United States Patent [19]

Miller

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[54] **IMMERSION BELL**

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[52] **U.S. Cl.** ..... **266/34 T**

[51] **Int. Cl.** **C21c 7/00**

[58] **Field of Search**..... 266/34 A, 34 T; 75/45, 50, 75/53, 61, 93 R

[56] **References Cited**

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[57] **ABSTRACT**

An apparatus for introducing reagents beneath the surface of molten metal comprising a tubular member which is detachably fastened to a closure member. Expansion spaces are provided between the sidewalls of the tubular member and the closure member minimizing thermal stress in the sidewalls.

13 Claims, 4 Drawing Figures

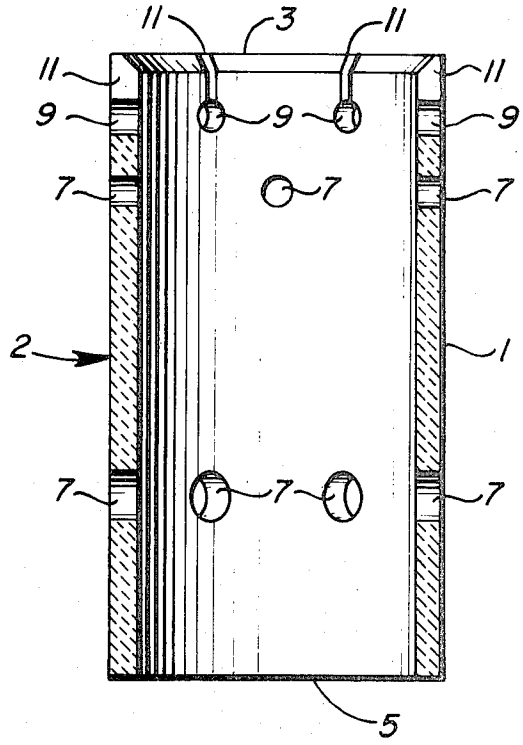
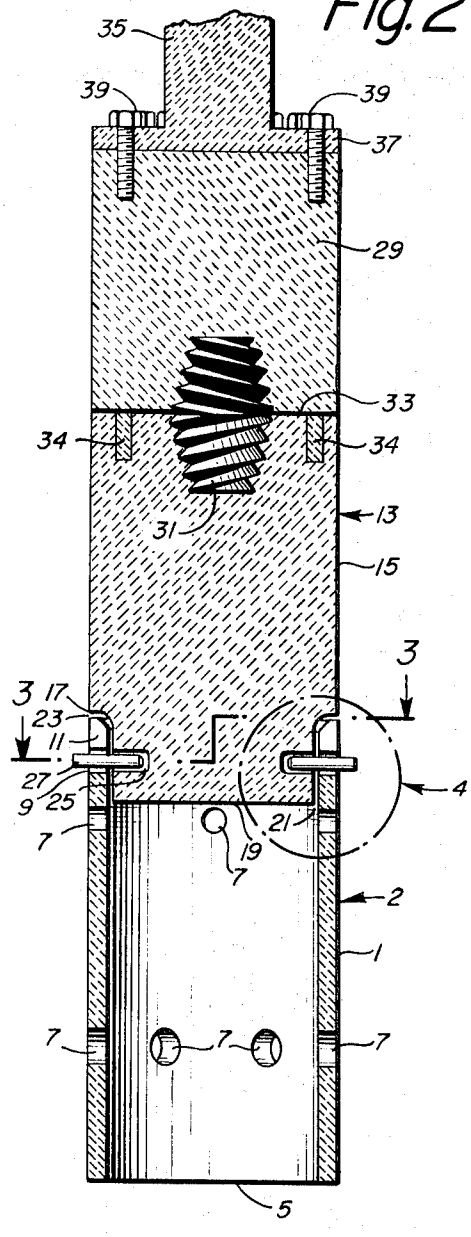


