WESTERN PACIFIC RAILROAD MUSEUM

AIR BRAKE PRINCIPLES
AND
SPECIFIC EQUIPMENT

From Original Operating Department Training Manual - 1974

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SPECIFIC EQUIPMENT

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INTRODUCTION

It is the purpose of this manual to provide a locomotive engineer with the knowledge of air brake equipment so he can operate a locomotive or train in a safe and efficient manner.

Section I covers the principles of all air brake equipment. Section II is devoted to the operation of specific types of brake equipment found on Western Pacific Locomotives.

The information contained herein will be an invaluable tool in attaining an understanding of air brake operation.

NOTE: While some of the equipment mentioned in this manual (such as the Alertor) is not in use at this time at the Western Pacific Railroad Museum, it is provided in its original content in this manual.

SECTION I

BRAKES - GENERAL

I PURPOSE

Although it may seem at first that brakes can only have one purpose, railroad brakes actually serve three different purposes:

1. Stopping
2. Slowing or Retarding
3. Holding

While this distinction is elementary, it is important to keep it in mind as we study types of brakes because certain brakes function better for some of these purposes and no single type of brake can serve all purposes under all conditions.

II TYPE OF OPERATION

There are three types of brakes used on the railroad:

1. AIR BRAKES - Air brakes serve a multiple purpose for they can stop, retard or hold locomotives or cars. There are limitations in their use for holding purposes and they will be covered later in this manual.

2. DYNAMIC BRAKES - Dynamic brakes are a form of electric brake on road locomotives. These brakes convert the energy of a moving train into electrical energy and dissipate the energy through fan cooled grids. Dynamic brakes are effective as retarding brakes only.

3. HAND BRAKES - Hand brakes are used primarily to hold locomotives and cars after they have stopped.

TRAIN AIR BRAKES

Although the overall air brake system in a train is complex, it nevertheless can be reduced to two main elements:

1. Air
2. Friction

Since the production and flow of air is so vital an element in train braking, it is necessary to understand some properties of air itself. Simply stated:

1. Air will exert equal pressure in all directions.

2. When air is compressed, it is heated.

3. When air expands, it is cooled.

4. When contained air is heated, the pressure increases.

5. When contained air is cooled, the pressure decreases.

6. Air contains moisture in the form of water vapor.

7. The warmer the air, the more water vapor it will hold.

8. When air is cooled, some of the water vapor will condense into water.

Air used in train braking is compressed and transmitted through the train. We will next discuss how the air is produced and utilized.

The following components are necessary to provide air and braking control of a train:

1. Compression - (Air Compressor)

2. Cooling and Filtering - (Filters - Separators)

3. Storage - (Reservoirs)

4. Measurement - (Air Gauges)

5. Transmission - (Piping and Hoses)

6. Control - (Operating Valves)

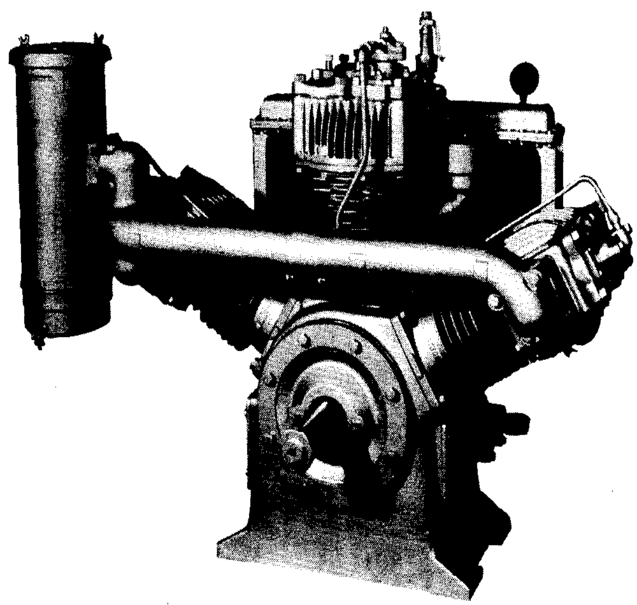
7. Application - (Cylinders, Levers, Rods, Shoes)

I COMPRESSION

On most Diesel Locomotives, air is compressed by a two-stage reciprocating air compressor driven directly off the crankshaft of the diesel engine. The compressor is running all the time the engine is running but compresses or pumps air only on demand by the compressor controls or governor. These controls are set to start the compressor pumping when main reservoir pressure drops to 130 lbs. and to stop the pumping (to unload the compressor) when the pressure reaches 140 lbs. The compressor control system on a modern locomotive is an electro pneumatic system with pressure switches and magnet valves in addition to the actual unloaders. This is done so that the compressors in multiple unit locomotive consists can be synchronized to equalize pumping.

In two stage compression, the air is first drawn through the intake filter into the low pressure cylinders where it is compressed to approximately 40 lbs. pressure. From there the air passes through the intercooler to the high pressure cylinder for final compression. As we have noted in the basic facts about air, cooling during compression is important. Since the air is heated by compression, if we were to allow all the cooling to take place later in the system, we would have to compress to a higher pressure, as the pressure would drop as the air cooled.

Air compressors are of two types (Figure 3-1) as far as cooling is concerned – air cooled and water cooled. Later model locomotives have water cooled compressors wherein engine cooling water is circulated through the compressor and intercooler for more efficient cooling and consequently more efficient compression.

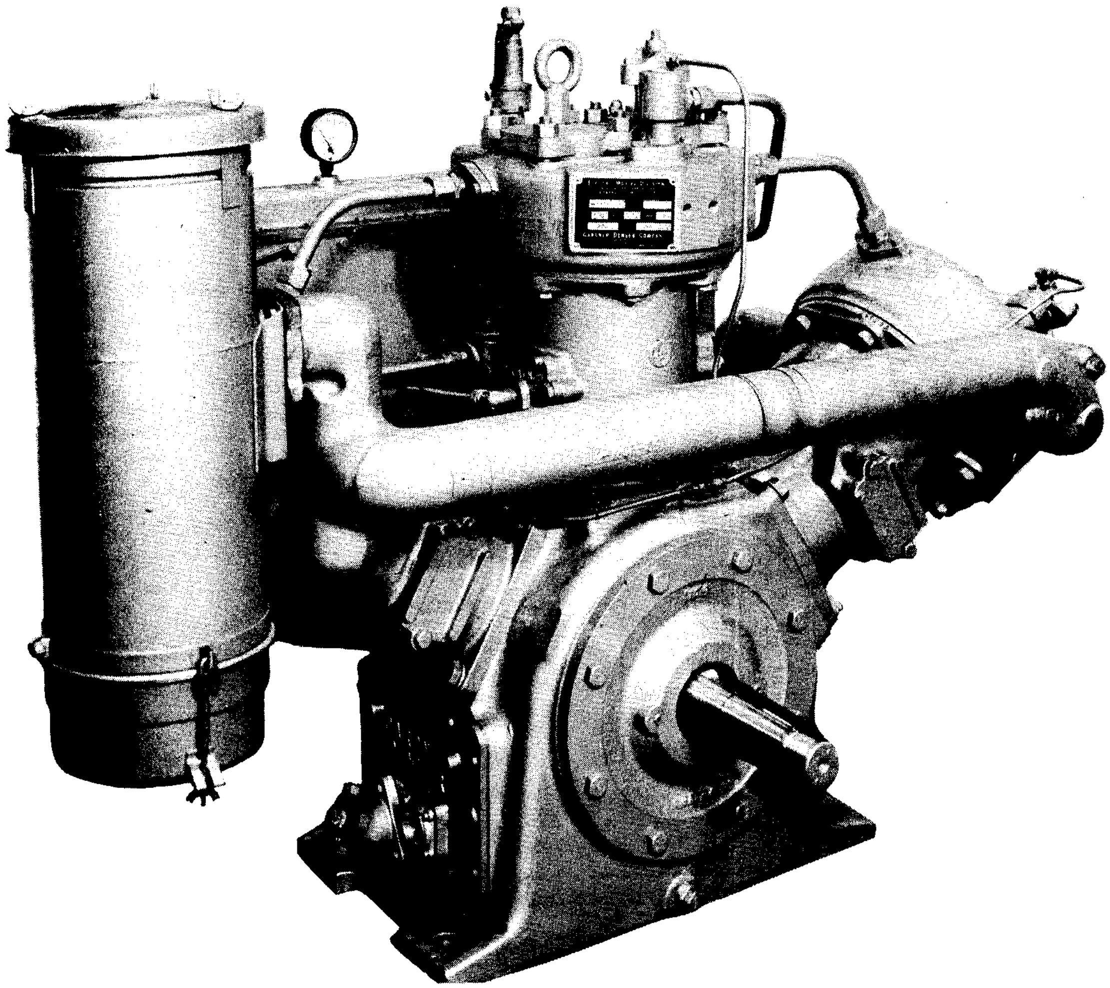


Three Cylinder – Two Stage Air Cooled

Figure 3-1

AIR COMPRESSOR

Water Cooled



Three Cylinder - Two Stage Water Cooled

Figure 3-1

Since the air compressor is the source of the stopping energy of the air, obviously a single unit locomotive cannot be operated safely with an inoperative compressor. A multiple unit locomotive may be operated with an inoperative compressor since air from the other unit is fed to the affected unit through the main reservoir equalizing line. In all cases, the engineman must assure himself of proper compressor operation by frequent observations of main reservoir pressure. This pressure will normally be between 130 and 140 lbs., but may drop slightly lower during heavy usage of air in charging train brakes or using auxiliary air devices. In any case the main reservoir pressure must always be at least 15 lbs. greater than the brake pipe pressure.

II COOLING AND FILTERING

Air leaving the final stage of the compressor is still much hotter than the ambient (outside) temperature and since it has been compressed to about 1/10 of its original volume it contains a great deal of moisture and a certain amount of oil picked up from the compressor. The cooling and filtering system serves to remove this water and oil and other foreign particles which could damage air brake controls and equipment.

The air leaving the compressor enters a cooling coil and then the No. 1 main reservoir (Figure 3-2). When air is cooled, some of the water vapor it holds will condense. The cooling effect of the coil and the reservoir itself will remove about 85% of the excess moisture from the air and will collect it in the main reservoir where it can be removed with a drain valve. From the No. 1 main reservoir, the air crosses over to the No. 2 main reservoir for further cooling and then to a centrifugal separator and filter with another drain.

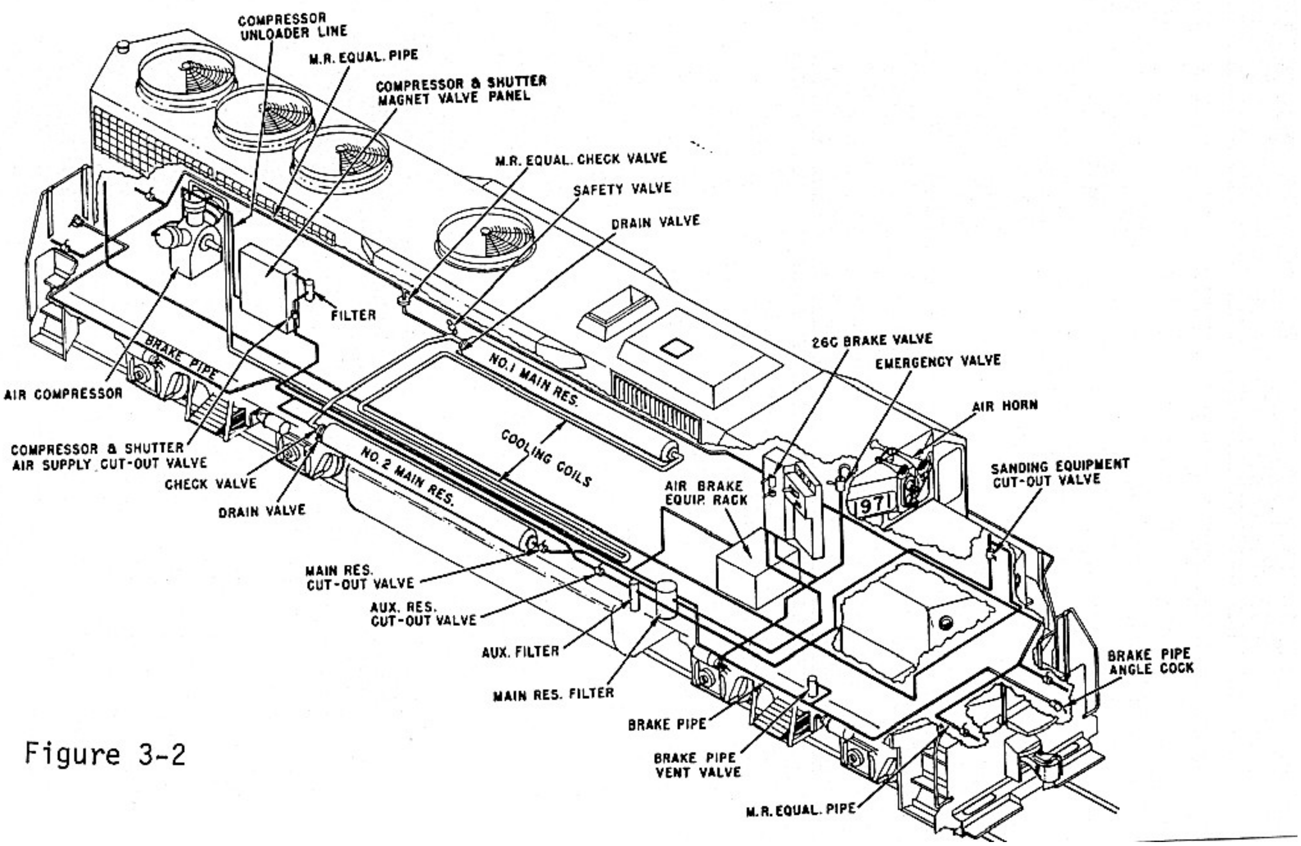


Figure 3-2

The drain valves are automatic on modern locomotives (Figure 3-4). On older locomotives still having only manual drain cocks, the cocks should be opened and condensation drained at least as often as the start of each shift or trip. In draining a reservoir the cock should be "cracked" open slightly as opening it fully and quickly can cause the expanding air to cool so rapidly the condensation will freeze plugging the opening.

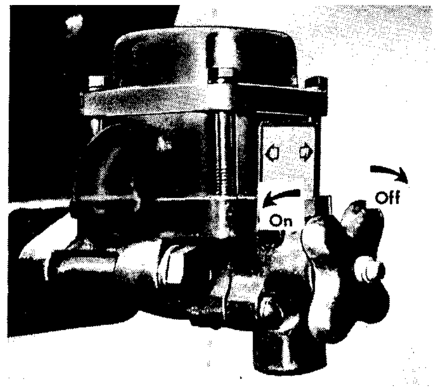


Figure 3-4

III **STORAGE**

Storage of the compressed air is in reservoirs on each locomotive unit and each car.

