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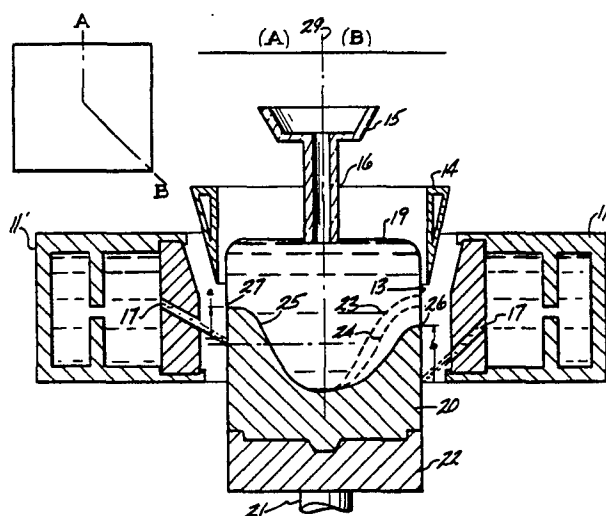
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Process and apparatus for electromagnetic forming of molten metals or alloys, coolant manifold for electromagnetic casting.

A method and apparatus is disclosed for electromagnetic casting of metal and alloy ingots of rectangular or other desired shape having corners or portions of small radius of curvature. A coolant application system is provided which lessens the severity of the rounding off of radius of the corners of the electromagnetically cast ingots by contouring the coolant application rate and/or elevation so that the rate and/or elevation is a minimum at the corners of the ingot.



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PATENTANWÄLTE
PROFESSIONAL REPRESENTATIVES BEFORE THE EUROPEAN PATENT OFFICE

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"Process and apparatus for electromagnetic forming of molten metals or alloys, coolant manifold for electromagnetic casting."

BACKGROUND OF THE INVENTION

This invention relates to an improved process and apparatus for control of corner shape in continuous or semi-continuous electromagnetic casting of desired shapes, such as for example, sheet or rectangular ingots of metals and alloys. The basic electromagnetic casting process has been known and used for many years for continuously or semi-continuously casting metals and alloys.

One of the problems which has been presented by electromagnetic casting of sheet or rectangular ingots has been the existence of high radius of curvature corners thereon. Rounding off of corners in electromagnetic cast sheet ingots is a result of higher electromagnetic pressure at a given distance from the inductor near the ingot corners, where two proximate faces of the inductor generate a larger field. This is in contrast to lower electromagnetic pressure at the same distance from the inductor on the broad face of the ingot remote from the corner where only one inductor face acts.

There is a need to form small radius of curvature corners on sheet ingots so that during rolling cross-sectional changes at the edges of the ingot are minimized. Larger radius of curvature corners accentuate tensile stress at the ingot edges during rolling which causes edge cracking and loss of material. Thus, by reducing the radius of curvature of the ingot at the corners there is a maximizing in the production of useful material.

It has been found in accordance with the present invention that rounding off of corners in electromagnetic casting can be made less severe or of smaller radius by contouring the coolant application rate or elevation (or both)

so that the rate and/or elevation is a minimum at the corners of the ingot.

PRIOR ART STATEMENT

Known electromagnetic casting apparatus comprises a three part mold consisting of a water cooled inductor, a non-magnetic screen and a manifold for applying cooling water to the ingot being cast. Such an apparatus is exemplified in U.S. Patent No. 3,467,166 to Getselev et al. Containment of the molten metal is achieved without direct contact between
10 the molten metal and any component of the mold. Solidification of the molten metal is achieved by direct application of water from the cooling manifold to the forming ingot shell.

In some prior art approaches the inductor is formed as part of the cooling manifold so that the cooling manifold supplies both coolant to solidify the casting and to cool the inductor. See U.S. Patent 4,004,631 to Goodrich et al.

Non-magnetic screens of the prior art are typically utilized to properly shape the magnetic field for containing the molten metal as exemplified in U.S. Patent No. 3,605,865
20 to Getselev. Another approach with respect to use of non-magnetic screens is exemplified as well in U.S. Patent No. 3,985,179 to Goodrich et al. Goodrich et al. '179 describes the use of a shaped inductor in conjunction with a screen to modify the electromagnetic forming field.

It is generally known that during electromagnetic casting the solidification front between the molten metal and the solidifying ingot at the ingot surface should be maintained within the zone of high magnetic field strength, i.e. the solidification front should be located within the inductor.
30 If the solidification front extends above the inductor, cold

folding is likely to occur. On the other hand, if it reaches to below the inductor, a bleed out or decantation of the liquid metal is likely to result. Getselev et al. '166 associate the coolant application manifold with the screen portion of the mold such that they are arranged for simultaneous movement relative to the inductor. In U.S. Patent No. 4,156,451 to Getselev a cooling medium is supplied upon the lateral face of the ingot in several cooling tiers arranged at various levels longitudinally of the ingot. Thus, depending on the pulling velocity of the ingot, the solidification front can be maintained within the inductor by appropriate selection of one of the tiers.

Another approach to improved ingot shape consisted of provision of more uniform fields at conductor bus connections (Canadian Patent No. 930,925 to Getselev).

In electromagnetically casting rectangular or sheet ingots, the ingots are often cast with high radius of curvature ends or corners which is indicative of the need for improved ingot shape control at the corners of such ingots.

Finally, United States Patent 3,502,133 to Carson teaches utilizing a sensor in a continuous or semi-continuous casting mold to sense temperature variations at a particular location in the mold during casting. The sensor controls application of coolant to the mold and forming ingot. Use of such a device overcomes instabilities with respect to how much extra coolant is required at start up of the casting operation and just when or at what rate this excess cooling should be reduced. The ultimate purpose of adjusting the flow of

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coolant is to maintain the freeze line of the casting at a substantially constant location.

