March 11, 1941. B. DICK 2,234,469

COMPRESSOR UNLOADING VALVE MECHANISM

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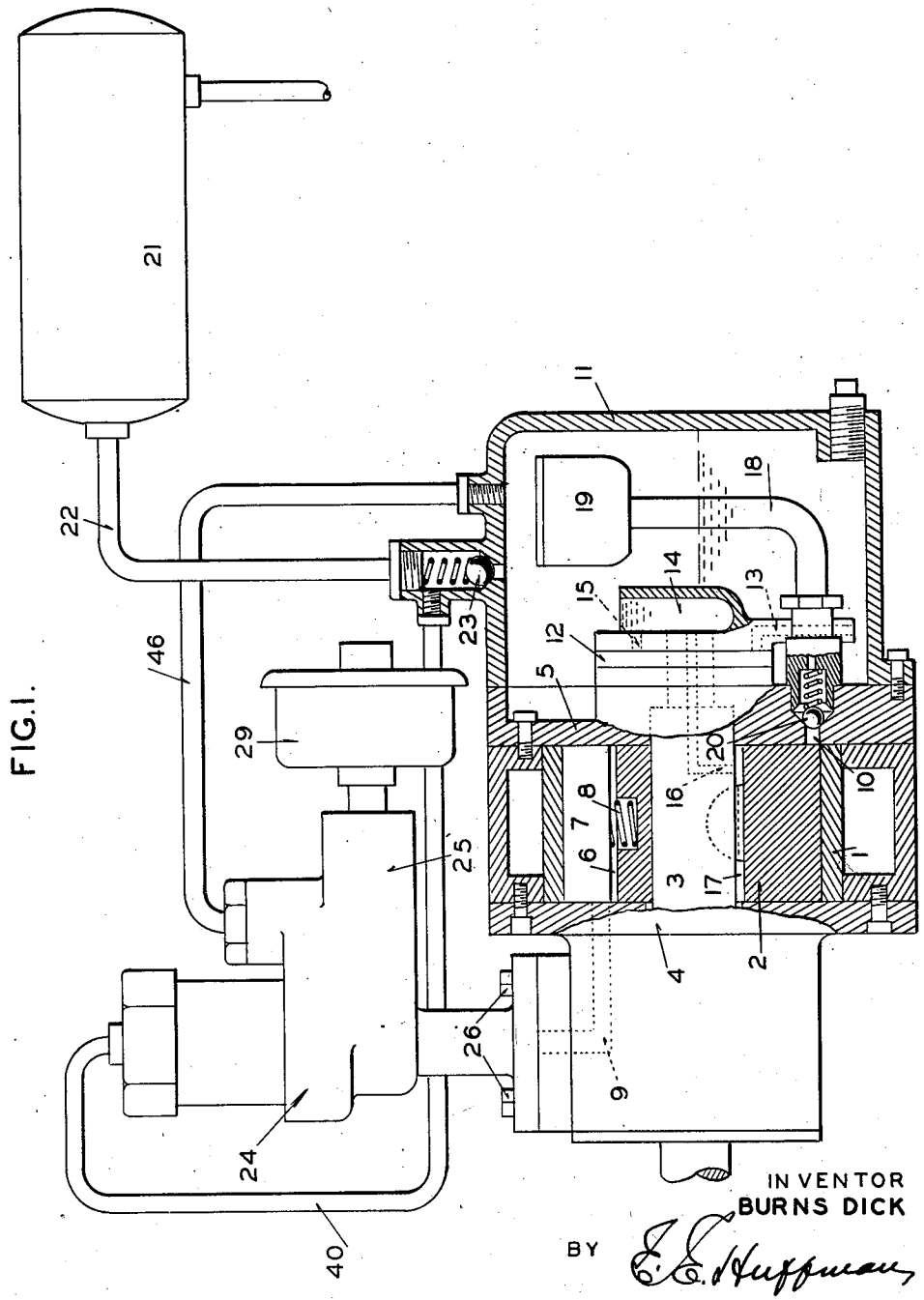



FIG. 1.

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FIG3.

