Dec. 24, 1935. A. W. BREARLEY 2,025,336

METHOD OF FORMING LARGE HOLLOW CASTINGS

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Fig. 1.

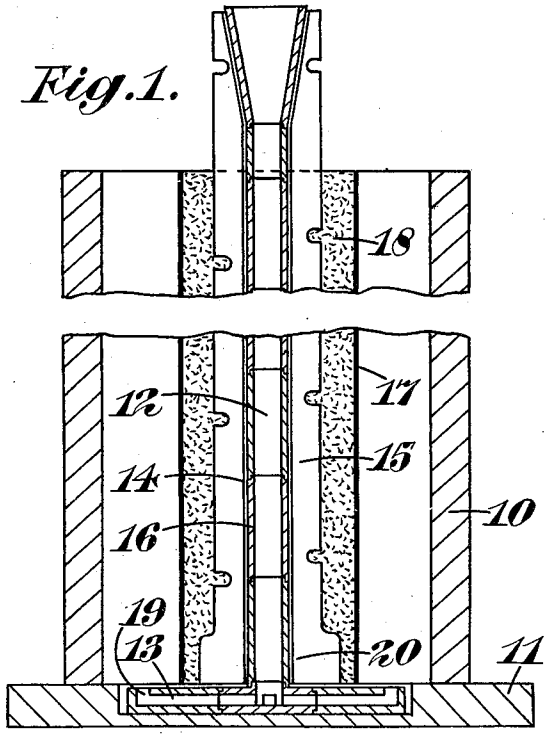
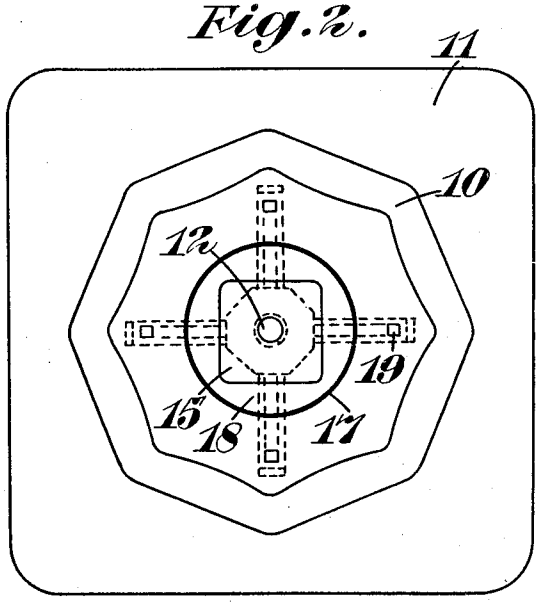


Fig. 2.



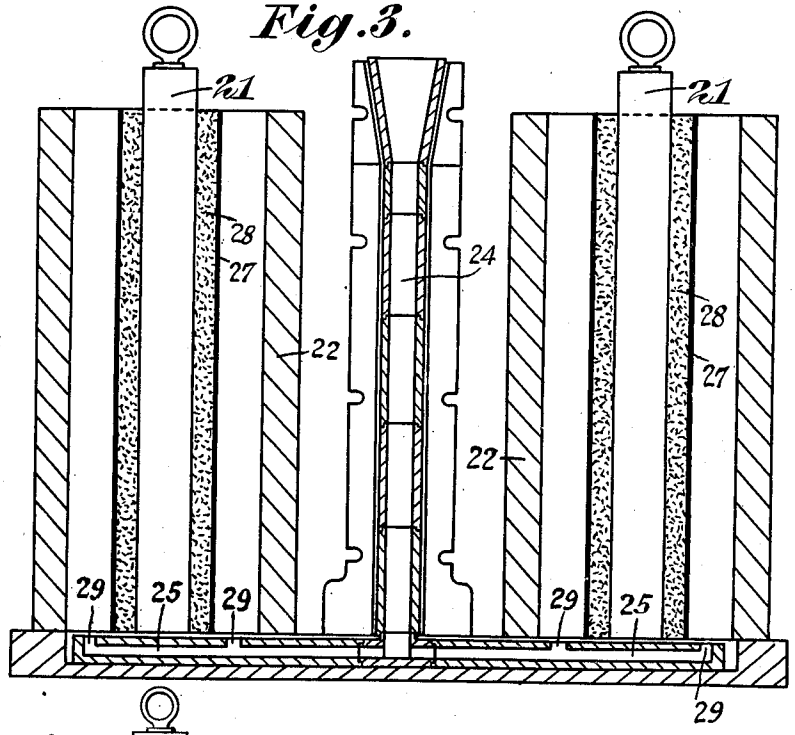
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Fig. 3.



