July 11, 1950 A. B. BORNSTEIN 2,515,110

ELECTROMAGNETICALLY OPERATING REFRIGERATION COMPRESSOR

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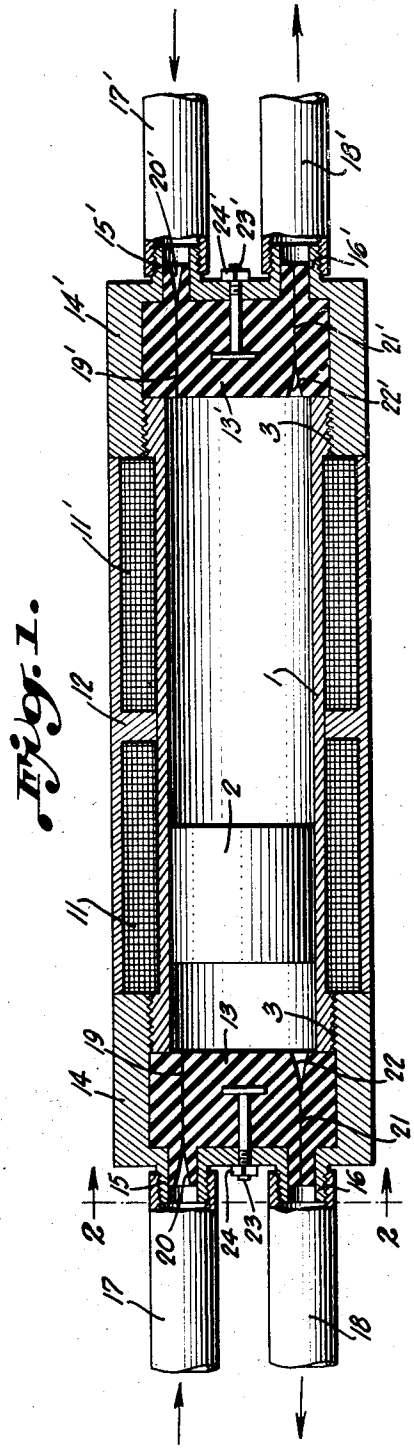

Fig. 1.

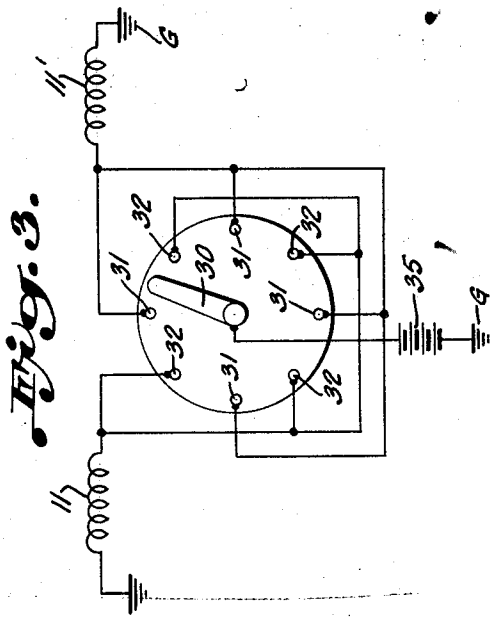

Fig. 3.

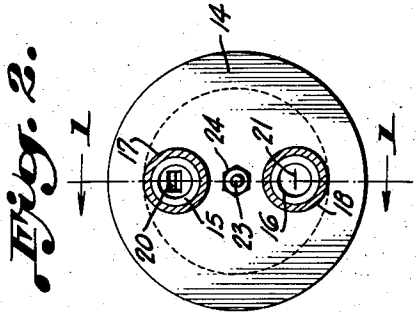

Fig. 2.

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ELECTROMAGNETICALLY OPERATING REFRIGERATION COMPRESSOR

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5 Claims. (Cl. 230—55)

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This invention relates to a compressor pump and more particularly to an electromagnetically operated reciprocating pump.

It is the object of the present invention to provide a compact, sturdy and reliable compressor pump which is particularly adapted to be used as a compressor in refrigerant systems.

It is a further object of the invention to provide an improved solenoid operated reciprocating compressor pump in which the compression chamber is effectively sealed against leakage in consequence of the elimination of any moving parts between the exterior and interior thereof.

