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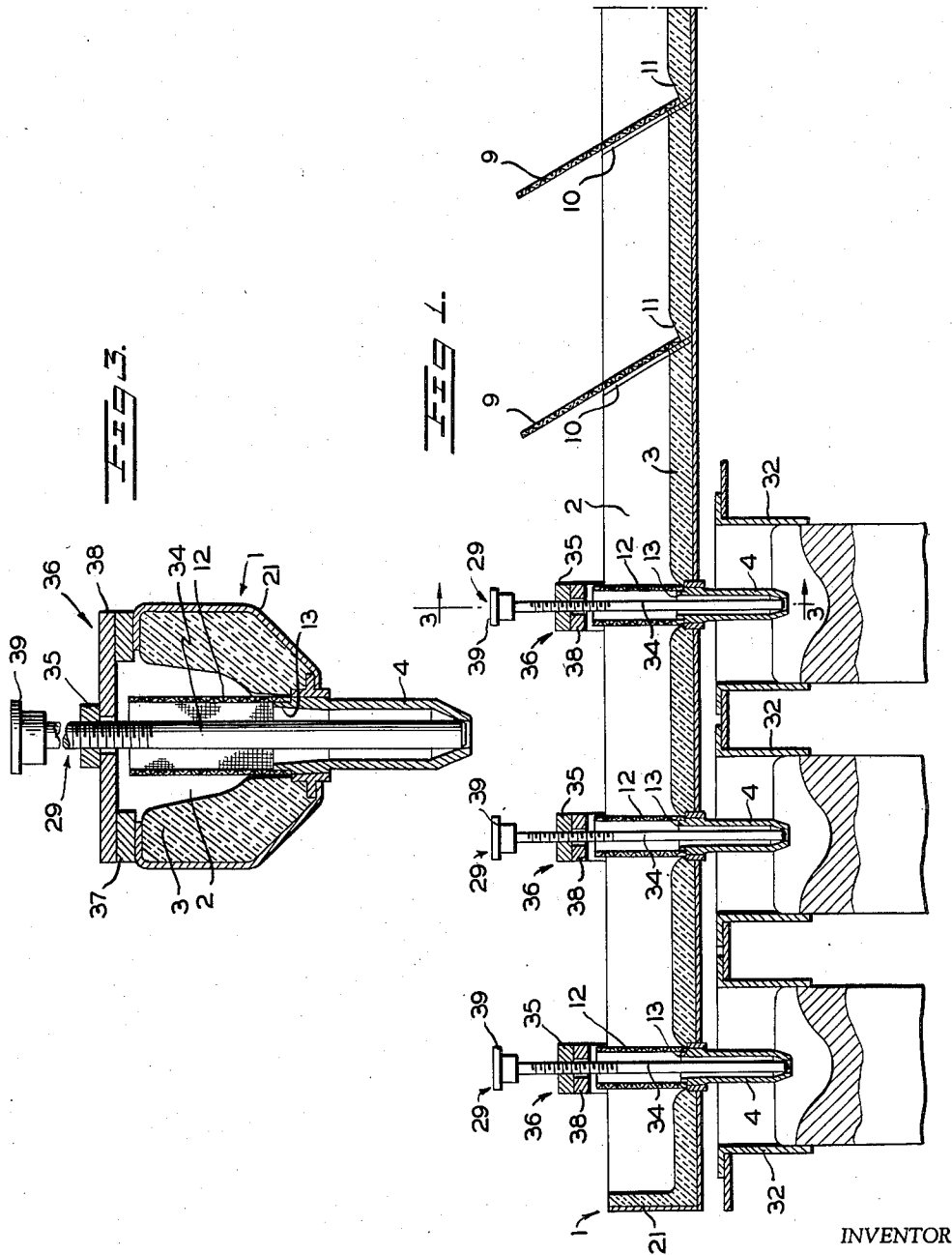
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APPARATUS AND METHOD FOR CASTING METAL

