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20 & 25 HORSEPOWER

Type 30 Compressors

This booklet covers the following Type 30 units.

Model T3025LTM	Model 20S	Model TPTA20
Model T3025HTM	Model 20S2	Model TPTA25
Model T3025LBP	Model 20S3	Model TPT2A20
Model T3025HBP	Model 20S4	Model TPT2A25
Model 20T	Model 25T	Model 20T2

1971-2071
CENTURY II

Ingersoll-Rand

TYPE 30 COMPRESSOR DIVISION
P.O. BOX 399
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INDEX

SECTION 1

GENERAL DESCRIPTION

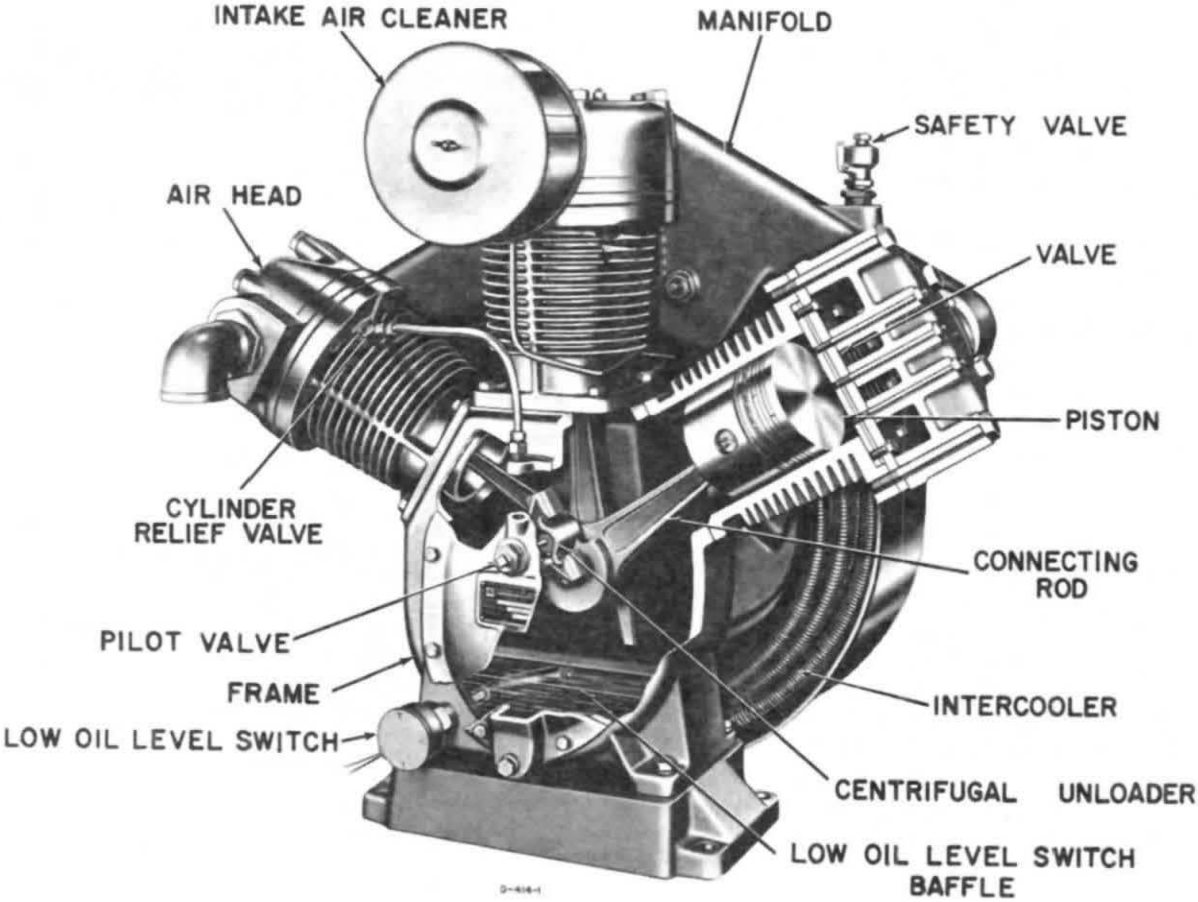

Figure 1-1. Internal Construction of Typical 20 and 25 H. P. Compressor.

This booklet covers both single and two-stage compressors. Since single and two-stage machines operate somewhat differently, the basic principle of operation of each is treated separately in the following paragraphs.

The single-stage 20S, 20S2, 20S3 and 20S4 compressors are built for low-pressure air applications and the basic principle of operation is as follows: on the suction stroke of the individual pistons, air at atmospheric pressure enters the cylinders through the individual air cleaners and the inlet section of the channel valves in each air head. On the compression stroke of each piston, the air is forced out through the discharge section of the channel valves and passes into a common discharge manifold which is piped to the air receiver or system.

For maintaining the air receiver, or system, air pressure within predetermined limits, the compressor is equipped with one of three types of regulation. The type of regulation used depends upon the compressor's application. See page 14 for details.

Starting unloading, or the discharge of air from the cylinders when the unit stops so that it is unloaded when started, is accomplished by the action of the centrifugal unloader operating a pilot valve, which in turn activates the air head unloaders, thus relieving pressure.

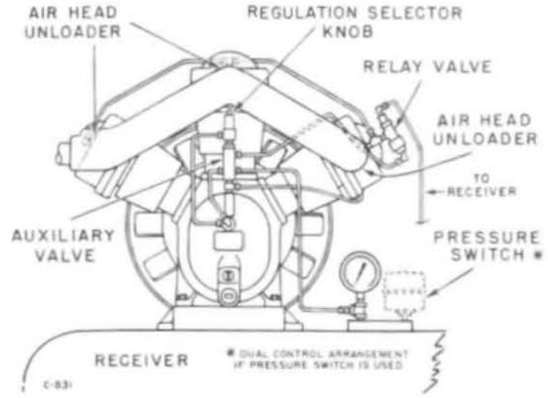

Figure 1-2. Single Stage Compressor.

The two-stage 20T, 20T2 and 25T compressors are built for higher-pressure air applications and the basic principle of operation is as follows: on the suction stroke of the two low-pressure pistons, air at atmospheric pressure enters the two low-pressure cylinders through the individual air cleaners and inlet sections of the channel valves. On the compression stroke of these pistons, the air is compressed to an intermediate pressure and discharge through the discharge portion of the channel valves to a common manifold. From the manifold the air passes through the intercooler tubes, where the heat of first-stage compression is removed by the action of the belt wheel fan passing cool air over the intercooler tubes. On the suction stroke of the high-pressure piston, the air in the intercooler enters the high-pressure cylinder through the inlet section of the channel valve. The compression stroke of the high-pressure piston compresses the air to the final discharge pressure and forces it out into the air receiver or system through the discharge section of the channel valve. If cooling of the discharge air is required, a water-cooled aftercooler should be installed between the compressor discharge and the receiver or system.

For maintaining the air receiver, or system, air pressure within predetermined limits, the compressor is equipped with one of three types of regulation. The type of regulation used depends upon the compressor's application. See page 14 for details.

Starting unloading, or the discharge of air from the cylinders and intercooler when the unit stops so that it is unloaded when started, is accomplished by the action of the centrifugal unloader operating a pilot valve, which in turn actuates the air head unloaders and intercooler vent valve, thus relieving pressure.

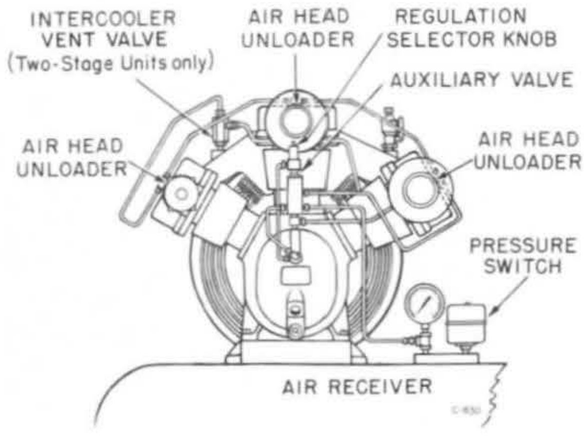

Figure 1-3. Two Stage Compressor.

SECTION 2
ACCESSORIES AND PIPING ARRANGEMENTS

AFTERCOOLERS

Two types of aftercoolers are used: air-cooled and water-cooled. The purpose of an aftercooler is to reduce the discharge temperature of the compressed air and to facilitate removal of water vapor and oil vapor.

AIR-COOLED AFTERCOOLER

The cooler consists of finned tubing through which compressed air passes on its way to the air receiver. Cooling air drawn over these tubes by the fan-type flywheel cools the compressed air and condenses moisture. This moisture passes on to the receiver and is drained either manually or by an automatic drain trap.

This type aftercooler also acts as a belt guard.

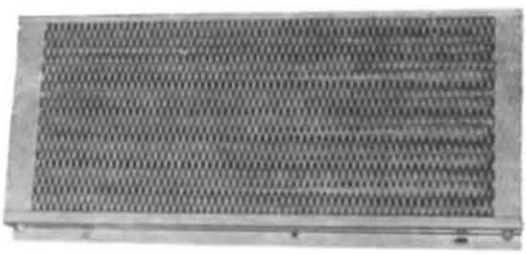

Figure 2-1. Typical Air-Cooled Aftercooler.

WATER-COOLED AFTERCOOLER

The standard water-cooled aftercooler consists of copper tubes with multiple quill-type spines located within steel shells. Headers on each end of the aftercooler provide pipe connections for water, air and condensate piping.

ACCESSORY PIPING ARRANGEMENTS

Typical accessory piping arrangements for base-mounted units are shown in Figures 2-3 and 2-7. These diagrams show the arrangements and tubing connections for obtaining automatic control of the water flow through the water-cooled aftercooler for the different types of compressor regulation. Tubing connections to the automatic drain trap are also illustrated.

NOTE

These diagrams are representative and show relative position only. Actual positions to be made to suit the installation.

Mount the aftercooler as close to the receiver as possible, using pipe of the same diameter as the compressor outlet if the total length is less than ten feet (3.04 m). If the length is more than ten feet (3.04 m), use the next larger size pipe. The aftercooler must be adequately supported.

Air piping from the compressor discharge to the aftercooler should be sloped in such a manner to prevent the condensate from draining into the compressor, but if overhead piping is used, a drain leg to trap condensate should be mounted next to the compressor as shown in Figures 2-3 & 2-7. If an automatic condensate drain trap is not used, a manually operated drain valve must be installed. Drain the aftercooler as frequently as necessary to prevent condensate from entering the compressor.

The D42 aftercooler is designed to reduce the final discharge temperature of the air and to facilitate removal of water vapor and oil vapor. The aftercooler, classified as a shell-and-tube-type heat exchanger, consists of four copper tubes fitted inside of individual metal shells. The tubes and shells are held in place at each end by headers, which also serve as pipe connections for the cooling water supply and condensate piping. See Figure 2-2.

The copper tubes are centered inside the shells by multiple spines that protrude from the surface of the tubes. The spines are formed integrally with the tube and increase the cooling surface area. A filler bar is centered inside each copper spine tube. Its purpose is to increase cooling efficiency.

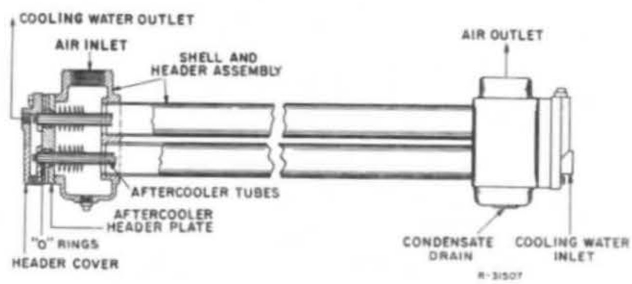

Figure 2-2. D42 Aftercooler.

In operation, the hot air passes over the spines in an opposite direction from the cooling water which flows through the tube.

The required maintenance for the water-cooled aftercooler consists of keeping the spines free from lacquer and carbon. This condition may occur because of high air temperature, and/or the use of high residue lubricating oil, and/or excessive oil consumption. This carbonized condition may be detected by noting changes in cooler efficiency as indicated by the increasing quantity of water required to cool the air. Maximum performance of the aftercooler can be insured by cleaning the aftercooler as soon as there is any indication of a loss of efficiency.

To inspect or clean the tubes, remove the header cover, pull off the header plates, and withdraw the tubes.

NOTE

Care must be used when removing or replacing the tubes to prevent damaging the two "O" rings associated with each tube. Care must also be taken when withdrawing or inserting the tubes to avoid damaging the spines.

If cleaning is required, soak the tubes overnight in a carbon solvent. When the solvent has loosened the carbon sufficiently, a stream of hot water may be used to remove the loosened carbon deposits. Very heavy deposits may require repeated applications. A chlorinated hydrocarbon type of solvent has been found to be effective in removing carbon deposits.

When replacing the tubes, be certain that the ends are smooth and clean. Otherwise, they may not be sealed off tight by the "O" rings. If the "O" rings have hardened or taken a set, they should be replaced with new ones. When installing new "O" rings, cover them with grease to help seal against leakage until the "O" rings have had time to seat.

AUTOMATIC WATER VALVE

The automatic water valve stops the flow of water through the aftercooler when the compressor stops or operates unloaded. When this valve is used, a hand valve must be installed in the line ahead of it to control the rate of water flow.

The method by which the automatic water valve is operated differs between single and two-stage compressors, and the following explanation covers each type of unit separately.

Two-Stage Compressors — On two-stage compressors, opening (A) of the automatic water valve is piped to the compressor intercooler manifold. See Figure 2-3. When the compressor starts (or operates loaded) manifold pressure is applied against the valve diaphragm (B), Figure 2-4 forcing the valve (C) down off its seat and water flows through the valve and aftercooler. When the compressor stops (or unloads) intercooler pressure is relieved from the manifold and automatic water valve by the unloading system. The valve spring (D) now pushes the valve (C) up against its seat and water flow through the valve and aftercooler is shut off.

