613

INSTRUCTION PAMPHLET

No. 5050-6

MARCH, 1938

PASSENGER CAR BRAKE EQUIPMENT

with

D-22-A CONTROL VALVE

WESTINGHOUSE
AIR BRAKE COMPANY
PITTSBURGH, PA., U. S. A.

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(Superseding Issue of August, 1937)

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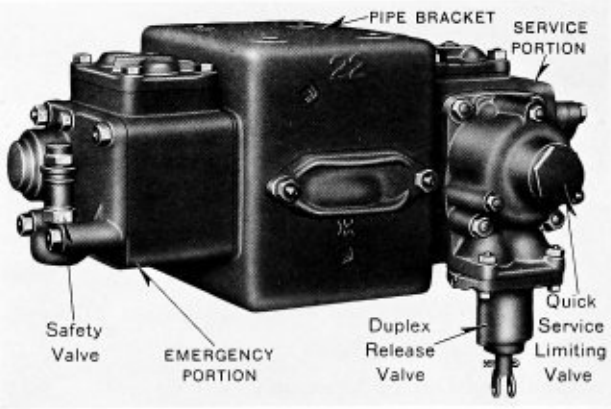

Fig. 1. Exterior View of the D-22-A Control Valve

PASSENGER CAR BRAKE EQUIPMENT WITH D-22-A CONTROL VALVE

The functional characteristics of this new brake equipment include the proven desirable elements of its predecessors in this class of service with the addition of features that provide a brake of greater flexibility as required for high speed operation of modern trains. Faster and more certain brake action is provided by features which produce improved functions in the following respects:

Improved Quick Service

This improved quick service feature operates during initial service brake application to insure fast transmission with positive movement of the service slide valve to application position regardless of service slide valve friction.

This feature, during initial application, also provides a limited, positive and uniform development of brake cylinder pressure on all cars with a minimum brake pipe reduction, which permits the train slack to adjust promptly without harsh action.

Improved Service Release

Positive release is insured regardless of service slide valve friction by a release insuring feature, which operates positively to release the brake when brake pipe pressure exceeds auxiliary reservoir pressure by more than 1½ pounds.

Improved Graduated Release

The operation of this feature is such that an exceedingly uniform and flexible brake cylinder pressure release is secured on all cars when graduating off the brake.

Improved Emergency Transmission Speed

This is most important during emergency brake application because it accomplishes a further improvement in control of slack action as compared to previous standard brake equipment.

Improved Release After Emergency

By the use of an accelerated release feature, a faster and more positive release is obtained than with the previous standard passenger brake. This is accomplished by connecting displacement reservoir and auxiliary reservoir air to the brake pipe during initial release to increase brake pipe pressure locally, thereby supplementing air flow from the brake valve to provide a fast rise in brake pipe pressure. This operation also makes a definite reduction of auxiliary reservoir pressure to insure positive and prompt release.

Increased Capacity

The maximum brake cylinder volume for which previous passenger brake control valves were designed is the equivalent of two 16 inch brake cylinders.

The D-22-A control valve is designed as a piloting device for operation of one or more large capacity relay valves; therefore, one standard control valve may be used with any desired number, size, or arrangement of brake cylinders.

More Uniform Brake Cylinder Pressure

Because of the automatic self-lapping feature of relay valves, the brake cylinder pressure developed for a given brake pipe reduction is not affected by varying brake cylinder piston travel or normal brake cylinder leakage. Air consumption, of course, is held to the desirable minimum with uniform minimum piston travel.

Simplified Construction

The D-22-A Control Valve is smaller than is the case with the previous standard operating valve. Space required for installation is also less by reason of combining in one structure the volume of the emergency, auxiliary and displacement reservoirs.

Because of more simple construction, the weight of the operating devices comprising this latest equipment is materially reduced as compared to the previous standard equipment.

Harmonious Interchange

The equipment operates in harmony with the previous standard passenger car brake when cars having either the previous or new standard equipment are associated in the same train.

High Speed Conversion

The D-22-A Control Valve is so designed that it can readily be adapted for electro-pneumatic operation with speed governor or decelakron control for ultra high speed service by the addition of the necessary available devices.

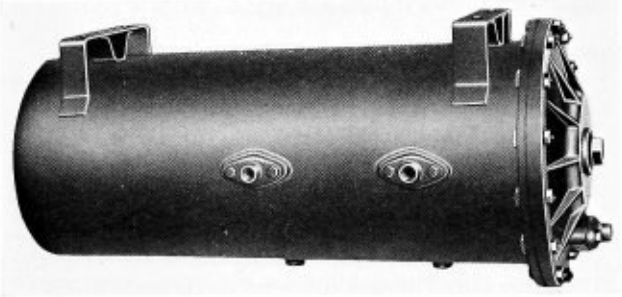

Fig. 2. Combined Auxiliary, Emergency and Displacement Reservoir

PARTS OF THE EQUIPMENT

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

1. *A Control Valve, Type D-22-A*, which corresponds in a general way to the universal valve now in common use. It operates to control the admission of air to and exhaust from the relay valve and to charge the reservoirs.

2. *A Type "B" or Type "A-4-A" Relay Valve*, which relays the application and release operation of the control valve, reproducing in the brake cylinders the pressure condition established in the displacement reservoir.

3. *Brake Cylinders* with pistons and rods so connected through the brake levers and rods to the brake shoes that when the pistons are forced outward by the air pressure, this force is transmitted through the rods and levers to the brake shoes and applies them to the wheels.

4. *A Combined Displacement, Auxiliary and Emergency Reservoir.* The displacement reservoir provides the required operating volume to develop the proper relation of brake pipe reduction. The auxiliary reservoir provides the air supply for proper functioning of the control valve service portion. The emergency reservoir air is used to provide the quick recharge, graduated release and high emergency pressure features.

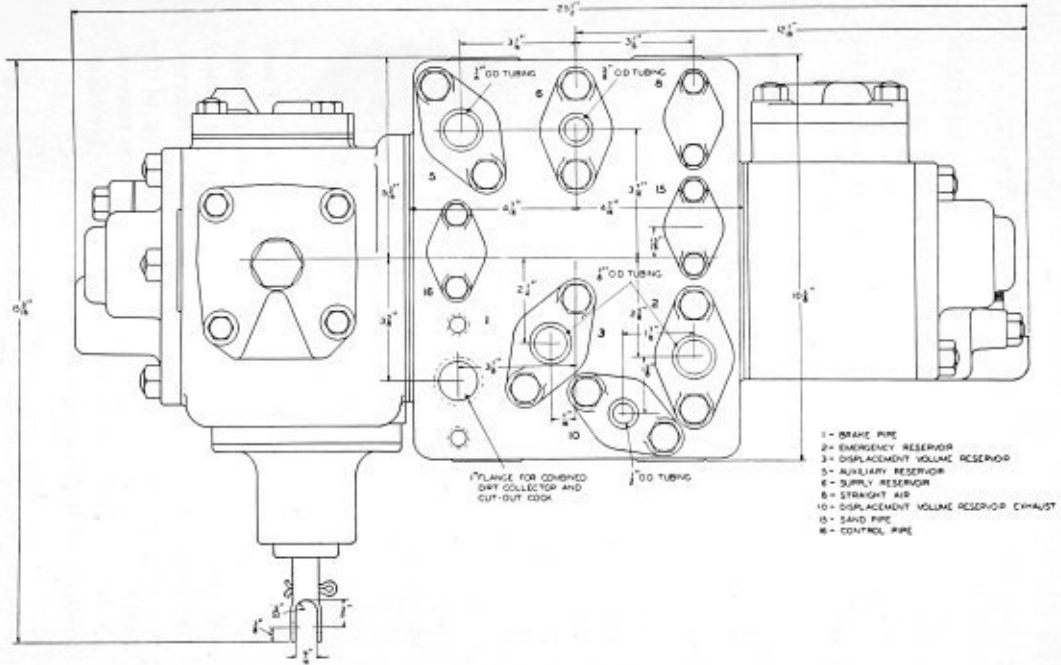

Fig. 3. Outline View of the D-22-A Control Valve, Showing Pipe Connections

5. *A Supply Reservoir*, which provides the air supply for the brake cylinders.

6. *Two B-3-B Conductor's Valves*, one at each end of the car, permit the conductor to apply the brake in case of accident or emergency.

7. *Two E-3 Brake Application Valves*, one in the brake pipe branch to each conductor's valve, function to vent the brake pipe when actuated by a conductor's valve.

8. *A Combined Dirt Collector and Cut-out Cock* is mounted on the control valve pipe bracket. The purpose of the dirt collector is to prevent entrance into the control valve of pipe scale, sand, cinders, or foreign particles of any kind. The cut-out cock provides a means of closing the pipe connections between the control valve and the brake pipe.

9. *Three Branch Pipe Tees*, which are bolted to the car underframe by means of bolting lugs. The purpose of the branch pipe tee is to prevent the passage of excessive moisture from the brake pipe into the branch pipe fittings.

10. *A Pressure Retaining Valve* which is connected by piping to the control valve exhaust. Its purpose, when the handle is placed in retaining position, is to retard the rate of brake cylinder exhaust while recharging the equipment.

11. *An Automatic slack adjuster*, used with each brake cylinder, maintains a predetermined brake cylinder piston travel.

12. *Various cut-out cocks, hose connections, dummy couplings, fittings, etc.*, incidental to the piping, the location and uses of which will be readily understood from the piping diagram of the equipment, and the description which follows.

The train signal system is not part of the brake equipment. It provides a means whereby signals may be transmitted from any part of the train to the locomotive and is described in a separate publication—Instruction Pamphlet No. 5061.

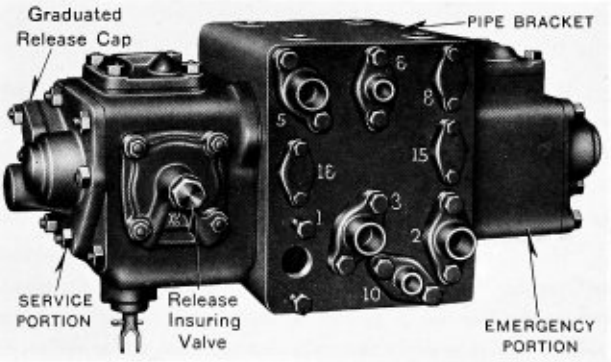

Fig. 4. Rear View of the D-22-A Control Valve

DESCRIPTION OF THE PARTS

D-22-A Control Valve

The D-22-A Control Valve consists of three portions as follows:

1. *A Two Face Pipe Bracket* to which are bolted the service portion and the emergency portion. The bracket is bolted to the car under-framing, all pipe connections being made permanently to the bracket by means of reinforced flanged unions so that no pipe joints need be disturbed when removing or replacing the operating portions.

2. *The Service Portion*, which controls the desired charging of the reservoirs and the service application and release of the brakes. It provides the proven desirable operating features of the universal passenger car service brake with improved quick service transmission, release insuring and graduated release features.

3. *The Emergency Portion*, which controls the quick action feature, high emergency brake cylinder pressure and the accelerated emergency release function. It provides the proven desirable operating features of the universal passenger car emergency brake with improved emergency transmission and accelerated release after emergency application.

The PIPE BRACKET contains the quick action chamber, a removable filter element 12 and two choke plugs in the service portion face. These plugs are iden-

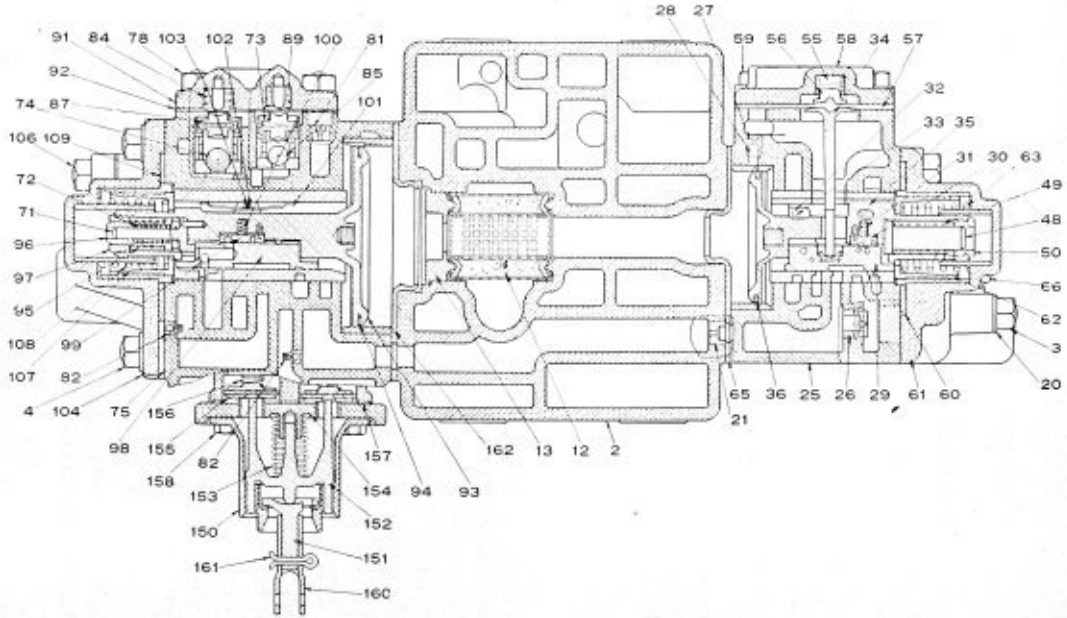

Fig. 5. Sectional View of the D-22-A Control Valve

tified by reference numbers on Fig. 8 and Plate as follows:

Ref. No. 7. Exhaust Choke Plug
Ref. No. 8. Service Port Choke Plug

A choke plug 21, Fig. 9, in the emergency portion face of the pipe bracket is for the purpose of controlling the rate of flow from the emergency reservoir to the displacement reservoir during an emergency brake application, thus providing the desired rate of brake cylinder pressure build-up.

The pipe bracket has the necessary pipe connections for later conversion to "HSC" operation, these being Nos. 8, 15 and 16 which have blanking flanges for automatic service, as shown on Fig. 3. Also the blanking flange 15 is arranged for replacement with a suitable double check valve or safety valve control portion for "HSC" service.

The SERVICE PORTION contains the following parts:

(a) *The service piston 93*, which moves the service graduating and slide valves when the brake pipe pressure is varied, and controls charging of the supply, auxiliary and emergency reservoirs from the brake pipe.

(b) *The service graduating valve 99*, which opens and closes the passages:

(1) Between the auxiliary reservoir and the chamber on face of the release piston in release position or between this chamber and the atmosphere, with the slide valve in application position.