The main storage is on the locomotive and is in the main reservoir. Each locomotive unit usually has two main reservoirs. Air is stored in these reservoirs at between 130 and 140 lbs. pressure for use in the locomotive and train brake systems and also to operate auxiliaries such as horn, bell, window wipers, shutter controls, etc. To protect these reservoirs from an overpressure, such as could occur from a malfunction in the compressor control, a safety valve is incorporated in the piping adjacent to the main reservoirs (Figure 3-5). The safety valves are set to relieve the pressure at 150 lbs.

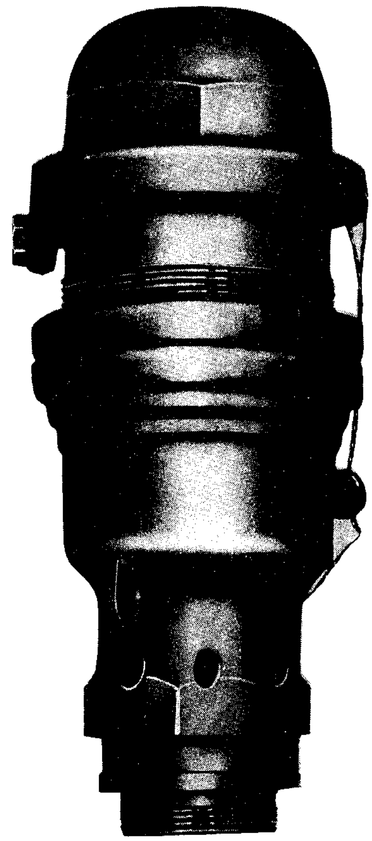


Figure 3-5

Locomotives have other reservoirs such as equalizing, auxiliary, emergency, displacement and timing reservoirs but these are used for control purposes and their function is best studied with controls. On locomotives the air that goes to the brake cylinders applying the brakes is furnished from the main reservoir supply.

Storage of air on freight cars is in a two compartment reservoir, one section called an auxiliary reservoir and the other the emergency reservoir. These reservoirs are fed or charged from the brake pipe. When they are fully charged, they store air at 90 lbs. pressure. This air is used to operate the brakes on the cars. Obviously the supply of air for braking cars is limited by the size of these reservoirs and the engineman must have sufficient knowledge of how these brakes operate in order to prevent depletion or wasting of this air while the train is in motion.

IV MEASUREMENT

The engineer is mostly concerned with the measurement of the pressure of compressed air. The technical name for the unit of measure for pressure is pounds per square inch, gauge or P.S.I.G.; however, the commonly used name for this unit of measure is pounds, abbreviated "lbs" or #. The use of the word "pounds" is so generally accepted on railroads that we will use it in this manual; however, keep in mind when used this way it is strictly a unit of pressure measurement and is not an indication of volume or weight.

There are four basic air pressure measurements an engineer must know at all times when operating a locomotive, these are:

Main Reservoir Equalizing Reservoir	On one gauge
Brake pipe Brake Cylinder	On one Gauge

These pressures are indicated on double pointer gauges with the two reservoir pressures on one gauge and the two pressures containing the word "brake" on the other gauge. The hands are color coded with the coding printed on the face of the gauges. These gauges indicate pressure existing on the locomotive only.

Another type of gauge is used on Road Locomotives called a Brake Pipe Flow Indicator. This gauge indicates the rate of flow of air into the brake pipe. It actually is a differential pressure gauge that measures the pressure drop across an orifice. Details on the use of this indicator will be covered later.

V TRANSMISSION

For transmission of the compressed air, a variety of sizes and types of piping and hoses are used. One pipe that all locomotive units and cars have in common is the brake pipe. This is a 1 1/4" pipe running the length of each unit or car with an angle cock, a hose and quick coupling (gladhand) on each end. When the cars and units are coupled, these hoses must then be coupled and angle cocks opened making a continuous brake pipe running the length of the train. This continuous brake pipe has sometimes been called a "train line" but since all rules, laws and gauge markings refer to it as brake pipe this is the term that should be used.

It should be noted that while the brake pipe is a conduit through which air flows, it nonetheless is a vital element in controlling train brakes. It is the variation of pressure in this pipe which causes train brakes to apply or release.

While this continuous brake pipe of many pipes and hoses is designed and maintained to keep leakage at a minimum, it should be recognized at the outset and always kept in mind that a certain amount of leakage will be present in every train. If this leakage is excessive, it can cause erratic and unsafe operation of the brakes. For this reason, a limit is placed on the rate of leakage by company rule and federal law. This limit is 5 lbs. per minute.

This leakage causes a difference in brake pipe pressure at the locomotive and at the rear of the train. The difference between pressures at these two points is called gradient and the maximum permitted gradient is 15 lbs.

In order to have consistent and safe operation, each railroad establishes a standard brake pipe pressure. The standard brake pipe pressure for freight service on the Western Pacific is 90 lbs. This pressure is governed by the setting of the feed valve on the locomotive.

In addition to the brake pipe, there are other air pipes on locomotives that the engineman should be familiar with. These pipes are used to control locomotive brakes when locomotive units are coupled in multiple, forming a locomotive consist.

These pipes run the length of the unit with a cut-out cock, a hose and gladhand on each end. These pipes are smaller than the brake pipe and are usually identified by badge plates at the hose connections at the ends of the unit. In order to have proper control of the consist, these pipes must be connected by the hoses and the cut-out cocks open between units.

Main reservoir equalizing is usually a 1" pipe that serves, as the name indicates, to equalize main reservoir pressure between units. This is done to aid in synchronizing compressors and also to furnish air to a unit with an inoperative compressor.

Another smaller pipe serves as a "reference" air pressure pipe to control the brake cylinder pressure on the trailing units to correspond with the brake cylinder pressure on the lead unit. This pipe is used with the "independent" brake control, which is the brake control for locomotive units only. This "reference" pipe is identified by two different names, being called brake cylinder equalizing pipe on No. 26 equipment, and independent application and release pipe on older No. 24 equipment. Although these pipes are identified differently on the locomotive, they should be coupled together between units of a consist having mixed brake equipment.

Also running through and between units is another small pipe identified as "actuating pipe." This pipe is used to transmit air from the lead unit independent control to release all locomotive unit brakes without releasing train brakes, or in other words, for independent release of an automatic application.

Some locomotive units also have sander control pipes which serve to control the sanders on trailing units from the lead unit. These are usually designated "sander for" and "sander rev", for controlling forward and reverse sanders.

Most locomotives have duplicate connections on each end for main reservoir equalizing, actuating and reference pipes. It is only necessary to hook up one set of hoses for these pipes but for the sander hoses, both hoses, on both sides of the unit, should be hooked up.

VI CONTROLS

Control of the compressed air is the most complex portion of an air brake system. These controls consist of manually operated, air operated and electrically operated valves and devices which will be studied in detail later in the manual.

The simplest is, of course, just a manually operated shut off valve or cock that is either fully open or closed. These fall into two general categories, angle cocks and cut-out cocks.

Angle cocks (Figure 3-6) are used at each end of the brake pipe on every locomotive unit and car. Angle cocks are open when the handle is in line with the run of the pipe and are closed when the handle is perpendicular to the run of the pipe. In order to have operating train brakes all angle cocks in a train must be open except the one at the front of the lead locomotive unit and the one at the rear of the caboose, or last car.

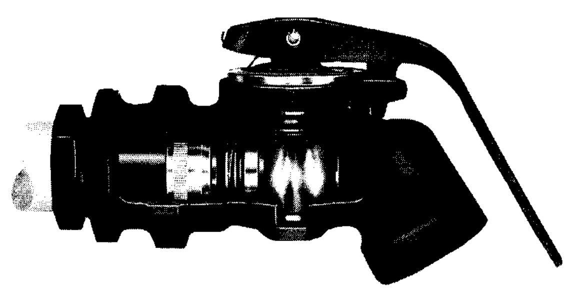
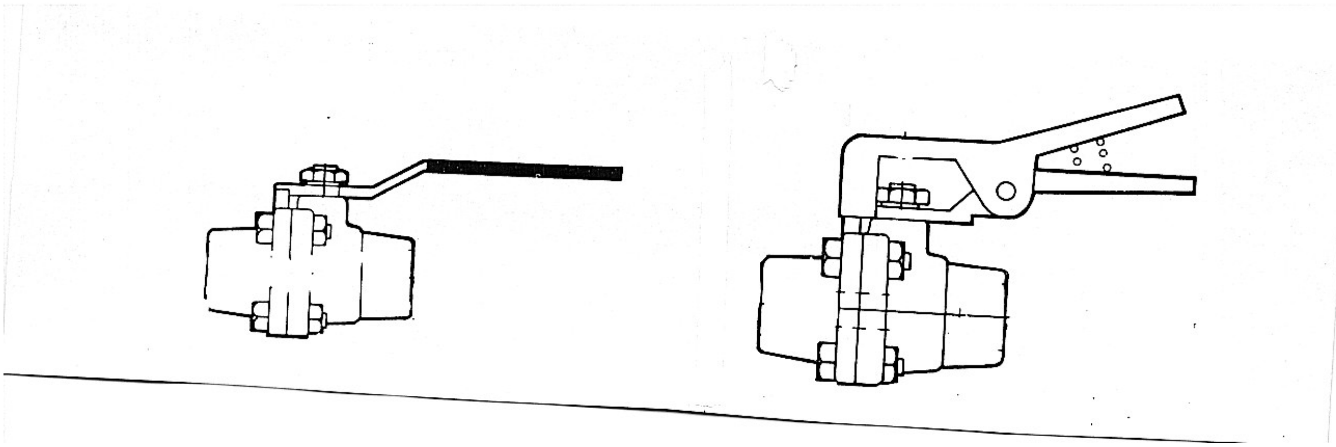


Figure 3-6

Cut-out cocks (Figure 3-7) are used to isolate or cut-out or cut in certain portions of piping or devices. They are also used at the end of multiple unit pipes on locomotives (other than the brake pipe). Cut-out cocks are open when the handle is perpendicular to the run of the pipe and closed when the handle is in line with the pipe.



STANDARD **LOCKING HANDLE**

Figure 3 -7

Both types of cocks have a groove or boss on the handle or on the top of the plug. The direction of this groove indicates the direction of air flow.

VII APPLICATION

Application of compressed air is accomplished with the brake cylinders acting through brake rigging to apply brake shoes to the wheels. Since air will exert equal pressure in all directions, when air flows into a brake cylinder and pressure builds up, it will force the only movable portion out (the piston) with a force equal to the area of the piston multiplied by the lbs. of pressure (psi). On most cars and locomotives this force is exerted on a series of levers to further increase the force applying the brake shoe to the wheel.

Figure 3-8 shows a typical arrangement for brake rigging on a freight car. The arrangement shown is for a body mounted brake cylinder.

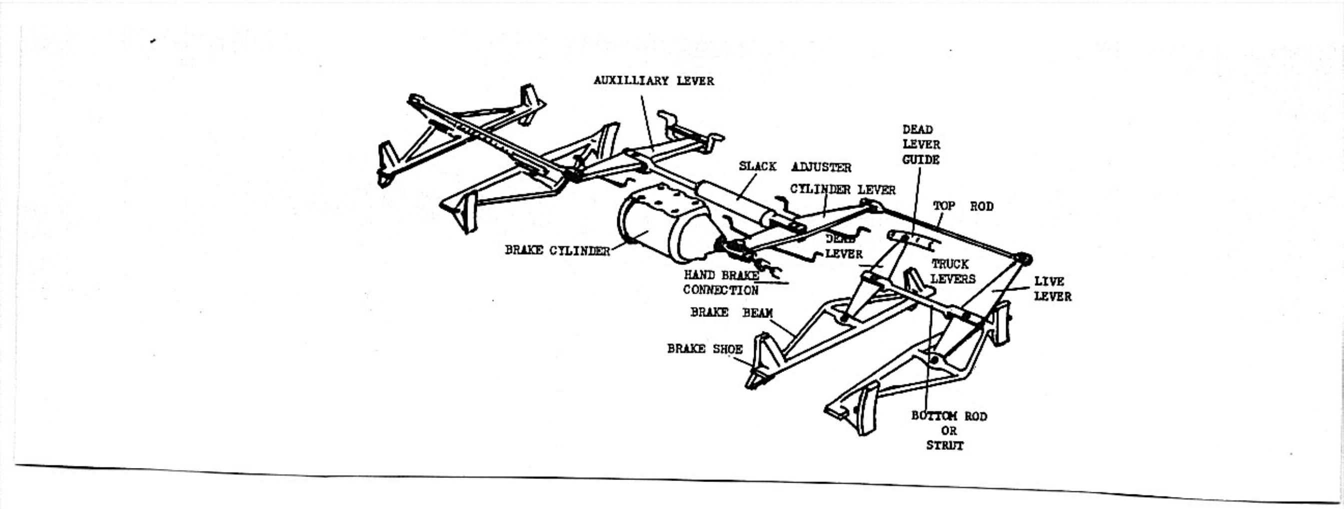
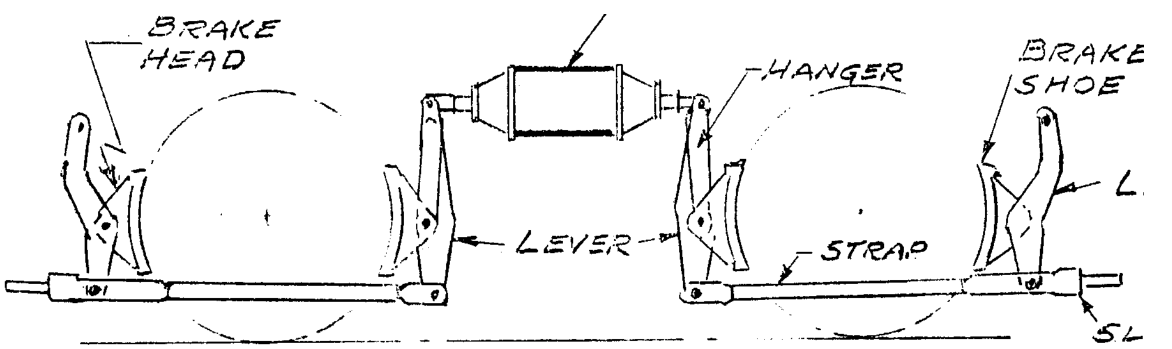


Figure 3-8

Figure 3-9 shows a typical arrangement for brake rigging on a diesel locomotive. Diesel locomotives have truck mounted brake cylinders.



Typical Brake Rigging
Switcher Locomotive

Figure 3-9

Note both these illustrations show slack adjusters. Slack in brake rigging is determined by measuring the distance the piston of the brake cylinder travels from release position to the applied position. A certain amount of slack is necessary to insure that the brake shoes are clear of the wheel when the brakes are released. As brake shoes wear, this slack is increased and if allowed to increase too much will affect the effectiveness of the brake.

