PROCESS AND APPARATUS PRODUCING SPHERICAL METAL PELLETS

Filed Feb. 8, 1960

Fig. 1

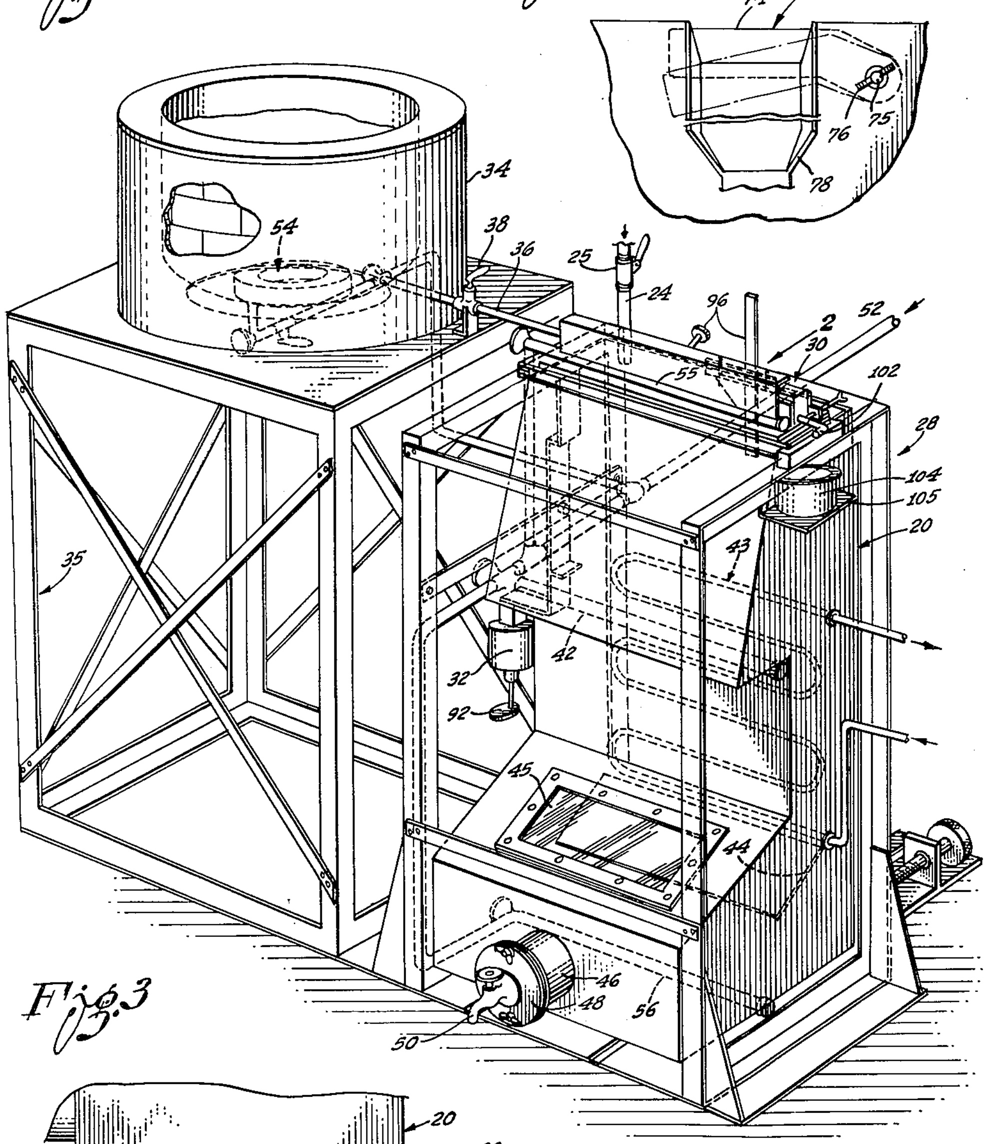
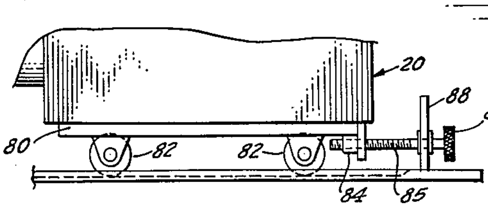


Fig. 2

Fig. 3



INVENTOR:
Louis W. Bliemeister
By Smyth & Roston
Attorneys.

