Sept. 4, 1956 A. B. NEWTON 2,761,616

COMPRESSOR UNLOADING APPARATUS

Filed April 19, 1955 2 Sheets-Sheet 1

Fig. 1

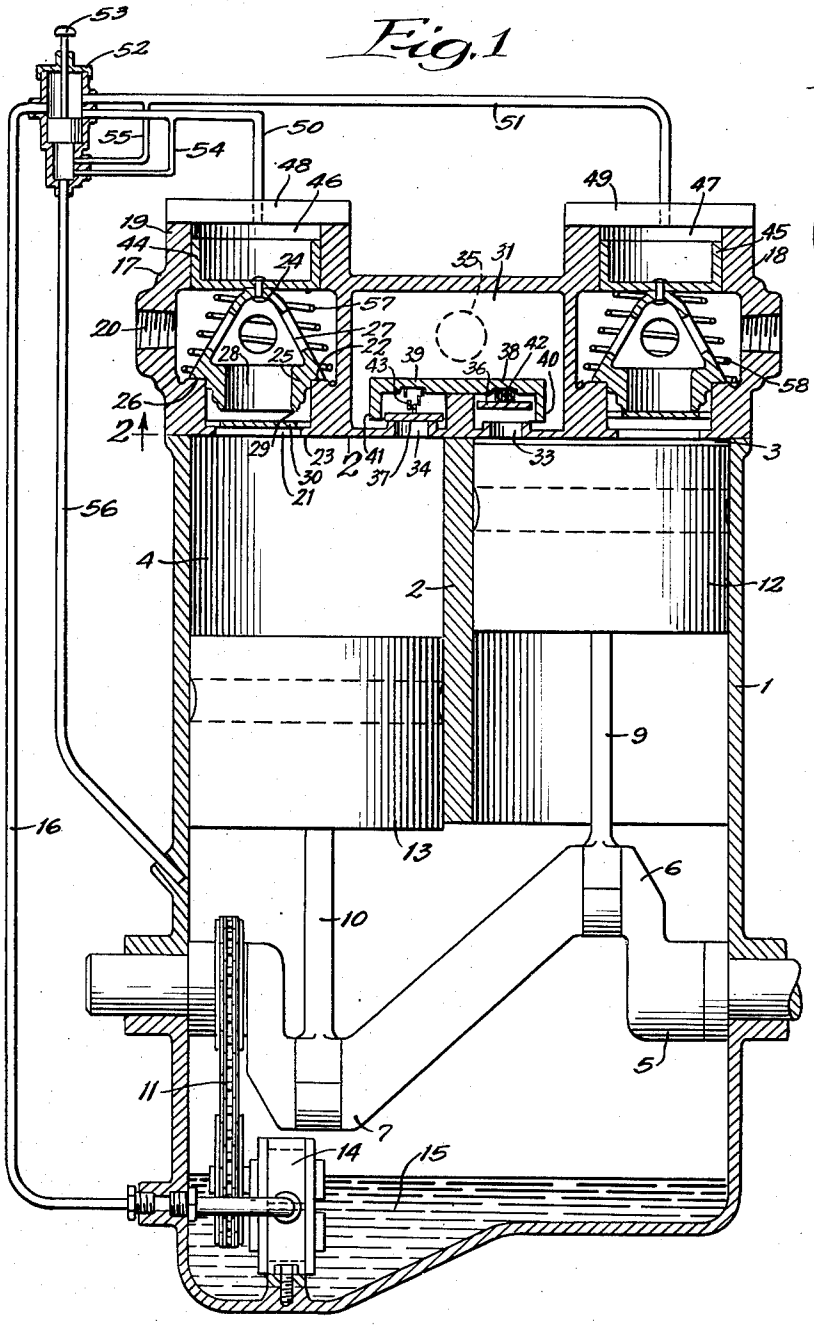
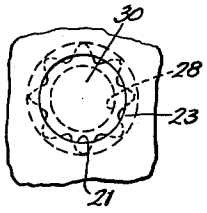


