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MIXING LADLE

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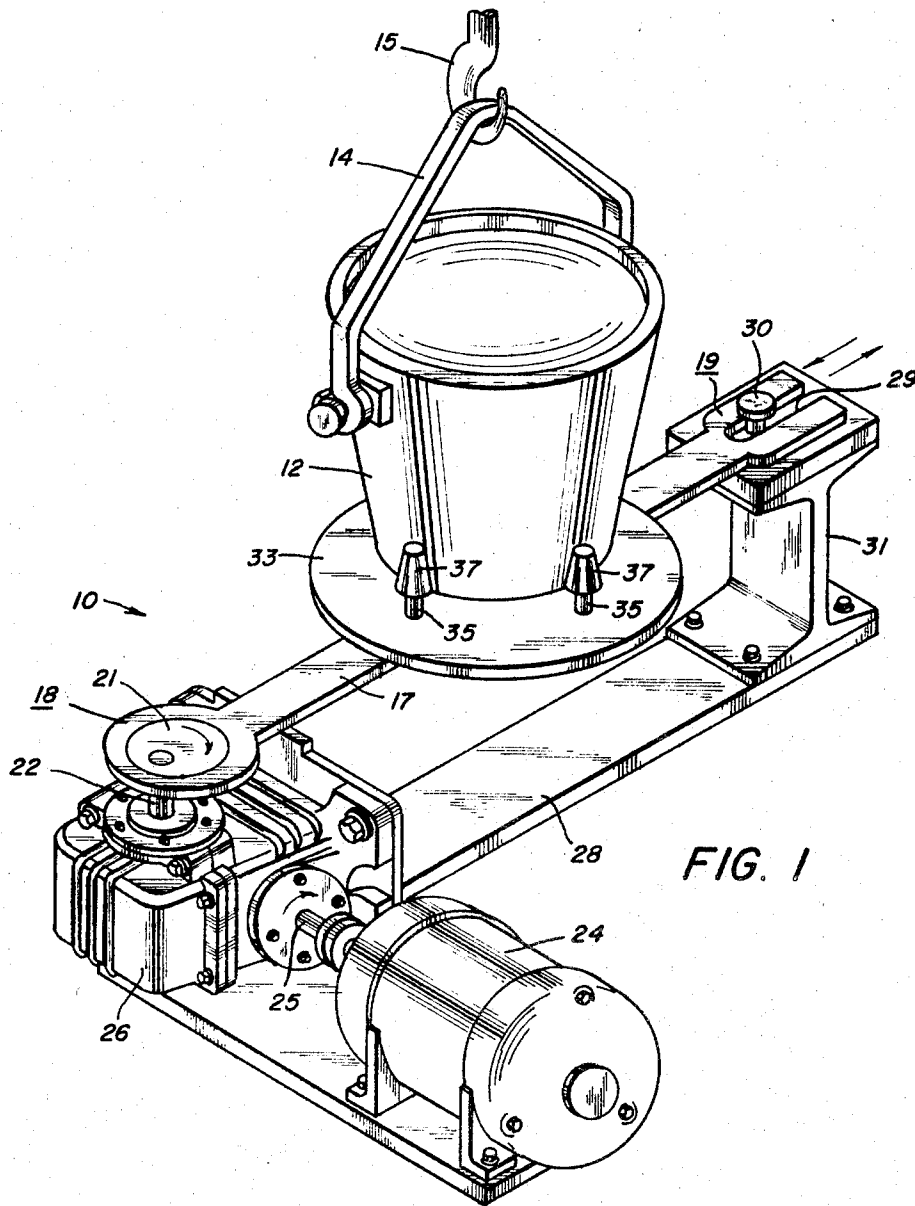