PROCESS AND APPARATUS PRODUCING SPHERICAL METAL PELLETS

Filed Feb. 8, 1960 3 Sheets-Sheet 2

Fig. 6

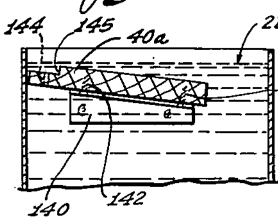


Fig. 4

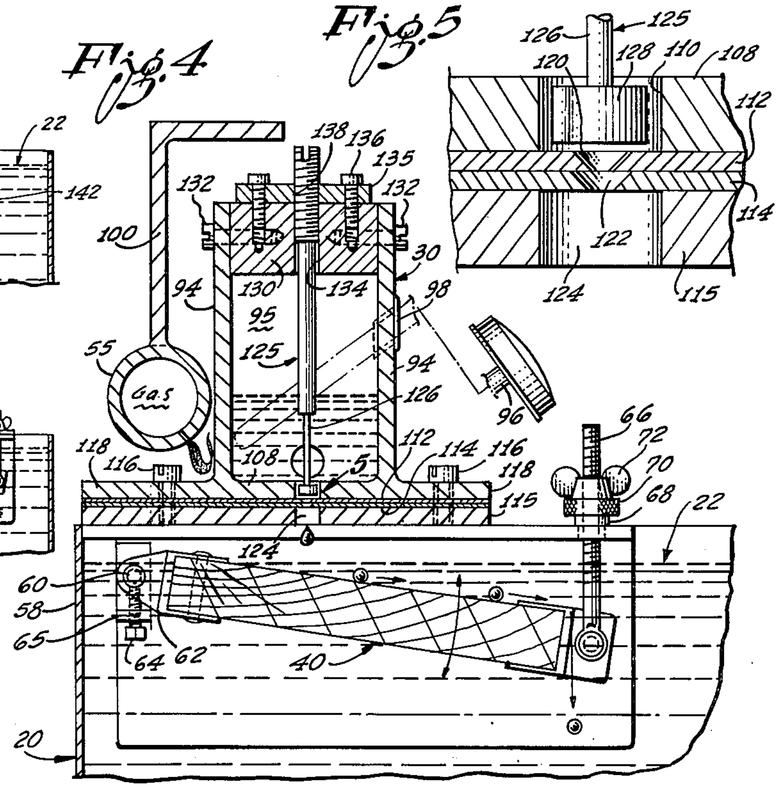


Fig. 5

Fig. 7

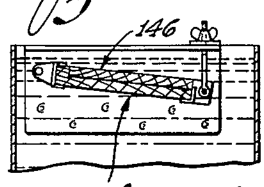
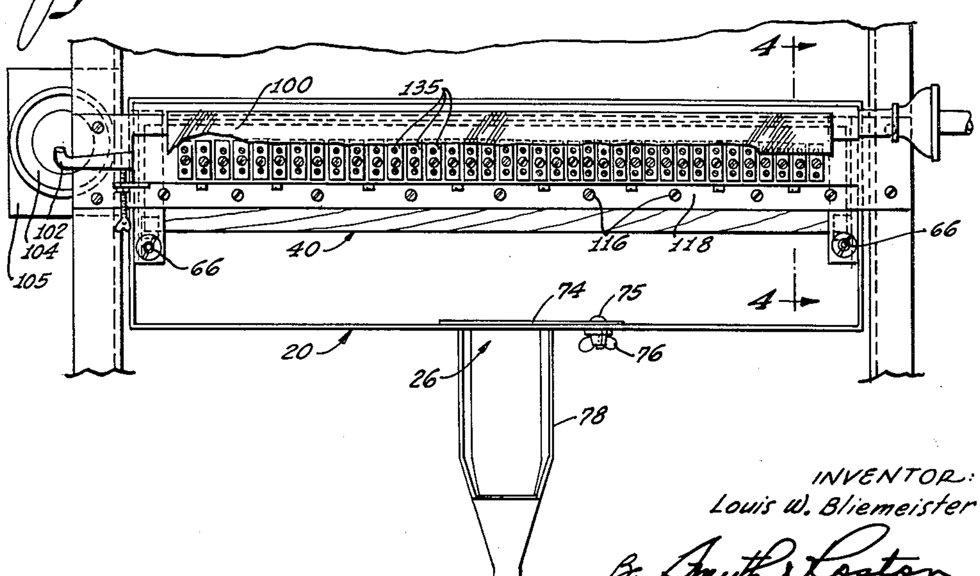


