Oct. 7, 1941. H. F. SMITH 2,258,425

REFRIGERATING APPARATUS

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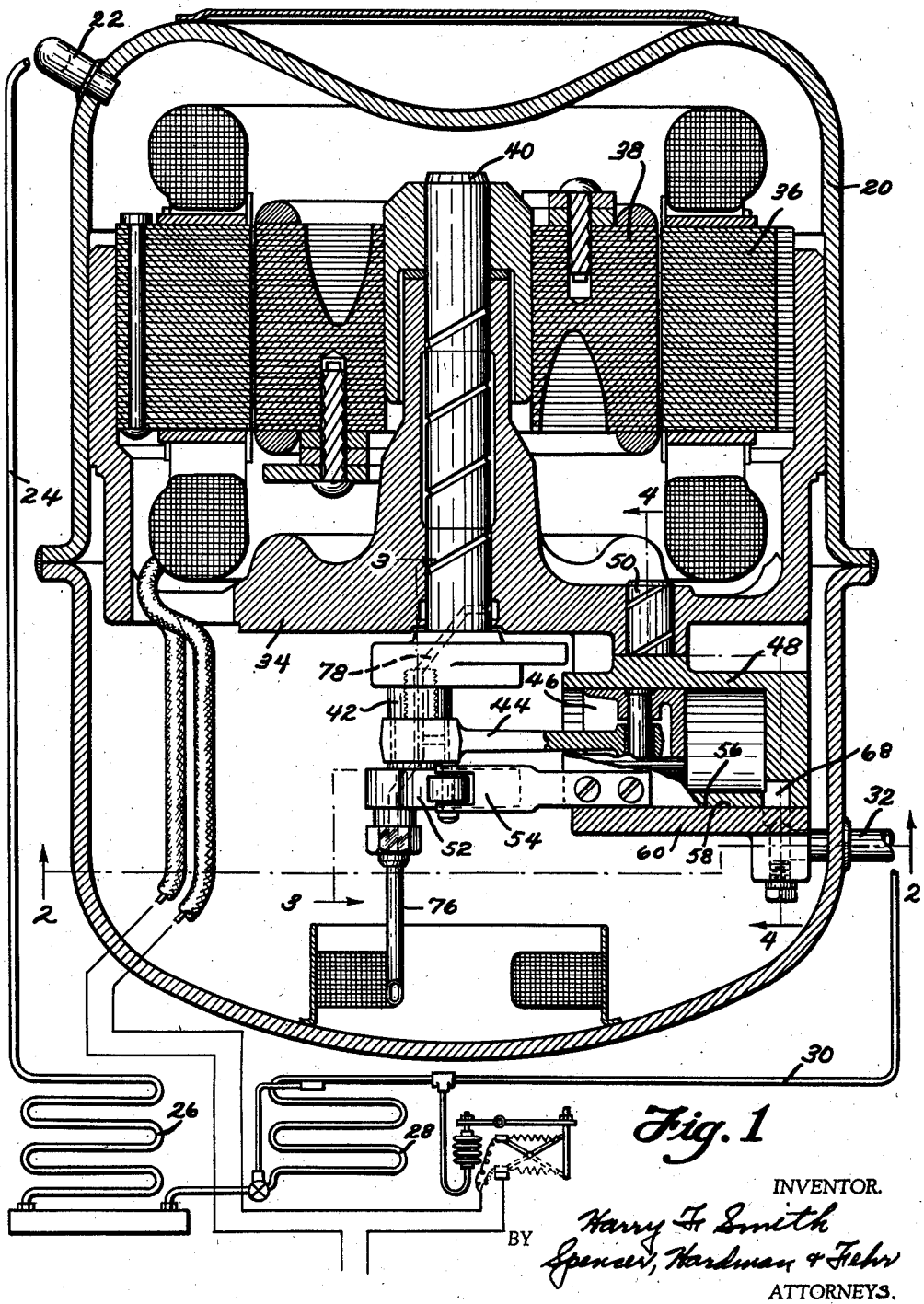


