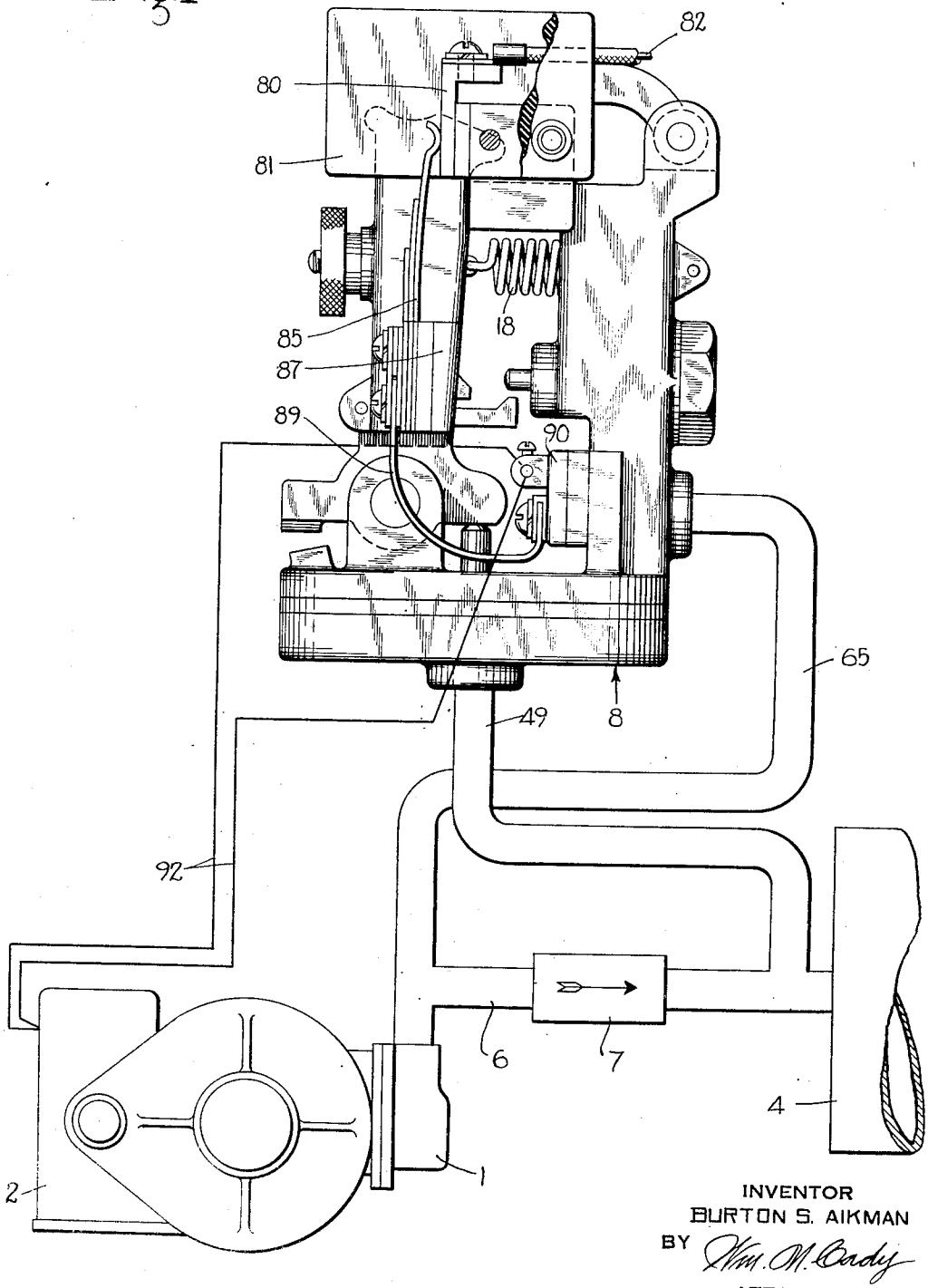
March 29, 1938. B. S. AIKMAN 2,112,414

COMPRESSOR CONTROL SYSTEM

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Fig. 1



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Fig. 2

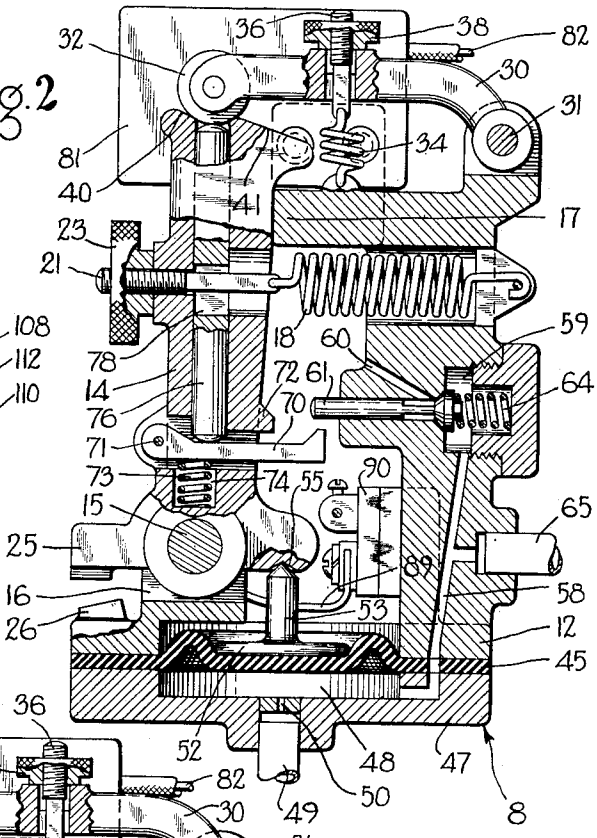


Fig. 4

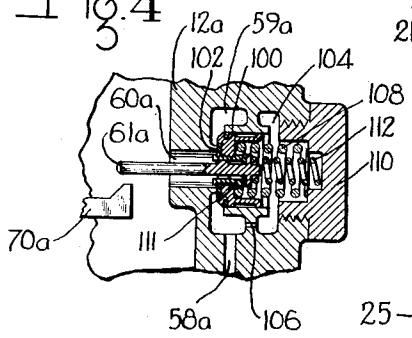
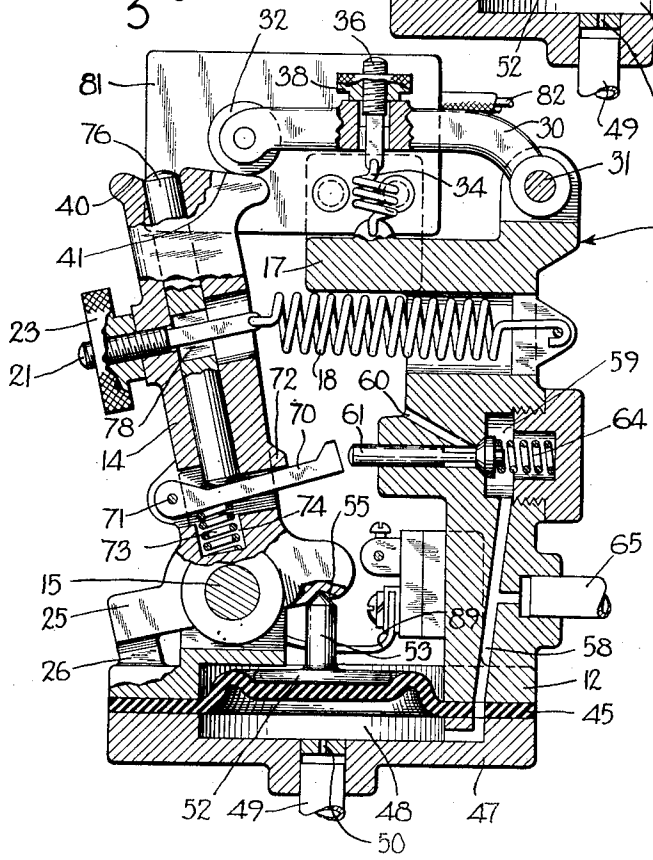


Fig. 3



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UNITED STATES PATENT OFFICE

2,112,414

COMPRESSOR CONTROL SYSTEM

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Application December 1, 1936, Serial No. 113,634

8 Claims. (Cl. 230—4)

This invention relates to control means for a fluid compressor, and is a continuation in part of my application, Serial No. 26,433, filed June 13, 1935 for a Compressor governor.

