INSTRUCTION LEAFLET

No. 2606-1

SEPTEMBER, 1955

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OPERATING INSTRUCTIONS
24-RL
LOCOMOTIVE
BRAKE EQUIPMENT

★

Westinghouse Air Brake
COMPANY
AIR BRAKE DIVISION WILMERDING, PA.

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24-RL LOCOMOTIVE BRAKE EQUIPMENT

The 24-RL Brake Equipment is a basic locomotive equipment which can be converted for use in any type of freight or passenger service by adding the necessary parts without disturbing the basic equipment or piping.

The equipment described in this pamphlet is for steam, diesel, diesel-electric and electric road locomotives. It is furnished with the following desirable features:

1. Pressure maintaining brake valve (optional).
2. Self-lapping independent brake valve.
3. Controlled release.
4. Safety control (optional).
5. Overspeed control (optional).
6. Automatic split reduction during train control-stop, safety control and overspeed applications on long trains (with service application portion).
7. Automatic power cut-off and sanding during emergency (optional).
8. Manually controlled sanding (optional).
9. Train control (optional).
10. High emergency braking forces.
11. Electro-pneumatic control (optional).
12. Speed governor control (optional).
13. First Service Position.

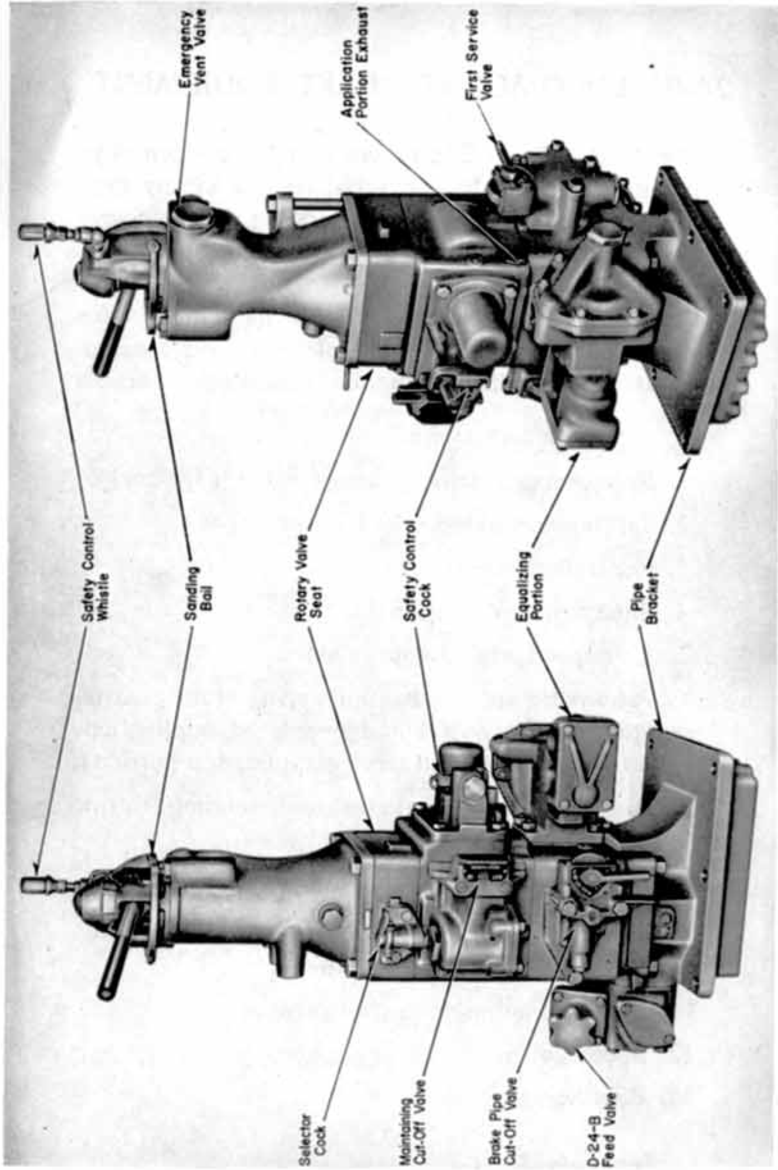


Fig. 1. DS-24-HM Brake Valve

As in former designs the locomotive brake may be used with or independently of the train brakes. The locomotive brake may be applied with the independent brake valve to any desired pressure between minimum and maximum. This pressure will be automatically maintained in the locomotive brake cylinders, regardless of leakage and of variation in piston travel, until released by the brake valve.

D-24 TYPE BRAKE VALVES

The D-24 type brake valve is designed to meet the fundamental requirements of railroad service. To this basic design can be added features that will meet any requirements.

All portions are designed to permit easy removal for inspection and repair. Complete removal of the portions can be made with only the pipe bracket portion remaining in place. All pipe connections are made to this pipe bracket, thereby eliminating considerable piping and providing a more compact cab installation.

Figs. 1 and 2 illustrate how the brake valve is assembled to incorporate the features available with the D-24 type brake valves. A service application portion is used when safety control, overspeed and train control are desired; a blank application portion is used when none of these controls are desired.

There are two basic D-24 type brake valves—the D-24 and D-24-M. The D-24 is a pedestal brake valve

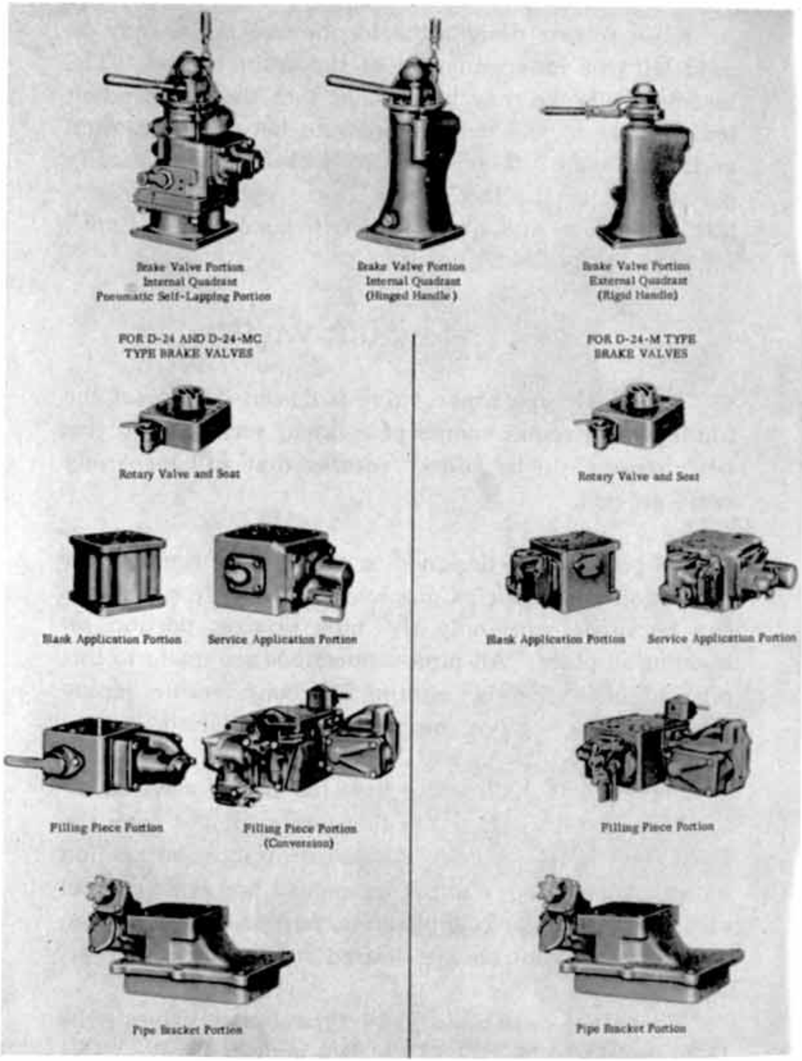


Fig. 2. Brake Valve Portions

with external quadrant arranged for diesel locomotive installation. It has a rigid, removable handle and a blank application portion. The independent brake valve is mounted separately.

The D-24-M is the same as the D-24 except that it is a pressure maintaining brake valve. Pressure maintaining makes possible many operating improvements in both level and grade braking. It can be cut out both manually and automatically. In addition, the D-24-M type brake valves have design changes which improve brake valve operation and reduce maintenance costs.

The following letters indicate changes from the basic types:

PREFIX LETTERS

S Service application portion for use in train control (stop and speed), safety control and overspeed control.

E Electro-pneumatic brake valve portion, which includes a self-lapping portion and has internal quadrant.

SUFFIX LETTERS

H Hinged handle and internal quadrant with provision for operating sander and suppressing safety control by depressing the handle.

M Pressure Maintaining.

MC Indicates D-24 type Brake Valve which has been converted to pressure maintaining type by substituting a different filling piece portion for the conventional one.

PORTIONS OF THE BRAKE VALVE

Brake Valve Portion: The brake valve portion is available in several designs. The hinged handle type, with internal quadrant, permits manual sanding, as well as hand control for suppressing a safety control operation. The rigid handle has an external quadrant which does not include provisions for either manual sanding or hand-controlled suppression of safety control. With each of these brake valves, a design incorporating a self-lapping portion for electro-pneumatic control, and a shifter lever to provide option of automatic or electro-pneumatic operation, can be obtained. On electro-pneumatic brake valves with rigid handle, the external quadrant is for guide purposes and the internal quadrant positions the handle.

The rotary valve seat portion contains the seat for the rotary valve to connect the various ports and passages in accordance with brake valve handle position. An attached selector cock provides either controlled or main reservoir air supply when charging in brake valve handle Release Position.

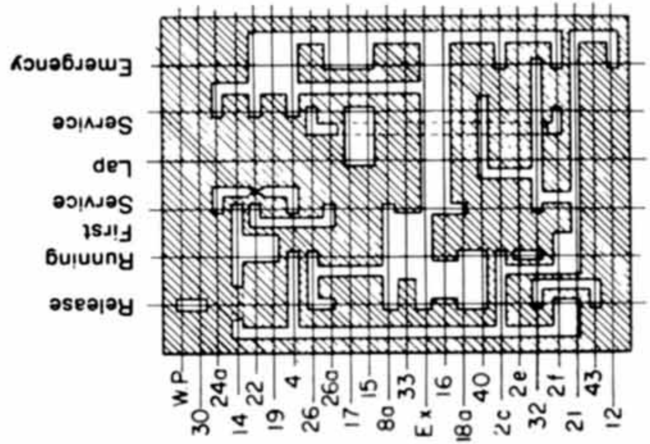
The D-24-and D-24-MC type brake valves use the same rotary valve seat portion, which differs from the rotary valve seat portion of the D-24-M type brake valve.

Application Portion: The service application portion provides a service application when initiated by a train control, overspeed or safety control operation. A blank application portion, which is a cored filling piece, is used when these controls are not wanted.

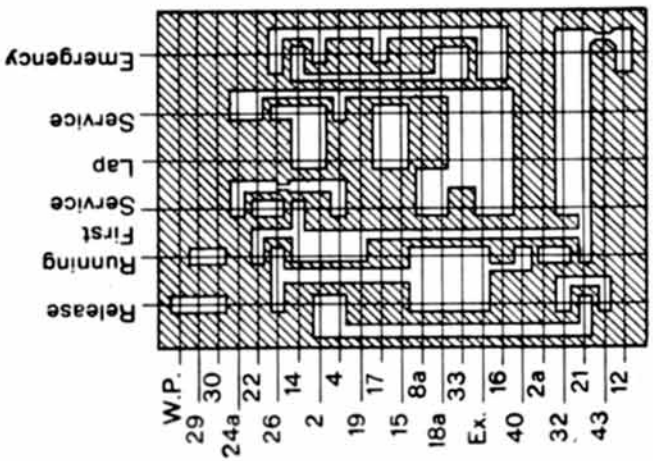
The service application portions used with the DS-24 and DS-24-MC type brake valves are identical. However, they are not interchangeable with the service application portion of the DS-24-M type brake valves. On the latter, the service application portion has a diaphragm, as well as a piston and ring, in order to eliminate the effects of ring leakage. It also has an attached maintaining cut-off valve which manually cuts in or out the pressure maintaining feature. Cut-off valve 843, which cuts off the supply connection between the automatic brake valve and the brake pipe during a "penalty" application, has "O" rings instead of piston rings. Valve 843 also functions to actuate an automatic cut-off of pressure maintaining during penalty brake applications or train-initiated emergencies in which the service application portion is actuated.

The blank application portions used on the D-24 and D-24-MC type brake valves are identical. The blank application portion of the D-24-M type brake valves is cored differently and has attached to it the maintaining cut-off valve.

Filling Piece Portion: There are three types of filling piece portions with no interchangeability among them. The filling piece portion of the D-24 type brake



-24-M Brake Valve



D-24 Brake Valve

Fig. 3. Rotary Valve Development

valves has a first service cock for cutting out first service operation of the brake valve. A brake pipe cut-out cock cuts out the automatic brake valve and the functions of the application portion on trailing A units when operating in multiple unit service and on the second locomotive when double heading. An attached equalizing portion controls the rate of brake pipe reduction when the brake valve handle is in either Service or First Service Position.

The filling piece portion of the D-24-M type brake valves functions as explained above but contains a number of improvements. The first service valve (equivalent to first service cock on the D-24 type brake valves) is a spool valve with "O" rings. Suppression in the First Service Position is controlled through this valve and is cut out when the First Service function is not used. The brake pipe cut-off valve (equivalent to brake pipe cut-out cock on the D-24 type brake valves) has "O" rings and the valve itself is larger in order to provide more flow capacity. The attached equalizing portion has a diaphragm, instead of a piston and ring, in order to insure against leakage from brake pipe to equalizing reservoir.

The filling piece portion of the D-24-MC type brake valves has all the refinements mentioned above. However, it differs in that the maintaining cut-off valve is attached. Cut-off valve 843 in this filling piece functions to actuate an automatic cut-off of pressure maintaining during penalty brake applications or train-initiated emergencies in which the service application portion is actuated.

Pipe Bracket Portion: All the pipe connections are made at the pipe bracket portion, which permits removal of any other brake valve portion without disturbing the piping. The feed valve is attached to this portion.

The pipe bracket portions of the D-24 and D-24-MC type brake valves are identical.

The pipe bracket portion of the D-24-M type brake valves has several changes. The No. 40 line is for emergency power knockout when the electro-pneumatic brake is being used. An H-5-A RELAYAIR® Valve is necessary in conjunction with this feature. The No. 2 pipe has been added to the bottom of the pipe bracket face to provide a brake pipe connection to the suppression valve.

S-40-F INDEPENDENT BRAKE VALVE

The independent brake valve is of the self-lapping type. The locomotive brake can be applied by movement of the brake valve handle forward in the Application Zone, or decreased by movement of the handle back toward Release. The brake application can be increased or decreased in this manner without fanning because the lapping function is a built-in feature of this type of brake valve. Leakage is automatically maintained by the self-lapping portion, which insures that the brake will not release due to leakage.

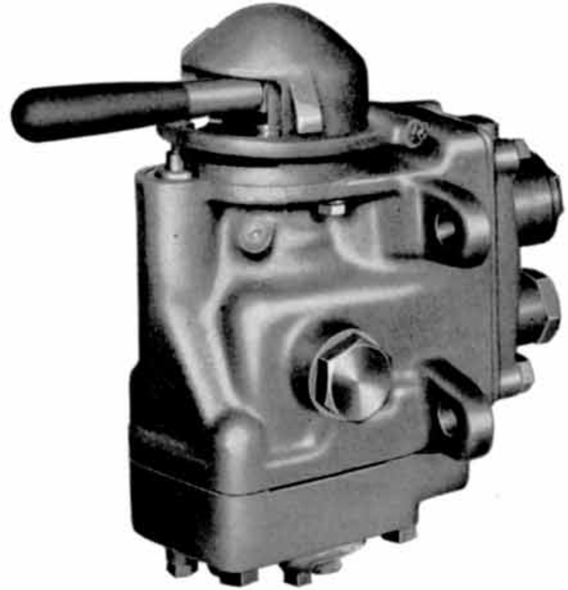
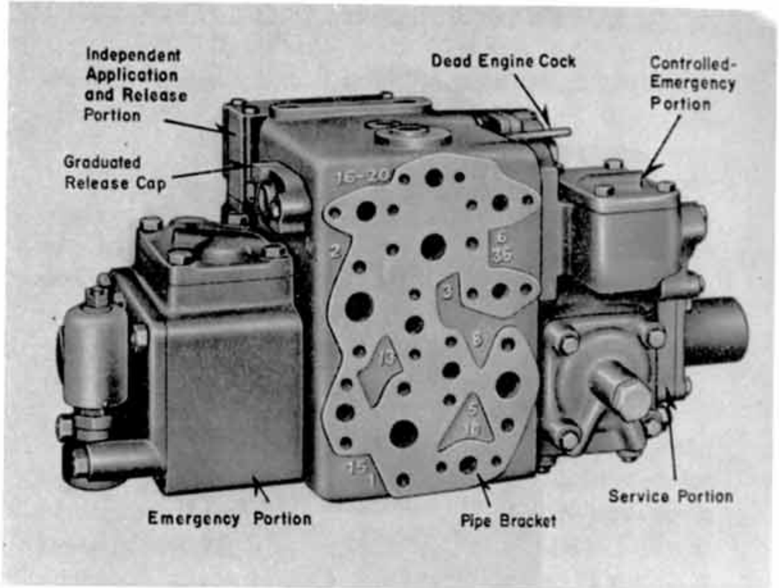


Fig. 4. S-40-F Independent Brake Valve

The S-40-F Brake Valve provides a gradual increase or decrease of braking pressures with increased smoothness as well as maintaining of pressure.

D-24 CONTROL VALVE

The D-24 Control Valve, Fig. 5, when actuated by the brake valve, charges, applies and releases the brakes of the locomotive. It includes an independent application and release portion, a dead engine cap or cut-out cock, a controlled-emergency portion, service portion, emergency portion and controlled-emergency cut-out



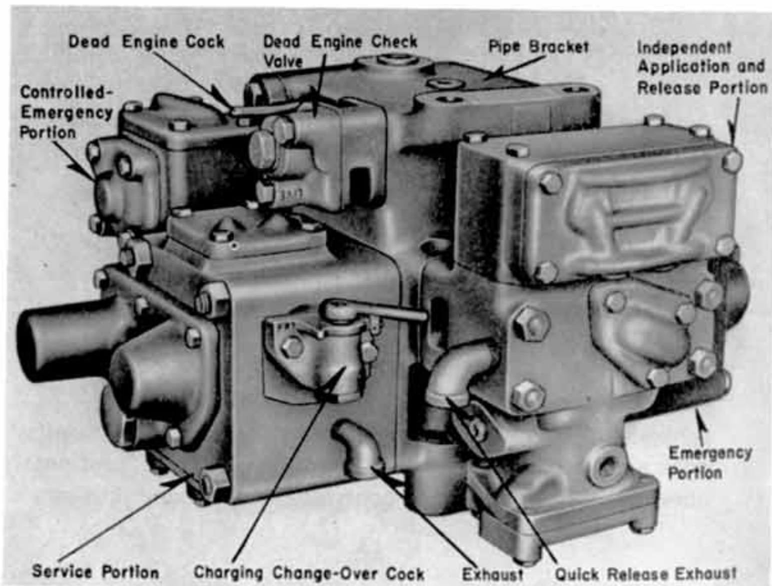


Fig. 5. D-24 Control Valve Exterior Views

cock on B units when necessary. Provision is made for the dynamic interlock portion to be added when dynamic braking is to be used.

The emergency portion makes the need of a brake pipe vent valve unnecessary. Automatic sanding can be provided in emergency regardless of how the emergency originates. A quick release of locomtive brakes can be made by depressing the independent brake valve handle.

TYPE H-24 RELAYAIR® VALVE UNIT

(Four-Face Bracket)

The type H-24 **RELAYAIR** Valve Unit, Fig. 6, is made up of a bracket upon which four **RELAYAIR** Valves can be mounted. When **RELAYAIR** Valves are omitted, they are replaced with blanking plates, as illustrated.

CUT-OFF VALVE

(1) The Cut-Off Valve operates to suppress a safety control application when the brake is applied with about 30 pounds pressure in relay valve control pipe 16. The Cut-Off Valve also provides permanent suppression when used with the overspeed suppression valve.

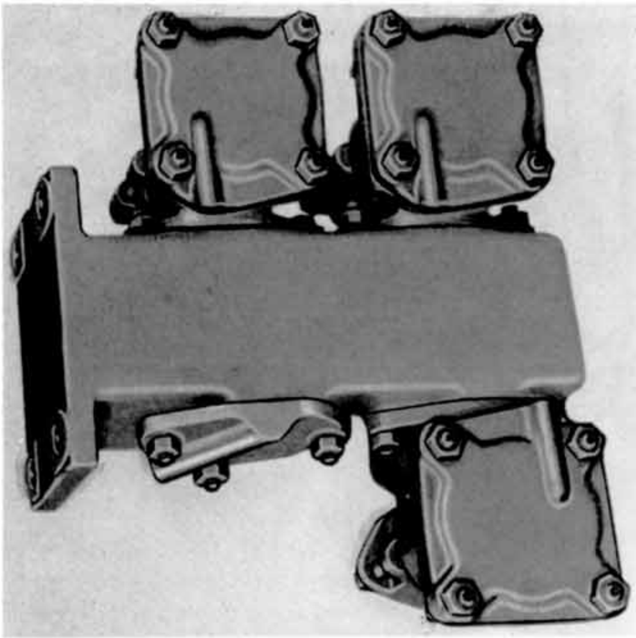


Fig. 6. H-24-C RELAYAIR® Valve Unit

OVERSPEED APPLICATION VALVE (3) The Overspeed Application Valve operates to cause a brake application (unless suppressed) when overspeed occurs, causing the overspeed feature to operate.

OVERSPEED SUPPRESSION VALVE (4) The Overspeed Suppression Valve operates to suppress an overspeed brake application when the brake valve handle is placed in First Service Position. This will cause a 20 second suppression, after which time the brake valve must be placed in Service Position for further temporary suppression, or the speed must be reduced below the maximum speed allowed. About 15 pounds service reduction will cause permanent suppression by operating the Cut-Off Valve.

Valves 1 and 3 are interchangeable. Valve 4 operates at a different pressure, requiring another type of spring. The valve and bracket each have a dowel pin and a dowel pin hole which prevent improper assembly on the bracket.

TYPE H-24 RELAYAIR® VALVE UNIT

(Five-Face Bracket)

This type H-24 RELAYAIR Valve Unit, Fig. 7, is made up of a pipe bracket upon which five **RELAY-AIR®** Valves can be mounted. Valves which are omitted are replaced with blanking plates.

CUT-OFF VALVE (1) The Cut-Off Valve operates to suppress a safety control application when the brake is applied with about 30 pounds pressure in relay valve control pipe 16.

OVERSPEED APPLICATION VALVE (3) The Overspeed Application Valve operates to cause a brake application (unless suppressed) when overspeed occurs, causing the overspeed feature to operate.

