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APPARATUS FOR CASTING METAL STRIPS

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Fig. 1.

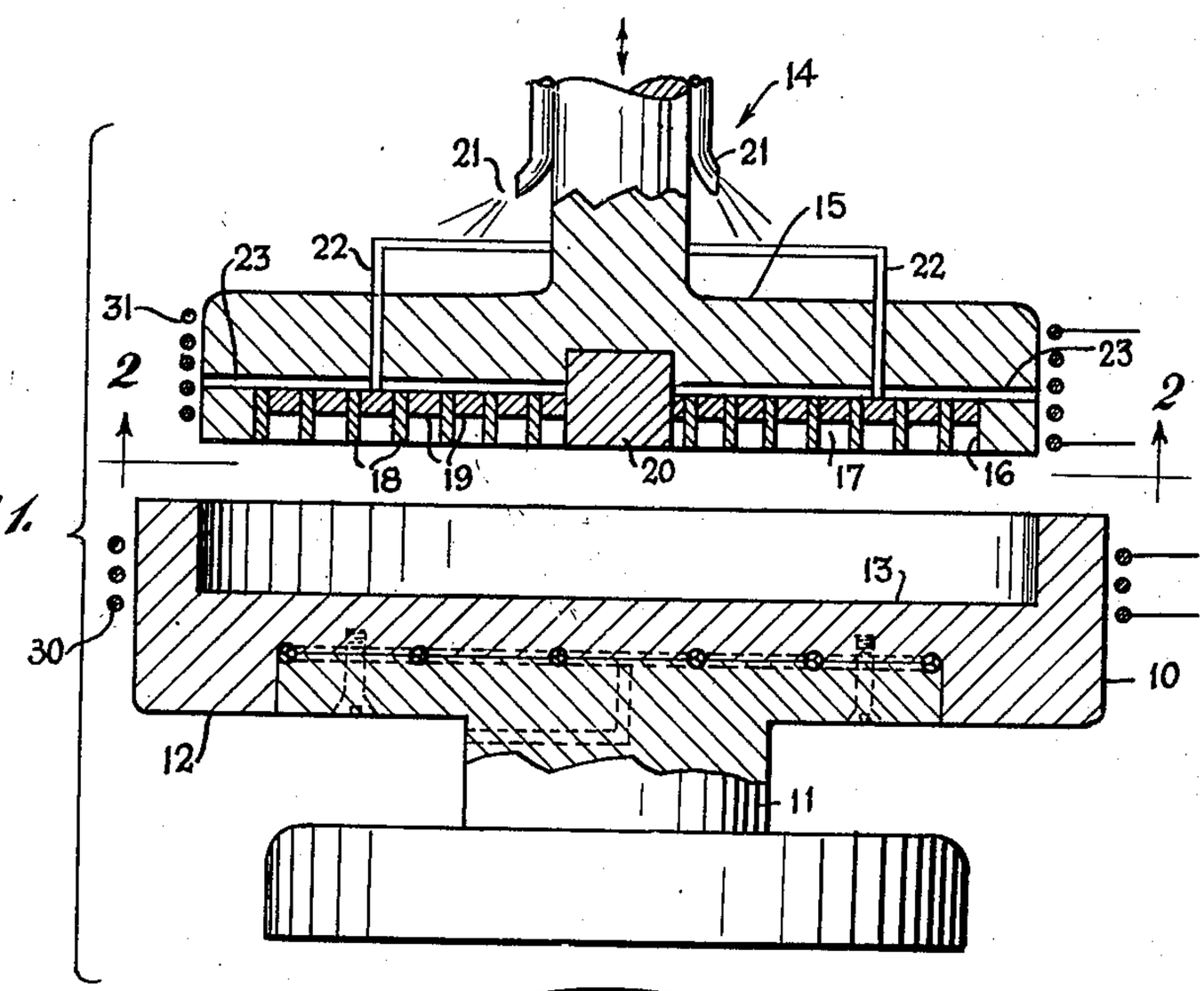
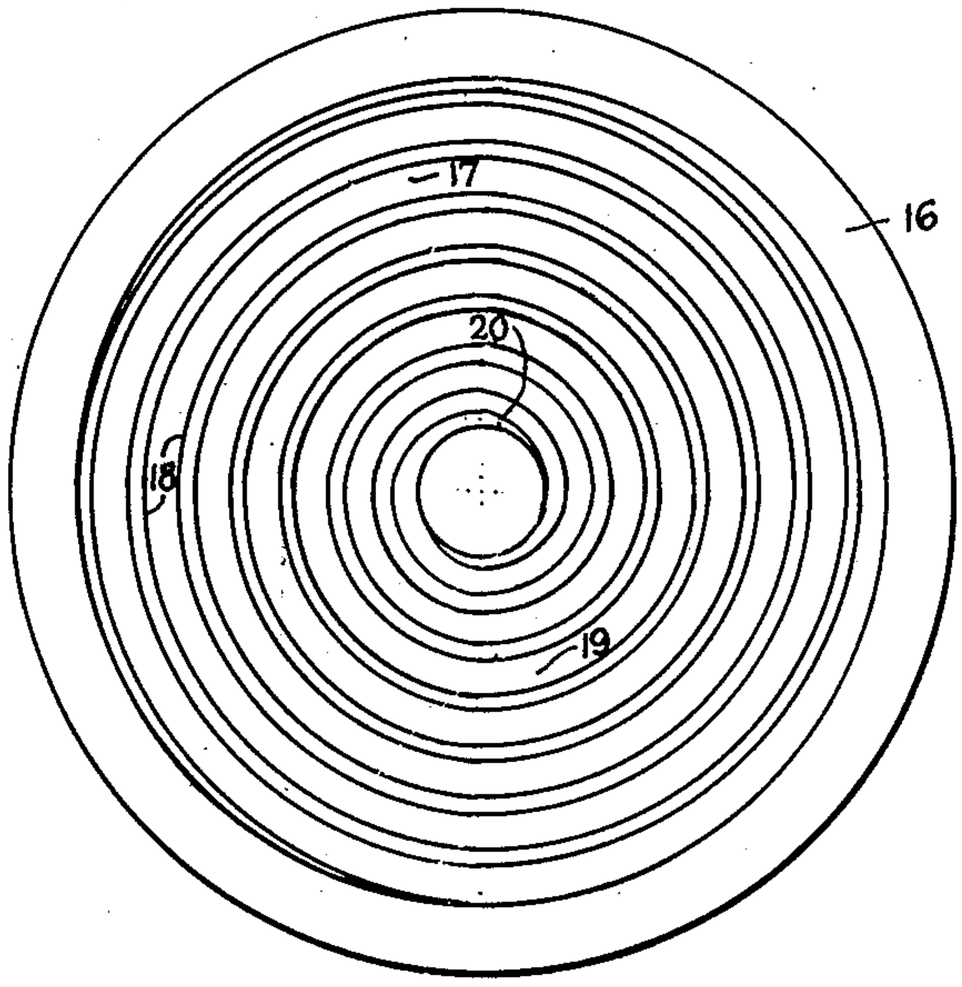


