Combined Automatic and Straight-Air Locomotive Brake Equipment

INSTRUCTION PAMPHLET

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WESTINGHOUSE AIR BRAKE CO.

PITTSBURGH, PA.

PREFACE

HOW TO STUDY THE AIR BRAKE

Because the air brake is a means of *train control,* a thorough understanding of its elementary functions and principles of operation on the part of railroad men who have anything to do with 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 freight and passenger traffic with minimum loss of life or damage to railroad rolling stock and lading.

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 railroad employes.

Practical operating and mechanical railroad 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.

Enginemen, Firemen, Conductors, Brakemen and Train Crews Generally in Actual Charge of Trains on the Road

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 the requisite engine and train brake tests, and how to operate the brake valve, throttle and sand, 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 intimately the internal workings of the various individual devices which make up the brake system or be familiar with all of the movements 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 engineman, 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 8 to 10 is, therefore, intended primarily for this class of employes.

In reporting repairs needed to internal parts it is of far greater value if the wrong operation is carefully noted and described as this enables the skilled repairman to use his more intimate knowledge of the interior of devices in locating the fault.

Air Brake Foremen, Repairmen, and Test Rack Operators

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 12 to 73 is, therefore intended primarily for this class of railroad employes.

Air Brake Instructors, Inspectors, Road Foremen of Engines, Train Masters, and Officials in Charge of Air Brake Operation and Instruction Generally

This class of railroad officials and employes must understand the functions and features available in each type of locomotive, passenger car, and freight car 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 including a thorough understanding of the conditions which produce break-in-two's, slid flat wheels, excessive shocks and stresses in train handling, or other damage to rolling stock and lading; should know the internal operation and functioning of individual devices; the maintenance of the apparatus in service; train and engine 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 possible practical results for the railroad.

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 Air Brake Company.

INDEX

The Combined Automatic and Straight-Air Locomotive Brake Equipment

Schedule A-1 with SWA and SWB

NOTE.—The reference numbers shown herein are for convenience only and are not to be used when ordering repair parts. See Part Catalogs giving Piece Numbers, etc.

The Combined Automatic and Straight-Air Engine and Tender Brake is now an obsolete equipment for new engines, having been superseded by the No. 6 ET Equipment, which provides additional advantages, with simplified apparatus. The Combined Automatic and Straight-Air Engine and Tender equipment is shown diagrammatically in Figs. 30 and 31, and consists of the *old quick-action automatic arrangement* employed on engine and tender, with the *addition* of a straight-air brake valve and a few simple parts which permit the use of straight-air on the engine and tender brakes *without interfering with their automatic action when the automatic brake valve is used, both being cut in at all times.* The many and important advantages of an independent engine and tender brake are thus obtained, while preserving the functions of the automatic on these and the train brakes.

MANIPULATION

The following instructions are general, and must necessarily be supplemented to a limited extent to fully meet the varying local conditions on different railways. The local offices of the Westinghouse Air Brake Co. (see last page) will, as usual, be glad to co-operate with the railways with this object in view.

The necessary instructions are briefly as follows:*

RUNNING

When not in use, carry the handle of the Automatic brake valve in *Running* position and that of the straight-air brake valve in *Release* position.

STRAIGHT-AIR OPERATION

When using *the straight-air brake only*, carry the handle of the automatic brake valve in *Running* position and insure that not less than 20 lbs. excess pressure is maintained. The straight-air application may be released by moving the straight-air brake valve handle to *Release* position.

While handling long trains of cars, in road or switching service, the straight-air brake should be operated with care, to prevent damage to cars and lading, caused by running the slack in or out too hard. In cases of emergency arising while the straight-air brake is applied, apply the automatic brake instantly. The safety valve will restrict the brake cylinder pressure to the proper maximum.

*Publications 9032 and 9037 cover more extensive treatment of brake handling in freight and passenger service, respectively. They may be obtained upon request

The brakes on the locomotive and on the train may be alternated in *heavy grade service* where conditions (such as short, steep grades or where grade is heavy and straight for short distance) require, to prevent overheating of driving wheel tires and to assist the pressure retaining valves in holding the train while the auxiliary reservoirs are being recharged. This is done by keeping the locomotive brakes released by use of cocks "C" and "D" when the train brakes are applied, and applying the locomotive brakes just before the train brakes are released, and then releasing the locomotive brakes after the train brakes are re-applied. *Be sure to close these cocks at the foot of the grade.*

Care and judgment should always be exercised in the use of driver brakes on grades to prevent overheating of tires.

The small gage will show at all times the pressure in the locomotive brake cylinders, and this gage should be watched in brake manipulation.

GENERAL

The train brakes should invariably be released before detaching the locomotive, holding with hand brakes where necessary. This is especially important on a grade, as there is otherwise no assurance that the car, cars, or train so detached will not start when the air brakes leak off, as they may in a short time where there is considerable leakage.

The automatic brakes should never be used to hold a locomotive or a train while standing even where the locomotive is not detached, for longer than ten minutes, and not for such time if the grade is very steep or the condition of the brakes is not good. The safest method is to hold with hand brakes only and keep the auxiliary reservoirs fully charged, so as to guard against a start from brakes leaking off, and to be ready to obtain any part of full braking force immediately on starting.

The straight-air brake is a very important safety feature in this connection, as it will hold a locomotive with a leaky throttle or quite a heavy train on a fairly steep grade if, as the automatic brakes are released, the slack is prevented from running in or out, (depending on the tendency of the grade) and giving the locomotive a start. To illustrate:—the best method to make a stop on a descending grade is to apply the straight-air brake heavily as the stop is being completed, thus bunching the train solidly; then when stopped, place and *leave* the handle of the straight-air brake valve in *Application* position; then release the automatic brakes and keep them charged. Should the straight-air brake be unable to prevent the train from starting, the automatic brakes will have become sufficiently recharged to make an immediate stop; in such an event enough hand brakes should at once be applied as are necessary to assist the independent brake to hold the train. *Many runaways and some serious wrecks have resulted through failure to comply with the foregoing instructions.*

When leaving the engine, while doing work about it, or when it is standing at a coal chute or water plug, always leave the straight-air brake valve handle in *Application* position.

PARTS OF THE EQUIPMENT

1. An *Air Compressor* to compress air for use in the brake system.

2. *Main Reservoirs* in which to store and cool the compressed air and collect water and dirt.

3. A *Compressor Governor* to automatically control the operation of the air compressor between pre-determined minimum and maximum pressures.

4. A *Triple Valve* on the engine, and one on the tender, to control the charging of the auxiliary reservoir, the admission of air to the brake cylinder and the exhaust of air from it, during automatic operations.

5. An *Auxiliary Reservoir* on the engine, and one on the tender, in which to store compressed air for the direct supply on each vehicle.

6. An *Automatic Brake Valve* to operate the locomotive and train brakes.

7. A *Feed Valve* to regulate the brake pipe pressure.

8. An *Equalizing Reservoir* to insure a gradual reduction of brake pipe pressure, and a gradual stopping of this reduction, regardless of the length of the train.

9. A *Duplex Air Gage* to indicate main reservoir and equalizing reservoir pressures.

10. *Driver-Brake, Truck-Brake and Tender Brake Cylinders, Cut-out Cocks, Centrifugal Dirt Collectors, Hose Couplings, Fittings,* etc. incidental to the piping for purposes readily understood.

11. A *Straight-Air Brake Valve* to operate the locomotive brakes alone.

12. A *Reducing Valve* to reduce the air pressure for straight-air brake use.

13. A *Single Pointer Air Gage* to indicate brake cylinder pressure during straight-air applications.

14. A *Double Check Valve* on the engine and one on the tender to separate the two systems, straight-air and automatic, from each other.

15. A *Safety Valve* on the engine and one on the tender, to limit the brake cylinder pressure to a safe amount.

LOCATION, ADJUSTMENT AND OPERATION OF THE PARTS

STEAM DRIVEN AIR COMPRESSOR

Two general types of Air Compressors are used, viz., the Simple and the Cross-Compound. These are fully illustrated and described in separate instruction pamphlets (Simple, or Single Stage type, No. 5036; Cross-Compound, No. 5026), which will be gladly sent on request. The size and number of compressors used depends upon the service in which the locomotive is engaged.

MAIN RESERVOIRS

As previously stated, the main reservoirs are used to store and cool the compressed air furnished by the air compressor and to collect water and dirt.

Enameled reservoirs are now 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.

All main reservoirs are numbered serially before leaving the factory and a certificate is furnished, setting forth in detail the design, material, construction and tests with a detachable portion covering the specific information which the Interstate Commerce Commission now requires all Interstate Carriers to file.

Fig. 1. Main Reservoir

Each reservoir is provided with a drain cock by means of which all residue may be drawn off at frequent intervals, as water or oil collecting will soon materially decrease the air storage capacity.

Main reservoir capacity for passenger and switch engines should not be less than 40,000 cubic inches, and for freight engines not less than 60,000 cubic inches.

We strongly recommend dividing the main reservoir capacity into two reservoirs of such suitable dimensions, so located and connected by piping, as to give the greatest possible radiating surface for cooling the air to atmospheric temperature, and consequently inducing the precipitation of moisture before the air is used in the brake system. Main reservoirs should be located in as cool a position as possible and never at the side of the fire box.

TYPE SD COMPRESSOR GOVERNOR

The duty of the compressor governor is to sufficiently restrict the speed of the air compressor, when the desired main reservoir pressure is obtained, to prevent this pressure from rising any higher.

The following will explain the construction and operation of the Type SD Compressor Governor.

Referring to Fig. 2—it will be seen that the governor comprises a Steam Portion and a Duplex Regulating Portion.

One steam connection leads to the boiler, while the other leads to the air compressor.

