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C. E. UNGER

2,398,455

METALLURGY

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FIG.1.

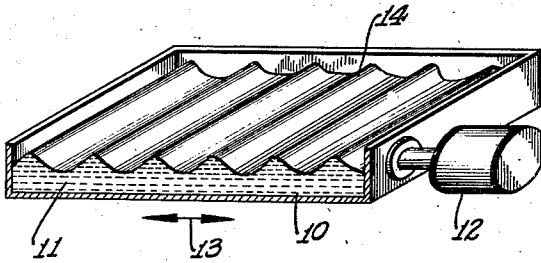


FIG.2.

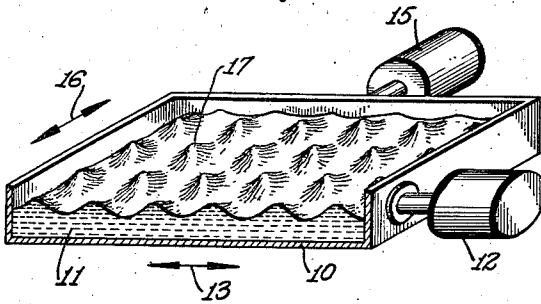


FIG.3.

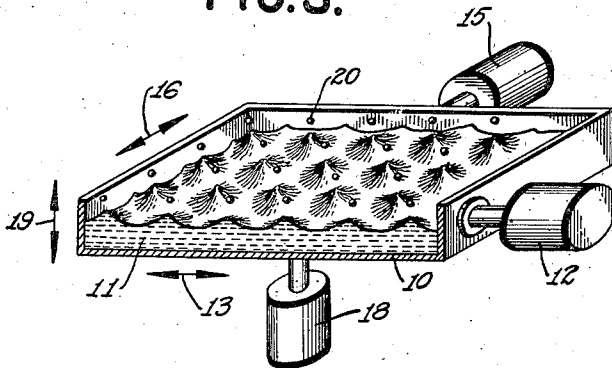


FIG.4.

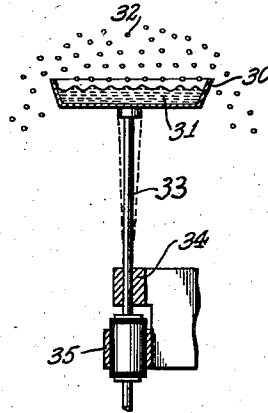
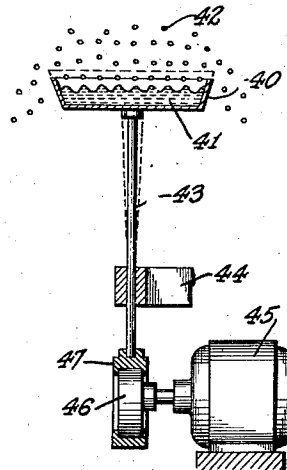


FIG.5.



INVENTOR.
CHESTER E. UNGER
BY *Albert M. Austin*
ATTORNEY

UNITED STATES PATENT OFFICE

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METALLURGY

Chester E. Unger, Mishawaka, Ind., assignor to
American Foundry Equipment Company,
Mishawaka, Ind., a corporation of Delaware

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6 Claims. (Cl. 83—91)

The invention relates to metallurgy and more particularly to a method and apparatus for manufacturing shot or pellets in globular form.

According to the invention, shot or pellets are made by subjecting a pool of molten metal to rapid vibrations in such manner as to project the shot or pellets out of the molten pool whence they are permitted to have a free fall to globulize them into spherical shape while still molten. The molten shot or pellets may be collected in a pool of water which causes them to solidify while in the form of round balls.

According to one form of the invention, the molten metal may be poured into an open top crucible and this crucible subjected to vibrations along three axes, a vertical axis and two horizontal axes perpendicularly related. The application of these vibrations is such as to cause the surface of the molten metal to form small peaks which detach themselves from the molten metal and are ejected from the molten bath upwardly and so spread that many fall back clear of the crucible into a suitable space permitting a free fall.

Electromagnetic or mechanical devices or a combination of the two, may be provided for imparting the desired vibrations to the molten bath. In some cases, instead of applying vibrations along three axes, it is sufficient to apply forced vibrations along a single vertical axis only, there being sufficient vibrations induced along the other axes to obtain the desired result.

The invention further consists in the new and novel features of operation and the new and original arrangements and combinations of steps in the process hereinafter described and more particularly set forth in the claims.

