INSTRUCTION PAMPHLET

No. T 5001-1

MARCH, 1927

SM-3 STRAIGHT-AIR BRAKE EQUIPMENT

WESTINGHOUSE
TRACTION BRAKE CO.
PITTSBURGH, PA., U. S. A.

SM-3
STRAIGHT-AIR
BRAKE EQUIPMENT

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CONTENTS

PREFACE

HOW TO STUDY THE AIR BRAKE

Because the air brake is a means of *car and train control*, a thorough understanding of its elementary functions and principles of operation on the part of railway men who have anything to do with car and train handling, either directly or indirectly, is not only the most important information that can be acquired but absolutely essential to the largest factor of safety and economy in the handling of traffic with minimum loss of life or damage to rolling stock.

A great deal of misapprehension and confusion of mind exists, however, in regard to the kind of practical air brake information *most essential* for different classes of railway employes.

Practical operating and mechanical railway officials in recent years have approved the following fundamental basis of approach to the subject of air brake education as most nearly meeting actual operating conditions and service requirements.

Motormen and Conductors

For this class of employes the *first* essential is the ability to skillfully *manipulate* the brake system as a whole, which involves merely a general knowledge of the functions and features obtainable in a given system, how to make preliminary car tests before starting out, and how to operate the brake valve to secure best results in train control under the different conditions that exist on any given road. It is of secondary and relatively minor

importance that operating employes of this class should know the internal workings of the various individual devices which make up the brake system, or be familiar with the movement of parts and the detailed intricacies of various air pressures in different chambers, ports, passages, etc. Of course, the more comprehensive the air brake education of the employe, the more valuable his services to his road, but for the motorman, for example, the ability to manipulate the brake valve with skill and judgment is of primary importance always. The section of this Instruction Book covered from pages 7 to 10, and pages 59 and 61, inclusive, is, therefore, intended primarily for this class of employes.

Air Brake Foremen and Repairmen, Employes who Adjust, Maintain, Repair and Test Air Brake Apparatus

For this class of employes who have to do primarily with internal construction, operation and proper functioning of moving parts of individual air brake devices, the study of ports, passages, chambers, air pressures and the whys and wherefores of internal operation is of first importance and a knowledge of manipulation secondary although desirable, of course, and to be encouraged so far as time and opportunity permit. The matter covering description, etc., from pages 15 to 58, is, therefore, intended, primarily for this class of railway employes.

Superintendents, Master Mechanics, Air Brake Instructors, Inspectors and Officials in Charge of Air Brake Operation and Instruction Generally

This class of railway officials and employes must understand the functions and features available in the brake equipment; should be familiar with our general recommendations as to manipulation and the specific instructions thereon as formulated and officially approved for a given road; should know the internal operation and functioning of individual devices; the maintenance of the apparatus in service; car tests for brake efficiency; tests for individual devices in repair shops; and, in general approved methods of organization and instruction for different classes of railroad employes in order to secure the largest practical results for the railway.

This Instruction Pamphlet has, therefore, been made sufficiently comprehensive throughout to meet all normal requirements of this class of officials. We feel very strongly that for those most concerned no effort is of greater practical benefit to the road served than that spent in the proper kind of air brake education and we are ready and willing, at all times, to assist in promoting these processes of education along practical lines in every way possible.

Price of this Instruction Pamphlet, single copies, 50 cents.

Westinghouse Traction Brake Company

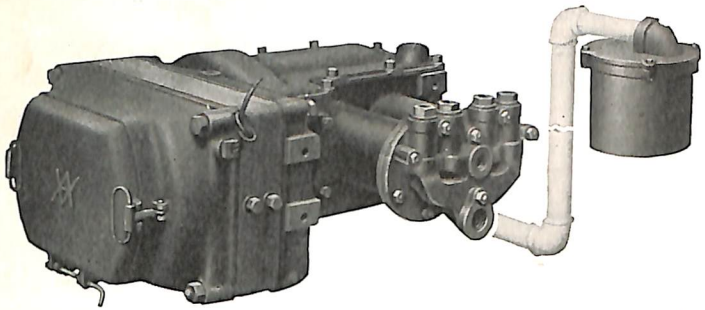

Fig. 1. DH-16 Motor Driven Air Compressor with 8″ Suction Strainer

RULES FOR OPERATING THE SM-3 BRAKE EQUIPMENT

The following rules are intended to cover in a condensed form the important instructions to be observed in handling this equipment in service. Where these rules conflict in any way with the railway company's operating rules, the railway rules should, of course, be followed.

Charging

Before starting the air compressor, *close* the drain cock in the main reservoir, and the whistle cut-out cock on the non-operative end of the car (if a whistle set is used).

Open the whistle cut-out cock in the operative end of the car (if a whistle set is used).

See that all hand brakes are fully released.

The fuse in the compressor circuit must be in place and "live".

Place a handle on the brake valve to be operated and move it to *Release and Running* position at the extreme left. Then start the compressor by closing the snap switches in the compressor circuit.

Do not attempt to move the car until the reservoir gage hand shows full main reservoir pressure.

Running

Keep the brake valve handle in *Slow Release* position when not being used.

In the event of sudden danger, move the brake valve handle quickly to *Emergency* position, at the extreme right, and leave it there until the car stops and the danger is past.

Service Application

To apply the brake for an ordinary stop, move the brake valve handle to *Service* position. When the desired brake cylinder pressure is obtained, move the brake valve handle back to *Lap* position, where it should remain until it is desired to release the brake or make a heavier application.

How heavy an application should be made, and whether a full application should be made at once or the brakes graduated on, depends upon the circumstances in each particular case, such as the speed and weight, condition of rail, grade, loading, kind of stop desired, and regard for the comfort of the passengers.

Because the retarding effect of any given brake cylinder pressure is greater at low than at high speeds, a heavy application at low speeds will result in an abrupt stop with perhaps discomfort to passengers or slid wheels. When running at high speeds, however, a heavy initial application should be made in order to obtain the most effective retardation possible when the momentum of the car is greatest.

If the brakes are applied lightly at first and the braking pressure increased as the speed of the car diminishes,

it not only makes a longer stop, but the high brake cylinder pressure at the end of the stop will be likely to produce a rough stop, perhaps slide the wheels and result in loss of time because of the necessity of waiting until this high cylinder pressure exhausts before the car can proceed.

The best possible stop will be made when the brakes are applied as hard, *at the very start*, as the speed, the conditions of the rail and comfort of passengers will permit, and then graduated off as the speed of the car is reduced, so that at the end of the stop little or no pressure remains in the brake cylinder.

To properly weigh all these varying factors in every stop becomes, after a little practice, an act of unconscious judgment. Careful attention to cause and effect at the very start and a real desire to improve are the most necessary qualifications in order to become expert in handling this or any other form of brake equipment.

Holding Brakes Applied

After an application has been made, the brake valve handle should be placed in *Lap* position and left there until it is desired either to make a heavier application or to release the brakes.

Never allow the brake valve handle to remain in Lap position, except while bringing the car to a stop, and it should not be allowed to remain in this position for a sufficient length of time to permit the cylinder leakage to diminish the braking force materially. If the car must be left standing for any length of time the hand brake should be set and the air brake released.

Release

To fully release the brakes, after any application, move the brake handle to *Quick Release* position. After the brakes have been released the handle should be moved to *Slow Release* position and left there at all times when the brakes are not in use.

To graduate or partially release the brakes, move the brake valve handle to *Slow Release* position for a moment then back to *Lap* position; repeat this operation as may be necessary until the car is brought to rest, only enough pressure being retained in the brake cylinder at the end of the stop to prevent the wheels from rolling.

With a very little practice, the motorman learns how long the handle should remain in *Slow Release* position to produce the results desired. Obviously this varies with the amount of brake cylinder pressure which it is desired to release.

Emergency

Should it become imperative to stop in the shortest possible time and distance, to save life or avoid accident, move the handle quickly from whatever position it may be in, to *Emergency* position, which is at the extreme right, and leave it there until the car stops and the danger is past.

Changing Ends

When changing from one end of the car to the other, remove the brake valve handle, and, after placing it on the brake valve at the other end of the car move it to *Slow Release* position. If a whistle set is used, open the whistle cut-out cock in the operative end and close that on the non-operative end.

The SM-3 BRAKE EQUIPMENT

with PV-3 Brake Valve and Safety Emergency Feature

This equipment is intended for use on cars operating as single units in electric railway service. Where it is necessary to use trailers the SME semi-automatic equipment should be used, and automatic equipment should be used for train operation, as it is neither safe nor satisfactory to employ the straight air brake for other than single-car operation.

Straight air brake equipment is the simplest form of air brake, comprising the least number of parts necessary to establish communication between the main reservoir and the brake cylinder, and at the same time posessing the feature of extreme flexibility which affords the operator control of brake cylinder pressure to a very fine degree.

A safety feature is incorporated with the equipment which functions in case of emergency pipe rupture, or operation of conductor's valve, to cause an emergency application of the brakes.

