Oct. 24, 1967 B. W. ROMERHAUS 3,348,764

PRESSURE EQUALIZING MEANS FOR COMPRESSORS AND THE LIKE

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Fig. 1

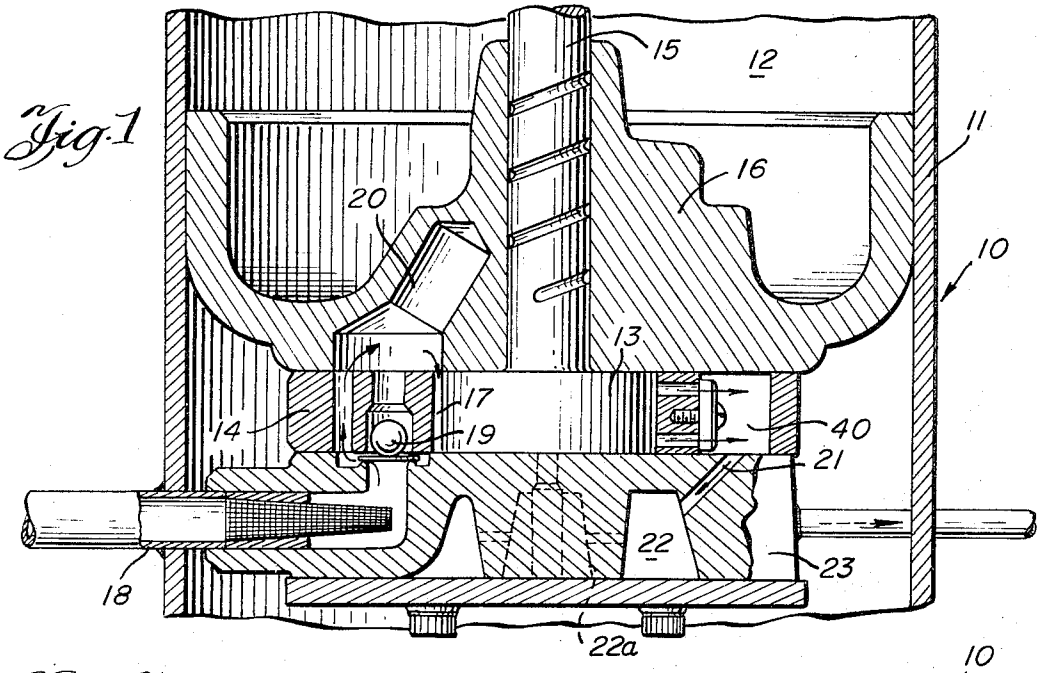
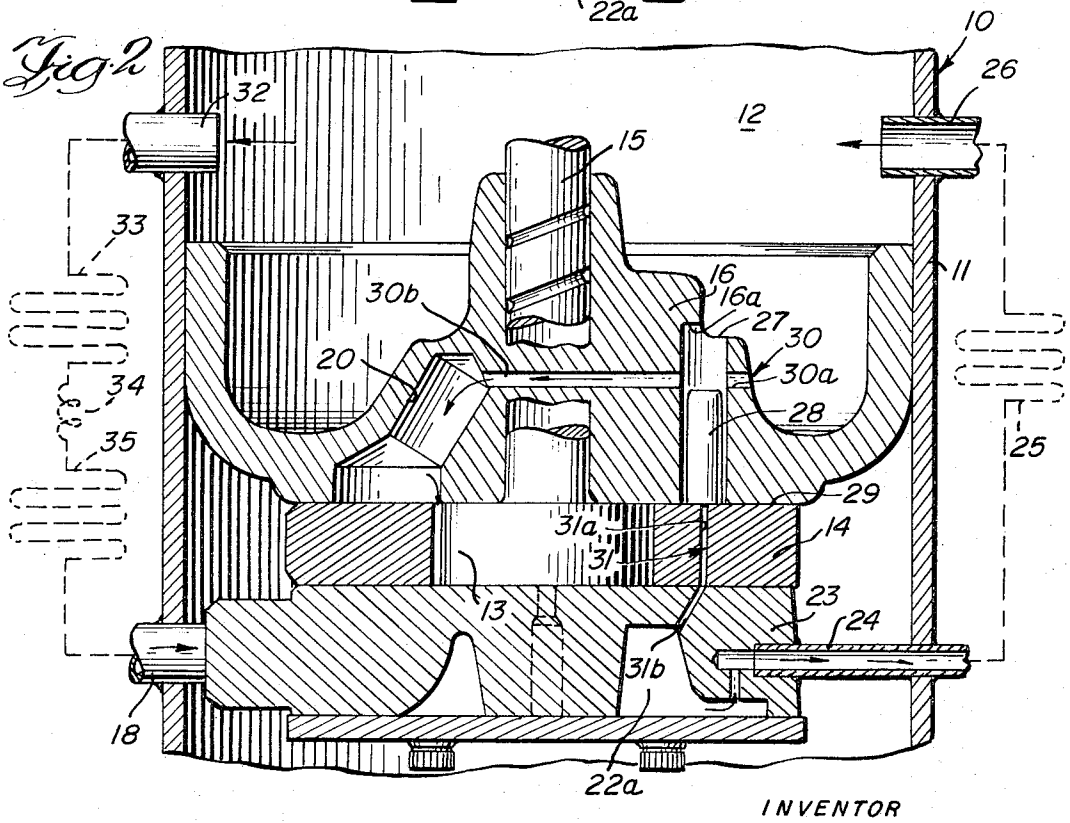


