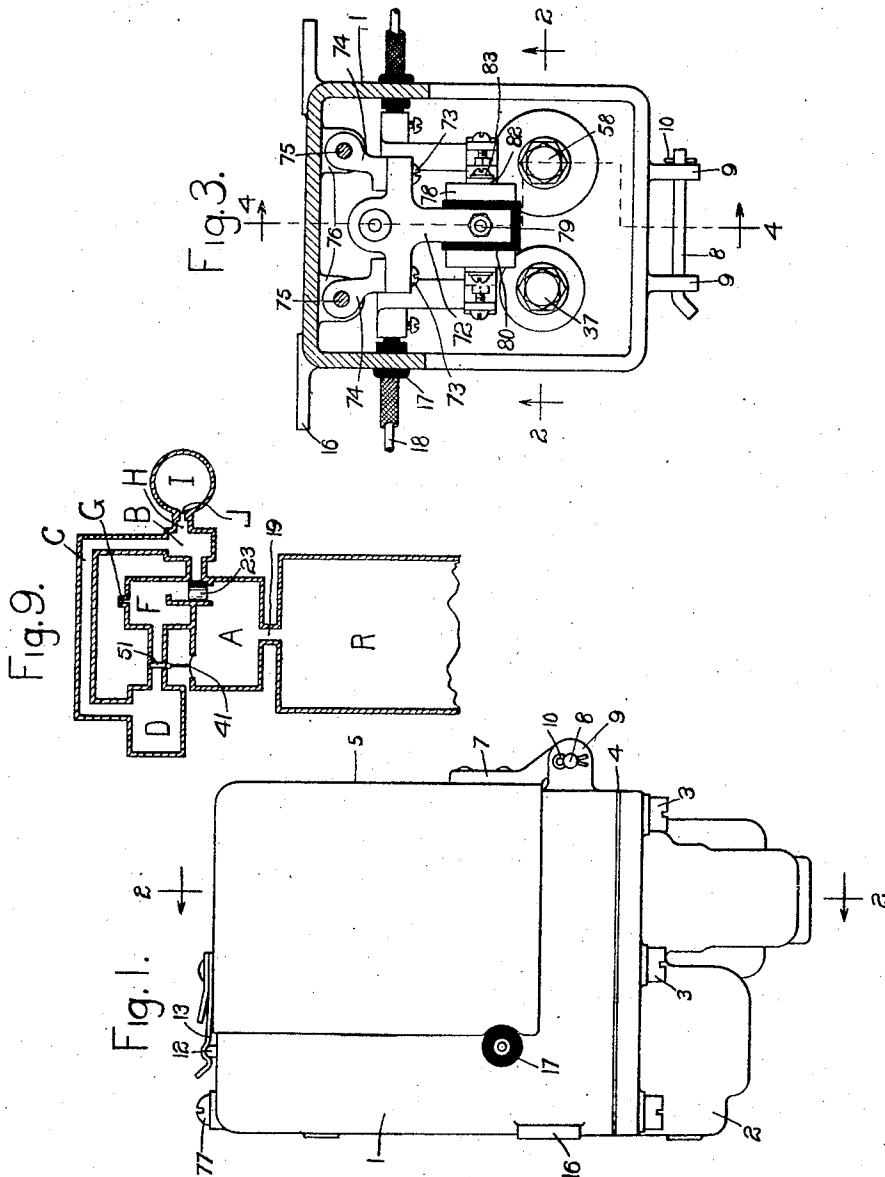


1,065,649.

Patented June 24, 1913.

2 SHEETS—SHEET 1.



Witnesses

George C. Higham.