Although the novel features which are believed to be characteristic of this invention will be particularly pointed out in the claims appended hereto, the invention itself, as to its objects and advantages, and the manner in which it may be carried out, may be better understood by referring to the following description taken in connection with the accompanying drawing forming a part hereof, in which

Fig. 1 illustrates diagrammatically the action of vibrations along a single horizontal axis on a pool of molten metal;

Fig. 2 represents diagrammatically the action of two horizontal, perpendicularly disposed vibrational forces on a pool of molten metal, Figs. 1 and 2 being shown to assist in explaining the invention;

Fig. 3 illustrates diagrammatically the effect

of applying vibrational forces along the three principal axes;

Fig. 4 illustrates diagrammatically the effect of applying electromagnetic vibrational forces along a single vertical axis to a pool of molten metal; and

Fig. 5 illustrates the mechanical application of a single vertical vibrational force to a pool of molten metal.

In the following description and in the claims, various details will be identified by specific names for convenience, but they are intended to be as generic in their application as the art will permit.

Like reference characters denote like parts in the several figures of the drawing.

In the drawing accompanying and forming part of this specification, certain specific disclosure of the invention is made for purposes of explanation, but it will be understood that the details may be modified in various respects without departure from the broad aspect of the invention.

Referring now to the drawing, and more particularly to Fig. 1, the vessel or container 10 holds a bath of molten metal 11 and the vessel has applied thereto vibrational forces by an electromagnet 12 in a single horizontal direction indicated by the arrows 13. It will be seen that these vibrational forces cause ripples across the horizontal surface of the bath forming traveling waves indicated by 14.

If, now referring to Fig. 2, a second electromagnet 15 is provided acting along a horizontal axis at right angles to the axis 13, additional horizontal waves acting along the axis 16 will be provided. The action of the two horizontal vibrating forces serves to break up the surface of the molten bath 11 into peaks indicated by 17.

If, now referring to Fig. 3, an additional electromagnet 18 is provided acting along a vertical axis 19, the forces applied to the peaks 17 will cause them to overcome the surface tension of the liquid, and the peaks 17 will be caused to separate from the surface of the liquid 11, forming globules of molten metal indicated by 20. These globules 20 will be projected upwardly forming a shower of molten globules which will be projected upwardly and spread laterally, falling downwardly free of the container, as illustrated in Figs. 4 and 5.

In some instances, it is only necessary to apply forced vibrations to the bath along a single axis. Both Figs. 4 and 5 show forms in which forced vibrations are applied only along a vertical axis. In both cases, the vertical vibrations set up induced horizontal vibrations having components

at right angles to each other so that peaks will be formed on the surface of the bath and molten globules will be ejected from the molten bath in a manner similar to that described above.

Referring now to Fig. 4, the crucible is denoted by 30 and bath by 31 and the ejected globules by 32. The crucible is supported by a vertical rod 33 slidably mounted in a stationary support 34 which also holds an electromagnet 35 operating upon an armature secured to the rod 33.

Referring now to Fig. 5, the crucible is denoted by 40, the bath by 41 and the molten globules by 42. Here the crucible is supported by a rod 43 slidably mounted in the support 44. For applying vertical vibrations lengthwise of rod 43, an electric motor 45 is provided driving an eccentric 46. The eccentric 46 cooperates with a strap 47 attached to rod 43.

It will be understood that the natural period of the induced horizontal vibrations in Figs. 4 and 5 will depend somewhat upon the mass and elasticity of the vibratory structure, the elasticity being imparted by the stiffness of the rod which bends laterally under the forced vibrations applied by the driving electromagnet or electric motor.

It is desirable in all cases that the frequency of the forced vibrations be substantially equal to the natural period of the vibratory system, thus obtaining a condition of resonance. It will be understood that, if desired, each of the forced vibratory systems above described may have an elastic element, such as a spring, incorporated therewith to give a natural period closely approaching or equalling the period of forced vibrations. In some cases the natural elasticity of the structure may be sufficient to give the proper natural period; if not, extra springs may be added.

The solenoids may be of any necessary or desirable construction. Also, any source of alternating current of the proper frequency may be used. In one form, the solenoids may comprise coils spaced axially having an armature disposed therebetween, which is attached to the crucible. Suitable rectifying apparatus may be connected to the source of alternating current for impressing an electric impulse first on one coil and then on the other coil, so as to pull the armature back and forth at the proper rate. Or, if desired, a polarized electromagnet of the types used in telephone receivers or loud speakers, may be used.

If desired, the process may be continuous by providing a suitable feed pipe for feeding the molten metal into the bath at a rate depending upon that at which the molten metal is discharged from the crucible. It will be understood that the crucible and feed pipe may be made of suitable structural material, such as iron or steel, provided with suitable lining to withstand the high temperatures.

The shape of the crucible is not especially critical, nor is its depth, so long as the bath has sufficient area and depth that the side walls do not interfere with the formation of the proper wave pattern. Furthermore, it is not necessary that the crucible partake of an actual bodily movement. In case of substantial amplitude of vibration, bodily movement of the receptacle will occur, but in some instances, the vibrations may have such small amplitude that the shock may be transmitted through the walls of the receptacle to the liquid bath without substantial movement of the receptacle itself.

