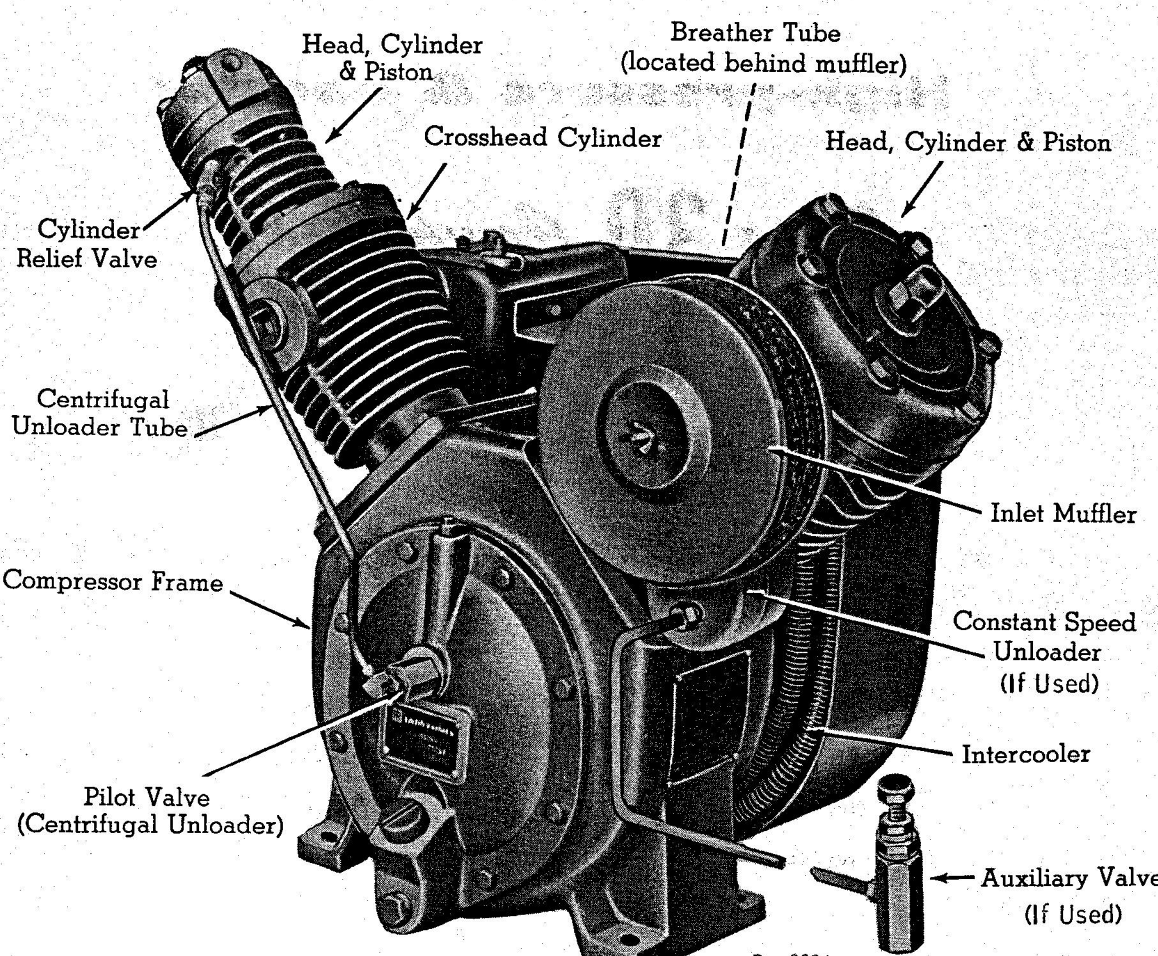
THIS INSTRUCTION BOOK COVERS TYPE-30, AIR-COOLED, HIGH PRESSURE COMPRESSORS



Typical two-stage high-pressure compressor.

-- NOTE --

The pictorial guide above is intended to acquaint the reader with the locations of the various compressor assemblies that are discussed in detail in this booklet. Reference to this guide during the reading of the text will aid in clarifying the location and relationship of the various assemblies. Although structural differences may exist between this typical compressor and other models covered in this booklet, the location of the assemblies will have the same general relationship and be in the same relative location as shown.

Various component parts differ from each other in their design and arrangement on some of the models. A Special Section Index, page 18, references your particular compressor with the specific component part it uses.

Section I
INSTALLATION

Section I

General Instructions

INSTALLATION

1. LOCATION

In cold climates, we recommend that the compressor be installed within a heated building. The location chosen should be clean and should provide ample space around the unit for cooling and general accessibility. The compressor may be bolted to any substantial floor; however, it is important that the surface is level. If the surface is not level, appropriate shims can be used under the compressor's base. After the foundation bolts are tightened down, the base should be rechecked for levelness. The belt side of the unit should be placed toward the wall, leaving at least 15" space for air circulation by the fan belt wheel. Do not locate the compressor in a boiler room or other similarly hot place.

In damp climates or where conditions of high humidity are encountered, the compressor should not be located in a cellar or similar unventilated place. This is particularly true of units on short cycle or very intermittent duty application. Locations such as described above are particularly conducive to the formation of water in the compressor crankcase which leads to rusting, oil sludging and rapid wear of running parts.

If the compressor is located where the motor will be exposed to appreciable quantities of water, oil, dirt, acid or alkaline fumes, the motor must be specially constructed.

2. ALIGNING FLEXIBLE COUPLED COMPRESSORS

When installing the complete unit on its foundation, the coupling alignment should be checked to insure smooth operation. See paragraph 28 in the Maintenance Section for instructions.

3. WIRING

Before wiring the compressor to the power supply, the electrical requirements shown on the motor name plate must be checked against the electrical service in your locality. If they do not agree, do not connect the motor or serious damage may result. Be certain to refer to the wiring diagram before wiring the unit.

Where a pressure switch is used in connection with a manual starter, the motor horsepower rating of the pressure switch is not to be exceeded.

If a pressure switch is used in connection with a magnetic starter, the pressure switch electrical rating is not important, since the switch is not carrying motor current.

It is important that the wire used be of ample size and all joints be secure both mechanically and electrically. To avoid invalidating your fire insurance, it is advisable to have the wiring done by a licensed electrician who is familiar with regulations of the National Board of Fire Underwriters and the requirements of the local inspector.

Sizes of wire to use for distances up to 100 feet from the feeder.

Motor Horsepower	Single Phase		Three Phase		Direct Current	
	110 V	220 V	220 V	440 V	115 V	230 V
Less than 1	14	14	14	14	14	14
1	12	14	14	14	14	14
1½	10	14	14	14	14	14
2	8	14	14	14	12	14
3	8	12	14	14	8	14
5	4	8	12	14	6	10
7½	—	6	10	14	3	6
10	—	4	8	12	1	6
15	—	—	6	10	2/0	4

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 will result unless it is amply protected.

The size of wire recommended by the National Board is a safe guide providing the distance from the feeder does not exceed 100 feet.

If the distance is over 100 feet, larger wire will probably be necessary and your electrical contractor or your local electric company should be consulted for their recommendation on wire size.

The use of the recommended wire size insures negligible feeder line voltage losses during starting and accelerating periods. Improper wire size results in sluggish operation, unnecessary tripping of the overload relays or blown fuses.

4. 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 5 H.P., 1750 RPM, 3-phase, 60 cycle, 220 volt motor is 12.9 amperes and 40 ampere fuses should be used. If your fuses are the correct size and still burn out, inspect for weak or bent clips. They cause local heating which reduces the actual capacity of the fuse.

5. STARTING SWITCH

For complete protection against burning out the motor, we strongly recommend the use of a separate starting switch with thermal or other overload relays. Failure of any one of the three power lines to a three-phase motor while the motor is running will burn out the motor very quickly without blowing the correct fuse. Proper overload relays should give the protection desired and are furnished with instructions for installation. We cannot accept responsibility for damage arising from failure to provide adequate motor protection.

6. 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.

7. PIPING

The compressors are equipped with inlet mufflers and cleaners. No inlet piping is furnished. If the owner desires, the inlet may be piped outdoors or to another room. In any case, the inlet muffler and cleaner must be used. (See paragraph 13 for cleaning instructions). Inlet piping should be as short and direct as possible and as large, or larger than, the diameter of the inlet connection. The inlet piping must increase in diameter for every 50 feet of length. If the total length of piping is between 50 and 100 feet, we recommend that the increase in pipe diameter is made at the mid-point in the length, i.e., if the total length is 80 feet, increase the pipe diameter at the 40 foot point.

Inlets piped outdoors should be hooded to prevent the entrance of rain and snow.

The discharge connections from the receiver to the equipment are far more important than is usually realized. Small leaks in the discharge system are the largest single cause of high operating cost. If your compressor runs more than you believe it should, the most likely cause is a leaky pipe line. Leaks are easily located by squirting oil around all joints.

If the air system is large enough in volume so that no air receiver is used, a condensate leg with drain valve should be placed in the piping at a point as far from the compressor as possible, and just ahead of the point at which the air is used. This leg should be kept drained and all the piping should slope toward it.

Where a subbase 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 receiver unless a safety valve is put in the piping between the valve and the compressor.
2. Run the piping down and not up from the compressor discharge. If this is not possible, install a "drain leg" consisting of a pipe at least 10" long projecting vertically downward from the compressor discharge opening. Put a drain cock at the end of this pipe and drain weekly.

Some of the compressors covered by this instruction book will be supplied with a condensate drain and "drain leg" as standard factory equipment. If the compressor has a condensate drain leg, it will not be necessary to install a second one.

For a typical detailed piping arrangement with accessories, see Section II.

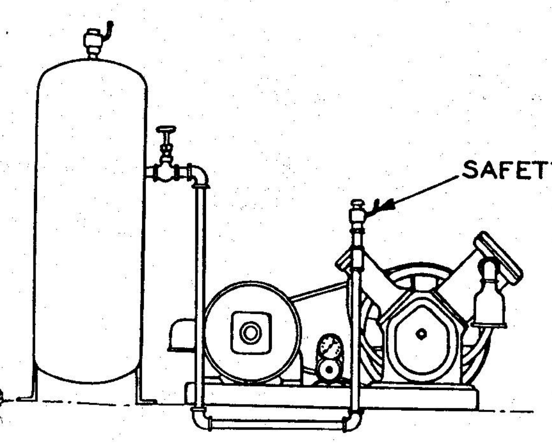


Fig. 1 Typical shut-off valve and safety valve arrangement.

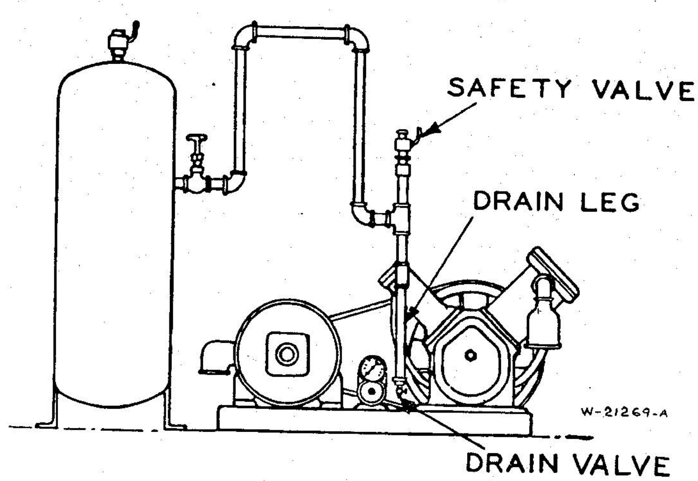


Fig. 2 Typical arrangement of overhead piping showing drain leg.

PRE-STARTING CHECKS & LUBRICATION

8. BEFORE INITIAL STARTING

A. Before starting a new compressor, always fill the crankcase up to the filler hole with a good grade of oil. Check the motor bearings for lubrication. See paragraph 9 and 10.
B. Check electric current specifications on motor name plate with your local electric company. See paragraph 3.
C. Turn compressor over a few revolutions by hand to see that everything is free and in working condition.
D. Check the tension of the belts. See paragraph 12.
E. Remove tools, rags and any other objects from the vicinity of the compressor before throwing the switch.
F. Never put hands on the belts of an idle unit. It may be connected to start and stop automatically, and should it start, a hand can very easily be caught between the belt and the motor pulley or belt wheel.

A daily inspection is not required, but a few minutes spent once a week at a regular established time (say the first thing Monday morning) will help keep the compressor running like new.

9. COMPRESSOR LUBRICATION

Change crankcase oil every 500 hours of operation, or every three months, whichever occurs first.

Experience indicates that the best lubricating oil for use in this class of air compressor is naphthenic-base oil without detergent additives.

The viscosity of the oil chosen should be based upon the ambient temperature, which is the temperature of the atmosphere immediately surrounding the compressor when it is in operation. The oil viscosities given below are selected on this basis and may be used as a guide.

- S.A.E. 10 or 20 if the compressor is installed in a heated building.
- S.A.E. 30 or 40 if the surrounding ambient temperature is 100 degrees or higher.
- S.A.E. 10-W if installation is subject to freezing temperature.

Condensation of moisture in the compressor crankcase leads to the breakdown of the lubriciant and the formation of sludge. As a general rule, moisture condensation is more likely to occur in machines operating on intermittent duty in an atmosphere of relatively high humidity and/ or cool ambient temperature. Moisture condensation is less likely to occur in machines operating for long periods of time in an atmosphere of relatively low humidity and/or warmer ambient temperatures.

Since moisture condensation in the crankcase is dependent upon the compressor application and various atmospheric conditions, Ingersoll-Rand recommends that a reputable oil dealer is contacted for his recommendations pertaining to the naphthenic-base oil best suited to your installation. However, if the owner desires, the amount of condensation in the crankcase can be detected by periodically testing the crankcase oil with a dip stick treated with a moisture indicating paste. This paste is easily obtainable and is reliable if the manufacturer's directions are followed. If this test indicates that moisture is forming in the crankcase, use a naphthenic-base oil with rust and oxidation inhibitors. If the test does not detect moisture, straight naphthenic-base oils are acceptable.

Crankcase oil capacities are as follows:

Model 7T2 - 2-1/2	Qts.
Model 15T2 - 5	Qts.
Model 15T3 - 5	Qts.
Model 41 - 2-1/2	Qts.
Model 52 - 4-1/2	Qts.
Model 64 - 4-1/2	Qts.
Model 67 - 1-1/4	Qts.
Model 220 - 7/8	Qts.
Model 231 - 7/8	Qts.
Model 5B1 - 2	Qts.
Model 5B2 - 2	Qts.

