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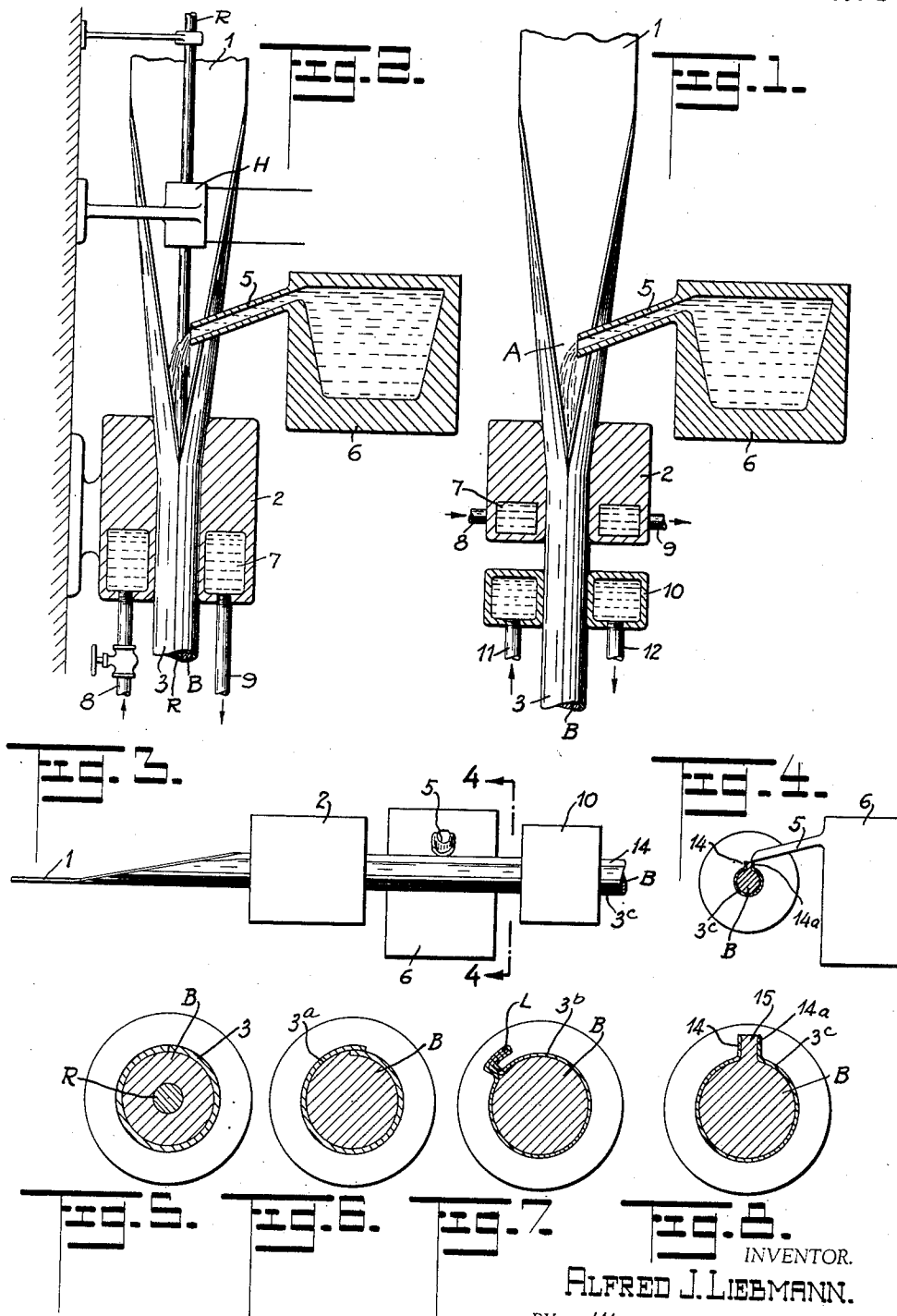
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2,055,980

