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(54) Mould for producing thin-wall castings by gravity pouring

Giessform zur Herstellung von dünnwandigen Gussstücken durch Schwerkraftgiessen

Moule pour articles à paroi mince coulés par gravité

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(56) References cited:
US-A- 4 989 665

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Description

This invention pertains to the production of thin-wall metal castings and more specifically to a mould design practice for producing such castings by gravity pouring as specified in the preamble of claim 1, for example as disclosed in US-A-4,989,665.

There is a need for a process for reliably producing high-quality, gravity-cast, thin-wall metal castings. This need is especially acute in the automotive industry where efforts to increase fuel economy require that attempts be made to reduce the mass of the automobile. Significant reductions in the mass of cast metal components such as automotive engine blocks and exhaust manifolds could be obtained if dimensionally-accurate, defect-free castings could be reliably and efficiently produced in high volume.

When reference is made to thin-wall castings, castings are meant which have substantial wall surfaces as small as one to three millimetres in thickness. Frequently, the thin-wall portions of such castings have a rounded cross-section (i.e., circular, elliptical, or octagonal) and are no more than about 160 mm in diameter. Examples of such castings are tubes, engine exhaust manifolds, cylinder heads, engine blocks, and pistons .

The difficulty with producing thin-wall castings arises from the need for cast hot molten metal to flow through extensive, relatively small cavity passages in an unheated mould. Any freezing of the metal before the cavity is completely filled will yield castings with non-uniform walls or castings with holes or other defects. There are existing commercial processes for the casting of thin-wall iron and aluminium castings that provide some inducement to the flow of the cast metal to promote complete mould fill before solidification. In these practices, a suitably designed resin-bonded sand mould is prepared that suitably defines the thin-wall portions of the casting. The mould is filled from the bottom utilizing a pump or a pressure differential to cause the molten metal to flow rapidly into the mould cavity to fill it before solidification occurs. In these practices, a continuous metal flow link must be made between a reservoir of molten metal and the mould. In one such practice, the reservoir is pressurized to cause the flow of molten metal towards the mould. In another practice, the mould is subjected to a vacuum to assist the flow of molten metal into the mould cavity. In other practices, both a vacuum in the mould and pressure on the reservoir are employed.

In each of these cases, it is necessary for the metal at the ingates to the casting cavity in the mould to freeze-off before the mould can be removed from the reservoir from which the metal is contained. This means that appreciable solidification must occur before the next mould can be filled from the molten metal reservoir. This slows a casting line, decreasing production rates.

Such prior-art practices have an additional disadvantage. They require special equipment to provide for pressurization of the molten metal reservoir or for containment of the mould in a vacuum chamber or both. In some practices, an electromagnetic pump is employed. Both of these metal flow-inducing mechanisms represent a substantial capital investment as well as process complexity which add to the cost of castings produced.

It is an object of the present invention to provide a resin-bonded sand mould design that will accommodate the gravity pouring of molten metal so that thin-wall, defect-free castings can be reliably, accurately and efficiently produced.

A mould according to the present invention, for the gravity pouring of molten metal to form a cast body comprising thin-wall portions about one to three millimetres in thickness, is characterised by the features specified in the characterising portion of claim 1.

It is a further object of the present invention to provide a gravity-castable mould design that permits all portions of the thin-wall mould cavity to be filled with hot metal at substantially the same temperature and the same time, thereby rapidly filling the whole cavity and minimizing the chances for premature metal freezing and faulty castings.

It is a still further object of the present invention to provide a resin-bonded sand mould that is specially adapted for the casting of thin-walled ducts for fluid flow such as, for example, tubes, engine exhaust manifolds, cylinder heads and engine cylinder blocks.

In accordance with a preferred embodiment of the present invention, these and other objects and advantages are accomplished as follows. The practice of the present invention utilizes high-strength, dimensionally-accurate, resin-bonded sand moulds made from a suitable foundry sand such as AFS No. 85 silica sand or lake sand. The sand is suitably bonded, for example, with about 1.5 weight percent of a no-bake, oil-urethane resin binder system. An example of a suitable binder system is the Lino-Cure system produced by Ashland Chemicals, U.S.A..

The present invention is suitable for use in the casting of thin-wall tubes, hollow ducts or similar, relatively small-diameter, rounded or circumscribed hollow shapes, and components containing such features. The invention is particularly suitable where such features can be cast in a substantially common horizontal plane. In a common and preferred embodiment, cope and drag mould portions are employed where the hollow body axes are generally aligned with the parting plane of the cope and drag portions of the mould. Thus, in this embodiment, the mould arrangement will comprise accurately-dimensioned duct wall cavities formed in the cope and drag portions of the mould with a suitable core member disposed at the parting plane so as to define the duct walls. In accordance with the present invention, duct walls may be as small as one to three millimetres in thickness and up to about 160 mm across the opening of the duct.

