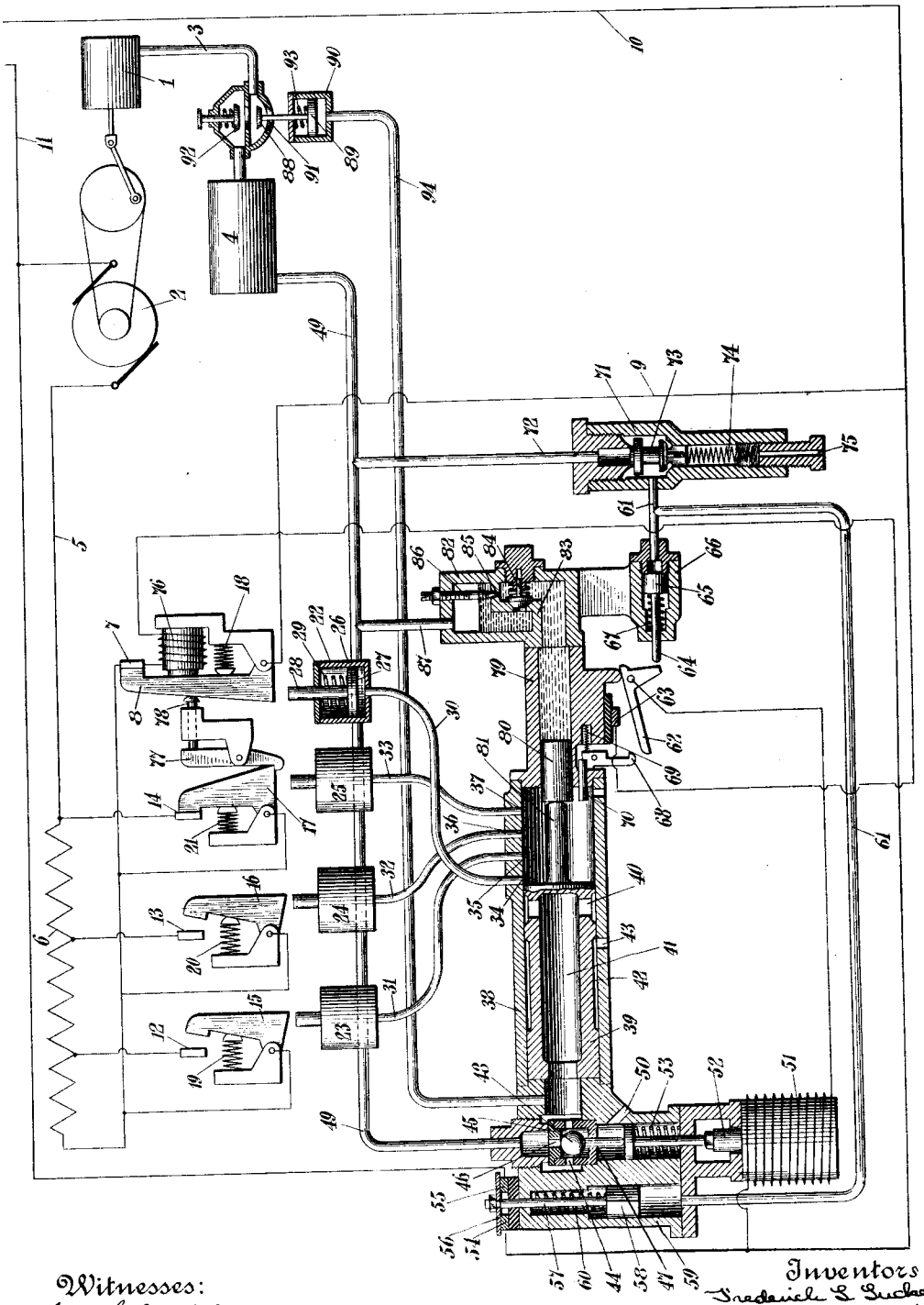
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REGULATING DEVICE FOR MOTOR DRIVEN COMPRESSORS.

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REGULATING DEVICE FOR MOTOR-DRIVEN COMPRESSORS.

