C.M. & E.E. (L.M.R.)
Training Section,
Nelson Street,
DERBY

# DAVIES AND METCALFE

# DUAL BRAKED LOCOMOTIVES

## AIR AND BRAKE SYSTEMS

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T4-23

# DAVIES & METCALFE DUAL BRAKED LOCOMOTIVES.

These notes are intended to highlight the differences in the main air, control air and brake system from locomotives fitted with conventional air/vacuum brake.

## Main Air System.

A schematic diagram showing the system used on some Class 47 locomotives is attach . but apart from minor variations which are detailed in the following notes, the system is similar to other locomotive types.

On most dual braked locomotives two Davies & Metcalfe Oerlikon electrically-driven compressors, Type 2 A 115, are fitted capable of delivering up to 37.5 cubic feet/min. at 140 lb./sq.in., one being operational at all times and the second in conjunction with the first for use when working air braked trains.

The compressors are of the two stage reciprocating type, two cylinders compressing the air initially then passing on via an intercooler to the high pressure cylinder.

After the air has been compressed it passes on to an after-cooler drip cup and non-return valve into the main reservoir/s.

The compressors are controlled by a compressor governor to maintain the pressure between 118/140 lb./sq.in. An isolating cock is provided to enable the compressor governor to be isolated.

To avoid excessive pressure in the system two safety valves are provided s t at 150 lb./sq.in.

A low main reservoir pressure governor connected to the main reservoirs cuts off locomotive power and initiates a D.S.D. brake application should main reservoir pressure fall below 65 lb./sq.in. An isolating cock is provided to enable the governor to be isolated.

An isolating cock is provided to enable the compressors and reservoirs to be isolated from the locomotive equipment.

The arrangement shown on the attached diagram is fitted to Class 47 locomotives which require air pressure to operate the Diesel engine starting contactors. With this arrangement a Duplex check valve set at 72.5 lb./sq.in. is fitted between the two compressors before they deliver air via a common pipe to the main reservoirs. The purpose of the valve is to allow No. 1 compressor to pass air to the control air reservoir without passing air to the main reservoirs during the locomotive starting sequence. When the pressure in the control air reservoir reaches 45 lb./sq.in. No. 1 compressor is stopped by the Prestart Governor thus avoiding excessive current being drawn from the battery.

After starting the Diesel engine the auxiliary generator voltage will cause either one or both compressors to run under the control of the compressor governor.

From the main reservoirs the air is supplied to the locomotive reservoir supply pipe which supplies air to the following:-

(1) Horns, Wipers and Sanding - Cocks provided for isolation.

(2) Direct air brake system, Driver's FD1 brake valves and D1 relay valve/s - Isolating cocks provided for bogie isolation.

(3) Auto air brake valves FV4.

(4) Boiler feed (where required).

(5) D.S.D. E.P. valve.

(6) A.W.S. equipment - main air feed to both A.W.S. change end switches and A.W.S. (Baldwin) E.P. valves.

(7) Auxiliary reservoirs serving the auto air brake LST3 distributor and each D1 relay valve. These feeds are taken via check valves, which prevent leak back of air should the main reservoir system fail. On other locomotive types one reservoir is provided to supply both D1 relay valves.

(8) Pressure control valve FVF2 set 100 lb./sq.in. supplies the main reservoir pipe. This pipe has two functions, i.e.

(a) When working 2-pipe air braked trains the end coupling is connected to the train main reservoir pipe coupling (coloured yellow) and provides a 100 lb./sq.in. feed to the train brake auxiliary reservoirs.

(b) When working in multiple as a pipe allowing pressure at 100 lb./sq.in. to pass to another locomotive whose main reservoir is at a lower pressure. In reverse air can be fed into the locomotive system from another locomotive via the check valve connected between the main reservoir pipe and locomotive reservoir supply pipe.

From the description of the pressure control valve it will be appreciated that if a serious leak develops on the main reservoir pipe the locomotive main reservoir supply pressure will be reduced. This undesirable arrangement was fitted to all locomotives fitted with dual brakes up to 1971.

Subsequently a Duplex check valve set at 75 lb./sq.in. has been included in the system connected in series with the pressure control valve and this restricts the loss of locomotive main reservoir pressure to 75 lb./sq.in. if the main reservoir pipe develops a leak. This arrangement is included on many locomotives converted to dual brakes since 1971.

(9) Main reservoir pressure gauge (140/118 lb./sq.in.)

(10) On recent conversions a Duplex gauge is fitted indicating main reservoir pressure (140/118 lb./sq.in.) and main reservoir pipe pressure (100 lb./sq.in.)

Control Air System.

An isolating cock is provided to enable the control air reservoir to be isolated from the main reservoir.

The system is controlled by a check valve and reducing valve to 72.5 lb./sq.in. from which the air passes into the control air reservoir which supplies the following equipment:-

(1) Electrical cubicle - for operation of air operated electrical equipment.

(2) Control air pressure gauge.

(3) Anti-slip E.P. valve - when energised passes an air feed to the distributor making a partial brake application.

(4) Accelerator valves (power-handle operated).

Conventional system of engine speed control - air passes from the accelerator valve to the regulating air pipe and through solenoid valve E.S.V. to the engine governor.

(5) Through a choke to the A.W.S./D.S.D. TMV7 valve and associated timing reservoirs.

Auto Air and Vacuum Brake System.

A diagram is attached to show the relationship of the equipment detailed below. The details of operation of each valve are given in the following notes.

1. Driver's Brake Valve.

An FV4A Driver's Brake Valve is provided in each cab. The valve controls air brake pipe pressure and a vacuum valve is fitted which destroys vacuum brake pipe when the handle is placed to "Emergency".

An electrical contact is fitted which closes in "Release" to speed up the exhausters and operates the exhauster choke valve.

An isolating cock is provided in the air supply pipe to both brake valves enabling the valves to be isolated for maintenance or under fault conditions. On Type 1 locomotives one cock isolates both brake valves.

2. Air/Vacuum Relay Valve.

A DV2 air/vacuum relay valve is provided and operates during "Vacuum" working to give proportional decrease in vacuum brake pipe to correspond to decrease in air brake pipe pressure.

An isolating cock is provided in the vacuum brake pipe connection to the valve to be used under fault conditions. When the cock is isolated the vacuum brake pipe governor will also be isolated.

A release valve (button type) is provided to enable the air control chamber pressure of the valve to be released. If the chamber retains an overcharge the vacuum/air brake pipe proportionality will be affected and also locomotive and train brakes may 'drag' when brake valve handle is placed in "Running".

3. Distributor.

An LST3GP Distributor (once called a Triple Valve) is provided which responds to change in Vacuum brake pipe or Air brake pipe pressure to apply or release the locomotive air brakes.

A hand operated release valve is provided to enable the distributor air control chamber pressure to be released. This would be used to release the locomotive brake if air brake pipe pressure was not available.

Two hand operated release valves, one in each cab, are provided to enable the distributor vacuum control chamber to be destroyed. This would be used to release the locomotive brakes when changing over from vacuum to air working or if vacuum could not be created.

Note: It should be noted that during changeover from vacuum to air working or after depot maintenance the distributor air control chamber pressure may be reduced. Under these conditions a full auto air locomotive brake application may not be available and up to four minutes should be allowed to recharge the distributor air control chamber.

4. Air/Vacuu Isolating Valve.

An air/vacuum isolating valve is provided and when working in vacuum positions, the valve renders the distributor auto air brake section inoperative.

5. Auto Air Relay Valves.

A D1 relay valve is provided for each bogie and applies the locomotive air brake initiated by the distributor. Bogie isolating cocks are provided in the feed from each relay valve to the brake cylinders. On some locomotives isolating cocks are fitted in the supply to the relay valves.

6. D.S.D. and A.W.S. Brake Application Valve.

A TMV.7 valve is provided and is initiated by either D.S.D. or A.W.S. system operation to reduce air brake pipe pressure.

In addition, should the main reservoir pressure fall below 65 lb./sq.in. the low main reservoir pressure governor will initiate a D.S.D. brake application.

An isolating cock is provided in the D.S.D. air brake pipe connection to the TMV.7 valve and can be used to isolate the D.S.D. system under fault conditions.

Note: IF THE D.S.D. IS ISOLATED AS ABOVE IT IS ESSENTIAL THAT THE D.S.D. PEDAL IS DEPRESSED AT ALL TIMES WHEN THE LOCOMOTIVE IS UNDER POWER IN ORDER TO MAINTAIN AIR BRAKE PIPE PRESSURE.

The A.W.S. equipment may be isolated by placing the cab A.W.S. change end switch isolating handles in both cabs to the "OFF" position and by operation of the isolation handle in a driving cab.

7. Vacuum Brake Pipe Governor.

A vacuum governor is connected to the vacuum brake pipe and cuts off locomotive power if vacuum falls below 13". In air working the brake selector switch shorts out the governor.

8. Air Brake Pipe Governor.

A governor is connected to the air brake pipe and cuts off locomotive power if pressure falls below 48 lb./sq.in.

9. Cab Gauges.

Gauges are provided in each cab to indicate air brake pipe pressure, brake cylinder pressures, vacuum brake pipe and vacuum chamber.

10. Brake Valve Isolators.

One electrically operated brake valve isolator is connected in the main reservoir supply to each auto air brake valve and closes in the event of a D.S.D. application.

Also one air operated brake valve isolator is connected in the feed from each auto air brake valve to the air brake pipe and will close in the event of an A.W.S. application.

On Type 1 locomotives one D.S.D. and one A.W.S. brake valve isolator is provided for both brake valves.

## Pressure Control Valve FVF 2.

Referring to diagram opposite.

With no air in the system the pressure regulating inlet valve will be held open by compression on the regulating spring.

As air pressure builds up in the system air passes into chambers (A) and (B) and builds up under diaphragms (C) and (D), causing the main inlet valve to open and pass air to the main reservoir pipe.

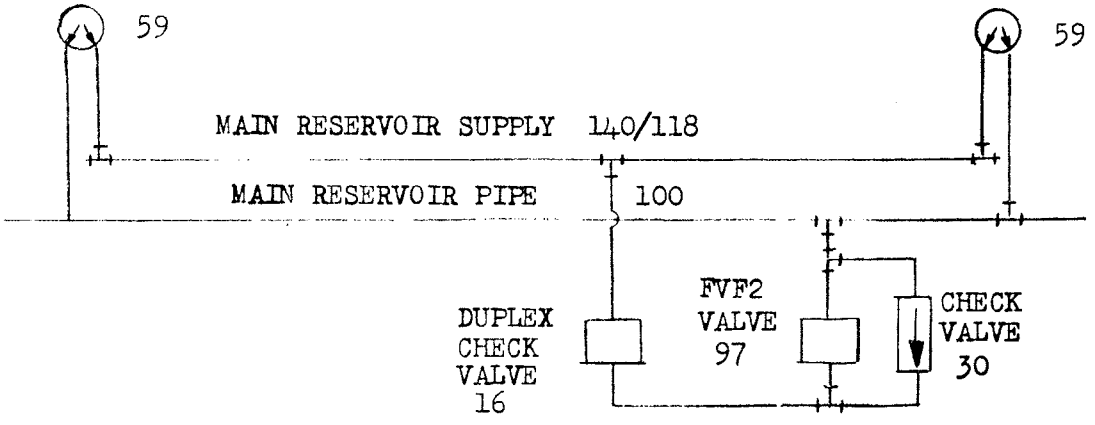
When 100 lb./sq.in. acts under diaphragm (C) the spring will compress causing the pressure regulating inlet valve to seat. The main inlet valve is held open by 100 lb./sq.in. acting under diaphragm (D) until 100 lb./sq.in. builds up in the main reservoir pipe and above diaphragm (D) at which time the diaphragm is in a balanced position and the main inlet valve will resume its seat.