Fig. 2.



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APPARATUS FOR CASTING METAL STRIPS

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10 Claims. (Cl. 22—153)

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This invention relates to apparatus for casting metal in strip form, especially to casting long, thin strips of alloy metal particularly suited for fabrication to article form, such as a bearing, in a press or brake.

In making alloy strip, such as bronze strip for use in the production of bearings, the present manufacturing processes limit the amount of lead that can be included in the alloy to about 10% whereas the properties of the bearings are ordinarily improved if more lead is present. Now only thick sections or billets of alloy metal can be cast, and they require a great deal of subsequent reduction or rolling which causes undesirable lead segregation. This is also true of other alloy strip wherein different melting point metals are incorporated in the same melt for casting alloys ultimately to be processed to strip form.

The general object of this invention is to avoid and overcome the foregoing and other disadvantages of present apparatus for producing alloy strip and to provide novel alloy strip forming apparatus characterized by its rapid freezing of molten metal in strip form.

Another object of the invention is to reduce the segregation of the lower melting point metal in the production of thin alloy metal strip.

Another object of the invention is to eliminate transfer of molten metal from a container therefor to a mold and to provide a metal mixing container also adapted to form part of a die.

A further object of the invention is to cast a metal alloy in strip form and to solidify such alloy rapidly when the liquid alloy is cast or molded to the desired shape.

Another object of the invention is to provide a practical, positive, uncomplicated die for casting alloy metal in strip form without objectionable segregation of the components thereof.

Another object of the invention is to provide an apparatus for forming a thin metal strip consisting of two layers of different metals.

Other objects of the invention are to provide different width coiled metal strips for use in defining a die cavity, to provide a die for casting measured quantities of metal therein, and to provide means for maintaining a pressure on the metal as it is cast.

The foregoing and other objects and advantages of the invention will be made apparent as the specification proceeds.

Attention is directed to the accompanying drawing, wherein:

Fig. 1 is a vertical section through apparatus embodying the principles of the invention, which

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apparatus also is adapted to practice the method of the invention; and

Fig. 2 is a bottom plan on line 2—2 of Fig. 1.

Referring more in detail to the drawing, a suitable container 10, usually metal, is shown as being mounted on a base 11 and provided for use in preparing liquid metal alloys to be processed in accordance with the principles of my invention. The container 10 has heating means ordinarily associated with it, in this instance, a helically positioned conduit 12 is formed in its base and connects to a suitable supply of heating fluid. In all events, the container 10 has an annular chamber 13 and is adapted to receive material therein and to heat such material to render or retain it fluid.

As a salient feature of my invention, I am able to use the container 10 as one half of a forming die and avoid transfer of molten metal from the container to a separate die or mold for solidification. Avoiding such metal transfer obviously avoids the metal flow and delay, with consequent metal segregation, as occurs with prior casting procedure. To achieve this result, I provide a novel mold or die section generally indicated at 14 which includes a die holder 15 that has an annular flange 16 extending therefrom designed so as to engage snugly with the chamber 13 of the container 10 to define therewith a die cavity. The die holder 15 is positioned by conventional means (not shown) for movement to and from engagement with the container 10. In order to form a long thin metal strip in the die, a helical cavity 17 is provided therein. This cavity 17 is formed by means of tightly coiling together a relatively wide metal strip 18 and a relatively narow metal strip 19 with the upper (as shown) edges of the strips being aligned. The strips 18 and 19 are tightly wound on an arbor 20 in the position shown in Fig. 1, being retained in such shape by a band placed therearound or by insertion into the die holder 15. The strips 18 and 19 may be secured in the die holder in any desired manner even to being retained therein by magnetic means, or by mechanical means, or combinations thereof. In all events, the coiled strips 18 and 19 tightly fill the die holder between arbor 20 and flange 16, when positioned therein.

The total quantity of alloy metal in the chamber 13 of the container 10 is predetermined so that it is exactly sufficient to fill the cavity 17. Thus, when the last metal, such as lead, is mixed with the metal in the chamber 13 to produce a homogeneous alloy, the die holder 15 is rapidly

brought down into engagement with the container 10 and all of the metal in the chamber 13 is forced into the helical cavity 17. As soon as the die holder 15 is seated in the chamber 13, the heating medium flowing through the conduit 12 is shut off, if it has not previously been shut off, and cooling fluid is sprayed on the associated die holder and container by nozzles 21 which are connected to a conventional supply of a cooling medium. The foregoing procedure effects a rapid chilling action on the material in the mold cavity, which action may be accelerated, if desired by flowing a coolant through the conduit 12, or by forming cooling fins on the die holder and container, or by use of other cooling means. Hence segregation of the low melting metal of the alloy is avoided since the molten metal in the chamber 13 is stirred continuously until the die holder 15 is engaged therewith. Conventional vents (not shown) are formed for the mold cavity and they may comprise tiny grooves (not shown) in the narrow band 18 extending transversely thereof. The vent grooves in the band 18 should connect to other vents 23 which may be formed in the die holder 15 for leading any entrapped gases to the atmosphere. Solidified alloy in the cavity 17 is ejected by knock out pins 22 slidably carried by the die holder for unitary action. Such pins 22 may eject the solidified metal and the strips 18 and 19 as a unit to be separated thereafter in any desired manner, or the pins 22 may pass through holes in the narrow strip 19 and eject only the solidified helical coil. In the latter case, it would be preferable to have the strips 18 and 19 integrally connected and suitably secured in the die holder. Usually the strips 18 and 19 are not integrally bonded or fixed in position.