The "Low Pressure" Top, on the left, is connected to a port in the brake valve, through which air from the main reservoir port flows to the feed valve when the brake valve handle is in *Running* position. When running over the road, therefore, with the brakes released, the "Low Pressure" Top of the governor controls the operation of the air compressor. As long as the main reservoir pressure in the chamber below diaphragm 36 is not able to overcome the pressure of spring 19, acting on top of the diaphragm, spring 19 holds diaphragm 36 down and thereby holds the small pin valve 33 to its seat. The

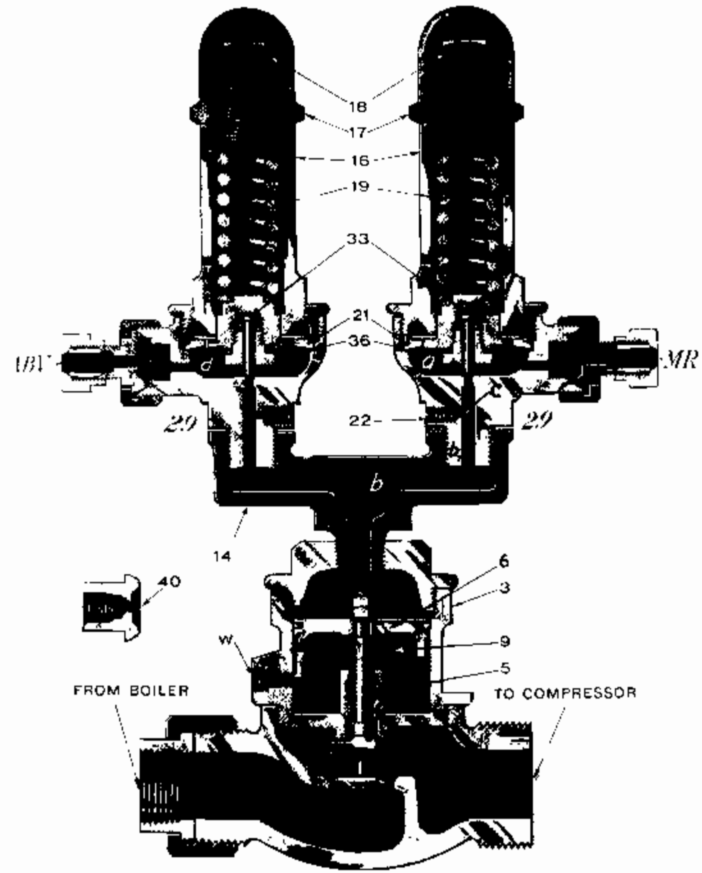

Fig. 2. Type SD Duplex Steam Compressor Governor

chamber above the governor piston 6 is open through a small vent port in the diaphragm body 15 to the atmosphere, which permits spring 9 below piston 6 to hold the latter and the attached steam valve 5 in the open position, Fig. 2.

When the main reservoir pressure in the chamber below diaphragm 36 becomes slightly greater than the spring pressure above the diaphragm, the diaphragm is raised, unseating pin valve 33 and allowing air from this chamber to flow to the chamber above piston 6. This forces piston 6 down to the closed position, compressing piston spring 9 and seating steam valve 5, thus cutting off the supply of steam to the air compressor except for the slight amount that can pass through the small port shown in steam valve 5. This is just sufficient to keep the compressor operating slowly so as to maintain the air pressure against leakage, and avoid troubles from steam condensation.

The chamber below piston 6 is open to the atmosphere through the drip pipe connection on the left. This is to permit the escape of any steam that may leak past the stem of valve 5 or air that may leak past piston 6. To avoid troubles from freezing and stopping up, the drip pipe should be as short as practicable.

The governor is adjusted by means of regulating nut 18 which regulates the pressure of spring 19 upon the diaphragm. To change the adjustment of the governor, remove the cap nut 17 and screw down regulating nut 18 to increase the main reservoir pressure or back off to lower main reservoir pressure, replacing cap nut 17 after the desired adjustment is made.

The "High Pressure" top on the right of the governor controls the operation of the air compressor when an application of the brakes is made. The relation of the brake valve ports is then changed so as to shut off the supply of air to the underside of the diaphragm of the "Low Pressure" governor top and its pin valve 33 remains held to its seat. Meanwhile, air from the main reservoir pipe can flow direct to the connection marked "Main Reservoir" of the "High Pressure" governor top and to the chamber beneath its diaphragm. This governor top will consequently control the operation of the air compressor as described for the "Low Pressure" top until the brakes are released and the brake valve handle again placed in *Running* position.

This arrangement permits the air compressor to operate against a comparatively low main reservoir pressure while the brakes are released, which is, however, ample to keep the system properly charged and supply any leakage which may exist, and requires it to operate against the maximum main reservoir pressure only during the time that the brakes are applied, which relieves the compressor of an unnecessary burden of work and at the same time provides for a high main reservoir pressure to insure a prompt release and recharge of the brakes.

TRIPLE VALVE

The Plain Triple Valve is used on both the engine and tender of a freight locomotive and on the engine only of a passenger locomotive (Quick Action Triple on tender). Fig. 3 shows an exterior view of the Plain Triple Valve, and Fig. 4 shows a sectional view. The triple valve is supported by the piping. It has four pipe connections marked as follows:

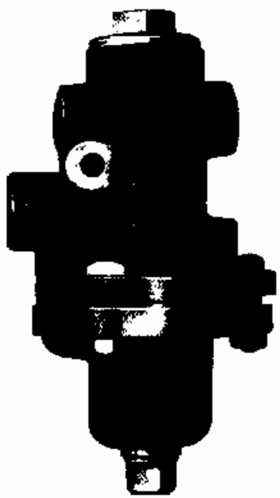

Fig. 3. Plain Triple Valve

BP—brake pipe; R—auxiliary reservoir; C—brake cylinder; and an outlet to the atmosphere. On the engine the triple valve governs the supply of air to both the driver and truck brake cylinders.

The Quick Action Triple Valve is used on the tender of passenger locomotives. Figures 5 and 6 show exterior and sectional views respectively. It is bolted to the pressure head of the brake cylinder.

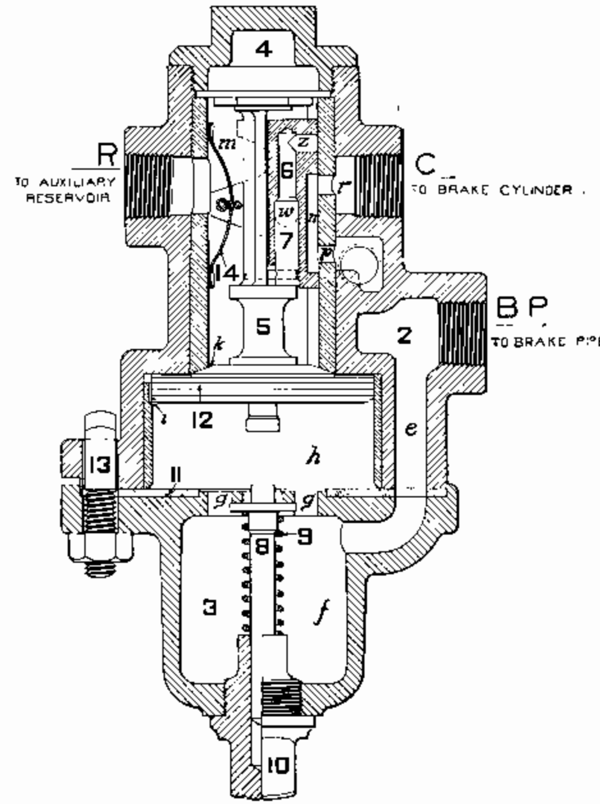

Fig. 4. Plain Triple Valve
Sectional View

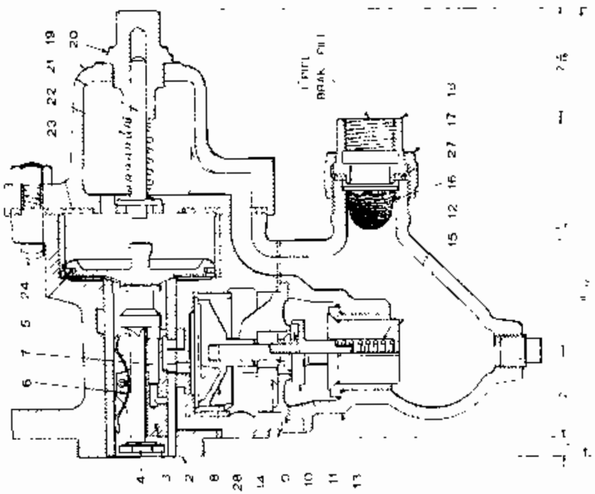

Fig. 6. Sectional View

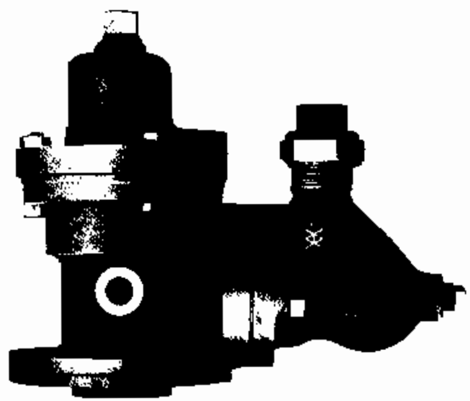

Fig. 5. Exterior View

QUICK ACTION TRIPLE VALVE

AUXILIARY RESERVOIR

The Auxiliary Reservoir is the direct source of compressed air for automatic brake applications.

Two auxiliary reservoirs are used on the engine, one for the driver brake cylinders and one for the truck brake cylinder. One reservoir is used on the tender.

Each reservoir is provided with a drain cock for the purpose of draining off any water which may collect. (Individual brakes can be released by hand, if necessary, by opening the drain cock and allowing enough air to escape from the auxiliary reservoir to reduce its pressure slightly below that in the brake pipe. When releasing a brake in this way the drain cock should be closed as soon as air is heard to exhaust from the triple valve.)

G-6 AUTOMATIC BRAKE VALVE

The G-6 Brake Valve is of the rotary valve type and has pipe connections as follows: (1) Main Reservoir; (2) Brake Pipe; (3) Equalizing Reservoir; (4) Air Gage (red hand, reservoir) and Governor Pipe; (5) Air Gage (black hand, brake pipe) Pipe. These connections are clearly indicated in Figures 8 and 9.

The five positions of the brake valve handle are, beginning at the extreme left: (1) *Release*, (2) *Running*, (3) *Lap*, (4) *Service*, and (5) *Emergency*. See Fig. 9. In the following paragraphs the positions are taken up in order in which they are most generally used rather than in their regular order as mentioned above.

Charging and Release Position. The purpose of this position is to provide a large and direct passage from the main reservoir to the brake pipe, to permit a rapid flow of air into the latter to (a) charge the train brake system; (b) quickly release and recharge the brakes.

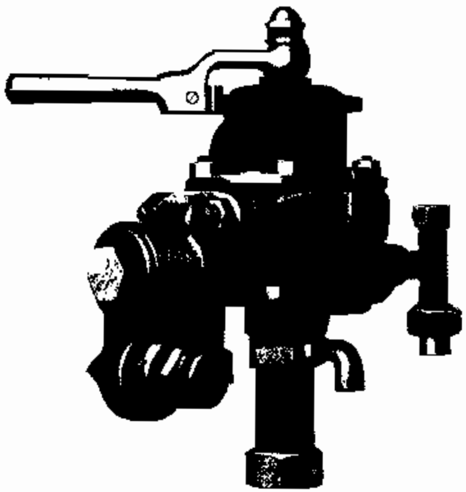

Fig. 7. G-6 Automatic Brake Valve

If the handle were allowed to remain in this position, the brake system would be charged to main reservoir pressure. To avoid this, the handle must be moved to *Running* position. To prevent the engineman from forgetting this, a small port discharges feed valve air to the atmosphere in *Release* position with sufficient noise to attract the engineman's attention to the position in which the brake valve handle is standing.

