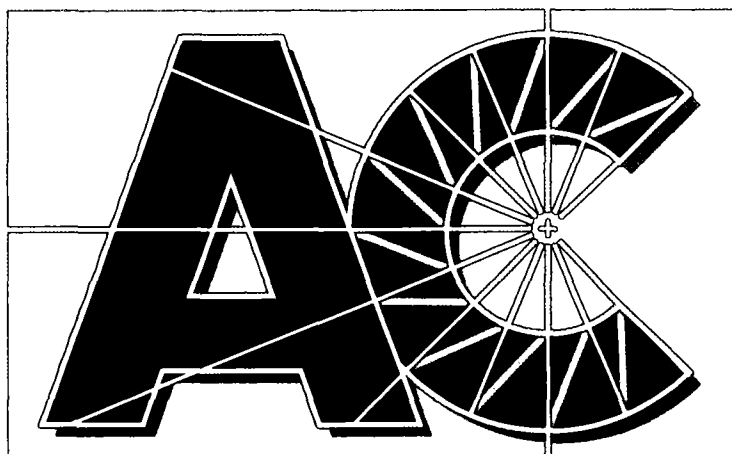


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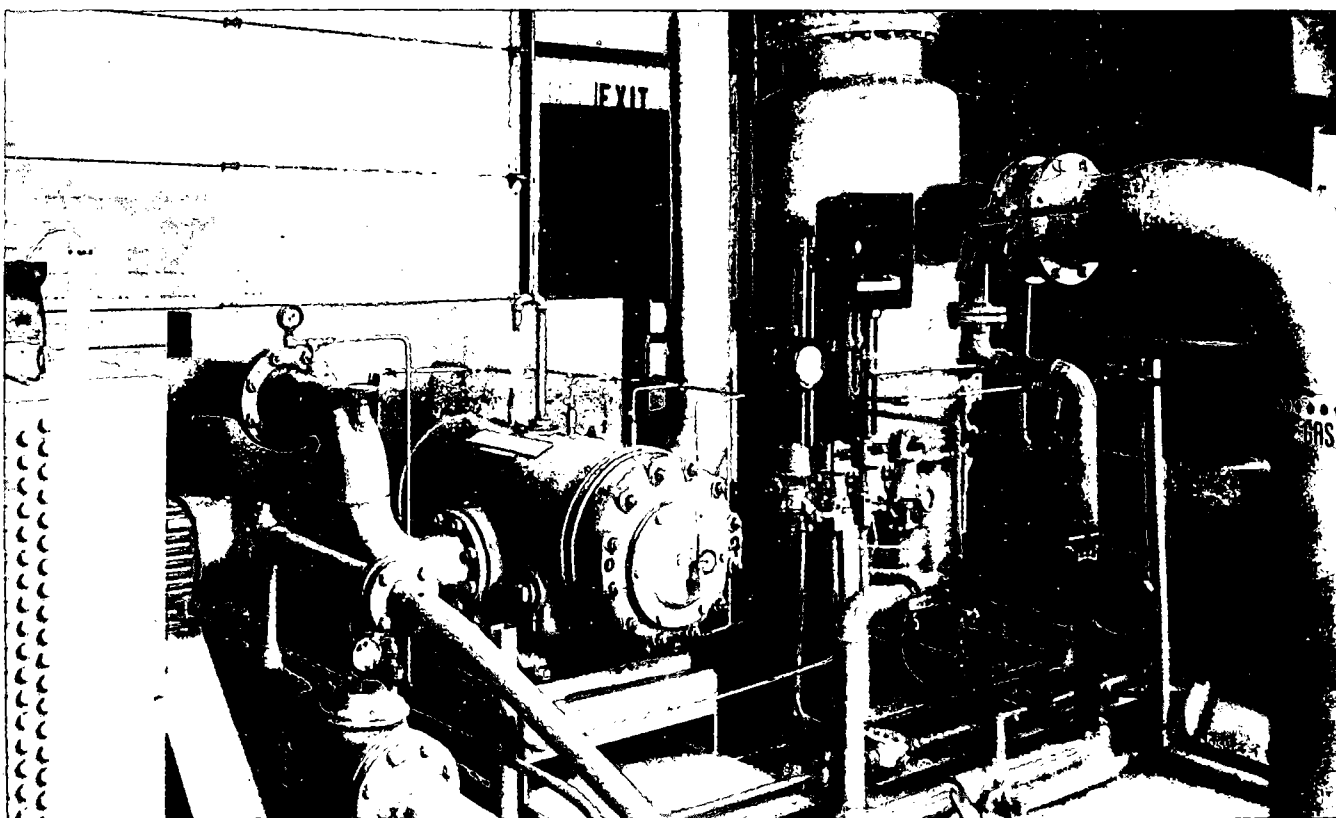
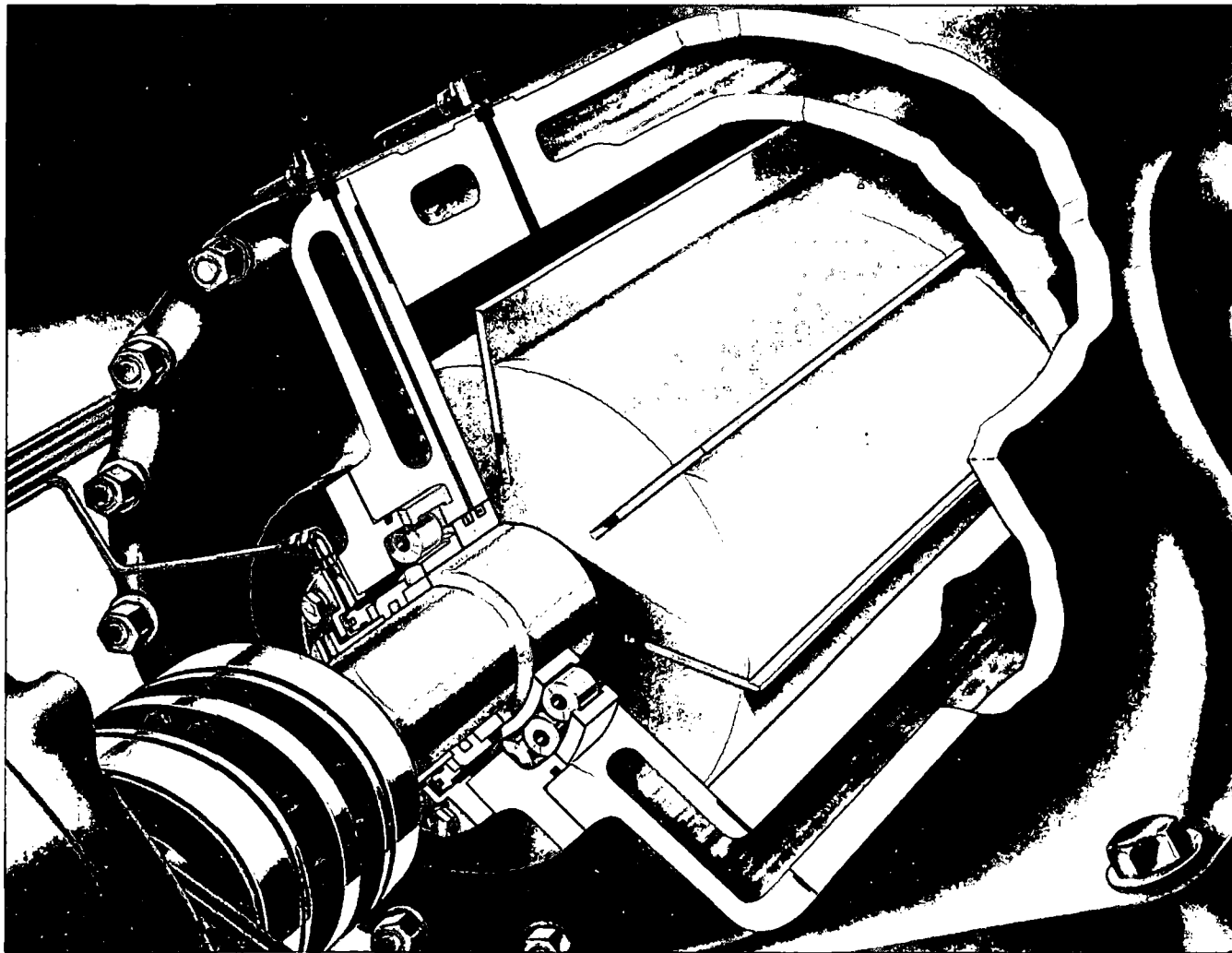


Compressor[®]

A **DOVER** DIVERSIFIED COMPANY

I N S T R U C T I O N S

Installation	SINGLE-STAGE
Operation	<i>Ro-Flo</i>[®]
Maintenance	COMPRESSORS and VACUUM PUMPS



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The information contained within is intended to assist operating personnel by providing information on the general characteristics of equipment of this type. It does not relieve the user of responsibility to use sound engineering practices in the installation, application, operation, and maintenance of particular equipment purchased.

I. INTRODUCTION

DESCRIPTION

Ro-Flo Sliding Vane Compressors

Air, or gases, are compressed by being trapped between blades in segments which become smaller as the segment rotates from its position at maximum blade projection to the point where the segment is open to the discharge port. This position of maximum blade projection is also where air or gas from the suction port is trapped between blades. As the volume of this segment is reduced, the pressure therein is comparably increased until its pressure is equal to the pressure in the discharge port area. At that point the leading blade exposes the segment to the discharge port area.

Blades are kept in contact with the cylinder wall by centrifugal force and move in and out of the rotor slots during each revolution. A small quantity of lube oil injected into the segment makes compressor valves unnecessary on a sliding vane compressor.

WARRANTY

General Provisions

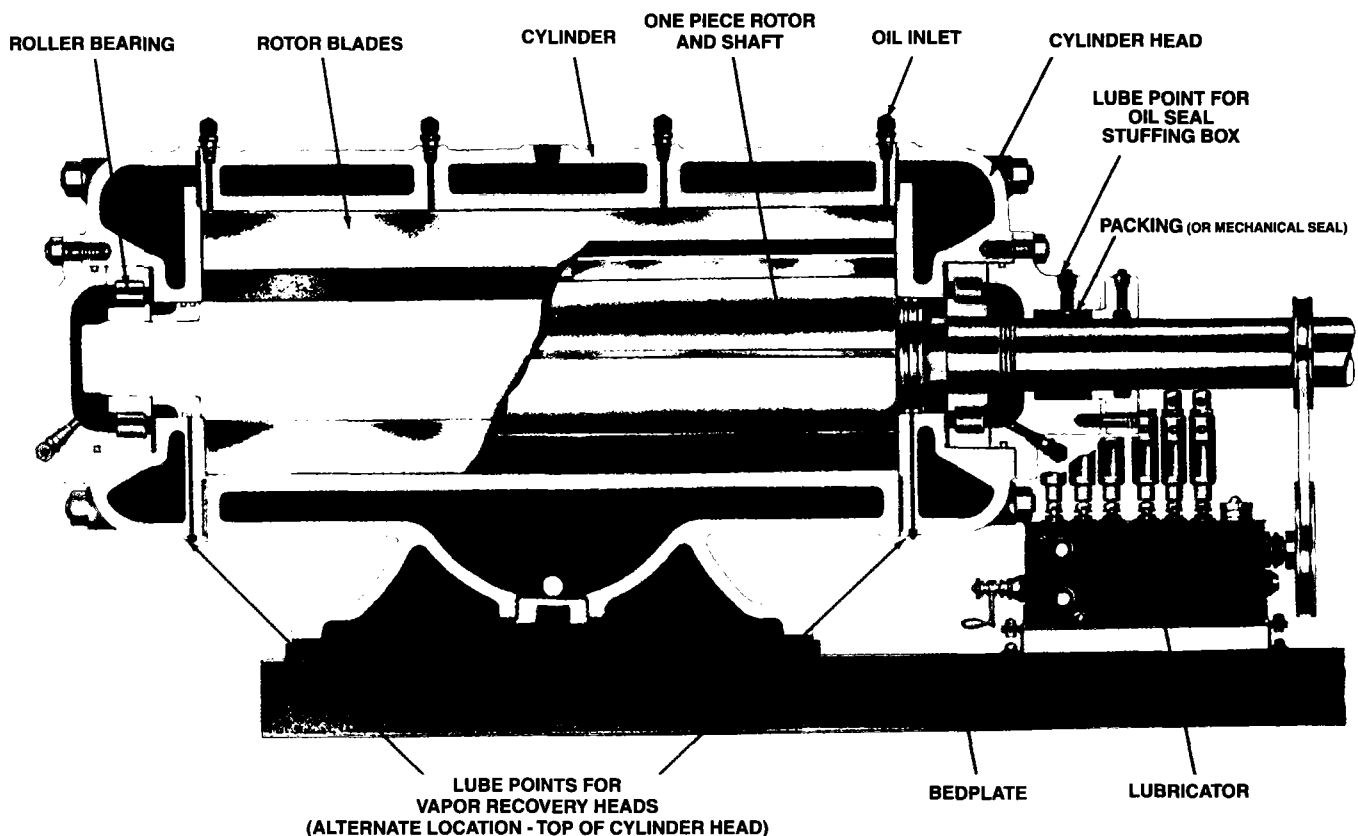
WARRANTY - Company warrants title to the product(s) and, except as noted below with respect to items not of Company's manufacture, also warrants to the product(s) on date of shipment to Purchaser, to be of the kind and quality described herein, merchantable, and free of defects in workmanship and material.

THIS WARRANTY IS EXPRESSLY IN LIEU OF ALL OTHER WARRANTIES, INCLUDING BUT NOT LIMITED TO IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS, AND CONSTITUTES THE ONLY WARRANTY OF COMPANY WITH RESPECT TO THE PRODUCT(S).

If, within one year from date of initial operation, but not more than eighteen months from date of shipment by Company of any item or product(s), Purchaser discovers that such item was not as warranted above and promptly notifies Company in writing thereof, Company shall remedy such non-conformance by, at Company's option, adjustment or repair or replacement of the item and any affected part of the product(s). Purchaser shall assume all responsibility and expense for removal, reinstallation, and freight in connection with the foregoing remedies. The same obligations and conditions shall extend to replacement parts furnished by Company hereunder. Company shall have the right of disposal of parts replaced by it.

ANY SEPARATELY LISTED ITEM OF THE PRODUCT(S) WHICH IS NOT MANUFACTURED BY COMPANY IS NOT WARRANTED BY COMPANY, and shall be covered only by the express warranty, if any, of the manufacturer thereof.

THIS STATES PURCHASER'S EXCLUSIVE REMEDY AGAINST COMPANY AND ITS SUPPLIERS RELATING TO THE PRODUCT(S), WHETHER IN CONTRACT OR TORT OR UNDER ANY OTHER



LEGAL THEORY, AND WHETHER ARISING OUT OF WARRANTIES, REPRESENTATIONS, INSTRUCTIONS, INSTALLATIONS OR DEFECTS FROM ANY CAUSE. Company and its suppliers shall have no obligation as to any product which has been improperly stored or handled, or which has not been operated or maintained according to instructions in Company or supplier furnished manuals.

Specification Data Sheet (16S9778) Must be completed for every new machine and must become a part of the service manual, furnished by A-C Compressor or supplier furnished materials.

Performance Guarantee is available from factory upon request.

Special Warranty Provision A-C Compressor Corporation shall not be responsible for damage caused by corrosion, carry over in the gas, or improper operation on the Purchaser's part.

Warranty Validation Date will correspond to arrival of equipment at the job site provided that the standard Unit Start-up Form #CCF0167 is completed by the customer or system fabricator and returned to A-C Compressor Corporation, 401 East South Island Street, Appleton, WI 54915, within 30 days of receipt of the compressor at the job site. Failure to submit the unit Start-up Form will result in a warranty validation date corresponding to the original factory ship date.

ALL REPAIR PARTS orders must be accompanied by the original compressor serial number. In the event that non-OEM parts have been used in conjunction with the repair or rework of this compressor, this warranty will become null and void.

LIFTING

The compressor can be lifted with a sling around the cylinder or from beneath the mounting feet. **DO NOT** lift from threaded holes in the top of the cylinder or cylinder head.

RECEIVING INSPECTION

Upon receipt of the compressor, promptly check for any damage which may have been incurred during transit. Make claim for damage to the carrier immediately.

Additionally, check the shipping manifest for assurance that all material ordered with the compressor(s) has been received or alternately accounted for on back order.

STORAGE

If the unit has not been prepared for outdoor or long-term storage at our factory, it is to be placed in a clean dry indoor storage area until used. Assure that all openings to the unit are sealed and that the factory applied rust preventative has not been removed from the shaft extension. All units shipped by A-C Compressor Corporation are coated internally with a protective light film or rust preventative which is adequate protection for a minimum of several months indoor storage. This rust preventative is automatically removed during initial hours of operation by the lubricating oil.

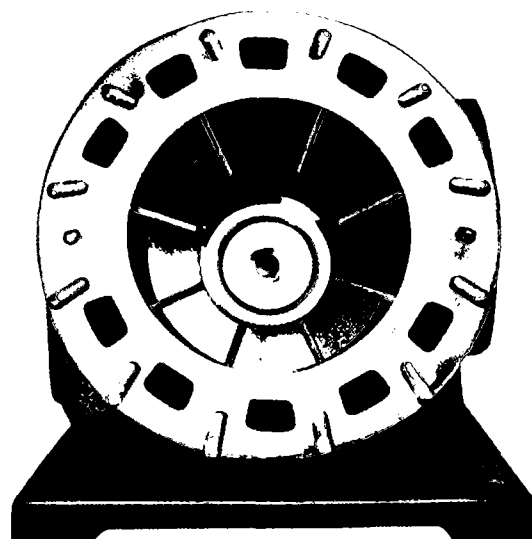
For long term indoor storage or for outdoor storage, consult the factory for guidance.

PROTECTION OF IDLE UNITS

During periods when the compressor remains idle, a degree of protection is advisable to avoid rusting of internal parts and swelling of blades in the rotor slots. The most desirable method of protection is to run the unit weekly for approximately one hour. When this is not practical, the unit should be sprayed thoroughly in the bore and each bearing cavity with a light rust preventative which meets U.S. Government Spec MIL-C-16173 Grade III. This will produce a dry film of less than .001 inch which is soluble in lube oil, hence, need not be removed when the compressor is placed back in service. Additionally, when inlet and/or discharge piping is removed or open to atmosphere during idle periods, the compressor openings should be sealed with plugs or coverplates to prevent entrance of humid air.

— APPROXIMATE WEIGHTS OF BARE UNITS —

MODEL NUMBER	WEIGHT	MODEL NUMBER	WEIGHT
4CCA, B	220#	211M	1250#
5CCA, B	240#	12S	2100#
7DA	510#	12L	2450#
7DB	510#	212M	1825#
7DC	510#	17S	3500#
8DA & B	800#	17L	4450#
8DE	780#	217M	2400#
208B	550#	19S	5100#
208E	550#	19L	5500#
10GB	1350#	219M	2900#
10GC	1350#	23C	10000#
210M	860#	27D	14400#
11S	2000#	33D	28000#
11L	2150#		



II. INSTALLATION

FOUNDATION

Bedplates should be mounted on a level foundation with shims such that deformation does not occur when foundation bolts are tightened. When bedplates are not supplied by A-C Compressor Corporation, they may be designed for the static loads of the compressor, driver, and other equipment mounted such that adequate stiffness exists to keep couplings in alignment. Filling bedplates and the area between the bedplate and foundation with high strength non-shrinking grout will aid in preventing baseplate movement and also aid in noise reduction.

Whether a bedplate or alternately a simple concrete slab with soleplates is used, the height above ground should be adequate for compressor servicing and maintenance.

ALIGNMENT; GENERAL INFORMATION

When units are purchased with a bedplate, the compressor and driver alignment has already been made at the factory. However, due to distortion from transit, mounting bedplate on foundation, or addition of other equipment, it is necessary to recheck alignment **before** piping the compressor to its system piping. Realignment, if necessary, should be done before bolting piping to the compressor. Failure to assure reasonable shaft alignment on coupling drive units will result in excessive noise, coupling wear, or bearing damage. With belt-driven units, improper shaft alignment results in belt slippage and unequal belt wear; hence, short belt life.

ALIGNMENT; DIRECT DRIVE UNITS

Refer to Figures 1, 2, and 3 illustrating angular and parallel misalignment and the dial indicator method for checking these. It is important to rotate both shafts simultaneously to avoid errors due to surface imperfections of the coupling hubs. Note that with each shaft revolution the coupling will flex for the combined parallel and angular misalignment. The sum of these may be considered as the overall shaft misalignment.

Although it would be desirable to have a .006 inch or less total misalignment, a practical value of .018 inch is reasonable and acceptable for **HO-FLO** compressors.

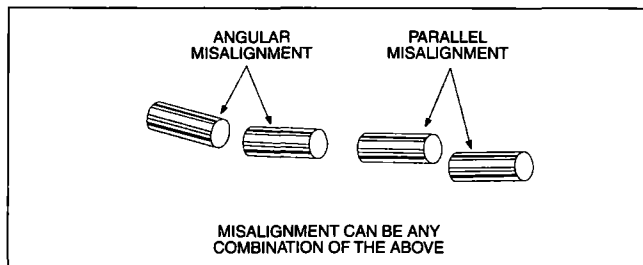


FIG. 1 — Angular and parallel misalignment illustrated.

SHAFT HORSEPOWER LIMITATIONS						
Model	Nominal Speed RPM	Maximum Speed RPM	Minimum Speed RPM	Maximum Horsepower		
				Belt Driven Form		Directly Coupled
				Inlet Side	Discharge Side	
4CCA	1160	2200	865	10	9	12
4CCB	1740	2200	865	14	12	16
5CCA	1160	2200	865	9	8	11
5CCB	1740	2200	865	13	11	15
7DA	865	1465	690	21	17	25
7DB	1160	1465	690	27	21	33
8DA	865	1465	600	26	24	35
8DB	1160	1465	600	28	28	47
8DE	1160	1465	600	27	27	60
10GB	865	1300	450	66	55	78
10GC	1160	1300	450	88	67	103
11S	865	1000	400	130	103	162
11L	865	1000	400	134	106	168
12S	865	920	380	133	132	213
12L	865	920	380	131	131	222
17S	690	760	310	205	205	345
17L	690	760	310	205	205	400
19S	575	640	275	162	162	410
19L	575	640	275	162	162	390
23C	495	520	300	175	175	410
23D	495	520	300	168	168	411
27D	435	520	300	160	160	369
33D	435	450	300	155	155	362
208A	865	1465	600	33	33	72
208B	1160	1465	600	36	36	96
208E	1160	1465	600	36	36	96
210B	865	1300	450	120	100	260
210C	1160	1300	450	108	81	340
211M	865	1000	400	178	167	450
212M	865	920	380	181	181	450
217M	690	760	310	226	226	574
219M	575	640	275	228	228	478

NOTES: Use "High Capacity" V-belts and sheaves

Minimum belt speed must not be less than 4500 feet per minute. The maximum belt speed should not normally exceed 6000 feet per minute. Consult the V-belt supplier to determine if dynamically balanced sheaves will be required at the selected belt speed.

Consult the factory for assistance if the horsepower requirements are higher than the BHP limits shown. In some cases special sheaves can be used to permit higher horsepower V-belt drive arrangements.

The maximum horsepower listed above are applicable only to the nominal speeds shown. If the unit is to be V-belt driven at a speed other than nominal contact the factory for maximum allowable horsepower.

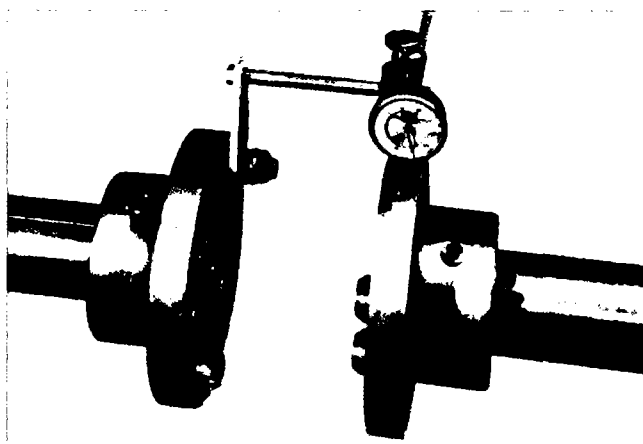


FIG. 2 — Checking parallel alignment with dial indicator on coupling flange.

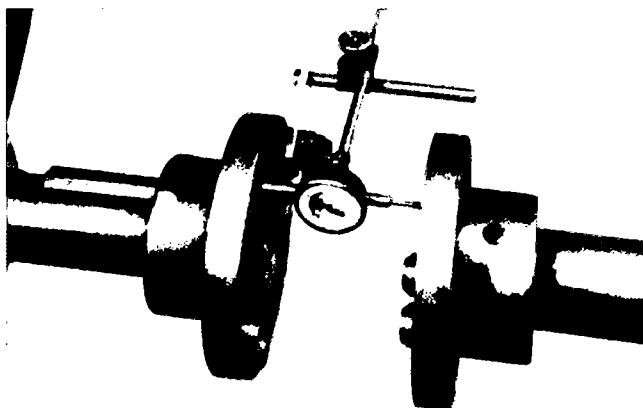


FIG. 3 — Checking angular alignment with dial indicator on coupling face.