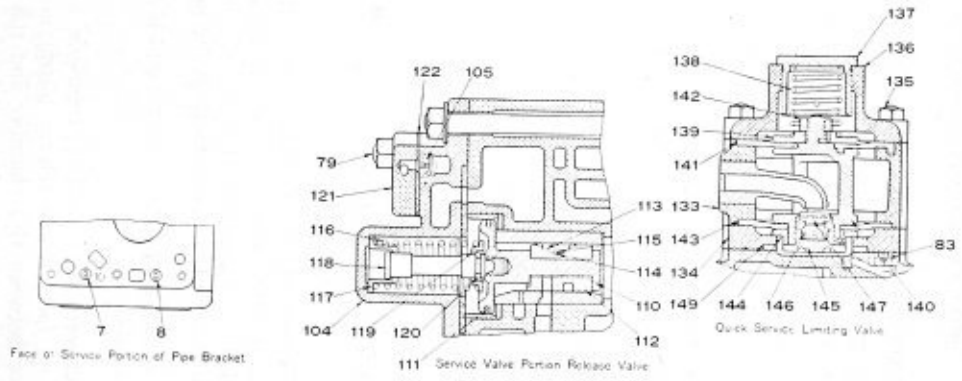

Fig. 6. Release Valve and Quick Service Limiting Valve Portions of the D-22-A Control Valve

(2) Between atmosphere and quick service volume in release position, or between this volume and brake pipe, with the graduating valve in preliminary quick service position.

(3) From auxiliary reservoir to displacement reservoir with the slide valve in service position.

(c) *The service slide valve 98*, which opens and closes ports and passages:

(1) Between auxiliary reservoir (service slide valve chamber) and chamber on face of release piston, past the graduating valve in release position, or between the release piston chamber and the atmosphere through the graduating valve in application position.

(2) Between the quick service volume and the atmosphere in release position, or between this volume and the brake pipe, through the graduating valve in preliminary quick service position.

(3) Between the brake pipe and the displacement reservoir (through quick action service limiting valve), during first stage service application.

(4) From auxiliary reservoir (service slide valve chamber) past the graduating valve to the displacement reservoir in service position.

(5) Between the auxiliary reservoir (service slide valve chamber) and the release insuring valve with the slide valve in release position, and between the slide valve exhaust and the release insuring valve with the slide valve in application position.

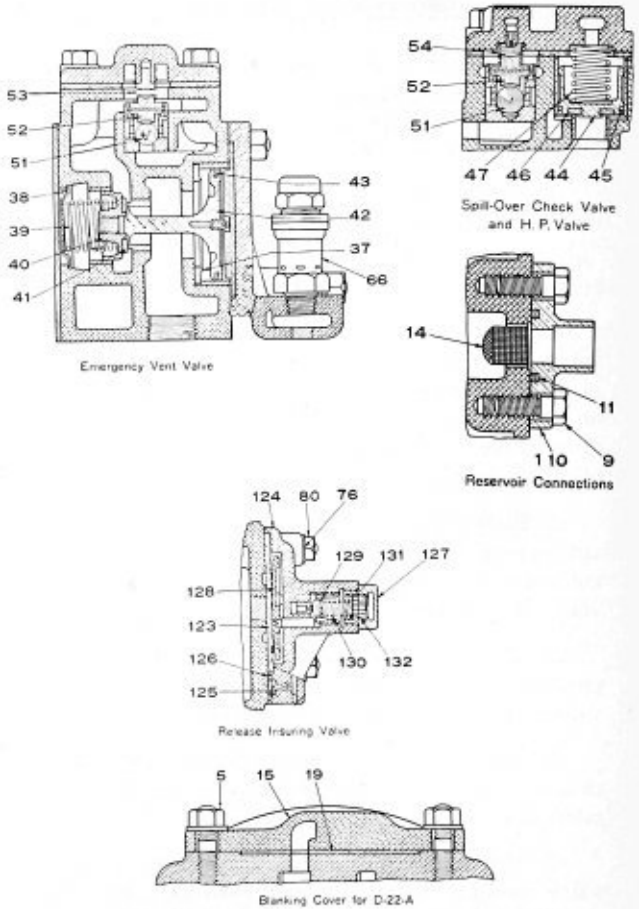

Fig. 7. Sectional Views of D-22-A Control Valve Details

(d) *The service piston return spring 108*, and *cage 107*, which prevent movement of the service piston beyond release position unless brake pipe pressure is about three pounds higher than auxiliary reservoir. In this event, brake pipe pressure under the graduating valve is cut off by the slide valve to prevent possibility of blowing the graduating valve off its seat.

(e) *The piston tail springs 72 and 95 and the spring guides 71 and 96*, which provide stability of quick service activity by preventing movement of the service piston to preliminary quick service position until a predetermined difference in pressure between the brake pipe and the auxiliary reservoir is attained.

(f) *The supply reservoir charging check 87 and ball check 74*, which permit charging flow from auxiliary reservoir to the supply reservoir but prevent back flow.

(g) *The emergency reservoir charging check 73 and ball check 85*, which permit brake pipe air to charge the emergency reservoir with the service piston in release position, but prevent any back flow of emergency reservoir air.

(h) *Supply reservoir charging check valve 73a and ball check 85a*, which permit charging flow from brake pipe to supply reservoir but prevent back flow.

(i) *The back flow check 73b and ball check 85b*, which serve to prevent flow of displacement reservoir air into the brake pipe, such as during emergency when displacement reservoir pressure is higher than brake pipe.

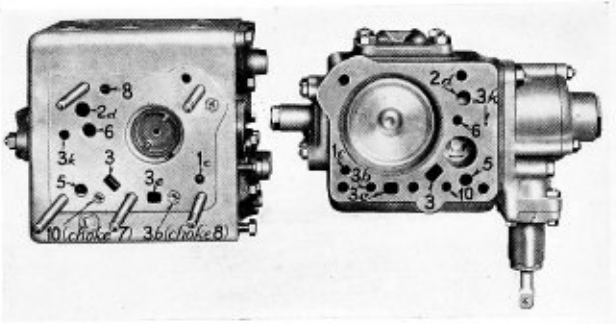

Fig. 8. Bolting Faces, Service Face of Pipe Bracket and Service Portion

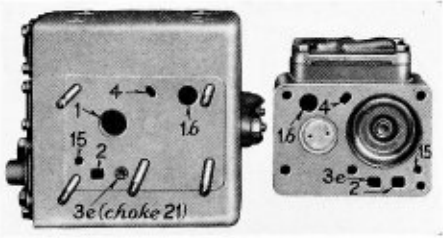

Fig. 9. Bolting Faces, Emergency Face of Pipe Bracket and Emergency Portion

(j) *The release piston 110 and slide valve 112*, which open and close the passage between the auxiliary and emergency reservoirs, and also between the displacement reservoir and exhaust.

(k) *The quick service choke plug 82a*, which controls the flow of brake pipe air to the displacement reservoir during the second stage of quick service.

(l) *The supply reservoir charging choke 83*, which controls the charging flow of brake pipe air to the supply reservoir.

(m) *The duplex release valve*, handle 160 of which controls the opening of auxiliary reservoir release valve 155 and emergency reservoir release valve 155a, permitting manual reduction of auxiliary reservoir pressure alone or both reservoirs together.

(n) *The quick service volume*, into which brake pipe air flows to initiate preliminary quick service.

(o) *The preliminary quick service exhaust choke plug 82*, which controls the continuous exhaust of quick service volume air to the atmosphere and provides the secondary quick service function.

(p) *The graduated release choke 105*, which controls the rate of recharging the auxiliary reservoir from the emergency reservoir during release and graduated release.

(q) *The quick service limiting portion 133*, with valve 147, controlled between diaphragms 141 and 143 by air pressure and spring pressure to terminate quick service activity after a 14 pound brake cylinder pressure is developed.

(r) *Graduated Release Cap 121* is for the purpose of conditioning the valve for Direct or Graduated Release. The cap is marked to indicate the desired position.

The EMERGENCY PORTION contains the following parts:

(a) *The emergency piston 35*, which moves the graduating valve 30 when a service rate of brake pipe reduction is made and also slide valve 29 when an emergency rate of reduction is created.

(b) *The emergency graduating valve 30*, which controls the flow of air:

(1) From quick action chamber to atmosphere during service applications.

(2) From quick action chamber to the vent valve piston 42 during emergency applications.

(c) *The emergency slide valve 29*, which controls the flow of air:

(1) From quick action chamber, through the graduating valve, to atmosphere during service applications.

(2) From quick action chamber to vent valve piston 42 during emergency applications.

(3) From emergency reservoir to the spring side of emergency valve 44 except during emergency applications.

(4) From spring side of emergency valve 44 to atmosphere during emergency applications.

(5) From the displacement reservoir, past accelerated release checks 51a and 52a, to the brake pipe during release after emergency.

(6) From displacement reservoir to the safety valve during a service application, and cuts off this connection during an emergency application.

(d) *Piston 42 and vent valve 40,* which vent brake pipe air to atmosphere during an emergency application.

(e) *The emergency piston return spring 63, and cage 62,* which during release cycles return the emergency piston from accelerated release to normal release position when quick action chamber pressure recharges to approximately brake pipe pressure.

(f) *The emergency piston spring 49, and spring guide 45,* which stabilize the emergency portion against undesired emergency.

(g) *The emergency valve 44,* which connects emergency reservoir air to the displacement reservoir during emergency applications.

(h) *The spillover check valve 52 and ball check 51,* which provide against overcharge of the quick action chamber.

(i) *The accelerated release check valve 52a and ball 51a,* which provide the accelerated build-up of brake pipe pressure (after emergency) from the combined volumes of the auxiliary reservoir and the displacement reservoir when the slide valve moves to accelerated release position.

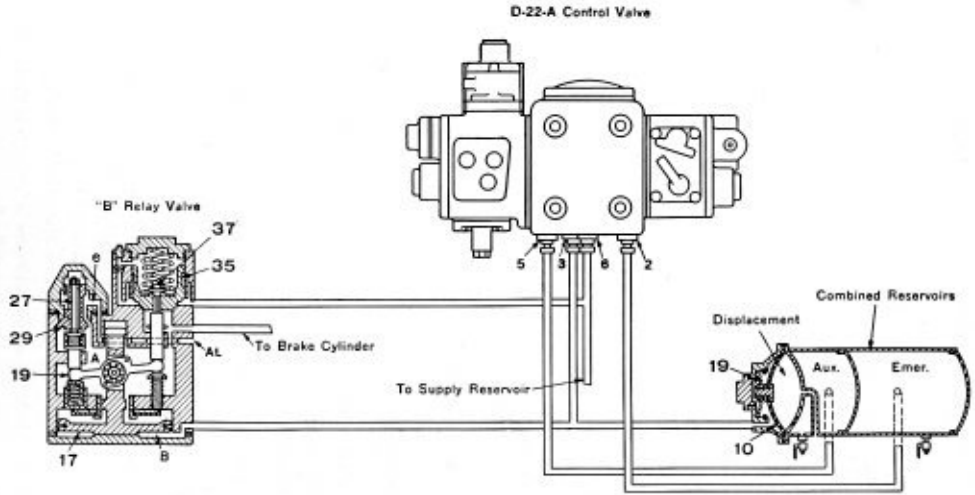

Fig. 10. Diagrammatic View of Displacement Reservoir and Type "B" Relay Valve

(j) *The diaphragm spring 55 and slide valve strut 34*, which serve to keep the slide valve seated in the absence of quick action chamber pressure.

(k) *The safety valve 66*, which limits displacement reservoir pressure during service brake applications to the safety valve setting. Since the safety valve is set to open at approximately 60 pounds and displacement reservoir pressure determines that supplied to the brake cylinders, service brake cylinder pressure is limited to this amount.

(l) *The charging choke plug 27*, which controls the rate of flow from the brake pipe to the quick action chamber. Felt strainer 28 protects the choke port against the possibility of restriction by fine dust.

(m) *The choke plug 20* in vent piston 42, and *choke* in the vent valve cylinder cover, which control the rate of exhaust of quick action chamber air during emergency, and thus provide the time interval required before release can be effected following an emergency application.

(n) *Wasp Excluder 26* in the emergency portion exhaust prevents the entrance of insects.

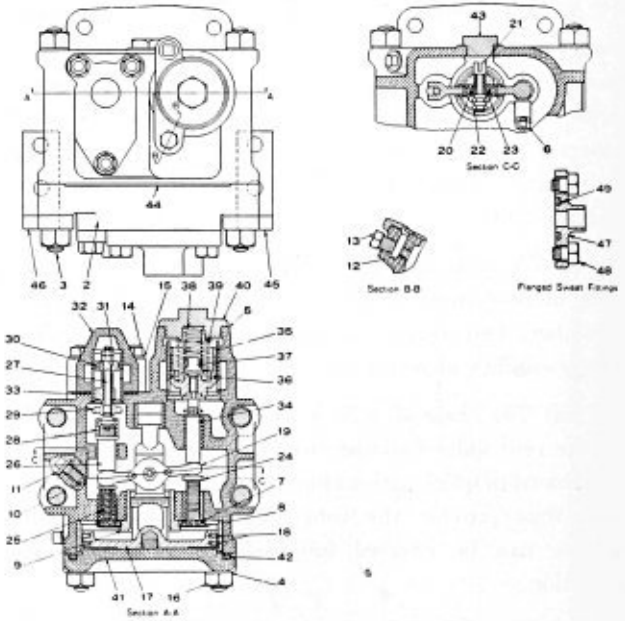

Fig. 11. Assembly View of Type "B" Relay Valve

"B" Relay Valve

The "B" relay valve relays the application and release operation of the control valve, reproducing in the brake cylinders, the pressure condition established in the displacement reservoir. It has a high capacity air flow which provides fast application and release rates for any combination of number and sizes of brake cylinders.

As shown in Fig. 11, it consists of a body mounted on a pipe bracket. Mounting brackets 45 and 46 are reversible, permitting either suspension or floor mounting of the valve. Piston 17 contains lever 19 mounted on ball bearing 20 on which the lever rotates when the piston is moved by pressure changes. The left end of the lever 19 controls the movements of exhaust valve

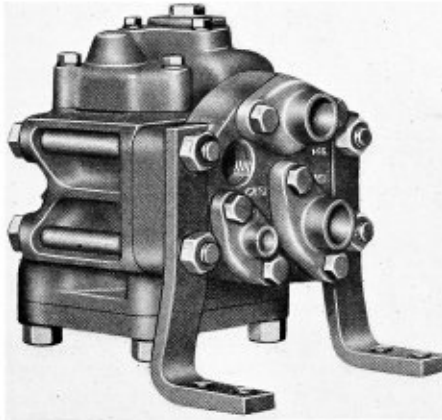

Fig. 12. Exterior View of the Type "B" Relay Valve

stem 26 and the latter in turn those of exhaust valve piston 29 and exhaust valve 27. The right end of the lever 19 controls movements of application valve stem 34 and the latter in turn, those of application valve 37 and application piston 35.

