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PATENTS ABSTRACTS OF JAPAN, vol. 7, no. 55 (M-198)1200r, 5th March 1983; & JP-A-57 202 947 (KAWASAKI SEITETSU K.K.) 13-12-1982

PATENTS ABSTRACTS OF JAPAN, vol. 7, no. 124 (M-218)1269r, 28th May 1983; & JP-A-58 41 656 (MITSUBISHI JUKOGYO K.K.) 10-03-1983

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Description

Background of the invention

Heretofore, processes and machines for the continuous casting of metal strands have fallen, for the most part, into two different groups. The first, and historically the earliest group, may be referred to as the vertical group in which the molten metal to be cast is poured continuously into the open upper end of a substantially vertically disposed mold passage of a chilled mold in which a continuous strand consisting of a solidified shell surrounding a molten core is formed as heat is withdrawn through the chilled walls of the mold passage. The embryo cast strand so formed is withdrawn downwardly continuously from the open lower end of the mold passage where it enters a secondary cooling zone in which it is subjected to further cooling and solidification by direct application of cooling fluid to the solidified surface. The US Patents Nos. 2,135,183 and 2,135,184 of Junghans are representative of the earliest commercially successful continuous casting processes of this group.

In this group, in order to reduce the overall height of the machines, it has been common practice to cause the downwardly moving strand to be curved, either by the use of a curved mold passage, or otherwise, so that the cast strand moves along a curved path through the secondary cooling zone. It is then straightened to cause it to move on in a substantially horizontal path in which it may be cut into manageable lengths. Within the secondary cooling zone it has been customary to support the strand by a structure sometimes referred to as a roller apron in which the surfaces of the strand are engaged by a series of pairs of rollers between which the cooling water is applied to the strand. Such roller aprons are cumbersome and expensive to build and maintain.

Virtually all commercial installations of continuous casting machines are of the vertical type above described.

The second group may be referred to as the horizontal group because the mold passage through the chilled mold is substantially horizontally disposed. However, the theoretical advantages of the horizontally disposed mold passage have been outweighed by practical difficulties which have been encountered in their use, particularly in feeding the molten metal into the mold passage. Machines and processes of this group have found very little commercial use.

It is an object of the present invention to provide a different approach to the problem of casting metals continuously by departing from the conventional methods in which molten metal is introduced into a mold passage that extends either vertically or horizontally through a chilled mold and an embryo cast strand is withdrawn from the mold passage either downwardly or horizontally therefrom.

I propose to depart from these known methods by forming an embryo cast strand on a chilled surface submerged within a pool of molten steel, and withdrawing the strand upwardly along a continuation of said chilled surface extending above the surface of the pool to continue and complete the solidification process.

For the continuous casting of thin walled ingots, there has recently been described a device, as laid out in the preamble of claim 6, comprising a reservoir containing a pool of molten metal, a mold having a mold wall having a transversely flat chilled surface which is curved longitudinally, and heat resistant means extending along the side edges of said chilled surface and projecting upwardly above said reservoir, and means for withdrawing the embryo cast slab continuously along said chilled surface (JP—A—57-202947; patent abstract of Japan, Vol. 7, No. 55 (M-198) (1200)), upon which the preambles of claims 1 and 6 are based.

In this device, the cooled bottom part of the mold is formed to a transversely flat curved hollow shape, and the mold is oscillated back and forth along the curving direction by an oscillating device, while the formed ingot is withdrawn in a horizontal direction by drawing rolls.

Obviously, the oscillating movement of the mold containing the molten metal requires additional mechanical structures and devices and presents difficulties and hazards during the casting operation and in controlling the quality of the ingot.

It is an object of the present invention to provide a different approach to the problem of casting metals continuously by departing from the conventional methods in which molten metal is introduced into a mold passage that extends either vertically or horizontally through a chilled mold and an embryo cast strand is withdrawn from the mold passage either downwardly or horizontally therefrom, but departing also from the methods by which an ingot is formed on a moving chilled surface.

