July 17, 1934. J. CRONING 1,966,615

METAL CASTING PROCESS

Filed Dec. 16, 1929 2 Sheets-Sheet 1

Fig. 1.

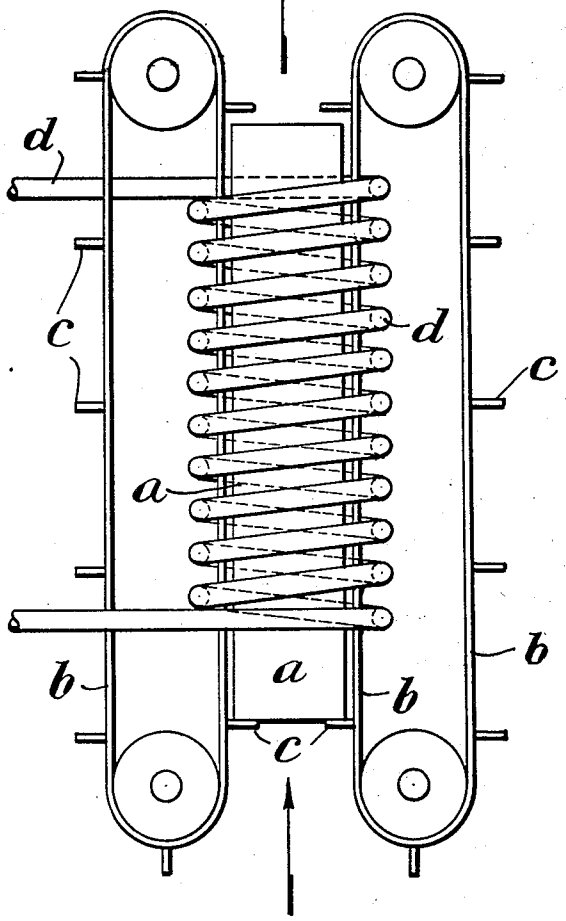
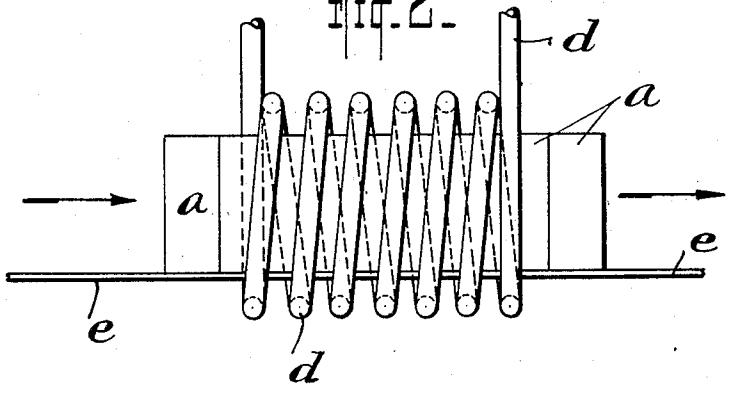


Fig. 2.



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Fig. 3.

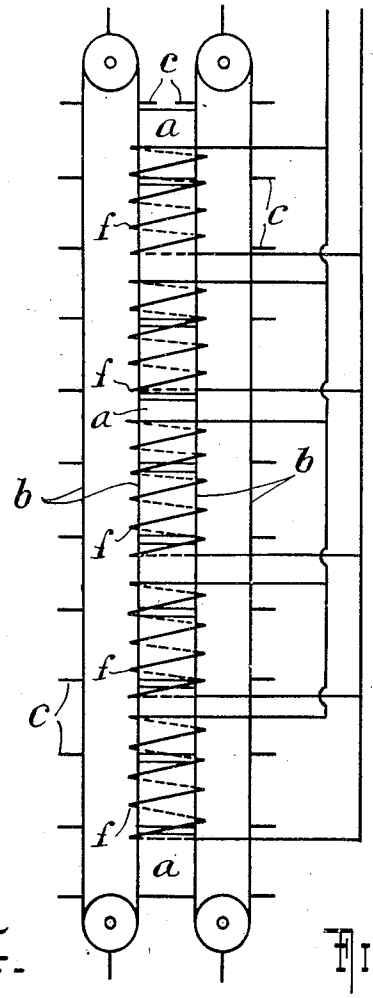


Fig. 4.