Carson '133 teaches that ingots having a width to thickness ratio on the order of 3 to 1 or more possess an uneven cooling rate during casting when coolant is applied peripherally of the mold in a uniform manner. To overcome this problem, Carson '133 applies coolant to the wide faces of the ingot and/or the mold walls and not at all (or at least at a reduced rate) to the relatively narrow end faces
10 of the ingot and/or the mold walls.

All patents and applications described herein are intended to be incorporated by reference herein.

SUMMARY OF THE INVENTION

The present invention comprises a process and apparatus for electromagnetic casting of metals and alloys into rectangular or sheet ingots and other desired elements of shape control having small radius of curvature corners or portions by application of controlled static head (through metal head or pressure modification). In particular, a method and
20 apparatus utilizing controlled differential static head by control of cooling water application to obtain refinement of ingot shape, particularly at the corners of rectangular ingots or other desired elements of shape in claimed.

According to the present invention control of ingot shape may be effected by selection of the rate or location of cooling water application to the forming ingot shell within or below the containment inductor. Rounding off of corners in electromagnetic casting can be made less severe or of smaller radius by contouring the water application
30 rate or elevation (or both) so that the rate or elevation

is a minimum at the corners of the ingot. Reduction of the water application rate or lowering the application level serves to reduce the local heat extraction rate along an ingot transverse cross section line of constant height. This in turn lowers the position of the solidification front at the ingot corner and correspondingly raises the metal static head or pressure at the corner. This increased pressure results in the liquid metal approaching the inductor more closely at the corner and thus filling the corner to form a smaller radius of curvature at the corner before the
10 increased static pressure is counterbalanced by an increased electromagnetic force.

In accordance with one embodiment of this invention a water manifold or cooling water application device is provided with drilled holes or slots of a size and/or local hole density which is modified to yield locally reduced rates of water application at the ingot or desired shape corners.

In accordance with another preferred embodiment of this invention a water manifold or cooling water application device
20 is provided wherein the elevation of the supply holes is modified so as to apply water at the lowest elevation at the ingot or desired shape corners.

In accordance with yet another preferred embodiment of this invention the holes or slots in a water manifold or cooling water application device are modified such that the angle of the holes or slots around the corners of the ingot cause the water to impinge on the ingot surface at a lower elevation at the ingot corners.

It is of course understood that hybrids of local hole cross section, hole angle, and hole elevation can also be
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utilized in accordance with the concepts of this invention.

In accordance with another preferred embodiment of this invention a water manifold or cooling water application device is provided which produces a water application rate of zero over short distances at the corners of the ingot or desired shape to further accentuate the effects of reduced local cooling.

Accordingly, it is an object of this invention to provide an improved process and apparatus for electromagnetic casting of metals and alloys into sheet ingots, or other desired
10 elements of shape control, characterized by small radius of curvature corners or portions thereon.

This and other objects will become more apparent from the following description and drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a schematic cross-sectional representation of a prior art electromagnetic casting apparatus utilizing a slot type coolant manifold for discharging water onto the faces of a forming ingot.

Figure 2 is a schematic cross-sectional representation
20 of an electromagnetic casting apparatus showing an inductor having drilled holes for supplying water to an ingot in accordance with this invention.

Figure 3 is a schematic cross-sectional representation of an electromagnetic casting apparatus showing a modified slot type manifold for supplying water to an ingot in accordance with this invention.

Figure 4 is a schematic cross-sectional representation of an electromagnetic casting apparatus showing another
30 embodiment of a modified slot type manifold for supplying coolant to an ingot in accordance with this invention.

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Figure 5 is a partial bottom plan view looking up into the manifold discharge slot of a manifold showing corners possessing different slot modifications in accordance with this invention.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

In all drawing Figures alike parts are designated by alike numerals.

Referring now to FIGURE 1 there is shown therein a prior art electromagnetic casting apparatus in accordance with U.S. Patent 4,158,379.

The electromagnetic casting mold 10 is comprised of an inductor 11 which is water cooled; a coolant manifold 12 for applying cooling water to the peripheral surface 13 of the metal being cast C; and a non-magnetic screen 14. Molten metal is continuously introduced into the mold 10 during a casting run, in the normal manner using a trough 15 and down spout 16 and conventional molten metal head control. The inductor 11 is excited by an alternating current from a suitable power source (not shown).

The alternating current in the inductor 11 produces a magnetic field which interacts with the molten metal head 19 to produce eddy currents therein. These eddy currents in turn interact with the magnetic field and produce forces which apply a magnetic pressure to the molten metal head 19 to contain it so that it solidifies in a desired ingot cross section.

An air gap exists during casting, between the molten metal head 19 and the inductor 11. The molten metal head 19 is formed or molded into the same general shape as the inductor 11 thereby providing the desired ingot cross section.

The inductor may have any desired shape including circular or rectangular as required to obtain the desired ingot C cross section.

The purpose of the non-magnetic screen 14 is to fine tune and balance the magnetic pressure with the hydrostatic pressure of the molten metal head 19. The non-magnetic screen 14 comprises a separate element as shown, and is not a part of the manifold 12 for applying the coolant.

Initially, a conventional ram 21 and bottom block 22
10 is held in the magnetic containment zone of the mold 10 to allow the molten metal to be poured into the mold at the start of the casting run. The ram 21 and bottom block 22 are then uniformly withdrawn at a desired casting rate.