The valve is self lapping thus any pressure drop in the main reservoir pipe is compensated by operation of diaphragm (D) and the main inlet valve.

The valve setting may be adjusted by varying the compression on the regulating spring by means of the adjusting screw.

NOTE: In future valves will be supplied with a small drilling through the length of valve operating stem 'D'. The drilling will improve sensitivity of the valve and ensure that the valve laps off at 100 lb./sq.in. in the main reservoir pipe, excess pressure being vented to atmosphere through the drilling.

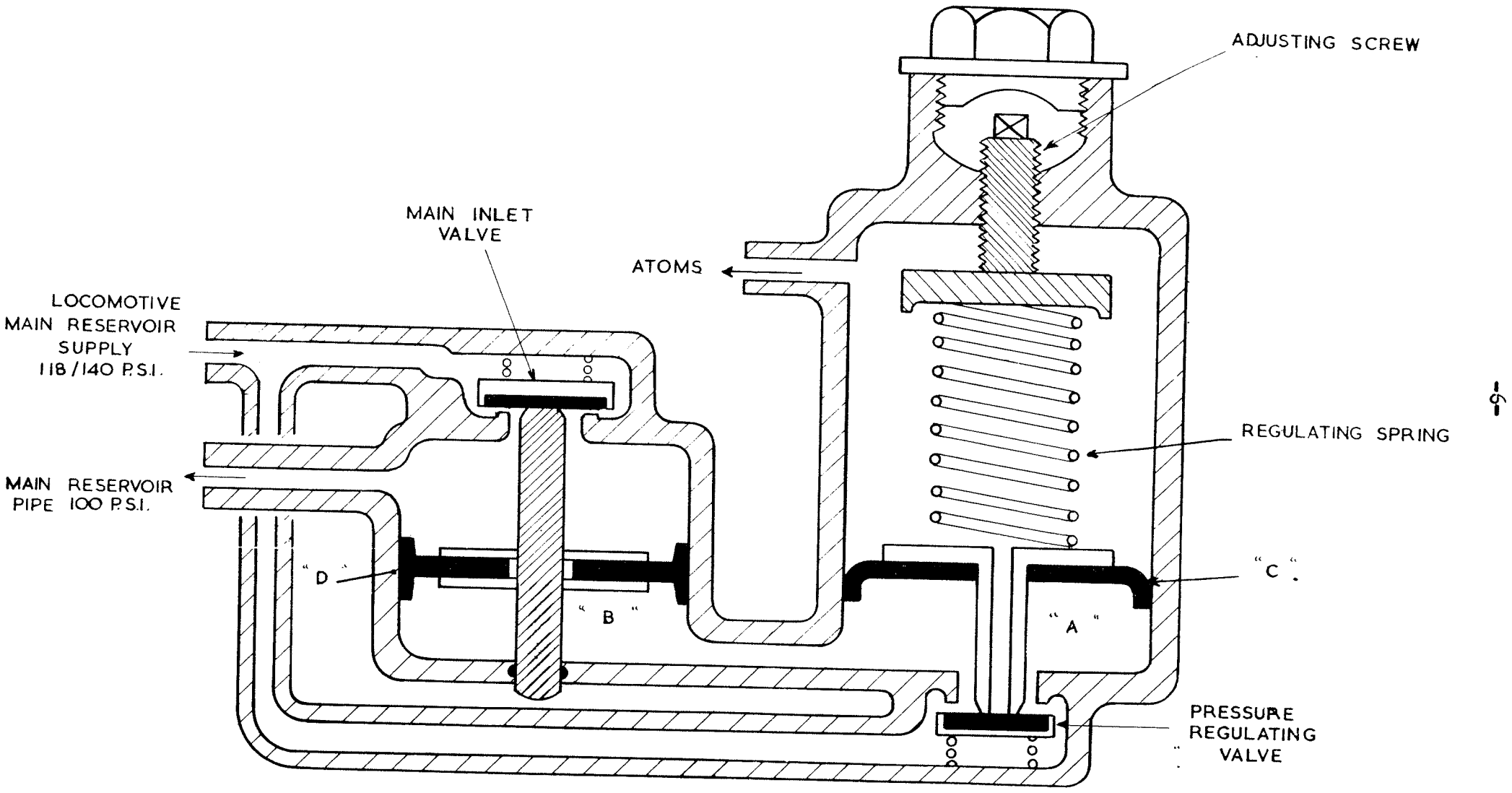
## Modified Arrangement Main Reservoir Pipe Supply.




This arrangement is fitted to all current Dual Brake conversions, as mentioned on Page 2.

With this arrangement Check Valve 30 replaces the two Check Valves 30 shown on the schematic diagram connected between the Main Reservoir Pipe and Main Reservoir Supply.

Also a Duplex pressure gauge in each cab recording Main Reservoir Supply and Main Reservoir Pipe pressures replaces the single gauge 59.




# PRESSURE CONTROL VALVE F.V.F. 2.

## Auto Air Brake Valve FV4A.

### Construction of Valve.

Referring to the attached diagram, the brake valve may be considered to consist of three main sections.

1. Pressure Regulator is a sensitive valve which responds to movement of the brake valve handle to pass varying pressure signals to the relay valve assembly. The valve incorporates a bleed hole (8) which increases the valve sensitivity since the valve will continually operate to vent to atmosphere any pressure above the brake valve setting. A choke (7) is incorporated into the valve hollow stem valve which gives a controlled rate of brake pipe drop during service brake applications.

2. Relay Valve is capable of handling large volumes of air and responds to pressure signals from the pressure regulator to charge or exhaust air from the air brake pipe. The operation is identical to the conventional relay valve, the response of the equalising diaphragm (21) being controlled through equalisation choke (27).

3. Cam operated valves which are operated by cam profiles fitted to the valve body dependent upon brake valve handle position. A diagram showing operation of the valves is shown opposite and detailed below:

(a) Emergency valve (40) which opens to vent the air brake pipe directly to atmosphere. Open in "Emergency" only.

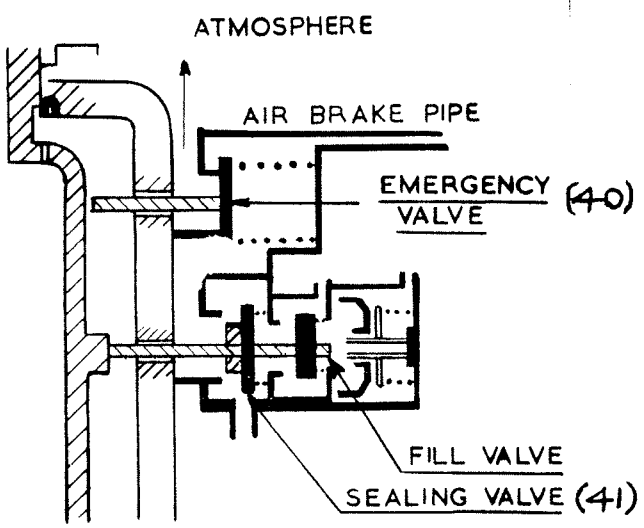
(b) Sealing valve (41) which controls the air flow from the relay valve assembly to the air brake pipe.

(i) Valve closed "Emergency" and "Shut Down".

(ii) Valve partially open "Running". Throttle washer (42) restricts flow of air from the relay valve assembly to the air brake pipe which prevents the brake valve overcoming a Guard's or Passenger brake application or burst hose on an air braked train.

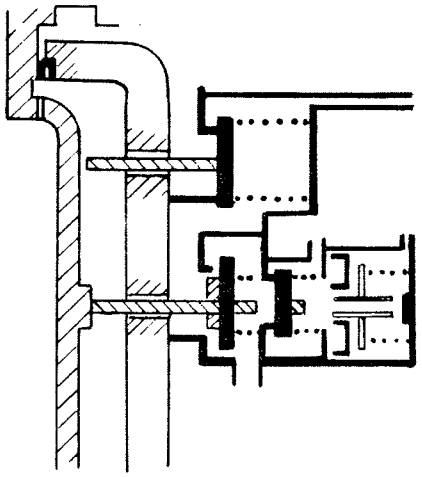
(iii) Valve fully open "Braking". Unrestricted flow from air brake pipe to relay valve assembly.

(iv) Valve fully open "Release". Valve lift greater than in "Braking" causing Fill valve to move off its seat which initiates an air brake pipe overcharge condition. Throttle washer does not restrict flow of air from relay valve assembly to air brake pipe.

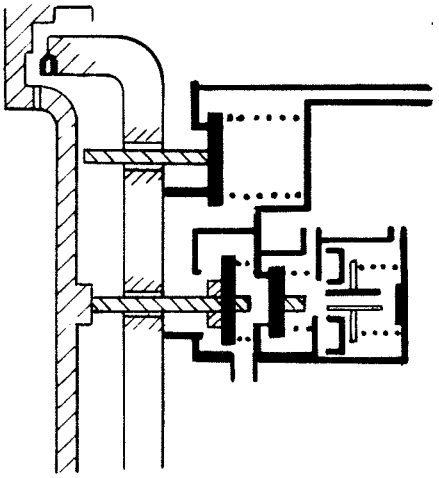



CAM SHAFT VALVE POSITIONS FOR FV4A BRAKE VALVE

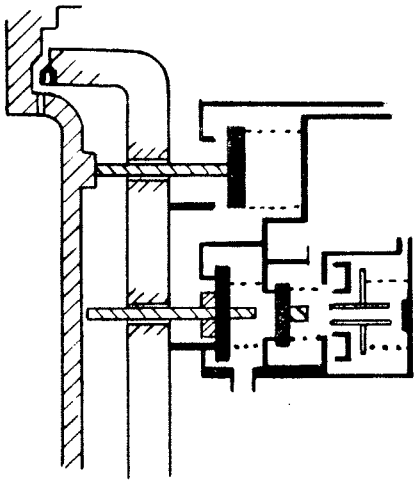
'RELEASE' POSITION



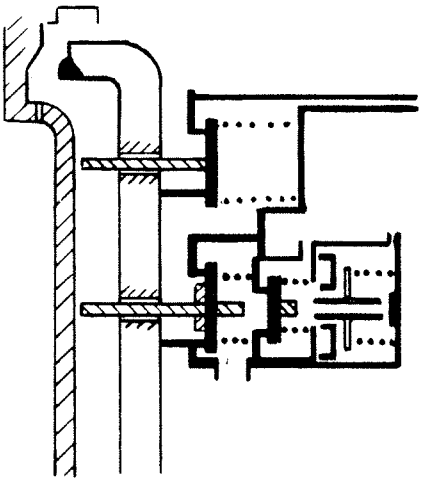
'RUNNING' POSITION



'BRAKING' POSITION



'EMERGENCY' POSITION



'SHUT DOWN POSITION'

Operation of the Valve.

"Running".

When the brake valve handle is placed to the "Running" position the cylindrical camshaft (1) which is rotated by the handle (2) is moved to its lowest position by the action of the spigot (3) moving along an inclined plane in the valve body (5). In this position the control spring (6) is compressed and forces the regulating diaphragm and stem valve (7) downwards until the tip of the stem valve seats on the inlet valve and seals chamber (10) from atmosphere; further downwards movement of the stem valve pushes the inlet valve off its seat allowing air from the main reservoir in chamber (9) to pass to chamber (10) until the pressure acting upwards on the diaphragm equals the downwards force of the control spring, when the return spring below the inlet valve closes the valve. Pressure in (10) is thus regulated to 72.5 lb./sq.in.

