Oct. 16, 1934. A. L. WHITESIDE 1,976,974

APPARATUS FOR AND METHOD OF REFINING FINELY DIVIDED MATERIAL

Filed Jan. 22, 1931 2 Sheets-Sheet 1

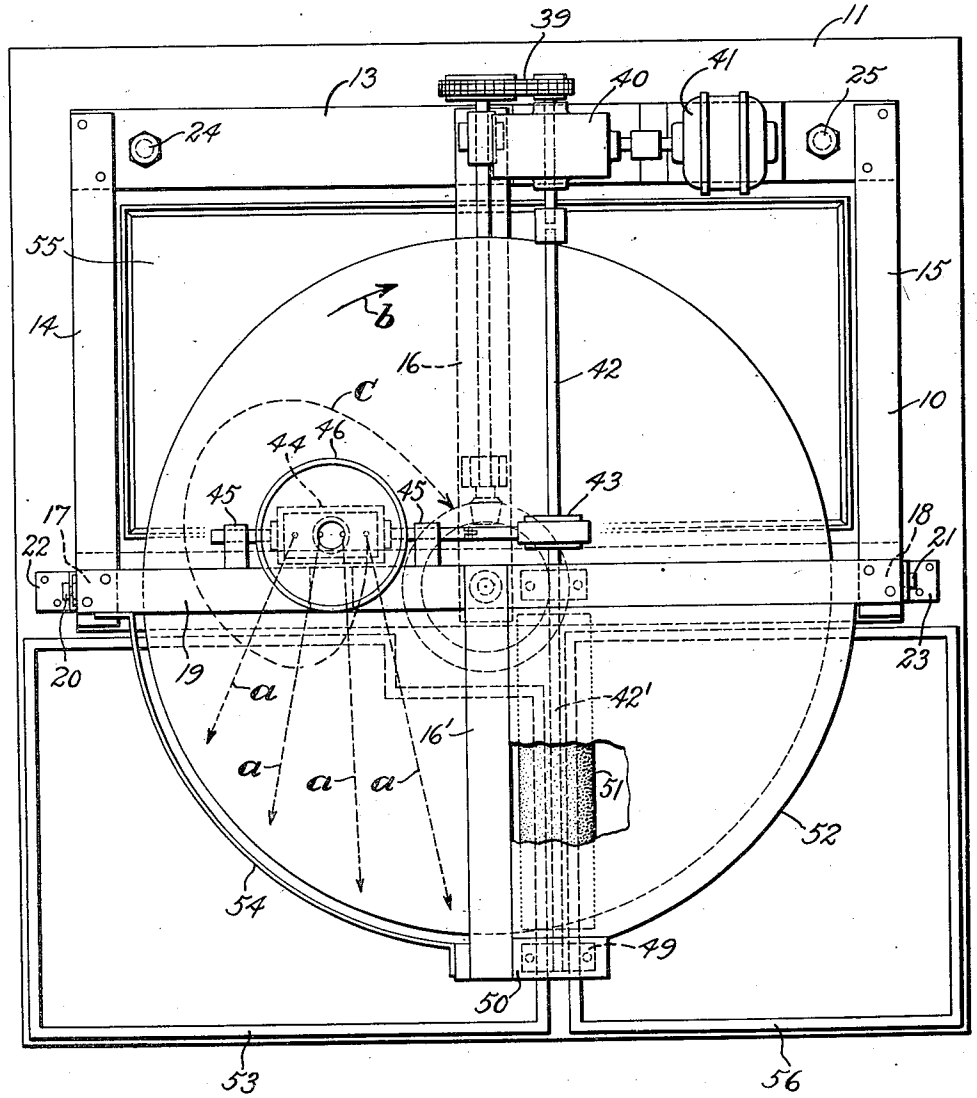


Fig. 1.