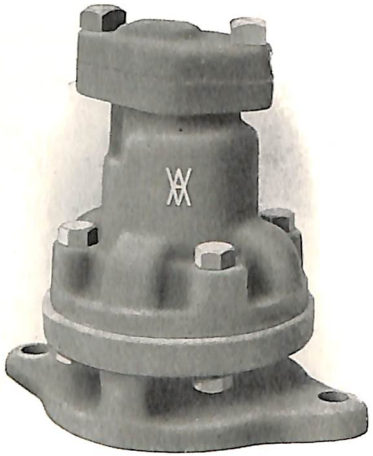

Fig. 2. Photographic View of the Type H-2 Emergency Valve

PARTS OF THE EQUIPMENT

The following is a list of the operating parts which make up this equipment, (See Fig. 29), with a short description of each:

1. A *motor driven air compressor with suction strainer*, which furnishes the compressed air for use in the brake system.

2. A *main reservoir* to which the compressed air is delivered from the air compressor, where it is cooled and stored for use in applying the brake.

3. An *electric compressor governor*, which automatically controls the operation of the compressor between pre-determined minimum and maximum pressures.

4. A *fuse block*, *fuse*, and two *snap switches*, for the protection of air compressor against any excessive flow of current and enabling the current supply to be entirely cut off when desired.

5. A *safety valve*, which protects against excessive main reservoir pressure, in case the governor for any reason fails to stop the air compressor.

6. Two *single pointer air gages*, one at each end of the car show the pressure in the main reservoir.

7. Two *brake valves*, one at each end of the car, through which (a) the air is allowed to enter the brake cylinder for the purpose of applying the brakes; (b) the air in the brake cylinder is allowed to escape to the atmosphere when releasing the brakes; and (c) the flow of air to or from the brake cylinder may be prevented as when the brakes are being held applied in service.

8. Two *exhaust mufflers*, one for each brake valve, placed under the platform to deaden the sound of the brake valve exhaust.

9. An *emergency valve* which functions only in case of emergency pipe rupture or conductor's valve operation to cause an emergency application of the brake.

10. A *quick release valve* which shortens the time required to release the brake.

11. A *brake cylinder*, with a piston and rod so connected through the brake levers and rods to the brake shoes that when the piston is forced outward by air pressure this force is transmitted through the rods and levers to the brake shoes and applies them to the wheels.

12. A *conductor's valve* located inside each car, enabling the conductor to apply the brakes if necessary.

13. While not a part of the air brake apparatus proper, the car is sometimes equipped with two *air alarm whistles*, one at each end of the car to be used as a warning of approach, with the necessary *whistle valves* and *cut-out cocks*.

With this equipment, two lines of pipe are used. The *emergency pipe*, connected to the emergency valve, supplies main reservoir air to the controlling brake valve. The *straight-air application and release pipe* connects the controlling brake valve to the brake cylinder (through the emergency valve), and forms the means of communication by which the motorman, by proper manipulation of the brake valve handle, can operate the brakes by supplying air to, or exhausting it from, the brake cylinder.

DESCRIPTION OF THE PARTS

DH-Type Air Compressor

This compressor is of the horizontal duplex air cylinder type, single acting (that is, the air is compressed on only one side of the piston), and is driven by a motor through herringbone gearing.

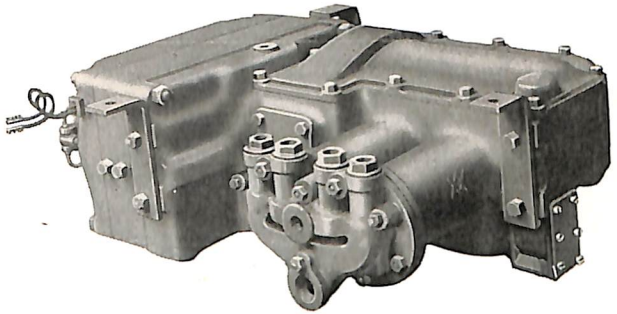

Fig. 3. "Bungalow" Type DH Compressor in Suspension Hangers

When the air compressor is operating, air is drawn into the cylinders through the suction strainer and past the inlet valves, compressed, and forced out past the discharge valves and through a radiating pipe to the *main reservoir*. (See Instruction Pamphlet No. T5002 for complete information covering the operation, maintenance, etc., of motor driven air compressors).

Suction Strainer

The suction strainer is connected by piping with the air inlet of the compressor. It is shown connected to the compressor in Fig. 1 and in section in Fig. 4.

Fig. 4. Suction Strainer, Sectioned View

The ample cross-sectional area provides for a slow rate of flow into and through the strainer, together with sufficient capacity to retain dirt and dust drawn into it without noticeable restriction to the flow of air. A compact layer of pulled curled hair prevents the passage through it of even the finest dust, the construction being such that all the air must filter through the entire thickness of the bed of hair. When the strainer is installed with the opening downward, as it should be, any dirt or dust which might be drawn into it when the compressor is running tends to be shaken out by the jolting of the moving car after the compressor stops.

Main Reservoir

The *main reservoir* is used for the purpose of storing an abundant supply of compressed air to permit a prompt application of the brakes, also for cooling the air and depositing the moisture, oil, or other foreign matter carried into the reservoirs, before passing on to the brake system. To assist in this, the piping should be so installed as to drain into the reservoir. As an accumulation of water or other foreign matter is not only injurious to the reservoir, but is liable to seriously reduce its capacity, it should be drained at regular and frequent intervals by means of the reservoir drain cock.

Fig. 5. Main Reservoir

Enameled reservoirs are strongly recommended on account of their durability and protection against corrosion, oxidation, etc., preserving a greater factor of safety than does the plain unenameled type. These reservoirs are enameled by a special process both inside and out.

S-16 Electric Compressor Governor

The S-16 governor is of the pneumatic double "safety valve" type and consists of two distinct portions; an operating portion and a pipe bracket. The operating portion includes the electrical details and the regulating mechanism.

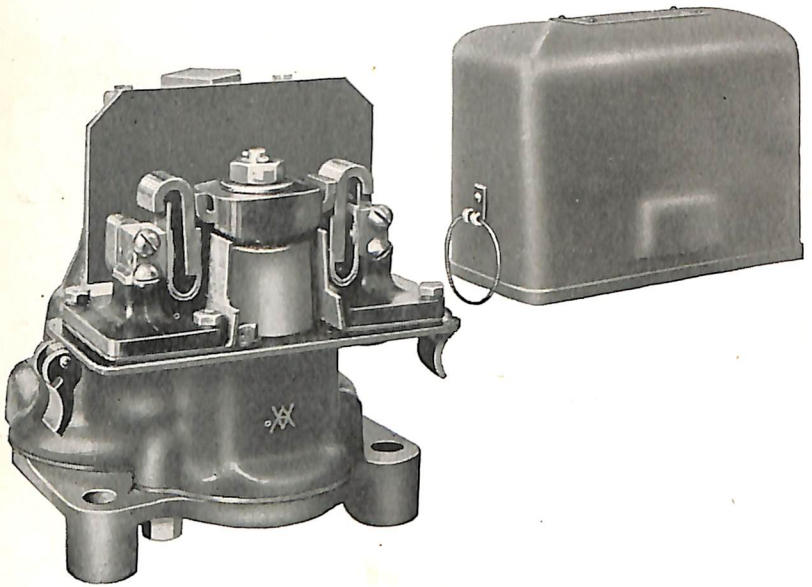

Fig. 6. Photographic View of the Type S-16 Electric Compressor Governor with cover removed

The governor is usually set for a 15-pound range, the actual pressures being determined by the operating conditions of each particular road. The standard and recommended cutting-in pressure is 50 pounds and cutting-out pressure 65 pounds. (See Instruction Pamphlet No. T5042-1 for complete information covering the operation, adjustment, etc., of electric compressor governors).

Air Gage

The *Single Pointer Air Gage*, Fig. 7, is connected to the main reservoir pipe under the brake valve and should be installed in the direct line of vision of the motorman while operating the controller handle, and where it is not obscured in any way by intervening objects, or with strong light back of or near it.

Safety Valve

Valve 4, Fig. 8, is held to its seat by the compression of spring 6 between the flanges of the stem and adjusting nut 7. When the air pressure below valve 4 is greater than the force exerted by the spring, it rises, and as a larger area is then exposed, its movement upward is very quick, being guided by the brass bush in the body 2. Two ports are drilled in this bush upward to the spring chamber; and eight outward through the body to the the atmosphere, although only one of each of these is shown in the cut. As the valve moves upward, its lift

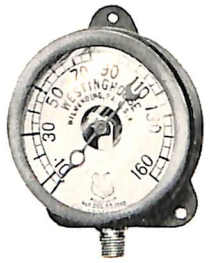

Fig. 7. Air Gage

is determined by the stem 5 striking cap nut 3. It closes the two vertical ports in the bush connecting the valve and spring chambers, and opens the lower ports to the atmosphere. As the air pressure below valve 4 decreases, and the compression of the spring forces the stem and valve downward, the valve restricts the lower ports to the atmosphere and opens those between the valve and spring chambers.

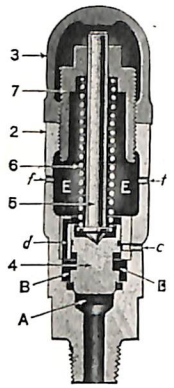

Fig. 8. E-1 Safety Valve

The discharge air pressure then has access to the spring chamber. This chamber is always connected to the atmosphere by eight small holes through the body, 2; the air from the valve chamber enters more rapidly than it can escape through these holes, causing pressure to accumulate above the valve and assist the spring to close it with a "pop" action.