Filed Dec. 9, 1955

3 Sheets-Sheet 1



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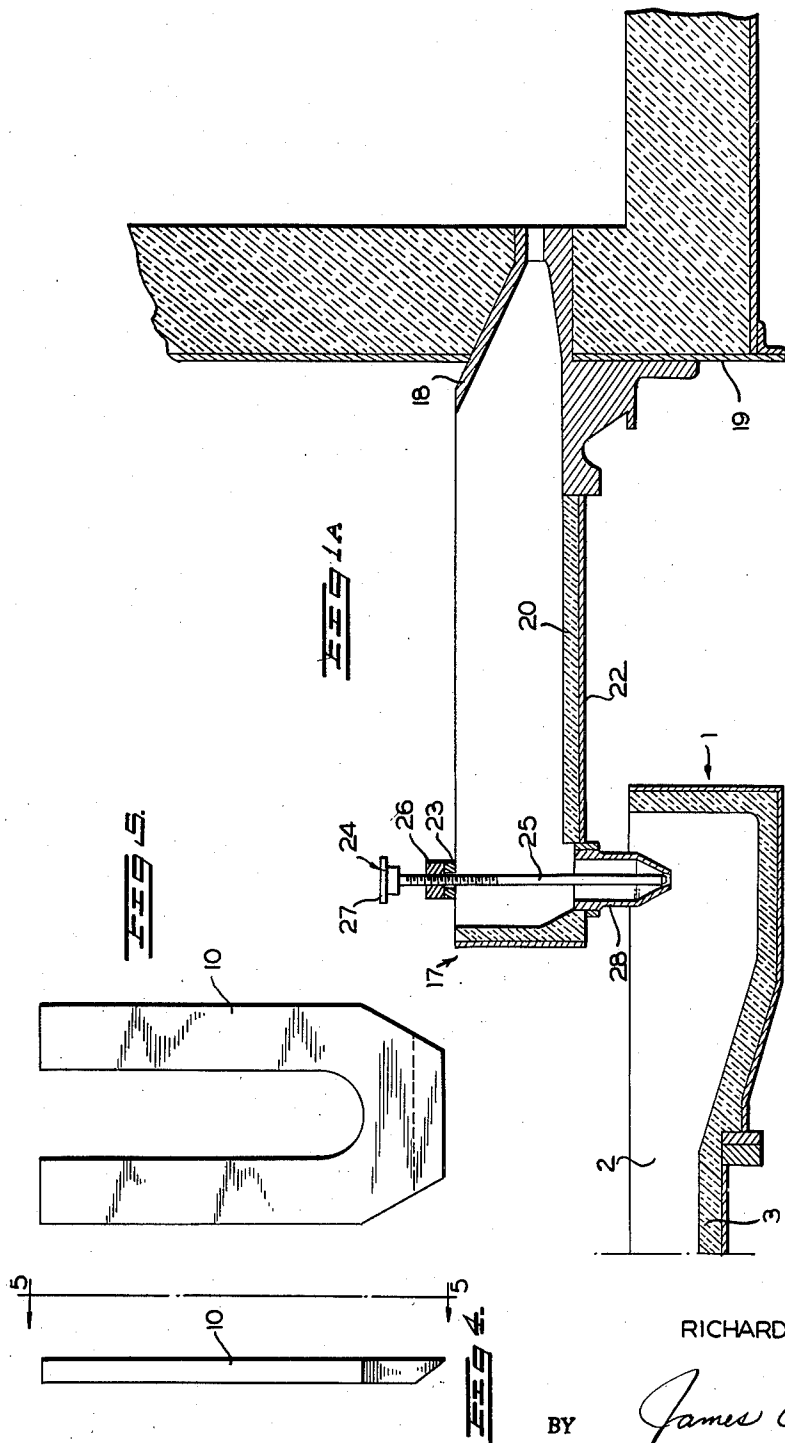
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APPARATUS AND METHOD FOR CASTING METAL

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Application December 9, 1955, Serial No. 552,025

18 Claims. (Cl. 22—79)

This invention relates to the handling of molten metal prior to the casting thereof. More particularly, this invention relates to a molten metal handling method and system for transfer of molten metal from the source thereof, e. g. furnace or other molten metal holding receptacle, to a mold and which is effective in eliminating or substantially reducing the presence of foreign material in the molten metal supplied to the mold and reducing the gas content thereof.

In the casting of metals, e. g. aluminum and aluminum alloys, it is common practice to provide a body of molten metal in a suitable holding receptacle, e. g. oil, gas, coal or coke fired open hearth or reverberatory furnace, electrical resistance heated furnace or induction heated furnace. The molten metal is generally fluxed in the holding receptacle and then transferred from the holding receptacle to the casting station. While in some instances the relative positions of the casting station and furnace may be such as to permit the molten metal to flow directly from the furnace into the casting station, it is common to find the furnace spaced a given distance away from the casting station and use made of transfer troughs for conveying the molten metal to the casting station. The molten metal may pass from the furnace through suitable means such as a short transfer trough and an underpour outlet into a long transfer trough, through the long trough, down through an underpour outlet and into the casting mold.

Such practice possesses certain inherent disadvantages with regard to the presence of inclusions and porosity in the ultimate cast body. In conventional practice, there is an appreciable quantity of particulate material in the molten metal from the furnace such as particles of refractory material from the furnace linings and dross particles which pass into the casting mold and result in inclusions in the casting.

Further, as the metal begins pouring out of the underpour outlet feeding molten metal into the long transfer trough, the metal will fall through the air until the liquid level in the long trough rises to a level sufficiently high to cover the lower end of the underpour outlet. During this period there is a tendency for entrapment of gases and moisture in the molten metal. This results in porosity in the ultimate casting. In addition, falling and splashing of the molten metal results in the formation of oxide particles which become inclusions in the casting. Further in the casting of aluminum and aluminum alloy ingots, generally, a continuous or semi-continuous casting method is employed such as that disclosed in Ennor Patent No. 2,301,027. Such apparatus generally comprises a short mold shell open at the top and bottom, suitable cooling means, and a vertically movable mold bottom. At the beginning of the casting operation the mold bottom is at its highest elevation wherein it closes the open bottom of the mold shell to form a receptacle for the molten metal. As the molten metal solidifies the mold bottom is lowered continuously withdrawing

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the embryo ingot from the bottom of the mold shell while molten metal enters through the open top of the mold shell. Generally that portion of the embryo ingot which is just leaving the mold shell has a molten center and a solidified portion about the outer periphery. In practice generally two or more casting apparatuses are in close proximity to each other and common lowering means is employed for all mold bottoms of such apparatuses. Accordingly these mold bottoms are lowered simultaneously and it is essential that the molten metal from the transfer trough flow into each mold simultaneously in order to have sufficient molten metal in each mold to start an ingot. Where a mold receives insufficient metal the outlet feeding the mold must be closed off to prevent escape of molten metal. This results in substantial loss of production and time. In conventional practice valve type flow regulators are employed to prevent flow of metal from the trough into the mold prior to the start of the casting operation. While such devices may be satisfactory for controlling rate of flow, it is exceedingly difficult to start metal flow through two or more such flow regulators simultaneously since the handles of such devices must be rotated manually several times before an appreciable quantity of metal begins to flow through.

These inherent disadvantages of the prior art practice have given rise to excessive production losses through failure to utilize each mold of a multiple continuous casting apparatus and losses through scrapping of castings due to inclusions and porosity.

