

June 17, 1924.

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ELECTROPNEUMATIC VALVE

Filed March 20, 1924

3 Sheets-Sheet 1

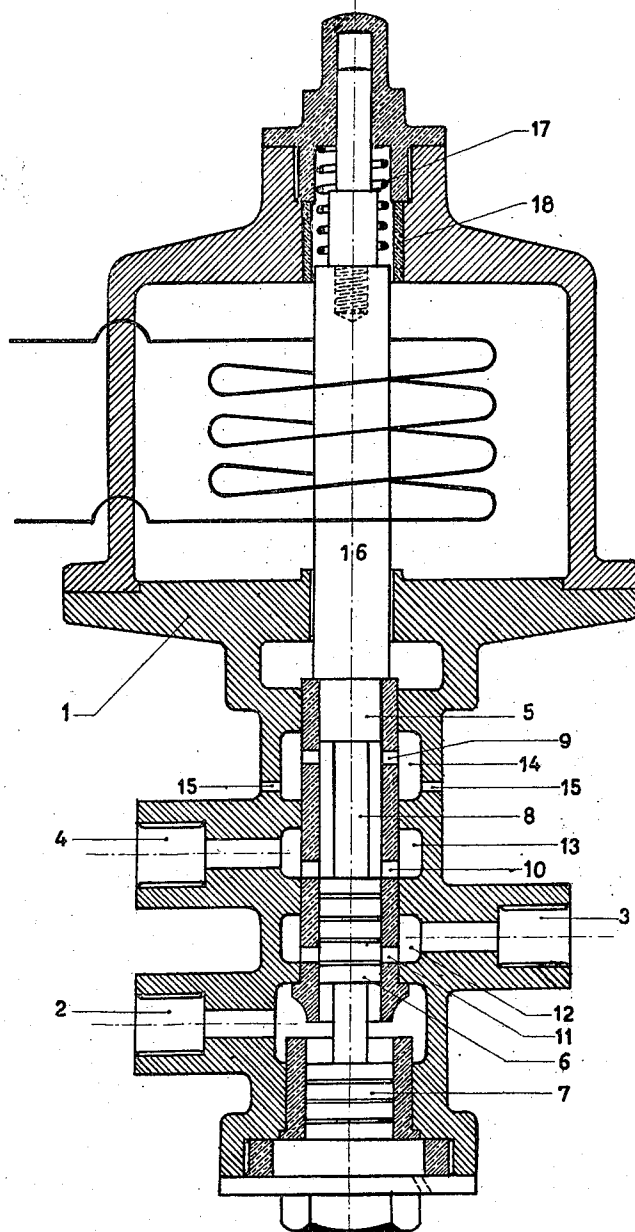


Fig. 1.