In general, the life (or oxidation life) of naphthenic-base oil will normally be quite long because of the relatively low crankcase temperatures of these compressors. Also, conservative compressor bearing ratings preclude the necessity of any "oilness" or extreme-pressure additives, which may be detrimental to long valve life.

10. MOTOR LUBRICATION & CARE

Sleeve bearing motors should be oiled at least every three months with an oil of about the same consistency as S.A.E. 10 (Sewing machine oils are too light for this service). Ball bearing motors should be repacked once a year using a grease of about the same consistency as vaseline (or a little stiffer). NEVER OIL THE COMMUTATOR, BUT KEEP IT CLEAN AND DRY. Do not use so much oil in the bearings that it is likely to work out onto the commutator.

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

Direct current motors and many single-phase motors have commutators and brushes which must be kept clean. Occasional wiping with a piece of canvas or non-linting cloth is usually sufficient.

NEVER OIL THE COMMUTATOR! Any oil or grease will collect dirt or carbon from the brushes and eventually result in a short circuit. If the commutator becomes dirty, it should be cleaned by a competent electrician.

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 the holders. DO NOT USE EMERY CLOTH.

If the motor is located in an atmosphere where it is exposed to appreciable quantities of water, oil, dirt, acid or alkaline fumes, it must be specially constructed. (Refer to the motor instruction book for more detailed instructions on the care of your motor.)

OPERATION

11. BASIC PRINCIPLE OF OPERATION

The basic principle of operation is as follows: on the suction stroke of the low-pressure piston, air at atmospheric pressure enters the first stage cylinder through the inlet muffler and inlet valve. The compression stroke compresses this air to an intermediate pressure and discharges it through the discharge valve into the intercooler tubing where the heat of first-stage compression is removed by the action of the flywheel fan passing cool air over the intercooler's finned tubes.

The suction stroke of the higher pressure piston now draws the cooled air through the second-stage inlet valve and into the second-stage cylinder where it is compressed to a still higher pressure. If the unit is a three-stage compressor, the air is passed to the third-stage for further compression before it is discharged to the system or receiver. On some units an air-cooled aftercooler is used between the compressor's discharge and the receiver. This aftercooler cools the compressed air in the same manner as the compressed air is cooled in the intercooler.

For maintaining the 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 10 for details.

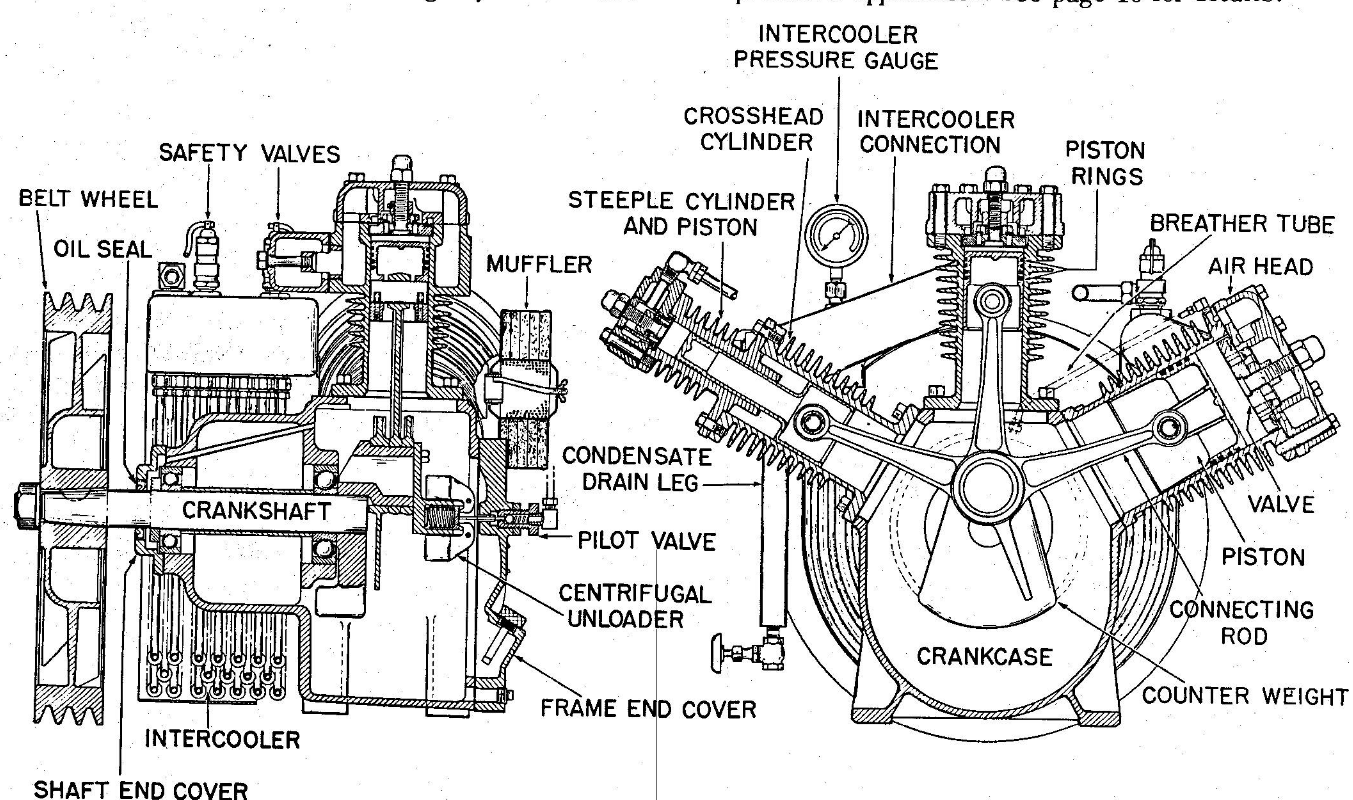


Figure 2A A typical three-stage compressor. (This sectional may be used as a location guide for all units.)

Starting unloading, or the discharge of air from the cylinder when the unit stops so that it is unloaded when started, is accomplished by the action of the centrifugal unloader operating the pilot valve, which in turn opens a line from the high pressure air head to atmosphere.

For details on the operation, care and maintenance of the various component parts, refer to the index on page 3.

12. BELT ADJUSTMENT

DO NOT PRY THE BELTS OVER THE PULLEY GROOVES, as this will damage the belts and greatly reduce their life. The proper tension can be determined by striking the belts with the hand. When too much slack exists the resulting vibration will feel "dead". When proper tension is reached, the belts will have a "live springy vibration". It is not necessary to have the belts "fiddle-string" tight.

As the belts will stretch slightly during the first few months of operation, a belt tightener is furnished for taking up slack. A belt too loose will slip on the motor pulley and cause undue heating and wear. A belt that is too tight will overload the bearings. Adjustment can be made by sliding the motor along on its base by turning the belt tightener clip nut. ALWAYS PULL THE SWITCH before starting this operation so that the motor cannot start while the operator is working on the unit.

When installing new belts, it is essential that the cap screws holding the electric motor or gasoline engine to the subbase be loosened and the driver slid toward the compressor. The new belts (we recommend replacing all the belts at the same time) can then be installed without damage.

13. AIR INLET MUFFLER AND CLEANER

It is very important that the air inlet muffler and cleaner be kept clean at all times. A dirty inlet cleaner not only reduces the capacity of the compressor but also causes premature wear of the working parts.

Either clean the pads as often as your experience indicates necessary or replace them with new ones. The filtering element should be taken out at least once a month and cleaned. As the dirt collects on the outside, the outside surfaces should be brushed with a stiff brush. Use a full set of pads at all times and keep extra pads on hand for replacements.

We recommend the use of a safety solvent for cleaning; however, if gasoline or kerosene is used in cleaning the air inlet muffler and cleaner, be certain it is thoroughly dry before replacing; otherwise, an explosion may result.

14. BREATHER TUBE

The breather tube connects the interior of the compressor frame to the inboard side of the inlet muffler. This connection permits pulsations, created by the reciprocating action of the pistons, to be channelled back to the inlet of the compressor.

15. SAFETY VALVE

A safety valve is provided in each intercooler. These are set at about 10-25 lbs. above the normal working pressure of the cylinder preceding the intercooler that the safety valve is mounted in. If an intercooler safety valve blows, and continues to blow for more than a minute, the compressor should be stopped at once. It indicates a leaky, broken or carbonized discharge valve in the next higher pressure cylinder.

A discharge safety valve is furnished as standard equipment on some models. (Note: if a machine is regulated by manual control, an "on-off" switch only, a discharge line safety valve must be used.) Discharge safety valves are set to blow off at about 10 per cent above the normal operating pressure, or slightly higher than the peak surging pressures found in the discharge piping. If the safety valve leaks, disassemble and clean.

Some of the higher pressure compressors are supplied with a "shear disc" type relief valve. See

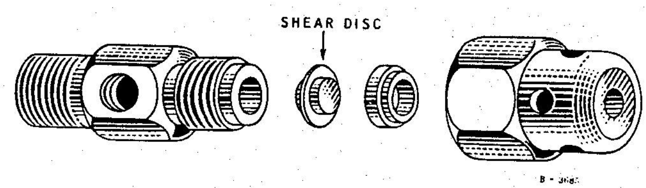


Fig. 3 "Shear disc" type relief valve.

Figure 3. The purpose of this valve is to provide protection in the event of a sudden, abnormal pressure rise, which in some cases, may occur at such a rate that the normal safety valve cannot open fast enough to relieve it. This relief valve does not open under normal or slightly abnormal conditions as its designed "shear" point is well above the normal operating pressure.

In the event that it does operate to relieve an excess pressure, it will be necessary to replace the shear disc itself with a new one. When this is done, an effort should be made to determine the cause of the sudden pressure rise. In most cases, it will be caused by failure to drain the intercoolers of condensate, which transfers to the high temperature region of the third stage cylinder.

16. INTERCOOLER

Do not permit the air flow to the fan-belt wheel to become obstructed. Keep the cooler tubes and fins free from dust and dirt.

An intercooler is located between each stage of compression to remove the heat of the previous stage of compression before the air enters the next higher compression stage.

Single-stage boosters do not have an intercooler.

Two-stage compressors and boosters have one intercooler located between the discharge of the first-stage and the intake to the second-stage.

Three-stage compressors and boosters have two intercoolers, one located between the discharge of the first-stage and the intake to the second-stage cylinder, and the second intercooler located between the discharge of the second-stage and the intake to the third-stage cylinder.

When necessary, the intercooler will be fitted with a condensate drain leg and valve. When these valves are provided, the condensate should be drained off at periodic intervals.

--CAUTION--
Do not open an intercooler drain valve while the unit is running.

The intercooler gauge pressures are a true indication as to the correct operation of the compressor. The cooler pressure will vary with individual machines, with operating temperatures, and with elevation above sea level. Note the pressure when the machine is new, and any marked deviation thereafter requires investigation of the cause; thus, possible troubles may be discovered before serious damage results.

If the intercooler pressure is abnormally high, one or more of the following conditions may be present in the next stage of compression.

1. Inlet or discharge valve broken, stuck or leaking badly.
2. Inlet or discharge valve spring broken or weakened enough to allow air "slip".
3. Carbonized valves or passages which restrict air flow.
4. Air leaking past valve seat.

If the intercooler pressure is abnormally low, one or more of the following conditions may be present in either preceding stage of compression.

1. Piston rings broken or stuck in grooves.
2. Head gasket blown or head not bolted tightly to cylinder.
3. Inlet valve leaking or stuck, spring broken or weakened.
4. Discharge valve broken, stuck or leaking.
5. Leaks in intercooler around the tube fittings or a cracked and leaking tube.

17. INTERCOOLER PRESSURES

Due to variable operating conditions, the pressure listed in the chart may not be identical to the intercooler pressure read on your unit. In this case, it is recommended that the intercooler pressure be recorded when the machine is new, and this reading should be used as the normal intercooler pressure.

Model	Disch. Pressure	1st Stage Intercooler	2nd Stage Intercooler
220	1500	185-225 lbs.	
	2000	200-250 lbs.	
231	500	78 to 82 lbs.	
41	500	80 to 85 lbs.	
	800	89 to 93 lbs.	
	1000	94 to 98 lbs.	
7T2	500	68 to 72 lbs.	
15T2	500	35 to 37 lbs.	165 to 180 lbs.
	750	37 to 39 lbs.	180 to 200 lbs.
	1000	39 to 41 lbs.	215 to 240 lbs.
15T3	1500	70 to 75 lbs.	350 to 400 lbs.
	2500	75 to 85 lbs.	400 to 450 lbs.
	3000	80 to 85 lbs.	450 to 500 lbs.
Size			

18. AIR-COOLED AFTERCOOLERS

Some high-pressure units are equipped with air-cooled aftercoolers, which resemble the intercooler's finned tubes. The aftercooler functions to remove

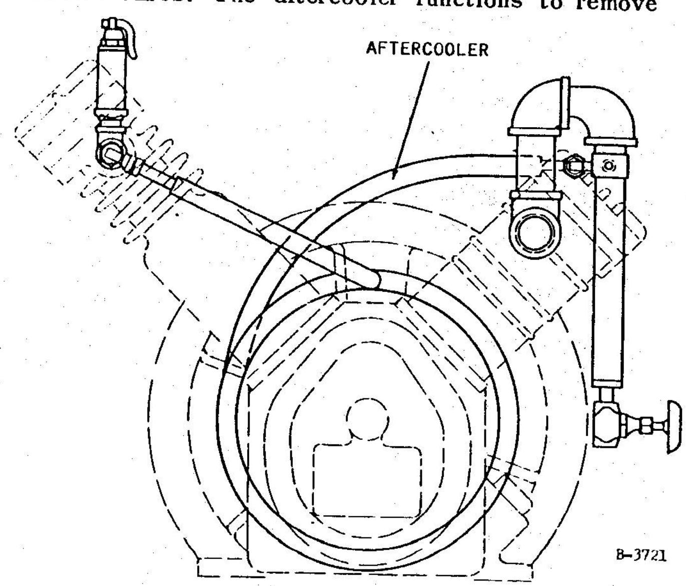


Fig. 4 Typical air-cooled aftercooler.

the heat of compression from the final discharge air before it is stored in the receiver.