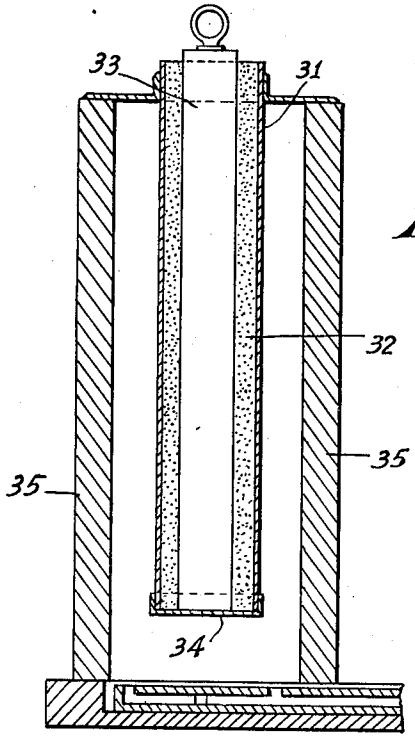


Fig. 4.

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METHOD OF FORMING LARGE HOLLOW CASTINGS

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In Great Britain March 24, 1933

3 Claims. (Cl. 22—200)

This invention relates to cores for heavy hollow steel ingots and other heavy steel castings.

Hitherto great difficulties have been experienced in attempts to cast such large heavy hollow steel ingots so that it is at present the universal practice in the production of such ingots, which are in considerable demand for the manufacture of large steel forgings for boiler drums, chemical reaction vessels and like hollow containers of large size, to cast the ingot solid and to remove the central unwanted portion by a machining operation. This process is unduly expensive and difficult because the weight of metal required to be cast is greatly in excess of that which would be required if the ingot were cast hollow, the ingot requires much greater time before removal from the mould and for annealing than if cast hollow and the machining operation is difficult, laborious and expensive. Moreover in some cases of very large ingots the extra weight involved by the unwanted central portion brings the total weight of the ingot above the load capacity of available lifting gear.

One of the main difficulties to be overcome in the casting of large hollow ingots is the shrinkage of the casting after it has been poured and has partly or wholly frozen. Such shrinkage is resisted by the core and undesirable internal strains, or, in some cases, actual cracks are formed in the ingot.

A further difficulty arises in the casting of heavy hollow ingots owing to the tendency of the molten metal in very large bulk to erode a core of rammed sand or fire clay and the liberation from such cores, under the intense heat, of gases such as water vapour.

The present invention has for its object the provision of an improved process of casting heavy hollow ingots, whether open at both ends or only at one end.

Another object is the casting of such heavy hollow ingots in such a manner that they are free from internal strains or cracks after they have cooled.

Another object is the utilization of loose dry sand, as opposed to rammed or moist coherent sand, in the casting of heavy hollow ingots.

Another object is the provision of a process of casting heavy hollow ingots in which the core maintains its form rigidly so long as is required for the poured steel ingot to freeze sufficiently to become self maintaining as to its shape and the molten steel, when poured, does not come into direct contact with the core which may evolve gases and may be eroded or disintegrated by the molten metal.

Other objects and advantages of the invention will be appreciated from the following description and accompanying drawings.

It has heretofore been proposed, for the purpose of preventing blistering of the interior surface of a hollow ingot to cast it about a collapsible core comprising a thin nickel plated tube filled with loose sand or other refractory material. According to this proposal the thin nickel plated core tube became fused to the molten metal and, upon contraction, the loose packing of sand was crushed. According to another prior proposal intended for the production of relatively light hollow castings, such as ordnance and projectiles therefore the core comprised sand rammed within a shell of sheet iron which melted and formed part of the casting. In this latter process the sheet iron was for the purpose of providing a cleaner mould than would be provided by sand alone thus to prevent the formation of blow holes and irregularities in the casting. It has also been proposed to provide a feeder head comprising an inner liner of thin sheet metal surrounded by loosely packed sand or other insulating material and to embed a closed case of sheet iron containing a non-metallic or silicious body wholly within an ingot or other casting. Light tubular articles such as iron pipes have been cast in a sand mould on to an internal shell of thin sheet steel or wrought iron filled with sand. All these proposals relate to comparatively light castings and not to heavy ingots of the nature of those with which the present invention is concerned. It has not hitherto been practical to utilize sand for heavy castings where the hydrostatic pressure of the large bulk of molten metal may exceed the stiffness of the sand.

