Feb. 16, 1954 N. H. GODBOLD 2,669,183
ELECTROMAGNETIC FLUID PUMP
Filed Feb. 27, 1951 2 Sheets-Sheet 1

Induction

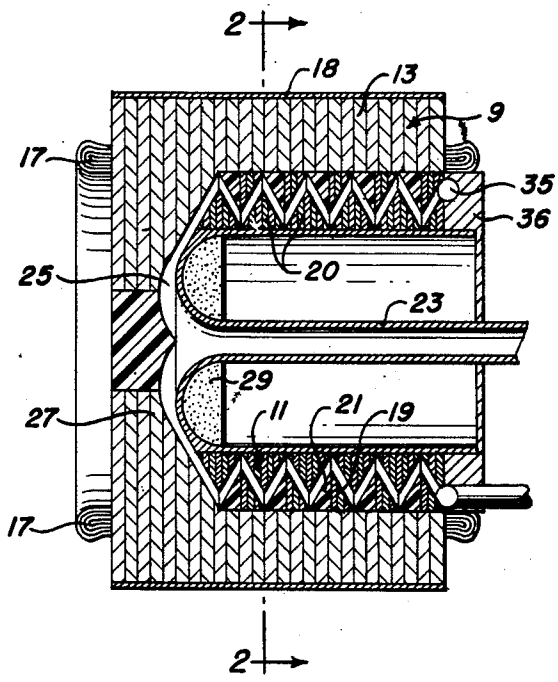

Fig. 1

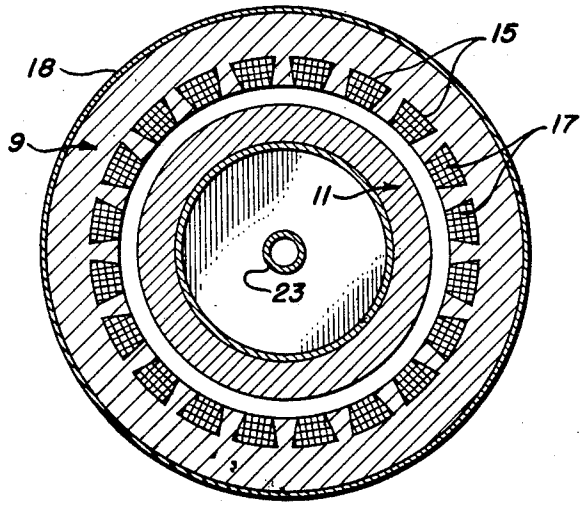

Fig. 2

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ELECTROMAGNETIC FLUID PUMP

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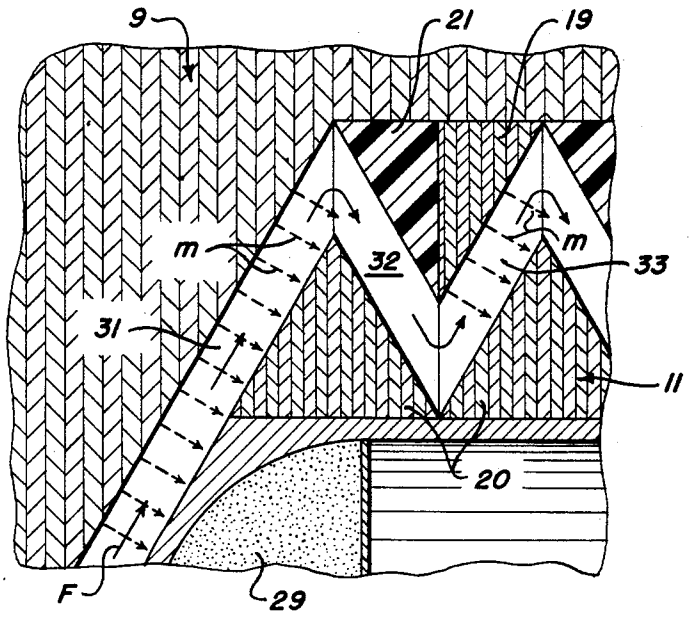

Fig. 3

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ELECTROMAGNETIC FLUID PUMP

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Application February 27, 1951, Serial No. 212,961

5 Claims. (Cl. 103—1)

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This invention is related to that disclosed in application Serial No. 182,121 filed August 29, 1950, by Nat H. Godbold, and is an improvement in electromagnetic fluid pumps of the type described therein.