Do not permit the air flow to the fan-belt wheel to become obstructed, and keep the aftercooler tubes and fins free from dust and dirt. The aftercooler condensate drain trap should be drained as frequently as necessary to prevent condensate water from entering the compressor.

Some high-pressure units may use a water-cooled aftercooler. In this case refer to Section II.

19. 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.

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 vapor 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.

20. STARTING UNLOADING

Starting unloading is accomplished by the action of the centrifugal unloader opening a pilot valve when the compressor stops, thus releasing to atmosphere the air trapped in the high-pressure cylinder.

Different types of pilot valves and cylinder relief valves are used on the various compressor models. For details pertaining to the centrifugal unloader and the particular type of pilot and cylinder relief valve used on your compressor, refer to the Individual Component Index on page 18.

REGULATION

21. TYPE OF REGULATION

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

1. Manual Control
2. Constant Speed Unloading
3. Automatic Stop and Start
4. Dual Control

Manual Control...A manually operated "on-off" switch is used to start and stop the compressor, and automatic regulation is not furnished.

Constant Speed Unloading...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.

Automatic Stop and Start...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.

Dual Control...Permits a selection between Constant Speed Unloading and Automatic Stop and Start, depending upon the air requirements.

22. MANUAL CONTROL

If the compressor is regulated by manual control, or an "on-off" switch only, a discharge safety valve must be installed in the discharge line to prevent over-pressuring in the event of negligence.

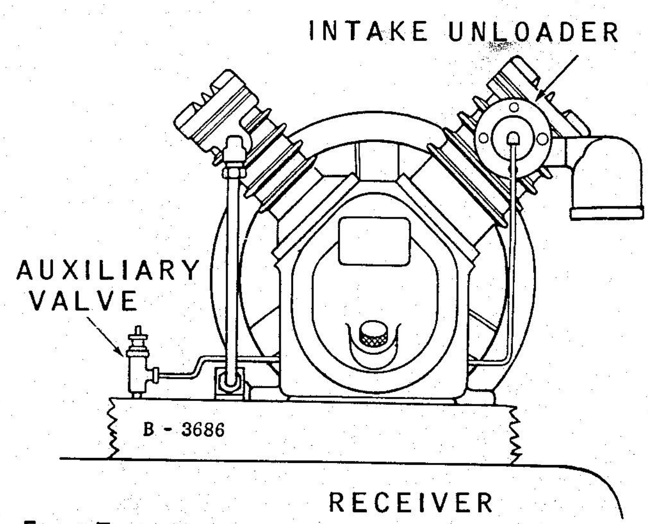


Fig. 5 Typical constant speed intake unloader arrangement.

23. CONSTANT SPEED UNLOADING

Constant speed unloading is accomplished by one of the various types of constant speed intake unloaders (Figure 5), located at the compressor's intake, or by the constant speed free air unloaders (Figure 6), located over all air cylinders. All types of free air unloaders and intake unloaders are operated by control air from the auxiliary valve.

The operation and adjustment of the auxiliary valve and the various types of unloaders is discussed in the Individual Component Section. The particular

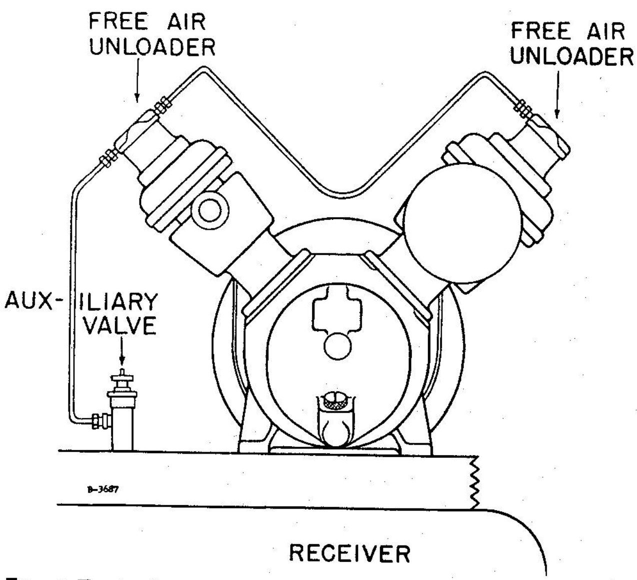


Fig. 6 Typical constant speed free air unloader arrangement.

type of unloader used on your unit may be determined by referring to the Individual Component Index on page 18.

24. AUTOMATIC STOP AND START

Automatic Stop and Start is obtained by means of a pressure switch, which makes and breaks an electrical circuit, starting and stopping the driving motor, and thereby maintaining the air receiver pressure within definite limits.

The pressure switch is piped to the air receiver and is actuated by changes in air receiver pressure.

Pressure switches are set at the factory for the pressure specified and should not be increased with-

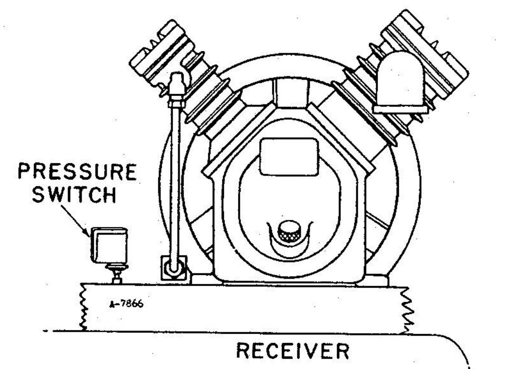


Fig. 7 Typical automatic stop and start arrangement.

out consulting the nearest Ingersoll-Rand office. Do not operate your compressor at a higher pressure than you actually need. To change the "cut-in" or "cut-out" points, refer to the instructions accompanying the switch. It is advisable to have as wide a differential as possible to avoid frequent starting and stopping of the compressor.

25. DUAL CONTROL (Special Application)

Dual control permits a selection depending upon the air requirements, between automatic start and stop control and constant speed unloading.

Dual control on all high pressure compressors and boosters must be specially designed for the particular model and application for which it is used, and for this reason it is not practical to cover all the possible variations in this book.

When a dual control unit is ordered, a separate diagram showing tubing, assemblies, and connections will be inserted in this book.

MAINTENANCE

--NOTE--

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 preform the more common maintenance functions without the need of detailed instructions.

-- CAUTION --

Before attempting any repair work on the unit, be sure the starting 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.

26. SPECIAL TOOLS

The only special tool recommended is a torque wrench. The table below gives the torque to which the wrench should be set for checking the air head, cylinder and valve cap screws and nuts.

Size of Threads	Ft. Lb. Torque	Size of Threads	Ft. Lb. Torque
5/16" - 16	10	5/16" - 24	8
3/8" - 16	25	3/8" - 24	14
1/2" - 13	50	1/2" - 20	42
5/8" - 11	60	5/8" - 18	50

27. VALVES

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 crankcase oil. If loss of compressor capacity is indicated, and it can be traced to no other reason, the air heads should be removed and the valves cleaned.

Different types of valves are used on the various compressor models. For details pertaining to the design and method of cleaning the particular type of valve used in your compressor, refer to the Individual Component Index on page 18.

28. FLEXIBLE COUPLED COMPRESSORS

Should it become necessary to disconnect either the motor or the compressor, it is easily accomplished by removing one half of the disc clamping bolts allowing the discs to remain clamped to either half of the coupling.

When installing the complete unit on its foundation or after having disconnected the coupling for any reason, the coupling alignment should be checked as follows:-

Mark one point on the coupling rim and use this point for checking dimensions "A" and "D"—(Figure 9). Rotate coupling to place this point at bottom center and check dimension "A" with a set of feeler blades. Rotate motor shaft and check "A" at the other coupling arms. Dimension "A" should remain constant within .005" at all positions, thus proving concentricity. If the variation is more than .005", it indicates that the subbase has been drawn down unevenly and should be re-shimmed to correct above alignment.

Next, repeat the process using a finely graduated scale and check dimension "D" at the three positions; this checks angular alignment. This is of less relative importance than concentricity, since the coupling discs, flex easily flatways but resist distortion edgewise.

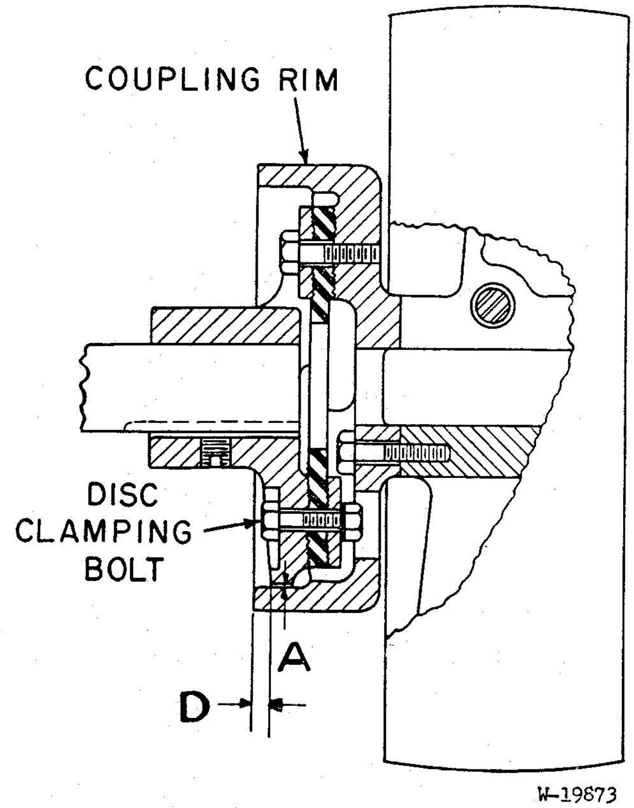


Fig. 9 Flexible Coupling.

On a complete coupled unit, the air compressor and motor are doweled to the base at the factory to preserve correct angular alignment. However, uneven shimming and drawing down on the foundation during installation will cause some variation in dimension "D". If this is excessive, the shimming should be corrected.

On coupled units shipped less the motor, it is expected that the mechanic installing the motor will follow the above instructions and provide the necessary shims and dowels to correctly align the motor and compressor.

29. PISTON RING REPLACEMENT

If oil pumping is encountered on a machine that has been in service for some time, installing new piston rings will not correct the condition if the cylinder is scratched, worn (as indicated by visible ridging at the end of ring travel), rough or out of round. Machines with any of these conditions must have their cylinder assembly replaced before effective oil control can be established.

If it is ever necessary to replace rings, we recommend that a complete new set be installed.

To expose the piston and rings, pull off the cylinder. If a new set of rings are to be installed, install them from the top. The bottom ring should be put on first and then the adjacent one and so on up to the top ring. To eliminate the possibility of breaking or distorting a ring, use a piston ring expander and never pass a ring over another. Stagger the ring joints as shown in Figures 10 and 11. When replacing the cylinder after new rings have been installed, use a piston ring compressor, if available, if not available, use extreme care when replacing the cylinder to avoid distorting or breaking the rings.

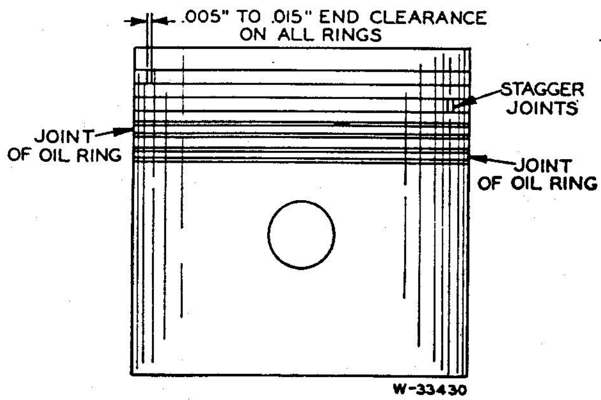


Fig. 10 Piston Ring Arrangement.

If it is ever necessary to replace one of the bottom compression rings, work the good ring above it down into the groove from which the faulty ring was discarded, and work each successive ring down into the next lower groove, installing the new ring in

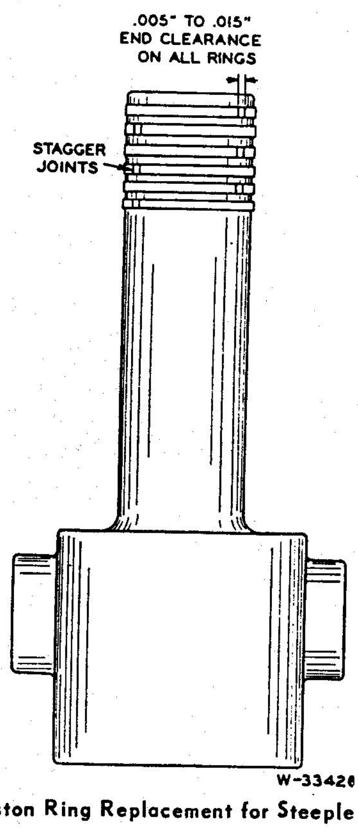


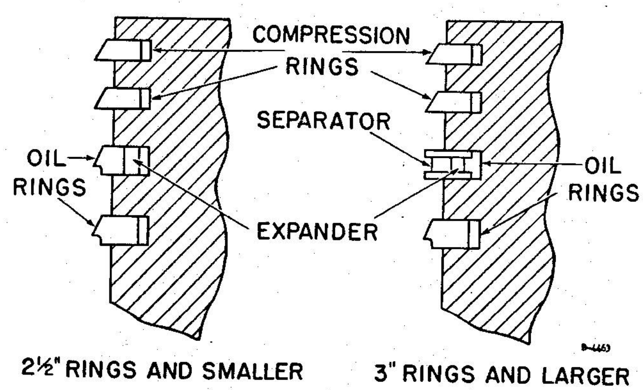
Fig. 11 Piston Ring Replacement for Steeple Type Piston.

the top groove. This method is not possible for oil control rings, since they are not identical as the compression rings are.

End clearance should be .005" to .015" when the rings are new. Check end clearance by putting the rings in the cylinder to simulate condition of rings in place in the piston. This end clearance is required for all rings to permit expansion.

Compression rings are classified as "taper-face" and have a slight taper machined on their outer surface to allow only a narrow contact edge with the cylinder wall. These rings must be installed with the taper toward the top and the scraping edge toward the bottom of the cylinder. The top side of the ring generally has the word "top" or a small punch mark on it.

