Dec. 17, 1957 W. I. GLADFELTER ET AL 2,816,466

PARTICLE SMOOTHING APPARATUS

Filed Nov. 29, 1950 2 Sheets-Sheet 1

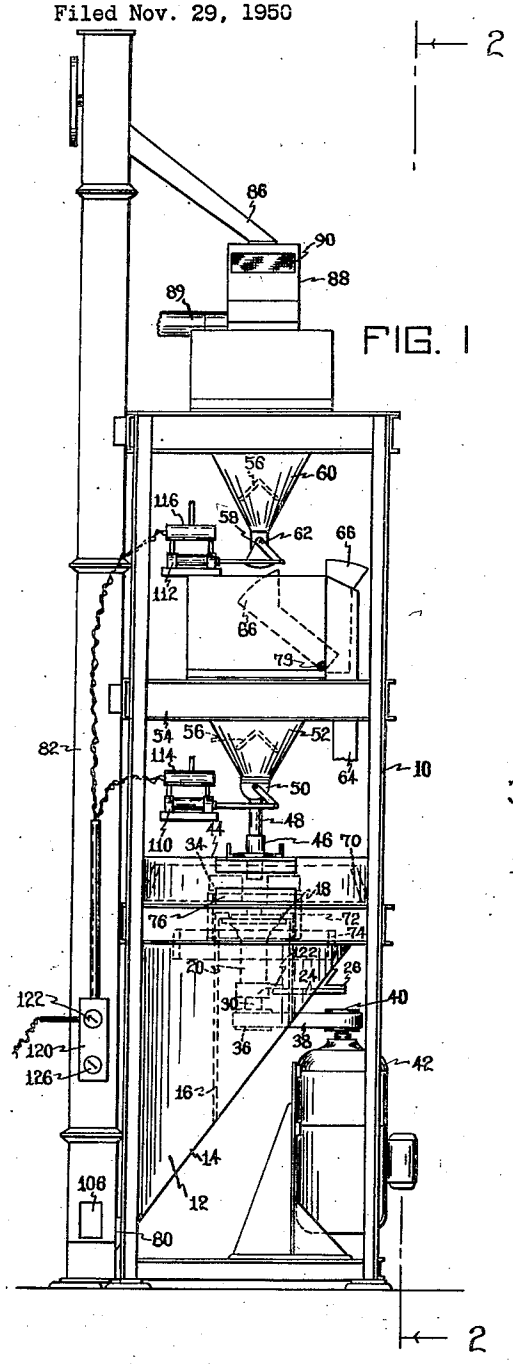

FIG. 1

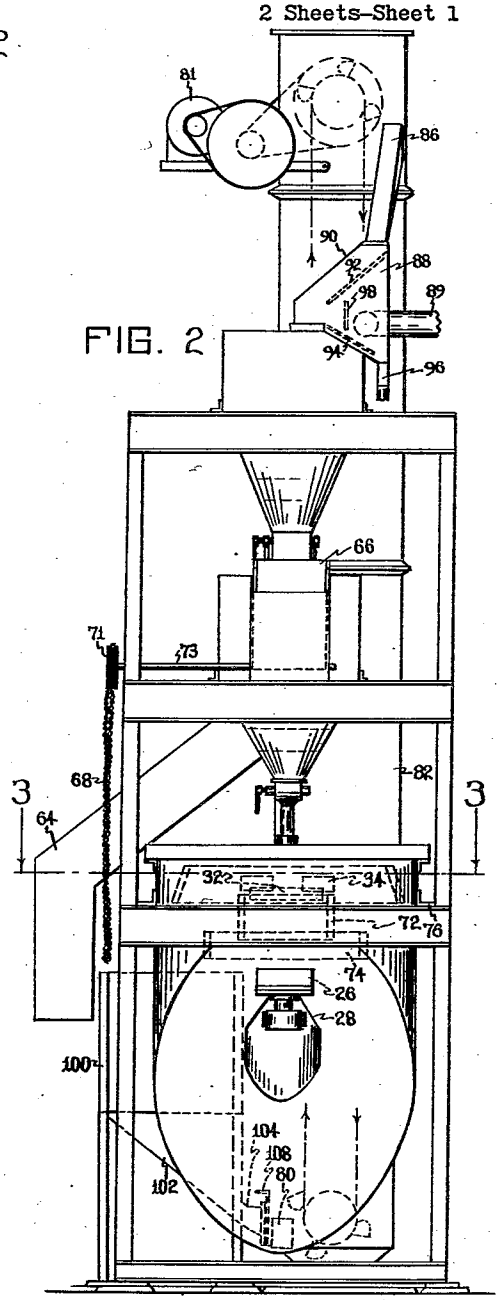

FIG. 2

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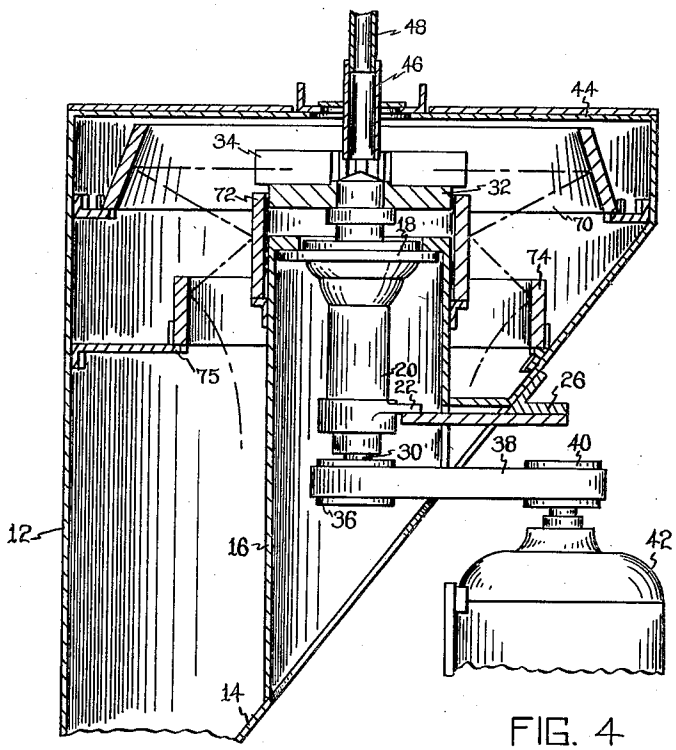

FIG. 4

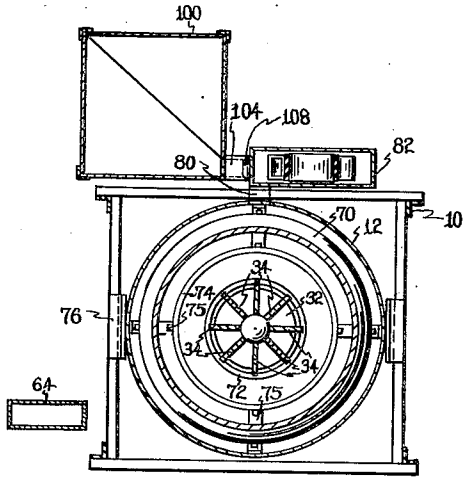

FIG. 3

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PARTICLE SMOOTHING APPARATUS

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Application November 29, 1950, Serial No. 198,114

6 Claims. (Cl. 78—1)

This invention relates to apparatus for smoothing small particles of deformable material such as metals, particularly to the smoothing of angularly shaped particles for the formation of ball-shaped ones.