OVERSPEED SUPPRESSION VALVE (4) The Overspeed Suppression Valve operates to suppress an overspeed brake application when the brake valve handle is placed in First Service Position. This will cause a 20 second suppression, after which time the brake valve handle must be placed in Service Position for further temporary suppression, or the speed must be reduced below the maximum speed allowed.

SANDING VALVE (5) The Sanding Valve operates from the D-24 Control Valve

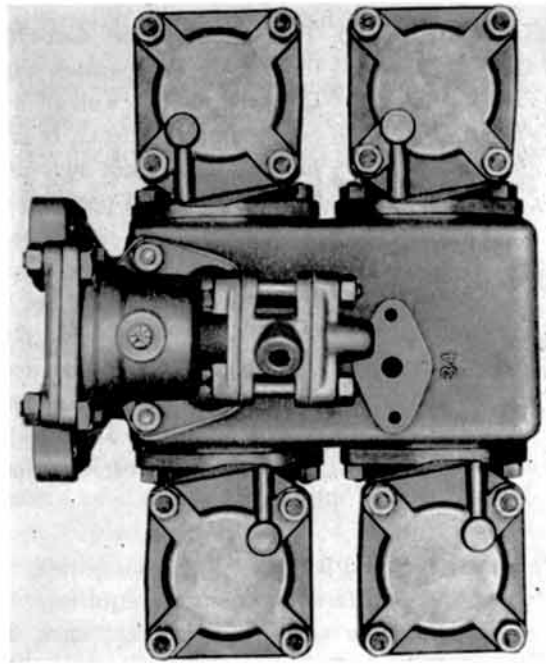


Fig. 7. HA-24-C RELAYAIR® Valve Unit

during an emergency application and permits the flow of air to the sanders. It also operates the Brake Pipe Cut-Off Protection Valve to provide the broken pipe protection feature.

BRAKE PIPE CUT-OFF PROTECTION VALVE (6) The Brake Pipe Cut-Off Protection Valve operates when the D-24 Control Valve assumes emergency position. It provides protection against loss of main reservoir air and possible release of brakes from an emergency application started from the train with the brake valve handle remaining in Running Position. This valve does not protect against the loss of main reservoir pressure caused by a broken main reservoir equalizing pipe.

Valves 1, 3, 5 and 6 are all interchangeable. Valve 4 operates at a different pressure, requiring another type of spring. The valve and bracket each have a dowel pin and a dowel pin hole which prevent improper assembling on the bracket.

K-2 ROTAIR® VALVE

The K-2 ROTAIR Valve, Fig. 8, is a selector valve

with three positions: Freight, Passenger and Lap. An escutcheon plate is provided having raised letters "FRGT", "PASS" and "LAP". The position in which the valve is set is indicated by a pointer on the handle.

Freight Position is obtained by placing the pointer on the handle over the raised letters FRGT. The ROTAIR® Valve is used in this position on long freight trains when it is desired to have the controlled-emergency feature operative. A split reduction is available in this position when the service brake application portion is used in the automatic brake valve.

Passenger Position is obtained by placing the pointer on the handle over the raised letters PASS. The ROTAIR Valve is used in this position on passenger trains and short freight trains where it is desired to have the controlled-emergency feature inoperative and no split reduction feature.

Lap Position is obtained by placing the pointer on the handle over the raised letters LAP. The ROTAIR Valve is placed in this position on all A units of a diesel locomotive other than that from which the brakes are controlled. This places the controlled-emergency feature under the control of the engineman where the controlled-emergency pipe is connected through. It also renders the independent brake valve inoperative on trailing A units.

K-2-A ROTAIR VALVE

The K-2-A ROTAIR Valve, Fig. 8, is a selector

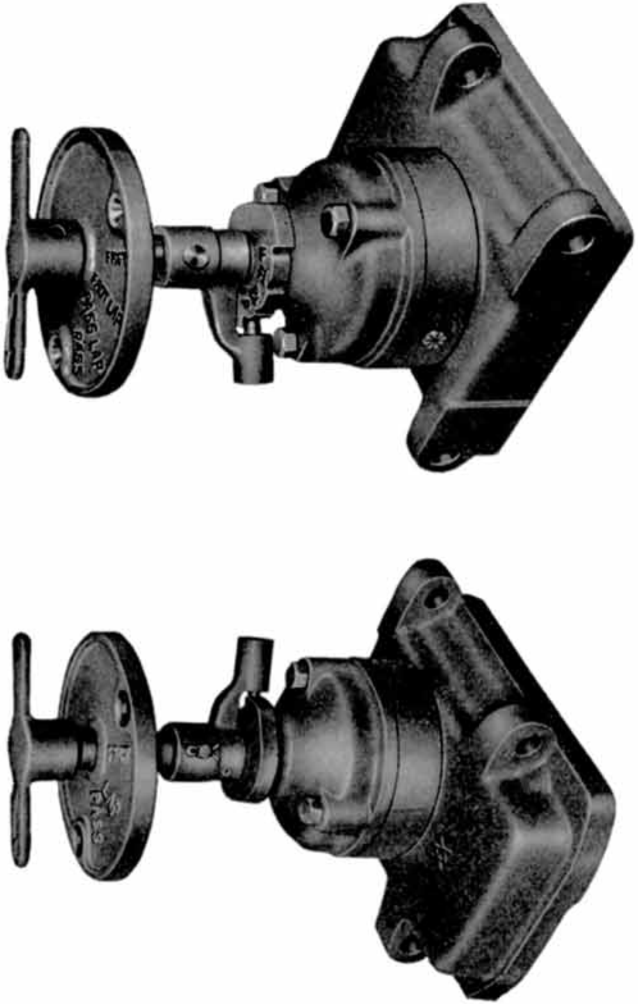


Fig. 8. K-2 and K-2-A ROTAIR® Valves

valve with four positions: Freight, Freight Lap, Passenger and Passenger Lap. The handle is placed in Freight Position, marked **FRGT**, when the locomotive is hauling a long freight train. On short trains, the handle is placed in Passenger Position, marked **PASS**. These handle positions also hold true on any non-control locomotive units which do not have the actuating pipes and independent application and release pipes connected to these respective pipes on the control unit. The **ROTAIR®** Valve handle is placed in the corresponding Lap Position, marked **LAP**, on all locomotive units in a train other than the locomotive from which the brakes are controlled and where the actuating pipes and independent application and release pipes of the control and non-control units are connected together. If the **K-2-A ROTAIR** Valve on the controlling unit is set at **PASS**, then the **K-2-A ROTAIR** Valve on the non-control unit should be set in **PASS LAP**. This also applies to the **FRGT** and **FRGT LAP** settings.

When the **K-2-A ROTAIR** Valve is used on the **A** units, a controlled-emergency cock must be added to the control valve pipe bracket on all **B** units.

Controlled or non-controlled emergency is obtainable on all units having a **K-2 ROTAIR** Valve and having the controlled-emergency pipe running the length of all units. However, the ability to nullify controlled-emergency on all units from the independent brake valve of the controlling unit is not available with the **K-2-A ROTAIR** Valve. It is thus necessary to manually operate valves or controlled-emergency cocks on all units when controlled-emergency is desired.

D-24-B FEED VALVE

The bellows-type diaphragm in the D-24-B Feed Valve, Fig. 9, offers a new high in ability for accuracy. Stretching and slippage of the flat diaphragm used in previous feed valves are eliminated by this new diaphragm.

This feature, which is in effect a great capacity with delivery openings unchoked while still retaining its accuracy, overcomes the objection of using the feed valve to supply the brake pipe in Release Position.

The feed valve, attached to the brake valve pipe bracket, regulates the pressure in the brake pipe with the automatic brake valve handle in Running Position and puts air on top of the rotary valve in other positions. It also supplies the brake pipe during Controlled Release and pressure maintaining functions.

The feed valve consists of a regulating portion set to deliver the required air pressure, and a supply portion which delivers main reservoir air at the pressures determined by the regulating portion. A felt protector minimizes the chances of dirt getting into the operating parts. The use of a poppet-type valve instead of a slide valve makes for easy maintenance. The feed valve is adjusted by turning the adjusting handle.

Fig. 9. D-24-B Feed Valve

MAIN RESERVOIR CUT-OFF VALVE

The Main Reservoir Cut-Off Valve is located in the main reservoir equalizing branch pipe. Its purpose is to prevent a total loss of air from the main reservoir in case of a broken main reservoir equalizing pipe. A minimum of about 85 pounds will be retained in the main reservoir to supply the brake equipment if a pipe is broken.

"B" and "F" TYPE RELAY VALVES

The relay valve, Fig. 10, relays the application and release operation of the control valve. It reproduces in the brake cylinders all or part of the air pressure called for by the control pipe.

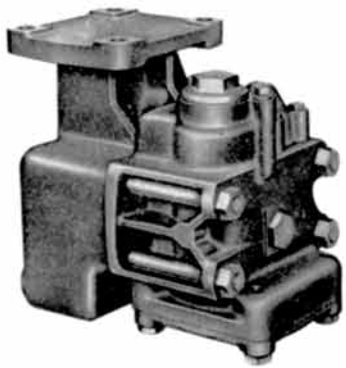


Fig. 10. FS-1864 (top) and B-3-A Relay Valves

B-3-A RELAY VALVE

The B-3-A Relay Valve will reproduce in the brake cylinders 100% of the pressure established in the control pipe. The pipe bracket has the same mounting holes and pipe locations as the "F" type relay valve.

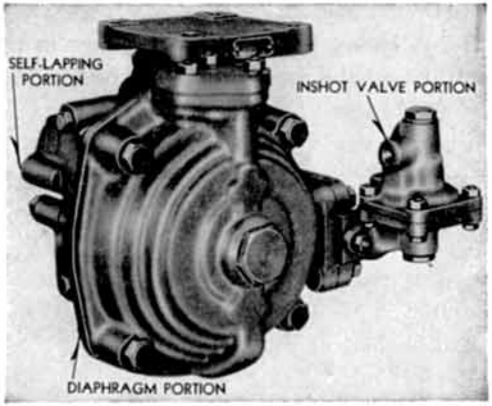
F-6, F-8, F-1 RELAY VALVES

These relay valves operate to reproduce in the brake cylinder 60%, 80%, and 100%, respectively, of the pressure established in the control pipe.

FS-1864 RELAY VALVE

The FS-1864 Relay Valve (used with Speed Governor Control) is a self-lapping valve which operates to supply and exhaust brake cylinder air during brake application. The brake cylinder air pressure provided is controlled by the speed governor in accordance with train speed. When speed governor control is not available, the brake cylinder pressure developed by the operation of the relay valve provides the same braking force as that used in standard service.

The FS-1864 Relay Valve will reproduce in the brake cylinder 100% of the pressure in the control pipe when speed is above 65 mph, 80% between 40 mph and 65 mph, 60% between 20 mph and 40 mph, and 40% under 20 mph. This provides greater braking ratios at high speeds, which is very desirable when operating high speed passenger trains.



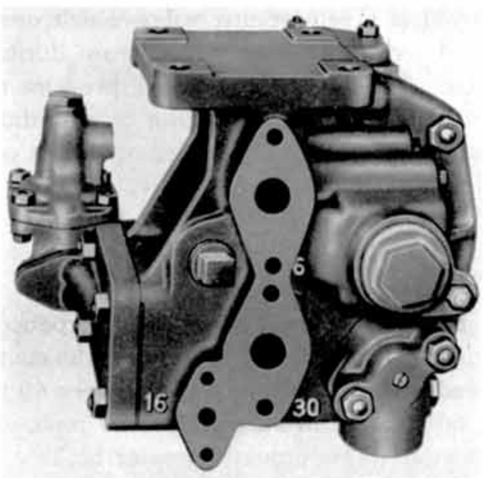
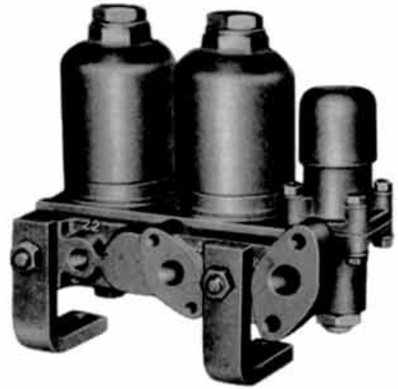


Fig. 11. F-6 Relay Valve



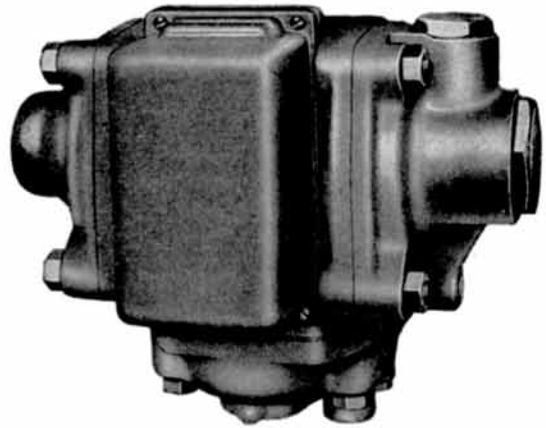


Fig. 12. No. 21-B Magnet (top) and Master Controller

The K-3-B Switch portion is used with the FS-1864 Relay Valve and is wired in the battery circuit to the magnet valves. It operates to establish battery supply between the relay magnets and speed governor relay cabinet when a brake application is made, thus conserving battery current when brakes are released.

ELECTRO-PNEUMATIC MASTER CONTROLLER —USED WITH ELECTRO-PNEUMATIC CONTROL, Fig. 12

An electro-pneumatic device which, in conjunction with magnet valves, control valves, and relay valves installed throughout the train, relays to the brake cylinders the operation of the self-lapping unit of the brake valve.

No. 21-B MAGNET VALVE—USED WITH ELECTRO-PNEUMATIC CONTROL, Fig. 12

Consists of a pipe bracket, application magnet valve, release magnet valve and a cut-off valve. The magnet valves are electrically connected to the master controller and, as controlled by the position of the handle of the brake valve in the electro-pneumatic position, control the pressure in the straight air pipe.

AIR COMPRESSORS

To supply compressed air for use with the air brake and auxiliary devices.

MAIN RESERVOIRS

There are two or more main reservoirs of sufficient capacity to provide an adequate air supply for operation of the air brake and auxiliary devices. A check valve is recommended between the last two reservoirs to prevent loss of main reservoir pressure in case of main reservoir pipe breakage.

SAFETY VALVES

A safety valve is located in the compressor discharge pipe. Set to blow off at 175 psi, it lowers the main reservoir pressure if the governor or unloading system allows a higher pressure than intended. A safety valve is located at the main reservoir.

COMBINED EQUALIZING AND REDUCTION LIMITING RESERVOIR

These two volumes are combined in one reservoir. The larger volume is the Equalizing Reservoir which is, in effect, an enlargement of the chamber above the equalizing piston of the automatic brake valve, providing an operating volume large enough to stabilize the equalizing piston against brake pipe volume underneath. The smaller volume is the Reduction Limiting Reservoir, into which the Equalizing Reservoir equalizes at the beginning of a brake application from First Service Position of the brake valve and also during a penalty application if the ROTAIR® Valve is set for long train operation. The pipe connections, 5 for the Equalizing Reservoir and 22 for the Reduction Limiting Reservoir, are plainly marked and are connected to respectively marked 3/8" pipe connections on the brake valve pedestal.

COMBINED AUXILIARY, EMERGENCY AND DISPLACEMENT RESERVOIR

In order to provide for installation in the least possible space and to keep weight as low as possible, the three reservoirs are combined in one structure. The Displacement Reservoir provides the required operating volume for the relay valve to develop the proper brake cylinder pressure for a given brake pipe reduction. The brakes of the locomotive will thus be synchronized with those on the cars of the train. 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.

"C" SIGNAL VALVE AND WHISTLE
CAR DISCHARGE VALVE
NS-1 AND NM-1 REDUCING VALVES

The above devices comprise the train air signal equipment.

The NS-1 or NM-1 Reducing Valve regulates the air

pressure for use in the train signal, train control and cab signal systems. The NS-1 on B units charges the brake pipe when operating with the hostler's brake valve. The reducing valve consists of a pipe bracket on which are mounted a check valve portion, the cut-out cock portion, and the reducing valve portion housed in the body. The check valve portion permits reducing valve air to flow to the signal system but prevents any back flow; the cut-out cock provides means of cutting off the air supply to the signal system. The reducing valve portion reduces the supply air to a predetermined amount.

The NM-1 Reducing Valve is identical to the NS-1 except that it has a cab signal magnet cut-out cock and whistle attached to the pipe bracket.

The *Car Discharge Valve* reduces signal pipe air pressure when the signal cord is pulled.

The *Signal Valve operates* to connect air to the signal whistle when the discharge valve reduces signal pipe air.

The *Signal Whistle* is sounded when the signal valve operates to give the signal to the engineman.

For a complete description of the train air signal equipment and its operation, refer to Instruction Pamphlet No. 5061.

SIPHON DRAIN COCKS

The siphon drain cocks, when used, are installed on the main reservoir to discharge the precipitated water from the reservoir.

The siphon drain cock is installed in one head of each reservoir at the lowest point. Complete drainage is effected by the siphon tube which, when the drain cock is opened, functions as a siphon to remove the water that may be present on the bottom of the reservoir.

AIR FILTER

An air filter in the main reservoir pipe is for protection of the automatic and independent brake valves and the signal equipment devices. The purpose of the filter is to prevent the entrance of dirt and moisture into the devices.

EMERGENCY-BRAKE VALVE

The Emergency-Brake Valve, connected to the brake pipe or E-3 Application Valve, permits a brake application to be made from any point in the locomotive where the valve is installed.

BRAKE CYLINDERS

The brake cylinders are located on the locomotive trucks and are connected by rods and levers to the

brake shoes. When air pressure is admitted to the brake cylinder, the brake shoes are moved against the treads of the locomotive wheels.

To prevent the entrance of dirt, the hollow piston rod is ground true in diameter and surface, and the non-pressure head is fitted with a felt packing seal lubricator and protector which is packed in grease and serves to lubricate the hollow rod, as well as to seal the interior of the cylinder against dirt and moisture.

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. This strainer is of the cartridge type held in place by a strainer retaining ring in a protected location, which prevents flying dirt and water contacting directly with the strainer.

The hollow rod packing seal is held in contact with the hollow piston rod by the force of release spring acting on spring seat. The angle of the non-pressure head and spring seat act to hold the felt packing seal against the hollow rod.

The non-pressure head contains a release piston spring guide which prevents the spring from resting on or vibrating against the hollow piston rod and causing wear.

AIR GAGES

There are two single pointer gages. One indicates the air pressure delivered to the main reservoirs by the compressor, and the other indicates the straight air pipe pressure (used with electro-pneumatic operation).

Three duplex air gages are located in the locomotive cab; one to indicate equalizing reservoir and main reservoir pressures, one to indicate application and suppression pressures and the other to indicate the brake pipe and brake cylinder pressures.

POWER CONTROL SWITCH

Used With Diesel Power Units

The control switch shuts off the locomotive power when a penalty or emergency application is made.

COMBINED DIRT COLLECTOR AND CUT-OUT COCK

A combined dirt collector and cut-out cock, located in the brake pipe branch pipe to the D-24 Control Valve, prevents the entrance of dirt and moisture into the control valve. The cut-out cock is used to disconnect the control valve from the brake pipe.

No. 15-C DOUBLE CHECK VALVE

Used With Diesel Power Units

The No. 15-C Double Check Valve automatically permits operation of the power knockout from a penalty or emergency brake application. It is also used with the break-in-two protection feature. The spring end of the valve should be toward the most restricted supply.

VARIOUS CUT-OUT COCKS, HOSE COUPLINGS, DUMMY COUPLINGS, ETC.

The location and use of these devices can readily be understood by referring to the piping diagram.

SA-2 HOSTLER'S BRAKE VALVE (B UNITS)

The SA-2 Brake Valve is a self-lapping brake valve used on B units of a diesel locomotive to control brakes when the unit is operating alone (in yards or roundhouse area, etc.). Main reservoir air controlled by the self-lapping valve is admitted to the relay valve through the independent application and release pipe.

AUTOMATIC SANDING

When a four-face RELAYAIR® Valve Unit is used, automatic sanding during emergency is obtained by means of a separate H-5-A RELAYAIR Valve operated from the control valve.

With a five-face RELAYAIR Valve Unit, automatic sanding during emergency is accomplished by the Sanding RELAYAIR Valve as explained on page 18.

SANDING RESERVOIR

This volume reservoir provides the air for operating the sander valves and the broken pipe protection feature during emergency, as controlled by an **H-5-A RELAYAIR®** Valve located in the line when a four-face **H-24 RELAYAIR** Valve Unit is used, or from the Sanding Valve on the five-face **H-24 RELAYAIR** Valve Unit.

AUTOMATIC SLACK ADJUSTERS

An automatic slack adjuster for each brake cylinder serves to maintain the predetermined brake cylinder piston travel.

For complete description and operation of slack adjusters, see Instruction Pamphlet 5041-1.

AFTERCOOLER

The aftercooler is located in the pipe between the first and second main reservoirs and is used to insure proper cooling of main reservoir air.

The aftercooler consists of two headers between which are eight finned copper tubes, the cooling effect of which is equivalent to about one hundred feet of 1¼″ iron pipe. The finned tubes are connected in parallel to the headers by pipe fittings, with special packing cups to seal the joints against leakage. The inlet header is provided with throttling orifices which insure uniform distribution of air flow through the tubes. The pipe connections, inlet at the top of one header and outlet at the bottom of the other, are provided with flanged pads for the pipe fittings.

AUTOMATIC DRAIN VALVE

The automatic drain valve is recommended to be installed in the main reservoir pipe between the first and second main reservoir and is used to discharge the precipitated water from the aftercooler and first main reservoir.

3-AP DECELOSTAT® EQUIPMENT

The **3-AP DECELOSTAT** System is an anti-wheel slip equipment which provides a mechanical-pneumatic means of improving braking on locomotives by preventing wheel sliding during brake application. It consists of a **P-3 DECELOSTAT** Controller and a **B-3 DECELOSTAT** Valve. For complete description and operation of **DECELOSTAT** Equipment, see Instruction Pamphlet 5067-3.

BRAKE PIPE FLOW INDICATOR

The Brake Pipe Flow Indicator shows the differential between feed valve and brake pipe pressures, thus disclosing the extent of charge in the brake pipe when the brake valve handle is in Running Position.

Safety Control Feature

PARTS REQUIRED FOR SAFETY CONTROL

The Safety Control feature, as incorporated with the 24-RL Brake Equipment, functions only in case the engineman fails to hold down the foot pedal or the automatic brake valve handle (with hinged handle only) without first making a brake application. Unless a brake application has first been made, resulting in about 30 pounds in the control pipe, an application of the brake will occur.

The following three parts are located on the brake valve and control all the safety features (Train Control, Cab Signal, Overspeed or Safety Control):

(a) *A brake pipe cut-out cock* (known as brake pipe cut-off valve on pressure maintaining brake valves), which is also used to cut out the Train Control, Overspeed and Safety Control features on trailing units.

(b) *A service application portion,* which when actuated from a train control, overspeed or safety control application starts a service brake application.

(c) *A safety control check valve* (only on brake valves with hinged handle), which suppresses a safety control service brake application when handle is depressed.

