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METHODS OF COATING INGOTS

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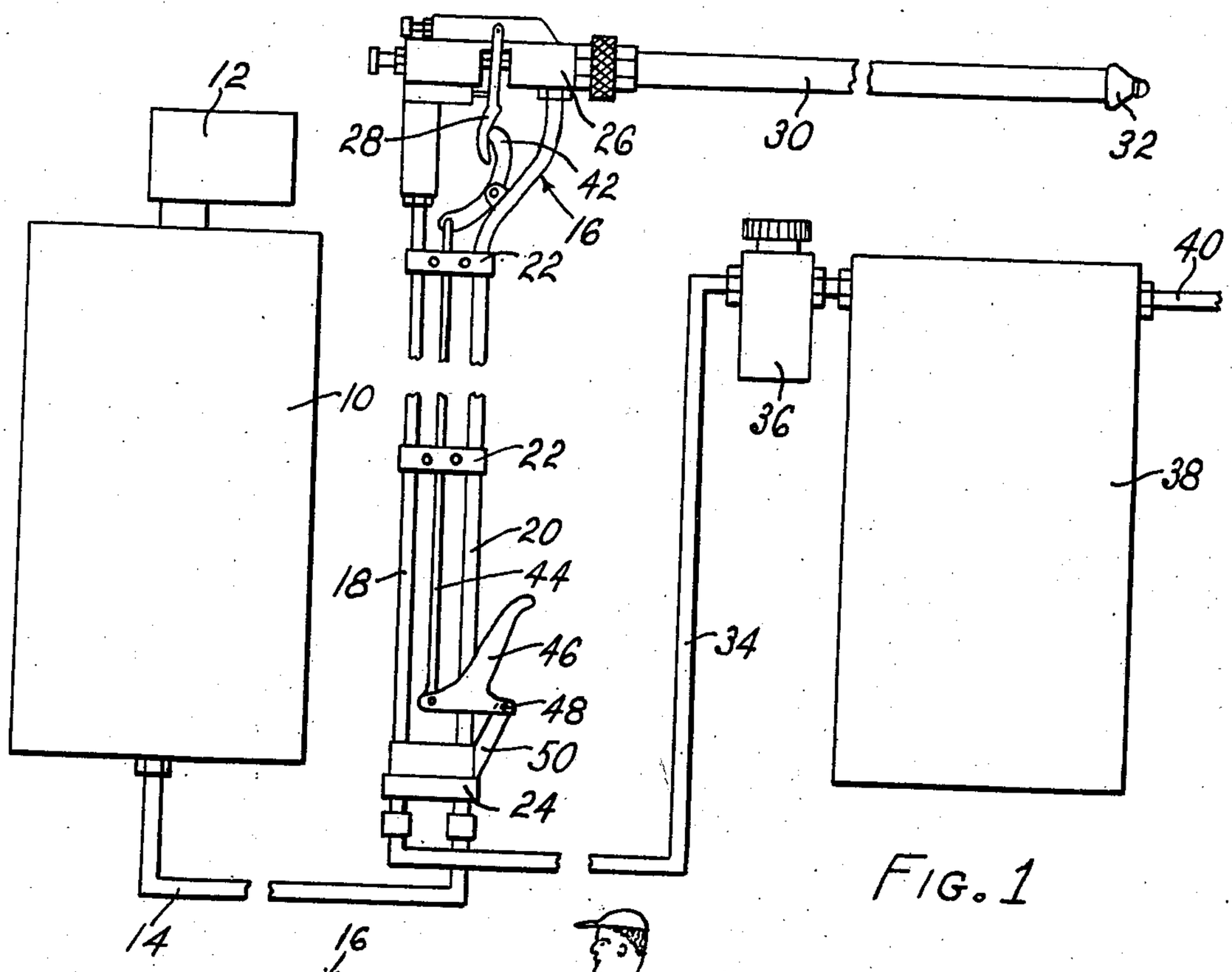

