

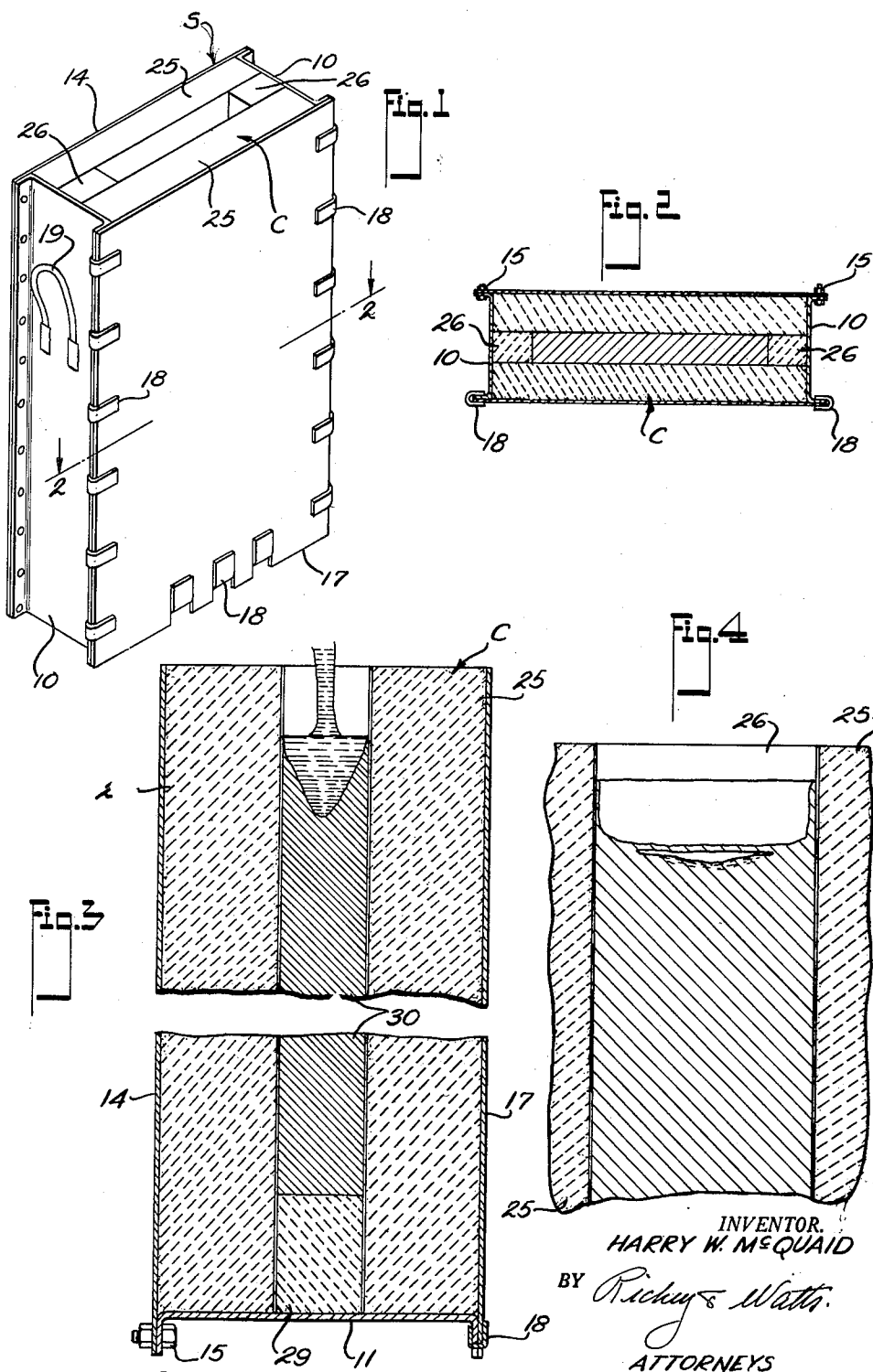
March 24, 1953

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2,632,216

APPARATUS FOR MAKING SLAB OR BILLET-TYPE INGOTS

Filed Aug. 4, 1949



UNITED STATES PATENT OFFICE

2,632,216

APPARATUS FOR MAKING SLAB OR BILLET-TYPE INGOTS

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Application August 4, 1949, Serial No. 108,445