Fig. 1

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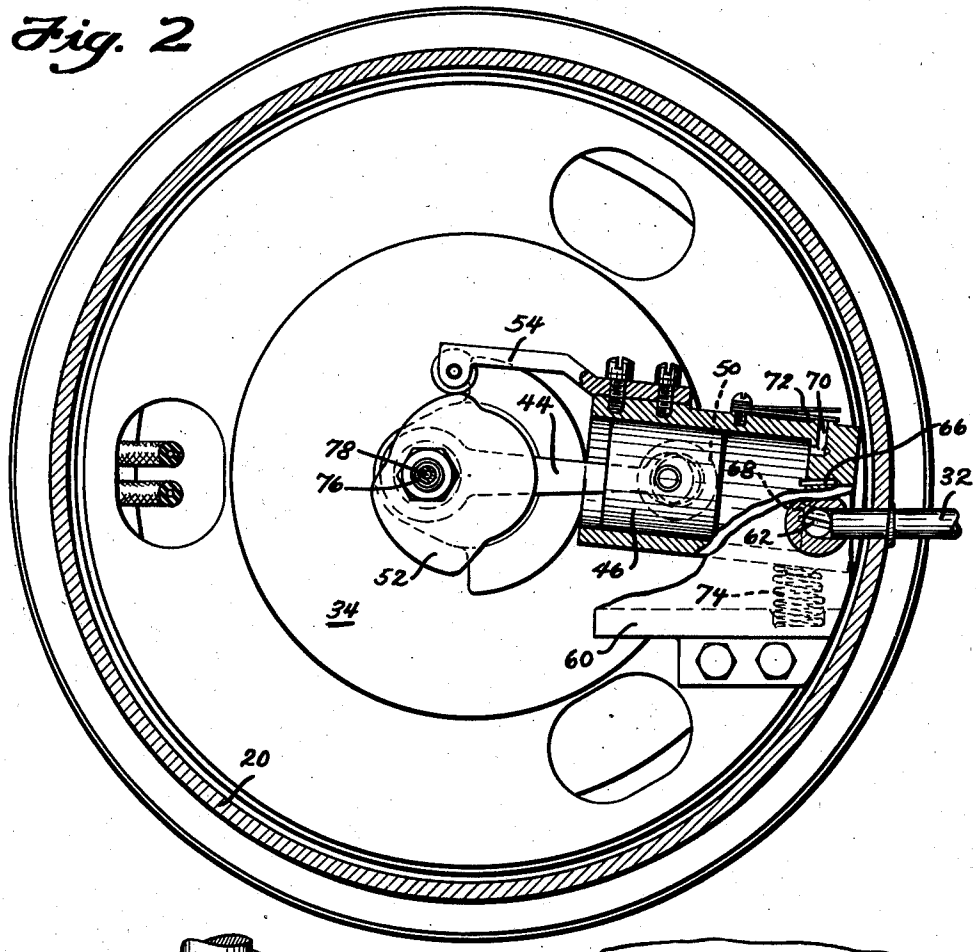
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REFRIGERATING APPARATUS

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Fig. 2



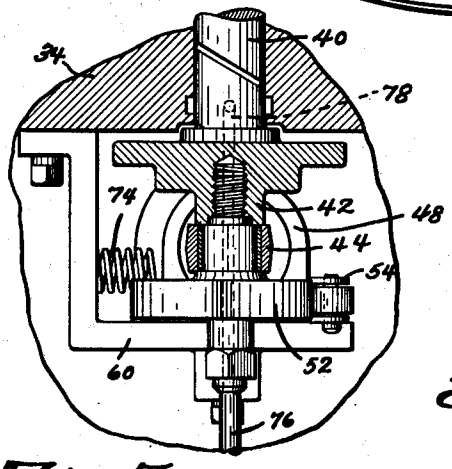


Fig. 3

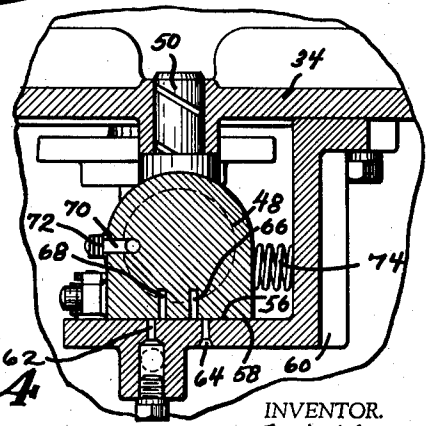


Fig. 4

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REFRIGERATING APPARATUS

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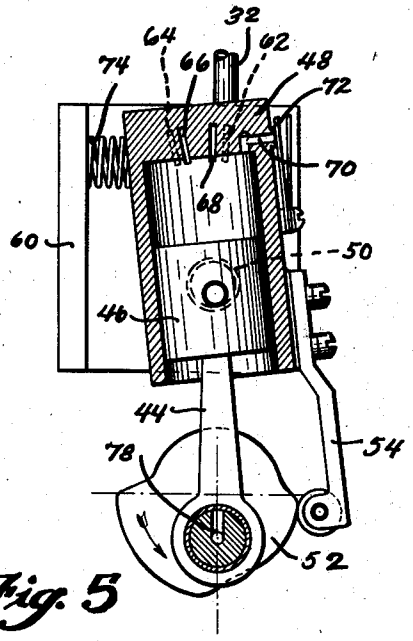