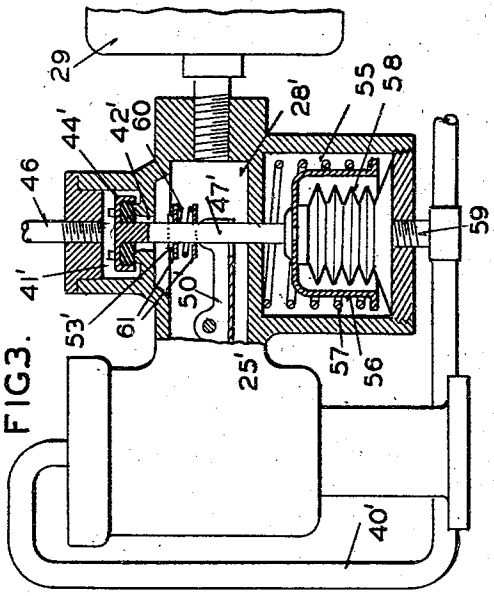
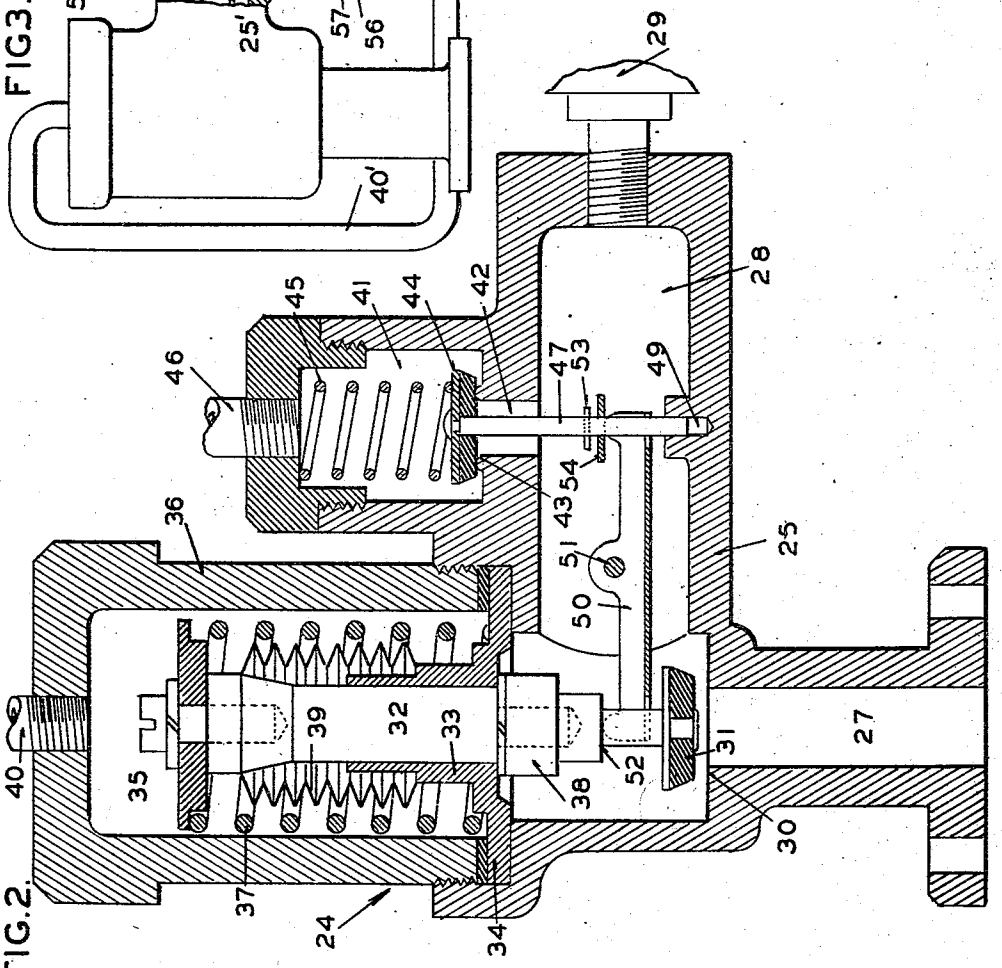



FIG.2.




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## COMPRESSOR UNLOADING VALVE MECHANISM

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Application November 8, 1939, Serial No. 303,379

4 Claims. (Cl. 230—31)

My invention relates to compressors and more particularly to valve mechanism for unloading the compressor under certain conditions.

One of the objects of my invention is to provide an improved valve mechanism for automatically closing the intake of a compressor and connecting the discharge port to atmosphere when the pressure in the receiver of the compressor is a predetermined value.

