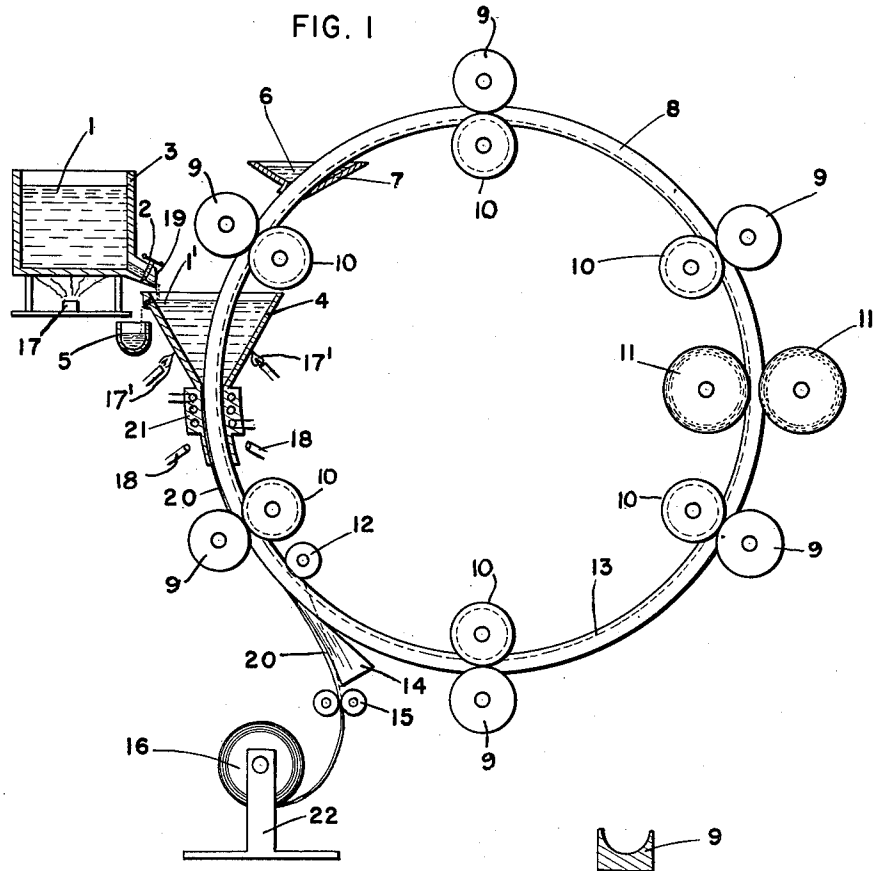
Aug. 2, 1955 J. B. BRENNAN 2,714,235

METHOD AND APPARATUS FOR CASTING STRIP METAL

Filed Feb. 18, 1950

FIG. 1



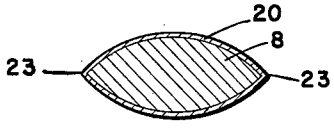


FIG. 4

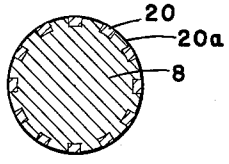


FIG. 3

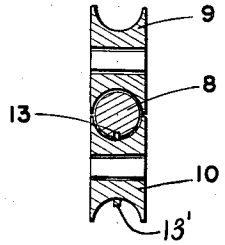


FIG. 2

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METHOD AND APPARATUS FOR CASTING STRIP METAL

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3 Claims. (Cl. 22—57.4)

This invention pertains to the continuous casting of strip metal and apparatus therefor.

According to this invention I move for example a partly immersed annular strip or ring of metal through a pool of molten metal and through a die adjacent thereto, and thereby cast a layer of the molten metal along and around the small diameter of said annular strip or ring of metal, which layer is chilled progressively around said annular strip or ring as it passes through said die, so that the annular strip or ring emerges from the die coated with a layer of the previously molten metal of a thickness corresponding to the spacing of the cooling die inner walls with the exterior of the small diameter surface of the annular strip or ring.

Referring to the drawings herewith:

Figure 1 is a section of mechanism for carrying out this invention.

Figure 2 is a section of large annular ring with guide and drive rolls thereabout.

Figure 3 is a cross section of a large annular ring for producing a multiple series of wires, according to this invention.

Figure 4 is an alternate shape of large annular form with metal sheath thereover for producing two strips of flat strip metal by parting the sheath along two lines instead of just one.

Referring to Figure 1:

The annular ring 8 which may be of chrome steel or graphite, or a combination of heat resisting rigid materials, rotates counterclockwise through funnel 7, having a pool of ceramic heat resisting parting compound paste 6 therein which deposits over ring 8 as it rotates therethrough and fills the groove 13 therein. A flame deposited carbon layer will also serve as a parting compound for coating ring 8 prior to entering the molten metal 1' in funnel crucible 4.

