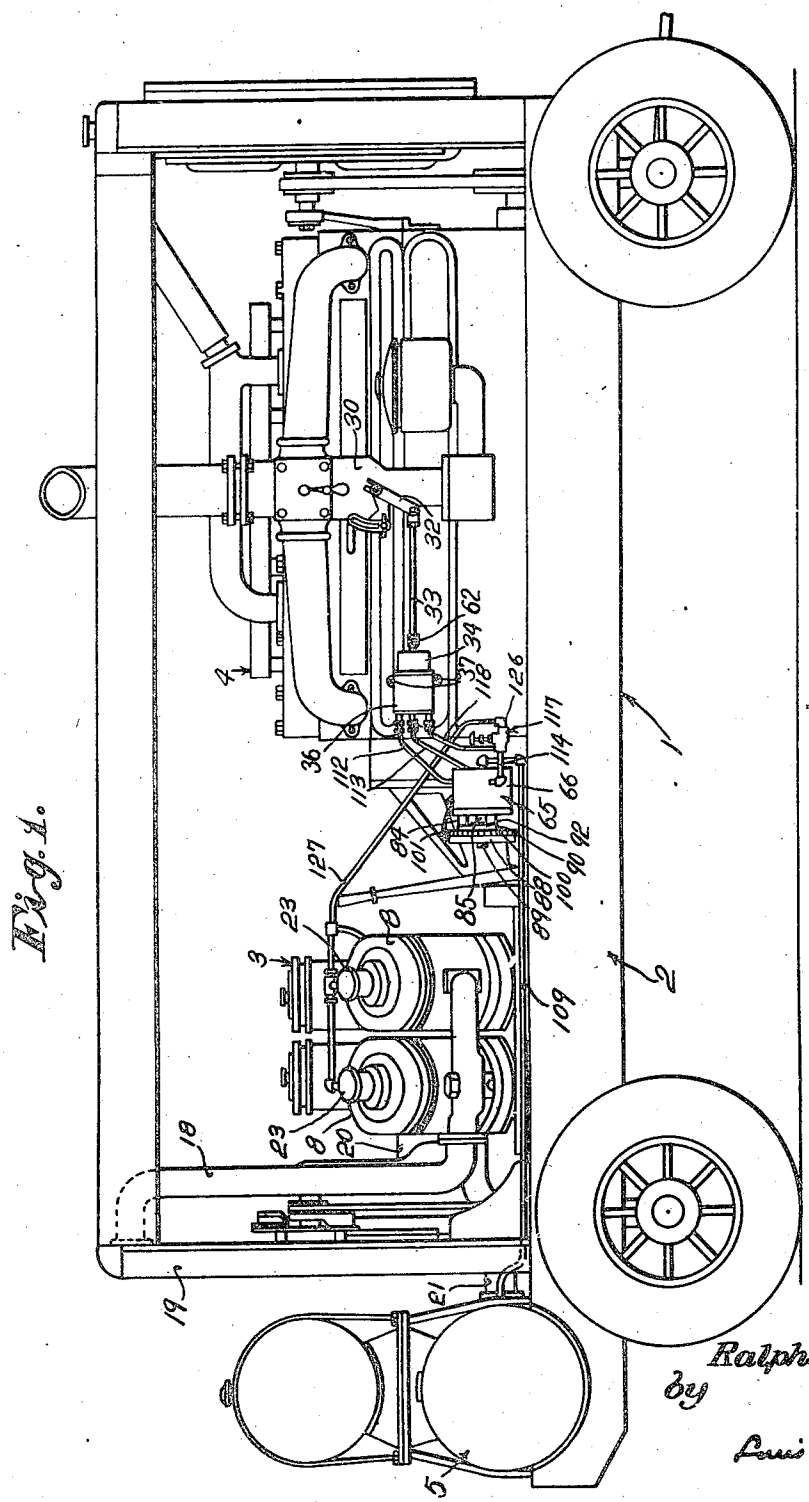
Nov. 12, 1946. R. E. LAMBERTON 2,410,824

PUMPING APPARATUS

Filed July 6, 1942 3 Sheets-Sheet 1



Inventor:
Ralph E. Lamberton
by
Louis A. Watson.
Atty.

Nov. 12, 1946. R. E. LAMBERTON 2,410,824

PUMPING APPARATUS

Filed July 6, 1942 3 Sheets-Sheet 2

Fig. 2.

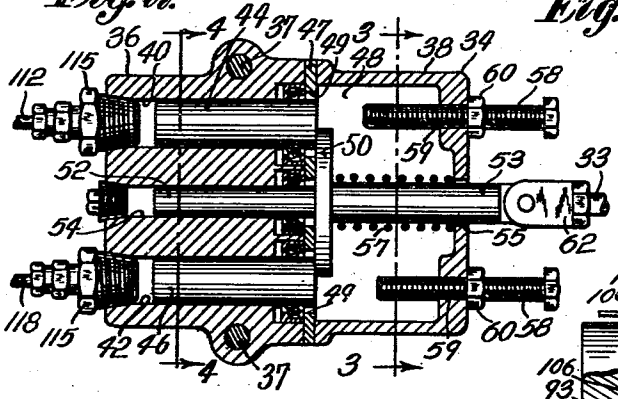


Fig. 3.