It is a further object of the present invention to provide a compressor for refrigerant gases of all types, which is simple in construction, quiet in operation, and which is operative for long periods of time without need for special attention or maintenance. When servicing is required, disassembly, replacement of parts and re-assembly can be performed easily and quickly.

The invention proceeds upon the principle of providing a compressor embodying a cylinder containing a freely floating piston therein which is actuated by a pair of alternately energized solenoids to impart reciprocating movements to the piston. While such types of compressors have been known heretofore, none of these has proven practical commercially in view of the mechanical difficulties incidental to the stopping of the travel of the piston in its opposite directions and the complex valving arrangements used in such units. The compressor in accordance with the present invention obviates all the previous difficulties by the utilization of valve members formed of rubber-like material which are provided with self-sealing openings functioning as suction and exhaust ports for the compressor which are operated automatically by the pressure conditions engendered by the movements of the piston within the cylinder. At the same time, the valve members act as buffers for the piston in its to-and-fro movements within the cylinder.

Other objects and purposes will appear from the more detailed description of the invention following hereinafter, taken in conjunction with the accompanying drawing, wherein

Fig. 1 is a longitudinal sectional view of the compressor pump in accordance with the present invention, with certain parts in elevation, taken along line 1—1 of Fig. 2;

Fig. 2 is a sectional view along line 2—2 of Fig. 1; and

Fig. 3 is a schematic diagram of one manner of alternately energizing the solenoids of the compressor.

In Fig. 1 is shown a compressor embodying a cylinder 1 of diamagnetic material, for example,

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brass or copper, into which is closely fitted a cylindrical piston 2 for reciprocating movement therewithin. The piston 2 is preferably formed of soft iron, for example, of iron-nickel alloy or Armco iron, having characteristics of low hysteresis loss and low remanence characteristics. A pair of solenoids 11 and 11' surround the cylinder 1 on opposite sides of the transverse median line thereof, which solenoids are surrounded by an iron sleeve 12 for concentrating the flux paths of the magnetic fields produced by the coils into the field of operation of the piston 2. The flux paths are also aided by the iron closures 14 and 14' which are threaded onto the externally threaded ends 3 of the sleeve 1.

The instant invention is directed to the improvement of the general assembly described above and known heretofore, in order to make a workable and practical compressor by the utilization of an improved valving arrangement therefor, which remains operative over a long period of time and requires minimum maintenance care.

These objectives are obtained in the compressor in accordance with the present invention by the insertion of a block of rubber-like material 13 and 13' into each end of the cylinder which are fitted into the base of the closing rings 14 and 14', respectively, between the ends of such rings and the ends of cylinder 1. Threaded tubular extensions 15 and 16 project from the base of the closure 14 for attachment thereto of inlet pipe 17 and exhaust pipe 18, respectively. Similar connections on the opposite end of the compressor for the inlet pipe 17' and exhaust pipe 18' are provided by threaded extensions 15' and 16', respectively. The blocks of rubber-like material 13 and 13' are provided with cylindrical projections which extend into the tubular extensions 15, 15', 16 and 16'. The projection extending into the pipe 15 is flared at 20 and is slit at 19 for the remainder of the thickness of the rubber block so that the same acts as a suction passage for the refrigerant gas as the piston moves to the right. The same arrangement is provided at the opposite end of the compressor by the flared opening 20' and the slit 19' which cooperates with the inlet conduit 17'. The rubber projection which fits into the tubular extension 16 is slit at the extension and flares outwardly at 22 adjacent to the compression chamber. The same construction characterizes the opposite end of the compressor by the provision of the slit 21' and flared opening 22' which is connected to the outlet conduit 18'. Therefore, passages 22—21 and 22'—21' act as outlet passages when the piston 2 moves towards these, respectively, while in the reverse movement they are automatically closed.

The rubber blocks 13 and 13' are mounted within the head 14—14', respectively, by the bolts 23, 23' imbedded in the blocks, which protrude to the exterior of the cylinder heads and are retained in place by nuts 24, 24', respectively.

The blocks 13 and 13' of rubber-like material, function not only to provide automatically operating suction and outlet check valves for the compressor, but in addition serve as buffers for the piston 2 in its to-and-fro movements.

