Jan. 6, 1959 R. B. DODDS ET AL 2,867,387

CENTRIFUGAL IMPACTING MACHINE

Filed Nov. 23, 1955 4 Sheets-Sheet 1

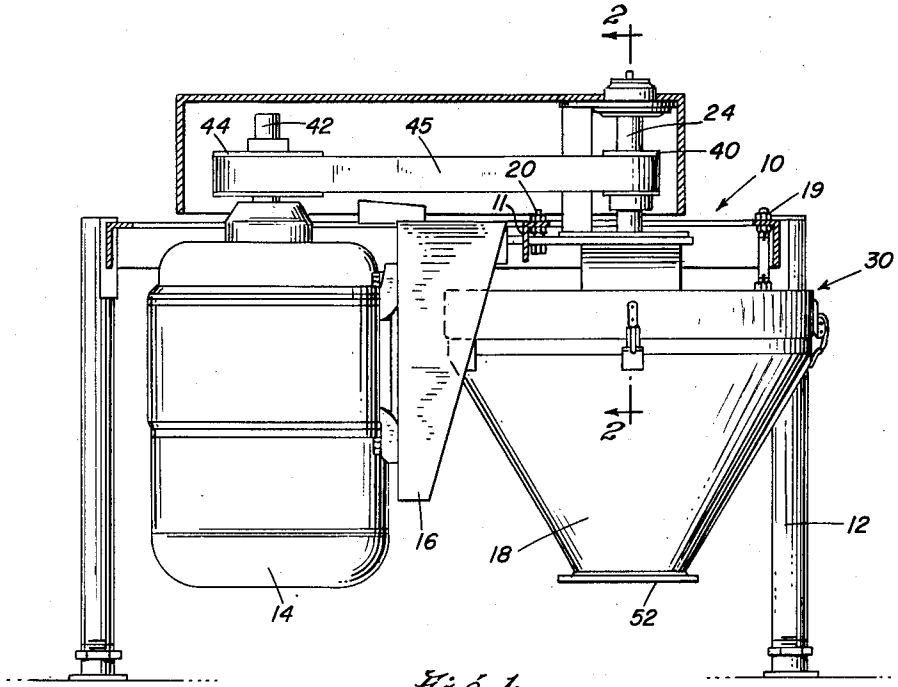

Fig. 1.

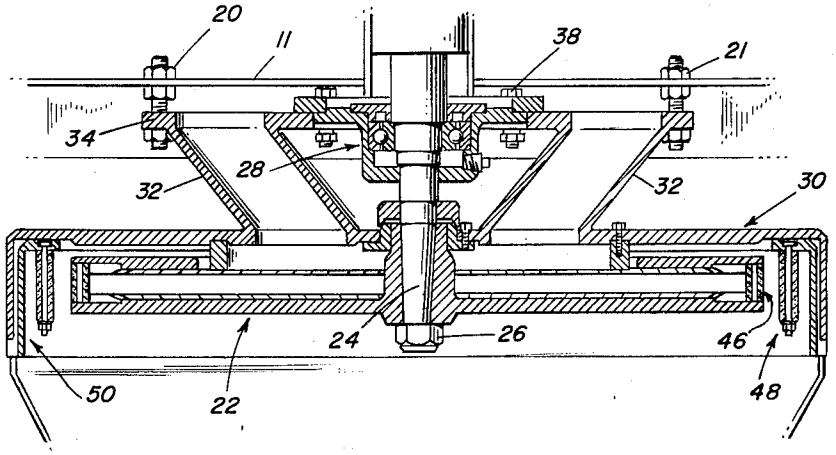

Fig. 2.