Fig. 2



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Fig. 3

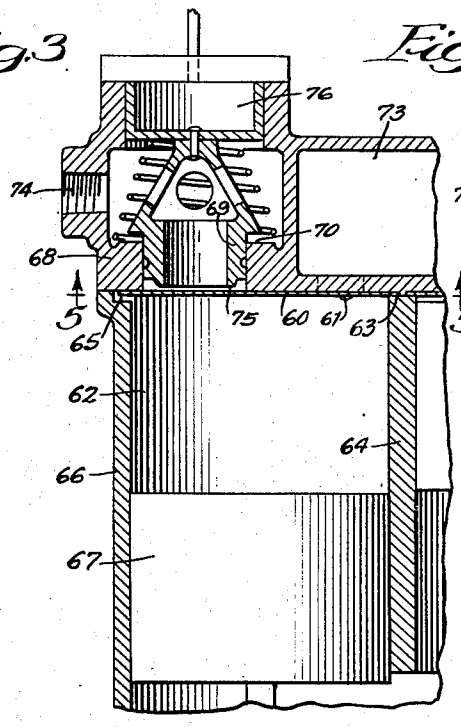


Fig. 4

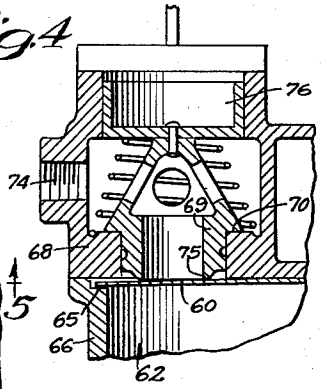
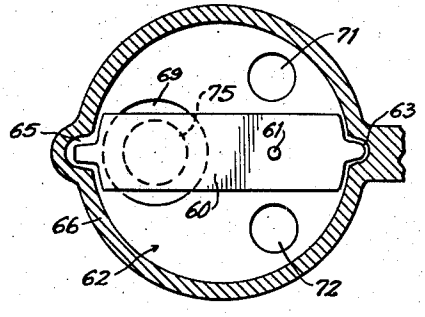


Fig. 5



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COMPRESSOR UNLOADING APPARATUS

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Application April 19, 1955, Serial No. 502,417

11 Claims. (Cl. 230—31)

This invention relates to a compressor unloading apparatus, and more particularly, to a fluid pressure operated piston and valve arrangement for controlling the flow of fluid into a compressor chamber.

One of the main objects of this invention is to provide an apparatus which delays the loading of a compressor until after the compressor motor has started. Another object is to provide a valve which is operated by fluid pressure and which moves to closed position for loading the compressor only after the compressor motor has operated a predetermined length of time, or after a predetermined condition is satisfied. A further object is to provide a valve for a compressor which has a primary and secondary flow passage therethrough, the primary passage allowing fluid to flow toward and from the compressor chamber, and the secondary passage permitting the flow of fluid only in a single direction toward the compressor chamber, and means for closing the primary passage after the compressor motor has started to operate. A still further object is to provide a cone-shape valve cage biased to open position and movable under the influence of oil pressure to closed position for loading the compressor. Additional objects and advantages will appear as the specification proceeds.

Embodiments of the invention are illustrated in the accompanying drawings, in which:

Fig. 1 is a sectional side elevation showing the compressor and control apparatus; Fig. 2 is a plan view taken along lines 2—2 of Fig. 1; Fig. 3 is a sectional side elevation illustrating a second embodiment of the valve unit; Fig. 4 is similar to Fig. 3, but shows the valve cage in seated position; and Fig. 5 is a sectional view taken along lines 5—5 of Fig. 3.

The compressor comprises a casing 1 which has a top portion divided by a wall 2 into a pair of compression chambers 3 and 4. While only a pair of chambers are shown in Figs. 1 and 3, it is apparent that a greater or smaller number may be provided, depending upon the particular use for which the compressor is to be adapted.

The lower portion of the casing carries crank shaft 5 which has eccentric portions 6 and 7 and which may be rotated by any suitable means, as for instance, by an internal combustion engine. Cylinder yokes 9 and 10 are slidably attached to the eccentric portions of the crank shaft 5 in the customary manner, as illustrated in Fig. 1. Yokes 9 and 10 have bearings securing them to pistons 12 and 13 which are slidably mounted within chambers 3 and 4 respectively.

