Sept. 4, 1973 J. J. A. ORMAECHEA 3,756,805

METHOD OF PRODUCING LEAD-BEARING STEEL

Filed Oct. 9, 1970 3 Sheets-Sheet 1

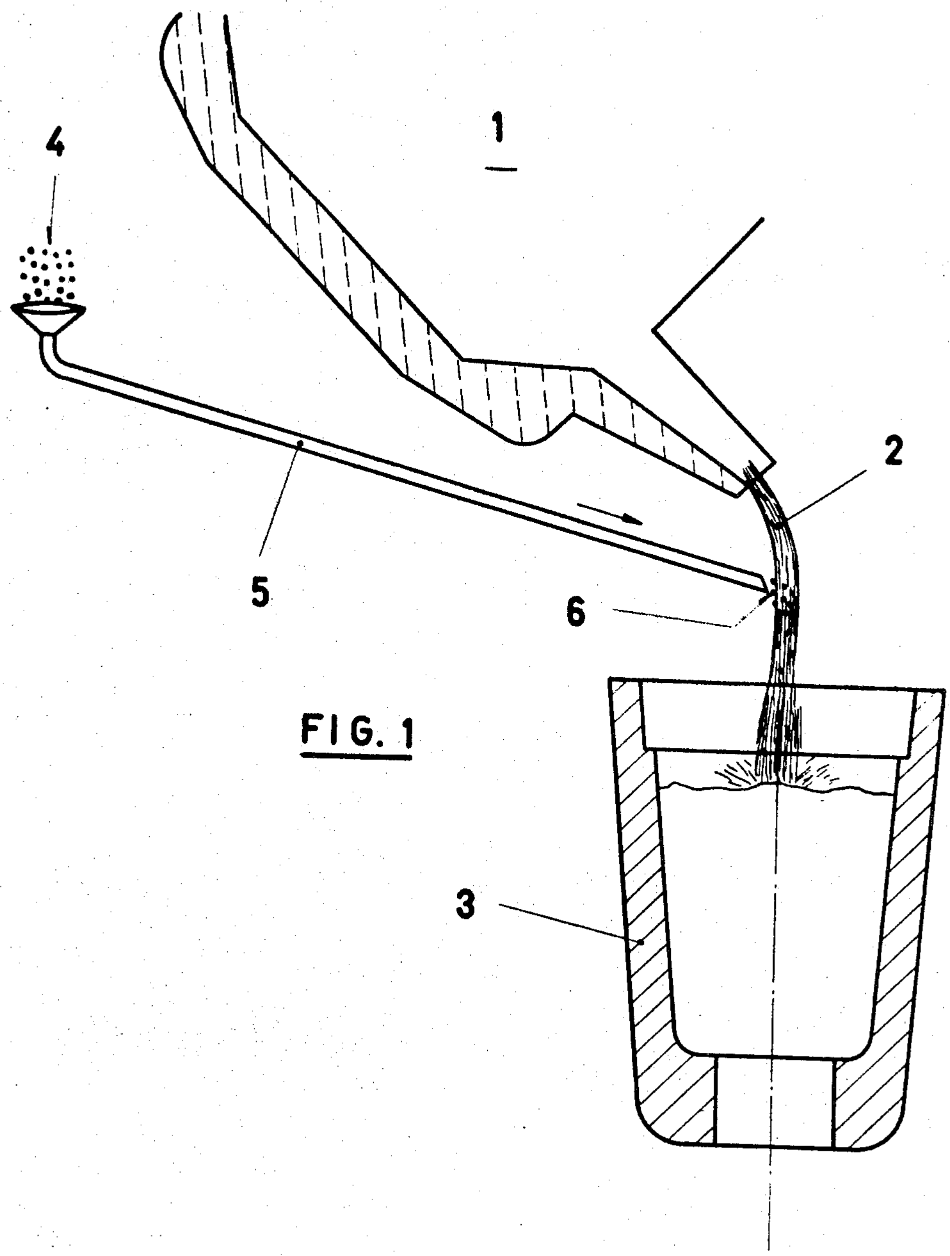


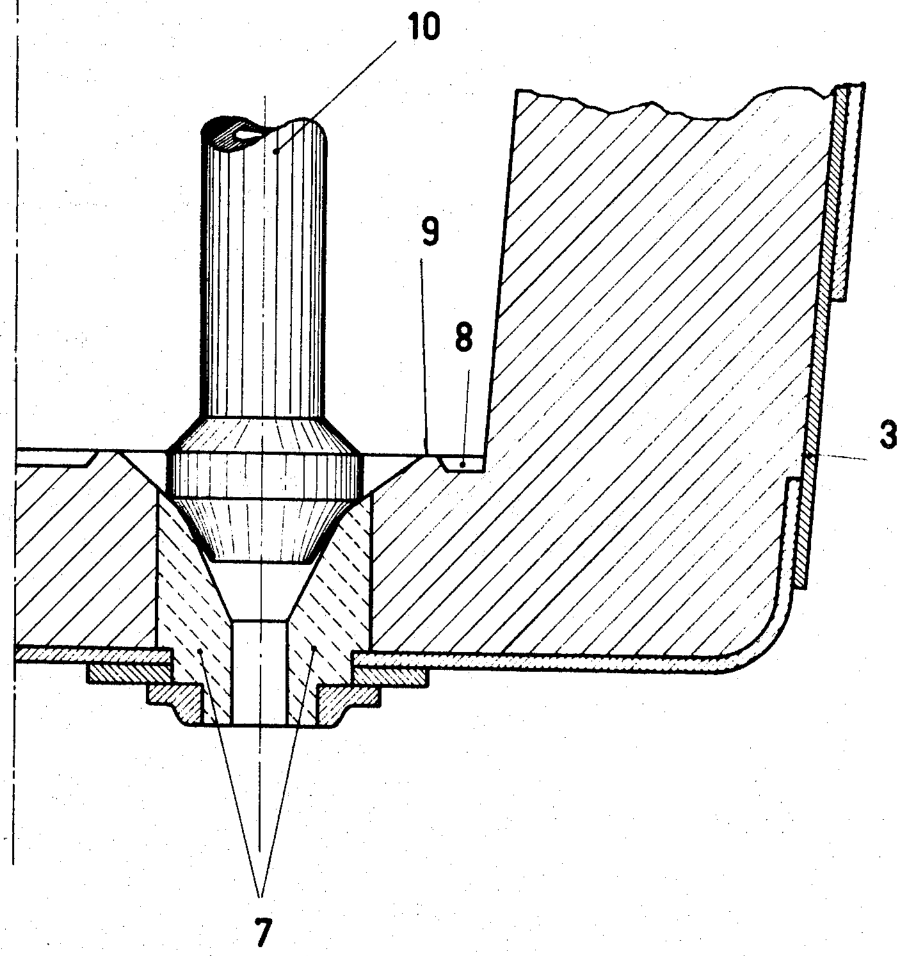
FIG. 1

Inventor:
Jose Joaquin Aguirre Ormaechea
By Innocent Montagne
attorney

METHOD OF PRODUCING LEAD-BEARING STEEL

Filed Oct. 9, 1970 3 Sheets-Sheet 2

FIG. 2



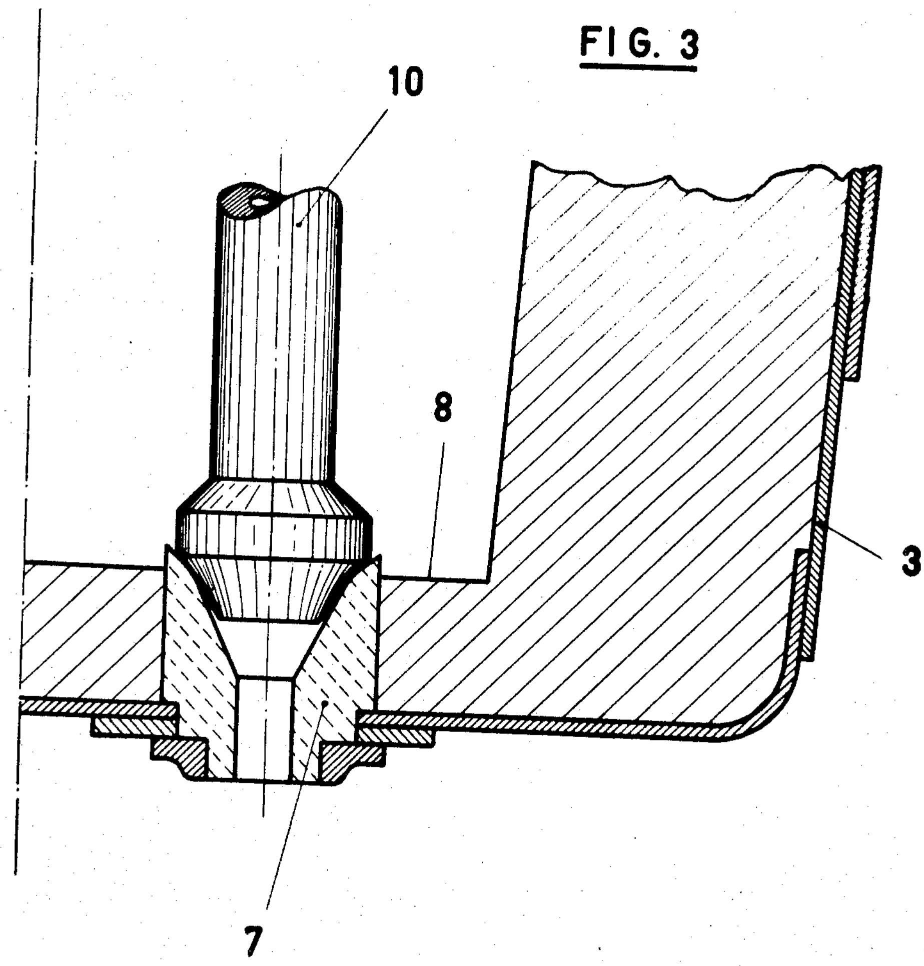
Inventor.
Jose Joaquin Aguirre
Ormaechea
By Ernest F. Montague
Attorney

Sept. 4, 1973 J. J. A. ORMAECHEA 3,756,805

METHOD OF PRODUCING LEAD-BEARING STEEL

Filed Oct. 9, 1970 3 Sheets-Sheet 3

FIG. 3



Inventor:
Jose Joaquin Aguirre Ormaechea
By Ernest G. Montague
Attorney

United States Patent Office

3,756,805
Patented Sept. 4, 1973

1

2

3,756,805

METHOD OF PRODUCING LEAD-BEARING STEEL

Jose Joaquin Aguirre Ormaechea, Independencia 1, Vitoria, Spain

Filed Oct. 9, 1970, Ser. No. 79,529
Claims priority, application Spain, Feb. 3, 1970, 376,188
Int. Cl. C22c *39/54*
U.S. Cl. 75—58 5 Claims

ABSTRACT OF THE DISCLOSURE