According to the present invention in a process of casting heavy hollow steel ingots about a core comprising a thin walled hollow protector of metal, capable of blending or alloying with the steel, filled with loose dry sand, the sand sinters at or near the melting point of the steel, the hollow protector is only sufficiently thick to support the sand without melting until after at least the surface layers of the sand have been sintered by the intense heat of the molten steel, the steel is flowed into the mould at the bottom and fills the mould from the bottom upwards substantially without turbulence and the sand is broken and loosened after the steel has frozen sufficiently to form in proximity to the core a solid wall of sufficient strength to maintain the shape of the hol-

low ingot, thus permitting unimpeded contraction of the ingot as it cools further.

The functions of the thin metal protector and of the sand are complementary to each other. The thin metal protector first supports and maintains the desired shape of the loose dry sand core, secondly it protects the loose sand core from being disintegrated by the molten steel and thirdly it permits the sand to be sintered without deformation of the core. The sand on the other hand, by the pressure exerted by it on the surface of the protector owing to its loose or mobile form prevents the collapse of the protector under the very great hydrostatic pressure of the molten steel. The sand moreover sinters before the protector melts, as it may in some cases, and thus forms a coherent wall of sufficient strength to withstand the hydrostatic pressure of the still molten metal against it. It is of secondary importance whether or not the protector melts after the sintering of the sand because, when the sand is sintered, the function of the protector is no longer necessary.

As above stated as soon as the cast steel has solidified sufficiently to retain the shape of the ingot the sintered sand is broken and loosened, the contraction of the ingot thus being permitted to take place with little or no restraint as the ingot cools.

The flowing of the molten steel into the bottom of the mould and filling of the mould from the bottom upwards substantially without turbulence is of importance, since pouring the steel into the top of the mould would inevitably set up turbulence and splashing which might cause premature melting of the protector before the sand has sintered sufficiently to maintain its shape.

In carrying out the invention a fracturing device is preferably embedded in the sand and, after the steel has frozen sufficiently, it is moved and preferably withdrawn to cause the sand to crumble. In casting a hollow ingot the steel may be poured through a central geat or conduit in known manner so that the molten steel is introduced through the center of the core to the bottom of the mould. In this case the geat is surrounded by a thin protector with an annular space between the geat and the protector filled with loose dry sand and, after the steel has frozen sufficiently, the sand is fractured and loosened by movement of the geat.

In casting a hollow ingot closed at one end the protector may be a sheet metal vessel having a closed and an open end. It is filled with loose dry sand and supported in the mould with its closed end lowermost and above the base of the mould and with its open end above the top of the ingot to be cast.

Other objects are to apply the invention to the casting of slab ingots and composite ingots.

In the accompanying drawings:—

Figure 1 is a sectional elevation of an ingot mould and core according to the present invention.

Figure 2 is a plan of Figure 1.

Figure 3 is a view similar to Figure 1 illustrating a modification.

Figure 4 is a section of a modified form of core.

With reference first to Figures 1 and 2, which illustrate the invention applied to the casting of a hollow steel ingot which is open at both ends, an ingot mould **10** of the usual material (cast iron) is placed in position on a casting plate **11** and a geat or conduit **12** for the molten metal is arranged at about the centre of the mould and is connected with runner bricks **13** fitted in the plate **11**.

The geat illustrated is of the type in which dry granular packing **14** is poured into the annular space between an outer metal case **15** and an inner refractory liner tube **16**.

A protector in the form of a hollow cylinder **17** of sheet metal is supported on the casting plate **11** co-axial with the geat or conduit **12** and the annular space between the protector **17** and the outer metal case **15** of the conduit is filled with dry sand **18** which is in a dry condition and may be warmed.

The runner bricks **13** are provided with the desired number of feed apertures **19** opening between the mould **10** and the protector **17**. Molten metal passing down the central geat or conduit **12** is thus formed into a hollow ingot between the mould **10** and the central core which comprises a wall of sand **18** re-inforced and protected from direct contact with the fluid metal by the protector **17**.

It is advisable to feed the ingot through a number of equally spaced runner bricks **13**, four of the feed apertures **19** from such bricks being shown in Figure 2, so that the steel may be delivered at an equalized temperature in different parts of the ingot, thereby preventing the production of a relatively hot and cold side which may lead to cracking when the ingot freezes.

At a suitable interval after casting, depending on the mass of the ingot, the central conduit or geat **15** is drawn out, allowing the sand **18** to collapse. A flange or laterally projecting feet or the like **20** may be provided on the outer metal case of the conduit to enable it to stand firmly on the casting plate **11** and to operate to fracture the sintered sand **18** when the conduit is extracted.

The shape of the protector **17** may vary according to circumstances and its thickness is governed by the mass and temperature of fluid metal in contact with it, its own melting point and the temperature at which the sand **18** sinters.