The manufacture of ball-shaped particles commercially used to peen metal surfaces for example, and thereby to increase the fatigue endurance of the treated metal, is well known. Heretofore however the peening particles have been made by cumbersome processes involving the preparation of a molten metal mass and the subdivision of the molten metal into suitably sized globules which are solidified to give the resulting balls. However the preparation of a mass of molten metal requires the use of expensive equipment and relatively large amounts of power. In addition the globules formed are not all of uniform size but show a considerable range extending into sizes that are useless for the intended purpose and should be separated out. Furthermore for practical purposes the globule solidification should be fairly rapid and the resulting metal balls are therefore usually rendered more brittle than is desirable. This brittleness makes it often necessary to anneal the final particles so that they are suitably softened. An extra treatment step is accordingly called for.

Among the objects of the present invention is the provision of particle smoothing apparatus which avoid the above and related disadvantages.

Further objects of the present invention include the provision of automatic machines for smoothing irregularly shaped deformable particles.

The above as well as additional objects of the present invention will be more readily understood from the following description of several of its exemplifications, reference being made to the accompanying drawings wherein:

Fig. 1 is a front elevation of a particle smoothing apparatus according to the present invention, parts being removed and other parts broken away in the interest of clarity;

Fig. 2 is a side view looking at the machine of Fig. 1 from the right, with other parts removed to better show the construction;

Fig. 3 is a sectional view of the apparatus of Figs. 1 and 2 taken along the line 3—3; and

Fig. 4 is a somewhat enlarged detail view of a portion of the apparatus of Fig. 1 with additional portions of the exterior broken away to show the interior.

In accordance with the present invention it has been found that irregularly shaped particles such as chopped pieces of metal wire, can be rapidly and efficiently converted into small balls by subjecting the particles to a series of smoothing passes through an omni-directional centrifugal throwing wheel surrounded by a generally ring-shaped anvil. The particles fed into the wheel are projected radially in substantially all directions and strike the anvil which is interposed in their path. These particles rebound from the anvil and are collected for another pass but the surface of the particle on the site at

which it strikes the anvil is at least partially smoothed by the striking. After a sufficient number of passes at selected striking velocities, the particles will emerge quite smooth and in the shape of round balls or spheres. A single wheel can be provided with a plurality of anvils arranged so that the particles successfully rebound from one anvil to the next, to increase the smoothing action per pass and thereby further increase the efficiency of the smoothing apparatus. The apparatus can advantageously be made automatic by having recycling mechanism connected to supply a batch of particles to the wheel and to automatically stop the recycling after a time sufficient for the batch to be subjected to a complete pass. The cycling control elements can be arranged to then begin another pass and to automatically terminate after the desired number of passes are completed.

In the form of the invention shown in the figures there is provided a structural framework **10** the lower portion of which supports a housing **12** in the general shape of a cylinder with its lower end cut off by an intercepting sloping wall **14**. Within housing **12** an internally reentrant cylinder **16** is suitably supported to provide a mount **18** for a drive shaft journal casing **20**. Another support **22** for this casing is shown as secured by plate **24** directly to an angle **26** fastened as by welding directly to wall **14**. For the penetration of supporting plate **24** the wall of cylinder **16** may be suitably notched away as shown at **28** in Fig. 2.

Within journal casing **20** is rotatably mounted a drive shaft **30** carrying at its upper end a throwing wheel **32** equipped with a set of radially disposed throwing blades **34**. Drive shaft **30** also carries a pulley **36** which is linked by one or more belts **38** with a drive pulley **40** suitably rotated by electric motor **42** secured to the framework **10**.