METHOD OF CASTING OR MOLDING METALS

Filed April 12, 1933

2 Sheets-Sheet 1



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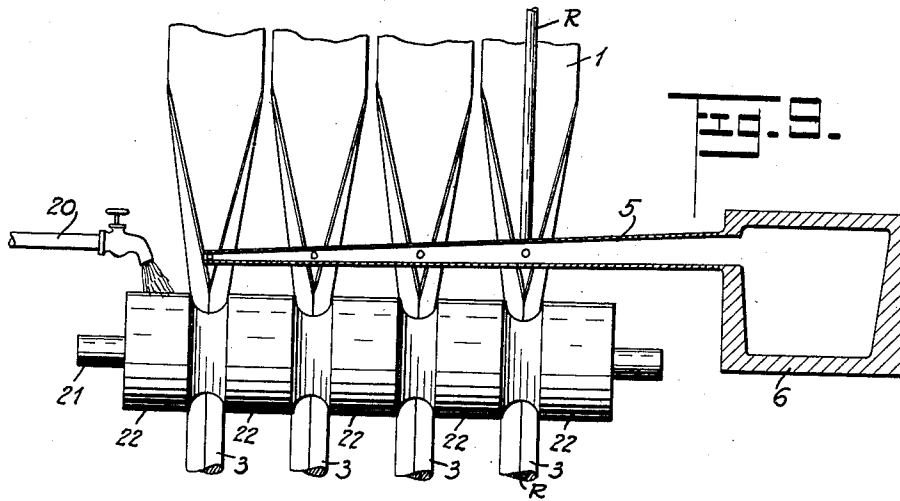
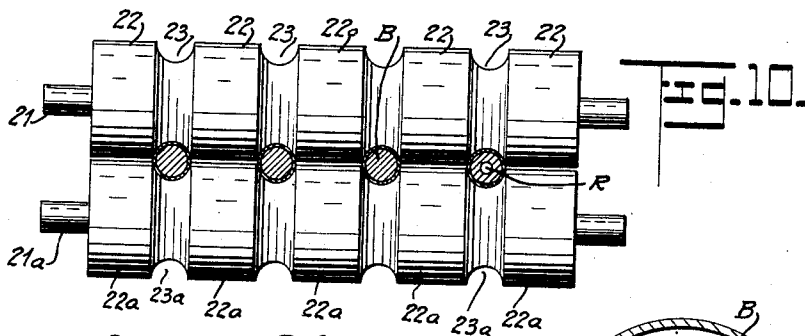
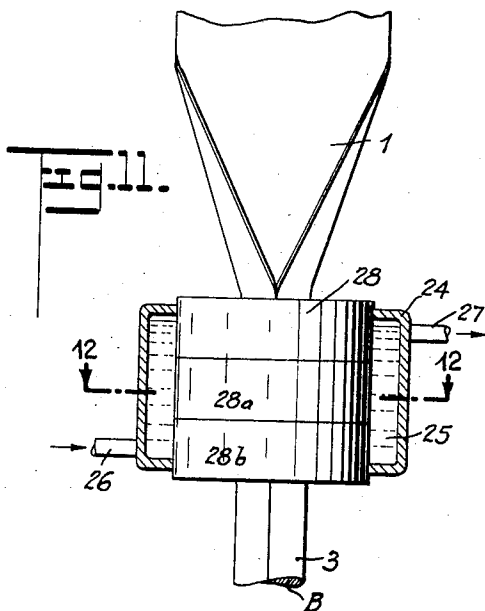
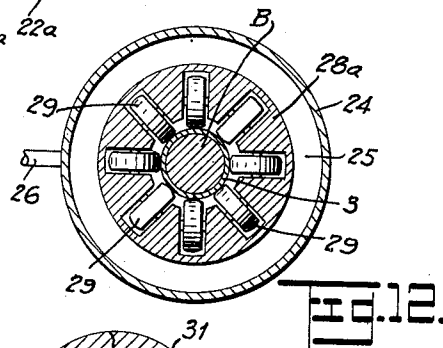
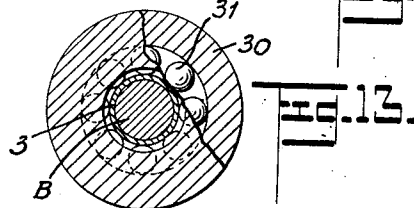
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METHOD OF CASTING OR MOLDING METALS

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UNITED STATES PATENT OFFICE

2,055,980

METHOD OF CASTING OR
MOLDING METALS

Alfred J. Liebmann, New York, N. Y.

