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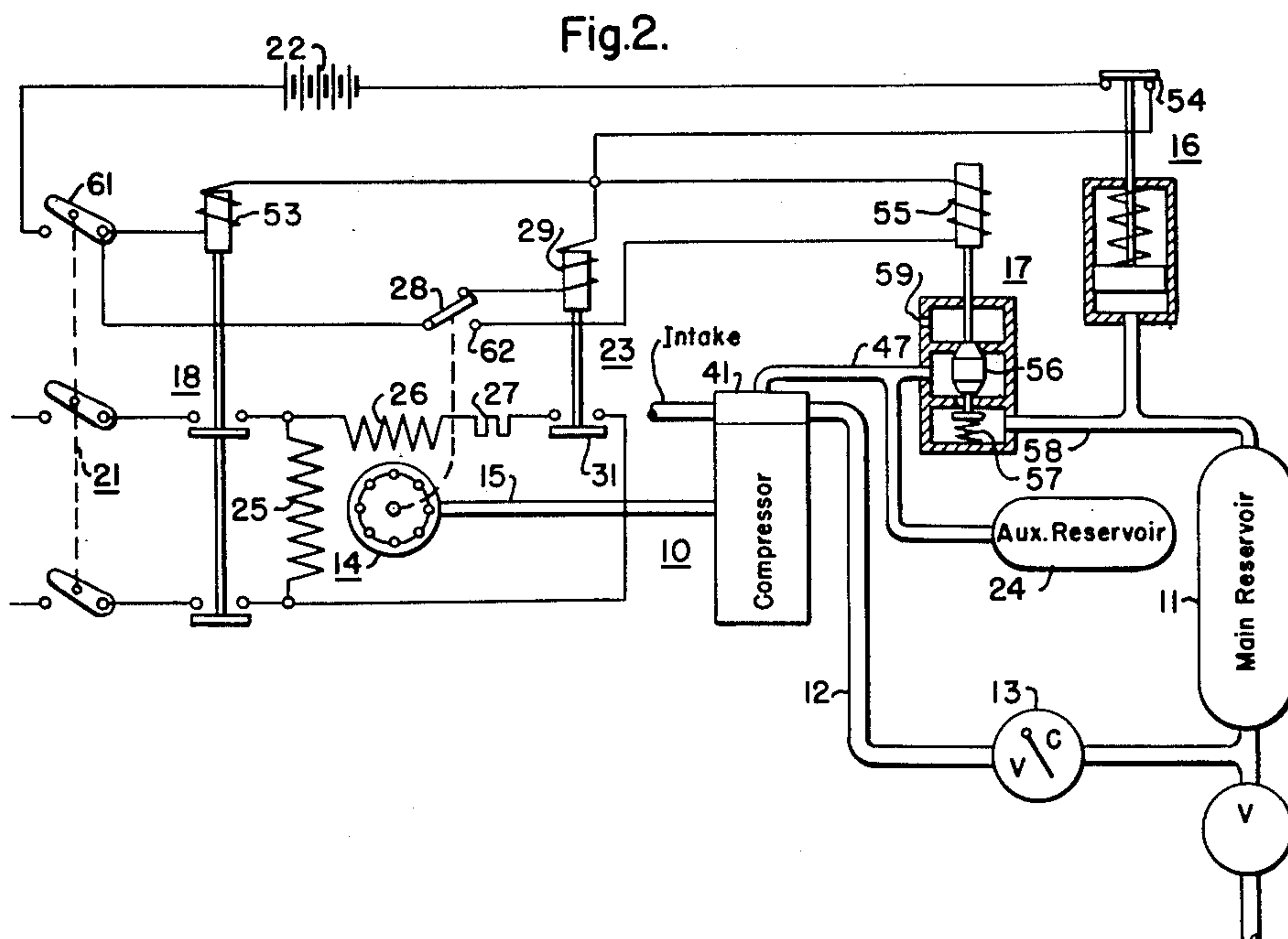
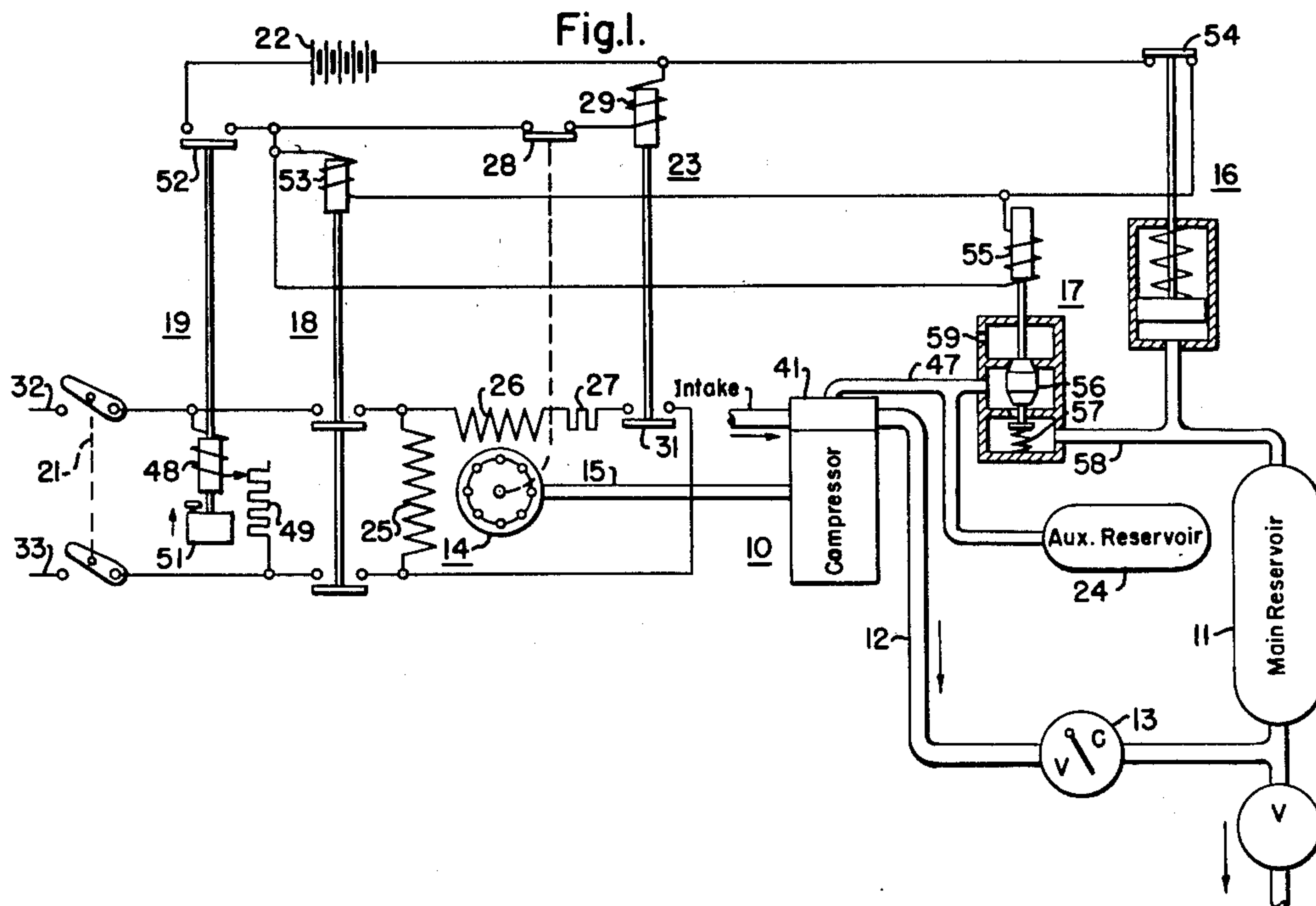
H. W. GRAYBROOK ET AL