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CENTRIFUGAL IMPACTING MACHINE

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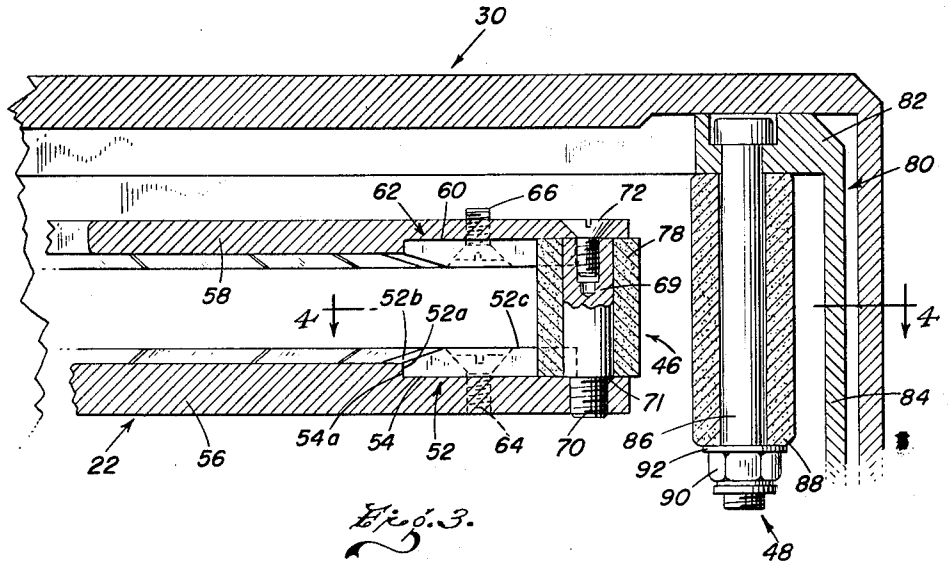

Fig. 3.

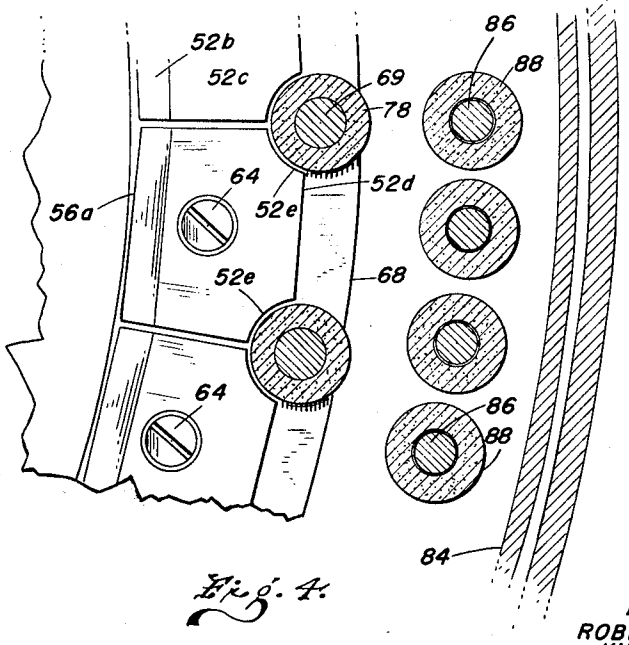

Fig. 4.

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CENTRIFUGAL IMPACTING MACHINE

Filed Nov. 23, 1955 4 Sheets-Sheet 3

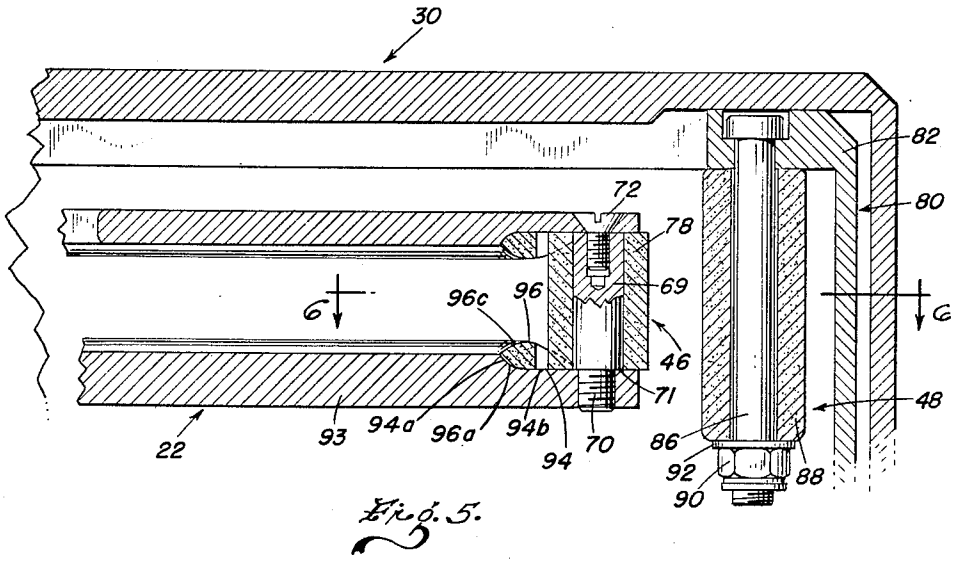

Fig. 5.