Electromagnetic fluid pumps of the type in which a conducting fluid is impelled along a channel by the reaction of a transverse current through the fluid and an impressed field are generally old, as shown for example, in Patents 2,397,785 and 1,298,644 to Freidlander and Chubb, respectively.

The prior art devices utilize directly the force resulting between the electric current in the fluid and the impressed magnetic field for causing movement of the fluid and this effect is not sufficient to create the pressure or volume of flow required for many purposes.

The referenced parent application 182,121 discloses a novel arrangement of an electromagnetic fluid pump of greatly improved performance over prior art devices. This is accomplished by an arrangement somewhat similar to the induction motor. The magnetic structure comprises the stator of an induction motor and a locked rotor with a fluid channel space between the stator and rotor. The field is energized with a rotating magnetic field so that fluid in the channel has induced in it, by the rotating magnetic field, electric currents which react in the usual manner with the rotating magnetic field to cause rotation of the fluid. In this way, kinetic energy is accumulated in the fluid during the passage of the fluid longitudinally through the channel so that a high angular velocity is present in the fluid by the time the exhaust port is reached. The rotational momentum of the fluid is readily translated into linear momentum by centrifugal force causing a practical pressure and volume of flow.

The present invention is directed to an improved magnetic and fluid channel structure in which the induction motor principle is utilized in a manner which results in enhanced fluid pressure and flow.

Other features and advantages not particularly enumerated will become apparent from further consideration of the specification which includes the drawing, and the appended claims.

In the drawing:

Figure 1 is a longitudinal cross section of an electromagnetic fluid pump embodying this invention.

Figure 2 is a diametrical cross section of the fluid pump of Figure 1 taken on the plane 2—2 thereof.

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Figure 3 is an enlarged fragment of the cross section of Figure 1.

Referring to the drawing, Figures 1 and 2, one preferred manner of practicing the concept of this invention is shown in diagrammatic form. The numerals 9 and 11 designate outer and inner magnetic structures which together constitute the stator. For convenience in expression, the outer member 9 is hereinafter entitled the field envelope and the inner member 11 is entitled the field core.

The field envelope 9 comprises a laminated iron structure 13 having a circular internal surface and slots 15 for housing electric windings 17. A metal band or canister 18 surrounds the field laminations to support them in place in a rigid assembly. A plurality of magnetically permeable and non-magnetic rings 19 and 21, respectively, are arranged in alternate sequence in the interior of the laminated structure 13. These rings are right triangles in cross section and one each of the permeable rings and the non-magnetic rings are juxtaposed with the sides adjacent the right angles in contiguous relation. It follows that the hypotenuses of the rings form a plurality of alternate converging and diverging surfaces. Each diverging surface is the boundary of a magnetically permeable ring 19 and each converging surface is the boundary of a non-magnetic ring 21.

The field core comprises a plurality of magnetically permeable triangular-shaped rings 26, each having a cross section similar in shape to a composite field envelope ring. The field core rings are positioned so as to nest with the field envelope rings with a space therebetween equal to the desired fluid channel thickness.

The fluid channel comprises an electrically conducting tube 23, a bell-shaped passage 25, and the zigzag passage between the field envelope and field core. The tubular channel portion is positioned centrally of the field core and merges at the exit end into the central part of the bell-shaped channel portion. The outer part of the bell-shaped portion merges with the first diverging passage portion between the field envelope and field core.

It has been found to be desirable to impress the rotating magnetic field across at least a part of the bell-shaped channel and, to this end, the field envelope includes magnetic material overhang 27 and the core structure includes permeable cap portions 29 which may be of laminated or powdered iron structure.

