310-11 SR CROSS REFERENCE SEARCH ROOM
FIP8502 XR 3,030,888

April 24, 1962 L. KELTZ 3,030,888

ELECTROMAGNETIC PUMP

Filed Nov. 12, 1957 2 Sheets-Sheet 1

FIG. 1.

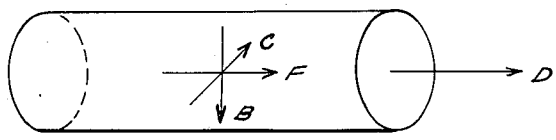


FIG. 2.

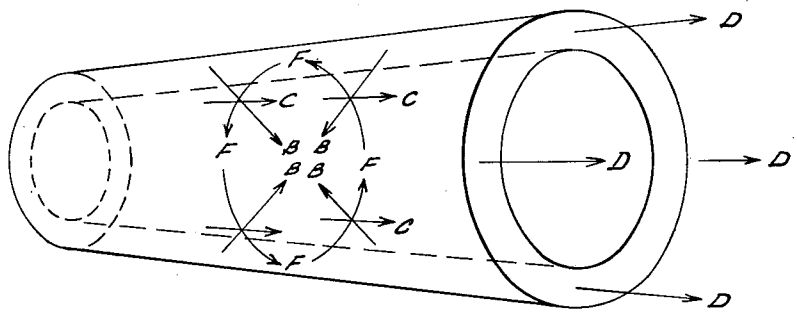
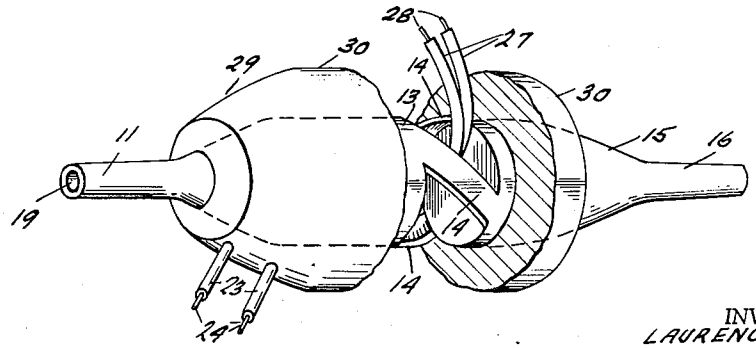


FIG. 3.



INVENTOR.
LAURENCE KELTZ
BY Astralek, Faber, Gerb & Soffen
ATTORNEYS

April 24, 1962 L. KELTZ 3,030,888

ELECTROMAGNETIC PUMP

Filed Nov. 12, 1957 2 Sheets-Sheet 2

FIG. 3.

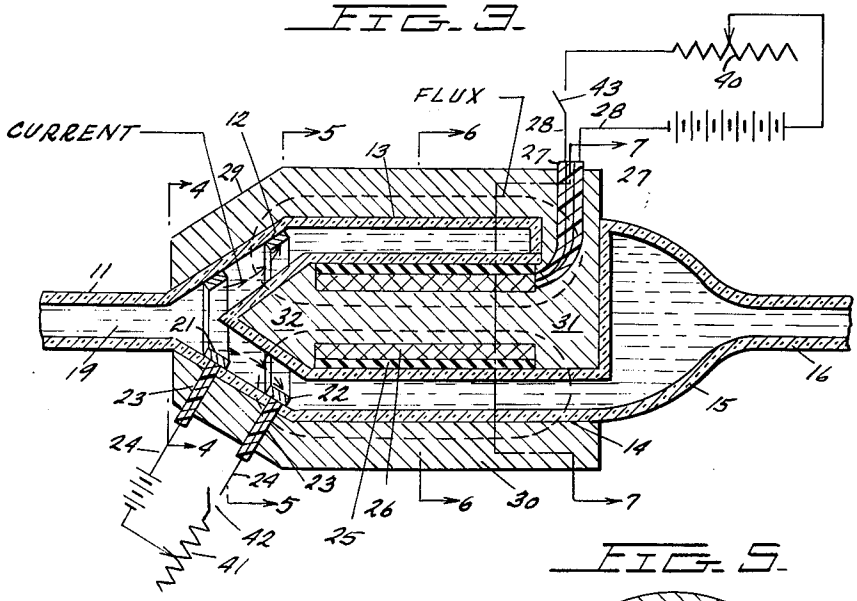


FIG. 4.