Other parts required:

A warning whistle, which sounds for a limited time if brakes are not applied before a safety control brake application is obtained and if neither the brake valve handle nor the diaphragm foot valve are depressed.

The Type C Diaphragm Foot Valve, located in the safety control pipe and having a pedal which is held down to suppress a safety control brake application.

A sealed cut-out cock in the pipe between the diaphragm foot valve and the **H-24 RELAYAIR®** Valve Unit—used to cut out the Safety Control feature.

A volume reservoir and check valve with choke, located in the pipe to the brake valve service application portion, which (1) provides a limited time for action by the engineman to suppress an unintentionally started safety control brake application by immediately depressing downward either the brake valve handle or the foot pedal of the diaphragm foot valve, and (2) stabilizes the operation of the brake valve service application piston during an overspeed or safety control application, or in train control operation when the timing valve is de-energized for short intervals of time.

FIRST SUPPRESSION RESERVOIR

This reservoir is connected to the timing valve for the purpose of providing a time interval between the first and second reduction of a split reduction of brake pipe pressure during a penalty application. It also provides temporary suppression for overspeed or train control in First Service Position of the brake valve.

SECOND REDUCTION RESERVOIR

This reservoir limits the brake pipe reduction to that required to obtain a full service brake application during a penalty application, providing the brake valve handle is moved to Lap Position when the application has begun.

Additional Parts Required For Overspeed Control

One FA-4 Magnet Valve, which operates to control the service application valve of the brake valve to cause a service application when overspeed prevails.

There are three types of overspeed control. The first type vents the application pipe through the **FA-4** Magnet Valve and the second admits main reservoir air through the **FA-4** Magnet Valve to the overspeed volume reservoir and the overspeed application **RELAYAIR®** Valve. With these types there is no temporary suppression available. The third type employs overspeed application, overspeed suppression, and cut-off **RELAYAIR** Valves to provide temporary suppression.

A temporary suppression is obtained in automatic operation if the brake valve handle is placed in First Service (**ROTAIR®** Valve in **FRGT** position) or Service Position before the limited warning time has elapsed. This admits air through the brake valve rotary valve and seat to the top of the overspeed suppression valve diaphragm. The diaphragm will move downward, seating a valve which will prevent the application pipe from exhausting to atmosphere through the overspeed application valve. This will hold the service application piston in release position and temporarily suppress an overspeed application.

An overspeed whistle, which blows and indicates that an overspeed brake application has been started.

Pneumatic Devices Required For Automatic Train Control

NS-1 or NM-1 Reducing Valve, located in the main reservoir pipe to the cab signal magnet, is used to reduce the main reservoir air pressure for use in the cab signal system.

A *Timing Valve,* which automatically causes the brake application valve to function when a signal indication is received in train control territory and operates the timing valve whistle and fireman's call signal circuit controlled in cab signal territory.

A *Stop Reservoir,* connected to the timing valve and the brake valve, is used to enforce a time interval and insure completion of a stop when a train control application takes effect.

A *Whistle,* connected to the timing valve, which blows a warning when a train control-stop application or cab signal indication is initiated.

A *Brake Application Valve Circuit Controller,* which prevents the release of a train control brake application until after the train has come to a stop, once the brake application piston moves to service position.

Cab Signal System includes a magnet valve, whistle, and acknowledging valve.

Intermittent Train Stop System includes a magnet valve, acknowledging valve, and acknowledging reservoir.

A *Sealed Cut-Out Cock,* in the pipe between the timing valve and the service piston of the brake valve, which cuts out train control operation when it is not desired.

Suppression Valve, recommended when temporary and permanent suppression of train control application is desired.

When a train enters restricted territory or the authorized speed is exceeded, the timing valve operates to start a train control brake application, which is indicated by the warning whistle sounding. A train control brake application will then occur in approximately six seconds unless the brake is applied manually. A brake application of prescribed amount will suppress the train control brake application for a limited time, which may be enough to reduce speed below the speed restriction in effect. If the train control brake application results from exceeding the speed restriction and speed is reduced below authorized speed limit, the brake may be released in a normal manner. If approaching a restricted signal under this temporary suppression condition, and the signal clears, the brake may be released in the normal manner and the train may proceed without being brought to a stop if the speed and length of train permit.

Speed Governor Control

With Speed Governor control, braking pressure is regulated by train speed, the purpose being to hold retardation as nearly uniform as practical. This makes possible the use of high braking forces required for high speeds without exceeding the braking forces practical at lower speeds. When Speed Governor control is not used, braking forces are the same as in conventional standard passenger service.

The basic principle of Speed Governor control is the use of a generator attached to the axle of one pair of wheels of each car and locomotive unit, the voltage of which is proportional to wheel speed, and the use of relays which operate at a generator voltage corresponding to certain speeds.

The speed governor protects against the development of braking pressure in excess of that which is practical for varying speed. The brake devices with which the speed governor devices are associated are designed to provide the development of braking force up to the maximum value of that permitted by the governor. This braking force can be applied to any desired degree by the engineman.

Functions of The Principal Pipes

BRAKE PIPE (1). The brake pipe runs the length of the train with connections on the locomotive units to the brake valve, the D-24 Control Valves, and the Emergency-Brake Valves. Its purpose is to supply the reservoirs of the control valves and to apply and release the brakes in automatic operation.

MAIN RESERVOIR PIPE (30). This is connected between units to create a single supply system for operation of the train brakes.

SIGNAL PIPE. The signal pipe runs the length of the train and provides means for signalling the engineer through use of the Signal Car Discharge Valves located on the units and the cars.

BRAKE CYLINDER PIPE. This is contained on all units and runs between the relay valves and the brake cylinders to supply and exhaust the air in the cylinders.

INDEPENDENT APPLICATION AND RELEASE PIPE (20). It is connected to all units from the independent brake valve through the ROTAIR® Valve on the controlling unit to all D-24 Control Valves. It controls the independent application and release of the locomotive brakes.

ACTUATING PIPE (13). It makes the same connections as the Independent Application and Release Pipe and provides air to release automatic applications on the locomotive independently.

CONTROLLED EMERGENCY PIPE (35). When the K-2-A ROTAIR® Valve is used, this pipe is contained in the A units only and connects the ROTAIR Valve and the independent brake valve to the D-24 Control Valve to select or nullify controlled-emergency. With a K-2 ROTAIR Valve, this pipe is connected to all units and performs the same function throughout.

RELAY VALVE CONTROL PIPE (16). It connects the D-24 Control Valve to the relay valve and the RELAYAIR® Valve Unit, and is contained in each unit. Pressure in this pipe controls that in the brake cylinders through the relay valves in any brake application. It also operates, on A units, the cut-off function of the Cut-Off RELAYAIR Valve.

APPLICATION PIPE (10). This pipe runs from the brake valve to the RELAYAIR Valve Unit and timing valve on A units. It carries main reservoir pressure. Reduction of pressure in the No. 10 pipe through safety, overspeed, or train control results in a brake application from the application portion of the brake
SAFETY CONTROL PIPE (3). It runs from the RELAYAIR Valve Unit to the brake valve through the diaphragm foot valve and is contained on A units. It carries air from the No. 10 pipe and is vented to cause a safety control application.

STRAIGHT AIR PIPE. This pipe connects the control

valves, No. 21-B Magnet portions, and the master controller, and runs the length of the train. Its purpose is to synchronize the electro-pneumatic brake.

SUPPRESSION PIPE. This leads from the 17 and 26 connections of the brake valve to the 17 connection of the RELAYAIR® Valve Unit to provide a temporary suppression of an overspeed and train control application (when a suppression unit is used). When a train control suppression valve is used, these same brake valve connections lead to similarly numbered connections on the suppression valve to provide for temporary suppression for overspeed and train control.

General Operating Instructions

OPERATING 8-EL AND 24-RL LOCOMOTIVES CONNECTED

Locomotives equipped with 24-RL and No. 8-EL Equipment can be operated together and have independent control of the brakes when the operating pipes are connected. The independent release pipe of 8-EL is connected to the actuating pipe of 24-RL for the independent quick release operation. The application pipes are connected for the independent application and release.

AUTOMATIC BRAKE APPLICATION

On short trains the ROTAIR® Valve is turned to position PASS, thus providing for an automatic full service in the event of a penalty application. On long freight trains, however, the ROTAIR Valve is turned to position FRGT to provide for an automatic split service application. The automatic split reduction makes smoother stops started from the Safety Control feature (available with service application portion).

A timing feature permits the engineman to suppress a safety control application, unintentionally started, if the foot pedal or automatic brake valve handle is immediately depressed when the safety control whistle sounds an alarm.

RELEASE AND CHARGING

With the selector cock in FV position the automatic brake valve has Controlled Release (extreme left position of the brake valve handle), in which a new large capacity feed valve provides a high rate of air flow to the brake pipe at feed valve pressures. This provides the same reliability of release previously obtained, without the liability of overcharge. A warning port operates in Release Position to inform the engineman of the brake valve handle position.

In Running Position the flow of air to the brake pipe is determined by the size of the ports in the brake valve and is equal to that of former equipments using the Type M feed valve. The brake valve handle is placed in this position to release the brakes after an application and to keep them charged and ready for immediate use.

SYNCHRONIZATION OF LOCOMOTIVE WITH TRAIN BRAKE IN BOTH SERVICE AND EMERGENCY

SERVICE—The locomotive brakes and train brakes apply uniformly on both a time and pressure basis. This is accomplished through the means of a displacement reservoir, which delays the beginning of effective brake cylinder pressure development on the locomotive to agree with that on the cars, after which both train and locomotive cylinder pressure build up uniformly.

EMERGENCY—Emergency applications are adjustable to provide slack control according to the service. This feature provides a rapid development of locomotive brake cylinder pressure for passenger and short freight trains, or a controlled build-up for long freight trains.

BRAKE PIPE SERVICE REDUCTION AUTOMATICALLY CONTROLLED ON LONG TRAINS

The automatic brake valve has a *First Service* Position for use on long trains. This position provides an initial normal service rate of brake pipe reduction sufficient to initiate quick service on the train brakes, after which a slower rate is imposed, allowing the brake pipe pressure to readjust itself throughout the train and avoiding a heavy reduction at the front end. A maintaining type of equalizing piston is employed to assure that this imposed rate is not exceeded. The engineman, therefore, is able to gather the slack gently by using this position, avoiding a heavy head end brake application and resultant hard run-in of slack.

ELECTRO-PNEUMATIC CONTROL

In addition to the automatic brake for conventional freight and passenger service, the locomotive brake equipment includes an electro-pneumatic brake which permits the control of trains operating in passenger service.

When operating the electro-pneumatic brake the brake valve shifter lever is moved to straight air position, with the letters "S.A." exposed to view. To move the shifter lever, place the brake valve handle in Running Position. Then pull out the shifter lever latch and swing the shifter lever to the "S.A." position and release the stop pin into the hole in the brake valve body casting. Running and charging position is identical to the automatic operation except that the brake valve handle cannot be placed in Release Position.

Emergency application is available at all times regardless of the position of the shifter lever.

BRAKE PIPE CUT-OFF PROTECTION FEATURE

The Brake Pipe Cut-Off Protection feature provides protection against loss of main reservoir air, and possible release of brakes, from an emergency application started from the train when the brake valve handle remains in Running Position.

Air supply to the brake pipe will be cut off by the cut-off valve in the brake valve, which is controlled by the service application slide valve, and will prevent loss of main reservoir air to atmosphere through the open brake pipe.

FIRST SERVICE POSITION

This position is for use with long trains where the brake pipe pressure is progressively lower from front to rear of the train. First Service Position reduces the brake pipe at a slow, controlled rate and prevents an excessive difference in brake cylinder pressure between the front and rear. Sudden slack changes and shock are thus reduced.

First Service can be used to advantage in passenger service for making slowdowns or the initial reduction for a stop, since the reduction is automatically limited and of about the proper amount, without observing the air gage. When used for making a stop, the brake valve handle should be moved to Service Position for the second reduction, of the required amount, about the time the brake pipe exhaust closes. The initial reduction in First Service Position is about 6 and 10 pounds respectively for 70 and 110 pounds brake pipe pressures.

DYNAMIC BRAKE INTERLOCK

The dynamic interlock magnet is used to release or prevent an automatic or electro-pneumatic brake application on the locomotive if the dynamic brake is on. Independent application and release of the locomotive brake is available at all times, thus the pneumatic brake from the independent brake valve is always available regardless of dynamic brake operation.

In emergency the dynamic brake is nullified, allowing the automatic emergency brake to operate. This provides a most positive brake for stopping the train under all conditions.

PROCEDURE FOR CHANGING ENDS

(Two Diesel A Power Units)

When changing ends on double end A equipment (two A units), proceed as follows:

Make a 20 pound brake pipe reduction with the automatic brake valve, after which move the brake valve handle to Lap Position. Move the independent brake valve handle to Full Zone Application Position. Close the brake pipe cut-out cock or valve and place the K-2 ROTAIR® Valve in LAP position or the K-2-A ROTAIR Valve in either FRGT LAP or PASS LAP. Move the automatic brake valve handle to Running Position and the independent brake valve handle to Release Position and remove both handles.

Control at the opposite end should be taken without delay, as follows: First insert the brake valve handles. Place the ROTAIR Valve in PASS or FRGT position, depending on the service used. Move the independent brake valve handle to Application Position. Open the brake pipe cut-out cock or valve. When changing pressures, to avoid the possibility of an overcharge, move the automatic brake valve handle to Emergency Position, then back to Lap. Depress the independent brake valve handle in Full Application Position for about 15 seconds. Move automatic brake valve handle to Running or Release Position, depress foot pedal, check gages to insure brake pipe and main reservoirs are fully charged, then release independent brake.

HAULING LOCOMOTIVE A UNIT DEAD IN TRAIN

Close the brake pipe cut-out cock or valve and remove the brake valve handle (in Running Position). Move shifter lever, if included, to AU position.

Open the dead engine cut-out cock (or change dead engine cap) on the D-24 Control Valve pipe bracket just above the service portion. This provides for charging the main reservoirs from the brake pipe. Open the brake pipe branch pipe cock to charge the control valve reservoirs.

Remove or keep the independent brake valve handle in Release Position.

Position the ROTAIR® Valve in PASS position. Place the graduated release cap in direct release position.

HAULING LOCOMOTIVE B UNIT DEAD IN TRAIN

Open the dead engine cut-out cock (or change the dead engine cap) on the D-24 Control Valve. This will provide for charging the main reservoir from the brake pipe.

With the hostler's brake valve in Release Position, remove the hostler's brake valve handle or secure it in this position. Open the cut-out cock in the independent application and release pipe under the hostler's brake valve.

Open the brake pipe branch pipe cut-out cock to charge the D-24 Control Valve reservoirs.

Where the controlled-emergency cock is used it must be placed in "P" passenger position.

The B unit must have an atmospheric opening from the actuating pipe, the independent application and release pipe and the straight air pipe (when used) to insure a release of the automatic brake. Open the cut-out cock and remove the plug from the alternate connection, opposite the air hose, at one end of each unit in the actuating, independent application and release and straight air pipes.

The cut-out cock to the reducing valve must be closed.

MULTIPLE UNIT OPERATION

When two or more diesel A power units are operated together (all hose couplings properly coupled together and all end cocks open), the brakes are controlled from the leading unit in accordance with preceding instructions. On all other A power units, however, close the brake pipe cut-out cock or valve, place the K-2 ROTAIR® Valve in Lap (or K-2-A in either FRGT LAP or PASS LAP) and remove the brake valve handles. The brakes are then controlled from the leading power unit. In case the actuating pipes and the independent application and release pipes cannot be connected between units, the ROTAIR Valve must be in FRGT or PASS position.

DOUBLE HEADING BEHIND STEAM LOCOMOTIVE

When preparing for double heading an **A** diesel power unit behind a steam locomotive, move the shifter lever (if included) of the brake valve to **AU** position. Make a full service application, close the brake pipe cut-out cock or valve, but leave the **ROTAIR®** Valve in **FRGT** or **PASS** position, depending upon the service required. Brakes are then controlled from the steam locomotive. However, the engineman on the second unit can make an emergency application by moving the automatic brake valve handle to Emergency Position, and can release the brakes on the diesel power unit by depressing the independent brake valve handle.

EMERGENCY APPLICATION STARTED FROM THE TRAIN

In case an emergency application originates from any source other than the brake valve, the brake valve handle should be placed in Emergency Position for passenger or freight service.

OPERATING B UNITS WITH HOSTLER'S BRAKE VALVE

Open the cut-out cock under the hostler's brake valve and move the brake valve handle into the Application Zone. Then open the cock at the reducing valve to recharge the brake system. Move the hostler's brake valve handle to Release Position. If the brakes fail to

release after a short interval of time, it may be necessary to make an emergency application by opening the Emergency-Brake Valve to reduce an overcharge of the auxiliary and emergency reservoir. When a controlled-emergency cut-out cock is used on the control valve, the handle should be placed in "P" position.

When the **A** and **B** units have been reassembled and the control transferred to the **A** unit, note that the cut-out cocks at the reducing valve and the hostler's brake valve are closed and all end hose are connected and the cocks open.

When the **B** unit is equipped with electro-pneumatic brake, the straight air pipe on the **B** unit must have an atmospheric opening either through the No. 21-B Magnet portion (cut-out cock where used) or through the end cut-out cocks. This applies any time the hose is not connected and open through into the **A** unit pipe.

POSITION OF COCK AND VALVE HANDLES

See Plates 1 and 2 for description of handle positions and pipe connections on automatic brake valve and D-24 Control Valve.

USE OF INDEPENDENT BRAKE VALVE

The independent brake valve handle should always be left in the Application Zone when there is no attendant in the cab.

It should be operated with care to prevent damage, to cars and lading, caused by running the slack in or out too fast. In case of emergency arising while the independent brake is applied, apply the automatic brake instantly.

PROCEDURE FOR CHANGING OPERATING VALVES

When the main reservoirs are charged proceed as follows: Place the automatic brake valve handle in Emergency Position and leave it there. Depress the independent brake valve handle in Release Position, with **ROTAIR® VALVE** in **PASS** position, until the auxiliary and emergency reservoirs are drained. Close the equipment cut-out cock (side-vented) located in the main reservoir pipe between the brake equipment and the last main reservoir. After the devices are changed, the equipment cut-out cock should be opened before the automatic brake valve handle is placed in a charging position.

ROTAIR VALVE POSITION COMBINATIONS

See Plate 3 for position combinations for the K-2 and K-2-A **ROTAIR** Valves.

Recommended Inspection When Units Are Assembled

*1. The K-2 and K-2-A **ROTAIR®** Valve handles on each A unit should be checked for proper position. This also applies to controlled-emergency cocks on the B units.

2. The B unit hostler's valve supply and the reducing valve brake pipe supply cocks must be closed. The hostler's brake valve handle should be removed.

3. The brake pipe cut-out cock or valve must be closed on all automatic brake valves except the lead or controlling unit. Both the automatic and the independent brake valve handles should be removed except on the controlling unit.

4. Connect all hose and open end cocks between all the units. Note that brakes apply and release on all the units from the lead or controlling independent brake valve.

5. After charging the brake pipe about six minutes, with D-24 Control Valve branch pipe cut-out cock open and charging change-over cock in **FRGT** position (or

*NOTE The ROTAIR Valves and controlled-emergency cocks, depending upon specific railroad instructions, may be positioned for **FRGT** after locomotives are attached to the train, and returned to **PASS** position when detached from the train. If locomotives are detached from the train and are being moved in **FRGT** position, place the automatic brake valve handle quickly in Emergency position if an emergency should arise. Follow this movement by quickly moving the independent brake valve handle to Full Application Position to nullify the controlled-emergency feature. The independent brake valve handle should be left in Full Application Position until the stop is completed or the occasion for the emergency application has passed.

about three minutes in **PASS** charging position), make a 15 pound brake pipe reduction and lap the brake valve. (With D-24-M or D-24-MC type brake valves, the Maintaining Cut-Off Valve must be manually cut off during the terminal leakage test.) Note the brake pipe gage for one minute for leakage, which should not exceed five pounds. Check the brake cylinder gage to see that brakes apply and remain applied for the one minute. Then close brake pipe cut-out cock or valve and move the automatic brake valve handle to Emergency Position and observe that the brake valve emergency exhaust opens and that brake pipe gage indicates zero. Check all units to see that brakes are applied. Then open the brake pipe cut-out cock or valve and place the brake valve handle in Running Position. Check all units to see that brakes have released.

6. Note that the Graduated Release Cap on each D-24 Control Valve is set in proper position. This cap can be changed without draining the reservoirs when the control valve is in release position.

7. When electro-pneumatic brake is used, move the shifter lever to SA position, brake valve handle in Running Position. Then move the brake valve handle to Full Application Position and note the pressure on the straight air pipe gage of the locomotive. The maximum pressure should be about 70 to 75 pounds and the time not more than five seconds to five pounds below the maximum pressure. Note the straight air pipe gage for any "pumping" action which may be due to leakage. The resulting brake cylinder pressure will depend upon

the type of relay valve used and may only be a ratio of that in the straight air pipe.

8. The engineer should inspect the seal on all sealed cocks to determine if they are properly sealed and should report any cock on which the seal is broken.

9. Locomotive enginemen, when taking charge of locomotives, must know that the brakes are in operating condition.

Suggested Procedure When Pipes Are Broken

AUTOMATIC BRAKE VALVE

EQUALIZING RESERVOIR PIPE 5

1. Close pipe to brake valve by plug or short, close bend. (See Note 1).

2. Close brake pipe exhaust (½″ pipe opening on rear of rotary valve seat) using ½″ pipe plug or well-fitted hard wood plug.

3. To apply the brake, move the brake valve handle into the Emergency Position zone, gradually opening the pilot emergency valve only. Functions of the Service Position are lost.

APPLICATION PIPE 10

When service application portion is used close the safety control cut-out cock on front of the brake valve. This cuts out the safety control, overspeed and train control operation.

BRAKE PIPE 1

Must be repaired or locomotive and train automatic brakes are inoperative. The locomotive independent brake is operative but the automatic brake valve handle should be placed in Lap Position.

CONTROL PIPE 11

Cut out the electro-pneumatic brake and proceed, using the automatic brake.

SAFETY CONTROL PIPE 3

When broken between the brake valve and the foot valve, proceed with safety control controlled with diaphragm foot valve only. Between foot valve and RELAYAIR® Valve Unit, close the cut-out cock on the service application portion. All functions of the application portion are lost.

STANDING PIPE 9

When broken between the brake valve and No. 15 Double Check Valve (with break-in-two protection feature), must be repaired or manual brake valve sanding will be lost. When the double check valve is not used, the break must be repaired or manual and automatic emergency sanding features are lost.

SUPPRESSION RESERVOIR PIPE 23

Stop leak on brake valve side of the break by plugging or close, tight bend. Proceed. Functions are the same as with ROTAIR® Valve in PASS.

REDUCTION LIMITING RESERVOIR PIPE 24

Close first service cut-out cock or valve and proceed, using Service Position for automatic brake operation.

POWER KNOCKOUT PIPE 25

Power cut-off for service application portion operation is lost. Stop leak from the brake valve.