On body mounted single capacity brakes as shown in Figure 3-8, the piston travel at the initial terminal must be between 7 and 9 inches to insure effective brakes for the trip. The reason for piston travel limits becomes obvious if we realize that as piston travel increases, the volume of air needed to fill the brake cylinder and build up pressure increases; since the air supply on cars is limited, if the piston travel increases too much it will not be possible to build up an effective brake cylinder pressure. If piston travel increases to 12" on this type brake, the brakes are considered ineffective.

On truck mounted brakes on a locomotive, maximum piston travel must not exceed 6 inches. Since, on locomotives, the brake cylinder pressure is furnished from main reservoirs which have adequate supply, excessive piston travel will not reduce the actual braking force but it will cause the brakes to apply and release more slowly.

Levers in brake rigging multiply the force of the brake cylinder mechanically. The degree of multiplication is called the lever ratio. The force applied at the brake shoe can be obtained by multiplying the force at the cylinder by the lever ratio.

The final output of force of the brake rigging is at the brake head which holds the replaceable brake shoe by means of a key. Brake shoes are of two general types, cast iron and composition, which have different characteristics and are not interchangeable without modifications in the braking system. (See "Friction" following.)

The brake rigging on cars and locomotives is designed to give a certain braking ratio which is the relation of the force of brake shoes against the wheels to the weight of the car or locomotive. Normally this ratio is given for a brake cylinder pressure of 50 lbs.

Since the weight of a locomotive unit does not vary much this braking ratio stays fairly constant for a specific unit. Depending on the design of the brake rigging it is usually somewhere around 60% to 80%.

Freight cars however, are another matter. The difference in weight of a loaded car and an empty car is considerable so that the braking ratio varies greatly. Most freight cars have what is known as a single capacity brake so that the same amount of braking force is used whether the car is empty or loaded. Braking ratios on freight cars can vary from as little as 18% for a loaded car to 75% for an empty car. Consequently, the same brake application will cause an empty car to decelerate at a quicker rate than a loaded car. Or to put it another way, a loaded car behind an empty car will tend to overtake the empty car bunching the slack, whereas an empty car behind a loaded car will try to pull back on the loaded car stretching the slack.

The word "slack" as used here should not be confused with "slack" as used previously in this section regarding slack in brake rigging. "Slack" in a train is made up of necessary "free play" in couplers and draft gear and the cushioned movement within draft gear and other cushioning devices. In other words, slack in a train is movement of a car in relation to adjacent cars.

FRICTION

Friction is the other basic element of train brakes. Friction can be defined as the resistance to the motion of one surface along another. The two points of friction that concern us in train braking are the friction of the brake shoe against the wheel and the friction of the wheel against the rail.

BRAKE SHOE TO WHEEL

First considering friction of brake shoe against wheel, when a brake shoe is forced against a wheel only a certain percentage of that force becomes frictional force to retard the turning of the wheel. This percentage varies greatly with the speed. The following table shows the approximate percentages at various speeds.

	CAST IRON SHOES	COMPOSITION SHOES
80 MPH	7 %	26 %
60 MPH	8 %	27 %
40 MPH	10 %	28 %
20 MPH	15 %	32 %
10 MPH	20 %	36 %
00+ MPH (Just before stop)	34 %	42 %

From these figures, it can be seen that even if brake shoe force (which the engineer reads as brake cylinder pressure) remains constant the frictional force or actual braking force increases greatly as the speed decreases and the rate of increase is greater for cast iron shoes than for composition shoes.

The friction of brake shoe against wheel is a form of sliding friction and an inevitable by product of this type of friction is heat. This heat must be dissipated through the shoe and the wheel to the air by radiation and if heavy braking is continued too long the heat is created faster than it can be radiated, resulting in overheated and damaged wheels.

WHEEL TO RAIL

The other friction point involved in braking is the friction between the wheel and the rail, commonly called adhesion. Adhesion is dependent upon the weight of the car or locomotive and is usually expressed as a percentage of the weight. It is also greatly dependent on rail conditions being practically unpredictable for wet or oily or frosty rail. In order to control the adhesion and make it more predictable, sand is applied to the rail by the locomotive sanders. A commonly used, practical, percentage for adhesion at low speeds is 25%. Adhesion tends to decrease slightly as speed increases so a percentage of 20% over 20 MPH can be used. If braking force is applied to a wheel that is greater than the adhesion, the wheel will slide. Sliding, in addition to damaging wheels, reduces the effectiveness of braking.

The basic principles of friction and adhesion can be illustrated by the following example. An EMD SW9 Switcher, such as WP 601 class weighs about 250,000 lbs. With a brake cylinder pressure of 50 lbs., the braking ratio of this locomotive is 82% (braking ratio is the relation of the total force of brake shoes on wheels to the weight of the car or locomotive). This locomotive has cast iron brake shoes; from the chart of friction percentages we see that at a very slow speed 34% of this braking force becomes frictional or retarding force.

Then total retarding force is:

250,000 X 0.82 X 0.34 = 69,700 lbs.

Adhesion under average conditions:

250,000 X 0.25 = 62,500 lbs.

Thus we see the frictional retarding force is greater than the adhesion; the result is sliding wheels. Obviously, a brake cylinder pressure of 50 lbs. should not be used on this locomotive at low speed.

Company rule establishes limits for brake cylinder pressure from an independent application, the limits being 35 to 40 lbs. This maximum pressure is governed by the setting of the independent reducing valve.

These limitations of brake cylinder pressure reduce the possibility of sliding wheels but do not eliminate it. It is also necessary for the engineman to exercise judgment by decreasing brake cylinder pressure as he nears a complete stop and/or by applying sand to improve adhesion.

These observations about increased braking forces at low speeds also apply to train brakes. Heavy brake applications at low speeds aggravate slack action in the train with possible results being lading damage, train separation, and personal injuries.

SIMPLIFIED BRAKE SYSTEMS

A. STRAIGHT AIR BRAKE (Figures 4-1 and 4-2)

This is the simplest and earliest form of air brakes. The disadvantages of the system when used as train brakes are obvious. All the air for application is supplied from a single source, the locomotive main reservoir. If a train separation occurred the cars behind the separation would lose all braking immediately.

Since all the air has to travel from the front of the train, the cars at the front of the train would have brakes applied fully before cars at the rear had any brakes at all. This would cause severe "run-in" of slack in the train. The brake system became impractical when train lengths reached 20 to 25 cars; however, an adaptation of the straight air brake is used on Diesel Locomotives where it is known as the independent brake.

STRAIGHT AIR BRAKE

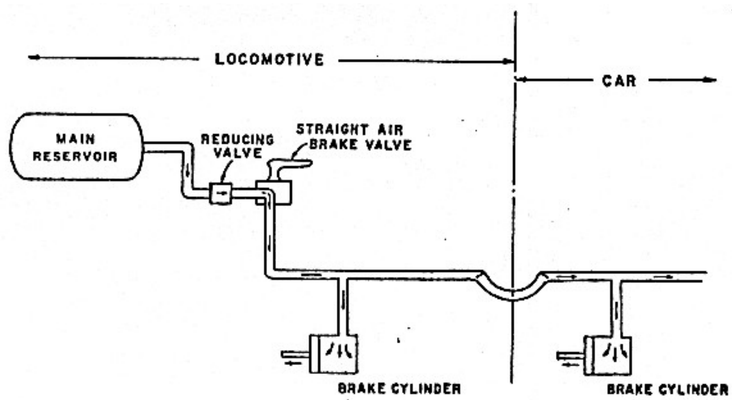


Fig. 4-1 APPLIED

STRAIGHT AIR BRAKE

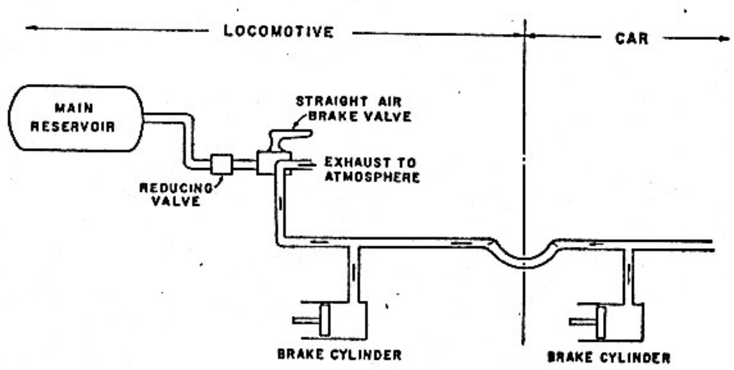


Fig. 4-2 RELEASED

B. INDEPENDENT BRAKE (Figures 4-3 and 4-4)

A simplified version of the independent brake on a multiple unit diesel locomotive consist is shown in Figure 4-3 (applied position) and Figure 4-4 (release position).

Note that the disadvantage of having all air furnished by the lead locomotive is overcome by the use of air operated relay valves so that each unit supplies air for the actual application from its own main reservoirs.

The "reference pipe" between units is necessary for this brake and a separation of the pipe would cause loss of independent brake on units behind. Separation between units rarely occurs and if it did, the units behind the separation would still have braking ability due to the automatic brake portion of the locomotive unit brake system.

INDEPENDENT (STRAIGHT AIR) BRAKE

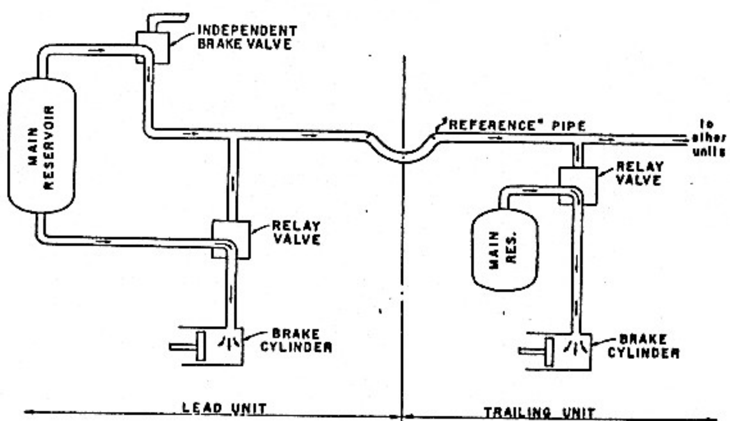


Fig. 4-3 APPLIED

INDEPENDENT (STRAIGHT AIR) BRAKE

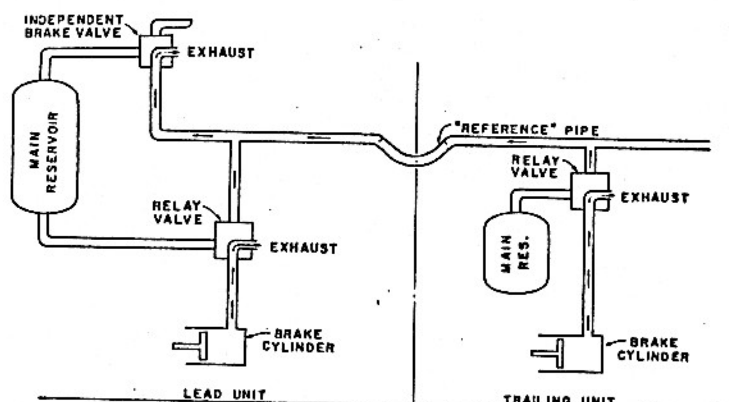


Fig. 4-4 RELEASED

C. AUTOMATIC AIR BRAKE (Figures 4-5 and 4-6)

Every locomotive unit and car is equipped with automatic brake equipment. With this train brake system, an application of brakes occurs when the pressure in the brake pipe is reduced. The brake is not truly "automatic" as it requires knowledgeable and skillful manipulation by the engineer. The only time it is really automatic is when an accidental separation of the train and brake pipe occurs. An application of brakes will then come about due to the "fail-safe" characteristic of this system.

The heart of the system is the "control valve" which performs three basic functions:

1. Apply brakes

2. Release brakes

3. Charge auxiliary reservoirs

On freight cars, the control valves are known as AB valves, or an improved version as ABD valves.

On locomotives with #24 equipment, the D-24 control valve is used; locomotives with #26 equipment, the 26F control valve is used. On older locomotives, the distributing valve serves the same purpose.

In Figure 4-6 you will note that auxiliary reservoir air is used to apply the brakes on a car. On locomotives, air is admitted by the control valve which pilots a relay valve admitting air from main reservoir supply to the brake cylinders. This is the same relay valve utilized by the independent brake (shown in Figure 4-3 and 4-4)

AUTOMATIC AIR BRAKE (SIMPLIFIED)

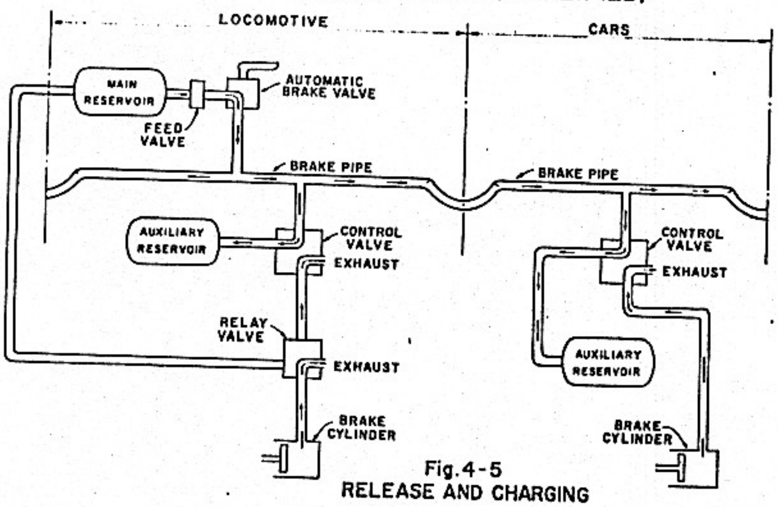


Fig.4-5
RELEASE AND CHARGING

AUTOMATIC AIR BRAKE (SIMPLIFIED)

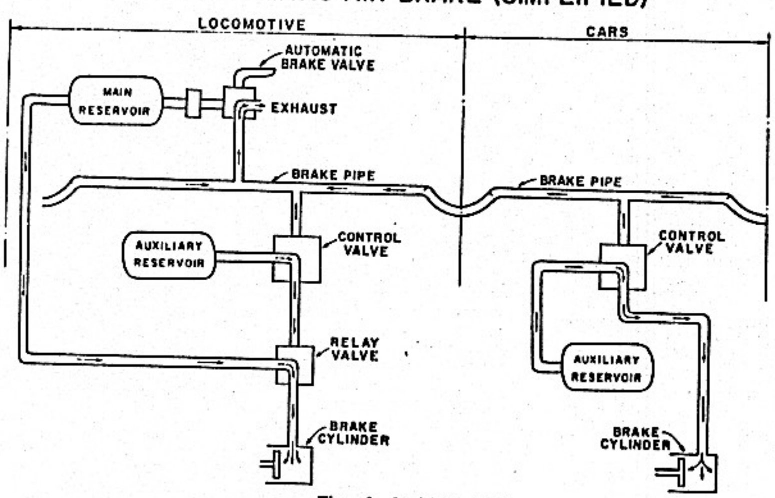


Fig. 4-6 APPLIED

AUTOMATIC BRAKE SYSTEMS – FEATURES AND DETAILS

APPLICATIONS

A. TYPES OF BRAKE PIPE REDUCTIONS AND APPLICATIONS

Brake applications using the automatic brake are caused by reduction of pressure in the brake pipe. There are two general types of brake pipe reductions:

1. Emergency Reduction

   An emergency reduction is an extremely rapid reduction of brake pipe pressure to zero. The rate of reduction cannot be controlled once the application is initiated.