The magnetically permeable field envelope rings 19 and the non-magnetic field envelope

rings 21 result in a much greater magnitude of magnetic flux across the diverging fluid channel portion than across the converging portions of the fluid channel portions.

The effect of this structure is best explained with reference to Figure 3. The bell-shaped channel portion is traversed by rotating magnetic flux designated by the vector indicators *m*. The fluid is effectively dragged by the rotating field so that the fluid acquires a rotational motion. The centrifugal force acting on the rotating fluid in the diverging channel portion 31 acts in the direction shown by vector F and causes the fluid to flow longitudinally over into converging channel portion 32. The fluid channel portion 32 is not acted upon by the magnetic field to anywhere near the extent of the interaction in channel portion 33 as a consequence of the non-magnetic ring 21. It follows as a result of the fluid in channel portion 32 slowing down in angular velocity a slight amount due to frictional losses that the fluid in channel portion 32 has a smaller integrated centrifugal force than that in channel portion 31. Accordingly, the fluid although rotating in a plane normal to the longitudinal axis of the pump, also has a motion generally longitudinal of the pump so that it flows out of diverging channel portion 31 into and through converging channel portion 32 and from thence into the next succeeding diverging channel portion 33. The fluid entering diverging channel portion 33 obviously has a higher rotational velocity than it had when it entered diverging channel portion 31. The fluid acquires another increment of rotational velocity in channel portion 33 and in each succeeding diverging channel portion until the terminal exhaust port 35 is reached.

The induced currents in the fluid may circulate through portions of the adjacent metallic structure, but in order to provide a low resistance path, the end diverging channel and exhaust port 35 is electrically connected to the inlet end of tube 23 by conducting ring 36.

While there has been herein described what is at present considered to be a preferred embodiment of this invention, it will be apparent to those skilled in the art that various changes and modifications may be made therein without departing from the spirit of the invention and, it is therefore intended that the appended claims cover all such changes and variations as are embraced within the spirit and scope of the invention.

What is claimed is:

1. An electromagnetic fluid pump for generating an impelling pressure on a conducting fluid comprising a magnetic core structure, and a fluid channel; said fluid channel having an inlet and an outlet end, said magnetic core structure comprising a field envelope and a field core, said field core being elongated and of closed geometric configuration in the direction normal to the elongation thereof and being bounded on the outside in the direction of elongation by a plurality of surfaces which alternately diverge and converge with respect to the channel inlet end, said field envelope having a magnetic material shell, winding slots in the magnetic material shell parallel to the elongation thereof, and polyphase electric windings threading the winding slots thereof, said field envelope having on the interior thereof a plurality of composite rings supported in adjacent relation, each of said composite rings being triangular in cross section and being composed of a magnetic material ring

juxtaposed with a non-magnetic material ring and being orientated so that the non-magnetic material ring is adjacent a channel portion which converges with respect to the inlet end; said field core being supported internally within said field envelope with the respective opposed surfaces in parallel relation and with a space therebetween to define the fluid channel, means electrically connecting the channel inlet end to the channel outlet end whereby under a condition of polyphase excitation of said winding a rotating magnetic field having radial components of magnetic flux is generated and a greater magnetic flux traverses all the channel portions having a similar inclination and being bounded by magnetic material than the channel portions having the opposite inclination and which are bounded at least in part by non-magnetic material, means for admitting fluid into the channel inlet end and means for exhausting fluid from said fluid channel outlet end.