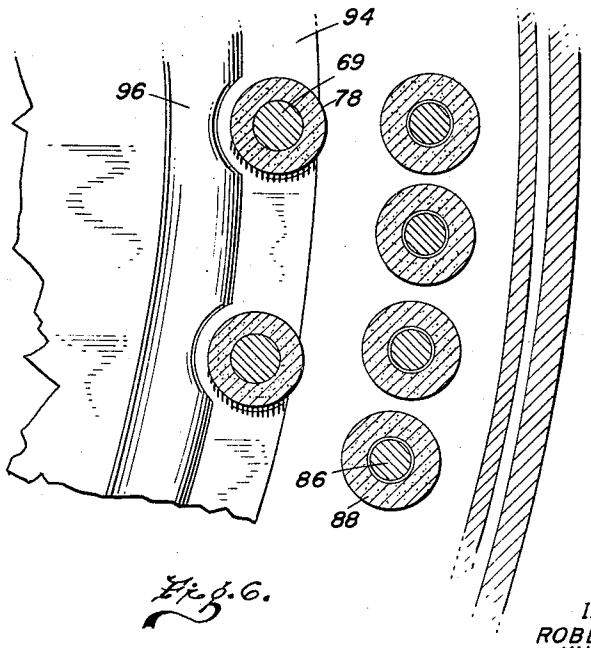

Fig. 6.

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CENTRIFUGAL IMPACTING MACHINE

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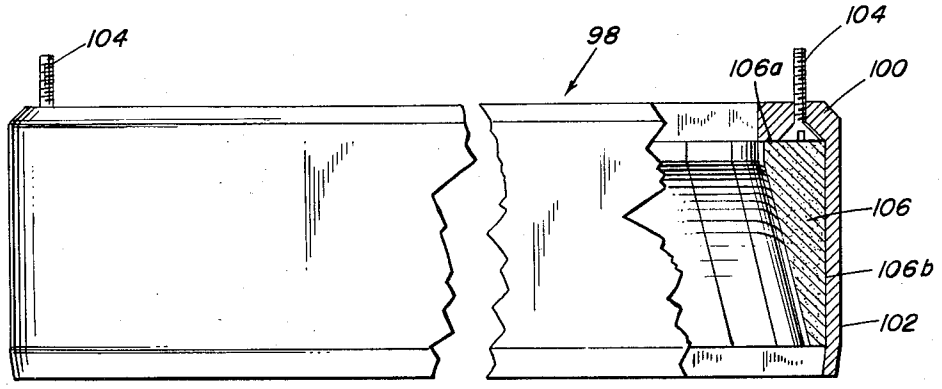

Fig. 7.

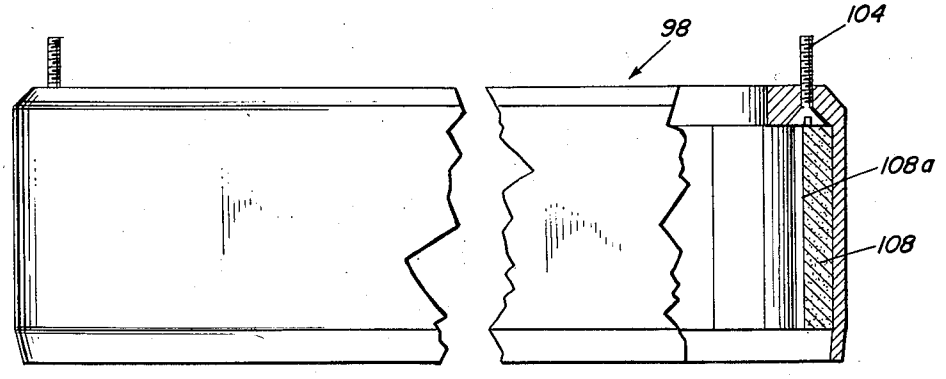

Fig. 8.