2. Service Reduction

   A service reduction takes place at a slower rate and is controlled by the locomotive engineer. A minimum service reduction is 6 to 8 lbs. With 90 lb. brake pipe pressure, the maximum effective service reduction is 26 lbs. This 26 lb. reduction is called FULL SERVICE. With a full service reduction, the pressure will equalize between the auxiliary reservoirs and the brake cylinders. With a 90 lb. brake pipe, the pressure will equalize at about 64 lbs., giving approximately a 64 lb. brake cylinder pressure. Since the pressure has equalized, it can be seen that any further service reduction cannot bring about more braking effort. The only way to increase braking effect beyond full service is to go on to an emergency application. With an emergency application, the pressure will equalize between the brake cylinders and the auxiliary and emergency reservoirs giving a higher brake cylinder pressure (approximately 77 lbs. with a 90 lb. brake pipe pressure).

B. CONTROL OF BRAKE PIPE REDUCTION BY ENGINEER'S BRAKE VALVE - SERVICE APPLICATION

In diagram 4-6, air is shown exhausting directly to atmosphere through the engineer's brake valve. In reality, this occurs only during an emergency application. The reduction in brake pipe pressure in a service application must be more accurately controlled and measured. This can be seen in Figure 5-1.

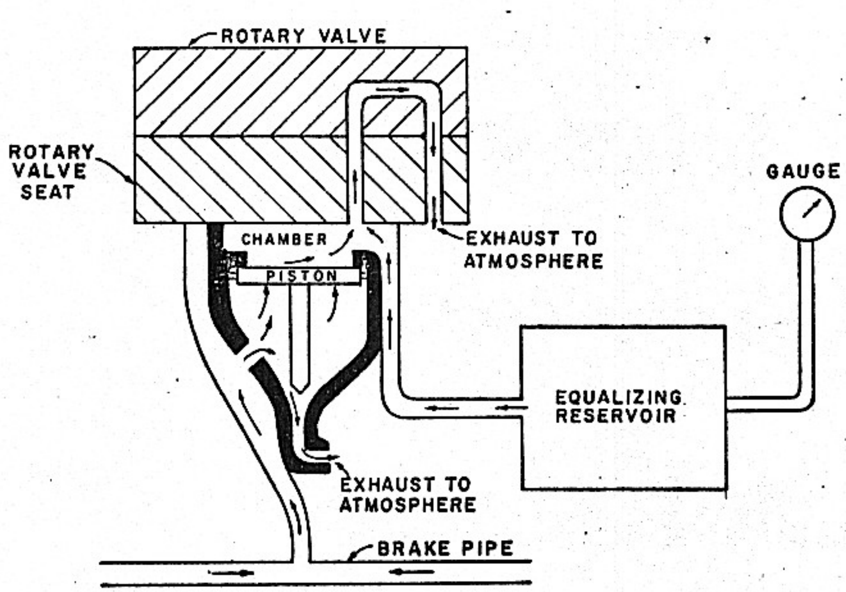

ROTARY VALVE
ROTARY VALVE SEAT
CHAMBER
PISTON
EXHAUST TO ATMOSPHERE
GAUGE
EQUALIZING RESERVOIR
EXHAUST TO ATMOSPHERE
BRAKE PIPE

Figure 5-1

The engineer using the automatic brake valve handle positions the rotary valve to the "SERVICE POSITION." This connects the chamber and the equalizing reservoir to exhaust to atmosphere. The equalizing piston rises, venting brake pipe air to atmosphere. The venting of the brake pipe air will continue until equalizing reservoir pressure and brake pipe pressure equalize. The exact method of stopping exhaust of equalizing reservoir varies with the type of equipment and will be covered later, but the principle of controlling brake pipe reductions by making equalizing reservoir reductions applies to all brake valves. The engineer reduces the equalizing reservoir pressure the desired amount and then the equipment reduces the brake pipe pressure a like amount.

C. QUICK SERVICE

In the earliest automatic brake (Figure 4-6) the reduction of brake pipe pressure was made at the engineer's brake valve only. This caused the brakes to apply on cars at the head-end of the train before they applied on cars at the rear-end. Severe slack action resulted from this operation. To overcome this effect, a feature known as quick service was incorporated in the control valve (Figure 5-2). Now, each control valve assists in reducing pressure thereby speeding up the action of the brakes through the train as each control valve triggers the one behind it in the train.

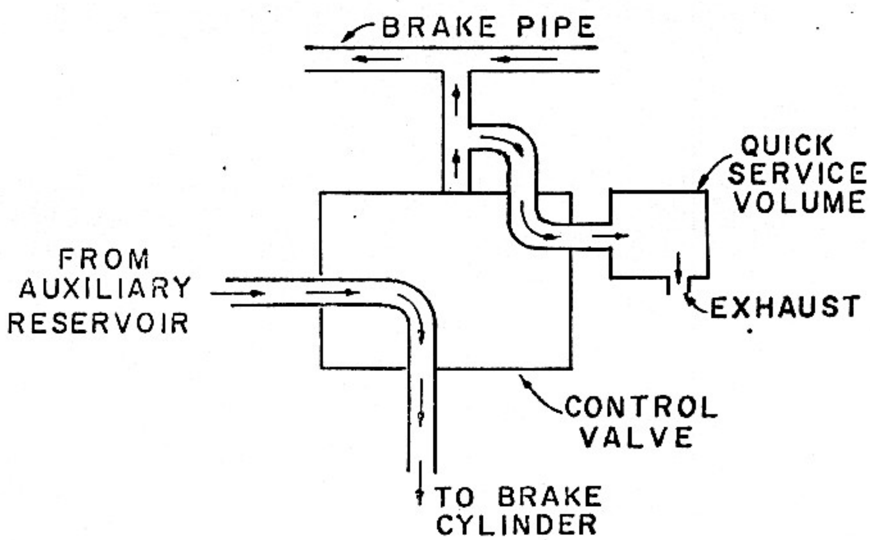


Figure 5-2

D. QUICK ACTION

Quick action is similar in principle to quick service, except that it occurs during an emergency application and takes air from the brake pipe at a much faster rate.

As cars and locomotives became longer and brake pipe volumes increased, it was found that the quick action feature of control valves would not propagate or trigger the emergency application forward or back throughout the train under all conditions. To overcome this, Vent Valves have been applied to locomotives and long cars. These vent valves open the brake pipe to atmosphere whenever they sense a rapid reduction in brake pipe pressure, thus insuring that the emergency action is transmitted rapidly throughout the train. Once a brake pipe reduction has been made at an emergency rate, control valves will move to emergency application position and stay that way for at least one minute. There is nothing an engineman can do to forestall or suppress this action, and he should not attempt to do so. The train should be allowed to come to a stop before recovery and release is initiated.

E. INITIATION OF BRAKE PIPE REDUCTIONS AND APPLICATION

The brake pipe reductions discussed so far were those made by the engineer with the automatic brake valve on the locomotive. Brake pipe reductions and applications can be made at other locations and by other means:

1. SERVICE RATE REDUCTIONS:

a. Engineers Automatic Brake Valve

The manner in which service reductions are made with this brake valve have been covered in a general way. The exact method varies with the type of brake equipment and is explained later in the section dealing with specific equipment.

b. Caboose Valve

This is a valve connected to the brake pipe in cabooses for the purpose of applying brakes from the rear of the train.
(Figure 5-3.) Varying degrees of service reductions can be made and an emergency reduction can also be made with this valve.

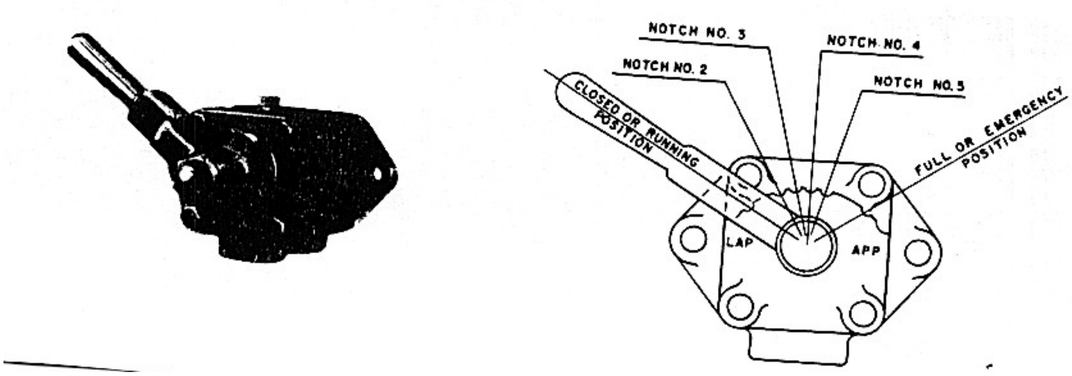


Figure 5-3

c. Brake Pipe Leakage

Brake pipe leakage can also reduce the brake pipe pressure at a service rate and cause automatic train brakes to apply. This can occur if no air is fed into the brake pipe from the locomotive. The leakage will gradually reduce the brake pipe pressure until some or all of the control valves assume a service application position and apply the brakes. The control valves will react to a small difference in pressure between brake pipe and auxiliary reservoir; usually about 1 1/2 lbs. lower pressure in the brake pipe than is in the auxiliary reservoir will cause the brakes to apply. If brake pipe leakage is within limits set by rule (5 lbs. per minute) and the engineer's brake valve is in the proper position, sufficient air will flow into the brake pipe to prevent a leakage application. If the automatic brake valve is not the pressure maintaining type, leakage can also increase a brake pipe reduction made at the automatic brake valve, causing brakes to set harder. When an engineer makes a brake pipe reduction, control valves will move to allow auxiliary reservoir air into the brake cylinders in proportion to the amount of the reduction (brake cylinder pressure will usually be 2 to 2 1/2 times the brake pipe reduction). If this reduction is less than full service, the control valve will assume a position known as service lap. (The term "lap" as used in connection with air valves, means that the device is in that position, which prevents air from flowing through it.) If leakage is present after the control valve assumes service lap and brake pipe pressure is not maintained, the control valve will eventually move back to application position, allowing more air into the brake cylinders.

d. Penalty Application (Also called Safety Control Application)

This is a reduction and application brought about by an automatic device on the locomotive. On Western Pacific locomotives, these devices cause a full service application. On road locomotives they cause a split reduction full service; on switch locomotives a straight full service. A split reduction is one that has two stages, first a small reduction, then a slight delay to allow slack to adjust, then a faster rate to full service. Penalty applications are sometimes confused with emergency applications because they both actuate the power knockout (P.C.) devices on locomotives, to kill the power and return the engine to idle. Penalty applications can be forestalled or suppressed if the cause of the penalty has been corrected. Emergency applications cannot be forestalled.

(1) Overspeed

This penalty application occurs when the track speed of the locomotive exceeds the setting of the device that actuates the brakes. These settings are as follows:

GP 7 & 9	701 - 732	67 MPH
GP 20	2001 - 2010	67 MPH
GP 35	3001 - 3022	75 MPH
GP 40	3501 - 3544	75 MPH
U23B	2251 - 2265	75 MPH
U30B	3051 - 3071	75 MPH

(2) Alertness Devices

Two types of alertness devices are in use on Western Pacific locomotives, the foot pedal (deadman) and "Alerter", which is an electronic device. The foot pedal device causes an application when the pedal is not depressed. The Alerter sounds a warning buzzer if the engineer has not touched or released a metallic object within a specified period of time, then if the warning has not been acknowledged by pushing a button, the brakes will apply. For details of operation and recovery or suppression, see specific equipment section.

2. EMERGENCY RATE REDUCTIONS

Automatic train brakes incorporate separate reservoir sections and separate control valve portions for use in emergency applications. (Figure 5-4) This is done so that an emergency application is available regardless of previous service applications that may have been made. In order for this safety feature to be functional, two conditions must be met:

a. Emergency reservoirs must be charged.

b. Brake pipe pressure should be 40 lbs. or more.

Enginemen must keep these facts in mind when making service reductions. The brake pipe pressure should not be reduced below equalization pressure (65 lbs.) with service reductions. Any service reduction below this will only waste air and time.

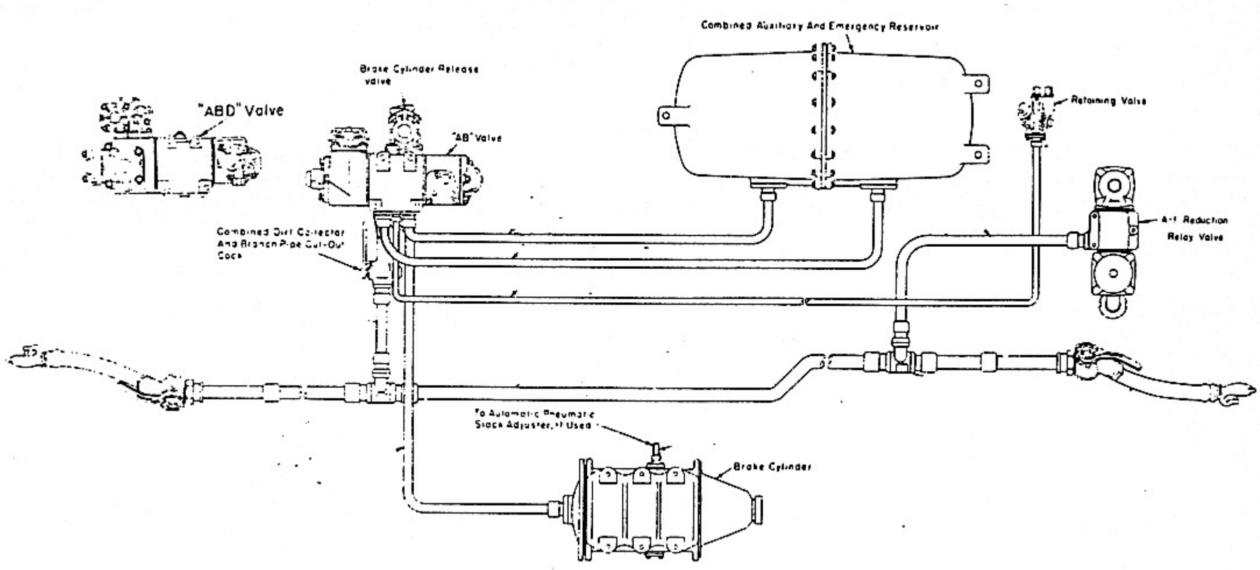


Figure 5-4

With the above qualifications, an emergency application is always available by the following means:

a. Automatic Brake Valve

The brake valve exhausts brake pipe air directly to atmosphere at a rapid rate when in emergency position. Although other operating positions vary with the type of brake valve, emergency is the same on all brake valves, being in the extreme counter clockwise position.

b. Emergency Brake Valve (Sometimes called Conductors Valve)

Each locomotive cab is equipped with at least one emergency brake valve. This valve is also used on cabooses. This valve (Figure 5-5) is connected directly to the brake pipe and when tripped, vents the brake pipe at an emergency rate. This valve has only two positions: "closed" (running) and "open" (emergency). If a true emergency arises and for some reason the application cannot be made with the engineer's automatic brake valve, this valve should be opened and left open until the train comes to a full stop.

