

BRAKE COURSE NOTES

CLASS 47

TRACTION TRAINING CENTRE
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BRAKING SYSTEMSDiaphragm Operated, Hollow Stem, Valve. Fig.1

The working principle of these valves is adopted on many of the air operated components fitted to the brake systems of locomotives and vehicles, e.g. relay valves, distributors, pressure limiting valves etc. It is therefore important that the principles of their operation is fully understood at this juncture.

A typical example of this type of valve is the relay valve Fig.1, its purpose being to react to small **controlling** air "signals" from the drivers straight air valve or locomotive distributor and pass a large volume of air which is required to supply the numerous brake cylinders on the locomotive.

Operation(a) Brakes "OFF"

No air (signal) being supplied to chamber "D", the control valve spindle (1) is at its lowest point hence the brake cylinders are in communication with atmosphere and are of .

(b) Brakes "ON" and Lapped

Control air supply from the Drivers Straight Air Brake (S.A.B.) or distributor, in the case of an automatic air brake application, enters chamber "D", acts against the control diaphragm (2) and lifts the control valve (1),

This achieves two operations:-

- (i) The hollow stem of the control valve (1) is sealed against the bottom of the inlet valve (3).
- (ii) The inlet valve (3) is lifted against the springs (4).

Main air, in chamber "A" therefore passes to the brake cylinders, chamber "B", to apply the brakes.

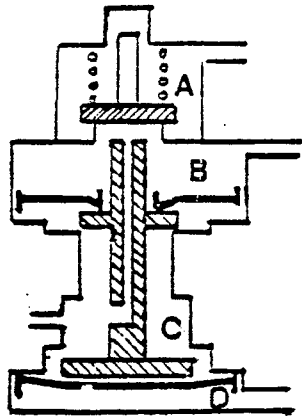
As the pressure in the brake cylinders builds up it will be reflected on the top of the equalising pressure diaphragm (5). The value of the pressure will depend on the degree of application made by the Driver and can vary between 0 - 70 p.s.i.

As the downward pressure on the equalising diaphragm (5) increases it will eventually equalise with the upward pressure exerted on the control diaphragm (2) thus the action of the string (4) will close the inlet valve (3). However, as the upward and the downward pressures are still equal the open end, exhaust port, of the control valve (1) is still closed, so maintaining pressure in the brake cylinder, i.e. the brake is "lapped on".

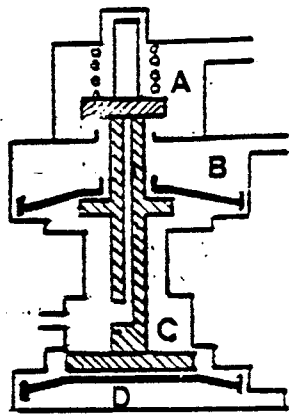
If a leakage exists in the brake cylinder or associated pipework the downward pressure on the equalising diaphragm (5) will reduce hence the now greater upward pressure on the control diaphragm (2) will move the control valve (1) up so as to open the inlet valve (3) and supply the brake cylinders to the original pressure before closing to the "lap on" as before,

(c) Release

When the Driver places the S.A.B. to release the pressure in the control chamber "D" is exhausted to atmosphere. The downward pressure on the equalising diaphragm (5) will push the control valve (1) down thus opening the exhaust port of the hollow spindle which will release the air in the brake cylinders, to atmosphere via the hollow stem hence the brakes will release.

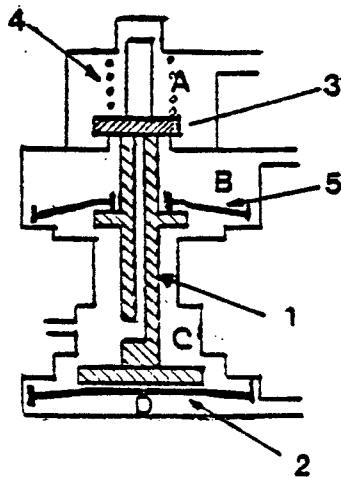


(a) Brake OFF



(b) Brake "ON"

No	
1	
2	
3	
4	
5	



(c) Brake "LAPPED"

Fig. 1.

JR

Check Valves Fig.2

These are also important in air systems to maintain air in certain parts of the system, such as reservoirs, in the instances of excessive leakage or failure of components.

Fig.2 is a typical example of a check valve and operates as follows:-

Air normally flows to the particular component from left to right and in doing so lifts the rubber seated valve. If the supply from the left hand side ceases the pressure already built up on the right hand side will exert a force downward on the valve to seat it off and thereby maintain the pressure in the system

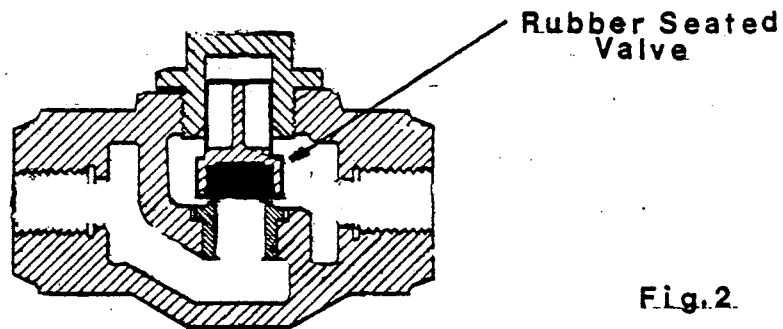


Fig.2.

Double Check Valve Fig.3

The purpose of the double check valve is to supply air to a single system from any one of two sources but ensure no air is fed back into the source not in use.

From Fig.3 it can be seen that the valve has 3 ports, two "IN" and one "OUT" and a slide valve which can close either of the "IN" ports whilst diverting the air from the remaining "IN" port to the "OUT" port, e.g. as shown in fig.3, air from the left hand port is exerting pressure on the slide valve so preventing any air from escaping through to the right hand port but enabling air to be passed to the "OUT" port.

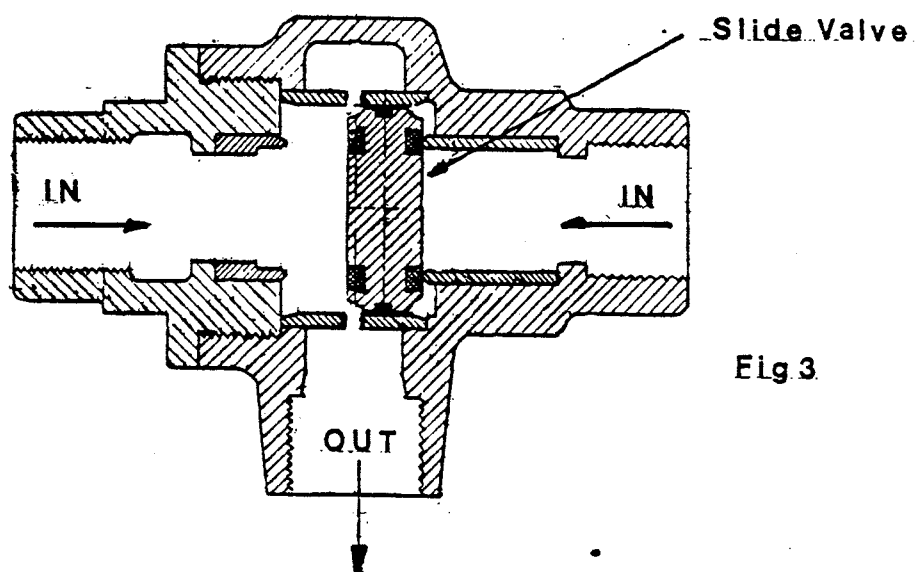
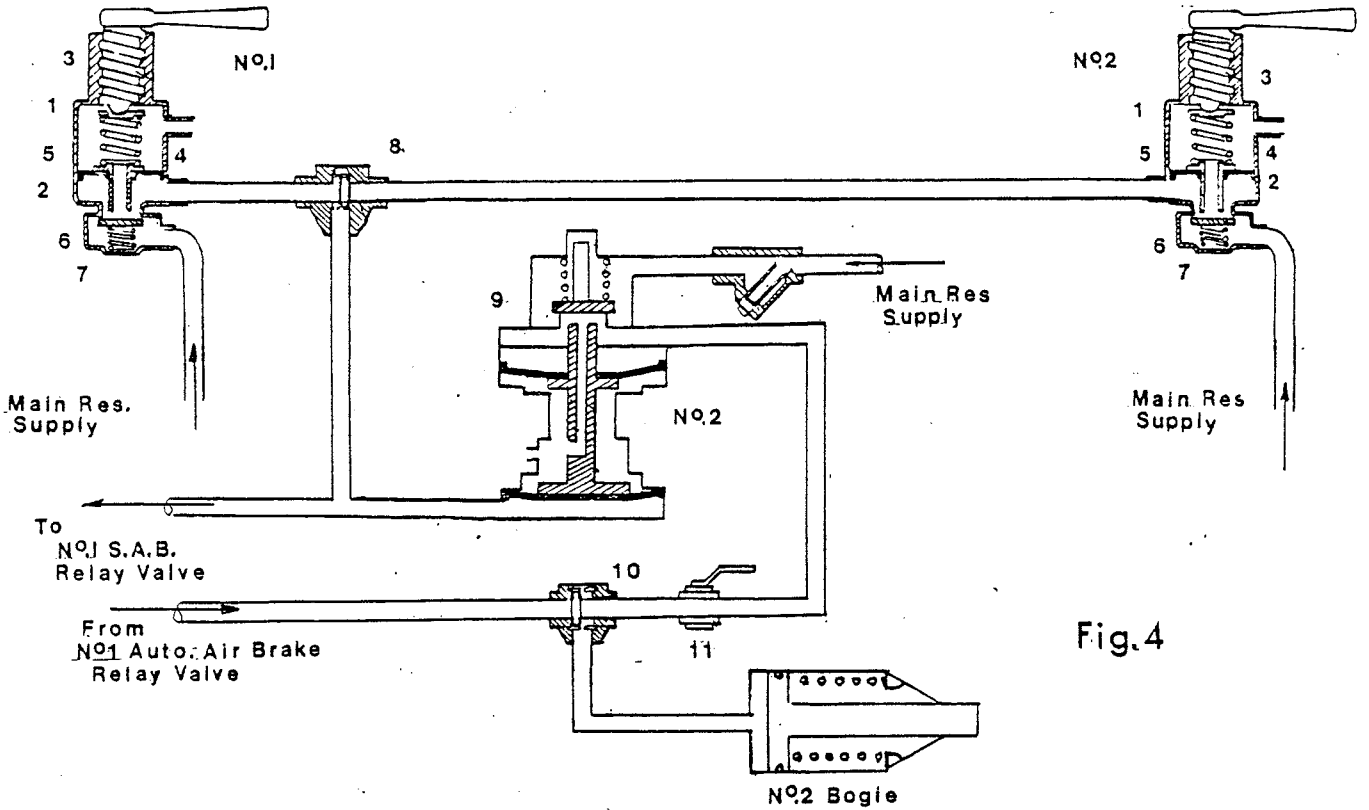


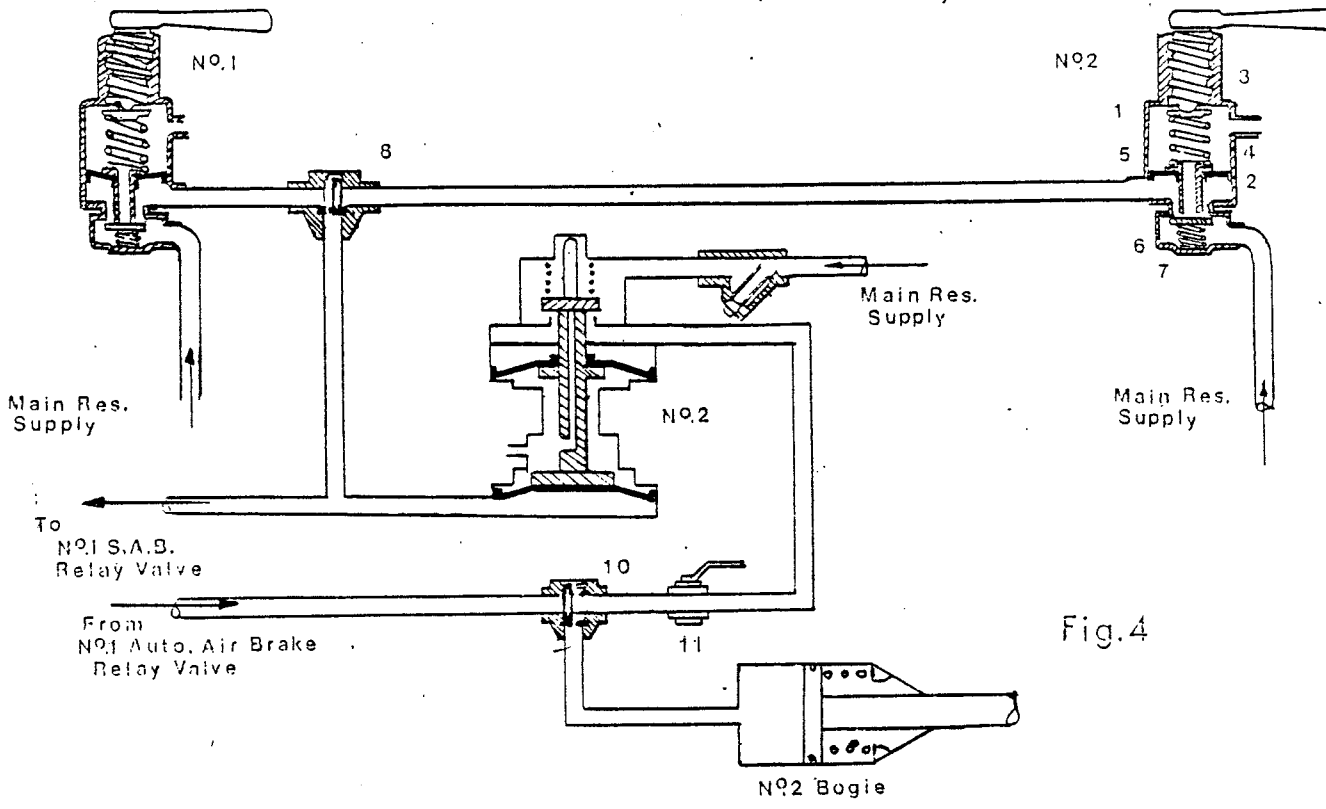
Fig 3

6
STRAIGHT AIR BRAKE SYSTEM (RELEASE)



58

STRAIGHT AIR BRAKE SYSTEM (APPLICATION)



58

Straight Air Brake System Fig.4

Drivers Straight Air Brake Valve (S.A.B.)

The S.A.B. (1) is for use when working light engines and lightly buffering up freight trains as described in Drivers Manual B.R. 33056/3.

The working of the S.A.B valve is similar in principle to the operation of the relay valve already described but in this instance the movement of the hollow stem control valve (2) is controlled by the rotational movement of the S.A.B. valve handle as follows:-

The brake valve handle is attached to a threaded shaft (3) located in the body of the valve housing. As the handle is moved from the "OFF" to "ON" position the action of the thread will cause the shaft to move down imparting tension on the control spring (4). When the tension of the spring overcomes the air pressure below control diaphragm (5) and spring (7) the end of the control valve (2) will close against the inlet valve (6) and allow air to pass from the main reservoir supply to the relay valve (9) via the double check valve (8).

The valve will remain in the lap position due to the balance of the upwards and downward forces as previously described.

NOTE

The spring tension is adjusted to limit the valve to a maximum pressure of 70 p.s.i. hence it could be described as an adjustable limiting valve.

When the brake valve handle is moved from the "ON" to the "OFF" position the tension of the control spring (4) is released hence the air pressure below the control diaphragm (5) will move the control valve up. This will cause the inlet valve to close and as the upward movement continues opens the end of the hollow stem to permit the escape of air from the lower side of the control diaphragm of the relay valve (9).

System Operation

When a brake application is made air passes from the S.A.B. to the double check valve (8) which will put the relay valve (9) into communication with whatever S.A.B. is in use, i.e. No.1 or No.2 cab. The relay will then operate to pass main air to the brake cylinders.

NOTE.

A double check valve (10) is situated in the brake cylinder air supply to each bogie between the locomotive distributor and S.A.B. systems. These ensure that only one supply at any one time can operate the brake cylinders.

AUTOMATIC AIR BRAKE SYSTEM

REASON FOR SYSTEM.

An air brake system is by far superior to the conventional vacuum brake system in that:-

- (a) Brakes applies quicker.
- (b) Brake is quicker to release.
- (c) The brake more or less applies evenly throughout the train and also releases evenly as well.
- (d) The braking force at the front and rear of the train are very much the same. (No tendency for the front part of the train to come to rest while the rear half of the train would still be moving, a cause of possible derailment or damage on a very long vacuum braked train).
- (e) A need to run much longer trains, especially in view of the already high line occupation on most running lines, plus a need to also increase the speeds of freight trains.
- (f) The anticipated interchange of traffic with the Continent.

DESCRIPTION OF TYPES OF SYSTEMS.

Continental system - This system which is U.I.C. (International Union of Railways) approved and consists of a one-pipe system, namely the Brake Pipe whose duty is to connect the locomotive driver's brake valve to the vehicle brake distributor (described later) and also charge up the brake supply reservoirs. The brake is held released at 72.5 p.s.i. and fully applied when the brake pipe pressure is lowered to 48.5 p.s.i. Provisions are made for the driver to increase the brake pipe pressure much higher than 72.5 p.s.i. The system also provides for individual vehicle brake isolation.

B.R. Two Pipe system - The two pipe system is also U.I.C. approved and consists of a brake pipe and a main reservoir pipe. The main reservoir pipe is charged from the locomotive main reservoir via a pressure control valve to 100 p.s.i., and is used to charge the brake supply reservoirs (auxiliary reservoir) via an isolating cock, check valve, strainer and choke, (described later). The brake pipe is used to connect the locomotive driver's brake valve to the vehicle brake distributors.

**AUTOMATIC AIR BRAKE SYSTEM
LOCOMOTIVE**

VEHICLE

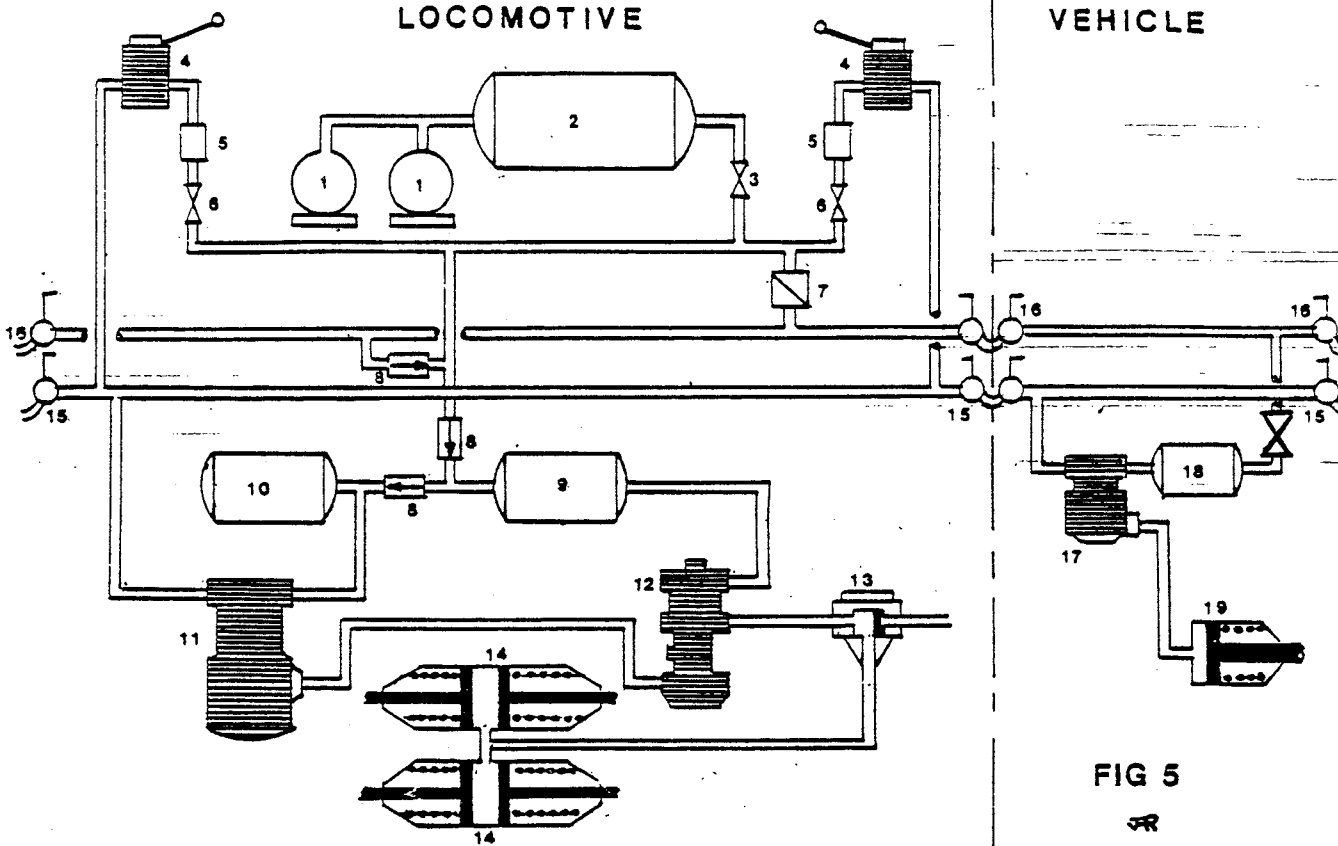


FIG 5

JR

NO	ITEM	NO	ITEM
1		10	
2		11	
3		12	
4		13	
5		14	
6		15	
7		16	
8		17	
9		18	
		19	

AIR BRAKED TRAINS

The brake equipment on these trains is designed so that they may be operated as on a one pipe system or a two pipe system.

When working with the one pipe system, the brake pipe is used to charge the brake distributors and their associated control and auxiliary reservoirs.

The brakes are released when the brake pipe is charged to a nominal 72.5 p.s.i.

A brake application is made by reducing the brake pipe pressure to some value between 72.5 p.s.i. and 48.5 p.s.i. the braking effort being controlled by the distributors and is proportional to the reduction in brake pipe pressure. The maximum braking pressure in the brake cylinders is 55 p.s.i. and is obtained when the brake pipe pressure is reduced to 48.5 p.s.i. The maximum pressure of 55 p.s.i. is not exceeded when an emergency brake application is made by reducing the brake pipe pressure to zero.

The partial release of the brakes is obtained by increasing the brake pipe pressure to any value between 48.5 p.s.i. and 72.5 p.s.i. At 72.5 p.s.i. the brakes are again released.

The one pipe system has the disadvantage of requiring the brake pipe to charge the auxiliary reservoirs during release of the brakes. This is particularly disadvantageous when working long trains when there would be some appreciable delay in completely releasing the brakes.

With the two pipe system, the brake pipe functions in the same manner as for the single pipe system. The additional pipe, the main reservoir pipe, ensures that the auxiliary reservoirs are constantly charged during application and release of the brakes.