Fig. 2



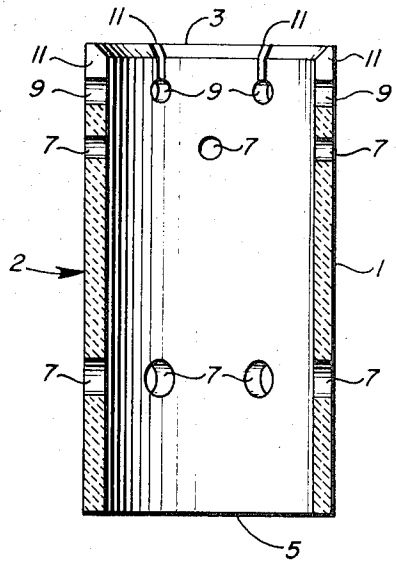


Fig. 1

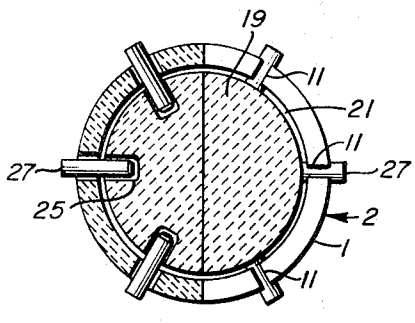


Fig. 3

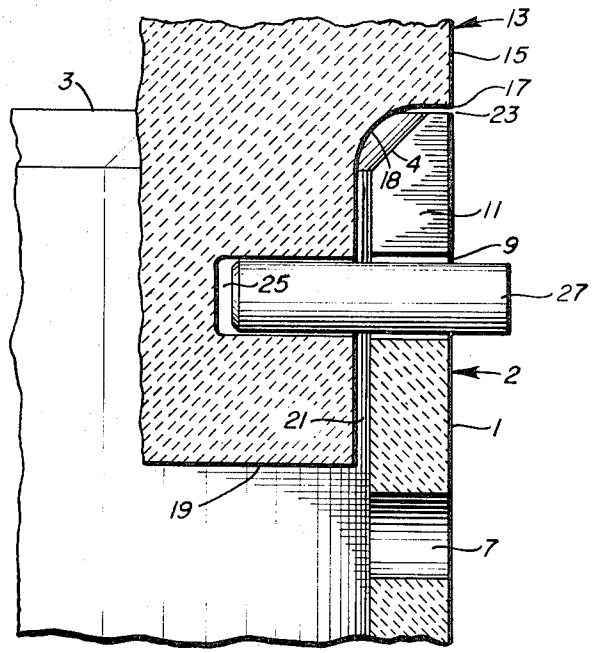


Fig. 4

IMMERSION BELL

BACKGROUND OF THE INVENTION

This invention relates to an apparatus for treatment of molten metals, and more particularly, an apparatus for introducing a volatilizable reagent such as magnesium into molten iron and steel.

Low boiling point alkali metal agents, such as magnesium, are often added to molten iron and steel to decrease or remove impurities. One form in which magnesium can be added is a material comprising a combination of coke and metallic magnesium, as described in U.S. Pat. No. 3,321,304 issued to William E. Snow on May 3, 1967.

One method for adding magnesium to molten metal is known as plunging and employs an immersion bell for introducing reagents beneath the surface of molten metal. Immersion bells are usually made of a suitable refractory material so they are reusable. Most reusable immersion bells resemble an inverted cup having sidewalls which converge into a top portion to which is attached a plunging rod. The plunging rod is usually comprised of a refractory protected metal shaft.

It has been discovered that reusable refractory immersion bells often crack due to thermal stresses arising as a result of its immersion into the molten iron or steel. These stresses can occur in the area where the relatively thin sidewalls merge into the more massive top part of the bell. The stresses are believed to occur because the thin sidewalls respond more rapidly to thermal changes than does the more massive top part of the bell.

In prior plunging bell designs, replacement of cracked sidewalls or a warped plunging rod is often difficult because the plunging rod is securely fastened to the top part of the immersion bell.

SUMMARY OF THE INVENTION

It is an object of this invention to provide an immersion bell which minimizes cracking due to thermal stress.

It is also an object of this invention to provide an immersion bell which permits rapid replacement of the sidewalls or plunging rod.

It has been discovered that the above objects can be achieved in an immersion bell having a refractory tubular member freely suspended from the bottom of a closure member, permitting the tubular member and closure member to respond individually to thermal changes.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a cross sectional elevation of the tubular member of this invention.

FIG. 2 is a cross sectional elevation of the apparatus of this invention.

FIG. 3 is a cross sectional view taken along line 3—3 of FIG. 2.

FIG. 4 is an enlarged view of the portion of the invention shown within circle 4 of FIG. 2.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to FIG. 2, heat resisting plunging rod **35**, as for example steel, is securely fastened to cylindrical graphite extension member **29** by any suitable means, in this case, flange **37** and a plurality of bolts **39**. Not shown is a splash deflector means which is securely fastened to plunging rod **35**. Also not shown is a suitable means for raising and lowering the immersion bell, and which is commonly an overhead crane or the like.

