Aug. 30, 1960 R. A. WILKINS 2,950,512

CASTING APPARATUS AND METHOD

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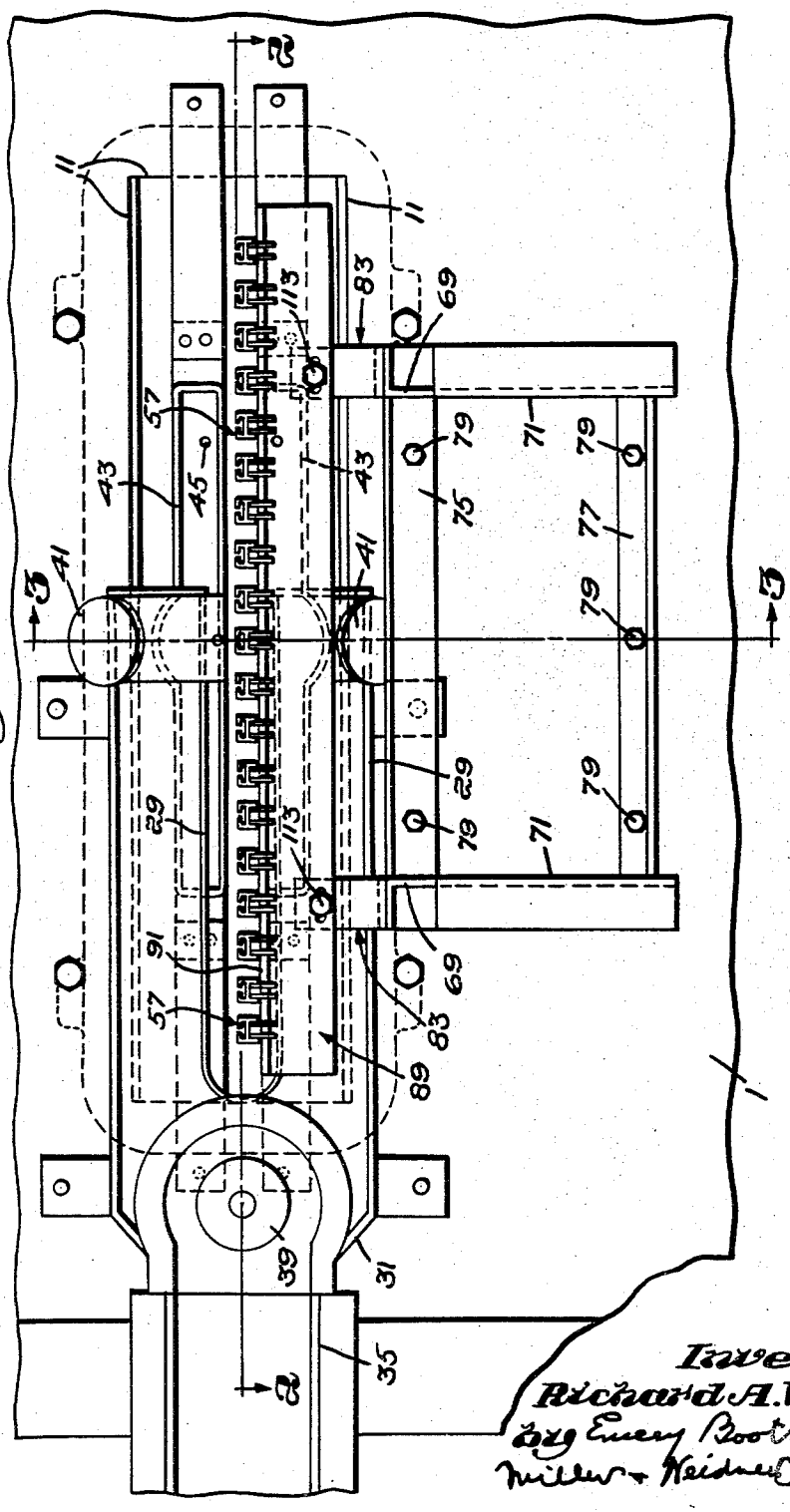


Fig. 1.

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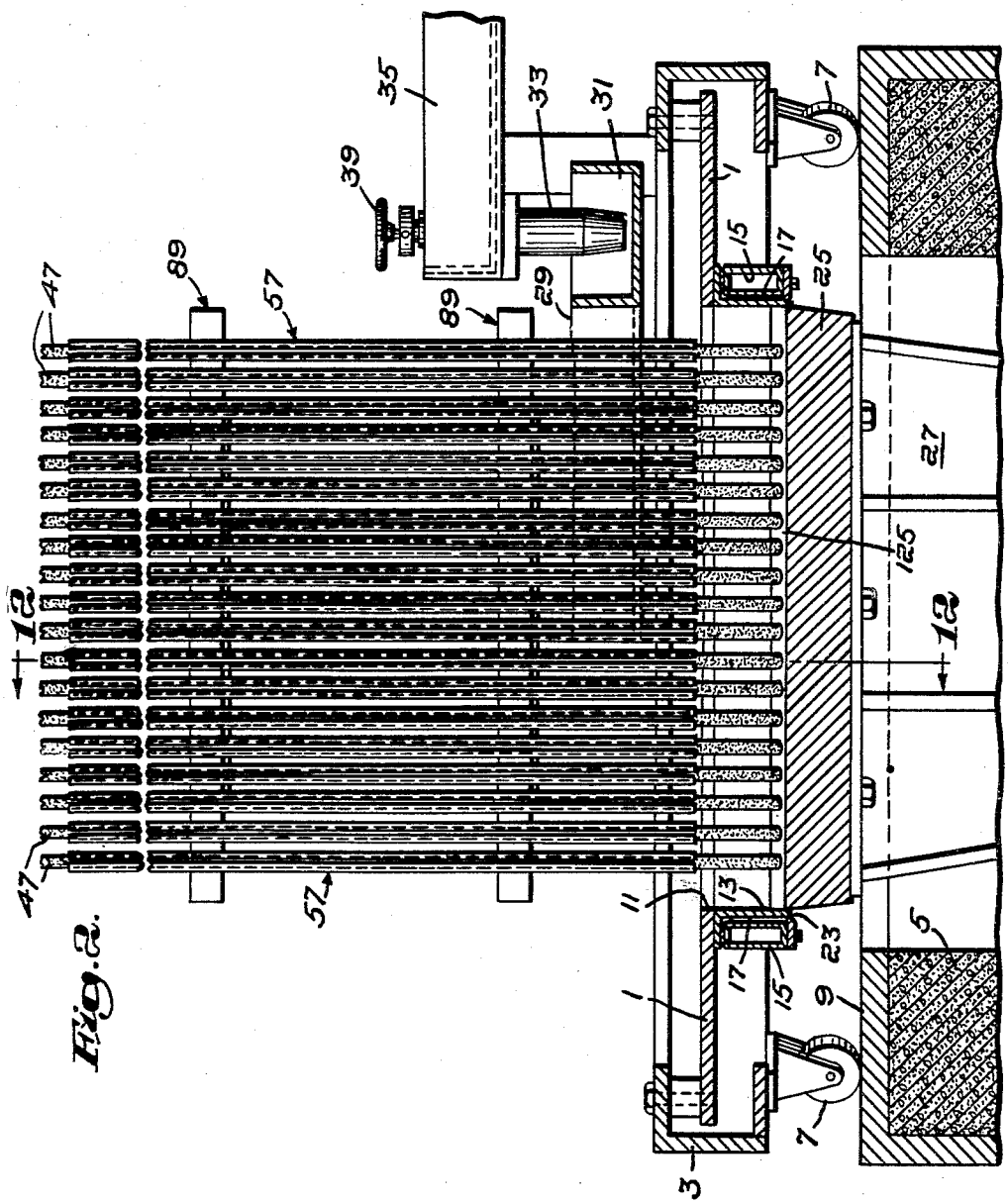


