Aug. 19, 1958 J. B. BRENNAN 2,847,737

CASTING METHOD

Filed May 2, 1955

2 Sheets-Sheet 1

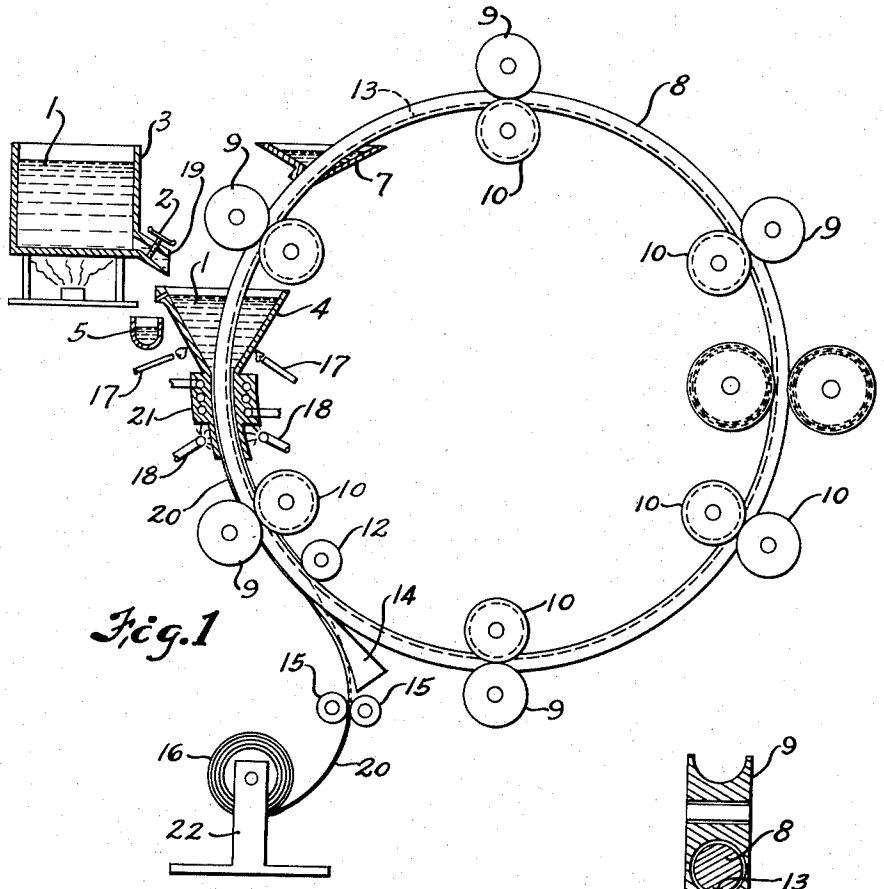


Fig. 1

Fig. 2

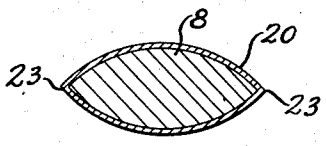


Fig. 4

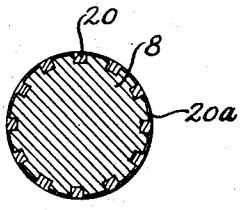


Fig. 3

INVENTOR.
JOSEPH B. BRENNAN

BY
Oberlin & Limbach
ATTORNEYS

Aug. 19, 1958 J. B. BRENNAN 2,847,737

CASTING METHOD

Filed May 2, 1955 2 Sheets-Sheet 2

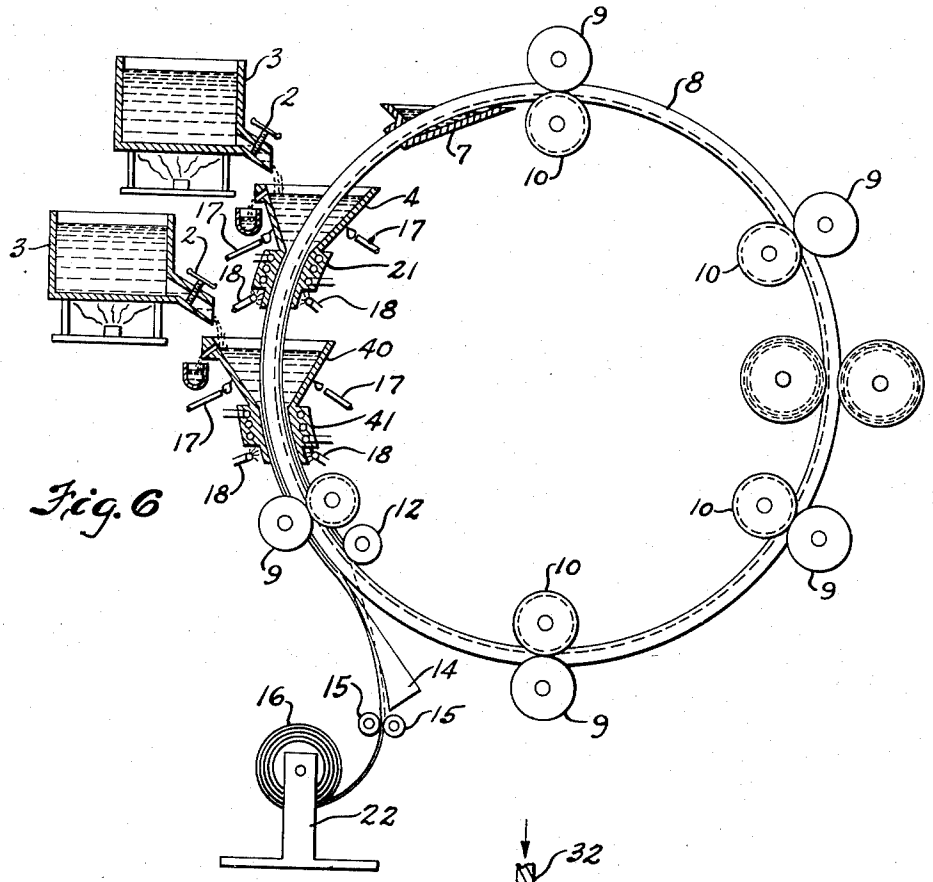


Fig. 6

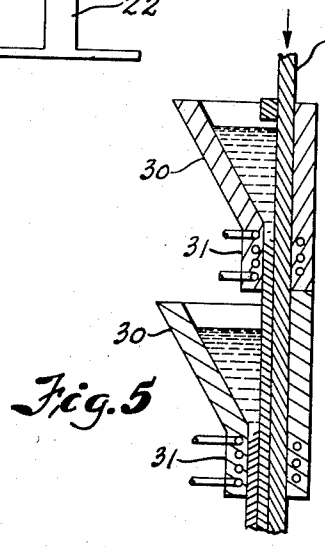


Fig. 5

INVENTOR.
JOSEPH B. BRENNAN
BY
Oberlin & Limbach
ATTORNEYS

United States Patent Office 2,847,737
Patented Aug. 19, 1958

2,847,737

CASTING METHOD

Joseph B. Brennan, Cleveland, Ohio

Application May 2, 1955, Serial No. 505,100

1 Claim. (Cl. 22—57.2)

This invention pertains to the casting of metal slab, strip metal and laminated metal and apparatus therefor. This application is a continuation-in-part of my co-pending application Serial No. 147,466, filed February 18, 1950, now Patent No. 2,714,235.

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.

According to this invention I also move a slab or bar of metal through one or more successive containers and chilling dies to cast a layer or successive layers of metal thereonto to thereby build up the cross-section size thereof. In this connection, laminated metal strip may be continuously cast by moving an endless core successively into a container having molten metal therein and through a chilling die and then into a container having a lower melting point metal therein and through another adjoining chilling die, and by stripping the composite metal strip from said core.

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.

Figure 5 is a cross-section view of an apparatus for applying successive layers of cast metal onto a metal bar or slab.

Figure 6 is a cross-section view of an apparatus similar to that of Figure 1 except showing the continuous production of laminated strip metal.

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 counter clockwise through funnel **7**, having a pool of ceramic heat resisting parting compound paste 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** acts 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 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 exteriorally 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**.

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 cop-

per 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 temperature 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.

Referring now to Fig. 5, there is shown a container **30** and an adjoining chilling die **31** through which a steel or other metal bar or slab **32** of 3" x 24" cross-section size for example is adapted to be moved to have a layer of molten steel or other metal in container **30** applied thereto and solidified in die **31**. This casting operation may be repeated any number of times finally to produce a steel bar, for example of say 24" x 24", or other cross-section size. Preferably a 3" thick layer of metal is applied at each casting operation in the foregoing example, but, obviously the cast layer thickness may be more than or less than 3". I have found that 4" is approximately the greatest thickness of penetration when using water-cooled dies **31** without resulting in cavities and piping in the successsive cast layers.

