Nov. 19, 1957 C. A. PARLANTI 2,813,319

METHOD OF CASTING HOLLOW ARTICLES IN LIGHT METALS OR LIGHT METAL ALLOYS

Filed Jan. 4, 1957

FIG. 1.

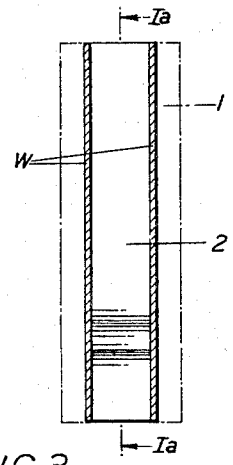


FIG. 1a.

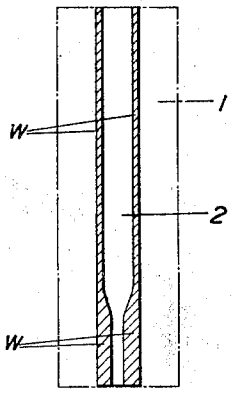


FIG. 2.

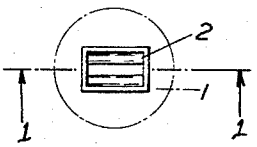


FIG. 3.

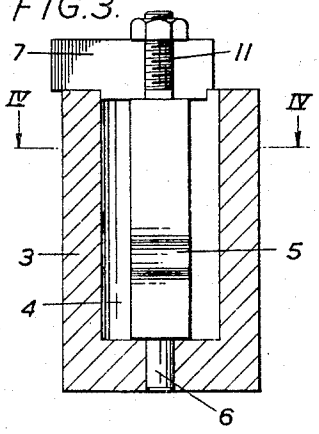


FIG. 4.

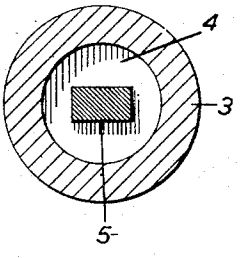


FIG. 5.

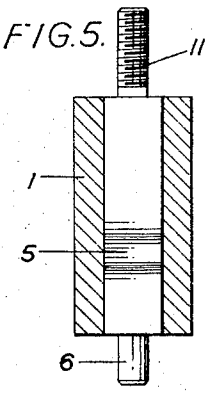


FIG. 6.

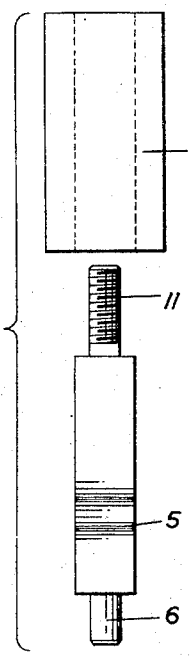
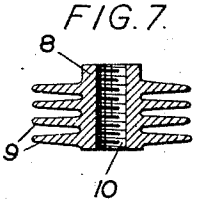


FIG. 7.



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METHOD OF CASTING HOLLOW ARTICLES IN LIGHT METALS OR LIGHT METAL ALLOYS

Conrad Anthony Parlanti, Natick, Mass.

Application January 4, 1957, Serial No. 632,502

4 Claims. (Cl. 22—212)

This invention relates to the casting of hollow metal articles and especially where the interior or cavity surface of the article has a low cross-sectional dimension/length ratio and yet is required to have a high standard of finish: the invention is still more concerned with producing cast articles where the required shape of the cavity is such as to present long parallel surfaces. Such a form arises for example in connection with wave guides which are employed in ultra-high-frequency apparatus, such guides comprising a light metal block having extending along its length a passage the cross sectional shape of which takes different forms but its faces are parallel for at least the major part of the length of the passage and where the surface is to be produced within somewhat close limits.

It would in any case be difficult to improve the finish of the cast surface of such a cavity by a machining operation and although various expedients could be used to finish the surface to the required standard, these expedients would add to the expense of production.

The main object of the invention is to provide a method of casting such as will enable the cavity surface to have the required standard of finish and conformity to tolerances without requiring any machining operation.