1,129,878. Specification of Letters Patent. **Patented Mar. 2, 1915.**

Application filed March 11, 1913. Serial No. 753,472.

To all whom it may concern:

Be it known that we, FREDERICK L. LUCKER and ALLAN O. CARPENTER, citizens of the United States, residing, respectively, at Brooklyn, in the county of Queens and State of New York, and at Corning, in the county of Steuben and State of New York, have invented a certain new and useful Improvement in Regulating Devices for Motor-Driven Compressors, of which the following is a specification.

This invention relates to regulating devices for motor driven compressors or fluid pumps and more particularly to regulating devices of the type wherein the motor is cut out when a predetermined maximum receiver pressure is reached and thrown in gradually when the receiver pressure again falls, by gradually cutting out the resistance of the motor circuit, the compression at the same time being unloaded so that the motor can reach its normal speed without difficulty.

The object of the present invention is to produce an efficient and economical apparatus for regulating the operation of the compressor and one which will be certain and positive in its action and strong and durable in its construction.

With this object in view we have devised a regulator a practical embodiment of which is shown in the accompanying drawing, which shows the complete apparatus partly in elevation and partly in section.

As shown, the system comprises a compressor 1 driven by a motor 2. From the compressor 1 a discharge pipe 3 leads to a receiver 4. From one terminal of the motor 2 a lead wire 5 leads through a resistance coil 6 to a contact plate 7 which co-acts with a switch arm 8 connected by a lead wire 9 to the main line wire 10. The other terminal of the motor 2 is connected to the other line wire 11. To different points in the resistance 6 are connected contact plates 12, 13 and 14 which co-act with switch arms 15, 16 and 17 which are in direct connection with contact plate 7, to cut out various parts of resistance 6, these switches being so arranged that when switch arm 15 is in contact with 12 a small part of the resistance 6 will be eliminated from the motor circuit, when switch 16 is in operation a greater part will be cut out and when switch 17 is in operation the motor is connected directly on the line without any intermediate resistance.

The switch arms 8, 15, 16 and 17 are provided with springs 18, 19, 20 and 21 tending to keep them in open position. To close these switches fluid actuated motors 22, 23 24 and 25 are provided which comprise, as shown in connection with motor 22, a cylinder 26 provided with a piston 27 to the upper end of which is attached an operating rod 28. A spring 29 normally holds the piston 27 in the lower part of the cylinder. The motors 23, 24 and 25 are identical with motor 22. To these motors 22, 23, 24 and 25 fluid pipes 30, 31, 32 and 33 lead from ports 34, 35, 36 and 37, arranged in the side of a valve chest 38 in which slides a controlling valve 39. The controlling valve 39 is in the form of a cylinder, in the outer surface of one end of which is an annular port 40 so placed as to register successively with the ports 34, 35, 36 and 37 as the valve 39 moves from one end of the valve chest 38 to the other. This annular port 40 is connected by means of an internal passage 41 to the opposite end of the valve chest 38. In the surface of the valve 39 is also a long annular depression 42 which is in communication with an atmospheric vent 43 and which successively registers with ports 34, 35, and 36 shortly after they have registered with the port 40 in the travel of the valve. From the end of the valve chest 38, into which the passage 41 opens, ports 44 lead into a trip valve chest 45. Oppositely opening inlet and exhaust ports 46 and 47 lead from the valve chest 45 and are controlled by a trip valve 48 which seats so as to close either port and open the other. The inlet port 46 is connected with the receiver through the pipe 49 while the exhaust port 47 exhausts to atmosphere through the port 50. To operate the valve 48 a solenoid or electromagnet 51 is provided the core 52 of which is operatively connected with the valve 48. A spring 53 tends to hold the valve 48 in a position to close the inlet port 46 when the solenoid 51 is not energized. Current to energize the solenoid 51 is taken from the main line wires 10 and 11 through a circuit which is interrupted by two switches called respectively the "main switch" and the "trip switch." The main

switch comprises two contacts 54 and 55 which are adapted to be connected by switch bar 56. This switch bar 56 is secured to a rod 57 attached to a piston 58 which slides in a cylinder 59. The switch is normally kept in a closed position by a spring 60 which presses on the upper side of the piston 58. Fluid pressure is admitted and exhausted from the lower part of the cylinder 59 by a pipe 61.

