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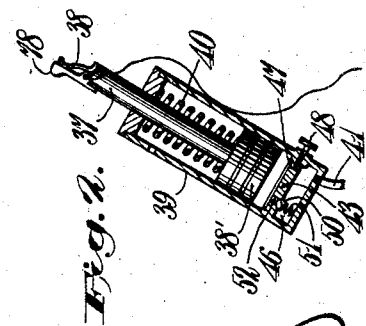
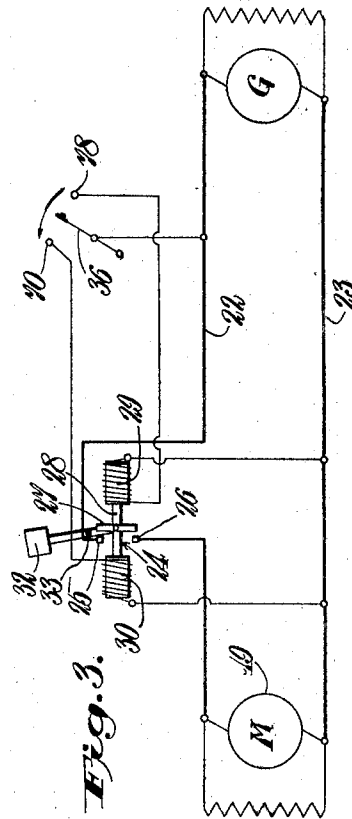
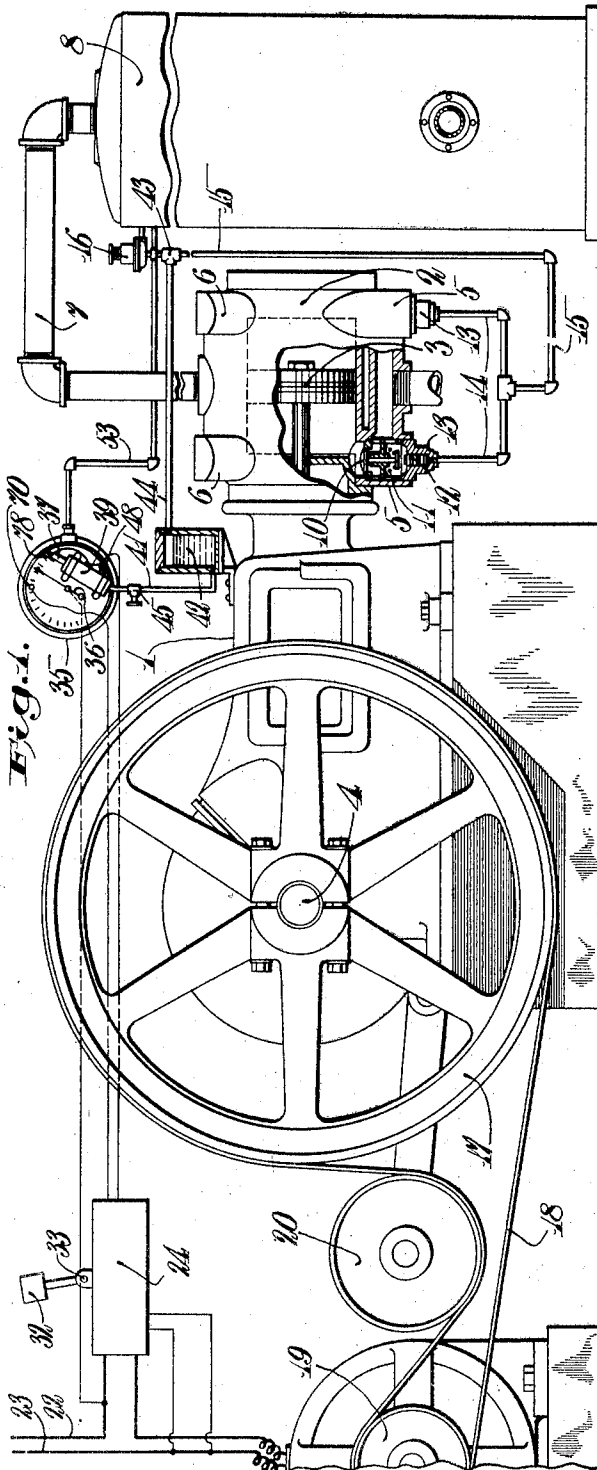
L. A. MAXSON

1,521,034

COMPRESSOR CONTROLLING MECHANISM

Filed Aug. 1, 1921

2 Sheets-Sheet 1



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2 Sheets-Sheet 2

Fig. 4.

