Aug. 21, 1956 | C. A. PARLANTI | 2,759,231

ANODIZED METAL MOLDS

Filed May 9, 1951 | 3 Sheets-Sheet 1

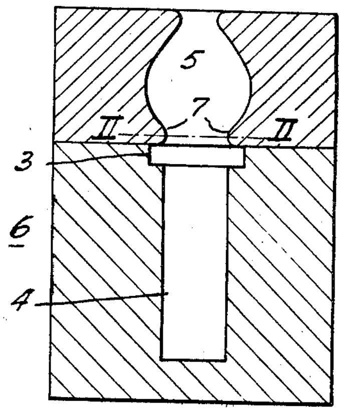

FIG. 1.

FIG. 2.

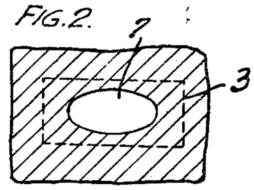

FIG. 3.

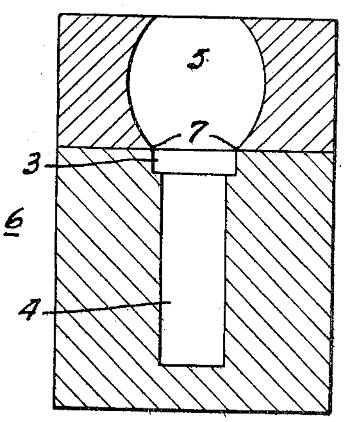

FIG. 4.

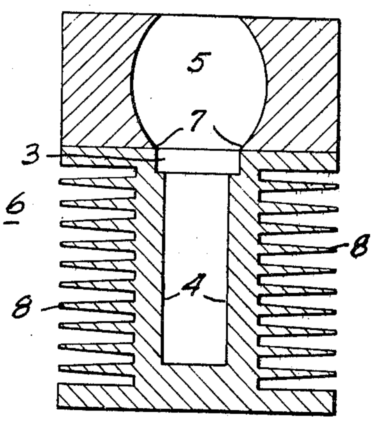

FIG. 5.

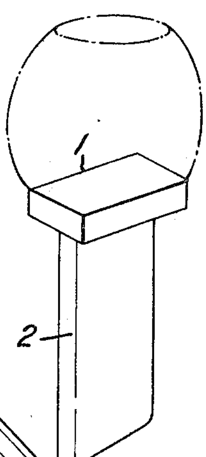

FIG. 6.

