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METHOD OF AND APPARATUS FOR PRODUCING STEEL SHOT AND THE LIKE

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9 Claims. (Cl. 29—1.22)

This invention relates to the production of steel shot or balls, especially to small steel balls for use as shot in ammunition or shot gun shells and the like, or else for use as ball bearings, or for other purposes.

Heretofore shot for shot gun shells has been made from lead by the so-called "dropping" process by which molten lead is dropped down a shot forming tower, the falling molten metal being broken up into particles, and being received in a pool of water at the bottom of the tower to solidify same. During the falling of the molten metal droplets, they assume a spherical form whereby a very satisfactory round condition is secured in the lead balls produced.

Heretofore it has been proposed to form such small articles from steel, as well as other metals. Steel shot or balls would be particularly desirable in many instances and for various reasons. However, molten steel, when dropped through a "shotting" tower does not form a true or spherical shape as it is falling so that the product obtained is undesirable because of the tear drop or otherwise unsymmetrical shape of the particles obtained.

In the past, some steel shot has been prepared and the general steps in producing same have been to cold head or hot head steel wire into substantially ball form and the roughly shaped balls are then placed between abrasive or grinding wheels or rolls used in forming balls for bearings whereby the pellets can be rounded off to form balls of the desired size and accuracy. Such a process has been slow and costly and has been relatively unsatisfactory due to the foregoing and other reasons.

The general object of the present invention is to provide a novel method of and apparatus for producing shot from steel wire.

Another object of the invention is to provide a special controllable anvil in a shot producing machine to regulate the angle of impact of moving shot particles thereagainst.

Another object of the invention is to provide a low cost method of providing accurately sized, round steel balls of any desired diameter.

A further object of the invention is to provide a relatively uncomplicated, substantially automatic apparatus for forming a cylindrical blank or pellet into substantially spherical shape by a controlled processing thereof.

Another object of the invention is to provide a novel method of forming steel balls for bearings wherein a minimum of grinding or polishing operations are required on the balls for finishing same.

The foregoing and other objects and advantages of the present invention will be made more apparent from a reading of the following specification and a study of the accompanying drawings.

Several presently best known embodiments of apparatus for practicing the present invention are shown in the accompanying drawings wherein:

Fig. 1 is a partially diagrammatic elevation of apparatus for forming shot blanks into spherical forms;

Fig. 2 is a fragmentary vertical section of the apparatus of Fig. 1 taken on line 2—2 thereof;

Fig. 3 is a fragmentary elevation, partially shown in section, of a modification of the apparatus of the invention particularly adapted for using air pressure as a motivating force for the blanks of the invention;

Fig. 4 is another fragmentary elevation of apparatus like shown in Fig. 3, except that a different anvil is used in this apparatus;

Fig. 5 is a perspective view of a blank used in forming a shot particle or ball in accordance with the invention;

Fig. 6 is elevation of a ball formed in accordance with the invention; and

Fig. 7 is an elevation of a ball blank showing the working of the metal from cylindrical to ball form.

The method of the present invention includes the steps of forming steel shot by usually severing substantially cubical blanks from a cylindrical steel wire, subjecting such steel blanks to a controlled number of impacts at a controlled pressure, reducing the impact force for the blanks and subjecting them to a second series of controlled number of impacts for smoothing up the surface of such blanks into substantially spherical or ball form, and thereafter usually surface finishing the balls either by a coating or grinding operation depending upon the product desired as balls for bearings require a grinding action on the formed ball whereas ammunition shot normally requires that the surfaces of the balls be copper plated or be otherwise metal covered.

In forming balls or shot in accordance with the present invention, it is necessary and possible to predetermine the movement of the metal as it is worked or shaped from a cylindrical blank over to substantially ball or spherical form. Normally the blank will produce a ball of larger diameter than the major length of the blank used in forming the balls since the corner end portions in the metal blank will be worked or upset in changing the blank to ball form and will increase the actual diameter and length of the blank. The cylindrical blanks used in the process of the invention may be produced in any conventional manner, usually by cutting wire into pellets or blanks.

