

*The* PC  
PASSENGER CAR BRAKE  
EQUIPMENT

INSTRUCTION PAMPHLET

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## INDEX

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Novel Functions .....	7
Parts of the PC Equipment .....	13
Location, Operation and Adjustment of Parts .....	17
Operation of the Control Valve .....	43
General Hints .....	86
Lubrication .....	90
No. 3-E Control Valve with Common Exhaust Outlet .....	95

## PREFACE

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### 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 employees.

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 preliminary train 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 engineer, 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 under "General Hints", is, therefore, intended primarily for this class of employes.

### **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 sections under "Operation", "General Hints" and "Lubrication" are, 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 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.

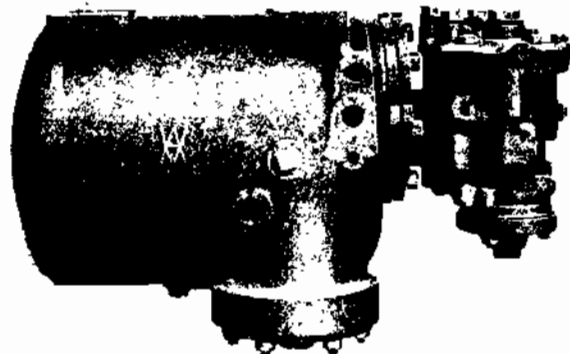
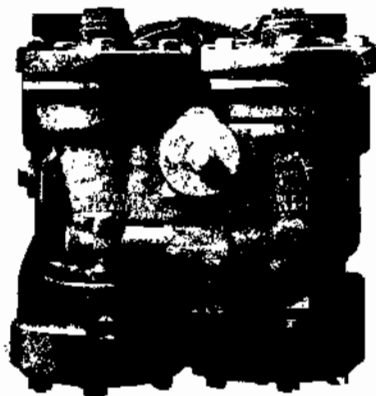


Fig 1 No. 3-E Control Valve, Front and Side Views

## "PC" Passenger Brake Equipment

### NOVEL FUNCTIONS

1st. *Graduated release and quick recharge*, obtained as with previous improved types of triple valves (e. g. Type L). The air supply to assist in recharging and to accomplish the graduations of the release is taken from the emergency reservoir.

2nd. *Certainty and uniformity of service action* secured by insuring that the valve parts move so as to close the feed grooves on the slightest brake pipe reductions, the design of the valves being such as to then require the necessary and proper differential to be built up to move the parts to service position as the brake pipe reduction is continued.

3rd. *Quick rise in brake cylinder pressure* provided for by insuring a prompt movement of the parts and direct and unrestricted passages from reservoirs to brake cylinders during applications.

4th. *Uniformity and maintenance of service brake cylinder pressure during the stop*, provided for in the same manner as by the application portion of the distributing valve.

5th. *Predetermined limiting of service braking power* fixed by the equalization of the pressure and application chambers of the control valve. This eliminates the safety valve feature of previous equipments and is both positive and uniform. After such equalization has taken place, any further brake pipe reduction causes the moving parts of the valve to travel slightly beyond the service position to the "over-reduction" position. Air then flows from the pressure chamber to the reduction limiting chamber until equalization takes place between these two chambers, if the brake pipe reduction is continued far enough. During this time the application chamber remains at the first equalization pressure and the brake cylinder pressure is maintained accordingly.

The maximum service brake cylinder pressure (service equalization) is fixed at 86 lbs., and the nominal braking power based on this pressure instead of 60 lbs. as with previous equipments. On this account it is possible to use a much lower total leverage ratio (which is necessary if the required efficiency of the foundation brake rigging for the classes of cars considered, is to be maintained). This equalization pressure corresponds to a reduction of 24 lbs. from 110 lbs. brake pipe pressure, which is the reduction required with high speed brake equipment to give maximum service brake cylinder pressure (60 lbs., corresponding to the opening point of the high speed reducing valve). *This insures uniformity of service operation of old and new equipments mixed in the same train.*

6th. *Automatic emergency application on depletion of brake pipe pressure.* If the brake pipe reduction is still further continued below the point at which the pressure and reduction limiting chambers equalize, the parts move to emergency position and cause both the quick action and emergency portions to operate, starting serial quick action throughout the train and obtaining emergency brake cylinder pressure.

7th. *Full emergency braking power at any time.* As the operation of the emergency and quick action portions just described is dependent only upon the movement of the parts to emergency position and as this can be caused at any time by making an emergency application with the brake valve, conductor's valve, etc., it follows that *full emergency braking power can be obtained at any time irrespective of a service application previously made.*

8th. *The service and emergency features being separated* permits the necessary flexibility for service applications to be obtained without impairing in the slightest the emergency features of the equipment.

9th. *A low total leverage ratio*, with correspondingly greater overall efficiency, is made possible by the use of two brake cylinders per car, and also higher service equalization pressure.

10th. *Less sensitiveness to the inevitable fluctuations in brake pipe pressure*, which tend to cause undesired light applications of the brake. This insures against brakes creeping on or dragging, burning of brake shoes, delays to the train and so on.

11th. *Maximum rate of rise of brake pipe pressure possible with given length of brake pipe with consequently greater certainty of brakes releasing when a release is made.* With non-graduated release equipments or previous graduated release equipments operating with graduated release feature cut-out, the recharging of the brake pipe toward the rear end of a train of any length may become very slow due to the draining away of the air from the forward end of the brake pipe by the large reservoirs with large sized feed grooves which take their entire supply from the brake pipe only. The quick recharge feature of the "PC" equipment overcomes this difficulty, with either the quick recharge or the graduated release cut in, by restoring the pressure to the pressure chamber on each car at as rapid a rate as the brake pipe pressure alone can be raised by the flow of air through the brake valve. Consequently up to the point of equalization of the pressure chamber and the emergency reservoir under each car (about 5 lbs. less than normal brake pipe pressure), no air is being drawn from the brake pipe. This insures a *prompt and certain release* of the brakes and a rapid recharge and prompt response to successive reductions which may be made, because (1) practically no air is drawn from the brake pipe; (2) pressure chamber and brake pipe recharge at the same rate; and (3) with graduated release or quick recharge cut-out, no air is supplied to pressure chamber except from brake pipe.

12th. *Greatly increased sensitiveness to release, as demanded by the changed conditions already referred to, which tend to produce a very slow rate of rise of brake*

pipe pressure when releasing and recharging, especially toward the end of a long train of heavy cars having large reservoirs. It then becomes necessary to provide the maximum sensitiveness to an increase in brake pipe pressure, in order to insure all valves in the train responding as intended.

13th. *The elimination of the graduated release feature* is especially provided for in the construction of the valve. During the transition period when graduated release equipment is likely to be handled in the same train with cars not equipped with a graduated release brake, especially where long trains are handled and the air supplied from the brake pipe likely to be limited in any way from any cause, it is usually best to cut out the graduated release feature until all cars are furnished with this type of brake. All that is required to change the "PC" equipment from the graduated to a direct release brake, either with or without the quick recharge feature, or vice versa, is the loosening of a nut and turning of the Release Regulating Cap on the front of the control valve head until the desired position is indicated, the nut being then re-tightened.\* (See Figs. 1 and 4.)

It should be further stated, that all the functions mentioned have been so combined that the requirements of interchangeability with existing equipments have been fully satisfied.

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\*NOTE- Some control valves in service have a special "one position" release regulating cap which can be placed in only one position--that which gives direct release with quick recharge.

## PARTS OF THE PC EQUIPMENT

The following is a list of the parts which make up the equipment with a short description of each:

1. The *control valve* which corresponds in a general way to the triple valve of the old style passenger equipment or more closely to the distributing valve of the "ET" locomotive brake. It operates to control the admission of air to and release of air from the brake cylinders.

2. *Two brake cylinders* (one for service and both for emergency applications) with pistons and rods so connected through the brake levers and rods to the brake shoes that when either piston is forced outward by air pressure, this force is transmitted through said rods and levers to the brake shoes and applies them to the wheels.

3. *Two supply or storage reservoirs* denoted as the *service* and *emergency* reservoirs respectively, according to the brake cylinders to which they are related.

4. A *centrifugal dirt collector*, connected in the branch pipe between the brake pipe and control valve as near the control valve as circumstances will permit for the purpose of preventing pipe scale, sand, cinders or foreign particles of any kind from reaching the control valve.

5. A *branch pipe air strainer*, inserted in the branch pipe close to the control valve for further protection to this valve.

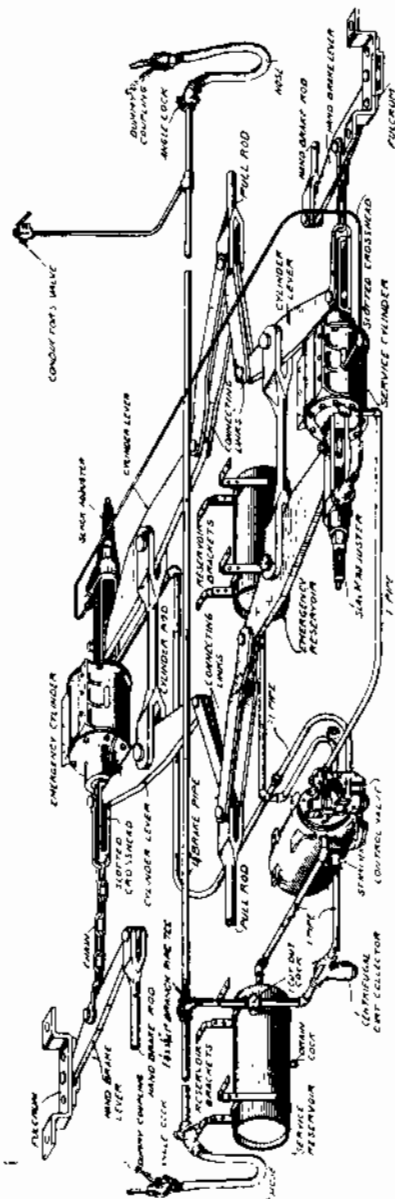


Fig. 2. PC Passenger Brake Equipment. Cylinders Pointing in Opposite Directions

6. A *conductor's valve* placed inside each car by means of which the brakes may be applied by the conductor in case of accident or emergency.

7. A branch pipe tee, various cut-out cocks, angle cocks, hose couplings, dummy couplings, etc., the location and uses of which will be readily understood from the isometric views of the equipment, Figs. 2 and 3, and the descriptions which follow.

8. Each brake cylinder is provided with an *Automatic Slack Adjuster*. This is a simple mechanism by means of which a predetermined piston travel and consequently a uniform cylinder pressure is constantly maintained, compelling the brakes on each car to do their full share of work, thus securing the highest efficiency and reducing the danger of flat wheels which are likely to accompany a wide range of piston travel. This device establishes the running piston travel; that is, the piston travel occurring when the brakes are applied while the car is in motion; and since this is the time during which the brakes perform their work, the running travel is most important.

**NOTE**—In addition to the above parts, one road has installed a "cut-off valve" in the pipe connecting the control valve and the emergency reservoir when the same size service and emergency brake cylinders are used. The purpose of this valve is to automatically cut off the flow of air from the emergency reservoir to the control valve and thereby prevent its use in the emergency brake cylinder but to permit its use for quick recharge. When the "broken" PC schedule is used, that is, when the emergency brake cylinder is smaller than the service brake cylinder, a choke is then located at the point where the pipe from the control valve enters the emergency reservoir. This choke limits the rate of rise of emergency brake cylinder pressure to that obtained on equipments where the cut-off valve is used.



## LOCATION, ADJUSTMENT AND OPERATION OF PARTS

The No. 3-E control valve\* consists of four portions:

- (1) Equalizing Portion.
- (2) Application Portion.
- (3) Emergency Portion.
- (4) Quick Action Portion.

These valve portions are supported upon the *compartment reservoir* which is bolted to the underframing of the car, all pipe connections being made permanently to this reservoir so that no pipe connections need to be disturbed in the removal or replacement of any one of the operating portions of the control valve.

The *compartment reservoir* is made up of the following chambers:

- Pressure Chamber.
- Application Chamber.
- Reduction Limiting Chamber.

The *equalizing portion* is similar, in a general way, to the equalizing portion of the distributing valve used with the "ET" equipment, or the plain triple valve of the old style brake. It is the portion which is directly affected by variations in brake pipe pressure and it controls (either directly or indirectly, through the medium of the other portions of the control valve), the desired charging of the reservoirs, the application of the brake, whether in service or emergency, and the release of the brake.

\*NOTE: For description and illustrations of the No. 3-E control valve with common exhaust outlet, see page 95.

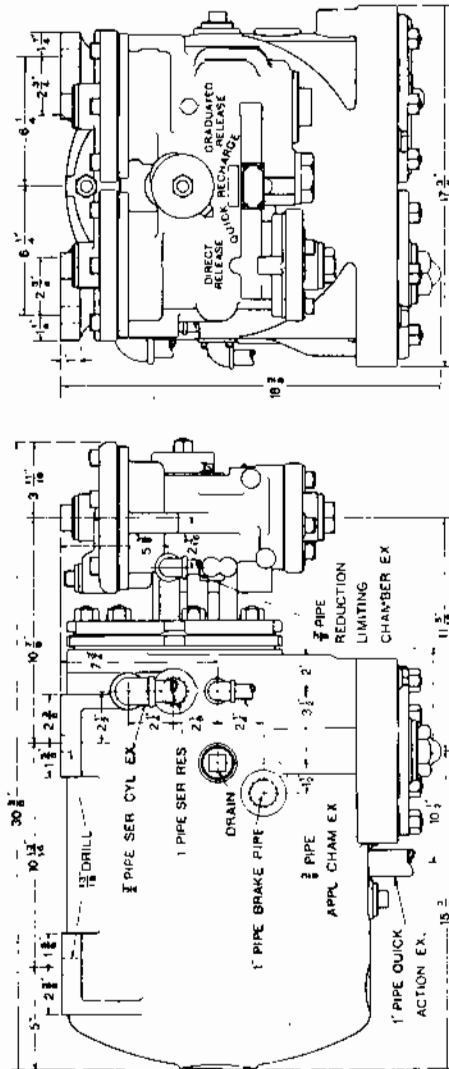


Fig. 4. No. 3-E Control Valve, Outline

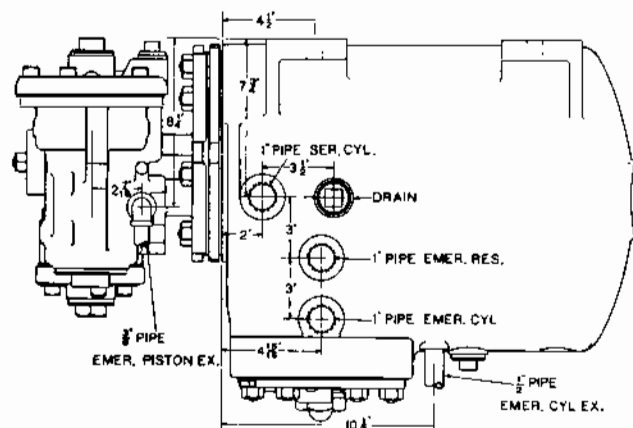


Fig. 5. No. 3-E Control Valve, Outline

The *application portion* corresponds to the application portion of the distributing valve used with the "ET" equipment. It controls the flow of air only from service reservoir to service brake cylinder and the release of same, and has nothing to do with the emergency reservoir or the emergency brake cylinder.

The *emergency portion* contains a double piston and slide valve which controls the flow of air from the emergency reservoir to the emergency cylinder and the release of same to the atmosphere.

The *quick action portion* corresponds in general design and function to the quick action portion of a triple valve. It operates only when an emergency application of the brakes is made, vents brake pipe air to the atmosphere locally on each car and closes the vent to the atmosphere automatically after the desired brake pipe reduction has been made.

