Dec. 23, 1930. J. W. SANFORD 1,786,128

COMPRESSOR CONTROLLING MECHANISM

Filed March 17, 1928 2 Sheets-Sheet 1

Fig. 1.

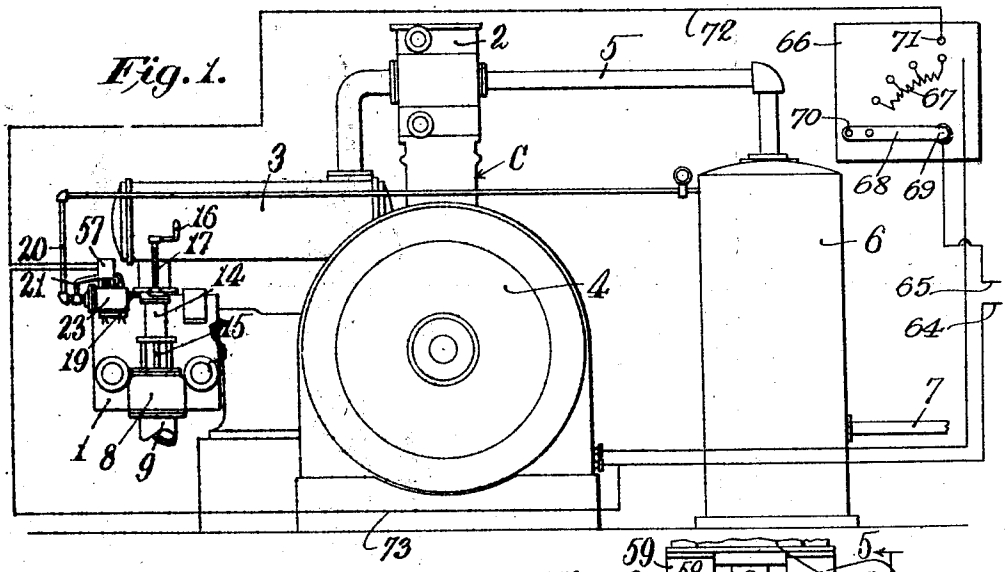


Fig. 2.

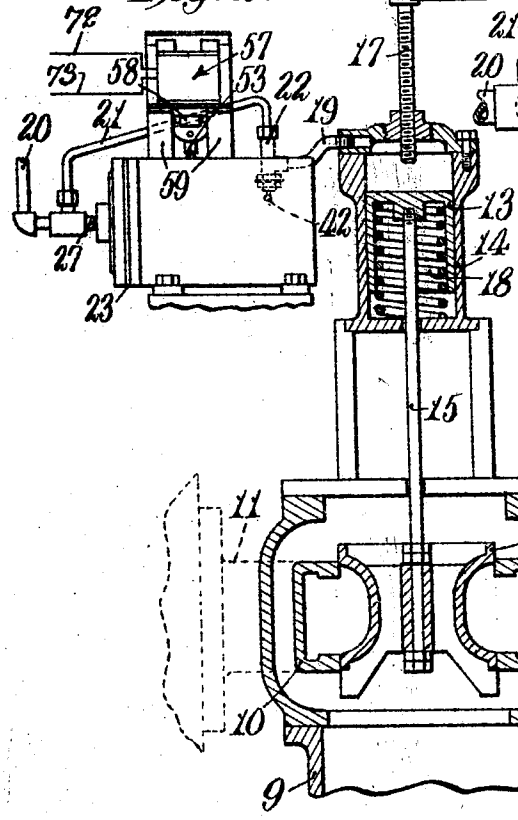


Fig. 3.

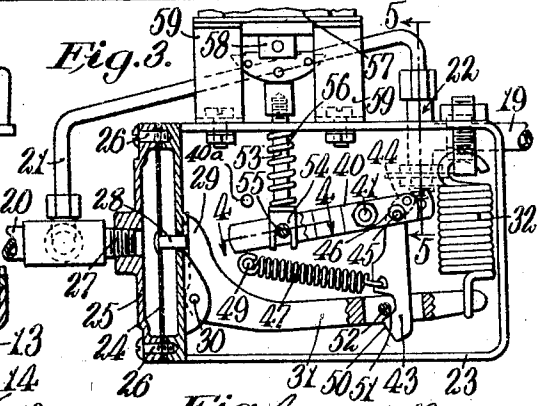


Fig. 4.