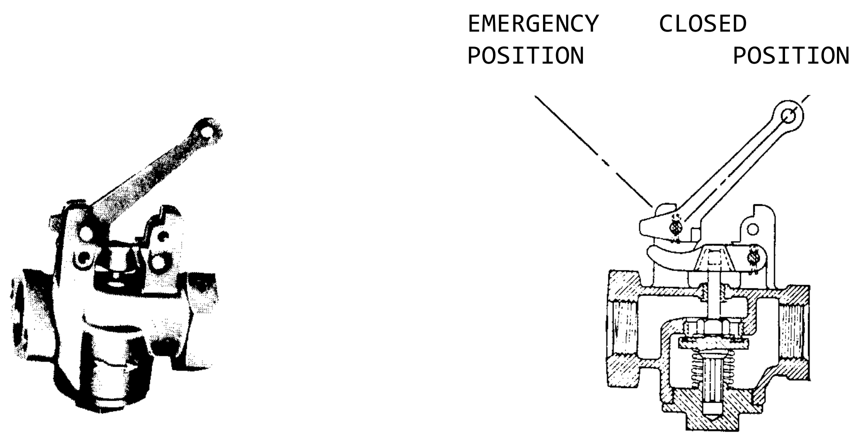


Figure 5-5

c. Caboose Valve

As mentioned previously, the caboose valve has an emergency position.

d. Angle Cock

An emergency application can be caused by opening an angle cock quickly if the pressure is lower on one side of the cock than the other. For example, if a charged cut of cars is coupled to an uncharged cut, unless the angle cock is opened slowly, an undesired emergency application will result.

e. Train Separation, Burst or Uncoupled Hose

Any of these occurrences will result in an emergency application.

f. Defective Control Valve (Dynamiter)

Can cause an emergency throughout the train by sticking in emergency position and through "quick action" feature transmit the application serially to other cars.

g. Improper Procedure in cutting operating air brake equipment in or out, such as when changing control from one unit to another, is a common cause of undesired emergencies. Exact procedures as outlined in Air Brake Rules and Notices should be followed.

F. CHARGING AND RECHARGING

Charging can be defined as supplying air to the brake equipment starting with only atmospheric pressure in the equipment.

Recharging refers to the replacing of air that has been used in an application. Recharging occurs at the same time as release.

Charging and recharging are affected by pipe friction, leaks, volume of reservoirs, and the brake equipment at the front of the train absorbing air needed at the rear of the train. Extreme cold weather also can affect charging and recharging.

Pipe friction is caused by the fact that air will exert equal pressure in all directions. When compressed air flows through a pipe, it also exerts pressure against the inside of the pipe causing a resistance to flow. This pipe friction restricts the amount of air that can be transmitted through a pipe at a given pressure.

Leaks in a train brake pipe are always present to a certain extent. The extent of the leak must be within certain limits as previously covered under "Transmission." The volume to be charged, although fixed by design of equipment, can vary depending on whether the car brakes have been completely "bled off" or partially bled off.

The problem of the front cars absorbing air needed for the rear of the train has been partially overcome by a feature in control valves known as uniform charging. With this feature, when the difference between brake pipe pressure and auxiliary reservoir pressure is great, as it will be near the front of the train, the charge is retarded by restricting the charging port. Toward the rear of the train where the difference in pressure is less, the charging ports are not restricted and the charge is not retarded. This tends to even out the charging of the train. The same effect applies to recharging. In recharging, in addition to air supplied by the brake pipe, air will also flow from the emergency reservoir into the auxiliary reservoir to assist in recharging.

Extreme cold weather can be a factor in charging. This is due to the characteristics of air -- the fact that pressure will drop when air is cooled and also due to the fact that more leaks are present due to lack of flexibility of gaskets.

When charging any brake equipment, adequate time must be allowed for the system to completely charge and stabilize. On a locomotive, the compressor must first be allowed to pump up main reservoirs until it unloads at 140 lbs.; then at least five more minutes should be allowed for the rest of the locomotive equipment to charge and stabilize.

A single freight car will require from seven to fifteen minutes to charge the equipment.

As for the time required to charge a train, the following can be used as a guide to indicate the minimum time required to completely charge a train (assuming all of the cars have atmospheric pressure only in the reservoirs):

25 cars or less	-	15 minutes
25 to 50 cars	-	20 minutes
50 to 75 cars	-	25 minutes
75 to 80 cars	-	30 minutes
80 to 90 cars	-	34 minutes

These charging times should not be used arbitrarily to determine if a train is ready for brake tests. Caboose gauge readings should be used for this purpose in accordance with air brake rules. However, if a train will not charge in approximately the time shown, it will usually indicate some defect, such as excess leakage is present in the train.

The engineer can also determine from the brake pipe flow indicator when a train is approaching a full charge (see brake pipe flow indicator in specific equipment section).

G. OVERCHARGE AND UNDERCHARGE

In order to understand the effects of overcharge and undercharge, it is necessary to keep in mind that control valves apply and release brakes by sensing the difference in pressure between the brake pipe and the auxiliary reservoir. If the pressure in the brake pipe is lower than the auxiliary reservoir the brakes will apply, and if the pressure in the brake pipe is higher than in the auxiliary reservoir, the brakes will release.

Train brakes are fully charged when the brake pipe, auxiliary reservoir and emergency reservoir are all charged to the feed or regulating valve setting of the locomotive, or 90 lbs. on freight trains. Due to leakage and other factors causing brake pipe gradient, this full charge may not be possible at the rear of the train. Therefore, cars at the rear of the train may be charged to a lower pressure. As long as this pressure is within limits set by rules and the brake pipe, auxiliary reservoir and emergency reservoir are charged to that same pressure, the charge is sufficient to start brake tests. This condition does not constitute an undercharge.

An undercharge occurs if the auxiliary reservoirs are not charged up to the same pressure as the brake pipe at that car. Then, the control valve, sensing brake pipe pressure to be higher than auxiliary reservoir pressure will keep the brakes released. A brake pipe reduction may or may not apply the brakes on these cars. If the brake pipe pressure after the reduction remain higher than the auxiliary reservoir pressure the brakes will not apply. For this reason, an adequate brake pipe pressure at the rear of the train does not necessarily indicate an adequately charged train. The auxiliary reservoir pressure, as indicated by caboose gauge, must also be known.

Although the above comments are concerned with initial charge, a similar condition can occur with recharge. If an engineer makes a reduction and release while running and follows it with another reduction before the auxiliaries have had time to recharge, there is a good possibility that at least some of the brakes will not apply from the second reduction, unless the second reduction is greater than the first.

An overcharge occurs when auxiliary and emergency reservoirs are charged to a higher pressure than the feed or regulating valve setting on the locomotive.

Control valves in sensing brake pipe pressure to be lower than auxiliary reservoir pressure, apply the brakes and the brakes cannot be released by ordinary means. Even if an apparent release is made, the brakes will frequently "creep" back on.

To get rid of an overcharge, the auxiliary and emergency reservoir pressures must be reduced below the feed or regulating valve setting. To accomplish this, a series of applications and releases is required and in extreme cases manual bleeding of individual cars is required (enginemen should be governed by current instructions from road foremen or train handling manual for exact procedure).

Since correction of an overcharge is time consuming, enginemen must avoid causing an overcharge. Some brake valves have provisions for charging brake pipe with main reservoir air (see specific equipment section). Use of this feature for charging must be stopped well below standard brake pipe pressure. Also, care should be used when setting feed or regulating valves. If the feed or regulating valve is inadvertently set too high, an application should be made before setting back to standard pressure to avoid an overcharge. Overcharges can also be caused by other factors such as improperly regulated yard air and defective equipment.

RELEASE

Release of automatic train brakes is accomplished by raising the pressure in the brake pipe higher than the pressure in the auxiliary reservoirs. The control valve will then move to exhaust brake cylinder air to atmosphere, releasing the brakes. The release of train brakes in freight service is a direct release. The engineer cannot "graduate off" or partially release an application. He can only release completely as far as manipulation of the automatic brake valve is concerned.

RELEASE CONTROL RETAINERS

In normal operation, release of brakes occurs at the same time as recharging, consequently the brake pipe cannot be recharged without releasing the brakes. Under certain conditions, such as long heavy grades when dynamic brake is not available, this is undesirable. To provide a means of keeping brakes applied while recharging, freight cars are equipped with release control retainers. Although, in the interest of simplification, our text and diagrams so far have shown brake cylinder air exhausting directly to atmosphere on freight cars, on freight cars it is exhausted through a retainer (Figure 5-4). This retainer can be set to exhaust direct to atmosphere or set to retain a given amount of brake cylinder pressure. These retainers must be set manually in accordance with timetable instructions.

RELEASE INSURING AND ACCELERATED RELEASE

Release insuring is a feature built into control valves to make release more positive. When brake pipe pressure is restored to one and a half lbs. greater than auxiliary reservoir pressure, this feature exhausts a small amount of air from the auxiliary reservoir so the pressure difference is greater and valve action more positive. This is done to reduce the possibility of stuck brakes, which can be a problem, particularly if a release is made after a light application.

Accelerated release is a feature of newer ABD control valves, which utilizes emergency reservoir air to assist in replenishing the brake pipe. This also serves to make release more positive.

INITIATION OF RELEASES

Releases are normally initiated by the engineer with the:

1. Automatic Brake Valve

2. Dynamic Brake Interlock

   This is an automatic electro-pneumatic device on locomotives that releases or holds off an automatic service application on locomotive units when the dynamic brake is in operation. This feature is nullified during emergency applications.

3. Independent Release

With this feature the engineer can hold off or release the automatic application on locomotive units only while leaving train brakes applied.

4. Car Release Valves

These are manually operated valves on freight cars which can be used to release the brakes on individual cars.

5. Truck Cut-outs - Locomotives

Locomotives have a side vented cut-out cock adjacent to each truck, which, when closed, will vent the brake cylinders and release the brakes. When these cocks are closed, the locomotive no longer has effective brakes on the adjacent truck. With these cocks closed it is possible to have an indication of brake cylinder pressure on the cab gauge without actually having brake cylinder pressure or an application of brakes on the locomotive.

UNINTENTIONAL RELEASES - CAUSES

Making too light an initial reduction with a maintaining type brake valve -- if an initial reduction is made of less than 6 to 8 lbs. -- there is a possibility brakes will start to apply and then release unintentionally. This can be caused by the quick service features of the control valves, which when sensing the brake pipe pressure drop will make a local brake pipe reduction greater than that made by the brake valve. If the brake valve is a pressure maintaining type, it will feed air into the brake pipe to raise it to the equalizing reservoir pressure, then the control valve, sensing a rise in brake pipe pressure, will release the brakes.

Making repeated brake pipe reductions without allowing time to recharge, if a second brake pipe reduction must be made before the first has been charged off, the second reduction must be greater than the first or unintentional releases can occur (see charging section for explanation).

Brake equipment improperly set on trailing locomotive units -- if the brake valve on a trailing unit is not properly cut out -- air can flow into the brake pipe from that unit and release brakes.

Making too small a reduction when coming to a stop -- if too small a reduction is made when coming to a stop, or if an anglecock is closed before the reduction is complete, there is a possibility that the air disturbance in the brake pipe caused by closing an anglecock will be sensed by control valves as a brake pipe recharge, causing some brakes to release.

INDEPENDENT BRAKE

This brake was covered briefly in Simplified Brake Systems. It is a modified straight air brake system on locomotive units only. The independent brake valve applies and releases this brake on a single locomotive unit or on all units of a multiple unit consist if the proper hoses are coupled and cut in.

The independent brake valve can also be used to release or prevent an automatic application on locomotive units. It is a simpler, quicker acting brake than the automatic brake and is used in braking light locomotive units in preference to the automatic brake. It is also used in switching operations, if the additional braking effort of cars is not required.

In general, it operates on the opposite principle from automatic brakes, in that air must be supplied through the brake valve for an application, not exhausted. Since it is a quick acting brake and rapid brake cylinder pressure build up is possible, it must be used with care to avoid sliding wheels. The brake cylinder pressure gauge must be observed closely when using the brake.

The independent brake is also used as a holding brake for standing locomotives and is effective for this purpose if the engine is running and the compressor functioning (see operating rules for additional precautions to be taken with standing locomotives).

The dynamic brake interlock does not affect the independent brake, consequently engineers should keep the independent brake released when dynamic braking is in use as the retarding effect of the dynamic and the independent is likely to cause sliding wheels.

SPECIFIC EQUIPMENT

26L BRAKE EQUIPMENT

The following locomotives are equipped with 26 brake equipment:

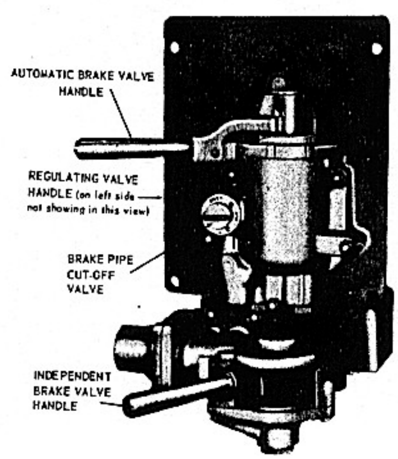
Locomotive Numbers	Locomotive Model
1501 – 1503	SW 1500
2001 – 2010	GP 20
2251 – 2265	U23B
3001 – 3022	GP 35
3051 – 3071	U30B
3501 – 3544	GP 40

The major components and features of this equipment are as follows:

26C Automatic Brake Valve (Figures 26-1 and 26-2)

This is a self-lapping, pressure maintaining brake valve that controls train brakes by regulating the pressure in the brake pipe.

