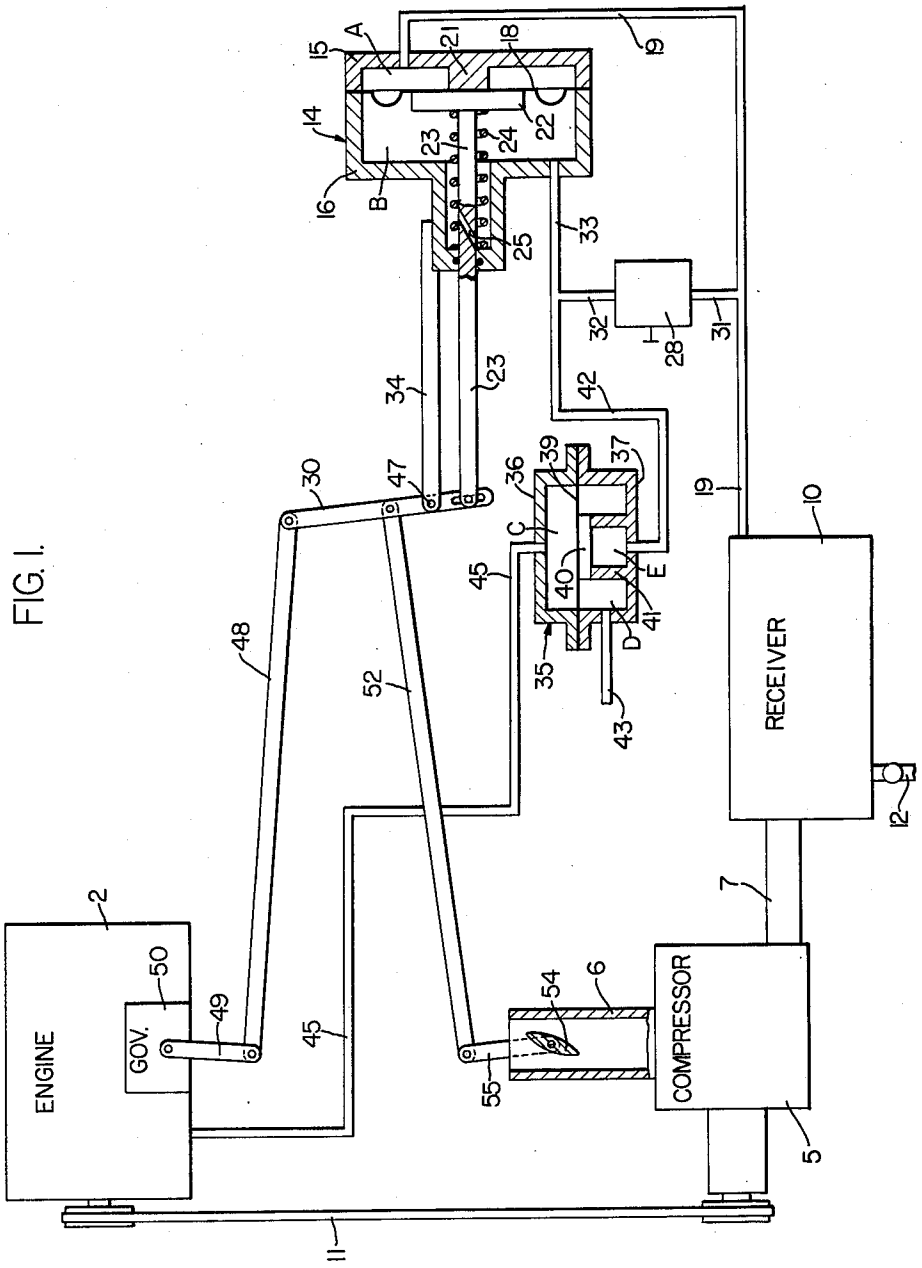
Dec. 28, 1965 R. B. GUSTAFSON 3,226,011

COMMANDAIR CONTROL SYSTEM

Filed March 27, 1964 2 Sheets-Sheet 1

FIG. 1.