ALIGNMENT; V-BELT DRIVES

Figure 4 illustrates the typical arrangement for V-belt drives with pedestal bearings and a "jackshaft." This arrangement eliminates side pull on the driven machinery. It may be used where sheave mounting directly on the compressor shaft (Figure 5) would result in excessive side pull. Alignment between compressor and jackshaft is checked in the same manner as with direct drive units.

It is advisable to consult A-C Compressor Corporation for assistance in determining if your horsepower requirements are higher than recommended for mounting the sheave directly on the compressor shaft.

Alignment of belt-driven units with directly mounted sheaves requires equal tension on all belts and excessive tension on none. The belt manufacturer's instructions will define which tension levels are excessive. Slight slipping on start-up may be permissible to avoid greater belt tension under normal running conditions.

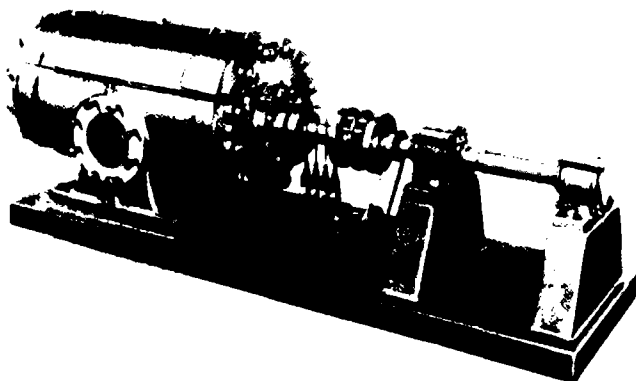


FIG. 4

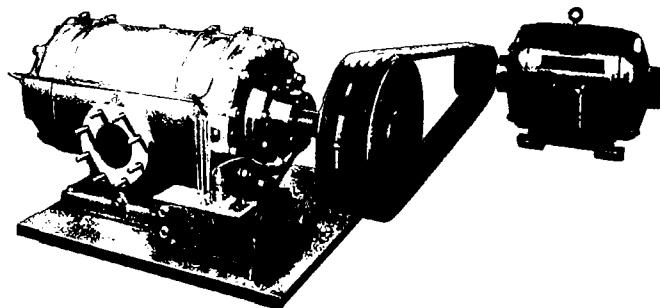


FIG. 5

PIPING; AIR AND GAS LINE

Piping connected to the compressor should be adequately supported and aligned such that minimal stress is transmitted to the compressor/piping connection. See table below for allowable flange loading for **RO-FLO** compressors/vacuum pumps. Additionally, the piping must have an adequate number of elbows, "T's," and spool pieces to permit their removal for accessibility to the compressor for service.

Where metal piping is installed on the suction side, the pipe internals must be cleaned. A 16 mesh start-up screen should be installed in the compressor inlet piping and removed as soon as checking indicates no further debris, millscale, or weld beads are being caught.

Where suction or discharge line piping is above the level of the compressor, or alternately moisture laden, drains and drop legs for oil and liquid accumulation are recommended as shown in Figure 6; page 8.

WARNING

Liquids passing through the compressor can result in broken blades and cracked cylinders.

Typical piping arrangements for air (Figure 7; Page 8) and gas (Figure 8; Page 9) installations contain many basic features, particularly:

- The discharge check valve mounted as close as possible to the compressor discharge to prevent reverse flow when the compressor is shut down.
- A discharge safety valve placed before the first isolation valve.
- Drain valves, either manual or automatic, for the drop legs and liquid separators.
- Intake filters to remove at least 90% of all dirt particles (10 microns or larger), from the compressor inlet. Pressure drop through filters should usually be less than several inches of water. The effectiveness of a filter is also measured by its ability to accumulate dirt without large increases in pressure drop.
- Gauges and thermometers at or within several feet of the inlet and discharge flanges are an absolute necessity for every compressor to determine how it is actually operating. Figure 9 illustrates one typical method of installing gauges and thermometers and also shows the importance of having a temperature probe reach into the center of a gas stream.

The features noted above are typical, hence may differ depending upon the compressor application. See drawings supplied with each new unit for specific instructions.

Loading Limits on Ro-Flo Inlet and Discharge Flanges

Model No.	Inlet Flange Diameter (in)	Discharge Flange Diameter (in)	Inlet Flange		Discharge Flange	
			Fx, y, z (lbs)	Mx, y, z (in-lbs)	Fx, y, z (lbs)	Mx, y, z (in-lbs)
4CC	2	1.5	100	1190	75	970
5CC	2	1.5	100	1190	75	970
7D	3	3	150	1500	150	1500
8D	4	3	200	1670	150	1500
10G	5	4	250	1670	200	1670
11S,L	6	5	300	1670	250	1670
12S,L	8	6	400	1670	300	1670
17S,L	8	6	400	1670	300	1670
19S,L	10	8	500	1670	400	1670
23C,D,E	12	8	600	1670	400	1670
27D,E	12	10	600	1670	500	1670
33D	16	14	800	1670	700	1670
207	3	2*	150	1500	80	970
208	3	2*	150	1500	80	970
210M	4	2.5*	200	1670	100	1375
211M	5	3*	250	1670	120	1500
212M	6	4*	300	1670	160	1670
217M	6	4*	300	1670	160	1670
219M	8	4*	400	1670	160	1670

* Vertical Orientation (Top Discharge)

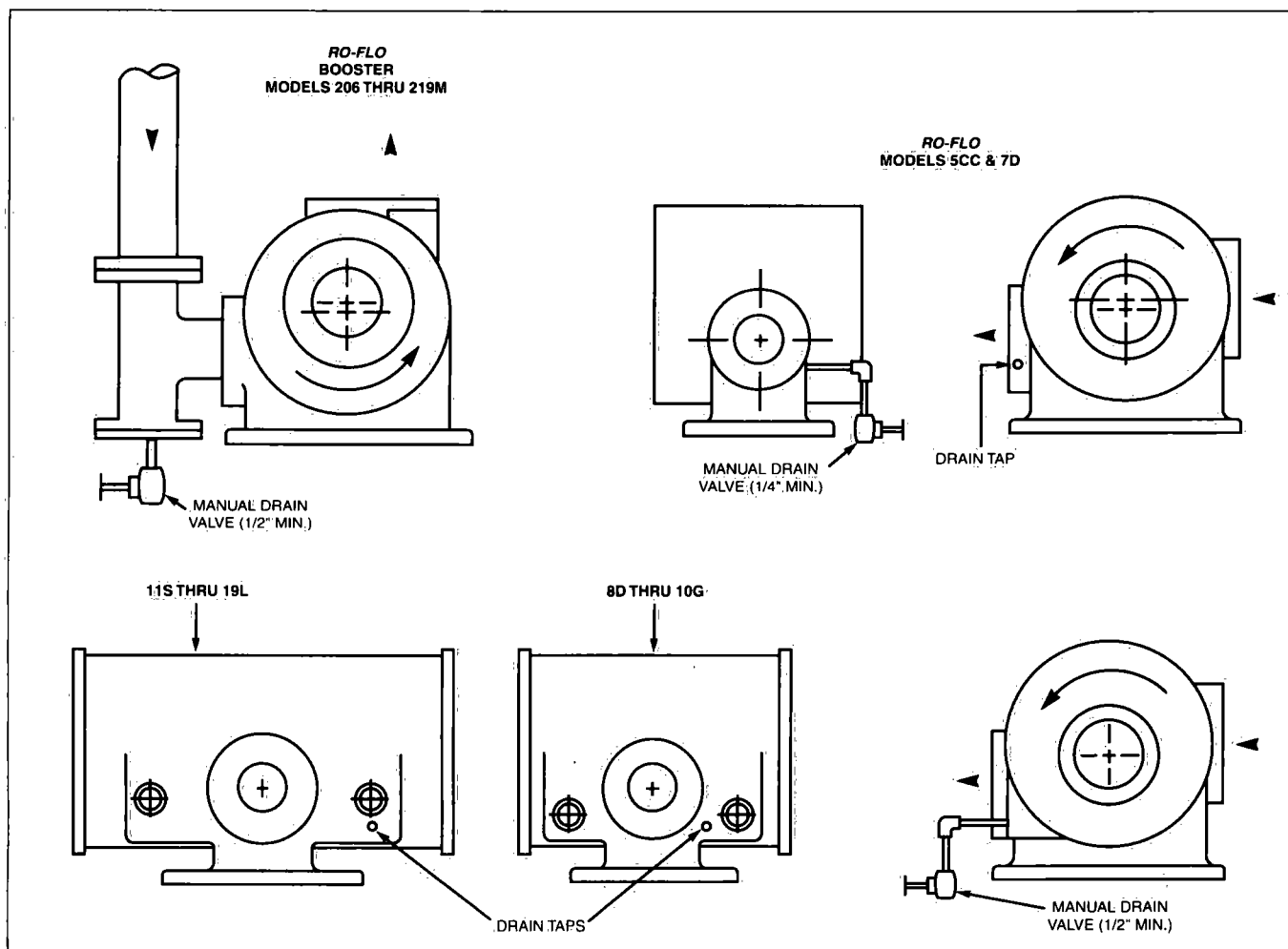


FIG. 6 — Ro-Flo cylinder drain locations/arrangements

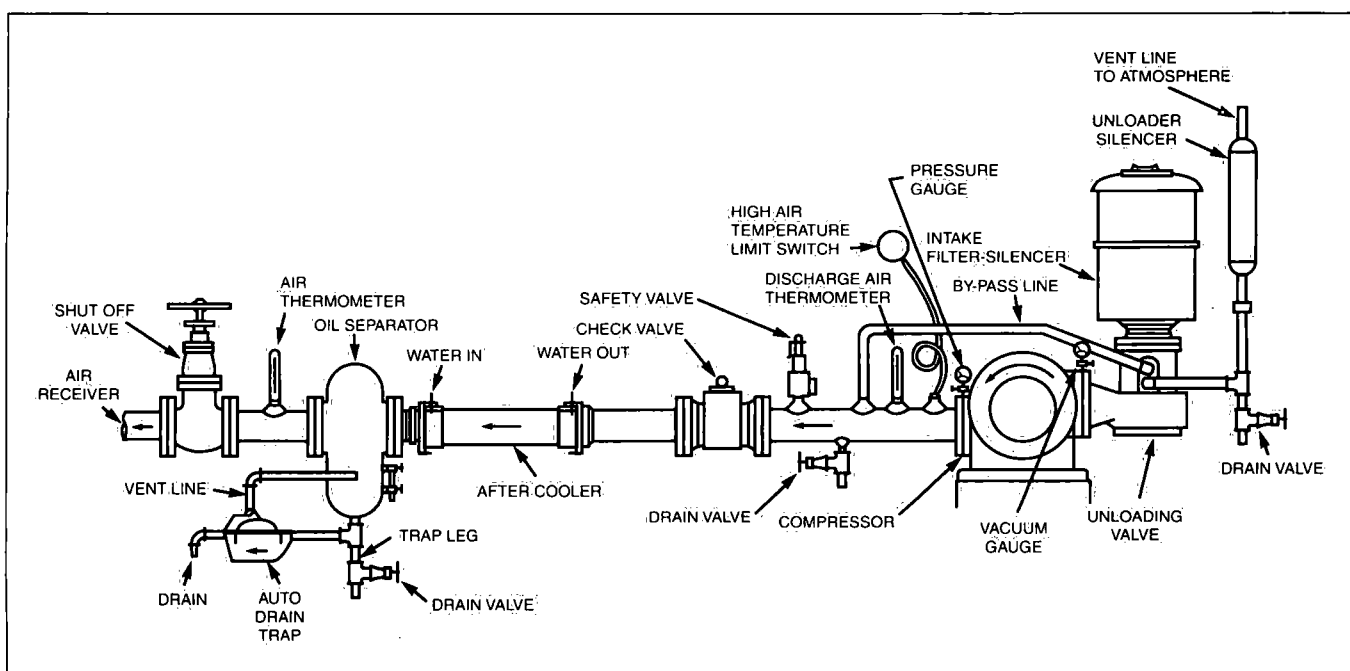


FIG. 7 — Typical piping arrangement for air installation.

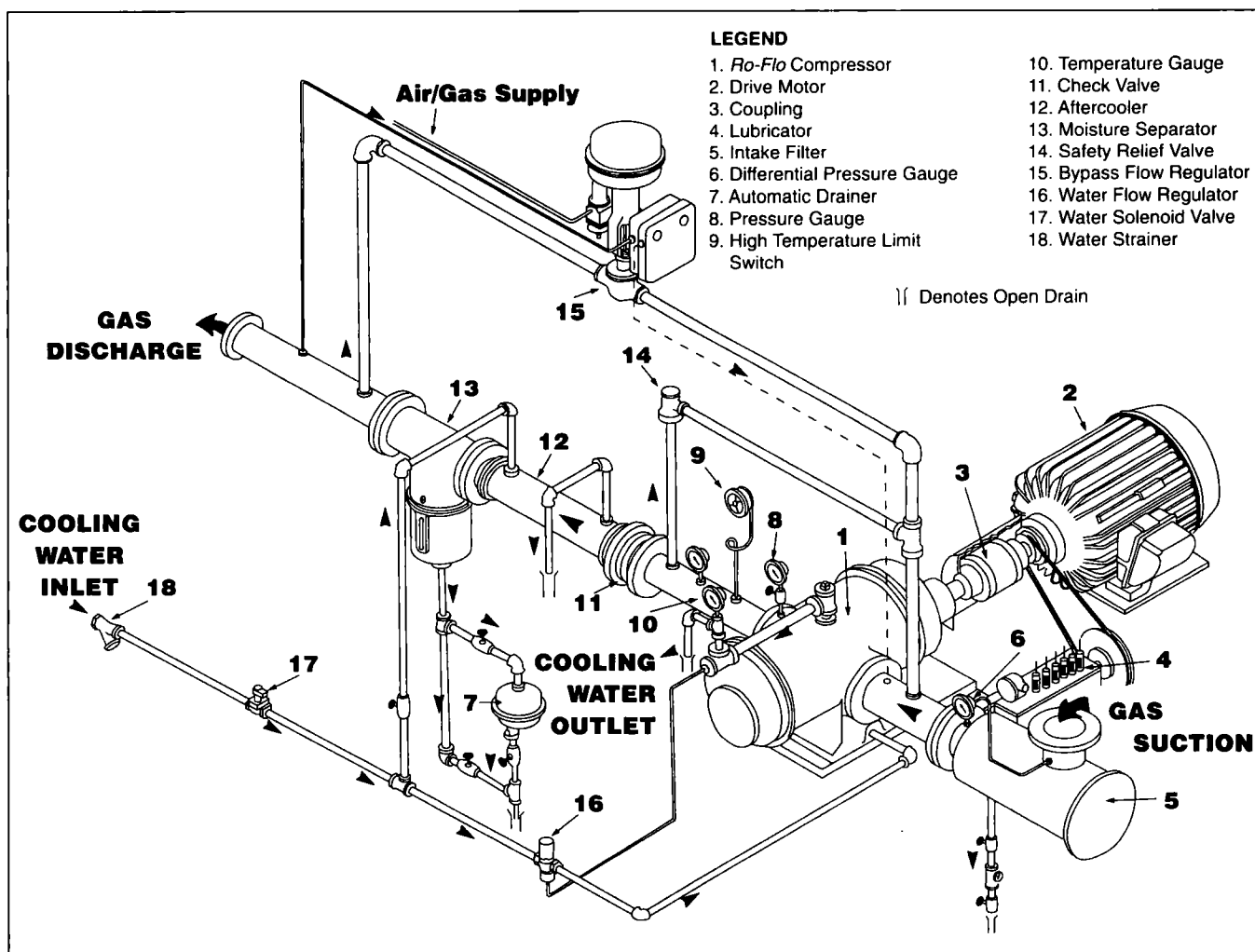


FIG. 8 — Typical piping arrangement for gas installation.

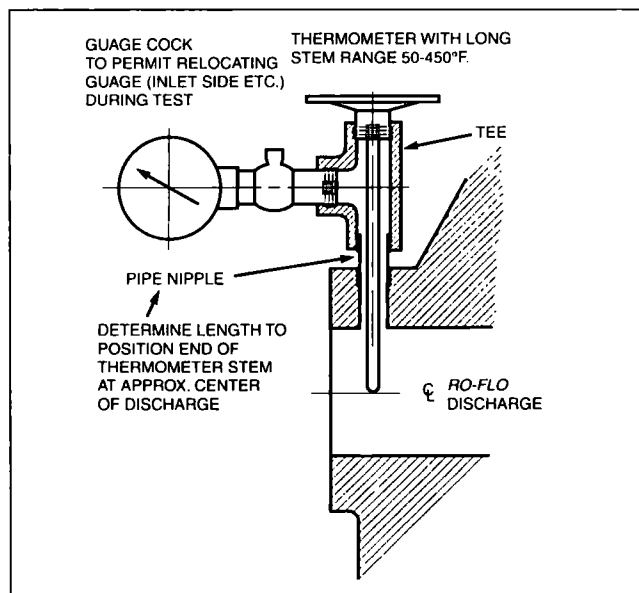


FIG. 9 — Typical pressure gauge and thermometer installation.

PIPING; COMPRESSOR COOLING

General

Coolant must always be in the compressor jackets prior to start-up. For some applications where little heat removal is required from the gas being compressed, the jacket filled with water, glycol/water, or oil may provide adequate cooling without continuous flow of coolant into and out of the jacket. A 1 to 3 foot high standpipe in the compressor coolant outlet is desirable to provide venting and also to easily check that liquid level is at top of compressor jacket. This arrangement may be used when the resultant gas discharge temperature will be less than 210°F. Static cooling usually applies in applications of low compression ratio through the compressor. Consult the factory to determine whether your application meets these criteria. See "Static Cooling" for details. Most applications, however, require an ample quantity of clean coolant to the jackets with the coolant outlet temperature maintained between 100°F and 110°F.

WATER TEMPERATURE FLOW REGULATOR

The most common once through cooling systems use a flow regulator installed as shown on Figure 10. Note that the sensing bulb is installed in a horizontal or vertical position such that the bulb is in full contact with all of the coolant flow. An adjustment on the valve is provided to set outlet liquid temperature to the desired $105 \pm 5^\circ\text{F}$. When operating the compressor for the first time, and also after coolant has been drained from the jackets, it is necessary to fill the jackets prior to start-up by means of the flow regulator bypass.

WATER SOLENOID SHUT OFF VALVE

Solenoid valves in Figure 10 are wired to open the coolant line when the compressor is started and close when the compressor is stopped, thus avoiding a manual valve operating task. Good piping practice requires bypass valves around the solenoid valve and the water control valve.

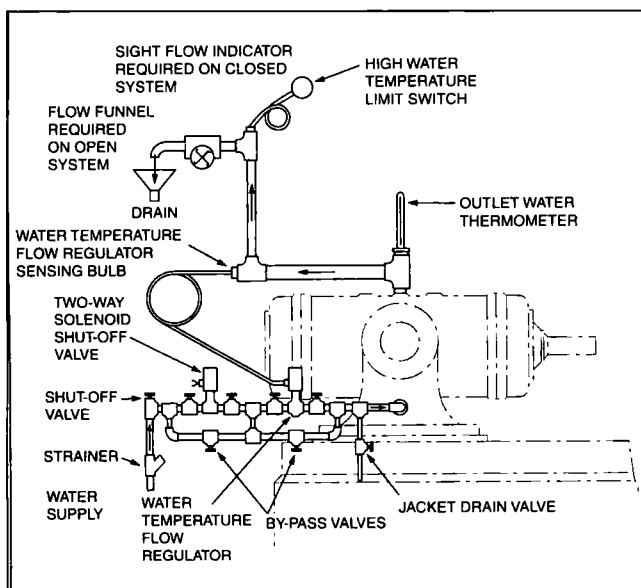


FIG. 10 — Typical compressor cooling (open loop system).

WARNING

Excessively cold jackets or circulation of coolant during shutdown periods may cause damage thru rotor/cylinder contact.

WATER FLOW QUANTITIES NEEDED

To remove the heat build-up in compressor jackets, which is equal to approximately 30% of motor horsepower, water piping should be installed to pass the following approximate gallons per minute flow rate:

$$\text{GPM} = \frac{\text{Motor Horsepower}}{10}$$

except on single stage vacuum pump applications where the approximate gallons per minute are:

$$\text{GPM} = \frac{\text{Motor Horsepower}}{5}$$

The above approximations are based on a design water temperature rise of 15°F. This quantity will maintain 105°F discharge temperature with 90°F incoming water. The use of aftercoolers or intercoolers on multistage applications will require additional coolant flow. Consult factory for guidance.

COOLING WATER CONTAMINANTS

The total water hardness (TDS) of the cooling water should not exceed 300 ppm (mg/l).

Contaminant levels approaching this level will cause mineral deposits over time and will require periodic acid cleaning of the water jackets.

Water containing suspended solids should not be used since the solids will rapidly settle out in the water jackets.

COOLING WATER PRESSURE DROP

For the above approximate cooling water flow rates of single stage compressors, a pressure drop of 5 PSI may be assumed. In addition, there will be a pressure drop of approximately 20 PSI through the water temperature flow regulating valve and inlet solenoid shut off valve.

CAUTION

Where cooling water pressure is less than 10 PSIG, a more detailed check of piping and component pressure drops is recommended to assure that the required coolant flow rate will pass through the system. Additionally, pressure in the water jackets must not exceed 50 PSIG.

RADIATOR COOLING

Closed loop glycol/water (Figure 11; Page 11) radiator cooling systems may be designed for the approximate flow rates shown in the section "Water Flow Quantities Needed." An adequately sized radiator will reduce the coolant temperature approximately 15°F and also no higher than 20°F above the ambient air temperature passing over the radiator. Thus, in hot environments with air passing over the radiator at 95°F, the compressor coolant temperatures will be 115°F in and 130°F out of the compressor. These resultant warmer jacket temperatures may limit the use of radiator cooling to lower compressor discharge pressures. The factory should be consulted to determine in your application is suitable for radiator cooling.

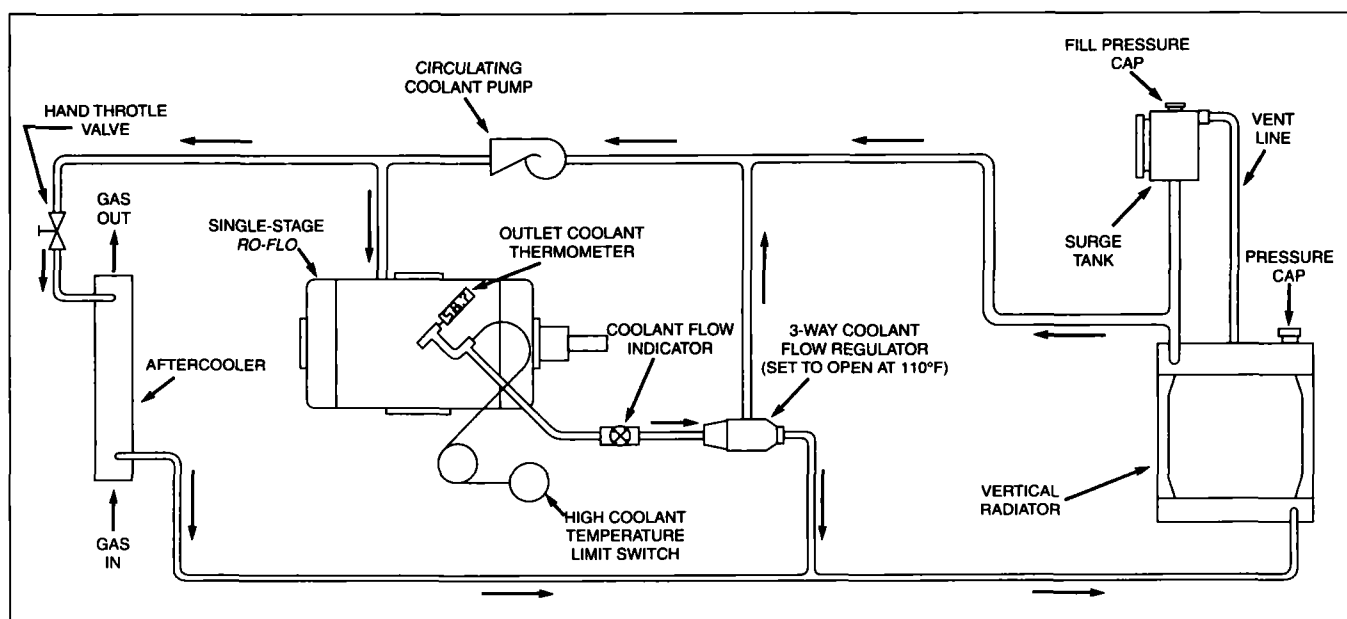


FIG. 11 — Typical compressor cooling (closed loop system).