Fig. 1 (lower view) shows the No. 3-E control valve from the side on which the *quick action portion* is located and Fig. 6 is a view of the opposite side with the portions separated from each other to show their relative location and method of assembling.

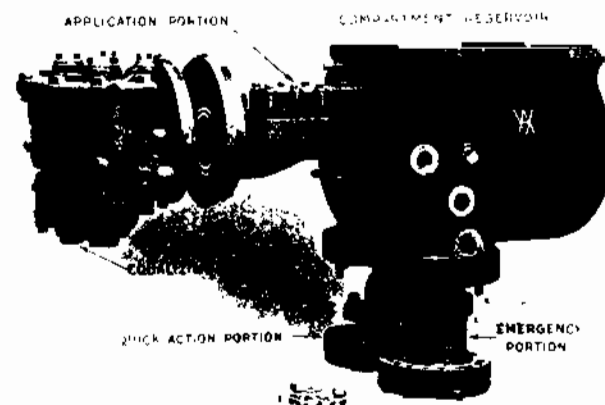


Fig. 6. No. 3-E Control Valve. Showing the Different Portions of the Valve

Fig. 1 (upper view) is a photograph of the equalizing portion mounted on the triple compartment reservoir, taken from directly in front. The release regulating cap with its pointer and positions for cutting graduated release in or out is clearly shown.

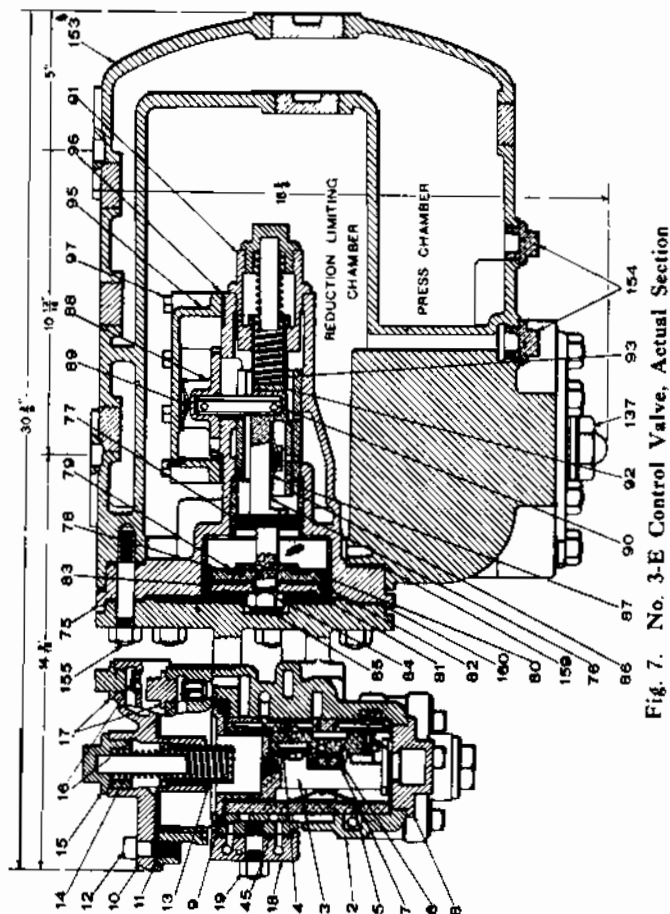


Fig. 7. No. 3-E Control Valve, Actual Section

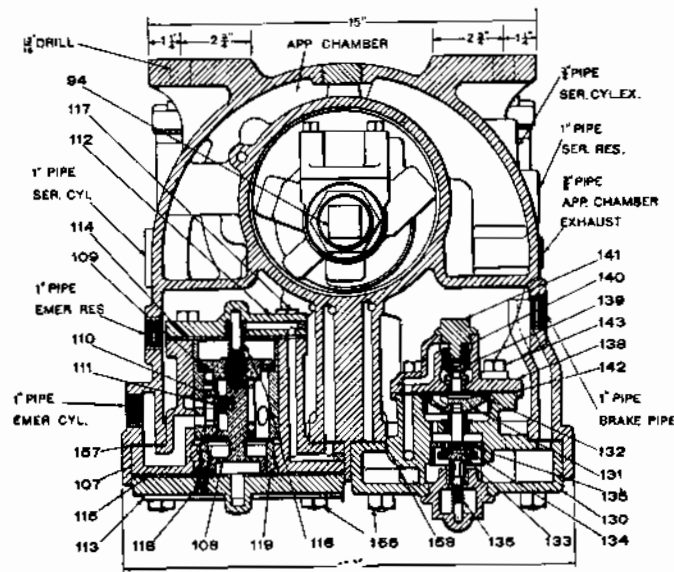


Fig. 8. No. 3-E Control Valve, Actual Section

Figs. 10, 11 and 12 show views of the seats and faces of the equalizing and release slide and graduating valves and of the emergency slide valve. The chambers, etc., to which the ports in the seats connect are as follows:—

Equalizing Slide Valve Seat: 1, Emergency Reservoir Check Valve (under side); 2, Brake Pipe; 3 Release Regulating Cap (open only when cap is adjusted for graduated release and for quick recharge); 4, Reduction Limiting Chamber Exhaust; 5, Small End (chamber G) of Service Reservoir Charging Valve; 6, Reduction Limiting Chamber; 7, Large End (chamber K) of Service Reservoir Charging Valve; 8, Release Slide Valve

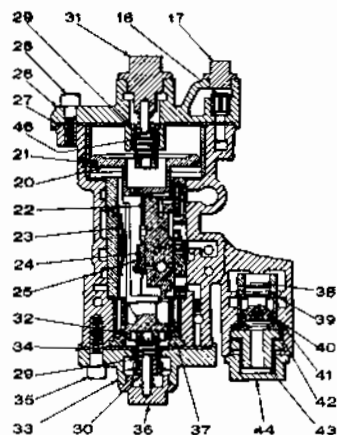


Fig. 9. No. 3-E Control Valve, Equalizing Portion

Chamber (chamber E); 9, Application Chamber and front of Application Piston (chamber C); 10, Emergency Reservoir; 11, Pressure Chamber; 12, Slotted Port; 27, Small Equalizing Piston (chamber F).

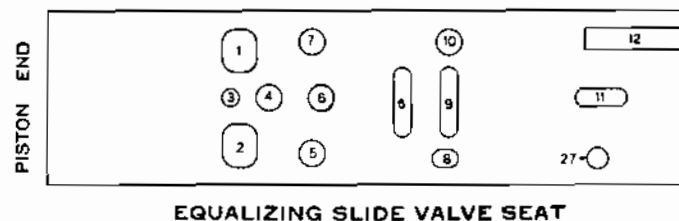
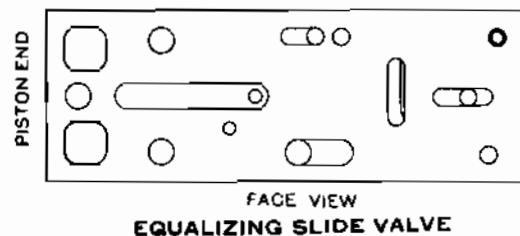
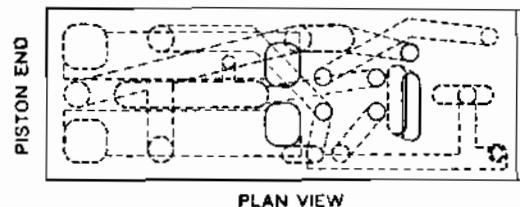
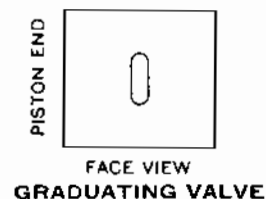


Fig. 10. Equalizing Graduating Valve, Slide Valve, and Slide Valve Seat

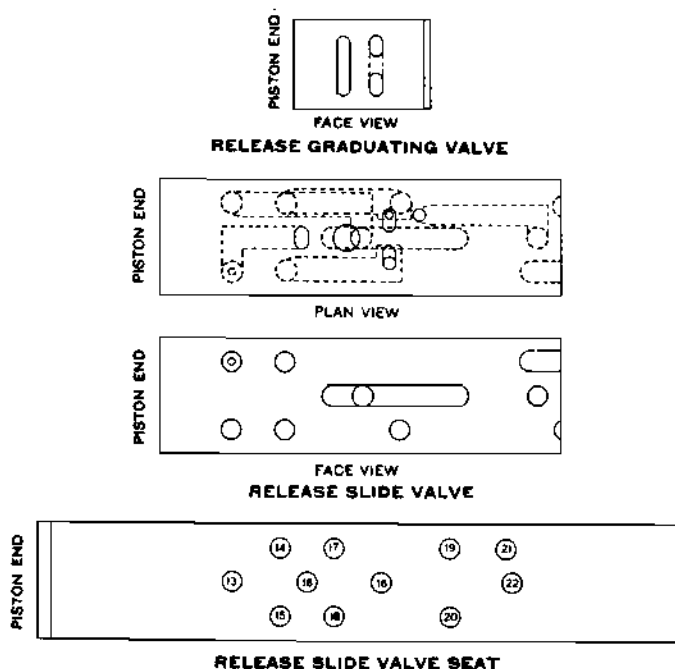


Fig. 11. Release Graduating Valve, Slide Valve, and Slide Valve Seat

Release Slide Valve Seat: 13, Large Emergency Piston (chamber P); 14, Small Emergency Piston (chamber S); 15, Release Regulating Cap (open only when cap is adjusted for graduated release and for quick re-

charge); 16, Emergency Piston Exhaust; 17, Release Regulating Cap (open only when cap is adjusted for direct release and for quick recharge); 18, Application Chamber Exhaust, also Release Regulating Cap (the latter open only when cap is adjusted for direct release and for quick recharge); 19, Application Chamber; 20, Quick Action Closing Valve; 21, Emergency Reservoir; 22, Small Equalizing Piston (chamber F).

Emergency Slide Valve Seat: 23, Service Brake Cylinder; 24, Back of Application Piston (chamber M); 25, Emergency Cylinder Exhaust; 26, Emergency Cylinder.

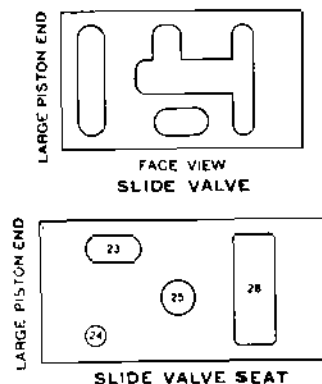


Fig. 12. Emergency Slide Valve and Slide Valve Seat

Fig. 13 shows the flanges of the different portions of the control valve and the seats on which these flanges fit, with all ports marked so as to assist in readily locating to what portions or chambers the openings are connected.

The diagrammatic drawings, Figs. 25 to 40 inclusive, have been made up to assist in describing the different operations of the various parts of the control valve. They illustrate diagrammatically only those parts of the valve which come into play as the various operations are performed. For the sake of clearness, the actual construction of the parts has been disregarded. All ports and parts of the valve concerned in the performance of the particular function to be described have been shown as if located in the same plane, with the connections indicated as clearly as possible and without attempting to follow the actual construction of the valve.

Furthermore, it will be noted that all ports and passages which are not operative in the various positions, have been omitted in the corresponding diagrammatic views (with the exception of Figs. 25 and 38), so that in considering each successive position of the valve, the functions being performed by the valve will be more easily explained and understood by the reader than if those ports which exist but which are not operative in the position shown, were allowed to remain.

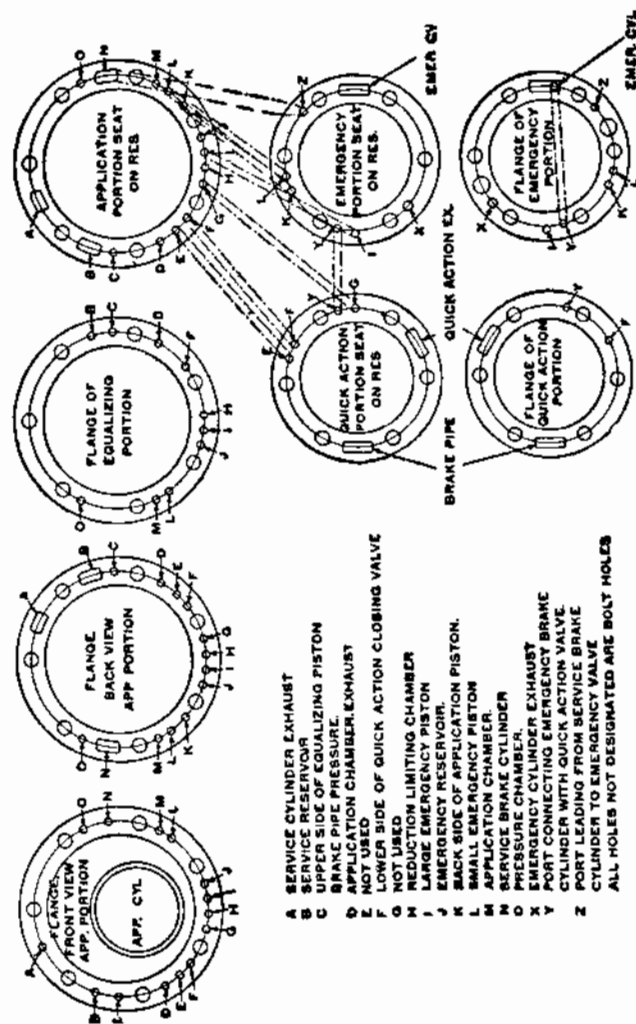


Fig. 13. Flanges of and Seats for No. 3-E Control Valve Portions

# Brake Cylinders

Two brake cylinders per car are used. (See Figs. 2 and 3.) Only *one* brake cylinder operates during service applications, but *both* are brought into play when an emergency application is made. This gives the necessary increased braking power for emergency applications by bringing the same brake cylinder pressure to act upon the pistons of two brake cylinders instead of one. This means that *double* the maximum service braking force is obtainable in emergency applications.

It will be noted that Figs. 2 and 3 differ in the arrangement of the brake cylinders and related parts. Fig. 2, with brake cylinders pointing in opposite directions, permits a somewhat simpler arrangement of the hand brake rigging, while the arrangement shown in Fig. 3 brings the slack adjusters and their connections into a more convenient location for some installations. Which of the two arrangements is to be recommended depends largely on the construction of the car underframing and the location of the apparatus under the car.

Fig. 14 illustrates the section and end view of the type of brake cylinder used with this equipment. The piston 3 has a solid push rod which is connected to the levers of the foundation brake rigging through the slotted crosshead; 12 is a release spring which forces piston 3 to release position when the air pressure is exhausted from the opposite end of the cylinder; the packing cup 9 presses against the cylinder wall and prevents the escape of air past the piston. A slotted crosshead 6

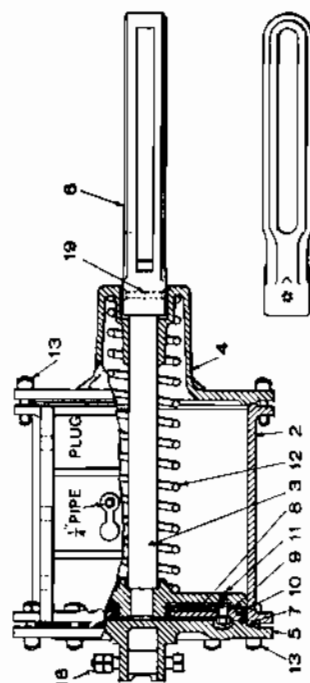
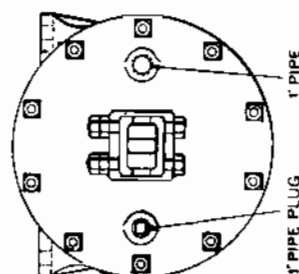


Fig. 14. Brake Cylinder



is used on the service cylinder when the hand brake rigging is designed to work in harmony with the air brake system—an arrangement which we strongly recommend for all conditions where it is practicable. The slotted crosshead on the emergency cylinder permits movement of the emergency cylinder lever in service application without a movement of the piston of the emergency cylinder.

