WESTINGHOUSE

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INTERLOCKED ELECTRO-PNEUMATIC BRAKE.

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THE
WESTINGHOUSE BRAKE COMPANY OF AUSTRALASIA
LIMITED,
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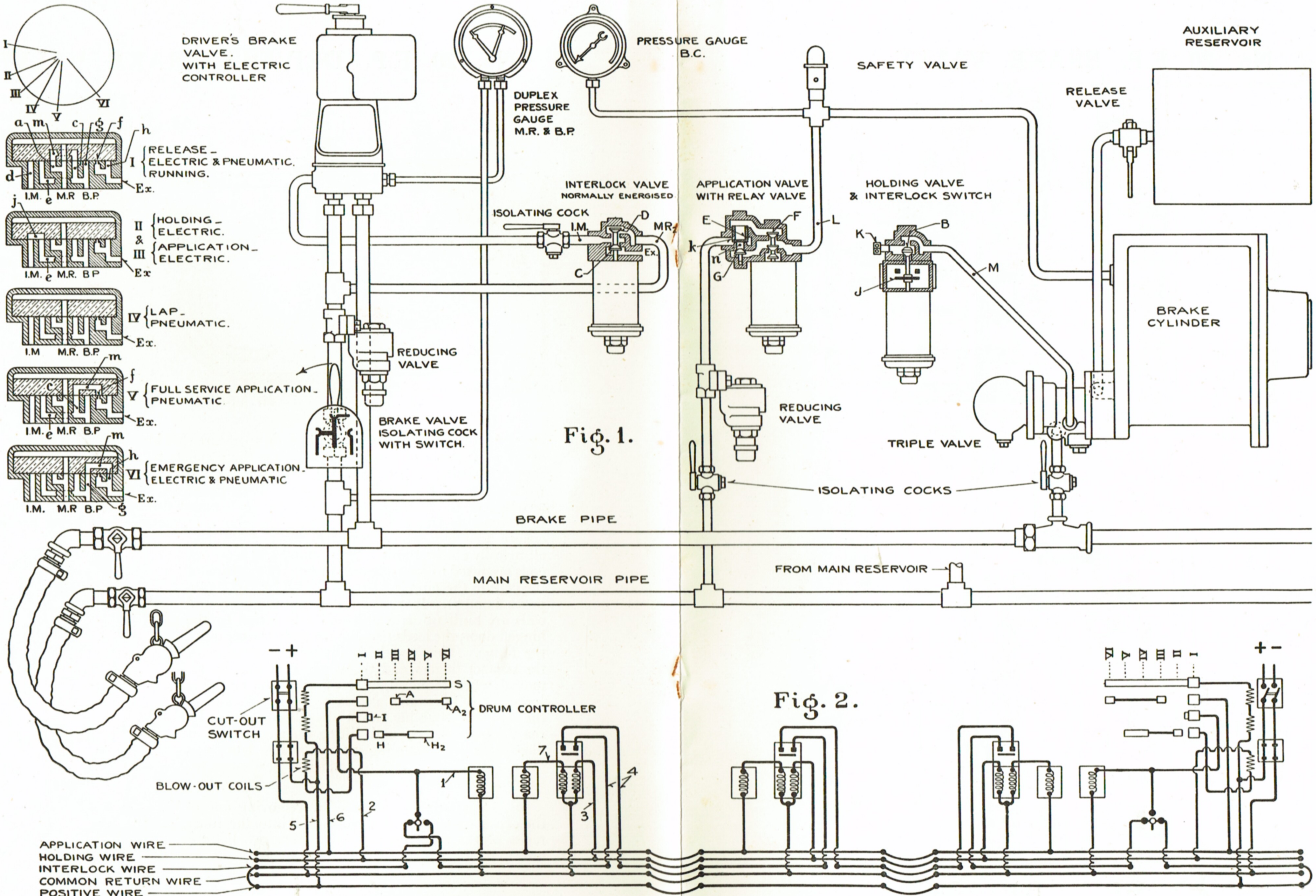

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THE WESTINGHOUSE INTERLOCKED ELECTRO-PNEUMATIC BRAKE.

