Instructions

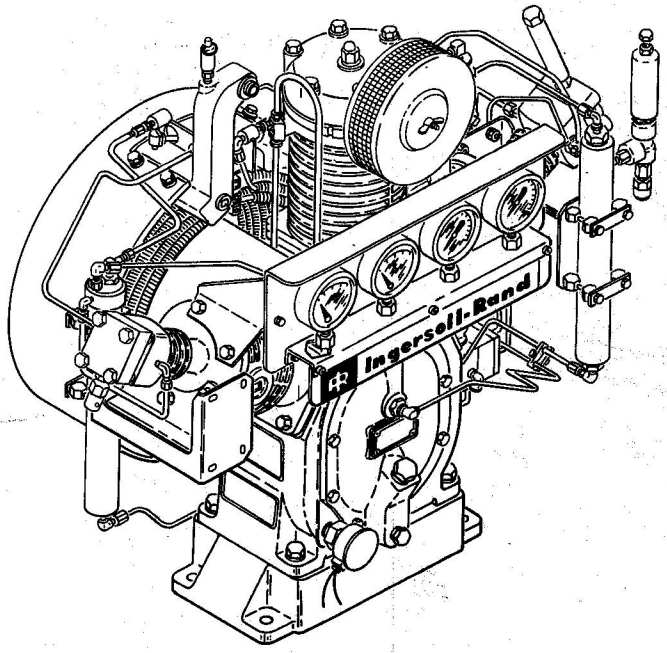
Type 30

HIGH-PRESSURE COMPRESSORS

Models

10T2 **H10T2**

15T4 **H15T4**



Ingersoll-Rand

Refer all communications to the nearest I-R Distributor; listed in Form 1537; or nearest branch office listed on the back cover.

Form 1166-A
September, 1970

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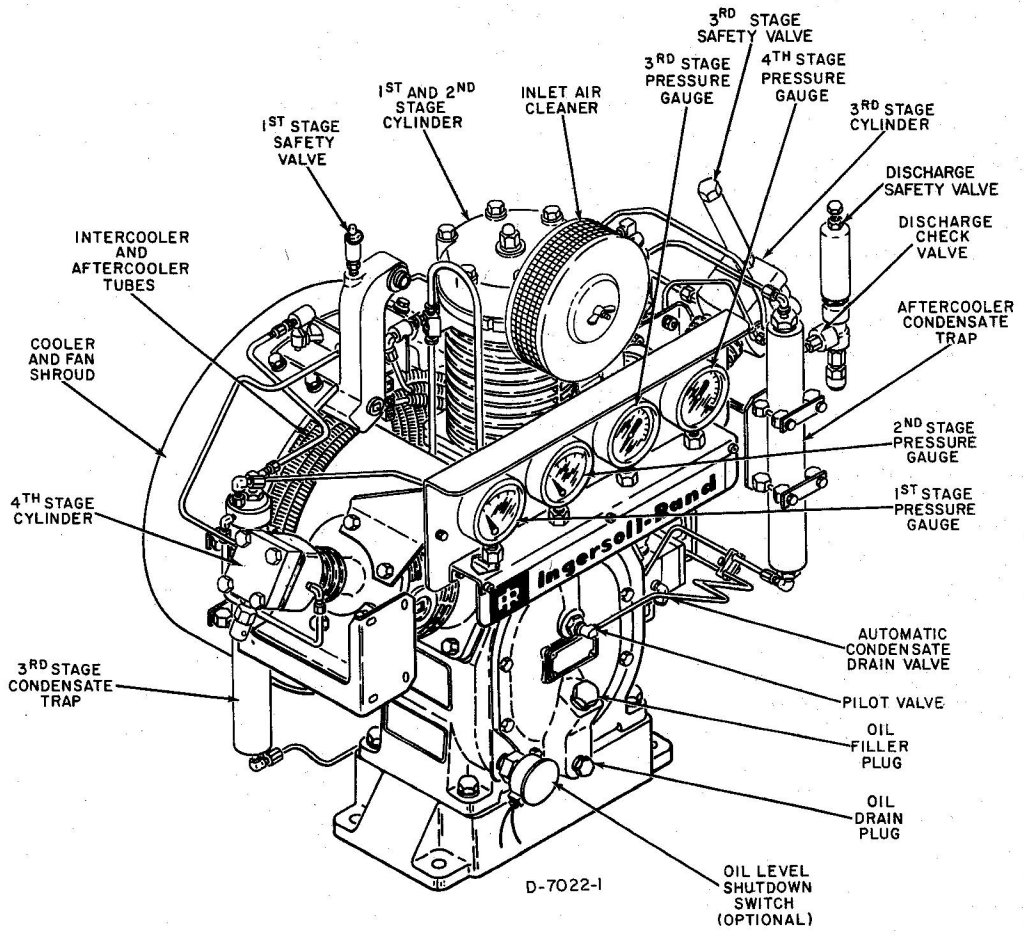

Figure 0-1

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SECTION I
GENERAL INFORMATION

Application . . . . The Models 10T2 and 15T4 compressors are intended to supply air for any application requiring air pressure at 2000 to 3500 psi. Models H10T2 and H15T4 operate at 4000 to 5000 psi. Their actual delivery covers the range from 10 to 20 c.f.m.

Construction . . . . The Models 10T2, H10T2 and 15T4, H15T4 compressors are compact, 4-stage, reciprocating units designed with properly proportioned compression ratios and efficient intercoolers to provide a dependable source of high pressure air. The first and second stage of compression are housed in the same cylinder assembly as shown in the simplified schematic diagram, Figure 1-1. The design of this assembly permits first stage compression to occur on the up-stroke of the piston and second stage compression on the down-stroke. Third and fourth stage compression occurs on the up-stroke of each steeple piston working in its crosshead guide and cylinder. The units are equipped with a dry-type suction inlet air cleaner, large volume condensate drain traps, and are positively protected by intercooler safety valves. The units are equipped with time proven Ingersoll-Rand dual plate valves. The compressors are splash lubricated and economical oil control is established through the use of efficient oil control rings.

INTERMITTENT DUTY FORMULA

Certain Models must be operated in accordance with the Intermittent Duty Formula, which appears below, whereas other models are designed to operate continuously.

Intermittent duty ordinarily means pump up to top pressure and stop. Pump up time should ordinarily not exceed 30 minutes or be less than 10 minutes. Shutdown periods between cycles of operation are necessary to allow the compressor to cool down. The shutdown period should be at least equal to the pump up time. Periodic inspection and preventive maintenance are a must for satisfactory operation.

Notes Regarding the Intermittent Duty Formula

1. The formula is not to be regarded as a hard and fast rule.
2. A maximum operating time limit with a following cooldown period is necessary to protect the valves and air heads against stabilized high operating temperatures, which could allow rapid valve carbonization.
3. A minimum operating time limit is required to prevent formation of condensate which will cause rusting of cylinders, valves and frame parts. Accumulation of condensate in the frame could give a false reading of oil level. Water and oil do not mix and their presence together cause rapid breakdown of the oil. The minimum time of operation should be long enough to allow the compressor to warm up sufficiently to evaporate condensated moisture.
4. When machine operation is too short for temperature to reach the normal level, a temperature control crankcase heater may be required. This is particularly true for areas of high humidity, such as along seacoasts. Also on applications such as air blast circuit breaker service, where operation may be extremely erratic, special materials may be required for air head and other parts.
5. All operating instructions should be read thoroughly and followed carefully by anyone operating these machines to give most efficient operation and longest possible machine life.

NOTE: Quotations and Orders must include Intermittent Duty Formula where it applies.

Air at atmospheric pressure is drawn into the first stage cylinder bore on the down-stroke of the piston as shown in Figure 1-1. On the compression stroke of the piston, air is forced out through the first stage discharge valve, through the first stage intercooler and into the second stage compression chamber. (Note that the second stage compression chamber area is the volumetric difference between the diameter of the cylinder wall and the diameter of the lower portion of the piston.) On the down-stroke of the piston, the air contained in the second stage compression chamber is compressed to the second stage pressure level and forced into the third stage steeple cylinder bore through the second stage discharge valve, second stage intercooler, condensate trap and third stage inlet valve. On the compression stroke of the third stage steeple piston, the air is compressed to the third stage pressure level and is forced into the fourth stage cylinder bore through the third stage discharge valve, third stage intercooler, condensate trap and fourth stage inlet valve. On the compression stroke of the fourth stage, the air is compressed to its final pressure and forced out through the air-cooled aftercooler and condensate separator into the external system.

The finned tube intercoolers and aftercooler serve to dissipate heat from the compressed air, thus condensing contained moisture. This condensate is then separated and collected in suitably designed traps.

The compressors are equipped with a complete starting unloading system. This automatically relieves pressure from all cylinders, intercoolers and the aftercooler, in addition to

draining all condensate from the traps, whenever the compressor stops.

Automatic regulation (optional) is obtained by a pressure switch which starts and stops the compressor at predetermined receiver pressures. An oil level shutdown switch also may be provided to protect the compressor in the event of low oil level.