It is an object of this invention to provide means responsive to the pressure of the fluid compressed by a compressor for controlling the supply of current to an electric motor for driving the compressor, and for also controlling means to effect unloading of the compressor when it is started.

A further object of the invention is to provide means of the type described which is operable in response to relatively small pressure variations.

Another object of the invention is to provide unloading means adapted for use on a fluid compressor not provided with unloading means.

A further object of the invention is to provide an improved compressor control system.

Other objects of the invention and features of novelty will be apparent from the following description taken in connection with the accompanying drawings, in which

Fig. 1 is a diagrammatic view showing a compressor equipped with control means embodying this invention,

Fig. 2 is a sectional view of the control device provided by this invention, and showing the relationship of the various parts of the device when the device is conditioned to complete the circuit to the driving motor for the compressor,

Fig. 3 is a view similar to Fig. 2 and showing the relationship of the parts of the device when the device is in the switch open position, and

Fig. 4 is a fragmentary sectional view showing a modified form of valve device which I may employ.

Referring to Fig. 1 of the drawings, there is illustrated therein a compressor 1, which is driven by means of an electric motor 2, and compresses fluid into a reservoir 4 through a pipe 6 having a check valve 7 interposed therein. The operation of the compressor 1 is controlled by means of a control device which is indicated generally by the reference numeral 8, and which controls the supply of current to the driving motor 2, and also controls the release of fluid under pressure from the pipe 6 for unloading the compressor in starting.

The compressor 1 may be of any suitable well known construction and has an exhaust passage into which fluid is compressed, and to which the pipe 6 leading to the reservoir 4 is connected.

The control device 8 comprises a body or support 12 having a switch controlling lever 14 pivotally secured thereon by means of a pin 15 which extends between ears 16 formed on the body 12. The lever 14 is yieldingly urged to move in a clockwise direction, as viewed in the drawings, into engagement with a portion 17 on the body 12 by means of a spring 18 which extends between a pin 20, which is secured to the body 12, and a threaded link 21, which extends through the lever 14 and is adjustably secured thereto by means of a knurled nut 23. The lever 14 has a projecting portion 25 formed thereon and engageable with a stop 26 on the body 12 to limit movement of the lever in a counterclockwise direction.

The control device 8 includes a second lever 30 having one end thereof pivotally secured to the body 12 on a pin 31, and having a roller 32 pivotally secured on the other end thereof and engageable with the free end of the lever 14. The lever 30 is urged to move in a counterclockwise direction by means of a spring 34 which has one end thereof secured to the body 12, and has its other end secured to a threaded link 36, which extends through the lever 30 and is adjustably secured relative thereto by means of a knurled nut 38.

When the switch controlling lever 14 is in the position in which it is shown in Fig. 2 of the drawings, the roller 32 on the lever 30 extends into a notch or recess 40 formed in the end of the lever 14, and when the lever 14 is in the position in which it is shown in Fig. 3 of the drawings, the roller 32 rests upon a cam surface 41 on the end of the lever 14.

The control device 8 includes, in addition, a movable abutment in the form of a flexible diaphragm 45, which is clamped between the body 12 and a cover section 47. The diaphragm 45 is subject on one side to the pressure of the fluid in a chamber 48 which communicates with the reservoir 4 by way of a pipe 49 and a restricted passage 50.

The diaphragm 45 has a follower 52 associated therewith and engaging the exposed face thereof. This follower has a stem 53 formed integral therewith and terminating in a pointed end which extends into a recess 55 in the lever 14, the recess 55 being located adjacent to the pin 15 on which the lever 14 is pivoted, but being spaced therefrom.

The chamber 48 communicates by way of the passage 58 with a chamber 59 formed in the body 12. Communication between the chamber 59 and the atmosphere by way of a passage 60 is controlled by a valve 61 which is located in a bore in the body 12, and is urged into engagement with a seat surrounding the passage 60 by means of a spring 64.