The trip switch mentioned above consists of a switch arm 62 adapted to contact with a plate 63 and thus make connection between one terminal of the solenoid 51 and the main line wire 10. The switch arm 62 is moved by a rod 64 attached to a piston 65 sliding in a cylinder 66. A spring 67 tends to hold the rod 64 in such a position that the switch arm 62 will be out of contact with the plate 63 from its own weight. A pivoted latch 68 is provided which catches the end of switch arm 62. A spring 69 tends to keep the latch 68 in a position to engage the switch arm 62 while a pin 70 extends through the valve chest 38 in such a way that the valve 39 on its forward travel will contact with the pin 70 and force the latch 68 from engagement with the switch arm 62 breaking the connection of the solenoid 51. To admit air to the cylinders 59 and 66 to operate the two switches, an auxiliary pressure controlled valve 71 is provided which forms no part of the present invention being fully described in an application of Castle and Rogers, Serial #791,709, filed September 25, 1913. For the purpose of the present application it is sufficient to say that at a predetermined pressure in the receiver 4 which is transmitted to the valve 71 through the pipe 72, the valve spool 73 will be moved downwardly against the spring 74 admitting fluid pressure to the pipe 61 and closing the exhaust passage 75, while when the pressure has fallen a definite amount below that which is necessary to move the valve spool 73 downwardly the spring 74 will force the valve spool 73 upwardly again opening the pipe 61 to atmosphere, through the exhaust passage 75. In circuit with the main switch 56 is also an electromagnet or solenoid 76 which is so arranged with respect to the switch arm 8 that it holds it in closed position when energized. This magnet or solenoid is so connected that it will be energized only when the main switch 56 is closed and the switch arm 8 is also in closed position. A holding means is likewise provided for the switch arm 17 in the shape of a pivoted latch 77 which engages the switch arm 17 only when both switch arm 8 and switch arm 17 are in closed position and is disengaged from switch arm 17 by a sliding pin 78 which forces away the latch hook when the switch arm 8 falls back into an inoperative position.

Returning to the controlling valve 39 it has been seen that under certain conditions receiver pressure is admitted by the trip valve 48 to move this controlling valve in one direction. To regulate this movement and to return the controlling valve to its original position when the trip valve 48 again shuts off live pressure, the following mechanism is provided. From the farther end of the valve chest 38 extends a cylinder 79 the diameter of which is considerably less than the diameter of the valve chest 38. In the cylinder 79 slides a piston 80 which contacts with a pin 81 projecting from the valve 39, this pin being of small enough diameter to slide for its full length into cylinder 79. Connected with the cylinder 79 is a fluid chamber 82 separated from the cylinder by a partition 83 in which are two valves, one a check valve 84 which allows a free passage of fluid from the chamber 82 into the cylinder 79, and the other a constricted opening 85, the size of which can be adjusted by a needle 86. The cylinder 79 and the chamber 82, to a certain level, are filled with some viscous liquid such as glycerin or heavy oil. To the top of chamber 82 a pipe 87 leads from the receiver so that there is a constant receiver pressure on the liquid in the chamber 82.

In order that the motor may not have to start the compressor against full receiver pressure an unloader is provided for the compressor. This may be of any suitable type but is here shown as a discharge line unloader comprising a valve 88 which is actuated by a piston 89 sliding in a cylinder 90 and which opens a port 91 in the discharge pipe 3 of the compressor to atmosphere, when it is desired to unload the compressor. A check valve 92 prevents the escape of the air already pumped into the receiver. The valve 88 is normally kept closed by a spring 93 pressing down on the piston 89 and is opened by receiver pressure conveyed to the cylinder 90 by a pipe 94 which leads from the end of valve chest 38 to which receiver pressure is admitted through the pipe 49 by the action of the trip valve 48.