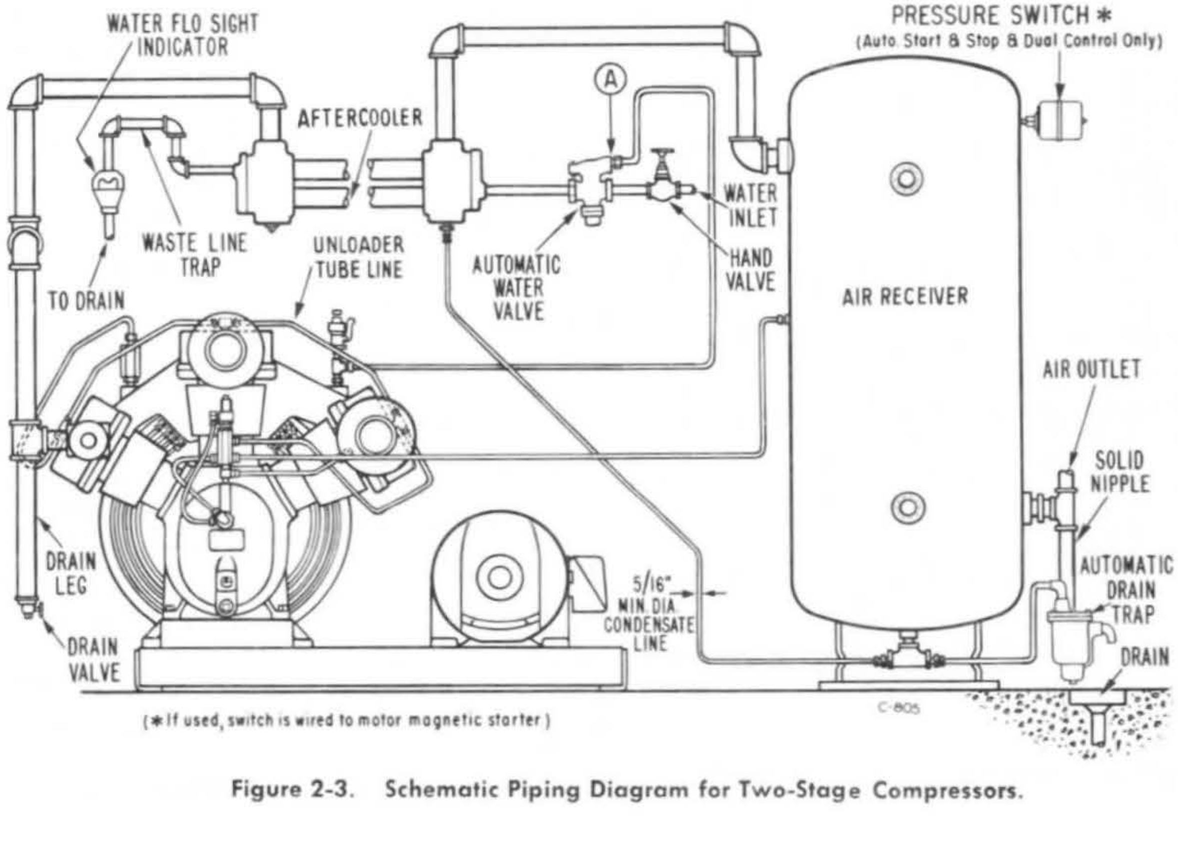

Figure 2-3. Schematic Piping Diagram for Two-Stage Compressors.

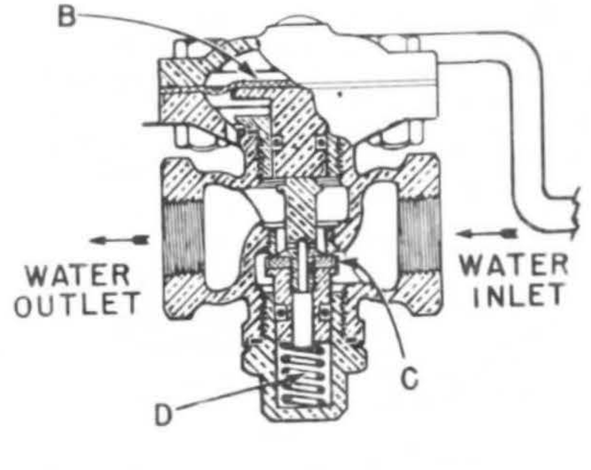

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Figure 2-4. Automatic Water Valve. (Two-Stage Compressors Only)

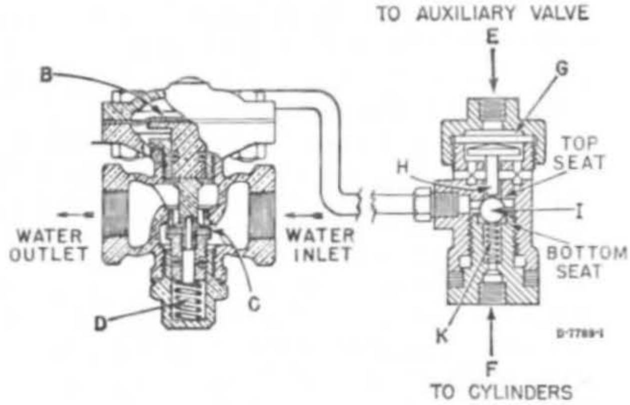

Figure 2-5. Automatic Water Valve & Reversing Valve. (Single-Stage Compressors Only)

Single-Stage Compressors Regulated by Constant Speed or Dual Control — These units are equipped with a relay valve as shown in Figure 2-6. The relay valve is slaved to the auxiliary valve and opens and closes in synchronization with it. When the compressor stops or operates unloaded, the auxiliary valve opens, in turn, opening the relay valve. Receiver air pressure passes through the relay valve into the unloader tube line and to the reversing valve. This pressure is applied against the reversing valve diaphragm (G), Figure 2-5. With pressure against the diaphragm, plunger (H) forces ball (I) against its bottom seat, blocking receiver air pressure to the water valve and permitting pressure over the water valve diaphragm (B) to bleed back through the reversing valve to atmosphere. As a result, the water valve spring (D) reseats the valve (C), shutting off water flow through the valve and aftercooler.

When the compressor starts or reloads, the auxiliary valve closes, in turn, closing the relay valve. Unloader tube line pressure is now shut off and exhausted through the relay valve exhaust port. The loss of pressure against the re-

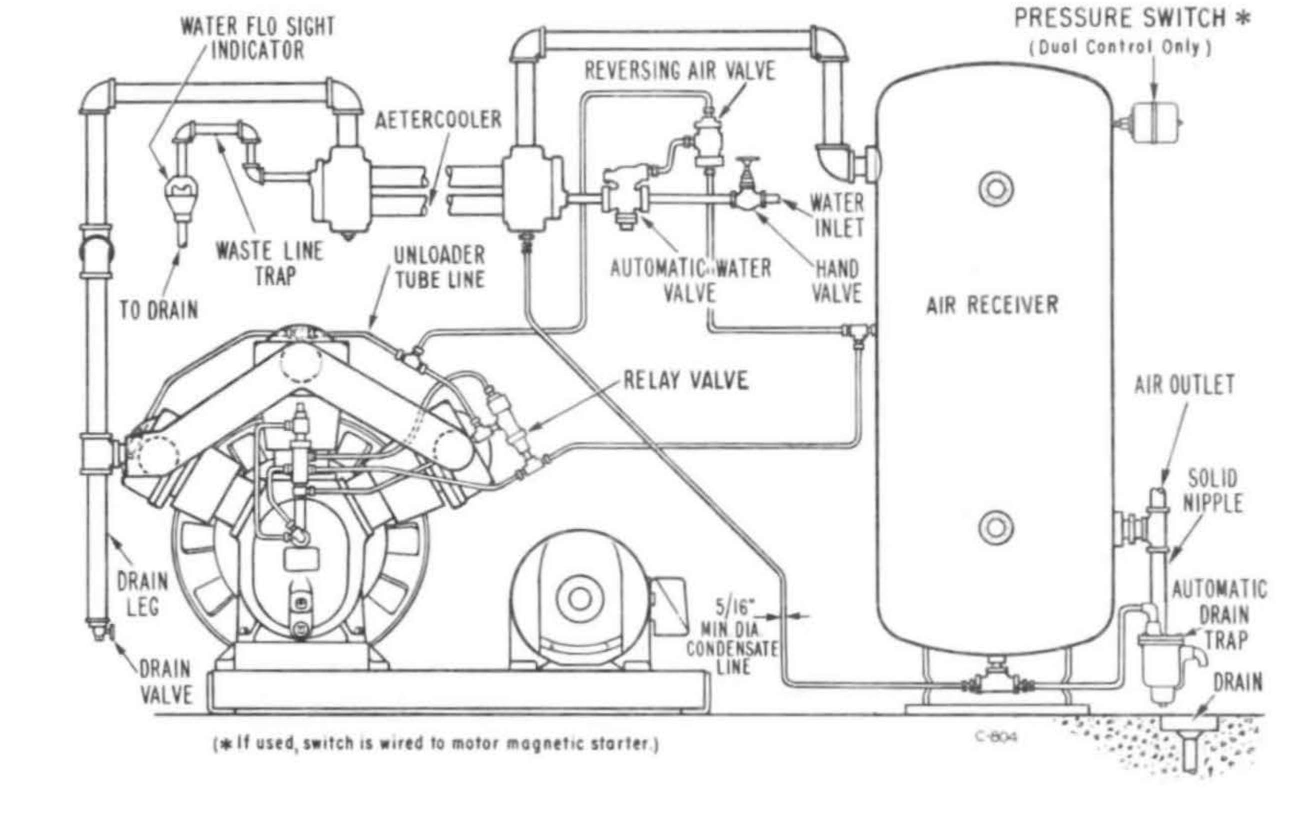

Figure 2-6. Schematic Piping Diagram for Single-Stage Compressors Regulated by Constant Speed or Dual Control.

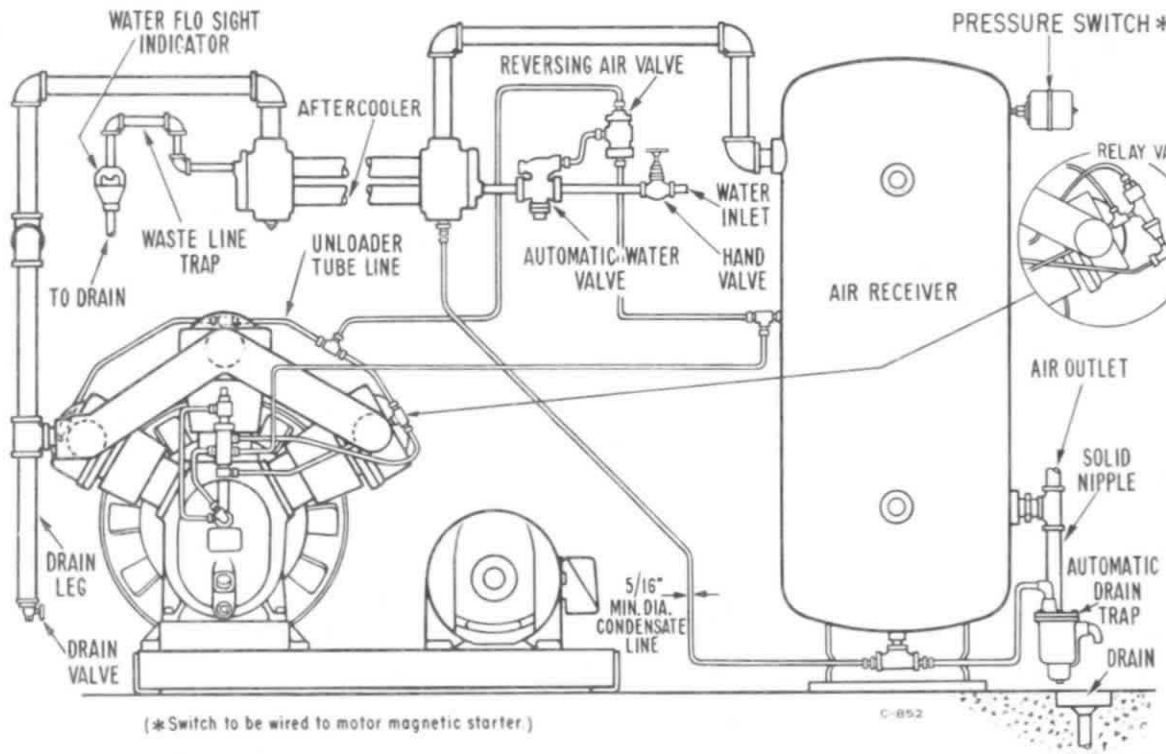

Figure 2-7. Schematic Piping Diagram for Single-Stage Compressors Regulated by Automatic Start & Stop Control.

versing valve diaphragm (G) allows the diaphragm to return to its neutral position and the spring (K) moves the ball (I) against its top seat, permitting receiver air pressure to pass through the reversing valve to the water valve diaphragm (B). With pressure against the water valve diaphragm, the valve (C) unseats and water flows through the valve and aftercooler.

Single-Stage Compressors Regulated by Automatic Start & Stop Control — The piping arrangement for these units is shown in Figure 2-7. When the compressor stops, the pilot valve opens, permitting receiver pressure to pass into the unloader tube line and to the reversing valve. The pressure is applied against the reversing valve diaphragm (G), Figure 2-5. With pressure against the diaphragm, plunger (H) forces ball (I) against its bottom seat, blocking receiver air pressure to the water valve and permitting pressure over the water valve diaphragm (B) to bleed back through the reversing valve to atmosphere. As a result, the water valve spring (D) reseats the valve (C), shutting off water flow through the valve and aftercooler.

When the compressor starts, the pilot valve closes, shutting off and exhausting unloader tube line pressure. The loss of this pressure against the reversing valve diaphragm (G) allows the diaphragm to return to its neutral position and the spring (K) moves the ball (I) against its top seat, permitting receiver air pressure to pass through the reversing valve to the water valve diaphragm (B). With pressure against the water valve diaphragm, the valve (C) unseats and water flows through the valve and aftercooler.

AUTOMATIC DRAIN TRAP

When specified on the purchase order, units are provided with an automatic condensate drain trap. The purpose of the drain trap is to expel the condensate from the receiver and/or the aftercooler.

When the inverted-bucket-style, automatic condensate drain trap is properly primed, and as pressure is built up in the air receiver, condensate is forced into the trap and out the trap outlet. However, if the trap is not properly primed, the inverted bucket remains in its down position; this causes the valve to remain open, allowing air pressure leakage to atmosphere.

When most of the condensate has been discharged from the air receiver, air pressure enters the trap and displaces the condensate contained in the top of the inverted bucket. This causes the inverted bucket to rise, closing the trap.

The top of the inverted bucket contains a small orifice, which allows some air pressure to pass through to the top of the trap.

As the air pressure in the top of the trap gradually increases, it displaces some of the condensate around the outside of the inverted bucket; this causes the bucket to lose buoyancy. However, air pressure over the valve seat will continue to keep the trap closed until the inverted bucket has lost sufficient buoyancy to allow the weight of the bucket to open the valve. When the valve opens, the air pressure in the top of the trap is purged through the trap outlet, this permits air pressure and condensate from the air receiver to enter the trap.