I propose to depart from these known methods, as laid out in the preamble of claim 1, by forming an embryo cast strand on a fixed chilled surface submerged within a pool of molten metal, and withdrawing the strand upwardly along a continuation of said chilled surface extending above the surface of the pool to continue and complete the solidification process.

It is a further object of the invention to reform the strand as it moves off the chilled surface while it retains sufficient residual heat to be reformable, thereby eliminating any need to reheat the strand.

Summary of the invention

The invention is especially adapted to the manufacture of relatively thin steel slabs of 12 to 25 mm (one-half to one inch) in thickness, and will be described more particularly hereinafter as applied thereto.

According to the present invention, I propose, as laid out in the characterizing portions of claims 1 and 6, to expose molten steel within a pool thereof to a fixed transversely flat chilled surface

curved longitudinally to form a convex arc and having a first portion submerged below the surface of the pool to form an embryo cast strand thereon, and to withdraw the embryo cast strand upwardly along a second portion of said chilled surface forming a continuation of said submerged surface and located above the surface of the pool, at a rate to permit withdrawal of sufficient heat through said flat submerged surface to form on said surface a partially solidified strand of the desired thickness and weight thereon.

I also propose to provide means resistant to heat transfer extending at least along the side edges of the submerged portion of the chilled surface and forming vertical walls projecting above said surface to restrict heat trasnfer from the strand except through said chilled surface.

I also propose that the first portion of said chilled surface, i.e., the submerged portion thereof, be curved convexly, longitudinally to form a short arc of a circle, and that the lower end of the arc be located substantially perpendicularly to the horizontal surface of the molten metal pool so that the embryo cast strand will move along the submerged portion of the chilled surface in a substantially vertical direction while it is accumulating metal from the pool and until it emerges from the pool.

I also propose that the second portion of said chilled surface be curved convexly to form an arc of a circle of the same radius as that of the submerged arc so that as the embryo strand moves from the submerged portion onto and along the second portion it is not subjected to bending or other stresses as it proceeds along said surfaces and during the time when the crystal structure of the strand is being formed and solidified by withdrawal of heat through said chilled surfaces.

I also propose to cause the solidified strand to move directly from the chilled surface to pass between forming rollers while it retains sufficient residual heat to be easily deformable without need to reheat the strand, thus making possible considerable saving in the cost of the product.

Preferably, the curved chilled mold surfaces may extend through a total circular arc of between 45° and 75° so that the strand may leave the second portion of the chilled surface moving toward withdrawal rolls and a work station such as a rolling mill, for example. The quantity of heat withdrawn from the strand is controlled to permit the strand to retain sufficient residual heat to be reshaped by rolling without reheating.

Description of the drawings

A preferred embodiment of the invention selected for purposes of illustration is shown in the accompanying drawings, in which:

Fig. 1 is a semi-diagrammatic vertical cross-section showing the process and apparatus in normal operating position;

Fig. 2 is a similar view of a portion of the apparatus showing the process in starting position;

Fig. 3 is a view of the upper portion of the starter apparatus;

Fig. 4 is a cross section on the line 4—4 of Fig. 1 showing guide strips to restrain lateral heat transfer from the chilled mold surfaces.

Description of the preferred embodiment

Referring to Fig. 1 of the drawings, the pool of molten metal to be cast may be stored in a suitable tundish or reservoir 1 of refractory material to which molten metal may be supplied in any suitable manner as through a spout 2. The flow of metal to the reservoir may be controlled in any suitable manner; i.e., either manually or automatically by known means responsive to the level of molten metal in the reservoir; i.e., to increase the flow of metal into the reservoir when the level tends to fall below a predetermined level, or to decrease the flow of metal when the level rises above the predetermined level.

At one side of the reservoir is a water cooled mold 3 having a transversely flat thermally conductive wall 4, preferably of copper, forming a flat chilled mold surface having a lower portion 5 that extends to the bottom of said reservoir and submerged in the molten metal therein. Thus the molten metal mold is exposed to the chilled surface 5 so that heat may be withdrawn through said surface to cause an embryo cast strand 6 to begin to be formed thereon.