A three-way coolant flow regulator, as shown on Figure 11, is an essential requirement to maintain compressor coolant outlet temperatures above 100°F during periods when ambient air temperature is less than 65°F.

COOLING SYSTEM ACCESSORIES

Desirable accessories for use on well designed cooling systems are shown on Figure 10; Page 10. Additionally, local circumstances may also merit installation of a solenoid drain valve to automatically drain the jackets when the motor stops. This is needed where cooling water is used in an area subject to freezing.

STATIC COOLING

Water can be used as a coolant up to 175°F gas discharge temperature; light oil (transformer oil) can be used up to 200°F. Higher gas discharge temperatures will cause water to evaporate and oil to deposit varnish on jacket walls. A standpipe with vent must be provided to allow for expansion. Somewhat higher temperatures may be tolerated if a heat transfer fluid is used. Examples of commercially available heat transfer fluids are: Paratherm NF®, Dowtherm ®J, and Syltherm® XLT. Note: above cited temperatures are those for running water cooling. Actual discharge temperature with static cooling will be higher.

COMPRESSOR COOLING WATER JACKET CAPACITIES

Compressor Model	Approx. Gallons
5CC	1.25
7D	3.00
8D	5.50
10G	8.00
11S	10.00
11L	10.50
12S	12.50
12L	13.75
17S	20.00
17L	24.50
19S	27.00
19L	30.00
206,207,208	2.8
210M	6.0
211M	9.0
212M	10.5
217M	13.0
219M	16.3
23C,D	57.5
27D,E	

III. OPERATION

PRE START-UP CHECKS

- Open inlet and discharge line drain valves to assure no liquid is present. Where no drain valves are installed, slack off the inlet and discharge flange bolts to determine if any liquid has entered the cylinder bore.

CAUTION

Liquids in the compressor during start-up can break the rotor blades or crack the cylinder.

- Manually rotate the compressor shaft to assure no rubbing or binding.
- Check motor for correct direction of rotating by momentarily "jog" start/stop.
- Recheck all piping and flange connections, in addition to valves on suction and discharge lines.
- Oil bath filters should be filled to correct level with SAE 5 oil in cold locations and SAE 30 oil in indoor installations.
- Lubricator should be filled with oil and each lube line primed by loosening the tubing nut at each oil line check valve and pumping oil until all air is purged from the lines - then retighten the tubing nuts. With belt-driven lubricators, assure belt has neither excessive slack nor excessive strain.
- Verify that jackets are filled with coolant and purged of air. (See installation instructions).
- Where automatic control valves are installed, verify that signal air or gas lines are properly connected and that operating air (if required) is at the correct pressure. Refer to the specific automatic control valve installation directions and the following Start-Up Section - Automatic Valves.
- Unloaded starting - On some compressor systems, it is desirable to start the compressor unloaded. Compressors fitted with A-C Compressor Corporation unloading valves should have a three-way solenoid unloading valve de-energized to start unloaded. An on/off switch is commonly provided for this purpose.
- Large vacuum pumps may be started unloaded, to reduce starting load, by closing the inlet valve until full speed is reached. The inlet valve must be slowly opened immediately after full speed is reached.

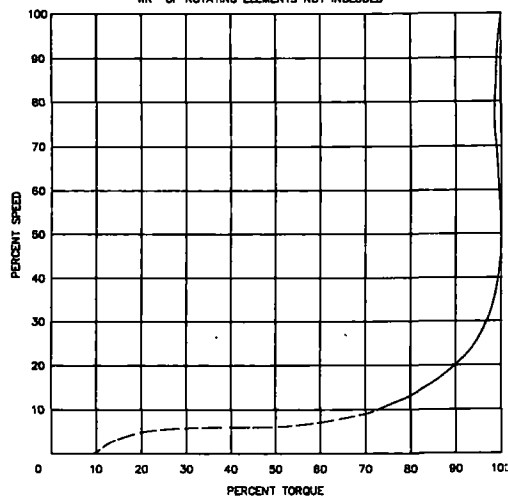
START-UP PROCEDURE AND CHECKS

Start the drive motor or turbine and observe the discharge pressure gauge as full speed is reached to assure the compressor and its attendant system of piping are responding as intended.

Visually check lubricator to assure that all oil feed points are receiving oil. Refer to this instruction book section entitled "Lubrication" for guidance (Page 21).

Load compressor or vacuum pump if it had been started unloaded.

STARTING TORQUE CHARACTERISTIC
FOR SINGLE STAGE ROTARY COMPRESSORS
SINGLE STAGE VACUUM PUMPS AND
TWO-STAGE VACUUM PUMPS
WR* OF ROTATING ELEMENTS NOT INCLUDED



TEMPERATURE CHECKS

Note the jacket coolant outlet temperature rise during the initial 20 minutes of operation to assure it stabilizes between 100°F and 110°F at the end of this period. Outlet temperatures higher than 110°F will result in excessive internal clearances and lower compressor volumetric efficiency. On compressors with a water temperature control valve, bring the coolant outlet temperature in this range. Allow approximately 15 minutes after each adjustment for the coolant to respond to the new adjustment. On radiator coolant systems, assure that the pre-set three-way coolant temperature valve is set to maintain 100°F to 110°F coolant outlet.

Aftercoolers and intercoolers with manual valves for controlling coolant flow rates should have flow rates throttled such that the air or gas outlet temperature is approximately 15 to 20°F higher than the coolant supply temperature. Note that when the correct coolant flow rate through the cooler has been reached, no significant reduction in cooler outlet temperature is possible by increasing coolant flow, thus unnecessarily high water flow rates are simply a waste of energy.

Discharge temperatures - This is the most important indication of how well the compressor is operating, hence should be noted **not only during start-up checks but periodically during normal operation**. To be valid, a temperature indicator must be at or within one foot from the discharge flange and additionally extend into the center of the gas stream (see Fig. 9; Page 9). Temperatures are then compared with the discharge temperatures which should normally exist with identical gas having the same conditions of:

- a. inlet temperature
- b. inlet pressure
- c. discharge pressure

The instruction book addendum entitled "Temperature Tells All" provides an easy to use nomograph (Page 18) determining discharge temperatures when dry air is compressed. Approximate discharge temperatures for gases other than air may be determined from the curve in the appendix titled "Gas Compressor Discharge Temperatures." Gases containing liquids in mist form will produce discharge temperatures which differ from air, hence, it may be advisable to contact A-C Compressor Corporation for guidance in determining the normal discharge temperature for your operating conditions.

Vacuum pumps compress very low density air or other gases, hence, discharge temperatures approximate those shown on Page 18.

CAUTION

Continuous operation with discharge temperatures at 350°F or above will result in reduced blade life and should be avoided.

After the preceding checks have been made and the compressor is operating smoothly with pressures and temperatures stabilized, the safety switches and automatic valves are to be checked and set.

PROTECTIVE SWITCHES

Detailed instructions are included with the specific type switches supplied with the compressor. Some important and basic considerations are noted below.

Checking Switches

All pressure and temperature switches must be set at the desired set point and tested, preferably by simulating the set point in actual operation. Common set points for temperature switches are the highest normal operating temperature expected for that compressor application PLUS 10°F to 15°F. A compressor operating at low discharge pressures in a cool climate will have lower temperature switch settings than a compressor operating at higher pressures in a warm climate. To check a switch after the compressor has reached normal operating pressure and temperature, its set point is reduced to equal the existing observed pressure or temperature, so the switch will actuate. After this verification of switch calibration, the set point is increased slightly to avoid false tripping from occasional small and reasonable increases above normal levels.

Lubricator low oil level and belt breakage switches must be tested by simulating the condition.

AUTOMATIC VALVES – PRESSURE CONTROL

General

Where automatic valves are supplied, they are to be adjusted and tested during start-up checks. Prior to beginning start-up checks on systems with back pressure or bypass control valves, the manual valves around these automatic valves are to be opened, or alternately flow from compressor discharge is diverted into the discharge line until the automatic valve is adjusted and found capable of actuating at the desired pressure.

Setting Automatic Pressure Control Valves

Specific details are included with each of the different type valves supplied. It is essential that all control valves be set and checked not only for their point of initial opening but also for the point where the full capacity of the compressor is flowing through the valve. Self-contained back pressure control valves will begin to open at a set pressure and open sufficiently to pass full flow at some pressure higher than the set pressure. This difference in pressure called "droop," should be checked and noted during initial start-up.

EXPECTED SOUND CHARACTERISTICS OF SINGLE STAGE ROTARY COMPRESSORS EXPECTED SOUND PRESSURE LEVELS, db

Ro-Flo Model	Speed RPM	Disch Press PSIG	dbA @ 3'	O C T A V E C E N T E R F R E Q U E N C I E S h z										dbC @ 3'
				31.5	63	125	250	500	1000	2000	4000	8000	16000	
5CCA	1160	50	75	61	62	66	73	70	69	62	60	59	55	77
5CCB	1740	50	78	63	64	69	76	72	72	71	68	64	60	80
7DA	865	50	76	66	72	74	72	69	67	63	61	66	63	79
7DB	1160	50	80	66	71	76	78	72	71	67	69	74	70	83
8DA	865	50	86	78	69	77	83	79	82	74	70	62	63	88
8DB	1160	50	89	77	73	85	86	81	75	77	85	86	83	92
8DE	1160	50	90	76	74	81	87	80	77	78	86	79	82	92
10GB	865	50	89	78	85	87	86	81	78	72	80	72	61	90
10GC	1160	50	90	69	73	85	89	84	80	77	74	84	66	93
11S	865	50	90	70	72	86	88	85	81	73	76	83	59	92
11L	865	50	91	72	76	88	84	83	78	76	77	86	60	93
12S	865	50	91	69	67	78	80	81	80	84	86	83	67	94
12L	865	50	94	71	74	86	91	83	80	78	80	89	70	97
17S	690	50	95	72	72	88	90	89	83	83	89	84	73	98
17L	690	50	96	70	73	82	90	90	81	87	90	94	90	99
19S	575	50	94	67	81	85	84	91	86	91	86	90	77	100
19L	575	50	95	69	78	87	89	88	85	89	93	91	90	101
23C	495	40	92	73	82	88	86	89	87	87	81	75	65	94
23D	495	40	92	74	81	87	89	91	88	86	82	76	67	94
23E	495	40	93	75	83	86	90	89	86	88	84	80	83	96
27D	435	30	101	80	89	97	98	97	96	91	85	76	61	104
27E	435	30	102	80	89	97	98	97	96	93	88	60	64	105
33D	435	15	104	82	90	98	96	98	89	82	79	86	89	106
208B&E	1160	40	85	59	62	71	84	76	73	70	78	80	70	87
210, 210M	1160	40	84	65	76	81	80	75	76	75	73	70	66	86
211, 211M	865	40	85	63	75	80	82	74	77	76	71	73	69	87
212, 212M	865	40	86	65	77	82	81	75	78	82	73	75	70	88
217, 217M	690	40	87	66	76	80	84	72	79	85	82	84	73	89
219, 219M	575	40	87	62	78	77	81	78	80	85	84	86	64	90
219	575	40	89	62	79	77	86	78	82	85	83	85	63	92

EXPECTED SOUND CHARACTERISTICS OF SINGLE STAGE ROTARY VACUUM PUMPS
EXPECTED SOUND PRESSURE LEVELS, db

Ro-Flo Model	Speed RPM	Disch Press PSIG	dbA @ 3'	O C T A V E C E N T E R F R E Q U E N C I E S h z										dbC @ 3'
				31.5	63	125	250	500	1000	2000	4000	8000	16000	
5CCA	1160	25"HgV	75	61	60	66	72	69	70	66	61	59	52	76
5CCB	1740	25"HgV	76	62	61	68	73	74	70	69	63	60	55	57
7DA	865	25"HgV	80	66	65	69	74	77	71	71	62	59	54	82
7DB	1160	25"HgV	82	63	70	68	72	78	76	73	64	65	59	84
8DA	865	25"HgV	85	64	73	72	76	79	74	75	66	61	56	87
8DB	1160	25"HgV	86	62	71	74	77	82	78	77	72	72	62	88
8DE	1160	25"HgV	86	62	71	74	77	82	78	77	72	72	62	88
10GB	865	25"HgV	87	69	72	75	80	81	80	80	75	76	56	89
10GC	1160	25"HgV	88	68	73	76	81	83	81	82	78	78	61	90
11S	865	25"HgV	88	72	71	76	82	81	84	81	77	80	57	89
11L	865	25"HgV	88	71	73	77	83	82	79	80	79	81	60	90
12S	865	25"HgV	88	71	72	76	82	80	77	79	80	70	63	89
12L	865	25"HgV	88	73	69	78	84	79	82	78	80	63	64	90
17S	690	25"HgV	88	74	74	81	84	81	81	81	79	69	60	90
17L	690	25"HgV	89	74	75	82	84	80	83	82	78	67	62	92
19S	575	25"HgV	90	71	74	84	83	84	82	80	79	70	60	92
19L	575	25"HgV	91	73	77	85	82	83	83	81	78	73	65	93
23C	495	25"HgV	87	69	75	78	79	78	79	77	76	70	64	89
23D	495	25"HgV	88	72	77	82	83	82	82	82	77	69	62	90
23E	495	25"HgV	88	72	78	84	84	81	83	81	80	71	59	91
27D	435	25"HgV	89	78	82	85	85	83	84	84	79	70	58	92
27E	435	25"HgV	90	78	83	86	86	83	84	85	80	70	60	93
33D	435	25"HgV	93	86	89	90	88	88	86	84	80	72	64	95

VIBRATION

The maximum allowable vertical or horizontal overall vibration displacement amplitude for Ro-Flo compressors or vacuum pumps measured at the bearing housings is 2 mils peak to peak. In normal operation, the expected amplitude is approximately 0.5 mils peak to peak.

The maximum allowable vertical or horizontal overall vibration velocity amplitude for Ro-Flo compressors or vacuum pumps is .31 in/sec peak (.22 in/sec rms). In normal operation, the expected amplitude is approximately .21 in/sec peak (.15 in/sec rms).

IV. MAINTENANCE

PREVENTIVE MAINTENANCE

A good maintenance program should provide for periodic inspection of the machine and its components. The composition and temperature of the gas handled, as well as the severity of operating conditions, will determine the extent of preventative maintenance necessary. The following schedule showing typical frequency of maintenance should be adjusted to meet the needs of each installation.

MAINTENANCE SCHEDULE

24 Hours (Daily)

- Drain all points of liquid accumulation in the gas system (receivers, control lines, droplegs, interconnecting piping, separators, etc...).
- Fill lubricator supply tank and check feeds to assure oil is flowing to all points.

- Note the temperature at the discharge flange and verify it is as expected for the operating compression ratio and gas inlet temperature. (Refer to Temperature Checks in the Operation section).
- Inspect water piping for possible leaks.

300 Hours

- Inspect and clean inlet filter after first 300 hours and as frequently as necessary thereafter. If filter is oil bath type, change oil. Check filter skirt adjustment.

2000 Hours (Quarterly)

- Check blades to determine wear rate and general condition using the "Blade Criteria" (Page 20). Initially, a blade inspection can be made by draining coolant from the jacket area and removing only the outboard cylinder head. A new gasket should be used on reassembly of the cylinder head. This will permit a concurrent inspection of the cylinder bore,

outboard bearing, seal rings and rotor. Excessive or erratic wear of the bore and/or wear and deposits in the rotor slots are signs of inadequate air filtration and/or inadequate lubrication. Subsequent blade checks between scheduled blade change-outs may be made through cylinder inlet port or (on some models) the inspection port at each end of the cylinder adjacent to discharge flange.

4000 Hours (Semi-Annually)

- Check blades as in 2000 hour inspection.
- Inspect inlet filter and, if supplied, radiator for dirt build-up.
- Check temperature switches to verify they actuate at the set temperatures.
- Recheck coupling alignment.

8000 Hours (Annually)

- Completely disassemble unit.
- Inspect mechanical seal carbon(s) and its mating seal ring. If the carbon(s) are cracked, chipped or worn, replace the complete seal assembly. To illustrate seal removal, see applicable single face or double bellows seal instructions on Page 30.
- Inspect bearing inner race and rollers for rough marks, pitting or scoring. Replace bearings only if visible defects are found. If replacement is required, the inner race is removed by heating with a torch.
- Inspect the cylinder bore for any unusual wear pattern which may have produced horizontal or circumferential grooves of .010 in., or greater, from a thru circle. Honing or hand stoning may be used to improve bore condition where bore deviations are not severe. When scoring or severe wear is found, reboring is required along with subsequent realignment of the rotor and redoweling.

- Check blades as in 2000 hour inspection.
- Replace cylinder head gaskets.
- Inspect cylinder coolant jackets and the water side of other system inter-coolers or aftercoolers for possible build-up of solids and/or mineral scale. Solids, such as mud, may be removed by flushing with clean water or alkaline solution. Removal of mineral scales, requires circulation of an acid solution after the initial alkaline solution has removed the oil film coating the mineral deposits. If a radiator is used, clean the exterior surfaces to ensure maximum cooling efficiency.
- Inspect non-return valves, safety valves, drain traps, temperature and pressure switches for their mechanical condition. Test each to verify that it operates exactly as required.

DISMANTLING PROCEDURE

Outboard Cylinder Head:

- Drain water jackets.
- With the end cover remaining bolted to the cylinder head, remove cylinder head nuts and jack head away from cylinder at a uniform rate on each of the two dowel pins. Two jackscrews are provided with each compressor for this purpose.
- When the cylinder head is free from the dowel pins, it is lifted off using an eye bolt in the tapped hole at the top of the cylinder head.
- **NOTE:** Booster units require removal of seal and support for the shaft as illustrated on Figure 12.

Inboard, or Drive end, Cylinder Head:

- Remove drive sheave or coupling hub and spacer.
- Unbolt seal, or packing gland, as illustrated.

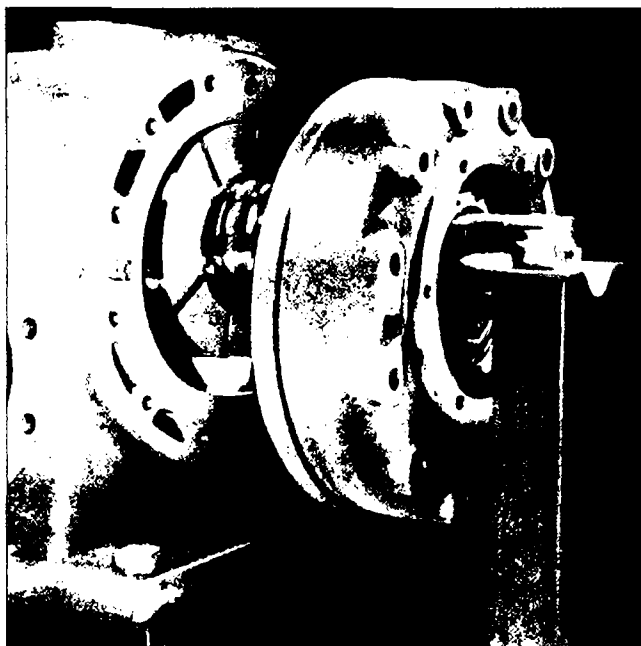


FIG. 12 — Shaft support-booster unit.

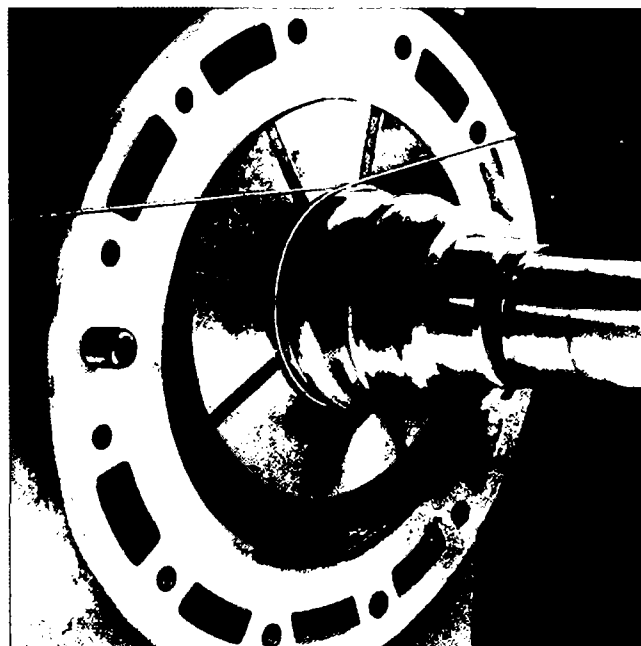


FIG. 13 — Compressing seal ring prior to replacing cylinder head.

- On models fitted with a bearing locknut, lockwasher and "H" ring, these must be removed before jacking the cylinder head away from the cylinder as described under "Dismantling Procedure Outboard Cylinder Head."

Blades:

- When blades are removed for periodic inspection, they should be kept in the same orientation for return to rotor slots.
- Refer to Blade Criteria in the Instruction Book Appendix for guidance with inspection.

Boosters — Maintenance Note:

- Boosters differ from Model 5 through 19 compressors in that the discharge flange points upward in the vertical direction and the rotor is close to the top of the cylinder as illustrated in Figs. 12 and 13.

The minimum "top clearance" stamped on the booster rating plate is set with the booster resting on its discharge flange (mounting feet up). See **RO-FLO** Nominal Dimensions Table.

Rotor/cylinder checks which are made with the booster discharge pointing upward will include bearing diametrical clearance in addition to minimum top clearance. Bearing diametrical clearance must be subtracted from the rotor/cylinder clearance determined in this manner in order to establish the true minimum "top clearance." Accordingly, it is preferable to accomplish booster disassembly and assembly work with the booster discharge clamped on the workbench facing downward.

Bearings — Also see Rotor:

- When bearing outer races and their accompanying shims are lifted from each cylinder head, their orientation should be noted such that they are reassembled in the same cylinder head and in the same direction as removed.

WARNING

The roller bearings used in **RO-FLO** compressors have special radial clearances (different than off-the-shelf bearings) to allow for thermal expansion and should never be replaced with non-factory specified bearings. Non-compliance can result in compressor failure and will void the warranty.

Seal Rings and Bearing Spacers:

- Rings are to be replaced if broken, worn or brittle.
- Bearing spacer rings which become scored, may be machined clean without their removal.
- Bearing spacer removal is accomplished by heat in the same manner as bearing inner race removal.

Rotor:

- For removal, slide the rotor part way out of the bore and support the outboard end to permit relocating lifting belt to the center of gravity for lifting rotor out of the cylinder. Lower rotor onto "V" blocks (on bearing inner races) for inspection and cleaning.
- Rotor straightness can conveniently be checked with dial indicator readings at each end of the rotor and shaft extension(s) while the rotor bearings are supported in the "V" blocks.
- The maximum allowable rotor runout at each end of the rotor, is .0015 inch total indicator reading taken while rotor rotates about its bearings or alternately bearing journals.
- When rotors are found to be bent beyond the above limit, A-C Compressor Corporation should be consulted for repair guidance.
- Removal of bearing inner races or bearing spacers is accomplished by applying heat quickly to the entire race or spacer such that expansion occurs before heat penetrates to the shaft.

REASSEMBLY PROCEDURES

- Install rotor into oil coated cylinder bore. On booster compressors, assembly is most convenient when the cylinder is clamped on the assembly table in an upside-down position.
- Check clearances and complete cylinder head and bearing assembly as described in the Section "Checking Clearances."
- Seal rings require compressing with a wire loop as illustrated on Fig. 13 (Page 15) to permit the cylinder head hub bore to slide over the rings.
- Reassembly after cylinder reboring will require redoweling as described in the Section "Redoweling Procedure."
- Cylinder head stud torque (ft.-lbs.) recommendations for lubricated studs:

Models	Stud Diameter Inches	Torque Ft.-Lbs.
4CC, 5CC, 7D, 10G, 210M	1/2	30
8D, 11, 12, 211M, 212M	5/8	60
17, 19, 217M, 219M	3/4	120
23, 27, 33	1	250

- Bearing H-ring, lockwasher and locknut (on units fitted with these) are installed after clearance checks are completed. The axial rotor float after "H" ring installation will then be limited to the small axial clearance within the bearing and its H ring.
- Stuffing boxes, when used in lieu of mechanical seals, should be packed snugly with adequate axial space remaining for retightening during operation.