The groove 13 may be eliminated, but is used if gear drive is chosen to rotate the annular ring 8, and also serves as an added guide for ring 8 as well as a relief for subsequently applied slitter.

1 represents a pool of molten metal in a holding crucible 3, maintained at a constant temperature by heater 17, which crucible supplies molten metal through valve 2 in discharge spout 19 leading to constant level crucible 4 wherein a constant head of molten metal 1' is maintained by keeping the level so that it overflows into a third crucible 5.

The annular ring 8 is driven by rolls 10 shown here operating in groove 13, which may have gear teeth therein, or may be smooth if friction drive will suffice. The annular ring 8 is guided and retained centrally through fluid cooled die 21, Fig. 1, and downward through the pool of molten metal 1' in funnel shaped crucible 4 by rolls 9.

Gas flames 17' maintain the metal 1' in funnel crucible 4 at a constant molten temperature and the fluid coolant sprays 18 act as additional cooling devices for the emerging layer of metal about annular ring 8.

When and as the annular ring 8 passes through the molten metal 1' in crucible 4 a skin of metal is chilled thereabout due to the heat absorbing capacity of ring 8 which skin is thinner than the spacing of the die 21 from the exterior surface of annular ring 8, and as this skin

advances into die 21 it carries with it exteriorly a layer of molten metal which is instantly and constantly chilled by fluid cooled die 21 so that the metal about annular ring 8 as it emerges from die 21 retains its shape, and though it be for example red hot as it emerges, is none the less in the shape of a sheath about the annular ring 8 section as it leaves die 21. The fluid sprays 18 further solidify and chill the sheath 20 of metal surrounding annular ring 8 as the ring 8 advances downward after leaving die 21.

Two sets of rolls are situated above and below the crucible 4 and die 21 to accurately retain the spaced relation of ring 8 and die 21.

The rotary saw 12 rotated against the inner circumference of ring 8 serves to slit the sheath 20 of metal from around the annular ring 8 as the ring 8 with the sheath 20 thereon revolves downward and the stripper shoe 14 with rolls 15 strip the metal sheath 20 after slitting, and roll it into a flat shape which is made into a coil 16 by mechanism 22, having a power driven clutch thereon with constant speed and tension. This saw 12 may be operated on the outer circumference of the ring 8 also, or otherwise if desired.

Referring to Figure 2: 10 represents a roll having teeth 13' therein which engage with teeth in groove 13 of annular ring 8 to drive the annular ring 8 through the molten metal and die, which forms the metal coating 20 over the ring 8. 9 represents an exterior guide roll for annular form 8. The rolls 10 between funnels 4 and 7 and between die 21 and saw 12 will not, of course, have any such teeth as just described so as not to disturb the paste 6 which fills the groove 13. The remaining rolls 10 may have such teeth if positive driving of ring 8 is desired; otherwise, as previously indicated, the rolls 10 may be smooth if a friction drive suffices.

Referring to Figure 3: 8 represents an alternate design of large annular form cross section whereby thick sections 20 and very thin sections 20*a* may be cast thereabout as a sheath which may be easily parted into multiple wires.

Referring to Figure 4: 8 represents an alternate cross section for large annular rotating form 8, having a sheath of metal 20 thereover, which may be readily slit at edges 23 thereof to make strips which may be rolled flat and coiled with less distortion than if a circular cross section is used in making annular ring 8.

Thus for example, if I use an annular strip or ring of heat resisting alloy metal or ceramic material, say 72" large diameter and 1" small diameter of the material, and pass it through the bottom of a crucible having a pool of molten Cu or Al therein having a bottom die in said crucible comprising a thin water cooled copper shell ⅛" larger in interior diameter than the small diameter of the annular strip or ring, and conforming in 1/16" spaced shape thereabout for a distance of a few inches or less, and force the annular strip or ring by rotation down and through the aforesaid pool of molten metal and through said water cooled die in exact spaced relation to said die, a layer of molten metal will cling to the exterior of the small diameter of the annular strip or ring and form a coating thereabout, which coating can be slit and stripped therefrom and formed into a continuous flat coil of metal which was previously molten.

It is to be understood that the sleeve or coating cast and cooled about the moving rod or shape may be slit into as many strips of metal as desired for removal.

The cross sectional shape of the rod moved through the pool of molten metal may be of any desired shape to produce the desired shape of strip metal.

Thus screw shaped grooves or longitudinal grooves may be put into the annular strip about which the sleeve or layer is cast, so that slitting and removal is made easier and less waste is encountered.

Grooves may extend longitudinally of the bar about which the sleeve is cast, which will fill with cast metal and very thin sections will be cast between the grooves, permitting easy slitting into one or more strips.