2 Claims. (Cl. 22—113)

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The present invention relates generally to the art of casting metal in molds and is more particularly concerned with a novel ingot mold having hitherto unobtainable and important advantages from the standpoint of the manufacture and use of the mold itself, and from the standpoint of the casting results obtained with the mold.

It has long been the common practice in the steel industry to cast steel ingots in integral cast iron molds, although this procedure has several serious shortcomings. For one thing, due to the tendency for steel splashings to stick to the sides of molds of this kind during the pouring operation and produce defects in the final ingots, it is necessary to apply a special mold coating to the walls of the mold. It is also considered necessary to taper the walls of these molds in a particular manner to facilitate stripping of the ingots therefrom and controlling to some degree shrinkage losses. Still further, the portions of these cast iron molds coming into contact with molten metal tend to deteriorate rapidly and attempts to extend the useful lives of these molds, to the best of my knowledge, have not brought any very improved results. Also, when a heat of metal is at an unusually high temperature, there is a tendency for the resulting ingot to stick to the mold, making stripping of the ingot difficult and causing damage to the mold.

In accordance with the present invention, hot tops may be eliminated without incurring piping losses as great as those normally incident to the use of cast iron molds to which hot tops are applied. Additionally, under certain circumstances defects in ingots attributable to splashing during the pouring operation may hereby be eliminated without resorting to special mold design or to special mold-coating materials. Further, this invention enables a substantial extension of the useful lives of ingot molds, in some common instances actually doubling the lives of these molds. Also, under certain circumstances, the foregoing advantages can be obtained together with the additional advantage of greater production without a corresponding increase in plant facilities. That is, for a given mold the operations of pouring molten metal into the mold, cooling and freezing the metal therein, and removing the resulting ingot therefrom, can be carried out by this invention more rapidly than heretofore commercially possible, due to a substantial increase in the rate of freezing of metal in the molds. Still further, molding to close tolerances is made much easier in accordance with this invention, thereby reducing the cost of precision casting operations.

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All these advantages are obtained in addition to the advantages of ease and economy of construction and maintenance of the molds of this invention because of the novel means by which these molds are fabricated and held in assembled relation. Only a few hammer blows are necessary to assemble or disassemble these molds, but when the parts are assembled together, they are firmly held for as long as desired in assembled relation and there is no danger of the molds breaking or falling apart in use due to failure or loss of the securing parts.

In a preferred form, this invention involves the use of carbon blocks or plates to define a mold cavity, but I contemplate the use of copper, ferrous metals, brass, and other metals and alloys for this purpose, water cooling or equivalent means being provided where necessary or desirable to protect the mold from the heat of the molten metal at the present greater rate of ingot production.

In general, an ingot mold of this invention comprises a fabricated sheet metal shell in which a metal-receiving opening is provided at the top, and a fabricated liner assembly is supported within this shell defining a mold cavity of predetermined size and shape. For a purpose predicated upon my discovery, subsequently to be described, the shell and the liner assembly together should weigh at least twice as much as the molten metal to be cast in the mold to produce an ingot, and the inner side walls of the assembly should be substantially parallel and preferably not more than 3 inches apart, while the ratio of the total number of cubic inches in the mold cavity to the total number of square inches of molten metal contact surface area should preferably be not more than about 1.5 to 1.0.