The two pipe system has the distinct advantage in that when the brakes are released, it is only necessary to re-charge the brake pipe, the auxiliary reservoirs having been maintained fully charged from the main reservoir pipe. Thus the brake release is more rapid.

In the event of a defective Main Reservoir Pipe trains equipped with the two pipe system may be worked with the brake pipe only.

An isolating cock is provided in the Main Reservoir Pipe connection to the Auxiliary Reservoir on each vehicle.

An isolating cock is also provided in the brake pipe connection to each distributor. The normal operative position of this cock is when the handle is pointing vertically downwards. Should it be necessary to isolate the brake on a vehicle, this handle should be turned to the horizontal position and the release valve operated.

On some bogie vehicles the distributor does not supply air directly to the brake cylinders but to two load proportional relay valves, one to each bogie, which control the admission of air from the auxiliary reservoirs to the brake cylinders.

A feature of the load proportional relay valves is that they control the braking effort of individual bogies according to the load they carry. Thus the braking effect is the same for loaded, partly loaded or empty vehicles.

Locomotives equipped to work air braked trains have the following air connection at each buffer beam.

- (1) The brake pipe, isolating cock and connecting hose with a 1" end coupling. Cocks and couplings coloured RED.
- (2) The main reservoir pipe, fitted with an isolating cock, connecting hose and $\frac{3}{4}$ " end coupling with sealing valve (this has two branches on Diesel locos). This pipe serves two purposes:-
 - (a) As the main reservoir pipe when working air braked trains.
 - (b) As a means of passing air from one loco to another when coupled to other locos. Cocks and couplings coloured YELLOW.

DUAL BRAKED LOCOMOTIVE SYSTEM

This brake system is designed so that the locomotive is capable of providing the following braking efforts.

- (1) Independent Locomotive Air Brake.

As previously described this braking effort is directly controlled by the Driver by means of the straight air brake valve. It is effective only on the locomotive on which the brake valve is operated. It is NOT effective on any locomotive which may be coupled in multiple or tandem.

- (2) Proportional Locomotive Air Brake

The locomotive's braking effort is governed by, and is proportional to, the degree of effort applied on the train the locomotive is hauling, whether air braked or vacuum braked.

- (3) Air Braked Trains

An air brake pipe is provided to enable the locomotive to work trains equipped with the air brake. usually a second compressor and additional reservoir capacity is provided.

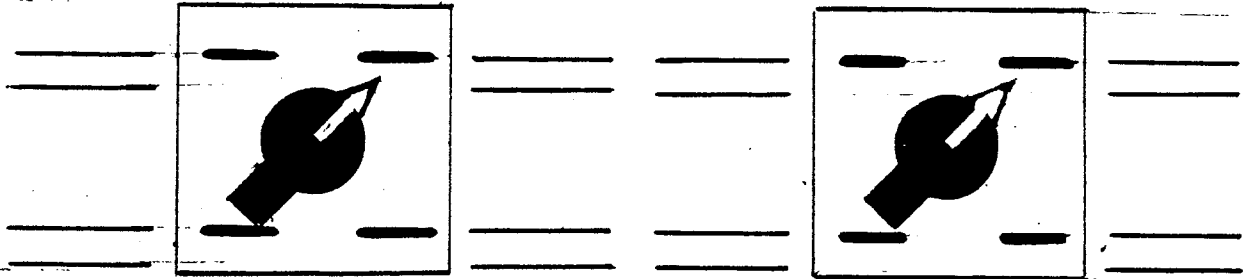
- (4) Vacuum Braked Trains

A vacuum brake pipe is provided to enable the locomotive to work trains equipped with the vacuum brake. Exhausters are provided to evacuate the vacuum brake pipe

THE BRAKE SELECTOR SWITCH

The switch is normally positioned with other locomotive auxiliary control switches in the switch and fuse panel or on the side of the locomotive down "A" Bank. It is operated to give any one of four braking modes as shown in the following diagram.

Brake Selector Switch FIG 6



Drivers Instructions BR.33056/3 page 40 ,gives details of the correct Brake Selector Switch position for the various types of trains.

The position selected is repeated in each driving cab on an illuminated sign located above the Drivers assistants door. The effect of selecting the various positions of the switch are as follows:-

Air Pass. The second compressor will run and both exhausters will stop. The vacuum control governor is "shorted out" so that the power control circuit can be "made" although there is no vacuum being created. The Air Goods/Passenger E.P. valve causes a large choke to be open in the distributor and the locomotive proportional brake application is only slightly delayed.

Air Goods As Air Passenger above but in addition the Air Goods/Passenger E.P. valve causes a smaller choke to be open in the distributor thus the locomotive proportional brake application has an extended delay should a brake application be initiated.

Vac Pass. The second compressor will not run but both exhausters will run providing their respective switches are at the "ON" position.

The Vacuum Goods/Passenger electro - magnetic valve causes a large choke to be open in the distributor and the locomotive proportional brake application is only slightly delayed. The Vacuum Control Governor is in circuit and therefore operative.

Vac Goods As in Vac.Pass, but in addition the Vacuum Goods/Pass. electro - magnetic valve causes a smaller choke to be opened in the distributor and the loco. proportional brake application time is appreciably extended. Also, an E.P. valve connected to the A.W.S. and D.S.D. brake application valve is operated. With A.W.S. or D.S.D. operation the rate of drop of air brake pipe pressure is much slower compared with the other switch positions thus the loco. proportional brake application time is appreciably extended.

LOCOMOTIVE DUAL BRAKE

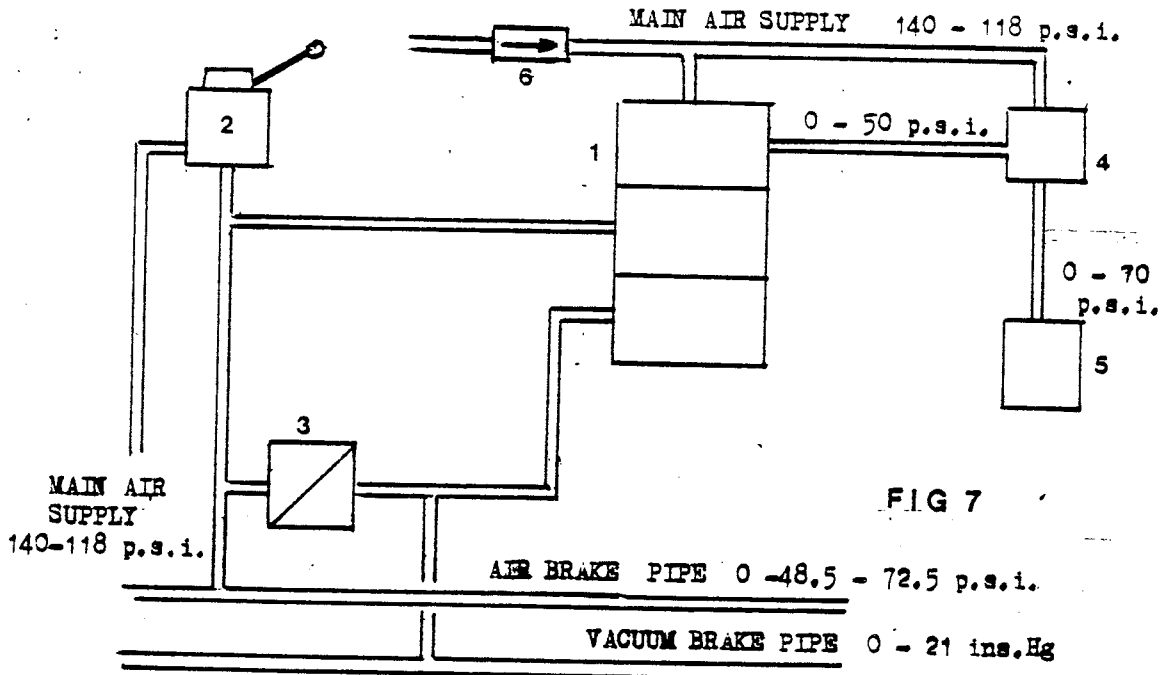


FIG 7

NO	ITEM
1	
2	
3	
4	
5	
6	

Fig.7 is a block diagram showing the relationship between the valves during air and vacuum working.

Air Brakes Working.

When the Brake valve is moved towards a braking position the reduction in Air Brake Pipe pressure will operate the Air section of the Distributor which will pass increasing pressure to Relay valve which, in turn, will operate to pass air to the locomotive brake cylinders.

The Air/Vacuum Relay Valve and Vacuum section of the Distributor will have no effect on the operation since the Exhausters do not run in Air working therefore no Vacuum is available.

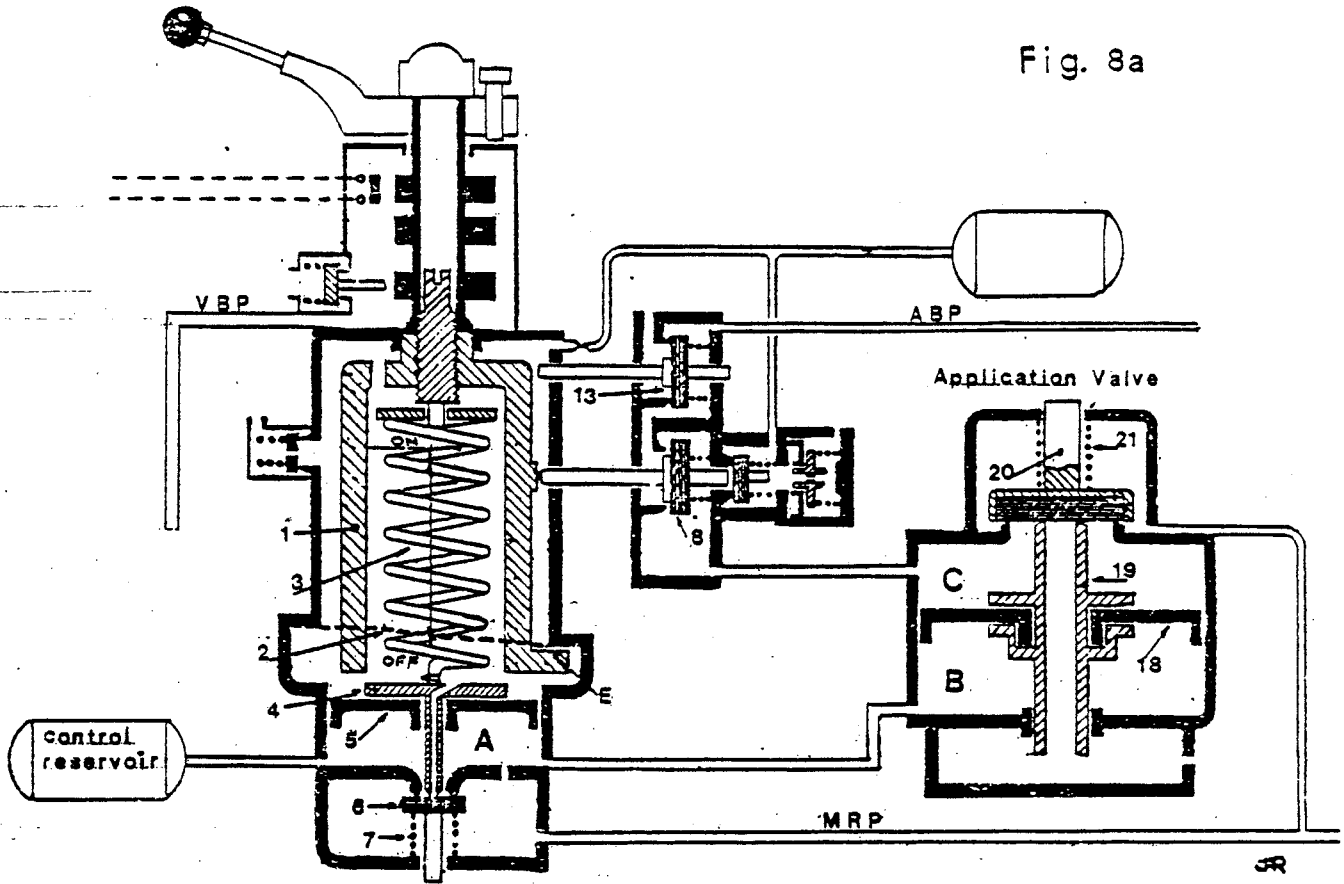
Vacuum Working.

When the Brake valve is moved towards a braking position the reduction in Air Brake Pipe pressure will operate the Air/Vacuum Relay valve which will decrease vacuum brake pipe by a proportional amount. The reduction in Vacuum will operate the Vacuum section of the Distributor which will pass increasing pressure to the Relay valve which, in turn, will operate to pass air to the locomotive brake cylinders.

The Air section of the Distributor will have no effect on the operation since it will have been made inoperative by the Air/Vacuum Isolating valve (not shown on diagram)

Drivers Auto. Air Brake Valve. — Running (brake pipe fully charged)

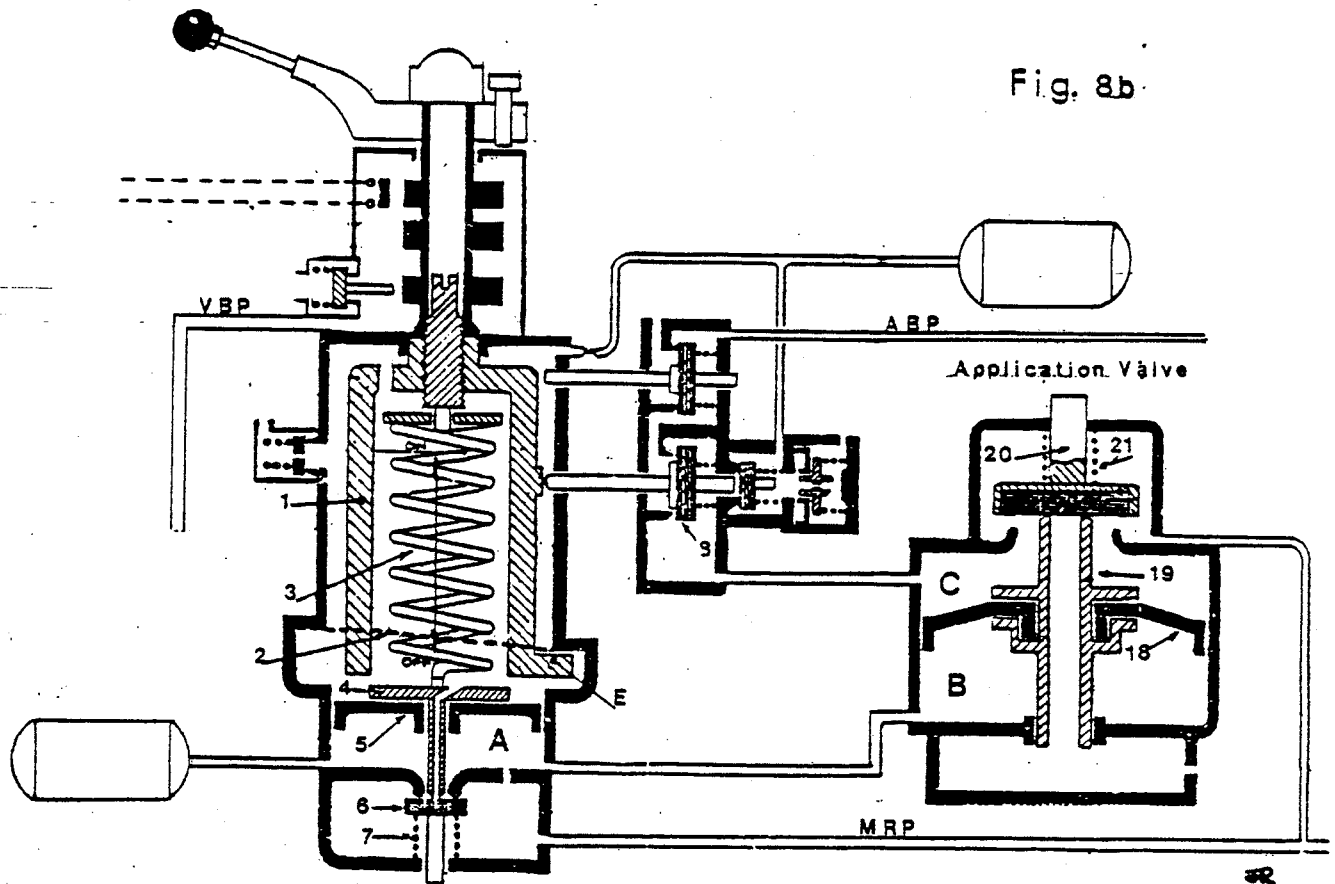
Fig. 8a



NO	ITEM	NO	ITEM
1		8	
2		13	
3		18	
4		19	
5		20	
6		21	
7			

Drivers Auto. Air Brake Valve — Running (brake pipe charging)

Fig. 8b



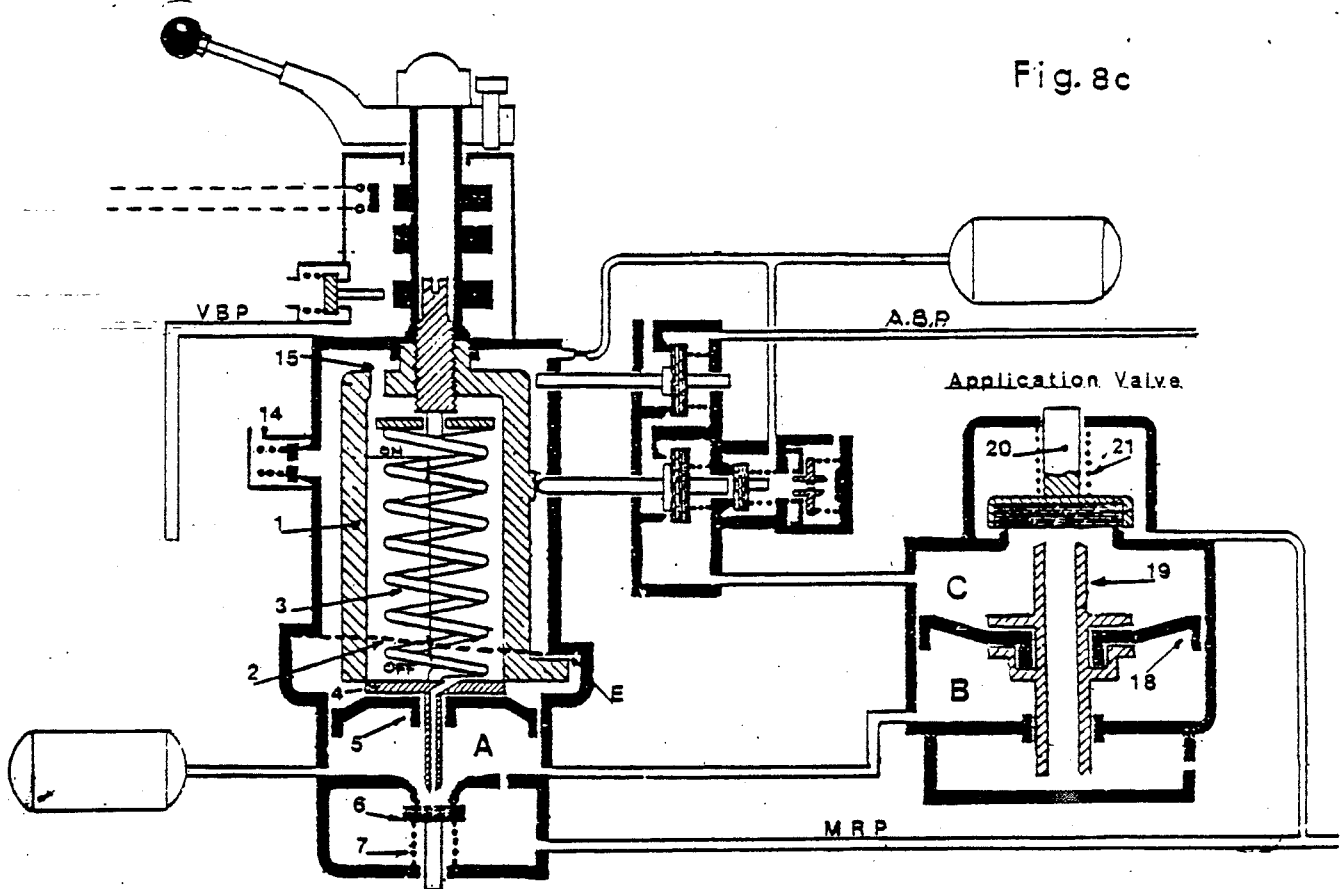
NO	ITEM	NO	ITEM
1		8	
2		14	
3		15	
4		18	
5		19	
6		20	
7		21	

RUNNING (brake pipe charging) fig.8b

If for some reason, a leakage occurs in the air brake pipe or equipment the pressure in chamber 'C' will reduce hence the now greater pressure in chamber 'B' will act upon Diaphragm 18 to move the valve stem 19 upwards and open main inlet valve 20.

Main air will now enter chamber 'C' and pass to the air brake pipe until such time as the pressure in 'C' equals the pressure in 'B' whereupon the inlet valve spring will push the whole assembly down and close the main inlet valve 20

Drivers Auto. Air Brake Valve. — Application

APPLICATION Fig. 8c

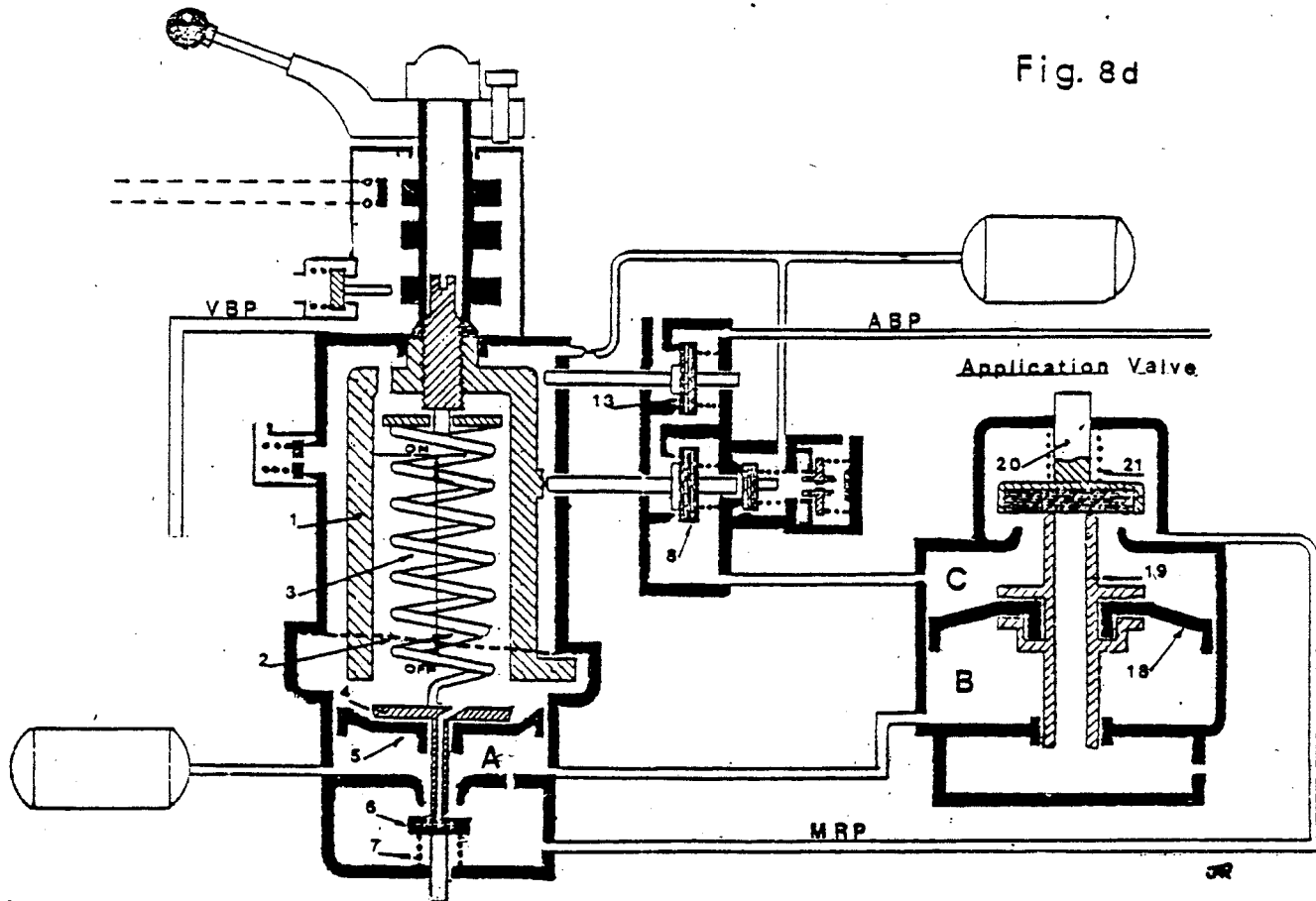
When the drivers air brake valve is rotated to an application position the action of the cam 2 will lift the camshaft and reduce the pressure of spring 3. The air pressure below regulating diaphragm 5 will lift the exhaust valve 4 so allowing air to escape from chambers 'A' and 'B' and it will pass to atmosphere via vent 15 and differential choke valve 14.

