July 29, 1941. A. G. CARPENTER, JR 2,250,947

PUMP

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FIG. 1

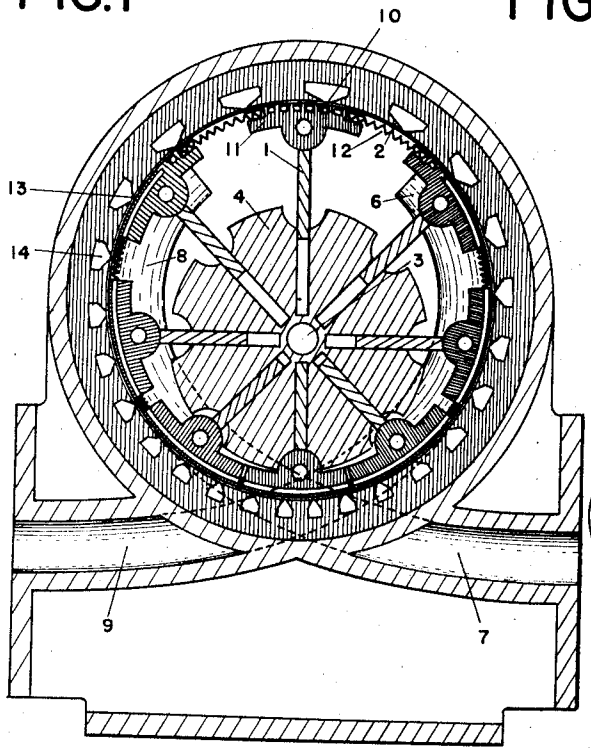


FIG. 2

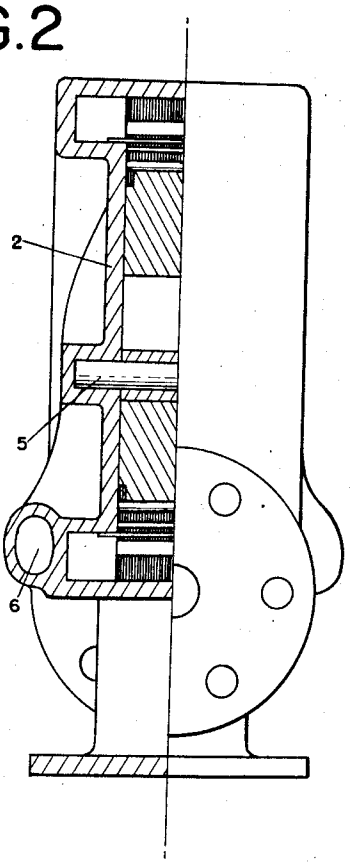


FIG. 3

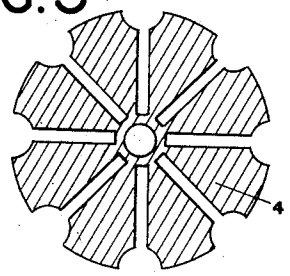
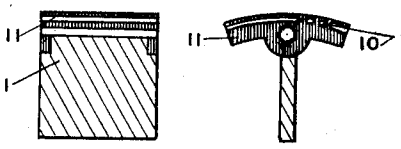


