Hand operation of the lubricator is accomplished by removing the top cover 48 and applying the priming handle 29 (Fig. 17) to the hole provided in the ratchet wheel. This handle is furnished with the lubricator. The priming handle must be removed and the top cover replaced and secured after this operation has been completed.

Lubricating Oil

It is imperative that only high grades of lubricating oils of a suitable type and viscosity be used in this lubricator to obtain proper lubrication of the compressor and associated devices. Since in general, each user has his own specifications for oil, no attempt is made here to provide a specification. If desired, however, W. A. B. Co. specifications for recommended lubricants will be supplied upon request.

Maintenance and General Care

The strainer in the filler inlets should be removed and inspected from time to time and cleaned if necessary. When the lubricator is removed for general inspection, it should be subjected to prescribed tests before being returned to service. Care must be exercised to replace each pump in the cylinder from which it was removed.

REPAIR SHOP AND ROAD TESTS

The Interstate Commerce Commission's "Rules and Instruction for Inspection and Testing of Steam Locomotives and Tenders" dated 1919, specified as follows regarding steam compressor tests:

"The compressor or compressors shall be tested for capacity by orifice test as often as conditions may require, but not less frequently than once each three months."

The above Rules and Instructions also specify that with a 9-32″ orifice to atmosphere and main reservoir pressure maintained at 60 pounds, the 8½″ compressor must make not more than 100 single strokes per minute. For altitudes over 1,000 feet, the speed of the compressor may be increased five single strokes per minute for each 1,000 feet increase altitude.*

We recommend the following method for making the above test:

Before making any test, the main reservoir should be drained and it and its connections should be tested for leakage as follows: After obtaining the main reservoir pressure corresponding to the governor setting, close the throttle to the compressor. Then close the main reservoir cut-out cock when the SD (or SF) governor is used; if, however, the SG type of governor or the SF type with a manifold providing for a single main reservoir

*NOTE—The above figures are for the 8½″—150 compressor only. The use of a 11/64″ diameter orifice to atmosphere with the 8½″—120 compressor, other test conditions remaining the same, will provide approximately the same relative condemning point for this machine.

connection to the governor is used, leave the main reservoir cock open and close the brake pipe cut-out cock under the brake valve and the cut-out cock in the supply pipe to the distributing valve and place the brake valve handle on lap. If no cut-out cock is used, as with the A-1 Equipment, place the brake valve handle on lap. Bleed down reservoir pressure to about 62 or 63 pounds. Allow the pressure to leak down to 60 pounds (that is, to settle down to an equalization of tempera-

Fig. 22. Disassembled View and Sectional View of Disc Holder with Disc

tures) and note the amount of drop from this pressure during one minute. This drop must not exceed 2 pounds. If a greater leakage than this exists, it must be reduced to this limit before proceeding with the compressor test, otherwise the test would indicate a poorer condition of the compressor than is the case, due to extra labor required to maintain this leakage.

After the main reservoir and its connections have been tested for leakage as above, the compressor should be tested as follows:

The orifice disc is placed in a special holder, Fig. 22, supplied for this purpose which should be connected to the main reservoir drain cock, as illustrated in Fig. 23,

with a test gage inserted between the disc holder and drain cock. Then close the main reservoir cut-out cock if the SD (or SF) governor is used; if, however, the SG type of governor or the SF type with a manifold providing for a single main reservoir connection to the governor is used, leave the main reservoir cock open and close the brake pipe cut-out cock under the brake valve and the cut-out cock in the supply pipe to the distributing valve and place the brake valve handle on lap. If no

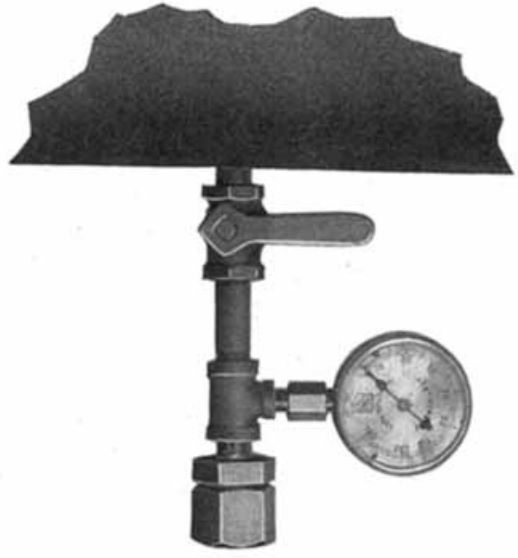

Fig. 23. Showing Orifice Disc Holder and Gage Connection to Main Reservoir Drain Cock

cut-out cock is used, as with the A-1 equipment, place the brake valve handle on lap. Then start the compressor and raise the pressure in the main reservoirs to slightly below 60 pounds. Open the drain cock to the orifice and throttle the steam supply to the compressor until