The side edges of the chilled mold wall 4, at least along the submerged portions thereof, abut the vertical walls 25 of guide strips 26 which extend along said edges and project above said chilled surface and restrain and smooth the side edges of the cast strand. However, it is important that heat be withdrawn only downwardly through the chilled surface of mold wall 4 and that it not be withdrawn laterally from the strand through the strips 26. Therefore, they are preferably made of materials which are resistant to heat transfer, such as refractory materials, for example. Since the surfaces of the submerged portions of the strips 26 are exposed to the molten metal in the pool and will be heated thereby, there will be little or no tendency for heat transfer through them from the strand, but if desired, electrical heating elements may be embedded in the strips, particularly those located above the surface of the pool.

Alternatively, however, said strips may be made of metal, such as steel, for example, in which case the strips, even though submerged, may have heating elements embedded therein to maintain the strips at a temperature sufficient to prevent heat transfer laterally from the strand.

In this connection it is to be noted that the embryo casts strand will be completely formed when it reaches the level of the metal in the pool. That is, no metal will be added to the strand above the pool level, although previously adhered metal in liquid or partially solidified state will be solidified subsequently by additional heat transfer as it moves along the second portion of the chilled surface above the pool level.

The strips 26 may be extended along the side

edges of the mold wall as far as desired, although, since complete solidification of the strand may occur within a reasonably short distance beyond the pool level, the strips may not be needed along the entire length of the mold wall.

The mold wall 4, although flat transversely, is curved longitudinally to form a circular arc of from 45° to 75°. The lower portion of the chilled surface designated by 5 forms only a short portion of the entire chilled surface of the mold and the lower end of the arc is located substantially perpendicularly to the bottom of the reservoir and to the surface of the molten metal pool. It extends only through an arc of 10° to 20° so that the embryo strand will move along the submerged chilled surface in substantially vertical direction while it is accumulating metal from the pool. Since the two convexly curved surfaces 5 and 7 are formed on the same radius, the embryo cast strand retains its contour as it moves along both portions and is not subjected to bending or other stresses as its crystal structure is being formed and solidified. Bending of the strand is required only as it reaches the withdrawal rolls 9, by which time solidification of the strand will have been completed.

If necessary, the surfaces of the mold wall 4 may be lubricated by methods known in the art.

The mold 3 may be supported in any suitable manner. The portion of the strand 8 between the surface 7 and the withdrawal rolls 9 may be supported by one or more rollers such as roller 10.

At the beginning of the operation, as shown in Figs. 2 and 3, a plurality of chains 11 may be arranged to extend down along the chilled surfaces 7 and 5 to the bottom of the reservoir 1 to be imbedded in the first of the solidified metal which forms on the surface 5. The other ends of the chains 11 may be extended upwardly over the surface 7 to the withdrawal rolls 9. In the beginning of the operation the level of the molten metal in the reservoir 1 is relatively low indicated in Fig. 2. When sufficient solidified metal has accumulated on the lower end of the chains to form a starter bar 12 extending transversely across the surface 5, the withdrawal rolls 9 may be activated to begin the withdrawal of the starter bar. At the same time the level of molten metal mold is allowed to rise as indicated in Fig. 1 and the embryo cast strand 6 continues to be formed by withdrawal of heat through the surface 5.

As the operation proceeds, the thickness of the cast strand may be determined by adjustment of either or both of two factors: (1) the depth of the molten metal in the pool and (2) the rate of withdrawal of the cast strand. The slower the rate of withdrawal, the greater the thickness of the cast strand. Likewise, the greater the depth of the molten metal in the pool, the greater the thickness of the cast strand. It will be understood that the molten metal will begin to solidify against the chilled surface 5 near the bottom thereof to form the embryo strand 6. The strand will be very thin at first but will thicken gradually as it is withdrawn upwardly along the chilled surface 5 until it reaches its maximum thickness as it emerges from the pool. Thereafter, the strand is cooled additionally as it moves along the continuation 7 of the chilled surface 5. If desired, it may be cooled still further by sprays from nozzles.