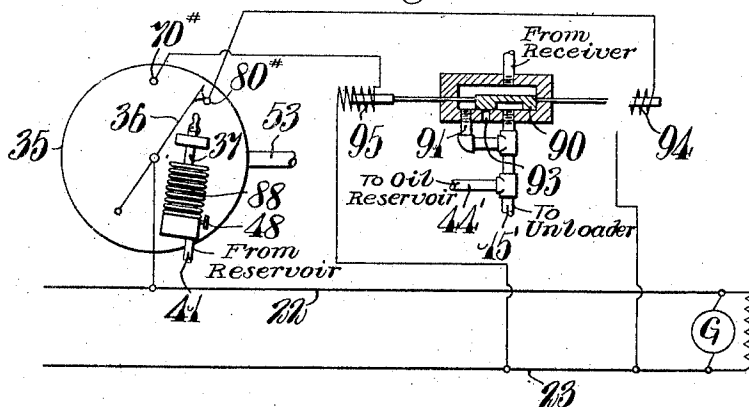


Fig. 5.

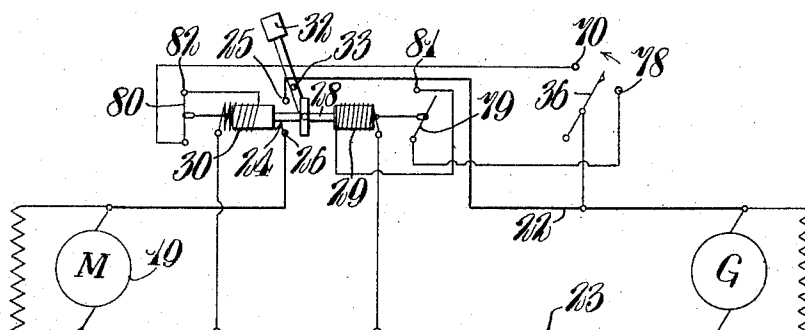
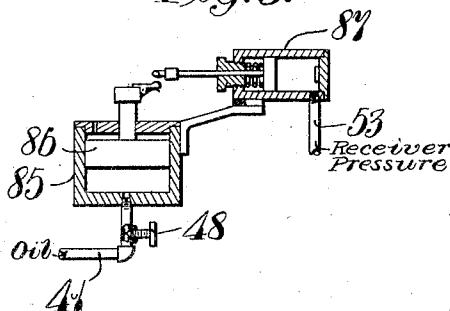


Fig. 6.



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UNITED STATES PATENT OFFICE.

LOUIS A. MAXSON, OF CLAREMONT, NEW HAMPSHIRE, ASSIGNOR TO SULLIVAN MACHINERY COMPANY, A CORPORATION OF MASSACHUSETTS.

COMPRESSOR-CONTROLLING MECHANISM.

Application filed August 1, 1921. Serial No. 429,093.

To all whom it may concern:

Be it known that I, LOUIS A. MAXSON, a citizen of the United States, residing at Claremont, in the county of Sullivan and State of New Hampshire, have invented certain new and useful Improvements in Compressor-Controlling Mechanism, of which the following is a full, clear, and exact specification.

My invention relates to compressor systems, and more particularly to mechanisms for controlling the operation of compressor systems.

An object of my invention is to provide an improved compressor controlling mechanism. Another object of my invention is to provide an improved mechanism for controlling the operation of electrically driven compressors whereby the utmost economy in operation may be realized. A further object of my invention is to provide an improved compressor controlling mechanism adapted to unload the compressor and to stop the same, the performance of one or both of these functions being automatically regulated by the nature of the load on the compressor system. Other objects of my invention will appear in the course of the following specification and the appended claims. In the accompanying drawings I have shown for purposes of illustration one embodiment which my invention may assume in practice.

In these drawings,—

Fig. 1 is a view mainly in side elevation but partially in section of a compressor system provided with the illustrative form of my improved mechanism.

Fig. 2 is a view in central longitudinal section through the illustrative embodiment of one element of my improved compressor controlling system.

Fig. 3 is a diagrammatic view showing the relation of the parts.

Fig. 4 is a fragmentary diagrammatic view of a somewhat modified arrangement.

Fig. 5 is a view corresponding to Fig. 3 and showing a further possible modification.

Fig. 6 is a detail showing a still different modification.