Fig. 5

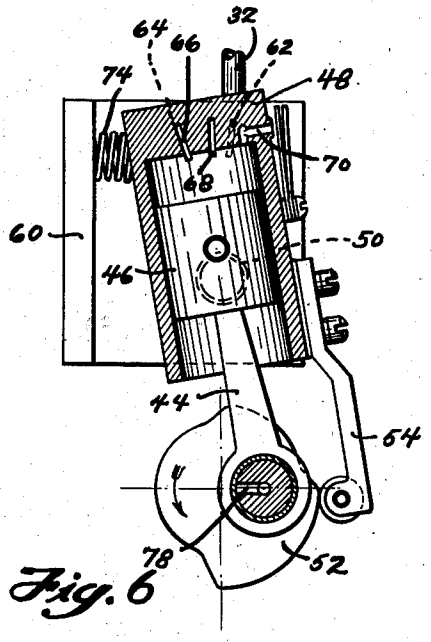


Fig. 6

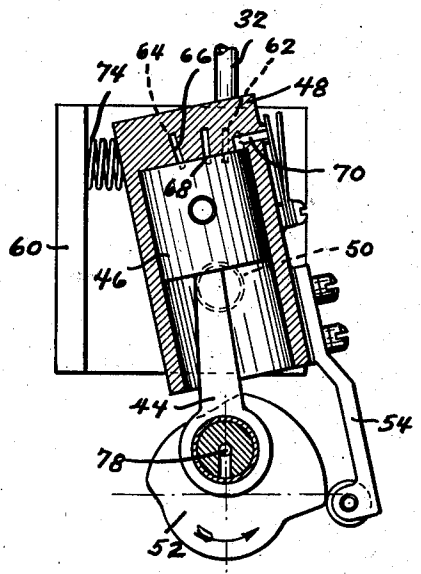


Fig. 7

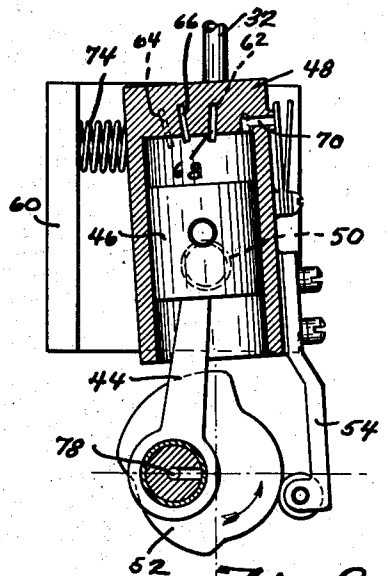


Fig. 8

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REFRIGERATING APPARATUS

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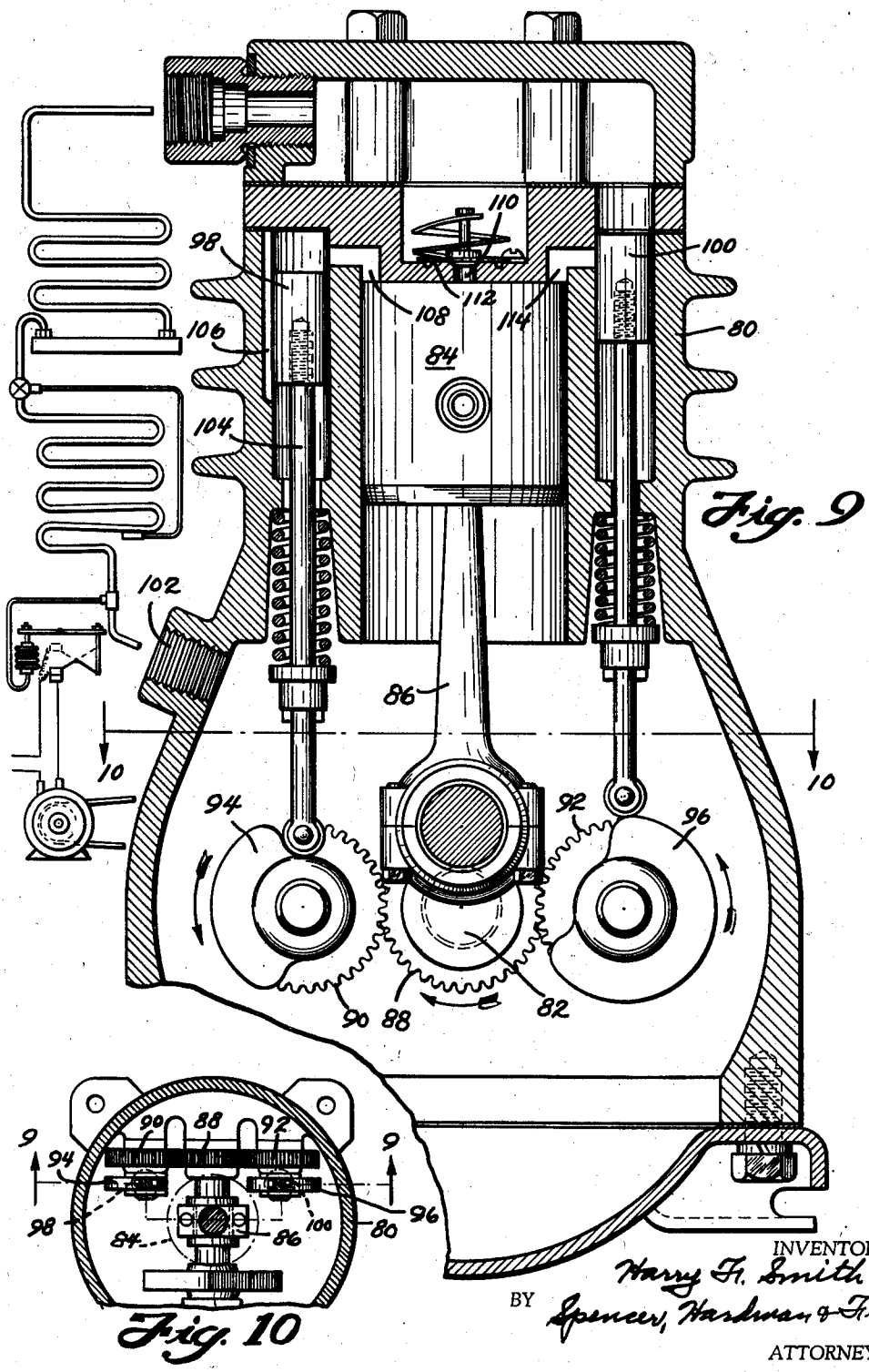