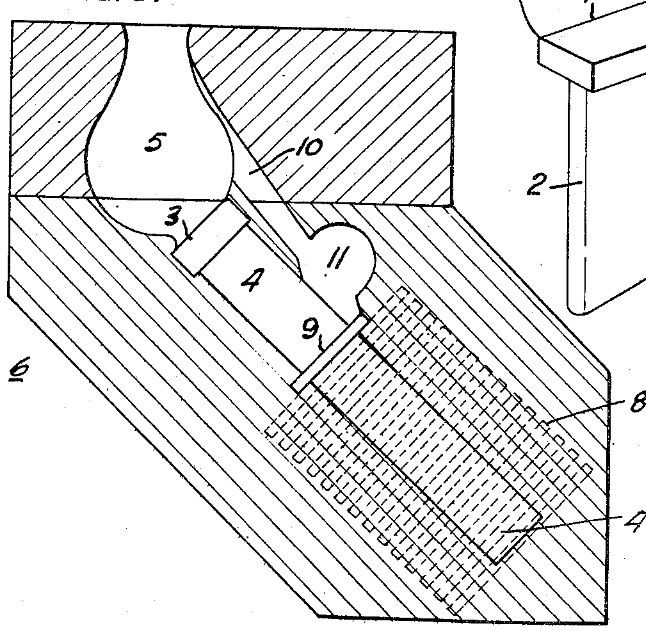

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FIG. 7

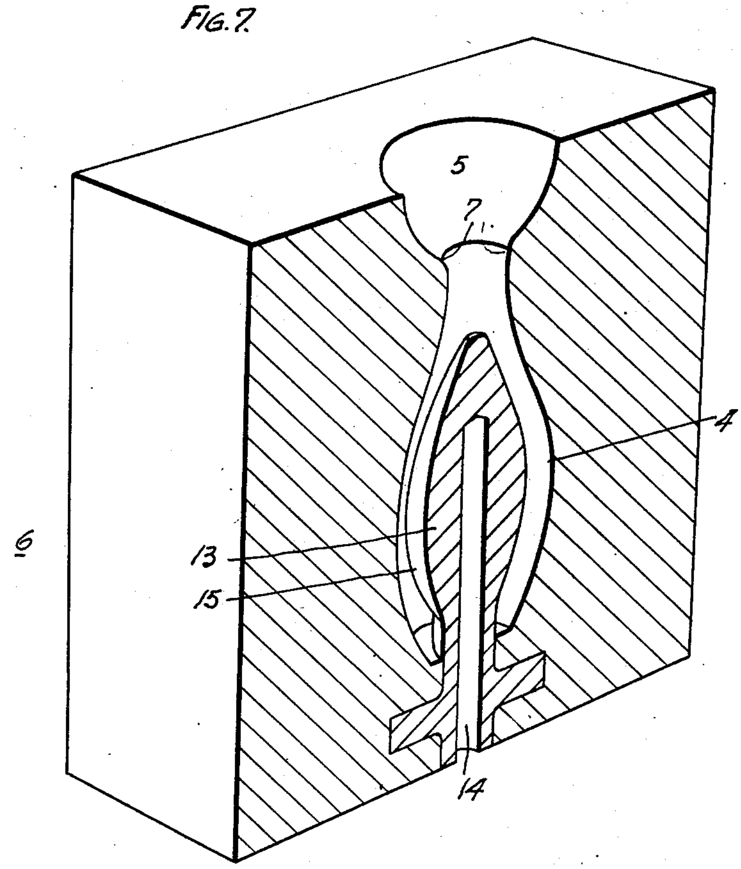

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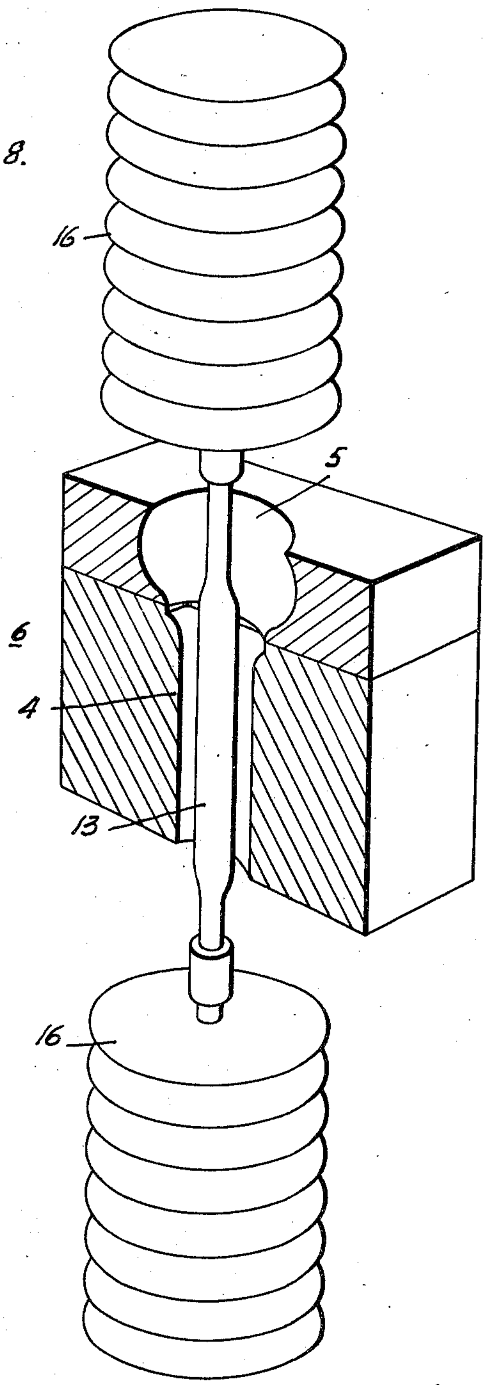
FIG. 8.