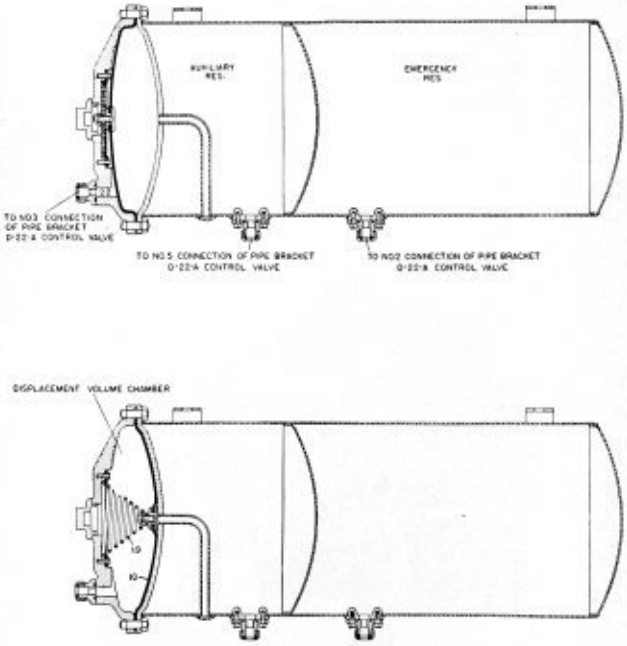

Fig. 13. Sectional Views of the Combined Reservoir showing the Displacement Diaphragm in Release and Applied Positions

Combined Auxiliary, Emergency and Displacement Reservoir

In order to provide for installation in the least possible space and keep weight as low as practical, these three reservoirs are combined in one structure.

The *auxiliary reservoir* is the local air supply used with the control valve to provide for proper functioning of the service portion.

The *emergency reservoir* is the local air supply used with the control valve to provide the quick recharge, graduated release and high emergency pressure features.

The *displacement reservoir* provides the required operating volume to develop the proper relation of brake pipe reduction. As previously described, the control valve operates to admit air to or exhaust air from this reservoir, the application and release rates being controlled by chokes 8 and 7 in the control valve pipe bracket. In this respect the equipment differs from present standard as in the latter the triple valve or universal valve applies and releases directly to the brake cylinders. Consequently when a brake application is made with the present standard equipment the first few pounds of build-up in the brake cylinder is consumed in replacing the partial vacuum created by movement of the brake cylinder piston from release to application position. The action of diaphragm 10 and spring 19 (Fig. 10) in the displacement reservoir duplicates this condition on the new equipment. When a brake application is made the diaphragm is deflected, Fig. 13, increasing the volume so that the initial rate of pressure develop-

ment is uniform with that of existing brake equipments. Therefore, although the equipment is intended for use in trains where it will be associated with previous standard passenger car brake equipment, it can easily be modified on assigned cars for use in high speed service only, by adjustment of the application and release chokes in the control valve pipe bracket.

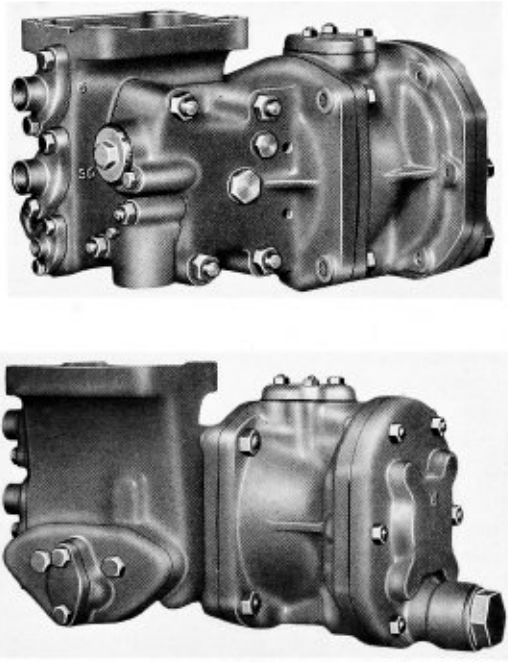

Fig. 14. Exterior Views of the A-4-A Relay Valve

A-4-A Relay Valve

The A-4-A relay valve is used, instead of the "B" type, on cars having the foundation brake rigging designed to provide the required high braking force for ultra high speed service. It provides the standard maximum braking ratio of 150% for conventional passenger service, but is so designed that available necessary parts can be added to provide governor control of maximum braking pressures for ultra high speed service without any fundamental changes in brake rigging.

As shown in Fig. 16, the pipe connections between the control valve, combined reservoir and the relay valve are the same as when the B relay valve, Fig. 10, is used. The A-4-A relay valve consists of a self-lapping portion like that of the "B" type except that the piston embodies a release spring 53 and faces a large diaphragm 62. A small diaphragm 75 acts on the large diaphragm through a suitable follower. Chamber A on the face of the small diaphragm is connected to pipe 16, thence to the displacement reservoir. Therefore, displacement reservoir pressure acts on the small diaphragm which, in turn, acts through the follower and large diaphragm to operate the lever 46 which reproduces the proper proportion of brake cylinder pressure. The self-lapping unit operates as described for the "B" type except that it is actuated by a diaphragm pile instead of a piston.

It will be noted that the self-lapping unit of the "B" relay valve reproduces brake cylinder pressure equivalent to displacement reservoir pressure. However, in the A-4-A relay valve, the area of the small diaphragm

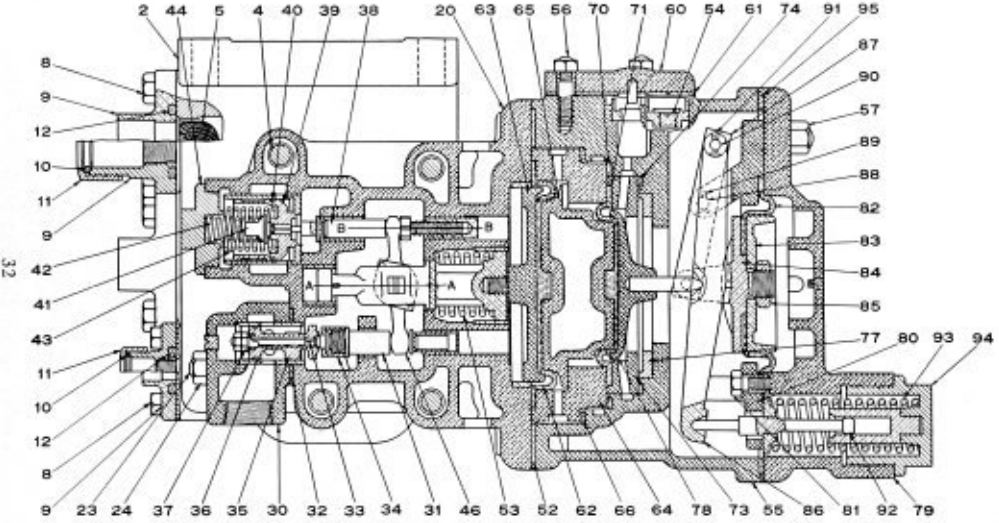

Fig. 15. Assembly View of the A-4-A Relay Valve

is less than that of the large diaphragm so that a proportionately lower brake cylinder pressure is produced on the large diaphragm by a given displacement reservoir pressure on the small diaphragm. This proportion is such that, on cars having the brake rigging designed for 250% braking ratio with 100 pounds brake cylinder pressure, the brake cylinder pressure is limited by the A-4-A relay valve to a maximum of 60 pounds, or 150% braking ratio, with 100 pounds maximum displacement reservoir pressure.

Release spring 53 in the piston of the self-lapping unit is designed to produce sufficient force to overcome resistance of the diaphragm portion in order to insure release with low brake cylinder pressure. This release force, if effective at all times, would prevent the desired close build-up of brake cylinder pressure with application pressure in chamber A. Therefore, the spring force is effective only with application pressure of low value. The levers 86 and 87, diaphragm 82 and spring 93 shown at the right of the diaphragm assembly balance the force of the release spring 53 and diaphragm resistance when application pressure in chamber A exceeds the low pressure for which it is adjusted.

With less than approximately five pounds application pressure in chamber A, the balancing diaphragm is in normal position and the lower end of the diaphragm lever 87, shown in dotted lines, is at its extreme left hand movement. The middle connection of this lever is fulcrumed and the upper end, which is attached to the upper end of the large balance lever 86, is at its extreme movement to the right. This carries the upper end of

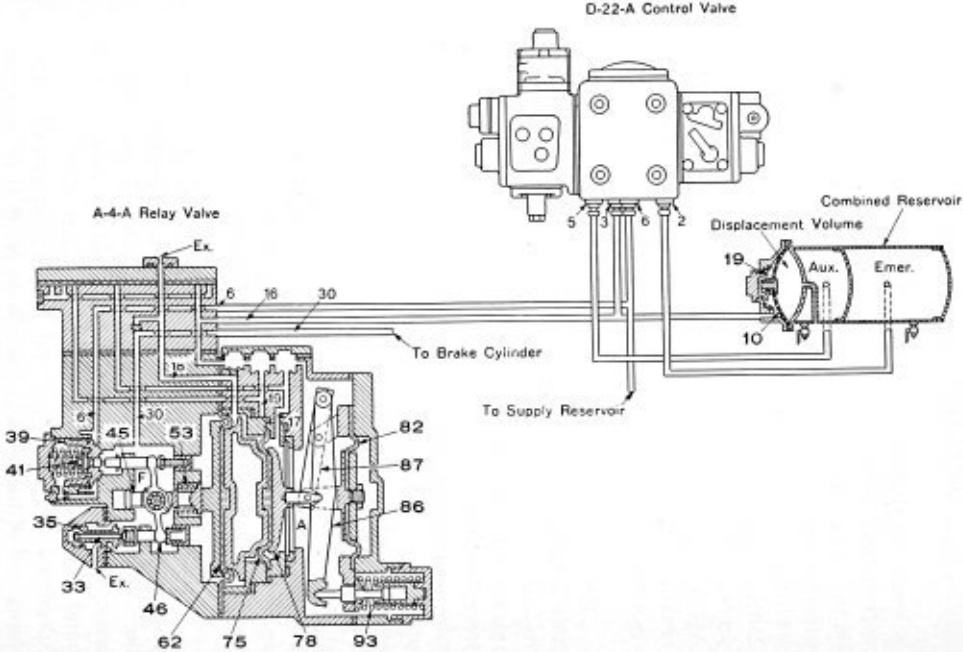

Fig. 16. Diagrammatic View of Displacement Reservoir and A-4-A Relay Valve

the balancing lever to the right and, as the lower end of the lever fulcrums on the balance spring 93, the middle connection does not offer resistance to the diaphragm follower 78 except when the diaphragm has moved far enough to the right to insure the release valve 35 of the self-lapping unit being open. This provides that the release bias of the release spring 53 of the self-lapping portion is effective to afford positive release when application pressure in chamber A is reduced to a low value.

When five to seven pounds application pressure is built up in chamber A, the balancing diaphragm 82 is deflected to the right. This carries the lower end of the diaphragm lever to the right and, as it fulcrums on the middle lever connection, the upper end moves to the left, carrying with it the upper end of the large balancing lever. This brings the middle connection of the large lever 86 into contact with the diaphragm follower 78, upon which the lever now fulcrums, and moves the lower end of the lever to the right, picking up the force of the balancing spring 93. The upper connection of the large lever now becomes the fulcrum and the force of the balancing spring is transmitted through the large lever to the diaphragm follower 78. The force delivered by the balancing spring 93 to the diaphragm follower by this arrangement is sufficient to offset the release spring bias and insure the required close relation between application pressure in chamber A and the pressure developed in brake cylinders.

By removing the follower 65 between the two diaphragms, installing two additional diaphragms with followers and substituting a magnet bracket for the

blanking flange now shown at the top face, the relay valve can be converted for speed governor control in which the diaphragms produce the proper ratio of brake cylinder pressure for a given pressure in chamber A, at predetermined speeds.

Type "UA" Brake Cylinders

The brake cylinders are located on the trucks or car body with piston rod 10 so connected through the brake levers and rods to the brake shoes that when the piston is forced outward by air pressure from the supply reservoir the force so developed is transmitted through the rods and levers to the brake shoes, forcing them against the wheels.

The number, size and location of brake cylinders depend on the weight of the car and the particular

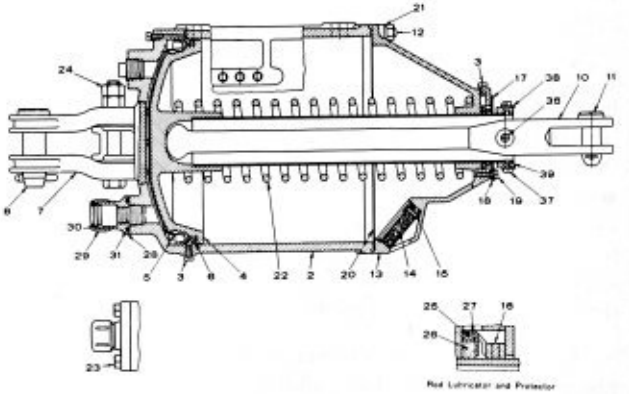

Fig. 17. Type "UA" Brake Cylinder

installation. The "UA" type brake cylinder, Fig. 17, is designed to prevent the entrance of dirt, and the construction is such as to permit the lubrication of moving parts without removal of the piston or opening of the cylinder.

The cylinder body and pressure head are combined into a single casting which is provided with a bolting flange for mounting and a reinforced flanged union for the pipe connection. The piston 4 has a hollow rod which provides for a loose push rod that is attached to the levers and rods of the foundation brake rigging, and a push rod holder 39 is attached to the outer end of the piston rod.

A solid WABCO packing cup 5 snaps onto the pressure face of the piston. The circumference (or perimeter) of the piston is machined to form a shoulder over which the packing cup is fitted, and a groove back of this shoulder contains a packing cup supporting ring and a lubricator assembly with a felt packing ring (or swab). The space back of the heel of the packing cup and in front of the felt swab provides a groove around the piston which, when filled with lubricant, serves to spread the lubricant over the cylinder wall with each movement of the piston. With the piston in release position, the grease cavity aligns with four grease ports in the cylinder body which are normally plugged. Lubrication is accomplished from the outside by means of a grease gun at any one of the four connections. The felt swab serves a double purpose; prevents overflow from the groove to the non-pressure side of the piston when introducing the lubricant, and, as it becomes saturated

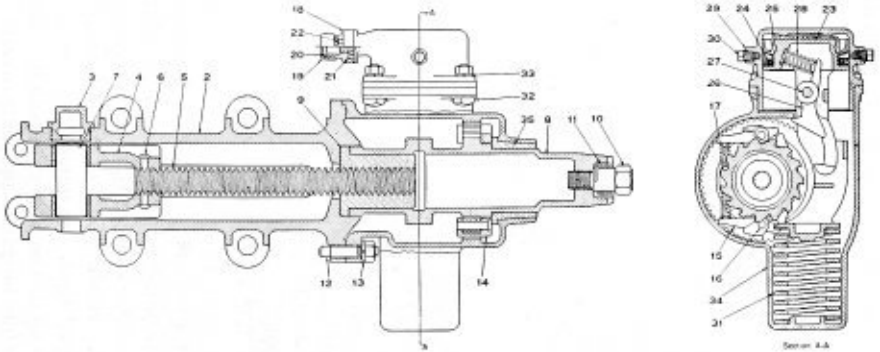

Fig. 18. Type C-16-D Automatic Slack Adjuster

with lubricant, results in the cylinder surface being re-lubricated with each application and release movement of the piston.