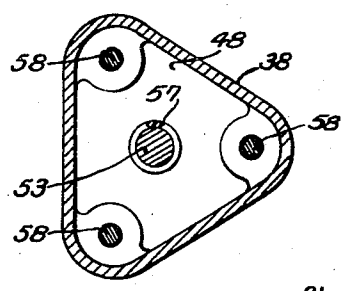


Fig. 4.

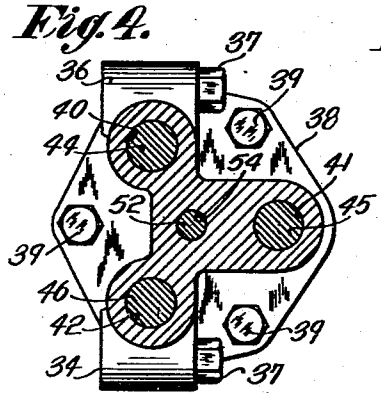


Fig. 5.

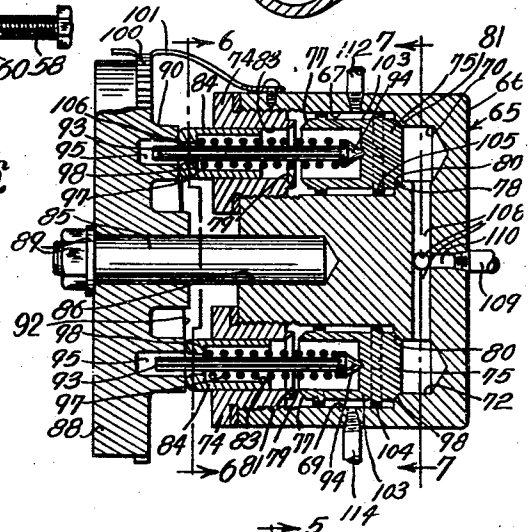


Fig. 6.

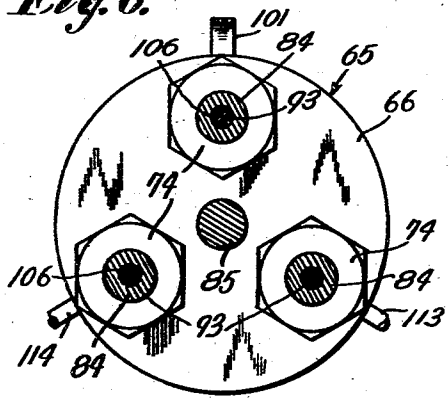
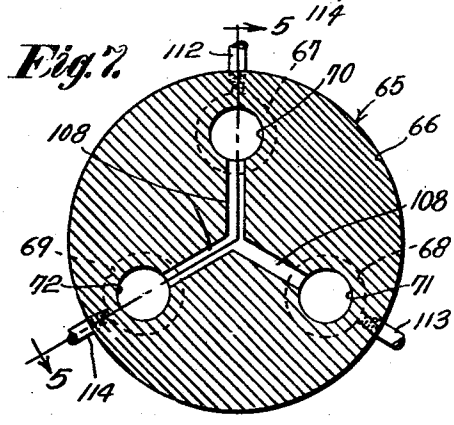


Fig. 7.



Inventor:
Ralph E. Lamberton
by
Louis A. Marson.
Atty.

Nov. 12, 1946. R. E. LAMBERTON 2,410,824

PUMPING APPARATUS

Filed July 6, 1942 3 Sheets-Sheet 3

Fig. 8.

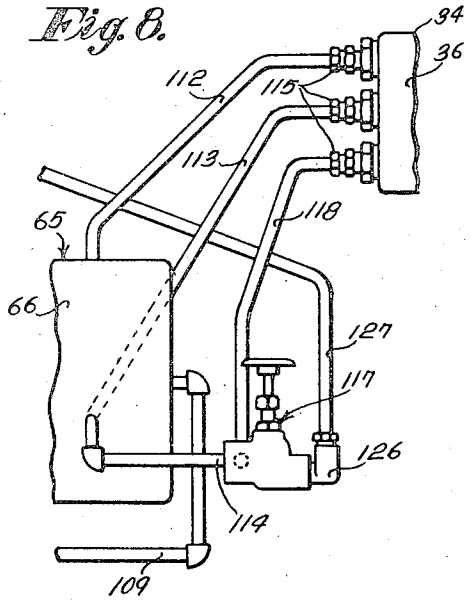


Fig. 9.