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3 Sheets-Sheet 2

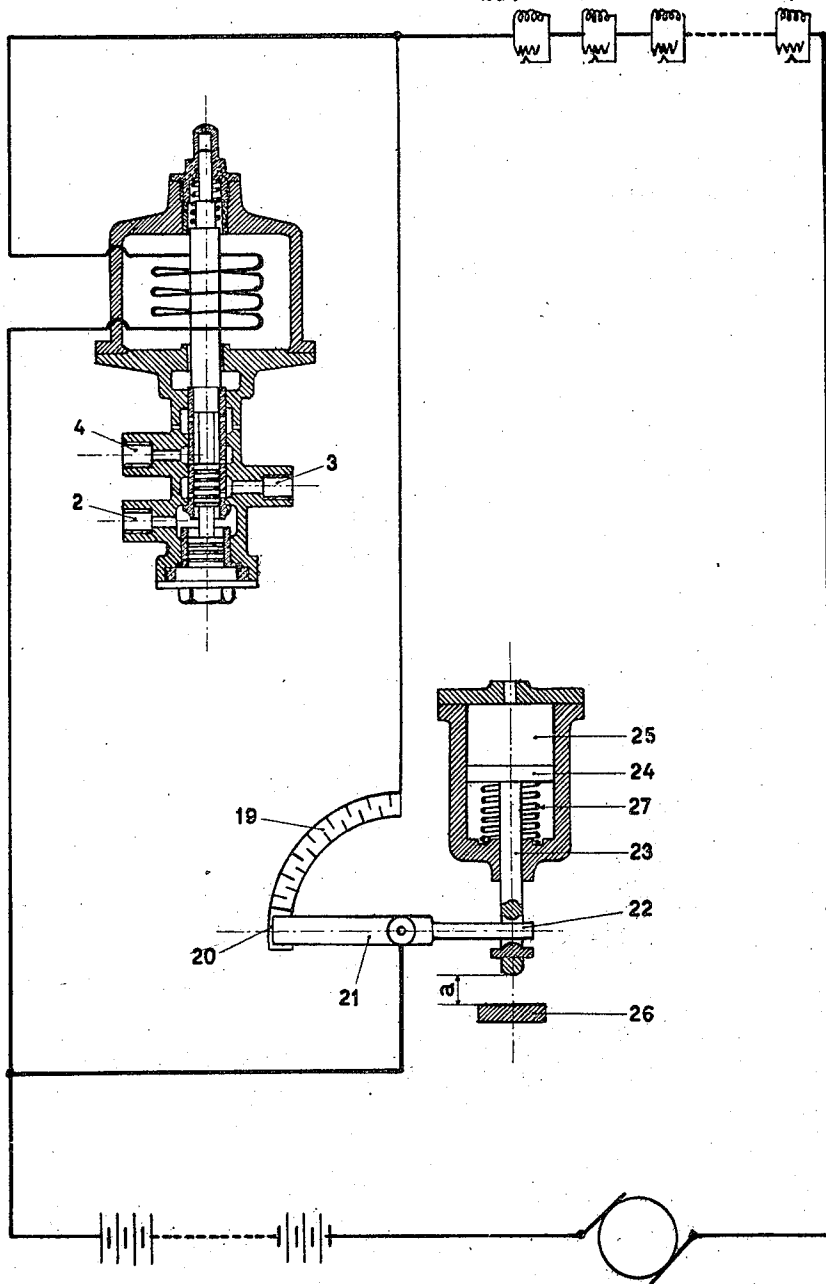


Fig. 2.