The chambers 48 and 59 also communicate by

way of the passage 58 and a pipe 65 with the pipe 6 at a point intermediate the compressor 1 and the check valve 7.

The switch controlling lever 14 has means associated therewith and controlling operation of the valve 61. This means comprises a latch 70 positioned in an opening extending through the lever 14 and pivotally secured to the lever 14 by means of a pin 71. The latch 70 is urged to move in a counterclockwise direction against a stop 72 by means of a coil spring 73 located in a recess 74 in the lever 14.

The lever 14 has a plunger 76 mounted in a bore therein, and the lower end of this plunger engages the latch 70, while the upper end thereof is engaged by the roller 32. The plunger 76 has an elongated opening 78 adjacent the mid-portion thereof through which the link 21 extends.

The body 12 has a pair of stationary contacts 80 associated therewith, one of these being shown in the drawings. These contacts are located on opposite sides of the switch controlling lever 14, and have arc shields 81 positioned on opposite sides thereof. The stationary contacts 80 are formed of suitable electrically conducting material, and are secured to, but insulated from, the body 12 and have connected thereto supply wires, one of which is indicated at 82, leading from a source of current supply.

The lever 14 also has a pair of movable contacts 85 associated therewith, one of these being shown in Fig. 1 of the drawings. One movable contact is located on each side of the lever 14. The construction of the movable contact 85 is best shown in Fig. 1 of the drawings, where it will be seen that this contact is constructed of a plurality of laminations of resilient, electrically conducting material, and terminates in a curved end portion adapted to engage a stationary contact 80. The movable contacts 85 are secured to, but insulated from, ears 87 which project from the lever 14, and are electrically connected by means of flexible conductors 89 with terminal blocks 90, which are adapted to have secured thereto wires 92 which are connected to the driving motor 2.

The movable contacts 85 are arranged so that when the lever 14 is in the position in which it is shown in Figs. 1 and 2 of the drawings, they will press firmly upon the stationary contacts 80 so as to establish good contact therewith.

In initially starting the compressor, the fluid in the chamber 48 at the face of the diaphragm 45 is at a relatively low pressure, and the switch lever 14 is held by the spring 18 in the position in which it is shown in Figs. 1 and 2 of the drawings. In this position of the lever 14, the movable contacts 85 are held in engagement with the stationary contacts 80 so as to complete the circuit to the motor 2 for driving the compressor 1.

In this position of the lever 14, the roller 32 associated with the lever 30 is positioned in the notch or recess 40 in the upper end of the lever 14, while the latch 70 is out of engagement with the end of the stem of the valve 61. The latch 70 is also held out of engagement with the stop 72 by the plunger 76, which is urged downwardly by the roller 32, which engages the upper end of the plunger at this time.

As the circuit to the driving motor 2 is complete, the compressor will be operated and will compress fluid under pressure into the pipe 6, through which it will flow past the check valve 7 to the reservoir 4 to increase the pressure of the fluid in this reservoir. In addition, fluid under pressure supplied to the pipe 6 will flow by way of the pipe 65 and the passage 58 to the chamber 48 at the face of the diaphragm 45 so that the pressure of the fluid in the chamber 48 will be increased substantially as rapidly as the pressure of the fluid in the reservoir 4 is increased.

On an increase in the pressure of the fluid in the chamber 48, force is exerted through the diaphragm 45 and the follower 52 tending to move the lever 14 in a counterclockwise direction about the pin 15. This movement of the lever 14 is opposed by the spring 18, and by the spring 34, which resists the upward movement of the lever 30 which is required to lift the roller 32 out of the recess or notch 40 in which it is positioned.

When the pressure of the fluid in the chamber 48 and in the reservoir 4 has increased to a sufficient value, the force exerted on the lever 14 and tending to move this lever in a counterclockwise direction is sufficient to overcome the forces opposing this movement, and the lever 14 will be moved, and in moving it will cause the arm 30 to move in a clockwise direction so that the roller 32 is lifted out of the recess 40 in which it is positioned.

After a small amount of movement of the lever 14, the roller 32 will engage the cam surface 41, which slopes away from the recess 40, and when the roller 32 is in engagement with this cam surface it tends to assist movement of the lever 14 against the spring 18 away from the position in which it is shown in Fig. 2 of the drawings. This insures that the lever 14 will move very rapidly to the switch open position after it starts to move away from the switch closed position.

