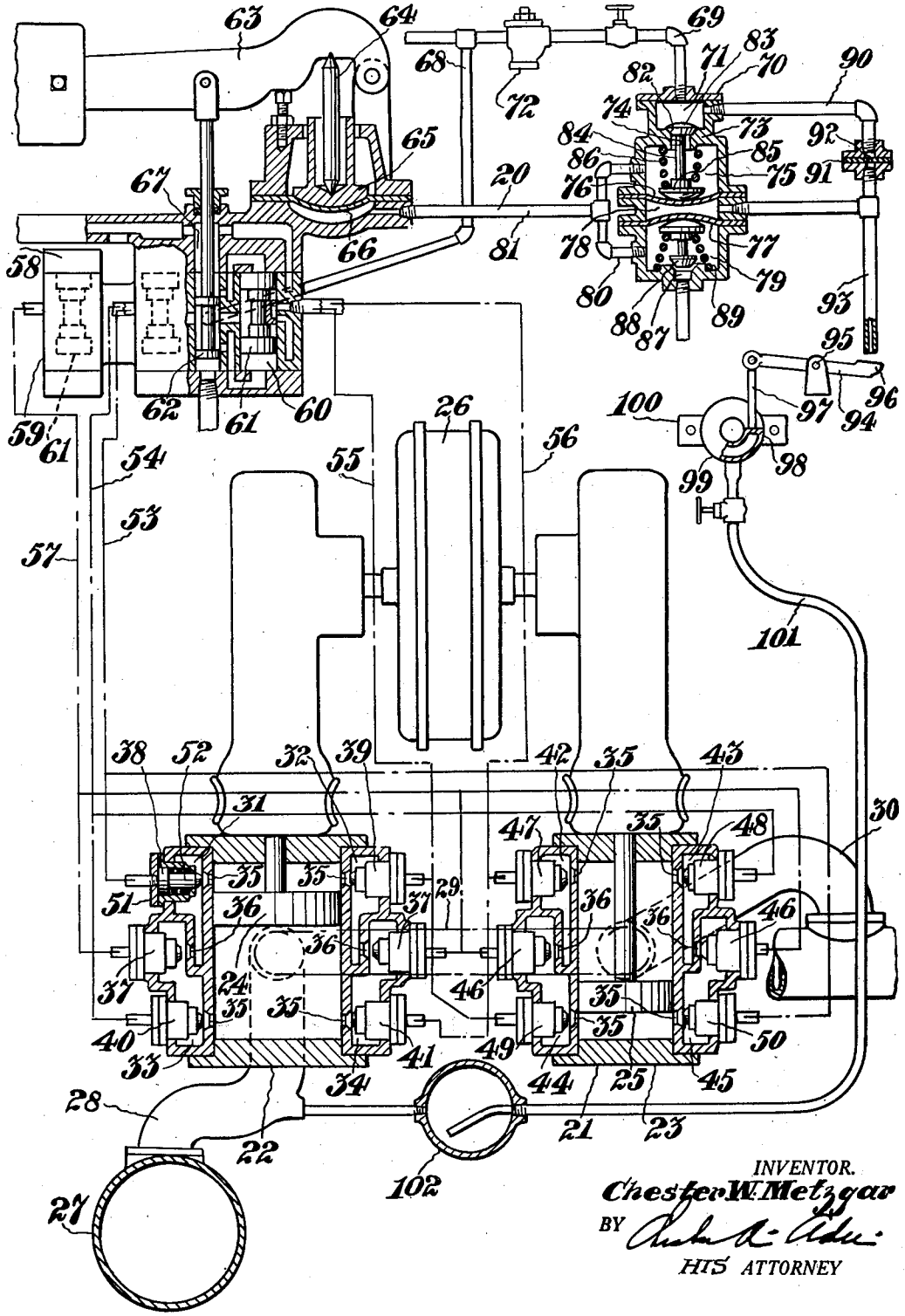
March 3, 1936. C. W. METZGAR 2,032,429

LOAD CONTROLLING APPARATUS FOR COMPRESSORS

Filed July 26, 1934



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Patented Mar. 3, 1936 2,032,429

UNITED STATES PATENT OFFICE

2,032,429

LOAD CONTROLLING APPARATUS FOR COMPRESSORS

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Application July 26, 1934, Serial No. 737,036

15 Claims. (Cl. 230—21)

This invention relates to compressors, and particularly to load controlling apparatus therefor.