Fig. 8



INVENTOR:
Louis W. Bliemeister

By Smyth & Roston
Attorneys

Fig. 9

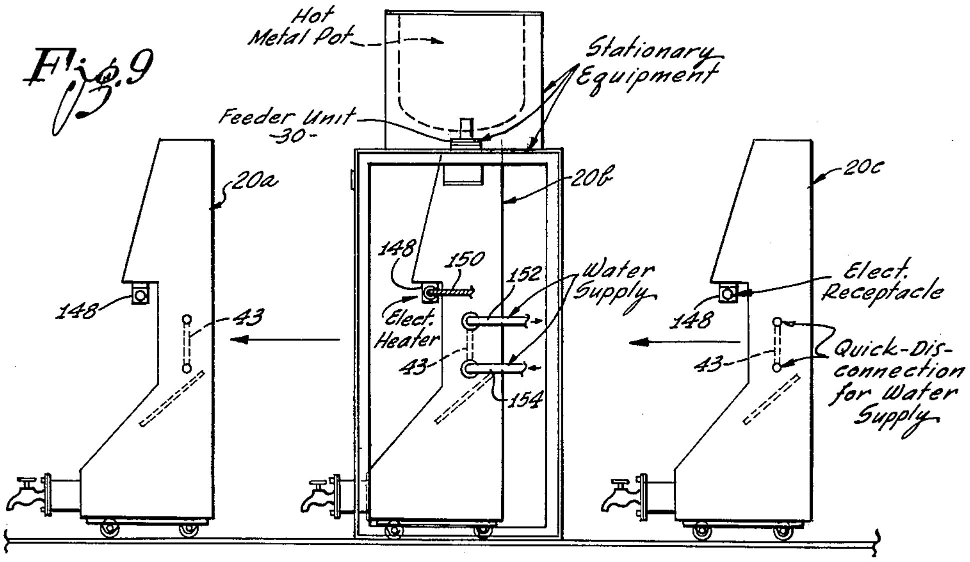


Fig. 10

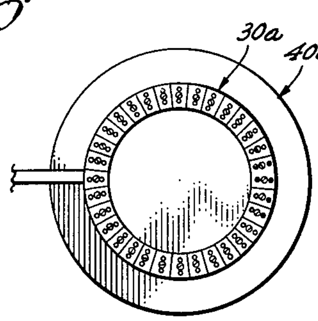
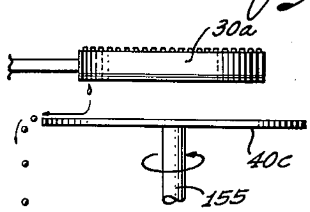


Fig. 11



INVENTOR:
Louis W. Bliemeister

By Smyth & Roston

Attorneys.

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PROCESS AND APPARATUS FOR PRODUCING SPHERICAL METAL PELLETS

Louis W. Bliemeister, 5410 W. 99th St., Los Angeles 45, Calif.

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11 Claims. (Cl. 18—2.4)

This invention relates to a process and apparatus for the production of spherical metal pellets and, more particularly, relates to the production of shot from low melting lead alloys.

One of the problems to which the invention is directed is to provide a low cost, compact, high production apparatus of this type. Such an apparatus may be installed and operated economically at numerous widespread locations to achieve decentralization of this industry. Decentralization is desirable for a number of reasons, and especially for reduction in shipping costs. The apparatus of the present invention for the production of shot of various sizes, together with associated equipment for processing, classifying and packing the shot, may be installed in an ordinary industrial room at moderate cost and may be operated with full efficiency by a single operator.

A second problem is to achieve a high percentage of any selected size of shot in a production run. The solution to this problem requires the production of uniform drops of melted metal and an efficient procedure for converting the molten drops into spherical pellets. The present invention produces more than 80% of selected sizes of shot and, in some instances, more than 90%. In this regard, a special feature of the invention is the ease and speed with which a transition may be made from the production of one size of shot to the production of another size.

A third problem that is important in some instances is to minimize oxidation of the product. Some degree of oxidation is inevitable when a highly heated metal is exposed to the atmosphere. The invention substantially eliminates such exposure.

The invention is based largely on the discovery that bodies of melted metal in the form of drops can be converted to solid spherical bodies in the course of falling through a body of quenching liquid of moderate depth, for example, of a depth substantially less than six feet, provided that the fall of the melted bodies through the quenching liquid is interrupted and moderate spin is imparted to the bodies while they are still molten. It has been discovered that the fall of the metal drops may be interrupted or blocked in a desirable manner by placing a member in the quenching liquid across the path of fall, which member presents an absorbent surface of low thermal conductivity, such as a surface of wood. The exceedingly hot metal of a falling body vaporizes the contiguous quenching liquid and the falling body may be observed to rebound from the blocking surface, apparently because of an intervening vapor cushion. The phenomenon is not fully understood but there is reason to believe that the presence of water absorbed in the surface structure of the blocking member is important and that the low thermal conductivity of the blocking member is also important.

The required moderate spin may be imparted to the melted metal bodies in two different ways. In one arrangement, the blocking surface is simply inclined to cause

the decelerated molten bodies to gravitate to its edge with rolling effect on the bodies. In another arrangement, a blocking disc is rotated to cause the molten metal bodies to move to its edge by centrifugal force. In each instance, spin is imparted to the molten bodies by rolling contact and then the spinning bodies are released to continue to fall through the quenching liquid and to solidify while falling.