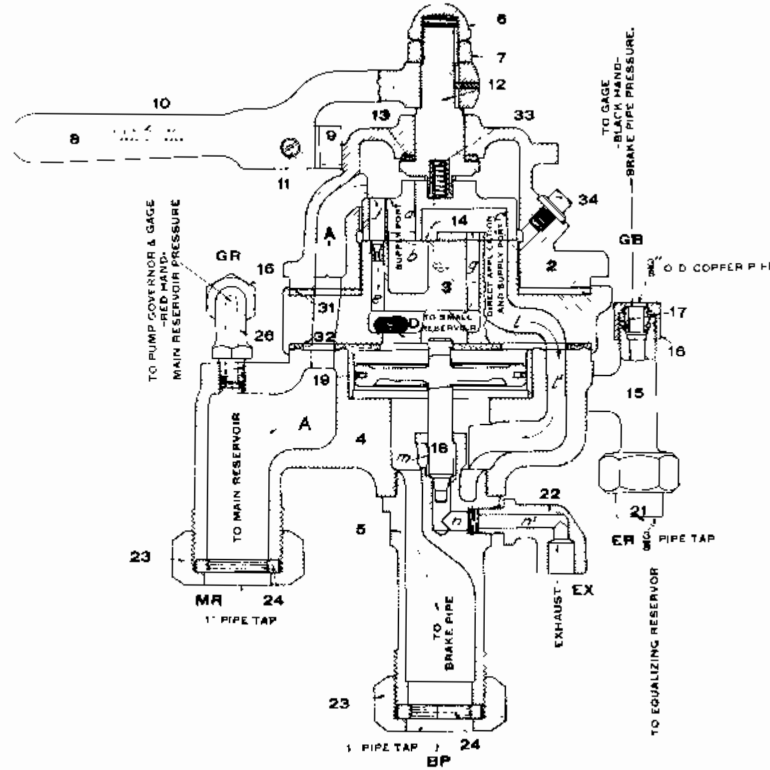

Fig. 8. G-6 Brake Valve, Release Position

Running Position. This is the proper position of the handle (a) when the brakes are charged and ready for use; (b) when the brakes are not being operated. In this position a large direct passage is opened from the feed valve to the brake pipe, so that the latter will charge

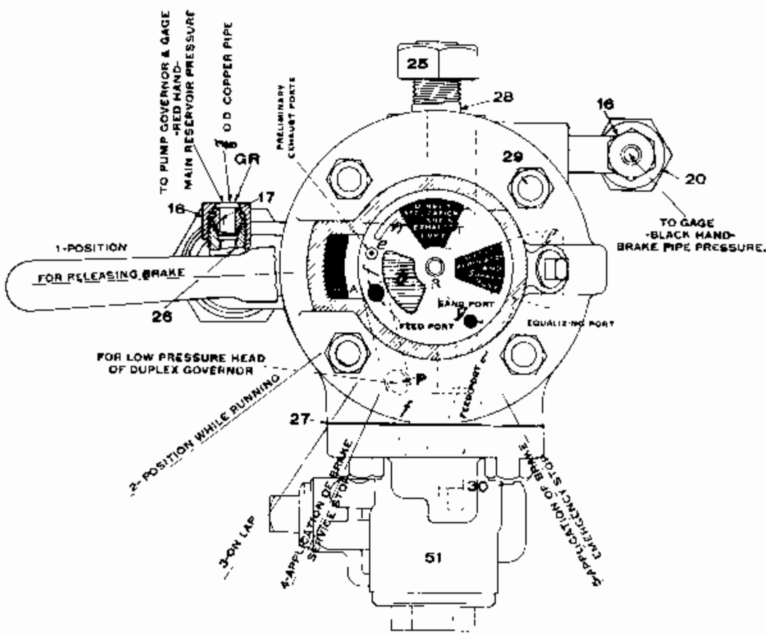

Fig. 9. G-6 Automatic Brake Valve, Plan View

up as rapidly as the feed valve can supply the air, but cannot attain a pressure above that for which the feed valve is adjusted. The equalizing reservoir charges uniformly with the brake pipe, keeping the pressure on the two sides of the equalizing piston equal. Air at main

reservoir pressure which is present at all times above the rotary valve, passes to the low pressure head of the governor.

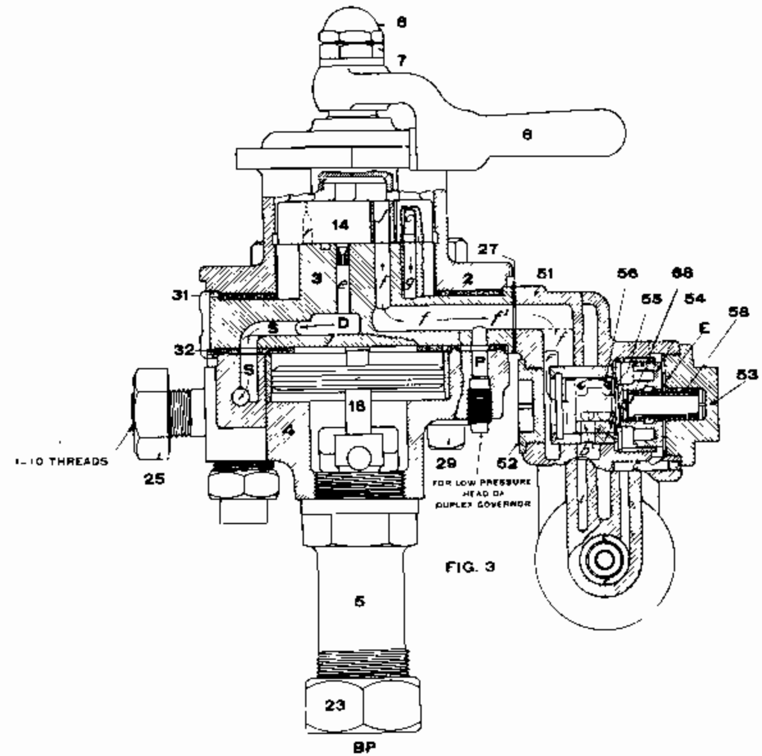

Fig. 10. G-6 Brake Valve, Running Position

Service Position. This position gives a gradual reduction of brake pipe pressure to cause a service application. The gradual reduction is to prevent quick action. The brake pipe discharge is also gradually stopped to prevent the pressure at the head end of the brake pipe being built up by the air flowing from the rear, which might cause some of the head brakes to "kick off."

Lap Position. This position is used while holding the brakes applied after a service application until it is desired either to make a further brake pipe reduction or to release them. All ports are closed.

Release Position. This position, which is used for releasing the train brakes after an application, without releasing the locomotive brakes, has already been described under Charging and Release on page 22.

Main reservoir air is admitted to the brake pipe, raising the pressure in the latter, thereby causing the triple valves to go to release position, which releases the train brakes and recharges the auxiliary reservoirs. When the brake pipe pressure has been increased sufficiently to cause this, the handle of the brake valve should be moved to *Running* position.

Emergency Position. This position is used when the most prompt and heavy application of the brake is required. A large and direct communication between the brake pipe and atmosphere is opened which makes a sudden and heavy discharge of brake pipe air, causing the triple valves to move to emergency position and give maximum braking force in the shortest possible time.

The brake valve should be so located that the engineman can operate it conveniently from his usual position, while looking forward or back out of the side cab window.

FEED VALVE

The Single Pressure Feed Valve, Type C-6, is bolted to the brake valve as shown in Fig. 7, in section in Figs. 11 and 12, and diagrammatically in Figs. 13 and 14.

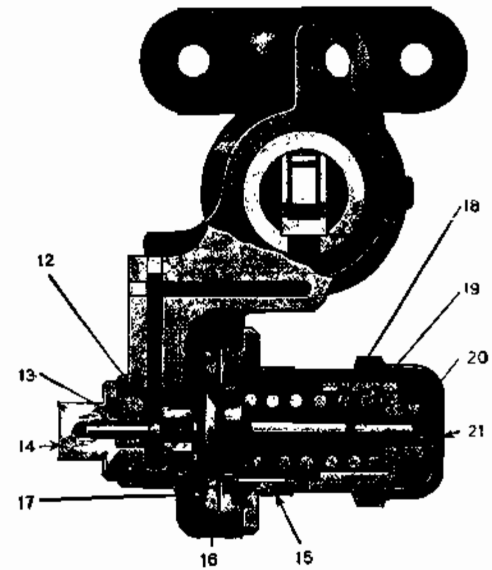

Fig. 11. C-6 Feed Valve, Actual Section Through Spring Box

It is of the slide valve type, consisting of two portions, the supply and regulating portions. The supply portion consists of a slide valve 7, and a piston 6, Fig. 12. The slide valve 7 opens or closes communication from the main reservoir to the brake pipe and is moved by the piston 6 which is operated by main reservoir air entering through passage *a* on one side or by the pressure of the piston spring 9 on its opposite side. The regulating portion consists of a brass diaphragm 17, on one side of which there is the diaphragm spindle 18, held against the diaphragm by the regulating spring 19, and on the other

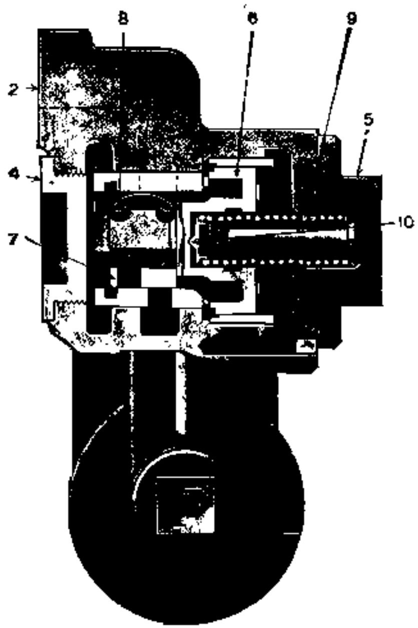

Fig. 12. C-6 Feed Valve, Actual Section Through Slide Valve

side a regulating valve 12, held against the diaphragm or its seat, as the case may be, by spring 13. Chamber L, on the face of the diaphragm, is open to the brake pipe through passage *e* and *d*. The feed valve is ad-

justed by screwing regulating nut 20 in or out, thus increasing or decreasing the pressure exerted by the spring on the diaphragm.