Fig. 2



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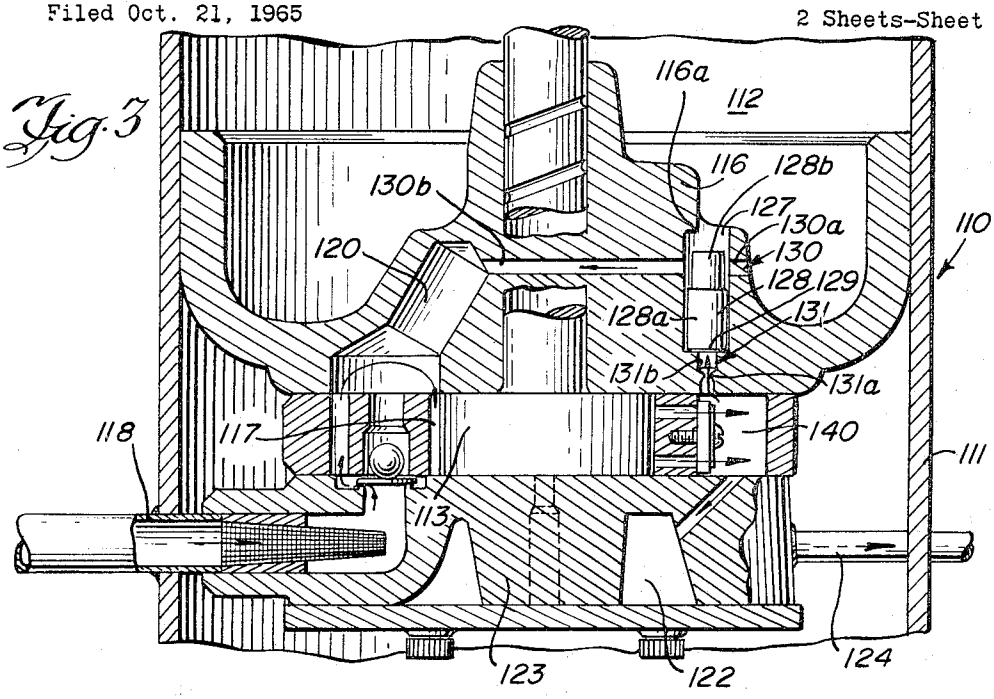
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Fig. 3