Oil control rings may be either a non-ventilated or a ventilated type. Conventional scraper type oil rings, with one expander, are supplied with ring sets 2-1/2" in diameter and smaller. Oil ring sets 3" in diameter or larger are the steel-rail type and are supplied with one separator and expander. In either case, all rings will seat against the cylinder wall either on one or two narrow edges. These rings must be installed with the sharp scraping edge toward the bottom of the piston.



On ring sets consisting of two or more compression rings and two oil control rings, the oil ring with the expander must be installed in the second groove from the bottom of the piston, and the oil ring without the expander is to be installed in the bottom groove.

It is of primary importance (and it cannot be over emphasized) that the following four conditions are absolutely necessary for effective oil control.

1. Cylinder walls must be in good condition.
2. Piston rings must be installed right side up.
3. Piston must not be cut or worn and sides of ring grooves must be smooth and flat.
4. Piston rings must be "light-tight". (This test may be made by individually placing the rings in the cylinder bore and placing a light behind them. A "fuzzy light" gap is generally acceptable; however, a clear

light gap indicates either an out of round cylinder or ring).

When new rings are installed in old cylinders which are in good condition, the cylinder wall must be "deglazed" or slightly roughened to provide a proper "seating-in" surface for the new rings. Use #80 grit abrasive cloth and go over the cylinder wall using a rotating and reciprocating motion. Do not overdo; dulling the glaze is usually sufficient and can be accomplished with light pressure.

The deglazing abrasive cloth should be wetted with kerosene or oleum spirits during deglazing to reduce the harshness of the surface and to keep feathered edges to a minimum.

After deglazing, the cylinder should be cleaned by scrubbing the bore thoroughly with a good stiff bristle brush (not wire), using ordinary bar soap and hot water. At the first scrubbing, the suds will turn grey. Scrub until the suds turn white. Rinse thoroughly with hot water and check the cleanliness of the surface by wiping with a soft white paper cloth. If not properly cleaned, the paper will discolor (turn black). When finished with cleaning, oil the cylinder with a light coat of compressor oil.

The pistons and compressor crankcase should also by cleaned in the same manner as described for the cylinders.

If the cylinders, pistons and rings meet all required conditions and proper deglazing and cleaning techniques have been followed, it is not necessary to use an abrasive agent such as "Bon Ami" to seat the rings. If proper conditions have not been established, "seating" the rings by use of an abrasive agent will not be of any help and could easily lead to serious trouble.

Before starting the machine after installing new rings, apply a liberal coating of oil to the cylinder bores.

After new rings have been installed, and the machine has been operated for at least ten hours at full pressure, check the oil consumption. See paragraph 30.

30. OIL CONSUMPTION CHECK

A rule of thumb for determining a "passing grade" for oil consumption is to consider consumption in the range of 25 to 50 horsepower-hours per ounce to be acceptable.

To apply this rule, consider the size of machine; say a 5 hp unit uses 2 ounces of oil every 10 hours of operation. Five (5) hp x 10 hours equals 50 horsepower hours, divided by 2 equals 25 horsepower-hours per ounce.

Machines using more than one (1) ounce of oil per 25 horsepower-hours would be classed as not meeting commercial standards, and further corrective action is suggested. A careful inspection of the cylinder and piston rings, and checks for excessive piston ring end gap, excessive side clearance, etc. should be made. End gap clearance exceeding .015" for new rings is considered to be excessive.

31. INSTALLING NEW CRANKSHAFT ASSEMBLY

To remove the old crankshaft assembly, it is first necessary to remove the beltwheel, beltwheel key and shaft end cover. Next remove the frame end cover and centrifugal unloader assembly. Pull the cylinders over the pistons and remove the connecting rods from the end of the crankshaft. See Figure 12A for locations. The snap ring, Figure 13, must now be removed. To remove the ring, grasp the ring near the end, then pull and spring it from its groove.

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

The new crankshaft assembly includes bearings, spacers, crankdisc, etc., all of which are installed as a unit. Before putting the new crankshaft assembly in the frame, remove the snap ring from the outer bearing in the same manner it was removed from the old assembly.

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.)

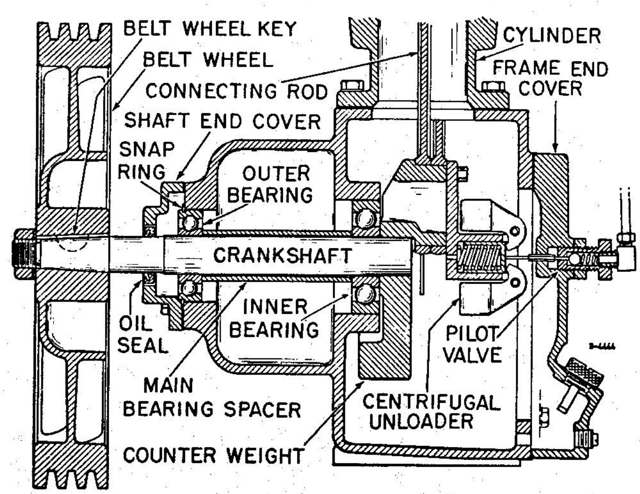


Fig. 13 Crankshaft Assembly.

The assembly must be pushed in until the snap ring groove in the outer bearing clears the end of the frame by about 1/8". Replace the snap ring by putting one end in the groove and prying it in place with a screw driver. Tap the assembly back until the snap ring is tight against the end of the frame. Now carefully replace the shaft end cover and oil seal. (See paragraph 32, if a new oil seal is to be installed). Make certain that there are no burrs on the shaft and that the edges of the keyway are smooth and slightly rounded to prevent damage to the oil seal.

Reassemble the rest of the compressor, using caution when replacing the cylinders over the pistons. If available, we recommend the use of a piston ring compressor in this operation.

32. OIL SEAL REPLACEMENT

Compressors with an open-type crankcase (atmospheric pressure) use a radial-type oil seal, which is installed with its sealing lip facing the outside.

To replace this seal, remove the belt wheel, 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 drive it out with a metal rod which is somewhat larger in diameter than the crankshaft. To install a new seal, coat the outside diameter of the seal case with shellac or pipe compound. The seal may be pressed into the cover by placing the cover and seal in a vise and tightening it. Be sure the face of the vise jaw contacts the entire surface of the seal. Compressor parts should be protected from damage from serated vise jaws by inserting brass or copper strips between the parts and the jaws. Install the new seal with the sealing lip facing in the same direction as the one removed. Check the crankshaft to make sure that it is free from burrs or sharp edges which may cut the sealing lip as it is passed over the shaft. If the compressor has a straight shaft and a seal with the sealing lip facing toward the inside, the end of the shaft should be smooth and all sharp edges of the keyway rounded. An assembly tool can be easily made in the form of a truncated cone of .003" brass shim stock. Place the large end of the cone over the shaft, lubricate the cone and slide the cover and seal over the cone and onto the shaft. Pull off the shim stock.

Booster compressors with up to 5 lbs. pressure in the crankcase will use the same type of oil seal as previously discussed, except that it will be installed with its sealing lip facing into the crankcase. Boosters with a crankcase pressure greater than 5 lbs. will be equipped with a refrigeration-type rotary seal. This seal is replaced as a unit and sometimes includes the shaft end cover. To replace this seal, remove the flywheel, key, shaft end cover and seal assembly. Remove any sharp edges or roughness from the shaft, coat with grease and slide the seal assembly over the shaft. Apply oil to the seal faces and assemble the shaft end cover to the frame, taking care to draw the cover down evenly.

SECTION II
DETAILED PIPING ARRANGEMENTS and ACCESSORIES

33. DETAILED PIPING ARRANGEMENT

Typical detailed piping arrangements are shown in Figure 14 and 14A. These diagrams include a water-cooled aftercooler, automatic water valve, automatic condensate drain trap and receiver.

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

34. WATER-COOLED AFTERCOOLER

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 then ten feet. If the length is more than ten feet, use the next larger diameter size pipe. The aftercooler must be rigidly supported from the ceiling or wall.

Discharge piping to the aftercooler should preferably lead down, but if overhead piping is used, a drain leg, to trap condensed moisture, should be mounted next to the compressor as noted in Figure 14. 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 water from entering the compressor.

35. MAINTENANCE OF WATER-COOLED AFTERCOOLER

There are two types of water-cooled aftercoolers that can be furnished with your unit. Both aftercoolers are similar with respect to their general arrangement and are classed as shell and tube type heat exchangers. These aftercoolers have only one tube in each shell, yet may have one, two or four shells in each assembly.

The cooling tubes are generally made of copper or aluminum but may be made of other materials, depending upon the cooling medium. Tubes are centered inside their shells by multiple quill-like spines that protrude from the surface of the tube. These

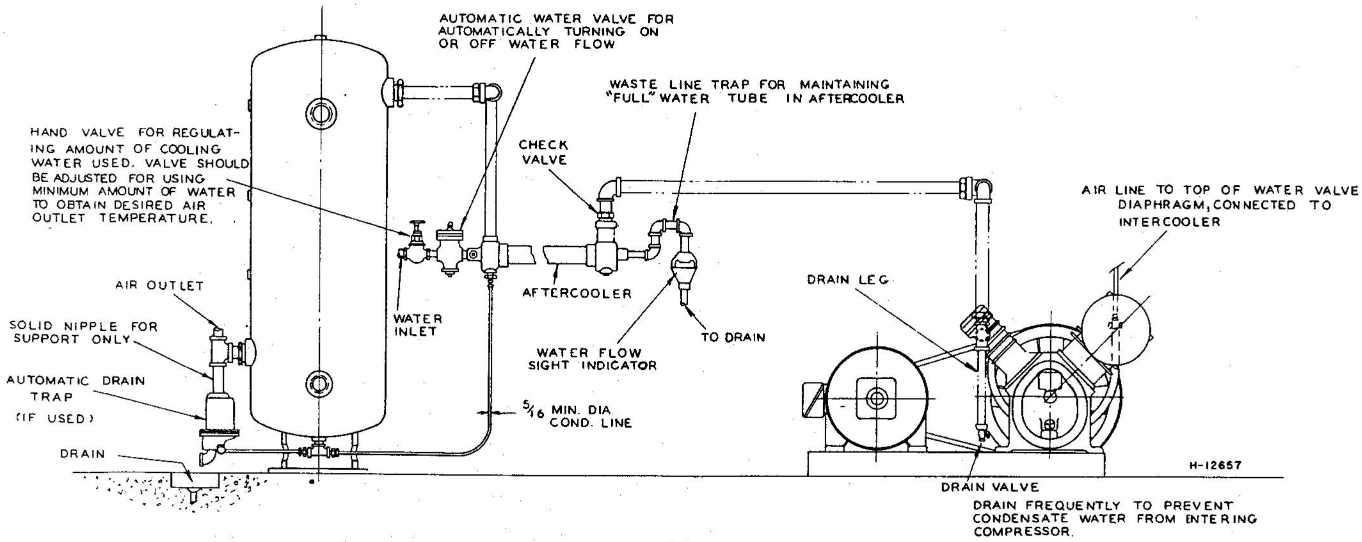


Fig. 14 Typical piping arrangement for base-mounted high-pressure compressors.

spines are formed integrally with the tube and permut greater cooling efficiency. In operation, the hot air passes over the spines in an opposite direction from the cooling water which flows through the center tube.

Headers, on each end of the aftercooler, serve to join the tubes and shells and provide pipe connections for the cooling water and condensate piping.

The basic difference in the construction of the two types of coolers is the method of holding the spine tubes in place. The unit assembly type has all component parts silver brazed together to form a single assembly. The removable tube type has removable end covers with the tube ends sealed off by means of elastic "0" rings. This arrangement permits removal of the tube for cleaning or replacement.

The required maintenance for both types of coolers consists of keeping the spines free from lacquer and carbon. This condition may sometime occur because of high air temperatures, resulting from a faulty compressor, and/or the use of a high residue lubricating oil and/or excessive oil consumption.

The carbonized condition of the cooler 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 cooler can be insured by cleaning the aftercooler as soon as there is any indication of a loss of efficiency.

To clean a cooler of the unit assembly type, it is

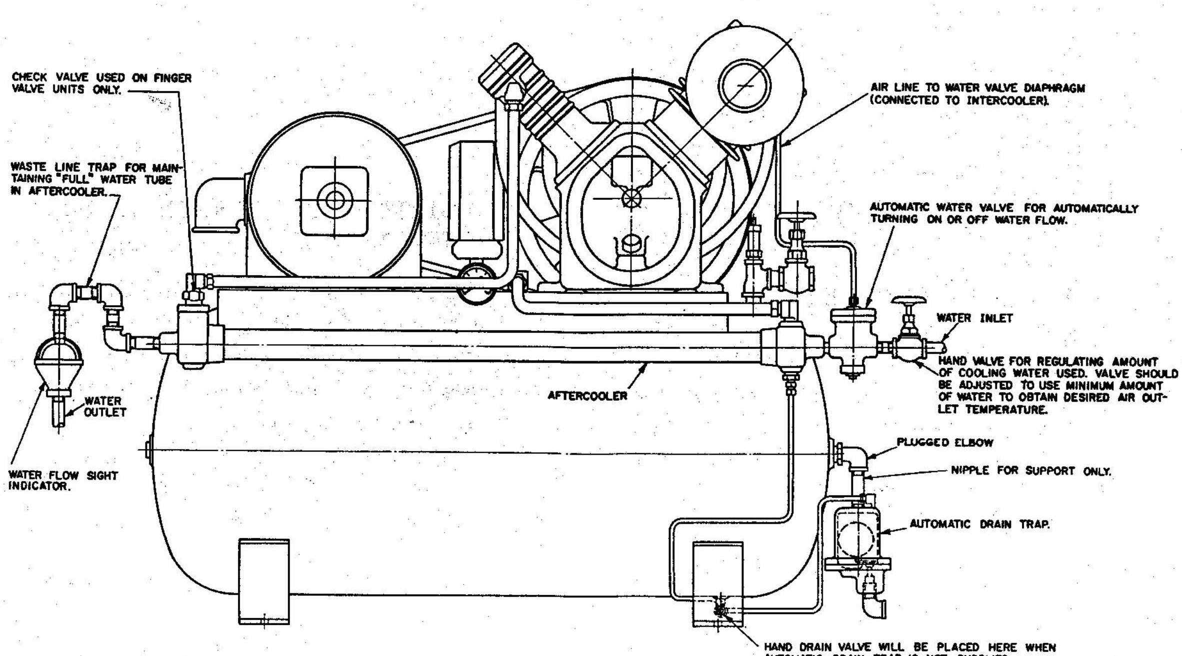


Fig. 14A Typical piping arrangement for tank-mounted, high-pressure compressors.

necessary to remove the pipe fittings from the air inlet and air outlet holes in the end headers. Disconnect the condensate drain line and plug the opening in the header. Fill the air side of the cooler with a carbon solvent and let it soak overnight. Drain and then flush with hot water to remove the loosened carbon deposits. Very heavy deposits may require repeated application.