Method for producing lead-bearing steel and the product produced thereby comprising discharging a stream of molten steel from a melting furnace to a ladle, and adding lead to the stream of molten steel as it is being discharged from the melting furnace at temperatures above 1600° C. and controlling the temperature of the bath, and dissolving oxygen in the bath in the ladle in order to favor the formation of lead-oxide.

The present invention relates to an improved method of making steel and a product produced thereby.

The present invention relates particularly to the manufacture of lead-bearing steels, having a lead content of between 0.10 and 0.8% which is distributed finely and homogeneously throughout the entire mass of the steel.

As is well known, lead-bearing steels have a greater machinability, when worked on chip-producing machine-tools, than steels of the same basic composition that do not contain lead.

Known classical methods of producing lead-bearing steels are based upon the hiterto accepted supposition that lead is insoluble in steel.

In order to produce, by classical methods, lead-bearing steels having an adequate degree of homogeneity, it has been thought necessary to add the lead in the form of granules, just before the steel solidifies, with the object of avoiding segregation of the lead due to gravity and as a result of the substantial difference between the density of steel and of lead. Consequently, in the classical method, the granules of lead are added to the molten material at the moment at which it is poured into the mold.

Contrary to the method of the present invention, the classical methods require precise co-ordination of the stream of granules and the stream of molten steel at the moment when addition takes place, and this calls for very great care as well as a high degree of professional skill on the part of the personnel in charge of the process of manufacture.

Nevertheless, the principal drawback to the methods hitherto used resides in the fact that, with these methods, it is not possible to produce steels in which the lead is distributed in a homogeneous manner. This segregation of lead of varying intensity always occurs, as well as agglomerations of this element, which break up the metallic structure and lower the quality of the steel.