Frank J. Shuler

Inventor

Burton S. Aikman

By

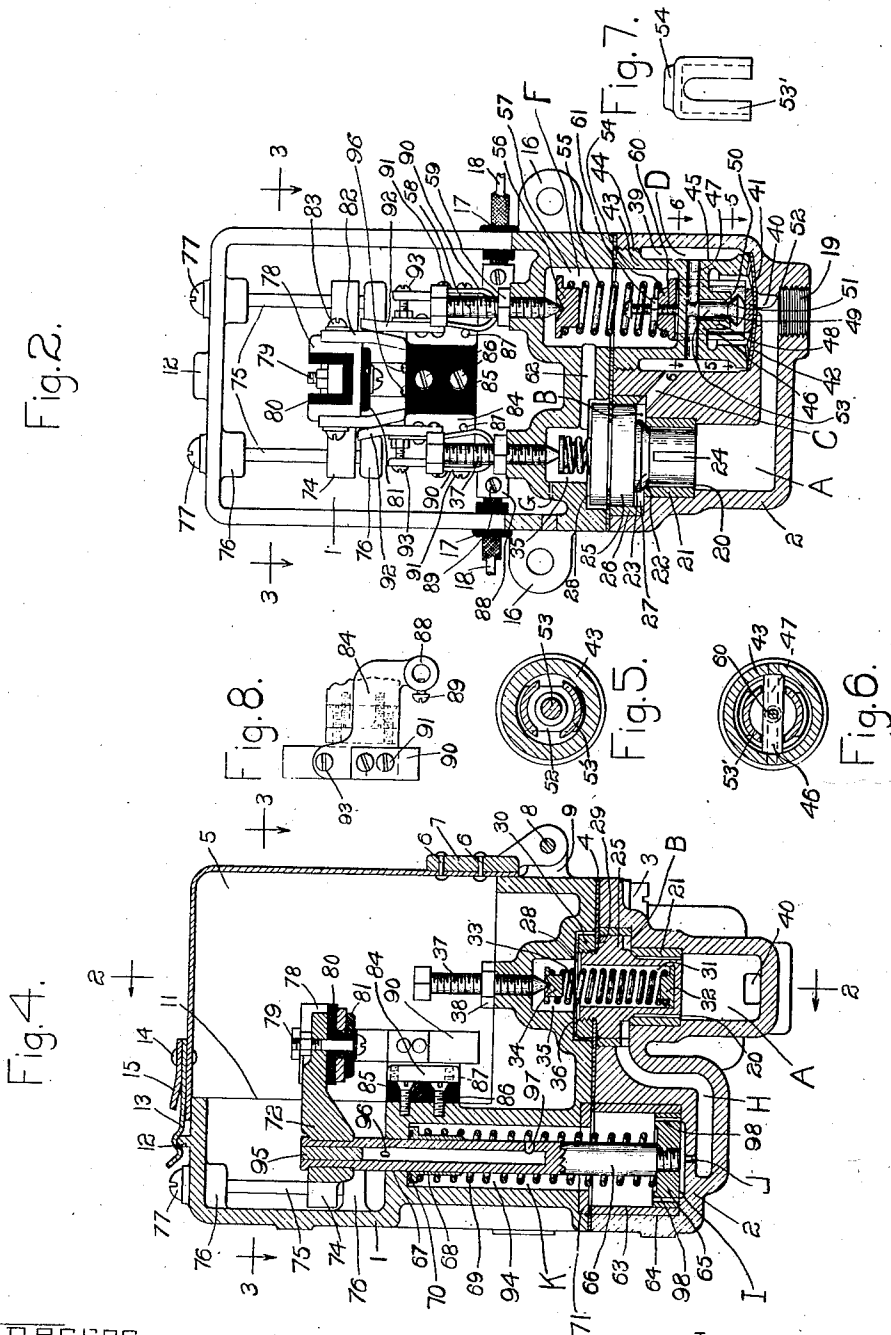
Brown & William
Attorneys

B. S. AIKMAN.
PNEUMATIC GOVERNOR.
APPLICATION FILED JAN. 11, 1910.

1,065,649.

Patented June 24, 1913.

2 SHEETS—SHEET 2.



Witnesses

George E. Higham.
Frank J. Kelen

Inventor
Burt S. Aikman
By *Brown & Williams*
Attorneys

UNITED STATES PATENT OFFICE.

BURTON S. AIKMAN, OF CHICAGO, ILLINOIS, ASSIGNOR TO NATIONAL BRAKE & ELECTRIC COMPANY, OF MILWAUKEE, WISCONSIN.

PNEUMATIC GOVERNOR.

1,065,649.

Specification of Letters Patent.

Patented June 24, 1913.

Application filed January 11, 1910. Serial No. 537,547.

To all whom it may concern:

Be it known that I, BURTON S. AIKMAN, a citizen of the United States, residing at Chicago, in the county of Cook and State of Illinois, have invented certain new and useful Improvements in Pneumatic Governors, of which the following is a full, clear, concise, and exact description, reference being had to the accompanying drawings, forming a part of this specification.