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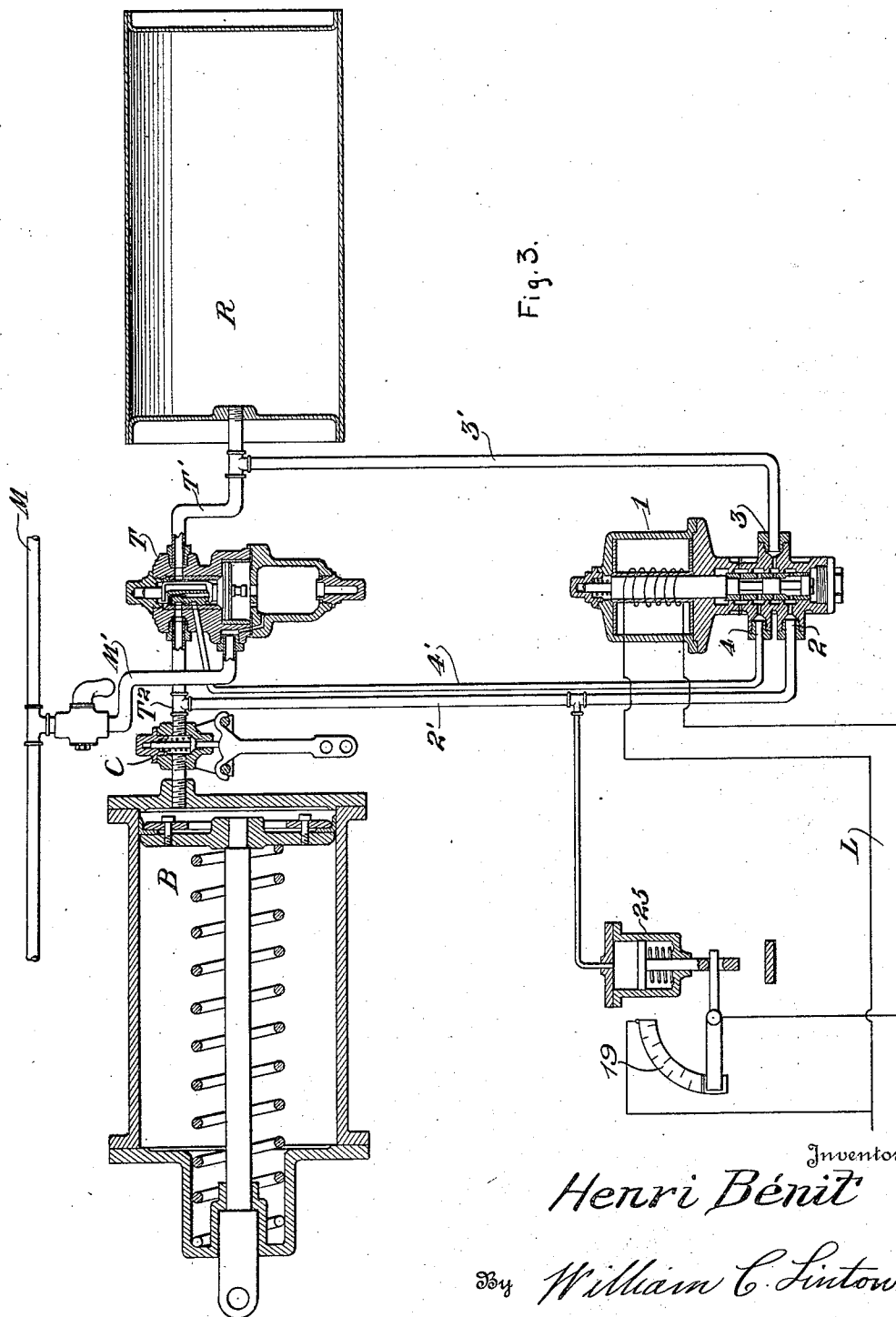
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3 Sheets-Sheet 3



UNITED STATES PATENT OFFICE.

HENRI BÉNIT, OF PARIS, FRANCE.

ELECTROPNEUMATIC VALVE.

Application filed March 20, 1924. Serial No. 700,730.

To all whom it may concern:

Be it known that I, HENRI BÉNIT, a citizen of the French Republic, residing at Paris, France, have invented certain new and useful Improvements in Electropneumatic Valves; and I do hereby declare that the following is a full, clear, concise, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

The present invention relates to an electropneumatic valve for compressed air brakes which permits the fulfillment of certain conditions not completely satisfied by the usual devices.

Hitherto it has been actually difficult if not impossible to brake all cars of a train simultaneously and rapidly and to obtain a certain damping effect both in applying and on releasing the brake which should be present in all braking devices.

The improved construction forming the subject of the present invention satisfies these different requirements fully and in addition affords other not less important features, as for example, uniformity of the braking action on long descents independent of the wear on the brake shoes and proportionately to the loading of the axles.

A further feature of the invention consists in this that the braking action is varied with the speed of traction and as it is proportional to the load of the axle as already stated it follows that the wheels are never locked when the initial adjustment has been properly made.

Other objects of the invention will be in part obvious, and in part pointed out hereinafter.

In order that the invention and its mode of operation may be readily understood by persons skilled in the art, I have in the accompanying illustrative drawings, and in the detailed following description based thereupon, set out one possible embodiment of the same.

In these drawings:—

Figure 1 is a vertical sectional view through the electropneumatic valve embodied in the present invention;

Figure 2 is a diagrammatical view of the electrical circuit in which is included the

electric pneumatic valve and load regulator; and,

Figure 3 is a diagrammatic view of a load regulated car air brake equipment with my invention embodied.