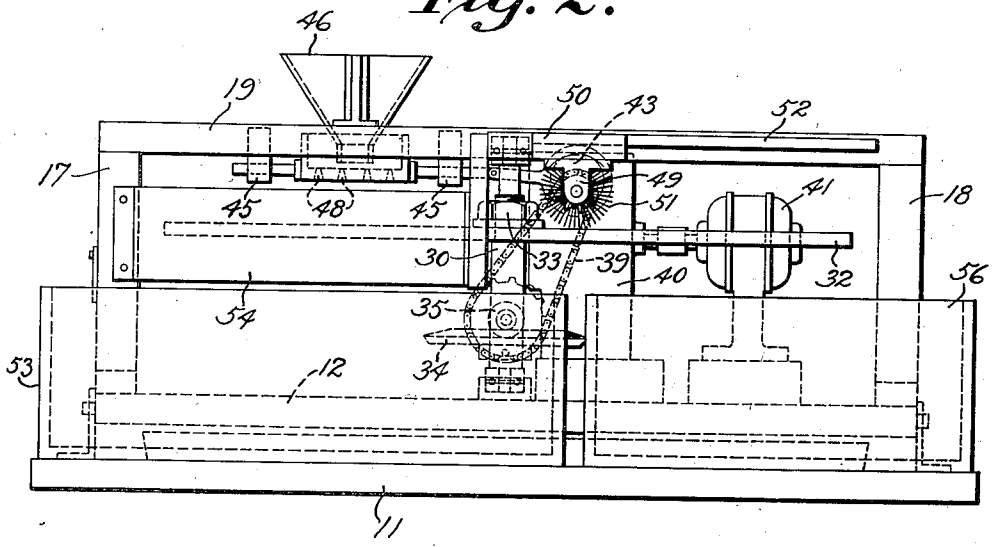
INVENTOR
Arthur L. Whiteside
BY
Wm. J. Stellmach
his ATTORNEY

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Filed Jan. 22, 1931 2 Sheets-Sheet 2

Fig. 2.



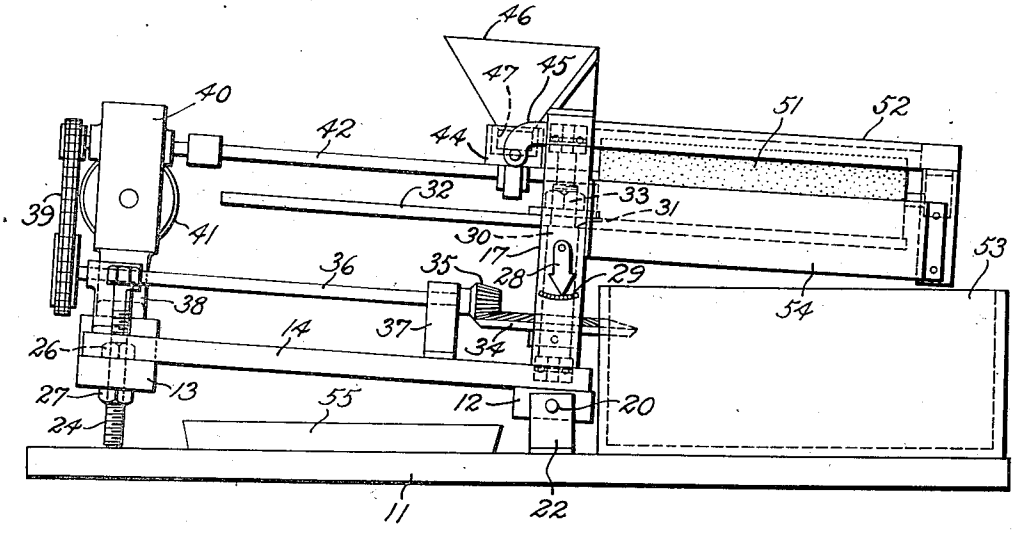


Fig. 3.

INVENTOR
Arthur L. Whiteside
BY
his ATTORNEY

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APPARATUS FOR AND METHOD OF REFINING FINELY DIVIDED MATERIAL

Arthur L. Whiteside, East Orange, N. J., assignor to Pulvis Aktiengesellschaft, Glarus, Switzerland, a corporation of Switzerland

Application January 22, 1931, Serial No. 510,409

9 Claims. (Cl. 209—6)

My invention relates to the refining of finely divided material and has particular reference to the refining of finely divided metallic material such as commercial chilled shot or the like.