Another and more specific object of my invention is to provide a mechanical connection comprising a lever between the compressor shut-off valve and the valve for connecting the discharge port to atmosphere whereby when the former is closed the latter will be positively and quickly opened.

Still another object is to provide a booster for association with an unloading valve mechanism of the type referred to which will assist in positively opening the valve for connecting the discharge port to atmosphere.

Other objects of my invention will become apparent from the following description taken in connection with the accompanying drawings in which Figure 1 is a view, partly in section, showing a rotary compressor having associated therewith an unloading valve mechanism embodying my invention; Figure 2 is a cross-sectional view showing details of the valve mechanism; and Figure 3 is a view, partly in cross section, showing a modified construction.

Referring to the drawings in detail, the rotary compressor is of known construction and comprises a stator 1 having eccentrically mounted therein a rotor 2 secured to a drive shaft 3 journaled in the end plates 4 and 5. The rotor 2 is provided with a plurality of spaced slots 6 extending in an axial direction in which are mounted reciprocable blades 7 (one only being shown) biased outwardly into engagement with the inner surface of the stator by springs 8. The end plate 4 is provided with an intake passage 9 and the end plate 5 with an outlet passage 10. Secured to the end plate 5 is an oil reservoir or dome 11 which contains oil for the purpose of lubricating the compressor. In the construction shown the shaft 3 of the compressor drives an oil pump 12 to pump oil from the body of oil through passage 13 and discharge it into a well 14 through the opening 15. The oil in the well is free to flow through the passage 16 in shaft 3 and then into the compressor by way of the keyway 17 to thus provide lubrication for the movable parts of the compressor. In order that the oil may be forced into the compressor under pressure during operation of the compressor, the body of oil in the oil dome is caused to be subject to the fluid under pressure discharged from the compressor. This is accomplished by having the discharge port 10 connected to a pipe 18 which extends above the oil line. An oil separator 19 removes any excess oil which may be discharged from the compressor together with the compressed air. The discharge port 10 has associated therewith a check valve 20 for preventing any of the compressed air from returning to the compressor. The oil dome communicates with the compressed air receiver or tank 21 by a conduit 22 and a check valve 23 prevents return of compressed air to the dome. The compressed air may be used for any purpose desired, as for example, the actuation of vehicle brakes.

In the type of compressor just described the compressor is generally automatically unloaded by shutting off the intake when the receiver for the compressed air discharged by the compressor reaches a predetermined value and again allowed to compress air when the compressed air in the receiver falls to a given pressure below the predetermined value. With such an arrangement, it has been discovered that when the compressor is unloaded, an excess amount of oil may be fed to the compressor and cause it to become "choked" because of the compressed air acting upon the oil and forcing it into the compressor. It has also been discovered that the shutting off of the compressor by closing the intake does not cause the compressor to run idle since the compressor still operates to compress the air remaining in the compressor which may be partially discharged into the oil dome against the compressed air already therein or, if this is not accomplished due to insufficient air to compress, recirculated and recompressed continuously. By the compressor being partially under load and performing work, it will continue to generate heat and use power, notwithstanding no additional compressed air is being added to the receiver. All of these undesirable operating features present when the compressor intake is shut off can be eliminated to a large extent by also unloading the oil dome at the same time the intake is shut off. With the air in the oil dome under atmospheric pressure, the oil forced into the compressor will be reduced and the air and oil being circulated in the compressor will be free to be discharged into the oil dome against atmospheric pressure instead of against compressed air. A superior operating compressor

results which will require less power to operate when no air is required to be compressed. Also the compressor will operate at a much cooler temperature, less oil will be used, and the life of the compressor extended.

My improved valve mechanism 24 comprises a casing 25 secured to the compressor adjacent the intake passage 9 by bolts 26. The casing is provided with interconnecting passages 27 and 28, the former communicating with the intake passage 9 and the latter with atmosphere through the air cleaner 29. The passage 27 has associated therewith a valve seat 30 and cooperating therewith is a valve member 31 mounted on a stem 32 which is guided in a sleeve 33 carried by a partition 34. The stem 32 projects into a chamber 35 formed by a secondary casing 36 screwed to the main casing. Interposed between the upper end of the stem and the partition 34 is a spring 37 which normally biases the valve member 31 to an open position, this open position being determined by the stop 38 on the stem which abuts the lower side of the partition. The stem is sealed to the guide sleeve by a bellows 39 and the chamber 25 is in constant communication with the compressed air in the receiver by means of a conduit 40. When the air pressure in the receiver reaches a predetermined value, the valve member 31 will be moved to closed position against the bias of the spring 37. In the particular construction shown, the spring is of such strength that the valve member 31 will be moved toward closed position when the pressure in the receiver is one hundred pounds per square inch.