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United States Patent Office 2,867,387 Patented Jan. 6, 1959

2,867,387

CENTRIFUGAL IMPACTING MACHINE

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Application November 23, 1955, Serial No. 548,667

7 Claims. (Cl. 241—275)

This invention relates to a centrifugal impacting machine designed for shattering or otherwise reducing granular products of all types including food, minerals and chemicals of all types. More specifically, the invention relates to a centrifugal impacting machine particularly designed to withstand the rough treatment accompanying the processing of hard, abrading materials and to impart a maximum shattering impact force to each individual particle.

This invention is in the nature of an improvement on the basic machine disclosed in the co-pending application filed on December 7, 1954 in the names of Robert B. Dodds, Robert B. Siedel and Kurt H. Conley for "Centrifugal Impact Milling Apparatus and Process of Impact Milling," and having Serial No. 473,546.

Machines of the type described in the above application comprise a rotor including two or more axially spaced disks and a plurality of impactors located therebetween adjacent its outer edge with means for feeding the product to the central portion of the rotor. In operation the product is thence flung outwardly by centrifugal force and hit by the impactors and discharged from the rotor either against a hard surface which may be abrasive or against a plurality of target members disposed about the outer casing facing the periphery of the rotor and thus concentric therewith. The rotor is driven at high speed and hence the product shoots outwardly at very high velocities.

Accordingly when the product being treated comprises particles which are very hard and abrasive, e. g., asbestos, the rotor plates, the impactors and targets as well as the interior of the machine casing may become badly worn to such an extent that the machine may be made inoperative in a relatively short time. Such abrading action has been found to develop a very substantial wear even when these parts are made of the hardest types of steel alloys available. Also the rotors of these centrifugal impact machines have a tendency to spread the granular product outwardly in a thin, even stream which is first hit by the impactors and then passes outwardly still in a comparatively thin stream to strike against the targets, the machine casing or lining, or both. It has been found in practice that there is a very considerable cushioning effect wherein many of the individual particles may follow each other to the impactors, targets or liners to pile up at the moment of impact. Where two or more of the particles to be impacted pile up one upon the other there is a definite cushioning effect which greatly reduces the efficiency of the machine operation.

It is an object of this invention to provide a centrifugal impact machine for shattering a granular product which is very sturdy in construction and thus well able to withstand hard usage and resist wear and tear. Another object of this invention is to provide a machine of the above character in which portions particularly exposed to wear and tear during the impacting operation are reinforced to resist deterioration. Another object is to provide a machine of the above character in which the

several difficulties referred to hereinabove are successfully and practically overcome. A further object of this invention is to provide a machine of the above character in which the efficiency of the impacting action is materially increased in comparison with existing machines. A still further object of this invention is to provide a machine of the above character in which the particles are so directed during their passage outwardly by centrifugal force that the cushioning of one particle on another during impact is reduced to an absolute minimum. Other objects will be in part obvious and in part pointed out hereinafter.

The invention accordingly comprises the features of the construction, combinations of elements, and arrangements of parts, which will be exemplified in the construction hereinafter set forth, and the scope of the invention will be indicated in the claims to follow.

For a fuller understanding of the nature and objects of the invention, reference should be had to the following detailed description taken in connection with the accompanying drawings, in which:

Figure 1 is a front elevation, partially in section, of a machine of the type in which the features of this invention may be incorporated,

Figure 2 is a fragmentary vertical sectional view of a portion of the machine shown in Figure 1, illustrating the centrifugal rotor and associated mechanism,

Figure 3 is a fragmentary enlarged vertical sectional view of a portion of the structure shown in Figure 2 which includes a part of the rotor, an impactor, a target and the machine liner,

Figure 4 is a transverse sectional view taken along the line 4—4 of Figure 3,

Figure 5 is an enlarged fragmentary vertical sectional view similar to Figure 3, showing another embodiment of the present invention,

Figure 6 is a transverse sectional view taken along the line 6—6 of Figure 5,

Figure 7 is an elevational view, partially fragmentary and partially broken away, of a liner for the machine shown in Figure 2 and showing another embodiment of the present invention, and,

Figure 8 is a fragmentary elevational view, partially broken away, of a liner for the machine shown in Figure 2 which is still another embodiment of the above invention.