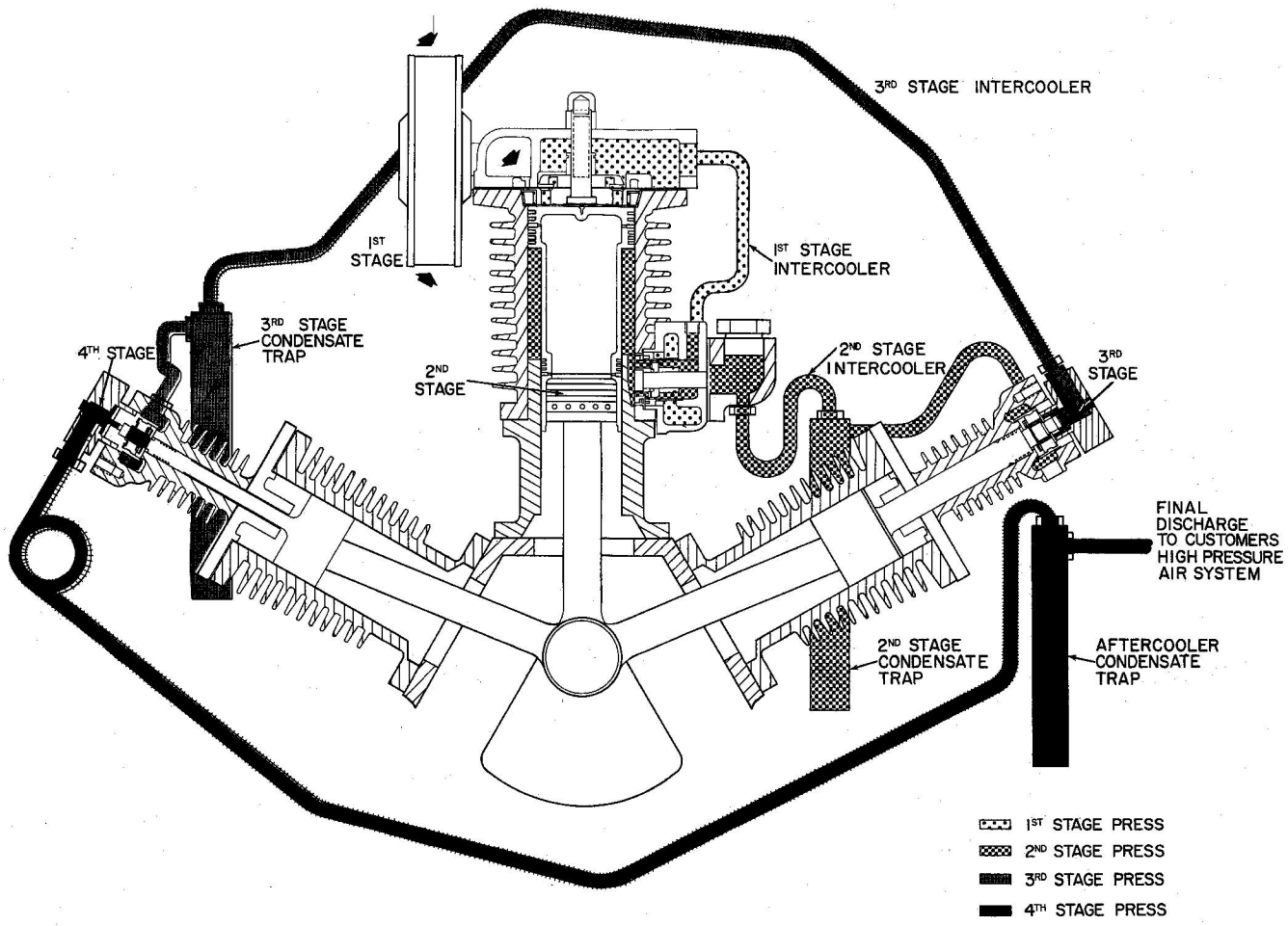

Figure 1-1. Simplified Air-Flow Diagram

SECTION II
INSTALLATION

1. LOCATION

The location at which the compressor is installed contributes significantly to the efficient operation of the unit. The following recommendations are to be observed when selecting a location for a non-portable installation. If the compressor is intended for portable service, observe the same rules if the unit is required to operate at a fixed location for extended periods of time.

In cold climates install the compressor within a heated building. Choose a clean, relatively cool area that provides ample space around the compressor for cooling and general accessibility. Do not place the compressor in a boiler room or other hot location. If the compressor is to be operated in damp climates or under conditions of high humidity, a well ventilated location must be chosen to minimize the formation of water in the frame. When installations are subject to such atmospheric conditions, it is also recommended that an appropriate rust-inhibiting oil be used in the frame. See "Compressor Lubrication" on page 8 for details.

When a suitable location is selected, place the belt side of the compressor toward the wall, leaving a space of at least 15 inches (382 mm) for air circulation to the fan. The compressor may be bolted to any substantial base. If necessary, insert shims under the compressor base for leveling purposes. Recheck the compressor after the foundation bolts have been tightened to make certain the unit sits level.

2. WIRING AND STARTING SWITCH (Motor Driven Units)

To avoid invalidating your fire insurance, it is advisable to have the electrical work done by a licensed electrician who is familiar with the regulations Board of Fire Underwriters and the requirements of the local code.

Before wiring the motor to the power supply, the electric rating of the motor, as shown on the motor nameplate, must be checked against the electrical supply. If they are not the same, do not connect the motor.

It is important that the wire used is the proper size and all connections secured mechanically and electrically. The size wire shown in the table is a safe guide if the distance from the feeder does not exceed 100 feet (30.5 m).

SIZES OF WIRE TO USE FOR DISTANCES UP TO 100 FEET (30.5 m) FROM THE FEEDER.

Motor Horse-power	THREE PHASE			
	230V		460V	
	AWG	SWG	AWG	SWG
10	8	10	12	14
15	6	8	10	12
20	4	6	8	10

The wire sizes recommended in the above table are suitable for the compressor unit. If other electrical equipment is connected to the same circuit, the total electrical load must be considered in selecting the proper wire sizes. A burned out motor may result unless is is properly protected.

If the distance from the feeder is over 100 feet (30.5 m), larger wire will probably be necessary and your electrical contractor or local electric company should be consulted for recommendations. The use of too small a wire size results in sluggish operation, unnecessary tripping of the overload relays or blown fuses.

Important: For complete protection against burning out the electric motor, we strongly recommend the installation of a magnetic starting switch equipped with overload relays. See Figure 2-1. Starting switches equipped with overload relays are furnished with the manufacturer's instructions for installation. Ingersoll-Rand cannot accept responsibility for damages arising from failure to provide adequate motor protection.

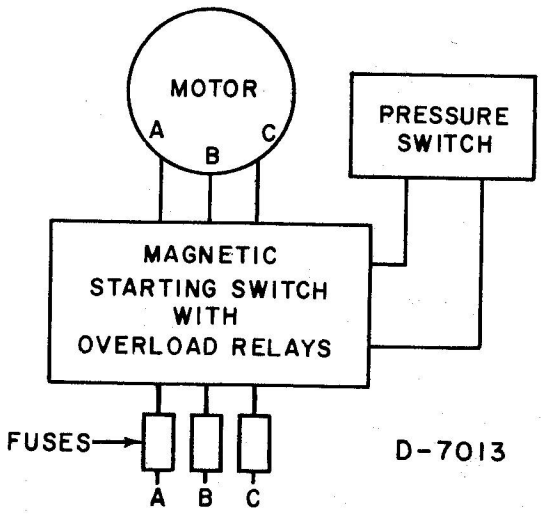

Figure 2-1. Units With Pressure Switch

If your compressor is regulated by a pressure switch (Automatic Start and Stop Control), the pressure switch is to be tapped into the system at a point where it will be activated by receiver pressure and wired back to the starter. **Note:** The pressure switch, in most cases, is not designed to carry motor current; therefore, never wire the pressure switch in series with the motor. See Figure 2-1.

If your compressor is equipped with a low oil level shutdown switch, see page 22 for wiring instructions.

3. FUSES

The momentary starting current of an electric motor is greater than its full load current; therefore, use a fuse with a capacity three times greater than the full load motor current. For example: If the full load current of a 15 hp motor is 40 amperes, 125 ampere fuses should be used. Fuse failure usually results from the use of fuses of insufficient capacity. If fuses are the correct size and still fail, check the conditions that cause local heating, such as bent, weak or corroded fuse clips.

4. PIPING

The piping requirements and arrangements depend upon compressor application and location. The following recommendations are offered as a general guide.

Inlet Piping — The inlet air cleaner is to be piped to a clean location to avoid the possibility of drawing dirty or contaminated air into the compressor. If necessary, the inlet may be piped outdoors or to source of clean air as shown in Figure 2-2. In any event, the inlet air cleaner must be used, and if the inlet is piped outdoors, it must be hooded to protect it against moisture. Inlet pipe is to be one size larger than the diameter of the compressor inlet port, and is not to exceed 10 feet (3.05 m) in length.

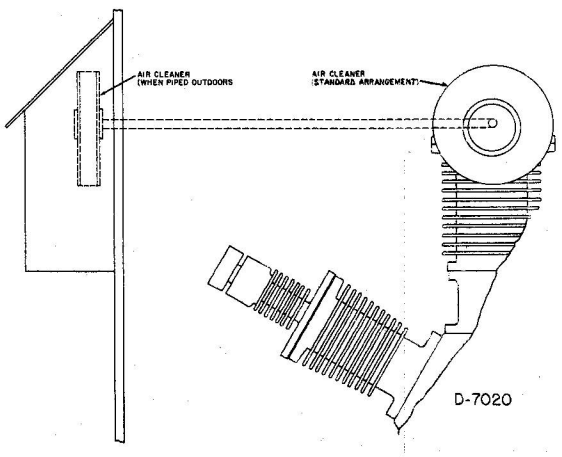

Figure 2-2. Alternate Inlet Piping Arrangement

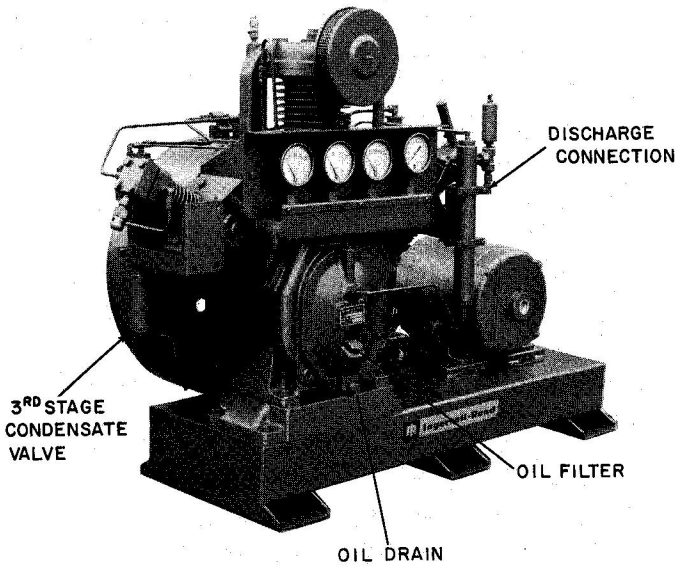

Figure 2-3. Base Mounted Motor Driven 15T4 Compressor

Discharge Piping — The compressor is equipped with a 4th stage condensate trap which contains a drain port, safety valve and check valve. An air filter and dryer is to be installed if pure, dry air is desired. Refer to Figure 2-3 and observe the following precautions when installing the discharge line and storage bank.