### The Automatic Slack Adjuster

The automatic slack adjuster is illustrated in Figs. 15 and 16. The brake cylinder piston acts as a valve to control the admission and release of brake cylinder pressure to and from pipe *b*, Fig. 15, through port *a* in the cylinder, this port being so located that the piston uncovers it when the predetermined piston travel is exceeded. Whenever the piston so uncovers port *a*, brake cylinder air flows through pipe *b* into slack adjuster cylinder 2 where the small piston 19, Fig. 16, is forced outward, compressing spring 21. Attached to piston stem 23 is a pawl extending into casing 24, which engages ratchet wheel 27, mounted within casing 24 upon screw 4, Fig. 15. When the brake is released and the brake cylinder piston returns to its normal position, the air pressure in cylinder 2 escapes to the atmosphere through pipe *b*, port *a* and the non-pressure head of the brake cylinder, thus permitting spring 21 to force the small piston to its normal position. In so doing, the pawl turns the ratchet wheel upon screw 4 and thereby draws lever 5 slightly in the direction of the slack adjuster cylinder.

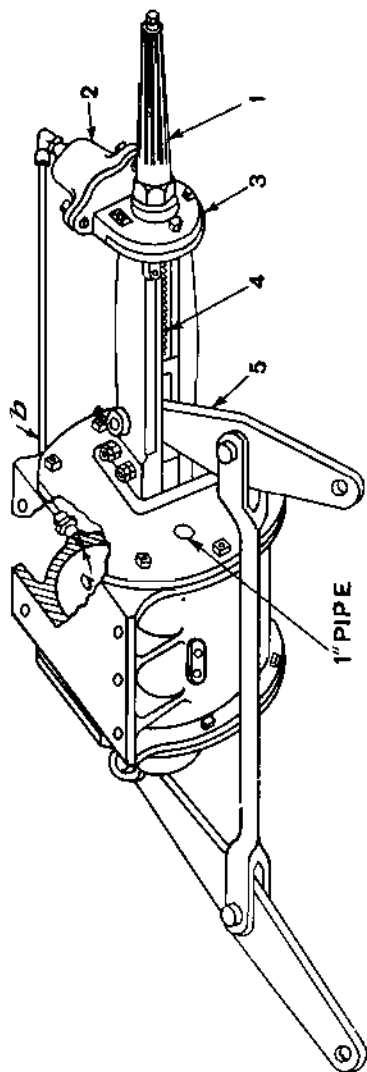


Fig. 15. Application of Slack Adjuster to Brake Cylinder



thus shortening the brake cylinder piston travel and forcing the brake shoes nearer the wheels. As the pawl is drawn back to its normal position, a lug on the lever side strikes projection *a*, Fig. 16, on the cylinder, thus raising the outer end of the pawl, disengaging it from the ratchet wheel and permitting the screw to be turned by hand if desired.

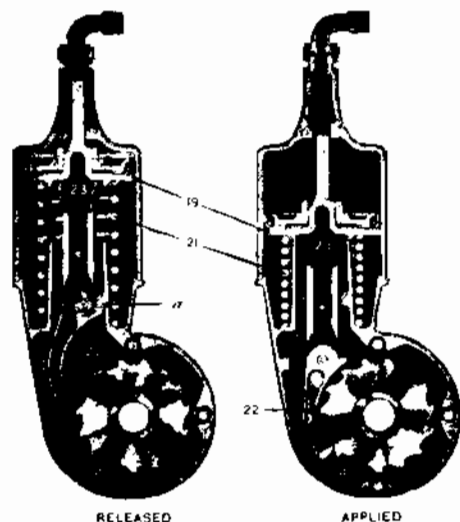


Fig. 16. Automatic Slack Adjuster Cylinder

To apply new shoes, turn casing 1 to the left, thus moving lever 5 toward the position shown in Fig. 15, until sufficient slack is introduced in the brake rigging. To bring the shoes closer to the wheels and shorten the piston travel, turn casing 1 to the right.

The screw mechanism is so proportioned that the brake shoe wear is compensated for at the rate of about  $\frac{1}{32}$  of an inch for each operation of the adjuster, thereby removing the danger of *unduly* taking up false travel which would result in the shoes binding on the wheels.

The best results are obtained by the use of copper pipe from the brake cylinder to the adjuster cylinder, since this pipe is more flexible and does not corrode. It should always be firmly secured.

Every time the brake cylinder is cleaned and oiled, the slack adjuster should receive the same attention, and, after each cleaning and oiling, a test of the brakes should also include one of the adjuster.



Fig. 17. Reservoir

## Reservoirs

The service reservoir is used to supply air only to the service brake cylinder. The emergency reservoir, in addition to supplying air to the emergency brake cylinder in emergency applications, is also the source of air supply utilized in obtaining the graduated release feature and the prompt recharging of the equipment in service operation.

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.

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.

Following is a list of the standard sizes of reservoirs used with the various sizes of brake cylinders:

Service Reservoir		Emergency Reservoir		Cylinders Used With
Size, Inches	Capacity, Cu. In.	Size, Inches	Capacity, Cu. In.	
16 x48	8577	16 x42	7436	2—14 in.
20½x36	10158	16 x48	8577	2— 16 in.
20½x48	14003	20½x36	10158	2—18 in.

## Conductor's Valve

The conductor's valve 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; however, one valve may be placed at each end which will

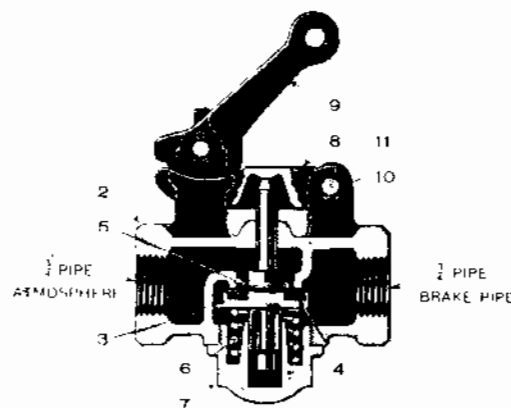


Fig. 18. B-3-A Conductor's Valve\*

obviate the necessity of the cord. When this valve is opened, the air from the brake pipe flows directly through it to the atmosphere, setting the brakes in emergency. It should therefore be used only in case of actual danger and should then be opened as wide as possible and left open until the train stops.

**Centrifugal Dirt Collector**

The *centrifugal dirt collector* is located in the branch pipe in order to protect the control valve against the entrance of pipe scale, sand, cinders, dirt, or foreign substances of any kind.

Fig. 19 is a sectioned view of the new standard "Check Valve Type" in which the detachable enlarged dirt chamber and the check valve are the outstanding features.

The new design comprises two separate portions; the upper or body portion to which the pipe connections are made, and the lower or dirt chamber portion which contains the brass umbrella shaped check valve. The two portions are bolted together and the joint between is protected by means of a rubber gasket.

The detachable dirt chamber provides for easier cleaning, and the increased capacity permits of longer time between cleaning periods (may be the same as for control valve and brake cylinder).

The purpose of the check valve is to hold in the dirt chamber the collected dirt under all conditions of air brake operation. The body portion has a machined seat against which the check valve seats when a heavy reduction in pressure occurs above it, such as that during an emergency application or recharging an empty equipment, thereby shutting off communication between the dirt chamber and the dirt collector outlet. The check valve is so designed and placed on the valve stem as to permit of a rocking motion whereby any fine dust which may collect on top of the check valve will be shaken off into the dirt chamber.

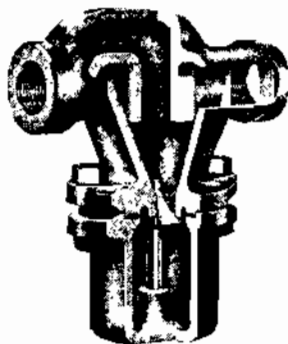


Fig. 19. Centrifugal Dirt Collector

## PIPE FITTINGS

The purpose of the *Branch Pipe Tee*, is to prevent moisture that may be deposited in the brake pipe, from any cause, draining into the branch pipe connection and from thence into the control valve. While the centrifugal dirt collector has proved very efficient in collecting moisture and dirt from the piping of the air brake system thereby protecting the control valve, the use of the branch pipe tee illustrated in Fig. 20 will materially assist in preventing the *excessive* deposit of moisture in

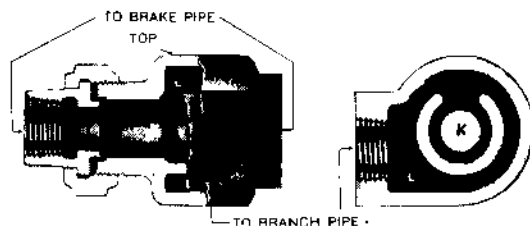


Fig. 20. Branch Pipe Tee

the branch pipe sometimes occasioned in charging and testing trains from poorly designed yard plants, or because the locomotive has insufficient reservoir capacity or cooling pipe to insure precipitation of the water before passing to the brake system. This fitting has the interior coring so designed that the outlet from the brake pipe to the branch pipe is at the top. Thus, as air enters at K from the brake pipe it is deflected upward and made to pass through the outer chamber L and

thence through the pipe opening at the side to the branch pipe, the moisture and heavy particles of dirt passing on through the brake pipe.

These fittings are made in two forms, one having the branch pipe connections at the side and the other having the connection at the bottom. Unless otherwise specified the former, as illustrated in Fig. 20, will be furnished.

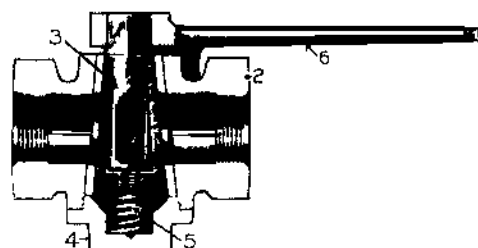


Fig. 21. Cut-Out Cock

The *cut-out cock*, of which there is one 1-inch in the branch pipe, should be placed where it can be easily reached but protected from accidental closing. The handle should be in such position that, as affected by vibration, it would tend to jar open instead of shut.

The Angle Cock ( $1\frac{1}{4}$ -inch), as used at each end of the brake pipe, is provided with a self-locking handle which locks in either open or closed position. This fea-

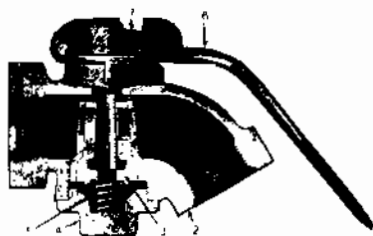


Fig. 22 Self-Locking Angle Cock

ture insures against accidental movement of the handle by flying missiles, loose brake rods, swinging check chains, or other causes.

*Hose Connections* make the brake pipe continuous throughout the train. When cars are being separated, as in switching, the hose should be uncoupled by hand, to prevent rupture or damage.



Fig. 23. Hose Connection

*Dummy Couplings* are provided at each end of the car to which the hose couplings should be attached when not coupled up, to protect against injury to the hose couplings or dirt entering the pipes.

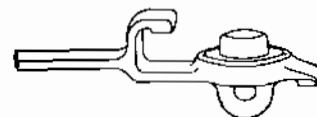


Fig. 24.  
Dummy Coupling

## OPERATION

Before taking up the various positions assumed by the valve, reference should be made to Fig. 25, showing diagrammatically all of the ports and operative parts of the control valve in Normal Position. This is the position which the various parts of the valve would occupy with all parts properly assembled, but before any air has been admitted to the brake pipe, and is shown here in order to indicate the relation of all the ports and detail parts of the valve which will not be shown complete in any of the succeeding views.

All of the chambers, connections and details parts of the valve are clearly indicated so that further explanation will be unnecessary. It will be noted that the various chambers, etc., have been designated either by name or by letter, but that the ports have not been designated. In describing the operation of the valve in detail, the portions from, and to, which the air moves in the various positions have been carefully explained but with only such references to the path pursued as will enable its course to be easily followed by reference to the illustrations. It should, therefore, be constantly borne in mind that the descriptive matter is incomplete without constant reference to the diagrammatic illustrations, and that only by a study of both the text and the diagrams can a clear understanding of the manner in which the functions of the control valve are performed, be obtained.

It will be noted that in Fig. 25 the release regulating cap is shown in its *Graduated Release* position. Just below it are shown the positions which the cap occupies

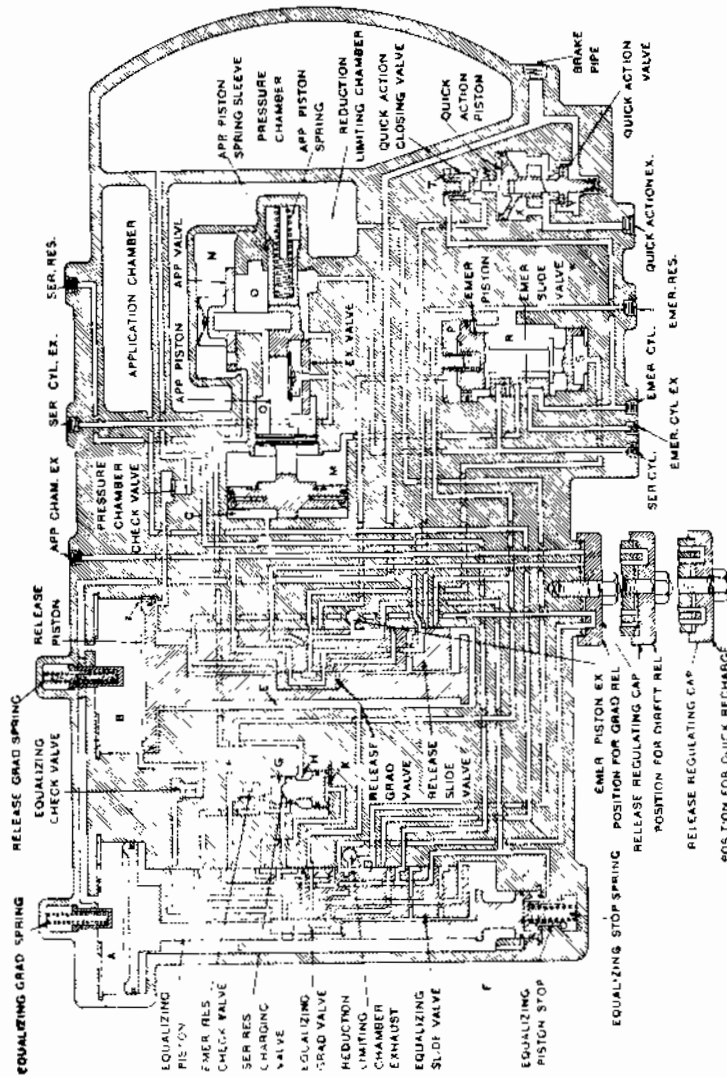


Fig. 25. Normal Position

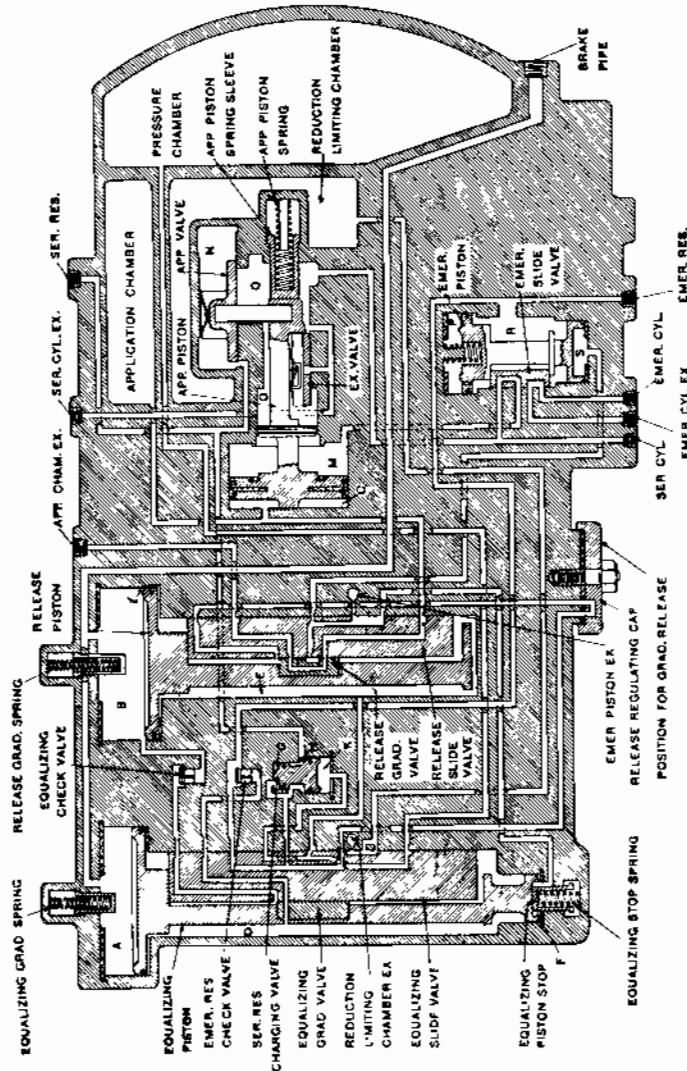


Fig. 26. Release Position, Charging Pressure Chamber, Emergency and Service Reservoirs

when adjusted for direct instead of graduated release. In all the succeeding views, except Figs. 37 and 38, the cap is considered to be adjusted for graduated release. Fig. 32 with the accompanying explanation, refers to the operation of the valve with the cap adjusted for direct release while Fig. 38 illustrates the valve with the cap adjusted for quick recharge.