Wall **14** acts as the bottom of the housing **12**, and a cover **44** closes off its top. Through a passageway in cover **44** a feed spout **46** projects for supplying particles to the center of wheel **32**, and an exit tube **48**, connected by valve **50** to a storage container **52**, leads into the feed spout **46**. Storage container **52** is supported as by beams **54** upon the framework **10** and carries directly over valve **50** an internally mounted angle iron deflector **56**. The top of storage container **52** is shown as open and as located underneath the discharge outlet **58** of a collector **60**. A control valve **62** controls the feeding of particles from collector **60** to storage container **52**. An unloading conduit **64** has its upper ends secured to a side wall of container **52**, and a portion of the container wall separating it from the discharge conduit **64** is pivoted on shaft **73** with respect to the remainder of the container wall and provided with flanges to act as a pivoted control chute **66**. When suitably manipulated as by chain **68** conected to bell crank **71** fixed to chute pivot shaft **73**, the chute **66** can be tilted to the dash-dot position shown in Fig. 1 where its upper end is moved under the discharge outlet **58** and discharged particles are guided into unloading conduit **64**. The bell crank **71** can be counterbalanced to normally keep the chute **66** in the full line position shown in Fig. 1 where it seals against the walls of container **52** and prevents any recycling particles from reaching the unloading conduit **64**.

Within the housing **12** is shown fastened a set of three anvils **70**, **72** and **74**. The uppermost one **70** encircles the throwing blades **34** and is supported by extensions of brackets **76** secured as by welding to the framework **10**. The intermediate anvil **72** is conveniently held by the walls of reentrant cylinder **16** while the lowest anvil **74** is fixed in place by external web portions **75** suitably fastened to the outer walls of housing **12**. The anvils are rings of hard metal such as high carbon or alloy steels to flatten or smooth particles projected against them, at

the site of the impact, and to cause the smoothed particles to rebound away from the anvil surface making way for other particles. As shown in the figures, the uppermost anvil has its rebounding surface tilted with respect to the direction in which the particles are thrown, to better direct the rebounding particles to the next anvil. By reason of the inclined rebounding, the remaining anvils can have impact surfaces of cylindrical shape to continue directing further rebounding to the successive anvils. Although three anvils are shown, more can be provided as by a hardened sheath around cylinder **16** below anvil **74**. Alternatively less than three anvils can be used if desired in which case provision should be made for reducing erosion of the apparatus by the rebounding particles. Thus extra heavy wear plates can be placed over the appropriate surfaces or the last rebound can be caught by a pocket in which some of the particles become trapped to form a protective surface that does not require any significant attention. The anvils are advantageously made readily removable and replaceable as by merely setting them on their supports within suitable upstanding positioning flanges as shown in Fig. 4.

After the last rebound, the projected particles drop to the bottom of housing **12** where they pass through opening **80** to the bottom of a conveyor elevator **82**. This conveyor is shown as of the conventional bucket type operated by electric motor **81** and lifts the particles into a feed spout **86**. From here the particles are dropped through a dust separator **88** into the collector **60**. The dust separator **88** is shown as operated by a stream of air sucked by means of pipe **89** from the outside through screened opening **90** and then through a stream of particles descending from the end of guide ledge **92**. The air carries the finer particles over to the sloping floor **94** where they then move to waste discharge **96** while the larger particles are not much affected by the air flow and fall into the collector **60**. A baffle **98** can be used to reduce the sucking of the finer particles directly into the suction pipe **89**.

To simplify loading of the apparatus with the irregularly shaped particles a separate loading bin **100** is shown (Figs. 2 and 3) as positioned alongside housing **12** and having a sloping bottom **102** which terminates at its lowest point in a neck **104** connected with another opening **106** at the bottom of the elevator. A valve such as slidable gate **108** is used when it is desired to close the opening and prevent passage of particles to or from the bin. The bin can be made removable in which case both neck **104** and opening **106** can be provided with closures.