FIG. 1

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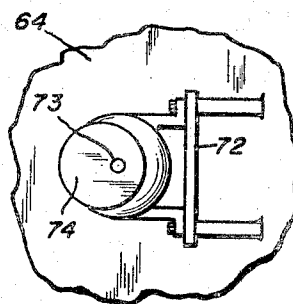
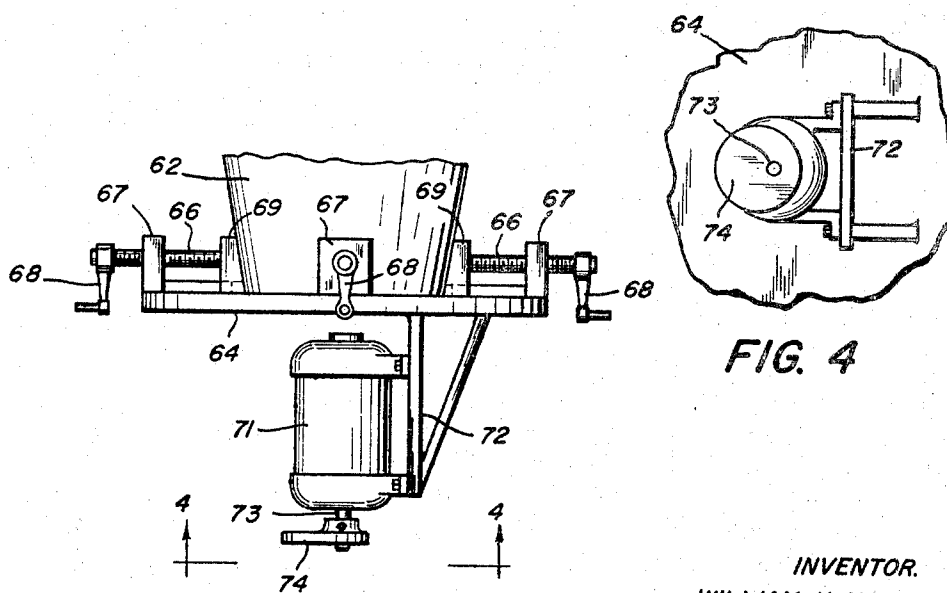
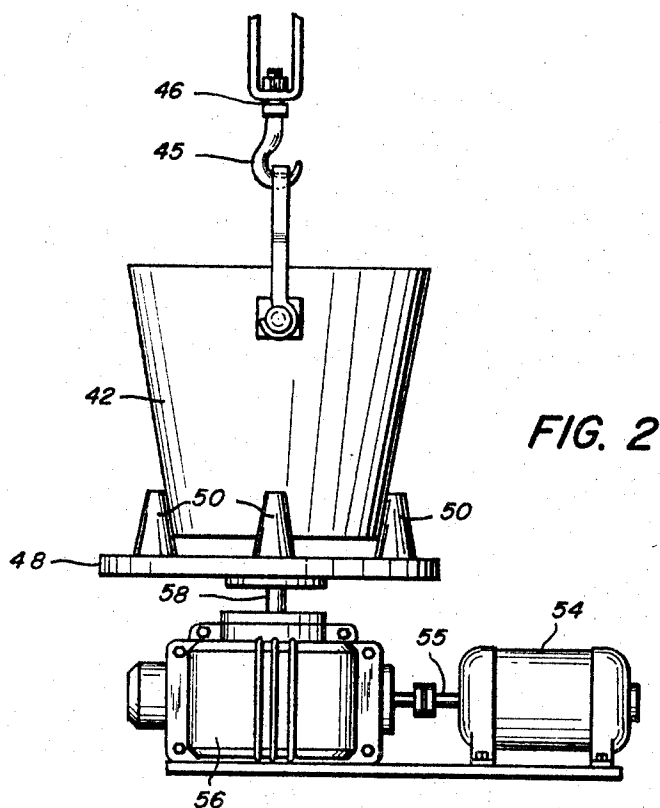
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2 Sheets-Sheet 2



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ABSTRACT OF THE DISCLOSURE

Apparatus and a method for incorporating additives into molten metal which includes the suspending of a ladle preferably by means of a cable so that substantially the entire weight is carried by the cable. An additive is added to the molten metal and the ladle is vigorously moved by apparatus connectable to the ladle. The apparatus disclosed herein may move the ladle through a generally elliptical path, a circular path, a combination of an oscillating and circular path, and combinations thereof.