Figure 26-1



Cut-Off Valve

The cut-off valve must be properly positioned for the automatic brake valve to be effective. Two types of cut-off valves exist, Two Position marked "out" and "in" and Three Position marked "FRT", "Pass" and "Out". To make the brake valve effective, the dial-type indicator handle should be pushed in and turned to "in" or "FRT". The "Out" position is used for trailing units or units hauled dead in train. "Out" position is also used during brake tests. The "Pass" position is for use with passenger equipment with graduated release; consequently it is not used on Western Pacific.

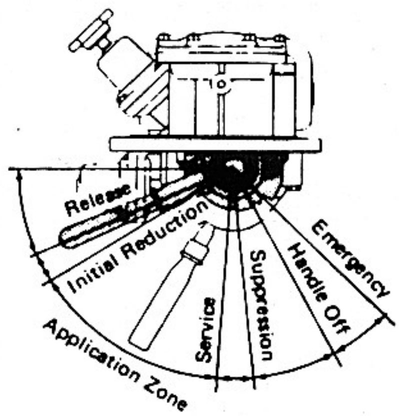
Regulating Valve

The regulating valve on the left back of the control stand is used for adjusting equalizing reservoir pressure, which in turn sets brake pipe pressure. This valve is used to set brake pipe pressure to standard (90 lbs.). Turning the valve clockwise increases the pressure, counter-clockwise decreases the pressure. This adjustment should only be made with the valve handle in release position.

Handle Positions

Handle positions for automatic brake valve (Figure 26-2) are as follows:

Figure 26-2



No. 26-L Brake Equipment
Automatic Brake
Valve Handle Positions

Release

This brake valve has one position for both running and release located at the extreme left or clockwise position on the quadrant. This position is used for release and recharge of automatic brakes, and the handle should be left in this position when running and no application is required. When in this position, the brake valve will maintain brake pipe pressure to the setting of the regulating valve (should be 90 lbs.).

Minimum Reduction

The first position to the right of release is minimum reduction position. In this position equalizing reservoir will be reduced 6 to 8 lbs. and the corresponding reduction made in brake pipe pressure. When left in this position, the brake valve will maintain brake pipe pressure at 82 to 84 lbs., allowing air to flow into the brake pipe if necessary to compensate for leakage.

This position is used to make initial applications to adjust train slack and set the brakes up for further heavier applications. As far as operation of the equipment is concerned, the brake valve should not be returned directly back to release from this position, since a release after such a light application can result in stuck brakes.

Service Application Zone

Movement of the handle further toward the right results in progressively greater equalizing reservoir reductions and progressively lower brake pipe pressures. The handle is moved to whatever point it reduces the equalizing reservoir the desired amount and then stopped. The valve will then "lap" itself stopping the reduction at that point. The brake pipe pressure will then reduce a like amount and the maintaining feature will then maintain that reduced pressure allowing air to flow into the brake pipe to compensate for leakage, if necessary.

The handle should not be moved to the left within the service zone, as the brakes cannot be graduated off in freight service. If a release is desired, the handle should be moved all the way to the left to release position. A full service application is available at the right end of the service zone near the quadrant stop. A resistance to further handle movement will be felt at that point.

Suppression

This position is immediately to the right of the service zone at the start of the hump in the quadrant. This position gives a full service application and suppresses a penalty application and recovers PC (power knockout) action, resulting from a penalty application. If the cause of the penalty has been corrected and a full service reduction has been made, the brakes can then be released without coming to a stop. This position will not suppress or recover an emergency application or recover PC action resulting from an emergency and no attempt should be made to use it for that purpose.

Handle Off

As the name implies, this position is for removing the brake valve handle when conditioning the unit for trail or dead movement. If the handle is placed in this position with the brake valve cut in, the brake pipe will reduce to zero at a service rate. As per air brake rules, a 20 lb. reduction should be made and brake valve cut out before moving handle to this position when conditioning units for trail.

Emergency

This position is at the extreme right hand (counter-clockwise) end of the quadrant. In this position the brake pipe is vented directly to atmosphere at an emergency rate to initiate an emergency application throughout the train.

In addition to initiating an emergency application, this position is also used when an emergency has been initiated from some other source. If an emergency application occurs on a moving train, regardless of source, the brake valve should be moved to emergency and left there until the train stops. If an unintentional emergency is initiated on a standing train, the brake valve must be put into emergency position. In any case, the brake valve handle must remain in emergency position at least one minute before brake control and PC action can be recovered by moving the handle to release position.

The emergency position is effective even with the brake valve cut out. That is, it will initiate an emergency application with the cut off valve in "out" position.

Multiple Unit Valve

This valve is located on the control stand and is used to cut the independent brake in and out. Two types of these valves exist.

1. MU 2A Valve

   This is a three position valve with positions marked "lead" or "dead", "trail 24 or 26" and "trail 6". For controlling lead unit, this valve must be in the "lead or dead" position in order to have effective independent brake control. The "trail 24 or 26" position is used to cut the independent brake control out when the unit is trailing a controlling unit with Number 24 or Number 26 brake equipment. The "trail 6" position is used when trailing a controlling unit with Number 6 brake equipment. This position is not normally used on the Western Pacific. The "lead or dead" position is also used when preparing a unit for movement dead in train. This is a spring-loaded valve; the indicator-handle should be depressed when turning to a different position.

2. Double Ported Cut-Out Cock

   This is a two position cock that serves the same purpose as the MU 2A Valve. The positions are marked "lead or dead" and "trail". This valve must be in the "lead or dead" position in order to have independent brake control from that unit. In the "trail" position the unit can be controlled from another unit having Number 24 or Number 26 brake equipment. As with the MU 2A Valve, the "lead or dead" position is also used for units being hauled dead in train.

SA 26 Independent Brake Valve (Figure 26-3)

This is a self-lapping type brake valve used to apply and release the brakes on the locomotive units only. This valve is pressure maintaining in that it will maintain a given pressure in the brake cylinders corresponding to the pressure originally applied to the brake cylinders by movement of the handle.

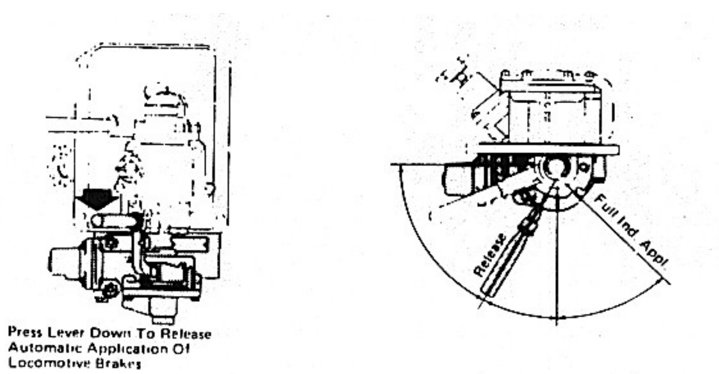


Figure 26-3

1. Release

Position is at the extreme left of the quadrant.

2. Full Application

Position is at the extreme right of the quadrant. Between release and full application is the application zone. Movement of the handle from left to right causes increasing applications. Brake can be graduated off; that is, movement from right to left will give decreasing brake cylinder pressures.

Independent Release of Automatic Application

When the independent brake valve handle is depressed or "bailed down" in the release position, it will cause an automatic application to release on the locomotive only.

When the independent brake valve handle is depressed in the application zone, it will cause an automatic application to release down to the pressure called for by the position of the independent handle on the quadrant.

This "bail down" feature is frequently used, especially in the release position, because there are operating conditions that make it desirable to keep locomotive brakes released while the rest of the train brakes apply. This feature will release all automatic applications, service and emergency, consequently the locomotive has no effective air brakes when the independent handle is bailed down in release position.

To assure release of brakes on all the units of a consist, the handle should be "bailed down" for four (4) seconds per unit.

24 RL BRAKE EQUIPMENT

The following locomotives are equipped with 24 RL brake equipment:

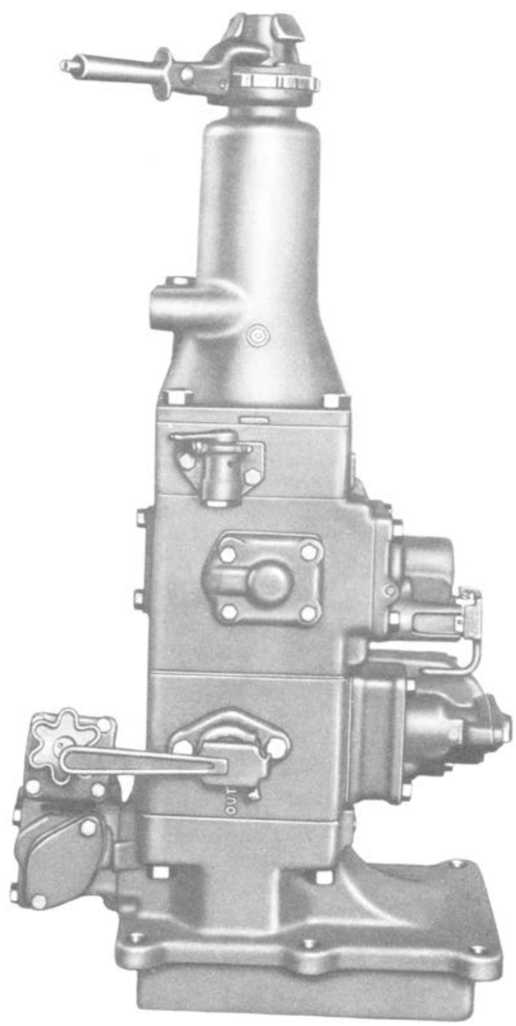
Locomotive Numbers	Locomotive Model
701 – 713	GP 7
725 – 732	GP 9
913 – 921	F 7

The major components and features of this brake equipment are as follows:

D24 Automatic Brake Valve (Figure 24-1)

This is designated as a Type II D24 Brake Valve. Explanation of various controls and handle positions follows:

Figure 24-1



D-24 TYPE BRAKE VALVE

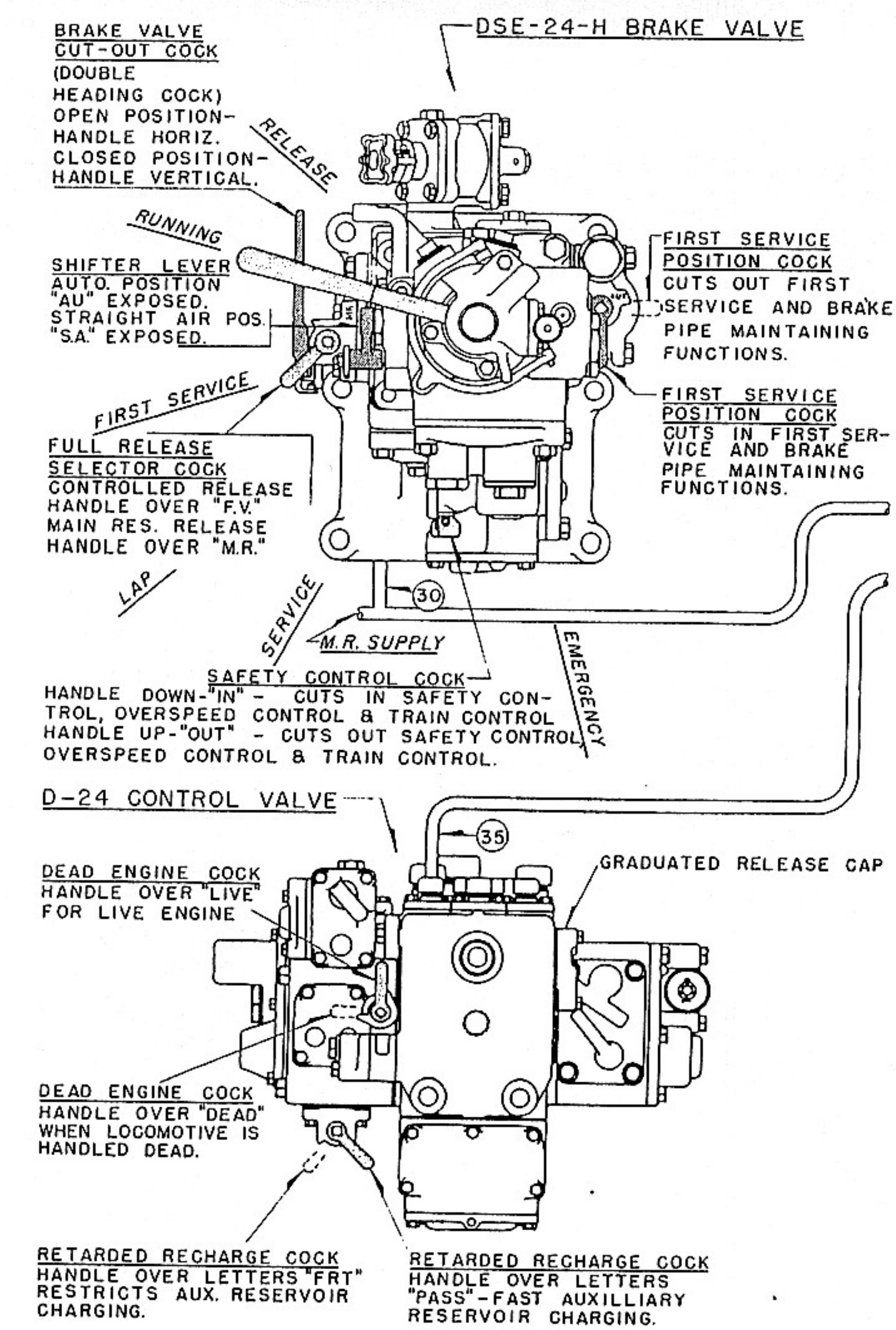

DSE-24-H BRAKE VALVE
BRAKE VALVE CUT-OUT COCK (DOUBLE HEADING COCK) OPEN POSITION- HANDLE HORIZ. CLOSED POSITION- HANDLE VERTICAL.
RELEASE
RUNNING
SHIFTER LEVER AUTO. POSITION "AU" EXPOSED. STRAIGHT AIR POS. "S.A." EXPOSED.
FIRST SERVICE
FULL RELEASE SELECTOR COCK CONTROLLED RELEASE HANDLE OVER "F.V." MAIN RES. RELEASE HANDLE OVER "M.R."
LAP
SERVICE
30
M.R. SUPPLY
EMERGENCY
FIRST SERVICE POSITION COCK CUTS OUT FIRST SERVICE AND BRAKE PIPE MAINTAINING FUNCTIONS.
FIRST SERVICE POSITION COCK CUTS IN FIRST SERVICE AND BRAKE PIPE MAINTAINING FUNCTIONS.
SAFETY CONTROL COCK
HANDLE DOWN-"IN" - CUTS IN SAFETY CONTROL, OVERSPEED CONTROL & TRAIN CONTROL HANDLE UP-"OUT" - CUTS OUT SAFETY CONTROL OVERSPEED CONTROL & TRAIN CONTROL.
D-24 CONTROL VALVE
35
GRADUATED RELEASE CAP
DEAD ENGINE COCK HANDLE OVER "LIVE" FOR LIVE ENGINE
DEAD ENGINE COCK HANDLE OVER "DEAD" WHEN LOCOMOTIVE IS HANDLED DEAD.
RETARDED RECHARGE COCK HANDLE OVER LETTERS "FRT" RESTRICTS AUX. RESERVOIR CHARGING.
RETARDED RECHARGE COCK HANDLE OVER LETTERS "PASS"-FAST AUXILLIARY RESERVOIR CHARGING.

