Westinghouse

Type CA Air Supply Unit

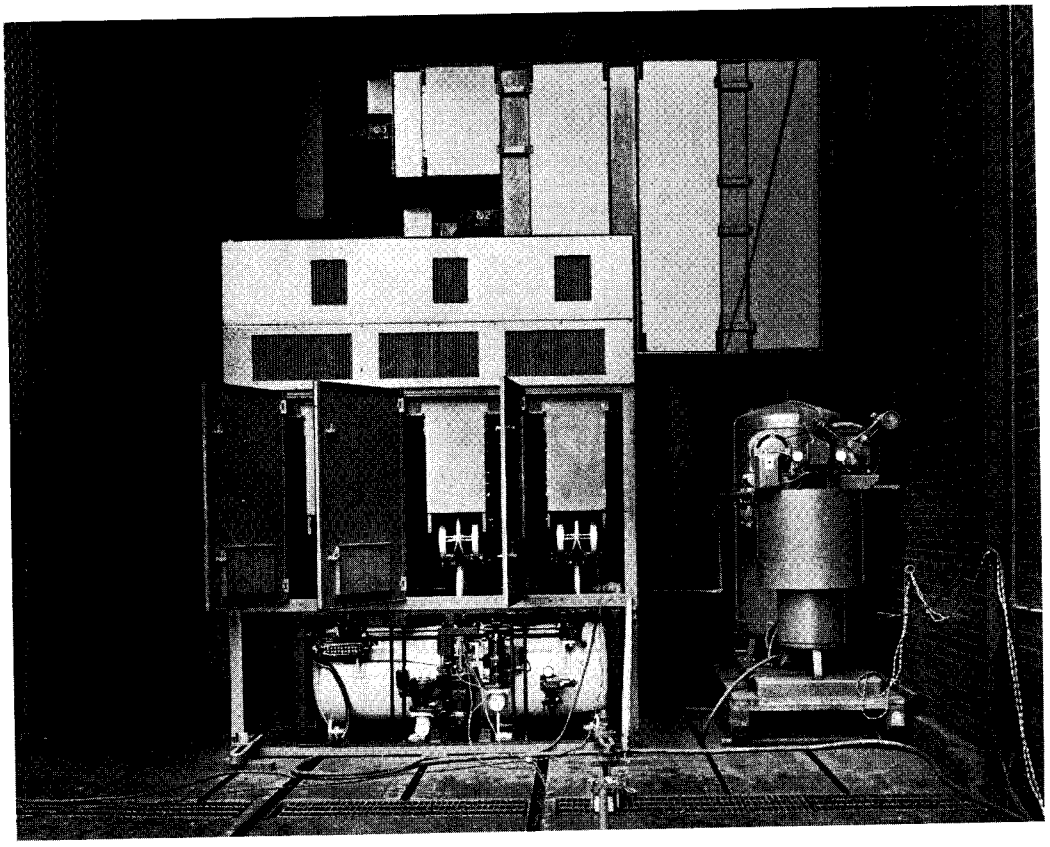
FOR

Indoor Compressed Air Circuit Breakers

INSTRUCTION BOOK

INSTALLATION

OPERATION MAINTENANCE



FRONTISPIECE. COMPRESSED AIR SUPPLY UNIT FEEDING 2,500,000-KV-A. COMPRESSED AIR BREAKER ON SHORT CIRCUIT INTERRUPTING TEST

Westinghouse Electric & Manufacturing Company

East Pittsburgh, Pa.

I. B. 33-680

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FOR

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GENERAL INFORMATION

The Type CA, indoor, compressed air supply unit is an automatic unit designed to maintain in its storage reservoirs a supply of compressed air at pressures, and in volumes, necessary for replenishment of the operating reservoirs of compressed air circuit breakers. The unit is adapted to use in indoor, powerhouse and substation, circuit breaker applications at alternating current voltages up to 33,000, in normal current ratings up to 5000 amperes, at frequencies of 25 and 60 cycles and for interrupting duties up to 2,500,000 Kv-a.

Description—The air supply unit consists essentially of a motor-driven compressor, complete with automatic control, and two storage reservoirs together with cooling coils and the necessary pipe connections, valves, pressure switches, etc., all mounted on a single bedplate ready for operation. Designed to conserve floor space, the compressor, motor and control equipment are mounted on one of the storage reservoirs, forming a compact unit readily accessible from all sides. A removable screen protects the compressor equipment and prevents accidental contact with moving parts by attendants.

The single compressor unit with one compressor mounted on the smaller of the two reservoirs as shown in Fig. 1, is normally supplied for installations of more than two breakers and for small applications where future additions are contemplated. To insure uninterrupted service, it is recommended that a spare unit be installed for use during inspection and maintenance periods or other

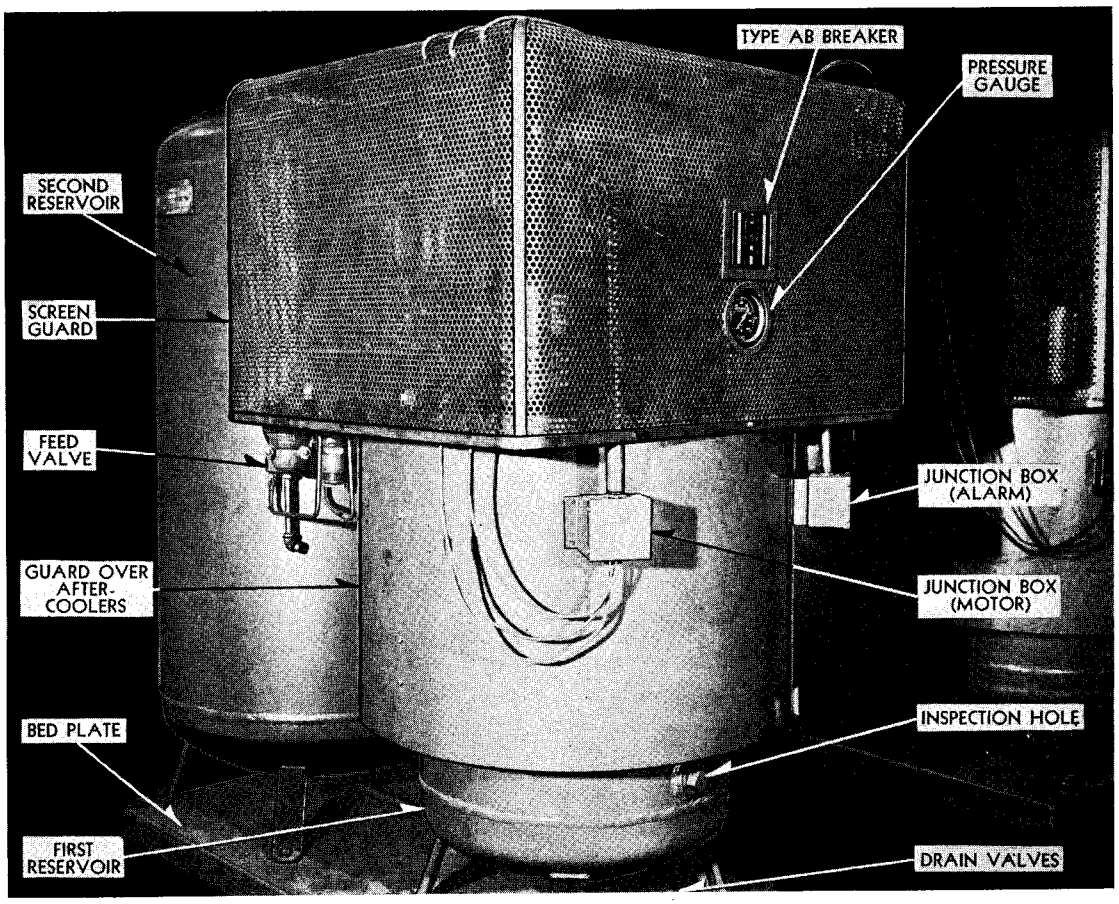


FIG. 1—COMPRESSED AIR SUPPLY UNIT WITH SINGLE COMPRESSOR

emergency. To derive the most benefit from this spare unit, the two should be located remotely from each other in order to limit interference from external sources such as a localized fire in the station.

The twin compressor unit carrying two smaller compressors as shown in Fig. 2, is normally supplied for installations of one or two breakers where there is little likelihood of future additions to the switching equipment. Storage volume is the same as for the single compressor unit but in this case the larger of the two reservoirs is arranged with its axis in a horizontal plane and both compressors are mounted on it. Operation may be by both compressors working in unison or by either one working alone, thus providing a spare compressor for use during maintenance periods.

Air Storage—The combined storage volume of the two reservoirs of either unit at atmospheric pressure is 32 cubic feet. Both reservoirs operate at a normal working pressure of 250 psi, making a total volume of approximately 540 cubic feet of free air available to replenish that used in breaker operation. Dependent on the size and rating of the breakers involved, this supply will provide for 12 to 20 opening operations without additional compressor operation.

An automatic pressure governor, normally set to cut in the compressor motor when storage pressure has dropped to 240 psi, serves to maintain the supply in the unit. For installations where two or more units are provided to feed a bank of breakers, the additional units may be set to cut in their motors at some point below 240 psi. All compressors cut out at 250 psi.

By this arrangement, all compressors are brought into service under unusual or emergency conditions while the first compressor to start provides for normal replenishment of the supply. Where it is desired that the second compressor be retained as a standby only, delivery connections may be so arranged that its reservoirs can be charged to full working pressure by the first compressor in order to obtain the extra storage for emergency use. It is recommended, however, that all compressors be allowed to run at successive settings and that the settings be alternated periodically to equalize duty on the compressors.

Compressors—Air Supply Units are equipped with Westinghouse Air Brake Company, Type "Y," two-stage compressors equipped with an intercooler between stages of compression to secure a maximum of heat dissipation before delivery. This effect is furthered by a vaned flywheel which maintains a continuous air stream over the finned cylinders while the compressor is in operation. A pressure lubricating system controlled by a piston pump driven by the crankshaft, insures adequate lubrication of the working parts without the hazard of oil passing into the delivery system.

A pressure unloader system (see Fig. 3), interlocked with the oil pump, is arranged to relieve pressure in the cylinders on stopping, and to prevent the application of load on starting until the motor has reached full speed. In event of an attempted start with low oil level, insufficient to operate the oil pump unloading system, the cylinders will remain unloaded and the compressor will not deliver full pressure. Further description of this device will be found on page 12 of this book.