Solidification of the molten metal which is magnetically contained in the mold 10 is achieved by direct application of water from the cooling manifold 12 to the ingot surface 13. The water is shown applied to the ingot surface 13 within the confines of the inductor 11. The water may be applied, however, to the ingot surface 13 from above,
20 within or below the inductor 11 as desired.

The solidification front 25 of the casting comprises the boundary between the molten metal head 19 and the solidified ingot C. The location of the solidification front 25 at the ingot surface 13 results from a balance of the heat input from the superheated liquid metal 19 and the resistance heating from the induced currents in the ingot surface layer, with the longitudinal heat extraction from the cooling water application.

Coolant manifold 12 is arranged above the inductor 11
30 and includes at least one discharge port 28 at the end of

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extended portion 30 for directing the coolant against the surface 13 of the ingot or casting. The discharge port 28 can comprise a slot or a plurality of individual orifices for directing the coolant against the surface 13 of the ingot C about the entire periphery of that surface.

Coolant manifold 12 is arranged for movement along vertically extending rails 38 and 39 axially of the ingot C such that extended portion 30 and discharge port 28 can be moved between the non-magnetic screen 14 and the inductor 11.
10 Axial adjustment of the discharge port 28 position is provided by means of cranks 40 mounted to screws 41.

The coolant is discharged against the surface of the casting in the direction indicated by arrows 43 to define the place of coolant application.

Figure 2 is a schematic cross-sectional representation of one embodiment of a system for application of a coolant in accordance with this invention. Line 29 divides Figure 2 into two sides (A) and (B). Side (A) shows a section through a face of rectangular ingot 20 and inductor 11' while
20 side (B) shows a section through the corner of the same elements. Coolant, typically water, is supplied to the peripheral surface 13 of ingot 20 via holes 17 in inductor 11'.

Rounding off of corners in electromagnetic casting results from higher electromagnetic pressure at a given distance from the inductor near the corner (where two proximate faces of the single turn inductor generate field) and from excess cooling or higher heat extraction rates at the corners because of geometric and higher heat transfer
30 characteristics. Referring to Figure 2, dotted line 23

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exemplifies the location of the solidification front at the corner of an ingot (side (B)) which is cooled by known uniform rate and height peripheral coolant flow directed to the surface 13 of rectangular ingot 20. As can be seen, excess cooling at the corners of the ingot 20 cause the solidification front to rise in comparison to the elevation of the solidification front along the faces of the ingot 20 (side (A)), denoted by dashed line 24. Thus, b, the height of the solidification front from the point of coolant

10 impingement at the corners of the ingot 20 is greater than a, the height of the solidification front from the point of coolant impingement along the faces of the ingot 20. This combination of higher solidification front (lower head) and increased magnetic pressure at the corners causes the pushing of molten metal away from the corners thereby producing a highly undesirable rounding off of the ingot corners.

In accordance with this invention coolant application devices are modified to produce controlled differential

20 static head leading to refinement of ingot shapes at the corners, and in particular to form smaller radius of curvatures at ingot corners.

Control of ingot shape is effected in accordance with the present invention by selection of the rate and/or location of cooling water impingement upon the surface of forming ingot shells. Rounding off of corners in electromagnetic casting can be made less severe or of smaller radius by contouring the water application rate and/or elevation so that the rate and/or elevation is a minimum

30 at the corner of the ingot. Reduction of the water

application rate and/or lowering of the application level serves to reduce the local heat extraction rate along an ingot transverse cross section line of constant height. This in turn lowers the position of the solidification front at the ingot corners and correspondingly raises the metal static head or pressure at the corners. This increased pressure results in the liquid metal approaching the inductor more closely at the corners and thereby filling the corner to form a smaller radius of curvature before the increased static pressure is counterbalanced by the increased electromagnetic force.

As can be seen from Figure 2, the elevation of the water impingement at the side (B) (the corner of ingot 20) in accordance with this invention is lower than the elevation at side (A) (along the face of the ingot 20) by virtue of the modification in elevation and angle of holes 17 in inductor 11'. The solidification front 25 forms as a result at a height b above the point of water impingement (point 26) but at a level lower than the point 27 where the solidification front 25 forms along the faces of ingot 20.

As an alternative to altering the angle and/or elevation of holes 17 in inductor 11' it would be possible to obtain a lowering of the solidification front at the corners of ingot 20 by reducing the diameter of holes 17 and/or by blocking one or more holes locally of the corners thereby partially reducing or reducing to zero the rate of water application at the ingot corners. Of course hybrids of hole size, density, elevation, angle and blockage could be devised to obtain the results desired with respect to cooling rate at the corners in accordance with this invention.



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Figure 3 shows a partial schematic cross-sectional representation of the electromagnetic casting apparatus of Figure 1 with a modified coolant manifold 12' in accordance with another embodiment of this invention.

Figure 3 shows extended portion 30 to have a discharge port 28' (Side (B)) having a modified slot discharge angle causing impingement of coolant water at a lower elevation at the corners of ingot 20. Side (A) shows a standard or unmodified discharge port 28 which impinges water at a higher level along the faces of ingot 20. Solidification front 25 is seen to be at a higher level as designated by point 27 along the faces of the ingot than at or near the corners of ingot 20, designated by point 26.

Figure 4 shows a partial schematic cross-sectional representation of the electromagnetic casting apparatus of Figures 1 and 3 with a modified coolant manifold 12" in accordance with yet another embodiment of this invention.

