Nov. 15, 1949 C. E. UNGER 2,488,353

METHOD AND MACHINE FOR FORMING METAL

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FIG. 1.

FIG. 2.

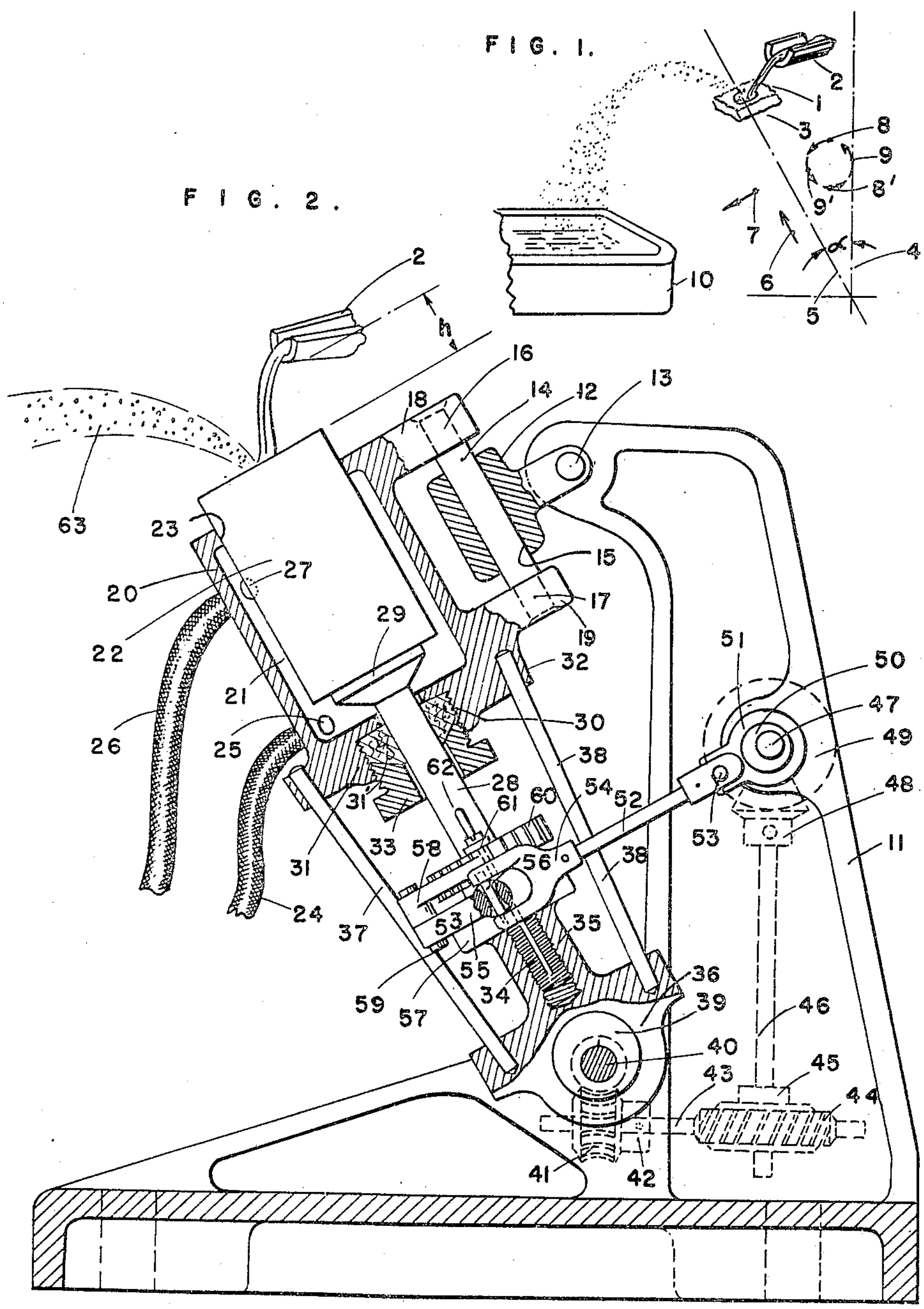

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FIG. 3.

