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METHOD AND APPARATUS FOR DETERMINING THE FLUIDITY OF MOLTEN METAL

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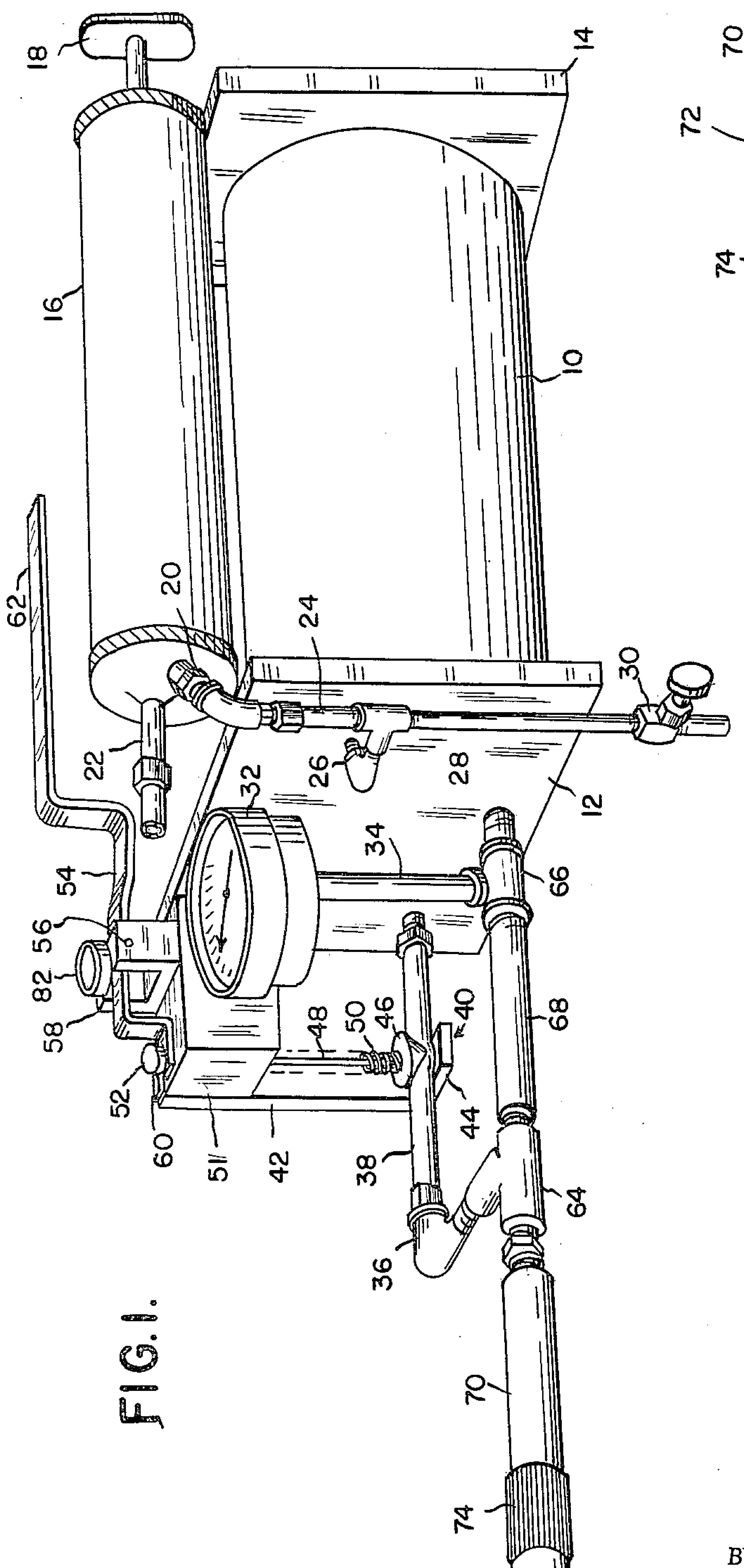

FIG.1.

