May 5, 1931. E. W. SWARTWOUT 1,803,660

COMPRESSOR AND PUMP

Filed Dec. 5, 1928 5 Sheets-Sheet 1

Fig. 1.

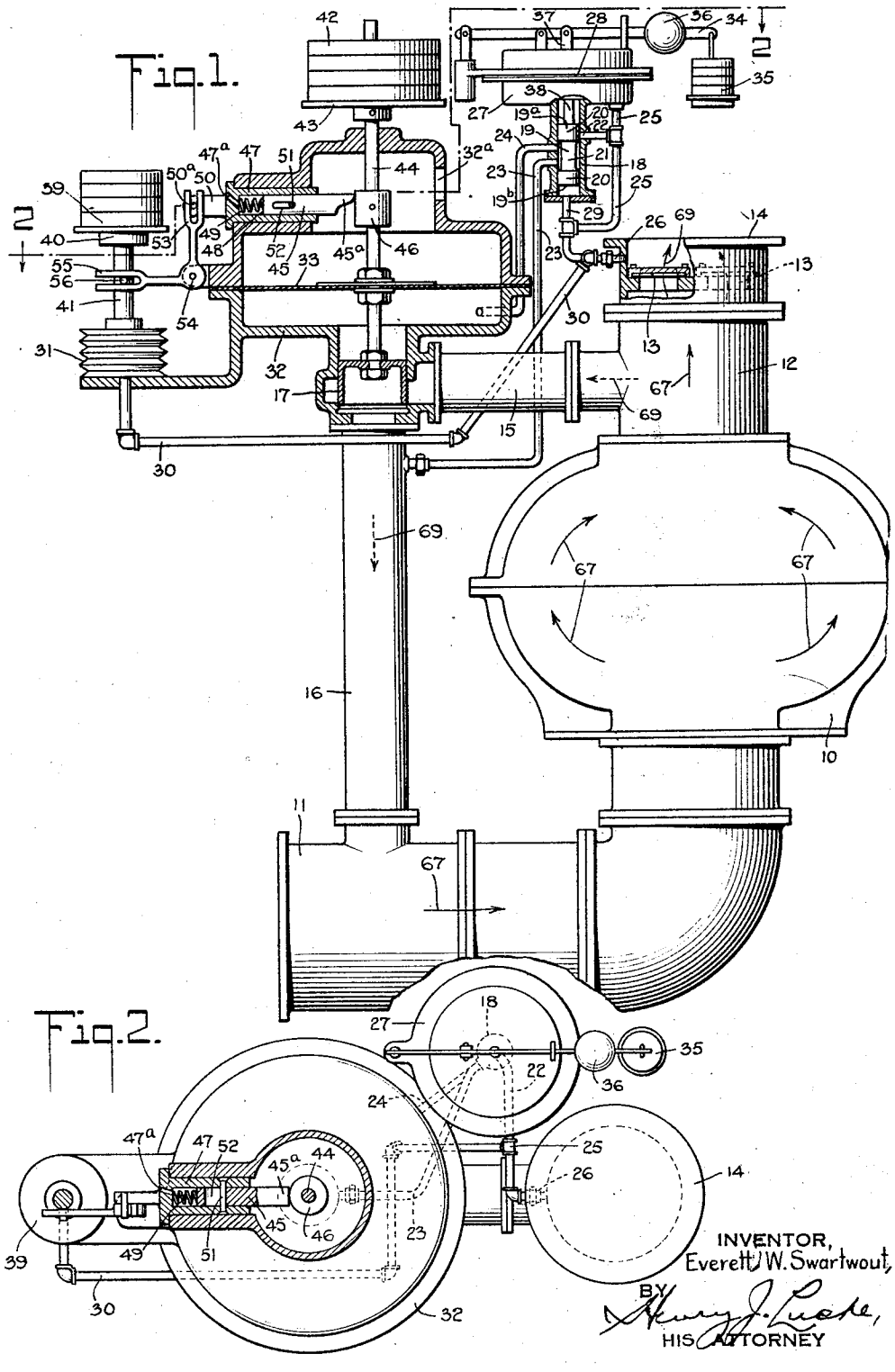

Fig. 2.

INVENTOR,
Everett W. Swartwout,
BY
Henry J. Lucke,
HIS ATTORNEY

May 5, 1931. E. W. SWARTWOUT 1,803,660

COMPRESSOR AND PUMP

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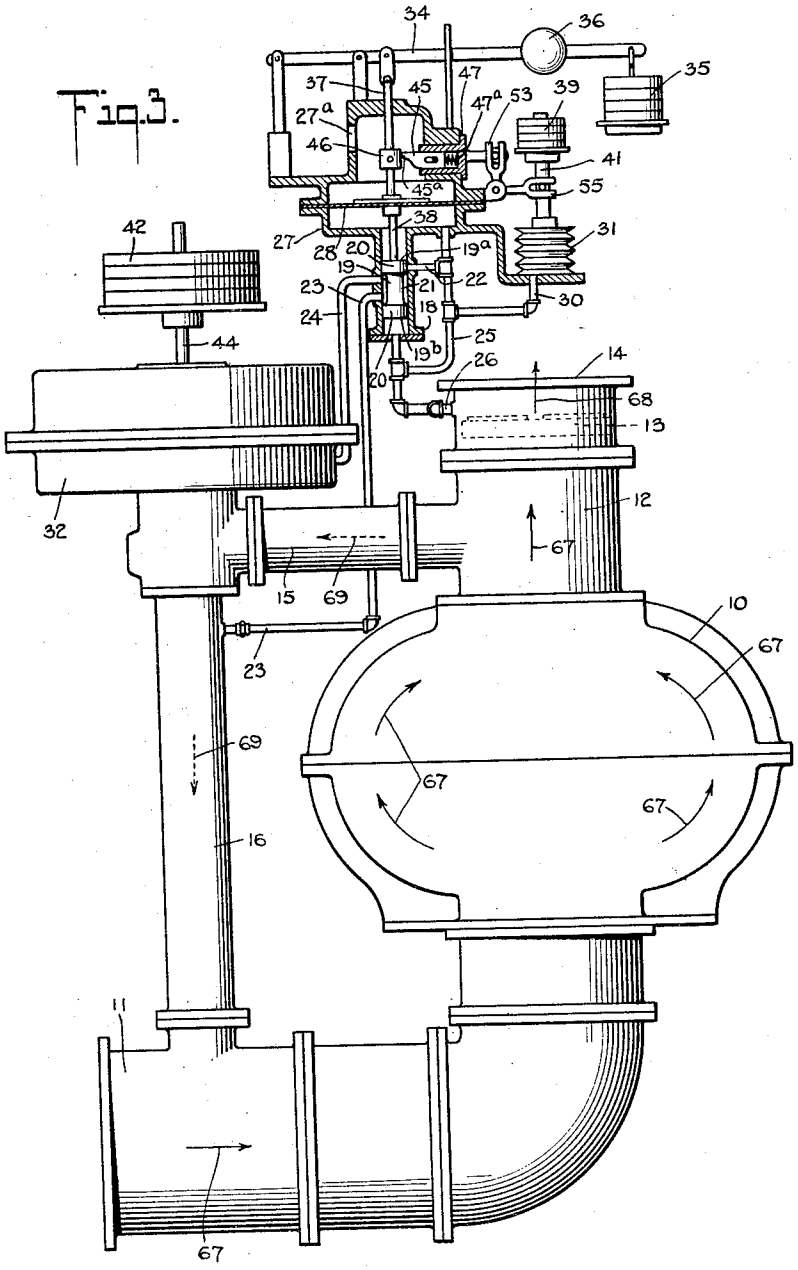
Fig. 3.