One object of the invention is to provide a compressor having load-controlling apparatus with means for effecting an alteration of the load on the compressor in response to variations in the value of the suction pressure of the fluid entering the said compressor.

Another object is to provide a compressor having load-controlling apparatus with connections for employing a power medium at a relatively low pressure to control the supply of a fluid medium at higher pressure to the various load-altering devices for actuating the latter.

A further object of the invention is to provide a compressor having load-altering devices with a regulator for said devices, and suitable means for controlling the action of said regulator. In practice said means is preferably connected so that it is influenced by a change in the suction pressure of the compressor.

An additional object of the invention is to provide a compressor having load-changing devices with a suitable regulator for determining the number of said devices which are effective, controlling means for said regulator and suitable connections between the controlling means and a source of power on the one hand, and the suction side of the compressor on the other, said connections to the compressor containing an appliance by which the controlling means itself is rendered effective.

A still further object of the invention is to provide in a construction adapted to attain the foregoing objects, a suitable appliance for the purpose of equalizing the suction pressure while still permitting it to vary, but preventing fluctuations which would derange the normal operation of the compressor.

Other objects and advantages will be in part obvious and in part pointed out hereinafter.

One purpose for which the invention can be especially utilized is in connection with the operation of cooling petroleum and the distillates thereof to facilitate the separation and the recovery of the paraffin therein. As I have set forth in my application entitled Load controlling apparatus, Serial No. 737,035, filed of even date herewith, oil containing paraffin, after receiving whatever treatment is necessary, is mixed in a suitable reservoir with a cooling medium, such as propane gas (C_3H_8) in liquid form. The pressure and temperature within the reservoir containing the oil are so adjusted that, when the process of mixing is complete, the propane is allowed to vaporize; and a quantity of heat determined by the specific heat of vaporization of the propane is taken from the oil; and the oil is thus cooled. The paraffin wax then separates out; and when the propane has been evacuated from the tank or reservoir the oil containing the paraffin is piped away from the reservoir, so that the paraffin can be removed. Some of the propane, however, is apt to remain absorbed in the oil as it leaves the tank; and my invention is adapted to save this residual propane. The intake of a compressor having the apparatus above mentioned is therefore connected to the delivery conduit of said reservoir, and as the oil containing what is left of the propane goes out of the reservoir, practically all of the propane is extracted.

The accompanying drawing illustrating one form which the invention may assume in practice, is a diagrammatic view, partly in section, of a load controlling apparatus constructed in accordance with the invention and showing it connected to a compressor.

Referring more particularly to the drawing, the load controlling apparatus, designated in general by **20**, is shown applied to a multi-stage compressor **21** comprising low and high pressure cylinders **22** and **23**, respectively. The cylinders **22** and **23** are equipped with double acting pistons **24** and **25** which are driven by a motor **26**.

The low pressure cylinder **22** is connected for instance, to a conduit **27**, by a conduit **28** and the fluid passing from the cylinder **22** flows directly through a conduit **29** into the high pressure cylinder **23**, whence it passes to a point of application through a discharge conduit **30**. It is understood, of course, that the connection of the cylinder **22** to the conduits **28** and **29**, and of the cylinder **23** to the conduits **29** and **30** is shown diagrammatically only; and that suitable valves to control the communication of the cylinders with these conduits are employed.

In order to enable the load on the compressor cylinders to be changed or controlled gradually, each cylinder is provided with suitable load-controlling devices consisting, for example, of clearance chambers and valves for controlling them. The low pressure cylinder accordingly has a plurality of clearance chambers, four being shown for illustrative purposes. Those adjacent the crank end are designated **31** and **32** while those associated with the opposite end of the cylinder are designated **33** and **34**. Each clearance chamber communicates with the adjacent end of the cylinder **22** through a port **35** and com-

munication is afforded between pairs of clearance chambers lying on one side of the cylinder through a by-pass port 36.

The latter ports are controlled by pressure actuated spring-pressed clearance valves 37 which operate to control the by-passing of fluid between ends of the cylinder. Valves of the same type and designated 38, 39, 40 and 41 are arranged in the chambers 31, 32, 33 and 34, respectively, to control the ports 35.

The high pressure cylinder 23 is likewise provided with a plurality of clearance chambers, two designated 42 and 43 being located at the crank end of the cylinder and a like number designated 44 and 45 at the opposite end of the cylinder. As in the low pressure cylinder, the clearance chambers lying on the side of the cylinder 23 also communicate with each other through ports 36 which are controlled by pressure actuated valve mechanisms 46. Each clearance chamber in the high pressure cylinder has a port 35 which opens into the adjacent end of the cylinder and said ports are controlled by pressure actuated valve mechanisms 47, 48, 49 and 50 arranged in the clearance chambers 42, 43, 44 and 45, respectively.

