

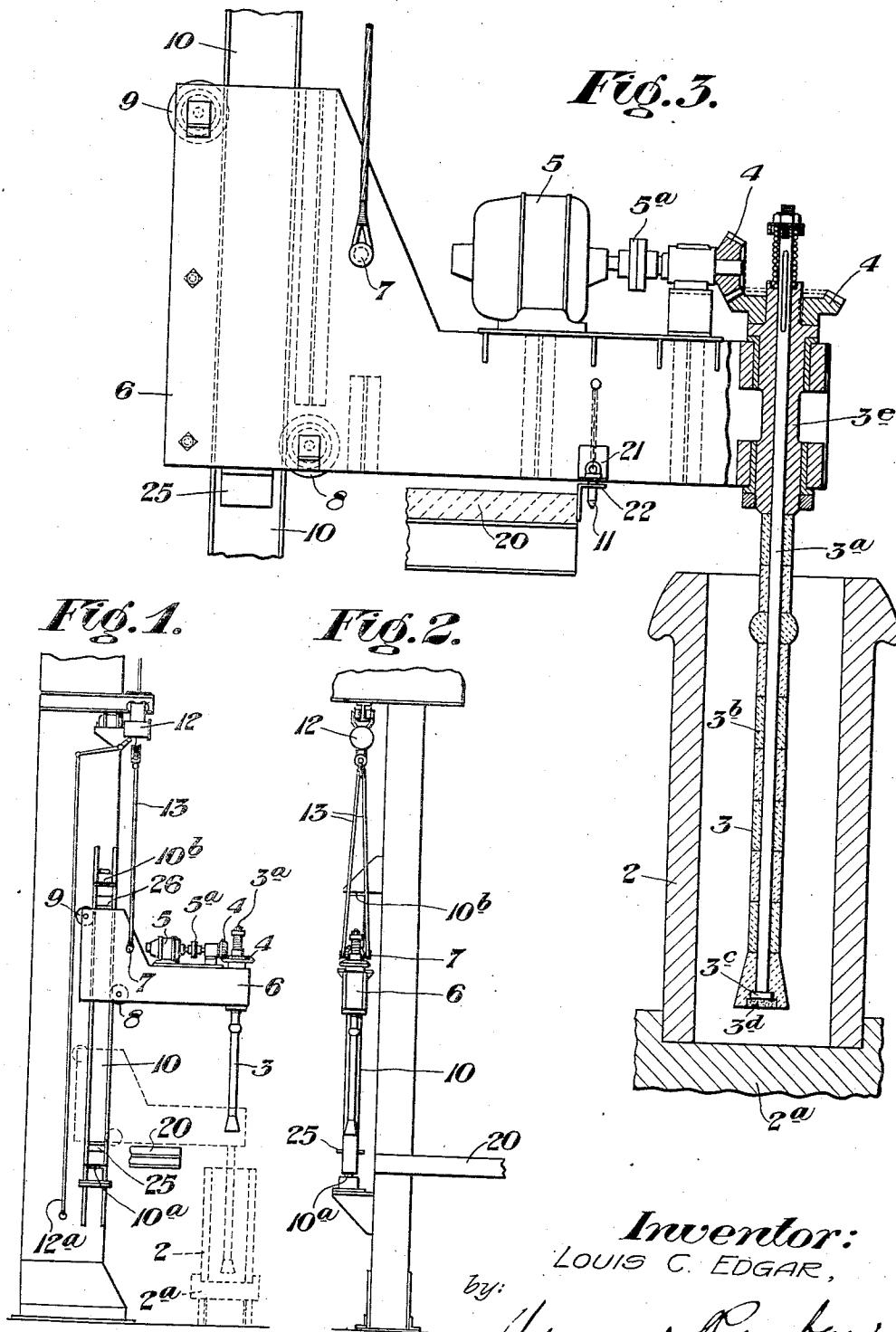
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APPARATUS FOR TREATING INGOTS

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APPARATUS FOR TREATING INGOTS

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This invention relates to a method of and apparatus for treating ingots in order to reduce or eliminate blowholes, segregation and piping found in ingots cast in the usual manner.