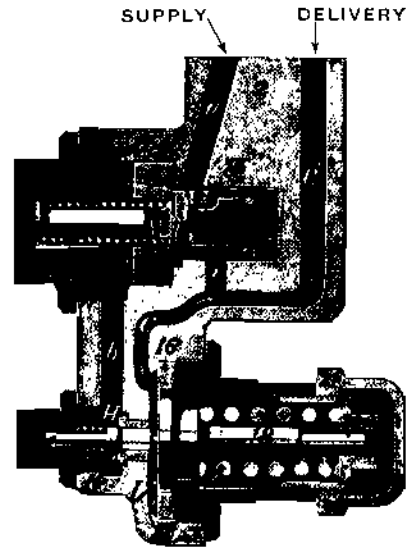

Fig. 13. C-6 Feed Valve (Diagrammatic), Closed

Suppose spring 19 to be compressed so as to exert a force equivalent to a 70-lb. air pressure on the opposite side of the diaphragm. Then, as long as the air pressure in the brake pipe and chamber L is less than 70 lbs., the spring holds the diaphragm over as far to the left as possible, as shown in Fig. 14. This holds the regulating valve 12 off its seat, thus opening port K which permits air to flow through port K and from passage H to chamber G at the back of supply piston 6. Consequently, as long as the air pressure in G, *h*, *e* and *d* is less than 70 lbs., the higher main reservoir pressure on the opposite side of piston 6 forces it to the extreme left, compressing spring 9 and opening port *c*, as shown

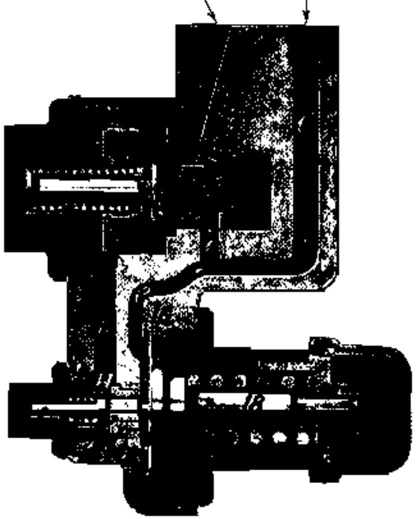

Fig. 14. C-6 Feed Valve (Diagrammatic), Open

in Fig. 14. Air, therefore, continues to flow from the main reservoir through *a*, *c* and *d* to the brake pipe, increasing its pressure and the pressure in chamber L, acting on diaphragm 17, until it reaches 70 lbs. The air pressure on the diaphragm is then able to overcome the spring pressure on the opposite side and force the dia-

phragm to the right by "buckling" it slightly in that direction. This allows the regulating valve spring 13 to return the regulating valve 12 to its seat, which closes port K. Chambers G and H are then no longer open to the brake pipe passage *d* at 70 lbs. pressure, and being small, are instantly raised to main reservoir pressure by the slight leakage of air past the supply piston which is made loose fitting for this purpose. As the air pressures become nearly equal on the opposite sides of the supply piston, the piston spring 9 forces the piston and its slide valve to closed position, Fig. 13, which prevents further flow of air from the main reservoir to the brake pipe. The operation of the valve as described, after the pressure in the brake pipe has reached 70 lbs., is almost instantaneous so that the brake pipe pressure is held constant at 70 lbs. until it is slightly reduced by leakage so that its pressure on diaphragm 17 is no longer able to withstand the pressure of the regulating spring, which then forces the diaphragm back, lifting the regulating valve from its seat and again opening port K. This allows the air (at main reservoir pressure) in chambers G and H to flow through K to chamber L, thus dropping the pressure behind piston 6 below that of the main reservoir acting on the opposite side of the piston. The higher pressure then forces the piston over into open position, as shown in Fig. 14, and allows sufficient air to flow through port *c* to the brake pipe to again raise its pressure to 70 lbs., when the feed valve closes.

The feed valve acts as a maintaining valve in this manner, keeping the brake pipe pressure constant at the amount for which the regulating valve is adjusted, so long as the brake valve handle is in *Running* position, as shown in Fig 33.

DUPLEX AIR GAGE

The Duplex Air Gage has two pipe connections to the brake valve, one of which is constantly in communication with main reservoir pressure (red hand), while the other is in constant communication with equalizing reservoir pressure (black hand).

The amount of brake pipe reduction during automatic applications is indicated by the black hand.

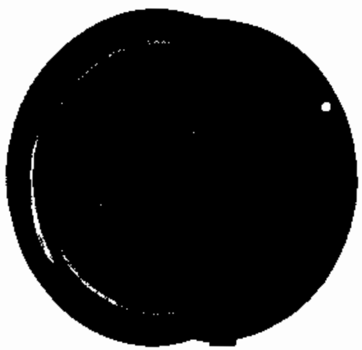

Fig. 15. Duplex Air Gage

The gage should be located in a vertical position a short distance forward of the brake valve, close to the right side of the boiler and low enough to be seen by the engineman from his usual position when conveniently braking, and without entirely losing sight of the track ahead.

BRAKE CYLINDERS

The type of driver brake cylinder depends upon the conditions of installation. Fig. 16 shows one type known as Type B. The piston 3 has a hollow sleeve in which is the push rod 14 attached to the levers of the driver brake gear. The pin 16 is attached to the push rod holder 9 which is in turn fastened to the hollow piston rod so that the push rod 14 moves in and out with the piston. This arrangement gives the necessary flexibility between the push rod and the lever arm of the driver brakes. The release spring 6 forces piston 3 to release position when the air pressure is exhausted from the opposite end of the cylinder; the packing leather 11 is pressed against the cylinder wall by the packing expander 12 and prevents the escape of air past the piston.

The engine-truck brake cylinder is known as the Type D and is similar to the Type B, illustrated in Fig. 16.

The tender brake cylinder for freight locomotives is designated Type L and is similar to the Type B illustrated in Fig. 16 except that the push rod holder and pin are not required.

The tender brake cylinder for passenger locomotives is designated type "K". It has a special pressure head, with seat for the quick action triple valve, as shown in Fig. 17. For ordinary automatic equipment the bosses *a* and *b* are not drilled, and port *c*, the opening into the brake cylinder from the triple valve, is not tapped. For the combined equipment, port *c* is tapped and closed with a ¾" flush plug. Either boss *a* or *b* is tapped for the ½" straight-air connection, whichever is the most convenient.

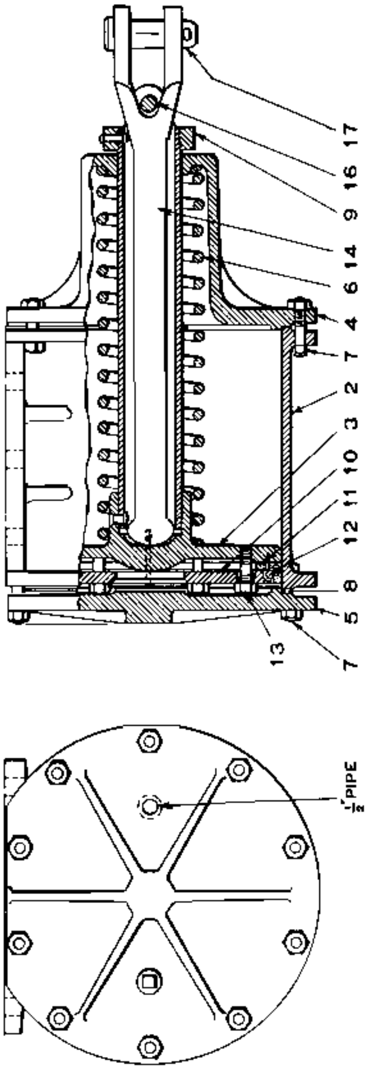

Fig. 16. Type B Driver Brake Cylinder

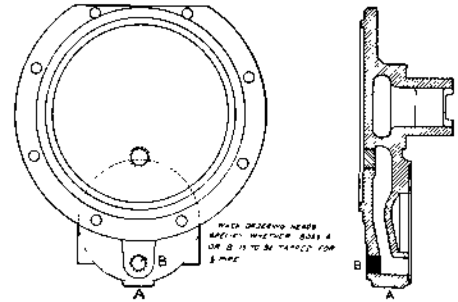

Fig. 17. Pressure Head for Passenger Tender Brake Cylinders

CENTRIFUGAL DIRT COLLECTOR

The centrifugal dirt collector, as illustrated in Fig. 18, is so constructed that, due to the combined action of centrifugal force and gravity, all dirt and foreign material is *automatically* eliminated from the air flowing through the collector—as when the brakes are applied or released —*without reducing the area of the opening in any way.* The design of the collector is such that the dirt and foreign matter eliminated falls into the bottom chamber and by means of a plug may be removed at intervals without breaking any pipe connections whatever.

Fig. 18. Centrifugal Dirt Collector

PIPE FIXTURES

The *Double-Heading Cock* is located in the brake pipe underneath the G-6 brake valve. In double-heading service, this cock must be closed on the second locomotive and the handles of the automatic and straight-air brake valves placed in *Running* position. Closing of this cock prevents charging of the brake pipe from main reservoirs located on other than the head engine; if this were not the case reductions of brake pipe pressure could not be controlled from the head engine as desired. With both brake valve handles carried in *Running* position, the locomotive brakes can be completely controlled from the head engine. However, the engineman on the second engine can apply or release his brakes independently of the train brakes by proper manipulation of the straight-air brake valve handle.

Cut-out Cocks are installed in the pipe connection to the truck brake cylinder and in the brake pipe branch on the tender.

Cocks *c* and *d* with their pipes are only for locomotives operating on heavy mountain grades. They are connected between the driver and tender triple valves and their double check valves. Leaving them open will prevent automatic action by allowing the air to pass directly to the atmosphere instead of through the double check valves. Cock *c* should be located adjacent to the gangway so it can be operated when running, and Cock *d* near the engineman's seat. In descending heavy grades both are left open. The driver and tender auxiliaries are recharged with those of the train but automatic application is prevented on the brakes of the former, thus

permitting the greatest use practicable, without danger of loosening driver tires when recharging the train brakes —the critical operation in braking down steep grades. These cocks should be closed when the foot of the grade is reached.

The brake pipe is provided with an Angle Cock at the tender end and with an ordinary Cut-out Cock at the pilot end of the locomotive.

The brake pipe and straight-air pipe between the engine and tender are connected by flexible hose. The hose couplings on these two lines are of the same general form but differ in detail so that it is impossible to couple one to the other.

As a rule, the engine and tender are permanently connected, for which reason Angle Fittings are ordinarily used instead of angle cocks or cut-out cocks in the pipe connections between the engine and tender.

STRAIGHT-AIR BRAKE VALVES

Type S-3

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. Fig. 22 is a horizontal section showing the relative location of the valves and pipe connections.

The air supply pressure to this brake valve is fixed by the regulation of the reducing valve to 45 lbs., and this is the maximum cylinder pressure that can be obtained.

Letters cast on the body of this valve indicate respectively its main reservoir, brake pipe and exhaust openings. The latter should have only a street ell to turn the discharge in the direction desired, the sound aiding the engineman in operation. The other two connections should have unions in the pipe near by to facilitate removal or replacement.