ELECTRO-PNEUMATIC POWER KNOCKOUT PIPE 40

Power cut-off during an electro-pneumatic emergency application is lost. Stop leak from the brake valve.

MAIN RESERVOIR 30

Must be repaired to have an automatic brake. The independent brake valve can be used if the main reservoir loss of air is cut off.

STOP RESERVOIR PIPE 8

Close pipe on the brake valve side by short, tight bend to be able to obtain a train overspeed or safety control release. The service application portion cut-out cock can be closed and operation resumed without any repairs.

SECOND REDUCTION RESERVOIR PIPE 18

Proceed without any repairs. Safety, overspeed and train control brake pipe reductions are unlimited.

SUPPRESSION RESERVOIR PIPE 19

Repair leak on brake valve side by close, tight bend on the pipe. Proceed with the loss of permanent suppression feature.

SUPPRESSION PIPES 26 AND 17

Repair leak on brake valve side by close, tight bend in the pipes. Proceed with the loss of partial suppression.

BROKEN GAGE PIPES

Repair the leak with close tight bend and proceed without the use of gage.

INDEPENDENT BRAKE VALVE AND ROTAIR® VALVE

MAIN RESERVOIR PIPE 30

If broken at any point, repair must be made to have the use of the independent brake valve. If the break occurs in the branch leading to the independent brake valve, stop the loss of main reservoir air, and the controlled emergency feature is still available. The automatic brake is not affected.

ACTUATING PIPE 13

Proceed without any repairs with the loss of the independent quick release feature.

APPLICATION AND RELEASE PIPE 20

Proceed with the independent brake valve handle in *Release Position* with the loss of the independent locomotive brake.

CONTROLLED EMERGENCY PIPE 35

Place **ROTAIR** Valve in **PASS** and proceed without the controlled-emergency feature and other freight functions (split reductions, etc.).

BRAKE CYLINDER RELAY VALVES

MAIN RESERVOIR PIPE 6

It must be repaired to have a locomotive brake. If repair cannot be made, stop loss of main reservoir air and follow instructions of the railroad involved.

BRAKE CYLINDER PIPE 30

Same as for main reservoir pipe 6, unless break in cylinder pipe is beyond the cylinder cut-out cock. In this case close the cock and proceed with these cylinders cut-out.

CONTROL PIPE 16

Must be repaired to have a locomotive brake, otherwise follow the instruction of the railroad involved.

MASTER CONTROLLER AND 21-B MAGNETS AND BRACKET

CONTROL PIPE 11 TO MASTER CONTROLLER

It must be repaired to have an electro-pneumatic brake. Move shifter lever to AU position and proceed with the automatic brake if repairs cannot be made.

STRAIGHT AIR PIPE 4

It must be repaired to have electro-pneumatic brake. If repairs cannot be made, move shifter lever to AU position and proceed with the use of the automatic brake.

AUXILIARY RESERVOIR PIPE 5

It must be repaired to have an electro-pneumatic brake. To have an automatic locomotive brake, the auxiliary reservoir leak must be stopped. The automatic locomotive brake can be cut-out by closing the brake pipe branch pipe cock. Use the independent brake.

D-24 CONTROL VALVE

DISPLACEMENT RESERVOIR PIPE 3

AUXILIARY RESERVOIR PIPE 5

EMERGENCY RESERVOIR PIPE 2

In case of breakage of any of these pipes, close the brake pipe branch pipe cut-out cock. The automatic locomotive brake is inoperative, but the independent brake can be used.

INDEPENDENT APPLICATION AND RELEASE PIPE 20

The independent application is lost, but the quick release is still available. No repairs need be made. Proceed and carry independent brake valve handle in Running Position.

ACTUATING PIPE 13

The independent quick release and electro-pneumatic locomotive brake cut-out features are lost. No repairs need be made.

STRAIGHT AIR PIPE 8

The use of the electro-pneumatic brake is lost on the locomotive if repairs cannot be made. The electro-pneumatic brake can be operated on all other units if the break is repaired on the straight air pipe side. However, do not close the pipe on the control valve side.

CONTROLLED-EMERGENCY PIPE 35

The controlled-emergency feature is lost. Proceed with the ROTAIR® Valve in PASS position.

If the break is between the D-24 Control Valve and the brake cylinder relay valve, repairs must be made to have a locomotive brake. If repairs cannot be made, follow the instructions of the individual railroad involved for moving a locomotive without an operating brake. If the break occurs beyond the branch leading to the brake cylinder relay valve, repair the leak with a short, close bend on the control valve side. Proceed with the loss of the RELAYAIR® Valve Unit cut-off valve function.

NOTE 1 A close, tight bend refers to tubing which can be doubled over and hammered tight enough to prevent serious leakage. Where the pipe breaks at the flange fitting, a well-fitted hardwood plug may be driven into the fitting to prevent serious leakage. Blank gaskets or discs under flange fittings or in iron pipe unions are methods that can be used to advantage.

NOTE 2 When moving a locomotive to a terminal with the brake pipe branch pipe closed, the auxiliary and emergency reservoirs should be drained and open to the atmosphere to guard against the possibility of cock key leakage resulting in a stuck brake. This may be obtained by disconnecting one of the pipes 2, 3 or 7.

Operation of The Equipment

It should be understood that the diagrammatics of the equipment are not intended to show the actual construction of the operative devices, but are laid out on one plane and drawn to make connections more easily understood.

The automatic brake valve described in this section is the basic D-24 Brake Valve. However, a short description of the pressure maintaining brake valves is in order before getting into the detailed operation of the equipment.

PRESSURE MAINTAINING BRAKE VALVES

Plates 4A, 4, 5A and 5

The operation of these brake valves is fundamentally the same as the operation of the D-24 type brake valves. In comparing these brake valves with the D-24 type, it must be remembered that:

(1) The D-24-M type is a new pressure maintaining brake valve. All its portions differ slightly in design from corresponding portions of the D-24 type brake valve. These changes in design, as explained under Description of the Parts, improve brake valve operation and reduce maintenance costs but do not affect basic operation.

(2) The D-24-MC is a D-24 type brake valve that has been converted into a pressure maintaining brake

valve. All portions of these two brake valves are identical except for the filling piece portion.

EQUALIZING PORTION

When pressure maintaining is used, it is very important that leakage from brake pipe to equalizing reservoir does not occur. With this in mind, the equalizing portion has been provided with a diaphragm in place of the former piston and ring. The diaphragm also helps to reduce maintenance costs.

Operation During Service Application

Reduction of equalizing reservoir pressure in passage 5 causes chamber D pressure to reduce. This allows brake pipe pressure to move the diaphragm assembly upward. Attached exhaust valve plunger 732 unseats exhaust valve 742 against its spring 741, connecting the brake pipe to atmosphere via the open exhaust valve, passage 15 and passage 16.

Brake pipe pressure decreases until the brake pipe pressure under the diaphragm drops to a value slightly below that of the equalizing reservoir pressure in chamber D. This causes the diaphragm assembly to move downward, seating the exhaust valve and cutting off any further exhaust of brake pipe air.

While the action described above is taking place, feed valve air is connected through passage 14a and the strainer to maintaining valve 717, which is held seated by spring 716.

Pressure Maintaining During First Service, Service or Lap Positions

When the brake valve is in any of these positions, the equalizing portion maintains a constant brake pipe gradient for any permissible amount of brake pipe leakage.

If the pressure differential across the diaphragm increases due to brake pipe leakage, the diaphragm assembly is moved downward until maintaining valve plunger 706 unseats maintaining valve 717. Feed valve air flows to brake pipe passage 2b by way of passage 14a, the strainer, the maintaining supply choke, and the open maintaining valve. When brake pipe pressure beneath the diaphragm increases to a sufficient value, the diaphragm assembly is moved upward. This allows maintaining valve spring 716 to seat maintaining valve 717, cutting off the maintaining supply.

The maintaining supply choke, located above the strainer, controls the amount of leakage that the feed valve is able to maintain.

Collapsible Diaphragm Feature

The collapsible diaphragm feature is used to prevent an overcharge of chamber D in the equalizing portions of the pressure maintaining brake valves. If, during Release and Charging, the equalizing reservoir pressure in chamber D becomes a few pounds greater than the brake pipe pressure in the chamber underneath, the diaphragm assembly is forced downward. The first movement of plunger 706 opens maintaining valve 717 against its spring 716. Feed valve air in passage 14a then flows to brake pipe passage 2b.

As the plunger continues downward, it contacts overcharge check valve plunger 720, which in turn unseats overcharge check valve 722 against its spring 723. This connects chamber D to brake pipe passage 2b by way of passage 5 and the open overcharge check valve. The air that is taken away from chamber D is thus used to help to build up the brake pipe pressure.

When brake pipe pressure becomes high enough to return the diaphragm assembly to its upward position, maintaining valve 717 and overcharge check valve 722 are seated by their springs.

MAINTAINING CUT-OFF VALVE

On the D-24-MC type brake valves, the maintaining cut-off valve is located on the filling piece portion. It is identical in construction and function to the maintaining cut-off valve of the D-24-M type brake valves. On the latter, however, the maintaining cut-off valve is attached to the application portion.

This valve provides manual and automatic control of the pressure maintaining feature. When its handle is turned to IN position, brake pipe air is allowed to flow through the open pilot valve to the face of maintaining valve piston 847. The downward movement of the piston unseats check valve 851, connecting feed valve

passage 21 to maintaining passage 14a. In its OUT position the handle forces maintaining pilot valve 859 to its lower position, cutting off the pilot valve spring chamber from maintaining valve piston 847 and connecting the face of this piston to exhaust. The upward movement of the piston closes feed valve passage 21 from maintaining passage 14a.

Automatic Cut-Off

With the DS-24-MC Brake Valve, cut-off valve 843 functions to actuate an automatic cut-off of pressure maintaining during penalty brake applications or train-initiated emergencies in which the service application portion is actuated.

The service application piston in its upward movement connects main reservoir air from passage 30 to passage 25 and the face of cut-off valve 843. When valve 843 is forced against its spring 845, it connects the brake pipe air above maintaining valve piston 847 to atmosphere at A via passage 2a. This allows piston spring 850 to force the piston upward, which causes check valve spring 852 to seat check valve 851. Feed valve air from passage 21 is thus disconnected from maintaining passage 14a.

When an emergency application is initiated by the brake valve, pressure maintaining is automatically cut off due to venting of brake pipe air, via passage 2a, from the chamber above maintaining valve piston 847. This enables piston spring 850 to move the piston upward, cutting off maintaining supply from the feed valve as explained in the previous paragraph.

On the DS-24-M Brake Valve, pressure maintaining is automatically cut off as described above except that brake pipe air above piston 847 is vented to atmosphere through passage 2a in service application slide valve 114.

BRAKE PIPE CUT-OFF VALVE

The brake pipe cut-off valve has "O" rings and spool valves, which offer considerable design improvement over the older plug type cut-out cock.

Cut-In Position

When the valve is manually moved to IN position, pilot valve piston 64 is moved downward. This allows passage 10 to be connected to passage 10a, which leads to the service application portion. Main reservoir air from passage 30 flows to the face of the cut-off valve, which overcomes the tension of spring 58 and connects brake pipe (1) to passage 2 and the rotary valve.

Mid Position

In this position pilot valve 64 is moved so that passage 10a is blanked off and passage 10 is connected to main reservoir air from passage 30. This quickly charges pipe 10 and prevents an unintended brake application when changing the valve handle from OUT to IN.

Air on the face of the cut-off valve is exhausted to atmosphere, allowing spring 58 to move the cut-off valve so that it blanks off brake pipe passage 2.

Cut-Out Position

In this position pilot valve 64 is moved to its upward position. This disconnects passage 10 from main reservoir air in passage 30. The cut-off valve is positioned as explained under Mid Position. The brake pipe is thus cut off from brake valve control.

FIRST SERVICE VALVE

The first service valve has a spool valve with "O" rings in place of the older plug type cut-out cock.

First Service Cut In

When the handle is moved to IN position, passage 14, which is feed valve supplied air, is connected through the spool valve to passage 14a. This permits feed valve air to flow to maintaining valve 717 in the equalizing portion and thus maintains against brake pipe leakage during first service applications.

Passage 24a is connected through the spool valve to passage 24. During a first service application, these passages connect equalizing reservoir pressure from chamber D to the reduction limiting reservoir for the purpose of obtaining a light, controlled drop of chamber D pressure.

Passage 26a is connected to passage 26 through the spool valve. These passages are connected so that air from the first suppression reservoir, through passage 26, can be used for temporary overspeed suppression with the brake valve in First Service Position.

On the D-24-MC type brake valves, passages 26a and 26 are not connected through the first service valve.

First Service Cut Out

When the handle is moved to its **OUT** position, communication between passages 14 and 14a and passages 26 and 26a is cut off, making it impossible to obtain a first service brake application.

Passage 24, however, is now connected through the spool valve and a ball and flat check valve to passage 24a. This connection is made so that reduction limiting reservoir pressure can be reduced when it is desired to make a brake pipe reduction on top of a penalty brake application with the first service feature cut out.

AUTOMATIC BRAKE OPERATION

Release and Charging—Brake Valve: Plate 6; Control Valve: Fig. 13

With the hinged handle type of brake valve and safety control, either the brake valve handle or the diaphragm foot valve must be held down while charging, or the

independent brake applied with 30 lbs. or more in control pipe 16. With the rigid type of brake valve handle the diaphragm foot valve must be held down or an independent brake application made.

With the air compressors cut in and operating, air flows to the first main reservoir. If an aftercooler is used it is connected between the first and second main reservoirs. Automatic drain valves can be connected to the aftercooler.

A check valve is connected between the last two main reservoirs to protect the last reservoir against loss of air in case of a broken pipe toward the compressor. A cut-out cock in the main reservoir pipe beyond the last main reservoir is used to cut off the main reservoirs from the rest of the equipment when desired. A filter is used to clean the air as it leaves the main reservoirs.

From the main reservoir the air flows through the main reservoir pipe and filter to the following branches:

(1) To pipe connection 6 of the D-24 Control Valve and the dead engine fixture.

(2) To pipe connection 6 of the relay valve and through a choke 15 to the top of the application pilot valve 32.

(3) To supply connection of the reducing valve for the signal equipment, cab signal magnet and train control.

(4) With 4 face RELAYAIR® Valve Unit:

To pipe connection 9 of the H-5-A RELAYAIR Valve, to chamber C through unseated charging valve 17 (closed in emergency), and a hole in supply valve 15 into chamber A and passage 11 to charge the volume reservoir.

With 5 face RELAYAIR® Valve Unit:

To pipe connection of the RELAYAIR Valve Unit, to chamber O of the Sanding Valve past unseated charging valve 17 (closed in emergency) and a hole in supply valve 15 into chamber F and passage 31 to charge the volume reservoir.

(5) To connection 30 of the automatic brake valve and

A. A duplex air gage in the locomotive cab.

B. The brake pipe cut-out cock.

C. A warning port in the rotary valve and seat.

D. The D-24-B Feed Valve, where pressure is reduced to feed valve setting, provided the selector cock is in controlled release position, with the brake valve in Release Position.

E. The service application portion.

F. With hinged handle type brake valve, a branch leads to the seated sanding valve which prevents flow to the sander pipe.

G. On brake valves with electro-pneumatic self-lapping portion, a branch to the self-lapping inlet valve 315, which is seated.

(6) With S-40-F Brake Valve, air from the main reservoir flows to pipe connection 30 through one branch to inlet valve 50, which is seated, preventing flow to chamber B. Another branch leads to release valve 22, which is held seated by spring 106 as long as valve handle 38 is not depressed, preventing flow of air to passage 13.

(7) Main reservoir air flows through the rotary valve seat 15 of the ROTAIR® Valve to the controlled-emergency pipe 35 with valve in FRGT position.

From chamber A of the automatic brake valve, the air is connected to passages 4 and 2 in Release Positior Passage 4 is connected to passage 5 to charge the equ izing reservoir and chamber D on the face of equal ... piston 77. When a service application portion is ... passage 4 is connected to passage 5 through c in service application slide valve 114.

Passage 2 connects air from chamber A ... the ... ging pipe through the brake pipe cut-out cock ... ough: nections 1 to passage 1 and emergency ... assage and through choke 202 to the top of ... e valve valve 243, to selector cock 204, passa ... y reser- passage 32 to the feed valve contr ... alve 89a trol of the feed valve supply pres ... is seated valve handle 26 (see position dia ... when the valve, Fig. 3). Passage 2 als ... passage 5. on the right side of equaliz bers D, N and the equalizing reservoir will charge uniformly with the brake pipe.

In the service application portion, air flows to both sides of cut-off valve piston 146. With air pressure balanced on both sides of the piston, spring 155 moves piston 146 to unseat the piston valve, allowing air to flow to chamber N of the equalizing piston portion and the brake pipe.

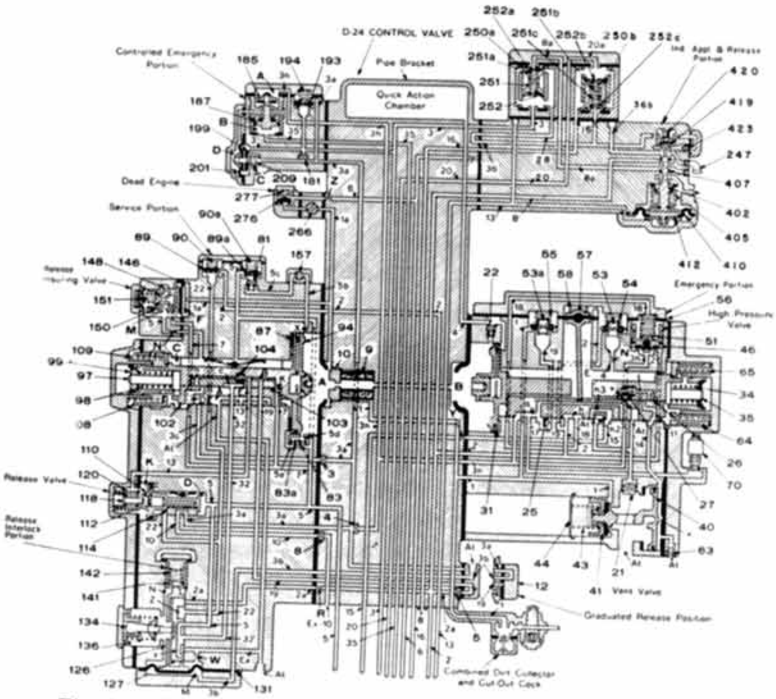


Fig. 13. D-24 Control Valve Diagrammatic—Charging Position

Brake pipe air enters the D-24 Control Valve through the combined dirt collector and cut-out cock and flows through passage *1* to the spring side of vent valve 41, to the top of the accelerated release check valve 53*a* and through strainer *9* to chamber *A* on the face of service piston *94* and chamber *B* on the face of emergency piston *31*.

If the rate of brake pipe pressure rise in chamber *A* on the face of service piston *94* is comparatively rapid, as during initial charging, the piston and attached slide valve *102* are moved to their innermost position, (restricted recharge) until piston *94* seals on its gasket *87*, compressing return spring *109* and moving return spring cage *108* to the left.

The purpose of seal *87* and choke *83* is to limit the rate of charging chamber C during initial charging of the brake system and during the time the brake is being released, thus helping to prevent overcharging of chamber *C* and the auxiliary reservoir.

With the piston in restricted recharge position the piston head uncovers charging choke *83* and the charging port *x*. Brake pipe air in chamber *A* charges through:

(a) Charging port *x*, passages *5b*, cock *157*, passage *5c*, choke *81*, and check valve *89a* to slide valve chamber *C* and passage *5* to the auxiliary reservoir with the cock *157* open. Check valve *89a* permits charging in this direction, but is seated by spring *90a* to prevent backflow when the brake pipe pressure is lower than in passage *5*.

(b) Choke *83* to service slide valve chamber *C*, thence through passage *5* to the release slide valve chamber *D* and the auxiliary reservoir.

With charging change-over cock *157* in PASS or open position, brake pipe air from chamber *A* charges chamber *C* and the auxiliary reservoir through passage *5b*, cock *157*, passage *5c*, choke *81*, and past check valve *89a*, in addition to flow through choke *83*. Thus, in retarded recharge position of the service piston *94*, a faster rate of recharge of chamber *C* is provided on short trains.

The service slide valve chamber *C* and the release slide valve chamber *D* are connected by passage *5* so that auxiliary reservoir pressure is the same in both chambers at all times. Auxiliary reservoir pressure in chamber C is also connected through ports *E* and *13* to chamber *K* on the spring side of release piston *110*. With air pressure on release piston *110* balanced, spring *120* moves the piston *110* and attached slide valve *114* to release position, where the cavity in slide valve *114* connects displacement reservoir and relay valve passage *3a* to exhaust passage *10*.

Passage *16* leading to the relay valve is connected through passages *36* and *28* to passages *3* and *3a*, and the displacement reservoir. As the latter is open to the release slide valve exhaust passage *10*, the relay valve is in release position, connecting the brake cylinders to atmosphere.

The emergency reservoir is charged simultaneously with the auxiliary reservoir from release slide valve

chamber *D*, through passage *22*, past flat check valve *89* and passage *2* to the emergency reservoir. Spring *90* is overcome and check valve *89* is unseated, permitting this charging flow as long as auxiliary reservoir pressure is higher than emergency reservoir pressure. When the emergency reservoir pressure is higher, it seats the check valve and prevents back flow from the emergency to the auxiliary reservoir.

The outer face of release interlock diaphragm *131* is connected through passage *3B*, *3a* through the cavity in slide valve *114* and passage *10* and choke *8* to the exhaust with the graduated release cover in "GRA-REL", graduated release position, and through passage *3b* to the exhaust in the graduated release cover *12* in "DIR-REL", direct release position, of the cover. Therefore, interlock slide valve *127* is in its lower position, where cavity *Y* connects auxiliary reservoir air from passage *5* to passage *32* and the graduating valve seat *103*, where it is blanked.

Brake pipe air from passage *1a*, and auxiliary reservoir air from passages *5* and *7* flow to the release insuring valve to provide the release insuring feature as later described.

In the emergency portion, brake pipe air in chamber *B* on the face of emergency piston *31* flows through charging choke *22* to chamber *E* on the slide valve side of the piston, and through passage *4* to the quick action chamber.

If the brake pipe pressure rise in chamber *B* on the face of the emergency piston is comparatively rapid, as during initial charging and release after emergency, the emergency piston *31* and attached slide valve *25* are moved to the innermost position, compressing return spring *65* and moving return spring cage *64* to the right. In this position cavity *S* in slide valve *25* connects passages *3h*, *17* and *19*. As passage *3h* is connected to atmosphere through passage *3a*, release slide valve *114* and passage *10*, spring *51* and emergency reservoir air from passage *18*, cavity *h* and passage *2* hold high pressure valve *46* seated; spring *55* and brake pipe air from passage *1* hold check valve *53a* seated. Safety valve *70* is connected to atmosphere through passage *17*, cavity *s*, passages *3h* and *3a*, release slide valve *114* and passage *10*.