The helical cavity 17 may be, for example, 2 inches deep, $\frac{1}{16}$ inch wide (radially) and 500 or more feet in length when the die holder is about 36 inches in diameter. Practice of the invention has produced copper-lead alloys with uniform lead distribution, when up to 20% lead has been present, with no lead particle larger than .010".

The helical alloy strip produced can be finished in any desired manner, such as by cleaning, mechanically rolling, heat treating, etc., although it may be used in some instances without any further shaping or forming thereof.

Adhesion between the cast material and the strips 18 and 19 is avoided by coating them with a suitable lubricant, such as lampblack, powdered mica, graphite, or plumbago prior to each casting cycle. The extreme casting speed reduces the erosion of the apparatus to a minimum.

Pressurized strip casting can be achieved by my invention, if desired, so as to produce a fine grain structure and increased tensile strength. For example, the cast metal can be subjected to any desired pressure as it is being cast if the narrow strip 19 is progressively pushed downwardly of the cavity 17 as edgewise shrinkage of the metal in the cavity occurs with metal cooling and solidification. This particular pressure action is especially desirable as it avoids turbulence in the metal being cast. However, the normal practice of the invention with an edgewise chilling gives an excellent grain structure for material to be fabricated into bearings.

The container 10 can be made of any material adapted to stand the high temperatures to which the apparatus is subjected. A material known as "Inconel" or "Inconelex," which is a high chromium nickel ferrous alloy, has been used to form

the wide strip 18 with excellent results. For bearing alloys, the strips 18 and 19 can be made of ordinary cold rolled strip steel while any metal material of higher melting point than the cast material can be used, as a general rule. The narrow strips 19 can be made from heat resistant non-metallic material, such as asbestos, or fiberglass, or combinations thereof. The strips 18 and 19 can be of the same thickness if desired, or of any desired thickness relation.

It is desirable, of course, to maintain an accurately controlled temperature, usually only a few degrees above the melting point of the material, on the metal in the chamber to facilitate the rapid solidification thereof. Usually the metal in the chamber is agitated in any conventional manner to be certain that the mixture is uniform in composition and temperature until immediately before the alloy mixture is prepared for casting. Then the die holder and the chamber are brought into engagement and molten metal is formed to the shape of a thin, helical coil with a minimum of turbulence and flow of the uniform molten metal in the chamber. Nearly all of the metal flowing into the cavity 17 moves the same distance and such movement is of minimum length as the metal is displaced from a normal level position in the chamber to a helical position in the die helder. This substantially equal casting flow results in an extremely uniform grain in the cast metal which has good characteristics and is free from segregation of non-alloying constituents.

In some instances, vacuum or suction creating means may be associated with the apparatus embodying the invention to facilitate and assist in the casting action and to aid in filling the cavity. Such vacuum on the casting cavity may be established by connection of a vacuum generator to the vents 23 formed in the die holder 15.

In some instances, it may be desirable to use a briquet of carbon or other heat resisting material in place of the arbor 20 as a core for the helical strips 18 and 19. As the coiled strips 18 and 19 will spring out to the largest diameter possible and thus leave the center of the coiled strips void of material, the core for the strips 18 and 19 could be positioned in the container 10 to extend up into the chamber 13. Such a core for the strips 18 and 19 could even originally be formed on or integral with the container 10 to position the molten metal in the chamber 13 in annular form prior to engagement of the die holder and the container.

The principles of the invention can be used to coat a metal strip on one side with a different metal. This action may be achieved by substituting two superimposed metal strips for the wider strip 18. Thus one surface of each strip would be exposed to the molten metal entering the die cavity. The surfaces of the double thickness metal strip 18, which are to bond to the cast metal, should be precleaned. A molten salt bath, for example potassium cyanate, is suitable for this cleaning action. Other preparatory steps, such as pretinning, or electroplating with copper or electroflashing with nickel facilitates bonding copper or silver bearing metals to steel strips in accordance with the invention.

The invention can be used in casting various metallic strips including alloys of aluminum, tin, copper, or lead. However, any metal or thermoplastic material can be processed in accordance with the invention when one desires to produce a helical article.