My invention relates to controlling devices, more particularly pneumatic governors, such as are employed in connection with air-compressing mechanism to control the starting and stopping of the device for operating the air-compressing mechanism, so that a substantially constant pressure may be maintained. In systems of this kind the compressed air is employed as an operating fluid, and, while there are frequent withdrawals from the supply of the compressed air, it is necessary that there be a substantial and practically constant pressure at all times. In the present day these arrangements are employed very considerably in electric railway systems, particularly for the purpose of operating the brake equipments. A motor compressor is connected with a supply tank to maintain therein a constant supply of compressed air at the required pressure, this tank being connected with the brake cylinders through a valve, and the motor being controlled to start and stop in accordance with certain variations in pressure.

The subject-matter of my invention is a governing unit, which comprises essentially a switch and means for closing this switch when the pressure in the supply tank has been reduced to a minimum and opening it when the pressure has again reached a predetermined maximum. This switch is either directly in the circuit of the motor for operating the compressor or in a local control circuit, automatic means being usually provided for placing the load upon the motor gradually rather than suddenly.

The particular nature of the connection between the controlling unit and the motor does not concern this invention, and I shall make no specific reference thereto. In fact, the entire invention herein is confined to a governor *per se*, and this description will be so confined, except as it is necessary to refer to the other parts so that the controlling unit itself may be properly understood.

It is, of course, apparent that it is not only desirable but in this day absolutely necessary that the compressor motor be controlled entirely automatically, and the prior art is replete with devices for securing this result mechanically or electrically. Pneumatic governors have also appeared in the prior art, but great difficulty has been encountered in their use for many reasons, chief among which are the employment of complicated structures or, in the more simple ones, the excessive arcing caused by the parting of the switch contacts, and the fact that efficient operation embodied in a simple structure has never presented itself. The excessive arcing above referred to in the device of the prior art has been due chiefly to the slow operation.

It is the object of my invention to overcome the disadvantages above noted, and to provide a simple and reliable governor which operates positively and not on a margin and which is not liable to become disordered and in need of repair.

It is one of the most important purposes of my invention to provide a governor in which the switch will be quick acting, and, further, to provide associated means eliminating the slight sparking which would even then be present.

It is a further object to provide a structure wherein the wearing parts may be easily and quickly replaced, and to so arrange the different parts that the necessary adjustment may be made without complicated means of access to the particular parts requiring attention for that purpose.

My invention is embodied in the structure illustrated in the accompanying drawings in which—

Figure 1 is a side elevational view of the structure; Fig. 2 is a longitudinal sectional view taken on the plane 2, 2 of Fig. 1, the cover being entirely removed; Fig. 3 is a cross-sectional view taken on the plane 3, 3 of Fig. 2, the section plane of Fig. 2 being indicated therein; and the cover being removed; Fig. 4 is a longitudinal sectional view taken on the planes 4, 4 of Fig. 3; the sectional planes of Figs. 2 and 3 being indicated therein; Fig. 5 is a detail sectional view taken on the plane 5, 5 of Fig. 2; Fig. 6 is a detail sectional view taken on the plane 6, 6 of Fig. 2; Fig. 7 is a detail elevational view of a spring thimble which

is employed, and which will later be referred to; Fig. 8 is a detail view illustrating the arrangement whereby one of the contact members is mounted, and, Fig. 9 is a diagrammatic view, which will be of assistance in describing the operation of the device.

Like reference numerals are applied to the same parts throughout the various figures.