The ingot molds in common use are tall, box-like shapes made of cast iron and open at both ends, one end of which is smaller than the other to give the mold a slight taper. The molds generally have a square or rectangular section rounding at the corners and when in use one end, usually the larger, is closed by a stool on which the mold stands in an upright position. As soon as the molten steel or metal is poured into the mold the metal next to the mold and stool solidifies at a rapid rate.

During the process of making steel, there is evolved large quantities of gases, some of which pass out of the liquid mixture during the refining process while in the furnace and ladle, while other gases are retained and do not pass out of the metal until solidification occurs. These latter gases are retained within the molten metal due to their density, and it is a known fact that the density of gas bubbles within a liquid increases as their size diminishes, due to the surface tension or sphere of molecular attraction of surrounding liquid. Therefore, as the liquid contains a great many very small gas bubbles, their density approaches the weight or density of the surrounding liquid with the result that their buoyancy is very slight. It is the object of this invention to remove the gases contained in the small bubbles or spheres within the molten metal prior to the solidification of the ingot.

When the process of solidification or crystallization starts the surface tension or sphere of molecular attraction is broken down and the gas pressure reduced, and the coalescing of these minute particles of gases form the cavities or blowholes appearing in the ingot as a part of the coalesced bubbles are trapped by the rapidly solidifying mass of metal. The trapping action of the metal may be diminished by retarding the speed of solidification by mixing the relatively hot steel in the center of the ingot with the cooler steel

against the walls of the molding stool as it is solidifying. This retarding action will give time for the coalesced bubbles to escape.

Steel, particularly liquid steel, is also characterized by the presence of gaseous impurities, which gases, frequently called "occluded" gases and comprising chiefly hydrogen, nitrogen, carbon monoxide and probably oxygen in the form of FeO , may pass out of the liquid mixture during the refining process in the furnace or ladle, or some may be retained and not pass out of the metal before solidification occurs.

The very small proportion of impurities generally found in steel of good quality has very little injurious effect upon its physical properties so long as the steel is chemically homogeneous, i. e., so long as such impurities are uniformly distributed throughout the metallic mass. These impurities become extremely injurious, however, when they show a tendency to segregate or to collect in certain portions of the metallic mass. With sufficient segregation there results a metal which is generally very brittle, weak and hard, and which has substantially little or no actual utility.

The present invention has for one of its objects the treatment of a casting during the solidification thereof which will minimize the objections due to the segregation of impurities. In its broader aspects, the invention contemplates the agitation of a mass of molten metal either during or after the teeming operations have been completed, from a point wholly within the casting, in such manner that the rapidity with which localized solidification occurs, such, for example, as that responsible for the initial skin formation, is retarded. In this manner there is afforded an opportunity for the escape of the gaseous impurities from the surface region of the casting, with a consequent reduction in the possibility of forming blow holes at or adjacent such region wherein surface oxidation readily occurs.

More specifically, my invention contemplates agitation, by stirring, of the teemed metal in such manner as to not only retard localized solidification, but to disturb or dis-

rupt the viscous or retaining nature of the metal so that "enclosures," "inclusions" and "occlusions" are not so readily obtained. At the same time, the stirring results in a substantially uniform distribution of the remaining impurities throughout the metallic mass, in such manner as to decrease to a minimum their deleterious effects.

Such stirring further produces desirable results in that it accomplishes a metal diffusion such that dendritic segregation is largely prevented, and a chemically homogeneous dendrite or dendritic structure is obtained.

Still further objects of this invention will be apparent from the detailed description contained in the following specification.

In the drawing:

Figure 1 is a side elevation of an apparatus used in carrying out the method of this application with the stirring mechanism shown in its foremost position in full lines.

Figure 2 is a front elevation taken at right angles to Figure 1.

Figure 3 is an enlarged detailed side elevation, partly in section, showing the stirring rod loaded into an ingot mold.

Referring more particularly to the drawing, the numeral 2 designates an ingot mold of standard design supported on the usual stool 2^a which closes the bottom of the mold. The agitating shaft or rod, which is revolved in the molten metal within the mold, is designated by the numeral 3 and comprises a central metal stem member 3^a which is enclosed within the sectional refractory casing 3^b composed of stopper brick. The lower end of the stem 3^a is added, as at 3^c, to support the casing member or brick 3^b and the lower brick is closed by a refractory filling 3^d to protect the stem 3^a from the molten metal of the ingot. The upper portion of the stem 3^a is keyed in a suitable bearing 3^e journaled in a bearing opening in a carriage member 6. A suitable motor 5 is mounted on the carriage 6 and has a drive connection to the upper end of the stem 3^a through a coupling 5^a and gears 4.