Accordingly, the primary purpose and object of this invention is to provide an improved method and means for handling molten metal prior to casting which eliminates or substantially reduces many of the disadvantages of the prior art techniques.

Another object of this invention is to provide a novel means for eliminating or substantially reducing defects such as porosity or inclusions in cast bodies.

Another object of this invention is to provide an apparatus for handling molten metal prior to casting bodies therefrom including means for the elimination or substantial reduction of inclusions from such bodies.

Another object of this invention is to provide a molten metal handling system for the elimination or substantial reduction of defects such as porosity or inclusions from cast light metal bodies, e. g. aluminum and aluminum alloys, by the use of suitable screening means disposed to screen the entire cross section of molten metal.

Another object of this invention is to provide a method and system for handling molten metal prior to the casting thereof featuring new and improved method and means for control of initial flow of molten metal.

Other objects and advantages of this invention will be apparent from the following description thereof in conjunction with the accompanying drawings.

In accordance with this invention, molten metal is transferred from a suitable holding receptacle to a casting station by means of an elongated transfer trough having at least one downwardly directed underpour outlet through which the molten metal is fed into the casting station. Suitable screens are placed either across the flow of molten metal or about the outlets or both in such a manner that all the molten metal passes through such screens to remove foreign material therefrom and the flow of molten metal passing through the outlets may be controlled by suitable control means passing down into the outlets from above. Further, this invention provides an improved method and means for control of the initial flow of molten metal. When the metal begins to flow, the temperature of the screens is lower than that of the molten metal. The lower temperature of the screens together with the

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screen of suitable mesh size produces a cooling effect on the metal which increases surface tension of the metal in contact with the screen whereby passage of molten metal through the screen with which it is in contact is prevented. By subjecting the screens to vibration, e. g. tapping, the surface tension is overcome permitting the metal to flow through thereby heating up the screens to the temperature of the molten metal whereby the metal continues to flow through. This effect is employed in accordance with the invention to provide excellent control of metal flow at the start of the casting operation to reduce the tendency toward inclusions and porosity in the cast body, and to permit much easier control in starting the casting operation, particularly continuous casting of multiple ingots wherein the occurrence of production losses through failure to utilize each mold of a multiple continuous casting apparatus due to non-simultaneous pouring of molten metal into such multiple apparatus may be reduced.

The accompanying drawings illustrate a presently preferred embodiment of the screening means of this invention and a presently preferred method of operation.

Figures 1 and 1A constitute a fragmentary longitudinal elevation, partly in section, of an elongated transfer trough and molds with parts removed for purposes of clarity showing the combination of flat and cylindrical screening means of this invention.

Figure 2 is a fragmentary longitudinal elevation partly in section of the inlet end of an elongated transfer trough with parts removed for purposes of clarity showing the use of the basket screening means of this invention.

Figure 3 is a cross-sectional view of the pouring trough of Figure 1 taken along the line 3—3 of Figure 1.

Figure 4 is an edgeview of a U-shaped member for supporting the flat screens of this invention.

Figure 5 is a view of the U-shaped member of Figure 4 along the line 5—5 of Figure 4.

Figure 6 is a view at right angles to the surface of a flat screen of this invention illustrating the curvature of the ends of the screen.

Referring now more particularly to the drawings in which the same reference numerals have been applied to corresponding parts, the present invention involves the use of cylindrical screens 12 and some form of screen preceding cylindrical screens 12 such as flat screens 9 or a basket screen 5 or both.

In general, casting operations of the type dealt with in this invention necessitate the transfer of molten metal from a source thereof, e. g. furnace 19, to a casting station and wherein use is made of an elongated transfer trough for conveying the molten metal from the source thereof to the casting station. The primary reasons for the use of such transfer trough is because of the space difficulties encountered in attempting to place the casting station closely adjacent the furnace tap hole such that the molten metal could flow directly from the place of exit from the furnace into the casting station and because of the desirability of placing the casting station such that it can be supplied with molten metal from a plurality of furnaces. The embodiment of the apparatus of the invention shown in Figures 1 and 1A comprises a relatively short trough or receptacle 17 suitably attached in a sealed fashion to a furnace 19 in communication with a tap hole 18. Receptacle 17 generally comprises a shell 22 and a suitable refractory lining 20. Additionally, cast iron or other suitable metal could be used for the receptacle. At the end of receptacle 17, opposite the end attached to furnace 19, is a flow regulator 24 which generally comprises an externally threaded elongated member 25 mounted in threaded relationship within a nut member 26 which is supported by a suitable member 27. On the top of member 25 is a suitable turning handle 27 for moving member 25 upwardly or downwardly. Attached to the bottom of receptacle 17 is an underpour outlet 28 through which the molten metal passes into a

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long transfer trough 1. Outlet 28 is provided with a tapered or conical lower end portion such that upon movement of member 25 upward or downward with respect to the lower end portion of outlet 28 the rate of flow of metal can be increased or decreased, respectively. In normal operation the lower end of outlet 28 is submerged in the molten metal pool contained in long transfer trough 1 except when transfer is begun.

While the use of a short transfer trough or receptacle 17 has been shown and described, it is to be distinctly understood that other means for transferring the molten metal from furnace 19 to long transfer trough 1 may be employed. For example an underpour outlet similar to outlet 28 could be suitably attached in a sealed fashion directly to furnace 19 or long transfer trough 1 could be so designed as to be attached directly in a sealed fashion to taphole 18 and level pour the molten metal from the furnace into the transfer trough 1.

Transfer trough 1 may be of conventional design with a metal shell 21 containing refractory lining 3 which defines a cavity 2 through which said molten metal passes from the entry end to the exit end of said trough.