INVENTOR,
Everett W. Swartwout,
BY
Henry J. Drake,
HIS ATTORNEY

May 5, 1931. E. W. SWARTWOUT 1,803,660

COMPRESSOR AND PUMP

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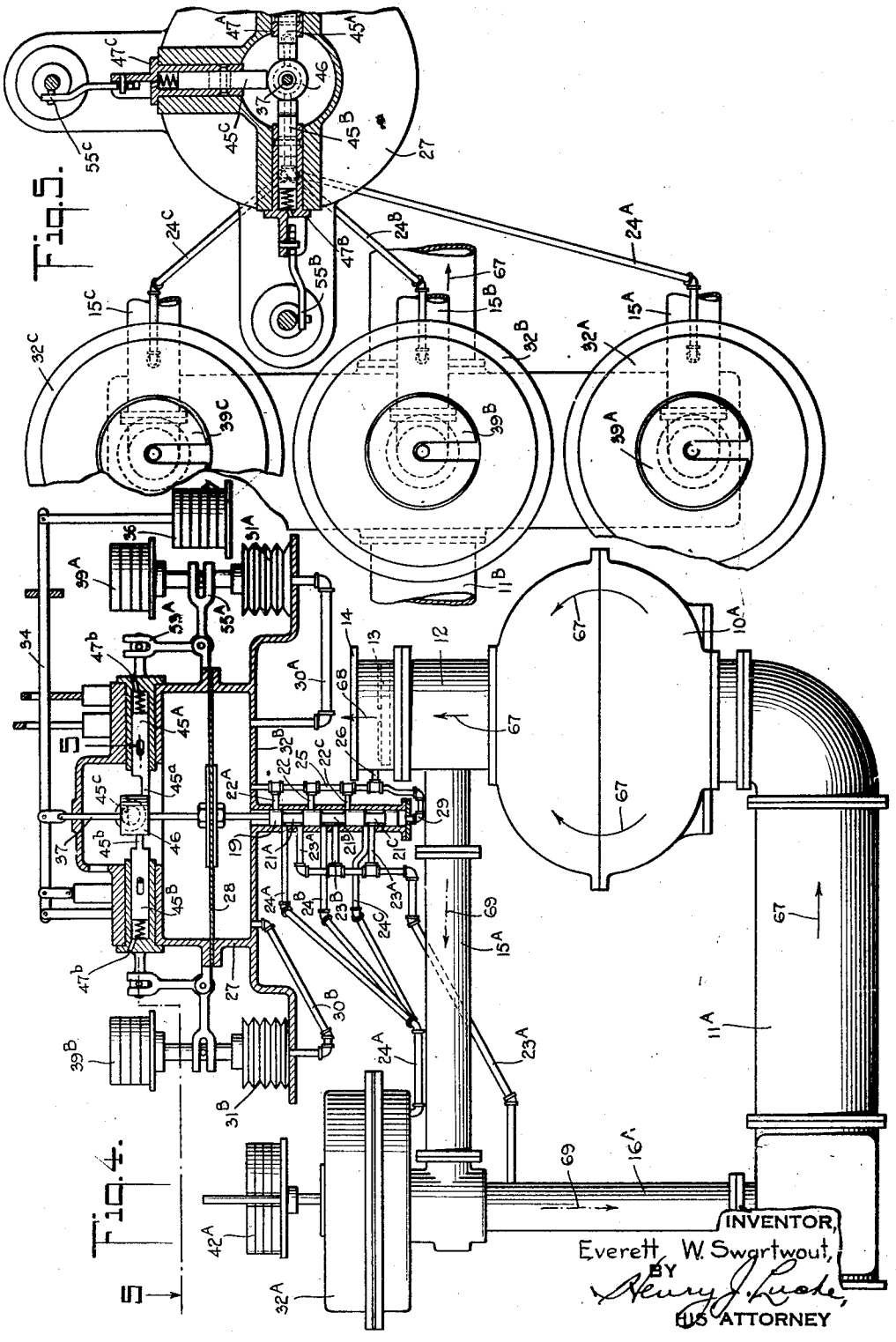

