Nov. 22, 1932. A. M. ERICHSEN 1,888,913

MOLD FOR CASTING METALS AND METAL ALLOYS

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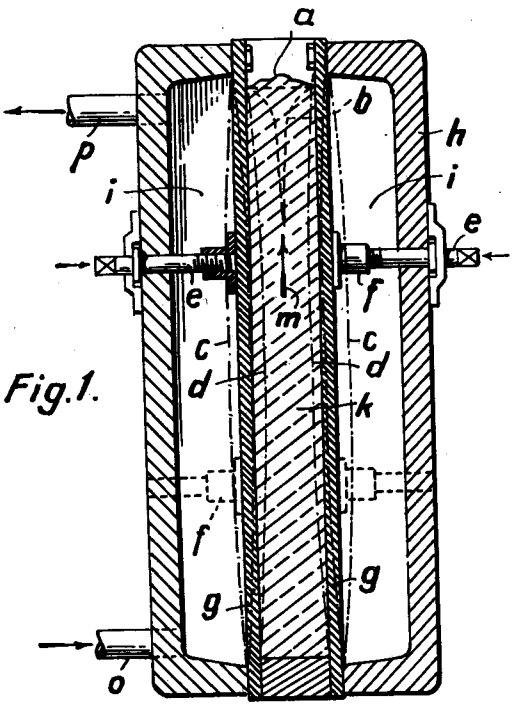


Fig. 1.

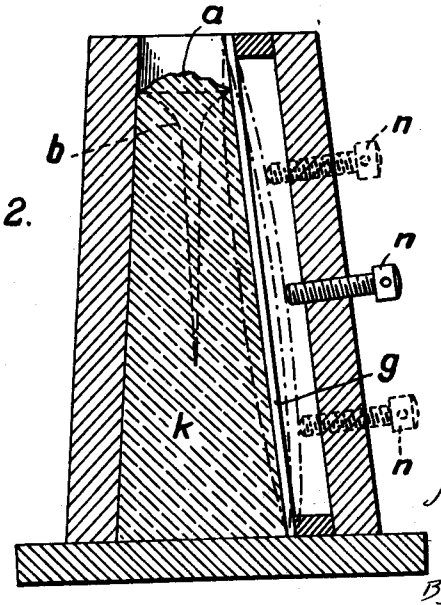


Fig. 2.

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Fig.3.

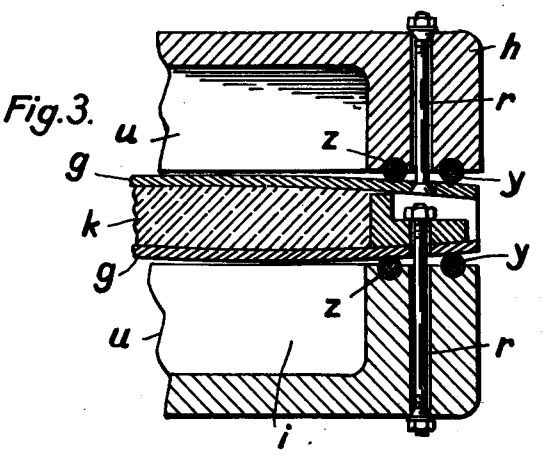
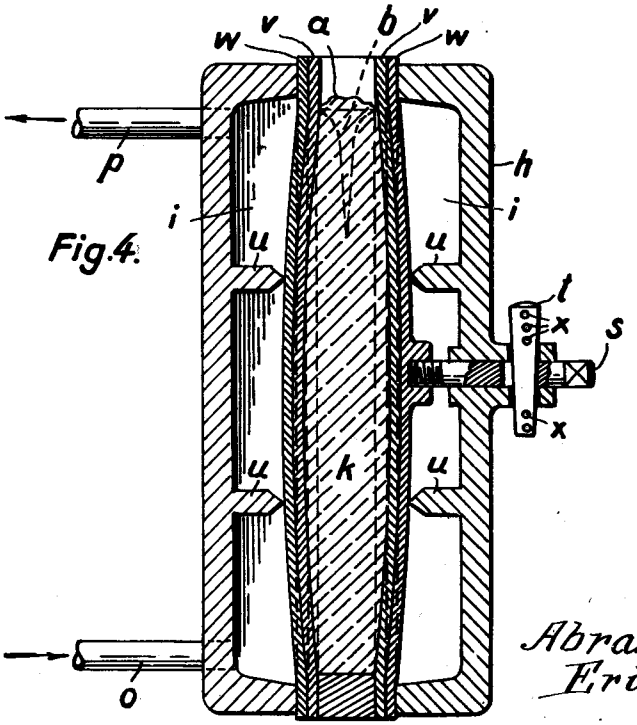


Fig.4.



