

June 26, 1951

E. J. WADE
ELECTROMAGNETIC PUMP

2,558,698

Filed March 24, 1950

2 Sheets-Sheet 1

Fig. 1

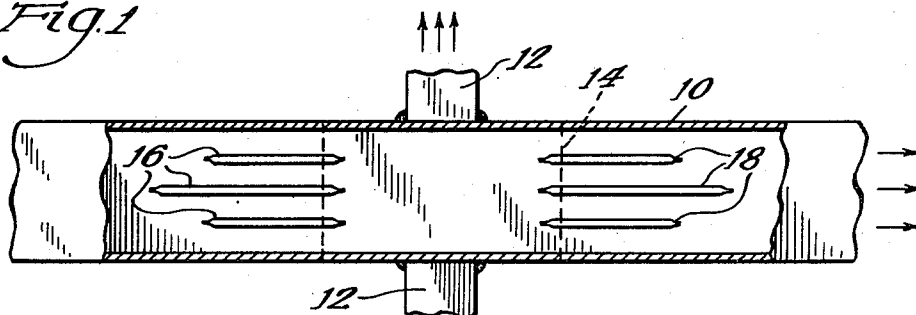


Fig. 2

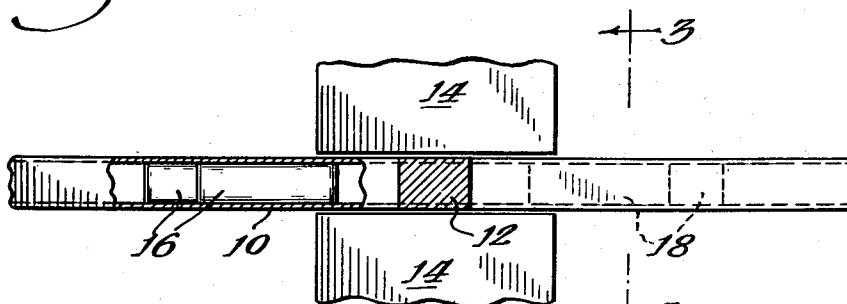


Fig. 4

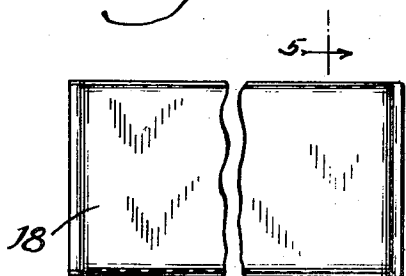


Fig. 5



Fig. 3

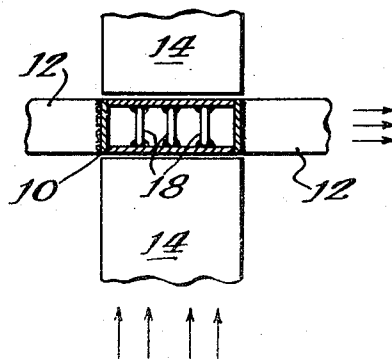


Fig. 6



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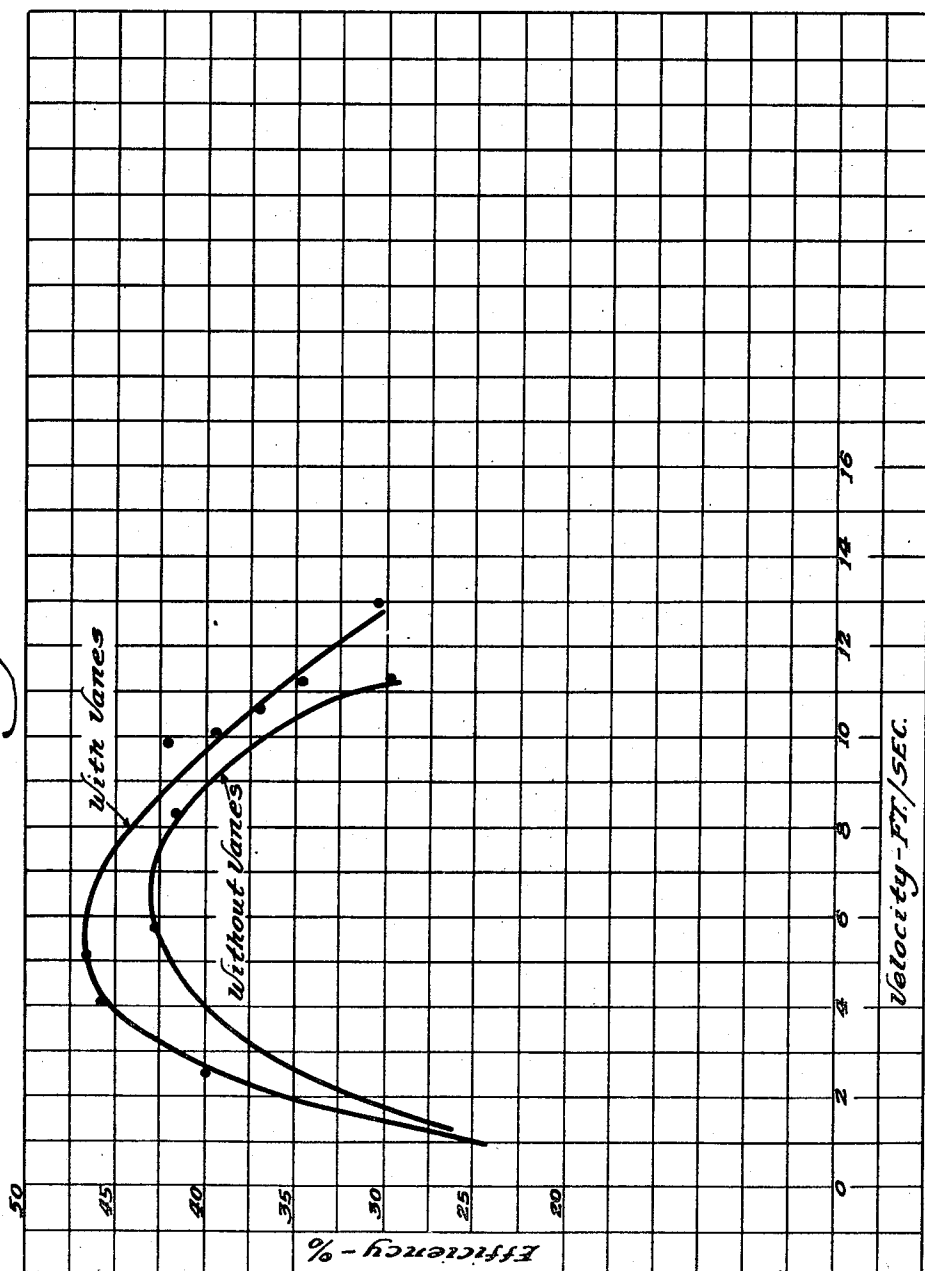
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Fig. 7



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UNITED STATES PATENT OFFICE

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ELECTROMAGNETIC PUMP

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Application March 24, 1950, Serial No. 151,731

2 Claims. (Cl. 103—1)

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The present invention relates to electromagnetic liquid metal pumps of the type in which the liquid metal is forced to flow along a conduit by the reaction between an electric current passing through the liquid metal having a component perpendicular to the direction of flow of the liquid metal, and a magnetic field having a component perpendicular both to the electric current and to the direction of flow of the liquid metal.

In recent years a need has developed for an electromagnetic pump capable of efficiently moving an electrically conducting liquid metal coolant such as sodium or an alloy of sodium and potassium. The advantage of pumps of this type resides in the fact that no moving parts are involved and also the liquid metal can easily be confined in a closed heat exchange system without requiring complicated seals and the like. The efficiency of such pumps has been less than that of conventional positive displacement pumps, and efforts have, therefore, been made to improve electromagnetic pumps.

It is the object of this invention to improve the efficiency of electromagnetic liquid metal pumps by reducing losses therein due to eddy currents in the liquid metal. This objective is achieved by the use of a series of insulating barrier vanes or baffles inside the liquid metal conduit and arranged to reduce the tendency of the pump current to diverge in passing through the liquid metal therein.

