United States Patent

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[54] **PROCESS FOR DOSING OF LIQUID METALS, ESPECIALLY FROM MELTING OR HEAT PRESERVING CONTAINERS BY MEANS OF AN ELECTROMAGNETIC CONVEYING TROUGH**
5 Claims, 1 Drawing Fig.

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[56] **References Cited**

UNITED STATES PATENTS

2,836,637	5/1958	Spagnoletti	417/50
2,573,319	10/1951	Dreyfus	417/50
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FOREIGN PATENTS

1,286,701	1/1969	Germany	417/50
1,291,061	3/1969	Germany	417/50

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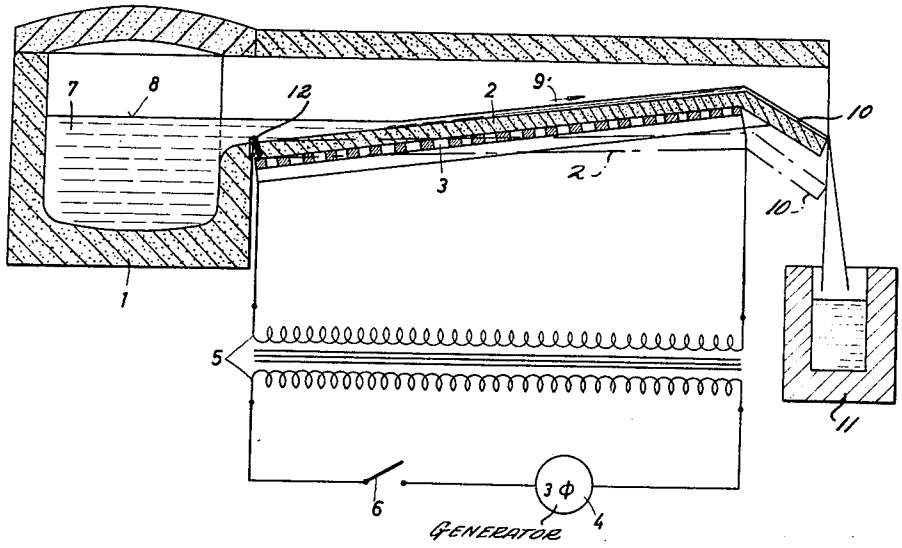
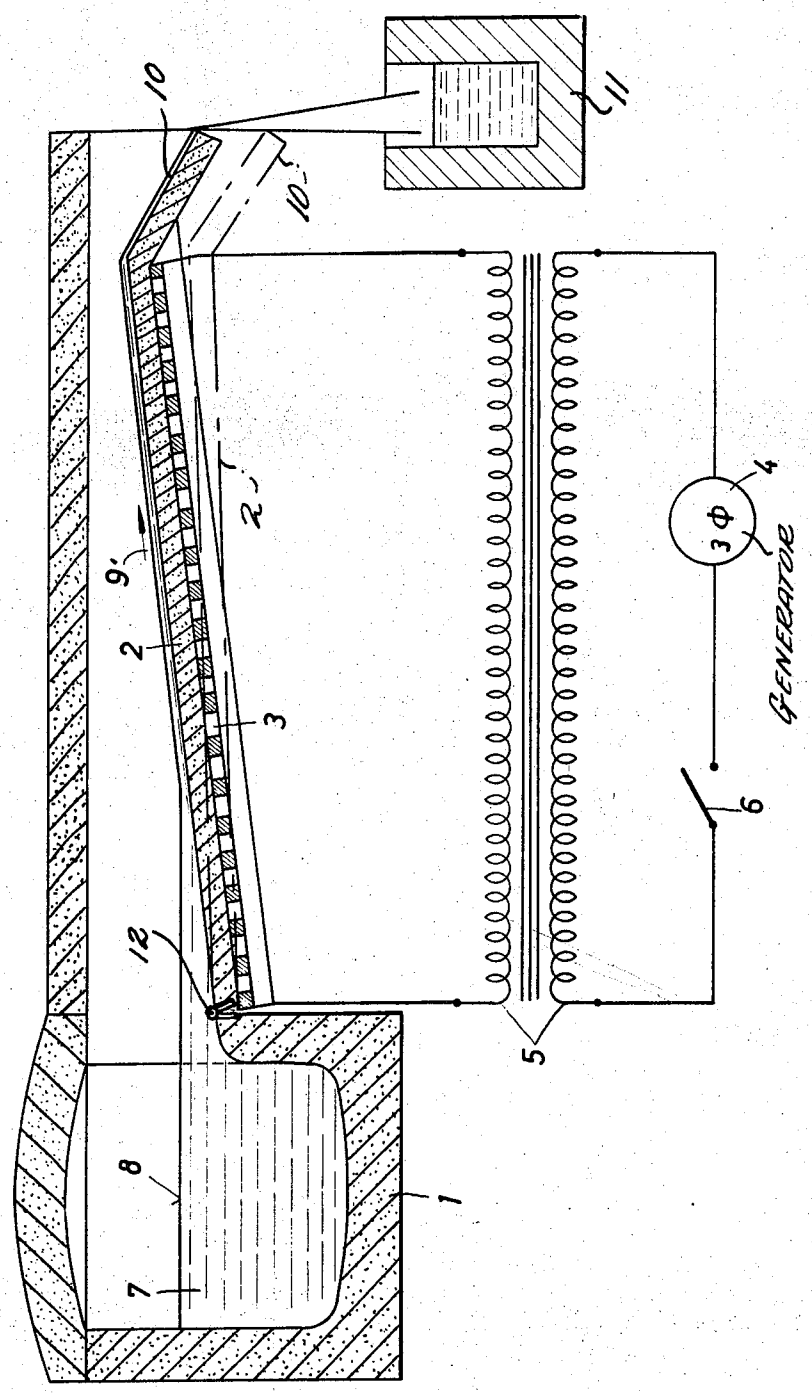
ABSTRACT: A method and apparatus for conveying molten metals up an inclined trough from a vessel by producing a travelling electromagnetic wave beneath the trough wherein the field strength of the wave is increased into a particular range in which substantial variations in field strength do not result in substantial variations in the thickness of the flow layer. The layer thickness in this range can be varied by varying the frequency of the three phase signal used to generate the electromagnetic wave or by varying the gradient of the trough with respect to the horizontal.