A continuous chain 11 extends about one end of the shaft 5 and is preferably connected to a gear-type pump 14 at the lower portion of casing 1. Since the pump structure is well known in the art, it is believed that a detailed description herein is unnecessary. Pump 14 is immersed in a pool of oil or other liquid 15 at the bottom of casing 1, and drives the oil into passage 16 upon the rotation of crank shaft 5.

The top portion of casing 1 encloses a pair of valve units 17 and 18 through which fluid must pass to enter

compression chambers 3 and 4. Since both the valve units 17 and 18, as shown in Fig. 1, are identical in structure and operation, only one of these units will be described in detail. Valve unit 17 comprises a generally tubular valve casing 19 having an opening 20 in its side wall and another opening 21 in one end to provide a flow passage therethrough leading into compression chamber 4. For purposes of clarity, this passage will be referred to as the primary flow passage.

Extending inwardly from the inner surface of casing 19 and substantially midway between opening 20 and the open lower end of the valve casing is a ledge or stop 22 which reduces the inner diameter of the lower portion of the casing and which provides an annular valve seat on its top surface. An annular lip 23 extends inwardly about opening 21 at the lowermost portion of the primary flow passage through casing 19.

Within the primary passage is a movable valve cage 24 having the general configuration of a hollow cone having a tubular portion 25 extending downwardly from its base. The tubular portion of the cage has an outer diameter less than the diameter of the cone's base, so that at the juncture of the tubular portion and the base of the conical portion there is an outwardly projecting peripheral ridge 26 which comprises an annular valve portion adapted for abutting or seating against the annular ledge or stop 22 of the valve casing and for closing the primary flow passage.

As illustrated in Figure 1, the tubular and conical portions of the cage are in communication with each other. Moreover, the wall of the cone is provided with a plurality of openings 27 and the free end 28 of the tubular portion is open to provide a secondary flow passage through the valve cage which also communicates with the compression chamber 4.

The outer diameter of the tubular portion 25 of the valve cage is less than the inner diameter of the lower portion of the casing below ledge 22, so that when the valve cage is unseated the primary flow passage is open and in communication with compression chamber 4. When the valve cage is seated against ledge 22, however, only the secondary flow passage through the valve cage communicates with the compression chamber, subject to certain limitations now to be described.

The movable cage is provided at the free end of the tubular portion 25 with an annular valve seat 29. A movable disc-shaped valve member 30 is freely mounted for reciprocal movement between the movable valve seat 29 and the annular lip 23 of the casing 19. As is best seen in Fig. 2, this disc-shaped valve member is provided with serrated edges so that when the valve seats against the valve seat 29 of the movable cage, the secondary flow passage through the cage is sealed, but when the disc-shaped member rests against annular lip 23, the flow passages may communicate with the compression chamber about the serrated edges of member 30. Moreover, when the valve cage is unseated from ledge 22, fluid may pass in either direction around the outside of the valve cage and about the serrated edges of the disc-shaped valve member whether that member is or is not in seated position against cage 24.

The top portion of casing 1 also encloses an exhaust chamber 31, shown in Figs. 1 and 3 as a chamber adjacent to and interposed between the valve units 17 and 18. The gases or fluids compressed in the compression chambers 3 and 4 may pass into the exhaust chamber through ports 33 and 34 respectively, and leave the exhaust chamber through opening 35 in the casing wall.

Valve seats are provided around ports 33 and 34, and valve members 36 and 37 are movably mounted within the exhaust chamber for movement to unseated positions

when the respective pistons move upwardly during the compression strokes and for movement to seated or closed position when the pistons move downwardly during the intake strokes. Therefore, fluid which has once entered the exhaust chamber cannot re-enter the compression chambers.

The valve members **36** and **37** are maintained in operating position by lateral extensions **38** and **39** at the uppermost portion of wall **2**. Each lateral extension is equipped with a plurality of downwardly extending peripheral fingers, such as the fingers **40**, **41** shown in Fig. 1, which retain the valve members for operation while at the same time allow fluid to flow into the exhaust chamber between the downwardly extending fingers. It may also be desirable to bias the valve members **36**, **37** to closed or seated positions by spring means, such as helical springs **42**, **43**.