The drawing shows electro-conductive coils 30 and 31 associated with the outer surfaces of the container 10 and die holder 14, respectively, and connected to a conventional source of high frequency electrical energy for inductively heating the apparatus and any material in the container, prior to a casting action.

From the foregoing, it will be seen that a novel, effective die is provided by the invention and that an improved metal strip can be provided by the invention.

One complete embodiment of the invention has been illustrated and described in detail herein, but it will be understood that the invention is not limited to the specific example set forth since modification may be resorted to within the scope of the appended claims.

I claim:

1. A casting mold, or die comprising two interwound helices of heat-resisting strip material of different widths, having one edge of each strip in the same plane, the other edge of one strip protruding appreciably from the corresponding edge of the second strip to define a helical mold cavity therebetween, said strips being separable to facilitate removal of a casting therefrom.

2. In a casting mold or die, a cavity forming device consisting of two interwound helices of thin wide strips of heat resisting material with one edge of each of the helices being exposed to a die chamber, one of said strips of material being wider than the other, said exposed edges being spaced axially of the mold from each other to expose a portion of one helix and define a helical cavity between adjacent surfaces thereof for forming a thin wide strip therein.

3. An article as in claim 2 wherein said strips are separate and said strip that is partially exposed is thinner than the other strip which determines the thickness of the die cavity.

4. In a matrix for forming thin strip metal in long lengths, the combination of a matrix body comprising two thin metal tapes of substantially different widths in edge alignment wound into a spiral, one edge only of each tape comprising said spiral being in the same plane, opposite edges of each tape being in substantially different planes, both faces of the narrower tape being in facial contact with only a portion of the faces of the wider tape, the remaining portions of the faces of the wider tape defining a hollow helical groove in conjunction with the unaligned edge of the narrower tape.

5. A matrix body comprising two thin metal tapes of substantially different widths in facial contact, having one edge of each tape in alignment, and wound in spiral fashion in the same plane defining a helical hollow open ended groove, the sides of which groove are defined by the exposed facial portions of the wider tape and the closed end of such helical groove being defined by the other edge of the narrower tape which is not in the same plane as the other edge of the wider tape.

6. In a matrix for forming thin strip metal, a pair of thin flexible heat resistant tapes one of which is about several inches wider than the other, said narrower tape being approximately $\frac{1}{16}$ in. thick and with said wider tape being thinner than the other said tape, said tapes being helically positioned in a unit in abutting face to face relationship to each other, said tapes being positioned with one lateral section and edge of said wider tape protruding from said unit and defining a narrow relatively deep mold cavity therebetween, said strips being separable after a molding action to facilitate removal of a cast strip therefrom.

7. In a matrix for forming thin strip metal, a pair of thin flexible heat resistant tapes one of which is appreciably wider than the other, said narrower tape being thicker than the other said tape, each of said tapes being positioned in a plurality of helical convolutions with the convolutions of each tape forming alternate laminae in a unit in abutting face to face relation to each other, said tapes being positioned with one lateral section and edge of said wider tape protruding from said unit and defining a narrow relatively deep mold cavity therebetween, said strips being separable after a molding action to facilitate removal of a cast strip therefrom.

8. In a matrix for forming thin strip metal, a pair of thin flexible metal tapes one of which is appreciably wider than the other, each of said tapes being positioned in a plurality of helical convolutions with the convolutions of each tape forming alternate laminae in a unit in abutting face to face relation to each other, said tapes being positioned with one lateral section and edge of said wider tape protruding from said unit and defining a narrow relatively deep mold cavity therebetween, said strips being separable after a molding action to facilitate removal of a cast strip therefrom.

9. In a matrix for forming thin strip metal, a pair of thin relatively wide flexible heat resistant tapes, said tapes being of different widths, said tapes being superimposed and being helically positioned in a unit in abutting face to face relationship to each other, said tapes being positioned with one lateral section and edge of one said tape protruding from said unit and defining a narrow relatively deep mold cavity therebetween.

10. A matrix as in claim 7 wherein said unit is positioned with its longitudinal axis extending substantially vertically and with said cavity being open from the lower surface of the matrix, and vent means in said unit and communicating with the upper portion of said cavity.

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