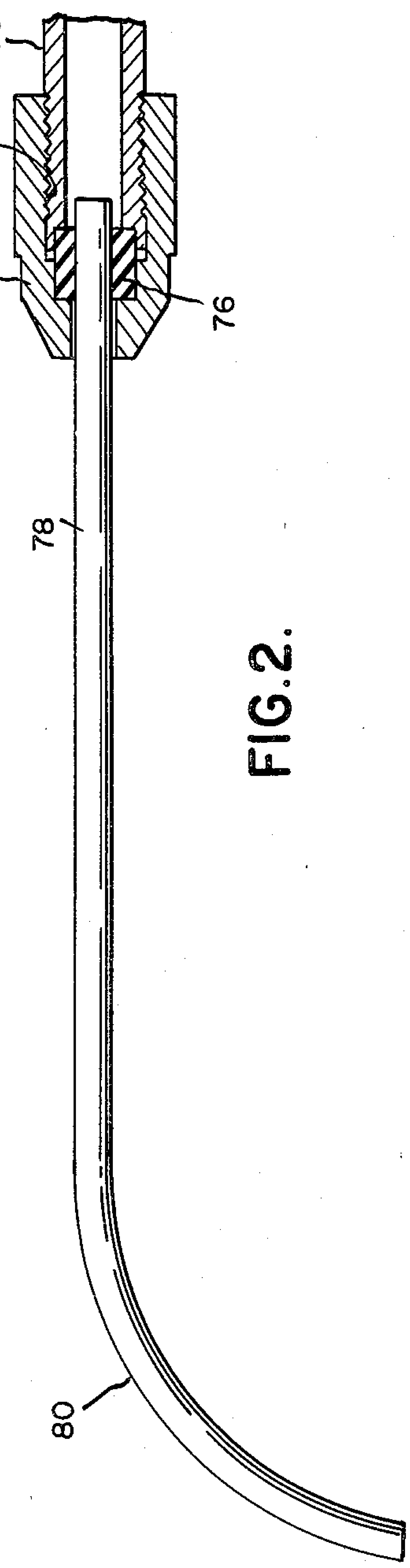

FIG.2.

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METHOD AND APPARATUS FOR DETERMINING THE FLUIDITY OF MOLTEN METAL

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The present invention relates to a method and apparatus for determining the fluidity of molten metal. The fluidity of molten metal is a factor which enters into a metal casting and particularly the design of molds, and especially, molds for producing thin walled castings. It is obviously necessary to determine how far a particular molten metal can be expected to flow in the mold from a gate before solidification so as to determine the proper number and spacing of gates.

The present invention enables a quick and accurate determination of the fluidity of a particular molten metal or alloy and this can be used to provide the proper number and spacing of gates or it may serve as an indication that for a given mold, fluidity must be increased by increasing temperature, if permissible, or by adding an ingredient to the alloy to increase its fluidity at a given temperature.

It is an object of the present invention to provide a method and apparatus for determining the fluidity of molten metal.

It is a further object of the present invention to provide a method and apparatus for determining fluidity of molten metal employing a tube having one end insertable in molten metal and the other end applied to a reduced pressure or partial vacuum for drawing molten metal into the tube by differential pressure for a distance limited by solidification of the metal.

More specifically, it is an object of the present invention to provide a method and apparatus for determining fluidity of molten metal as described in the preceding paragraph, which is characterized by the sudden and abrupt application of the reduced pressure or partial vacuum to the tube to effect an extremely rapid movement of the metal into the tube.

Other objects and features of the invention will become apparent as the description proceeds, especially when taken in conjunction with the accompanying drawing, illustrating a preferred embodiment of the invention, wherein:

FIGURE 1 is a perspective view of the fluidity tester with the tube broken away.

FIGURE 2 is an elevational view of the tube and coupling partly in section.