The drops of melted metal as they are initially formed in the air above the quenching liquid are, of course, elongated. They do not have an immediate opportunity to become spherical and especially so because of the disturbing transition from air to water. Apparently the interruption in the fall of the melted bodies below the surface of the quenching liquid is important in permitting equalization of the forces that act on the metal bodies in all directions and, apparently, the moderate spin of the bodies in vertical planes while the still molten eliminates the initial vertical elongation of the bodies.

A feature of the preferred practice of the invention is a method of producing uniform liquid metal drops in quantity. The invention utilizes special feed passages at the bottom of a melted metal reservoir and, in addition, vibrates the reservoir and the feed passages to dislodge the formed drops. The vibration keeps the adjustment of the feed passages from being critical. In the preferred practice of the invention, each of the drop-forming feed passages includes registered apertures in two transverse sheets that are clamped together face to face, both of the apertures being downwardly tapered and the upper or innermost aperture being the smaller aperture.

A further feature of one practice of the invention is the concept of providing a feed unit to supply the melted metal drops in combination with a plurality of tanks for use interchangeably and successively with the feed unit. Each of the interchangeable tanks contains a body of quenching liquid and is equipped with means for interrupting the fall of the molten bodies to impart spin to the molten bodies. When a desired quantity of finished shot accumulates in one tank, the tank is replaced with a second tank. The quenching liquid is drained from the replaced tank and the tank is used as a hopper to feed the shot therein to suitable equipment for further processing.

The features and advantages of the invention may be understood from the following detailed description and the accompanying drawings.

In the drawings, which are to be regarded as merely illustrative:

Fig. 1 is a perspective view of a selected embodiment of the invention;

Fig. 2 is a fragmentary elevation viewed as indicated by the arrow **2** in Fig. 1 and showing an adjustable overflow control to vary the level of the quenching liquid;

Fig. 3 is a fragmentary side elevation showing how a tank of quenching liquid may be adjusted by screw means;

Fig. 4 is an enlarged transverse cross section showing the construction of the feed unit for releasing the melted metal in drop form and also showing the means in the quenching liquid for interrupting the fall of the metal bodies;

Fig. 5 is an enlarged portion of Fig. 4, which portion is indicated by the arrow **5** in Fig. 4 and shows the construction of a drop-forming feed passage;

Fig. 6 is a fragmentary sectional view showing a modified form of the means for interrupting the fall of the metal bodies;

Fig. 7 is a similar view of a second modification of the interrupting means;

Fig. 8 is a fragmentary plan view of the feed unit and adjacent structure;

Fig. 9 is a simplified diagrammatic view showing how a plurality of tanks for quenching liquid may be used interchangeably with a feed unit;

Fig. 10 is a simplified diagrammatic plan view of a circular feed unit and a rotary means under the circular feed unit to interrupt the fall of the molten metal bodies and to impart spin to the molten bodies; and

Fig. 11 is a simplified side elevational view of the structure shown in Fig. 10.

General arrangement

The principal parts of the selected embodiment of the invention shown in Figs. 1 to 3 and 4 to 8 include: an upright receptacle or metal tank, generally designated **20**, to contain a body of quenching liquid **22** (Fig. 4); an overhead water pipe **24** with a valve **25** for supplying water as needed to serve as the quenching liquid; an adjustable overflow outlet, generally designated **26** (Figs. 2 and 8) to control the level of the quenching liquid in the tank; an upright rectangular frame, generally designated **28**, straddling the tank **20** and separate from the tank; a feed unit, generally designated **30**, mounted on the top of the frame **28** above the tank **20** to release drops of molten metal into the quenching liquid; a vibrator **32** mounted on the frame **28** to vibrate the feed unit **30** to facilitate the dislodgement of the drops of melted metal; a crucible or pot **34** supported by a frame **35** for melting the metal; a pipe **36** extending from the pot **34** to the feed unit **30** to supply the melted metal thereto; a valve **38** in the pipe **36** to control the rate of supply of the melted metal; a member **40** (Fig. 4) in the body of quenching liquid in the tank **20** to interrupt the fall of the molten metal bodies and to impart spin to the molten metal bodies, this interrupting member being in the form of an inclined plate of suitable material, preferably pine or cypress; means in the form of a gas burner **42** to heat the upper levels of the quenching liquid in the tank **20**; and a heat exchange coil **43** to cool the lower levels of the liquid to facilitate the solidifying of the falling metal bodies.