Referring now to Fig. 6, there is shown therein an apparatus like that of Fig. 1 except that one or more additional containers **40** and adjoining dies **41** are employed to produce laminated strip metal. The higher melting point metal or alloy is first cast onto the ring or core **8** as the core passes through container **4** and adjoining water-cooled die and then another metal or alloy of lower melting point is cast onto the first metal layer as the core **8** and metal thereon passes through container **40** and die **41**. After the two-layer casting emerges from die **41** it may have additional layers cast thereon, and finally the saw **12** slits laminated product for removal in strip or wire form from the core **8**. As an example, steel may first be cast onto core **8** and then bronze is cast onto the congealed steel layer. As another example, an aluminum or aluminum alloy layer may be first cast followed by casting of a bearing metal or

alloy such as a 98% lead 2% silver alloy, for example.

Other modes of applying the principle of the invention may be employed, change being made as regards the details described, provided the features stated in the following claim, or the equivalent of such, be employed.

I therefore particularly point out and distinctly claim as my invention:

The method of casting composite strip metal comprising the steps of continuously and cyclically passing a core through a first bath of molten metal and an adjoining chilling die to continuously cast a first layer of molten metal on said core; shaping and cooling said first layer of metal on said core as it passes through said die to cause the metal to cling thereto by shrinkage; continuously and cyclically passing said core and first layer of metal thereon through a second bath of molten metal and another adjoining chilling die to continuously cast a second layer of molten metal on the first layer of metal on said core; shaping and cooling said second layer of metal on said first layer as it passes through the die adjoining said second bath of molten metal to cause said

second layer of metal to shrink onto said first layer of metal; and continuously removing the composite strip metal comprising said first and second layers of metal from said core prior to continuously and cyclically passing said core through said first and second baths of molten metal and said adjoining chilling dies.

References Cited in the file of this patent

UNITED STATES PATENTS

223,077	Tasker	Dec. 30, 1879
1,948,505	Bray	Feb. 27, 1934
2,301,902	Merle	Nov. 10, 1942
2,348,178	Merle	May 2, 1944
2,433,903	Hensel et al.	Jan. 6, 1948
2,664,605	Beste	Jan. 5, 1954
2,714,235	Brennan	Aug. 2, 1955

FOREIGN PATENTS

711,133	Germany	Sept. 26, 1941
844,806	Germany	July 24, 1952