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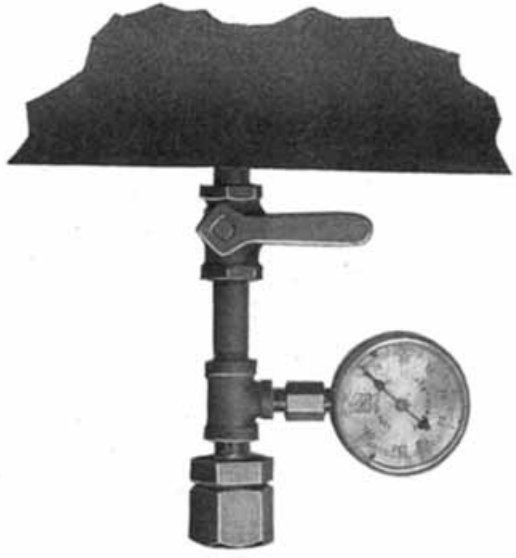

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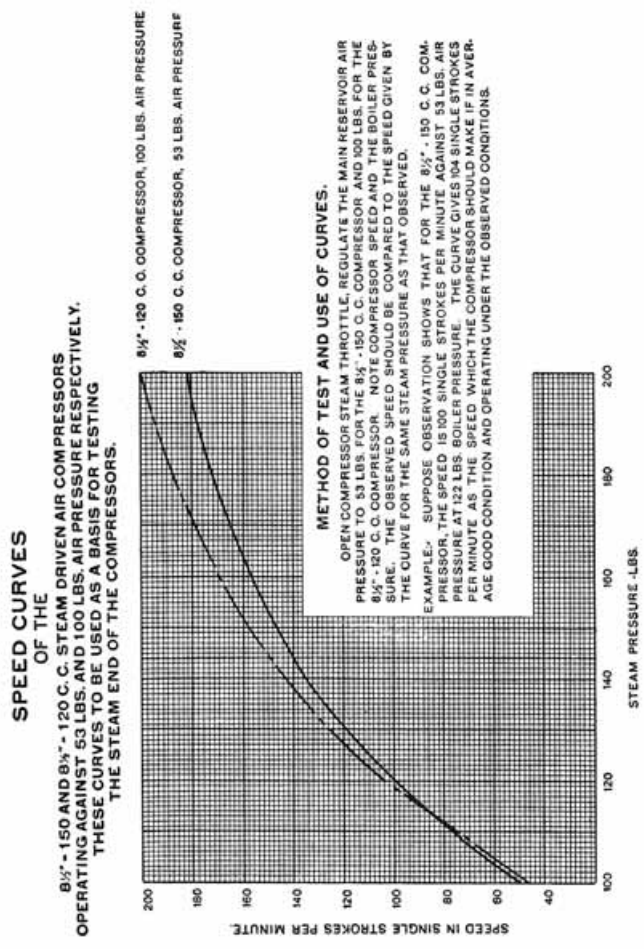

Fig. 24. Speed Curve for the 8½"-150 and 8½"-120 Compressors

the main reservoir pressure is maintained at approximately 60 pounds. Then count the strokes of the compressor required to maintain this pressure during one minute. This number must not be in excess of 100.

During the tests it should be assured that boiler pressure is at all times at least sufficient to obtain the required number of strokes against 60 pounds air pressure when the throttle to the compressor is full open.

Test of Steam End

While the Interstate Commerce Commission makes no mention of tests of the steam end, such tests should be made to determine whether or not the efficiency of the steam end of the compressor is lower than warrants continuing it in service or after having been repaired and over-hauled, it is in proper condition to be returned to service.

The test specifications given hereinafter are based upon the performance of a number of compressors in what may be termed a good average condition. It should be understood that the limits specified are neither those which should condemn a compressor nor necessarily the best performance which should be expected from a compressor in the best possible condition. The condemning limit should be established by those familiar with existing service requirements. The tests specified merely indicate the method which we would recommend.

In establishing a minimum passable performance of the compressor, it should be borne in mind that this limit should not be set too low. This is to prevent the compressor getting into such poor condition as to require expensive repairs. For this reason, we strongly

recommend that the condemning limit should *never* be established below 75 per cent, for the steam end of the tests specified hereinafter, no matter what the service may be or the apparent ability of the compressor to meet operating requirements, even with a considerably lower efficiency than this. Where operating conditions demand a more rigid requirement, the condemning limit should be raised to an amount determined by the judgment of those in charge.

The steam end of the compressor should be tested in the following manner:

The compressor steam throttle should be opened wide and the main reservoir pressure should be regulated by means of a cock or valve leading to the atmosphere until the pressure in the reservoir reaches 53 pounds. When this pressure has been obtained, the locomotive boiler pressure and the compressor speed in single strokes per minute should be observed and compared with that shown on the curves, Fig. 24, which represent what the performance ought to be if its steam end is in good average condition.

For example, suppose with the steam throttle opened wide and the main reservoir pressure maintained at 53 pounds, by bleeding it to the atmosphere at a given rate, observations show that a speed of 100 single strokes per minute is attained with a boiler pressure of 122 pounds. The curves show that, if the steam end is in good average condition, the 8½"-150 compressor operating against a main reservoir pressure of 53 pounds, with 122 pounds boiler pressure, should make 104 single strokes per minute, and that the 8½"-120 compressor operating against a main reservoir pressure of 100 pounds, with 122 pounds

boiler pressure, should make 110 single strokes per minute. If the observed speed is less than that indicated on the curves for the given conditions, the judgment of those in charge should determine whether the compressor should be over-hauled.