Extension member **29** is connected by a well known means to a solid cylindrical graphite closure member shown generally as **13**. Closure member **13** and extension member **29** together are long enough to extend above the surface of the molten metal during the immersion cycle. Preferably, extension member **29** and closure member **13** are connected by threaded and tapered graphite pin **31** and a suitable refractory cement **33**, and threaded holes **34** are filled with graphite powder. If extension member **29** is not used, plunging rod **35** is fastened to the upper end of closure member **13**.

Closure member **13** includes a body portion **15**, a shoulder portion **17** engaging the body portion **15** and a lower end **19** of reduced diameter. Closure member **13** extends into top opening **3** formed by sidewalls **1** of cylindrical tubular member shown generally as **2**. Lower end **19** of closure member **13** is spaced from sidewalls **1** providing an annular expansion space **21** between sidewalls **1** and lower end **19**. Shoulder **17** is spaced from the top edge of sidewalls **1** providing annular expansion space **23** between top edge of sidewalls **1** and shoulder **17**.

In the preferred embodiment, the diameter of body portion **15** is not less than the outside diameter of cylindrical tubular member **2**, and the diameter of lower end **19** is slightly less than the internal diameter of tubular member **2**.

Lower end **19** includes a plurality of pin receiving holes **25**. In the preferred embodiment, six pin receiving holes are spaced at equal intervals around the periphery of lower end **19**, with the centerlines of the holes at the same elevation below the shoulder **17**.

The sidewalls **1** have extending through their thickness a plurality of fastener holes **9** spaced to coincide with pin receiving holes **25**.

Tubular member **2** freely suspends from closure member **13**, by means of cylindrical graphite pins **27**, which extend through fastener holes **9** and into pin receiving holes **25**, detachably fastening tubular member **2** to closure member **13**. Tubular member **2** and closure member **13** are individually free to expand laterally and longitudinally. The pins **27**, pin receiving holes **25** and fastener holes **9** are but one means of connecting tubular member **2** to the bottom of closure member **13**. Other suitable means can be used, so long as individual expansion of tubular member **2** and closure member **13** is permitted.

FIG. 1 shows cylindrical tubular member **2**, having sidewalls **1** terminating at a top opening **3** and a bottom opening **5**. Preferably, the sidewalls **1** are substantially parallel, of uniform thickness, and are made of graphite. The length and thickness of sidewalls **1** can be any suitable dimension. The sidewalls **1** have extending through their thickness a plurality of vapor escape holes **7** of various sizes, and at various positions, as is well known in the art.

Extending between the top edge of sidewalls **1** and each fastener hole **9** and pin **27** is a slot **11**. The slot **11** penetrates the full wall thickness of sidewalls **1** and can be made with any suitable saw blade. Such slot helps minimize thermal stresses which might occur in side-

walls 1 thus minimizing the growth of cracks along the full length of sidewalls 1.

FIG. 3 more clearly shows annular expansion space 21 between cylindrical sidewalls 1 and lower end 19 of closure member 13. Lower end 19 substantially closes top opening 3.

FIG. 4 more clearly shows sidewalls 1 fastened to lower end 19. Shoulder 17 is shown to engage lower end 19 by means of a fillet 18. The interior of upper edge of sidewalls 1 forms a chamfer 4. The clearance between pin 27 and fastener hole 9, together with slot 11 and expansion spaces 21 and 23 forms an expansion joint which permits tubular member 2 and closure member 13 to respond individually to thermal change.

One method of forming sidewalls 1 is by hollowing, with well known means, scrapped graphite electrodes of the type used in electric arc furnace. However, other forming methods can be used, such as casting or extrusion, and other refractory materials well known in the art can be employed, such as fireclay. Closure member 13 and extension member 29 can be made from the same type electrodes or refractory material as sidewalls 1.

Referring to FIG. 2, an alternative means of connecting extension member 29 to plunging rod 35 is by adapting extension member 29 and plunging rod 35 to receive a tapered and threaded pin similar to 31.

A second alternative embodiment is one in which the diameter of body portion 15 is made equal to the diameter of lower end 19.