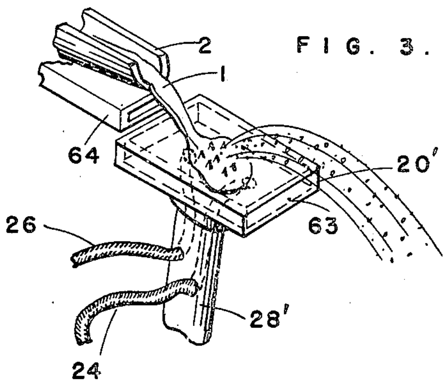
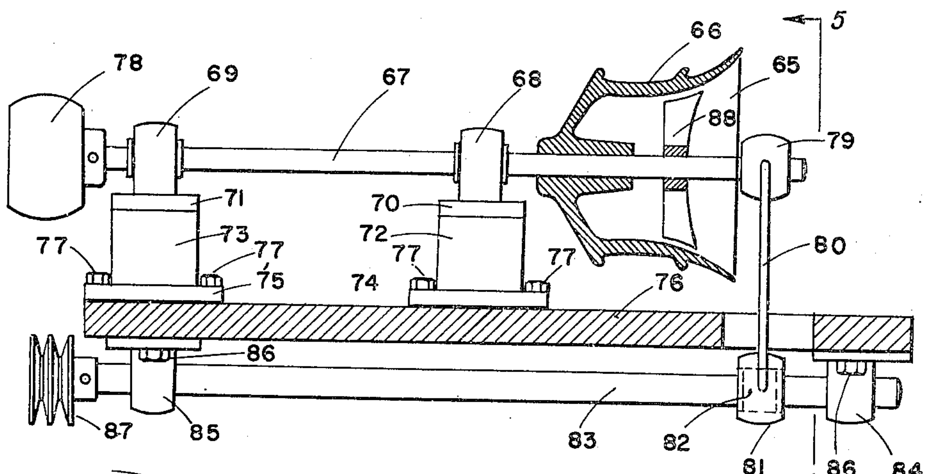


FIG. 4.



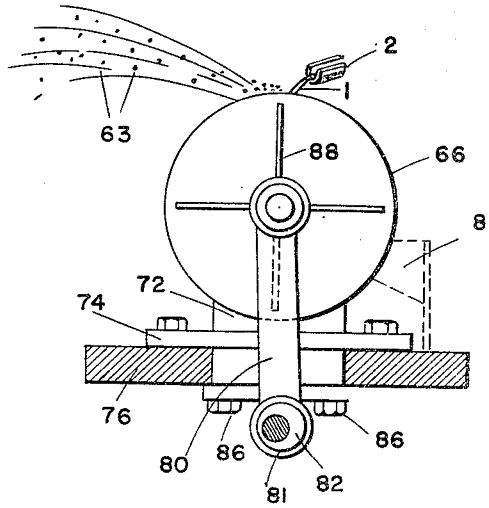


FIG. 5.

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METHOD AND MACHINE FOR FORMING METAL

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9 Claims. (Cl. 18—2.6)

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This invention relates to a method and machine for forming metal, more particularly to a method and machine for making metal shot.

The invention provides a method and machine for producing metal shot, such as for example steel shot, in a continuous operation from a stream of molten metal.

According to the invention a stream of molten metal is directed onto a surface while the surface is being imparted a compound movement consisting of a rapid vibratory movement in a direction substantially normal to the surface element impacted by the stream of metal and a translatory movement substantially at right angles to the direction of the vibratory movement. The stream of metal directed onto the vibrating surface is broken up into individual particles and the particles are discharged from the surface in a predetermined direction. Subsequently the particles are cooled below their solidification point and collected.

The vibrating surface may be made of a refractory material to which the metal will not adhere. It may also be made of metal, means being provided for producing a protective film on the metal surface to prevent the molten metal from adhering. According to a feature of this invention a protective film is formed by a layer of rapidly moving air, the air film being created at the periphery of a rapidly spinning wheel.

The invention further provides machines for the continuous production of metal shot according to my method.

The various objects, features and advantages of this invention will appear more fully from the detailed description which follows accompanied by drawings illustrating my method and showing preferred forms of machines for carrying it out.

The invention also consists in certain new and original features of construction in combination of parts hereinafter set forth and claimed.

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, its objects and advantages, and the manner in which it may be carried out may be better understood by referring to the following detailed description taken in connection with the accompanying drawings forming a part of it in which—

Fig. 1 is a diagram illustrating the method of continuously producing metal shot;

Fig. 2 is a side elevation, partly in section, of a machine for the continuous production of cast metal shot;

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Fig. 3 is a perspective view of a vibrating member which may be used in the machine shown in Fig. 2;

Fig. 4 is an elevational side view, partly in section, of a vibrating wheel for making metal shot; and

Fig. 5 is an end view of the machine shown in Fig. 4, a section being taken on line 5—5.

In the following description and in the claims various details will be identified by specific names for convenience. These names, however, are intended to be as generic in their application as the art will permit. Like reference characters refer to like parts in the several figures of the drawings.

