Sept. 30, 1952 K. E. WAKEFIELD 2,612,109

ELECTROMAGNETIC PUMP

Filed June 20, 1950

Fig. 1.

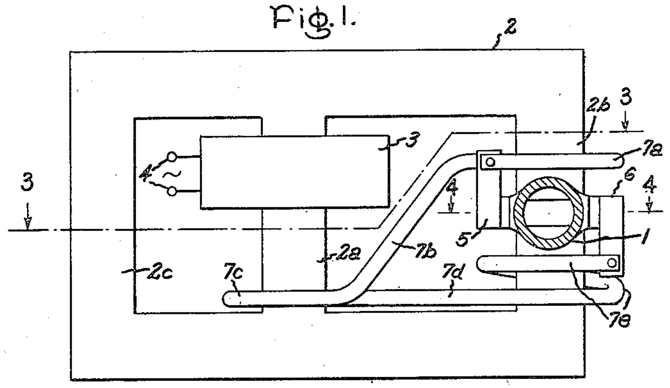


Fig. 3.

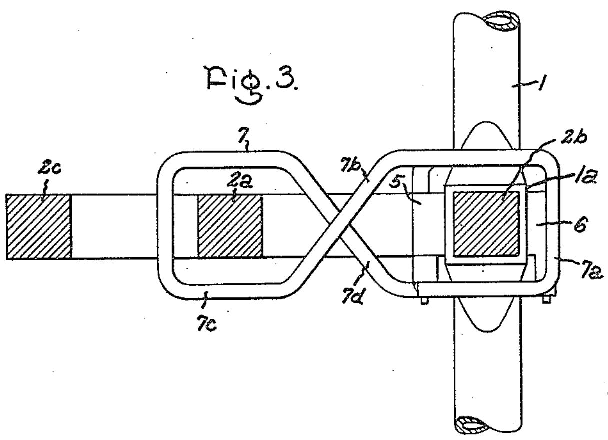


Fig. 2.

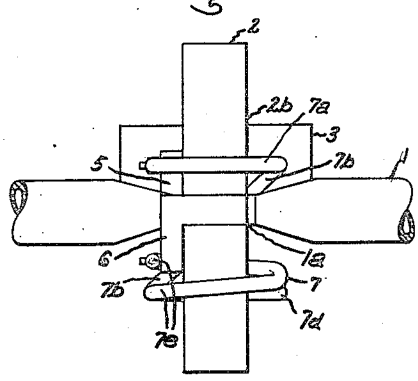
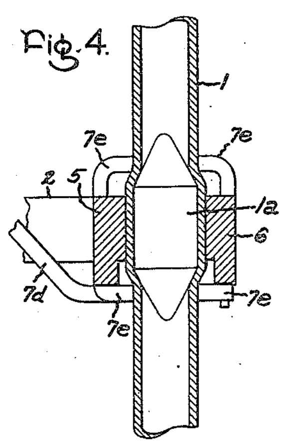


Fig. 4.



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UNITED STATES PATENT OFFICE

2,612,109

ELECTROMAGNETIC PUMP

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4 Claims. (Cl. 103—1)

This invention relates to electromagnetic pumps for electrically conductive fluids, of the type in which magnetic flux is provided transversely through the fluid and electric current is also provided transversely through the fluid in a direction perpendicular to the magnetic flux, thereby producing a pressure gradient within the fluid.

Pumps of this type require large currents at low voltage. Therefore the pump is preferably operated from alternating current so that stepdown transformers may be used to provide the large currents from conventional electric power supplies. For good efficiency it is necessary that the current and the magnetic flux through the fluid be kept substantially in phase. Previous alternating current electromagnetic pumps have suffered from one or more of the following disadvantages: poor efficiency, undue complexity, such as requiring separate power supplies to provide the magnetic flux and the current respectively, and large magnetizing current requirements.

An object of this invention is to provide an improved alternating current electromagnetic pump which is simple and compact, and has better efficiency and lower magnetizing current requirements than prior pumps.

Other objects and advantages will appear as the description proceeds. For a better understanding of the invention, reference is made in the following description to the accompanying drawing in which Fig. 1 is a side elevation of an improved electromagnetic pump; Fig. 2 is a front elevation of the same pump; Fig. 3 is a section along line 3—3 of Fig. 1; and Fig. 4 is a section along line 4—4 of Fig. 1.

Referring now to the drawing, a fluid conducting pipe 1 is provided to contain the electrically conductive fluid to be pumped. A 3-legged magnetic core 2 serves as the core of a stepdown transformer which provides current through the fluid and also serves as the magnet core to provide magnetic flux through the fluid. Upon the center leg 2a of core 2 is a primary winding 3 having terminals 4 which connect to any suitable source of alternating electric power. One of the outer legs 2b of core 2 has a gap through which pipe 1 passes as shown, so that magnetic flux across the gap passes transversely through the fluid within pipe 1. Preferably pipe 1 has a flattened portion 1a which fits snugly within the gap of leg 2b, so that the portion of the pipe within the gap is relatively wide and thin. This permits the gap to be small, with a resulting increase in magnetic flux density and electric current density, thereby providing increased pumping action.