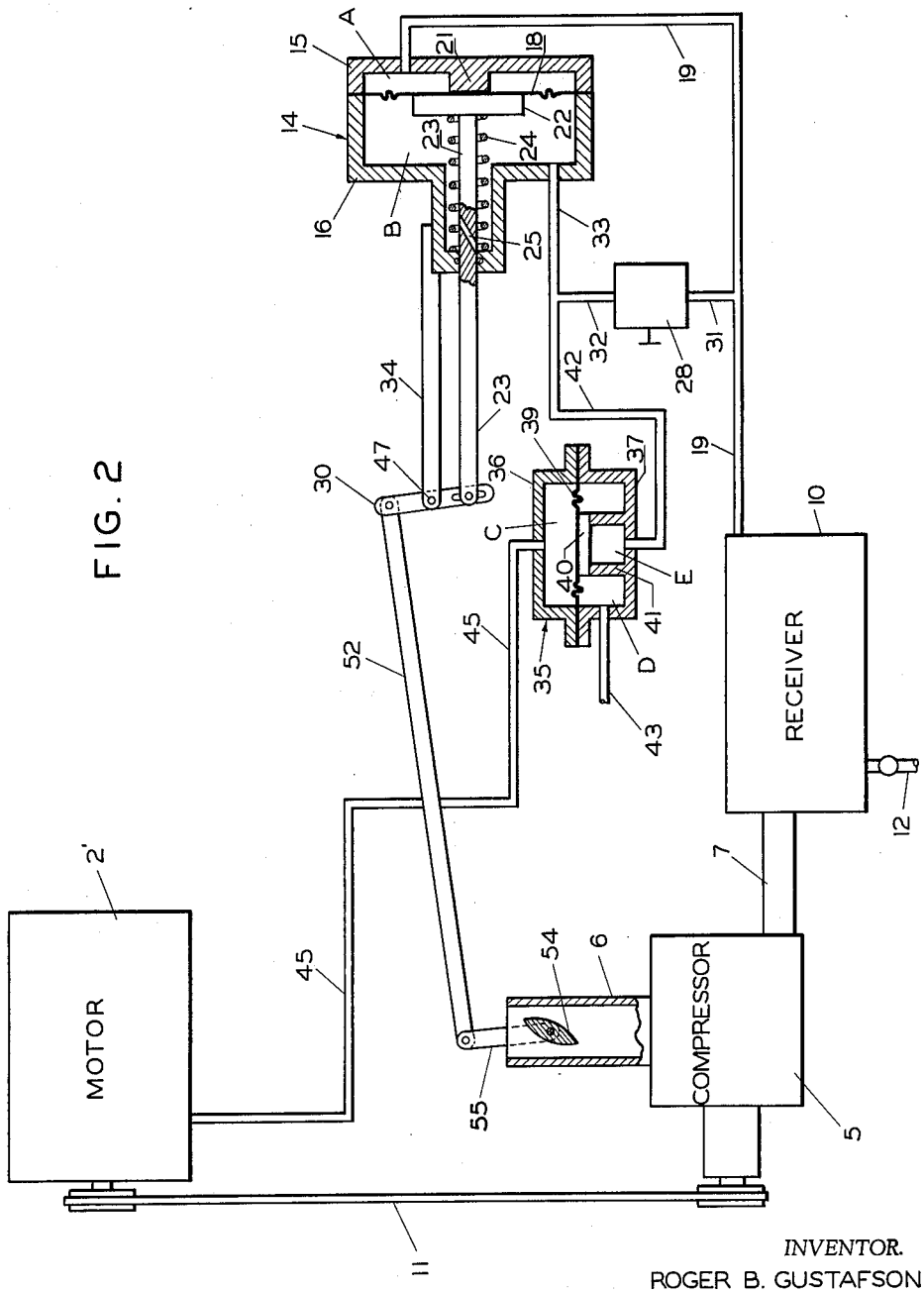
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FIG. 2



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COMMANDAIR CONTROL SYSTEM

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12 Claims. (Cl. 230—2)

This application is a continuation-in-part of application Serial No. 203,557, filed June 19, 1962, now abandoned.

This invention relates to a compressor apparatus and more particularly to a control system for a combustion engine driven compressor unit.

In prior installations of this nature, the mass of air delivered by the compressor to the receiver has been controlled by governing the speed of the prime mover in dependence upon the pressure of air or gas in the air receiver and in addition, an air actuated disc valve throttles the inlet to the compressor. In systems such as these, modifications on the disc valve and the compressor intake have been made; however, such systems have had to prevent a backflow of air from the compressor to the air cleaner on shutdown thereby requiring auxiliary equipment which complicates the system.