### RELEASE AND CHARGING POSITION

Fig. 26 shows diagrammatically only those parts and ports which are operative while the brake is being released and the *pressure chamber* and *emergency* and *service reservoirs* are being charged.

In charging the empty equipment, air from the *brake pipe* entering the control valve at the point indicated, passes to *chambers B* and *A* and forces the equalizing and release pistons of the equalizing portion, with their attached valves, to *Release* position. Brake pipe air then passes from *chamber B*, lifting the equalizing check valve, and by way of the equalizing slide valve into *chamber D*. Air from *chamber D* then flows through the equalizing graduating and slide valve, (so shown in the diagrammatic drawing for the sake of clearness. In this and a number of instances following, this port in actual valves opens *past the end of* instead of *through the* graduating valve), past the emergency reservoir check valve and thence in two directions, (1) to *chamber R* and to the *emergency reservoir* and (2) through the equalizing slide valve to two different ports connecting (1) to the *service reservoir charging valve*, thence to the *service*

reservoir and (2) by way of the release regulating cap and through the release slide valve and past the end of the release graduating valve to *chamber E*.

Air from the *brake pipe* and *chamber B* also flows through *feed groove i* and charges *chamber E*.

From *chamber E*, the air flows by way of the equalizing slide valve in two directions, (1) to the *pressure chamber* direct (which is thus charged to brake pipe pressure) and (2) to *chamber K*. With substantially the same pressures (brake pipe pressure as explained) in *chambers G* and *K*, and a lower pressure (service reservoir pressure) in *chamber H*, the service reservoir charging valve remains in the position shown in Fig. 26, being held in this position until the recharging is completed, since *chamber K* is relatively small and the ports leading to it of ample capacity to charge it more quickly than the pressure can be built up in *chambers G* and *H*.

Referring to Fig. 25, it will be noted that the pressure chamber check valve prevents the air in *chamber E* from flowing directly to the *pressure chamber*. Consequently this check valve is not shown in Fig. 26. It allows, however, a free passage of air in the opposite direction. That is to say, when charging or recharging, air reaches the *pressure chamber* only by way of the equalizing slide valve but during an application of the brakes (to be explained later) the *pressure chamber* and *chamber E* are to all intents and purposes one and the same and may be then referred to as such.

*Chamber F* at the small end of equalizing piston is connected through the release slide valve to the emer-

gency piston exhaust and *atmosphere*, thus holding the equalizing piston and its valves positively in *Release* position.

*Chamber S* at the small end of the emergency piston is connected through the release slide valve to the emergency piston exhaust and the *atmosphere* in *Release* position, thus holding the emergency piston and its valve positively in the proper position.

The *reduction limiting chamber* is connected through the equalizing slide valve to the reduction limiting chamber exhaust and *atmosphere*.

The *application chamber* and *chamber C* are connected through the release slide valve and graduating valve to the application chamber exhaust port leading to the *atmosphere*.

The *service brake cylinder* is connected through the exhaust slide valve of the application portion to the service brake cylinder exhaust port leading to the *atmosphere*.

The *emergency brake cylinder* is connected through the emergency slide valve to the emergency cylinder exhaust port leading to the *atmosphere*.

It will be noted that Fig. 25 and some that follow show a small cavity in the release graduating valve. This cavity is connected to the emergency piston exhaust in all positions of the valve, but has no other connection. The purpose of this cavity is merely to insure that, under all conditions, there will be sufficient differential pressure acting on the graduating valve to hold it to its seat.



## SERVICE APPLICATION

## a. Preliminary Service Position

With the equipment fully charged as explained above, the result of a service reduction in brake pipe pressure will be to lower the pressure in *chambers A* and *B* below that in *chambers D* and *E*, thus creating a differential pressure on the equalizing and release pistons. Since *chamber F* is open to the *atmosphere* (see Fig. 26), the release piston will move on a much less differential than the equalizing piston. There is a small amount of lost motion between the release piston and release graduating valve and somewhat more between release piston and release slide valve so that during the first movement of the release piston, the release slide valve still remains in its *Release* position, thus keeping *chamber F* open through the emergency piston exhaust port to the *atmosphere*. The release piston, therefore, is the first to move when a brake pipe reduction is made and it carries with it the release graduating valve and finally moves the release slide valve to the position shown in Fig. 27, called *Preliminary Service* position. In this position the piston has closed the feed groove *i* (which is therefore not shown in Fig. 27) and just touches the release graduating piston sleeve.

The function of the valve in this position is to close the port leading from the *application chamber* to the *atmosphere* (which is therefore not shown in Fig. 27) to close the port connecting *chamber F* to the *emergency piston exhaust* and to open this latter port, connecting *chamber E* past the end of the release graduating valve and through the release slide valve to *chamber F*. Pres-

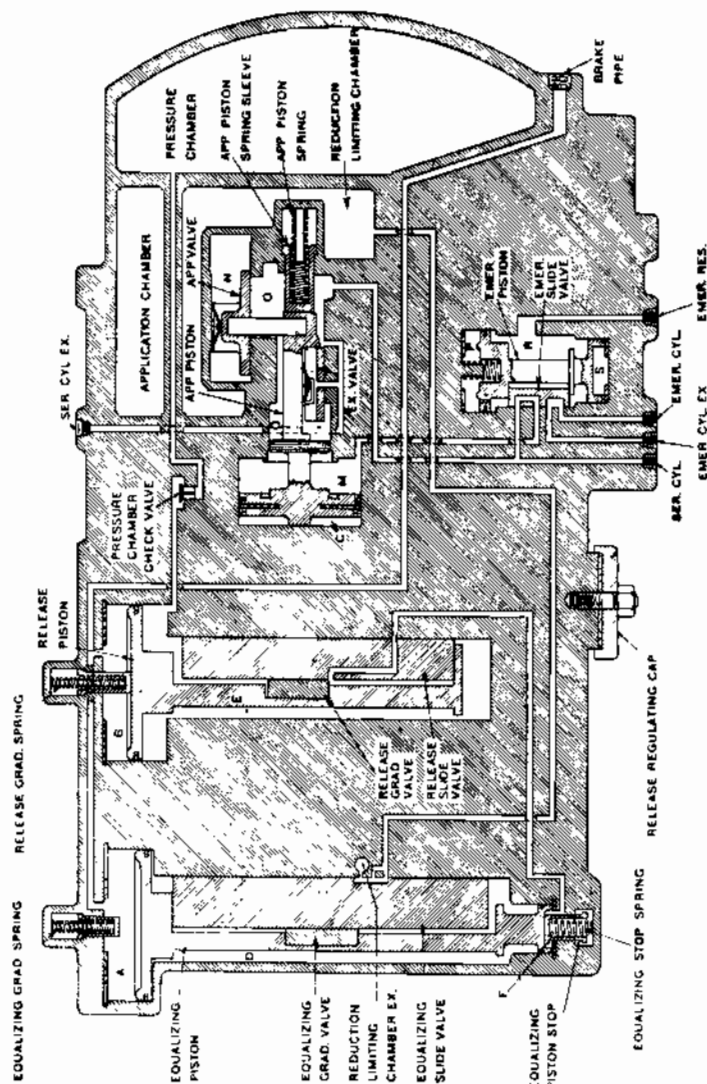


Fig. 27. Preliminary Service Position

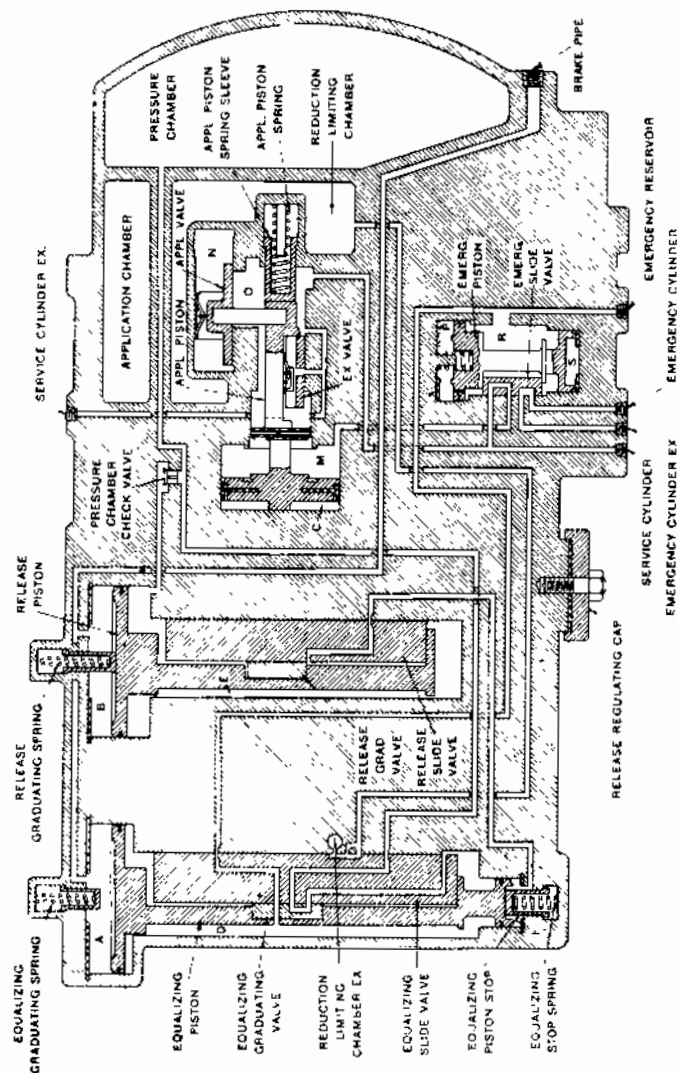


Fig. 28. Secondary Service Position

sure chamber air is therefore free to flow past the pressure chamber check valve to *chamber F*, thus balancing the pressures in *chambers F* and *D* on the opposite sides of the small end of the equalizing piston.

The other connections shown in Fig. 27, which remain as shown in Fig. 26, continue to perform the same functions as explained with reference to Fig. 26, and consequently do not need to be again referred to.

This position, it should be understood, is assumed only momentarily and should be regarded as the first stage only of the complete movement of the parts from *Release and Charging* to the *Service* position of the parts.

#### b. Secondary Service Position

The balancing of the pressures in *chambers F* and *D*, as explained, permits the equalizing piston to move in accordance with the difference of pressure already existing between *chambers D* and *A*. When the shoulder on the end of the piston stem comes in contact with the equalizing slide valve, as shown in Fig. 28, a connection is momentarily made from the *emergency reservoir* through the equalizing slide valve and past the end of (although shown as *through* in the diagrammatic view: the graduating valve to *chamber D*. The purpose of this connection (which is cut off, it will be observed, as soon as the equalizing piston is moved beyond the equalizing piston stop sleeve) is to prevent a drop in pressure in *chamber D* which would otherwise take place on account of the movement (displaced) of the equalizing piston. The displacement of the equalizing piston is sufficiently great, compared with the volume of *chamber D*, to require the provision just explained.

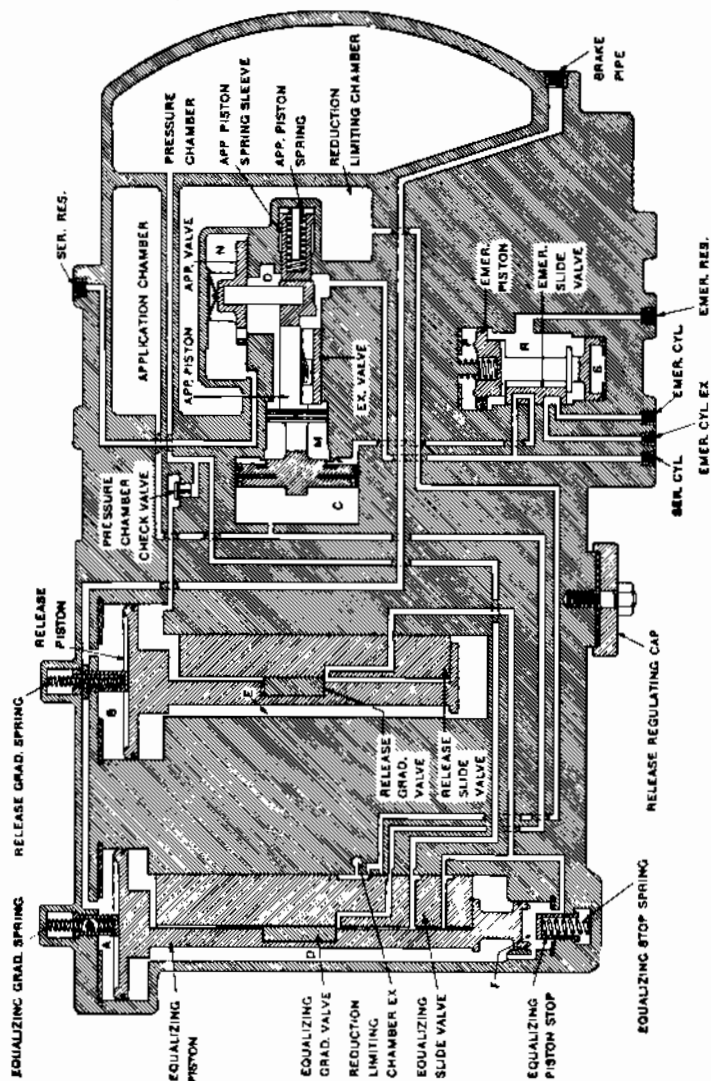


Fig 29. Service Position

At the same time the *pressure chamber* is connected through the equalizing slide valve and graduating valve to *chamber D*, thus keeping the pressures in these two chambers equal.

The other connections remain as explained under the heading "Preliminary Service Position."

