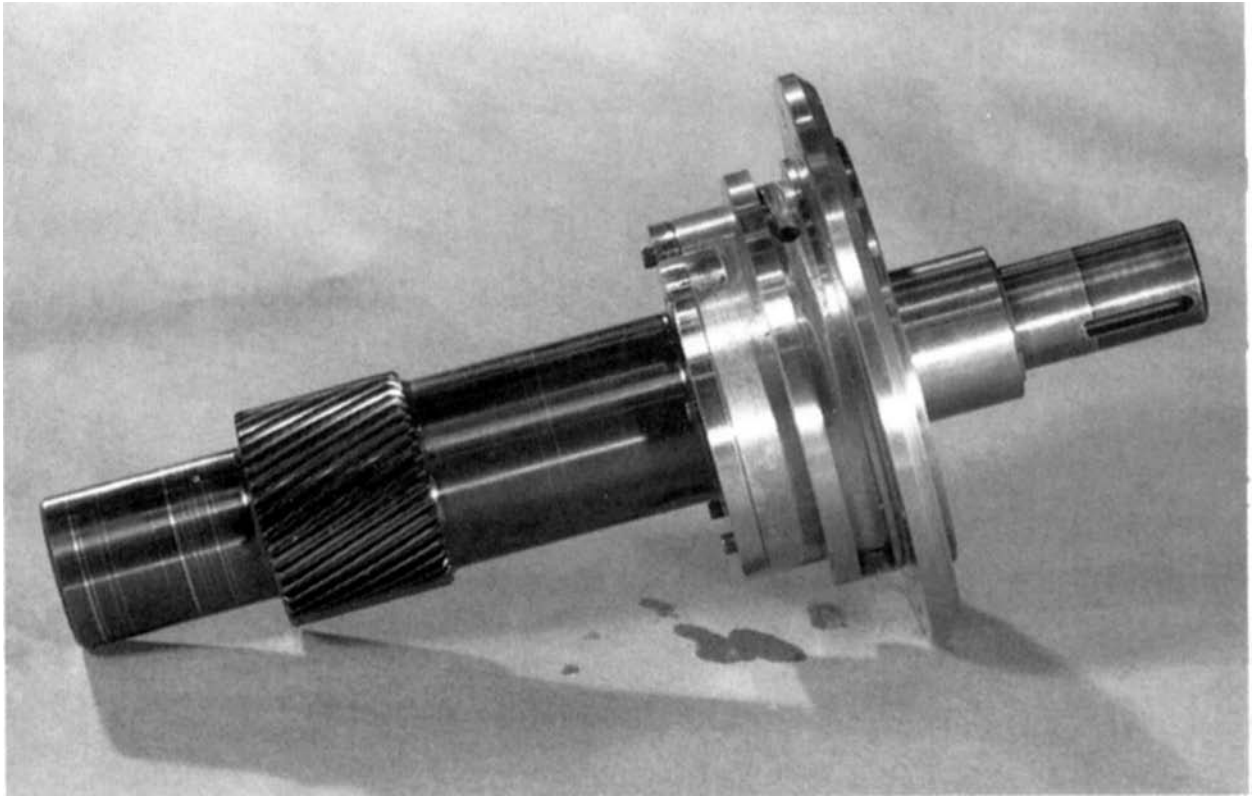

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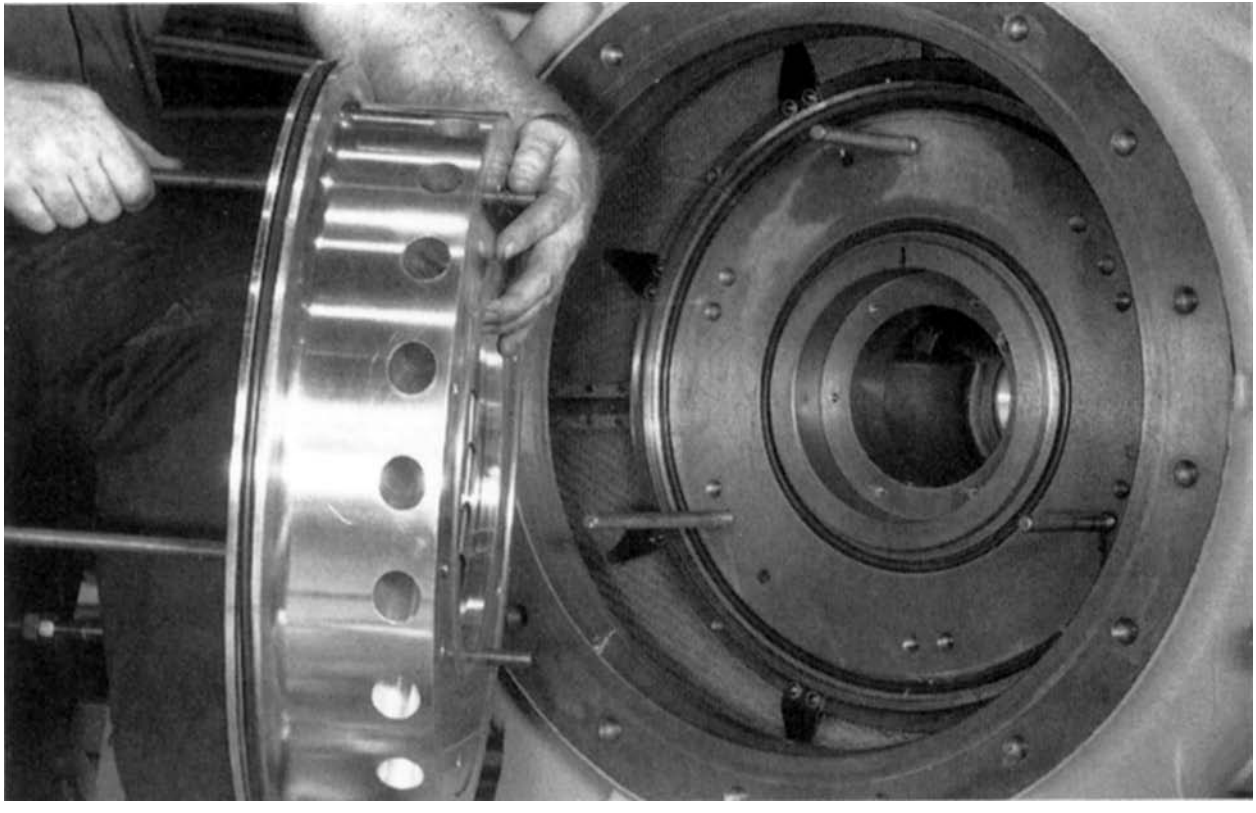

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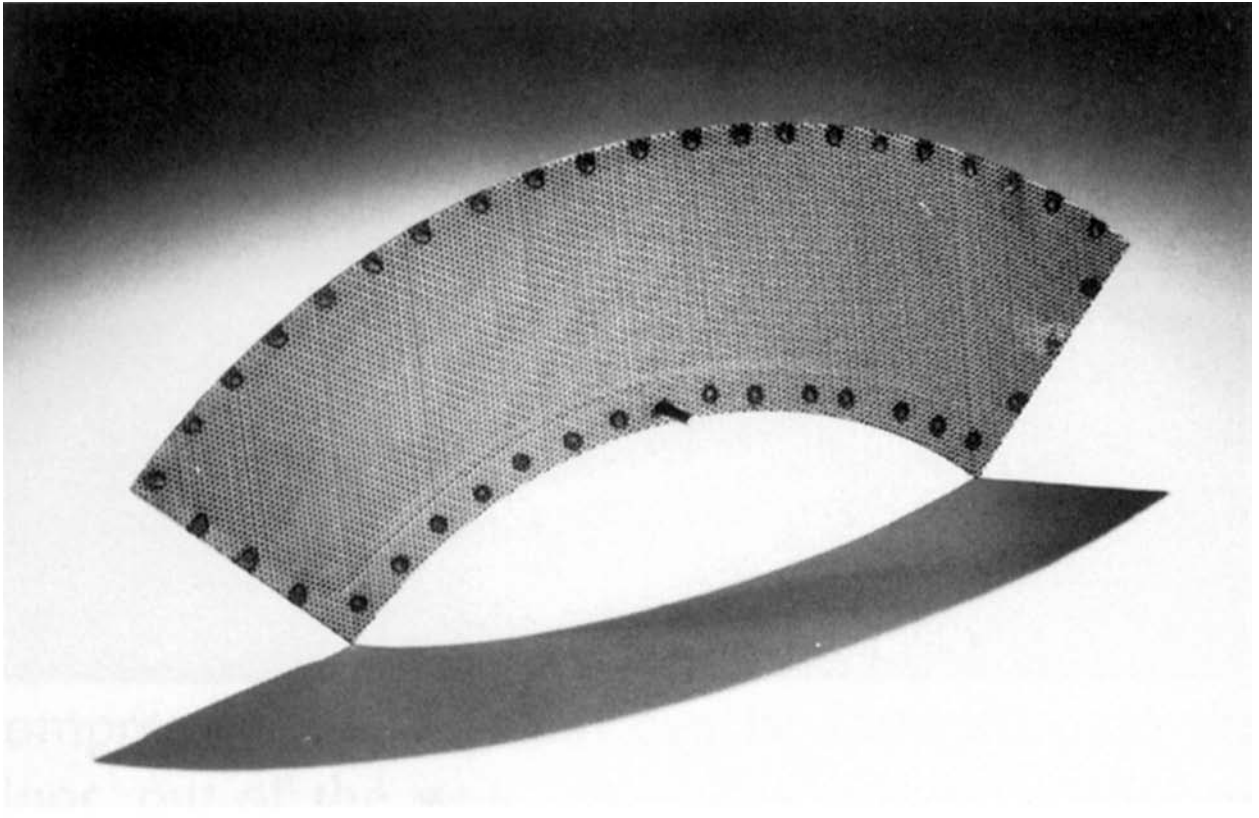

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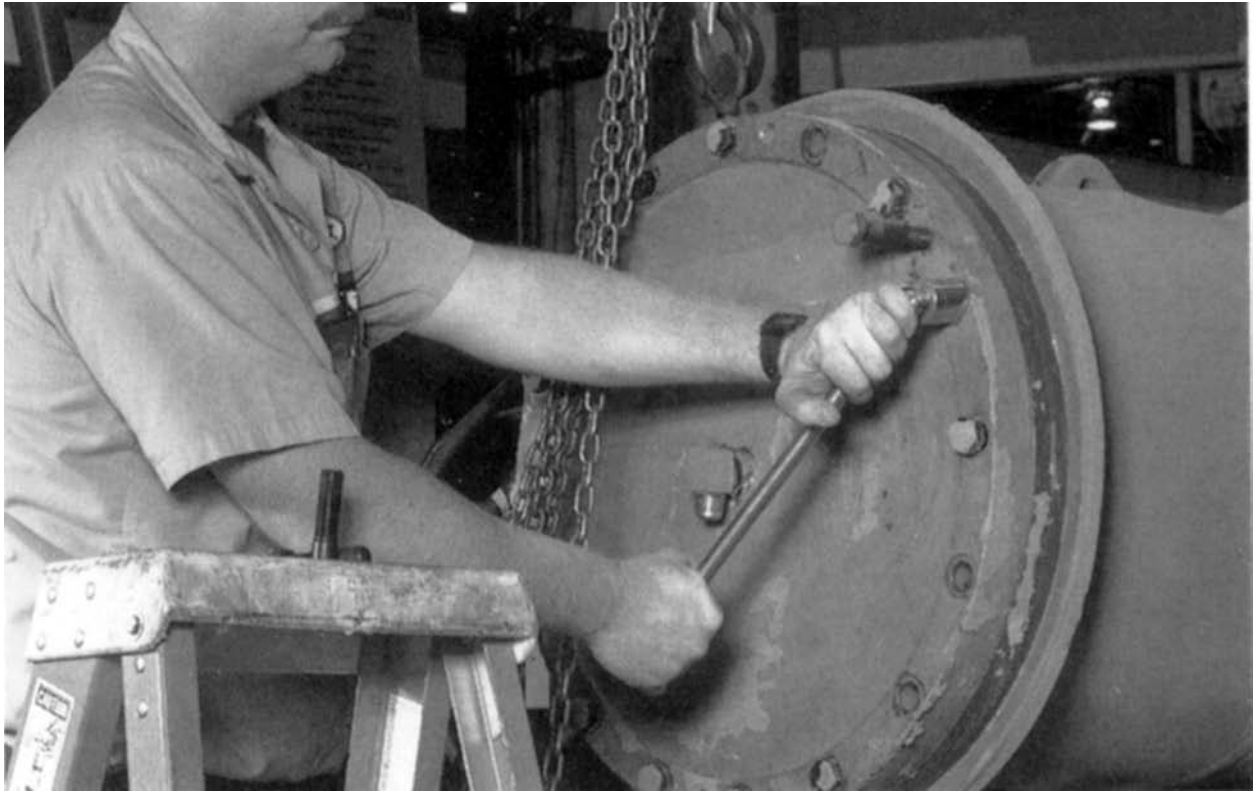

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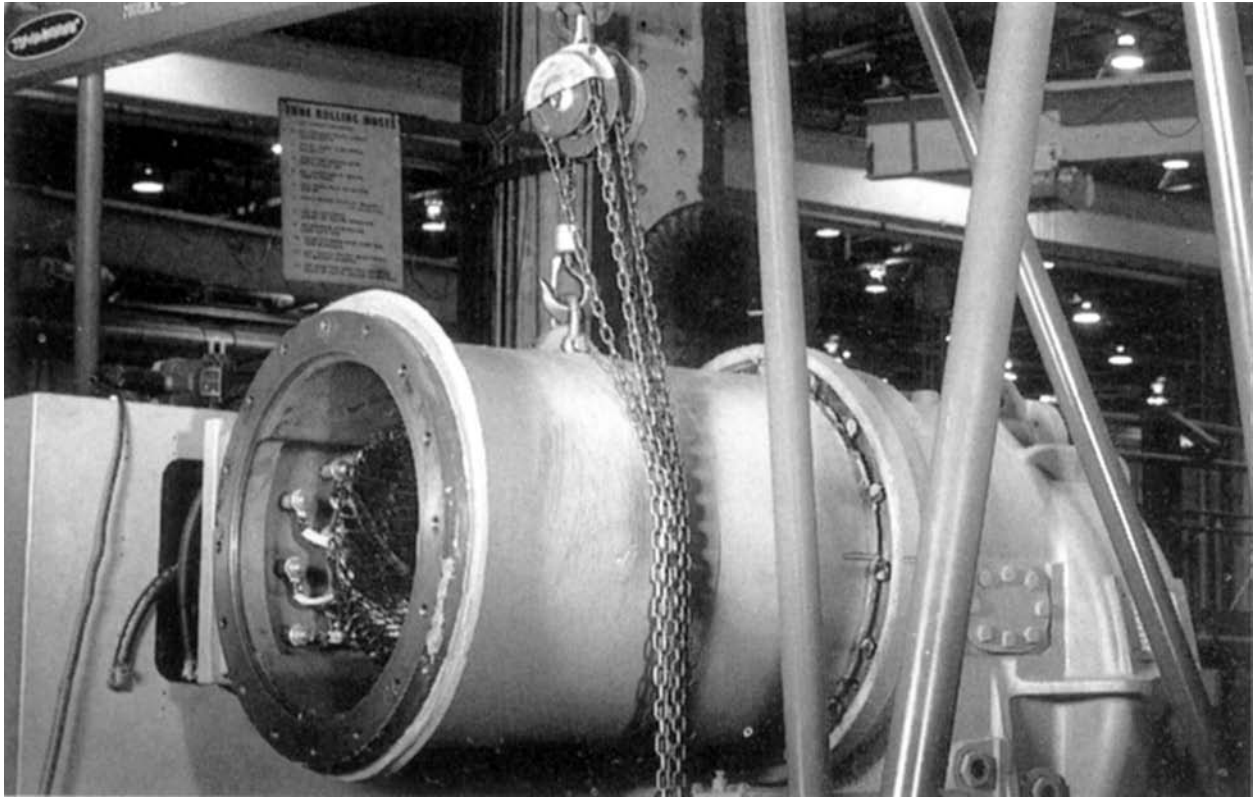