Emergency reservoir air is connected to the underside of emergency slide valve *25* by passage *2*. In order to prevent slide valve *25* being unseated when the quick action chamber is not charged, the slide valve is balanced by spring *58* and strut *57*. Emergency reservoir air, connected to a small diaphragm area on the upper side of the cover gasket through passage *2*, exerts downward pressure through strut *57* 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 *E* holds slide valve *25* 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 light spring *58*, which does not materially increase slide valve friction.

Emergency reservoir air is connected through passage

2 to the spring chamber above spillover check valve *53*. The underside of the check valve is connected by a passage with choke N to the emergency slide valve chamber *E* and the quick action chamber.

If quick action chamber pressure becomes higher than emergency reservoir pressure, as determined by check valve spring *54*, check valve *53* will be unseated, permitting the higher air pressure in the quick action chamber to flow to the emergency reservoir and thus prevent emergency application through undesired operation of the emergency portion upon return of the brake valve handle from Release to Running Position. The use of spring loaded check valve *53* and choke *N* provides double protection against the back flow of air to the quick action chamber, which would tend to cause the brake to operate in emergency during a service application.

Emergency reservoir air from passage *2* is connected to the outer area of high pressure valve *46*. In release position of emergency slide valve *25*, emergency reservoir air from passage *2* is connected by means of cavity *h* in slide valve *25* to passage *18* and the spring side of high pressure valve *46*. Therefore, spring *51* will move the valve to its seat and hold it closed.

In the independent application and release portion, the chamber below diaphragm piston *412* is connected to atmosphere through passage *13*, actuating pipe *13*, ROTAIR® Valve, and passage *13* in the independent brake valve. Spring *405* holds the diaphragm piston in its lower position, connecting passage *8* and *8a* to the top of check valve *252a* and the straight air pipe. Check valves *252* and *252a* are thus free to move up and permit displacement reservoir air to flow to the relay valve during automatic brake operation. Quick release check valve *419* is held seated by its spring *420*.

In Freight (FRGT) position of the ROTAIR® Valve, main reservoir air flows through rotary valve *15* to pipe *35*, thence to passage *35* of the control valve and chamber *B* of the controlled emergency portion. The controlled emergency piston is moved upward, seating larger piston *187* and unseating small piston *185*. Thus, air from passage *3h* can flow past unseated piston *185* to chamber *D* and seat diaphragm valve *199*, which provides for a controlled build-up of brake cylinder pressure during an emergency application. However, in passenger position of the ROTAIR Valve, passage *35* is connected to atmosphere, so that chamber *B* is vented and the controlled emergency piston is moved down, seating small piston *185* and unseating larger piston *187*. Thus, air from passage *3h* cannot flow past seated piston *185* to chamber *D*. Diaphragm valve *199* is moved and held to the left by spring *209* so that air from passage *3a*, during an emergency application, can flow unrestricted to passage *3* to apply the brake.

RUNNING POSITION—Plates 4a and 4

In Running Position of the automatic brake valve, main reservoir passage 30 is disconnected from the warning port, W. P., so that the main reservoir exhaust is cut off. Thus the release warning signal is cut out in

Running Position. Passage 32 from control chamber G in the feed valve is cut off from 43 and is connected to passage 2 through cavity E and passage 2a. Thus the brake pipe air from passage 2 is connected to the feed valve control chamber G at all times in Running Position and the pressure is controlled in accordance with the setting of the feed valve.

Feed valve air from chamber A is supplied to passages 2 and 4, as in Release Position, and also to passages 14 and 22. Passage 14 connects to passage 14a and the top of maintaining valve 87, which is held seated by spring 88. Passage 22 is connected to passage 23 by cavity R in slide valve 114, thus connecting feed valve air to the ROTAIR® Valve and, in FRGT position, through passage 33 to charge the first suppression reservoir. In passenger position of the ROTAIR Valve, passage 33 is disconnected from passage 23.

In the D-24 Control Valve, brake pipe air charges the service portion chamber C and the emergency portion chamber E, as described under Release. However, in Running Position, return spring 109 moves spring cage 108, service piston 94, slide valve 102 and graduating valve 103 back to normal release. The charging connection remains established as described under Release Position, but passage 5e past service piston seal 87 is opened, permitting charging of brake pipe air from chamber A through port 83a, passage 5e, past seal 87 to chamber C. In the emergency portion, return spring 65 returns cage 64 to the left, moving piston 31, slide valve 25 and graduating valve 26 to release position. In this position the port connections remain established as described for initial charging, except that slide valve cavity s is moved to the left and cuts off connection between passages 3h and 17 from passage 19.

The reservoirs continue to charge, as described under Release Position, until completely charged, after which the parts remain in the position shown.

AUTOMATIC SERVICE POSITION—Plate 9 and Fig. 14.

This position of the brake valve produces the proper rate of brake pipe pressure reduction to cause a service brake application. The exhaust port in the rotary valve seat registers with passage 4, allowing air from equalizing piston chamber D and the equalizing reservoir to escape through the exhaust to atmosphere. As all other ports are closed, the fall of pressure in chamber D causes the higher brake pipe pressure in chamber N to move equalizing piston 77 to the left. As the piston moves it carries attached lever 79, which is thereby rotated to compress spring 83 and unseat equalizing discharge valve 82. Brake pipe air from passage 2b and chamber N then escapes past unseated discharge valve 82 to passage 15.

In Service Position brake pipe air from passage 15 flows to passage 16, which is connected to the exhaust passage by a port in rotary valve seat 216. A choke between passages 15 and 16 restricts the air flow so that the pressure in the brake pipe, as well as in the

equalizing reservoir and chamber D, is reduced at a controlled rate.

When the pressure in the equalizing reservoir and chamber D is reduced the desired amount, the brake valve handle is moved to Lap Position, thus stopping any further equalizing reservoir reduction. As rotary valve 216 connects passage 16 to the exhaust passage in Lap Position, air continues to discharge from the brake pipe until the pressure has fallen slightly lower than that retained in chamber D, permitting the pressure in this and the equalizing reservoir to move equalizing piston 77 to the right. The short end of lever 79 is rotated upward with the piston movement, thus allowing spring 83 to close equalizing discharge valve 82 as piston 77 moves to the right. As the piston movement is influenced by the rate at which the brake pipe pressure is reduced, the valve will close more slowly with a long train than with a short train. It will be seen, therefore, that the amount of reduction in the equalizing reservoir determines the amount of brake pipe reduction regardless of the length of the train.

The controlled reduction in brake pipe pressure is to prevent quick action, and the gradual stopping of this discharge is to prevent the brake pipe pressure at the head end of the train from being built up by the air flowing from the rear, which might cause some of the head brakes to kick off. This is the automatic feature of the brake valve, since it requires the brake valve handle to be in Service Position the same length of time for a given reduction regardless of train length.

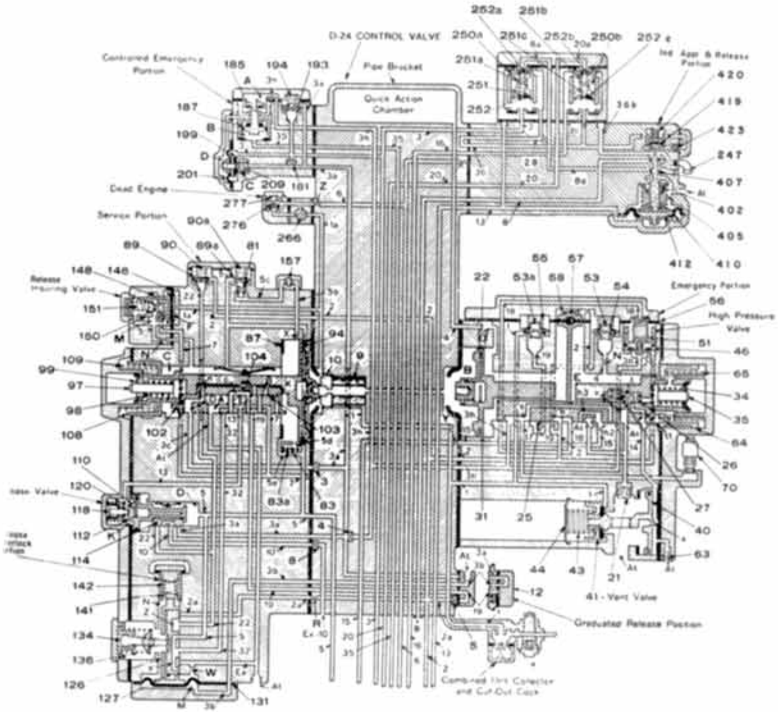


Fig. 14. D-24 Control Valve Diagrammatic—
Service Position

Progress of the brake pipe reduction at the brake valve is reflected immediately in chamber A on the face of D-24 Control Valve service piston 94. When a service reduction has been made, the auxiliary reservoir pressure in chamber C moves service piston 94, slide valve 102 and graduating valve 103 to service position.

The movement of service piston 94 to the right first moves graduating valve 103, which disconnects graduating valve passage B from slide valve passage 19, thus cutting off supply of emergency reservoir air to the auxiliary reservoir in direct release operation. Further movement of the service piston 94 to the right moves slide valve 102 which:

(a) Disconnects slide valve port K from seat port 7 which cuts off the supply of auxiliary reservoir air to the chamber on the right side of release insuring valve 150.

(b) Disconnects slide valve port E from seat port 13, thus cutting off supply of auxiliary reservoir air to the chamber on the left side of release piston 10.

(c) Connects seat port 7 from the release insuring valve 150, and seat port 13 from chamber K of the release valve to cavity A in the slide valve and the exhaust passage in the slide valve seat. This permits the auxiliary reservoir air in chamber D on the right side of piston 110 to overcome spring 120 and move piston 110 and release slide valve to the left, thereby disconnecting displacement reservoir passage 3a from exhaust passage 10 to permit the development of pressure in the displacement reservoir.

(d) Connects graduating valve port n to slide valve cavity D and slide valve seat passage 3c, which permits auxiliary reservoir air to flow to service choke 3 and passage 3a. From passage 3a the auxiliary reservoir air flows past diaphragm valve 199 to passage 3 and out pipe 3 to the displacement reservoir at a rate controlled by service choke 3 in passage 3c. Auxiliary reservoir air from passage 3 also flows past check valve 252, through passages 28, 36, past check valve 252c and passage 16 to the relay valve, which is thereby operated to apply the locomotive brake. The pressure developed in the displacement reservoir is dependent on the amount of brake pipe reduction. If full service reduction is made before the brake valve is lapped, pressure in the auxiliary reservoir and displacement reservoir will equalize. The passage 3h is connected to passage 3a at emergency choke 4, Fig. 15. Thus displacement reservoir air can flow to the safety valve from passage 3a through emergency choke 4, passage 3h, cavity S and passage 17. The displacement reservoir air pressure is thus limited to safety valve setting during a service brake application. Passage 3h is also connected to controlled-emergency portion, chamber A, and with the ROTAIR® Valve in FRGT position, auxiliary reservoir air from passage 3h flows past unseated check valve 185 to chamber D. However, in service application, auxiliary reservoir air from passage 3a aids spring 209 in holding diaphragm 201 and its valve 199 to the left, and flows unrestricted to passage 3 before the auxiliary reservoir air in chamber D can build up to move diaphragm 201 and its valve to the right.

When release piston 110 and slide valve 114 move to application position, seat passage 22 is blanked, preventing backflow from emergency reservoir to chamber D.

The service reduction in brake pipe pressure also reduces the pressure in chamber B on the face of emergency piston 31 slightly lower than quick action chamber pressure in slide valve chamber E. Piston 31 and graduating valve 26 move to the left until emergency piston spring guide 35 contacts slide valve 25. In this position the piston closes charging choke 22, and vent port t (through graduating valve 26) registers with exhaust port v in slide valve 25. This allows quick action chamber air to flow to atmosphere and reduce pressure in the quick action chamber back of emergency piston 31 at a rate that keeps the quick action chamber pressure from attaining a differential over the brake pipe pressure sufficient to move the piston and compress piston spring 34 enough to cause the graduating valve to open port t1 and cause an emergency brake application. By this means the emergency piston is stabilized against emergency, but emergency application is available any time the system is charged, as described under "Emergency."

SERVICE LAP POSITION—Fig. 15

As described under Automatic Service Position, when the desired reduction is made (as indicated on equalizing reservoir gage) the brake valve handle is moved to

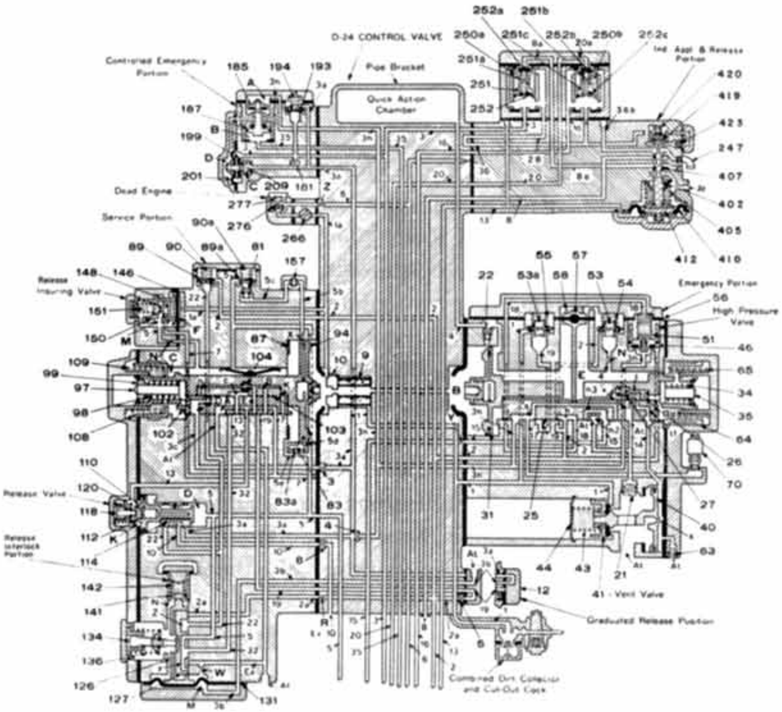


Fig. 15. D-24 Control Valve Diagrammatic—Service Lap Position

Lap Position. At the D-24 Control Valve, the auxiliary reservoir air pressure is reduced slightly below brake pipe pressure by flowing to the displacement reservoir. Thus service piston 94 and it graduating valve 103 move to the left until the piston stem shoulder engages the slide valve, Fig. 15, in which position graduating valve 103 blanks the service port n to cavity D in slide valve

102 and cuts off further flow of auxiliary reservoir air to passage 3c and the displacement reservoir. Release piston 110 and its slide valve 114 remain in service position, holding exhaust passage 10 closed and the brake applied.

Emergency piston 31 with its graduating valve 26 returns to blank the vent port v in the slide valve, thereby preventing further reduction of quick action chamber pressure.

RELEASE AND RECHARGE AFTER SERVICE APPLICATION—Fig. 13

During a service brake application, the emergency reservoir remains at the pressure charged prior to the brake application. When the brake pipe pressure in chamber A on the face of the D-24 Control Valve service piston 94 is increased by moving the locomotive brake valve handle to Release or Running Position, the higher pressure returns the service piston and slide valve 102 to release position, where:

(a) Port 13 is disconnected from cavity A and the exhaust port "At." and connected to auxiliary reservoir air in the slide valve chamber through port E in slide valve 102. Auxiliary reservoir air is thus present on both sides of release piston 110. Piston spring 120 then moves the release piston 110 and slide valve 114 to the right, the slide valve cavity connecting displacement reservoir passage 3a to exhaust passage 10.

(b) Port 19 is connected to port B in graduating valve 103, thus emergency reservoir air from pipe 2 (in direct release) can flow through spillover plug choke 5, passage 19 and port B into chamber C to connect emergency reservoir air and auxiliary reservoir air. Direct release recharge choke 5 provides a method for preventing an accumulative overcharge of the emergency reservoir as might occur in cycling operation. By keeping the emergency reservoir down, a spillover is provided at all times for the quick action chamber. This also aids in the quick recharge of the auxiliary reservoir. Movement of service piston 94 to the right to service position, by flow of emergency reservoir air pressure to chamber C of the service portion, is prevented by graduating valve 103, which blanks port 19 at the initial movement of piston 94 toward service position. This cuts off flow of emergency reservoir air into chamber C before the piston can pick up slide valve 102 and move it to service. When the brake pipe pressure is raised above auxiliary reservoir pressure, piston 94 is again moved to release and permits charging from emergency reservoir. With graduated release cover 12 in graduated release position, quick recharge of the auxiliary reservoir is obtained (until interlock piston 126 moves down at approximately 6 pounds displacement reservoir pressure) from the emergency reservoir pipe 2 to choke "R", passage 2a, cavity "Z" of release interlock slide valve 127 and passage 22 to the release slide valve chamber D, which is always connected to the auxiliary reservoir by passage 5. Charging changeover cock 157 (which is open when the graduated release cover is in graduated release position) provides another means of quick recharge of the auxiliary reservoir from the brake pipe, but is important only when a quick release is made.

Overcharging the quick action chamber during release and possible undesired operation of the emergency piston are prevented by spillover check valve 53, which unseats and allows flow of air from the quick action chamber and emergency slide valve chamber E to emergency reservoir passage 2, when quick action chamber pressure slightly exceeds that in the emergency reservoir but prevents backflow during brake application.

RELEASE INSURING, Figs. 13 and 14.

The release insuring feature operates to positively release the brake in the event that excessive friction prevents prompt movement of the service piston and slide valve to release position after brake pipe pressure has built up in excess of 2 pounds over auxiliary reservoir pressure. This function is provided by a release insuring valve 150, which is shown *open* on Fig. 13. Chamber F on one face of diaphragm 146 of this valve is connected to brake pipe air through passage 1a. Chamber M on the other face of the diaphragm is connected to the auxiliary reservoir air through passage 5 and a choke. Thus, as long as brake pipe pressure does not substantially exceed auxiliary reservoir pressure, spring 151 keeps valve 150 seated, closing the connection between chamber **M** and passage 7. In service position of the service slide valve, Fig. 14, passage 7 registers with the slide valve exhaust cavity **A**. Should the service slide valve fail to move to release position when the brake pipe pressure exceeds auxiliary reservoir pressure by more than 2 pounds, the greater brake pipe pressure in chamber **F** overcomes release insuring spring 151, deflects diaphragm 146 and unseats valve 150, Fig. 13, connecting auxiliary reservoir air from chamber **M** to passage 7, thence to exhaust cavity **A**, Fig. 14. 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, Fig. 13, the slide valve cuts off the exhaust cavity **A** and connects passage 7 to auxiliary reservoir air in slide valve chamber **C** (through port **K**).

GRADUATED RELEASE LAP—Fig. 16

When Graduated Release Cap 12 is in Graduated Release position, as shown on Fig. 16, the graduated release function is cut in. Then, to reduce the brake cylinder pressure in steps, that is, to "graduate it off", the automatic brake valve handle must be returned to Lap Position before the brake pipe pressure has been fully restored. The brake will be entirely released if the brake pipe pressure is fully restored, but if the pressure

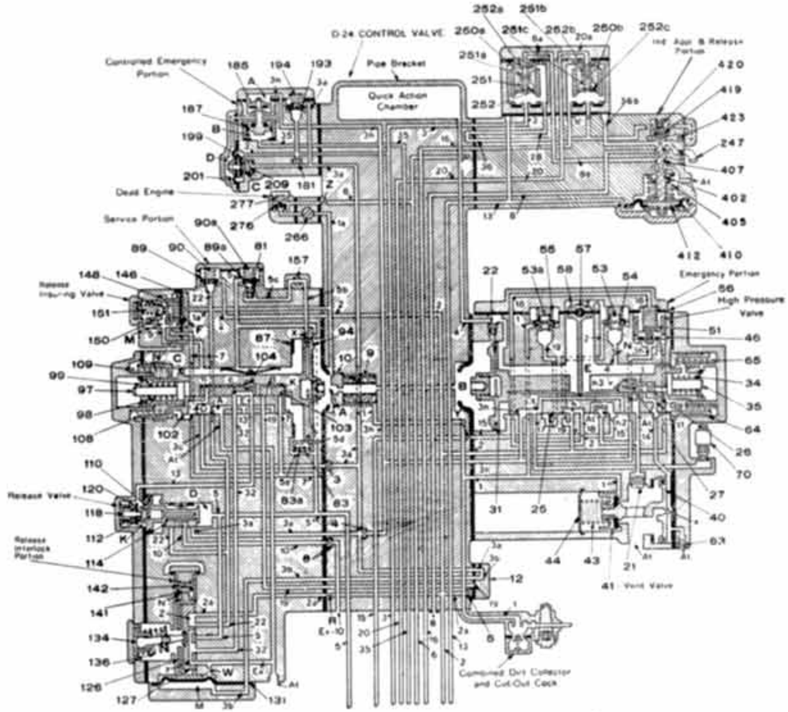


Fig. 16. D-24 Control Valve Diagrammatic—
Graduated Release Lap Position

is only partially restored, the brake will only partially release.

After the brake pipe pressure has been increased by the initial release, so that service piston 94 and slide valve 102 return to release position, Fig. 13, a port in graduating valve 103 registers with port **E** in slide valve 102 and seat port 13. Auxiliary reservoir air then flows to chamber **K** on the spring side of release piston

110. With air pressure on each side of piston 110 thus balanced, release piston 110 and slide valve 114 are returned to release position by spring 120, allowing displacement reservoir air to flow to atmosphere through passages 3, 3a, through the cavity in slide valve 114 and exhaust passage 10.

While brake pipe pressure in chamber **A** on the face of the service piston does not increase after the brake valve handle is lapped, Fig. 16, auxiliary reservoir pressure in service slide valve chamber **C** is increasing owing to air flow from the emergency reservoir through passage 2, choke **R**, passage 2a, cavity **Z** in release interlock slide valve 127, passage 22, and release slide valve chamber **D** and thence through passage 5. Release interlock slide valve 127 is held in its upper position, maintaining connection between passages 2a and 22 through cavity **Z** as long as displacement reservoir pressure on the lower side of release interlock diaphragm 131 exceeds approximately six pounds.

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 94 and graduating valve 103 toward service position, until stopped by engagement of the tail end of the piston stem with the end of slide valve 102, as shown on Fig. 16. This is Graduated Release Lap position, in which cavity c in graduating valve 103 connects slide valve ports 13 and 32, thus venting the air from chamber **K** on the left side of release piston 110 through passage 13, cavity c in graduating valve 103, passage 32, cavity y,

in release interlock slide valve 127 to the interlock slide valve exhaust passage to atmosphere, "At." Auxiliary reservoir air pressure in chamber **D** then moves release piston 110 and slide valve 114 to the left, cutting off the cavity connecting displacement reservoir passage 3a and exhaust passage 10. This also blanks emergency reservoir seat port 22 to the auxiliary reservoir.

With the release slide valve exhaust thus closed, the air remaining in the displacement reservoir is retained and can be released in successive steps by graduated release operation. The amount of reduction in displacement reservoir pressure for any given graduation depends on the amount of air pressure that has been restored in the brake pipe, this condition existing until displacement reservoir pressure is reduced to approximately six pounds, at which point release interlock spring 142 moves release interlock slide valve 127 to the lower position.