RO-FLO TROUBLE SHOOTING CHART

TROUBLE	PROBABLE CAUSE	REMEDY
Discharge air or gas temperature excessive.	<ol style="list-style-type: none"> 1. Operation of machine at higher pressure ratio than rated. 2. Excessive suction temperature. 3. Insufficient or high temperature inlet water. 4. Scale or residue build-up in water jacket. 5. Clogged intake filter. 6. Unloading valve not fully open or clogged. 7. Suction valve not fully open. 8. Insufficient or wrong lubricating oil. 9. Swelled or warped rotor blades. 10. Improper clearances. 	<ol style="list-style-type: none"> 1. Operate unit at rating plate pressures. 2. Reduce suction temperature. 3. Increase water flow rate or provide cool water supply. 4. Clean water jacket and filter or treat water supply as required. 5. Clean intake filter. 6. Clean valve and replace any worn or broken parts. 7. Open suction valve. 8. Use correct oil and feed rates recommended in instruction manual or lube sheet. 9. Dry out or replace rotor blades. 10. Reassemble unit to proper clearances.
Excessive blade wear.	<ol style="list-style-type: none"> 1. Insufficient quantity of lubricant to one or more cylinder feeds. 2. Incorrect lubricant and/or viscosity. 3. Dirty inlet air or gas. 4. Excessive discharge temperature. 5. Floating rings stuck on Models 23C, 23D, 27D, or 33D. 6. Excessive discharge gas pressure. 7. Faulty lube oil check valve. 	<ol style="list-style-type: none"> 1. (a) Inspect lubricator V-belt for slippage or breakage; tighten or replace as required. (b) Check lube rate and increase by several drops per minute. (c) Inspect lubricator sight glasses; replace if cracked. (d) Inspect cylinder lube check valves; clean or replace as required. (e) Inspect oil holes in cylinder; clean if dirty. 2. Use correct oil and viscosity as recommended on lube oil recommendation sheet or instruction manual. 3. Clean and inspect intake filter or scrubber. 4. See remedies under excessive discharge gas or jacket outlet water temperature. 5. Disassemble unit and free floating rings. 6. Operate unit at rating plate pressures. 7. Replace or repair check valve.
Jacket outlet water temperature excessive.	<ol style="list-style-type: none"> 1. Insufficient or high temperature inlet water. 2. Fouled or faulty water temperature flow regulator. 3. Supply valve (manual or automatic type) either not fully open or clogged. 4. Inlet water strainer clogged. 5. Scale or residue build-up in water jacket. 	<ol style="list-style-type: none"> 1. Increase water flow rate or provide cool water supply. 2. Clean, repair or replace regulating valve. 3. Open or clean valve. Check solenoid and wiring on automatic type valve. 4. Clean strainer. 5. Clean water jacket.
Water drained from main or inspection ports.	<ol style="list-style-type: none"> 1. Leaky head gasket. 2. Leaky aftercooler or intercooler. 	<ol style="list-style-type: none"> 1. Replace gasket. 2. Remove cooler and hydrostatic test for leaks. Repair or replace leaky cooler.
Undue noise, vibration or periodic knocking.	<ol style="list-style-type: none"> 1. Worn bearing. 2. Excessive blade wear. 3. Erratic cylinder wear. 4. Insufficient lubrication. 5. Rotor contacting cylinder heads. 6. Misalignment. 7. Swelled or warped rotor blades. 8. Compressor unloaded. 9. Inadequate piping support. 10. Bad foundation. 	<ol style="list-style-type: none"> 1. Replace bearing. 2. Replace blades and check lubrication. 3. Rebore, redowel, and check lubrication. 4. See remedies under excessive blade wear. 5. Check temperature and pressure conditions; check internal clearances. 6. Realign units. 7. Dry out or replace rotor blades. 8. Load compressor. 9. Support piping. 10. Fix or replace foundation.
Low or no capacity.	<ol style="list-style-type: none"> 1. Restricted suction line. 2. Clogged inlet filter. 3. Defective bypass loop. 4. Wrong speed. 5. Excessive internal clearance. 6. Blades rubbing cylinder heads. 7. Blades binding in slots. 	<ol style="list-style-type: none"> 1. Remove restriction. 2. Clean inlet filter. 3. Repair valve or controls. 4. Operate at correct speed. 5. Reassemble unit to proper clearance. 6. Dry or replace blades. 7. Dry or replace blades.
Low or no pressure.	<ol style="list-style-type: none"> 1. Broken blades. 2. Defective bypass loop. 3. Blades binding in slots. 4. Leaky piping. 5. Restricted discharge piping upstream of gauge. 	<ol style="list-style-type: none"> 1. Replace blades. 2. Repair valves or controls. 3. (a) Clean slots or blades. (b) Dry or replace blades. (c) Reduce operating temperatures. 4. Fix leaks. 5. Remove restriction.
Excessive power consumption.	<ol style="list-style-type: none"> 1. Blades swelled or warped. 2. Operation at wrong pressure ratio. 3. K-value (ratio of specific heats) too high. 4. Inadequate lubrication. 5. Improper clearances. 6. Speed too high. 7. Scale or residue build-up in water jacket. 8. Abrasives/particulates in gas stream. 	<ol style="list-style-type: none"> 1. Dry out or replace blades. 2. Operate unit at correct pressure ratio. 3. Reduce pressure ratio. 4. See remedies under excessive blade wear. 5. Reassemble unit to proper clearances. 6. Reduce speed. 7. Clean water jacket. 8. Filter inlet gas.

TEMPERATURE TELLS ALL

Temperatures which deviate from normal are generally the first and most significant signs of machinery malfunction! To make use of this maxim in evaluating machinery performance, it is necessary to know:

1. Where are the most significant temperatures measured?
2. What are the temperatures of "normal" operation?

This instruction is concerned with temperatures which are used to evaluate the efficiency of compressing air or gas from suction to discharge.

Four facts are necessary to evaluate operation:

1. How much air or gas is going in.
 - a. For jobsite evaluation of **RO-FLO** compressors, flow rates which are too low can be detected by Items 2 and 3.
2. Pressure and temperature at the suction flange.
3. Pressure and temperature at the discharge flange.
4. The extent of jacket cooling, such as the quantity of cooling water and its inlet and outlet temperature.
 - a. With cooled compressors, performance is evaluated based upon a constant water outlet temperature. If this reading is correct, evaluation of water flow rates is not required.

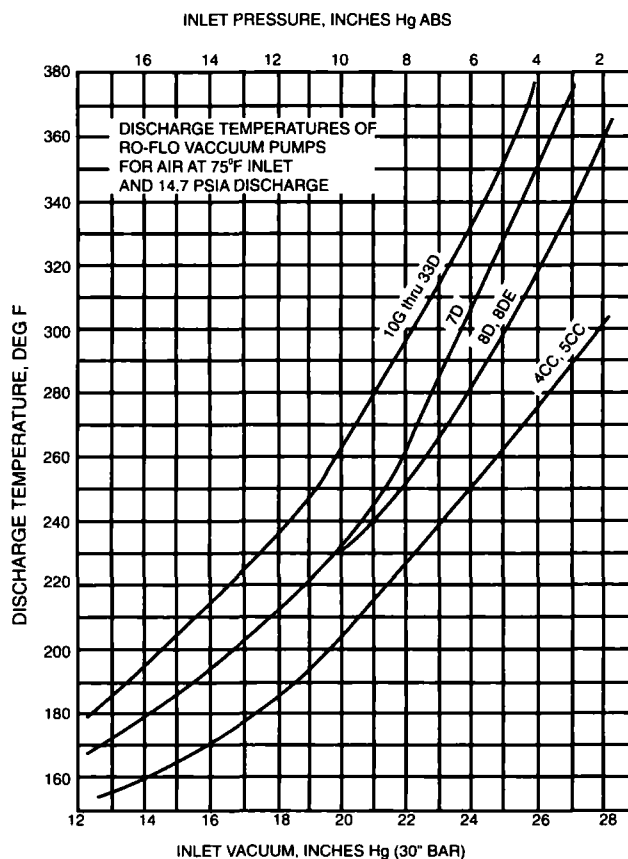
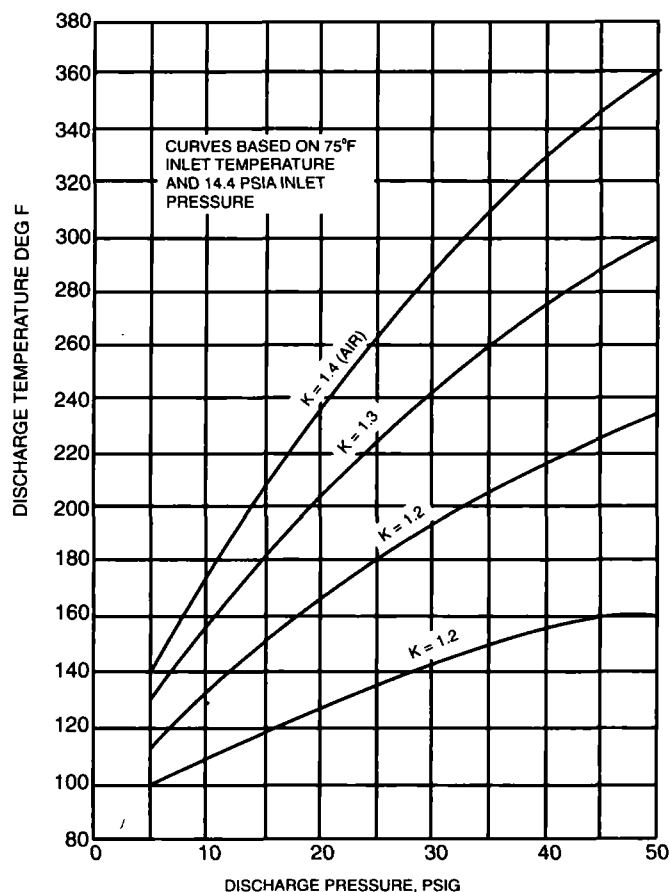
NOTE: Items 2 and 3 specify pressures and temperatures at the actual stage inlet and discharge. Discharge gas temperatures will change in passing through a partially plugged check valve or in flowing five, ten or fifteen feet downstream of the compressor discharge. If a thermometer is not located at the flange, it may be necessary to temporarily locate one at this point. Additionally, dirty intake filters, or faulty inlet side controls located ahead of the actual inlet, can be detected by taking pressure and temperature readings at the actual stage inlet flange.

Also recall that the compressor "sees" **absolute** inlet and discharge pressure rather than gauge pressures. Hence, to figure pressure ratio, add barometric pressure to observed inlet and discharge pressure readings. For most jobsite calculations, the use of 14.4 psia for barometric pressure will provide sufficient accuracy. Typical filter and inlet piping pressure drop for conservative discharge temperature estimates is .4 psi.

For example:

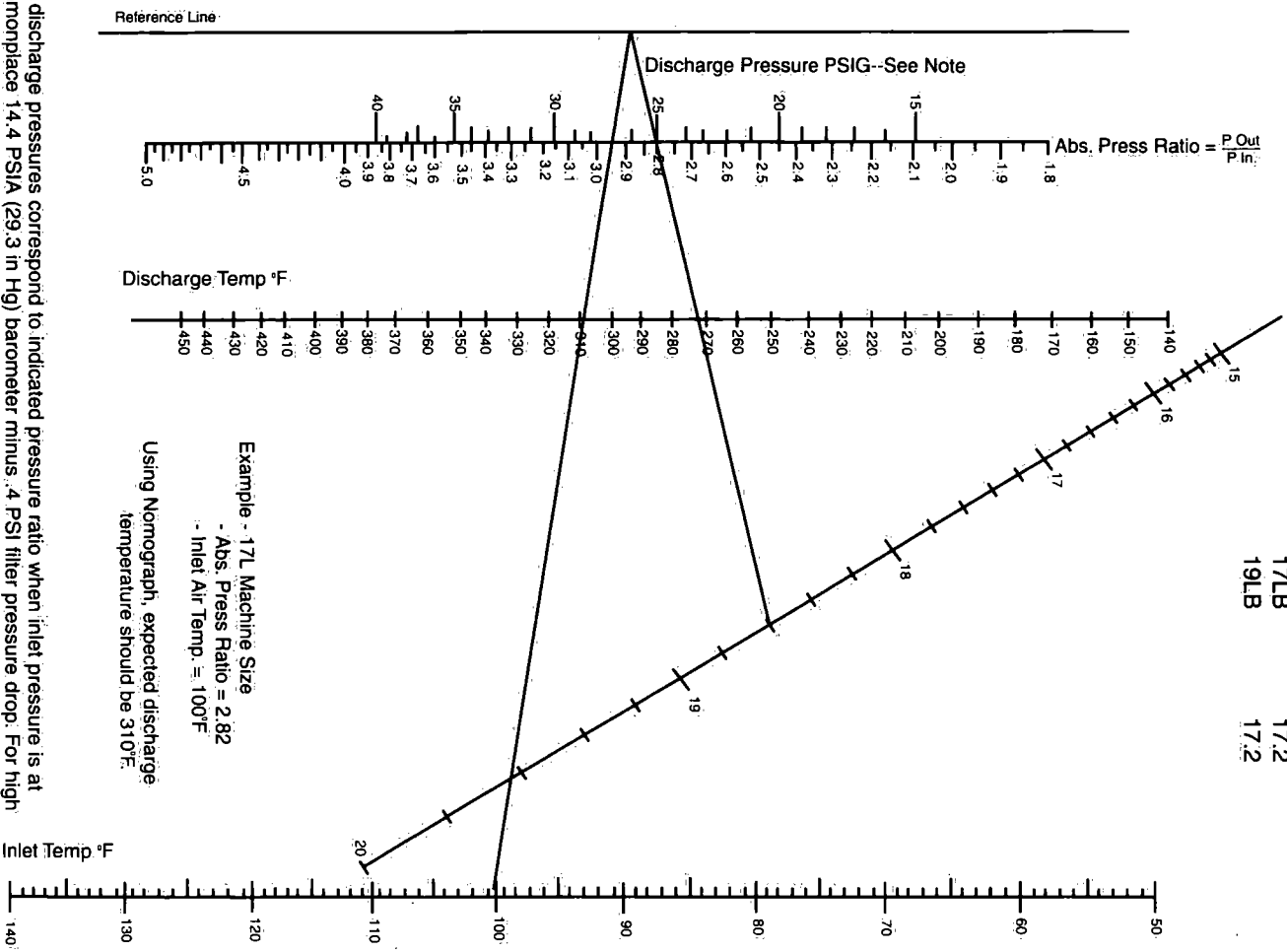
1st Stage Inlet:	14.0 psia
1st Stage Discharge Pressure:	25.0 psig
1st Stage Pressure Ratio =	$\frac{25.0 + 14.4}{14.0} = 2.81$

The nomograph on the following page will provide a quick answer to the question: What should the normal discharge temperature be for a **RO-FLO** air compressor?



1. Select the index point from the chart below.
2. Join the appropriate index point with the actual jobsite pressure ratio and extend this line to intersect the reference line.
3. From the point on the reference line, draw a line to the actual jobsite inlet temperature.
4. Read discharge temperature.

Machine Size	Index Point	Machine Size	Index Point
7D	19.0	208B	17.4
8DB	20.0	208E	18.0
8DE	19.2	210M	17.4
10GB	19.6	210M	17.2
10GC	19.3	211M	16.8
11S	20.0		
11L	20.0		
12S	19.9	212M	18.2
12L	20.0	217M	18.4
17S	18.6		
17L	18.6		
19S	18.6	219M	16.2
19L	18.6		
17LB	17.2		
19LB	17.2		



Note: The discharge pressures correspond to indicated pressure ratio when inlet pressure is at commonplace 14.4 PSIA (29.3 in Hg) barometer minus .4 PSI filter pressure drop. For high altitudes and boosters, use the pressure ratio after determining exact barometer reading.

GAS COMPRESSOR DISCHARGE TEMPERATURES

To determine approximate discharge temperatures of single stage **RO-FLOs** handling various "k" value gases at their saturated vapor condition, refer to the curve "Gas Compressor Discharge Temperatures." These discharge temperatures may be corrected for actual jobsite inlet temperatures which differ up to 40°F higher or lower than 75°F by adding or subtracting an equal amount from the curve discharge temperature.

Example: Gas with "k" value of 1.3 and an inlet temperature of 50°F (i.e. 25°F less than the curve value of 75°F) compressing to 30 PSIG.

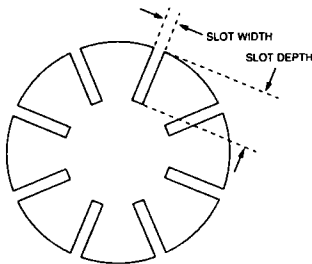
From the curve discharge temperature of 242°F subtract 25°F, hence, corrected discharge temperature is 217°F.

Additionally, because these curves are based upon gases at their saturated vapor condition, any lower actual jobsite discharge temperature will indicate "wetness" in the inlet gas stream.

BLADE CRITERIA

Wear occurs on the blade width as a result of the rubbing action against the cylinder wall, and on the thickness as a result of the rubbing action against the trailing edge of the rotor slot. The maximum allowable wear recommended is, on the width, 10% of the rotor slot depth, and on the thickness, 15% of the rotor slot width. For example, on a 10G unit:

Rotor Slot Depth2.375"
Allowable Blade Width
Wear0.238" (10%)
Rotor Slot Width0.250"
Allowable Blade
Thickness Wear0.038" (15%)



There is a safety factor built into the above limits, and based on many years of experience, these limits are an excellent reference and should therefore be followed. The "Blade Wear Limits Chart" below shows the allowable limits for blade wear on standard **RO-FLO** models if the slot width and depth are unknown.

BLADE WEAR LIMITS (Non-Refrigeration Only)

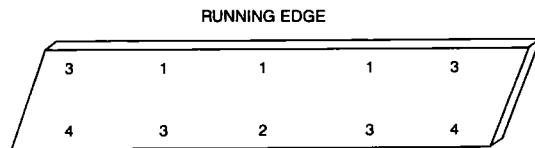
Model	Thickness Dimension (15% Wear)	Width Dimension (10% Wear)
4CC	.106"	1.012"
5CC	.106"	1.012"
7D	.159"	1.530"
8DB, 8DE	.212"	1.800"
10G	.212"	2.137"
11S, 11L	.265"	2.540"
12S, 12L	.265"	2.709"
17S, 17L	.319"	3.150"
19S, 19L	.372"	3.825"
23C, 23D, 23E	.425"	5.175"
27D, 27E	.425"	5.850"
33D	.535"	7.425"
208B, 208E	.212"	1.518"
210M	.265"	1.746"
211M	.319"	2.286"
212M	.319"	2.457"
217M	.371"	3.150"
219M	.425"	3.609"

Most blade failures result from the strain of flexure imposed on a weakened blade. Where the strain is minimal, such as in a vacuum pump, there is less probability of breakage than in a compressor with large pressure differentials between rotor segments.

The most common cause of weakened blades is a combination of time and temperature destroying the resins which bond the blade material. As a general rule of thumb, blade temperature is equal to discharge temperature. As noted in "Temperature Tells All" (Page 18) discharge temperature depends upon inlet temperature and pressure ratio.

From this we can conclude that blade resin will deteriorate much slower on a 25 psig unit than on a 40 psig unit. Furthermore, the rate of deterioration increases as temperatures exceed 300°F.

We have spoken of blade temperatures as though they were uniform throughout the blade. Actually, blade temperatures vary as shown in the illustration, where the numbers indicate relative magnitude of temperature. The number 4 designates the highest temperature.



This review of factors determining blade condition is intended to show why a simple test of either operating hours, wear, or pressure is not adequate to determine if blades should be replaced.

The following are some definitive guidelines in determining blade replacement:

- **Do not** reverse blade orientation because this causes a reversal of stresses.
- Signs of severe delamination of blade material or chipping indicate decay of blade resins and brittleness, hence, blade change is recommended.
- Regardless of low duty operating conditions, if a machine is opened after two years, change blades.
- On two-stage 100 psig units opened after 4000 hours of good operation, change both the low and high pressure blades as a precautionary measure.
- When inspecting a unit operating at discharge temperatures in the range of 325°F, the maximum prudent blade life expectancy should be based on 3000 hours. Therefore, if the unit is opened at 2500 hour intervals, blades should be changed.
- When jobsite operating conditions cannot be directly resolved according to these guidelines, a jobsite decision should take into account the factors described above.

BLADE PROTECTION ON IDLE UNITS

During idle periods, the rotor blades will swell due to the absorption of moisture, ammonia, or other vapors. The amount of swelling will depend on the amount of vapors or liquids present, the length of time the unit is idle, and the material used for the rotor blades.

WARNING

Blades that swell may bind in the rotor slots, causing additional stress to be imposed on any free sliding blades. This can result in broken blades and catastrophic failure of the compressor.

To prevent harmful swelling, the following action should be taken:

1. Run the compressor at least two hours a week. If the unit is exposed to high humidity, this running time should be increased. This will drive out any moisture absorbed by the blades.
2. If the unit is to remain out of service for six weeks or more, the blades should be removed and stored with a desiccant in a dry sealed container. The internals of the compressor should be sprayed with Tectyl 511-M coating or equal.

If the blades have swelled so they are tight in the rotor slots through moisture absorption, drying can restore their dimensions and can be accomplished as follows:

1. Stack the blades and clamp them together between metal plates to prevent warpage during the drying operation.
2. Bake the blades in an oven at approximately 260° for 24 to 48 hours.
3. After drying, the blades should be oiled and reinstalled in the compressor.

LUBRICATION

RO-FLO Compressors are oil lubricated by a forcefeed lubricator. The oil type and viscosity recommended for your unit are stamped on the rating plate. The printed "Lubrication Recommendations 16S9778-11 (form 3016-843)" sheet sent with your compressor should be used to select appropriate oils and to set oil feed rates. If the operating conditions or gas handled change, the following three items must be checked to ensure proper compressor lubrication:

1. **Oil Viscosity** — depends on gas discharge temperature.

RECOMMENDED OIL VISCOSITY GRADES

Gas Discharge Temp.	SAE Number	ISOVG
Below 200°F	20	32-68
200–250°F	30	68-100
250–300°F	40	150
Above 300°F	50	220

If the gas handled is expected to condense and dilute the oil, use the next higher viscosity grade. Multi-viscosity grades of oil are recommended for air inlet temperatures below 32°F, as are lubricator reservoir heaters and thermostat. On multistage units, use the highest discharge temperature to select the oil viscosity. If the inlet and/or discharge temperatures are consistently 70°F lower than those printed on the "Lubrication Recommendations" sheet, use the next lower viscosity grade. For solvents, heavy paraffins, and gasoline vapors use the next higher viscosity grade.

2. **Oil Type** — depends on chemical nature of gas/vapor being handled. See the "Lubricant Recommendations for **RO-FLO** Compressors" chart.
3. **Oil Quantity** — depends on compressor size and chemical/physical action of gas/vapor being handled. Refer to table on Page 22.

LUBRICANT RECOMMENDATIONS FOR RO-FLO COMPRESSORS

A-C Type	Description	Usage	Suggested Brands
A	Non-Detergent, Wax Free	Refrigeration — Ammonia Refrigeration - Freon	Amoco Refrigeration Compressor Oil Chevron Ammonia Refrigeration Oil ISO 68 Citgo Northstar Conoco Ice Machine Oil Exxon Zerice 68 and N68 Mobil Gargoyle Arctic Oil 300 Phillips Baltic Oils Shell Clavus AB Refrigeration Oils Texaco Capella WF Chevron Refrigeration Oils WF
B	Detergent plus additive package: Detergent, Antioxidant, Corrosion Inhibitor, Antiwear Agent, Foam Inhibitor Meets API C or S category for four stroke engines (eg. CG-4) low to medium ash Viscosity Index .....90-105 Pour Point.....10°F or lower Flash Point.....445°F or higher Fire Point.....490°F or higher	Air, All Non-Alkaline, Non-Polymerizing Gases	Amoco 300 Series Chevron Industrial Oils EP Chevron Delo 400 and Delo 100 Chevron RPM Heavy Duty Motor Oils Citgo Citgard 500 or 600 Citgo Pacemaker Gas Engine Oil 700 or 1600* Conoco HD Fleet Supreme Engine Oil Conoco El Mar 4000 Exxon XD-3* Exxon Estor Super, Select, GLX Mobil Delvac 1200 Mobil Delvac 1300* Phillips Super HD II Phillips XDS* Shell Rotella T Shell Fire & Ice Shell Mysella Oils Texaco Geotex Gas Engine Oil Texaco Ursa Extra Duty
C	Non-Detergent May contain corrosion inhibitor and antioxidant, Demulsifiers Viscosity Index 80-105 Pour Point 20°F or lower Flash Point 425°F or higher Fire Point 475°F or higher	Air, Inert Alkaline Clean Gases below 250°F. Where Separation from Water Desired	Amoco American Industrial Oils Chevron Turbine Oils GST Chevron Machine Oils AW Chevron R&O Machine Oil Citgo Pacemaker Oil R&O Conoco Dectol R&O Exxon Teresstic 100 or 150 Mobil DTE Oil Heavy or Extra Heavy Mobil Rarus 427 Phillips Magnus or RLX Natural Gas Engine Oil Shell Corena S Oils Texaco Regal R&O 100 or 150
D	Polar Compounded (3-10% fatty acids or polymers), Non-Detergent, Antioxidant, Corrosion Inhibitor, Emulsifiers	Wet Service below 250°F Do Not Use for Alkaline Gases. Does not separate from Water	Amoco Rock Drill Oil Heavy Chevron Rock Drill Oil Vistac Chevron Cylinder Oils W Citgo Rock Drill Oil Conoco EP Rock Drill Oil Conoco Syncon R&O Mobil DTE Oils 105 Mobil Rarus 427 Phillips Rock Drill Lubricant Texaco Cepheus
R	Polyalkylene Glycol	When Solubility in Water Desired, For Gas Turbine Booster	Mobil Glygoyle 22, 30 Phillips PAG Coolant Shell Madrela AS Oils UCON 50-HB-660-xy Anti-OX
S	Phosphate Esters	When Fire Safety Desired	Exxon Firexx HF-DU Mobil Pyrogard 53 Shell Madrela P Oils

NOTE: With oil types B and E, liquid type lubricator sight glasses are initially filled with a fluid called Fluorochemical 101 (FC-101). Each sight glass holds about 2 ounces by weight. FC-101 is a product of Minnesota Mining & Mfg. Co. and can be purchased directly from 3M when sight glasses require replenishing. A 50/50 mixture of water and glycerine is an inexpensive and easily obtainable substitute which may in time become cloudy from detergents in some oils.