GENERAL DESCRIPTION.

NOTE.—Before reading, open out Diagram opposite page 4.

The Electric-Pneumatic Brake apparatus consists of the standard Westinghouse pneumatic brake equipment, to which electric features have been added in order to facilitate the rapid and uniform application and release of the brake. Fig. 1 shows in diagrammatic form the principal fittings on a motor car, and Fig. 2 the wiring diagram on a three car train consisting of two motor cars and a trailer car. It will be noted that the motor cars have application, holding, and interlock magnet valves, and the trailer car application and holding magnet valves only.

The operation of the magnet valves is controlled by the manipulation of the driver's brake valve handle, to which a drum controller is coupled, in addition to the pneumatic rotary valve.

Electric applications of the brake are made by admitting main reservoir air direct to the brake cylinder through the relay valve, which is actuated by the application magnet valve.

The release of the brake is controlled by the holding magnet valve which is connected to the triple valve exhaust boss, the air admitted to the brake cylinder during electric applications having free access to the holding valve through the exhaust cavity in the triple valve slide.

The operation of the electric brake is independent of the triple valve, which remains in full release position while the brake is being controlled electrically, the auxiliary reservoir remaining charged.

The function of the interlock valve is to effect a pneumatic application of the brake automatically in the event of a failure of current, or of any portion of the electrical equipment. Its action is dependent on the correct operation of the application and holding magnets when the driver's brake valve handle is in either the " Holding " or the " Application " position (Position II. or III.)

Where main reservoir air is mentioned in this description it should be understood that this is air from the main reservoir, which has been reduced in pressure by the reducing valves below the driver's brake valve and in the branch pipe to the application magnet.

The pneumatic portion of the driver's brake valve is of the non-equalising type, that is, air is vented directly to atmosphere in pneumatic service position, the service port being restricted to give a suitable rate of brake pipe reduction for service stops. In emergency position a large port is opened to give the quickest possible rate of reduction.

The Brake Valve Isolating Cock is provided with a three point switch to establish the correct electrical circuits throughout the train.

OPERATION.

The brake valve isolating cock at the driving end of the train should be in the open position, all other similar cocks on the train in shut position.

All cut out switches on the train should be opened except the one on the operative car which should be closed.

The positions of the Driver's Brake Valve Handle are :—

I.	Release and running.
II.	Holding (electric).
III.	Application (electric).
IV.	Lap (pneumatic).
V.	Service (pneumatic).
VI.	Emergency (electric and pneumatic).

Position I.—Release and Running.

The brake valve handle being removable in the release position, which is also the running position of the operative brake valve, the relative positions of the ports in the rotary valves and seats will be as shown at position I. Air from the reducing valve then enters the operative brake valve at M.R. and flows to the chamber above the rotary valve, and also by way of port (*a*), cavity (*m*) in the valve, and port (*c*) to the brake pipe, which is thus charged to the pressure to which the reducing valve is set, and the brake is in release. The air admitted to the brake pipe also has access to the top of the rotary valves of all of the non-operative valves, but it is cut off from the main reservoir pipes connected to these valves since their isolating cocks are closed. All other ports in the valve are cut off. The only electrical circuits which are closed in this position are those to the interlock magnets, but the magnet at the driving end only is operative, since, although the magnet at the non-operative end is energised, the interlock port IM is blanked by the rotary valve (see port diagram position I.)

Current then flows from the supply contact S on the controller drum to the contact I, thence by way of wire 1 to the coil of the interlock magnet and to the common return wire. The energising of the interlock magnet lifts valve C and closes the outlet of the pipe IM to atmosphere, but at the same time establishes through valve D, communication between the pipes MR2 and IM. No flow of air, however, takes place through these pipes, since ports (*d*) and (*e*) in the Brake Valve are not now connected, but the interlock magnet is in a position to supply air to the brake pipe immediately the brake valve handle is moved away from the release position.

Position II.—Holding (Electric).