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UNITED STATES PATENT OFFICE

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MOLD FOR CASTING METALS AND METAL ALLOYS

Application filed October 9, 1930, Serial No. 487,591, and in Germany February 28, 1929.

When iron, other metals or metal alloys are cast, more particularly in plates or ingots, a zone is formed where the formation of fissures is more predominant; and also in cases where impurities are present or there is a plurality of metals present to form an alloy liquation or the separation of certain components occurs in this zone. The zone is usually centrally disposed and is found to remain in a liquid state for a longer period than the other parts of the casting. This zone causes lack of homogeneity, both in composition and strength, and consequently many attempts have been made to eliminate it. For example, one of the side walls has been pressed inwards against the casting during solidification with a view to extruding the metal contained in this zone out of the main body of the casting, and at the same time to force metal into those parts of the mold which remain unoccupied.

Whereas in the known methods, pressure has been applied to the molten metal through rigid but movable parts of the mold, the present invention comprises a mold for casting metals and metal alloys, having a wall or walls which under the action of stresses, due to temperature changes, occurring in the material forming the walls, or of external pressure can, by distortion or by resumption of normal shape after a prior distortion, exert pressure on metal forming a casting prior to and/or during the solidification thereof.

By this means, the unwanted zone is removed and any fissures tending to form are filled by an upward flow of molten metal under pressure.

Each operative wall of the mold may either be distorted so that it will have an inwardly cup-shaped configuration, or it may be first distorted so that it has an outwardly cup-shaped configuration and subsequently forced inwardly to form a flat surface. The latter method is preferable when a casting having the flattest possible outer surfaces is desired.

By adjustment of the pressure and the total quantity of molten metal poured into the mold, a greater or less quantity of metal can be forced out so that when solidification is complete, the casting is entirely free of fissures, and at the same time the inferior metal, contained in the unwanted zone is no longer present in the main body of the casting.

It is preferable to apply the pressure while the metal to form the casting is solidifying, but it may be applied prior to, or prior to and during the process of solidification. As the whole of the casting, while solidifying is still soft and malleable and the central portion remains molten, relatively small pressures on the wall of the mold suffice to express the molten metal from the centre. It has been found, particularly with copper alloys and other metals which liquefy readily, that the stresses resulting from contraction and expansion with temperature changes and produced in the casting itself are sufficient, if the thickness and conductivity and expansion coefficients of the cooling plates be suitably to extrude the fluid core from the casting.

It is common practice when casting iron and steel ingots, to link several moulds together by channels, so that when the metal is poured into one mould, it rises simultaneously in the others. When the mould is filled gradually from the bottom upwards in this manner, the lower end of the casting remains warm and mouldable for a longer period than if the fluid metal is poured in at the top, and consequently the fluid core can be squeezed out downwardly or upwardly or towards both ends of the casting.

In order to obtain pressure effects by temperature change alone, the walls of the mould may comprise two or more plates of metals of which the coefficients of expansion differ, the plates being joined together in any suitable manner.

The advantages of the invention do not reside solely in the elimination of fissures and liquation. Equally important is the fact that by the extrusion of metal in the manner described, the formation of large crystals is avoided, growth of the crystals being prevented or retarded. In ingot cast according to the invention has markedly fine crystals;

a fact of considerable importance in the further treatment of the metal.

The pressure and subsequent movement affects the crystals in the half-solidified casting similarly to rolling or pressing. Radiating fissures which are normally produced in castings during solidification are also completely eliminated by the use of a mould according to the invention.

It is common practice when casting copper alloys and the like, to employ cold or chilled moulds. Such moulds may be formed in accordance with the present invention by constructing the cold plates in the form of diaphragms and applying pressure to the centres thereof.

It is sufficient if the pressure be applied on one side of the casting only, that is to say, if only one of the side plates be cupped and movably mounted, but both side walls of the mould may be mounted flexibly and the pressure may be applied on both sides.

It is preferable to make the mould from a metal of low heat conductivity such as nickel steel, Erical, Invar and the like, as then the rate of solidification is reduced and the advantageous results of the pressure on the casting increased.

The extruded metal forms a ridge or protuberance on the top of the plate or ingot, or the quantity of metal may be sufficient for it to flow over the top of the mould.

Several embodiments of the invention are, by way of example, illustrated diagrammatically in the accompanying drawings.

Figure 1 is a longitudinal section of a mould for casting plates provided with liquid cooling, in which two walls can be pressed inwardly.