*Previously type E super-detergent oils meeting API classifications SC, SD and CD with MS and DS additive packages.

In the table below, the oil quantities given are for air (1.0 multiplier). **For other gases, the following list of multipliers must be used to increase both the drops/min. and pints/hr. quantities shown.**

Gas/Vapor Handled	Multiplier
For air & dry inert gases	1.0
Water vapor, wet non-corrosive gases & vapors, condenser service	1.1
Refrigeration, sweet natural gas, methane, ethane, propane, butane	1.2
Sour natural gas, sludge gas, heavy hydrocarbons (pentane & heavier)	1.5

Gas/Vapor Handled

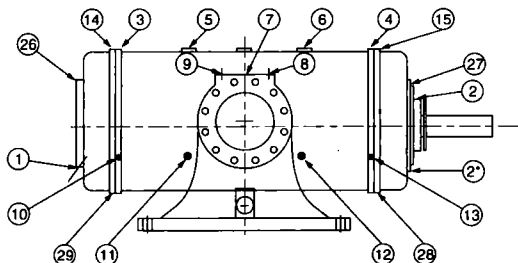
Vapor recovery, solvents, acids, ketones	2.0
Gasoline vapors	4.0

Multiplier

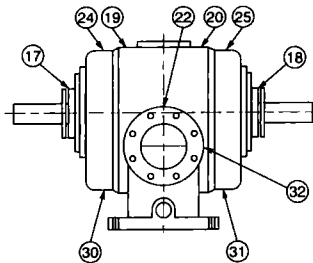
Note

1. Double the oil feed for initial break-in period of 300 hours.
2. Prime all oil feed lines before starting compressor.
3. **The rates shown are for guidance only. Set lubrication feed rates in accordance with the "Lubrication Recommendations 16S9778-11 (form 3016-843)" sent to you with the drawing transmittal. These recommendations take into account the rated speed of the compressor. The rates shown here are for compressors rotating at the standard rated speed.**
4. Inlet flange lubrication points 7, 8, 9, 22, 32, must have an inlet quill/check valve for proper cylinder lubrication.

LUBRICATING OIL QUANTITY REQUIREMENTS (Based on 1.0 multiplier)



INLET SIDE SHOWN



NOTE THE CRITERIA FOR CORRECT OIL FLOW RATE IS PINTS PER HOUR. DROP PER MINUTE INFO BELOW IS FOR GUIDANCE ONLY! USE DROP PER MINUTE INFO FOR INITIAL SETUP ONLY!
***ON UNITS WITH STUFFING BOX ONLY.**

Model	Points of Lubrication	Total # of Feeds	Pints/Hour Total	Drops/Min/Feed Wet Type 1*	Drops/Min/Feed Dry Type 2*
4CCA	1-2-7-14-15	5	.04	1	2
4CCB	1-2-7-14-15	5	.07	2	4
5CCA	1-2-7-14-15	5	.04	1	2
5CCB	1-2-7-14-15	5	.07	2	4
7DA	1-2-3-4-7-14-15	7	.06	1	2
7DB	1-2-3-4-7-14-15	7	.10	2	4
7DC	1-2-3-4-7-14-15	7	.15	3	6
8DA	1-2-5-6-7-14-15	7	.10	2	4
8DB,E	1-2-5-6-7-14-15	7	.15	3	6
10GB	1-2-11-12-7-14-15	7	.21	4	8
10GC	1-2-11-12-7-14-15	7	.26	5	10
11S	1-2-3-4-5-6-28-29	8	.24	4	8
11L	1-2-3-4-5-6-28-29	8	.30	5	10
12S	1-2-3-4-5-6-7-28-29	9	.34	5	10
12L	1-2-3-4-5-6-7-28-29	9	.34	5	10
17S	1-2-3-4-5-6-7-28-29	9	.34	5	10
17L	1-2-3-4-5-6-7-28-29	9	.41	6	12
19S	1-2-8-9-10-11-12-13-28-29	10	.38	5	10
19L	1-2-8-9-10-11-12-13-28-29	10	.45	6	12
23C,D,E	1-2-8-9-26-27	6	.61	6	12
	5-6	2		23	46
27D,E	1-2-8-9-26-27	6	.61	6	12
	5-6	2		23	46
33D	1-2-8-9-26-27	6	.76	6	12
	5-6	2		33	66
206, 207, 208A	17-18-19-20-30-31-32	7	.10	2	4
208B,E	17-18-19-20-30-31-32	7	.10	2	4
210B	17-18-19-20-22-30-31	7	.10	2	4
210C	17-18-19-20-22-30-31	7	.10	2	4
211	17-18-19-20-22-24-25	7	.15	3	6
212	17-18-19-20-22-24-25	7	.15	3	6
217	17-18-19-20-22-24-25	7	.21	4	8
219	17-18-19-20-22-24-25	7	.21	4	8
220	17-18-19-20-22-24-25	7	.26	5	10
210BM	17-18-19-20-22-30-31	7	.10	2	4
210CM	17-18-19-20-22-30-31	7	.15	3	6
211M	17-18-19-20-22-24-25	7	.21	4	8
212M	17-18-19-20-22-24-25	7	.21	4	8
217M	17-18-19-20-22-24-25	7	.26	5	10
219M	17-18-19-20-22-24-25	7	.26	5	10

*1. Drops/Min/Feed quantities based on 5000 drops/pint for a liquid-filled (tubular, SVK) wet type sight glass lubricator.

*2. Drops/Min/Feed quantities based on 14,000 drops/pint for a dry vacuum type lubricator.

Since most modern installations use dry vacuum type lubricators that allow the operator to see and count drops/minute, we are providing the following conversion information for various manufacturers and models.

Manzel Model 88V	14,115 drops = 1 pint	Premier Model P55	12,608 drops = 1 pint
Manzel Model 94 Dri-vac	14,115 drops = 1 pint	Lincoln Model 551	14,000 drops = 1 pint

Average drop size equals .0023 cubic inches; however, the oil viscosity may vary the drop size.

INLET QUILL / SHEAVE SIZE AND PART NUMBERS

Unit Size	No. of Lube Points (VR)	Inlet Quill Length "A" dim. and P/N	Compressor Lube Sheave
4/5	5	3" 00-733-637-012	3" 16-132-506-501
7	7	4" 00-733-637-016	3" 16-132-506-502
8	7	5" 00-733-637-020	3" 16-132-506-502
10	7	5" 00-733-637-020	4" 16-132-492-503
11	8	N/A	5" 16-132-534-501
12	9	6" 00-733-637-024	5" 16-132-534-501
17	9	6" 00-733-637-024	5" 16-132-399-501
19	10	8" (2 required) 00-733-637-032	5" 16-132-399-501
23/27 33	8	8" (2 required) 00-733-637-032	5" 16-132-399-501
206 Thru 208E	7	3" 00-733-637-012	3" 16-132-506-501
210M	7	4" 00-733-637-016	4" 16-132-492-503
211M 212M	7	5" 00-733-637-020	5" 16-132-534-501
217M 219M	7	6" 00-733-637-024	5" 16-132-399-501

Lubricator pulley 9.85 pitch dia. .5 bore 16-132-948-021
.625 bore 16-132-948-023

COMPRESSOR CLEARANCES

Important:

Clearances between the ends of the rotor and cylinder, the bottom of the rotor and cylinder, and in the bearings are all closely held and are extremely important for successful operation.

Note:

When reassembling a compressor, the clearances listed in the "**RO-FLO** Nominal Dimensions" table must be used. These clearances will be different from those shown on the nameplates of some existing compressors. Refrigeration compressors will have special clearances, so consult the factory if you are unsure of the proper clearances for your application. The new clearances should be stamped on the nameplate of every compressor so changed.

For identification, the driver end of the compressor is designated as the (A) end and the opposite end (with bearing end cover) as the (B) end.

Total Rotor Float:

Total Rotor Float is the axial movement of the rotor with the cylinder heads drawn up tight and the bearing outer race and roller assembly loose (not positioned) in the cylinder heads. Briefly, it is the difference between the inside cylinder length and the rotor length. (See Fig. 37, Detail 1).

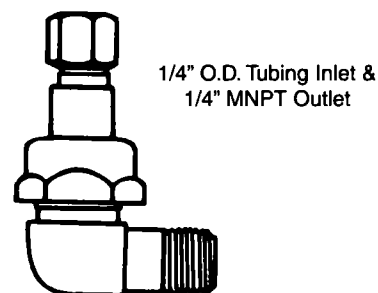
Fixed Rotor End Clearances:

Fixed Rotor End Clearances are the distances which the rotor ends are held away from the cylinder head faces after the bearings have been positioned. Bearings are positioned by inserting suitable thicknesses of shims between the outer bearing races and the machined bore in the cylinder heads. (See Fig. 37, Detail 2).

LUBRICATOR ACCESSORIES

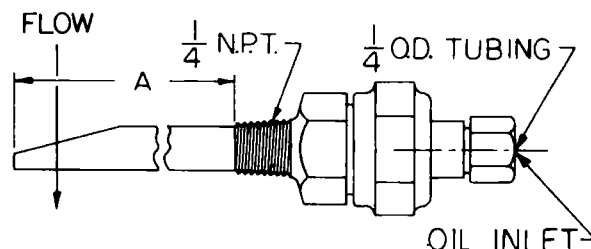
DOUBLE CHECK ANGLE TYPE TERMINAL CHECK VALVE

Part Number 00-733-627-217



COMBINATION CHECK VALVE AND QUILL

(see table for part numbers)



Free Net Rotor Float:

Free Net Rotor Float is the axial movement of the rotor after the fixed rotor end clearances have been set but without the H-ring installed. (See Fig. 37, Detail 3)

Note: H-Rings are installed on single-stage Models 17S thru 33D supplied with a single-face mechanical seal. H-Rings are also installed on single-stage models 11S thru 33D supplied with a double-face bellows seal.

The sum of the Fixed Rotor End Clearances and the Free Net Rotor Float should equal the Total Rotor Float.

Fixed Rotor Float:

Total axial movement or float of the rotor **AFTER** the H-ring (if provided) has been installed (See Fig. 38). The fixed rotor float is governed by the manufacturing tolerances of the (A) end bearing and the H-ring. This float reading should be recorded at start-up for future maintenance reference.

Bottom Clearance:

Bottom Clearance is the clearance between the bottom of the rotor and the cylinder bore. (see Fig. 37, Detail 4)

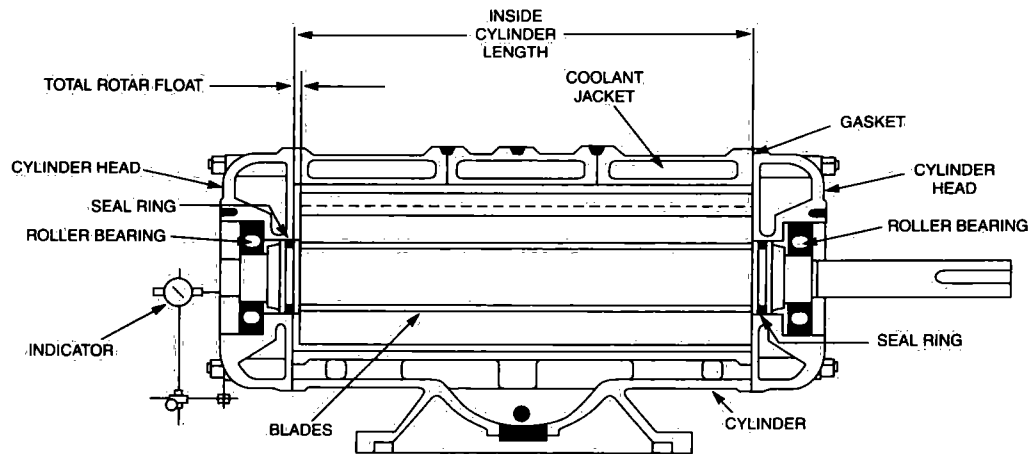
Top Clearance:

Top Clearance is the clearance between the top of the rotor and the cylinder bore (Booster units only).

FIGURE 37

(B) END

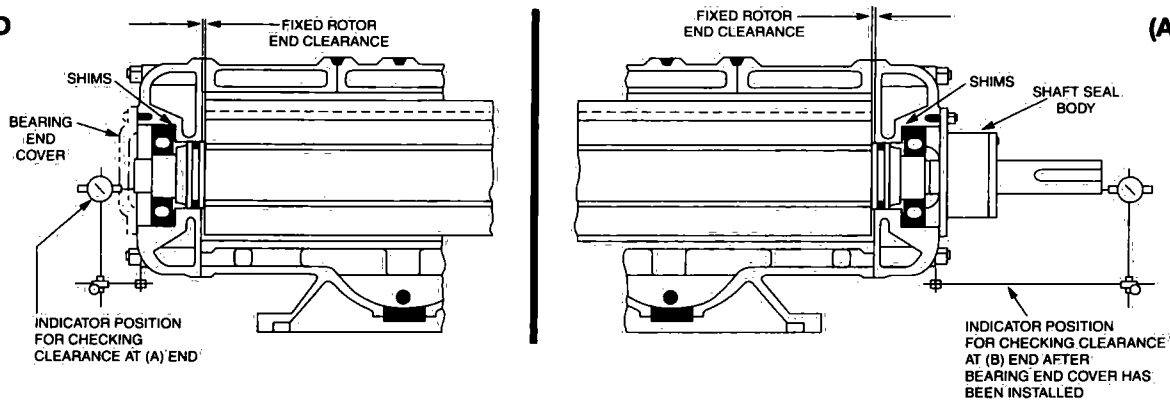
(A) END



DETAIL 1 — TOTAL ROTOR FLOAT — BEARINGS NOT POSITIONED BY SHIMS

(B) END

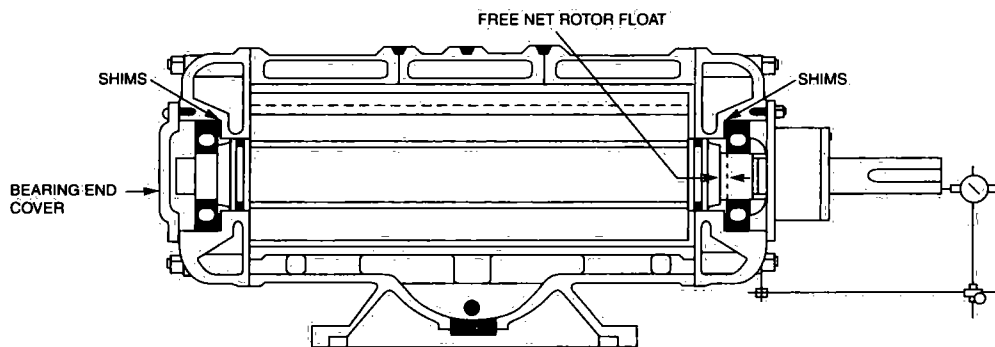
(A) END



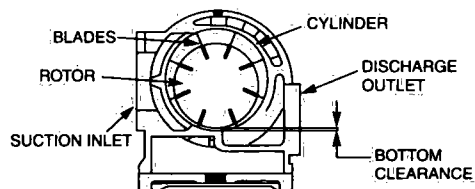
DETAIL 2 — FIXED ROTOR END CLEARANCES — BEARINGS POSITIONED BY SHIMS

(B) END

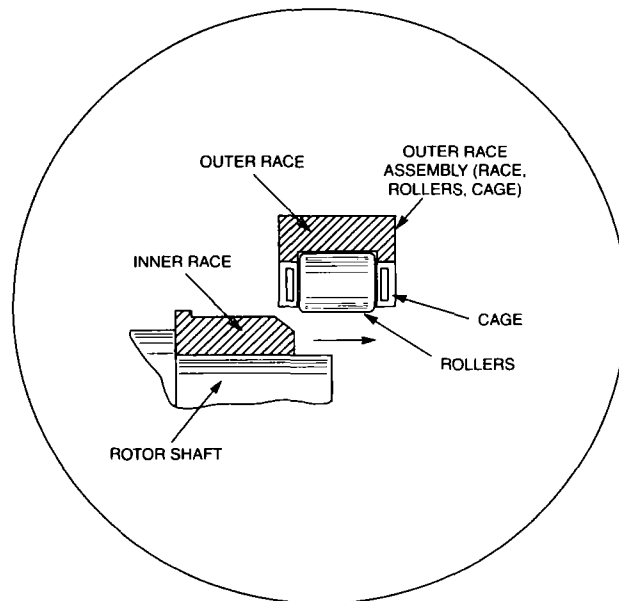
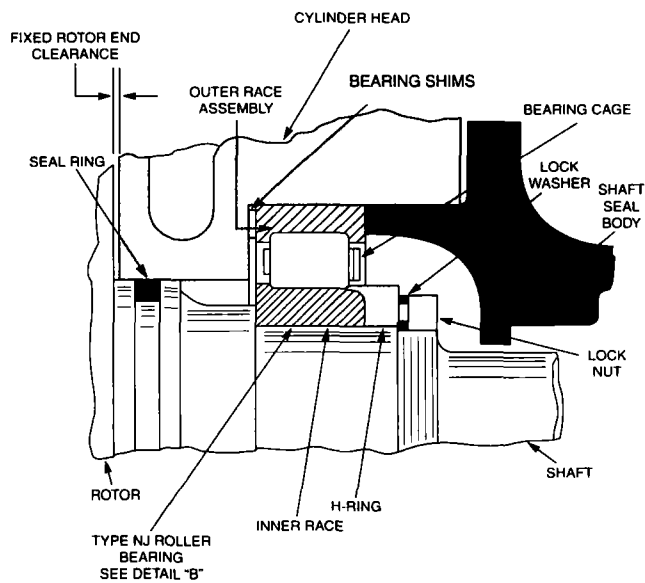
(A) END



DETAIL 3 — FREE NET ROTOR FLOAT (TOTAL ROTOR FLOAT LESS SUM OF FIXED ROTOR END CLEARANCES)



DETAIL 4 — BOTTOM CLEARANCE



OUTER RACE ASSEMBLY
REMOVED FROM INNER RACE
DETAIL "B"

FIG. 38 — FIXED ROTOR FLOAT, H-RING INSTALLED, ROLLER BEARING DETAILS

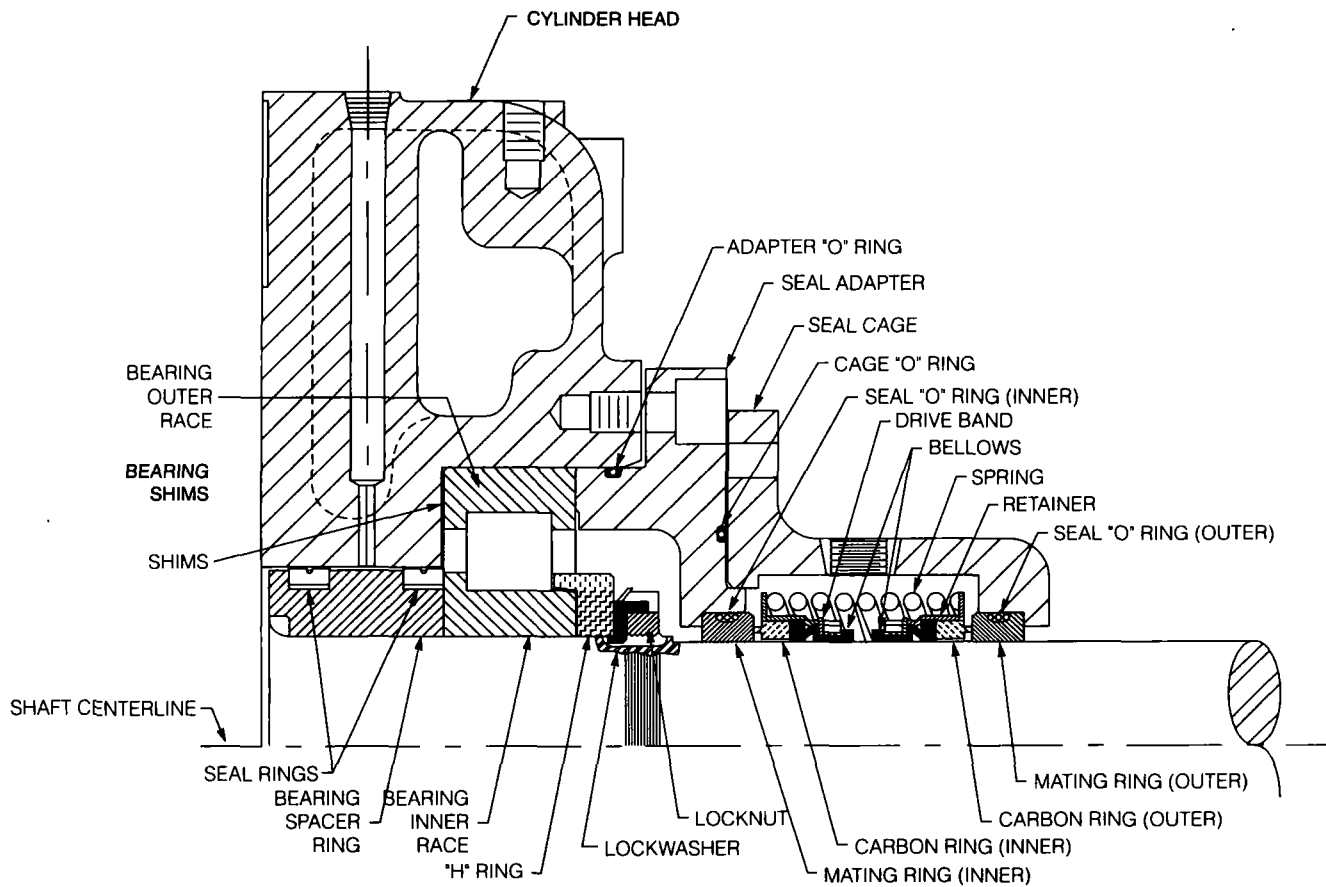


FIG. 39 — FIXED ROTOR FLOAT, H-RING AND DOUBLE BELLOWS SEAL INSTALLED

CHECKING CLEARANCES

Important: All clearance measurements must be made with the compressor parts at room temperature (approximately 70-75°F).

1. Place rotor in cylinder such that one end of rotor is flush with cylinder face at that end. Using a one inch depth micrometer, measure the distance from the opposite cylinder face to the end of the rotor at the point where rotor and cylinder bore touch.

If only one end of the cylinder is open, slack off 1/8 inch on the opposite end cover/or seal adapter bolts—whichever applies—to allow the rotor to be pushed against the cylinder head—then measure as described above.

This measured difference between cylinder and rotor length will equal the sum of net float and both end clearances, hence indicate how much axial play should exist when both heads are bolted to the cylinder and both the seal adapter and end cover are loose.

2. Install bearing outer races in their respective cylinder heads. Place gas-kets on each end of the cylinder and seal ring(s) on the rotor.
3. Install one head and bolt to the cylinder. Install blades from the open end assuring that they have freedom of movement within their slots and do not extend beyond the rotor diameter. Install the second cylinder head and bolt to the cylinder.
4. Force the rotor against one cylinder head with the aid of a pitch bar. Set a dial indicator at zero on one end of the rotor and force the rotor against the opposite cylinder head. The resultant measured axial movement from one head to the other is called **total float**. Refer to Fig 37, Detail 1. Its numerical value should be the difference in length between rotor and cylinder length (see step 1 above) less a tolerance of .002 inch for allowable misalignment.
5. A measured total float less than the amount by which rotor is shorter than the cylinder denotes either:
 - a. A small object (high spot) on a cylinder head or end of rotor preventing contact; or
 - b. The axis of the rotor is not parallel to the cylinder bore axis due to misalignment of one or both cylinder heads.
6. Measure the distance between the rotor and bottom of the cylinder at both ends of the cylinder using thickness gauges (feelers) as shown of Figure 14.
 - a. Distances measured on each end should be uniform within .001 inch, and equal to the value stamped on the nameplate as "Bottom Clearance."
 - b. A greater bottom clearance on one end will cause the rotor to be out of parallel with its cylinder bore as described in the preceding section 5 (b), thus necessitating redoweling. (See Redoweling Procedures on Page 28).
 - c. Bottom clearance readings which are equal but more than .002 greater than the nameplate value will result in a reduction in efficiency due to increased "blowby," hence redoweling may be recommended.