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PROCESS FOR DOSING OF LIQUID METALS, ESPECIALLY FROM MELTING OR HEAT PRESERVING CONTAINERS BY MEANS OF AN ELECTROMAGNETIC CONVEYING TROUGH

The invention relates to a method and apparatus for conveying molten metals.

Molten metals, such as aluminum or aluminum alloys as well as metals with a higher melting point such as copper, nickel or iron, are frequently conveyed from one place to another in electromagnetic conveyor troughs. Such conveyor troughs conventionally include a heat-resistant nonmagnetic trough body below which is disposed the stator of a three-phase linear motor for producing an electromagnetic travelling field which moves along the longitudinal direction of the trough.

This trough body can be mounted with a gradient, usually 15–30 percent, relative to the horizontal so that its lower end dips into a smelting or holding furnace from which the molten metal is conveyed and its upper end into a pouring nozzle from which the metal leaves the trough. When an electromagnetic travelling field of suitable intensity is produced by the stator of the three-phase linear motor, the molten metal in the trough body moves in an open stream toward the pouring nozzle against gravity and is thereby transported from the furnace via the trough and pouring nozzle into a suitable collecting vessel.

As described in German Pat. Nos. 1,286,701 and 1,291,061 conveyor troughs have been used in the past for the metered casting of molten metals. The desired metering quantity is usually varied by controlling the conveying time.

However, in practice it has been found that in accurately metering molten metals with such a conveyor trough, the three-phase current producing the travelling field must be carefully regulated to prevent variations in amplitude and this generally requires additional and expensive equipment in the power supply.

The invention of this application involves a method for metering molten metals whereby the molten metal to be conveyed is moved in an electromagnetic conveyor trough against the force of gravity in a metered open stream by means of an electromagnetic travelling field and whereby the extra cost required to produce a carefully regulated travelling field is avoided.

This is achieved by making the field strength of the electromagnetic travelling field so high that a further increase causes no substantial rise in the thickness of the liquid layer conveyed in the conveyor trough and accordingly no substantial change in the metered quantity.

According to an advantageous embodiment the method and apparatus of the invention is further characterized in that, for a given trough, the layer thickness of the flow of molten metal produced in the trough can be varied by simply varying the frequency of the current producing the travelling field so that a larger layer thickness results from a smaller frequency and vice versa.

According to a further embodiment of the method and apparatus of the invention for a given conveyor trough the layer thickness of the metal flow produced in the trough can be varied by varying the gradient of the trough so that with a larger trough gradient a smaller layer thickness is obtained and vice versa.