When the air pressure in 'A' and 'B' balances with the pressure of spring 3 the exhaust valve 4 will drop and close off the hollow stem so as to prevent further escape of air.

The reduction of pressure in chamber 'B' will cause the higher pressure in the air brake pipe to move valve stem 19 down and pass brake pipe air to atmosphere via the hollow stem. When it attains a pressure slightly lower than the pressure in 'B' the valve 19 will move up and seal off the hollow stem against the inlet valve so preventing further escape of air from the brake pipe, i.e. the brake is 'LAPPED' in an application position.

Drivers Auto. Air Brake Valve.— Running (immediately following an application)

Fig. 8d



NO	ITEM	NO	ITEM
3		18	
4		19	
5		20	
6		21	

RUNNING (following an application) Fig. 8d

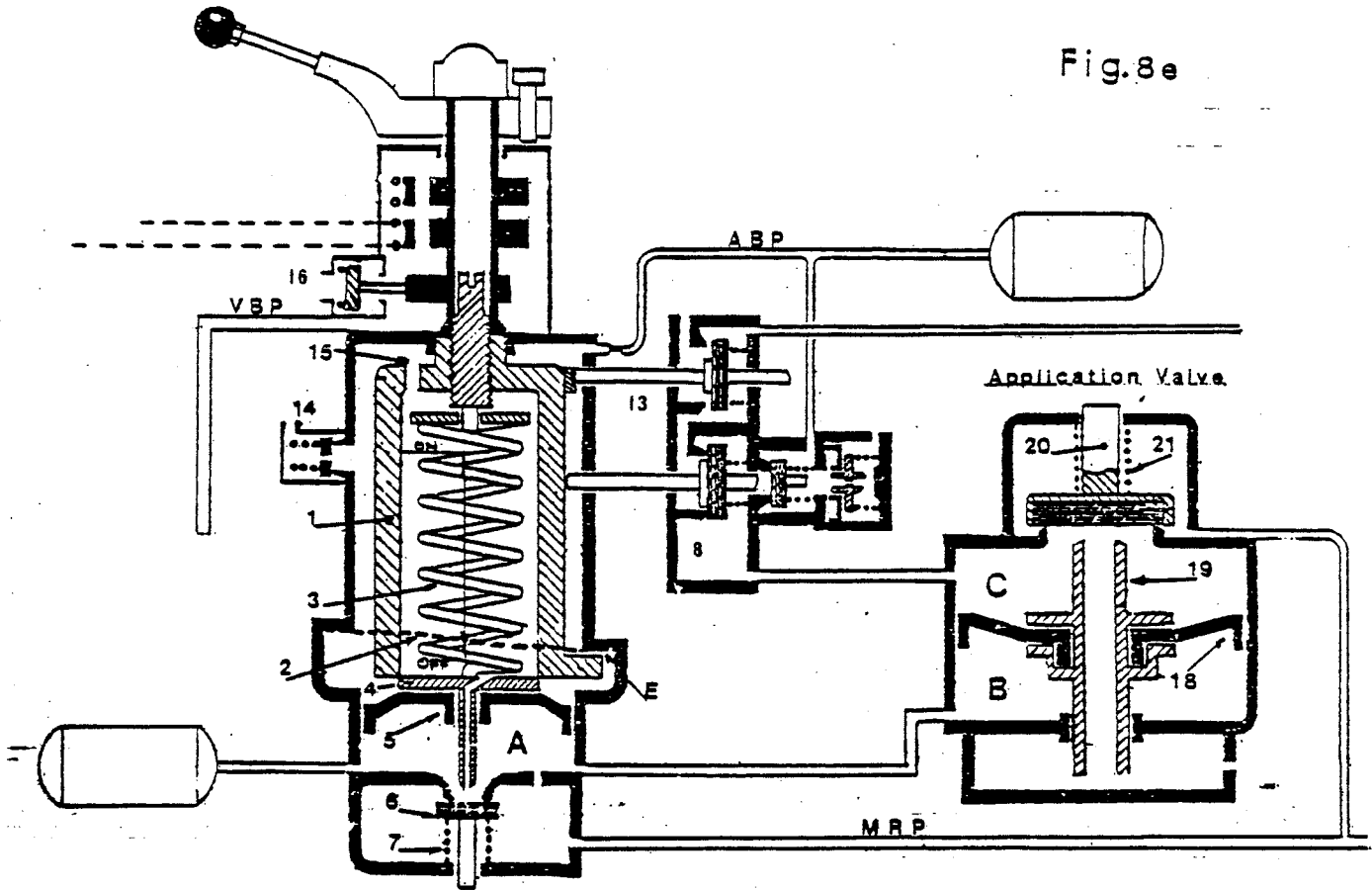
When the brake valve handle is returned to the 'RUN' position the tension of spring 3 is increased against the regulating ~~exhaust~~ valve 4 and diaphragm 5 which will move downward and push the inlet valve 6 off its seat. Main air will pass into chambers 'A' and 'B' until such times as it attains a pressure of 72.5 p.s.i. when it will move up and allow spring 7 to close inlet valve 6

The increased pressure in chamber 'B' acts upon diaphragm 18 to move valve stem 19 upward to open main inlet valve 20 and pass main air to the air brake pipe.

When the brake pipe pressure attains 72.5 p.s.i. diaphragm 18 will be in balance hence spring 21 will close the inlet valve and so seal off the air brake pipe.

Drivers Auto. Air Brake Valve. — Emergency

Fig.8e

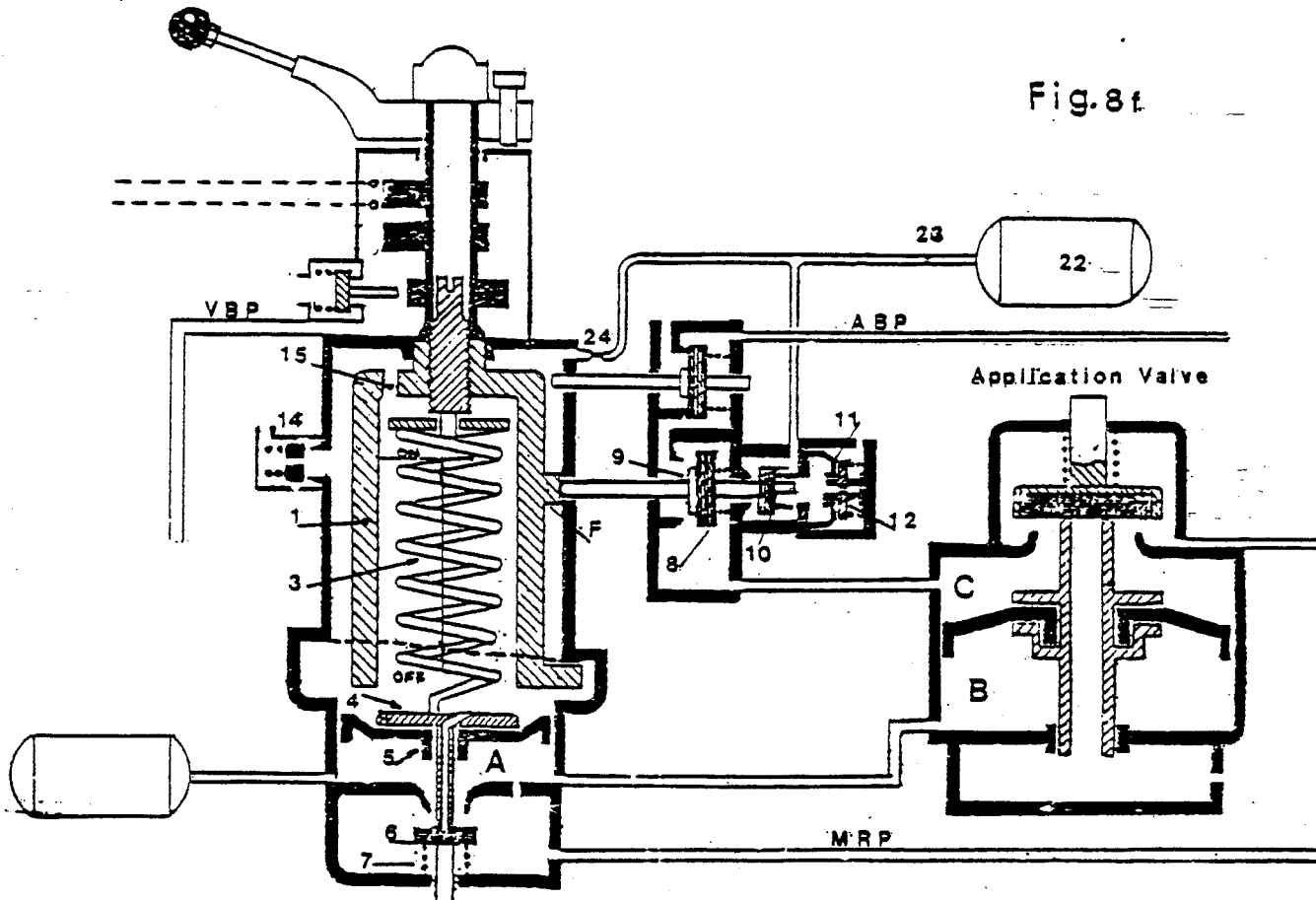


NO	ITEM	NO	ITEM
8		19	
13		21	
16			

EMERGENCY Fig.8.e

In moving the brake valve handle to the 'EMERGENCY' position the cam operated valves 13 and 16 are opened to vent the air and vacuum pipes direct to atmosphere. In this position the sealing valve 8 must be closed so as to prevent the air brake pipe pressure drop registering in chamber 'C'. This would cause the valve stem 19 to lift and open the main application valve 21 and result in venting the main reservoir pipe to atmosphere against the emergency application.

Drivers Auto. Air Brake Valve. — Release (overcharge)

RELEASE (overcharge) Fig. 8f

When the brake handle is placed in the 'RELEASE' position cam F pushes the sealing valve 8 further open such that the throttle washer 9 clears the port and permits a quicker passage of air to the air brake pipe.

Fill valve 10 is pushed open and in consequence air pressure acts upon fill valve diaphragm 11 which, in turn, moves the fill release valve 12 against the seal on the valve body and close off it's hollow stem.

The air then passes up to fill the reservoir 22 and also, through choke 24, to the inside of the brake valve body. The tension of the spring 3 is the same as in 'RUN' position but this air now flowing into the body of the brake valve and inside the camshaft 1 via the vent 15 now acts upon the topside of exhaust valve 4. This additional pressure is limited to a small value equal to the spring tension of differential valve choke 14 and acts in addition to the pressure of spring 3 to move the regulating diaphragm 5 down and open the inlet valve 6. Any pressure within the valve body greater to that required will force the differential valve choke off it's seat and release the excess to atmosphere.

The action explained above will increase the pressure in chamber 'A' and 'B' so as to activate the application valve, as explained earlier in the text, resulting in an increase of brake pipe pressure to 78.5 p.s.i.

Drivers Auto. Air Brake Valve—Running (overcharge bleed down)

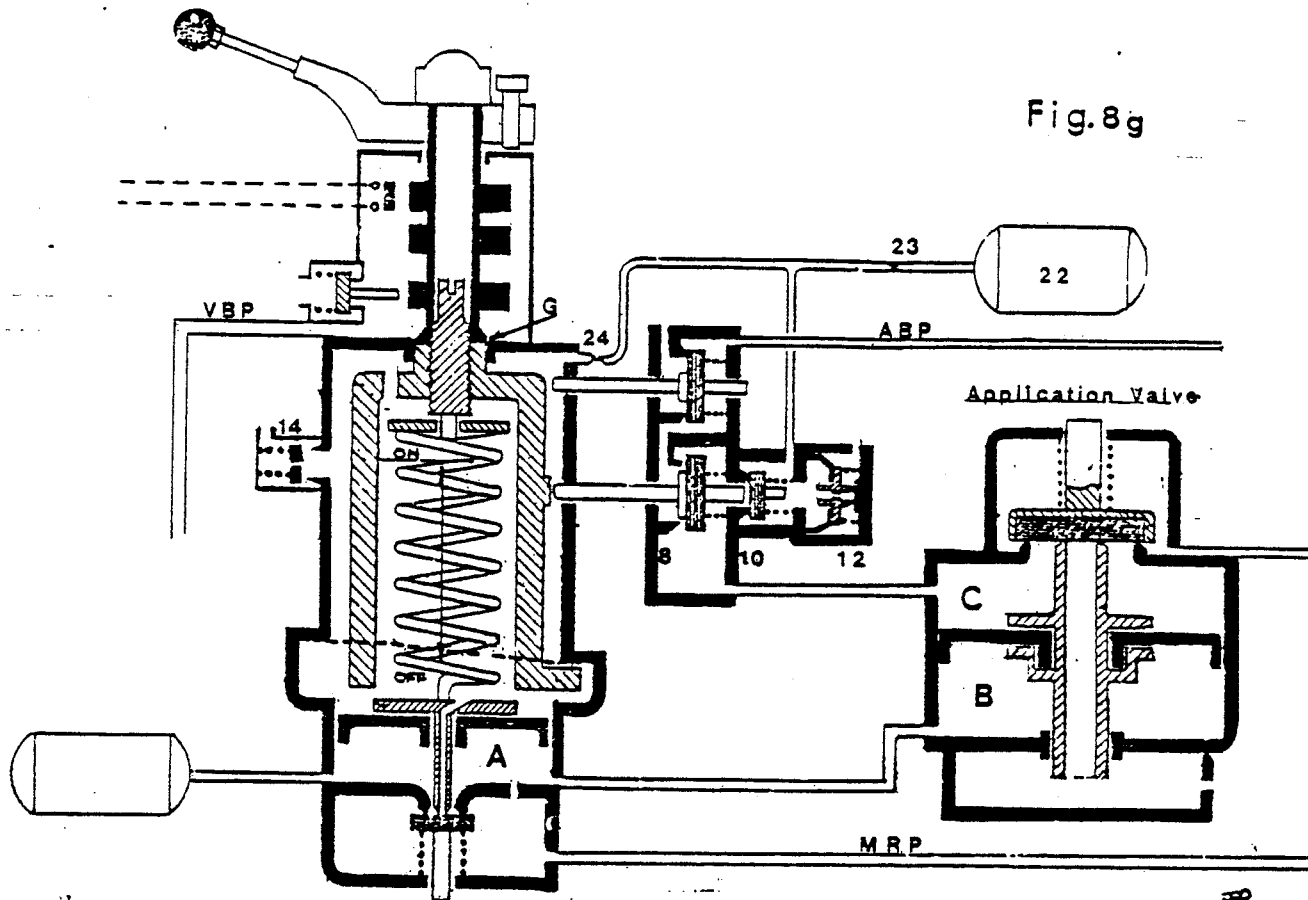


Fig. 8g

NO	ITEM	NO	ITEM
1		21	
2		22	
3		23	

RUNNING (overcharge bleed down) Fig 8g

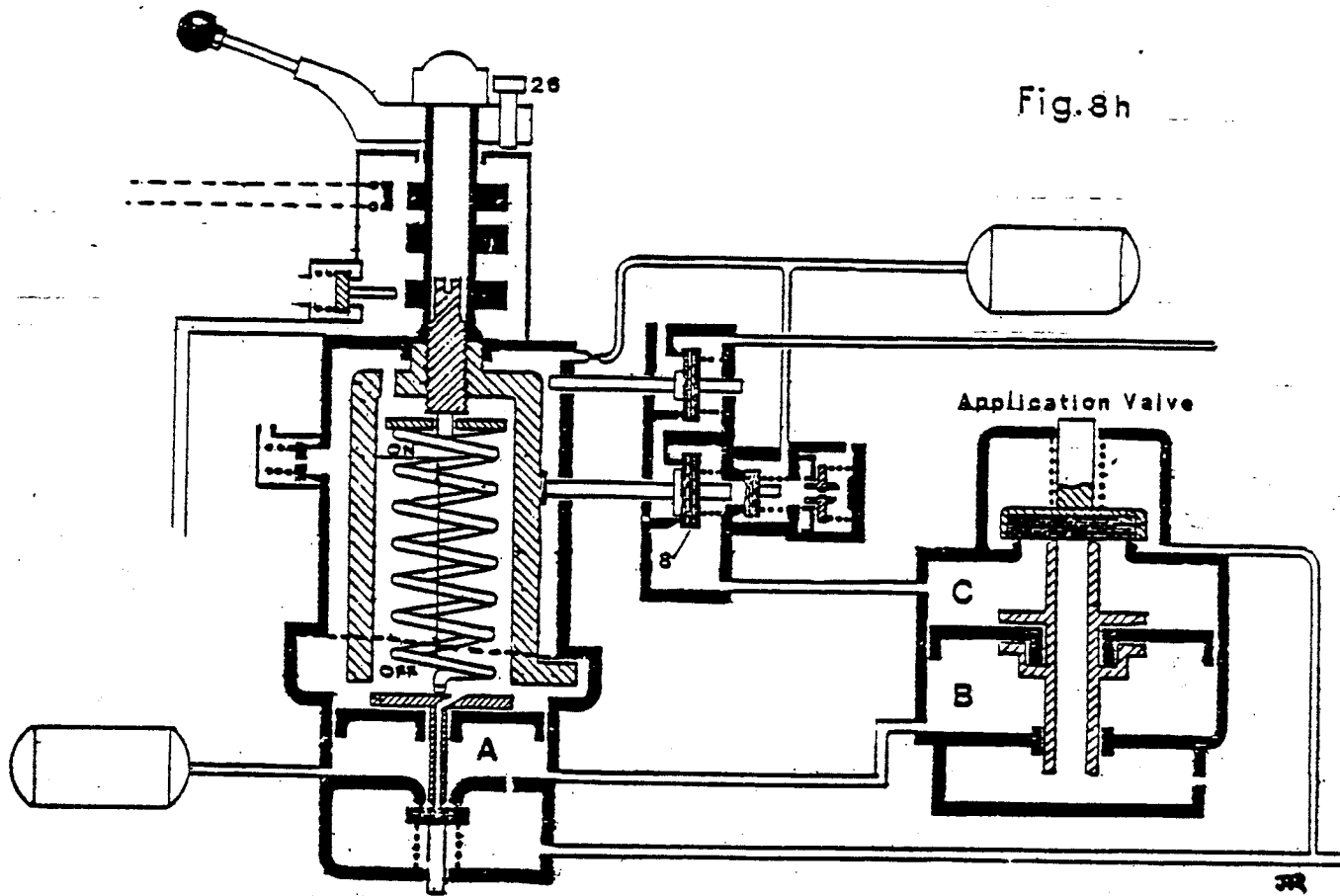
When the brake valve handle is returned to the 'RUN' position the sealing valve 8 will return to it's original position and fill valve 10 will close. The air pressure within the brake valve body and brake pipe will leak down via the differential choke but it's rate of leakage will be slow due to chokes 23,24 and the capacity of reservoir 22. At some time during the bleed down the spring will return the fill release valve to it's normal position hence the rate of leakage will be more rapid through the fill release valve choke until the brake pipe reduces to it's 'RUNNING' pressure of 72.5 p.s.i.

NOTE

The brake valve handle should not be moved from 'RELEASE' TO AN 'APPLICATION' position as this could cause difficulty in releasing the brakes on the train whether it be air or vacuum operated.

If the brake is applied during the time that overcharge air is within the brake valve body, in the application position a seal (G) between the brake valve handle stem and the brake valve body opens to dissipate the air.

Drivers Auto. Air Brake Valve. Shut Down.



NO	ITEM	NO	ITEM
1		21	
2		22	

SHUT DOWN Fig 8h

When the brake valve handle is placed in the 'shut down' position the sealing valve 8 is closed so that should a brake application be made from the brake valve in the other cab the decrease in brake pipe air will not be reflected in chamber 'C' which would result in the valve stem 19 moving up to open the main inlet valve to feed the air brake pipe against the application being made from the cab in use.

Stop pin 26 is spring loaded to ensure the brake valve does not move from the 'SHUT DOWN' position when not in use.

NOTE

If a passenger or guards emergency brake application is made it's effect would be to reduce the pressure in chamber 'C' which would result in the application diaphragm being displaced upwards and opening the main inlet valve 20 to feed air into the brake pipe. In the absence of the throttle washer 9 on the sealing valve 8 the emergency brake application would be overcome by this unrestricted supply to the brake pipe

BRAKE VALVE ISOLATORS Figs. 8 (j & k)

It was explained previously in the text that the Drivers Brake Valve is a "Feed" and "Bleed" device and that it will automatically feed the Air Brake Pipe in the event of the A.B.Pipe pressure falling below 72.5 p.s.i. whilst in the running position.

It therefore follows that if a brake application is initiated by another means i.e. A.W.S / D.S.D. the drivers brake valve will endeavour to feed the A.B.Pipe against the A.W.S./ D.S.D. application resulting in the brakes not being fully applied and an excessive loss of main reservoir pressure.

The purpose of the Brake Valve Isolators, A.W.S. and D.S.D., is to ensure that the drivers brake valve does not feed the air brake pipe against an A.W.S./D.S.D. application.