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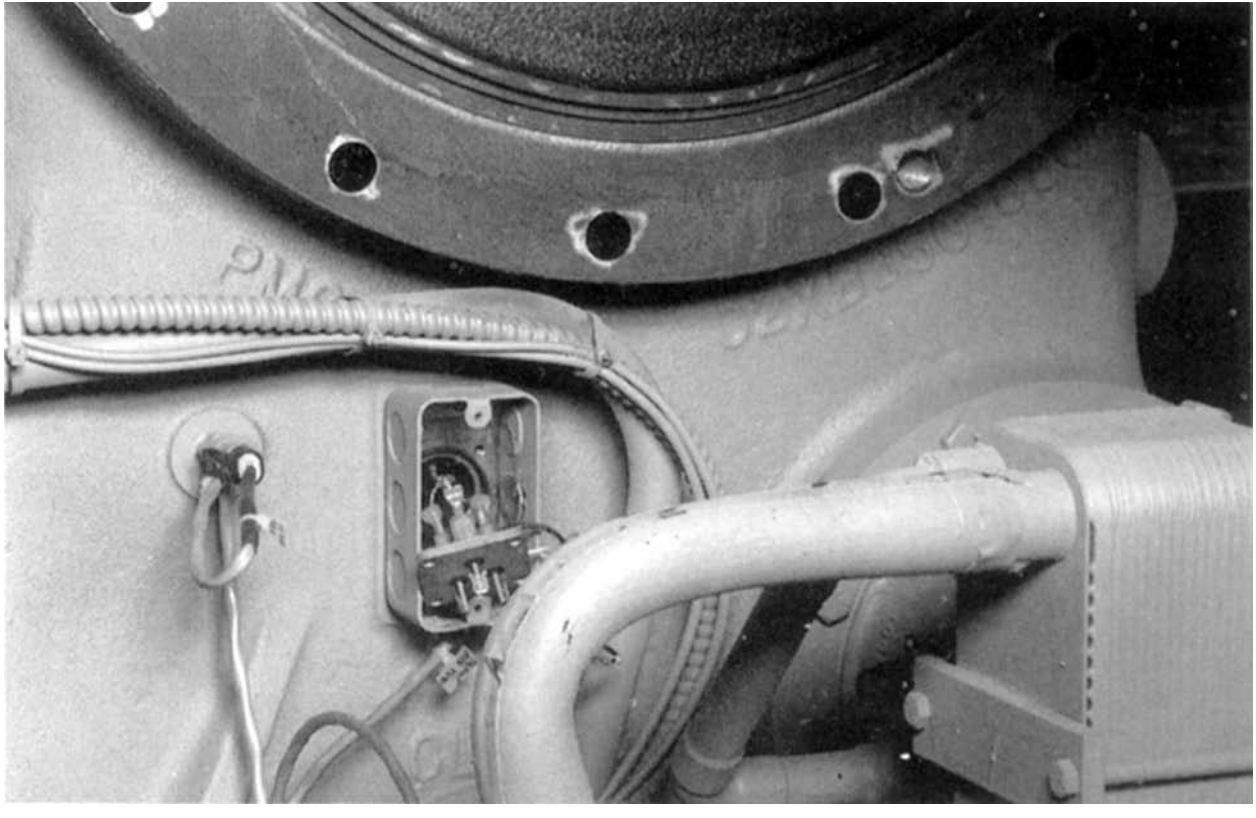

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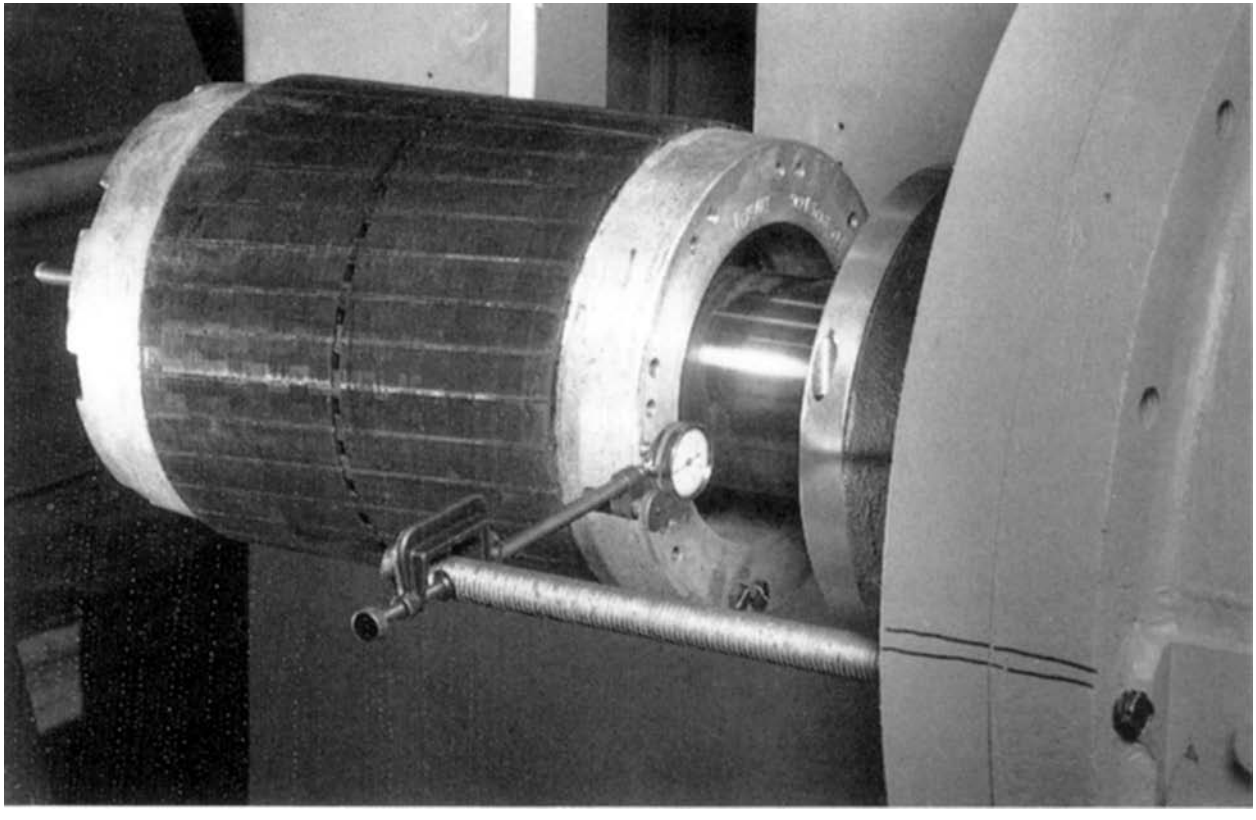

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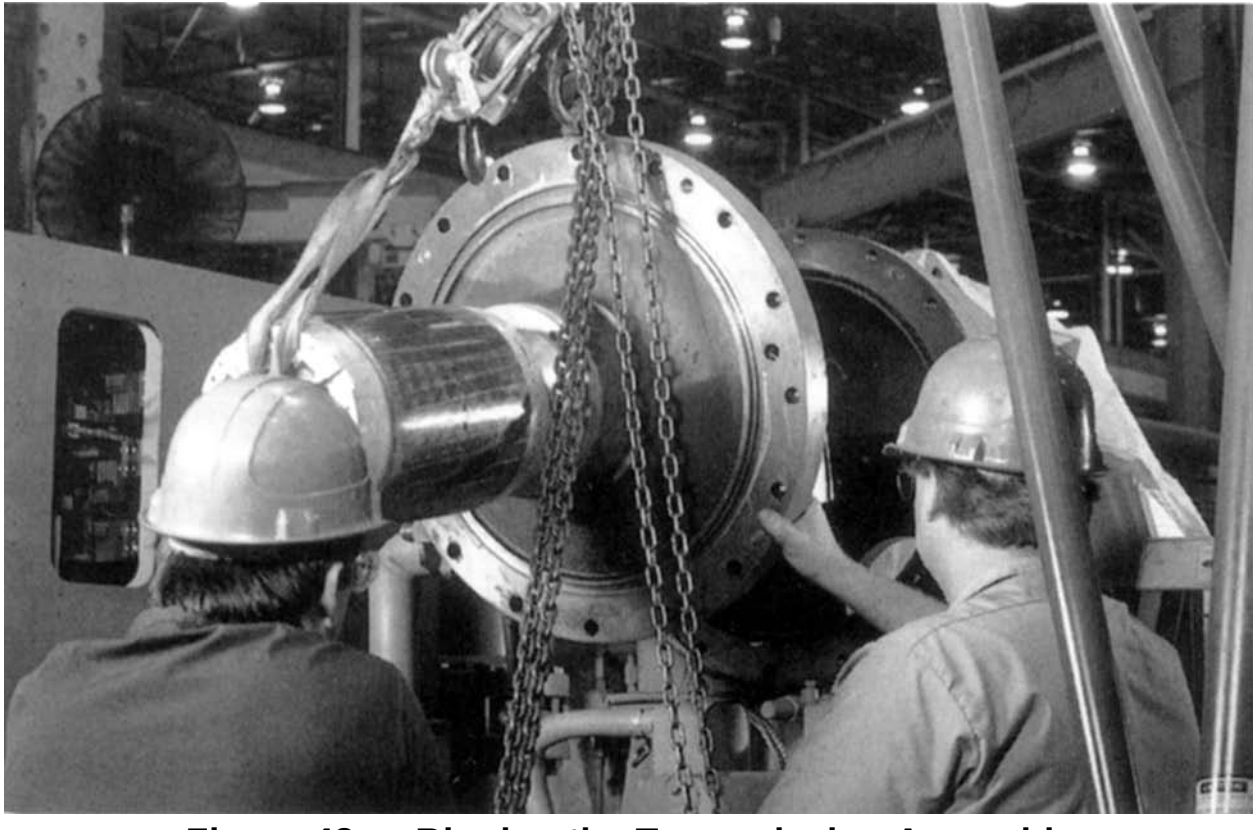

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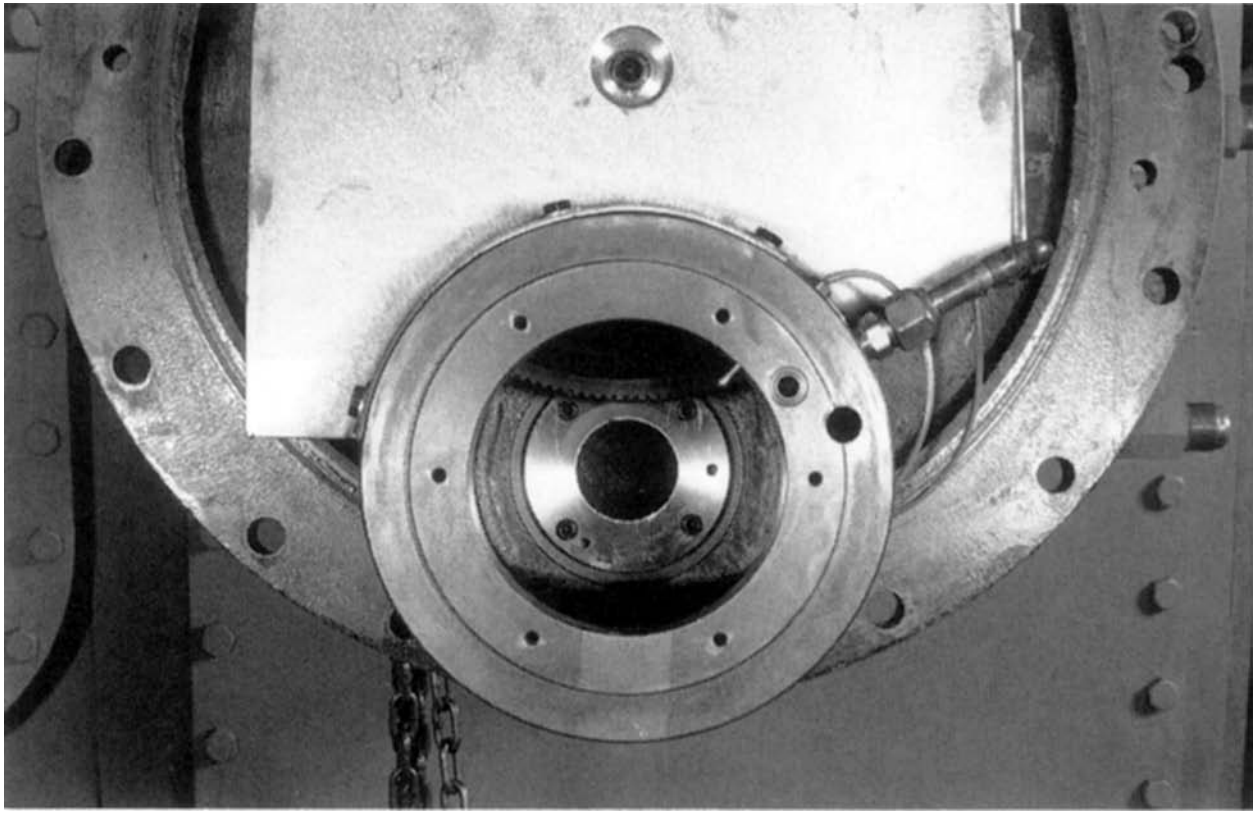

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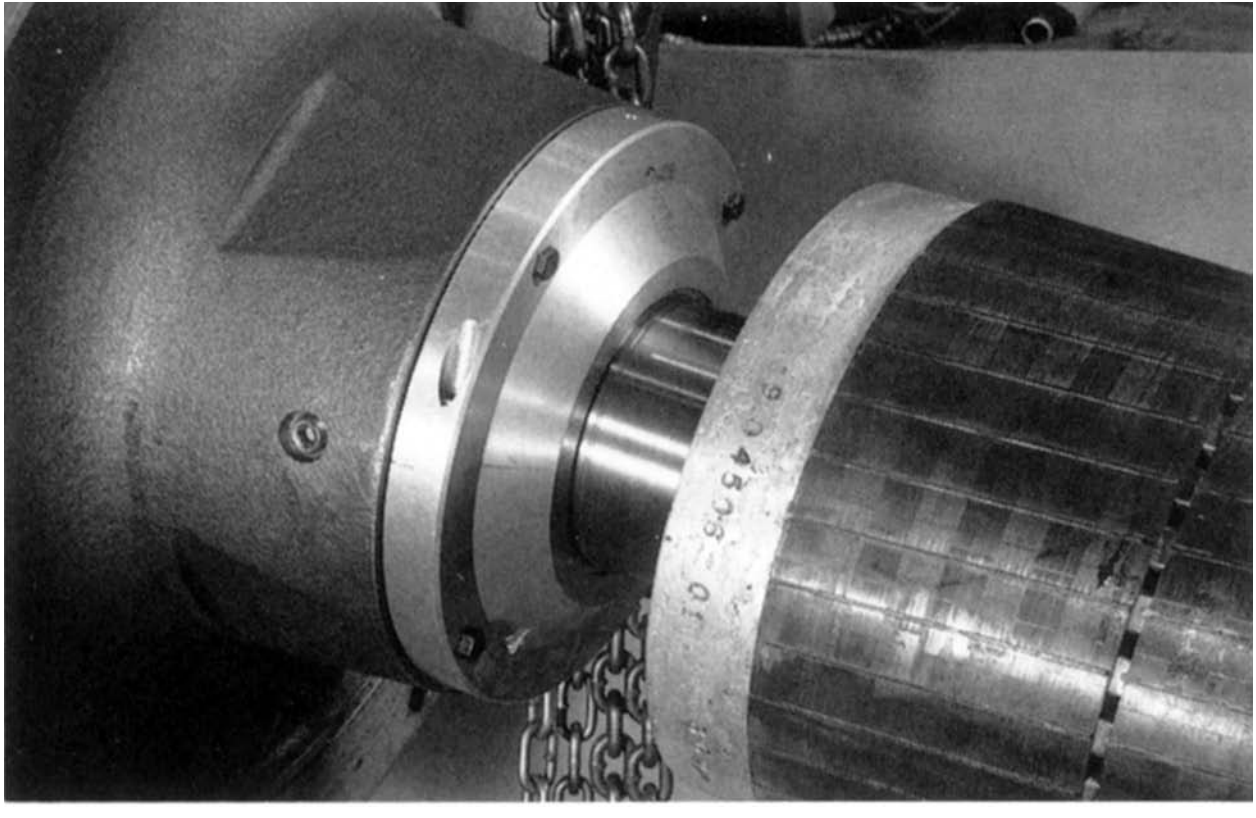