My invention relates to a ladle device adapted to be moved vigorously and, more particularly, to an improved method of incorporating alloys and addition agents into molten metal.

Mixing of alloys and addition agents with molten metal has been accomplished by many means, including stirring with a wooden pole, a metal, or a refractory rod. More recently, gas, introduced below the surface of the metal through a porous refractory plug, has been used to impart a stirring or mixing motion to the metal. Another popular method employed by those skilled in the art, is to use a special ladle adapted to move mechanically in such a way that vigorous mixing of the contents of the ladle becomes possible. These devices have come to be known as shaking ladles. My invention relates to an improved type of shaking ladle.

An object is to provide an apparatus and method of shaking a ladle, to impart movement of the metal contained therein.

A further object is to provide an apparatus and method which will help promote desulphurization of molten metal, using chemical desulphurizing agents.

A further object is to provide a means of improving the homogeneity of molten metal, to which alloys have been added.

A further object is to provide an inexpensive means of incorporating alloys of low solubility into molten metal.

Still further objects will be apparent from the specification and drawings, in which:

FIGURE 1 is an isometric view of one form of the apparatus of the present invention;

FIGURE 2 is an elevational view of another form of the apparatus of the present invention;

FIGURE 3 is a fragmentary elevational view of still another form of the apparatus of the present invention; and

FIGURE 4 is a view taken generally along the line 4—4 of FIGURE 3.

The efficient and effective incorporation of certain materials and alloys into molten metal has always presented a special problem to foundrymen and metallurgists. Certain alloys which are completely soluble in molten metal, such as—silicon in cast iron, tin in copper, or nickel in steel, may be incorporated into a bath of molten metal without any great difficulty. Certain other alloys have higher melting points than the metal to which they are being added, or else are not completely miscible in this metal. Examples would be tungsten in cast iron or steel and lead in copper. Such alloys can only be added successfully when they are thoroughly stirred into the metal

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or when a stirring or mixing action is deliberately promoted in the metal.

Certain other additives, such as carbon in cast iron, cannot be incorporated, without some vigorous mixing action.

In desulphurizing cast iron or steel using calcium carbide, soda ash, or other sulphur fluxing materials, a stirring action constantly presenting fresh metal-to-slag contact is essential for success. Such action is preferably accompanied by a folding action, where the materials are caused to be drawn under the surface of the metal, so that losses of these materials by oxidation at the surface is at a minimum. Effective stirring greatly decreases both the time and the cost involved in desulphurizing.

In recent years several machines adapted for shaking ladles have become available on the market. These machines, in general, consist of a special vessel, which rotates and oscillates to impart a defined wave action to the molten metal, or they consist of a special table to which a ladle is attached, for the same purpose.

Machines of this type have to be robust, in order to support the full weight of the ladle or vessel, as well as that of the molten metal. Consequently, they require a very substantial capital investment and their use is, therefore, strictly limited to large operations.

I have discovered that movement may be imparted to a ladle of metal which is suspended from a crane and this movement is particularly effective in incorporating additive materials into the metal. As the ladle of metal is hanging freely in the air during this movement, the power required for imparting movement to the molten metal in the ladle, is quite low. Further, this improved metal is readily adaptable to utilize crane ladles already available in the foundry and used for the purpose of transporting molten metal. This allows incorporation of materials into the metal in the minimum time, as it is not necessary to transfer this metal into special ladles fixed on rotating tables, which is common practice in the art. The speed and convenience of my apparatus and method results in conservation of the temperature of the molten metal.

It is important that movement be imparted to the molten metal in the process of my invention and that it cause agitation and constant motion between the additives and the metal. While I prefer a circular movement with sufficient speed and eccentricity (resulting in a generally elliptical path) to cause a wave action at the metal of the surface, it is also possible to impart a forward and reverse rotating movement to the ladle, which also provides an intensive mixing action. The more important feature of my invention is that the ladle of metal be suspended freely from a crane or hoisting device, when the movement is imparted to it.