The present invention controls the output of a compressor by providing an extremely simple control system which simultaneously controls the speed of the prime mover as well as throttling the inlet valve to the compressor to reduce the air flow therein without resort to auxiliary equipment as will become more apparent. The system of the present invention solves the problem created when the compressor is shut down by the novel coordination of a butterfly valve with the control device while simultaneously achieving effective throttling of the intake to the compressor. Accordingly, the present invention control system takes care of any inlet valve leakage by compensation in a manner to be described. In addition, the control system prevents damage to any compressor air cleaner by preventing air from blowing back through the inlet valve.

An object of this invention is to provide an improved means for regulating the supply of operating fluid to an engine driven compressor.

A further object of this invention is to provide a simple control means for controlling the output of the compressor over the entire range of the compressor load range.

Another object of this invention is to provide a new and novel means for controlling the compressor output in accordance with the variation in discharge pressure of the compressor by regulating the speed of the compressor, compressor's driving motor and the flow of pressure fluid into the compressor.

A further object of this invention is to provide an improved regulating mechanism which is responsive to compressor outlet pressure for operating simultaneously the compressor input as well as the engine output.

A more specific object of this invention is to provide a new and improved regulating mechanism which controls the input to the compressor to provide a more efficient output giving maximum fuel economy.

A further object of this invention is to provide a new and novel control means for regulating an engine driven compressor which facilitates shutting down of a compressor, preventing blow back through the inlet valve.

A further object of this invention is to take care of inlet valve leakage in an economical manner with a minimum number of parts.

These and other objects of the invention will become more apparent upon consideration of the following detailed description of a preferred embodiment thereof when

taken in conjunction with the following drawings in which:

FIG. 1 is a diagrammatic view of an engine driven compressor unit and its control system; and

FIG. 2 is a diagrammatic view of a motor driven compressor and its control system.

Referring to FIG. 1, 5 indicates a compressor driven by an engine 2 wherein the output of the engine 2 is connected to the input of the compressor 5 through a suitable drive belt 11. The compressor 5 is of the positive displacement rotary type and serves to compress air, or other gases, which is discharged through a conduit 7 into a receiver 10 wherein such compressed air is stored prior to its use for actuating tools or other machinery through conduit means 12.

The engine compressor unit shown is equipped with a control device 14 which is actuated in response to variations in discharge pressure of the compressor to control the speed of the engine 2 in a manner to be described. Control device 14 has a cup shaped tubular member 15 and a closed end tubular member 16 with the edges of their open ends in abutting engagement with the marginal portions of a diaphragm 18, which diaphragm 18 partitions the cup shaped tubular member 15 and the closed end tubular member 16 into separate chambers such that the enclosure formed by the cup shaped tubular member 15 and the diaphragm 18 defines a chamber A and the enclosure formed by the closed end tubular member 16 and the diaphragm 18 defines a chamber B. Pressure fluid is supplied to the pressure chamber A from the receiver 10 by means of a conduit 19 connected therebetween.

Cup shaped tubular member 15 has a projection 21 on its central intermediate portion which acts as a stop member limiting the inward movement of the diaphragm 18 into chamber A. The closed end tubular member 16 has a piston 22 and piston rod 23 located centrally therein, with piston 22 in abutting engagement with the diaphragm 18 while the rod 23 is slidably guided by the closed end of tubular member 16 for extension therethrough. The one end of rod 23 is integral with the piston 22 while the other end of rod 23 is pivotally connected to one end of a control lever 30. A closed end helical spring 24 encompasses the rod 23 in chamber B and has its one end suitably seated on the closed end of tubular member 16 and the other end thereof seated on the piston 22 to bias the piston 22 into engagement with the diaphragm 18 and the projection or stop member 21. The intermediate portion of rod 23 is cross drilled to provide a slanted bore 25 such that in the normal position of the rod 23 where chambers A and B of substantially the same pressures, bore 25 is entirely within chamber B; however, upon movement of piston 22 to the left as viewed in FIG. 1 a sufficient distance, one end portion of bore 25 communicates with the chamber B while the other end portion of bore 25 communicates with atmosphere thereby discharging a flow of air from chamber B to take care of air which has leaked by the inlet valve as will be apparent from the description to be developed. A conduit 31 connected to conduit 19 supplies the upstream pressure from the receiver 10 to a control device or pressure regulator 28. Pressure regulator 28 is a commercially available regulator which is presettable to maintain a desired pressure on its downstream side. Thus, the setting of pressure regulator to 100 lbs. pressure per sq. inch will permit the passage of fluid therethrough only until 100 lbs. per sq. inch is reached and reopens only when the downstream side has fallen below 100 lbs. per sq. inch. A discharge conduit 32 is connected to the downstream side of the control device or pressure regulator 28 whereby a preset adjusted pressure is maintained in conduit 32