On moving the brake valve handle into position II. the direct feed between the main reservoir pipe and the brake pipe through the ports (*a*) (*m*) and (*c*) is cut off, but the feed is still maintained through the interlock valve D, the pipe IM, the cavity (*j*) in the rotary valve, and port (*e*) to the brake pipe. All other ports are cut off. The contact I is opened in this positon, but a circuit is established through contact H and wire 2 to the holding wire. Current therefore flows through wire 3 and the R.H. coil of the holding magnets to the common return wire, and the holding valve B is held to its seat, preventing any flow of air from the triple valve exhaust to atmosphere. The armature stem of this magnet also operates a contact J which completes the circuit through the interlock wires 4, the contacts on the operative brake valve isolating cock, the interlock coil by way of wire 1, and the return wire. The interlock magnet is then energised by current flowing from the cut out switch through wire 5, the positive wire down the train, through the dummy connector at the end of the train, and the contacts on the brake valve isolating cock at the non operative end. The interlock valve is therefore in series with all of the interlock switches on the holding magnets. Should a failure of current occur in any part of the circuit the interlock valve will become de-energised, valve D will seat, cutting off the feed to the brake pipe, and valve C open, permitting air to escape from the brake pipe BP to atmosphere through port (*e*), cavity (*j*) and pipe IM, thereby causing the triple valve to operate and apply the pneumatic brake. The contacts on the drum controller are so arranged that the contact H is picked up before contact I is dropped. This is to prevent a momentary de-energisation of the interlock magnet coil when moving the handle from position I to position II. The brake can be graduated off in small steps by moving the brake valve handle between positions II and I, or fully released by moving it to position I. In moving from position II. the holding magnet becomes de-energised, which permits valve B to drop from its upper seat, allowing the air previously admitted to the brake cylinder to escape to atmosphere through pipe M and exhaust plug K.

Position III.—Application (Electric).

The ports in the rotary valve are in the same relative position as position II., the feed to the brake pipe is therefore the same as in this position. The application contact A is now energised, but contact H de-energised. Current flows through wire 6 to the application wire, thence through the application magnet coil, wire 7, the L.H. coil of the holding magnet, and to the return wire. The holding magnet therefore remains in the same position as in position II. and the interlock circuit is intact. The application magnet valve embodies a relay valve E which controls the admission of air from the main reservoir pipe to the brake cylinder, this relay valve being provided with a small hole (*k*) to permit air to flow to its upper side, and to the top of valve F, which is operated by the armature stem. The latter in its upward movement unseats valve F, permitting the air above the valve E to flow to the brake cylinder through pipe L. This causes valve E to lift, allowing air from the main reservoir pipe to pass to the brake cylinder by way of hole (*n*), check valve G, and pipe L. The brake may be fully applied by moving into position III., or gradually applied by moving to position III. and then back to position II., or may be released as described under Holding (Electric). The reducing valve in the branch pipe from the main reservoir pipe controls the maximum pressure in the brake cylinder obtainable in electric operation, and this pressure should not exceed 60 lbs. per sq. in. It will be noted that the air admitted to the brake cylinder will have access to the pipe M since the triple valve piston is in release position, but the holding magnet being energised, the valve B will prevent this air from passing to exhaust through the exhaust plug K. The purpose of the check valve G is to prevent rapid loss of pressure should a rupture occur in the main reservoir line couplings during a brake application. A slight leak would, however, take place through the small hole (*k*) in the relay valve.

Position IV.—Lap (Pneumatic).

All ports in the rotary valve are cut off. Electrically, the circuits are identical with those described under position II., except that the holding magnet is now energised through the contact H2 instead of H, contact A being broken. The holding magnet and interlock magnet are therefore energised, but a failure of current at this time would not cause any further venting of the brake pipe, as the ports (*d*) and (*e*) in the rotary valve are not now connected.

Position V.—Service (Pneumatic).

In moving to this position the rotary valve establishes communication between the brake pipe BP and the atmosphere, by way of port (*c*), cavity (*m*) in the rotary valve, restricted port (*f*), and thence to exhaust hole Ex. The brake is thus applied by the operation of the triple valve in the usual way. The brake is gradually applied by moving the handle between positions IV. and V. or fully applied by moving to position V. The electric circuits are, in this position, identical with those in position IV. The brake is released by moving into position I.