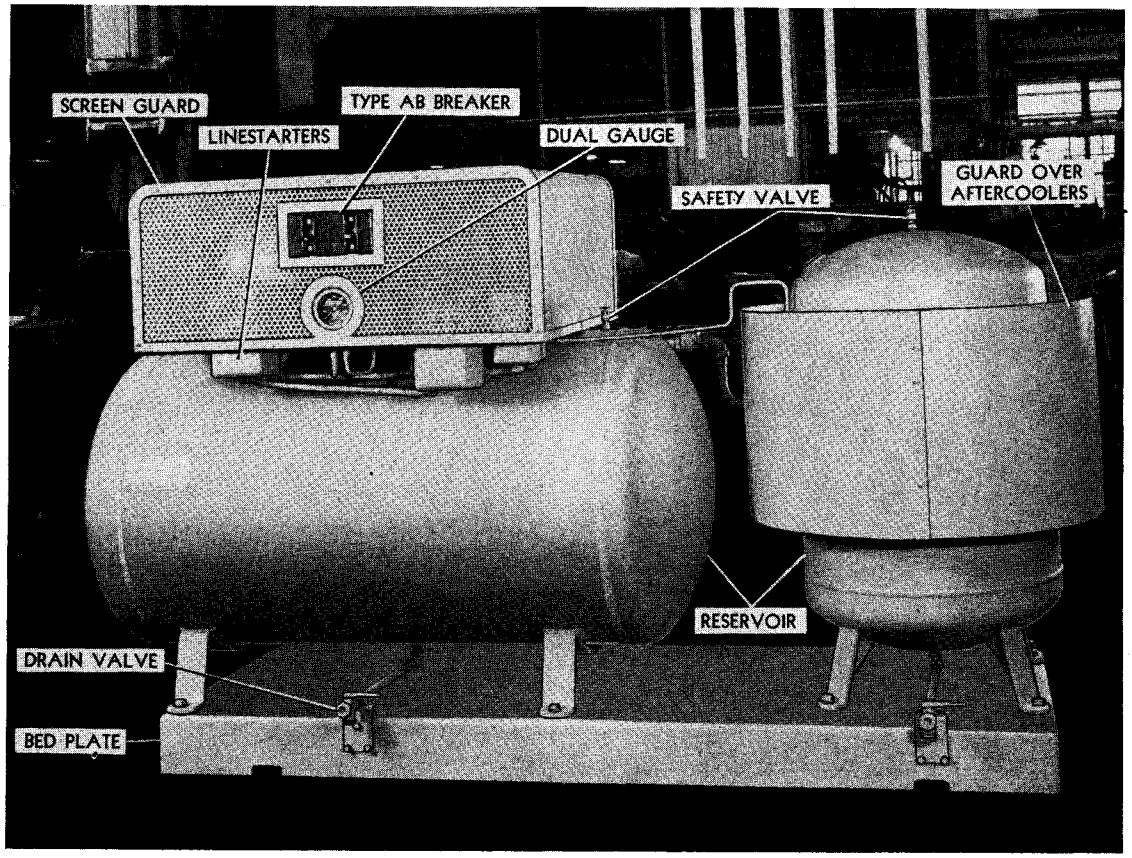


FIG. 2—COMPRESSED AIR SUPPLY UNIT WITH TWIN COMPRESSORS

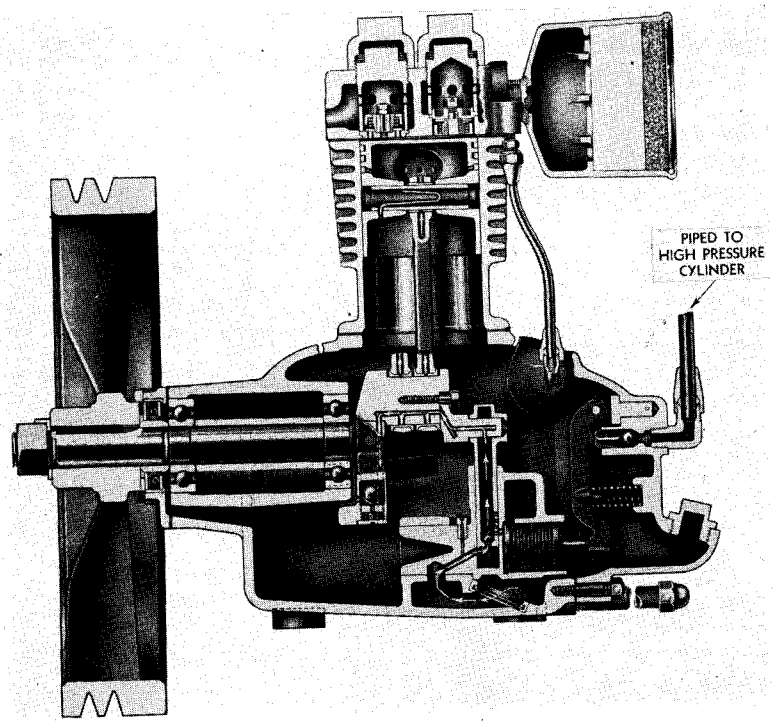


FIG. 3—TYPE "Y" AIR COMPRESSOR—SECTION THROUGH CRANKCASE AND LOW PRESSURE CYLINDER

The single compressor supply unit (Fig. 4) will normally be supplied with a Type 2YC compressor, 4 and 2⅛ x 2¾, which at 450 rpm delivers an average of 6.4 cfm of free air, charging the storage reservoirs of the unit from atmospheric to full working pressure of 250 psi in 90 minutes. For installations in which for operating reasons it may be desirable to decrease this charging time, the unit can be supplied with a Type 3YC compressor, 5 and 2½ x 3½, which at 500 rpm delivers approximately 15 cfm of free air, charging the unit to full working pressure in 38 minutes.

The twin compressor unit (Fig. 5) is supplied with two Type 1AYC compressors, 3½ and 1⅞ x 2, which at 525 rpm will deliver approximately 4.4 cfm of free air each. With both compressors running, the unit can be charged to full working pressure in 68 minutes, one compressor requiring double that time or 136 minutes. Supply units of other storage volumes and compressors with other delivery ratings may be supplied for installations where the standard units do not meet all requirements.

Motors—Compressors are driven by Westinghouse, Type CS, 220/440-volt, 3-phase, squirrel cage, induction motors equipped with sealed sleeve, ball or roller bearings and operating at 1720 to 1730 rpm. While these motors are equipped with terminals for connection to either 220 or 440-volt supply, the equipment for their control is designed for one voltage only and any change in supply voltage must be accompanied by a corresponding change in control auxiliaries. Protection against overload currents is provided by a thermal relay in the linestarter and protection against short circuit currents by a thermal cutout in the Type AB master control breaker. Motors are supplied in horsepower ratings as follows.

Compressor	Motor H.P.
Type 1 AYC	1½
Type 2YC	2
Type 3YC	5

Motor Control—A schematic arrangement of control for the motor on a single compressor supply unit is shown in Fig. 6, and for a twin compressor unit in Fig. 7. The units are completely wired and tested as shipped from the factory, with motor power leads brought to a junction box ready for connection to the a-c supply. Leads for an alarm circuit, normally d-c, to give warning of undue reduction in storage pressure, are brought to a separate junction box. All wiring is enclosed in conduit or flexible covering.