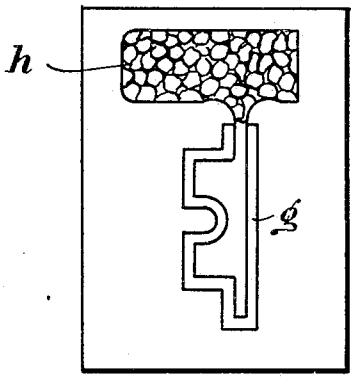
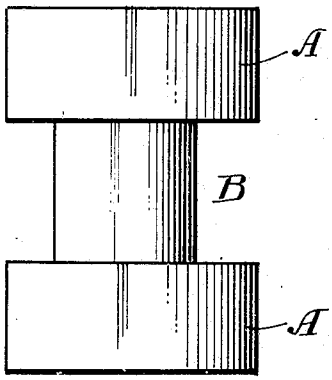


Fig. 5.



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Patented July 17, 1934 1,966,615

UNITED STATES PATENT OFFICE

1,966,615

METAL CASTING PROCESS

Johannes Croning, Hamburg, Germany

Application December 16, 1929, Serial No. 414,571
In Germany November 21, 1929

1 Claim. (Cl. 22—200)

This invention relates to improvements in the art of metal casting, and has particular reference to a process wherein a mould for the metallic body to be produced is subjected to the action of a high frequency alternating current.

The metal casting processes hitherto known may be divided into three classes, both from a technical heating point of view and also as regards the actual procedure.

In the use of one of these classes, i. e., the melting, the heat radiating from the heated crucible is conducted to the metal until the latter is melted and can leave the crucible to be cast.

In a second class, i. e. the casting, the material that has been melted gives off the heat stored within it to its surroundings, viz., the air, the walls of the casting channels and the walls of the mould. In this process, there exists the drawback, to overcome which efforts have been constantly made, that the air carried along by the flowing movement of the metal and a portion of the air in the hollow space of the mould is enclosed by the molten and flowing mass and the increasing inertia of the metal cooling off on the walls gives the air no possibility of escape, so that bubbles and shrinkage holes (the so-called "pipes") must arise. The expedient of casting superheated material is hypothetical and applicable with but a very small minority of metals, as superheated metal is exceedingly apt to form gas and in this way the porosity of the casting would be increased.

The third class of metal casting is the solidification of the flowing mass of the casting within the mould. The metal transmits its heat to the cold walls of the mould, so that the outer layers have cooled off while in the interior there is still a liquid core. Small sections of a casting give up their own heat more rapidly to the walls of the mould than is the case with heavy masses of material. All these points lead to the formation of pipes, casting stresses and cracks in the casting.

The object of the present invention is to eliminate all these disadvantages, insofar as they refer to the technique of casting and to simplify matters insofar as the disadvantages arise from technical working.

Electrical induction furnaces of medium or high periodicity are specially adapted for carrying out the process to be described below.

Induction furnaces are known that cause metals to melt by the fact that an ordinary crucible is surrounded by a water-cooled copper pipe and alternating current of high periodicity is passed through this solenoid, by which process the metal within the alternating field of this current is heated to such an extent that it melts. The metal becomes heated per se, transmits merely radiating heat to the crucible surrounding it and, owing to the eddy currents, it becomes gradually subject to great movement, so that the thorough stirring of the smelting bath of the crucible, which can otherwise be effected only by mechanical means and from the outside, ensues from within by means of the electric heating current.

If, however, in lieu of the crucible and in accordance with the present invention, one or more non-metallic moulds, furnished with "dead-heads" (upper hollow spaces in the moulds), are enclosed on all sides with their hollow spaces preliminarily filled with pieces of metal, and are introduced into the alternating field of high periodicity currents, the metal in the dead-head and in the mould melts, at the same time causing a strong whirl in the melting material and thus thoroughly fills up all the hollow spaces in the moulds.

The process according to this invention may be improved by arranging the copper coil in such a way that the moulds or crucibles can be moved closely following each other, practically without any intervening space, through said coil in the direction of its axis by means of a conveyor band or another suitable mechanism.

In the drawings, showing preferred embodiments of the inventive idea by way of example,

Figure 1 shows in side elevation means for moving moulds in a vertical direction through a coil used to carry out the process according to this invention.

Figure 2 is similar to Figure 1, but shows means for moving moulds in a horizontal direction.

Figure 3 shows vertically conveying means wherein a plurality of coils are employed.

Figure 4 illustrates a modified form of a mould-half.

Figure 5 shows a type of article which may be manufactured by means of the casting process according to this invention.