### c. Service Position

The differential between the brake pipe pressure in *chamber A* and the pressure in *chamber D* (*pressure chamber* pressure as explained) is sufficient to move the equalizing piston and its valves past the intermediate secondary service position into *Service* position (Fig. 29) in which the equalizing piston just touches the equalizing graduating spring sleeve.

*Chambers F* and *D* are in communication by way of a feed port around the small end of the equalizing piston.

The *pressure chamber* is connected to *chamber D* through two channels, first, by way of the *pressure chamber* check valve to *chamber E* and thence past the end of the release graduating valve through the release slide valve to *chamber D* by way of a port past the end of (shown as *through in cut*) the equalizing slide valve, as well as through *chamber F*, and, second, the *pressure chamber* is also connected directly to the seat of the equalizing slide valve and past the end of (shown as *through in cut*) the slide valve direct to *chamber D*.

From *chamber D* air from the *pressure chamber* can flow past the end of the equalizing graduating valve and through the equalizing slide valve to the *application chamber* and *chamber C* on the face of the application piston.

The pressure of the compressed air thus admitted to *chamber C* causes the application piston to move to its *Application* position, compressing the application piston spring in so doing.

In this position the brake cylinder exhaust slide valve closes the brake cylinder exhaust ports (which, therefore, are not shown in Fig. 29) and the application slide valve opens the application port, permitting air from the *service reservoir (chamber N)* to flow to *chamber O* and the *service brake cylinder*, thus applying the brakes. The air flowing thus to the *service brake cylinder* also flows by way of the emergency slide valve to *chamber M*, in which the pressure is increased equally with that of the *service brake cylinder*. The flow of air from the *service reservoir* to the *service cylinder* continues, therefore, until the pressure in the *service brake cylinder* and in *chamber M* becomes substantially equal to that in the *application chamber* on the opposite side of the application piston. The application piston spring then returns the piston and the application slide valve back to *Lap* position (see Fig. 30), thus holding the brakes applied with a *service brake cylinder pressure* substantially equal to that put into the *application chamber*, as before mentioned.

It will be noted that in *Service* position, the *reduction limiting chamber* and *emergency brake cylinder* still remain connected to the *atmosphere*, as explained under the heading "Release Position."

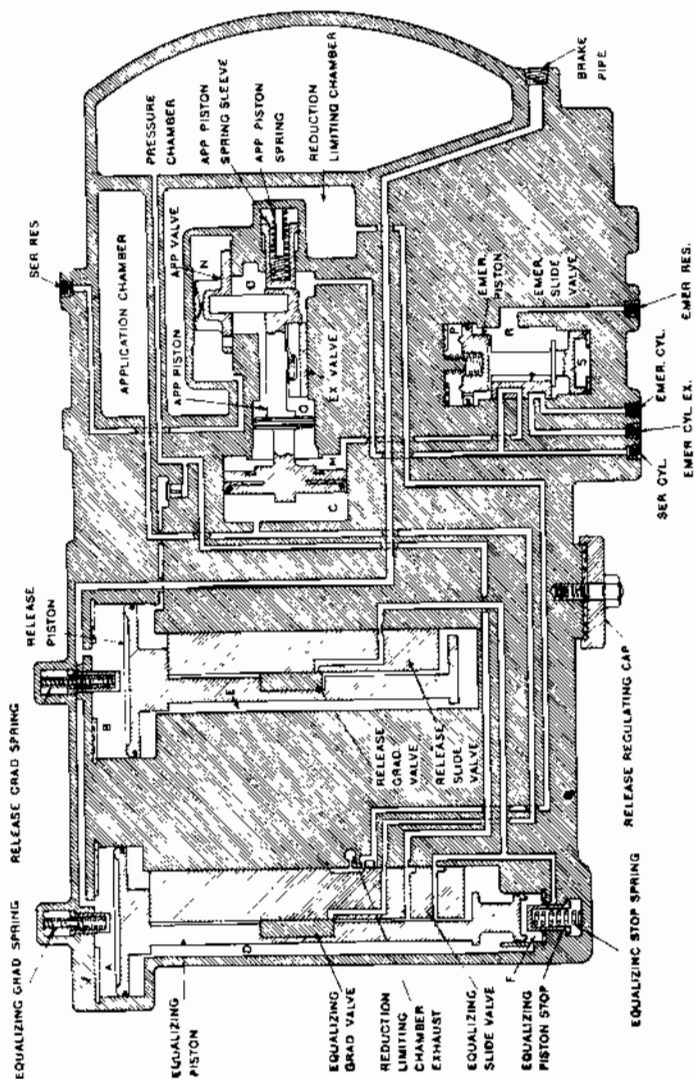


Fig. 30. Service Lap Position

### d. Service Lap Position

In case that less than a full service reduction is made, that is to say that the brake pipe pressure is not reduced below the point at which the *pressure chamber* and *application chamber* pressures equalize, the flow of air from the *pressure chamber* to the *application chamber* as explained under the heading "Service Position" will finally reduce the pressure in *chamber D* to slightly below that to which the *brake pipe* pressure is reduced. The slightly higher brake pipe pressure in *chamber A* then causes the equalizing piston and graduating valve to return to their *Service Lap* positions (Fig. 30) and close communication from the *pressure* to the *application chamber* and holding whatever pressure was built up in *chamber C* and the *application chamber*.

It will be plain that any decrease in brake cylinder pressure, due to leakage, will now reduce the pressure in *chamber M* below that which is bottled up in the *application chamber (chamber C)*. The differential pressure thus established on the application piston will cause it to move again toward its *Service* position and open the application valve port, as shown in Fig. 31, just enough to supply a sufficient amount of air from the *service reservoir* to the *service brake cylinder* to restore the depleted brake cylinder pressure to its original amount, following which the application valve will be again lapped as already explained. In this way, the *brake cylinder pressure will be maintained constant, regardless of leakage, up to the capacity of the service reservoir.*

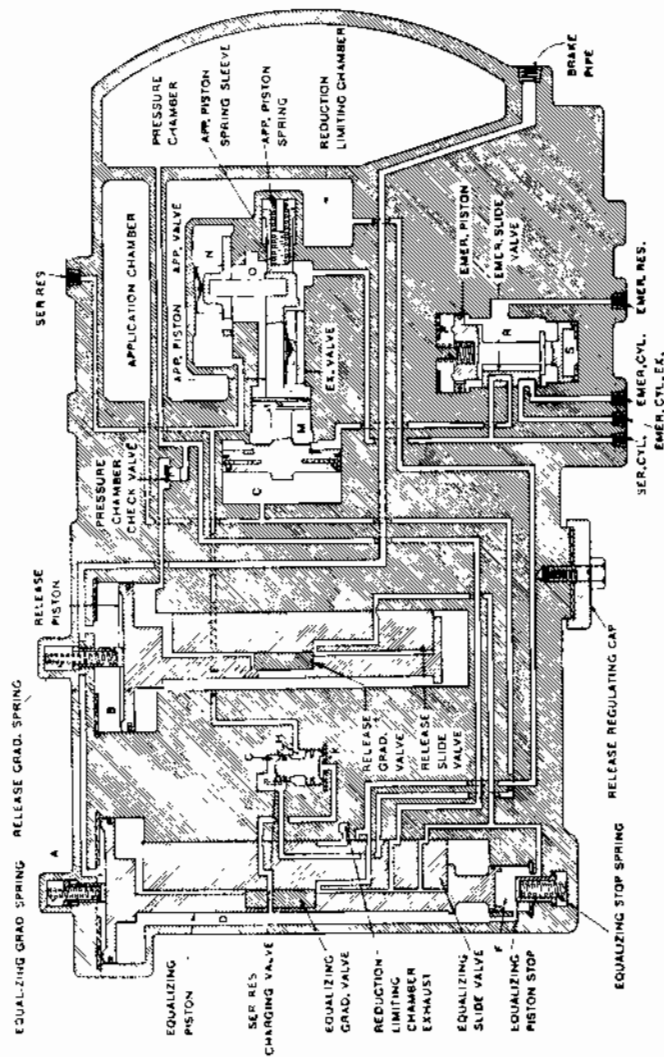


Fig. 31. Over Reduction Position

The release piston and graduating valve may or may not return to their *Lap* positions at the same time as, and in a manner similar to the movement of, the application piston and valves, but they perform no function in either case.

Otherwise the parts remain the same as in *Service* position.

#### e. Over Reduction Position

If the brake pipe reduction is carried below the point at which the *pressure* and *application chambers* equalize (86 lbs. when using 110 lbs. brake pipe pressure and 55 lbs. with 70 lbs. brake pipe pressure), such an over reduction results in lowering the pressure in *chamber A* below that in *chamber D* (*pressure chamber pressure*). The equalizing piston consequently moves beyond its *Service* position (Fig. 29) carrying with it the equalizing slide valve and graduating valve to what is called the "Over Reduction Position" (Fig. 31).

The relative resistances of the release and equalizing graduating springs is such that the release piston and its valves still remain as in *Service*, although for the moment the same differential between *pressure chamber* and *brake pipe* pressure is acting upon the release piston as was sufficient to move the equalizing piston and its valves to the *Over Reduction* position.

The result is that air from the *pressure chamber*, (which is still connected to *chamber D* in substantially the same manner as explained under "Service Position") now flows past the end of the equalizing graduating valve and through the equalizing slide valve to the *reduction limiting chamber* instead of to the *application chamber* as in *Service* position.

The *reduction limiting chamber* being at atmospheric pressure, permits the pressure in the *pressure chamber* (and *chambers E* and *D*) to drop in accordance with the continued over reduction of brake pipe pressure, to the point of equalization of the *reduced pressure chamber pressure* and the *reduction limiting chamber pressure*. Otherwise the condition of the pressures in the reservoirs and brake cylinders controlled by the control valve is unchanged, except that in the movement of the equalizing slide valve to *Over Reduction* position, a connection is made from the *application chamber* and *chamber C* by way of the equalizing slide valve to the top (*chamber G*) of the service reservoir charging valve, and from *chamber D* (*pressure chamber pressure*) past the end of the equalizing graduating valve and through slide valve to *chamber K*. Since the pressure in the *pressure chamber* is being reduced, as already explained, while that in the *application chamber* is about 86 lbs. pressure, the service reservoir charging valve is not lifted, but is held down to its seat.

The application valve port is shown partly open, supplying brake cylinder leakage.

# f. Over Reduction Lap Position

Provided the brake pipe reduction is not carried below the equalizing point of the *pressure chamber* and *reduction limiting chamber*, a slight reduction of the pressure in the *pressure chamber* (and chambers *D* and *E*) below that held in the *brake pipe*, resulting from the continued flow of air from the *pressure* to the *reduction limiting chamber*, will cause the equalizing piston and graduating valve to be returned to *Over Reduction Lap* position (Fig. 32). This closes the port from the *pressure chamber* to the *reduction limiting chamber* and prevents further flow of air in this direction, but otherwise all parts and pressures are as explained above under heading "Over Reduction Position," except that the port connecting chamber *D* past the end of the equalizing graduating valve and through slide valve to chamber *K* is blanked by the movement of the equalizing graduating valve.

Should the brakes be held applied in *Over Reduction Lap* position for a sufficient length of time, with an *application chamber* leakage so great that the air from the service reservoir could not get past the ring in the small end of the service reservoir charging valve fast enough to supply such leakage, the service reservoir charging valve will finally be lifted, making wide open connection from the *service reservoir* to the *application chamber*.

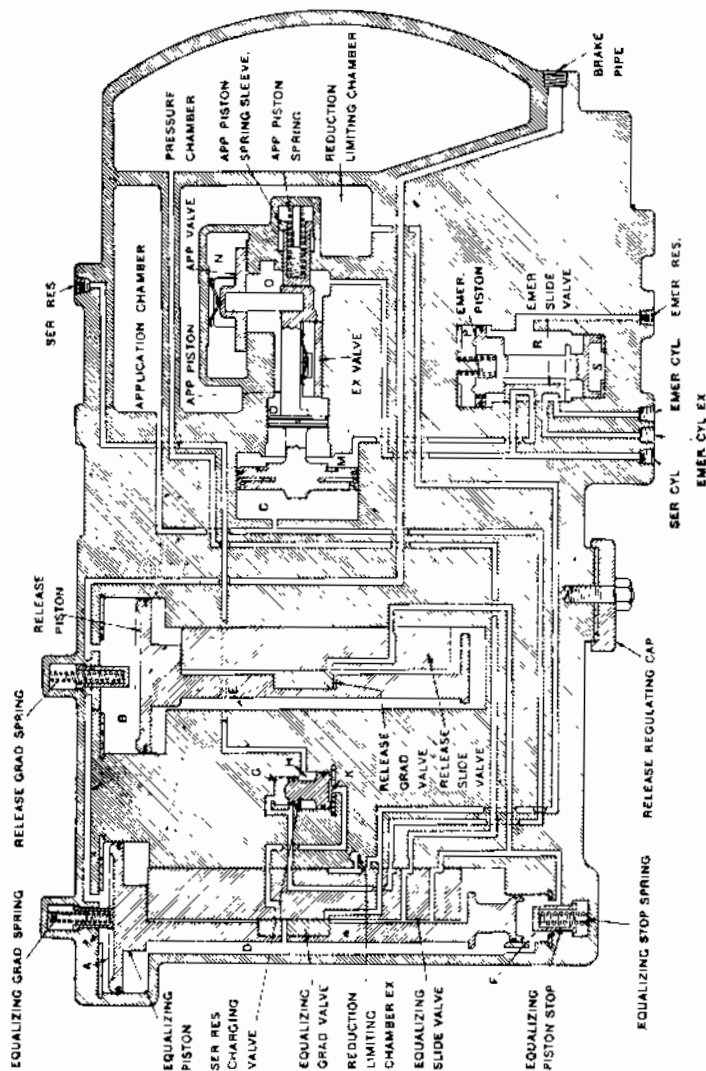


Fig. 32. Over Reduction Lap Position

From what has been said, it will be plain that if the brake pipe reduction is continued below the point at which the *pressure* and the *reduction limiting chambers* equalize, the pressure in the *pressure chamber* can no longer continue to reduce in accordance with the still falling brake pipe pressure. This results in a differential being established between the pressure in the *pressure chamber* (and *chambers D* and *E*) and the *brake pipe* pressure which, when the brake pipe pressure is reduced below 60 lbs. when carrying 110 lbs. brake pipe pressure or below 38 lbs. with 70 lbs. brake pipe pressure, is sufficient to cause the release piston to travel to its extreme (*Emergency*) position and produce quick action and an emergency application of the brakes as will be explained under the heading "Emergency Position."

## RELEASING

### a. Preliminary Release Position

Whether the parts are in *Service Lap* or *Over Reduction Lap* position, after an application has been made, an increase in *brake pipe* pressure above that in the *pressure chamber* (*chambers D* and *E*) will cause the equalizing piston and its valves to return to the release positions described below.

The equalizing piston moves before the release piston, the parts being designed to require a somewhat higher differential to move the release piston and its attached valves than is sufficient to move the equalizing piston and its attached valves.

In *Preliminary Release* position (Fig. 33), it will be noted that *chamber E* behind the release piston, is connected by way of the equalizing slide valve and graduating valve to the *reduction limiting chamber exhaust*. This connection is made but momentarily, in what may be considered the first stage of the movement of the parts to *Release* position. It plays a very important part, however, in the release operation of the valve, since by thus insuring a momentary but material drop in the pressure in *chamber E* below that in the *brake pipe* and in *chamber B*, the release piston is forced to return positively to its *Release* position shown in Fig. 34—*Secondary Release* position.