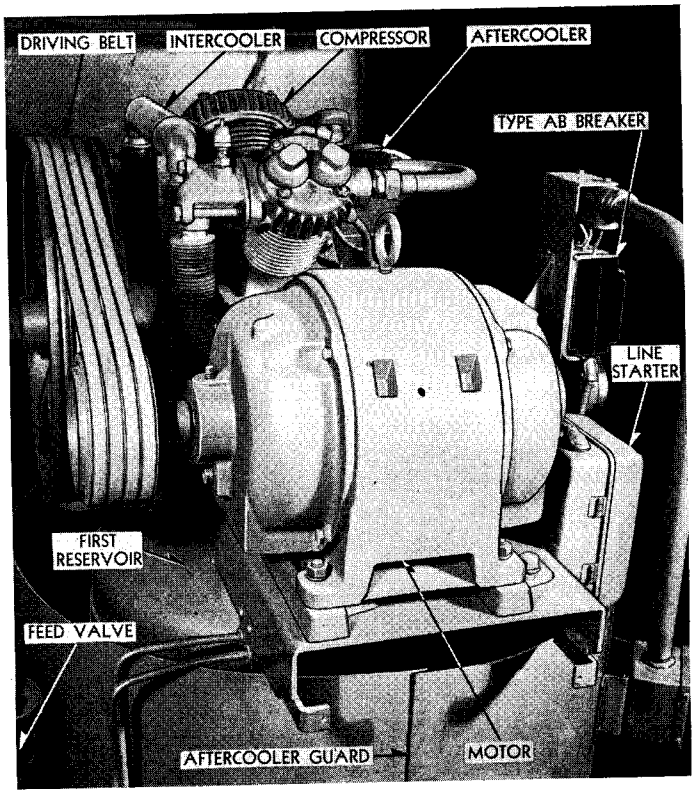


FIG. 4—SINGLE AIR COMPRESSOR FOR SUPPLY UNIT

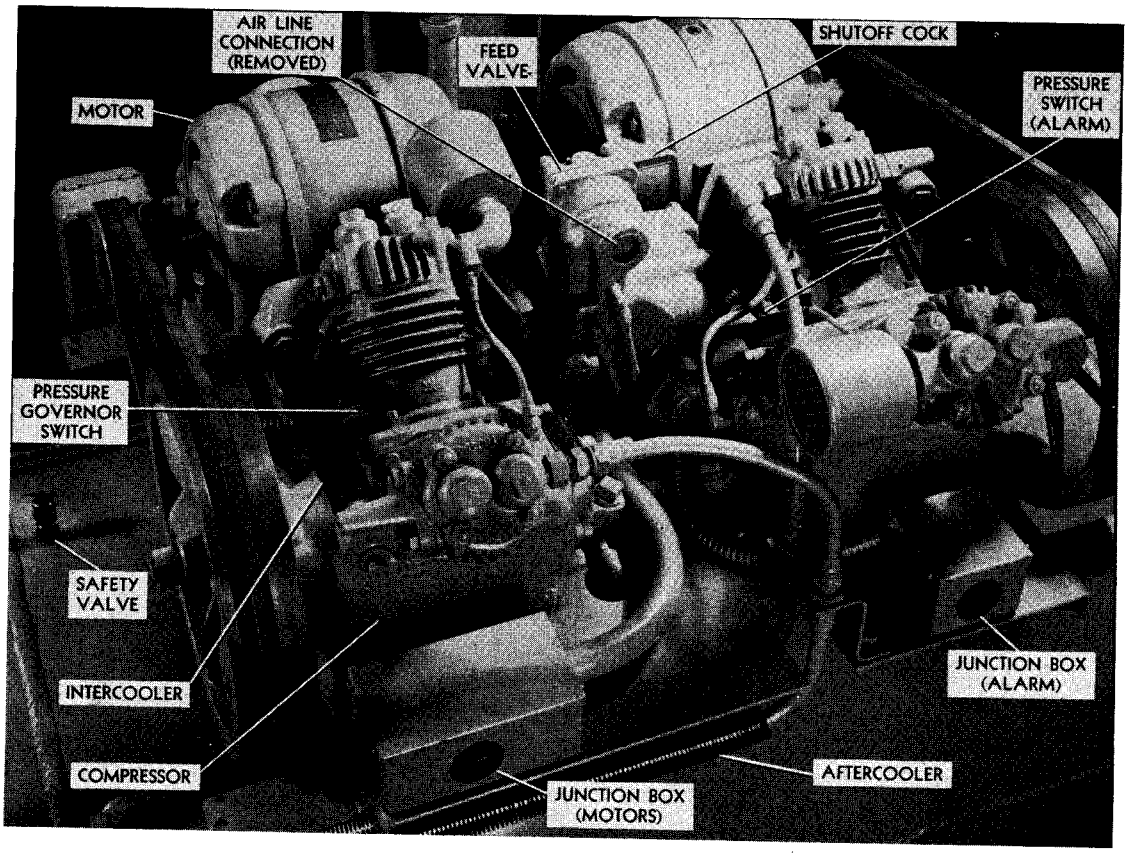


FIG. 5—TWIN AIR COMPRESSORS FOR SUPPLY UNIT

A Westinghouse, "De-ion," metal-enclosed, non-reversible linestarter is provided for across-the-line starting of motors (see Fig. 6). A Westinghouse, Type AB circuit breaker controls power supply to the motors; closing this breaker is all that is required to start the unit in operation. Thereafter, starting and stopping of the motor is controlled automatically by a pressure governor switch, actuated by reservoir pressure, as long as the AB breaker remains closed.

Belt Drive—The compressors are driven by a multiple, "V" belt drive, quiet in operation and easily replaceable. The 1½ and 2-horsepower motors are supplied with a drum carrying two belts and the 5-horsepower motor with four belts. Since trade practice permits the use of a single size of flywheel for more than one compressor rating, some air supply units may be delivered with a greater number of grooves in the flange of the flywheel than in the drum on the motor shaft. The motor drum will determine the number of belts required for any application. Motors are mounted on a slotted base, permitting adjustment for proper belt tension.

Pressure Switches—Pressure Switches supplied with the unit are Square D Company, Model 9100 switches arranged with such bellows and spring combinations as to make or break a contact at certain predetermined points over a stated pressure range stamped on the switch nameplate. These switches are readily adjusted within their specified range to meet requirements of any particular application.

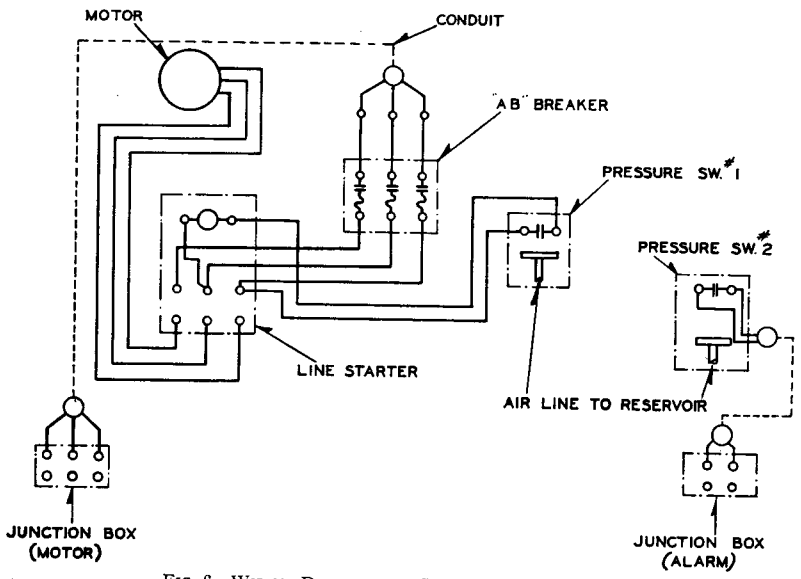


FIG. 6—WIRING DIAGRAM FOR SINGLE COMPRESSOR UNIT

The pressure governor switch is adjusted to close its contact, energizing the linestarter, when storage pressure has decreased to some predetermined point, normally 240 psi for the first unit, with remaining units picking up at some lower point in the range. All switches are adjusted to open their contacts, de-energizing the linestarter, when reservoir pressure reaches 250 psi.

A pressure alarm switch is also provided, adjusted to close its contact at some predetermined pressure, normally 200 to 210 psi, completing the circuit to an alarm, visible or audible, at any remote point, as an indication of a low pressure condition requiring investigation. The remote alarm equipment is not regularly supplied with the unit.

Protective Air Devices—Safety valves, conforming in design to the A.S.M.E. Code for Unfired Pressure Vessels, are supplied with the unit, one on the compressor between stages of compression adjusted to discharge at 60 psi, and one on each reservoir adjusted to exhaust at 260 to 265 psi. A one-way check valve at the inlet to the second reservoir permits exhausting air from the first reservoir and the cooling coils for inspection or maintenance work while maintaining the second reservoir at full working pressure.

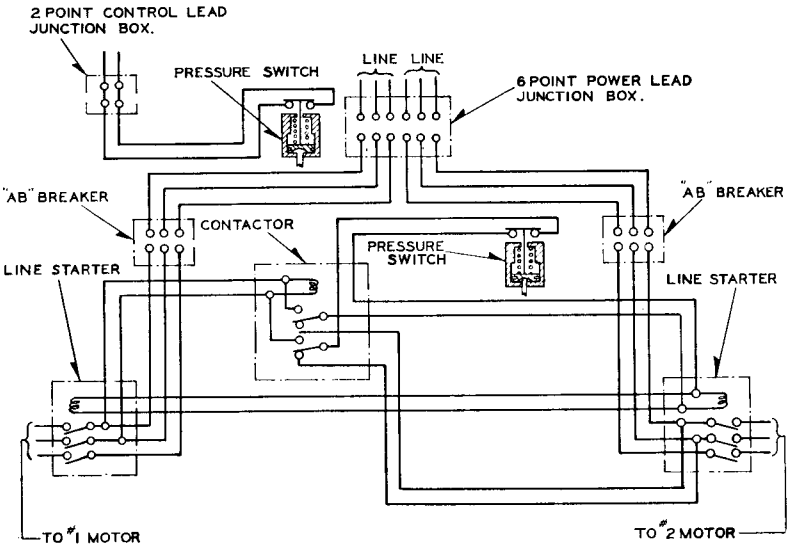


FIG. 7—WIRING DIAGRAM FOR TWIN COMPRESSOR UNIT

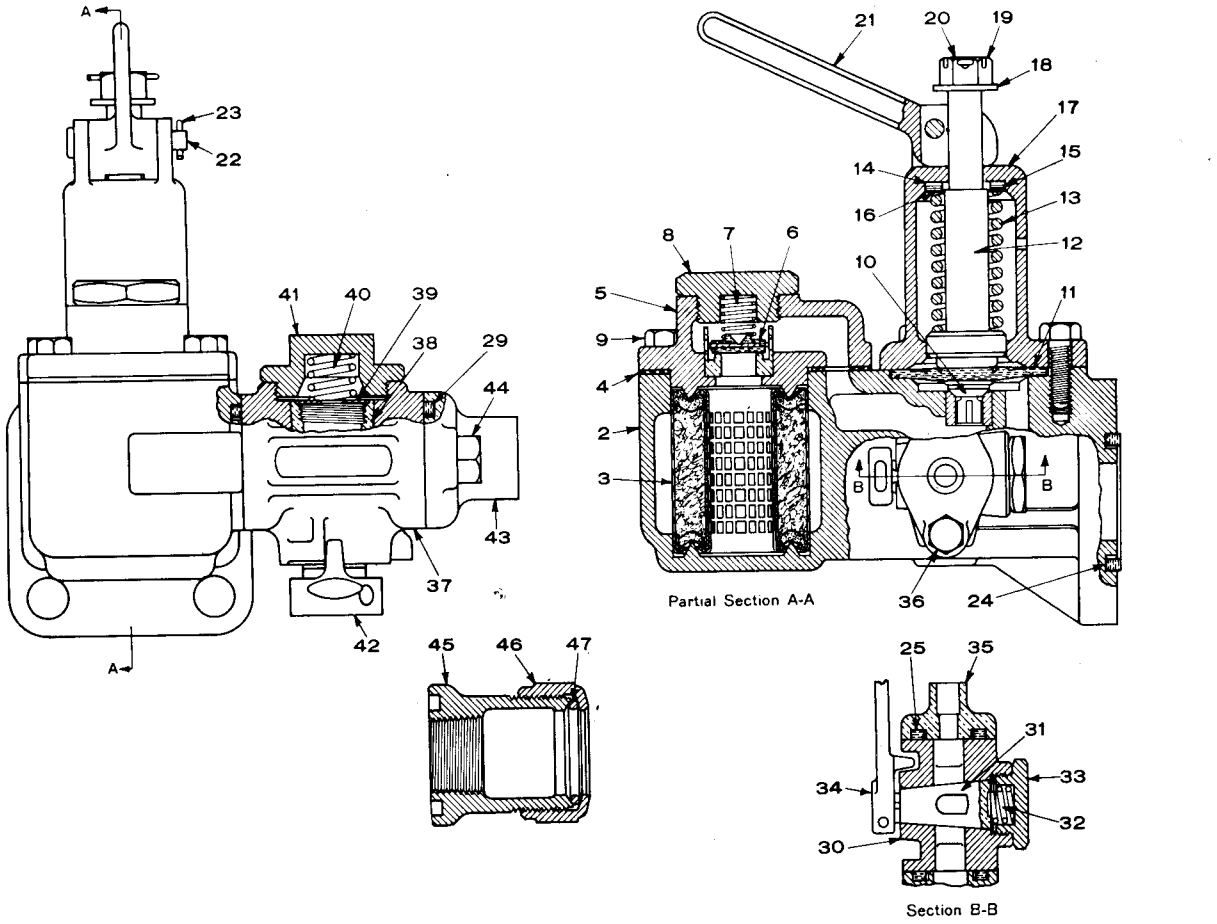


FIG. 8—PROTECTION VALVE

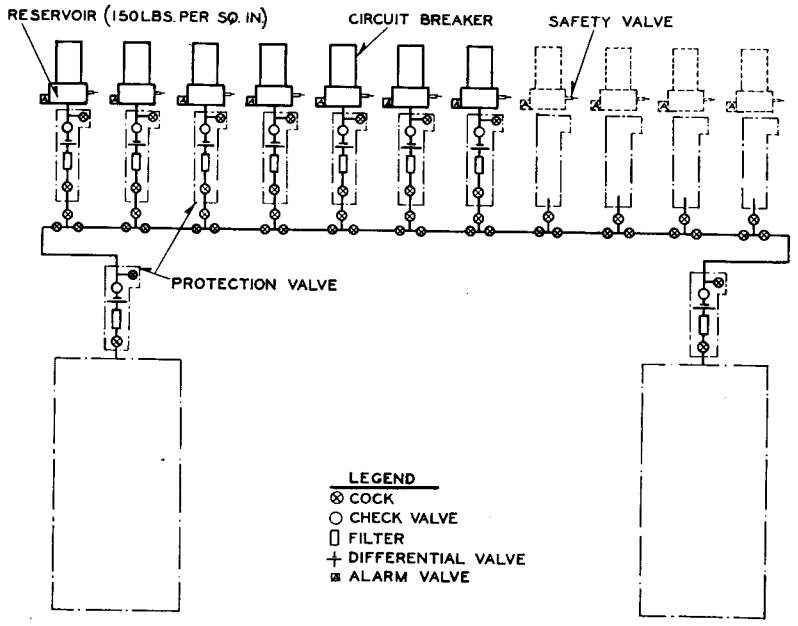


FIG. 9—TYPICAL LAYOUT FOR COMPRESSED AIR DELIVERY SYSTEM (TWO COMPRESSORS)