Because the condensate lies in the bottom of the air receiver, air pressure, over the condensate, forces it into the trap first; thus expelling the condensate through the trap outlet. Air pressure from the receiver, after purging the condensate, causes the inverted bucket to recover its buoyancy; thus the cycle repeats itself.

Where there is little or no condensate present in the air receiver, the trap will continue to expel a small amount of air pressure each time the inverted bucket loses buoyancy. The amount of air pressure lost by the cycling of the inverted bucket is negligible; however, it may present the appearance of a faulty automatic condensate drain trap if this cycling is not properly understood. It is very important to understand that this small amount of intermittent air leakage is perfectly normal and should not give cause for alarm. However, if air leakage occurs on a continuous basis, it could be an indication the trap has lost its prime or that the trap may be faulty.

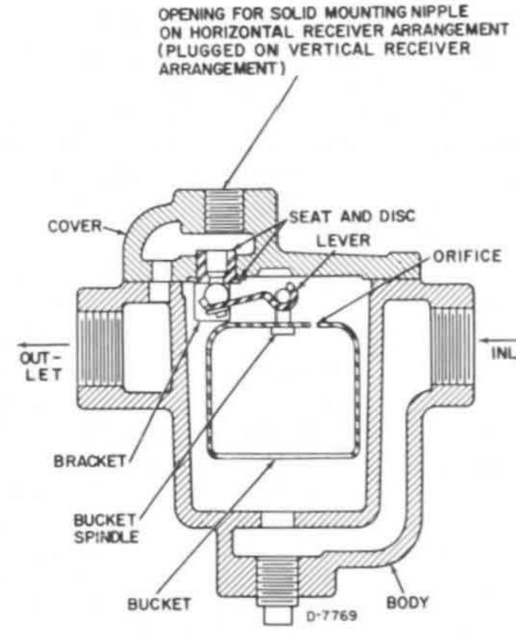

Figure 2-8. Inverted-Bucket Style, Automatic Condensate Drain Trap.

SECTION 3
INSTALLATION

LOCATION & FOUNDATION

In cold climates, we recommend that the unit is installed within a heated building. The location should be clean, relatively cool and provide ample space around the unit for cooling and general accessibility. The beltwheel side should be placed toward the wall, leaving at least 15" (380 mm) for air circulation to the beltwheel fan.

A well ventilated location should be chosen for units operating in damp climates or under conditions of high humidity. These atmospheric conditions are conducive to the formation of water in the frame, and if adequate operation and ventilation are not provided, rusting, oil sludging and rapid wear of running parts will result. This is particularly true for compressors operating on very intermittent duty applications. Also, if the unit is exposed to appreciable quantities of water, dirt, oil, acid, or alkaline fumes, the motor must be specially constructed.

The unit may be bolted to any substantial, relatively level floor or base. If such a surface is not available, an adequate base must be constructed. Should a concrete base be necessary, make certain the foundation bolts are positioned correctly to accept the receiver feet, and that these bolts project at least 1" (25.4 mm) above the surface of the foundation.

To prevent vibration and insure proper operation, it is important that the unit be level and the receiver feet pulled down on shims in such a manner as to avoid pre-stressing the feet and

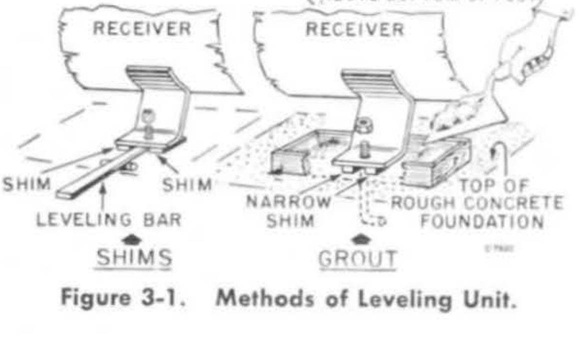

Figure 3-1. Methods of Leveling Unit.

receiver. The following technique is recommended for anchoring the compressor to its base:

A. Tighten evenly, and to a moderate torque, the nuts of any three of the four receiver feet. Check the unit for level. If the unit is not level, insert metal shims, as shown in Figure 3-1 under one or two of the feet to obtain level, and retighten the nuts.

B. Note the distance the unanchored foot is elevated above the base and insert a metal shim of the necessary thickness under this foot to provide firm support.

C. After all shims are inserted and the unit is level, pull up the nuts on all receiver feet to a moderate (not excessively tight) torque.

INSTALLING BELTS OR ALIGNING COUPLING

Your compressor may be belt driven or directly coupled to the driver. If the unit is directly coupled, the coupling must be checked

Figure 3-2. Belt-Driven Unit.

Figure 3-3. Flexible Coupled Unit.

for proper alignment after the unit is secured to its foundation. See page 27 for alignment instructions. If your unit is belt driven, refer to page 26 for belt installation instructions.

WIRING

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 of the National Board of Fire Underwriters and the requirements of the local code.

Before wiring the compressor to the power supply, the electrical rating shown on the motor nameplate must be checked against the electrical supply. If they are not the same, they should not be wired up as serious damage may result.

It is important that the wire used is the proper size and all connections secured mechanically and electrically. The size of wire shown on the attached 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	Three-phase 460V
20	4	8
25	3	8

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, otherwise a burned out motor may result unless it is amply protected.

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

FUSES

Frequent blowing of fuses is usually due to fuses being too small. It must be remembered that the momentary starting current is higher than the full load motor current, and that the fuses must have a current carrying capacity approximately three times the current rating of the motor in order to carry this load. For example: the full load current of a 20 H. P., 1750 RPM, 3-phase, 60 cycle, 220 volt motor is 55 amperes and 165 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 for conditions that cause local heating, such as bent, weak or corroded fuse clips.

STARTING SWITCH

The electrical wiring between the power supply and electrical motor varies according to the type of regulation used and the horsepower of the motor.

Figure 3-4 illustrates the method of wiring the magnetic starter to the push button station on a compressor regulated by constant speed control; Figure 3-5 illustrates the method of connecting the pressure and snap switch to the starter on a unit regulated by automatic start and stop or dual control. Note that both the push button station in Figure 3-4, and the pressure switch and snap switch in Figure 3-5 are wired to the operating coil of the magnetic starter and serve to interrupt current flow to the motor.

All magnetic starters include thermal overload protection to prevent possible motor damage from overloading.

Starting switches are furnished with the manufacturer's instructions for installation. Ingersoll-Rand cannot accept responsibility for damages arising from failure to provide adequate motor protection.

After the wiring is completed, momentarily start the motor to make certain the compressor beltwheel rotates in the same direction as that indicated by the direction arrow on the compressor beltwheel.

OIL LEVEL SWITCH

A float actuated switch is supplied as a protection against damage to your Type 30 air-cooled compressor due to insufficient oil level.

The low oil level switch is a single pole, single throw switch, designed in only 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, frictionless 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 frame.

Low oil level in the frame causes the switch contacts to open, thus shutting the unit down until the proper oil level has been restored. The switch is located in the frame as shown in Figure 1-1.

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 units provided with constant speed regulation.

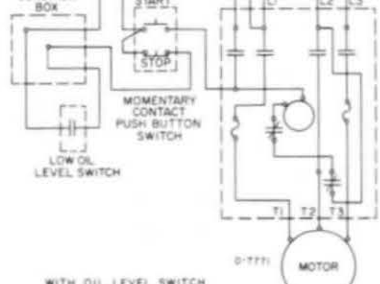

Figure 3-4. Schematic Wiring Diagram for Constant Speed Control Regulation.

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 frame to the proper level with the correct grade of lubricating oil. This automatically resets the low oil level switch. See page 18.

CAUTION

Be sure to disconnect the main switch to prevent the unit from accidently starting up while the frame is being filled.

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

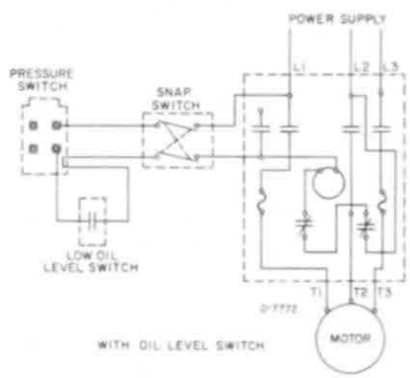

Figure 3-5. Schematic Wiring Diagram for Automatic Start & Stop or Dual Control Regulation.

GASOLINE ENGINE DRIVEN UNITS

Instructions for gasoline engine drive are contained in a separate booklet published by the engine manufacturer. A copy of this is included with the compressor unit when shipped.

INLET AND DISCHARGE AIR PIPING

The following general instructions cover only the installation of inlet and discharge piping and the placement of the pressure switch and/or auxiliary valve in systems using a detached receiver. Piping and control tubing arrangements for accessory equipment, such as the water-cooled or air-cooled aftercooler and the various valves used in conjunction with them are given on pages 6, 7, and 8.

Inlet Piping — If the air in the vicinity of the compressor is unduly dirty or contains corrosive fumes, we recommend piping the air cleaner to a source of cleaner air or use a special heavy duty filter. If it is found necessary to install

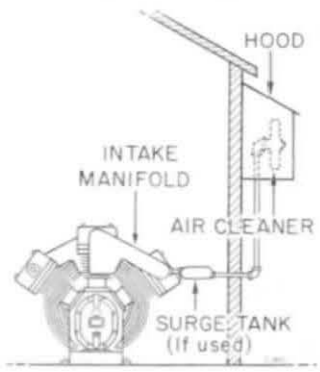

Figure 3-6. Air Cleaner Piped Outdoors.

inlet piping, make the line as short and direct as possible and as large, or larger than the diameter of the inlet connection at the compressor. The inlet piping must increase in diameter for every 50 feet (15.25 m) of length. If the total length is between 50 (15.25 m) and 100 (30.5 m) feet, increase the pipe diameter at the mid-point in the length, i.e., if the total length is 80 feet (24.4 m), increase the pipe diameter at the 40 foot (12.2 m) point. Attach the air cleaner to the end of the inlet air line, and if the inlet is piped outdoors, it should be hooded to prevent the entrance of rain or snow. Fine airborne dust, such as cement and rock dust, require special filtration equipment not furnished as standard equipment on these compressors. Such filtration equipment is available from Ingersoll-Rand Company.

IMPORTANT

Compressors regulated by constant speed control or dual control should not have the inlet piped away from the unit unless a surge tank is installed in the inlet piping next to the compressor. See Figure 3-6. If the surge tank is not installed air that surges in and out of the inlet when the unit operates unloaded will cause the inlet piping to heat, thus heating the inlet air and contributing to carbonization and subsequent valve trouble. Surge tank capacity should be 500 cu in. (8.2 liters). Compressors regulated by automatic start and stop control do not require installation of a surge tank.

Discharge Piping — Discharge piping should be the same size as the compressor discharge connection (on bare compressors) or the receiver discharge connection (on receiver-mounted compressors). . All pipe and fittings must be certified safe for the pressures involved. Pipe thread lubricant is to be used on all threads, and all joints are to be made up tightly, since small leaks in the discharge system are the largest single cause of high operating costs. If

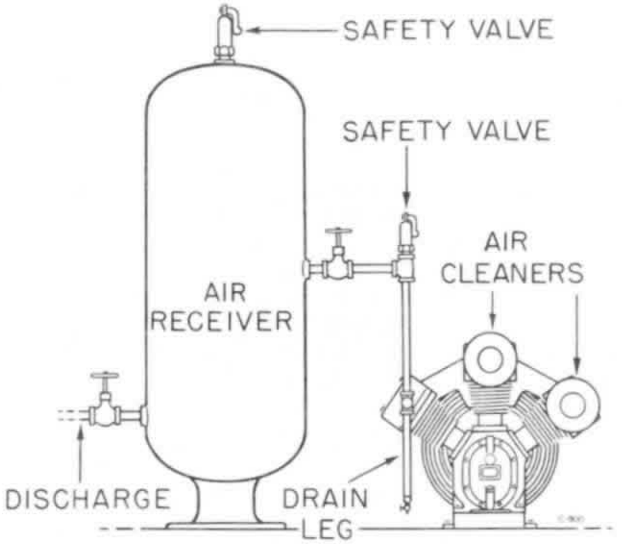

Figure 3-7. Typical Overhead Piping Arrangement for Bare or Subbase Mounted Units.

your compressor runs more than you believe it should, the most likely cause is a leaky pipe line. Leaks are easily located by squirting soap and water solution around all joints and watching for bubbles.

Where a sub-base mounted unit or a bare compressor is supplied, it is very important to observe the following points when installing the piping between the compressor and the receiver.

1. **Never install a shut off valve** (such as a gate or globe valve) between the compressor and the air receiver unless a safety valve is put in the piping between the valve and the compressor. See Figure 3-7.
2. **If possible, run the piping down** from the compressor to permit condensate to drain into the air receiver. If this is not possible, install a "drain leg" as shown in Figure 3-7. The "drain leg" is to be at least 10″ (250 mm) long and is to project down from the compressor discharge. Put a drain valve at the end of this pipe and drain at least weekly, or as often as necessary.

SECTION 4
REGULATION

TYPES OF REGULATION

Your compressor may be regulated by one of the following methods:

Automatic Start & Stop Control — Makes or breaks electrical contact to the motor at predetermined pressures. This type of regulation is used when the demand for air is small or intermittent but where pressure must be continuously maintained.

Constant Speed Control — Unloads the compressor at a predetermined pressure while the motor continues to operate. This type of regulation is used when the demand for air is practically constant at the capacity of the compressor.

Dual Control — Permits a manual selection between Constant Speed Control and Automatic Start & Stop Control depending upon the air requirements.

AUTOMATIC START & STOP CONTROL

Automatic start & stop control is obtained by means of a pressure switch which makes and breaks an electrical circuit, starting and stopping the driving motor; thereby, maintaining the air receiver pressure within definite limits. The pressure switch is piped to the receiver and is activated by changes in air receiver pressure.

Figure 4-1. Automatic Start & Stop Control Arrangement for Two or Single-Stage Units.

Pressure Switch Adjustment — The pressure switch may be mounted in any position and secured directly to the connecting pipe.

The pressure switch has a cut-out adjustment and a differential adjustment. The cut-out is the pressure at which the switch contacts open and the differential is the span between the cut-in and cut-out settings. Note: there is interaction between these two adjustments, i.e., if the cut-out is increased the differential will also increase, or if the differential is narrowed, the cut-out will be reduced, etc. These factors must be considered when adjusting the switch and compensated for accordingly.