Position VI.—Emergency (Electric and Pneumatic).

In emergency the brake valve handle should be moved quickly into this position and left there ; this establishes a large direct opening from the brake pipe to atmosphere through the port (*g*) cavity (*m*) in the rotary valve, port (*h*) and hole Ex. The triple valve piston is therefore moved into application position and the brake is fully applied. The application magnet is also energised through contact A2, so that air is also admitted to the brake cylinder electrically as described under position III., the other circuits being as in this position. A slightly higher brake cylinder pressure will be obtained in emergency, due to the additional air admitted electrically.

Isolating Cocks are provided to cut out of operation the application magnet, should this fitting for any reason be defective.

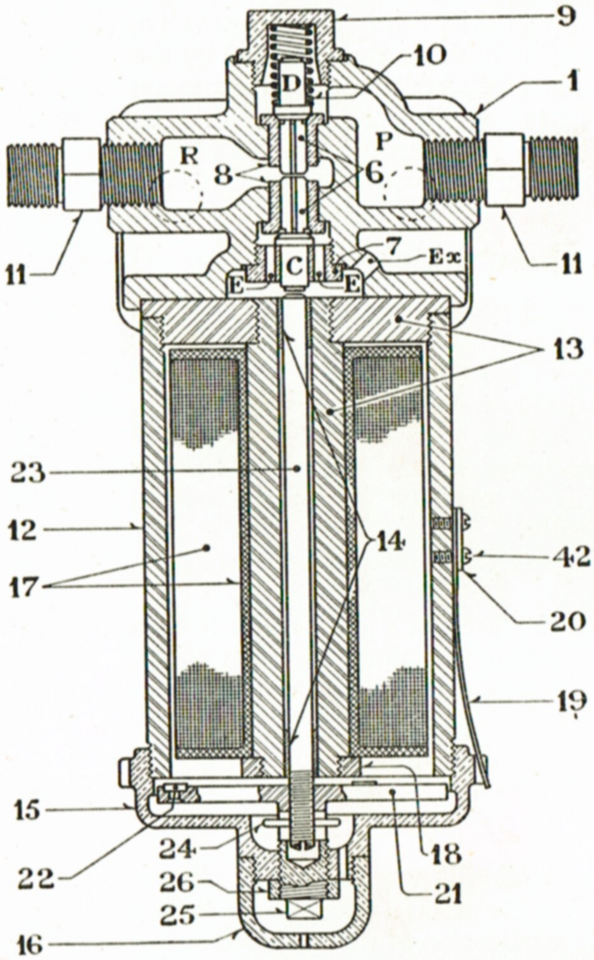
A cock is also fitted in the pipe leading from the brake valve to the interlock valve, so that operation of the interlock feature may be prevented should current not be available on the train, or a circuit become defective during a run. In the latter case the cut-out switch should be opened and the brake valve operated as in an ordinary pneumatic brake.

Changing Ends.

Assuming that the train has been brought to a standstill by means of the electric brake, and that the driver's handle is in either position II. or III., the cut-out switch should first be opened. This will cause a pneumatic application of the brakes through the interlock valve. The brake valve isolating cock should then be closed, after which the brake valve handle should be brought back to release position, where it can be removed. The brake is therefore applied whilst the driver is passing to the other end of the train. On reaching the operative end, the reverse of the above operations should be carried out, release of the brake taking place when the isolating cock is opened.

