Oct. 18, 1966 J. W. YATES 3,279,003

COMPOSITE POURING TUBE

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FIG 2

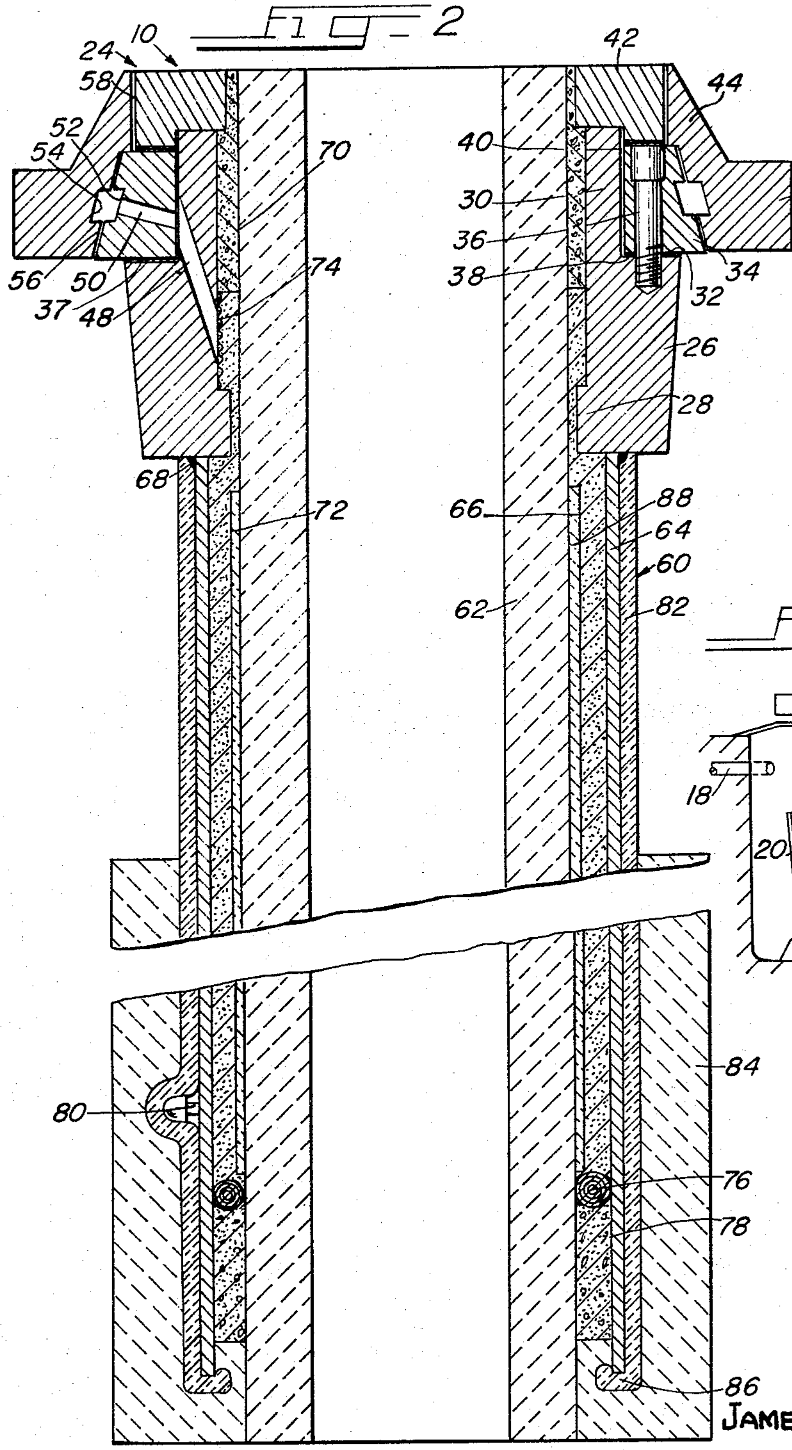
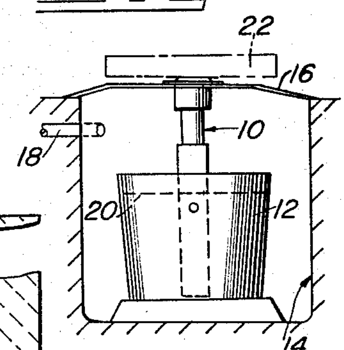


FIG 1



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COMPOSITE POURING TUBE

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The present invention relates to a composite pouring tube.