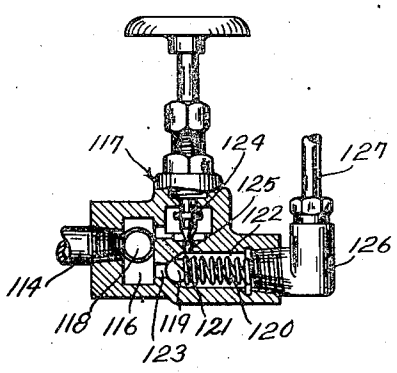
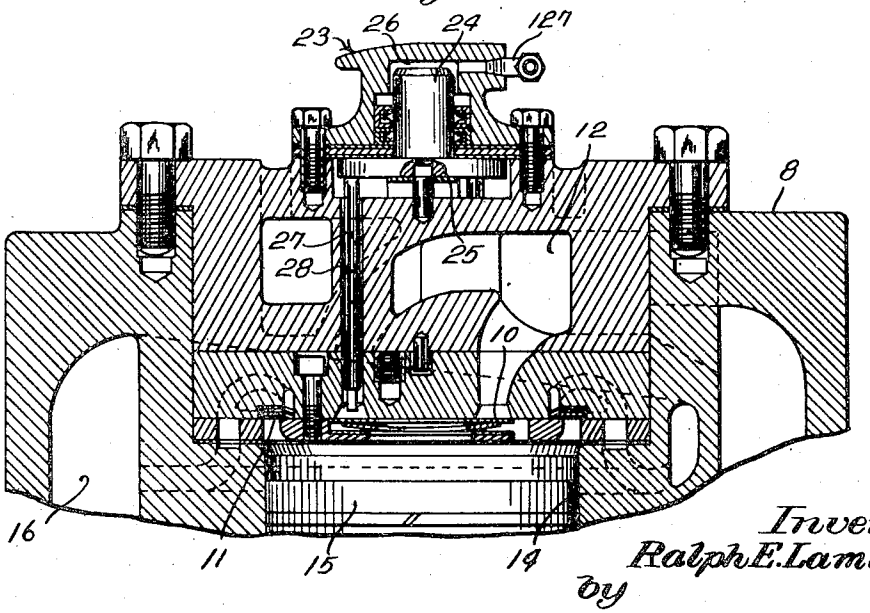


Fig. 10.



Inventor:
Ralph E. Lamberton
by
Louis A. Watson
Atty.

Patented Nov. 12, 1946

2,410,824

UNITED STATES PATENT OFFICE

2,410,824

PUMPING APPARATUS

Ralph E. Lamberton, Michigan City, Ind., assignor to Joy Manufacturing Company, a corporation of Pennsylvania

Application July 6, 1942, Serial No. 449,864

19 Claims. (Cl. 230—3)

1

This invention from one aspect relates to regulators for power driven pumps, and more particularly to adjustable regulators for controlling the operation of a pump and its driving means in accordance with pump discharge pressures.

From another aspect it relates to automatically controlled pumping systems.

It is customary to provide with a pumping system a regulator operating in accordance with the pump discharge pressure for controlling the speed at which the pump is driven, or for effecting a loaded or unloaded operation of the pump, or both. The regulated pumping system may be similar to that shown in my copending application, Ser. No. 370,043, now matured into Patent No. 2,294,410, granted September 1, 1942, in which a fluid compressor is driven by an internal combustion engine and delivers compressed fluid to a receiver. The regulator for this system operates at predetermined receiver pressures for varying the supply of operating fluid to the engine, and, at a predetermined maximum receiver pressure, operates to effect an unloading of the compressor and an operation of the engine at idling speed. The operation of the regulator is determined by the adjustment of pressure responsive valves which open at the desired pressures and permit pressure fluid to flow to plungers which actuate means for controlling the flow of operating fluid to the internal combustion engine. At a predetermined maximum pressure, one of the valves operates to supply pressure fluid to a compressor unloading device and also to a plunger which actuates the operating-fluid-control-means to effect an operation of the engine at idling speed.

It is desirable at times to vary the pressure settings of the valves so that adjustments in the speed of the engine and an unloading and reloading of the compressor take place at different receiver pressures. It has been the practice to provide means with each valve for adjusting its pressure setting but, where there are several valves to be adjusted, the time and labor involved is something to be considered. By providing means for adjusting the settings of all of the pressure responsive valves simultaneously so that each operates at the different desired pressures, an appreciable saving of time and labor is obtained. Moreover, the differentials between different steps may be maintained notwithstanding either a raising or a lowering of the operating range, and by proper construction either constant differences in pressures or constant ratios of pressures may be obtained; and very rapid changes can be made in control conditions, with

2

the capacity for instant return to prior conditions.

In a preferred embodiment of the invention from its regulator aspect, a plurality of controlling valves may be arranged for movement by a fluctuating pressure and each may be provided with yieldable loading means. Such loading means may desirably have reaction devices against which they individually react in providing forces for maintaining the valves closed. There will desirably be provided means for simultaneously altering the positions of such reaction devices in a manner to maintain, as desired, uniform differentials between the forces exerted, or uniform ratios between the forces exerted, or any other desired relation between the forces exerted. In a preferred embodiment simultaneously moved inclined surface devices may be utilized, and these may be arranged preferably as a common unit, and all move together. An arrangement in which the several inclined surface devices are arranged consecutively, as in a helical surface, may be especially desirable, especially when the valve devices are arranged so that their loading means are relatively uniformly distributed around the axis of turning of the inclined surface device. The foregoing indication of a preferred embodiment will make clear the wide range of deviations possible within the scope of my invention as defined in the appended claims.

