PATENT SPECIFICATION

Convention Date (Germany): Dec. 27, 1927.

303,065

Application Date (in United Kingdom): Dec. 24, 1928. No. 38,091/28.

Complete Accepted: May 26, 1930.

COMPLETE SPECIFICATION.

Electrodynamic Movement of Fluid Metals particularly for Refrigerating Machines.

We, Prof. ALBERT EINSTEIN, of Swiss Nationality, of 5, Haberlanderstrasse, Berlin, Germany, and Dr. LEO SZILARD, of Hungarian Nationality, of 95, Prinzregentenstrasse, Berlin-Wilmersdorf, Germany, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

This invention relates to apparatus in which fluid metal moves forward under the influence of a magnetic field on the liquid through which electric current is passing, more particularly in which fluid metal is pumped from a chamber that is under low pressure into a chamber under higher pressure. Such apparatus can be employed for pouring molten metal into a mould or it may be used in refrigerating machines for feeding mercury or other liquid metals to the device. If the electric current is not passed into the liquid through electrodes but is induced in it in such manner that the stream lines of the electric current are wholly in the liquid and form closed lines therein, difficulties are avoided that are inherent in the transmission resistance between electrode and liquid, but generally a field of ponderomotive force is created in the liquid which is not free from eddies. If this field of force in the fluid metal is not free from eddies, there is a great loss of energy owing to useless agitation of the liquid.

The invention relates to apparatus in which the field of ponderomotive force is free from eddies within the liquid; according to the invention the field of ponderomotive force, which acts upon the liquid, results from a magnetic field of which the lines of force cut or cross an annular chamber through which the liquid stream is caused to flow, the magnetic field being produced by at least two or more coils energized by electric current.

Figure 1 of the accompanying drawings illustrates diagrammatically a form of apparatus according to the invention, by way of example.

An iron core 2 is inserted into an iron cylinder 1. Mercury flows in the cylindrical annular chamber between the iron core and the tube 1, under the influence of the magnetic fields produced by the windings 4, 5, 6 and 7, in the direction of the longitudinal axis of the cylinder, and, if the polarity be suitably chosen, from top to bottom. The windings 4 to 7 surround the tube 1. The currents which flow in the adjacent windings are about 90° out of phase relatively to each other, while on the other hand the windings 4 and 6—likewise the windings 5 and 7—may be connected up in series. 8 and 9 are sheet iron plates shown in laminated form on the section line A—B. When the polarity is correctly chosen, the magnetic field in the mercury in the cylindrical annular chamber is moved from top to bottom; the rate of change of the magnetic field is obtained by multiplying the frequency by the identity distance apart of the windings. In the mercury an electric current is induced which circulates around the iron core 2. Such a line of force is shown in this figure of the drawings. The ponderomotive force that influences the mercury is at all points parallel to the axis of the cylinder, and the ponderomotive field is practically free from eddies.

A 90° displacement of phase between the currents in adjacent windings is produced in known manner as has been proposed for the production of the artificial phase for asynchronous motors.

Figure 2 illustrates diagrammatically a refrigerating machine according to the invention in which 10 is a device for causing mercury to move by electro-dynamic means. The mercury is forced into the tube 11 and fed to the mercury jet pump 12. The vapour of a cooling agent (for example, methyl alcohol or a suitable hydrocarbon) is drawn off through the pipe 13, compressed in a vertically extending pipe, and forced into the vapour separating chamber 15. The mercury passes out of this chamber, through the downwardly directed pipe 16, and back into the device 10, while the vapour of the cooling agent flows through the pipe 19 into the air-cooled condenser 17, where

it is liquefied; the cooling medium then flows through a throttle 20 into the vaporiser 18.

If a three phase current is available, the apparatus shown in Figure 1 is connected to the source of current in such manner that a uniformly moving magnetic field is produced—that is to say, the windings 4, 5 etc. are connected in similar manner to the windings of a three phase current motor and there is produced a magnetic field moving in a straight line instead of a rotating field.

The transmission of energy from the mercury to the vapour that is to be compressed may be variously effected in the refrigerating machine. For example, water may be drawn in by means of a mercury jet pump and the vapour compressed by the water. Alternatively, by intermittently reversing the direction of motion of the magnetic field, the mercury can be caused to flow intermittently into a vessel which communicates by valves with two chambers that are under different pressures, so that the mercury compresses the vapour, and forces it into the chamber under the higher pressure, while the vapour is drawn off by the mercury from the chamber which is under the lower pressure.

In order that this action may be better understood one form of such an apparatus is hereinafter more fully described by way of example and illustrated diagrammatically in Figure 3 of the accompanying drawings.

10 is the electro-magnetic device in which the direction of movement of the fluid metal is reversed by changing the polarity of one part of the winding. In this way the fluid metal is drawn out of the cylinders 21 and 22, or is forced into them, alternately. The valves 23 and 24 permit the compressed vapour to pass into the pressure pipe 25, while the vapour is drawn by suction out of the suction pipe 26 through the valves 27 and 28 into the cylinders 21 and 22.

Having now particularly described and ascertained the nature of our said invention and in what manner the same is to be performed, we declare that what we claim is:—

1. Apparatus for moving fluid metals, intended more particularly for use with refrigerating machines, in which a magnetic field influences metal traversed by electric current, characterised in that a stream of the liquid metal is caused to flow through an annular chamber which is cut or crossed by the lines of force of a magnetic field produced by at least two or more coils energised by electric current, the magnetic field inducing electric currents in the annular chamber, which currents circulate around the axis of the chamber.

2. Apparatus according to claim 1, characterised in that the currents in two adjacent coils have a phase difference, thus producing a magnetic field which moves in a straight line parallel to the axis of the annular chamber in the manner that the field in a poly-phase motor moves in a circular path.

3. Apparatus according to claim 1 or claim 2, comprising a tube having an iron core disposed therein, an annular space being formed around the core and iron sheets disposed outside the annular space.

4. Apparatus according to claim 1, claim 2, or claim 3, characterised in that in a refrigerating machine mercury is moved by the apparatus.

5. Apparatus according to claim 1, claim 2 or claim 3, characterised in that fluid metal is poured into a mould by the apparatus.

Dated this 24th day of December, 1928.

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Redhill: Printed for His Majesty's Stationery Office, by Love & Malcomson, Ltd.—1930.