

Jan. 21, 1958

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2,820,263

DEVICE FOR ULTRASONIC TREATMENT OF MOLTEN METAL

Filed May 13, 1955

FIG 1

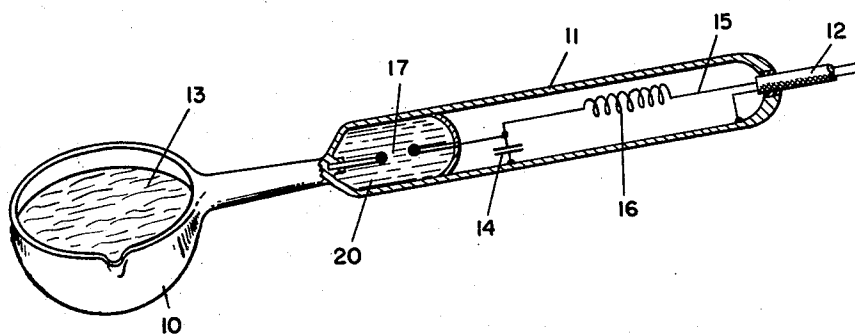
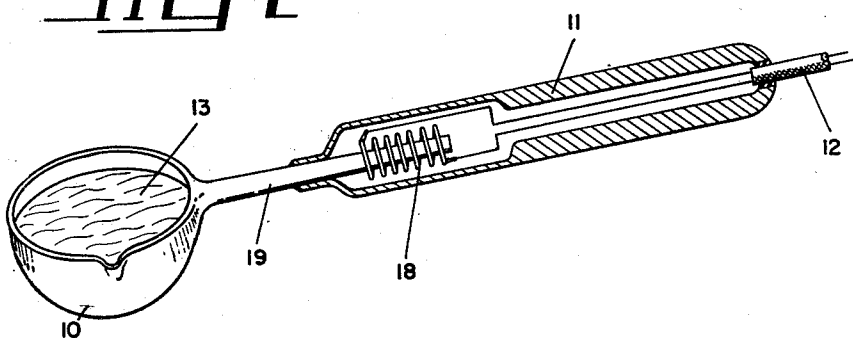


FIG 2



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DEVICE FOR ULTRASONIC TREATMENT OF MOLTEN METAL

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Application May 13, 1955, Serial No. 508,246
In Germany October 1, 1948

Public Law 619, August 23, 1954
Patent expires October 1, 1968

4 Claims. (Cl. 22—86)

The present invention relates to ultrasonic treatment of molten metal and has as one of its objects to provide simple means for such treatment being beneficial in degassing the metal and in obtaining a finer grain in the finished casting.

In the prior art there have been disclosed various methods aiming at introducing ultrasonic energy into a batch of molten metal, but none of these methods could gain widespread recognition because there is not available an ultrasonic transducer that could safely be inserted directly in molten metal. It was necessary to insert long intermediate members, such as rods of tungsten or porcelain between ultrasonic transducer and molten metal, which members caused considerable loss of ultrasonic energy particularly on account of high absorption at vibration frequencies not inherent in members of such material; or it was necessary to excite the crucible, holding the molten metal, by a suitable transducer, which latter practice requires great amounts of ultrasonic energy due to considerable size of the crucible and the thickness of its lining. Besides, an ultrasonic transducer is hard to apply on a crucible of conventional form.

It is a purpose of this invention to provide a simple device and a method for employing ultrasonic vibration in connection with conventional foundry and casting equipment causing little additional expenses.

With this purpose in view, the invention provides for ultrasonic treatment of molten metal on its way between crucible and mold, i. e., directly in the pouring ladle and provides therefor a special ladle having an ultrasonic generator or transducer in its long handle.

Some preferred examples of embodiments of this invention will now be described with reference to the accompanying drawing in which:

Fig. 1 is a diagrammatic view of a pouring ladle having a long handle in which ultrasonic shock wave generating means are arranged; and

Fig. 2 is a similar view showing magnetostrictive means for producing ultrasonic vibration in the handle of a pouring ladle.

The ladles 10, shown in their conventional form as half-spherical bowls, are provided with long handles 11 to which electrical connections are made in the form of cables 12. Pouring ladles are generally not provided with a refractory inner lining, but are coated with a graphite preparation which is a good conductor for ultra sound. Therefore, it is readily possible to subject the molten metal 13 in the ladle to ultrasonic vibration which can be generated in the long handle of the ladle itself. Such ultrasonic generating means may include, as shown in Fig. 1, a storage condenser 14 to which one conductor 15 of cable 12 is connected through an impedance 16. The other terminal of condenser 14 and the other conductor of the cable are grounded to the handle and complete a circuit to which an external source of voltage impulses can be connected for charging condenser 14, whereby impedance 16 serves to limit the charging rate.