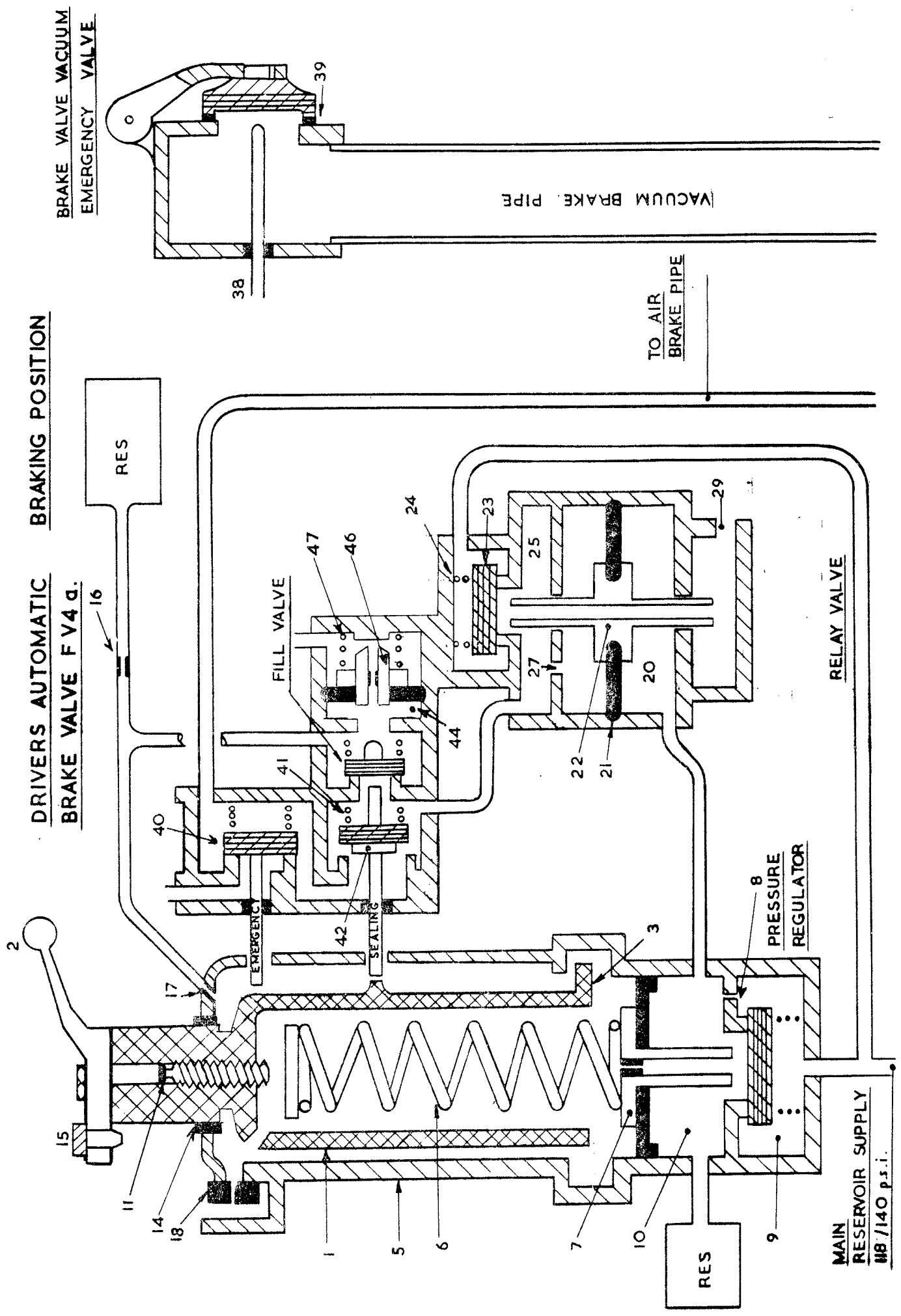
Air at the same pressure as in chamber (10) passes to chamber (20) of the relay valve and acts on the underside of the diaphragm (21) and lifts the stem valve (22) upwards until its tip seats on the underside of the inlet valve (23) and seals chamber (25) from atmosphere. Further upwards movements of the stem valve lift the inlet valve off its seat and allow air from the main reservoir chamber (24) to flow to (25), above the diaphragm (21) and via the sealing valve (41) to the air brake pipe. When pressure in (25) and above diaphragm (21) reaches 72.5 lb./sq.in. the diaphragm will be in a balanced condition and the return spring (24) above the inlet valve closes the valve thus regulating the air brake pipe pressure to 72.5 lb./sq.in.

Braking - "Running" - "Full Service".

When the brake valve handle is moved towards the Full Service position the cam cylinder rotates anti-clockwise. The spigot moving along the inclined plane raises the cam cylinder and thus reduces the compressive force in the control spring (6) according to the degree of movement of the valve handle. The reduction in the downwards force on the diaphragm (7) allows the pressure in chamber (10) to lift the diaphragm until the tip of the stem valve leaves the inlet valve, allowing air in (10) to escape to atmosphere via valve body seal (14) until the pressure in (10) is reduced by an amount to equal the new downwards force in the control spring (6).

The reduction in pressure in chamber (10) is also reflected in chamber (20) of the relay valve, but at this instant pressure in (25) and the air brake pipe is still at 72.5 lb./sq.in. which means that pressure above diaphragm (21) is greater than that below it. This results in the stem valve moving downwards until the tip of the stem leaves the underside of the inlet valve (23) allowing air to escape to atmosphere via (29) until the pressure falls to the new lower pressure in (20) when the stem valve again lifts until its tip seats on the inlet valve.

If it is necessary to partially release a brake application, the brake valve handle is moved toward the running position and the compressive force in the control spring (6) is increased. This results in pressure increasing in chamber (10) and (20) with a resultant increase in pressure in the air brake pipe.


DRIVERS AUTOMATIC BRAKING POSITION
BRAKE VALVE F V4 a.
BRAKE VALVE VACUUM EMERGENCY VALVE
VACUUM BRAKE PIPE
TO AIR BRAKE PIPE
RES
FILL VALVE
RELAY VALVE
PRESSURE REGULATOR
EMERGENCY
SEALING
MAIN RESERVOIR SUPPLY 118/140 p.s.i.
RES
1
2
3
5
6
7
8
9
10
11
14
15
16
17
18
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21
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23
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38
39
40
41
42
44
46
47

"Release".

When the brake valve handle is placed in the "Release" position the movement of the sealing valve (41) will cause the Fill valve to open. This permits air brake pipe pressure at 72.5 lb./sq.in. to pass into chamber (44) which acts on diaphragm assembly (46) to compress spring (47) and seal the hollow stem valve; air pressure also passes via choke (16) to charge up the overcharge reservoir and via choke (17) into the body of the brake valve (5). Air feeding into the brake valve body is vented through choke (18) but because the choke is smaller than choke (17) a pressure will build up in the valve body which acts on the top of the diaphragm assembly (7) which moves downwards. This forces the inlet valve of the pressure regulator to open allowing air pressure to build up in chamber (10). When pressure has increased by 6/7 lb./sq.in. the diaphragm assembly (7) will be in a balanced condition and return to its original position, closing the inlet valve. The increase in pressure in chamber (10) is sensed in chamber (2) of the relay valve, hence air brake pipe pressure will be raised by 6/7 lb./sq.in. to an overcharge condition of approx. 78.5 lb./sq.in.

When the brake valve handle is returned to "Running" the Fill valve will close cutting off the air feed to the brake valve body. The pressure in the valve body will reduce at a controlled rate determined by the discharge to atmosphere through choke (18), the capacity of the overcharge reservoir and the sizes of chokes 16 and 17, consequently the air brake pipe pressure will gradually return to 72.5 lb./sq.in. The time taken for the air brake pipe pressure to fall from 78.5 lb./sq.in. to 72.5 lb./sq.in. is known as the "bleed down" time and is critical for the first 4 lb./sq.in. drop. When the air brake pipe pressure drops to approximately 74 lb./sq.in. insufficient pressure is available to hold diaphragm assembly (46) against its seat thus spring (47) will return the assembly to its normal position. This exposes the assembly hollow stem valve which gives an additional point for pressure in the overcharge reservoir and valve body to escape to atmosphere.

It should be noted that if the brake valve is placed in a braking position whilst in an overcharge condition the brake valve body and overcharge reservoir pressure will vent through the valve body seal (14).

Adjustment of Brake Valve.

The setting of the brake valve in the "Running" position may be carried out by means of adjusting screw (11).

## Air/Vacuum Relay Valve DV2.

### Construction of Valve.

Referring to diagram attached, the air/vacuum relay valve can be considered to consist of two main sections:

(1) A device sensitive to chance in air brake pipe pressure.

(2) A device sensitive to change in vacuum brake pipe.

Considering (1). This consists of a shallow cylinder separated by a diaphragm into two separate chambers (J) and (K).

Chamber (J) is connected to the air brake pipe. When the air brake pipe is charged to a nominal 72.5 lb./sq.in. air pressure in (J) forces the loose inner section of the diaphragm away from its supporting plate to allow air to flow into (K) until this chamber and its associated air reservoir are charged to 72.5 lb./sq.in. The diaphragm is now in a balanced condition.

Next consider that a brake application is made by reducing the air brake pipe pressure, say to 60 lb./sq.in. Pressure in (J) is also reduced to 60 lb./sq.in. but the pressure in (K) at this instant is still 72.5 lb./sq.in. which means that the loose inner section of the diaphragm is forced against the supporting plate, sealing off the holes drilled through to (J). There is now a pressure difference of 12.5 lb./sq.in. acting upwards on the air diaphragm and its supporting plate which is transmitted to central spindle, moving it upwards. At the top of the spindle is the vacuum valve which places the vacuum brake pipe in communication with the atmosphere. Thus by varying the air brake pipe pressure between 72.5 lb./sq.in. and 48.5 lb./sq.in. a varying force is transmitted to the vacuum valve spindle.

Considering (2). This consists of a somewhat larger shallow cylinder separated by a diaphragm into two chambers (M) and (N). Chambers (M) and (L) are common because of the choke in the plate separating them, whilst (L) is integral with the vacuum brake pipe. With the brakes released there will be 21" of vacuum in the vacuum brake pipe and in (L) and (M). Any atmospheric air in (N) will lift the loose inner annular section of the vacuum diaphragm supporting plate and will be drawn through the holes drilled through the plate into (M) until the vacuum in (N) rises to 21". When there is 21" of vacuum in (M) and (N) the vacuum diaphragm will be in a balanced condition.

If the vacuum valve is lifted from its seat, atmospheric air will enter (L), the vacuum brake pipe and chamber (M). Atmospheric pressure acting on the upper side of the vacuum diaphragm forces the loose inner section against the supporting plate, sealing the holes communicating with (N). Thus vacuum will be maintained at approximately 21" in (N). There is now a downwards force transmitted by the vacuum diaphragm to the vacuum valve spindle proportional to the reduction in vacuum brake pipe.

### Operation of Valve.

Considering the air sensitive device (1) in conjunction with the vacuum sensitive device (2) and that the brakes are released, there will be 72.5 lb./sq.in. pressure in the air brake pipe and 21" of vacuum in the vacuum brake pipe. Air pressures being equal in (J) and (K) the air diaphragm will be in a balanced condition; vacuum being equal in (M) and (N), the vacuum diaphragm will also be in a balanced condition. Hence no force is transmitted to the vacuum valve spindle and the return spring above the vacuum valve in (P) holds the valve on its seat.