In the drawings accompanying, and forming part of this description certain specific disclosure of the invention is made for the purpose of explanation, but it is understood that details may be modified in various respects without departure from the broad aspects of the invention.

The principle of the invention is diagrammatically illustrated in Fig. 1. A stream of molten metal 1 is directed from a pouring spout 2 onto a small surface element 3 which in actual practice forms a part of a larger surface. The surface element may be inclined by an angle appearing in the diagram between a vertical line 4 and an axis 5 normal to the surface element. A rapid vibratory motion substantially in the direction of axis 5 is imparted to the surface element as indicated by an arrow 6. A further and translatory movement is imparted to the surface element 3 in a direction substantially parallel to the surface element. This translatory movement may be combined with the vibratory movement and may either be of oscillatory or continuous character. The direction of the translatory movement is indicated by an arrow 7. The translatory movement may, as will later be shown, be produced by continuous rotation of the surface element in one direction or it may be produced as a component of a compound movement such as for example a substantially orbiculate motion of the surface element indicated by a series of arrows 8, 8' and 9, 9'. The arrows 8 and 8' represent the translatory component, and arrows 9 and 9' the normal component of the movement.

The stream of metal 1 is broken up at the surface element 3 into individual particles which are thrown off and cooled below their solidification point, for example by letting them drop into a bath of cooling liquid 10.

Referring now to Fig. 2 showing a machine for practicing the illustrated method, a base 11 carries a crosshead 12 movable about a pivot 13. A rod 14 is slidable in a bore 15 of the crosshead 12 and is mounted with its ends 16 and 17 in lugs 18 and 19 of a head 20.

The head 20 forms a hollow chamber 21 accommodating a dispersing member 22 which protrudes through an aperture 23 at the top of the chamber.

Cooling liquid may be circulated in the chamber 21 and enters through a flexible tube 24 at a port 25 and is withdrawn through a flexible tube 26 leading from a port 27.

The dispersing member 22 may be made of a ceramic material capable of withstanding the high temperatures of molten metal and possessing sufficient strength to stand up under vibrations. Graphite has been found satisfactory as material for the dispersing member.

The dispersing member is mounted on a stem 28 provided with a collar 29 supporting the lower end surface of the dispersing member. The stem extends through a threaded aperture 30 in a boss 31 at the bottom of the chamber. Cooling liquid is prevented from escaping past the stem 28 by a packing 31′ in a hollow portion 32 at the bottom of the head 20, the packing being compressed by a threaded packing collar 33.

The stem 28 is provided with a threaded end 34 screwed in a threaded sleeve 35 in an outer member 36 of an eccentric. The outer member 36 supports the head 20 by rods 37 and 38.

An eccentric disk 39 is mounted on a drive shaft 40 connected to a suitable source of motive power (not shown).

A worm gear 41 is mounted on the drive shaft 40 and meshes with a worm wheel 42 on an intermediary shaft 43. The intermediary shaft 43 also carries a worm gear 44 meshing with a further worm wheel 45 on a vertical shaft 46.

The vertical shaft 46 drives a feed shaft 47 through bevel gears 48 and 49 on shafts 46 and 47 respectively.

The feed shaft 47 carries an eccentric disk 50 engaging an outer member 51 to which a connecting rod 52 is hingedly connected at 53. The connecting rod 52 carries a fork pivotally engaging a ratchet support 55 at 56. The ratchet support is rotatable mounted on a flange 57 of the sleeve 35 and carries a pawl 58 pivoted at 59. The pawl engages a ratchet wheel 60 provided with a key 61 engaging a keyway 62 in the stem 28 so as to rotate the stem.

The operation of the machine is as follows:

The drive shaft 40 is driven at a rapid rate. The eccentric 39, 36 imparts to the head 20 and the dispersing member 22 a vibratory movement whose chief component is an oscillation in the direction of the axis of the stem 28. In addition the head 20 and the dispersing member 22 perform an oscillating movement about the pivot 13. The oscillatory movement in the direction of the axis of the stem 28 causes the rod 14 of the head to slide back and forth in the bore 15 of the crosshead and the oscillatory movement about the pivot 13 causes the head to tilt about the pivot 13. Cooling liquid may be circulated through the chamber 21 of the head 20 through conduits 24 and 26.

A stream of molten metal is discharged from the spout 2 onto the top surface of the dispersing member 22 and is broken up into individual particles 63 which are thrown off by the dispersing member in a predetermined direction.