The presence of lead segregations and the lack of homogeneity in the distribution of the lead is manifested by a reduction in the mechanical properties of the steel, especially those measured in the transverse direction of the eventual billet or strip, as well as, in a substantial increase in the content of macro- and micro-inclusions.

The absence of homogeneity and the existence of segregations can be revealed by the Wragge impression or test, which, in the case of steel produced by the classical methods, disclose more or less discontinuous defects extending in the longitudinal direction of the eventual billet or strip. These do not appear when the same test is carried out on steel produced by the method of the present invention particularly disclosed herein. The lack of homogeneity can also be observed in a magnetoscope test for magnetic particles, and by microscopic examination.

Because the above-mentioned deficiencies, steel manufactured by the classical methods have generally been used for the production of parts subjected to low or medium load when in service.

It is an object of the present invention to provide a method of making lead-bearing steel, avoiding the above-mentioned disadvantages, and in which solid or liquid lead is added to a stream of molten steel as it is discharged from a melting furnace to a ladle.

With this and other objects in view which will become apparent from the following detailed description, the present invention will be clearly understood in connection with the accompanying drawings in which:

FIG. 1 is a schematic vertical longitudinal section through a melting furnace, a ladle and the means for adding the lead at the moment at which the metal is poured into the ladle and the addition of lead is made;

FIG. 2 is a schematic vertical longitudinal section through the ladle showing one construction thereof according to the present invention of the ladle outlet; and

FIG. 3 is a schematic vertical longitudinal section through the ladle showing another ladle outlet construction.

Referring now to the drawings, and more particularly to FIG. 1, there is shown a melting furnace **1**, from which a stream of molten steel **2** passes from the melting furnace **1** to a ladle **3**. A feed means **4** feeds a solid or liquid lead into a duct **5** which carries the lead to the molten stream of metal with which it joins up at point **6**.

The ladle outlet **7** is more particularly disclosed in FIGS. 2 and 3. FIG. 2 shows an arrangement in which a base **8** of the ladle has a projecting portion or upstanding rim **9**, whereby it is raised above the opening of the ladle outlet. In FIG. 3 there is shown another arrangement in which a sleeve **7** defining the ladle outlet has one end thereof raised above the flat base **8** of the ladle. A plug **10** is provided for opening and closing the ladle outlet.

The process according to the invention comprses adding solid or liquid lead to the stream of molten metal as the steel is poured from a melting furnace to a ladle. The lead is thus added under conditions in which the temperature and oxidation of the bath are controlled.

At the moment when the addition is made, the steel-bath should exhibit a presence of reactive oxygen sufficient to permit the formation of lead-oxide, the vapour of which is soluble in the molten steel. The lead-oxide formed has a low boiling point and causes bubbling of the steel bath which becomes saturated with this compound.

The bubbling caused by the lead-oxide vapour which passes through the bath and saturates it, reduces the content of oxygen, hydrogen and other gases dissolved in the steel, and thus indirectly improves the quality of the steel.

The amount of reactive oxygen necessary for the formation of lead-oxide will depend upon the composition of the steel, and care is taken not to add aluminium to the bath before the lead has been added.

In the case of aluminium-killed steels, aluminium is added to the metal in the ladle in the final stages. This constitutes no drawback since it corresponds to normal manufacturing procedure.

Table No. 1 shows the solubility of lead-oxide as a function of the temperature of the bath, as established on the basis of numerous tests:

TABLE NO. 1

Temperature of the bath in degrees C.:	Percent Pb dissolved in the form of PbO_2
1600	0.05
1610	0.08
1620	0.12
1630	0.17
1640	0.20
1650	0.22
1660	0.24

The solubility of lead in steel is independent of the composition of the steel and is determined solely by temperature.

The temperature at which the metal is poured into the ladle should be greater than 1600° C. and is governed by the percentage of lead required in the steel, as shown in Table No. 1.

As can be seen from the table, when the temperature of the bath drops below 1600° C., as occurs in most cases when the steel is still in the ladle, the solubility of the lead in the steel is practically zero. Under these conditions lead-oxide is precipitated in the form of a fine and homogeneous dispersion, the particles of which do not settle by means of gravity, so that the lead is homogeneously distributed after solidification has taken place.