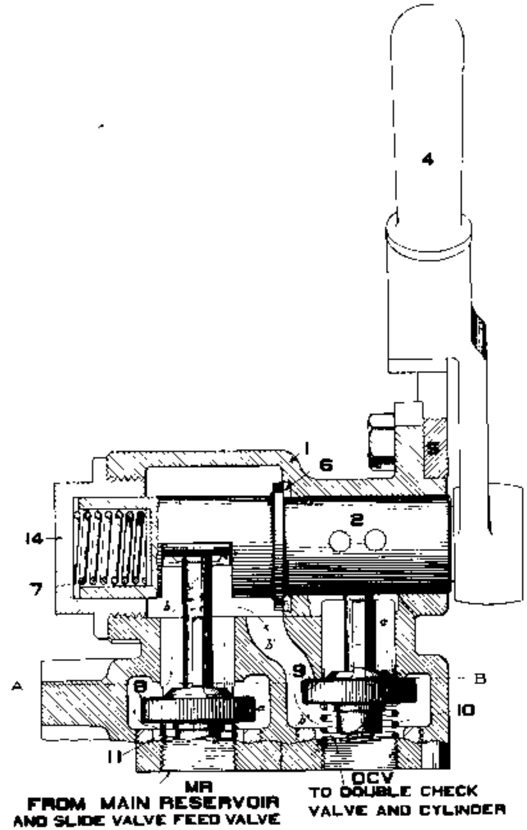

Fig. 19. S-3 Straight-Air Brake Valve in Application Position

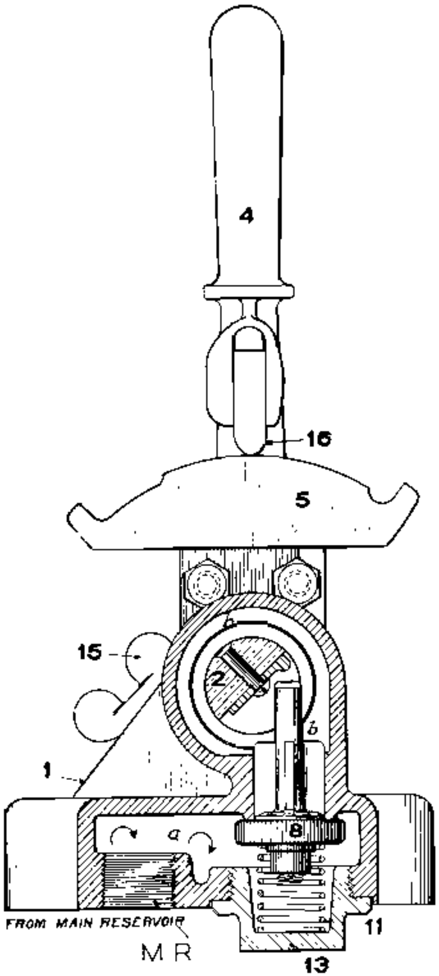

Fig. 20. Cross Section of S-3 Straight-Air Brake Valve in Lap Position

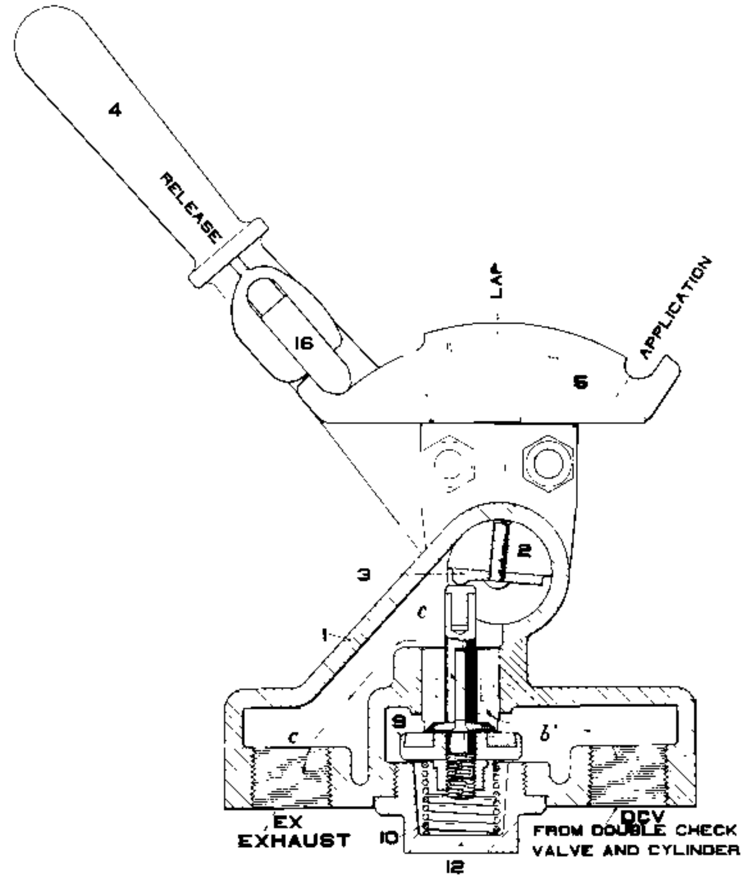

Fig. 21. Cross Section of S-3 Straight-Air Brake Valve in Release Position

The valve should be substantially secured and so located as to be within reach of the engineman when leaning from the side cab window, the latter being of the utmost importance to facilitate work. When the space between the cab and the boiler head permits, it should be located either on the side of the cab at a convenient height and a trifle forward of the edge of

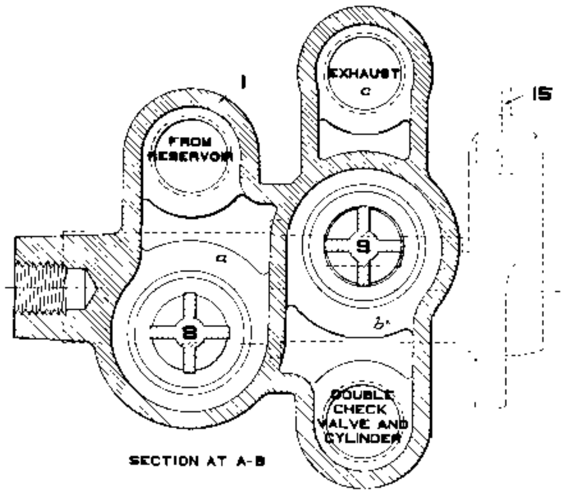

Fig. 22. S-3 Straight-Air Brake Valve, Horizontal Section

the side window which opens, or on the side of the boiler head, just forward and a little above the automatic brake valve. The handle of the valve should preferably be so located that *Release* position will be nearest the engineman; in all cases the release movement should invariably be in the same direction in relation to the position of the engineman when braking, so as to insure uniformity of operation on all engines.

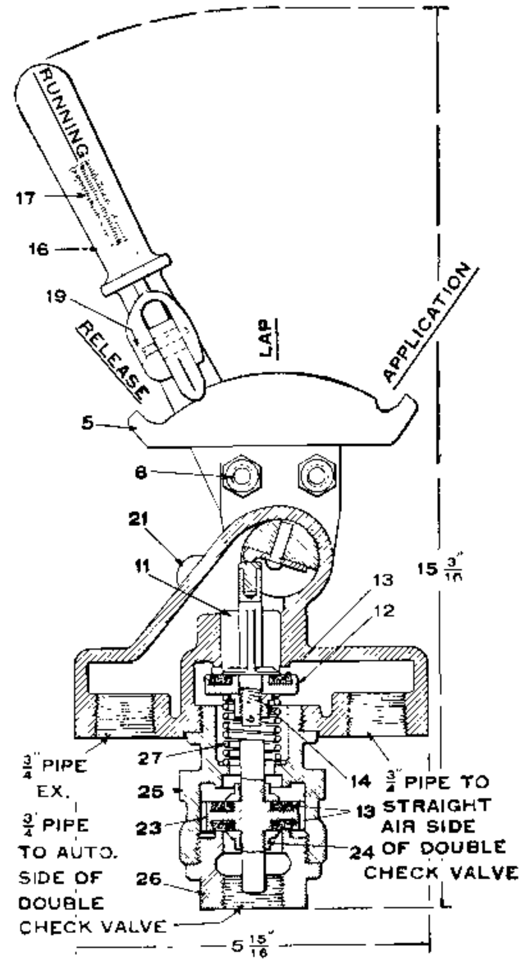

Fig. 23. Cross Section of S-3-A Straight-Air Brake Valve in Running Position

TYPE S-3-A

The S-3-A Straight-Air Brake Valve is a special valve which has been furnished in some cases, when it was desired to provide for independent driver brake release. It is similar to the S-3 Straight-Air Brake Valve, except for the addition of a device called the Driver Brake Release Attachment and the addition of a *Running* position notch to the quadrant corresponding to the *Release* position of the S-3 brake valve, the *Release* position of the S-3-A brake valve being used for the independent release of the driver brake cylinders. The Driver Brake Release Attachment is arranged to screw into the body of the brake valve, as shown in Fig. 23, in place of the cap nut 12, Fig. 21, and makes possible the releasing of the driver brakes after an automatic application, without affecting the brakes on the train or tender, thereby providing for independent operation of the driver brakes.

This attachment is connected by piping to the automatic side of the driver brake cylinder double check valve, the other connections to the brake valve remaining the same as for the S-3 brake valve.

NOTE—The present design of the S-3 brake valve uses the same handle quadrant as the S-3-A, this being done for convenience in manufacturing, simplifying storeroom stock, etc. The only difference between this quadrant and that formerly furnished is that the release notch is extended, forming at its opposite end Running position in the S-3-A brake valve. In the S-3, however, the use of either position produces the same results

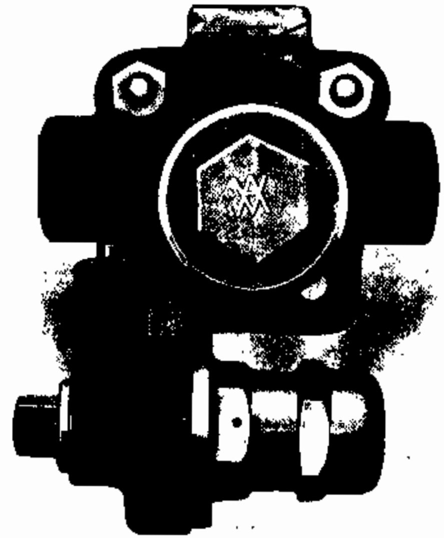

Fig. 24. C-6 Reducing Valve

C-6 REDUCING VALVE

This valve, illustrated in Fig. 24, is the same as the feed valve on the G-6 brake valve, but it is attached to a pipe bracket located in the piping between the main reservoir and the straight-air brake valve. Its purpose is

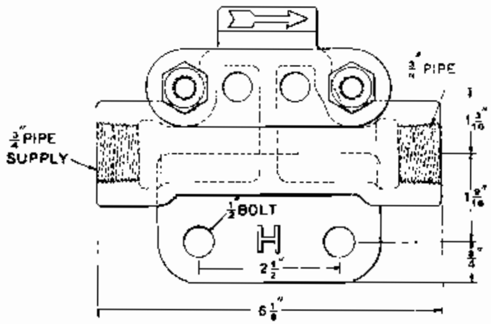

Fig. 25. Reducing Valve Pipe Bracket

to reduce main reservoir pressure for straight-air operation to a single fixed pressure, which in this equipment is 45 pounds. It should always be located in the cab and at a point where in cold weather it will be prevented from freezing, yet where it will be accessible for adjustment and inspection.

Fig. 25 illustrates the special pipe bracket to which the reducing valve is attached. The inlet and outlet ports come opposite the similar ports in the feed valve. An arrow on the projecting part of the bracket shows the direction of flow of air.