It is a well known fact that in the case of electrically driven compressor systems, it is more economical to run the compressor system unloaded for a matter of several minutes, due to the low current consumption of

the motor when no more than a friction load is being carried, rather than to stop the motor and draw heavily upon the mains as is the case in starting up the motor. Furthermore wear upon the starting apparatus may be reduced by avoiding the stopping of the motor except in instances when it will be found advantageous from the standpoint of economy to discontinue the compressor drive. It has been found possible in practice for each compressor installation to ascertain the period of idle running which would be equivalent in the terms of current and expense to starting up the compressor driving motor and bringing the compressor up to speed.

My invention consists of improved compressor controlling mechanism adapted to be adjusted so that it may unload the compressor and not stop the same if the rate of air consumption is such as to render the probable period of unloaded operation of the compressor less than the predetermined period for which it would be financially economical to shut down the driving motor and which by a novel control system serves to stop the motor shortly after the compressor has been unloaded if the air consumption is not such as to render it economical to maintain the compressor driving motor in operation until further pumping is needed.

In the accompanying drawings in which I have shown for purposes of illustration one form which my invention may assume in practice, a compressor is indicated at 1. This compressor comprises a cylinder 2 in which a piston 3 is reciprocable by usual mechanism driven from the crank shaft 4. Suitable inlet valve mechanisms 5 are provided and by way of suitable discharge mechanism indicated at 6 the compressed fluid from the compressor cylinder is discharged to a line 7 from which it passes to the receiver 8. The inlet valve mechanisms 5 comprise inlet valves 9 which are adapted to be opened by atmospheric pressure upon creation of a suction in the ends of the cylinder during the suction strokes of the piston and which are adapted to be seated by light springs 11. Arranged in line with these valves are pistons 12 of a well-known construction which are reciprocable in cylinders 13 and are adapted to be moved by receiver pressure transmitted to them through branch pipes 14 and main pipe 15 under the

control of a pilot valve 16, which is responsive to receiver pressure in a well-known manner and which pilot valve is in the illustrative form shown of the well-known Jackson type. From the description of this mechanism up to this point, it will be evident that when the receiver pressure exceeds a predetermined desired amount, the pilot valve 16 will permit the passage of receiver pressure through the line 15 and branch passages 14 beneath the pistons 12 and the latter will then open the inlet valves 10 and maintain them open during the continued running of the compressor and so stop compressive action, the air simply by-passing from end to end of the cylinder 2. This mechanism so far described is well-known and is in common commercial use.

The compressor crank shaft 4 is provided with a combined fly and driving wheel 17 which is connected by a belt 18 with the compressor driving motor 19, a suitable idler pulley 20 serving to maintain the belt in contact with the major portions of the peripheries of the driving wheel 17 and motor driving pulley. For the purpose of effecting stoppage of the motor 19 in the event that this be found desirable and to accomplish this stoppage promptly if it is to be accomplished at all, I have provided improved mechanism cooperating with the pilot valve 16, one illustrative form of which is shown herewith. Referring to Fig. 3, the generator G supplies current through the mains 22 and 23 to the motor M and the main 22 is controlled by a main line switch 24. To simplify the disclosure none of the motor starting equipment is illustrated except the main line switch 24. The main line switch 24 comprises contacts 25 and 26 adapted to be electrically connected by a switch member 27 which is mounted upon a rod 28, and the latter is adapted to be moved in opposite directions by electro-magnets 29 and 30 respectively. It will be noted that one end of each of these electromagnets is connected to the main 23 while the other end of the winding of the magnet 29 is connected to an electric contact designated 78 and the other end of the winding of the magnet 30 is connected to the contact designated 70. For the purpose of maintaining the switch member 24 more positively in open or closed position after the circuits through the magnets 29 and 30 are broken, I employ a pivoted weight 32 as indicated, the fulcrum of this weight, 33, being located mid-way between the open and closed positions of the switch member 27 and the lower end of the weight lever being pivoted to the switch member whereby as the switch opens and closes the weight passes from one side to the other of a vertical line passing through the fulcrum 33.