In *Preliminary Release* position, the *pressure chamber* is connected by way of the equalizing slide valve to *chamber F*. The pressure thus acting in *chamber F*, in addition to the force of the equalizing stop spring, serves to insure that the equalizing piston and its valves hesi-



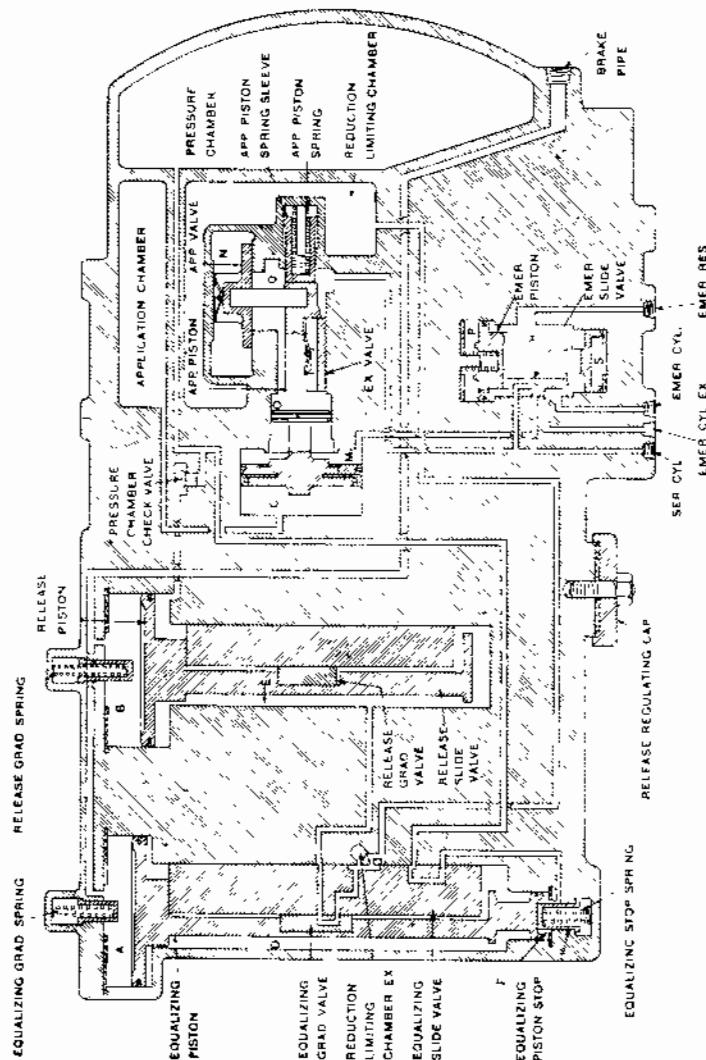


Fig. 33. Preliminary Release Position

tate in *Preliminary Release* position for a sufficient length of time to reduce the pressure in *chamber E* (as already explained).

It will be observed that the application piston is still in its *Lap* position, holding the pressure in the service brake cylinder. This continues until the release of air from the *application chamber* and *chamber C*, which does not take place until the parts move to the next stage in the release movement, called *Secondary Release* position, Fig. 34.

In the movement of the equalizing slide valve to *Preliminary Release* position, the *reduction chamber* is connected to the *reduction chamber exhaust port* and the *atmosphere* and so remains until the parts again move to *Over Reduction* position or beyond.

Although there are other connections made in the *Preliminary Release* position as shown in Fig. 33, they perform no particular function other than has already been described, and consequently do not need to be again referred to.

### b. Secondary Release Position

In the movement of the parts to *Release* position, the next stage, following the *Preliminary Release* position, is called the *Secondary Release* position and is shown in Fig. 34. It will be seen from the illustration that the venting of the air from *chamber E* through the equalizing slide valve and graduating valve to the *reduction limiting chamber exhaust* has resulted in the relatively higher brake pipe pressure moving the release piston and its valves to their *Release* positions, although for an instant

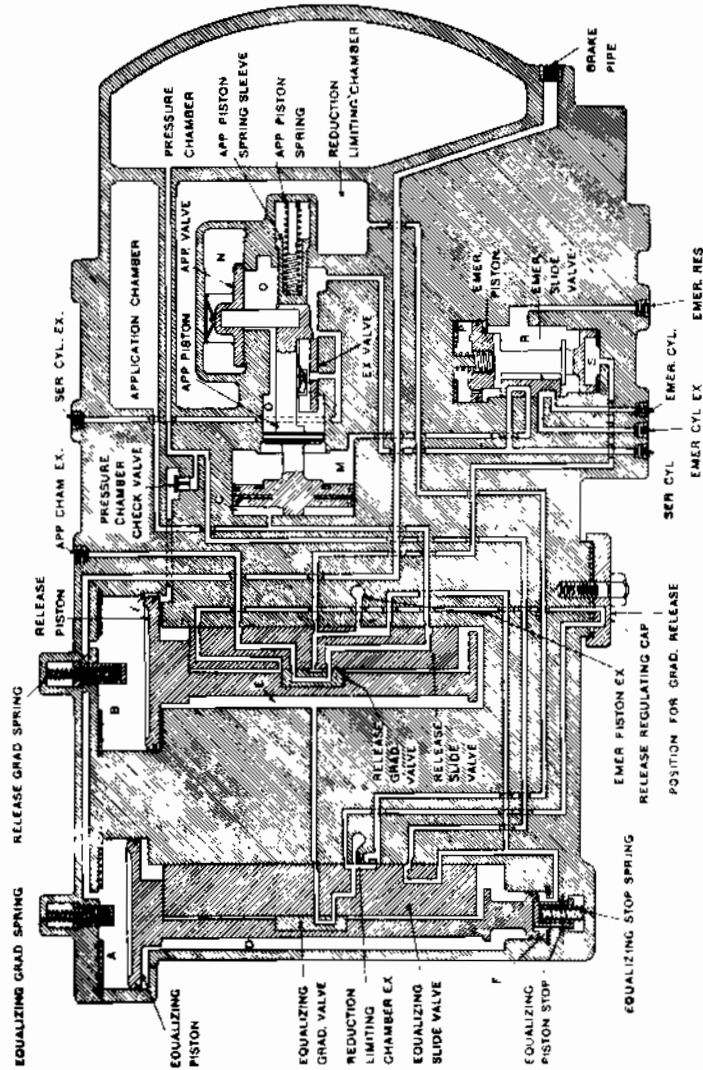


Fig. 34. Secondary Release Position

the equalizing piston and its valves still remain as shown in Fig. 33—*Preliminary Release position*.

With the release piston and its valves in the position shown in Fig. 34, a connection is made from *chamber F* through the release slide valve to the *emergency piston exhaust*. At the same time the *pressure chamber* is connected by way of the equalizing slide valve to the same port which connects *chamber F* to the *atmosphere*. This tends to maintain the pressure in *chamber F* temporarily so as to insure the connection from *chamber E* to the *atmosphere* being held open, as explained above, until the release piston and its valves are entirely back in their *Release positions*. In so moving, however, the release slide valve is gradually increasing the size of the opening from *chamber F* to the *atmosphere*, until a point is reached where the pressure in *chamber F* is lowered sufficiently to permit the differential pressure already acting on the equalizing piston to start this piston toward its *Release position*. The resulting movement of the equalizing slide valve restricts and finally stops entirely the flow of air from the *pressure chamber* to *chamber F*, the pressure in which is, therefore, rapidly exhausted to the *atmosphere* through the ports already mentioned and the equalizing piston and its valves are then held positively in their *Release position* as shown in Fig. 35.

Comparing Fig. 33 and Fig. 34, it will be noted that the movement of the release piston, slide valve and graduating valve from the position shown in Fig. 33 to that



## c. Graduated Release Position

As already stated, the movement of the release slide valve to its *Release* position connects *chamber F* to the emergency piston exhaust and *atmosphere*, causing the equalizing piston and its valves to be moved to and held positively in their *Release* positions, as shown in Fig. 35.

It should be clearly understood that a very slight increase in brake pipe pressure (about  $1\frac{1}{2}$  to 2 lbs.) above that remaining in the pressure chamber, is sufficient to move the parts through the successive momentary positions of *Preliminary* and *Secondary Release* as just explained, until they reach their final positions shown in Fig. 35—*Graduated Release* position.

In this position (graduated release being assumed to be cut in), the *application chamber* and *chamber C* are open through the release slide valve and graduating valve to the application chamber exhaust and *atmosphere*. So far as this connection is concerned, the release would be complete provided the parts did not move, but it will be noted that in this position also the *emergency reservoir* is connected by way of the equalizing slide valve, and the release regulating cap (which is adjusted to give graduated release) through the release slide valve and past the end of the release graduating valve to *chamber E*. The pressure in the *emergency reservoir* is substantially that to which it was originally charged, namely, normal brake pipe pressure. The pressure in *chamber E*, it will be remembered, was reduced equally with the pressure chamber pressure when the brake application

was made. Air from the emergency reservoir, at the higher pressure, will therefore flow into *chamber E* and, from *chamber E*, by way of the equalizing slide valve, to the *pressure chamber*, at the lower pressure, and tend to increase the pressure in *chamber E* and the *pressure chamber* at the same time that the brake pipe pressure in *chamber B* is being increased. If the pressure in *chamber E* rises faster than that in *chamber B*, the higher pressure which will soon be built up in *chamber E* will move the release piston and graduating valve over toward *Graduated Release Lap* position (Fig. 36) and either partially restrict or wholly stop the flow of air from the *application chamber* to the *atmosphere*, and from the *emergency reservoir* to *chamber E*. If the brake pipe pressure is increased very slowly, the relatively rapid increase of pressure in *chamber E* may cause the release piston and graduating valve to graduate the release as explained in connection with Fig. 36.

The escape of air from the *application chamber* and *chamber C* to the *atmosphere* as already explained in connection with Fig. 34 results in the application piston-spring and brake cylinder pressure acting in *chamber M*, moving the application piston with its valve back from their *Lap* positions, as shown in Fig. 33, to their *Release* position, as shown in Figs. 34 and 35, in which position air from the *brake cylinder* is exhausted to the *atmosphere* by way of the exhaust valve and service cylinder exhaust port. Whether the brake cylinder pressure is entirely or only partially released depends upon whether the exhaust of air from the *application chamber* and *chamber C* is partial or complete. This has already been

referred to and will be further mentioned in connection with Fig. 36. It will be noted that in Figs. 33, 34 and 35, the *reduction limiting chamber* is connected to the reduction limiting chamber exhaust and *atmosphere* through the equalizing slide valve, and that in Figs. 34 and 35 *chamber S* is connected through the release slide valve to the emergency piston exhaust and *atmosphere*, so that the air in these chambers is completely exhausted to the atmosphere when either a graduated or direct release is made.

Referring to Fig. 35, it will be noted that *chamber E* is connected to *chamber K* and that air from the *emergency reservoir* has access to *chamber G*. These connections being opened by the movement of the equalizing slide valve to its *Release* position whether or not the service reservoir charging valve will be opened and permit the recharging of the service reservoir to begin at once, will depend on the relative pressures in the pressure chamber, emergency and service reservoirs. With the ordinary manipulation of the brake, the service reservoir charging valve will remain closed, as shown in Fig. 35, preventing the air from the *emergency reservoir* reaching the *service reservoir* and the *pressure chamber* only will be recharged until its pressure has been increased to within about 5 lbs. of that in the *emergency reservoir*.

The other connections which are shown in Fig. 35 have been fully explained in what has preceded and require no further mention at this time since they are not concerned in the particular function under discussion.

As already indicated, if the brake pipe is fully recharged without a graduation of the release being made, the parts will remain in the positions shown in Fig. 35 and the release will be complete and without graduations. The only change which takes place while such a release is being made is the movement of the service reservoir charging valve from the position shown in Fig. 35 to that shown in Fig. 36, which should properly be regarded as illustrating the final stage in the recharging of the equipment of which Fig. 35 illustrates the initial stage. That is to say, at first the *pressure chamber* alone is recharged and this recharge is accomplished (as has been pointed out) from the *emergency reservoir* only, without any air being drawn for this purpose from the *brake pipe*. The air which is supplied through the brake valve to the *brake pipe* is, therefore, given every possible advantage and opportunity to accomplish what is intended when the brake valve handle is moved to *Release* position, namely, to *release the brakes* by causing an increase of pressure sufficient to accomplish this, throughout the entire length of the *brake pipe*.

After the release has been thoroughly established in this manner, the recharging of the reservoirs to their original pressure takes place as explained in connection with Fig. 26. That is to say, when the pressure chamber has been recharged to within about 5 lbs. of the pressure remaining in the emergency reservoir, the service reservoir charging valve is lifted from its seat, opening the connection from the *emergency reservoir* to the *service reservoir* and as the brake pipe pressure continues to be increased, the *service reservoir*, *emergency reservoir* and

pressure chamber are finally recharged to full brake pipe pressure by the air coming from the *brake pipe*, as already explained in connection with Fig. 26.

#### d. Release Lap Position

If, however, the brake pipe pressure is not fully restored, a graduation of release being made; that is, if the *brake pipe* is partially recharged and the brake valve handle then returned to *Lap* position, the continued flow of air from the *emergency reservoir* to *pressure chamber* and *chamber E*, as previously explained, will increase the pressure in the *pressure chamber* and *chamber E* above that of *chamber B* which is now stationary, causing the the release piston and graduating valve to move over until the shoulder on the end of the release piston stem comes in contact with the release slide valve as shown in Fig. 36. This closes the exhaust from the *application chamber* to the *atmosphere* and prevents further flow of air from the *emergency reservoir* to the *pressure chamber* and *chamber E*.

The flow of air from the *service brake cylinder* to the *atmosphere* (continuing as explained in connection with Fig. 35), will at once reduce the pressure in *chamber M* below that now retained in *chamber C* by the small amount which is sufficient to cause the application piston to move over to the position shown in Fig. 36, in which the exhaust valve is closed, thus preventing further release of air from the *service brake cylinder*. The other connections remain as already explained.

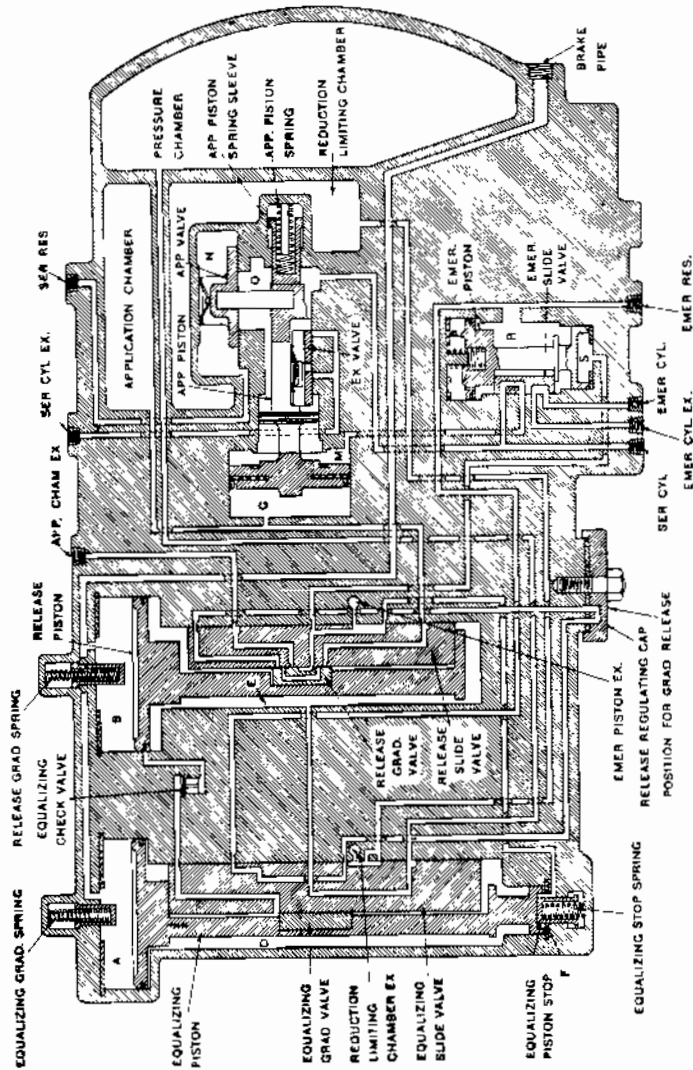


Fig. 36. Graduated Release Lap Position

### e. Release and Charging Pressure Chamber and Emergency and Service Reservoirs

The gradual release of brake cylinder pressure may be continued as explained above (Fig. 36) until the pressures in the *emergency reservoir* and *pressure chamber* have become equal. On account of the relatively large volume of the *emergency reservoir* compared with that of the *pressure chamber*, this equalization will not take place until the *pressure chamber* has been recharged to within about 5 lbs. of the brake pipe pressure carried. Beyond this point, whatever small amount of pressure may remain in the *service brake cylinder* is released entirely and the *emergency* and *service reservoirs*, as well as the *pressure chamber*, are recharged from the *brake pipe* as described in connection with Fig. 36.

