This invention relates to the casting of metals and is more particularly concerned with a method of providing a thermal barrier between cast metals and casting molds. The efficient and economical casting of metals requires that the physical separation of a cast metal from a casting mold be easily and conveniently accomplished, that the continuous or repeated casting of a metal in a casting mold not cause the rapid deterioration or destruction of the casting mold, and that the cooling of the cast metal in a casting mold does not occur in such a manner as to cause a substantial segregation in the cast metal of alloy constituents. These three requirements are difficult to meet in the casting of metal and are particularly difficult to meet in the continuous casting of metal where elaborate and time consuming preparation of a casting mold each time it is used is not possible.

Accordingly, it has been customary in the continuous casting of metal and in most other casting techniques to tolerate undesirable deterioration of casting molds and the undesirable segregation of alloy constituents in the cast metal and to meet the requirement for the physical separation of the cast metal from a casting mold by using various parting and releasing agents. However, even this last requirement has not always been successfully met. This is because previous parting and releasing agents have rarely been applied to casting molds in a uniform manner.

The invention disclosed herein meets the three requirements for the efficient and economical casting of metal mentioned above in a simple and effective manner by providing a uniformly distributed thermal barrier between the cast metal and a casting mold in which the metal is cast. The thermal barrier serves to physically separate the cast metal from the casting mold so that the cast metal is easily released by and parted from the casting mold. In addition, the thermal barrier retards the initial transfer of heat from the cast metal to a casting mold. This serves to prevent the deterioration of the casting mold by exposure to the initial heat of the cast metal, and to prevent that segregation of alloy and trace constituents in the cast metal which would result from rapid initial cooling of the peripheral portions of the cast metal.

The thermal barrier of the invention may be formed from any of many well known materials having the physical characteristics of being a relatively poor conductor of heat, of having a melting point well above that of the cast metal, and of being relatively easy to apply in a uniform manner and in various selected thicknesses to a casting mold. Soot is a material having these physical characteristics when used in the casting of copper and metals having a lower melting point, and which is also relatively inexpensive and easy to obtain. Accordingly, the present invention is described herein in terms of a thermal barrier formed of soot.

It is also described in terms of applying a thermal barrier to the casting wheel and belt of a casting machine used in the continuous casting of metal. This is because the application of previous parting and releasing agents in a uniform manner to the continuously moving casting wheels and belts of casting machines has not been previously accomplished in a satisfactory manner and because the present invention is particularly well adapted to use in the continuous casting of metals. However, it will be understood that the thermal barrier of the present invention may be formed of materials other than soot and may be applied to casting molds other than those formed by a casting wheel and belt.

From the foregoing, it will be understood that it is an object of the present invention to provide a method of forming an improved parting or releasing agent for casting molds. Another object is to provide a novel, simple and improved method of retarding the transfer of heat from cast metal to casting molds. A further object of the present invention is to provide a method of preventing the deterioration of casting molds by the heat from cast metal. In addition, it is an object of the invention to provide a method of reducing the segregation of alloy constituents in cast metal so as to improve the characteristics of the cast metal. It is also among the objects of the invention to provide a method of advantageously applying a uniform coating of material to a continuously moving mold surface.

These and other features, advantages and objects of the present invention will become apparent from consideration of the following specification taken in conjunction with the accompanying drawings, in which:

FIG. 1 is a fragmentary side elevational view of the casting wheel and belt of a casting machine and of apparatus adapted for applying a thermal barrier to the continuously moving mold surfaces.

FIG. 2 is an enlarged sectional view taken along the line 2—2 in FIG. 1 showing the burner arrangement for applying a thermal barrier to the belt.

FIG. 3 is an enlarged fragmentary side elevational view of the burner arrangement for applying a thermal barrier to the casting wheel groove.

FIG. 4 is a sectional view taken along the line 4—4 of FIG. 3.