FIG. 1

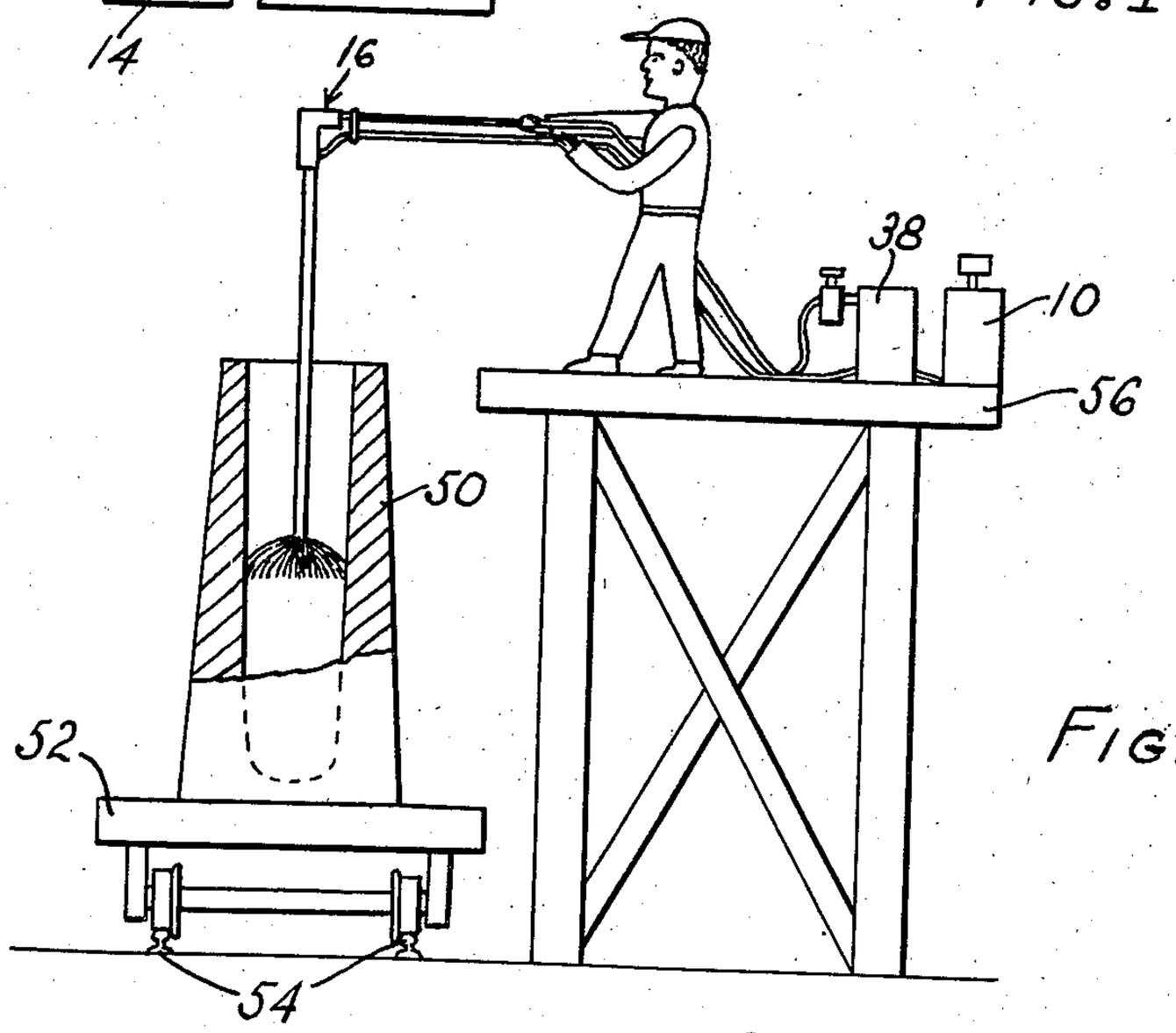

FIG. 2

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METHOD OF COATING INGOTS

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This invention relates to methods for casting ingots, and the like, and is concerned with methods for materially extending the life of ingot molds, and with methods for noticeably improving the character of the ingots cast in the ingot molds.