As an important step in forming balls from the steel blanks, such balls are subjected to a controlled number of impacts at a desired pressure, or at a desired speed whereby the metal in the blanks is actually worked, or broken down without shattering or flattening the blanks, after which the blank is subjected to less severe impacts whereby a rounding or smoothing of the surface of the blank is produced. It is important that in breaking down the metal in the blank that the blank contact an impact anvil at an angle other than a direct right angle whereby a skidding, slipping, or rotating movement is produced between the blank and the anvil member to aid in getting a forming action on such blanks without producing a shattering action on the blanks. As indicated in the drawings, the blanks strike the anvil at a small acute angle to produce a ricocheting of the blank with relation to the anvil.

Attention is now directed to the details of the structure shown in the drawings, and apparatus, indicated in general by the numeral 1, is shown for performing the novel shot making process of the invention. This apparatus 1 includes a frame 2 to which most of the apparatus is secured and which includes a storage hopper 3 positioned at the upper portion of the frame 2. The storage hopper 3 is of conventional construction and it has a valve 4 provided at the bottom thereof, which valve is of the type that opens when a predetermined weight is positioned in such hopper and thereby supported by the valve 4 or means associated therewith. Usually the valve 4 will

remain open for a predetermined interval to permit the contents of the hopper to flow therefrom, after which the valve will automatically close and be ready for a further automatic opening action when means have deposited sufficient weight ot material in the hopper 3 for reopening the valve 4. Any material collected in the storage hopper 3 moves to a feed hopper 5 usually directly below the hopper 3 and also supported by the frame 2. The feed hopper 5 has a valve 6 at the bottom thereof, which valve 6 is like the valve 4 except that it closes when no load is positioned thereon, or a predetermined low weight load is positioned thereon, or retained in the hopper thereby, and the valve 6 will open automatically when any predetermined force is applied thereto. These hoppers 3 and 5 are used, of course, for feeding the blanks used in forming shot in accordance with the invention to the blank forming means provided, and disclosed hereinafter in detail.

It is an important feature of the invention that the blanks passing from the feed hopper 5 fall into a feed conduit 7 that is associated with an impact member, such as a rotor or impellor 8, which has a plurality of radially extending rotor or impellor blades 9 suitable secured thereto. These blades 9 usually are positioned to extend normally from the flat surface provided on the rotor 8. The rotor 8 has a hub 10 and the conduit 7 connects to this hub 10 for feeding the shot blanks to the rotor blades by which the blanks are given a high velocity movement and are thrown rapidly therefrom against a forming member, as will be described hereinafter in more detail. Any conventional drive may be provided for the rotor 8 and a motor 11 is shown connected thereto by means of a belt 12. However, any suitable means may be used for driving the rotor 8 and for controlling the speed thereof and they may comprise means like those shown. A Reeves drive may be provided for the rotor 8 or else manual or automatic adjustment means may be provided, by which the speed of rotation of the rotor 8 may be varied easily and controlled to a predetermined value for any use in the apparatus of the invention.

As an important feature of the present invention, the shot blanks thrown from the rotor 8 are impelled against an arcuate anvil 13 that is positioned within an impact chamber 14 much larger than the anvil 13. Fig. 4 of the drawings best shows that the rotor 8 and blades 9 are snugly received in an offset 15 provided in a side of the chamber 14 and that the anvil 13 is quite narrow in relation to the width and length of the chamber 14 and any blanks thrown against the anvil 13 will be confined in the chamber 14 for further processing by the apparatus of the invention. Shot particles only can be discharged from the rotor 8 towards the anvil 13 as indicated in Fig. 1, and, of course, are smoothly fed to the rotor through the hub thereof. One end of the anvil 13 normally is secured to a wall of the chamber 14 by a hinge pin 16 engaged with the chamber 14 by brackets 17.

The position of the anvil 13 is preferably controlled with relation to the rotor 8 by means of a crank 18 which threadably engages a positioning sleeve 19 in a wall of the chamber 14. A crank arm 18*a* is provided on the crank 18 for rotating the crank 18 and moving it into or out of the chamber 14, as desired. The end of the cap screw 18 may contact or bear on a bracket 20 on the back of the anvil 13 to support the free end of the anvil 13 in the chamber. Or the crank may engage a member that is pivotally carried by the anvil so that rotation of the crank 18 to move it into or out of the chamber can vary the angular position of the anvil 13 in the chamber 14.