A portion of casing 25 is so formed as to provide a chamber 41 which is connected to passage 28 by a short passage 42. This connecting passage has associated therewith a valve seat 43 and cooperating therewith is a valve member 44 which is normally held seated by a spring 45. The chamber 41 is in constant communication with the oil reservoir 11 by a conduit 46. The valve member 44 is provided with a valve stem 47 which extends across passage 28 and is guided in a bore 48 in the wall of said passage.

Within the passage 28 is a lever 50 pivotally mounted at its center on a pin 51. One end of this lever cooperates with a shoulder 52 on the valve stem 32 and the other end of the lever is adapted to operate the valve stem 47. The connection between this valve stem and the lever comprises a pin 53 carried by the stem and a loose washer 54 surrounding the stem and resting on the end of the lever. The position of the pin on the stem 47 is such that the lever may have limited relative movement with respect to the stem 47 before the washer abuts the pin 53 and causes movement of the valve stem. The relative movement permits the valve member 31 to move a portion of the distance toward its seat from full open position before any force can be transmitted through the lever to operate the valve stem 47.

When the compressor is operating, the parts of the valve mechanism are as shown in Figure 2. Under these conditions, air is free to pass into the compressor through the intake, be compressed and then forced out into the oil reservoir. From the oil reservoir it is free to pass through the check valve 23 into the air receiver. The oil reservoir will be sealed since the valve 44 is seated. When the pressure in the receiver reaches a value of one hundred pounds per square inch, the fluid pressure in chamber 35 will be sufficient to move the valve stem 32 downwardly and cause the valve member 31 to approach seat 30. When the valve stem 32 has moved downwardly a sufficient amount to cause the relative movement between the lever 50 and the stem 47 to be taken up, an added resistance will be imposed upon the movement of the valve stem due to the action of spring 45 and the pressure in chamber 41 holding the valve member 44 seated. At this time the valve member 31 is close enough to seat 30 that a slight suction will be effective on valve member 31 tending to pull it closed, this suction being created by the continued operation of the compressor. As the compressor continues to operate and build up a small additional amount of pressure in the receiver and also in chamber 35, the stem 32 will be moved downwardly an additional extent. This additional movement of the stem will now cause the lever to move the valve member 44 off its seat and release the pressure in chamber 41. When this occurs, the resistance to movement of the valve stem 32 is considerably decreased and the valve member 31 will move very rapidly onto its seat, which movement will be assisted by the vacuum pull on the valve member as it approaches the seat.

The closing of the valve member 31 and the opening of the valve member 44 results in the intake of the compressor being cut off and the oil reservoir placed in communication with the atmosphere by way of conduit 46, chamber 41, passages 42 and 28 and the air cleaner. The compressed air in the oil receiver is thus vented. With the intake shut off, no more air will enter the compressor and any air that is already in the compressor will be readily forced out through the check valve 20 at the discharge port since there is now no compressed air pressure acting on this valve to hold it seated in addition to its spring. Since the compressor is no longer compressing any air, it will run idle and the power necessary to rotate it will be decreased to a minimum. Also, due to the fact that the blades are no longer performing any compressing, the temperature of the compressor will drop rapidly as will also the oil in the compressor and the reservoir. Since the interior of the oil reservoir is at atmospheric pressure, the oil in well 14 will no longer be positively forced into the compressor. The amount of oil entering the compressor by the force of gravity and the effect of suction in portions of the compressor will now be a minimum and there will be little danger of the compressor becoming "choked" with oil during its unloading period.

When sufficient air is used from the compressed air receiver 21 to cause the pressure therein and also in chamber 35 to drop to such a low value that spring 37 can move valve member 31 off its seat against the forces acting to hold it closed. The intake will again be opened and the oil reservoir sealed by the closing of the valve member 44. The compressor can now operate to restore the maximum pressure in the receiver at which time the compressor will again be shut off and the oil receiver vented to atmosphere in a manner already described.

In Figure 3 there is disclosed a modified construction wherein a booster is associated with the oil reservoir venting valve in order to assist in opening it at the proper time against the fluid pressure in the oil reservoir tending to maintain it closed. In the construction shown, the intake shut-off valve is the same as already described.