In Figure 4, extended portion 30 of modified coolant manifold 12" is constructed with discharge port 28 completely blocked off at or near the corners of ingot 20 (Side (B)) by portion 31 of coolant manifold 12". Thus there is zero local cooling in the immediate corners of ingot 20 causing solidification front 25 to drop to the point 26 at the corners of ingot 20. Side (A) shows that the solidification front 25 stays at point 27 along the faces of the ingot.

Where slot type coolant manifolds such as depicted in Figures 1, 3 and 4 are used, the slot cross section can be accurately contoured to produce a smoothly varying water flow rate with a minimum or zero flow rate at or near the ingot corner positions.

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In addition to altering the angle of slot discharge, it is contemplated to alter the extended portion 30 at the areas of the corners of the ingot 20 to modify the elevation of the slot discharge ports so as to be lowest at the ingot corners. Thus the elevation of the impinging water can be altered by altering the angle and/or the actual elevation of the discharge slots. Again, hybrids of contoured slot cross section, elevation and angle could be devised to carry out the process of this invention.

10 Figure 5 is a bottom plan view looking up into an extended portion 30 of a manifold and shows corners possessing different slot modifications in accordance with this invention. Extended portion 30 comprises an inner wall 32, an outer wall 34 and a discharge port 28. Corner C shows an unmodified full slot discharge port 28 with a slot width equal to that along the four faces of extended portion 30. Corner D shows a contoured slot discharge port 28 with zero slot width (closed) at the exact corner 62 of extended portion 30. Corner E shows a contoured slot discharge port 28 with zero
20 slot width over about half the corner radius 64 of extended portion 30 and corner F shows zero slot width over about virtually the whole corner radius 66 of extended portion 30.

The aforescribed variants in coolant applying equipment are typically designed so as to modify the coolant application rate and/or impact point within about three inches on either side of a corner while the maximum extent of the modifications in coolant application is to result in substantial absence of coolant application over about one inch or less of the ingot surface about the corner.

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The novel method and apparatus of the present invention find applicability in the electromagnetic casting of any shapes wherein it is desired to form portions thereon of low radius of curvature.

It is apparent that there has been provided with this invention a novel process and means for utilizing controlled differential static head by control of coolant application to obtain refinement of ingot shape during electromagnetic casting which fully satisfy the objects, means and advantages set forth herein before. While the invention has been described in combination with specific embodiments thereof, it is evident that many alternatives, modifications and variations will be apparent to those skilled in the art in light of the foregoing description. Accordingly, it is intended to embrace all such alternatives, modifications and variations as fall within the spirit and broad scope of the appended claims.

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THE EMBODIMENTS OF THE INVENTION IN WHICH AN EXCLUSIVE
PROPERTY OR PRIVILEGE IS CLAIMED ARE DEFINED AS FOLLOWS:

1. In an apparatus for electromagnetic forming of molten metals or alloys into a casting of desired shape having at least one portion of small radius of curvature comprising means for generating an electromagnetic force field to receive and form said molten metals or alloys into said casting and means for applying coolant to the peripheral surface of said casting, the improvement characterized by means for lowering the solidification front and increasing the molten metal or alloy static head along the peripheral surface of said casting at said at least one portion of small radius of curvature, whereby the molten metal or alloy more closely approaches said electromagnetic force field generating means at said at least one portion of small radius of curvature.

2. An apparatus as in claim 1 characterized in that said means for lowering the solidification front and raising the molten metal or alloy static head comprises means for controlling the rate at which said coolant impinges upon said peripheral surface such that the rate of impingement in the area of said at least one portion of small radius of curvature is different as compared to the rate of impingement at peripherally adjacent areas of said casting.

3. An apparatus as in claim 2 characterized in that said means for controlling is constructed so as to cause said coolant to impinge on said peripheral casting surface at said at least one portion of small radius of curvature at a lower rate as compared to peripherally adjacent areas of said casting.

4. An apparatus as in claim 1 characterized in that said means for lowering the solidification front and raising the molten metal or alloy static head comprises means for controlling the elevation at which said coolant impinges upon said peripheral surface such that the elevation of impingement in the area of said at least one portion of small radius of curvature is different as compared to the elevation of impingement at peripherally adjacent areas of said casting.

5. An apparatus as in claim 4 characterized in that said means for controlling is constructed so as to cause said coolant to impinge on said peripheral casting surface at said at least one portion of small radius of curvature at a lower elevation as compared to peripherally adjacent portions of said casting.

6. An apparatus as in claim 1 characterized in that said means for lowering the solidification front and raising the molten metal or alloy static head comprises means for controlling the rate and elevation at which coolant impinges upon said peripheral surface such that the rate and elevation of impingement in the area of said at least one portion of small radius of curvature is different as compared to the rate and elevation of impingement at peripherally adjacent areas of said casting.

7. An apparatus as in claim 6 characterized in that said means for controlling is constructed so as to cause said coolant to impinge on said peripheral casting surface at said at least one portion of small radius of curvature at

a lower rate and elevation as compared to peripherally adjacent areas of said casting.

8. An apparatus as in any of claims 3, 5, 6, or 7 characterized in that said means for lowering the solidification front and raising the molten metal or alloy static head is part of said means for generating an electromagnetic force field.

9. An apparatus as in any of claims 3, 5, 6, or 7 characterized in that said means for lowering the solidification front and raising the molten metal or alloy static head comprises a coolant manifold.

10. In a process for electromagnetic forming of molten metals or alloys into a casting having at least one portion of small radius of curvature comprising providing means for generating an electromagnetic force field for forming said molten metals or alloys into said casting, providing a coolant applying means, pouring said molten metal or alloy into said electromagnetic force field, and applying coolant from said coolant applying means to the peripheral surface of said forming casting, the improvement characterized by applying said coolant to said peripheral surface so as to lower the solidification front and increase the molten metal or alloy static head along the peripheral surface area of said casting at said at least one portion of small radius of curvature whereby the molten metal or alloy more closely approaches said electromagnetic force field generating means at said at least one portion of small radius of curvature.