For certain uses it is desirable to provide a mass of finely divided metallic material having the general characteristics of a dry powder and consisting entirely of individual substantially perfectly spherical bodies of substantially uniform size, so that such material may be subjected in use to impact and to relative movement of the individual bodies with respect to each other without causing breakage of the individual bodies or undue wear thereof because of the presence of abrading, non-spherical particles.

Metallic material having the above characteristics is particularly useful as a power transmitting medium in clutches of the general type disclosed in my copending application Serial No. 508,818, filed January 15, 1931, Patent No. 1,910,270, issued May 23, 1933, and for purposes of illustration in the present application I will describe my invention, which includes both a novel method and novel apparatus, in connection with the refining of commercial chilled shot for use in such clutches, although it is to be understood that neither the method nor the apparatus herein disclosed are limited to the refining of this particular material.

For an understanding of the objects and nature of the invention reference may best be had to the ensuing detailed description, taken in conjunction with the accompanying drawings forming part of this specification and illustrating the novel apparatus provided for effecting one of the steps in the method.

In the drawings, Fig. 1 is a plan view of a device constructed in accordance with the invention and adapted to effect a separating operation on finely divided material;

Fig. 2 is a front elevation of Fig. 1; and

Fig. 3 is a side elevation looking from the left of Fig. 1 and illustrating the device in horizontally inclined position.

In order to produce suitable material for use as a power transmitting medium in clutches of the type above referred to, it is desirable that the material have the following characteristics: (*a*) it should contain only substantially spherical bodies; (*b*) the individual bodies should be of substantially uniform size; (*c*) the individual bodies should each be structurally sound to minimize the possibility of fracture thereof into non-spherical particles when the material is in use; and (*d*) the surfaces of the individual bodies should be coated with sufficient lubricant of relatively dry nature, such for example as graphite, to prevent abrasive metal to metal contact between the individual bodies, but the quantity of graphite or like substance employed should not be sufficient to destroy the characteristic of dryness of the material.

In order to refine finely divided material, such for example as commercial chilled shot, into a material having the characteristics above set forth, I propose, in accordance with my invention, to remove from the commercial shot all oversize shot and oversize foreign particles by passing the shot through a screen having interstices of known area, which screening operation serves to establish the upper limit of size of the bodies in the material used.

The material which is not rejected in the screening operation is subjected to impact in order to crack or break any defective bodies in the material. Subjection of the material to impact may be carried out in various known ways. For example, the material may be tumbled in a tumbling barrel which, depending upon its construction, may or may not have steel bars or other like impact members placed in the barrel with the material. When impact members are not employed the tumbling barrel should be of known form equipped with internal baffles or plates adapted to lift the material upon rotation of the barrel in order to secure impact due to dropping of the material within the barrel.

Another suitable means for subjecting the material to impact is the ordinary known form of pneumatic sand blasting equipment into which the material to be subjected to impact is introduced instead of sand, the desired impact being secured by the striking of the material against the surface toward which the blast is directed. In this connection, it is to be noted that commercial chilled shot of small diameter is frequently used in lieu of sand in certain commercial sand blasting operations, and in plants where the cleaning of castings or other objects by this process is required, desirable economies may be effected by making this step of the present process perform an additional useful function.

The material which has been subjected to impact treatment is passed through a screen having interstices of smaller area than the first screen employed, and all bodies, fragments and foreign particles of a size smaller than a predetermined minimum are separated from the useful material by this screening operation. The retained material consists of bodies which are of

uniform size between the limits established by the screening operations and which are structurally sound.

I prefer to carry out the above described steps in the order named, that is, first screening the material to remove oversize material, then subjecting the screened material to impact treatment, and then screening the impact treated material to remove undersize bodies, but this order to steps is not essential. By following the order of steps specified, the quantity of material which must be handled in the step of impact treatment is reduced, and the screening for the removal of undersize bodies, when it is preceded by the impact treatment, permits the removal at one time not only of all of the undersize bodies in the original commercial material, but also of the undersize fragments produced by the breakage incident to the impact treatment. The material which has been screened to substantially uniform size and from which structurally defective bodies have been removed is next subjected to a treatment which separates the substantially perfectly spherical balls from all balls which are of other than spherical shape and from all fragments and foreign particles which may not have been removed from the material in the screening operations.