An object of this invention is to provide an improved pressure responsive control device for a pumping system. Another object is to provide in a control device having a plurality of pressure responsive valves, improved means for adjusting the pressure settings of said valves. Still another object is to provide improved means for adjusting simultaneously the pressure settings for a plurality of pressure responsive valves of a control device. Still another object is to provide an improved control device including a member having a cam surface acting as a spring abutment for a plurality of pressure responsive valves, and adjustable for varying simultaneously the pressure settings of the valves. A further object of the invention is to provide an improved automatically controlled pumping system. Other objects of the invention will, however, hereinafter more fully appear.

In the accompanying drawings, in which I have shown for purposes of illustration one embodiment which my invention may assume in practice:

Fig. 1 is a side elevational view of a pump mechanism having my invention embodied therein.

Fig. 2 is an enlarged longitudinal vertical sec-

tional view through a portion of the control mechanism shown in Fig. 1.

Fig. 3 is a transverse sectional view taken substantially on line 3—3 of Fig. 2.

Fig. 4 is a transverse sectional view taken on the plane of the line 4—4 of Fig. 2.

Fig. 5 is in part a sectional view taken on the planes of the line 5—5 of Fig. 7, and in part a side elevation, showing a pilot valve mechanism which forms part of the control mechanism.

Fig. 6 is a view taken on the plane of the line 6—6 of Fig. 5.

Fig. 7 is a transverse sectional view taken on the line 7—7 of Fig. 5.

Fig. 8 is an enlarged view of the fluid connections for the control mechanism shown in Fig. 1.

Fig. 9 is an enlarged sectional view of a control valve for the fluid system.

Fig. 10 is an enlarged fragmentary sectional view of one of the pump cylinders and the unloading means therefor.

My invention is shown in the drawings incorporated in a portable compressor mechanism, generally designated 1. This compressor mechanism includes a wheeled truck frame 2 having mounted thereon an air compressor 3, an internal combustion engine 4, and an air receiver 5. It will be understood, however, that my invention is adapted for use with other varieties of pumping apparatus and with other types of compressors, and, indeed, is not limited in its use to pumping apparatus of any type.

The compressor shown is of the two-stage four cylinder V-type having reciprocating pistons connected in driven relation with the power shaft of the engine 4. The high pressure cylinders of the compressor are not shown, but the low pressure cylinders 8, 8 are arranged at the opposite side of the V from the high pressure cylinders. The cylinders are severally provided, as shown in Fig. 10, with an inlet valve 10 and a discharge valve 11. Fluid is conducted through an intake passage 12, past the inlet valve 10, to the cylinder bore 14, where it is compressed by a reciprocating piston 15 and discharged past the discharge valve 11 to a discharge passage 16. As shown in Fig. 1, fluid is delivered from the low pressure cylinder discharge passages through a conduit 18 to an intercooler 19, and then through a conduit 20 to the intake side of the high pressure cylinders where it is compressed again and delivered through a conduit 21 to the receiver 5.

An unloading mechanism of any suitable type may be provided for effecting an unloading of the compressor. In this case there is provided for each cylinder, as shown in Fig. 10, an unloading mechanism 23 including a plunger 24 yieldably supported by a spring 25 within a chamber 26 in the cylinder head. Rods or fingers 27 are fixed to the plunger 24 and extend through openings 28 in the cylinder head to positions above the inlet valve 10. When pressure fluid is supplied to the chamber 26, the plunger 24 is forced downwardly, causing the rods 27 to unseat the inlet valve 10 and effect an unloading of the cylinder.

The engine 4 is provided with a valve in a connection 30 to the intake manifold, and a control lever 32 is connected to the valve for adjusting the latter to vary the flow of operating fluid to the engine. When the control lever is moved in a counter clockwise direction, as viewed in Fig. 1, the supply of operating fluid is reduced and the engine is slowed down. The outer end of the lever is connected by a rod 33 to a pressure responsive device 34 which operates, on the supply of pressure fluid thereto, to adjust the position of the valve.