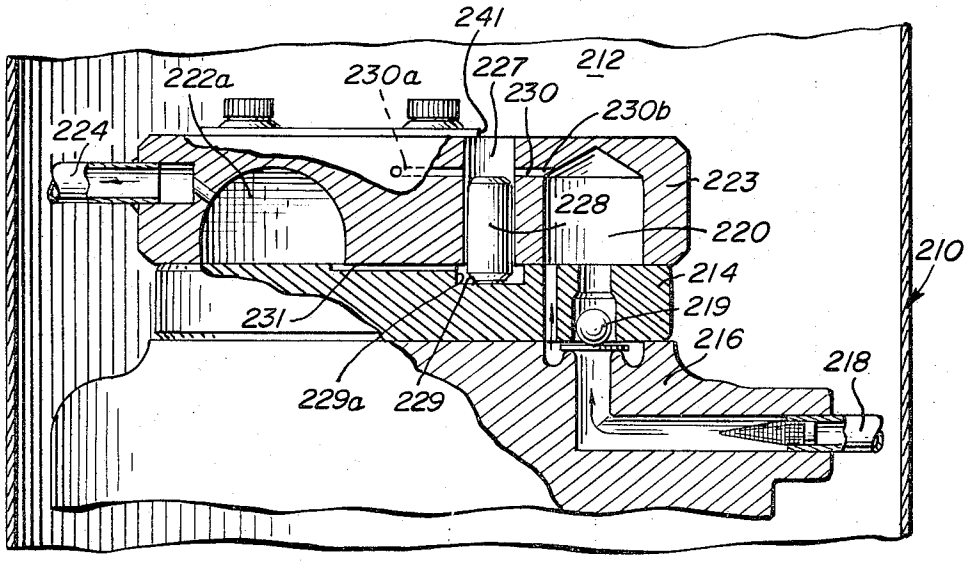


Fig. 4

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PRESSURE EQUALIZING MEANS FOR COMPRESSORS AND THE LIKE

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7 Claims. (Cl. 230—22)

ABSTRACT OF THE DISCLOSURE

A pressure equalizing device for a compressor wherein a gravity biased valve member is normally in a position permitting communication between the compressor inlet and outlet to equalize pressure across the compressor and wherein the valve member is responsive to a pressure differential across two points in the compressor discharge passages to terminate communication between the compressor inlet and outlet. A restriction on the high pressure side of the valve member causes a delayed reaction of the valve member to the pressure differential.

This invention relates to compressors, pumps, and the like, and in particular to means for providing facilitated start-up of a compressor.

In compressors of the type conventionally in use for refrigeration apparatus, the repeated cycling of the system places a severe strain on the electric motor normally provided for driving the compressor. More specifically at start-up the substantial pressure normally occurring between the suction and discharge side of the compressor requires that the electric motor develop a high starting torque. Thus, motors, such as split phase motors, having a relatively low starting torque cannot be satisfactorily employed without incorporating some means to unload, i.e. effectively eliminate this high pressure differential in the compressor during the start-up periods. While a number of different devices have heretofore been developed for this purpose, none have proven completely satisfactory. The present invention is directed to an improved means for unloading the compressor during the start-up period to permit the start-up with effectively minimized torque requirement, and automatically subsequently restoring the compressor to the normal operating arrangement wherein the desired pressure differential is obtained between the suction and discharge sides of the compressor.

Thus, a principal feature of the present invention is the provision of new and improved start-up, pressure unloading means for use in a compressor or the like.

A further feature of the invention is the provision of such start-up means having extremely simple and economical construction.

Another feature of the invention is the provision of such a start-up means for use in a compressor having means responsive to gravity for controlling the unloading operation.

Still another feature of the invention is the provision of such an unloading means having new and improved means for effecting a desired time delay to provide a preselected duration of the unloaded start-up operation.

A yet further feature of the invention is the provision of a compressor having means defining a pressure chamber, means defining a suction chamber, and means for pumping fluid from the suction chamber to the pressure chamber, means for causing the pressure in the pressure chamber and suction chamber to be substantially equal during initiation of operation of the pumping means and permitting the chambers to have a pressure differential therebetween during subsequent operation of the pumping means, comprising means defining an equalization passage between the pressure chamber and suction chamber, means for closing the equalization passage as a result of initiation of operation of the pumping means including valve means having a movable valve member for selectively closing the equalization passage, and means biasing the valve member to open the equalization passage when the pumping means is inoperative, and means for applying pressure developed by operation of the pumping means to the valve means for delayedly moving the valve member in opposition to the biasing means to close the equalization passage after a preselected period of time.