The pouring tube of the present invention is particularly adapted to use with casting iron and steel in which the molten metal involved is of extremely high temperatures and is highly deleterious to equipment and materials used in connection therewith.

The invention has further particular adaptation to pouring tubes for pressure pouring where the pouring tubes are immersed in the molten metal to be cast.

Pouring tubes for use in casting iron and steel are normally composed of, or include as a substantial component thereof, refractory material which is capable of withstanding attacks by the molten metal. Refractory material is relatively brittle and weak, and it has the further disadvantage that it is porous, enabling, at least in certain instances, air and gases to penetrate therethrough and into the molten metal being cast, resulting in bubbles in the casting which, of course, constitute defects.

A broad object of the present invention is to provide a pouring tube for use in pressure pouring iron and steel which incoporates a steel shell therein which serves the dual purpose of providing strength to an otherwise weak tube, and forms an impermeable membrane to the passage of air and gases through the wall of the pouring tube.

Such a steel shell has certain disadvantages, the most serious of which it its liability to attack by molten iron and steel. It has another disadvantage in that it has a high coefficient of expansion relative to refractory and other materials normally used in pouring tubes of this general nature.

Another and more specific object of the invention therefore is to provide a composite pouring tube which includes refractory and other material capable of withstanding attack by the molten metal, which incorporates a steel shell therein for the purposes stated, and further in which the steel shell is incorporated in such a manner as to protect it from attack by the molten metal, and to compensate for differential in coefficients of expansion of the steel and refractory material.

Still another and specific object of the invention is to provide a composite pouring tube of the character just referred to wherein the securement between the steel shell and the refractory materials is located principally adjacent one end of the tube whereby to accommodate relatively greater expansion and contraction between the steel shell and refractory material throughout a greater portion of the length of the tube, as contrasted with providing such securement throughout the length of the tube.

Other objects and advantages of the invention will appear from the following detailed description taken in conjunction with the according drawings wherein:

FIGURE 1 is a small scale view showing the use of a pouring tube in conjunction with a ladle and mold in a pressure pouring arrangement; and

FIGURE 2 is a large scale longitudinal sectional view of such a tube embodying the features of the present invention.

Referring now in detail to the drawings, attention is directed first to FIGURE 1. A pressure pouring tube is shown at 10 mounted in conjunction with a ladle 12 in which the lower end of the tube extends into the ladle to a point adjacent the bottom thereof. The ladle is suitably disposed, such as in a pit 14 closed by a cover 16 which surrounds the pouring tube and also serves as a means for mounting and supporting the pouring tube in the desired position. Air or other gas is provided from a suitable source (not shown) and transmitted through a conduit 18 into the interior of the pit. Upon the air or other gas reaching the necessary pressure it forces the molten metal 20 in the ladle upwardly through the pouring tube and into a mold 22 placed above the tube and having an ingate passage in communication with the pouring tube. After the mold is filled, the supply of air is cut off and the mold removed and replaced by another mold in repeated steps until the molten metal in the ladle is substantially completely poured.

Such pouring tubes are of various sizes according to the installations in which they are used and the bigger sizes present correspondingly greater problems. Because the lower end of the tube must extend substantially to the bottom of the ladle, the problems are intensified because a greater portion of the tube is subjected both inside and out to molten metal in the ladle, for at least portions of the pouring operations.