If the condemning limit for the steam end has been set at 75 per cent of the performance of a compressor in good average condition, the speed of the compressor should not be less than 75 per cent of the speed called for by the curve at a point corresponding to the particular condition of steam pressure under which the compressor was tested. For instance, in the case under consideration, the compressor should have a speed of not less than 75 per cent of 104 strokes, or 78 single strokes per minute.

DISORDERS

Causes and Remedies

NOTE: Experience has demonstrated that the major portion of compressor disorders is caused by lack of proper lubrication and the entrance of dirt which results in the formation of carbon. These disorders are practically eliminated with the use of the "F-1-A" mechanically operated lubricator and the Type "G" air filter, providing these two devices are properly maintained in normal operating condition.

COMPRESSOR REFUSES TO START. CAUSE:—Insufficient oil, due to improper feed of lubricator, or oil washed out of cylinder by water of condensation; leaky piston rings in the small end of the main valve piston; or rust having accumulated during time compressor has lain idle. Remedy:—shut off steam, take off reversing valve cap, pour in a small quantity of oil, replace cap, and then turn on steam quickly. In many cases when the compressor will not start when steam is first turned on, if steam is then turned off and allowed to remain off for one or two minutes, and then turned on quickly, it will start without the use of any oil, except that from the lubricator.

COMPRESSOR GROANS. CAUSE:—(1) air cylinder needs oil. Remedy:—(1) put some oil in air cylinder. Cause:—(2) piston rod packing dry and binding. Remedy:—(2) saturate piston swab with oil. Cause:—(3) steam cylinder needs oil. Remedy:—(3) adjust lubricator to correct feed.

Excessive leakage past the air piston packing rings, or past a discharge valve, causes heating, destroys lubrication and results in groaning.

UNEVEN STROKES OF THE COMPRESSOR. CAUSE:—probably (1) sticky air valves; (2) improper lift of air valves; (3) clogged discharge valve passages; (4) clogged strainers under upper intermediate valves; (5) leaky air valves; or (6) binding or cutting of the reversing rod. Remedy:—locate cause, if possible, and correct it by cleaning out clogged or dirty passages, air valves and strainers, replacing worn or leaky valves, or straightening or replacing the reversing rod.

SLOW IN COMPRESSING AIR. CAUSE:—(1) leakage past the air piston packing rings, due to poor fit, or wear in cylinder or rings; (2) valves and passages dirty; or, (3) air filter clogged. Remedy:—(1) and (2) To determine which is causing the trouble, obtain about 90 pounds air pressure, reduce the speed to 40 or 60 single strokes per minute, then *listen* at the "Air Inlet Openings" and note if air is drawn in during only a portion of each stroke, and if any blows back. (Note:—When both air inlet openings are connected to a common air inlet manifold, it is necessary to disconnect the air inlet manifold before making this investigation). If the latter, an inlet valve is leaking. If the suction does not continue until each stroke is nearly completed, then there is leakage past the air piston packing rings or back from the main reservoir past the air discharge valves. Remedy:—(3) clean air filter thoroughly.

COMPRESSOR HEATS. CAUSE:—(1) air passages are clogged; (2) leakage past air piston packing rings; or (3) the discharge valves have insufficient lift. Remedy:—(1) clean air passages; (2) renew air piston rings; (3) regulate lift of discharge valves to 3-32 of an inch on the

8½" and to 5-32 of an inch on the 10½" compressor. A compressor in perfect condition will become excessively hot and is liable to be damaged if run very fast and continuously for a long time.

COMPRESSOR POUNDS. CAUSE:—(1) air piston is loose; (2) compressor not well secured to boiler, or causes some adjacent pipe to vibrate; (3) the reversing valve plate 18 is loose; or, (4) the reversing rod or plate may be so worn that the motion of compressor is not reversed at the proper time. Remedy:—repair and renew worn parts and tighten loose connections.

COMPRESSOR ERRATIC IN ACTION. CAUSE:—In addition to the causes of erratic action described in the preceding paragraphs, a worn condition of valve motion, or leakage past the steam piston packing rings, may also cause erratic action. Remedy:—renew the worn parts.

MAINTENANCE

In connection with the problem of good maintenance for steam driven air compressors of this type, the heating of the air cylinders incident to air compression is perhaps the most important. The operation of the compressor continuously at high speed or against excessive pressures inevitably results in high temperatures which tend to destroy the lubrication, causing the air cylinders to cut, and the groaning of the air compressor, besides filling the discharge passage with deposits from burnt oil, producing undesirable condensation of moisture in the brake system and in general, reducing the overall efficiency of the compressor.

Under normal conditions, the speed should not exceed 140 exhausts per minute, and such a speed should not be maintained continuously for any considerable time as even this speed will cause excessive heating. Continuous running at high speed will cause excessive heating of the air end of the compressor. Overheating from this cause is an indication that a compressor of larger capacity is required.