The pressure responsive device 34, as shown in Figs. 2 to 4, includes a cylinder block 36 attached to a stationary part of the engine, as by bolts 37, and a casing member 38 attached to one end of the block, as by bolts 39. Formed in the cylinder block are parallel bores 40, 41 and 42 so arranged that points in their axes lying in a plane to which said axes are perpendicular, lie at the corners of an equilateral triangle. Reciprocably contained within the bores are plungers 44, 45 and 46. Clamped between the cylinder block 36 and the casing 38 is a plate 47 cooperating with the casing to form a chamber 48. Extending through the plate 47 are openings 49 through which the plungers may be projected into the chamber 48. A circular plate 50 is supported for reciprocation in the chamber 48 by means of alined stems 52 and 53 herein formed integrally with the plate and guided respectively within a bore 54 formed in the cylinder block and an opening 55 in the casing member 38. The common axial line of the stems 52 and 53 is parallel to the axes of the plungers 44, 45 and 46 and equidistant from each of the three last mentioned axes. The radial dimension of the plate 50 is such that the plate laps a small amount over the inner edges of the plungers—so that each of the plungers upon projection from its respective bore will be operative to move the plate and the stems 52 and 53. A coiled spring 57 acts between the casing member and the plate for holding the latter normally against the ends of the plungers. Stop screws 58 are threaded through openings 59 in the casing member 38 and are so positioned that the plate 50 moves freely between them. The screws are, however, also so positioned that they will be severally engaged by the outer ends of the plungers when the latter have been forced predetermined distances out of their bores. The stop screws are held by lock nuts 60 in the following adjusted positions: The stop screw which is associated with the plunger 44 is so arranged that this plunger will engage the screw after moving but a short distance. The stop screw associated with the plunger 45 permits the plunger to move the plate a short additional distance before the plunger engages its stop screw. The stop screw associated with the plunger 46 permits the plunger to move the plate 50 still further before the plunger engages its stop screw. The stem 53 is pivotally connected to the rod 33 by a connecting element 62 so that movements of the plate 50 cause the control lever 32 to operate the valve in the connection 30 and regulate the supply of operating fluid to the engine.

Attached in any suitable manner to a stationary part of the outfit is a pilot valve mechanism, generally designated 65, for controlling the supply of pressure fluid to the unloading mechanisms 23 for the compressor cylinders and to the pressure responsive device 34. This pilot valve mechanism comprises, as shown in Figs. 5 to 7, a valve block 66 having parallel bores 67, 68 and 69 opening through one end of the block and communicating at their inner ends with reduced bores 70, 71 and 72 arranged, respectively, in coaxial relation with the bores 67, 68 and 69. The bores 67, 68 and 69 are so arranged that points in their axes lying in a plane to which the axes are perpendicular, lie at the corners of an equilateral triangle. Threaded within the outer end of each of the bores 67, 68 and 69 is a plug 74, and reciprocably

contained within each of these bores is a valve piston 75 having, on its opposite ends, surfaces 77 and 78 which are engageable with valve seat surfaces 79 and 80 formed, respectively, on the associated plug 74 and on a shoulder 81 at the inner end of the bore. Extending axially through each plug 74 is an opening 83, and a sleeve-shaped member 84 is reciprocably mounted therein. Projecting from the end of the valve block adjacent the plugs 74 is a pin 85. This pin is so arranged that its axis is spaced equal distances from the axes of the valve bores 67, 68 and 69, and it is fixed to the valve block as by a force fit within an opening 86. Rotatably mounted on the outer end of the pin is a circular disk 88 held against outward movement along the pin by a nut and washer arrangement 89. Formed on the face of the disk adjacent the valve block is an annular projection 90 having an inclined cam surface 92 engageable by the outer ends of the sleeve-shaped members 84. Extending through each of the sleeve-shaped members is a pin 93 having an enlarged head 94 on its inner end engageable with the valve piston 75 and having its outer end projecting into an annular groove 95 formed in the projection 90 on the circular disk 88. A coiled spring 97 surrounds each pin 93 and acts between a shoulder 98 on the sleeve-shaped member 84 and the enlarged head 94 on the pin for holding the sleeve-shaped member against the inclined surface 92 on the projection 90 and holding the valve piston 75 normally against the seat 80 at the inner end of the valve bore. It will be seen that the amount of compression of the different springs varies since the sleeve-shaped members 84 engage the inclined surface 92 at different points. With the disk 88 in the position shown in Fig. 5, the valve pistons 75 in the bores 67, 68 and 69 are held against their forward seats with progressively increasing pressures. By rotating the disk 88 in one direction or the other, the valve seating pressures may be increased or decreased simultaneously. Formed in the periphery of the disk are notches 100 engageable by a flexible member 101 attached to the valve block for holding the disk in its adjusted positions. Each of the valve pistons 75 is provided with a reduced portion 103, and spaced enlarged portions 104 slidably engaging the walls of the valve bore. The enlarged portions 104 are traversed by openings 105 for connecting the space between the reduced portion 103 and the walls of the valve bore in communication with the spaces at the ends of the bore. Between the pins 93 and the sleeve members 84 are clearances 106 whereby fluid may escape from the valve bores to atmosphere through the annular groove 95 when the valve pistons are moved away from the valve seats 79. The reduced bores 70, 71 and 72 at the inner ends of the valve bores are connected in communication with each other by radially extending passages 108 in the valve block. Pressure fluid is supplied continuously from the receiver 5 through a conduit 109 and a passage 110 in the valve block to the passages 108. When the receiver pressure reaches values sufficient to move the pistons 75 from their seats against the force of the springs 97, the surfaces 77 on the valve pistons move into engagement with the seat surfaces 79 for cutting off communication between the valve bores and atmosphere, and pressure fluid flows from the reduced bores 70, 71 and 72 to the space in the valve bores surrounding the reduced valve portions 103.