The remainder of the lead, insoluble in the steel at the temperature at which the addition is made, forms relatively large droplets, which each settle by gravity over a period of time not greater than 5 minutes, and are deposited on the base of the ladle. Thus, after the lead has been added, a minimum period of about 5 minutes should be allowed to elapse so that this deposition can take place before the steel is poured into the mold.

The quantity of lead added in solid or liquid form should be greater than that theoretically required, and preferably should be 40% greater than the quantity that it is desired to incorporate in the steel.

The lead is added at the feed point via means **4** (FIG. 1) at a rate equal to that required at the upper part **6** of the stream of molten steel.

The rate of supply of the lead needed at the feed point **4** in FIG. 1 can be determined by simple tests, the aim being to have a supply of solid or liquid lead reaching the stream of molten metal during practically the entire period during which pouring takes place. Nevertheless, the system does not call for a high degree of co-ordination in this operation, since, as previously indicated, if too much lead is added this does not become incorporated in the bath but is deposited on the base of the ladle.

The method of the present invention does not require any high capital cost equipment. The only requirement is that of positioning the ladle outlet **7** or a rim **9** in such a way that it projects upward of or beyond the plane of the base **8** of the ladle **3**, thus preventing the lead, deposited on the base, from being entrained by the stream of steel which emerges through the mouth-piece **7** when casting takes place.

Despite the above-mentioned precautions, a small quantity of lead may be deposited directly on the surface of the ladle outlet. This lead can be eliminated simply by slight purging of the steel prior to casting it in the mold.

The method to which the present invention relates can be applied to all kinds of steel compositions and can be adopted in present-day steel-producing techniques.

The method of the present invention can be used in all the usual steel-making processes, for example, Siemens-Martin, electric furnace, L.D., continuous casting, or mold-casting by the siphon or direct methods.

These improvements result in advantages regarding an even and finely-dispersed distribution of the lead both at the top and the bottom of the ingot. Similarly, segregations do not occur either on the surface or in the middle of the ingot.

Consequently, ingots manufactured by the method of the present invention do not need to be end-cropped, as is the case with ingots manufactured by the classical methods.

In this connection, experience from numerous casting operations has shown that with the method of the present invention, an output can be obtained that is of the same order of magnitude as that obtained with steels of an identical basic compositions, but containing no lead.

The lead particles form a fine, homogeneous dispersion, the grain-size of which is often less than one micron.

Tests carried out so far using the new method in accordance with the present invention show that this particular method for the addition of lead has no adverse effect upon the fatigue behaviour of the steel or upon its mechanical properties.

While I have disclosed one example of the present invention, it is to be understood that this example is given by illustration only and not in a limiting sense.

I claim:

1. A method of producing lead-bearing steel, containing a uniform distribution of lead, comprising the steps of

discharging a stream of molten steel from a melting furnace into a ladle,

adding lead to said stream of molten steel at the moment as it is being discharged from said melting furnace between the latter and the ladle at temperatures above 1600° C. and controlling the temperature of the bath, and

dissolving oxygen in the bath in the ladle in order to favor the formation of lead-oxide.

2. The method, as set forth in claim **1**, wherein

sufficient lead is added to said stream of molten steel to provide a lead content of 0.10 to 0.80% by weight homogeneously distributed in said steel.

3. The method, as set forth in claim **1**, further comprising the step of

allowing the steel in said ladle to stand for at least 5 minutes before it is poured or tapped into a mold.

4. The method, as set forth in claim **3**, further comprising the step of

aluminium-killing said steel after it has been allowed to stand for at least 5 minutes and before it is poured or tapped.

5. The method, as set forth in claim **1**, further comprising the step of

preventing any deposited lead from being discharged from said ladle by catching said deposited lead in a projecting rim adjacent the discharge of the ladle.

References Cited

UNITED STATES PATENTS

2,197,259	4/1940	Nead	75—129
2,259,342	10/1941	Harder	75—129
2,595,292	5/1952	Reece	75—122
2,854,716	10/1958	Funk et al.	75—129
3,141,767	7/1964	Funk	75—129
3,260,591	7/1966	Brown et al.	75—129
3,634,075	1/1972	Hoff	75—135
3,671,224	6/1972	North	75—129

FOREIGN PATENTS

519,572	4/1940	Great Britain	75—123 F

L. DEWAYNE RUTLEDGE, Primary Examiner

U.S. Cl. X.R.

75—129