July 21, 1964 C. R. FUNK 3,141,767

STEEL CASTING PROCESS AND APPARATUS

Filed Sept. 29, 1960 2 Sheets-Sheet 1

FIG. 1

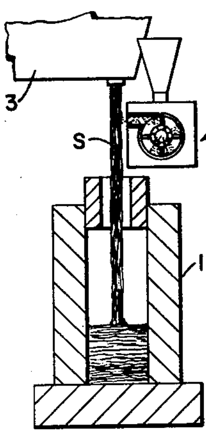
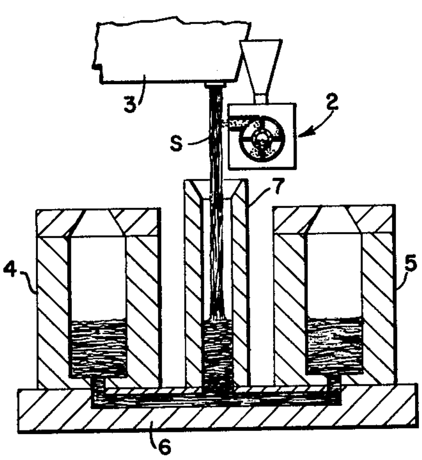



FIG. 2



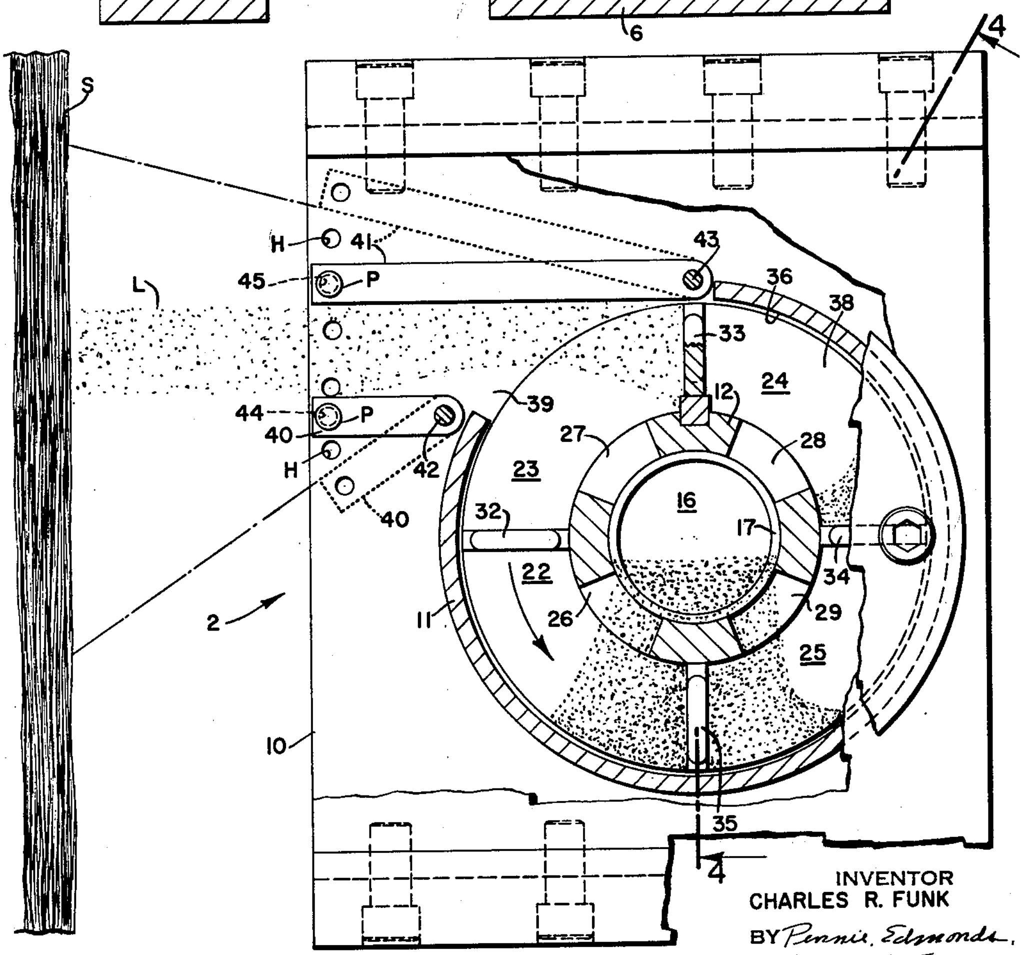




FIG. 3

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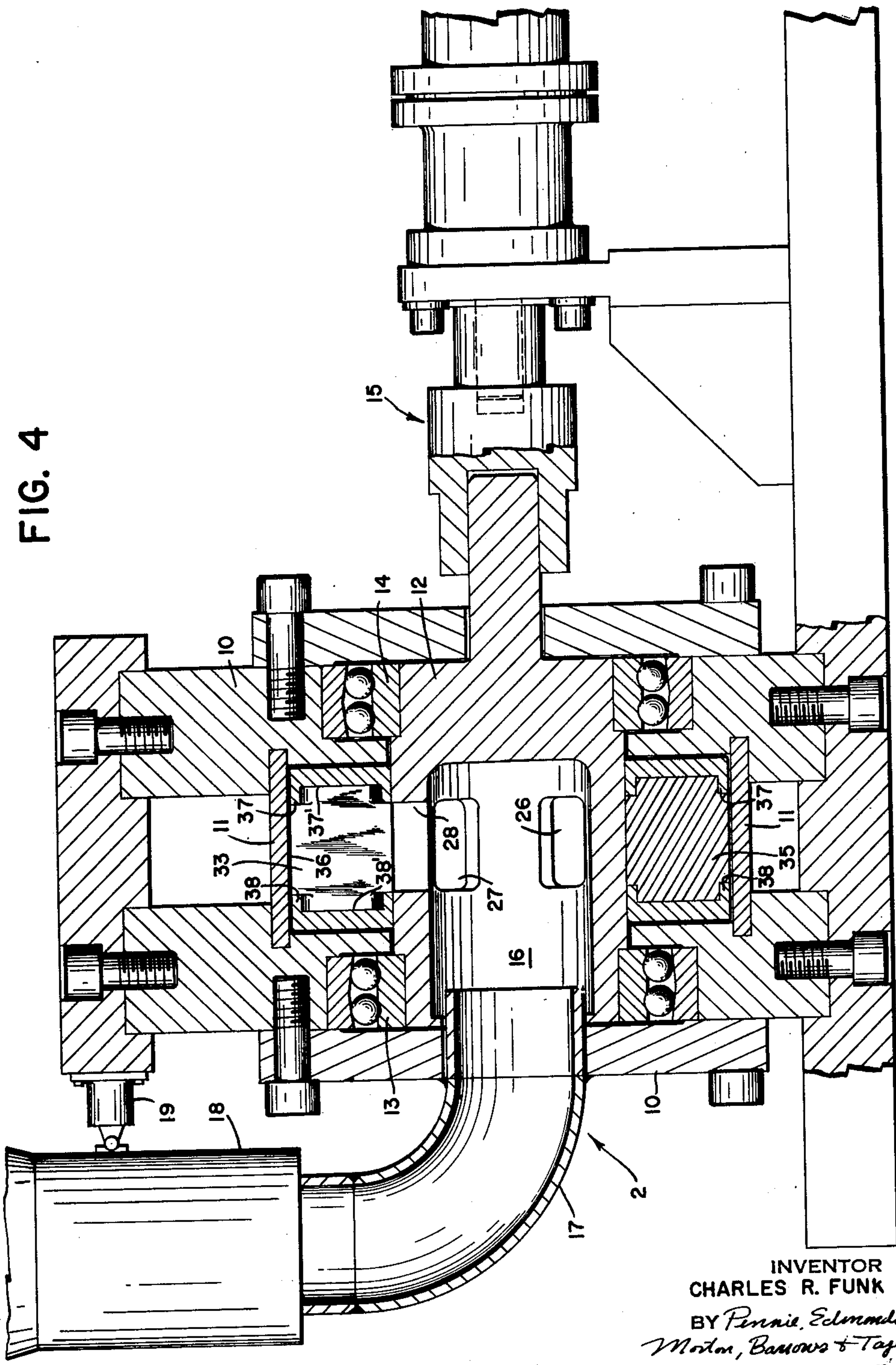
STEEL CASTING PROCESS AND APPARATUS

Filed Sept. 29, 1960 2 Sheets-Sheet 2

FIG. 4

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# STEEL CASTING PROCESS AND APPARATUS

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This invention relates to leaded steel, which is an alloy of steel containing small percentages of lead, and has for its object the provision of an improved process for producing such steel and apparatus for injecting the lead in particulate form into molten steel.