May 5, 1931. E. W. SWARTWOUT 1,803,660

COMPRESSOR AND PUMP

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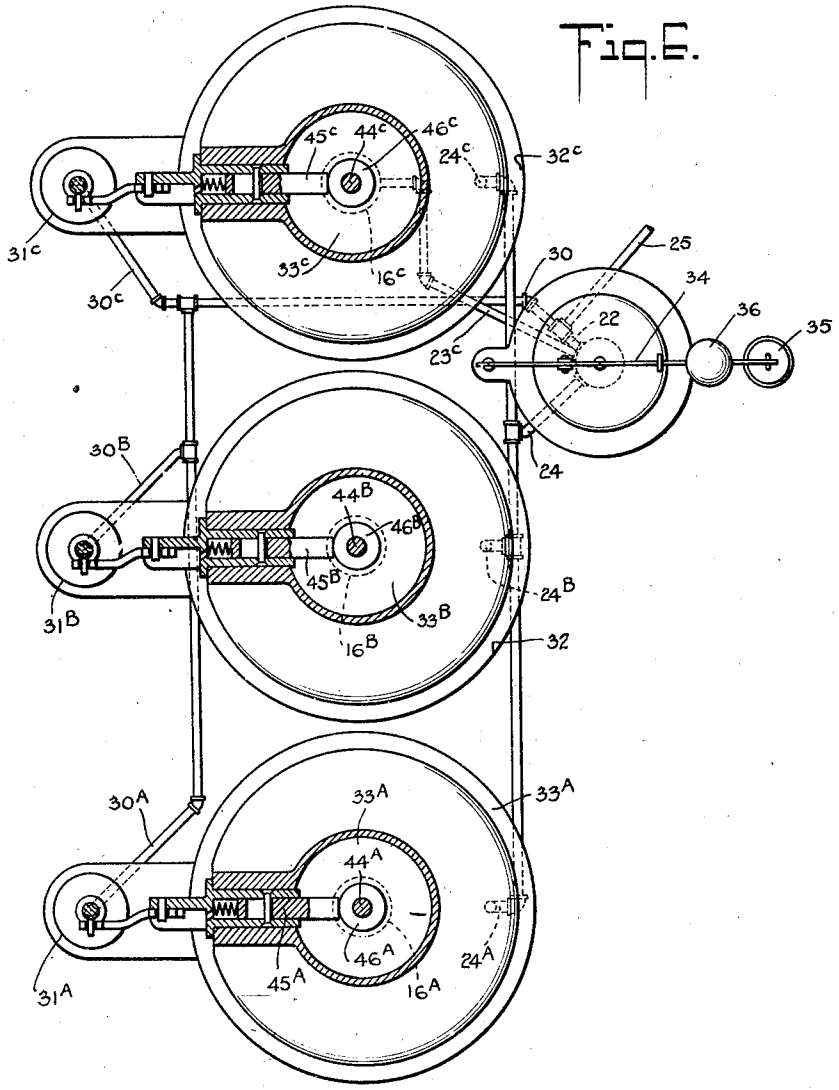
Fig. 5.



INVENTOR,
Everett W. Swartwout,
BY
Henry J. Lucke,
HIS ATTORNEY

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COMPRESSOR AND PUMP

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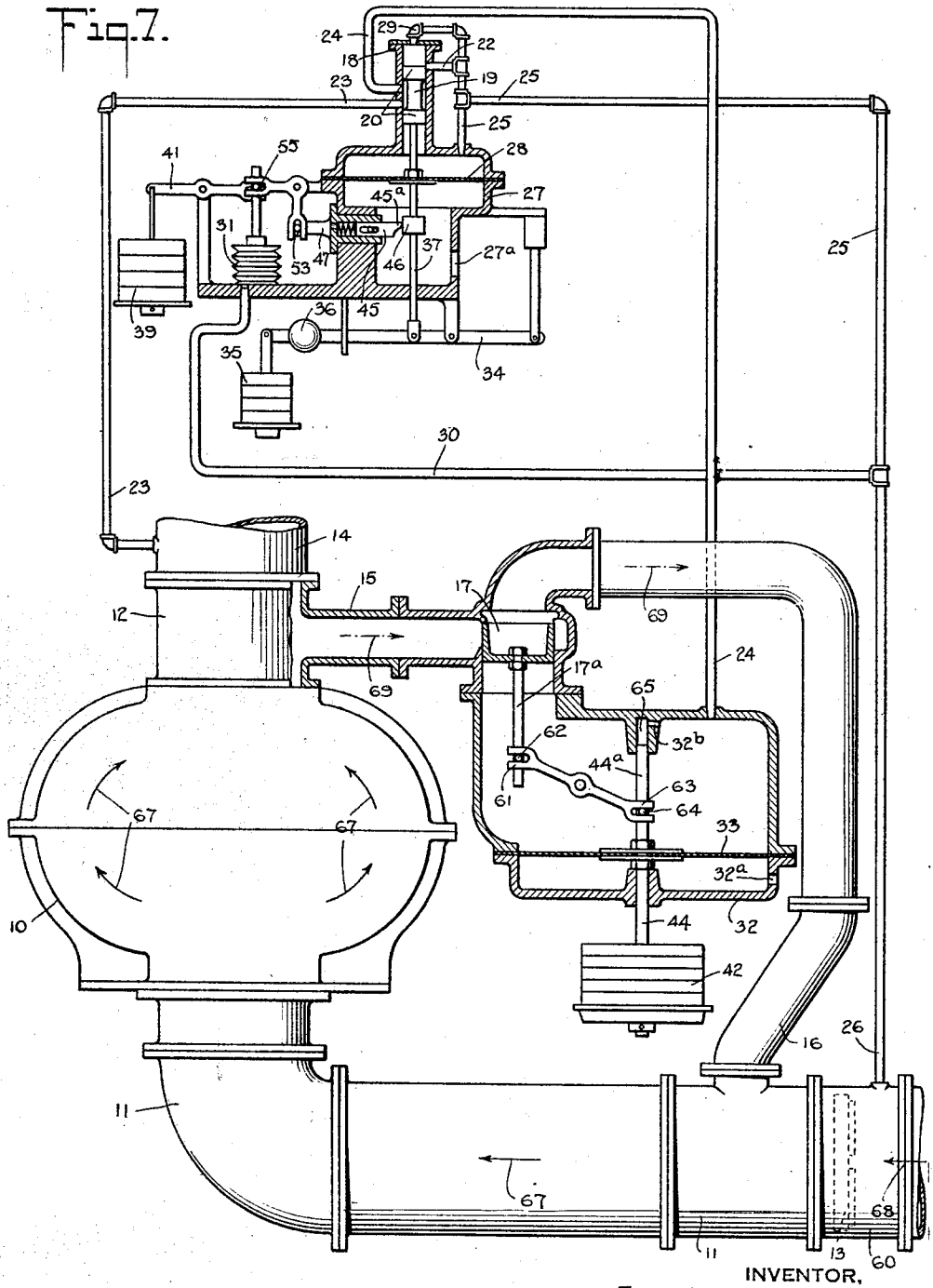
Fig. 7.



INVENTOR,
Everett W. Swartwout,
BY
Henry J. Lucke,
HIS ATTORNEY

Patented May 5, 1931 1,803,660

UNITED STATES PATENT OFFICE

EVERETT W. SWARTWOUT, OF WHITE PLAINS, NEW YORK

COMPRESSOR AND PUMP

Application filed December 5, 1928. Serial No. 323,980.

This invention relates to compressors and pumps.