The cope mould is placed on the drag mould, and the drag mould is placed on a resin-bonded sand mould slab that defines an ample molten metal reservoir directly underlying the tube or duct cavity-defining portions of the mould. A vertical sprue mould member is employed that rises above the cope portion of the mould to supply molten metal to the mould and to provide a metallo-static head of metal. The sprue member, cope, drag and slab each have a connected cylindrical passage down through the cope and drag portions, laterally offset from the tubular cavities, to conduct cast molten metal past the casting cavity to the reservoir in the slab. A plurality of vertical cylindrical runners is provided in the drag and lower portions of the cope members of the mould rising from the reservoir in the slab member up to the casting cavity or just offset from the cavity and connected thereto by horizontal ingates. The number and location of these runners and ingates are determined by the effective filling distance of the molten metal in the thin-wall portion of the cavity(ies).

Thus, in the practice of the present invention, hot molten metal is poured into a suitable pouring basin in the sprue and through the mould members so that it flows into and fills the reservoir in the slab underlying the drag portion before any metal can flow up towards the casting cavity. The reservoir underlies the critical thin-wall portions of the mould cavity and is shaped to minimize heat loss from the metal and to promote mixing for uniform metal temperature. Once the reservoir underlying the mould cavity is completely filled, molten metal then rises straight up substantially simultaneously in the plurality of vertical runners up to the mould cavity, filling it substantially uniformly with hot molten metal of substantially uniform temperature. In this way, molten metal quickly and uniformly fills the mould cavity so that the thin-wall portions of the mould are completely filled before any metal solidifies.

The practice of the invention is based on a mould design that requires the cast metal to first fill a reservoir underlying the thin-wall portions of the casting cavity. When the reservoir is full, the metal rises simultaneously in a plurality of vertical runners to fill the thin portions of the cavity quickly from several points of entry. The spacing of these points of entry, known as ingates, should be no greater than a determinable effective filling distance within the cavity which is a function of the metallo-static head and pouring temperature (superheat) of the cast metal and the wall thickness of the cavity. This distance may be, e.g., in the range of 25 to 450 mm. This practice has been successfully used to cast ferrous metal alloy thin-walled tubes and thin-wall exhaust manifolds ranging in wall thickness sizes from one to three millimetres.

Apart from being able to reliably cast dimensionally-accurate thin-wall castings by the mould design practice of the present invention, it also offers the advantage of not requiring additional equipment to force the metal into the mould cavities. Furthermore, this atmospheric gravity pouring practice offers the important advantage of permitting the mould to be moved away from the pouring source of molten metal before any solidification has occurred.

Other objects and advantages of the present invention will become more apparent from a detailed description thereof which follows. In this detailed description, reference will be had to the accompanying drawings, in which:

Figure 1 is an elevational view, partly broken-away and in section, of mould members suitable for the practice of the invention to produce thin-walled tube castings;

Figure 2 is a plan view, partly in section, taken along lines 2-2 of Figure 1; and

Figure 3 is an illustration of an exhaust manifold casting for an automotive internal combustion engine depicting all of the solidified metal as the casting was poured.

The practice of the present invention is applicable to the manufacture of gray iron, nodular iron, austenitic and ferritic stainless steel castings and plain carbon steels and alloy steels. The practice of the present invention is also applicable to the practice of making aluminium castings and castings of other non-ferrous metal. However, it will be appreciated that it is particularly applicable to making ferrous metal castings with thin-walled tubular sections because the iron alloys are poured at high temperatures and can readily solidify prematurely in the relatively cold thin-wall mould sections.

As stated above, a high quality foundry sand is used such as a silica sand of AFS No. 85 designation or a suitable lake sand. The sand mould members require to be resin-bonded sand so that they are durable and resist the erosion of rapidly flowing hot molten metal. Again, as indicated above, the use of a no-bake oil-urethane resin binder system, such as that specified above, is preferred.

In the following description of specific embodiments of the moulds, specific dimensions will be provided for better illustration. The drawing figures are not to scale.

As seen in Figures 1 and 2, a mould 10 comprises a cope portion 12, a drag portion 14, a slab 16 underlying drag portion 14, a pouring sprue 18, and a pouring funnel 20. Each of these mould pieces is made of resin-bonded sand.

The cope and drag mould portions co-operate with one another to define therebetween a cavity 22 of a thin-wall tube (31.75 mm I.D.) having flange portions 24 (69.85 mm O.D. x 12.7 mm) at each end. In accordance with the practice of the invention, the thin-wall tube (304.8 mm long between flanges) as defined by cavity 22 may be in the range of one to three millimetres in thickness. The internal surface of the tube is defined by core member 26, which is supported by and between the cope portion 12 and the drag portion 14 of the mould. It is seen that the centre line of the cylindrical core 26 lies at a horizontal parting surface 28 between the cope 12 and drag 14 portions of the mould.