The cut-out point may be increased by screwing the range nut clockwise. See Figure 4-2. Screwing the range counterclockwise decreases the cut-out point. Note the pressure at which the compressor cuts in and out and re-establish the differential pressure setting if necessary. Important: if your unit is regulated by dual control, the cut-out point of the pressure switch is to be set 5 psi (.351 Kg/sq cm) above the unload point of the auxiliary valve.

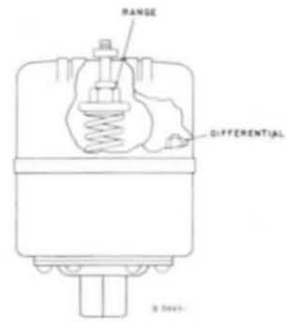

Figure 4-2. Pressure Switch Cut-In and Cut-Out Adjustment.

The differential pressure span may be increased by screwing the differential adjusting screw clockwise. Backing off the screw will narrow the span. It is advisable to have as wide a differential as possible to avoid frequent starting and stopping of the compressor. Note the pressure gauge reading at which the compressor cuts-out and re-establish this point if necessary.

CONSTANT SPEED CONTROL

Constant speed control regulates the discharge pressure of the compressor by unloading and loading the cylinders at predetermined pressures while the compressor continues to run.

IMPORTANT CAUTION

The auxiliary valve is equipped with a manually operated regulation selector knob, see Figure 4-4. On units regulated by Constant Speed Control only (NOT DUAL CONTROL), the knob should always be screwed up to the constant speed position. If the knob is screwed down the compressor will not unload, but will continue to increase the pressure, possibly damaging the compressor.

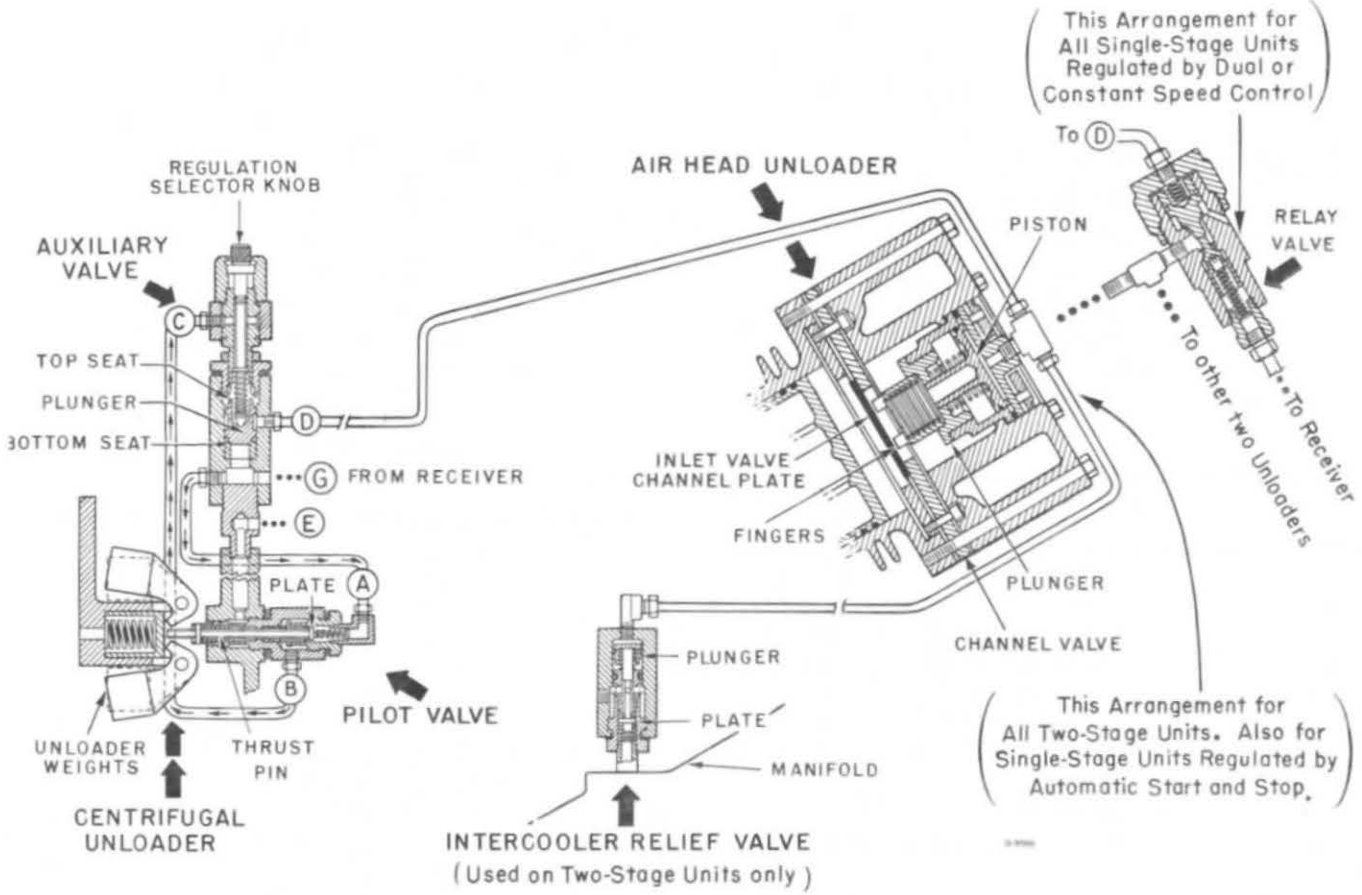

Figure 4-3. Schematic Diagram of Starting Unloading & Regulation System. (For all Models Except 25T)

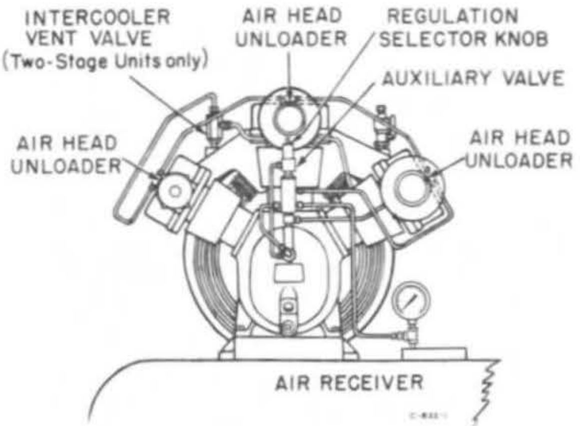

Figure 4-4. Constant Speed Control Arrangement for Two-Stage Units. (See Figure 4-5 for Constant Speed Control Arrangement for Single-Stage Units.)

Unloading the compressor is accomplished by the air head unloader opening the inlet valve in each cylinder. All two-stage units are equipped with an intercooler vent valve which exhausts intercooler pressure to atmosphere when the compressor unloads. The air head unloaders and the intercooler vent valve operate simultaneously; however, for simplicity, the following explanation covers the operation of each separately.

Unloading the Cylinders — Receiver pressure is applied against the auxiliary valve plunger through (G), see page 15. When the receiver pressure reaches the predetermined unload setting of the auxiliary valve, it acts against the plunger, forcing it off its bottom seat. Receiver pressure now passes directly through the auxiliary valve to the air head unloaders on two-stage units. (Note: on single-stage units regulated by dual or constant speed control, this air pressure opens a non-adjustable relay valve, which in turn permits receiver pressure to pass to and activate the unloaders). This pressure enters each unloader assembly, forcing the piston and plunger down. Fingers on the lower end of the plunger contact the inlet valve channel plates, pressing them down and holding the valve open. Air now surges in and out of the cylinders through the open inlet valves and air cleaner(s) to atmosphere, and the cylinders are unloaded. Single-stage compressors are unloaded at this point. If the compressor is equipped with an intercooler vent valve, the intercooler is unloaded in the following manner.

Unloading the Intercooler — The intercooler vent valve is tapped into the high-pressure manifold and opens the intercooler to atmosphere whenever the compressor unloads. The pressure that operates the unloaders also forces the vent valve plunger down, unseating the plate and air surges in and out of the open valve.

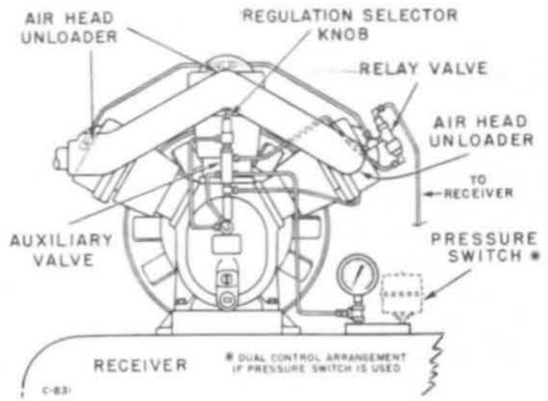

Figure 4-5. Dual or Constant Speed Control Arrangement for Single-Stage Units.

Loading the Cylinders — When the receiver pressure drops to the predetermined load setting of the auxiliary valve, the auxiliary valve plunger spring forces the plunger to its bottom seat. As a result, pressure to the unloaders is shut off either directly through the auxiliary valve (or indirectly through the relay valve). The pressure trapped over the unloader pistons bleeds back through (D), (C) and (B), through the pilot valve's hollow thrust pin and out at (E) to atmosphere. (If a relay valve is used, this pressure bleeds to atmosphere through the vent port in the relay valve). With pressure relieved from over the unloader pistons, the spring returns the plunger to neutral and the plunger fingers disengage the inlet valve channel plates, permitting the inlet valve to function normally, reloading the cylinders. Single-stage compressors are loaded at this point. If the compressor is equipped with an intercooler vent valve, the intercooler is loaded in the following manner.

Loading the Intercooler — When pressure is exhausted from the air head unloaders it is also exhausted from over the vent valve plunger and the plate seats, closing the vent valve and permitting pressure to build up in the intercooler. The intercooler vent valve is non-adjustable; however, worn "O" rings may cause it to leak.

Auxiliary Valve Check — To check the operation of the auxiliary valve, refer to Figure 4-6 and proceed as follows: Remove the tube from the side of the pilot valve body (B). Plug this port and run the machine up just below the normal unload pressure. Stop the unit manually and check the tightness of the plunger against the bottom seat of the auxiliary valve by noting the amount of leakage through the open port (C). Next, with (B) remaining plugged, bleed down and then start the compressor and allow it to reach the unload pressure and run unloaded. Now the tightness of the top seat may be checked by noting if there is any leakage through the open port (C). If excessive leakage is detected through this port, take the valve apart and clean it.

Auxiliary Valve Adjustment — The valve has an unload adjustment and a differential adjustment. The unload point is the pressure at which the valve will unload the compressor, and the differential is the span between the load and unload settings. Note: there is an interaction between these two adjustments, i.e., if the unload point is increased, the differential will be expanded, or if the differential is

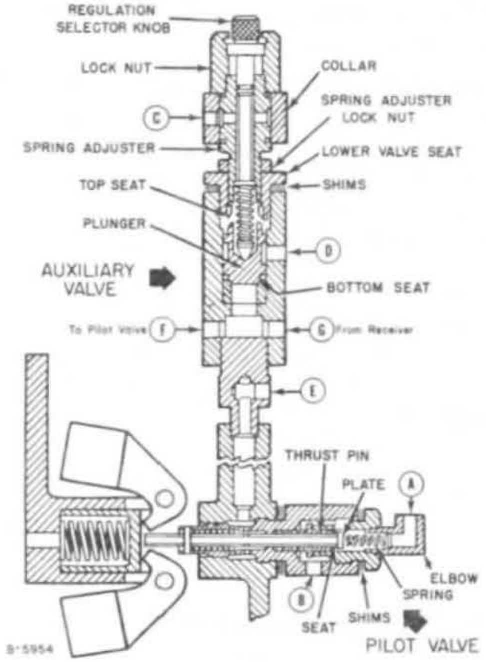

Figure 4-6. Auxiliary Valve Adjustment.

narrowed, the unload point will be decreased, etc. These factors must be considered when adjusting the valve and compensated for accordingly. To adjust an auxiliary valve proceed as follows:

1. Loosen the spring adjuster lock nut & turn the spring adjuster clockwise to increase the pressure at which the compressor will unload or counterclockwise to decrease the unload point.
2. If the differential is to be adjusted, record the pressures at which the compressor loads and unloads and relieve all pressure from the system. Remove the tube from (C) and then remove the lock nut, collar, spring adjuster and lower valve seat.
3. Add or remove shims to correct the differential pressure. Add shims to decrease the differential or remove shims to increase the differential. Each shim added or removed will affect the differential by approximately 2 psi (.14 Kg/sq cm).
4. Reassemble the valve and tubing and if necessary re-establish the unload point by repeating step (1).

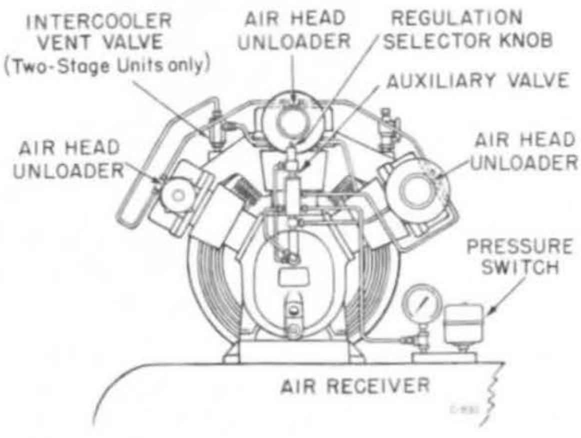

Figure 4-7. Dual Control Arrangement for Two-Stage Units. (See Figure 4-5 for Dual Control Arrangement for Single-Stage Units.)

DUAL CONTROL

Dual control permits a manual selection between constant speed control and automatic start & stop control. The operator may change from one type of regulation to the other by turning the regulation selector knob on top of the auxiliary valve. See Figure 4-7. With the knob screwed up the auxiliary valve's plunger is free to move. Under this condition, the auxiliary valve controls the regulation and the compressor is being regulated by constant speed control. With this type of regulation the compressor loads and unloads according to air receiver pressure while the compressor continues to operate. Refer to the following paragraph titled "Constant Speed Control" for details on this type of regulation.