The bottom clearance shown in Fig 37, detail 4 will require resetting only when the cylinder or cylinder heads have been replaced or if the cylinder bore and/or rotor have been remachined and the unit must be doweled or redoweled (see Redoweling Procedures on Page 28).

The following steps to set rotor end clearance are to be taken only after correct axial float and bottom clearances exist (see Fig 37, Det 2).

7. To check end clearances, slack off 1/8 inch on the end cover or seal adapter bolts and force the rotor against one cylinder head.
8. Place a dial indicator on the opposite end of the shaft and set to zero.



FIG. 14 — Bottom rotor clearance check.

9. Tighten the end cover or seal adapter bolts on the end being checked such that the bearing outer race is pushed to its farthest inward position in the cylinder head. As the bearing moves inward, its rollers will push the rotor off the cylinder head.
10. The dial indicator will measure this distance which the rotor has been pushed away from the cylinder head. Move the rotor back to the head to insure a true reading (dial goes back to zero). This distance is called **End Clearance** and should equal the value stamped on the nameplate or listed in the **RO-FLO** Nominal Dimensions Table.
11. Should the dial indicator show an end clearance greater than the desired value, shims must be added between the bearing outer race and cylinder head. Conversely, if the end clearance was found to be less than the desired value, shims must be removed and end clearance rechecked. Example: if the desired clearance is 0.006" and the rotor movement was 0.015", then 0.009" of shims must be **ADDED**. Conversely, if the rotor movement was 0.004", then 0.002" of shims must be **REMOVED**. To remove a bearing outer race use a brass rod of approximately 1/8 inch diameter and bent with a small hook on one end. Insert the hooked end between rollers to the inboard side of the bearing and pull the bearing outward while concurrently relieving the rollers of shaft weight with a pitch bar exerting upward force on the end of the shaft.
12. Repeat steps 8 through 11 on the opposite end of the cylinder.
13. After the proper end clearances have been established, the rotor's axial float is again checked with the dial indicator. This movement from one bearing thrust collar to the opposite thrust collar is called **Net Float** and is numerically equal to the total float (step 4 above) minus both end clearances. (See Fig. 37, Detail 3)
14. For units supplied with H-rings, the **Fixed Rotor Float** should also be checked and recorded prior to start-up (see Fig. 38). The fixed rotor float is established when the H-ring, locking washer, and locknut are installed on the roller bearing at the shaft seal end of the compressor and the shaft seal adapter is bolted in place.

CAUTION

Be sure the rotor is positioned all the way toward the driver (A) end of the compressor before installing the H-ring. The fixed rotor float can be measured by installing a dial indicator on the (A) end of the rotor shaft and moving the rotor first toward the (B) end and then back toward the (A) end.

The machine clearances described provide proper bearing alignment and adequate clearance for rotor growth from the heat of compression, hence, assembly with the correct clearance is vital to trouble-free operation.

RO-FLO Nominal Dimensions

(All dimensions in inches)

Model	Flange Size		Shaft Diameter at Coupling	Clearances		
	Inlet	Disch		Net Float		Bottom
				Min	Max	
5CC	2	1.5	1.250	0.012	0.017	.002-.003
7D	3	3	1.625	0.023	0.030	.0025-.0035
8DB	4	3	1.625	0.034	0.044	.003-.004
8DE	4	3	1.625	0.034	0.044	.003-.004
10G	5	4	2.625	0.047	0.056	.004-.005
11S	6	5	3.000	0.050	0.062	.006-.007
11L	6	5	3.000	0.057	0.069	.006-.007
12S	8	6	3.000	0.055	0.067	.007-.008
12L	8	6	3.000	0.062	0.075	.007-.008
17S	8	6	3.500	0.065	0.078	.008-.009
17L	8	6	3.500	0.075	0.091	.008-.009
19S	10	8	3.500	0.080	0.097	.009-.010
19L	10	8	3.500	0.087	0.105	.009-.010
23C	12	8	3.500	0.080	0.096	.015-.016
23D	12	8	3.500	0.098	0.114	.015-.016
23E	12	8	3.500	0.098	0.114	.015-.016
27D	12	10	3.500	0.104	0.120	.017-.018
27E	12	10	3.500	0.104	0.120	.017-.018
33D	16	14	3.500	0.122	0.138	.020-.021
208B	3	2	1.625	0.014	0.021	.002-.003
208E	3	2	1.625	0.017	0.023	.002-.003
210M	4	2.5	2.625	0.024	0.030	.002-.003
211M	5	3	3.000	0.032	0.040	.002-.003
212M	6	4	3.000	0.035	0.043	.002-.003
217M	6	4	3.500	0.038	0.046	.002-.003
219M	8	4	3.500	0.033	0.041	.003-.004

REDOWELING PROCEDURES

Redoweling of cylinder and head is required when:

- Cylinder has been rebored.
- Cylinder or cylinder heads are replaced.
- Dowel pins have been deformed or broken.
- Rotor O.D. has changed.

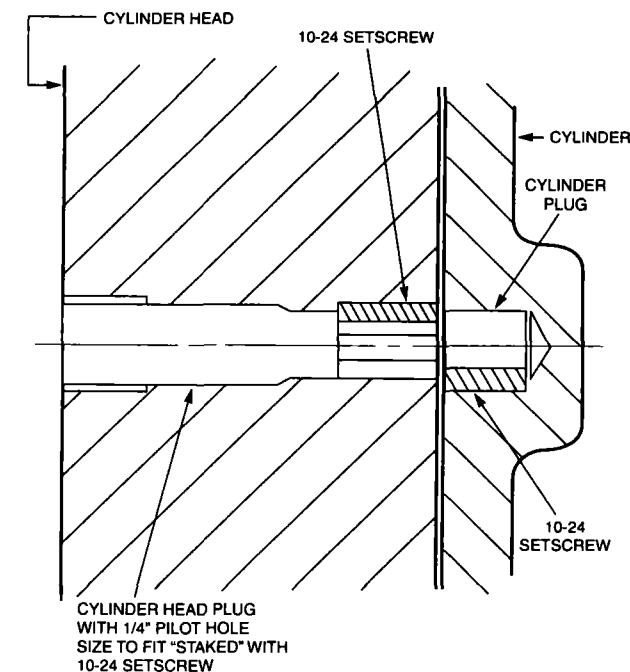


FIG 15. — Cylinder head plug with 1/4 inch pilot hole size to fit "staked" with 10-24 setscrew.

Preparation of rotor, heads, and cylinder for redoweling:

- The rotor must be indicated by rotating about its bearings (if bearing inner races are on the rotor) or bearing journal area. The maximum allowable runout between bearing journal and adjacent end of rotor is .0015 inch total indicator reading. The rotor diameter and ends must also be uniform and free of burrs.

Size of dowels:

The size of dowels to be used is determined from existing jobsite circumstances:

- Cylinder or cylinder head replacements on units which have 3/8 or 1/2 inch dowels may be redoweled with the next larger size dowel pin using standard size reamers and a portable hand drill.
- Redoweling on units which have larger dowels may be redoweled with the next larger size dowels. Alternately cast iron plugs (steel is too difficult to ream) may be machined for insertion into the existing cylinder dowel holes and secure with "Loctite" and an Allen setscrew between insert O.D. and cylinder (Figure 15). Similar cast iron inserts for the cylinder heads should be machined with a 1/4 inch pilot hole and secured as shown on Figure 15. These inserts will permit redoweling with 3/8 or 7/16 inch dowels. After redoweling, the diameter of jackscrew tips must be cut down to less than dowel diameter.

Rotor Alignment for Redoweling

1. Place rotor into cylinder. On booster units, the alignment work is to be done with cylinder upside down.

2. Note bottom clearance from nameplate and place shims equal to this rotor/cylinder clearance, plus .002, under each end of rotor approximately 1 inch in from cylinder flange. If nameplate bottom clearance is unavailable, see "**RO-FLO** Nominal Dimensions" for assembly clearances. These clearances do not apply to non-standard machines such as those in refrigeration applications.
3. Rotate rotor slightly so that the two uppermost rotor slots point approximately 22° to the right and left of centerline, respectively.
4. Secure rotor at three points on each end with brass bolts and nuts, as shown in Figure 16. The head of each bolt will butt against cylinder wall. The shank of the bolts, which are 22° from centerline, will extend into rotor slot. The third bolt wedges top of cylinder to top of rotor. The nut on each bolt is turned to lock the rotor into position.
5. Measure the distance between cylinder flange and the end of rotor at 90° each way from vertical centerline with a depth micrometer or feelers. If the axis of the rotor is parallel with the cylinder axis, the right and left rotor sides will be equidistant from cylinder flanges.
6. If, as expected, the above two readings are initially unequal, adjust two bolts at the 22° angle position on one end of rotor, then the corresponding two bolts on other end, to shift the rotor into alignment with the cylinder axis until flange/rotor depth micrometer readings are equal on both the right and left side of the rotor end.
7. Double check both rotor ends by measuring the comparable rotor end to cylinder flange distances. If one end of the rotor is "square" with the cylinder flange, the opposite end of the rotor must also be "square" with its adjacent cylinder flange. Only two possible conditions would give differing readings:
 - a. Cylinder flanges not machined perpendicular to cylinder axis.
 - b. Rotor ends not parallel due to shaft bend or improper machining.

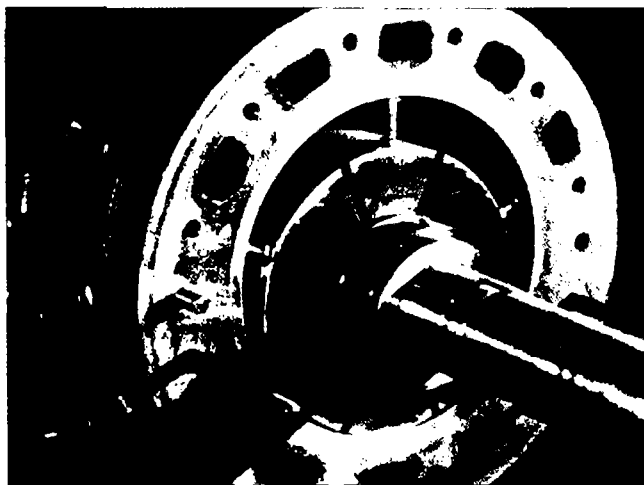


FIG 16. — Rotor alignment for redoweling.

POSITIONING HEAD FOR DOWELING:

- Assemble each cylinder head with its bearing outer race onto the cylinder carefully to avoid shifting the rotor and install a flat washer and nut, hand tight, on two opposite studs.
- Rotate the bearing outer race such that the two rollers on the bottom are equidistance from the vertical centerline.

- Rotate the head clockwise and counter-clockwise, within its travel as limited by the stud holes, to locate the head in the center of travel, then slightly snug both head bolts. The head positioned at the center of its rotation will guard against binding on the studs during removal.
- Gently lift each head vertically using an assembled nut and bolt as a jack beneath the head. The head is lifted just to the point where the bottom two rollers touch the inner race and all bearing clearance is between the top of the inner race and the rollers.
- "Fine tune" the position of each head by sliding a .0015 or .002 inch shim between the top roller and inner race clockwise and counter-clockwise. If the feeler does not slide an equal distance on either side of the inner race, tap the head to relocate its central position then tighten the nuts on both studs. Install the remaining nuts and washers on the studs and tighten firmly.

DRILLING AND REAMING:

- Protect the bearing from drill dust and chips with clean rags.
- If a cast iron plug with 1/4 inch pilot hole, as described under "Size of Dowels" has been installed in the cylinder head(s) the initial drill size should be 1/4 inch. Thus, the existing 1/4 inch hole in the plug will provide a guide for drilling one inch into the cylinder.
- Using a drill diameter 1/64 inch smaller than the selected dowel pin size, drill through the head(s) and one inch into the cylinder.

WARNING

The drill position must be exactly perpendicular to the cylinder flange.

- Remove the cylinder head(s) and shims from under the rotor. Hand ream the remaining 1/64 inch such that the dowels fit size to size in the cylinder heads and slightly snug in the cylinder. If a reamer of sufficient shank length is available, reaming may be done prior to removing heads.
- Break the sharp edges of the reamed holes and drive the dowels into the cylinder using a lead or brass hammer to prevent "mushrooming" the dowels.
- After all dowels have been driven into the cylinder and cylinder head dowel pins finish reamed, the heads are bolted into place for the check of rotor to cylinder clearance. The tolerances which govern rotor/cylinder clearance are more accurately governed by compressor size and operating temperatures. However, for jobsite guidance, the following tolerances apply:
 - Minimum bottom clearance: Nameplate clearance must be minimum.
 - Maximum bottom clearance: Nameplate plus .002.
 - See "**RO-FLO** Nominal Dimensions" for bottom clearance tolerances on standard machines.

- Maximum difference in clearance between "A" and "B" ends: .001 on units with blade lengths less than 12 inches, and .002 on units with longer blade lengths.
- Total float measured by dial indicator should be not less than .002 inch of the measured difference between rotor and cylinder length.

When replacement dowels are smaller in diameter than jackscrew drive tips, the tips must be cut down to less than dowel pin diameter. If clearance checks are not within tolerance after doweling rotor/cylinder, redoweling is necessary.

SINGLE FACE MECHANICAL SEAL (Rebuildable Cartridge Type)

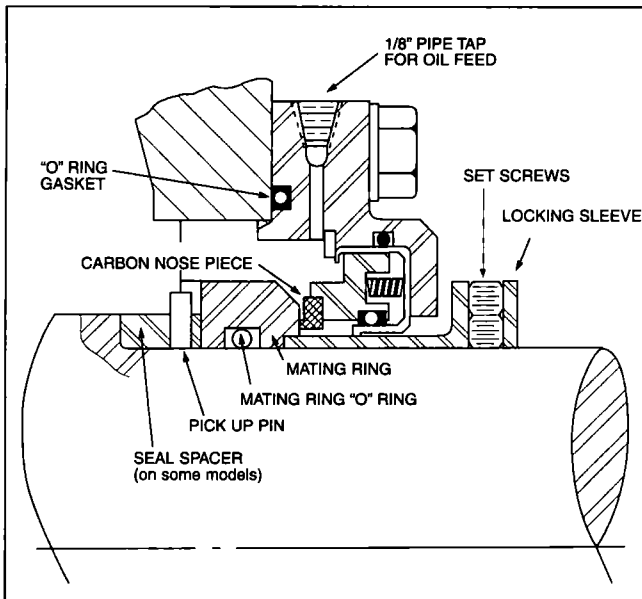


FIG. 17 — Single-face (KP type) mechanical seal.

These seal faces are lapped within two light bands and, therefore, should be handled with extreme care. To replace the seal:

1. Remove compressor coupling half.
2. Remove all old seal parts, except pick-up pin and seal spacer.
3. Remove all burrs from shaft and keyway.
4. Clean shaft and seal adapter bore.
5. Lubricate shaft and "O" ring in mating ring.
6. Slide mating ring on shaft until pick-up pin is in slot and mating ring is up against seal spacer. Mating ring must be square to the shaft to avoid seal wobble and premature failure.
7. Apply oil to seal faces with a lint free material such as facial tissue; do not wipe or rub dirty fingers over seal faces.
8. With o-ring gasket in place, slide seal assembly onto seal adapter.
9. Approximately 1/8" compression on seal wave spring should be observed to provide sufficient "preload" on seal faces.

10. Replace seal bolts and lock washers; tighten seal flange evenly.
11. Replace locking sleeve by holding locking sleeve tight against mating ring while tightening set screws.

DOUBLE BELLOWS TYPE SEAL

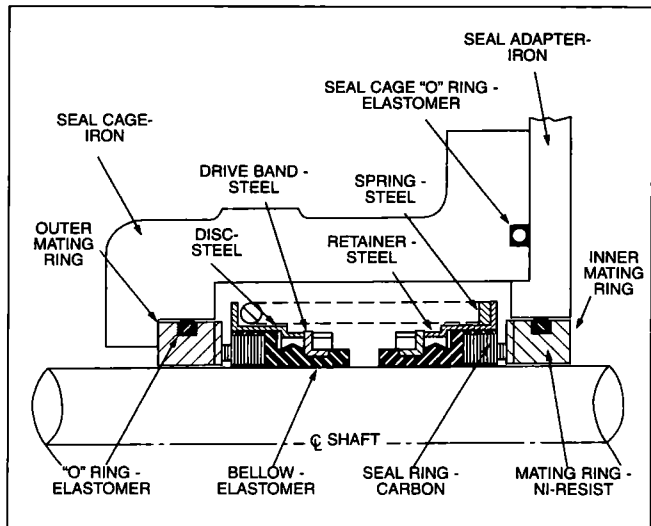


FIG. 18 — Details of double bellows mechanical seal.

General

The shaft seal (Figure 18) consists of two carbon seal rings (inner and outer) and two Ni-resist iron seal collars with a spring retaining ring, springs and the necessary gaskets and O-rings to provide gas tightness. The mating running face of the seal rings and collars are perfectly flat and accurately finished when fitted with a pressurized seal oil system (Figure 19) will provide a gas tight seal.

Replacing the Shaft Seal

Seal parts for all **RO-FLO** compressors are similar, physical dimensions of parts being determined by the shaft diameter.

If the shaft seal does not hold tight and frequent refilling of the oil reservoir is necessary, the seal should be replaced.

In servicing the shaft seal, care should be taken to follow the prescribed sequence for disassembly and assembly in order to avoid damage to the seal parts.

Disassembly

1. Pump the compressor down, close compressor suction and discharge isolation valves and the isolation valve feeding the shaft seal oil system. (see Figure 19).
2. Remove burrs from shaft using a file and emery cloth.
3. Drain oil and remove seal cage.
4. Carefully remove outer carbon ring from its steel retainer and from the shaft.
5. Lubricate the shaft generously with oil.

6. Pull on outer seal retainer to loosen outer rubber bellows and remove from the shaft. NOTE: Once the bellows has released its set on the shaft, it will slide easier off the shaft.
7. Remove spring from the shaft.
8. Pull on inner steel retainer to loosen inner bellows and remove bellows, retainer and inner carbon ring from the shaft.
9. Remove seal adapter. Inspect carbon ring for wear, chipping or pitting signs. Inspect mating ring faces for signs of wear or scratches. Inspect bellows and O-rings for signs of hardening, cracking or deterioration.

Assembly

1. Remove any burrs on shaft. Reinstall seal adapter.
2. If removed, replace inner mating ring into seal adapter by sliding it over the shaft and carefully push it into the adapter bore squarely until it bottoms on the shoulder in the bore. Be sure to lightly oil o-ring and bore before assembling.
3. Oil the shaft inner carbon ring and bellows of the matching seal part.

CAUTION

Elastomer bellows will swell when it absorbs oil, therefore, the entire seal must be assembled within seven or eight minutes after the parts are oiled. An elastomer lubricant such as P-80 sold by International Products Corp. will extend available assembly time.

Slide the carbon ring-retainer-bellows assembly over the shaft until carbon face contacts the inner mating ring face.

4. Slide the spring over the shaft.
5. Oil outer carbon ring and bellows and slide the ring-retainer-bellows assembly over the shaft until the retainer contacts the spring.
6. If removed, replace outer mating ring in the seal cage bore. Oil ring and bore lightly and push ring squarely into bore until it bottoms on the bore shoulder.
7. Carefully locate bore of seal cage with the shaft end and slide cage over the shaft until the outer mating ring contacts the outer carbon ring.

CAUTION

Be sure not to hit outer ring face on the shaft end while installing cage.

With one hand, push the seal cage until it contacts the seal adapter, being careful to make sure that the cage O-ring stays in the groove in the adapter face. Install two cap screws opposite each other and turn them until cage is up tight against the seal adapter. Install remaining cap screws.

Shaft Seal Oil System for Double Bellows Type Seal

The shaft seal oil system is designed to keep the seal parts submerged in oil and to maintain the pressure on this oil at all times regardless of system suction pressure. Thus, if leakage of the seal should occur, due to wear or otherwise, at the outer seal ring and collar, it will be outward or toward the atmosphere and air will not be drawn into the system. Leakage at the inner ring and collar would result only in the passage of a limited amount of oil from the shaft seal cavity into the compressor.

The double bellows type seal (See Figure 18) consists of two carbon rings which rotate and seal against two highly polished stationary iron rings. The seal is oil flooded by an oil reservoir mounted above the seal cage. The seal is both lubricated and cooled by thermal circulation of the oil.

The oil reservoir must be piped as shown in Figure 19. Be sure that the oil connection on the seal housing, closest to the discharge side, is piped to the oil reservoir upper connection to insure proper oil circulation. Use piping 1/2" or larger. Locate oil reservoir so piping is as straight as possible to minimize restriction to convective oil flow.

After filling the oil reservoir to the top of the gauge glass through the top connection, tube the top connection to the 1/4" F.P.T. connection on the top of the compressor discharge flange. This pressurizes the seal to provide the proper balance on the seal faces. Alternatively, an inert gas can be supplied if contamination is a concern.

NOTE: Be sure to maintain oil level in reservoir above upper pipe connection to provide proper oil circulation. Oil level will drop slightly during initial start-up.

Install a 1/4" valve in the oil reservoir pressurizing line to permit filling of reservoir. This will allow operator to valve off compressor discharge and vent oil reservoir to atmosphere for top filling.

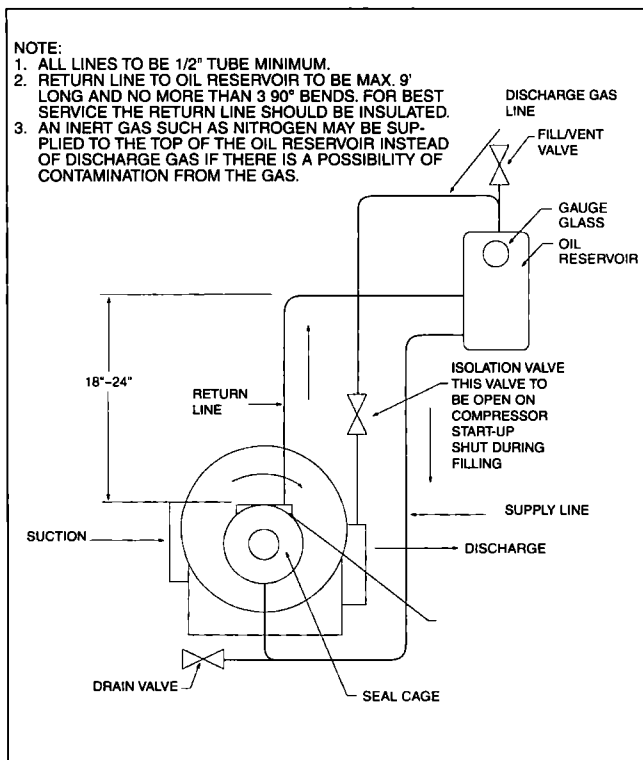
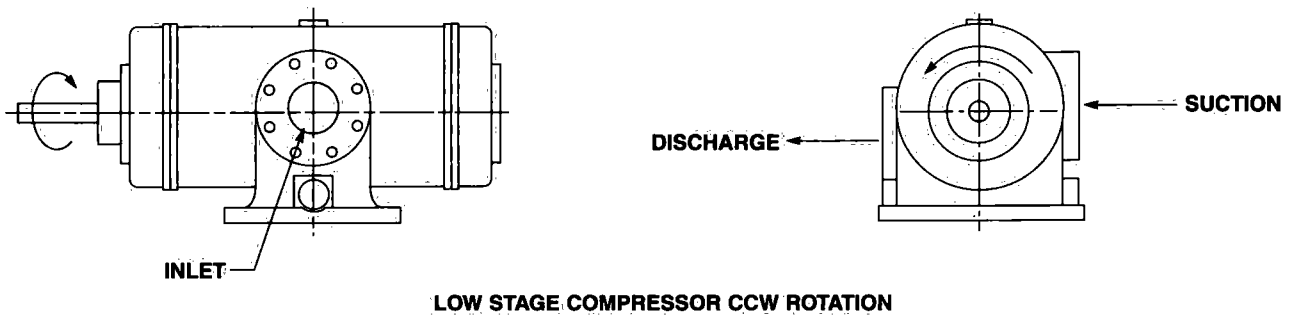
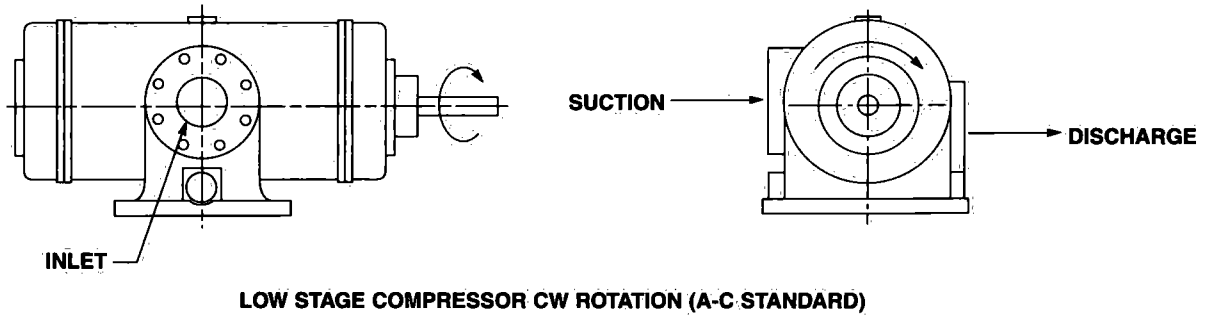


FIG. 19 — Piping arrangement for double bellows seal.