The present invention consists in casting a hollow article by the method which comprises using a mold formed of a light metal which is anodized at its surface including the surface of its casting cavity, in locating in the mold a core formed of a metal having a high heat retentivity factor compared with the metal to be cast, in charging the casting space between the core and the mold cavity with molten metal to form the cast article, in allowing complete cooling of the cast metal and core to take place, and then re-heating the cast article and the core to cause the cast metal to expand relatively to the core to free the latter for separation from the cast metal.

This application is a continuation-in-part of my prior copending application, Serial No. 342,778, filed March 17, 1953, now abandoned.

The invention is illustrated in the accompanying drawings in which Figures 1, 1*a* and 2 are views of a typical piece to be cast by the method of this invention, Figure 1 being a section on the line **1—1**, Figure 2, Figure 1*a* being a section on the **1*a*—1*a*** of Figure 1, and Figure 2 being an end elevation. Figures 3, 4, 5 and 6 are diagrammatic views showing the various stages in the casting of the article shown in Figures 1, 1*a* and 2, Figure 3 being a vertical section showing a mold and a core in position therein in readiness for the casting operation, Figure 4 being a section on the line IV—IV, Figure 3, Figure 5 being a vertical section of the core and the cast metal removed from the mold in readiness for treatment to permit the cast article to be separated from the core and Figure 6 being an elevation showing the cast article and the core when separated. Figure 7 is a section of a cooling component which may be applied to the core.

Referring to the drawings and considering firstly Figures 1 and 2 the reference **1** indicates a hollow article: the article as shown is intended for use as a wave guide, and has a cavity **2** the length of which is large compared with its cross-sectional dimensions, the opposed surfaces or walls W of the cavity being parallel or having substantial portions which are parallel. Such an article is difficult to produce by any usual method of manufacture especially when the cavity **2** is required to be finshed with a high degree of accuracy and clean surface finish.

Now, it is proposed according to this invention to produce the cavity **2** with the required accuracy and surface finish by a casting method such as will avoid any further operation. For this purpose there is used a mold **3** formed of a light metal or an alloy thereof the whole surface of which, including the surface of its casting space **4**, is anodized. The invention also requires a core **5** formed of a metal which has a low heat conductivity factor (or a high heat retention factor) compared with that of the metal to be cast. For example where the metal to be cast is a light metal the core could be formed of steel, the external surface of the core being formed to correspond to the required finished dimensions of the cavity **2** to be formed in the cast article.

The core **5**, having preferably had its surface graphited is inserted into the casting space **4** of the mold **3** as is shown in Figure 3, the core being located at its lower end by an extension **6** entering an opening in the mold and at its upper end by a spider **7** engaging the wall of the mold.

The molten metal to be cast is then poured into the casting space **4** of the mold, i. e. the space between the inner wall of the mold **3** and the outer surface of the core **5**.

The cast metal is then allowed to cool to cause at least a partial solidification. The cooled cast metal and the core are then removed from the mold, the parts removed being shown in Figure 5.

In order now to separate the core readily from the cast metal, the removed part as shown in Figure 5 is then completely cooled to substantially normal room temperature. It is then re-heated as by being placed vertically in an electric muffle furnace: this sets up a relatively sudden thermal shock which expands the cast metal from the core **5** which remains sensibly unaffected in the thermal sense and as a result the core is enabled to be removed readily from the cast metal leaving the cast metal to cool to the required size and surface finish.

Instead of removing the cast metal and the core **5** from the mold, the entire assembly consisting of the mold, core and cast metal could be placed in a muffle furnace for the purpose of freeing the core.

In some applications it may be desirable to arrange for the controlled dissipation of heat from the core **5**. For this purpose a component such as that shown in Figure 7 could be used. This component comprises a body **8** which is formed with heat dissipating fins **9**. This body is arranged to be connected to the core **5** for which purpose the body **8** can have a screw thread **10** enabling it to be screwed on to the threaded end **11** of the core. Of course the core can have heat dissipating fins formed integral with it but the core being of ferrous metal and the dissipating body being preferably formed of light metal by reason of its greater rate of heat conductivity, the two would be separate and require some provision such as the screw-threads shown for this connection in heat conducting relation.

The cast article having completely cooled, can now be finished as to its external dimensions by any normal machining operation: e. g. the peripheral surface of the

cast article can be machined to leave a wall thickness of say 1/16" around the aperture 2.

It may be pointed out that the results achieved by the present invention can be regarded as being based on the following consideration.