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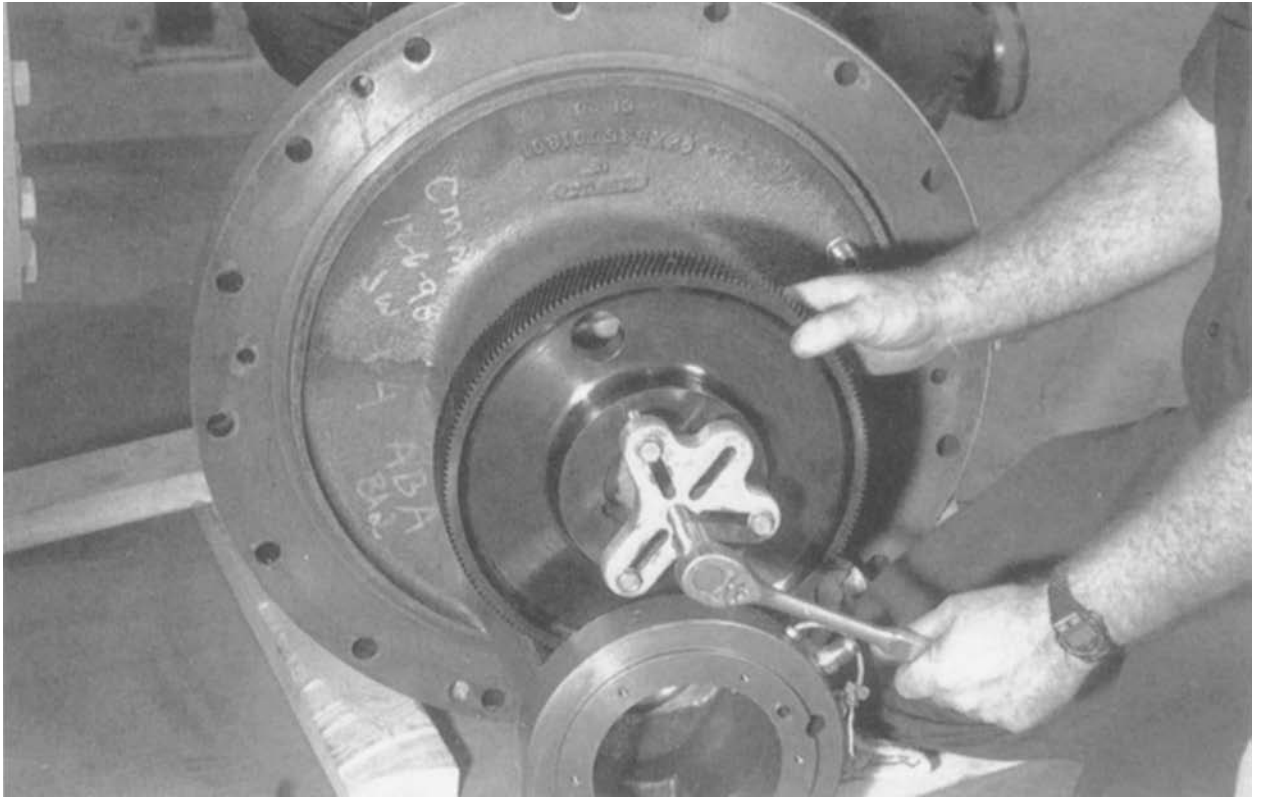

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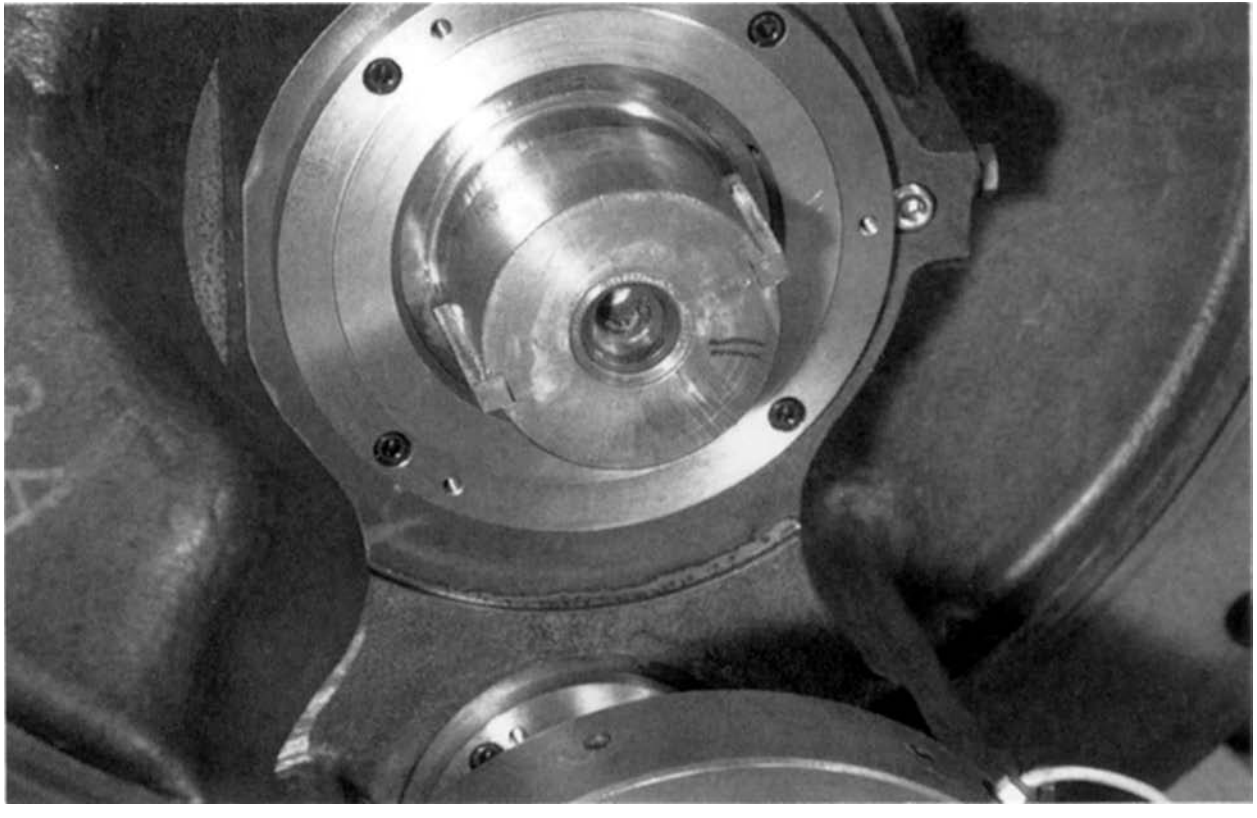

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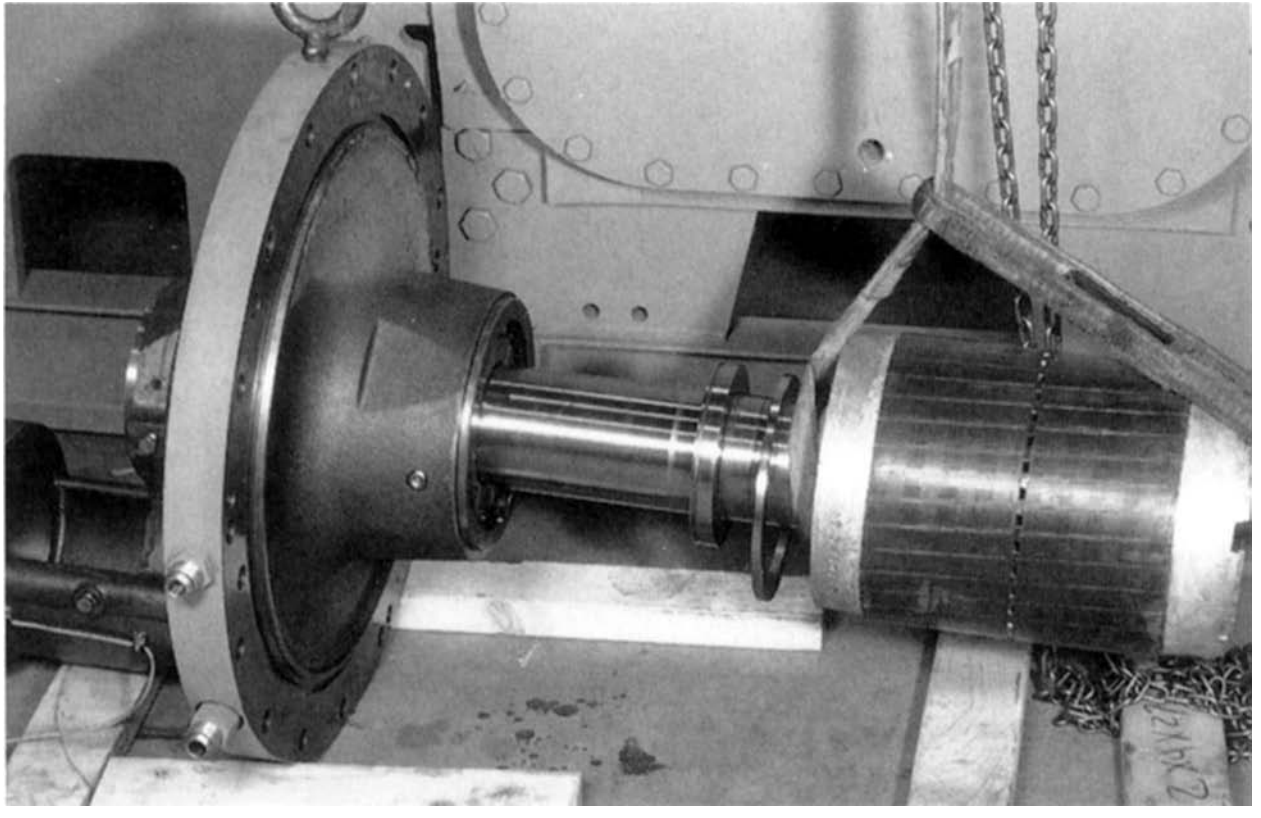

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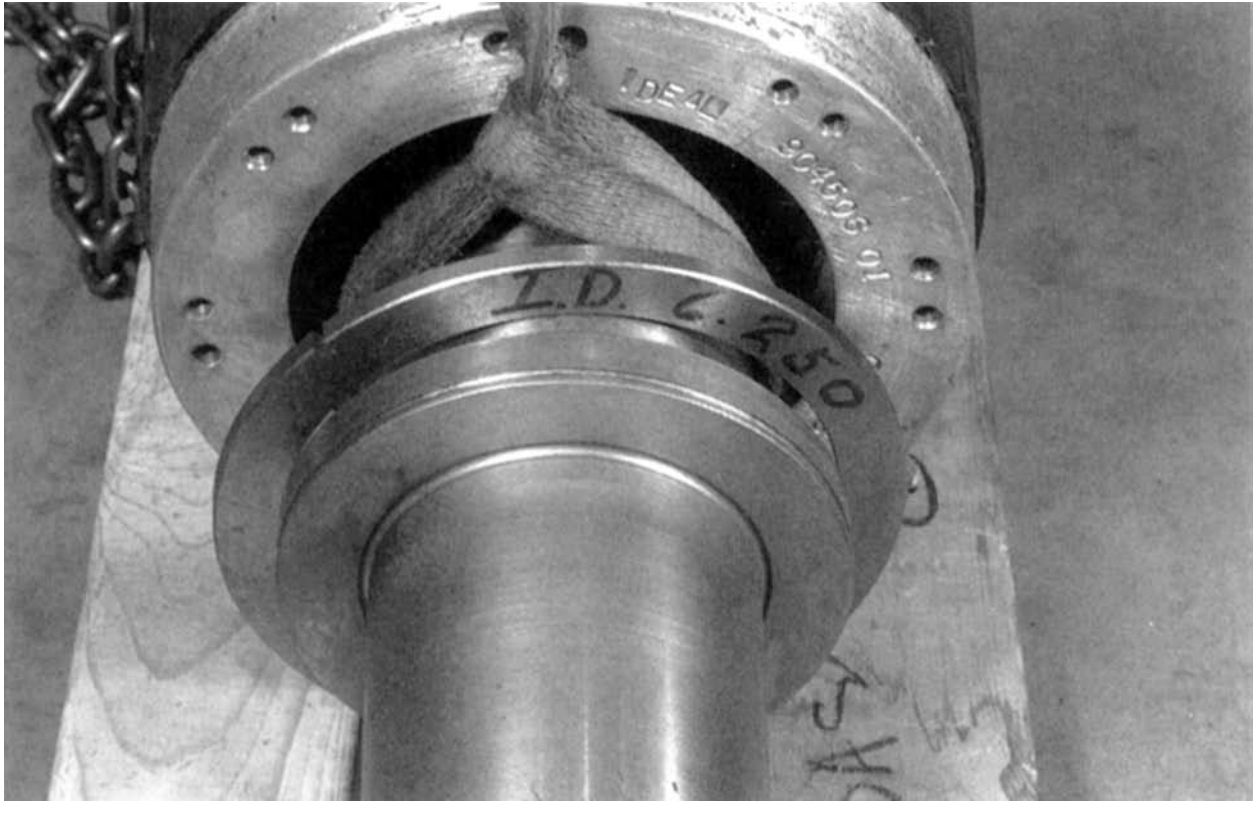

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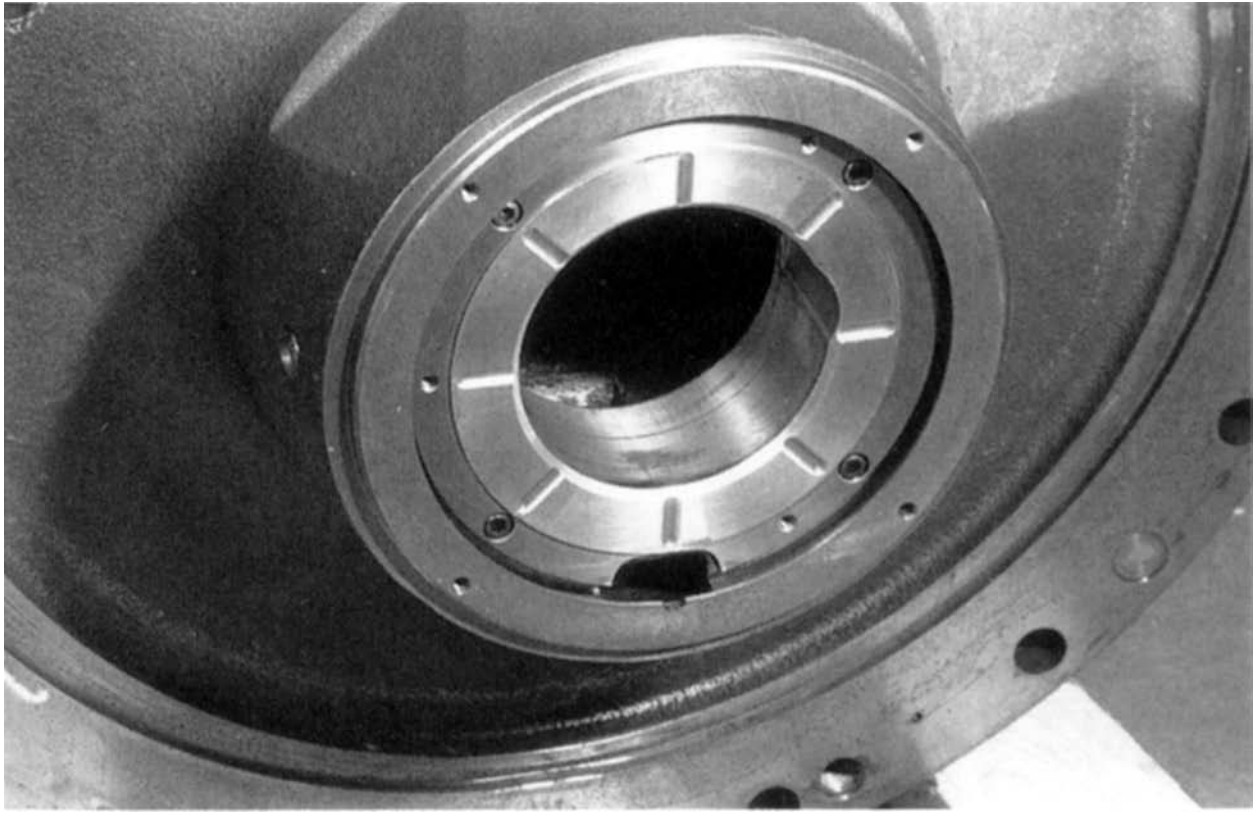

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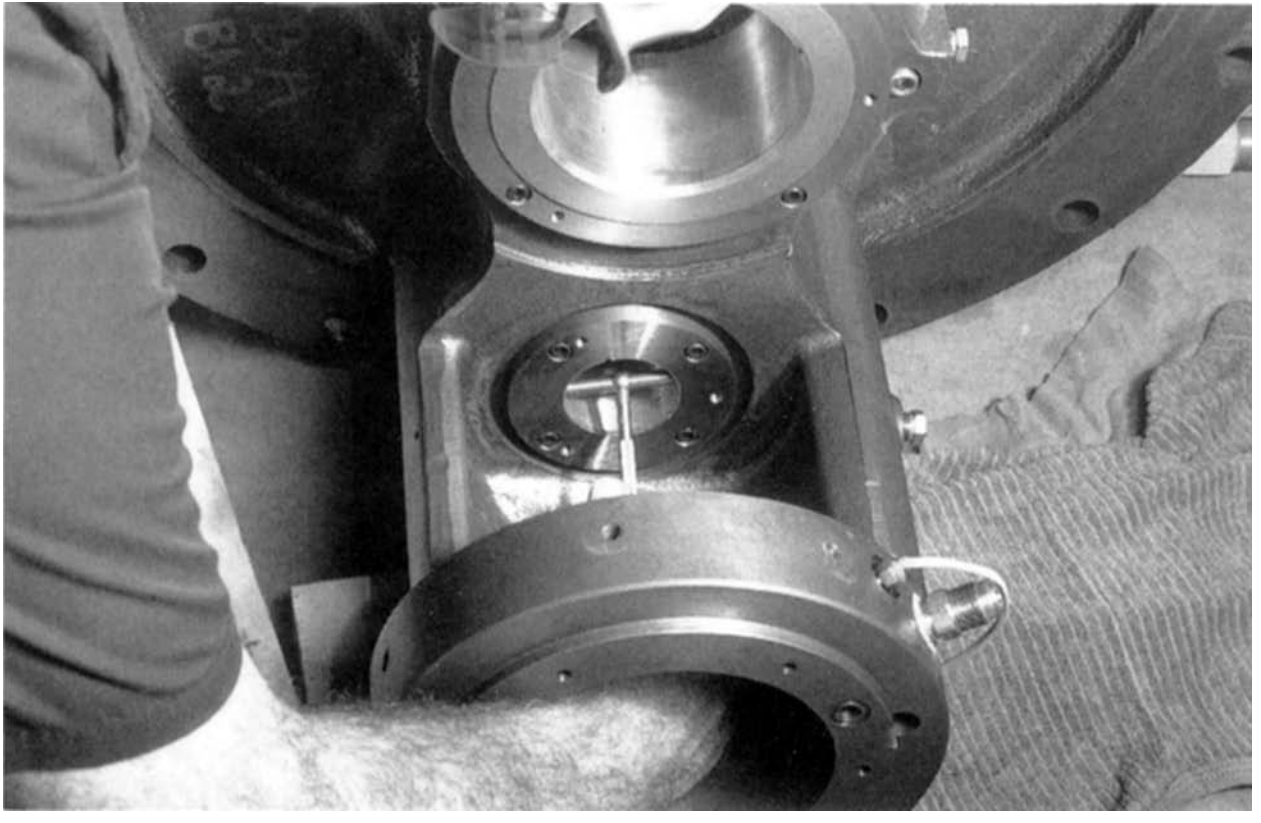