Figure 2 is a longitudinal section of a mould for casting plates provided with a flexible wall on one side only.

Figure 3 is a section of part of a cold mould with cold plates secured as diaphragms and provided with packing pieces.

Figure 4 is a section of a cold mould provided with cold plates, each comprising two connected plates of different metals.

In the mould for casting plates as shown in Figure 1, which is employed more particularly for casting plates of copper, nickel, aluminum and the like, as well as their alloys, such as, brass, nickel silver and the like, the plates g are secured in the mould h as diaphragms, so that a small distortion or cupping is possible both outwardly towards the water chamber i and inwardly into the casting chamber k. c is a position (drawn in dotted lines) the plates g may occupy before the metal is poured in, and d is the position they may occupy when pressure is being exerted during the solidification of the casting k. The plates g may be bent from the outwardly cupped position c or from the vertical position shown in full lines into the inwardly cupped position d, or they may be previously cupped outwardly to such an extent that sufficient pressure will be obtained by bending them back to the vertical position in order to obtain a casting having flat surfaces.

The fissure or liquation zone which obtains in the casting k under normal conditions is denoted by b; according to the invention this is removed, forcing it right out in the direction indicated by the arrow m by pressure applied on the plates g, so that finally the metal contained in this zone occupies a position at the head of the casting k and may form there a protuberance a, the size of which will depend on the pressure applied and the excess of molten metal that was added during the pouring.

Mechanism for exerting the required pressure comprises screws e co-operating with internally threaded nuts f which are fixed to the plates g' so that by rotating the screws e, the plates g may be moved inwardly or outwardly to occupy any desired position. As an alternative to this arrangement the screws e might be rotatably mounted in a hinged device secured to the plates g and the nuts f provided in some other position along the screw, for example, on the main casing h.

o, p are the water supply and discharge pipes for the cold water chamber i.

In the construction according to Figure 2, the mold h is provided with a movably held resilient plate g, which, without outside pressure, bends towards the casting when heated, so that during casting the zone b is forced out in an upwardly direction. A protuberance a will likewise be formed in this case.

A screw n forms an adjustable stop to limit the outward movement of the plate g, which can thus be adjusted in accordance with its initial stress and which generally presses tightly against the stop. A number of screws n, as shown in dotted lines in Figure 2, or other adjustable or fixed stops may be employed.

In order that the walls of the mold may be cupped outwardly beforehand so that they form a flat surface when pressed in, they may be mounted as diaphragms on two separate packing pieces y, z, as shown in Figure 3, the outer piece y being of a harder material than the inner piece z, which is made of a soft or resilient material such as rubber or is rendered resilient by an insertion of rubber or the like in suitable manner, for which purpose it may comprise, for example, a thin walled metal tube with a rubber core. By tightening the screws r, several of which are situated along the periphery of the plates g, the plates will be cupped towards the water-side i, as the outer harder packing piece y does not "give" to the same extent as the inner packing piece z. By this means, the cooling plates g bear tightly against the ribbed body u of the mold, but can bend

in both directions like a diaphragm without failure of the packing. As the cold plates bend in and out, the soft inner piece *z* will produce a tight joint, while the hard outer piece *y* provides counter pressure, so that the cold plates are stressed in the desired manner towards the water chamber *i*.

Figure 4 illustrates a cold mould with cold plates, each comprising two plates *v*, *w*, secured together in any suitable manner.

The cold plates are shown cupped towards the water chamber *i*; they may be distorted either as a result of prior treatment which tends to give them a cupped configuration normally, or by the action of packing pieces and screws, as described with reference to Figure 3. A further device is shown in the drawings. It comprises a screw *s* which is screwed a certain way into the plate *w* and then forced outwardly, dragging the plate with it, by means of a wedge *t*. The outward movement of the plates *v*, *w*, however produced, is limited by stops *u*. When metal is poured with the mould, the plates *v* being closer than the plates *w* will absorb more heat and so expand a greater extent, thus tending to straighten the double plates *v*, *w*, an effect which will be greatly enhanced if the plates *v* and *w* are constructed of metals having different coefficients of expansion. The inward straightening movement of the plates will be prevented by the screw *s* bearing against the wedge *t*. When this is loosened, however, the plates will bend inwardly and exert considerable force against the side of the casting *k* and the beneficial results described above will thus be obtained. In order to limit the amount of distortion, the wedge *t* is provided with adjustable pins or stops *x*, so that its movement is limited with consequent limitation of the distortion of the plates in either direction. As the screw *s* is adjustable, the limit to the distortion can be adjusted as desired.