When the lever 14 moves, the movable contacts 85 are moved with it, and are moved out of engagement with the stationary contacts 80, thus interrupting the circuit to the driving motor 2 for the compressor 1 and interrupting operation of the compressor.

When the switch controlling lever 14 moves to the switch open position, which is the position in which it is shown in Fig. 3 of the drawings, the latch 70 is moved upwardly into engagement with the stop 72 by the spring 73 as the plunger 76 is no longer held by the roller 32.

On a reduction in the pressure of the fluid in the reservoir 4 as a result of the withdrawal of fluid therefrom, or for any other reason, there will be a similar reduction in the pressure of the fluid in the portion of the pipe 6 intermediate the check valve 7 and the compressor 1, and in the chamber 48, as fluid under pressure may flow therefrom past the check valve 7 to the reservoir 4.

If, while the compressor is not being operated, there should be a reduction in the pressure of the fluid in the chamber 48, and in the portion of the pipe 6 intermediate the check valve 7 and the compressor 1, to a value below that of the fluid in the reservoir 4, as may occur due to leakage of fluid past the exhaust valve of the compressor, fluid will flow to the chamber 48 and the connected portion of the pipe 6 from the reservoir 4 by way of the pipe 49 and the choke 50 to maintain the pressure of the fluid in the chamber 48 at substantially the same pressure as is present in the reservoir 4.

While the compressor is idle, therefore, the pressure of the fluid in the chamber 48 of the control device 8 will be maintained at substan-

tially the same pressure as is present in the reservoir 4.

When the pressure of the fluid in the chamber 48 is reduced to a predetermined value, the force exerted thereby through the diaphragm 45 is insufficient to maintain the lever 14 against the opposing force of the spring 18. The spring 18 will thereupon cause the lever 14 to move in a clockwise direction. After a small amount of movement of the lever 14 from the switch open position towards the switch closed position, the end of the latch 70 engages the end of the stem of the valve 61, and on further movement of the lever 14 the latch 70 causes the valve 61 to move against the spring 64, thereby permitting fluid to escape from the chamber 59 to the atmosphere by way of the passage 60. The chamber 59 communicates with the chamber 48 by way of the passage 58, and also communicates by way of the pipe 65 with the portion of the pipe 6 intermediate the check valve 7 and the compressor 1. When the valve 60 is open, therefore, fluid under pressure is released from the chamber 48 at the face of the diaphragm 45, and also from the portion of the pipe 6 adjacent the compressor 1.

The passage 60 and the valve 61 are arranged so that the rate at which fluid is released from the chamber 59 and the connected volumes greatly exceeds the rate at which fluid is supplied to the chamber 48 from the reservoir 4 through the choke 50, so that when the valve 61 is unseated there will be a rapid reduction in the pressure of the fluid in the chamber 48 and in the portion of the pipe 6 adjacent the compressor 1.

As a result of the reduction in the pressure of the fluid in the chamber 48 caused by the release of fluid therefrom, there will be a rapid reduction in the force exerted by the diaphragm 45 on the switch controlling lever 14, and the spring 18 will be able to move the switch controlling lever 14 towards the switch closed position very rapidly.

When the switch controlling lever 14 moves to the switch closed position, which is the position in which it is shown in Figs. 1 and 2 of the drawings, the roller 32 is forced into the recess 40 by the spring 34, and the roller engages the upper end of the plunger 76, forcing the plunger downwardly and moving the latch 70 against the spring 73 and out of engagement with the end of the valve 61. This permits the valve 61 to be moved to its seat by the spring 64 to cut off the release of fluid under pressure from the chamber 59 and the connected volumes.

When the valve 61 is moved away from its seat so as to release fluid under pressure from the chamber 59, fluid is released from the pipe 65, and from the portion of the pipe 6 adjacent the compressor 1, so that when the switch controlling lever 14 moves to the closed position and current is supplied to the driving motor 2 of the compressor to initiate operation of the compressor, there will be little opposition to operation of the compressor resulting from the fluid pressure against which the compressor has to operate, as there will be little pressure in the pipe 6 into which the compressor discharges fluid. This reduces the load on the motor 2 in starting the compressor, and thereby effects the unloading of the compressor during the starting period.

