March 30, 1965 W. R. DIRK 3,175,758

COMPRESSOR CONSTRUCTION WITH INERTIAL SUCTION VALVE

Filed April 30, 1962 2 Sheets-Sheet 1

Fig.1

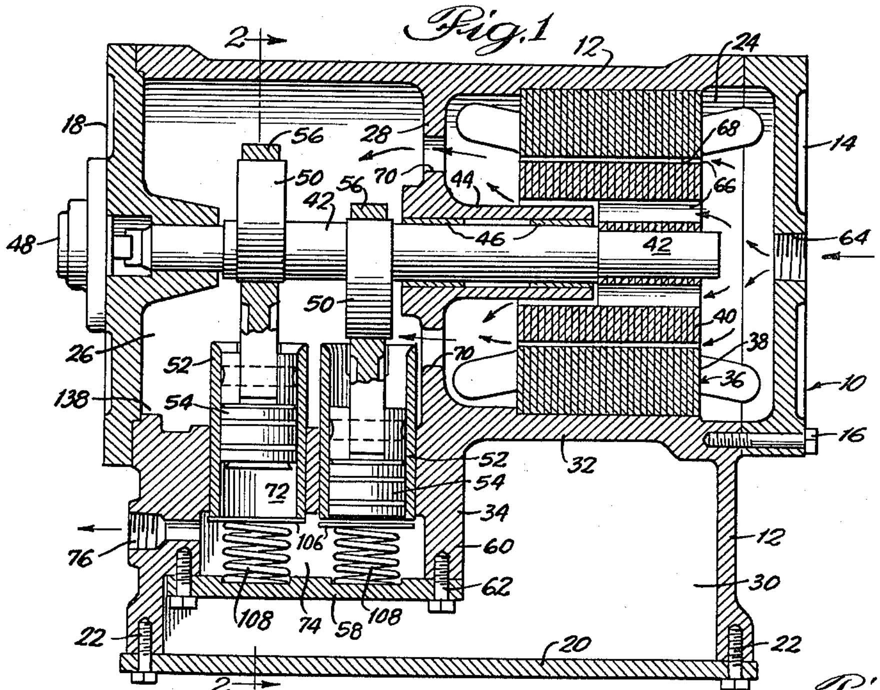


Fig.2

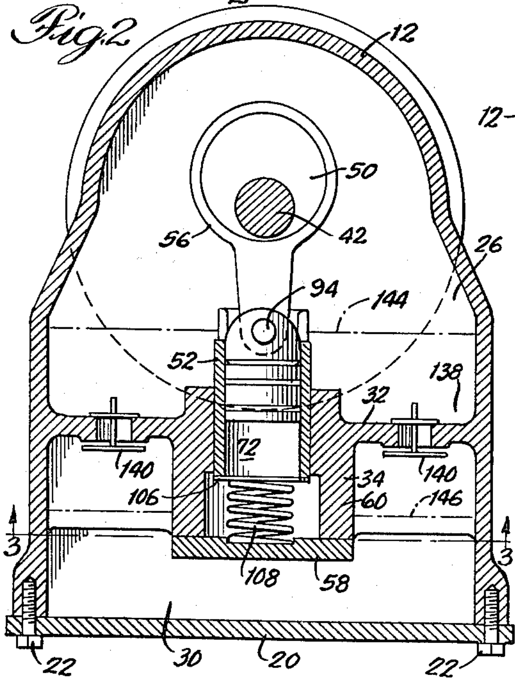
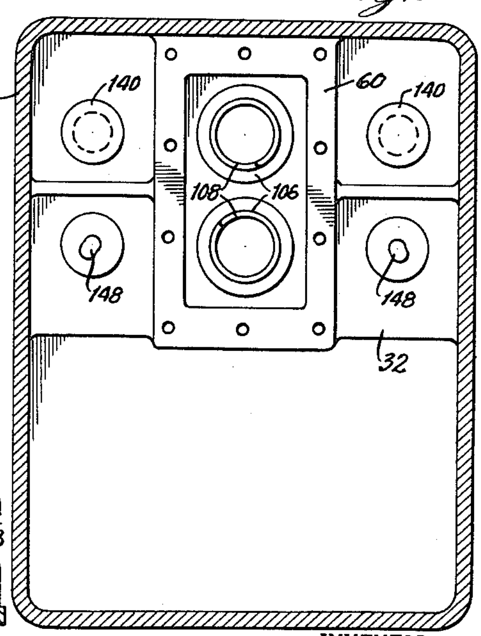


Fig.3



INVENTOR:
William R. Dirk,
BY
Bair, Freeman & Molinare
ATTORNEYS.