Application April 12, 1933, Serial No. 665,657

4 Claims. (Cl. 207—12)

My invention relates to a new and improved method of casting or molding metals.

One of the objects of my invention is to provide a method of continuously casting or molding a metal body, said body being made of copper or any other suitable metal so that the cast body may be made of any desired length and of any desired diameter.

Another object of my invention consists in providing a new and improved method for forming a composite metal body, which has a core made of one metal, and an outer coating upon said core which is made of a different metal.

The invention applies particularly to forming copper-clad articles having a core made of steel or other iron alloy, in order to prevent corrosion of the core, but the invention is not to be restricted to any particular combination of metals. The invention also relates to an improved cast metal object, including an improved cast composite metal object and more particularly a copper-clad object having a core made of steel or other iron alloy.

Whenever I refer to casting a metal, it is to be understood that I include alloys as well as metals.

One of the advantages of my invention is that the cast object can be molded so that it has a suitable small diameter so that wire can be immediately drawn. Likewise, metal rod can be immediately formed, of any suitable diameter, which can be made as small as is desired. According to my invention the billet is not cast in such manner that a large mass of molten metal is allowed to gradually congeal. Such slow solidification always causes the solidifying metal to trap gases, thus producing a porous cast body of inferior quality. According to my improved process of continuous casting, the molten metal is caused to flow continuously from a suitable reservoir to a point where it enters a partial or partially formed casing which is continuous in the sense that it has any desired length, and the molten metal is then quickly solidified so that the molten metal forms only a very thin layer within the casing before the molten metal is congealed. This permits the occluded gases to escape, and such gases are forced out when the metal contracts during the solidification thereof.

According to my invention, the cooling of the molten metal proceeds in the direction of the axis of the casing so that the crystals grow and they are arranged in a parallel manner in the same direction, namely, the longitudinal axis of the cast body.

According to my invention I form an outer cas-

ing of metal and the molten metal is poured into this outer casing before the formation thereof is complete. This outer casing is made of a metal which has a suitably high melting point so that said outer casing maintains the desired shape. This outer casing may be made of sheet iron or any other suitable material which may be formed from a flexible strip which can be unrolled from a reel. This outer casing may be completed at the entrance point of a cooling chamber, and the metal is solidified as it passes through said cooling chamber, in unison with and enclosed by the outer casing. This casing may be shaped out of perforate material such as metal gauze or metal mesh, and said outer casing may also be formed of any suitable non-metallic heat-resistant material, such as asbestos or the like. Since the molten metal is solidified almost instantaneously as it enters a metal casing, the molten metal will not leak through the openings (if any) in the casing. Likewise, the practically instantaneous cooling and solidification of the molten metal prevents the contamination of the molten metal, by the material of the outer casing.

Likewise, in casting certain metals and alloys such as copper, brass, and the like, upon the exterior of a metal core, it is desirable to instantaneously chill, and solidify the metal as quickly as possible in order to prevent diffusion between the metal of the core and the coating.

My invention has particular advantages in casting copper around a core made of steel or other iron alloy because I obtain a perfect bond between the core and the protective layer of copper, and the copper is specially free from air-holes and pores, due to the fact that the metal is solidified almost instantaneously, and no gases are trapped in the thin outer layer of copper.

Other objects of the invention will be set forth in the following description which illustrates certain embodiments of my invention, it being understood that the above general statement of the objects of my invention is intended merely to generally explain the same and not limit it in any manner.

Fig. 1 is a diagrammatic view, partially in elevation and partially in section, illustrating one embodiment of the invention in which a solid billet is formed within an outer sleeve or casing.

Fig. 2 is a diagrammatic view similar to Fig. 1 showing how the billet is formed with a core.

Fig. 3 illustrates another embodiment of my invention, in which the outer casing is moved in a horizontal direction instead of being moved

in the vertical direction which is illustrated in Fig. 1 and in Fig. 2.

Fig. 4 is a sectional view on the line 4—4 of Fig. 3.