In this position, Fig. 13, release interlock slide valve 127 cuts off cavity **Z** connection between passages 2a and 22, terminating auxiliary reservoir recharge from the emergency reservoir. Brake pipe pressure continues to build up in chamber **A** on the face of service piston 94 so that service slide valve 102 remains in release position, and the service piston and graduating valve 103 return to release position, where slide valve port **E** connects auxiliary reservoir air from slide valve chamber **C** to passage 13 and chamber **K** on the spring side of release piston 110. With auxiliary reservoir air also present in chamber **D** on the opposite face of the piston, spring 120 holds the piston and slide valve 114 in release position, where the cavity connects the displacement reservoir passage 3a to exhaust passage 10, fully releasing the brakes.

As the displacement reservoir is graduated off, the relay valve operates to reduce brake cylinder an equal amount.

FIRST SERVICE POSITION—Plate 9

This position is for use with long trains where excessive brake pipe leakage causes the brake pipe pressure to be progressively lower from front to rear of the train. First Service Position causes a normal, light initial reduction, then reduces the brake pipe at a slow, controlled rate and prevents an excessive difference in brake cylinder pressure between the front and rear. Sudden slack changes and shock are thus reduced.

With service application portion, when the brake valve handle is placed in First Service Position, equalizing reservoir air flows through passage 5, cavity Q, passage 4, through a restricted port in rotary valve 216 to passage 24a (through cock 42) leading to the reduction limiting reservoir, reducing equalizing reservoir pressure about six pounds as explained. Thereafter the reduction continues at a much slower rate through exhaust choke N (located in the application slide valve 114), which vents air from the reduction limiting reservoir passage 24.

In this manner the equalizing reservoir is reduced normally by an amount sufficient to initiate quick service on the train brakes, after which the reduction continues at a slow rate predetermined by the size of choke N or (111). The equalizing reservoir is connected by passage 5 to chamber D on the face of equalizing piston 77, while the brake pipe is connected by passages 1, 2 and 2b to chamber N on the opposite side of the piston. As pressure is reduced from the equalizing reservoir side of the piston 77, the higher brake pipe pressure moves the piston and carries the long end of operating lever 79 to the left. This causes the short end of the lever 79 to move down to engage with a collar on equalizing discharge valve 82 and unseat the valve, allowing brake pipe air to escape through passage 15, choke Y, passage 16, rotary valve 216 and the exhaust passage to atmosphere.

If the brake pipe pressure becomes slightly lower than equalizing reservoir pressure, which may be due to the too rapid reduction of brake pipe pressure on the front of the train, piston 77 will move to the right and allow the short end of lever 79 to move upward out of contact with equalizing discharge valve 82. Spring 83 will then cause the equalizing discharge valve to close and prevent further flow of brake pipe air past this valve.

With the handle of the brake valve in First Service Position, feed valve air in chamber A above brake rotary valve 216 is connected through the rotary valve, passage 14, cock 42 and 14a to maintaining valve 87.

If, for any reason, brake pipe pressure reduces at a faster rate than the controlled rate of equalizing reservoir pressure reduction imposed in First Service Position, brake pipe pressure acting on the right side of equalizing piston 77 will be less than equalizing reservoir pressure acting on the left side of the piston. This will cause the piston to move to the right, lever 79 will contact with maintaining valve 87 and move it from its seat, allowing feed valve air from passage 14a to flow into chamber N, thence through passage 2b to the brake pipe and prevent brake pipe pressure reducing at a faster rate than equalizing reservoir pressure is being reduced. This action causes the brake pipe pressure reduction to be slower throughout the train than would otherwise be possible, thereby accomplishing a more uniform control of the braking force and minimizing slack action.

First Service Position may be cut-out by turning cock 42 to "OUT" position, which closes seat passages 14a and 24 leading to the maintaining valve and the reduction limiting reservoir, respectively. First Service Position may then be used as a Lap Position, since the cut-out cock closes the active ports.

EMERGENCY POSITION—Fig. 17

In Emergency Position of the brake valve, rotary valve 216 connects the various passages as indicated in "Emergency" position of the "Position Diagram of Automatic Brake Valve." Emergency valve plunger 240 unseats emergency pilot valve 243, which permits emergency valve 241 to quickly unseat and provide a large and direct passage from the brake pipe and port 1 to the exhaust, so that an emergency rate of brake pipe reduction is obtained.

At the equalizing portion, the reduction of brake pipe pressure in chamber N permits the higher equalizing reservoir air pressure in chamber D to move piston 77 to the extreme right. This uncovers the by-pass port and connects chamber D to chamber N. The equalizing reservoir air then flows from chamber D to chamber N through passages 2b and 2 to brake pipe passage 1, which connects to atmosphere through emergency valve 241 as described above. Thus the equalizing reservoir air is connected and vented to atmosphere during emergency application.

In the service application portion of the automatic brake valve, cut-off valve 151 is balanced in Emergency Position of the brake valve by venting of the air from both ends of the cut-off valve piston. Air from below cut-off valve piston 146 flows through passage 2a and port t in the application slide valve 114 to join the air from the top of cut-off valve 151 in passage 2, thence through rotary valve 216 and the exhaust passage to atmosphere. Thus spring 155 holds the cut-off valve unseated, which will permit recharging of the brake pipe as soon as the brake valve handle is moved to Release or Running.

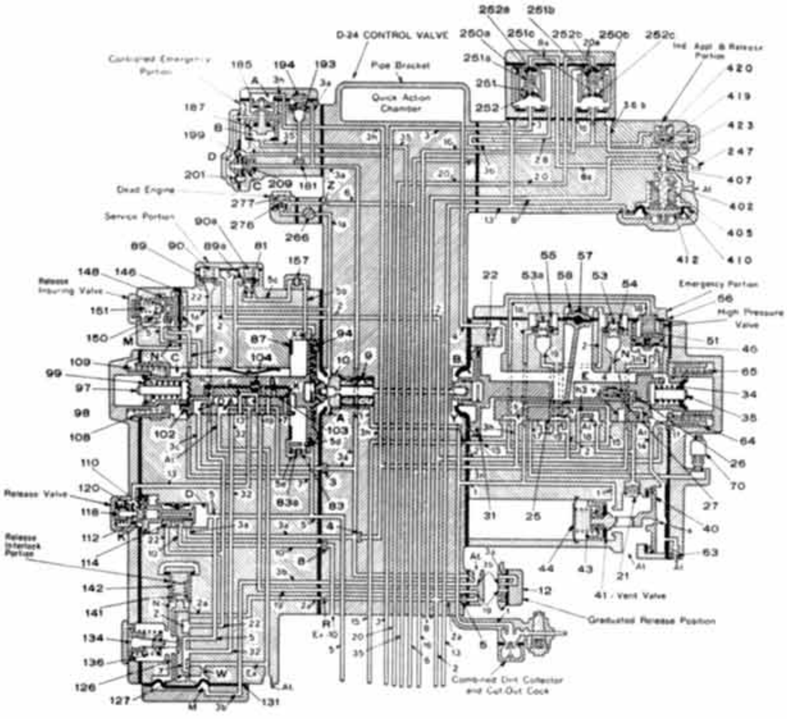


Fig. 17. D-24 Control Valve Diagrammatic—Controlled-Emergency Position

When an emergency rate of brake pipe reduction takes place from the brake valve or from any cause, Fig. 14, quick action chamber pressure cannot reduce through the vent port t in the D-24 Control Valve emergency graduating valve 26 and port v in the slide valve to atmosphere at the same rate; therefore, sufficient differential is built up across the emergency piston to compress spring 34 and allow graduating valve 26 to move

far enough on the slide valve to open port tl in the slide valve, which is connected with port 14 in the slide valve seat, allowing quick action chamber air to flow to the face of vent valve piston 40, Fig. 17. The resulting movement of this piston unseats vent valve 41, opening a large and direct passage from brake pipe passage 1 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 left position, Fig. 17, which carries slide valve port tl out of register with seat port 14. However, port 14 is now uncovered in the slide valve seat and quick action chamber pressure remains connected to the vent valve piston.

The emergency slide valve now connects the spring side of high pressure valve 46 to the exhaust port, At., through passage 18 and cavity h3 in the slide valve 25. This vents air pressure from the spring side of the high pressure valve. Emergency reservoir air in passage 2, acting on the outer area of the face, unseats valve 46, permitting emergency reservoir air to flow through passage 3h, 3a, and 3 to the displacement reservoir, the rate of flow being controlled by choke 4 in passage 3h. Meanwhile, the emergency rate of reduction in brake pipe pressure has caused service piston 94 and slide valve 102 to move to the extreme right, where graduating valve 103 uncovers the service port n, through which auxiliary reservoir air flows into passage 3c, choke 3, passage 3a and to 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 safety valve passage 17 is blanked by emergency slide valve 25, a higher displacement reservoir pressure is obtained than is possible from a full service application, which results in a higher brake cylinder pressure.

While quick action chamber air pressure is reducing through choke x in vent valve piston 40 and choke 63 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 44 will reseat the vent valve. The purpose of this is—first, to insure transmission of quick action, and second, to insure closure of the exhaust so that the brake pipe pressure can be restored when desired.

RELEASE AFTER EMERGENCY APPLICATION, ACCELERATED RELEASE POSITION—Fig. 18

When brake pipe pressure on the face of emergency piston 31 is restored at proper rate after emergency application, the piston moves to the right compressing return spring 65. Emergency slide valve 25 connects

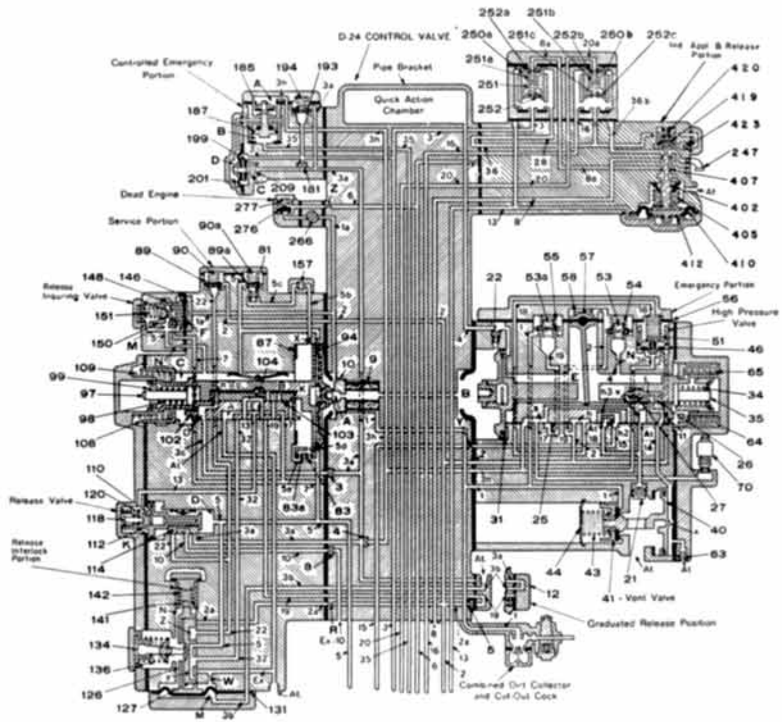


Fig. 18. D-24 Control Valve Diagrammatic—Release after Emergency-Accelerated Release Position

emergency reservoir pressure to the spring side of high pressure valve 46 through passage 2 cavity h, in slide valve 25 and passage 18. With air pressure thus balanced on the high pressure valve, spring 51 moves the valve to its seat, cutting off the supply of emergency reservoir air to the displacement and auxiliary reservoirs. No further change takes place in emergency reservoir pressure (after emergency application) until service slide valve 102 moves to release position and restores the auxiliary reservoir connection.

With the emergency slide valve in Accelerated Release position, the displacement reservoir is connected to the underside of rubber-seated check valve 53a through passages 3a, 3h, cavity s in the slide valve and passage 19.

Since the displacement reservoir and the auxiliary reservoir are connected, through port n in graduating valve 103 and cavity D in service slide valve 102 (which is still in application position), the pressure under check valve 53a is greater than brake pipe pressure above from passage 1. The check valve is therefore unseated and combined displacement reservoir and auxiliary reservoir air is permitted to flow through passage 1 into the brake pipe until these pressures are within a few pounds of equalization, thus providing a quick initial build-up of brake pipe pressure.

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

The quick action chamber is being charged through charging choke 22. Return spring 65 will move the emergency piston and slide valve from accelerated re-

lease to normal charging position as soon as the pressures on both sides of the emergency piston become substantially equal. This slide valve movement blanks port 19 in the seat. The accelerated release check valve seats and prevents 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, service piston 94 and slide valve 102 are moved to release position and the brake will be released and reservoirs recharged as previously described under "Release and Recharge after Service Application."

EMERGENCY WITH CONTROLLED BRAKE CYLINDER DEVELOPMENT FOR LONG TRAINS—Fig. 17

When a controlled build-up of emergency brake cylinder pressure is desired, the ROTAIR® Valve handle is moved to FRGT position (Freight), where main reservoir air from passage 30 flows through rotary valve 15 and controlled-emergency pipe 35 to the D-24 Control Valve, thence through passage 35 to chamber B below piston 187 of the controlled-emergency portion. Piston 187 is moved upward and unseats small check valve 185, thus connecting chamber D on the left side of the diaphragm 201 to chamber A and passage 3h.

When there is no brake application, passage 3h is connected to atmosphere through choke 4, passage 3a, slide valve 114, passage 10 and choke 8 to "Ex." However, when an emergency application is made, Fig. 17, emergency reservoir air in passage 3h flows to the controlled-emergency portion, chamber A, past unseated check valve 185 to chamber D. In chamber D, diaphragm 201 is moved to the right, compressing spring 209, seating valve 199, which disconnects passage 3a and 3. Thus the combined auxiliary and emergency reservoir air in passage 3a will flow through choke 181 to passage 3 and the displacement reservoir and relay valve. The controlled build-up of this air pressure and, therefore, of the brake cylinder pressure, is obtained at a rate determined by choke 181.

EMERGENCY WITH RAPID BRAKE CYLINDER PRESSURE DEVELOPMENT FOR SHORT TRAINS—Fig. 17

When a rapid build-up of brake cylinder pressure is desired the ROTAIR® Valve handle is moved to PASS position (Passenger), where controlled-emergency pipe 35 is connected by rotary valve 15 to Ex. Thus chamber B below piston 187 in the controlled-emergency portion of the D-24 Control Valve is connected to atmosphere, which will permit piston 187 to move down and seat check valve 185. Therefore, when an emergency application is made, emergency reservoir air from passage 3h and chamber A cannot flow past seated check valve 185 to chamber D. When the com-

bined auxiliary and emergency reservoir air in passage 3a reaches chamber C on the right hand side of valve 199, diaphragm 201 and valve 199, held to the left by spring 209, permit the air to flow unrestricted from passage 3a to passage 3 and the displacement reservoir and relay valve. Thus a fast build-up of brake cylinder air pressure is obtained.

INDEPENDENT BRAKE VALVE IN RELEASE POSITION—Plate 4

The cam on independent brake valve shaft 11 engages pusher 68 attached to floating levers 67. In Release Position of the brake valve, the cam is at lowest position so that the balance levers float freely and inlet valve spring 51 holds inlet valve 50 seated, and spring 63 unseats exhaust valve 64 opening the brake valve chamber B to atmosphere, "At." Poppet valve 25 is held unseated by dog 15 controlled from the cam of the brake valve shaft, thereby connecting independent application and release pipe 20 into the brake valve chamber B, and thence past exhaust valve 64 to atmosphere. Spring 106 holds plunger 17 unseated, opening actuating pipe 13 to atmosphere.

In the independent application and release portion of the control valve, the chamber under diaphragm piston 412 is open to atmosphere, via actuating pipe 13, at the independent brake valve. Diaphragm spring 405 thus holds the diaphragm piston in its lower position.

INDEPENDENT BRAKE APPLICATION—
Plate 4 and Fig. 19

To obtain an independent brake application, move handle 38 of the independent brake valve to the right. The farther the movement the greater the pressure obtained in the brake cylinders. As the handle is moved to the right the cam on shaft 11 moves pusher 68 and attached lever 67 the ends of which are positioned on inlet valve 50 and exhaust valve 64. Spring pressure, plus air pressure acting to hold inlet valve 50 closed, is stronger than the spring pressure acting to hold exhaust valve 64 open; therefore, the first movement of the handle cam to move the floating lever causes exhaust valve 64 to close, cutting off the brake valve exhaust to atmosphere, "At." Further movement of the brake valve handle to the right causes additional movement of the floating lever, which now fulcrums on closed exhaust valve 64 and opens inlet valve 50, allowing main reservoir air from passage 30 to flow into chamber B of the brake valve and thence past unseated valve 25 to passages 20 and 44 to the ROTAIR® Valve. At the ROTAIR Valve, rotary valve 15 connects passage 44 to application and release pipe 20.

As air pressure builds up in chamber B of the independent brake valve, it acts upon spring-loaded piston 59, which forms the exhaust valve seat, and moves the piston and exhaust valve 64 against the force of regulating spring 58, the exhaust valve thus remaining closed. The exhaust valve end of floating lever 67 moves with the exhaust valve and piston until regulating

spring 58 is compressed sufficiently to balance the cam pressure on the lever, after which the application valve end of the lever moves away from inlet valve 50, which is then closed by its spring 51. In this manner the self-lapping unit operates to quickly and accurately build up pressure in the application and release pipe corresponding to the position of the brake valve handle in the Application Zone.

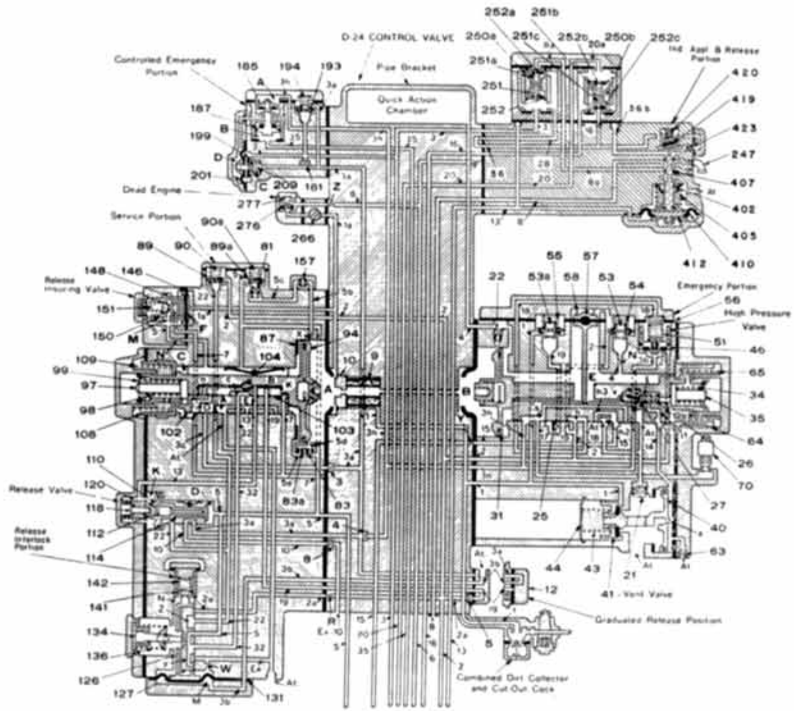


Fig. 19. D-24 Control Valve Diagrammatic—
Independent Brake Application Position

At the D-24 Control Valve, Fig. 19, the air from the application and release pipe flows through passages 20 and 20a to the upper face of check valve 252b. Thus check valve 252b is moved downward to seat lower check valve 252c, sealing off the displacement reservoir and automatic passage 36, and uncovering passage 16 to the relay valve, which develops brake cylinder pressure.

INDEPENDENT BRAKE RELEASE DURING AN AUTOMATIC APPLICATION—Fig. 20

An automatic brake application may be independently released on the locomotive by depressing the independent brake valve handle in Release Position.

At the D-24 Control Valve, with the automatic brake applied, application pressure in passage 16 from the displacement reservoir flows to the underside of quick release check valve 419. This valve remains seated because its spring 420 exerts a greater force than the application pressure underneath.

When the independent brake valve handle 38 is depressed, it contacts upper plunger 20 which depresses springs 29 and 19 and moves valve plunger 17 downward on its seat, closing the actuating pipe exhaust passage 13. Simultaneously, valve plunger 17 unseats pilot valve 105. Thus main reservoir air from passage 30 is connected to passage 13 and the ROTAIR® Valve, the actuating pipe and the D-24 Control Valve.

At the control valve, actuating pipe air reaches the chamber under diaphragm piston 412 by way of passage

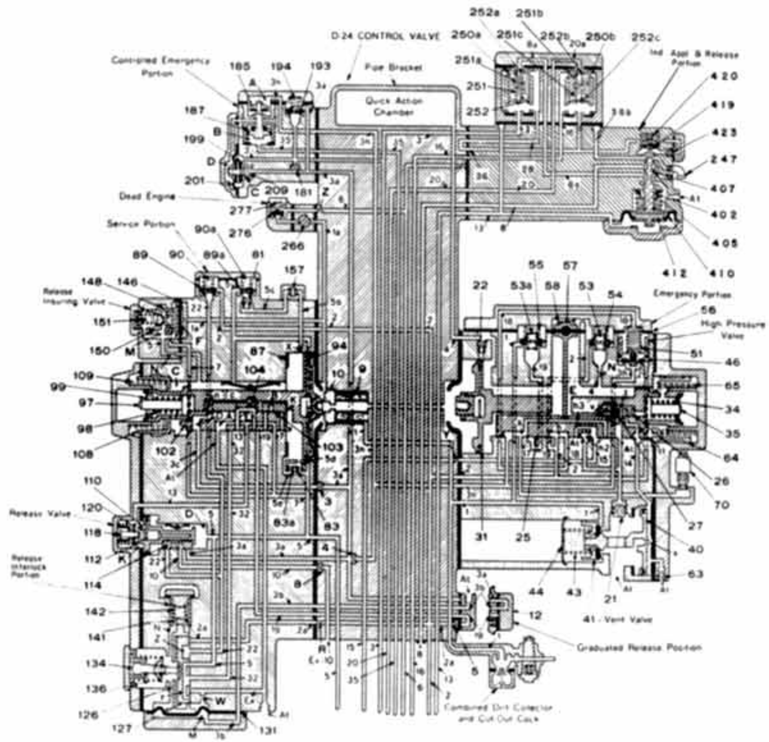


Fig. 20. D-24 Control Valve Diagrammatic—Independent Brake Release after an Automatic Application

13. Because this pressure is greater than the tension of springs 405 and 420, the diaphragm piston is moved to its upper position, which unseats check valve 419. Application pressure in passage 16 is vented to atmosphere at elbow exhaust 247, releasing the locomotive brakes through the relay valve.

GRADUATED INDEPENDENT BRAKE RELEASE AFTER AUTOMATIC APPLICATION—Fig. 20

The locomotive brake cylinder pressure may be graduated off by depressing the independent brake valve handle in the Application Zone, the amount of pressure retained being that amount corresponding to the handle position. When the independent brake valve handle is depressed, brake cylinder pressure will be reduced to zero and will reapply to the value equivalent to the handle position. Just as the pressure is increased in independent application by moving the handle forward in the Application Zone, so it may be decreased after an automatic application by depressing the handle in the Application Zone and moving it toward Release.