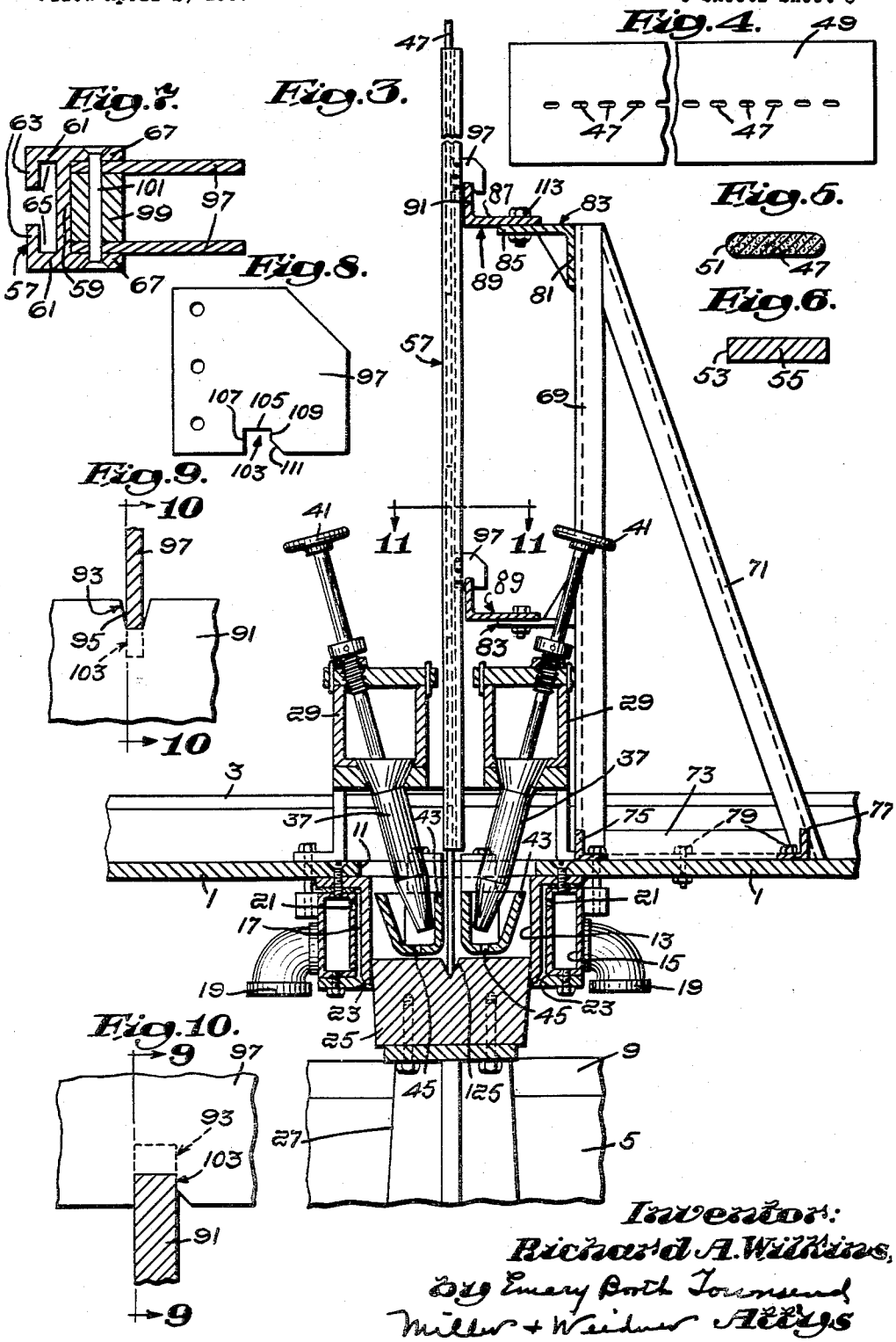
Fig. 2.

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Fig. 11.

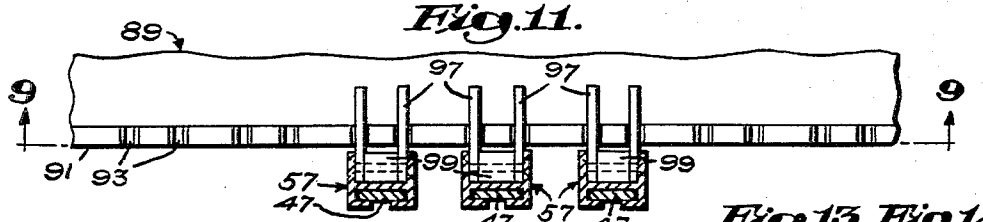


Fig. 12.

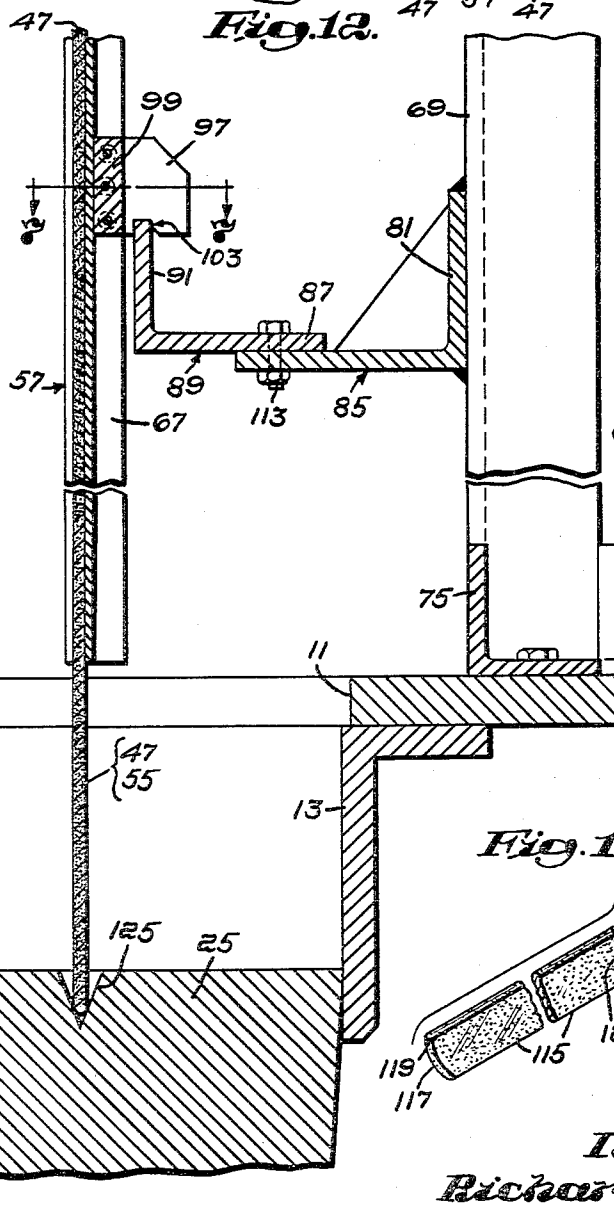


Fig. 13. Fig. 14.