(A) Nominal 1/4" (5.85 mm) I.D. high-pressure hose, tubing or pipe may be used as the discharge line. The line, fittings, storage bottles, etc. must be certified safe for at least 5000 psi (351 Kg/cm²).

(B) The line is to be short, direct and adequately braced. It is good practice to install a shut off valve between the compressor discharge and the air receiver and also between the air receive and the point at which the air is used.

Pressure Switch, Pressure Gauge & Misc. Piping — The compressor has a pressure gauge for each stage. A discharge pressure switch is available as optional equipment. If the pressure switch is to be installed in the system, observe the following instructions.

(A) Install the pressure switch at a pulsation free point in the system that registers receiver pressure. Select a high point where condensate will not accumulate. The pressure switch may be mounted in any position, but it must be securely mounted against a solid surface. The connecting line is to be short and direct and certified safe for at least 5000 psi. Wire the pressure switch to the motor magnetic starter according to the schematic diagram accompanying the switch. **Note:** Pressure switch adjustment instructions are given on page 10.

(B) The compressor is equipped with an automatic drain valve; the discharge from which may be piped outdoors or to a suitable drain. As back pressure will effect the proper operation of this valve, drain lines must be at least one size larger than the drain valve connections, in addition to being as short and straight as possible. To prevent the piping from whipping during the blowdown cycle, the ends must be firmly secured.

(C) A low oil level shutdown switch is optional. If used, see page 22 for instructions.

5. PRE-STARTING CHECKS

(A) Before starting a new unit, fill the frame to the overflow point with lubricating oil and check the oil level daily - Refer to "Compressor Lubrication" for recommendations. Lubricate the electric motor, if necessary - Refer to "Motor Lubrication & Care" for recommendations.

(B) Check the electric current and voltage specifications on the motor nameplate against the electric supply available. Make certain the motor is correctly wired. Particularly check the wiring and voltage of dual voltage motors.

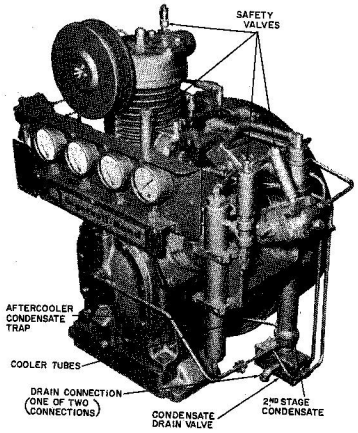

Figure 2-4. Automatic Condensate Drain System

(C) Rotate the beltwheel through several revolutions by hand to see that everything is free and in working condition.

(D) Check the tension of the belts. See "Belt Installation & Adjustment" on pages 9 & 10.

(E) Remove rags, tools and any other objects in the vicinity of the compressor before throwing the switch.

(F) Momentarily start the unit and make certain the direction of crankshaft rotation is the same as that shown by the direction arrow on the flywheel. If rotation is incorrect, interchange two of the three leads on 3-wire, polyphase motors. For other types of motors, follow the reversing instructions given on the motor nameplate.

(G) Start the compressor, but do not leave it unattended unless it is equipped with automatic regulation (pressure switch) for stopping the unit when a specific receiver pressure is reached.

6. COMPRESSOR LUBRICATION

The oil level should be checked daily, and if necessary, replenish to the overflow point. Oil changes should be made every 500 hours of operation or every 60 days, whichever occurs first. The oil capacity is 3-1/2 quarts (3.32 liters) for the 10T2, H10T2 and 5 quarts (4.75 liters) for the 15T4, H15T4.

CAUTION

When changing oil, never use kerosene or gasoline to flush out the frame. The use of such cleaning agents is dangerous and their use must be absolutely prohibited.

We recommend the use of a non-detergent, naphthenic base oil containing rust and oxidation inhibitors. The oil viscosity should be selected for the temperature immediately surrounding the unit when it is in operation. See the following table.

OIL VISCOSITY TABLE

Temp. Range	Viscosity at 100°F. (37.8°C) SSU	Centistokes
40°F & Below (44°C & Below)	150	32
40°F to 80°F (44°C to 26.7°C)	500	110
80°F to 125°F (26.7°C to 51.7°C)	750	650

The exact type and brand of lubricating oil best suited for your use depends upon operating conditions. For example, the application, duty cycle and/or atmospheric conditions under which the compressor operates may be conducive to the accumulation of water in the frame, which leads to the formation of sludge and the rapid wear of moving parts. (**Note:** Since water will settle at the bottom of the frame of an idle machine, a test for water can be made by loosening the oil drain plug sufficiently to permit leakage and noting if the initial flow is water-saturated oil.)

Due to the variable circumstances affecting the selection of lubricating oil, we suggest that a reputable industrial oil dealer be consulted for specific recommendations. Usually, motor oils stocked by gasoline filling stations are not suitable for use in this compressor.

7. MOTOR LUBRICATION AND CARE

Depending upon the type of electric motor

driving your unit, the following lubrication schedule should be observed.

Sleeve Bearing Motors — are to be oiled at least once every 3 months with oil of a viscosity of 150 to 250 SSU @ 100°F (32 to 55 centistokes @ 37.8°C). **Note:** Do not fill the oil reservoir with an excessive amount of oil, since it may work onto the commutator.

Ball Bearing Motors with Grease Fittings — Ball bearing motors that have grease fittings and plugs near the bearings are to be repacked with grease once a year. Use a very good grade of ball bearing grease.

Pre-Lubricated Ball Bearing Motors — Pre-lubricated motors have no grease fittings or plugs near the bearings and do not require lubrication.

Several major points contributing to proper motor care are given in the following paragraphs. For more detailed instructions refer to the motor manufacturer's specific recommendations.

On some types, such as direct current motors, the commutator and brushes should be cleaned periodically with a piece of canvas or non-linting cloth. If the commutator of any motor becomes contaminated with oil or grease, it should be cleaned immediately by a competent electrician, otherwise serious damage will result.

It is also good practice to occasionally blow off the motor windings with a jet of air to prevent an accumulation of dirt. An occasional revarnishing of the windings will greatly prolong the life of the motor.

If it is ever necessary to renew brushes, they must be carefully sanded to fit the contour of the commutator, and must be made to fit loosely in their holders. Do not use emery cloth for fitting purposes.

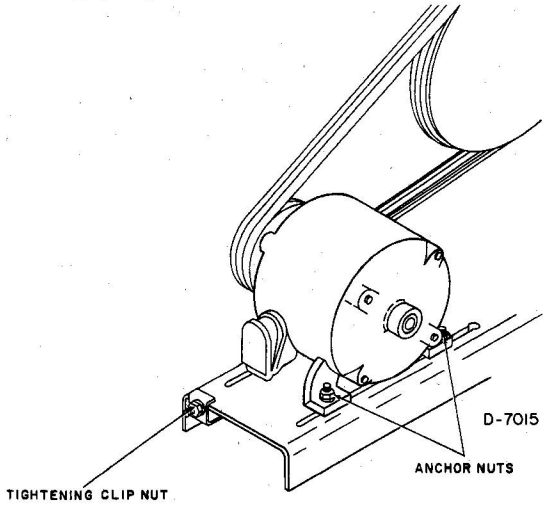

Figure 2-5. Belt Adjustment

8. BELT INSTALLATION AND ADJUSTMENT

When removing or installing new belts, do not pry them over the pulley grooves. The proper method of removing and installing new belts is to loosen the motor anchor nuts, Figure 2-5 and push the motor toward the compressor. Use the tightener nut to adjust belt tension on new belts.

Experience has shown that a new belt can be tightened initially to two times normal tension to allow for any drop in tension during run in. Check belt adjustment weekly during the first month of operation and thereafter check every four or five months.

It is important that belts be properly adjusted. A belt that is too loose will slip and cause heating and wear, and a belt that is too tight may overload the bearings. A quick check to determine if belt adjustment is proper may be made by observing the slack side of the belts for a slight bow when the unit is in operation. See Figure 2-6. If a slight bow is evident, the belts are usually adjusted satisfactorily.

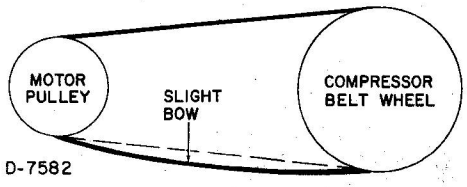

Figure 2-6. Visual Method

However, a more accurate method of checking belt tension is by the spring scale measurement technique that follows.

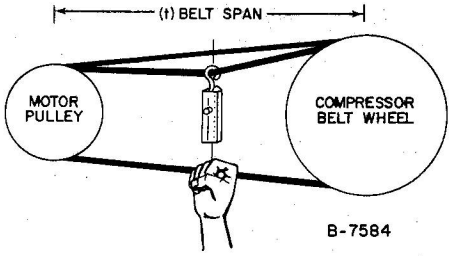

Figure 2-7. Spring Scale Method

(A) Measure the belt span (t) as shown in Figure 2-7.

(B) At the center of the span (t) attach a spring scale to the belt and apply a force perpendicular to the span. The force applied to this spring scale should be sufficient to deflect the belt 1/64″ (.396 mm) for every inch of span length (t).

For example: The deflection of a 100 inch (2,540 mm) span would be 100/64″ or 1-9/16″ (39.6 mm); thus, the force applied to the spring scale should deflect the belt to 1-9/16″ (39.6 mm).

(C) When the belt is deflected the necessary distance, compare the spring scale reading (in pounds force) with the values given in the following tables.