A feature of the present invention is the fact that the number of smoothing passes through the apparatus illustrated in the figures can be accurately controlled. Furthermore this control is very easily made automatic. As shown for example in Fig. 1, valves **50**, **62** are operated by air cylinders **110**, **112** respectively, which are in turn separately controlled as by air-directing solenoid valves **114**, **116**. A timer **120** is suitably connected so that it alternately operates the solenoids according to a sequence determined by adjustable control knobs **122**, **126**. One of the knobs is connected to determine the frequency at which the smoothing cycles take place, and the other knob the number of smoothing passes. The machine is started by loading the collector **60** with suitable angularly shaped particles such as chopped pieces of metal wire. The loading can be either by way of bin **100** or directly into the collector or storage container. With the valve **50** closed and valve **62** open, the particles are brought into the storage container if they are not there already. To accomplish this the conveyor and the valves may be operated as by a separate control not shown. With the throwing wheel operating, one of the timer controls is then set so that it closes valve **62**, opens valve **50** and maintains this condition for a period of time sufficient for the entire load to be passed through the smoothing treatment and return to collector **60**. After this time both valves are operated to their reciprocal positions, permitting the collected particles to drop into storage container **52**, ready for another pass. The other control is set so that this valve operating cycle is repeated the desired number of times. According to one modification of the present invention the timer can also be connected to change the speed of wheel impelling motor **42** after a predetermined number of passes, preferably between about 50 and 100. If desired, the motor speed control may also be made selectable as by a third dial not shown.

It has been discovered that particles as angular as chopped wire are very conveniently and rapidly converted into round balls. With only a single anvil a hundred passes through a throwing wheel having a one and one-half foot diameter, rotating at a speed of 2150 revolutions per minute (R. P. M.), followed by 50 passes through the same wheel at a speed of 1000 R. P. M. gives highly effective results. With more anvils fewer passes are needed.

A further feature of the present invention is the efficient manner in which the smoothing passes are effected. Thus the omni-directional characteristics of throwing wheel **32** enables the very rapid treatment of large quantities of shot in a single relatively small sized apparatus, and in combination with one or more generally ring shaped anvils, provides a compact smoothing apparatus in which one ton of angular particles can be subjected to a single pass in as little as three minutes or less.

For optimum smoothing the metal wire should be chopped to a uniform length substantially the same as their diameter as by means of the chopper shown for example in the copending Gladfelter patent application Serial No. 125,621 filed November 4, 1949. The wire may have a cross section that is either circular, rectangular or of any other shape. Although cut wire makes a very satisfactory starting material by reason of the uniformity of the individual particles, other types of angular particles such as crushed metal fragments of crudely shaped shot, or other non-uniform particles, can also be used in the apparatus of the present invention. The size of the individual particles to be treated is not critical and particles as small as 100 mesh or as large as 20 to the pound are satisfactorily smoothed by the illustrated apparatus. The smoothing does not remove any substantial amount of the particles but appears to cover the external surface of the particles with flats which result from the individual impacts and which merge into each other. An additional feature of the present invention is the fact that each impact appears to deform the particles to some extent, and this works the particle mass to a degree that the resultant rounded product is exceedingly tough and shows a considerable life when used for blast peening. For peening use the particles are not limited to any particular form of blasting arrangement, and any suitable device such as a throwing wheel, air blast or liquid stream is effective.

The rounded particles produced in accordance with the present invention can also be used for other purposes such as for shotgun shells or the like. The deflector **56** shown in storage container **52** and collector **60** reduces the erosion effect of dropping shot on the walls of the lower ends of these containers as well as on the valve mechanism which is there located. However the deflectors can be eliminated as by building these walls thicker and/or offsetting collector **60** so that the falling particles roll down its sloping walls instead of falling freely down to the bottom. Offsetting of collector **60** will at the same time similarly shift the flow of particles into the storage container **52**.

The throwing wheel **32** can be of very simple form having merely a single disc-shaped head and a set of radially disposed undercut channels in which are pinned suitably shaped blades, as shown for example in U. S.

Patent No. 2,359,313 granted October 3, 1944 to W. L. Keefer. Inasmuch as it is preferred that the wheel of the illustrated apparatus be omni-directional, that is does not confine projected particles into a narrow swath of limited length, the directional controlling elements shown in the above Keefer patent as mounted centrally of the blades can be completely eliminated.