However, I propose to control the total quantity of heat withdrawn from the strand 8 through the surfaces 5 and 7 and by the sprays from nozzles 13 before it reaches the withdrawal rolls 9 so that as it leaves the withdrawal rolls 9 it will still contain sufficient residual heat to permit it to be reduced in thickness or otherwise reshaped without reheating. Thus as the strand 8 leaves the withdrawal rolls, it may be moved directly between pairs of rolls 14 and 15 which reduce the thickness of the strand. For example, if the apparatus shown in the drawings is used to form a strand such as a steel slab having a thickness of 25 to 38 mm (one inch to one and one-half inches) as it leaves the pool, the thickness of the strand could be reduced by rolls 14 and 15 to provide hot rolled sheet steel having a thickness of 6,4 mm (one quarter inch) or less. For this purpose, the forming rolls 14, 15 and the withdrawal rolls 9 may be mounted together as a unit in a supporting structure (not shown) forming part of the supporting structure for the mold.

Claims

1. A process for the continuous casting of thin steel slabs of uniform transverse thickness which comprises exposing a pool of molten metal to a chilled surface which is flat transversely and curved longitudinally and extends between heat resistant surfaces which project upwardly along its side edges, withdrawing heat from the molten metal through said chilled surface to form an embryo flat cast slab thereon, and withdrawing the embryo cast slab continuously along said chilled surface, characterized by exposing the pool of molten metal to a fixed chilled surface (4, 5, 7) which is flat transversely and curved longitudinally to form a convex arc and which has a first portion (5) submerged within the pool and a second portion (7) extending above and beyond the surface of said pool as a continuation of said first portion, said second portion having a length greater than said first portion, withdrawing heat from the molten metal in one direction only through said first portion (5) of said chilled surface while restricting heat transfer from the molten metal along the side edges of said chilled surface to form an embryo flat cast slab (6) thereon which is of uniform thickness across its width, and withdrawing the embryo cast slab (6) continuously along said chilled surface (5, 7) while restricting heat trasnfer from the embryo flat cast slab along the side edges of said slab, at a rate to permit withdrawal of heat through said chilled surface sufficient to cause a flat slab (8) of the desired thickness to be formed thereon.

2. The process claimed in claim 1 in which the submerged portion (5) of said chilled surface

extends substantially perpendicularly to the horizontal surface of the pool and the cast slab (6) moves substantially vertically as it is withdrawn.

3. The process claimed in one of claims 1 or 2 in which the thickness of the slab (8) is determined by controlling the rate of withdrawal of the slab.

4. The process claimed in at least one of claims 1 to 3 in which the thickness of the slab (8) is determined by controlling the depth of molten metal in the pool.

5. The process claimed in at least one of claims 1 to 4 in which the total quantity of heat withdrawn from the slab (8) is controlled to cause the slab (8) to retain sufficient heat to permit it to be reshaped without reheating after it leaves said surfaces (5, 7).

6. Apparatus for the continuous casting of metal slabs of uniform transverse thickness comprising a reservoir (1) containing a pool of molten metal, a mold having a mold wall (4) having a transversely flat chilled surface which is curved longitudinally, and heat resistant means (26) extending along the side edges of said chilled surface and projecting upwardly above said reservoir, and means (9) for withdrawing the embryo cast slab continuously along said chilled surface, characterized by the chilled surface being a fixed transversely flat chilled surface (5, 7) which is curved longitudinally to form a convex arc, and said chilled surface having a first portion (5) in said reservoir (1) through which heat is withdrawn from the molten metal in one direction only to form an embryo cast slab (6) thereon, the heat resistant means (26) extending along the side edges of said chilled surface being resistant to heat transfer to restrict heat transfer from said embryo cast slab (6) except through said chilled surface (5), said chilled surface having a second portion (7) forming a continuation of said first portion (5) extending above and beyond said reservoir (1) for a length greater than the length of said first portion, and the means for withdrawing the embryo cast slab continuously along said chilled surface including a set of withdrawing rollers (9).

