Feb. 3, 1959 S. A. KILPATRICK 2,871,529

APPARATUS FOR CASTING OF METAL

Filed Sept. 7, 1954 2 Sheets-Sheet 1

FIG. 1.

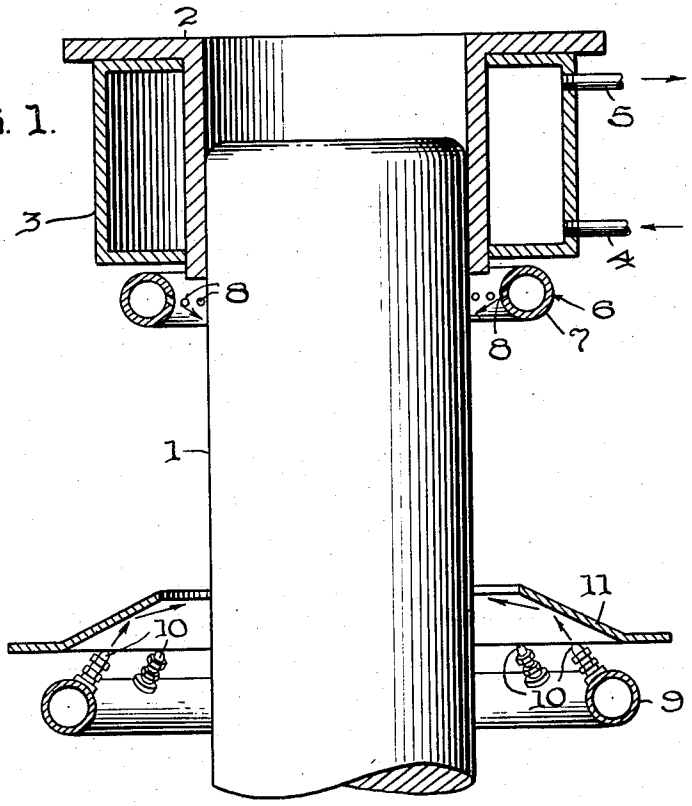
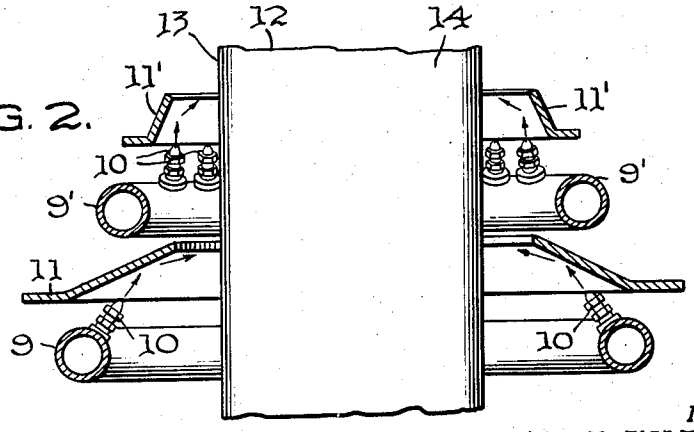


FIG. 2.



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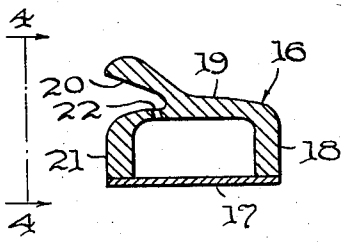


FIG. 3.

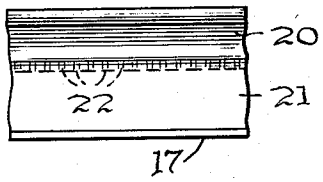
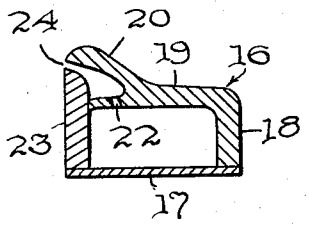


FIG. 4.

FIG. 5



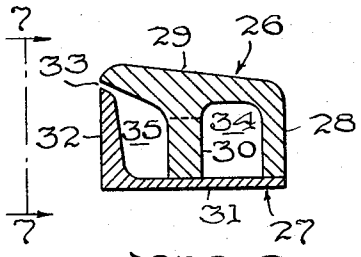


FIG. 6.