The bottom of the tank **20** is enlarged to serve as a hopper for the finished shot and preferably an inclined baffle **44** is positioned to divert the falling solidified shot for the purpose of distributing the shot over the enlarged bottom of the hopper. A glass window **45** makes it possible to observe the interior of the tank to ascertain when a desired quantity of shot has been accumulated. A cylindrical port **46** for removing shot from the bottom of the tank is provided with a removable cap **48** and the cap in turn is equipped with a faucet **50** to permit the tank to be drained before the cap is removed.

Operation

The feed unit **30** has a row of feed apertures to produce successive drops of melted metal close to the surface of the quenching liquid. The formed drops fall into the quenching liquid and are immediately blocked by the interrupting member **40**. The drops initially travel through the air a relatively short distance to reach the liquid, usually much less than an inch for minimum oxidation by the atmosphere. The metal bodies may be observed to rebound slightly from the interrupting member **40** and to gravitate to the lower edge of the interrupting member with the consequent impartation of spin to the metal bodies while they are still molten. The spinning metal bodies harden in the course of their continued fall through the quenching liquid and are completely solidified by the time they reach the deflecting baffle **44**.

As will be explained later, the feed unit **30** is of a special construction that forms uniform drops of liquid metal of a selected size, the feed unit being readily adjustable to change from one size to another. Various adjustments may be made within the skill expected in this art to set the apparatus for the production of shot from different alloys in different sizes. The distance through which the metal drops fall before they reach the quenching liquid **22** may be varied by manipulating the adjustable overflow outlet **26** to raise or lower the level of the quenching liquid. In general, it is desirable to reduce this distance for the larger sizes of shot and it is also desirable to reduce the distance of the interrupting member **40** below the surface of the quenching liquid.

The angle of inclination of the interrupting member **40** may best be between 10° and 20°. An angle from horizontal of 17° gives good results for shot of sizes 8 and 9 (.090 inch diameter and .080 inch diameter) respectively. The angle should be decreased for increased sizes of shot. For example, an angle of 12° is recommended for number 6 shot (.110 inch diameter).

The length of the travel of the molten metal bodies along the inclined surface of the interrupting member **40** should be increased with increase in the sizes of shot and vice versa. For this purpose, the interrupting member may be horizontally adjustable in the tank, but in the present embodiment of the invention, it is contemplated that the tank will be moved horizontally relative to the feed unit whenever such an adjustment is desirable.

In the present practice of the invention, the quenching liquid is water. Other liquids may be used, however, and in general higher liquid densities are desirable for the larger shot sizes. The temperature of the water should be reduced slightly for the larger sizes. In general, the temperature to which the metal is heated is approximately 130° above its melting point and the temperature of the quenching liquid is approximately in the range of 190° F.–205° F. For number 9 shot, 205° F. is desirable, and 195° F. is desirable for the larger number 6 shot.

Structural details

Gaseous fuel for the various burners may be obtained from a supply pipe **52** which has a branch to the previously mentioned burner **42**. Other branches supply fuel to a burner **54** under the melting pot **34**, a burner **55** (Figs. 1 and 4) that extends lengthwise of the feed unit **30**, and a burner **56** under the bottom wall of the tank. The burner **56** may be omitted but is useful to keep the water up to temperature whenever a production run is interrupted.

The tank **20** is shaped to overhang the burner **42** that maintains the upper levels of the quenching liquid at a desired temperature. The heating of the quenching liquid by the burner **42** releases gases from the liquid and causes a certain amount of vaporization of the liquid. The consequent bubbles should be free to rise to the top surface of the quenching liquid in a region well away from the paths of fall of the metal bodies from the interrupting member **40**. As may be seen in Fig. 4, the upper end of the interrupting member **40** is spaced substantially from the adjacent wall **58** of the tank **20** to permit free travel of the bubbles past the upper end of the interrupting member. The upwardly tilted edge of the interrupting member serves as an effective barrier to keep the bubbling action from disturbing the quenching liquid along the upper surface of the interrupting member.

As best shown in Fig. 4, the interrupting member **40** comprises a plate of wood, for example pine or maple, which is hingedly mounted at its upper end on a cross rod **60** by means of a fitting **62**. The cross rod **60** is supported at each end by a screw **64** in a support bracket **65**, the screw being adjustable to raise or lower the cross rod. The lower edge of the interrupting member **40** may be adjustably supported by a pair of upright screw members **66** which are pivotally connected to the interrupting member. Each of the screws extends through a fixed unthreaded support bushing **68** and through a knurled adjustment nut **70**. A winged nut **72** may be added to serve as a lock nut.