To clean a cooler of the removable tube type, it

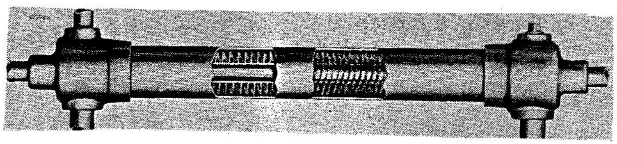


Fig. 15 Water-cooled aftercooler.

is necessary to disconnect the cooling water piping and remove the header covers and plates. The tubes can then be pushed out for examination and cleaning. Soak the tubes in a carbon solvent in a similar manner to that described for the unit type cooler. A length of pipe, capped on one end will make a convenient container for holding the tube while it is being soaked.

A chlorinated, hydrocarbon type of solvent has been found to be effective in removing carbon deposits.

In replacing the tubes, be sure the ends are smooth and clean, otherwise they may not be sealed off tight by the elastic O-rings. If the O-rings are hardened or have taken a set, they should be replaced with new ones. Cover the O-rings with grease to help seal against leakage until the O-rings have had time to seat.

36. AUTOMATIC WATER VALVE

The automatic water valve permits water to flow through the aftercooler only when the unit is in operation (in the case of Automatic Stop and Start Control) or operating loaded (in the case of Constant Speed Unloading).

The automatic water valve, operates from control air from the intercooler, discharge, or centrifugal unloader line, depending upon the compressor's application, and type of regulation.

This valve (Figure 16) is furnished only when specified. It is to be installed in the water inlet line ahead of the aftercooler. A globe valve is to be installed ahead of the automatic water valve to control the amount of water flow.

When the compressor starts or loads, pressure from the compressor is applied to the top of the diaphragm "A" and the water valve "B" is pushed down, opening the passage to the aftercooler. When the compressor stops or unloads, pressure is relieved from the top of diaphragm "A" and valve

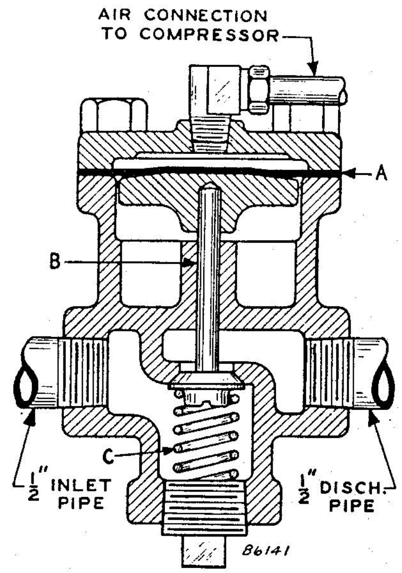


Fig. 16 Automatic water valve.

"B" is closed by the force of spring "C" and the water is shut off.

37. AUTOMATIC CONDENSATE DRAIN TRAP

When specified on the purchase order, units are provided with an automatic condensate trap (Figure 17). The purpose of the drain trap is to expel the condensate moisture from the receiver and/or the aftercooler.

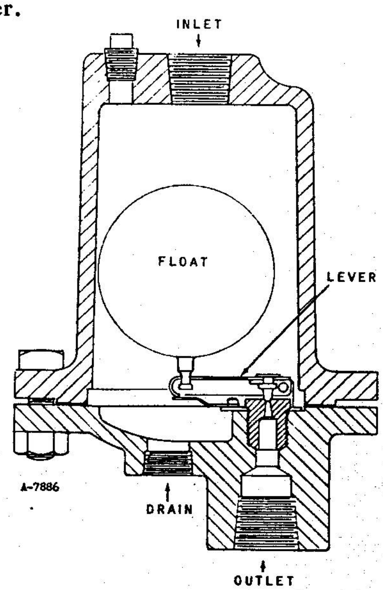


Fig. 17 Automatic condensate drain trap.

Support the automatic drain trap at the top by a solid nipple. Connect the drain line from the bottom of the drain trap to the bottom of the receiver. Water drains from the aftercooler into the receiver, and as the receiver air pressure increases, water is forced into the drain valve, causing a ball float inside the valve to rise. When the ball float reaches a certain level, the valve opens, draining the receiver of condensate. The automatic drain trap should not require any attention in normal service.

Section III

INDIVIDUAL COMPONENT SECTION

-- NOTE --

This section covers instructions on operation, adjustment, and repair of similar component parts that differ from each other in their design and arrangement on the various compressor models.

The Index, shown below, references your particular compressor model with the specific component part it uses. The model number is found on the compressor's nameplate.

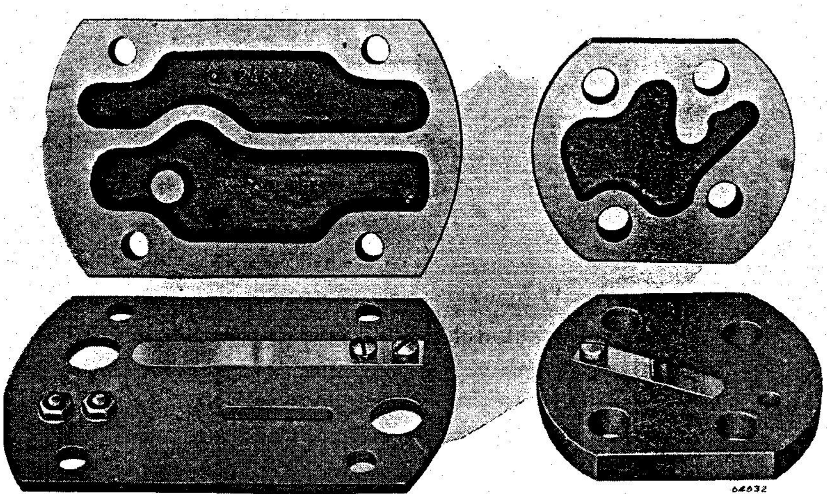
INDIVIDUAL COMPONENT INDEX

COMPONENTS	MODELS										
	41	52	64	67	220	231	7T2	15T2	15T3	5B1 5B2	Booster
Inlet & Discharge Valves	Para 39	Para 39	Para 39	Para 39	Para 38 & 41	Para 38	Para 40	Para 40	Para 40 & 41	Para 40	Para
Constant Speed Unloading	23	23	23	23	23	23	23	23	23	23	
Auxiliary Valve	42	42	42	42	42	42	42	42	42	42	
Intake & Free Air Unloader	45	45	45	45	43	43	44	44	44	46	
Starting Unloading	47	47	47	47	47	47	47	47	47	47	
Pilot Valves........................	51	48	48	48	51	51	52	52	52	49	
Cylinder Relief Valves........	54	55	55	55	55	54	53			53	

— Valves —

38. FINGER TYPE VALVES

To clean the valves, take out the air head bolts, and the valve plate assembly can be removed from the cylinder. See Figure 18. Take the valve fingers off the valve plate, and clean both the valve and seat by a light scraping or a stiff brushing. In handling the valves, be careful not to kink or scratch them. When replacing them be sure they lie flat on the plate all around the port hole, otherwise, they will leak air, which will reduce the compressor output and cause them to carbonize.



LOW PRESSURE HIGH PRESSURE

Fig. 18 Finger Type Valves.

39. PLATE TYPE VALVES

To clean these valves, first remove the valve cap's cap screws. Unscrew the valve cage, thus exposing the valve assembly. Lift the valve from its seat, using extreme care not to damage the seating surfaces. See Figure 19.

If necessary to take the valve apart to get it clean, be careful not to damage the valve seat by holding it in a vise or wrench. A good way to hold the valve while turning off the valve stud nut is to clamp in a vise a pair steel pins about the same diameter as the port holes in the valve. These pins should be spaced so they will enter the valve ports and prevent the valve from turning when removing the nut. When taking the valve apart, note the manner in which the parts were assembled to assure the correct assembly of the valve before it is put back in service.

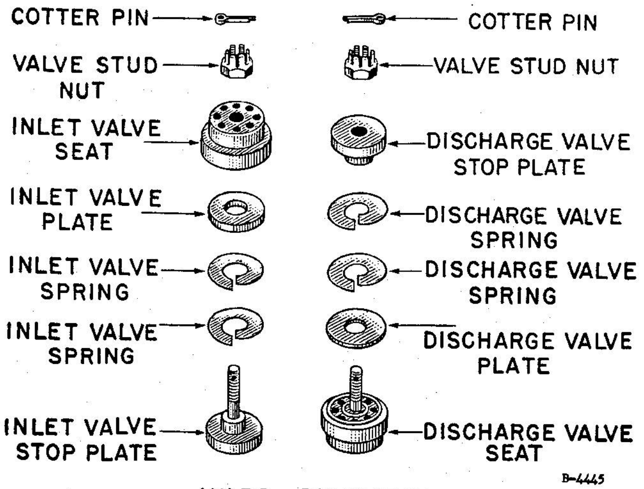


Fig. 19 Plate Type Valves.

40. CONCENTRIC-RING TYPE VALVES

To remove an automatic ring-type valve, loosen the valve bolt acorn nut, then take out the air head cap screws and remove the head. Unscrew the valve bolt acorn nut and lift out the valve. See Figure 20 and 21

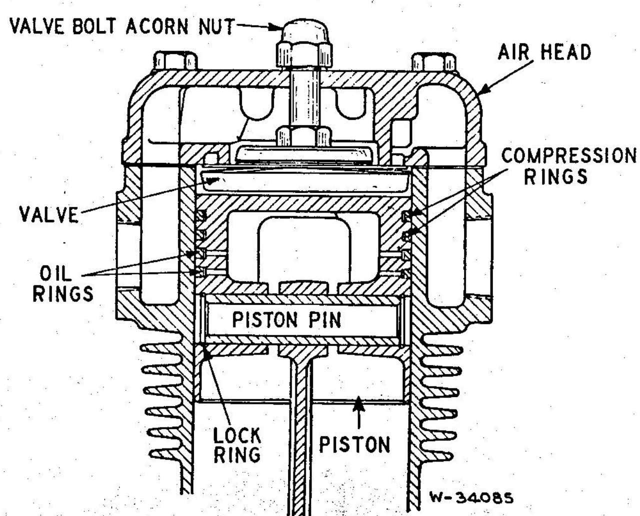


Fig. 20 Air Head and Valve Assembly.

Before replacing the valve, the valve bolt acorn nut steel washer should be covered with shellac to help seal the air from leaking under the nut. Scrape off the old shellac before putting on the new. Do not overtighten the valve bolt acorn nut, as this will upset the flatness of the discharge valve seat and cause it to leak. The valve bolt locknut should be tightened according to the torque valve given on page 12.

- NOTE -

When placing valve assembly in head, be sure inlet valve plate is centered on its guide before pulling valve up with acorn nut. If valve plate is pinched between bottom of air head and discharge seat, it will be damaged. Check to see that valve is free to lift (after it is assembled in head) by lifting at its edges with a knife blade.

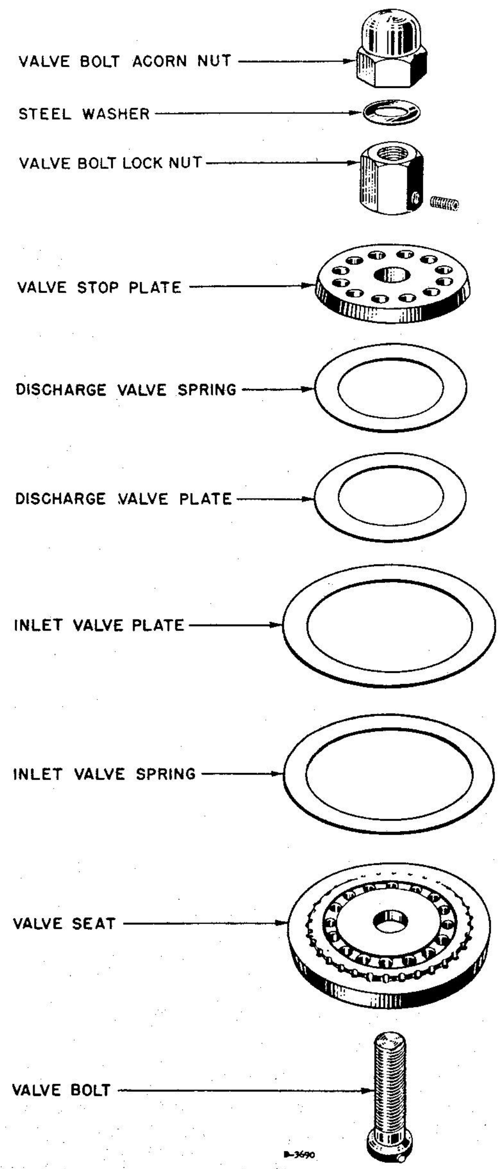


Fig. 21 Concentric-Ring Type Valve.

Figure 21 shows an exploded view of the concentric-ring-type valve.

41. BUTTON TYPE VALVES

These valves consist of the valve seat, stop plate, valve plate, valve spring and valve retainer spring. See Figure 22.

To remove the valves for cleaning, first unscrew the valve caps. By unscrewing the valve cages, the valves will be exposed. The valves are threaded to take a 5/16" - 24 pitch thread cap screw to be used in pulling them from the head.

The valve assemblies may be taken apart for cleaning by removing the snap retainer rings. Use extreme care in handling valve parts, as a slight nick or dent in any of the parts will seriously affect the operation of the valve. The valve plates and seats should be smoothed up and trued by rubbing them on a razor hone.

The valve seating surfaces must be absolutely clean, since a slight speck of dirt will allow air to leak past and cause trouble. A piece of clean cloth fastened on the end of a wire is a satisfactory means of wiping out particles of dirt (rust or carbon) that may accumulate.

- NOTE -

Do not mix the inlet and discharge valve parts, and be certain to replace the valves in their proper cylinder head locations.