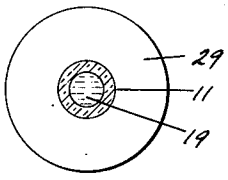


FIG. 5.

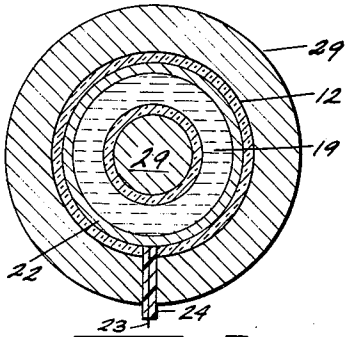


FIG. 6.

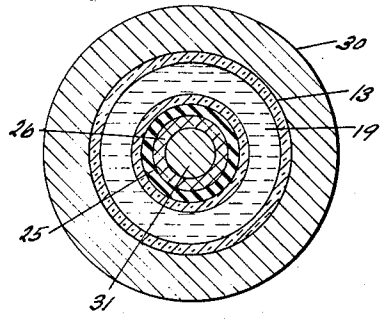
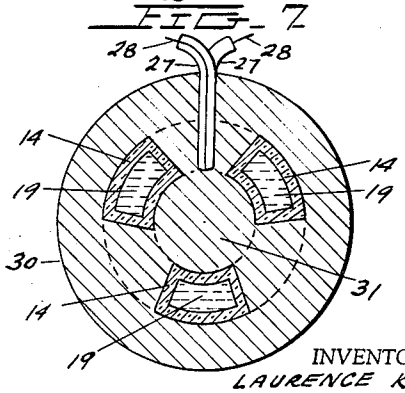


FIG. 7.



INVENTOR.
LAURENCE KELTZ

BY Ostrolenk, Faber, Gerb & Soffen
ATTORNEYS

United States Patent Office 3,030,888 Patented Apr. 24, 1962

3,030,888

ELECTROMAGNETIC PUMP

Laurence Keltz, Rte. 1, Malvern, Pa.

Filed Nov. 12, 1957, Ser. No. 695,940
3 Claims. (Cl. 103—1)

My invention relates to electromagnetic pumps of the type employed to move electrically conductive fluids such as molten metals without the use of pistons or rotors.

It is known that if an electric current and an intersecting magnetic field are applied to conductive liquid or gas, a force will be exerted thereon which is perpendicular to the plane of the current and magnetic field. This effect has been used in the past to pump liquid sodium through heat exchangers in atomic reactors wherein the electric current and a magnetic field lie in a plane which is perpendicular to the fluid conduit axis.

In this arrangement, a force is exerted on the liquid which is parallel to the axial liquid flow, the direction of the force, and therefore the direction of displacement of fluid, depending upon the choice of electrical and magnetic polarities. Thus, the fluid is accelerated in the axial direction. Note, however, that in this way it is also quickly moved out of the accelerating field of the intersecting current and magnetic field, thus cutting short the time during which the liquid is accelerated.

In my novel pump, the electric current is passed through the conductive fluid longitudinally instead of transversely, and intersects a transverse magnetic field. The intersecting magnetic field and electric current consequently exert a force on the conducting fluid circumferentially instead of axially. Means such as a conically flared member are then provided to deflect the fluid spinning under the influence of this force, in an axial direction.

Thus, in contrast to the prior art, my novel electromagnetic pump does not propel the fluid directly out of the accelerating field. Instead it prolongs the acceleration by whirling the fluid within the accelerating field for a longer time before indirectly ejecting it therefrom.

Ordinary tangential ducts, deflector vanes, or the like may be provided for redirecting the spinning fluid. A preferred embodiment involves a conical outer wall reacting against the centrifugal force of the spinning fluid to redirect the fluid in a spiral path having an axial displacement. The direction of spin of the spiral will depend on the choice of electrical and magnetic polarities, but irrespective of direction of spin the axial feed direction of the spiral will be from the smaller to the larger end of the cone defined by the conical wall.

The circular component of the spiral keeps the fluid whirling circumferentially within the accelerating field for a relatively long time, acceleration continuing all the while. The axial component of the spiral gives the fluid an indirect motion in the axial direction, thus feeding it gradually out of the accelerating field. This axial feed is always in the same direction regardless of polarities.