In accordance with the practice of the invention, molten metal is poured into an opening 30 in the pouring funnel 20 and flows downwardly through a cylindrical opening 32 (38.1 mm diameter) in the pouring sprue 18, through a cylindrical opening 34 in cope portion12 and a cylindrical opening 36 in drag portion 14 into a well 38 in slab 16. The height of sprue 18 is such that a minimum of 150 mm head of molten metal can be maintained above the top of vertical runners 48 and ingates 50. From well 38, the molten metal flows through runner portions 40, 42 and 44 into a large (406.4 mm long x 152.4 mm wide x 12.7 mm high) horizontal reservoir chamber 46. Only at such a time as reservoir 46 is completely filled with the cast molten metal can the level then rise into vertical runners 48. In the arrangement shown in Figures 1 and 2, it is seen that there are eight such vertical runners 48 (6.35 mm diameter) that are of equal length (101.6 mm), four on each side of the tube cavity 22. The vertical runners are 50.8 mm from their nearest neighbour on the same side of the tube cavity 22. Thus, molten metal will simultaneously rise at substantially the same rate in each of the vertical runners 48, reaching the level of the horizontal ingates 50, of which there are eight, and thus into the tube cavity 22 and flange cavities 24. Once the critical thin-wall cavity has been filled, molten metal can then rise out of the flange cavities 24 through riser/vents 52 (3.175 mm diameter). The small amount of metal flowing into and through these vents 52 quickly freezes and permits the higher level of metal in sprue 18 to keep liquid pressure on the metal in the cavity 22 as it solidifies. Thus, it is seen that the vertical sprue for the incoming molten metal co-operates with the reservoir 46 to supply a suitable metallo-static head of gravity-cast molten metal to uniformly and rapidly fill the critically thin-wall casting cavity 22. Preferably the molten metal (here a nodular iron alloy) is cast at a temperature of at least 90°C above the temperature for the cast alloy at which the first solidification occurs. The reservoir 46 is located immediately below the critical casting cavity and supplies molten metal substantially simultaneously and at approximately equal rates to several different locations in the critically thin cavity 22 as shown in Figures 1 and 2. These locations, i.e., ingates 50, are established after determining the effective filling distance based on the superheat and at least a 150 mm metallo-static head of iron or an equivalent head for other alloys.

Figure 3 illustrates another embodiment in the practice of the present invention. In this view, a solidified casting is illustrated wherein all of the cast metal remains before the non-product portion has been removed. This view of the full casting may better illustrate how the cast metal flowed into the mould which can be visualized in place about the casting.

Thus, illustrated in Figure 3 is the total solidified metal casting 100 for an exhaust manifold piece 102 that comprises exhaust ducts 104, 106, 108 and 110 for a four cylinder internal combustion engine. The ducts merge into a manifold exhaust duct 112 terminating in a flange 114 for connection to an exhaust pipe. Flanges 116, 118 and 120 are adapted to connect the exhaust ducts to an engine cylinder head. As revealed in the total finished casting 100, vertical sprue portion 122 (38.1 mm diameter in cylindrical portion) is the solidified metal that was left in the sprue portion of the mould (not shown) after the casting had completely solidified. Portions 124, 126 and 128 are horizontal runner portions of supplied metal to a horizontal reservoir portion 130 of the mould. The generally triangular reservoir 130 is about 25.4 mm wide x 22.225 mm deep x 1117.6 mm long (perimeter). Reservoir 130 is a channel-type reservoir underlying the periphery of the exhaust manifold casting 102 for supply of molten metal simultaneously to all regions of the casting. Also clearly shown in the finish casting 100 is the solidified metal that remained in a plurality of vertical risers, i.e., runners 132. Thirteen vertical runners 132 are employed. They are all 9.525 mm in diameter. Due to the downward curvature of ducts 104, 106 and 108, the runners 132 are not all of the same length. The longest runners (104.775 mm) are adjacent flange 114 and the shortest runners (85.725 mm) are adjacent duct 104. However, the number and deployment of the runners are suitable to successfully cast this complex shape thin-wall body. Portions 134 of the casting are the metal that solidified in the horizontal ingates of the mould. The remainders of the casting indicated at 136 represent the metal that solidified in the closed riser portions of the mould.

It can be seen that, in the gravity pour casting of the exhaust manifold 102, molten metal was first poured through two equivalent runner 128 paths into a mould reservoir (casting portion 130) underlying the manifold mould cavity. The sprue portion of the casting 122 extended 254 mm above the level of the ingates 134. Molten metal of uniform temperature then flowed upwardly from the reservoir simultaneously in thirteen vertical mould runners (casting portions 132) to quickly and substantially uniformly fill the thin sections of the principal casting cavity. The spacing between the runners varied from 15.875 mm to 152.4 mm. In this way, the thin portions of the unheated mould were rapidly filled with molten metal before any premature solidification could occur to produce a defective casting. It is also seen that such vertical runners could be extended upwardly through their respective closed riser 136 to supply additional thin-wall casting cavities of one or more identical castings located successively directly above a first cavity. Thus, each such additional cavity can be filled with metal from the same plurality of points of entry. Furthermore, once such a mould has been filled with molten metal, it can be removed from the pouring source so that another mould can be poured.