The casing is divided mainly into three parts, the upper main part 1, the base part 2, which is secured to the upper part 1 by means of cap-bolts 3, a gasket 4 of compressible material intervening for obvious purposes, and a cover 5, which is secured by means of rivets 6, 6 to a supporting member 7 which is hinged by way of a rod 8 to the outwardly extending lugs 9, 9 on the upper part 1 of the casing, a cotter pin 10 being employed to hold the rod in place. The upper part 1 of the casing is cut away, as indicated at 11, and the cover 5 has but four walls so that it may complete the casing in an obvious manner. The parts 1 and 2 are cast, while the cover 5 is made of sheet metal. At the top of the upper part 1, near the edge which receives the edge of the cover when it is closed, there is provided a catch-lug 12, which is arranged to be engaged by a latch-hook 13, secured to the cover 5 by means of a rivet 14, this latch being formed so that it may be engaged by one's finger and removed from the catch lug. The latch-hook 13 is of spring metal; and a distance-piece 15 is also secured in place by the rivet 14 to guard the hook, as is clear from the drawings. The device as a unit may be supported in any convenient fashion, lugs 16, 16 being provided through which suitable securing bolts may be passed for that purpose. At either side of the upper part 1 of the casing an entry opening is provided, an insulating bushing 17 being inserted in each of them, for the reception of the circuit wires 18, 18, which lead from the motor circuit or some local control circuit in any suitable manner and which are connected with the switch contacts inside the casing, as will hereinafter be more fully pointed out.

The operating parts of my invention comprise a pneumatically operated switch and two control elements in the way of a high pressure element and a low pressure element. Both of these pressure elements are subject to the standing pressure in the reservoir, the high pressure element, in the embodiment herein shown, being in the form of a valve directly connected with the reservoir and operative to open when a maximum pressure has been attained. The low pressure element, in the present embodiment, is in the form of a diaphragm, the chamber under which is directly connected

with the reservoir, this diaphragm operating to control a valve and to keep it closed, while the pressure remains between the predetermined maximum and minimum limits. The pneumatically operated switch is connected in this pneumatic system between the two valves referred to, the high pressure valve, when open, serving to connect the operating fluid with the switch to open it, and the low pressure valve, when open, admitting the operating fluid to close, with mechanical assistance, the high pressure valve, and to connect the pneumatically operated switch with the exhaust. The primary chamber, to the pressure in which the two pressure elements are subject, is shown at A and, by means of a port 19 and suitable piping, is connected with the storage reservoir R. The chamber A has an outlet opening at 20 in which a wearing bushing 21 is disposed, this bushing presenting the valve seat 22 for the high pressure valve 23. This valve is held in proper alinement by means of the projections 24 on the cylindrical part thereof which extends within the bushing, and also by the enlarged portion 25 carried thereby which fits snugly within a wearing bushing 26 disposed in a well 27 to form an ante-chamber B. The lower part of the upper portion 1 of the casing is formed to present a pocket 28 into which the upper end of the part 25 of the valve extends.

In normal alinement with the gasket 4, which has heretofore been referred to, the part 25 is provided with a shoulder 29 upon which the gasket may extend and be clamped by means of the clamping ring 30, having threaded engagement with a reduced portion of the part 25, as clearly shown in Fig. 4. The valve member 23 is provided with a central bore 31 at the bottom of which is disposed a thimble 32 with which a helical spring 33 is connected, the other end of the spring being provided with a thimble 34 which extends up into a pocket 35 secondary to the pocket 28, so as to leave a shoulder 36. An adjusting screw 37 passes through the casing part 1, having threaded engagement therewith, and engages the thimble 34, as clearly shown in Fig. 4. This screw may be manipulated in either direction so as to adjust the tension of the spring 33, a jam-nut 38 being provided to hold the screw in any adjusted position. It is to be noted that the diameter of the annular outlet formed when the valve 23 is raised is considerable, and very slight movement of the valve immediately presents an outlet of considerable area. The gasket 4 acts quite in the manner of a diaphragm, the movement of the valve being very slight, and the valve controls merely the connection between the chambers A and B. The tension of the spring 33 is adjusted so that it will withstand and hold the valve

down against any pressure up to a predetermined maximum. When this maximum is reached the valve 23 is raised to allow air to pass across the seat 22 and into the cavity or chamber B. By reason of the rapidly increased area of the outlet the valve will

move to its upward limit of travel, thereby establishing instantly full and complete communication between the chambers A and B.