Figs. 5—8 are respectively sectional views illustrating different embodiments of the outer casing.

Fig. 9 is an elevation, partially in section, which illustrates a different embodiment, in which the casing is formed by sets of grooved rollers. This figure illustrates a unit for simultaneously forming a plurality of casings, and this is considered as being the best embodiment of the invention.

Fig. 10 is a bottom view of Fig. 9.

Fig. 11 is an elevation, partially in section, which illustrates a different device for forming the casing.

Fig. 12 is a sectional view on the line 12—12 of Fig. 11.

Fig. 13 is a sectional view which illustrates a modification of the device shown in Fig. 12.

Referring to Fig. 1, a flat strip 1, made of any suitable metal, such as copper, steel or the like, is led through a forming member 2, in which forming member the flat strip 1 is formed into a casing.

The forming device for causing the edges of the strip 1 to approach each other, in order to form a casing, may be of any suitable or well known type.

The casing 3 is made of metal which has a higher melting point than the molten metal which is poured so as to enter said casing, or it may be made of the same metal.

Referring to Fig. 1, molten metal, such as copper, is poured in the molten form through a spout 5, so as to enter the interior of the casing, before the same has been completely formed into cylindrical shape. That is, the casing has not been completely formed at the point A, where the molten metal is introduced. The temperature of the molten metal may be at about the melting point thereof, or higher. The molten metal may be introduced from a suitable vessel 6, or from any suitable source of molten metal.

The former 2 is intensively cooled so that the molten metal which is poured into the casing 3, before said casing is closed, is immediately solidified. For this purpose I can cool the metal former 2 by any suitable means. I have conventionally shown a cooling chamber 7 having an inlet 8 and an outlet 9. Water or any other suitable cooling medium can be circulated through the member 2.

If desired, and as shown in Fig. 1, the casing 3 may be additionally cooled by passing the same through an annular hollow member 10 through which a cooling liquid is circulated by means of an inlet pipe 11 and an outlet pipe 12. There is a very close fit between the interior wall of chamber 7 and the casing, and the casing and the metal therein are slightly reduced in diameter, in passing through member 10.

In the embodiment shown in Fig. 2, a rod R made of steel or other suitable material is guided so that it moves in unison with the strip 1. This rod R is shown in Fig. 5 and the steel rod R is thus covered with copper, in order to protect the rod against corrosion.

The rod R can be preheated by means of the heater H so that it is at a suitable temperature when it comes into contact with the molten metal. This temperature is preferably equal to the temperature of the molten metal, it being understood that the rod R is made of metal

which has a higher melting point than the molten metal which is used to form the billet B.

In the embodiment shown in Fig. 3, the strip 1 is led through a horizontal forming member 2, and this forms a casing 3 having separated lips 14 and 14a. The molten metal is poured between said lips.

The operation of the embodiment shown in Figs. 3 and 4 is exactly the same as that shown in Figs. 1 and 2, save that the billet B is formed with a longitudinal projection 15. The former or die 2 is exactly the same as the member 2 which is shown in Figs. 1 and 2.

In the embodiment shown in Fig. 6, the casing 3a is formed with a lap-joint.

In the embodiment shown in Fig. 7, the casing 3c is formed with interlocking ribs L so as to leave the interior of the casing cylindrical.

The outer casing 3 may be made as thin as possible and it can be removed in any suitable manner either by mechanical or chemical means. For example, if the outer casing is made of sheet iron, it can be removed by means of acids which do not attack the cast metal, which may be copper or the like. Likewise, the thin outer casing may be removed by a lathe or by any other mechanical means.

If the cast object is formed with a fin 15, between lips 14 and 14a of the casing 3c, as shown in Fig. 8, said fin may be removed by mechanical means.

When the outer casing is moved downwardly, the molten metal is directed so that it falls directly against the inner wall of the metal of the casing. The molten metal is immediately solidified and additional molten metal is then directed against said inner layer of solidified metal. The molten metal is almost instantaneously and successively solidified in the form of thin layers. The rate of pouring and speed of movement of the casing are adjusted so that the casing is completely filled with the solidified metal as indicated in the drawings. The casing may be made of material which has high heat conductivity so that said casing can be intensively cooled in any suitable manner, it being understood that the method of cooling which is illustrated in the drawings is wholly diagrammatic and that any suitable cooling system may be employed.