A stop cock at the outlet to the air delivery mains provides for segregation of the complete unit from the remainder of the system. A dual pressure gauge indicates both storage and line pressures.

For installations where two or more air supply units feed into an air delivery system, it is recommended that a protection valve (not regularly supplied with the unit) be installed in the delivery line, adjacent to each unit, to prevent complete drainage of air storage in event of an accidental break in the air line.

The protection valve (Fig. 8) as applied to air delivery lines, incorporates several functions in a single valve casing. In addition to a plug cock to isolate the unit, an exhaust valve to permit draining the delivery main, and a one-way check valve against reverse flow, the protection valve incorporates a two-way check designed to operate on a differential in pressure between its two sides and to close on a high rate of flow in either direction such as might result from breakage of the air line or other emergency.

By reference to Fig. 9, it will be obvious that without such protection a break at any point in the air line would permit air storage in both supply units to be completely drained to atmosphere. A protection valve supplied with each circuit breaker prevents the breaker reservoirs from draining and a similar valve adjacent to each supply unit will likewise prevent them from draining until the break can be isolated by closing adjoining plug cocks.

Feed Valve—The air supply unit feeds air into the delivery system through a pressure reducing valve located at the outlet of the second (larger) reservoir as shown in Fig. 1. The valve supplied is a slightly modified design of the Westinghouse Air Brake Company, Type M-3 feed valve, established through long service in railway and industrial service.

Essentially, this feed valve consists of a piston exposed to reservoir pressure on both sides but normally spring-biased to one end of its travel, closing the port to the air line as shown in Figs. 10 and 11. A spring-backed diaphragm, exposed to line pressure, is so arranged that reduction in line pressure permits this diaphragm to move in the direction of its spring pressure, opening a regulating valve which bleeds air from one side of its main piston, allowing it to move due to reservoir pressure on its opposite side and open a port to the line.

Replenishment of line pressure to its normal value returns the diaphragm against its spring, allowing the spring-backed regulating valve to close, which equalizes the pressure on both sides of the main piston and permits it to return to its spring-biased, closed-port position thus stopping air flow to the line. Screw thread adjustment of the diaphragm spring permits variation in line working pressure within a reasonable range. Further description of feed valve operation will be found on page 14.

Moisture Removal—In addition to the intercooler between stages of compression, a first aftercooler is located between the high pressure outlet of the compressor and the first (smaller) reservoir, with a second aftercooler between the reservoirs, as shown in Fig. 12.

Both aftercoolers are coiled around the smaller reservoir, protected by a metal shield. All cooling coils are of finned copper tubing and the arrangement is designed to reduce the air supply to ambient temperature at the point of passing into the air delivery mains to the circuit breaker.

Service experience with these units shows that a major portion of the moisture content of the air is condensed

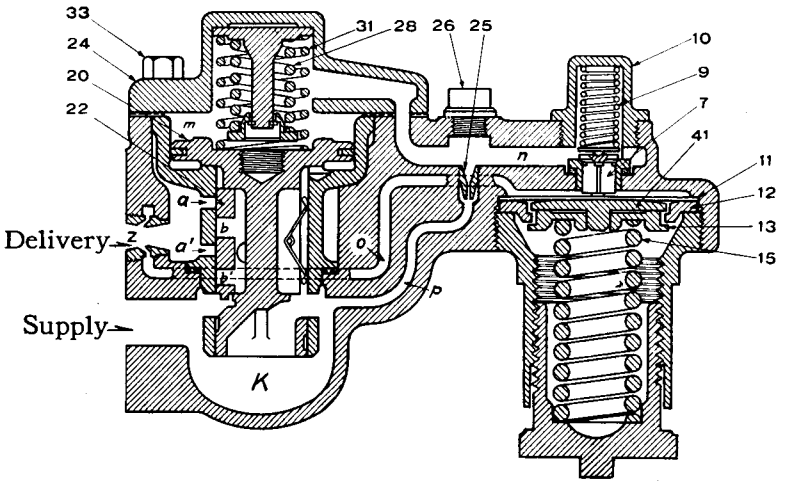


FIG. 10—TYPE M-3 FEED VALVE—DIAGRAMMATIC VIEW SHOWING CLOSED POSITION

and deposited in the first reservoir, with some further condensation in the second reservoir of the unit. Since air leaves the supply unit at substantially ambient temperature, little if any further condensation takes place after this and a supply of dry air for circuit breaker operation is assured. An air filter at the compressor intake assures also that this air will be free from dust and dirt.

Safe Operation—In the design of the air supply unit careful attention has been given to elimination of the fire hazard sometimes found present in heavy duty compressor systems. Such hazard in the past has been traced to long continuous duty on the compressor, to the point of excessive heating at the compressor outlet, coupled with the presence of oil vapor in the air stream.

Compressors supplied with these units work well within their rating and are subject to intermittent duty only. They are equipped with a forced-circulation lubricating system rather than a splash system, thus reducing the amount of oil carried to the vicinity of the compression chambers. Pistons are supplied with an oil ring in addition to the conventional sealing rings, again reducing the amount of oil or oil vapor that may pass into the compression chamber.

The cooling system of moisture removal utilized in this unit readily condenses any remote trace of oil vapor and deposits it in the first reservoir where it may be drawn off with the water collected there. All possibility of oil being carried over to the circuit breaker air system is thus removed.

Air Delivery System—Fig. 9 shows a typical schematic arrangement of the air delivery system for a battery of circuit breakers with two air supply units. Provision is made by suitably located shut-off valves, for completely isolating either supply unit for maintenance or inspection purposes while the other unit continues to feed the system.

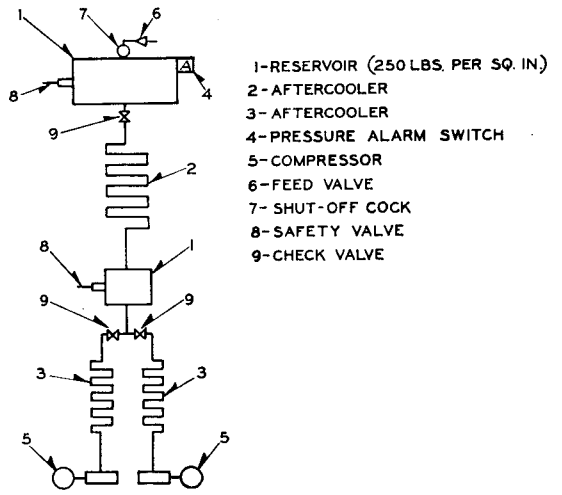


FIG. 12—SCHEMATIC ARRANGEMENT OF SUPPLY UNIT (TWO COMPRESSORS)

It is recommended that copper tubing, 1⅛" outside diameter, the equivalent of Chase, Type K tubing, be used for the delivery system and that all joints and connections be made with solder-type, brass fittings of sufficient weight to withstand a working pressure of not less than 150 psi. Brass tubing of equivalent size and weight may be substituted if desired. For larger installations, or where delivery over several floors is contemplated, larger sizes of tubing may be necessary to provide against excessive friction losses.

All soldered, sweated or brazed joints should be made in the manner specified by the manufacturers of the tubing and fittings used, in order to provide adequate, leakproof joints. All tubing should be properly supported and braced, and should be protected from injury by contact with other equipment.

At the point of connection to the supply unit or circuit breaker reservoirs, the installation should be such as to minimize mechanical stresses on the tubing or joints. At points where the tubing may be attached to or installed near other apparatus involving excessive vibration, suitable precautions should be taken to cushion the tubing from these vibrations.

Iron pipe or steel tubing may be used only with some attending hazard and where used should not be regarded as a permanent installation. Where it is absolutely necessary to use this material, the internal surfaces should be thoroughly freed from all scale and rust and given protective treatment as follows.

The cleaning process consists of pickling by immersion in a hydrochloric (muriatic) acid solution of not less than 10% and not more than 25% strength. Immersion time should be sufficient to dissolve all scale. The pipe should be washed thoroughly by immersion in running water and by spraying water through the inside. Drying must be complete, preferably with the pipe hanging vertically.. Circulation of heated air through the pipe will accelerate the drying process.

To prevent oxidation from starting again, a primer should be applied as soon as possible after drying. Apply one coat of red primer by pouring through, taking care that both primer and pipe are of

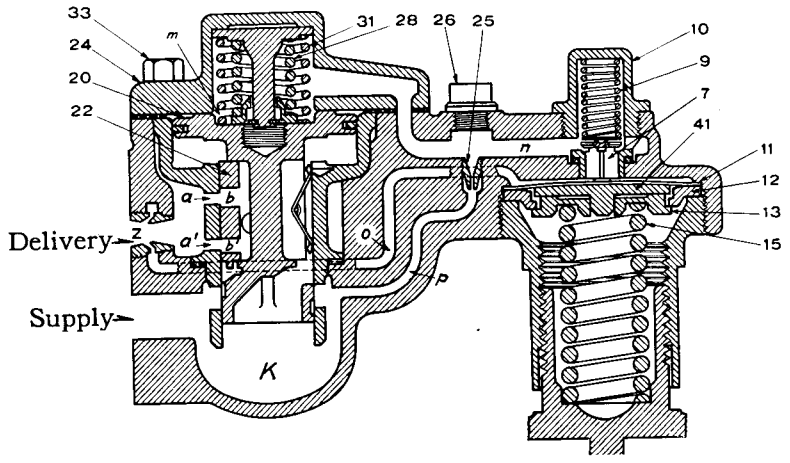


FIG. 11—TYPE M-3 FEED VALVE—DIAGRAMMATIC VIEW SHOWING OPEN POSITION

approximately the same temperature. Thinning of the primer is recommended in the ratio of one quart of turpentine to one gallon of primer. Air dry for five hours with the pipe hanging in a vertical position.