Fig. 9

Fig. 10

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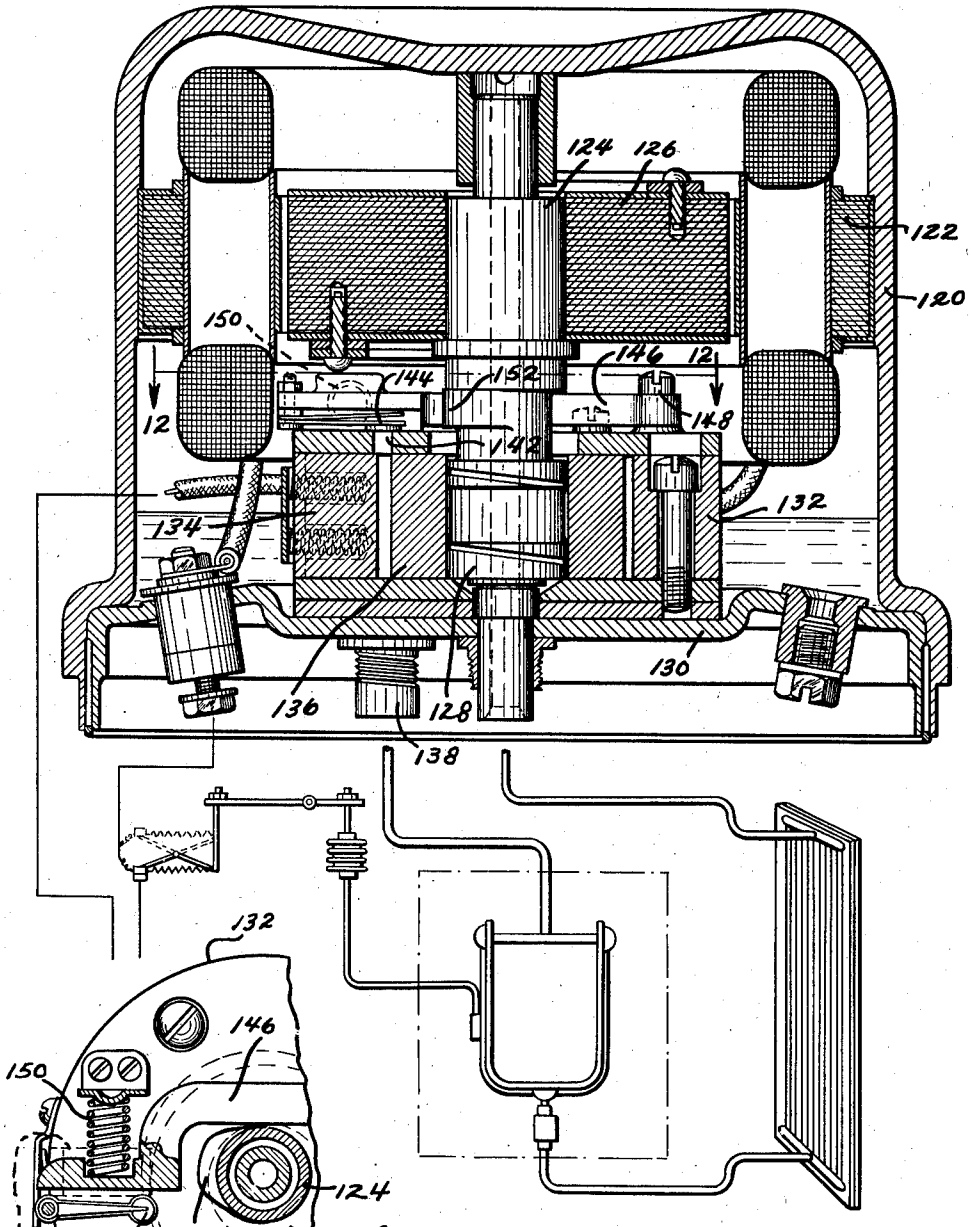