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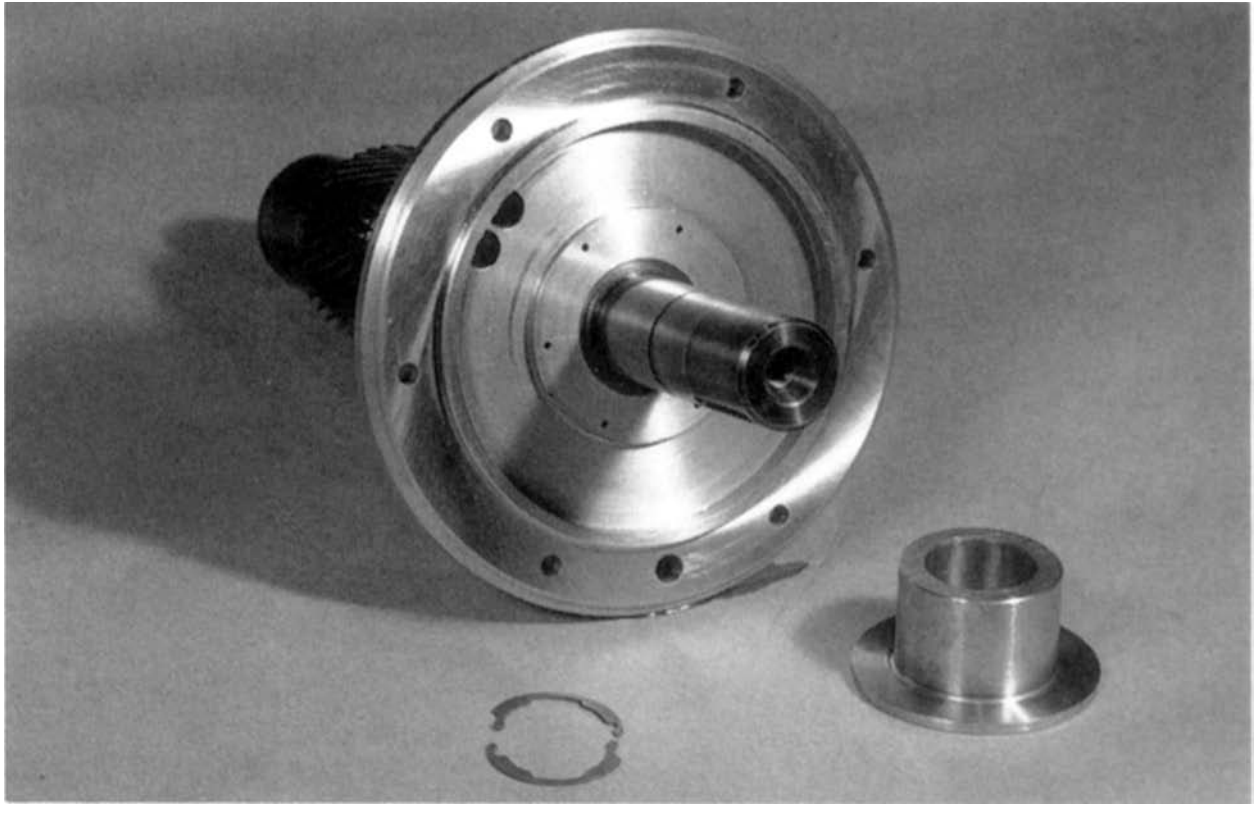

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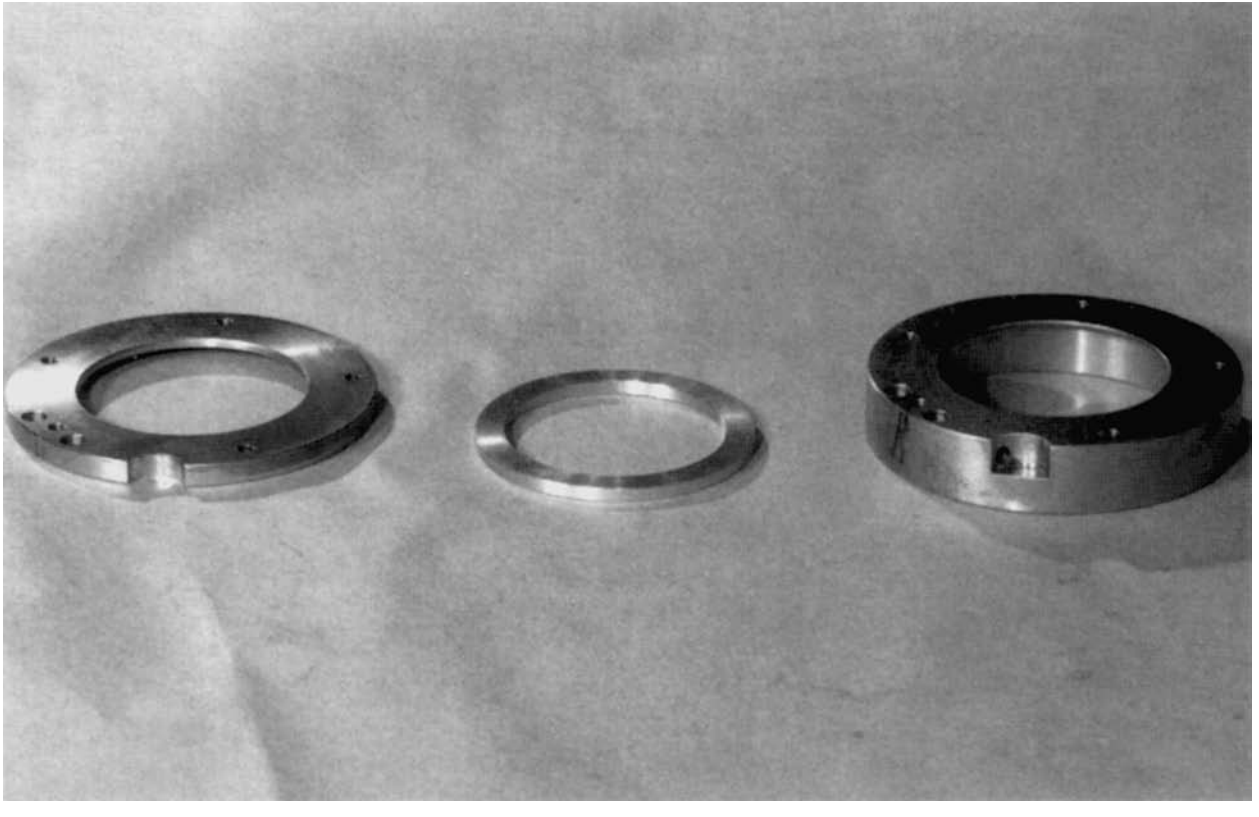

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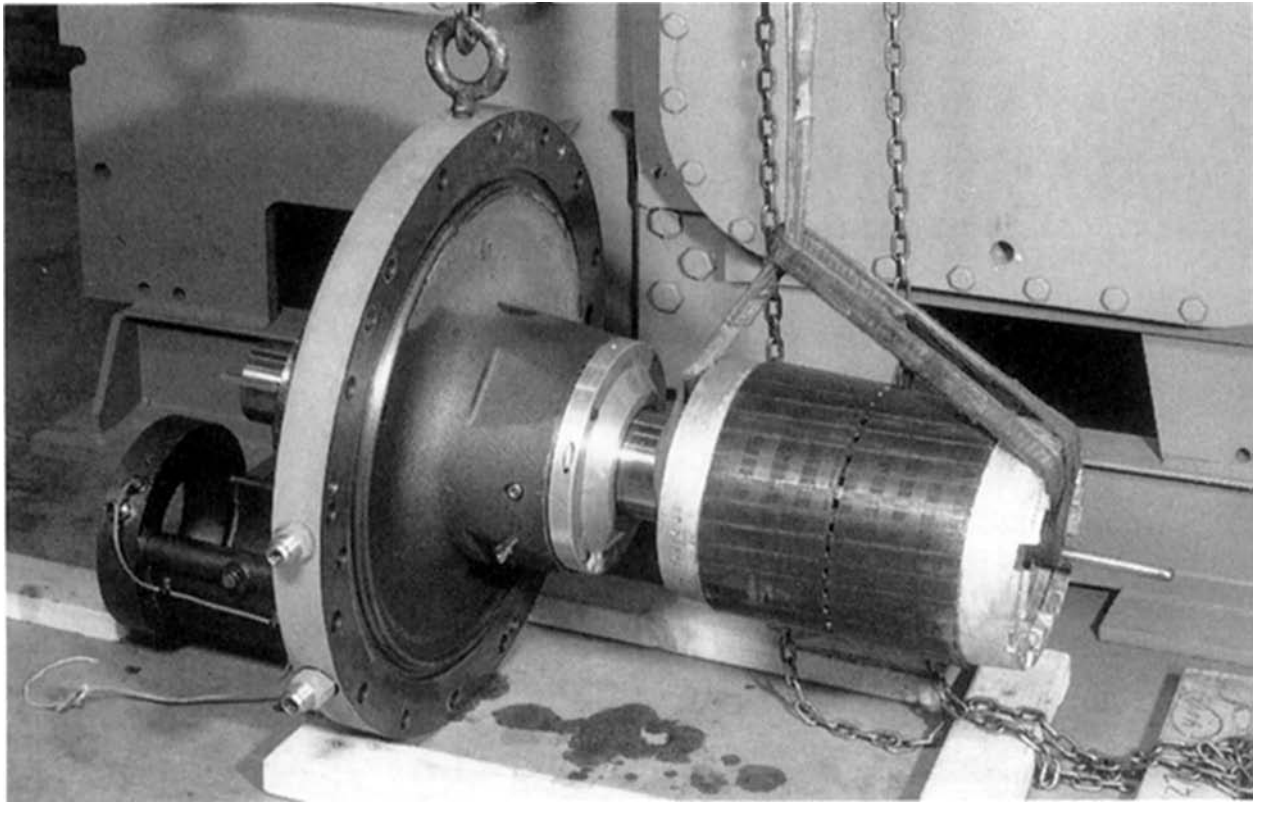

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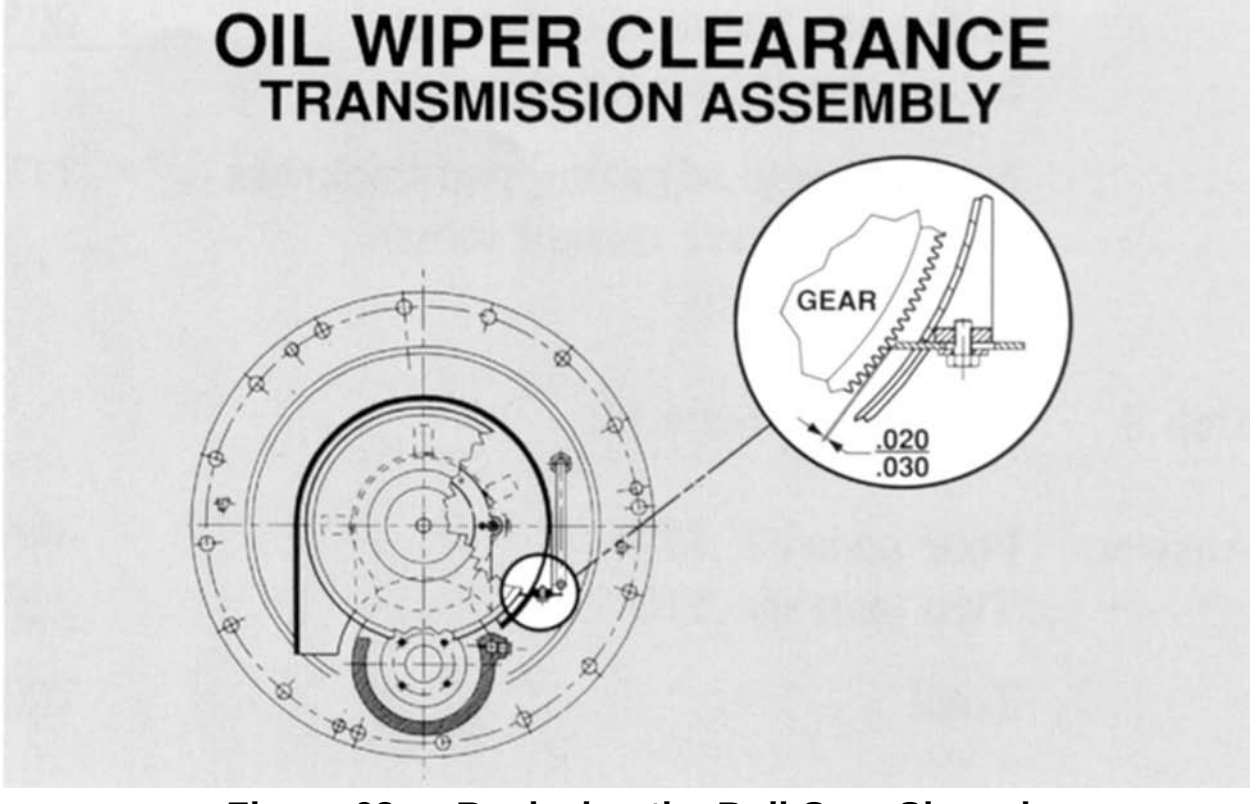

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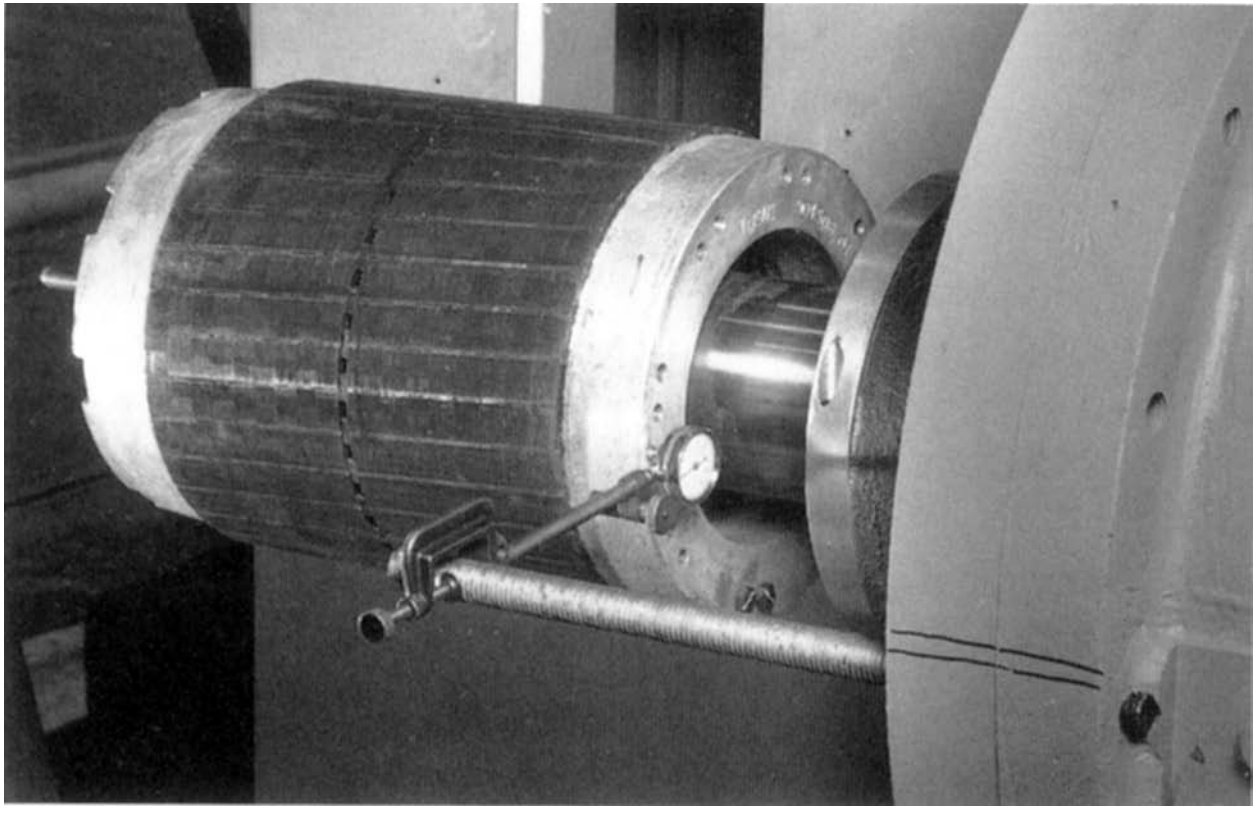