More particularly, my invention relates to reciprocating compressors, rotary blowers and pumps having one or more compression or suction compartments, each compartment provided with a piston, or with lobed impellers, or the equivalent for the passage of the medium under compression or otherwise and means for unloading the one or more compartments respectively within pre-determined ranges of unloading pressure.

In my application Ser. No. 219,225, entitled Rotary blowers and pumps, filed by me on Sept. 13, 1927, I have set forth and claimed the construction of rotary blowers and pumps having one or more compartments provided with lobed impellers, preferably with suitable means for discharging the medium through the discharge outlet of the blower or pump into the discharge line, and means for loading and unloading the blower or pump under the control of a pilot valve set to unload and to load up again at any desired maximum unloading pressure.

In my co-pending application Ser. No. 222,455, entitled Rotary blowers, pumps and meters, filed by me on Sept. 28, 1927, I have set forth and claimed constructions of rotary blowers, pumps and meters comprising a plurality of compartments in each of which is disposed lobed impellers or the equivalent for the passage of the medium under compression or otherwise, and means for progressively loading and unloading the respective compartments under pilot valve control preset for maximum unloading pressures for the respective compartments. Such plurality of compartments may or may not have adiabatic means for delivering the respective media into the delivery lines.

Pursuant to the present invention, the loading and unloading means with control for the respective one or more compartments, is effective to set the loading and unloading means into operation at a predetermined maximum delivery pressure and when the capacity is excessive, to make effective and maintain the continuation of the unloading means until the delivery pressure attains a predetermined minimum pressure, thus positively preventing any "hunting" action of the controlling means and its coordinative parts in its operation of the loading and unloading means; when unloaded, and when the reduction in delivered capacity in the discharge line results in a drop in pressure to the predetermined minimum pressure, loading up again will result. Thus, when delivering into, or exhausting from, systems of substantial capacity, the number of loadings and unloadings in any given time will be relatively small while at the same time, the capacity will be varied to suit the actual requirements of the distribution system, maximum saving in power will result, and smooth operation obtained.

Further features and objects of the invention will be more fully understood from the following detail description and the accompanying drawings, in which

Fig. 1 shows a side elevation of a compressor, its inlet and discharge pipes equipped with unloading means and a power control therefore. Pursuant to my invention, a portion of the unloading means and portions of the control are indicated in central vertical section;

Fig. 2 is a sectional elevation on line 2—2, Fig. 1;

Fig. 3 is a side elevation showing a modification; a portion of the pilot control appears in central vertical section;

Fig. 4 is a side elevation showing my invention applied to a machine having a plurality of compression compartments having a common pilot for controlling the same in which a portion of the pilot is illustrated in central vertical section;

Fig. 5 is a sectional elevation on line 5—5, Fig. 4;

Fig. 6 is a horizontal section of a modification of the arrangement shown in Fig. 4; and Fig. 7 shows my invention applied to the vacuum system.

Referring to Figs. 1 and 2, the compressor or blower 10 is illustrated as of the single compartment type. The impelling means is preferably a pair of lobed impellers, as is illustrated and described in my aforesaid co-

pending applications Ser. Nos. 219,225 and 222,455. The inlet pipe is shown at 11. The discharge of the unit 10 is indicated at 12 and between the same and the discharge line is provided the check valve 13, preferably disposed within a separate cylindrical pipe casing 14.

Between the discharge 12 and 11 I arrange the unloading passage comprising its inflow piping 15 and its outflow piping 16, the communication of which is controlled by the valve 17, in turn controlled by the pilot means, as appears more fully hereinafter.

In this form of my invention, as illustrated in Figs. 1 and 2, the pilot proper comprises the main valve body 18 in which is disposed the pilot valve 19 having at its opposite ends full diametrically enlarged heads 20, and an intermediate portion 21 of reduced diameter, thus providing for an annular clearance controlling the communication and non-communication of the pipe connections 22, 23 and 24.

The pipe connection 22 communicates with the piping 25 communicating at its inlet 26 with the interior of the housing 14 at a location posterior of the check valve 13 and thus subject to the pressure of the discharge line. The piping 25 has an upper extension 26 communicating with the interior of the casing 27 below its diaphragm 28, and also effective upon the upper face 19*a* of the pilot valve 19. The piping 25 communicates also through its extension 29 with the interior of the main valve body 18, to its bottom, to be effective upon the lower face 19*b* of the valve 19.

The pipe 30 communicates at one end with the piping 25, thus subject to the delivery pressure, and at its opposite end leads to the interior of the expansible bellows or other pressure expansion device 31.

The piping 23 leads from the interior of the main valve body 18 at its one end to the interior of the outflow loading passage 16, and thus subject to the inlet pressure. The piping 24 leads at its one end from the central interior of the main valve body 18 to its other end to the interior of the casing 32 at the lower or valve side of the diaphragm 33 controlling the loading and unloading valve 17.

The diaphragm 28 is pre-set in critical pressure operating value by means of the scale beam 34, pendant weights 35 and sliding weight 36, effective by means of the link 37 engaging diaphragm 28 at substantially its center and extending by the rod 38 into rigid connection with the movable pilot valve member 19.

The expansible bellows 31 or equivalent is controlled in its pre-set vertical pressure value position by the weights 39 resting upon the platform 40 supported by arm 41 upon the upper and expansible end of the bellows 31.

The diaphragm 33 is pre-set by the weights 42 resting upon the platform 43 supported by the rod 44 upon the upper face of the diaphragm 33.

Associated with the above stated parts, I have illustrated in the form shown in Figs. 1 and 2, a trigger 45 which co-operates at its end 45*a* with the maximum and minimum stop member 46, the latter being suitably positioned upon the rod 44 of diaghragm 33. The trigger 45 is suitably mounted in the reciprocable barrel 47 extending at one side through the upper portion of the casing 32 and biased by the expansion spring 49 lodged within the closed end of the barrel 47. The barrel 47 is reciprocable within the circular opening of the casing 32. The barrel 47 is provided with a pin 51 received within the opposite, closed ended slot 52 in the trigger 45. The outer arm 50 of the barrel 47 is pivotally connected by a pin at 50*a* within the slot of the forked end 53 of the bell crank, pivoted at its center 54, and having an opposite forked end 55, the slot of which receives the pin 56 carried by the arm 41 of the weight 39 and expansible bellows 31. The barrel 47 is provided with an air vent 47A.

The interior of the casing 32 on the side of the diaphragm 33 opposite to that of the valve 17, communicates with the atmosphere through the opening 32*a*. And likewise the casing 27 through the air vent 27*a*, see Fig. 3.