SINGLE POINTER AIR GAGE

A gage, Fig. 26, for the straight-air is absolutely necessary for satisfactory service. It should be connected so as to show brake cylinder pressure in automatic as well as straight-air application, such connection being shown in Fig. 37. For attaching a test gage a tee should

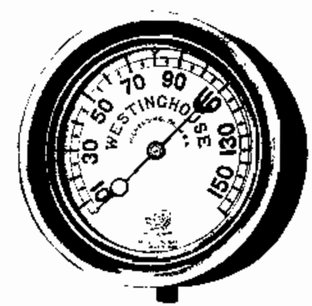

Fig. 26. Single Pointer Air Gage

be put in the brake cylinder gage pipe. It should be near the straight-air brake valve, so that, by taking out the ¼-inch plug in its side opening and connecting a gage, the latter can be seen while operating the brake valve and adjusting the reducing valve.

NO. 2 DOUBLE CHECK VALVE

Figs. 27 and 28 show the double check valve in section, the several pipe connections being indicated in these views.

With the piston valve 10 against seat *b* as shown in Fig. 27, port *c* affords a free passage for the air between the straight-air brake valve and the brake cylinder. The opening leading to the triple valve (which is now in *Release* position) is closed so no leakage can take place.

With the straight-air brake valve in *Release* position, where it should be when not in use, when an automatic application is made, air from the triple valve on entering the double check valve will force the piston valve to the right against seat *d*, as shown in Fig. 28, thus preventing any escape at the straight-air brake valve and opening ports c^1 so the air can flow on into the brake cylinder, returning the same way in release.

The double check valve must be placed in a horizontal position so that its piston valve will not be moved except by air pressure. Then the mere act of using either automatic or straight-air will cause its piston valve to move automatically to the proper position.

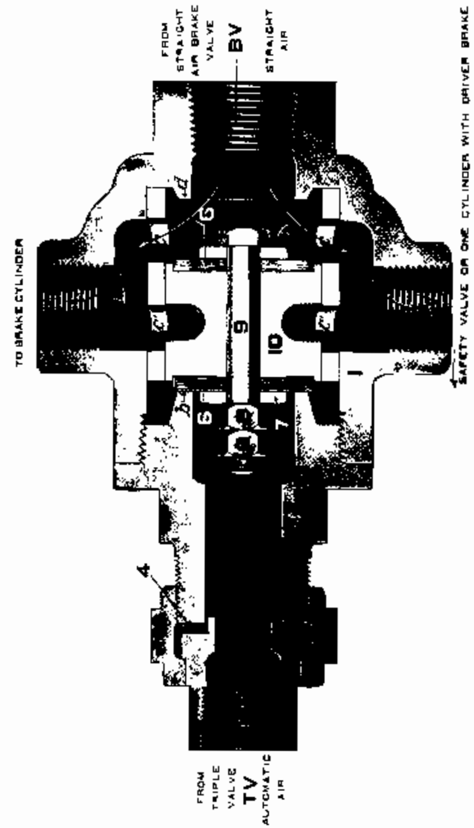

Fig. 27. No. 2 Double Check Valve in Straight-Air Brake Position

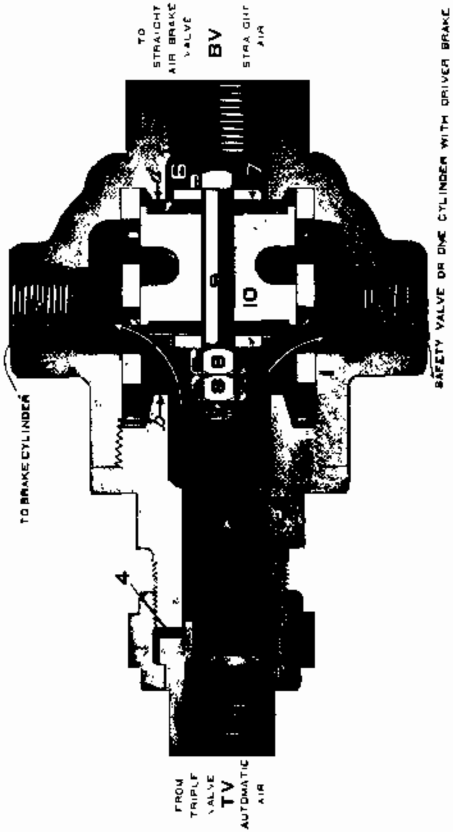

Fig. 28. No. 2 Double Check Valve in Automatic Brake Position

SAFETY VALVE

The safety valve, Fig 29, should be in direct communication with brake cylinder pressure whether the automatic or straight-air is used, and should be placed vertically upward so that dirt and water cannot accumulate inside. On the tender it may be screwed into one of the cylinder connections of the double check valve as indicated in Fig. 37, or in the pipe between the brake cylinder and double check valve. On the engine it may be placed in either of the driver brake cylinder pipes.

As the straight-air should never give over 45 lbs. cylinder pressure, and the automatic not over 50 lbs., a correctly adjusted safety valve will never operate unless an improper condition exists, but under the latter will guard against a dangerously high cylinder pressure.

Valve 4 is held to its seat by the compression of spring 6 between the flange 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 atmosphere, although only one of each of these is shown in the cut. As the valve moves upward, its lift 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. 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.

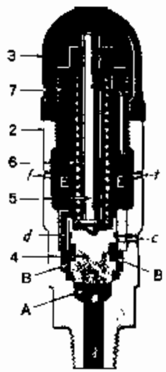

Fig. 29. Type E-1 Safety Valve

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.

This safety valve should be adjusted for 53 pounds. Like all adjustable devices, the safety valve is most easily and accurately adjusted when the work is done on a shop testing rack.

AUTOMATIC OPERATION

CHARGING THE SYSTEM

To insure a prompt charging of the system the brake valve handle is first placed in *Release* position. Air flows from the main reservoirs to the brake valve, entering through passage A, Fig. 8, and flowing to chamber A above the rotary valve (represented by space A at the center of the rotary valve, Fig. 32. Port *a* in the rotary valve registers with port *b* in the seat, so air flows through these ports and cavity *c* and passages L and Y directly into the brake pipe and to the underside of the equalizing piston. At the same time air in cavity *c* flows through the equalizing port *g* to chamber D above the equalizing piston and to the equalizing reservoir through port *s*. Port *j* registers with preliminary exhaust port *e* and air flows to chamber D through these ports also. A branch from the equalizing reservoir pipe leads to the black hand of the duplex air gage which therefore really registers the pressure in chamber D and the equalizing reservoir. However, as will be seen from what follows, this bears such a relation to the brake pipe pressure that the black hand of the gage is usually considered to show brake pipe as well as equalizing reservoir pressure.

The end of the equalizing piston stem is called the "equalizing discharge valve" which, when open, allows air from the brake pipe to flow through port *m,* past the equalizing discharge valve and through port *n* to the service exhaust fitting and atmosphere. This valve is held to its seat during the time the brake pipe is being charged as above, as well as at all times when the air pressure (in pounds per square inch) is the same on the under and upper sides of the piston, because the pressure of the air above the piston acts on the entire area of the piston, while that below it acts on an area which is less than that above by the amount of the cross-sectioned area of the piston stem. This makes the total pressure on the top of the piston slightly higher than that below, thus holding the piston down and the equalizing discharge valve on its seat.

Air entering the brake pipe at Y flows through this pipe the entire length of the train, and through the branch pipe to the triple valve on each vehicle. Passing through the branch pipe and branch pipe cut-out cock on the engine, air enters the plain triple valve through port *e* to chamber *f* and through passages *g* to chamber *h*, in which the triple valve piston 5 moves. The air pressure in chamber *h*, acting on the face of the piston, forces it to its extreme position to the right, which is *Release* and *Charging* position. In this position air can flow from chamber *h* around the piston through feed groove *i* in the bushing and *k* in the piston seat into chamber *m* and thence, through the pipe connection at R, as shown, to the auxiliary reservoir.

From Fig 32, it will be seen that the triple valve piston 5 has a stem on which are two collars. Between these two collars is a slide valve 6, shorter than the distance between the collars on the piston stem, so that there is a certain amount of clearance or "lost motion" between the piston stem and the slide valve. The function of this slide valve 6 is to make proper connections between the space *m* (auxiliary reservoir pressure) and the brake cylinder port *r* in the seat of the valve, or between the

brake cylinder port *r* and the exhaust port *p*, also in the seat, or to close these ports, according to the positions to which the slide valve is moved by the triple valve piston, as described later. In the *Release* position shown, Figs. 32 and 33, air at auxiliary reservoir pressure is acting above and on all sides of the slide valve, but cannot flow past or through it, since all ports through the valve are closed. The exhaust cavity *n* in the face of the valve, however, makes an opening across from the brake cylinder port *r* in the seat to the exhaust port *p*, so that the brake cylinder is then connected through the pipe connection to the triple valve and the ports named to the exhaust opening and atmosphere. Any compressed air contained therein will then flow to the atmosphere, thus permitting the release spring acting on the opposite side of the piston to force it back to *Release* position and release the brake shoes from the wheels.

The air from the brake pipe flowing through the branch pipe and cut-out cock on the tender enters the quick-action triple valve, through chamber *a* in the lower case and port *e*. The passage of air through this triple valve to the auxiliary reservoir is then the same as described on page 54 for the plain triple valve, the ports, cavities, etc., being lettered the same. The parts in the lower portion of the quick-action triple valve are practically additions to the upper portion (which is, in effect, a plain triple valve), their function being to vent brake pipe air directly into the brake cylinder, thus producing a quick-action or "emergency" application, as described on page 63. As they do not act, however, except when an emergency application takes place, they need not be referred to further here.

While the brake valve handle remains in *Release* position, main reservoir air flows through the warning port *r* in the rotary valve and port *k* in the seat to the atmosphere. The noise made by this escaping air indicates to the engineman that the handle is in *Release* position and thus attracts his attention if it is left there by mistake.

RUNNING

After the brake valve handle has been in *Release* position the proper length of time, it is moved to *Running* position. This closes the warning port, stops the direct flow of main reservoir air to the brake pipe and the equalizing reservoir, and opens the supply of air to these ports through the feed valve.

Port *j* through the rotary valve registers with port *f* in the seat, allowing air to flow to the feed valve, which is attached directly to the brake valve as shown. The feed valve reduces the pressure of the air from that carried in the main reservoir to that which is to be carried in the brake pipe. From the feed valve the air re-enters the brake valve through port *i* which has two branches.

One branch leads to port *l* in the seat (*direct application and supply port*), through which air flows to the cavity *c* in the rotary valve, thence to the equalizing port *g* in the seat and through this to the chamber D above the equalizing piston in the lower part of the brake valve. Chamber D is connected through port *s* and pipe connections as shown to the equalizing reservoir. The purpose of the equalizing piston and reservoir will be described later, page 58.

The other branch of port *i* leads from the feed valve to the brake pipe connection at Y and to the underside of the equalizing piston. Therefore, with the brake valve handle in *Running* position, the feed valve maintains a practically constant pressure (70 lbs. being the usual pressure for which the feed valve is adjusted) in the brake pipe and on the under side of the equalizing piston and the same pressure in the equalizing reservoir and chamber D on the upper side of the piston.