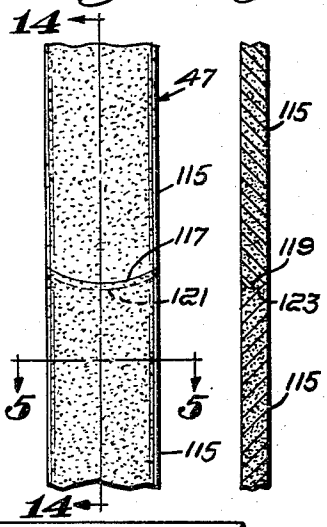
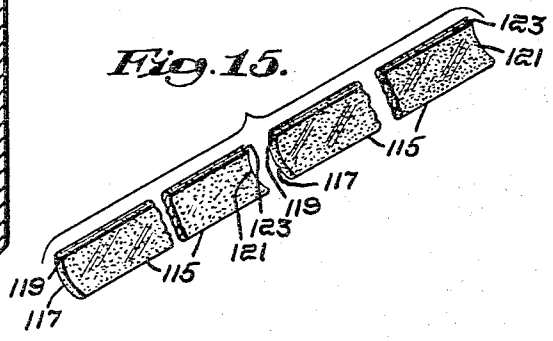


Fig. 15.



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Fig. 16. Fig. 17. Fig. 18. Fig. 19.

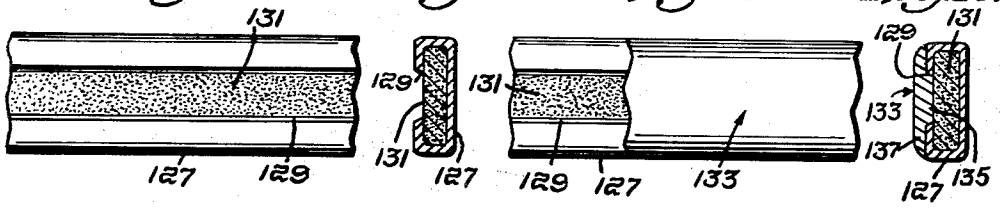


Fig. 20.

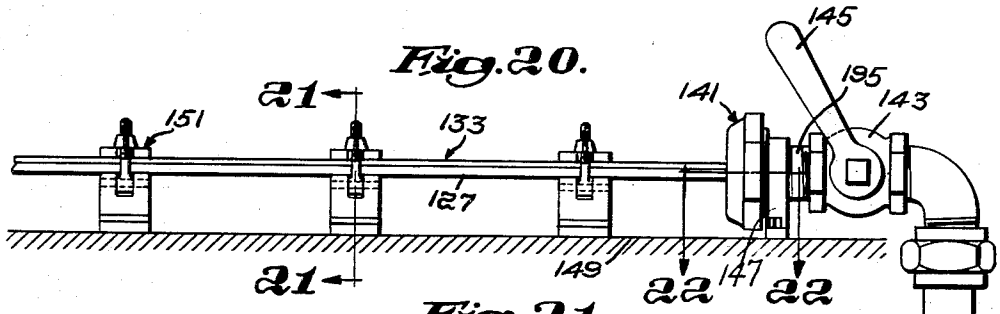
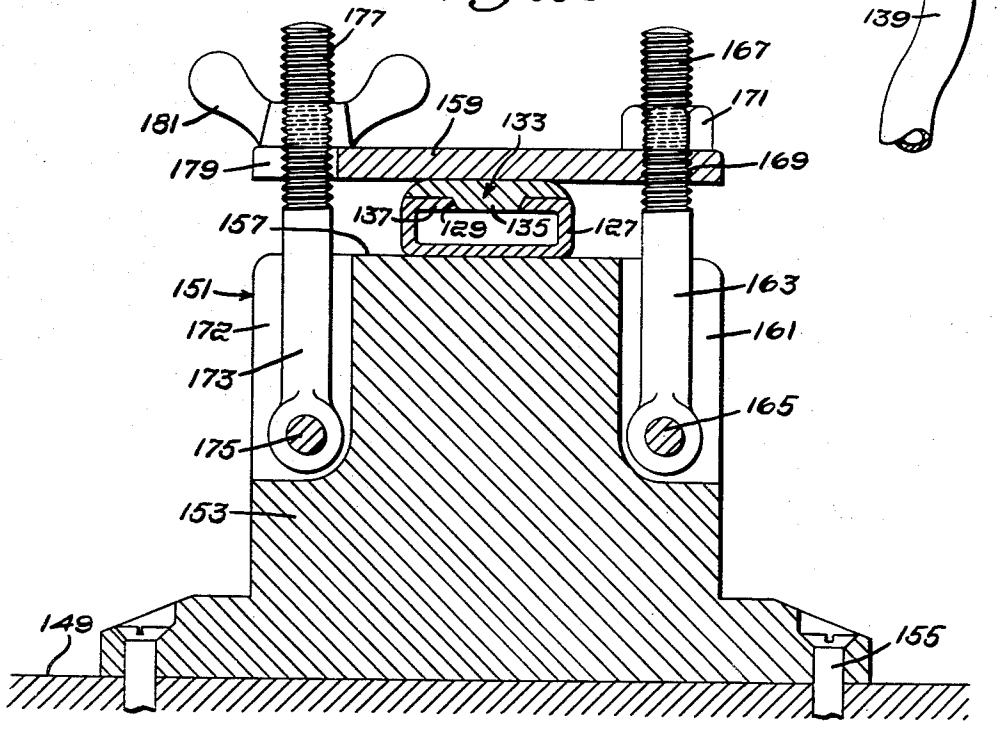


Fig. 21.



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Fig. 22.