In disclosing the embodiment of the present invention here chosen by way of illustration, FIG. 1 shows a portion of a casting machine of known type. The peripheral of the wheel 10 is provided with the conventional circumferential groove 11 in its rim 41 into which molten metal is poured for casting. A continuous belt 12 moves with the wheel 10 engages a fixed sector of the peripheral of the continuously moving wheel 10 to form a closed mold between the groove 11 and the belt 12. The belt 12 passes from and to the wheel 10 over an idler pulley 14 in the direction indicated by the arrow 9 in FIG. 1. Thus, it will be understood that the belt 12 is tangent to the casting wheel 10 at two points so as to provide an entrance for the molten metal and an exit for the cast bar. Molten metal is fed into the groove 11 from a conventional pouring pot 15 through a spout 16, the spout 16 having its discharge end substantially at the point of tangency of the belt 12 as it first engages the wheel 10.

For removal of the cast bar from the groove 11, an extractor shoe 18 is mounted at a point somewhat removed from the departing tangential point of the belt 12 with the wheel 10. The extractor shoe 18 is rigidly secured to a fixed block 19 supported by a portion of the machine frame (not shown).

In the operation of the foregoing conventional and well known equipment, as the wheel 10 is rotated in the direction shown by the arrow 9' in FIG. 1, carrying with it the belt 12, molten metal is poured into the groove 11 enclosed by the belt 12. The metal cools as it is carried between the wheel and belt to emerge as a solid cast bar or rod. Since the continuously moving inner arc 12a of the belt 12 and the continuously moving inner arc 11a of the groove 11 constitute mold surfaces, it will be understood that the thermal barrier of the invention must be continuously applied thereto.

For applying a thermal barrier of soot to the belt 12, there is provided a burner arrangement having a burner
3 mounted within a shield 21 supported by an arm 22 secured to the block 19. The burner 20 is of elongated tubular construction and is disposed transversely of the belt 12. One end of the burner 20 is closed while the opposite end receives gas from a gas tube 24. A valve 23 is provided for varying the rate of gas flow to the burner 20 from any convenient source of gas (not shown). It will be understood that varying the gas flow rate permits the rate of soot production to be varied with the rate of travel of the belt 12 and to provide soot coatings of various selected thicknesses. Facing the belt 12, the burner 20 is provided with a uniformly spaced row of gas emission ports 25.

The shield 21 includes a flat mid-section 26 disposed parallel with the axis of the burner 20 and side edges 28 which extend toward the belt 12 to provide a transversely disposed open ended channel. The edges 28 act to confine the soot for uniform transverse deposits on the belt 12 while water vapor and gaseous products resulting from the combustion of a gas escape from the open ends of the channel.

For coating the groove 11 of the wheel 10, a burner arrangement having a burner 30 is provided. The burner 30 is similar to the burner 20 and extends transversely of the groove 11. Burner 30 is supplied with gas from any convenient source of gas (not shown) through a gas tube 34. The gas is emitted through burner perforations 35 for combustion and a valve 33 in the tube 34 provides control of the rate of soot production may be varied with the rate of travel of the groove 11 and with the thickness of soot coating desired. The burner 30 is provided with a shield 31 and an arm 32 attached to the block 19 supports the burner 30 and the shield 31. The shield 31 includes a central flat portion 36 positioned tangential to the wheel 10 adjacent its periphery. Soot resulting from the combustion of a gas in the burner 30 is confined by shield flanges 38 disposed within the groove 11 and shaped to conform with the cross-sectional configuration of the groove 11. The shield 31 defines an open ended transverse channel outwardly of the wheel 10 and water vapor and gaseous products resulting from the combustion of a gas escape from the open ends of the channel.

It has been found that the application of a thermal barrier such as a thermal coating of soot is facilitated if the surface to which it is applied is relatively cool. Thus, a nozzle 40 is provided to supply coolant water to the inner surface of the wheel rim 41. The nozzle 40 is fixedly attached on a stationary ring 42 which is positioned in a known manner with the wheel 10 and water from any convenient source (not shown) is fed to the nozzle 40 by piping of known type and arrangement (not shown). In this connection it will be noted that the free flight of the belt 12 over the pulley 14 provides for adequate cooling of the belt 12.