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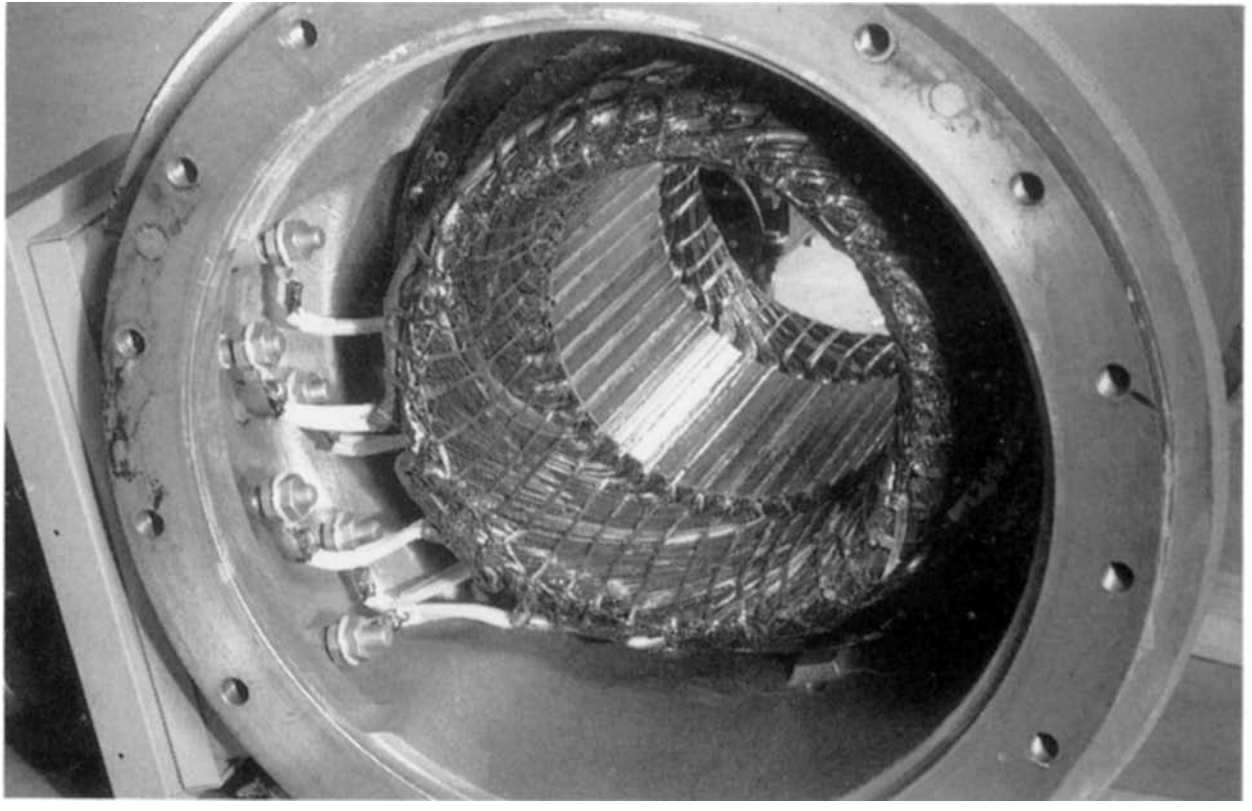

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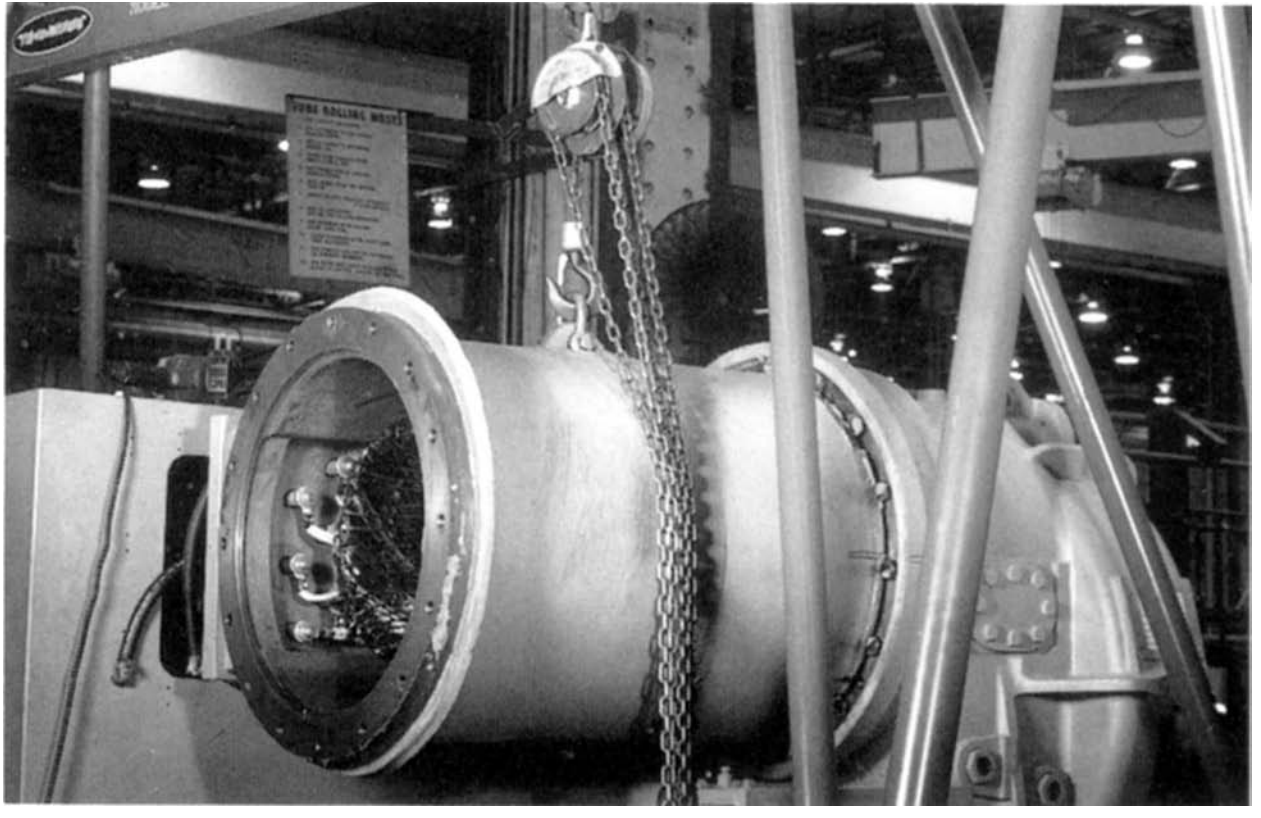

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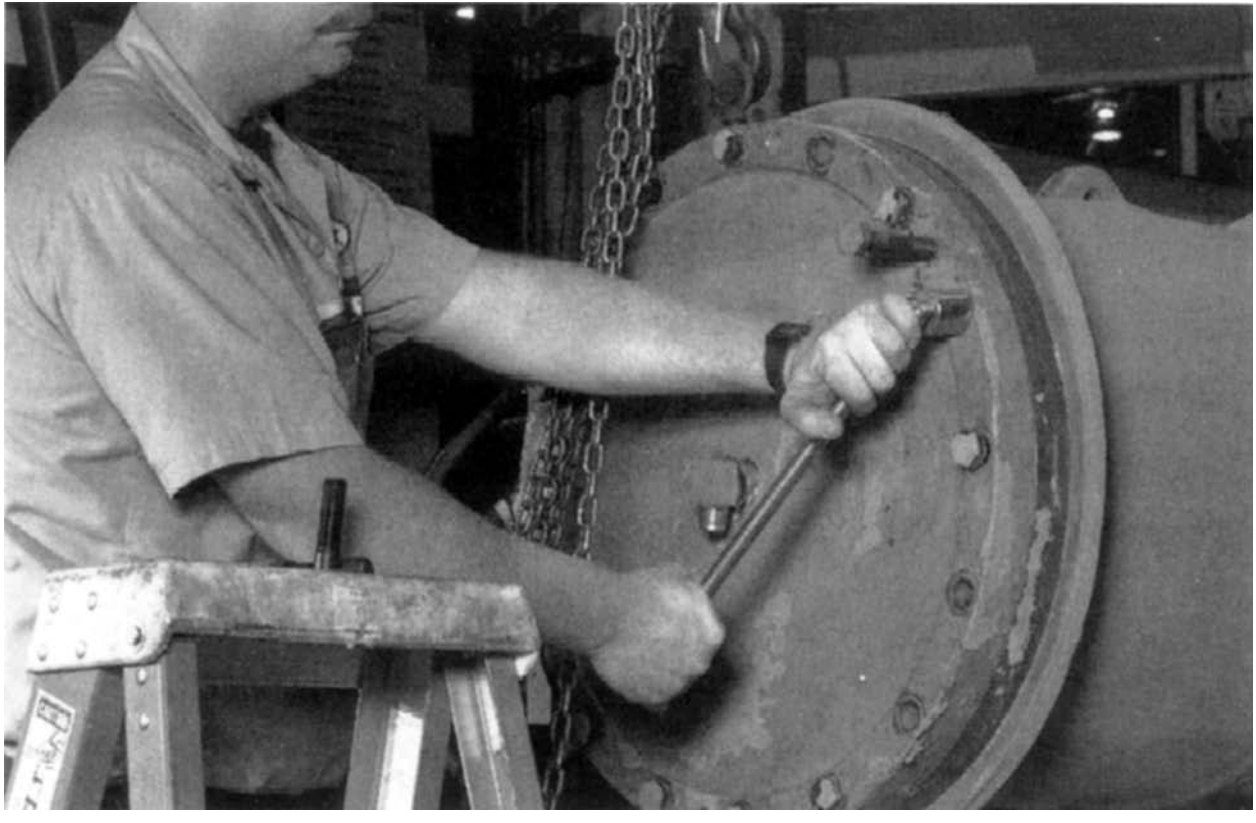

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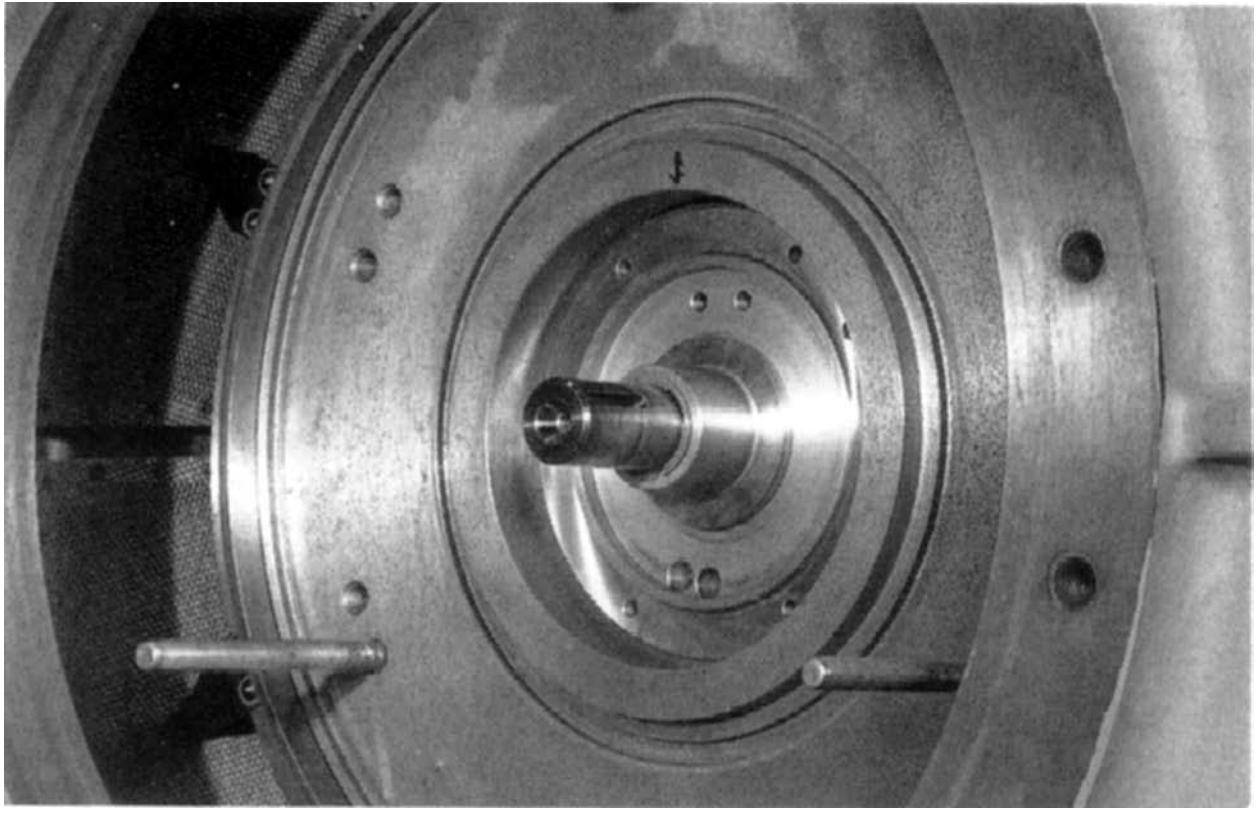

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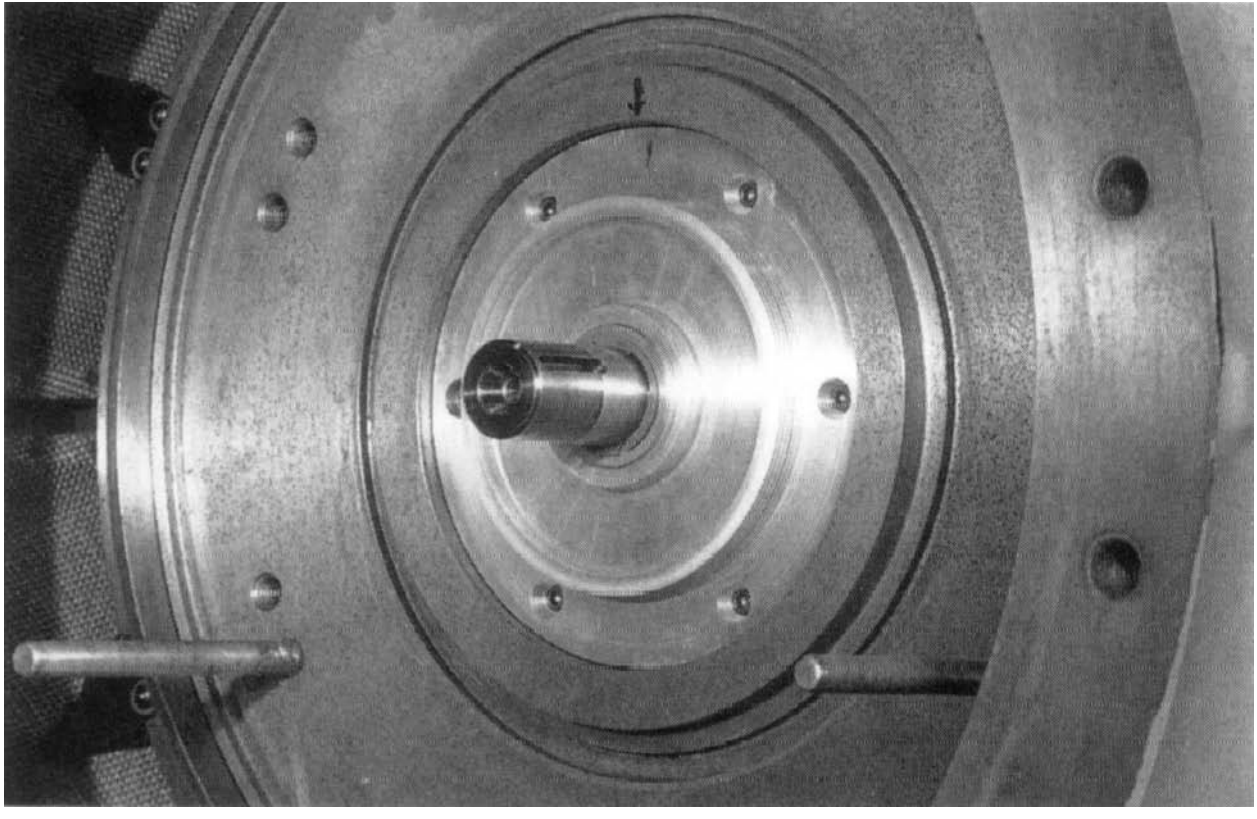