The purpose of the apparatus shown in Figure 4 is to enable a high pressure acting over a limited distance to be suddenly applied, that is, consequent of a single blow with a hammer.

It is to be understood that the screw and other devices illustrated in the drawings are shown by way of example only and if desired they may be replaced by levers, hydraulic pressure, contracting rings, wedges of any other device capable of exerting mechanical pressure on the outside of the mould plates. The tension devices may similarly be replaced, a still further example comprising a distance piece of a fusible metal which will melt during casting and so release the plates.

The invention can be employed for casting and adapted to the special requirements of all metals and metal alloys in cooled or uncooled metal moulds. It may be employed for casting iron, steel and the like but is more particularly adapted for casting non-ferrous metals, precious metals and their alloys, such as copper, nickel, German silver, brass and the like. It will be understood that one or more walls of the mould may be provided as pressure walls with or without cooling.

The walls of the mould may preferably consist partly or wholly of metals that have a low heat conductivity coefficient but such a coefficient of expansion that the resulting effect will be to increase the pressure acting on the casting. Suitable examples of such metals are alloys containing nickel and chromium and having a coefficient of heat conductivity less than 0.10 calories per centimetre second, for example, Erical, Invar, or the like.

I claim:

1. In a mold for casting metals and metallic alloys, a wall made of material subject to distortion when exposed to differences in temperature; a support for said wall, rigidly connected to the ends of the latter for maintaining said ends in fixed relation and leaving the intermediate portion of the wall free to become distorted upon pouring, and exert a pressure on the mass poured in the mold.

2. In a mold for casting metals and metallic alloys, a wall made of material subject to distortion when exposed to differences in temperature; a support for said wall, rigidly connected to the ends of the latter for maintaining said ends in fixed relation and leaving the intermediate portion of said wall free to become distorted upon pouring, and exert a pressure on the mass poured in the mold; and means carried by said support and cooperating with the intermediate portion of the wall to urge the same in its pressure exerting distortion.

3. In a mold for casting metals and metallic alloys, a wall made of a material subject to distortion when exposed to differences in temperature; a support for said wall, rigidly connected to the ends of the latter for maintaining said ends in fixed relation and leaving the intermediate portion of the wall free to become distorted upon pouring, and exert a pressure on the mass poured in the mold; and means associated with said support and acting on the intermediate portion of the wall to limit the distortion thereof.

4. In a mold for casting metals and metallic alloys, a wall made of a material subject to distortion when exposed to differences in temperature; a support for said wall, rigidly connected to the ends of the latter for maintaining said ends in fixed relation and leaving the intermediate portion of the wall free to become distorted upon pouring, and exert a pressure on the mass poured in the mold; and, a packing between the wall and its point of attachment to the support.

5. In a mold for casting metals and metal-

lic alloys, a wall made of a material subject to distortion when exposed to differences in temperature; a support for said wall, rigidly connected to the ends of the latter for maintaining said ends in fixed relation and leaving the intermediate portion of the wall free to become distorted upon pouring, and exert a pressure on the mass poured in the mold; and, a packing between the wall and its point of attachment to the support, said packing consisting of an inner and outer member, the inner member being softer than the outer member.

6. In a mold for casting metals and metallic alloys, a wall made of a material subject to distortion when exposed to differences in temperature; said wall consisting of a plurality of adjacent plates each being acted upon differently by the change in temperature; a support for said wall, rigidly connected to the ends of the latter for maintaining said ends in fixed relation and leaving the intermediate portion of the wall free to become distorted upon pouring, and exert a pressure on the mass poured in the mold.

7. In a mold for casting metals and metallic alloys, a wall made of a material subject to distortion when exposed to differences in temperature; a support for said wall, rigidly connected to the ends of the latter for maintaining said ends in fixed relation and leaving the intermediate portion of said wall free to become distorted upon pouring, and exert a pressure on the mass poured in the mold; and, means carried by said support and engaging the intermediate portion of the wall for normally holding the same against distortion, whereby upon releasing said holding means, the wall will become suddenly distorted and exert a pressure with increased force upon the mass poured in the mold.

8. In a mold for casting metals and metallic alloys, a wall made of a material subject to distortion when exposed to differences in temperature; a cooling jacket about the outer side of said wall, and rigidly connected to the ends of the latter for maintaining said ends in fixed relation and leaving the intermediate portion of the wall free to become distorted upon pouring, and exert a pressure on the mass poured in the mold.

In witness whereof I have hereunto set my hand.

ABRAHAM M. ERICHSEN.