2. An electromagnetic fluid pump comprising a magnetic structure having a first and a second field core element, a polyphase electric winding, and a fluid channel; said fluid channel having an inlet end and an outlet end, said first field core element being of elongated annular shape and supporting internally thereof alternately juxtaposed magnetic and non-magnetic material rings with the non-magnetic ring of each pair of rings being on the side more closely adjacent than the magnetic ring on the channel inlet end, said rings being right triangular in cross sectional shape and juxtaposed in pairs with the right angles of the rings in each pair being adjacent to each other whereby the interior surface of the first field core element is zigzag in the direction of the elongation thereof and circular normal to the elongation, said second field core element having on a circumferential surface a plurality of magnetic material rings having a cross sectional shape approximately similar to each pair of first field core magnetic and non-magnetic rings, said second field core element rings being supported in nested relation to the first field core element rings with a space therebetween for defining a fluid channel having channel portions which alternately diverge and converge with respect to the fluid channel inlet end, said electric winding being supported in longitudinal slots in said first field core element whereby under a condition of polyphase excitation of said electric winding the channel portions bounded on one side by the first field core element magnetic rings are traversed by a rotating magnetic field having a radial component, means external of the fluid channel electrically connecting together the inlet end and the outlet end of the fluid channel, and means for admitting conducting fluid into the small end of the first of said channel portions and means for exhausting said conducting fluid from the large end of the last of said channel portions.

3. An electromagnetic fluid pump comprising an alternating current magnetic structure and a fluid channel, said fluid channel having an inlet end and an outlet end, said magnetic structure comprising an outer annular magnetic member having an inner surface of cylindrical shape, a series of rings of right triangular cross section having an outer diameter approximately equal to that of the inner surface of the outer magnetic member, said rings being alternately of non-magnetic and magnetic material and disposed in pairs with the right angle of a non-

magnetic ring adjacent the right angle of a magnetic ring and with the bases of the rings supported adjacent the inner surface of the outer magnetic member, said non-magnetic ring of each pair of rings being closer to the inlet end of said fluid channel than the magnetic ring of the said pair of rings, an inner magnetic member of generally annular shape having an outer surface similar to the inner surface of the assembled non-magnetic and magnetic rings and spaced therefrom by the width of the fluid channel, an electrical connection from the outlet end of the fluid channel to the inlet end of the fluid channel and means for generating in the magnetic members and the fluid channel a rotating magnetic field having radial components of flux and having its axis of rotation coincident with the axis of the magnetic members, whereby the fluid channel portions adjacent each magnetic ring are traversed with a higher density of rotating magnetic field than the channel portions adjacent the non-magnetic material.

4. An electromagnetic fluid pump for creating an impelling force on a conducting fluid comprising an annular fluid channel having an inlet end and an outlet end, said channel being of substantially uniform cross section and having channel portions, which relative to the channel inlet end, alternately diverge and converge, said diverging and converging channel portions being supported in close magnetic coupling and loose magnetic coupling respectively with a magnetic field structure, means for generating a rotating magnetic field having radial components of magnetic flux and having its axis of rotation coincident with the axis of the fluid channel in said magnetic structure to thereby traverse the fluid channel diverging portions with a stronger magnetic field than the field which traverses the converging channel portions, means electrically connecting the outlet end of said fluid channel with the inlet end of the fluid channel.

5. An electromagnetic fluid pump comprising an annular magnetic structure supporting thereon a polyphase electrical winding for generating a rotating magnetic field having radial components in said magnetic structure and a fluid duct having an inlet end and an outlet end, said fluid duct being supported in said magnetic structure and having a plurality of annular portions which have their axes coincident with the axis of the magnetic structure and which alternately diverge and converge relative to the duct inlet end, the first and last fluid duct portions being diverging, all said diverging duct portions being supported in close proximity to the adjacent magnetic structure and said converging duct portions being bounded on at least one side with non-magnetic material, the inlet and outlet ends of the duct being electrically connected together to provide closing paths for electrical currents induced in the fluid, whereby electrical currents induced in the fluid interact with the rotating magnetic field to impart a greater torque on the fluid in the diverging duct portions than on the fluid in the converging duct portions to cause migration of the fluid from the inlet end of the duct to the outlet end thereof due to pressure generated by centrifugal force.

NAT H. GODBOLD.

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2,397,785	Friedlander	Apr. 2, 1946
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