The anodizing of the internal surface of the casting cavity 4 of the mold 3 holds back to some degree the transmission of heat from the cast metal to the body of the mold. The heat which does pass into the body of the mold is conducted rapidly away to the outer anodized surface by which the heat is dissipated rapidly by radiation: the mold 3 is thus saved against fusion by the heat of the cast metal but at the same time that heat is absorbed by the core 5 which therefore expands. During the permitted cooling the heat content of the core 5 is held back from dissipation and the core having a greater heat retentivity factor than that of the cast metal the core remains in its expanded condition or contracts more slowly while the cast metal and the mold 4 contract on partial cooling. The cast metal is thus pressed during cooling and formation firmly against the surface of the core which can readily be preproduced with a surface finish and accuracy of the necessary standard and in consequence the interior surface of the cast article has the same finish and accuracy imparted to it during the formative stage.

The final re-heating is carried out to cause the core which obviously becomes embedded to the surface it has formed to be freed from the cast article: this action is obtained without distortion of the cast metal for the heat, being applied externally to the mold or to the cast article, causes temporary expansion of the cast metal to a greater extent than that of the core. The subsequent heating can be applied by placing the cast article and the core or the mold with the cast metal and the core, into a close fitting muffle furnace.

A typical case will now be referred to.

The light metal used for the casting was of the Y type having the following proportions:

3.5–4.5% Cu
1.2–1.7% Mg
1.8–2.3% Ni
Other constituents 2%
Balance to 100% Al

This material has the following thermal properties: Coefficient of expansion (per 0° C. at 20–400° C.)—0.0000268. Thermal conductivity rate (calories per second cm.^{2} per degree C. per cubic cm.)—0.410. The core used was steel of between 0.3% and 13% Cr (chemical formula). This steel has the following thermal properties: Coefficient of expansion (per 0° C. at 20–400° C.)—0.0000099. Thermal conductivity rate (calories per second per cm.^{2} per degree C. per cubic cm.)—0.066.

The light metal having been fed to the mold to form the light metal about the core, the whole was allowed to cool completely to substantially normal room temperature. The cast metal was then machined externally to a square section of 4 x 4 cm., the length being 50 cm.

The cast metal and the core were then placed in a vertical electric furnace, the temperature of which at the centre was 600° C. After 10 minutes pyrometer readings were taken showing that the light metal had reached a temperature of 216° C. but the core a temperature of only 80° C. The cast metal was now found to be free from the core which was then removed easily without damaging the finish of the surface of its cavity as it had been defined by the core when the light metal was supplied to the casting space of the mold.

The lower temperature of the core arises from its lower rate of heat conductivity and this coupled with its smaller coefficient of expansion as compared with that of the cast light metal which rises to the higher temperature quicker than the core gives the requisite clearance between the core and cast metal.

While a ferrous metal is preferred for the core, a non-ferrous metal could be used provided that it had a low coefficient of expansion and a low thermal conductivity factor when compared with the metal to be cast.

The term "light metal" which is used in this specification and in the appended claims is intended to mean aluminum or magnesium or alloys including those metals.

The term "substantially normal room temperature" which is used in this specification and in the appended claims is intended to include the normal range of temperatures which prevail in foundries and the like in which casting operations are ordinarily performed.

I claim as may invention:

1. The method of casting a hollow article having a cavity in which at least two opposed faces are parallel and in which said cavity is formed to a high degree of dimensional accuracy and clean surface finish, which comprises locating a core within the cavity of a light metal mold having its interior and exterior surfaces anodized, said core being finished to correspond to the desired shape and dimensions of the cavity of the hollow article and being formed of metal having a low heat conductivity factor compared with that of the metal being cast, charging the mold cavity with molten metal, allowing the molten metal to solidify and cool completely to substantially normal room temperature, applying heat to the outside of the solidified casting to cause it to expand to free itself from the core, and withdrawing the core from said cavity.

2. The method set forth in claim 1 which includes the step of removing the solidified casting and core from the mold before applying heat to the solidified casting.

3. The method set forth in claim 1 in which the metal of said core also has a low coefficient of expansion compared with that of the metal being cast.

4. The method set forth in claim 1 in which the metal being cast is an aluminum alloy and in which said core is a steel alloy.

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