Communicating with the valve bores 67, 68 and 69 between the ends of the latter are conduits 112, 113 and 114. The conduits 112 and 113 are connected directly in communication with the bores 40 and 41 of the pressure responsive device 34 by means of connecting elements 115. The conduit 114 is connected, as shown in Fig. 9, to a chamber 116 formed in the casing of a valve mechanism 117, and a conduit 118 connects the chamber 116 directly in communication with the bore 42 of the pressure responsive device 34. The valve mechanism 117 is provided with a ball valve 119 urged by a spring 120 toward a seat 121 so as to permit fluid to flow in but one direction between the chamber 116 and a chamber 122 through a port 123. A manually adjusted valve 124 permits a restricted flow of fluid from the chamber 122 to the chamber 116 through a port 125. The chamber 122 is connected through a connecting element 126 to a conduit 127 which is connected in communication with the chambers 26 in the unloading mechanisms 23 for the compressor cylinders.

The operation of the mechanism described is as follows: The engine 4 is caused to operate at a predetermined speed and drive the compressor for supplying air to the receiver. The compressed air in the receiver is delivered through the conduit 109 to the passages 108 in the valve block of the pilot valve mechanism 65. The passages 108 conduct the compressed air to the reduced bores 70, 71 and 72 where it acts on the inner ends of the valve pistons 75, but, until the air pressure reaches values sufficient to overcome the springs 97, the valve pistons are held in engagement with the valve seat surfaces 80, and the spaces between the reduced portions of the valve pistons and the walls of the bores are connected to atmosphere through the sleeve-shaped members 84 and the annular groove 95 in the circular disk 88. Thus the conduits 112, 113 and 114 are vented. As the air pressure builds up, the piston 75 in the bore 67 is moved into engagement with the valve seat surface 79 cutting off the communication of the bore with the atmosphere and permitting air to flow into the valve bore and through the conduit 112 to the bore 40 in the pressure responsive device 34. The plunger 44 in the bore 40 is then forced by the air pressure against the plate 50 to move the latter until the plunger engages its stop screw 58. Movement of the plate 50 causes the rod 33 to move and swing the lever 32 in a direction to close partially the valve in the supply line of the engine, thereby effecting a predetermined decrease in the engine speed. If the receiver pressure continues to increase, the valve piston in the bore 68 is forced against its seat 79 and pressure fluid is delivered through the conduit 113 to the bore 41 of the pressure responsive device 34. The plunger 45 in the bore 41 is forced against the plate 50 by the pressure fluid, and the plate is moved to the right in Fig. 2 until the plunger engages its stop screw 58. This causes the rod 33 to move and swing the lever 32 in a direction to effect a still further reduction in the supply of operating fluid to the engine. At a predetermined maximum receiver pressure the valve piston 75 in the bore 69 is moved to its seat 79, and pressure fluid is delivered through the conduit 114 to the chamber 116 in the valve mechanism 117. Pressure fluid flows from the chamber 116 through the conduit 118 to the bore 42 in the pressure responsive device where it actuates the plunger 46 to effect a further reduction in the engine speed; and fluid also flows from the chamber 116 past the ball

valve 119 to the chamber 122 where it is delivered to the conduit 127 leading to the unloading devices for the compressor cylinders. The compressor is then driven unloaded at an idling speed until the receiver pressure drops to a value at which the valve piston in the bore 69 is forced to its seat 80. The conduit 114 opening into the bore 69 is then connected to exhaust through the sleeve member 84 and the annular groove 95, and pressure fluid is vented immediately from the bore 42 in the pressure responsive device through the conduit 118, the chamber 116 and the conduit 114 to effect a speeding up of the engine. The unloading devices for the compressor cylinders are connected to exhaust through the conduit 127, the chamber 122, the restricted port 125, the chamber 116 and the conduit 114. Due to the restricted vent, the reloading of the compressor is delayed until the speed of the engine has been increased. If the receiver pressure continues to drop, the valve pistons in the bores 68 and 67 move successively to their seats 80 to vent pressure fluid from the bores 41 and 40 and effect stepped increases in the engine speed. If it is desired that the changes in engine speed and the unloading of the compressor take place at different pressures, it is only necessary to rotate the disk 88 so as to present different points on the inclined surface 92 for contact by the sleeve-shaped members 84.

As a result of this invention there is provided an improved control mechanism for a pump system. The control mechanism operates at predetermined pressures to control the operation of the pump system, and is adjustable to vary its responsiveness to pressures in any desired predetermined manner. If the rotatable cam surface is on a uniform helix and the springs 97 are uniform, the pressure differences between successive steps may be kept substantially uniform as the general range is raised or lowered. By varying the slope of the cam surface at different points, a uniform relation between the pressures (uniform ratios) can be had. Other possibilities by varying both slopes and springs will be obvious. Still other possibilities and advantages will be clearly apparent to those skilled in the art. It will further be noted that I have provided an improved automatically controlled pumping system having improved means for varying at will the critical controlling pressures.