I have found that the substantially perfect balls in the material may be readily separated from all imperfect material if the material to be separated is dropped on a horizontally inclined moving surface, since the perfect balls will take paths of travel, after striking the surface, which are considerably different from the paths of travel taken by the imperfect bodies comprising the remainder of the material. The surface upon which the material is dropped is preferably of glass, and it is preferable to drop the material on such surface in a zone where the surface inclines upwardly with respect to the direction of movement of the surface. When the material is dropped on such a surface the perfect balls will roll down the inclined surface and in substantially straight lines, so that all such balls will reach the edge of the surface in a well defined zone which is fixed with respect to the position of the zone in which the material is dropped on the moving surface. The imperfect bodies comprising the remainder of the material will either roll relatively slowly and in irregular paths of travel which, due to the movement of the surface, prevent them from reaching the edge of the surface in the zone reached by the perfect balls, or, if they have flat faces, will remain on the surface and be carried away from the zone of movement of the perfect balls by the moving surface. Bodies having flat faces and tending to remain on the surface may readily be removed therefrom at still another zone by brushing or other mechanically equivalent means.

The more specific details of this step in the method will appear more fully in connection with the description of the preferred form of apparatus for carrying this step into effect which will hereinafter be described.

The substantially perfect balls separated by the above described steps are collected and treated by coating them with graphite to avoid abrasion when the refined material is used in a manner subjecting the balls to impact or rubbing. I prefer to accomplish this coating by tumbling the balls in the presence of graphite and then screening the graphite treated balls to remove excess graphite. The amount of graphite in the finished product should be the minimum consistent with the desired coating and, generally speaking, should be less than 5%. I prefer to keep the graphite content as low as 1% in the finished product.

Referring now to the drawings, I have illustrated a novel form of separating device for effecting the separating step hereinbefore referred to. The particular device illustrated has been used in the refining of commercial chilled shot to produce a refined material in which the individual balls are between 20 and 23 thousandths of an inch in diameter, these limits being established by previous screening operations.

The device comprises a frame indicated generally at 10, said frame being adapted to be mounted in adjustably tilted position upon a suitable base or support 11. Frame 10 comprises two parallel frame bars 12 and 13, joined together by means of end cross members 14 and 15 and a central cross member 16, which has an overhung portion 16'. Vertical supports 17 and 18 serve to hold the frame member 19 above member 12. The entire frame is pivotally supported by means of suitable axially extending pins 20 and 21 passing through the vertical webs of angle plates 22 and 23 secured to the base 11, and the angle of inclination of the frame is determined by means of adjusting bolts 24 and 25 passing through the member 13 and provided with lock nuts 26 and 27. The frame is preferably provided with an indicator to show the angle of inclination, this indicator conveniently comprising a pivotally hung pointer 28 adapted to cooperate with an arcuate scale 29 secured to the vertical support 17.

A vertical shaft 30 is rotatably mounted centrally of the frame, preferably in anti-friction bearings, between the vertically spaced members 12 and 19. The portion of this shaft between the vertically spaced members is shouldered as at 31, this shoulder serving to support a circular member in the form of a plate 32, the upper surface of which is preferably of glass. Plate 32 may conveniently consist entirely of glass. The plate 32 is secured against relative rotation with respect to shaft 30 by means of a clamp nut 33 screwed on the shaft 30, above the plate. Below the plate 32, shaft 30 has secured thereto a bevel drive gear 34 meshing with a pinion 35, the latter being secured to a shaft 36 mounted in suitable bearing brackets 37 and 38 on the frame. Shaft 36 is driven through the medium of a drive chain 39 which receives its power from the speed reducing gear 40 mounted on member 13, said gear being driven by a motor 41 also mounted on this frame member.