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ANODIZED METAL MOLDS

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Claims priority, application Great Britain May 10, 1950

6 Claims. (Cl. 22—152)

This invention relates to the casting of metals by the use of what are usually termed "permanent moulds" which are hereinafter referred to merely as "moulds."

A process has as is known already been developed by me for the gravity or pressure die-casting of non-ferrous metals such as aluminium and magnesium or alloys in which those metals form the preponderating component; that process consists broadly stated in employing a mould, formed of aluminium or an aluminium alloy, the internal or casting surface and it may be also its external surface of which has been anodized: such a process was well adapted to very large scale production since the moulds can readily be cast from a master mould.

The process has gone into fairly extensive use, and although that process does in general produce satisfactory castings the process, like any other casting process, has been found liable to produce imperfect castings having internal stress areas, cavities, surface imperfections and other defects.

In using that process, there seemed no good reason why the practice employed in normal casting methods should not be used, and this was accordingly done especially as regards the ratio of the mass of the feed of metal to the mould to the mass of the casting in the mould, this ratio being hereinafter referred to as the "mass ratio." However, in view of the need for the consistent production of sound castings free of defects and having good finish I carried out extensive experiments and research and have discovered that the adoption of the normal recognised standard casting technique is the main cause of the production of imperfect castings.

My present invention therefore is primarily based upon this fact and it consists in casting metals in an anodized mould of aluminium or an aluminium alloy by the method which consists in employing a mass ratio which is larger compared with that which would be adopted in like circumstances in the normal casting technique. This mass ratio would of course vary with the particular form of casting, but in every case it is true to say that a surprisingly large mass ratio is employed.

It has been found that the mass ratio could vary from 1:1 to 10:1. The range covered by the figures given is, of course, necessary to allow for any necessary compensation to suit any particular form of casting.

This invention also relies upon ensuring that the whole of the casting space is fed from a feed header during cooling and solidification, and as a practical consideration the parts of the casting most distant from the feed header should be where possible those of the thinnest section, the section increasing towards the header.

In some cases however the casting may consist of masses which are somewhat isolated in relation to the remainder of the casting and in such a case special steps would have to be taken to obtain the full benefit of this invention, and this could be effected by making use of the control of heat transfer by the mould itself in the

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manner already referred to. In other cases, the feed header could have a branch duct leading direct to the mass in question.

My researches have also shown that it is very necessary not only to anodize the inner (or moulding) surface and the outer surface of the die but also to apply a refractory coating to that inner surface; this refractory coating serves to assist the anodic film in restricting the rate of heat transfer to the body of the mould to such an extent that surprisingly metals having a much higher fusion point that aluminium or its alloys can readily be cast in a mould formed of such metal; this discovery obviously extends the range of usefulness of the anodized aluminium mould; it also gave an important technical advance in the art of casting. It is well known that the quality of a casting and especially its freedom from cracks and internal imperfection depends greatly on the chill control which is exercised for any particular casting. The metals normally used to form moulds (e. g. cast-iron) have a low heat-conductivity factor which of course implies a low sensitivity for control; aluminium (or its alloys) on the other hand has a high heat conductivity factor with a correspondingly high sensitivity and thus, as the invention enables aluminium to be used to form the mould, it enables the property of that metal to be used to regulate the chill.

Such regulation can be effected in several ways: the thickness or the nature of the refractory coating can be varied locally; the thickness of the mould metal can be varied in its different parts to suit any particular casting or the mould can be formed with cooling fins disposed as required; in some cases provision can be made to apply heat externally to the mould at selected parts. Whatever be the form of chilling control employed, its ability to exercise that control depends essentially on the property of aluminium (or its alloys) which in turn is rendered capable of use for casting metals at large by this invention.

It has in fact been found possible to increase the rate of chilling to a point which in normal casting technique would be regarded as disadvantageous but the control exercised by this invention coupled with the mass ratio of the feed as is also suggested by this invention enables such rapid chilling to be used to advantage.

Thus the invention enables the advantage of easy production of satisfactory moulds for the die-casting of light metals to be applied with equal success to the die-casting of ferrous and other metals, and this represents a substantial step forward in casting procedure.