After priming, apply one coat of black bakelite enamel by pouring through. Thinning the enamel with Xylol in the ratio of one quart of Xylol to one gallon of enamel is recommended. Air dry for 24 hours with the pipe hanging in a vertical position. A moderate heat rising through the pipe will assist in hardening the enamel; avoid an open flame as some enamels are inflammable when fresh.

Brass fittings should be used with iron pipe or steel tubing where obtainable. If it becomes necessary to use cast iron or malleable fittings, they should be given the same protective treatment recommended for iron pipe. The use of commercial, iron body valves in air delivery lines is not recommended. Frequent inspections should be made of iron or steel pipe lines in service to insure that they remain free from rust.

Caution

The manufacturers of this equipment have complied in all respects with the A.S.M.E. Code for Unfired Pressure Vessels. All air reservoirs supplied with the equipment are built and tested under inspection of the National Board of Boiler Inspectors and each reservoir carries a nameplate with a serial number which is on file at National Board Headquarters. However, since the manufacturers do not make the complete installation, plans for such installations should be made with due reference to rulings of the Indemnity Company writing insurance for the particular property in question.

It should further be borne in mind that many states have codes covering such installations, these codes being by no means uniform throughout the country. In addition, many municipalities and local districts have ordinances not always conforming to the code of the state in which they are located. State and local rules governing such matters should be studied in planning compressed air installations.

INSTRUCTIONS FOR INSTALLATION

General—The compressed air supply unit is a completely assembled unit designed to provide automatically a continuous supply of compressed air for circuit breaker operation. The equipment in this unit is selected as the best available for the purpose it is to fulfill and it is tested before it leaves the factory to insure that it meets fixed standards of operation. Whether or not it continues to meet these standards depends upon the treatment accorded it after it leaves the factory. Supply units received before preparations for installation are completed, should be stored in a clean, dry location where they will not be exposed to an accumulation of dirt from building operations or moisture from exposure to outside atmosphere.

Immediately upon receipt of a supply unit, an examination should be made for any evidence of damage sustained while enroute. If injury is evident, or indication of rough handling is visible, a claim for damage should be filed at once with the carrier (Transportation Company) and the nearest Westinghouse Sales Office should be notified promptly.

Unpacking—The unit should be moved as near as possible to the point of installation before removing it from the packing case. Care should be taken in unpacking to insure that delicate parts of the mechanism are not injured. Do not open the packing case with a sledge hammer or heavy bar—use a nail puller.

Examine the apparatus carefully for breakage, distortion or anything else that may cause improper operation, and see that all packing blocks are removed from the mechanism. Remove all excelsior, dirt or other foreign matter and look over the moving parts and auxiliaries carefully to see that they are in proper operating condition.

Do not lift the unit by slings placed under projecting parts of the mechanism; to do so may distort it. Use the lifting eyes where provided for that purpose. Supply units used during the period of installation for a stepladder, platform or other purposes for which they are not intended, may not give satisfactory performance when placed in service—some of the adjustments are delicate.

Installation—In a cold climate it is recommended that the air supply unit be installed in a heated building. If necessary to locate it in a building where heat is not provided, more efficient service will be obtained if an adequate enclosure is provided with space heaters for use under extreme temperature conditions. Adequate circuit protection from compressed air circuit breakers may not be obtained if oil in the compressor is so cold as to hinder its operation.

The unit is shipped from the factory on a single bedplate which may be bolted to any substantial floor without necessity for a special foundation. It is so arranged that controls are all brought out to one side of the unit but for convenience in operation and maintenance, it should be accessible from at least three sides. A location free from smoke, moisture, corrosive gases and dust, with a reasonably good source of light, is desirable.

Caution

These units are subject to periodic inspection by representatives of Indemnity Companies, and in some localities by State or local bureaus. Some states require at least 12″ clear on all sides of the reservoirs for inspection purposes.

Wiring—The unit is completely wired when shipped from the factory, motor power leads being brought out to a junction box for connection to the power circuit (see Fig. 13). Supply leads connected at this box should be adequate for the size of the motor, and the phase relationship of the connections should be such that the compressor flywheel rotates in a counter clockwise direction (facing the flywheel) as indicated by the arrow cast on the wheel.

Unless specified otherwise, the motor as shipped will be connected for service at 220 volts, 60 cycles. These motors will operate satisfactorily with a voltage variation within 10% and frequency within 5% of their nameplate ratings, or with a combined voltage and frequency variation of 10%, but not necessarily within the standards of performance established for operation at their normal rating.

Additional terminals on the motor permit connection for 440-volt service but before making any change to a supply source of voltage other than that specified on the master nameplate of the unit, the rating of the linestarter and of the Type AB breaker should be checked to insure that they are adequate.

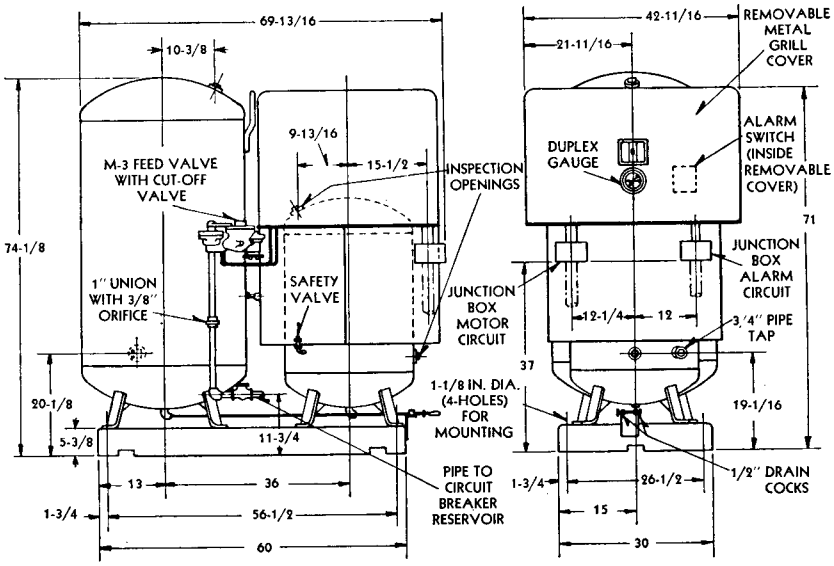


FIG. 13—OUTLINE OF SUPPLY UNIT (SINGLE COMPRESSOR)

A separate junction box (see Fig. 13) is provided for leads from a pressure switch which serves to energize an alarm (not supplied with the unit) at any remote point desired, by closing its contacts when storage pressure has been reduced to 200 psi or slightly over. The pressure alarm switch is supplied for a maximum of 3 amperes at 125 volts, d-c, or 1.5 amperes at 250 volts, d-c. No other wiring is necessary except that other conditions in the station may make it desirable to ground the unit.

Air Connections—The air delivery line (not regularly supplied with the equipment) should be connected to the unit at the outlet of the feed valve located at the side of the larger storage reservoir as shown in Fig. 1. Recommendations for installation of these lines are given on page 7 of this book.

Trial Operation—Before starting the compressor, check the motor bearings for lubrication. Sleeve bearing motors may have their oil removed before shipment. See that the overflow cups are filled with a good grade of dynamo or machine oil until the level rises nearly to the top of the cup. Ball bearing motors are lubricated before leaving the factory. However, if the motors have been standing for some time in a high ambient temperature, the grease cups should be checked, if necessary, adding a small quantity of neutral, medium consistency grease free from grit.

Fill the crankcase of the compressor up to the tapped portion of the filler hole with a good grade of automobile engine oil. If installed in a heated building, use a light grade of oil (S.A.E. 10 or 20). If the unit is located in a high ambient temperature (100 degrees Fahrenheit or above, as in the vicinity of steam apparatus), S.A.E. 30 or 40 is recommended. Where the unit must be subjected to temperatures below freezing, S.A.E. 10-W oil should be used. Check the oil level again after trial operation.

Rotate the compressor flywheel by hand to see that it is free and in operating condition. Check the tension of the driving belts and see that they are not loose enough to slip on the pulley, or tight enough to overload the bearings. Remove tools and rags or other foreign matter from the vicinity of the compressor before starting.

Check to see that the proper voltage is being applied to the motor and that the phase relationship of the motor connections is such as to cause rotation of the flywheel in the direction of the arrow cast on the wheel (counter clockwise when facing the wheel).

Operation of the unit is started by closing the Type AB master control breaker. This breaker carries a thermal cutout as protection against short circuit on the control system. After an automatic opening, this breaker is reset by moving its handle to the **extreme** open position, then closing it. In event of failure to secure control voltage at the unit, check by this resetting operation to see if there has been an automatic opening. Also check the thermal relay heaters on the linestarter, using the hand reset button.

It is recommended that the air delivery line be shut off, using the stop cock in the feed valve casing, when charging the unit from atmospheric to full working pressure; then fill the system and breaker reservoirs from a full storage head. Watch the compressor to see that it is operating satisfactorily. Note the pressure gauge to see that pressure builds up steadily. See that the motor cuts off automatically when full storage pressure of 250 psi is reached.