FIG. 4 FIG. 5



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FIG. 6

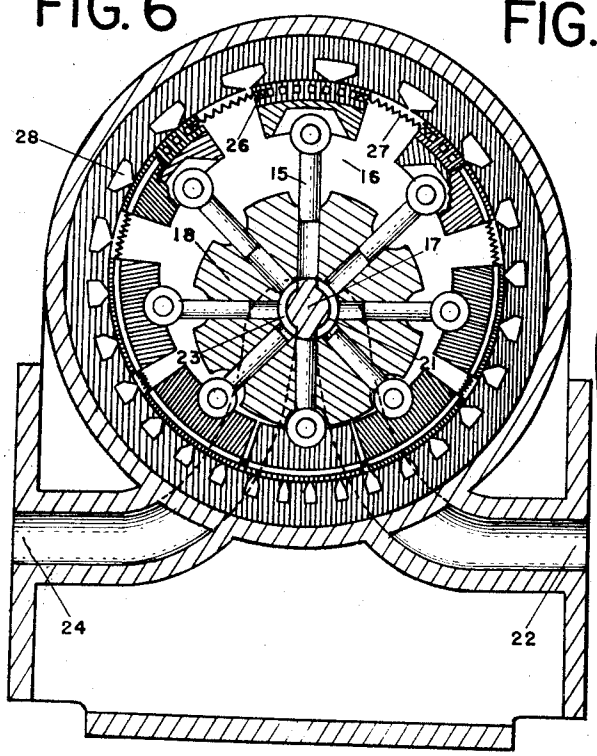
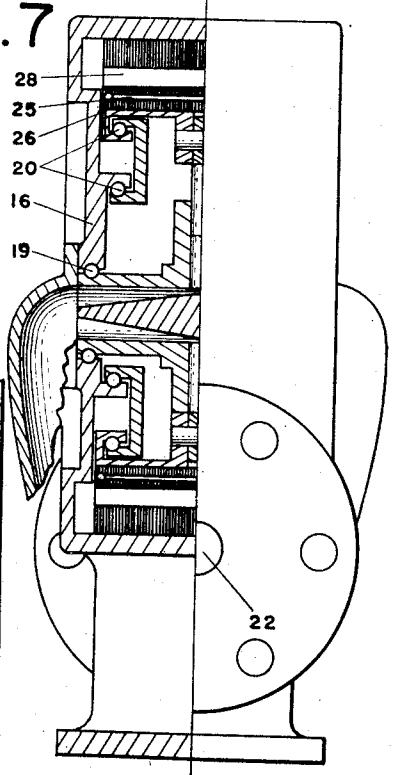
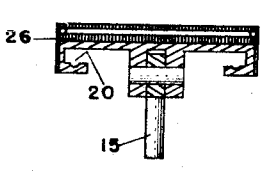


FIG. 7





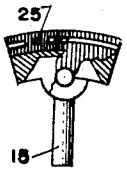


FIG. 8

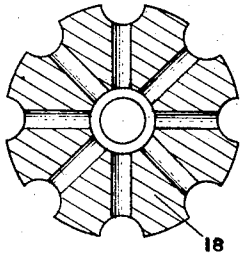


FIG. 9 FIG. 10

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Patented July 29, 1941 2,250,947

UNITED STATES PATENT OFFICE

2,250,947

PUMP

Albert Guy Carpenter, Jr., Yonkers, N. Y.

Application June 17, 1938, Serial No. 214,207

7 Claims. (Cl. 103—118)

My invention relates to an electromagnetic means in mechanisms for actuating pumps or parts of pumps requiring progressively varying speed and/or which are subject to progressively varying load during a cycle of operation.

For convenience, I will describe and illustrate herein my invention as it is utilized in rotary pumps and compressors of the sliding vane and piston type to which my invention is particularly applicable, but it should be understood that my invention is not limited to such use but is applicable to other pump mechanisms such as are described in my application No. 730,047, filed June 11, 1934.

One object of my invention is to construct pumps and compressors that require no packing glands or stuffing boxes and having no openings in their casings except the inlet and outlet orifices.

Another object is to construct pumps and compressors that require no external rotating shaft, or shaft journal, or bearings.

Another object is to provide a means by which the motivating force is applied directly to the actuated parts at or toward their outer or peripheral extremity instead of by a rotating shaft at their inner axis.

Another object is to provide a device that will consume less power per cycle of operation or per unit of material handled.

Further objects are increased efficiency, low initial cost, low maintenance cost, small number of parts, convenience in cleaning, inspecting, and repairing.

Fig. 1 is a transverse sectional view of one embodiment of my electrically driven pump, where the electromagnetic driving force is progressively applied at the periphery of the rotating impellers.

Fig. 2 is a longitudinal semi-sectional view of the pump of Fig. 1.

Fig. 3 is a side view of the mechanical aligning cylinder which is shown in the pump of Figs. 1 and 2.

Fig. 4 is an end sectional view of one of the impellers used in the pump of Figs. 1 and 2.

Fig. 5 is a radial sectional view of the impeller of Fig. 4.

Fig. 6 is a transverse sectional view of another embodiment of my electrically driven pump where the electromagnetic driving force is applied at the periphery of the radial pistons.

Fig. 7 is a longitudinal semi-sectional view of the pump of Fig. 6.

Fig. 8 is a side view of the mechanical aligning cylinder which is shown in the pump of Figs. 6 and 7.

Fig. 9 is an end sectional view of one of the pistons used in the pump of Figs. 6 and 7.

Fig. 10 is a radial sectional view of the piston of Fig. 9.

Referring to Figs. 1 and 2, I will describe completely the structure and application of my invention, namely, the special electromagnetic field of progressively varying pole pitch to a rotary pump of the sliding vane type.