Similar reference characters refer to similar parts throughout the several views of the drawings.

Turning first to Figure 1 the machine comprises a frame generally indicated at 10 having legs 12 for support on a floor. An electric motor 14 is suspended from frame 10 in any convenient manner and is supported in such position by a bracket piece 16. A casing 18 is also suspended from frame 10 as by bolts 19, 20, and 21 and forms an enclosure for the rotor of the impacting machine in a manner to be presently described in detail.

More particularly, as shown in Figure 2 the rotor generally indicated at 22 is secured on one end of a drive shaft 24 by a nut 26, shaft 24 being rotatably supported in a conventional bearing generally indicated at 28. A top cover plate generally indicated at 30 has a pair of angularly disposed chutes 32 preferably integral therewith and converging toward the central portion of the rotor 22 to deposit the product to be treated thereon. The upper portions of the chutes 32 are preferably integral with a plate 34 which is bolted to crosspiece 11 of frame 10 by bolts 20 and 21 (Figure 2), bearing 28 being supported on plate 34 by bolts 38. The upper openings of chutes 32 may be connected to suitable conduits which preferably feed the grain by gravity thereto so that it may be deposited on the rotor for treatment. As better seen in Figure 1 the upper portion of shaft 24 has a pulley 40

connected thereto and the shaft 42 of motor 14 also carries a pulley 44. Pulleys 40 and 44 are interconnected by any suitable type of driving belt 45 and thus the motor 14 drives shaft 24 and the rotor 22 connected thereto when the machine is in operation.

Accordingly upon operation of motor 14 rotor 22 is driven by pulley 44, belt 45, pulley 40 and drive shaft 24. At the same time the granular product being treated is fed down through the chutes 32 on to the central portion of the rotor 22 which when operating at high speed propels the product outwardly in a substantially even, thin stream to be struck by impactors generally indicated at 46 and flung or otherwise impelled against the targets generally indicated at 48. Some of the particles of the product pass between the targets to hit the liner generally indicated at 50 whereupon all of the product falls down through the casing 18 to leave the machine at the outlet 52.

With the rotor traveling at high speed it is believed that the product has a tendency to assume a relatively thin layer in the vicinity of impactors 46, i. e., the product being treated is disposed in a pattern, probably not more than several grains thick. However, the individual particles tend to assume regular paths and hence follow each other. This pattern of regularity is believed to be responsible for considerable piling up of the individual particles at the moment of impact with the impactors and targets thereby creating a cushioning effect which greatly inhibits the shattering impact which the machine is designed to give each individual particle. Furthermore, it has been found in practice that where the machine is processing a particularly hard and abrasive product, the impactors 46 and the portions of the rotor 22 adjacent thereto, as well as the targets 48 and the liner 50, are all subject to rigorous wear and tear, sufficient in many instances to wear even the hardest steel alloys to an unusable extent in a relatively short period of time. The construction now to be described is designed primarily to overcome such difficulties in a practical and economical manner.

As can be better seen in Figures 3 and 4 a series of wear plates generally indicated at 52 are arranged adjacent impactors 46 in an annular groove 54 formed in the bottom disk 56 of rotor 22. Similarly the top disk 58 has a groove 60 formed therein for similarly shaped and positioned wear plates 62; screws 64 and 66 hold the wear plates 52 and 62 in the position shown with their heads preferably countersunk below the surface of the wear plates although such attachment could be done in any convenient manner as by the use of a suitable adhesive. Plates 52 and 62 are substantially similar in shape and construction and accordingly only plate 52 will be described in detail.