The low pressure element is in the form of a diaphragm. On a cross center line passing through the center of the high pressure valve the lower part 2 of the casing is bored to form a pocket 39, and the chamber A is provided with an outlet 40, which would extend into and connect directly with the pocket 39 except for the employment of a diaphragm 41 held upon the diaphragm seat 42 by means of a valve frame 43 disposed in said pocket and having threaded engagement with the casing part 2 as indicated at 44. The main part of this valve frame is reduced in diameter, as shown at 45, to form a chamber D, which is connected with the chamber B by means of a direct passageway C. The valve frame 43 is hollow except for the cross member 46, which is provided with the transverse channel 47 and with the central downwardly extending boss 48. This boss is provided with a central bore 49 and presents a valve seat 50, upon which a valve 51, seated upon a saddle 52, is arranged to engage, this valve being guided by a stem 53 extending up into the bore. The saddle 52 rests upon the diaphragm 42 and operates therewith. Over the cross piece 46 a bifurcated thimble 53' is disposed, the ends thereof extending downwardly into engagement with the saddle 52. The top of the thimble is provided with a boss 54, upon which a helical spring 55 rests, the other end of this spring being provided with a thimble 56, which is disposed in a pocket 57 in the upper part 1 of the casing, bored in alignment with the pocket 39 in the lower part 2. An adjusting screw 58 passes through the casing part and engages the thimble 56 in precisely the same relation as was described with reference to the adjusting screw 37 and the thimble 34 of the high pressure arrangement. A jam-nut 59 is provided to hold the adjusting screw 58 in any desired position. In order to relieve the diaphragm 42 of all strain when the valve 51 is open, the thimble 53' is provided with an adjusting screw 60 which can be manipulated, as is clear from Fig. 2, so as to hold the thimble itself away from the cross piece 46 to any desired extent. A jam-nut 61 is provided to hold this arrangement in any adjusted position. The interior of the valve frame 43, the pocket 57, and the pocket 35, which is connected with the pocket 57 by means of a channel 62, all go to form an air-tight chamber which will

hereinafter be referred to broadly as the chamber F. This chamber has the restricted outlet G to the atmosphere.

The operating chamber is formed by the disposal of a wearing bushing 63 in a pocket 64 bored centrally near the rear of the lower part 2 of the casing. In the chamber thus formed the operating piston 65 is disposed, the chamber below this piston being hereinafter referred to as the piston chamber and being designated by the letter I in the drawings. A port J connects the piston chamber I with channel H, which leads directly to the chamber B. The piston rod 66 has threaded engagement with the piston 65 and extends upwardly through the bore K in the upper part 1 of the casing concentric with the piston chamber I. The piston rod 66 leaves the chamber K through a snug bearing 67, just below which a collar 68 is provided. A helical spring 69 extends between the top of the piston 65 and the collar 68 and tends to hold the piston in its lowered position. A gasket 70 is employed in the collar so as to confine the air as much as possible to another passageway which will be referred to hereinafter. The upward movement of the piston 65 is limited by its engagement with a gasket 71 disposed in a seat at the lower end of the bore K and held in place by engagement with the bushing 63. At the upper end of the piston rod 66 a contact arm 72 is carried, this contact arm having secured thereto, by means of screws 73, 73, the eye pieces 74, 74, which are guided by the guide rods 75, 75 mounted between the bosses 76, 76 on the casing and held in place by means of screws 77, 77. It is by this arrangement that the contact arm 72 is properly guided in its upward movement. This arrangement is particularly useful, since the contact arm can be easily removed without interfering with the associated parts, this being desirable, since, in cases of repair, it is this arm which usually or most frequently would require attention. At its forward end the contact arm 72 is provided with the contact holder piece 78, held in place by means of a bolt 79, insulating pieces 80 and 81 being employed in order to electrically isolate the contacts carried thereby. Upon each side of the contact carrier 78 a contact member 82 is secured by means of a screw 83, and it is these contacts which form the connecting bridge between the two terminal ends of the controlling circuit entering the governor.

Secured to the part 1 of the casing and in proper relation to the moving contact members which have just been described is the stationary contact holder 84, one of these contact holders being provided for each of the movable contacts 82. The stationary contact holders are held upon the

casing through the medium of an insulating block 85 and screws 86, 86 and 87, 87. Each of these contact holders terminates in a binding terminal 88, to which the conductors 18, as they enter the casing, may be secured, the set screws 89, 89 being employed to secure them in place. Each of the contact carriers 84 is provided with a U-spring 90 secured thereto by means of screws 91, 91, the free end of this spring extending upwardly and having secured thereto, in any suitable manner, the stationary contact members 92, 92, these members being so disposed that they may be simultaneously engaged by the movable contact members 82, 82. In order that the stationary contact members 92 may be adjustable, so that they may engage or be engaged by the movable contacts to the best advantage, I provide the adjusting screws 93, 93, which pass through the contact holders proper and engage with the back of the springs 90, so that they may force them toward the path of the contacts 82 against their own tension.