The carriage 6 is mounted for vertical movement on a supporting column 10 of H or I cross-section, and is provided with flanged wheels 8 and 9 for movement on the column 10. The column 10 is mounted for pivotal movement about its vertical axis by bearing members 10^a and 10^b at its bottom and top ends, respectively. A suitable hoisting cable is anchored to the carriage 6 at a point 7, and is adapted to be connected to a standard form of hoisting mechanism 12 for raising and lowering the carriage on the column 10. The hoisting mechanism 12 is provided with control ropes or cables 12^a which extend downwardly within reach of an operator on the floor.

The pouring platform from which the

metal is poured into the ingot molds is designated at 20. A suitable lock is provided, composed of overlapping angles 21 and 22 which are mounted on the carriage 6 and the floor 20, respectively, and a pin 11 is provided for locking the carriage 6 in alined position with the ingot mold into which the rod 3 is adapted to be rolled.

Suitable stop lugs 25 and 26 are provided on the column 10 to limit the movement of the carriage 6 in both down and up positions, and suitable limit switches will be provided as is usual on the standard hoisting mechanism 12 for stopping the hoisting mechanism prior to the engagement of the carriage 6 with the stops or lugs 25 and 26.

In carrying out the method of this invention the ingot mold 2 will be positioned to receive the metal from the ladle in the usual manner. As soon as the mold is filled with the molten metal, solidification commences at that part of the metal in contact with the mold and stool. Therefore, as soon as possible after the mold has been filled the carriage 6 will be rolled into position with the rod 3 immersed in the molten metal, and the motor 5 will be started to revolve the rod 3 and thereby agitate the molten metal in the mold. This agitation of the molten metal will diminish the speed of solidification and transmit mechanical action to the bubbles of gases within the metal so as to aid in coalescing the bubbles and assist said bubbles to escape prior to the solidification of the metal.

Experience has shown that the agitation of the molten metal prevents the formation of the tube-like cavities that extend at right angles to the skin wall of the ingot and toward the center, and other defects which are due to retained gases in the ingot cast in the usual manner and without agitation.

To those skilled in the art, it will be apparent that the agitating or stirring mechanism above described may be readily brought into the desired cooperative relation to a mold so as to permit the desired agitation or stirring whenever desired.

The stirring mechanism may be positioned within the mold during the teeming operation so as to be effective on the metal substantially as soon as it is received by the mold, or it may be inserted into the metal immediately upon the conclusion of the teeming process. In many cases, since it is desirable to institute the agitation as soon as possible, the first mentioned procedure will be practiced so as to insure the prevention of localized solidification and the desired escape and distribution of impurities as well as the desired metal diffusion.

As the solidification progresses, the agitating mechanism may be progressively raised until it is ultimately withdrawn from the mold at such time as it has served its full purpose.

While I have shown and described one specific embodiment of my invention and specific steps of the method it will be understood that I do not wish to be limited thereto, since various modifications may be made without departing from the scope of my invention, as defined in the appended claims.

I claim:

1. Apparatus for stirring molten ingots, including the combination of a movable carriage, means for moving said carriage vertically, a stirring rod depending from said carriage and including a metal stem covered by brick elements, and means on said carriage for imparting stirring movement to said rod.

2. Apparatus for stirring molten ingots, including the combination of an upright column, a carriage fixed to said column for

vertical movement, means for vertically moving said carriage, a rotative stirring rod depending from said carriage and including a metal stem covered with brick elements, and means on said carriage for imparting stirring movement to said rod.

3. Apparatus for stirring molten ingots including the combination of an upright rotative column, a carriage fixed to said column for vertical movement, means for vertically moving said carriage, a rotative stirring rod depending from said carriage and including a metal stem covered with brick elements and means on said carriage for imparting a stirring movement to said rod.

In testimony whereof, I have hereunto set my hand.

LOUIS C. EDGAR.

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