July 26, 1960 W. G. FIRM 2,946,115

METHOD OF PRODUCING ROUND METAL PELLETS

Filed March 13, 1957 2 Sheets-Sheet 1

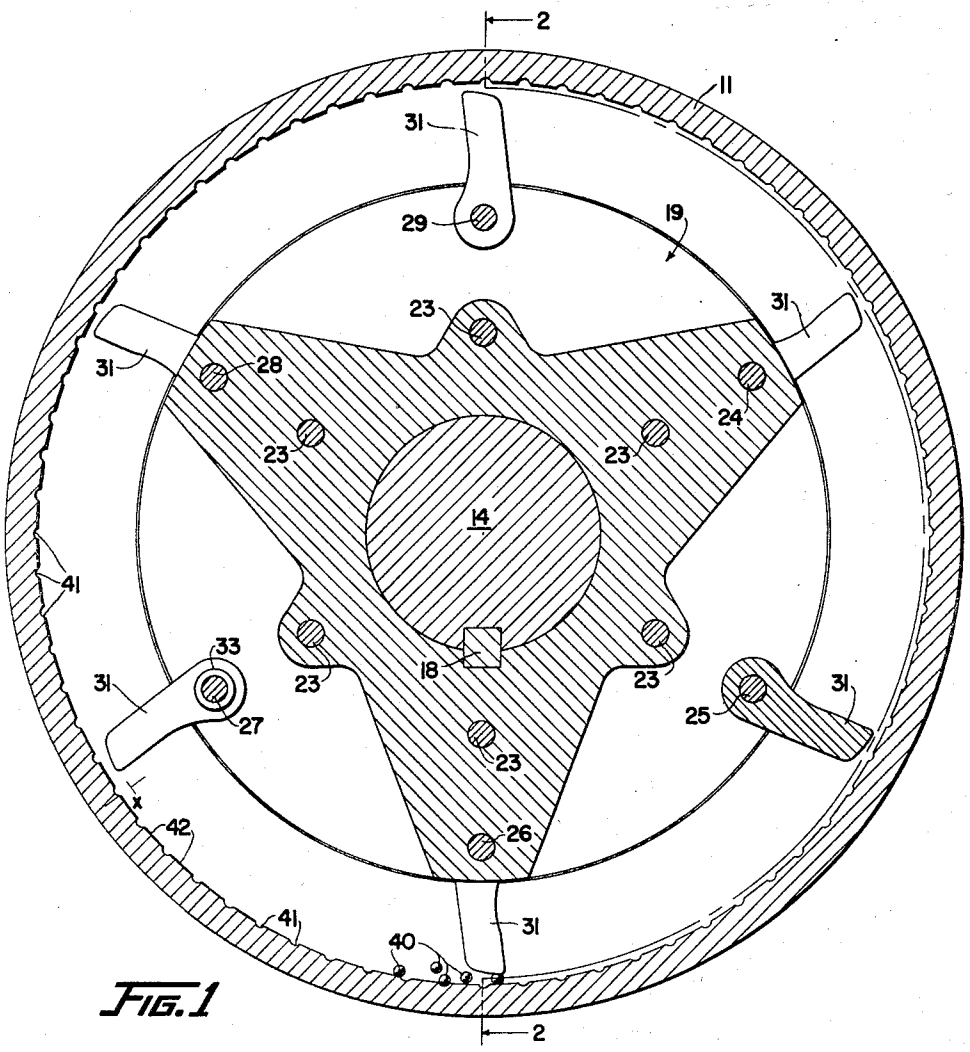


FIG. 1

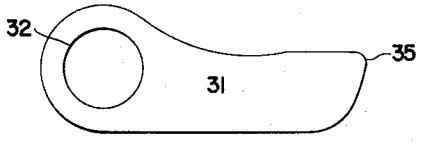


FIG. 3

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METHOD OF PRODUCING ROUND METAL PELLETS