Referring now more particularly to the drawings, wherein like and corresponding parts are designated by similar reference characters throughout the several views, the letter M indicates the main line from which the fluid pressure is supplied having the valved branch line M' which leads to the ordinary "Westinghouse" triple valve T. Communicating with the triple valve are the two branch lines T' and T², one of which leads to the auxiliary reservoir or receiver R and the other to the brake cylinder B. The branch line leading to the brake cylinder has positioned therein a testing or cleaning valve C, all of which are of the usual and well known construction employed in an air brake equipment. The present invention provides an electric pneumatic valve or distributor which comprises a metal housing 1 consisting of a casting and may be provided with a bronze coating. This housing is provided with three branch openings, indicated by the numerals 2, 3, and 4, respectively, of which the branch opening 2 is in communication with the brake cylinder B by means of the pipe line 2'; the opening 3 is in communication with the auxiliary receiver R by means of the pipe line 3'; and, the opening 4 communicates with the outlet of the triple valve T by means of the pipe line 4'.

These branch openings 2, 3, and 4 are in communication with a central bore or valve seat formed within the housing 1 and vertically slidable within this bore are the three pistons or valves 5, 6 and 7 which may be of bronze or any other suitable material. The piston 7 has twice the cross sectional area of the piston 6 which is of the same diameter as the piston 5 and all of these pistons or valves are connected and secured to a rod 8. A cylindrical sleeve is positioned within the central of the housing 1 having the openings 9, 10 and 11 arranged therein, which are in communication with the annular chambers 12, 13 and 14, respectively. The annular chamber 12 is in communication with the

port or branch opening 3, whereas the chamber 13 is in communication with the branch opening 4 and the annular chamber 14 is in communication with a plurality of ports 15 which lead to the atmosphere.

The piston rod 8 is of bronze and is extended upwards by the rod 16 of soft iron which is nickelplated, tinned or coated with copper to prevent rusting. This rod serves as the armature of an electro-magnet of special construction which is described in detail hereinafter and which forms part of the releasing device. The electro-magnet is so arranged that its power of attraction is independent of the movement and depends only on the strength of the current flowing through the coils. On the rod acts a return spring 17 which returns the rod into the position shown in the drawing on interruption of the current. Current is supplied to the electro-magnets by means of the supply circuit L and the current passing there-through is controlled by a switch or brake valve located near the driver of the train. Thanks to the experiments of Picon and Perrot, electro-magnets with a long stroke may be used which satisfy the following equation:—

$$F = 2\pi(ni)^2 \frac{dP}{dx}$$

in which F denotes the force of attraction, ni the number of ampere turns, P the magnetic permeability and x the stroke.

In the present case for a definite value i , F in all positions of the stroke is constant i. e.,

$$\frac{dP}{dx} = \text{constant},$$

a condition which is fulfilled by the present construction shown in the drawing in which there is a constant air gap produced by the thickness of the non-magnetic housing 18 in the upper part of the electro-magnet. The cross-sectional area of the air gap for the lines of force and also the permeability varies in proportion to the stroke so that

$\frac{S}{X}$ and $\frac{P}{X} = \text{constant}$, in consequence of which

$$\frac{dP}{dx} = \text{constant}.$$

In this manner the condition $F = \text{a constant}$ is fulfilled for all points of the path of movement. The braking action is thus alone dependent on the strength of the current flowing through the winding.

All the electro-magnets of a train are disposed in series, the current being returned through a second line preferably through the rails.

As the resistance of the rails varies very much, both conductors are connected at the end of the train with one another being per-

mitted to rub against one another by means of suitable devices.