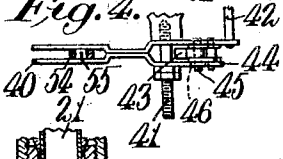
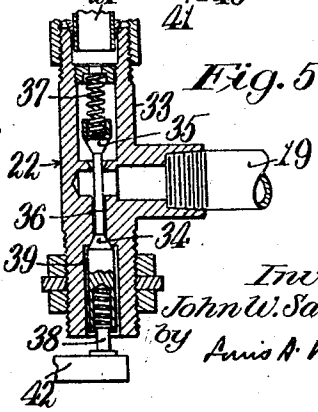


Fig. 5.



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Fig. 6.

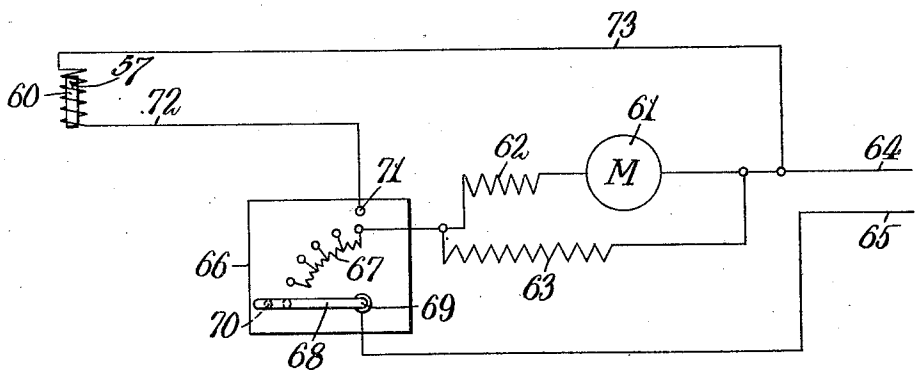
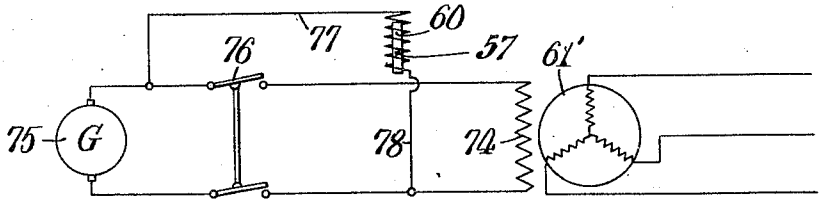


Fig. 7.



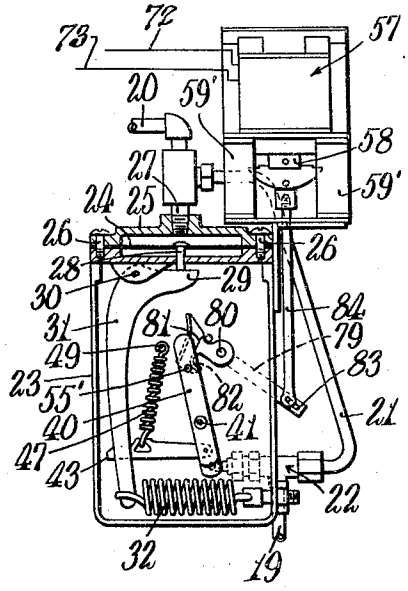


Fig. 8.

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UNITED STATES PATENT OFFICE

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COMPRESSOR-CONTROLLING MECHANISM

Application filed March 17, 1928. Serial No. 262,520.

My invention relates to compressor controlling mechanism, and more particularly to means for rendering the unloading device of a compressor inoperative to load the same until its driving motor comes up to speed.

An object of the invention is to provide an improved compressor controlling system. Another object is to provide an improved means for holding the compressor in an unloaded condition until it comes up to speed. A further object of the invention is to provide improved means operating in conjunction with a device normally controlling loading and unloading in response to variations in receiver tank pressure to insure that the compressor may always come up to speed before having its load applied. A more specific object of the invention is to provide improved electro-magnetic means controlled by means for controlling the driving motor of a compressor, operating to hold a device which normally controls loading and unloading in its unloading position until the driving motor reaches its normal operating speed. Other objects and advantages of the invention will hereinafter more fully appear.

In the accompanying drawings I have shown for illustrative purposes two mechanical modifications of the invention and electrical connections for types of motors in common use for driving a compressor.

In these drawings,—

Fig. 1 represents a diagrammatic elevation view of a fluid compressing system.

Fig. 2 is a detail view, partly in elevation and partly in vertical section, of the unloading device of the compressor.