Where the saw slitter functions it is desirable to have a groove to permit clearance for the same, and the metal cast therein is removed by the saw. If on the other hand a very thin section is produced by cross sectioned shape of the large annular strip about which the metal is cast, stripping and slitting may be accomplished by a parting tool.

Wires may be produced by using a large annular casting strip having many grooves therein which will be filled with metal with only extremely thin joining sections. The die and annular strip could be so closely fitted that only wires would be cast if one chooses to maintain extremely close tolerances between the exterior of the grooved large annular ring and the inside diameter of the cooling die.

It is also to be understood that the molten metal pool about the large annular strip may be piped thereabout through a conduit leading from a remote metal crucible under pressure if desired in accordance with this invention.

In any case, according to this invention a sleeve of cast metal is forced and carried out of the cooling die by the adherence of such sleeve of cast metal to an interior moving bar or strip to which the cast metal sleeve has greater adherence than that evinced between the cast metal sleeve and the cooling die.

The apparatus of this invention may be enclosed in an inert or non-oxidizing atmosphere chamber.

Coating of the annular strip around which the metal is cast to prevent non-adherence may be done with graphite or other anti-stick materials.

If high frequency is used to maintain the temperature of the pool of molten metal the large annular form into which the coating is deposited may be made of a material not highly responsive to the frequency of the heating coils so that economy of heating is secured. A composite annular casting form may also be used, such as a ceramic coated metallic rod or a corrosion resistant lamination or metallic overlay may be applied to the long annular casting form to lend stability thereto.

It is preferable according to this invention to keep the temperatre of the long annular strip or ring at all points on its body at less than the melting point of the metal being cast, and this is even true as the best procedure at the section where the strip passes through the molten metal. This saves energy and also lessens corrosion on the large annular strip as well as permitting greater speed and higher production rates.

Laminations may be cast by this method and apparatus by having two or more pots of metal and dies through which the bar or annular strip is passed and coated sequentially prior to stripping.

It is preferred in all cases according to this invention that the cross sectional tensile strength of the large annular strip or ring which is passed through the molten metal and coating die be greater than the cross sectional tensile strength of the deposited metal thereabout. It is the addition of the large annular strip's tensile strength which enables me to overcome the die sticking tendency which heretofore has prevented the efficient casting of thin constant dimensioned continuous metallic strip. The cross sectional strength of the large annular strip or ring must be such under the temperature to which it is controlled or limited as by cooling fluid, that it may be withdrawn through the chill die even though there is a considerable tendency for the chilled metal to adhere and stick to the inner die wall.

Gear teeth for rotating may be incorporated in the inside periphery of the large annular strip or ring onto which the thin layer of molten metal is cast. These teeth are preferably coated or filled with ceramic non-sticking material prior to passing through the molten metal.

The heat absorption and radiation capacity of the large annular strip or ring must be of such an order that it may be constantly and continuously pressed through the molten metal pool and the chilling fluid cooled die and be maintained constantly at a temperature sufficiently lower than the melting point of the metal being cast to cause a skin of molten metal to solidify therearound constantly without fusion thereto.

It is also contemplated according to this invention to form a sheet of pre-fabricated metal as steel around a bar or shape or large annular strip or ring, by rolling such strip metal thereover and fitting therearound tightly, or even welding the abutted edges thereof, then passing this sheath with the strip or ring inside through the pool of molten metal and casting thereabout a layer of molten metal and solidifying said layer in the chilling die whereby a laminated fused layer as of copper may be fused and evenly deposited to the superposed and pre-formed tubular shape and thereafter stripping the unitary lamination from the large annular ring.

I claim:

1. Continuous metal strip casting apparatus comprising a heat resistant, self-supporting, and endless core of uniform cross-section, a container for molten metal surrounding a portion of said core, a die including an open ended passage of uniform cross-section surrounding an adjacent portion of said core in spaced relation thereabout and in communicative relationship with said container, means for moving said core through said container and said die passage for coating said core with a continuous tubular layer of molten metal of thickness in accordance with the space between said core and said die passage, means for cooling the wall of said die passage and thus the shaped layer of metal on said core, and means for longitudinally severing and stripping said coating from said core to produce a metal strip.

2. Method of making continuous strip metal comprising the steps of continuously and cyclically passing an endless core through a bath of molten metal to continuously form an uninterrupted layer coating around the core, continuously extracting heat from the coating promptly after leaving the bath, continuously longitudinally severing the metal coating to produce at least a single strip, and continuously stripping and flattening the metal coating from said core to produce continuous strip metal.

3. Method of making continuous strip metal comprising the steps of continuously and cyclically passing an endless core through a bath of molten metal to continuously form an uninterrupted layer coating around the core, continuously extracting heat from the coating promptly after leaving the bath, continuously longitudinally severing the metal coating to produce at least a single strip, and continuously stripping the metal coating fom said core to produce continuous strip metal.

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