If a brake application is made by reducing the air brake pipe pressure to say 60 lb./sq.in. a pressure difference of 12.5 lb./sq.in. acts upwards on the air diaphragm and on the vacuum valve spindle which rises and lifts the vacuum valve off its seat. Atmospheric air enters the vacuum brake pipe via (L) and also in (M) where it exerts a downwards force on the vacuum diaphragm. When the downwards force on the vacuum diaphragm equals the upwards force on the air diaphragm the diaphragm will be in a balanced condition and the return spring will close the vacuum valve, this would occur at approximately 11" in the vacuum brake pipe.

If, because of the action of the exhausters, the vacuum brake pipe rises above 11" the downwards force on the vacuum diaphragm will be reduced below that of the upwards force acting on the air diaphragm. The air diaphragm will again lift the vacuum valve off its seat allowing atmospheric air to enter the vacuum brake pipe until vacuum is reduced to 11". Thus the air/vacuum relay valve is self lapping. Thus any reduction in vacuum brake pipe can be obtained and held according to the reduction in air brake pipe pressure simply by moving the FV4 brake valve handle to a position giving the desired reduction in air brake pipe pressure.

A rough guide as to the degree of reduction in vacuum brake pipe to expect when reducing the air brake pipe pressure whilst making a brake application is to allow 1" reduction in vacuum for each 1 lb./sq.in. reduction in air brake pipe pressure between the "Running" and "Full Service" positions of the air brake valve handle.

Incorporated into the valve are the following features:

(a) Emergency Vacuum Valve.

The purpose of this feature is to guard against any failure of the valve to destroy vacuum brake pipe when a brake application is made or if main reservoir pressure is lost.

The vacuum Emergency valve is held open by a spring which is compressed if the air brake pipe pressure is above 40 lb./sq.in. to close the valve. It follows that if air brake pipe pressure falls below 40 lb./sq.in. the vacuum valve will be forced off its seat allowing atmosphere into the vacuum brake pipe.

(b) Pressure Limiting Valve.

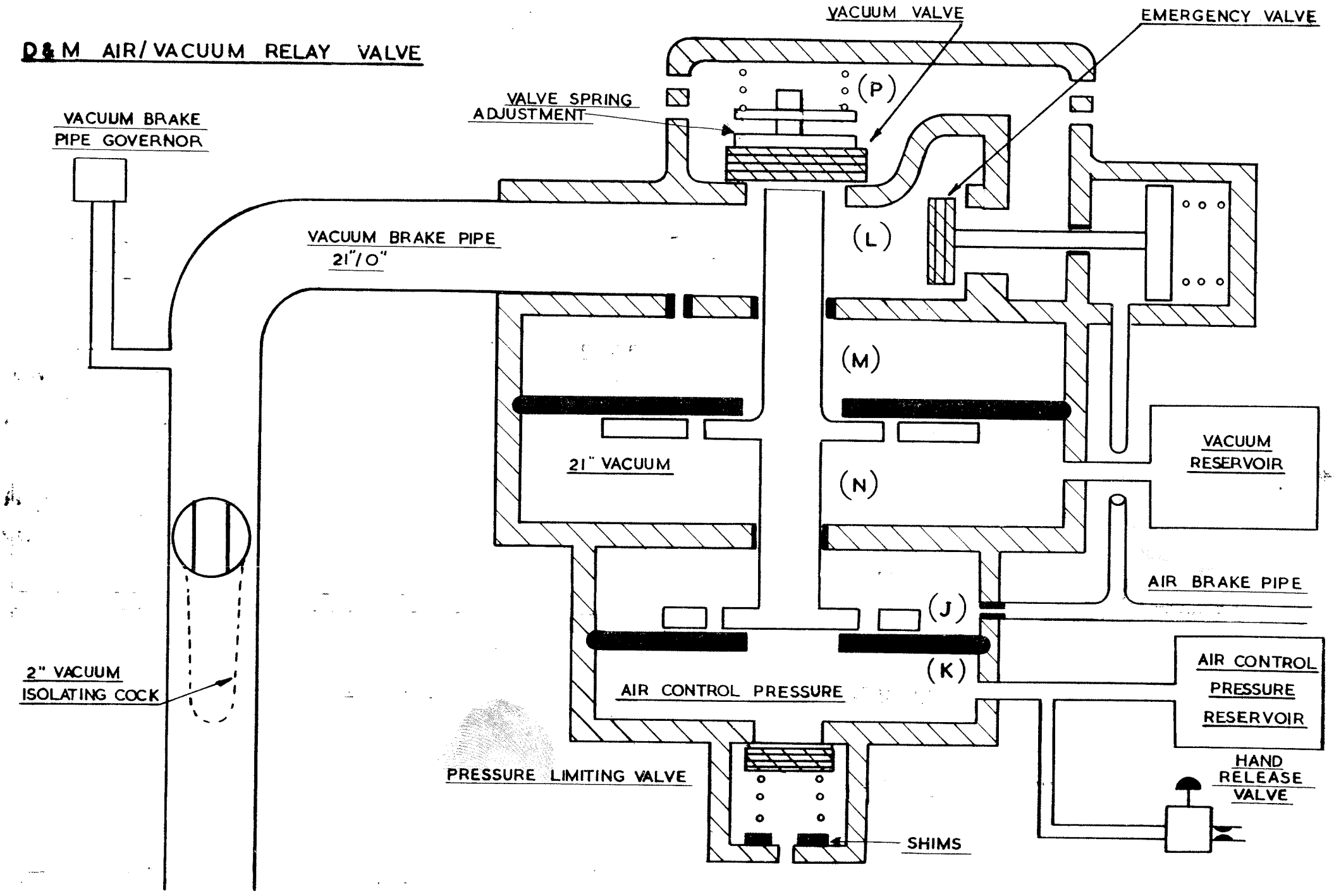
The purpose of this feature is to limit the pressure in the air control chamber (K) of the valve to a nominal 72.5 lb./sq.in. when the FV4 brake valve is placed in the "Release" position and air brake pipe pressure rises to 78.5 lb./sq.in.

The pressure limiting valve is held on its seat by a spring which will compress when the pressure in chamber (K) exceeds 72.5 lb./sq.in. to vent excess pressure to atmosphere. The correct setting of the pressure limiting valve is achieved by inserting shims in between the spring and the body of the valve.

Adjustment of Valve.

To obtain correct air brake pipe/vacuum brake pipe proportionality an adjuster is incorporated into chamber (P) which may be used to vary the compression on the valve return spring.

# D & M AIR/VACUUM RELAY VALVE



## Air/Vacuum Isolating Valve.

### Operation.

Referring t· diagram opposite.

(a) Air Working.

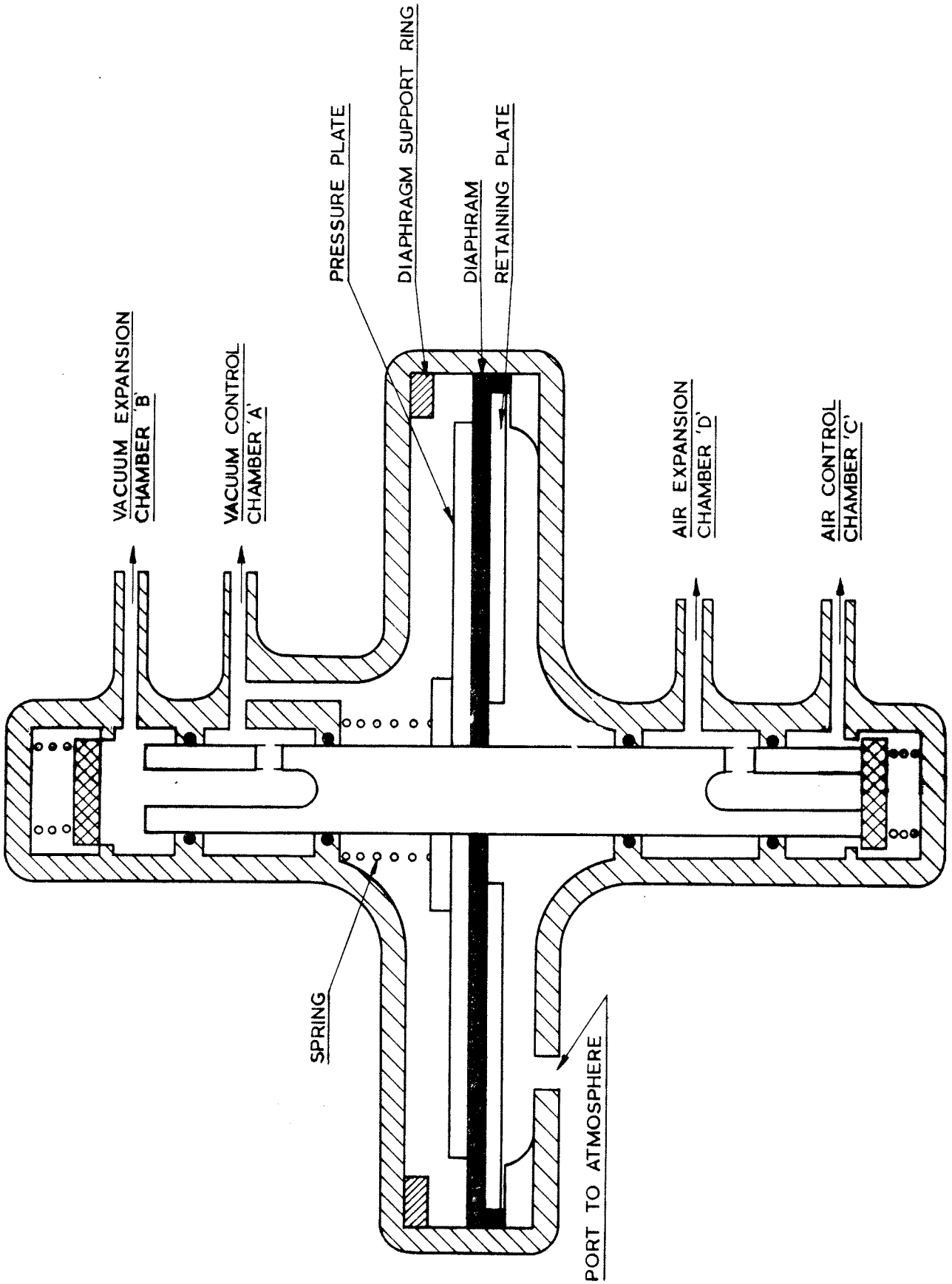
When working air braked trains the brake selector switch will be in either of the "Air" positions. In these positions the exhausters will not run consequently there will be no vacuum in the vacuum brake pipe or in the distributor vacuum control and expansion chambers and hence above the operating diaphragm of the air/vacuum isolating valve.

The spring above the operating diaphragm will force the double hollow stem valve downwards until its lower tip seats on the lower sealing valve which seals distributor air control chamber (C) from the air expansion chamber (D). At the same time the upper tip moves away from the upper sealing valve which connects the distributor vacuum control chamber (B) to the vacuum expansion chamber (A) rendering the distributor vacuum control diaphragm inoperative.

(b) Vacuum Working.

When working vacuum braked trains the brake selector switch will be in either of the "Vacuum" positions. In these positions the exhausters will run creating vacuum in the vacuum brake pipe, in the distributor vacuum control and expansion chambers and above the operating diaphragm of the air/vacuum isolating valve.