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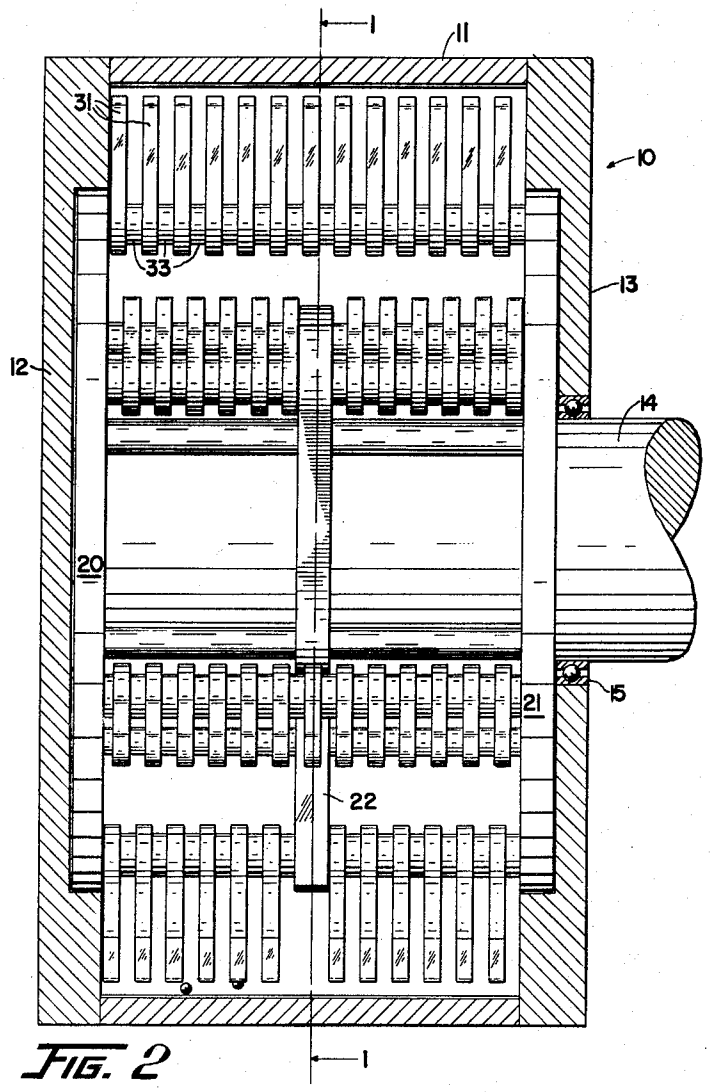


FIG. 2

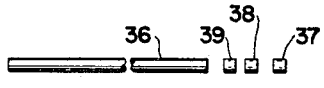


FIG. 4

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METHOD OF PRODUCING ROUND METAL PELLETS

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5 Claims. (Cl. 29—148.4)

This invention relates to the production of metal balls or pellets, such as, for example, steel shot or the like, and more particularly to small steel balls for use as projectiles in ammunition and the like, for use as ball bearings, or for other purposes.

Heretofore, metallic pellets for ammunition projectiles have chiefly been made from lead by a well known "dropping" process in which molten lead is dropped in discrete droplets from a shot forming tower, the falling molten metal being further divided into smaller particles, and being ultimately quenched in a pool of liquid at the bottom of the tower. The liquid is arranged to properly freeze or solidify the various discrete particles. The surface tension and density characteristics of lead are such that a satisfactory round condition is obtained in a lead particle so produced. Unfortunately, certain other harder metals such as steel and the like do not form true spheres while molten and falling but actually through such an arrangement form a tear drop or other undesirable shape.

Other processes have been developed for the preparation of round steel balls which involve a substantial amount of abrasive working, milling, heat treating, individual impacts of various pellets against an arcuate surface, or similar operations. Such processes are readily recognized as either slow or costly or both, and hence generally not suitable for present day mass production requirements.

According to the present invention, a hammer mill arrangement is employed to form round steel balls from discrete metal particles which in raw stock form are not necessarily round. During the operation of the mill, these particles are hindered from free motion around the inner periphery of the stator portion of the mill and are more effectively beaten therein. According to this process, large quantities of steel or other hard metal balls having a substantially spherical shape and falling within reasonably close size tolerances may be prepared expeditiously and without the need for making a large initial outlay of capital. Since pellets made according to the present invention have a relatively true spherical shape, they may find use in a wide variety of applications. The raw material used in the present apparatus may conveniently be short slugs or cylindrical members cut or otherwise obtained from wire or rod stock or the like.

It is therefore an object of the present invention to provide a novel and inexpensive method for preparing spherical bodies of relatively hard material such as steel or the like.

It is a further object of the present invention to provide a novel method for forming spherical balls from rod stock or the like.