Snap Switches and Fuse Block

Fig. 9. Snap Switch

Fig. 10. Open Fuse Block

In the circuit between the trolley and governor are placed two *snap switches*, Fig. 9, and an *open fuse block* with *fuse*, Fig. 10. The snap switch affords a means of cutting off the current to the air compressor when so desired; while the fuse serves to protect the motor from a dangerous continued overload by blowing, and thus opening the circuit, when the amount of current flowing to the compressor exceeds the capacity of the fuse.

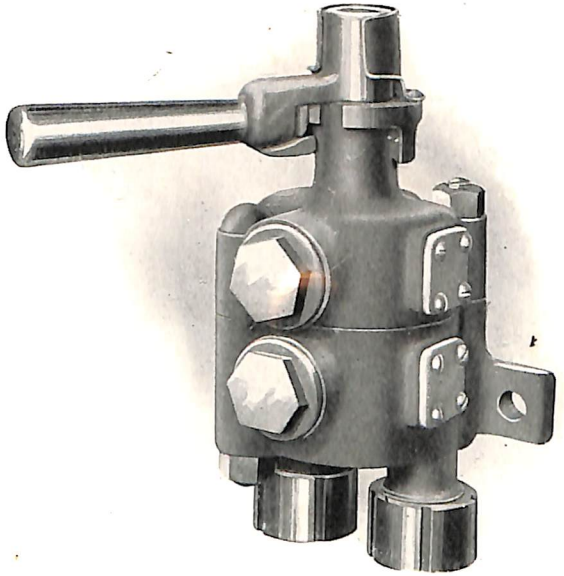

Fig. 11. PV-3 Brake Valve

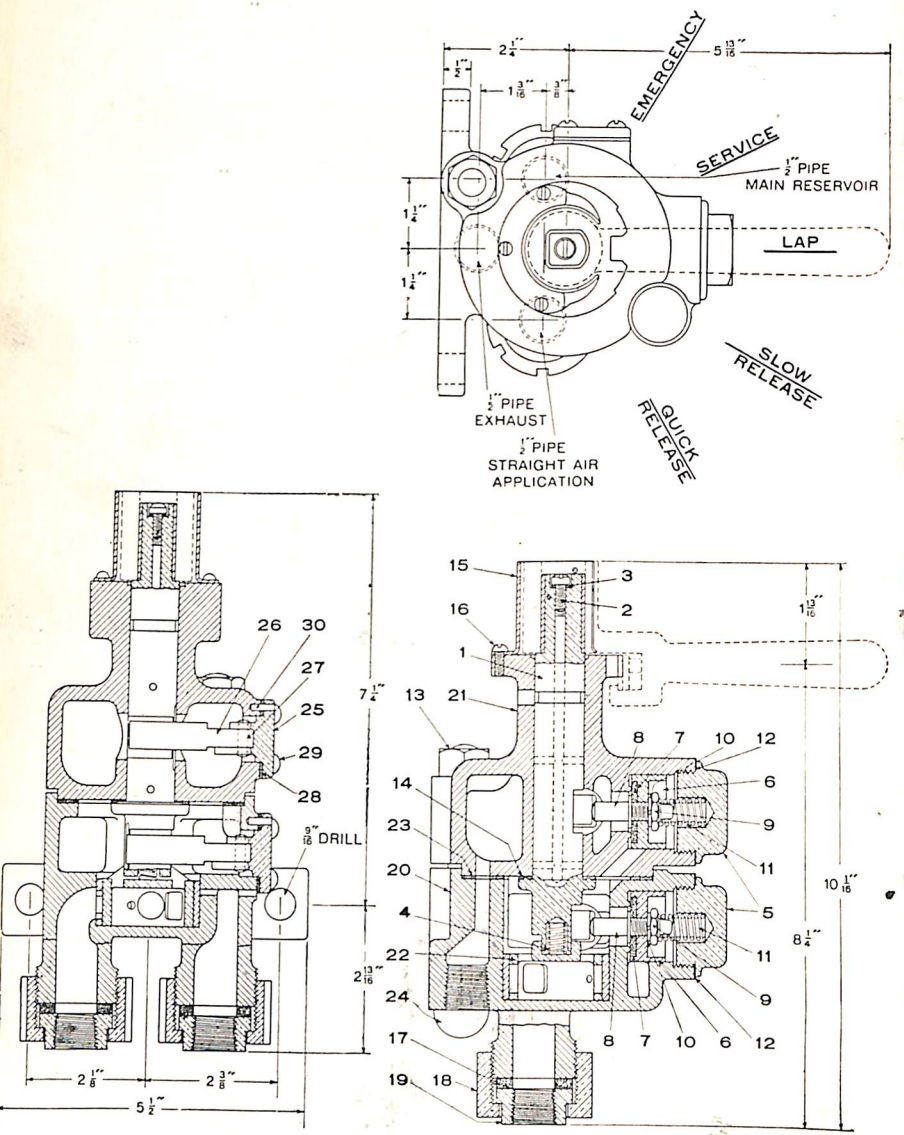

Fig. 12. PV-3 Brake Valve, Plan View and Vertical Sections

Brake Valve

The brake valves are located in the motorman's compartment at each end of the car. The PV-3 Brake Valve is of the piston valve type with a removable handle.

Three pipe connections are made to the lower portion or bracket as follows: straight-air application and release pipe, emergency pipe or main reservoir pipe, and exhaust pipe.

The different positions of the brake valve handle, in order from left to right, are:

1. *Quick Release* position in which the brake cylinder is connected to the exhaust.

2. *Slow Release* position in which the brake cylinder is connected to the exhaust through a restricted port.

3. *Lap* position in which all the ports are blanked except the exhaust, thus holding any pressure in the brake cylinder that may have been established therein. This is the only position in which the handle can be removed.

4. *Service* position in which connection is made from the reservoir pipe to the application and release pipe through a relatively small opening, thus admitting air to the brake cylinder and applying the brake.

5. *Emergency* position in which a large opening is made from the reservoir pipe to the application and release pipe, thereby admitting main reservoir pressure into the brake cylinder in the shortest possible time.

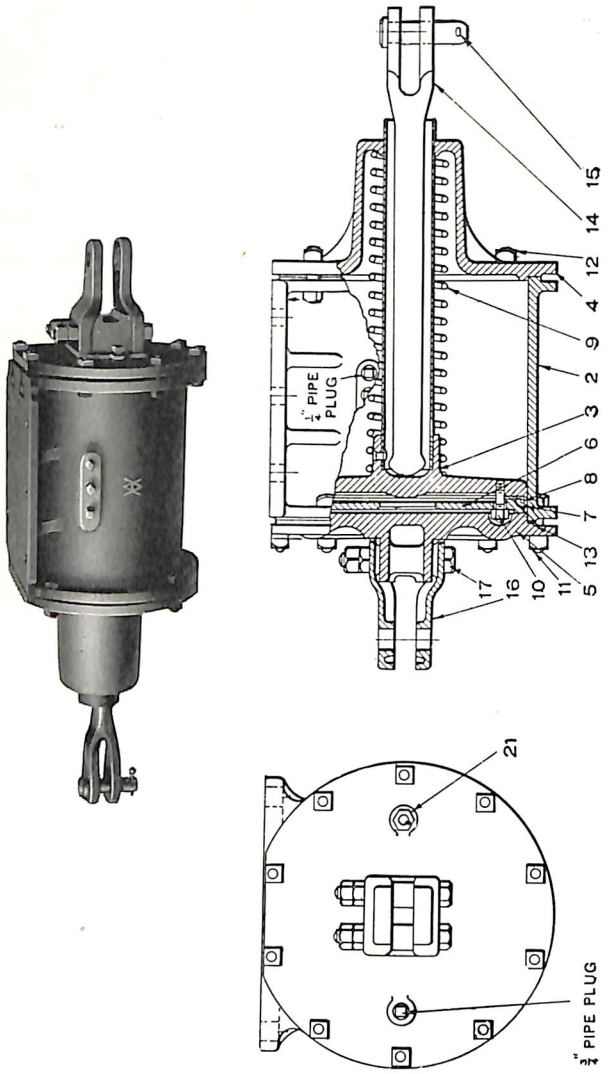

Fig. 13. Type S Brake Cylinder, Exterior and Sectional Views

Brake Cylinder

The *brake cylinder*, Fig. 13, should be located in such a manner that it is convenient for inspection work.

The piston, 3, has a hollow rod in which is a solid push rod, 14, attached to the levers of the foundation brake rigging. This allows the brakes to be applied by hand without moving the piston, but a pneumatic application forces out both hollow piston rod and push rod. The movement of the brake rigging must therefore be free from binding or undue friction, and adequate clearance provided for both hand brake and air brake systems, to insure that the push rod shall return fully home when a release is made.

The release spring, 9, forces the piston to release position when the air pressure is exhausted from the opposite side of the piston.

The packing cup 7 presses against the cylinder wall and prevents the escape of air past the piston.

Alarm Whistles

The *alarm whistle valve* should be within easy reach of the motorman while operating the controller handle. The *alarm whistle*, *whistle valve* and *whistle cut-out cock* are connected directly to the main reservoir pipe.