Pursuant to the specific parts thus described, and the relative positions of the parts as illustrated in Fig. 1, the pressure of the delivery line effective upon the movable diaphragm 28 at its lower face is less in value corresponding to that exerted by the pendant weights 35 and sliding weights 36, thus causing the movable pilot member 19 to be moved upwardly, bringing its lower enlarged end 20 in closing position relative to the pipe opening 23, and its upper enlarged end 20 free of the pipe opening 22.

Under these circumstances the clearance afforded by the reduced portion 21 of the movable pilot valve 19 effects communication between the pipe connections 23, 24, thus subjecting the lower face of the diaphragm 33 to the inlet or suction pressure of the blower 10.

Fig. 1 also represents a certain movement of expansion of the expansible bellows 31 under effect of an increase of the delivery line pressure, causing an extent of clockwise movement of its bell-crank 53—55, and corresponding motion of the arm 50 and barrel 47 to its full extent to bring its extended flange 47*a* into engagement with the sides of the cylindrical opening in the casing 32, advancing the pin 51 to contact with right hand end of slot 52, and fully compressing the spring 49.

Under further increase of the delivery line pressure, such increased delivery line pressure applied to the bottom of diaphragm 28

causes the upward displacement of the valve member 19 to the status when the pipe connection 22 communicates with the pipe 24 through the clearance about the reduced valve portion 21, at which position the communication of the pipe 23 with such clearance is shut off. Such connection of the pipe 24 with the pipe 22 subjects the under face of the diaphragm 35 to such relatively increased pressure and overcomes the effective value of the weights 42, causing the diaphragm 33 to rise and therewith the unloading valve 17 to open communication between the unloader inlet passage 15 with its outlet passage 16.

Upon the rise of the diaphragm 33 the rod 44 and its stop 46 are elevated until the stop 46 is moved free of the end 45*a* of the trigger 45 to project its end 45*a* under the stop 46.

Under unloading conditions the passage of the medium under compression through the blower is effected out of its discharge port, thence through the unloading passages 15, 16 to return through the inlet of the blower, and thus without effective delivery into the delivery line.

We will now assume that the pressure in the delivery line has decreased, arising upon withdrawal by consumption or otherwise of the medium.

It will be recalled that upon reaching the maximum pre-set pressure the operation of the pilot valve and associated devices results as above stated, and the delivery line pressure is applied to the lower face of the diaphragm 33, by communication of the piping 26, 25, thence through 24 to such interior portion of the casing 32 of the diaphragm 33; the delivery line pressure is also effective upon expansible bellows 31 through the piping 26 and 30. Hence, upon decreased value of pressure in the delivery line, the weights 39 cause the flexible corrugated diaphragm 31 to contract, moving the arms 41 downwardly, rotating the bell crank 55—53 counter-clockwise, as viewed in Fig. 1, causing the pin 51 to move to the left in its slot 52 until it engages the left hand closed end of the slot and eventually forces the end 45*a* of the trigger 45 from under the under face of the stop 46 until the same is free thereof. Upon such withdrawal of the trigger 45 from the stop 46, the weights 42 cause the diaphragm 33 to drop, moving the valve 17 downwards to its shut-off position, and interrupting communication between the pipe 15 and the pipe 16 of the unloading means in which status the operation of the blower becomes effective to pass the medium under compression through the check valve 13 into the delivery line.

The restored delivery of the medium under compression into the delivery line continues until the pressure of the delivery line again exceeds that pre-set by the weights 35, 36, controlling the movable valve member 19, and the weights 39 controlling the flexible corrugated diaphragm 31 and the trigger 45, similarly as previously described.

It will be observed that the pipe 26 communicates at one end with the discharge line and connects with the pipe 29 leading to the bottom of the casing 18 of the movable valve member 19, thus subjecting the lower face 19*b* of the movable valve member 19 to the discharge line pressure; the pipe 26 also connects with the pipe 25 which communicates with the lower portion of the casing 27 and thus with the upper portion of the casing 18 of the movable valve member 19, and hence subjects the upper face 19*a* of the movable valve member 19 also to substantially the same discharge line pressure; accordingly, the opposite faces of the movable member 19 are subjected to substantially equal pressure and are balanced for all positions of the movable valve member within its casing 18.

My invention illustrated in Fig. 3 is similar in many respects to that illustrated in Figs. 1 and 2, and like parts are designated by like reference numbers. In the form illustrated in Fig. 3, the expansible bellows is positioned to co-operate with a stop associated with the diaphragm of the pilot means, in this instance, the stop 46 being positioned upon the link 37 of the pilot means, in lieu of being positioned upon the rod 44 of the diaphragm 33 controlling the shut-off valve 17 of the unloading means. The pipe connections and relative operations of the expansible bellows 31, its bell crank 53—55, its trigger 45 in co-operation with the stop 46 carried by the link 37 of the pilot diaphragm 28 correspond in a similar manner as in the construction of Figs. 1 and 2. Similarly, the weights 42 cooperate with the diaphragm 33 and the shut-off valve 17 of the unloading means in a like manner.

In this arrangement the pipe 30 leading at one end to the interior of the expansible bellows 31 is of relatively short length as compared with the arrangement shown in Figs. 1 and 2; the other end of the pipe 30 communicates with the pipe 25, and in turn with the pipe 26 leading to the discharge line.

In the form of my invention illustrated in Figs. 4 and 5, a plurality of compartments is provided for the blower, compressor or like device; these compartments may be of equal or unequal relative capacities. Individual unloading means are provided for the respective compartments, the shut-off valve of which is controlled by individual pre-set weights or equivalent. The blower discharge may communicate with separate discharge lines or a single discharge line, as desired.

In Figs. 4 and 5, the control of the respective shut-off valves for the individual unloading means follows the construction for the single compartment type illustrated in

Fig. 3 and hereinabove described. Like reference numbers designate like parts, the suffix "A" being applied to the parts of one compartment, its associated unloading means and its controlling device, the suffix "B" to the second group of these associated parts, and the suffix "C" to the third group of the associated parts.

In the arrangement indicated in Figs. 4 and 5, the discharge outlets of respective compartments communicate with a single discharge line, that is to say, the compartments discharge into a common discharge line through individual discharge passages 12 and individual check-valves 13.