Fig. 11

Fig. 14

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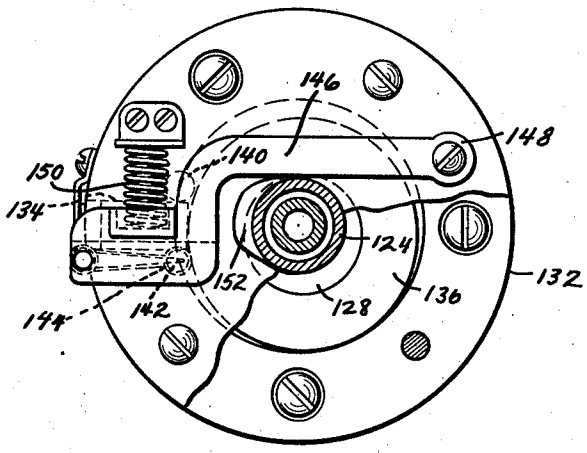


Fig. 12

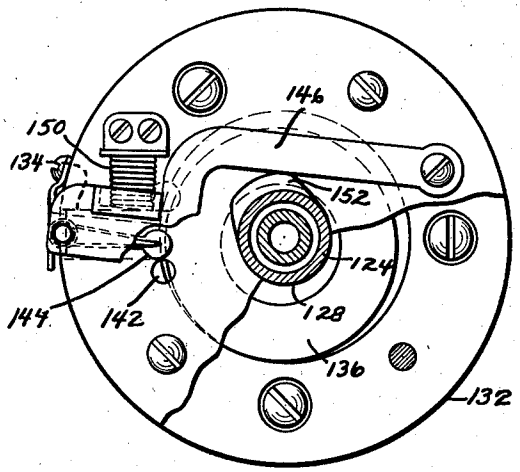


Fig. 13

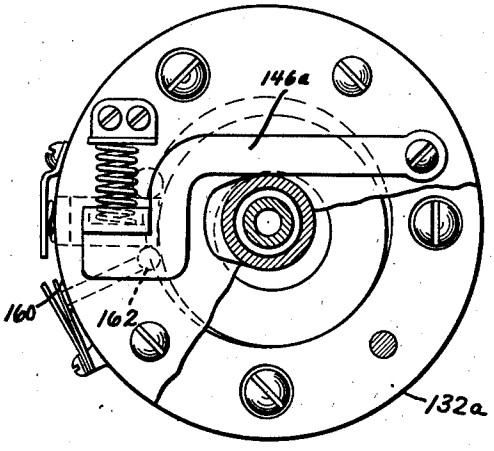


Fig. 15

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Patented Oct. 7, 1941

2,258,425

UNITED STATES PATENT OFFICE

2,258,425

REFRIGERATING APPARATUS

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Application July 7, 1938, Serial No. 217,938

16 Claims. (Cl. 230—175)

This invention relates to refrigerating apparatus and more particularly to refrigerating systems in which the compressor is provided with a reed valve or the like and is further provided with mechanically operated means for checking the discharge from the compressor at the end of the compression stroke.

One object of this invention is to provide a system which is more efficient and at the same time more silent in operation.

Another object of this invention is to provide a check valve of reduced size which may be allowed a longer time for closing.

Still another object of this invention is to provide a by-pass opening around the usual form of automatic check valve and to provide this opening with a mechanically operated valve.

Further objects and advantages of the present invention will be apparent from the following description, reference being had to the accompanying drawings, wherein a preferred form of the present invention is clearly shown.