The invention will be more completely understood by reference to the appended figures wherein:

Fig. 1 is an elevational view of a pump embodying the present invention with portions broken away;

Fig. 2 is a plan view of the pump shown in Fig. 1;

Fig. 3 is a cross sectional view along line 3—3 of Fig. 2;

Fig. 4 is a detail view of an insulating vane of the type shown in Figs. 1 and 3;

Fig. 5 is a cross section taken along line 5—5 of Fig. 4;

Fig. 6 is an edge view of the vane shown in Fig. 4, with portions broken away; and

Fig. 7 is a graph which compares the efficiency of a pump made in accordance with this invention with an electromagnetic pump lacking insulating barrier vanes.

With particular reference to Figs. 1 and 2, the pump applies a force to liquid sodium by means of a magnetic field and an electric current mutu-

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ally at right angles. As constructed, the pump consists of a stainless steel tube or conduit 10 which is rectangular in cross section. Heavy copper electrodes 12 are welded to opposite sides of the conduit 10 and are connected to a suitable source of direct current (not illustrated). Magnetic pole pieces 14 are disposed adjacent the remaining two sides of the conduit 10. (Figs. 2 and 3.) These pole pieces may be excited either by shunt or series coils (not illustrated) in a manner well known to the art.

In the operation of a pump of this type, the flowing liquid metal generates a counterelectromotive force which opposes the flow of current. This causes some of the current to diverge around the region of intense magnetic field and thus decreases the efficiency of the pump. There are also eddy currents set up by the gradient of the magnetic field which have a similar effect.

To overcome the foregoing difficulties, insulating barriers 16, 18 are inserted in the conduit 10 as shown in Figs. 1 and 3. Figs. 4, 5, and 6 show detail views of one of these barriers. The barrier may be made of flattened stainless steel tubing which has been welded at the ends to prevent the admittance of liquid metal which is present in conduit 10. The barriers extend across the conduit 10 and are welded to opposite sides thereof as shown in Fig. 3. Two sets of barriers are employed, one on either side of the path followed by the current in passing through the liquid metal.

An electromagnetic pump embodying the present improvement has been constructed and operated with liquid sodium as the metal pumped. In this example the conduit 10 consisted of stainless steel tubing approximately $2\frac{3}{8}$ " by 1" in cross section and 0.032" in wall thickness. The electrodes 12 consisted of heavy copper bus approximately 1" by $1\frac{1}{4}$ " thick and rectangular in cross section. The copper bus was welded to opposite sides of the conduit 10. The barriers 16, 18 were constructed of stainless steel tubing flattened until opposite walls were spaced approximately $\frac{1}{8}$ " apart. Six barriers were employed, three on either side of the current path through the liquid sodium. Due to the large ratio between the conductivity of sodium and stainless steel, these barriers are effective in controlling current flow. The number of barriers and their lengths are chosen on the basis of calculations and experience to balance economic factors and electric and hydraulic efficiency. In the embodiment illustrated in the drawings, six barriers are employed, four being 3" and two being 4" in length.

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Comparative tests were conducted with the pump in which the effectiveness of the barriers in increasing pumping efficiency was demonstrated. The result of these tests is shown in the graph, Fig. 7 wherein the per cent efficiency of the pump is plotted against the velocity of the liquid sodium in feet per second. The test, which was conducted at a sodium temperature of 300° C. and a magnetic intensity of 6300 Gauss, showed that at all pumping speeds the pumping efficiency was increased when barrier vanes were included in the liquid sodium conduit; with maximum improvement being noted at pumping speeds of approximately 4 feet per second. At this speed the efficiency increased from 40% to 45%, or an improvement of 12½% over performance without barrier vanes.

It is understood that the foregoing description of a specific embodiment of this invention is illustrative merely and is not to be interpreted as a limitation of the invention, the scope of which is defined in the appended claims.

I claim:

1. In a pump for electromagnetically pumping a conducting liquid metal, said pump having a conduit for the liquid metal, means secured to opposite sides of said conduit and arranged to pass an electric current through the conducting

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liquid in a direction at right angles to the direction of flow of said liquid in said conduit, and means for establishing a magnetic field at right angles to both said direction of flow and said current, the improvement which consists in providing insulating vanes in said conduit on either side of the path of said electric current, the insulating vanes consisting of flat, hollow metal barriers extending between and secured to opposite sides of said conduit, whereby eddy currents and current divergence are reduced.

2. An electromagnetic pump, as set forth in claim 1 having six vanes, three vanes being arranged in mutually parallel relationship within the conduit on either side of the current path.

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The following references are of record in the file of this patent:

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