COMPRESSOR ROTATION DESIGNATIONS FOR LOW STAGE MODELS 4CC THRU 33D

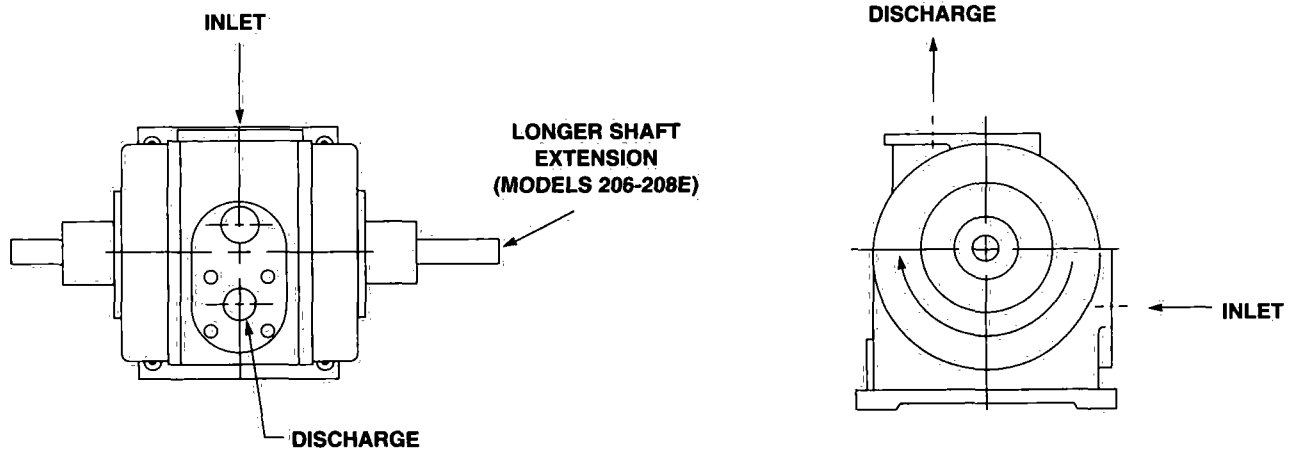


Clockwise Rotation — When viewing the driven end of the shaft, the inlet will be on the left side and the shaft rotates clockwise. When viewing the inlet of the compressor, the shaft is on the right side.

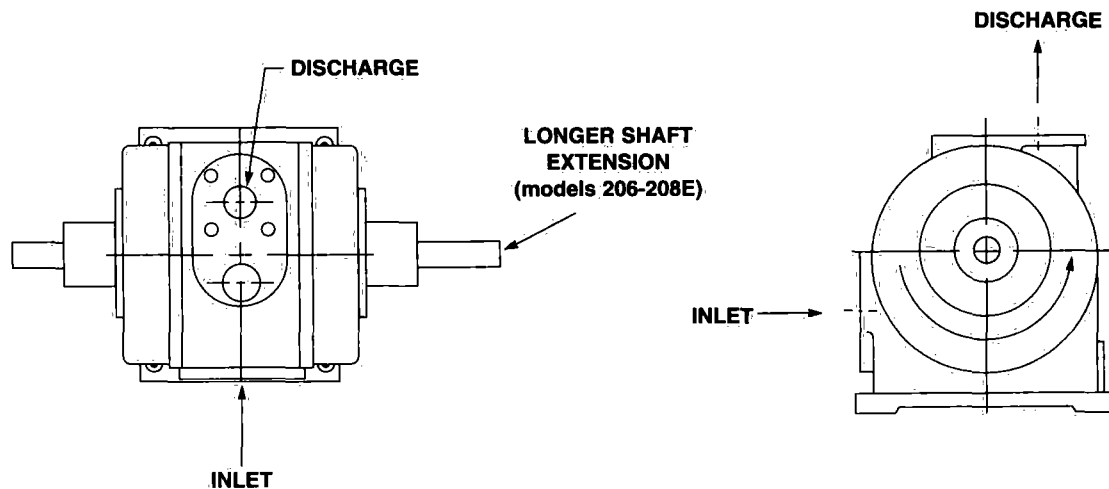
Counterclockwise Rotation — When viewing the driven end of shaft, the inlet will be on the right side and the shaft rotates counterclockwise. When viewing the inlet of the compressor, the shaft is on the left side.

NOTE: Unless rotation is specified at the time of order, all low stage compressors will be furnished clockwise rotation.

COMPRESSOR ROTATION DESIGNATIONS FOR BOOSTERS (HIGH STAGE) MODELS 206 THRU 219M



BOOSTER (HIGH STAGE) COMPRESSOR CW ROTATION (A-C STANDARD)

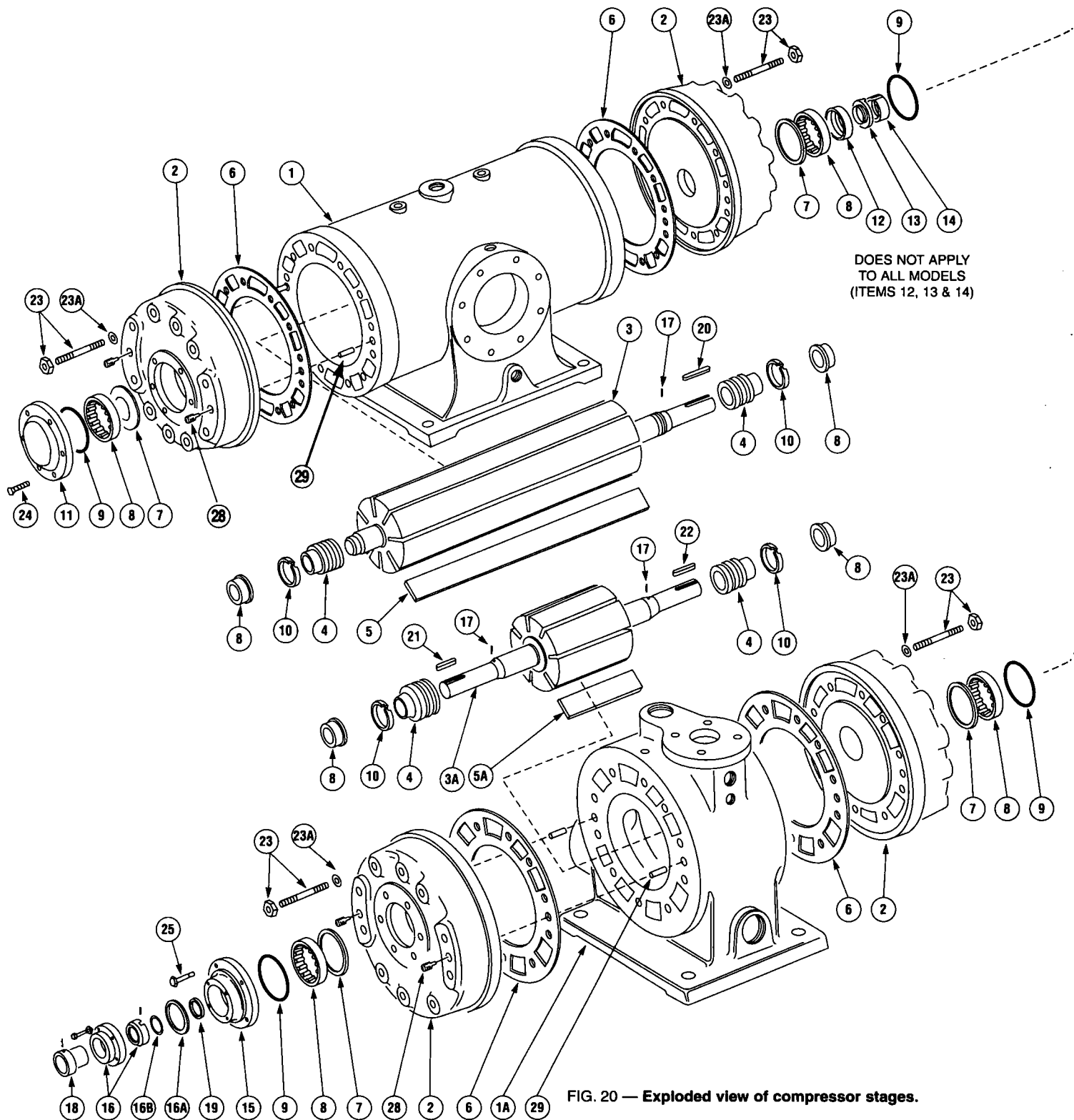


BOOSTER (HIGH STAGE) COMPRESSOR CCW ROTATION

Clockwise Rotation — When viewing the longer end of the shaft, the inlet will be on the right side and the shaft rotates clockwise. When viewing the inlet of the compressor, the longer shaft is on the left side.

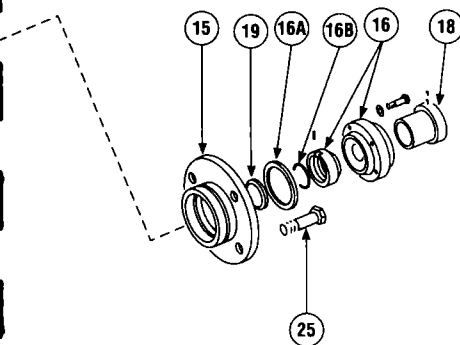
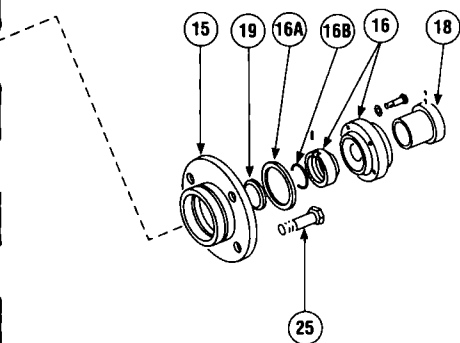
Counterclockwise Rotation — When viewing the longer end of the shaft, the inlet will be on the left side and the shaft rotates counterclockwise. When viewing the inlet of the compressor, the longer shaft is on the right side.

NOTE: Unless rotation is specified at the time of order, all boosters (high stage) compressors will be furnished as clockwise rotation standard.



NOTE: Some **RO-FLO** models are fitted with stuffing box or double bellows type seal in lieu of the single face mechanical seal shown above.

RO-FLO COMPRESSOR PARTS LIST

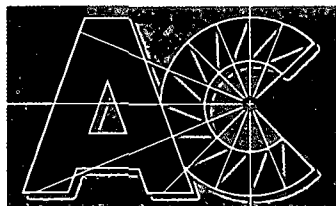


ITEM	PART DESCRIPTION	NO. REQ'D PER STAGE	REMARKS
1	Cylinder, Low Pressure	1	
1A	Cylinder, Booster	1	
2	Cylinder Head	2	
3	Rotor Shaft, Low Pressure	1	
3A	Rotor Shaft, Booster	1	
4	Bearing Spacing Ring	2	
*5	Rotor Blade Set Low Pressure	1	
*5A	Rotor Blade Set Booster	1	
*6	Cylinder Head Gasket	2	
7	Bearing Shim Set	2	
*8	Bearing	2	
*9	O-Ring	2	
*10	Seal Ring	4	
11	End Cover	1	
12	Bearing "H" Ring	1	Required on Models 17S and up
13	Bearing Lockwasher	1	supplied with KP (single face)
14	Bearing Locknut	1	mechanical seals and Models
			11S and up supplied with Crane
			(double face) mechanical seals.
			(items 12, 13, and 14)
15	Seal Adapter		One per Shaft Extension
*16	Mechanical Seal Assembly		One per Shaft Extension
17	Seal Drive Pin		One per Seal
18	Locking Sleeve		One per Seal
19	Seal Spacer	2	Models 208 and 210 Only
			Not used on boosters 211 and up
20	Key, Low Pressure	1	
21	Key, Interstage	1	
22	Key, Booster Drive End	1	
23	Stud and Nut - Cylinder End		
23A	Washer - Cylinder Head Stud		As Required, Low Pressure
24	Screw - End Cover		And Booster
25	Screw - Seal Adapter		
26	Screw - Seal		
27	Lockwasher - Seal		
28	JackscREW - Cylinder Head	2	
29	Dowel Pin - Cylinder Head	4	

* Recommended Spare Part

HOW TO ORDER REPLACEMENT PARTS

Machine serial numbers together with part descriptions are required when placing parts orders. This exploded view with the accompanying cross reference to part description will aid in identifying parts. Maintenance and rebuild kits are also available. Please call (920) 738-5246 for quotations and for placing orders.



Compressor[®]

A DOVER DIVERSIFIED COMPANY

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24 Hour Service: (920) 995-9222

Parts: (920) 738-5246

Website: www.accompressor.com

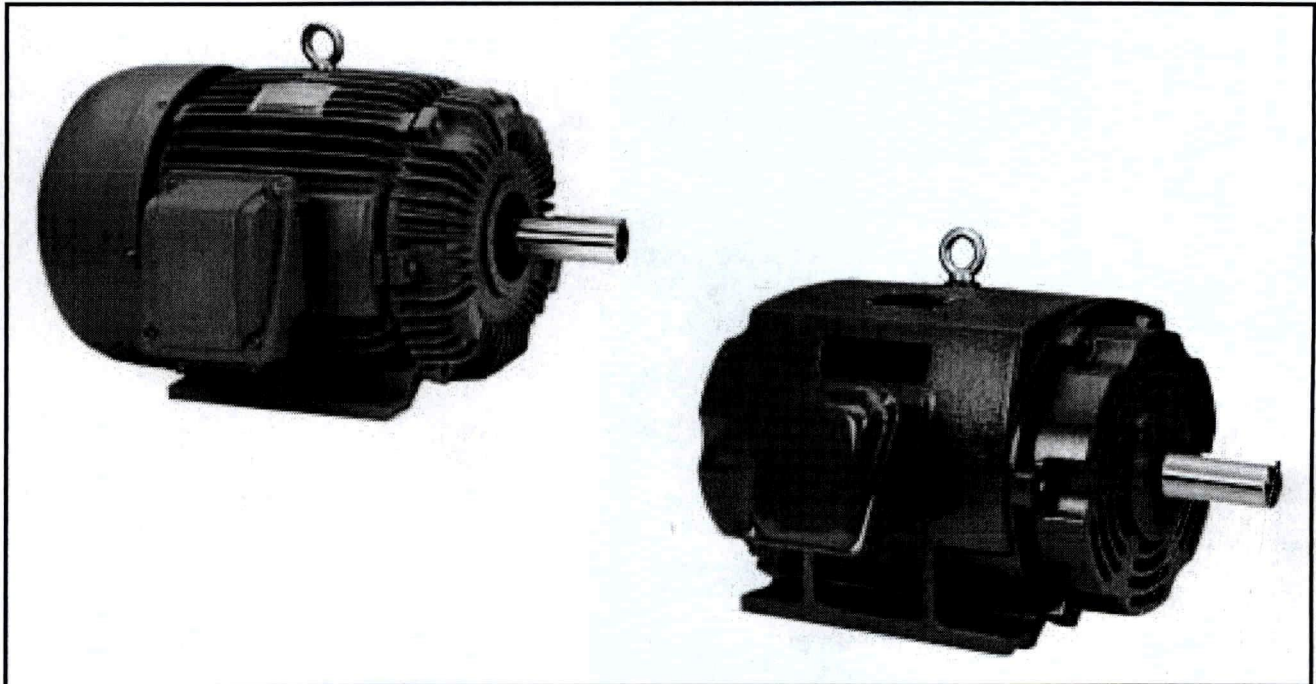
E-mail: roflo@accompressor.com

The information contained herein is general in nature and is not intended for specific construction, installation, or application purposes. A-C Compressor Corporation reserves the right to make changes in specifications shown herein or add improvements at any time without notice or obligation.



INSTALLATION AND MAINTENANCE INSTRUCTIONS FOR THREE PHASE INDUCTION MOTORS

Frames 143T - 449TZ



5100 North IH 35 Round Rock, Texas 78681
Phone: 800-451-8798 512-255-4141 Fax: 512-244-5512

RECEIVING

1. Check nameplate data.
2. Check whether any damage has occurred during transportation.
3. After removal of shaft clamp, turn shaft by hand to check that it turns freely.
4. If motor is to be reshipped (alone or installed to another piece of equipment) the shaft must again be clamped to prevent axial movement.

Note: Remove the bearing clamp before turning the shaft on 284T-449TZ frame motors.

WARNING

THE FOLLOWING SAFETY PRECAUTIONS MUST BE OBSERVED:

1. Electric rotating machinery and high voltage can cause serious or fatal injury if improperly installed, operated or maintained. Responsible personnel should be familiarized with NEMA MG2; Safety Standards for Construction and Guide Selection. Installation and Use of Electric Motors and Generators; National Electric Code and all local safety requirements.
2. When servicing, all power sources to the motor and to the accessory devices should be de-energized and disconnected and all rotating parts should be at standstill.
3. Lifting means, when supplied, are intended for lifting the motor only. When two lifting devices are supplied with the motor a dual chain must be used.
4. Suitable protection must be used when working near machinery with high noise levels.
5. Safeguard or protective devices must not be by-passed or rendered inoperative.
6. The frame of this machine must be grounded in accordance with the National Electric Code and applicable local codes.
7. A suitable enclosure should be provided to prevent access to the motor by other than authorized personnel. Extra caution should be observed around motors that are automatically or have automatic re-setting relays as they may restart unexpectedly.
8. Shaft key must be fully captive or removed before motor is started.
9. Provide proper safeguards for personnel against possible failure of motor-mounted brake, particularly on applications involving overhauling loads.
10. Explosion proof motors are constructed to comply with the label service procedure manual, repair of these motors must be made by TECO-Westinghouse Motor Company or U/L listed service center in order to maintain U/L listing.

LOCATION

1. Drip-proof motors are intended for use where atmosphere is relatively clean, dry, well ventilated and non-corrosive.
2. Totally enclosed motors may be installed where dirt, moisture, or dust are present and in outdoor locations.
3. Explosion-proof motors are built for use in hazardous locations as indicated by Underwriters' label on the motor.
4. Chemical duty enclosed motors are designed for installation in high corrosion or excessive moisture locations.

Note: in all cases, no surrounding structure should obstruct normal flow or ventilating air through or over the motor.

MOUNTING

1. Mount motor securely on a firm, flat base. All ball bearing normal thrust motors up to and including 256T frame size may be side-wall or ceiling mounted; all others check nearest TECO-Westinghouse office for mounting recommendations.
2. Align motor accurately, using a flexible coupling if possible. For drive recommendations, consult with drive or equipment manufacturer, or TECO-Westinghouse.
3. Mounting bolts must be carefully tightened to prevent changes in alignment and possible damage to the equipment. The recommended tightening torque's for medium carbon steel bolts, identified by three radial lines at 120 degrees on the head, are:

Bolt Size	Recommended Torque (Ft-lb.)	
	Minimum	Maximum
2/8	25	37
1/2	60	90
5/8	120	180
3/4	210	320

4. V-belts Sheave Pitch Diameters should not be less than those shown in Table 1 (NEMA recommended values)
5. Tighten belts only enough to prevent slippage. Belt speed should not exceed 5000 ft. per min.

TABLE 1. V-Belt Sheave Pitch Diameters (MG1-14.42)

Frame Number					V-Belt Sheave			
					Conventional A, B, C, D AND E		Narrow 3V, 5V, AND 8V	
					Minimum Pitch Diameter Inches	*Maximum Width Inches	Minimum Outside Diameter Inches	**Maximum Width Inches
	Horsepower at							
	Synchronous Speed, RPM							
3600	1800	1200	900					
143T	1.5	1	.75	.5	2.2	4.25	2.2	2.25
145T	2-3	1.5-2	1	.75	2.4	4.25	2.4	2.25
182T	3	3	1.5	1	2.4	5.25	2.4	2.75
182T	5	...	...	...	2.6	5.25	2.4	2.75
184T	...	...	2	1.5	2.4	5.25	2.4	2.75
184T	5	...	...	...	2.6	5.25	2.4	2.75
184T	7.5	5	...	...	3.0	5.25	3.0	2.75
213T	7.5-10	7.5	3	2	3.0	6.5	3.0	3.375
215T	10	...	5	3	3.0	6.5	3.0	3.375
215T	15	10	...	...	3.8	6.5	3.8	3.375
254T	15	...	7.5	5	3.8	7.75	3.8	4
254T	20	15	...	...	4.4	7.75	4.4	4
256T	20-25	...	10	7.5	4.4	7.75	4.4	4
256T	...	20	...	...	4.6	7.75	4.4	4
284T	...	...	15	10	4.6	9	4.4	4.625
284T	...	25	...	...	5.0	9	4.4	4.625
286T	...	30	20	15	5.4	9	5.2	4.625

TABLE 1. V-Belt Sheave Pitch Diameters (MG1-14.42)

Frame Number					V-Belt Sheave			
					Conventional A, B, C, D AND E		Narrow 3V, 5V, AND 8V	
					Minimum Pitch Diameter Inches	*Maximum Width Inches	Minimum Outside Diameter Inches	**Maximum Width Inches
	Horsepower at Synchronous Speed, RPM							
	3600	1800	1200	900				
324T	...	40	25	20	6.0	10.25	6.0	5.25
326T	...	50	30	25	6.8	10.25	6.8	5.25
364T	40	30	6.8	11.5	6.8	5
364T	...	60	...	...	7.4	11.5	7.4	5.785
365T	50	40	8.2	11.5	8.2	5.785
365T	...	75	...	...	9.0	11.5	8.6	5.785
404T	60	...	9.0	14.25	8.0	7.25
404T	50	9.0	14.25	8.4	7.25
404T	...	100	...	...	10.0	14.25	8.6	7.25
405T	75	60	10.0	14.25	10.0	7.25
405T	...	100	...	...	10.0	14.25	8.6	7.25
405T	...	125	...	...	11.5	14.25	10.5	7.25
444T	100	...	11.0	16.75	10.0	8.5
444T	75	10.5	16.75	9.5	8.5
444T	...	125	...	...	11.0	16.75	9.5	8.5
444T	...	150	...	...	...	16.75	10.5	8.5
445T	125	...	12.5	16.75	12.0	8.5
445T	100	12.5	16.75	12.0	8.5
445T	...	150	...	...	...	16.75	10.5	8.5

*Max. Sheave width = $2(N-W) - .25$

**Max Sheave width = $N-W$

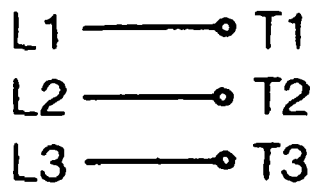
***Sheave ratios greater than 5:1 and center-to-center distance less than the diameter of the large sheave should be referred to TECO-Westinghouse.

POWER SUPPLY & CONNECTIONS

1. Wiring of motor and control, overload protection and grounding should be in accordance with National Electrical Code and all local safety requirements.
2. Nameplate voltage and frequency should agree with power supply. Motor will operate satisfactorily on line voltage within $\pm 10\%$ of nameplate voltage; or frequency with $\pm 5\%$ and with a combined variation not to exceed $\pm 10\%$. 230-volt motors can be used on 208-volt network systems, but with slightly modified performance characteristics as shown on the nameplate.
3. Dual voltage and single voltage motors can be connected for the desired voltage by following connection diagram shown on the nameplate or inside of the conduit box.
4. All Explosion Proof motors have Temperature Limiting Devices in the motor enclosure to prevent excessive external surface temperature of the motor in accordance with U/L standards. Terminals of thermal protectors (P1 & P2) should be connected to the motor control equipment, according to the connection diagram inside of the conduit box.
5. Standard connection diagram for three phase, not thermally protected, dual rotation motors are shown in diagrams A through E.