With the knob screwed down the auxiliary valve's plunger is locked against its bottom seat making the auxiliary valve inoperative. Under this condition, the pressure switch regulates the compressor by automatic start & stop control. With this type of regulation the compressor starts and stops according to air receiver pressure. Refer to the following paragraph titled "Automatic Start & Stop Control" for details on this type of regulation. Note: the pressure switch used with dual control units is set at 5 psi (.351 Kg/sq cm) above the pressure at which the compressor will unload when regulated by constant speed control. This setting eliminates the possibility of interaction between the two types of regulation.

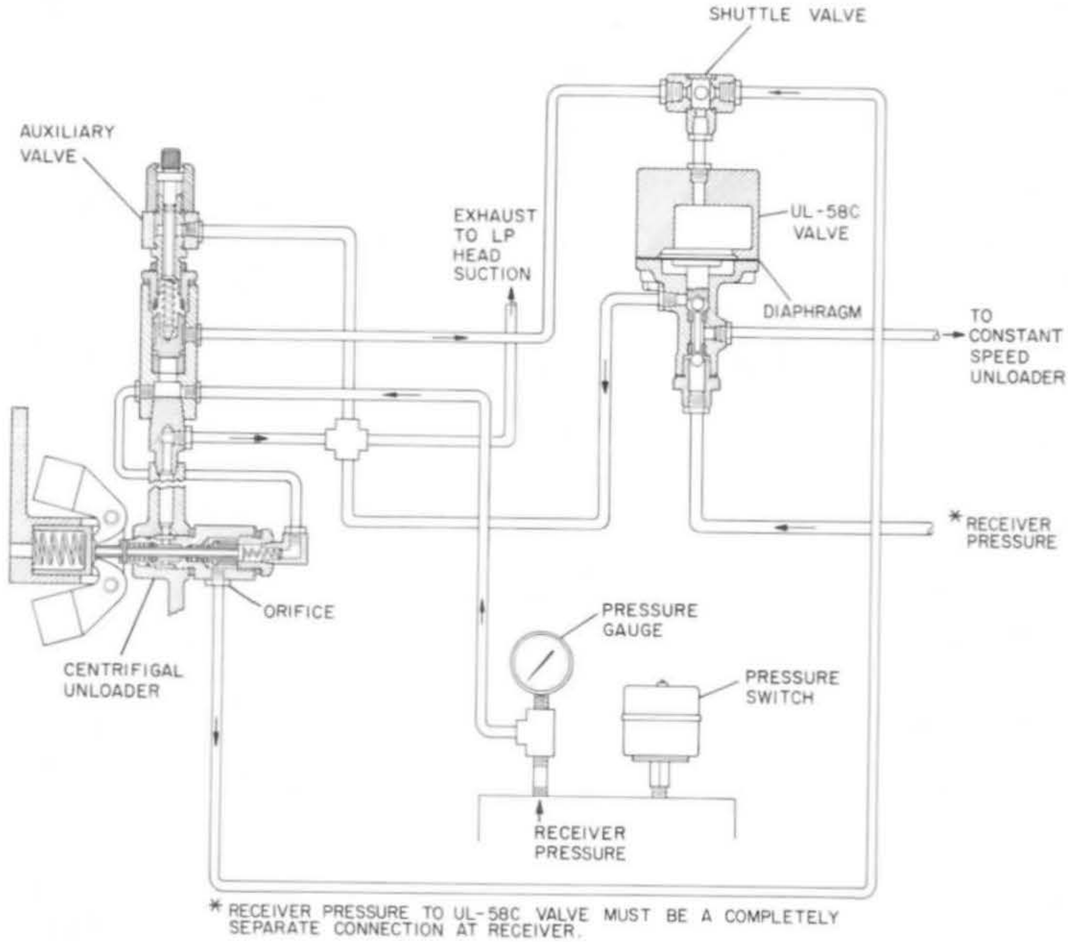

Figure 4-8. Schematic Diagram of Model 25T Unloading and Control Regulation.

MODEL 25T CONTROL SYSTEM

The MODEL 25T Type 30 is almost identical in operation to the 20T except for modifications in the control system.

Figure 4-8 illustrates the unloading system for the MODEL 25T. This system is similar to that shown for other models except the addition of an orifice, UL58C three-way valve and shuttle valve.

The UL58C is a diaphragm operated three-way valve. Receiver pressure is piped to the bottom of this valve. If operating air is applied to the diaphragm of the UL58C, it applies air to the unloaders. If operating air is exhausted from the diaphragm of the UL58C, it exhausts air from the unloaders.

The shuttle valve is a device which permits the UL58C to be operated by either the auxiliary valve or the centrifugal unloader pilot valve. The output of the shuttle valve is connected to the diaphragm connection of the UL58C. One of the "in" connections of the shuttle valve is connected to the auxiliary valve output. When running on constant speed control, the auxiliary valve operates the UL58C through the shuttle valve and the UL58C operates the unloaders. This is the same as the operation described for other models. except the UL58C acts as a direct acting relay valve between the auxiliary valve and the unloaders.

The second "in" connection of the shuttle valve is connected to the centrifugal unloader pilot valve output with an orifice between the two. When the compressor is shut down the centrifugal unloader operates applying air through the orifice and shuttle valve to the diaphragm of the UL58C. The UL58C applies air to the unloaders.

When the compressor is started the centrifugal unloader operates and starts to exhaust air from the UL58C through the shuttle valve and orifice. Because of the restriction of the orifice, it takes about ten seconds for the air to bleed from the diaphragm chamber of the UL58C and then exhaust air from the unloaders allowing the compressor to load. This ten second delay is for starting unloading.

SECTION 5
OPERATION

IMPORTANT OPERATIONAL NOTES

1. **On units regulated by dual control,** the auxiliary valve is equipped with a regulation selector knob. Screwing this knob "up" permits the compressor to be regulated by constant speed control. Screwing the knob "down" changes the regulation to automatic start and stop control. See Figure 4-7.
2. **If the unit is not equipped with an automatic draining system,** all condensate collectors, such as the receiver, drain leg (if used) and water or air-cooled aftercooler (if used), must be drained weekly or more often if necessary.
3. **Check the frame oil level weekly,** and change oil every 500 hours of operation, or every three months, whichever occurs first.
4. **Compressors operating above 200 psig. (14 kg/cm²)** are to be operated on an intermittent duty basis only.
5. **As an initial precaution** against loss of efficiency and oil, we recommend that all cap screws and nuts be checked and tightened after the first 25 or 50 hours of operation. Tighten to the torque values recommended on page 25.
6. **If a water-cooled aftercooler is used,** the rate of water flow through it will be determined by your particular discharge air temperature requirements. In most cases a water flow rate of 2½ gallons per minute (9.5 liters/min.) is recommended.

PRE-STARTING CHECKS

1. Before starting a new unit, fill the frame to the overflow point with compressor oil. Check the motor bearings for lubrication.
2. 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 voltages of dual voltage motors.
3. Turn compressor over a few revolutions by hand to see that everything is free and in working condition.
4. Check the tension of the belts on belt driven units, or the alignment of the coupling on flexible coupled units. See pages 26 or 27 for details.
5. Remove tools, rags and any other objects from the vicinity of the compressor before throwing the switch.
6. Momentarily start the unit and make certain that the direction of crankshaft rotation is the same as that shown by the direction arrow on the compressor. If rotation is incorrect, interchange two of the three leads on three-wire polyphase motors. For other types of motors, follow the reversing instrutions given on the motor nameplate.
7. Start the unit. Unless otherwise specified by the customer, these units are equipped with a pressure regulating system which will automatically maintain air pressure at a predetermined level.
8. If a water-cooled aftercooler is used, turn on the cooling water and adjust its rate of flow to your particular discharge air temperature requirements.

COMPRESSOR LUBRICATION

Oil changes should be made every 500 hours of operation or every ninety days, whichever occurs first. Frame oil capacity is 5 qts. (4.73 liters).

CAUTION

When changing oil, never use kerosene or gasoline to flush out the frame. The use of such cleaning agents is dangerous and is absolutely prohibited. Use a regular flushing oil for this purpose.

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

Temp. Range	Viscosity @ 100°F (37.8°C)	
	SSU	Centistokes
40°F & Below (4.4°C & Below)	159	32
40°F to 80°F (4.4°C to 26.7°C)	500	110
80°F to 125°F (26.7°C to 51.7°C)	750	165

The viscosities given in the table are intended as a general guide only. Heavy-duty operating conditions require heavier viscosities, and where borderline temperature conditions are encountered, the viscosity index of the oil should be considered. Always refer your specific operating conditions to your lubricant supplier for recommendations.

MOTOR LUBRICATION & CARE

Depending upon the type of electric motor driving your unit, the following lubricating schedule should be observed.

Sleeve Bearing Motors — Are to be oiled at least once every three months with an oil of a viscosity of 150 to 250 SSU at 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.

Ball Bearing Motors Prelubricated for Life — These motors have no grease fittings or plugs near the bearings and do not require lubrication.

Several major points contributing to proper motor operation and care are given in the following paragraphs. For more detailed instructions, refer to the motor manufacturers' specific recommendations.

On some types of motors, 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 a 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 lift of the motor.

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

If the motor is located in an atmosphere where it is exposed to appreciable quantities of water, oil, dirt or fumes, it must be specially constructed.

PRIMING THE DRAIN TRAP

Before starting your compressor for the first time, it will be necessary to prime the drain trap to insure proper operation of the automatic condensate drain system.

The trap may be primed by either of the following methods: (1) open the plugged opening, located in the tee in the inlet piping to the trap; and fill the trap with water; or (2) if a convenient opening in the air receiver is available, pour about one quart (.95 liters) of water directly into the receiver. Then, close the isolation valve, located between the air receiver and the drain trap, and start the unit. It will be necessary to keep the isolation valve closed until full air pressure has built up in the air receiver, at which time the isolation valve may then be opened.

An alternate method, to insure proper operation of the automatic condensate drain system, would be to keep the isolation valve closed for the first few days of operation in order to allow sufficient condensate to build up in the air receiver to prime the trap when the isolation valve is reopened.

INTERMITTENT DUTY FORMULA

Compressors operating above 200 psig are to be operated according to the "Intermittent Duty Formula".

Intermittent Duty Formula — The pump up time should not ordinarily exceed thirty (30) minutes or be less than ten (10) minutes. Shut down periods between cycles of operation should be at least equal to the pump up time. Note: When the compressor is regulated by Constant Speed Control, the shut down period is the time the compressor is operating unloaded.

A pump-up time limit with a following cool down period is recommended to protect the valves and heads against stabilized high operating temperatures, which would rapidly build up carbon in these areas.

All inquiries for high pressure compressor applications where the "use" cycle differs from the "Intermittent Duty Formula" should be referred to the nearest Ingersoll-Rand branch office.

INLET AIR CLEANER

It is very important that the inlet air cleaner be kept clean at all times, since a dirty air cleaner not only reduces the capacity of the compressor but also may cause premature wear of the working parts, if it allows dirt to pass through.

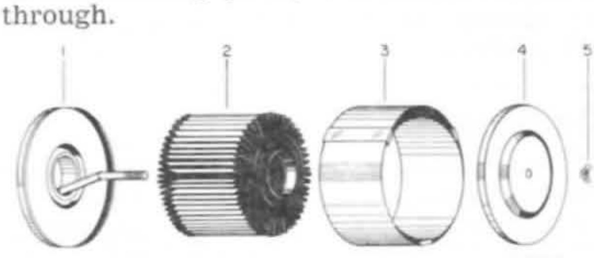

Figure 5-1. Inlet Air Cleaner.

Clean the inlet air cleaner element of any dirt by vacuum cleaning or by applying compressed air to the inside surface of the element first and then to the outside surface. If the element cannot be adequately cleaned by the methods indicated above, it may be necessary to soak it in a nonflammable safety solvent or wash in soap or detergent and water. The element should be replaced if it shows signs of damage or cannot be adequately cleaned. The inlet air cleaner should be inspected and cleaned at regular intervals. See **Routine Inspection and Service**, page 24.

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.

INTERCOOLER (Two-Stage Units Only)

Two-stage compressors are equipped with an intercooler between the first and second-stage. See Figure 5-2. The purpose of the intercooler is to remove most of the heat of first-stage compression from the air before it enters the second-stage, thus improving efficiency and decreasing the final discharge air temperature.

The intercooler consists of a number of finned tubes connecting the discharge of the first-stage to the inlet of the second-stage. The compressed air flows through these tubes and its heat is transferred to the cooling fins, where the air from the belt wheel fan passing air over the fins dissipates the heat to atmosphere.

Never permit the air flow to these tubes to become obstructed, and clean the surfaces of the tubes whenever deposits of oil, dirt or grease are observed. Use a non-flammable safety solvent for cleaning purposes. During regular overhaul periods, the tubes should be removed from their headers and inspected internally. If the interior of the tubes requires cleaning, cap one end and fill it with a non-flammable safety solvent to help loosen internal deposits of oil, dirt and carbon. Always flush the tubes with warm water and permit them to dry thoroughly before replacing.

AIR RECEIVER

If the air system into which the compressor discharges does not have sufficient volume, the compressor will load and unload too frequently. In this case, an air receiver must be used to provide enough volume for the control system.

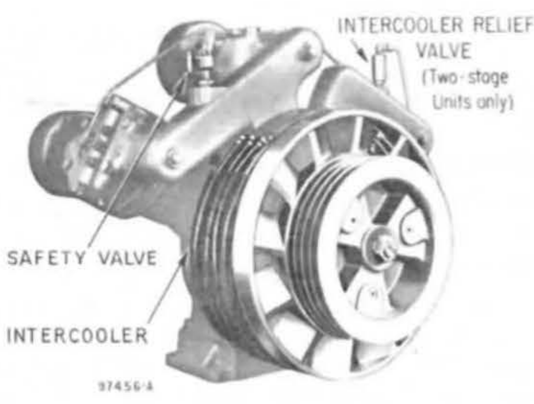

Figure 5-2. Intercooler Arrangement.

It is important that the air receiver sets on a level surface as close to the compressor as possible. If leveling is necessary, shims may be inserted under the feet. The bolts securing the receiver to the foundation must be drawn down evenly to avoid introducing stresses.

Air receivers collect moisture that condenses after the air has been compressed and cooled. This condensate should be drained from the receiver as often as necessary.

Air receivers must meet the safety requirements of the state in which they are used.

SAFETY VALVE

Safety valves are designed to protect against damage from over pressure. A safety valve is provided on the intercooler of all two-stage units. See Figure 5-2. This valve is set to blow at 65 psig. (4.56 Kg/sq. m). If the valve blows and continues to blow for more than a minute, the compressor should be stopped at once and the cause determined. Refer to the trouble chart on page 23.