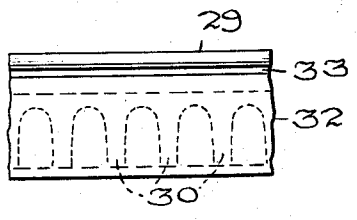


FIG. 7.

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APPARATUS FOR CASTING OF METAL

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11 Claims. (Cl. 22—57.2)

This invention relates to the casting of metals. More particularly, this invention relates to apparatus for use in the continuous casting of metal.

In one method of continuous casting, molten metal is fed into one end of a relatively short open-ended mold shell which is cooled by suitable means. The casting is continuously withdrawn by any suitable means from the opposite end of the mold shell while at the same time a supply of fluid coolant, e. g. water, is applied continuously to the casting as it emerges from the mold shell. The term "continuous" casting as used herein is intended to include casting procedures which may be of a strictly continuous nature (in which the casting is cut to length without interruption of the casting procedure) or where the casting is of a semi-continuous nature; i. e., a casting of desired length may be cast, the flow of metal stopped, the casting removed and the procedure commenced anew.

While the application of coolant directly to the casting as it emerges from the mold shell has served to promote rapid freezing of the metal and to improve metallurgical quality considerably, it was found that uninterrupted flow of coolant down the surface of the casting often leads to excessive internal stresses resulting in the occurrence of defects such as splits and cracks. This may be avoided, without losing the advantages of direct cooling, by proper restriction of the length of travel of the coolant down the surface of the casting thereby overcoming excessive cooling of the casting.

Various means have been proposed for accomplishing restriction of the coolant flow. One means is to collect the coolant by the use of a cup arranged to fit around the emerging casting at a suitable distance from the mold shell and wherein the casting passes through a suitable aperture in the bottom of the cup. Due to the provision of clearance between the casting and the edge of the aperture some coolant tends to pass along the casting beyond the point of exit from the cup. To minimize such leakage a gas stream, wherein the casting surface forms one wall of the gas chamber, is provided below the cup to perform the function of a sealing means against passage of coolant through the clearance and to remove any coolant which does manage to pass therethrough. A coolant collector of this type is not very satisfactory since close control of the gas flow and even level of removal of the coolant is extremely difficult due to variation in clearance space between the casting and the collector cup and gas chamber apparatus which fits around the casting caused by surface irregularities on the casting. Also, such apparatus is complicated and not adapted to a wide range of adjustment.

It has also been proposed to rely simply upon gas streams, e. g., air streams, to remove the coolant from the casting at the desired level. Also, it has been proposed to use a pair of air streams acting in opposed directions to remove the coolant from the casting. The apparatus for such gas streams may take the form of tubular members provided with openings to form jets

therein or wherein nozzles are provided on the tubular members. Coolant removal means of this type have the disadvantage that it is often difficult to obtain the desired even removal of the coolant due to factors such as out of alignment of the jets, lack of uniformity and smoothness in the jet openings, overlapping of the air sprays from adjacent jets or nozzles, and variations in air pressure.

Accordingly, it is the primary purpose and object of this invention to provide a novel apparatus for coolant removal which overcomes or substantially reduces the disadvantages present in the use of apparatus as heretofore known.

Another object of this invention is to provide a simple and efficient means for obtaining a substantially even level of coolant removal from a casting over any desired portion of the periphery of the casting during the continuous casting thereof.

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

Figure 1 is a fragmentary diagrammatic illustration, partly in section, of a vertical section through part of a continuous casting apparatus showing one embodiment of coolant removal apparatus embodying the principles of the present invention,

Figure 2 is a fragmentary diagrammatic illustration, partly in section, of the coolant removal apparatus of Figure 1 but where such apparatus is provided at different levels along the casting,

Figure 3 is a vertical section, with parts removed for purpose of clarity, of another embodiment of apparatus of the invention,

Figure 4 is a fragmentary front elevation of the apparatus of Figure 3, taken along the lines 4—4 of Figure 3,

Figure 5 is a vertical section, with parts removed for purpose of clarity, of a modification of the apparatus shown in Figures 3 and 4,

Figure 6 is a vertical section, with parts removed for purpose of clarity, of a further embodiment of the invention, and

Figure 7 is a fragmentary front elevation of the apparatus of Figure 6, taken along the lines 7—7 of Figure 6.