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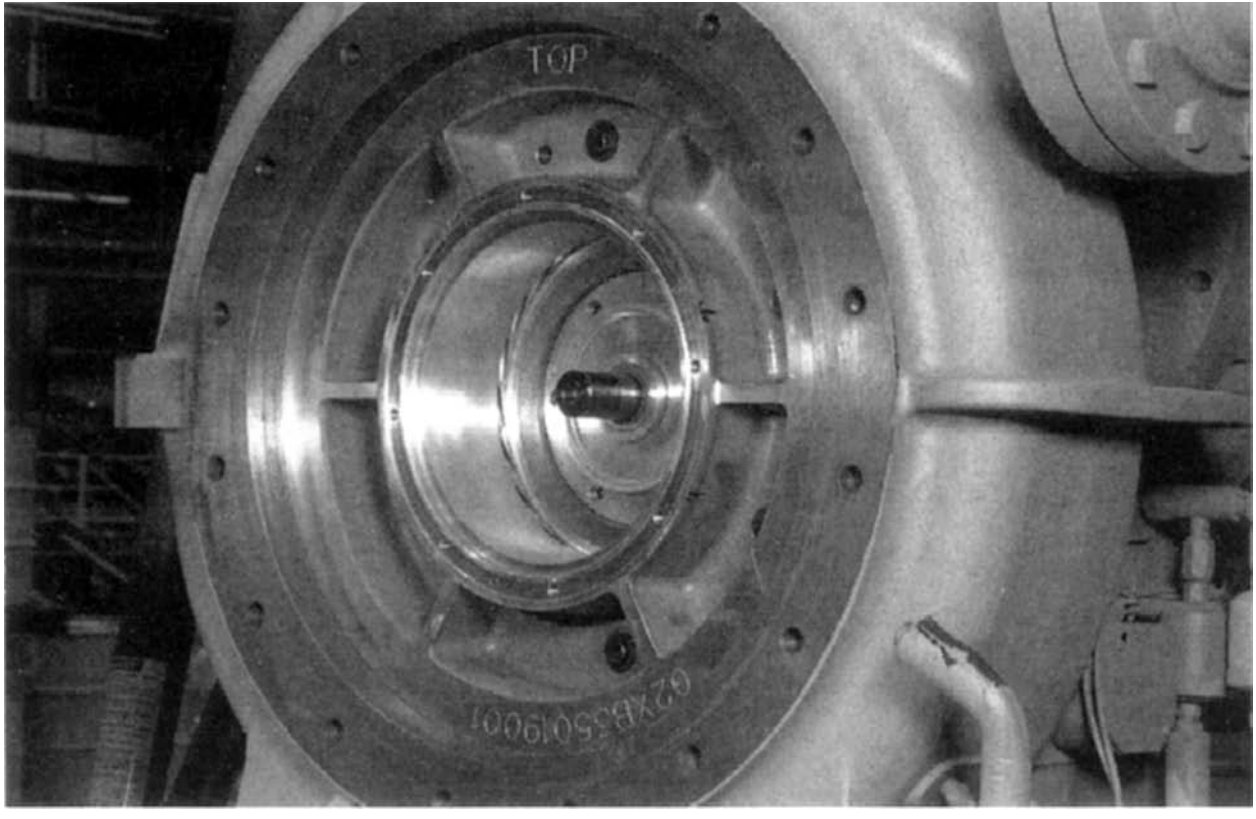

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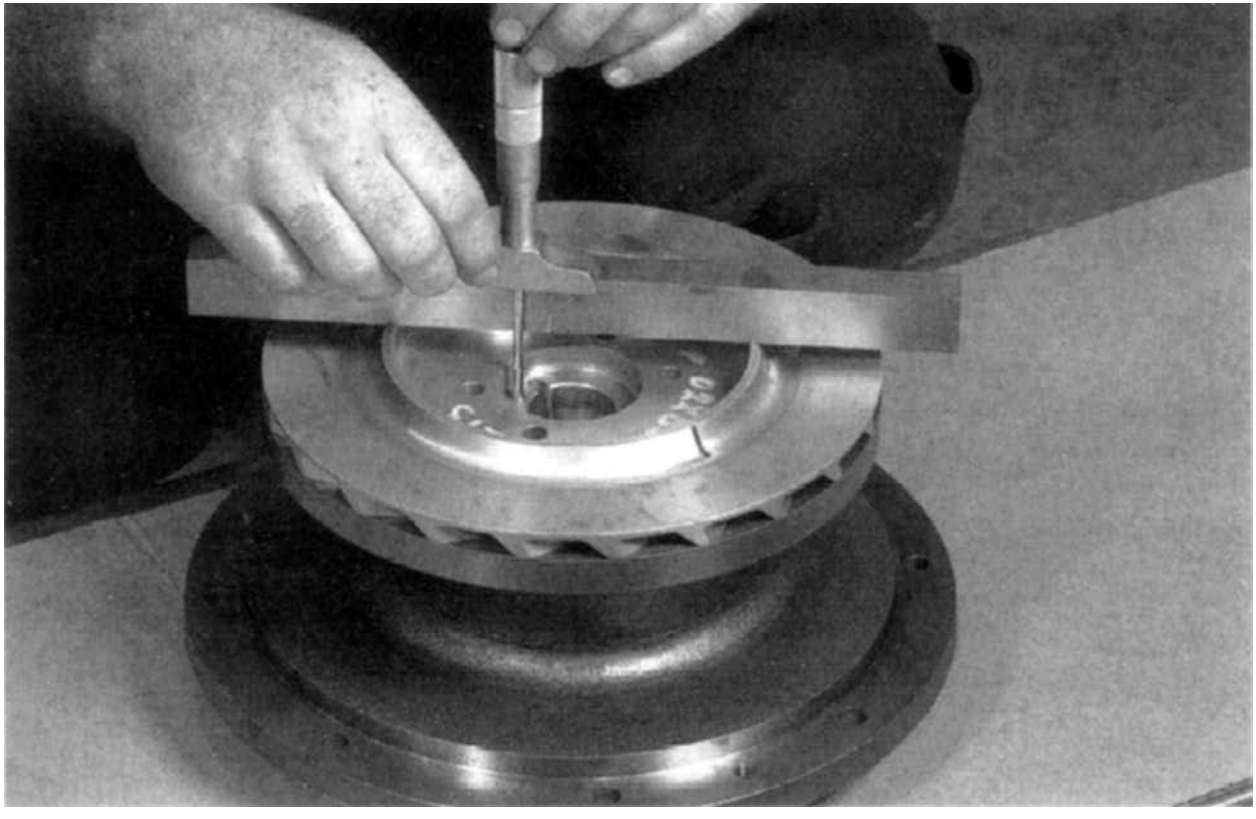

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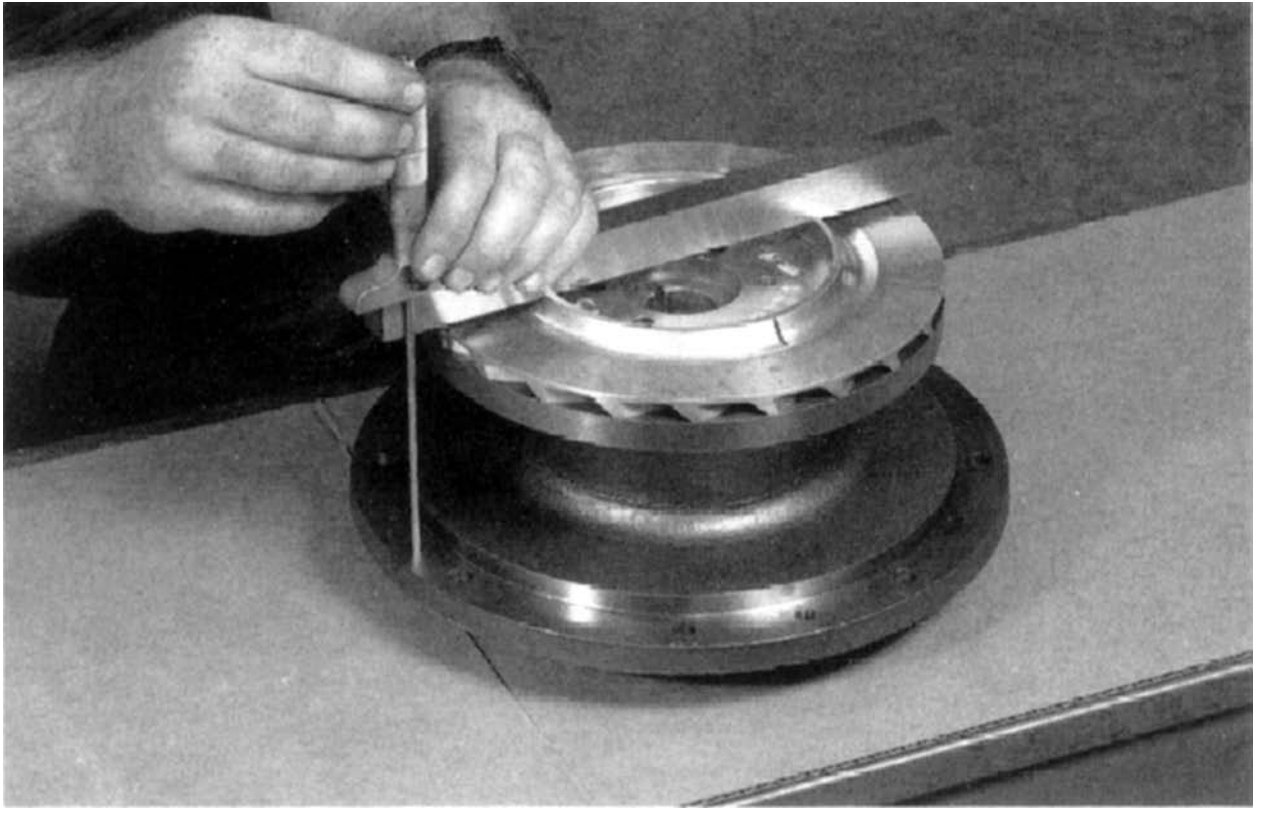

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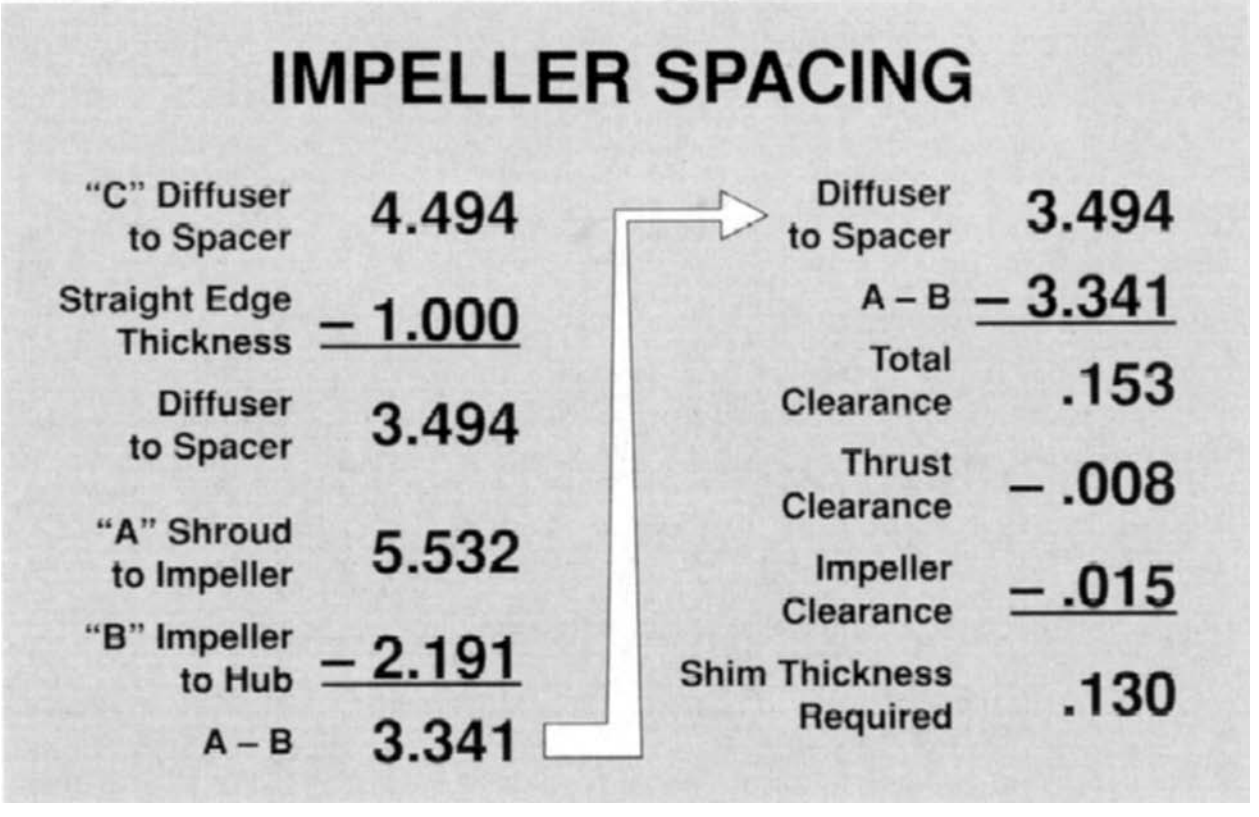

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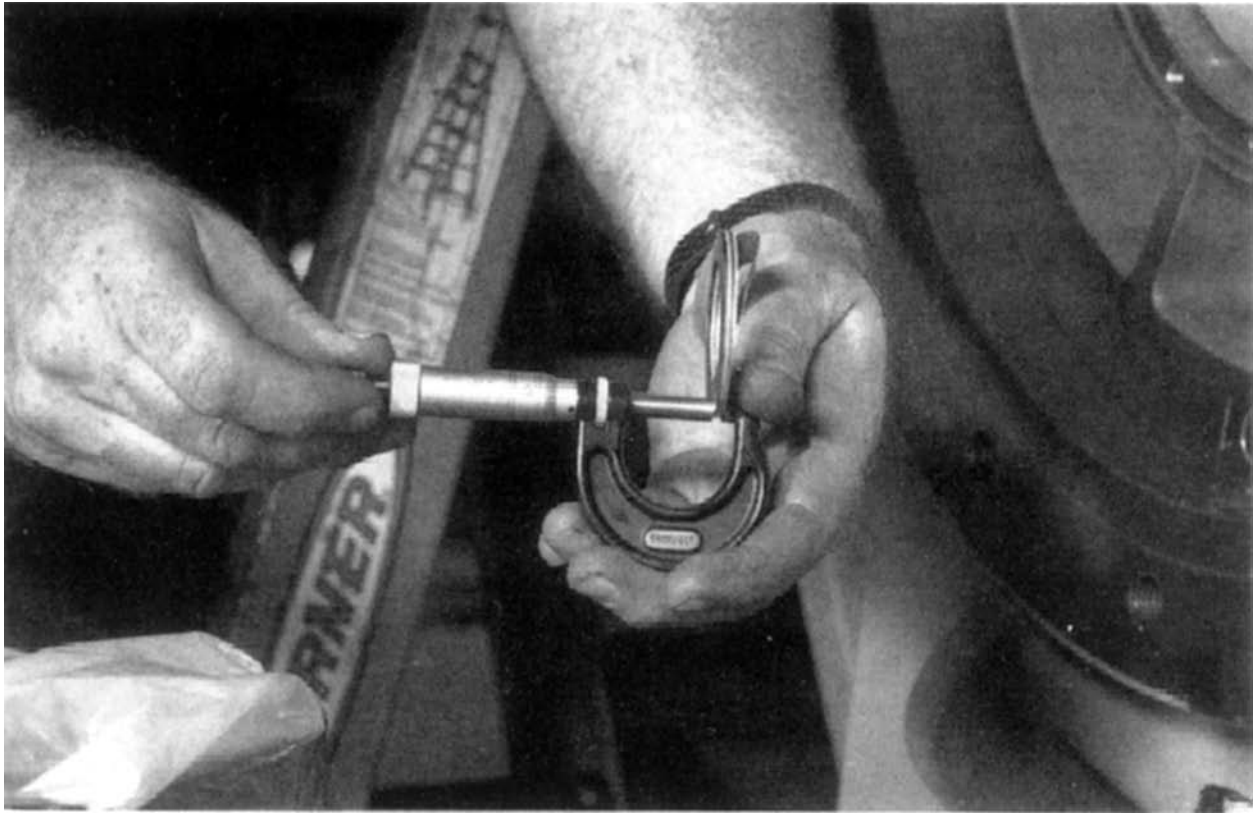