While there is specifically described in this application one form which the 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 valve mechanism, in combination, a plurality of valve seats, valve members engageable with said valve seats, means for subjecting said valve members to the action of a pressure fluid supplied from a common source, means forming chambers in which said valve members are individually movable and which are severally adapted for connection to devices to be controlled, said chambers receiving pressure fluid past said valve seats when said valve members are unseated, means for yieldingly holding said valve members in engagement with said valve seats including means for necessitating the subjection of said valves to severally different predetermined pressures to unseat them, whereby said valves open in definite sequence upon predetermined increases in the pressure, and adjustable means for altering simultaneously the pressures at which said valve members will lift from their seats operative to maintain the order of opening of said valves.

2. In a valve mechanism, in combination, a plurality of valve seats, valve members engageable with said valve seats, means for subjecting said valve members to the action of a pressure fluid supplied from a common source, means forming chambers in which said valve members are individually movable and which are severally adapted for connection to devices to be controlled, said chambers receiving pressure fluid past said valve seats when said valve members are unseated, means for yieldingly holding said valve members in engagement with said valve seats including means for necessitating the subjection of said valves to severally different predetermined pressures to unseat them, whereby said valves open in definite sequence upon predetermined increases in the pressure, and adjustable means for altering simultaneously the pressures at which said valve members will lift from their seats operative to maintain substantially constant the differentials between such pressures.

3. In a valve mechanism, in combination, a plurality of valve seats, valve members engageable with said valve seats, means for subjecting said valve members to the action of a pressure fluid supplied from a common source, means forming chambers in which said valve members are individually movable and which are severally adapted for connection to devices to be controlled, said chambers receiving pressure fluid past said valve seats when said valve members are unseated, means for yieldingly holding said valve members in engagement with said valve seats including means for necessitating the subjection of said valves to severally different predetermined pressures to unseat them, whereby said valves open in definite sequence upon predetermined increases in the pressure, and adjustable means for altering simultaneously the pressures at which said valve members will lift from their seats operative to maintain the order of opening of said valves, said adjustable means including an element having a cam surface movable to alter simultaneously in predetermined amounts the pressures requisite to lift said valve members from their seats.

4. In a valve mechanism, in combination, a plurality of ports having their axes parallel to and spaced equal distances from a common straight line, valve seats surrounding said ports, valve members engageable with said valve seats, means for supplying pressure fluid from a common source to said ports to act on said valve members, means forming chambers in which said valve members are individually movable and which are severally adapted for connection to devices to be controlled, said chambers communicating with said ports when said valve members are unseated, means for yieldingly holding said valve members in engagement with said valve seats including loading devices individual to each of said valve members, said loading devices necessitating the subjection of said valves to severally different pressures to unseat them, and adjustable means coacting with said loading devices and adjustable to alter simultaneously the pressures at which said valve members will lift from

their seats while still maintaining the order of opening of said valves unchanged, said adjustable means including a member supported for rotation on an axis coincident with said common straight line and coacting with each of said loading devices to vary the load imposed thereby.

5. In a valve mechanism, in combination, a plurality of ports having their axes parallel to and spaced equal distances from a common straight line, valve seats surrounding said ports, valve members engageable with said valve seats, means for supplying pressure fluid from a common source to said ports to act on said valve members, means forming chambers in which said valve members are individually movable and which are severally adapted for connection to devices to be controlled, said chambers communicating with said ports when said valve members are unseated, means for yieldingly holding said valve members in engagement with said valve seats including loading devices individual to each of said valve members, said loading devices necessitating the subjection of said valves to severally different pressures to unseat them, and adjustable means coacting with said loading devices and adjustable to alter simultaneously the pressures at which said valve members will lift from their seats while still maintaining the order of opening of said valves unchanged, said adjustable means including a member supported for rotation on an axis coincident with said common straight line and providing a cam surface forming an abutment, and said loading devices each including yieldable means reacting against said abutment.

6. In a valve mechanism, in combination, a plurality of ports having their axes spaced equal distances from a common straight line, valve seats surrounding said ports, valve members engageable with said valve seats, means for individually yieldably urging said valve members toward their seats, and a member having a helical cam surface providing an abutment for said individual yieldable means, said member being supported for rotation on an axis lying in said common straight line to present different points on its cam surface for engagement by said yieldable means.

7. In a valve mechanism, in combination, means forming a plurality of valve chambers each communicable with a device to be controlled and each having opposed valve seats respectively surrounding fluid supply and exhaust ports, valves, one reciprocable between each pair of opposed seats and engageable with the latter for controlling the flow of fluid through said ports, means for supplying pressure fluid to said supply ports from a common source, a plurality of seating springs for said valves for pressing the latter in the direction of one of the seats therefor, and means for simultaneously changing the compression of said springs in a predetermined manner.