In a specific example an ingot weighing from seven to twenty tons may thus be cast around a protector **17** made from mild steel sheet one sixteenth of an inch thick. In another example an ingot weighing three to five tons may be cast around a protector **17** made from mild steel sheet of twenty six gauge thick. In both cases the outer or exposed surface of the protector remains solid, its inner surface being welded to the casting.

Whether the protector **17** melts wholly or partially during the pouring operation, it may be arranged to distribute the pressure of the fluid metal to the main body of the sand **18** (thus preventing the latter from crumbling) until it has frit or sintered and is in a condition to withstand that pressure without the aid of the protector.

In the modification illustrated in Figure 3 the geat or conduit **24** is disposed outside the mould **22** and a rod **21** is embedded in the sand **28** inside the protector **27**. The rod **21** forms a fracturing or removing device so that on withdrawing it, after casting, the sand **28** will collapse and will oppose no resistance to contraction of the ingot as it freezes. The geat or conduit **24** may feed more than one mould, two being shown in Figure 3. The molten steel is fed to the base of the mould through runner bricks **25** provided with feed apertures **29** as illustrated in Figure 3, arranged in the annular space between the protector **27** and the mould **22**.

If desired the rod **21** may be provided with

lateral projections to ensure that the sand shall collapse on removal of the rod.

In order to provide a hollow ingot which is closed at one end the protector may be in the form illustrated in Figure 4, being that of a sheet metal vessel or thimble comprising a hollow cylindrical portion 31 provided with a cover 34 at one end. This protector supports a sand wall 32 which may either fill the protector or, as illustrated, may be situated in an annular space between the wall 31 and a fracturing or removing rod 33 contained inside the protector. The complete core comprising the protector 31, 34, supporting the wall of sand 32 and containing the rod 33 is supported or suspended in an ingot mould 35, with its closed end 34 the desired distance from the base of the mould and its open end above the casting level or top of the ingot.

The invention may also be applied to the coring of castings other than ingots, especially where it is desirable that the core shall oppose no resistance to contraction of the casting.

The metal wall of the tube or protector must not be of such thickness that it may by itself, when heated to the temperature of the molten metal in contact therewith, withstand the hydrostatic pressure of the metal, but on the other hand must require interior support at such temperatures in order to maintain its shape. On the other hand the metal wall of the tube must not be so thin that it will melt and permit penetration of molten metal to the sand core prior to the time when the layer of sand next adjacent the same has been raised to a sintering temperature. By the term "thin" used in the appended claims in describing the thickness of the wall of the tube is meant a tube having a wall the thickness of which lies between the limits above set forth. The actual thickness of the metal wall of the tube to be used in any particular instance may vary somewhat with variations in the diameter of the ingot to be cast, as indicated in the examples previously set forth.

What I claim is:—

1. The method of forming a void or cavity in a large casting, during a casting operation, with the aid of a core of loose dry sand having the capacity to sinter under heat, which comprises the steps of protecting the loose dry sand core by a facing sheet of metal capable of blending or alloying with the metal to be cast, said sheet being relatively thin so as to readily transmit heat from a body of molten metal to the sand, while at the same time preventing access of the molten metal thereto until the sand layer next adjacent the sheet has sintered and become self-sustaining against the action of molten metal and, after the molten metal has cooled sufficiently to become self-sustaining, destroying the core.

2. The method of forming an axial cylindrical void or cavity in a large thick walled casting, during a casting operation, with the aid of a core of loose dry sand having the capacity to sinter under heat, which comprises the steps of protecting the loose dry sand core by a relatively thin cylindrical facing sheet of metal capable of blending or alloying with the metal to be cast, said sheet readily transmitting heat from a body of molten metal to the sand, while at the same time preventing access of the molten metal thereto until the sand layer next adjacent the facing sheet has sintered and forms a rigid wall self-sustaining against the action and pressure of the surrounding body of molten metal and, after the molten metal has itself cooled sufficiently to become self-sustaining, destroying the core, including the sintered outer wall, to permit free contraction of the casting.

3. The method of forming an axial void or cavity in a large thick walled casting, during a casting operation, with the aid of a core of loose dry sand having the capacity to sinter under heat, which comprises the steps of protecting the loose dry sand core by a relatively thin facing sheet of metal capable of blending or alloying with the metal to be cast, said sheet readily transmitting heat from a body of molten metal to the sand, while at the same time preventing access of the molten metal thereto until the sand layer next adjacent the facing sheet has sintered and forms a rigid wall self-sustaining against the action and pressure of the surrounding body of molten metal, filling the mold with which the core and protector are associated with molten metal by a bottom pouring operation and, after such molten metal has cooled sufficiently to become self-sustaining, destroying the core, including the sintered outer wall, to permit free contraction of the casting.

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