The D.S.D. Brake Valve Isolator

This valve is sometimes known as the "Feed Cut Off Valve" and is electrically operated. Under normal operating conditions, when the D.S.D. pedal or hold over button is depressed, the solenoid 1 is ENERGISED hence valve 2 is closed and 3 is open. Main reservoir air flows through passage "A", via 3 and on to piston 4. Due to the larger area of 4 it will close valve 5 against the spring 6 and main reservoir air will be fed to the pressure regulator 7 of the drivers brake valve.

When the solenoid 1 is de - energised valve 3 will close and 2 open hence 5 will close to the action of spring 6 thereby ensuring that the drivers brake valve cannot replace the air displaced from the air brake pipe by the D.S.D. application.

A.W.S. Brake Valve Isolator

This valve is pneumatically operated by control air from the A.W.S. E.P. Valve.

Under normal operating conditions when the A.W.S. Change - over switch is at "ON" control air is fed to piston 8 and opens valve 10 against spring 9 thus allowing the drivers brake valve to feed the air brake pipe.

Failure to cancel an A.W.S application causes the E.P. Valve to exhaust the control air to atmosphere hence spring 9 will close valve 10 to prevent the drivers brake valve feeding the air brake pipe.

NO	ITEM	NO	ITEM
1		7	
2		8	
3		9	
4		10	
5		11	
6		12	

Drivers Auto. Air Brake Valve

Brake Valve Isolators

DSD Normal

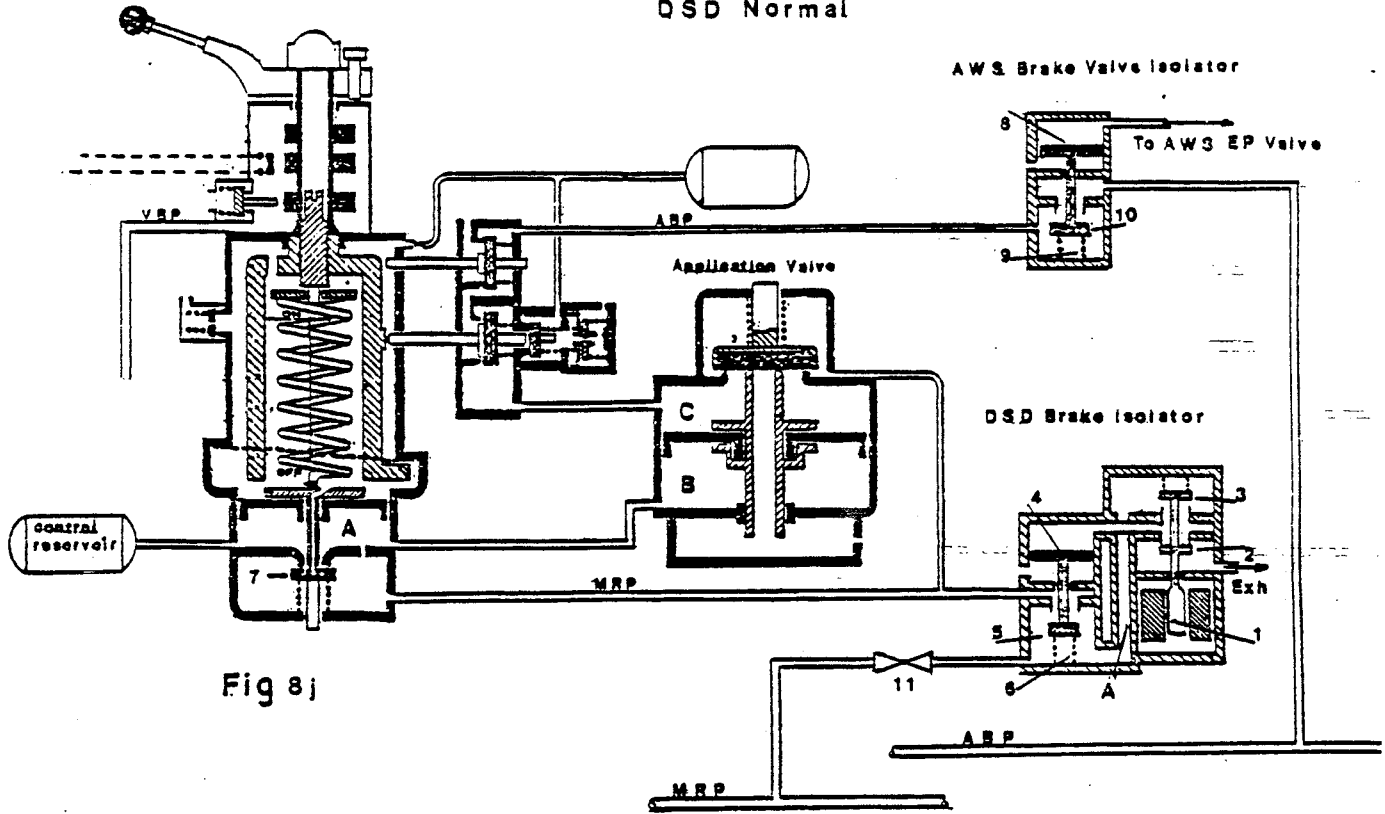


Fig 8j

Drivers Auto. Air Brake Valve

Brake Valve Isolators

DSD Applied

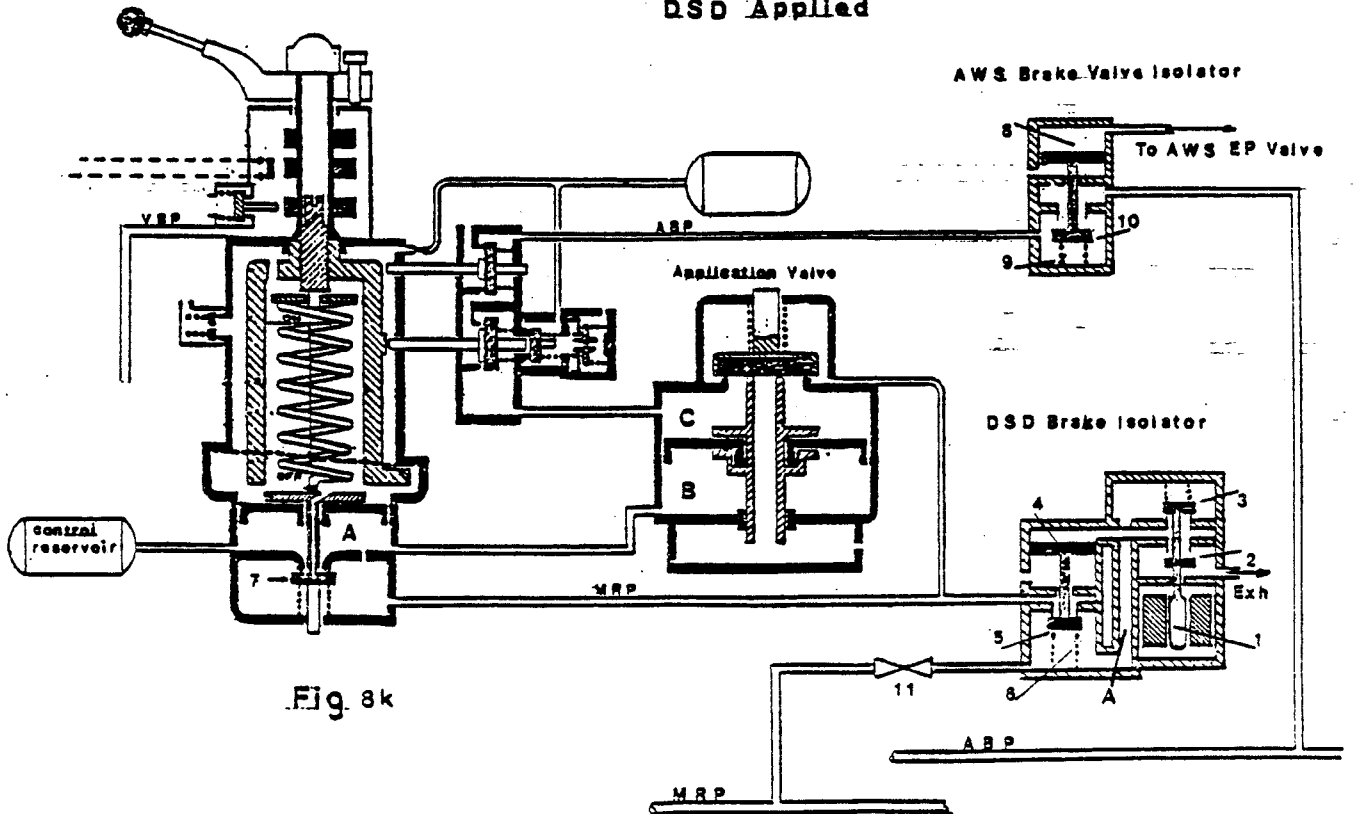


Fig 8k

AIR/VACUUM ISOLATING VALVE Fig 9.

This valve operates in conjunction with the locomotive distributor and is vacuum operated.

When the Selector Switch is turned to either Vac.Goods or Pass. position the exhausters create a vacuum in the vacuum brake pipe (V.B.P.) and also in chambers X of the Air /Vac. isolating valve. Atmospheric pressure lifts diaphragm 1 which lifts valve stem 2 and so seals the top hollow stem against it's seal 3 but the movement also separates the end of the bottom hollow stem from seal 4. This will isolate the vacuum expansion and control chambers 6 from each other but places the air expansion and control chambers 5 into communication with each other. When the vacuum brake is applied there will therefore be a pressure differential across the vacuum expansion and control chambers only

When the selector switch is turned to Air Goods or Pass. the exhausters will not work hence the valve stem 2 will be in it's lowest position resulting in the air expansion and control chambers being isolated and the vacuum expansion and control chambers 6 being in communication. There will therefore be a pressure differential across the air expansion and control chambers only, when the air brake pipe pressure varies.

DUAL BRAKE DISTRIBUTOR

This is a device whereby the control of the locomotive brakes is governed by variations in air or vacuum brake pipes according to the mode of braking selected.

Air Braking (Running) Fig. 9a

Under air braking conditions chambers C & D are isolated from each other by the Air/Vac. isolating valve. When the air brake pipe is charged air flows into chambers C & D which are thus equal in pressure hence the inlet valve 12 will be closed by it's spring to isolate the auxiliary air supply, chamber K, from the brake cylinder relay valves, chamber M. Also, the control spindle 7 is at it's lowest position thereby placing the brake cylinder relay valves in communication with atmosphere via the hollow stem and releasing the brakes.

NO	ITEM	NO	ITEM
1		5	
2		6	
3		7	
4		12	

Locomotive Distributor and Air/Vac. Isolating Valve

(Air Application)

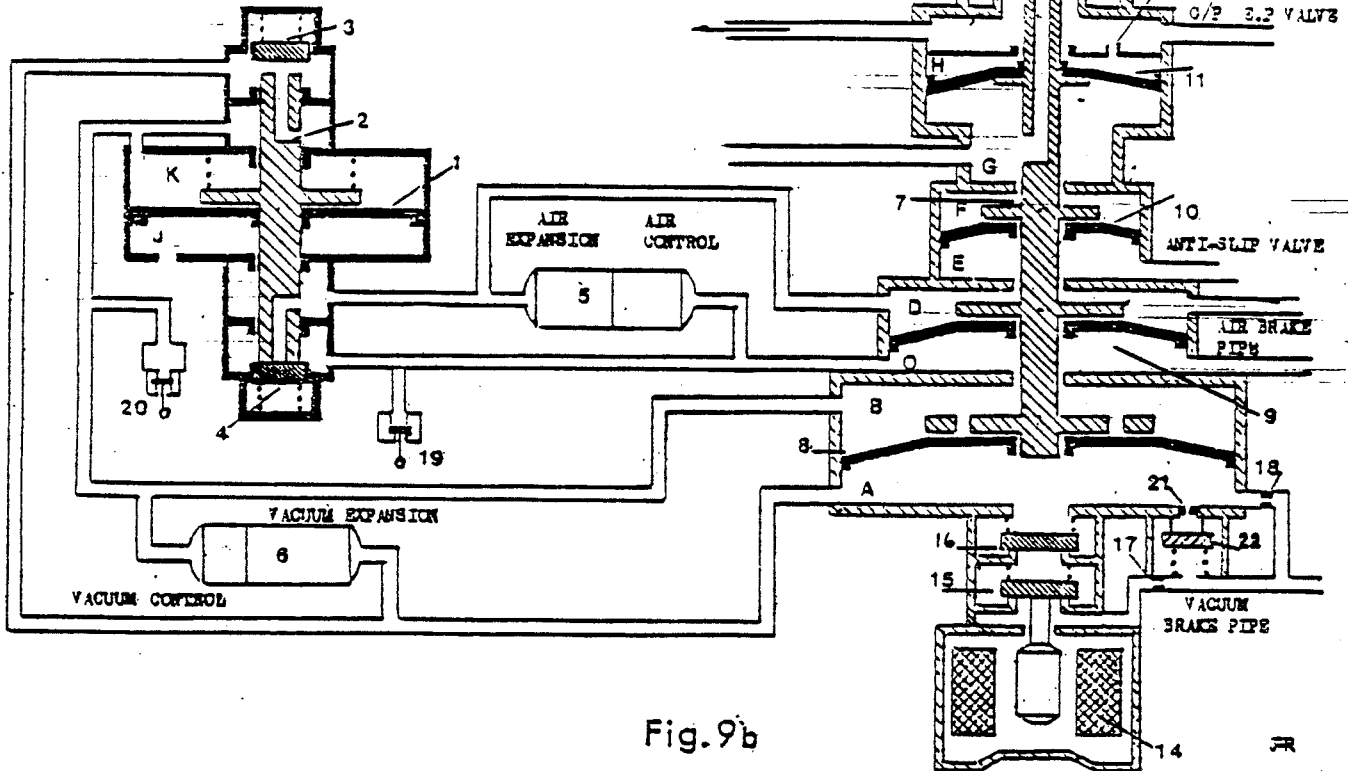


Fig. 9b

Air Braking (Application) Fig. 9b

When the brake is applied the air brake pipe pressure in chamber D is reduced but the control air pressure, i.e. 72.5 p.s.i. in chamber C is "locked" in hence the pressure differential across diaphragm 9 will lift the control spindle 7, close the hollow stem and simultaneously lift the inlet valve 12 against its spring. Air will now pass from the auxiliary reservoir, chamber L, to chamber M and thence to the brake cylinder relay valves to apply the brakes.

As the air pressure builds up in the brake cylinders it will pass through choke 13 into chamber H where it will effect a downward pressure on diaphragm 11. Depending on the degree of braking applied this downward pressure on diaphragm 11 will be in opposition to the upward pressure of diaphragm 9 and will eventually equalise. This will allow the spring of the inlet valve 12 to push the assembly down to close the inlet valve 12 but still hold the end of the hollow stem against its seat. Pressure will therefore be retained in the brake cylinders.

Should there be a leakage of air from the brake cylinder or associated equipment, the downward pressure on diaphragm 11 will decrease hence the now greater upward force on diaphragm 9 will push the assembly up to open the inlet valve 12 and replace the loss of pressure until balance is again restored on diaphragms 9 & 11.

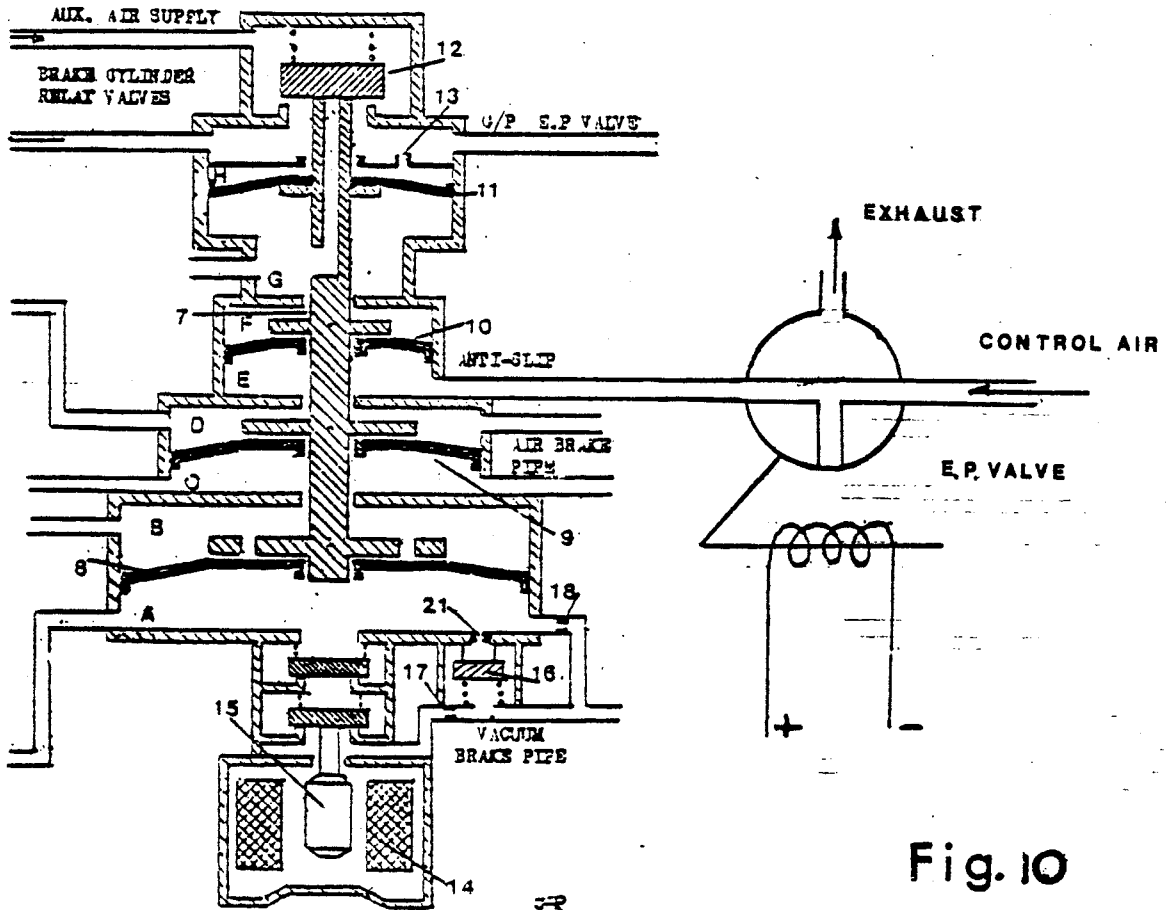
Anti - Slip Application

Should wheel - slip occur, depressing the button on the end of the power controller operates an E.P. Valve which passes a supply of air to the chamber E. This air pressure acting on diaphragm 10 will move the control spindle up to open the inlet valve 12 and pass auxiliary air to the brake cylinder relay valves to give a 15 p.s.i. brake application.

When wheel - slip has ceased and the button released, the air in chamber E is exhausted via the E.P. Valve hence the control spindle 7 will move down to release the brakes as already described.

It is to be noted that if a full brake application is made i.e. maximum brake cylinder pressure of 70 p.s.i. attained, operation of the anti - slip button will apply an additional upward force on the control spindle 7 which will reflect in the brake cylinder to attain a maximum pressure of 85 p.s.i.

This practice can cause severe wheel skid and damage the wheel tyres hence it must be avoided.



LOCOMOTIVE DISTRIBUTOR AIR TIMINGS

Passenger Air Running Fig.11(a)

In this position the air expansion and control chambers C & D respectively are isolated from each other. Also, the Goods/Passenger Changeover valve 4 is de-energised hence the Goods Filling and Release choke 5 is bypassed.

When the air brake pipe is charged air flows via the Passenger Release and Filling chokes 1 & 3 respectively, the G/P changeover valve, sealing valve 6 to chamber D and to chamber C via the Control Filling choke 7.

Note. Choke 7 is very restricted thus it will take some time, 3 to 4 minutes) before the control chamber C is fully charged to 72.5 p.s.i. from 0 p.s.i.. If a brake application is attempted before chamber C is fully charged then maximum brake cylinder pressures on the loco. or train cannot be attained. In an extreme case it could result in no brake application whatsoever.

Chokes 1 & 3 have a reasonably large bore hence no great restriction is imposed on the flow of air entering chamber D.

When the pressures in C & D equalise the brakes will be fully released as explained earlier in the text.

For brake release times refer to B.R.33056/3.

STUDENTS NOTES

Lined area for student notes, consisting of approximately 20 horizontal lines.

Locomotive Distributor Air Timings

Passenger Air Running

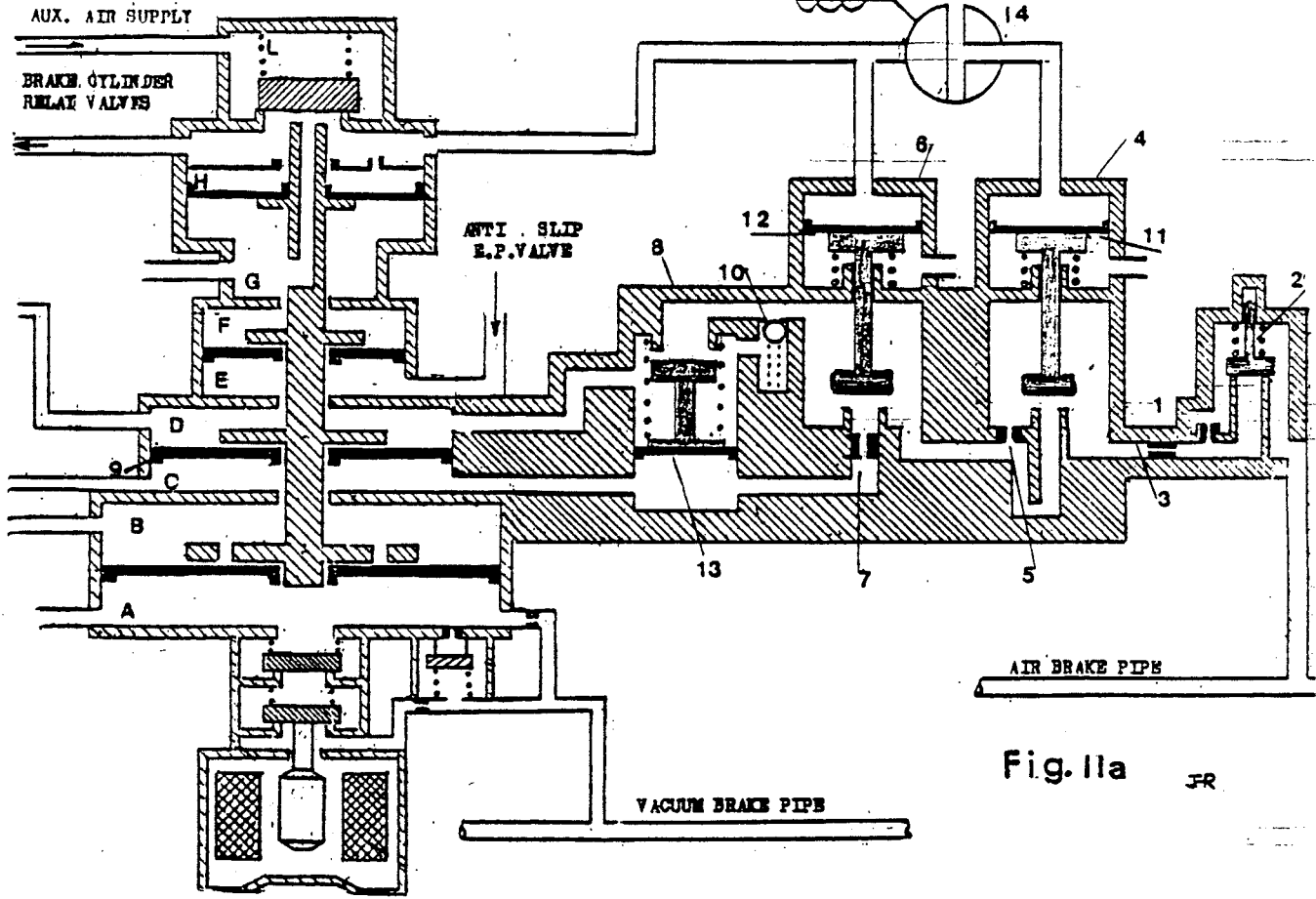


Fig. 11a JR

NO.	ITEM	NO.	ITEM
1		8	
2		9	
3		10	
4		11	
5		12	
6		13	
7		14	

1. Passenger Fig.11 (b).

When the brake is applied and air brake pipe pressure reduced air passes from chamber D through maximum pressure limiter 8, sealing valve 6, G/P. changeover valve 4, bypass, through passenger filling chokes 3 and bias the passenger release non - return valve 2 open thus bypassing the passenger release choke 1.