The rotating movement is preferably imparted to the ladle by attaching it temporarily to a table adapted to rotate with the desired speed and eccentricity. I have found, also, that a motor with eccentric flywheel, may be attached to the ladle, so that it hangs suspended with the ladle and promotes a circular and/or oscillating movement to the ladle, when the motor is activated and the eccentric flywheel is caused to rotate.

FIGURE 1 is an isometric view of one form of an apparatus constructed under the teachings of the present invention, which has been indicated generally by the reference numeral 10. This apparatus includes in combination a ladle 12 having a conventional handle 14 and the ladle is supported by means of a hook 15 in turn carried by a cable or chain suspended or carried from an overhead crane or other vertically extending means. In this particular embodiment, the hook may or may not swivel relative to the cable during the movement which is imparted by means of the apparatus 10.

Motive power means are provided for imparting the movement which will be described hereinafter and this motive power means includes an arm 17 having first and second end portions 18 and 19 respectively. The first end portion 18 is carried by a rotatable member 21 which is adapted to rotate relative to the first end portion 18 and this rotatable member is driven by a shaft 22 which is mounted off the center of the rotatable member 21 thereby effectively making the rotatable member 21 a crank. The shaft 22 is driven by a motor 24 which may be electric or of any other suitable type. The motor 24 has a shaft 25 which drives the shaft 22 through a gear box 26. The motor and gear box are suitably mounted on a base 28 and the second end portion 19 of the arm 17 is formed with a guideway 29 which cooperates with a guide pin 30 which is mounted on a vertical extension 31 of the base 28. It will therefore be apparent as the rotatable member 21 is caused to rotate the arm 17 is caused to move in a crank-like manner and the guideway and guidepin 29, 30 properly attend to the positioning and location of the second end portion 19 of the arm 17.

Attaching means are provided to interconnect the motive power means to the ladle, and in this particular embodiment the attaching means comprises a circular plate 33 welded or otherwise suitably attached to an intermediate portion of the arm 17. Projections 35, preferably four in number and located 90 degrees apart, extend vertically from the upper surface of the plate 33 and these projections include an upper generally conically shaped portion 37 with the taper on the conically shaped portion generally conforming to the taper on the lower portion of the ladle. Because of the positioning of the projections 35 and the generally mating surfaces of the conically shaped portions 37 relative to the sides of the ladle, the ladle is held without the necessity of supporting the weight of the ladle and the metal by way of the plate 33 and the rest of the apparatus of FIGURE 1. In other words, the ladle is not lowered to a point where any substantial part of the weight thereof is carried by the apparatus, but merely so that the lower part of the ladle is confined between the projections 35. The bottom of the ladle is spaced from the plate 33 as in FIGURE 2.

It will therefore be seen that as the arm 17 and plate 33 go through the movement prescribed by the crank action of rotatable member 21, and a given point in or on the ladle will be caused to move through a generally elliptically shaped path and molten metal contained within the ladle will be subjected to a movement which will cause additives placed therein to be vigorously mixed therewith. The amount of agitation imparted will of course be partially a function of the speed of rotation of the rotatable member as well as the throw of the crank arm. It is appreciated of course that this movement is imparted to the ladle while substantially the entire weight of the ladle is supported by the hook 15 and the vertically extending cable or chain to which it is attached. It will also be appreciated by those skilled in the art that the drive motor 24 may be supplied with a mechanism which enables the movement of the crank to be reversed at various intervals thereby reversing the direction of movement of the ladle. Supports may also be provided with this apparatus which will safeguard against accidental upsetting of the ladle while it is being moved.