for communicating such pressure to a conduit 33 which is connected to the chamber B.

A control valve 35 comprising a pair of closed end tubular members 36 and 37 with their open edges in abutting engagement with the marginal portions of a diaphragm 39 partitions the enclosed chamber of the control valve 35 into a pair of chambers C and D wherein chamber C is defined by the diaphragm 39 and the closed end tubular member 36 whereas chamber D is defined by the diaphragm 39 and the closed tubular member 37. Concentrically mounted within the closed end tubular member 37 is an annular member 41 having its lower portion integral with the tubular member 37 and its upper end portion in abutting contact with a circular valve member 40 which valve member 40 is integral with the diaphragm 39 for movement therewith. The chamber defined by the annular member 40 as bounded by the circular valve member 40 and the bottom portion of tubular member 37 is designated chamber E.

A conduit 42 connected to the juncture of discharge conduit 32 and conduit 33 communicates through the tubular member 37 into chamber E such that any build up of pressure within the chamber E upon collapse of pressure in chamber C displaces valve member 40 and diaphragm 39 upwardly relative to the tubular member 37 to permit the passage of pressurized fluid from within chamber E to chamber D. Chamber D is vented to atmosphere by a discharge conduit 43 extending through the wall portion of tubular member 37 connecting chamber D to atmosphere for a purpose to be described.

The upper end portion of tubular member 36 has a conduit 45 communicating chamber C with the engine oil of engine 2, or other source of pressure fluid wherein the pressure is maintained only during operation of the engine 2, whereby the engine oil pressure will hold the diaphragm 39 and valve member 40 into closed abutting contact with annular member 41 by exerting pressure against the diaphragm. Upon stopping of the engine the pressure would dissipate thereby permitting the pressure in chamber E to move valve member 40 upwardly as viewed in FIG. 1 to unseat the valve member 40 from the annular member 41 and communicate chamber E with chamber D which is vented to atmosphere via conduit 43.

Control lever 30 is pivotally mounted on a frame member 34 rigidly connected to control device 14 by a pivot means 47 with one end of lever 30 connected to the rod 23 and the other end of lever 30 connected to a lever member 48, which lever member 48 is connected via a linkage member 49 to a governor 50 which controls the speed of the engine 2.

An air intake conduit 6 of the compressor 2 has a pivotally mounted butterfly valve 54 suitably mounted thereon for progressively throttling the inflow of air to the compressor 5. The spindle of the butterfly valve 54 is provided with an external actuating lever 55, the free end of which is articulated by a link 52 connected to an intermediate portion of the control lever 30 for movement thereby.

In the operation in the above installation where the normal operating conditions require and demand compressed air from the receiver and the pressure therein is below some predetermined set level, as by the setting of the control device or pressure regulator 28, the engine 2 and the compressor 5 are operating under full load conditions such that the engine 2 is at full speed and the intake to the compressor 5 is at full open throttle. Under such conditions the pressure in chamber A is likewise below the predetermined level so that the piston rod 23 and the piston 22 are biased by spring 24 into engagement with the stop member 21. With pressure regulator 28 set to hold 100 lbs. per sq. inch and with such pressure in the receiver, then such pressure will also exist in chambers A and B since the receiver 10 is connected via conduit 19 directly to chamber A and the pressure regulator 28 allows the passage of pressurized fluid up to 10 lbs. per sq. inch which thereby pressurizes chamber B to such pressure since pressure regulator 28 is directly connected to chamber B via conduits 32 and 33. With equal pressures in chambers A and B, and with spring 24 biasing piston 22 and diaphragm 18 against stop 21, there will be no movement nor displacement of diaphragm 18 and rod 23. Since link 52, actuating lever 55 and lever member 48 are controlled by control lever 30 and lever 30 is maintained by rod 23 in its furthermost counter-clockwise position as viewed in FIGURE 1, the butterfly valve 54 is at its full open position and the governor 55 maintains the engine at full speed.