According to the present invention, in a continuous casting process of the type described hereinbefore wherein there is a restriction of the length of travel of the coolant down the surface of the casting, there is provided an improved coolant removal apparatus whereby the gas which is used for removing the coolant from the casting contacts the casting at a substantially uniform pressure and without substantial variation lengthwise of the casting such that the coolant may be removed at a substantially constant level over any desired portion of the periphery of the casting. As distinguished from apparatus heretofore known for effectively removing all or substantially all of the coolant from the casting wherein use is made of a plurality of jets spaced from the casting and directed to discharge a plurality of gas streams against the casting, the apparatus of the present invention provides for the gas directed toward the casting being substantially in the form of what may be termed a "sheet." To produce such a gas stream there is provided at least one deflecting surface so constructed and arranged relative to the casting and jets that the plurality of gas streams impinge against such deflecting surface prior to contact with the casting thereby compensating for such things as out of alignment of the gas streams, pressure variation, overlapping of adjacent streams, etc., and providing substantially a gas sheet directed toward the casting.

The term "gas," as used herein, is intended to apply to any suitable gas, including air, nitrogen, the noble gases as well as any other gaseous media. Air is commonly utilized since it is the most economic gas and is not hazardous.

The invention will now be more fully described in conjunction with the accompanying diagrammatic drawings, it being understood that the drawings are to be considered by way of illustration rather than limitation with regard to the present invention. As can be seen from Figure 1, a casting **1** is emerging from the open-ended mold shell **2**. A coolant jacket **3** is provided as means for cooling the mold shell. Suitable inlet and outlet means, 4 and 5, respectively, are provided in the coolant jacket for passage of coolant, which preferably is water. It is to be noted that other means for cooling the mold shell may be used as, for example, the use of coolant spray rings or a spray box wherein the coolant, after contact with the mold shell, may flow down onto the casting. Below the coolant jacket is provided a means **6** for applying coolant to the casting. Such means may comprise a pipe **7** provided with a plurality of openings **8** which are directed at an angle to discharge coolant on the casting. Alternatively, the openings **8** may consist of merely an elongated slot. If desired, the means for applying coolant to the casting can be combined with the mold shell cooling means in various well known manners.

Below the coolant means **6**, and spaced from the casting, is a member **9** which is provided with a plurality of nozzles or jets **10**. Member **9** is connected to a suitable source of compressed gas (not shown) and forms a chamber for receiving the gas. Above member **9** and jets **10** is positioned a deflector plate **11** which may be affixed in suitable manner to member **9** or be supported independently thereof. As shown, the forward portion of plate **11** extends beyond the ends of jets **10** toward the casting and also is disposed at an angle toward the mold shell **2**. Although not shown, suitable means may be provided for support and adjustment of the position of the jets and deflector plate relative to the mold shell. The jets **10** are disposed at such angle that the gas streams issuing therefrom will be caused to impinge against deflector member **11** and the thus modified gas streams then directed against the casting as indicated by the arrows. Where there is any tendency for coolant removed from the casting by the gas stream to fall downwardly relatively close to the casting, the deflector member **11** will function also to deflect such coolant away from the casting.

Where the casting possesses a cross-sectional configuration having corners or edges, e. g., square, rectangular, etc., it may be desired to selectively remove the coolant at different levels along the casting to assist in maintaining uniform cooling of the casting, it being known that generally the metal at the corner or edge portions of a casting tends to cool at a faster rate due to the greater surface area for heat abstraction per unit amount of metal than exists with regard to portions of the casting between the corners or edges. In such case provision may be made for the apparatus of the invention to be used at different levels as illustrated in Figure 2, wherein **12** denotes a casting having a substantially square cross-section and wherein the surface of the casting comprises rounded corners **13** and flat surfaces **14** located between the corners. As can be seen, a suitable gas receiving member **9'** having nozzles or jets **10** mounted thereon and a deflector plate **11'** positioned thereabove is provided at each corner **13** at a level which is closer to the mold shell than the means for removing coolant from the flat surfaces **14**. Where the cross-section of the casting is substantially rectangular and the edge thereof is relatively thin as compared to the width, it may be desirable to remove the coolant completely across the edge at a level different from that where the coolant is removed from the faces of the casting and, as such, require the gas receiving chamber and deflector plate to extend completely across the edge.