After the molten metal has entered trough 1 it flows to the end furthest removed from the entry end and passes downwardly into casting molds 32 through flow control regulators 29 which are similar to that hereinbefore described in connection with underpouring the metal into trough 1 from furnace 19. Each flow control regulator 29 generally comprises an externally threaded elongated member 34 mounted in threaded relationship within a nut member 35 which is supported by and affixed to a suitable member 36. With reference to Figure 3 it can be seen that member 36 includes vertical portions 37 and a horizontal portion 38. Vertical portions 37 are of sufficient thickness to permit horizontal portion 38 to clear the upper end of cylindrical screen 12. On the top of member 34 is a suitable turning handle 39 for moving member 34 upwardly or downwardly. Attached to the bottom of transfer trough 1 are underpour outlets 4 through which the molten metal passes into molds 32. While three outlets are shown in Figure 1 it is within the scope of this invention to employ a greater or lesser number of outlets 4 depending on the number of molds 32. Outlets 4 are provided with tapered or conical lower end portions such that upon movement of member 34 upward or downward with respect to the lower end portion of outlets 4 the rate of flow of metal can be increased or decreased respectively. Since the casting apparatus forms no part of the present invention, further description of same is deemed unnecessary. However, it is to be noted that the invention is applicable to the handling of molten metal preparatory to casting in any type of casting apparatus, e. g. continuous casting, semi-continuous casting, use of closed bottom mold, etc.

Cylindrical screens 12 are installed over each of the underpour outlets 4 which conduct metal to the mold. In one embodiment of this invention, cylindrical screens 12 are supported as shown particularly in Figure 3 by projecting portions 13 on the upper extremity of each outlet 4. Each cylindrical screen 12 has an inside diameter slightly greater than the outside diameter of its respective projecting portion 13 and thus the projecting portion 13 fits snugly within the cylindrical screen 12 whereby each screen 12 is held in place.

In the preferred practice of this invention cylindrical screens 12 are of a sufficient height that when in position each screen 12 extends to a position above the top of transfer trough 1. This avoids the danger of having the molten metal level rise to a point above the upper edge of cylindrical screens 12 whereby a portion of the metal flows over the upper edge and down into the mold without screening. Accordingly, all the molten metal passing through trough 1 must pass through cylindrical screens 12. Cylindrical screens 12 are fabricated from suitable screening material such as black iron, stainless steel,

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glass, etc. An example of a screen wire size and mesh which been found to perform satisfactorily is a 12 mesh cylindrical screen fabricated from .035" diameter wire.

Spaced along the length of trough 1 is at least one and preferably two or more flat screens 9 which are disposed across the entire cross-section of cavity 2 transverse to the longitudinal axis thereof and inclined away from the entry end of trough 1. Flat screens 9 may be supported by suitable members 10 illustrated in Figures 4 and 5 which are embedded in the refractory lining 3 of transfer trough 1 and have the configuration of cavity 2 which in the case of the trough of Figures 1 through 3 is a U shape. The width of flat screens 9 is slightly greater than the width of cavity 2 and accordingly the refractory lining 3 is hollowed out, as indicated at 11, thereby widening and deepening the cavity 2 for a short distance along the portions of the trough lining 3 adjacent to that side of each member 10 which contacts flat screen 9. This permits placing each flat screen 9 in the trough in such a manner that all the molten metal must flow through the screen. It has been found that with conventional trough linings members 10 are very desirable since without members 10 the grooves cut in the refractory material 3 have their corners worn away by flow of molten metal such that screens 9 are no longer firmly supported. In the practice of this invention it is desirable for flat screens 9 to be at least double the length required to fit within cavity 2 when supported by members 10 with both extremities shaped to fit within cavity 2 when in contact with member 10 as shown in Figure 6. This design makes it possible to use each screen twice before it is thrown away or cleaned. When a clean screen is used one end is placed in cavity 2 as shown in Figure 1. When casting is complete metal freezes within the openings of that end of the screen which was in use. For the next cast the opposite or clean end is placed in cavity 2. After the second casting operation is complete the screen is either thrown away or cleaned for further use. Flat screens 9 are fabricated from suitable screening material, preferably stainless steel. An example of the screen wire size and mesh which has been found to perform satisfactorily is a 10 mesh flat screen fabricated from .047" diameter wire.

In general this invention may be carried out by employing just cylindrical screens 12 and flat screens 9, as shown in Figure 1, however, where an outlet 28 is employed for conducting metal into trough 1, it may in some instances be advantageous to employ a basket screen 5 positioned immediately below such an outlet as shown in Figure 2, in lieu of or in addition to flat screens 9. Basket screen 5 is fabricated from suitable screening material preferably stainless steel with cylindrical side wall 7 and a flat bottom 6, the top of basket screen 5 being open. An example of the screen wire size and mesh which has been found to perform satisfactorily is a 10 mesh screen fabricated from .047" diameter wire. Immediately below outlet 28 and resting on the bottom 6 of basket screen 5 a suitable deflector such as a flat piece of refractory brick 8 may be provided to prevent direct flow of metal from the underpour outlet 28 from burning out the bottom 6 of basket screen 5.