March 30, 1965 W. R. DIRK 3,175,758

COMPRESSOR CONSTRUCTION WITH INERTIAL SUCTION VALVE

Filed April 30, 1962 2 Sheets-Sheet 2

Fig.4

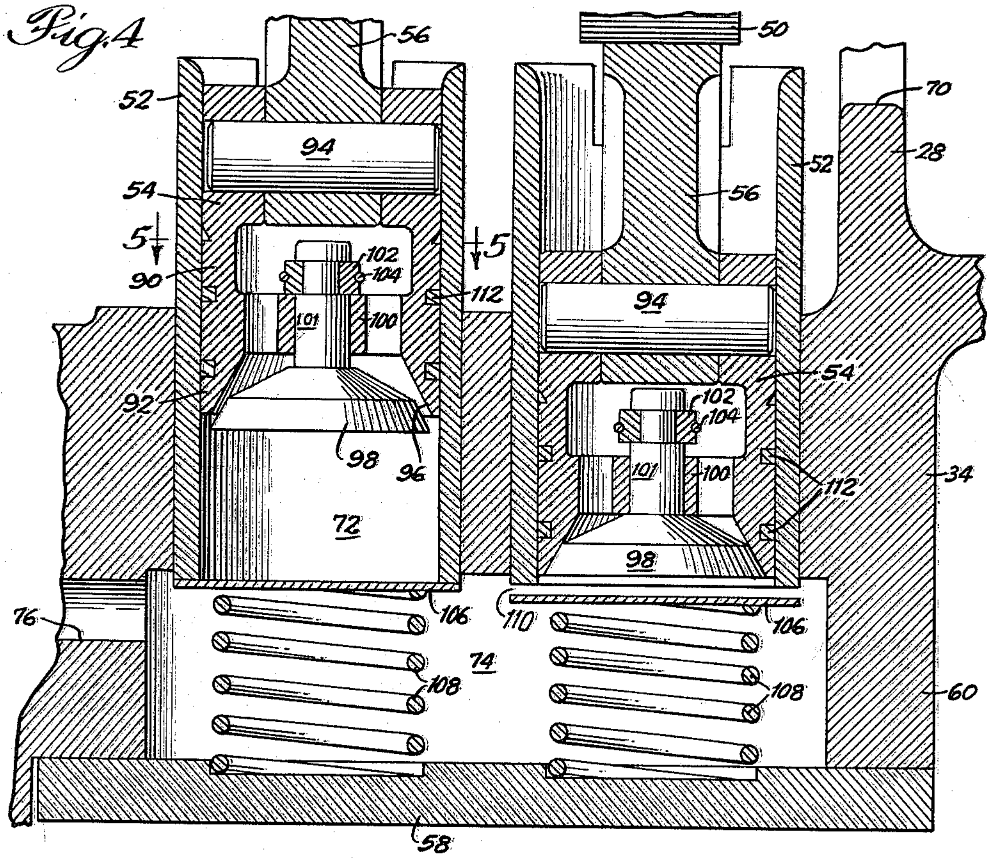
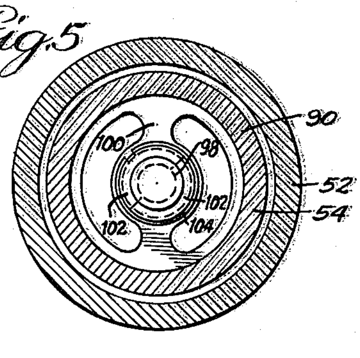


Fig.5



INVENTOR:
William R. Dirk
BY
Bair, Freeman & Molinare
ATTORNEYS.