Utilizing casting moulds like that described above in connection with Figures 1 through 3, exhaust manifolds have been cast from a nodular iron composition in which the wall thickness of the exhaust ducts was in the range of 2.7 to 3.2 millimetres. Stainless steel exhaust manifolds have been cast having duct walls 2.6 to 3.2 millimetres in thickness. The cross-sections of the ducts of the Figure 3 casting were shaped like rounded corner rectangles and ranged in size from 30 mm x 40 mm to 55 mm x 60 mm. The length of the cast duct passages are often 300 to 600 mm. A turbine inlet shroud of nodular iron has also been cast. The shroud was shovel-shaped, had a wall thickness of 3 mm and other dimensions of 620 mm long x 600 mm wide x 200 mm high.

As many as three thin-wall exhaust manifolds have been cast at one time by stacking mould sections vertically so that the manifold cavities were positioned in layers above the metal reservoir. Each cavity was fed by vertical sprue risers from the reservoir. Applicants are able to do this on a repetitive and reliable basis. The same practice can be used to cast even thinner wall thicknesses. The exhaust manifolds are complex because the tubes are curved and the metal must flow in several directions in order to fill the mould cavities. In the case of straight tubes such as those depicted in Figures 1 and 2, tubes with walls one millimetre, two millimetres and three millimetres in thickness have been cast in the same casting. The internal diameter of the round tubes in each case was about 30 mm and the length about 300 mm.

The practice of the present invention has been described using cope and drag moulds with horizontal parting planes. Other mould arrangements utilizing other parting planes may be utilized. The essential feature of the practice of the present invention is the positioning of the thin-wall cavity(ies) about a horizontal level(s) with an underlying horizontal reservoir and a plurality of vertical runners from the reservoir to the cavity(ies)

Mould Design Principles

The object of the mould design of the invention is to deliver a steady, generally quiescent flow of molten metal to all of the thin-wall portions of a mould cavity at substantially the same time and at substantially the same temperature.

When an iron-based alloy is being cast, the vertical pouring sprue extends to a height at least 150 mm greater than the height of the tallest vertical runner rising from the reservoir. In the case of other metals, this length is inversely proportional to the ratio of the density of the metal to that of iron. In each case, the height is measured from the level of the reservoir. The sprue must also extend to a height above the highest portion of the casting cavity. The casting cavity is vented at its highest portions so that air can be expelled from the cavity as the cast metal flows upwardly from the reservoir through the vertical runners into the cavity. Since the sprue extends higher than any other portion of the flow path of the cast metal, it provides a metallo-static head of metal which keeps pressure on the mould cavity and assures that it is full of molten metal as the casting solidifies. In fact, the metal in the sprue is intended to be the last metal to solidify in the mold system. Once air has been expelled from the cavity vent, if the vents are suitably sized, the rising metal will quickly freeze there, indicating that the cavity has been filled with molten metal and plugging the vent from further expulsion of metal.

It should be evident by now that the horizontal reservoir is a critical part of the mould design of the invention. An important feature of the reservoir is that it is horizontal and that it completely fills with metal that mixes in the reservoir and attains substantially a uniform temperature there before the flow rises from the reservoir through the vertical runners. The reservoir is to be designed in the mould so as to underlie either the entire casting cavity as was illustrated in the Figure 1/Figure 2 embodiment of the invention or at least those portions of the mould cavity to which metal must be supplied to form the thin-wall portions of the cavity. The Figure 3 embodiment of the invention illustrates the channel-type reservoir underlying the casting cavity at the peripheral portions of the cavity where molten metal is introduced through vertical runners into each of the several thin-wall portions of the cavity. Preferably the reservoir should be designed with a volume-to-surface area ratio that is conducive to the mixing of the incoming cast metal but minimizes the heat loss therefrom. In general, the experience of the inventors has been that this is achieved if the volume of the reservoir divided by its geometrical surface area is greater than or equal to about 5 millimetres. The configuration of the reservoir should accommodate mixing of the flowing molten metal so as to deliver molten metal of a uniform temperature to the casting cavity. The goal is to design the flow passages from the downsprue to the reservoir so that the reservoir is filled with a constant temperature molten metal before any metal flows upwards towards the mould cavity.

The cross-sectional area of the reservoir should be greater than the cross-sectional area of the downsprue.

It is preferable to position the cavity of the thin-wall body to be cast in the mould so that the vertical runners deliver metal into the cavity at as close to the same height as possible. This enables the molten metal to rise in the vertical runners and enter all portions of the mould cavity at substantially the same time and at substantially the same temperature. The mould illustrated in the Figure 1/Figure 2 embodiment, of course, has vertical runners of equal height. The mould depicted by the cast metal in the Figure 3 embodiment has some variation in the height of the vertical runners. Preferably the variation in the height of the vertical runners above the reservoir to the point where the metal enters the casting cavity should be less than or equal to about 63 millimetres. Again, the purpose of this feature is to minimize temperature gradients in the molten metal entering the mould cavity.

It is desirable to position the vertical runners so that they introduce molten metal into the thin-wall portions of the cavity either at the side (as was done in the Figure 1/Figure 2 and Figure 3 embodiments) or at the bottom of the thin sections. When metal is poured for castings that are stacked in vertical planes, it is preferable that the respective cavities should be positioned directly above each other, that they follow the runner placement rules that have been defined, and that the same vertical runners sequentially fill each casting from the lowermost to the uppermost. Of course, the height of the casting pouring sprue must be increased so that it provides sufficient metallo-static head to fill the uppermost cavity.