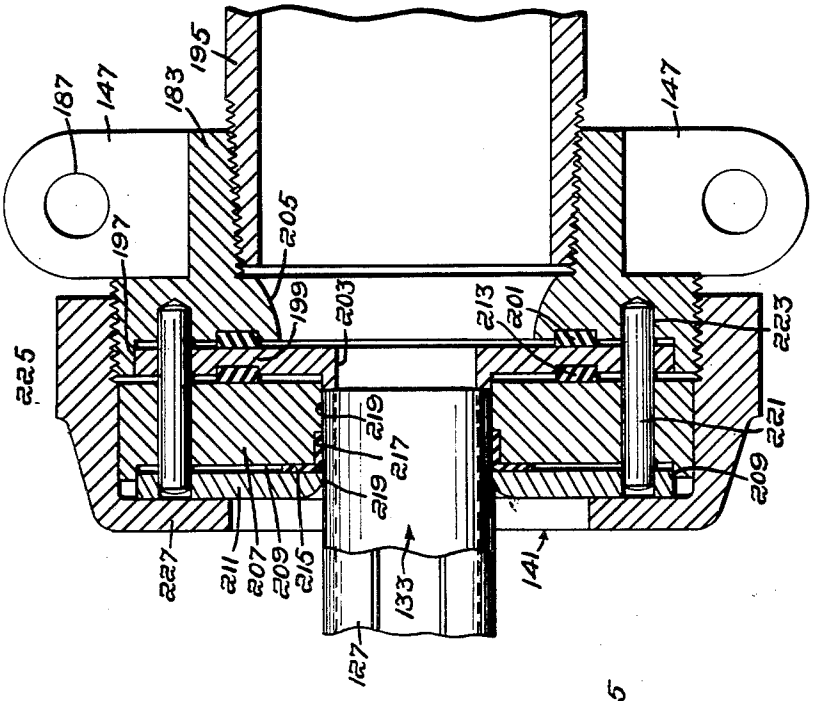
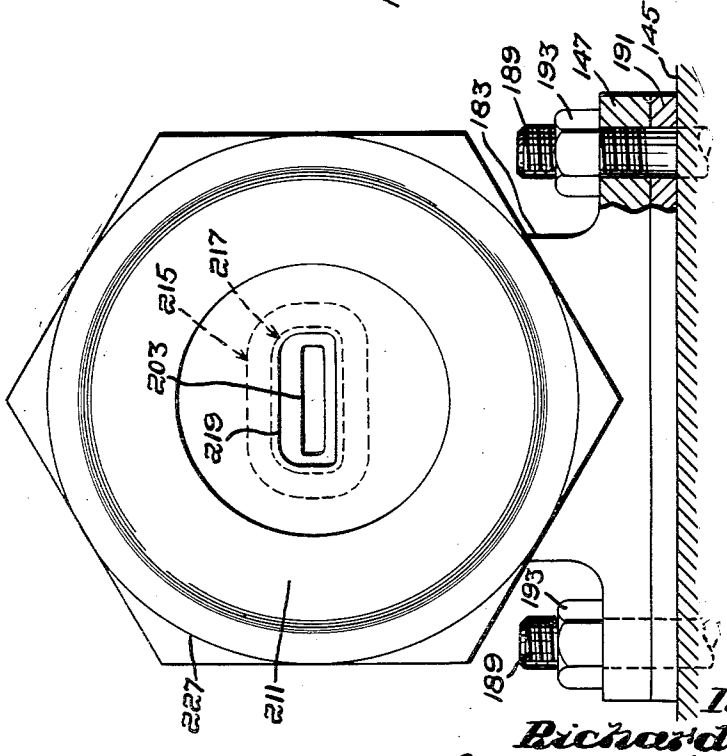


Fig. 23.



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United States Patent Office 2,950,512 Patented Aug. 30, 1960

2,950,512

CASTING APPARATUS AND METHOD

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Filed Apr. 2, 1957, Ser. No. 650,133

11 Claims. (Cl. 22—57.2)

My invention relates to continuous casting apparatus for forming metal billets, more particularly but not exclusively aluminum billets, of the kinds disclosed by my co-pending application Serial Number 518,768, filed June 29, 1955, and Serial Number 570,372, filed March 8, 1956.

These billets, as disclosed by said applications, contain longitudinally extending pulverizable members which will crush to weld preventing powder when the billet is rolled for producing relatively thin strip having between its faces slits capable of being expanded to form passages.

The invention has among its objects an improved means for supporting and guiding the elongated pulverizable members so that they will be properly positioned to have the metal cast about them in forming the billet by use of continuous casting apparatus.

The invention however will be best understood from the following description when read in the light of the accompanying drawings, while the scope of the invention will be more particularly pointed out in the appended claims.

In the drawings:

Fig. 1 is a plan of a fragment of continuous casting apparatus according to the invention;

Fig. 2 is a section on the line 2—2 of Fig. 1;

Fig. 3 is a section on the line 3—3 of Fig. 1 on an enlarged scale, with parts omitted and parts in elevation;

Fig. 4 is a transverse section through one form of billet that may be produced by the apparatus;

Fig. 5 is a section on the line 5—5 of Fig. 13;

Fig. 6 is a transverse section, corresponding to Fig. 5, of another form of elongated pulverizable member about which the metal of the billet may be cast;

Fig. 7 is a section of one of the guide members on the line 7—7 of Fig. 12, on an enlarged scale;

Fig. 8 illustrates a detail;

Fig. 9 is a fragmentary view of a section on the line 9—9 of Fig. 11 on an enlarged scale, the section line 9—9 for clearness of illustration also being applied to Fig. 10;

Fig. 10 is a section on the line 10—10 of Fig. 9;

Fig. 11 is a section on the line 11—11 of Fig. 3 on an enlarged scale, with parts omitted and parts broken away;

Fig. 12 is a section on the line 12—12 of Fig. 2 on an enlarged scale, with parts omitted and parts broken away;

Fig. 13 is a side view of a fragment of a sectional elongated pulverizable member according to the invention having the transverse cross-section according to Fig. 5;

Fig. 14 is a section on the line 14—14 of Fig. 13;

Fig. 15 is a perspective view of the sectional elongated pulverizable member, according to Figs. 13 and 14, in exploded position and with parts broken away;

Fig. 16 is a plan, and Fig. 17 an end view, of a modified form of elongated pulverizable member enclosed in a meltable metallic casing;

Fig. 18 is a plan with parts broken away, and Fig. 19 an end view, of the encased elongated member according to Figs. 16 and 17 assembled with a cover which is placed on the casing preparatory to filling the casing with the material forming the elongated pulverizable member;

Fig. 20 is a more or less diagrammatic view illustrating a form of apparatus for injecting the material forming the elongated pulverizable member into the tubular part of the assembly according to Figs. 18 and 19;

Fig. 21 is a section on the line 21—21 of Fig. 20 on an enlarged scale;

Fig. 22 is a section on the line 22—22 of Fig. 20 with parts in elevation; and

Fig. 23 is an end view of the nozzle according to Fig. 22.

The casting apparatus illustrated, in respect to its construction and operation making it of the continuous casting type, does not form part of the present invention, and therefore will not be described herein with any more particularity than necessary to explain the present invention.

Referring to the drawings, the continuous casting apparatus, as best shown by Fig. 2, comprises a platform, in the form of a horizontal plate 1, rigidly carried by a frame 3 positioned above the pit 5 for receiving the billet as it is being progressively cast and descends. The frame is mounted on rollers 7 resting on a support 9 at the upper open end of the pit so that the frame with the platform or plate 1 and the parts carried by the latter may be moved horizontally from above the pit by swinging the frame about a vertical pivot (not shown) carried by the support 9.