Regarding my discovery, I have found that when the foregoing relations exist, it is possible to pour vertical ingots of any practical height with less than 10 percent of discard or scrap necessary because piping, even in killed steel, is practically eliminated. By way of example, using a mold of the type generally described above in which the mold cavity is 120 inches high, 2½ inches across and 10 inches wide, and casting therein a completely killed steel, I have consistently produced ingots having less than 4 inches of their tops affected by shrinkage cavity and requiring discard. In this particular mold cast iron was used as the liner assembly to define the mold cavity, but similar results may be obtained with molds of other metals, as set forth above, slight modifications in the dimensions of the mold cavity and the relative weights of the complete

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molds being made to compensate for the different thermal and density characteristics of the various metals. Thus, if carbon is substituted for cast iron in the present molds, the total mass of the ingot could be 10 to 20 percent greater, or the ratio of molten metal contact area to mold cavity volume could be correspondingly smaller, or both these factors could be adjusted to a lesser degree to give equivalent results.

Those skilled in the art will gain a further understanding of the present invention on consideration of the following detailed description of the drawings accompanying and forming a part of this specification, in which:

Figure 1 is a perspective view of a fabricated mold including a shell and liner assembly of a preferred form of this invention;

Figure 2 is a horizontal, sectional view of the mold of Figure 1 taken on line 2—2 thereof and showing an ingot cast into the mold;

Figure 3 is a vertical, sectional view of the mold of Figure 1, showing a partially formed ingot and molten metal in the mold; and,

Figure 4 is an enlarged, fragmentary view of the upper part of the liner assembly of the mold of Figure 1, showing the upper part of an ingot frozen in the mold.

The illustrated mold, comprising a shell S and a carbon liner assembly C disposed within the shell, as stated above, is relatively long or high but the mold cavity is critically thin in order that the rate of chilling and freezing of the molten metal introduced into the cavity will be sufficiently great to produce the foregoing results. The width of the cavity may be of any practical dimension, as may its length or height, the only limitations being those set forth above, namely the critical ratios of mold weight to cast metal weight and cast metal contact surface to mold cavity volume.

Shell S comprises in general, a metal box-like body which is open at its top end, and in front and it is provided with flanges and a plate constituting a cover for the front of the body bearing firmly against the flanges by means engaging the plate and flanges.

More in detail, shell S comprises a pair of spaced channels 10, the back portions of which are opposed to each other. A third channel 11, is disposed below channels 10 and bears on the lower ends of said channels; constituting the bottom portion of the shell. A back plate, 14, bears upon the flanged portions of channels 10 and channel 11 and is fastened to the flanges thereof by means of nuts and bolts 15, the bolts extending through registered openings in the flanges and plate, as shown in Figure 2. A front plate 17, of substantially the same dimensions as back plate 14, is provided as a cover for the front of the shell and is fastened to the other parts thereof by means of a plurality of U-shaped clips 18, which are fitted over the forward flanges of channels 10 and 11 to hold the vertical edge portions of the plate in firm engagement with these flanges. The intermediate portion of the forward flange of channel 11 is cut away and the opposed lower end portion of plate 17 is similarly formed to provide floor clearance for clips 18 along the under side of the front of shell S as shown in Figure 3.

From the foregoing, it is seen that assembly of shell S may be carried out easily and quickly and that the partial assembly or disassembly thereof, that is, removal and attachment of plate 17 to the remainder of the shell, is primarily

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merely a hammer job. Thus, the liner assembly C may readily be inserted into or removed entirely or in part from the shell by taking off plate 17, and maintenance and repair of the mold is therefore economical.

A pair of lifting handles or lugs 19 are welded to the outer sides of channels 10 near the upper ends thereof to aid in lifting and carrying shell S and any contents thereof, such as assembly C and an ingot therein. Where convenient, a magnet (not shown) carried by a crane or the like may alternatively be used to lift and carry shell S and its contents.