In another embodiment, lower end 19 of closure member 13 can be eliminated and closure member 13 can be spaced above top opening 3 and sidewalls 1 forming annular expansion space 23 between sidewalls 1 and closure member 13. Any suitable connecting means can be used to connect tubular member 2 to closure member 13.

It should be understood that tubular member 2, closure member 13 and extension member 29 are preferably cylindrical but other shapes can be used.

In actual practice, I have successfully used immersion bells 15 to 30 times each in which the tubular member 2 is 42 inches long, 24 inches in outside diameter with sidewalls 1 two inches thick, a slot 11 1/16 inch wide, and 2⅛ inch diameter fastener holes 9 drilled four inches below the top edge of the sidewalls 1. The closure member 13 is 44 inches long, with a body portion 15 24 inches in diameter, a lower end 19 19½ inches in diameter, pin receiving holes 25 2-1/16 inch in diameter, 3½ inches deep, drilled 4-1/16 inches below the shoulder 17 of the closure member. Fillet 18 is one inch and chamfer 4 is one ench at an angle of 45°. Two inch diameter pins 27 are used. The annular expansion space 21 is one-fourth inch, while annular expansion space 23 is one-sixteenth inch. The clearance between the pin 27 and sidewalls 1 is one-sixteenth inch.

I claim:

1. An immersion bell for introducing reagents beneath the surface of molten metal comprising:
   a. a plunging rod;
   b. a solid closure member secured to one end of said plunging rod;
   c. a tubular member freely suspended from the lower end of said closure member; and
   d. said tubular member having substantially parallel sidewalls spaced from said closure member.

2. An immersion bell for introducing reagents beneath the surface of molten metal comprising:
   a. a tubular member having sidewalls terminating in a top opening;
   b. a closure member extending into said top opening and spaced from said sidewalls;
   c. expansion joint means to fasten said tubular member to the lower end of said closure member; and
   d. means to fasten the upper end of said closure member to a plunging rod.

3. An immersion bell for introducing reagents beneath the surface of molten metal comprising:
   a. a tubular member having sidewalls terminating in a top opening;
   b. a closure member extending into said top opening and spaced from said sidewalls;
   c. expansion joint means to fasten said tubular member to the lower end of said closure member including a plurality of pins extending through said sidewalls and into the lower end of said closure member; and
   d. means to fasten the upper end of said closure member to a plunging rod.

4. Apparatus according to claim 3 in which said sidewalls contain a plurality of slots extending between each said pin and the top edge of said sidewalls.

5. Apparatus according to claim 4 in which said sidewalls contain a plurality of vapor escape holes.

6. An immersion bell for introducing reagents beneath the surface of molten metal comprising:
   a. a tubular member having substantially parallel sidewalls terminating in a top opening;
   b. a closure member including:
      1. a body portion,
      2. a shoulder portion spaced from the top edge of said sidewalls, and
      3. a lower end portion extending into said top opening and spaced from side sidewalls;
   c. expansion joint means to fasten said tubular member to said lower end portion of said closure member; and
   d. means to fasten the upper end of said body portion to a plunging rod.

7. An immersion bell for introducing reagents beneath the surface of molten metal comprising:
   a. a tubular member having sidewalls terminating in a top opening;
   b. a closure member including:
      1. a body portion,
      2. a shoulder portion spaced from the top edge of said sidewalls, and
   c. expansion joint means to fasten said tubular member to said lower end portion of said closure member comprising a plurality of pins extending through said sidewalls and into said lower end portion of said closure member; and
   d. means to fasten the upper end of said body portion to a plunging rod.

8. Apparatus according to claim 7 in which said sidewalls contain a plurality of slots extending between each said pin and the top edge of said sidewalls.

9. Apparatus according to claim 8 in which the diameter of said body portion is not less than the outside diameter of said tubular member.

10. Apparatus according to claim 7 in which the diameter of said lower end is slightly less than the inside diameter of said tubular member.

11. Apparatus according to claim 8 in which the sidewalls contain a plurality of vapor escape holes.

12. An immersion bell for introducing reagents beneath the surface of molten metal comprising:

a. a tubular member having substantially parallel sidewalls terminating in a top opening;

b. a closure member above said opening and spaced from said sidewalls;

c. expansion joint means to fasten said tubular member to said closure member to allow said tubular member to freely expand in a lateral and longitudinal direction; and

d. means to fasten the upper end of said closure member to a plunging rod.

13. Apparatus according to claim 10 in which said sidewalls contain a plurality of vapor escape holes.

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