The *modus operandi* of the distributor valve is as follows:

When the switch or brake valve located near the driver is in driving position, that is, the circuit open so that no current is supplied to the electro-magnet within the distributor valve, the latter will be at rest, or in the position as shown in the drawings. When this valve or controlling switch is closed, current will be supplied to the electro-magnet, whereby the armature is attracted and the piston 6 is caused to move so as to close the ports 10 and open the ports 11 within the distributor housing. As the ports 11 are opened, fluid pressure from the auxiliary reservoir may pass into the brake cylinder, thereby bringing the brakes of the car into operation, in the usual manner. When this port 11 is opened, the compressed air from the auxiliary reservoir passes through the pipe line 3' into the annular chamber 12, then through the port 11 to the opening 2, through the pipe line 2' and subsequently to the branch line T' into the brake cylinder. This passage of air ceases as soon as the pressure in the brake cylinder acting on the piston 7 exceeds the force of the attraction of the electro-magnet, since the piston 7 has twice the cross sectional area of the piston 6. The force of the compressed air upon the piston 7 causes the same to move downwardly, thereby again bringing the piston 6 in alignment with the openings 11, which in turn closes the supply of compressed air from the auxiliary receiver, but still holding the valve 6 over the port 10 to prevent the exhaust of the brake cylinder through the pipe 4' from the exhaust port of the triple valve, that is, this "holding position" retains the air in the brake cylinder until the magnet is deenergized.

All of the cars of the train are braked simultaneously as the braking action is regulated from the switch located in the engine of the train, which switch adjusts the current strength passing through the electro-magnet. As long as the circuit is closed, in which is included the electro-magnet, sufficient compressed air will be supplied to the brake cylinder for applying braking action to the cars of the train and should the cars be loaded or require additional braking action, the electro-magnetic powers of the electro-magnet are increased by supplying additional current thereto, in which case the piston 6 will remain in its lowermost position so that sufficient compressed air may pass into the brake cylinder. It is of course to be understood that the auxiliary receiver of each car contains enough air to supply the brake cylinder of that car, but should the pressure in the main pipe line drop, due to a breakage within the main pipe line, the triple valve

will come into play whereby the compressed air from the auxiliary receiver will be admitted directly to the brake cylinder, thereby applying braking action instantaneously to the car and in such cases of emergency, the distributor valve is not brought into play.

In order to release the brakes of the cars of a train, it is only necessary to open the switch near the driver, as the circuit in which the electro-magnets of the distributor are included will then be broken. When the supply of current to these electro-magnets is discontinued, the compressed air contained in the brake cylinder will exert a force upon the piston 7 and with the aid of the spring 17, this piston, together with the pistons 5 and 6 will move downwardly until the openings 11 are closed and the openings 10 opened, or the normal position thereof is had, as is shown in the drawings, whereby the compressed air to the brake cylinder is discontinued and the air contained within this cylinder may exhaust by passing through the pipe line 4' to the annular chamber 13, then through the openings 10 and 9 to the annular chamber 14 from where the air can freely pass to the atmosphere through the openings 15.

In order to obtain a braking action proportional to the load on the axle as is desired particularly on goods trains where the proportion of the load to be taken by the axles varies within much wider limits than in passenger trains, the arrangement shown diagrammatically in Fig. 2 is employed in each car. In shunt to the winding of the electro-magnet shown in Fig. 1 is arranged a sector 19 of nickel silver which is provided in the manner of shunt circuits usual in ammeters with a number of projecting ribs. The lower end 20 of this sector is completely insulated and indicates the position of greatest current strength and forms the support for a lever 21 insulated and pivoted at the centre of the arc and adapted to move over the sector 19. When the end 22 of the lever rests on a lug 26 connected with the grease box of the car it is clear that the resistance formed by the shunt circuit becomes greater and greater corresponding to the increasing load until at full load the full current passes through the winding. In intermediate positions the resistance is regulated by the position of contact ribs on the arc 19 for each position of the lever and thus also the part of the full current which flows through the winding. With this arrangement, however, rapid wear of the contacts takes place as the lever 21 follows all the movements of the spring supporting the axle. To avoid this disadvantage the end 22 of the lever 21 is connected with the rod 23 of a small piston 24, the cylinder 25, of which is filled with air from the brake cylinder.