The power delivering shaft on the speed reducing gear 40 drives a second shaft 42 located above plate 32 and provided with an eccentric 43 adapted to oscillate a material feeding member 44 mounted in brackets 45 attached to the frame member 19. A hopper 46 is mounted on the frame above the feeding member 44 and comprises a spout 47 extending downwardly to a point close to the bottom of member 44. A number of holes 48 are provided in the bottom of member 44, these holes being spaced from each other and preferably extending in a line generally transverse to the direction of movement of the plate immediately below the feeding member. In the feeding member illustrated four holes are employed, but this number may be varied, although the number should be relatively small for reasons which will hereinafter appear.

Shaft 42 is extended as at 42', the outer end of the shaft being supported in a bearing 49 car-

ried by a block 50 secured to the outer end of the frame extension 16'. The extended portion 42' of shaft 42 has mounted thereon a brush 51 adapted to sweep the plate 32, and the portion of the plate above the brush is preferably enclosed by a cover 52 which may be removably secured to the frame in any suitable manner.

The good material separated by the device is conveniently collected by means of a box 53, into which it is directed by the deflecting strip or guard 54, while the pan 55 and box 56 serve to collect the imperfect material separated by the device.

In a device suitable for separating material of the dimensions above specified I have found that a suitable diameter for plate 32 is about 30 inches and that the plate should be rotated at a speed of about ten revolutions per minute. The shaft 42 for rotating brush 51 and for oscillating feeding member 44 should operate at about 180 revolutions per minute and by using a speed reducing gearing having a ratio of ten to one the device may be operated by a small high speed electric motor of one-eighth horse power. The speeds at which the brush and the feeding member operate need not be the same, and they may vary considerably without materially affecting the operation of the device. The speed at which the plate rotates, however, is a more important factor and variation in this speed will affect the manner of operation of the device.

For separating material of the character described I have found that holes 50 thousandths of an inch in diameter are suitable for use in the feeding member and that the device should be tilted approximately 10° with respect to the horizontal to secure the best results. Obviously, if material comprising bodies of a materially different size is to be separated the size of the holes in the feeding member should be changed, and also, depending upon the size and character of the material, the angle of inclination of the plate may require change in order to secure the best results.

In operation, material is fed from the hopper 46 to the feeding member 44 and the oscillating movement of this member causes the material to be dropped in a scattered state through the holes 48 to the surface of plate 32. The projection of hopper 46 to a point adjacent to the bottom of the feeding member 44 serves two useful functions. It maintains the material in the feeding member at a substantially constant depth and the relative motion between the lower end of the hopper and the material in the feeding member serves to agitate the material and facilitates an even rate of feed through the several holes 48.

It is to be noted that the scattering of the material is important to the successful operation of the device, since if the separating action is to be effective, individual bodies in the material should fall to the surface of the plate free and clear of contact with, or interference from, other bodies. Obviously, this scattering action in the feeding mechanism can be obtained by other than oscillating movement of the feeding member, but I have found this motion to be both easy to obtain and effective in use. In the device described, the member 44 has a path of travel of about one inch.

Upon striking the surface of the plate the individual bodies bounce or roll from their respective points of contact and, due to the inclination of the surface of the plate, the perfectly spherical bodies roll downwardly along the inclined surface in the general direction indicated by the dotted arrows *a* toward the box 53. Their paths of travel are affected to some extent by the movement of the plate, which is rotating in the direction indicated by the arrow *b*, but due to the slow speed of rotation of the plate and the short paths of relatively rapid roll of the perfectly spherical bodies, they leave the plate in a definite zone comprising a relatively restricted portion of the circumference of the plate having a fixed position with respect to the location of the feeding zone.

The imperfect bodies which are capable of rolling take irregular paths of travel and roll at a slower speed than the spherical bodies. Consequently such imperfect bodies are carried upwardly by the moving plate and take various irregular paths of travel such as that indicated by the dotted arrow *c*, to be finally removed from the plate by the action of the brush 51. Some of these imperfect bodies may leave the surface of the plate in the upper portion to drop into the pan 54, but the amount of material leaving the part of the plate under which this pan is placed is relatively small. Imperfect bodies having flat faces come to a position of rest on the plate and are carried around thereby to the brush 51, which serves to remove these bodies and also the irregularly rolling bodies which follow paths of travel similar to that indicated at *c*.