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11. A process as in claim 10 characterized in that said step of applying comprises controlling the rate at which said coolant impinges upon said peripheral surface such that the rate of impingement in the area of said at least one portion of small radius of curvature is different as compared to the rate of impingement at peripherally adjacent areas of said casting.

12. A process as in claim 11 characterized in that said coolant impinges on said peripheral casting surface at said at least one portion of small radius of curvature at a lower rate as compared to peripherally adjacent areas of said casting.

13. A process as in claim 10 characterized in that said step of applying comprises controlling the elevation at which said coolant impinges upon said peripheral surface such that the elevation of impingement in the area of said at least one portion of small radius of curvature is different as compared to the elevation of impingement at peripherally adjacent areas of said casting.

14. A process as in claim 13 characterized in that said coolant impinges on said peripheral casting surface at said at least one portion of small radius of curvature at a lower elevation as compared to peripherally adjacent areas of said casting.

15. A process as in claim 10 characterized in that said step of applying comprises controlling the rate and elevation

at which said coolant impinges upon said peripheral surface such that the rate and elevation of impingement in the area of said at least one portion of small radius of curvature is different as compared to the rate and elevation of impingement at peripherally adjacent areas of said casting.

16. A process as in claim 15 characterized in that said coolant impinges on said peripheral casting surface at said at least one portion of small radius of curvature at a lower rate and elevation as compared to peripherally adjacent areas of said casting.

17. A coolant manifold for use in electromagnetic casting of molten metals or alloys characterized by said manifold forming a substantially closed loop defining a central enclosed area, and having at least one corner, and said manifold including a peripheral slot or plurality of orifices geometrically positioned, sized, and elevated peripherally along said loop so as to direct a flow of coolant material from said at least one corner at a different rate or elevation as compared to flow from adjacent peripheral areas of said manifold.

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18. A coolant manifold as in claim 17 characterized in that said slot or orifice openings are narrower at areas of said manifold at said at least one corner as compared to adjacent peripheral areas of said manifold.

19. A coolant manifold as in claim 18 characterized in that said slot or orifice openings are closed at areas of said manifold at said at least one corner.