Figure 24-1

1. Release Position

Position is at the extreme left of the quadrant.

2. Running Position

The next position to the right (counter clockwise) of release is running. With the handle in this position, air flows through the feed valve and through ports in the brake valve into the brake pipe. This position will also release the automatic brakes and will maintain brake pipe pressure at the feed valve setting. When an application is not required, this is the normal position in which brake valve handle is carried.

3. Pressure Maintaining Position

This is the next position to the right of "running". In this position, air will flow at a slow rate into the brake pipe to compensate for leakage after a reduction has been made. The handle should not be moved to this position from any position other than "service". Also the brake valve handle should not be moved from "pressure maintaining" position to "running" or "lap" and then back to "pressure maintaining." When using this feature the service reduction is made in "service" position and then the handle moved to "pressure maintaining" position while air is exhausting from the service port. (Do not pause at lap.) This pressure maintaining feature is cut in or out by a cock on the right side of the brake stand.

4. Lap Position

The next position to the right of maintaining is lap. In this position, all operating ports are closed and no air will flow through the brake valve.

The handle is placed in this position after a service reduction if the maintaining feature is not desired or required, such as when making brake pipe leakage test.

This position can also be used to suppress a penalty application. If the cause of the penalty has been corrected, the handle can be placed in this position to forestall the full penalty application. When the reduction has stopped, the handle can then be moved to running for recovery of PC action and release of brakes. The throttle must also be returned to idle to recover PC action.

5. Service Position

Next position to the right is service. In this position the equalizing reservoir pressure is reduced and brake pipe pressure reduced accordingly, at a service rate. This brake valve is not self-lapping in this position; that is, the reduction will not be limited by the valve. Equalizing reservoir pressure should be reduced the desired amount, and then handle should be moved to lap or pressure maintaining position, whichever is required.

6. Emergency Position

This position is at the extreme right (counter clockwise) position of the quadrant. In this position, brake pipe air is exhausted directly to atmosphere at a rate rapid enough to cause all control valves to assume emergency position. An emergency application can be initiated in this position regardless of whether the brake pipe cut-out cock is closed or open. If an emergency application is initiated from some location other than the controlling brake valve, the handle on the controlling brake valve should be put in emergency position until the train stops. Then, to recover brake control and PC switch, place handle in lap for about one minute, then to running or release if conditions permit a brake release.

Safety Control Cock

This cock is located on the front lower portion of the brake stand. It cuts in or out the feature providing for penalty applications. With the handle down safety control features are cut in and effective. With the handle up, safety control features are not effective and penalty applications will not occur if the unit is in the lead (controlling).

D 24 B Feed Valve

This valve is located on the back of the brake stand near the cab floor. The setting of this valve controls the brake pipe pressure. The pressure of the air flowing into the brake pipe is governed by this valve when the brake valve is in "running" or "release FV" position. The pressure should be adjusted by the handwheel with the brake valve in "running" position, taking proper precaution to avoid an overcharge after reducing pressure.

K2A Rotair Valve (Figure 24-3)

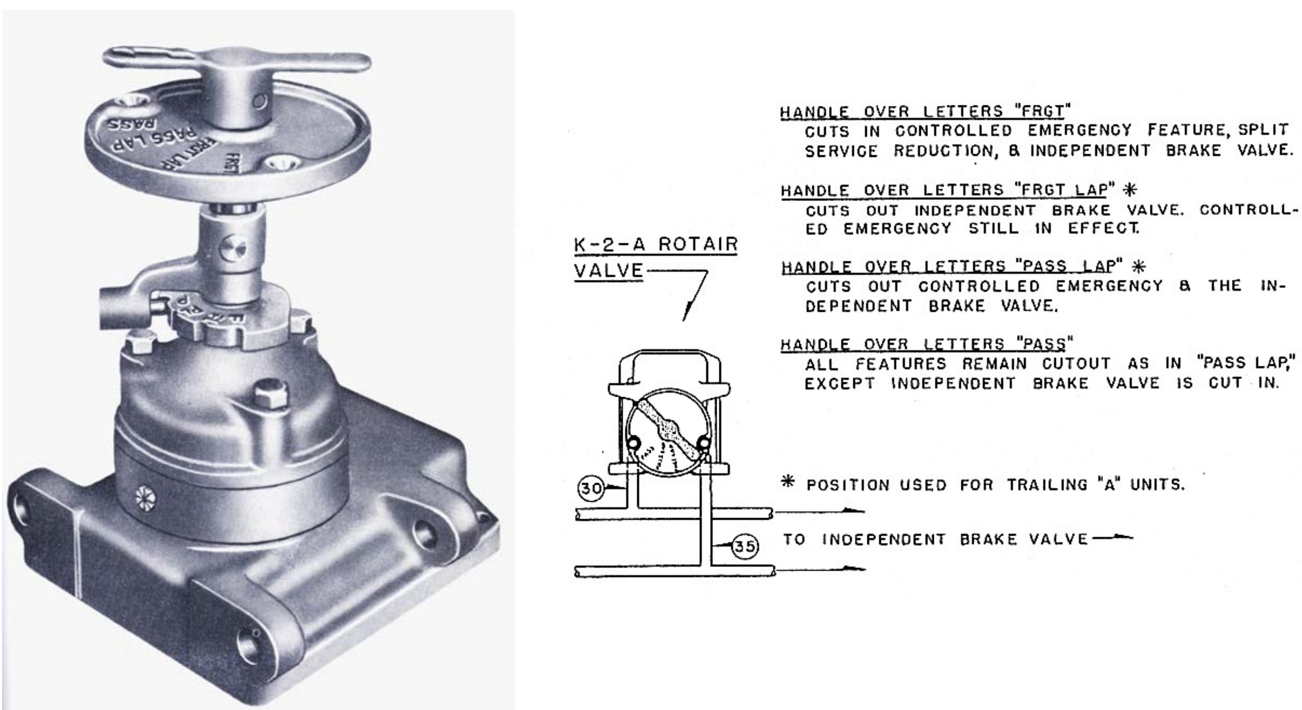


Figure 24-3

This valve is located either on the back of the control stand or on the floor of the cab on the opposite side of the control stand from engineer's seat. This valve has four positions and must be positioned properly in order to have effective independent brake control. This valve also affects certain features of the automatic brake control. Handle positions are as follows:

1. Freight (Marked "FRGT")

   In this position, the independent brake valve is cut in and effective. The automatic brake is conditioned for "controlled emergency", which is a feature that delays an emergency application on the locomotive units until after the application has taken effect on the cars in the train. The automatic brake is also conditioned for split reduction from penalty applications. This position should be used only on the controlling (lead) unit of a locomotive with a train of 40 cars or more.

2. Passenger (Marked "PASS")

   In this position, the independent brake valve is cut in and effective. The controlled emergency and split reduction features of the automatic brake are cut out.

   This position should be used on the lead (controlling) unit of locomotives with trains of less than 40 cars. It should also be used when the unit is used as a switcher locomotive and when the unit is to be hauled dead in train.

3. Freight Lap (Marked "FRGT LAP'')

   This position conditions the equipment to trail a controlling unit that has its rotair valve in "FRGT" position. The independent brake valve is not effective on a unit with the rotair valve in this position. This position should be used only when the unit is trailing a controlling unit with 24RL brake equipment having its rotair valve in freight position.

4. Passenger Lap (Marked "PASS LAP")

   The independent brake valve is not effective on a unit having the rotair valve in this position. This position is used on units trailing controlling 24RL units with rotair valve in "PASS". It should also be used on units trailing controlling units with 26L equipment.

S-40 Independent Brake Valve (Figure 24-4)

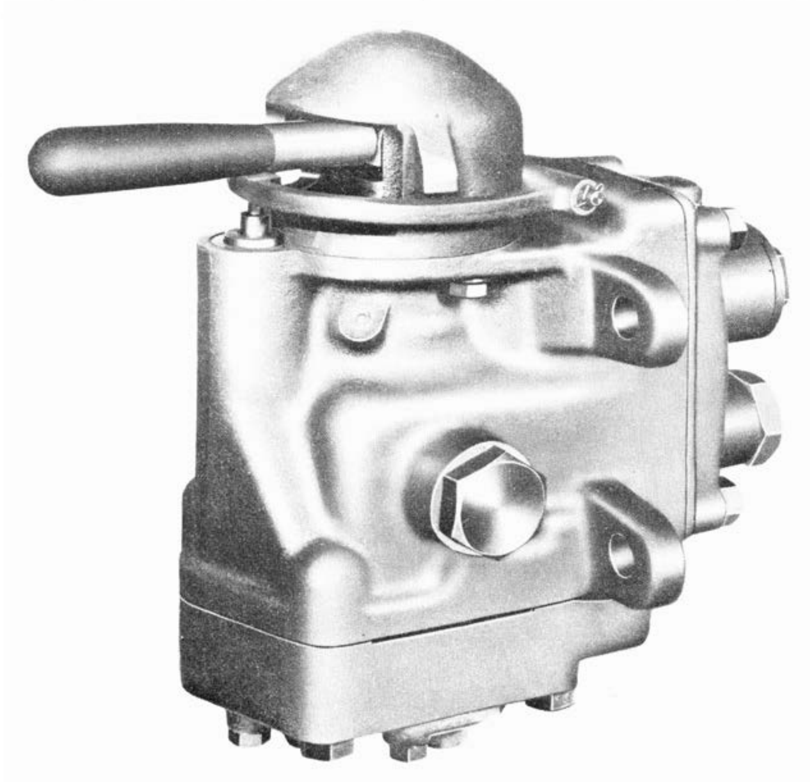


Figure 24-4

This is a self-lapping type valve that will also maintain against leakage. This valve controls the brakes on the locomotive units only.

Handle Positions (Figure 24-5)

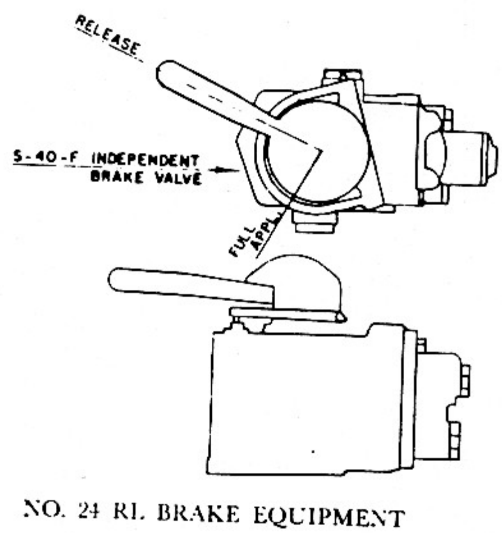


Figure 24-5

Release

This position is at the extreme left of the quadrant. With the handle in this position, an independent application will be released. Also, if the handle is depressed or "bailed down" in this position, it will release an automatic application of locomotive brakes. To assure a positive release of brakes on all units, the handle should be held down four (4) seconds for each unit in the consist.

Full Application

This position is at the right of the quadrant. With the handle in this position, locomotive brakes will be applied to full brake cylinder pressure as set by internal adjustment of the valve. Standing locomotives should have this valve left in this position.

Between "release" and "full application" is the Application Zone. Movement of the handle from left to right will cause increasing brake cylinder pressures. This brake can be graduated off; that is, movement of handle from right to left will cause decreasing brake cylinder pressures.

Freight Emergency

This position is to the right of full application. There is a built- in resistance to handle movement beyond full application, as the handle is not normally moved beyond that point. If the handle is moved to overcome this resistance, moving it against the positive stop, a quick emergency application will occur on the locomotive if the automatic brake valve is in emergency position and the rotair valve is in "freight" position. This position is used to overcome the controlled emergency normally in effect on the locomotive when the rotair valve is in "freight" position. Use of this position with automatic brake valve in any position other than emergency will result in the same application as "full application" position. An air blow will be audible as a reminder that the position should not be used in that case. With the rotair valve in "pass" position this position will have the same effect as "full application" position.

14EL BRAKE EQUIPMENT

The following units are equipped with this type brake:

Locomotive Numbers	Locomotive Model
401 – 402	SW 1
557 – 561, 745	S2
564	S4
607 – 608	NW 2
746 – 747	RS 1

The major components and features of this equipment are as follows:

K-14 Brake Valve

This equipment features various models of the K-14 brake valve (Figure 14-1). The upper, smaller brake valve is the independent, and the lower, larger, the automatic.

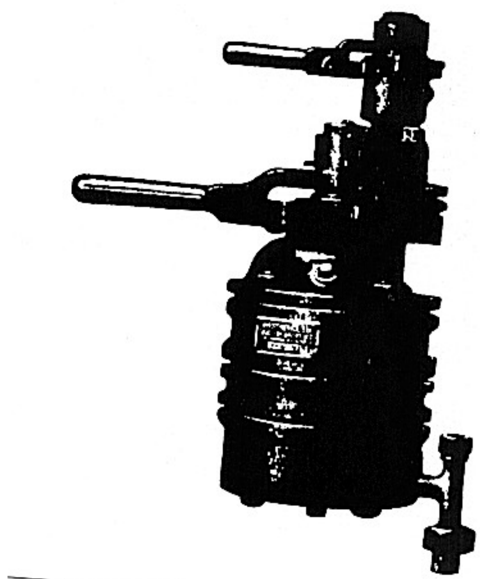


Figure 14-1

In order for the automatic brake valve to be effective, the brake pipe cut-out cock must be open. Two different types of cut-out cocks are used with this equipment: two position and three position.

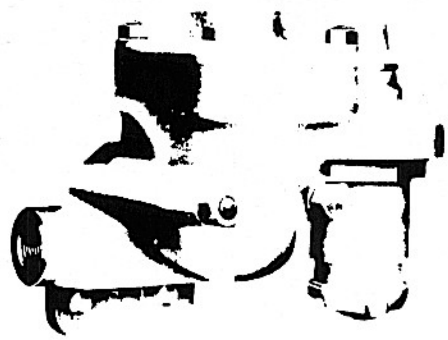
With the two position cock, the cock is open when the handle is horizontal (crosswise to the pipe). This position gives full brake control to the unit. Closed position (handle parallel with pipe) is used when hauling unit dead in train.

With the three position cock, No. 1 position (handle crosswise to pipe) cuts in the automatic brake valve. No. 2 position conditions the unit to trail another controlling unit in multiple. (This position not normally used.) No. 3 position is used to condition the unit for movement dead in train.

<u>Feed Valves</u>

This equipment has an M-3-A Feed Valve (Figure 14-2) for adjusting and regulating brake pipe pressure with automatic brake valve in running position.