It is one of the important features of my invention that I provide means for effectually reducing or practically eliminating the spark which occurs when the contact members are parted to break the controlling circuit. I secure this result by blowing out the arc with a draft of air coming direct from the reservoir with which the governor is connected. As clearly shown in Fig. 4, the piston rod 66 is provided with a central bore 94, the top of this bore being plugged, as indicated at 95. Above the plane of the journal 67, or directly in line therewith, there are ports 96. Below the journal 67 a port 97 is provided, this port leading from the bore 94 to the chamber K which has hereinbefore been referred to. The piston 65 is provided with the by-passes 98, 98, and it is clear that a rush of air in the piston chamber I will result in a part thereof being carried to the blow-out holes 96, which, as shown in Fig. 2, are directed toward the contact points of the contact members. Thus, as the piston is raised by a rush of air in the chamber I, the contact arm 72 is raised to separate the contact members and at the same time a draft of air from the outlet 96 extinguishes the spark formed at each of the contact points.

The structural embodiment of my invention having now been fully described, I shall proceed with a description of the operation thereof: The relation of the various valves and chambers is clearly shown in Fig. 9. This figure is purely diagrammatic and it is intended alone to assist in the understanding of the operation of the various associated parts. The parts of the diagrammatic figure have been lettered to correspond with the analogous parts shown in the structural

figures, where the operation may also be followed for that matter. It is clear that the reservoir is directly connected with the chamber A and it is this chamber in which the critical pressure is contained. It will be seen further that the diaphragm 41 and the valve 23 are subject to the pressure in this chamber. As before stated, the valve 23 is the high pressure element and the diaphragm 41 is the low pressure element. As hereinbefore explained, the reservoir is connected with a compressor, operated by a motor, and it is thereby constantly supplied with air. Depending upon the position of the adjustment screws 37 and 58, the maximum and minimum critical pressures may be adjusted in accordance with existing circumstances. For the purposes of description let it be assumed that the critical low pressure is sixty pounds and that the critical high pressure is seventy pounds. It is then apparent that at all times must the pressure be maintained between those limits for the proper operation of the air brakes or other operative devices. With the pressure in the reservoir at zero or, in fact, any pressure below sixty pounds in the present instance, the diaphragm 41 will occupy its lower position and the valve 51 will be opened. Furthermore, the high pressure valve 23 will be closed to cut off any communication between the chambers A and B. The spring 55 of the low pressure element being adjusted so that it will be overpowered by sixty pounds pressure, it follows that when the pressure in the reservoir, and consequently in the chamber A, has reached that point, the diaphragm 41 will be raised to close the valve 51. The spring 33 of the high pressure element being adjusted so that seventy pounds pressure is required to overpower it, it follows that the valve 23 will remain in the position shown in Fig. 9 until the pressure in the reservoir, and consequently in the chamber A, has reached the maximum point. As will later appear more clearly, the opening of the valve 23 results in the opening of the switch contact and it follows that, while the pressure is between sixty and seventy pounds and the parts are in the position shown in Fig. 9, the motor will be operating. When, however, the maximum pressure is reached, the valve 23 will be raised to immediately connect chamber A with chamber B. As before stated, the valve outlet in this case is an annular one and the slight movement of the valve is sufficient to immediately open up a wide outlet area. Thus the valve 23 acts quickly and a rush of air passes into chamber B through the passageway H and port J and into the piston chamber I. This immediately results in the raising of the piston 65, a quantity of air at the same time passing through the by-passes 98 and the ports 97, 130

94 and 96 so as to thrust a draft of air in the direction of the contact members. This will effectively extinguish the spark which is formed upon the parting of the members.

5 The ports 96 and 97 and the by-passes 98 are made of such relative sizes that the pressure above the piston 65 will not be raised. This action stops the motor and consequently the compressor, and from then on the pressure
10 in the reservoir is gradually lowered until it reaches the minimum limit. During all this time the pressure maintains the diaphragm 41 in its raised position, but when the minimum has been reached the spring
15 55 overcomes the pressure in the reservoir and the diaphragm 42 is lowered to open the valve 51.