To compensate for wear of the top surface of the dispersing member 22 the member is progressively rotated and also fed outwardly by the feed mechanism. The feed cam 50 operating the pawl and ratchet arrangement is driven at a relatively slow rate through the reducing worm gears 41, 42 and 44, 45 and bevel gears 48, 49. The pawl 58 slowly and intermittently turns the ratchet wheel 60 in one direction and the stem 28 by reason of its engagement with the ratchet wheel through the key 61 turns with it. The rotation of the stem moves new surface to the area of impact of the stream of metal on the dispersing member and also feeds the dispersing member outwardly so as to maintain the distance h between the top surface of the dispersing member and the pouring spout 2 substantially constant.

It has been found advantageous to incline the axis of the stem 28 approximately fifteen degrees with respect to the vertical in order to direct the discharge of the molten metal particles. This is a particular feature of the machine permitting a trough of cooling liquid to be so placed with respect to the machine that all the discharged metal particles drop into it without spillage.

Steel shot of the commercial sizes of between Nos. 15 and 40 have been produced with this machine. The size of the shot may be controlled by adjusting the rate of the drive shaft 40. A rate of between 3500 and 4000 R. P. M. has been found to give excellent results. Uniform spherical shot predominantly of size No. 20 has been produced by the machine operated at a rate of 3800 R. P. M. of the drive shaft 40, steel of a temperature of 3000° Fahrenheit being discharged onto the dispersing member at the rate of 50 pounds per minute. The stroke of the cam 39 in this instance was one quarter of one inch.

A modified form of dispersing member is shown in Fig. 3. The dispersing member 20′ comprises a hollow steel plate 63 mounted on a non-rotatable stem 28′. Cooling liquid is circulated through the hollow interior of the plate 63 through ducts 24 and 26. An orifice 64 discharges a burning jet of acetylene gas which is directed onto the top surface of the hollow steel plate 63 and deposits a protective layer or film of carbon thereon to prevent the molten metal from adhering to the steel surface.

The operation of the device shown in Fig. 3 corresponds in all details to the operation of the machine shown in Fig. 2 with the exception that no continuous feeding of the dispersing member towards the pouring spout 2 is required since the dispersing steel plate is not subject to appreciable wear.

A modified form of machine for the continuous production of metal shot is shown in Fig. 4. The machine comprises a bell shaped wheel 65 having a smooth peripheral dispersing surface 66. The wheel is mounted on a substantially horizontal drive shaft 67 resting in bearings 68 and 69. The bearings have base plates 70 and 71 to which are vulcanized blocks 72 and 73 of rubber or other resilient material. The resilient blocks 72 and 73, in turn, are vulcanized to mounting plates 74 and 75 secured to a base 76 by bolts 77.

One end of the drive shaft 67 carries a drive pulley 78 and the other end of the shaft engages the upper bearing 79 of a connecting rod 80.

The lower end of the connecting rod 80 forms the outer member 81 of an eccentric. An eccentric disk 82 runs in the outer member 81 and is fixedly mounted on a shaft 83 supported in bearings 84 and 85 secured to the underside of the base 76 by bolts 86. A drive pulley 87 is secured to one end of the drive shaft 83 for the eccentric.

A cooling fan 88 is mounted on the drive shaft for the wheel within the hollow bell-shaped space of the wheel. The fan acts in the manner of a centrifugal fan causing a flow of air into the interior of the bell shaped wheel space along the drive shaft 67 and a discharge of air along the inner periphery of the wheel thus cooling the rim of the wheel. A wiper 89 may be mounted adjacent the periphery of the wheel.

The operation of the device is as follows:

The drive pulleys 78 and 87 are preferably connected to different prime movers provided with means for controlling their speeds. The shaft 67 is driven at a rapid rate, preferably of the order of 3000 to 4000 R. P. M. The shaft 83 is driven causing a rapid vibratory motion to be imparted to the wheel 65 through the eccentric 81, 82 and the connecting rod 80. The rubber blocks 72 and 73 in the supports of the bearing 68 and 69 permit of sufficient deflection of the axis of the shaft 67 from the horizontal to execute the vibratory movements forced upon the wheel 65 by the eccentric.

A stream 1 of molten metal is discharged onto the periphery 66 of the wheel from a spout 2 and is dispersed into individual particles 63 which are discharged in a predetermined direction to be cooled and solidified.

The rapid rotation of the wheel causes a film of air to be dragged along the periphery of the wheel. This film of air is found to act as a protective layer preventing the molten metal from adhering to the metal rim of the wheel.