STANDARD BELTS

Belt Type	Normal Tension	150% Normal Tension
C	4½ lbs. (1.93 Kg)	6¼ lbs. (2.83 Kg)

If the reading is between the value for normal tension and 150% normal tension, the belt tension should be satisfactory. A reading below the value for normal tension indicates belt slack should be reduced, and conversely, a reading exceeding the value for 150% normal tension indicates belt slack should be increased.

The belt set must be matched to permit equal load distribution. For details, consult the belt supplier.

9. PRESSURE SWITCH ADJUSTMENT

The pressure switch (if used) automatically regulates the compressor, starting and stopping the driving motor at specific receiver pressures.

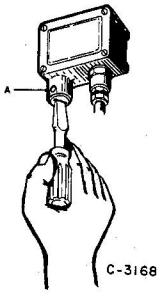

Figure 2-8. Pressure Switch Adjustment

To adjust the switch, loosen set screw (A), Figure 2-8, with an Allen wrench. With a screw driver, turn the adjusting screw clockwise to raise the cut-out point (increase pressure) or counterclockwise to lower the cut-out point (decrease pressure). When the desired pressure is established, tighten the set screw. The differential, or span between cut-out and cut-in, is fixed and varies with the cut-out setting of the switch. (Important: Do not increase the cut-out setting beyond the point originally established at the factory without consulting the nearest I-R branch office.)

10. AIR VALVES

The valves used in these compressors are very efficient and durable, but any valve used in high-pressure service will require more frequent cleaning than valves used in low-pressure service. For this reason, we recommend that the valves are inspected monthly, and if necessary, disassembled and cleaned. See "Valve Servicing" on page 13 for procedure.

11. SAFETY VALVES AND STAGE PRESSURES

The 1st, 2nd, 3rd and 4th stages are equipped with safety valves as standard equipment. In addition, a "shear-disc" type relief valve is furnished on the 4th stage heads. See Figure 0-1 for location of safety valves.

The safety valves are set slightly above the normal working pressure of the stage that they protect. These valves are the automatic reset type and if they should leak, replace them.

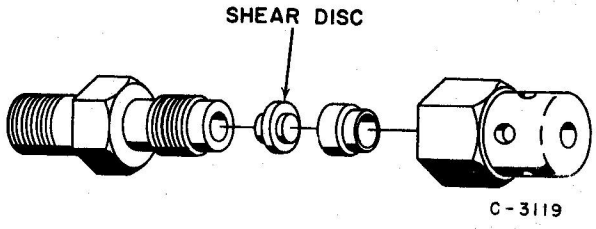

Figure 2-9. Shear-Disc Relief Valve

The "shear-disc" relief valve protects against any sudden, abnormal pressure surge, which conventional safety valves may not relieve quickly enough. The "shear-disc", shown in Figure 2-9 is replaceable.

WARNING

It is not safe to increase the blow off pressure of a safety valve. Do not remove the valve and replace it with a plug, since this will eliminate the protection provided and may result in injury to personnel and damage to the compressor.

The stage pressures listed in the following table are valid for a compressor in good mechanical condition operating at or near sea level. Stage pressures for a compressor operating at higher altitudes should be recorded when the machine is new and these readings

used as the normal stage pressures.

Discharge	1st Stage	2nd Stage	3rd Stage
10T2	**PSI**	**PSI**	**PSI**
2000 psi	40–48	225–245	750–830
3000 psi	41–49	236–256	855–945
H10T2	**PSI**	**PSI**	**PSI**
4000 psi	42–50	246–266	960–1060
5000 psi	43–51	255–275	1070–1170
15T4	**PSI**	**PSI**	**PSI**
2000 psi	38–46	215–235	710–790
3000 psi	39–47	225–245	785–865
H15T4	**PSI**	**PSI**	**PSI**
4000 psi	39–47	232–252	865–955
5000 psi	40–48	240–260	940–1040

12. INLET AIR CLEANER

It is very important that the air inlet muffler and cleaner be kept clean at all times. A dirty inlet cleaner reduces the capacity of the compressor.

Either clean the pads as often as your experience indicates necessary or replace them with new ones. The filtering element should be taken out at least once a month and cleaned.

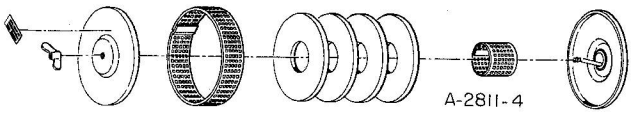

Figure 2-10. Air Inlet Muffler and Cleaner

As the dirt collects on the outside, the outside surfaces should be brushed.

The standard inlet air cleaner is suitable only for normal industrial applications. Should the compressor be located in an area where the atmosphere contains a heavy concentration of dust and dirt, an air cleaner utilizing a specially designed, high capacity element should be used.

All applications of this nature should be referred to the nearest Ingersoll-Rand branch office.

CAUTION

We recommend the use of safety solvent for cleaning. Never use gasoline, kerosene or similar fluids to clean the air inlet muffler and cleaner.

13. AIR BOTTLES

Charged high-pressure bottles are potentially lethal instruments and all safety precautions in their charging, handling and storage must be observed.

The bottles used must be certified safe for the pressure involved and must meet the safety codes of the state in which they are used. While charging, transporting or storing, the bottles are to be securely braced. When handling, use extreme care to avoid dropping or bumping against any solid object and inspect the bottles frequently for indications of damage to the tank or valve. It is good practice to drain bottles frequently to prevent condensate from accumulating. Accumulation of condensate in the bottle leads to rusting and a possible safety hazard.

14. COMPLETE AUTOMATIC STARTING UNLOADING & CONDENSATE DRAINING

The compressor is equipped with complete starting unloading and condensate draining. The purpose of this system is to relieve cylinder pressure and to empty condensate from the condensate traps whenever the compressor stops. Relieving cylinder pressure when the unit stops permits it to start against a light load; increasing the life of the compressor, driver and belt and also reduces the possibility of tripping the overload relay or stalling the gasoline engine (if used). The system operates in the following manner.

The centrifugal unloader is connected to the end of the compressor crankshaft. When the compressor is operating, centrifugal force acts upon the weights and they swing outward (Figure 2-11). When the compressor stops, these weights retract, permitting the plunger spring to move the plunger and thrust pin outward. The thrust pin unseats the pilot valve plate, and 1st stage cylinder pressure escapes to atmosphere through the pilot valve and the inlet filter. Loss of 1st stage pressure against the automatic drain valve outer diaphragm permits 2nd stage pressure, to move the inner diaphragm off its seat. This action opens a direct path to atmosphere for 2nd stage cylinder pressure through the automatic drain valve discharge port. Loss of 2nd stage pressure to the automatic drain valve piston, allows draining of 3rd and 4th stage condensate in similar fashion.

The pressure from these stages now blows to atmosphere through the condensate traps and

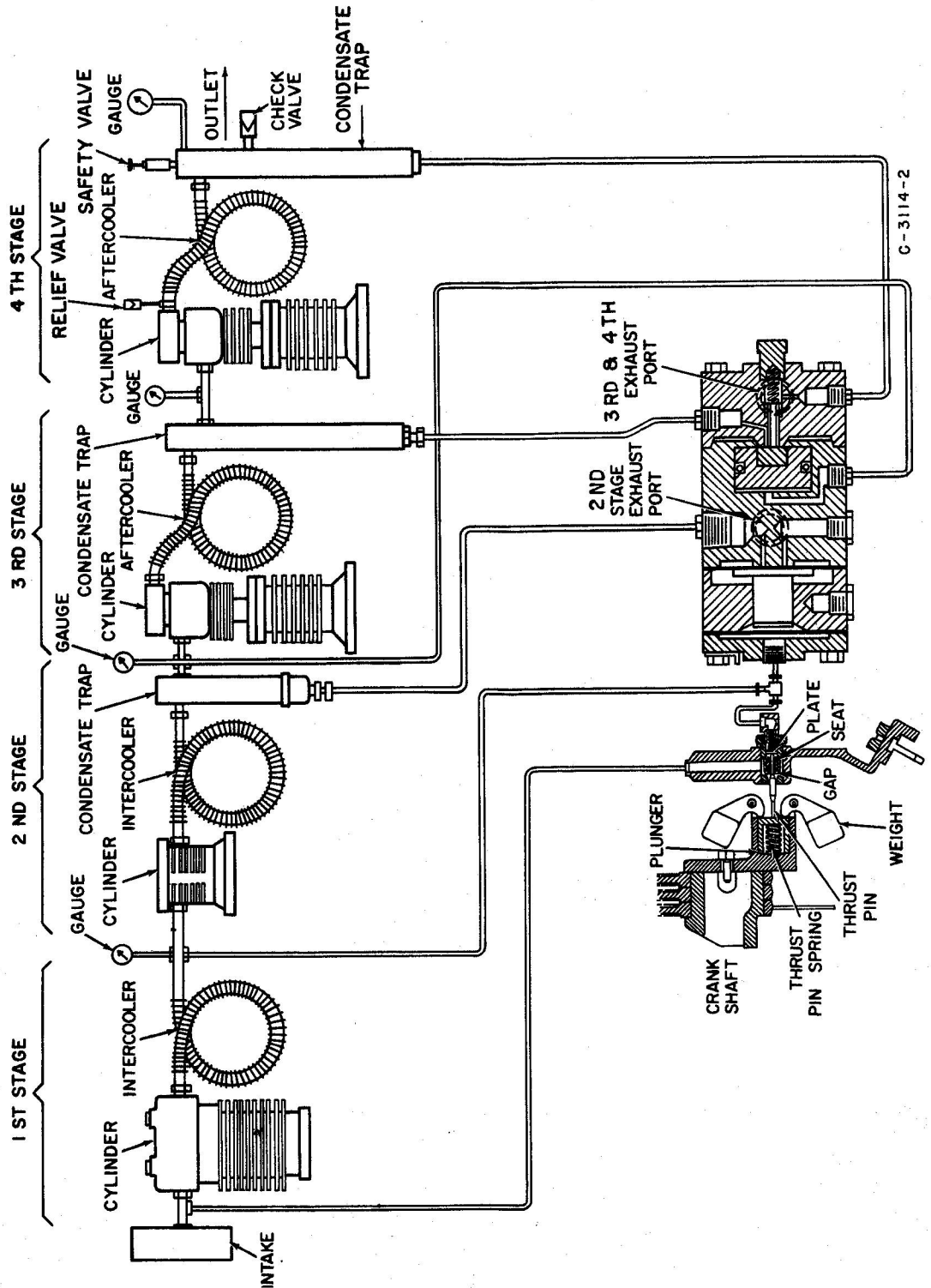

Figure 2-11. Complete Automatic Starting Unloading & Condensate Draining System

automatic drain valve, emptying the traps of condensate in the process.