Units that are supplied mounted on an air receiver will be supplied with a discharge safety valve. This valve is set at the factory to blow off at the rated working pressure of the receiver, except for most compressors operating below 80 psig. where the valve is set 10 to 20 psig. above the compressor operating pressure. If a hand valve is installed between the compressor and air receiver, a safety valve must be installed between the compressor and hand valve. See Figure 3-7.

Do not change the blow off pressure of a safety valve. Do not remove the safety valve and replace it with a plug, since this will eliminate the protection provided and may result in serious damage to the compressor or receiver. Safety codes require a safety valve to protect the receiver from over pressure.

STARTING UNLOADING

Starting unloading relieves all pressure from the compressor when it stops permitting it to start against a light load; increasing the life of the driver and belts and also reducing the possibility of tripping the overload relays or stalling the gasoline engine (when used).

Relieving pressure from the compressor when it stops is accomplished by the air head unloaders opening the inlet valves in each cylinder. All two-stage units are equipped with an intercooler vent valve which relieves intercooler pressure. The air head unloaders and the intercooler vent valve operate simultaneously; however, for simplicity, the following explanation covers the operation of each separately.

Unloading the Cylinders — As shown in Figure 4-3, the centrifugal unloader is attached to the end of the crankshaft, and when the compressor is stopped the unloader weights go into a retracted position, moving the pilot valve thrust pin outward, unseating the pilot valve plate. Air receiver pressure is constantly applied to the pilot valve at (A), and when the pilot valve plate is unseated, air receiver pressure passes through the pilot valve and out at (B). From there the air is piped into the auxiliary valve at (C), down through its top section and out the side opening (D) directly to the air head unloaders on two-stage units. (Note: on single-stage units regulated by dual or constant speed control, this air pressure opens a relay valve, which in turn permits receiver pressure to pass to and activate the unloaders). The air receiver pressure enters each air head unloader assembly, forcing the air head piston and plunger down. Fingers on the lower end of the unloader plunger contact the inlet valve channel plates, pressing them down and holding the valve open. This action results in relieving all air pressure from the cylinders by permitting the pressure to escape to atmosphere through the open inlet channel valve and air cleaner(s). As long as the centrifugal unloader weights remain in the retracted position, receiver air pressure will hold the inlet valve channels open. Single-stage compressors (or two-stage units not equipped with an intercooler relief valve) are unloaded at this point. If the compressor is equipped with an intercooler vent valve, the intercooler is unloaded in the following manner.

Unloading the Intercooler — The intercooler vent valve is tapped into the high-pressure intercooler manifold and relieves pressure from the intercooler whenever the compressor stops. The pressure that operates the unloaders also forces the vent valve plunger down, unseating the plate and intercooler pressure exhausts to atmosphere through the vent valve body.

Loading the Cylinders — When the compressor starts, the pilot valve remains open until the unit reaches approximately three-quarter speed, permitting the driver to start the compressor against a very light load. As the compressor approaches operating speed, the weights swing outward, see Figure 4-3, moving the pilot valve thrust pin inward, allowing the pilot valve plate to seat. As a result, pressure to the unloaders is shut off directly through the pilot valve (or indirectly through the relay valve). The pressure trapped over the unloader pistons bleeds back through (D), (C) and (B), through the pilot valve's hollow thrust pin and out at (E) to atmosphere. (If a relay valve is used, this pressure bleeds to atmosphere through the vent port in the relay valve). With pressure relieved from over the unloader pistons, the spring returns the plunger to neutral and the plunger fingers disengage the inlet valve channel plates, permitting the channel valve to operate normally, reloading the compressor. Single-stage compressors are loaded at this point. If the compressor is equipped with an intercooler vent valve, the intercooler is loaded in the following manner.

Loading the Intercooler — When the pressure is relieved from the air head unloaders it is also relieved from over the vent valve plunger and the plate seats, closing the vent valve and permitting pressure to build-up in the intercooler. The intercooler vent valve is non-adjustable; however, worn "O" rings may cause it to leak.

PILOT VALVE ADJUSTMENT

If the starting unloading system fails to operate satisfactorily, check the adjustment of the pilot valve. To make this check, proceed as follows:

1. Stop the compressor, bleed off the pressure from the system, and remove the tube that is connected to (A), Figure 5-3. Remove the elbow, spring and plate.
2. Measure the projection of the end of the thrust pin beyond the edge of the seat. This measurement should be between 1/32" (.790 mm and 3/32" (2.38 mm). If the distance is less than 1/32" (.790 mm) remove shims from between the pilot valve body and the hex head nut; if it is more than 3/32" (2.38 mm) add shims. After adding or removing shims, recheck to be certain the stroke is between 1/32" (.790 mm) and 3/32" (2.38 mm).
3. To further check the adjustment of the valve, plug the opening in the auxiliary valve support at (F). Start the compressor. Now check the position of the thrust pin. The end of the thrust pin must be behind

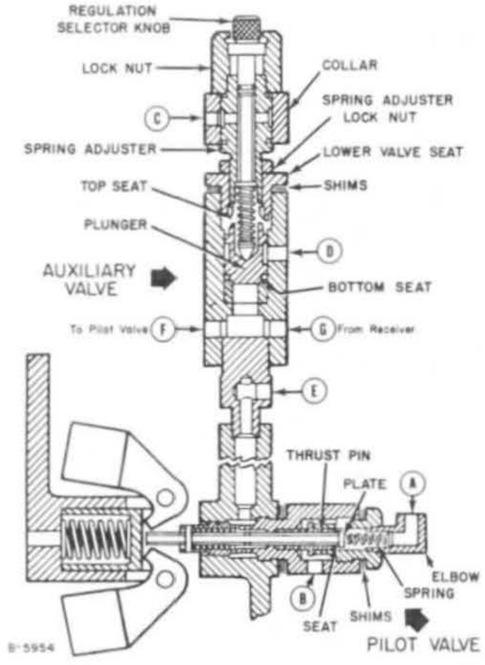

Figure 5-3. Pilot & Auxiliary Valve Adjustment.

the pilot valve seat by at least 1/32″(.790 mm). If it is less, add shims to the space between the pilot valve body and the hex head nut.

4. Next, replace the pilot valve plate, spring, elbow and also replace the tube to (A). Operate the compressor at approximately 20 psi. (1.4 Kg/sq cm) (to accomplish this, bleed off the excessive pressure at the receiver drain). Remove the tube that connects to (B) and if more than a slight amount of air leakage is detected through this port, it indicates that the pilot valve plate is not seating properly against its seat. If readjustment does not correct the problem, the pilot valve seat and plate should be replaced. If there is little or no leakage, pump the compressor up to just below the cut-out pressure. Stop the compressor manually and remove the tube at (E). If there is more than a slight leakage from this port, smooth and true up the end of the thrust pin.

SECTION 6
TROUBLE CHART

TROUBLE	CHECK POINT NOS.
Oil pumping	1-7-9-11-17-23-24
Knocks or rattles	3-18-19-20-21-22-23-24
Air delivery has dropped off	1-3-6-17-19-20-23-24
Intercooler safety valve pops	19-26
Trips motor overload or draws excessive current	8-13-14-15-16-17-19-20-22-24
Water in frame or rusting in cylinders	11-12
Compressor won't unload	20
Auxiliary valve chatters, leaks around stem	20
Excessive starting and stopping (auto start)	2-4-6-13
Compressor doesn't unload when stopped	17-20-27
Compressor runs excessively hot	2-5-10-19
Compressor won't come up to speed	14-17
Lights flicker when compressor runs	14-15
Water hammer (on units equipped with water-cooled aftercoolers)	25

Check Point Nos. **Trouble Cause**

1. Clogged intake air cleaner.
2. High pressure discharge valve leaking.
3. Loose belt wheel or motor pulley or motor with excessive end play in shaft.
4. Air receiver needs draining.
5. Air to belt wheel fan blocked off.
6. Air leaks in piping. (on machine or in outside system)
7. Oil viscosity too low.
8. Oil viscosity too high.
9. Oil level too high.
10. Oil level too low.
11. Detergent type oil being used. Change to non-detergent type with rust and oxidation inhibitor.
12. Extremely light duty or located in a damp humid spot.
13. Should have constant speed control due to steady air demand.
14. Check line voltage, motor terminals for good contact, tight starter connections, proper starter heaters.
15. Poor power regulation (unbalanced line). Consult with power company.
16. V-Belts pulled excessively tight.
17. Leaking or maladjusted centrifugal pilot valve, or defective O-Ring on pilot valve.
18. Carbon on top of piston.
19. Leaking, broken, carbonized or loose valves.
20. Leaking, broken or worn air head unloader parts. Auxiliary valve dirty, seats worn.
21. Worn or scored connecting rod, piston pin or crank pin bushings.
22. Defective ball bearing on crankshaft or on motor shaft. Loose motor fan.
23. Piston rings broken or not seated in, end gaps not staggered, stuck in grooves, rough, scratched or excessive end gap .015" (.381mm) under 5" (127 mm) or over .027" (.685 mm) 5" (127 mm and up, or side clearance over .006" (.152 mm).
24. Cylinders or pistons scratched, worn or scored.
25. Adjust rate of water flow through aftercooler.
26. Intercooler tubes plugged.
27. Malfunctioning intercooler vent valve.

SECTION 7
MAINTENANCE

CAUTION

Before attempting any repair work on the unit, be sure the isolation switch is in the "off" position, or the wiring is disconnected from the line. Blow down the pressure from the receiver, and isolate the unit from any outside sources of air pressure. These simple precautions will prevent accidents.

ROUTINE INSPECTION AND SERVICE

WEEKLY

1. **Frame Oil Level** .... Inspect and fill to the overflow point.
2. **Air Receiver & Condensate Traps** ..... Drain at least weekly or more often if necessary.

500 HOURS OF OPERATION

1. **Frame Oil** .... Change oil. See page 18 for details.
2. **Tighten all Bolts** .... See the Torque Value Table on page 25.
3. **Intake Air Cleaner** .... Inspect and if necessary clean or replace the element. See pages 19 & 20 for details.

1000 HOURS OF OPERATION

1. **Compressor Valves** .... Inspect and if necessary clean. See pages 25 & 26 for details.
2. **Electric Motor** .... If necessary lubricate and clean. See page 19 for details.
3. **Clean the Compressor** .... If necessary clean the external surfaces of the cylinder and intercooler tubes with a jet of air.

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. If maintenance problems arise that are beyond the scope of this booklet, please contact the nearest Ingersoll-Rand branch office. A trouble chart is given on page 23.

TORQUE VALUES

We strongly recommend the use of a torque wrench. The following table gives the torque to which the wrench should be set for tightening the different size cap screws and nuts.

TORQUE VALUE TABLE

NATIONAL COARSE					NATIONAL FINE				
Dia. Pitch	Ft. Min.	Lbs. Max.	Meter Min.	Kilograms Max.	Dia. Pitch	Ft. Min.	Lbs. Max.	Meter Min.	Kilograms Max.
1/4"-20	6	7	.83	.97	1/4"-28	5	6	.69	.83
5/16"-18	12	14	1.66	1.93	5/16"-24	9	10	1.24	1.38
3/8"-16	21	24	2.90	3.32	3/8"-24	14	16	1.93	2.21
1/2"-13	52	59	7.20	8.15	1/2"-20	40	42	5.52	5.80
5/8"-11	105	120	14.50	16.60	5/8"-18	60	70	8.30	9.55
3/4"-10	170	190	23.50	26.20	3/4"-16	100	120	13.80	16.60

COMPRESSOR VALVES

The Channel Valve, developed and patented by Ingersoll-Rand, is entirely different in design and principle from any other compressor valve now in use. The valve is extremely efficient and durable and permits quiet, trouble-free operation.

Compressors in normal operation are reasonably free from carbon trouble. Carbon is caused by a leaky or broken valve, too high a discharge pressure or incorrect frame oil. If loss of compressor capacity is indicated, and it can be traced to no other source, the valves should be inspected and cleaned. Disassemble and reassemble valves as follows:

1. Remove air heads from the air cylinders. Then separate the valve assemblies from the air heads by removing the nuts from the center studs in each head.
2. Lay each valve assembly on a clean surface with the studs pointing up. Remove the cap screws that hold the valve plates together. With a thin blade, pry the upper plate off the dowels and remove it. This will expose the valve channels; discharge valves are channel up (valve springs exposed); intake valves are flat side up (springs underneath).
3. Lay each channel and its spring carefully to one side. Keep them in order and be careful not to turn them end for end. If they are to be used again, they must be replaced exactly as they were before removal in order to return them to the same seating surface. If turned end for end, the valve channels will not seat tightly. Also, the inlet and discharge springs must not be interchanged.
4. Clean each channel and spring carefully by brushing or scraping lightly, using a non-flammable safety solvent to help loosen the carbon. Do not change the shape of the valve springs by bending.

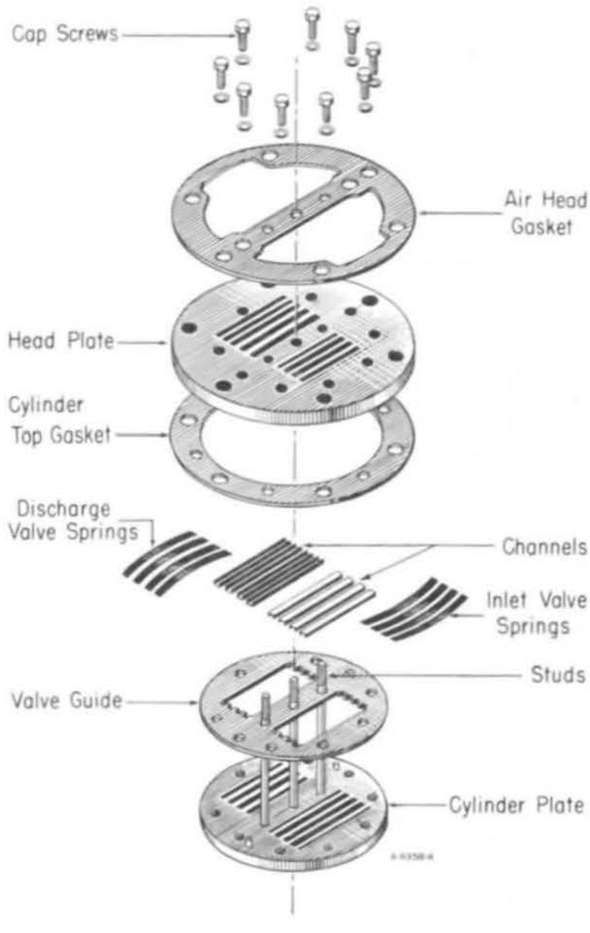

Figure 7-1. Typical Channel Valve.