Figures 3 and 4 illustrate a modification of the coolant removal apparatus shown in Figure 1 wherein the gas receiving chamber, jets and deflecting surfaces are substantially combined in one part. As shown, the assembly comprises an upper part **16** and a base **17** suitably affixed together to provide a gas chamber and wherein part **16** is comprised of a downwardly projecting rearward portion **18**, a top portion **19**, a forward and upwardly projecting deflector portion **20**, a forward and downwardly projecting portion **21**, and a plurality of jets **22**. Figure 5 illustrates a modification of the apparatus shown in Figures 3 and 4 wherein the forward and downwardly projecting portion **21** is replaced by member **23** which extends upwardly close to the deflector portion **20** thereby defining a slot **24**.

Figures 6 and 7 illustrate a further modification of the coolant removal apparatus shown in Figures 3–5. The apparatus comprises an upper part **26** and a lower part **27** which are suitably affixed together. Part **26** is composed of a rearward and downwardly projecting portion **28**, a top portion **29** and downwardly projecting portions **30**. The lower part **27** is composed of a base portion **31** and a forward upwardly extending portion **32**, the top of portion **32** cooperating with the forward end of top portion **29** to define a slot **33**. Assembled parts **26** and **27** define therebetween chambers **34** and **35**. The function of downwardly projecting portions **30** is to act as a further equalizer to compensate for direction of flow of incoming gas, pressure variations, etc., in that gas entering chamber **34** will be first caused to pass through the plurality of passages provided by portions **30** before entrance into chamber **35** and exit through slot **33**. Such additional structure may be added to the other coolant removal structures illustrated.

It will thus be seen that by means of the present invention, apparatus is provided which will produce the desired even level of coolant removal and which may be used for removing coolant around the entire periphery of the casting or for coolant removal only over a desired portion of the casting periphery. Although the invention has been illustrated in connection with the production of a casting having a circular or square cross-section, it will be understood that it is applicable to the production of castings of various cross-sectional configurations, e. g. square, circular, rectangular, elliptical, etc. Where selective removal of the coolant at different levels over given portions of the periphery of the casting is desired, simultaneous use can be made of the apparatus of the invention at various levels on the casting, as described hereinbefore.

It will be obvious that various changes, modifications and alterations may be made to the present invention without departing from the spirit and scope thereof and it is not to be taken as limited except by the appended claims herein.

What is claimed is:

1. In apparatus for the continuous casting of metals comprising a mold shell, means for cooling said mold shell, means for applying coolant upon a casting emerging from said mold shell, the combination therewith of means positioned below said means for applying coolant to said casting for effectively removing said coolant at a substantially even level, said coolant removal means comprising a chamber for receiving gas, said chamber being provided with a plurality of gas jets for passage of gas therefrom, and at least one deflecting surface against which the gas issuing from said jets impinges upon, said deflecting surface being so constructed and arranged relative to the casting and the jets that the gas will be directed against the casting to effectively remove the coolant at a substantially even level.

2. An apparatus according to claim 1 wherein the means for deflecting the gas includes two spaced surfaces which define a slot therebetween.

3. In apparatus for the continuous casting of metals comprising a mold shell and means for applying coolant to a casting emerging from said mold shell, the combination therewith of a plurality of gas jet nozzles positioned below said coolant means, a deflector positioned above said nozzles and fixed relative thereto, said deflector extending to a point closer to the casting than said nozzles, said deflector being so constructed and arranged and said nozzles being directed to discharge gas in a direction such that the gas will impinge upon said deflector and then be directed against the casting at an angle toward said mold shell to effectively remove said coolant from the casting at a substantially even level.

4. In apparatus for the continuous casting of metals comprising a mold shell and means for applying coolant to a casting emerging from said mold shell, the combination therewith of a chamber for receiving gas therein positioned below said coolant means, said chamber being provided with apertures therein through which the gas will flow therefrom, and a deflecting surface provided above said apertures and extending toward said casting and being so constructed and arranged relative to the casting and apertures that the gas flowing from said chamber will impinge upon said deflecting surface and then be directed against the casting and at an angle toward said mold shell to effectively remove said coolant from the casting at a substantially even level.