As a result of operation of the compressor, fluid under pressure is supplied to the pipe 6, and flows therefrom by way of the pipe 65 and the passage 58 to the chamber 48 at the face of the diaphragm 45 and increases the pressure of the fluid therein. The volume of this chamber and of the pipe 65 is relatively small so that after a few revolutions of the compressor crankshaft the pressure of the fluid therein will be increased to a value exceeding that of the fluid in the reservoir 4, and fluid under pressure will thereupon flow through the check valve 7 from the compressor 1 to the reservoir 4. However, the pressure in the adjacent portion of the pipe 6 will not increase so as to greatly oppose operation of the compressor until the compressor has been operated for several revolutions, and this is sufficient to enable the driving motor to start the compressor readily.

The control device 8 incorporates means by which the pressure at which it operates to interrupt the supply of current to the compressor driving motor, and to establish this supply, may be adjustably varied if desired. The control device also incorporates means by which the difference between these pressures may be adjustably varied if desired.

The pressure which is effective to move the lever 14 from the switch closed position to the switch open position may be adjustably varied by varying the tension on the spring 18, which is accomplished by adjusting the nut 23.

The differential between the opening and closing pressures is governed by the spring 34 and may be adjustably varied by varying the adjustment of this spring, which is accomplished by adjusting the nut 38.

In Fig. 4 of the drawings there is illustrated a modified form of valve device which I may employ in place of the valve 61, which is employed in the control device shown in Figs. 1 to 3 of the drawings. This valve device is mounted in a chamber 59*a* in the body 12*a* of the control device. This chamber is connected by way of a passage 58*a* with the chamber at the face of the diaphragm of the control device and with the pipe leading to the compressor.

The body 12*a* of the control device has a bore therein in which is mounted a valve piston 100 having a sealing gasket secured on the face thereof, which is adapted to engage a seat rib 102 surrounding a passage 60*a* leading to the atmosphere. The face of the valve piston 100 outwardly of the seat rib 102 is subject to the pressure of the fluid in the chamber 59*a*, while the valve piston 100 is subject on the other face to the pressure of the fluid in a chamber 104, which is constantly connected with the chamber 59*a* by means of a choke or restricted passage 106 extending through a wall in the body 12*a* of the control device. A spring 108 extends between the valve piston 100 and a threaded plug 110 and yieldingly presses the valve piston 100 against the seat rib 102.

The valve piston 100 has a passage extending therethrough, while a pilot valve 61*a* extends through this passage and carries a sealing gasket adapted to seat upon a seat rib 111 on the valve piston 100 surrounding the passage therethrough. A spring 112 extends between the pilot valve 61*a* and the threaded plug 110, and yieldingly presses the pilot valve against the seat rib 111 on the valve piston 100.

The various parts of this valve device are arranged and proportioned so that the pilot valve 61*a* occupies substantially the same position relative to the latch 70*a* as the valve 61 bears to the latch 70 in the device shown in Figs. 1 to 3 of the drawings.

In the operation of this valve device, when the switch lever 14 is in the switch open position, the chambers 59a and 104 are charged with fluid under pressure at the pressure present in the reservoir as explained above. When the switch lever 14 is moved towards the switch closed position, the latch 70a engages the end of the stem of the pilot valve 61a and moves it against the spring 112, thereby opening communication from the chamber 104 through the passage in the valve piston 100 to the passage 60a and thence to the atmosphere. When the pilot valve 61a is moved away from its seat, the fluid under pressure present in the chamber 104 may escape therefrom, thus reducing the force exerted thereby on the valve piston 100, and this valve piston will thereupon be moved against the spring 108 by the higher pressure of the fluid in the chamber 59a at the opposite face thereof.