2,629,537

COMPRESSOR MOTOR CONTROL SYSTEM

Filed Aug. 19, 1950

2 SHEETS—SHEET 1



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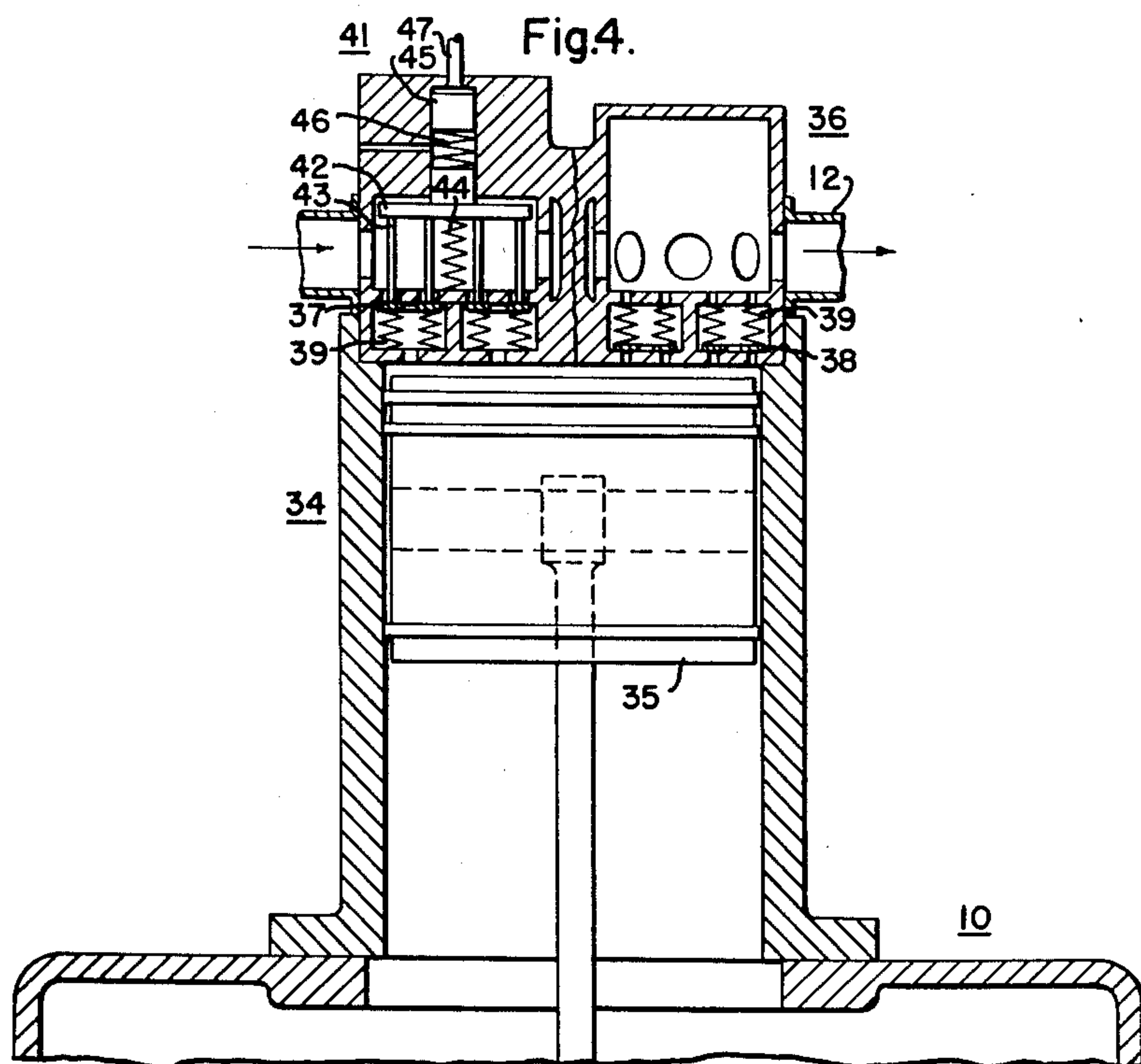
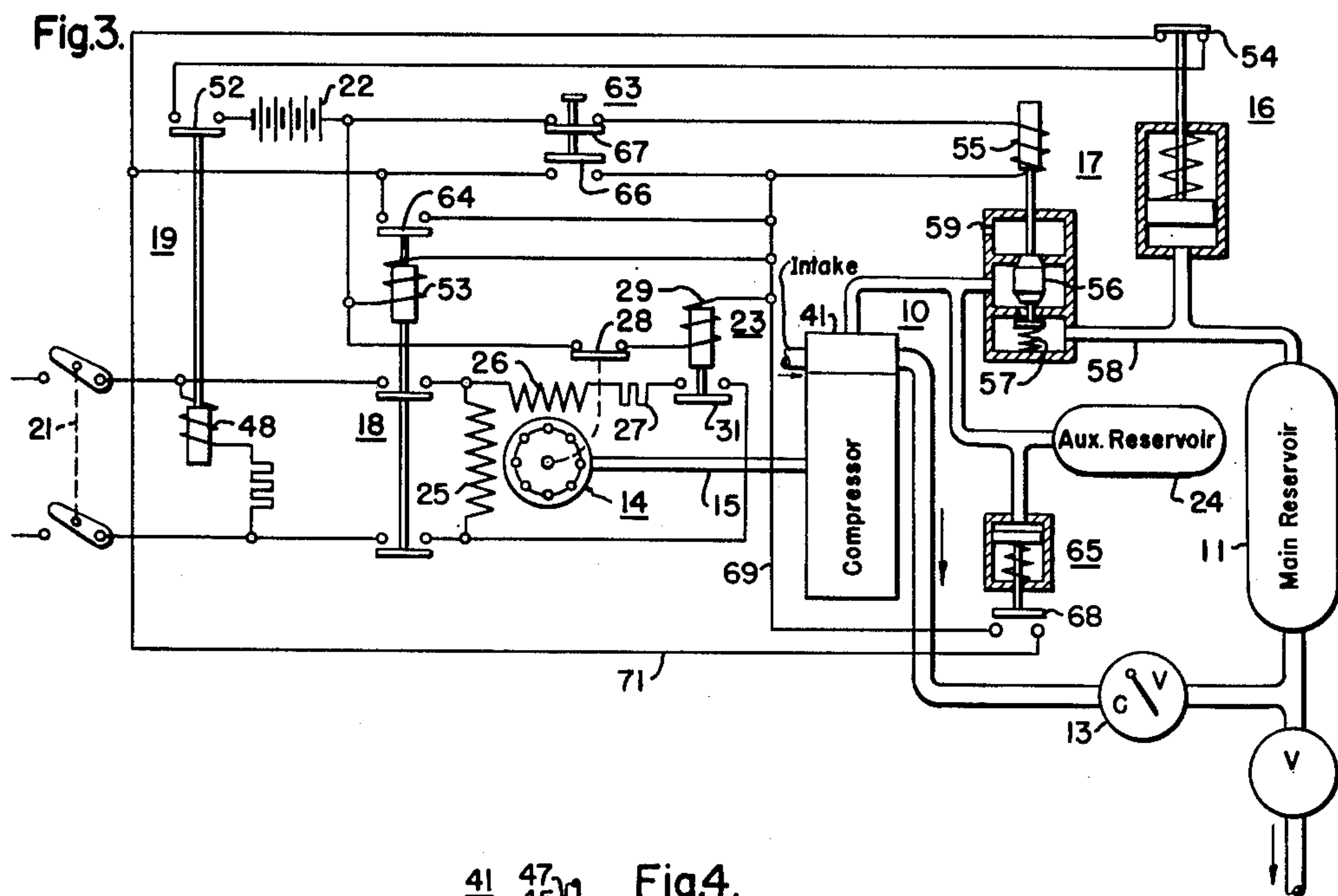
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COMPRESSOR MOTOR CONTROL SYSTEM