Fig. 3 is a further detail view showing the mechanism for controlling the compressor unloading valve.

Fig. 4 is a detail view, partially in plan and partially in section along the line 4—4 of Fig. 3.

Fig. 5 is a detail view of the valve mechanism on line 5—5 of Fig. 3 with one of the connections turned at right angles to facilitate illustration.

Fig. 6 is a wiring diagram of my invention as applied to a compressor driving motor of the direct current type.

Fig. 7 is a modification of the wiring diagram as applied to an alternating current motor of the synchronous type.

Fig. 8 is a view somewhat similar to Fig. 3 illustrating a modification.

In Fig. 1 I have illustrated my invention as incorporated with a compressor C of the angle compound type having a low pressure cylinder 1 and a high pressure cylinder 2 with an intercooler 3 interposed between the two cylinders. The compressor is shown as being driven by a direct connected motor 4. Compressed fluid is discharged from the high pressure cylinder by way of a pipe 5 to a receiver tank 6 from which it may be supplied through a connection 7 for any desired purpose. It will of course be understood that my invention is equally applicable to any other type of compound or single stage compressors driven by any suitable means.

In the particular compressor illustrated there is provided an unloading system of the intake closure type employing an intake closure valve 8 controlling the supply to the compressor of air entering through the inlet pipe 9. It will of course be understood that the automatic control system can be adapted to any other type of unloading system where fluid pressure is used to actuate the unloading system. As best illustrated in Fig. 2, this valve comprises a casing 10 which communicates with the compressor through a connection 11 illustrated in dotted lines, and a movable valve element 12 for controlling communication between the interior of this casing and the inlet 9. This valve is adapted to be actuated by means of a piston 13 operating in a cylinder 14 and connected to the valve element by means of a rod 15. The position of this valve may be controlled by means of a crank 16 controlling a screw 17. The valve is actuated in one direction by means of the coil spring 18 surrounding the piston rod 15 and in the opposite direction by means of fluid pressure supplied to the cylinder through the pipe 19 which in this instance is supplied with compressed fluid from the receiver tank through pipes 20 and 21 and a valve mechanism 22, which valve mechanism is adapted

to be automatically controlled in a manner to be later described.

The valve mechanism 22 comprises a valve casing 33 in which are loosely mounted a plurality of valve elements 34 and 35 having valve stems freely guided in a reduced bore 36. The valve member 35 is normally held in closed position by the coil spring 37, but the same is adapted to be moved to open position as shown in Fig. 5 by means of a plunger 38 operating through the valve 34 and each of the valve stems. It will be noted in the use of this valve that while the valve 35 is seated, the valve 34 is open, thereby allowing the pipe 19 and the cylinder 14 to be vented to the atmosphere through the bore 36 and a chamber 39 in which the valve member 34 is loosely mounted.

The mechanism for automatically controlling the valve elements 34 and 35 will now be described. A frame member 23 has a diaphragm 24 mounted at one end thereof and secured in position by means of a cover plate 25 and retaining screws 26. One side of the diaphragm 24 is constantly subjected to the pressure of the compressed fluid in the receiver tank with which it communicates through the pipe 20 and the connection 27. The movement of the diaphragm 24 is transmitted through a pin 28 to one arm 29 of a bell crank lever which is pivoted at 30. The other arm 31 of the bell crank lever extends forwardly of the casing and is connected to a relatively strong spring 32 normally tending to urge the bell crank lever in a direction opposite to the pressure acting against the diaphragm 24. A lever 40 is pivoted at 41 and has a stop 42 projecting into the path of the plunger 38 as illustrated in Fig. 5. In normal operation the pivoted lever 40 is controlled by means of a link 43 having a lost motion connection with the pivoted lever 40 which in this instance takes the form of a supplemental link member 44 pivotally connected to the lever 40 and link 43, the latter pivot comprising a pin 45 cooperating with an enlarged slot or hole 46 in the pivoted member 40. A tension spring 47 having one end fixed to the frame member at 49 is connected to the link 43 and normally tends to urge the link to the left as viewed in Fig. 3. This horizontal force of the spring 47 serves to actuate the link 43 upwardly or downwardly dependent upon the position of the arm 31 of the bell crank lever. This is accomplished by the cooperation between cam shaped surfaces 50 and 51 and a pin 52 carried by the arm 31. Clockwise motion of the lever 40 on its pivot 41 is limited by the stop 40^a.