The same principle is utilized when the casing is moved in a horizontal direction.

The invention is not necessarily limited to pouring the metal into a partially formed casing.

If it is desired to form billets, rods, or the like of relatively short length, the casing may be completely closed at one end thereof, and the molten metal can be introduced into the interior of the casing by using a sufficiently long spout. In such case the molten metal would enter the casing through one end of the casing.

While I have illustrated an outer casing of cylindrical contour, the invention is not to be limited to any particular shape of casing.

In the embodiment shown in Figs. 1 and 2, the casing may be formed without exerting any substantial pressure upon the solidified metal. If desired, the casing could be formed so as to exert any desired transverse pressure upon the solidified metal during the formation of the billet. For example, the casing could be drawn so as to decrease its internal diameter, by suitably shaping the interior of the former, as it is well known to draw tubes, rods, and the like. However, the cast object is not subjected to any force in the direction of its longitudinal axis, as the same is formed,

because such longitudinal stress or force is taken up by the material of the outer casing. Since the billet or cast body is drawn or subjected to lateral pressure while the crystals are being formed, the cast body is in much superior condition for subsequent mechanical working. This lateral pressure elongates the crystals in the direction of the axis of the billet.

In the embodiment shown in Figs. 1 and 2, the casing can be pulled downwardly by any suitable means through the former.

In the embodiment shown in Fig. 3 the partial casing may be pulled or pushed by any suitable mechanism.

If a hollow cast body is desired, the core may be made of material which can be readily removed, either by chemical or mechanical means.

Whenever I refer to a casing in the claims, it is to be understood that I generally refer to any outer envelope, either perforate or imperforate, and that said envelope may have its edges separated or abutting or overlapping. However, when a vertical billet is cast, the casting is laterally continuous, so that the molten metal cannot contact with the interior wall of the chamber through which the casing is being moved.

Referring to Fig. 1, the molten metal is introduced into the casing, as close as possible to the point at which said casing is completed. It is to be understood that the drawings are not to scale and that they are wholly diagrammatic.

The diameter of the cast billet may be from 1-1 $\frac{3}{4}$ ", and even smaller, so that the billet can be directly drawn into wire by means of dies. However, the diameter of the billet may be as large as is desired.

The casing may be formed in any desired length, so that the cast object can be formed in any desired length.

When the operation is started, it may be found advantageous to first form the front or lower end of the casing and to plug said front or lower end, before starting to pour the molten metal. This prevents the molten metal from passing out of the casing.

Assuming that the casing is moved at a predetermined speed, it requires a specified unit of time for a zone of said casing to move through the combined former and cooler. The rate of pouring should be coordinated so as to supply, during said unit of time, enough molten metal to always fill up the vacant interior of said zone. The rate of cooling should be sufficiently intensive so as to solidify the molten metal as it passes through the cooler, although after-cooling may be used, if desired. It is important to coordinate the three factors of rate of pouring, speed of movement of the casing, and the rate of cooling.

As a practical example, (and without limiting the invention), it may be assumed that I desire to cast a solid copper rod having a diameter of 1 $\frac{1}{4}$ ", by means of the device shown in Fig. 1. The casing has its bottom end completed, and the bottom of said casing is plugged, by closing said bottom end, or by welding a cap thereto. The casing would then be moved through the former at the rate of about three inches per minute, and the height of the combined former and cooler would be about six inches, so that it would take two minutes for the casing to pass through the cooling zone. The rate of pouring is regulated so that a volume of molten metal is supplied in two minutes, which corresponds to six inches of the height of a rod whose cross-section has a diameter of 1 $\frac{1}{4}$ ". The cooling

is sufficiently rapid to solidify this volume of metal in two minutes. This makes it possible to consecutively solidify the molten metal in the form of successive and very thin layers. However, a continuous and uniform cast body is secured, because the pouring is continuous, and said pouring is localized upon a suitable zone of the casing.