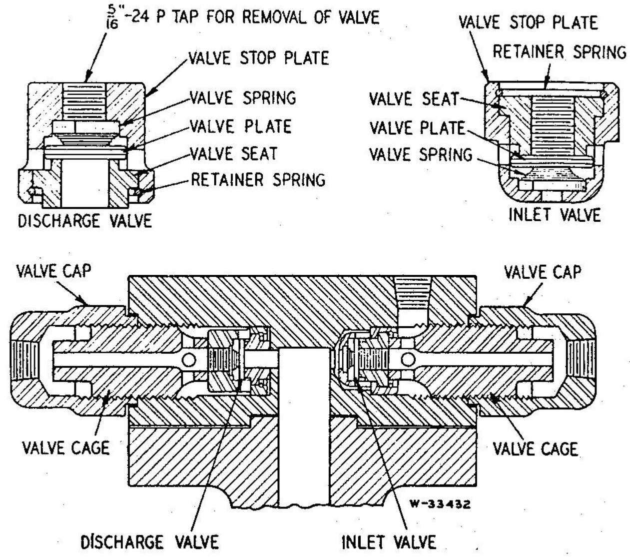
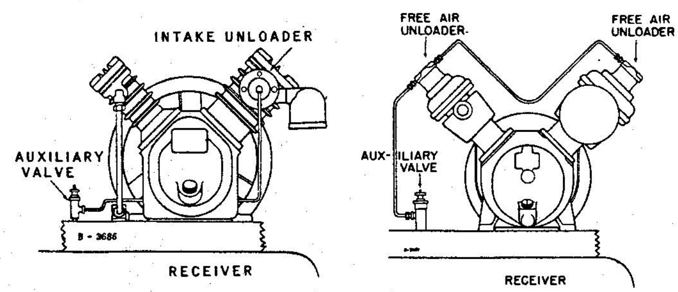


Fig. 22 Button Type Valves.

— Constant Speed Unloading —



42. AUXILIARY VALVE

The auxiliary valve controls the admission and exhaust of air to and from the constant speed intake or free air unloaders.

The valve (bare) opens when the receiver air pressure overcomes the preset tension of the valve spring unseating the valve. This action permits the receiver pressure to pass to the intake or free air unloaders, thus operating the unloader and permitting the compressor to unload. When the receiver pressure falls below the pressure differential for which the auxiliary valve is set, the valve (bare) closes, and the pressure to the unloader is cut off, again operating the unloader and permitting the compressor to reload.

The auxiliary valve should be mounted on the receiver, if possible, and piped back to the unloader. Support the valve in a vertical position, where vibration cannot occur. The valve spring adjustor should be located at the bottom, when practical.

The valve is correctly adjusted at the factory prior to shipment and must not be tampered with inless a change in unloading pressure is desired.

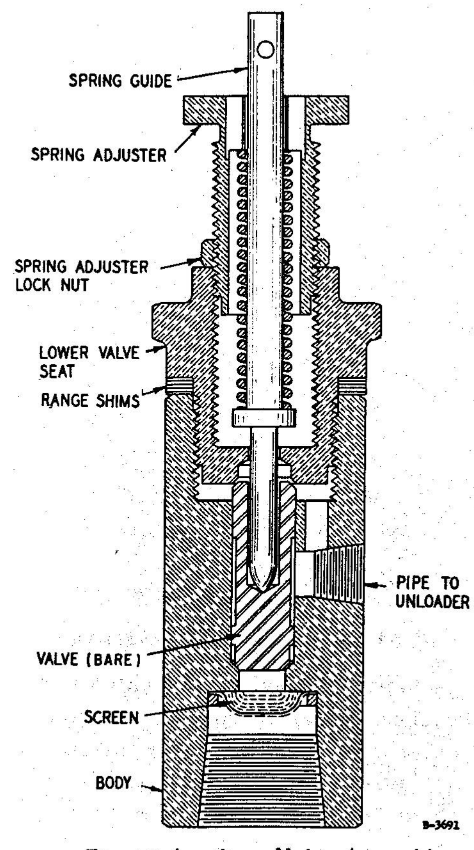


Fig. 23 Auxiliary Valve Assembly.

After considerable service, if unloading pressure requires adjustment, it may be changed. Turning the spring adjuster "in" raises the pressure at which the compressor unloads. Turning the spring adjuster "out" lowers the pressure at which the compressor loads.

If the auxiliary valve sticks, it should be taken apart and cleaned with care. A slight dent on the valve seat will cause it to leak.

43. CONSTANT SPEED INTAKE UNLOADER

The intake unloader shown in Figure 24 is one form of the outside-mounted type. It unloads the compressor by shutting off the intake air before it enters the cylinder. When the compressor is operating loaded, the valve is held off its seat by the spring and intake air passes into the first-stage cylinder.

When the auxiliary valve applies air pressure to the plunger, the spring is compressed, and the valve

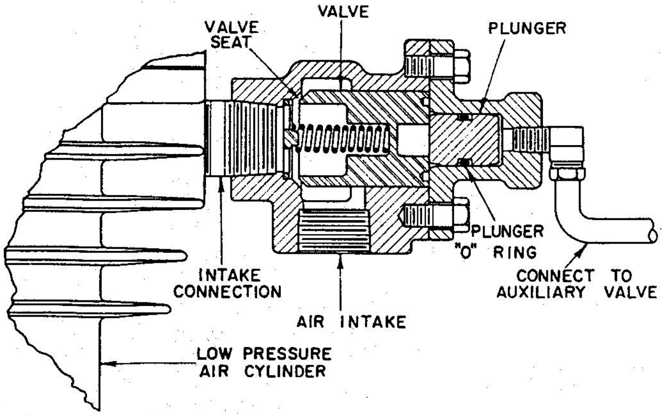


Fig. 24 Constant Speed Intake Unloader.

moves to its seat. With the valve seated, no air can enter the first-stage cylinder, and the compressor is unloaded. When the receiver pressure drops, the auxiliary valve closes, and the spring returns the valve and plunger to their normally open position, allowing air to enter the first-stage cylinder, reloading the compressor.

44. CONSTANT SPEED INTAKE UNLOADER

The intake unloader shown in Figure 25 is another form of the outside-mounted type. This unloader also unloads the compressor by shutting off the intake air before it enters the low-pressure cylinder. The intake air passes between the valve plate and seat into the first-stage cylinder. The valve plate is held off its seat by the spring "A". When the auxiliary valve applies air pressure to the unloader piston, it compresses the piston spring overcoming spring "A", and the valve plate moves to its seat. With the valve plate seated, no air can enter the low-pressure cylinder, and the compressor is unloaded. When the receiver pressure drops, the auxiliary valve closes, and the piston and valve plate return to their normally open position, allowing air to enter the low-pressure cylinder, reloading the cylinder.

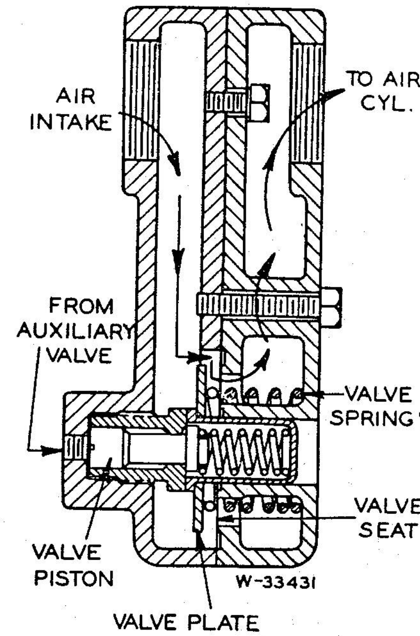


Fig. 25 Constant Speed Intake Unloader.

45. CONSTANT SPEED INTAKE UNLOADER

The intake unloader shown in Figure 26 is the head-mounted type. Unloading is accomplished by covering the low-pressure inlet valve, preventing air from entering the low pressure cylinder. While pumping, the unloader valve is poised above the low-pressure inlet valve, allowing the inlet valve to operate normally. When the air from the auxiliary valve pushes the unloader plunger down, it in turn, pushes

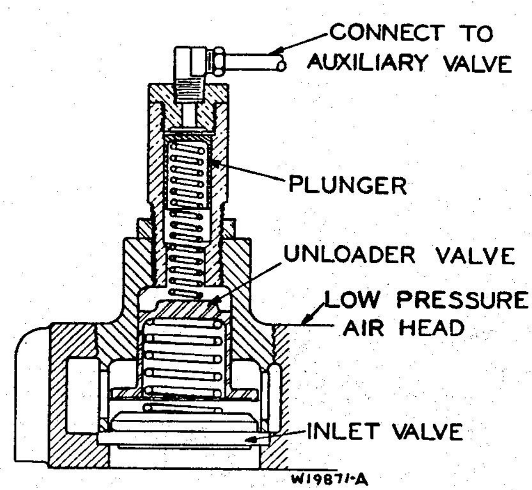


Fig. 26. Constant Speed Intake Unloader.

the unloader valve down to seat, closing off the inlet valve and unloading the machine. When the receiver pressure drops, the auxiliary valve closes and the unloader valve and plunger return to their normally open position, allowing air to enter the low-pressure cylinder, reloading the compressor.

46. CONSTANT SPEED FREE AIR UNLOADER

When free air unloaders are used, one will be located in each air head and will be operated by control air from the auxiliary valve. See Figure 27. This control air will enter the top of each unloader, forcing the unloader piston and plate down, and the fingers on the plate will hold the inlet valve open. As the compressor continues to run, air will surge in and out of the inlet valve, but none will be compressed. When the receiver pressure drops, the auxiliary valve will release the control pressure and the unloader springs will move the piston and plate back up, reloading the compressor

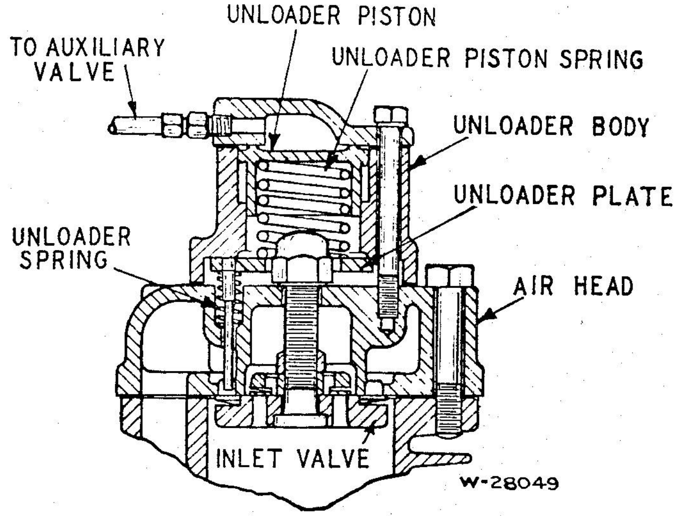


Fig. 27 Constant Speed Free Air Unloader.

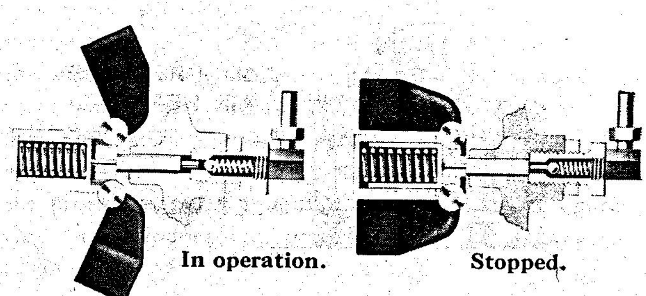
— Starting Unloading —

47. CENTRIFUGAL UNLOADER

The purpose of the centrifugal unloader is to exhaust the pressure from the compressor when it stops so that it is unloaded when it starts again.

The centrifugal weight portion of the unloader system is the same type for all the high pressure compressors. When the compressor starts and comes up to speed, the unloader weights will fly out, pushing the unloader plunger inward, allowing the pilot valve to seat. This shuts off the air connection to the cylinder or intercooler.

As the compressor stops, the weights return to their original position and the unloader plunger spring pushes the plunger out, unseating the pilot valve. This action allows air pressure to escape from the cylinders and intercooler to the atmosphere either inside or outside the crankcase, depending on the type of pilot valve assembly..



The cylinder relief valve acts as a check valve to prevent air from surging in and out of the centrifugal unloader tubing; thereby, maintaining a high volumetric efficiency. See Figure 28.

If the tubing from the cylinder relief valve to the pilot valve seems unusually hot throughout its length, either of these two valves are leaking.

If the tubing is hot only at the pilot valve end, the pilot valve is leaking. To adjust the pilot valve, remove the elbow and spring. With a pencil, push the steel ball down against the resistance of the unloader spring until it is seated. Mark this position

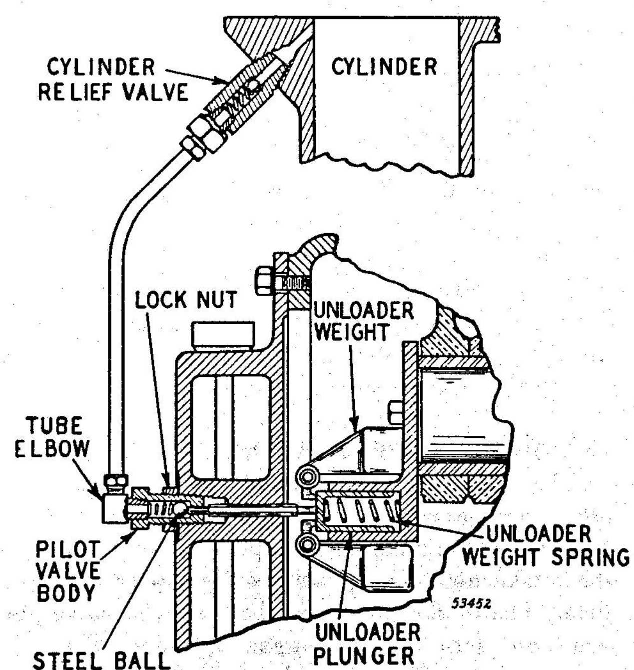


Fig. 28 Centrifugal Unloader.

on the pencil on a line with the outer edge of the pilot valve body. Allow the pilot valve to back off its seat and mark this position on the pencil. There should be 1/16" between the marks on the pencil. If less than this, screw in the pilot valve body, and if more than 1/16" turn it counter-clockwise.

If the tubing is hot only at the cylinder relief valve, this is the faulty valve. In this case, refer to the instructions given under "Cylinder Relief Valve" on page 24.