It is therefore desirable, first, that the compressor be of ample capacity for the service desired (if one compressor does not have sufficient capacity, the obvious remedy is to install two compressors); second, that it be well lubricated and otherwise maintained in good condition, and, third, that leakage from any source whether within the air compressor itself or in the brake system be minimized in every practical way.

One of the most serious leaks is through the air cylinder stuffing box if the stuffing box packing is not prop-

erly maintained, as it not only greatly decreases the air delivered, but the faster speed required increases the heating, and it also causes pounding through loss of cushion. When tightening the packing, do not bind the rod, as to do so will damage both the packing and the rod. Be careful not to cross the gland nut threads.

With two compressors per engine, the separate throttles should be kept wide open and the speed regulated by the main compressor throttle. The purpose is to equally divide the work.

If necessary to replace a broken air valve on the road or elsewhere not permitting of proper fitting, at the earliest opportunity have the repairman replace the temporary valve with another so as to insure the correct angle and width of valve and seat contact, the needed ground joint and the proper lift. The standard lift for all valves of the 8½" compressor is 3-32 of an inch; for the 10½" compressor, 5-32 of an inch for the suction and discharge valves and ⅛ of an inch for the intermediate valves. When the combined wear of the valve and seat increases this lift more than $\frac{1}{16}$ of an inch, the seat is liable to be injured and the valve broken, with consequent annoyance and delay. For the purpose of readily determining the lift of air valves, an Air Valve Lift Gage, as illustrated in Figs. 25, 26 and 27, may be purchased from us.

To determine the lift of the upper air valve, the gage is first applied to the top flange of the air cylinder, as illustrated in Fig. 25, and the sliding arm adjusted until its end rests against the top of the stop on the air valve, in which position it is locked by means of the thumb nut.

With the arm thus locked, the gage is applied to the valve cap, as illustrated in Fig. 26, and if the valve has proper lift, the under side of the collar of the valve cap will just rest upon the shoulder of the sliding arm, as illustrated. If the gage arm fails to touch the stop on the valve when the shoulder on the sliding bar rests upon the face of the collar, the valve has a lift greater

Fig. 25

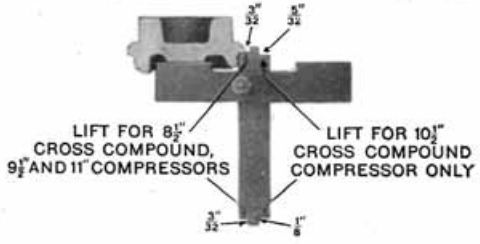

Fig. 26

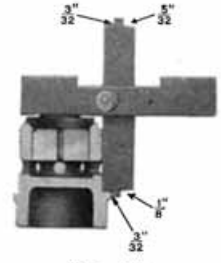

Fig. 27

than standard by an amount equal to the distance between the gage arm and the stop. If this lift is greater than the maximum permissible, a repair valve having a long stop should be substituted for the old valve and the stop lowered until the standard lift is reached, as indicated by the gage.

To determine the lift of the lower air valve, the gage is first applied to the bottom flange of the air cylinder, as illustrated in Fig. 25, and the sliding arm adjusted until its end rests against the stop in the cylinder, in which position it is locked by means of the thumb nut. With the arm thus locked, the gage is applied to the air valve cage and air valve, as illustrated in Fig. 27, and if the valve has proper lift, the shoulder on the sliding arm will just rest upon the upper side of the collar of the air valve cage, as illustrated. If the gage arm fails to touch the stop on the valve when the shoulder on the sliding bar rests on the collar face on the cage, the valve has a lift greater than standard by an amount equal to the distance between the stop and the gage arm.

In case the cylinders have been counterbored at the entrance for the valve cage and valve and valve chamber cap in such a way as to interfere with the application of the gage, as above described, it will be found necessary, in order to use the gage properly, to file away the small portion of the ridge so that the cross-bar of the gage will rest on the refaced surface of the valve chamber. In doing this, care should be taken to avoid injury to the refaced surface.

Never remove or replace the upper steam cylinder head with the reversing valve rod in place, as to do so will almost invariably result in bending the rod. A bent rod is very liable to cause a "pump failure."

When installing the reversing valve assembly in the new type top head, it is recommended that the upper piston first be entered in the cap nut. Then pick up the cap nut and reversing valve assembly and insert the

assembly in the reversing valve bush, observing that each piston with its rings properly enters the bush. If the reversing valve assembly is inserted before applying the cap nut, the reversing valve assembly should be lifted sufficiently to observe that the upper piston rings are properly entered before the cap nut is screwed into place.

When assembling the sections of the main valve, special care should be taken to insure proper alignment and thereby avoid possible trouble from binding of the piston in the bushing.

It is evident that a compressor cannot compress more air than it draws in and not that much if there is any leakage to the atmosphere about the air cylinder. Bearing this in mind, practice frequently listening at the "Air Inlet" when the compressor is working slowly while being controlled by the governor, and whenever a poor suction is noted on either or both strokes, locate and report the fault.