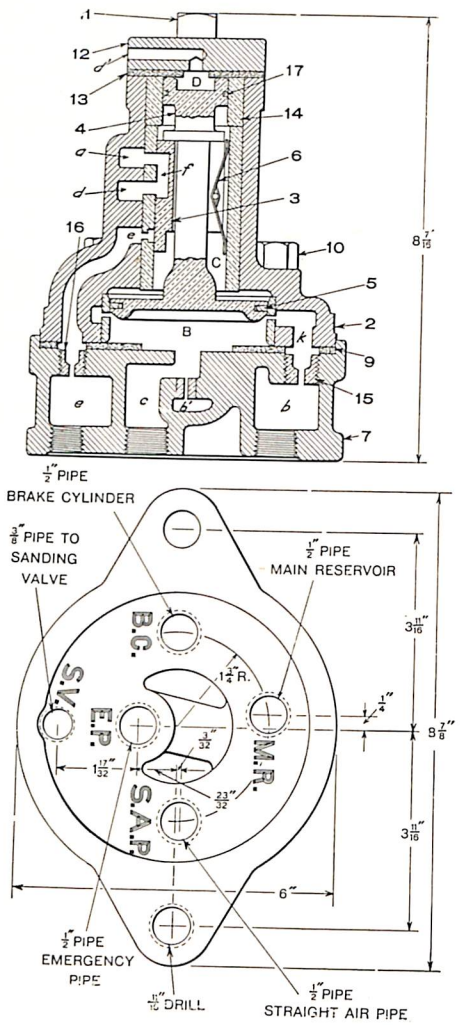

Fig. 14. Section and End View of the Type H-2 Emergency Valve

H-2 Emergency Valve

The *emergency valve* is mounted on a pipe bracket to which all pipe connections are made, so that the emergency valve can be removed for cleaning and repairs without breaking any pipe joints. The bracket provides for pipe connections as follows:

½″ pipe to brake cylinder, marked "B.C."
½″ pipe to main reservoir, marked "M.R."
½″ pipe to straight-air pipe, marked "S.A.P."
½″ pipe to emergency pipe, marked "E.P."
⅜″ pipe to sanding valve, marked "S.V."

The emergency valve is a protective device only with this equipment as it is inoperative during normal operation, but functions in case the emergency pipe is broken, or the conductor's valve opened, to cause an emergency application of the brake by supplying main reservoir pressure direct to the brake cylinder. During normal operation of the equipment, the emergency valve piston 4 and slide valve 3 are in release position as shown in the sectional view, Fig. 14. Port *a* in the seat leading to the brake cylinder and port *d* leading to the straight air pipe are connected by cavity *f* in the slide valve, so that communication is open through the emergency valve between the brake cylinder and the brake valve, and the brake can be applied and released as desired by proper manipulation of the brake valve.

Quick Release Valve

The *quick release valve* is installed in the branch from the straight-air pipe to the emergency valve as shown on the isometric piping diagram of the equipment, Fig. 29, for the purpose of shortening the time required to release the brake.

Fig. 15 is a sectional view of the quick release valve in which the parts are shown in normal position. No function is performed by this device during brake application, straight-air pipe pressure on top of piston 3 forcing it down and flowing past valve 4 to the brake cylinder, but when the brake is released, brake pipe pressure under piston 3 forces the piston upward and unseats the exhaust valve 5 which allows the brake pipe pressure to exhaust direct to the atmosphere.

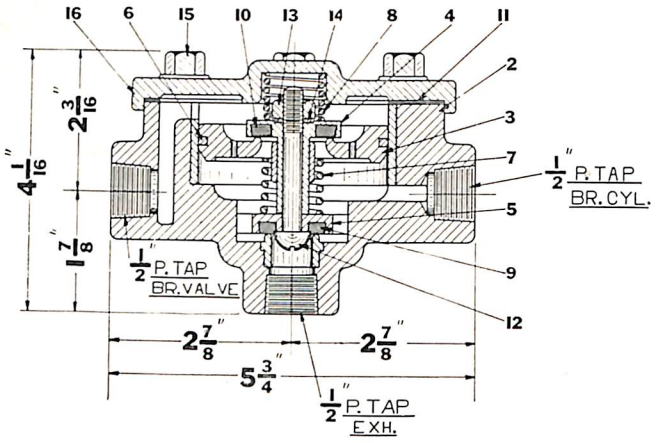

Fig. 15. Sectional View of the Quick Release Valve

Conductor's Valve

The *Conductor's Valve*, an additional safety device of no small importance, Fig. 16, is connected to the emergency pipe and may be located at any convenient point in the car, preferably with a cord attached to its handle and running the length of the car. When this valve is

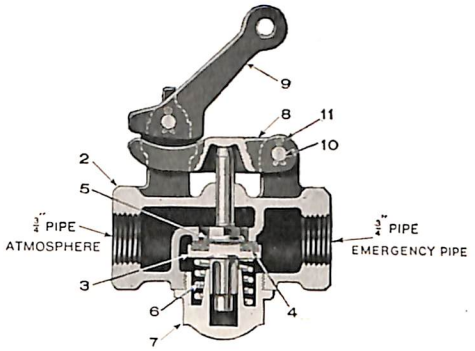

Fig. 16. B-3-A Conductor's Valve

opened, the air in the emergency pipe flows directly through it to the atmosphere, setting the brakes in emergency. Therefore, it should be used only in case of actual danger, and should then be opened as wide as possible and left open until the car stops. This style of conductor's valve is of the non-self-closing type and must therefore be closed by hand.

OPERATION OF THE EQUIPMENT

Figs. 23 to 27 show diagrammatically the relation of the different parts of the equipment corresponding to the different positions of the brake valve handle. The actual proportions and mechanical construction of the parts have been disregarded where necessary to make the connections and operation more easily understood.

Charging

With the main reservoir charged and the brake valve handle in either *Quick Release* or *Slow Release* positions, Fig. 23, air flows from the main reservoir through passage b' in the emergency valve, and choke into passage c leading to the emergency pipe and to chamber B on the face of the large piston. Assuming that the double piston 3 is in its lower position, main reservoir air also flows through passages k and b into the slide valve chamber C. The large piston then has main reservoir pressure acting on both sides while the small piston has main reservoir pressure under it and atmospheric pressure on top. The greater pressure underneath the small piston then forces the double piston and slide valve 4 upward to release position, as shown in Fig. 23.

The emergency pipe is charged to main reservoir pressure through passages b' and c, and the brake cylinder is connected to the atmosphere through the emergency valve (slide valve cavity f), quick release valve (ports c in piston 7), and to brake valve exhaust through the straight air application and release pipe.

Service

To apply the brake the handle of the brake valve is moved to *service* position, Fig. 24. In this position the admission valve (in bracket portion 20) is open, permitting main reservoir air in passage *a* to flow through restricted port *l* of the graduating valve 22 and passage *g* to the brake cylinder, (through the straight air application and release pipe, quick release valve and emergency valve), forcing the piston outward and applying the brake.

Air from the straight air application and release pipe flows through passage *e* into chamber *d* of the quick release valve, forcing piston 7 downward away from valve 9 and continuing past this valve through chamber *b* and passage *a* to the emergency valve, and thence to the brake cylinder through passages *d* and *a* in the seat and cavity *f* in the slide valve.

Holding

When the desired brake cylinder pressure has been obtained, the brake valve handle should be placed in *Lap* position, Fig. 25. In this position all valves are closed, thus cutting off further flow of air to the brake cylinder.

When brake cylinder pressure rises to within a few pounds of straight air pipe pressure, spring 6 under piston 7 of the quick release valve will move the piston back to normal position in which valve 9 is closed, and final equalization of these pressures takes place through ports *c* in the piston.

Quick Release

When the brake valve handle is placed in *Quick Release* position, Fig. 26, air from the straight air pipe flows through passage *g*, port *b* of the graduating valve 22, past the release valve (in upper portion 21), and passage *e* to the exhaust pipe.

The reduction in straight air pipe pressure also takes place in chamber *d* above piston 7 of the quick release valve through passage *e*. Brake cylinder pressure under the piston in chamber *b* then forces the piston upward (against spring 14) carrying with it valve 9 and the attached exhaust valve 5, thereby unseating the exhaust valve and allowing brake cylinder pressure to flow rapidly to the atmosphere through passage *a* and chamber *b*, past the exhaust valve and to the quick release valve exhaust through passage *g*.

Whether the brake valve handle is left in *Release* position or moved to *Lap* position, brake cylinder pressure will continue to exhaust through the quick release valve until the pressure is reduced nearly to that in the straight air pipe. Spring 14 will then move the piston back to normal position, seating exhaust valve 5, and the remaining pressure in the brake cylinder will flow through ports *c* in the piston and to atmosphere through the brake valve exhaust.

The release spring in the brake cylinder then forces the piston back, thus releasing the brake shoes from the wheels.

Slow Release

The operation of the brake valve with the handle in *Slow Release* position is the same as in *Quick Release* position, Fig. 26, except that the small port *l* (also used in *Service* position) of the graduating valve 22 is open in *Slow Release*, thus permitting a more gradual reduction of brake cylinder pressure, than *Quick Release* position in which the larger port *b* is open. *Slow Release* is generally used as *Running* position.