The mould design of the present invention is especially adapted for the casting of ferrous-based alloys such as nodular iron, stainless steels and alloy steels. In general, it is preferred that the molten metal should be at least 90°C above its first solidification point. This amount of superheat is not unusual for the casting of such metal alloys.

The maximum spacing of the vertical runners to the thin-wall portions of the mould cavity is influenced by the amount of superheat of the molten alloy and its metallo-static head. The following generalized empirical relationships have been developed for the minimum spacing of the vertical runners in millimetres for the following ferrous alloys.

1. For example, high silicon, molybdenum, nodular iron alloys have been cast with superheats varying from 235°C to 300°C and with a sprue head height of 230 to 495 millimetres above the height of the highest vertical runner. In general, it has been found that the maximum allowable spacing of vertical runners for a wall thickness of one millimetre was about 150 mm spacing and for a wall thickness of two millimetres was 300 mm spacing. Assuming a further linear relationship, one would specify a maximum vertical runner spacing of about 450 mm for a three millimetre wall thickness casting.
2. Castings with a non-hardenable stainless steel composition have been prepared at superheats of 175°C to 250°C and head heights of 150 to 460 mm. In general, the experience was that a vertical runner spacing should not exceed about 50 mm for a wall thickness of one millimetre, a spacing of about 175 mm for a casting wall thickness of two millimetres, and a 300 mm runner spacing for a casting thickness of three millimetres.
3. For a representative hardenable alloy steel (SAE 4340), castings were prepared with superheat values ranging from 110°C to 225°C and head heights of 215 to 585 mm. It was found that, in general, a maximum suitable runner spacing of about 50 mm was appropriate for a one millimetre wall thickness, a maximum runner spacing of 150 mm for a two millimetre casting wall thickness, and a maximum spacing of about 300 mm for a three millimetre wall thickness.

In summary, the mould design of the present invention is based on a goal of causing substantially equal temperature metal to flow at the same time into several different thin-wall portions of the casting cavity so as to fill the casting cavity with a quiescent flow of metal from several points of entry and to thereby completely fill the cavity before any solidification of metal in the cavity occurs.

Thus, whilst the present invention has been described in terms of a specific embodiment thereof, it will be appreciated that other forms could readily be adapted by those skilled in the art within the scope of the following claims.

Claims

1. A mould (10) for the gravity pouring of molten metal to form a cast body comprising thin-wall portions as small as one to three millimetres in thickness, said mould (10) comprising:a mould cavity (22) defining said cast body and with cavity portions defining said thin-wall portions, a reservoir (46) below said mould cavity (22) and underlying at least said thin-wall-defining cavity portions, a plurality of runners (48) rising from said reservoir (46) and connecting to said thin-wall-defining cavity portions, and a vertical sprue (18) with a cast metal-inlet (32) above the level of said cavity (22), said sprue (18) having an outlet (36) in fluid flow communication (40,42,44) with said reservoir (46), characterised in that said mould (10) is formed of resin-bonded sand and has said mould cavity (22) oriented with said cavity portions defining said thin-wall portions positioned about a common horizontal level (28); said reservoir is a horizontally-disposed reservoir (46) being shaped with a volume-to-geometric surface area ratio of at least five millimetres; said runners (48) rise vertically from said reservoir (46) to connect to said thin-wall-defining cavity portions, the difference in length between the longest and shortest of said runners (48) being no more than about 63 mm; and said vertical sprue (18) has said cast metal inlet (32) at a distance above the height of the tallest of said runners (48) that provides, at such a height, a minimum metallo-static head equivalent to 150 mm of molten iron, the cross-sectional area of said sprue (18) being no greater than the cross-section of said flow communication (40,42,44) into said reservoir (46); and said vertical sprue (18), reservoir (46) and vertical runners (48) co-operate with each other and with the thin-wall portions of the mould cavity (22) so that poured metal enters and fills said reservoir (46) with metal before rising simultaneously in each of said vertical runners (48) so as to feed molten metal to the thin wall portions of the mould cavity (22) from a plurality of sources spaced within determined effective cavity-filling distances of each other so as to completely fill said mould cavity (22) with said molten metal before solidification thereof occurs.