As shown, the plate 1 is formed with a rectangular opening 11. Secured to the under side of the plate is a chilled ring comprising the rectangular downwardly extending wear sleeve 13, the sleeve being in registry with said opening 11 in the plate. Also carried by the plate at its under side and surrounding the sleeve is an annular rectangular water jacket 15, the inner surface of the opening of the water jacket being slightly spaced from the outer surface of the sleeve as indicated at 17 (Fig. 3). Water is supplied to the water jacket through a plurality of elbows 19, which latter are connected to water supply hoses (not shown), such hoses being flexible to permit the above described horizontal movement of the frame 3 and plate 1. The inner wall of the water jacket adjacent its top is provided with openings 21 which discharge water from the jacket into the space 17, the water discharging from the bottom of said space through an opening 23 of narrow width extending entirely about the lower end of the sleeve, such discharging water forming a spray directed against the sides and edges of the billet as the latter moves downwardly out of the sleeve so as to aid in cooling the billet.

Cooperating with the chilled ring above described is a platen 25 carried by a pedestal 27 on the upper end of a piston rod (not shown) of a hydraulic ram positioned in the pit 5. When the piston rod is at the upper end of its stroke the platen projects slightly into the lower portion of the sleeve 13 as shown in the drawings. When molten metal is poured into the chilled ring for solidifying the metal the piston rod is caused in a known manner slowly to descend so that the platen will move downwardly into the pit and cause the billet, the lower end of which rests on the platen, to be progressively cast.

As shown, for pouring the metal into the chilled ring is provided a pair of spaced horizontal elongated runner boxes 29 removably carried by the plate 1 above the chilled ring. These runner boxes at one end are connected by a transverse portion 31, into which portion the molten metal is poured through a nozzle 33 from a removable trough 35 and to which trough molten metal is supplied from a melting furnace (not shown). The runner boxes extend to adjacent the vertical axis of the chilled

ring where they are provided with nozzles 37 for discharging molten metal from the boxes into the ring. As shown, the nozzles 33 and 37 are provided with valves, the handles of which are shown at 39 and 41 respectively, for regulating the rate of flow through the nozzles of the molten metal and hence the rate of flow of the molten metal into the chilled ring. If desired, associated with each nozzle 37 may be a skimming pan 43 positioned within the chilled ring and removably carried by the plate 1. Each skimming pan at its bottom is provided with holes 45 for permitting discharge of molten metal from the pan into the ring, the dross collecting in the upper portion of the pan above the molten metal therein.

According to the present invention, simultaneously with the descent of the platen 25 and the progressive casting of the billet is fed into the chilled ring a row of the elongated pulverizable members 47 so as to cast a billet 49 having the transverse cross-section shown in Fig. 4. These elongated members, as shown, are of rectangular cross-section, and may be of various materials, for example soapstone and the other materials described in my co-pending application Serial Number 518,768, or the pressed-board consisting of vitreous fibers and loading material described in my co-pending application Serial Number 570,372. When of soapstone or other relatively brittle material the opposite edges of the rectangular members may be rounded, as shown at 51 (Fig. 5), to insure against chipping at the corners of such members. The members made of pressed-board may be sawed or otherwise cut from sheets of such material, and such material being tough the edges of the members may have square corners as indicated by the edges 53 of the members 55 (Fig. 6). The members when of quarried soapstone may be formed of sections of relatively short length say 10 or 12 inches, as soapstone in longer length is difficult and expensive to obtain. When the members are of pressed-board they ordinarily can be in continuous lengths say as long as the billet to be cast, which in some instances may be 15 feet.

For supporting the elongated members, and guiding them downwardly into the chilled ring by gravity, is provided a row of vertically positioned horizontally spaced guides 57, these guides extending through the space between the two runner boxes 29 to adjacent the top of the chilled ring. These guides, which may be formed of extruded aluminum or brass, are substantially tubular and are of such dimensions that the elongated members received therein fit their interiors with no more clearance than necessary to permit the members to descend through them without binding.

As best shown in Fig. 7, each guide 57 comprises a longitudinally extending base portion 59 having integrally formed therewith at each of its opposite edges a projecting web 61 extending longitudinally thereof, the outer edges of these webs being formed with longitudinally extending flanges 63 extending toward each other in parallel relation to the base portion for part of the width of the latter so as to form between the free edges of said flanges a space for viewing the elongated pulverizable member contained in said space. By this construction is provided a substantially tubular guide having an interior rectangular space 65 for receiving the elongated pulverizable member 47 or 55 as indicated by the member 47 in Fig. 11. As further shown, each guide is provided, as best illustrated in Fig. 7, with a rearwardly extending flange 67 in alignment with the web 61 at each of opposite edges of the base portion 59 of the guide.

For supporting the row of guides the plate 1 at one longer side of the opening 11 therein carries an upwardly extending bracket comprising a pair of vertically spaced posts constituted by angle-irons 69. Each of these posts is braced by a downwardly inclined angle-iron 71 welded at its upper end portion to the upper end portion of the post and, at its lower end portion, to the right hand end (as viewed in Fig. 3) of a horizontally extending angle-iron 73, this latter angle-iron at its left hand end being welded to the lower end of the post. Connecting the lower ends of the posts is a horizontal angle-iron 75 welded at opposite ends to said posts, while connecting the lower ends of the two inclined angle-irons 71 and the adjacent portions of the angle-irons 73 is a horizontal angle-iron 77 welded at opposite ends to said angle-irons 71 and 73. The lowermost flanges of the angle-irons 73, 75 and 77 rest on the upper side of the plate 1 and are secured thereto by bolts 79.

Welded to each post 69 adjacent its upper end and at a point intermediate the height of the post are the vertical webs 81 of angle-brackets 83 having horizontal webs 85 projecting laterally of the post toward the guides. Resting on the horizontal web 85 of each angle-bracket is the horizontal flange 87 of an elongated angle-iron 89 having the upwardly projecting flange 91. As best illustrated in Figs. 9 and 11, the upper edge of each angle-iron 89 is formed with spaced pairs of spaced notches 93 having the upwardly diverging side walls 95.

At spaced points along its length each guide is shown as provided with a laterally projecting portion each constituted by a pair of flat plates 97. These plates, as best illustrated in Fig. 7, lie against the inner sides of the rearwardly projecting flanges 67 of the guide and are held against said sides by a spacer 99, the plates and spacer being secured to the flanges 67 by rivets 101 extending through aligned perforations in the flanges, plates and spacer.

As best illustrated in Fig. 8, the lower edge of each plate 97 projecting laterally from the guides 57 is provided with a downwardly opening notch 103 having the upper wall 105 and the opposite side walls 107 and 109, the outer corner of the side wall 109 being cut away adjacent the opening of the notch to form a short inclined surface 111. The guides are removably supported on the angle-irons 89 by mutual engagement of the above described notched portions of the plates 97 and the notched portions of the vertical flanges 91 of those angle-irons 89, as best illustrated in Figs. 3, 9 and 10. The downwardly converging side walls of the notches 93 in the angle-irons and the inclined surfaces 111 at one side of the notches in the plates facilitate ready engagement of the notched portions of one with those of the other.

It will be observed that by the above described construction the vertically positioned guides 57 are readily removably rigidly detachably secured to their support in horizontally spaced relation.

The angle-irons 89 are detachably secured to the angle-brackets 83 by bolts 113, thus enabling angle-irons 89 having differently spaced pairs of notches 93 to be substituted for each other so as to secure different desired horizontal spacings of the guides 57. Similarly guides 57 adapted to carry elongated pulverizable members of different desired transverse cross-sectional dimensions may be readily substituted for each other.