7. Apparatus as claimed in claim 6 in which the lower end of said chilled surface (5) extends substantially vertically.

8. Apparatus as claimed in one of claims 6 or 7, wherein said set of withdrawing rollers (9) is in generally horizontal alignment with the upper end of said chilled surface (7), and further including a set of reshaping rollers (14, 15) in generally horizontal alignment with said set of withdrawing rollers (9) for reshaping said cast slab (8) by passing said slab through said reshaping rollers after said slab leaves said withdrawing rollers and while said slab still retains sufficient residual heat to permit reshaping without reheating.

9. Apparatus as claimed in at least one of claims 6 to 8 and further including starter bar apparatus (11, 12) for insertion into said reservoir (1) along said chilled mold surface (5, 7) for withdrawing an embryo bar (6) formed on said chilled surface from molten metal in the pool upwardly from said pool along said chilled mold surface and transferring said embryo bar to said set of withdrawing rollers (9).

Patentansprüche

1. Verfahren zum kontinuierlichen Gießen dünner Stahlbrammen mit gleichmäßiger Dicke in Querrichtung, wobei ein Bad von geschmolzenem Metall einer gekühlten Fläche ausgesetzt wird, die in Querrichtung flach und in Längsrichtung gebogen ist und sich zwischen wärmebeständigen Flächen erstreckt, die längs ihrer Seitenkanten nach oben vorspringen, und wobei Wärme dem geschmolzenen Metall durch die gekühlte Fläche entzogen wird, um auf dieser eine embryonale flache Gußbramme zu bilden, und die embryonale Gußbramme kontinuierlich längs der gekühlten Fläche abgezogen wird, dadurch gekennzeichnet, daß das Bad des geschmolzenen Metalls einer feststehenden gekühlten Fläche (4, 5, 7) ausgesetzt wird, die in Querrichtung flach und in Längsrichtung unter Bildung eines konvexen Bogens gebogen ist und die einen ersten Abschnitt (5), der im Bad untergetaucht ist, und einen zweiten Abschnitt (7) aufweist, der sich über und jenseits der Oberfläche des Bades als Fortsetzung des ersten Abschnittes erstreckt und eine größere Länge als der erste Abschnitt hat, Wärme dem geschmolzenen Metall nur in einer Richtung durch den ersten Abschnitt (5) der gekühlten Fläche entzogen wird, während der Wärmeübergang vom geschmolzenen Metall längs der Seitenkanten der gekühlten Fläche begrenzt wird, um auf dieser eine embryonale flache Gußbramme (6) mit gleichmäßiger Dicke über ihre Breite zu bilden, und die embryonale Gußbramme (6) kontinuierlich längs der gekühlten Fläche (5, 7) unter Begrenzung des Wärmeübergangs von der embryonalen flachen Gußbramme längs deren Seitenkanten mit einer solchen Geschwindigkeit abgezogen wird, daß genügend Wärme durch die gekühlte Fläche entzogen werden kann, um auf dieser die Bildung einer flachen Bramme (8) der gewünschten Dicke zu bewirken.

2. Verfahren nach Anspruch 1, wobei sich der untergetauchte Abschnitt (5) der gekühlten Fläche im wesentlichen im rechten Winkel zur horizontalen Oberfläche des Bades erstreckt und die Gußbramme (6) sich im wesentlichen vertikal bewegt, während sie abgezogen wird.

3. Verfahren nach einem der Ansprüche 1 oder 2, wobei die Dicke der Bramme (8) durch Regelung der Geschwindigkeit des Abziehens der Bramme bestimmt wird.

4. Verfahren nach wenigstens einem der Ansprüche 1 bis 3, wobei die Dicke der Bramme (8) durch Regelung der Tiefe des geschmolzenen Metalls im Bad bestimmt wird.

5. Verfahren nach wenigstens einem der Ansprüche 1 bis 4, wobei die Gesamtmenge der der Bramme (8) entzogenen Wärme so geregelt wird, daß die Bramme (8) genügend warm bleibt, so daß sie, nachdem sie die Flächen (5, 7) verläßt, ohne erneutes Erhitzen umgeformt werden kann.