With vacuum above the diaphragm atmospheric pressure will force the double hollow stem valve upwards until its upper tip seats on the upper sealing valve which seals the distributor vacuum control chamber (A) from vacuum expansion chamber (B). At the same time the lower tip moves away from the lower sealing valve which connects the distributor air control chamber (C) to the air expansion chamber (D) rendering the distributor air control diaphragm inoperative.




AIR/VACUUM ISOLATING VALVE (AIR POSITION)

Distributor LST.3G/P.

Description.

Referring to the diagram attached, the valve can be considered to consist of six main sections:

(1) A hollow stem valve, balancing diaphragm, anti-slip brake diaphragm and main inlet valve.

(2) An air control diaphragm which separates chambers (C) and (D) and is sensitive to change in air brake pipe pressure when working air braked trains.

(3) The sealing and the maximum pressure limiting valves.

(4) The goods/passenger valve (air brake timings).

(5) A vacuum control diaphragm which separates chambers (A) and (B) and is sensitive to change in vacuum brake pipe when working vacuum braked trains.

(6) The vacuum brake timing electro-magnet valve.

The sections are dealt with in the following notes.

Operation.

It should be appreciated that only the appropriate control diaphragm should be operative according to type of brake system in use on the train. The control diaphragm not applicable to the braking system in use on the train must be maintained in a balanced and non-operative condition. This is achieved by the air/vacuum isolating valve as described previously.

Operation of the Distributor. Air Braked Trains.

From the previous notes the vacuum control diaphragm is in a balanced condition and ineffective.

Air from the air brake pipe is fed to air expansion chamber (D) via the goods/passenger valve and the normally open maximum pressure limiting valve.

At the same time air from the air brake pipe also feeds to air control chamber (C) via the sealing valve and control charging choke.

When pressures in (C) and (D) are at the nominal running pressure of 72.5 lb./sq.in. the air control diaphragm is in a balanced condition.

Consider that a brake application is made by reducing the air brake pipe pressure to 60 lb./sq.in. Pressure in (D) falls to 60 lb./sq.in. but at this instant, because of the restriction offered by the control charging choke, pressure in (C) remains at approximately 72.5 lb./sq.in.

A pressure difference of 12.5 lb./sq.in. is acting on the air control diaphragm lifting it upwards until the tip of the hollow stem valve seats beneath the main inlet valve and then lifts the valve from its seat, allowing air from the main supply to pass into chamber (F) and thence to the auto brake relay valve. At the same time, air feeds from chamber (F) to the sealing valve, forcing the diaphragm and valve down to close the control charging choke. Chamber (C) is thus isolated from the air brake pipe and pressure in (C) is maintained at approximately 72.5 lb./sq.in.

As pressure builds up in chamber (F) it passes through the equalisation choke and acts on the balancing diaphragm in chamber (E). When the force on this diaphragm balances that of the air control diaphragm the inlet valve is closed by the return spring, cutting off the air supply to the auto brake relay valves. Thus any degree of reduction in air brake pipe pressure between 72.5 lb./sq.in. and 48.5 lb./sq.in. will cause a corresponding pressure difference across the air control diaphragm, which in turn will be counterbalanced by the pressure acting on the balancing diaphragm. The distributor is, therefore, self lapping in operation in a similar manner to the usual proportional valve on conventional braked locomotives.

The Maximum Pressure Limiting Valve.

The purpose of this valve is to prevent the maximum locomotive brake cylinder pressure being exceeded should the air brake pipe pressure be reduced to zero, as would be the case during an emergency brake application.

Normally the maximum locomotive brake cylinder pressure is 65/70 lb./sq.in. dependent upon locomotive type, which is obtained when the air brake pipe pressure is reduced to 48.5 lb./sq.in. when a pressure difference of 24 lb./sq.in. acts across the air control diaphragm. If air brake pipe pressure is reduced to zero, then a pressure difference of 72.5 lb./sq.in. would act across the air control diaphragm which would result in the locomotive brake cylinder pressure rising to that of the main supply pressure of 118/140 lb./sq.in.

To prevent this excessive pressure it is necessary to limit the pressure drop in chamber (D) to 48.5 lb./sq.in. when the air brake pipe pressure is reduced to zero. This is achieved by a spring loaded diaphragm and valve contained in the maximum pressure limiting valve which, providing the pressure differential in chambers (C) and (D) does not exceed 24 lb./sq.in., maintains the maximum pressure limiting valve open.

If air brake pipe pressure is reduced to any value below 48.5 lb./sq.in. the pressure differential across the spring loaded diaphragm will exceed 24 lb./sq.in., the spring resistance is overcome, and the diaphragm rises so that the valve closes isolating chamber (D) from the air brake pipe. Pressure in (D) is thus maintained at approximately 48.5 lb./sq.in. during an Emergency brake application.

The Goods/Passenger Valve.

The purpose of this valve is to control the rate at which the locomotive brake is applied when the brake selector switch is in either of the "Air" positions.

If the brake selector switch is in the "Air Passenger" position the Goods/Passenger E.P. valve is energised closed allowing a rapid reduction of pressure in chamber (C) through the Air Passenger application choke when a brake application is made.

If the brake selector switch is in the Air Goods position the Goods/Passenger E.P. valve is de-energised open. If a brake application is initiated, the E.P. valve remains de-energised and open allowing air from chamber (F) to pass to the top of the Goods/Passenger valve diaphragm forcing it and its associated valve to close. The flow of air from chamber (D) is now restricted by the Air Goods application and release choke, hence the rate at which the locomotive brake applies is retarded.

Air Brake Timings.

Below are given typical application and release timings detailing which size of choke controls the timing. For details of identification of individual chokes refer to attached diagram.

| | APPLICATION | | RELEASE | |
|---|---|---|---|---|
| | Choke | Time | Choke | Time |
| AIR PASSENGER | LARGE | 3/5 Secs. | MEDIUM | 9/12 Secs. |
| AIR GOODS | SMALL Over 15 lb./sq.in. B/C pressure. | 20/28 Secs. | SMALL Over 15 lb./sq.in. B/C pressure. | 30/45 Secs. |
| | *LARGE Below 15 lb./sq.in. B/C pressure. | | MEDIUM Below 15 lb./sq.in. B/C pressure. | |

* Inshot Feature

Note: Above timings obtained when brake valve moved from 'RUNNING' to 'EMERGENCY'.

Anti-Slip Brake.

When the anti-slip brake is operated the anti-slip E.P. valve is energised which passes control air pressure under the anti-slip diaphragm causing the valve assembly to operate as for an air or vacuum brake application to give a brake cylinder pressure of 12/15 lb./sq.in.

When the anti-slip E.P. valve is de-energised the chamber beneath the anti-slip diaphragm is connected to atmosphere through the E.P. valve.

Operation of the Distributor - Vacuum Braked Trains.

From the previous notes the air control diaphragm is in a balanced condition and ineffective.

With the exhausters running and vacuum in the vacuum brake pipe, atmospheric air is withdrawn from chamber (A) and (B) via the release valve and choke until 21" of vacuum is created in both chambers and in the vacuum control and expansion reservoirs. In this condition the vacuum control diaphragm is balanced.

When a brake application is made, vacuum is reduced in the vacuum brake pipe and in chamber (A), but is maintained at 21" in chamber (B). There is now a pressure difference acting across the vacuum control diaphragm which is proportional to the reduction of vacuum in chamber (A). The diaphragm lifts the hollow stem valve until its tip seats beneath the inlet valve and then lifts the valve from its seat allowing air from the air supply into chamber (F) and thence to the auto brake relay valve. In the same manner as when the distributor is operating for air braked trains, pressure building up in chamber (F) also acts on the balancing diaphragm in chamber (E). When the force acting on the balancing diaphragm balances the force acting on the vacuum control diaphragm, the main inlet valve is closed by its return spring, cutting off the air supply to the auto brake relay valves.

Thus any degree of reduction in vacuum brake pipe between 21" and 0" will cause a corresponding pressure difference across the vacuum control diaphragm, which in turn will be counterbalanced by the pressure acting on the balancing diaphragm.

The Vacuum Timings. Electro-magnet Valve.

The purpose of this valve is to control the rate at which the locomotive brake applies when the brake selector switch is in either of the "Vacuum" positions.

If the brake selector switch is in the "Vacuum Passenger" position the magnet valve is energised and the solenoid valve will be lifted off its seat. When a brake application is made, atmospheric air entering the vacuum brake pipe passes into chamber (A) through the Passenger and Goods chokes resulting in a rapid destruction of vacuum in that chamber and after a short time delay, the locomotive brakes apply.

If the brake selector switch is in the "Vacuum Goods" position, the magnet valve is de-energised and the solenoid valve remains seated. If vacuum brake pipe is destroyed, atmospheric air enters chamber (A) through the Goods choke only, thus vacuum in this chamber is reduced at a slow rate. Consequently there is a delayed application of the locomotive brakes.

Vacuum Brake Timings.

| | APPLICATION. | RELEASE. |
|---|---|---|
| VACUUM PASSENGER | 5/8 SECS. | 10 SECS. |
| VACUUM GOODS | 25/30 SECS. | 10 SECS. |

Modified Proportionality.

(1) It was found that when working vacuum braked with this distributor when a partial brake application was made the majority of braking load was taken by the locomotive in comparison with the train vehicles. This resulted in a fire risk from locomotive brake block sparks and overheating of locomotive tyres.

To overcome this deficiency a modification was carried out on distributors fitted to locomotives which were fitted with dual brakes 1969 - 71 as follows:-

(a) A spring fitted above the vacuum diaphragm pressure plate making the diaphragm inoperative until vacuum brake pipe falls to 16".

(b) The above modification reduces the maximum brake cylinder pressure in vacuum working, consequently an additional balancing diaphragm with a smaller pressure plate than normal is fitted. In air working the normal pressure plate is used to give the maximum brake cylinder pressure, in vacuum working the smaller pressure plate is used. This is achieved by an additional E.P. valve which is energised open in both "Vacuum" positions of the brake selector switch to pass air pressure between the small and normal pressure plates. This renders the normal pressure plate inoperative and balancing is effected by the smaller pressure plate which gives normal brake cylinder pressure.

A diagram showing the above arrangement is shown opposite.

(2) Experience with the above arrangement has shown that the same effect can be achieved by the following modification:

(a) Spring above vacuum control diaphragm as previously.

(b) Smaller pressure plate balancing diaphragm assembly.

(c) Smaller pressure plate air control diaphragm.

(d) Smaller pressure plate anti-slip brake diaphragm.

Some locomotives converted to dual braking after late 1971 are fitted with the above arrangement and the modification may be made retrospective to other locomotives.

Identification of Distributors.

(a) Conventional Distributor LST.3G/P Type 2.