As hereinbefore indicated, the guides 57 may be much shorter than the length of the billet being cast. When the elongated pulverizable members are in continuous lengths they may be much longer than the guides so as to project well above the upper ends of the guides at the start of the casting operation. When the elongated members are in the form of longitudinal endwise abutting sections and the guides are shorter than the billet being cast additional sections may be inserted in the guides through their upper ends as the platen 25 descends.

As illustrated in Figs. 13, 14 and 15, alignment of the endwise abutting sections 115 of the sectional pulverizable members may be facilitated by having one of their abutting end faces convexly curved both widthwise of the member, as indicated at 117, and thicknesswise of the member, as indicated at 119, and having the adjacent end face of the abutting section complementarily concavely curved both widthwise of the member, as indicated at 121,

and thicknesswise of the member, as indicated at 123, to form in said adjacent end face a cavity for receiving the convexly curved end face of the other section.

For facilitating holding the lower ends of the elongated pulverizable members in proper alignment with the guides preparatory to the initiation of the casting operation the upper surface of the platen 25 is preferably formed with a groove 125, of V-shaped transverse cross-section, for receiving the lower ends of said members, the lower ends of said members widthwise thereof binding against the inclined walls of the groove. As soon as the casting operation commences the molten metal which flows into the chilled ring solidifies in the groove and the portions immediately above it so as continuously to hold the portions of the elongated pulverizable members below the lower ends of the guides 57 in proper spaced relation as the billet is being progressively cast. This groove is particularly desirable when the elongated members are in the form of relatively short sections as it enables the lowermost sections to be properly held in vertical position at the start of the casting operation with only relatively short portions of the upper ends of such sections received by the guides.

In situations where it is difficult to obtain the elongated pulverizable members in massive form such as soapstone and graphite strips, and pressed-board from which strips may be cut, such members may be formed by filling the bores of elongated substantially tubular metallic parts with a paste formed essentially of the material of such members. The parts may be made of the material in preferably coarse powder form mixed with a suitable binder, which paste after the tubular part is filled with it may be baked for driving off its liquid content and hardening it. The metal of the tubular part is preferably the same as that of the billet to be formed. When the molten metal of the billet is being cast about the elongated pulverizable member encased by the tubular part the metal of such part will melt and mix with and form part of such molten metal leaving a space in the billet filled by said pulverizable member when the billet solidifies.

The tubular part above referred to may take the form of a flat tube 127 (Figs. 16 and 17) having a bore of substantially rectanglar cross-section and formed on one of its flat sides with a slot-like opening 129 extending for its full length. As shown, this tube is tightly filled throughout its length with a body 131 of hardened paste constituting the elongated pulverizable member. The slot-like opening 129 permits the escape of vaporized moisture or other liquid from the paste filling the bore when the tubular part is baked, and permits the escape of any gases which may be evolved from the hardened paste while the tubular part containing it is being heated and melted during the casting operation.

The paste for forming the elongated pulverizable member 131 may be entered into the tubular part 127 by the apparatus shown by Figs. 18 to 23. As best shown in Figs. 18 and 19, which indicate the tubular part filled with the paste, there is placed on the tubular part prior to filling it a flat strip-like metal cover 133 of the length of the part, having at one side a projection 135 which enters and fits the slot-like opening 129. At opposite sides of said projection the cover strip has flanges 137 which rest on the flat side of the tubular part at opposite sides of the opening 129. The purpose of this cover strip is to prevent escape of the paste through the opening when the paste is being forced under pressure into the bore of the tubular part.

The paste may be forced into the tubular part 127, while the cover strip 133 is in place, from a suitable source of the paste under pressure, from which source leads a flexible hose 139 (Fig. 20) to a nozzle 141 in which the end of the tubular part with its cover in place is removably inserted. A stop valve 143 having an operating handle 145 is shown as interposed in the connection between the hose and nozzle. When the tubular part is inserted in the nozzle, and the stop valve is opened by the operator, paste will be forced from the source of supply into the bore of said part to fill it, and when the operator observes such paste issuing from the free end of the part in a full stream he may close the valve to discontinue the supply to said bore, after which the tube with its cover may be withdrawn from the nozzle and the cover removed. The instrumentality for supplying the paste under pressure may be of the type commonly employed in motor vehicle service stations for supplying grease under pressure to grease nipples of bearings, said apparatus comprising a receptacle and power driven means for automatically maintaining grease in such receptacle under a predetermined pressure.

As shown in Fig. 20, the nozzle 141 has a support 147, which latter rests on the top of a bench, indicated at 149, and is fixedly secured to said bench. For holding the cover strip 133 in assembled relation with the tubular part 127 during the filling operation are provided a row of spaced clamps 151 distributed along the tubular part and also fixedly carried by the bench on the top of which the clamps rest. These clamps also serve to prevent the tubular part with its cover from being ejected from the nozzle while the paste is being supplied under pressure to said part.

As shown, each clamp 151 comprises a metal block 153 (Fig. 21) resting on the top of the bench and secured thereto by screws 155. The block has an upper flat side 157 on which the unslotted side of the tubular part 127 may be placed with the cover strip 133 in position. The tubular part and cover strip may then be clamped to the block by means of a clamping plate 159 resting on the upper side of the cover strip. As shown, the block at one side thereof is formed with a slot 161 which receives a bolt 163, the lower end of which bolt is hingedly secured to the block by a pin 165. The upper portion of the bolt is screw-threaded, as indicated at 167, and extends through a screw-threaded perforation 169 in the clamping plate 159 for securing said plate to the bolt. By this construction rotation of the plate about the bolt will adjustably position the plate relative to the block when the parts are in clamping position, so as to accommodate tubular parts 127 and cover strips 133 of varying thicknesses, a lock nut 171 being provided for holding the plate in such adjusted position. At its side opposite the bolt 163 the block 153 is formed with a further slot 172 for receiving a bolt 173 hingedly secured to the block at its lower end by a pin 175. The upper screw-threaded portion 177 of the bolt is adapted to be removably received by a slot 179 in the clamping plate 159 and at the upper side of the plate carries a wing nut 181 for clamping the plate against the cover strip 133.

The nozzle 141, as shown in Figs. 22 and 23, may comprise a body portion 183 provided with the support or feet 147 hereinbefore referred to, through perforations 187 of which feet pass stud bolts 189 (Fig. 23) projecting upward from the upper surface of the bench 149. Between the feet and bench top is positioned a shim plate or plates 191 for adjusting the height of the nozzle above the bench for aligning it with tubular parts 127 of various thicknesses when secured by the clamps 151, nuts 193 on the stud bolts being provided for securing the nozzle in place.