The impellers 1 of the pump are constructed essentially to fill the space between the walls 2, guiding block 4 on the shaft 3, and the outer periphery of the pump casing, and to include a small angle of the pump circumference. They are held in definite positions by the guiding block 4, eccentrically placed and operating on bearings 5, causing their motion to be definitely constrained to a cycle of operation such that they will extend or spread out from the center when passing the inlet duct 6, located in the walls of the pump and leading from the inlet orifice 7, and will retract when passing over the outlet duct 8, leading to the outlet orifice 9, such that a displacement of fluid will occur within the pump, and pumping action will obtain. Each impeller 1 rotates with the center block 4, sliding in same individually. None of the impellers has to be affixed to the shaft which in this case may either be stationary or free to turn within the walls of the pump. Each impeller, however, in its periphery has imbedded in it a suitable electrical winding 10, generally taking the form of rotor bars as used in a standard induction motor, these bars being placed in laminations 11, to increase the electrical efficiency, and short circuited at each end. All impellers are connected together by the electrical conducting springs 12.

Outside of these impellers and usually separated from same by a suitably thin wall of non-magnetic high resistance material 13, which may take the form of a glass compound, a stainless steel, or steel alloy, a composition insulating compound molded in between the poles, or any other suitable substance which will not be reacted upon by the fluid pumped, not to be unduly affected by heat and having high non-abrasive qualities, lies a second winding 14, taking the form of the stator or stationary winding of this electrical pump, the electrical poles of which may be completely separated from the rotating impellers by the separating substance, or may be protruding through same in suitable slots formed

for the purpose; nevertheless, the windings being completely sealed by close fits and by the use of sealing compounds from the impeller casing.

It is essential that the separation between the rotor winding 10 and the stator windings 14 be an absolute minimum.

The unique and fundamentally new principle involved in this device and divulged in my patent application, No. 730,047, filed June 11, 1934, is the non-symmetrical placing of the poles which are staggered about the periphery to conform essentially with the geometric motion of the impellers, and the fact that the winding reacts on each impeller individually instead of driving all impellers at once, as is done in other combination motor-pumping devices of this nature.

The operation of this device is as follows: If the stator winding 14 is of such a nature, namely, being capable of producing a rotating magnetic field either by split-phase or multiphase currents or their equivalent, this field when current is flowing through the windings will set up currents in the rotor windings 10, within the impellers 1, the reaction of which will serve to drag the latter around in the direction of field rotation. Since the electrical field rotation with a constant frequency source is constant in speed, it is necessary to make the distance traversed by the electrical field conform to the distance traversed by the impellers during their motion, or else there will be great positive and negative rotor slippage. That is, at some points the electrical field would be going considerably faster than the rotor sectors at those points, while at other points the rotor sectors would be going faster than the electrical field. This, of course, would be the result of the fact that the rotor impellers are tied together mechanically by the block 4. Under heavy load conditions of pumping there would, of course, just be positive slippage, or no impellers would ever lead the field.

To obviate any great difference in motion between the impellers and the field, the pole spacing of the field, as mentioned above, is made to conform with the geometric motion of the impellers. That is, where the impellers come together there also are the poles placed closer together, and where the impellers spread apart, there also are the poles separated to correspond.

Figs. 6 and 7, with auxiliary Figs. 8, 9, and 10, show another method of construction of a radial member pump, where the electrical windings are used to drive radial pistons individually.

The operation of this pump is essentially the same as the aforementioned radial impeller type of pump.

Referring to Figs. 6 and 7, the piston members 15, shown separately in Figs. 9 and 10, are constructed to slide in cylinders cut in the aligning block 18, shown separately in Fig. 8. These pistons are held in definite angular positions by the eccentrically placed aligning block 18, the shaft of which 17, is supported on bearings 19, causing the motion of the pistons to be constrained to a definite cycle of operation, such that they will extend or spread out from the center when passing the inlet opening 21, located adjacent the shaft 17 and leading from the pump inlet orifice 22, and will retract when passing the outlet opening 23, leading to the outlet orifice 24, so that a displacement of fluid will occur in the pump and pumping action will obtain. Each piston 15 rotates with the center block 18 sliding in same individually, the piston members being supported by pressure bearings and ring race 20 at the periphery. None of the piston members has to be affixed to the shaft 17, which in this case may either be stationary and serve as the inlet to outlet separating wall. Each piston member, however, in its periphery has imbedded in laminations 26 placed therein a suitable electrical winding 25, similar to that in the impellers of the aforedescribed impeller type pump, said windings short circuited on the ends and also connected together in a continuous circuit at each end by springs 27.