The bore of the passenger release choke is smaller than that of choke 3 hence the application timing is quicker than the release timings. Refer to B.R.33056/3.

Air will also pass from chamber C via choke 7 but due to it's very restrictive bore the air loss is negligible compared with the air loss from chamber D hence diaphragm 9 will be biased to apply the brakes as previously described.

When locomotive brake cylinder pressure attains 4.5 p.s.i. the air will pass to the top side of the sealing valve diaphragm which will seal off any further escape of air from the control chamber C.

It is for this reason that the brake valve must be placed in the "INITIAL" position thus attaining a minimum drop of air brake pipe pressure of 6 p.s.i. thereby creating an adequate pressure drop to activate the control spindle and close the sealing valve as shown. It also ensures that the train distributors are operated correctly.

2. Goods Fig.(C)

When the B.S.S. is switched to a "Goods" position the G/P changeover valve is de-energised and it's diaphragm is placed into communication with the brake cylinder air supply.

When the brake is applied the sequence of events is similar to that described previously in the text and initially the air will flow from chamber D via the passenger filling choke 3 as before i.e. passenger timing, but as the pressure builds up in the brake cylinders it will act on the diaphragm of the G/P changeover valve and seal off the goods filling and release choke bypass hence the air from chamber D will have to pass through the very restrictive goods choke 5 thus considerably lengthening the brake application time. Refer to B.R.33056/3.

Note that there is a small delay before the G/P changeover valve operates hence, momentarily the pressure in the air brake pipe is dropped quickly. This is termed "inshot" and serves the purpose of "triggering off the distributors on the train and locomotive to ensure their stable operation and to move the brake blocks or pads to the wheel or disc quickly.

NO	ITEM	NO	ITEM
1		8	
2		9	
3		10	
4		11	
5		12	
6		13	
7		14	

Locomotive Distributor Air Timings

Passenger Air Application

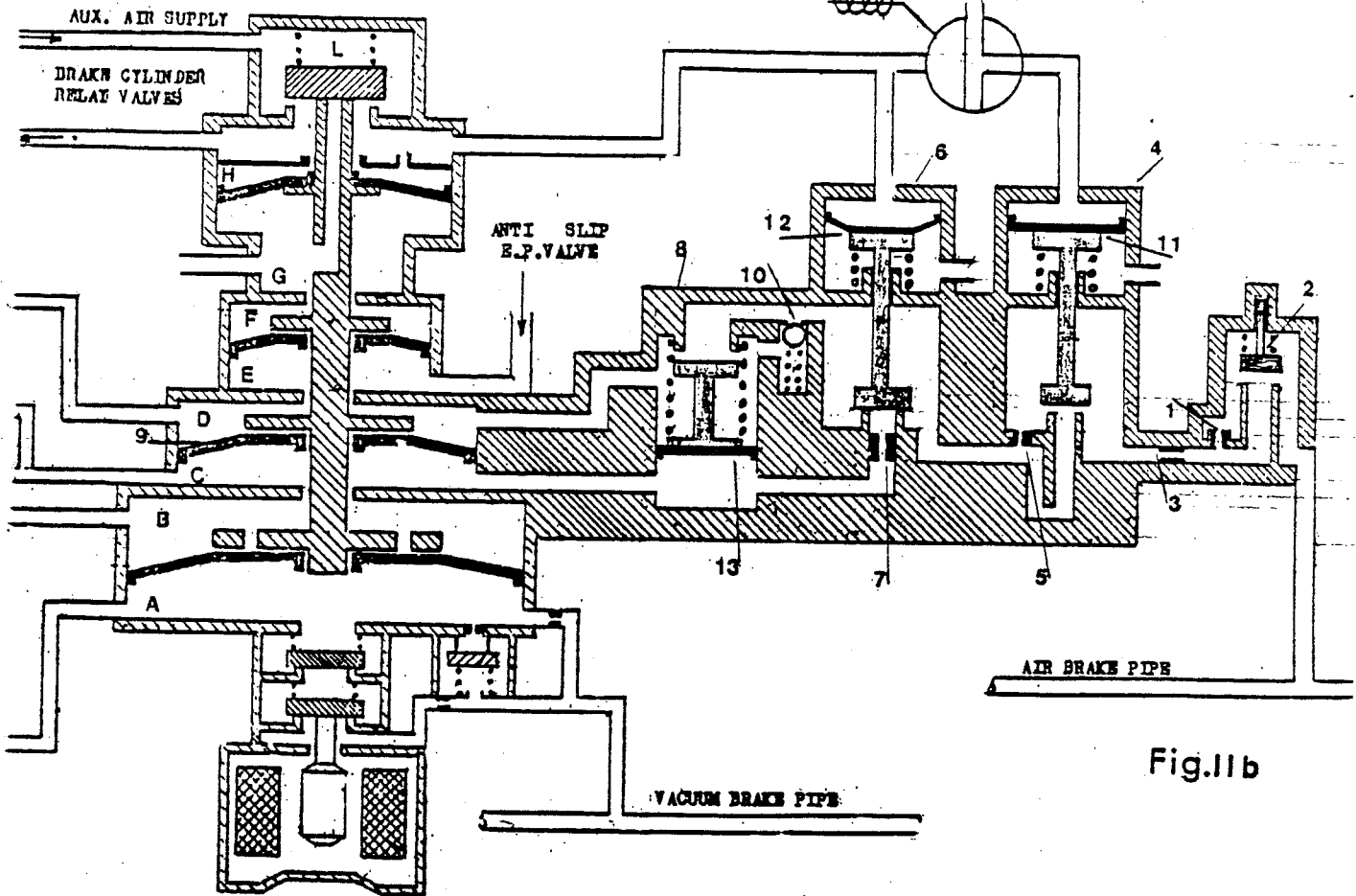


Fig. IIb

Locomotive Distributor Air Timings

Goods Air Application

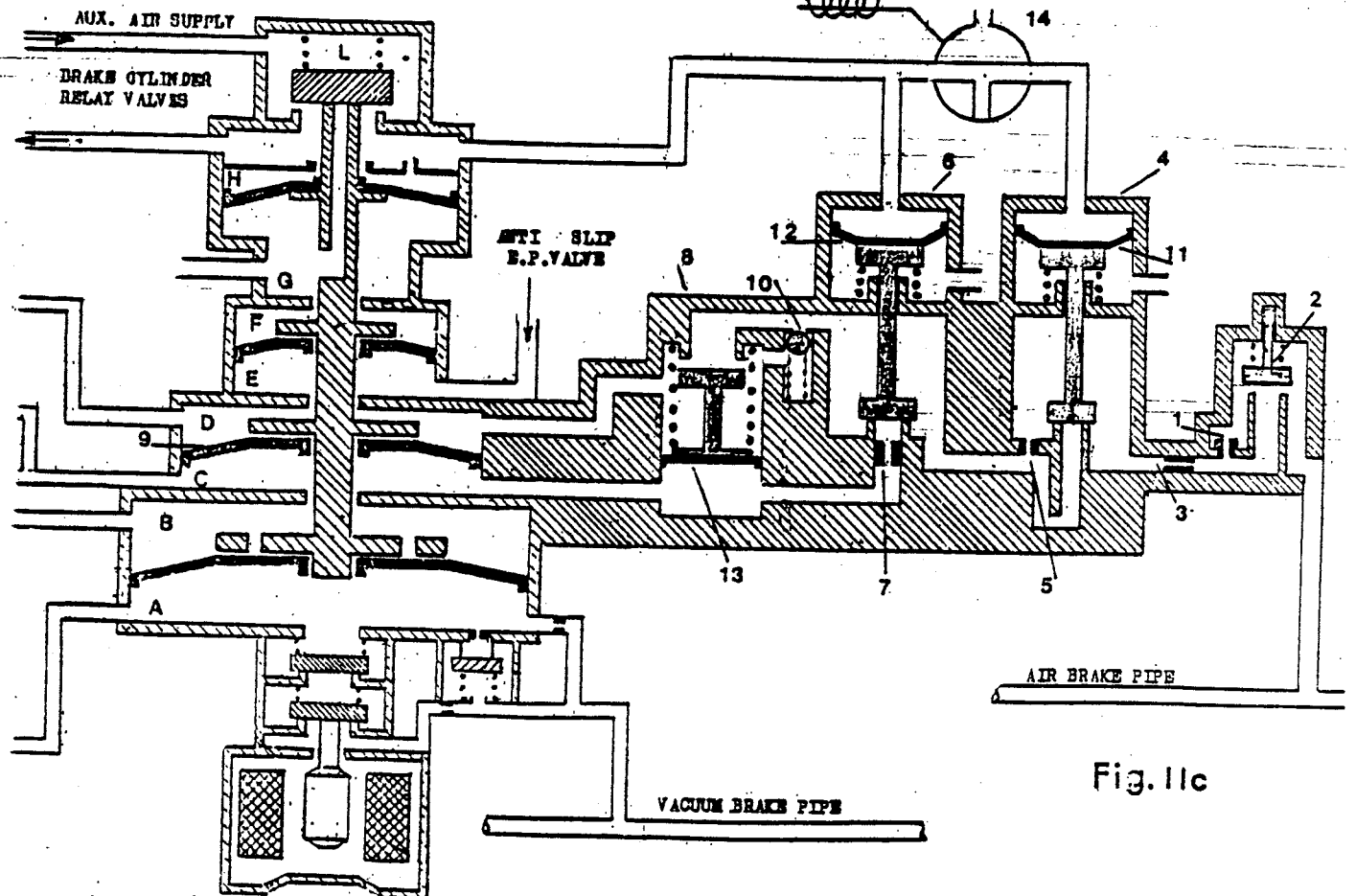


Fig. IIc

AIR RELEASE

(1) Passenger

This has already been described under Passenger Air Running

(2) Goods Fig. 11(d)

When the Driver's brake valve is returned to "Running or "Release" the pressure in the air brake pipe will rise to the appropriate maximum pressure and flow back into chamber D via the same path and chokes as described in "Application" position.

The distributor will then operate as previously described to release the brakes.

Locomotive Distributor Air Timings

Release Air Goods

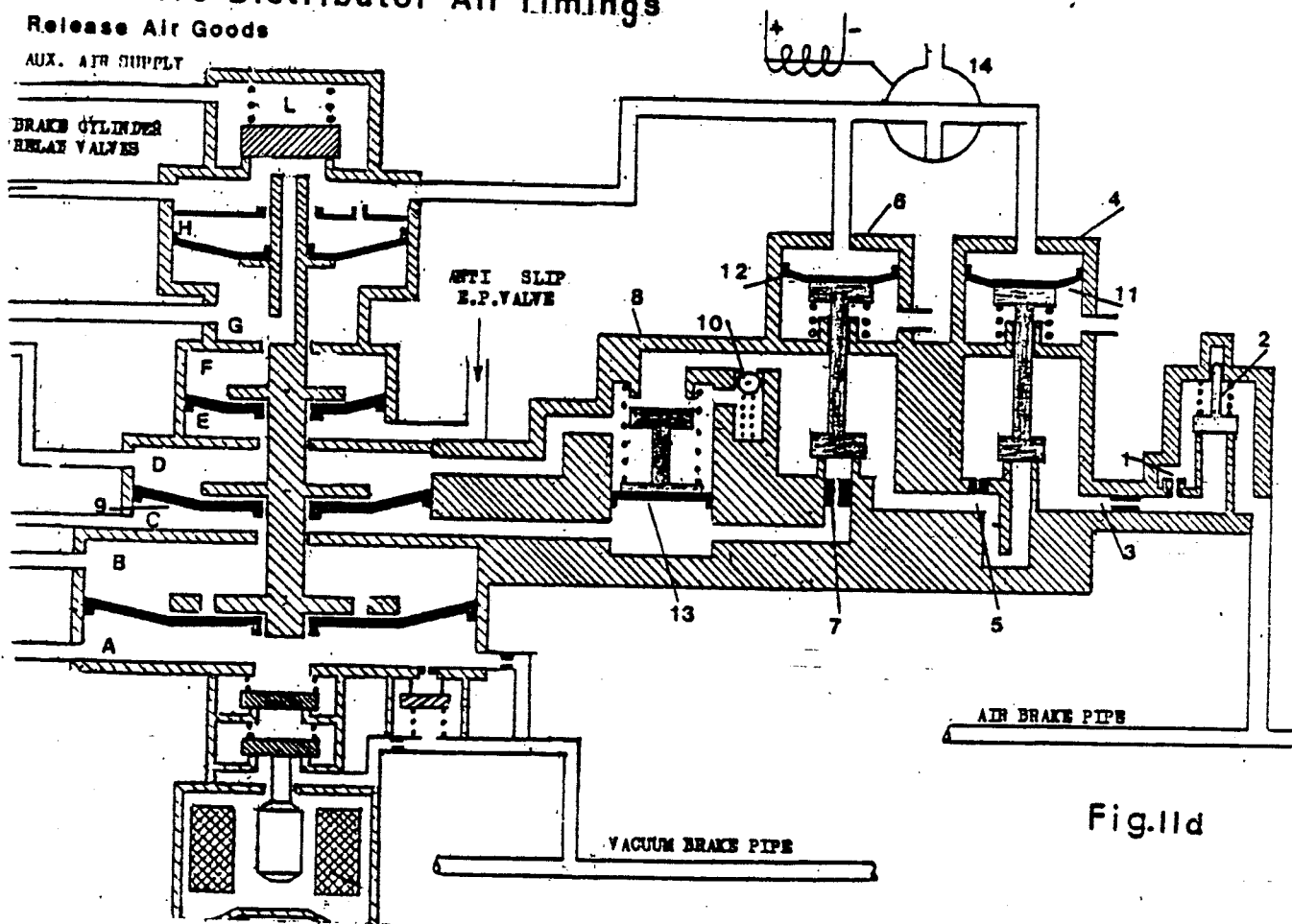


Fig.11d

NO	ITEM	NO	ITEM

EMERGENCY APPLICATION AND RELEASE Fig. 11 (e)

A normal "Full Service" brake application is made by a 22 p.s.i. reduction of air pressure in the brake pipe.

This pressure differential across the control diaphragm 9 will produce in the equalising chamber 'H' a control pressure in the brake cylinder relay valve equivalent to the maximum brake cylinder pressure. Should this differential across 9 be exceeded so will maximum brake cylinder pressure, To prevent this occurring the maximum pressure limiter 8 is required.

During emergency braking the air brake pipe is reduced from 70 p.s.i. to 0 hence the pressure difference across the control diaphragm 9 is exceeded. When the pressure difference across 9 exceeds 22 p.s.i. the the control pressure acts on diaphragm 13 of the maximum pressure limiter 8 hence any further reduction in the expansion chamber D is prevented thus limiting the brake cylinder pressure to it's maximum.

To facilitate the release of the brake when the maximum pressure limiting valve is closed a non - return valve 10 is provided to allow air to escape during control reservoir recharge (brakes releasing).

Locomotive Distributor Air Timings

Brakes releasing following Emergency Application

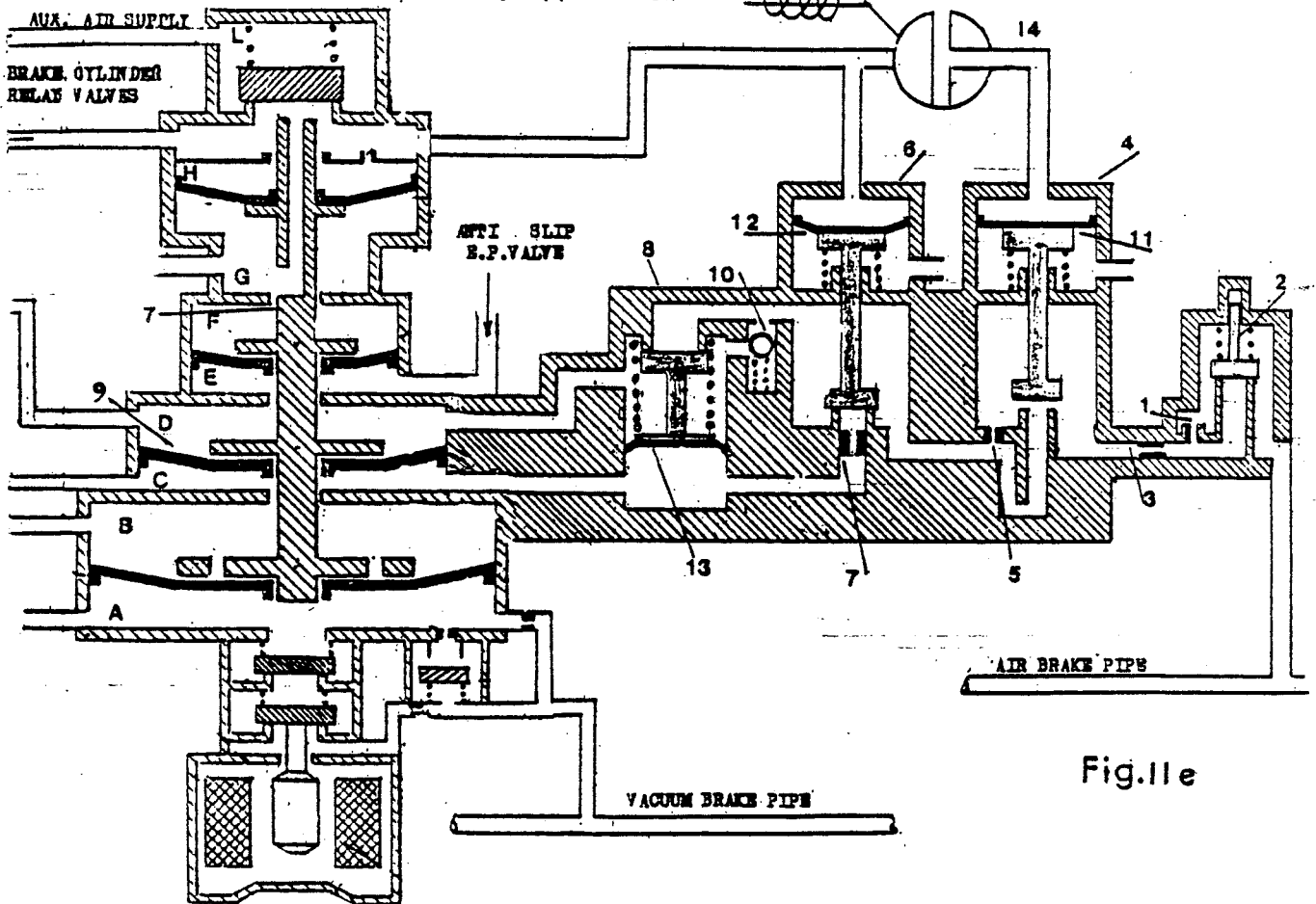
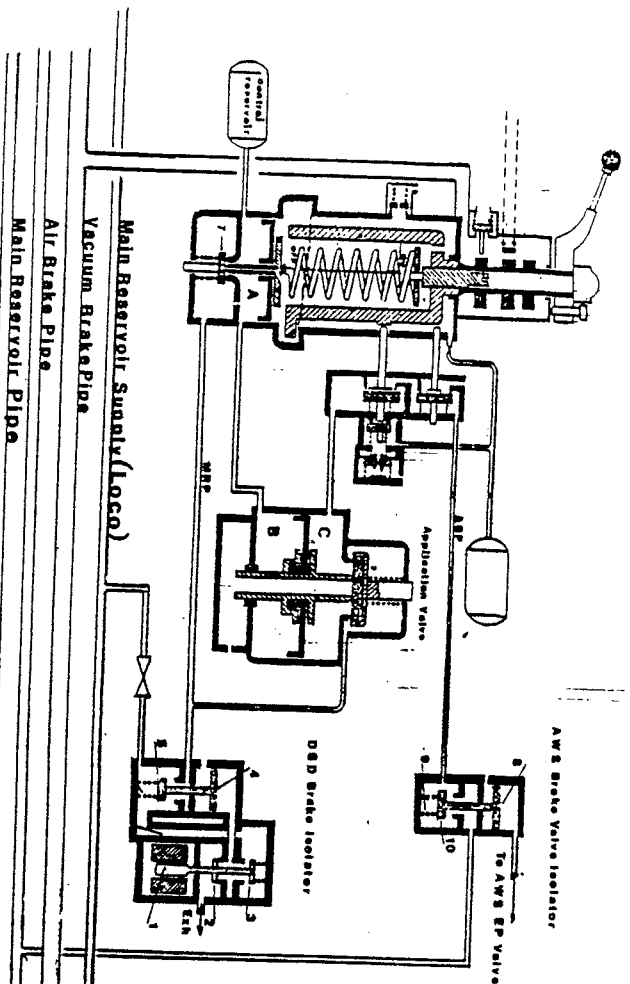
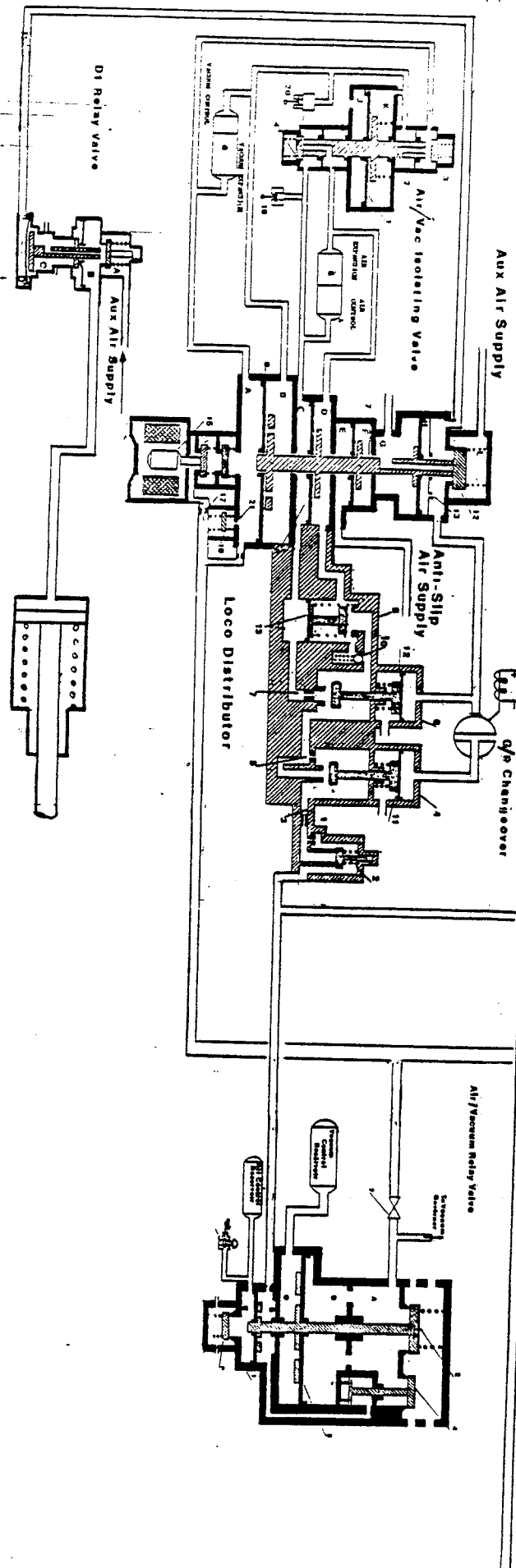