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2 SHEETS—SHEET 2



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COMPRESSOR MOTOR CONTROL SYSTEM

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Our invention relates, generally, to control systems and, more particularly, to systems for controlling the operation of electric motors which drive fluid compressors.

On electric locomotives it is the usual practice to drive the air compressors with auxiliary motors which are supplied with current through the current collectors on the locomotives. Therefore, the motors may be subjected to power interruptions of relatively short duration and it is desirable that the motors be prevented from starting the compressors against a head pressure after a momentary interruption of power.

An object of our invention, generally stated, is to provide a compressor motor control system which shall be simple and efficient in operation and which may be economically manufactured and installed.

A more specific object of our invention is to provide a compressor motor control system which ensures that the compressor is always unloaded during starting of the motor.

Another object of our invention is to provide for automatically maintaining an adequate supply of compressed air or other fluid in a fluid pressure system.

Other objects of our invention will be explained fully hereinafter or will be apparent to those skilled in the art.

In accordance with our invention, a motor driven compressor is provided with valves which are opened by fluid pressure whenever the motor is required to start the compressor against a head pressure. The valve lifters are actuated by fluid stored in a reservoir which is so connected in the system that fluid pressure is automatically applied to the valve lifters when power to the motor is interrupted. The valves are automatically closed at a predetermined time after power is re-applied to the motor.

For a better understanding of the nature and objects of our invention, reference may be had to the following detailed description, taken in conjunction with the accompanying drawings, in which:

Figure 1 is a diagrammatic view of a control system embodying the principal features of our invention;

Fig. 2 is a diagrammatic view of a modification of the invention;

Fig. 3 is a diagrammatic view of another modification of the invention; and

Fig. 4 is a view, in section, of a portion of a compressor suitable for utilization in the system.

Referring to the drawings, and particularly to

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Figure 1, the system shown therein comprises a fluid or air compressor 10 which is connected to a main reservoir 11 through a pipe 12 and a check valve 13, a motor 14 for driving the compressor 10 through a shaft 15, a governor or pressure-actuated switch 16, a magnet valve 17, an electrically operated switch 18, a voltage responsive relay 19, a manually operated switch 21, a battery 22, an electrically operated starting switch 23 and an auxiliary reservoir 24.

The motor 14 may be of the split phase type having a main winding 25 and a starting winding 26 which is connected in series-circuit relation with a resistor or capacitor 27 during starting of the motor. A centrifugally operated switch 28 controls the energization of the actuating coil 29 of the starting switch 23, thereby controlling the energization of the starting winding 26 through contact members 31 of the switch 23. The motor 14 may be supplied with power through power conductors 32 and 33 which may be connected to any suitable source of single-phase alternating current power.