The previously mentioned adjustable overflow outlet **26** comprises an opening in the upper edge of the tank **20** and a gate or angular blade **74** which serves as an adjustable edge of the opening. The gate **74** is pivotally mounted on a screw **75** which is equipped with a wing nut **76**. It is apparent that the wing nut **76** may be loosened to permit change in the position of the gate for change in the level of the quenching liquid. The overflow outlet empties into a drainage trough **78** which in turn may empty into a waste pipe or may empty into a reservoir for reuse. If quenching liquid is continually supplied from the overhead pipe **24**, the quenching liquid will overflow at a corresponding rate. If no quenching liquid whatsoever is added, the tank will still overflow because of the displacement of the liquid by the accumulating shot at the bottom of the tank.

The heat exchange coil **43** may be adjusted to cause the surrounding water to be 10° F. lower than the upper water and may be simply a coil of the configuration shown for the use of cooling water. The inlet end of the coil may be connected to any suitable water supply. If desirable, the cooling water may be continuously recirculated through the coil **43**.

As heretofore stated, the tank **20** may be movable relative to the feed unit **30** to vary the distance that the molten bodies travel down the inclined surface of the interrupting member **40**. For this purpose, the tank **20** may be mounted on a carriage **80** in the manner shown in Fig. 3, the carriage having support wheels **82**. One end of the carriage **80** is equipped with a fixed nut **84** in screw-threaded engagement with a screw **85** having a knurled head **86**. The screw **85** is journaled in a fixed bracket **88** so that manual rotation of the screw by the knurled head **86** moves the carriage **80** relative to the fixed bracket **88** for horizontal adjustment of the interrupting member **40** relative to the feed unit **30**.

As heretofore stated, the feed unit **30** is mounted on an upright frame **28** that is separate from the tank **20** to permit the tank to be moved relative to the feed unit. The previously mentioned vibrator **32** for vibrating the frame **28** and the feed unit **30** thereon may be a motor having a motor shaft **90** equipped with an eccentric weight **92**.

In the preferred practice of the invention, the feed unit **30** is of the construction shown in Figs. 1, 4, 5 and 8. The feed unit comprises an elongated rectangular receptacle with two parallel side walls **94** and two end walls **95**. In the construction shown, a suitable thermometer **96** extends through a bushing **98** in one of the side walls **94** to indicate the approximate temperature of the liquid metal. A pyrometer (not shown) may be additionally provided for accurate temperature readings.

Metal is continuously supplied to the feed unit **30** from the melting pot **34**. The previously mentioned burner **55** keeps the metal in the feed unit heated to the desired temperature, for example a temperature of 130° above the melting point of the metal. The burner **55** is provided with a longitudinal baffle **100** (Fig. 4) of angular configuration to facilitate heating the metal and maintaining the metal at the desired temperature.

The valve **38** is adjusted to supply melted metal to the feed unit at slightly above the rate at which the metal is dispensed by the feed unit in drop form. The excess metal flows into an elbow fitting **102** (Fig. 8) at the end of the feed unit and the elbow fitting overflows into a small pot **104** that is mounted on a shelf **105** on the side of the feed unit frame **28**. It is a simple matter to vary the angle of the elbow fitting **102** thereby to vary the head or depth of the liquid metal in the feed unit. In general, the depth of the molten metal is lowered for the larger sizes of shot since larger feed openings are used for the larger shot. The head of melted metal may range from one-half inch to one and one-fourth inches.

An important feature of the invention is the manner in which the feed unit **30** is constructed to form the liquid metal drops. For this purpose, the bottom of the feed unit is provided with a row of feed passages of the configuration shown in Fig. 5. Each feed passage is characterized by a configuration in which a restriction is followed by an expansion space and the expansion space is again followed by a restriction at the outlet end of the passage where the metal drops are to be formed. A row of such feed passages in the bottom of the feed unit may be provided in various ways in various practices of the invention.

In the construction shown in Figs. 4 and 5, the bottom wall **108** of the feed unit receptacle is formed with a relatively large bore **110** for each of the feed passages. A pair of relatively thin metal sheets **112** and **114** are clamped against the bottom wall **108** of the feed unit receptacle by means of a clamping plate **115**. In the construction shown, the clamping plate is secured by screws **116** on opposite longitudinal sides of the feed unit receptacle, the screws extending through opposite side flanges **118** of the feed unit receptacle and extending through the two sheets **112** and **114** into threaded engagement with the clamping plate **115**. The upper metal sheet **112** is provided with a row of relatively small apertures **120** which register with the corresponding bores **110** in the bottom wall **108**. The relatively small apertures **120** are countersunk to give them the downwardly tapered configuration shown in Fig. 5. Thus the bottom edge of each of the apertures **120** serves as a restriction for the feed passage.

The second lower thin sheet **114** is provided with a row of larger apertures **122** that register with the small apertures **120** of the sheet **112**. The larger apertures **122** are also countersunk to give them a downwardly tapered configuration. The larger apertures **122** may be considered the outlet ends of the feed passages since the successive metal drops form at the lower edges of these larger apertures. The clamping plate **115** is formed with relatively large bores **124** that register with the apertures **122** of the thin sheet **114**. The bores **124** are large enough to avoid contact with the successively formed drops of melted metal.