The apparatus designed for determining the fluidity of molten metal comprises a vacuum tank 10 of cylindrical form having flat end closure plates 12 and 14 which also constitute a support for the structure. A hand operated vacuum pump 16 is provided having an operating plunger 18 by means of which the pump may be operated to evacuate the tank 10. The pump is provided with an inlet check valve 20 and an outlet check valve 22. Connected to the inlet check valve is a passage 24 having a branch passage 26 leading to the interior of the tank 10. A bleed passage 28 is connected to the passage 24 and is provided with a manually controlled bleed valve 30. A pressure gauge 32 is provided connected to the interior of the tank 10 by a passage 34. Also connected to the interior of the tank 10 is a passage 36 including as a portion thereof a resilient tube 38. The tube may be of rubber or other resilient material having sufficient resilience to spring to open position as soon as released. Associated with the tube is a pincher indicated generally at 40 comprising a bracket 42 having a foot portion 44

against which the resilient tube 38 rests. Above the resilient tube 38 is a pincher element 46 carried at the lower end of a vertically movable rod 48 surrounded by a compression spring 50. The upper portion of the rod 48 passes through an opening in a support block 51 which is welded or otherwise secured to the outer surface of the plate 12 and carries at its upper end a head 52. Manually operable means are provided for effecting abrupt application of reduced pressure or vacuum and this comprises a lever 54 pivoted as indicated at 56 to a supporting yoke 58 and having a bifurcated end portion 60 engaged below the head 52 of the rod 48. The lever 54 includes an elongated handle 62, downward movement of which moves the pincher element 46 upwardly against the force of the spring 50. The passage 36 connects to a T 64 and between the T 64 and a T 66 provided in the connection to the pressure gauge 32 there is located a solid cylindrical body 68. Connected to the T 64 is a tube 70 the outer end of which is threaded as indicated at 72 in FIGURE 2, and carries a coupling 74 and sealing gasket 76 for supporting the inner end of the testing tube 78 therein.

The tube 78 may be formed of metal or a transparent heat resistant material such for example as Pyrex. The outer end of the tube 78 is curved as indicated at 80 so that its outer end may be disposed downwardly while the major portion of its length may be disposed horizontally. In order to maintain the apparatus in horizontal position so as to eliminate or minimize the effects of gravity on the flow of molten metal, the apparatus may be provided with a level indicated at 82.

In general terms the fluidity of the molten metal is determined by the distance which the molten metal flows into the outer open end of the tube 78 when the end of the tube is immersed in the liquid and a predetermined constant reduced pressure or partial vacuum is applied abruptly to the inner end of the tube.

A number of different factors determine the distance which molten metal will flow into the tube before its flow is arrested by solidification. In the first place the essential controlling factor is fluidity of the material, which in turn is determined by the composition thereof and by its temperature. In the second place, the degree of vacuum applied to the tube will control the flow. The internal diameter of the tube is critical in determining the distance of flow. Any turbulence of flow as might be induced by an abrupt bend in the tube would have an effect on the distance of flow.

In determining the fluidity of any particular material, a tube 78 is applied by the coupling 74 to the tube 70. At least for any particular material or class of materials, the tubes have uniform internal diameters which are accurately controlled as to dimensions. In general, internal diameters of between three and ten millimeters will be employed and satisfatcory results have been obtained employing tubing having an internal diameter of five millimeters and an outside diameter of seven millimeters.

In order to avoid an abrupt change in direction of the molten metal as it is drawn rapidly into the tube, it is preferred to provide the arcuately curved end portion thereof with a curvature having a radius of at least two inches. Excellent results have been obtained in practice when the radius of curvature is about four inches.

The hand pump 16 is capable of evacuating the tank 10 to a vacuum of about 300 millimeters of mercury. Excellent results have been obtained with the equipment as so far described when an operating vacuum of about 150 millimeters of mercury is developed and appiled to the molten metal.

It is desirable to control the conditions under which the equipment is operated so that the metal will flow into the tube for a distance of between ten and twenty inches. This may be controlled for the particular metal by a variation in the degree of vacuum applied to the tank. This obviously may be controlled by first drawing a vacuum somewhat greater than required and reducing the vacuum by bleeding air into the tank through the bleed valve **30**. It is contemplated that in use the pressure gauge **32** may have indicia thereon indicating the suitable operating vacuum to be applied to different materials such for example as gray iron, white metal, and the like. By this means it is possible to obtain approximately the same distance of flow into the tube **78** for widely different materials.