It is to be noted that when the piston 65 is raised to the upward limit of its travel, it encounters the gasket 71 which effectively
20 closes the by-passes 98, 98. The valve 23 being open, it is clear that the reservoir pressure will be effective in chamber B and, through passageway 47 in the valve frame
25 43, will operate in effect to open the low pressure valve 51. Thus the spring 55 is assisted at this time by the pressure in the reservoir. It is to be noted, furthermore, that although it requires the maximum
30 amount of pressure to move the high pressure valve 23 from its lower position to its upper one, it does not require that amount of pressure to hold it in its raised position. It is thus apparent that the pressure in the
35 reservoir is effective in the chamber B, since the valve 23 is in its raised position and the ports 98, 98 are closed. Reference to Fig. 2 will show how, by way of the passageway 47, this pressure tends to open the low pressure
40 valve 51. Thus this pressure assists the spring 55 in moving the diaphragm 41 to its lowered position when the pressure in the reservoir has reached the predetermined minimum. Thus when the diaphragm 41 is
45 lowered, the low pressure valve 51 is opened and the pressure in the chamber D is transmitted to chamber F, where it is effective upon the top of the valve 23. This pressure in the chamber F, together with the
50 spring 33, forces the valve down, the outlet G to the atmosphere being restricted so as not to affect the pressure created by this sudden rush of air in any material manner. The valves 23 and 51 being now both in
55 their lowered positions, it is clear that the chamber I is connected directly with the atmosphere through the port J, passageway H, chamber B, pass C, chamber D, passageway 47, chamber F and outlet G. This allows the air to exhaust from the chamber I and the piston 65 may lower quickly to bring down the contact arm 72 so that the contact members carried thereby will electrically unite the two contact members 92, 92
65 and close the controlling circuit which starts

the motor. The compressor then operates to again raise the pressure in the reservoir and this pressure is again gradually raised until the maximum is reached to open the valve 23 and again raise the operating piston 65
70 to open the circuit. This completes the cycle of operation and it is clear that repetition thereof will clearly maintain a constant pressure in the reservoir, so that air brakes or other devices operated thereby may be
75 supplied with a substantially continuous pressure of the same magnitude within proper limits.

I claim as new and desire to secure by Letters Patent:

1. In a pneumatic governor, in combination, a piston chamber, a piston operating in said piston chamber, controlling mechanism operated by the movement of said piston, a
80 primary pressure chamber, a high pressure valve controlling the connection between said piston chamber and said primary pressure chamber, and a low pressure valve operated by the pressure in said primary pressure
85 chamber controlling connection between said piston chamber and the atmosphere.

2. In a circuit-controlling device, in combination, a switch, a piston chamber, a piston operating in said piston chamber and mechanically connected with said switch, a
95 primary pressure chamber, a high pressure valve controlling the connection between said piston chamber and said primary pressure chamber, and a low pressure valve operated by the pressure in said primary pressure
100 chamber controlling connection between said piston chamber and the atmosphere.

3. In a circuit-controlling device, in combination, a switch, a piston chamber, a piston operating in said piston chamber and mechanically connected with said switch, a
105 primary pressure chamber, a valve operative to open by a predetermined maximum pressure in said primary pressure chamber and controlling connection between said primary pressure chamber and said piston chamber, and a valve controlling connection between
110 said piston chamber and the atmosphere, said last-named valve being operatively connected with a diaphragm over said primary pressure chamber.

4. In a circuit-controlling device, in combination, stationary switch contacts, a piston chamber, a piston reciprocating in said
120 piston chamber and carrying a bridge for electrically connecting said stationary contact members, a spring tending to hold said piston in position to close the switch, a primary pressure chamber, a valve controlling
125 connection between said primary pressure chamber and said piston chamber, said valve being operative to be opened by the maximum pressure in said primary pressure chamber, a pressure chamber in which
130

the pressure operates on the opposite side of said valve, said chamber having a restricted outlet to the atmosphere, a valve controlling the connection between said piston chamber and said last named chamber, and a diaphragm operated by the pressure in said primary pressure chamber and mechanically connected with said last named valve, said diaphragm being held in position to close said last named valve by at least the predetermined minimum pressure, a spring for said first named valve operating against the pressure in said primary pressure chamber, a spring for said diaphragm operating against the pressure chamber, and means for adjusting the tension of said springs.