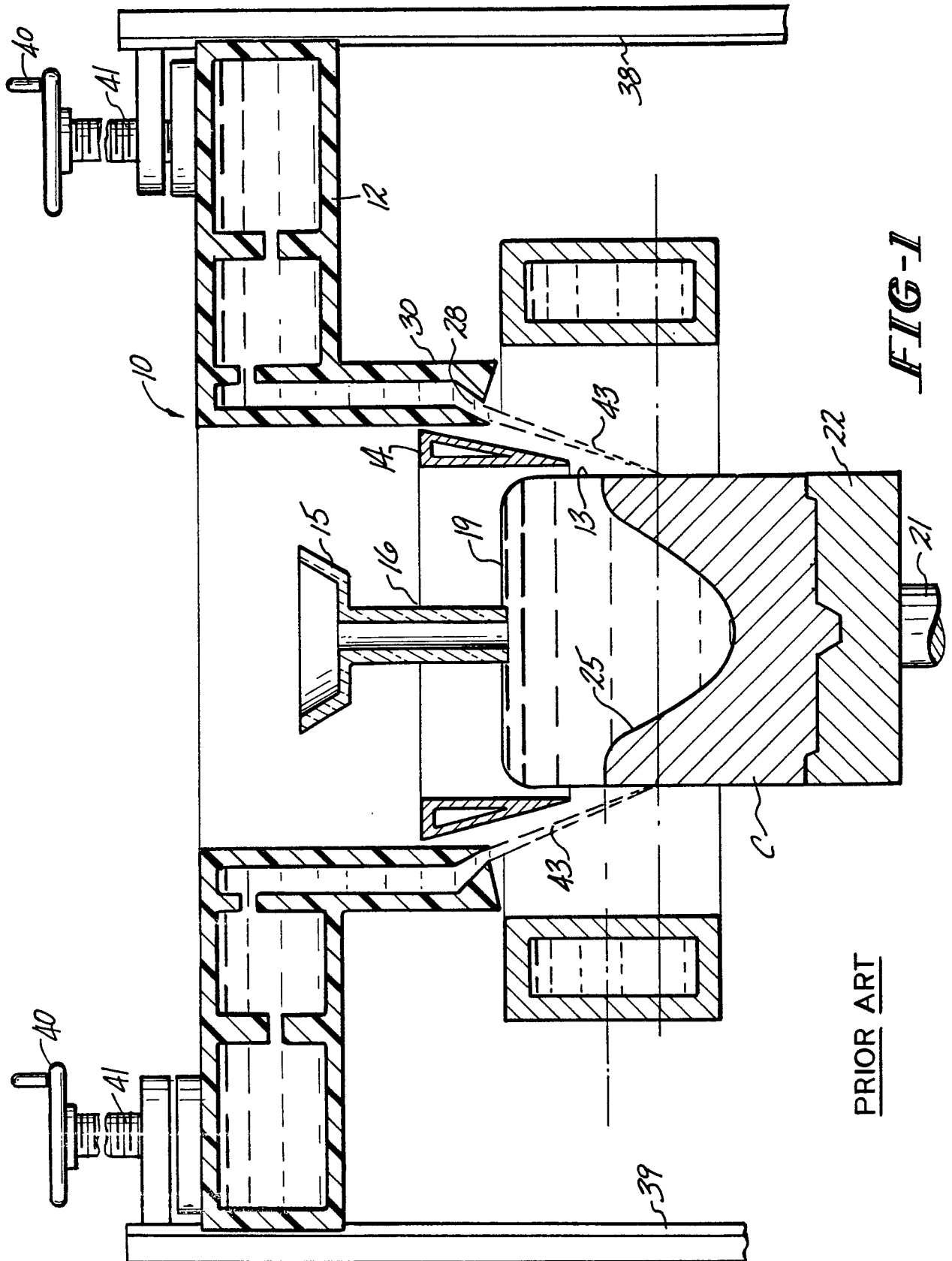
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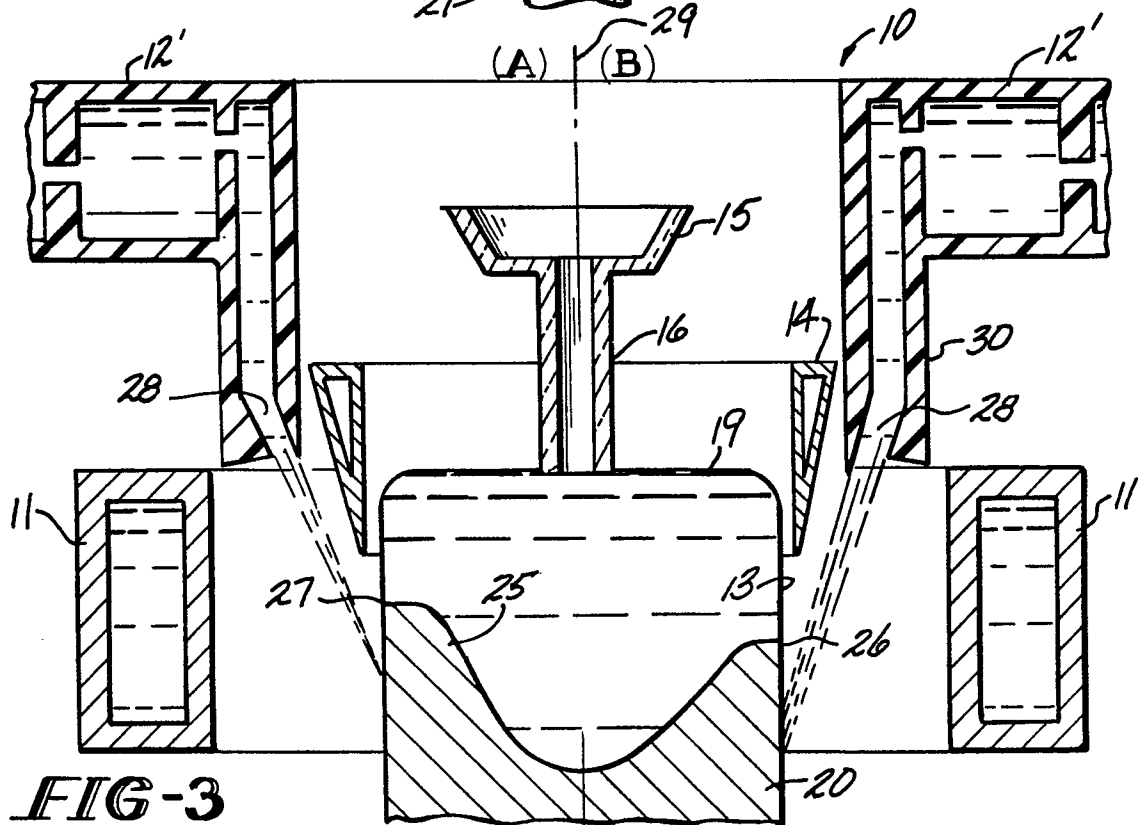
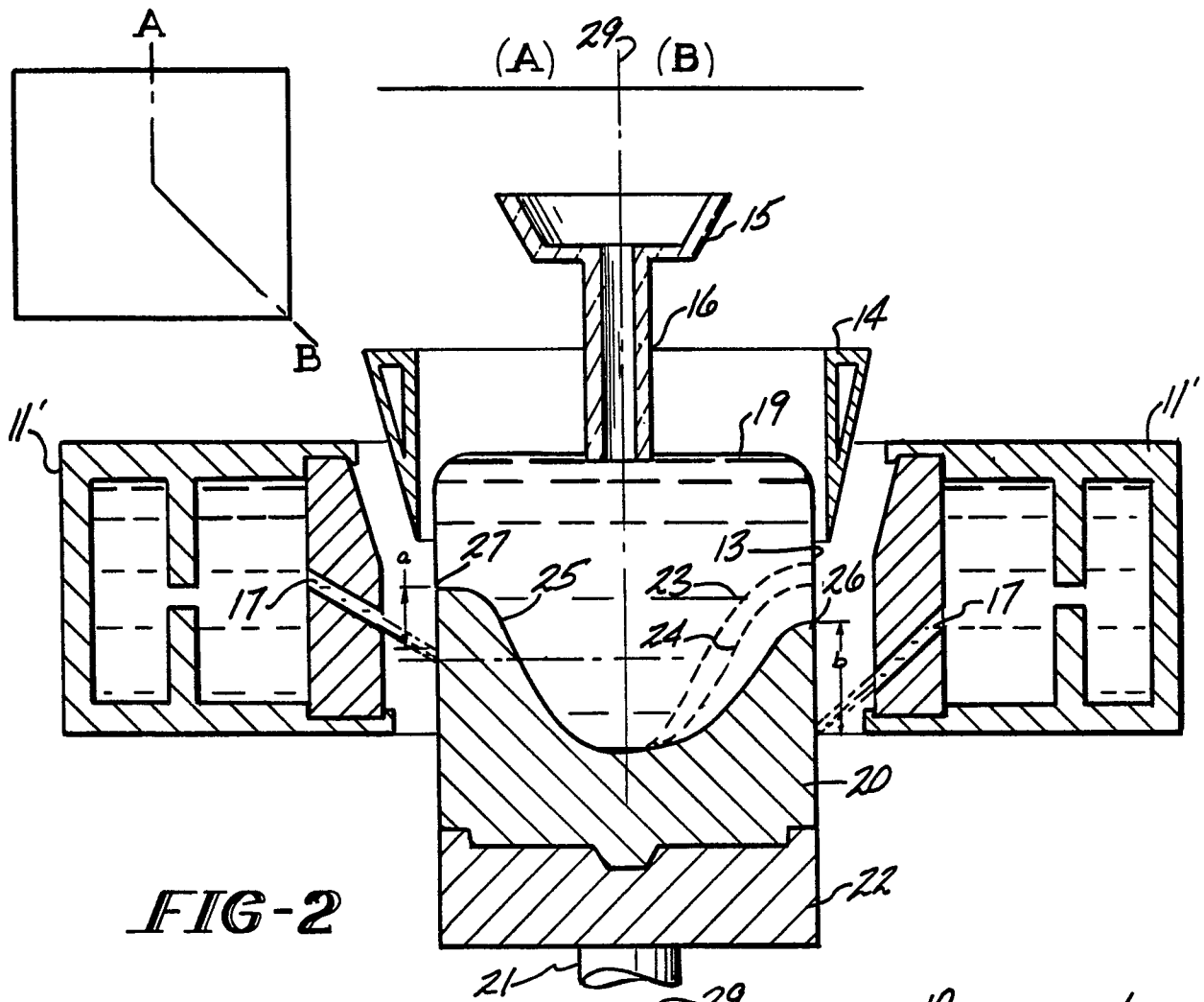
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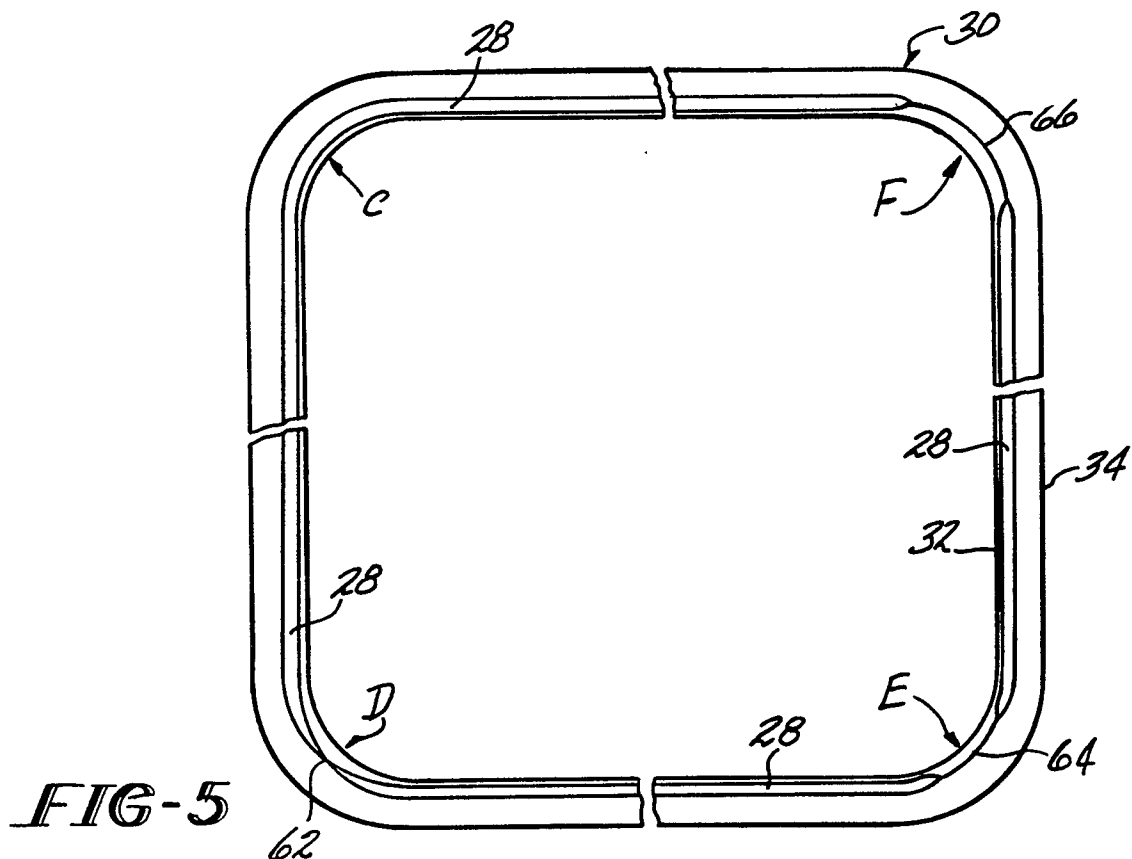