If less compressed air is being used than delivered by the compressor 5, the pressure in the receiver 10 will build up above the preset pressure which in the example was indicated 100 pounds per sq. inch. As pressure is built up in the receiver 10 it is reflected in chamber A because of the direct connection thereto whereas chamber B is at the preset pressure thereby creating a pressure differential across diaphragm 18 which results in the moving of rod 23 to the left as viewed in FIG. 1. Such leftward movement of the rod 23 pivots control lever 30 in a clockwise direction about pivot means 47 to move lever member 48 and lever 55 rightward, which action correspondingly slows down the engine 2 via governor 50. On initial movement of lever 55, movement of butterfly valve 54 does not affect the intake of air to the compressor because of its design; however, on further clockwise movement of control lever 30, movement of lever member 48 slows down the engine 2 further while with movement of lever 55, butterfly valve 54 begins to throttle the flow of air to the compressor 5. During such initial movement of lever 55 and butterfly valve 54, the output of the compressor is influenced only by the speed of the prime mover or engine 2 whereas on such further clockwise movement of control lever 30, the output of the compressor is influenced by the butterfly valve 54 and the speed of the prime mover or engine 2. The butterfly type valve 54 has excellent throttling characteristics and in addition provides convenient direct linkage control from the control device 14. The slowing down of the engine 2 and the throttling of the air intake operates progressively thereafter as the differential pressure between chambers A and B increases until the governor 50 reduces the engine speed to idle and the butterfly valve 54 closes the intake 6 to the compressor.

Upon use of compressed air by the tools or other machinery which are connected to the receiver 10 via conduit 12 there will result a drop in pressure in the receiver 10 as well as in the chamber A which action is registered as a drop in differential pressures between chambers A and B which moves the diaphragm 18 and rod 23 rightward. Such rightward movement of rod 23 pivots control lever 30 counterclockwise to open slightly the butterfly valve 54 as well as speed up the engine 2 slightly. On increased use of the compressed air, which results in a drop in receiver pressure as well as differential pressure across diaphragm 18, the control lever 30 is pivoted further counterclockwise to speed up the engine 2 as well as open the butterfly valve 54.

At idle position and because of the nature of a butterfly valve 54, leakage will occur into the intake conduit 6; however, since rod 23 is cross-drilled by bore 25, chamber B will communicate with atmosphere through the cross-drilled hole 25 to bleed off sufficient pressurized fluid to compensate for the leakage. It is to be noted that the regulator 28 supplies the deficiency to chamber B to maintain an equilibrium condition between the intake leakage and discharge from the compressor 5 which thereby prevents the buildup of pressure in the receiver 10.

When the compressor is shut down in order to prevent air from flowing back through the inlet valve 54 and intake conduit 6 which would damage the air cleaner located above the intake conduit 6, chamber C is connected to the engine oil pressure reservoir such that upon closing down of the engine 2 the pressure in the engine oil reservoir drops down to zero or experiences a breakdown in pressure whereby the pressure in chamber E overcomes the pressure in chamber C and slowly vents air from chamber B via conduits 33 and 42 to atmosphere faster than the regulator 28 can replace it, thus maintaining an unbalanced pressure across diaphragm 18 which will maintain the inlet valve 54 in its closed position.

Thus the receiver pressure is balanced by a regulated pressure in chamber B and a spring 24 thereby making the control more sensitive and improving the response thereof. With the use of the regulator 28, the control of the receiver pressure is simplified. It is also within the scope of this invention to eliminate the lever member 48, linkage member 49 and governor 50, utilizing a constant speed electric motor 2' as the prime mover (see FIG. 2) where the compressor output is controlled by the butterfly valve 54 only and line 45 communicates with a source of pressure fluid maintaining pressure only as long as the motor 2' is in operation.