Fig.11e

Driver's Auto. Air Brake Valve

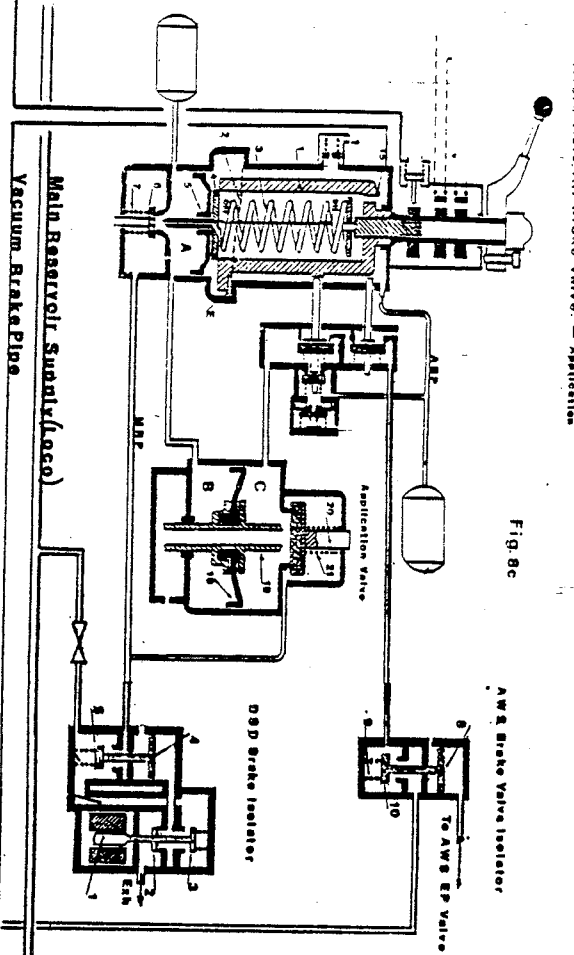


AIR RUNNING

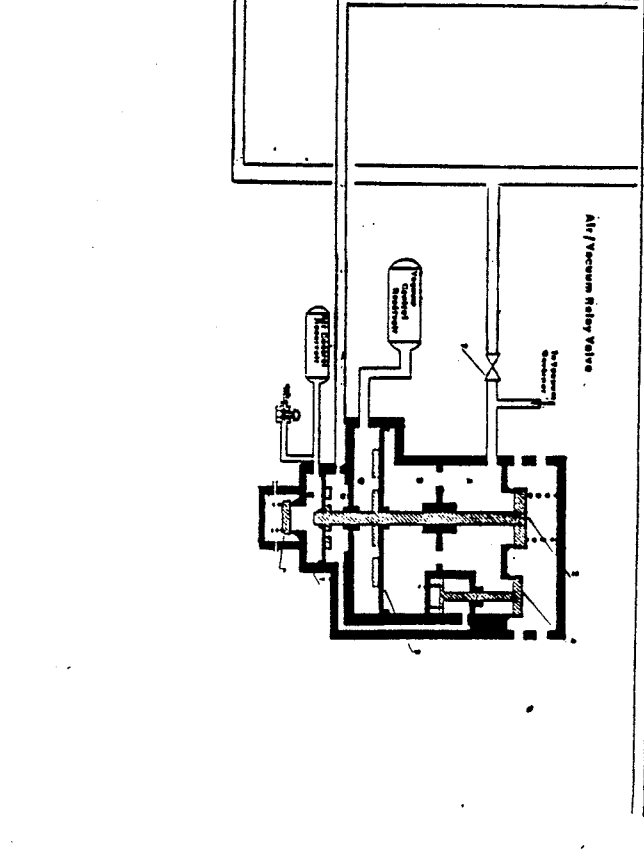
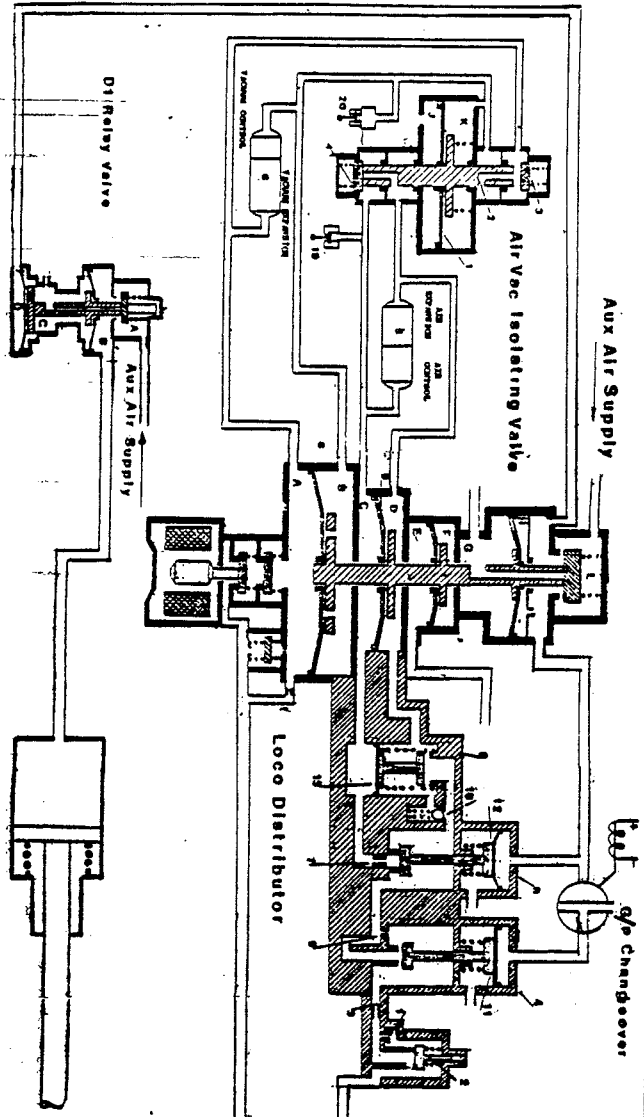
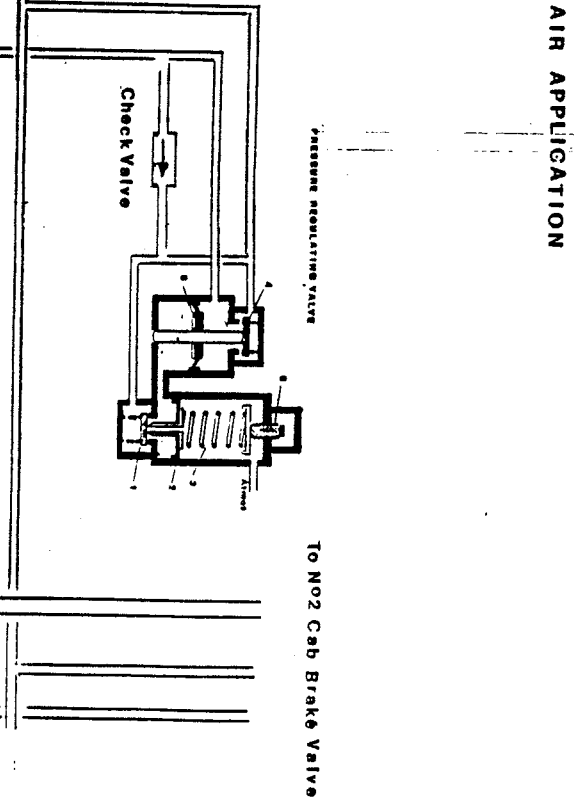


Drivers Auto Air Brake Valve - Application

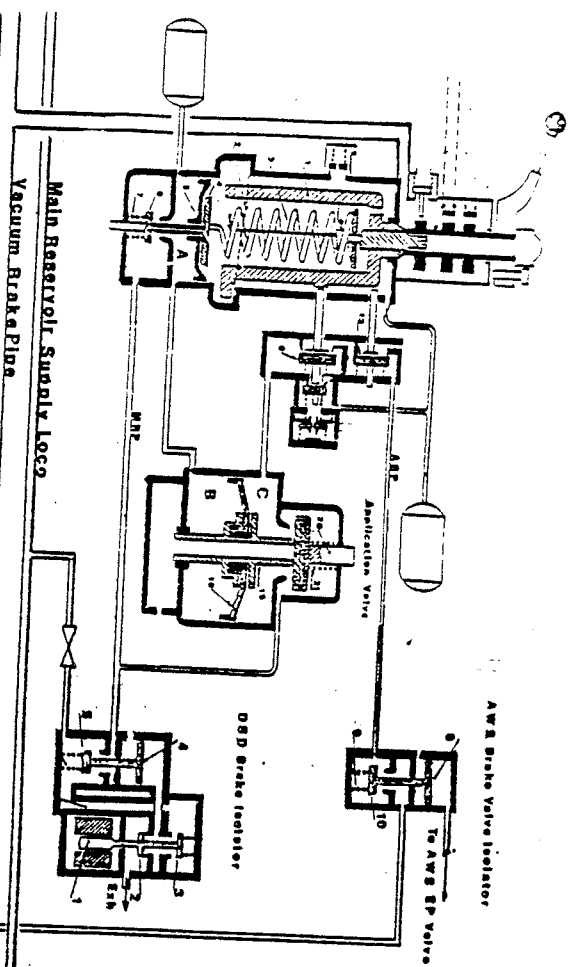
Fig. 8c



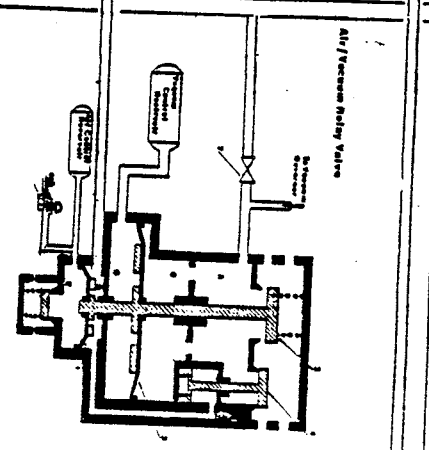
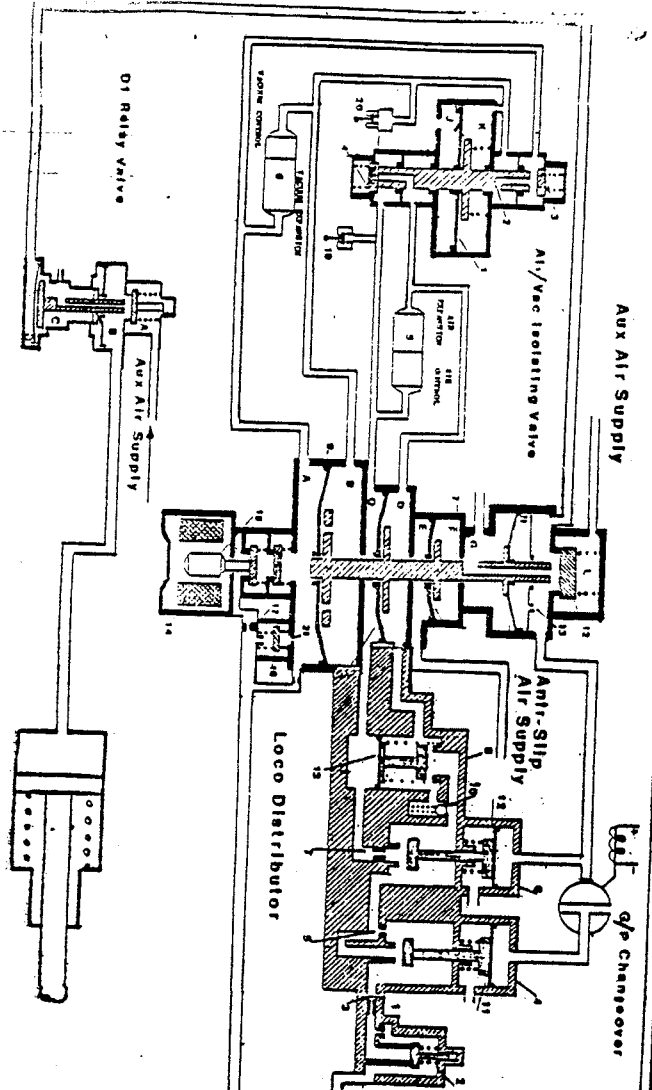
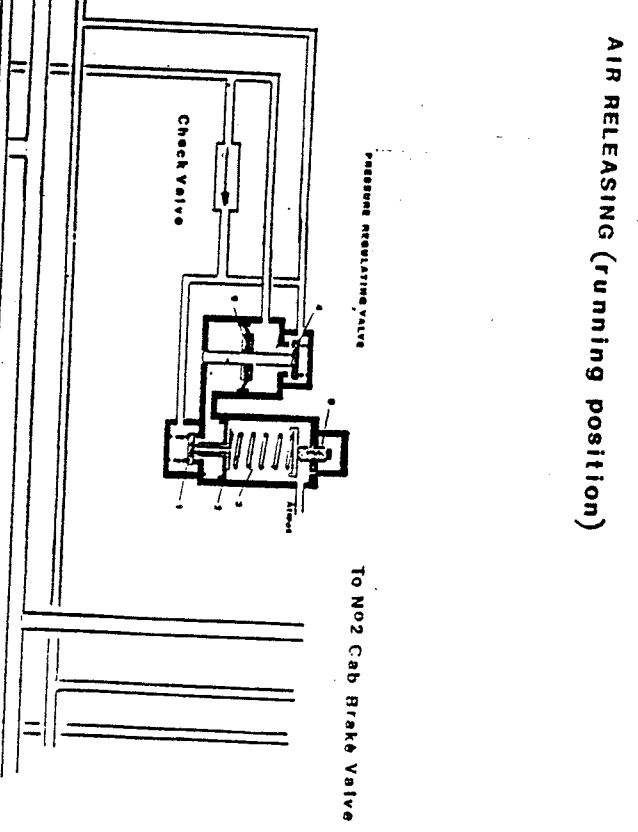
AIR APPLICATION



Drivers Auto Air Brake Valve



AIR RELEASING (running position)



THE VACUUM BRAKE

The Theory Of Vacuum

Atmospheric pressure is due to the weight of air above the ground. It is approximately 15 p.s.i. absolute at sea level but may vary slightly according to climatic conditions. This fact is essential to understand the measurement and operation of vacuum equipment.

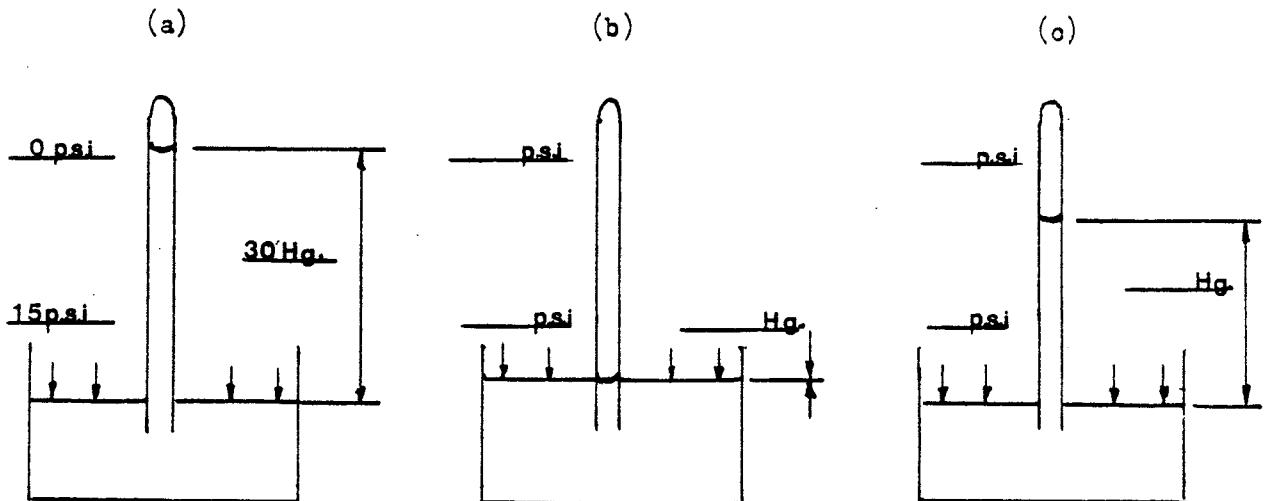
The sketch below shows a simple barometer in which a tube filled with mercury is inverted in a bowl of the same liquid.

Initially the mercury will drop in the tube but will finally arrive at a level of 30 inches which is equal to the pressure of the atmosphere, 15 p.s.i., on the surface of the mercury in the bowl, fig (a). The space above the mercury in the tube must be devoid of all matter i.e. a complete or absolute vacuum.

Note then that an absolute vacuum of 30 ins. mercury (Hg.) is equal to a difference of pressure across the wall of the tube OF 15 p.s.i. thus each 2 ins Hg. of vacuum equals a pressure difference of 1 p.s.i. across the tube wall.

If atmospheric air is now allowed into the tube the mercury will drop to the level of that in the bowl, refer to fig.(b), i.e. 0 ins.Hg equals a pressure differential of 0 p.s.i. across the tube.

Fig (c) shows that sufficient air has been allowed into the tube to drop the column of mercury to 21 ins.Hg. As was stated earlier, each 2 ins Hg. equals a differential of 1 p.s.i. across the tube hence 21 ins.Hg. equals a difference of $10\frac{1}{2}$ p.s.i. across the tube. Considering that atmospheric pressure is 15 p.s.i. then the pressure in the tube is $4\frac{1}{2}$ p.s.i. i.e. $15 - 10\frac{1}{2} = 4\frac{1}{2}$ p.s.i.



THE VACUUM BRAKE CYLINDER

The foregoing theory can be put to practical use to do useful work and in our particular case, work on a piston to apply the brake of a vehicle.

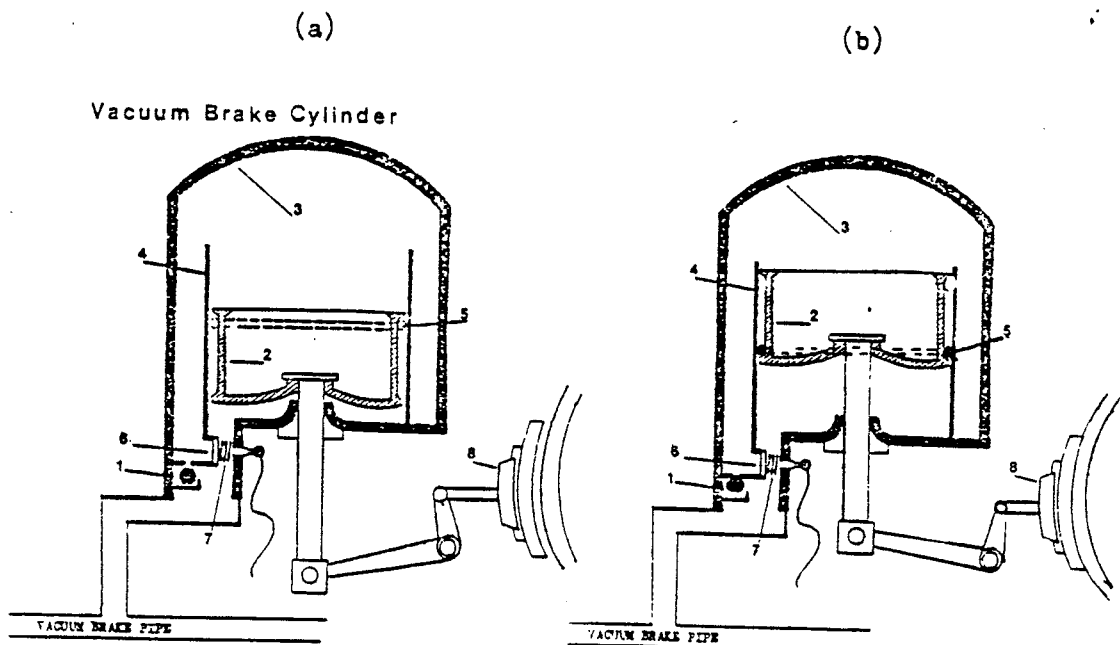
Figure (a) of the following diagram shows that when the vacuum is created in the vacuum brake pipe the vacuum reservoir will also be evacuated via the ball valve 1 hence the piston will fall to the bottom of the cylinder due to it's own weight.

Fig (b) shows that when atmospheric air enters the vacuum brake pipe it will push the ball valve on to it's face to seal the reservoir off from the brake pipe and so retain 21 ins. of vacuum. the air in the brake pipe side of the piston will drive the piston up the cylinder and apply the brake blocks to the wheel via the brake rigging. The rubber rolling ring ensures there is an air tight seal between the brake pipe side and reservoir side of the piston.

In the instances when it is required to release the brakes by hand the release valve can be manually pulled off it's face against the pressure of it's spring. This will equalise the pressure on both sides of the piston which will drop to the bottom of the cylinder and so release the brakes.

As stated before, at 21 ins. Hg. there will be a pressure differential of $10\frac{1}{2}$ p.s.i. on every square inch of the piston hence a considerable force can be applied on a piston of 21 inches in diameter to apply the brakes.

Note, it has also been observed that there is $4\frac{1}{2}$ p.s.i in the reservoir side when the brakes are released. When the brakes are applied and the piston rises it will compress the air in the reservoir and could eventually equalise with the brake pipe before the brakes are fully applied. To overcome this anomaly it can be seen that the reservoir is greatly enlarged so as to absorb any excess rise in the reservoir pressure.