The production of leaded steel by present practices is not entirely satisfactory and has at least two principal difficulties. One of these has to do with segregation of the lead with a resulting lack of metal uniformity. Another has to do with oxidation of the lead on its contact with the hot steel forming vapors of lead oxide, a toxic oxide material which contaminates the atmosphere, is dangerous to the workmen, and requires expensive ventilating equipment.

It has been the practice heretofore to add lead pellets (shot) to molten steel by dropping the shot onto the steel surface and letting it sink into the steel, and also to blow the shot by means of an inert gas onto the surface of the metal. The dropping of the shot does not effect such a rapid penetration as to avoid surface melting and oxidation of the lead. The blowing of lead shot onto the surface of molten steel has not been satisfactory because the velocity of the shot has not effected penetration without oxidation, and the blowing of gas, even nitrogen gas, has had an adverse effect on the steel.

As a result of my investigations of the production of leaded steel I have discovered that the aforementioned difficulties can be avoided and a superior alloy produced with a minimum loss of lead. I have found that by ejecting or hurling particles of lead, for example shot, at a suitable high velocity that the particles will penetrate the molten steel without oxidizing, and that they can be uniformly dispersed into the steel. When the size of the particles in relation to their velocity is properly coordinated, the momentum of the particles causes them to overcome the surface tension and viscosity of the steel and enter the steel before the lead melts and oxidizes.

In accordance with the process of my invention I direct a controlled stream of lead shot, or the like, into the molten steel while it is being cast at such velocity that the particles enter the steel so rapidly that they cannot be heated to oxidizing temperature while exposed to air. I prefer to use a velocity of at least 4000 feet per minute and shot particles varying from 0.03 to 0.09 inch in diameter. This not only avoids the formation of toxic oxides but results in an efficient use of the lead. The process gives a highly uniform sub-microscopic dispersion of lead in the steel, regardless of the size of the casting. This dispersion prevents the lead in the molten steel from migrating into objectionable segregates just below the ingot surface and in other portions of the ingot body. The methods heretofore used are inconsistent in lead recovery, both in the bottom and top pouring of ingots. For instance, with the bottom pour method lead recoveries usually range from 50% to 85% whereas with the top pour method recoveries usually range from 45% to 65%.

I have found that if the lead is properly introduced into the pouring stream, either in top or bottom pour practice, at a sufficiently high velocity so as to force the lead inside, or beneath the surface of the stream of steel before the lead is melted, the objectionable features of the presently known practices will be materially eliminated for any size ingot and excellent quality ingots will be obtained.

In the production of steel ingots the shot is preferably thrown laterally into the stream falling from the ladle to the ingot mold. In the production of steel castings, or single ingots as made in small plants, it is practical to throw the shot into the surface of the tapping stream of steel while it is going into the ladle.

One effective form of apparatus for practicing the process of the invention comprises a receptacle for lead shot and a mechanically operated shot ejector arranged to be located near the molten steel to direct a uniformly dispersed or scattered stream of shot into the steel at high velocity. In a preferred embodiment of apparatus the ejector comprises a rotary wheel to which the shot is fed at a uniform rate and the centrifugal action of the wheel forces the lead to the periphery where it is discharged at high velocity through an opening, and into the steel. The apparatus includes means for feeding a controlled stream of shot from the receptacle into a housing for the wheel, and a gated opening in the housing which controls the shape and size of the shot stream to effect the desired contact with the steel.

The lead is preferably fed from a hopper through a pipe which is connected to the center of the wheel. To assure uniform feeding to the wheel the orifice opening from the hopper to the pipe is varied with the quantity of lead needed. Further, a small vibrating unit may be attached to the hopper wall to further assure uniform flow of lead from the hopper to the wheel.

These and other novel features of the invention will be better understood with reference to the accompanying drawings and the following discussion:

FIG. 1 is a more or less diagrammatic illustration of an arrangement of apparatus of the invention, in sectional elevation, for top-feed ingot casting;

FIG. 2 is a more or less diagrammatic illustration of an arrangement of apparatus of the invention, in sectional elevation, for bottom-feed ingot casting;

FIG. 3 is a side view, with parts in section, of apparatus of the invention; and

FIG. 4 is a sectional view at 4—4 of FIG. 3.