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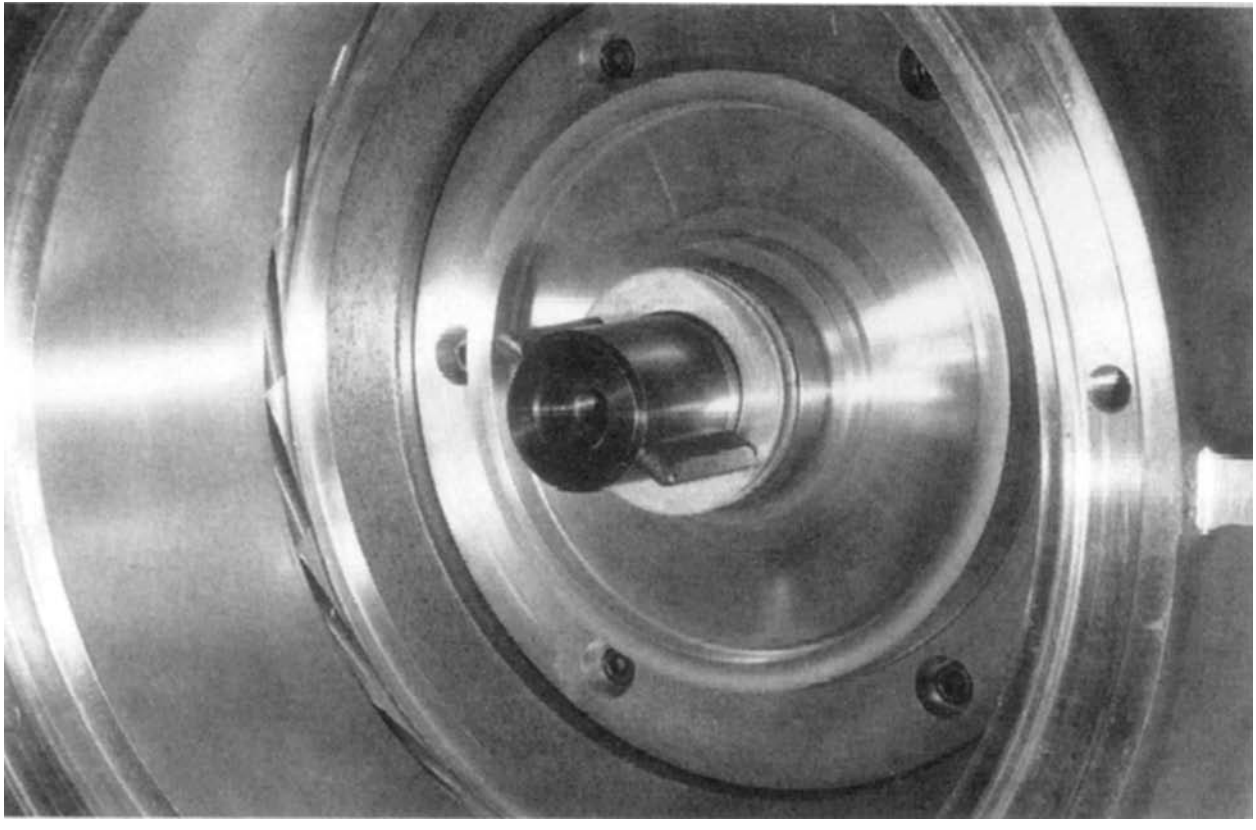

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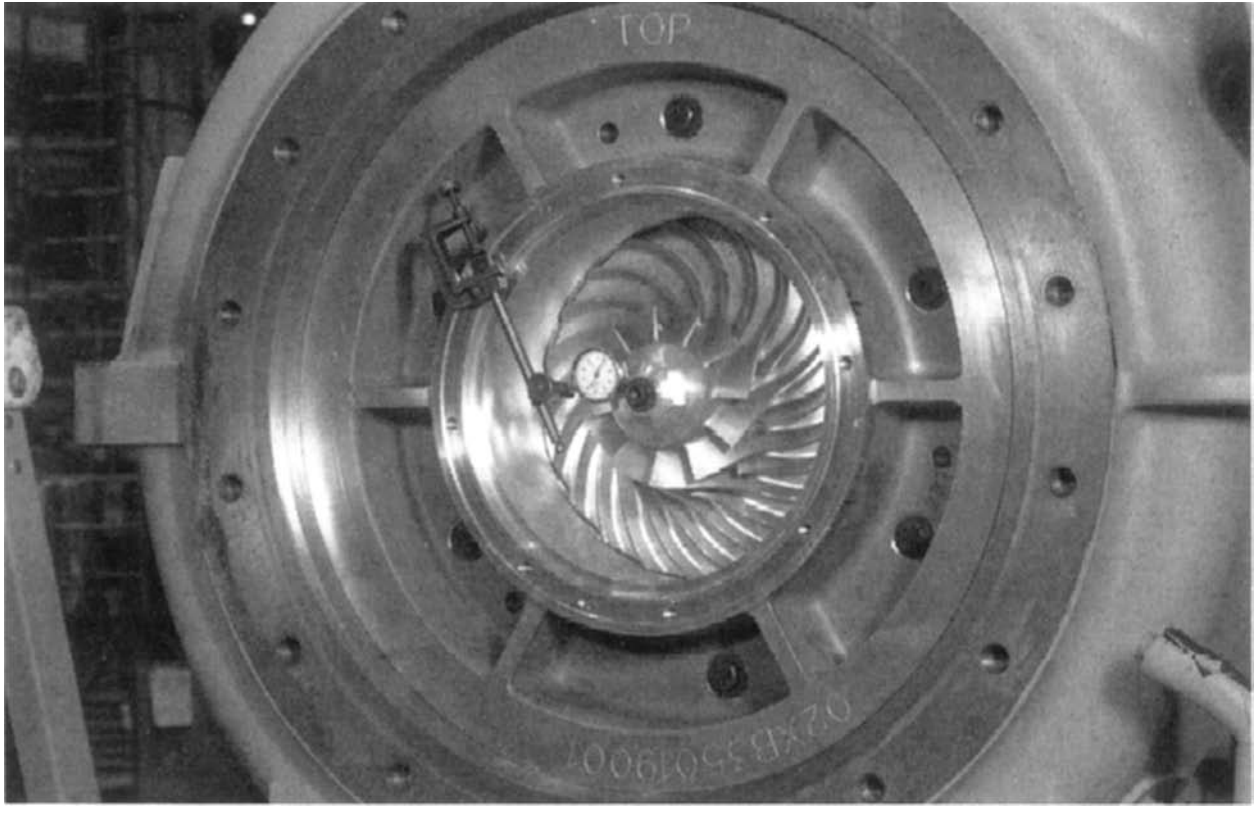

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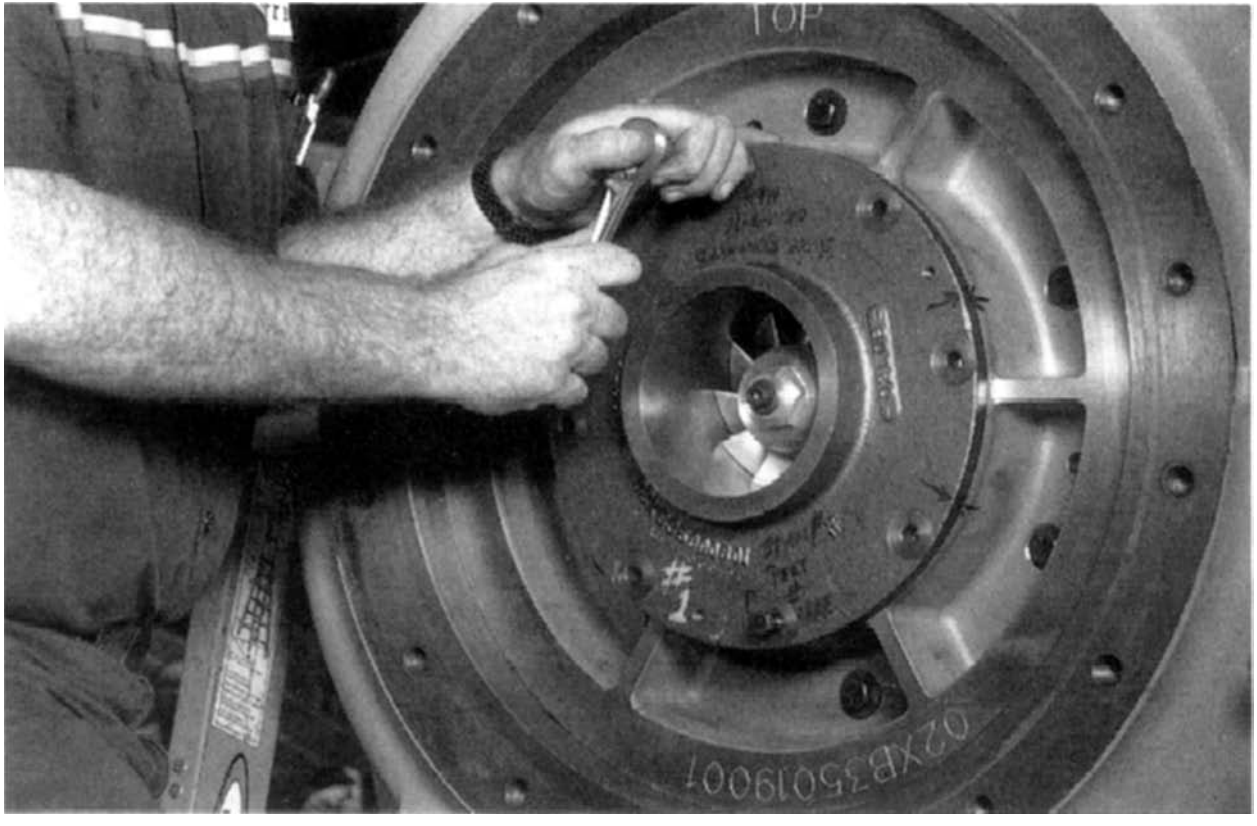

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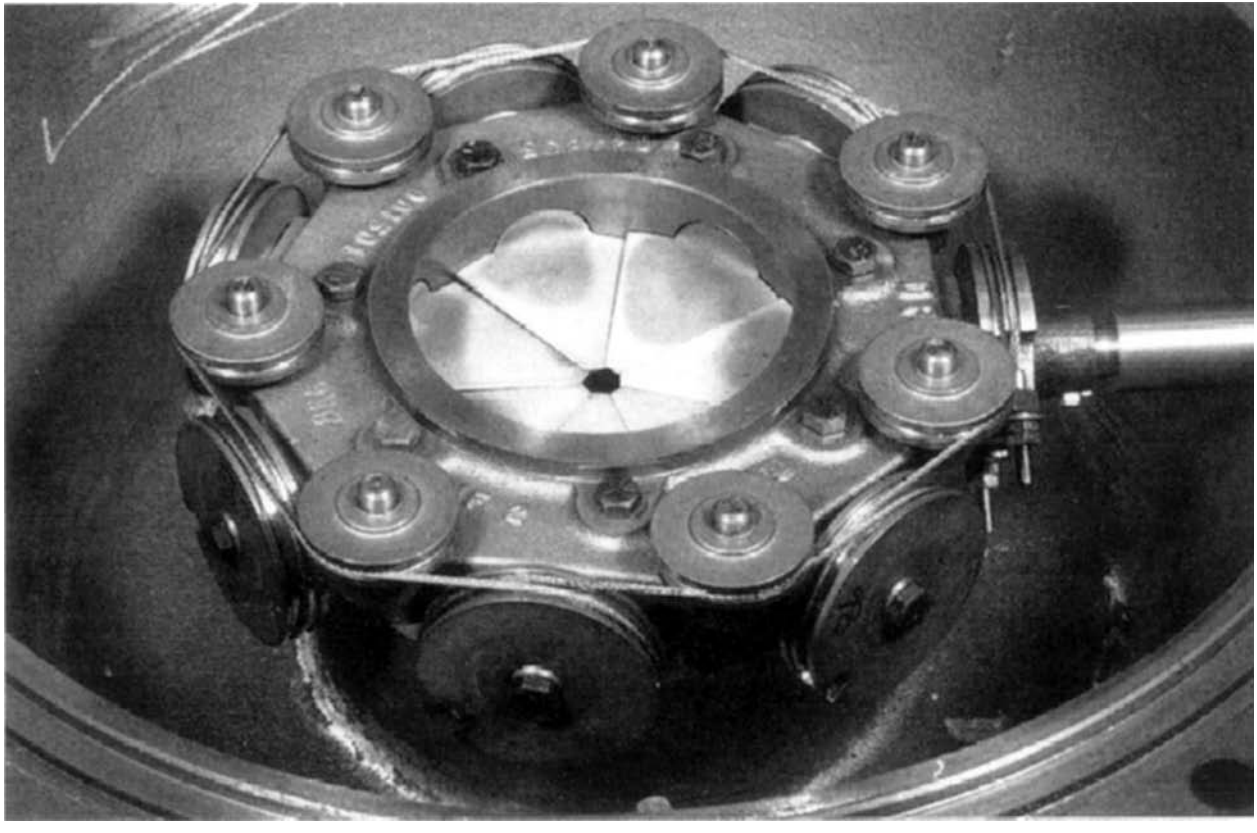

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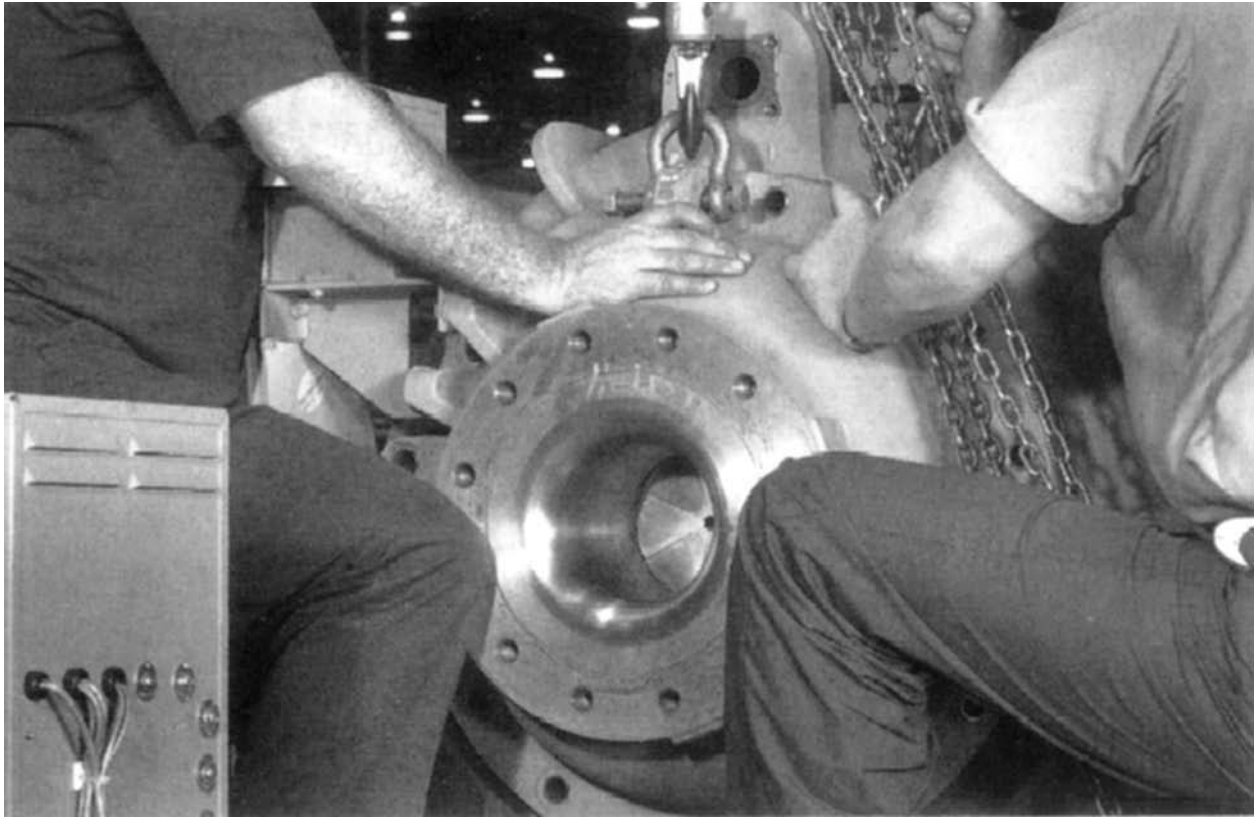