In the drawings:

Fig. 1 is a partly diagrammatic view of a refrigerating system showing the compressor in section;

Fig. 2 is a sectional view taken on line 2—2 of Fig. 1;

Fig. 3 is a fragmentary sectional view taken on line 3—3 of Fig. 1;

Fig. 4 is a fragmentary sectional view taken on line 4—4 of Fig. 1 showing the arrangement of the ports for the mechanically operated valves;

Fig. 5 is a fragmentary sectional view showing the position of the various elements at the beginning of the compression stroke;

Fig. 6 is a view similar to Fig. 5 showing the arrangement of the elements during the last half of the compression stroke;

Fig. 7 is a view similar to Figs. 5 and 6 showing the position of the elements at the end of the discharge stroke;

Fig. 8 is a view similar to Figs. 5, 6 and 7 showing the arrangement of the elements during the suction stroke;

Fig. 9 is a view partly diagrammatic showing a modified form of compressor connected into a refrigerating system;

Fig. 10 is a fragmentary sectional view taken on the line 10—10 of Fig. 9;

Fig. 11 is a view, partly diagrammatic, showing a cross sectional view of a rotary compressor equipped with a still further modified valve arrangement;

Fig. 12 is a fragmentary sectional view taken on line 12—12 of Fig. 11 showing the valve in its fully closed position;

Fig. 13 is a view similar to Fig. 12 showing the valve in its fully open position;

Fig. 14 is a view similar to Fig. 12 with parts broken away so as to more clearly show the valve structure; and

Fig. 15 is a still different modified arrangement showing a rotary compressor provided with a reed valve located on the side thereof and a mechanically operated valve located on the top thereof.

One of the problems in designing a refrigerating system is to design a system which will operate silently and yet operate efficiently. The efficiency of any system is largely determined by the efficiency of the compressor and the valves. A large number of inventors have devised various forms of compressors equipped with various types of valve mechanisms, some of which have been fairly satisfactory in operation but have either been too noisy or been impractical for other reasons. It is old to provide a compressor with an automatic valve and it is likewise old to provide a compressor with a mechanical valve but each type has its advantages and disadvantages. Systems constructed in accordance with my invention have the advantages of systems employing wholly automatic check valves and also the advantages of systems employing mechanically operated valves.

Referring now particularly to the arrangement shown in Figs. 1 through 8, the compressor 20 is provided with a discharge outlet 22 which is connected to the refrigerant vapor line 24 leading to the condenser 26. The condensed refrigerant is supplied to the usual form of evaporator 28 from which the vaporized refrigerant flows through the line 30 which connects with the compressor inlet 32. The compressor is of the hermetically sealed type in which the moving parts are journaled in a main frame 34. The usual form of motor having a stator 36 and a rotor 38 is provided. The main rotor shaft 40 is provided with a crank 42 which drives a connecting rod 44 which, in turn, causes reciprocation of the piston 46. The piston 46 reciprocates within the cylinder 48 which is pivotally mounted on the main frame 34 by means of the pivot 50. On the lower end of the main rotor shaft 40 there is provided a cam 52 which cooperates with a cam follower 54 carried by the cylinder 48 and which serves to oscillate the cylinder 48 about the pivot 50. As best shown in Fig. 4, the main cylinder 48 has a flat bottom surface 56 which is in sliding engagement with the flat surface 58 of the member 60 which has

a passage 62 communicating with the inlet 32 and has a separate passage 64 through which a portion of the compressed refrigerant is discharged from the compressor chamber at such times when the passage 64 is in alignment with a passage 66 formed in the wall of the cylinder 48. The wall of the cylinder 48 is also provided with a second passage 68 which is in alignment with the passage 62 during the intake stroke of the piston by virtue of the cam arrangement. The wall of the cylinder 48 is also provided with a passage 70 which leads to the conventional form of check valve 72.

In order to produce the proper movement of the main cylinder 48 a spring 74 is provided which biases the cylinder in a clockwise direction about the pivot 50 as viewed in Fig. 5. The cam 52 and cam follower 54, therefore, definitely determine the angular position of the cylinder 48 with respect to the member 60. Referring to the showing in Figs. 5 through 8, it will be noted that as the cylinder of the compressor rocks about the pivot 50 the inlet and outlet passages 62 and 64 are covered and uncovered mechanically in the manner explained hereinafter. Referring to Fig. 5, it will be observed that at the beginning of the compression stroke the passages 62 and 64 are both covered and remain covered during the first half of the compression stroke. As the pressure within the piston increases to a point above the pressure within the main compressor housing the flap valve 72 will open. Under normal conditions, the flap valve 72 will open before the passages 64 and 66 move into alignment.

Fig. 6 shows the cylinder in the position in which the passage 66 is in alignment with the passage 64. When these passages come into alignment the compressed gas in the cylinder tends to flow freely through these passages with the result that the flap valve 72 will slowly close without making the usual noise. At the end of the discharge stroke the parts are in the position shown in Fig. 7. Immediately at the beginning of the suction stroke the main cylinder 48 shifts into the position shown in Fig. 8 in which the passages 62 and 68 are in alignment, thereby permitting the piston to withdraw gas from the evaporator in the usual manner. The cylinder 48 remains in the position shown in Fig. 8 throughout the suction stroke of the piston, and immediately at the end of the suction stroke the cylinder shifts back into the position shown in Fig. 5.