6. Vorrichtung zum kontinuierlichen Gießen von

Metallbrammen mit gleichmäßiger Dicke in Querrichtung mit einem Behälter (1), der ein Bad von geschmolzenem Metall enthält, einer Form mit einer Formwand (4), die eine in Querrichtung flache gekühlte Fläche hat, die in Längsrichtung gebogen ist, und mit wärmebeständigen Einrichtungen (26), die sich längs der Seitenkanten der gekühlten Fläche erstrecken und nach oben über den Behälter vorspringen, und mit Vorrichtungen (9) zum kontinuierlichen Abziehen der embryonalen Gußbramme längs der gekühlten Fläche, dadurch gekennzeichnet, daß die gekühlte Fläche eine feststehenden in Querrichtung flache gekühlte Fläche (5, 7) ist, die in Längsrichtung unter Bldung eines konvexen Bogens gebogen ist und in dem Behälter (1) einen ersten Abschnitt hat, durch welchen Wärme dem geschmolzenen Metall in nur einer Richtung entzogen wird, um auf diesem eine embryonale Gußbramme (6) zu bilden, daß die sich längs der Seitenkanten der gekühlten Fläche erstreckenden wärmebeständigen Einrichtungen (26) wärmedämmend sind, um den Wärmeübergang von der embryonalen Gußbramme (6) außer durch die gekühlte Fläche (5) zu begrenzen, daß die gekühlte Fläche einen zweiten Abschnitt (7) hat, der eine Fortsetzung des ersten Abschnittes (5) bildet und sich oberhalb und jenseits des Behälters über eine größere Länge als die Länge des ersten Abschnittes erstreckt, und daß die Vorrichtungen zum kontinuierlichen Abziehen der embryonalen Gußbramme längs der gekühlten Fläche einen Satz von Abzugswalzen (9) aufweisen.

7. Vorrichtung nach Anspruch 6, worin sich das untere Ende der gekühlten Fläche (5) im wesentlichen vertikal erstreckt.

8. Vorrichtung nach einem der Ansprüche 6 oder 7, worin der Satz von Abzugswalzen (9) im ganzen horizontal fluchtend mit dem oberen Ende der gekühlten Fläche (7) ist und weiter ein Satz von Umformwalzen (14, 15) in im ganzen horizontaler Flucht mit dem Satz von Abzugswalzen (9) vorgesehen ist, um die Gußbramme (8) umzuformen, indem sie nach dem Verlassen der Abzugswalzen und während sie noch genügend Restwärme enthält, um ein Umformen ohne Wiedererhitzen zu gestatten, durch die Umformwalzen geführt wird.

9. Vorrichtung nach wenigstens einem der Ansprüche 6 bis 8, die außerdem eine Starterstangenvorrichtung (11, 12) zum Einführen in den Behälter (1) längs der gekühlten Formfläche (5, 7) aufweist, um eine auf der gekühlten Fläche aus geschmolzenem Metall im Bad gebildete embryonale Bramme (6) aus dem Bad längs der gekühlten Formfläche nach oben abzuziehen und die embryonale Bramme zum Abzugswalzensatz (9) zu überführen.

Revendications

1. Procédé de coulée continue de brames d'acier minces d'épaisseur transversale uniforme qui comporte l'exposition d'un bain de métal fondu à une surface refroidie qui est plate transversalement et incurvée longitudinalement et s'étend entre des surfaces réfractaires faisant saillie vers le haut le long de ses bords latéraux, l'extraction de chaleur du métal fondu par l'intermédiaire de ladite surface refroidie en vue de former une brame coulée (4) embryonnaire sur celle-ci, et le retrait de la brame coulée embryonnaire continuement le long de ladite surface refroidie, caractérisé par l'exposition du bain de métal fondu à une surface refroidie fixe (4, 5, 7) qui est plate transversalement et incurvée longitudinalement pour former un axe convexe et qui possède une première partie (5) immergée dans le bain et une seconde partie (7) s'étendant au-dessus et au delà de la surface dudit bain en tant que prolongement de ladite première partie, ladite seconde partie possédant une longueur supérieure à ladite première partie, l'extraction de chaleur du métal fondu dans une direction seulement à travers ladite première partie (5) de ladite surface refroidie tout en limitant le transfert de chaleur du métal fondu le long des bords latéraux de ladite surface refroidie en vue de former une brame coulée plate embryonnaire (6) sur celle-ci qui soit d'épaisseur uniforme d'un bord à l'autre de sa largeur, et le retrait de la brame coulée embryonnaire (6) continuement le long de ladite surface refroidie (5, 7) tout en limitant un transfert de chaleur depuis la brame coulée plate embryonnaire le long des bords latéraux de ladite brame, à une vitesse permettant une extraction de chaleur par l'intermédiaire de ladite surface refroidie suffisante pour provoquer sur celle-ci la formation d'une brame plate (8) d'épaisseur désirée.