The anvil 13 can be made from any desired material and usually is made from steel, metal compositions or alloys, abrasives, or Carborundum. In some instances it may even be desirable to embed abrasives in the metal or other material forming the anvil 13. In all events, the working surface of this anvil is of arcuate contour and may have a roughened or a knurled surface.

Shot blanks projected against the anvil 13 will ricochet therefrom and be confined in the chamber 14, falling to the bottom thereof. A hopper 21 forms the bottom of chamber 14 and usually has a drain spout 22 pivotally secured thereto by suitable means. The spout 22 is particularly adapted to deliver shot blanks or partially formed shot particles therefrom into a box or similar container 23 which has an endless conveyor 24 running therethrough. The conveyor 24 carries a plurality of buckets 25 thereon and the conveyor is journalled on and supported by suitable sprockets or the like 26 and 27 with the sprocket 26 being positioned within the container 23. Sprocket 27 is likewise suitably positioned in a suitable container or hopper 28 into which the buckets 25 of the conveyor discharge. The spout 22 is adapted to discharge shot blanks or other partially formed particles into the buckets 25 provided on the conveyor in those instances.

The container 28 has a discharge spout 29 connected thereto for feeding the shot particles back into the feed hopper 5 where they are collected until a predetermined weight or poundage of such shot particles have been collected as a group or unit. Thus it will be seen that the apparatus of the invention is adapted to process shot particles automatically and send them through any desired number of impacts at a controlled speed.

One important feature of the present invention is that the number of impacts of the shot blanks is accurately controlled, and a second feature is that the speed of the impact be controlled or regulated within desired ranges in order to have the desired reshaping or working action upon the shot particles or blanks used.

Any desired means (not shown) may be provided for changing the rotary speed of the rotor 8 at a predetermined number of passes of the shot particles through the apparatus of the invention. That is, assume that 500 pounds of shot were to be processed in accordance with the invention, then the drive for the rotor 8 would be so arranged and connected to one of the valves 4 or 6 provided so that after such valves have opened a predetermined number of times for passage of the entire poundage of shot through the apparatus of the invention, then the speed of the rotor drive would be automatically reduced to a desired value. Likewise, such change in speed can be effected manually, if desired.

In one example of forming shot by use of the apparatus shown in Fig. 1 of the drawings, cylindrical steel wire blanks .093 inch in length, made from wire of the same diameter, and containing .1010 carbon or less were formed into satisfactorily round balls the diameters of which varied from .097 to .102 inch. These initial blanks used were subjected to approximately 75 passes through the machine shown in Fig. 1, which obtained a breakdown of the original cylindrical blank and shaped it to roughly ball form. The initial breakdown of these blanks occurred at 9650 R. P. M. of the rotor 8. Thereafter the partially formed blanks were subjected to a second series of approximately 75 passes through the machine at a rotation of approximately 1000 to 1250 R. P. M. for the rotor in the machine and this effected a desired finishing action on the partially formed balls to render them sufficiently round for use as shot in ammunition.

Substantially 100% of the balls produced in accordance with the example referred to hereinbefore were within the size range referred to hereinbefore. Usually the tolerances on the starting blanks should be within .003 of an inch.

Of course, after the blanks have been formed in the machine of the invention, they may then be tin plated, copper plated, lead coated, or be otherwise covered with a surface metal in any desired and conventional manner.

In an example of use of the apparatus shown in Fig. 4, blanks usually should be processed in such a machine for a period of about 3 hours under 125 pounds per square inch of air pressure and this provides the initial breakdown desired in the blanks. Next the batch of the blanks being treated were processed for approximately 4 hours at a pressure of between about 115 to 120 pounds, which completed the real shaping of the blanks whereas the blanks then were finished in about an additional 5 hours of processing in this type of apparatus when the air pressure in the apparatus was approximately 80 pounds per square inch. In this test, the sample cylindrical blanks used had a diameter and a length of .177 inch whereas the pellets produced ranged from .176 inch to .184 in diameter but the great majority of such blanks or balls produced were adjacent the larger size of this size range.