The valve cages, such as valve cage **24**, are riveted or fastened by any other suitable means to movable cup-shaped pistons **44**, **45** which slide within piston chambers **46**, **47** within the upper tubular portions of valve casings **19**, **18**. Each of the chamber are sealed by covers **48**, **49** which are apertured so that the chambers communicate with passages **50** and **51** respectively. Each valve cage and piston unit may be biased upwardly to open or unseated position by spring means, such as springs **57**, **58** disposed between the cup-shaped pistons and the annular ledges provided by the valve casings.

A valve **52** is interposed between passages **50**, **51** and **16** to control the flow of a pressure fluid, such as oil, to chambers **46**, **47**. Valve **52** is of customary construction and is adapted to shut off the flow of oil to either chamber **46** or chamber **47**, or both, depending upon the manual or automatic setting of valve stem **53**. Bleed lines **54** and **55** extend from passages **50** and **51** respectively, and carry oil from chambers **46** and **47** into passage **56** and back to the lower portion of casing **1** when passages **50** and **51** are closed. The bleed lines which connect with passages **50** and **51** are small in diameter and, therefore, have a high resistance to the flow of oil. Thus, oil flowing through the open valve **52** increases the pressure in lines **50** and **51** and in chambers **46** and **47**.

While I have shown valve **52** adapted to interrupt the flow of fluid to chambers **46** and **47**, it is apparent that the same result might be obtained if the valve operated to close the bleed lines **54**, **55** instead of opening the oil lines. Moreover, other suitable hydraulic systems for controlling the pressures in chambers **46** and **47** might be used, such as a controller responsive to suction pressure changes, as is well known in the art.

The operation of my invention is as follows: When the compressor is idle, no pressure fluid is supplied by pump **14** to chamber **46** and valve cage **24** is maintained in unseated position by spring **57**, thereby leaving the primary flow passage open. As the crank shaft **5** starts to rotate and piston **13** moves downwardly, vaporized refrigerant or other gaseous fluid flows through opening **20**, through the primary flow passage of valve casing **19**, around the serrated edges of disc-shaped valve member **30**, and into the compression chamber **4**. As the piston **13** moves upwardly, the gas is directed back through the open primary passage and out opening **20**. Therefore, during the initial revolutions of crank shaft **5**, there is no load upon the compressor and there is substantially no work performed by the means applied to rotate the crank shaft, such as an internal combustion engine (not shown). However, as pump **14** pumps oil from pool **15** upwardly into chamber **46**, piston **44** is directed downwardly and cage **24** moves to seated position, thereby closing the primary flow passage and causing fluid entering opening **20** to follow the secondary flow passage through cage **24**, around the serrated valve disc **30**, and into the compression chamber **4** when piston **13** moves downwardly in its intake stroke. As the compressor piston **13** starts its upwardly compression stroke, the disc-shaped valve member **30** is forced upwardly by the reversed flow of gas to seated position against the annular valve seat **29** provided by cage **24**, thus closing the secondary flow passage. As a result, the compressed gas is forced through port **34** about valve member **37**, into the exhaust chamber **31**, and out port **35**. Port **35** may in turn communicate with the condenser of a refrigerator system.

The loading of the compressor may be further delayed after crank shaft **5** begins rotation by the closing of valve **52**. Until this valve is opened, oil will not pass from passage **16** into chamber **46**. The valve **52** may be adapted for manual operation, or may be connected for automatic operation, as for instance, with a suitable thermostatic element which opens valve **52** only when an internal combustion engine or other driving means reaches a desired operating temperature, or with a controller responsive to suction pressure.

Furthermore, while the operation of only one valve unit has been described in detail, it will be seen from Fig. 1 that valve **52** may be set to shut off the supply of pressure fluid to both or either of the chambers **46** and **47**, so that both or either of the compressor pistons **12** and **13** may be arranged to operate without a load. Thus, the load upon a large compressor consisting of several compressor pistons, compressor chambers and valve units, may be varied by loading or unloading the separate units, thus altering the capacity of the compressor as a whole.