Lubricant is fed to the main bearings by use of the lubricant supply pipe 76 carried at the lower end of the main shaft 40. Lubricant collected by the pipe 76 flows upwardly through the passage 78 which supplies lubricant to the various bearing surfaces in the well-known manner.

In Fig. 9 of the drawings I have shown my invention applied to a reciprocating type of compressor employing a stationary cylinder housing 80. In this modification the crank shaft 82 imparts reciprocation to the piston 84 by means of the usual form of piston rod 86. The crank shaft 82 is provided with a gear 88 which imparts rotation to a pair of gears 90 and 92 which operate the valve operating cam segments 94 and 96 respectively. The cam segments 94 and 96 reciprocate the slide valves 98 and 100 respectively. When the valve 98 is in the position shown in Fig. 9, the low pressure refrigerant entering the compressor crankcase at 102 flows to the head end of the piston via the passage 104 surrounding the stem of the slide valve 98, the by-pass 106 around the valve 98, and the passage 108. The arrangement of the cam 94 is such that the slide valve 98 remains in the position shown during the full suction stroke and, at the end of the suction stroke, the valve 98 moves upwardly thereby closing the passage 108. During the compression stroke of the piston 84 the compressed fluid discharges through the port 110 which is provided with the usual form of valve flap 112 which is free to move away from the valve port 110 whenever the pressure within the cylinder is greater than the head pressure. The construction of the cam 96 is such that during the latter portion of the compression stroke the slide valve 100 uncovers the discharge port 114 with the result that the compressed refrigerant tends to flow through the port 114 rather than through the port 110. Consequently, the flap valve 108 slowly closes the port 110 before the completion of the compression stroke. It will be noted that in this modification the cylinder is stationary; whereas, in the first modification the cylinder oscillated about a pivot. It will also be noted that the mechanically operated valve 100 is in parallel with the flap valve 112. For purposes of illustration, the inlet valve has been shown as being a mechanically operated valve but may be any other form of valve suitable for refrigerant compressors.

Referring now to Figs. 11 through 14 in which I have shown a still further arrangement suitable for use in a rotary compressor unit, the rotary compressor unit comprises an outer casing 120 which supports the motor stator 122 and the centrally disposed rotary shaft 124 which in turn carries the motor rotor 126 adjacent its upper end and the compressor eccentric 128 adjacent its lower end. The bottom wall 130 of the outer casing supports the main compressor casing 132 which is provided with the usual form of divider block 134. The eccentric 128 imparts movement to the impeller 136 in the usual manner. The low pressure refrigerant vapor enters the compressor casing through the inlet 138 which communicates with the inlet port 140 of the compressor. The compressed refrigerant leaves the compressor via the discharge port 142 provided on the upper side of the compressor housing. A flap valve 144 is provided for the outlet port 142. This flap valve is carried at the outer end of the arm 146 which is pivotally supported from the compressor casing at its one end by means of the pivot 148. The arm 146 is biased into the position shown in Figs. 12 and 14 by the spring 150. During the latter portion of the discharge stroke of the compressor, the arm 146 is cammed into the position shown in Fig. 13 by the cam segment 152 provided on the main shaft 124.

In the modification shown in Figs. 11 through 14, the valve flap 144 opens like any other reed valve and, when in the open position, is moved sidewise away from the valve port 142 with the result that the valve flap 144 moves into engagement with the upper wall of the casing 132 at a point adjacent the port 142. The port 142 is closed when the arm 146 carrying the valve flap 144 slides the valve flap 144 into position over the port 142. By virtue of this mode of valve operation, the valve makes practically no noise during operation.

In Fig. 15 is shown a slightly modified arrangement for use in a rotary compressor in which the discharge passage from the compressor is

provided with two valves in parallel, one of which is a flap valve 160 mounted on the side wall of the main compressor casing 132a and the other of which comprises a slidable member 146a, corresponding to arm 146 in Fig. 13, which covers and uncovers the outlet port 162 provided on the upper side of the compressor casing. The arm 146a is operated in the same manner in which the arm 146 in the preceding modification is operated.

In the refrigerating systems disclosed in this application all of the advantages of the mechanically operated valve are present and, at the same time, all of the advantages of the automatically operated valve are present. It will be noted that in the systems disclosed herein the closing of the mechanically operated valve may be accurately timed with the result that it is possible to check the flow of refrigerant at that point at which maximum efficiency may be obtained. The point at which the check valve opens will of course be determined by the head pressure in each case and will, therefore, vary considerably. The timing of the mechanically operated valves may be varied to suit the particular requirements by changing the design of the cam member.

While the form of embodiment of the invention as herein disclosed, constitutes a preferred form, it is to be understood that other forms might be adopted, all coming within the scope of the claims which follow.