Patentansprüche

1. Gußform (10) für das Schwerkraftgießen von geschmolzenem Metall, um einen Gußkörper zu bilden, der Dünnwandabschnitte so klein wie ein bis drei Millimeter dick umfaßt, wobei die Gußform (10) umfaßt: einen Gußformhohlraum (22), der den Gußkörper festlegt und mit Hohlraumabschnitten, die die Dünnwandabschnitte festlegen, ein Reservoir (46) unterhalb des Gußformhohlraums (22) und mindestens die dünnwandfestlegenden Hohlraumabschnitte unterlegend, wobei eine Vielzahl von Gießrinnen (48) von dem Reservoir (46) aufsteigt und mit den dünnwandfestlegenden Hohlraumabschnitten verbindet, und einen vertikalen Einlauf (18) mit einem Gußmetalleinlaß (32) über dem Niveau des Hohlraums (22), wobei der Einlauf (18) einen Auslaß (36) in Fluidfließverbindung (40, 42, 44) mit dem Reservoir (46) aufweist, dadurch gekennzeichnet, daß die Gußform (10) aus harzgebundenem Sand gebildet ist und den Gußformhohlraum (22), ausgerichtet mit den Hohlraumabschnitten, welche die Dünnwandabschnitte festlegen, auf einem gemeinsamen horizontalen Niveau (28) positioniert aufweist; das Reservoir ein horizontal angeordnetes Reservoir (46) ist, das mit einem Verhältnis von Volumen zu geometrischer Oberfläche von mindestens fünf Millimeter geformt ist; die Gießrinnen (48) vertikal von dem Reservoir (46) ansteigen, um mit den dünnwandfestlegenden Hohlraumabschnitten zu verbinden, wobei der Längenunterschied zwischen der längsten und kürzesten der Gießrinnen (48) nicht mehr als ungefähr 63 mm beträgt; und der vertikale Einlauf (18) den Gußmetalleinlaß (32) in einem Abstand über der Höhe der größten der Gießrinnen (48) aufweist, der bei einer solchen Höhe einen minimalen metallostatischen Kopf äquivalent zu 150 mm geschmolzenem Eisen schafft, wobei die Querschnittsfläche des Einlaufs (18) nicht größer als der Querschnitt der Fließverbindung (40, 42, 44) in das Reservoir (46) hinein ist; und der vertikale Einlauf (18), das Reservoir (46) und die vertikalen Gießrinnen (48) miteinander und mit den Dünnwandabschnitten des Gußformhohlraums (22) zusammenwirken, so daß gegossenes Metall in das Reservoir (46) eintritt und dieses mit Metall füllt, bevor es gleichzeitig in jeder der vertikalen Gießrinnen (48) ansteigt, um geschmolzenes Metall zu den Dünnwandabschnitten des Gußformhohlraums (22) von einer Vielzahl von Quellen zuzuführen, die innerhalb festgelegter, wirksamer, hohlraumfüllender Abstände voneinander beabstandet sind, um den Gußformhohlraum (22) vollständig mit dem geschmolzenen Metall zu füllen, bevor dessen Verfestigung auftritt.

Revendications

1. Moule (10) pour la coulée par gravité de métal fondu pour former un corps coulé comprenant des parties à paroi mince d'une épaisseur descendant jusqu'à un à trois millimètres, ledit moule (10) comprenant : une empreinte de moule (22) qui définit ledit corps moulé et comporte des parties d'empreintes qui définissent lesdites parties à paroi mince, un réservoir (46) situé au-dessous de ladite empreinte de moule (22) et qui se trouve au-dessous desdites parties d'empreinte définissant des parois minces, une pluralité de canaux (46), qui s'élèvent en partant dudit réservoir (46) et qui se raccordent auxdites parties de l'empreinte définissant une paroi mince, et une descente verticale (18) qui présente une entrée de métal coulée (32) au-dessus du niveau de ladite empreinte (22), ladite descente (18) ayant une entrée (36) en communication pour l'écoulement du fluide (40, 42, 44) avec ledit réservoir (46), caractérisé en ce que ledit moule (10) est formé de sable à la résine et présente ladite empreinte de moule (22) orientée de façon que lesdites parties d'empreinte qui définissent lesdites parties à paroi mince soient positionnées de part et d'autre d'un niveau horizontal commun (28) ; ledit réservoir est un réservoir (46) disposé horizontalement qui est conformé avec un rapport entre volume et superficie géométrique d'au moins cinq millimètres ; lesdits canaux (48) s'élèvent verticalement à partir dudit réservoir (46) pour se raccorder auxdites parties de l'empreinte qui définissent une paroi mince, ladite différence de longueur entre le plus long et le plus court desdits canaux (48) n'étant pas de plus d'environ 63 mm ; et ladite descente verticale (18) présente ladite entrée de métal coulé (32) à une distance au-dessus du niveau du plus grand desdits canaux (48) qui engendre, à cette hauteur, une charge de pression métallo-statique minimum équivalent à 150 mm de fer fondu, l'aire de section transversale de ladite descente (18) n'étant pas supérieure à la section transversale de ladite communication d'écoulement (40, 42, 44) donnant dans ledit réservoir (46) et ladite descente verticale (18), ledit réservoir (46) et lesdits canaux verticaux (48) coopèrent entre eux et avec les parties à paroi mince de l'empreinte de moule (22) de manière que le métal coulé entre dans ledit réservoir (46) et le remplisse de métal avant de s'élever simultanément dans tous les canaux verticaux (48) de manière à fournir le métal fondu aux parties à paroi mince de l'empreinte (22) du moule en partant d'une pluralité de sources espacées de distances d'écartement mutuel comprises dans l'intervalle de distances déterminé assurant un remplissage efficace de l'empreinte de manière à remplir entièrement ladite empreinte (22) du moule avec ledit métal fondu avant que la solidification de ce métal ne s'effectue.