FIGURE 2 is a modified form of an apparatus constructed in accordance with the teachings of the present invention and in this embodiment there is disclosed a ladle 42 carried by a hook 45 which is provided with a swivel construction as at 46. In other words, the swivel construction 46 enables the hook to rotate without in effect winding up the chain or cable which extends vertically above and which carries the weight of the ladle by means of a crane or other device. The attaching means in this embodiment comprises a plate 48 which has a plurality of vertically extending projections 50 extend-

ing vertically therefrom and being preferably at least four in number and having a taper which generally matches the taper on the bottom walls of the ladle. The interconnection between the bottom of the ladle and the projections is in effect slightly wedging and is sufficient to carry the ladle through its rotational travel with essentially no slippage therebetween but which does not cause substantially any of the weight of the ladle to be exerted upon the plate and the construction located vertically below the same.

The motive power means in this particular construction comprises a motor 54 which may be an electric motor or other suitable power plant which has a shaft 55 which extends to a gear box 56 and another shaft 58 extends out of the gear box and is connected to the plate 48. As a result of this construction the motor 54 causes the ladle to be rotated through a rotational path which is permitted by way of the swivel construction 46 and the speed of rotation of course is a function of the motor speed and gear box construction. This apparatus can be caused to be reversed at various intervals if desired to aid the action mixing between molten metal carried in the ladle and additives which are added thereto.

FIGURE 3 is still another form of the apparatus of the present invention and in this embodiment the ladle 62 may be carried either by the construction shown in FIGURE 1 or the construction shown in FIGURE 2. In other words, a swivel connection can be provided as at 46 in FIGURE 2 or there may be no swivel construction. In this particular embodiment the attaching means comprises a plate 64 or equivalent structure which carries a plurality of screw members 66, preferably four in number and located 90 degrees apart, which screw members are carried by vertical members 67. The ends of the screw members opposite the cranks 68 carry engaging blocks 69 which are adapted to be moved into and out of contact with the lower tapered sides of the ladle 62. The motive power means in this particular embodiment comprises a motor 71 which is carried by a support 72 which extends off the bottom side of the plate 64 and a shaft 73 from the motor is adapted to drive what may be referred to as an eccentric mass 74. The eccentricity of the mass can best be seen in FIGURE 4.

The device of FIGURES 3 and 4 is utilized by attaching the plate to the bottom portion of the ladle as shown when the ladle is brought into a position to be vigorously agitated. When the plate is attached by screwing the blocks 69 into tight engagement with the sides of the ladle, the motor 71 is then energized causing the eccentric mass to be rotated at the desired rotational speed. If the hook and cable construction has no swivel connection, the ladle will be caused to in effect oscillate back and forth, at least after the slack in the cable is wound up, causing additives to be more readily incorporated into the molten metal. In the event a swivel type construction is provided as in FIGURE 2, the motor 71 and eccentric mass 74 will cause the ladle to travel in a generally circular path while also moving back and forth. The path may be described as a wavy generally circular path.

As a result of the constructions in FIGURES 1, 2 and 3 it may be said that a method has been provided for incorporating additives into molten metal which involves or comprises the steps of suspending the ladle from a vertically extending cable or other equivalent means where substantially the entire weight of the ladle and metal is supported thereby. An additive is then committed to the molten metal and the ladle is then vigorously moved while so suspended to facilitate incorporation of the additive into the molten metal. The apparatus of FIGURE 1 causes the ladle to be moved through a generally elliptical path whereas in FIGURE 2 the ladle moves in a generally circular path. In the device of FIGURE 3 the ladle may be either moved through an oscillating path or through a combination of an oscillating and circular path.

The working of my invention is conveniently illus-

trated by a small laboratory size 6" diameter ladle, holding 20 pounds of molten metal and attached to an eccentric arm rotating at 100 r.p.m., with an eccentricity of 3½" in a device similar to that shown in FIGURE 1.

A molten cast iron having a sulphur content of 0.08% was placed in a ladle together with 2% of calcium carbide. This mixture was thoroughly stirred by hand with a steel rod for two minutes and the metal was then cast into a pig, which was analyzed for sulphur. This sulphur content was found to be 0.07%, representing a sulphur reduction of 12½%.

