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Jan. 17, 1956 K. O. DONELIAN ET AL 2,730,951

ELECTROMAGNETIC CENTRIFUGAL PUMP

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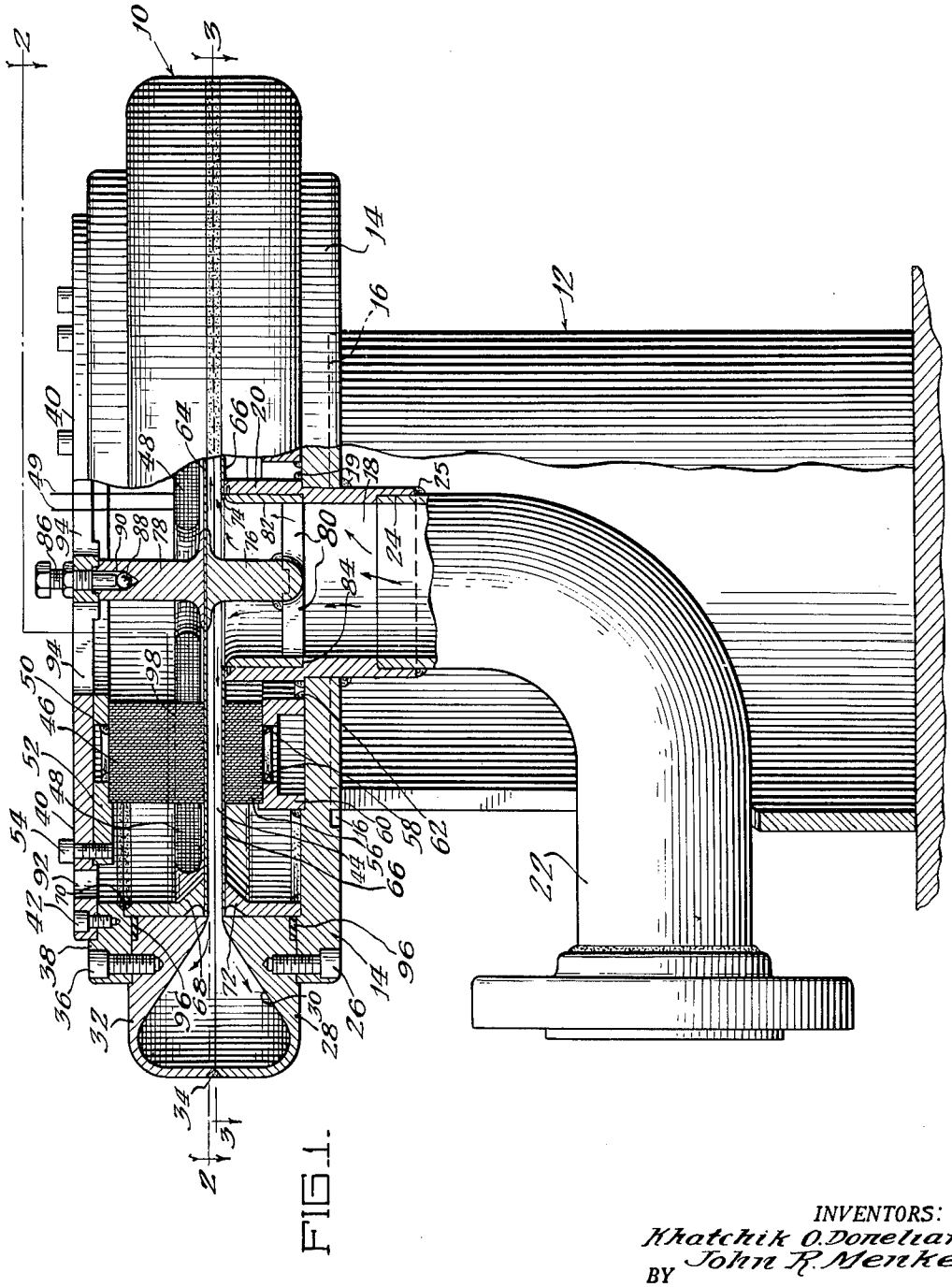


FIG. 1.

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FIG. 2.