As many apparently widely different embodiments of this invention may be made without departing from the spirit and scope hereof, it is to be understood that the invention is not limited to the specific embodiments hereof, except as defined in the appended claims. Thus the anvils need not be absolutely circular but can be elliptical or angular in cross section. In addition the impact surfaces on these anvils may be smooth or may be provided with protuberances as by knurling, although a smooth surface gives more directional rebounding.

What is claimed is:

1. In an apparatus for repeatedly subjecting angularly shaped deformable particles to a smoothing treatment for changing the particles into the shape of balls, a support, smoothing mechanism connected to said support for receiving the particles to be rounded and giving them a single smoothing pass, cycling structure connected to the smoothing mechanism for collecting the particles subjected to a smoothing pass and returning them for another pass to form a cycling circuit, said cycling structure including control elements connected to automatically close down the cycling circuit while a batch of particles is given a single smoothing pass to closely control the number of smoothing passes.

2. The combination as defined by claim 1 in which the control elements include a storage container in the recycle path, a particle supply valve and a particle discharge valve connected for respectively controlling the supply to and discharge of the particles from the container, and valve-operating mechanism for holding the supply valve closed and the discharge valve open for a predetermined period of time at least long enough for a complete pass of a batch of particles, for then opening the supply valve and closing the discharge valve to cause the passed particles to be returned to the storage container, and for then restoring the valves to the first-mentioned conditions for continuing with another smoothing pass.

3. In a particle-smoothing apparatus for accurately subjecting a mass of angular particles to impacting treatment, a centrifugal particle-throwing wheel for receiving said particles and centrifugally projecting them, at least one anvil positioned in the path of projection to cause the particles to be partially smoothed by subjection to a predetermined number of striking engagements and then to drop down, valve-controlled feeding structure connected to supply the particles to the wheel, collecting structure connected to collect the dropping particles, recycling mechanism connected to return the collected smoothed particles to the feeding structure, said recycling mechanism including automatic feed-control elements connected to keep the feed valve open for the passage of a single batch of particles through the wheel, and automatically keeping the recycling path closed for a period of time corresponding to the cycling time of that batch.

4. In an apparatus for forming rounded metallic shot from metallic wire, the combination of a collecting bin, an elevator positioned adjacent said collecting bin and connected to lift particles from said bin to a predetermined height, a storage hopper positioned adjacent said height and connected to receive said particles from the elevator, a control valve coacting with said storage hopper to control the discharge of particles therefrom, a second hopper disposed beneath said first hopper to receive said particles therefrom, a second control valve coacting with said second hopper to control the discharge of particles therefrom, a centrifugal throwing machine including a throwing wheel positioned beneath said second hopper, guide means to lead said particles from said second hopper to said throwing wheel, an anvil structure positioned in the throwing path of said centrifugal throwing wheel, and having hardened surface portions for the thrown particles to strike and from which they rebound and drop, additional guide means to conduct the dropping particles to the collecting bin, and control structure for sequentially controlling the passage of said particles through said throwing machine a predetermined number of times, said control structure including automatic valve-actuating apparatus for alternately and sequentially opening and closing the respective hopper valves.

5. In an apparatus for making metal balls, a housing, a plurality of vertically-spaced anvils in said housing, said anvils being positioned in individual substantially parallel planes, a projecting device positioned in said housing, said projecting device being adapted to project metal particles therefrom in a linear direction at high speed, one of said anvils being arranged in an inclined, opposed relationship relative to said projecting device so as to receive the impact of particles linearly projected from said projecting device and to deflect said particles at an acute angle, and a second of said anvils being entirely radially offset inwardly of said first-mentioned anvil in a position to receive the impact of particles deflected from said first-mentioned anvil.

6. The apparatus of claim 5 wherein there are at least three vertically and radially offset anvils, each anvil being arranged in the particle-deflection path of the vertically preceding anvil.

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