Other features and advantages of the invention will be apparent from the following description taken in connection with the accompanying drawing wherein:

FIGURE 1 is a fragmentary diametric vertical section of a compressor having unloading means embodying the invention;

FIGURE 2 is a fragmentary diametric vertical section taken substantially at right angles to the section of FIGURE 1;

FIGURE 3 is a fragmentary diametric section generally similar to that of FIGURE 1, but illustrating a compressor having a modified form of unloading means embodying the invention; and

FIGURE 4 is a fragmentary vertical diametric section of still another compressor having another modified form of unloading means embodying the invention.

In the exemplary embodiment of the invention as disclosed in FIGURES 1 and 2 of the drawing, a compressor generally designated **10** is shown to comprise a housing, or dome, **11** defining a pressure chamber **12**. Fluid such as refrigerant gas is compressed in compressor **10** by means of a rotor **13** provided in a cylinder **14** and driven by a motor shaft **15** rotatably carried in a front head, or hub, **16**. As seen in FIGURE 1, the low pressure refrigerant gas is delivered to the rotor chamber **17** through a suction line **18** provided with a check valve **19** for preventing reverse flow of the refrigerant gas therein. As shown, the refrigerant gas flows through a suction chamber **20** in front head **16** in passing from the suction line **18** into the rotor chamber **17**.

The high pressure refrigerant gas is delivered from the rotor chamber **17** into a pump outlet chamber **40** and thence through a transfer passage **21** into a series of muffler chambers **22** disposed in the rear head **23** of the compressor. From the last muffler chamber **22***a*, the high pressure gas is delivered through an outlet conduit **24** to external apparatus such as precooler **25**, and then back into the dome chamber **12** through an inlet conduit **26**. As some pressure drop occurs in passing through the external apparatus **25**, the high pressure gas in dome chamber **12** is at a pressure slightly lower than the pressure of the gas in muffler chamber **22***a*, illustratively 2 or 3 p.s.i. less.

As best seen in FIGURE 2, the front head **16** is provided with a bore defining a valve chamber **27** in which is movably mounted a valve member **28**. Valve member **28** herein comprises a cylindrical slug biased by gravity to rest in the bottom of the chamber **27** on the upper surface **29** of the rotor cylinder **14**. Front head **16** is provided with a corner portion **16***a* which is engaged by the valve member **28** to limit the upward movement thereof. Although not shown, the valve member **28** could be biased to rest at the bottom of chamber **27** by a spring located between corner portion **16***a* and the top of valve member **28**. An equalizing passage **30** is provided in the front head **16**, having a first portion **30***a* communicating between the dome chamber **12** and the valve chamber **27**, and a second portion **30***b* communicating between the valve chamber **27** and the suction chamber **20**. As shown in FIGURE 2, the inlet portion **30***a* and the outlet portion **30***b* of the equalizing passage are in axial alignment slightly above the position of the valve member **28** when

the valve member is resting on the upper surface **29** of cylinder **14**. As further shown in FIGURE 2, a restrictive passage **31** provides communication between the valve chamber **27** and the muffler chamber **22***a*, the passage **31** including a first portion **31***a* in the cylinder **14** and a second, continuing lower portion **31***b* in the rear head **23**. The valve member **28** herein comprises a relatively heavy slug of material such as a metal. The transverse area of the valve chamber **27** is preferably substantially larger than the transverse area of the restrictive passage **31**. In the preferred embodiment, passage **31** has a diameter of 0.025 inch.