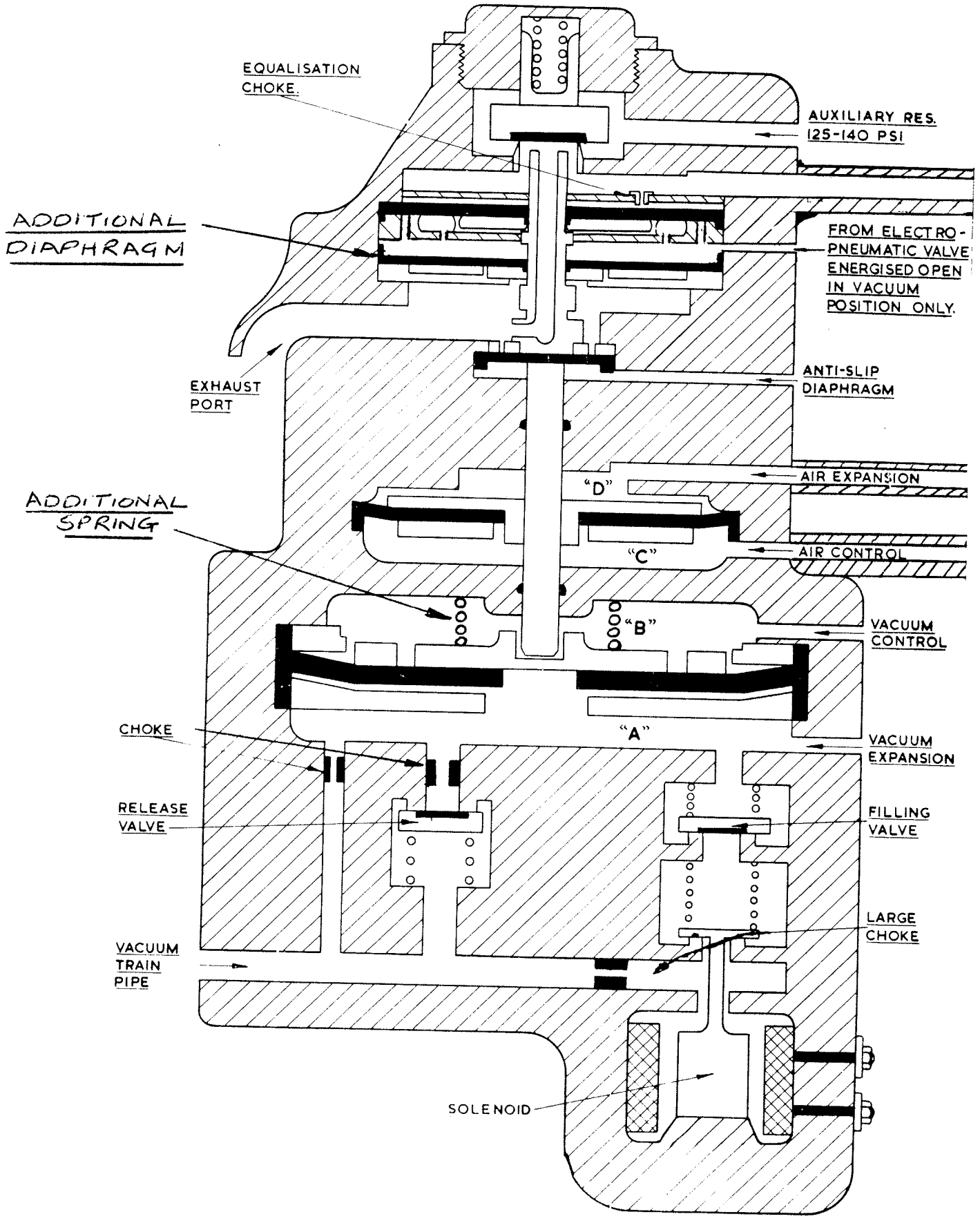
(b) Distributor with E.P. valve modified proportionality LST.3G/P Type 7.

(c) Distributor with altered pressure plates modified proportionality LST.3G/P Type 8.

Note: Distributor (a) can be fitted in place of (b) or (c) Distributors, no modified proportionality.

Distributor (b) can be fitted in place of (a) or (c) Distributors, no modified proportionality. Maximum brake cylinder pressure low in "Vacuum" working.

Distributor (c) can be fitted in place of (a) or (b) Distributors, modified proportionality obtained.




DISTRIBUTOR WITH MODIFIED PROPORTIONALITY.

## A.W.S. and D.S.D. Braking Equipment.

When either A.W.S. or D.S.D. applications take place both the locomotive brake and train air or vacuum brake must apply within a specified time limit. This is done by exhausting the air brake pipe pressure to atmosphere at a controlled rate at the TMV.7 D.S.D. valve. To prevent the air brake valve in the locomotive driving cab feeding air into the air brake pipe, brake valve isolators are provided to shut off the air supply to the air brake pipe during A.W.S. or D.S.D. applications.

### D.S.D. Valve TMV.7.

Referring to diagram opposite, the TMV.7 valve may be considered in two main sections:-

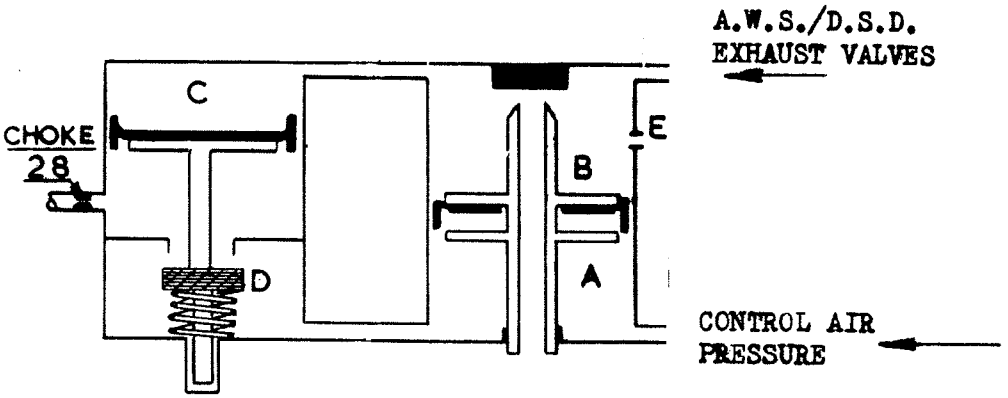
(1) The left hand section, comprising of two chambers (C) and (D). Chamber (D) communicates with the timing reservoir/s and houses a valve, normally held closed by a spring. When this valve is open chamber (D) is connected to atmosphere via choke 28.

Chamber (C) communicates with the air brake pipe through the A.W.S. and D.S.D. exhaust valves and contains a diaphragm attached by a spindle to the valve in (D).

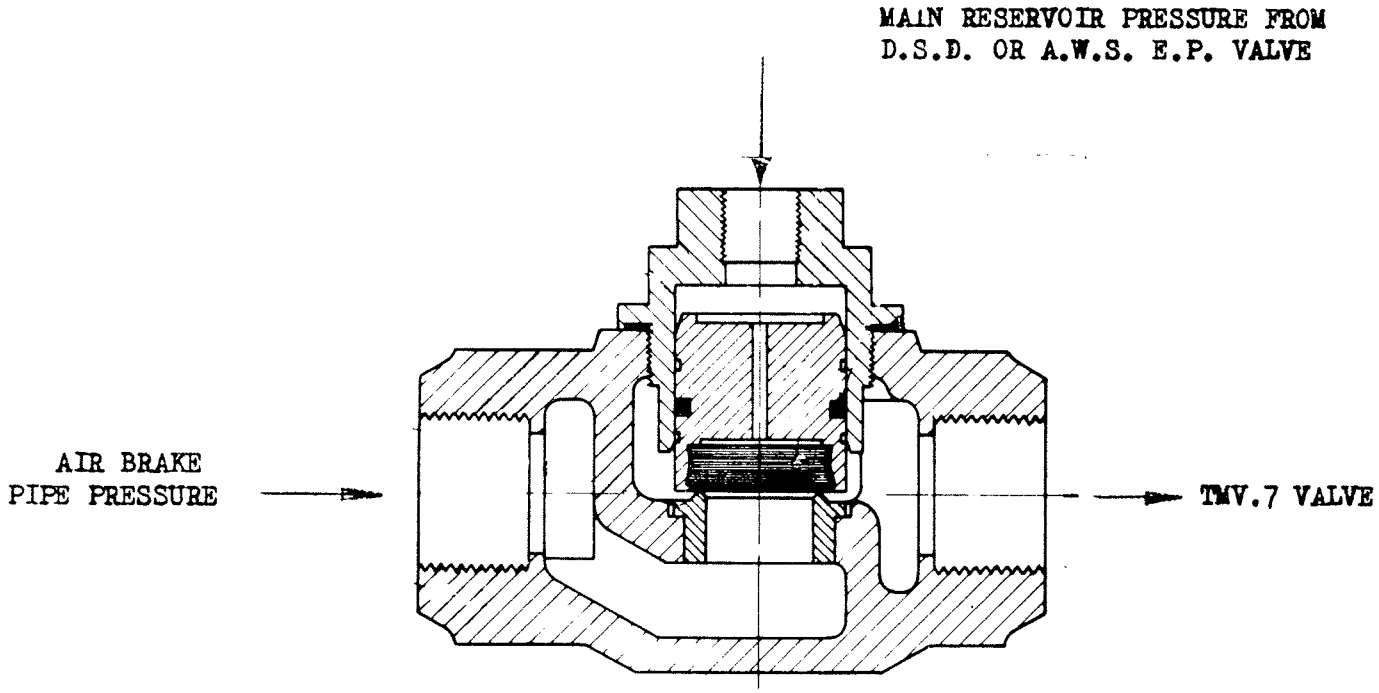
(2) The right hand section comprising of two chambers (A) and (B), which are separated by a diaphragm. The diaphragm is attached to a hollow stem immediately above which is sealing valve. When the stem is away from the sealing valve chamber (B) is in communication with the atmosphere. When the stem is lifted and seats on the sealing valve, chamber (B) is isolated from the atmosphere. A bleed hole (E) is provided in chamber (B) to enable any trapped air in chambers (B) or (C) to escape to atmosphere.

### Exhaust Valves.

As shown opposite, each exhaust valve consists of a plunger type piston subjected to main reservoir pressure on its upper larger area, and to air brake pipe pressure on its lower smaller area. When main reservoir pressure acts on the plunger, it is forced downwards and isolates the air brake pipe connection to the TMV.7 valve. If main reservoir pressure is exhausted from above the plunger, air brake pipe pressure lifts the plunger to its upper position and the air brake pipe is placed in communication with chambers (B) and (C) in the TMV.7 valve.




TMV.7 VALVE




EXHAUST VALVE

## Brake Valve Isolators.

Two brake valve isolators are provided for each air brake valve, one operated by the A.W.S. and the other by the D.S.D. system.

(a) A.W.S. Brake Valve Isolator.

Refer to diagram opposite.