This novel pump structure is found to have the advantages of high pressure and fine control. In addition, the direction of net displacement of liquids is independent of electrical and magnetic polarities and no moving parts are required in the pump.

Accordingly, the primary object of my invention is to provide a novel electromagnetic pump which exerts a circumferential force on a fluid.

Another object of my invention is to provide a novel electromagnetic pump which whirls a fluid within an accelerating field, ejecting it therefrom indirectly.

Another object of my invention is to provide a novel

electromagnetic pump which prolongs the acceleration period of a conductive fluid.

Another object of my invention is to provide a novel electromagnetic pump which accelerates fluid over a path long in comparison to the net axial displacement thereof.

Another object of my invention is to provide a novel pump with no moving parts.

Another object of my invention is to provide a novel pump which develops a high pressure.

Another object of my invention is to provide a novel pump which can be finely controlled.

Another object of my invention is to provide a novel pump in which the path over which the fluid is accelerated is of such a shape as to maximize its length.

Another object of my invention is to provide a novel pump in which the direction of net displacement of liquid is independent of electrical and magnetic polarities.

These and other objects of my invention will become apparent from the following description when taken together with the drawings, in which:

FIGURE 1 is a schematic diagram of an electromagnetic pump of the prior art.

FIGURE 2 is a corresponding schematic diagram of my novel electromagnetic pump.

FIGURE 3 is a longitudinal cross-sectional view of my novel pump taken partially along the helical conduits.

FIGURES 4 through 7 are transverse cross-sectional views of my novel pump taken along lines **4—4** through **7—7** respectively of FIGURE 3, looking in the direction of the arrows.

FIGURE 8 is a perspective view of my novel pump with part of the magnetic jacket cut away to expose part of the conduit to view.

FIGURE 1 shows the operating principle of a well known type of electromagnetic pump wherein arrow C shows the direction of an electric current passing transversely across the pipe and through the fluid, arrow B shows the direction of magnetic flux transversely across the pipe, and perpendicular to arrow C. Arrow F shows the direction of the resultant force exerted on the fluid and arrow D shows the direction of direct displacement of fluid out of the accelerating field.

FIGURE 2 shows the novel principle of the instant invention in conjunction with a conical conduit into which a fluid is introduced. The current direction shown by arrow C is longitudinal, the flux shown by arrow B is radial, and the resultant force shown by arrow F is circumferential. The axial displacement D is an indirect by-product of the rotational motion of the fluid, caused by its centrifugal reaction against the outer conical wall which serves as a deflecting means to redirect the fluid being rotated within the conical conduit.

FIGURES 3 through 8 show a preferred embodiment of my novel invention where a conductive fluid **19** flows through a conduit system consisting of intake conduit or intake pipe **11**, conical conduit **12** which serves as an accelerating chamber, cylindrical conduit **13**, three helical conduits **14**, funnel **15**, and outlet conduit or outlet pipe **16**.

It will be noted that the sectional view in FIGURE 3 is taken along the helical conduits in the portion showing the helical conduits **14**.

This conduit can be made of any material appropriate for containing the particular conductive fluid **19** to be pumped. In the case of molten metals, a refractory material may be required. Conical conduit **12** has two annular shaped electrodes of appropriate diameter, **21** and **22**, mounted at the smaller and larger ends respectively of its inner surface. The conical walls are preferably of insulating material to prevent short circuiting of the current path through the conductive fluid by the cone walls.

A cylindrical coil **26** is mounted coaxially within the

internal bore of cylindrical conduit **13**. Coil **26** and the conduit **13** may be separated by a coaxially mounted cylindrical heat insulator **25** to protect coil **26** from hot fluids passing through conduit **13**.

The pump is then provided with a magnetic structure consisting of integral parts **29**, **30**, **31**, **32** which surround conduits **12** and **13** and coil **26** as best seen in FIGURE 3.

Conductors **28** surrounded by insulators **27** puncture the magnetic jacket part **30** and are connected to energize coil **26** from a variable source of D.-C. power to serve as a flux generating means and set up a magnetic flux through parts **29**, **30**, **31**, **32** of the magnetic jacket.

Conductors **24** surrounded by insulators **23** puncture magnetic jacket part **29**, electrodes **21** and **22** being connected thereby to the opposite sides of a second variable source of D.-C. power to form a part of the electrical energizing system for the pump. This connection will cause a current to flow between electrodes **21** and **22** through the conductive fluid **19**.