INDEPENDENT BRAKE RELEASE AFTER AN ELECTRO-PNEUMATIC APPLICATION—Fig. 21

An electro-pneumatic brake application may be independently released on the locomotive by depressing the independent brake valve handle in Release Position. If the brake valve handle is released, the brakes will reapply.

At the D-24 Control Valve, with electro-pneumatic brake applied, application pressure in passage 16 from passage 8a and the straight air pipe is under check valve 419. This valve remains seated because its spring 420 exerts a greater force than the application pressure underneath.

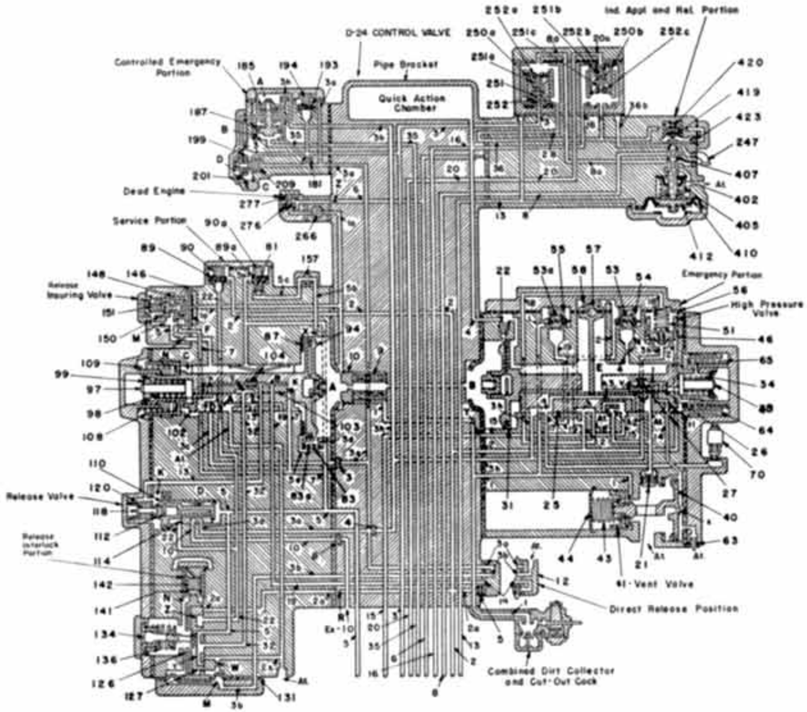


Fig. 21. D-24 Control Valve Diagrammatic—Independent Brake Release after an Electro-Pneumatic Application

When independent brake valve handle 38 is depressed, it contacts upper plunger 20, which depresses springs 29 and 19 and moves valve plunger 17 downward on its seat, closing the actuating pipe exhaust 13. Simultaneously, valve plunger 17 unseats pilot valve 105. Thus main reservoir air from passage 30 is connected to passage 13 and the ROTAIR® Valve, the actuating pipe and the D-24 Control Valve.

At the control valve, actuating pipe air reaches the chamber under diaphragm piston 412 by way of passage 13. Because this pressure is greater than the tension of springs 405 and 420, the diaphragm piston is moved to its upper position, which unseats check valve 419. With passage 16 now connected to atmosphere at elbow exhaust 247, and electro-pneumatic application air from passage 8 and the straight air pipe cut off from the relay valve by valve stem 402, the locomotive brakes must release.

ELECTRO-PNEUMATIC BRAKE OPERATION—Plates 6 and 7

When operating the electro-pneumatic brake, the brake valve shifter lever 268 is shifted to straight air position, with the letters "SA" exposed to view. To move the shifter lever, the brake valve handle is first placed in Running Position. Then pull out the shifter lever latch and swing the shifter lever to the "SA" position. Release the stop pin into the hole in the brake valve body casting. The selector key 253 is thus disengaged from the quadrant 247 operating rotary valve 216 in automatic service, and engages cam 254 for operating the self-lapping portion in electro-pneumatic service. Running and charging positions are identical to those in automatic operation except that the brake valve handle cannot be placed in Release Position.

BRAKE APPLICATION—Plate 6 and Fig. 22

When a brake application is made, the brake valve handle is moved to the right out of Running Position

into the Application Zone. This rotates shaft 257 and engaged selector collar key 253. Thus cam 254 is rotated, which moves dog 229, pusher 336 and the attached lever 333, the ends of which are positioned on the inlet valve 315 and exhaust valve 329. The first movement of the cam causes the exhaust valve 329 to close, cutting off the exhaust opening to "At," atmosphere. Further movement of the brake valve handle to the right causes additional movement of the floating lever now fulcrumed on the closed exhaust valve to open inlet valve 315, allowing main reservoir air from passage 30 to flow into chamber Y and thence to control pipe 11.

As the air pressure builds up in chamber Y, it acts upon spring-loaded piston 322, which forms the exhaust valve seat, and moves the piston and exhaust valve 329 to the left against the force of regulating spring 321, the exhaust thus remaining closed. The exhaust end of lever 333 moves with the exhaust valve and piston until the regulating spring 321 is compressed sufficiently to balance the cam pressure on the lever, after which the application end of the lever moves away from the inlet valve, which is then closed by spring 316. Thus the self-lapping unit operates to build up pressure in control pipe 11 corresponding to the position of the brake valve handle in the Application Zone.

The air pressure developed in control pipe 11, by the positioning of the brake valve handle in the Application Zone, builds up and flows to chamber B of the electro-pneumatic Master Controller. This deflects application diaphragm 18 to the right and thus moves shaft 32 and its contact levers 40 and 41. As spring 24 is compressed, lever 41 first closes release contact, (Rel.) after which spring 23 is compressed, and lever 40 closes application contact, (Appl.), thereby energizing the release and application wires, which are connected to application and release magnet valves of the No. 21-B Magnet and Bracket. The armature of the No. 21-B Magnet is pulled down against spring pressure beneath the valves; release magnet valve 62 is seated, closing off the straight air pipe exhaust passage x in the magnet bracket, and application magnet valve 34 is unseated, opening passage 6a to 4b. Auxiliary reservoir air thus flows to the straight air pipe, building up the straight air pipe pressure.

Cut-off valve 5 of the No. 21-B Magnet is held unseated by spring 17, permitting auxiliary reservoir air flow to passage 6a as long as auxiliary reservoir pressure exceeds approximately 75 pounds, which is the value of spring 10.

In the event of straight air pipe breakage or abnormal magnet valve operation, which would result in loss of auxiliary reservoir air, spring 10 will seat valve 5 and thus retain 75 pounds auxiliary reservoir pressure. This is sufficient to permit an effective pneumatic brake application.

The brake valve rotary valve 216 remains in charging position to maintain the pressure in the pneumatic system. Thus the brake pipe pressure is higher

on the face of the control valve service piston during applications than auxiliary reservoir air pressure back of the piston since auxiliary reservoir air pressure is reduced into the straight air pipe at the No. 21-B Magnet Valve. Consequently, the service piston remains in release position during an electro-pneumatic service brake application.

The straight air pipe is connected through choke 11 to chamber **A** on the face of the Master Controller release diaphragm 18a. As pressure is built up in the straight air pipe, it acts on the release diaphragm in opposition to the control pipe pressure in chamber B, acting on the application diaphragm 18. When the air pressure acting on these diaphragms becomes balanced, spring 23 moves the diaphragm, shaft 32 and lever 40 to lap position, breaking the application wire contact, (Appl.). The application magnet circuit is thus deenergized and spring 35a closes application magnet valve 34 of the No. 21-B Magnet. Spring 24 of the Master Controller remains compressed, however, so the release contact, (Rel.), of the Master Controller remains closed, energizing the release wire and 21-B release magnet, holding release magnet valve 62 seated and retaining the pressure in the straight air pipe approximately equal to that in the control pipe. If pressure in the control pipe is increased by further brake valve handle movement, straight air pipe pressure is increased an equal amount by the application operation of the Master Controller as described.

The straight air pipe also connects to connection 8

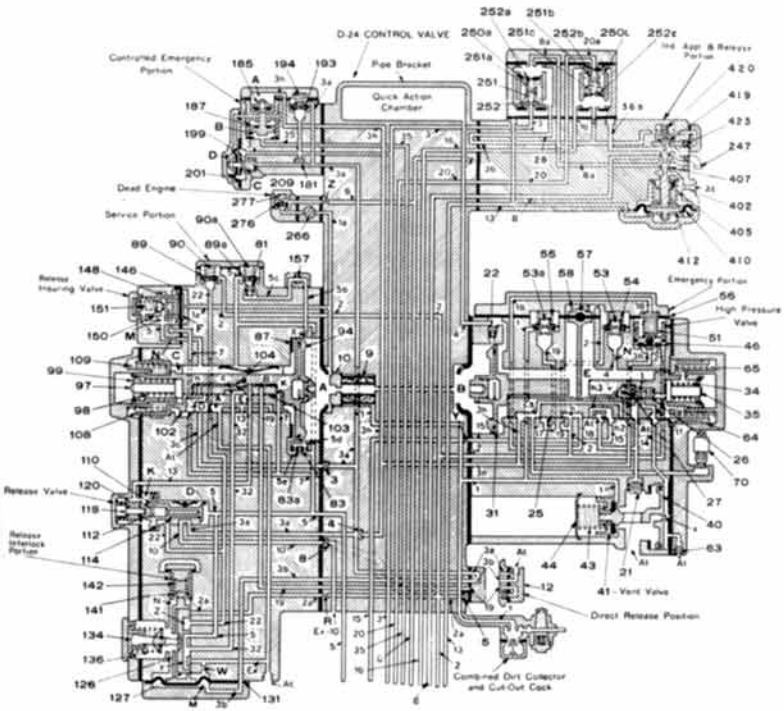


Fig. 22. D-24 Control Valve Diagrammatic—
Electro-Pneumatic Straight Air Brake Application

of the control valve, Fig. 22. Thus air from the 21-B Magnet Valve flows through pipe 8, passage 8, through valve stem 402, and passage 8a to the top of the double check valve 252a. This seats lower check valve 252, sealing off passage 3 which is open through the cavity of release slide valve 114 to exhaust passage 10, and unseats upper check valve 252a, so that air from the straight air pipe flows through passages 28, 36 and 16 to the relay valve (see relay valve operation).

RELEASE AFTER ELECTRO-PNEUMATIC BRAKE APPLICATION

After making a brake application, the braking force may be reduced by moving the brake valve handle toward Running Position, and fully released by placing the handle in Running Position.

As the brake valve is moved toward Running Position, the cam 254 moves away from floating lever 333 of the self-lapping unit. The lever then pivots on the closed inlet valve 315 and the discharge valve spring 328 moves the discharge valve 329 away from its seat, allowing control pipe 11 air to flow to atmosphere through the brake valve exhaust port. If the brake valve handle is moved only part way toward Running, control pipe pressure in the brake valve cavity Y and acting on the piston type discharge valve seat 322 will be partially reduced, and the regulating spring 321 will move the seat into contact with the discharge valve and prevent further flow of air from the control pipe. With the brake valve handle in Running Position, the cam 254 is moved away from the floating lever and the discharge valve spring holds its valve 329 open to vent all air pressure from the control pipe.

As the control pipe pressure in chamber B acting on diaphragm 18 of the Master Controller is reduced below the straight air pipe pressure in chamber A on the face of release diaphragm 18a, shaft 32 of the Master Controller lever 41 are moved and the release (Rel.) contact opens to de-energize the release wire and, therefore, the release magnet of the 21-B Magnet Valve. Spring 35 then unseats release magnet valve 62 of the 21-B Magnet Valve, opening the exhaust so that pressure from passage 4a, the straight air pipe and the relay valve is reduced the same amount that control pipe 11 pressure is reduced.

In making a graduated release the relay portion will lap and retain brake cylinder pressure in accordance with the lapping action of the Master Controller so that the brake cylinder pressure can be released in small increments to produce a smooth stop.

EMERGENCY APPLICATION

An emergency brake application may be obtained by moving the handle of the brake valve to its extreme right position. The self-lapping portion of the brake valve produces electro-pneumatic application as described under service brake operation. However, in this handle position, emergency valve 241 and its pilot valve 243 are unseated by a cam on the brake valve handle shaft, allowing air from passage 1 and the brake pipe to escape rapidly to exhaust, Ex. This provides an emergency rate of brake pipe reduction that is transmitted to the control wire, which is operated to produce automatic emergency pressure in the brake cylinder.

Thus when an emergency rate of brake pipe reduction takes place from the brake valve or from any cause, Fig. 14, quick action chamber pressure cannot reduce

through the vent port t in the D-24 Control Valve emergency graduating valve 26 and port v in the slide valve to atmosphere at the same rate; therefore, sufficient differential is built up across the emergency piston to compress spring 34 and allow graduating valve 26 to move far enough on the slide valve to open port t1 in the slide valve which is connected with port 14 in the slide valve seat, allowing quick action chamber air to flow to the face of vent valve piston 40, Fig. 17. The resulting movement of this piston unseats vent valve 41, opening a large and direct passage from brake pipe passage 1 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 or other cars to emergency position.

The rapid reduction of brake pipe pressure causes the emergency piston and slide valve to move to the extreme left position, Fig. 17, which carries slide valve port t1 out of register with seat port 14. Port 14 is now uncovered by the emergency slide valve 25 so that quick action chamber pressure remains connected to the vent valve piston.

The emergency slide valve now connects the spring side of high pressure valve 46 to the exhaust port, At., through passage 18 and cavity h3 in the slide valve 25, Fig. 17. This vents air pressure from the spring side of the high pressure valve. Emergency reservoir air in passage 2, acting on the outer area of the face, unseats valve 46, permitting emergency reservoir air to flow through passages 3h, 3a and 3 to seated check valve 252, the rate of flow being controlled by choke 4 in passage 3h. Meanwhile, the emergency rate of reduction in brake pipe pressure has caused the service piston 94 and slide valve 102 to move to the extreme right where the graduating valve 103 uncovers the service port n, through which auxiliary reservoir air flows into passage 3c, 3a and 3, combining with the flow from the emergency reservoir. The combined auxiliary and emergency reservoir air pressure moves the double check valve upward, seating check valve 252a to cut off the straight air passage 8a, and unseating lower check valve 252. Thus the combined auxiliary and emergency reservoir air flows to the displacement reservoir and relay valve, which is thereby operated to produce brake cylinder pressures as adjusted by the speed governor.

Both the emergency and the auxiliary reservoirs equalize into the displacement reservoir during emergency, and the safety valve passage 17 is blanked by the emergency slide valve 25.

While quick action chamber air is reducing through choke x in vent valve piston 40 and choke 63 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 43 will reseat the vent valve. The purpose of this is to insure proper operation of the quick action parts.

WESTINGHOUSE AIR BRAKE COMPANY

AIR BRAKE DIVISION

Wilmerding, Pa., U. S. A.

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Plate 1 Cock Handle Positions for Operation of 24-RL Equipment in Various Types of Service

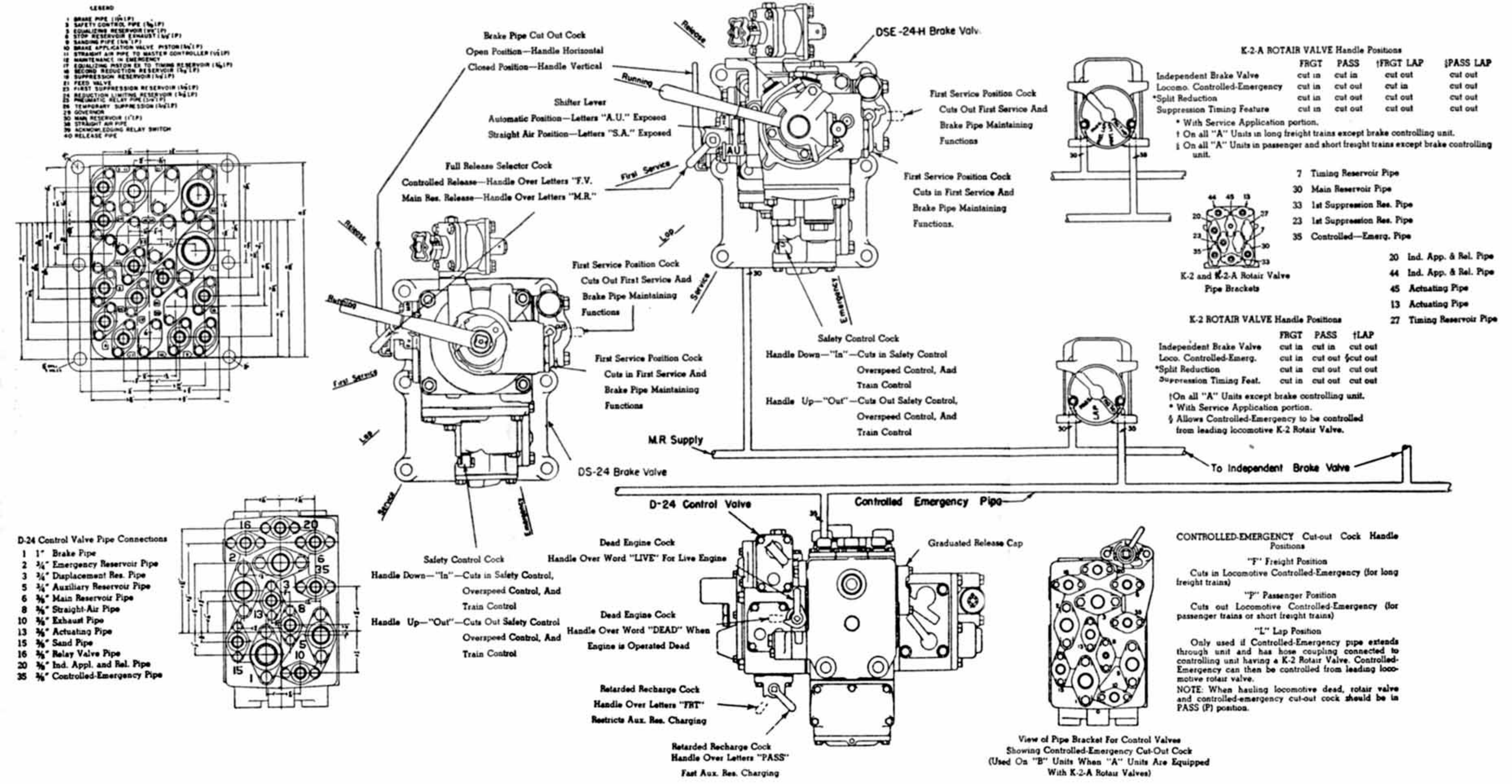

Plate 1 Cock Handle Positions for Operation of 24-RL Equipment in Various Types of Service

LOCATION OF COCKS AND VALVES

Cocks And Valves	New Brake Valve	Converted Brake Valve
Brake Pipe Cut-Off	Filling Piece Portion	Filling Piece Portion
Safety Control	Application Portion	Application Portion
Maintaining Cut-Off	Application Portion	Filling Piece Portion
First Service	Filling Piece Portion	Filling Piece Portion
Selector Cock	Rotary Valve and Seat	Rotary Valve and Seat

	Legend		Legend
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
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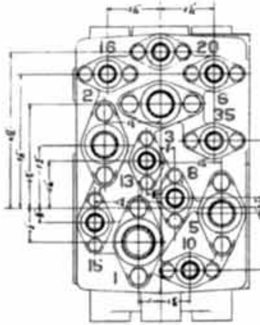
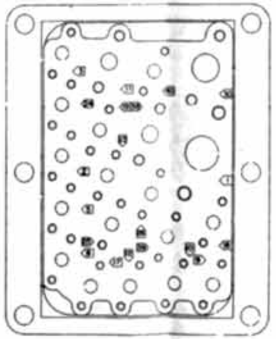
[illegible]	[illegible]		

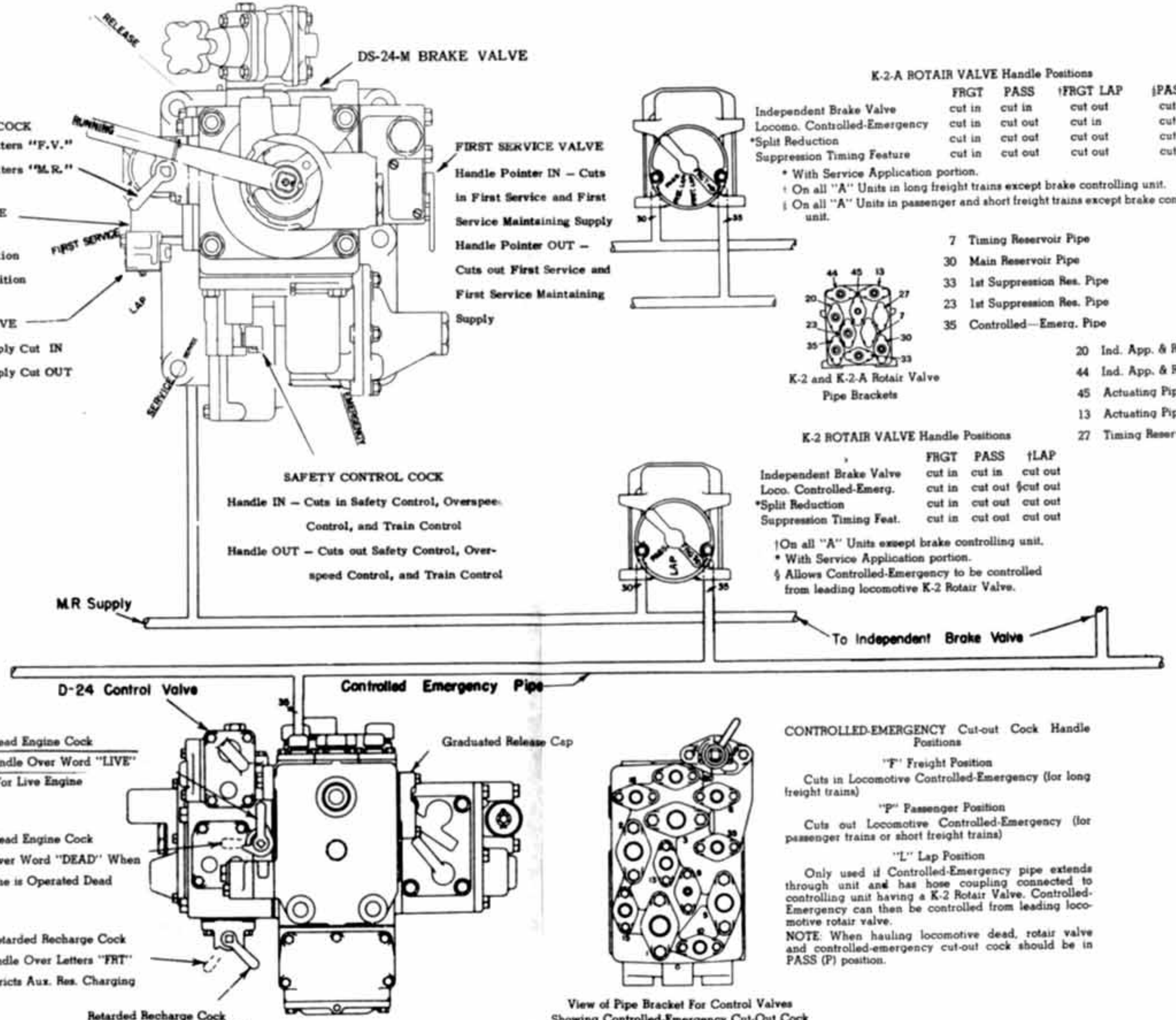
D-24 Control Valve Pipe Connections

1 1" Brake Pipe
2 ¾" Emergency Reservoir Pipe
3 ¾" Displacement Res. Pipe
5 ¾" Auxiliary Reservoir Pipe
6 ⅜" Main Reservoir Pipe
8 ⅜" Straight-Air Pipe
10 ⅜" Exhaust Pipe
13 ⅜" Actuating Pipe
15 ⅜" Sand Pipe
16 ⅜" Relay Valve Pipe
20 ⅜" Ind. Appl. and Rel. Pipe
35 ⅜" Controlled-Emergency Pipe





PIPE BRACKET
D-24-M Type Brake Valve



K-2-A ROTAIR VALVE Handle Positions

	FRGT	PASS	†FRGT LAP	‡PASS LAP
Independent Brake Valve	cut in	cut in	cut out	cut out
Locomo. Controlled-Emergency	cut in	cut out	cut in	cut out
*Split Reduction	cut in	cut out	cut out	cut out
Suppression Timing Feature	cut in	cut out	cut out	cut out

* With Service Application portion.
† On all "A" Units in long freight trains except brake controlling unit.
‡ On all "A" Units in passenger and short freight trains except brake controlling unit.