To prevent the entrance of dirt, the piston rod is ground true as to diameter and surface, and the non-pressure head 13 is fitted with a piston rod lubricator and protector consisting of a felt swab and three bronze rings, which are packed in grease and serve to lubricate the piston rod as well as seal the interior of the cylinder against dirt and moisture. A tapped opening in the non-pressure head provides a means of lubrication of the piston rod and rings.

Since atmospheric air must enter the non-pressure end of the cylinder during the release movement, the non-pressure head is fitted with a curled hair strainer *4*. This strainer is of the cartridge type held in place by a breather cover which prevents flying dirt and water contacting directly with the strainer.

Automatic Slack Adjusters

The automatic slack adjuster functions to maintain a predetermined brake cylinder piston travel. There are three general types of slack adjusters depending on brake cylinder location and mounting. Type "B" is for mounting on the end of the brake cylinder when the cylinder is located on the car body. Fig. 17 shows the lever brackets 7 and lug which accommodates the adjuster for this mounting. Type "A" is for mounting on the end of the truck frame: Type "C" for mounting on the top or side of the truck frame. Brake cylinders used

with "A" and "C" adjusters therefore do not require slack adjuster lug and lever brackets on the cylinder pressure head. Plate 8 shows the relative location of the "C" slack adjuster. The slack adjuster engine is the same general construction for all types, the variations being only in the body 2 to suit mounting requirement.

Referring to Fig. 18, the slack adjuster body contains a movable crosshead 4 which serves as a fulcrum for the brake rigging cylinder lever. Movement is imparted to the crosshead through a screw 5, combined with ratchet nut 8, and pawl 26, the pawl being operated by piston 23 and spring 31.

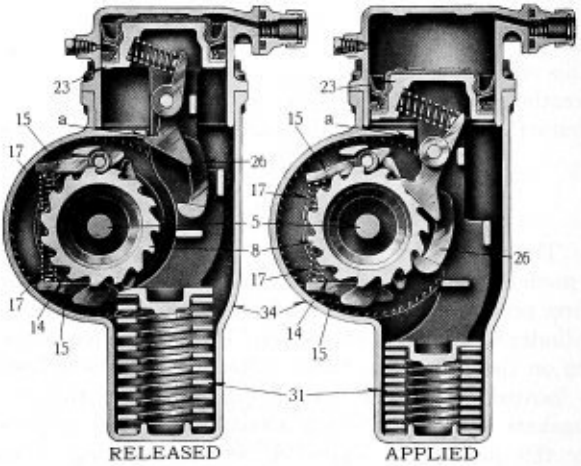

Fig. 19. Diagrammatic Views of the Automatic Slack Adjuster

The brake cylinder piston and packing cup act as a valve to control the admission and release of brake cylinder pressure to and from the pipe connecting the slack adjuster to the brake cylinder. The port in the brake cylinder to which this pipe is connected is so located that the packing cup uncovers it when the predetermined piston travel is exceeded. Whenever this port is so uncovered, brake cylinder air flows through the pipe into the slack adjuster cylinder where piston 23 is forced outward, compressing spring 31, Fig. 19. Attached to the piston stem is a pawl 26 extending into casing 34, which engages ratchet wheel 8, mounted within casing 34 upon screw 5.

When the brake is released and the brake cylinder piston returns to its normal position, the air pressure in the slack adjuster cylinder escapes to atmosphere through the pipe and the non-pressure head of the brake cylinder, thus permitting spring 31 to force the piston to its normal position. In so doing, pawl 26 turns the ratchet wheel upon screw 5 and thereby draws the cylinder lever slightly in the direction of the slack adjuster 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. 19), 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.

Ratchet pawls 15 (mounted on floating ring 14) provide against movement of the ratchet wheel due to vibration, the end of one of the two levers being held in

contact with a tooth in the slack adjuster casing by spring 17. A trip is provided to disengage the holding lever when making hand adjustment in either direction, a pull of sufficient force being required that, while unlocking is accomplished without undue effort, there is enough movement required and adequate resistance to insure against false movement due to vibration.

To apply new shoes, turn ratchet nut 8 to the left, thus moving the cylinder lever toward the brake cylinder until sufficient slack is introduced in the brake rigging. To bring the shoes closer to the wheels and shorten the piston travel, turn ratchet nut *8* to the right. When the piston travel is less than 4″ or more than 5″, (truck mounted cylinders) the slack adjuster should be adjusted so that the piston travel is 4½″ with 50 lbs. brake cylinder pressure. Where the cylinder is mounted on the body, the piston travel should be adjusted to 7½″.

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.

If the adjuster crosshead is allowed to work out to the outer end of the adjuster body it will become locked. To release, loosen the stop screw in the end of ratchet nut 8 about one-half turn, rotate ratchet nut one-eighth turn to the right to free the pawl, then turn to the left to let out the required slack. Be sure that the stop screw is re-tightened.

The best results are obtained by the use of copper pipe from the brake cylinder to the adjuster cylinder,

Fig. 20. Exterior View of the B-3-B Conductor's Valve

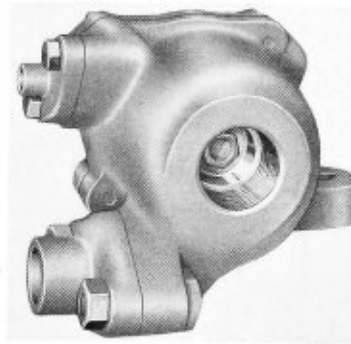

Fig. 21. Exterior View of the E-3 Application Valve

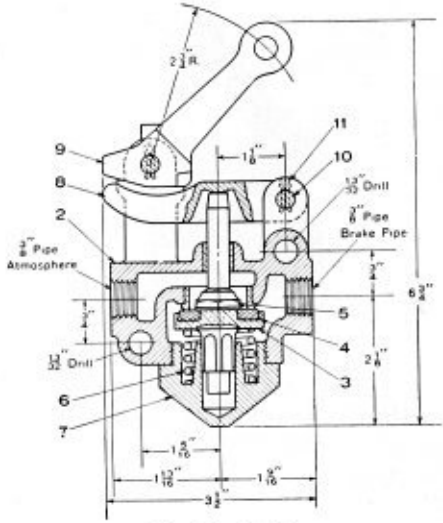

Fig. 22. B-3-B Conductor's Valve

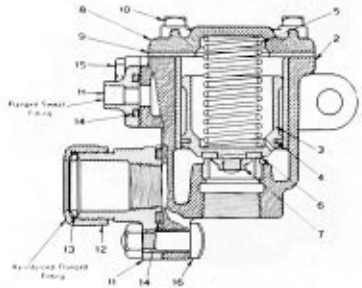

Fig. 23. E-3 Brake Application Valve

since this pipe is more flexible and does not corrode. It should always be firmly secured.

The slack adjuster cylinder should be cleaned and lubricated, and all other adjusting parts carefully inspected and given necessary attention each time the brake cylinder is cleaned.

B-3-B Conductor's Valve
E-3 Brake Application Valve

These devices are used to permit the conductor to obtain an emergency brake application.

The B-3-B Conductor's Valve, Fig. 22, with a cord attached is located at the end of a brake pipe branch pipe on each end of the car. As shown in Plate 8, its brake pipe opening is connected to the side connection of the E-3 brake application valve. The E-3 brake application valve, Fig. 23, is connected to the brake pipe so that, normally, brake pipe air flows beneath the outer area of piston valve 3, thence through the small port in this valve to the spring chamber, thence out the side connection to the conductor's valve. With air pressures equal on both faces of the valve 3, the force of spring 5 holds the valve seated, sealing the atmospheric opening below seat 6.

When the handle of the conductor's valve is pulled by means of the cord or otherwise, the handle lever unseats valve 3 and permits the air to escape from the conductor's valve pipe faster than it is supplied through the port in the piston valve 3 of the E-3 brake application valve. Consequently, the pressure above the piston

valve is quickly reduced and the greater brake pipe pressure on its outer area unseats the valve and makes a large direct opening from the brake pipe to the atmosphere, which permits brake pipe air to escape at an emergency reduction rate and causes emergency brake application of the control valves as described under "Emergency."

The conductor's valve should be used only in case of actual danger, and then should be left open until the train stops.

Retaining Valve

The retaining valve is piped to the control valve exhaust as shown on Plate 8, and is used for the purpose of releasing brake cylinder pressure at a slow rate during the time required for recharging when descending heavy grades.

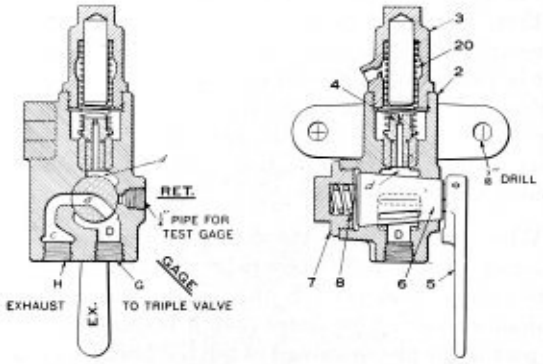

Fig. 24. Pressure Retaining Valve

The cock key 6 has two outlets, one to the atmosphere through the pipe tap marked "exhaust," and one to cavity *d* leading to valve 4.

A wasp excluder is used in the exhaust ports to prevent the entrance of insects.

When the handle of the retaining valve is turned down, passage *a* in the cock key connects chamber *D* to the outlet port *c*. Consequently, when turned down, the control valve exhaust is open through the retaining valve pipe, chamber *D*, passage *a* and exhaust port *c* to the atmosphere. When the handle is turned up to the horizontal position, passage *a* connects chamber *D* below the cock key with chamber *d*, so that when a release is made the air exhausting from the brake cylinder flows to the retaining valve and through passage *a* and passage *d* to the face of the valve 4, which it must lift against the pressure of spring 20 in order to flow to the atmosphere through the vent port in the cap nut. As long as the pressure of the air from the brake cylinder is greater than 10 pounds, valve 4 is unseated and the air exhausts to the atmosphere through the vent port which, being small, makes the release of the brake much slower than when the retaining valve is not set up. When the pressure has been reduced to 10 pounds it is no longer able to hold valve 4 off its seat and the valve then closes and the remaining 10 pounds is exhausted through the small choke in valve 4 to the vent in the cap nut. The purpose of the choke in valve 4 is to prolong the final release and therefore the available recharge time, or allow a complete release if necessitated by grade conditions, without the delay involved in turning down the retaining valve on each car through the train.

Fig. 25. Combined Dirt Collector and Cut-out Cock with Reinforced Flanged Union

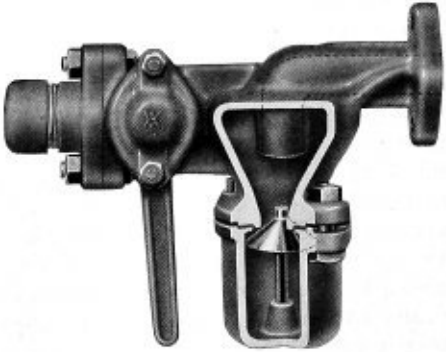

Fig. 26. Sectioned View showing the Dirt Collector Portion

Combined Dirt Collector and Cut-out Cock

This device is a combination of two of the branch pipe fittings—the centrifugal dirt collector which protects the control valve against entrance of dirt, and the cut-out cock which opens (handle vertical) or closes (handle horizontal) communication between the control valve and the brake pipe. Bolting flanges are provided for both pipe connections, the flange on the dirt collector end bolting direct to the control valve pipe bracket while the flange on the cock end is provided with a reinforced flange union.

The dirt collector is the standard check valve type with the detachable dirt chamber. It is only necessary to remove two nuts to drop the dirt chamber for cleaning.

The purpose of the umbrella shaped 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, 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.

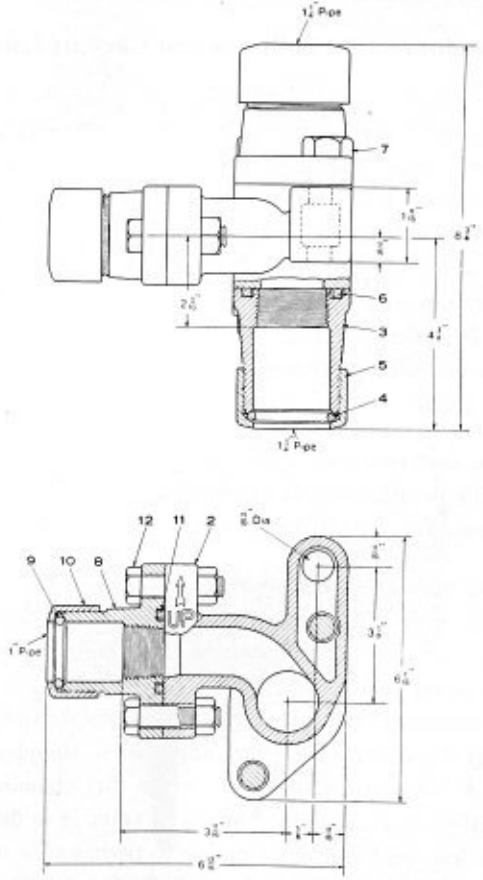

Fig. 27. Sectional Assembly Views of the Branch Pipe Tee

Branch Pipe Tee

Three Branch Pipe Tees are used, one each in the brake pipe branches to the conductor's valves and one in the brake pipe branch to the control valve.

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 valves.

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 passes through the brake pipe, it flows upward into a chamber 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.

Fig. 28. Exterior View of the Branch Pipe Tee

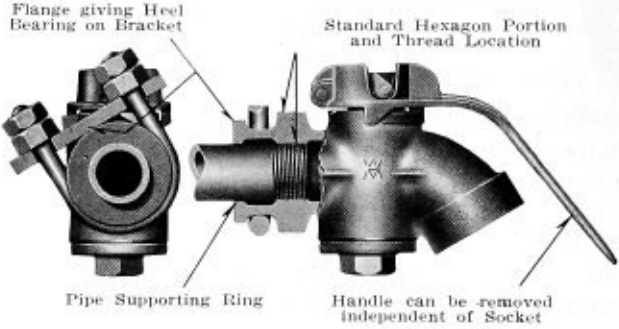

Fig. 29. View showing Angle Cock Features

Fig. 30. View of the Angle Cock showing Split Type Handle Socket

Angle Cock

Figs. 29 and 30 illustrate the angle cock, one of which is installed at each end of the brake pipe. The cock is open with the handle parallel to the pipe line, as illustrated, and closed with the handle crosswise or at right angles to the pipe line.