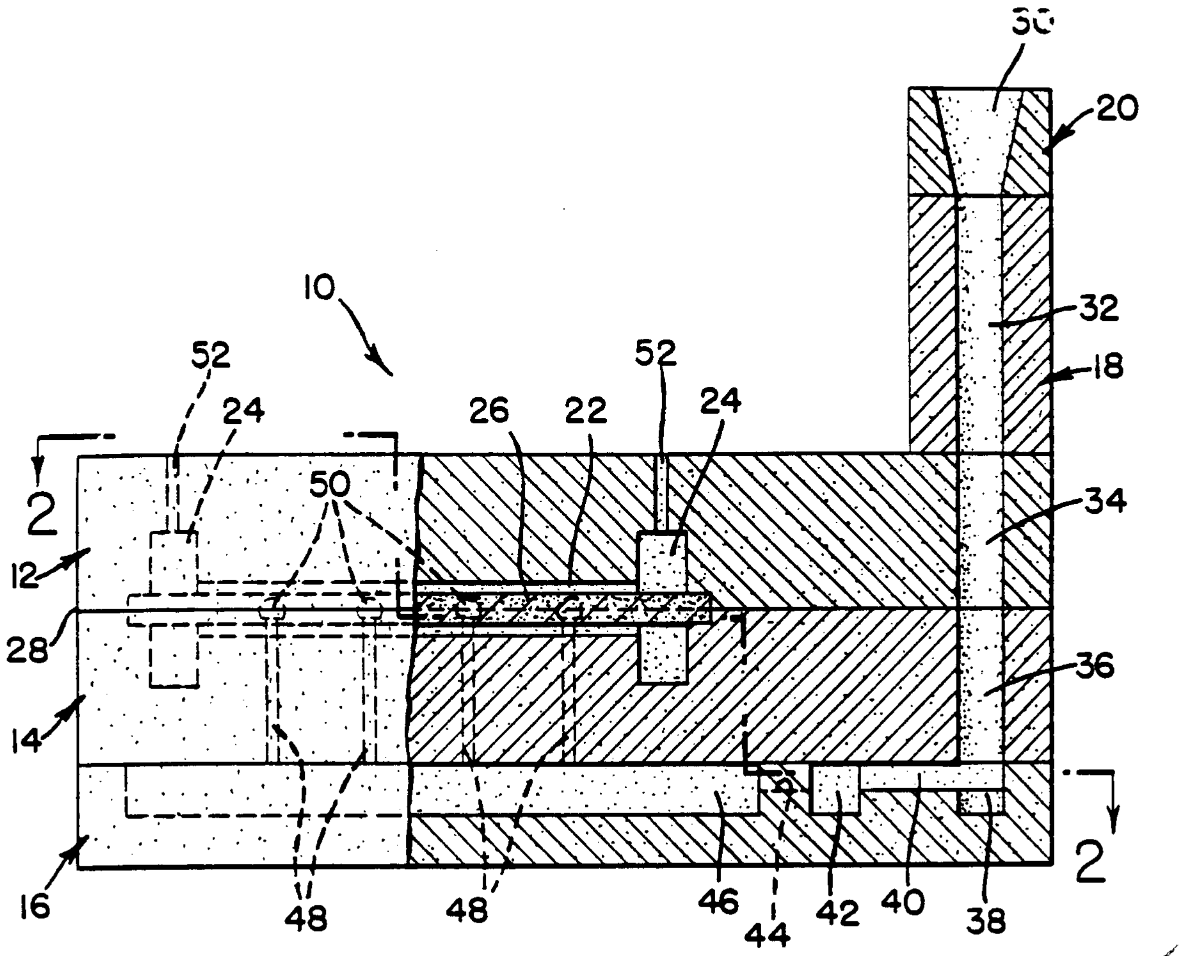
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FIG. 1

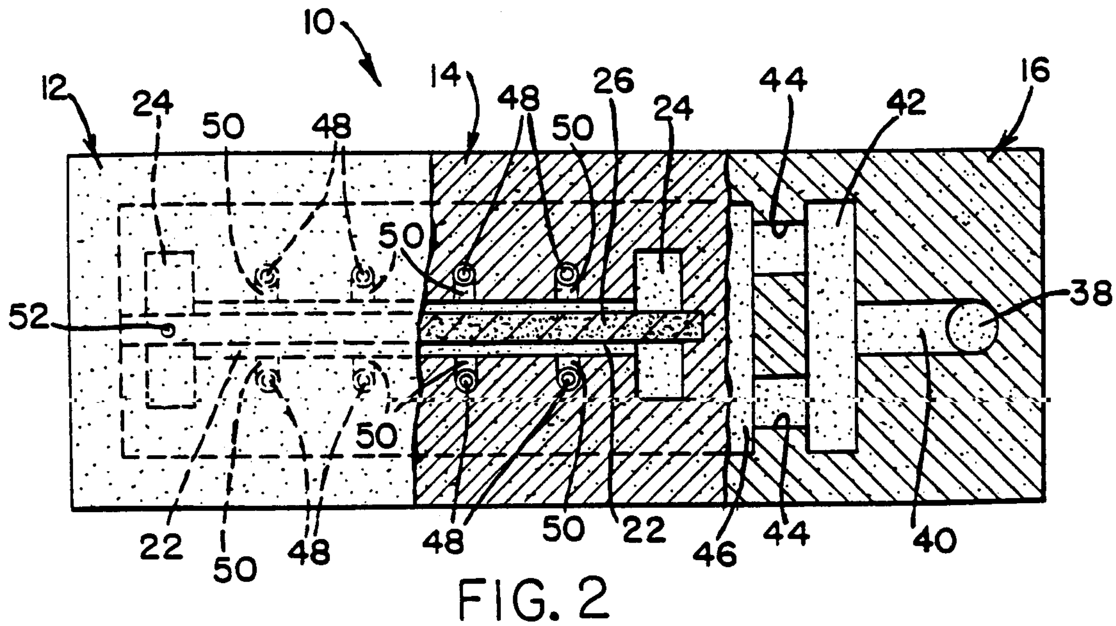
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FIG. 2