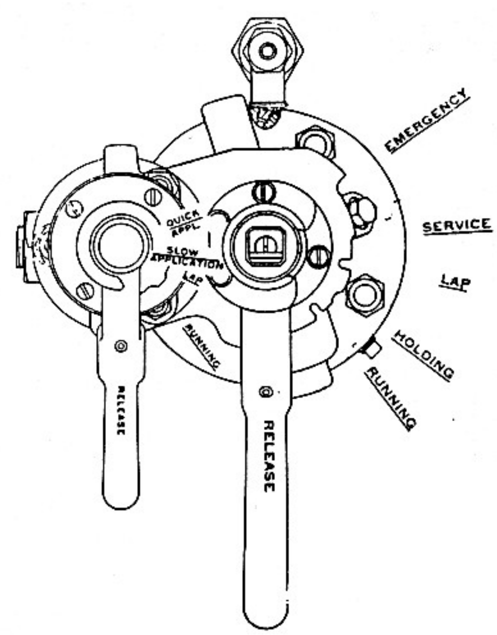
Figure 14-2



A similar appearing M-3 Feed Valve is used to regulate maximum brake cylinder pressure from an independent application. This valve should be set at 35 lbs.

Handle positions for the automatic brake valves (Figure 14-3) are as follows:

Figure 14-3



Release

Release position is at the extreme left of the quadrant, permits air at main reservoir pressure to flow into the brake pipe for rapid build up of brake pipe pressure. It should be used with caution to avoid overcharges. A blow of air is audible with handle in this position.

Running

Brake pipe will be charged up to the setting of the feed valve and maintained at feed valve setting. This position is used for normal release and charging or recharging of automatic brakes. When an application is not required, this is the normal position for the handle.

Holding

When handle is moved to this position after an application, locomotive brakes will stay applied and train brakes (cars) will release.

Lap

In this position all operating ports are closed off. This position is used after a service reduction to hold automatic brakes applied until either a further reduction or release is required.

Service

Service position gives a brake pipe reduction at a service rate as controlled by equalizing reservoir pressure. This brake valve is not self lapping in this position, consequently after desired reduction in equalizing reservoir pressure has been made, handle should be moved to lap.

Emergency

This position vents brake pipe directly to atmosphere at a rapid rate to cause control valves to move to emergency application position. This position is used to initiate an emergency application, and the handle should also be moved to this position if an emergency application has been initiated by some other means.

Handle Positions

Independent Brake valve handle positions (Figure 14-3) are as follows:

Release

Release position at the extreme left is for releasing locomotive brakes that have applied from an automatic application without releasing train brakes.

Running

Running position is the normal position for the handle when brake application is not required. An independent application will be released in this position.

Lap

All operating ports are closed in this position. This position is used to hold an application.

Slow Application

As the name implies, slow application causes a slow brake application. After the desired brake cylinder pressure is obtained the handle must be moved to lap to hold that application.

Quick Application

Quick application operates the same except brake cylinder pressure is built up at a more rapid rate.

NOTE: This independent brake valve is not self-lapping.

Alertness Devices

Locomotives Numbers 401-402, 557-561, 745 and 564 have electronic alertness devices, details of which are covered in Diesel Operation Notice No. 10-6 which is included in this manual.

Locomotives Numbers 607-608 and 746-747 have foot pedal alertness control. With this device foot pedal must be depressed anytime locomotive brakes are released or a penalty brake application will occur. Recovery from this penalty requires depressing the foot pedal, lapping the automatic brake valve and pushing a button type recovery valve adjacent to the brake stand.

6BL BRAKE EQUIPMENT

This equipment is found on switcher locomotives 601-606, EMD Model SW9.

The brake valve assembly is designated as H-6-L and consists of an H-6 automatic brake valve and an LA-6-P independent brake valve.

H-6 Automatic Brake Valve

This brake valve is not self lapping and is pressure maintaining only in "running" position.

In order for the automatic brake valve to be effective, the brake pipe cut-out cock must be in the proper position. This is a three position cock located on the back of the brake stand. The three positions are marked "LEAD", "TRLG" (Trailing) and "DEAD".

Lead

Lead position opens the brake pipe to the automatic brake valve and makes the brake valve operable and effective.

Trlg (Trailing)

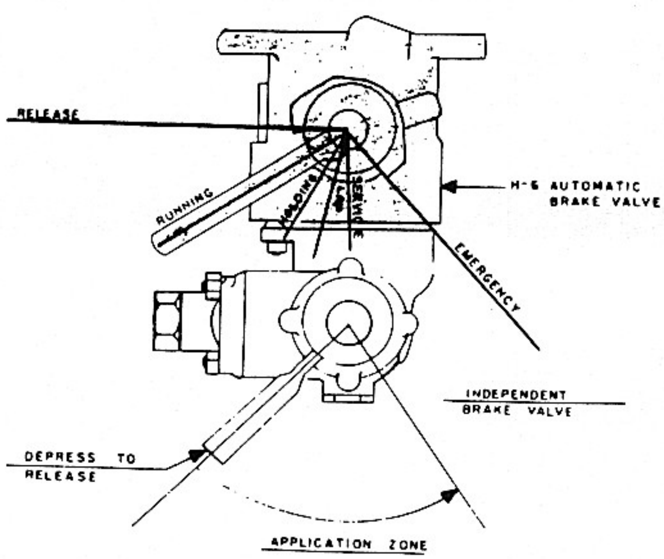
This position conditions the unit to trail another controlling unit. Although these units are capable of operating in multiple they are not compatible with all other units and are not normally operated in multiple. Therefore the "trailing" position should not be used unless specifically instructed to do so.

Dead

In this position the brake pipe is cut off from the automatic brake valve. This position is used when hauling the unit dead in train or when double heading.

Handle positions for H-6 Automatic Brake Valve (Figure 6BL-1) from left to right, (counter clockwise) are as follows:

Figure 6BL-1



Release

Release position at the extreme left of the quadrant, permits air at main reservoir pressure to flow into the brake pipe for rapid build up of brake pipe pressure. It should be used with caution to avoid overcharges. A blow of air is audible with handle in this position.

Running

Brake pipe will be charged up to the setting of the feed valve and maintained at feed valve setting. This position is used for normal release and charging or recharging of automatic brakes. When an application is not required, this is the normal position for the handle.

Holding

When handle is moved to this position after an application, locomotive brakes will stay applied and train brakes (cars) will release.

Lap

In this position all operating ports are closed off. This position is used after a service reduction to hold automatic brakes applied until either a further reduction or release is required.

Service

This position gives a brake pipe reduction at a service rate as controlled by equalizing reservoir pressure. This brake valve is not self lapping in this position, consequently after desired reduction in equalizing reservoir pressure has been made, handle should be moved to lap.

Emergency

Emergency position vents brake pipe directly to atmosphere at a rapid rate to cause control valves to move to emergency application position. This position is used to initiate an emergency application, and the handle should also be moved to this position if an emergency application has been initiated by some other means.

F4B Feed Valve is located on the engineer's side of the brake stand under the automatic brake valve. This valve is used to set the brake pipe pressure and will maintain the brake pipe at the set pressure with the automatic brake valve in running position. The hand wheel should be adjusted only with the automatic brake valve handle in running position and precautions against overcharge should be observed when lowering brake pipe pressure.

LA-6-P Independent Brake Valve

This is a self lapping type independent brake which will maintain against leakage when applied. This valve has two positions, release at the extreme left of the quadrant and full application at the extreme right. Between these two positions is an application zone where movement to the right will increase brake cylinder pressure and movement to the left will decrease brake cylinder pressure. Depressing or bailing down on the handle in release position will release the brakes quickly regardless of the source of the application.

Alertness Control

These units are equipped with electronic alertness control (commonly called "Alertor"). Details of the operation of this device are covered in Diesel Operation Notice No. 10-6, copy of which is included in this manual. If conditions called for by this device are not met, a penalty application will occur. This is done by venting the equalizing reservoir at a service rate with a consequent venting of brake pipe pressure and application of automatic brakes accompanied by loss of power through PC switch actuation. Diesel Operation Notice No. 10-6 gives full particulars on method of recovery.

Figure 6BL-2 Brake Equipment, brake valve handle position.

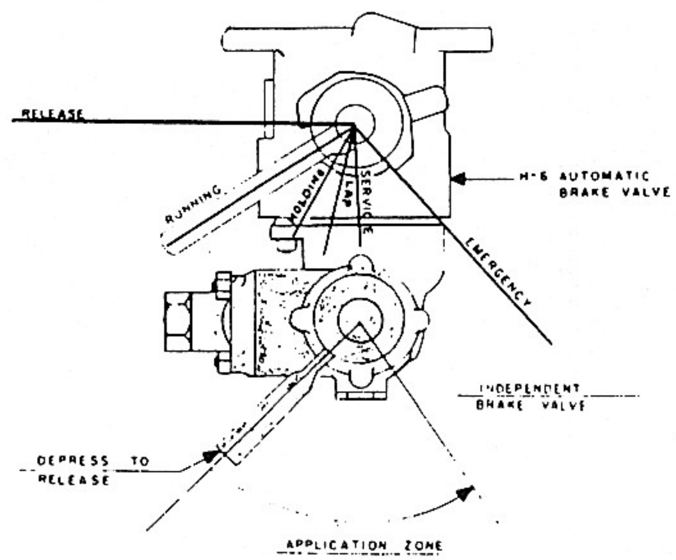


Figure 6BL-2

BRAKE PIPE FLOW INDICATOR

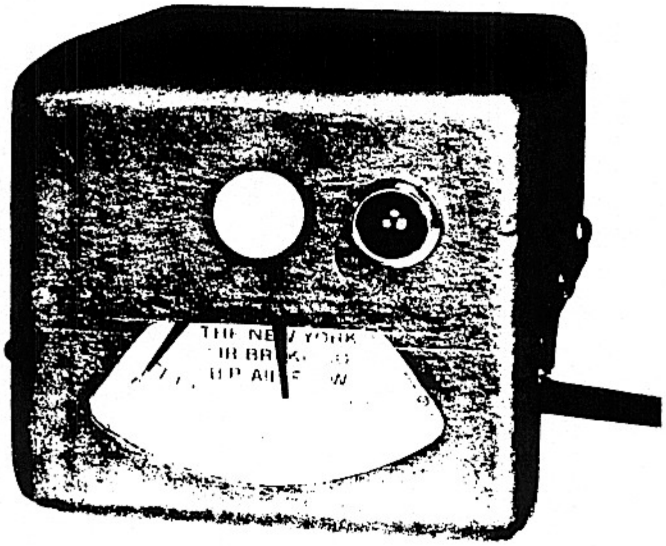
Road locomotives are equipped with brake pipe flow indicators. These devices give an indication of the flow of air through the locomotive feed or regulating valve into the brake pipe. This device is desirable because the brake pipe gauge indicates the pressure in the brake pipe at the locomotive but gives no indication of how much air is flowing into the brake pipe to maintain that pressure. These indicators are actually differential pressure gauges that measure the pressure drop across an orifice in a brake pipe flow indicator adaptor. The greater the flow the greater the pressure difference, giving a higher flow indication.

Although these devices will show the flow of air necessary to maintain brake pipe leakage, they should not be used to determine actual brake pipe leakage during brake tests. They can be used to determine when charging is nearly complete but the actual leakage test must be made by observation of brake pipe pressure gauge and timing with watch in accordance with air brake rules. The graduations shown on these devices are indications of flow; they do <u>not</u> necessarily represent "pounds" or "pounds per minute."

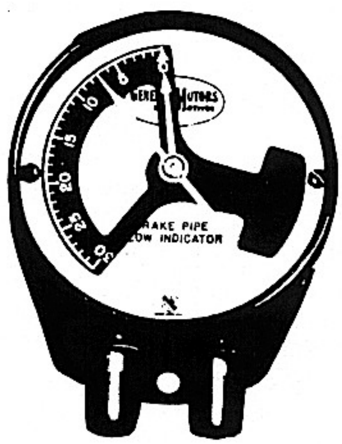
Two different types of these indicators are in use, the "two pointer" and the "sector type".

The two pointer type, Figure BPF-1, has a black hand which responds to the flow of air and a red hand which can be set by the knob on the front of the instrument. This instrument also has an amber warning light. This light will come on when the flow exceeds the setting of the red hand.

The sector type is shown in Figure BPF-2. With this type the differential between the pointer hand and the sector hand gives the indication of flow into the brake pipe. (The indication on the Figure BPF-2 is 7.)



BPF-1



BPF-2

ALL CONCERNED: DIESEL OPERATION NOTICE NO. 10-6

Subject: Switch Engine Alertor Operation

On switcher locomotives having Electronic Alertness Device the following instructions will apply.

This device called an "ALERTOR" senses the Engineer's normal movements while operating the locomotive. The unit will operate as follows:

1. Anytime the independent brake is applied with a brake cylinder pressure of 25 lbs. or more, the "ALERTOR" is nullified.

2. As soon as the Engineer is seated at the controls and the independent brake is released or has less than 25 lbs. brake cylinder pressure, the "ALERTOR" is in operation.

3. If the Engineer touches or releases, (makes or breaks contact with) any metallic object in the cab once every 20 seconds, there will be no change in the normal operation of the locomotive. If he should fail to make any such movement within 20 seconds, a buzzer will sound and a red light will flash on the "ALERTOR" box. This warning can be acknowledged by the Engineer making one of the following movements.

    a. By making contact with his hands to any metallic object in the cab.

    b. If he is holding a metallic object he must break contact with it momentarily or make contact with his other hand.

    c. By pressing the ACKNOWLEDGE button. This button cannot be held in the depressed position as this will result in a penalty application.

    Making one of the above movements will cause the warning light to go out and the buzzer will stop sounding.

4. If the Engineer fails to acknowledge the warning within approximately 10 seconds after the buzzer and light come on, a penalty brake application will occur and the locomotive will lose power.

5. If a penalty application occurs, the following must be done to recover:

    a. Reduce throttle to idle.

    b. Touch a metallic object, or if a metallic object is being held, break contact with it or press "ACKNOWLEDGE" button.

    c. Press "RESET" button.

6. If the "ALERTOR" becomes inoperative, proceed as follows:

   a. Break seal and close "ALERTOR" cut-out cock. This cock is located in cab of all switch engines below feed valve.

   b. Break seal and open "ALERTOR" circuit breaker located on forward cab wall just inside electric locker on right side.

   c. Whenever seals are broken and "ALERTOR" is cut out it must be reported on work report.

7. If locomotive is to be towed dead in train, controls and brake equipment are to be positioned as per previous instructions and, in addition, the following must be done:

   a. Break seal and close "ALERTOR" cut-out cock.

   b. Be sure main battery switch is open.

8. If the locomotive has been standing with the battery switch open, or if the "ALERTOR" circuit breaker has been open, the "RESET" button must be pressed before brakes can be released.