Highly satisfactory results are obtained with a wheel having a diameter of 12 inches driven at a rate of 3600 R. P. M. and vibrated between 1000 and 3600 cycles per minute. Molten steel SAE 1030 discharged at the rate of 50 pounds per minute onto the wheel surface was formed into perfect solid round steel shot of the commercial sizes between 10 and 40. Due to the effective cooling provided by the fan 88 no appreciable increase in heat of the periphery of the wheel was observed during the operation.

Obviously the present invention is not restricted to the use of the specific machines herein shown and described. Various changes and substitutions may be made, for example the protective film of air formed around the periphery of the wheel may be replaced by a film of other matter such as carbon as hereinbefore described. A film of water may be applied to the periphery of the wheel either by spraying water on the wheel or by immersing the lowermost portion of the wheel in a bath of water causing enough water to be dragged along by the wheel to form a protective surface on it. The air cooling of the wheel may be replaced by water cooling. Also various features may be added or omitted, equivalent devices and features may be substituted, dimensions and speeds may be correspondingly changed and various other changes be made. All such modifications will be apparent to a person skilled in the art and manifestly do not involve a departure from the spirit and teachings of this invention.

What is claimed is:

1. The method of making metal shot which comprises, directing a continuous flow of molten metal onto an imperforate surface; simultaneously imparting to said surface a definite and controlled vibratory motion in a direction substantially normal to the extent of the surface element impacted by said flow and a movement in a direction substantially parallel to said surface element, the vibration being sufficiently rapid to disperse said flow of metal into individual particles by rebound from said surface; and cooling said particles below their solidification point.

2. The method of making metal shot which comprises, imparting to an imperforate surface a translatory movement substantially in the direction in which said surface extends and a controlled and definite vibratory motion in a direction substantially normal to said surface; directing a continuous flow of molten metal onto said surface, the vibratory motion of said surface being sufficiently rapid to cause said flow of metal to be broken up into individual particles by rebound from said surface; and cooling said particles below their solidification point.

3. The method of making metal shot which comprises, directing a flow of molten metal onto the periphery of a wheel spinning about a substantially horizontal axis, imparting to the wheel simultaneously a controlled and definite vibration in a direction at right angles to the spin axis and substantially normal to the surface area of the periphery impacted by the flow of metal, the vibration being sufficiently rapid to cause the flow of metal to be broken up into individual particles by rebound from said periphery; and cooling said particles below their solidification point.

4. The method of making metal shot which comprises, directing a flow of molten metal onto the substantially smooth periphery of a wheel having a substantially horizontal axis; simultaneously imparting to the wheel a controlled and definite vibration in a direction substantially normal to the surface area of the periphery impacted by the flow simultaneously spinning said wheel about said axis, thereby causing a film of air to be dragged along by said periphery, the rate of spin being sufficiently high to set up a film of air dense enough to prevent said flow of metal from penetrating said film and adhering to said periphery, the vibration being sufficiently rapid to cause said flow to be broken up by rebound into individual particles; and cooling said particles below the solidification point.

5. The method of making metal shot which comprises, directing a continuous flow of molten metal onto an imperforate dispersing surface; simultaneously imparting a definite and controlled compound vibratory motion to said surface having a translatory component substantially in the direction of the surface impacted by said flow and a vibratory component substantially normal to said surface, the vibratory motion being sufficiently rapid to cause said flow to be broken up into individual particles by rebound from said surface; and cooling said particles below the solidification point.

6. The method of making metal shot which comprises, directing a continuous flow of molten metal onto a solid dispersing surface; simultaneously imparting a controlled and definite compound vibratory motion to said surface having a translatory component substantially in the direction of the surface impacted by said flow and a vibratory component substantially normal to said surface, the vibratory motion being sufficiently rapid to cause said flow to be broken up into individual particles by rebound from said

surface, maintaining an insulating film on said surface to prevent the molten metal from adhering to said surface; and cooling said particles below the solidification point.

7. A machine for the continuous production of metal shot comprising, in combination, a wheel; means for spinning said wheel about a substantially horizontal axis; means for directing a stream of molten metal against the rim of said wheel; and means for vibrating said wheel in a substantially vertical direction.

8. A machine for the continuous production of metal shot comprising, in combination, a wheel; means for spinning said wheel about a substantially horizontal axis; means for directing a stream of molten metal against the rim of said wheel; and means for vibrating said wheel in a direction substantially normal to the area of the rim impacted by the stream of the molten metal.

9. A machine for the continuous production of metal shot comprising, a wheel; a substantially horizontal shaft supporting said wheel; a bearing resiliently supporting said shaft near one end; a free bearing on said shaft near the other end; and an eccentric engaging said free bearing to impart a vibratory motion to said shaft; and means for directing a stream of molten metal against the rim of said wheel.

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