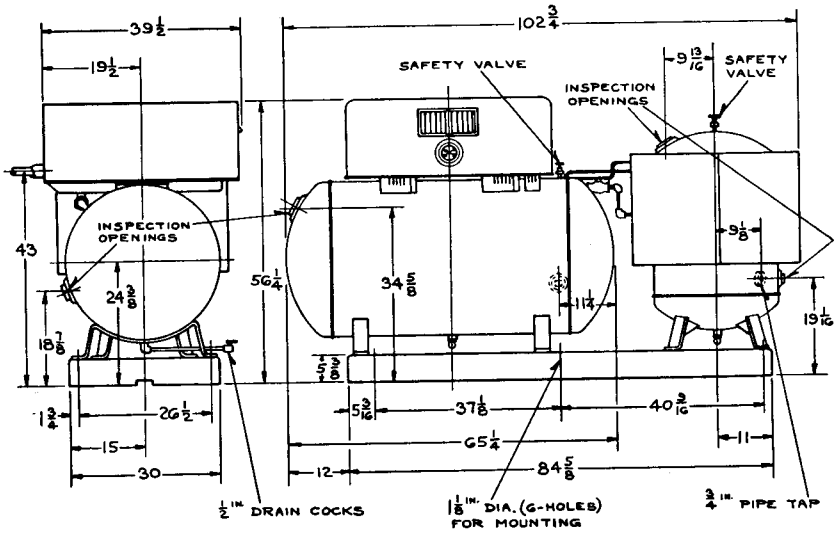


FIG. 14—OUTLINE OF SUPPLY UNIT (TWIN COMPRESSORS)

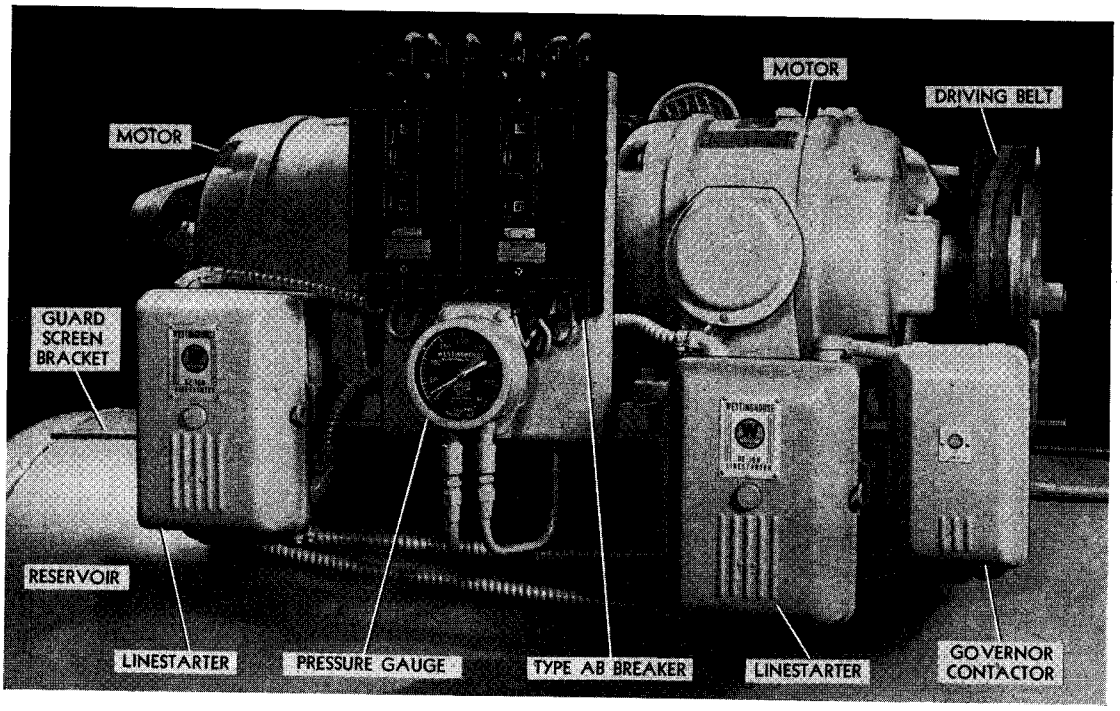


FIG. 15—CONTROL EQUIPMENT FOR TWIN COMPRESSORS

After the compressor has stopped, exhaust the air slowly through the drain valve on the larger reservoir and note the gauge reading at which the motor cuts in again. The compressor should start running when storage pressure has dropped to 240 psi. For installations in which two units are supplied, the second unit may pick up at some lower pressure. Both compressors should stop at 250 psi.

The pressure alarm switch may be checked by opening the Type AB breaker, cutting the supply to the motor, and exhausting air slowly through the drain valve on the larger reservoir until the switch contacts close. This should occur at 200 psi or slightly above. Instructions for adjusting the pressure switches, if it should become necessary, will be found on page 13 of this book.

When the supply unit has been completely checked, the air delivery lines should be inspected for leaks. If the delivery system is a large one with isolating valves conveniently located, it is desirable to examine the line in sections, adding another section as each one is checked. Even slight leaks in the line may result in appreciable running time for the compressor and each joint of the line should be inspected carefully, using soapy water to detect leaks.

An absolutely tight line may not be obtainable for the working pressures involved here but, while a practicable limit is difficult to establish due to the wide variety of conditions encountered, experience indicates that the average compressor running time need not exceed three minutes per hour for each two compressed air breakers fed from a single unit, when tested over a period of 15 to 20 hours.

For delivery systems in which a protection valve is installed adjacent to the air supply unit, it will be necessary to reset this valve by hand when admitting air to an empty line. Move the pivoted reset handle (Item 21 in Fig. 8) toward the valve casing and hold it in that position until line pressure has reached 90 to 100 psi. The valve will pass air into the line automatically for all pressures above this point.

Observe the line pressure gauge on the supply unit to see that normal working pressure is maintained in the delivery line. Should it be necessary to adjust the setting of the feed valve to secure this result, instructions will be found on page 14 of this book. Always open the plug cock in the feed valve to the air delivery line when checking the feed valve setting.

INSTRUCTIONS FOR OPERATION AND MAINTENANCE

General—The compressed air supply unit when shipped from the factory has been completely tested and adjusted to maintain automatically a continuous supply of air for operation of compressed air circuit breakers. How long it will continue to perform its function satisfactorily depends to a considerable extent on the care and maintenance given it in service. Due to the wide range of conditions under which these units may operate, it is impracticable to lay down a definite schedule for maintenance work to meet requirements of all applications.

Recommendations made here for such work are intended to apply in the case of average duty encountered in powerhouse switching service but it is anticipated that maintenance personnel in carrying out these recommendations will eventually evolve a maintenance schedule, definite as to periodicity, suited to the equipment in their care. As in the case of any new apparatus involving reciprocating equipment, it is desirable that, when first placed in service, the supply unit be given daily inspections for

several days to insure that it is working properly.

Information on adjustments is given here as a guide for general maintenance and to facilitate reassembly of parts in case they have been removed for any reason or require replacement at any time. It should not be necessary to change the adjustments unless they have been disturbed by disassembly, or unless it is obvious that the equipment is not functioning properly.

Compressors—Working parts of the Type "Y" air compressor are shown clearly in Figs. 3 and 16. This two-stage, V-type compressor is made up of separately cast crankcase, cylinders and cylinder heads, making possible ready access to internal parts. A counter-balanced crankshaft rotates in two sets of ball bearings, spaced well apart by a spacer tube, with the flywheel keyed to the outboard end of the shaft. Both connecting rods are operated by a single crank pin through adjustable split-type bearings.

Each piston is fitted with two compression rings and one oil ring. The cylinder heads have two valves each, accessible upon removal of a cap nut and cage. Both cylinders carry circular fins, cast integrally to provide maximum radiation, and the six-blade fan flywheel maintains a constant stream of cooling air through these fins. Operation of the compressor is as follows.

Referring to Fig. 3, on the down stroke of the low compression piston (larger cylinder), a partial vacuum is formed above the piston. The differential in pressure thus formed permits atmospheric pressure outside the intake in the cylinder head to overcome the force of the valve spring, opening the valve. Air then flows through the intake filter and through the open intake into the cylinder until pressure on both sides of the intake valve is substantially equal and the intake valve is closed by its spring.

On the upward stroke of the low compression piston, air in the cylinder is compressed, holding the intake valve tightly closed and opening the discharge valve against the force of its spring. Air under pressure from the rising piston, flows out of the discharge valve and through the finned intercooler to the manifold of the high compression cylinder. As the piston reaches the end of its upward stroke, forcing all the air out of the cylinder, pressure on the two sides of the discharge valve becomes substantially equal and the valve closes ready for the next intake stroke.

While the low compression piston is moving upward on its compressing stroke, the high compression cylinder is moving downward on its intake stroke, receiving air at an intermediate pressure from the low compression cylinder and compressing it to final storage pressure by the same cycle of operations previously described. Any accumulation of pressure in the crankcase, due to possible slippage past the piston rings, is vented to the intake side of the low compression cylinder.

The valve caps on the cylinder heads should be removed periodically and the inlet and discharge valves, with their seats, thoroughly cleaned. Do not use a file or emery cloth on the valves or valve seats. If there is evidence of improper seating, the condition may be remedied by coating the seat with a mixture of fine grinding compound and light oil, then rotating the valve evenly on its seat. Clean both valve and seat thoroughly after grinding. Valve seats which have been deeply scored or otherwise distorted, may not answer to this treatment.

It should not be necessary to remove the piston rings unless it is evident that they have accumulated sufficient dirt or other foreign matter to hinder them from expanding properly, or that they have become worn to the point of permitting excessive leakage past them. In any replacement of piston rings, it is recommended that a complete new set be installed. Leave a clearance of .010 to .020 of an inch at the joint of the ring when expanded against the cylinder wall. Stagger the joints 180 degrees.

The compressor is designed to provide maximum dissipation of the heat generated by its operation. A coating of grease and dirt on its radiating surfaces hinders this dissipation of heat and impairs the efficiency of the unit. Keep the external surfaces of the compressor clean.

Compressor Lubrication — The compressor is equipped with a piston-type oil pump, hinged in a bearing almost completely submerged in the crankcase oil and driven directly from the crankshaft. This single oil pump, operating in conjunction with ball checks and the centrifugal action of its drive, provides pressure lubrication controlled in accordance with compressor speed. Lubrication is positive since the oil pump comes into action simultaneously with starting of the compressor and remains in action as long as the compressor is running.

Referring to Fig. 3, oil enters the pump through a strainer in the pump bearing and, on the down stroke of the pump plunger, is forced past the ball check, up to the crankpin bearings, and up through the drilled piston rods to the

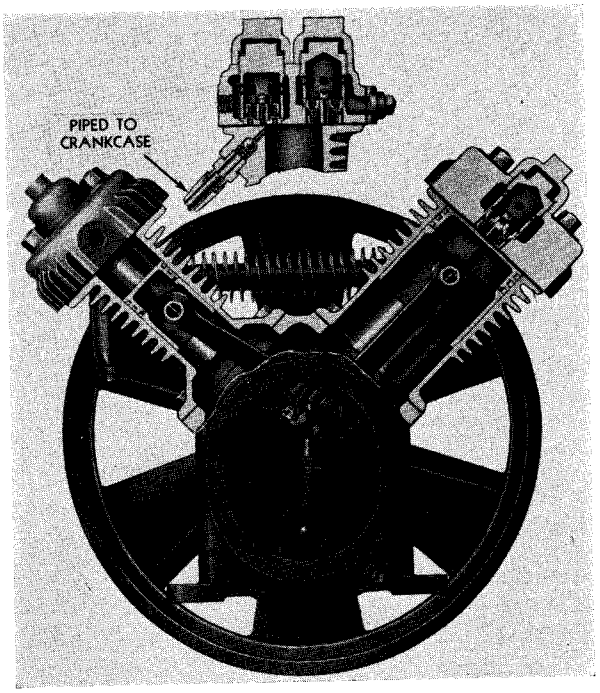


FIG. 16—TYPE "Y" AIR COMPRESSOR—END VIEW AND HIGH PRESSURE CYLINDER HEAD SECTION

wristpin bearings. An extension of the oil passage through the crankshaft counterweight admits oil to a chamber beneath a ball check near the main crankshaft bearings.