Any unusual click or pound should be reported as it may indicate either a loose piston or a reversing valve plate cap screw or other serious fault.

Any steam leakage that can reach the Air Inlet of the compressor should be promptly repaired as such increases the danger of water entering the brake pipe.

Keeping the air intake filter clean is of the utmost importance, as even a slightly clogged strainer will greatly reduce the capacity where the speed is at all fast. A seriously or completely obstructed filter, as by accumulated frost, aggravated by rising steam, will increase the compressor speed and will also be indicated by inability to raise or maintain the desired pressure.

CLEANING THE TYPE "G" AIR FILTER

Method of Cleaning Air Filter Unit

At locomotive shopping periods, the filter unit should be removed for cleaning. If the dirt deposited on the convolutions of the strainer is dry, it may be dislodged by jarring the strainer on a hard surface and by the use of compressed air that is free from precipitated moisture. The blast of air should be directed along and not against the outside surface of the convolutions. If the dirt is oily, the strainer should be dipped in an approved alkali-free hydrocarbon solvent, and then subjected to an air blast as previously described. If means are available to spray the fluid on the strainer, this system can be followed to advantage as it avoids excessive absorption of cleaning fluid.

Filter Body

The filter casing should be thoroughly cleaned. If any corrosion is noted, the casing should be wire brushed then dipped in Trichlorethylene or a suitable solvent cleaner. Following the cleaning, the casing should be heated to a temperature of approximately 200 degrees F., after which it should be immersed in NO-OXID at the same temperature. Remove and drain thoroughly, after which the filter can be re-assembled.

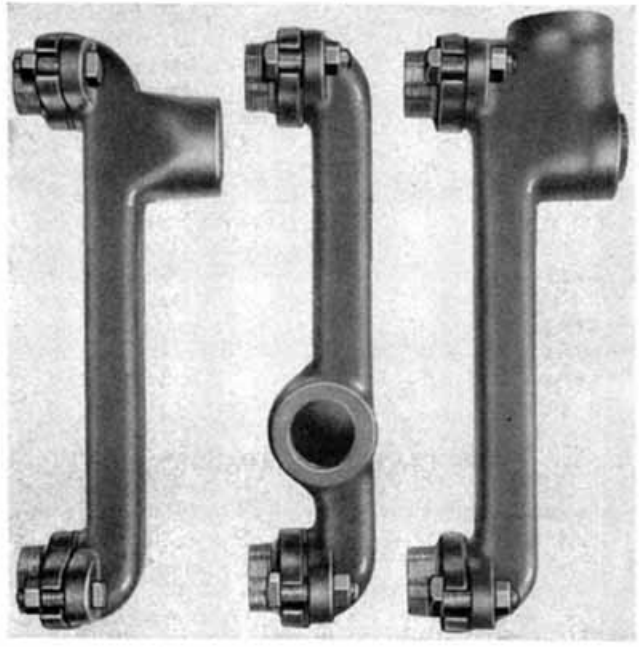

Fig. 28. Types "A", "B" and "C" Air Inlet Manifolds

WESTINGHOUSE AIR BRAKE COMPANY

Wilmerding, Pa.

OFFICES

ATLANTA 3,	Candler Building
BOSTON 16,	Statler Building
CHICAGO 4,	Railway Exchange Building
CLEVELAND 15,	Midland Building
DENVER 2,	Denver National Building
HOUSTON 2, TEX.	Commerce Building
LOS ANGELES 14,	Pacific Electric Building
MEXICO CITY, MEXICO–3a	Puente de Alvarado, No. 67
NEW YORK 1,	Empire State Building
ST. LOUIS 3,	1221 Locust Street
ST. PAUL 1,	Endicott Building
SAN FRANCISCO 5,	Matson Building
SEATTLE 1,	Securities Building
TOPEKA	Columbian Building
WASHINGTON 4, D. C.	Munsey Building

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CANADIAN WESTINGHOUSE COMPANY, LTD.
Hamilton, Ontario, Canada