5. In a circuit-controlling device, in combination, a switch, means for pneumatically operating said switch, a high pressure diaphragm, a low pressure diaphragm, tension means on each of said diaphragms, means for adjusting said tension means, and a valve operated by each of said diaphragms, the high pressure valve controlling connection between the pneumatically operated means and the pressure means and the low pressure valve controlling connection between the pneumatically operated means and the atmosphere.

6. In a circuit-controlling device, in combination, a two-part casing, a gasket held between the parts of said casing, a switch, means for pneumatically operating said switch, a primary pressure chamber, a valve chamber in one part of said casing, an aligning chamber in the other part of said casing, a piston part in one of said chambers, said gasket extending partly over said chambers and said piston part to form a diaphragm, and a controlling valve carried with said piston part.

7. In a circuit-controlling device, in combination, a switch, means for pneumatically operating said switch, a primary pressure chamber, a valve controlling connection between said primary pressure chamber and said pneumatic means, a pressure chamber in which the pressure operates on the opposite side of said valve and which has but two outlets, one to the piston chamber and the other restricted and to the atmosphere, and a valve controlling connection between said piston chamber and said last named chamber.

8. In a circuit-controlling device, in combination, a switch, a piston chamber, a piston operating in said piston chamber and mechanically connected with said switch, a primary pressure chamber, a valve controlling connection between said pressure chamber and said piston chamber, a low pressure diaphragm, a valve operating with said diaphragm for controlling connection between said piston chamber and the atmosphere, a thimble supported so as to have its ends in

proximity to said diaphragm, a spring exerting pressure upon said thimble, and an adjusting screw for distancing said thimble from the member by which it is supported.

9. In a circuit-controlling device, in combination, a switch, a piston chamber, a piston operating in said piston chamber and mechanically connected with said switch by means of a piston rod, said piston and piston rod having an air passage therethrough terminating in an outlet directed toward the contacts of said switch, a primary pressure chamber, and a valve controlling connection between said primary pressure chamber and said piston chamber.

10. In a circuit-controlling device, in combination, a switch, a piston chamber, a piston operating in said piston chamber, a piston rod mechanically connecting said piston and the movable member of said switch, and means for connecting said piston chamber with an air supply, said piston rod having an opening therethrough and an outlet directed toward the contacts of said switch and said piston having restricted openings therethrough to connect said air supply with said outlet.

11. In a circuit-controlling device, in combination, a switch, a piston chamber, a piston operating in said piston chamber, a piston rod mechanically connecting said piston and the movable member of said switch, means for connecting said piston chamber with an air supply, said piston rod having an opening therethrough and an outlet directed toward the contacts of said switch and said piston having restricted openings therethrough to connect said air supply with said outlet, and means for closing said restricted openings in the piston when the piston reaches the end of its stroke.

12. In a pneumatic governor, in combination, a piston chamber, a piston operating in said piston chamber, a controlling device operated by the movement of said piston, a primary pressure chamber, a high pressure valve controlling connection between said piston chamber and said primary pressure chamber, a low pressure valve operated in one direction by the pressure in said primary pressure chamber and controlling connection between said piston chamber and the atmosphere, said low pressure valve being operated in the other direction partly by the pressure in said primary pressure chamber.

13. In a pneumatic governor, in combination, a piston chamber, a piston operating in said piston chamber, a controlling device operated by the movement of said piston, a primary pressure chamber, a valve operative to be opened by a predetermined maximum pressure in said primary pressure chamber and controlling connection between said primary pressure chamber and said piston chamber, said valve being held open by a pres-

sure less than that required to open it, and a valve controlling connection between said piston chamber and the atmosphere, said last-named valve being operated by the pressure in said primary pressure chamber.

14. In a pneumatic governor, in combination, a piston chamber, a piston operating in said piston chamber, a controlling device operated by the movement of said piston, a primary pressure chamber, a valve operated by a predetermined maximum pressure in said primary pressure chamber, and direct

connection between said primary pressure chamber and said piston chamber, said direct connection being controlled by said valve.

In witness whereof, I hereunto subscribe my name this 30th day of December, A. D. 1909.

BURTON S. AIKMAN.

Witnesses:

ARTHUR H. BOETTCHER,
LEONARD W. NOVANDER.