When the compressor is running, the ball check in the main bearing is held to its seat by centrifugal force and, as this force varies with compressor speed, oil line pressure varies accordingly. When oil line pressure exceeds the centrifugal force for any speed, it unseats the check valve, allowing oil to pass out to the crankcase through a restricted opening in the counterweight. The higher the compressor speed, the greater the velocity and quantity of oil thrown into the crankcase, thus forming a secondary splash feed for working parts not reached by the pressure lubricating system. A trough located in the wall of the crankcase is arranged to catch a supply of this splashed oil for lubrication of the two main bearings.

The oil level should be checked weekly. This is done by removing the filler plug and observing the oil level through its opening. If necessary, add sufficient oil to bring the level up to the bottom of the tapped opening and replace the plug. Never remove the oil plug while the compressor is running. Instructions for inspection of the pressure lubricating system will be found under the heading "Starting Unloader" below.

At least once every six months a sample of oil should be drained from the crankcase and the condition of this sample should govern the necessity for complete draining of the crankcase and refilling. Oil in these compressors is not subject to the same deteriorating effects as that in an automobile engine and it should not carbonize excessively if a good grade is used. A change of oil every 500 hours of running time is good practice. Recommendations for the grade of oil to be used will be found under "Instructions for Installation" on page 8.

Starting Unloader—The Type "Y" compressors are equipped with an unloading feature, interlocked with the oil supply, to insure that full compression load is not applied to the motor until it has reached full speed after starting Referring to Figs. 3 and 16, there is a tube connection from the high compression cylinder to the crankcase with a ball unloading valve at the entrance to the crankcase, and an unloader lever and piston in the crankcase.

When the compressor is operating, oil pressure moves the oil pump unloading piston which in turn rotates the unloader lever about its fulcrum to a position that seats the ball unloading valve, sealing off the connection to the high compression cylinder. When the compressor stops, oil pressure drops, the unloader spring returns the unloader lever to a position which permits the unloader valve to unseat and air from the high compression cylinder escapes into the crankcase. Pressure from the low compression cylinder will then force its way into the high compression cylinder and escape in the same way. At the next start, the cylinders remain unloaded until oil pressure is raised to the point of operating the unloader piston, thus enabling the motor to reach full speed before the compressor load is imposed.

In event of there not being sufficient oil supply to operate the oil pump unloading piston against the force exerted by the unloader spring, the unloader valve will not be seated when the compressor starts. Thus if the oil level is low, the cylinders remain unloaded and the compressor will not deliver full pressure. If the compressor fails to deliver its load, the oil level in the crankcase should be checked at once. Unusually high temperature of the unloader tube connection is one indication of lubrication trouble.

If the unloading system still fails to function properly, drain the oil from the crankcase, disconnect the tubing from the unloader valve and remove the end cover from the crankcase. Examine the ball check in the unloader valve on the inside of the end cover for indications of improper seating due to dirt or other foreign material, thus allowing air from the high compression cylinder to escape through the crankcase. See that the unloader lever and spring on the inside of the end cover are working freely.

With the end cover removed, the oil pump may be pulled out of its bearing and inspected. Remove the strainer under the pump by releasing its snap ring, and clean out any sludge or dirt that may have collected in the pump chamber below it. Examine the ball check in the pump plunger and clean it if necessary to make it seat properly. Just behind the plunger chamber of the pump is a pneumatic cushion port whose function is to admit air to the oil piston chamber at the top of the piston stroke, in order to cushion the succeeding pressure stroke. See that this port is operating freely.

While the pump is removed, the relief ball check in the crankshaft counterweight should be inspected since leakage past the ball check will result in reduced oil pressure. Remove the valve cap on the underside of the counterweight and see that the ball is engaging its seat properly, cleaning both ball and seat if necessary. See that the ports in the valve cap and the opening in the counterweight are clear.

Motors—Motors should be inspected at regular intervals, noting in particular that mounting bolts, bracket bolts and pulleys are tight, and that the bearings are properly lubricated. Increase in operating temperature, localized heating or excessive noise, indicate approaching failure and should be investigated at once. An inspection of this nature at the regular periods for lubrication should be sufficient.

For installations where motors are supplied from feeders on which phase relationship may be changed due to operations at some other point, a check should be made at each inspection to insure that the compressor flywheel is rotating in the proper direction.

It is desirable to overhaul and clean the motor thoroughly at intervals of one to two years, particularly if they are operating in an atmosphere bearing dust or dirt. Revarnishing the windings when the motors are overhauled will lengthen their life. Suitable varnish (baking varnish is recommended) may be obtained from the nearest Westinghouse Sales Office, and Westinghouse Service Shops are equipped to bake motors.

For removing tight pulleys, a pinion puller should be used. If it is necessary to drive the pulley into position when reassembling ball bearing motors, it is important that the end of the shaft opposite the extension be backed up so that the force of the blow is not taken in the bearing.

Caution

The air supply unit is automatic in operation. Do not place the hand on the belt or other moving parts; it may start at any time. Always open the Type AB master control breaker before making any inspection.

Motor Lubrication—The overflow cups on sleeve bearing motors should be filled with a good grade of dynamo or machine oil until the level rises nearly to the top of the cup. In ordinary service, this supply should not require replenishing

oftener than once in six months. When any motor is given a general overhauling, the bearing chambers should be cleaned with kerosene or gasoline to remove any dirt or sediment that may have collected.

Standard ball bearing motors are properly lubricated with grease when leaving the factory and in ordinary service will run for a year as received. It is recommended, however, that a small quantity of neutral, medium consistency grease be added every six months to insure an even lubricating condition. The grease must be free from grit and must not separate into soap and oil when left standing, or when subjected to the temperatures which occur in the bearing. Soda base soap greases are preferable on account of their higher melting point.

When overhauling a ball bearing motor, the bearings and enclosures should be washed with carbon tetrachloride or a similar solvent to remove the residue of soap which is left from the grease. Then fill with fresh grease.

Belts—Belt tension should be checked on periodic inspections and adjusted if necessary. The belts should not be loose enough to slip on the pulley nor tight enough to overload the bearings. Note also any evidence of undue wear or abuse of the belts. For belt renewals, it is recommended that all the belts in a multiple "V" belt drive be renewed at one time.

Replacement of belts is accomplished by loosening the holding bolts and sliding the motor on its slotted base until the belts can be slipped into position without stretching. With one belt in position, a pull of 60 pounds on the motor will give satisfactory tension when the motor is sliding freely on its base. Then scribe the base, release the motor and assemble the remaining belts, finally returning the motor to the scribed position. Be sure that the motor is firmly bolted down after any adjustment.

New belts will stretch slightly during the early period of service. When first placing a new unit in service, or after any renewal of belts, it is desirable to make one or two inspections at 30-day intervals, readjusting the belt tension as required.

Pressure Governor—The cut-in and cut-out points of compressor operation are controlled by a pressure switch actuated by storage reservoir pressure (see Fig. 17). As shown in Fig. 18, this switch is arranged with such bellows and spring combinations as to make or break a contact at certain predetermined points over a stated pressure range which is stamped on its nameplate.

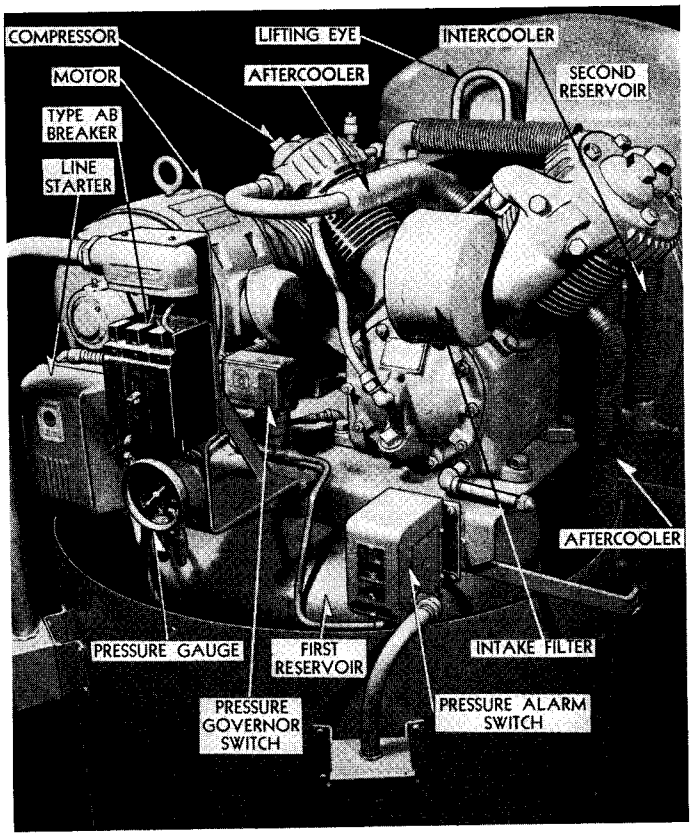


FIG. 17—CONTROL EQUIPMENT FOR SINGLE COMPRESSOR

In addition to the combination of bellows and spring, the pressure switch contacts are under the influence of a magnet which biases them to one position. As bellows pressure varies, it reaches a point at which the pull of the magnet is overcome and the switch contact, relieved of this pull, snaps to the opposite position. In returning, the contact must be moved by bellows pressure to the point where it can be pulled into its first position by the magnet. It is thus inherent in the design of the switch that more bellows pressure is required to move its contact in one direction than in the opposite direction, resulting in what is known as a differential, the value of which is also stamped on its nameplate. The actual value of the cut-in and cut-out points for any given installation may not appear on the name plate.

Adjustment of the switch is accomplished by raising or lowering the range, that is, the cut-in and cut-out points, the differential remaining the same. With a screwdriver, turn the right hand (facing the cover) screw on top of the case clockwise to raise the cut-in and cut-out points, and counterclockwise to lower them. The indicator pin protruding from the slot in the cover indicates limits between which adjustments may be made, the bottom of the slot being the highest range. Any change in adjustment of this switch should be checked by exhausting air slowly from the storage reservoirs, noting the gauge readings at which the motor picks up and cuts off.

