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E. T. WILLIAMS

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COMPRESSOR

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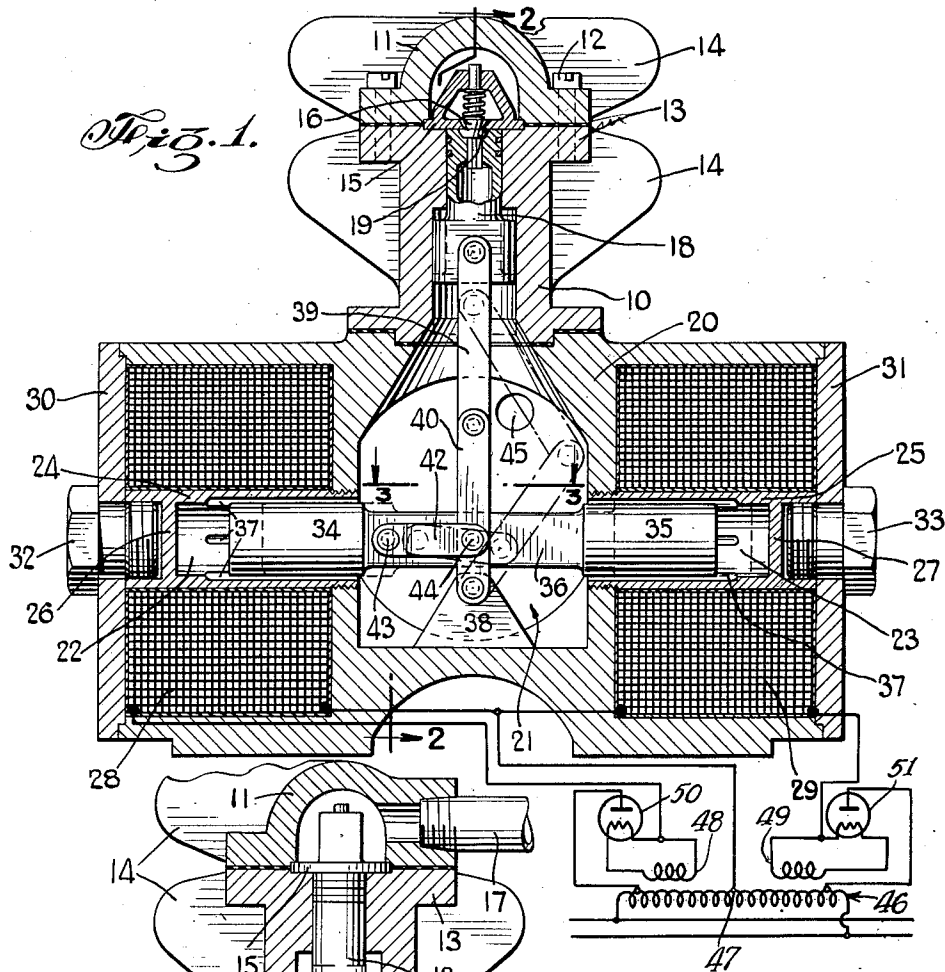
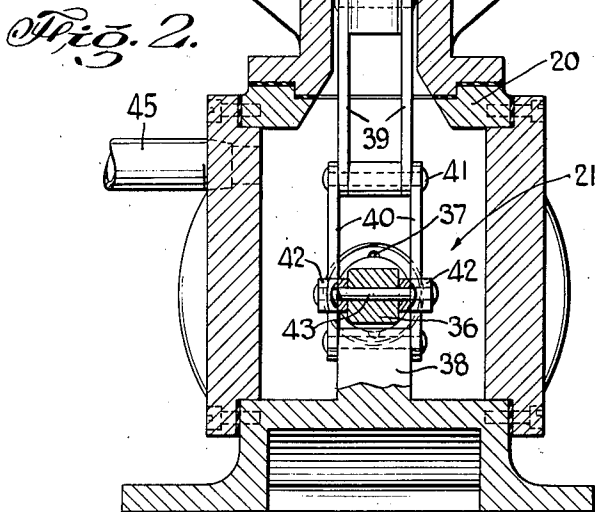
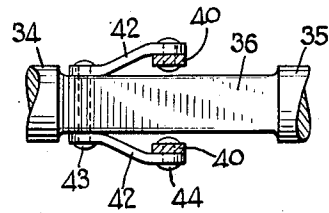


Fig. 3.

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COMPRESSOR

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8 Claims. (Cl. 230—55)

My invention relates to gas compressors, particularly to compressors for use in refrigerating systems, and in general constitutes certain improvements in compressors of the type disclosed in my Reissue Patent No. 16,693.