If the casing is made of the same metal as the billet, it is unnecessary to remove the casing. For example, the casing may be made of copper, and filled with solidified copper, so as to make a copper rod. The strip 1, or the casing, may even be made of a metal which has a lower melting point than the molten metal, by cooling with sufficient rapidity. The casing may be made of cellulose material, or of any material which can be readily removed. For example, a paper of a heat-resistant type may be used. This paper or the like can serve as a liner for the forming device, as the billet is poured and solidified. The paper or the like may be partially carbonized by the heat, but it serves to confine the molten metal in order to produce the desired billet. Such temporary material can be very easily removed from the billet.

Referring to Figs. 9 and 10, rollers 22 and 22a are provided with grooves 23 and 23a, and said rollers are mounted on shafts 21 and 21a. Said shafts are turned in unison, and the grooves are shaped so as to form the casing or casings by a rolling action. This largely eliminates the friction of the casing in a former which has fixed walls, so that the speed of operation can be greatly increased.

The rollers 22 and 22a may be cooled in any suitable manner. I have conventionally illustrated a water jet issuing from the nozzle 20 for cooling said rollers, but any suitable cooling system may be employed.

Referring to Figs. 11 and 12, the former consists of three superposed sections or bearing rings 28, 28a, and 28b. These are located in a cooling chamber 24, through which water, oil, or other cooling fluid is forced by means of an inlet pipe 26 and an outlet pipe 27. The cooling fluid is forced through the annular cooling chamber 25.

Each of said bearing rings has rollers 29 whose inner ends form the casing 3. This type has very low friction.

The device shown in Fig. 13 has an outer ring or ball-race 30, in which the balls 31 are suitably mounted, so that said balls can turn freely. The casing is formed by means of said balls. Cooling fluid can be forced, vertically or in any other direction, between the inner surface of the member 30 and the casing 3. Cooling liquid can be sprayed or allowed to fall upon balls 31, so as to directly cool them.

It is not necessary to have the molten metal completely fill the casing, because annular cast objects can be formed by partially filling the casing. It is to be noted that copper contracts when it solidifies but I may pour metals which expand when they solidify.

The turnable type of former which is shown in Figs. 9-13 may be used for forming the horizontally moving casing which is shown in Figs. 3 and 4.

I have shown a preferred embodiment of my invention, but it is clear that numerous changes and omissions can be made without departing from its spirit.

It will be noted that the heat can be con-

ducted away, in a direction which is lateral to the casing and to the direction of pouring of the molten metal. Hence, the removal of the heat is quick and uniform because the cooling system
5 always operates in a fixed cooling zone. If it were attempted to remove the heat by longitudinal conduction, the cooling effect could not be controlled as efficiently.

Likewise, when the casing is formed from a
10 flat strip, the formation of the casing is gradual and continuous, so that it is possible to introduce the metal very close to the point where it is solidified, thereby eliminating splashing and unnecessary turbulence in pouring the metal.
15 Likewise, the casing acts as a funnel to guide the molten metal to the point where it is solidified.

I claim:

1. A method of casting a metal body which
20 consists in continuously forming a unitary casing from a strip of material, introducing molten metal into the interior of said casing before said casing has been completed, and cooling the molten metal so that the solidified metal fills at
25 least part of the vacant space in the interior of said casing.

2. A method of forming a metal object having a metallic coating, which consists in moving said

metallic object through a cooled zone, while pouring molten metal around said object and solidifying said molten metal around said object by withdrawing heat from said molten metal while said object passes through said cooled zone,
5 while preventing any contact between said molten metal and the interior wall of said zone by moving spacing material between said molten metal and said interior wall.

3. A method of forming a metallic object hav-
10 ing a metallic coating which consists in moving a laterally continuous casing through a cooled zone and also moving said metallic object through said cooled zone while said metallic ob-
15 ject is located within said casing, introducing molten metal between said object and the inner wall of said casing and solidifying molten metal around said metallic object in said cooled zone by withdrawing heat from said molten metal.

4. A method of casting a metal body which
20 consists in forming a casing from a single strip of material while longitudinally moving said casing, and introducing molten metal into said casing close to the point at which said casing is completed, and cooling the molten metal so that
25 the solidified metal fills at least part of the vacant space in the interior of said casing.

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