When the compressor starts, centrifugal force acts upon the unloader weights and they swing outward, pushing the plunger and thrust pin inward, permitting the pilot valve plate to seat. See Figure 2-11. This action seats the pilot valve plate, closing the escape path to atmosphere for first-stage cylinder pressure. Since the first-stage is now pumping air, cylinder pressure builds up in the pilot valve tube line and acts against the automatic drain valve diaphragm. As a result, it moves against the inner diaphragm blocking the escape path to atmosphere for 2nd stage pressure. As 2nd stage pressure builds up, it moves the automatic drain valve piston closing the 3rd and 4th stage condensate valve seats. With all paths to atmosphere closed, the compressor pumps in a normal manner.

15. PILOT VALVE ADJUSTMENT

To adjust the outside exhaust pilot valve, refer to Figure 2-12 and proceed as follows:

(A) Stop the compresor. Remove the pilot valve tube fitting and withdraw the spring and plate.

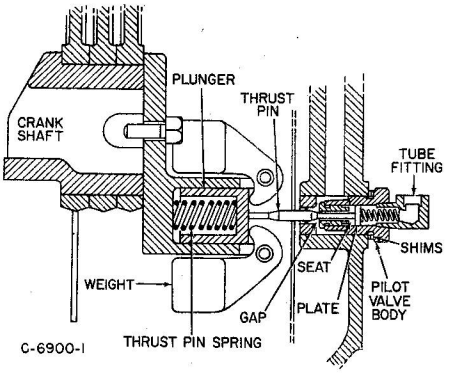

Figure 2-12. Pilot Valve Adjustment

(B) Insert an appropriate measuring tool into the open end of the pilot valve and measure the distance between the seat and the end of the thrust pin. This measurement should be between 1/16″ (1.59 mm) and 1/8″ (3.18 mm).

(C) If the measurement is under 1/16″ (1.59 mm), remove shims from between the pilot valve body and the frame; if more than 1/8″ (3.18 mm), add shims until the required measurement is obtained.

(D) Start the compressor and push the thrust pin into the pilot valve body with a small dowel until resistance is felt. The end of the thrust pin should now be located behind the seat so that the plate can seal against the seat. If this is not the case, re-adjust the thrust pin stroke by adding shims between the body and frame.

(E) Recheck the adjustment and make certain the operating position of the end of the thrust pin is behind the seat and the stopped position of the pin is 1/16″ (1.59 mm) to 1/8″ (3.18 mm) ahead of the seat.

16 CHECK VALVE SERVICE

The check valve is not adjustable. Leaky valves can sometimes be corrected by disassembling the valve and cleaning the seating surface. If cleaning does not stop the leaking, the valve should be replaced.

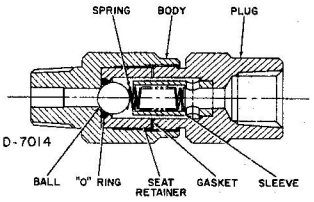

Figure 2-13. Typical Check Valve

17. INTERCOOLERS, AFTERCOOLER & CONDENSATE TRAPS

The 2nd, 3rd and 4th stages are equipped with condensate drain traps. Also, each stage is equipped with an intercooler or aftercooler.

The intercoolers and aftercooler consists of finned tubes, connected between the stages as shown in Figure 2-11 on page 12. The compressed air flows through these tubes and its heat is transferred to the tube's finned surface where the action of the fan passing air over the tubes rapidly dissipates the heat to atmosphere. As a result, the temperature of the air being compressed is reduced considerably, trapping the moisture contained in the air in the condensate traps.

NOTE

These traps are to be drained hourly, through actuation of the automatic draining system.

Servicing the Cooler Tubes — Clean the surface of the cooler tubes with a jet of air at least once a month. If satisfactory results can not be obtained using this method, clean the exterior of the tubes with a non-flammable safety solvent whenever deposits of oil, dirt or grease are observed. During regular overhaul periods, the tubes should be removed and inspected internally. If the interior of the tubes are blocked with carbon or other deposits, the tubes are to be replaced or cleaned.

The tubes may be cleaned by capping one end and filling the tube with a non-flammable safety solvent to help loosen internal deposits of oil, dirt or carbon. (A chlorinated, hydrocarbon type of solvent is a good cleaner.) Always flush the tubes and permit them to dry thoroughly before replacing.

SECTION III
MAINTENANCE

CAUTION

Before doing any repair work on the unit be certain the starting switch is in the "off" position or the wiring disconnected from the line to prevent the unit from accidently starting. Blow down all pressure from the compressor, and isolate the unit from any outside sources of air pressure. These simple precautions will prevent accidents

18. GENERAL

The maintenance section of this book covers only those operations with which maintenance personnel may not be too familiar. It is expected that the average mechanic's training and experience will permit him to perform the more common maintenance functions without the need of detailed instructions.

19. TORQUE VALUE

The table below gives the torque to which a torque wrench should be set for tightening the various size attaching screws and nuts. (See the parts list for the diameter and pitch of the different caps screws and nuts.)

TORQUE VALUE TABLE

NATIONAL COARSE

Dia. Pitch	Ft. Lbs.		Meter Kilograms	
	Min.	Max.	Min.	Max.
¼"-20	6	7	.83	.97
5/16"-18	12	14	1.66	1.93
⅜"-16	21	24	2.90	3.32
½"-13	52	59	7.20	8.15
⅝"-11	105	120	14.50	16.60
¾"-10	107	190	23.50	26.20

NATIONAL FINE

Dia. Pitch	Ft. Lbs.		Meter Kilograms	
	Min.	Max.	Min.	Max.
¼"-28	5	6	.69	.83
5/16"-24	9	10	1.24	1.38
⅜"-24	14	16	1.93	2.21
½"-20	40	42	5.52	5.80
⅝ -18	60	70	8.30	9.55
¾"-16	100	120	13.80	16.60

20. 1ST AND 2ND STAGE VALVE CLEANING

To remove and clean a concentric ring-type valve, observe the following step-by-step procedure:

(A) Loosen the valve acorn nut as shown in Figure 3-1; then take out the air head cap screws and remove the air head from the cylinder.

(B) The valve itself may now be disassembled. To facilitate the valve disassembly, screw two bolts part way into the two threaded ports located in the valve seat. Clamp these bolts firmly in a vise and remove the pal nut and hex nut. Note the manner in which the valve parts are assembled and replace them in the same order and position.

NOTE

Handle the valve parts with care. Do not nick, scratch or bend them.

(C) The valve parts may be cleaned by light scraping or stiff brushing (do not use a wire brush.) If necessary, use a non-flammable safety solvent to loosen dirt, oil or carbon deposits.

(D) Re-assemble the valve parts in their proper sequence and position. Make absolutely certain that the stop plate is centered properly on its guide; otherwise, the valve will be damaged when it is pulled up tight in the air head. Replace the hex nut on the valve bolt and tighten it to the torque value recommended on page 14. Replace the pal nut.

(E) Before replacing the valve in the air head, scrape the old shellac off the valve bolt steel washer and coat it with new shellac to prevent air from leaking under the washer. Replace the acorn nut and tighten it to the lower limit of the torque value, recommended on page 14. Do not over tighten this nut, since this will distort the springs and plates, causing the valve to leak. After the valve has been replaced in the air head, make certain that the valve operates freely by lifting at its edges with a knife blade.

(F) Replace the air head gasket on the cylinder; then replace the air head. Tighten the air head cap screws to the torque recommended on page 14.

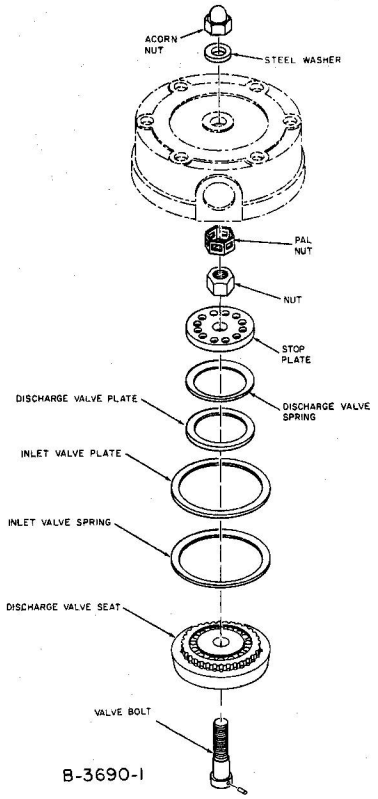

Figure 3-1. Concentric Ring-Type Valve

21. SERVICE 3RD OR 4TH STAGE PLATE-TYPE VALVE

Refer to Figure 3-2 and remove the 3rd or 4th stage air head from the cylinder and pull the valve out of the head. Note: If necessary, soak the valves in a suitable carbon solvent overnight to permit easier disassembly.

(A) Remove the snap ring from the valve by prying under its tapered edge with a pen knife. Withdraw the internal parts of the valve and place them on a clean surface in the correct relationship so that the valve can be properly reassembled.

(B) Clean the valve parts by a light brushing or scraping. When cleaning valve parts use extreme care to prevent damaging the parts.

(C) When reassembling the valve, make certain all parts are replaced exactly as removed and that the gaskets and "O" rings are not damaged. Figure 3-2 illustrates the relationship of these parts. Note: The "O" rings are made of special high temperature resistant material and are to be replaced with genuine I-R replacement "O" rings only.