When using the screening system of this invention the screens 5, 9 and 12 are heated before the furnace is tapped to a temperature lower than the temperature of the molten metal. Thus, as the metal contacts each screen there is a slight cooling effect which increases surface tension whereby passage of molten metal through the screens is prevented. The screen may then be tapped or vibrated whereby the surface tension is overcome thereby permitting the metal to flow through the screen. This heats the screen to the temperature of the molten metal whereby the metal continues to flow through. If the screens are pre-heated to the temperature of the molten metal, this effect will not be present. On the

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other hand, if the screens are too cold, the metal will get slushy and plug up the openings such that tapping or vibration of the screens will not result in the flow of molten metal therethrough. Accordingly, an intermediate temperature is necessary. In accordance with preferred practice where the molten metal temperature ranges from 1300° F. to 1400° F. the screens are pre-heated such that at the time the molten metal contacts the screen the temperature of the screen will be not less than 600° F. nor more than 1200° F.

The above described effect has distinct advantages for control of initial metal flow. For example, where a basket screen 5 is employed the metal tends to fill up the basket screen before it flows on through the rest of the trough. When basket screen 5 is almost full, it may be tapped or vibrated allowing the metal to flow through to the first flat screen 9. If the screen was not present it would take a substantial length of time for the molten metal to fill the entire cavity 2 of the trough 1 to the point where the lower end of underpour outlet 28 is covered. As pointed out previously, prior to the time that the metal level rises sufficiently to cover this outlet there is a tendency for gas and moisture entrapment and entrapment of skim and dross due to the free fall of the molten metal into the trough and undesirable turbulence created thereby. Such conditions increase the tendency for porosity and inclusions to be present in the ultimate casting. By use of the chilling effect of the screens, the metal level surrounding the outlet rises much more rapidly, thus minimizing porosity and inclusions.

After vibrating the basket screen 5 the metal which flows through is stopped by the first flat screen 9 thereby preventing the metal issuing from the basket from attempting to fill the entire trough cavity 2 and thus preventing the metal level from dropping to a point below the lower end of underpour outlet 28. Where as shown in Figure 1, cylindrical screens 12 and flat screens 9 are employed without basket screen 5, the molten metal issuing from outlet 28 is stopped by the first flat screen 9 whereby the metal level surrounding outlet 28 rises much more rapidly than if the entire cavity 2 had to be filled. When the pre-determined height of molten metal is reached, the first flat screen 9 is tapped or vibrated and the molten metal then flows through the screen to the second flat screen 9 which stops the metal flow. The metal level is again allowed to come up to the desired level after which the second flat screen 9 is tapped or vibrated and the metal flows through said flat screen. By the use of the blocking action of cylindrical screens 12 the molten metal may be allowed to fill the trough cavity 2 from end to end before passing through underpour outlets 4 into the mold. When the trough is full, a greater quantity of metal will flow into the mold in a given period of time than when the molten metal passes through a trough which is not full. The greater the quantity of molten metal which flows into the mold in a given period of time the faster the metal level in the mold rises to a point above the bottom of outlets 4 thereby resulting in further minimization of porosity and oxide inclusions in the ultimate casting.

In addition the blocking action of cylindrical screens 12 makes it possible to start the metal flow through all outlets 4 simultaneously merely by simultaneously subjecting all screens 12 to vibration as by tapping. This is advantageous particularly for semi-continuous and continuous casting operations since it eliminates or substantially reduces production losses through failure to utilize each mold of a multiple continuous casting apparatus resulting from non-simultaneous pouring of molten metal into such multiple apparatus having common lowering means for the mold bottoms.

One example of the practice of this invention pertains to the casting of two 11" by 44" 7075 aluminum alloy ingots having a length on the order of 81 inches. Approximately 10,000 lbs. of 7075 aluminum alloy were

charged and melted in an oil fired open hearth furnace. The molten metal was stirred for about 5 minutes and sampled for spectrometric analysis. Upon receipt of the analysis, the alloy composition was corrected to the exact 7075 alloy composition desired by adding the necessary alloying constituents. The composition of the melt was approximately 0.13% Si, 2.55% Mg, 1.60% Cu, 5.76% Zn, 0.20% Cr, 0.28% Fe, 0.03% Ti, balance aluminum. The molten metal was fluxed by a suitable method and means. The temperature of the metal was on the order of 1340° F. The metal was underpoured from the furnace through an underpour outlet into a transfer trough containing two outlets. Immediately prior to the metal entering the transfer trough two 12 mesh cylindrical screens fabricated from .035" diameter wire were heated to a temperature of approximately 800° F. and placed over each outlet in the manner shown in Figures 1 and 3 and described above. Since only two ingots were cast in this example the trough employed had only two outlets rather than three as shown in Figure 1. In addition two 10 mesh flat screens fabricated from .047" diameter wire and of the type shown in Figure 6 were heated to a temperature of 800° F. and placed in the transfer trough as shown in Figure 1. The molten metal was then passed into and along the transfer trough into contact with the first flat screen. Since the temperature of the flat screen when contacted by the molten metal was 800° F. or slightly less due to air cooling the molten metal was cooled by the screen increasing the surface tension of the molten metal thereby effectively preventing the flow of molten metal through the screen. Passage of the molten metal from the furnace into the transfer trough was continued to provide a molten metal pool of a pre-determined height, e. g. a height sufficient to cover the bottom of the underpour outlet through which the molten metal enters said trough. After the pre-determined height was reached, the flat screen was subjected to vibrations by tapping to overcome the surface tension whereby the molten metal passed through the first flat screen toward the second flat screen. As with the first flat screen the molten metal was cooled by the second flat screen by increasing surface tension, thereby preventing flow of molten metal through said second flat screen. When the molten metal pool reached a pre-determined height behind the second flat screen, it was subjected to vibration by tapping whereby the molten metal passed therethrough toward the cylindrical screens. As with the flat screens the cylindrical screens cooled the molten metal in contact therewith increasing the surface tension thereof thereby effectively preventing the flow of molten metal therethrough. Flow of molten metal from the furnace into the trough was continued to provide a molten metal pool from end to end of said trough. The control pin for each outlet was opened prior to commencement of the pouring operation. Accordingly, when the molten metal pool had reached the pre-determined height and the casting operation was ready to begin, both of the cylindrical screens were simultaneously subjected to vibrations by tapping to effectively overcome the surface tension whereby molten metal simultaneously passed through both of the cylindrical screens and down both outlets into the two continuous casting molds and two ingots were made therefrom. All metal passing through the trough and into the molds was subjected to screening action by the two flat screens and the two cylindrical screens, to remove foreign material therefrom.