The blocks of rubber-like material 13, 13' may be made of any synthetic rubber-like material and "neoprane" compounds have been found ideally suited for this purpose since this material possesses the desired physical and chemical characteristics such as tensile strength, resilience, elasticity and abrasion resistance and its properties are virtually unchanged by continued exposure to oils, chemicals, heat, freezing, sunlight, ozone and natural aging. "Neoprene" is a commercial trade mark for a synthetic plastic marketed by E. I. duPont de Nemours & Co., Inc., which is identified commercially as a chlorobutadiene polymer and more specificially as the polymer of 2-chlorobutadiene or chloroprene.

Any other synthetic rubber composition having generally the same physical and chemical properties evidenced by "neoprene" could be used as well in the compressor disclosed herein. Many types of synthetic rubber-like products are available commercially which include polychloroprene, as exemplified by "neoprene," polybutadiene, interpolymers of butadienes with styrene or acrylic acid nitrile, organic polyalkylene polysulfides, polybutenes, polyvinyl chlorides, etc. For further reference to other suitable elastomers which include butadiene rubbers, dimethylbutadiene rubbers, isoprene rubbers, haloprene rubbers as exemplified by polychloroprene rubber or "neoprene" and polybromoprene rubber as well as other products of polymerization processes of all types of natural and synthetic resins, reference may be had to a treatise on synthetic rubber-like products, designated as Butolastic products, in the text "Butolastic-Polymers, A Treatise on Synthetic Rubbers" by F. Marchionna (1946).

In Fig. 3 is shown one way of electrically energizing the solenoid coils 11 and 11' which may be done by a rotary switching arrangement embodying a rotary switch 30 which may be operated by a clock motor to alternately complete the circuit to the respective coils through the series of alternately disposed contacts 31 and 32 and a source of direct current energy 35 which may be a battery. One end of the battery may be grounded as is the case with one end of each of the solenoid coils.

Any other system for alternately energizing the solenoids could be used in the attainment of the instant invention.

While I have described my invention as embodied in a specific form and as operating in a specific manner for purposes of illustration, it should be understood that I do not limit my invention thereto, since various modifications will suggest themselves to those skilled in the art without departing from the spirit of my invention, the scope of which is set forth in the annexed claims.

I claim:

1. A compressor pump comprising a cylinder of diamagnetic material disposed symmetrically on the opposite sides of a transverse median, solenoid coils surrounding said cylinder on the opposite sides of said transverse median and adapted to be energized alternately, a piston of magnetic material reciprocable within said cylinder by the alternate energization of said solenoid coils, and a valve member of rubber-like material at each end of said cylinder having an inlet and an outlet opening therein which openings are self-closing and are operable solely by the variable pressure conditions produced by the to-and-fro movements of said piston within said cylinder, each valve member in addition acting as a resilient buffer for said piston as it strikes against the opposite ends of said cylinder in its reciprocating movements.

2. In a solenoid operated reciprocating compressor pump having a straight chamber with a floating piston reciprocable therein, a valve assembly therefore comprising a block of rubber-like material at each end serving as a resilient snubber for said piston, and each block having two slits extending therethrough, one of said slits being tapered on its external end towards the interior of the block adapted to function as an inlet port, and the other slit being tapered on its internal end adjacent to the pump chamber towards the interior of the block and adapted to function as an exhaust port.

3. A compressor pump as set forth in claim 2 wherein said blocks of rubber-like material are formed of a chlorobutadiene polymer.

4. A refrigerator compressor pump comprising a cylinder of diamagnetic material disposed symmetrically on the opposite sides of a transverse median, a pair of solenoid coils surrounding said cylinder on the opposite sides of said transverse median and adapted to be energized alternately, a piston of magnetic material reciprocable within said cylinder by the alternate energization of said solenoid coils, a closure for said cylinder at each end thereof having a threaded extension for an inlet pipe and another threaded extension for an outlet pipe, a valve member of rubber-like material connected to each closure and provided with projections extending into said extensions, said projections having slits therein extending through said valve member to said cylinder, which slits are self-closing and are operable solely by the variable pressure conditions produced by the to-and-fro movements of said piston within said cylinder, each valve member in addition acting as a resilient buffer for said piston as it strikes against the opposite ends of said cylinder.

5. A refrigerator compressor pump as set forth in claim 4 wherein each valve member is formed of a synthetic rubber-like material with the slit at the inlet projection being tapered towards the interior of the valve member while the other slit is tapered from the opposite end of the valve member towards the interior of the valve member.

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