### f. Direct Release and Charging Position (Without Quick Recharge)

Up to this point, the release regulating cap has been assumed to be in the position for graduated release. Fig. 37 corresponds to Fig. 35, except that the release regulating cap is adjusted for direct release. It will be noted that there is now no connection from the *emergency reservoir* to the *pressure chamber* or *chamber E*. Consequently the *pressure chamber* is being recharged only by air from the *brake pipe* going through feed groove *i* to *chamber E*, and thence by way of the equalizing slide valve, to the *pressure chamber*. The pressure in *chamber E* cannot, therefore, increase above that in *chamber B* and the release piston, graduating valve and slide valve remain in the position shown in Fig. 37.

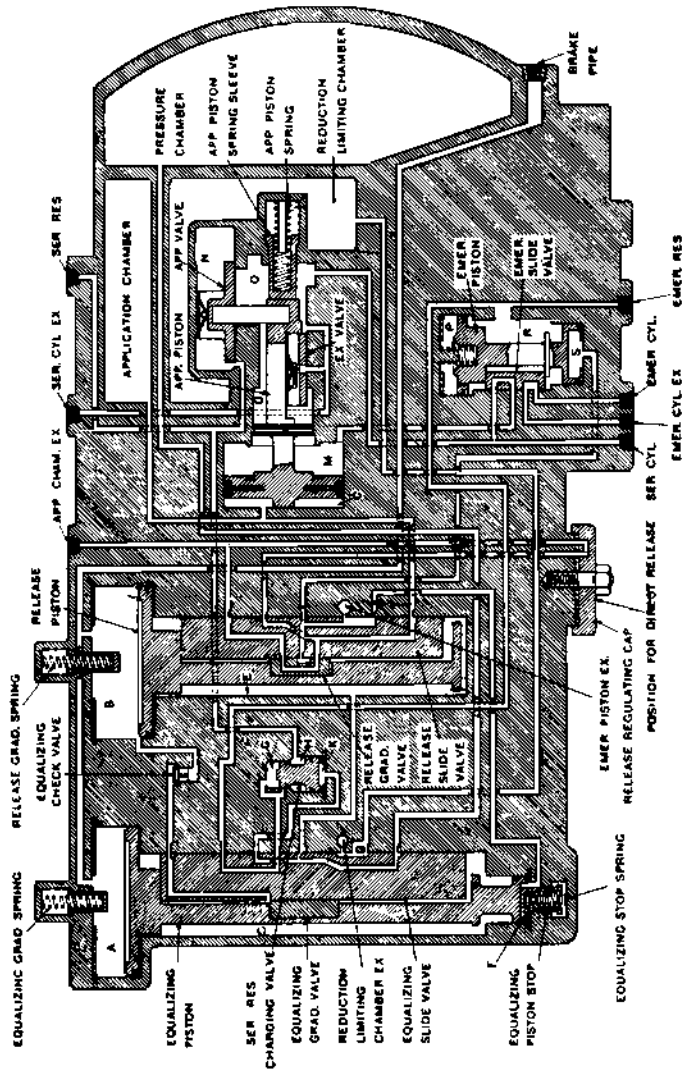


Fig. 37. Direct Release, Charging Chamber Only



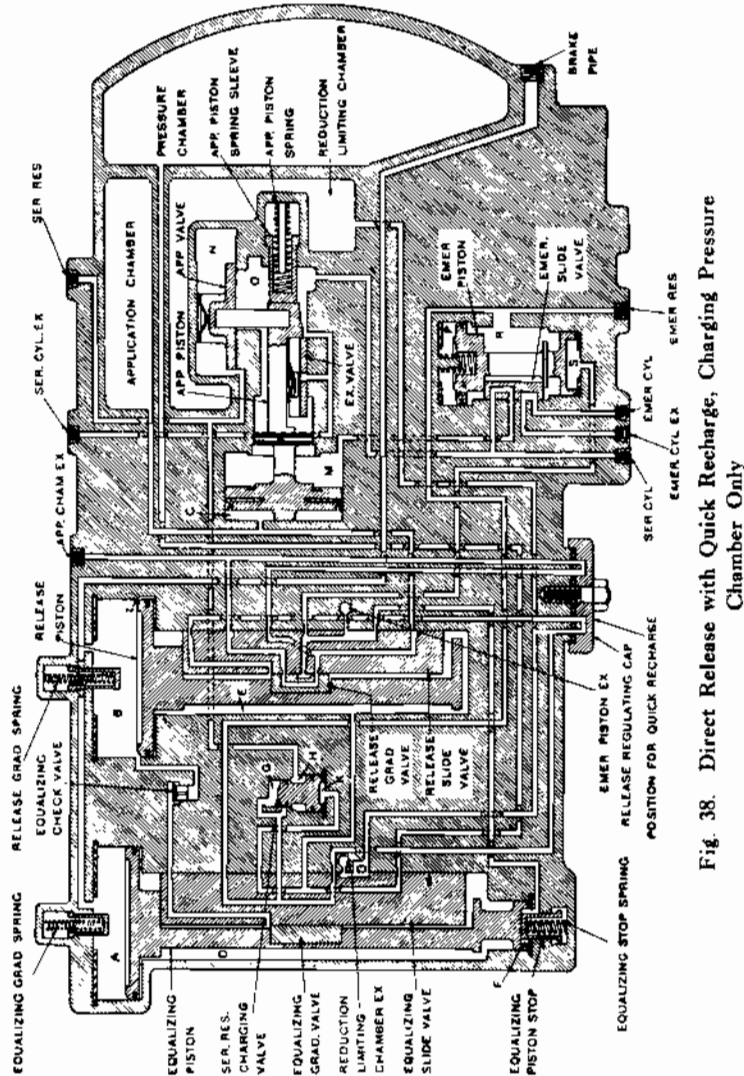


Fig. 38. Direct Release with Quick Recharge, Charging Pressure Chamber Only

With the release regulating cap adjusted for direct release, it will be noted from Fig. 37 that the *application chamber* and *chamber C* are open through the release slide valve to a port connecting through the release regulating cap to the application chamber exhaust and *atmosphere*. This affords an outlet from the *application chamber* to the *atmosphere* which cannot be closed as long as the release slide valve remains in the position shown, even though the release piston and graduating valve, should, from any cause, be moved back so that the release graduating valve would partially or entirely restrict the application chamber release port, which is also shown to be open through the release graduating valve in Fig. 37. Moreover, it will be noted that there are *two* outlets from the *application chamber* to the *atmosphere* when the valve is adjusted for *direct release* as compared with *one* when *graduated release* is cut in. This, together with the fact that the direct release port is of greater capacity than the graduated release port, results in a more rapid rate of release being obtained with the direct than with the graduated release adjustment of the equipment, as is desirable. As the other connections shown in Fig. 37 are the same throughout as explained in connection with Fig. 35, it will be unnecessary to make further reference to same.

#### g. Direct Release and Charging Position (With Quick Recharge Feature)

With the release regulating cap in quick recharge position, as illustrated in Fig. 38, the *emergency reservoir* is connected through the equalizing and release slide



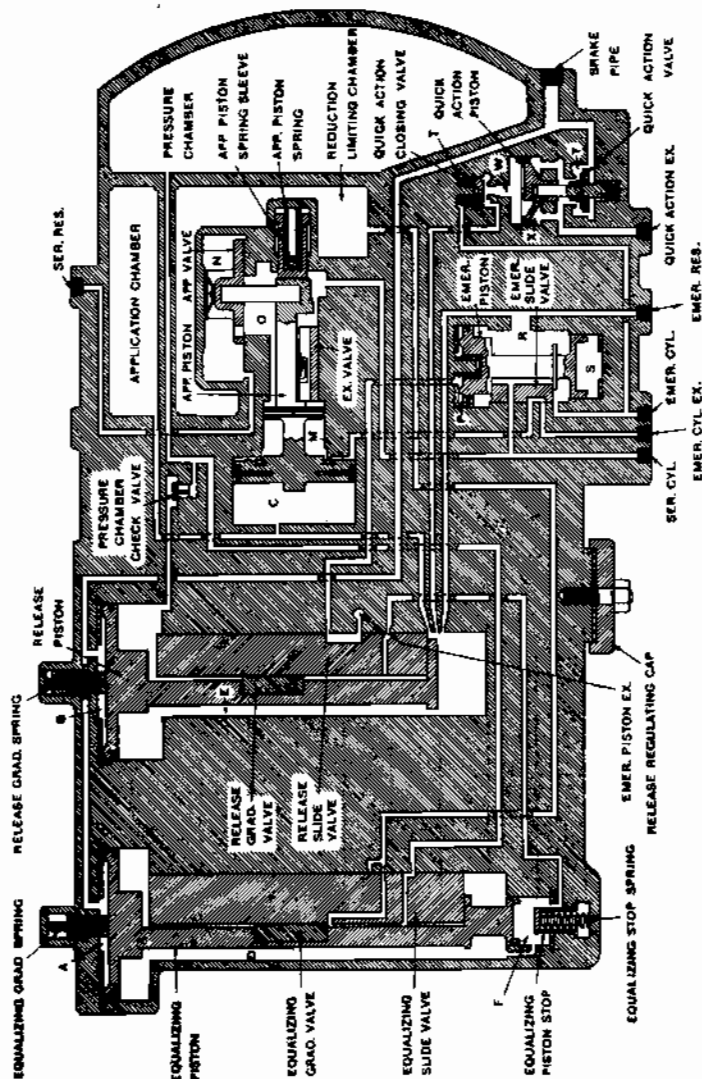


Fig. 39. Emergency Position, Quick Action Valve Venting

valve and the release regulating cap to *chamber E* and the *pressure chamber*, the same as in graduated release position, thereby securing the advantage of the quick recharge feature, as previously explained under "Graduated Release Position." At the same time, the application chamber and *chamber C* are open to the *atmosphere* through the release slide valve and graduating valve and also through the release regulating cap, as in direct release position just explained.

## EMERGENCY POSITION

### a. Quick Action Valve Venting

When the brake pipe pressure is reduced faster than at the predetermined rate for service applications, or if the brake pipe reduction should be continued below the point at which the *pressure and reduction limiting chambers* equalize (as explained above under the heading "Over Reduction Position") the differential pressure acting on the release and equalizing pistons becomes sufficient to move them to their extreme or *Emergency positions* as shown in Fig. 39.

In this position, air from the *emergency reservoir* flows directly to *chamber E* and from *chamber E* to the under side of the quick action closing valve. *Chamber T*, above the quick action closing valve, is connected to the emergency brake cylinder port, in which there is no pressure even though a full service application of the brakes may have just preceded the emergency application.

The higher pressure on the under side of the quick action closing valve therefore raises this valve and air

flows to *chamber W* above the quick action piston, forcing the latter down and opening the quick action valve against brake pipe pressure in *chamber Y*. As soon as the quick action valve is unseated in this manner, air from the *brake pipe* flows past the quick action valve to the quick action exhaust and *atmosphere*, causing a local venting of brake pipe air and transmitting the quick application serially throughout the train.

Air from the *emergency reservoir* flowing to *chamber E* also flows directly to the application chamber and *chamber C* which forces the application piston and its valve over into their extreme positions, opening the *service reservoir* through the application slide valve and *chamber O* to the *service brake cylinder*, thus permitting the pressures in the *service reservoir* and *service brake cylinder* to equalize.

At the same time *chamber P*, above the large emergency piston, is connected through the release slide valve to the emergency piston exhaust and *atmosphere*, permitting the emergency reservoir pressure in *chamber R* to force the emergency piston and its slide valve upward to their *Emergency* positions.

In this position of the emergency parts, the *emergency reservoir*\* is connected past the end of the emergency slide valve to the *emergency brake cylinder*, thus permitting the pressures in the *emergency reservoir* and

\*NOTE When the cut-off valve is used, the emergency reservoir is cut off from the control valve in emergency applications, as previously explained. In this case the service reservoir, in addition to supplying air for the service cylinder, also supplies air for the emergency cylinder through the emergency slide valve and slide valve chamber and port past the end of the slide valve. This permits equalization of the service reservoir and service and emergency brake cylinders.

*brake cylinder* to equalize. *Chamber R* is also connected through the emergency slide valve to the *service cylinder port* which permits equalization of the service and emergency reservoirs and brake cylinders.

It will be noted that in this position the emergency slide valve opens a port which connects *chamber M*, behind the application piston, through the emergency slide valve to *emergency cylinder exhaust*. This, in connection with the admission of air from the *emergency reservoir* to the *application chamber* and *chamber C*, as already explained, still further insures a quick and positive movement of the application piston and its valves to *Emergency* position.

In this position the *pressure chamber* is connected through the equalizing slide valve to *chamber D*. The *pressure chamber* is also connected past the pressure chamber check valve to *chamber E*, and *chamber D* is connected past the end of the equalizing graduating valve through the equalizing slide valve to the *reduction limiting chamber*. These connections perform no particular function except to insure pressure acting on all slide valves, graduating valves, etc., so as to hold them to their seats as well as to provide for the equalization of all chambers, reservoirs, etc., of the equipment when an emergency application is made.

#### b. Quick Action Valve Closed

The emergency brake cylinder pressure and that in *chamber T*, above the quick action closing valve, continues to rise and the pressure in the *emergency reservoir* and in *chamber W* below the quick action closing valve falls, as explained above, until these pressures become

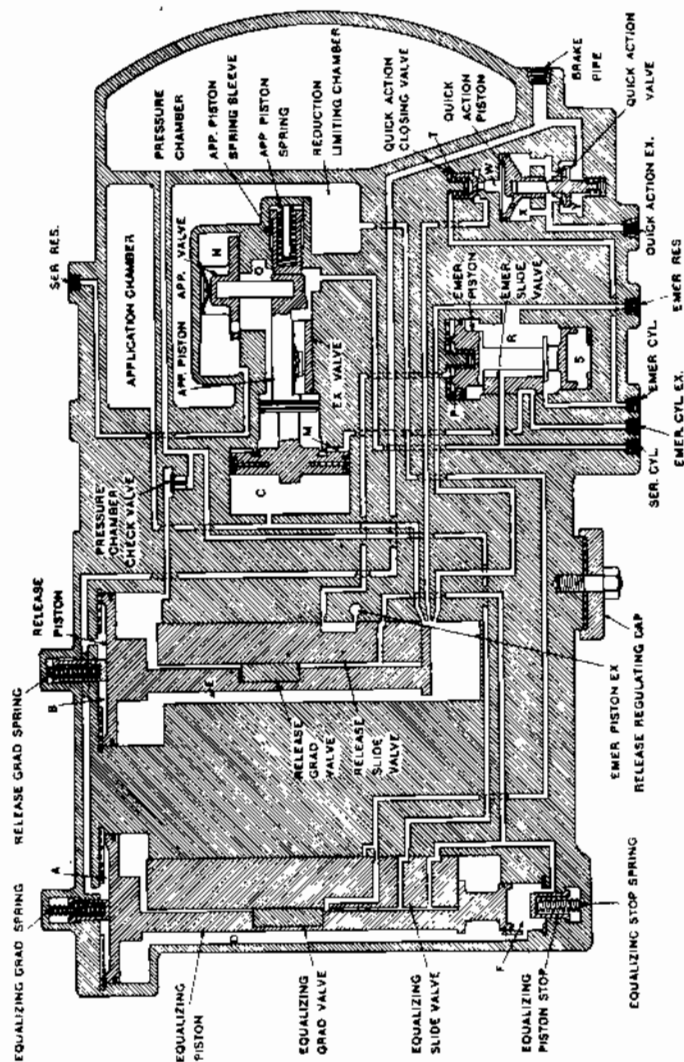


Fig. 40. Emergency Position, Quick Action Valve Closed

substantially equal. This equalization of the pressures on the opposite sides of the quick action closing valve permits its spring to return the valve to its seat, cutting off further flow of air to *chamber W*. *Chamber W* is connected through the leakage hole in the quick action piston to *chamber X* so that as soon as the quick action closing valve is seated, the pressure in *chamber W* expands through this leakage hole to *chamber X* and the *atmosphere*, through the quick action exhaust opening. The balancing of the pressures in *chambers X* and *W* thus permits the quick action valve spring to return the quick action valve to its seat, closing the outlet from the *brake pipe* to the *atmosphere*, as shown in Fig. 40. This insures against an escape of air from the *brake pipe* to the *atmosphere*, when a release is made following the operation of the quick action parts.