In another experimental test performed, a .71 carbon, .80 to 1.10 chrome steel was used to produce a satisfactory round ball from blanks that measured .062 inch by .062 inch and were of cylindrical shape. This roundness was secured by approximately 125 passes of the blank under 112 pounds of air and then a finishing passage through the apparatus shown in Fig. 3 wherein only 90 pounds of air was used and the blanks had between 25 to 50 passes through the apparatus of the invention.

It should be understood that in some instances it may be desired to form initial cylindrical blanks partially by the mechanical apparatus disclosed herein and then finish them by use of an air blast, or it may even be desired to reverse these steps of the combination process.

It will be appreciated that the working conditions on the blanks used vary with the composition and size of the blanks used. These blanks can be annealed or not, or be otherwise heat treated, as desired, before or after being processed, and usually should be checked for size several times during the processing of the blanks to insure that the product will have the desired uniformity.

It should be especially noted that knurling or roughening the surfaces of the anvil plate used in the process of the invention may speed up the rounding action obtained.

When a blank is said to have been formed into satisfactory spherical or ball shape, it is taken that such roundness produced is plus or minus .003 inch of being true and completely round since for normal uses of shot in ammunition, absolute roundness is not required.

If a ball bearing is to be produced in accordance with the invention, the blank, after being processed through the apparatus disclosed, will then be put through conventional grinding machines for ball bearings and one or two passes through such machines would produce an excellent ball bearing.

The apparatus of the invention can be used to make so called peening shot and for such type of shot usually it only is necessary to put the blank through one series of controlled number and amount of impacts so that the balls are roughly spherical in shape when discharged from the apparatus. No final polishing or smoothing action is required on such particles and the apparatus would have successfully "aged" cylindrical pellets for use as shot peening particles in a relatively short time.

Of course it would be appreciated that the rotor in the apparatus disclosed can either be positioned with its axis in a vertical or in a horizontal plane, or in any other desired manner.

It will be appreciated that the speed of the rotor in the apparatus as shown in Figs. 1 and 2 may be varied appreciably without interfering with the desired result. Very hard, tough steels may require rotor speeds of up to approximately 15,000 R. P. M. in order to get the desired impact velocity or force on the pellets or blanks being worked. However, such impact velocity and force must not shatter any appreciable number of the pellets, whereas it also should not flatten the pellets. Weak impact forces on the pellets do not produce the desired working or change in shape of metal in the original particle, so that it has been established that a minimum of about 5000 R. P. M. is about as low as can be used for forming or shaping steel blanks in accordance with the invention. Likewise it seems that air pressures appreciably above 90 pounds per square inch must be used in order to produce the desired working or reshaping of a metal particle by the use of an air pressure blast and 125 pounds per square inch has given good results on some blanks. The air pressure would be lowered to about 80 to 90 pounds per square inch after the desired working of the metal is effected to form a roughly ball shaped blank, in order to finish the ball.

Heretofore in grinding bearings from rough blanked balls, the grinding operation has taken an appreciable amount of time and has cost about two and one-quarter cents for each ball of a conventional size. By the present invention, the grinding operation used to produce a ball for a bearing is relatively rapid and costs approximately one-tenth of a cent per ball.

In test runs that have been made on the apparatus of this general type, the anvil has been positioned approximately 18 inches from the edge of the rotor. Apparatus of this type has treated about 500 pounds of shot particles per minute and consequent passage of approximately 30,000 pounds of shot per hour through the apparatus of the invention.

It should be noted that the rotor 8 may be of any conventional construction and may be positioned in any desired relation to the impact chamber. It will be appreciated that the valve 4 will not open until the hopper 3 collects therein the entire batch of shot blanks being processed. The discharge opening of the valve 6 is usually controllable to regulate the discharge flow of the blanks being processed.

With reference to the structure shown in Figure 3, hoppers 30 and 40 like those shown in Fig. 1 of the drawing are provided. Shot particles are adapted to be discharged from the hopper 40 through a control valve 41 provided thereon, which releases a controllable stream of the shot particles into a flexible receiving tube or conduit 42.