On this movement of the valve piston 100, the sealing gasket carried thereby is moved away from the seat rib 102, thus opening a large communication between the chamber 59a and the atmosphere through the passage 60a to permit the rapid release of fluid under pressure from the chamber 59a, and also from the chamber at the face of the diaphragm of the control device and from the portion of the discharge pipe adjacent the compressor. On the release of fluid under pressure from the chamber 59a and the connected volumes there is a reduction in the force exerted on the switch lever 14, as explained above, and this lever is rapidly moved to the switch closed position, while the roller 32 extends into the notch 40 and presses upon the plunger 76 to move the latch 70a away from the end of the stem of the pilot valve 61a. The pilot valve 61a is thereupon moved into engagement with the seat rib 111 on the valve piston 100 by the spring 112.

The valve piston 100, however, will not be moved against the seat rib 102 by the spring 108 assisted by the spring 112, until the pressure of the fluid in the chamber 59a is reduced to a value insufficient to maintain the valve piston 100 against the opposing force of the springs 108 and 112, whereupon the valve piston 100 will be moved to the seated position to cut off the further release of fluid under pressure from the chamber 59a and the connected volumes.

The various parts of the equipment are arranged and proportioned so that the valve piston 100 will not be moved into engagement with the seat rib 102 until the pressure of the fluid in the chamber 59a and the connected volumes has been reduced to a relatively small value. This insures that the pressure of the fluid in the portion of the pipe 6 adjacent the compressor into which fluid is compressed by the compressor will be at a relatively low value, and that there will be little opposition to operation of the compressor.

On the subsequent increase in the pressure of the fluid in the chamber 59a, fluid flows therefrom through the choke 106 to the chamber 104 at the spring side of the valve piston 100 to increase the pressure of the fluid in this chamber and assist the springs 108 and 112 in maintaining the valve piston 100 in engagement with the seat rib 102 to prevent the release of fluid from the chamber 59a to the atmosphere through the passage 60a. At this time the pilot valve 61a is held in the seated position by the spring 112 so that fluid under pressure is not released from the chamber 104 to the passage 60a.

While one embodiment of the improved compressor control system provided by my invention, together with a modified form of valve device which I may employ in the control device employed in this system, have been illustrated and described in detail, it should be understood that the invention is not limited to these details of construction, and that numerous changes and modifications may be made without departing from the scope of the following claims.

Having now described my invention, what I claim as new and desire to secure by Letters Patent, is:

1. In combination, a fluid compressor, a reservoir, a conduit connecting the discharge passage of the compressor with the reservoir, a check valve in said conduit and operable to permit fluid to flow from the compressor to the reservoir and to prevent the flow of fluid from the reservoir to the compressor, and a compressor governor comprising a switch adapted to control the circuit to the compressor driving motor, a member controlling operation of said switch, a body having a chamber therein, a movable abutment subject to the pressure of the fluid in said chamber, the abutment controlling said switch controlling member, means for supplying fluid under pressure to the chamber from the reservoir at a predetermined rate, means connecting the chamber with the conduit between the reservoir and the compressor at a point intermediate the compressor and the check valve, said means being adapted to permit fluid to flow to said chamber at a more rapid rate than said predetermined rate, and means associated with the switch controlling member for releasing fluid from said chamber at a rate more rapid than said predetermined rate.

2. In combination, a fluid compressor, a reservoir, a conduit connecting the discharge passage of the compressor with the reservoir, a check valve in said conduit and operable to permit fluid to flow from the compressor to the reservoir and to prevent the flow of fluid from the reservoir to the compressor, and a compressor governor comprising a switch adapted to control a circuit to the compressor driving motor, a member controlling operation of said switch, a body having a chamber therein, a movable abutment subject to the pressure of the fluid in said chamber, the abutment controlling the switch controlling member, means for supplying fluid under pressure to the chamber from the reservoir at a predetermined rate, means connecting the chamber with the conduit between the compressor and the reservoir at a point intermediate the compressor and the check valve and being adapted to permit fluid to flow to said chamber at a more rapid rate than said predetermined rate, and means operable on movement of the switch controlling member from the switch open position towards the switch closed position for releasing fluid from said chamber.