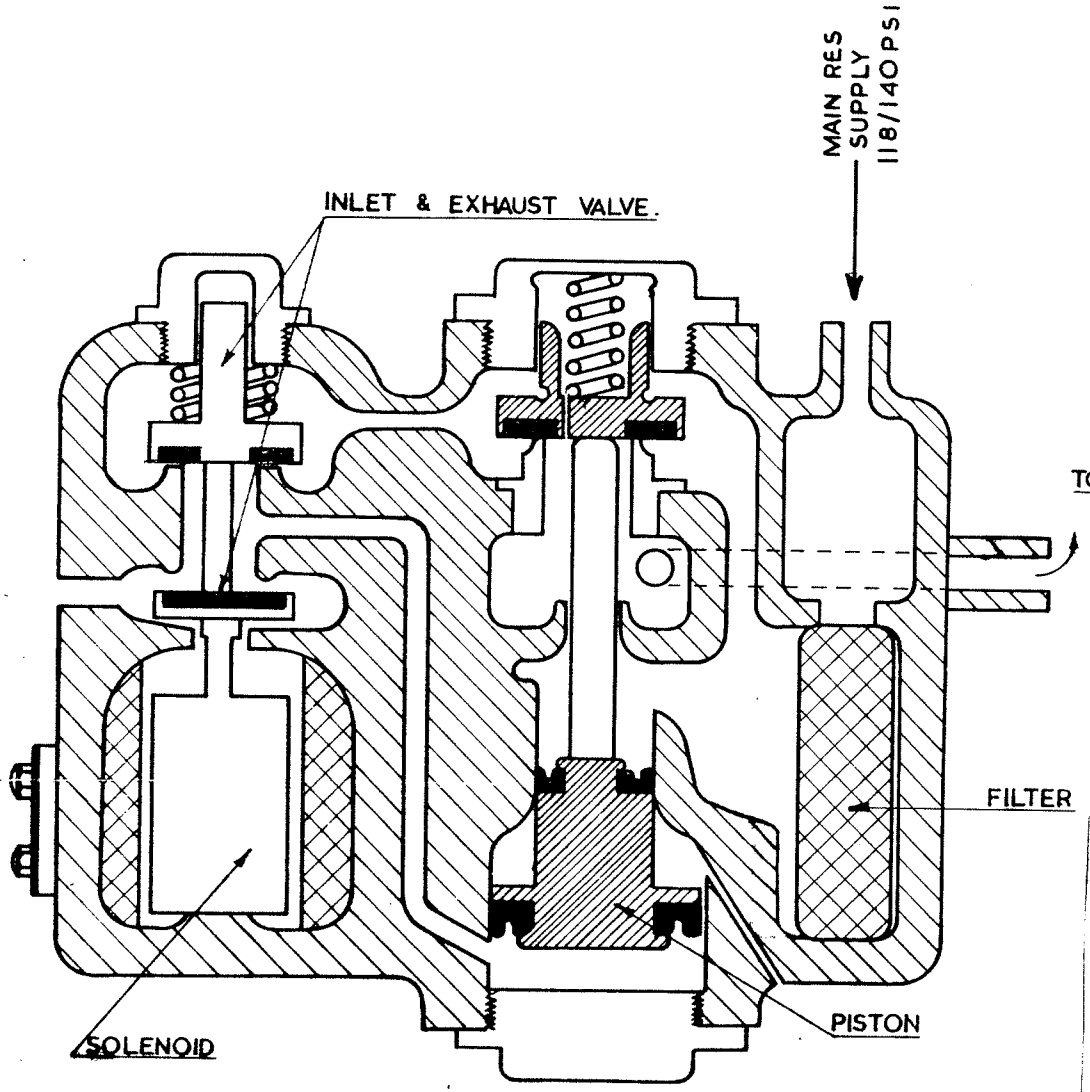
The valve is connected in the supply from the air brake valve to the air brake pipe. When the A.W.S. equipment is in the running condition air pressure from the A.W.S. Baldwin E.P. valve acts under the piston which lifts to open the inlet valve and allows free flow between the air brake valve and air brake pipe. When an A.W.S. application occurs, air from beneath the piston is vented to atmosphere through the A.W.S. Baldwin E.P. valve and the inlet valve closes shutting off the supply to the air brake pipe.

(b) D.S.D. Brake Valve Isolator.

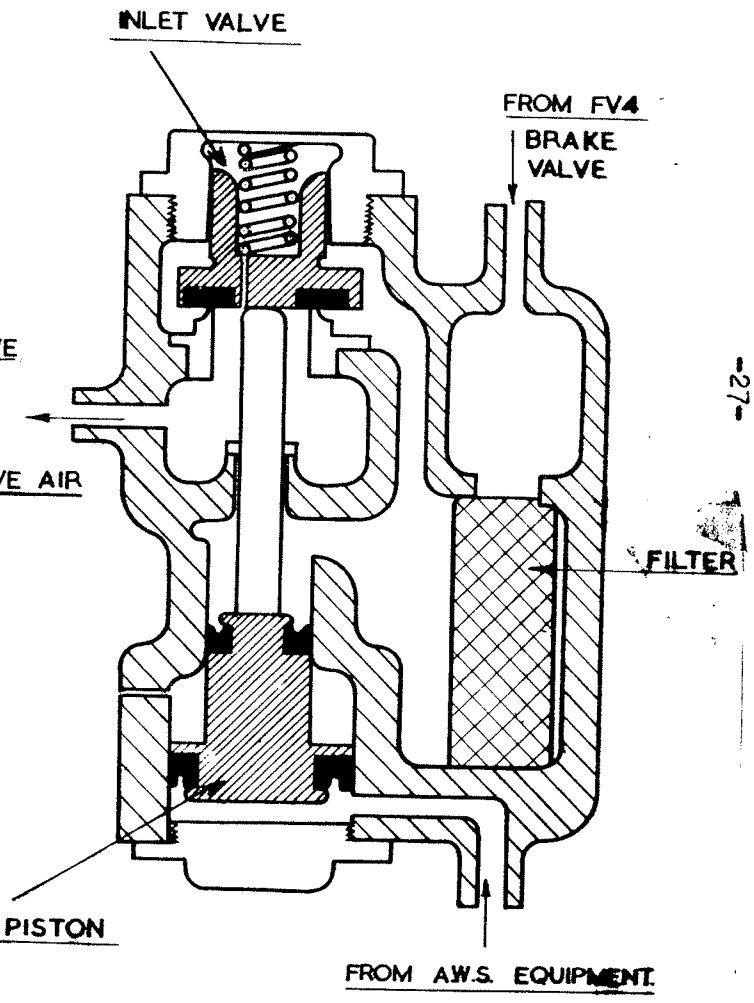
Refer to diagram opposite.

The valve is connected in the supply from the main reservoir to the air brake valve and is electrically operated by a solenoid valve which is electrically connected with the D.S.D. E.P. valve and is energised open by the Driver's D.S.D. pedal or holdover button.

It will be seen that the operation of the isolating section of the valve is identical to the A.W.S. brake valve isolator with the exception that the piston is operated by air pressure from the attached solenoid valve. When the solenoid valve is energised air passes to the piston which opens the inlet valve and when the solenoid is de-energised the air under the piston exhausts to atmosphere and the inlet valve closes, shutting off the supply of air to the brake valve.




D. S. D. BRAKE VALVE ISOLATOR.




A.W.S. BRAKE VALVE ISOLATOR.

## Operation of A.W.S. and D.S.D. Systems.

1. D.S.D. System - Refer to diagram opposite.

When the D.S.D. pedal or holdover button is depressed, the D.S.D. E.P. valve is energised, allowing air at main reservoir pressure to charge the timing reservoir and to close the exhaust valve.

Air from the air brake pipe feeds via an isolating cock to the underside of the exhaust valve but at this instant cannot pass the valve into the connection to the TMV.7 valve.

Air from the control air system feeds into the timing reservoirs F and and chambers (A) and (D) of the TMV.7 valve. In chamber (A) it acts on the underside of the diaphragm of the hollow stem valve lifting the stem upwards until it seats on the underside of the sealing valve.

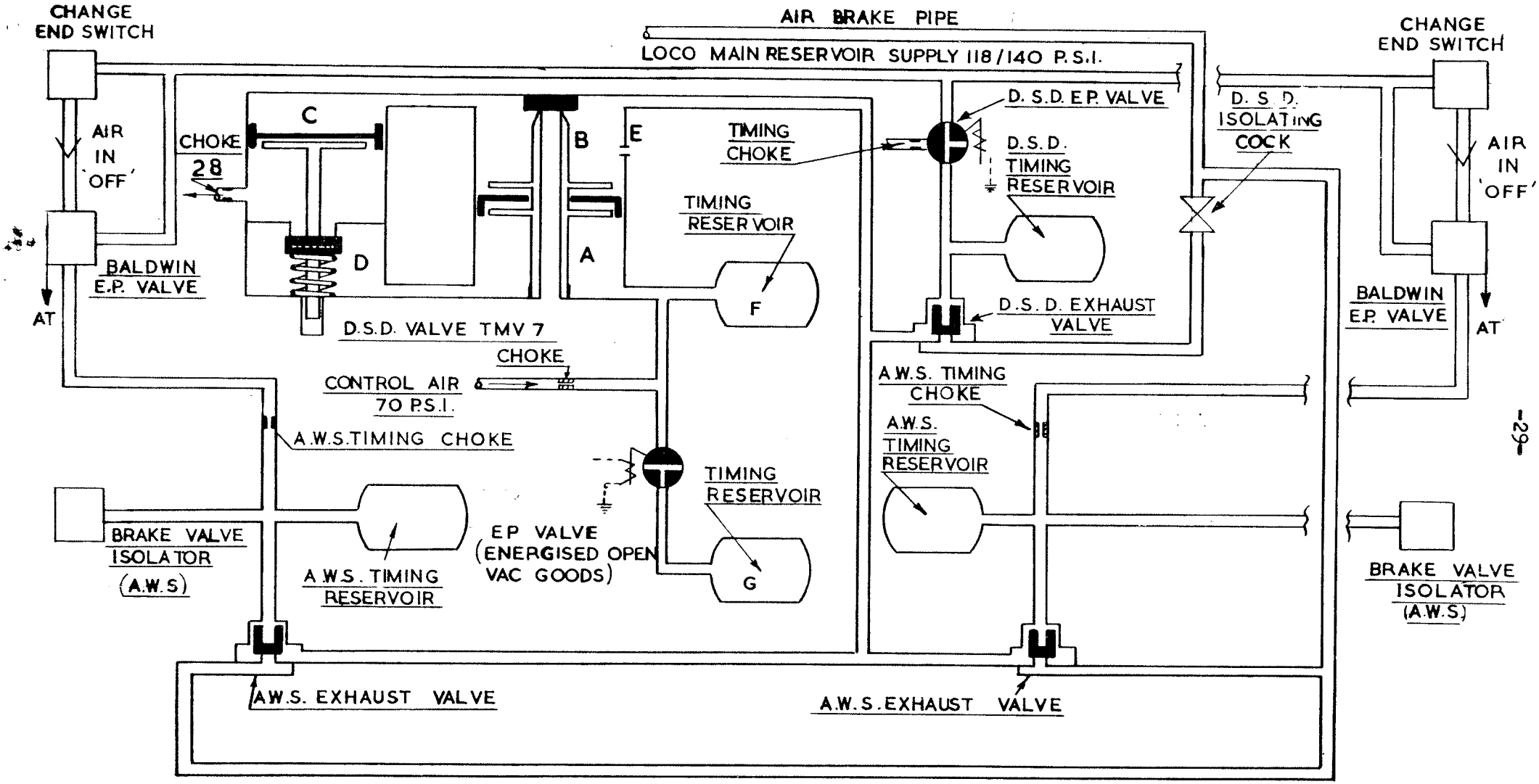
If the D.S.D. pedal is released the D.S.D. brake valve isolator is de-energised and closes and the D.S.D. E.P. valve is de-energised, allowing air in the timing reservoir and above the exhaust valve to escape at a controlled rate to atmosphere. After a delay of approximately 5 - 7 seconds, pressure above the exhaust valve will have fallen sufficiently to allow the air brake pipe pressure to lift the valve to its upper position connecting the air brake pipe to the TMV.7 valve.

Air from the air brake pipe enters the TMV.7 valve chamber (B) but at this instant the hollow stem is seated beneath the sealing valve preventing air brake pipe air escaping to atmosphere. However, air brake pipe pressure acts on the piston in chamber (C) which is pushed downwards and unseats the valve in chamber (D) allowing control air to escape via choke 28. Pressure in chambers (A) and (D) now falls at a rate depending on whether one or both timing reservoirs F and G are connected, and when pressure in chamber (A) falls below that of the air brake pipe pressure acting above the diaphragm in chamber (B), the hollow stem is moved downwards and leaves the underside of the sealing valve thus placing chamber (B) in communication with the atmosphere.