The operation of the embodiment shown in FIGURE 2 is the same as that described with reference to the embodiment of FIGURE 1 where full throttle operation is being described. When, however, less compressed air is being used than is being delivered by the compressor 5, the pressure in the receiver 10 will build up above the preset pressure, which in the example was indicated as 100 pounds per square inch, the pressure built up on the receiver 10 and applied to the chamber A results in leftward moving of the rod 23 as viewed in FIGURE 2 and as described with reference to the embodiment of FIGURE 1. Such leftward movement of the rod 23 pivots the control lever 30 in a clockwise direction about the pivot means 47 causing the butterfly valve 54 to throttle the flow of air to the compressor 5. As the pressure within the receiver 10 continues to increase, the output of the compressor is progressively reduced as a result of the throttling effect of the butterfly valve 54 on the intake to the compressor 5 through the intake conduit 6 until the butterfly valve 54 closes the intake 6 and the compressor operates in a substantially unloaded condition as long as no compressed air is being used.

Upon use of compressed air by the tools or other machinery which are connected to the receiver 10 by conduit 12 there will result a drop in pressure in receiver 10 as well as in the chamber A which action is registered as a drop in differential pressures between chambers A and B which moves the diaphragm 18 and the rod 23 rightward. Such rightward movement of the rod 23 pivots control lever 30 counterclockwise to slightly open the butterfly valve 54 to give a controlled amount of intake air to the compressor to match the amount of compressed air being used by the tools. The operating characteristics of the embodiment of FIGURE 2 are the same as those described for the embodiment of FIGURE 1 excepting only those characteristics which are dependent upon changing the speed of the engine 2 which are of course not applicable to the operating of an embodiment which utilizes a constant speed electric motor 2'.

Shut down of the compressor, by stopping motor 2', results in a breakdown of pressure in conduit 45 and maintains valve 54 in a closed position during bleed off of the receiver pressure as described for the embodiment of FIGURE 1.

It is to be realized that the above described operation of valve 54 can be achieved by the use of a solenoid, energized from the conductors which furnish electric current to the motor 2', to hold valve member 40 in a closed position as long as motor 2' is operating, and to allow valve 40 to open whenever the motor 2' is shut off.

It should be understood, of course, that the foregoing disclosure relates to only a preferred embodiment of the invention and that numerous modifications or alterations may be made without departing from the spirit and the scope of the invention as set forth in the appended claims.

I claim:

1. A compressor control system for an engine driven compressor comprising; power means for driving such compressor, flow control means for controlling the flow of fluid to the compressor, a control regulator having a movable diaphragm therein dividing said regulator into a first and second chamber, stop means mounted in said first chamber limiting the movement of said diaphragm in a first direction to reduce the volume of said first chamber, linkage means connecting said diaphragm and said flow control means for regulating fluid flow through said flow control means, said regulation of fluid flow resulting upon movement of said diaphragm away from said stop means which direction defines a second direction opposite in direction to said first direction, said flow control means regulatable from a full open position through a progressive throttling to a shut-off position wherein the flow of fluid to the compressor is correspondingly controlled by movement of said diaphragm from a position adjacent said stop means to a position further away from said stop means resulting from movement in said second direction to a fully extended position corresponding to said shut-off position of said flow control means, said linkage means having flow restrictive means actuated upon movement of said diaphragm to said fully extended position for venting said second chamber to atmosphere, said second chamber having spring means for biasing said diaphragm against said stop means, a control device having a pre-settable valve therein for controlling the upper limits of pressures of fluid passing therethrough, said control device having an upstream connection to said receiver and a downstream connection to said second chamber, said presettable valve maintaining the downstream pressure in said downstream connection at a pressure up to said upper limit, and said diaphragm being responsive to a difference in the pressures in said chambers to regulate said flow control means.

2. A compressor control system as set forth in claim 1 wherein valve means communicates with said downstream connection, said valve means having passage means for venting said downstream connection to atmosphere, said valve means being connected to a pressurized source for maintaining said passage means closed, and said valve means operative upon a breakdown in pressure from said pressurized source for opening said passage means for connecting said downstream connection to atmosphere.

3. A compressor control system as set forth in claim 2 additionally comprising a governor means connected to said power means; wherein said linkage means has a connection to said governor means for progressively slowing down said power means upon movement of said diaphragm in said second direction.

4. A compressor control system as set forth in claim 2 wherein said valve means comprises a pair of chambers separated by a movable diaphragm, one of said chambers being connected to said power means for maintaining a pressure therein during operation of said power means, the other of said chambers being connected to said downstream connection, said diaphragm being movable upon a breakdown in pressure in said one chamber to connect said other chamber to atmosphere for venting said first chamber to atmosphere to close said flow control means on shutdown of the compressor.