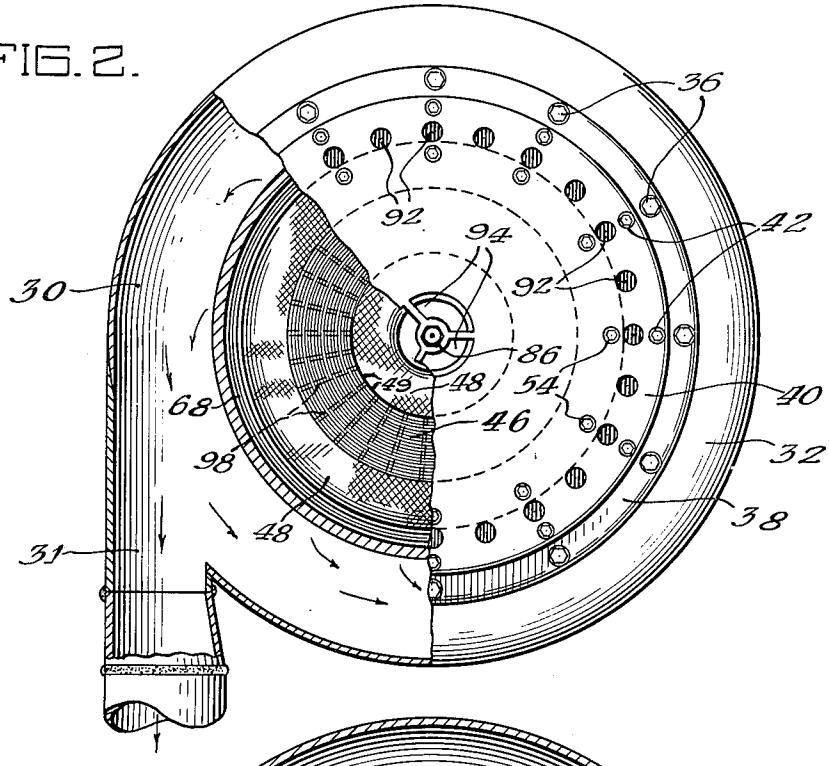
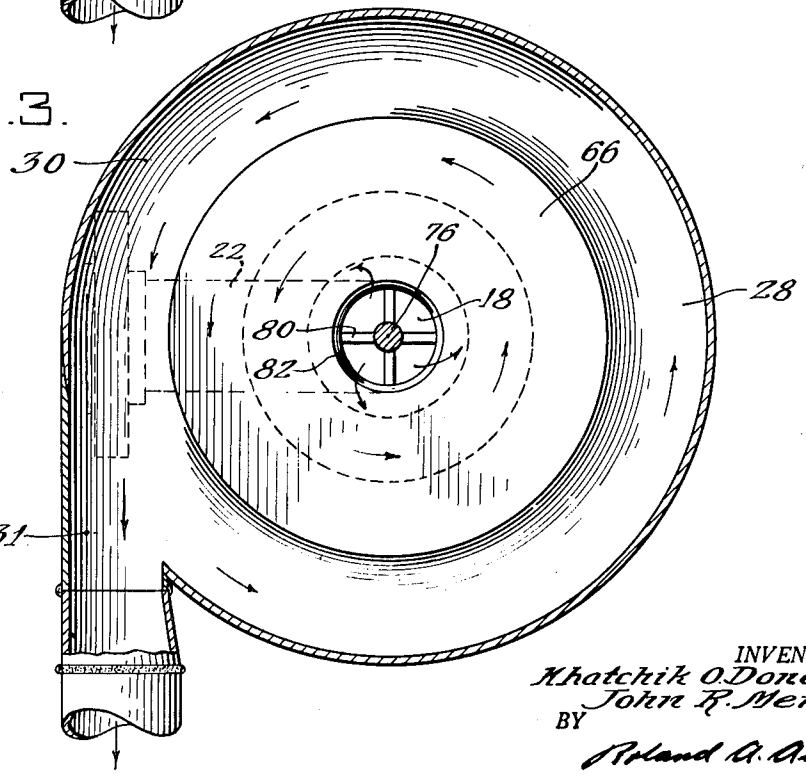


FIG. 3.



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ELECTROMAGNETIC CENTRIFUGAL PUMP

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Application January 20, 1950, Serial No. 139,604

2 Claims. (Cl. 103—1)

This invention relates to electromagnetic pumps and more particularly to an improvement in such pumps wherein a magnetic field revolves in a circular path, such as in pumps of the type described in U. S. Patent 2,658,452 issued to K. O. Donelian on November 10, 1953.