As shown in Fig. 4, the compressor 10 may have one or more cylinders 34, each cylinder having a piston 35 disposed therein and a cylinder head 36 disposed on top of the cylinder. In accordance with the usual practice a plurality of inlet valves 37 and exhaust valves 38 may be provided in the cylinder head 36. Valve springs 39 may be provided for biasing the valves to their closed position.

As explained hereinbefore, a valve lifter 41 is provided for opening the intake valves 37 under predetermined conditions. The valve lifter 41 comprises a plunger 42 having prongs 43 thereon for engaging the valves 37, a spring 44 for biasing the plunger 42 outwardly or upwardly, an unloader valve or piston 45 and a spring 46 disposed between the piston 45 and the plunger 42. When pressure fluid is admitted through a pipe 47, the piston 45 and the plunger 42 are actuated downwardly, thereby causing the prongs 43 to "lift" or open the inlet valves 37.

As explained hereinbefore, the inlet valves 37 are opened by the valve lifter to prevent the motor 14 from starting the compressor 10 against a head pressure. As also explained hereinbefore, the motor 14 may be subjected to momentary interruptions of power, particularly when the current for the motor is supplied through a current collecting device such as a pantograph mounted on a locomotive and engaging an overhead trolley conductor, thereby causing a momentary loss of high speeds the pantograph may bounce from the

conductor, thereby causing a momentary loss of power to the motor. Thus it is necessary to prevent the motor from starting the compressor against a head pressure both during normal operation of the system and also during abnormal conditions such as those caused by momentary interruptions in the power supply.

In the present system, in the form shown in Fig. 1, the auxiliary reservoir 24, the governor or pressure-actuated switch 16, the magnet valve 17, the electrically operated switch 18 and the voltage relay 19 are utilized to provide the necessary protection for the motor. The functioning of the protective features may be explained by describing the operation of the system.

During the initial starting period the valves are not lifted and there is no head pressure since there is no pressure in the main reservoir. The manual switch 21 is closed, in Fig. 1, thereby energizing the actuating coil 48 of the voltage relay 19 through a resistor 49. As shown the relay 19 is of the time delay type having a dashpot 51 which delays the closing of contact members 52 of the relay 19.

When the contact members 52 are closed the coil 53 of the line switch 18 and the coil 29 of the starting switch 23 are connected across the battery 22 through contact members 54 of the pressure actuated switch 16 and through the centrifugally operated switch 28, respectively.

The closing of the switches 18 and 23 connects the motor 14 to the power source and the motor starts to rotate. When the motor attains a predetermined speed the centrifugal switch 28 is opened, thereby deenergizing the coil 29 of the starting switch 23. The contact members 31 of this switch are opened to disconnect the starting winding 26, thereby causing the motor to run with its main winding 25 energized.

When the compressor has filled the main reservoir 11 and the air system to a predetermined pressure, the pressure-actuated switch 16 opens its contact members 54 to interrupt the energizing circuit for the coil 53 of the line switch 18. This switch then opens, thereby stopping the motor. At the same time the coil 55 of the magnet valve 17, which was previously energized simultaneously with the energization of the coil 53 of the line switch 18, is deenergized, thereby permitting the valve member 56 to be actuated by a spring 57 to the position shown in the drawing in which air pressure is diverted from the main reservoir 11 through a pipe 58, the magnet valve 17 and the pipe 47 to the auxiliary reservoir 24 and the valve lifter 41.

When the air pressure in the main reservoir 11 drops to a predetermined value the pressure-actuated switch 16 closes the battery circuit, thereby causing the line switch 18 to be reclosed to reapply power to the motor 14. At this time the coil 55 of the magnet valve 17 is also energized, thereby actuating the valve member 56 to stop the flow of air from the main reservoir 11 to the auxiliary reservoir and the valve lifter 41, and to permit the air pressure in the auxiliary reservoir 24 and the valve lifter 41 to be exhausted at a predetermined rate through a restricted opening 59 in the magnet valve 17. Thus, the motor is permitted to attain full speed before the valves in the compressor are permitted to seat and the compressor begins pumping against the main reservoir head pressure.

If there should be a momentary interruption of the alternating-current supply the time delay

relay 19 will drop out immediately, thereby interrupting the energizing circuits for the line switch 18, the starting switch 23 and the magnet valve 17. Because of the time delay construction of relay 19 it can not reconnect the battery circuits to cause starting of the motor even though power is reapplied to the conductors 32 and 33 until sufficient time has elapsed to lift the valves in the compressor.