As an important feature of the present invention, an air discharge nozzle or tube 43 is provided and is suitably positioned in a wall of an impact chamber 46. The nozzle tube 43 has two input tubes 44 and 45 provided therefor and tube 42 connects to the tube 44. Any suitable means (not shown) connect to the tube 45 for supplying compressed air or other gas to the nozzle 43. The discharge end of the nozzle 43 extends into the chamber 46. Thus it is seen that shot particles or blanks will continually flow from the receiving tube 42 into the nozzle 43 and the blast of air passing therethrough will carry or throw shot particles into the chamber 46. An anvil 48, like the anvil 16, is adjustably positioned in the chamber 46 and the shot particles supplied to the apparatus are thrown thereagainst.

Another type of an anvil, which in this instance is a substantially bell-shaped anvil 50, is shown in Fig. 4 of the drawing. In this instance, a storage hopper 51 is provided which received shot blanks from a feed hopper (not shown) positioned above this hopper 51 and being adapted to discharge shot particles therein like the hopper 3 and valve 4 referred to hereinbefore. A discharge valve 52, like the valve 6, is provided for the hopper 51 and permits shot particles or blanks to drop down into a carrier tube 53 that connects to an air blast supply tube or conduit 54. This air blast tube 54 has a suitable source of compressed air or similar gas supplied thereto and it connects to a nozzle 55 that is positioned within an impact chamber 56. Thus the shot particles suspended in or carried by the air blast issuing from the nozzle 55 will be forced or thrown against the anvil 50 on the inner surfaces thereof at

an angle that is substantially parallel to the longitudinal axis of the anvil 50. However, due to the curved surfaces of the anvil 50, substantially all of the shot particles thrown against it will contact the anvil at an angle other than 90° and will produce a desired skidding, rotating or sliding action on the particles thrown or blasted thereagainst. Particles thrown against the anvil 50 will drop down into a hopper bottom 57 provided in the chamber 56 and pass therefrom through a spout 58 that discharges into a suitable conveyor or container like the spout 22 does in the embodiment of invention shown in Fig. 1.

In some instances, it may be desirable to adjust the position of the rotor 8 with relation to the anvil 13. Thus Fig. 1 shows that the offset 15 for the chamber 14 may have elongate feet 15ª provided thereon and several apertures may be provided at vertically spaced parts thereof. Usually a cap screw 100 extends through only one aperture at each end to secure the rotor unit and drive means to the chamber 14 and permit adjustment of such unit with relation to the anvil by use of other apertures. The feet 15ª are long enough to cover the opening in the chamber 14 over which the offset 15 is positioned in any variation of the position thereof. Or, the rotor and associated means may be otherwise mobily positioned, if desired. Thus the feed conduit 7 will be of a flexible construction. Usually the discharge spout 22 will have a swivel connection to the hopper 21 to facilitate discharge of material from the apparatus. The crank 18 is shown seating in a pin 100 journaled in the bracket 20.

Transversely directed lines on the anvil 13 would extend across such anvil over the shorter dimension thereof, as the anvil is shown in plan in Fig. 2.

From the foregoing, it will be apparent that an inexpensive, effective method of and apparatus for forming shot or the like has been provided for working blanks such as a blank B in Fig. 5 to a ball or shot C shown in Fig. 6. The actual movement of metal in a blank is indicated in Fig. 7 that shows the general lines of flow of metal in the corner or edge portions of a blank. The apparatus and method are positive in action and can be substantially automatic in action so that the objects of the invention are achieved.

While several complete embodiments of the invention have been disclosed herein, it will be appreciated that modifications of these particular embodiments of the invention may be resorted to without departing from the scope of the invention as defined by the appended claims.

Having thus described my invention, what I claim is:

1. In apparatus for producing metal balls or the like from metal blanks, an enclosing chamber, an elongate narrow anvil having an arcuate working surface, means positioning said anvil in said enclosing chamber, and means for linearly propelling metal blanks to be processed into said enclosing chamber towards said anvil, said last-named means being positioned and operable to direct the propelled blanks towards the working surface of said anvil at a small acute angle to provide a skidding ricocheting metal working contact between the working surface and the blanks to work the blanks towards spherical shapes.