The inner edge 52*a* of plate 52 abuts the annular shoulder 54*a* of groove 54 and surface 52*b* of plate 52 slopes upwardly away from the inner surface 56*a* of disk 56 while the top surface 52*c* of plate 52 is substantially horizontal and spaced above surface 56*a*. As best seen in Figure 4, the front edge 52*d* of plate 52 is spaced inwardly from the periphery 68 of the rotor thereby forming a step from the top surface 52*c* to the rotor surface 56*a* of disk 56. Accordingly, during operation with the rotor in rotation, the granular product passes outwardly over surface 56*a* of bottom disk 56 by centrifugal force and strikes the upwardly sloping surface 52*a* of the wear plate 52 at high speed; it is thereby given an upward trajectory and a substantially tangential spreading push just before reaching the path of the impactors to effect a horizontal and vertical spreading of the individual particles before impact.

More particularly, as the product is fed through the chutes 32 (Figure 2) down upon the bottom disk 56 of rotor 22 the individual particles fan outwardly in relatively thin, fast moving planar streams, probably not more than several particles thick when they reach the vicinity of plates 52. As these particles hit the upwardly sloping surfaces 52*b* of plates 52 they change direction and move upwardly with great rapidity. Thence they fan out vertically so that practically all individual particles are dispersed vertically between plates 52 and 62 as they move rapidly into the path of impactors 46. At the same time another action is transpiring further assisting the spreading of the individual particles to avoid the above-mentioned cushioning. As the particles move outwardly on disk 56 of the rotor it is believed they take a substantially spiral path which becomes increasingly tangential as the particles move toward the impactors. When the particles reach surface 52*b* their unit pressure thereagainst is momentarily increased thus increasing the friction between the particles and surface 52*b*. However the stream of particles at this time is only several particles thick and only the bottom layer engages surface 52*b*. Accordingly the tangential speed of the bottom particles becomes considerably greater than that of the particles thereabove and this makes for a substantially horizontal spreading to complement the vertical spreading described above. The net effect of this action is to disseminate and thoroughly scatter the particles in all directions as they move into the path of the impactors. This action eliminates for all practical purposes the cushioning effect usually caused by individual particles piling up one upon the other during impact. Further, because of this scattering action, the particles diverge and remain substantially separated as they are flung out against the targets 48 to further eliminate cushioning effects at this additionally important point of impaction. Thus, the operation resulting from the construction of this rotor makes for a very efficient impacting action in which each individual particle of the product processed in the machine is assured a thorough impacting treatment during processing in the machine.

Still referring to Figure 4 it can be seen that wear plates 52 have arcuate shaped cutouts 52*e* to accommodate impactors 46 in a manner now to be described. Impactors 46 include studs 69 having reduced ends 70 threaded into disk 56 (Figure 3) with shoulders 71 resting thereagainst. Screws 72 extending through disk 58 are preferably countersunk therein and threaded into studs 69. Preferably studs 69 are enclosed in collars 78 which extend between disks 56 and 58 and fit about the studs being accommodated in such position by the arcuate cutouts 52*e* in the wear plates 52. Thus these collars 78 completely enclose the studs 69 forming the interior structure of the impactors 46 and may thus be used for protection of the studs in a manner to be described.

An annular liner ring generally indicated at 80 includes a horizontal portion 82 resting flush against top plate 30 and secured in this position in any suitable manner as by screws (not shown). A vertical portion 84 of ring 82 extends downwardly to form a liner for the casing 18 concentric with and oppositely spaced from the periphery of the rotor 22. A plurality of bolts 86 extend from ring 82 (Figures 3 and 4) and these support collars 88 by nuts 90 and washers 92.

Preferably wear plates 52 and 62 and collars 78 and 88 are made of a ceramic material, for example aluminum oxide, which appears to have wear-resistant characteristics far exceeding those of the hardest types of alloy steels. However, we may substitute other hard, abrasion-resistant materials for a ceramic such as aluminum oxide and hence such suggested use should not be interpreted as limiting in any sense. In practice we have found that by making the wear plates and collars of such material, products may be processed in the machine which are hard and very abrasive with little wear on the various parts even after long and substantial use.