7 Timing Reservoir Pipe
30 Main Reservoir Pipe
33 1st Suppression Res. Pipe
23 1st Suppression Res. Pipe
35 Controlled—Emerg. Pipe
20 Ind. App. & Rel. Pipe
44 Ind. App. & Rel. Pipe
45 Actuating Pipe
13 Actuating Pipe
27 Timing Reservoir Pipe

K-2 ROTAIR VALVE Handle Positions

	FRGT	PASS	†LAP
Independent Brake Valve	cut in	cut in	cut out
Loco. Controlled-Emerg.	cut in	cut out	§cut out
*Split Reduction	cut in	cut out	cut out
Suppression Timing Feat.	cut in	cut out	cut out

†On all "A" Units except brake controlling unit.
* With Service Application portion.
§ Allows Controlled-Emergency to be controlled from leading locomotive K-2 Rotair Valve.

CONTROLLED-EMERGENCY Cut-out Cock Handle Positions

"F" Freight Position

Cuts in Locomotive Controlled-Emergency (for long freight trains)

"P" Passenger Position

Cuts out Locomotive Controlled-Emergency (for passenger trains or short freight trains)

"L" Lap Position

Only used if Controlled-Emergency pipe extends through unit and has hose coupling connected to controlling unit having a K-2 Rotair Valve. Controlled-Emergency can then be controlled from leading locomotive rotair valve.

NOTE: When hauling locomotive dead, rotair valve and controlled-emergency cut-out cock should be in PASS (P) position.

View of Pipe Bracket For Control Valves Showing Controlled-Emergency Cut-Out Cock (Used On "B" Units When "A" Units Are Equipped With K-2-A Rotair Valves)

Plate 2 Handle Positions, 24-RL Equipment With Pressure Maintaining Brake Valve

LEAD "A" UNIT					"B" UNIT			TRAILING "A" UNIT				
K-2 ROTAIR			K-2-A ROTAIR					K-2 ROTAIR			K-2-A ROTAIR	
No. 35 Pipe Thru	No. 35 Pipe Thru Selector Cock on C.V.		No. 35 Pipe Not Thru	No. 35 Pipe Thru	No. 35 Pipe Thru No Selector Cock on Control Valve	No. 35 Pipe Thru Selector Cock on C.V.	No. 35 Pipe Not Thru Selector Cock on C.V.	No. 35 Pipe Thru	No. 35 Pipe Thru Selector Cock on C.V.		No. 35 Pipe Not Thru	No. 35 Pipe Thru
Rotair Pos.	Rotair Pos.	Cock Pos.	Rotair Pos.	Rotair Pos.		Cock Position	Cock Position	Rotair Pos.	Rotair Pos.	Cock Pos.	Rotair Pos.	Rotair Pos.
Frt.					Controlled From Lead Unit			Lap	Lap	Lap	Frt. Lap 2	Frt. Lap
Pass.					Controlled From Lead Unit			Lap	Lap	Lap	Pass. Lap 2	Pass. Lap
Frt.						Lap		Lap	Lap	Lap	Frt. Lap 2	Frt. Lap
Pass.						Lap		Lap	Lap	Lap	Pass. Lap 2	Pass. Lap
Frt.							Frt.	Lap 3	Lap	Frt.	Frt. Lap	Frt. Lap 1
Pass.							Pass.	Lap 3	Lap	Pass.	Pass. Lap	Pass. Lap
	Frt.	Lap			Controlled From Lead Unit			Lap	Lap	Lap	Frt. Lap 2	Frt. Lap
	Pass.	Lap			Controlled From Lead Unit			Lap	Lap	Lap	Pass. Lap 2	Pass. Lap
	Frt.	Lap				Lap		Lap	Lap	Lap	Frt. Lap 2	Frt. Lap
	Pass.	Lap				Lap		Lap	Lap	Lap	Pass. Lap 2	Pass. Lap
	Frt.	Lap 1					Frt.	Lap 3	Lap	Frt.	Frt. Lap	Frt. Lap 1
	Pass.	Lap 1					Pass.	Lap 3	Lap	Pass.	Pass. Lap	Pass. Lap
			Frt.		Control Dependent on			Lap 3 4	Lap	Frt. 8	Frt. Lap 8	Frt. Lap 6
			Pass.		Trailing "A" Unit			Lap 3	Lap	Pass. 5	Pass. Lap	Pass. Lap
			Frt.			Frt.		Lap 3 7	Lap	Frt.	Frt. Lap	Frt. Lap
			Pass.			Pass.		Lap 3	Lap	Pass.	Pass. Lap	Pass. Lap
			Frt.				Frt.	Lap 3 7	Lap	Frt.	Frt. Lap	Frt. Lap
			Pass.				Pass.	Lap 3	Lap	Pass.	Pass. Lap	Pass. Lap
				Frt.	Controlled From Lead Unit			Lap	Lap	Lap	Frt. Lap 2	Frt. Lap
				Pass.	Controlled From Lead Unit			Lap	Lap	Lap	Pass. Lap 2	Pass. Lap
				Frt.		Lap		Lap	Lap	Lap	Frt. Lap 2	Frt. Lap
				Pass.		Lap		Lap	Lap	Lap	Pass. Lap 2	Pass. Lap
				Frt. 1			Frt.	Lap 3	Lap	Frt. 1	Frt. Lap	Frt. Lap 1
				Pass.			Pass.	Lap 3	Lap	Pass.	Pass. Lap	Pass. Lap

1 Close No. 35 Cut-out Cock at end of unit.

2 Close No. 35 cut-out cock at rear of preceding unit.

3 Open No. 35 cut-out cock at end of unit.

4 Controlled Emergency available only on Lead Unit.

5 Cock may be placed in Lap if No. 35 pipe cut-out cocks are open to At.

6 By connecting No. 35 pipes between units, Controlled Emergency is available on "A" Unit. Feature can be annulled from Lead Unit.

7 Controlled Emergency not available on Trailing "A" Unit.

8 Controlled Emergency available only on Lead and Trailing "A" Units.

Plate 3 ROTAIR® Valve Position Combinations

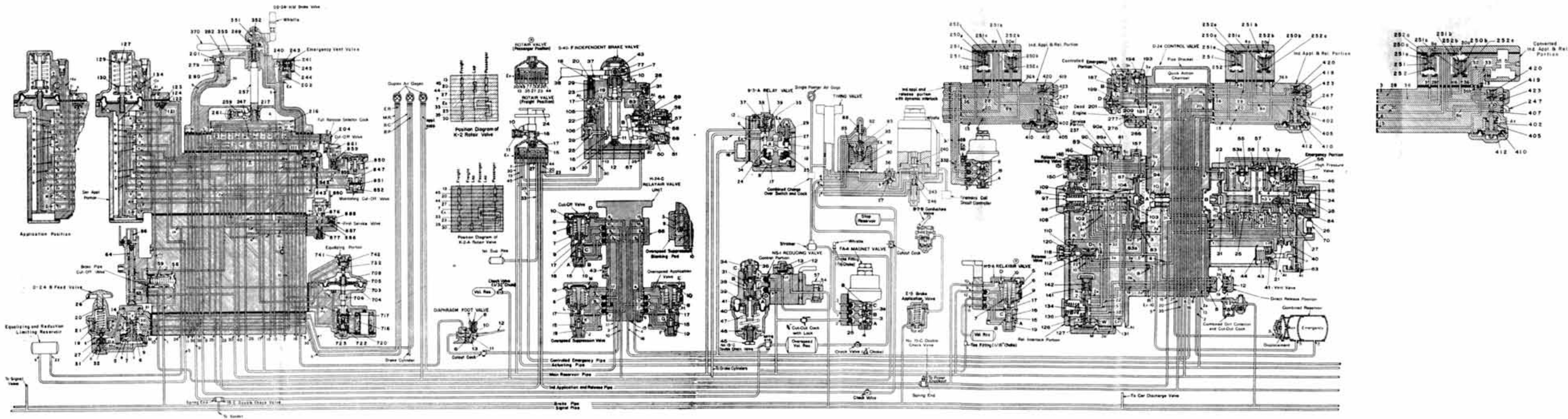


Plate 4 Diagrammatic—24-RL Locomotive Brake Equipment with DS-24-HM Brake Valve and Four-Face RELAYAIR® Valve Unit

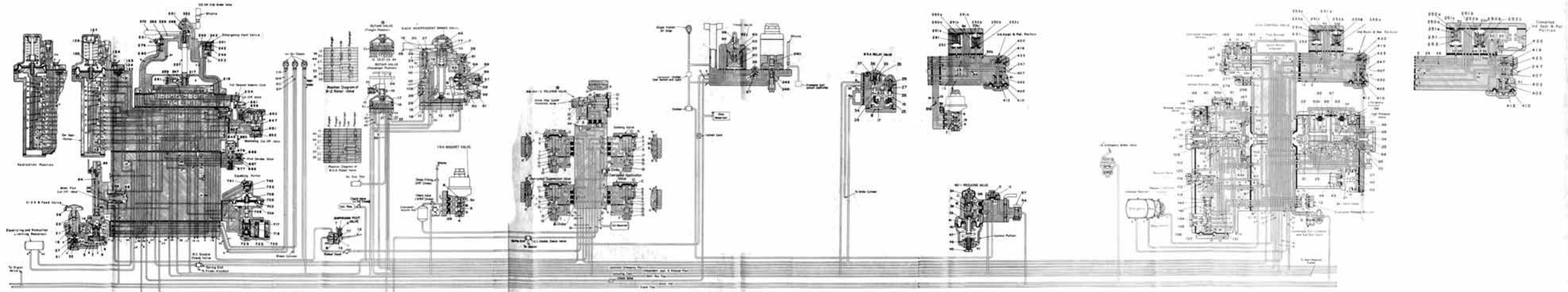


Plate 5 Diagrammatic—24-RL Locomotive Brake Equipment, A Unit with DS-24-HM Brake Valve and Five-Face RELAYAIR® Valve Unit

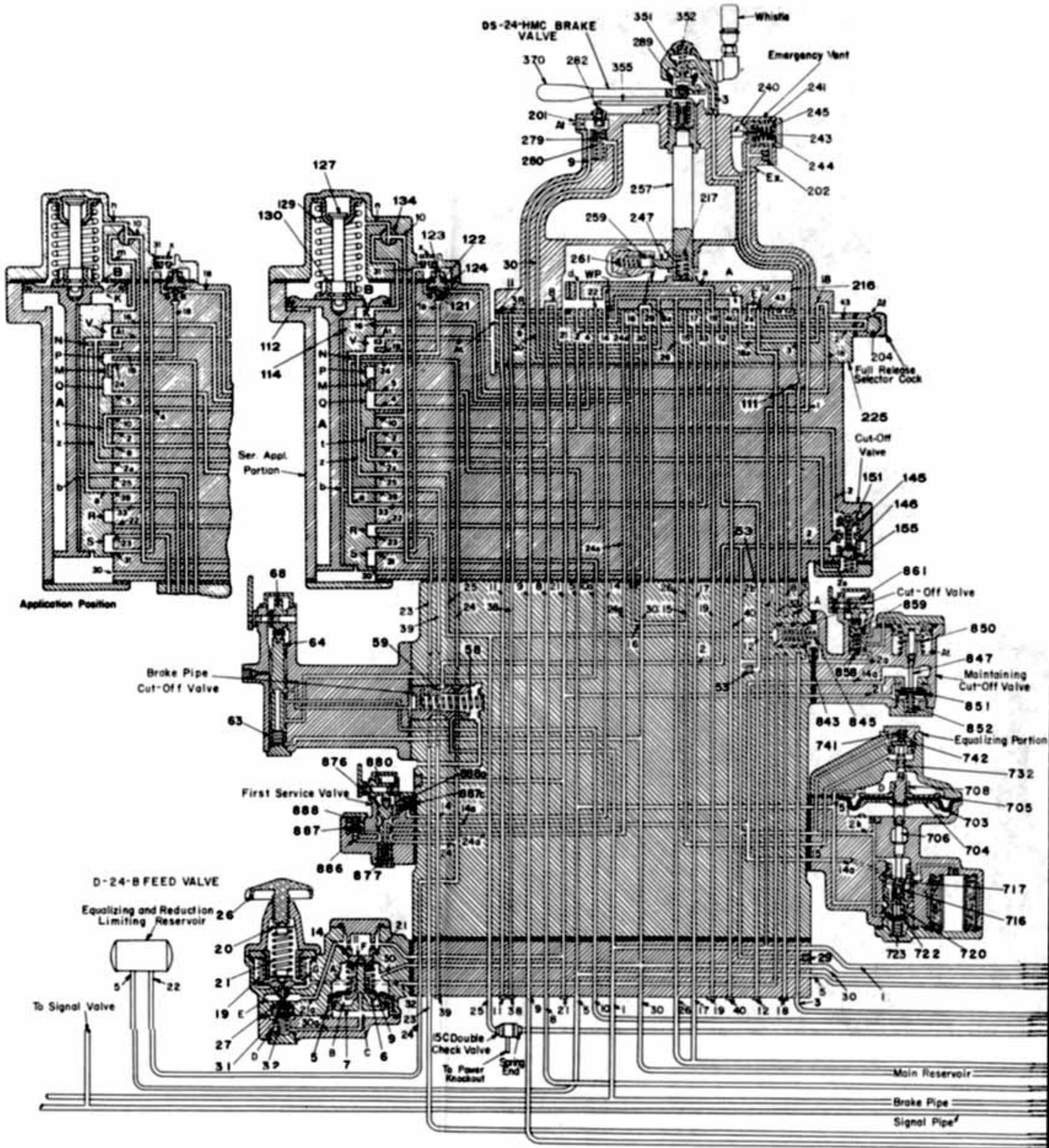


Plate 5A Overlay—DS-24-HMC Brake Valve

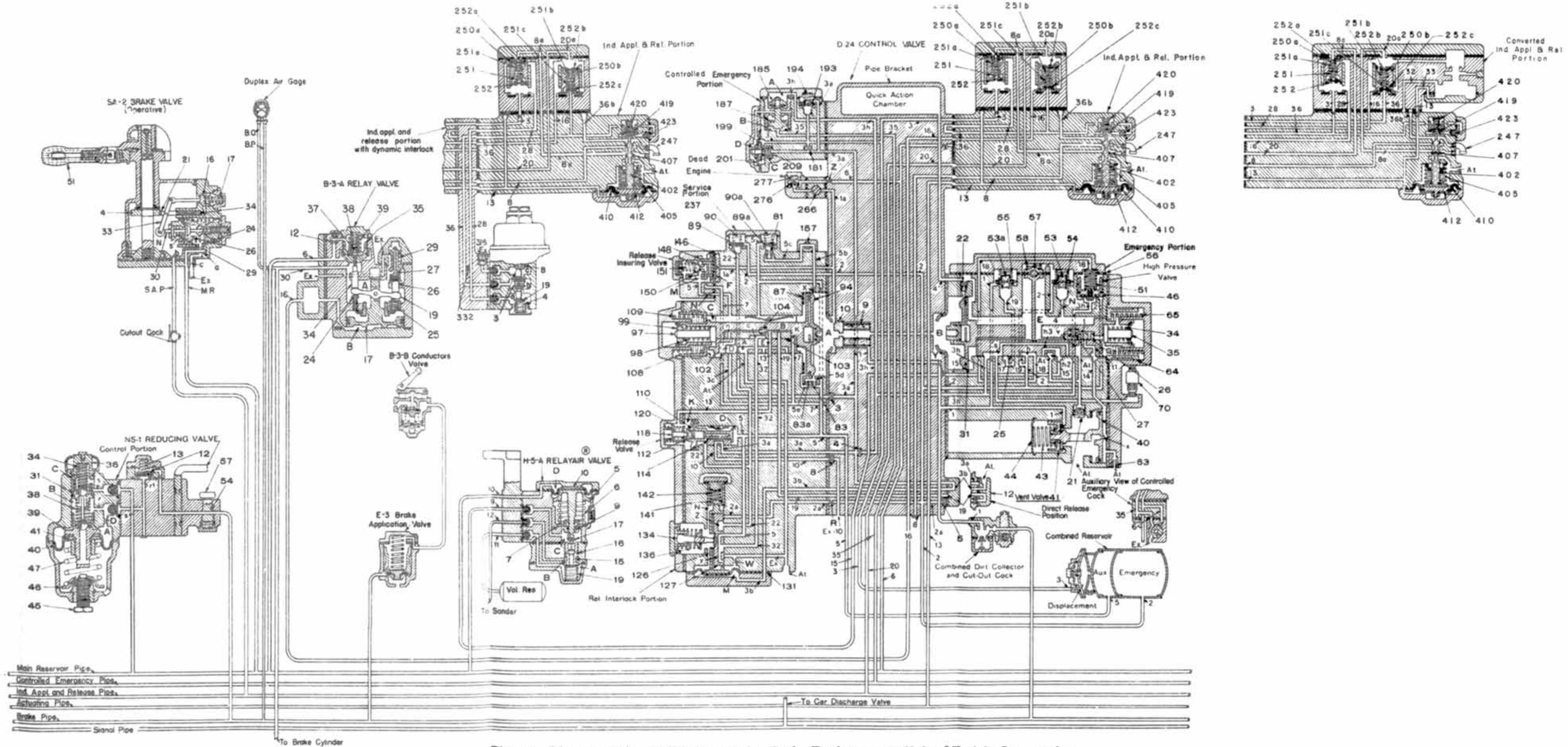


Plate 8 Diagrammatic—24-RL Locomotive Brake Equipment, B Unit of Freight Locomotive.

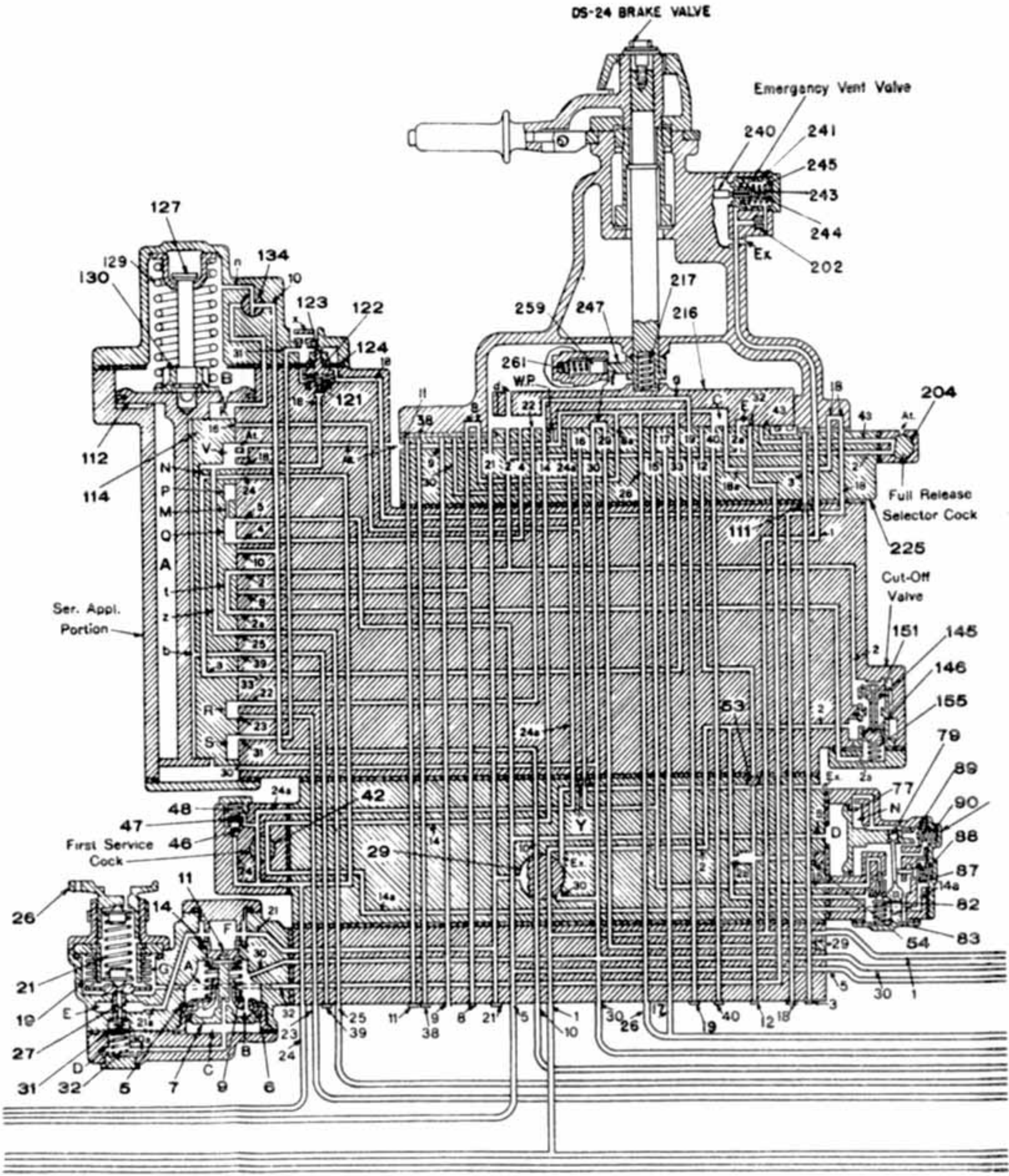


Plate 9. Diagrammatic—Supplemental View of DS-24 Brake Valve for Freight Service