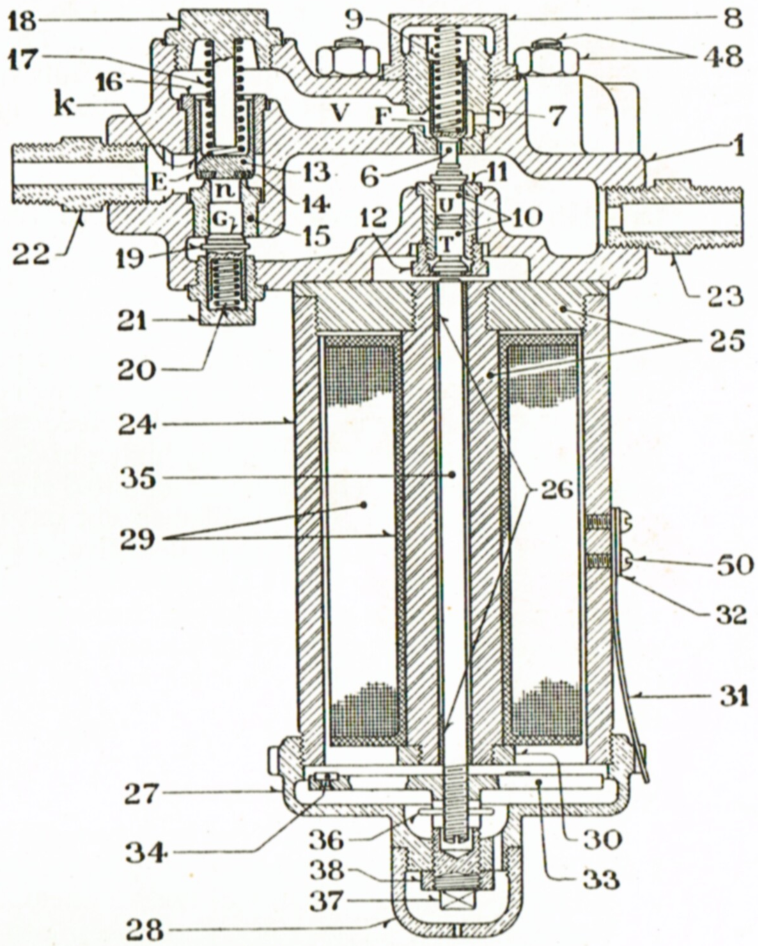
The wiring diagram Fig. 2 is for a low voltage supply. High voltages require the interposition of individual resistances in series with the magnet coils.

INTERLOCK MAGNET VALVE.