The type of compressor as fully disclosed in my reissue patent comprises one or more compression cylinders with pistons actuated electromagnetically. I prefer as the operating means a pair of aligned solenoids having a single core or pair of connected cores, the solenoid windings being energized in alternation by the opposite wave-halves of single phase alternating current obtained by means of suitable rectifying means which may be of the electrolytic or vacuum tube type as well known in the art. However any means for obtaining reciprocating motion may be used. This type of compressor may be constructed without stuffing boxes, shaft seals, or the like, thereby eliminating major disadvantages of other types of mechanical compressors for use in refrigerating systems.

My present invention contemplates a compressor of the above type in which the maximum current and therefore the maximum force of the operating means closely coincides with the maximum compression load. Furthermore, motion is transmitted from the reciprocating operating means to the piston or pistons at right angles with substantially no perpendicular force on the operating means. In addition, two strokes of the compressor piston or pistons constituting a complete cycle are obtained with a single stroke of the operating means.

Another very important feature of my invention is the storage of energy in the compressor operating means at both ends of the stroke, which is returned upon reversal in the direction of movement when the instantaneous value of the current is substantially zero. This storage of energy is accompanied by a cushioning effect on the operating means at each end of the stroke which is highly advantageous in such a device operating at high rates of speed.

Other objects and advantages will be apparent from the following description taken in connection with the accompanying drawing, in which

Fig. 1 shows schematically, with parts in vertical section, a compressor contemplated by my invention;

Fig. 2 is a section on line 2—2 in Fig. 1; and

Fig. 3, a detail section on line 3—3 in Fig. 1.

Referring to the drawing, a compressor cylinder 10 is provided with a cylinder head 11 which may be secured thereto in a well known manner

by bolts 12, the joint being filled by a gasket 13, or other means for securing a gas tight joint. Both the cylinder 10 and cylinder head 11 are provided with heat radiating fins 14 which are preferably cast integrally with the cylinder and cylinder head but of course may be formed separately and secured thereto as by welding or brazing. The upper end of the cylinder is closed by a valve plate 15 provided with a discharge valve 16 and the gas discharge conduit 17 is connected to the cylinder head as best shown in Fig. 2. The piston 18 is hollow and open toward the end of the cylinder opposite the compression end while at the latter end the piston is provided with an intake valve 19.

The cylinder 10 is secured with a gas tight joint to a housing 20 having a central chamber 21 which communicates with the compressor cylinder when the latter is secured in position forming therewith a gas tight chamber. The gas inlet conduit 45 is connected to the chamber 21. Extending along the same axis from opposite sides of chamber 21 and perpendicular to the axis of the compressor cylinder are operating cylinders 22 and 23 respectively. These operating cylinders are formed by threading or otherwise securing members 24 and 25 in appropriate openings in casing 20 into the chamber 21. The outer ends of the cylinder members 24 and 25 are closed by integral walls 26 and 27 whereby the cylinders 22 and 23 form gas tight extensions of the chamber 21.

The operating cylinders 22 and 23 are surrounded by electromagnetic operating coils 28 and 29 respectively. The casing 20 is extended as shown to provide a housing for the coils 28 and 29 and provided with enclosing end plates 30 and 31 from which the outer ends of the cylinder members 24 and 25 are further supported by bolts 32 and 33 or the like. Magnetic cores or armatures 34 and 35 adapted to reciprocate in operating cylinders 22 and 23 respectively are connected by rod 36. The walls of cylinders 22 and 23 are provided with axial grooves 37 from the ends of the cylinders toward the chamber 21 to a point short of the other ends of the cylinders, as best shown in Fig. 1. The purpose of these grooves will be brought out in the description of operation hereinafter set forth.

Between the piston 18 and a lug 38 at the bottom of the chamber 21 is located a toggle linkage comprising a lever arm 39 pivoted at one end to the piston 18 and a second lever arm 40 pivoted at one end to the lug 38, the other ends of the levers 39 and 40 being pivoted together

at 41. This toggle linkage is designed such that when it is in its fully extended or "dead centre" position the piston 18 is at the end of the compression stroke as shown in full lines in Fig. 1. The rod 36 joining the armatures 34 and 35 is connected to the toggle by a link 42 which is pivoted on the rod 36 at 43 and the lever 40 at a point 44.

The electromagnetic operating coils 28 and 29 are preferably energized in alternation by the wave-halves of single phase alternating current which may be rectified by any well known means, for instance electrolytic or vacuum tube rectifiers. As shown in Fig. 1, a transformer 46 is connected to a single phase line 47. The secondary windings 48 and 49 of the transformer are connected to the filaments of rectifier tubes 50 and 51 respectively. One end of each of the operating coils 28 and 29 is connected to the neutral point of the transformer 47 and the other ends of the operating coils are connected to the filaments of the rectifier tubes 50 and 51. The plate electrodes of the rectifiers 50 and 51 are connected to such turns of the transformer as will give the desired voltage across the operating coils. Since current can flow only from the plate to the filament of each rectifier tube, one half of each alternating current cycle will be imposed upon the operating coil 28, and the other half of each cycle will be imposed upon the operating coil 29, whereby these coils are alternately energized by opposite wave halves of the alternating current cycle. For more detailed description of the alternate energization of the electromagnets and suggestive electrical connections reference may be had to my above-mentioned Reissue Patent 16,693.