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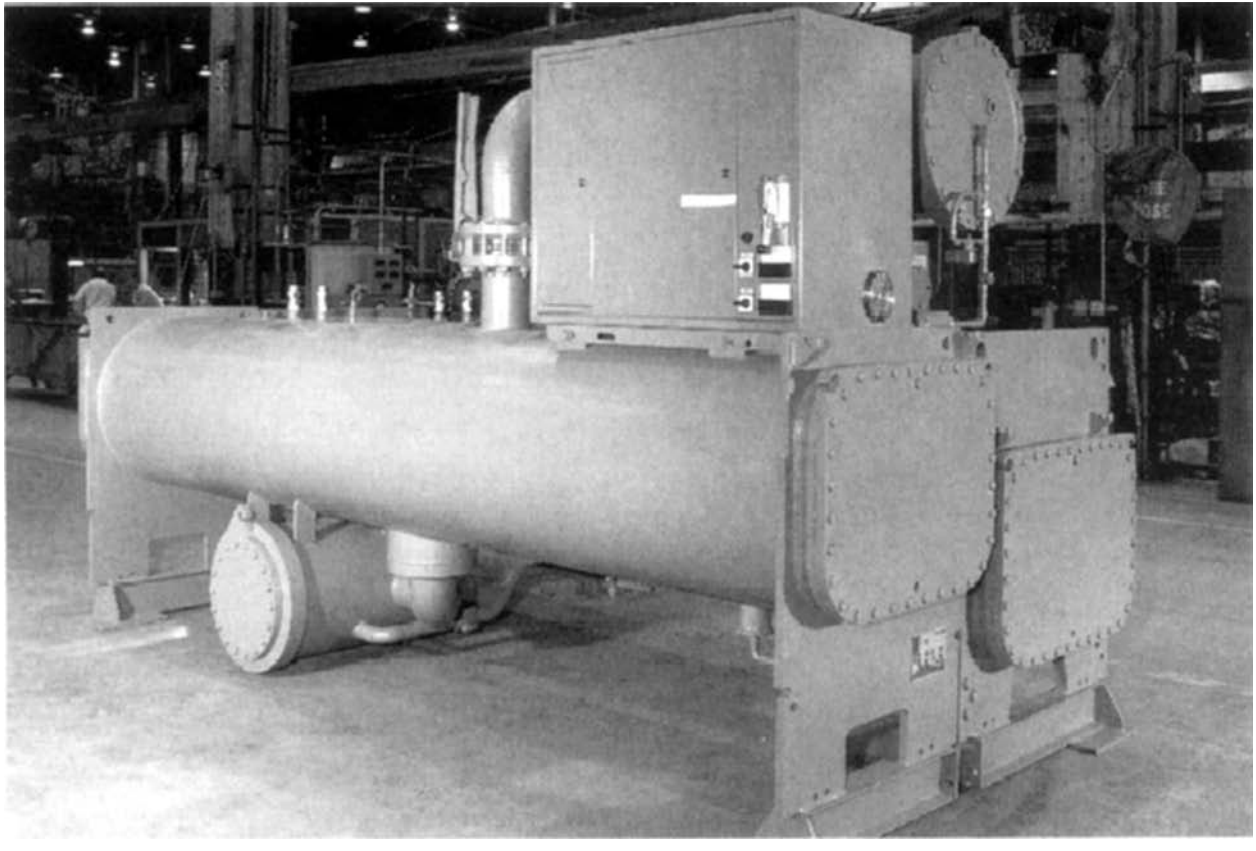

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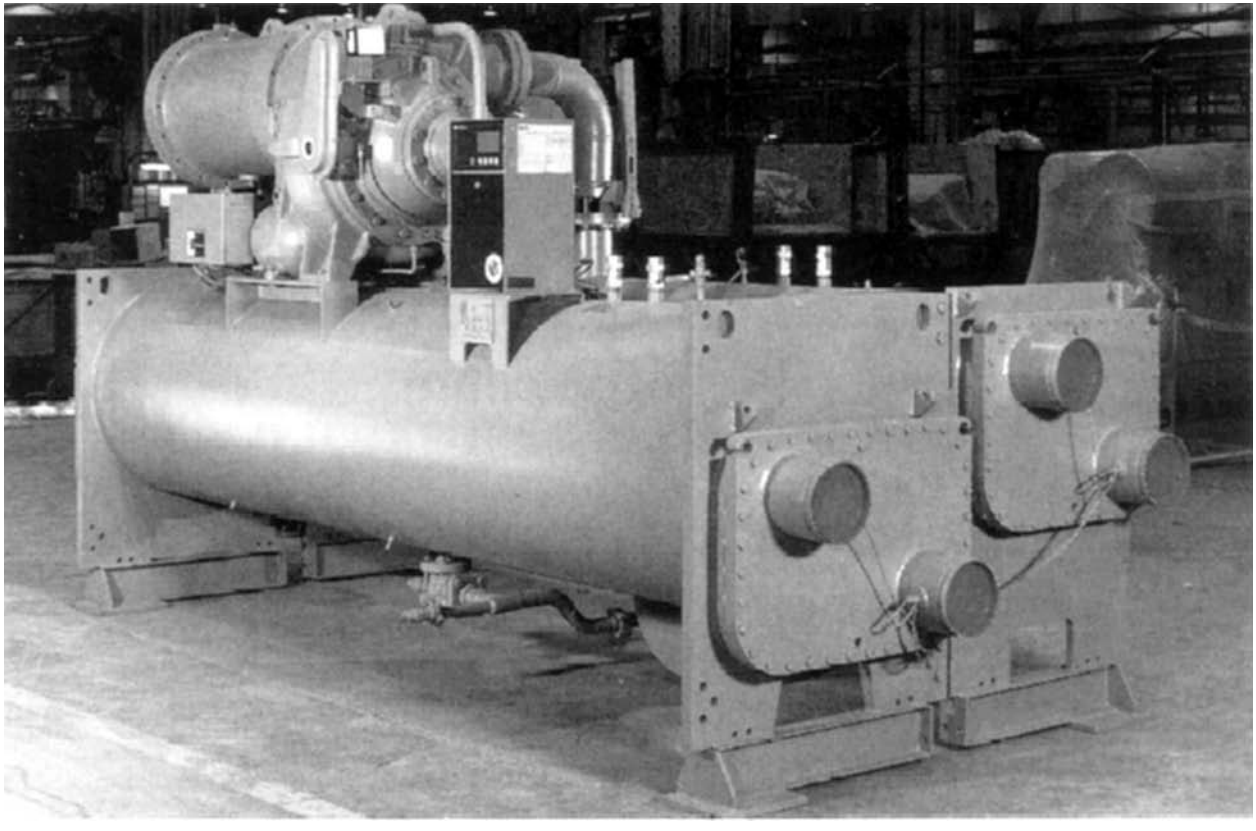

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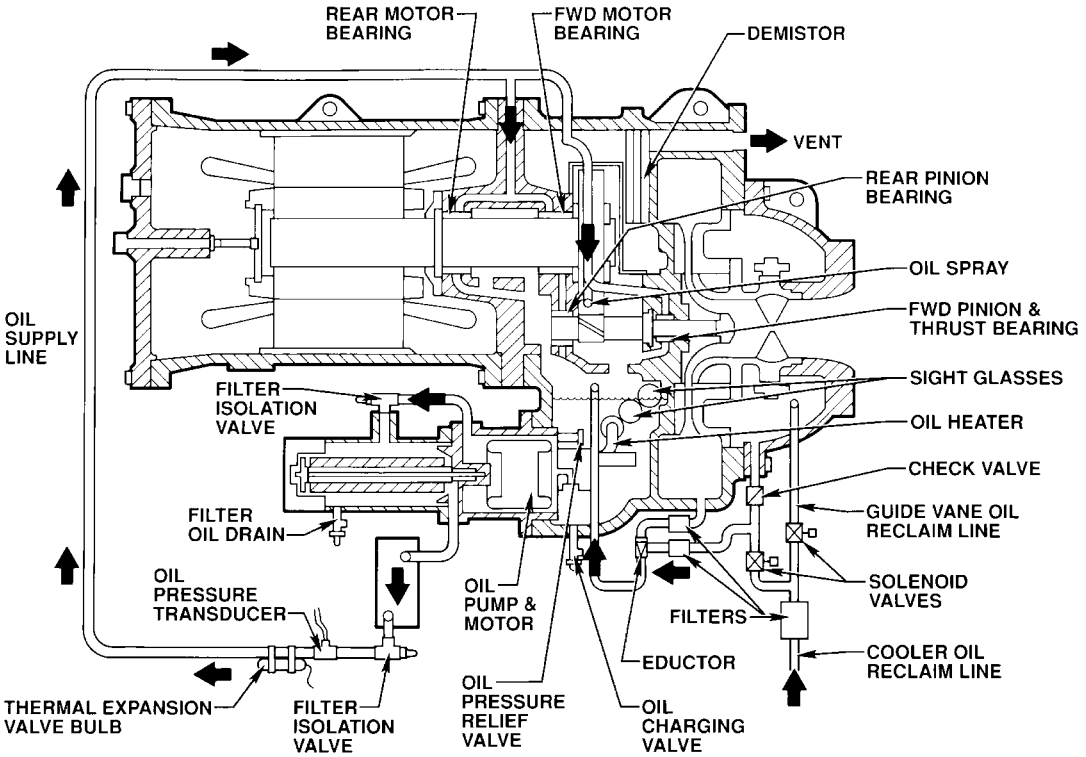

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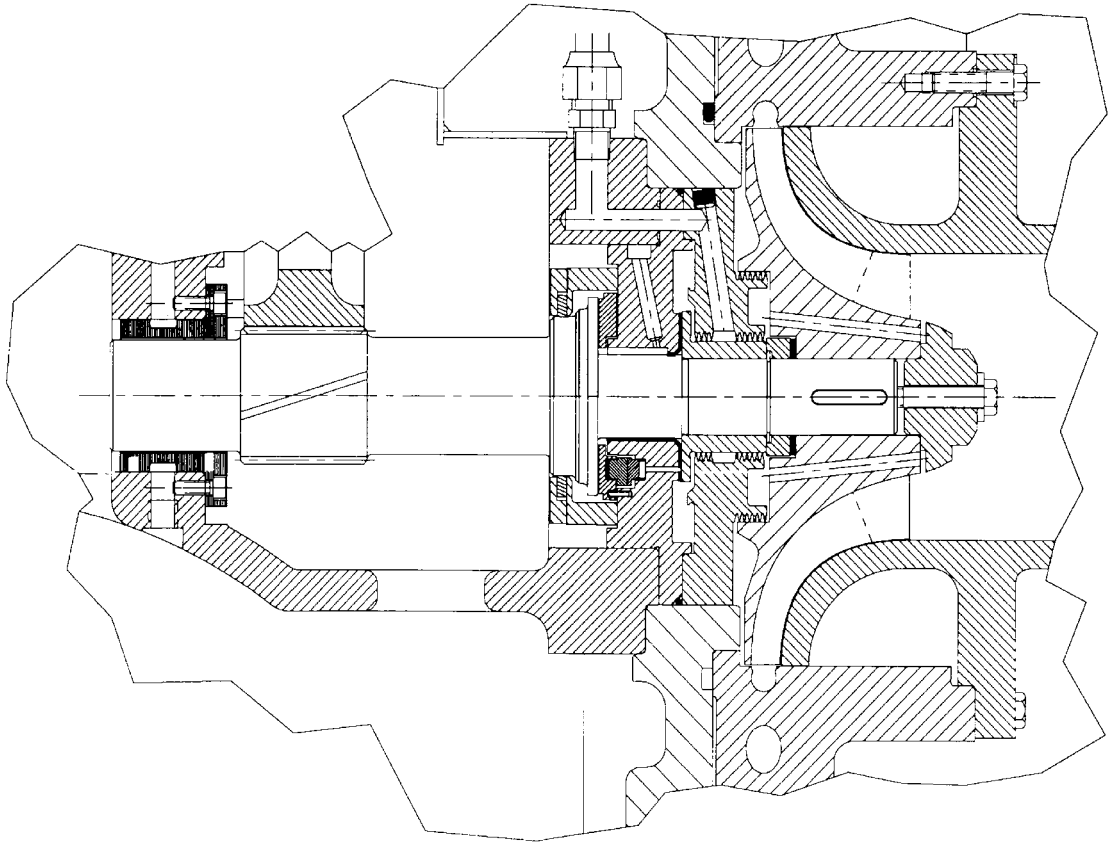

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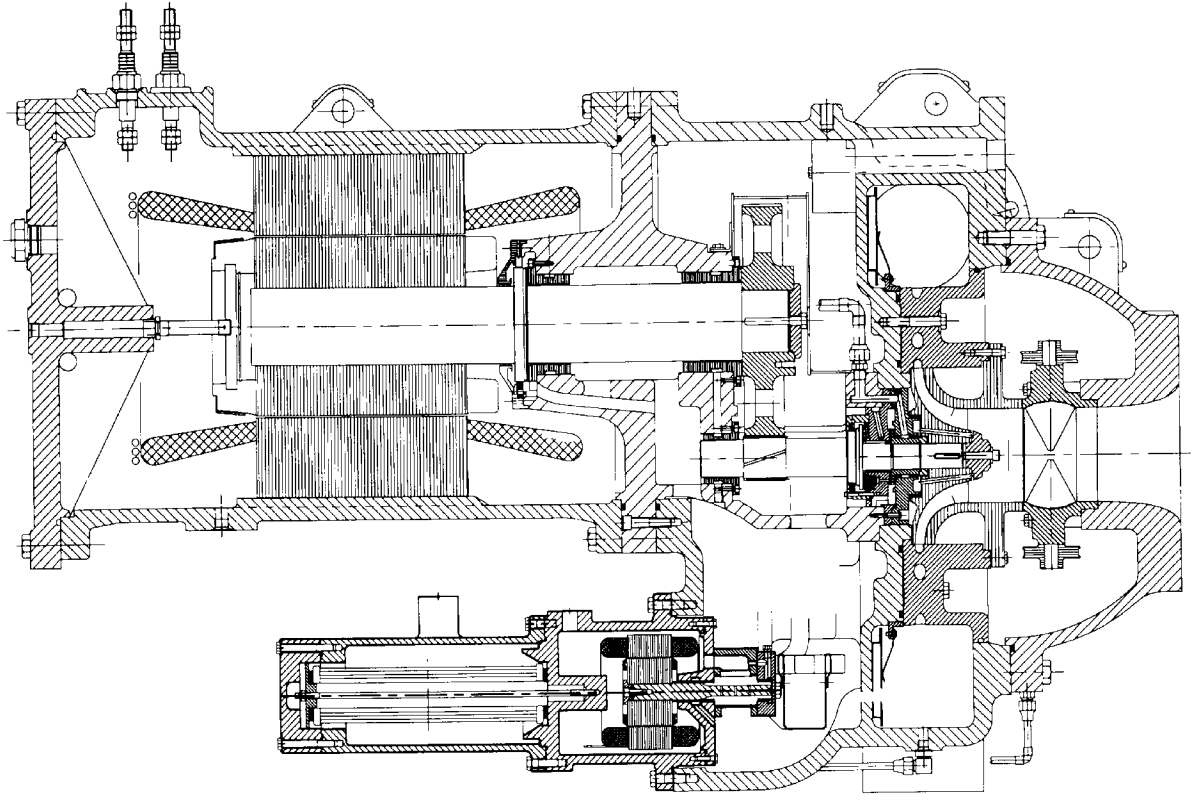

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IMPELLER SPACING (SHIM SIZING)

IMPELLER WORKSHEET

"C" DIFFUSER TO SPACER (Top of straight edge)_____

MINUS THICKNESS OF THE STRAIGHT EDGE –_____

==========

DIFFUSER TO SPACER _____

"A" STRAIGHT EDGE TO SHROUD _____

MINUS "B" STRAIGHT EDGE TO HUB –_____

==========

_____

"C" DIFFUSER TO SPACER _____

MINUS VALUE OF A-B –_____

==========

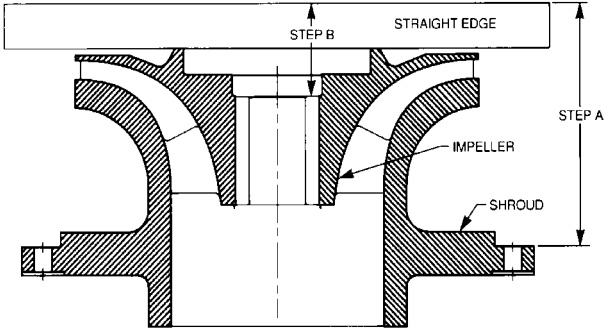
TOTAL CLEARANCE _____

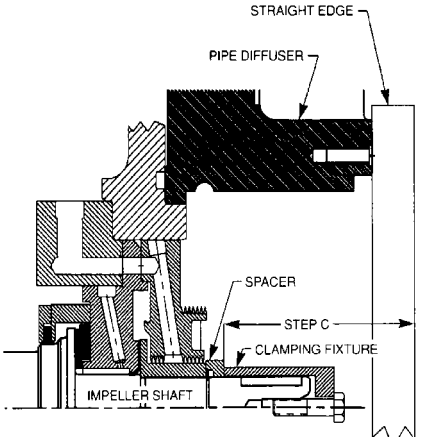
MINUS THRUST CLEARANCE –_____

MINUS DESIRED IMPELLER CLEARANCE –_____

==========

SHIM THICKNESS REQUIRED _____





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