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A discharge circuit of condenser 14 includes a spark gap 17 preferably arranged in a sealed chamber 20 filled with water or other liquid. When now the peaks of the condenser charging pulses are higher than the breakdown voltage of the spark gap, sparks will jump through the gap and cause ultrasonic shock waves in the liquid imparting in turn ultrasonic vibration to the content of the ladle.

The arrangement depicted in Fig. 1 is very effective, rugged and reliable in operation, but it is not the only means of producing ultrasonic vibration in a pouring ladle and magnetostrictive transducers can also be employed as indicated in Fig. 2. Here high-frequency current is fed through cable 12 to a coil 18 wound around a handle extension 19 of magnetostrictive material such as, for instance, nickel. When coil 18 is energized by a current of suitable frequency, handle extension 19, being preferably designed for a harmonic natural frequency, will execute ultrasonic vibration which will be imparted on the content 13 of the ladle and will effect ultrasonic treatment thereof. The arrangement shown is of simple construction since the coil can operate with low voltage and is not exposed to excessive heat.

Suitable frequencies for magnetostrictive transducers lie in the range from 5,000 to 150,000 cycles per second. It is, however, advantageous to operate ladles according to this invention, particularly for industrial application, with a frequency of about 10,000 cycles per second, because generating sets for this frequency are extensively used in the field of induction heating, are therefore commercially available, and deliver high-frequency energy at reasonable cost.

Whenever for certain alloys ultrasonic treatment must be extended for longer periods, it may become necessary to apply heat to the ladle in order to prevent excessive cooling of its content before actual casting. Such heating can be provided for by electric heating elements or the ladle can be put on a heater surface for the duration of ultrasonic treatment. Current for heating elements provided in the ladle can be fed through the same cable as the high-frequency or voltage impulse current necessary for producing the ultrasonic energy.

In another arrangement for magnetostrictive excitation of the ladle, a projection of magnetostrictive material can be secured to the bottom or any other part of the ladle proper, which then for the period of ultrasonic treatment can be temporarily inserted in a conveniently located stationary coil excited by current of proper frequency.

The very simplest arrangement for taking advantage of ultrasonic treatment for molten casting material would be a ladle of conventional construction provided with a flat bottom portion which can be brought in close contact with the plane surface of an ultrasonic transducer or can be immersed in a bath which in turn is excited by ultrasonic vibration. For such operation, the transducer is mounted stationary and can be combined with the heating means probably required for keeping the metal melt of temperature.

It will be understood that other arrangements and construction of parts essential for ultrasonic treatment of molten metal in a pouring ladle are possible without departing from the spirit and scope of the invention.

What is claimed is:

1. A device for ultrasonic treatment of molten metal comprising in combination a metal pouring ladle having a long handle, electric means for producing vibration of ultrasonic frequency arranged in said handle, and connecting means for supplying electric energy in suitable form to said vibration producing means.

2. A device for ultrasonic treatment of molten metal comprising in combination a metal pouring ladle having a long handle, a storage condenser accommodated in said

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handle, means for connecting said condenser to a source of voltage impulses for charging the condenser, a discharge circuit for said condenser arranged in said handle and including spark gap means designed for a breakdown voltage lower than the peak of said charging impulses, said spark gap means arranged in a chamber formed in said handle and filled with a liquid, whereby a spark discharge is caused in said liquid whenever the impulse voltage surpasses the breakdown voltage of said spark gap means, said spark giving rise to ultrasonic shock wave radiation exciting said pouring ladle for ultrasonic treatment of its content.

3. A device as set forth in claim 1, wherein said vibration producing means include a spark gap means, handle portions forming a chamber filled with a liquid in which said spark gap means is submerged, and means for causing electric discharges across said spark gap means.

4. A device for treatment of molten metal comprising in combination a metal pouring ladle having a long handle, electric energy storage means accommodated in said handle, connecting means for supplying electric energy to said storage means from an external source, a discharge circuit for said storage means arranged in said handle, handle portions forming a chamber filled with a liquid, said discharge circuit including spark gap means within the liquid filling of said chamber, the breakdown

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potential of said spark gap means being lower than the maximum potential reached by said storage means when electric energy is supplied thereto, whereby a spark discharge is caused across said spark gap means within said liquid whenever the potential of said storage means reaches the breakdown potential of said spark gap means, said spark discharge giving rise to shock wave radiation exciting said pouring ladle for vibration treatment of its content.

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