22. PISTON RING REPLACEMENT

We recommend replacing all piston rings at the same time. To remove and replace rings observe the following step by step procedure.

(A) To replace piston rings on the 1st or 2nd stage double-ended piston, both the cylinder and piston are to be removed from the compressor. To replace piston rings on the 3rd stage steeple piston and the 4th stage built-up piston, only the compression cylinder need be removed. Remove the cylinders in the manner outlined under "Cylinder & Piston Removal & Replacement" on page 18.

(B) Pull the old rings off the 1st and 2nd stage double-ended piston. See Figure 3-3. Remove the rings from the 4th stage steeple piston by driving out the dowel pin and unscrewing the piston top. See Figure 3-4. The rings and spacers may then be pulled off the center bolt.

(C) With the rings removed, thoroughly clean the pistons by brushing or scraping lightly. Pay particular attention to cleaning the piston ring grooves, oil return holes and gasket seating surfaces on the cylinder.

(D) Inspect the cylinder bore for scoring or scuffing. If the cylinder bore shows signs of being scored or worn (as indicated by a visible ridging at the end of ring travel,) it must be replaced to establish effective oil control.

(E) Inspect the piston for signs of excessive scoring or cracking. Particularly check the condition of the ring grooves for wear on the sides of the ring lands. If any of these conditions are observed, the piston should be replaced.

(F) To replace the rings of the 1st and 2nd stage double-ended piston, or 3rd stage steeple

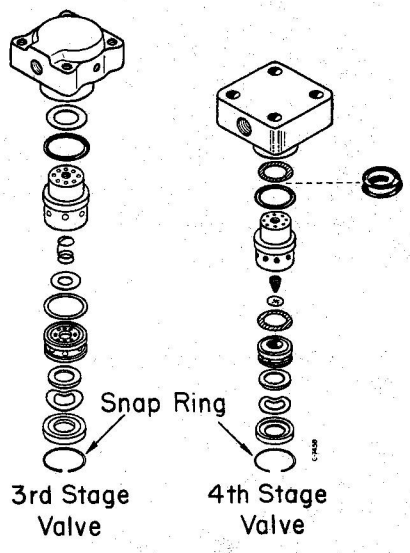

Figure 3-2. Plate-Type Valve

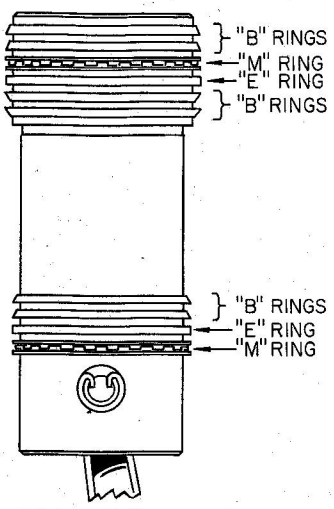

Figure 3-3. Double Acting 1st & 2nd Stage Piston

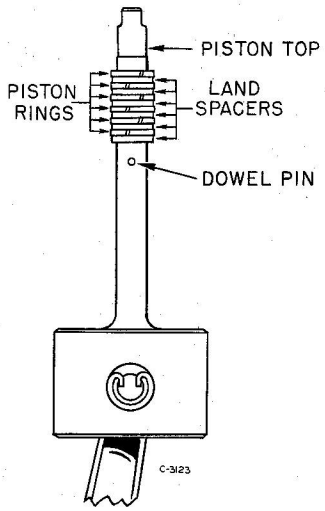

Figure 3-4. Built-up 4th Stage Piston

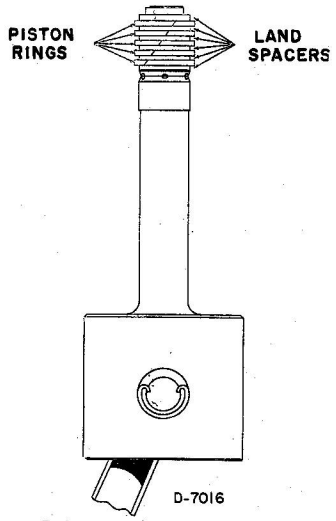

Figure 3-5. 3rd Stage Steeple Piston

piston, lubricate the ring grooves and replace the rings with a piston ring expander to avoid breakage and distortion. The "B", "E" and "M" type rings are to be installed in the grooves as indicated in Figure 3-3. Work from bottom compression ring up on the top end of the piston and from the top compression ring down on the lower end. Note in Figure 3-3 the manner which the tapers are to be positioned.

The step seal rings of the second, third and fourth stages are marked for proper positioning in their ring grooves. The word "top", a white dot or similar marking must face the compression chamber. Caution then must be exercised in placement of the step seal rings labeled "E" on the second stage piston in Figure 3-3. The upper "E" ring will have its "top" mark facing the crankcase. On the lower "E" ring the marking will face away from the crankcase.

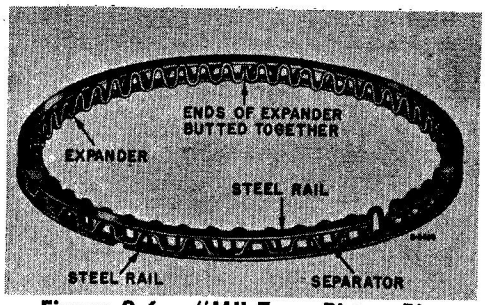

Figure 3-6. "M" Type Piston Ring

The "M" ring is a four piece oil wiper with an expander, separator and two steel rails. See Figure 3-6. Place the expander in the groove and butt the ends together inside the groove. Do not overlap the expander and make certain that these ends do not overlap accidently when installing the other ring segments. Next, install one of the steel rails in the bottom of the groove — this will hold the expander in place. Now install the separator on top of the steel rails and over the expander. Make certain the butt ends of the expander and the end gap of the separator are 180° apart. The second steel rail may now be installed in the top of the ring groove over the separator. With all rings installed, stagger the end gaps.

(G) To replace the rings of the 4th stage piston, first examine the spacers and make certain they are not worn or damaged. Next, insert the spacers and rings on the center bolt in the sequence shown in Figure 3-4. The small diameter groove spacers (not shown on the illustration) are inserted on the center bolt inside the piston rings. With all rings and spacers in place, return the center bolt to the piston; tighten it and replace the dowel pin. After the center bolt has been tightened, check to make certain that each ring has a slight freedom of movement (as opposed to extreme rigidity which may occur if the rings are pinched by the spacers).

(H) When new piston rings are to be installed in the original cylinder of the 1st or 2nd stage, the cylinder bore must be "deglazed" to provide a proper seating surface for the rings. Use a #80 grit abrasive cloth and go over the cylinder bore using a rotating, reciprocating motion. Do not overdo "deglazing"; dulling the glaze is usually sufficient and can be accomplished with light pressure.

CAUTION

Do not attempt to deglaze the cylinder bore with a harsh abrasive agent. The use of such abrasive agents usually results in faulty compressor operation.

After deglazing, the cylinder walls should be thoroughly cleaned by scrubbing the bore with

a stiff bristle (not wire) brush using ordinary soap or a detergent and hot water. Rinse thoroughly with hot water and then check the cleanliness of the cylinder bore by wiping it with a soft white cloth.

(I) The cylinders may now be replaced. Replace the cylinders in the manner outlined under "Cylinder & Piston Removal & Replacement" on page 18.

(J) After the new piston rings have been installed, the compressor should be operated for at least 10 hours at full load before checking for proper air delivery or oil consumption.

23. CRANKSHAFT BEARING REPLACEMENT

Replacing crankshaft bearings is not to be attempted unless adequate facilities and trained personnel are available. If bearing replacement is necessary, we strongly recommend the installation of a new crankshaft (with bearings attached). Ingersoll-Rand cannot accept responsibility for the successful operation of the compressor unless a genuine I-R crankshaft complete is used as a replacement. Refer to the parts list for ordering instructions.

24. INSTALLING CRANKSHAFT ASSEMBLY

A new crankshaft assembly includes bearings, spacers, etc., all of which are installed as a unit. To remove the old crankshaft and install the new one proceed as outlined in steps (A) thru (M). Important: When reassembling the compressor, the attaching screws are to be tightened to the torque values given on page 14.

(A) First, drain the oil from the frame. Then remove the beltwheel, beltwheel key and shaft end cover. (Note: prevent damage to the belt by removing it as outlined on page 9.)

(B) Remove the frame end cover. Disconnect tubing to the pilot valve and remove the frame end cover and pilot valve as a unit. Next, take the centrifugal unloader assembly off the end of the crankshaft. To remove the connecting rods from the end of the crankshaft, it is necessary to first remove the cylinders and pistons as outlined in steps (D) and (E) under "Cylinder & Piston Removal & Replacement" on page 18.

(C) Pry off the snap ring from the outer bearing.

(D) The crankshaft assembly is a moderate press fit in the frame and may be forced out by tapping the beltwheel end of the shaft with a lead hammer.

(E) Prepare the new crankshaft assembly for installation by removing the snap ring from the outer bearing by springing it from the groove.

(F) The new crankshaft may be inserted into the frame from the frame end cover side. Since the assembly is a moderate press fit, it may be forced into position by tapping it with a lead hammer (be certain to strike the center of the shaft, since an off center blow may spring it.)

(G) The crankshaft assembly must be pushed in until the snap ring groove in the outer bearing clears the end of the frame by about 1/16" (1.56 mm). Replace the snap ring by putting one end in the groove and springing it into place.

(H) Tap the crankshaft back until the snap ring is tight against the frame.

(I) Before replacing the shaft end cover, make certain that there are no burrs on the beltwheel end of the crankshaft and that the edges of the keyway are smooth and slightly rounded to prevent damage to the oil seal. When satisfied that the crankshaft is smooth, replace the shaft end cover. As an added precaution against cutting the oil seal, cut a piece of .003" (.076 mm) brass shim stock to the necessary size and form it into a cone. Lubricate the surface of the cone; position it on the shaft as shown in Figure 3-7 and slide the cover and seal over the cone and into position against the frame.