The valve mechanisms controlling the ports 35 and 36 may be of a well known type and identical in all essential respects. Each valve mechanism comprises a casing 51 and a pressure actuated spring-pressed plunger 52 adapted to seat into the ends of the ports. The valve mechanisms are preferably operated in groups for the sake of maintaining a desirable balance of the driven elements of the compressor. In furtherance of that end the valve mechanism 38 of the cylinder 22 and that designated 50 of the cylinder 23 are connected to a common conduit 53 through which pressure fluid may be supplied to and exhausted from the valves connected thereto.

In like manner, the valve mechanism 40 of the cylinder 22 and the valve mechanism 48 of the cylinder 23 are connected to a common conduit 54, while the valve mechanisms 39 and 49 of the cylinders 22 and 23, respectively, are connected with each other and to a conduit 55, and the valves 41 and 47 of the low and high pressure cylinders, respectively, are connected to a conduit 56. As a preferred arrangement all the valves 37 and 46 controlling the by-pass ports 36 of both cylinders are connected to a common conduit 57 so that said valves may be simultaneously operated for loading or unloading the cylinders.

Each of the supply conduits 53 to 57, inclusive, is connected to a regulator 58 of the type illustrated in United States Patent No. 1,430,578 to C. W. Metzgar, dated October 3, 1922, and comprising a casing 59 having a series of valve chambers 60 containing main valves 61 which control the supply of pressure fluid to the valve mechanisms in the compressor cylinders and are in turn controlled by an auxiliary valve 62. The auxiliary valve is pivotally connected to a weighted lever 63 pivoted at one end to the casing 59 and resting upon a pin 64 of which the other end seats in a hollow plunger 65 supported by a diaphragm 66 in the casing 59.

In the drawing only three main valves 61 are illustrated. It is, however, to be understood that these valves are of the same number as the conduits connected to the casing 59, in the manner explained in the aforementioned patent to which one is referred for a full description of the regulator.

The diaphragm 66, plunger 65, pin 64 and lever 63 constitute an actuator for the regulator 59.

The pressure fluid employed for actuating the auxiliary valve 62 and that distributed by said valve and the main valves 61 is derived from a source of high pressure fluid supply, as for instance a receiver tank (not shown). Such pressure fluid is conducted to the chamber 67 containing the valve 62 by a conduit 68 having a branch conduit 69 which is connected to an end of a valve casing 70 and opens into a chamber 71 in the casing 70. In order to prevent the presence of pressure fluid in excess of a certain predetermined value in the chamber 71 the conduit 69 is provided with a reducing valve 72.

In the casing 70 is a wall 73 constituting a bounding surface for the chamber 71 and having a port 74 through which pressure fluid flows into a chamber 75 bounded at its opposite end by a diaphragm 76. A similar diaphragm 77 cooperates with the diaphragm 76 to form a chamber 78 in the intermediate portion of the casing 70 and the diaphragm 77 forms the upper bounding surface of a chamber 79 in the lower portion of the casing. The chambers 75 and 79 are in direct communication with each other through a pipe 80 from which leads a pipe 81 to supply pressure fluid to the diaphragm 66.

The end of the port 74 confronting the branch conduit 69 constitutes a seat 82 for a valve 83 having a stem 84 to the lower end of which is attached a head 85 which seats upon the diaphragm 76 and serves as a seat for an end of a spring 86 of which the other end bears against the wall 73. The valve 83 controls the port 74 and thus the supply of pressure fluid to the diaphragm 66 and to the chamber 79. The latter chamber has an exhaust port 87 which is controlled by a valve 88 seating against the diaphragm 77 and pressed thereagainst by a spring 89.

The chamber 78 constitutes a pressure chamber into which pressure fluid is introduced for causing actuation of the valves 83 and 88 against the forces exerted by the springs 86 and 89. The pressure fluid employed for this purpose is conducted into the chamber 78 by a pipe 90 leading from the chamber 71 to the chamber 78 and having interposed therein a plate 91 in which is an orifice 92 to restrict the flow of pressure fluid to the chamber 78. A vent pipe 93 connected to the pipe 90 opens directly to the atmosphere and serves as an outlet for the pressure fluid exhausted from the chamber 78 and also for such pressure fluid as flows through the orifice 92 during the time the diaphragms 76 and 77 are inactive.