The body portion 183 of the nozzle 141 at its rearward side has a screw-threaded opening into which is screw-threaded a nipple 195 (Figs. 20 and 22) which connects the nozzle to the valve 143. At its forward side the body portion 183 is formed with a circular recess 197 in which is received a removable disc-like plate 199 which fits the peripheral wall of the recess, and between which plate and the bottom of the recess is positioned an annular packing gasket 201. This plate is formed with a central opening 203 of the same cross-sectional shape and size as the bore of the tubular part 127, this opening being connected by a passage 205 to that portion of the body 183 which receives the nipple 195. The tubular part

127 with its cover 133 is inserted in the nozzle and bears against the forward side of the plate 199 adjacent the opening 203 therein so that said plate acts as a stop limiting the amount of insertion of said part and cover into the nozzle. When the valve 143 is opened the paste is extruded through the opening 203 into the bore of the tubular part. Forwardly of the plate 199 is positioned a removable disc-like plate 207 which at its forward side is formed with a circular recess 209 removably receiving a further disc-like plate 211 which fits the circular peripheral wall of the recess. Between the plates 199 and 207 is positioned an annular packing gasket 213. Between the plate 207 and plate 211 is clamped the radially outwardly extending flange 215 of a "hat washer" 217 that fits the exterior surfaces of the assembled tubular part 127 and its cover 133 when inserted in the aligned openings 219 formed in the plates 207 and 211, which openings are of such size and shape that said assembled tubular part and cover fit them. For holding the openings of the three plates 199, 207 and 211 in alignment are provided pins 221 extending through and fitting perforations in those plates and into and fitting holes 223 formed in the forward side of the body 183. For clamping the parts to the body 183 is provided a coupling sleeve 225 screw-threaded on the body portion and having an annular flange 227 which bears against the outer side of the plate 211. It will be understood that plates 199, 207 and 211 having various sizes of openings to accommodate different sizes of tubular parts 127 and cover strips 133 may be substituted for those shown.

The elongated pulverizable members in their tubular casings according to Figs. 16 and 17 may be fed to the chilled ring of the continuous casting apparatus hereinbefore described in exactly the same way as are fed to the ring the elongated pulverizable members 47. Each tubular casing is progressively melted lengthwise thereof as it is fed downward through the pool of molten metal maintained in the chilled ring. As the fraction of the casing in this pool melts it leaves exposed to the molten metal of the pool the bare elongated pulverizable material that was encased by that fraction. As the pool of molten metal is relatively shallow the so exposed fraction of the elongated pulverizable member is of relatively short length, and as the portions of that member above and below its exposed fraction are enclosed by the tubular member and casting respectively assurance is had against rupture of said fraction.

The particular powdered material of the paste which forms the elongated member 131 (Figs. 16 and 17) is selected in accordance with its suitability for use with the particular metal being cast. Preferably talc, or graphite formed by coarsely powdering massive graphite, is selected where the metal of the billet permits its satisfactory use because of its lubricating characteristics facilitating its being spread along the slits formed by the rolling of the billet. Talc may ordinarily be satisfactorily employed in respect to securing best results only with metals having a relatively low pouring temperature such as zinc and aluminum, as with metals of higher pouring temperature, such as copper, talc loses its water of crystallization and becomes unduly hard. The residual graphite left in the slits of the rolled product when graphite is employed tends to corrode zinc, and to some extent aluminum, when the inflated passages of the product conduct many liquids, and therefore preferably is not employed with such metals. Further, graphite tends to react, with the cuprous oxide contained in copper which is not deoxidized, to form CO and CO_2, and thus causes to be formed blow holes in the cast billet and therefore, when graphite is employed with copper, deoxidized copper is preferably used. Graphite also preferably is not employed with ferrous metals such as carbon steel and stainless steel as it readily dissolves in them when in molten condition. Substances such as alumina, magnesia, China clay, fused quartz, and fused aluminum silicate, in powder form, are suitable for making the paste for use with almost all metals except that the quartz powder is preferably not employed with ferrous and nickeliferous metals of high iron and nickel content because at the high pouring temperatures of those metals it tends to unduly soften, and sometimes to dissolve in them when they are in molten condition.

As a suitable binder for making the paste there may be employed a suspension in water of colloidal silica. Also there may be employed Portland cement or powdered calcium aluminate. In all cases the mixture may contain sufficient water to make a thick paste somewhat of the consistency of ordinary tooth paste enabling it to be readily forced into the tubular part in the way above described. The amount of binder employed is not critical, and in any ordinary case may be from about 5 to 30% of the content of the paste neglecting its water or other liquid content.

It will be understood that when employing the unencased elongated pulverizable members, such as the members 47 hereinbefore described, such members necessarily must be of sufficient thickness to give them the requisite rigidity to permit them to be handled without liability of breakage. Such requisite thickness is commonly in excess of that necessary to produce the rolled product, and the excess must be squeezed from the billet by the reducing rolls during the initial portions of the rolling operation. When the pulverizable members are encased in a tubular part, as shown by Figs. 16 and 17, the thickness of the members need be no more than necessary to present sufficient weld preventing substance satisfactorily to form the rolled product and for the reason that the tubular casing imparts sufficient rigidity to permit the encased member to be safely handled.

It will be understood that within the scope of the appended claims wide deviations may be made from the forms of the invention herein described without departing from the spirit of the invention.

I claim:

1. In continuous casting apparatus of the type having an operatively circumferentially continuous and substantially rectangular chilled ring for receiving and solidifying molten metal discharged into it and a descendable means on which the end of the solidified metal rests to cause a billet of the metal and of cross-sectional shape and size corresponding to the interior shape and size of said ring to be progressively direct chill cast longitudinally thereof, the combination with said ring and descendable means of means for guiding a row of horizontally spaced vertically positioned elongated members from above said ring downward into it in spaced relation to its interior walls and with said row in parallel relation to its longer walls for causing the metal to be cast about such members, said means for guiding said members comprising a separate substantially elongated tubular guide for each member and each formed with a side opening for rendering visible the elongated member contained therein, vertically spaced horizontally extending supporting members above said ring for supporting said guides and holding them in horizontally spaced parallel relation, horizontally extending laterally projecting parts on each guide spaced longitudinally thereof, means on said parts and means cooperating therewith on said horizontally extending supporting members for ready detachable securement of said parts to such supporting members.

2. In continuous casting apparatus of the type having an operatively circumferentially continuous and substantially rectangular chilled ring for receiving and solidifying molten metal discharged into it and a descendable means on which the end of the solidified metal rests to cause a billet of the metal and of cross-sectional shape and size corresponding to the interior shape and size of said ring to be progressively direct chill cast longitudinally thereof, the combination with said ring and descend-

able means of means for guiding a row of horizontally spaced vertically positioned elongated members from above said ring downward into it in spaced relation to its interior walls and with said row in parallel relation to its longer walls for causing the metal to be cast about such members, said means for guiding said members comprising a separate guide for each member, vertically spaced horizontally extending supporting members above said ring for supporting said guides and holding them in horizontally spaced parallel relation, horizontally extending laterally projecting parts on each guide spaced longitudinally thereof and having portions formed with downwardly opening notches, and said horizontally extending supporting members having portions formed with upwardly opening notches in horizontally spaced relation to each other, the notches on said supporting members receiving the notched portions of said parts and the notches on said parts receiving the notched portions of said supporting members whereby said portions mutually and detachably interlock.