What is claimed is as follows:

1. In a refrigerating system, a compressor having a compressing chamber, inlet and outlet means for said compressing chamber, refrigerant flow control means for said outlet means so constructed and arranged that refrigerant may flow from said chamber at a predetermined difference in pressure between said chamber and said outlet means and is free to flow until the end of the compression stroke of the compressor irrespective of pressure in said chamber and said outlet means.

2. In a refrigerating system, a compressor, inlet and outlet means for said compressor, a plurality of discharge valves arranged in parallel relationship between said compressor and said outlet means, means whereby one of said valves opens first and closes after another of said valves opens but before said other valve closes.

3. In a refrigerating system, a compressor having an outlet means, a plurality of discharge valves between said compressor and said outlet means arranged in parallel relationship, mechanical means for opening and closing one of said valves once during each compression stroke of said compressor, and means whereby another of said valves operates in response to a pressure differential between said compressor and said outlet means.

4. In a refrigerating system, a compressor having a compressing chamber, outlet means for said compressor, a check valve between said compressing chamber and said outlet means, and a mechanically operated valve between said compressing chamber and said outlet means, the construction being such that said mechanically operated valve opens subsequent to the opening of said check valve.

5. In a refrigerating system, a compressor having a compressing chamber, outlet means for said compressor, a check valve between said compressing chamber and said outlet means, and a mechanically operated valve between said compressing chamber and said outlet means, the construction being such that said mechanically operated valve closes subsequent to the closing of said check valve.

6. In a refrigerating system, a compressor, said compressor having a movable cylinder block provided with a compressing chamber, discharge means for said compressor, a plurality of valve ports between said compressing chamber and said discharge means, said ports being arranged in parallel relationship, and means whereby movement of said cylinder block opens and closes one of said ports.

7. In a refrigerating system, a compressor, an outlet for said compressor means for controlling the flow of refrigerant from said compressor to said outlet comprising a flap valve, and mechanically operated means for positively delaying the closing of said flap valve.

8. In combination with a refrigerant compressor having an outlet port provided with a pressure-operated check valve, means for by-passing said check valve, and means whereby said by-pass is open during substantially the last half of the compression stroke of said compressor and is closed the remainder of the time.

9. In combination with a cylinder of a refrigerant vapor compressor for use in a system in which varying amounts of lubricant are circulated with the refrigerant vapor, an impeller in said cylinder, an intake port for said cylinder, a plurality of discharge ports for said cylinder, a rotary shaft, means whereby rotation of said shaft imparts an impelling movement to said impeller, means whereby rotation of said shaft opens and closes one of said discharge ports, and a reed valve for opening and closing another of said ports.

10. In a refrigerant vapor compressor, a stationary cylinder, a reciprocating piston in said cylinder, an intake port for said cylinder, a plurality of discharge ports for said cylinder, a pressure operated valve for one of said ports, a slide valve for another of said ports, and means whereby said slide valve is normally opened after said pressure operated valve has opened and is normally closed after said pressure operated valve has closed.

11. In a rotary compressor for use in a refrigerating system in which a mixture of refrigerant vapor and lubricant is required to pass through the compressor, means forming a compressing chamber, an impeller therein, a shaft having an eccentric in driving engagement with said impeller, a first discharge port for said compressing chamber, a reed valve for said port, a second discharge port arranged in parallel with said first port, means operated by said shaft for opening and closing said second port.

12. In combination, a support, an oscillating cylinder mounted thereon, a piston reciprocable in the bore of said cylinder, a first discharge port for said cylinder, means whereby oscillation of said cylinder covers and uncovers said port, a second discharge port for said cylinder in parallel with said first discharge port, and a check valve for said second port.

13. In a sealed refrigerating system in which a lifetime mixture of refrigerant and lubricant is sealed into the system, a compressor having first means forming a compression chamber and having second means for compressing refrigerant gas in said chamber, a plurality of discharge ports in said first named means, pressure responsive apparatus controlling the flow through one of said ports, and means whereby movement

of one of said compressor means positively controls the flow of refrigerant through the other of said ports.

14. In a compressor, means forming a pumping chamber, a piston within said chamber, an outlet port for said chamber, a spring-loaded valve for said port adapted to open upon an increase in the compression pressure above the discharge pressure, and means for positively holding said valve open during a portion of each compression stroke.

15. In combination, means forming a compression chamber including a valve port, a pressure operated valve for said port, a piston in said chamber, piston operating means, means operated by said piston operating means for positively holding said valve open for a portion of the time during each stroke of said piston.

16. In a compressor, a cylinder, a piston operable therein and forming with said cylinder a compression chamber, an intake port, outlet port means, a pressure operated valve for said outlet port means, valve means for said inlet port, resilient means biasing said outlet valve into closed position, and means in addition to said resilient means for positively moving said outlet valve to its closed position substantially at the end of the compression stroke.

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