5. Remove the valve guide and clean all valve seating surfaces of both plates. Do not cut or gouge the seating surfaces of the plates.
6. Replace any broken parts. For identifying new springs; low pressure inlet valve springs all have a free height (bow) of 3/32" (2.38 mm) while high pressure inlet and all discharge valve springs are bowed 5/32" (3.96 mm). Used springs may vary from these dimensions. Replace the complete valve assembly if the seats on the

plates are so badly worn that new channels will not seat properly.

7. Place the valve guide on the cylinder plate and reassemble the clean valves and springs as originally found. Make certain that the valve spring ends do not extend beyond the channels.
8. Reassemble the head plate and then insert and tighten the assembling cap screws.
9. Test the valve action of each channel by pushing the channel off its seat to see that it moves freely in the guide and seats properly.
10. Reassemble the valve assembly to the air head and the head to the cylinder from which it was removed.

BELT INSTALLATION & ADJUSTMENT
(Belt Driven Units Only)

When installing new belts, do not pry the belts over the pulley grooves. The proper method of removing and installing new belts is to loosen the anchor nuts, Figure 7-2 and push the motor toward the compressor.

When more than one belt is used to drive the compressor, the belt set must be matched to permit equal load distribution. For details consult the belt supplier.

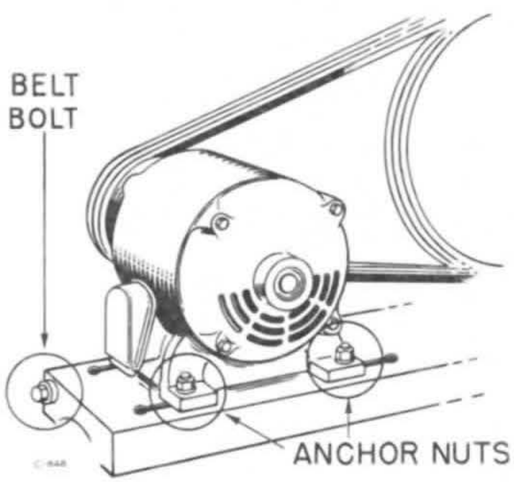

Figure 7-2. Belt Adjustment.

It is important that the 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 belt for a slight bow when the unit is in operation. See Figure 7-3. If a slight bow is evident, the belts are usually adjusted satisfactory. However, the recommended method of checking belt tension is by the more accurate spring scale measurement method that follows:

1. Measure the belt span (t) as shown in Figure 7-4.

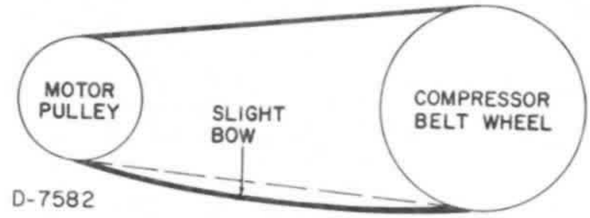

Figure 7-3. Visual Method.

2. At the center of the span (t), apply a force (perpendicular to the span) by attaching a spring scale to both belts when two belts are used, or to the two outside belts when three are used. The force applied to the spring scale should be sufficient to deflect the belts 1/64″ (.396 mm) for every inch of span length (t). For example: The deflection of a 100″ (2540 mm) span would be 100/64″ or 1-9/16″ (39.6 mm), thus, the force applied to the spring scale should deflect the belts to 1-9/16″ (39.6 mm).
3. When the belts are deflected the necessary distance, compare the spring scale reading (in lbs. force) with the values given in the following table.

STANDARD BELTS

Belt Type	Normal Tension	150% Normal Tension
C	5-1/2 lbs. (2.5 Kg.)	8-1/4 lbs. (3.74 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 the belt slack should be reduced, and conversely, a reading exceeding the value for 150% normal tension indicates the belt slack should be increased. Experience has shown that a new drive can be tightened initially to two times normal tension to allow for any drop in tension during run-in.

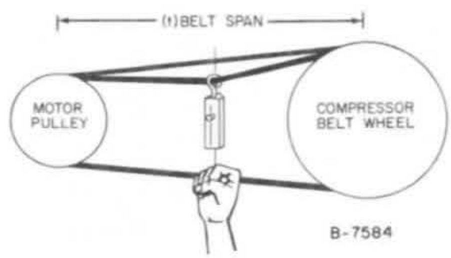

Figure 7-4. Spring Scale Method.

ALIGNING A FLEXIBLE COUPLING
(Flexible Coupled Units Only)

Always check the alignment of a flexible coupling after drawing down the foundation bolts since uneven shimming will cause misalignment. Check the coupling alignment as follows:

1. Mark a point on the coupling rim and use this point for checking dimensions "A" and "D". See Figure 7-5.
2. Rotate the coupling to place this mark at the bottom center, and check dimension "A" with a set of feeler blades. Rotate the motor shaft and check "A" at the other coupling arms. The dimension "A" should remain constant within .005″ (.127 mm) at all positions, thus proving concentricity. If the variation is more than .005″ (.127 mm), it indicates that the subbase has been drawn down unevenly and should be reshimmed to correct for the misalignment.
3. Next, check the angular alignment. Dimension "D" should not vary more than 1/32″ (.794 mm) at the three coupling arms. Angular alignment is not as critical as concentricity, since the coupling disc flexes easily flatwise but resists distortion edgewise.

A few days after the unit has been put into operation, the coupling disc clamping bolts should be retightened.

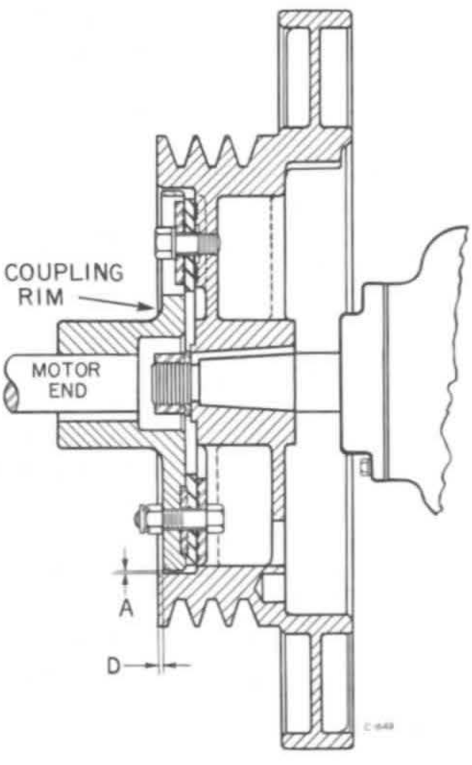

Figure 7-5. Flexible Coupling.

PISTON RING REPLACEMENT

Piston ring replacement is usually considered necessary when a compressor does not meet its normal air delivery or when its oil consumption is considered to be too great. If the compressor's normal air delivery has dropped off or if the oil consumption of the compressor is considered to be excessive, it may be an indication of several possible causes of trouble, one of which may be that the piston rings could either be broken or worn. Worn piston rings can often be a contributing factor in a decline in performance of a compressor that has been in service for a long period of time.

A general rule in determining if a compressor's oil consumption is excessive is to consider a good grade of oil consumption to be approximately fifty horse-power-hours per ounce. To apply this rule, consider the size of a compressor, for example; a five horse-power unit uses four ounces of oil in forty hours of operation. Five horse-power multiplied by forty hours equals fifty horse-power-hours per ounce. Any compressor using more than four ounces of oil per one hundred horse-power-hours would be classed as not meeting commercial standards and would require corrective action, such as replacement of the piston rings. If it has been determined that replacement of the piston rings is necessary, Ingersoll-Rand Company recommends that a complete new set of rings be installed and that these instructions be used as a guide for piston ring replacement.

New replacement piston rings are of the quick-seating-type in that they are distinguished by their narrow seating edge where they contact the cylinder wall. Compression rings are classed as "B" type rings and are a single piece, taper-faced style in that they have a slight taper machined on their outer surface to provide line contact with the cylinder wall for quicker seating and better oil control. See Figure 7-6.

Figure 7-6. Illustration of "B" Type or Single Piece, Taper-Faced Style Compression Ring.

One or several of these compression rings may be used depending on the pressures involved. Oil rings are classed as "H" type or "M" type rings. The "H" type ring is a single-piece, non-ventilated, beveled-scraper style ring.

This style ring has both beveled and undercut edges which allow it to act as a combination oil-scraper and compression sealing ring. See Figure 7-7.

Figure 7-7. Illustration of "H" Type or Single-Piece, Non-Ventilated Beveled-Scraper Style Oil Control Wiper Ring.

Either one or two of these oil rings may be used on a piston. The "M" type ring is a four piece, ventilated, chrome plated, steel rail style ring. This style ring utilizes an expander which exerts a uniform pressure all the way around two independent, thin, cylinder contacting rails, the rails being held apart by an open separator. The style of ring provides maximum oil drainage with the most uniform and positive conformability. See Figure 7-8.

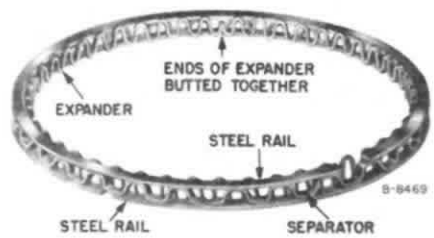

Figure 7-8. Illustration of "M" Type or Four-Piece, Ventilated, Chrome Plated Steel Rail Style Oil Control Wiper Ring.

This style ring may be used alone when only one oil control wiper is required or it may be used in conjunction with an "H" type ring when two oil control wiper rings are required.

The following paragraphs contain complete instructions, in step-by-step procedure, for the disassembly, cleaning, inspection and replacement of cylinders, piston rings and pistons; therefore, before installing new replacement piston rings, we recommend that the entire procedure be very carefully read.

1. Disconnect any tube lines to the air head. Remove the air head attaching screws and washers and then remove the entire air head assembly from the cylinder. Remove the air head gasket. If the gasket sticks, a thin blade may be used to pry the gasket loose from the air head of the cylinder.
2. Remove the cylinder attaching screws and washers and then carefully remove the cylinder from over the piston and piston rings. Remove the cylinder-to-frame gaskets.
3. Remove the piston from its connecting rod and then remove all of the old piston rings from the piston.
4. Thoroughly clean the air head by brushing or scraping lightly to remove any accumulated carbon deposits. Make sure the gasket surface is thoroughly cleaned of any gasket particles.
5. Thoroughly clean the cylinder of any accumulated oil, using a non-flammable safety solvent. Pay particular attention to the cleaning of the cylinder bore. Make sure the cylinder-to-air head and the cylinder-to-frame gasket surfaces are thoroughly cleaned of any gasket particles.
6. Thoroughly clean the piston of any accumulated oil, using a non-flammable safety solvent. Pay particular attention to the cleaning of the piston ring grooves and the oil return holes in the oil control wiper ring grooves.
7. Inspect the cylinder bore for any signs of scoring and scuffing. If the cylinder bore shows any signs of being scored or worn, as indicated by visible ridging at the end of the ring travel, it must be replaced; otherwise, effective oil control will not be established even with the new piston rings.
8. Inspect the piston for any signs of scoring or for any indication of cracked or broken lands which would require replacement of the piston. If the piston shows no signs of being scored or of having any cracked or broken lands, check the general condition of the ring grooves for any signs of excessive wear. Wearing of the ring grooves may cause "tapering" of the grooves, which would result in excessive clearance between the piston ring and their corresponding grooves.
9. Assemble the new piston rings on the piston by first applying compressor lubricating oil to the piston ring grooves. To eliminate the possibility of breaking or distorting a piston ring, always use a piston ring expander and never pass one ring over another. If a piston ring expander is not available, spread the piston rings only far enough to allow them to be placed over the piston. The bottom oil control wiper ring is always installed first and then the adjacent one, when used, then each compression ring on up to the top.

"H" type rings — To install the "H" type or single piece, non-ventilated, beveled-scraper style ring, slip the ring into the ring groove, making sure that the bevel is toward the head of the piston and the undercut groove is toward the bottom of the piston. When two oil control wiper rings are required, the "H" type ring is always installed in the bottom ring groove.

"M" type rings — Install the "M" type or four piece, ventilated, chrome plated steel rail style ring by first placing the expander in the ring groove with the free ends toward you. Push the ends of the expander to the inside of the ring groove, butting the ends together. Make sure the ends of the expander do not overlap. Caution: do not clip or cut the ends of the expander or the tension will be destroyed. Thread one of the two steel rails over the expander and into the bottom side of the ring groove. This rail will hold the expander in position. Again check to be certain that the ends of the expander are not overlapping. Place the open separator over the expander and adjacent to the steel rail, with the free ends of the separator away from you. Thread the second steel rail around the expander and into the remaining clearance at the top of the ring groove. Again be certain that the free ends of the expander are butted together and are not overlapping.

"B" type rings — Install the "B" type or single piece, taper-faced style compression rings by placing each ring into its groove, starting with the bottom compression ring and working towards the top. Each taper-faced style compression ring is identified in some manner, usually with the word "top", the letter T, a dash, a dot or a paint mark to aid in making sure that the ring will be positioned properly in the ring groove. That is, each compression ring must be installed so that the top of the ring is towards the head or top of the piston.

10. After all of the piston rings have been installed on the piston, it may then be replaced on its corresponding connecting rod.

11. When a new replacement piston ring set has been installed and the original cylinder is to be reused, the cylinder wall must be "deglazed" or slightly roughened to provide a proper "seating-in" surface for the piston rings. Use a No. 80 grit abrasive cloth and go over the cylinder wall using a rotating and reciprocating motion. The abrasive cloth should be wetted with some type of oleum spirits or safety solvent during deglazing to reduce the harshness if its surface and to keep feathered edges to a minimum. Do not over-do the deglazing; dulling the glaze is usually sufficient and can be accomplished with a very light pressure. After deglazing, the cylinder wall should be thoroughly cleaned by scrubbing the bore with a good stiff bristle (not wire) brush, using ordinary soap or detergent and hot water. Rinse thoroughly with hot water and then check the cleanliness of the cylinder bore by wiping with a soft white paper cloth. If the paper shows more than slight discoloring, the cylinder bore has not been completely cleaned.