Under normal conditions the quick release valve will not function with the brake valve handle in *Slow Release* position. The flow of brake cylinder pressure through port *l* in the graduating valve 22 is so restricted that this pressure is maintained above piston 7 of the quick release valve through ports *c* and consequently the piston remains in normal position, with the exhaust valve closed.

Emergency

The *Emergency* position of the brake valve handle should be used only when it is necessary to stop the car within the shortest possible distance in order to avoid accident. In this position, Fig. 27, main reservoir air is admitted to the brake cylinder through passage *a*, past the admission valve (in bracket portion 20), through port *h* of graduating valve 22, and passage *g*. The size of port *h* in the graduating valve is such as to permit a rapid equalization of main reservoir and brake cylinder pressures. The flow of air to the brake cylinder through the quick release valve and the emergency valve is the same as described under "Service".

No movement of the emergency valve parts takes place during a brake valve emergency as the choke ports in the emergency valve and the graduating port in the brake valve are so proportioned that emergency pipe pressure can not reduce rapidly enough to cause the emergency piston to go to application position.

Conductor's Valve Emergency

Opening the conductor's valve permits pressure in the emergency pipe to flow to the atmosphere faster than it can be admitted to chamber *B* in the emergency valve, through the choke ports *b'* and *k* from the main reservoir. The greater pressure in the slide valve chamber *C* causes the piston 3 and slide valve 4 to move downward to application position, Fig. 28. This movement uncovers port *a* in the slide valve bush so that the main reservoir has direct communication with the brake cylinder, in consequence of which air flows rapidly from the reservoir to the brake cylinder until both pressures become equalized.

In the same way, should the emergency pipe become ruptured, the resulting drop in emergency pipe pressure will insure an emergency application of the brake as described. It will be noted that port *e* leading to the sander is open through port *h* in the slide valve to chamber *C*, thus permitting main reservoir air to flow to the sander.

With the emergency valve parts in application position, the brake can not be released until the conductor's valve is closed, or rupture in the emergency pipe repaired and pressure restored in the emergency pipe. The slide valve and piston will not move, however, and the brake

will remain applied, until the pressure in chamber *B* (and the emergency pipe) has become equal to the pressure in chamber *C*, when due to the fact that chamber *D* is connected to the atmosphere, the double piston will return to non-operative position. When the piston is in application position, the only source of supply for chamber *B* is through port *b* and the choke, thereby lengthening the time of equalization and the consequent release of the brake.

SX-2 BRAKE VALVE

Equipment with the SX-2 brake valve which is recommended for use with 8″ and 10″ Brake cylinders only, is illustrated diagrammatically by Figures 30 to 33. The quick release valve and the emergency valve are not included in these illustrations, however, as they are described under "Operation of the SM-3 Equipment."

Running

Fig. 30 illustrates the equipment while running along the road with brakes fully released and main reservoir charged.

Service

To apply the brakes the brake valve handle is moved to *Service* position, Fig. 31. In this position restricted port *l* in the rotary valve of the brake valve registers with port *g* in the seat, permitting main reservoir air in chamber A to flow through these ports to the brake cylinder, forcing the piston outward and applying the brakes.

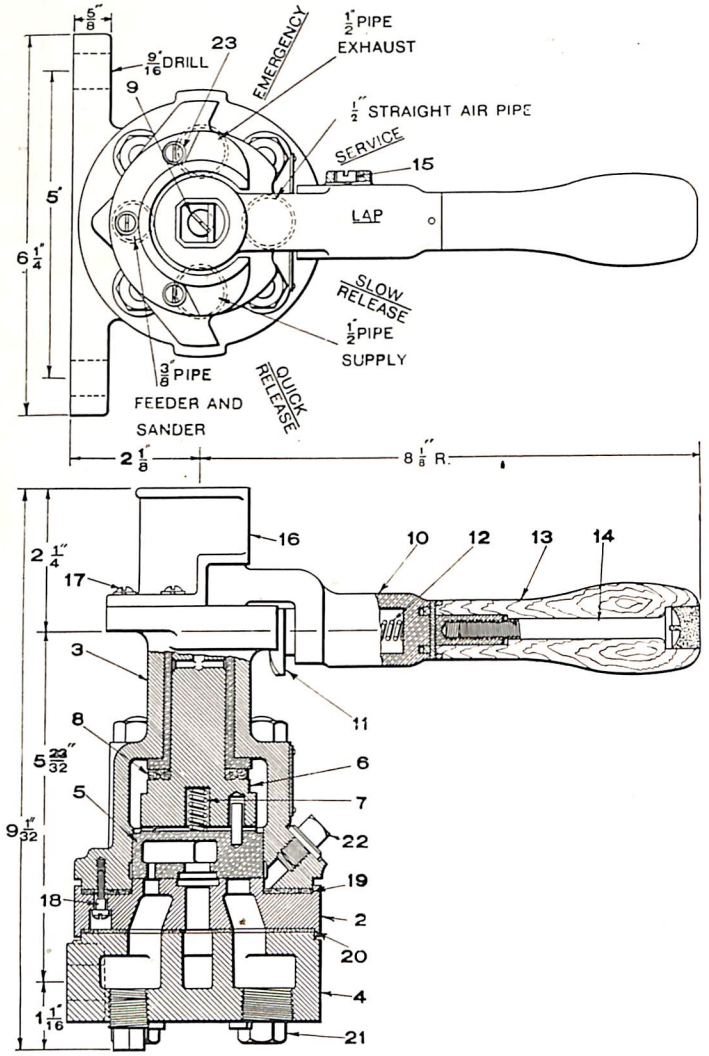

Fig. 17. SX-2 Brake Valve Plan and Vertical Section

Holding

When the desired brake cylinder pressure has been obtained, the brake valve handle should be placed in *Lap* position, Fig. 32. This blanks port *g* and cuts off further flow of air to the brake cylinder.

Release

When the brake valve handle is placed in *Release* position, Fig. 30, air from the brake cylinder flows back through passage *g* in the brake valve, ports *b* and *d* and cavity *c* in the rotary valve and passage *e* in the seat to the atmosphere. The release spring acting on the opposite side of the brake cylinder piston then forces it back and releases the brake shoes from the wheels.

Emergency

The *Emergency* position of the brake valve should be used only when it is necessary to stop the car within the shortest possible distance to avoid accident. In this position main reservoir air is admitted to the brake cylinder through passage *a* in the brake valve, thence through the large port *h* in the rotary valve and port *g* in the seat, Fig. 33, in consequence of which air flows quickly from the reservoir to the brake cylinder until both pressures become equalized.

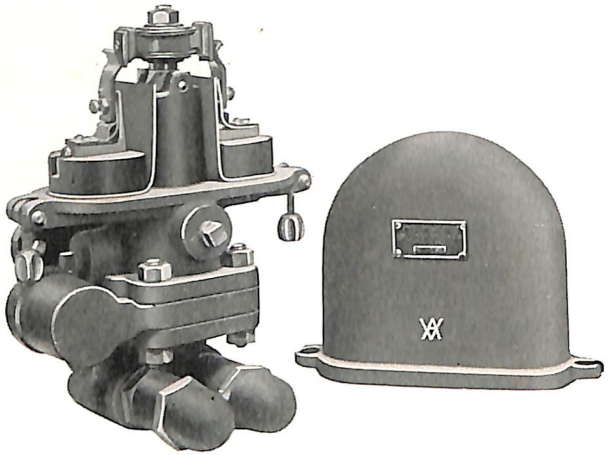

Fig. 18. Photographic View of the Type S-6-A Compressor Governor with cover removed

LOCOMOTIVE STRAIGHT AIR BRAKE

The S-6-A Compressor Governor and the S-3 Straight Air Brake Valve are sometimes used on small single end industrial locomotives. Fig. 18 is a photographic view of the S-6-A governor which is fully described in Instruction Pamphlet No. T 5042-1.

Type S-3 Brake Valve

This brake valve is of the "poppet" valve type. There are two leather-seated valves, the application valve 8 and the release valve 9. The positions of the brake valve handle are *Release*, *Lap*, and *Application*.

Fig. 19, is a longitudinal section showing the application valve open and the release valve closed. Fig. 20 is a cross section at the application valve with the handle in *Lap* position, both valves being closed. Fig. 21 is a cross section at the release valve showing this valve open, viz., with the handle in *Release* position.