(J) Replace the pistons and cylinders as outlined in steps (F) and (G) under "Cylinder & Piston Removal & Replacement" on page 18.

(K) Replace the centrifugal unloader assembly and frame end cover. Reconnect all tubing.

(L) Replace the beltwheel key, and beltwheel. (Note: Replace and adjust the belt as outlined on pages 9 & 10.)

(M) Fill the frame with oil to the overflow point of the filler hole.

25. OIL SEAL REPLACEMENT

To replace the oil seal, refer to Figure 3-7 and proceed as follows.

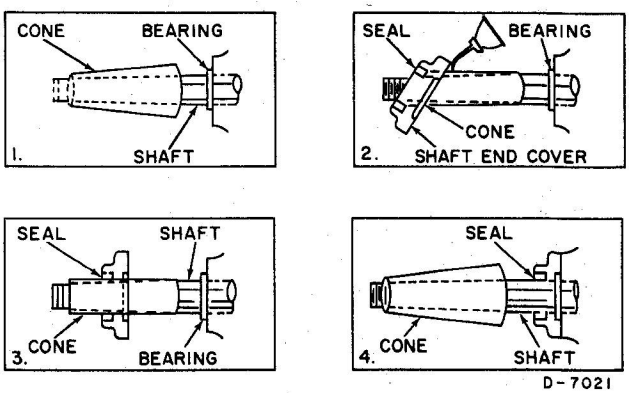

Figure 3-7. Oil Seal Replacement

(A) Remove the beltwheel, beltwheel key and shaft end cover. (Note: Prevent damage to the belt by removing them as outlined on pages 9 & 10.)

(B) The oil seal may be removed from the cover by prying under the inside lip with a pinch bar or driving it out with a metal rod.

(C) Insert the new seal with the sealing lip facing in the same direction as the one removed and coat the outside diameter of the seal with shellac or pipe compound. Press the seal into the shaft end cover with a vise. (Note: Pad serrated vise jaws to prevent damaging the seal.)

(D) After the seal has been installed in the shaft end cover, the cover should be returned to its original location on the frame by sliding it over the end of the crankshaft. To avoid cutting the sealing lip, it is important that the surface of the crankshaft is free of burrs and sharp edges. As an added precaution against cutting the seal, cut a piece of .003" (.076 mm) brass shim stock to the necessary size and form it into a cone. Lubricate the surface of the cone; position it on the shaft as shown in Figure 3-8 and slide the cover and seal over the cone and into position against the frame.

(E) Replace the beltwheel key and beltwheel. (Note: Replace and adjust the belt as outlined on pages 9 & 10.)

26. PISTON PIN REMOVAL AND REPLACEMENT

(A) To remove a piston from its connecting rod, first remove the piston and rod from the compressor as outlined under "Cylinder & Piston Removal & Replacement" on page 18.

(B) With the piston and connecting rod removed from the compressor, remove the lock rings at the ends of the piston pin. See Figure 3-8. With a dowel of appropriate size and a soft hammer drive out the pin. Important: To prevent distorting the piston during this operation, play between the piston pin boss and the connecting rod must be eliminated by inserting fork-type shims of the necessary thickness between the rod and the boss.

(C) To install the new pin, align the connecting rod between the bosses inside the piston, and insert the same number of shims between the boss and rod that were used when the pin was driven out.

(D) Lubricate the pin and drive it into the piston and through the connecting rod with an appropriate dowel and a soft hammer. When the pin is in place, snap the lock rings back in their grooves.

(E) To replace the assembled piston and rod in the compressor, follow the instructions given under "Cylinder & Piston Removal & Replacement" on page 18.

27. CYLINDER AND PISTON REMOVAL AND REPLACEMENT

To Remove Cylinders and Pistons — Proceed as follows:

(A) Disconnect all tubing connected to the cylinders and drain the oil from the frame.

(B) Disconnect tubing to the pilot valve and remove the frame end cover and pilot valve as a unit.

(C) Remove the centrifugal unloader assembly from the end of the crankshaft.

(D) To remove the 3rd and 4th stage pistons, first take out the attaching screws between the compression and crosshead cylinders, and pull the compression cylinder off the piston. Next, take out the attaching screws connecting the crosshead cylinder to the frame and pull the crosshead cylinder off the piston. Pull the end of the connecting rod off the end of the crankshaft and withdraw the rod and piston. If the piston is to be removed from the connecting rod, follow the procedure outlined under "Piston Pin Removal and Replacement" on page 18.

(E) To remove the 1st and 2nd stage double-acting piston, first take out the attaching screws between the 1st and 2nd stage cylinders, and pull the 1st stage cylinder off the top of the piston. Next, take out the attaching screws between the 2nd stage cylinder and the frame. Pull the end of the connecting rod off the end of the crankshaft and lift the cylinder (with the piston inside) off the frame. The piston may now be pushed out of the cylinder. Note: If the piston is to be removed from the connecting rod, follow the procedure outlined under "Piston Pin Removal and Replacement" on page 18.

To Replace Piston and Cylinders — Proceed as follows:

(F) To replace the 1st and 2nd stage double-acting piston, lubricate the 2nd stage cylinder bore and insert the connecting rod and small diameter end of the piston into it. Use an appropriate piston ring compressor method to prevent damage to the rings when inserting, and push the piston into the cylinder as far as possible. Next, replace the frame-to-cylinder gasket, after which, the cylinder, piston and connecting rod may be replaced as a unit by inserting the connecting rod (with its oil dipper

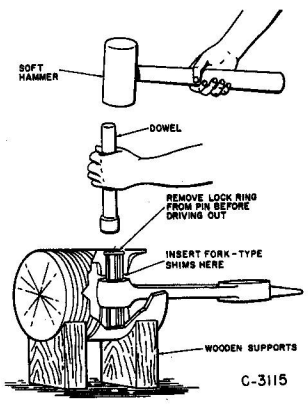

Figure 3-8. Removing a Piston Pin

pointing down) into the frame. Slip the end of the connecting rod over the crankshaft throw and bolt the cylinder to the frame. Next, replace the gasket between the 1st and 2nd stage cylinders. Lubricate the piston rings and slide the 1st stage cylinder over the piston using an appropriate piston ring compressor method to prevent damage to the rings. With the 1st stage cylinder replaced, bolt it to the 2nd stage cylinder. Important: If the air heads have been removed from the cylinders, they must be replaced according to the procedure outlined under "Air Head Replacement" on page 19.

(G) To replace the 3rd & 4th stage pistons, lubricate the bore of the crosshead cylinder and insert the connecting rod and piston into it. Next, replace the cylinder to frame gasket, after which the cylinder, piston and connecting rod may be replaced as a unit by inserting the connecting rod (with its oil dipper pointing down) into the frame and slipping the end of it over the crankshaft throw. With this done, bolt the cylinder to the frame. Next, replace the gasket between the crosshead and compression cylinder. Lubricate the piston rings and slide the compression cylinder over the piston using an appropriate piston ring compressor method to prevent damage to the rings. With the compression cylinder replaced, bolt it to the crosshead cylinder. Important: If the air head was removed, it is essential that it be replaced in the manner described under "Air Head Replacement" on page 19.

(H) Replace the centrifugal unloader assembly to the end of the crankshaft.

(I) Replace the frame end cover and all tubing and fittings that were removed.

(J) Fill the frame to the overflow point with oil.

28. AIR HEAD REPLACEMENT

The attaching screws for all air heads are to be tightened evenly and in rotation to the torque value given in the table on page 14. Important: To avoid faulty valve operation, the 3rd and 4th stage air head attaching screws must be tightened as closely as possible to the torque values given, and a feeler gauge is to be used between the air head and cylinder to make certain the air head is drawn down evenly.

29. PRECAUTIONS FOR STORING

Whenever the compressor is taken out of service, the following precautions must be taken to prevent general deterioration.

(A) Drain all condensate from the drain traps and drain the oil from the frame. To prevent rusting, all interior surfaces of the unit must be treated with a rust inhibiting oil. To treat all interior surfaces properly, remove the air heads from all cylinders, and fog or pour a small amount of rust inhibiting oil directly into the cylinder. Remove and clean the valves (see pages 14 & 15 for instructions) and treat the valves and heads with rust inhibiting oil. Reassemble the valves in the air head and replace the heads on the cylinders according to the instructions given under "Air Head Replacement & Torque Settings" on pages 19 & 14 respectively. Now fill the frame with a suitable rust inhibiting oil, and operate the machine for about 10 minutes. Leave the rust inhibiting oil in the frame until the compressor is put back in service.

(B) Relieve tension from the V-belt.

(C) Redrain the condensate traps, and tape shut all openings to prevent moisture from entering the unit.

(D) Store the unit in a dry, sheltered location.

(E) Drain all condensate from the air storage bottles. Follow the manufacturer's instructions for storing the electric motor, gasoline engine or any system that may be used in conjunction with the compressor.

30. (OPTIONAL) LOW OIL LEVEL SHUTDOWN SWITCH

A float actuated switch is available as a protection against damage to this compressor due to low oil level.

The low oil level switch is a single pole, single throw switch, designed in a NEMA I enclosure. The switch has a maximum rating of 15 amperes at 125, 250, and 480 volts AC. The switch operates on a fail-safe principle and is mechanically actuated for sealed, friction-less operation. A special feature of this switch is its safety control head of solid metal. Because magnetic force is used to rotate the internal magnetic and switch actuator, no shaft passes through the control head, thus preventing oil seepage from the crankcase.

Low oil level in the crankcase causes the switch contacts to open, thus shutting the unit down until the proper oil level has been restored.