At the conical gap between flux guiding means or magnetic jacket parts **29** and **32**, the magnetic flux intersects the electric current substantially perpendicularly, exerting a tangential force on the conducting fluid **19** which tends to spin the fluid in a circumferential path within conduit **12**. The centrifugal motion thus imparted to liquid **19** forces it against the conical wall of conduit **12**, and fluid **19** is deflected strongly toward the wider end of conical conduit **12**, regardless of the direction of circumferential spin.

Thus, fluid **19** follows a substantially spiral path through the accelerating field in the conical conduit **12**, and because of the relatively great length of the spiral path the fluid is kept within the accelerating field for a relatively long time.

The fluid **19** is thus driven into cylindrical conduit **13** to break into three helical streams in leaving the pump through conduits **14**, and then converges in funnel **15** prior to being ejected through outlet pipe **16** under high pressure.

Variation of the resistance in this portion of the electrical energizing system or the energizing circuits for coil **26** and electrodes **21** and **22**, as by a rheostat **40** or **41** respectively connected in series with control switches **42** and **43** respectively will vary the performance of the pump with considerable sensitivity.

I have described my invention in terms of a specific embodiment thereof solely for purposes of illustration, and I intend to be bound only by the appended claims.

I claim:

1. A pump; said pump comprising an intake conduit; a conical accelerating chamber and an outlet conduit; said intake conduit, conical accelerating chamber, and outlet conduit being connected to receive a fluid flow therethrough; said conical accelerating chamber comprising a first conical pole piece and a second conical pole piece concentrically positioned with respect to said first conical pole piece and in spaced and substantially parallel relationship with respect to said first conical pole piece; a flux generating means; said flux generating means being disposed to pass magnetic flux across the gap defined by said spaced first and second pole pieces; a first and second annular electrode; said first and second annular electrodes being coaxially disposed in said conical accelerating chamber and being axially spaced from one another; said first and second annular electrodes being operable to pass current through a fluid in said conical accelerating chamber at an angle to said magnetic flux to exert a circumferential force on the fluid within said conical accelerating chamber.

2. An accelerating chamber for a pump for conductive fluid; said accelerating chamber comprising a first conical pole piece and a second conical pole piece, and a first and a second annular current electrode; said first and said second conical pole pieces being comprised of magnetic material; said second pole piece being disposed in concentric relation with respect to said first pole piece; the adjacent faces of said first and second pole pieces being in spaced and substantially parallel relationship with respect to one another to define an annular conical gap; said first and second annular current electrodes being disposed in said annular conical gap in coaxial relationship with said annular conical gap and in spaced axial relationship with respect to one another.

3. A pump for an electrically conductive fluid medium; said pump including an intake conduit, a conically shaped accelerating chamber having an intake end and an outlet end and an outlet conduit; said intake conduit being connected to said intake end of said conically shaped accelerating chamber; said outlet conduit being connected to said outlet conduit; an electrical system for passing a current through conductive fluid in said conically shaped accelerating chamber in a direction parallel to the slant height of said conically shaped accelerating chamber; said electrical system including a first and second electrode positioned within said conically shaped accelerating chamber and being spaced from one another in the axial direction of said accelerating chamber; means operatively associated with said accelerating chamber for generating a magnetic flux across said accelerating chamber; at least a component of said magnetic flux being perpendicular to the surface of said conically shaped accelerating chamber.

References Cited in the file of this patent

UNITED STATES PATENTS

788,506	Ashcroft	May 2, 1905
1,298,664	Chubb	Apr. 1, 1919
2,224,505	Unger	Dec. 10, 1940
2,652,778	Crever	Sept. 22, 1953
2,655,107	Godbold	Oct. 13, 1953
2,658,452	Donelian	Nov. 10, 1953
2,669,183	Godbold	Feb. 16, 1954
2,669,931	Godbold	Feb. 23, 1954
2,716,943	Vandenberg	Sept. 6, 1955
2,741,984	Lindenblad	Apr. 17, 1956
2,770,196	Watt	Nov. 13, 1956
2,786,416	Fenemore	Mar. 26, 1957

FOREIGN PATENTS

156,029	Germany	Apr. 3, 1904
239,816	Switzerland	Dec. 3, 1943
528,091	Great Britain	Oct. 22, 1940
718,429	Great Britain	Nov. 17, 1954
973,645	France	Sept. 20, 1950