Figure 28 shows one type of pilot valve being operated by a typical unloader weight arrangement.

— Pilot Valves —

48. PILOT VALVE - Ball Type Inside Exhaust

To adjust the stroke of the pilot valve shown in Figure 29, follow the measuring and adjusting technique outlined in paragraph 47, and proceed as follows: Loosen the pilot valve lock nut and screw pilot valve body in or out until the 1/16" stroke is reached. Then tighten lock nut and replace spring and elbow.

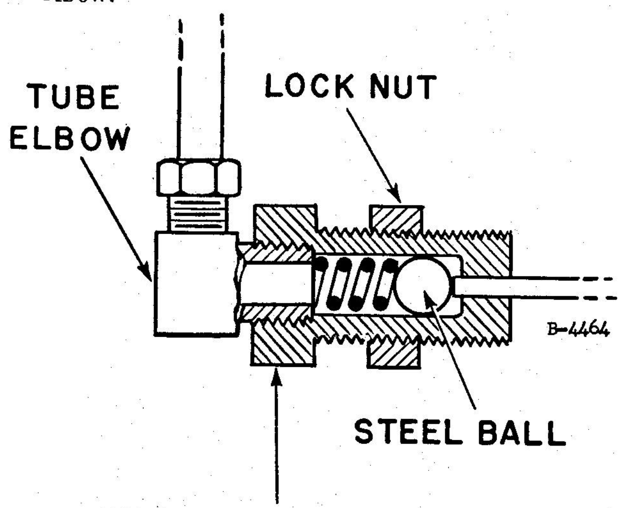


Fig. 29 Ball Type Inside Pilot Valve.

If the tubing is still hot at the pilot valve end, the pilot valve is still leaking. If the leaking cannot be traced to a faulty part, or cannot be corrected be readjustment, the valve should be removed and the ball reset by "Tunking" it into the seat with a small steel rod and light hammer.

If the tubing is hot at the cylinder relief valve end, this valve is leaking. To replace parts of a relief valve, refer to page 24.

49. PILOT VALVE - Plug Type Inside Exhaust

To adjust the stroke of the pilot valve shown in Figure 30 follow the measuring technique outlined in paragraph 47, and proceed as follows: Add or remove shims behind the pilot balve body shoulder until the stroke is between 1/16" and 1/8". Addition of shims decreases the stroke, and removal of shims increases the stroke. When proper adjustment has been made, replace the spring and plug.

The air from the high pressure cylinder is carried to the centrifugal pilot valve through a tube connected to the top of the crankcase end cover and through a drilled passage in the cover down to the pilot valve. The air pressure is sealed from leaking into the crankcase by a synthetic rubber gasket, called and "0" ring, placed in a groove cut in the

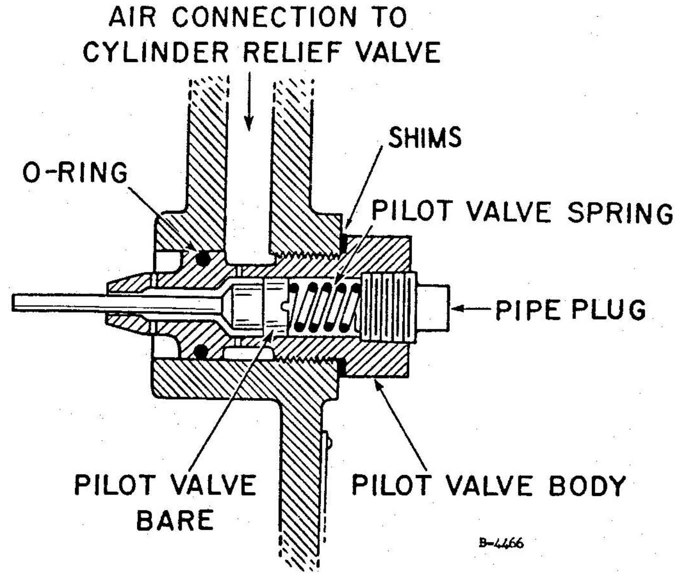


Fig. 3 0Centrifugal Unloader and Inside Exhaust Pilot Valve.

pilot valve body. If the pilot valve is ever removed from the cover, be careful that the "0" ring is not cut or damaged in any way; otherwise, air will leak past it into the crankcase.

If the tubing near the pilot valve still seems hot after adjustments have been made, it indicates that the pilot valve is still leaking. If this leaking cannot be traced to a faulty part, or cannot be stopped with readjustment, we recommend that the seat be ground in. To grind in the seat of a pilot valve, remove the pipe plug, pilot valve spring and pilot valve (bare). Apply a fine grade of grinding compound to the tip of the pilot valve (bare), and replace it in the pilot valve body. A screw driver slot is provided on the cap of the pilot valve (bare) for the purpose of inserting a screw driver and working it back and forth, thus grinding in the seat. When finished, carefully wipe off all grinding compound, making certain that none gets into the crankcase.

If the tubing is hot at the cylinder relief valve end, this valve is leaking. To replace parts of a relief valve, refer to page 24.

50. PILOT VALVE - Disc Type Inside Exhaust

To adjust the stroke of the pilot valve shown in Figure 31, follow the measuring and adjustment technique outlined in paragraph 47, and proceed as follows: Loosen the pilot valve lock nut and screw the pilot valve body in or out until the 1/16" stroke is reached. Then tighten lock nut and replace spring and elbow.

If the tubing is still hot at the pilot valve end, the pilot valve is still leaking. If readjustment

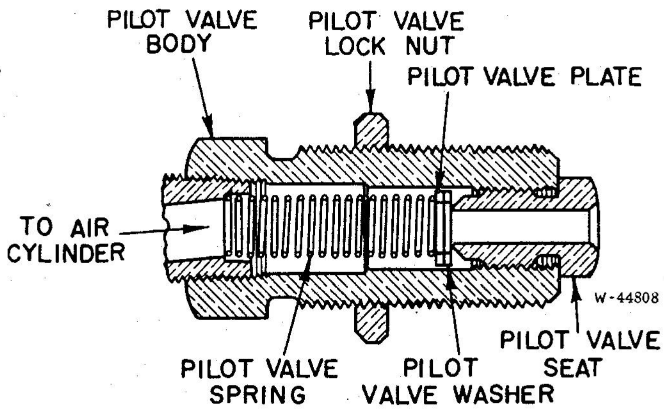


Fig. 31 Disc Type Inside Exhaust Pilot Valve.

does not stop the leaking, replace the pilot valve washer.

If the tubing is hot at the cylinder relief valve end, this valve is leaking. To replace parts of a relief valve, refer to page 24.

51. PILOT VALVE - Disc Type Outside Exhaust

On outside exhaust pilot valves the air from the from the cylinders and intercooler passes into the pilot valve adaptor and on out through the side port to atmosphere, or it can be piped away. The air cannot enter the crankcase due to the seal formed by the "O" ring between the adapter body and the thrust pin.

To adjust the stroke of the pilot valve shown in Figure 32, follow the measuring and adjustment technique outlined in paragraph 47, and proceed as follows: Loosen the pilot valve lock nut and screw pilot valve body in or out until the 1/16" stroke is reached. Then tighten the lock nut and replace the elbow and spring.

If the tubing is still hot at the pilot valve end, the pilot valve is still leaking. If readjustment does not stop the leaking, replace the pilot valve washer.

If the tubing is hot at the cylinder relief valve

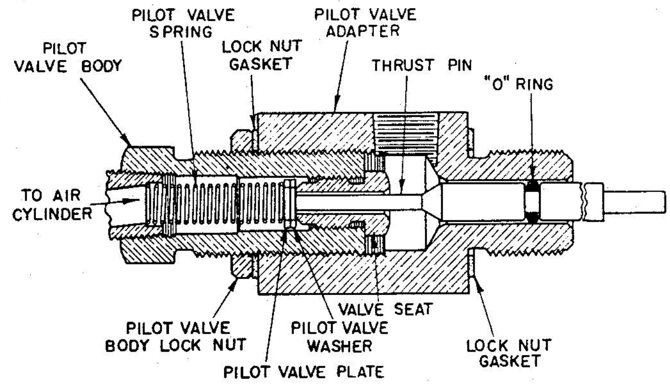


Fig. 32 Disc Type Outside Exhaust Pilot Valve.

end, this valve is leaking. To replace parts of a relief valve, refer to page 24.

52. PILOT VALVE Disc Type Outside Exhaust (Similar to valve shown in Figure 32).

On outside exhaust pilot valves the air from the cylinders and intercooler passes into the pilot valve adapter and on out through the side port to atmosphere, or it can be piped away. The air cannot enter the crankcase due to the seal formed by the "O" ring between the adapter body and the thrust pin.

To adjust the stroke of this type of pilot valve. follow the measuring technique outlined in paragraph 47 and proceed as follows: Add or remove shims behind the pilot valve body shoulder until the stroke is between 1/16" and 1/8". Addition of shims decreases the stroke, and removal of shims increases the stroke. When proper adjustment has been made replace the spring and plug.

If the tubing is still hot at the pilot valve end, the pilot valve is still leaking. If readjustment does not stop the leaking, replace the pilot valve washer.

If the tubing is hot at the cylinder relief valve end, this valve is leaking. To replace parts of a relief valve, refer to page 24.

— Cylinder Relief Valves —

53. CYLINDER RELIEF VALVE - Cup Type

Should the cylinder relief valve spring become broken or the valve (bare) damaged or stuck, the tubing nut to the relief valve can be disconnected and the relief valve assembly removed from cylinder. This will permit a complete examination of the parts, and will enable the operator to make replacements if required. See Figure 33.

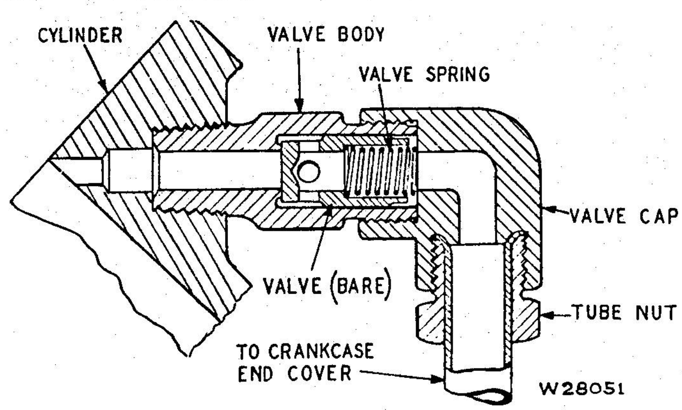


Fig. 33 Cup Type Relief Valve.

54. CYLINDER RELIEF VALVE - Disc Valve Type

To inspect for broken spring or damaged plate, remove the elbow exposing the spring and plate. If the seat is damaged, remove the relief valve body from the cylinder, and remove and replace the seat in the body. See. Figure 34.

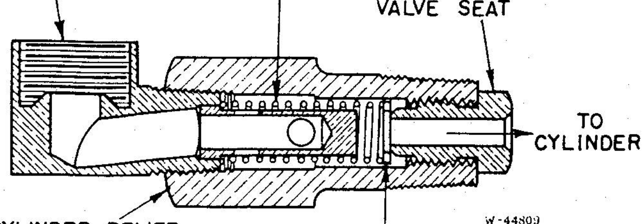


Fig. 34 Disc Type Relief Valve.

55. CYLINDER RELIEF VALVE - Ball Valve Type

To inspect for broken spring or damaged ball, remove the connector exposing the spring and ball. Replace with a complete new valve, or replace spring if broken. Replace faulty part.

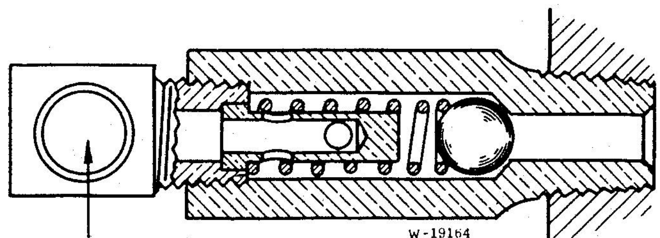


Fig. 35 Ball Type Relief Valve.

Section IV

BOOSTER COMPRESSOR INSTRUCTIONS

--NOTE--

The information given here is supplementary instructions covering certain installation and operation features that are applicable to booster compressors only. For general installation, operation and maintenance information, refer to the general instruction section.

56. GENERAL

Booster compressors built by Ingersoll-Rand are employed in the pumping of various gases. Extreme caution should be exercised when working on a unit of this type. The gas may be either inflammable, toxic, or otherwise harmful to operating or maintenance personnel. Since Ingersoll-Rand does not supply tags stating the purpose for which the booster is to be used, we strongly recommend that the customer affix some type of tag or plate to the booster, clearly showing the type of gas being compressed. This will enable anyone working with the unit to take the proper precautions needed for the gas involved.

57. PIPING

The intake gas to a booster must be as dry as possible. It is usually necessary to install a moisture separator of one form or another ahead of the compressor intake. One type of separator can be made by installing a tee in the intake line and a piece of pipe down from the tee. The pipe should be at least 10" long and a drain cock installed at the lowest point. Drain the condensate from the separator regularly. There are various types of commercial separators available, some of which have means for automatic draining of condensate.

A hand shut off valve should be installed in the intake line to the booster. If the booster has a pressure tight crankcase and an intake drain leg the hand valve should be located ahead of the drain leg so that the drain leg cock can be used to bleed off the crankcase pressure. If there is no drain leg, install a bleed off valve between the intake shut off valve and the booster. If the air system on the discharge side of the booster cannot be blown down so the booster can be serviced, a shut off and a bleed off valve should be installed in the discharge line.

--CAUTION--

When installing a shut off valve in the discharge line, be certain to install a safety valve ahead of it.

Due to line surging it may be necessary to set the safety valve considerably higher than the maximum discharge pressure. If the booster is handling a gas that should not be allowed to escape to the atmosphere around the booster, the exhaust from the safety valve must be piped outdoors or back to the intake piping and a pressure tight crankcase must be used. If the safety valve exhaust is piped back to intake, a special safety valve which can be set to operate on differential pressures will be required.

Open crankcase units or units employing an auxiliary valve in the control system will exhaust a small percentage of the gas the booster is handling into the atmosphere immediately surrounding the booster. If it is not permissible for the gas to be exhausted in this immediate area, the breather line and/or the auxiliary valve tail piece may be piped outdoors where the gas may be safely dispersed.