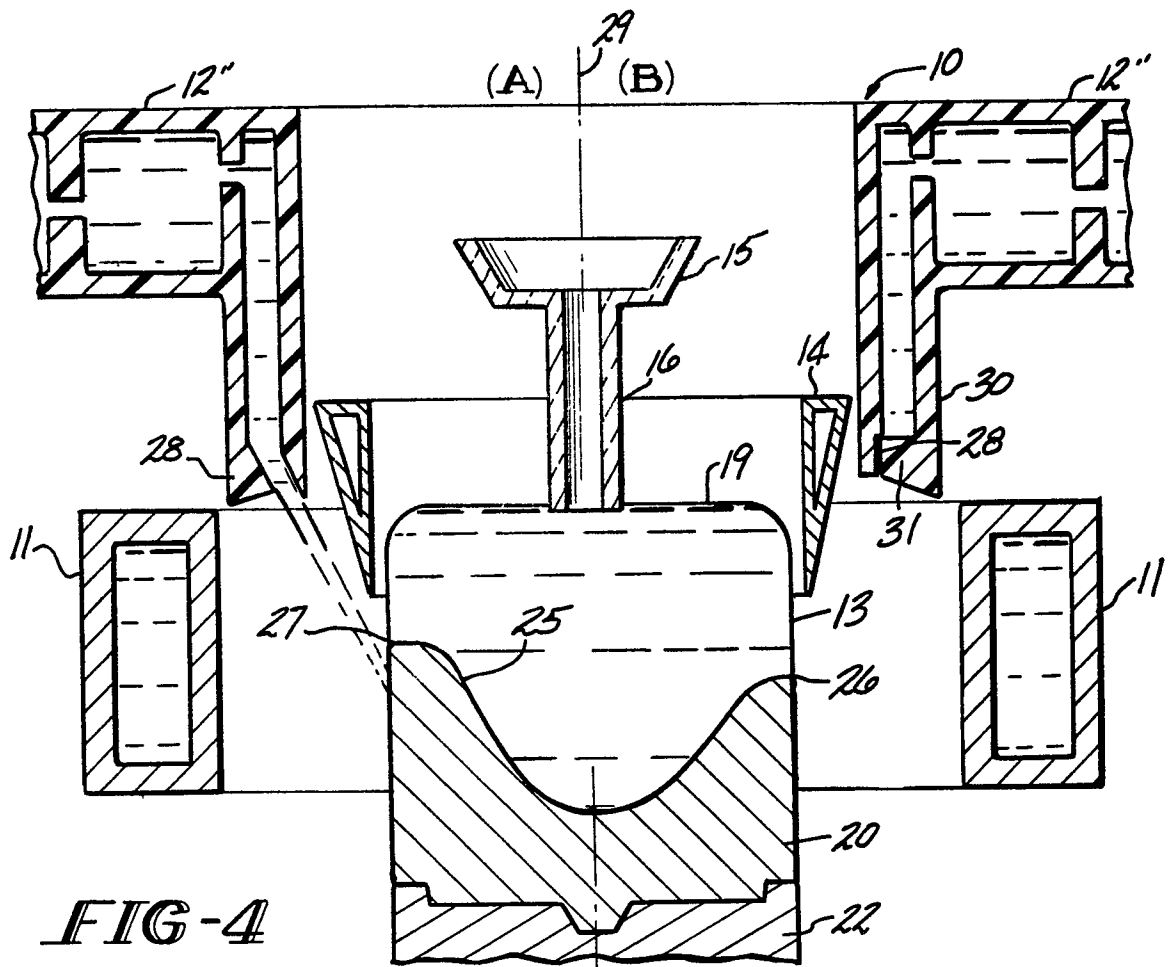
20. A coolant manifold as in claim 17 characterized in that said orifices are of less density at areas of said manifold at said at least one corner as compared to adjacent peripheral areas of said manifold.