In Figures 5 and 6 there is shown another embodiment of the invention particularly concerned with a modification of the rotor 22. Preferably the machine includes the top casing 30, chutes 32 and associated structure impactors 46 as well as targets 48, and ring 82 and collars 78 and 88, all these parts being substantially similar in construction to the corresponding parts of Figures 3 and 4. Adjacent the outer periphery of the bottom plate 93

there is formed an annular groove or depression **94** whose inner surface **94***a* is substantially concave or arcuate in shape. A ring **96** is secured in groove **94** adjacent concave inner edge **94***a* in any convenient manner as by welding. Ring **96** preferably has a convex surface **96***a* corresponding in shape and dimension to surface **94***a* of groove **94** and a flat surface **96***b* resting on the bottom of groove **94**. The upper convex surface **96***c* of ring **96** slopes upwardly in a substantially arcuate shape. Accordingly, in operation the individual particles of the product fan out on the bottom plate **93** as described above with reference to Figures 3 and 4 and as they engage the top surface **96***c* of ring **96** they are given an upward trajectory and spread both vertically and horizontally, much in the manner described above with respect to the embodiment of Figure 3; thus each individual particle hits one of the impactors **46** to thereby avoid a cushioning effect as described above. It has been found in some applications that it is desirable to have this ring with an arcuate upper surface which seems in some cases to make for a better impacting action.

Turning now to Figure 7 in which there is shown another embodiment of the invention it has been found that in certain instances ceramic liners for the casing **30** are desirable. These may be used with or without the targets **48** and may be made from material having an abrading action on the particles. It has been found that a more important characteristic, however, is hardness and resistance to wear. Therefore these liners are preferably made from some very hard ceramic such as aluminum oxide. As can be seen in Figure 7 a supporting ring generally indicated at **98** which is preferably L-shaped in cross section has an upper base portion **100** with a depending cylindrical flange **102**. The ring **98** may be supported in the casing **30** concentric with rotor **22** in any convenient manner as by screws **104**. A plurality of ceramic blocks **106**, preferably made from aluminum oxide in a well-known manner, may be secured in position on the ring as shown in Figure 7 in any convenient manner as by an adhesive cement. More particularly, blocks **106** have a horizontal surface **106***a* resting on base portion **100** and a vertical surface **106***b* resting on the cylindrical flange **102**. The inner surfaces of the blocks in this embodiment of the invention slope outwardly from the top to the bottom thus presenting an angular sloping surface to the particles being flung from the rotor. These blocks may take a variety of shapes depending upon what is best suited for the particular product being treated by the machine. Thus in the embodiment shown in Figure 8 blocks **108** are substantially oblong so that the inner surfaces **108***a* thereof are substantially normal to the trajectory of the particles of the product flung from the rotor. Blocks **108** are also preferably formed from a ceramic material such as aluminum oxide.

It will now be seen that we have provided a thoroughly practical and efficient centrifugal impacting machine in which the several objects hereinabove referred to as well as many others are successfully accomplished. More particularly the rising slope provided in the path of the particles being treated on the rotor, which acts to spread the particles both vertically and horizontally prior to entering the path of the impactors, provides for a very thorough and efficient impacting action substantially free from cushioning effect. Furthermore, by providing protective ceramic liners near the edge of the rotor and on the impactors, targets and casing surfaces, these impacting machines are made much more versatile, having wider application for the processing of hard abrasive materials such as chemicals and natural minerals for example asbestos, concrete and coal. Accordingly, centrifugal machines embodying the features of this invention have wide application in a number of industries where they may achieve vastly superior impacting action on a wide variety of materials.

Since certain changes may be made in the above constructions without departing from the scope of the invention, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

We claim:

1. In a machine for centrifugally impacting a granular product, in combination, a casing, a shaft rotatably mounted in said casing, a rotor secured to said shaft and comprising a pair of vertically spaced disks with the upper disk having a central opening therein, means for directing the product to be treated through said opening to the central portion of the bottom disk of said rotor, a plurality of impactors arranged in circumferentially spaced relationship adjacent the periphery of said rotor and spanning the space between said disks, the opposing central surfaces of said disks being substantially normal to the axis of said shaft, said central portions comprising the major portion of their radial dimensions, and the surface of said bottom disk thence sloping upwardly a relatively short distance at a point closely adjacent the inner side of said impactors to form an annular ridge and then continuing outwardly to said impactors substantially normal to said shaft, the distance between said opposing surfaces adjacent said impactors being less than the corresponding distance between the normal surfaces of said disks, and means forming a target concentric with and spaced from said rotor located in the path of the product as it is discharged therefrom during operation of the machine, whereby said product lands on said central portion of said bottom disk, is impelled outwardly by centrifugal force over the surface of said disk to finally engage said annular ridge to be flung upwardly and thereby fanning out crosswise of the space between said disks before hitting said impactors, thereby materially reducing any substantial cushioning action caused by particles of the product piling on one another during impacting.