The 7075 aluminum alloy ingots produced above had excellent metallurgical properties and were satisfactory for the production of high quality products by rolling, forging or extrusion operations. The ingots were subjected to reflectoscope tests and evidence of inclusions or porosity was found to be within the maximum limits set by sonic standards for 7075 plate.

Another example of the practice of this invention

pertains to the casting of two 11" by 44" 7075 aluminum alloy ingots having a length on the order of 82 inches. Approximately 10,000 lbs. of 7075 aluminum alloy were charged and melted in an oil fired open hearth furnace.

The molten metal was stirred for about 5 minutes and sampled for spectrometric analysis. Upon receipt of the analysis, the alloy composition was corrected to the 7075 alloy composition desired by adding the necessary alloying constituents. The composition of the melt was approximately 0.15% Si, 2.61% Mg, 1.58% Cu, 5.75% Zn, 0.20% Cr, 0.33% Fe, 0.03% Ti, balance aluminum. The molten metal was fluxed by a suitable method and means. The temperature of the metal was on the order of 1340° F. The metal was underpoured from the furnace through an underpour outlet into a transfer trough containing two outlets. Immediately prior to the metal entering the transfer trough two 12 mesh cylindrical screens fabricated from .035" diameter wire were heated to a temperature of approximately 800° F. and placed over each outlet in the manner shown in Figures 1 and 3 and described above. Since only two ingots were cast in this example the trough employed had only two outlets rather than three as shown in Figure 1. In addition two 10 mesh flat screens and one basket screen fabricated from .047" diameter wire were heated to a temperature of 800° F. and placed in the transfer trough as shown in Figures 1 and 2. The molten metal was then passed into and along the transfer trough into contact with the basket screen. Since the temperature of the basket screen when contacted by the molten metal was 800° F. or slightly less due to air cooling the molten metal was cooled by the screen increasing the surface tension of the molten metal thereby effectively preventing the flow of molten metal through the screen. Passage of the molten metal from the furnace into the basket screen was continued to provide a molten metal pool of a pre-determined height, e. g. a height sufficient to cover the bottom of the underpour outlet through which the molten metal enters said trough. After the pre-determined height was reached, the basket screen was subjected to vibrations by tapping to overcome the surface tension whereby the molten metal passed through the basket screen toward the first flat screen. As with the basket screen the molten metal was cooled by the first flat screen by increasing surface tension thereby preventing flow of molten metal through said first flat screen. When the molten metal pool reached a pre-determined height behind the first flat screen, it was subjected to vibration by tapping whereby the molten metal passed therethrough toward the second flat screen. When the molten metal pool reached a pre-determined height behind the second flat screen, it was subjected to vibration by tapping whereby the molten metal passed therethrough toward the cylindrical screens. As with the flat screens the cylindrical screens cooled the molten metal in contact therewith increasing the surface tension thereof thereby effectively preventing the flow of molten metal therethrough. Flow of molten metal from the furnace into the trough was continued to provide a molten metal pool from end to end of said trough. The control pin for each outlet was opened prior to commencement of the pouring operation. Accordingly, when the molten metal pool had reached the pre-determined height and the casting operation was ready to begin both of the cylindrical screens were simultaneously subjected to vibrations by tapping to effectively overcome the surface tension whereby molten metal simultaneously passed through both of the cylindrical screens and down both outlets into the two continuous casting molds and two ingots were made therefrom. All metal passing through the trough and into the molds was subjected to screening action by the basket screen, two flat screens and the two cylindrical screens, to remove foreign materials therefrom.

The 7075 aluminum alloy ingots produced above had

excellent metallurgical properties and were satisfactory for the production of high quality products by rolling, forging or extrusion operations. The ingots were subjected to reflectoscope tests and evidence of inclusions or porosity was found to be within the maximum limits set by sonic standard for 7075 plate.

While there has been shown and described hereinabove the present preferred embodiments of this invention, it is to be understood that the invention is not limited thereto and that various changes, alternations and modifications can be made thereto without departing from the spirit and scope thereof as defined in the appended claims, wherein what is claimed is:

1. A molten metal handling system comprising an elongated transfer trough having at least one underpour outlet in said trough, a vertically disposed cylindrical screen in axial alignment with said outlet, said cylindrical screen extending from a position in contact with the upper end of said outlet to a position above the top of said transfer trough.

2. The molten metal handling system of claim 1 wherein a projecting portion is provided on the upper extremity of said underpour outlet which projecting portion fits snugly within the lower portion of said cylindrical screen thereby supporting said screen.

3. A molten metal handling system comprising a source of molten metal, a transfer trough having a cavity through which said molten metal passes from the entry end to the exit end of said trough, means for passage of metal from said source to said transfer trough, said transfer trough being provided with at least one underpour outlet passing from the bottom of said cavity at the exit end of said trough to a position below the bottom of said transfer trough, a vertically disposed cylindrical screen in axial alignment and in contact with said outlet said cylindrical screen extending from the upper end of said outlet to a position above the top of said transfer trough, and at least one flat screen disposed ahead of said cylindrical screen and across the entire cross section of said cavity transverse to the longitudinal axis of said trough and inclined away from the entry end of said trough.