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Turin, Italy

COMPAGNIE DES FREINS & SIGNAUX WESTINGHOUSE
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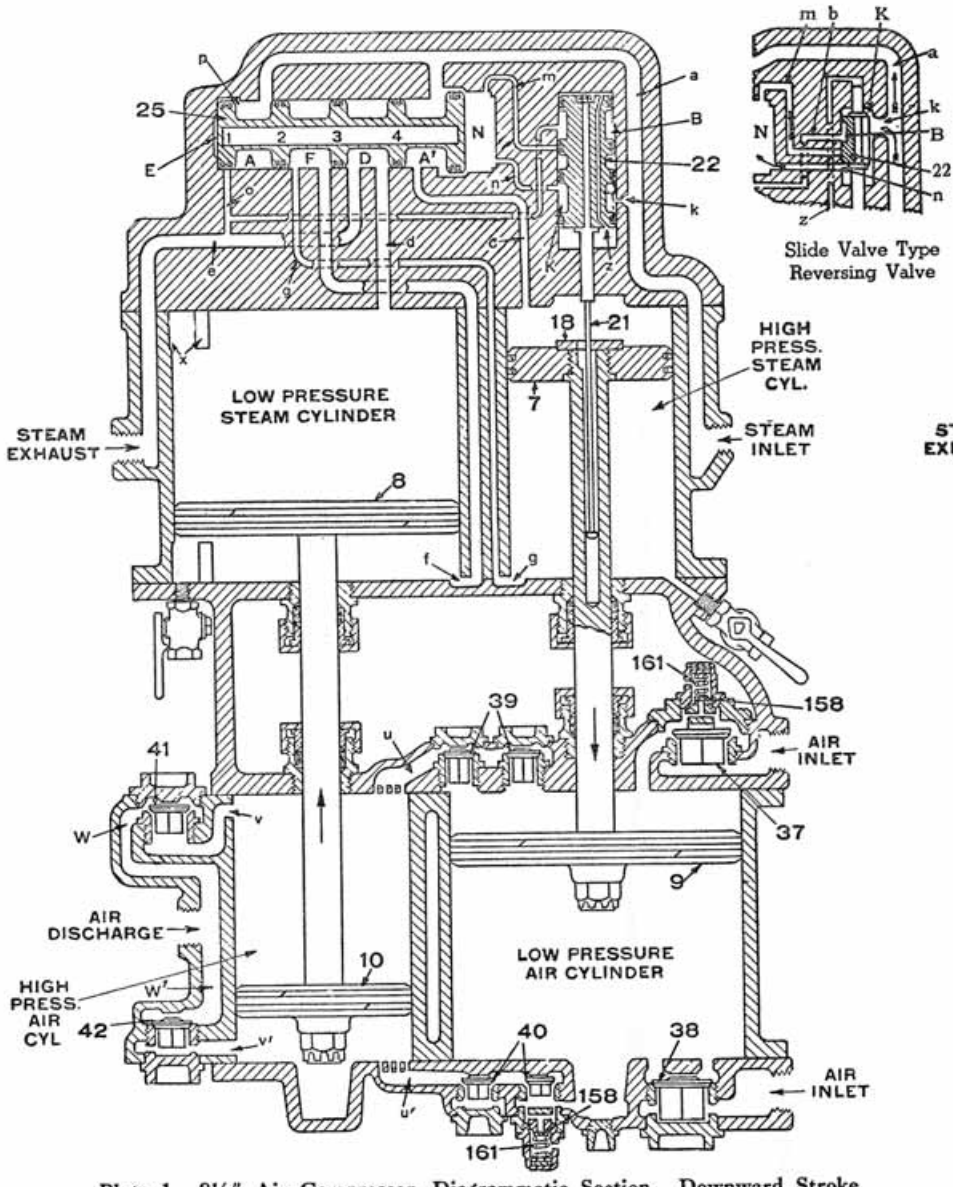


Plate 1. 8½" Air Compressor, Diagrammatic Section. Downward Stroke of High Pressure Steam (low pressure air) Piston