The tube 10 made according to the present invention and shown in detail in FIGURE 2 includes a head assembly 24 which constitutes the means for supporting the tube in position by the cover 16. This head 24 is preferably made up of a plurality of steel parts including an inner ferrule 26 having a radially inwardly extending flange 28. The upper portion 30 of this ferrule is of reduced diameter forming a shoulder 32 on which is disposed a ring 34 secured in place by cap screws 36 inserted in holes therein and threaded into the ferrule 36. An asbestos gasket 37 is interposed between this ring and the shoulder 32, but preferably a vent space 40 is provided between the ring and the outer cylindrical surface of the extension 30. The radially outer portion of the ring 34 constitutes the part that directly engages the cover 16 of the pit for supporting the tube in position. A collar 42 is fitted above the ring 34 and has a radially inwardly directed flange 44 overlying and engaging the upper end of the ferrule 26. Surrounding the foregoing is a holding ring 44 having a radially outwardly directed flange 46.

The ferrule 26 is provided with one or more diagonal holes 48 communicating between its inner surface above the flange 28 and its outer surface opening through the reduced portion 30. Communicating with the holes 48, or the vent space 40, or both, are one or more vent holes 50 formed in the ring 34 and extending generally radially outwardly. These vent holes open into an annular recess 52 in the ring which mates with another annular groove 54 in the holding ring. These two grooves form an annular channel which communicates with the exterior through a vent space 56 between the ring 34 and the holding ring 44, both above and below the channel, this vent space then communicates with another vent space 58 between the collar 42 and holding ring 44. The foregoing head assembly 24 in general has been known, and does not enter into the present invention per se, except that it provides venting spaces for cooperation with the remainder of the pouring tube, the remainder of the construction of the pouring tube in this respect including at least certain features of the invention.

The remainder of the pouring tube other than the head assembly is indicated at 60 and is mounted on and carried by the head assembly 24. This pouring tube includes an inner refractory element 62 extending the full length of the intended ultimate pouring tube, being preferably flush at its upper end with the upper end surface of the head assembly. This inner tube or liner 62 in itself is of known construction, being preferably of refractory material. It withstands attack by molten iron and steel as much as any other material, but it is fragile and relatively weak. It is also porous and permeable to gas, to an extent, through the wall thereof.

The pouring tube structure includes a tubular steel shell 64 in surrounding relation to the inner tube 62, and spaced therefrom as will be referred to again hereinbelow. This steel shell is mounted to the head assembly 24 preferably by abutting it to the lower end surface of the ferrule 26 and welding it thereto as indicated at 68. The steel shell terminates at its lower end above the lower end of the remainder of the tube, as determined by the lower end of the tube 62, the details of which will be referred to again hereinbelow.

A quantity of cement 70 of known kind is placed in the annular space 66 in the upper end of the tube and permitted to harden. It may extend a short distance downwardly terminating above the diagonal holes 48, and below the cement 70 is a quantity of sand 72 filling the space between the cement to a point adjacent the lower end of the steel shell. This sand may be put in place by inverting the tube relative to the position shown, after placement of the cement 70, and then pouring in the sand, the sand being cured by a known process. A fine mesh cloth screen 74 may be placed over the holes 48 to hold the sand in the space intended.

After the sand is put in place a gasket 76 is put in the annular space 66 in contact with the sand. This gasket may be of asbestos and O-ring in shape. Then another quantity of cement 78 is put in the space filling it nearly to the end of the steel shell, in the position then assumed by the tube at the top.

A plurality of rivets 80 are secured to the outer surface of the steel shell as by inserting them in holes in the shell or welding them thereto. These rivets are preferably round headed and are approximately eight in number and distributed at random over the surface of the steel shell. These rivets form the principal means anchoring the outer protective sheath 82 of refractory material to the steel shell, as referred to again hereinbelow. The rivets are located principally at the lower end of the tube, providing anchoring between the steel tube and the outer sheath at the lower portion of the tube enabling the upper portion of the sheath to migrate longitudinally of the tube, as also described hereinbelow. The rivets preferably are located in approximately the lower third of the length of the pouring tube, although the exact area of this distribution is not critical.