Outside of these impellers is placed a split-phase or polyphase stator winding 28, similar to that of the impeller type pump described. In this pump it is not necessary to separate the stator windings from the impellers by any material shield since no fluid is found in this part of the pump. The poles of this stator winding are of variable pitch, progressing around the pump casing to correspond with the constrained relative geometric motion of the piston extremities, thereby producing an electromagnetic field the peripheral speed of which varies to correspond with the relative motion of said pistons.

From the nature of the eccentric pumping motion involved in these two pumps it is obvious that the greatest load will occur where the impellers or pistons are contracted during the discharge part of the cycle of rotation. The windings may, therefore, themselves be increased in strength, during the discharge half to produce a maximum torque at discharge, or else they may be uniformly distributed, taking advantage of the eccentric spacing blocks to transmit power from one section of the device to where it will do the most good at some other section; in fact, various constructions of electrical strength of windings may be resorted to, to relieve the blocks of a non-uniform load.

It is possible to stage these pumps very easily so that enormous pressures may be obtained in the final stages. If the pumped fluid is compressible, the various stages may be decreased in size the proper amount to insure complete displacement with or without intercoolers.

There are other methods of constructing pumps, utilizing this variable pole pitch driving field to obtain high torques, such as placing the windings an extreme distance from the impellers or pistons, that is, having the pumping section of pump at center with the windings at a considerable distance from same to increase the torque arm. Such a construction was shown in my application No. 730,047, filed June 11, 1934.

In the case of the pumps illustrated in Figs. 1, 2, 6 and 7, the width of the impellers or diameter of pistons may be made small, while the width of the windings may be made much greater. This scheme was also shown in my application mentioned above.

The important advantages of the electrical pump drive are these: the use of the windings, which are completely sealed from the fluid pumping section of the pump, place the driving force of the pump in the exact positions most suitable for same, namely, upon each individual impeller or piston.

The nature of the electric drive also tends to remove the strain upon the pump since each impeller or piston is driven individually and the electrical field tends to smooth out the shock resulting from the accelerations and decelerations of the impellers or pistons for the same reason that amortisseur windings are placed in synchronous electrical machines to prevent hunt-

ing of same. Simply, the electrical field not only drives the impellers or pistons but produces a drag upon them which greatly smooths out operation.

The use of electrical windings also eliminates the necessity for any driving mechanism external to the pump casing, hence, the pump may be sealed up tight, having only an inlet and an outlet, eliminating all stuffing boxes and relying upon the pumped fluid for lubrication, although some auxiliary means for lubricating may be resorted to.

This feature of being able to seal the pump completely, is a decided advantage, especially in the pumping of volatile substances such as ammonia in refrigerating machines.

In cheap, low pressure, small volume pumps, it is not necessary to use staggered electrical poles, especially if the stroke per impeller or piston is kept low, nor is it even necessary to use laminations or rotor bars in the impellers or piston members, especially if the latter are made of a magnetic and electrical conducting material.

Since a small torque is applied during the suction period on the impellers or pistons it is even possible to construct this pump with all poles equally spaced but making the magnetic strength of the poles along the suction sector of less strength than those along the pumping sector, with the poles along the latter designed for minimum slip, thus the effect of great negative slip along the suction sector will not be felt greatly in the machine. This construction was illustrated in my application No. 730,047, filed June 11, 1934.

Having described my invention, I now claim:

1. In combination a pump comprising a casing having a chamber with inlet and outlet, a shaft mounted within said chamber eccentrically thereof, a spacing block supported for rotation on said shaft, impellers rotatably mounted in the same plane and sliding in slots within said spacing block in such a way that the rotation of the impellers causes a progressively periodic variation in their extension in the slots of the spacing block and a variation in their peripheral spacing creating a displacement therebetween within said chamber, segmental induction rotor windings attached to each impeller member, flexible means on the windings on adjacent impeller members electrically connecting said windings together, and an electro-magnetic field surrounding the impellers and adapted to drive and control the same, said field having the same center as the casing but having poles, the spacing or pitch of which poles varies progressively about the field to correspond with the spacing and motion of the impellers at their periphery.