2. In apparatus for producing metal balls or the like from metal blanks, an enclosing chamber, an anvil having an arcuate working surface, means positioning said anvil in said enclosing chamber, means for propelling metal blanks to be processed into said enclosing chamber towards said anvil, said last-named means being positioned to make the propelled blanks contact the working surface of said anvil at a small acute angle to provide a skidding metal working contact between said working surface and said blanks, and means for varying the position of said anvil in said enclosing chamber to alter the acute angle of contact between propelled blanks and said anvil's working surface.

3. In apparatus for producing metal balls or the like, an enclosing chamber, an elongate anvil having an arcuate working surface with abrasive material present in such working surface, means positioning said anvil in said enclosing chamber, and means for linearly propelling metal blanks to be processed into said enclosing chamber, said last-named means being positioned to make the propelled blanks contact the working surface of said anvil at a small acute angle to provide a skidding ricocheting metal working contact between said working surface and said blanks.

4. In apparatus for producing metal balls or the like from metal blanks, an enclosing chamber, an elongate anvil having an arcuate working surface, means positioning said anvil in said enclosing chamber, and means for substantially linearly propelling metal blanks to be processed into said enclosing chamber towards said anvil, said last-named means being positioned and operable to direct the propelled blanks towards the working surface of said anvil at a small acute angle to provide a skidding ricocheting metal working contact between the working surface and the blanks to work the blanks towards spherical shapes, said last-named means comprising a discharge nozzle connected to receive a supply of blanks, and compressed gas supply means connected to said discharge nozzle for discharge therefrom to carry blanks from said discharge nozzle.

5. In apparatus for producing metal balls or the like from metal blanks, an enclosing chamber, an elongate anvil having an arcuate working surface, means positioning said anvil in said enclosing chamber, a rotor for substantially linearly propelling metal blanks to be processed into said enclosing chamber towards said anvil, said rotor being positioned and operable to direct the propelled blanks towards the working surface of said anvil at small acute angles to provide a skidding and ricocheting metal working contact between the working surface and the blanks to work the blanks towards spherical shape, and adjustable speed means for driving said rotor.

6. Apparatus for forming balls from non spherical blanks of deformable metal material including the combination of anvil means, means for directing the blanks at high speed against the anvil means at a relatively small acute angle to produce a skidding and ricocheting contact between the blanks and the anvil means, and means for adjusting the position of the anvil means to change the acute angle of contact between the blanks and the anvil means, and means for collecting and returning the blanks to the directing means for a controlled number of additional passes.

7. Apparatus for forming balls from non-spherical blanks of deformable metal material including the combination of anvil means having an arcuate working surface, means for directing the blanks at high speed against the working surface of the anvil means at a relatively small acute angle to produce a skidding and ricocheting contact between the blanks and the anvil means, and means for adjusting the position of the anvil means to change the acute angle of contact between the blanks and the anvil means but to maintain the anvil means so that projected planes defined by pairs of spaced transversely directed parallel lines on the working surface of the anvil means nearest the blank directing means would have small acute angles of contact with blanks directed towards said anvil means if actually contacting such planes.

8. A method of producing balls, shot, or the like from steel material blanks of substantially cubical shape and having substantially right angle corners thereon, which method comprises the steps of providing the blanks of a batch of blanks with rapid substantially linear motion, impacting the blanks against a solid surface to provide a pronounced skidding and rotating impact action to work the blanks towards substantially spherical

shape and to round off the corners on the blanks, controlling the number of impacts of the individual blanks of the batch to give all blanks at least substantially similar treatment, providing the blanks with rapid substantially linear motion and giving the substantially spherical blanks a second series of skidding impacts with a solid surface at a reduced impact force to work the blanks towards more nearly true spherical shape, and controlling and at least substantially equalizing the number of the second series of impacts that all blanks of the batch receive.