The operation of the device is as follows: As shown, the parts are in the positions they assume when the compressor is in operation and the receiver is at normal pressure. If now the pressure in the receiver rises to a point which is determined by the adjustment of the auxiliary valve 71 valve spool 73 will be moved downwardly closing off the exhaust passage 75 and admitting fluid at receiver pressure to the pipe 61. This pressure will be communicated to the cylinder 66 moving the piston 65 so that the trip switch 62 is moved into contact with the contact plate 63 and latched into position by the latch 68. This

operation has no immediate function but is merely in preparation for the later reloading of the compressor system. At the same time pressure is admitted to the cylinder 59 moving the piston 58 upwardly and breaking the connection between contact plates 54 and 55. This will deënergize the solenoid 76 and allow the spring 18 to force back the switch arm 8 breaking its connection with the plate 7. At the same time the pin 78, which is in contact with the switch arm 8 will disengage the latch 77 from the switch arm 17 allowing the spring 21 to break the connection of the switch arm 17 and contact plate 14. The release of these two switches will break the motor circuit and stop the compressor. It will be noticed that only the parts described will be affected by the rising pressure in the receiver and that the operation of the auxiliary valve 71 has no effect upon the other apparatus. Suppose now that after a certain interval, the compressor not being operated, the receiver pressure falls to a point below that required to operate the valve spool 73, in the first instance, this point being again regulated by the auxiliary valve 71. When this point is reached the valve spool will move upwardly again under the pressure of the spring 74. This will allow the air in cylinder 66 to be exhausted through the pipe 61 and exhaust passage 75 and allow the piston 65 to return to the position shown in the figure. As the switch 62 however is held in closed position by the latch 68 this contact will not be again broken when the piston 65 returns. The pressure in the cylinder 59 will also be exhausted through the pipe 61 and passage 75 allowing the main switch bar 56 to contact with plates 54 and 55. As the switch 62 is closed, the closing of the switch 56 will establish a circuit through the solenoid 51. The current passing through the solenoid 51 draws down the core 52 and allows the trip valve 48 to move so that it closes exhaust port 47 and opens inlet port 46 allowing fluid at receiver pressure to pass into the valve chest 38 through the ports 44. As one result of this admission of fluid to the valve chest 38, fluid under pressure is conveyed through the pipe 94 to the cylinder 90 opening the valve 88 through the movement of the piston 89. This opens the discharge of the compressor to the atmosphere through the exhaust opening 91 and thus unloads the compressor. The other result of the admission of fluid to valve chest 38 is that the pressure of the fluid acting on the surface of the valve 39 moves is gradually to the right, this movement being opposed by the liquid in the cylinder 79 which can only escape therefrom through the constricted passage 85, against the pressure of the air at receiver pressure on its surface in chamber 82. The rate of flow of the fluid through passage 85 and hence the speed of movement of the valve 39 can be accurately regulated by the adjustable needle 86. As the valve 39 moves to the right the port 40 first registers with the port 34 which allows fluid to pass through the passage 41 and pipe 30 into the motor 22 raising the piston 27 to the top of the cylinder and forcing switch arm 8 against contact plate 7. This will throw in the motor with all the resistance 6 in circuit and will also complete the circuit through the magnet or solenoid 76 which is only complete when both switches 56 and 8 are closed. As the valve 39 travels still farther to the right the port 40 will successively register with ports 35 and 36 conveying fluid under pressure to motors 23 and 24 which will successively close the switch arms 15 and 16 and cut out portions of the resistance 6. The port 40 finally registers with the port 37 admitting fluid under pressure to the motor 35 which will throw in switch 17 cutting out all the resistance 6 and connecting the motor 2 directly on the line. As the switch 17 is thrown in it is latched in position by latch 77. This leaves switches 8 and 17 both in circuit, the reason for such an arrangement being that it is desirable to throw the line current, in the first instance, through the switch arm 8 which has heavier contacts than the lighter resistance cutting out switches 15, 16 and 17 and is therefore not so likely to be subject to fusion from the contact.