When not operating, the compressor will be arranged as shown in FIGURE 2 of the drawing with the valve member **28** in the lowermost position permitting communication through passage **30** between the dome chamber **12** and the suction chamber **20**, thereby equalizing the pressure on the opposite sides of the rotor and, thus, unloading the compressor. When operation of the rotor **13** is commenced by rotation of motor shaft **15**, the unloaded condition of the compressor permits the motor to readily start the operation of the compressor with minimum torque requirements. As the pressure of the gas delivered into the pump outlet chamber **40** builds up, the pressure correspondingly builds up in the muffler chambers **22**. The increased pressure in muffler chamber **22***a* is delivered through restrictive passage **31** against the bottom of valve member **28** tending to raise the valve member from its seated position on the upper surface **29** of the cylinder **14**. Because of the restrictive nature of passage **31** and the pressure drop through it, the valve member **28** will not immediately be thrown upwardly to block off passage **30**. After several revolutions of the rotor **13**, the pressure behind the valve member slug **28** will be the same as that within the muffler chamber **22***a* since there will no longer be flow of gas through passage **31** and, hence, it will become ineffective as a restrictor. At this time, the pressure within the dome acting on the upper end of slug **28** will be slightly lower than the pressure on the underside of the slug **28** as explained above. This small pressure differential will cause the slug **28** to remain in its raised position to thereby block off passage **30**. The specific length of time to effect this blockage of the passage **30** is obviously a function of the transverse area of the restrictive passage **31**, the transverse area of the chamber **27**, the weight of the valve member **28**, and the pressure differential existing between the dome chamber pressure **12** and the pressure in muffler chamber **22**. Suitable selection of these parameters may be made, as will be obvious to those skilled in the art, to obtain a desired duration of the unloaded start-up condition. Thus, the drive of rotor **13** may be by means of a relatively inexpensive, low-starting torque motor such as a split phase motor while yet the compressor operation is efficiently and quickly started.

The raised position of the valve member slug **28** is maintained during the operation of the compressor, thereby assuring efficient conventional operation of the compressor for providing compressed fluid to external apparatus as desired. As shown in FIGURE 2, the high pressure gas may be delivered from the dome chamber **12** through an outlet conduit **32** to conventional refrigeration apparatus, such as a condenser **33**, capillary tube **34** and evaporator **35**. The low pressure refrigerant gas is returned from the external apparatus through the suction line **18** for recompression with the rotor chamber **17** as discussed above.

Turning now to the embodiment of the invention disclosed in FIGURE 3, a modified compressor generally designated **110** is shown to comprise a compressor generally similar to compressor **10**, but having a modified means for unloading the compressor during the start-up operation wherein a passage **131** is provided in the front head **116** to provide communication between the bore **127** and the pump outlet chamber **140**. The passage **131** is provided with a restricted portion **131***a* for controlled, restricted flow of the high pressure refrigerant gas from the pump outlet chamber **140** to the enlarged cavity portion **131***b* and thence to the valve chamber **127**. The valve member **128** is generally similar to valve member **28**, except that it is provided with a lower portion **128***a*, and an upper portion **128***b* which is smaller in transverse section than the lower portion **128***a*. As shown in FIGURE 3, the reduced portion **128***b* is aligned with the portions **130***a* and **130***b* of the passage **130** when the valve member is in the lowermost position resting on the surface **129** defining the bottom of the bore **127**. Thus, fluid may flow freely around the reduced portion **128***b* and through passage portion **130***b* into the suction chamber **120** at this time. When, however, the valve member **128** is raised by the differential between the dome chamber **112** pressure and the pressure acting on the underside of the valve member as delivered through the passage **131** from the pump outlet chamber **140**, the large lower portion **128***a* of the valve member becomes aligned with the equalization passage portions **130***a* and **130***b*, thereby blocking the passage and preventing further communication between the dome chamber **112** and the suction chamber **120**. Thus, for any given diameter of bore **127**, the valve member **128** of FIGURE 3 is heavier than that of valve member **28** embodied in FIGURE 2 because of the additional mass added in the upper reduced portion **128***b*. Depending upon the valves of the other various design parameters, this additional weight of the valve member may be necessary in order to achieve the desired time delay in lifting the valve member to its raised position during compressor start-up.

As shown in FIGURE 3, the front head **116** includes a corner portion **116***a* which is engaged by valve portion **128***b* at the uppermost extreme of its movement, thereby limiting the movement of the valve member and maintaining the lower portion **128***a* in passage blocking position during the operation of the compressor **110**.

As discussed above relative to compressor **10**, the specific parameters of the area of the passage **131**, the area of the bore **127**, the weight of the valve member **128** and the pressure differential between pump outlet chamber **140** and dome chamber **112** may be selected by one skilled in the art to obtain a desired time delay for providing the desired unloaded start-up operation. As in the case of the embodiment shown in FIGURE 2, the restricted portion **131***a* may comprise an opening of approximately 0.025 inch in diameter. In addition to the variables mentioned above, the embodiment shown in FIGURE 3 introduces a further parameter in obtaining a time delay operation of valve member **128**. Thus, the provision of the enlarged cavity portion **131***b* of passage **131** upstream of the restricted portion **131***a* results in increased time delay and, hence, the volume of this enlarged portion **131***b* along with the other parameters mentioned can be chosen to give the valve member the desired amount of time delay during start-up of the compressor.