Other and still further objects of the present invention will be apparent to those skilled in the art upon a study of the following specification and its claims with reference to the accompanying drawings wherein:

Figure 1 is a vertical sectional view taken along the lines and in the direction of the arrows 1—1 of Figure 2, and;

Figure 2 is an end view showing the apparatus of the present invention with the cover portions cut away along the lines and in the direction of the arrows 2—2 of Figure 1, and;

Figure 3 is a front elevation view of one of the hammers used in connection with the apparatus of the present invention, and;

Figure 4 is a plan view of the wire or rod stock and cylindrical slugs cut therefrom which are adapted for use as raw materials in the preparation of balls according to the present invention.

In carrying out the preferred modification of the present invention, discrete raw slugs are placed within the interior of the hammer mill generally designated 10, and while therein they are subjected to the beating of the various hammers as well as the attrition among the various discrete pieces of material one against another. Suitable entry and discharge means, not shown, may be provided for loading and unloading the apparatus. Due to the action of the particular hammer members against the metal slugs, together with the retarding effect provided by the grooves in the shell or stator portion of the mill, the discrete slugs are transformed into spherical members after a certain period of time. The finished products are substantially true spheres, and as such may be subjected to a further hardening treatment if necessary in order to prepare them for use as ball bearing members, or they may be used directly as produced for projectiles and shot-shells or the like.

Attention is now directed to Figures 1 and 2 of the accompanying drawings wherein there is shown a hammer mill prepared in accordance with the present invention. The mill 10 includes a cylindrical stator shell 11 which is provided a pair of end or cover plates 12 and 13. The shaft 14 is appropriately journalled within the covers 12 and 13 and adapted for free rotation therein by the bearing member 15. Obviously the opposite end of shaft 14 is provided with necessary bearing means, not shown, for free rotation within the stator. Appropriate drive means are provided for rotation of the shaft 14, the particular drive mechanism not being shown. The shaft 14 is keyed at 18 and thereby drives the internal or rotor portion of the mill generally designated 19. The rotor 19 includes a pair of end plates 20 and 21 and a central stabilizing plate 22. A plurality of rods 23—23 are included and are adapted to maintain the covers 20 and 21 as well as the stabilizing plate 22 in properly spaced relationship. The rotor portion 19 additionally includes a plurality of hammer retaining rods 24, 25, 26, 27, 28 and 29. Suitable retaining means, not shown, are provided to maintain the hammer mounting shafts in properly spaced relationship. Individual hammers, such as are shown in detail in Figure 3 are mounted in spaced relationship upon the shafts 24–29. Attention is directed to Figures 1 and 2 wherein the hammers 31—31 are shown as mounted upon the shaft 29 and arranged for free rotation therearound at the mounting hole 32. Suitable spacers 33—33 are provided between adjacent hammers. Each of the spacers 33—33 are substantially the same width thereby giving equal spaces between the various hammers 31—31. Of course, in order that dead spots do not occur in the area between the rotor and the stator portions, offset spacing is provided between the individual rows of hammers, that is, those mounted on shaft 29 will be somewhat displaced from those mounted on shaft 24. In this connection, a different width spacer may be included between the cover plates 20 and 21 and the first or next adjacent hammer as respects the individual rows of hammers. Thus, it will be appreciated that upon a rotation of shaft 14 and its associated rotor portion, the centrifugal force will cause the hammers to be extended outwardly from their respective shafts, and thus provide a proper means for application of an impact or force to the discrete slugs which are retained in the annular zone between the rotor and the stator.

The configuration of the hammers 31 is important with regard to the proper operation of the device. Each of the hammers 31 is designed in order that its center of gravity, when rotating with the rotor member, effectively leads the heel 35 of the hammer. When prepared in this fashion, it is not probable that the heel portion will overtake the center of gravity of the hammer, an occurrence which could cause considerable difficulty in operation of the apparatus. It will be appreciated that if the heel portion is permitted to lead the other body portion, the heel may be wedged between various pieces of the work and the stator housing. Upon an overtaking of the hammer so positioned, damage could result to the mechanism if the work became jammed between the overly extended hammer and the stator. Occurrences of this type are held to a minimum and seldom, if ever, occur when the apparatus is designed as indicated.