The contact 70 is insulatedly mounted, in

this illustrative form of my invention, upon the face of a pressure gauge 35 which is of relatively large size. The contact 78 is a movable contact and is carried, in this illustrative form of my invention, at the outer end of a piston rod 37 to which it is pivotally connected and relative to which it is held in a predetermined position by a light spring 38. The piston rod 37 is provided with a suitably packed piston 38' reciprocable in a cylinder 39, which cylinder is secured to the face of the gauge 35 in such manner that the contact 78 may in one position occupy a position corresponding to the contact 70 but spaced therefrom by a distance equal to eight pounds on the gauge reading. The piston 38' is normally forced substantially to the bottom of the cylinder 39 by a spring 40 and is adapted to be moved upwardly in the cylinder 40 by fluid under pressure, herein oil, supplied through a pipe 41 from a reservoir 42 which is adapted to be subjected to receiver pressure upon opening of the pilot valve 16, fluid being conducted from the line 15 by means of a T 43 and a pipe 44. The pipe 41 is provided with a stop cock 45 and the lower end of the cylinder 38 is provided with an initial receiving chamber 46 from which, by port 47 controlled by an adjustable needle valve 48, the fluid is discharged into the lower end of the cylinder 39. To facilitate the return of fluid from the cylinder 39, a ball check valve 50 controlled by a spring 51 controls the passage 52 through a partition 43 separating the initial receiving chamber 46 from the bore of the cylinder 39. It will be noted that the pressure gauge 35 is subjected to receiver pressure through a direct connection 53. For purposes of illustration, let it be assumed that the compressor system is adapted to be unloaded at the moment when receiver pressure reaches 80 pounds and is adapted to be reloaded at the moment when receiver pressure has dropped to 70 pounds. The contact member 70 is disposed on the face of the gauge 35 at a point corresponding to the pressure of 70 pounds. Contact 78 carried on the piston rod 37 is adapted only when the piston 38' has moved to its uppermost position in the cylinder 39 to occupy a position in the same arc with the contact 70 and corresponding on that arc to a pressure of 78 pounds. There is a lead from the main 22 to the indicator needle 36 which needle is insulated from the gauge and is thereby caused to perform the functions of a pilot switch.

Let it be assumed that it has been calculated or found by experiment that if the compressor remains unloaded more than five minutes the quantity of current used and expense will be less if the motor is stopped than would be the case if the motor were to be kept running with but the light load of

the unloaded compressor. It will be evident that if the compressor load is substantially constant over a considerable period of time the drop over a short period of time will probably bear a definite proportion to the drop over a greater period of time. For example, if the receiver pressure drops from 80 pounds to 78 pounds in one minute, it will probably drop to 70 pounds in about five minutes. Now, let it be assumed that the needle valve 48 is so adjusted as to cause the piston 38' to move upward under the action of oil from the receiver 42 at such rate as to bring the contact 78 out to the arc in which the contact 70 lies in just one minute, and, assuming that the compressor unloaded at 80 pounds, it will be evident that if the air consumption is less than at such a rate as to cause the compressor to be reloaded at the end of five minutes or less, the needle 36 will still have its extremity in such position as to be contacted by the contact 78 when the latter has reached its highest position, but that if the rate of use of air from the receiver 8 is such so as to cause the compressor to be reloaded in, say, three minutes the pressure drop will have been so rapid as to cause the needle 36 to have moved beyond the path of contact 78 prior to the instant when the latter reaches the arc in which the contact 70 is located. It will thus be evident that if the load is such as to render it economical to stop the compressor, the circuit controlled by the contact 78 and the needle 36 will be closed and the compressor stopped, but if the air consumption is so great as to cause the compressor to be reloaded say in 1, 2, 3, or 4 minutes instead of some period over five minutes, the needle 36 will have moved so rapidly toward the contact 70 that it will not be touched by contact 78 at all and so that the compressor will not be stopped.

Noting now Fig. 3, it will be clear that the compressor motor is idle, the switch 24 being open and hence the needle 36 is moving in the direction of the arrow if any air is being used or leaking. When this needle touches the contact 70 a circuit will be closed through the magnet 30 and the main line switch will be closed. The unloader valve 16 is so adjusted as to cause the compressor unloading mechanism indicated by the parts 12, 13, etc., to reload the compressor at 70 pounds or slightly below. It will thus be evident that the motor will start first and the compressor will then be loaded. Preferably, the pilot valve 16 will be so constructed that its reloading range is about 1 pound more than the range of the electric control so that the motor will start the compressor before it is reloaded. When the pressure has been built up in the receiver 8 to 80 pounds, the pilot valve 16