From the foregoing, it will be seen that as a fuel such as a hydrocarbon gas, e.g., acetylene (CH2=H2) or the like, is supplied through the tubes 24 and 34 to the burners 20 and 30 respectively, the ignition of the gas will produce a uniform adherent soot coating 50 on the inner face 12a of the belt 12 just prior to contact of the belt with the periphery of the groove 11. Concurrently, a soot coating 51 is deposited on the inner face 11a of the groove 11 just prior to the application of molten metal to the groove 11. Thus, the burners 20 and 30 continuously produce a coating of soot in the casting mold formed by the groove and belt just prior to the reception of molten metal between the wheel 10 and belt 12.

The coating of soot is applied to the sides 10a and 11b of this casting mold in a uniform manner since adjustment of the valves 23 and 33 permits the gas to be burned at various substantially constant rates selected to provide for the constant and uniform application of soot coatings 50 and 51. It will be understood that by adjusting the valves 23 and 33, the uniform application of the soot coatings 50 and 51 can be maintained regardless of the rotational speed of the wheel 10.

It will also be understood that by adjusting the valves 23 and 33, the thickness of the soot coating 50 and 51 applied to the walls 10a and 11b may be varied. Moreover, it will be understood that by adjusting the positions of the side edges 28 of the shield 21 and of the shield flanges 38 of the shield 31, excessive soot may be scraped from the surfaces 10a and 11b and the surfaces 10b and 11c are applied. Thus, the apparatus permits a thermal barrier B of soot to be applied to a casting mold in a uniform manner and to a selected thickness.

It has been found that when a thermal barrier B is formed by coatings of soot 50 and 51 applied in a uniform manner to a thickness of approximately two thousandths of an inch, copper having small traces of iron, zinc and other alloy constituents which will segregate as alloy constituents under certain known cooling conditions can be continuously cast at an initial pouring temperature of approximately 2150 degrees Fahrenheit using a casting wheel 10 of a metal such as copper which will deteriorate at a temperature of approximately 1800 degrees Fahrenheit without deterioration of the casting wheel 10 or substantial segregation of alloy constituents. These conditions are obtained with the casting wheel having a diameter of approximately fifty inches and a rotational speed of approximately three revolutions per minute and being cooled by action of the nozzle 40 at a temperature of approximately 300 degrees Fahrenheit when the coating of soot 51 is applied. It will be understood that the belt 12 has a speed related to the rotational speed of the wheel 10 and is cooled by travel to and from the pulley 14 at a similar temperature when the coating of soot 50 is applied.

It will also be understood that regardless of thickness, the soot coatings 50 and 51 serve as a parting and releasing agent to permit the easy removal of cast metal from the groove 11 and that the thickness of the thermal barrier B required to prevent deterioration or damage to a casting mold and substantial segregation of alloy constituents will vary in accordance with certain conditions. These conditions are the thermal conductivity of the material applied as the thermal barrier, the temperature at which the casting mold deteriorates or is otherwise damaged by heat, the temperature at which the cast metal is poured into the casting mold, the temperature at which the cast metal is poured, and the cooling rate of the cast metal at which segregation of alloy constituents occurs.

These conditions determine the thickness of the thermal barrier B because they relate to the transfer of heat from the cast metal to the casting mold, and to the transfer of heat which is permissible without deterioration of the casting mold and segregation of alloy constituents, and because it is the control of this transfer of heat by the thermal barrier B which prevents the deterioration of a casting mold and the substantial segregation of alloy constituents. Thus, if the casting mold is relatively cool and the cast metal is relatively hot when the cast metal is poured, the thermal barrier B must be sufficiently thick to retard that initial transfer of heat resulting from the initial difference in temperature between the casting mold and the cast metal which would raise the temperature of the casting mold to a temperature at which the casting mold deteriorates and which would cause the peripheral surfaces of the cast metal to cool so rapidly that those temperature gradients in the cast metal known to cause segregation of alloy constituents occur.