It has been proposed heretofore to coat the inside of an ingot mold prior to casting an ingot therein. In the commercial practice these methods have been limited to substantially the dry pitch or sugar dusting method and to the liquid tar blowing method. In the dry pitch or sugar dusting method one man inserts a regular air hose into the mold and swings the hose around and around to agitate the air, and at the same time another man dusts dry pitch or sugar into the molds with a dipper. The molds must be hot enough to melt the pitch or sugar onto the mold surface. However, if the mold is too hot the pitch or sugar burns away leaving only a carbonaceous residue which is injurious to an ingot surface, and with the steel of the ingot very possibly absorbing the carbonaceous residue to alter the chemical characteristics of the steel ingot. If the mold is too cold the pitch or sugar will not be deposited on the mold but will collect in a large puddle at the bottom of the mold (as it sometimes does even though the mold is of the proper coating temperature) and this puddle of mold coating material at the bottom of the mold will splash and even explode when the molten steel is first poured into the ingot mold, and thereby provides a very dangerous and unsatisfactory condition. In any event, the very haphazard coating achieved by the procedure just described invariably results in a non-uniform coating on the ingot mold surface even though the ingot mold is of exactly the proper temperature to melt the dry pitch or sugar without burning. Uneven coating on the ingot mold surface results in a non-uniform action on the ingot cast with too much coating material in some parts of the ingot mold and too little coating material in other parts of the mold.

The liquid tar blowing method of coating ingot molds also requires the services of two men, one to insert the end of a hose into a bucket of heated tar and to control the supply of hot tar, and the other to handle a blow pipe adjacent the mold and through which compressed air is passed. The hose from the tar bucket is connected to the blow pipe so that the passage of air through the pipe causes a suction in the hose from the tar bucket to pull tar into the blow pipe. The blow pipe is inserted into the ingot mold and moved around therein to effect a coating operation, and the tar hose is inserted into the pail of heated tar intermittently causing a bubbling and intermittent type of flow of tar in the tar hose. The result is a non-uniform and uncontrolled type of coating action with the emission of very considerable smoke and offensive fumes. In this method of liquid tar blowing an atomizing or spraying action is not achieved, but the air blown through the blow pipe merely serves to scatter the tar around. One very definite fault of this liquid tar blowing method is that the coating applied is much too heavy, and in this connection I have found that a very thin coating is decidedly superior to a thick coating which may have an adverse gaseous bubbling action and which may alter the chemical analysis of the ingot cast in the coated mold. This is particularly true in dead-killed steels and in the higher alloy steels.

Problems of too hot or too cold ingot molds adversely effect the liquid tar blowing method of coating ingot molds, and with the molds too hot the liquid tar may be burnt off to form a carbonaceous residue which is undesirable for reasons discussed above. If the molds are too cold the liquid tar may not properly adhere to the inner surface of the mold. In any event, and in the practice of the described methods of ingot mold coating several steel companies have gone so far as to build ingot molds preheating plants for bringing the ingot molds to exactly the desired temperature prior to coating the molds. This operation entails a considerable cost factor to say nothing of the initial and maintenance cost of the heating apparatus itself.

In times of ordinary production requirements of steel most of the steel manufacturing companies have a sufficient number of ingot molds so that the ingot molds return to atmospheric temperature between ingot casting operations. This has been the reason that ingot mold preheating apparatus has been required in the manner described in the preceding paragraph. However, with large production requirements or with an insufficient number of ingot molds available the usual result is that the ingot molds must be used to cast additional ingots so soon after previous casting operations that the ingot molds never return to atmospheric temperature. It is possible to coat ingot molds with the known methods if the ingot molds do not exceed temperatures of approximately 350 degrees Fahrenheit. However, in large steel production operations many of the ingot molds are being returned to be used for casting with the ingot molds at

temperatures of over 350 degrees Fahrenheit. It is substantially impossible to coat ingot molds with known methods when the ingot mold has a temperature of more than about 350 degrees Fahrenheit. It is therefore necessary to allow the mold temperature to drop by natural cooling or by artificial means to a temperature below 350 degrees Fahrenheit if the ingot mold is to be coated, or, as is often done, the coating operation is dispensed with and the steel is cast directly in the uncoated ingot mold. It is now well understood that ingot mold life is materially reduced if the mold is not coated.

It is the general object of my invention to avoid and overcome the foregoing and other difficulties of and objections to known ingot mold coating methods by the provision of an improved ingot mold coating method for quickly and uniformly coating an ingot mold whether hot or cold.

Another object of my invention is the provision of an ingot mold coating method whereby the ingot mold can be properly and uniformly coated even though it is at a temperature of up to about 800 degrees Fahrenheit.

Another object of my invention is the provision of a method for coating ingot molds whereby the coating material is atomized and deposited as a very fine film of uniform thickness on the ingot molds.