A device for pumping electrically conductive liquids, such as alloys of sodium and potassium, by means of an electromagnetic centrifugal system is disclosed in the above-mentioned copending application. In general, the liquid is whirled within a pump chamber by the interaction of a rotating magnetic field and of the currents induced in the conducting liquid by the rotating field, causing the conducting liquid to follow the field in its circular path at a relatively high velocity and then to be thrown outwardly by centrifugal force into an annular peripheral chamber from which the liquid exits through an outlet passage at the periphery.

The pump forming the subject matter of the present invention is an improvement over previous electromagnetic pumps in that better use is made of kinetic energy accumulated by the rotating liquid. This is accomplished by the use of a flat disk-shaped chamber into which the electrically conductive liquid enters at the center and is caused to whirl by the rotating magnetic field as it is centrifugally forced to a circumferential outlet. The magnetic field is perpendicular to the radius of the chamber, and its axis of rotation is parallel to the direction of the field. It is in this manner that the expenditure of kinetic energy is in the direction of normal flow toward the outlet.

The foregoing constitutes certain objects and advantages of the present invention others of which will become apparent from the study of the following specification, taken together with the drawings, in which:

Figure 1 is a vertical sectional view partly in elevation of an electromagnetic centrifugal pump;

Figure 2 is a horizontal sectional view partly in elevation, taken on the line 2—2 of Figure 1; and

Figure 3 is a horizontal sectional view, taken on the line 3—3 of Figure 1.

The pump is devised to move liquid metal through it by centrifugal force. This is attained by causing the metal to enter at a central inlet into a flat disk-shaped chamber, at which place the metal begins to whirl as the result of the interaction between a magnetic field that is rotating in a circular path within the chamber and the radial electric current induced in the liquid by the rotating magnetic field. As the whirling velocity increases, the metal is thrown outwardly by centrifugal force into an annular peripheral chamber from which the metal exits through an outlet passage at the periphery.

One embodiment of this invention is described below. Referring first to Figure 1, the pump generally indicated at 10 is supported on a cylinder 12 which rests upon a solid base. The top edge of the cylinder 12 is fixed into an annular groove 16 in an annular plate 14 which is the undersurface of the pump. At the center of the annular

plate 14 is a central inlet 18 which is formed by a collar 20 that extends above and below said plate 14 and is welded to it at 19. An inlet pipe 22 fits into the lower extension of collar 20 at 24 and is welded at 25. Attached to the plate 14 by means of bolts 26 is an annular housing 28 which forms the lower portion of a peripheral annular chamber generally indicated at 30. The upper portion of said chamber is enclosed in an annular housing 32 that is welded around the circumference at 34 to the lower housing 28. An annular member 38 is attached to the upper housing 32 by means of bolts 36. Likewise, a cover plate 40 is secured to the annular member 38 by bolts 42. Referring to Figures 2 and 3, a tangential outlet 31 is located in the periphery of the annular chamber 30 which may be regarded as an enlarged portion of a disk-shaped chamber 44 (Fig. 1).

Within the pump is the flat disk-shaped chamber 44 which is horizontally disposed between the central inlet 18 and the annular peripheral chamber 30. An annular core 46 with windings 48 connected by supply lines 49 to a source of alternating current (not shown), is positioned above the disk-shaped chamber 44 and adjacent thereto between the central inlet 18 and the annular peripheral chamber 30. The annular core 46 is welded at 50 to an annular plate 52 which is attached to the cover plate 40 by means of bolts 54. Below the disk-shaped chamber 44 is an annular armature 56 which is adjacent thereto between the central inlet 18 and the annular peripheral chamber 30, and which is welded at 58 to an annular member 60 which is, in turn, welded at 62 to the annular undersurface plate 14. The disk-shaped chamber 44 is formed by upper and lower walls 64 and 66, respectively, of nonmagnetic and relatively electrically resistant material, such as an alloy of 80% Ni, 15% Cr, and 5% Fe, commonly called Inconel. The upper wall 64 is disposed adjacent to the annular core 46 and is welded at its periphery to an annular supporting member 68 which is integrated with the annular member 38 by the weld 70. The lower wall 66 is positioned adjacent to the annular armature 56 and is welded at its periphery to an annular supporting member 72. This lower wall 66 is centrally apertured at 74, and the collar 20, having an inner diameter substantially corresponding to the diameter of the aperture 74, is welded to the lower wall to form the central inlet passage 18.