Locomotive Distributor and Air/Vac. Isolating Valve

Vacuum Running

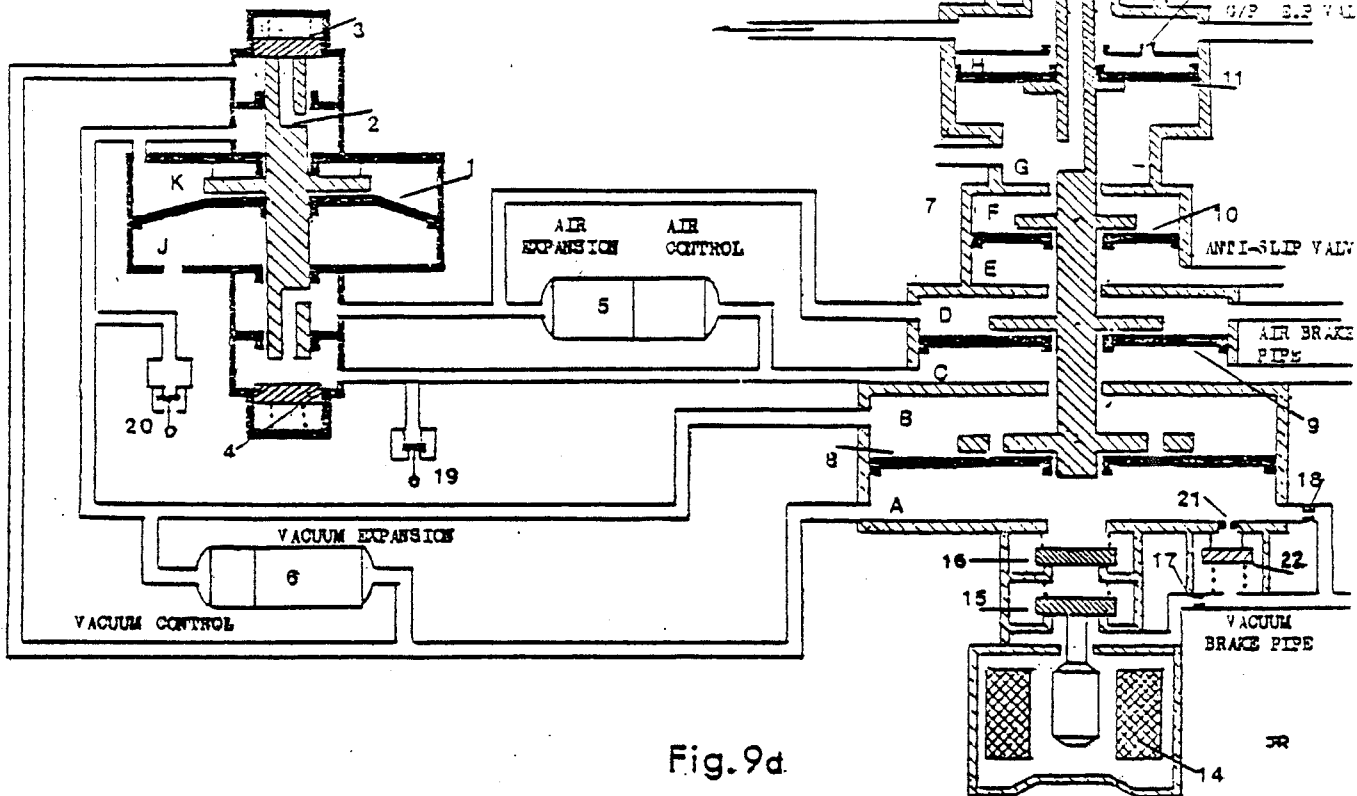


Fig. 9d

Vacuum Braking (Running) Fig. 9d

When the Selector Switch is turned to the Vacuum Pass. or Goods position the exhausters are connected to run and evacuate the vacuum brake pipe.

As already explained on page 26 the vacuum operated Air/Vac. isolating valve will actuate so as to isolate the vacuum expansion and control chambers A & B respectively in the distributor but place the air expansion and control chambers in communication with each other so that air brake pipe pressure variations have no effect on the operation of the distributor.

When vacuum is created in the vacuum brake pipe air is withdrawn from chamber A via choke 21 and also chamber B through the drillings in the diaphragm 8 follower (or plate) and the centre hole of diaphragm 8. Balance will therefore be attained on the valve assembly thus inlet valve 12 will close, and the control spindle 7 will lower to unseat the end of the hollow stem to put the brake cylinder relay valve in communication with atmosphere. The brakes will therefore be released on the locomotive.

Locomotive Distributor and Air/Vac. Isolating Valve

Vacuum Application (Goods)

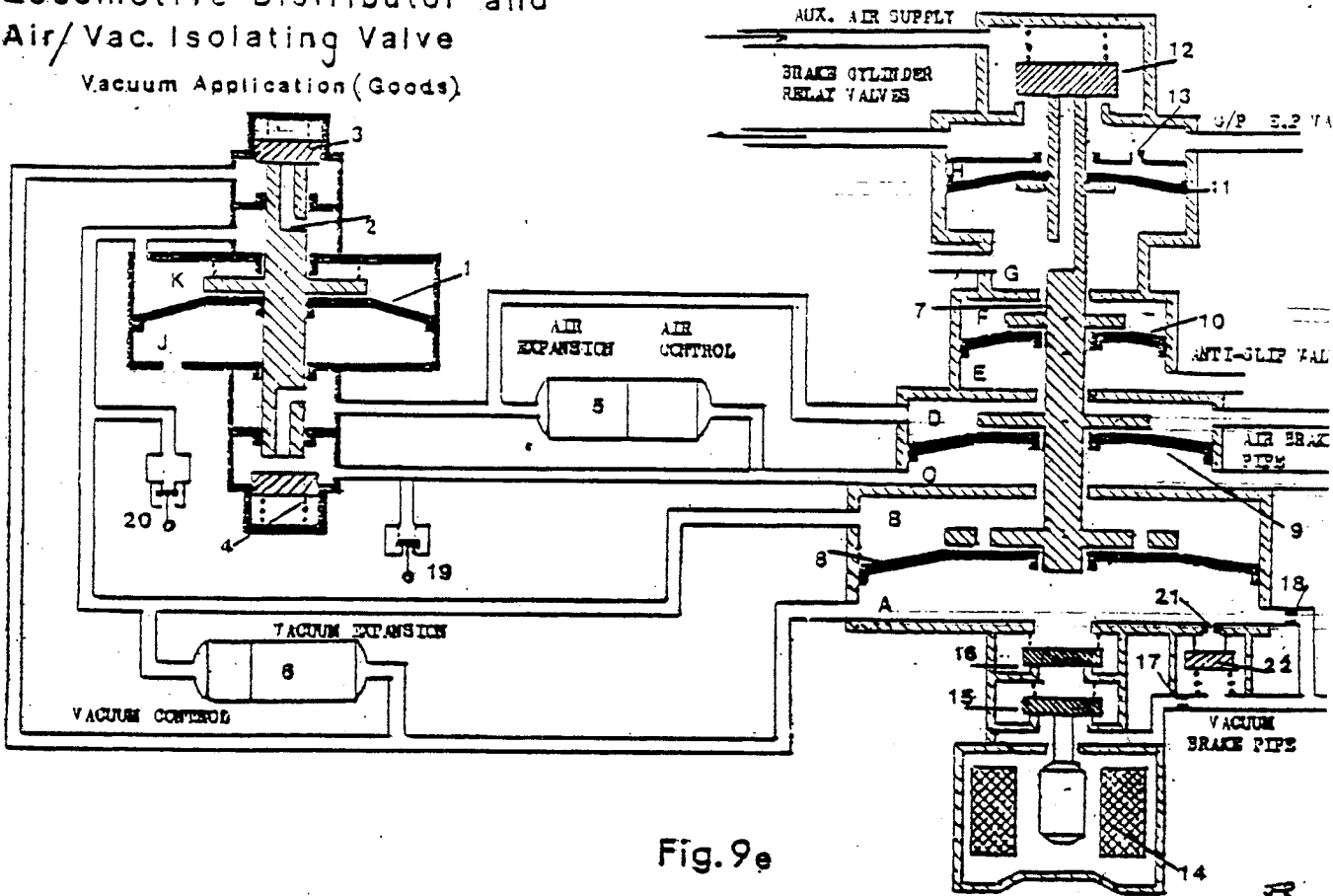


Fig. 9e

Vacuum Braking (Goods Application) Fig. 9e

When the Selector Switch is in the Vacuum Goods position the solenoid 14 is de-energised thus valves 19 and 16 are closed and prevent the passage of air through choke 17.

When a vacuum brake application is made and the vacuum in the brake pipe lowered, atmospheric air enters chamber A via the "Goods" choke 18, induces a pressure against diaphragm 8 to seal off the holes in the diaphragm follower (or plate) and retain 21 ins. Hg. vacuum in the control chamber B. This pressure differential across diaphragm 8 will lift the valve assembly to allow the auxiliary air to pass to the brake cylinder relay valves and apply the brakes.

The sequence of events of "lapping" and maintaining a constant pressure in the brake cylinders against leakage is the same as explained under the heading Air Braking (Application) Page 28 but in this instance the upward force is applied by the atmospheric air in chamber A.

NO	ITEM	NO	ITEM
7		16	
8		17	
12		18	
14		21	
15			

Locomotive Distributor and
Air/Vac. Isolating Valve
Vacuum Application (Passenger)

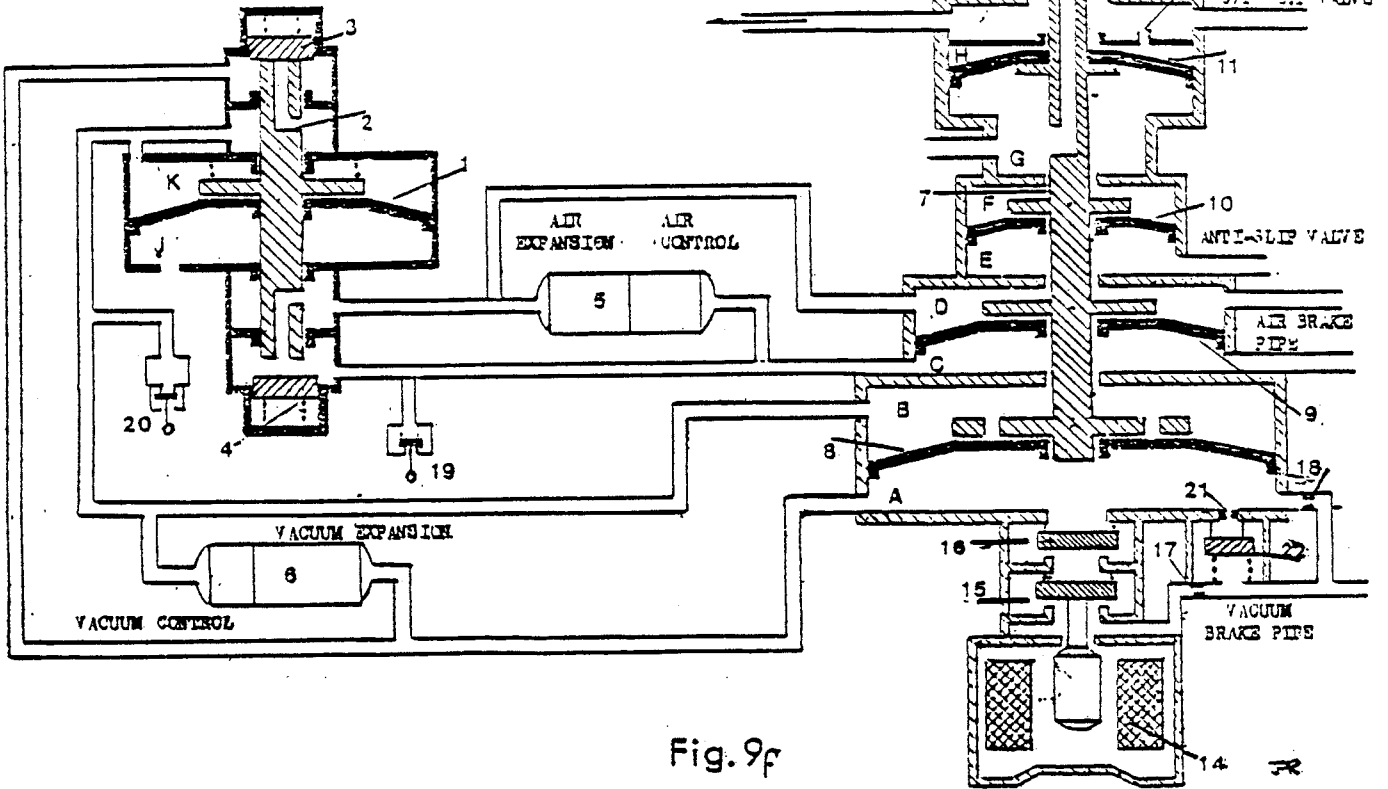


Fig. 9f

Vacuum Braking (Passenger Application) Fig. 9f

In this position of the Selector Switch solenoid 14 is energised to open valve 15.

When a vacuum brake application is made atmospheric air will enter chamber A through the goods choke 18 and, in addition, through Pass Application choke 17, past open valve 15 and push open valve 16 against its spring to enter chamber A.

It can be seen that chokes 17 and 18 are in parallel hence the flow rate into chamber A will be faster than that of a "Goods" application.

The sequence of events from this point to applying the brakes is the same as described under Vacuum Braking (Goods Application)

NO	ITEM	NO	ITEM
1		21	
2		22	
3		23	
4		24	
5		25	

Locomotive Distributor and Air/Vac. Isolating Valve

Vacuum Release

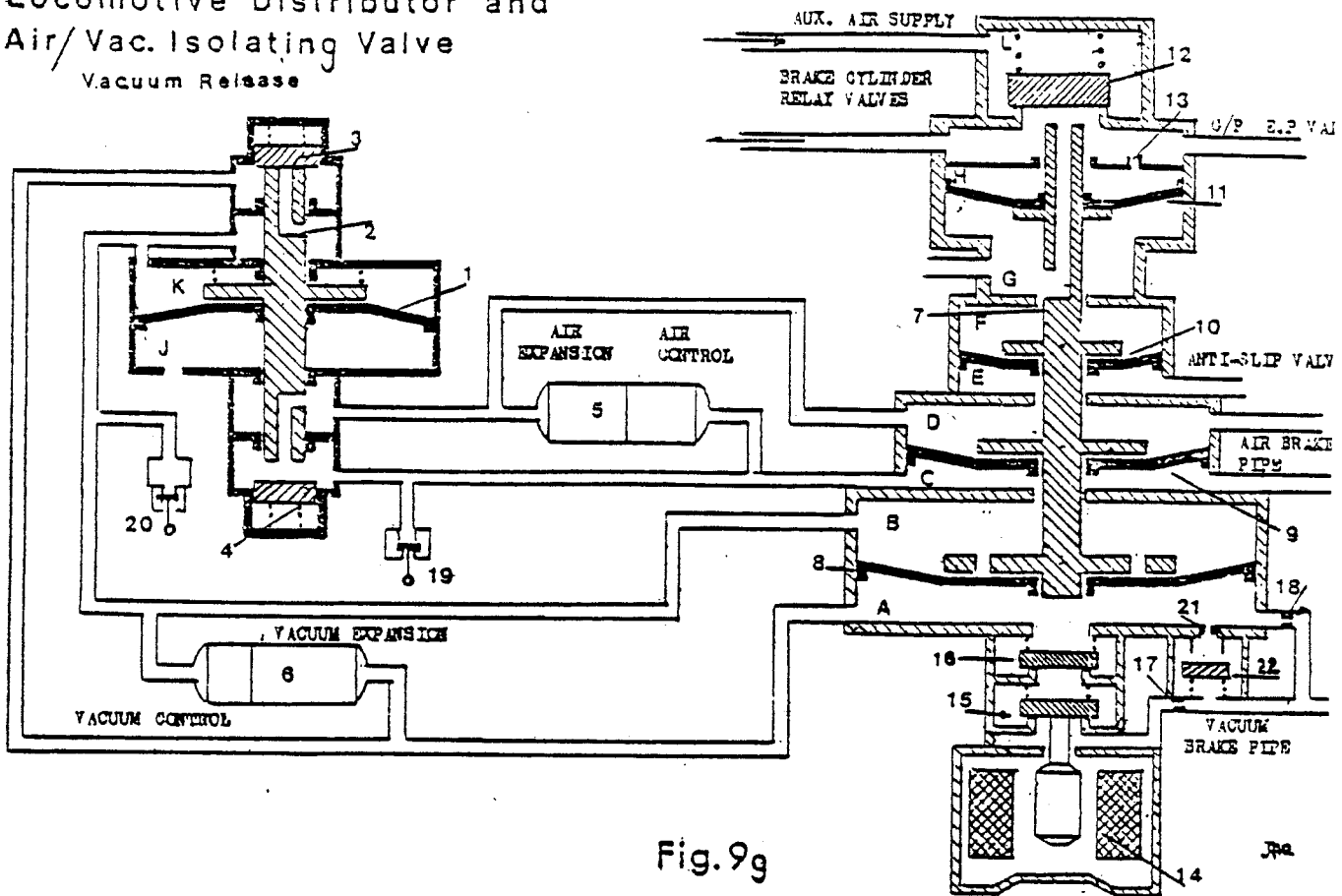


Fig. 9g

Vacuum Braking (Release) Fig. 9g

When the Drivers Brake Valve is placed in the "Running" position following an application the exhausters will run at normal speed to evacuate the brake pipe. If however, the "Release" position is chosen the exhausters will be "weak fielded" by means of the exhauster speed up switches in the Drivers Brake Valve, refer to Figs. 8.

(a) Goods

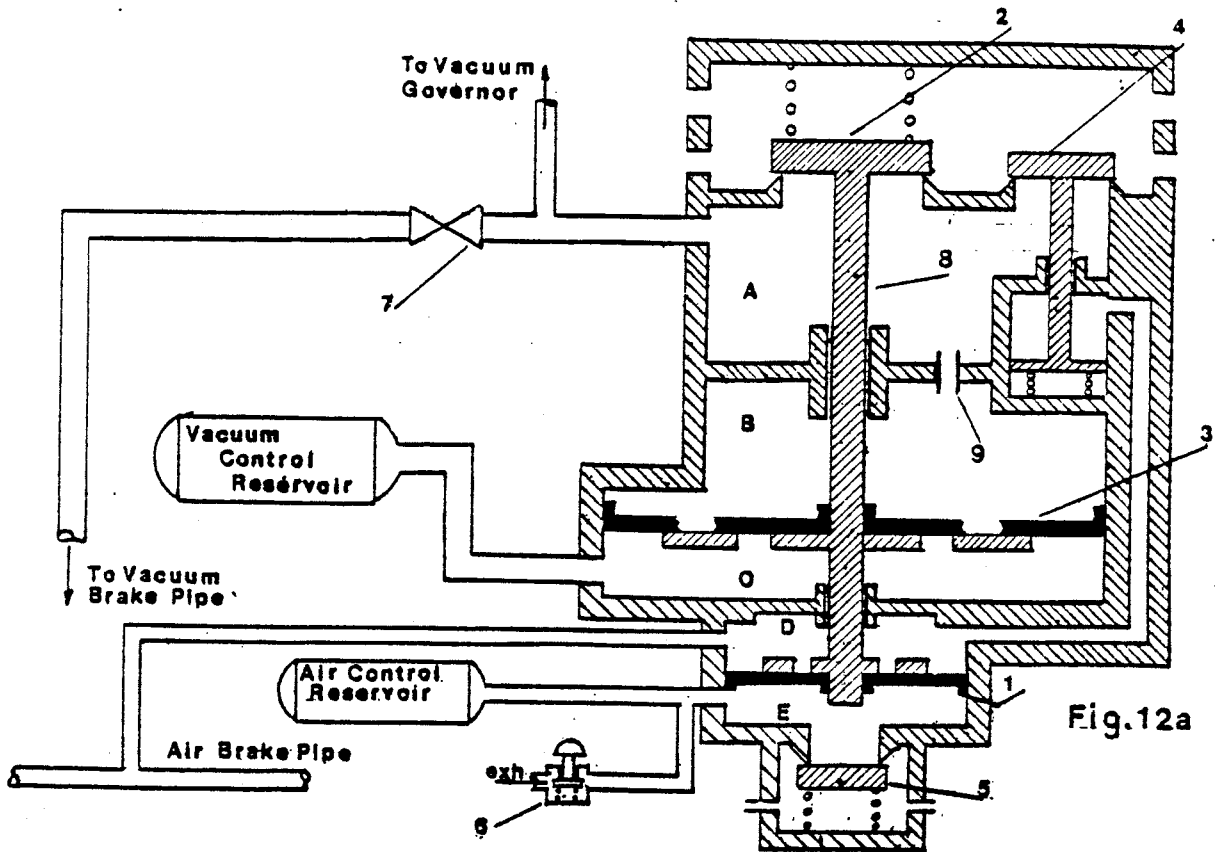
On evacuating the vacuum brake pipe the air in chamber A will also be evacuated via the Goods application chokes 18 and will, in addition, push valve 22 off its face to permit the evacuation of A through the release choke 21 hence the brake release times are faster than the application times.

When chambers A & B eventually equalise the spindle 7 will move down, close the inlet valve 12 and open the end of the hollow stem to permit the discharge of the brake cylinder relay valve control air to atmosphere.

(b) Passenger

The sequence of events is similar to that described under Goods release but it is to be observed that in this instance, the Selector Switch in Vac. Pass., solenoid 14 is energised hence valve 15 is open. However, air passing from the chamber A will maintain valve 16 closed therefore no air is released through the Pass. Application choke 17. It can therefore be seen that the brake release timings are the same for both passenger and goods.

Air/Vacuum Relay Valve Running



NO	ITEM	NO	ITEM
1		5	
2		6	
3		7	
4		8	

AIR/VACUUM RELAY VALVE

This valve is actuated by variations of the Air Brake Pipe pressure. Its purpose is to vary the level of vacuum in the Vacuum Brake Pipe in proportion to the pressure changes in the Air Brake Pipe.

Running Fig. 12(a)

When the air brake pipe is charged air will pass into the expansion chamber D and thence through the air control diaphragm 1 into the control chamber E. As these two pressures will be equal. Similarly, the exhausters will be running hence chambers A and B will be evacuated to 21 ins. Hg. Chamber C will be evacuated via the holes in diaphragm 3 and it's follower.

In this condition the relay valve will be in balance and the main inlet valve 2 will be closed.