It may also be said that the invention enables castings to be produced consistently through an entire range with improved physical properties as compared with those produced by the moulds normally used. In fact castings produced in accordance with this invention have physical properties comparable with those of drop forgings but of course without requiring the forging operation itself, castings produced by this invention being ready for subsequent heat treatment for the imparting of some particular quality to the metal.

It has been found that in the particular case of alloy steels, those cast according to this invention have improved machining qualities as compared with those cast in the normal manner. This enables the introduction of chromium, which is frequently introduced to improve machinability, to be avoided and this in its turn reduces the cost of production of such castings.

The refractory coating (which may consist of finely ground mineral silicates) not only protects the mould, but also absorbs air as it expands in the pouring of the metal and allows the casting easily to be withdrawn.

The refractory coating can be applied to the surface of the mould as by spraying in the form of a fine powder which is suspended in solution.

In practising this invention, the usual risers are not employed. Expanding air is absorbed by the refractory coating of the mould, but supplementary provision may be made to vent the casting space of the mould by very small vents which may be formed conveniently along the usual split line of the mould.

In casting by normal methods, it has been difficult when producing hollow articles in the case of metals having a higher melting point than aluminium or its alloys to ensure the production of an article with a uniform wall thickness of consistent "nature." It has been found that the present invention enables such a casting to be consistently produced.

The core, whatever its shape, and whether withdrawable or not, may be die cast and positioned in the mould. The core may be so constructed that the heat of the chilled casting, as the latter cools, may cause the core to melt and flow out from the casting. Such melting may be controlled by making the core hollow and by selection of the wall thickness, the melting being slowed down by increasing the wall thickness or even in some cases by providing fins thereon. The core may also be arranged to collapse at any desired point, to relieve stress, by removing the anodized or other refractory coating from that point. If desired, the construction of the core may be such that it remains in position within the casting until the latter is subjected to heat treatment which serves the two-fold purpose of removing the core and at the same time giving the cast metal the desired physical properties.

The invention is, of course, generally applicable to the casting of metals, but to give an illustration of a practical example, reference will now be made to the accompanying drawing which illustrates development in the casting of turbine blades. In this drawing Figure 1 is a sectional elevation through a mould; Figure 2 is a section on the line II—II, Figure 1; Figure 3 is a sectional elevation of a modified mould and Figure 4 is a similar view of a further modified mould; Figure 5 is a perspective view showing a turbine blade as it is produced by the mould shown in Figure 4; Figure 6 is a sectional elevation showing yet another form of mould.

Referring to the drawings, the moulds shown in Figures 1–4 are designed to produce a turbine blade which as is shown in full lines in Figure 5 comprises a root **1** from which extends a thin blade part **2**. For that purpose the moulds shown in Figures 1, 3 and 4 have a die cavity **3** to form the root **1** and a die cavity **4** to form the blade part **2**. In the various forms of mould shown in Figures 1–4 the die has a feed header **5** into which is poured the molten metal to be cast. The cavities **3** and **4** and the header **5** are formed in the usual form of mould body indicated generally at **6**.

In all constructions the mould was anodized both at its external surface and also at the surface of the die cavities **3** and **4**. In addition the anodized surfaces of the cavities were coated with a refractory coating applied by spraying a suspension of mineral silicates. The feed header **5** was also anodized and coated with a refractory. The header **5** as shown in Figures 1 and 2 was found to have a mass ratio which was too small, i. e. the mass of metal which would be contained in the volume defined by the header **3** was too small in relation to the mass of metal in the casting cavities **3**, **4**. Accordingly the volume of the header **5** was increased as shown in Figure 3 to give a mass ratio of 7:1 and at the same time the neck area of the feed opening indicated at **7** in Figures 1 and 2 was increased until it corresponded in area to the maximum area available, i. e. the area of the cavity **3**; although this gave an improved casting it was not regarded as completely satisfactory; it was however considered that the mass ratio was sufficiently high and accordingly attention was paid to the chilling effect of the die. The method of chill control selected consisted in forming the mould body **6** with cooling fins **8** distributed over the extent of the cavity **4**.

The cast blade (shown in Figure 5 complete with the protuberance due to the large header **5**) was now found to be completely satisfactory with a high tensile strength, uniform and faultless nature which was in fact comparable with that produced by a forging. The surface had a good finish.