Means are provided for causing the diaphragms 76 and 77, their associated valves and, therefore, the diaphragm 66 to act in response to pressure conditions at the source of suction supply, such as the pipe 27. To this end a lever 94 suitably fulcrumed, as at 95, is disposed adjacent the end of the pipe 93 for which an end 96 of the lever 94 serves as a closure. Pivotally connected to the other end of the lever is a rod 97 which is secured to an extremity 98 of a helical tube 99 having its other end affixed to a support 100. The latter end of the tube 99 is connected to a conduit 101 leading from the conduit 28. An equalizer tank 102 is interposed in the conduit 101 to dampen the pulsations in the conduit 28 incident to the admission and cutoff of fluid to the low pressure cylinder 22.

The operation of the device is as follows: Let

it be assumed that the motor 26 is in operation and that the pressure of the intake supply has dropped to that predetermined value at which the tube 99 is actuated to initiate loading of the compressor. With these conditions prevailing the helical tube 99 is caused to unwind and bring the end 96 of the lever element 94 into throttling position over the end of the pipe 93. A portion or all of the fluid passing through the orifice 92 will then be entrapped in the chamber 78 and associated conduits to expand the diaphragm walls 76 and 77 of the chamber 78. This movement of the diaphragms causes the valve 83 to be opened and the valve 88 to be closed. Pressure fluid then flows from the chamber 71 through the port 74, the chamber 75 and the pipes 80 and 81 into the regulator to act against the diaphragm 66.

As the pressure acting against the diaphragm 66 increases it will raise the member 63 and, therefore, the auxiliary valve 62 to admit pressure fluid to that valve 61 controlling the conduit 57. After said valve 61 is shifted pressure fluid flows to the valve mechanisms 37 and 46 and closes them, thereby effecting partial loading of the compressor. Upon further increase of the pressure acting against the diaphragm 66 the remaining valves 61 are caused to be shifted one after another to connect the valve mechanisms which they control with the supply line 68. For example, as a second step of load addition the valve 61 controlling the conduit 53 may be actuated for admitting pressure fluid to said conduit for closing the valve mechanisms 38 and 50, thus further increasing the load on the compressor.

Upon a further increase of the pressure acting against the diaphragm 66 another valve 61 will be shifted and a clearance valve in each of the cylinders will be closed to further increase the load on the compressor, and when the diaphragm 66 is subjected to maximum pressure the auxiliary valve 62 is moved to a position to admit pressure fluid to the remaining pair of interconnected clearance valves, thus fully loading the compressor.

During the time the compressor is fully loaded pressure fluid is entrapped in the pipe 93 and associated passages and chambers and its value is maintained at a predetermined maximum by the reducing valve 72. The compressor continues operating in this wise until the pressure value of the intake supply has been reduced, through withdrawal of the fluid medium from the pipe 27, to a predetermined low value. The helical tube 99 then contracts and shifts the end 96 of the arm 94 from its true sealing position. Thereupon a portion or all of the pressure fluid is exhausted from the chamber 78 and the springs 86 and 89 will act to shift the valves 83 and 88.

Upon complete exhaustion of the pressure fluid from the chamber 78 the valve 83 is closed by its spring to cut off the further flow of pressure fluid to the diaphragm 66, and the valve 88 is opened to exhaust the pressure fluid which may be present in the chambers 75 and 79, thus permitting the arm 63 to depress the valve 62 and cause the valves 61 to be shifted one after the other for unloading the compressor and in the reverse order to that followed for loading the compressor. More specifically, the pair of clearance valves operating to effect the final step of loading of the compressor will then be caused to operate for effecting the first step of unloading. The remaining valve mechanisms in the cylinders will then successively operate, in pairs, to effect further steps of unloading and, as a final step of unloading, the valve 61 controlling the by-pass valves 37 and 46 will be shifted to open the by-pass ports.

The casing 70 and its associated parts thus constitutes means for controlling the regulator and enabling it to be actuated as conditions demand; and this controlling means is in turn governed by the action of the suction pressure in the pipe 101.

It will be clear from the foregoing that the compressors will withdraw all of the propane gas remaining in the oil coming through the conduit 27 from the tank where it has been cooled; and discharge it through the conduit 30 into a storage vessel; and will continue working as long as there is any propane gas left. Although the pressure of this gas may be quite low it will influence the lever 94 and move it towards the vent 93; and thus make the controlling means act upon the regulator, and cause the load-altering devices to work as needed until all of the propane is collected.