Many changes and variations in the apparatus and method hereinbefore described by way of example may be made within the scope of the invention, which also contemplates the use of some of the steps of the method to the exclusion of others. It is further to be understood that the invention is applicable to the refining of various finely divided materials of different nature and intended for uses other than in power transmitting mechanism.

What I claim is:

1. The method of refining commercial shot which comprises subjecting the shot to impact to crack defective shot and dropping the shot in scattered state on a horizontally inclined moving surface to separate substantially perfect shot from the remaining shot due to the different paths of travel of the shot after striking said surface.

2. The method of refining commercial shot which comprises tumbling the shot to crack defective shot and dropping the tumbled shot in scattered state on a horizontally inclined moving surface to separate substantially perfect shot from the remaining shot due to the different paths of travel of the shot after striking said surface.

3. The method of preparing commercial shot for use as a power transmitting medium in clutches or the like which consists in subjecting the shot to impact to crack defective shot, dropping the shot in scattered state on a horizontally inclined moving surface to separate substantially perfect shot from the remaining shot due to the different paths of travel of the shot after striking said surface, and coating the substantially perfect shot with graphite.

4. The method of preparing commercial shot for use as a power transmitting medium in clutches or the like which consists in subjecting the shot to impact to crack defective shot, dropping the shot in scattered state on a horizontally inclined moving surface to separate substantially perfect shot from the remaining shot due to the different paths of travel of the shot after striking said surface, tumbling the separated sub-

stantially perfect shot in the presence of graphite and screening the graphite treated shot to remove excess graphite therefrom.

5. The method of preparing commercial shot for use as a power transmitting medium in clutches or the like which consists in screening the commercial shot to establish a maximum size of shot, tumbling the screened shot to crack defective shot, screening the tumbled shot to establish a minimum size of shot, dropping the sized shot in scattered state on a horizontally inclined moving surface to separate the substantially perfect shot from the remaining shot due to the different paths of travel of the shot after striking said surface, and coating the separated substantially perfect shot with graphite.

6. The method of preparing commercial shot for use as a power transmitting medium in clutches or the like which consists in screening the commercial shot to establish a maximum size of shot, tumbling the screened shot in the presence of impact members to crack defective shot, screening the tumbled shot to establish a minimum size of shot, dropping the sized shot in scattered state on a horizontally inclined moving surface to separate the substantially perfect shot from the remaining shot due to the different paths of travel of the shot after striking said surface, tumbling the separated perfect shot in the presence of graphite and screening the graphite treated shot to remove excess graphite therefrom.

7. A device for refining finely divided metallic material containing substantially spherical bodies comprising a frame, means for tilting the frame, a glass plate rotatably mounted on the frame and adapted to tilt therewith, feeding means for dropping said material on said plate including a stationary hopper, a movable feeding member mounted on the frame beneath the hopper, the lower end of said hopper extending to adjacent the surface of said feeding member, and means mounted on the frame for rotating the plate and for oscillating said feeding member whereby the adjacent stationary end of said hopper agitates material in said feeding member.

8. A device for refining finely divided metallic material containing substantially spherical bodies comprising a frame, means for tilting the frame, a glass plate rotatably mounted on the frame and adapted to tilt therewith, feeding means for dropping said material on said plate including a movable feeding member mounted on the frame and a revolvable brush mounted on the frame generally radially of and contacting said plate, and means mounted on the frame for rotating the plate and the brush and for oscillating the feeding member.

9. A device for refining finely divided metallic material containing substantially spherical bodies comprising a frame, means for tilting the frame, a glass plate rotatably mounted on the frame and adapted to tilt therewith, feeding means for dropping said material on said plate including a movable feeding member mounted on the frame, a motor mounted on the frame, means including speed reducing gearing actuated by said motor for rotating said plate at relatively low speed, and means actuated by said motor for oscillating said feeding member and for rotating said brush at speeds materially greater than the speed of rotation of said plate.

ARTHUR L. WHITESIDE.