A wrapping 82 of heat insulation material is placed on the outer surface of the steel shell, which also accommodates changes in the physical dimensions of the various elements resulting from differential expansion of the steel and other elements. This wrapping 82 is of refractory material and in its original form is a wet and highly pliable sheet. It is wrapped around the steel shell in the area desired, and through the course of the construction of the pouring tube it solidifies and hardens sufficiently to hold it in place, and although it becomes less pliable to working by the hand, it is highly resilient to the forces produced by expansion and contraction of the elements of the tube. The wrapping 82 in being applied is plied over the rivets 80 and it entirely encompasses them. The lower end of the wrapping is worked inwardly over the lower end of the steel shell as indicated at 86.

The assembly made according to the foregoing is then placed in a mold for applying the refractory sheath 84. Such a mold may be a simple cylindrical container receiving the lower end of the tube, the lower end of the inner tube 62 resting on the bottom of the mold. The space in the mold surrounding the tube structure is filled with a refractory material of known type, which is in suitable plastic form. It is put in such a manner as to fill the annular space 66 below the lower end of the cement 78 in completely surrounding relation to the lower end of the steel shell and the lower turned-in end of the wrapping. It will be observed that the refractory material forming the sheath 84 completely envelopes the rivets 80 and the portions of the wrapping thereover to provide the desired physical anchorage between the steel shell and the sheath.

Preferably the sheath 84 terminates at its upper end below the head assembly 24, being of suitable length to extend the full depth of any level of molten metal in the ladle so as to prevent contact by the molten metal with that portion of the tube above the sheath.

If desired, as an optional construction, a sleeve 88 of material similar of the wrapping 82 may be applied directly to the inner tube 62 between the gasket 76 and adjacent to but below the ferrule 26.

Bubbles of air and other gases forming in the molten metal have long been recognized as a difficulty encountered in this type of casting. Air entrapped in the pores of the inner tube 62 as well as other elements incorporated in tubes heretofore, expands upon the molten metal moving upwardly in the pouring tube in engagement with the inner tube 62. This air must, of course, have an escape passage and in the absence of other escape passages would flow through the wall of the inner tube 62 and into the passage thereof and into the molten metal, forming defects in the castings. Another source of air or gas in the pouring tube is the superatmospheric pressure developed in the pit 14. This pressure is of extremely high value and air heretofore has been forced through the wall of the pouring tube, with detrimental effects mentioned.

The steel shell 64 in the present instance provides an impermeable membrane in the pouring tube preventing the passage of air entirely through the wall of the pouring tube. The air in the pores of the sand 72 is permitted to escape through the vent holes 48 and other vent passages outwardly thereof, as described above. Air trapped in the pores of the inner tube 62 may also escape through these vent passages.

The coefficient of expansion of steel is substantially greater than that of the other elements in the construction of the pouring tube and, particularly, the refractory material of the sheath 84. As the steel shell is heated it elongates at a rate substantially greater than the refractory sheath. However, because of the position of the rivets 80 adjacent the lower end of the tube, the sheath is permitted to migrate, relatively speaking, up and down the steel shell, thus eliminating or greatly minimizing any damage to any of the elements, particularly the sheath which is relatively brittle. This migration is permitted complete freedom in the upper portion of the sheath.

Expansion of the steel shell, of course, takes place radially and this expansion is at a greater rate than that of the sheath. However, the installation of the wrapping 82 compensates for this differential to a substantial degree. This wrapping also offers a degree of accommodation to the relative movement in longitudinal direction between the steel shell and refractory sheaths.