In the drawings, Figures 1, 2 and 3 represent modifications of conveying means for moving a plurality of moulds through one coil or a plurality of coils, these modifications differing from each other only in detail. In Figure 1 moulds *a* are slowly moved by means of abutments *c* rigidly connected with conveyor chains *b* through a coil *d*.

Figure 2 is also a side elevation and shows moulds *a* placed upon a conveyor band *e* without being connected with said band in any other way.

The band *e* slowly moves the moulds *a* through a coil *d*.

The device shown in Figure 3 differs from the device shown in Figure 1, in that it comprises a plurality of coils *f*, connected with each other in parallel. It is, however, possible to connect the coils *f* in series or in any other convenient way.

A preferred modification of a mould-half to be used in connection with the process according to this invention is shown in Figure 4. The mould, which is provided with a dead-head *h*, consists mainly of coal, graphite, or a similar substance, and its interior walls, shaped to produce a casting of a desired form, are provided with a ceramic coating *g*.

There are certain types of products which can be most advantageously manufactured by a method according to this invention, one of these types being shown in Figure 5. Owing to the fact that in such castings the thinner part B cools off more quickly than the thicker part A, cracks are liable to occur in the casting if prior art methods are employed for producing it. According to this invention, however, the cooling takes place in such a way that the part B loses its additional heat uniformly and more slowly than the part A, with the result that for all practical purposes the whole casting is cooled off in a uniform way. This uniform cooling may be achieved by arranging a plurality of coils which may be switched off one after another, as shown in Figure 3.

The use of movable moulds has the following advantage:

It is known that electrical eddy currents are usually very strong in the middle of a coil and weak at its ends, especially if an electrical current of a high frequency is sent through the coil. Since, due to these eddy currents, the heat generated by the coil is unevenly distributed, the metal contained in a stationary mould cannot be heated uniformly. This drawback is obviated if a movable mould is used.

The advantage of using a plurality of coils arranged one behind another consists also in the possibility of increasing the velocity of the movable mould and thus shortening the time of moulding, although the distance of travel during which the mould is subjected to heat must be increased also.

The molten metal in the dead-head flows by its own weight into the actual mould and supplies what is there lacking in volume of metal. The air expelled from within the mould and the noxious gases can escape in a well-known manner through fine ventilating ducts adapted to this purpose into the dead-head or into the open air.

During the solidifying process the mould is in the first place left within the magnetic field of the current, but after the melting temperature has been attained the intensity of the current is gradually reduced, so that the cooling of the casting does not ensue, as hitherto, from the outside to the inside but distributed uniformly over the entire cross-section. Parts with a smaller cross-section are kept liquid by means of the reduced current sufficiently long for the parts with a larger cross-section to have solidified to such an extent that pipes, stresses, and cracks are avoided.

As the melting period, the casting period, and the solidifying period take place within one and the same hollow space and without coming out of the alternating field of the high frequency coil all three steps, from a technical heating point of view, are comprised in one function.

The advantages at the same time from a metallurgical point of view lie in the facts that no superheating of the material to be smelted need take place, the molten mass is protected to a far-reaching extent from oxidizing by exposure to the air, a good whirling of the mass is insured, and the cooling down of the cast can be so regulated that pipes, stresses, or cracks in the casting are avoided.

The subsequent hot treatment of a casting, such as tempering or annealing, which is frequently customary, for the purpose of eliminating stresses, or for refining purposes, can be dispensed with in most cases, as the solidifying process can be regulated in every respect and any desired graining of the metal is attainable.

In addition to the advantages described above, this process permits the use of permanent moulds. These moulds may be in two or several parts and are most suitably made of ceramic materials as already known, or of chemically combined substances.

As the dynamic effect of the liquid stream of metal is reduced to the lowest grade due to the uniting of the melting period and the casting period, this process also permits the employment of light cores and sharp transitions in the design of the casting. Cores of moulding sand too, that are destroyed after the casting, may be used in conjunction with the permanent moulds.

According to this new process, ferric or non-ferric metals, metals with high or low melting points, may be melted and cast in deoxidizing gases or in neutral air.

What is claimed is:

In a metal casting process, the steps of inserting pieces of metal into at least a part of the hollow interior of a non-metallic mould having a hollow dead-head, closing said mould on all sides, said pieces of metal being completely surrounded on all sides by the walls of said mould, introducing said mould into an alternating current field of a high periodicity coil to melt said pieces of metal, whereby the hollow spaces of said mould are filled, and forming a finished casting having the shape of said hollow spaces by gradually and uniformly reducing the intensity of said current to solidify the molten mass within said moulds.

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