Another object of my invention is the provision of a method of coating an ingot mold in less than about 30 seconds and so that each square foot of mold surface has deposited thereon less than about .01 pound of coating material.

Another object of my invention is the provision of a method of coating ingot molds and the like and whereby the coating material is atomized and directed to coating position by an inert gas, such as carbon dioxide, so as to materially reduce the burning off of the coating at elevated mold temperatures.

Another object of my invention is the provision of a method of coating an ingot mold wherein the air normally within the ingot mold is displaced by an inert gas and then the entire mold surface is sprayed with atomized coating material.

Another object of my invention is the provision of a mold coating method including the steps of spraying atomized coating material in the form of substantially a circular cone and effecting relative movement between the axis of the cone and the axis of the mold to uniformly coat the entire mold surface.

Another object of my invention is the provision of a mold coating method which can be quickly and uniformly practiced by a single operator, and which substantially eliminates supplemental mold heating or cooling equipment.

The foregoing objects of my invention, and other objects which will become apparent as the description proceeds, are achieved by the provision of a coating method which includes the steps of standing the ingot mold upright, atomizing a liquid coating material with a gas, directing the atomized liquid coating material with the atomizing gas so as to form a fully circular substantially conical fine spray, effecting relative movement between the spray and the ingot mold axially of the mold and at a speed so that substantially the entire inner surface of the ingot mold is coated in less than about 30 seconds and so that each square foot of mold surface has deposited thereon less than about .01 pound of coating material. I particularly contemplate that the atomizing gas be an inert gas, such as carbon dioxide, specifically when the mold coating operation is to be performed upon ingot molds having a temperature higher than about 350 degrees Fahrenheit. Further, I may displace the air normally present in the ingot mold with an inert gas heavier than air, such as carbon dioxide, for operations upon ingot molds of a temperature higher than about 350 degrees Fahrenheit.

For a better understanding of my invention reference should be had to the accompanying drawing wherein Fig. 1 is a side elevation of a typical apparatus adapted to practice the method of my invention; and Fig. 2 is a side elevation rather diagrammatically indicating the manner of practicing the method of my invention.

Having particular reference to the drawing, the numeral 10 indicates generally a storage tank for storing the liquid coating material. I should say here that the principles of my invention are broadly applicable to the handling and depositing of an ingot mold surface of any of a wide variety of coating materials. However, the method of my invention is best practiced in conjunction with the improved coating material including pigment, resin, drying oil, and thinner, all fully disclosed and claimed in Harold A. Kelly Patent No. 2,289,709. Associated with the storage tank 10 may be any suitable agitating mechanism 12. The storage tank 10 is adapted to be connected by a suitable conduit 14, usually of flexible character, with an atomizing and spraying apparatus indicated as a whole by the numeral 16.

The apparatus 16 includes a long handle portion formed of a pair of pipes 18 and 20 connected together by clips 22 and a casting 24 so that the pipes 18 and 20 are held in parallel relation. The conduit 14 is connected to the pipe 20 and the pipe 20 in turn extends to a spray gun 26 of the atomizing type and controlled by a trigger 28. The spray gun 26 has a long nozzle portion 30 terminating in a discharge head 32. The nozzle 30 is approximately as long as the depth of the ingot mold to be coated, for example, usually about 6 feet. The pipes 18 and 20 connected to the gun 26 are generally about 4 feet long, and are positioned, as shown, at right angles to the nozzle 30 so that the apparatus is adapted to the mold coating operation, as hereinafter particularly described.

The pipe 18 is connected to the spray gun 26 in the manner shown, and at its other end is connected to a conduit 34 of flexible character which in turn extends to a suitable source of gas under pressure. If the gas employed is air the conduit 34 will be connected to the usual air supply line (not shown) in the plant where the equipment is used. If the gas employed is carbon dioxide or other inert gas the conduit 34 extends, as illustrated in the drawing, to a gas transformer 36 adapted to control the pressure of gas flowing to the conduit 34. The gas transformer 36 is connected to a suitable gas storage tank 38 which may or may not have a conduit 40 extending to a source of additional gas.

The trigger 28 of the spray gun 26 is conveniently controlled by a rocking lever 42 pivoted to the pipe 20 and connected by a pull rod 44 to a handle 46 pivotally secured, as at 48 to a bracket 50 extending up from the casting 24.