will operate to unload the compressor and simultaneously will admit pressure to the reservoir 42. Under the action of this pressure, the oil will cause the piston 38' to begin to rise in the cylinder 39. If the rate of use from the receiver is such as to cause the compressor to turn over idly for, say, seven or eight minutes before reloading, the contact 78 will close the circuit with the needle 36 before the latter is moved under the influence of falling pressure out of the path of travel of the contact 78 and thus the compressor will be shut down. On the other hand, if the rate of pressure drop is rapid due to the rapid use of air the needle 36 will move so rapidly that the circuit through the magnet 29 will not be closed at all and so reloading of the compressor will occur only when the valves 10 are allowed to seat due to the action of the pilot valve 16. The fact that the needle 36 will contact with the member 70 will be immaterial since it will simply cause a current to pass through the magnet 30 tending to close the switch which is already closed. As the windings of the magnets 29 and 30 are quite fine, there will be very little current used in this mechanism and further it will be obvious that the current flow through these circuits will occur only during the time when the needle 36 is in contact with either of the contacts, 70 or 78 which condition exists only a relatively small portion of the time. If desired, automatic means could be provided to cause the switch 24 on opening to break the circuit through the needle 36 and the contact 78 and on closing to restore the circuit to condition to be closed while interrupting the circuit through the magnet 30 which it has just closed, this being possible by arranging, for example, an auxiliary switch controlled by a movement of the weight 32 or by the movement of the rod 28 in each of the pilot circuits. One such arrangement is diagrammatically shown in Fig. 5 where the auxiliary movable switch members 79 and 80 respectively cooperate with fixed contacts 81, 82 to interrupt the circuits through the solenoids 29, 30 after the solenoids have done their work, it being understood that the switches will be insulated in some suitable manner from the rod. It will be noted that the spring 38 exerts such a light pressure upon the contact 78 that the needle 36 will not be bent or distorted as the contact 78 touches it.

From the foregoing description, it will be evident that my improved mechanism, so-to-speak, anticipates the load and regulates the compressor automatically in accordance with the prospective load. It will be understood that this device is primarily of use in installations where the rate of discharge of air or its use from the re-

ceiver is relatively constant. Such conditions would be found in plants using a large number of small hand air motors for, on the average, approximately the same number would be in use at all times or better put, the demand for air would not be rapidly fluctuating, but more or less uniform at any given time. Another type of installation in which this mechanism would be of utility would be in air lift pumping plants where the rate of discharge to a plurality of wells would be more or less constant depending upon the number of wells in use. The primary function of this device is evidently for use where the load is relatively constant or where the variations in load while not infrequent are sustained over reasonably definite periods of time.

It is evident that a pressure gauge need not be employed, but that other mechanism especially designed for the purpose could be provided such as is shown in Fig. 6 where the cylinder 85 and piston 86 take the place of the cylinder 39 and piston 38' and where the mechanism 87 takes the place of the pressure gauge 35. It is also evident that other means, for example a collapsible diaphragm, such as is shown at 88 in Fig. 4, could be used instead of the cylinder 39 and piston 38'. It will also be evident that an electrically controlled pilot valve could be substituted for the pilot 16 and be controlled by the needle 36 and additional fixed contacts. Such a mechanism would result in absolute synchronism of the needle moving mechanism and the mechanism for moving the contact 78 and so would be excellent in practice. In Fig. 4 such a mechanism is shown. It will here be evident that only the additional mechanism or the substitute mechanism is illustrated, the connections for controlling the motor starting and stopping switch 24 not being illustrated, as they would remain the same as in the diagrams of Fig. 3. Here it will be noted that a D-valve 90 controls the supply through a passage 91 to the oil reservoir and to the unloader through the passages 15' and 44' respectively, and that it also is adapted to connect these passages with a vent 93. For the purpose of moving the D-valve 90, a pair of solenoids 94 and 95 are provided, the solenoid 95 being adapted to be energized when the needle 36 contacts with the contact 70#, the circuit then being between the wire 22, through the needle 36, contact 70#, solenoid 95, back to the wire 23, and as a result of this connection, the valve 90 will be shifted from the position shown in Fig. 4 to its opposite position and will vent the lines 44' and 15' causing re-loading of the compressor. It will also be observed that in the position of the parts shown, the solenoid 94 is ener-

gized and so the valve 90 has been moved to the position occupied with the result that receiver pressure passes through the pipe 91 to the pipe 15' and to the pipe 44' to unload the compressor and to supply fluid to the tank 42.