In this manner the motor 14 is permitted to start the compressor unloaded under all conditions, thereby preventing damage to the motor. An adequate supply of compressed air is assured since the motor automatically starts the compressor (if the pressure-switch contacts 54 are closed), after power interruptions of short duration.

In the modification shown in Fig. 2, in which like parts are designated by the same reference characters as in Fig. 1, the voltage relay 19 is omitted and the battery circuit is closed and opened by a third switch-blade or contact member 61 on the manually operated switch 21. Also, an additional contact member 62 is provided on the centrifugal switch 28. Otherwise the system shown in Figure 2 is similar to the one shown in Figure 1.

The motor 14 is initially started, in Fig. 2, by closing the manual switch 21. When the motor attains a predetermined speed the centrifugal switch 28 opens the energizing circuit for the starting switch 23 and closes the energizing circuit for the magnet valve 17. If for any reason the motor voltage fails or allows the motor speed to drop to a point where the centrifugal switch 28 drops back to its starting position, the magnet valve circuit is opened, thereby permitting the air pressure from the main reservoir to fill the auxiliary reservoir 24 and to lift the valves in the compressor.

When the motor starts again, and attains a certain intermediate speed, in Fig. 2, the centrifugal switch 28 closes the magnet valve circuit, thereby permitting the air in the auxiliary reservoir 24 and the valve lifter 41 to exhaust through the magnet valve and the valves to seat. The compressor then starts building up pressure in the main reservoir in the manner previously described.

In the modification of the invention shown in Figure 3 a starting push-button switch 63, an auxiliary contact member 64 on the line switch 18, and an auxiliary pressure-actuated switch 65 are provided, in addition to the apparatus shown in Fig. 1. Also, the time delay device 51 is omitted from the voltage relay 19. Otherwise the system shown in Fig. 3 is similar to the one shown in Fig. 1.

To ready the motor 14 for starting, the manual switch 21 is closed, thereby energizing the voltage relay 19. The starting push button 63 is depressed to close its contact members 66, thereby energizing the line switch 18 and the starting switch 23, from a battery-energized circuit including the contacts 52 and 54. The auxiliary contact 64 on the line switch 18 establishes a holding circuit for the line switch 18 and the starting switch 23, thereby permitting the push-button switch 63 to be released after these switches have closed. The motor 14 starts and at a predetermined speed the centrifugal switch 28 opens the starting switch 23.

After the compressor has filled the air reservoir 11 to a predetermined pressure, the pressure-

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actuated switch 16 opens the circuits for the line switch 18 and the magnet valve 17 in the manner previously described. It should be noted that the magnet valve 17 in Fig. 3 was energized through contact members 67 on the push-button switch 63 when this switch was released after starting the motor. When the magnet valve 17 is deenergized the auxiliary reservoir 24 is filled and air pressure is applied to the valve lifter 41 to lift the valves in the manner previously described.

When the air pressure in the main reservoir has dropped to a predetermined value the pressure-actuated switch 16 closes the circuit to the line contactor 18 and the starting switch 23 provided there is a minimum predetermined pressure in the auxiliary reservoir 24 as measured by the auxiliary pressure switch 65 of Fig. 3. As shown, contact members 68 on the switch 65 establish a circuit through conductors 69 and 71 which parallels the circuit through the contact members 66 of the push-button switch 63, and also parallels the circuit through the contact members 64 of the switch 18. The pressure in the auxiliary reservoir 24 prevents the valves from seating, so that the compressor is unloaded and the motor can not start under load. At this time the magnet valve 17 is energized, thereby permitting the air from the reservoir 24 to be exhausted at a predetermined rate as previously explained. When the pressure has decreased to a predetermined value the valves are permitted to close and the compressor starts pumping.

If there should be a momentary interruption in the alternating-current supply, in Fig. 3, the voltage relay 19 drops out, thereby opening the line switch 18 immediately. The magnet valve 17 is also deenergized at this time. When the voltage relay 19 is again energized by the restoration of power the compressor and the motor are prevented from starting unless the valves have been lifted by a predetermined pressure in the auxiliary reservoir 24 as measured by the auxiliary pressure switch 65.

As previously explained it is necessary for the contact members 68 of this auxiliary pressure switch 65 in Fig. 3 to be closed in order for the motor to be restarted automatically. When the pressure in the auxiliary reservoir 24 is sufficient to close the contact members 68 of the switch 65 the motor is automatically started upon the restoration of power (assuming that the main pressure-switch contacts 54 are closed), and the valves are lifted in the manner hereinbefore described. If the pressure in the auxiliary reservoir 24 is not sufficient to actuate the auxiliary pressure switch 65, the motor will not automatically start. In this manner damage to the motor is prevented.