During the time the brake valve handle remains in *Running* position, air continues to flow from the feed valve through the brake valve, brake pipe, and triple valve to the auxiliary reservoir in this way until the system is charged up to the pressure at which the feed valve is adjusted to close, after which any leakage from the system, which reduces the pressure slightly, will cause the feed valve to open again and supply air to the system. As a very slight drop in brake pipe pressure will cause the feed valve to open, it will be seen that the brake pipe and auxiliary reservoirs are maintained at a practically constant pressure as long as the brake valve handle remains in running position and the feed valve is operating properly.

The condition just described, viz., the brake valve handle in *Running* position, the triple valve pistons and slide valve in *Release* position, and the brakes released, and the auxiliary reservoirs charged and maintained at the pressure for which the feed valve is adjusted ("standard brake pipe pressure"), is the normal condition of the brake system when the train is running over the road and the brakes are not being used.

SERVICE

The system being charged as has been described, say to 70 lbs. brake pipe pressure, when it is desired to make an ordinary "service" stop, the brakes are applied by placing the brake valve handle in *Service Application* position, Fig 34. This cuts off all air supply to the brake pipe or equalizing reservoir and opens the small port *e*, called the *preliminary exhaust port*, leading to chamber D and the equalizing reservoir. This permits air to escape from above the equalizing piston through port *e* in the rotary valve seat, cavity *p* in the rotary valve and the *direct application and exhaust port*, *k*, to the atmosphere. This at once reduces the pressure of the air on the top of the equalizing piston below that in the brake pipe under the piston, and the higher pressure forces the piston upward, raising the attached equalizing discharge valve from its seat and allowing air from the brake pipe to flow through opening *m*, past the valve, and through passage *n* and the service exhaust fitting to the atmosphere.

The description which follows will apply equally to the operation of the plain and quick-action triple valves, except where special reference is made to one or the other of these valves. As the brake pipe is connected to chamber *h* of each triple valve, a reduction in brake pipe pressure, as described, will lower the pressure on the brake pipe side of the triple valve piston below that of the auxiliary reservoir on the opposite side of the piston. The higher auxiliary reservoir pressure will then cause the piston to move in the direction of the weaker pressure, thereby closing communication between chamber *h*

and the auxiliary reservoir through feed groove *i*. Attached to the piston stem is a pin valve 7, called the *graduating valve*, which, when seated, Fig 32, closes communication between port *w* leading from chamber *m* to the graduating valve seat in the slide valve and the service port *z* leading from the graduating valve seat to the face of the slide valve. The first movement of the triple valve piston also unseats the graduating valve 7 so that the air in chamber *m*, entering port *w*, flows to the service port *z*.

There is a small amount of clearance between the slide valve 6 and the collar or "spider" on the end of the triple valve piston stem so that the first movement of the piston, which closes the feed groove *i* and opens the graduating valve 7, does not move the slide valve, but brings the spider on the stem against the end of the valve. Further movement of the piston then causes the slide valve to move until it has closed communication between brake cylinder port *r* and exhaust port *p* and opened port *r* to the auxiliary reservoir through port *z* and *w*, as shown in Fig. 34. The piston then comes into contact with the graduating stem and the resistance of the graduating spring combined with the reduction in auxiliary reservoir pressure then taking place prevents further movement of the parts. The valve is then in *Service* position and air from the auxiliary reservoir flows through the service port to the brake cylinder, forcing the piston outward and applying the brake.

In flowing to the brake cylinder the air must pass through the double check valve, forcing its piston to the straight-air side and cutting off communication with the straight-air brake valve (see Fig. 28).

SERVICE LAP

When the desired reduction in equalizing reservoir pressure has been made the brake valve handle is moved to *Lap* position, closing the preliminary exhaust port *e*, which prevents further reduction in this reservoir. Air will continue to discharge from the brake pipe until its pressure is a slight amount below that remaining in the equalizing reservoir when the discharge valve will close and prevent further brake pipe reduction.

Whether this flow of air from the brake pipe ceases at once or continues for a period of time after the handle is placed in *Lap* position depends upon whether the train is a long or short one. With a short train the total volume of air in the brake pipe is not very great, so that it can escape through the service exhaust nearly as fast as the air in chamber D and the equalizing reservoir is flowing out through the preliminary exhaust port *e*, thus the pressure below the equalizing piston is falling at about the same rate as that above.

In such a case, as soon as the pressure in chamber D ceases to fall, the brake pipe pressure below the equalizing piston becomes slightly less than that above the piston and the higher pressure forces the piston downward, seating the equalizing valve and preventing further flow of air from the brake pipe.

On a long train, however, the total volume of air in the brake pipe is large, so that it takes very much longer for sufficient air to escape through the service exhaust fitting to reduce its pressure from 70 lbs. to 60 lbs. and the pressure below the equalizing piston therefore falls at a much lower rate than that above it. In such a case, air continues to escape from the brake pipe after the handle has been placed in *Lap* position for a period of time, depending upon the length of the train, until the brake pipe pressure has been reduced slightly below that in chamber D, when the equalizing piston is forced downward and the service exhaust opening closed as explained.

While the pressure in the brake cylinder rises, that in the auxiliary reservoir falls and tends to become lower than that in the brake pipe. As soon, however, as the pressure on the auxiliary reservoir side of the triple valve piston falls slightly below that on the brake pipe side the higher pressure causes the piston to move back toward its former (*release*) position, until the graduating valve is seated, closing communication between ports *w* and *z*. This prevents further flow of air from the auxiliary reservoir, the pressure in which is then practically equal to that in the brake pipe, and at the same time prevents further movement of the triple valve piston toward *Release* position, because the slightly higher pressure on the brake pipe side of the piston, which was able to move the piston and graduating valve alone, is not sufficient to move the slide valve also. The parts are then in *Service Lap* position, Fig. 35, and, assuming that there is no leakage, the brake pipe and auxiliary reservoir pressures will remain balanced and the brake cylinder pressure held constant until the brake pipe pressure is further reduced, in order to apply the brakes harder; or increased, in order to release the brakes.

If a further reduction in brake pipe pressure is made, after the parts are in *Service Lap* position, the reduction of pressure on the brake pipe side of the triple valve piston below that on the auxiliary reservoir side causes the piston and its attached graduating valve to move as described for the first service application of the brakes. The slide valve, however, is already in *Service* position, consequently as soon as the graduating valve is opened, air from the auxiliary reservoir flows to the brake cylinder and increases the pressure therein, thus increasing the pressure of the brake shoes against the wheels. If the brake pipe reduction is continued indefinitely, the auxiliary reservoir pressure will continue to fall and the brake cylinder pressure rise until they become equal, or "equalize." This occurs at about 50 lbs. cylinder pressure, when carrying 70 lbs. brake pipe pressure.

After the pressures in the auxiliary reservoir and brake cylinder have "equalized" in this manner, air ceases to flow out of the reservoir and into the cylinder, because there is no longer any difference of pressure to cause a flow. Consequently, when the brake pipe pressure is reduced below the "point of equalization," the brake cylinder pressure cannot rise above the "equalizing point," even though the brake pipe may be reduced far below 50 lbs. For this reason, therefore, nothing is gained by reducing the brake pipe pressure below the "equalizing point" as explained above. Moreover, it is a needless waste of air and interferes with the proper release of the brakes.

RELEASE AND RECHARGE

When the brake pipe pressure is again increased by the use of *Release* or *Running* position of the brake valve as the case may be, the triple valve parts will be

returned to release position, the auxiliary reservoir recharged and air from the brake cylinder released, as already described under *Charging*.

EMERGENCY APPLICATION

When it is desired to make the shortest possible stop the brake valve handle is placed in *Emergency* position, Fig. 36. This opens the brake pipe directly to the atmosphere through the large port *l*, cavity *c* and port *k*, causing a sudden and rapid drop in brake pipe pressure. In *Emergency* position also, cavity *p* in the rotary valve connects the feed port *f* and the preliminary exhaust port *e* to the exhaust port *k*, thus allowing the air in the feed port, chamber D and the equalizing reservoir to escape to the atmosphere. The reduction in brake pipe pressure thus caused takes place so much more rapidly than during a service application of the brakes that the pressure in chamber *h*, on the brake pipe side of the triple valve piston is reduced at a much more rapid rate than can that in the auxiliary reservoir on the opposite side of the piston. The difference of pressure thus obtained is sufficient to cause the piston to move over to *Emergency* position, Fig. 36, compressing the graduating spring.

Up to this point, all statements made regarding the operation of the triple valve have applied equally to the plain or quick-action triple valve, but during an *Emergency* application their action is different.

When the piston and slide valve of the *plain triple valve* move to *Emergency* position, Fig. 36, the brake cylinder port *r* is uncovered, and air from the auxiliary reservoir flows past the end of the slide valve directly through port *r* into the brake cylinder until the brake cylinder and auxiliary reservoir pressures become "equalized." The pressure obtained in the brake cylinder is no higher than when a full service application is made, but the maximum pressure is obtained more quickly.

When the piston and slide valve of the *quick-action triple valve* move to *Emergency* position, Fig. 36, port *s* in the slide valve registers with port *r* in the seat, allowing air to flow from the auxiliary reservoir to the brake cylinder. Port *s* is small, however, and in this position the slide valve also opens port *t* in its seat, allowing air to flow from chamber *m* through port *t* to the chamber above the emergency piston 8. The other side of the emergency piston 8 is connected to the brake cylinder, in which there is no air pressure, consequently the emergency piston is forced downward, pushing the emergency valve 10 from its seat and allowing the air in chamber Y above the check valve 15 to flow past the emergency valve 10 to chamber X and the brake cylinder. Brake pipe air in *a*, below the check valve 15, then raises the check valve against the resistance of its spring 12 and also flows to the brake cylinder through the passages mentioned. During an emergency application, therefore, the quick-action triple valve supplies air to the brake cylinder from the brake pipe as well as from the auxiliary reservoir. Port *s* is small, so as to restrict the flow of air from the auxiliary reservoir to the brake cylinder and thus allow as much air as possible to enter the brake cylinder from the brake pipe. Approximately 60 lbs. brake cylinder pressure is, therefore, obtained on emergency applications, the air from the brake pipe increasing the

cylinder pressure about 20% above the maximum obtainable with a full service application.

Not only does the air vented from the brake pipe give a higher cylinder pressure, but it causes a local drop in brake pipe pressure *at the triple valve.* This sudden drop in pressure causes the next triple valve to apply in "quick-action," and it the next, thus transmitting the quick action from triple valve to triple valve, serially throughout the train in a very short time, with the result that all the brakes in the train are applied in a small fraction of the time which would be required if all the valves were plain triple valves and all the brake pipe reduction had to be made at the brake valve.

The release after an emergency application is made the same as after a service application, except that it requires a longer time, the brake pipe having to be recharged from zero to slightly above the pressure in the auxiliary reservoirs before the triple valve pistons can move to release position.