3. In continuous casting apparatus of the type having an operatively circumferentially continuous and substantially rectangular chilled ring for receiving and solidifying molten metal discharged into it and a descendable means on which the end of the solidified metal rests to cause a billet of the metal and of cross-sectional shape and size corresponding to the interior shape and size of said ring to be progressively direct chill cast longitudinally thereof, the combination with said ring and descendable means of means for guiding a row of horizontally spaced vertically positioned elongated members from above said ring downward into it in spaced relation to its interior walls and with said row in parallel relation to its longer walls for causing the metal to be cast about such members, said means for guiding said members comprising a separate guide for each member, said guides being substantially tubes of rectangular transverse cross-section and having their widthwise transverse medial planes in alignment with each other, vertically spaced horizontally extending supporting members above said ring for supporting said guides and holding them in horizontally spaced parallel relation, horizontally extending laterally projecting pairs of spaced opposite flat plates carried by each guide at opposite sides of and parallel to the thicknesswise transverse medial plane of the guide, the lower edge of each of said plates being formed with a notch, and means on the supporting members for cooperation with said plates on the guides comprising means presenting horizontally extending vertical plates having spaced notches on their upper edges for receiving the notched portions of the lower edges of the first mentioned plates while said notches on said first mentioned plates receive the notched portions of the second mentioned plates.

4. In continuous casting apparatus of the type having an operatively circumferentially continuous and substantially rectangular chilled ring for receiving and solidifying molten metal discharged into it and a descendable means on which the end of the solidified metal rests to cause a billet of the metal and of cross-sectional shape and size corresponding to the interior shape and size of said ring to be progressively direct chill cast longitudinally thereof, the combination with said ring and descendable means of means for guiding a row of horizontally spaced vertically positioned elongated members from above said ring downward into it in spaced relation to its interior walls and with said row in parallel relation to its longer walls for causing the metal to be cast about such members, said means for guiding said members comprising a separate guide for each member, vertically spaced horizontally extending supporting members above said ring for supporting said guides and holding them in horizontally spaced parallel relation, horizontally extending laterally projecting parts on each guide spaced longitudinally thereof, said laterally projecting parts on the guides and said supporting members having interlocking portions, upwardly extending supporting means for said horizontally extending supporting members, and readily detachable means for fixedly securing said horizontally extending supporting members to said upwardly extending supporting means whereby different horizontally extending supporting members having such interlocking portions thereon in different spaced relations may be readily substituted for each other for holding said guides in different corresponding spaced relations.

5. The method of forming a metal billet having between its opposite faces and opposite edges one or more elongated bodies, extending longitudinally thereof in contact therewith, of pulverizable material capable of being reduced to a powder for preventing welding together of the opposite sides of the spaces occupied by said bodies when the billet is operated upon for thinning it, comprising direct chill casting the molten metal of the billet about and in contact with one or more elongated metal members which are substantially tubular and the bores of which contain said bodies entered thereinto in the form of a paste or the like filling said bores and baked for hardening to be form retaining, the tubular members having provision for discharge of gas and vapors through their walls during the baking and casting operations, the metal of said members having a melting temperature not higher than that of the molten metal being cast about them so that the portions of said members contacted by said molten metal will be melted by and mix with such molten metal and leave the corresponding portions of said bodies in contact with the cast metal, said elongated bodies being relatively fragile but being reinforced by said metal members which contain them for preventing their breakage at points along their lengths during the handling of them and during the casting operation, said bodies however being form retaining per se whereby to cause them to keep their shape when the portions of said members about them are so melted.

6. The method according to claim 5 wherein the paste comprises the weld preventing material in powder form.

7. The method according to claim 5, the tubular members being so formed prior to casting the molten metal about them as to present a longitudinally extending slot extending substantially throughout their lengths for escape of gases and vapors through their walls during the baking and casting operations.

8. The method according to claim 5, the tubular members being so formed prior to casting the molten metal about them as to present a longitudinally extending slot extending substantially throughout their lengths for escape of gases and vapors through their walls during the baking and casting operations, the paste comprising the weld preventing material in powder form.

9. The method of forming a metal billet having between its opposite faces and opposite edges one or more elongated bodies, extending longitudinally thereof in contact therewith, of pulverizable material capable of being reduced to a powder for preventing welding together of the opposite sides of the spaces occupied by said bodies when the billet is operated upon for thinning it, comprising direct chill casting the molten metal of the billet about and in contact with one or more elongated metal members which are substantially tubular and of flattened transverse cross-section, and are formed in at least one of their wider walls with openings for escape from their bores of gases and vapors during the casting operation and the bores of which contain said bodies and are filled by them, the metal of said members having a melting temperature not higher than that of the molten metal being cast about them so that the portions of said members contacted by said molten metal will be melted by and mix with such molten metal and leave the corresponding portions of said bodies in contact with the cast metal, said elongated bodies being relatively fragile but being reinforced by said metal members which contain

them for preventing their breakage at points along their lengths during the handling of them and during the casting operation, said bodies however being form retaining per se whereby to cause them to keep their shape when the portions of said members about them are so melted.

10. The method of forming a metal billet having between its opposite faces and opposite edges one or more elongated bodies, extending longitudinally thereof in contact therewith, of pulverizable material capable of being reduced to a powder for preventing welding together of the opposite sides of the spaces occupied by said bodies when the billet is operated upon for thinning it, comprising direct chill casting the molten metal of the billet about and in contact with one or more elongated metal members which are substantially tubular and of flattened transverse cross-section, and are formed in one of their wider walls with a slot extending substantially throughout their lengths for escape from their bores of gases and vapors during the casting operation and the bores of which contain said bodies and are filled by them, the metal of said members having a melting temperature not higher than that of the molten metal being cast about them so that the portions of said members contacted by said molten metal will be melted by and mix with such molten metal and leave the corresponding portions of said bodies in contact with the cast metal, said elongated bodies being relatively fragile but being reinforced by said metal members which contain them for preventing their breakage at points along their lengths during the handling of them and during the casting operation, said bodies however being form retaining per se whereby to cause them to keep their shape when the portions of said members about them are so melted.

11. The method of forming a metal billet having between its opposite faces and opposite edges one or more elongated bodies, extending longitudinally thereof in contact therewith, of pulverizable material capable of being reduced to a powder for preventing welding together of the opposite sides of the spaces occupied by said bodies when the billet is operated upon for thinning it, comprising direct chill casting the molten metal of the billet about and in contact with one or more elongated metal members which are substantially tubular and of flattened transverse cross-section, the material of the elongated pulverizable bodies being entered into the bores of said members in the form of a paste comprising the weld preventing material of said bodies in the form of a powder, baking said members containing such paste for hardening the latter to form said bodies, each of said tubular members being so formed prior to the casting operation as to present in one of its wider walls a slot extending substantially throughout its length for escape from its bore of gases and vapors during the baking and casting operations and the bores of which members contain said bodies and are filled by them, the metal of said members having a melting temperature not higher than that of the molten metal being cast about them so that the portions of said members contacted by said molten metal will be melted by and mix with said molten metal and leave the corresponding portions of said bodies in contact with the cast metal, said elongated bodies being relatively fragile but being reinforced by said metal members which contain them for preventing their breakage at points along their lengths during the handling of them and during the casting operation, said bodies however being form retaining per se whereby to cause them to keep their shape when the portions of said members about them are so melted.

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