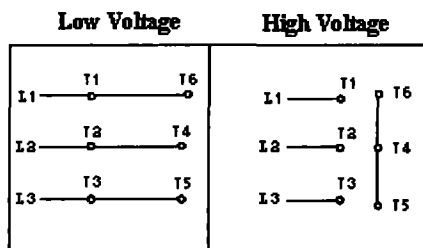
(Note: To change rotation, Interchange any two line leads)

A. 3 Lead, Single Voltage

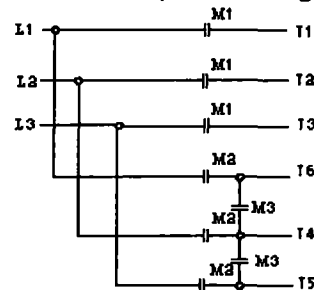


B. 6 Lead, Dual Voltage & Voltage Ratio 1 to 3

B-1 Across the Line Start & Run



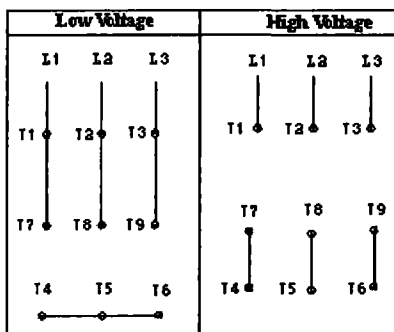
B-2 Wye Start & Delta Run
(Low Voltage only)



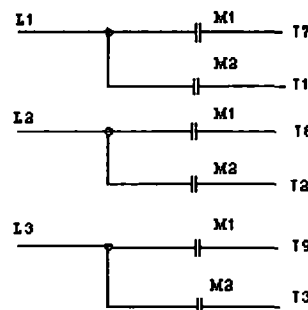
	START	RUN
M1	CLOSE	CLOSE
M2	OPEN	CLOSE
M3	CLOSE	OPEN

C. 9 Leads; Dual Voltage & Voltage Ratio 1 to 2, Wye Connected

C-1 Across the Line Start & Run



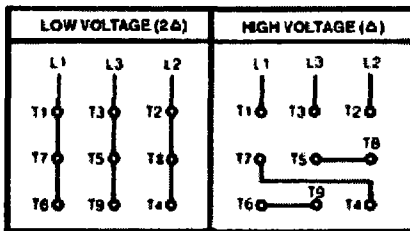
C-2 Part Winding Start
(Low Voltage only)



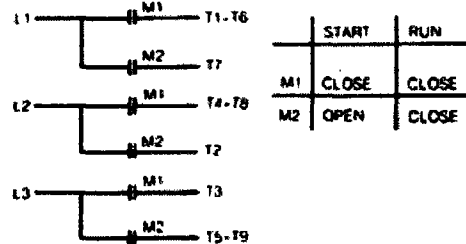
	START	RUN
M1	CLOSE	CLOSE
M2	OPEN	CLOSE
He (T4-T5-T6) Together		

D. 9 Leads; Dual Voltage & Voltage Ratio 1 to 2, Delta Connected

D-1 Across the Line Start & Run

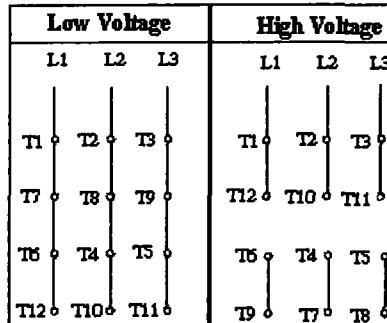


D-2 Part Winding Start
(Low Voltage only)

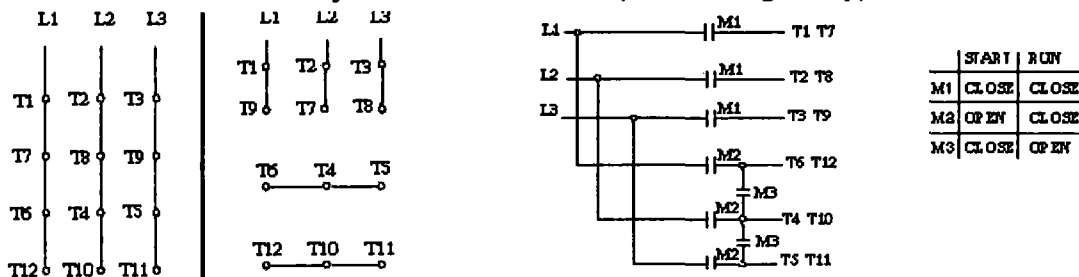


E. 12 Leads, Dual Voltage

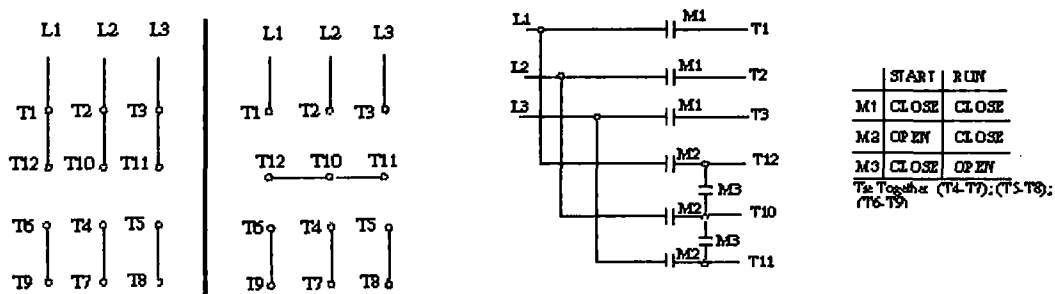
E-1 Across the Line Start & Run



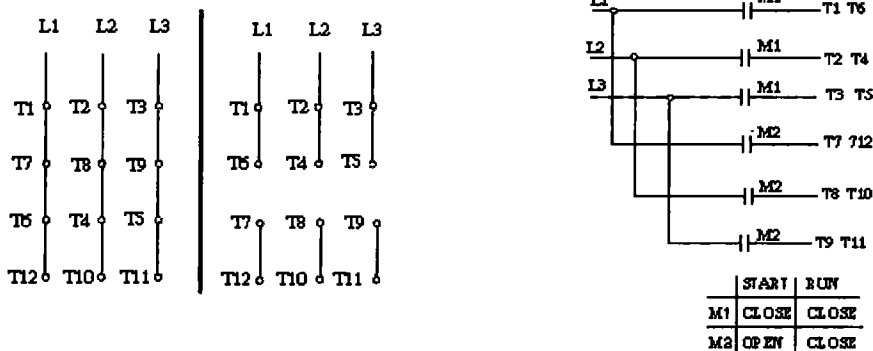
E-2-1 Wye Start & Delta Run (Low Voltage only)



E-2-2 Wye Start & Delta Run (High Voltage only)



E-3 Part Winding Start (Low Voltage only)



***Important:** For Part Winding Start, M2 contactor should be closed within two (2) seconds after M1 contactor is closed.
Only 4 pole and above (e.g., 6P, 8P...) motors are satisfactory for Part Winding Start at low voltage.

START UP

1. Disconnect load and start motor. Check direction of rotation. If rotation must be changed, **ALLOW THE MOTOR TO STOP COMPLETELY**. Interchange any two leads of a three-phase motor.
2. Connect load. The motor should start quickly and run smoothly. If no, shut power off at once. Recheck the assembly including all connections before restarting.
3. If excessive vibration is noted, check for loose mounting bolts too flexible motor support structure or transmitted vibration from adjacent machinery. Periodic vibration checks should be made; foundations often settle.
4. Operate under load for short period of time and check operating current against nameplate.

TESTING

If the motor has been in storage for an extensive period or has been subjected to adverse moisture conditions, it is best to check the insulation resistance of the stator winding with a megometer. Depending on the length and conditions of storage it may be necessary to regrease or change rusted bearings.

If the resistance is lower than one megohm the windings should be dried in one of the following two ways:

1. Bake in oven at temperatures not exceeding 194°F until insulation resistance becomes constant.
2. With rotor locked, apply low voltage and gradually increase the current through windings until temperature measured with a thermometer reaches 194°F. Do not exceed this temperature.

MAINTENANCE

INSPECTION

Inspect motor at regular intervals. Keep motor clean and ventilation openings clear.

LUBRICATION

1. Frame 143T-256T: Double shielded and pre-lubricated ball-bearing motors without grease fittings and don't need relubrication, except on MAX-E1® and MAX-E2® products which have regreasable features.
2. Frames 280TS, 320-449TZ(TS): Motors having grease fittings and grease discharge devices at brackets. Motors are shipped with grease for initial running. It is necessary to relubricate anti-friction bearing motors periodically, depending on size and type of service. See Table 2 to provide maximum bearing life. Excessive or too frequent lubrication may damage the motor.

TABLE 2

Horsepower	Standard Conditions	Severe Conditions	Extreme Conditions
1 Thru 30 Hp, 1800 rpm and below	7 years	3 years	180 days
40 Thru 75 Hp, 1800 rpm and below	210 days	70 days	30 days
100 Thru 150 Hp, 1800 rpm and below	90 days	30 days	15 days
1 Thru 20 Hp, 3600 rpm	5 years	2 years	90 days
25 Thru 75 Hp, 3600 rpm	180 days	60 days	30 days
100 Thru 150 Hp, 3600 rpm	90 days	30 days	15 days

Note:

- A. Standard conditions: 8 hours operation per day, normal or light loading, clear and 40°C ambient conditions.
 - B. Severe conditions: 24-hour operation per day or light shock loading, vibration or in dirty or dusty conditions.
 - C. Extreme conditions: With heavy shock loading or vibration or dusty conditions.
 - D. For double shielded bearings, above data (lubrication frequency) means that the bearing must be replaced.
3. Be sure fittings are clean and free from dirt. Using a low-pressure grease gun, pump in the recommended grease until new grease appears at grease discharge hole.
 4. Use the ALVANIA R3 grease or equivalent lithium based grease unless special grease is specified on the nameplate.
 5. If relubrication is to be performed with the motor running, stay clear of rotating parts. After regreasing, allow the motor to run for ten to thirty minutes.

RENEWAL PARTS

1. Use only genuine TECO-Westinghouse renewal parts or as recommended by TECO-Westinghouse Motor Company.
2. When you order renewal parts please specify complete information to TECO-Westinghouse office/agent such as type, frame no., poles, horsepower, voltage, series no., quantity, etc.

FOR FURTHER INFORMATION PLEASE CONTACT TECO-WESTINGHOUSE MOTOR COMPANY

SALES OFFICE:	Allentown, PA	(610) 391-9690
	Houston, TX	(713) 864-5980
	Los Angeles, CA	(714) 670-2722
	Portland, OR	(503) 684-3363
	Round Rock, TX	(512) 255-4141
	Spartanburg, SC	(864) 576-0356



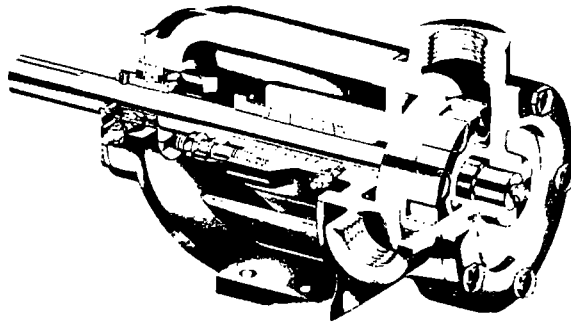
PO Box 277 (78680-0277)
5100 N. IH-35
Round Rock, Texas 78681
Phone: 800-451-8798
512- 255-4141
Fax: 512-244-5512
www.tecowestinghouse.com



MAINTENANCE AND REPAIR INSTRUCTIONS

SERIES 115

WHEN ORDERING REPLACEMENT PARTS, PROVIDE COMPLETE NAME OF PART, PART NUMBER REFERENCE, MATERIAL, MODEL AND SERIAL NUMBER OF PUMP, THE PUMP MODEL AND SERIAL NUMBER CAN BE FOUND ON THE NAMEPLATE ATTACHED TO THE PUMP OR BASE.



Models: G, H & HX4

MAINTENANCE

WARRANTY

Vican Pump Company of Canada Limited warrants Vican Products to be free from factory defects in material and workmanship under normal use and service for a period of one year from date of shipment. Our obligation shall be limited to the repair or replacement of any parts at our option, F.O.B. factory. Defect of a part or parts of a unit which can be replaced shall not be construed to indicate that the unit is defective. The workmanship and material in special metal pumps shall be first class, but the Company cannot assume responsibility for the performance or life of pumps constructed of special metals. This warranty shall not apply to any part which has been subject to accident, alteration, abuse, misuse, damage or flood, fire or act of God or where the unit has been improperly installed or applied.

Vican Pump Company of Canada Limited shall not be liable for service, labour or transportation charges or for damages or delay caused by defective material or workmanship or for personal injuries or damage to property caused directly or indirectly by any Vican Product or by its use or operation, or for work done or repairs effected by others. In case of components purchased by Vican Pump Company of Canada Limited from another manufacturer, such as starters, motors, controls, etc., the warranty of the manufacturer will be extended to the purchaser in lieu of any warranty by the Company.

The above warranties are in lieu of all other warranties expressed or implied. No representative or other person is authorized or permitted to make any warranty or assume for the Company any liability not strictly in accordance with the foregoing.

The SERIES 115 PUMPS are designed for long, trouble free life under a wide variety of application conditions with a minimum of maintenance, however, the following should be considered.

- (1) **LUBRICATION** – Periodic external lubrication should be applied slowly with a hand gun at all lubrication fittings provided. A good quality general purpose grease is satisfactory in a majority of cases. However, in applications involving high or low temperatures and/or applications involving liquids that could cause a chemical breakdown of general purpose greases, other types of lubricant may be required. Do not over-grease. Consult factory if you have any specific lubrication questions.
- (2) **PACKING ADJUSTMENT** – New packed pumps generally require some initial packing adjustment to control leakage as packing “runs in”. Make initial packing adjustments carefully and do not over-tighten the packing gland. After initial adjustment occasional inspection will reveal the need for packing gland adjustment and/or replacement of the packing. See instructions in disassembly and reassembly regarding packing the pump.
- (3) **END CLEARANCE ADJUSTMENT** – After long term operation it is sometimes possible to improve the performance of the pump without major repair, through adjustment of end clearance of the pump. Refer to instructions under Step 6 of reassembly.
- (4) **STORAGE** – If the pump is to be stored or not used for any appreciable length of time it should be drained and a light coat of lubricating and preservative oil should be applied to the internal parts. Lubricate all fittings.

DISASSEMBLY

- (1) Mark the head and casing position and remove the head from the pump. If a relief valve has been supplied it must be removed from the head first. Note the valve position when removing.
- (2) Remove the head and gasket. Avoid tilting the head down as the idler may slip off causing possible damage to the idler and/or bushing.



VICAN PUMPS

DISASSEMBLY CONTINUED

- (3) Remove the idler and bushing assembly from the pin. Inspect for signs of excessive pin, head, idler and/or bushing wear. Replace any worn parts.

Note the pin grease groove position, if applicable, prior to removing.

- (4) Loosen the set screws holding the bearing to the shaft. Remove the cap screws that secure the casing and bracket assembly. The casing, with the rotor and shaft assembly, can be removed from the bracket.
- (5) Loosen the packing gland nuts. Note, with mechanical seal pumps, remove the seal seat retainer which exposes the seal. Carefully remove the mechanical seal. Remove the seal cavity plug and loosen the setscrews securing the set

collar to the shaft. Remove the set collar. Inspect the seal for signs of wear and/or scouring.

- (6) Carefully remove the rotor and shaft from the pump. Once removed inspect for signs of excessive scouring and/or wear. Replace if required.
- (7) Inspect the casing bushing for signs of excessive wear. If it must be replaced it can be pressed out through the stuffing box.
- (8) The bearing can be removed from the bracket by removing the capscrews and aluminum retainer. Inspect for damage and replace if necessary.
- (9) All parts can be inspected again for wear, scouring and/or damage before the pump is reassembled.

REASSEMBLY

NOTE: Should it be necessary to install new carbon bushings, extreme care should be taken to prevent the bushings from fracturing. It is a brittle material and easily cracked. If cracked, these bushings will quickly disintegrate. An arbor press should be used to install carbon bushings. Be sure the bushing is started straight and do not stop the pressing operation until the bushing is in the proper position. Starting and stopping this operation invariably results in bearing failure.

Carbon bushings for high temperature systems are supplied with extra interference fits and must be installed by an arbor press after heating the bearing bracket or idler to 450°F. Check the bushing for cracks after installation.

- (1) Press the casing bushing into place and check the after press fit value to ensure .002 inches minimum running clearance exists between the bushing and shaft. Lubricate prior to startup.
- (2) Remove all burrs and rough surfaces from the rotor and shaft and assemble in the casing. Start the shaft through the casing bushing and slowly, turning the rotor, push it into the casing as far as it will go.
- (3) Place the head gaskets on the head. The proper amount of gaskets should be used to provide the necessary end clearance within the pump so it turns freely with no appreciable end play.
- (4) Press the idler bushing into the idler and ensure .002 inches minimum running clearance exists between the bushing and pin. Replace the idler disc if one was originally supplied. Ensure this area is lubricated prior to startup.
- (5) Replace the idler pin at this time by pressing the old one out. The new pin can be inserted but check the pin bore condition as a liquid sealant may be required if scouring is present. Ensure the pin is below the highest point on the head crescent after insertion. Put the idler on the head and ensure it rotates freely.
- (6) The head can now be assembled on the pump. Tilt the top of the head away from the pump slightly until the crescent enters the inside diameter of the rotor and rotate the idler until its teeth mesh with the rotor teeth. Do not damage the head gaskets. Check that the head and casing position markings are aligned. Tighten the head capscrews or nuts evenly and then check the end clearance. If the pump shaft cannot be

rotated, more gaskets must be added. If, however, the pump has any noticeable end play, remove enough gaskets so the pump has no appreciable end play but still turns freely.

- (7) Pack the pump. It is good practice to install a set of new packing. A packing suitable for the liquid being pumped should be used. If the pump has a lantern ring it must be located below the grease fitting or flushing connection. The grease fitting may be removed to facilitate positioning of the lantern ring. Cut the packing into individual rings that wrap exactly around the shaft. Install and seat each ring one at a time, staggering the ring joints from one side of the shaft to the other. Lubricate the packing rings with oil, grease or graphite to aid in assembly. A length of pipe or tubing will help in seating the packing rings. When installing the gland it must enter the stuffing box at least one-eighth of an inch tightening the packing gland nuts.
- (8) Install the mechanical seal: Place the setcollar on the shaft and tighten the setscrew through the connection provided. The seal is simple to install and good performance will result if care is taken in its installation. (Never touch the sealing faces with anything except the fingers or a clean cloth). Spread a film of lubricating oil on the inside diameter of the synthetic rubber bellows. Check the end of the pump shaft for sharp burrs or edges which might cut the bellows. Slide the seal rotary member over the shaft and up against the spring. (The spring washer and spring must be put on the shaft first and in that order). Coat the synthetic rubber seal seat retainer with lubricating oil and push the seal seat into the ending cap. Put the end cap gasket on the end of the casing. Slide end cap over the shaft and flush both the seal seat and carbon wear ring in the seal rotary member with oil. Push the end cap up until the mating surfaces of the seal meet. Install the capscrews then tighten evenly.
- (9) Replace the ball bearing if necessary and reassemble into the bracket. Tighten the capscrews to secure the bearing retainer. Place the shaft through the bearing and locate the bracket onto the casing. Tighten the capscrews securing the casing and bracket. Ensure that the assembled unit rotates freely then secure the bearing setscrews. Failure to tighten these setscrews will result in rapid pump wear.

NOTE: The after press fit value is the final size for carbon bushings. No sizing should be required.

RELIEF VALVE INSTRUCTIONS

DISASSEMBLY

- (1) Remove valve bonnet.
- (2) Measure and record the length of extension of the adjusting screw.
- (3) Loosen the adjusting nut and rotate the adjusting screw counter-clockwise until the spring pressure is released fully.
- (4) Remove the cap, retainer, disc, spring and poppet, from the valve body. Clean and inspect all parts for wear or damage and replace if necessary.

REASSEMBLY

Simply reverse the procedure outlined under disassembly. If the valve has been removed from the pump for inspection, be sure to replace in the same position. The bonnet should point towards the suction port.

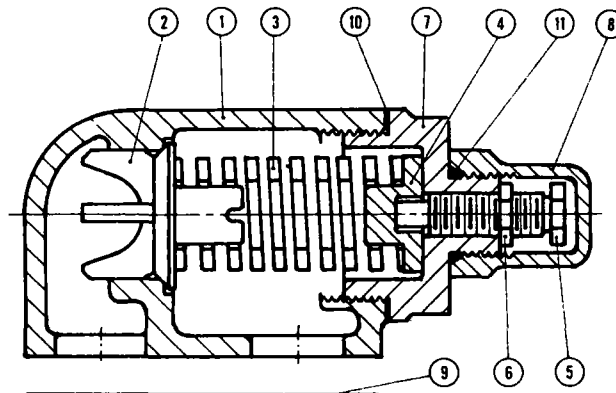
PRESSURE ADJUSTMENT

The pressure setting on any relief valve supplied on a pump should be adjusted and/or checked for setting on individual applications as the valve is supplied with a spring that is adjustable within a given pressure range.

To check the setting place a pressure gauge in the discharge line between the pump and discharge gate valve. Slowly close the gate valve until full bypass pressure is obtained. This pressure should be greater than the normal operating pressure. If not, it can be increased by turning the relief valve adjusting screw inward until the desired setting is achieved. After the relief valve has been set, the locking nut can be tightened and the bonnet can be re-assembled.

When ordering relief valve springs, be sure to state the maximum operating pressure required.

REPLACEMENT PARTS LIST



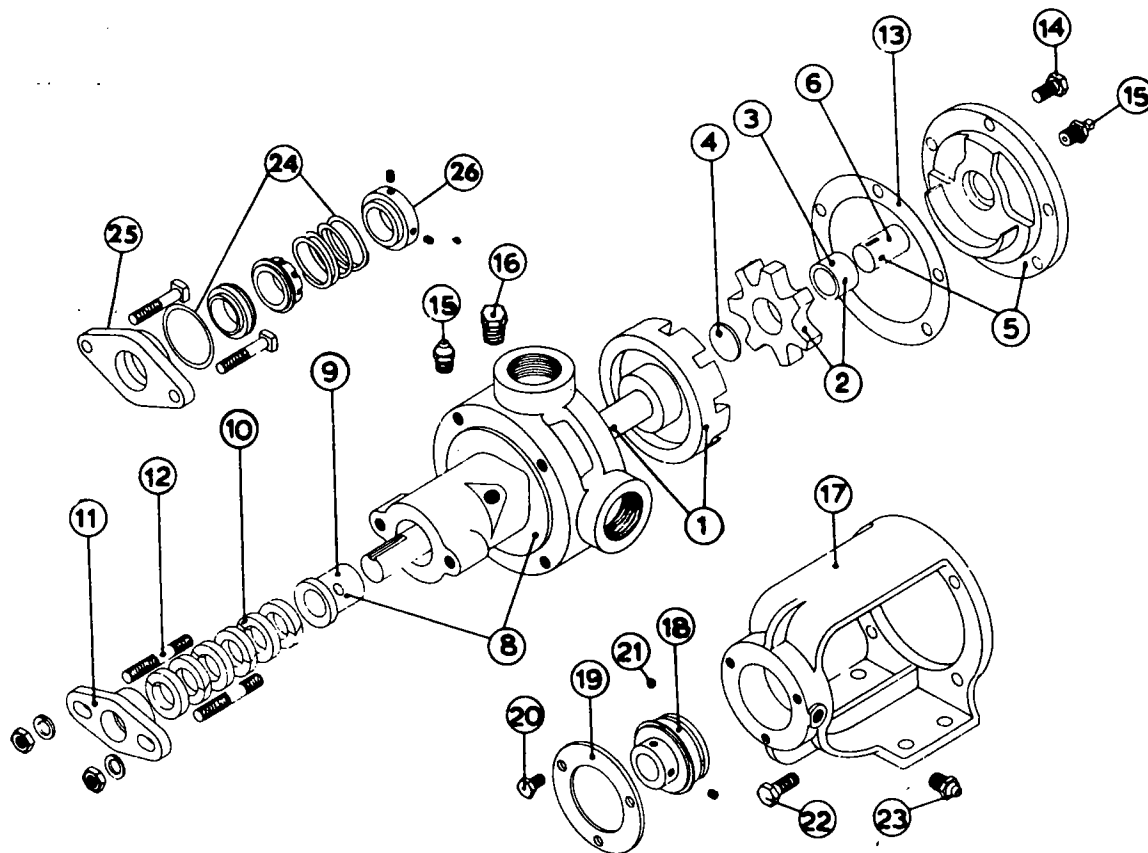
ITEM NO.	NAME OF PART
1	BODY
2	POPPET
3	SPRING
4	RETAINER DISC
5	ADJUSTING SCREW
6	ADJUSTING NUT

ITEM NO.	NAME OF PART
7	CAP
8	BONNET
9	GASKET (PORT)
10	GASKET (CAP)
11	GASKET (BONNET)



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REPLACEMENT PARTS LIST



ITEM NO.	NAME OF PART
1	ROTOR & SHAFT ASSEMBLY
2	IDLER & BUSHING ASSEMBLY
3	BUSHING (Idler)
4	IDLER DISC
5	HEAD & IDLER PIN ASSEMBLY
6	IDLER PIN
8	CASING & BUSHING ASSEMBLY
9	BUSHING (Casing)
10	PACKING
11	PACKING GLAND
12	PACK'G GLAND STUDS, NUTS & WASHERS
13	GASKET (Head)

ITEM NO.	NAME OF PART
14	HEAD BOLT
15	GREASE FITTING
16	PIPE PLUG
17	BEARING HOUSING
18	BALL BEARING
19	BEARING RETAINER
20	RETAINER BOLT
21	SET SCREW
22	HOUSING BOLTS
23	GREASE FITTING
24	MECHANICAL SEAL ASSEMBLY
25	SEAL SEAT RETAINER
26	SET COLLAR



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