Returning to the valve 39 it will be noticed that after the port 40 has traveled by the ports 34, 35 and 36 these parts are opened sucessively to the atmosphere through the annular depression 42 and exhanst port 43 allowing the fluid to exhaust from the motors 23, 24 and 25. As the valve 39 reaches the end of its travel its forward end comes in contact with the latch release pin 70 and, by moving this pin, pushes back the pivoted latch 68 and allows the switch arm 62 to break contact with contact plate 63. This breaks the circuit through the solenoid 51, releases the core 52 and allows the spring 53 to raise the trip valve 48 so that it closes the inlet port 46 and at the same time opens the exhaust port 47. The fluid under pressure in the valve chest 38 can therefore escape through the ports 44, 47 and 50. The receiver pressure on the surface of the fluid in chamber 82 will then be free to force the fluid out of said chamber through the check valve 84 which allows free passage to the fluid in this direction into the cylinder 79 driving the piston 80 to the left and with it the valve 39 which returns to the position shown in the figure. At the same time the fluid under pressure in the unloader cylinder 90 will be allowed to escape through the pipe 94 so that the valve 88 will close the exhaust opening 91 again loading the compressor.

One of the important features in the present invention is that the controlling valve 39 is arranged to return to its former inactive position as soon as the motor is fully thrown in. This allows the motor to be thrown in again immediately if the line current is momentarily cut off for any reason, by simply throwing in the switch 62 by hand and it also obviates a considerable amount of leakage which occurs when the valve 39 is allowed to remain at the end of its outer stroke all the time the compressor is unloaded.

Another feature of importance is that the unloader is only operated for the short period of time when it is actually needed thus eliminating further leakage.

It is to be understood that the present showing and description discloses only one specified modification of this invention and other forms and modifications are included in the spirit and scope of the invention as expressed in the claims.

What we claim is:

1. In combination, a compressor, its receiver, a driving motor for said compressor, resistance in the motor circuit, a series of switches for progressively cutting out the resistance in the circuit and throwing in the motor, fluid actuated motors for operating the switches, a valve for serially introducing fluid into said motors, means for operating said valve at a predetermined minimum receiver pressure and means to return said valve to its initial position after operating said switch motors.

2. In combination, a compressor, its receiver, a driving motor for said compressor, resistance in the motor circuit, a series of switches for progressively cutting out said resistance and throwing in said motor, fluid actuated motors for operating said switches, a valve for serially introducing fluid into said switch motors, a fluid operated unloader for said compressor, a trip valve for admitting fluid pressure to said switch motors and said unloader, means for operating said trip valve at a predetermined minimum receiver pressure and means for returning said trip valve, switch motor valve and unloader to normal inactive position as soon as said resistance is cut out and said motor fully thrown in.

3. In combination, a compressor, its receiver, a driving motor, a rheostat mechanism for gradually throwing in said motor, fluid actuated motor mechanism for operating said rheostat mechanism, means for actuating said motor mechanism at a predetermined receiver pressure and means for returning said motor mechanism to normal inactive position when said driving motor is fully thrown in.

4. In combination, a compressor, its receiver, a driving motor, a rheostat mechanism for gradually throwing in said motor, fluid actuated motor mechanism for operating said rheostat mechanism, a fluid operated unloader for said compressor, a trip valve for admitting fluid to said motor mechanism and said unloader, means for operating said valve at a predetermined minimum receiver pressure, means for returning said trip valve, said rheostat operating motor mechanism and said unloader to normal inactive position when said driving motor is fully thrown in and means for cutting out said driving motor at a predetermined maximum receiver pressure.

5. In combination, a compressor, its receiver, a driving motor, resistance in the motor circuit, a series of fluid actuated switches for gradually cutting out said resistance and throwing in said motor, a fluid actuated valve for serially admitting fluid to throw in said switches, and exhausting said fluid to allow said switches to return to open position, means for holding the last thrown switch in operative position, means for admitting fluid to operate said valve at a predetermined minimum receiver pressure, means for allowing said valve to return to normal inactive position when the last switch has been thrown in, and means for releasing said last thrown switch at a predetermined maximum receiver pressure.