Air/Vacuum Relay Valve Application

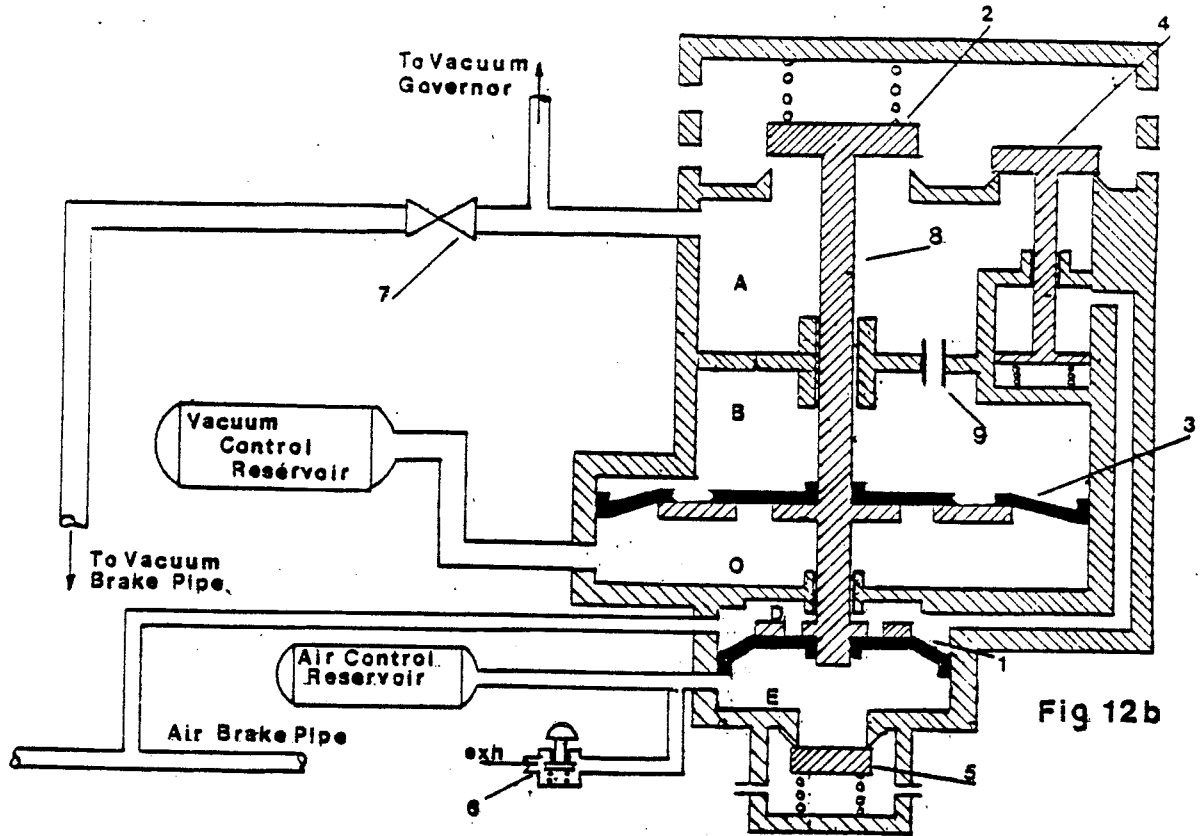


Fig 12b

NO	ITEM	NO	ITEM
1		5	
2		6	
3		7	
4		8	

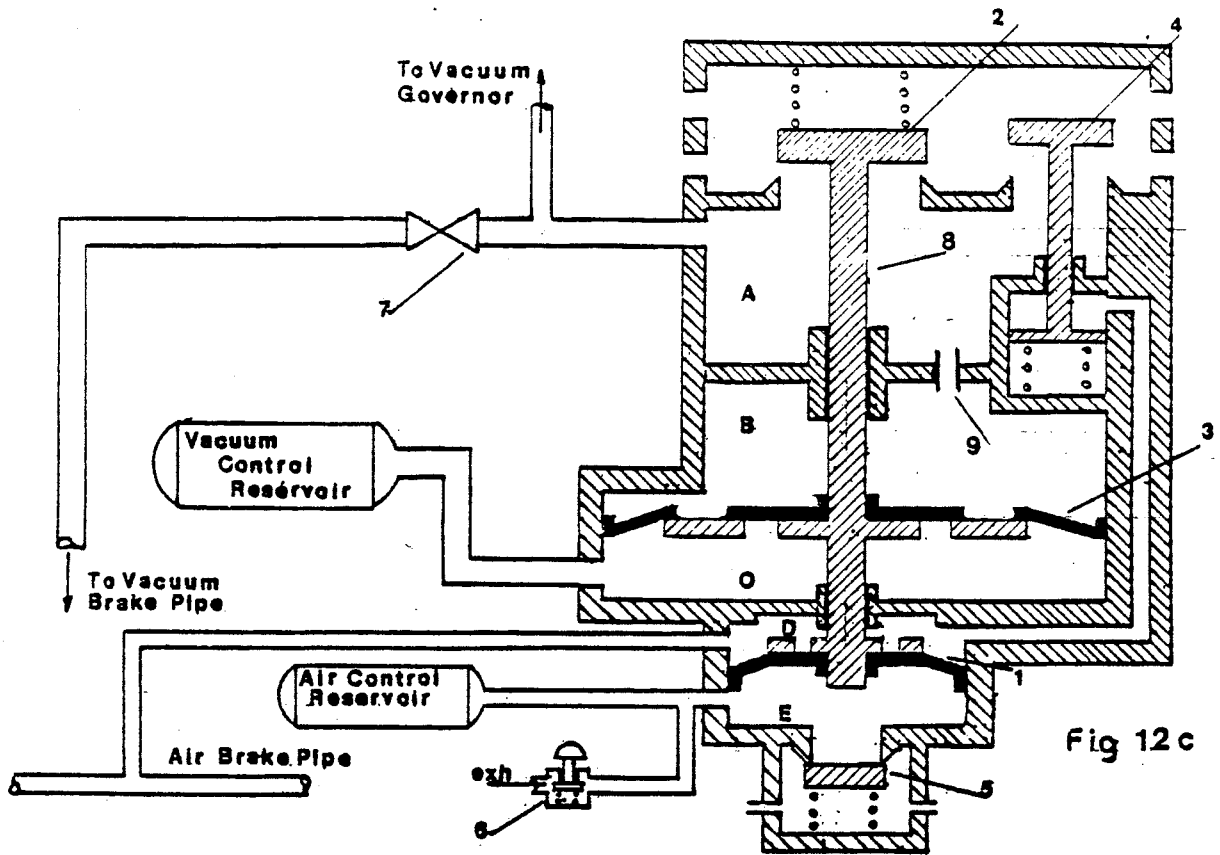
Application Fig 12(b)

When the brake is applied the subsequent drop of pressure in the air brake pipe will be reflected in the air expansion chamber D hence the control air pressure on the underside will lift the control spindle 8 and open the inlet valve 2. Atmospheric pressure entering the vacuum brake pipe will also pass through choke 9 and exert a downward balancing force on diaphragm 3. The valve will then 'lap' with a drop in vacuum brake pipe proportional to the pressure reduction made in the air brake pipe.

The inlet valve 2 remains open in the 'lap' position thus giving a balanced flow of atmospheric air into the vacuum brake pipe against the continuously running exhausters which are still connected to the vacuum brake pipe through a $\frac{5}{8}$ ins. choke.

A vacuum brake pipe reduction from 21 ins.Hg. to zero corresponds to a normal pressure reduction of 72.5 to 50.5 p.s.i. in the air brake pipe.

Air/Vacuum Relay Valve Emergency Application



NO	ITEM	NO	ITEM
1		5	
2		6	
3		7	
4		8	

Emergency Application Fig 12 (c).

The emergency valve is held closed by air brake pipe pressure which is greater than it's spring, and will remain closed as long as the air pipe pressure only varies between 72.5 p.s.i. to 50.5 p.s.i. If the drivers brake valve is placed into the emergency position when the air brake pipe falls to 47 p.s.i. the emergency valve spring will overcome the air brake pipe pressure, the valve will open fully and drop the vacuum brake pipe to zero almost instantly.

Air/Vacuum Relay Valve Overcharge Release

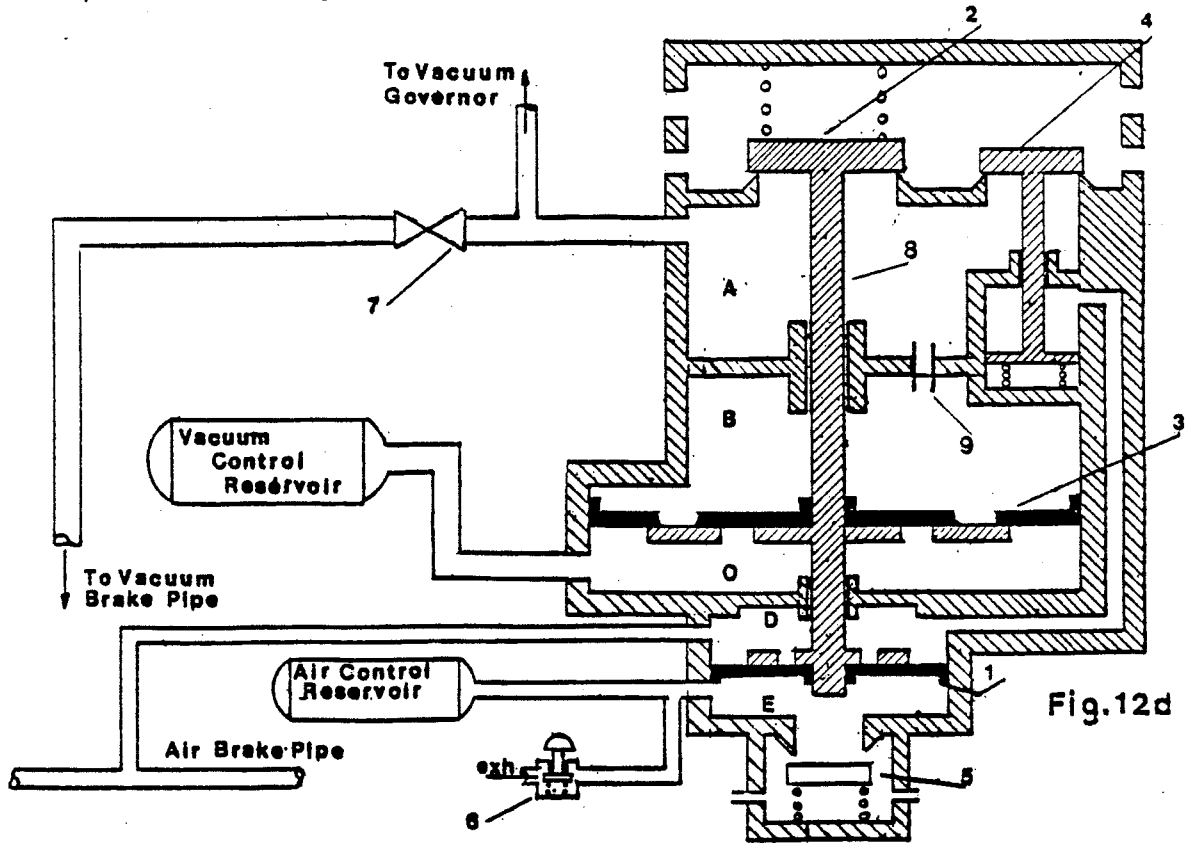


Fig.12d

NO	ITEM	NO	ITEM
1		5	
2		6	
3		7	
4		8	

Overcharge Release Fig. 12(d).

When the drivers brake valve is placed in the 'Release position the air brake pipe is raised temporarily to approximately 78.5 p.s.i. If this pressure was trapped in the control chamber E after the air brake pipe pressure had returned to the normal 'running' pressure of 72.5 p.s.i. it would result in an application of the brakes. This is prevented by automatically venting the air control reservoir by the use of the overcharge release valve 5 Which will open in the event of the air brake pipe pressure being in excess of the control chamber pressure.

The manual overcharge valve 6 carries out the same function as the overcharge release valve 5 and permits the main inlet valve to be reseated in the event of an accidental overcharge occurring in the air control reservoir.

PRESSURE REGULATING VALVE (P.V.F.2)

Spring 3 is tensioned at 100 p.s.i. and will hold valve 1 open and allow Main Reservoir air to enter chamber A. When 100 p.s.i. is attained in this control chamber it acts against diaphragm 2 and Main reservoir air is shut off.

The 100 p.s.i. in the control chamber acts against diaphragm 5 so opening the inlet valve 4 and allows Main Reservoir air to enter the Main Reservoir Pipe. (sometimes termed the "brake feed pipe") until 100 p.s.i. is attained whereupon spring 4 will close the inlet valve due to equal pressures now acting across diaphragm 5.

Any drop of pressure in the Main Reservoir Pipe will unbalance diaphragm 5 and thereby open valve 4 to constantly equate the control and Main Reservoir Pipe pressures.

Any excess pressure build up in the control chamber A. due to say a leak on the face of valve 1, will act on diaphragm 2 to push the exhaust valve 7 open and dump the excess pressure to atmosphere.

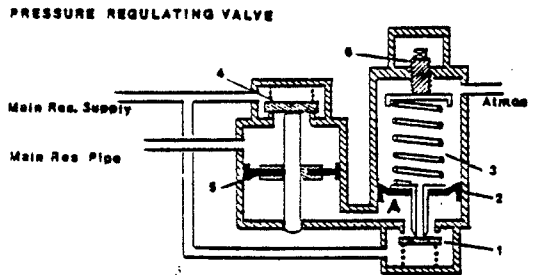


fig.13a

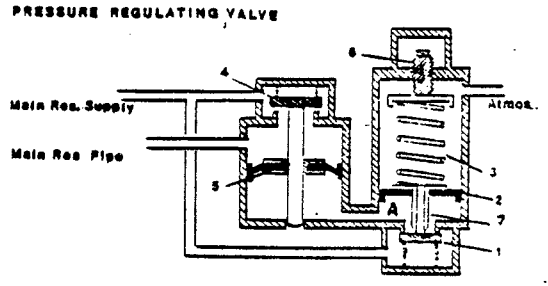


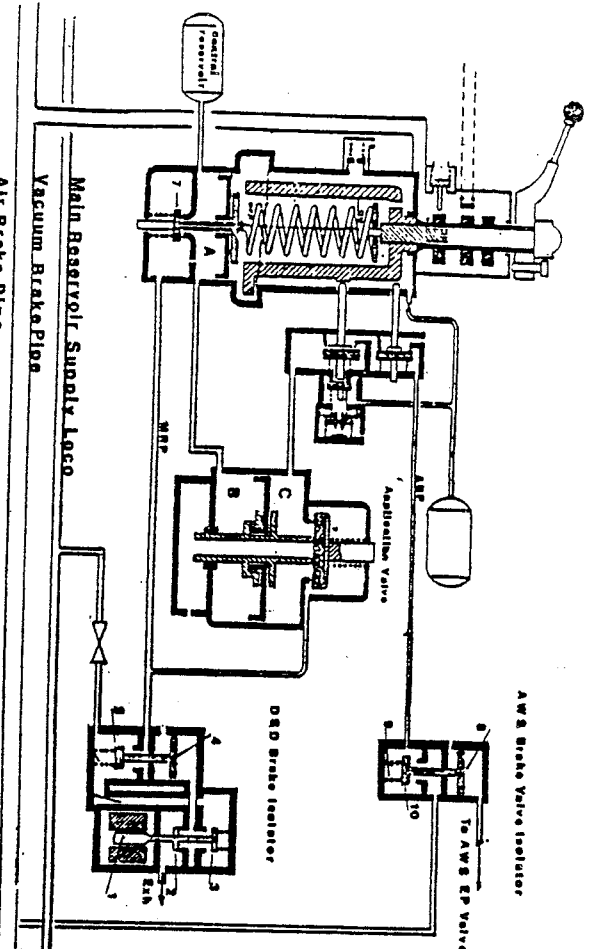
fig.13b

AR

NO	ITEM	NO	ITEM
1		6	
2		7	
3		8	
4		9	
5		10	

Drivers Auto. Air Brake Valve

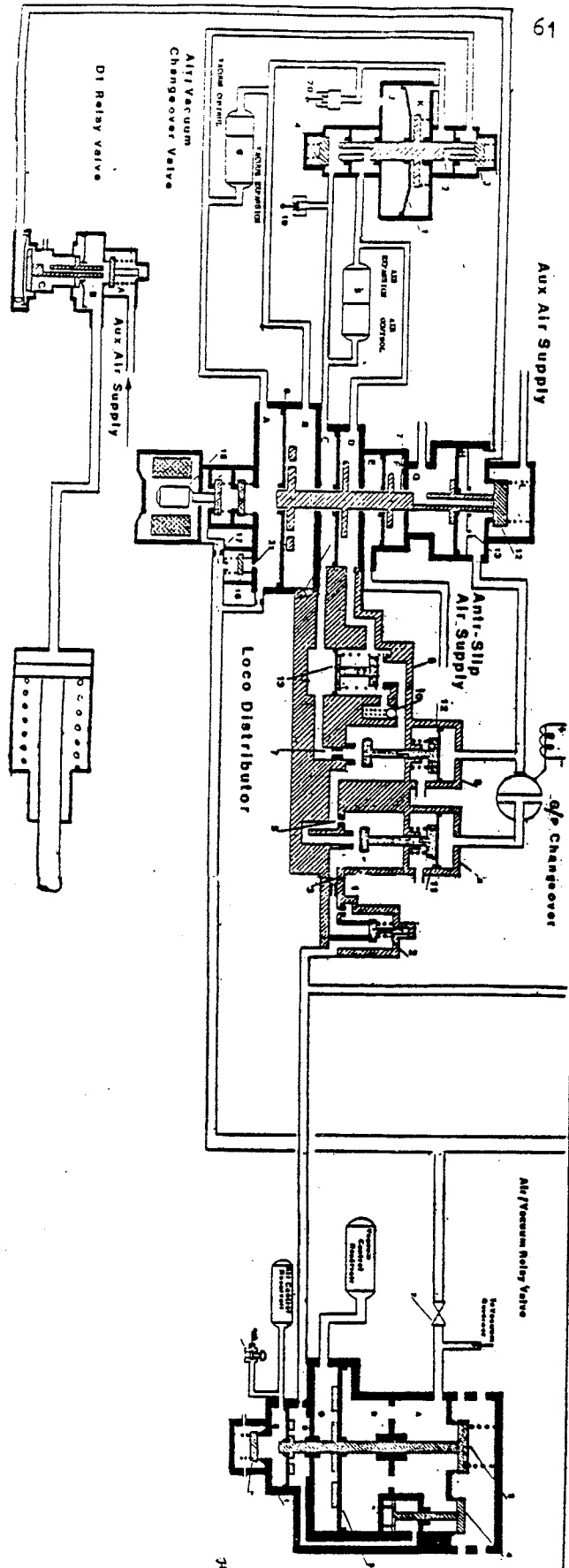
VACUUM RUNNING



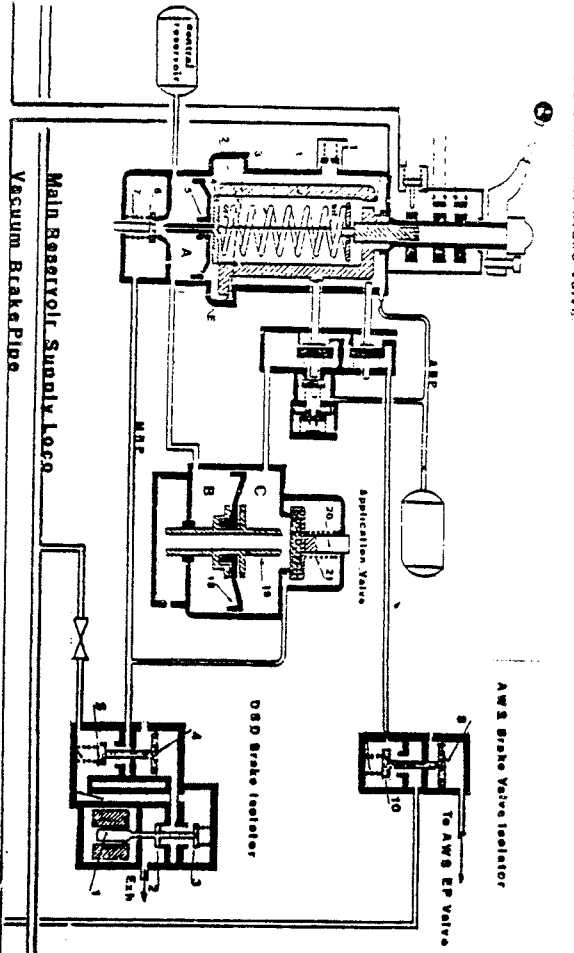
To No2 Cab Brake Valve

Air Brake Pipe
Main Reservoir Pipe
Vacuum Brake Pipe

51



30



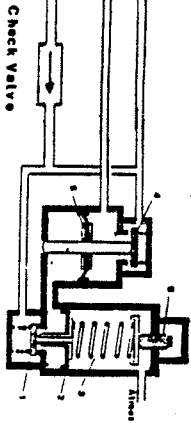
OSD Brake Valve Isolator

To AWS EP Valve

Vacuum Application (goods)

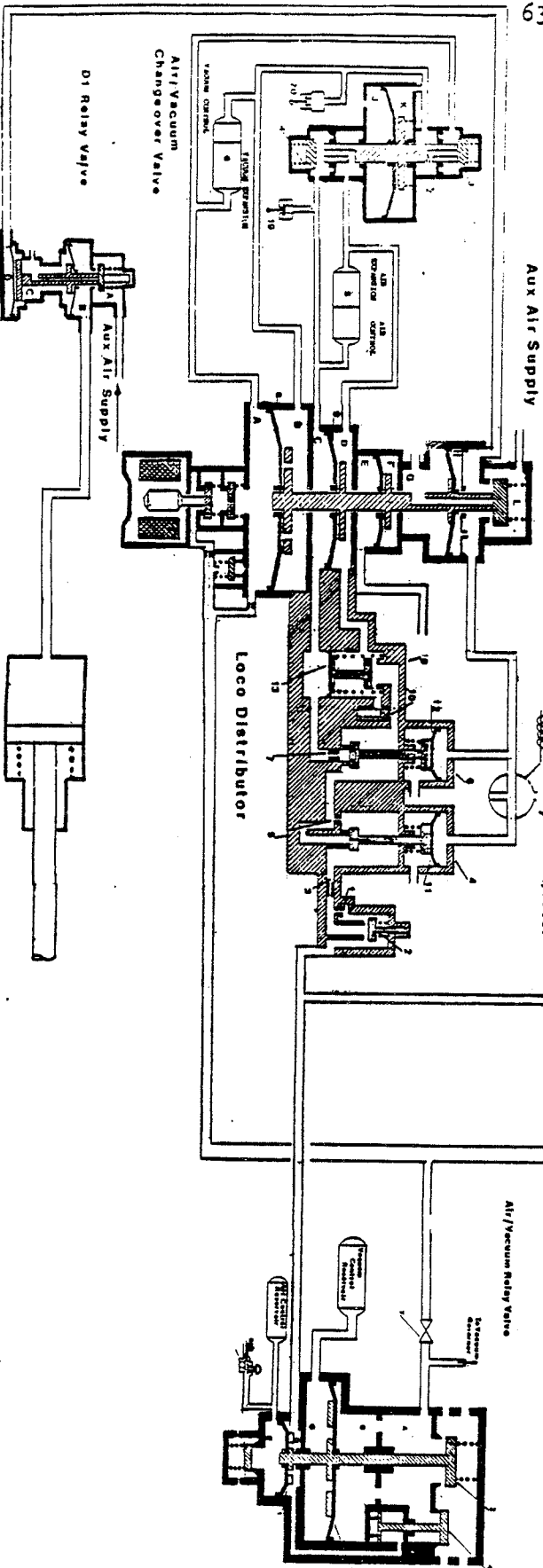
To No2 Cab Brake Valve

PRESSURE REGULATING VALVE



Check Valve

Air Brake Pipe
Main Reservoir Pipe



Aux Air Supply

g/o Changeover

Loco Distributor

Air/Vacuum Relay Valve

Air/Vacuum
Changeover Valve

DI Relay Valve