Electrodes 5 and 6 are positioned upon opposite sides of the flattened portion of pipe 1 and adjacent to the core gap so that electric current between the two electrodes passes transversely through the fluid within pipe 1 perpendicular to the magnetic flux across the gap. This current is substantially in phase with the magnetic flux, as hereinafter more fully explained, so that the current and flux act upon the fluid to produce a pressure gradient lengthwise along pipe 1. Pipe 1 may conveniently be of metal having an electrical conductivity which is less than that of the fluid within the pipe, so that the larger part of the current flows through the fluid rather than around the pipe walls.

A secondary winding 7 is connected between electrodes 5 and 6. Since it must carry large currents, winding 7 is a heavy conductor of relatively large cross section and low electrical resistance. Winding 7 comprises in series at least one turn about the core leg 2b and at least one turn about the center core leg 2a. For example, in the embodiment shown, portion 7a is connected to electrode 5 and partly circles leg 2b, portion 7b extends diagonally to the center leg 2a, portion 7c makes one turn about the center leg, portion 7d extends diagonally back to leg 2b, and portion 7e make one-and-one-half turns about leg 2b and is connected to electrode 6 as shown.

In the operation of this pump, primary winding 3 is energized with alternating current and provides magnetic flux through the center leg 2a and the left-hand leg 2c of core 2. Relatively little of this flux provided by the primary flows through the right-hand leg 2b, because the gap through which pipe 1 passes makes the magnetic reluctance of this leg much greater than that of the left-hand leg which has no gap. Since a closed, low-reluctance magnetic path is provided for the flux produced by primary 3, the magnetizing current drawn by this pump is relatively low. The magnetic flux in the center leg 2a of the core induces voltage in portion 7c of the secondary winding, which causes current to flow through the secondary and thus between electrodes 5 and 6 through the fluid within pipe 1. Since portion 7c of the secondary comprises but a single turn, while primary 3 may comprise many turns, a stepdown transformer of large ratio is provided and very large currents may be obtained in the secondary winding.

Currents flowing in portions 7a and 7e of the secondary produce magnetic flux in the right-hand leg 2b and thus transversely through the fluid within pipe 1. The return path of this flux is through leg 2c. Since this flux is produced by current in the secondary winding and since the electrical resistance of the secondary winding, including the pipe section, is relatively low, the current and the magnetic flux through the fluid are always substantially in phase, thereby providing efficient operation of the pump.

Having described the principle of this invention and the best mode in which I have contemplated applying that principle, I wish it to be understood that the apparatus described is illustrative only, and that other means can be employed without departing from the true scope of the invention.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. An electromagnetic pump for electrically conductive fluids, comprising a fluid-conducting pipe, a three-legged magnetic core, a primary winding upon one leg of said core, another leg of said core having a gap through which said pipe passes whereby magnetic flux across said gap passes transversely through the fluid in said pipe, electrodes positioned upon opposite sides of said pipe adjacent to said gap so that electric current between said electrodes passes transversely through the fluid in said pipe perpendicular to the magnetic flux across said gap, and a secondary winding connected between said electrodes, said secondary winding comprising in series at least one turn about each of two legs of said core.

2. An electromagnetic pump for electrically conductive fluids, comprising a fluid-conducting pipe, a three-legged magnetic core, a primary winding upon one leg of said core, another leg of said core having a gap through which said pipe passes whereby magnetic flux across said gap passes transversely through the fluid in said pipe, electrodes positioned upon opposite sides of said pipe adjacent to said gap so that electric current between said electrodes passes transversely through the fluid in said pipe perpendicular to the magnetic flux across said gap, and a secondary winding connected between said electrodes, said secondary winding comprising in series at least one turn about the leg of said core having

said primary winding thereon and at least one turn about another leg of said core.

3. An electromagnetic pump for electrically conductive fluids, comprising a fluid-conducting pipe, a three-legged magnetic core, a primary winding upon one leg of said core, another leg of said core having a gap through which said pipe passes whereby magnetic flux across said gap passes transversely through the fluid in said pipe, electrodes positioned upon opposite sides of said pipe adjacent to said gap so that electric current between said electrodes passes transversely through the fluid in said pipe perpendicular to the magnetic flux across said gap, and a secondary winding connected between said electrodes, said secondary winding comprising in series at least one turn about the leg of said core having said gap and at least one turn about the leg of said core having said primary winding thereon.

4. An electromagnetic pump for electrically conductive fluids, comprising a fluid-conducting pipe, a three-legged magnetic code, a primary winding upon the center leg of said core, one outer leg of said core having a gap through which said pipe passes whereby magnetic flux across said gap passes transversely through the fluid in said pipe, electrodes positioned upon opposite sides of said pipe adjacent to said gap so that electric current between said electrodes passes transversely through the fluid in said pipe perpendicular to the magnetic flux across said gap, and a secondary winding connected between said electrodes, said secondary winding comprising in series at least one turn about the outer leg of said core having said gap and at least one turn about the center leg of said core.

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