Assembly C is made up of a pair of opposed carbon blocks 25 of approximately the same length and width dimensions as plates 14 and 17 of the shell. Blocks 25 are spaced apart a predetermined distance equivalent to the desired thickness of the ingot and another pair of blocks 26, are disposed between blocks 25 and engaged therewith, and are spaced apart the width of the desired ingot. A bottom block 29 defining the floor of the mold cavity is disposed between the blocks 25 and 26 and engaged therein and is of predetermined width according to the height of the ingots to be cast in the mold. These several carbon blocks are preferably bonded together to prevent relative movement in the assembly and leakage of molten metal between the blocks. The ordinary electrode joint compound may be used for this purpose.

Whether carbon, copper, aluminum, or the like is used in making up the fabricated liner assembly, the life of these molds may be doubled and extended far beyond anything heretofore known in commerce through the use of the usual cast iron molds, by reversing the elements making up the said assembly. For example, in the mold illustrated, after the sides of the blocks 25, 26 and 29 defining the mold cavity have been eroded to the point where they are no longer satisfactory for the purpose, these blocks may be turned around and these worn sides made the outside surface portions of the assembly, bearing against the inside walls of the shell S.

One stage in the production of an ingot in these molds is illustrated in Fig. 3, this being the typical condition of the ingot and molten metal during the pouring of molten metal into a mold. The initial chill of this metal has converted all the said metal in the vicinity of the mold walls into solid form while the metal in the core of the ingot has been converted to a non-liquid state (i. e. a pasty or soft condition). Also, a solid meniscus has been formed and there exists only a shallow conical pool of molten metal atop the partially formed ingot where fresh molten metal is caught in the mold. In Fig. 4 the final ingot is illustrated as having a small shallow cavity closely under a surface crust on the top of the ingot, and as being free of the sides of assembly C for ready removal from the mold. Thus, because of the manner in which molten metal is frozen in this mold, as described above, shrinkage loss in the ingot is very small even if "hot tops" are not used. Furthermore, as the ingot cools, it shrinks substantially and tends to contract from the mold cavity walls. This tendency is most pronounced when the coefficient of thermal expansion of the ingot metal is considerably greater than that of the mold assembly as in this case, where the ingot is steel and the mold assembly is carbon.

The term "mold cavity" as used herein and in the appended claims means and refers to

that space in a mold which is substantially filled with molten metal in making ingots. Thus, in a mold having a recess 200 inches deep in which molten metal cannot or would not be poured to a depth greater than 100 inches, the "mold cavity" is only 100 inches deep. The foregoing critical values on mold dimensions obviously apply only to the useable and used portion of the space with molds.

Having thus described the present invention so that those skilled in the art may be able to understand and practice the same, I state that what I desire to secure by Letters Patent is defined in what is claimed.

What is claimed is:

1. An ingot mold comprising a fabricated sheet metal shell having a metal-receiving opening in its top portion, and a fabricated carbon liner assembly supported within and bearing against the shell and defining a generally flat sided mold cavity of predetermined size, said shell comprising a metal body open at its top and in front and having outwardly directed flanges, a plate constituting the front of said shell and bearing against said flanges and a plurality of clips spaced from the liner assembly and engaging said plate and flanges for holding the plate in assembled relation, said shell and plate and carbon assembly together weighing at least twice as much as the molten metal to be cast therein, and said carbon assembly having inner side walls spaced not more than 3 inches apart, and the ratio of the total number of cubic inches in the mold cavity to the total number of square inches of molten metal contact surface area of said assembly being not more than about 1.5 to 1.0.

2. An ingot mold comprising a fabricated sheet metal shell having a metal-receiving opening in

its top portion, and a fabricated carbon liner assembly supported within the shell and defining a generally flat sided mold cavity of predetermined size, said shell and assembly together weighing at least twice as much as molten metal to be cast in the mold to produce an ingot, and said assembly having inner side walls spaced not more than 3 inches apart, and the ratio of the total number of cubic inches in the mold cavity to the total number of square inches of molten metal contact surface area of said assembly being not more than about 1.5 to 1.0.

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