Thus, compressor **110** functions generally similar to compressor **10** except that in compressor **10** the restricted passage **31** is connected to the last muffler chamber, whereas in compressor **110**, the passage **131**, with its restricted portion **131***a*, is connected directly to the pump outlet chamber. Connecting the passage **31** to the last muffler cavity, as done in compressor **10**, has the advantage of making valve member **28** less sensitive to pressure pulses occurring in the pump outlet chamber **40**. On the other hand, connecting the passage **131** to pump outlet chamber **140**, as done in compressor **110**, results in a greater pressure differential between the dome chamber **112** and the underside of the valve member **128** which, depending upon the valves of the other design parameters, may be a necessary requirement. As is obvious to those skilled in the art, the slightly different structures of the valve members **28** and **128** may be used interchangeably. The other portions of the compressor **110** which are

similar to those of compressor **10** require no further description here, it being understood that similar parts are identified by similar reference numerals except one hundred higher in compressor **110**.

Referring now to FIGURE 4, a further modified form of compressor generally designated **210** is shown to comprise a compressor generally similar to compressor **10**, but reversely arranged in that the uppermost head of the compressor comprises the rear head **223** with the suction line **218** being connected to the front head **216** for delivering the low pressure gas to the suction chamber **220** under the control of the check valve **219**. The suction chamber **220** is placed in communication with the dome chamber **212** by means of an equalizing passage **230** having a first portion **230***a* communicating between the dome chamber **212** and a valve chamber **227** in the rear head **223**, and a second portion **230***b* communicating between the valve chamber **227** and the suction chamber **220**. A slug type valve member **228** is provided in the valve chamber and is arranged to rest under the influence of gravity on a surface **229** defining the lower end of a recess **229***a* in the cylinder **214** and comprising a downward extension of the valve chamber **227**. The recess **229***a* is in communication with the muffler cavity **222***a* through a passage **231** in the cylinder **214**.

Compressor **210** functions generally similar to compressor **10** in that the rotor is unloaded in the de-energized condition of the compressor by the downward movement of the valve member slug **228** to unblock the passage **230** between the suction chamber **220** and the dome chamber **212**. However, as the pressure builds up in the muffler chamber **222***a* upon initiation of operation of the compressor, the valve member slug **228** is delayedly moved upwardly against stop **241** to close the passage **230** after a pre-selected time whereby unloaded start-up of the compressor is obtained.

In all other respects, compressor **210** is similar to and functions similar to compressor **10**. Elements of compressor **210** which are identical to elements of compressor **10** are identified by similar reference numerals but two hundred higher.

Thus, in each of compressors **10**, **110** and **210**, new and improved means are provided for equalizing the pressure at the suction and discharge sides of the compressor rotor at the time of start-up of the compressor. After a preselected time interval, the equalization of the two pressures is automatically discontinued and the high dome pressure is segregated from the suction pressure for normal continued operation of the compressor in the conventional manner. The pressure equalizing means of the present invention, is extremely simple and economical of construction utilizing a simple gravity biased valve member providing long trouble-free life. The invention comprehends that movement of the valve member to the equalizing-passage closing position be controlledly delayed so as to provide the unloaded start-up duration. This desired time delay is illustratively obtained by suitable restrictive means which limit the flow of fluid to or from the valve chamber. The compressor may be of the generally conventional hermetically sealed type as disclosed in the illustrated embodiments, including the inverted type as illustrated in the FIGURE 4 embodiment, or as will be obvious to those skilled in the art may be of any suitable construction permitting the provision of the desired equalizing passage and valve control means to provide the novel time delay control of the equalized start-up as disclosed.