The lever 40 may be held in position to hold the plunger 38 in elevated position and thus unload the compressor regardless of the position of the diaphragm 24 and arm 31 of the bell crank lever and for this purpose I have provided a movable stem 53 carrying on its end a fork 54 which engages a pin 55 carried by the lever 40. This stem may be actuated by a compression spring 56 to the position shown in Fig. 3, thereby holding the plunger 38 in elevated position, or the stem 53 may be moved entirely out of the way against the force of the spring 56, by means of a solenoid or electro-magnet mechanism generally designated 57 and having a movable core 58 connected to the member 53 in any suitable manner. The solenoid or electro-magnet mechanism may be mounted by means of brackets 59 directly on the frame member 23 of the pilot valve mechanism.

Examples of connections whereby this solenoid or electro-magnet mechanism may be controlled when different types of motors are used are illustrated in Fig. 1, and also in Figs. 6 and 7, wherein numeral 60 indicates the coil of the solenoid or electro-magnet. In Fig. 6 a direct current motor 61 is indicated diagrammatically and has a series field 62 and shunt field 63. The motor 61 is adapted to be supplied with power from the direct current lines 64 and 65 through a controller 66. This controller may be of any suitable manually operated or automatic type, but is herein illustrated as comprising an adjustable resistance 67 controlled by a lever 68 pivoted at 69. The lever 68 carries a supplemental movable contact 70 adapted to engage the contact 71 when the controller handle is moved to its on position. This makes a circuit through the solenoid coil 60 from the wire 65 through the lever 68 to a wire 72 through the solenoid coil 60 and wire 73 to the other power line 64.

In Fig. 7 there is shown a diagram of a synchronous motor and suitable connections for the solenoid coil 60 so as to prevent the coil being energized until the motor has reached synchronous speed. The motor is indicated at 61′ and has field coils 74 which are excited during operation of the machine by a direct current generator 75. Synchronizing may be controlled by any suitable means represented in the present instance by a manually controlled switch 76. The coil 60 is connected in parallel with the motor field 74 by wires 77 and 78 in such a manner as to be controlled by the synchronizing switch. By using a double pole switch and connecting the coil in the manner shown the voltage generated in the motor field winding during the starting period is not applied to the coil 60, and thus there is no liability of the coil burning out during the starting period.

The operation of the improved compressor controlling system should now be readily understood in view of the above description. Assuming the parts to be in the positions indicated in the drawings where the holding mechanism controlled by the solenoid 57 is

operative to hold the compressor unloading device in unloaded position, the motor will be started through the operation of the starting apparatus, which in Fig. 6 comprises the controller 66 and when the motor reaches substantially its normal operating speed, solenoid coil 60 is energized since the controller handle 68 will be moved into position to form a connection between the contacts 70 and 71. When the solenoid 57 is energized, the stem 53 will be raised against the force of the spring 56 into such position that it will not interfere with the free movement of the pivoted lever 40. The unloading device is now free to operate to load and unload the compressor in response to variations in receiver tank pressure which are communicated to the diaphragm 24 through pipe 20. If air pressure is low, the bell crank lever 29 will be in the position illustrated in Fig. 3 and when the stem 53 is raised the lever 40 will be rotated in a clockwise direction by the downward thrust of the link 43 caused by the tension of the spring 47 and the cooperation between the cam surface 51 and the pin 52. It will be understood of course that when air pressure is low, pin 52 will be in engagement with the surface 51. This movement of lever 40 moves the stop 42 away from plunger 38 thus allowing the same to drop, whereby valve 34 will be opened and valve 35 simultaneously closed. Thus the cylinder 14 will be vented through the connection 19 by valve 34 to atmosphere and spring 18 will operate to move the unloading valve to its elevated or open position, whereupon the compressor is loaded. When pressure in the receiver tank builds up, diaphragm 24 will be actuated to the right in Fig. 3, causing the bell crank lever to pivot in a clockwise direction against the tension of spring 32. When the pressure reaches the point where the pin 52 moves over the point between surfaces 50 and 51, spring 47 cooperating with the cam surface 50 and pin 52 will elevate the link 43, thus rotating lever 40 in a counterclockwise direction and raising stop 42, plunger 38 and valve elements 34 and 35. This operation opens the connection between pipes 21 and 19 to admit air pressure to cylinder 14 and move valve 12 to its closed or unloading position.

When the pressure in the receiver tank goes down due to pressure fluid consumption, spring 32 will overbalance the action of the diaphragm 24 on the bell crank lever, thus raising pin 52, and when this pin again passes the point between surfaces 50 and 51, spring 47 cooperating with the inclined surface 51 will again pull the link 43 to its lower position, thereby closing valve 35 and opening valve 34, whereupon the compressor is again loaded.