The apparatus illustrated in FIG. 1 comprises a top-feed mold **1**, a lead shot ejecting apparatus **2** of the invention, and a pouring ladle **3** from which the stream of steel S flows into the ingot mold.

The apparatus illustrated in FIG. 2 comprises a pair of bottom-feed ingot molds **4** and **5** connected together by a feed runner **6** which receives metal from the riser **7**, the lead shot ejecting apparatus **2** of the invention, and a pouring ladle **3** from which the stream of molten steel S flows into the riser **7**.

In FIGS. 1 and 2 the lead particles, preferably lead shot L, are thrown laterally at high velocity into the streams of molten steel S and immediately penetrate the surface and enter into the steel before the lead becomes heated to oxidizing temperature.

As best shown in FIGS. 3 and 4, the lead shot ejecting apparatus **2** comprises a base supporting and mounting structure **10** having an interior cylindrical wheel housing **11** with its axis arranged horizontally. The wheel **12** is mounted on the roller bearings **13** and **14** for rotation within the housing, and is rotated at high speed by shaft **15** which is driven, for example, by an electric or air driven motor (not shown). The wheel has a central opening **16** which connects to the duct **17** for receiving shot, or the like, from the receptacle **18**. This receptacle is preferably provided with a vibrator **19**, such as a device known as a Syntron, which assures a uniform flow of shot into the duct and central opening **16**. The wheel has segmented compartments **22**, **23**, **24** and **25** which are connected by ports **26**, **27**, **28** and **29** respectively to the central opening **16**, and the compartments are separated by blades **32**, **33**, **34** and **35** which extend to the housing inner wall **36** with a close running fit. The housing has two arcuate liners **37** and **38** which make close contact with the side edges **37'** and **38'** of the blades. The housing **11** has an opening **39** the width of the blades **32** to **35** which is above and partly to one side through which the shot L is thrown. In order to control or vary the size of this opening to control the direction and dispersion of the shot, adjustable baffles **40** and **41** are pivotally mounted by pins **42** and **43** to the base **10**. A series of holes H are provided in the base structure and coincident holes **44** and **45** are provided in the ends of the baffles. By means of pins P inserted through these holes in the baffles and the base the baffles may be set to provide a narrow ejection opening as shown in full lines, or spread apart as shown in broken lines (FIG. 3) to provide a wide opening.

A typical process of the invention will be described with reference to the casting of ingots in which a stream of steel S flows from a ladle downwardly in a substantially columnar shape into the ingot mold. An ejection apparatus of the invention is located at one side of the stream so that the lead shot L can be directed in a controlled and dispersed state into the stream of steel. In using lead shot varying from 0.03 to 0.09 inch in diameter it is preferred to throw the shot at a velocity of from 4000 to 8000 feet per minute. The smaller shot require a higher velocity and larger shot a slower velocity. The shot in the upper range does not disperse as effectively as the shot in the lower range.

I claim:

1. The process for producing leaded steel which comprises injecting a controlled stream of solid lead particles varying in size from 0.03 to 0.09 inch in diameter at a velocity of at least 4000 feet per minute through the surface of molten steel and into the body of steel, whereby melting and oxidation of the lead on contact with the steel are avoided and the lead is dispersed throughout the steel.



2. In the production of leaded steel ingots the improvement which comprises injecting a stream of lead particles varying in size from 0.03 to 0.09 inch in diameter at a velocity of at least 4000 feet per minute in a lateral direction into a downwardly flowing stream of steel from a ladle to an ingot mold, the velocity and size of the particles being such that the particles are injected into the stream without oxidizing resulting in the lead being dispersed throughout the ingot.

3. In the production of leaded steel castings the improvement which comprises injecting a stream of dispersed lead particles varying in size from 0.03 to 0.09 inch in diameter at a velocity of at least 4000 feet per minute into a furnace tapping stream from a furnace to a ladle, the velocity and size of the particles being such that the particles are injected into the stream without oxidizing resulting in the lead being highly dispersed throughout the casting.

4. In the production of leaded steel castings the improvement which comprises injecting a stream of dispersed lead shot varying in size from 0.03 to 0.09 inch in diameter at a velocity of at least 4000 feet per minute into the stream of steel from a ladle to a casting runner, the velocity and size of the particles being such that the particles are injected into the stream without oxidizing resulting in the lead being highly dispersed throughout the steel casting.

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