The greater the thermal conductivity of the material used as a thermal barrier B, the thicker the material must be applied in order to retard this initial transfer of heat. On the other hand, for any given material used as a thermal barrier B, the thermal barrier B may be of decreasing thickness as the difference in temperature be-
between the casting mold and cast metal when poured decreases, as the temperature at which the casting mold deteriorates or is otherwise damaged increases, or as the rate of cooling of the cast metal at or above which segregation of alloy constituents occurs increases.

Moreover, regardless of the material selected, for application as a thermal barrier B to a casting mold, when an enclosed casting mold such as that provided by the wheel 10 and belt 12 is used, the material must have sufficient thermal conductivity to allow that substantially constant continuous transfer of heat to the casting mold which will cause the cast metal to solidify within the time allowed therefor. It has been found that this continuous transfer of heat will occur without the rate of cooling of the cast metal reaching that rate which causes a temperature gradient in the cast metal which will result in the segregation of alloy constituents.

It will also occur without the temperature of the casting mold reaching that temperature at which it deteriorates. This can be insured by using any of the various well known arrangements (not shown) for cooling casting molds with a cast metal therein. Thus, it will be seen that the present invention provides a thermal barrier B which retards initial transfer of heat and permits the easy physical separation of a cast metal from a casting mold while at the same time permitting the cast metal to be cooled in the time allotted therefor. It will also be seen that the material selected for the thermal barrier B and the thickness of the thermal barrier B can be readily calculated by those skilled in the art once the conditions defined herein are established and considered in each specific application of alloy constituents.

It will, of course, be understood that the specific apparatus herein presented is by way of illustration only, and is meant to be in no way restrictive; therefore, numerous changes and modifications may be made and the full use of equivalents resorted to without departing from the spirit or scope of the invention as outlined in the appended claims.

What is claimed as invention is:

1. In a process of continuously casting metal by the substantially complete solidification of said metal in a mold defined by the peripheral groove in a casting wheel and by a belt which closes a length of said groove, the steps of applying a thermal coating to a surface of said mold and of subsequently pouring said metal into said mold, cooling said metal in said mold to obtain the substantially complete solidification of said metal and removing said metal from said mold; the thickness of said thermal coating being controlled during the step of applying said thermal coating to a surface of said mold so that said thermal coating retards that initial transfer of heat from said metal to said mold which is a result of the initial difference in temperature between said metal and said mold and so that said thermal coating does not substantially increase the time required for the substantially complete solidification of said metal in said mold relative to the time required for the substantially complete solidification of said metal in said mold in the absence of said thermal coating.

2. The process of claim 1 in which said thermal coating is selected and controlled during the step of applying a thermal coating so that said thermal coating is a parting means for aiding in removing said metal from said mold.

3. The process of claim 1 in which said initial transfer of heat is limited to a rate which is less than that rate at which substantial segregation of alloy constituents in said metal occurs.

4. The process of claim 1 including the step of cooling said metal by the transfer of heat from said metal to a coolant and in which said initial transfer of heat from said metal to said mold does not exceed said transfer of heat from said mold to a coolant by an amount sufficient to cause heating of said metal to a temperature at which substantial deterioration of said mold occurs.

5. The process of claim 1 in which said step of applying a thermal coating to a surface of said mold includes directing the combustion products resulting from the incomplete combustion of a hydrocarbon fuel toward said surface.

References Cited

UNITED STATES PATENTS

1,963,149 6/1934 Russell et al. 22-65
1,982,762 12/1934 Russell et al. 22-65
2,206,930 7/1940 Webster 22-57.3
2,714,235 8/1955 Brennan 22-200.1 X

J. SPENCER OVERHOLSER, Primary Examiner,
R. S. ANNEAR, Assistant Examiner,