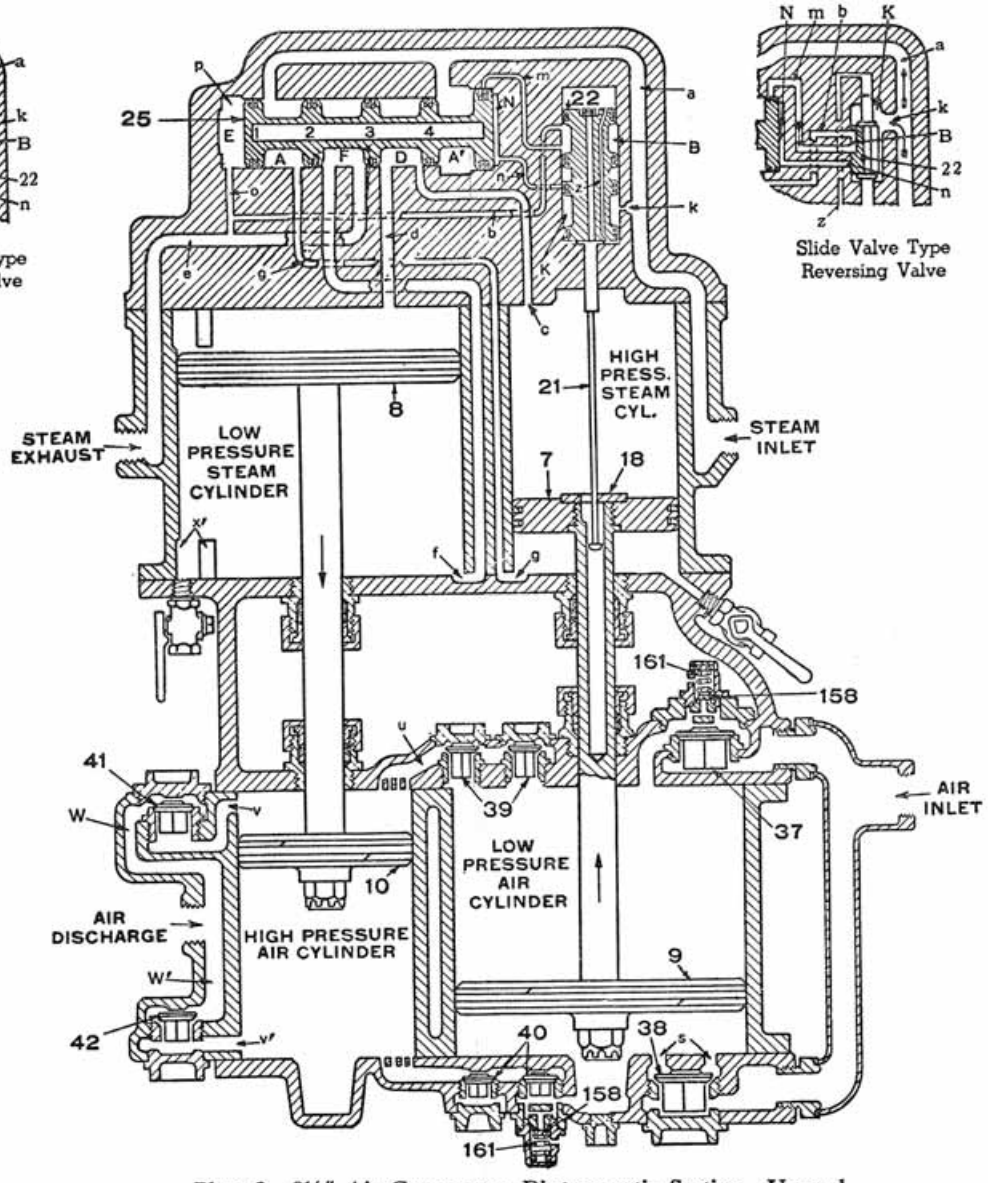
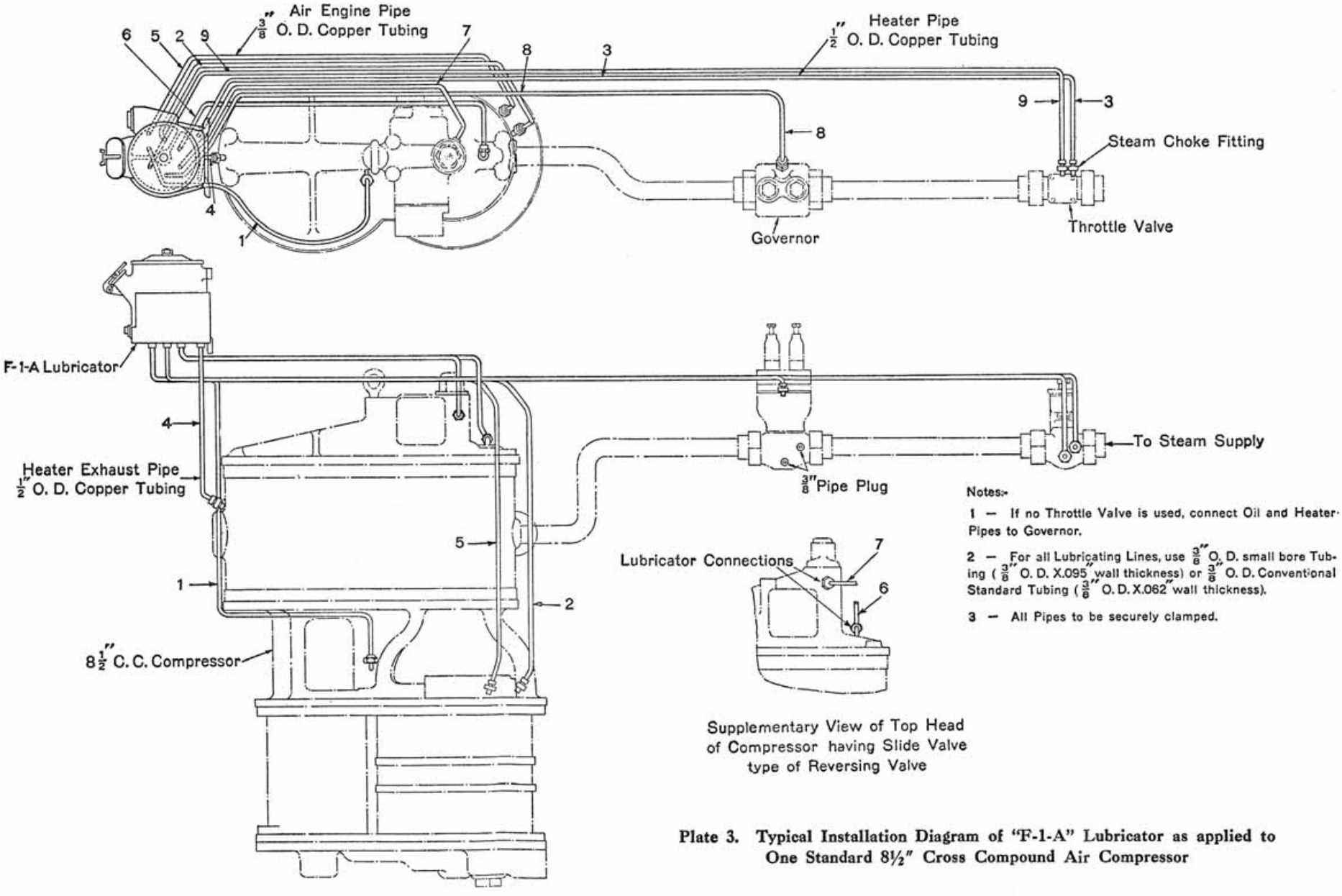