The handle may be removed independently of the socket. After driving out the hinge pin, the handle may be easily removed by first depressing it and then sliding it forward to permit the web to clear the socket lugs.

The handle, of course, locks in both open and closed positions. When so locked, it is necessary to slightly raise the handle before it can be turned, thus insuring against accidental opening or closing by being stepped upon, flying missiles or loose rods and chains.

An extension with a U bolt groove to the brake pipe end of the angle cock serves to support the brake pipe entering the angle cock while the groove in the extension permits the angle cock to be positively attached to the hanger bracket.

A split type socket is used and the rivet pin hole for locking the socket to the key is drilled through the split portion, engaging a notched-out cavity in the square of the key.

Fig. 31. Exterior View of the Double Locking Angle Cock

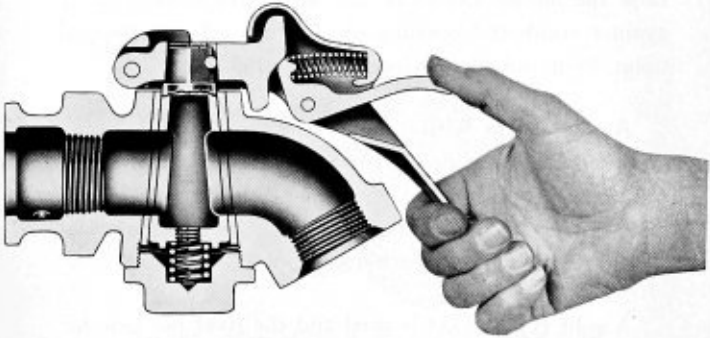

Fig. 32. Sectional View of the Double Locking Angle Cock

Double Locking Angle Cock

This new type Angle Cock Handle has a double lock that prevents accidental movement of the handle and discourages unauthorized tampering.

A latch, hinged in the handle, must be depressed before the handle can be raised to unlock and turn the cock key. As this requires two distinct and opposite forces, which can only be coordinated manually, the cock is safe against accidental opening from a single force such as that applied by the foot or by a swinging chain.

A spring holds the latch in engagement with the socket, locking the socket and handle together so that the handle cannot be raised to clear the stop lugs on the body. To turn the cock it is necessary to depress the latch while lifting the handle. This is done by gripping the handle in a normal manner and applying light thumb pressure on the latch.

While serving as a lock, the spring also acts to maintain a positive contact between locking surfaces, thus avoiding loose movements and resultant wear.

Reinforced Flanged Union Fittings

The purpose of the reinforced flanged union fittings is to produce iron or steel pipe joints which can be made and maintained permanently air tight and at the same time avoid costly failures in road service due to the breakage of pipe or fittings. The fitting is designed to clamp the pipe back of the threaded end so as to relieve the thread of tension stresses, and it is arranged so that removals and re-applications can be conveniently made.

Unless these fittings are correctly installed, the protection against pipe failures at the point of the exposed threads may be lost. To fully accomplish the purpose of these fittings, the piping assembly should be made up as follows:

After slipping the clamping nut and anchor ring over the threaded end of the pipe, the flanged fitting must be screwed on the pipe so as to make a rigid and air tight

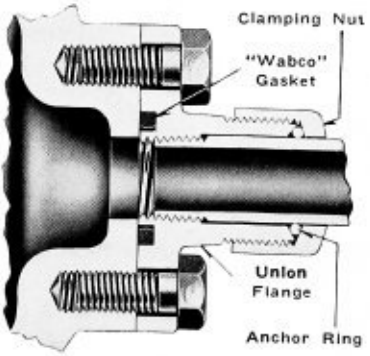

Fig. 33. Sectional View of the Flanged Union Connection

joint at the threads when the bolt holes are in line with the tapped holes in the face to which it will be bolted. The anchor ring and clamping nut must then be moved into place and the nut firmly tightened so as to solidly close the anchor ring on the pipe.

To insure that the anchor ring will have a full supporting bearing on the pipe, the thread must be straight, that is, cut substantially parallel with the axis of the pipe. This will automatically occur if the pipe threading tools are in proper condition.

The pipe must be so formed and fitted that when it is in place the face of the flanged fitting, with the gasket removed, will contact squarely with the surface to which it will be clamped, and that the bolt holes are in line to permit application of the cap screws without springing the pipe. The gasket can then be applied and the fitting clamped in place with the cap screw bolts which should be solidly tightened.

The design of the pipe runs between clamping points must be such that the pipe can have sufficient flexibility in itself to take up any small deflections that may be caused by movements in the car body. This flexibility is best secured by designing the pipe run to have one or more easy bends of not less than six inch radius. Where the form of the pipe and the installation of the flanged union is made as described, there will be adequate mechanical strength in the flange union assembly to cause the pipes to deflect sufficiently to compensate for normal maximum car body movements without the production of excessive stresses within the fittings.

When the assembly is made in accordance with the above instructions the pipe and flange fittings will be free from initial tension. The flange fitting will be drawn solidly metal to metal and, therefore, be free of any motion, and the pipe will have a solid metal support outside of the threaded joint which, acting as a fulcrum, changes any stresses at the exposed pipe threads from tension on a small area to a shear force on the whole diameter of the pipe. This shear force may be many times as great as the tension force cited without causing failure.

Flanged union fittings for these connections are available for copper pipe in O. D. sizes as shown on Plate 8, or in outside diameters identical with the I. P. sizes. These fittings are designed for brazing or sweating with a hard solder.

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. 34. 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.

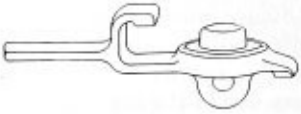

Fig. 35. Dummy Coupling

OPERATION OF THE EQUIPMENT

As it is impossible to show all the ports and connecting passageways by any single section taken through the control valve, Plates 1 to 7 inclusive have been made to show in a purely diagrammatic way the relation of the various ports to each other, for the different operating positions. The actual proportions and mechanical construction of the parts have been disregarded, where necessary, in order to make the connections and operation more easily understood.

Full Release and Charging Position—Plate 1

Brake pipe air passes through the branch pipe cut-out cock and dirt collector into passage *1* and thence through filter element 12 to chambers *A* and *B* on the faces of service piston 93 and emergency piston 35, moving both pistons to release position as illustrated. Brake pipe air also continues around the strainer to passage *1b*, thence to the spring side of quick action vent valve 40 and through passage *1g* to the top of accelerated release check valves 52a and 51a.

Brake pipe air in chamber "*A*" on the face of service piston 93 flows in three directions, charging the auxiliary, emergency and supply reservoirs:

(a) Through feed groove *V* in the service piston bushing to the service slide valve chamber *C*, thence through passage *5a* to release piston chamber *D*, thence through passage *5* and pipe 5 to the auxiliary reservoir. Passage *5* is also connected through branch *5b* to the spring chamber above auxiliary reservoir check valve 155.

(b) Through charging port *X* in the service piston bushing, past ball check valve 85 and flat check valve 73 to passages *2d* and *2*, and pipe 2 to the emergency reservoir. Passage *2d* is also connected to the top of emergency reservoir check valve 155a (through passage *2b*) and to the graduated release cap 121 (through passage *2a*).

(c) Through passages *1c* and *1d*, choke 83, limiting valve chamber *H*, past check valve 147, to passages *1e* and *1f*, past ball check valve 85a and flat check valve 73a to the chamber above check valves 74 and 87, thence through passage *6* and pipe 6 to the supply reservoir. A branch of passage *1e* is also connected to the face of the service graduating valve past ball check 85b and flat check valve 73b, a choke, and passages *d1* and *d*. Brake pipe air also flows through passage *1c* to chamber *F* on the left of release insuring diaphragm 123.

The service slide valve chamber *C* and the release slide valve chamber *D* are connected by passage *5a* so that auxiliary reservoir pressure is the same in both chambers at all times. In release position, auxiliary reservoir pressure in chamber *C* is also connected to the spring side (chamber *K*) of release piston 110, through port *a* in service slide valve 98 and passage *a1*. With air pressure acting on release piston 110 balanced, spring 116 moves the piston and attached slide valve 112 to release position, where cavity *Q* in the slide valve connects displacement reservoir passage *3* to exhaust passage *10*, thereby releasing the brake. Passage *2c* in the seat connects emergency reservoir passage *2a* to slide valve chamber *D*, (through graduated release cap 121

and choke 105) which is, in turn, permanently connected to auxiliary reservoir pressure through passage *5a*. This provides for the quick recharge and graduated release feature as later explained.

With the release slide valve in release position, auxiliary reservoir air from chamber *D* flows through port *r* in the release slide valve to passage *r1*, past ball check valve 74 and flat check valve 87 to passage *6* and pipe 6, charging the supply reservoir. Thus the supply reservoir is charged from the auxiliary reservoir as well as from the brake pipe as previously described.

Charging Check valves 87 and 74 lift and permit charging flow from the auxiliary reservoir to the supply reservoir but seat and prevent back flow when supply reservoir pressure is higher than auxiliary reservoir pressure.

Charging check valves 85a and 73a lift and permit charging flow from brake pipe to the supply reservoir but seat and prevent back flow when supply reservoir pressure is higher than brake pipe pressure.

In the emergency portion, brake pipe air in chamber *B* on the face of emergency piston 35 flows through the charging choke 27 to chamber *E* on the slide valve side of the piston and through passage *4* to the quick action chamber.

Emergency reservoir air is connected to the underside of the emergency slide valve 29 by passages *2* and *2e*. In order to prevent the slide valve 29 being unseated when the quick action chamber is not charged, the slide valve is balanced by spring 55 and strut 34. Emergency reservoir air is connected to a small diaphragm area on

the upper side of the cover gasket 57 through passage *2g* and port *2h*, and exerts downward pressure through strut 34 to keep the slide valve seated when there is no air pressure above the slide valve. When the quick action chamber is charged, the pressure in the emergency slide valve chamber holds the slide valve to its seat and the pressure on both sides of the diaphragm area of the cover gasket is the same; consequently, the stem is balanced, removing downward strut pressure except that of the light spring 55 which does not increase slide valve friction materially.

Emergency reservoir air is connected through passages *2*, *2e*, and *2g* to the spring chamber above the spillover check valves, ball check 51 and flat check valve 52. The underside of ball check valve 51 is connected by a choked passage to the emergency slide valve chamber *E* and the quick action chamber.

In the event of the quick action chamber becoming overcharged, as might occur on the head of a long train by reason of improper use of release position of the automatic brake valve, if quick action chamber pressure becomes a small amount higher than emergency reservoir pressure, as determined by the check valve spring 54, ball check 51 and the spring loaded check valve 52 will be unseated, permitting the overcharge in the quick action chamber to flow to the emergency reservoir and thus prevent emergency application through undesired operation of the emergency portion upon returning the brake valve handle from release to running position. The use of the spring loaded check valve 52 and ball check 51 provides double protection against the quick action chamber charging from the emergency reservoir.

Emergency reservoir air from passage *2* is at all times connected to the outer area of the face of emergency valve 44. In release position of the emergency slide valve, emergency reservoir air from passage *2e* is connected by means of cavity *h* in the slide valve to the spring side of the emergency valve through passage *h1;* therefore, spring force will move the valve to its seat and hold it closed.

As shown in Fig. 36 chamber "*B*" on the face of the "*B*" relay valve piston 17 is connected to the displacement reservoir (D.R.) and the application piston 35 to the supply reservoir (S.R.) Supply reservoir air flows through choke 12 to the spring chamber, back of the application piston 35, balancing the pressure on both faces of the application piston. With brakes released, there is no pressure in the displacement reservoir and

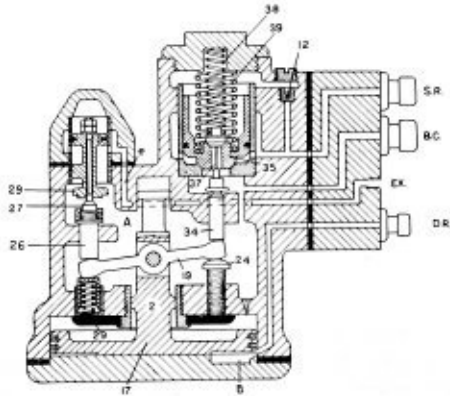

Fig. 36. Type "B" Relay Valve—Release Position

chamber *B* on the face of the relay piston 17; therefore, the piston is in release position, springs 38 and 39 hold the application valve and piston seated, and exhaust valve 27 and piston 29 are in their lower position, opening chamber *A* and the brake cylinders to exhaust passage *e*.

Preliminary Quick Service Position—Plate 2

When a service brake pipe reduction is started, the service piston 93 first moves to the left far enough for the spring guides 71 and 96 at the end of the piston stem to engage the slide valve, where springs 72 and 95 are slightly compressed and the piston closes the feed groove *V*, cuts off brake pipe air in chamber *A* from the emergency reservoir charging port *x* and connects this port to auxiliary reservoir air in slide valve chamber *C*. Check valves 73 and 85 seat and prevent flow from the emergency reservoir to chamber *C*.

The piston springs 72 and 95 and guides 71 and 96 stabilize the preliminary quick service so that a predetermined differential of auxiliary reservoir and brake pipe pressures is required to move the service piston and graduating valve 99 to preliminary quick service position. Undesired quick service activity which might otherwise occur, due to moderate fluctuations of brake pipe pressure, is thereby prevented.

As the brake pipe pressure reduction continues, enough differential is created to compress the piston springs 72 and 95 and move the piston and graduating valve until cavity *k* in the graduating valve connects slide valve ports *c* and *d*. Seat port *d1* containing brake

pipe air now registers with slide valve port *d*, and port *c* leads to the quick service volume (Q.S. Vol.). Brake pipe air thus flows through passages *1c* and *1d*, past limiting valve 147 to passage *1e*, past check valves 85b and 73b to passage *d1*, slide valve port *d*, cavity *k* in the service graduating valve, port *c* in the slide valve to the Q.S. Vol., thereby producing a local reduction in brake pipe pressure.

This preliminary local reduction of brake pipe pressure, controlled by the graduating valve, results in rapid quick service action throughout the train.

The quick service volume is permanently connected to atmosphere through choke 82 and by this means local brake pipe reduction is continued until the slide valve moves. After the quick service volume has been cut off by the movement of the slide valve, remaining air pressure in this volume is exhausted through choke 82.