3. In combination, a reservoir, a fluid compressor adapted to compress fluid into a communication through which fluid may be supplied to said reservoir, valve means operative to prevent back-flow of fluid from said reservoir to said communication, a valve device for releasing fluid from said communication, an electric motor for driving said compressor, a switch controlling the supply of current to said motor, and a movable abutment operated on an increase in the pressure of the fluid in said communication to effect movement of the switch to the open position to interrupt the supply of current to said motor, and op-

erated on a reduction in the pressure of the fluid in said communication to effect movement of the switch to the closed position to supply current to said motor and to operate said valve device to release fluid from said communication.

4. In combination, a reservoir, a control chamber, a fluid compressor adapted to compress fluid into said control chamber, a check valve operative to permit flow of fluid from said chamber to said reservoir and to prevent flow of fluid from the reservoir to said chamber, an electric motor for operating said compressor, a switch controlling the supply of current to said motor, valve means operative to vent fluid from said control chamber, a movable abutment subject to and operated on an increase in the pressure of the fluid in said control chamber for opening said switch, said abutment being operated upon a predetermined reduction in said chamber pressure to effect closing of the switch and to operate said valve means to release fluid from said control chamber.

5. In combination, a reservoir, a control chamber, a fluid compressor adapted to compress fluid into said control chamber, a check valve operative to permit flow of fluid from said chamber to said reservoir and to prevent flow of fluid from said reservoir to said chamber, an electric motor for operating said compressor, a switch controlling the supply of current to said motor, valve means operative to vent fluid from the control chamber at a predetermined rate, means for supplying fluid under pressure from the reservoir to the control chamber at a rate less rapid than said predetermined rate, a movable abutment subject to and operated on an increase in the pressure of the fluid in said control chamber for opening said switch, said abutment being operated on a predetermined reduction in said chamber pressure to effect closing of the switch and to operate the valve means to release fluid from said control chamber.

6. In combination, a reservoir, a control chamber, a fluid compressor adapted to compress fluid into said control chamber, a check valve operative to permit fluid to flow from the control chamber to the reservoir and to cut off the flow of fluid from the reservoir to the control chamber, an electric motor for driving the compressor, a switch for controlling the supply of current to said motor, valve means for releasing fluid from said control chamber, a movable abutment subject to the pressure of the fluid in said control chamber, a spring, a member subject to the opposing forces of said spring and of the force exerted by said abutment for operating said switch and said valve means, said member being operated upon an increase in fluid pressure in said control chamber to open said switch, and being operated on a reduction in the pressure of the fluid in said control chamber to close the switch and to operate the valve means to release fluid from the control chamber, and means to adjustably vary the force exerted by said spring on said member.

7. In combination, a reservoir, a control chamber, a fluid compressor adapted to compress fluid into said control chamber, a check valve operative to permit fluid to flow from the control chamber to the reservoir and to cut off the flow of fluid from the reservoir to the control chamber, an electric motor for driving the compressor, a switch for controlling the supply of current to said motor, valve means for releasing fluid from said control chamber at a predetermined rate, means for supplying fluid under pressure from the reservoir to the control chamber at a rate less rapid than said predetermined rate, a movable abutment subject to the pressure of the fluid in said control chamber, a spring, a member subject to the opposing forces of said spring and of the force exerted by said abutment for operating said switch and said valve means, said member being operated on an increase in fluid pressure in said control chamber to open said switch, and being operated on a reduction in the pressure of the fluid in said control chamber to close the switch and to operate the valve means to release fluid from the control chamber, and means to adjustably vary the force exerted by said spring on said member.

8. In combination, a reservoir, a fluid compressor adapted to compress fluid into a communication through which fluid may be supplied to said reservoir, a check valve operative to prevent back flow of fluid from said reservoir to said communication, an electric motor for driving said compressor, a switch for controlling the supply of current to said motor, an operating member for moving said switch between its open and closed positions, a movable abutment subject to and operated on an increase in the pressure of the fluid in said communication for moving said operating member from the switch closed position to the switch open position, said abutment being operated on a reduction in the pressure of the fluid in said communication to permit the switch operating member to be moved from the switch open position to the switch closed position, valve means operative by said switch operating member on movement thereof from the switch open position towards the switch closed position to release fluid under pressure from said communication, and yielding resistance means associated with said operating member and operated on movement of said member to the switch open position to yieldingly resist movement of said member away from the switch open position towards the switch closed position.

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