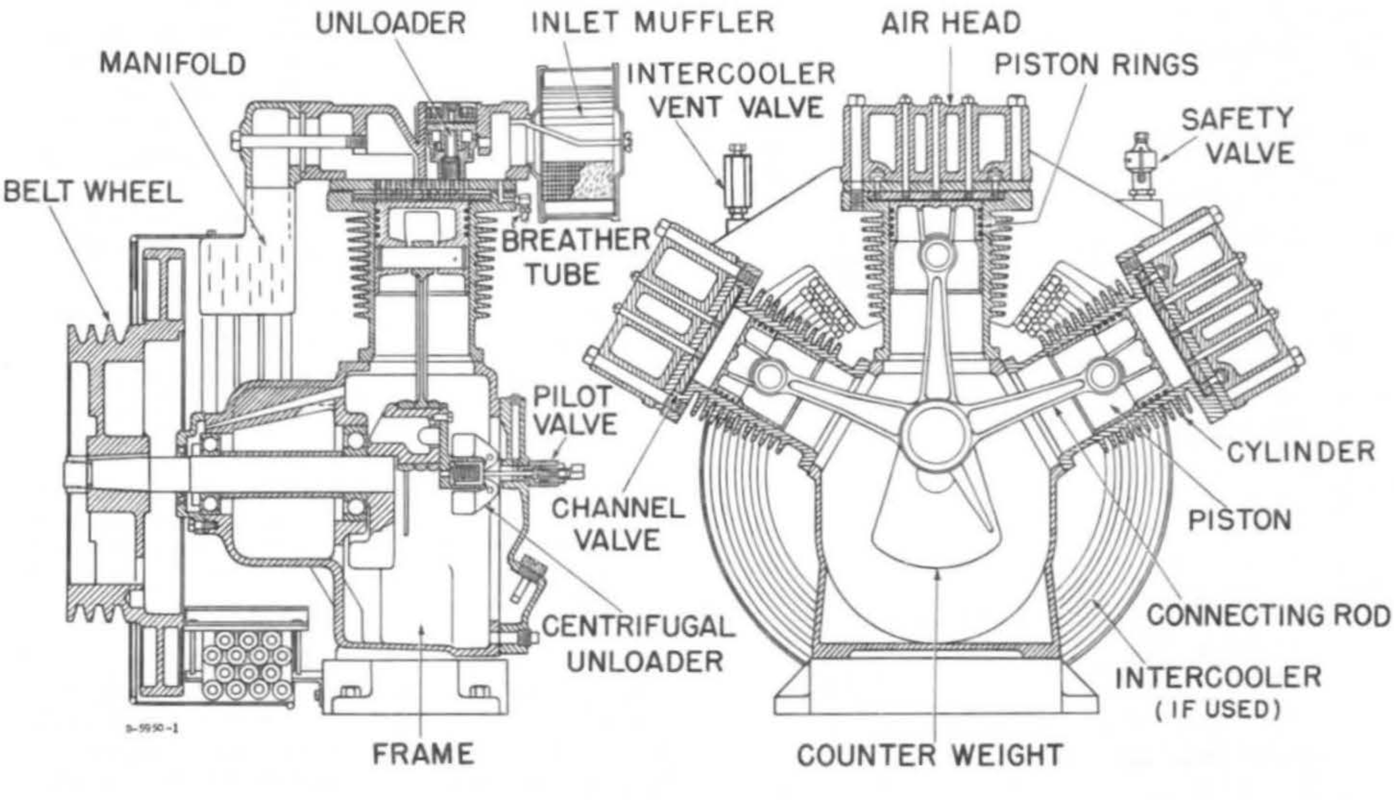

Figure 7-9. Sectional of a Typical 20 H. P. Compressor. (May be used as a location guide for all units.)

NOTE

If the piston rings, the piston and the cylinder meets all required conditions and proper "deglazing" and cleaning technique of the cylinder bore has been followed, the use of an abrasive or lapping compound to seat the piston rings is not necessary and is not recommended. After the cylinder has been thoroughly cleaned, apply compressor lubricating oil to the cylinder bore and replace it on the compressor frame, making sure a new gasket is used between the cylinder and frame. Extreme care must be used when replacing the cylinder over the piston rings to avoid distorting or breaking the rings. The use of a piston ring compressor is highly recommended. Replace the cylinder attaching screws, tightening each screw to a recommended torque value of 25 ft. lbs.

12. Apply a liberal amount of compressor oil to the cylinder bore and then replace the air head on the cylinder, making sure a new gasket is used between the air head and the cylinder. Replace the air head attaching screws, tightening each screw to its recommended torque value.
13. After new replacement piston rings have been installed, the compressor should be operated for at least 10 hours at full load before checking for proper air delivery and oil consumption.

PISTON PIN REMOVAL & REPLACEMENT

To remove a piston and replace a piston pin, proceed as follows.

1. Disconnect any piping or assemblies that will prevent removing the air head or cylinder. With this done, take out the air head cap screws and remove the air head. Now, take out the cylinder cap screws and pull the cylinder up over the piston.
2. To avoid the possibility of bending the connecting rod when removing the piston pin from the piston, we strongly recommend that the connecting rod be removed from the crankshaft. To remove the connecting rod, first take off the frame end cover and the centrifugal unloader assembly, after which the rod may be pulled off its throw. See Figure 7-9.

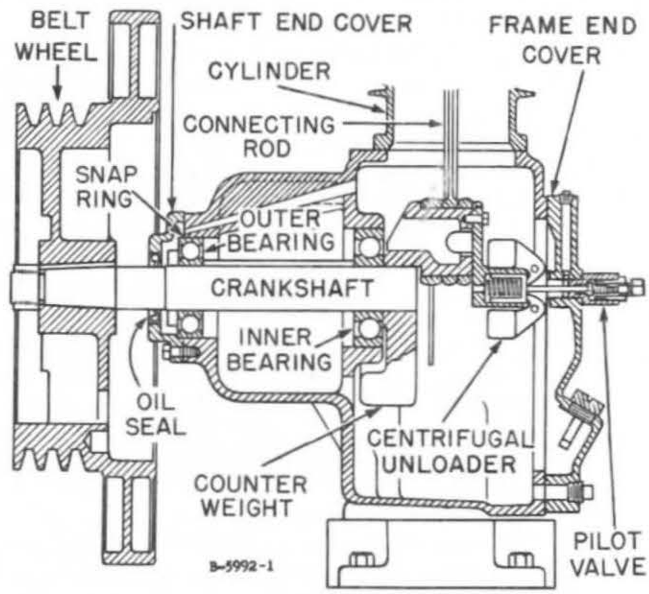

Figure 7-11. Crankshaft Assembly.

3. Remove the piston pin lock rings from their grooves and with a dowel of appropriate size and a soft hammer, drive out the piston pin. Important: To prevent piston distortion during this operation, play between the piston pin bosses and connecting rod must be eliminated by inserting fork-type shims of the necessary thickness between the rod and boss. See Figure 7-10.
4. Before installing the new pin, oil the walls of the pin, align the connecting rod between the bosses in the piston and drive in the new pin using an appropriate dowel and a soft hammer.
5. When the piston pin is in place, put the lock rings back in their grooves.
6. Put the connecting rod back on the crankpin and replace the centrifugal unloader and frame end cover.
7. Oil the cylinder bore and replace the cylinder (use a piston ring compressor for this operation). Replace the air head and any other assemblies or piping that were removed.

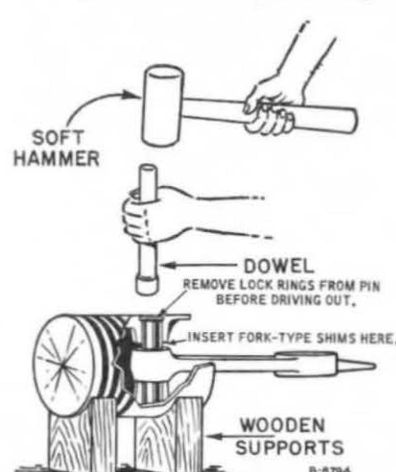

Figure 7-10. Piston Pin Removal & Replacement.

CRANKSHAFT BEARING REPLACEMENT

If bearing replacement is necessary, we recommend the installation of a new crankshaft complete (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 appropriate parts list for ordering instructions.

CRANKSHAFT ASSEMBLY REPLACEMENT

A new crankshaft assembly includes bearings, spacers, crankdisc, etc., all of which are installed as a unit. To remove the old crankshaft and install a new one, proceed as follows:

1. First remove the beltwheel key and shaft end cover. Next, drain the frame oil, then remove the frame end cover and centrifugal unloader assembly.
2. Remove the cylinder to frame cap screws and pull the cylinders over the pistons. Remove the centrifugal unloader and connecting rods from the end of the crankshaft, and take the snap ring from the outer bearing. It may be necessary to drive the crankshaft endwise before removing snap ring.
3. The crankshaft assembly is a moderate press fit in the frame and may be forced out by tapping the belt wheel end of the shaft with a lead hammer.
4. Prepare the new crankshaft assembly for installation by removing the snap ring from the outer bearing by grasping it near the end and springing it from the groove.
5. 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 careful to strike the center of the shaft, since an off center blow may spring it.)
6. The assembly must be driven in until the snap ring groove in the outer bearing clears the end of the frame by about 1/16″ (1.59 mm). Replace the snap ring by putting one end in the groove and springing the ring into place.
7. Tap the crankshaft back until the snap ring is tight against the frame.
8. Before replacing the shaft end cover (includes oil seal), make certain that there are no burrs on the belt wheel 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, an assembly tool can easily be made in the form of a truncated cone of .003″ (.076 mm) brass shim stock.
9. Re-assemble the rest of the compressor, using caution when replacing the cylinders over the pistons. We recommend the use of a piston ring compressor in this operation.
10. Fill the frame with oil.

OIL SEAL REPLACEMENT

1. Remove the beltwheel, key and shaft end cover. 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.
2. 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 housing with pipe compound. Press the seal into the shaft end cover with a vise or in a press. Note: Protect the parts from damage from serrated vise jaws by padding the jaws.
3. After the seal has been installed in the shaft end cover, it is returned to its original location by sliding it over the end of the crankshaft as described in paragraph (8) of Crankshaft Assembly Replacement.

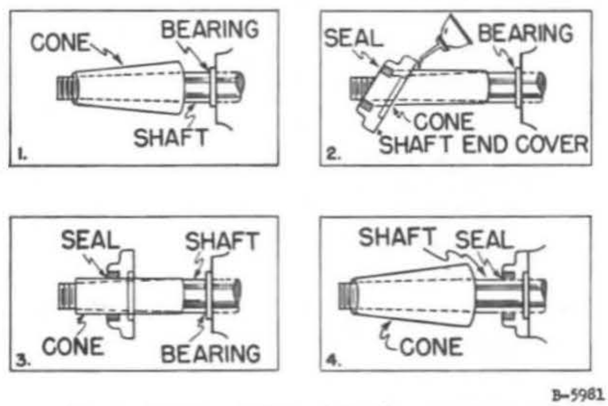

Figure 7-12. Oil Seal Replacement.

PRECAUTIONS FOR EXTENDED SHUTDOWN

Whenever the unit it taken out of service for long periods of time, certain precautions must be taken to prevent general deterioration.

1. All interior surfaces of the unit should be protected against rust by draining the frame and refilling it with a suitable rust inhibiting oil. The unit should now be operated for fifteen minutes and the oil should be fogged into the compressor intake, thus coating all internal surfaces. Leave the rust inhibiting oil in the frame: Note: When putting the unit back into service, replace the rust inhibiting oil with compressor lubricating oil.
2. After this operation, all openings are to be taped shut to prevent moisture from entering the unit.
3. Drain the air receiver of all moisture and store the unit in a dry sheltered location.
4. Follow the manufacturer's instructions for storing the electric motor or gasoline engine.

Ingersoll-Rand.

USERS SURVEY FORM

SERVICE LITERATURE

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Form No. ______________ Date ______________

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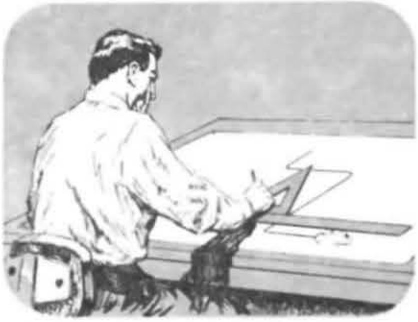


SPECIAL ENGINEERING SERVICE

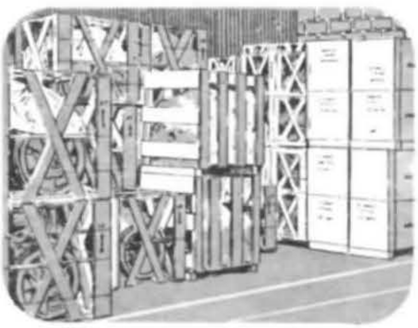
We can help you with your compressed air problems by surveying your needs and recommending the proper compressor and air piping system for maximum efficiency.

SPARE PARTS

We stock genuine I-R spare parts for your I-R equipment, avoiding possible costly delays or the substitution of inferior parts. As a result, old machines are kept in good-as-new condition.

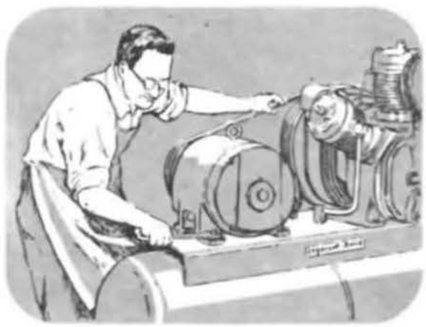
FAST EFFICIENT FIELD SERVICE

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



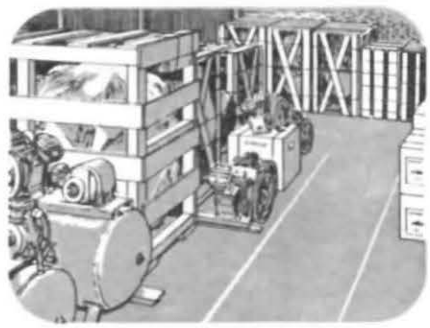
COMPLETE STOCK OF EQUIPMENT

Our stock of complete machines which can usually take care of any need is backed up by Ingersoll-Rand prompt factory shipment to assure you on-time delivery.



COMPLETE REPAIR SERVICE

Trained mechanics will repair or overhaul compressors by factory recommended methods, using only genuine parts.



EXCHANGE SERVICE PLAN

We maintain stocks of compressors that can be substituted for your compressor while repairs are being made. This means no lost production time for you.

INGERSOLL-RAND

DISTRIBUTOR

RECIPROCATING CENTRIFUGAL HELICAL ROTOR AXIAL FLOW SLIDING VANE THERMAL

Ingersoll-Rand

Type 30 Compressor Division
Campbellsville, Kentucky 42718