In preliminary quick service position, graduating valve movement on the service slide valve cuts off auxiliary reservoir air from slide valve port *a*, leading through passage *a1* to the spring side of release piston 110, and cavity *m* connects port *a* to port *b* and the exhaust port *Ex.*, thereby exhausting air pressure from the face of the release piston. The air pressure (auxiliary reservoir) in chamber *D* on the slide valve side of the release piston then overcomes the force of spring 116 and moves the piston and slide valve to the right, moving cavity *Q* out of register with port *3*, thereby disconnecting the displacement reservoir from the exhaust passage *10*. The quick recharge and graduated

release passage *2c*, to the emergency reservoir, is blanked by the release slide valve.

During preliminary quick service, the emergency piston 35 and graduating valve 30 assume service position as described under "Service Position."

Service Position—Plate 3

The preliminary quick service reduction causes the service piston and its slide valve to move to service position where brake pipe air flows through the limiting valve to the displacement reservoir until brake cylinder pressure of a predetermined amount is developed. Cavity *n* of the slide valve connects passages *d1* and *3d*, and brake pipe air from passage *1c* flows through passage *1d* to limiting valve chamber *H*, thence past limiting valve 147, (which is still unseated as shown on Plate 2) to passage *1e*, past check valves 85b and 73b, to passage *d1*, service slide valve cavity *n*, passage *3d*, choke 82a, passages *3c* and *3* to pipe *3* and the displacement reservoir.

Displacement reservoir air also flows through passage *3a*, passage *W* in blanking flange 15, and passage *3k* to the chamber above upper diaphragm 143 of the limiting valve. When the pressure in this chamber reaches approximately 14 pounds, the force of spring 138 under the lower diaphragm is overcome, and both diaphragms move down, permitting spring 146 to seat limiting valve 147. This cuts off connection between passages *1d* and *1e*, preventing further flow of brake pipe air past check valves 85b and 73b, to the service slide valve, and consequently into the displacement reservoir, thereby terminating all quick service activity.

Meanwhile, with the service piston and slide valve in service position, graduating valve 99 uncovers the service port *f* through which auxiliary reservoir air flows from chamber *C* to passage *3b* in the slide valve seat, thence through choke 8 and passage *3* to the displacement reservoir, the pressure developed in the displacement reservoir depending on the amount of brake pipe reduction. If more than a full service reduction is made before the brake valve is lapped, pressure in the auxiliary reservoir and displacement reservoir will equalize.

Check valves 73b and 85b in the service portion lift and permit free flow of brake pipe air to the displacement reservoir during quick service reduction, but in the event of an over-reduction or an emergency brake application in which the brake pipe pressure is reduced lower than the pressure in the connected auxiliary and displacement reservoirs, the check valves seat and prevent back flow from these reservoirs to brake pipe.

In the emergency portion, the safety valve passage *s1* is connected through a cavity in the emergency slide valve 29 and passages *3f*, *3e*, *3c* and *3* to the displacement reservoir. Thus displacement reservoir air builds up under the safety valve, which is set to open at approximately 60 pounds, to which maximum displacement reservoir pressure is thereby limited in service brake application.

The service reduction in brake pipe pressure also reduces the pressure in chamber *B* on the face of the emergency piston 35 slightly lower than quick action chamber pressure in chamber *E* on the slide valve side of the piston. The piston and graduating valve 30 move

to the right until the piston spring guide 48 contacts the slide valve. In this position the piston closes the charging choke 27, and vent port *t*, (through graduating valve 30), registers with exhaust port *y* in the slide valve. This allows quick action chamber air to flow to atmosphere and reduce pressure in the quick action chamber back of the emergency piston at the same rate that brake pipe pressure is being reduced on the face of the piston. This keeps quick action chamber pressure from attaining a differential over brake pipe pressure sufficient to cause the piston to move and compress the piston spring 49 enough to cause the graduating valve to uncover port *t1* and cause an emergency brake application.

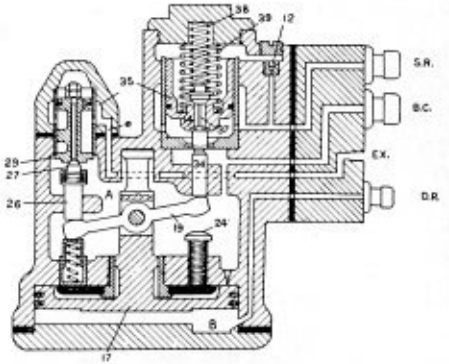

Fig. 37. Type "B" Relay Valve—Applied Position

By this means the emergency piston is stabilized against undesired emergency, and emergency application is made available any time the system is charged, as described under "Emergency."

When a brake application is made, air from the displacement reservoir builds up in chamber *B* on the face of the relay valve piston 17 (Fig. 37) moving the piston and attached piston lever 19 upward. Application valve spring 38 resists the first movement and thus fulcrums lever 19 at the right end between application valve stem 34 and adjusting screw 24. The left end of piston lever 19 moves upward, lifting exhaust valve stem 26, seating exhaust valve 27 on its valve seat on piston 29 and moving the latter against its bushing seat, thus limiting the upward travel of the left end of lever 19. This closes off the connection between the brake cylinder (chamber *A*) and the exhaust passage *e*. As piston movement continues upward, lever 19 now becomes fulcrumed at the left end and application valve stem 34 is lifted, unseating application valve 37. This permits supply reservoir pressure above the application piston 35 to flow into chamber *A* and to the brake cylinder faster than the rate of supply permitted by choke 12, and the reduced pressure above allows supply reservoir pressure underneath to lift the piston, permitting supply reservoir pressure to flow to brake cylinder. By reducing the force required to open the large application piston 35, the valve 37 and the choke 12 thus function to provide easy, sensitive operation of the application valve.

Service Lap Position—Plate 4

When the desired amount of brake pipe reduction has been made and auxiliary reservoir pressure is reduced slightly below brake pipe pressure by flowing to the displacement reservoir, the service piston 93 and its graduating valve 99 move to the right until the piston stem shoulder engages the slide valve, in which position the graduating valve blanks the service port *f* through the slide valve and cuts off further flow of auxiliary reservoir air to passage *3b* and the displacement reservoir. The release piston 110 and slide valve 112 remain in application position, holding the exhaust passage 10 closed, and the brake applied.

The emergency piston 35 and graduating valve 30 return to charging position, blanking the vent port *y* in the slide valve, thereby preventing further reduction of quick action chamber pressure.

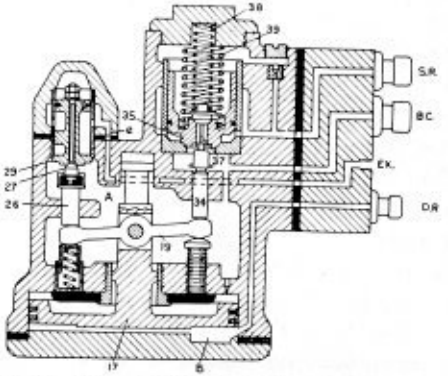

Fig. 38. Type "B" Relay Valve—Lap Position

Brake cylinder pressure continues to build up in chamber *A*, Fig. 38, and on the back of piston 17 until it equals displacement reservoir pressure on the face of this piston (chamber *B*) when springs 39 and 38 return the application piston 35 and its valve 37 to their seats and move stem 34, the right end of lever 19 and piston 17 downward. During this movement the left end of the lever fulcrums on stem 26 and holds the exhaust valve seated. This is lap position in which the relay valve maintains brake cylinder pressure against leakage, as any reduction in pressure in chamber *A* on the back of piston 17 below that in the displacement reservoir on the face of the piston (chamber *B*) causes lever 19 to move upward, opening the application valve 37 and allowing supply reservoir pressure to flow to brake cylinder until the balance is restored.

Release and Recharge after Service Application—Plate 1

During a service brake application, the emergency reservoir remains at the pressure charged previous to the brake application. When brake pipe pressure is increased by moving the locomotive brake valve handle to Release position and the service slide valve returns to release position, port *a1* is disconnected from the exhaust port *Ex.* and connected to auxiliary reservoir air in the piston chamber *C*, through port *a* in the slide valve. Auxiliary reservoir air is thus present on both sides of the release piston 110. The piston spring 116 then moves the release piston and slide valve to the left, the slide valve cavity *Q* connecting the displacement reservoir passage *3* to the exhaust passage *10*, releasing

the brake. Passage *2c* is uncovered by the release slide valve and emergency reservoir air then flows through passages *2*, *2d*, *2a* and *2c* to release slide valve chamber *D* thence to the auxiliary reservoir through passage *5*, at a rate controlled by choke 105 in passage *2a*. This provides for the graduated release and quick recharge features. The quick recharge feature provides positive and prompt release of brakes through the train by recharging the auxiliary reservoirs from emergency reservoirs during initial release and permitting a quicker build-up of brake pipe pressure throughout the train than possible if all recharge were from the brake pipe.

Overcharging the quick action chamber during release and possible undesired operation of the emergency piston is prevented by the spillover check valves 52 and 51, which unseat and allow flow of air from the quick action chamber and emergency slide valve chamber *E* to the emergency reservoir passage *2g* when quick action chamber pressure slightly exceeds that in the emergency reservoir, but prevent against back flow during brake application.

When displacement reservoir pressure on the face of piston 17 (Fig. 36) is reduced, brake cylinder pressure on the back of the piston causes it to move downward and, as the lever 19 is fulcrumed at its right end, moves the left end of the lever downward, allowing exhaust valve 27 to open. This allows brake cylinder pressure to flow past the exhaust valve, thus balancing the pressure on the exhaust piston 29 and allowing it to open easily. This permits brake cylinder pressure in chamber *A* to flow to exhaust through passage *e*. If displacement reservoir

pressure is completely released, brake cylinder pressure will also completely release. If only a partial release of displacement reservoir pressure is made, brake cylinder pressure will continue to flow to exhaust until the pressure on the back of the piston 17 is lower than that on the face, at which time the piston moves upward to lap position, seating the exhaust valve and exhaust piston and cutting off further flow of brake cylinder pressure to exhaust.

Release Insuring—Plates 1 and 3

The release insuring feature operates to positively release the brake in the event that excessive friction prevents prompt movement of the service slide valve to release position after brake pipe pressure has built up in excess of 1½ pounds over auxiliary reservoir pressure. This function is provided by a release insuring valve 129. Chamber *F* on one face of diaphragm 123 of this valve is connected to brake pipe pressure through passage *1c*. Chamber *M* on the other face of the diaphragm is connected to auxiliary reservoir pressure through passage *5c*. Thus, as long as brake pipe pressure does not substantially exceed auxiliary reservoir pressure, the spring 130 keeps valve 129 seated, closing connection between chamber *M* and passage *g1*. In service position of the service slide valve, Plate 3, passage *g1* registers through slide valve ports *b* and *b1* with the slide valve exhaust. Should the service slide valve fail to move to release position when the brake pipe pressure exceeds auxiliary reservoir pressure by more than 1½ pounds, the greater brake pipe pressure overcomes the release insuring spring 130, deflects diaphragm 123 and unseats valve 129,

connecting auxiliary reservoir air from chamber *M* to passage *g1* thence through the slide valve ports *b1* and *b* to the exhaust. This reduces auxiliary reservoir pressure until brake pipe pressure has obtained a sufficient excess to move the service piston to release position. In release position, Plate 1, the slide valve blanks port *b1*, and connects passage *g1* to auxiliary reservoir air in slide valve chamber *C*, (through port *g*), thus equalizing the pressures on the release insuring diaphragm and terminating the release insuring activity.

Graduated Release—Plate 1

If it is desired to reduce the brake cylinder pressure in steps or to "graduate it off," the brake valve handle must be returned to Lap position before the brake pipe pressure has been fully restored. In other words, the brake will be entirely released if the brake pipe pressure is fully restored, but if the pressure is only partially restored, the brake will only partially release.

After the brake pipe pressure has been increased by the initial release so that the service piston and slide valve return to release position, port *a* in the slide valve registers with seat passage *a1*, and auxiliary reservoir air flows to chamber *K* on the spring side of release piston 110. With air pressure on each side thus balanced, the release piston and attached slide valve are returned to release position by spring 116, allowing displacement reservoir air to flow to the atmosphere through passage *3*, cavity *Q* in the slide valve and the exhaust passage *10*.

While brake pipe pressure in chamber *A* on the face of the service piston does not increase after the brake

valve is lapped, auxiliary reservoir pressure in service slide valve chamber *C* is increasing due to air from the emergency reservoir flowing into the release slide valve chamber *D* through passages *2*, *2d*, *2a* and *2c* and thence to service slide valve chamber *C* through passage *5a*. The pressure in chamber *C* consequently becomes greater than brake pipe pressure in chamber *A* acting on the piston face, resulting in movement of piston 93 and graduating valve 99 toward service position until stopped by spring guide 96 contacting with slide valve 98.

In this position, *Graduated Release Lap*, Plate 5, cavity *m* in the graduating valve connects chamber *K* of release piston 110 to the atmosphere by way of passage *a1* and ports *a* and *b* in the slide valve. With no pressure on the spring side of the release piston (chamber *K*), auxiliary reservoir pressure in chamber *D* on the slide valve side moves the release piston and slide valve to the right, cutting off connection between the displacement reservoir passage *3* and the exhaust passage *10*, and blanking the emergency reservoir seat passage *2c*.

With the displacement reservoir passage blanked by the release slide valve, the air remaining in the displacement reservoir is retained and can be released in successive steps by the graduated release operation. The amount of reduction in displacement reservoir pressure for any given graduation depends upon the amount of air pressure which has been restored in the brake pipe. When the auxiliary reservoir has equalized with the emergency reservoir, the service piston remains in release position, no further graduation can be made, and the brake is fully released.

In graduated release lap position, the graduating valve is stabilized against movement to preliminary quick service position by stabilizing spring 95 and thus cuts off connection between slide valve ports *c* (Q.S. Vol.) and *d;* but, if, for any reason, the graduating valve should move far enough to permit cavity *k* to connect these ports, preliminary quick service application is definitely annulled by the limiting valve which closes with approximately 14 pounds displacement reservoir pressure.

As displacement reservoir pressure is reduced the "*B*" relay operates to reduce brake cylinder a like amount in the manner already described.

Emergency Position—Plate 6

When an emergency rate of brake pipe reduction takes place from any cause, quick action chamber pressure cannot reduce through the vent port *t* in the emergency graduating valve 30 and port *y* in the slide valve to atmosphere at the same rate; therefore, sufficient differential is built up across the emergency piston to compress spring 49 and allow the graduating valve 30 to move far enough on the slide valve to uncover port *t1* in the slide valve which registers with port *t2* in the seat, allowing quick action chamber air to flow to the face of vent valve piston 42. The resulting movement of this piston unseats the vent valve 40, opening a large and direct passage from brake pipe passage *1b* to atmosphere. The rapid venting of brake pipe air causes an emergency reduction rate of brake pipe pressure to pass serially and rapidly through the train, due to the same

operation of connected valves, and insures the prompt movement of valves on other cars to emergency position.