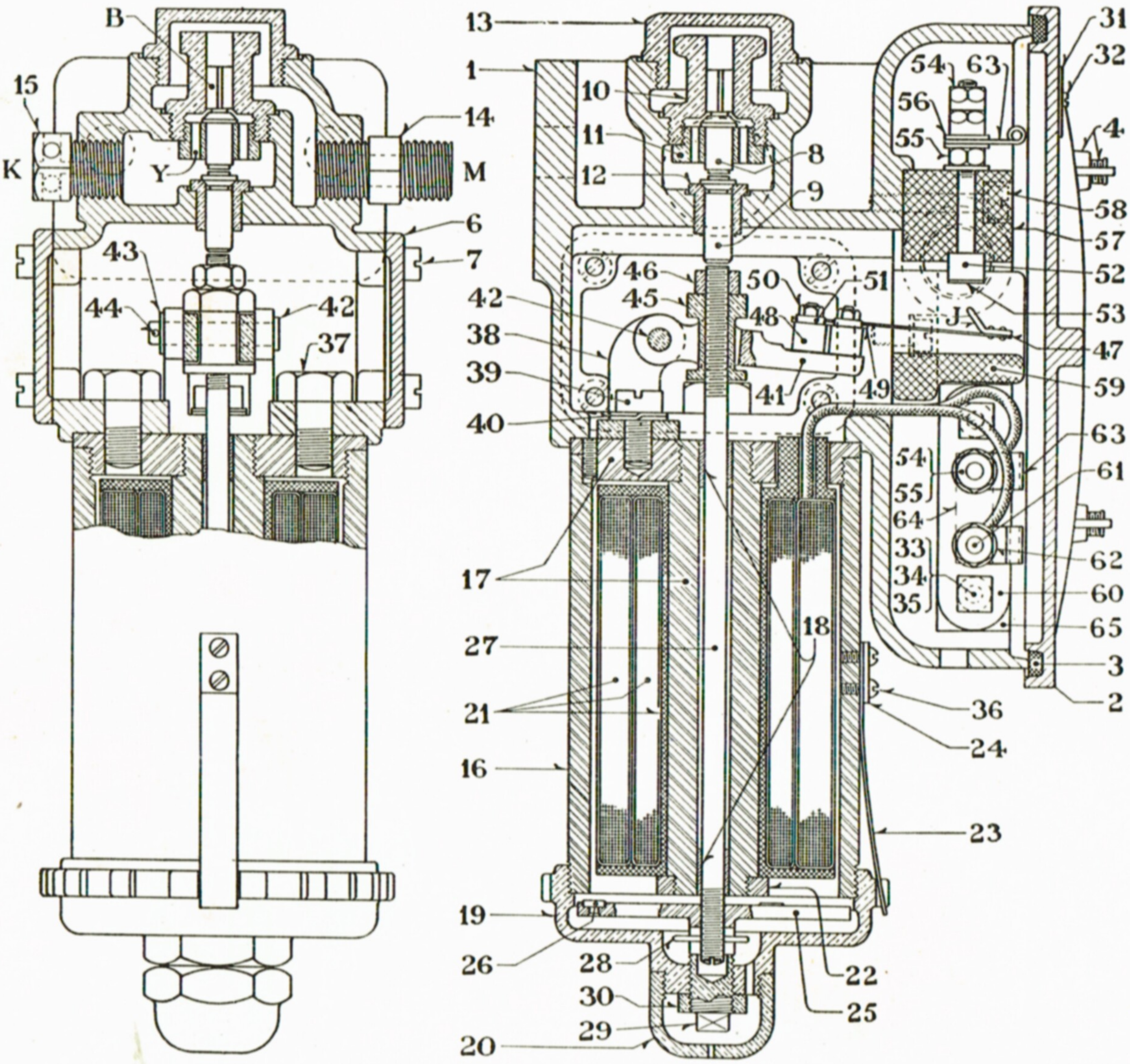


When the magnet is energised, the armature stem 23 is in contact with the exhaust valve C which is held to its upper seat: at the same time valve D is forced off its seat. Air is then free to flow from the main reservoir chamber P, through valve D to chamber R, and thence to the driver's brake valve and the brake pipe. Upon the magnet becoming de-energised the spring 10 assisted by the air pressure in chamber P, will close valve D, cutting off the flow of air to the brake valve. The air in chamber R will force valve C off its seat and escape to the atmosphere through holes E and Ex.

APPLICATION MAGNET VALVE
WITH RELAY VALVE.



When the magnet is de-energised the armature stem 35 will be out of contact with the valve T so that valves U and F are free to seat. Air from the main reservoir pipe, entering at the nipple 22, passes through hole (k) to the top of the relay valve E, which is therefore held to its seat above hole (n). When the magnet is energised, the armature stem 35 lifts valve T to its seat and unseats valves U and F. The air in chamber V is vented to the brake cylinder through valve F and nipple 23, and, since the feed through this valve is quicker than that through the hole (k), valve E will lift, permitting air to flow to the brake cylinder through hole (n) check valve G and nipple 23, which is provided with a restricted hole proportioned to the size of the brake cylinder, the amount of air passing to the brake cylinder depending upon the time that the magnet is energised.



COMBINED HOLDING VALVE AND INTERLOCK SWITCH.

When the magnet is de-energised the armature stem 27 is out of contact with the sealing valve 9 which is then free to drop to its seat, valve B falling off its seat. A free passage is therefore opened up from the triple valve exhaust, connected at M, to the exhaust plug K by way of the valve B and holes Y. The valve 9 is provided to ensure that all of the air from the brake cylinder will pass out through the plug K which regulates the rate of exhaust. In this position the contact arm 41 is at the lower extremity of its travel, and the contact J is broken. When the magnet is energised armature stem 27 will force valve 9 upwards, causing valve B to seat and prevent air passing from the brake cylinder to exhaust. During the upward movement of the armature, the trunnion nut 45, on the armature stem engages with the arm 41, which is carried upwards, causing the contact J to bridge the two contacts 52, thereby completing the interlock circuit. The contact spring 47 is carried by insulating studs 48.

It will be noted that the magnet spool consists of two windings, an inner and an outer coil. The winding is so arranged that energisation of either coil has the effect of operating the magnet valve as described above.