Release and Running

The S-3 Brake Valve handle should be carried in this position at all times when the brake is not in use (see Fig. 21). The application valve 8 is held seated by its spring and main reservoir pressure with which it is al-

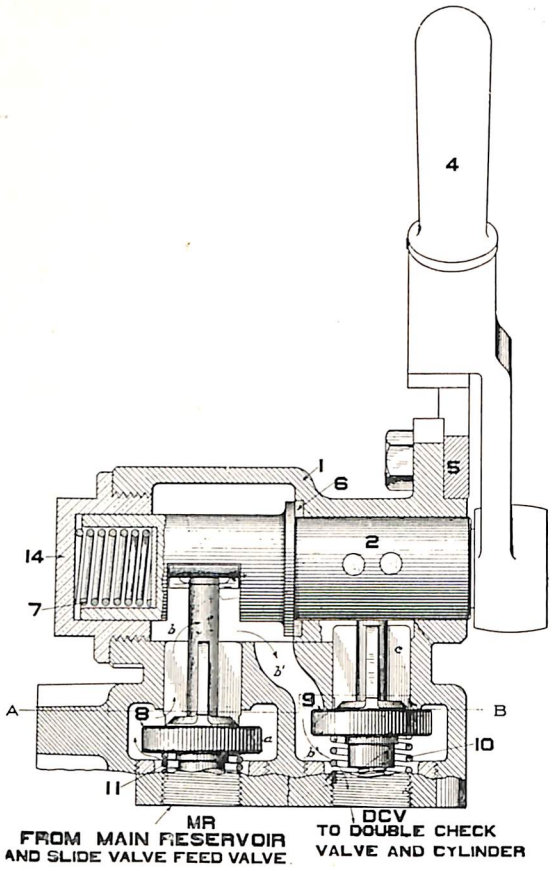

Fig. 19. S-3 Straight-Air Brake Valve in Application Position

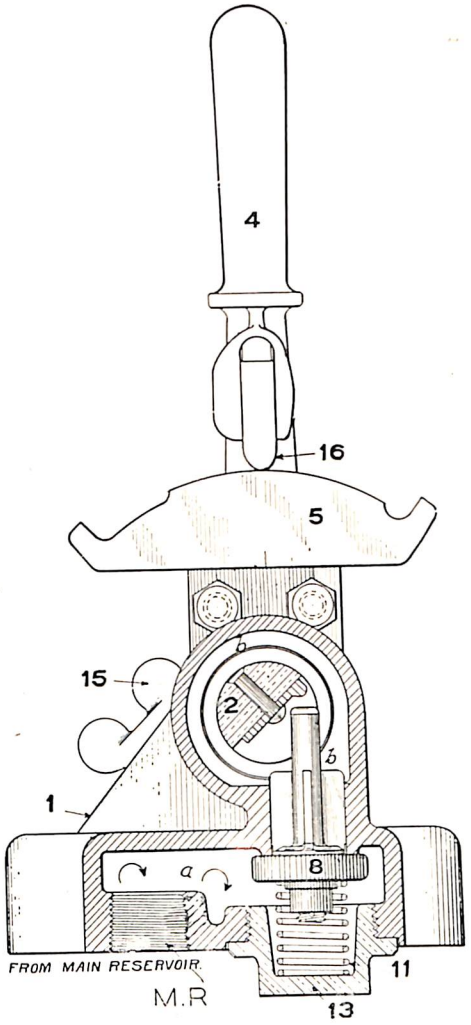

Fig. 20. Cross Section of S-3 Straight-Air Brake Valve in Lap Position

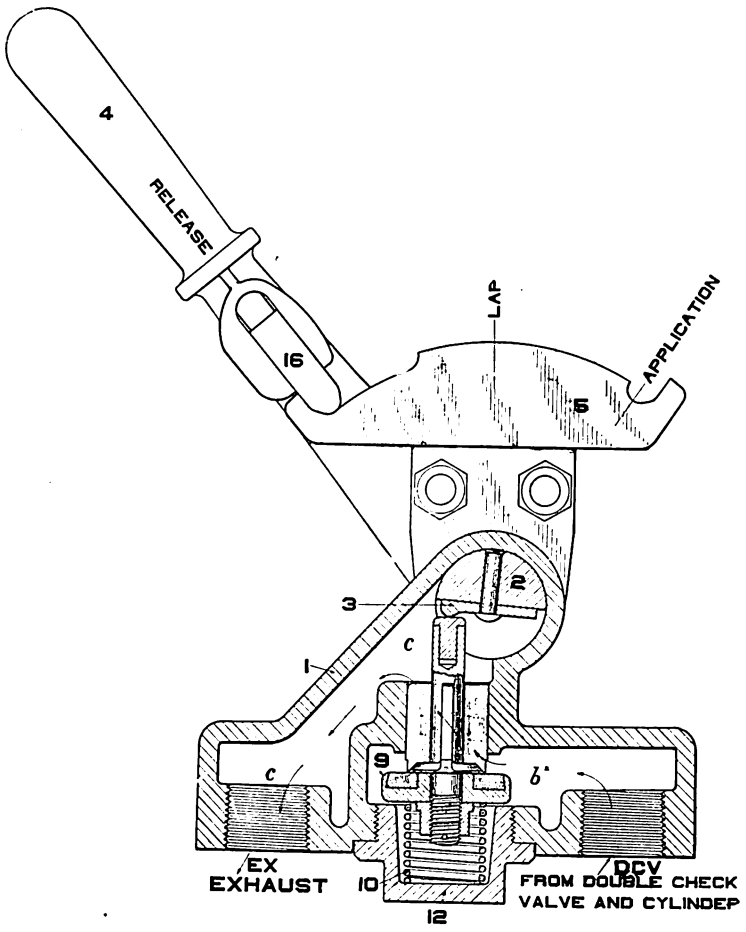

Fig. 21. Cross Section of S-3 Straight-Air Brake Valve in Release Position

ways in communication, and the release valve 9 is held open by the steel tappet 3 attached to the shaft 2. This opens communication between the straight-air pipe and the exhaust opening.

Application

When the brake valve handle is placed in *Application* position, Fig. 19, the release valve is closed by its spring and the application valve opened by its tappet on the shaft. Main reservoir pressure is then admitted to the straight-air pipe and flows direct to the brake cylinders.

Lap

Lap position is used to hold the brake applied after the desired cylinder pressure is obtained, both application and release valves being closed, as in Fig. 20. The brakes are thus held applied until a further application or release is made.

Release

To release the locomotive brakes the handle of the brake valve is moved to *Release* position (Fig. 21) in which the release valve 9 is open, connecting the straight-air pipe with the exhaust opening, which permits air in the brake cylinders to escape to the atmosphere.

Fig. 22. Showing Initial Step in Fitting Piston Packing Cup into the Brake Cylinder

INSTALLATION

Piping

All piping should be so installed that there are no pockets in which moisture can collect and freeze in cold weather. Before installing the brake valves, the pipes should be hammered to loosen the scale and dirt, have fins removed, and be thoroughly blown out to remove all this foreign matter. Bends should be used wherever possible instead of ells. A suitable compound to make a tight joint should be applied on the male threaded portion only, and never in the socket. Do not use red or white lead. After piping is complete, all joints should be thoroughly tested under pressure with soap-suds and made air tight.

It is recommended that individually tested pipe fittings known as "Extra Quality Fittings" be used in connection with all air brake piping. These fittings are thoroughly tested under pressure and guaranteed not to leak; in addition, they are carefully threaded and finished so that the installation of pipe and fittings is carried out with the least amount of testing and substitutions in the way of refitting. Also, it is especially recommended that brass to iron seat unions be used. These insure air tight joints and greatly facilitate the removal of valves to which pipes are connected. Furthermore, the necessity for providing the ordinary gaskets and keeping account of same is obviated.

Twenty-five feet of radiating pipe should be installed between the compressor and the main reservoir, five feet or more of which, adjacent to the main reservoir to be 2 inch-pipe, the remainder to be the same as the compressor discharge. For obvious reasons, the reservoir and radiating pipe should be placed as low and as near the outside of the car as possible, and well removed from sources of heat, such as resistance grids, motors, etc.

The *suction strainer* is connected by piping with the air inlet of the compressor and should be so located, preferably on top of the car, as to insure a supply of clean, dry, cool air, which adds materially to the efficiency and life of the compressor.

The *Safety Valve* should be installed in a branch pipe about one foot long taken from the discharge pipe not more than four feet from the compressor. The branch pipe should be so arranged as to drain toward the discharge pipe and the safety valve should be installed as near a vertical position as possible. It should be set at a pressure 10 pounds above the cutting-out point of the governor.

The safety valve is adjusted by removing cap nut 3, and screwing up or down the adjusting nut 7. After the proper adjustment is made, cap nut 3 must be replaced and securely tightened, and the valve operated a few times. Particular attention must be given to see that the holes in the valve body are always open, and that they are *not changed in size,* especially the two upper holes.

The eight holes in the safety valve body are wrapped with insulating tape, when in storage or being shipped, to prevent entrance of dirt into the valve.

Wiring

The *wiring* should be installed in a thorough manner, great precaution being taken to avoid the possibility of grounds developing after the car has been in service for a time. Whenever practicable, the wiring should be run inside the car, securely cleated in place, and must always be so located that it may not be damaged when the body is being jacked up. At exposed places underneath the car and particularly at those points where the wire comes in contact with iron, it must be covered with rubber tubing. The size of rubber insulated wire which we recommend for compressors up to and including 38 cu. ft. displacement when operating on standard railway voltage is No. 14 B. & S. gage. Although smaller sizes might do the work without excessive drop in voltage or danger of overheating, still they lack mechanical strength and a smaller size of wire than No. 14 is undesirable on this account. Under these conditions, the 50 ft. displacement compressor should be wired with No. 12 B. & S. gage.

The sequence in which the various parts should be connected is shown in Fig. 29, but the point at which the compressor circuit shall be tapped to the main trolley line is one to be determined in each individual case. We recommend connecting between the choke coil and circuit breaker in order to obtain lightning protection, but to be independent of the circuit breaker.