The rapid reduction of brake pipe pressure causes the emergency piston and slide valve to move to the extreme right position, which carries slide valve port *t1* out of register with seat port *t2*, but port *t2* is now uncovered by the slide valve so that quick action chamber pressure remains connected to the vent valve piston.

The emergency slide valve now connects the spring side of emergency valve 44 to the exhaust port *Ex.*, through passage *h1* and a cavity in slide valve 29. This vents air pressure from the spring side of the emergency valve, and emergency reservoir air in passage *2*, acting on the outer area of the face unseats this valve, permitting emergency reservoir air to flow through passages *3e*, *3c* and *3* to the displacement reservoir. Meanwhile, the emergency rate of reduction in brake pipe pressure has caused the service piston and slide valve to move to the extreme left where the graduating valve uncovers the service port *f*, through which auxiliary reservoir air flows into passage *3b* and to the displacement reservoir passage *3*, combining with the flow from the emergency reservoir.

As both the emergency reservoir and the auxiliary reservoir thus equalize into the displacement reservoir during emergency, and the safety valve passage *s1* is blanked by the emergency slide valve, a higher displacement reservoir pressure is obtained than is possible from a full service application.

While quick action chamber air is reducing through choke 20 in vent valve piston 42 and choke *z* in the body,

the rate of exhaust is such that the vent valve will remain open a definite time until the pressure is reduced to a certain value, when spring 39 will reseat the vent valve. The purpose of this is threefold—first to insure transmission of quick action, second to prevent release of an emergency brake application before the train is at rest (in order to avoid possible damage to the train), and third, to insure closure of the exhaust so that the brake pipe pressure can be restored when desired.

The "*B*" relay valve operates as described under "Service" to develop pressure in the brake cylinders equal to that in the displacement reservoir.

Release After Emergency Application

Accelerated Release Position—Plate 7

When brake pipe pressure on the face of the emergency piston is restored after emergency application, the piston moves to the left, compressing accelerated release spring 63, and the emergency slide valve connects emergency reservoir pressure to the spring side of the emergency valve, through cavity *h* in the slide valve and seat passages *2e* and *h1*. With air pressure thus balanced on the emergency valve, spring 47 moves the valve to its seat, cutting off the supply of emergency reservoir air to the displacement and auxiliary reservoirs, and no further change takes place in emergency reservoir pressure (after emergency application) until the service slide valve moves to release position and connects this pressure to the auxiliary reservoir (by returning the release piston and slide valve to release position).

With the emergency slide valve in accelerated release position, the displacement reservoir is connected to the underside of ball check 51a and rubber seated check valve 52a, through passages *3c*, *3e* and *3f*, cavity *S* in the slide valve and passage *3g* in the seat.

Since the displacement reservoir and the auxiliary reservoir are connected, through port *f* in the service slide valve (which is still in service position), the pressure of these combined volumes under check valves 51a and 52a is greater than brake pipe pressure above from passage *1g*. Both check valves are, therefore, unseated and combined displacement reservoir and auxiliary reservoir air is permitted to flow through passages *1g* and *1b* into the brake pipe until these pressures are within a few pounds of equalization, thus providing a quick, serial initial build-up of brake pipe pressure.

Since auxiliary reservoir pressure is being partially reduced while the brake pipe pressure is being initially built up throughout the train, the development of that brake pipe pressure needed to release the brakes is accomplished much sooner than it would be by raising brake pipe pressure through the brake valve alone and, therefore, a very prompt and positive release of the brake is accomplished.

The quick action chamber is being charged through the charging choke 27. Return spring 63 will move the emergency piston and slide valve from accelerated release to charging position as soon as the pressures on both sides of the emergency piston become substantially equal. This slide valve movement blanks port *3g* in the seat thereby preventing further flow of displacement res-

ervoir air past the accelerated release check valves to the brake pipe. The accelerated release check valves seat and prevent brake pipe air from flowing to the displacement reservoir in case the emergency slide valve is forced to accelerated release position when displacement reservoir pressure is lower than brake pipe pressure.

When brake pipe pressure becomes slightly in excess of auxiliary reservoir pressure the service piston and slide valve are moved to release position and the brake will be released and reservoirs recharged as previously described under "Release and Recharge after Service Application."

Duplex Release Valve

A duplex release valve is attached to the service portion by means of which the auxiliary reservoir air may be drained alone or both auxiliary and emergency reservoir air may be drained at the same time.

The release valve handle 160, Plate 1, may be moved in any direction to open the release checks. The plunger 152 has two stems which are lifted to unseat the release checks 155 and 155a when the handle is moved. There is less clearance between auxiliary reservoir release check 155 and its plunger stem than between emergency reservoir release check 155a and its stem. Therefore, if handle 160 is moved part way the auxiliary reservoir release check 155 is lifted from its seat and the reservoir is drained without opening the emergency reservoir release check 155a. If handle 160 is moved its full travel both release checks are unseated and both reservoirs drained.

INSTALLATION AND MAINTENANCE

All the pipe connections are permanently made to the control valve pipe bracket and no pipes need be disconnected to remove the operating portions of the valve, loosening the bolts which hold them in place being all that is required. The bracket should be installed as near the brake pipe as possible so that the branch pipe may be short; short bends in the piping should also be avoided. Care should be taken in locating the valve to have it free from obstructions which would render inspection or removal difficult. The control valve should be placed above the general level of the piping and the piping itself so arranged as to avoid pockets in which moisture may collect. If this point does not receive proper attention, trouble may be experienced in cold weather from the freezing of water in the pipes or even in the valve.

Before installing the control valve, all the piping should be thoroughly hammered and blown out, in order to loosen and remove all scale or foreign matter. This is especially important in new installations. A suitable compound to make a tight joint should be applied on the male threaded portion only, and never in the socket. Do not use red or white lead. After the piping is complete, all the joints should be thoroughly tested under pressure with soapsuds and made air-tight.

Never remove the operating parts of the control valve while on the car. If one of the portions of the valve is not working properly, or needs cleaning and lubricating, take it down and replace by a portion in good condition. All cleaning and lubricating should be

done at a bench, by a competent man, where the liability of damage to the internal parts of the valve is least. Any attempt to remove the moving parts of the valve while still on the car is almost sure to result in a large percentage of valves being injured by careless handling or dirt getting inside the pipes or valve.

LUBRICATION

Control Valve—Service Portion

The piston, slide valve, graduating valve, and bushings must be thoroughly cleaned so as to remove all dirt, oil, gum or grease. Benzine, gasoline or other approved cleaning fluid can be used for this purpose.

The piston packing ring and its groove should be cleaned without removing the ring from the piston groove. This can be done by dipping the piston in the cleaning fluid and then moving the ring around in the groove. This operation should be repeated until the groove and ring are thoroughly cleaned, after which the excess cleaning fluid can be blown away or dried by using an air jet.

Where rings are stuck with dirt too tightly to be moved in the groove, it may be necessary to soak the ring in penetrating oil and then tap the ring gently with a hard wood block. For this purpose a maple or hickory wooden block about 1" x 1" x 4" (with square ends) should be used to tap the ring so as to drive it flush with the top edge of the groove. This tapping should start at one side of the ring joint and progress around the piston in short steps until the ring is loosened sufficiently to be moved in the groove. If this procedure will not loosen the ring, it is

evidence that the groove is binding in which case the groove must be reconditioned and a new ring fitted.

The face of the graduating valve, the upper surface of the slide valve (which is the graduating valve seat), the slide valve seat and the upper portion of the bushing (slide valve spring bearing) must be glazed with the best grade of very fine pure dry air brake graphite.

To apply the graphite, it will be found convenient to use a small wooden paddle about 8" long having a small piece of chamois skin glued to the paddle end. The width of this paddle must be somewhat less than the width of the slide valve seat in the bushing. Place a small quantity of the graphite on the chamois skin and rub the surfaces specified until they show a dark copper color. There must be no free graphite allowed to remain on the valves or seats and they must be free from any oil or grease before the graphite is applied.

Before the cleaned piston is replaced in the piston bushing, press the side of the packing ring opposite the scarf to the bottom of its groove, then introduce three drops of approved triple valve oil in the groove through the ring scarf opening, after which restore the ring to its normal position and carefully rotate it in its groove to distribute the oil. Next, place three drops of the triple valve oil in the clean, dry bushing and distribute it over the entire surface in a manner to avoid introducing dirt or other grit. Then insert the piston and slide valve in the body, leaving them in release position, after which place three additional drops of triple valve oil in the cylinder bushing and again distribute it on the bushing surface as previously described.

The preceding instructions also apply to the Release Piston and its slide valve.

Control Valve—Emergency Portion

When the emergency portion is to be dismantled for cleaning, the main piston can not be removed without first removing the upper cover and taking out the diaphragm strut which serves to hold the slide valve to its seat. Damage will result if force is used to remove the emergency piston from its bushing without first removing the diaphragm strut.

The spring behind the emergency vent valve is held in place by a circular sheet metal retainer which has lugs on two opposite sides. These lugs engage under a lip around the outer end of the cavities in the body casting. To remove the spring and valve, press down on the spring retainer and tilt it so that one lug is exposed upward. When in this position, the parts can be readily removed and they can be reassembled by using the same method.

The individual parts of the emergency portion, such as pistons, rings, bushings, valves, springs and gaskets, must be cleaned and inspected in the same manner as was specified for similar parts of the service portion.

Type "UA" Brake Cylinders

Remove the upper $\frac{1}{8}$" pipe plug from the pressure end of the cylinder. Attach an approved pressure gun to this connection and inject about $2\frac{1}{2}$ cubic inches of brake cylinder lubricant. Replace the $\frac{1}{8}$" pipe plug.

Remove the $\frac{1}{8}$" pipe plug at the outer end of the non-pressure head. Attach pressure gun and inject about $1\frac{1}{4}$ cubic inches of brake cylinder lubricant. This will lubricate the piston rod bearing and dirt protection seal in the non-pressure head. Replace the $\frac{1}{8}$" pipe plug.

When a cylinder has been re-lubricated and check tests show objectionable leakage, the cylinder must be dismantled and the fault determined and remedied. It is recommended that cleaning and re-conditioning the piston and non-pressure head assembly be done in a clean room where special tools for this purpose are available, and the work can be done without the possibility of damage to the parts which might occur if this work is attempted at the car. Protection against dirt should be provided during the movement of these parts from the repair shop to the car, and care exercised to keep dirt from the piston when applying to the cylinder.

When a cylinder is dismantled, the packing cup must be removed, cleaned and inspected. If there are any cuts or deep scratches on the packing bearing surface, or packing is worn so that it does not hold a proper bearing surface on the cylinder wall, it should be replaced. The WABCO packing cup covers the entire piston and is designed so that it snaps on the piston and is held in place by a bead on the piston which fits into a groove around the non-pressure side of the packing. When applying the packing cup to the piston, one side of the packing should be held slightly away from contact with the piston to allow escape of air from under the packing just before it is finally snapped into place. This

is to prevent an air pocket forming between the packing and the piston head, which might prevent a proper fit of the packing on the piston.

Before the packing is replaced or re-applied, the felt swab of the lubricator assembly on the piston should be carefully cleaned by brushing, and also re-lubricated by soaking the unit in oil. If visual inspection indicates that the swab would not have full contact with the cylinder wall, as will be the case if the felt does not extend evenly above the holder, the swab should be adjusted to provide proper contact. This may be accomplished by inserting a tool with thin blade between the felt and the holder, running this tool around the edge of the swab and prying up the felt whenever necessary. The cylinder also must be cleaned so as to remove all dirt and old lubricant, and the walls re-lubricated with an approved brake cylinder lubricant. The groove between the packing cup and the felt swab must be filled with lubricant, and a light coating of lubricant spread over the bearing surface of the packing before the piston is returned to the cylinder.

The release spring must be inspected and, if necessary, be cleaned so as to remove any rust or dirt adhering to it which might later find its way to the cylinder walls. If the spring has shown any rust spots, after cleaning, it should be given a coating of approved rust preventive.

The hair strainer and piston rod seal rings in the non-pressure head must be dismantled, inspected and cleaned. The strainer can be removed from the inside of the non-pressure head, being held in place by a spring. By closing the ends of the spring, the strainer is released for removal.

If the piston rod or metallic rings are worn so that they are not a close fit on the piston rod, new parts must be applied. To properly apply the piston rod protection swab and metallic rings, it is necessary to have the piston rod in the non-pressure head and the release spring in place; therefore, a holding device should be used for this purpose. The felt swab is held in contact with the piston rod by a circular spring wire around the outer diameter of the swab. Care must be taken to know this spring is properly located. This may be easily accomplished by using a sleeve about 6" long having an inside diameter which is a loose fit over the piston rod, and an outside diameter slightly larger than the outside diameter of the felt swab. Another sleeve about 3½" long with an inside diameter which is a sliding fit over the long sleeve is used. After placing the felt swab over the piston rod and in the ring cavity in the non-pressure head, the spring wire is placed over one end of the long sleeve and this end of the sleeve put over the piston rod and in contact with the felt swab. The short outer sleeve is then moved along the long sleeve so that the spring wire is forced off the long sleeve. This places the spring wire in its proper position around the felt swab to hold it in contact with the piston rod.

Before applying a reconditioned piston and non-pressure head assembly, the cylinder must be cleaned so as to remove all dirt and the old lubricant, and the cylinder wall re-lubricated as previously stated.

General Hints

In releasing an individual brake by means of the duplex release valve on the service portion of the control valve, the brake pipe being charged, pull the handle only far enough to open the auxiliary reservoir check but not far enough to open the emergency reservoir check, and then permit auxiliary reservoir pressure to drain only until the brake cylinder exhaust is heard to start.

When there is no air in the brake pipe, drain both auxiliary and emergency reservoirs by pulling the duplex release valve handle its full travel and holding both check valves open until all pressure is depleted.

A cut-out cock which vents brake cylinder pressure when closed is installed in the brake cylinder pipe to each truck. This provides for adjustment of piston travel or brake shoe renewal without the necessity of cutting out the brake by bleeding reservoirs in order to protect against injury due to unexpected brake applications. Thus, the brake on one truck of a car may be cut out if necessary, due to defective brake rigging without affecting normal brake operation on the other truck.

When it is found necessary to cut out the brake on a car, close the branch pipe cut-out cock (which is combined with the dirt collector) and drain both auxiliary and emergency reservoirs by pulling the duplex release valve handle its full travel and holding until the pressure is depleted.