2. Procédé selon la revendication 1 dans lequel la partie immergée (5) de ladite partie refroidie s'étend sensiblement perpendiculairement à la surface horizontale du bain et la brame coulée (6) se déplace sensiblement verticalement lorsqu'elle est extraite.

3. Procédé selon une des revendications 1 ou 2 dans lequel l'épaisseur de la brame (8) est déterminée en contrôlant la vitesse d'extraction de la brame.

4. Procédé selon au moins une des revendications 1 à 3 dans lequel l'épaisseur de la brame (8) est déterminée en contrôlant l'épaisseur de métal fondu dans la flaque.

5. Procédé selon au moins une des revendications 1 à 4 dans lequel la quantité totale de chaleur extraite de la brame (8) est contrôlée pour amener la brame (8) à retenir suffisamment de chaleur pour lui permettre d'être refaçonnée sans réchauffage après qu'elle ait quitté lesdites surfaces (5, 7).

6. Appareil de coulée en continu de brames de métal d'épaisseur transversale uniforme comportant un réservoir (1) contenant un bain de métal fondu, un moule possédant une paroi de moule (4) ayant une surface refroidie transversalement plate qui est incurvée longitudinalement, et des moyens réfractaires (26) s'étendant le long des bords latéraux de ladite surface refroidie et faisant saillie vers le haut au-dessus dudit réservoir, et des moyens (9) en vue d'extraire la brame

coulée embryonnaire continuement le long de ladite surface refroidie, caractérisé en ce que la surface refroidie est une surface refroidie plate transversalement fixe (5, 7) qui est incurvée longitudinalement pour former un arc convexe, et ladite surface refroidie possédant une première partie (5) dans ledit réservoir (1) par l'intermédiaire de laquelle de la chaleur est extraite du métal fondu dans une direction seulement pour former sur celle-ci une brame coulée embryonnaire (6), les moyens réfractaires (26) s'étendant le long des bords latéraux de ladite surface refroidie résistant à un transfert de chaleur pour limiter un transfert de chaleur depuis ladite brame coulée embryonnaire (6) sauf par l'intermédiaire de ladite surface refroidie (5), ladite surface refroidie possédant une seconde partie (7) constituant un prolongement de ladite première partie (5) s'étendant au-dessus et au delà dudit réservoir (1) sur une longueur supérieure à la longueur de ladite première partie, et les moyens de retrait de la brame coulée embryonnaire continuement le long de ladite surface refroidie comprenant un jeu de rouleaux d'extraction (9).

7. Appareil selon la revendication 6 dans lequel l'extrémité inférieure de ladite surface refroidie (5) s'étend sensiblement verticalement.

8. Appareil selon l'une des revendications 6 ou 7, dans lequel ledit jeu de rouleaux d'extraction (9) est en alignement généralement horizontal avec l'extrémité supérieure de ladite surface refroidie (7), et comprenant en outre un jeu de rouleaux de refaçonnage (14, 15) en alignement généralement horizontal avec ledit jeu de rouleaux d'extraction (9) en vue de refaçonner ladite brame coulée (8) en faisant passer ladite brame à travers lesdits rouleaux de refaçonnage après que ladite brame ait quitté lesdits rouleaux d'extraction et tandis que ladite brame conserve encore suffisamment de chaleur résiduelle pour permettre un refaçonnage sans réchauffage.