Pursuant to this arrangement, the triggers 45A, 45B, 45C co-act with a common stop 46 on the arm 37 of the common pilot means, and the respective pointed ends 45*a*, 45*b* and 45*c* are arranged in vertically spaced relation, relative to the common stop 46; the trigger end 45*a* is shown lower than the trigger end 45*b* and the trigger end 45*c* shown higher than the trigger end 45*b*. By such arrangement, upon the upward flexing of the diaphragm 28 occasioned by a predetermined range of rise of pressure in the discharge line, transmitted through the pipe 26, thence through the pipe 25 to the interior of the lower portion of the casing 32, under the conditions hereinabove set forth, the lowermost trigger end 45*a* is the first, upon upward displacement of the diaphragm 28, to be positioned below the stop 46 to thereby lock the stop 46 and effect the opening of the unloading valve to provide for unloading of the blower 10A; in the event of further increase of predetermined range of rise of the delivery line pressure and corresponding further upward flexing of the diaphragm 28, the intermediate trigger end 45*b* will next be positioned under the stop 46 for locking engagement therewith and effect the unloading of the blower 10B in a similar manner; and finally upon further pre-determined range of increase of delivery line pressure and corresponding further upward flexing of the diaphragm 28, the highest trigger end 45*c* is brought under the stop 46 in locking relation therewith.

To effect such conjointed control of, say, three compressors or compressing compartments and the common pilot means, the movable pilot member 19 is formed in this instance to have three reduced sections 21A, 21B, 21C for the respective sets of pressure conveying pipes, the set of pipes 22A, 23A and 24A for the control of the valve 17A of the unloading passages 15A, 16A for the blower compartment 10A; such valve 17A is provided with a diaphragm similar to the above described diaphragm 33 within the casing 32A and pre-set by the weights 42A; and similarly for the second blower or compressor compartment, and similar for the third blower or compressor compartment, the last two named having individual unloading passages of like construction, individual casings 32B, 32C for the respective diaphragm corresponding to the aforesaid diaphragm 33 and pre-set for range of variation of pressure by selective weights 39B, 39C, these parts being shown in partial plan view in Fig. 5.

In a like manner the set of pipes 22B, 23B, 24B lead from the region of movement of the intermediate reduced portion 21B of the common movable valve 19 for the control of the diaphragm of the casing 32B to control its valve 17B, and similarly for the set of pipes 22C, 23C and 24C for the control of its valve 17C similarly actuated by its diaphragm and controlled in range of pressure variation by its pre-set weights 39C.

The reduced valve portions 21A, 21B and 21C are related to the respective sets of pipes just enumerated to effect operative relation between the coacting parts upon rise of the predetermined range of the delivery line pressure to effect the closure of the pipe 23A relative to the pipe 22A, the pipe 24A for the stage of rise upward movement of the common pilot valve 19 is brought into communication with the pipe 23A. For the second stage of rise of the predetermined range of the common pilot valve 19 similar operations take place for the pipes 22B, 23B and 24B and similarly for the final range of pressure increase of the delivery line for the pipes 22C, 23C and 24C.

Such successive stages of operation of the respective unloading means effects the opening of the valve and the unloading of the blower compartment 10A, with continued operation of the two remaining blowers or compressor compartments for the stage of first pre-set range of increase of the delivery line pressure; upon occasion of the second pre-set range of rise of delivery line pressure, the valve of its unloading passages is then moved to its open position, thus providing for the unloading of the second blower or compressor compartment together with the unloading of the aforesaid first blower or compressor compartment, while the third blower or compressor compartment is continued in discharging communication with the delivery line. In the event of the third, and in this instance, maximum range of increase of delivery line pressure, the third blower or compressor compartment is placed in unloading status, namely, by the opening of its valve corresponding to the aforesaid valve 17 of its unloader.

However, in the event that the third range of increase of the delivery line pressure does not take place, the third blower or compressor compartment continues in full operation; in the event that the delivery line pressure decreases below the pre-set second

range of pressure variation, the valve of the unloading means of the second blower or compressor compartment is moved to its closed position, thus placing the second blower or compressor compartment, as well as the third blower or compressor compartment in full delivery status. Upon the drop of the delivery line pressure in excess of the first pre-set range of pressure variation, the unloader of the first blower or compressor compartment is moved to its closed position, thus placing all blowers or compressor compartments in full delivery discharge with the delivery line.

Similar operations take place for any desired number of blowers or compressor compartments co-related in a similar manner pursuant to my invention.

It will be observed that the respective pipes 30A, 30B and a similar pipe for the third blower or compressor compartment, lead respectively from the second expansible bellows 31A, 31B and similarly for the third expansible bellows 31A, 31 to the interior of the lower portion of the common casing 27, and thereby communicate through the pipe 25 with the pipe 26 leading to the discharge line, thus subjecting the respective expansible bellows to the delivery line pressure.

My invention as illustrated in Fig. 6 follows the type of my invention illustrated in Figs. 1 and 2, and is applicable for a multiple blower or compressor compartments, in this instance three being indicated. Like parts are designated by like reference numbers.

In this type of my invention, the triggers 45A co-act with the stop 46A on the stem 44A of the diaphragm 33A within the casing 32A, similarly, the trigger 45B coacts with stop 46B on the stem 44B of the diaphragm 33B in the casing 32B and the trigger 45C co-acts with the stop 46C on the stem 44C of the diaphragm 33C in the casing 32C. Pipe 30 communicates through its branch 30A with the interior of the lower portion of the casing 31A through its branch 30B with the interior of the lower portion of the casing 31A, and through its branch 30C to the interior of the lower portion of the casing 32C.

In a similar manner my invention is applicable for compressors of the reciprocating type, whether single or in multiple, and discharging into a single discharge line or separate discharge lines.

Also, in a similar manner, my invention is applicable for controlling the vacuum, i. e., suction pressure, of the inlet pressure line of an exhauster of the interlobal or other rotary type, or of a reciprocating vacuum pump, for effecting a desired vacuum within a pre-determined range of variation.

As an illustration of one form of such embodiment of my invention, I have shown in Fig. 7 a vacuum pump, say, of the interlobal type and associated unloading means controlled by an expansible bellows and pilot corresponding to the inter-relation of these associated parts conforming generally to the hereinabove described arrangement illustrated in Fig. 3. Like parts are designated by like reference numbers.