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LIST OF ILLUSTRATIONS (Continued)

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Plate 1. Release Position—D-22-A Control Valve
(Cut No. 28110)

Plate 2. Preliminary Quick Service Position—D-22-A Control Valve
(Cut No. 28120)

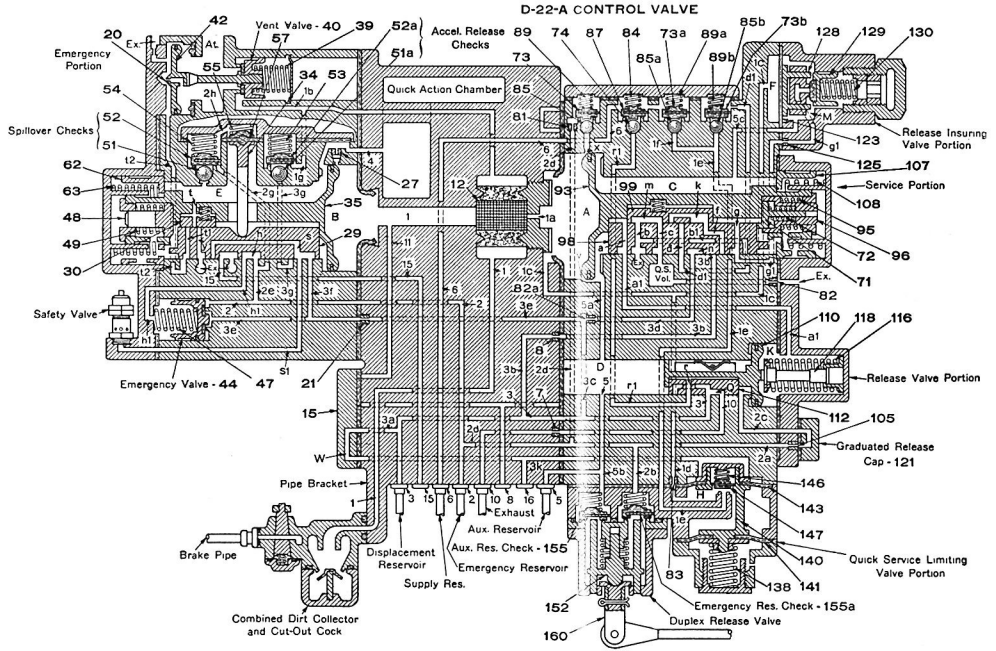

Plate 1. Release Position—D-22-A Control Valve
(Cut No. 28119)

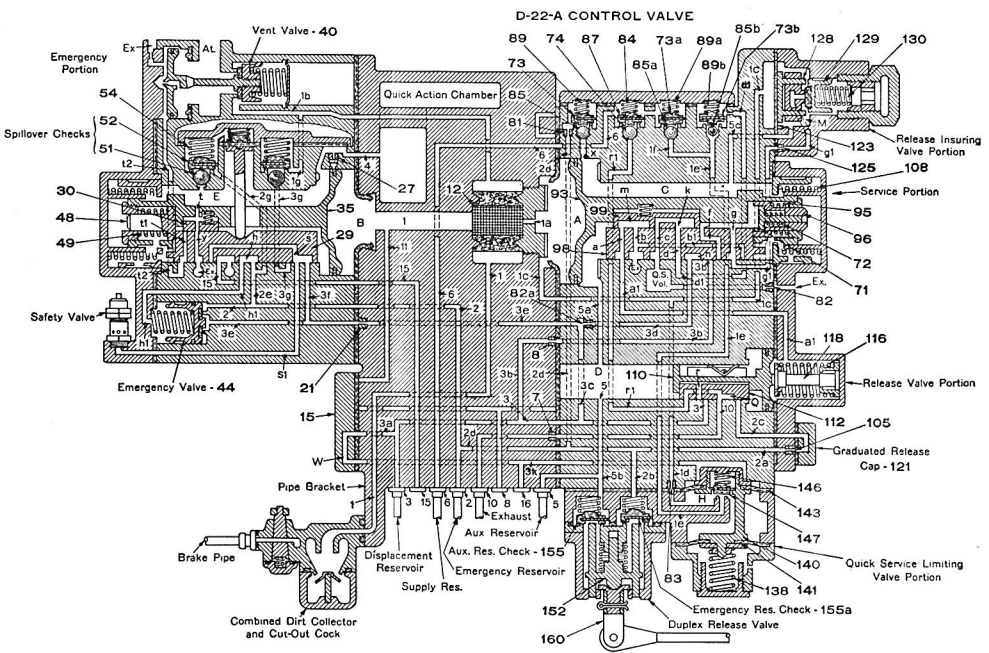

Plate 2. Preliminary Quick Service Position—D-22-A Control Valve
(Cut No. 28120)

Plate 3. Service Position—D-22-A Control Valve (Cut No. 28121)

Plate 4. Service Lap Position—D-22-A Control Valve (Cut No. 28122)

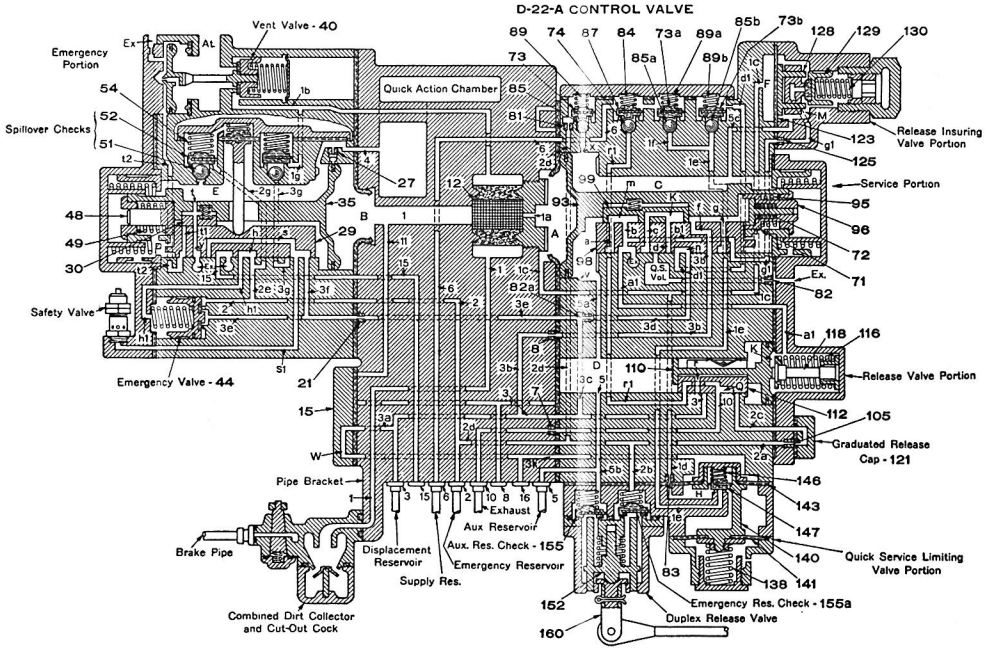

Plate 3. Service Position—D-22-A Control Valve
(Cut No. 28121)

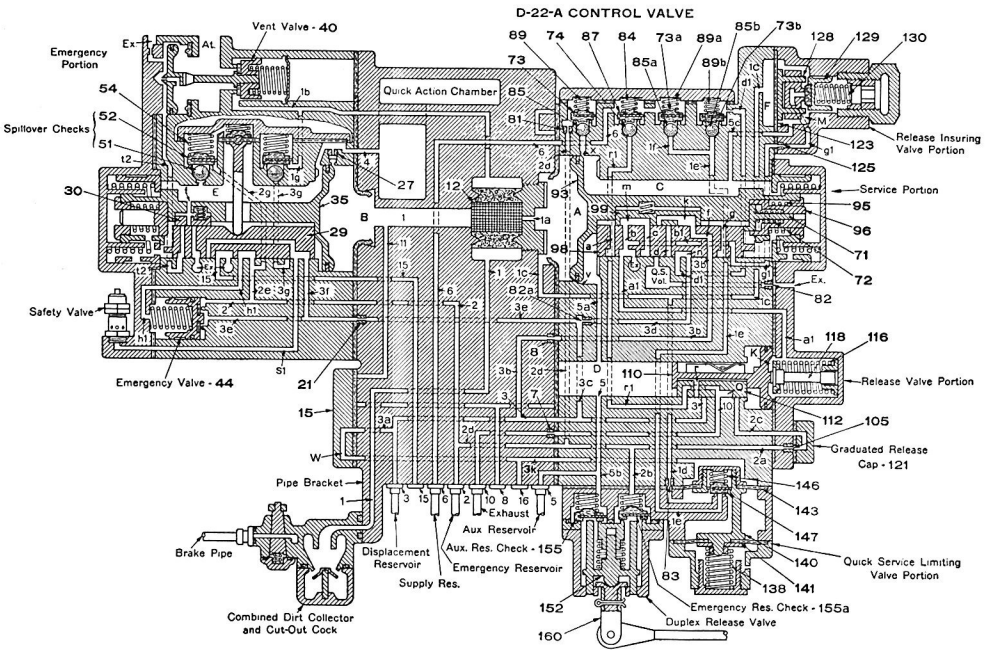

Plate 4. Service Lap Position—D-22-A Control Valve
(Cut No. 28122)

Plate 5. Graduated Release Lap Position—D-22-A Control Valve (Cut No. 28123)

Plate 6. Emergency Position—D-22-A Control Valve (Cut No. 28124)

Plate 7. Accelerated Emergency Release Position D-22-A Control Valve (Cut No. 28125)

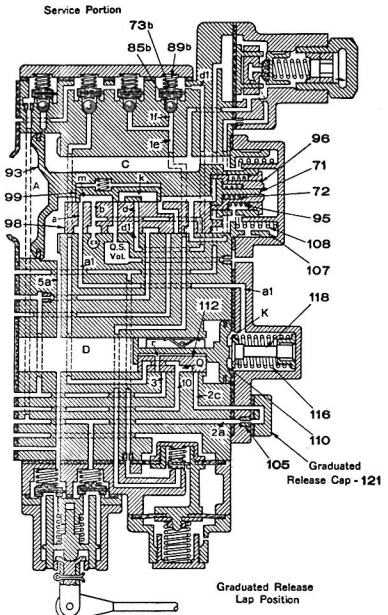

Plate 5. Graduated Release Lap Position—D-22-A Control Valve
(Cut No. 28123)

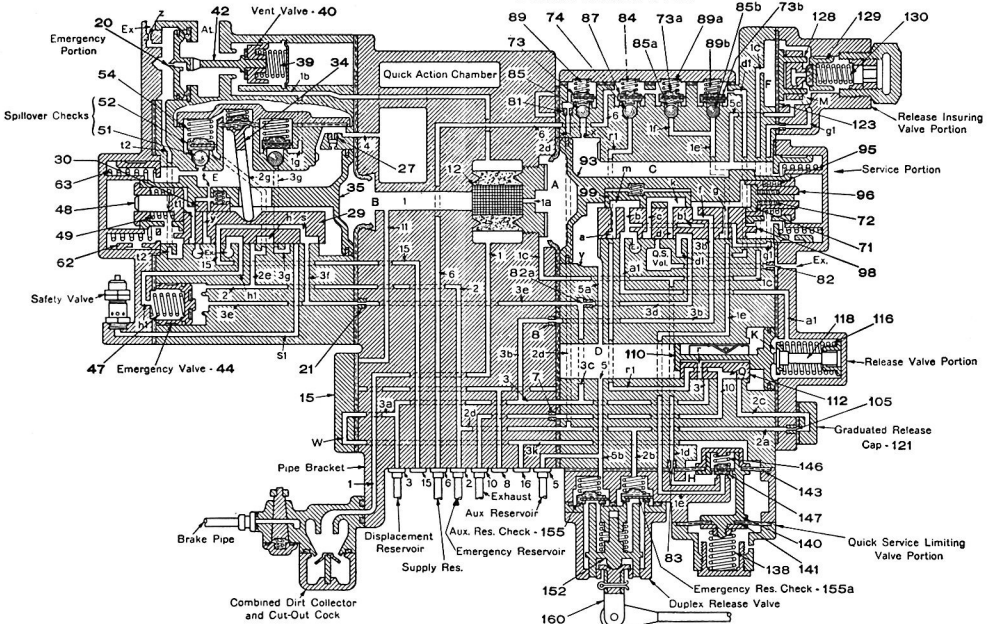

Plate 6. Emergency Position—D-22-A Control Valve
(Cut No. 28124)

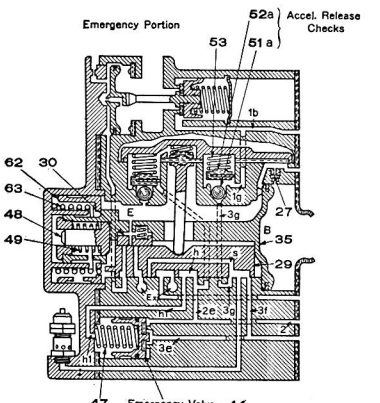

Plate 7. Accelerated Emergency Release Position
D-22-A Control Valve
(Cut No. 28125)

Plate 8. Piping Diagram of the D-22-A Passenger Car Brake Equipment (Cut No. 28134)

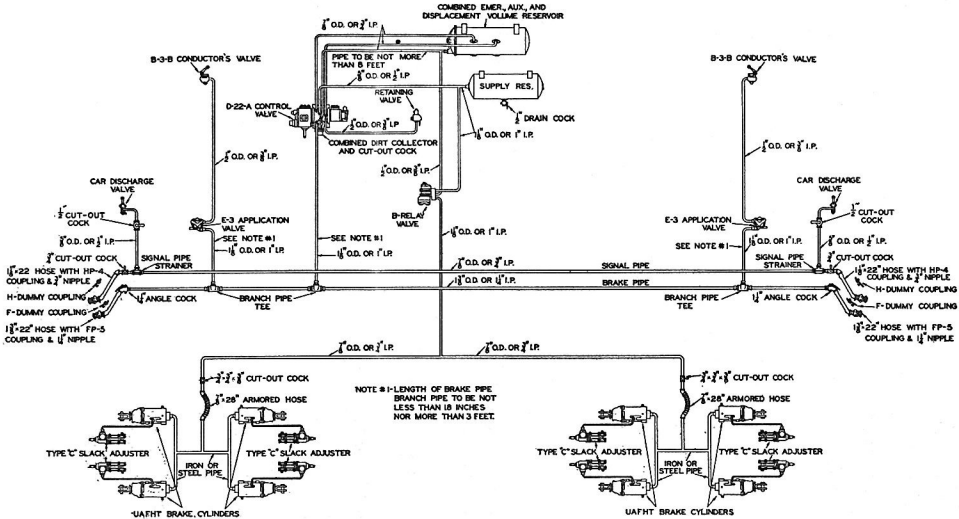

Plate 8. Piping Diagram of the D-22-A Passenger Car Brake Equipment
(Cut No. 28134)