While I have described the invention in regard to a special purpose that it is designed to serve, it is obviously capable of use for other purposes; and may be used to extract and compress other gases than propane; and while a given construction has been shown and described, changes in said structure may, of course, be made, and the invention is to be construed as residing broadly in the features pointed out in the appended claims.

In practice the gas extracted from the conduit 27 may be delivered through the pipe 30 to a condenser; and the compression pressure at which the gas is discharged from the cylinder 23 will be such as the condenser requires.

I claim:

1. The combination of a compressor, a load controlling device therefor, means for causing actuation of said device and requiring a power medium at relatively high pressure to operate said means, and means responsive to a power medium at lower pressure produced by the compressor to transmit said power medium at high pressure to actuate the first said means.

2. The combination of a compressor, a load controlling device, means to be actuated by a power medium at a relatively high pressure to cause operation of said device, and means responsive to variations in the suction pressure of the compressor for transmitting said power medium to actuate the first said means.

3. The combination of a compressor, a pressure-actuated load controlling device therefor, means actuated by a power medium at a relatively high pressure to cause operation of said device, and means responsive to variations in the suction pressure of the compressor to transmit said medium to actuate the first said means.

4. The combination of a compressor, power-actuated load controlling devices therefor, a pressure-responsive regulator for causing operation of said devices by a power medium at higher pressure than the suction pressure of the compressor, means for transmitting said medium to actuate the regulator, means acting responsively to variations in the suction pressure for controlling the last-named means, and a conduit for conveying said medium to the regulator for distribution to the load controlling devices.

5. A compressor comprising a load-changing device, a regulator for said device, an actuator for the regulator and means to operate said actuator and enable said regulator to be controlled.

6. The combination of a compressor, a load-changing device therefor, a regulator to transmit a pressure medium to operate said device, an actuator for the regulator, and means connected to the source of said pressure medium to control said actuator.

7. The combination of a compressor, a load-changing device therefor, a regulator, means for controlling said regulator, and a connection by which the suction pressure of said compressor causes operation of the controlling means.

8. The combination of a compressor, a load-changing device therefor, a regulator, means for transmitting a pressure medium to the regulator for the actuation of said device, means for controlling the regulator, and a connection by which the suction pressure of the compressor operates the controlling means.

9. The combination of a compressor, a load-changing device therefor, a regulator for said device, means for controlling the regulator, and a connection from said means to the suction side of the compressor to enable the said means to be operated, said connection having an element therein to enable the controlling means to take effect.

10. The combination of a compressor having a load-changing device, a regulator for said device, means for controlling said regulator, a connection with a source of pressure medium to enable said regulator and said means to be actuated, and a connection from said means to the suction side of the compressor, said connection including an element to enable the controlling means to cause operation of the regulator to increase the load on the compressor as the suction pressure rises.

11. The combination of a compressor, a load-changing device therefor, a regulator for said device, means for controlling the regulator, and a connection from said means to the suction side of the compressor, said connection comprising a vent and a member movable towards and from open position with respect to said vent to render the controlling means effective to a greater or lesser degree.

12. The combination of a compressor having a load-changing device, a regulator for said device, means for controlling said regulator, a connection from the regulator to the suction side of the compressor whereby the action of the controlling means is varied according to changes in the suction pressure, said connection comprising a vent and an element operable in response to changes in the suction pressure to move towards open or closed position with respect to the vent in accordance with the variations in said suction pressure.

13. The combination of a compressor having a load-changing device, a regulator to cause said device to take effect, connections for transmitting a power medium through said regulator to said device, controlling means also connected to said regulator, said means comprising diaphragms and valves for enabling said pressure medium to influence the regulator in varying degree, and a connection from the suction side of said compressor to said controlling means to enable the action of said controlling means to be determined in accordance with variations in said suction pressure.

14. The combination of a compressor having a load-changing device, a regulator to cause said device to take effect, connections for transmitting a power medium through said regulator to said device, controlling means connected to said regulator, said means comprising diaphragms and valves for enabling said medium to influence the regulator in varying degree, and a connection from the suction side of said compressor to said controlling means to enable the action of said controlling means to be determined in accordance with variations in said suction pressure, said last-named connection comprising a vent, an element responsive to suction pressure to move towards and from open position with respect to said vent, and an equalizing chamber in said last-named connection.

15. A compressor having a plurality of pressure actuated loading devices, and means responsive to decrease in the pressure at the compressor intake to control the operation of the loading devices to progressively load the compressor.

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