2. In combination a pump comprising a casing having a chamber with inlet and outlet, a shaft mounted within said chamber eccentrically thereof, a spacing block supported for rotation on said shaft, pistons rotatably mounted in the same plane and sliding in cylinders within said spacing block in such a way that the motion of the pistons causes a progressively periodic variation in their extension in the cylinders of the spacing block and a variation in their peripheral spacing, said variation in extension creating a displacement in said cylinders, segmental induction rotor windings attached to each piston member, flexible means on the windings on adjacent piston members electrically connecting said windings together, and an electro-magnetic field surrounding the pistons and adapted to drive and control the same, said field having the same center as the casing but having poles, the spacing or pitch of which poles varies progressively about the field to correspond with the spacing and motion of the pistons at their periphery.

3. A pump comprising a casing having a chamber provided with an inlet and an outlet, a rotatable member mounted within said chamber eccentrically thereof, fluid displacement members or pistons mounted to slide within said rotatable member, each fluid displacement member being movable radially with respect to every other impeller or piston but constrained in its motion by its angular position within the chamber to which its center of rotation is eccentric, segmental induction rotor windings attached to each fluid displacement member, flexible means on the windings on adjacent fluid displacement members electrically connecting said windings together, an electro-magnetic means for applying a variable driving and controlling force individually to each fluid displacement member in proportion to the peripheral spacing from each adjacent fluid displacement member so that as the linear spacing of adjacent fluid displacement member extremities varies its motion varies also to correspond.

4. A pump of the type in which flow is produced by progressive variation in the radial extension of fluid impellers, comprising a casing having a cylindrical chamber with inlet and outlet passages, a shaft mounted within said chamber eccentrically thereof, a cylindrical spacing block mounted for rotation on said shaft eccentric to the pump casing, fluid impellers supported to slide within said block and engage the cylindrical wall of said chamber, each impeller being free to move radially with respect to every other impeller, the radial motion of said impeller being controlled by the cylindrical wall of the pump chamber, segmental induction rotor windings attached to each impeller, flexible means on the windings on adjacent impeller members electrically connecting said windings together, an electro-magnetic constraining means to drive and control each impeller individually at a speed in proportion to the spacing of the extremities of each impeller from the adjacent impellers to correspond with the spacing brought about by the eccentrically placed spacing block and the pump chamber which compels the impellers to vary the volume displaced by them from a certain minimum to a certain maximum during each rotation, and to a certain amount in any one point in the rotation, the progressive increasing of the linear spacing between impellers drawing the fluid into the pump and the progressive decreasing of the spacing forcing the fluid out of the pump.

5. A pump comprising a casing having a chamber with inlet and outlet passages, a rotatable separating block mounted within said chamber eccentrically thereof, impellers slidably mounted in said rotatable separating block, segmental induction rotor windings attached to each impeller or piston member, windings on adjacent impeller members electrically connecting said windings together, and an electro-magnetic field comprising progressively variably spaced poles about the impellers adapted to drive the same individually at speeds corresponding to the spacing of the poles to which said impellers are adjacent so as to maintain the progressive spacing of the impeller extremities as brought about by

the sliding action within the pump casing, the volume displaced by impellers varying from a definite minimum to a definite maximum and being a definite amount at any one point in each rotation, a progressive increase and decrease in the linear spacing of the impellers, causing fluid to be drawn into and forced out of the pump.

6. In combination a pump casing having a chamber with inlet and outlet, fluid displacement members rotatably supported within said chamber and movable with respect to one another the angular separation of impellers, or pistons, remaining constant, segmental induction rotor windings attached to each fluid displacement member, windings on adjacent fluid displacement members, flexible means on said windings electrically connecting said windings together, and electro-magnetic means devoid of mechanical connection with the impellers, or pistons, to drive the same individually at varying speeds so that the relative speed of each impeller, or piston extremity, varies progressively from a definite minimum to a definite maximum during each rotation and is the same for any given point in each rotation.

7. A pump comprising a casing having a chamber with inlet and outlet openings, fluid displacement members mounted for rotation within the pump chamber having fixed angular spacing with respect to their center of rotation, means to control the volume displaced by said fluid displacement members from a definite minimum to a definite maximum during each rotation and to a definite amount at any given point of any rotation, segmental induction rotor windings attached to each fluid displacement member, flexible means on the windings on adjacent fluid displacement members electrically connecting said windings together, and an electro-magnetic field having poles about the impellers, or pistons, to drive the same, the spacing of said poles varying progressively in proportion with the volume displaced by those impellers, or pistons, immediately opposite the poles on the casing, the progressive increasing and decreasing of the volume displaced by impellers, or pistons, causing fluid to be drawn into and forced out of the pump.

ALBERT GUY CARPENTER, JR.