However, in Fig. 7, the check valve 13 is disposed within the inlet pressure line 60 arranged to communicate through the check valve 13 with the inlet passage 11 of the exhauster or vacuum pump 10; the discharge passage 12 in this instance may connect directly with the discharge line 14, that is to say, without a check valve. The passage 15 of the unloading means communicates at its one end with the discharge passage 12 and the passage 16 communicates at its one end with the inlet passage 11 posteriorly of the check valve 13. The valve 17 controlling the intercommunication of the adjacent ends of the unloading passages 15, 16, is controlled by the diaphragm 33, disposed in the casing 32. The diaphragm 28 of the pilot means, in this instance, controlled in its effective extent of displacement by the trigger 45^a in coaction with the stop 46 carried by the link 37. The expansible bellows 31, as hereinabove set forth, by communication of its piping 30 with with the pipe 26 is rendered subject to variations of the pressure to be controlled, namely, the vacuum or suction pressure by connection with the pipe 26 with the vacuum pressure line 60 anteriorly of the check valve 13. The pipe 26, as heretofore, communicates with the pipe 25, which in turn communicates with the pipe 22 leading to the interior of the casing 18 of the pilot valve, similarly as hereinabove set forth.

The pipe 23, in this instance, communicates at one end with the delivery line 14 and at its opposite end with the interior of the pilot valve casing 18, and the pipe 24 in this instance communicates at one end with the interior of the pilot casing 18 and at the opposite end with the sealed interior of the casing 32.

In such embodiments of my invention wherein vacuum, i. e., "inverse" pressures are to be controlled, the respective variable weights 35, 36 of the diaphragm 28 of the pilot means are arranged with respect to the fulcrum to exert a pressure on the diaphragm 28 through the link 37 in "inverse" direction to that of my modifications as hereinabove set forth. The link 37, in this instance, following the modification of Fig. 3, carries the stop 46 for the trigger 45.

Also, similarly, the variable weights 39 of the expansible bellows 31 is applied in "inverse" direction through the lever 41, in lieu of the standard 41 in Fig. 3. The bell crank 55, 53 tends to move the housing 47 and therewith the trigger 45 inwardly to the casing 32 upon the downward, i. e., in the "inverse" di-

rection upon expansion of the expansible bellows 31.

Also, similarly, the variable weights 42 applies its pressure through the rod 44 upon the diaphragm 33 downwardly, that is to say, in the "inverse" direction as compared with the corresponding arrangement of Fig. 3.

For convenience the mechanical connection between the diaphragm 33 and the unloading valve 17 is had by a centrally pivoted swinging back, whose fork 61 at one end embraces the pin 62 of the stem 17*a* of the valve 17 and whose fork 63 at the opposite end embraces the pin 64 on the rod 44*a* of the diaphragm 33. The casing 32 is provided with the air vent 32*b* for the recess 65 for guiding the rod 44*a* in its vertical reciprocating movement, incident to the flexing of the diaphragm 33.

It will be observed that the valve 17, its stem 17*a*, the bell crank 61, 63, and the diaphragm rod 44*a* are located in the casing 32 on the side of the diaphragm to which the pipe 24 is connected, and accordingly the casing 32 on such side is constructed to seal against the outer or atmospheric pressure, thus avoiding the use of gaskets, packing or the like, for the unloader valve 17, the rod 44*a* and the immediately associated parts.

The position of the movable valve member 19 within its casing 18 corresponds to that shown in Fig. 3.

Corresponding interrelations and objects attained of the controlling and associated parts are present in the form of my invention shown in Fig. 7 as in that of Fig. 3. My invention is similarly applicable for a single vacuum pump pursuant to the arrangement of the controlling and associated parts corresponding to that of Figs. 1 and 2, and for multiple vacuum pumps or compartments corresponding to the forms shown in Figs. 4 and 5, and in Fig. 6.

The operations of the respective parts of the various forms of my invention will be understood from the foregoing.

In these illustrated various forms of my invention I have appended the arrows 66 to indicate the flow of the medium through the inlet passage and the compressor or vacuum pump 10, as the case may be; the arrows 67 indicate the flow of the medium in the pressure line whose pressure is to be controlled, to wit, that of the discharge line in the forms illustrated in Figs. 1 to 6 and of the inlet line illustrated in Fig. 7. The arrows 68, in dot-and-dash outline indicate the direction of flow of the medium during the stage of unloading.

In the claims I have employed the expansion "pressure device" to include blowers of the rotary type such as interlobal compressors, also reciprocating pumps and other compressors, and further to include suction or vacuum exhausters of the rotary, reciprocating and other types, the aforesaid being of single or multiple compartments or units applicable or as designated otherwise in the respective claims.

Whereas I have described my invention by reference to specific forms thereof, it will be understood that many changes and modifications may be made without departing from the spirit of the invention.

I claim.

1. The combination of a pressure producing device having an inlet passage and a discharge passage, a pressure line communicating with one of said passages, unloading means for said device including passage means for interconnecting said discharge passage with said inlet passage of said device, a valve for said unloading means, and means preset for a definite and substantial range of variation of the pressure of the pressure line for moving said valve to and from its closing and opening positions.

2. The combination of a pressure producing device having an inlet passage and a discharge passage, a pressure line communicating with one of said passages, unloading means for said device including passage means for interconnecting said discharge passage with said inlet passage of said device, a valve for said unloading means, and means including a pilot valve preset for a definite range of variation of the pressure of the pressure line for moving said valve to and from its closing and opening positions.

3. The combination of a pressure producing device having an inlet passage and a discharge passage, a pressure line communicating with one of said passages, unloading means for said device including passage means for interconnecting said discharge passage with said inlet passage of said device, a valve for said unloading means, a member controlling said valve, means for subjecting said member to the pressure line pressure, means for presetting said member to a predetermined pressure value, and a preset pilot responsive to the pressure line pressure co-acting with said valve controlling member.

4. The combination of a pressure producing device having an inlet passage and a discharge passage, a pressure line communicating with one of said passages, unloading means for said device including passage means for interconnecting said discharge passage with said inlet passage of said device, a valve for said unloading means, a member controlling said valve, means for subjecting said member to the pressure line pressure, means for presetting said member to a predetermined pressure value, pilot means subject to the pressure line pressure and co-acting with said valve controlling member, and means for presetting said pilot means for a predetermined pressure value.

5. The combination of a pressure produc-

ing device having an inlet passage and a discharge passage, a pressure line communicating with one of said passages, unloading means for said device including passage means for interconnecting said discharge passage with said inlet passage of said device, a valve for said unloading means, and means preset for a definite range of variation of the pressure of the pressure line for moving said valve to and from its closing and opening positions, said pressure range presetting means including a pressure responsive expansible bellows.