The air brake pipe is vented to atmosphere via the hollow stem and the locomotive and train brakes are applied.

## Low Main Reservoir Pressure Protection.

The low main reservoir pressure governor is electrically connected in circuit with the D.S.D. E.P. valve and brake valve isolators. Thus the D.S.D. cannot be energised if main reservoir pressure has not reached 85 lb./sq.in. and a D.S.D. brake application will occur if the main reservoir pressure falls below 65 lb./sq.in.




A.W.S. & D.S.D. SYSTEM

RUNNING POSITION

2. A.W.S. System - Refer to diagram attached.

One Baldwin E.P. valve, change end switch, timing reservoir, brake valve isolator and exhaust valve is provided for each cab of the locomotive.

Under normal running conditions both Baldwin E.P. valves will be energised, passing main reservoir supply pressure to charge the timing reservoirs, open the brake valve isolators and close the exhaust valves.

If the A.W.S. operates for a 'WARNING' condition both Baldwin E.P. valves will de-energise and the following will occur.

(a) Driving Cab.

The Baldwin E.P. valve admits air to the horn and at the same time exhausts air from the brake valve isolator timing reservoir and the exhaust valve. After a delay of approximately three seconds, pressure above the exhaust valve will have fallen sufficiently to allow the air brake pipe pressure to lift the valve to its upper position. The air brake pipe is now connected to the TMV.7 valve which now functions exactly as for a D.S.D. operation. Also the brake valve isolator will close.

(b) Non-driving Cab.

The change-end switch will be in the 'OFF' position, and air at main reservoir pressure is supplied continually to the timing reservoir and exhaust valve and brake valve isolator. Thus the A.W.S. equipment for this end is inoperative when the Baldwin E.P. valve is de-energised.

A.W.S. and D.S.D. Application Braking Rate.

The rate at which the TMV.7 valve discharges the air brake pipe pressure to atmosphere depends upon the capacity of the timing reservoirs connected to chambers (A) and (D).

Two timing reservoirs are provided; Reservoir F is connected to the TMV.7 valve in all positions of the brake selector switch and a larger reservoir G is connected to the valve through an E.P. valve which is energised open when the brake selector switch is in 'Vacuum Goods'.

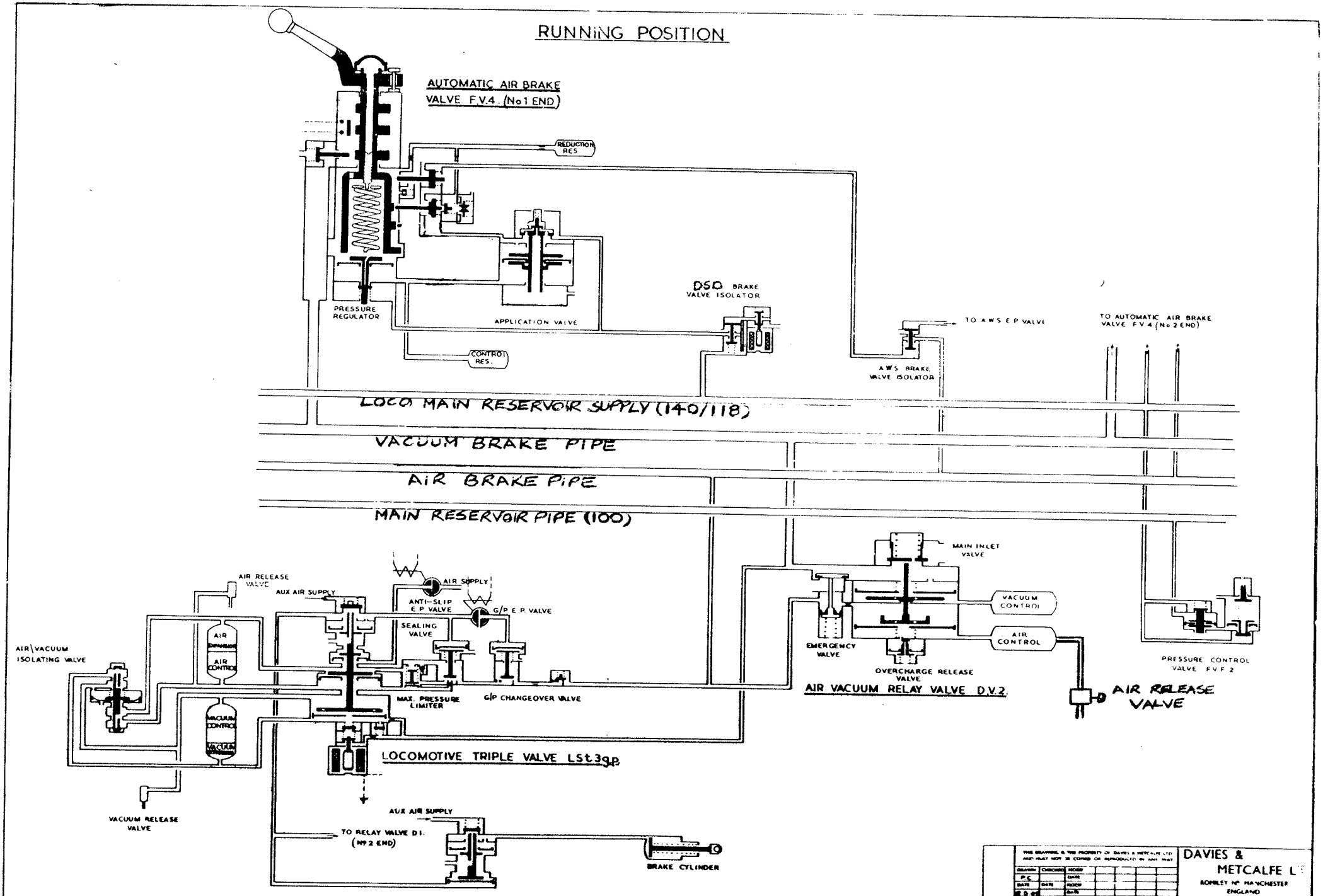
Thus the rate at which the air brake pipe pressure falls in 'Air Passenger', 'Air Goods' and 'Vacuum Passenger' is constant and in 'Vacuum Goods' the rate is much slower.

A.W.S. and D.S.D. Timings.

| Brake Selector Switch Position. | Air Brake Pipe to drop 72.5/48.5 lb/sq.in. | Loco. Brake cylinder pressure to rise 0 - 65 lb./sq.in. |
|---|---|---|
| AIR PASSENGER | 12/15 secs. | 12/15 secs. |
| AIR GOODS | 12/15 secs. | 20/28 secs. * Distributor Timing. |
| VACUUM PASSENGER | 12/15 secs. | 12/15 secs. |
| VACUUM GOODS | 30/40 secs. | 30/40 secs. |

Note: For details of operation of the Baldwin E.P. valve, refer to A.W.S. system notes.

# RUNNING POSITION






| DRAWN | CHECKED | ISSUED |
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TITLE
DIAGRAM OF AUTOMATIC AIR/VACUUM EQUIPMENT

DRAWING No. D 350 – 1

ISSUE No. 1

SUPERSEDES

SCALE

# Davies and Metcalfe Dual Brake

## Air and Brake Schematic Diagram.

### Key to Components.

| Part No. | Component. |
|---|---|
| 1 | Compressor No. 1. |
| 1A | " No. 2. |
| 2 | Air Filter. |
| 3 | Anti-freezer. |
| 4 | Drip Cup. |
| 5 | Check Valve. |
| 6 | Safety Valve. |
| 7 | Main Reservoir. |
| 9 | Drain Cock. |
| 10 | Automatic Drain Valve. |
| 11 | Main Reservoir Isolating Cock. |
| 12 | Drip Cup. |
| 13 | Isolating Cock (Governors). |
| 14 | Compressor Governor. |
| 15 | Main Reservoir Pressure Governor. |
| 16 | Duplex Check Valve. |
| 17 | Driver's Brake Valve (Auto Air) FV4a. |
| 18 | Combined Timing/Control/Reduction Reservoir. |
| 19 | Brake Valve Isolating Cock. |
| 20 | Air Line Sieve. |
| 21 | Loco. Distributor LST3 g/p. |
| 22 | Combined Control & Expansion Reservoir (Air). |
| 23 | " " " " " (Vacuum). |
| 24 | Air/Vacuum Isolating Valve. |
| 25 | Isolating Cock (Air/Vacuum Relay Valve). |
| 26 | Auxiliary Reservoir. |
| 28 | Choke 3/16". |
| 30 | Check Valve. |
| 34 | Relay Valve D1 (Auto Brake). |
| 35 | Vacuum Hose. |
| 36 | Air/Vacuum Relay Valve DV2. |
| 37 | Combined Air/Vacuum Control Reservoir. |
| 38 | Bogie Isolating Cock (Vented). |
| 39 | Bogie Hose. |
| 40 | Double Check Valve. |
| 41 | Vacuum Governor. |
| 42 | Air Brake Pipe Governor. |
| 43 | Direct Air Brake Valve FD1. |
| 47 | Choke 3/16". |
| 49 | Relay Valve D1 (Direct Air Brake). |
| 51 | Duplex Brake Cylinder. |
| 57 | Duplex Air Gauge (Bogie 1/Bogie 2 Brake Cylinder Pressure). |
| 58 | Duplex Vacuum Gauge (V.T.P./V.C.) |
| 59 | Single Air Gauge (Main Reservoir). |
| 60 | Single Air Gauge (Air Brake Pipe). |
| 62 | Vacuum Hose & Coupling. |
| 65 | Exhausters Reavell. |
| 66 | Flexible Hose. |
| 67 | Check Valve. |
| 68 | Air Line Filter & Relief Valve. |
| 69 | Exhauster Choke Valve. |
| 70 | D.S.D. Timing Reservoir. |
| 71 | D.S.D. Exhaust Valve. |

| Part No. | Component. |
|---|---|
| 72 | D.S.D. E.P. Valve EV.4. |
| 73 | D.S.D. Timing Choke (fitted in 72). |
| 74 | Brake Valve Isolator (D.S.D.) |
| 75 | D.S.D. Isolating Cock (Sealed). |
| 76 | Pneumatic Horn. |
| 77 | Duplex Air Valve. |
| 79 | Isolating Cock (Horns & Wipers). |
| 80 | Release Valve (Air). |
| 81 | Release Valve (Vacuum). |
| 82 | G/P E.P. Valve EV.4. |
| 83 | Anti-slip E.P. Valve EV.4. |
| 88 | Isolating Cock (Control Reservoir). |
| 89 | Reducing Check Valve and Strainer. |
| 90 | Control Reservoir. |
| 91 | Isolating Cock (Control Cubicle). |
| 93 | End Cock. |
| 97 | Pressure Control Valve PVF2. |
| 101 | A.W.S./D.S.D. Valve TMV.7. |
| 102 | Timing Reservoir. |
| 103 | Timing Reservoir (Vacuum Goods). |
| 104 | Vacuum Goods E.P. Valve EV.4. |
| 105 | Choke. |
| 106 | A.W.S. Exhaust Valve. |
| 107 | A.W.S. Timing Reservoir. |
| 108 | A.W.S. Timing Choke 7/64". No. 1 End. |
| 109 | A.W.S. Timing Choke $\frac{1}{8}$". No. 2 End. |
| 110 | Brake Valve Isolator (A.W.S.) |
| 111 | Pre-start Governor. |
| 116 | Release Valve and Choke. |