By tapping on the trolley line outside the main switches we overcome all disadvantages, and if the connection is made between the first main switch and the

point where the light circuit is tapped off, *and the lamp circuits are turned on during storms,* a very efficient *lightning arrester* is provided. The better plan, of course, is to provide a separate arrester for the compressor circuit, which involves only a slight additional expense.

From the trolley connection, run the wire first to one compressor snap switch and then to the other, connecting them in series, and making sure that when they are open, their dials show the word "Off" and when closed "On"; thence through the fuse block to the governor where the connection may be made to whichever terminal is most convenient. From the remaining terminal run a wire to the motor where the connection must be made to the field lead. The other lead must be connected to the main motor ground wire; by this means a grounded field coil or lead can cause no damage to the armature. The positive wire leading to the motor, and the ground return from same should, under no circumstances, pass through the same hole or be cleated together, but should be kept three or more inches apart.

The compressor snap switches, one at each end, should be placed within easy reach of the motorman without necessitating his moving from his customary position.

The fuse block should be connected between the last snap switch and the governor. It ought not to be placed so that a screw driver or other implement is needed to remove or replace the fuse, but should be easily accessible, in a dry place, and well removed from any possible ground connections.

MAINTENANCE

Piston Travel

The travel of the piston should be adjusted to 4 inches (standing) as nearly as practicable. This is important for if the piston travel is too short a high braking power will be obtained when only a low braking power is desired, a given brake cylinder pressure will be obtained more quickly, and the time in which the motorman can perform the operation is greatly reduced. On the other hand, if the piston travel is too long there is danger of the piston striking the cylinder head or fouling of the levers; besides the air consumption is excessive.

The correct operation of the brakes can be secured only by maintaining a uniform piston travel. The increase in the slack of brake rigging, due to the wearing away of brake shoes, must be constantly watched and taken up by means provided in the brake rigging, thereby maintaining the piston travel as nearly uniform as possible. By far the best means for accomplishing this is to install, in all cases where possible, the Automatic Slack Adjuster. Where this is not done, proper inspection and adjustment must be made at sufficiently frequent intervals to prevent any material increase in piston travel. As this inspection and adjustment has to be made while the car is standing, it must be remembered that running travel in traction service is generally from ½″ to 1″ longer than standing travel, so that if a 5″ running travel is desired, the standing travel should be

adjusted to about 4″. If the Automatic Slack Adjuster is used, its pipe should be connected with the brake cylinder at the hole located 5⅜″ from the pressure head.

Piston travel should never be altered to obtain sufficient shoe clearance. This should be obtained by using a brake cylinder of proper size for the brake force to be developed, and through proper proportioning of the foundation brake rigging. When inserting new shoes to replace those worn out, the brake slack should be let out first, and the piston travel adjusted properly after the new shoes are in place.

Lubrication

Brake Cylinder

Close the branch pipe cut-out cock and drain the auxiliary reservoir. Fasten the piston sleeve and non-pressure head together with a nail or pin through the hole provided in the sleeve or with a suitable clamp. Remove the nuts from non-pressure head bolts, then remove the piston from the cylinder.

CLEANING CYLINDERS. Scrape the old lubricant from the cylinder wall and leakage groove and wipe these surfaces clean and dry. Kerosene may be used for assisting in cylinder cleaning but must be completely removed to prevent serious damage to rubber cylinder gaskets and leather packing cups when used. If the cylinder wall is rusted, the rust should be removed with sand paper.

CLEANING PISTON AND PACKING CUP. Remove expander ring (if used) from piston. Scrape old lubricant from the metal part and packing cup and wipe all surfaces clean and dry. The packing cup should be carefully examined and should be renewed if thin at any point, cut, cracked, or otherwise defective. Examine piston and follower plate for cracks and tighten up follower plate nuts.

PACKING LEATHER EXPANDER RINGS. Replace the packing leather expander ring (if used) with one which has been checked in a special gage designed for this purpose; the displaced ring to be returned to the shop for checking. No expander ring is used with WABCO cups.

APPLYING NEW PACKING CUPS. Examine follower studs for tightness in the piston. Locate the packing cup centrally on the piston. Place the follower in position and apply the nuts, bringing them in contact with the follower without tightening. Then draw them down uniformly.

APPLICATION OF LUBRICANT. Apply a coating of brake cylinder lubricant to the wall of the cylinder and to the outside of the packing cup with a brush.

ASSEMBLING. The piston should be stood on end, with the top edge or flat side of the non-pressure head flange and the opening of the expander ring (if used) toward the workman. With the piston in this position, enter it into the cylinder. The sleeve or rod should then be slowly raised and the piston moved into the cylin-

der until the upper portion of the packing cup engages the cylinder wall. Form this portion into the cylinder while the sleeve or rod is being gradually raised, taking special care not to crimp or otherwise damage the packing cup. Then pull upward and outward on the sleeve or rod until it is in horizontal position. Push the piston to its release position and then raise the sleeve or rod to the top of the cylinder to determine whether the expander (if used) is in its proper position, which will be indicated by freedom of movement.

When assembling pistons in brake cylinders in other than the customary location below the underframe, the methods employed must be changed as required to produce similar results.

Lubrication of Brake Valves

A good grade of graphite grease is recommended for use on the rotary valve seat and the rotary valve key whenever it can be conveniently applied, as when assembling the device after overhauling, repairs, etc. However, as graphite grease can not be used for lubricating the valve after it is assembled, the oil screw in the rotary valve key should be removed occasionally and a few drops of a good grade of oil applied. Whatever lubricant is used should be applied very sparingly.

Lubrication of the Emergency Valve

Under ordinary service conditions, the emergency valve should be thoroughly cleaned and lubricated once in three months. The proper intervals is best determined for each particular case by a careful inspection and trial.

Where conditions are severe, more frequent inspections will, no doubt, be found necessary. Where the valve is not subjected to hard usage the interval may be lengthened.

Never remove the movable parts of the emergency-valve while it is on the car. If the valve is not working properly or needs cleaning and oiling, take it down and replace it by a valve in good condition. All cleaning and oiling should be done at a bench, by a competent man, where the liability of damage to the internal parts of the valve is least. Any attempt to take the emergency valve apart while still on the car is almost sure to result in a large percentage of valves being injured by careless handling or dirt getting inside the pipes or valve.

Following is the recommended practice with reference to lubricating emergency valve:

All oil, gum or grease should be thoroughly removed from the slide valve and its seat in the bush, using benzine or gasoline to insure this.

The slide valve and its seat and the upper portion of the bushing where the slide valve spring bears should be lubricated with a high grade of very fine, dry, pure graphite, rubbing it in until the slide valve and seat show a dark copper color.

To apply the graphite, use a stick in the shape of a paddle about 8 inches long and having a small piece of chamois glued to one end. Put a small amount on the chamois skin and rub on the surfaces specified. Leave no free graphite on the face of the slide valve or seat. When the work is completed, the slide valve and its seat must be entirely free from oil or grease. Care should be taken when handling the parts after lubricating that the hands do not come in contact with the lubricated parts as the thin coating of graphite is easily removed.

The emergency valve double piston should be removed and both the large and small bushings thoroughly cleaned out with a cloth saturated with a good grade of lubricating oil, filling the pores of the metal with oil. Then wipe out the bushings with a clean cloth and apply the double piston without lubrication on the ring.

CAR TESTS

In preparing the car for service and before making the following tests follow carefully the rules given under the heading, *Charging*, page 7.

See that the hand brake is released. The fuse in the compressor circuit must be in place and "live". Then close the compressor switches and start the compressor.

Test No. 1: When the system is charged and the governor stops the compressor, apply the brakes in service and return the handle to *Lap* position. The brake inspector or conductor should then proceed at once to the side of the car noting that the piston travel is correct, that the brake shoes are tight against the wheels and that the brakes are properly applied. If the brake releases after the service application it may be caused by a brake valve not being properly "lapped", by a leaky valve, or brake cylinder packing leather. If any improper operation is observed during this test it should be corrected before proceeding with the next test.

Test No. 2: Following Test No. 1, after having noted that the brakes apply after a service application, release the brakes by placing the brake valve handle in *Full Release* position. Leaving the handle in this position, the brake inspector should return to the side of the car, examining the push rod to see that it has moved back to "full release" and that all brake shoes hang free from the wheels.

Test No. 3: While it is ordinarily safe to assume that the brakes will apply on an emergency application if they apply satisfactorily in service test No. 1, yet the brakes should occasionally be tested by making an emergency application to make sure that no obscure causes exist which would interfere with this most important feature of the brake.

The emergency protection feature should also be tested occasionally by opening the conductors' valve and observing that a prompt application of the brake is obtained and that sand is blown on the track.

HINTS TO MOTORMEN AND CONDUCTORS

Cutting Out Brakes. It is very important not to cut out the power brake unless it is absolutely impossible to operate it safely. Small leaks or temporary inconvenience are not sufficient cause for cutting out the brakes.

Rail Sanding. Whenever it is necessary to sand the rails, this should be done, if practicable, before the brakes are applied, for the reason that if the brakes are set and the wheels begin to slide, the application of sand will not—in all probability—cause them to revolve again, and flat spots are almost sure to result. In such event the best practice is to release the brake slightly at the moment of applying the sand, after which a much higher brake cylinder pressure can be used without causing wheel sliding. If sand is used, the rails should be well and continuously sanded until the stop is made or the brakes released.