58. OPERATION

Booster compressors are sold to operate under a specific set of conditions. If it is desired to change the kind of gas being compressed, the suction pressure, or the discharge pressure, secure approval from our nearest branch office. A change in in conditions can result in an overloaded motor or a possible safety hazard.

59. ADDING OIL TO 5B1 & 5B2 BOOSTERS

If your unit is not equipped with an oil filler pot, replenish the crankcase oil supply according to the instructions given in paragraphs A or B.

If your unit is equipped with an oil filler pot (see Figure 36), replenish the crankcase oil supply according to the instructions given in paragraph C.

--CAUTION--

Never service any piece of equipment until you are certain that the equipment cannot be started either automatically or accidentally.

A. Open Crankcases

Close the intake shut off valve and stop the unit. Remove the oil filler plug and fill the crankcase to the point of overflowing.

B. Pressure Tight Crankcases

Close the intake shut off valve and stop the unit. Open the suction bleed off valve. Remove the filler plug and fill to the point of overflowing.

C. Units Equipped with Oil Filler Pots

When filling the crankcase for the first time, remove the oil filler plug and fill the pot to the top. With a long screw driver, or a light rod, reach down through the oil and push open the check valve in the oil filler support. The oil will now flow into the crankcase. Repeat this operation until the oil level reaches the proper level on the bull's eye in the crankcase.

When replenishing oil in the filler pot, it is advisable to stop the compressor, but it isn't neces-

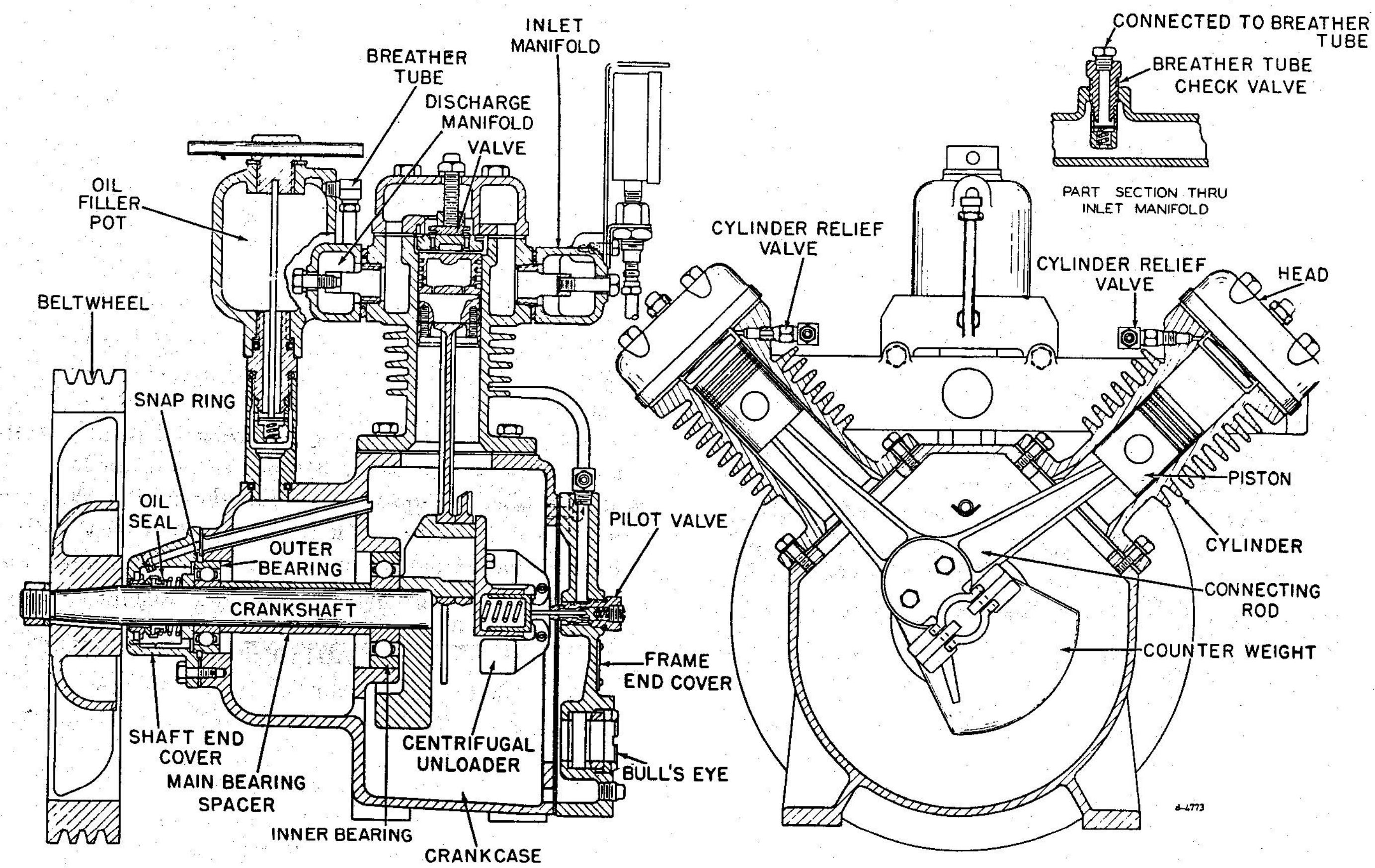


Fig. 36 Model 5B1 or 5B2 Booster Compressor.

sary to close the intake shut off valve or bleed off the line and crankcase pressure. These compressors are equipped with a special oil filling device which allows oil to be put into the crankcase without exhausting the gas in it. The tee handle oil filler plug (in the top of the oil filler pot) has a long stem on the inside. The stem projects through the bottom of the oil filler pot and holds open a check valve that is located in the oil filler pot support. When the oil filler plug is being removed, the first few turns allows the check valve to close, sealing off the crankcase. The next few turns opens a relief slot in the top of the oil filler pot thread, which allows the gas in the filler pot to escape. The filler plug can then be removed and the pot filled with oil. The breather tube line which runs from the top of the oil filler pot to the inlet manifold is prevented from blowing back by a check valve located in the inlet manifold.

When the oil filler pot has been filled, screwing the plug to its seat will open the check valve and allow the oil to flow into the crankcase.

The crankcase should be drained after the first 25 hours of operation to remove any of the initial "breaking in" wear particials that may be in the oil. After this oil change, seasonal changes should be satisfactory.

60. VALVES

Before removing heads, be sure that the discharge and the intake sides of the compressor are bled down. Open intercooler and drain leg drain cocks. The valves can then be removed and serviced as detailed in Individual Component Section.

61. STANDARD BOOSTER REGULATION

Open crankcase booster compressors are usually equipped with either a solenoid valve or a manually operated hand valve located at the compressor's gas inlet. The primary functions of these valves are to (1) close off the gas supply whenever the unit stops, thus permitting the compressor to start in an unloaded condition; and (2) prevents the gas being handled by the compressor from entering the cylinder of a stopped unit and escaping to atmosphere through the cylinder's discharge valve, intercooler and constant speed unloader.

The solenoid valve may also be used as part of the compressor's constant speed unloading system. In this case, the solenoid serves as an inlet unloader by blocking the gas supply to the compressor as required by a pressure sencing device, or pressure switch.

Booster compressors with pressure tight crankcases do not require the use of a manually operated hand valve or solenoid valve to prevent the escape of gas when the machine stops. However, a solenoid valve, free air unloaders of pneumatically operated intake unloaders may be used to accomplish constant speed unloading in this type of compressor. The regulation system used depends upon the unit's application. Instructions covering free air unloaders and intake unloaders are given on page 10.

62. SPECIAL BOOSTER REGULATION

In some applications of a booster compressor, the unit is used in circulation service or close ratio compression stages. This type of unit has a continuous heavy loading on the connecting rod bearings. In order to prolong the life of the connecting rods and the compressor in general, a means of delay starting unloading is employed. The duration of delay is usually three minutes and can be accomplished manually or automatically by either a hand valve or a time delay relay and solenoid valve. In either case, the compressor equipped with this device runs unloaded for three minutes, establishing proper lubrication of bearings before loading. If the machine is equipped with a manual intake line shut-off valve, there will be an instruction plate explaining its proper use. These instructions should be followed closely, as the life of your compressor depends on this procedure. If the unit has automatic delay starting, its proper maintenance and operation is imperative, since improper operation or failure to operate could shortly destroy the compressor.

TROUBLE CHART

TROUBLE	Check Point Nos. *
1. Oil pumping	1 - 2 - 4 - 5 - 16 - 18
2. Knocks or rattles	3 - 5 - 6 - 7 - 9 - 10 - 11 - 15
3. Air delivery has dropped off	1 - 2 - 3 - 4 - 7 - 13
4. Intercooler safety valve pops	7
5. Trips motor overload or draws excessive current	2 - 5 - 7 - 10 - 25
6. Water in crankcase or rusting in cylinders	21 - 20
7. Constant Speed Unloaders	
Machine won't unload	9
Auxiliary valve chatters, leaks around stem	9
8. Excessive starting and stopping (Autc Start)	8 - 13 - 14 - 22
9. Compressor doesn't unload when stopped	2
10. Compressor runs excessively hot	3 - 7 - 12 - 14
11. Compressor won't come up to speed	2 - 23
12. Light flicker when compressor runs	23 - 24
13. Abnormal piston, ring or cylinder wear	17 - 19 - 20

*Refer to corresponding numbers on list of servicing check points.

Servicing Check Points for Use with Trouble Chart

Check Point Nos.	Trouble Cause
1.	Clogged Intake Filter.
2.	Leaking or maladjusted centrifugal pilot valve, or defective "O" Ring on pilot valve.
3.	Leaking cylinder relief valve.
4.	Piston rings broken or not seated in, end gaps not staggered, stuck in grooves, rough, scratched or excessive end gap (over .020" worn) or side clearance (over .006").
5.	Cylinder or pistons scratched, worn or scored.
6.	Loose belt wheel or motor pulley or motor with excessive end play in shaft.
7.	Leaking, broken, carbonized or loose valves.
8.	Receiver needs draining.
9.	Leaking, broken or worn constant speed unloader parts. Aux. valve dirty, seats worn.
10.	Worn or scored connecting rod, piston pin or crank pin bearings.
11.	Defective ball bearing on crankshaft or on motor shaft. Loose motor fan.
12.	Air to fan wheel blocked off.
13.	Air leaks in piping (on machine or in outside system).
14.	Receiver check valve leaking or high pressure discharge valve leaking (no check valve).
15.	Carbon on top of piston.
16.	Oil viscosity too low.
17.	Oil viscosity too high.
18.	Oil level too high.
19.	Oil level too low.
20.	Detergent type oil being used. Change to non-detergent type with rust and oxidation inhibitor.
21.	Extremely light duty or located in a damp humid spot.
22.	Should have constant speed control due to steady air demand.
23.	Check line voltage, motor terminals for good contact, tight starter connections, proper starter heaters.
24.	Poor power regulation (unbalanced line). Consult power company.
25.	V-Belts pulled excessively tight.

ROUTINE INSPECTION AND SERVICE

GENERAL

Routine inspection and service of your compressor will assure you of maximum performance at minimum operating costs. We strongly recommend that particular attention be given to the following Inspection and Service Guide.

WEEKLY INSPECTION AND SERVICE

1. Crankcase Oil Level - At least once a week, check the oil level in the crankcase. Replenish if necessary.

2. Air Receiver - The receiver must be drained once a week to remove the condensate that will accumulate. The receiver collects all the vapor that condenses after the air has been compressed and cooled. The amount of condensation will vary with different atmospheric conditions. If draining the receiver is neglected, water will rise to a point where it passes into the service lines.

MONTHLY INSPECTION AND SERVICE

1. External Cleaning - In order to maintain maximum cooling efficiency, clean the cylinder and intercooler fins with a jet of air at least once a month.

2. Air Intake Filter - A clogged, dirty filter not only reduces the compressor capacity but also is a contributing factor is causing premature wear of working parts.

Either clean the filter pads as ofter as your experience indicates necessary, or replace them with new ones. The filtering element should be taken out frequently and cleaned with a jet of compressed air. Use a full set of pads at all times, and keep extra pads on hand for replacements.

We recommend the use of a safety solvent for cleaning; however, if gasoline or kerosene is used in cleaning the air inlet muffler and cleaner, be certain it is thoroughly dry before replacing; otherwise, an explosion may result.

3. Compressor Valve Care - In order to obtain the maximum efficiency from the compressor, the inlet and discharge valves must be tight against air leakage. Valves should be inspected regularly, and any dirt or carbon which may have formed on the valve seats should be removed. See that each finger is free from defects and that each seats properly on its plate.

4. Electric Motor Care - It is good practice to periodically blow off the motor windings with a jet of dry air to prevent accumulation of foreign matter. An occasional revarnishing of the windings will greatly prolong the life of the motor.

FIVE-HUNDRED HOUR INSPECTION & SERVICE

1. Crankcase Oil - Change crankcase oil after every 500 hours of operation, or every 3 months, whichever occurs first.

2. Tighten Bolts - Check and tighten all bolts, especially the air head and mounting bolts.

TECHNICAL DATA

The following information gives the operating data of each compressor covered by this Instruction Book.

Model	Cylinder Sizes & Stroke	Maximum Discharge Pressure (psig.)	Piston Discpacement (cfm.)
7T2	5" & 2" x 4"	500	36 at max. psig.
15T2	5-1/2" & 3" & 1-5/8" x 4"(10 hp. units)	1000	33 at max. psig. (10 hp. units)
15T2	5-1/2" & 3" & 1-5/8" x 4"(15 hp. units)	1000	44 at max. psig. (15 hp. units)
15T3	4" & 1-5/8" & 3/4" x 4" (7-1/2 hp. units)	3000	17.4 at max. psig. (7-1/2 hp. units)
15T3	4" & 1-5/8" & 3/4" x 4" (10 hp. units)	3000	23.2 at max psig. (10 hp. units)
15T3	4" & 1-5/8" & 3/4" x 4" (15 hp. units)	3000	26 at max. psig. (15 hp. units)
41	4" & 1-1/2" x 3-1/2"	1000	12.7 at max. psig.
220	2-1/2" & 3/4" x 2-3/4"	2000	6.25 at max. psig.
231	3" & 1-1/4" x 2-3/4"	500	7.4 at max. psig.
5B1	2-1/4" & 2-1/4" x 3-1/2"	250	
5B2	3" & 3" x 3-1/2"	250	