Except for the closing of the quick action valve and return of the quick action parts to *Normal* position, as explained in the preceding paragraph, the positions of the other parts of the valve and connections between the various reservoirs and cylinders, etc., remain as already explained in connection with Fig. 39.

When releasing after an emergency application, as soon as the brake pipe pressure in *chambers A* and *B* is increased above that which remains in *chambers D* and *E*, the parts will move to their Release positions, exhausting the air from the brake cylinders and recharging the reservoirs and pressure chamber as explained under the heading "Release and Recharging," Figs. 33, 34 and 35.

## GENERAL HINTS

The brake should be handled by the engineman in the same manner as with cars equipped with quick-action triples, the only difference being that an emergency application will be obtained should a service reduction of the brake pipe pressure be continued below 60 lbs. when carrying 110 lbs. pressure or below 35 lbs. with 70 lbs. brake pipe pressure.

When it is found necessary to cut out the brake, close the cut-out cock in the crossover pipe and bleed both the service and emergency reservoirs.

Should it become necessary to bleed the brake when the locomotive is detached, or air connection is not made, first bleed the brake pipe and then bleed both the service and emergency reservoirs.

The two sets of cylinder levers are connected to the same truck pull rods as stated above. Therefore, when a service application of the brake is made, the push rod end of the emergency cylinder lever will move the same distance as the push rod end of the service cylinder lever, but the crosshead being slotted, the piston of the emergency cylinder will not move. Consequently, the fact that the *emergency cylinder* crosshead is in release position does *not* indicate that the air brakes are released. To determine this, look at the ends of either the service or emergency cylinder levers.

Whenever it is necessary to change the adjustment of the automatic slack adjuster, it is imperative that the

crossheads of the two adjusters be left at the same distance from their respective brake cylinder heads, in order that the piston travel of the two cylinders in emergency application will be the same.

The various exhaust openings referred to in the following are plainly marked on the outline drawings, Figs. 4 and 5.

The Quick Action Exhaust is the one-inch opening in the bottom of the control valve reservoir. Should there be a continual blow at this opening, make an emergency application and then release; if the blow continues, remove the quick action portion and substitute a new or repaired portion or repair the quick action valve seat which will be found defective. The quick action portion is at the left hand when facing the equalizing portion.

There are three control valve exhaust openings, two on the equalizing portion and one on the side of the control valve reservoir, all tapped for  $\frac{3}{8}$ -inch pipe.

Should there be a blow at the Application Chamber Exhaust ( $\frac{3}{8}$ -inch exhaust opening on side of the control valve reservoir) with the brakes applied or released, it indicates a defective equalizing portion and a new one or one that has been repaired, should be substituted.

Should there be a blow at the Reduction Limiting Chamber Exhaust ( $\frac{3}{8}$ -inch exhaust on left side of equalizing portion) in release or service position it indicates a defective application portion and a new one, or one that has been repaired, should be substituted. This portion is located back of the equalizing portion, inside the reservoir. If the blow occurs only after 30 lbs. brake pipe reduction, it indicates a defective emergency reservoir

check valve (the middle check valve in the equalizing portion) and a new one, or one that has been repaired, should be substituted. If the blow does not cease, it indicates a defective equalizing portion and a new one, or one that has been repaired, should be substituted.

Should there be a blow at the Emergency Piston Exhaust ( $\frac{3}{8}$ -inch exhaust on the right hand side of the equalizing portion) make a 15-lb. brake pipe reduction and lap the brake valve. If the blow ceases, it indicates that either the emergency portion or seal on the small end of the equalizing piston is defective and a new portion, as found to be needed, or one that has been repaired, should be substituted. If the blow does not cease, it indicates that the equalizing portion is defective and a new one, or one that has been repaired, should be substituted.

A hard blow at the service Brake Cylinder Exhaust (tapped for  $\frac{3}{4}$ -inch pipe and located on the left side of the control valve reservoir) with the brakes applied, indicates that the application portion is defective and a new one, or one that has been repaired, should be substituted. This portion is located back of the equalizing portion inside the reservoir. If this blow occurs when the brakes are released it indicates either a defective application or emergency portion and a new one or a repaired portion, as found to be required on investigation, should be substituted.

A hard blow at the Emergency Cylinder Exhaust (tapped for  $\frac{1}{2}$ -inch pipe and located on the bottom of the control valve reservoir) with the brakes either applied

or released, indicates a defective emergency portion and a new one, or one that has been repaired, should be substituted.

If the trouble described in the five paragraphs immediately preceding is not overcome by the remedies therein suggested, remove the application portion and examine its gasket, as a defect in same may be the cause of the difficulty.

When removing the application, emergency and quick action portions, their respective gaskets should remain on the reservoir. On removing the equalizing portion, its gasket should remain on the application portion, except when the application portion is shipped to and from points where triple valves are cared for.

When applying the different portions the gaskets should be carefully examined, to see that no ports are restricted, and that the gasket is not defective between ports. See also that all nuts are drawn up evenly to prevent uneven seating of the parts.

On the front and at the center of the equalizing portion is located the release regulating cap (held by a single stud) on which is a pointer. (See Fig. 1, upper view.) The position of this pointer indicates whether the valve is adjusted for direct release, graduated release, or quick recharge. This cap should be adjusted for direct or graduated release or quick recharge according to the instructions issued by the railroad.

## LUBRICATION

### No. 3-E Control Valve

The control valve parts should be lubricated as follows:

**EQUALIZING PORTION.** The equalizing and release slide and graduating valves and seats should be lubricated with dry graphite instead of oiling.

All oil, gum or grease should be thoroughly removed from the slide valves and their seats in the bushings and the face of the graduating valves. Use benzine or gasoline to insure this.

The face of the graduating valves, both upper and lower surfaces of the slide valves, the slide valve seats and the upper portion of the bushing where the slide valve springs bear 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. Dip the skin-covered end in dry graphite and rub on the surfaces specified. Leave no free graphite on 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 piston rings of the equalizing and release pistons and the bushing in which they work should be sparingly lubricated by first pushing the pistons 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 pistons back and forth several times to insure proper distribution of this oil on the walls of the cylinders.

The bush in which the service reservoir charging valve moves should also be sparingly lubricated with a good grade of oil.

When oiling, as just directed or in the cases which follow, only a thin coating of oil is necessary and care should be taken not to leave any free oil on the parts.

**APPLICATION PORTION.** The application valve and seat of the application portion should be cleaned, rubbed in and sparingly lubricated with graphite grease. The exhaust valve should be lubricated with dry graphite, the same as the slide valves in the equalizing portion.

Before applying the piston to application portion, clean the application cylinder and piston. Lubricate the walls of the cylinder and piston ring, using a good grade of lubricant specially prepared for the purpose.

**EMERGENCY PORTION.** After the bearing surfaces have been properly cleaned and rubbed in and before applying the slide valve to the emergency portion, remove the top cover and take out the loose fitting cylinder bushing. Lubricate the large piston with a few drops of a good grade of oil and apply dry graphite to the slide valve, in the same manner as to the equalizing slide valve, then enter the slide valve into the portion. Lubricate the slip bushing for the small emergency piston, applying a few drops of oil to inner circumference. Apply the bushing to the portion and bolt on top cover. Move the piston to its other position and put a few

drops of triple valve oil on the walls of the large cylinder bushing. Move the slide valve and piston back and forth several times to insure a proper distribution of the oil. Apply the large cover to the emergency portion.

**QUICK ACTION PORTION.** No parts of the quick action portion require lubrication.

### Brake Cylinder

Close the branch pipe cut-out cock and drain all 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 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 pur-

pose; 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 initial step in fitting the piston with packing cup into the cylinder is illustrated on the opposite page. If leather packing with expander ring is used, the opening of the expander ring should be toward the workman. To prevent possible damage from the sharp edges of the cylinder, the packing cup should be pressed inward at the points of contact as shown in the illustration. 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 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.



Fig 41. Showing Initial Step in Fitting Piston Packing Cup into the Brake Cylinder

### No. 3-E Control Valve With Common Exhaust Outlet

Figs. 42 to 47 inclusive illustrate the No. 3-E Control Valve with common exhaust outlet. This design of valve differs from the one covered in the foregoing portion of this pamphlet in that it has a special reservoir provided with a common exhaust chamber to which all exhaust passages are cored. This permits of piping the

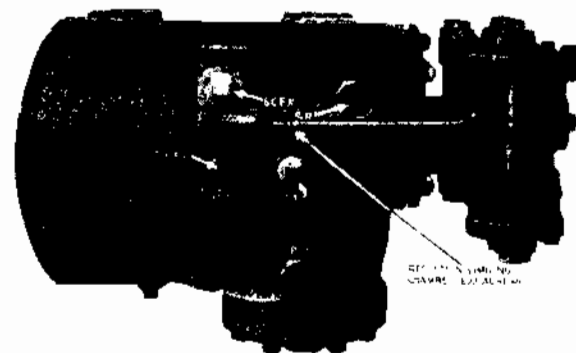


Fig. 42 No. 3-E Control Valve with Common Exhaust Outlet

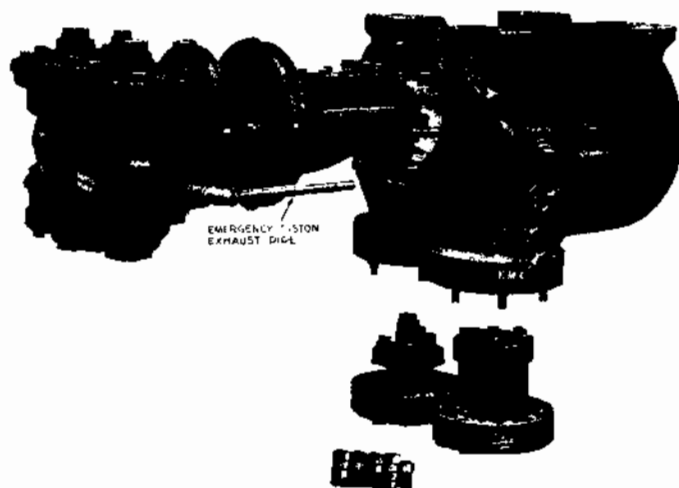
common exhaust outlet to a protected place and thereby protecting the exhaust passages from the possibility of becoming clogged with ice or slush. The exhaust chamber is located between the two walls of the reservoir, as illustrated in Fig. 44.

Like the valve with the independent exhaust, this common exhaust valve has a three position release reg-





Front View



Showing the Different Portions

Fig. 43. No. 3-E Control Valve with Common Exhaust Outlet

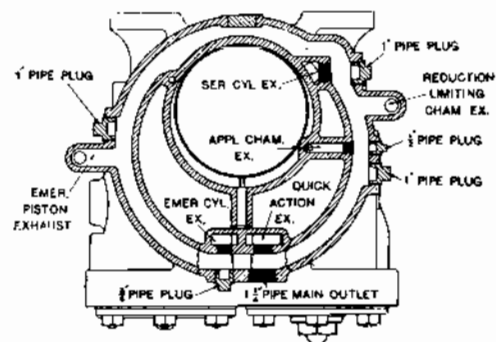


Fig. 44. Section Through Reservoir with Common Exhaust Outlet

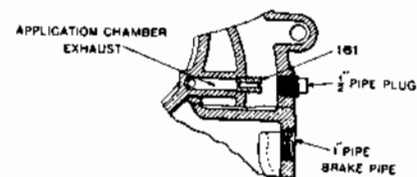


Fig. 45. Showing Location of Choke Plug, when Used, in Application Chamber Exhaust

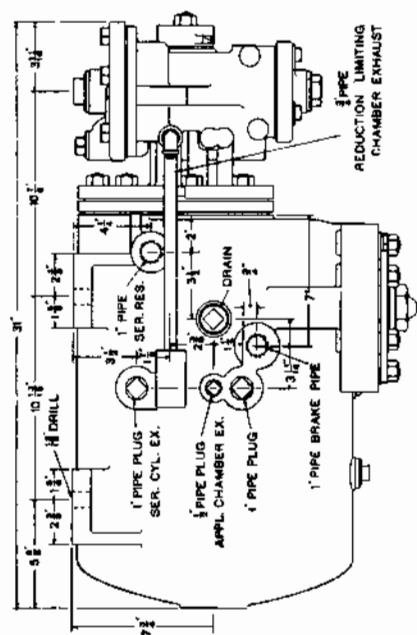
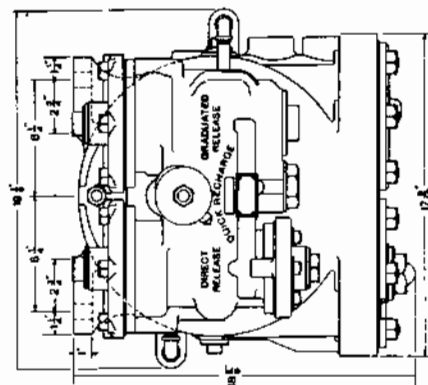


Fig. 46. No. 3-E Control Valve with Common Exhaust Outlet, Outline

ulating cap giving direct release, graduated release or quick recharge.\*

To enable tests for leakage to be made, tapped openings have been provided leading into the individual cores of the exhaust openings from the various portions. These are plugged with standard pipe plugs which should be removed and a pipe nipple attached direct to the cored passages in order to determine from which exhaust port the blow is occurring.

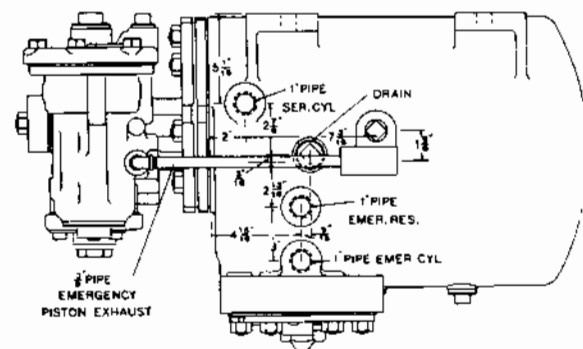


Fig. 47. No. 3-E Control Valve with Common Exhaust Outlet, Outline

\*NOTE—Common exhaust control valves in service have a special "one position" release regulating cap which can be placed in only one position—that which gives direct release with quick recharge.

Also, when it is desired to lengthen out the time of release a choke plug is screwed into the application chamber exhaust port within the reservoir, as shown in Fig. 45.

# Westinghouse Air Brake Company

Pittsburgh, Pa., U. S. A.

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