United States Patent Office

3,175,758

Patented Mar. 30, 1965

1

3,175,758

COMPRESSOR CONSTRUCTION WITH INERTIAL SUCTION VALVE

William R. Dirk, Fort Worth, Tex., assignor to Lennox Industries Inc., Marshalltown, Iowa, a corporation of Iowa

Filed Apr. 30, 1962, Ser. No. 191,223
2 Claims. (Cl. 230—190)

This invention relates generally to improvements in compressors, and motor particularly to compressors for use in refrigeration apparatus. The invention is especially applicable to compressors adapted for use in air conditioning systems.

There has long been a need in the design of air conditioning equipment to provide a compressor capable of providing higher operating capacity at a lower basic cost. The recent design trend in the compressor field has been directed toward the use of smaller and lighter weight electric motors of high speed to achieve the desired increase in capacity with a reduction in cost. These desired advantages, however, have not been solved without encountering other design difficulties. Higher motor speeds greatly increase the displacement for compressors of a given bore and stroke. The provision of adequate valving areas under such conditions has proven to be a difficult problem. Conventional refrigeration compressors in the past have incorporated both the suction and discharge valves in the cylinder head, resulting in limited available valving area in high speed units. Such prior known structures have utilized flat, thin, high tensil strength steel valve elements. Such valves have maintained a low mechanical inertia.

The present invention contemplates the entirely different approach of an improved inertial valve structure for a refrigerant compressor. By utilizing a "poppet" valve with a relatively short valve stem and guide means, it is possible to utilize inertia for opening and closing operation. In this way, it is possible to maintain starting torque at a low level because the compressor is unloaded during start-up and does not begin to load until the inertia forces are sufficient to close the valve, at which time the motor will be operating at high speed. In this way, the demands upon the motor performance are greatly lessened, so as to facilitate the utilization of relatively lower cost motors of smaller size and weight but still capable of providing high speed operation.

This design approach for refrigerant compressors enables utilization of the unique physical properties of polytetrahalogenethylene materials. The use of such materials in the inertial valve structures of the type disclosed by the present invention achieve marked reduction in operating noise and minimize lubrication requirements and the accompanying problems of excessive lubricating oil flow with the refrigerant fluid.

An important general object of the invention, therefore, is to provide a high-capacity, high-efficiency compressor which is especially adapted for air conditioning system applications.

A particular object is to provide an inertial suction valve for a refrigerant compressor which enables the use of simpler and lower cost motor drive means.

Another particular object is to provide an inertial suction valve for a refrigerant compressor utilizing polytetrahalogenethylene to reduce operating noise and to provide self-lubricating valve operation.

2

These and other objects, advantages and functions of the invention will be apparent from the specification and from the attached drawings illustrating a preferred embodiment of the invention, in which:

FIGURE 1 is a vertical cross-sectional view of an embodiment of the present invention;

FIGURE 2 is a vertical cross-sectional view of the compressor shown in FIGURE 1, taken substantially as indicated along the line 2—2 of FIGURE 1;

FIGURE 3 is a bottom plan and sectional view of the compressor, taken substantially as indicated along the line 3—3 of FIGURE 2;

FIGURE 4 is an enlarged fragmentary vertical sectional view of the compressor shown in FIGURE 1, illustrating the structure and operation of the inertial suction valve structure of the present invention; and

FIGURE 5 is a cross-sectional view of the compressor shown in FIGURE 4 taken substantially as indicated along the line 5—5 of FIGURE 4.

The illustrative embodiment of the invention as shown in the drawing is characterized by having a piston and cylinder construction including a suction valve port in the piston head, and an inertial suction valve mounted on the piston head over the suction port. The advantages of the invention are achieved by providing a "poppet" type of suction valve in the piston head for suction gas flow through the hollow body of the piston to the suction valve port. The suction valve is constructed of a polytetrahalogenethylene such as polytetrafluoroethylene, known by the trade name Teflon, and polytrifluoromonochloroethylene, known by the trade name Kel-F. The valve is thus uniquely durable, efficient, and quiet.