On the brake being released a spring 27 raises the piston 24. Only at the moment the brake is applied is the piston 24 forced down by the braking air so that its rod 23 will press against the lug 26 connected with a grease box; the distance apart a varies with the load, the lever 21 assumes a position dependent thereon and regulates the value of the shunt circuit of the winding and thus the intensity of the braking action. The whole apparatus may be enclosed and fitted within a dust-tight casing of cast iron or other suitable material. The necessary connexions for supplying the current to the electro-magnet are not shown in detail as they may be arranged in any suitable way.

By interposing resistances in the supply circuit the intensity of the braking action may be varied. The interposition of this variable resistance weakening the current is effected by the driver according to the indication of an ammeter either graduated according to the current strength or the pressure. The current is supplied by a dynamo driven from the axle and co-operating with a battery of accumulators. Usually the dynamo charges the battery; when the brake is applied it is switched into series with the battery by suitable devices.

As the voltage of the dynamo which raises the voltage of the battery falls off on a fall in speed so the current and thus the intensity of the braking action falls until the moment when the battery alone is supplying current. The condition in the main air pipe line may always be watched by the driver by the provision of known devices.

Although in the foregoing description the preferred application of the invention is disclosed various modifications may be made, as for example, the replacement of the accumulators by a turbo dynamo machine or the employment of an axle dynamo as a means for reducing the constant voltage in a net work or the provision of an independent system in which the voltage is lowered in the consuming circuit by the automatic switching in of resistances or by interposing a speed regulator in the exciting circuit. The resistances interposed in the circuit are of the kind used for damped regulation.

By reason of all the arrangements to which the distributor valve of the present invention may be suited the problem of braking by direct braking may be considered as solved since on rupture of the couplings automatic braking takes place without the arrangement of the brake being any more complicated than in existing brakes.

This distributor valve may be adapted to all kinds of brakes without interfering with its operation even in the case of simultaneous emergency braking from any part of the train, the additional devices being

suitably varied to suit the braking system used without departure from the scope of the invention.

5 Having now particularly described and ascertained the nature of my invention and in what manner the same is to be performed, I declare that what I claim is:—

10 1. An electropneumatic valve for compressed air brakes consisting of a throttle valve acting as a distributor and an electro-magnetic releasing device permitting a simultaneous damped braking action on all the cars of the train both on applying and on releasing the brake, the braking action
15 being independent of the wear of the brake shoes and proportional to the load on the axle and varying or falling off with the speed of traction.

20 2. An electropneumatic valve for compressed air brakes as claimed in claim 1 characterized by an electro-magnet the force of attraction of which is independent of the movement and is dependent only on the strength of the current flowing there-
25 through, the force of attraction serving to release the pressure of the air in the brake cylinder at the moment of actuation of the electropneumatic brake.

30 3. An electropneumatic valve for compressed air brakes as claimed in claim 1 characterized in that the valves of a train are connected in series, the current returning through a second conductor, preferably the rails and connected at the end of
35 the train with the first conductor by a suitable rubbing contact.

4. A pneumatic air brake system for cars having an electro-distributor valve included therein, and a variable resistance coil in shunt with said valve, varying with the
40 weight placed upon a shaft of the car whereby the current to said electro-distributor valve may be controlled.

5. An air brake system having an electro-distributor valve included therein, a vari-
45 able resistance coil electrically connected to said electro-distributor valve for controlling the supply of current thereto, and said variable resistance coil being brought into operation only at the moment the brakes of
50 the system are applied.

6. An arrangement of the electropneumatic valve in a circuit consisting of a battery and a dynamo for charging the bat-
55 tery driven by the axle characterized by this that the voltage of the supply current falls off with the speed until it reaches a minimum limit when the battery alone supplies the current.

7. An arrangement as claimed in claim
60 6 characterized by this that the battery is replaced by a turbo dynamo machine.

8. An air brake system including a brake cylinder, a triple valve and an auxiliary
65 reservoir, a distributor valve having ports therein, means of communication between said ports and brake cylinder, triple valve and auxiliary reservoir, and variable power actuating means for said distributor valve.

In witness whereof I have hereunto set
70 my hand.

HENRI BENIT.