6. The combination of a pressure producing device having an inlet passage and a discharge passage, a pressure line communicating with one of said passages, unloading means for said device including passage means for interconnecting said discharge passage with said inlet passage of said device, a valve for said unloading means, and means preset for a definite range of variation of the pressure of the pressure line for moving said valve to and from its closing and opening positions, said pressure range presetting means including a diaphragm subject to the pressure line pressure.

7. The combination of a pressure producing device having an inlet passage and a discharge passage, a pressure line communicating with one of said passages, unloading means for said pressure device including passage means for interconnecting said discharge passage with said inlet passage for said device, a valve for said unloading means, and means preset for a definite range of variation of the pressure of the pressure line for moving said valve to and from its closing and opening positions.

8. The combination of a pressure producing device having an inlet passage and a discharge passage, a pressure line communicating with one of said passages, unloading means for said device including passage means for interconnecting said discharge passage with said inlet passage for said device, a valve for said unloading means, and means preset for a definite range of variation of the pressure of the pressure line for moving said valve to and from its closing and opening positions, a pressure responsive diaphragm and means controlled by an expansible bellows for controlling the displacement of said diaphragm.

9. The combination of a pressure producing device having an inlet passage and a discharge passage, a pressure line communicating with one of said passages, unloading means for said device including passage means for interconnecting said discharge passage with said inlet passage for said device, a valve for said unloading means, and means preset for a definite range of variation of the pressure of the pressure line for moving said valve to and from its closing and opening positions, a pressure responsive diaphragm, a stop element displaced upon the displacement of said diaphragm and a co-acting stop element controlled by an expansible bellows.

10. The combination of a pressure producing device having an inlet passage and a discharge passage, a pressure line communicating with one of said passages, unloading means for said device including passage means for interconnecting said discharge passage with said inlet passage for said device, a valve for said unloading means, and means preset for a definite range of variation of the pressure of the pressure line for moving said valve to and from its closing and opening positions, and variable means for controlling the effective expansion of an expansible bellows.

11. The combination of a pressure producing device having an inlet passage and a discharge passage, a pressure line communicating with one of said passages, unloading means for said device including passage means for interconnecting said discharge passage with said inlet passage for said device, a valve for said unloading means, and means preset for a definite range of variation of the pressure of the pressure line for moving said valve to and from its closing and opening positions, variable means for controlling the effective expansion of an expansible bellows, a pressure responsive diaphragm and variable means for controlling the displacement of said diaphragm.

12. The combination of a pressure producing device having an inlet passage and a discharge passage, a pressure line communicating with one of said passages, unloading means for said device including passage means for interconnecting said discharge passage with said inlet passage of said device, a valve for said unloading means, and means preset for a definite range of variation of the pressure of the pressure line for moving said valve to and from its closing and opening positions, said pressure range presetting means including an expansible bellows, weights for variably controlling said expansible bellows, a stop element controlled by the effective expansion of said expansible bellows, a pressure responsive diaphragm, a stop element subject to the displacement of said diaphragm and coacting with said first-named stop element, weights for variably controlling the displacement of said diaphragm, pilot valve means for alternately subjecting said diaphragm to the inlet pressure of said device and the pressure line pressure and weights for predetermining the movement of said pilot valve means.

13. The combination of a pressure producing device having an inlet passage and a discharge passage, a pressure line arranged to communicate with one of said passages, unloading means for said device including

a valve, and means responsive to a predetermined substantial range of pressure variation of the pressure line for moving said valve to effect unloading and loading of said device relative to said pressure line.

14. The combination of a pressure producing device having an inlet passage and a discharge passage, a pressure line arranged to communicate with one of said passages, a check valve disposed between said one passage and said pressure line, unloading means for said device including a valve, and means responsive to a predetermined and substantial range of pressure variation of the pressure line for moving said valve to effect unloading and loading of said device relative to said pressure line.

15. The combination of a pressure producing device having a plurality of pressure units, inlet and discharge means respectively for said pressure units, a pressure line arranged to communicate with one of said means, unloading means for said pressure units respectively including a valve for said respective unloading means, and means responsive to the pressure line pressure for controlling said valves respectively for predetermined ranges of variation of the pressure line pressure to effect unloading and loading of said pressure units.

16. The combination of a pressure producing device having a plurality of pressure units, inlet and discharge means for said pressure units, a pressure line arranged to communicate with one of said means, said one means being provided with check valves, unloading means for said pressure units respectively including a valve for said respective unloading means, and means responsive to the pressure line pressure for controlling said valves respectively for predetermined ranges of variation of the pressure line pressure to effect unloading and loading of said pressure units.

17. The combination of a pressure producing device having a plurality of pressure units, inlet and discharge means for said pressure units, a pressure line arranged to communicate with one of said means, each of said one means being provided with a check valve, unloading means for said pressure units respectively including a valve for said respective unloading means, and means responsive to the pressure line pressure for controlling said valves respectively for predetermined ranges of variation of the pressure line pressure to effect unloading and loading of said pressure units.

18. The combination of a pressure producing device having a plurality of pressure units, inlet and discharge means for said pressure units, a pressure line arranged to communicate with one of said means, unloading means for said pressure units respectively including a valve for said respective unloading means, and means responsive to the pressure line pressure for controlling said valves respectively for predetermined ranges of variation of the pressure line pressure to effect unloading and loading of said pressure units, said pressure responsive means including a diaphragm controlling said valve.

19. The combination of a pressure producing device having a plurality of pressure units, inlet and discharge means for said pressure units, a pressure line arranged to communicate with one of said means, unloading means for said pressure units respectively including a valve for said respective unloading means, and means responsive to the pressure line pressure for controlling said valves respectively for predetermined ranges of variation of the pressure line pressure to effect unloading and loading of said pressure units, said pressure responsive means including a pliot valve responsive to the pressure line pressure.

20. The combination of a pressure producing device having a plurality of pressure units, inlet and discharge means for said pressure units, a pressure line arranged to communicate with one of said means, unloading means for said pressure units respectively including a valve for said respective unloading means, and means responsive to the pressure line pressure for controlling said valves respectively for predetermined ranges of variation of the pressure line pressure to effect unloading and loading of said pressure units, said pressure responsive means including diaphragm means controlling said valves respectively, and further including a common pilot valve responsive to the pressure line pressure and controlling the pressures effective upon said diaphragm means respectively.

In testimony whereof I have signed this specification this 2nd day of Oct., 1928.

EVERETT W. SWARTWOUT.