In the case of a transparent tube, the distance of flow will of course be readily apparent and the tubing may be graduated with suitable indicia. In the event the tube is a metal tube the distance of flow may be measured by inserting into the inner end of the tube a measuring wire graduated inversely to show distance of flow.

It is of course an essential feature of the invention to provide for abrupt application of vacuum to the tube. When this is done the molten metal flashes into the tube and its flow is terminated by solidification in an extremely short interval, normally a fraction of a second.

The drawing and the foregoing specification constitute a description of the improved method and apparatus for determining the fluidity of molten metal in such full, clear, concise and exact terms as to enable any person skilled in the art to practice the invention, the scope of which is indicated by the appended claims.

What I claim as my invention is:

1. The method of determining the fluidity of molten metal which comprises inserting one downturned end of a tube in the molten metal, maintaining the major portion of the tube substantially horizontal to eliminate the effect of gravity on flow, applying a known vacuum to the other end of the tube, drawing molten metal into the tube until flow is stopped by solidification and observing the distance of flow as a measure of fluidity.

2. The method of determining the fluidity of molten metal which comprises inserting one downturned end of a translucent tube in the molten metal, maintaining the major portion of the tube substantially horizontal to eliminate the effect of gravity on flow, applying a known vacuum to the other end of the tube, drawing molten metal into the tube until flow is stopped by solidification, and observing the distance of flow as a measure of fluidity.

3. A fluidity tester for molten metal comprising a tube having a straight horizontal portion and a down turned outer end, a source of reduced pressure, a quick-opening valve for connecting the inner end of said tube to said source, the outer end of said tube being insertable in the molten metal to provide for flow of metal into the tube induced by pressure differential to a point limited by solidification thereof.

4. A fluidity tester for molten metal comprising a tube having a straight horizontal portion and a down turned outer end, the down turned end being curved on a substantial radius, a source of reduced pressure, a quick-opening valve for connecting the inner end of said tube to said source, the outer end of said tube being insertable in the molten metal to provide for flow of metal into the tube induced by pressure differential to a point limited by solidification thereof.

5. A fluidity tester for molten metal comprising a tube having a straight horizontal portion and a down turned outer end, said tube being formed of translucent heat-resistant material, a source of reduced pressure, a quick-opening valve for connecting the inner end of said tube to said source, the outer end of said tube being insertable in the the upper surface of a quantity of molten metal directly to provide for flow of metal into the tube induced by pressure differential to a point limited by solidification thereof.

6. A fluidity tester comprising a vacuum tank, a pump connected to said tank, a bleed valve connected to said tank, a pressure gauge connected to said tank, a tube having a straight portion adapted to be held in horizontal position during testing and a down turned outer end portion, a quick-opening valve connecting the inner end of said tube to said tank, said quick-opening valve comprising a resilient tube, a pincher for closing said tube, and means for effecting abrupt release of said pincher.

7. A fluidity tester for molten metal comprising a thin-walled opaque tube having a straight horizontal portion and a down-turned outer end, a source of reduced pressure, a quick-opening valve for connecting the inner end of said tube to said source, the outer end of said tube being insertable into the upper surface of molten metal to provide for flow of metal directly into the tube induced by pressure differential to a point limited by solidification thereof.

8. A fluidity tester for molten metal comprising a single continuous tube the major portion of which is straight and horizontal, a relatively short outer end portion of the tube extending downwardly, the entire downwardly extending outer end portion of the tube being curved substantially uniformly at a substantial radius to minimize resistance to flow, a source of reduced pressure, passage means including a quick opening valve connecting the inner end of said tube to said source, the end of the downwardly extending end portion of said tube being insertable in molten metal to provide for a flow of metal in the tube induced by the pressure differential between atmospheric pressure and the pressure of said source to a point limited by solidification of the metal.

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