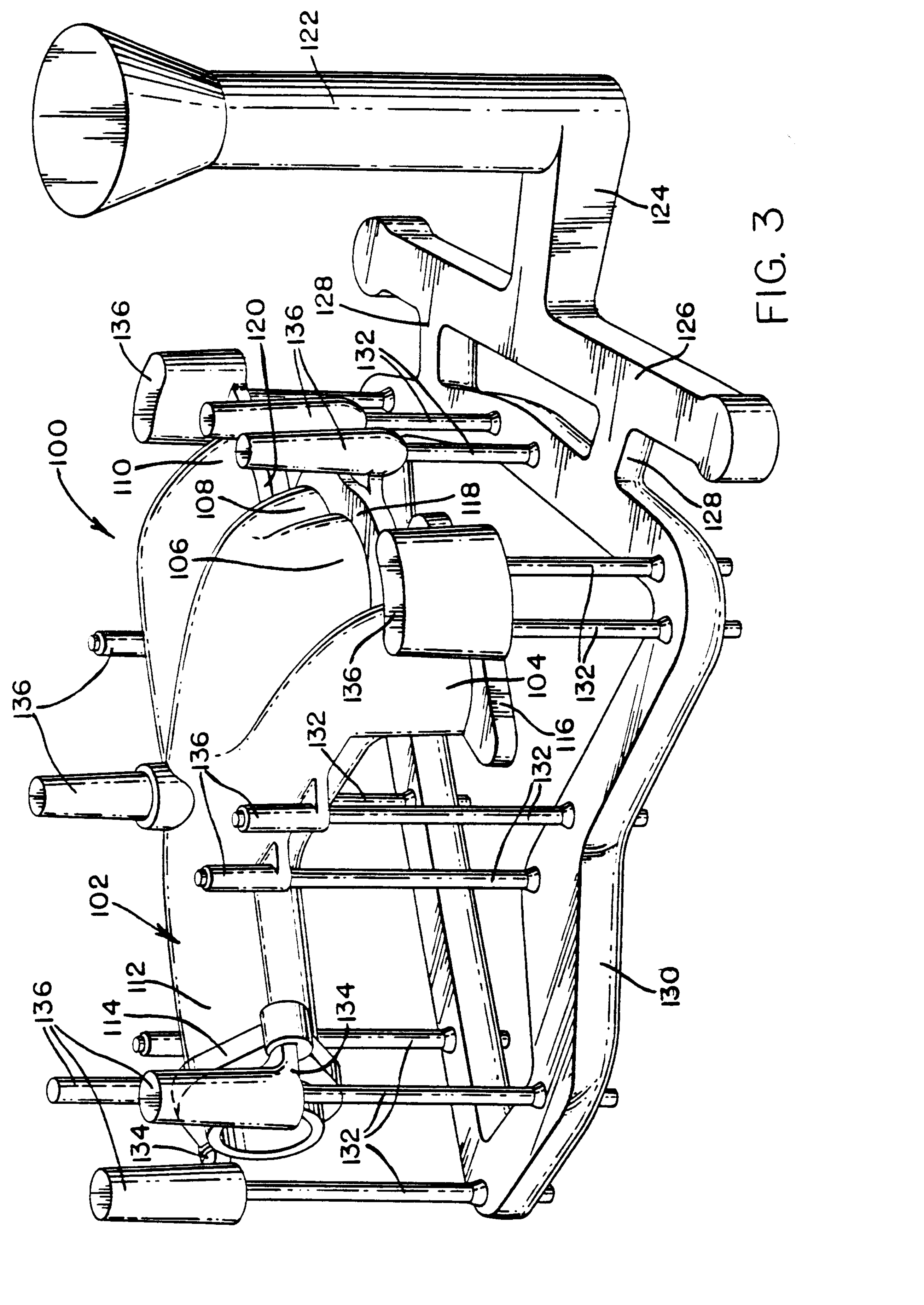
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FIG. 3