Turning now to Fig. 2 of the drawing, the nu-

meral 50 indicates an ingot mold, partly broken away in section, adapted to be treated by the coating method of my invention. The ingot mold 50 is carried in an upright position upon any suitable type of flat car, drag, or dolly 52, and usually adapted to mount a plurality of molds along in side by side relation. Ordinarily, a plurality of the flat cars 52 are connected in end to end relation for movement along a track 54 which runs parallel to an elevated platform 56 so that once a row of ingot molds 50 have been moved into position along side of the platform 56 an operator can walk along the platform and perform a mold coating operation upon each ingot mold in turn. Fig. 2 illustrates generally the manner in which an operator will employ the apparatus of Fig. 1 to achieve a mold coating operation. Specifically, the operator grasps the handle portion of the apparatus provided by the pipes 18 and 20 and holds the handle portion substantiatlly horizontal to the ground with the nozzle portion 30 of the apparatus extending in a substantially vertical position. Now the operator will position the nozzle 30 axially of the ingot mold cavity and will move the head 32 of the nozzle 30 down to the bottom of the mold. Thereafter, the operator will depress the handle 46 to operate the trigger 28 of the spray gun 26 and the apparatus will throw a fully circular substantially conical or umbrella like spray of finely atomized liquid coating material out against the sides of the ingot mold. The operator will then raise the apparatus to effect relative movement of the nozzle with respect to the axis of the mold, and preferably the apparatus is raised by the operator at a speed so that the entire inner surface of the ingot mold is coated in less than about 30 seconds. The apparatus is adapted to very finely atomize the liquid coating material with the gas from the storage chamber 38, and with the same gas being used to direct the finely atomized liquid coating material against the inner walls of the ingot mold being coated. The speed of movement of the atomizing and spraying apparatus with respect to the inside of the mold is such that no square foot of ingot mold surface receives more than about .01 pound and never more than .015 pound of coating material in the dried on state, and usually about .005 pound of coating material per square foot of ingot mold surface. I have found that one gallon of the improved liquid coating material disclosed and claimed in Mr. Kelly's above identified patent will coat 10 to 12 ingot molds each having a cavity approximately 25 inches in diameter and 72 inches in depth. It should be recognized that the human element in production operations may cause the number of molds treated with a gallon of coating material to be more or less than the last indicated number. Further, I have found that one man can coat a complete drag of approximately 35 molds in 8 to 10 minutes or less by my improved method so that the actual spraying time per each ingot mold is often closer to 15 seconds than to 30.

The method and apparatus just described is adapted to be employed with air as the atomizing gas when performing coating operations on ingot molds below temperatures of about 350 degrees Fahrenheit. In operations upon ingot molds having temperatures of greater than 350 degrees Fahrenheit, and up to about 800 degrees Fahrenheit or more, the atomizing gas employed is an inert gas, such as carbon dioxide. I have found that when employing an inert gas to atomize the liquid coating material and to spray the atomized coating material against the ingot mold cavity surfaces that a very definite flash resistant result is obtained. I believe that this result is due to the fact that the atomized liquid coating material is substantially surrounded by and directed by the inert gas which excludes the presence of air or oxygen from contact with the liquid coating material so that it can be deposited upon ingot mold cavity walls even though these cavity walls are at temperatures which would be sufficient to flash or ignite the coating material if air or oxygen were preesnt adjacent the material. Further, I believe that the inert gas used to atomize and direct the coating material against the ingot mold walls is absorbed to a considerable extent in the liquid coating material and is, in fact, deposited therewith so that the inert gas acts as a deoxidizer and makes the burn off temperature of a coating material higher. In other words, the relatively thin layer of uniformly applied coating material of my invention does not burn off of the ingot mold surface in advance of the molten steel in the same way that results with other mold coating materials and applied by different methods.