4. The system of claim 3 wherein a member conforming to the cross-section of said cavity is affixed in said trough to support said flat screen and wherein the width of said flat screen is slightly greater than the width of said cavity, said cavity having a portion which has been widened and deepened for a short distance along the portion of said trough, adjacent the side of said member which contacts said flat screen.

5. The molten metal handling system of claim 4 wherein said flat screen is at least double the length required to fit within said cavity when supported by said member and wherein both ends of said flat screen are shaped to fit within said cavity in contact with said member.

6. A molten metal handling system comprising a suitable transfer trough through which molten metal passes from the entry end to the exit end of said trough, said trough comprising a metal shell containing a refractory lining which defines a cavity, and at least one underpour outlet passing from the bottom of said cavity at the exit end of said trough through said refractory lining to a position below the bottom of said transfer trough, a vertically disposed cylindrical screen in axial alignment and in contact with said outlet, said cylindrical screen extending from the upper end of said outlet to a position above the top of said transfer trough, a projecting portion being provided on the upper end of said underpour outlet which projecting portion fits snugly within the lower portion of said cylindrical screen thereby supporting said screen, at least one flat screen disposed ahead of said cylindrical screen and across the entire cross-section of said cavity transverse to the longitudinal axis of said trough and inclined away from the entry end of

said trough, a suitable member conforming to the cross-section of said cavity embedded in said refractory lining to support said flat screen, the width of said flat screen being slightly greater than the general width of said cavity, said cavity having a portion which has been widened and deepened for a short distance along the portion of said trough adjacent the side of said U-shaped member which contacts said flat screen.

7. The system of claim 6 wherein the screening comprising said cylindrical screen is 12 mesh and fabricated from .035" diameter wire while the screening comprising said flat screen is 10 mesh and fabricated from .047" diameter wire.

8. A molten metal handling system comprising a transfer trough through which said molten metal passes from the entry end to the exit end of said trough, said trough including a refractory lining defining a cavity, and at least one underpour outlet in the exit end of said trough which outlet passes from the bottom of said cavity through said refractory material to a position below said transfer trough, downwardly directed outlet means disposed above the entry end of said trough and through which molten metal passes into the entry end of said trough, a basket screen comprising a cylindrical side wall and a flat bottom, the top of said basket screen being open, said basket screen being positioned within said cavity of said trough immediately below said outlet means through which the molten metal enters said trough, at least one flat screen disposed across the entire cross-section of said cavity transverse to the longitudinal axis of said transfer trough and inclined away from the entry end of said trough, a cylindrical vertically disposed screen in axial alignment and in contact with said outlet in the exit end of said trough, said cylindrical screen extending from the upper end of said outlet to a position above the top of said transfer trough.

9. A molten metal handling system comprising a holding receptacle for molten metal, a suitable transfer trough having a refractory lining defining a cavity through which said molten metal passes from the entry end to the exit end of said trough, downwardly directed means for feeding molten metal from said receptacle to said trough, at least one underpour outlet in the exit end of said trough which outlet passes through the bottom of said cavity through said refractory material to a position below said transfer trough, a basket screen comprising a cylindrical side wall and a flat bottom, the top of said basket screen being open, said basket screen being positioned within said cavity of said trough immediately below said downwardly directed means through which the molten metal flows from said holding receptacle to the entry end of said trough, at least one flat screen disposed intermediate the basket screen and exit end of the trough and across the entire cross-section of said cavity transverse to the longitudinal axis of said transfer trough and inclined away from the entry end of said trough, a suitable U-shaped member embedded in said refractory lining to support said flat screen, the width of said flat screen being slightly greater than the width of said cavity, said cavity having a portion which has been widened and deepened for a short distance along the portion of said trough adjacent the side of said U-shaped member which contacts said flat screen, said flat screen being at least double the length required to fit within said cavity when supported by said U-shaped member, both ends of said flat screen being shaped to fit within said cavity in contact with said U-shaped member, a vertically disposed cylindrical screen in axial alignment and in contact with the upper extremity of said outlet, said cylindrical screen extending from the upper end of said outlet to a position above the top of said transfer trough, a projecting portion being provided on the upper end of said underpour outlet which projecting portion fits snugly within said cylindrical screen thereby supporting said screen.

10. The molten metal handling system of claim 9

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wherein the screening employed in said basket screen is 10 mesh and fabricated from .047" diameter wire, the screening employed in said flat screen is 10 mesh and fabricated from .047" diameter wire and the screening employed in said cylindrical screen is 12 mesh and fabri-

11. A system for handling molten metal prior to casting ingots therefrom featuring novel means for control of initial flow of molten metal comprising a source of molten metal, an elongated transfer trough having a cavity through which said molten metal passes from the entry end to the exit end of said trough, means for passage of metal from said source to said transfer trough, said transfer trough being provided with at least one underpour outlet passing from the bottom of said cavity at the exit end of said trough to a position below the bottom of said trough, a vertically disposed cylindrical screen in axial alignment and in contact with the upper end of said outlet, said cylindrical screen extending from the upper end of said outlet to a position above the top of said transfer trough, and at least one flat screen disposed ahead of said cylindrical screen and across the entire cross-section of said cavity transverse to the longitudinal axis of said cavity and inclined away from the entry end of said trough, each of said screens being so constructed and arranged that when maintained at a temperature lower than the temperature of the molten metal prior to passage of molten metal therethrough the surface tension of the molten metal is increased by contact with each of said screens whereby passage of molten metal through the screen with which it is in contact is prevented until said screen is vibrated after which the surface tension of the molten metal is broken permitting it to flow through.