A second portion of this same metal was placed in another ladle, together with 2% of calcium carbide. This ladle was suspended from a crane and its lower end was connected to the eccentric arm, which was activated for a period of 1½ minutes. The metal was then pigged and analyzed for sulphur content, which was found to be .01%, representing a sulphur reduction of 87½%.

In actual foundry practice utilizing ladles of 1000 lbs. or 2000 lbs. capacity, I have found sulphur reductions in the order of 90 to 95% in a period of one minute using 2% of calcium carbide, or 1½ minutes using 1½% of calcium carbide, or two minutes using 1% of calcium carbide.

To suit the varying dimensions and shapes of foundry ladle, I have found it is most convenient to have an eccentric arm, which can be varied, both in speed of rotation and in degree of eccentricity. Where the ladle is large in capacity, I prefer to use a higher speed of rotation and a lesser degree of eccentricity; whereas when the ladle is small in capacity, I prefer to use a slower speed and a higher degree of eccentricity. In any case, the speed and eccentricity are varied to give maximum motion of the molten metal, without the danger of spilling it over the sides of the ladle and to decrease the impact forces on the crane or suspending means.

I usually prefer to use a cover on the ladle to minimize the danger of splashing and to conserve molten metal temperature. I have found that speeds ranging from 5 r.p.m. to 200 r.p.m. and eccentricities ranging from 1" to 24" are usually sufficient to give adequate mixing to all normal foundry ladles.

I have also found that my shaking ladle device is particularly effective for adding carbon to molten cast iron and in non-ferrous metal is effective for incorporating high lead contents in leaded bronzes. The use of this ladle device has allowed the use of smaller quantities of material in such procedures as desulphurizing, nodularizing, etc.

In addition to this, my device, because of its low cost and utilization of standard foundry equipment, has made available to all foundries a simple and effective mixing device, without the need for major capital investment.

Although my invention has been described in its preferred form with a certain degree of particularity, it is understood that the present disclosure of the preferred form has been made only by way of example and that numerous changes in the details of construction and in the combination and arrangement of parts may be re-

sorted to, without departing from the spirit and scope of the invention as hereinafter claimed.

What is claimed is:

1. The method of incorporating additives into molten metal carried in a ladle comprising the steps of suspending the ladle from a vertically extending cable whereby substantially the entire weight of the ladle is supported thereby, adding an additive to the molten metal, and vigorously moving said ladle while so suspended to facilitate incorporation of said additive into the molten metal.

2. The method of claim 1, wherein the ladle is moved through a generally elliptical path.

3. The method of claim 1, wherein the ladle is moved about a substantially fixed axis in a circular path.

4. The method of claim 1, wherein the ladle is moved through a rapidly oscillating path.

5. The method of claim 1, wherein the ladle is moved through a path which is a combination of an oscillating and a circular path.

6. Apparatus for incorporating additives into molten metal including in combination a ladle for holding molten metal, means extending vertically above said ladle and connected thereto for freely suspending the same and to carry substantially all of the weight thereof, motive power means located adjacent the lower portion of said ladle, and attaching means for connecting said motive power means to said lower portion of said ladle whereby said ladle is vigorously moved upon actuation of said motive power means, said attaching means comprising a plate having generally vertically extending projections engaging said lower portion of said ladle and said motive power means comprising an arm connected intermediate its end portions to said plate and driven through an elliptical path by a crank mechanism in turn driven from a motor.

7. Apparatus for incorporating additives into molten metal including in combination a ladle for holding molten metal, means extending vertically above said ladle and connected thereto for freely suspending the same and to carry substantially all of the weight thereof, motive power means located adjacent the lower portion of said ladle, and attaching means for connecting said motive power means to said lower portion of said ladle whereby said ladle is vigorously moved upon actuation of said motive power means, said attaching means comprising a plate having generally vertically extending projections engaging said lower portion of said ladle and said motive power means comprising a motor connected to said plate by a shaft which drives said plate through a rotational path.

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