5. A compressor control system comprising, a compressor having an intake means, power input means op-

eratively connected to said compressor for driving said compressor, a butterfly valve mounted in said intake means for regulating the air intake into said compressor, a receiver connected to the output of said compressor for storing compressed air therefrom, a regulator having a means therein operatively separating said regulator into first and second chambers, said first chamber having a connection to said receiver whereby the pressure in said first chamber is at receiver pressure, movable means operatively connected to said means in said regulator for movement therewith, said movable means having a connection to said butterfly valve for regulating the position of said butterfly valve, said means positionable in said regulator in response to a pressure differential in said chambers, a conduit connecting said second chamber to said receiver, a second regulator mounted in said conduit wherein said second regulator has a pre-settable valve for maintaining the pressure in said second chamber at the pressure set by said pre-settable valve, spring means mounted in said second chamber for biasing said means in said regulator to complement the action of said second regulator, said butterfly valve being operatively connected to said means in said regulator and responsive to movement of said means upon existence of a pressure differential in said first and second chambers to progressively throttle said butterfly valve.

6. A control system as set forth in claim 5 wherein said movable means of said regulator has flow restrictive venting means operative upon movement of said butterfly valve to its full limit of movement for venting to atmosphere said second chamber of said regulator to compensate for fluid leakage through said butterfly valve.

7. A compressor control system as specified in claim 6 additionally comprising a blow-down conduit communicating between said second chamber and the ambient atmosphere, blow-down valve means in said blow-down conduit, valve operating means for holding said blow-down valve means closed during operation of said power input means.

8. A compressor control system comprising; a compressor for compressing a gaseous medium, intake means on said compressor, a receiver connected to output means of said compressor, power means connected to said compressor for driving said compressor, throttle means mounted in said intake means for regulating the flow of gaseous medium into said compressor, a compressor regulator having a hollow interior, movable separator means dividing the interior of said regulator into a first chamber and a second chamber, said first chamber having a fluid conducting connection to said receiver, movable means mechanically connecting said separating means to said throttling means for regulating the action of said throttling means, a fluid conducting conduit connecting said second chamber to said receiver, a pressure regulator mounted in said conduit, adjustable valve means in said pressure regulator to maintain a pressure in said second chamber not greater than a predetermined desired maximum pressure resulting in a pressure differential between said first chamber and said second chamber when the pressure in said receiver rises above said predetermined maximum pressure whereby said separator means is positionable within said compressor regulator in response to said pressure differential.

9. A compressor control system as set forth in claim 8 additionally comprising; governor means connected to said power means for controlling the speed of said power means, said movable means being mechanically connected to said governor means for progressively slowing down said power means as said pressure differential increases.

10. A compressor control system as specified in claim 8 additionally comprising a blow-down conduit communicating between said second chamber and the ambient atmosphere, blow-down valve means in said blow-down conduit, valve operating means for holding said blow-down valve means closed during operation of said power means.

11. A compressor control system comprising, a compressor having an intake means, electric motor means operatively connected to said compressor for driving said compressor, flow control means mounted in said intake means for regulating the air intake into said compressor, a receiver connected to the output of said compressor for storing compressed air therefrom, a regulator having a means therein operatively separating said regulator into first and second chambers, said first chamber having a connection to said receiver whereby the pressure in said first chamber is at receiver pressure, movable means operatively connected to said means in said regulator for movement therewith, said movable means having a connection to said flow control means for controlling fluid flow through said intake means, said means positionable in said regulator in response to a pressure differential in said chambers, a conduit connecting said second chamber to said receiver, a second regulator mounted in said conduit wherein said second regulator has a pre-settable valve for maintaining the pressure in said second chamber at the pressure set by said pre-settable valve, spring means mounted in said second chamber for biasing said means in said regulator to complement the action of said second regulator, said flow control means being operatively connected to said means in said regulator and responsive to movement of said means upon existence of a pressure differential in said first and second chambers to progressively reduce fluid flow through said intake means.

12. A compressor control system as specified in claim 11 additionally comprising a blow-down conduit communicating between said second chamber and the ambient atmosphere, blow-down valve means in said blow-down conduit, valve operating means for holding said blow-down valve means closed during operation of said electric motor means.

No references cited.

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