Plate 2. 8½" Air Compressor, Diagrammatic Section. .Upward Stroke of High Pressure Steam (low pressure air) Piston



Supplementary View of Top Head of Compressor having Slide Valve type of Reversing Valve

Plate 3. Typical Installation Diagram of "F-1-A" Lubricator as applied to One Standard 8½" Cross Compound Air Compressor

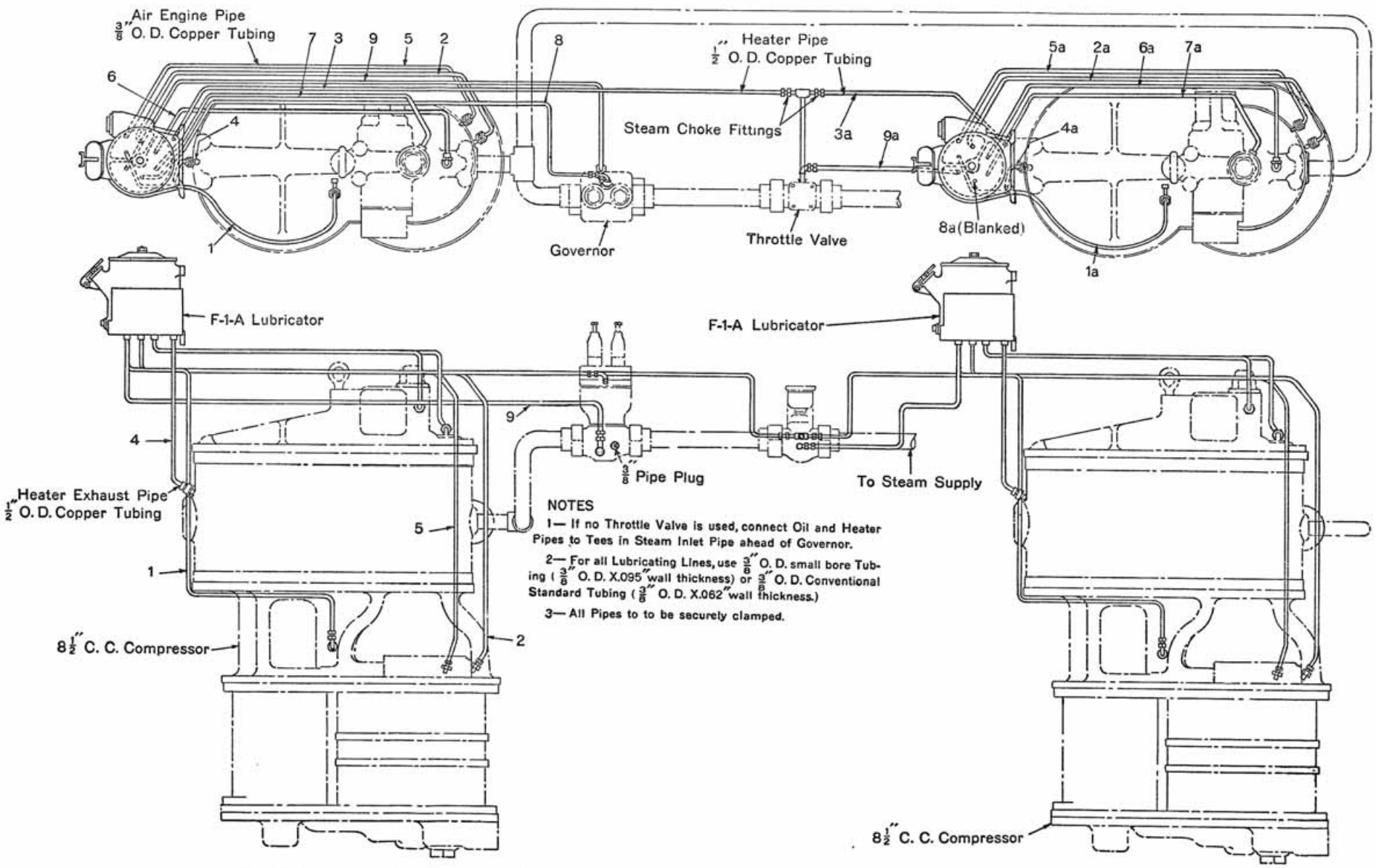


Plate 4. .Typical Installation Diagram of "F-1-A" Lubricator as applied to Two Standard 8½" Cross Compound Air Compressors