While I have shown and described certain embodiments of my invention, it is to be understood that it is capable of many modifications. Changes, therefore, in the construction and arrangement may be made without departing from the spirit and scope of the invention as defined in the appended claims.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. In a compressor having means defining a pressure chamber, means defining a suction chamber, means defining a dome chamber, and means for pumping fluid from said suction chamber to said pressure chamber, means for causing the pressure in said pressure chamber and suction chamber to be substantially equal during initiation of operation of said pumping means and means causing the pressure and dome chambers to have a pressure differential therebetween during subsequent operation of the pumping means, comprising:

means defining an equalization passage between said dome chamber and suction chamber;

means for closing said equalization passage as a result of initiation of operation of said pumping means including valve means having a movable valve member for selectively closing said equalization passage, and means biasing said valve member to open said equalization passage when the pumping means is inoperative; and

means for applying said pressure differential developed by operation of said pumping means to said valve member for delayedly moving said valve member in opposition to the biasing thereof to close said equalization passage after a preselected period of time.

2. The compressor means of claim **1** wherein said pressure differential applying means comprises a delivery passage for conducting fluid from said pressure chamber to said valve means and having means therein for throttling fluid flow therethrough.

3. The compressor means of claim **2** wherein said throttling means comprises a fixed restriction means.

4. The compressor means of claim **1** further including means for maintaining the pressure differential across the valve member and thereby maintain said valve member in the equalization passage-closing position during subsequent operation of the pumping means.

5. The compressor means of claim **1** wherein said valve means comprises means defining a bore intersecting said equalization passage and having an inlet opening to said pressure chamber and said valve member comprises a slug movable in said bore by said pressure differential against the weight thereof for selectively blocking said equalization passage.

6. In a compressor having means defining a pressure chamber, means defining a suction chamber, and means for pumping fluid from said suction chamber to said pressure chamber, means for causing the pressure in said pressure chamber and suction chamber to be substantially equal during initiation of operation of said pumping means and permitting the chambers to have a pressure differential therebetween during subsequent operation of the pumping means, comprising:

means defining an equalization passage between said pressure chamber and suction chamber;

means for closing said equalization passage as a result of initiation of operation of said pumping means including valve means having a movable valve member for selectively closing said equalization passage, and means biasing said valve member to open said equalization passage when the pumping means is inoperative; and

means for applying pressure developed by operation of said pumping means to said valve means for delayedly moving said valve member in opposition to said biasing means to close said equalization passage after a preselected period of time, said pressure applying means comprising a delivery passage for conducting fluid from said pumping means to said valve means, said delivery passage having a first restricted portion and a second enlarged cavity portion upstream from said first restricted portion.

7. In a compressor having means defining a pressure chamber, means defining a suction chamber, and means for pumping fluid from said suction chamber to said pressure chamber, means for causing the pressure in said pressure chamber and suction chamber to be substantially equal during initiation of operation of said pumping means and permitting the chambers to have a pressure differential therebetween during subsequent operation of the pumping means, comprising:

means defining an equalization passage between said pressure chamber and suction chamber;

means for closing said equalization passage as a result of initiation of operation of said pumping means including valve means having a movable valve member for selectively closing said equalization passage, and means biasing said valve member to open said equalization passage when the pumping means is inoperative; and

means for applying pressure developed by operation of said pumping means to said valve means for delayedly moving said valve member in opposition to said biasing means to close said equalization passage after a preselected period of time, said valve means comprising means defining a bore, said equalization passage having an inlet opening into said bore and an outlet opening outwardly from said bore, said

valve member comprising a slug movable in said bore for selectively blocking fluid flow between said inlet and outlet, and said slug including a lower portion and a transversely reduced upper portion, selectively aligned with said inlet and outlet and permitting fluid flow therearound through said bore, and spaced from alignment with said inlet and outlet with said lower portion disposed to block said fluid flow.

References Cited

UNITED STATES PATENTS

711,689	10/1902	Wittenmeier	230—22
831,522	9/1906	Reardon	230—22
876,359	1/1908	Karger	230—22
1,128,077	2/1915	Taylor	103—42
1,911,105	5/1933	Buchler	230—22
1,934,758	11/1933	Temple	103—42
1,965,420	7/1934	Lipman	230—22
2,373,909	4/1945	Penn	230—24
2,470,565	5/1949	Loss	230—22

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