From the foregoing description it is apparent that we have provided a control system which automatically controls the starting and stopping of a compressor motor and prevents the motor from being started against a head pressure, thereby preventing injury to the motor. The system described herein provides for automatically restarting the motor after momentary interruptions of power, thereby insuring an adequate supply of compressed air or other pressure fluid at all times during the operation of the locomotive or other vehicle on which the system is installed.

Since numerous changes may be made in the above described construction and different embodiments of the invention may be made without departing from the spirit and scope thereof, it

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is intended that all matter contained in the foregoing description or shown in the accompanying drawing shall be interpreted as illustrative and not in a limiting sense.

5 We claim as our invention:

1. In a control system, in combination, a fluid compressor having a fluid-actuated valve lifter therein, a motor for driving the compressor, power conductors, electrically controlled switching means for connecting the motor to the power conductors, a main reservoir connected to the compressor, an auxiliary reservoir connected to the valve lifter, electrically operated valve means for controlling the admission of pressure fluid from the main reservoir to the auxiliary reservoir, a fluid-actuated switch responsive to the pressure in the main reservoir for controlling the operation of said switching means and said valve means, and relay means responsive to the voltage across said power conductors for also controlling the operation of said switching means and said valve means.

2. In a control system, in combination, a fluid compressor having a fluid-actuated valve lifter therein, a motor for driving the compressor, power conductors, electrically controlled switching means for connecting the motor to the power conductors, a main reservoir connected to the compressor, an auxiliary reservoir connected to the valve lifter, electrically controlled valve means for controlling the admission of pressure fluid from the main reservoir to the auxiliary reservoir and the valve lifter and for controlling the exhausting of the pressure fluid from the valve lifter and the auxiliary reservoir, a fluid-actuated switch responsive to the pressure in the main reservoir for controlling the operation of said switching means and said valve means, and time delay relay means responsive to the voltage across said power conductors for also controlling the operation of said switching means and said valve means.

3. In a control system, in combination, a fluid compressor having a fluid-actuated valve lifter therein, a motor for driving the compressor, power conductors, electrically controlled switching means for connecting the motor to the power conductors, a main reservoir connected to the compressor, an auxiliary reservoir connected to the valve lifter, electrically operated valve means for controlling the admission of pressure fluid from the main reservoir to the auxiliary reservoir, a fluid-actuated switch responsive to the pressure in the main reservoir for controlling the operation of said switching means and said valve means, and relay means responsive to the voltage across said power conductors for also controlling the operation of said switching means and said valve means, said relay means having a device thereon for delaying the closing of the relay contact members.

4. In a control system, in combination, a fluid compressor having a fluid-actuated valve lifter therein, a motor for driving the compressor, power conductors, electrically controlled switching means for connecting the motor to the power conductors, a main reservoir connected to the compressor, an auxiliary reservoir connected to the valve lifter, electrically operated valve means for controlling the admission of pressure fluid from the main reservoir to the auxiliary reservoir, a fluid-actuated switch responsive to the pressure in the main reservoir for controlling the operation of said switching means and said valve means, relay means responsive to the voltage

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across said power conductors for also controlling the operation of said switching means and said valve means, and an additional fluid-actuated switch responsive to the pressure in the auxiliary reservoir cooperating with said relay means.

5. In a control system, in combination, a fluid compressor having a fluid-actuated valve lifter therein, a motor for driving the compressor, power conductors, electrically controlled switching means for connecting the motor to the power conductors, a main reservoir connected to the compressor, an auxiliary reservoir connected to the valve lifter, electrically operated valve means for controlling the admission of pressure fluid from the main reservoir to the auxiliary reservoir, a fluid-actuated switch responsive to the pressure in the main reservoir for controlling the operation of said switching means and said valve means, relay means responsive to the voltage across said power conductors for also controlling the operation of said switching means and said valve means, an additional fluid-actuated switch responsive to the pressure in the auxiliary reservoir cooperating with said relay means, and auxiliary contact members on said switching means connected in parallel-circuit relation to the contact members on said additional fluid-actuated switch.