To prevent vibration at the center of the pump, the upper disk-shaped wall 64 is clamped in place between an anvil member 76 and a clamping member 78 (Figs. 1 and 3). The anvil member 76, which is disposed in the central inlet 18, is held in place by means of a spider-like frame comprising four spokes 80 (Fig. 3), radiating outwardly from the lower end of the anvil member 76 and a cylinder rim member 82 which rests on a shoulder 84 provided on the inner surface of collar 20. Positioned directly above the anvil member 76 is the clamping member 78 that is held in place by means of a set-screw 86 (Figs. 1 and 2) which is screwed into the cover plate 40. Pressure on the clamping member 78 is equally distributed by means of a ball 88 in a cavity 90 in the upper end of said clamping member. In order to ventilate the core 46 and windings 48, the cover plate 40 is apertured at 92 and 94 (Figs. 1 and 2). Leakage of liquid metal from the pump is prevented by annular gaskets 96 clamped between the member 38 and the housing 32 and between the bottom plate 14 and the housing 28, respectively.

The laminated annular core 46 is constructed by rolling a single elongated strip of silicon steel with mica insulation into a coil. The windings 48, indicated schematically in the drawing, are similar to the windings of the stator of a conventional three-phase motor. However, they differ from conventional windings in the position of core slots 98 into which the windings are placed (Figs. 1

and 2). Radial core slots **98** are cut into the side of the core **46** which is adjacent to the chamber **44**. The magnetic field is thereby induced across the chamber in a direction parallel with the axis of the annular core.

The operation of the pump is as follows: To start the pump it is necessary to prime it with liquid metal by methods conventional to centrifugal pumps so as to fill the pump chamber **44** and to close the electrical circuit to energize the magnet. As indicated by the flow arrows in the drawings, the liquid metal enters through inlet pipe **22**. The interaction between the rotating magnetic field produced by windings **48** and the radial electric currents in the liquid metal induced by the moving magnetic field whirls the liquid about chamber **44** to centrifugally force it into the enlarged chamber **30** from which it exits through the outlet **31** in the periphery.

While the above description presents a single embodiment of the invention, it is obvious that other pumps embodying the principles of the invention may be devised. For example, the armature could be constructed so as to rotate rather than remain fixed. Likewise, the lower walls could be made of magnetic material. Other modifications will be immediately apparent.

What is claimed is:

1. An electromagnetic pump for electrically conductive fluids comprising a pair of spaced substantially parallel walls forming a flat partitionless chamber, an inlet in a wall disposed substantially centrally thereof, an enlarged annular chamber surrounding and communicating with the first chamber and having an outlet in the plane of the first chamber, and electromagnetic means for creating a magnetic field rotating about said inlet and across the first chamber in a direction parallel with the axis of the annular chamber, said means including an annular laminated core coaxial with the inlet, said core being on one side of the first chamber and abutting one of said walls, radial slots extending throughout one end of the core, windings in the slots, and an annular laminated armature abutting the other wall and disposed on the side of the chamber opposite the core.

2. An electromagnetic pump for electrically conductive fluids comprising a pair of spaced parallel nonmagnetic walls forming a flat circular partitionless chamber, an inlet centrally disposed in one of the walls, an enlarged annular chamber of substantially round cross-section disposed about the periphery of and communicating with the first chamber, an annular laminated core coaxial with the inlet, said core being fixed on one side of the first chamber and abutting one of the nonmagnetic walls, radial slots extending completely through the core on the side adjacent to said wall, windings in the slots, an annular laminated armature abutting the other wall in a fixed position and disposed on the side of the first chamber opposite the core, said elements creating a rotating magnetic field about the inlet and across the first chamber in a direction parallel with the axis of the annular chamber, and a tangential outlet in the enlarged annular chamber disposed in the plane of the first chamber, whereby a fluid, upon entering the pump, is caused to whirl about the first chamber until centrifugally forced into the enlarged annular chamber from which it exits through the outlet in the periphery.

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