The suction valve employes inertia for its opening and closing action. In this way, it is not necessary to start and stop the flow of gas itself to fill the cylinder on the suction stroke. In effect, the piston moves into a column of suction gas, so that more gas reaches the cylinder in the suction stroke, thus enhancing the capacity of the compressor in direct ratio to its displacement.

The large size of the suction valve provided by the invention furnishes very high compressor efficiency. The valve can thereby handle liquid as well as refrigerant gas. A discharge valve also of very large size is provided, and together they cooperate to eliminate the well-known "slugging" problem and provide other advantages. The discharge valves can open any selective amount to allow liquid to flow without a hydraulic buildup within the cylinders. Valve and journal shock is thus eliminated. There is no pressure drop between the compression chamber in the cylinder and the collecting head, so that the fluid is moved with less power.

The features and advantages of a thin "poppet diaphragm" type of discharge valve, as generally illustrated herein, are fully described in detail in my copending application, Serial No. 191,222, filed April 30, 1962, now abandoned. Reference may be made thereto for a fuller understanding of the problem of "slugging" and the advantageous use of the large diameter discharge valve in cooperation with a large diameter suction valve.

Referring to FIGURE 1 of the drawings, an air conditioning compressor is illustrated which includes a housing **10**. Housing elements include a body casting **12**, a motor end bell **14** connected to the body by bolts **16**, a pump end bell **18** connected to the body by bolts not shown in this view, and a base plate **20** connected to the body by bolts **22**.

The housing includes a motor compartment 24 and a crankcase 26 separated from each other by a vertical partition wall 28. An oil sump 30 is provided at the base of the compressor, and it is separated from the motor compartment and from the crank case by a horizontal partition wall 32. A cylinder block 34 is integral with the latter partition wall, and it extends into the crankcase 26 at its upper end and into the oil sump 30 at its lower end.

A motor 36 is mounted in the motor compartment 24. Advantageously, the motor may be a 2-pole, 3450 r.p.m. motor, for high-speed, high-capacity operation with a smaller, lighter and less costly motor. The motor includes a stator 38 and an inner concentric circular rotor 40.

The rotor axially engages a crankshaft 42 extending into the motor compartment, by a keyway and key, not shown. The crankshaft is journalled in a hub 44 integral with the partition wall 28, with suitable bearings 46 interposed therebetween. The crankshaft is connected at the opposite end by suitable means to an oil pump 48 mounted on the pump end bell 18. The crankshaft is provided with eccentrically mounted journals 50 for driving the pistons.

Tubular cylinder sleeves 52 are vertically mounted in the cylinder block 34. Alternatively, such means can be formed integrally as a part of the block 34. Pistons 54 are mounted in the sleeves for reciprocable movement therein. The pistons are driven by connecting rods 56 engaging the crankshaft journals 50. The lower end of the cylinder block 34 is closed by a cylinder head made up of a head plate 58 secured by bolts 62 to a wall 60 integral and depending from the cylinder block.

In general, the operation of the embodiment of FIGURE 1 is as follows:

Suction refrigerant gas enters the housing 10 through a suitable conduit secured in an opening 64 in the motor end bell 14. The gas passes through a plurality of openings 66 extending through the rotor 40 in the direction of its axis, and through the rotor clearance space 68. The gas leaves the motor compartment through discharge ports 70 in the partition wall 28, and flows into the crankcase 26. The gas enters the upper ends of the cylinder sleeves 52, flows through the piston heads 54, is compressed in the cylinder piston or compression chamber 72, enters the collecting chamber 74 in the cylinder head, and leaves by way of an opening 76 in the cylinder head.

Referring more particularly to FIGURES 4 and 5 of the drawings, the piston 54 of the former embodiment includes a hollow flow-through body 90 and a head 92. The piston is connected to the connecting rod 56 by a wrist pin 94. Suction gas flows around the connecting rod, into the hollow body, and out a suction valve port 96 formed in the piston head, around the head and adjacent the periphery thereof. A poppet valve 98 of truncated conical form is mounted in the valve port, to provide a large diameter annular opening for gas flow into the piston chamber 72 during the upward suction stroke of the piston.