We recommend that all apparatus requiring repairs of any consequence be returned to our shops for that purpose. Our facilities for doing this work are of the best, and we can therefore do it more quickly and accurately, at a lower cost and guarantee better satisfaction than where it is handled by other shops not so well equipped. Furthermore, it is of the utmost importance that the manufacturers' standards be not departed from if the parts of apparatus are to be perfectly interchangeable.

GENERAL HINTS

To gain time and economy in the use of power for propelling the car, the brake application should be adapted to the speed and load condition. For example—at a high speed or with a heavy load, make a full application of the brakes and graduate off the pressure by partial releases as the car is coming to a stop. During the stop, the point at which these graduations should be begun and the amount of the graduations will be readily acquired through experience. The initial application should be heavy enough and the distance from the stopping point at which it is begun should be such that the car will stop before reaching the stopping point, unless the graduations are made as related. When the actual stop is made, there should be just sufficient brake cylinder pressure to insure that the car will remain standing.

It is to be remembered that in making these graduated releases, if a mistake in judgment has been made and the car is not likely to stop until it is past the stopping point, the cylinder pressure should be increased by making a re-application. With a small amount of practice, the required degree of skill in making correct stops can be very readily obtained. The condition of the rail is to be considered at all times when making brake applications so as to avoid wheel sliding which greatly lengthens stops.

Westinghouse Traction Brake Company

Pittsburgh, Pa., U. S. A.

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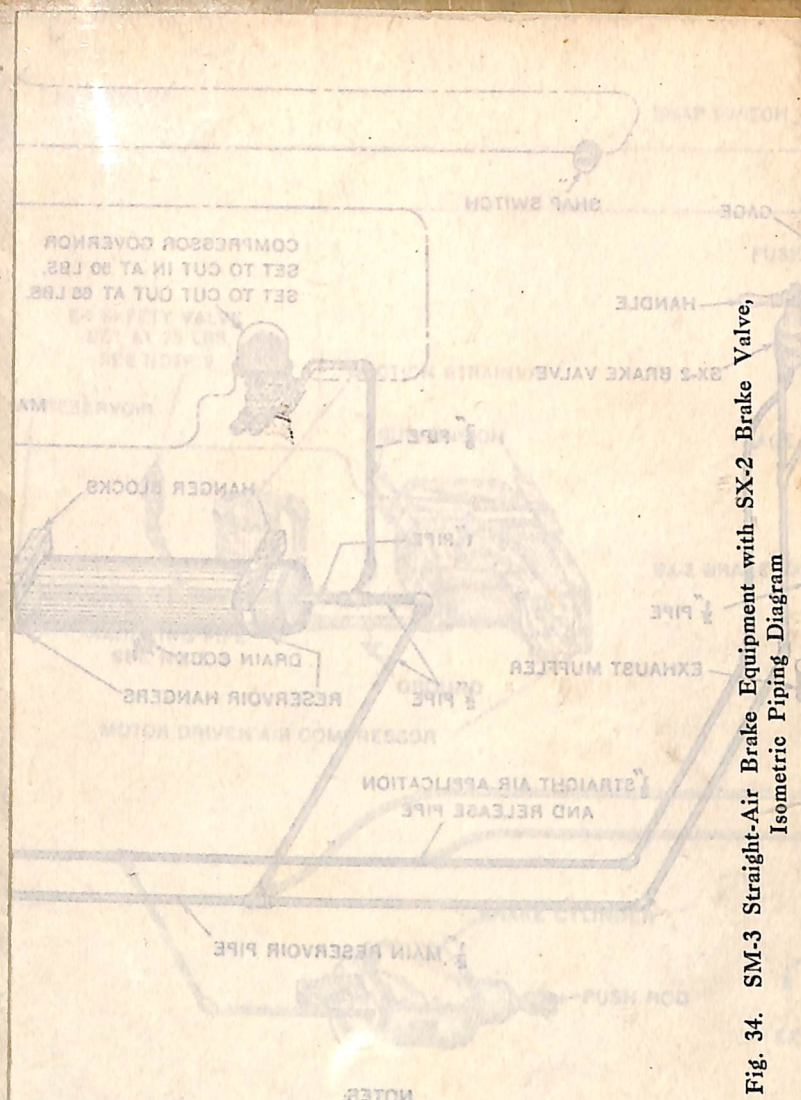
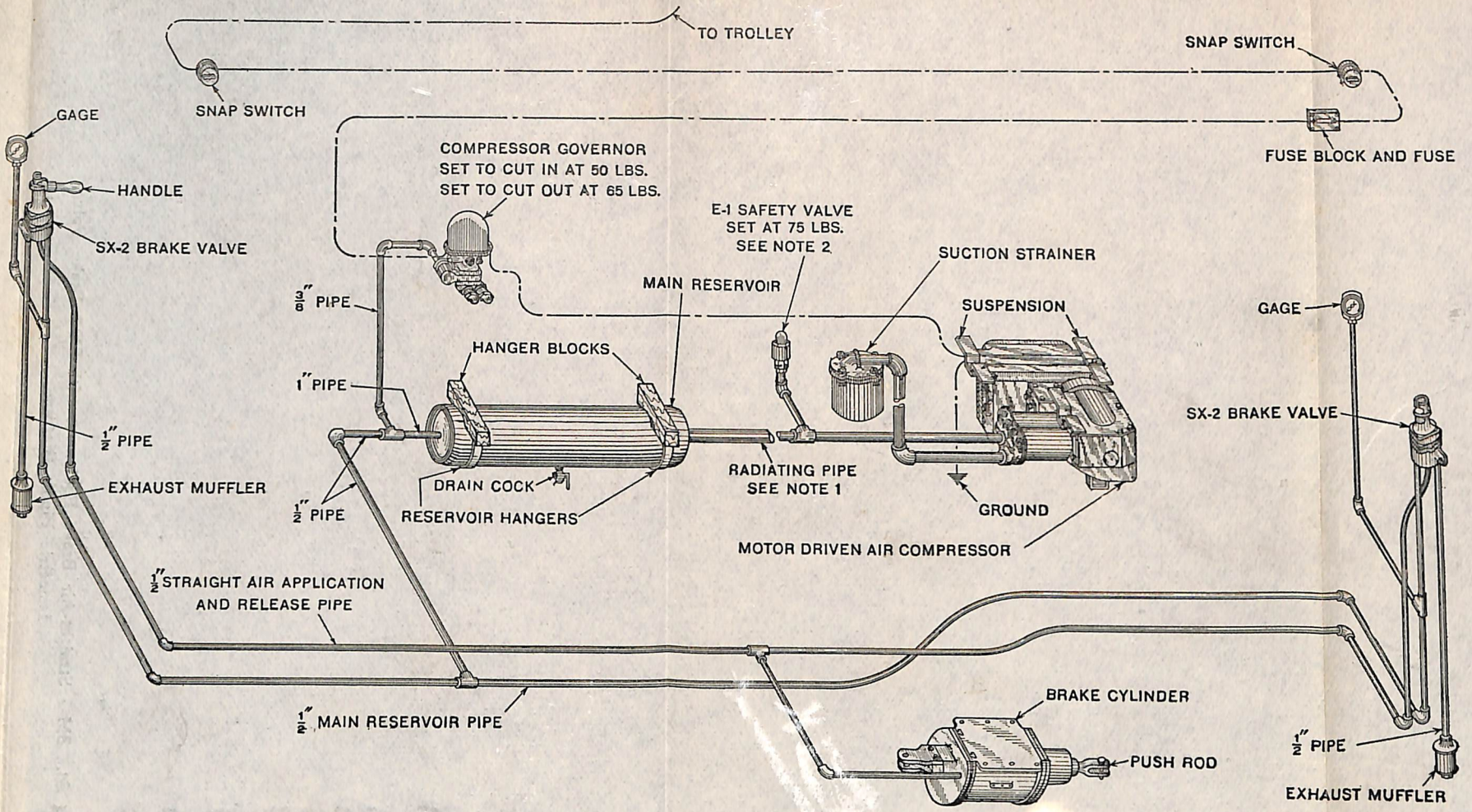


Fig. 34. SM-3 Straight-Air Brake Equipment with SX-2 Brake Valve, Isometric Piping Diagram



NOTES:

(1) 25 FT. OF RADIATING PIPE OF WHICH FIVE FT. OR MORE ADJACENT TO MAIN RESERVOIR TO BE 2 INCHES AND THE REMAINDER TO BE THE SIZE OF DISCHARGE AT COMPRESSOR.

(2) SAFETY VALVE TO BE INSTALLED IN BRANCH PIPE ABOUT 1 FT. LONG, TAKEN FROM THE DISCHARGE PIPE ABOUT 4 FT. FROM THE COMPRESSOR. THE BRANCH PIPE TO BE SO ARRANGED AS TO DRAIN TOWARD THE TEE AND THE SAFETY VALVE TO BE IN VERTICAL POSITION.

Fig. 34. SM-3 Straight-Air Brake Equipment with SX-2 Brake Valve, Isometric Piping Diagram