In all cases the molten globules are ejected vertically and spread laterally so that a great

shower of particles falls clear of the crucible. These particles may be given any suitable subsequent treatment. For example, they may be permitted to fall freely into a pool of water to solidify them into round metal particles or pellets. If desired, to prevent oxidation the process may be carried out in an inert or non-oxidizing atmosphere.

The size or sizes of the shot or pellets formed will depend upon the frequency or frequencies at which the bath vibrates. It is not necessary that the forced vibrations applied along the three reference axes be of equal frequency or in phase, although it may be desirable to have all three vibrations of equal frequency or else multiples of the same frequency.

The presence in the bath of more than one frequency, either natural or forced, causes different sizes of shot to be made simultaneously. The presence of more than one frequency may be due to a number of causes. For example, it may be caused by the natural periods of the vibratory mass not being the same as those of the forced vibrations. Or, it may be caused by applying impure forced vibrations, that is, vibrations which do not correspond to pure sine waves but which have harmonics present. Or it may be caused by deliberately making the forced vibrations applied along the different axes different from one another in frequency.

In any event, where different sizes of pellets are formed, they may be separated out in any desired type of sizing machine. It has been found that the sizes of the shot manufactured according to the invention corresponds closely to the frequencies present in the bath, and that the various sizes of shot made in any one operation all lie within a limited range of commercial sizes.

Thus a simple and inexpensive method of making shot or pellets is provided. This method will apply to any material capable of being heated to a liquid stage and held in a receptacle and which can be converted to a solid stage after ejection from the receptacle. Such a method is particularly applicable to metals, especially iron and steel, including the so-called hard irons, alloy irons and alloy steels. The invention is especially adaptable for the manufacture of shot used in shot blast machines either of the air blast type or of the centrifugal blast type, for cleaning or removing scale or dirt from castings or forgings, for peening the surface of materials for the purpose of increasing their fatigue life, or for producing a pleasing and attractive finish.

It is a comparatively simple operation to apply molten metal to the crucible and to vibrate this crucible at a frequency or frequencies corresponding to the size or sizes of shot desired. Great uniformity of size is obtained, which size may be accurately controlled by the value of the frequency or frequencies applied.

While certain novel features of the invention have been disclosed herein, and are pointed out in the annexed claims, it will be understood that various omissions, substitutions and changes may be made by those skilled in the art without departing from the spirit of the invention.

What is claimed is:

1. The method of producing metal pellets which comprises subjecting molten metal contained in an open top vessel to forced vertical vibrations acting along a substantially vertical axis, said vibrations being of such frequency and amplitude as to eject a shower of molten particles upwardly from the open top of the vessel and

causing said ejected particles to have free fall to cause them to solidify into spherical pellets.

2. The method of producing metal pellets which comprises subjecting molten metal contained in an open top vessel to forced vertical vibrations acting along a substantially vertical axis, causing said forced vibrations to induce in the molten metal natural vibrations along a plurality of horizontal axes, said vibrations being of such frequency and amplitude as to eject upwardly a shower of molten particles from the vessel, and causing said ejected particles to have free fall to cause them to solidify into spherical pellets.

3. The method of producing metal pellets which comprises subjecting molten metal contained in an open top vessel to forced simultaneous vibrations, separately applied in a vertical axis and in two horizontal axes perpendicular to each other, said vibrations being of such frequency and amplitude as to break up the surface of the molten metal into peaks and to eject said peaks in a shower from the surface of the metal and thereafter permitting said peaks to have a free fall to freeze them into solid pellets.

4. The method of making metal pellets by a continuous process which comprises feeding molten metal on to a solid surface, while vibrat-

ing said surface in a direction substantially transverse to the extent thereof, in such manner as to cause molten globules to separate from the molten metal in a direction substantially normal to the surface thereof and to fall free thereof, then causing said molten globules to solidify as metal pellets, and recovering said pellets.

5. The method of making metal particles which comprises, placing a quantity of molten metal on an imperforate surface, generating vibratory energy, imparting said energy to said metal by vibrating said surface to cause particles of the molten metal to separate from said quantity and to be thrown off in a direction substantially normal to the surface of the quantity of metal; and cooling said particles below their solidification point.

6. The method of making ferrous particles which comprises, placing molten ferrous metal on an impervious solid surface; generating vibratory energy, applying said vibratory energy to said solid surface in a direction substantially normal to its extent to disperse spontaneously the molten metal into molten particles and to direct said particles substantially perpendicularly away from said surface; and cooling said particles below their solidification point.

CHESTER E. UNGER.