12. In a molten metal handling system, means for control of initial flow of said molten metal comprising a transfer trough through which said molten metal passes from the entry end to the exit end of said trough said trough including a refractory lining defining a cavity and at least one underpour outlet in the exit end of said trough which outlet passes from the bottom of said cavity through said refractory material to a position below the bottom of said transfer trough, downwardly directed outlet means disposed above the entry end of said trough and through which molten metal passes into the entry end of said trough, a suitable basket screen comprising a cylindrical side wall and a flat bottom, the top of said basket screen being open, said basket screen being positioned within said cavity of said trough immediately below said outlet means through which the molten metal enters said trough, at least one flat screen disposed across the entire cross-section of said cavity transverse to the longitudinal axis of said cavity and inclined away from the entry end of said trough, a cylindrical vertically disposed screen in axial alignment and in contact with said outlet, said cylindrical screen extending from the upper end of said outlet to a position above the top of said transfer trough.

13. In a method of casting metal bodies wherein a body of molten metal is provided in a holding receptacle, molten metal is passed therefrom into one end of an elongated transfer trough containing at least one downwardly directed outlet and wherein the molten metal passes along said trough to said outlet and thereafter passes downwardly through said outlet and into a mold, the improvement comprising passing said molten metal along said trough into contact with an upwardly extending screening surface provided within the trough and surrounding the mouth of said outlet, said screening surface being of a mesh size and at a temperature below the temperature of the molten metal such that the molten metal in contact with the screening surface is cooled to increase the surface tension of the molten metal in contact with said screening surface thereby effectively preventing flow of molten metal therethrough, continuing

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to pass molten metal from said receptacle into said trough to provide a molten metal pool from end to end of said trough, and thereafter subjecting the screening surface to vibration to effectively overcome said surface tension whereby molten metal passes through said screening surface and down said outlet into the mold while simultaneously being subjected to a screening action to remove foreign materials therefrom.

14. A method according to claim 13 wherein said screening surface is at a temperature of from about 600° F. to 1200° F. at the moment molten metal flows into contact therewith.

15. A method according to claim 13 wherein a plurality of metal bodies are being cast simultaneously and wherein the screening surfaces are simultaneously subjected to said vibration such that molten metal flows downwardly into each respective mold at the same time and at the same rate of flow.

16. A method according to claim 13 wherein intermediate said screening surface and the end of said trough receiving molten metal from said holding receptacle, all of the molten metal is passed through at least one screening surface having a coarser mesh size than said first mentioned screening surface and wherein the molten metal first passes into contact with the second mentioned screening surface, said second mentioned screening surface being of a mesh size and at a temperature below the temperature of the molten metal in contact therewith such that the molten metal is cooled to increase the surface tension of the molten metal in contact with the screening surface thereby effectively preventing flow of molten metal therethrough, continuing to pass molten metal from said receptacle into said trough to provide a molten metal pool of predetermined height and thereafter subjecting the screening surface to vibration to effectively overcome said surface tension whereby molten metal passes through said screening surface and toward said first mentioned screening surface.

17. In a method of casting metal bodies wherein a body of molten metal is provided in a holding receptacle, molten metal is passed therefrom downwardly through an outlet into one end of an elongated transfer trough containing at least one downwardly directed outlet and wherein the molten metal passes along said trough to said outlet and thereafter passes downwardly through said outlet and into a mold, the improvement comprising passing said molten metal downwardly into said transfer trough and into a screening surface extending upwardly and surrounding said incoming molten metal, said screening surface being of a mesh size and at a temperature below the temperature of the molten metal such that the molten metal in contact therewith is cooled to increase the surface tension of the molten metal thereby effectively preventing flow of molten metal therethrough, continuing to pass molten metal into said screening surface until the level of molten metal is raised above the lower end of said receptacle outlet, and thereafter subjecting the screening surface to vibration to effectively overcome said surface tension whereby molten metal passes through said screening surface and into said trough, passing the molten metal along said trough and into contact with at least one further screening surface positioned such that upon contact therewith by said molten metal the level of molten metal in the trough is still above the lower end of said receptacle outlet, said further screening surface being of a mesh size and at a temperature below the temperature of the molten metal such that the molten metal in contact therewith is cooled to increase the surface tension of the molten metal in contact therewith thereby effectively preventing flow of molten metal therethrough, continuing to pass molten metal into said trough to increase the height of the pool of metal back of said further screening surface, and thereafter subjecting said screening surface to vibration thereby overcoming said surface tension whereby by molten metal passes through said screening surface

and into contact with an upwardly extending screening surface provided within the trough and surrounding the mouth of the outlet of said elongated transfer trough, said screening surface being of a mesh size and at a temperature below the temperature of the molten metal such that the molten metal in contact with the screening surface is cooled to increase the surface tension of the molten metal in contact with said screening surface thereby effectively preventing flow of molten metal there-through, continuing to pass molten metal from said receptacle into said trough to provide a molten metal pool from end to end of said trough, and thereafter subjecting said screening surface to vibration to effectively overcome said surface tension whereby molten metal passes through said screening surface and down said outlet into the mold while simultaneously being subjected to a screening action to remove foreign materials therefrom, the level of the molten metal pool in said trough remaining above the lower end of the holding receptacle outlet.

18. A method according to claim 17 wherein said screening surfaces are at a temperature of from about 600° F. to 1200° F. at the moment the molten metal passes into contact therewith.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 2,840,871

July 1, 1958

Richard E. Gaffney

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 7, line 6, for "allowing" read -- alloying --.

Signed and sealed this 31st day of January 1961.

(SEAL)

Attest:

KARL H. AXLINE
Attesting Officer

ROBERT C. WATSON
Commissioner of Patents