5. Apparatus according to claim 4 wherein a second surface is provided from the forward end of said first mentioned deflecting surface thereby defining a slot whereby said gas, after impingement upon said first deflecting surface, is directed through said slot and against said casting to remove said coolant from the casting.

6. In apparatus for the continuous casting of metals comprising a mold shell and means for applying coolant to a casting emerging from said mold shell, the combination therewith of a chamber for receiving gas therein positioned below said coolant means, said chamber being provided with a substantially continuous slot disposed to discharge gas against the casting substantially in the form of a sheet of gas and at an angle toward said mold shell to effectively remove the coolant from said casting.

7. Apparatus according to claim 6 wherein a second chamber is provided in gas flow relationship with said first mentioned chamber, said chambers being connected by means of a partition provided with openings therethrough, whereby the gas first enters said second chamber, passes through said openings, and then is discharged through said slot.

8. In apparatus for the continuous casting of metals comprising a mold shell, means for cooling said mold shell, means for applying coolant upon a casting emerging from said mold shell, the combination therewith of means positioned below said means for applying coolant to said casting for effectively removing said coolant at a substantially even level, said coolant removal means comprising a chamber for receiving gas, said chamber being provided with a plurality of gas jets for passage of gas therefrom, and at least one deflecting surface against which the gas streams issuing from said jets impinge upon, said deflecting surface being disposed relative to the casting and the jets such that the gas streams impinging upon said surface will be directed against the casting and wherein the deflected gas streams will be substantially in the form of a sheet of gas.

9. In apparatus for the continuous casting of metals comprising a mold shell and means for applying coolant around substantially the entire periphery of a casting emerging from said mold shell, the combination therewith of a plurality of substantially uniformly spaced gas jet nozzles positioned below said coolant means and adapted to substantially surround the casting, a deflector member positioned above said nozzles, said nozzles being directed to discharge gas streams in a direction such that the gas streams will impinge upon said deflector and then be directed against the casting at an angle toward said mold shell and in substantially the form of a sheet of gas to remove said coolant from the casting.

10. In apparatus for the continuous casting of metals comprising a mold shell, means for cooling said mold shell, means for applying coolant upon a casting emerging from said mold shell, the combination therewith of means positioned below said coolant applying means for effectively removing said coolant at a substantially even level, said coolant removal means comprising a chamber for receiving gas, said chamber being provided with a plurality of gas jet nozzles for passage of gas therefrom, and at least one deflector plate positioned above said nozzles and against which the gas issuing from said nozzles impinges upon, said deflecting plate being so constructed and arranged relative to the casting and the nozzles that the gas will be directed against the casting to effectively remove the coolant at a substantially even level and wherein the portion of said deflector plate contacted by the gas is directed at an angle toward the mold shell.

11. In apparatus for the continuous casting of metals, wherein the casting is of such a cross-sectional configuration that certain portions of the casting have greater surface area for heat abstraction per unit amount of metal than other portions, comprising a mold shell, means for applying coolant upon a casting emerging from said mold shell and wherein coolant is applied around substantially the entire periphery of the casting, the combination therewith of a plurality of means positioned below said coolant applying means for effectively removing said coolant from various portions of the casting periphery, each such coolant removal means comprising a chamber for receiving gas, said chamber being provided with a plurality of gas jets for passage of gas therefrom, and at least one deflector surface positioned above said jets and against which the gas issuing from said jets impinges upon, said deflecting surface being so constructed and arranged relative to the casting and jets that the gas will be directed against the casting to effectively remove the coolant at a substantially even level and wherein the portion of said deflector surface contacted by the gas is directed at an angle toward the mold shell, the jets of each such coolant removal means being substantially uniformly spaced apart, the combined removal means being adapted to substantially effectively surround the casting with the coolant removal means adapted to be adjacent the portions of the casting having greater surface area for heat abstraction per unit amount of metal being positioned closer to the mold shell than the coolant removal means adapted to be adjacent other portions of the casting.

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