9. A method of producing balls, shot, or the like from steel material blanks having substantially cubical shape and having sharp corners thereon, which method comprises the steps of providing the blanks of a batch of blanks with rapid substantially linear motion, changing the direction of said motion of the blanks by a relatively small angle by a skid-producing impact force applied thereto to work the blanks towards round shape and round the corners on the blanks, collecting a number of blanks being processed into a batch of blanks, again propelling the blanks of a batch of blanks by

rapid substantially linear motion, again changing the direction of motion of the blanks by a skid producing impact force applied thereto to shape the blanks to more nearly round shape, and repeating the collecting, propelling and motion changing actions until all the blanks of a batch have been substantially uniformly processed and are of at least roughly spherical shape, and subjecting the blanks to a further series of collecting, propelling and motion changing actions under reduced force impact actions to work the blanks to substantially spherical shape.

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FIG. 1

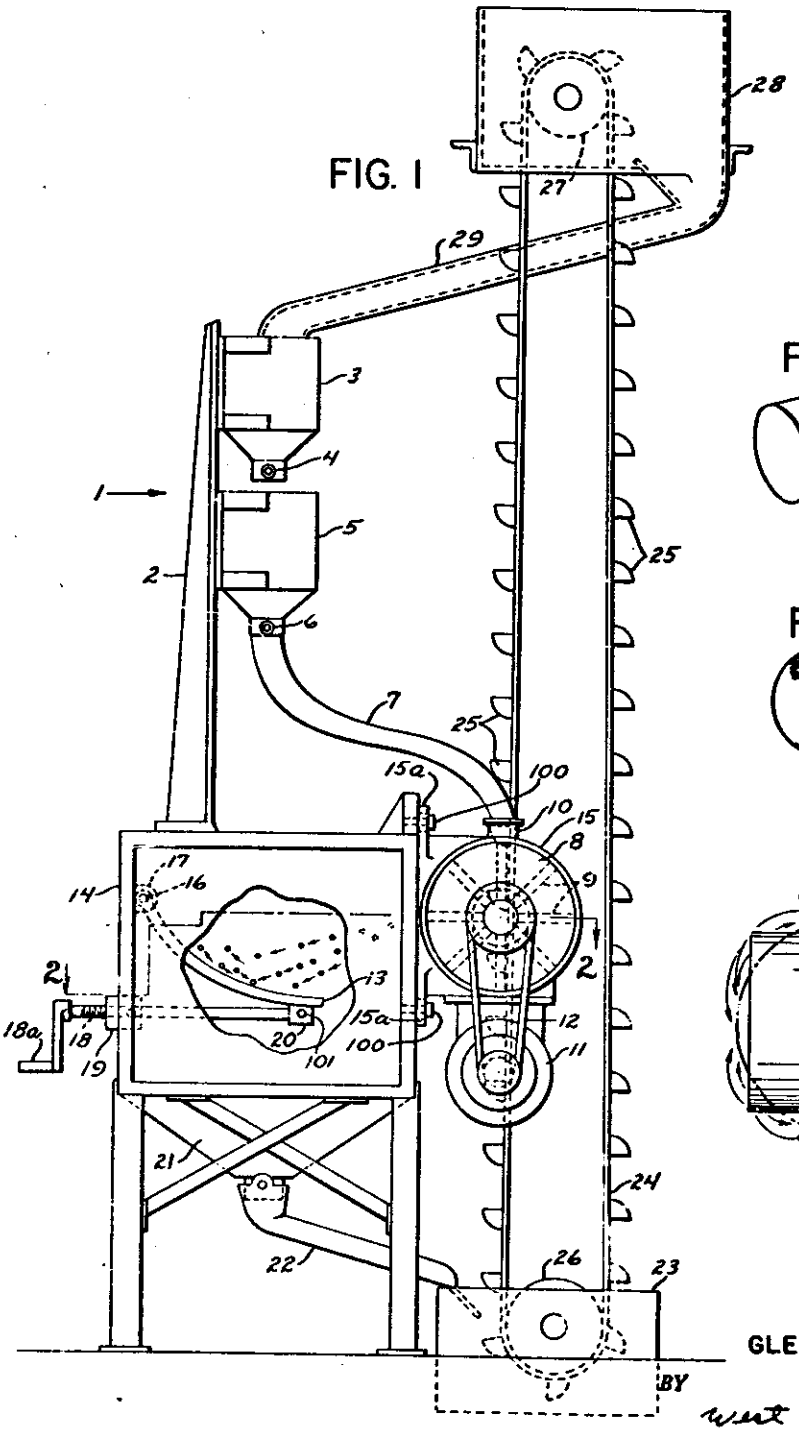

FIG.5

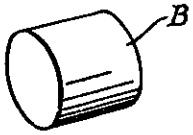

FIG.6

FIG.7

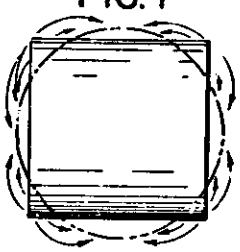

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FIG. 3

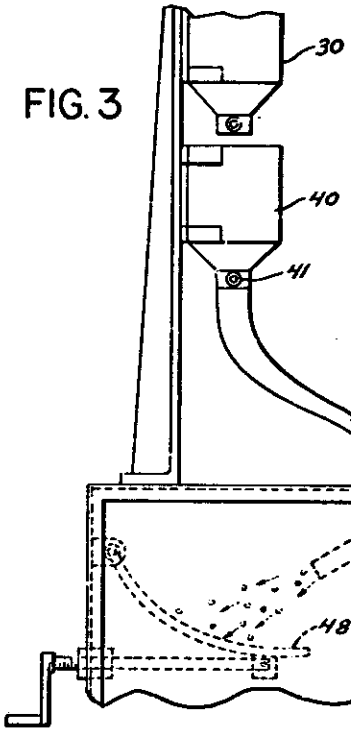


FIG. 4

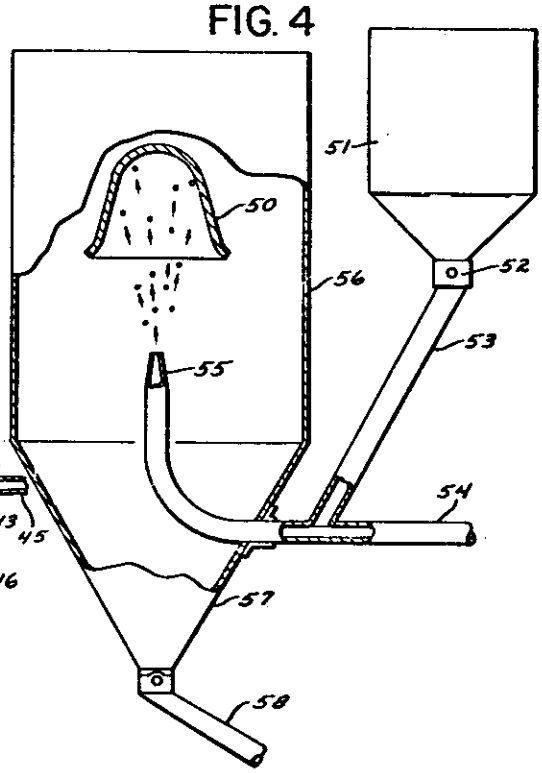
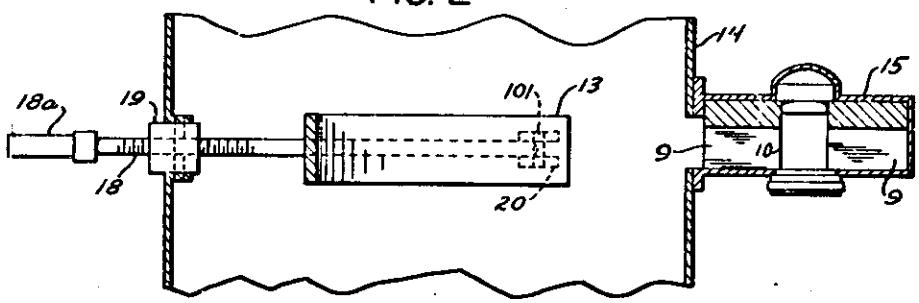


FIG. 2



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