2. In a machine for centrifugally impacting a granular product, in combination, a casing, a shaft rotatably mounted in said casing, a rotor secured to said shaft and comprising a pair of vertically spaced disks with the upper disk having a central opening therein, means for directing the product to be treated through said opening to the central portion of the bottom disk of said rotor, a plurality of impactors arranged in circumferentially spaced relationship adjacent the periphery of said rotor and spanning the space between said disks, the opposing central surfaces of said disks being substantially normal to the axis of said shaft, said central portions comprising the major portion of their radial dimensions, and the surface of said bottom disk thence sloping upwardly a relatively short distance at a point closely adjacent the inner side of said impactors to form an annular ridge and then continuing outwardly to said impactors substantially normal to said shaft, the distance between said opposing surfaces adjacent said impactors being less than the corresponding distance between the normal surfaces of said disks, and a plurality of target members concentric with and spaced from said rotor located in the path of the product as it is discharged therefrom during operation of the machine, whereby said product lands on said central portion of said bottom disk, is impelled outwardly by centrifugal force over the surface of said disk to finally engage said annular ridge to be flung upwardly and thereby fanning out crosswise of the space between said disks before hitting said impactors, thereby materially reducing any substantial cushioning action caused by particles of the product piling on one another during impacting.

3. In a machine for centrifugally impacting a granular product, in combination, a casing, a rotor rotatably mounted in said casing, said rotor comprising a pair of vertically spaced disks, means for directing the product to be treated onto the bottom disk of said rotor, a plurality of impactors arranged substantially adjacent the edge of said rotor and spanning the space between said disks, said bottom disk having an annular groove adjacent said im-

pactors on the periphery of said rotor, and a plurality of plates mounted in said groove and shaped to provide a surface sloping upwardly towards the impactors.

4. In a machine for centrifugally impacting a granular product, in combination, a casing, a rotor rotatably mounted in said casing, said rotor comprising a pair of vertically spaced disks, means for directing the product to be treated onto the bottom disk of said rotor, a plurality of impactors arranged substantially adjacent the edge of said rotor and spanning the space between said disks, said bottom disk having an annular groove adjacent said impactors on the periphery of said rotor, and a plurality of ceramic plates mounted in said groove and shaped to provide a surface sloping upwardly towards the impactors.

5. In a machine for centrifugally impacting a granular product, in combination, a casing, a rotor rotatably mounted in said casing, said rotor comprising a pair of vertically spaced disks, means for directing the product to be treated onto the bottom disk of said rotor, a plurality of impactors arranged substantially adjacent the edge of said rotor and spanning the space between said disks, said bottom disk having an annular groove adjacent said impactors on the periphery of said rotor, a plurality of ceramic plates mounted in said groove and shaped to provide a surface sloping upwardly towards the impactors, and a plurality of ceramic collars fitting about said impactors and spanning the space between said disks.

6. In a machine for centrifugally impacting a granular product, in combination, a casing, a rotor rotatably mounted in said casing, said rotor comprising a pair of vertically spaced disks, means for directing the product

to be treated onto the bottom disk of said rotor, a plurality of impactors arranged substantially adjacent the edge of said rotor and spanning the space between said disks, said bottom disk having an annular groove adjacent said impactors on the periphery of said rotor, and a plurality of plates mounted in said groove and fitting behind said impactors.

7. In a machine for centrifugally impacting a granular product, in combination, a casing, a rotor rotatably mounted in said casing, said rotor comprising a pair of vertically spaced disks, means for directing the product to be treated onto the bottom disk of said rotor, a plurality of impactors arranged substantially adjacent the edge of said rotor and spanning the space between said disks, said bottom disk having an annular groove adjacent said impactors on the periphery of said rotor, and a plurality of plates in said groove and fitting behind said impactors, the rear edges of said plates being substantially flush with the surface of said bottom disk and said plate surface sloping upwardly from said disk surface.

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