9. Appareil selon au moins une des revendications 6 à 8 et comprenant en outre un appareil de barre de départ (11, 12) en vue d'une introduction dans ledit réservoir (1) le long de ladite surface de moule refroidie (5, 7) pour extraire une barre embryonnaire (6) formée sur ladite surface refroidie à partir du métal fondu dans le bain vers le haut à partir dudit bain le long de ladite surface de moule refroidie et en vue de transférer ladite barre embryonnaire audit jeu de rouleaux d'extraction (9).

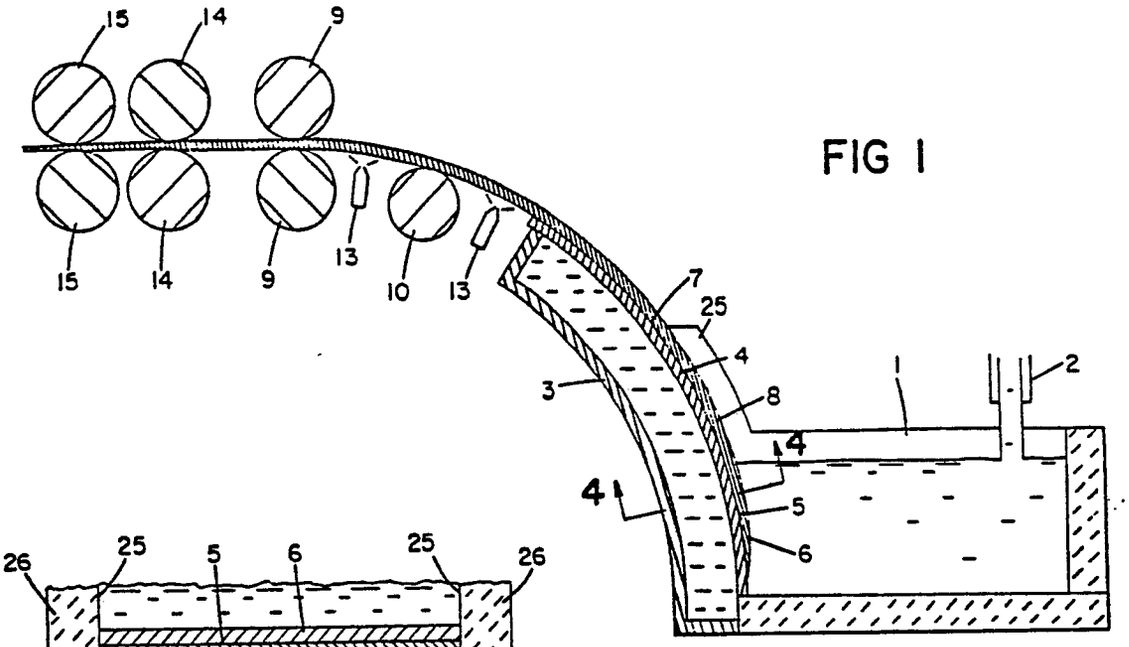


FIG 1

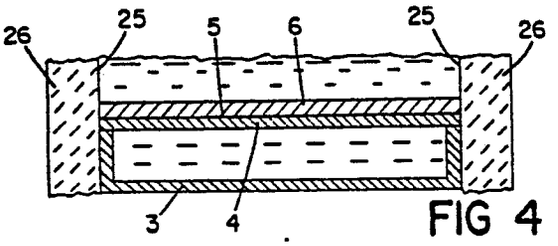


FIG 4

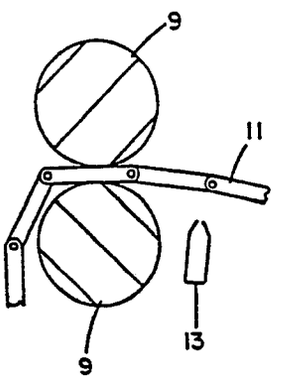


FIG 3

FIG 2