21. A coolant manifold as in claim 17 characterized in that said slot or orifices are at a lower elevation at areas of said manifold at said at least one corner as compared to adjacent peripheral areas of said manifold.

22. A coolant manifold as in claim 17 characterized in that said slot or orifices have a smaller angle of inclination with respect to the axis of said central enclosed area at areas of said manifold at said at least one corner as compared to adjacent peripheral areas of said manifold.









European Patent
Office

EUROPEAN SEARCH REPORT

0022566
Application number

EP 80 10 3976.9

DOCUMENTS CONSIDERED TO BE RELEVANT			CLASSIFICATION OF THE APPLICATION (Int. Cl.3)
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	
P	<u>FR - A1 - 2 429 633</u> (GOSUDARSTVENNY NAUCHNO-ISSLEDOVATELSKY I PROEKTNY INSTITUT SPLAVOV I OBRABOTKI TSVETNYKH METALLOV "GIPROTSVETMETO- BRABOTKA" et al.) * fig. 1 * --	1	B 22 D 11/01 B 22 D 11/04 B 22 D 11/10
A	<u>US -A - 4 158 379</u> (YARWOOD et al.) * fig. * --	1	
A	<u>US - A - 4 014 379</u> (GETSELEV) * fig. 1 * --	1	TECHNICAL FIELDS SEARCHED (Int.Cl.3) B 22 D 11/00
A	<u>US - A - 3 646 988</u> (GETSELEV) * fig. 1 * --	1	
A,D	<u>US - A - 3 467 166</u> (GETSELEV et al.) * fig. * --		
A	<u>AU - B - 460 318</u> (KUIBYSHEVSKY METALLUR- GICHESKY ZAVOD IMENI V.I.) * fig. * ----	1	
			CATEGORY OF CITED DOCUMENTS X: particularly relevant A: technological background O: non-written disclosure P: intermediate document T: theory or principle underlying the invention E: conflicting application D: document cited in the application L: citation for other reasons
The present search report has been drawn up for all claims			&: member of the same patent family, corresponding document
Place of search Berlin		Date of completion of the search 30-09-1980	Examiner GOLDSCHMIDT