There are various arrangements which might be employed for controlling the excitation of the solenoid coil in different types of motors. The arrangement shown in Fig. 7 is adapted for use in conjunction with a synchronous motor drive since it insures that the load will never come on the compressor until the motor has been synchronized and is capable of carrying its full load.

The modification illustrated in Fig. 8 is similar to the form shown in Figs. 1 to 5, differing therefrom only in respect to the mechanical connection between solenoid 57 and lever 40 of the pilot valve mechanism. A lever 79 is pivoted on casing 23 of the pilot valve mechanism at 80 and has a cam shaped surface 81 which cooperates with pin 55′ on the lever 40 to hold the same in unloaded position, which is the position illustrated, or, when moved counterclockwise about its pivot, to permit the normal movement of lever 40 in the operation of loading and unloading. The cam surface has a portion 82 formed so as to make the device self-locking in the position shown. The lever 79 has an arm 83 disposed on the outside of casing 23 and has connected thereto a link 84 which is in turn actuated by core 58 of the solenoid 57. This solenoid is attached to the casing of the pilot valve mechanism by means of suitable brackets 59′ in a position preferably at right angles to the position shown in Fig. 3 so that the weight of the moving parts of the solenoid and the link 84 will tend to operate lever 79 to the position shown where it will hold the compressor unloaded by the influence of gravity alone which takes the place of spring 56 shown in the other embodiment. When the solenoid is energized, link 84 is lifted and lever 79 rotated in a counterclockwise direction, which will swing the cam surface 81 to a position which will permit the necessary freedom of movement of the pin 55′ as will be clear from the drawing. In all other respects the operation of this mechanism is identical with the operation of the other form which has been described above in detail. One possible advantage of this form is that if anything happened which would render the solenoid inoperative, link 84 might be disconnected from the lever 79 which could then be positioned manually to loaded or unloaded position as desired.

As a result of my invention it will be apparent that simple means have been provided which may be easily applied to a widely used form of pneumatically operated unloading system used to control loading and unloading of the compressor in response to demands for air.

While I have in this application specifically described a few forms which my invention may assume in practice, it will be understood that these forms of the same are used for purpose of illustration and that the invention may be modified and embodied in various other forms without departing from its spirit or the scope of the appended claims.

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

1. In an automatic compressor control system, an electric motor for driving the same, a pressure responsive pilot valve for controlling loading and unloading of said compressor during normal operation in response to variations in discharge pressure while the compressor is running continuously, a controlling device for said motor, and means controlled thereby for actuating said pilot valve to unloaded position and holding the same in such position until the motor reaches substantially normal operating speed.

2. In combination, a compressor, an electric driving motor therefor, means including a pressure responsive pilot valve for controlling loading and unloading of said compressor in response to variations in discharge pressure while the compressor is running, a controlling device for said motor, and electromagnetic means controlled by said controlling device and cooperating with said unloading means to control loading and unloading of said compressor independently of discharge pressure.

3. In combination, a compressor, an electric motor for driving the same, pneumatic means for loading and unloading said compressor during continued running, means for controlling the supply and exhaust of fluid pressure to and from said pneumatic means, said controlling means including a valve, a controlling device for said motor, and means controlled by said device for holding said valve in position to unload the compressor until it reaches substantially normal operating speed.

4. In an automatic compressor control system, a compressor, an electric driving motor therefor, mechanism for normally controlling loading and unloading of said compressor in response to variations in demand for compressed fluid, a controller for said motor comprising an adjustable resistance, electromagnetic means cooperating with said mechanism, means operated by said controller for energizing said electromagnetic means when the controller is moved to its on position, a connection between said electromagnetic means and unloading mechanism for holding said mechanism in position to unload the compressor when there is no current in said electromagnetic means and for permitting free movement of said unloading mechanism to load and unload the compressor in response to variations in discharge pressure when said electromagnetic means is energized.

5. In a compressor controlling mechanism, the combination of a compressor, a motor driving the compressor, an unloader for the compressor, a regulator responding to pumped pressure normally controlling the unloader, and operative to effect power supply thereto to effect unloading when pumped pressure reaches the desired maximum, an electrically actuated device controlling the unloader independently of pumped pressure, and means for controlling current flow in said device to effect unloading during the period while said motor is coming up to speed.