Another embodiment of this invention is illustrated in Figs. 3, 4 and 5. An elongated and flexible leaf valve member **60** is secured by rivet **61** or by any other suitable means to the top wall of the compressor chamber **62**. I prefer to tightly fit one end of valve **60** in a notch **63** provided in wall **64**. The opposite end of leaf valve **60** is fitted loosely in a recess **65** in the wall of casing **66** so that the loose-fitting valve member **60** may flex downwardly within recess **65** to admit gas into chamber **62** and may also flex upwardly within recess **65** when piston **67** executes its compression stroke. As shown in Fig. 5, the width of elongated valve member **60** is less than the inner diameter of the lower portion of the valve casing **68** but is greater than the inner diameter of the lower tubular portion of valve cage **69** which is slidably mounted within valve casing **68**. Moreover, as illustrated in Fig. 4, when valve cage **69** rests upon ledge **70** the valve seat **75** provided by cage **69** is substantially in line with the lower end of valve casing **68** and is positioned to make sealing contact with flexible valve member **60**.

A pair of exhaust ports **71**, **72** are provided for each compression chamber and lead into exhaust chamber **73**. In other respects the compressor structure is similar to the structure described in reference to Fig. 1, including the exhaust valve assembly which is not shown in Figs. 3–5.

The operation of this embodiment is as follows: As the compressor piston executes its intake stroke, gas flows into the valve casing **68** through opening **74**, through the valve cage **69**, and around the downwardly flexed leaf spring **60** into chamber **62**. This occurs whether or not the valve cage **69** rests upon ledge **70**.

As the piston **67** moves in its upward compression stroke, the gas in chamber **62** will be exhausted through the same passages by which it entered as long as the valve cage is not in seated position on ledge **70**. Therefore, when the valve cage **69** is unseated, no load is imposed upon the compressor. When the valve cage is forced downwardly against ledge **70** by pressure fluid within piston chamber **76**, however, the cage is then positioned to co-act with valve **60**, as illustrated in Fig. 4. As the compressor piston **67** moves upwardly, the compressed fluid within compression chamber **62** flexes valve **60** upwardly against valve seat **75**, thereby sealing the flow passage through valve cage **69** and causing the compressed fluid to flow through the exhaust ports **71**, **72** into exhaust chamber **73**.

It is therefore apparent that the loading or unloading of any single compressor unit, and the capacity of a compressor consisting of multiple compressor units, depends upon the position assumed by the valve cage or cages. When valve cage **69** and its integral valve seat **75** are moved away from leaf valve **60**, the compressor performs no work. When the valve cage is moved downwardly by fluid pressure within piston chamber **76**, however, the leaf valve **60** may seat against the valve seat provided by the movable cage and the compressor will be in operating condition.

While in the foregoing specification, specific structures have been set forth in considerable detail for the purpose of illustrating embodiments of this invention, it will be understood that such details of structure may be varied widely by those skilled in the art without departing from the spirit of my invention.

I claim:

1. In a compressor apparatus having a compression chamber, a tubular valve casing having a flow passage therethrough, said casing also having a ledge on the inner surface thereof, a movable valve cage within said casing having the general configuration of a perforate hollow cone provided with a tubular portion extending from the base thereof and having a passage for the flow of fluid therethrough, said cage having a peripheral ridge defined by the base of said cone for the seating of said valve cage against said ledge, said movable cage also being provided with a movable valve seat adjacent the lower end of said tubular portion, and a movable valve member mounted for movement between seated and unseated position against the movable valve seat provided by said movable cage, whereby the flow of fluid through said casing from said compression chamber is prevented only when said cage is seated against the annular ledge and said movable valve member is seated against the movable valve seat provided by said cage.

2. The structure of claim 1 in which said tubular valve casing has an inwardly directed annular lip at one end thereof, said movable valve member having a generally disc-shape and mounted for reciprocal movement between unseated position against said annular lip and seated position against said movable valve cage.