The rate of flow of the melted metal through each of the feed passages is controlled by a corresponding regulating or retarding member **125** which is formed at its lower end with a slender shank **126** terminating in an enlargement or head **128** that is suspended in the corresponding bore **110** in the bottom wall **108**. The head **128** overhangs the upper smaller aperture **120** in an adjustable manner for ample flow clearance around the circumference of the head. As best shown in Fig. 4, the receptacle of the feed unit has a cover in the form of a heavy plate or bar **130** that is secured by suitable lateral screws **132**. The cover **130** has a vertical bore **134** for each of the regulating members **125**, which bore is oversized for freedom of movement of the regulating member. Each regulating member is mounted by screw threads in an individual metal plate **135**, each of the individual metal plates being secured to the cover **130** by a pair of screws **136**.

In the preferred practice of the invention, the threaded bore **138** in each of the small metal plates **135** is oversized relative to the corresponding regulating member **125** so that the regulating member has appreciable freedom to swing in any direction at its lower end. By virtue of this arrangement, the head **128** at the lower end of the regulating member is free for universal movement radially of the axis of the corresponding feed passage and seeks a central equilibrium position at which the fluid flow is uniformly restricted around its circumference. In practice, the head **128** may accumulate dross but the head is free to shift in compensation for any such change in configuration.

In the initial embodiment of the invention, the bores **110** on the bottom plate **108** of the feed unit receptacle are 0.270 inch diameter and the outside diameter of the head **128** is approximately 0.250 inch. The two sheets **112** and **114** are 0.040 inch thick. The diameter of the apertures **120** in sheet **112** is .020 inch and the diameter of the lower, larger apertures **122** in sheet **114** is .025 inch which produces a large percentage of shot .090 to 0.95 inch in diameter. Other shot sizes may be obtained by employing other size apertures. Shot sizes may be varied in a limited degree by adjusting members **125** or by increasing or decreasing head pressure by manipulating elbow **102**.

The regulating members **125** are adjusted relatively close to the apertures **120** in the upper sheet **112**, the heads **128** being adjusted in the range of .005–.010 inch from the sheet **112**. The rate at which the melted metal seeps past the heads **128** through the smaller apertures **120** into the larger apertures **122** is regulated to cause successive drops of the desired size to be formed. The restriction of the flow through the smaller apertures **120** reduces the static head to facilitate the formation of the drops. Adjusting the regulating members **125** to reduce the rate of flow through the smaller apertures has the effect of increasing the size of the drops. To make the apparatus capable of producing a wide range of sizes of shot, different sets of the pairs of sheets **112** and **114** may be employed with different sizes of apertures **120** and **122** for the different sizes of shot. As heretofore pointed out, the vibration of the feed unit by the vibrator **32** facilitates release of the drops and also makes the dimensions and adjustments less critical for the successful operation of the feed unit.

Fig. 6 shows how the interrupting member **40** of Fig. 4 may be replaced by a member **40***a* which is mounted on a pair of angular side brackets **140** by suitable screws **142**. The upper end of the tilted member extends relatively close to the wall of the tank but is provided with a plurality of bores **144** for the free passage of bubbles to the surface of the quenching liquid **22**. The upper end of the member **40***a* is cut away to form a shoulder **145** which serves as a barrier to prevent the turbulence that is created by the bubbles from extending over the upper surface of the member **40***a*. For the purpose of varying the elevation of the surface of the member **40***a*, a set of such members of different thicknesses is provided for interchangeable use.

Fig. 7 shows an interrupting member **40***b* which also may be substituted for the member **40** in Fig. 4. The member **40***b* is of the same general construction as the member **40** but has a removable top panel **146**. The elevation of the top surface of the member **40***b* may be varied by selecting a panel **146** from a set of interchangeable panels of varying thickness.

Fig. 9 shows how a set of tanks **20***a*, **20***b*, **20***c*, etc., may be employed interchangeably with the feed unit **30**. The interchangeable tanks roll freely into position to receive the melted metal drops from the feed unit and serve as containers for transporting the formed shot to other equipment for processing and classifying the shot. Each of the interchangeable tanks may be provided with an electrical heater **148** which may be plugged into a suitable current source by a cable **150**. Each of the interchangeable tanks is provided with the usual heat exchange coil **43**, the opposite ends of which have quick disconnect fittings for connection to a pair of corresponding flexible hoses **152** and **154** for circulating water.