When coil 28 is energized by one-half the current, armature 34 is drawn to the left and when coil 29 is energized by the other half of the cycle the armature 35 is drawn to the right. This movement of the armatures 34 and 35, which are connected by rod 36, is transmitted through lever 42 and the toggle comprising levers 39 and 40 to move the piston 18 through a compression and suction stroke upon the movement of armature 34 to the left and a compression and suction stroke upon the movement of armature 35 to the right. Thus for a single stroke of the operating means the compressor passes through two strokes or a complete cycle.

On the suction stroke gas flows through conduit 45, chamber 21, the hollow portion of piston 18, and intake valve 19 into the cylinder and on the compression stroke gas is forced from the cylinder through discharge valve 16 and the cylinder head into the discharge conduit 17. Obviously the instantaneous values of current in each of the operating coils 28 and 29 increase from zero to maximum during the compression stroke of the piston through which the compression load gradually rises, and decrease from maximum to zero during the suction or intake stroke. Thus the maximum instantaneous current, and therefore the maximum force of the electromagnet, closely coincides with the maximum load on the compressor at the end of the compression stroke.

Gas filling chamber 21 also fills the spaces in the operating cylinders 22 and 23 due to passage through the axial grooves 37 in the cylinder walls. Thus when armatures 34 and 35 move past the ends of the slots 37 the gas trapped in the ends of the cylinders is compressed. This compressed gas acts as a cushion to the movement of the armatures and its energy is returned upon the reversal in the direction of movement.

It will be obvious to those skilled in the art that various other changes may be made in the construction and arrangement without departing from the spirit of the invention and therefore the invention is not limited to what is shown in the drawing and described in the specification but only as indicated in the appended claims.

I claim:

1. In a compressor, a casing enclosing a fluid tight chamber, a fluid inlet connection to said chamber, a compressor cylinder forming an extension of said chamber, a discharge valve in the head of said compressor cylinder, a piston in said cylinder having a longitudinal fluid passage therethrough and an intake valve controlling said passage, a toggle joint in said chamber between said piston and a part of said casing on the axis of said piston, a pair of oppositely disposed cylinders axially aligned perpendicularly through the axis of said piston and also forming extensions of said chamber, said pair of cylinders having internal grooves extending a portion of their length from said chamber, a pair of reciprocable magnetic armatures in said pair of cylinders, a rod connecting said armatures, a substantially horizontal link connecting said rod and said toggle, and a pair of electromagnetic coils associated with said pair of cylinders in a manner to reciprocate said pair of armatures when alternately energized.

2. In a compressor, a reciprocable piston, reciprocatory electromagnetic operating means alternately energized by opposite wave halves of rectified alternating current, and means operably connecting said piston and electromagnetic means such that the increase to maximum of the instantaneous current is substantially coincident with the rise to maximum of the compression load on said piston.

3. In a compressor, a reciprocable piston, reciprocatory electromagnetic operating means alternately energized by opposite wave halves of rectified alternating current, and means operably connecting said piston and electromagnetic means such that the increase in value of the instantaneous current occurs on the compression stroke of said piston.

4. In a compressor, a reciprocable piston, reciprocatory electromagnetic operating means alternately energized by opposite wave halves of rectified alternating current, a fixed member, and a toggle between said piston and fixed member, said operating means being connected to oscillate said toggle through the axis of said piston whereby the maximum instantaneous current substantially coincides with the maximum compression load on said piston.

5. In a compressor, a reciprocable piston, a fixed member, a toggle between said piston and fixed member, and reciprocatory electromagnetic operating means comprising opposed solenoids alternately energized by opposite wave halves of rectified alternating current connected to oscillate said toggle through the axis of said piston whereby the maximum instantaneous current substantially coincides with the maximum compression load on said piston.

6. In a compressor, reciprocatory electromagnetic operating means alternately energized by opposite wave halves of rectified alternating current, and means associated with said operating means for storing energy at the end of each stroke and returning the stored energy at the start of the next stroke when the instantaneous current is zero.

7. In a compressor, reciprocatory electromagnetic operating means alternately energized by opposite wave halves of rectified alternating current, and means associated with said operating means for storing energy at the end of each stroke and returning the stored energy at the start of the next stroke when the instantaneous current is zero, said means comprising gas chambers closed by said reciprocatory means near the end of each stroke thereof.

means comprising opposed solenoids alternately energized by opposite wave halves of rectified alternating current, and plungers in said solenoids mechanically connected, said solenoids forming gas pockets in the path of said plungers near the end of each stroke, the stored energy of compressed gas in said pockets being returned at the start of the next stroke when the instantaneous current is zero.

8. In a compressor, reciprocatory operating

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