The method and apparatus according to the invention is further explained with the aid of the drawing which shows a trough disposed at an angle to the horizontal for conveying metal with a travelling electromagnetic field.

In the drawing, vessel 1 of a holding or smelting furnace is shown schematically and in section. To this vessel 1 is connected an electromagnetic conveyor trough having its trough body 2 mounted at a gradient to the horizontal with its lower end terminating in vessel 1. Under trough body 2, a schematically represented stator winding 3 of a three-phase linear motor is mounted. Stator winding 3 is supplied from a three-phase current source 4 via the transformer 5, and, for connecting three-phase current source 4 to transformer 5, suitable switching means 6 are provided on the primary side of transformer 5.

In vessel 1 of the holding or smelting furnace is a quantity of molten metal 7 with its fluid level 8 extending onto the lower portion of trough body 2. When a three-phase current source is connected to transformer 5, the three-phase current flowing in winding 3 produces an electromagnetic travelling field moving in the direction of arrow 9, which in turn causes an open stream of molten metal in trough body 2 to flow along arrow 9 against gravity and eventually to flow out nozzle 10 into container 11. The thickness of this flowing liquid layer increases, starting from the lower field strengths, initially with rising field strength.

It has now found that after the field strength has increased to particular field strength, further increases in this field strength do not result in any appreciable raise in the layer thickness and thus do not substantially increase the metered quantity. Accordingly, in this field strength range, relatively small variations in the coil currents lead to no appreciable changes in the thickness of the flow layer. It was observed that when working in this field strength range, variations in the coil currents of about 10 percent only resulted in corresponding variations in the layer thickness of less than 1 percent. Consequently a considerably simpler power supply plant can be used for metering purposes than for the case when working takes place in a lower field strength range where this saturation phenomenon does not yet occur. This field strength for any given trough can be easily found by trying increasing values until the particular level is reached.

The boundary layer thickness obtainable in this manner at a conveyor trough gradient of 15–30 percent is in the range $\delta/2-\delta$, whereby δ represents the penetration depth of the electromagnetic field into the molten metal. If with a given conveyor trough it is desired to increase or reduce this boundary value of the layer thickness, this can be done by increasing or decreasing the frequency of the three-phase current, supplying winding 3. Source 4 is preferably capable of producing a wide range of frequency values. Considerably smaller boundary values of the layer thickness can be obtained at an operating frequency of 2,000 Hz. or above than at lower operating frequencies such as 50 Hz. for a given amplitude.

Further, the layer thickness can also be varied by varying the gradient of the trough body 2. By reducing the gradient, the layer thickness boundary value is increased while increasing the trough gradient results in reducing the boundary value. In the drawing, trough body 2 is connected to vessel 1 by hinge 12 for altering the gradient as desired.

Many other changes and modification in the invention can also be made without departing from the scope of the invention and accordingly that scope is intended to be limited only by the scope of the appended claims.

What is claimed is:

1. A method of metering molten metals by means of an electromagnetic conveyor trough having means for producing a travelling electromagnetic wave for causing said meals to move up an inclined trough body against gravity in an open stream including the step of generating said wave with its field strength in a range such that substantial variations in said field strength do not cause substantial variations in the thickness of said stream.

2. A method as in claim 1 wherein said step of generating includes the step of applying a sinusoidal signal to the stator winding of a linear motor mounted below said trough body and further including the step of varying the frequency of said signal to vary said thickness of said stream.

3. A method as in claim 1 including the step of varying the gradient of said inclined body to vary the thickness of said stream.

4. Apparatus for conveying molten metals comprising:

a trough body for guiding a stream of molten metal and inclined with respect to the horizontal,

a linear motor having its stator winding mounted beneath said body and

means for generating a sinusoidal electrical signal and for applying said signal to said motor to produce a travelling electromagnetic wave which causes molted metal to

move against gravity in an open stream up said inclined body and which has its field strength in a range such that substantial variations in said field strength do not cause substantial variations in the thickness of said stream and including means for varying the frequency of said signal as to vary the thickness of said stream.

5. Apparatus for conveying molten metals comprising:

a trough body for guiding a stream of molten metal and inclined with respect to the horizontal,

means for generating a travelling electromagnetic wave along said body for causing molten metal in said body to move against gravity in an open stream up said inclined body and having its field strength in a range such that substantial variations in said field strength do not cause substantial variations in the thickness of said stream and means for varying the angle of said inclined surface with regard to the horizontal so as to vary the thickness of said stream.

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