6. In a compressor controlling mechanism, the combination of a compressor, an unloader for the compressor, a regulator responsive to pumped pressure normally controlling the unloader during running of the compressor, an electrically actuated device acting through the regulator for controlling the unloader independently of pumped pressure, and means for controlling current flow in said device.

7. In a compressor controlling mechanism, the combination of a compressor, a motor for driving the compressor, a fluid actuated unloader for the compressor operative on fluid supply thereto to effect unloading, a regulator responsive to compressor discharge pressure having a movable element controlling the unloader normally in accordance with the pump pressure, a holding device adapted for engagement with said element for holding the same in position to effect unloading of the compressor independently of compressor discharge pressure, and means for automatically controlling said device.

8. In a compressor controlling mechanism, the combination of a compressor, a motor driving the compressor, a fluid actuated unloader for the compressor operative on fluid supply thereto to effect unloading, a regulator responsive to compressor discharge pressure including a valve controlling the unloader normally in accordance with the compressor discharge pressure, a holding device for holding said valve in position to effect unloading of the compressor independently of compressor discharge pressure, and a controlling device for the motor also controlling said holding device so as to hold the compressor unloaded until the motor comes up to speed.

9. In a compressor controlling mechanism, the combination of a compressor, a motor driving the compressor, a fluid actuated unloader for the compressor operative on fluid supply thereto to effect unloading, a regulator responsive to pumped pressure normally controlling the unloader, said regulator having a movable element, a holding device normally in holding position for holding said element in position to cause unloading, electromagnetic means connected to said element, and means for energizing said electromagnetic means to retract said element.

10. In a compressor controlling mechanism, the combination of a compressor, a motor driving the compressor, a fluid actuated unloader for the compressor operative on

fluid supply thereto to effect unloading, a regulator responsive to compressor discharge pressure normally controlling the unloader, said regulator including a valve, a holding device for holding said valve in position to effect unloading of the compressor independently of compressor discharge pressure, a controlling device for the motor, electromagnetic means for moving said holding device to inoperative position when energized, and means for energizing said electromagnetic means under the control of said motor controlling device.

11. In a compressor controlling mechanism, the combination of a compressor, a motor for driving the compressor, a fluid actuated unloader for the compressor, a pilot valve responsive to compressor discharge pressure normally controlling said unloader in response to demand for compressed fluid, an electrically actuated device controlling the unloader to insure unloading until the compressor has come up to speed, a controlling device for the motor, and means controlled thereby for controlling flow of current in said electrically actuated device.

12. In a compressor controlling mechanism, fluid pressure operated unloading means operative on fluid pressure supply thereto to effect unloading, and controlling means therefor including valve mechanism controlling fluid flow relative to said fluid pressure operated unloading means, and compressor discharge pressure and electro-magnetically governed controlling means for said valve mechanism.

13. In a compressor controlling mechanism, fluid pressure operated unloading means operative on fluid pressure supply thereto to effect unloading, and controlling means therefor including valve mechanism controlling fluid flow relative to said fluid pressure operated unloading means, and compressor discharge pressure and electro-magnetically governed controlling means for said valve mechanism, said electro-magnetically governed controlling means being operative under predetermined conditions to prevent control of said valve mechanism by said compressor discharge pressure governed controlling means.

14. In a compressor controlling mechanism, fluid pressure operated unloading means operative on fluid pressure supply thereto to effect unloading, and controlling means therefor including valve mechanism controlling fluid flow relative to said fluid pressure operated unloading means, and compressor discharge pressure and electro-magnetically governed controlling means for said valve mechanism, said electro-magnetically governed controlling means being operative until said compressor is operating at substantially full speed to prevent control of said valve mechanism by said compressor discharge pressure controlled governing means.

15. In a pump controlling mechanism, pump unloading means, actuating means therefor operative on power supply thereto to effect unloading, and means for controlling said actuating means including a controlling device governed by variations in the pressure affected by loaded operation of said pump and electro-magnet governed means for controlling said actuating means to the exclusion of said first mentioned controlling means when said pump is operating below a predetermined speed.

16. In a pump controlling mechanism, pump unloading means, actuating means therefor operative on power medium supply thereto to effect unloading, and means for controlling said actuating means including a controlling device governed by variations in the pressure affected by loaded operation of said pump, electro-magnet governed means for controlling said actuating means to the exclusion of said first mentioned controlling means when said pump is operating below a predetermined speed, and means for rendering ineffective said last mentioned controlling means when said pump is brought up to substantially normal speed from an idle condition.

In testimony whereof I affix my signature.

JOHN W. SANFORD.