The inner tube 62 and the sheath 84 both provide a high degree of heat insulation to the steel shell, being particularly effective with respect to that portion of the tube actually immersed in the molten metal. Above the sheath where the molten metal does not directly contact the tube, the wrapping 82 provides a high degree of heat insulation to the steel shell.

While I have herein disclosed a preferred embodiment of the invention, changes may be made therein within the scope of the appended claims.

I claim:

1. A composite pouring tube for use in casting iron and steel and adapted for insertion of its lower end into the molten metal therefor, comprising a wall including an inner layer and an outer layer of refractory material, a steel shell embedded in the wall between the inner and

outer layer and having its lower end completely enveloped in the wall and confined therein against exposure therethrough, and means for positively anchoring the outer layer of refractory material to the steel shell, said last-mentioned means including a plurality of projections secured to the steel shell and extending radially outwardly therefrom and embedded in the refractory material of the outer layer, said projections being contained within the lower portion of the pouring tube.

2. A composite pouring tube for use in casting iron and steel and adapted for insertion of its lower end into the molten metal therefor, comprising a wall including an inner layer and an outer layer of refractory material, a steel shell embedded in the wall between the inner and outer layer and having its lower end completely enveloped in the wall and confined therein against exposure therethrough, said composite pouring tube including a head assembly with said steel shell welded directly thereto, said inner layer of refractory material being porous and the head assembly being provided with vent passages communicating with the pores in the inner layer of refractory material and extending to the exterior of the head assembly.

3. A composite pouring tube for use in casting iron and steel and adapted for insertion of its lower end into the molten metal therefor, comprising a wall including an inner layer and an outer layer of refractory material, a steel shell embedded in the wall between the inner and outer layer and having its lower end completely enveloped in the wall and confined therein against exposure therethrough, the steel shell and inner layer of refractory material being of such relative diameters as to provide an annular space therebetween, said annular space being filled to the greater extent by sand, the tube being provided with vent passages communicating with the pores in the sand and in the inner layer of refractory material and extending to the exterior of the pouring tube.

4. A composite pouring tube for use in casting iron and steel and adapted for insertion of its lower end into the molten metal therefor, comprising a wall including an inner layer and an outer layer of refractory material, a steel shell embedded in the wall between the inner and outer layer and having its lower end completely enveloped in the wall and confined therein against exposure therethrough, the steel shell and inner layer of refractory material forming an annular space therebetween, and a layer of resilient heat insulating material surrounding said inner refractory layer in direct engagement therewith and throughout the greater portion of the length of said steel shell, said space, except as limited by said layer of heat

insulating material, being filled at least in major portion with sand.

5. The invention set out in claim **3** wherein said sand terminates short of both the upper and lower end of the pouring tube, and a quantity of cement is interposed in said space at each the upper and lower end and operative for confining said sand in said space.

6. The invention set out in claim **5** wherein an asbestos gasket is interposed between the lower end of the sand and the cement therebelow.

7. The invention set out in claim **6** wherein the inner layer of refractory material extends downwardly beyond the lower end of the steel shell, the cement at the lower end terminates downwardly short of the lower end of the steel shell, and the outer layer of refractory material extends beyond the lower end of the steel shell and engages the outer surface of the inner layer of refractory material, completely enveloping the lower end of the steel shell and engaging the lower end of the cement at that location.

8. A composite pouring tube for use in casting iron and steel and adapted for insertion of its lower end into the molten metal therefor, comprising a wall including an inner layer and an outer layer of refractory material and a steel shell embedded in the wall, and a layer of resilient heat insulating material interposed between the steel wall and outer layer of refractory material.

9. The invention set out in claim **8** wherein the layer of heat insulating material is applied directly to and engages the steel shell.

10. The invention set out in claim **9** wherein the layer of heat insulating material extends from the lower end of the steel shell where it is turned inwardly over the lower end of the steel shell to the upper end of the steel shell, and the outer layer of refractory material terminates upwardly below the upper end of the steel shell.

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