8. In a valve mechanism, in combination, means including a plurality of pressure responsive valves each reciprocable between a pair of opposed seats and cooperating with the latter for controlling the flow of pressure fluid relative to a device to be controlled, a plurality of seating springs for said valves pressing the latter in the direction of one of the seats therefor, means for subjecting said valves to a pressure fluid tending to move said valves against the action of said springs, adjustable abutment means for said springs, said abutment means holding said springs compressed different amounts so as to produce different seating pressures on said valves, and means for adjusting said abutment means so as to change simultaneously the compression of said springs while maintaining a predetermined relation between their exerted pressures.

9. In a valve mechanism, in combination, means providing a plurality of chambers communicable severally with devices to be controlled, a plurality of pressure responsive valves, one received within each of said chambers, valve seats for each of said valves and with which valve cooperation takes place respectively in controlling admission of pressure fluid to and venting of pressure fluid from said chambers, a plurality of springs pressing said valves toward said seats past which pressure fluid is admitted to said chambers, separate means for delivering pressure fluid from a common source to said valve seats toward which said valves are pressed, abutments for said springs, and means for concurrently changing the positions of said abutments.

10. In a valve mechanism, in combination, a plurality of pressure responsive valves, a plurality of seating springs for said valves, separate abutments for said springs, and means rotatable without translatory movement and presenting an inclined surface in contact with each of said abutments for concurrently changing the position of said abutments.

11. In a valve mechanism, in combination, means providing a plurality of chambers, an admission port and an exhaust port opening into each of said chambers, a valve seat surrounding each of said ports, a plurality of pressure responsive valves, one for each of said chambers, cooperating with said valve seats for controlling the flow of fluid through said ports, each of said valves responsive to a different pressure and movable on attainment to such pressure to a position closing the one of said exhaust ports controlled thereby, and means for simultaneously changing the responsiveness of said valves in a predetermined manner.

12. In a controlling device of the character described, in combination, a plurality of load responsive controlling devices subjected continuously to a load to be controlled and each responsive to a different load, and means for simultaneously changing the load-responsiveness of said devices in a predetermined manner.

13. In a controlling device of the character described, in combination, a plurality of load responsive controlling devices subjected continuously to a load to be controlled and each responsive to a different load, and means having a cam surface for altering simultaneously in predetermined amounts the responsiveness of said load responsive controlling devices.

14. In a compressor mechanism, in combination, a prime mover, a compressor connected in driven relation with said prime mover, pressure responsive unloading means for said compressor, pressure responsive means for controlling the supply of motive fluid to said prime mover, a plurality of pressure responsive valves subjected continuously to the discharge pressure of said compressor, a plurality of springs for seating said valves, and means for simultaneously changing the compression of said springs in a predetermined manner for controlling the responsiveness to the discharge pressure of said compressor by said valves for controlling the supply of pressure fluid to said controlling means and to said unloading means.

15. In a compressor mechanism, in combination, a prime mover, a compressor connected in driven relation with said prime mover, pressure responsive unloading means for said compressor, pressure responsive means for controlling the supply of motive fluid to said prime mover, a plurality of pressure responsive valves subjected continuously to the discharge pressure of said compressor and each responsive to a different compressor discharge pressure for supplying pressure fluid to said controlling means and to said unloading means, and means for simultaneously changing the responsiveness of said valves to the compressor discharge pressure.

16. In a compressor mechanism, in combination, a prime mover, a compressor connected in driven relation with said prime mover, pressure responsive means operative on the supply of pressure fluid thereto for effecting an unloading of said compressor, pressure responsive means operative on the supply of pressure fluid thereto for effecting a reduction in the supply of motive fluid to said prime mover, means for controlling the supply of pressure fluid to each of said pressure responsive means including a plurality of pressure responsive valves subjected continuously to compressor discharge pressure and each operative at a different pressure for supplying fluid to said pressure responsive means, and means including a cam for changing simultaneously the responsiveness of said valves.

17. In a valve mechanism, in combination, a plurality of ports, valve seats surrounding said ports, valve members engageable with said valve seats, springs for seating said valve members, separate abutments for said springs, and means

providing a cam surface engaging said abutments for compressing said springs different amounts, said last mentioned means being adjustable to present different points on said cam surface for engagement by said abutments.

18. In a valve mechanism, in combination, a plurality of ports having their axes parallel to and spaced equal distances from a common straight line, valve seats surrounding said ports, valve members engageable with said valve seats, springs for seating said valve members, separate abutments for said springs, a member supported for rotation on an axis coincident with said common straight line and having a cam surface engaging said abutments for compressing said springs different amounts, said member being rotatable on its axis to present different points on its cam surface for engagement by said abutments.

19. In a valve mechanism, in combination, a plurality of pressure responsive valves, means providing for each valve a separate chamber communicating with a device to be controlled, a fluid supply port opening into each of said chambers, said valves cooperating with said ports for controlling the flow of fluid to said chambers, means for delivering pressure fluid from a common source to each of said ports, a plurality of seating springs for said valves, means for compressing said springs different amounts so as to produce different seating pressures on said valves, and means for adjusting said last mentioned means so as to change simultaneously the compression of said springs while maintaining a predetermined ratio between their exerted pressures.

RALPH E. LAMBERTON.