6. In combination, a compreessor, its receiver, a driving motor, resistance in the motor circuit, a series of fluid actuated switches for gradually cutting out said resistance and throwing in said motor, a fluid actuated controlling valve for serially admitting fluid to throw in said switches, a fluid operated unloader for said compressor, a trip valve for admitting fluid to operate said controlling valve and said unloader, means for operating said trip valve at a predetermined receiver pressure, means for returning said trip valve, controlling valve and unloader to normal inactive position when said driving motor is fully thrown in, and means for cutting out said driving motor, at a predetermined maximum receiver pressure.

7. In combination, a compressor, its receiver, a driving motor for said compressor, a series of fluid operated switches for gradually throwing on said motor, a fluid actuated controlling valve for serially admitting fluid to actuate said switches, means comprising an electromagnet to hold the last thrown switch in operative position, a trip valve for admitting fluid to actuate said controlling valve, an electromagnet for actuating said trip valve, a trip switch in said trip electromagnet circuit, a main switch controlling said driving motor switch holding electromagnet and said trip electromagnet, means for closing said main switch at a predetermined minimum receiver pres-

sure to energize said switch holding electromagnet, and to actuate said trip valve to admit fluid pressure to actuate said controlling valve, and means to release said trip switch to deënergize said trip electromagnet when said controlling valve has thrown in the last of said driving motor switches.

8. In combination, a compressor, its receiver, a driving motor for said compressor, a series of switches for gradually throwing on said driving motor, fluid actuated motors for operating said switches, an electromagnet for holding the last thrown switch in operating position, a controlling valve cylinder, a fluid actuated controlling valve in said cylinder adapted to move therein to serially admit and exhaust fluid in said switch motors, a trip valve to admit and exhaust fluid pressure in said controlling valve cylinder, a trip electromagnet to actuate said trip valve so as to admit fluid pressure, a trip switch in said trip electromagnet circuit, a main switch controlling said motor switch holding electromagnet and said trip electromagnet, means for closing said main switch at a predetermined minimum receiver pressure, a latch for holding said trip switch in closed position, means actuated by the movement of said controlling valve to open said trip switch after said controlling valve has moved to throw in the last motor switch, and means for closing said trip switch and opening said main switch at a predetermined maximum fluid pressure.

9. In a fluid operated motor starting mechanism, a motor circuit, resistance in said circuit, a switch for completing the circuit with full resistance therein, a series of switches for progressively cutting out said resistance, the last of said switches giving direct connection, fluid operated motors for operating said switches, a valve for serially admitting fluid to said motors, means for operating said valve to admit and release fluid in said motors, and means for holding said first and last mentioned switches in operative position during the operation of the motor.

10. In a fluid operated motor starting mechanism, a motor circuit, resistance in said circuit, a switch for completing the circuit with full resistance therein, electromagnetic means for holding said switch in position, a series of switches for progressively cutting out said resistance, the last switch giving direct connection, fluid operated motors for closing said switches, valve mechanism for serially introducing and releasing fluid in said motors, means for actuating said valve mechanism, and for energizing said electro-magnetic means when desired to complete said motor circuit, and a connection for holding said direct connection switch in operative position from said full resistance switch when said electro-magnetic means is energized.

11. In combination, a compressor, its receiver, a driving motor for said compressor, resistance in the motor circuit, a switch for completing the circuit with full resistance therein, a series of switches for progressively cutting out said resistance, the last of said switches giving direct connection, fluid operated motors for closing said switches, valve mechanism for serially admitting fluid to said switches, means for moving said valve to admit and exhaust fluid from said switches at a predetermined minimum receiver pressure, means for holding the first and last switches in operative position during operation of the motor, and means for releasing said switches at a predetermined maximum receiver pressure.

In testimony whereof, we have hereunto set our hands.

FREDERICK L. LUCKER.
ALLAN O. CARPENTER.

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Copies of this patent may be obtained for five cents each, by addressing the "Commissioner of Patents, Washington, D. C."