The valve member 44' for controlling passage 42' between the chamber 41' and the passage 28' is provided with a stem 47' which extends completely across the passage 28' and into a chamber 55 formed on the casing 25'. The end of this stem has secured thereto a cup-shaped member 56 and a spring 57 cooperating therewith holds the valve member 44' seated. A Sylphon bellows 58 is also connected to the end of the valve stem and this bellows is placed in constant communication with the conduit 40' by a branch conduit 59. The bellows is thus subject to the same fluid pressure as that in the air receiver. The lever 50' which is operated by the valve stem 32 of the intake valve member 31 (Figure 2) is operatively connected to the valve member 47' through a spring 60, such spring being interposed between two washers 61, one of which engages a pin 53' by the valve stem and the other of which rests on the end of lever 50'.

When the pressure in the receiver reaches a value of one hundred pounds per square inch and causes the intake valve member 31 to move toward closed position, the lever 50' will compress the spring 60 and apply a force tending to open the valve member 44'. At the same time the pressure effective in the Sylphon bellows 58 will also so act as to tend to move the valve member 44' off its seat against the bias of the spring 57 and the fluid pressure in chamber 41'. When the valve member 31 is just reaching its seat to close off the intake, the pressure applied by the lever 50' and the fluid pressure effective in the Sylphon bellows will snap the valve member 44' off its seat, thereby venting the oil reservoir to atmosphere. By the use of the booster for opening the valve 44', the force necessary to be applied by the lever to open the valve is decreased, thus resulting in removing a portion of the load off the fluid motor acting to close the valve 31 and permitting this valve to have a smoother operation.

Being aware of the possibility of other modifications in the particular structures herein described, without departing from the fundamental principles of my invention, I do not intend that their scope be limited except as set forth by the appended claims.

Having fully described my invention, what I claim as new and desire to secure by Letters Patent of the United States is:

1. In compressed air storage apparatus comprising a receiver and an air compressor provided with intake and discharge ports, automatically operable means for closing the intake port and connecting the discharge port to atmosphere, said means comprising a valve casing provided with a passage for placing the intake port in communication with the atmosphere, a normally open valve associated with said passage, a fluid motor for closing said valve when the fluid pressure in the receiver is a predetermined value, means including said passage for connecting the discharge port to atmosphere, a normally closed valve, and means comprising a lever positioned in said passage and operatively connected to the valves for causing the opening of the second valve when the first valve is closed.

2. In compressed air storage apparatus comprising a receiver and an air compressor provided with intake and discharge ports, automatically operable means for closing the intake port and connecting the discharge port to atmosphere, said means comprising a spring biased normally open valve for closing the intake, a fluid motor for closing said valve when the fluid pressure in the receiver is a predetermined value, a normally closed valve for placing the discharge port in communication with the atmosphere and movable to open position against fluid pressure, and means for causing the closing movement of the first named valve to open the second named valve and comprising a lever interconnecting the movable elements of the valves and embodying a lost motion connection permitting partial closing of the first named valve prior to any movement of the movable element of the second named valve to open position.

3. In compressed air storage apparatus comprising a receiver and an air compressor provided with intake and discharge ports, automatically operable means for closing the intake port and connecting the discharge port to atmosphere, said means comprising a valve for closing the intake, a second valve for placing the discharge port in communication with the atmosphere and movable to open position against compressed air, means controlled by a predetermined pressure in the receiver for closing the first valve, means controlled by fluid pressure tending to open the second named valve, and connecting means operable by the closing means of the first named valve for causing opening the second named valve with the assistance of the last named fluid pressure controlled means.

4. In compressed air storage apparatus comprising a receiver and an air compressor provided with intake and discharge ports, automatically operable means for closing the intake port and connecting the discharge port to the source of fluid to be compressed, said means comprising a normally open valve for closing the intake, a fluid motor for closing said valve when the fluid pressure in the receiver is a predetermined value, a normally closed valve for placing the discharge port in communication with the source of fluid, means for causing the closing movement of the first named valve to apply an opening force to the second named valve and comprising a lever interconnecting the movable elements of the valves and embodying a yieldable connection permitting partial closing of the first named valve prior to movement of the movable element of the second named valve to open position, and a fluid pressure-operated booster for assisting the opening of the second named valve.

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