6. In a control system, in combination, a fluid compressor having a fluid-actuated valve lifter therein, a motor for driving the compressor, power conductors, electrically controlled switching means for connecting the motor to the power conductors, a main reservoir connected to the compressor, an auxiliary reservoir connected to the valve lifter, electrically operated valve means for controlling the admission of pressure fluid from the main reservoir to the auxiliary reservoir, a fluid-actuated switch responsive to the pressure in the main reservoir for controlling the operation of said switching means and said valve means, relay means responsive to the voltage across said power conductors for also controlling the operation of said switching means and said valve means, an additional fluid-actuated switch responsive to the pressure in the auxiliary reservoir cooperating with said relay means, auxiliary contact members on said switching means connected in parallel-circuit relation to the contact members on said additional fluid-actuated switch, and a manually-operable switch having contact members connected in parallel-circuit relation to both said auxiliary contact members and the contact members on said additional fluid-actuated switch.

7. In a control system, in combination, a fluid compressor having a fluid-actuated valve lifter therein, a motor for driving the compressor, power conductors, switching means for connecting the motor to the power conductors, a main reservoir connected to the compressor, an auxiliary reservoir connected to the valve lifter, a magnet valve for controlling the admission of pressure fluid from the main reservoir to the auxiliary reservoir, a fluid-actuated switch responsive to the pressure in the main reservoir for controlling the operation of said switching means and said magnet valve, and switching means responsive to the motor speed for also controlling the operation of said magnet valve.

8. In a control system, in combination, a fluid compressor having a fluid-actuated valve lifter therein, a motor for driving the compressor, power conductors, switching means for connecting the motor to the power conductors, a main

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reservoir connected to the compressor, an auxiliary reservoir connected to the valve lifter, a magnet valve for controlling the admission of pressure fluid from the main reservoir to the auxiliary reservoir, a fluid-actuated switch responsive to the pressure in the main reservoir for controlling the operation of said switching means and said magnet valve, and a centrifugal switch actuated by the motor for also controlling the operation of said magnet valve.

9. In a control system, in combination, a fluid compressor having a fluid-actuated valve lifter therein, a motor for driving the compressor, power conductors, switching means for connecting the motor to the power conductors, a main reservoir connected to the compressor, an auxiliary reservoir connected to the valve lifter, a magnet valve for controlling the admission of pressure fluid from the main reservoir to the auxiliary reservoir, a fluid-actuated switch responsive to the pressure in the main reservoir for controlling the operation of said switching means and said magnet valve, a centrifugal switch actuated by the motor for also controlling the operation of said magnet valve, and a manually operable switch cooperating with said centrifugal switch.

10. A motor-operated fluid-pressure assembly, comprising electrical power-supply conductors subject to momentary power-interruptions, an electric motor, main switching-means for energizing said motor from said supply-conductors, a fluid compressor, a mechanical driving-connection between said motor and said compressor, a fluid-pressure reservoir connected to said compressor, a fluid-pressure-operated unloader for unloading said compressor in response to the application of a predetermined fluid-pressure to said unloader, an electromagnetically operated fluid-valve-means, including a valve-magnet, for normally connecting said unloader to said reservoir to unload said compressor when the valve-magnet is deenergized, and for responding to an energization of the valve-magnet by disconnecting said unloader from said reservoir and slowly venting said unloader in a time which allows the motor sufficient time for starting and attaining an operative motor-speed before the compressor becomes loaded, and under-pressure means, responsive to a predetermined minimum desired fluid-pressure in said reservoir, for both causing said main switching-means to assume a motor-energizing condition and also energizing said valve-magnet, in combination with an auxiliary switching-means, responsive to a deenergized motor-condition, for opening the energizing-circuit of said valve-magnet.

11. The invention as defined in claim 10, characterized by said auxiliary switching-means being also operative to open said main switching-means, in combination with means for subsequently reclosing said main switching-means and reenergizing said valve-magnet after the unloader has had time to unload the compressor.

12. The invention as defined in claim 10, characterized by said auxiliary switching-means being also operative to open said main switching-means, and further characterized by said auxiliary switching-means being a voltage-responsive switching-means which drops out quickly in response to a predetermined drop in voltage in said power-supply conductors, and which picks up slowly enough to give the unloader time to unload the compressor in response to a restoration of voltage in said power-supply conductors.

13. The invention as defined in claim 10, characterized by said motor having a speed-responsive means associated therewith for responding to an intermediate motor-speed during the starting of the motor, and further characterized by said auxiliary switching-means being a make-contact on said speed-responsive means, said make-contact closing in response to a predetermined speed during motor-acceleration and opening in response to a predetermined speed during motor-deceleration. 5 10

14. The invention as defined in claim 10, characterized by said auxiliary switching-means being also operative to open said main switching-means, in combination with means responsive to

the attainment of an effective operative-pressure on the unloader for reclosing said main switching-means and reenergizing said valve-magnet.
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