Referring to the modified form of mould shown in Figure 6 this is intended to produce a blade having an intermediate mass along its length. In such a case the header **5** would have opening into it a runner **10** which would itself open into what may be termed a sub-header **11** from which is drawn the molten metal required by the intermediate mass, the cavity of which is indicated at **9** the rate of heat transfer to the mould itself being regulated in the manner already described.

Figure 7 is a broken perspective view of a mould intended to form hollow articles and therefore employing cores.

In this figure, in which parts corresponding to those already referred to are given corresponding reference numerals, the core is indicated at **13**, the core being positioned temporarily in the body **6** of the mould.

This core is formed of aluminium (or an alloy thereof) and of course leaves between itself and the cavity **4** a casting space into which flows the molten metal which is poured into the pouring header **5**, this metal having of course a melting point considerably higher than aluminium.

The mass of the core and its form is governed by the conditions under which it is required to operate. Thus in the case shown, the core is itself hollow by the formation of the central passage **14** which leaves such a mass in the core as will ensure its being melted and so freeing the cast metal, by running out through the base of the mould. In the case shown in Figure 8 on the other hand, the point of fusion of the core is retarded by extending the core to radiating fins **16** which will accelerate the dissipation of heat from the core for a time period calculated to enable the core to retain its form during the pouring and initial forming of the cast metal and then to be melted out.

This feature of employing a fusible core is not limited to its use in the anodized aluminium mould described. It could be employed to advantage in moulds of other forms e. g. iron or steel moulds and sand or other refractory moulds for it possesses great advantages in producing uniform hollow articles as compared with cores such as are normally used.

It will be understood that the technique of forming the mould **6** itself as already described would generally be applied equally to the formation of the core, i. e. the core is usually anodized and its forming surface indicated at **15** may be coated with a refractory coating the disposition and thickness of which may be varied to suit the particular job in hand so as to exercise differential chill control.

In the appended claims, the term aluminium is used as applied to the metal of which the mould is formed, but it is to be understood that this term is intended to include aluminium alloys.

I claim:

1. For use in casting metals, an aluminum mold having a casting cavity and a feed cavity therein, said feed cavity having an exit aperture opening into an entrance aperture to said casting cavity, the interior and exterior surfaces of said mold being anodized, the ratio of the volume of said feed cavity to the volume of said casting cavity being in excess of 1:1, and the cross sectional area of the casting cavity at the exit aperture from the feed cavity being no larger than the area of said exit aperture.

2. A mold as claimed in claim 1 in which successive transverse sections of the feed cavity immediately adjacent the casting cavity progressively increase in area away from said casting cavity.

3. A mold as claimed in claim 1 in which the transverse section of the casting cavity which is of maximum area is immediately adjacent the feed cavity.

4. A mold as claimed in claim 1 in which the transverse section of the casting cavity which is of maximum area is immediately adjacent the feed cavity, and in which successive transverse sections of the feed cavity immediately adjacent the casting cavity progressively increase in area away from said casting cavity.

5. For use in casting metals having a melting point considerably higher than aluminum, an aluminum mold having a casting cavity and a feed cavity therein, said feed cavity having an exit aperture opening into an entrance aperture to said casting cavity, the interior and exterior surfaces of said mold being anodized, the ratio of the volume of said feed cavity to the volume of said casting cavity being in excess of 1:1, a hollow aluminum core in said casting cavity, said core having a free interior surface and a free forming surface and having a wall between said surfaces of a thickness sufficient only to support the molten metal until the latter is partially solidified and then to fuse and collapse solely by the influence of the heat of the casting, the forming surface of said aluminum core being anodized.

6. For use in casting metals, an aluminum mold having a casting cavity and a feed cavity therein, said feed cavity having an exit aperture to said casting cavity, the interior and exterior surfaces of said mold being anodized, the ratio of the volume of the feed cavity to the volume of said casting cavity being in excess of 1:1, the transverse section of the casting cavity which is of maximum area being immediately adjacent the feed cavity, and in which successive transverse sections of the feed cavity immediately adjacent the casting cavity progressively increase in area away from said casting cavity.

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