STRAIGHT-AIR OPERATION

RELEASE AND RUNNING

The S-3 Brake Valve handle should be carried in this position at all times when the straight-air brake is not in use (see Fig. 21). The application valve 8 is held seated by its spring and reduced main reservoir pressure with which it is always 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. Reduced main reservoir pressure is then admitted to the straight-air pipe. This flows to the double check valve on the engine and to that on the tender. The piston of each double check valve will then be shifted to its automatic side, cutting off communication with the triple valve whose exhaust port is open, and permitting air to flow direct to the brake cylinders.

Since the supply to the straight-air brake valve is fixed by the regulation of the reducing valve to 45 lbs., this is the maximum cylinder pressure that can be obtained.

LAP

Lap position is used to hold the straight-air 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.

The driver brakes may be released independently of the train brakes after an automatic application if the S-3-A brake valve is used. Referring to Fig. 23, when brakes are applied automatically, the double-seated check valve 23 will be forced upward and seal against upper seat, preventing escape of air through the brake valve exhaust port. To make an independent release of the driver brakes after an automatic application, the straight-air brake valve handle is moved to *Release* position, at the extreme left, as usual, which will force the extended portion of release valve 14 against the upper projection of the double seated check valve, forcing the latter downward from its seat and allowing the driver brake cylinder air to pass by the check valve through the vertical grooves in its circumference, and to the atmosphere through the brake valve exhaust opening.

The operation when applying the brakes by straight-air is the same as with the S-3, except that the brake cylinder pressure is on top of the double-seated valve and forces it to its lower seat, thus preventing brake cylinder pressure from escaping through the triple valve exhaust port by way of connection to automatic side of Double Check Valve. The release can be made by using either *Release* or *Running* position but after releasing the brakes the handle should invariably be returned to and left in *Running* position, as shown in Fig. 23.

LUBRICATION

BRAKE CYLINDER

Close the branch pipe cut-out cock and drain the auxiliary reservoirs. Remove the nuts from non-pressure head bolts, then remove 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 the cylinder gaskets and the packing leather. If the cylinder wall is rusted, the rust should be removed with sandpaper.

CLEANING PISTON AND PACKING LEATHER. Remove expander ring from piston. Scrape old lubricant from the metal part and packing leather and wipe all surfaces clean and dry. Leather should be carefully examined and should be renewed if brittle, 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 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.

APPLYING NEW LEATHERS. Examine follower studs for tightness in the piston. Place the leather centrally on the piston, flesh side against the piston. Place the follower in position. Apply the nuts, bringing them in contact with the follower without tightening. Then draw them down uniformly.

APPLICATION OF LUBRICANT. Apply a thin coating of brake cylinder lubricant to the wall of the cylinder with a brush. Fill the expander ring groove, at the same time coating the inside of the leather and place the expander ring in position.

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 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 cylinder until the upper portion of the leather engages the cylinder wall. Form this portion of the leather into the cylinder with a dull edge, round cornered, putty knife or similar instrument, while the sleeve or rod is being gradually raised, taking special care not to crimp or otherwise damage the leather. 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 is in its proper position, which will be indicated by freedom of movement.

The above instructions for assembling apply particularly when the brake cylinder is in a horizontal position. However, for other positions, the methods employed must be changed as required to produce similar results.

TRIPLE VALVE

Never remove the movable parts of the triple 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 triple 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 valves. If repairs are necessary, such triple valves should be returned to our shops for that purpose. Our facilities for doing this work are of the best. We can, therefore, do it more quickly, accurately, and guarantee better satisfaction than where it is handled by other shops not so well equipped. Futhermore, it is of the utmost importance that the manufacturer's standards be not departed from if the parts of the apparatus are to be perfectly interchangeable.

In cleaning the triple valve, special care should be given to the slide valve, the graduating valve, the slide valve seat, the packing ring of the triple valve piston, and the emergency rubber-seated valve. In order to avoid springing the triple valve piston ring, it should never be removed except for the purpose of renewal. The triple valve piston ring should be caused to work freely in its groove before replacing.

In lubricating the triple valve, no lubricant should be used on the quick action parts.

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

Both upper and lower faces of the slide valve, the slide valve 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 parts show a dark copper color.

To apply the graphite, use a stick in the shape of a paddle about 8 inches long, having a small piece of chamois glued to one end. Dip the skin covered end in dry graphite and rub on the surfaces specified. 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 triple valve piston ring and the bushing in which it works should be sparingly lubricated by first pushing the piston to release position and applying a drop or two of oil to the circumference of the piston bushing, spreading it over the surface as uniformly as possible and then moving the piston back and forth several times to insure proper distribution of this oil on the wall of the cylinder. There should be no free oil left on the parts. Care should be taken not to permit any oil to get upon the gaskets or rubber-seated valves.

The graduating and check valve springs should be examined and removed if not in proper condition and the slide valve spring tension should be very light.

FEED VALVE AND REDUCING VALVE

The only part of the feed valve and reducing valve requiring lubrication is the slide valve which should be lubricated with dry graphite.

GOVERNOR

The governor receives the necessary lubrication on account of its location in the steam supply pipe between the lubricator and the compressor, and requires no further oiling.

DOUBLE CHECK VALVE AND SAFETY VALVE

These devices should be thoroughly cleaned, but no oil is required.

Westinghouse Air Brake Company,

Pittsburgh, Pa., U. S. A.

Works at Wilmerding, Pa.

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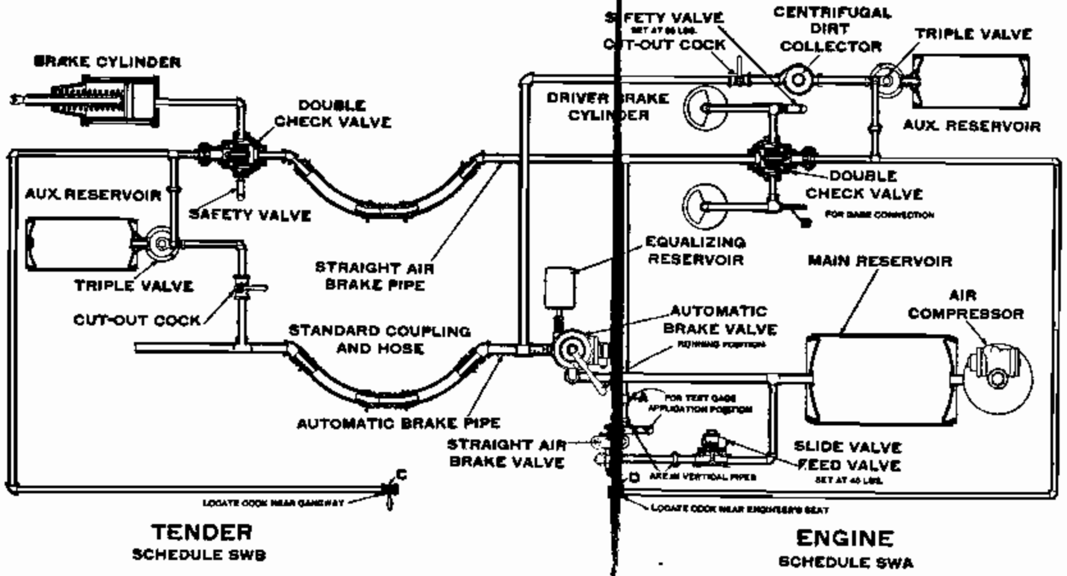
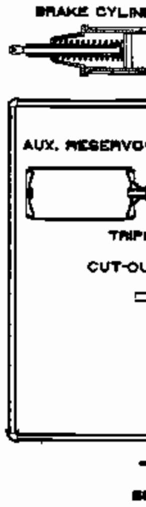


Fig. 30. Diagrammatic of Combined Automatic and Straight-Air Freight Locomotive Equipment when Straight-Air Brake is applied



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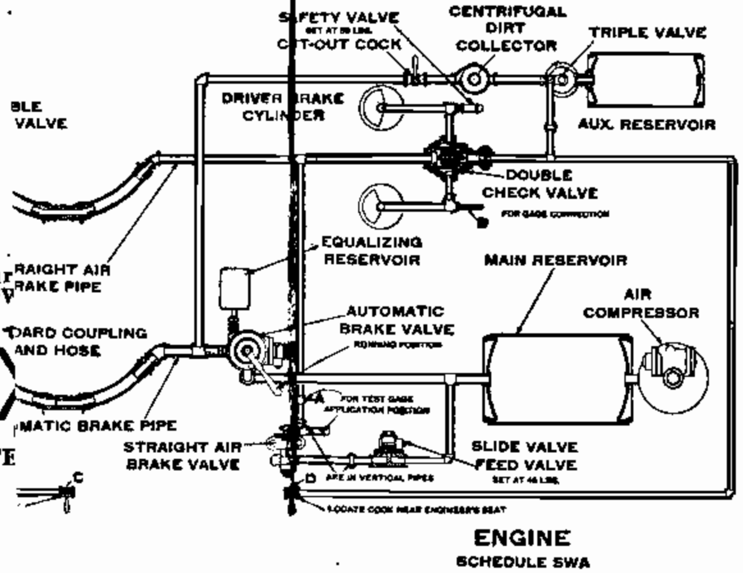

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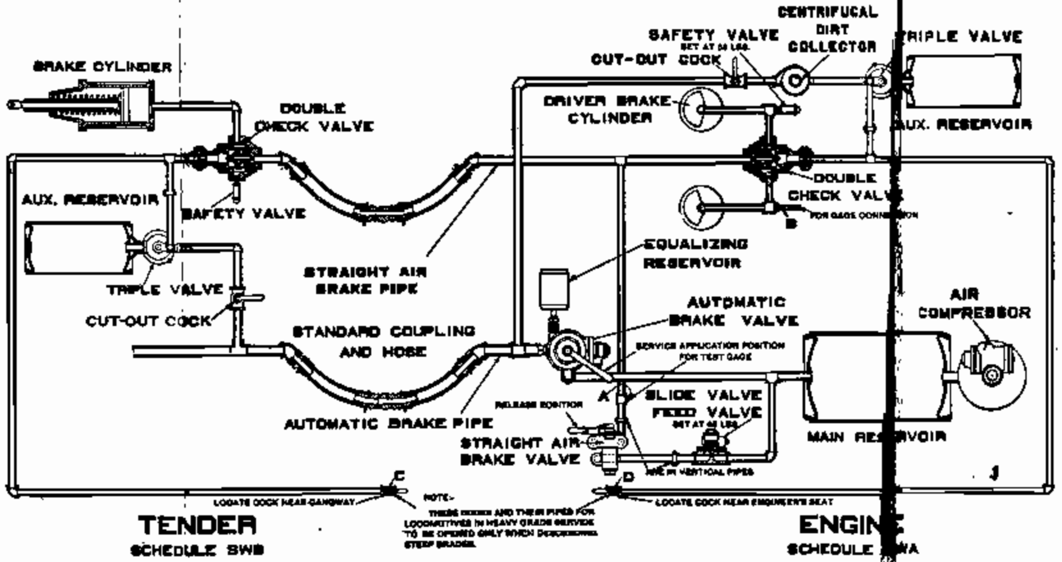

Fig. 31. Diagrammatic of Combined Automatic and
Straight-Air Freight Locomotive Equipment
when Automatic Brake is applied