Figs. 10 and 11 show an arrangement which may be used in some practices of the invention for interrupting the fall of the molten metal bodies and to impart spin to the metal bodies before releasing the metal bodies for continuing their fall through the quenching liquid. In this arrangement, a circular feed unit **30***a* is employed of the same general construction as the previously described feed unit **30**. The feed unit **30***a* has a series of feed passages arranged in a circle to release successive drops of melted metal to fall on a submerged disc-shaped interrupting member **40***c* which may be made of suitable wood. The disc **40***c* is mounted on an upright shaft **155** for rotation about an upright axis at a rate to cause the molten metal bodies thereon to travel to the outer edge of the disc. Thus the molten metal bodies are momentarily interrupted in their fall and are caused to spin in molten state as they resume their fall.

My description in specific detail of the selected practices of the invention will suggest various changes, substitutions and other departures from my disclosure within the spirit and scope of the appended claims.

I claim:

1. A method of forming spherical metal pellets, including the steps of: releasing bodies of the metal in the form of liquid drops to fall into a body of quenching liquid onto a surface of a transverse member in the quenching liquid of absorbent material of low thermal conductivity while the bodies are still molten; causing the molten bodies to move along said surface for imparting spin to the molten bodies and releasing the spinning bodies from said surface to continue to fall through the quenching liquid to cause the spinning metal bodies to solidify while falling.

2. A method as set forth in claim 1 in which said material is fibrous liquid-absorbent material.

3. A method as set forth in claim 2 in which said material is wood.

4. A method of forming spherical metal pellets, including the steps of: releasing bodies of the metal in the form of liquid drops to fall into a body of quenching liquid onto a surface of a member of low thermal conductivity extending transversely across the paths of fall while the metal bodies are still molten; rotating said member about an upright axis to cause the molten bodies to be urged across said surface by centrifugal force for imparting spin to the molten bodies; and continuing the fall of the spinning metal bodies in the quenching liquid to permit the metal bodies to solidify while falling.

5. A method of forming spherical metal pellets with minimum surface oxidation, including the steps of: releasing bodies of the metal in the form of liquid drops immediately above the surface of a body of quenching liquid with minimum exposure of the drops to air above the liquid surface; breaking the fall of the metal bodies in the liquid while they are still molten by impact against a surface of porous material of low thermal conductivity; causing the molten bodies to travel across said surface to impart spin to the molten bodies; and continuing the fall of the spinning metal bodies in the quenching liquid to permit the metal bodies to solidify while falling.

6. A method of forming spherical metal pellets, including the steps of: releasing bodies of the metal in the form of liquid drops to fall into a body of quenching liquid onto a surface of a member of fibrous material of low thermal conductivity while the metal bodies are molten to cause the formation of vapor between the molten metal bodies and said surface to cause rebound of the molten metal bodies for interrupting the fall of the molten bodies; causing the molten bodies to travel along said surface with the consequent imparting of spin to the metal bodies; and releasing the metal bodies to continue to fall through the quenching liquid and to solidify while falling.

7. An apparatus to form spherical metal pellets, comprising: a reservoir to hold a supply of the metal in melted form; a plurality of passage means to release bodies of the melted metal from the reservoir in drop form; means confining a body of quenching liquid close to said passage means in the path of fall of the metal bodies from said passage means to cause the metal bodies to fall through the quenching liquid and to solidify while falling; and means in said liquid extending across the paths of fall of the metal bodies to interrupt the falls momentarily while the metal bodies are still molten and to impart spin to the metal bodies before they solidify, said interrupting means providing an inclined surface

blocking the path or fall of the metal bodies from said passage means, said surface being made of liquid-absorbing material of low thermal conductivity and being inclined from horizontal to cause the metal bodies to travel along the inclined surface while they are still molten thereby to impart spin to the molten bodies.

8. A combination as set forth in claim 7 which includes means to adjust the vertical distance between said inclined surface and said passage means.

9. An apparatus as set forth in claim 7 which includes means to adjust the inclination of said surface.

10. An apparatus as set forth in claim 7 which includes means to vary the distance the molten metal bodies travel along said surface.

11. An apparatus to form spherical metal pellets, comprising: a reservoir to hold a supply of the metal in melted form; a plurality of passage means to release bodies of the melted metal from the reservoir in drop form; means confining a body of quenching liquid in the path of fall of the metal bodies from said passage means to cause the metal bodies to fall through the quenching liquid and to solidify while falling; means in said liquid extending across the paths of fall of the metal bodies to interrupt the falls of the metal bodies while the metal bodies are still molten, said interrupting means having a surface of low thermal conductivity positioned transversely of the paths of fall of the metal bodies from said passage means; and means to rotate said interrupting means about an upright axis to cause the metal bodies to move along said surface by centrifugal force to impart spin to the metal bodies while they are still molten.

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