The raw material which may be utilized in this apparatus is not critical. It has been found desirable to cut discrete cylindrical bodies of conventional wire or rod stock along the lines as is suggested in Figure 4. There is shown in Figure 4 a supply of rod stock 36 from which the cylindrical members 37, 38 and 39 have been severed. These cylindrical slugs of rod stock are then placed within the mill 10, as are shown for purposes of illustration at 40. In order to impede free travel of the work slugs 40 between the rotor and stator portions of the mill, a plurality of grooves 41—41 are provided at spaced intervals along the interior periphery of the stator. The diameter and depth of these grooves depend for the most part upon the size of the spherical pellet desired as a final product. The radius used for the impeding grooves is preferably somewhat greater than the radius of the spherical pellets of the final product and the depth of the groove somewhat less. After an appropriate period of running time, sufficient beating has occurred between the hammers and the work pieces 40, and sufficient attrition has occurred between the individual work pieces themselves to cause them to assume a substantially spherical shape.

The clearance between the heels 35 of the hammers 31 and the flat portions 42 of the stator is a function of the finished size of the spherical particles. Suitably sized raw material is also provided for the finished product size desired. In other words, the clearance will become larger or smaller depending upon the resultant product desired. In practice, it has been found that the clearance "x" should be substantially equal to or somewhat less than the diameter of the finished product. Of course, it will be appreciated that each of the hammers is identical in size and configuration one to another as is the interface of the stator 11; hence each of the hammers has an equal distance between the heel portion thereof and the face portion 42 of the stator.

Upon completion of a run, the discharge door of the mill, not shown, is opened and the product is ejected by the action of the hammers. Because of the various factors involved in the operation of this device, fast processing and cycling is possible.

Example I

The following example illustrates the procedures utilized to prepare spherical balls having a diameter of .100". In this connection, a rotor-stator portion was employed wherein the stator had an interior diameter of 14.000". A clearance of .085" was used between the heels of the hammers and the interior portion of the stator, the hammers having a weight of between 70 and 90 grams. Short lengths of .093" diameter wire (1012 steel) were used, the individual cylinders having a length of about .088". The mill was operated at a speed which would give the hammers a velocity of about 6,000 feet per minute. Upon filling the mill with about 5,000 raw slugs, the mill was run at the desired speed for about

20 seconds whereupon the supply of .100 diameter spheres was obtained.

In a similar manner, spheres of materials other than the 1012 steel as used in Example I may be prepared.

It will be appreciated that various modifications may be made in the process and apparatus as discussed herein without departing from the spirit and scope of the present invention. It is understood that the specific illustrations given herein are for purposes of illustration only and there is consequently no intent to limit the coverage to these specific arrangements.

I claim as my invention:

1. The method of preparing metal spheres having a predetermined diameter which includes the steps of introducing discrete metal stock members having a dimension which exceeds said predetermined diameter into a certain annular treating zone, said zone being defined between a pair of relatively movable surfaces, exerting a yieldable impact of substantial force against said stock members which have a dimension exceeding said predetermined diameter, and impeding the free motion of said stock members along said treating zone.

2. The method of preparing metal spheres having a predetermined diameter which includes the steps of introducing discrete metal stock members having a dimension which exceeds said predetermined diameter into a certain annular treating zone, said zone being defined between a rotor and concentrically positioned cylindrical stator, exerting a yieldable impact of substantial force against said stock members which have a dimension exceeding said predetermined diameter, and impeding the free motion of said stock members along said treating zone.

3. The method of preparing metal spheres having a predetermined diameter which includes the steps of introducing discrete metal stock members each dimension of which exceeds said predetermined diameter into a certain annular treating zone, said zone being defined between a rotor and a stator shell positioned thereabout, exerting a yieldable impact of substantial force against said stock members which have dimensions exceeding said predetermined diameter, said impact being developed by the centrifugal force of said rotor, and impeding the free motion of said stock members along said treating zone.

4. The method of preparing metal spheres having a predetermined diameter which includes the steps of introducing discrete metal stock members each dimension of which is at least equal to said predetermined diameter into a certain annular treating zone, said zone being defined between a pair of relatively moveable surfaces, applying a series of repeated impacts of substantial force against said stock members while impeding the free motion of said stock members along said treating zone, and continuing said impact until said stock members have acquired a substantially spherical form.

5. The method of preparing metal spheres having a predetermined diameter which includes the steps of introducing discrete cylindrical metal stock members the length dimension of which is at least equal to said predetermined diameter into a certain annular treating zone, said zone being defined between a pair of relatively moveable surfaces, applying a series of repeated impacts of substantial force against said stock members while impeding the free motion of said stock members along said treating zone, and continuing said impacts until said stock members have acquired a substantially spherical form.

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