It will be clear that the piston 38' and cylinder 39 could be replaced by an expansible diaphragm of a form now in common commercial use and with such a diaphragm, there would be no leakage whatever possible. It will be also evident that the pressure gauge 35 is merely used for purposes of illustration and that other mechanism for accomplishing the same function could be devised.

While I have in this application specifically described one embodiment which my invention may assume in practice, it will be understood that this form of the same is shown for purposes 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 a compressor system, in combination, a compressor, unloading means therefor, a driving motor for said compressor, means for starting and stopping said motor, and means governed by the rate of air consumption controlling the operation of said compressor system.

2. In a compressor system, in combination, a compressor, unloading means therefor, a driving motor for said compressor, means for starting and stopping said motor, and means operative when said compressor is unloaded to control said last mentioned means to effect stopping of the motor if air consumption is at less than a predetermined rate.

3. In a compressor system, in combination, a compressor, unloading means therefor, a driving motor for said compressor, means for stopping and starting said motor, means controlled by receiver pressure for controlling said first and second mentioned means, and means controlled by the rate of air consumption affecting the control of said second mentioned means.

4. In a compressor system, in combination, a compressor, unloading means therefor, a driving motor for said compressor, means for starting and stopping said motor, and means operative when said compressor is unloaded to control said last mentioned means, said means being governed by the rate of air consumption.

5. In a compressor system, in combination, a compressor, unloading means therefor, a driving motor for said compressor, a control switch for said motor, means operative when discharge pressure exceeds a pre-

determined limit by a predetermined amount to unload said compressor and means operative to operate said control switch to stop said motor if said predetermined limit is exceeded for a predetermined time.

6. In a compressor system, in combination, a compressor, unloading means therefor, including means operative to unload the same when a predetermined discharge pressure is reached, a driving motor for said compressor, and means for stopping said motor if the air consumption is at less than a predetermined rate.

7. In a compressor system, in combination, a compressor, a driving motor therefor, means for controlling said compressor system including means to unload the compressor and stop the motor, and means responsive to the rate of air consumption which determines whether one or both of said events shall occur.

8. In a compressor controlling system, in combination, a compressor, and a control mechanism comprising a member responsive to receiver pressure variations, a timing element, and means controlled by said member and element controlling the operation of said compressor.

9. In a compressor controlling system, in combination, a compressor, and a control mechanism comprising a member responsive to receiver pressure variations, an adjustable timing element, and means controlled by said member and element controlling the operation of said compressor.

10. In a compressor system, in combination, a receiver, a compressor, a driving motor therefor, unloading means for said compressor controlled by receiver pressure, a motor control switch, and means operative to stop said motor shortly after said compressor has been unloaded including a timing element, a cooperating receiver pressure variation indicating element, and means controlled by the cooperation of said elements controlling said motor switch.

11. In a compressor controlling mechanism, in combination, a compressor, a member movable in accordance with compressor discharge pressure variations, a member moving at a predetermined rate, said members moving in intersecting paths, and means controlled by the engagement of said members to effect control of said compressor.

12. In a compressor system, in combination, a driving motor, a compressor, a compressor discharge pressure controlled unloading means therefor, and means controlling the driving motor including mechanism controlled by said first mentioned means and governed by the rate of change in compressor discharge pressure.

13. In a compressor system, in combination, a compressor, unloading means therefor, a driving motor, a switch therefor, and controlling means for said switch including a member operative in one position to effect closure of said switch, movement of said member being controlled by compressor discharge pressure, and means adapted to cooperate with said member in another position thereof to effect opening of said switch, said last mentioned means being movable in accordance with compressor discharge pressure and the cooperation of said member and means being controlled by the rate of compressor discharge pressure variations.

14. In a compressor system, in combination, a compressor unloading means therefor, a driving motor for said compressor, a control switch therefor, and controlling means operative on the attainment of a predetermined compressor discharge pressure to cause said unloading means to unload the compressor and to thereafter cause opening of said switch or not in accordance with the demand for air.

15. In a compressor system, in combination, a compressor, unloading means therefor, a driving motor for said compressor, means for starting and stopping said motor, and means operative when the compressor discharge pressure is in excess of a predetermined amount and governed by the rate of air consumption for controlling said last mentioned means.

16. In a compressor system, in combination, a compressor, a member movable in accordance with compressor discharge pressure variations, a member moving to a predetermined position in a predetermined time, said members moving in intersecting paths, and means controlled by the engagement of said members to effect control of said compressor.

In testimony whereof I affix my signature.

LOUIS A. MAXSON.