The differential of this switch may be adjusted within certain limits. This adjustment is controlled by the left hand screw on top of the case, the maximum and minimum points being indicated by the scale attached to the case. Changing the differential adjustment varies only the cut-out point while the cut-in point remains fixed. Any change in adjustment of differential should be checked by building up storage pressure, noting the gauge reading at which the motor cuts off.

Switches of this type are designed as direct and reverse action switches. In a direct action switch, the contacts close at low pressure and open at high pressure. In a reverse action switch, the contacts close at high pressure and open at low

pressure. For any change from direct to

Feed Valve—The reducing feed valve

As pressure in the delivery line de-

Westinghouse Type CA Air Supply Unit for Indoor Compressed Air Circuit Breakers

Safety valves on the storage reservoirs are set to exhaust at 260 to 265 psi; on the compressor manifold at approximately 60 psi. Valves supplied with these reservoirs reset with a differential of 10% or slightly over, that is, a valve which exhausts at 260 psi will not reclose again until pressure has been reduced to from 230 to 235 psi.

Any tendency of these valves to leak is generally traceable to dirt or other foreign matter lodged on the valve seat. Raise the stem with a sharp pull and release quickly, repeating the operation several times if necessary to blow the dirt out. Do not rotate the valve on its seat; to do so with dirt present may score the seat beyond repair. Exhaust the air from the reservoir, remove the valve and clean the seat if necessary. Safety valves should be checked periodically to insure that they have not become clogged or otherwise rendered ineffective.

Protection Valve. The protection valve as shown in Fig. 18, is supplied with a solder-type inlet fitting (43) for 1⅛ inch O.D. (1 inch nominal) tubing unless otherwise specified. The outlet (at seal 24) provides for a flanged connection. A plug cock, shown at (38), controls the air inlet and a second cock (31) exhausts air from the outlet side of the valve.

Under conditions of pressure below 90 to 100 psi on the outlet side of the valve, the reset handle (21) must be used to compress spring (13), allowing diaphragm (11) and valve (10) to be raised by inlet pressure and pass air to the line. Above this point the inlet and outlet pressures combined are sufficient to raise the diaphragm and allow inlet air to feed through automatically.

For inspection purposes the diaphragm (11) may be examined by removal of the cap (17). Unscrewing the cap (8) will permit inspection of the check valve (6) and on removal of the cover (5) the filter element may be lifted out. This filter element should be given the same care as recommended for the compressor intake filter (page 15).

Inspection—The frequency of inspection of the various elements of the air supply unit described here will depend on the activity and duty to which the unit is subjected and upon such other factors as freedom of the surrounding atmosphere from dust, smoke, corrosive gases, etc.

It is recommended that the following such time as sufficient service experience has accumulated to warrant formulating a final program for any given installation. Details of the various features requiring inspection will be found under the paragraph headings describing the equipment in this section of the Instruction Book.

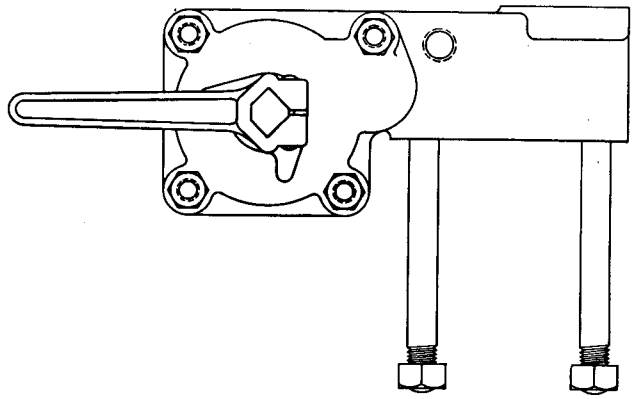
(1) Every 7 days:
- Drain water from the storage reservoirs.
- Check the oil level in the compressor crankcase.

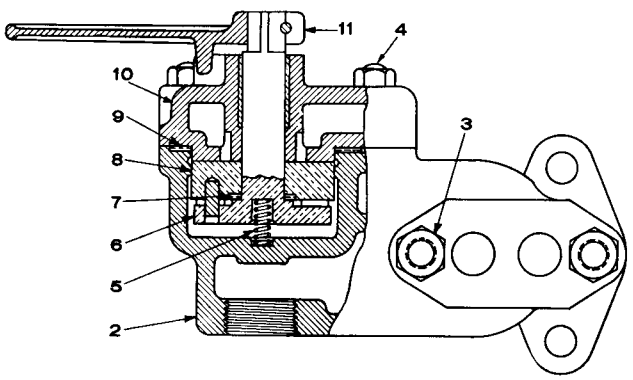
(2) Every 30 days:
- Remove the compressor intake filter element and clean it with a low pressure air jet. Observe the general performance of the unit for evidence of improper operation, excessive noise, looseness in assembly or leakage of oil or air.

(3) Every 90 days:
- Remove the cap nuts and cover on the feed valve and clean the valve if necessary.

(4) Every 6 months:
- Check the motor lubrication.
- Check the crankcase oil by taking a sample.
- Check the belt tension.
- Check bolts, nuts, pulleys, etc., for tightness.
- Check the safety valves.
- Renew the filter elements in the compressor intake and in the protection valves, or wash them in hydrocarbon solvent, rinse thoroughly, blow out with a low pressure air jet and dry them.
- Check diaphragm in the protection valve.
- Inspect the intake and discharge valves in the cylinder heads.
- Inspect the contacts on pressure switches, linestarters, etc.
- Clean the external surfaces of the compressor.

(5) Every 12 months:
- Inspect the compressor lubricating system.
- Inspect the compressor unloader system.
- Clean out oil enclosures and grease cups on the motors.
- Blow out the motor windings with an air jet.
- Inspect wiring for loose connections, etc.





Renewal Parts—A list of renewal parts for the air supply unit is available upon request to the nearest Westinghouse Sales Office. In ordering a stock of renewal parts for any particular application, due consideration should be given to a number of factors, for instance: the number of supply units installed; the relative importance of maintaining all units in service; the length of time required to procure new parts from the factory as in the case of applications outside the continental United States, and such other considerations as may be peculiar to the particular application in question.

When ordering renewal parts, give the Stock Order number of the unit as shown on its master nameplate. For parts which carry an individual nameplate, specify the Westinghouse Style No., or the Stock Order No., or the supplier's type symbols which appear on that nameplate. Parts carrying no nameplate may be specified by the names given in the renewal parts list, or by the names used in this book, but the Stock Order No. stamped on the master nameplate of the unit should always be given.

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ǂPITTSBURGH, PA., 6526 Hamilton Ave.
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ǂPORTLAND, OREGON, 1518 N. W. Marshall St.
¶*†PROVIDENCE, R. I., 16 Elbow St.
*RALEIGH, N. C., 803 North Person St., P.O. Box 2146
*RICHMOND, VA., 301 S. Fifth St.
*ROCHESTER, N. Y., 1048 University Ave.
*ROCKFORD, ILL., 130 South Second St.
*SACRAMENTO, CALIF., Rooms 411 & 412 Ochsner Building, 719 K St.
¶*ST. LOUIS, MO., 411 North Seventh St.
†ST. LOUIS, MO., 717 South Twelfth St.
ǂST. LOUIS, MO., 710 N. Twelfth Blvd., c/o Central Terminal Co.
§*SALT LAKE CITY, UTAH, 10 West First South St.
†SALT LAKE CITY, UTAH, 346 A Pierpont Ave.
ǂSALT LAKE CITY, UTAH, 520 West Second South St.
*SAN ANTONIO, TEXAS, 115 W. Travis St.
*SAN DIEGO, CALIF., 861 Sixth Ave.
¶*SAN FRANCISCO, CALIF., 1 Montgomery St.
§SAN FRANCISCO, CALIF., 1355 Market St.
¶ǂ†*SEATTLE, WASH., 3451 East Marginal Way
§SEATTLE, WASH., 1051 First Ave., So.
xSHARON, PA., 469 Sharpsville Ave.
*SIOUX CITY, IOWA, 2307 Kennedy Drive
*SOUTH BEND, IND., 216 East Wayne St.
xSOUTH PHILA. WKS., Essington, Pa. First-class mail, P.O. Box 7348, Phila., Pa.
*SPOKANE, WASH., 158 S. Monroe St.
*SPRINGFIELD, ILL., 601 E. Adams St., Box 37
¶*†SPRINGFIELD, MASS., 395 Liberty St.
xSPRINGFIELD, MASS., 653 Page Boulevard
xSUNBURY, PA., 1354 Susquehanna Ave.
*SYRACUSE, N. Y., 420 N. Geddes St.
*TACOMA, WASH., 1115 "A" St.
*TAMPA, FLA., 417 Ellamae Ave., Box 230
*TOLEDO, OHIO, 245 Summit St.
xTRAFFORD, PA.
*TRENTON, NEW JERSEY, 444 South Broad St.
*TULSA, OKLA., 303 East Brady St.
¶*†ǂUTICA, N. Y., 113 N. Genesee St.
¶*WASHINGTON, D. C., 1625 K Street, N. W.
*WICHITA, KANSAS, 233 S. St. Francis Ave.
†¶*WILKES-BARRE, PA., 267 N. Pennsylvania Ave
*WILLIAMSPORT, PA., 348 W. Fourth St.
*WORCESTER, MASS., 507 Main St.
*YORK, PA., 137 So. George St.
*YOUNGSTOWN, OHIO, 25 E. Boardman St.

Where address and P.O. box are both given, send mail to P.O. box, telegrams to address indicated.

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§CINCINNATI, OHIO, 2329-2331 Gilbert Ave.
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FORT WORTH, TEXAS, 210 Jones St.
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GREENVILLE, S. C., 226 Pendleton St.
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INDIANAPOLIS, IND., 137 S. Pennsylvania St.
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LOS ANGELES, CALIF., 905 East Second St.
MADISON, WISC., 1022 E. Washington Ave.
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①NORFOLK, VA., 2600 Hampton Blvd., P.O Box 1570
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PHILADELPHIA, PA., 1101 Race St.
PHOENIX, ARIZONA, 315 West Jackson St.
PITTSBURGH, PA., 575 Sixth Ave.
PORTLAND, OREGON, 134 N. W. Eighth Ave.
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RALEIGH, N. C., 319 W. Martin St.
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ST. PAUL, MINN., 145 East Fifth St.
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SIOUX CITY, IOWA, 1005 Dace St.
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TULSA, OKLA., 307 East Brady St.
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* Sales Office † Mfg. and Repair Shop x Works ǂ Warehouse § Merchandising Products Only Headquarters ¶ District Eng. and Service Dept.

①Changed or added since previous issue.

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