The poppet valve includes a stem 101 journalled in a hub 100 integral with the body 90, and is adapted to move freely relative to the piston body in the axial direction due to its inertia. The valve is retained by a keeper 102 and a split ring 104. It will be noted from a comparison of the adjacent poppet valves of the two cylinders shown in FIGURE 4 that the travel distance for opening and closing action of the poppet valve 98 is relatively short. During the suction stroke, the piston 54 ascends through a column of refrigerant gas communicating with the crankcase, and a relatively large quantity of gas enters the piston chamber 72 during the suction stroke. The valve 98 closes during the downward compression stroke due to its inertia and to resistance of the gas to compression.

If desired, although not illustrated the suction valve may be provided with a supplemental spring loading means to maintain it in a normally open position. Such additional spring means will serve to prevent closing of the valve on the compression stroke until the compressor is operating at a sufficiently high speed. Inertial operation of the suction valve, with or without a supplemental spring bias, serves to reduce the compressor starting shock because the compressor is unloaded at the start-up and does not begin to load until sufficient mechanical inertia is reached to effect closure of the suction valve. When these operating conditions are reached, the motor will be at relatively high speed, thus reducing noise and electrical system load.

A discharge valve in the form of a free or floating disc 106 is mounted over the fully open end of the piston chamber 72, on the end of the sleeve 52. It is normally biased toward a closed position by a compression spring 108 bearing on the valve disc 106 and seated on the cylinder head plate 58. Suitable external guide means, not shown, may be provided about the periphery of said valve disc, if desired. The valve disc 106 opens during the compression stroke to provide an annular discharge valve port 110 between the cylinder and the valve disc. The valve disc preferably is constructed of flat, thin, very high tensile strength Swedish steel. Other elements of the piston and cylinder construction include convention piston rings 112.

As illustrated for the right-hand piston in FIGURE 4, when the piston 54 completes its compression stroke, there is zero clearance in the cylinder sleeve 52. This feature is very important to high volumetric efficiency, especially in a refrigeration compressor. Conventional compressors require a cavity of about 3% to 5% of total displacement. The new construction achieves a substantial reduction in refrigeration power requirements, and is therefore highly advantageous for heat pump and low temperature applications.

The invention thus provides a compressor especially suited for air conditioning, which operates at high efficiency over a long useful and trouble-free life, and at substantially reduced costs. The compressor is characterized by the absence of "slugging."

It will be apparent that various changes and modifications may be made in the construction and arrangement of the preferred compressor structures which have been illustrated, within the spirit and scope of the invention. It is intended that such changes and modifications be included within the scope of the appended claims.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. In a refrigeration compressor, a compression cylinder including a piston chamber, a piston reciprocable in said cylinder, drive means for reciprocating said piston, a hollow body on said piston, said body being adapted to communicate at one end with a column of suction gas, a piston head on said piston body at the opposite end reciprocable in said piston chamber, said piston head having a hub therein, means forming a suction valve port in said piston head, an inertially reciprocable poppet suction valve constructed of polytetrahalogenethylene material and including a relatively short stem freely slidably mounted in said hub in said piston head, and keeper means on said stem for retaining said stem in said hub, said suction valve being normally biased open and being adapted to close during the compression stroke, whereby the cylinder is unloaded at start-up and does not begin to load until the inertia forces and the resistance of the gas in the piston chamber to compression are sufficient to close said suction valve.

2. A compressor as defined in claim 1 wherein said poppet suction valve is of truncated conical form, and

wherein said suction valve port is of annular form disposed adjacent the periphery of said piston head, thereby to provide a suction flow area of relatively large size for a relatively short length of valve movement.

References Cited by the Examiner

UNITED STATES PATENTS

1,529,258	3/25	Lipman	230—190
1,590,766	6/26	Lipman	230—190
1,599,716	9/26	Replogle	230—190
1,695,721	12/28	Smith	230—190
1,736,470	11/29	Torrey	230—191
1,943,091	1/34	Schmidt	230—190
1,985,841	12/34	Shepherd et al.	230—190
2,288,596	7/42	Pierce	230—190
2,930,401	3/60	Cowan	251—368

LAURENCE V. EFNER, *Primary Examiner.*

JOSEPH H. BRANSON, Jr., *Examiner.*