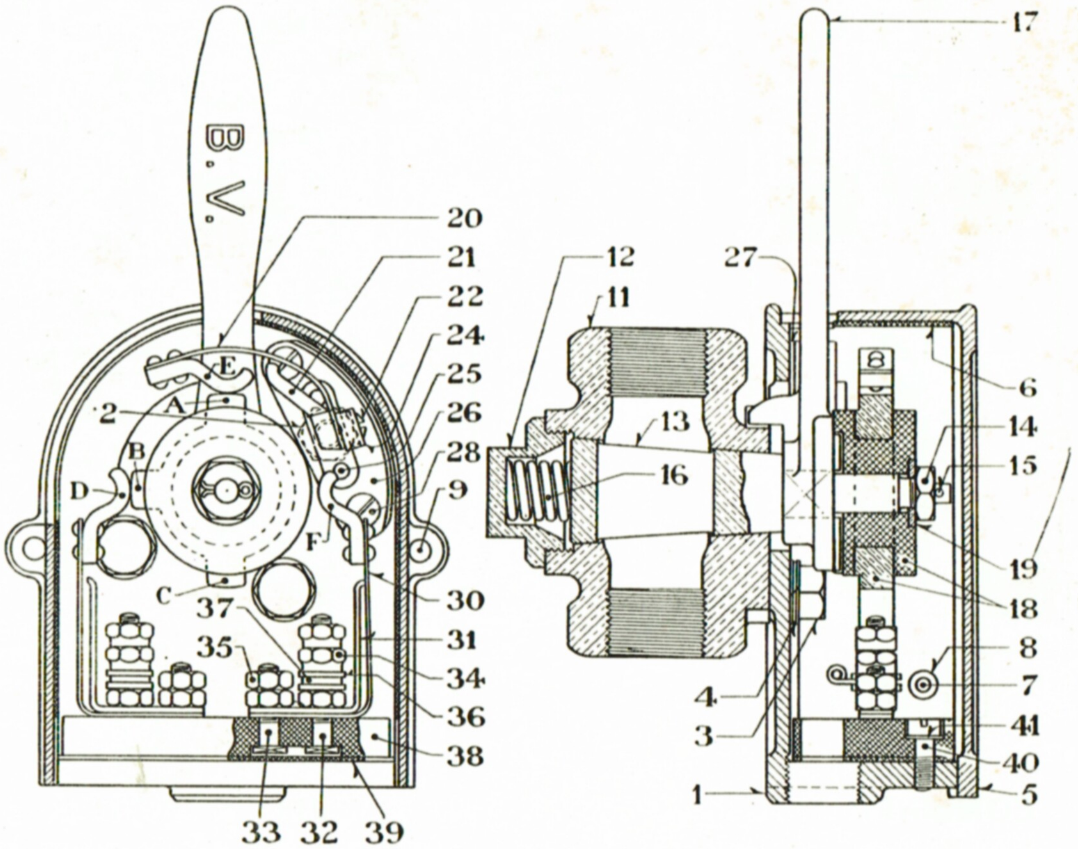
Adjustment of Magnets.

Normally the armature residual pins 26 should be 1/64 in. clear of the bottom of magnet cover 16, when the armature 25 is at the upper extremity of its stroke. The cover 19 being removed, adjustment may be made by revolving the armature on its stem, the armature boss being castellated to receive the locking pin 28.

The screw 29 should then be adjusted to give 1/32 in. clearance between the top of the armature stem 27 and the bottom of valve 9, and then locked by nut 30.

When the magnet is de-energised the break between contact J and the contacts 52 should be $\frac{5}{16}$ in. This can be adjusted by means of trunnion 45.

(The above numbers refer to the Holding Magnet Valve, but the same method of adjustment should be adopted for the Interlock and Application Magnet Valves).



ISOLATING COCK SWITCH.

An extension of the cock plug 13 carries the insulated spider 18 which has three contacts A., B., C. These are arranged to bridge the contact fingers D and E when the cock is in the open position, and the fingers D and F when the cock is closed. The finger springs are fixed to insulating blocks 26 and 38, which also carry the terminals.

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