When operating upon ingot molds having relatively high residual temperatures prior to coating, for example, temperatures of over 350 degrees Fahrenheit, and up to or over 800 degrees Fahrenheit, it is sometimes advisable to displace the air from the inside of the ingot mold by an inert gas prior to coating the ingot molds. This may be achieved in a plurality of ways, but I particularly contemplate directing the inert gas into the ingot mold by means of the apparatus 16 with the apparatus being adjusted so that no liquid coating material is atomized and injected into the ingot mold until a considerable proportion of the air in the ingot mold has been displaced by the inert gas, usually, an inert gas having a greater specific gravity than air, for example carbon dioxide. Again, I may introduce into the ingot mold an additional conduit which will displace the air from the inside of the ingot mold prior to the atomizing and spraying of the ingot mold with the liquid coating material. Finally, I may throw several pieces of dry ice, solidified carbon dioxide, into the bottom of each ingot mold a minute or so prior to atomizing and spraying a liquid coating on the ingot mold surfaces.

When inert gas is employed to atomize and spray the coating material or when inert gas is used to displace the air inside of the mold prior to coating or when a combination of these methods is employed I usually position a sheet of metal over the top of the ingot mold until the ingot casting operation so that substantially no inert gas will escape from the mold before ingot casting. This further eliminates any possible flash or explosion.

From the foregoing it will be recognized that the various objects of my invention have been achieved by the provision of an improved, relatively inexpensive, easily practiced method whereby a single operator can uniformly and efficiently coat a large plurality of ingot molds. The ingot molds can be uniformly and properly coated substantially irregardless of the ingot mold temperature, and even though this temperature ranges from atmospheric temperature of less than 32 degrees Fahrenseit up to temperatures of 800 degrees Fahrenheit or even more.

A very finely divided and atomized coating is provided of relatively thin but uniform character over the entire mold surface which not only effects an economy of coating material but which has been found to be definitely superior to relatively thick non-uniform coatings and to avoid the formation of pockets of coating material which results in explosions and gives unsatisfactory cast ingot qualities. I have found that ingot molds treated in accordance with my invention and with the liquid mold coating material of the identified Kelly patent result in an increase in ingot mold life of three or even more times over the life of an uncoated ingot mold, and that the ingots produced in the coated molds have noticeably less surface defects than those produced in uncoated molds or produced in molds coated by the dry pitch or sugar dusting method or by the liquid tar blowing method. In fact, the savings resulting from the improvement in cast ingot quality have been found to pay many times over for the mold coating costs.

While in accordance with the patent statutes I have specifically illustrated and described at least one embodiment of my invention, nevertheless it is to be particularly understood that I am not to be limited thereto or thereby, but that the scope of my invention is defined in the appended claims.

I claim:

1. That method of coating ingot molds which includes the steps of standing the ingot mold upright, atomizing a liquid coating material with an inert gas, directing the atomized liquid coating material with the atomizing gas so as to form a fully circular substantially conical fine spray, effecting relative movement between the spray and the ingot mold axially of the mold and at a speed so that substantially the entire inner surface of the ingot mold is coated in less than about 30 seconds and each square foot of mold surface has deposited thereon less than about .01 pounds of coating material.

2. That method of coating ingot molds which includes the steps of standing the ingot mold upright, atomizing a liquid coating material with an inert gas, directing the atomized liquid coating material with the atomizing gas so as to form a fully circular substantially conical fine spray, and effecting relative movement between the spray and the ingot mold axially of the mold.

3. That method of coating ingot molds which includes the steps of standing the ingot mold upright, atomizing a liquid coating material with carbon dioxide gas, directing the atomized liquid coating material with the carbon dioxide gas so as to form a fully circular spray, moving the spray upwardly through the ingot mold at a speed so that each square foot of mold surface has deposited thereon less than about .01 pound of coating material.

4. That method of coating molds which includes the steps of atomizing a liquid coating material with an inert gas, directing the atomized liquid coating material with the inert gas so as to form a spray, and effecting relative movement between the spray and the mold to coat the surface of the mold.

5. That method of casting an ingot which includes the steps of standing an ingot mold upright, displacing the air from the mold cavity by an inert gas, atomizing a liquid coating material with an inert gas, directing the atomized liquid coating material with the atomizing inert gas through the inert gas in the mold cavity and against the mold cavity surface to form a coating thereon, covering the ingot mold to prevent the escape of inert gas from the cavity thereof until the ingot is cast, removing the cover, and casting molten metal in the mold.

6. That method of coating an ingot mold which includes the steps of standing an ingot mold upright, displacing the air from the mold cavity by an inert gas, atomizing a liquid coating material with an inert gas, directing the atomized liquid coating material with the atomizing inert gas through the inert gas in the mold cavity and against the mold cavity surface to form a coating thereon.

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