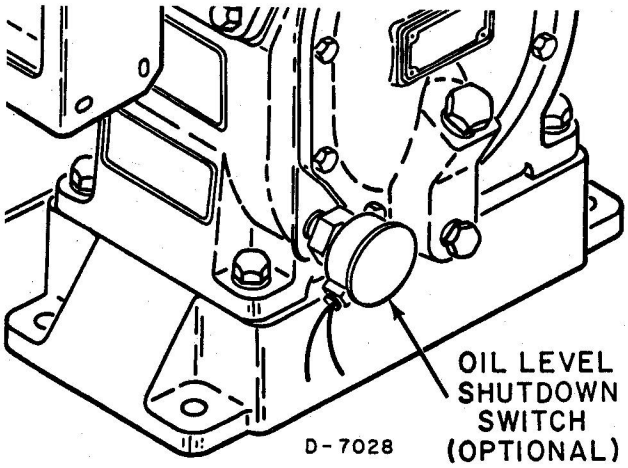

Figure 3-9. Location of Low Oil Level Switch on Compressor

Before putting your unit into operation, be sure the compressor is setting exactly level. Make sure the low oil level switch is installed with the letter "T" directly on top. Do not attempt to turn the switch more than a few degrees in either direction without first making sure the float has been removed.

Use 3/8 inch nominal size flexible steel conduit, of a length as required, over the switch lead wires. Securely attach the conduit to the switch, connect the lead wire and the other end of the conduit to: (a) the pressure switch enclosure on units equipped with automatic start and stop or dual control regulation; or, (b) a locally approved separate mounted junction box for

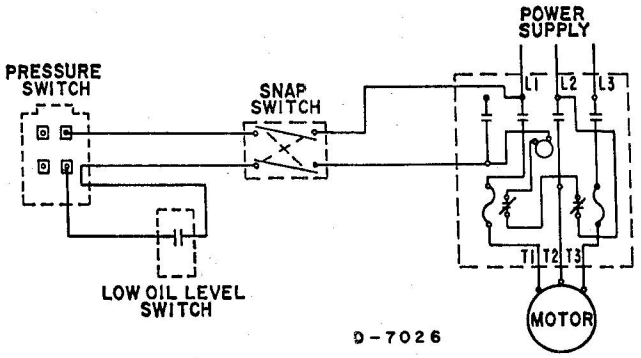

Figure 3-10. Schematic Wiring Diagram for Automatic Start & Stop

units provided with constant speed regulation. Refer to the schematic wiring diagrams, Figures 4 and 5.

> **CAUTION**
>
> Never connect the low oil level switch leads in series with the motor. The switch must always be connected through the control circuit of a magnetic starter.

Fill the crankcase to the proper level with the correct lubricating oil. This automatically resets the low oil level switch.

> **CAUTION**
>
> Be sure to disconnect the main switch to prevent the unit from accidently starting up while the crankcase is being filled.

The unit may now be operated normally until a lowering of the crankcase oil level occurs at which time the unit will automatically shut down.

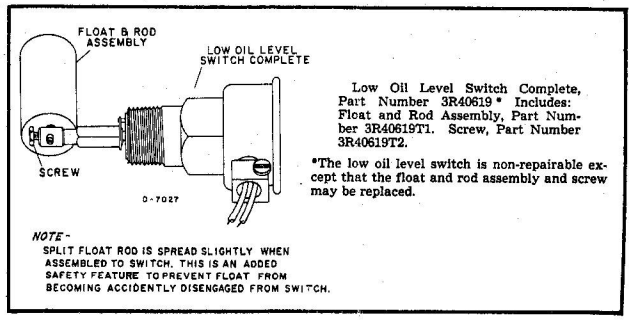

Figure 3-11. Illustration of Low Oil Level Switch and its Parts

ROUTINE INSPECTION AND SERVICE

To maintain top compressor efficiency this inspection and service schedule must be followed.

HOURLY

1. Drain Condensate Traps ..... All condensate traps are to be drained at least every hour, through actuation of the automatic draining system.

Typical operation on automatic start and stop will conform to this schedule. In the isolated cases where pump up and/or operational time exceeds one hour other arrangements must be provided.

DAILY

1. Frame Oil Level ..... Inspect and fill to the overflow point.
2. Drain Condensate ..... Drain condensate from the air storage bottles.

WEEKLY

1. Inlet Air Cleaner ..... Inspect and clean. See page 11 for details.

MONTHLY

1. Air Valves ..... Inspect and clean. See page 10 for details.
2. Electric Motors ..... Lubricate (if required) and service. See page 9 for details.
3. Intercooler & Aftercooler ..... Clean the exterior surface. See page 13 for details.

AFTER FIVE HUNDRED HOURS OF OPERATION

1. Change Frame Oil ..... See pages 8 & 9 for details.

2. Tighten All Attaching Screws ..... Use the torque values given in the table on page 14.

TROUBLE CHART

TROUBLE	CHECK POINTS
Oil Pumping	1-6-8-10-17-21-22
Knocks or rattles	4-16-18-20-22-23-24
Air delivery has dropped off	1-5-17-18-19-21-22
Safety valve pops	18-19
Trips motor overload or draws excessive current	7-13-14-15-16-18-19-22-23-25-26
Water in frame or rusting in cylinders	2-10-11
Excessive starting and stopping (Auto Start)	2-5-12
Compressor doesn't unload when stopped	17-18-19
Condensate drain trap will not drain automatically	17-19
Compressor runs excessively hot	2-3-9-18-27
Compressor won't come up to speed	13-17-19
Light flicker when compressor runs	13-14
Abnormal piston, ring or cylinder wear	6-7-9-10-28
Air and/or condensate leaking from 1st and 2nd stage out of automatic drain valve	29
Air and/or condensate leaking from 3rd and 4th stage out of automatic drain valve	30
Unit very noisy when operated	4-18-19

Check Point & Probable Cause

1. Clogged Intake Filter.
2. Leaking check valve.
3. Air to fan blocked off or fan shroud not in place.
4. Loose beltwheel or motor pulley or motor with excessive end play in shaft.
5. Air leaks in piping (on machine or in outside system).
6. Oil viscosity too low.
7. Oil viscosity too high.
8. Oil level too high.
9. Oil level too low.
10. Detergent type oil being used. Change to non-detergent type with rust and oxidation inhibitor.
11. Extremely light duty or located in a damp humid spot.
12. Readjust pressure switch setting. (Increase differential).
13. Check line voltage, motor terminals for good contact, tight starter connections, proper starter heaters.
14. Poor power regulation (unbalanced line). Consult power company.
15. V-Belt pulled excessively tight.
16. Loose motor fan.
17. Leaking or malajusted centrifugal pilot valve, or defective "O" ring in pilot valve.
18. Leaking, broken, carbonized or loose valves, or restricted air passages.
19. Automatic condensate drain valve defective.
20. Carbon on top of piston.
21. Piston rings broken or not seated in, end gaps not staggered, stuck in grooves, rough, scratched or excessive end gap (over .020" worn) (.508 mm) or side clearance (over .006") (.152 mm).
22. Cylinder or pistons scratched, worn or scored.
23. Worn or scored connecting rod, piston piston pin or crankpin bearings.
24. Defective ball bearing on crankshaft or on motor shaft.
25. R.P.M. too high. Check with tachometer & refer to motor nameplate for correct r.p.m.
26. Voltage too low. Check with voltmeter & refer to motor nameplate for correct voltage.
27. Wrong direction of rotation.
28. Extremely dusty atmosphere. Need more effective air inlet muffler and cleaner.
29. Ruptured seat diaphragm in automatic condensate valve.
30. Actuating piston in automatic drain valve sticking.

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Our Distributor Service Organization offers a complete range of services that are available to you for the entire life of your equipment — to keep it working for you longer, more efficiently and at lowest overall cost.

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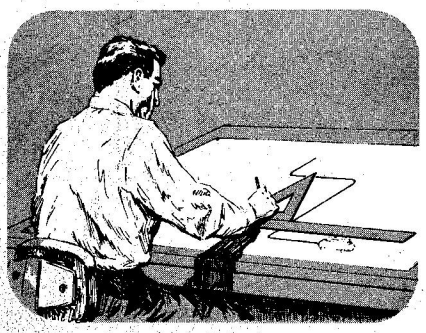

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We can help you with your compressed air problems by surveying your needs and recommending the proper compressor and air piping system for maximum efficiency.

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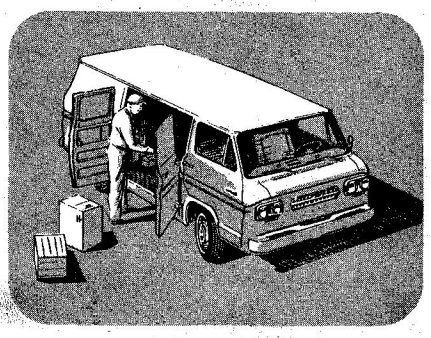

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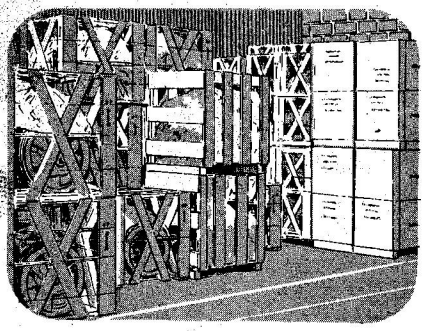
We maintain a staff of trained mechanics and service trucks to provide you with preventive maintenance or meet any emergencies you may have.



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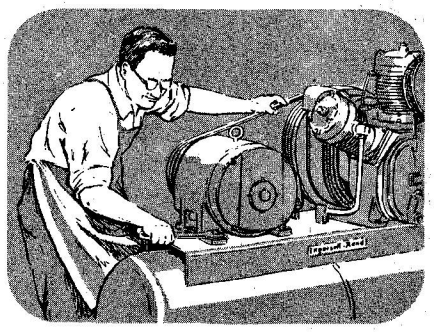

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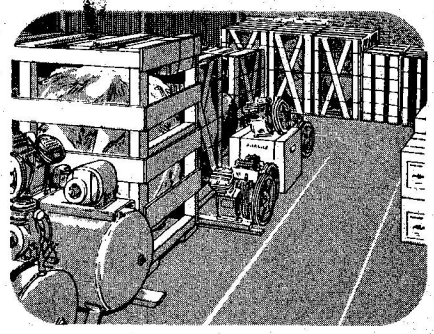

EXCHANGE SERVICE PLAN

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