3. In a compressor having a compression chamber and being provided with a primary flow passage communicating therewith, a valve stop adjacent one end of said primary passage, an opposed valve seat having a secondary flow passage therethrough and being movable between two positions within said primary passage, a valve member freely movable between a first position against said valve stop and a second position remote therefrom when said valve seat is in either of said two positions, said valve member having a dimension less than said primary passage and a dimension greater than said secondary passage, said valve member being cooperable with said valve seat for preventing the flow of fluid through said secondary passage only when said valve seat is in one of the aforesaid two positions and said valve member is in its second position, and means for moving said valve seat between the aforesaid two positions.

4. In a compressor having a compression chamber and being provided with a primary flow passage communicating therewith, a valve stop adjacent one end of said primary passage, an opposed valve seat having a secondary flow passage therethrough and being movable between a first and a second position within said primary passage, a valve member freely movable between a first position against said valve stop and a second position remote therefrom when said valve seat is in its first position and also when said valve seat is in its second position, said valve member having a dimension narrower than said primary passage and wider than said secondary passage for preventing the flow of fluid through said secondary passage only when said valve seat is in its second position and said valve member is also in its

second position, biasing means for urging said valve seat away from said valve member and towards said first position, and pressure-responsive means for overcoming the force of said biasing means and for moving said valve seat towards said valve member and into said second position in response to a pressure condition produced by the operation of said compressor.

5. The structure of claim 4 in which said valve member has a generally disc shape and is free to move within said primary passage between said first and second position.

6. The structure of claim 4 in which said valve member comprises an elongated strip having a free end movable between said first and second position for regulating the flow of fluid through said secondary passage when said valve seat is in its second position.

7. In a compressor having a compression chamber and being provided with a primary flow passage communicating therewith, a valve stop adjacent one end of said primary passage, an opposed valve seat having a secondary flow passage therethrough and being movable between two positions within said primary passage, a valve member freely movable between a first position against said valve stop and a second position remote therefrom when said valve seat is in either of its two positions, said valve member having a dimension smaller than said primary passage and larger than said secondary passage and being cooperable with said valve seat for preventing the flow of fluid through said secondary passage only when said valve seat is in one of the aforesaid two positions and said valve member is in its second position, and means for moving said valve seat sequentially between the aforesaid two positions in response to variations in a condition which is changed by the operation of said compressor.

8. In a compressor having a compression chamber, a movable valve for regulating the flow of fluid to be compressed within said chamber, an opposed valve seat having a flow passage therethrough and being movable between a first and second position, a stop adapted to limit the movement of said valve in a direction towards said seat, said valve being movable towards and away from said stop when said valve seat is in said first and said second positions, said valve being cooperable with said valve seat when said seat is in said second position for controlling the flow of fluid through said flow passage, and means for moving said valve seat between said first and said second position.

9. The structure of claim 8 in which said valve comprises an elongated member mounted at one end upon said compressor and having a free end movable toward and away from said valve seat for regulating the flow of fluid through said passage when said seat is in said second position.

10. The structure of claim 9 in which biasing means are provided for urging said valve seat away from said valve and toward said first position, and pressure-responsive means are provided for overcoming the force of said biasing means and for moving said valve seat toward said valve and into said second position in response to a pressure condition arising from the operation of said compressor.

11. In a compressor having a compression chamber, a movable valve for regulating the flow of fluid to be compressed within said chamber, a valve seat having a flow passage therethrough and being movable between a first and a second position, a first stop adapted to limit the movement of said valve in a direction toward said seat, a second stop adapted to limit the travel of said valve in a direction away from said seat, said valve being positioned between said second stop and said seat and being unrestricted in its movement between said stops when said valve seat is in both said first and said second positions, said valve being cooperable with said valve seat when said seat is in said second position for

controlling the flow of fluid through said flow passage, and means for moving said valve seat between said first and second positions.

References Cited in the file of this patent

UNITED STATES PATENTS

534,813 Christensen ---------- Feb. 26, 1895
598,283 Christensen ---------- Feb. 1, 1898
1,291,854 Haight ---------- Jan. 21, 1919

FOREIGN PATENTS

420,212 Great Britain ---------- Nov. 27, 1934