Dec. 20, 1960 S. MESSERSCHMIDT 2,964,886

BALL GRINDING MACHINES

Filed Jan. 6, 1958 2 Sheets-Sheet 1

FIG. 1

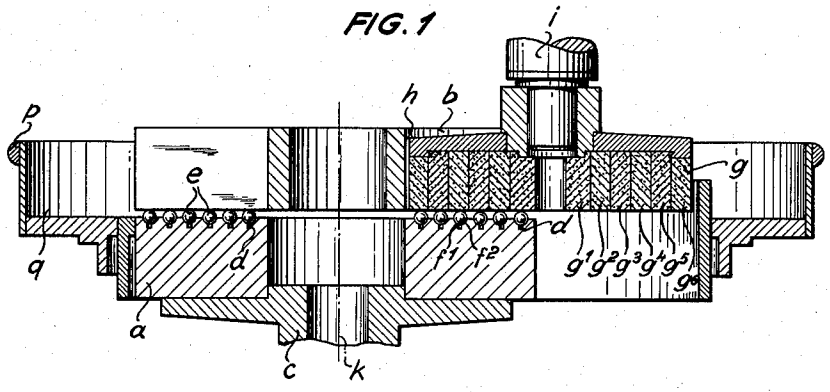
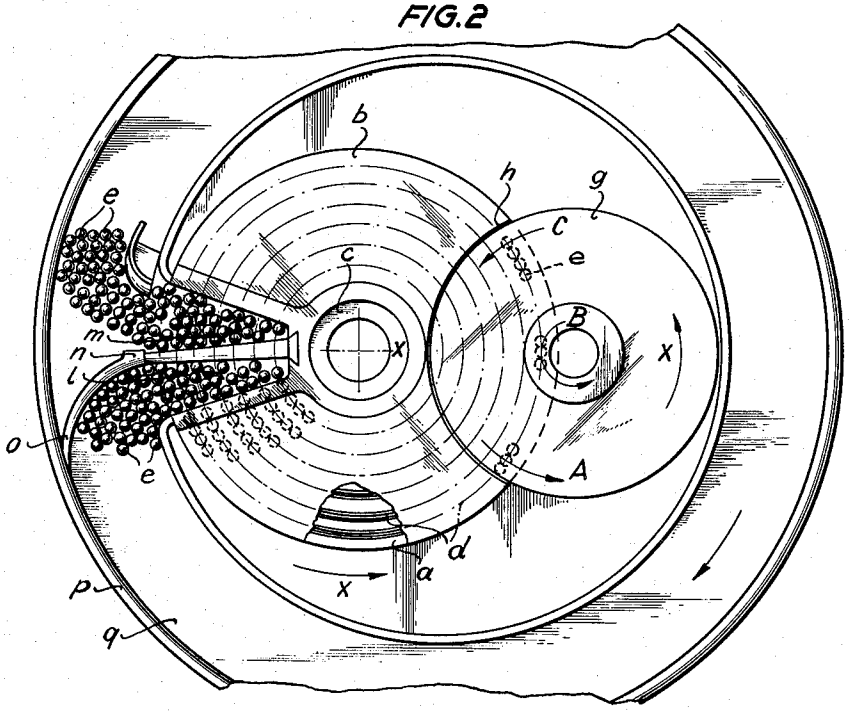


FIG. 2



INVENTOR
SEBASTIAN MESSERSCHMIDT

BY P. M. Craig, Jr.

ATTORNEY.

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Filed Jan. 6, 1958 2 Sheets-Sheet 2

FIG. 3

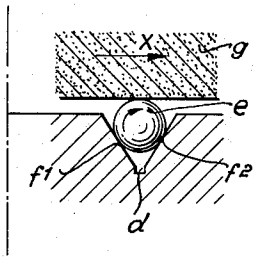


FIG. 4

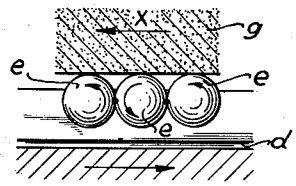


FIG. 5

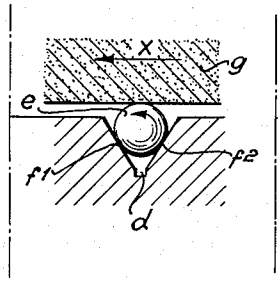


FIG. 6

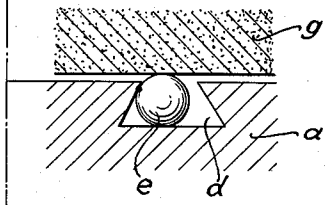
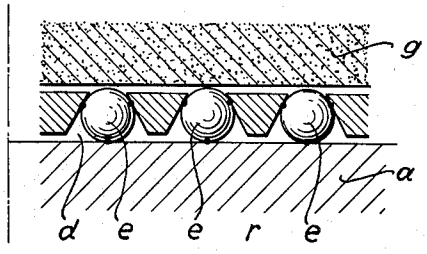


FIG. 7



INVENTOR

SEBASTIAN MESSERSCHMIDT

BY P. M. Craig Jr.

ATTORNEY.

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BALL GRINDING MACHINES

Sebastian Messerschmidt, 3 Altstadtstrasse, Schweinfurt, Germany

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14 Claims. (Cl. 51—130)

There are substantially two methods which are generally employed for grinding balls.

One method consists in introducing the balls between discs, one of which is a metal disc and the other a ceramic disc. The balls run partly between grooves. Due to the rotation of the grinding disc, the balls are rotated and assume on their periphery more or less the speed of the rotating grinding disc so that a slight relative movement occurs, which is to cause the grinding process. It has been found, however, that the rotating balls roll on the grinding discs and in so doing dress. Consequently this arrangement does not enable the grinding discs to be run at normal cutting speeds such as generally used. On the contrary this process can only be carried out with very slow running and particularly very hard grinding discs. On this account this method of finishing cannot be rightly be called an abrasive or grinding process, but is rather a milling or crushing process. The output of the machine is moreover very low.

The second method is to maintain the balls to be ground in contact with a rotating steel disc by means of two guiding discs, so as to enable a geometrical rolling of these balls on the steel disc, whereby a grinding disc attacks the exposed side. In this case the grinding disc can certainly work at an economical speed. However, this method of working is such that it is only possible to grind one row of balls at a time. As a consequence this also means a low finishing output per unit of time and therefore this is a very expensive working process.

The invention relates to a ball grinding machine in which the balls are guided from the time they are introduced until they pass out, between two superposed discs carrying out a relative movement the one to the other, at least one of these discs being provided with guide grooves for the balls.

The object of the invention is to produce a ball grinding machine with which, due to a repeated change of movement of the balls, a perfect grinding effect is attainable, while at the same time enabling an increased cutting speed to be employed, so that the production turn-out per unit of time is considerably higher.

This object is attained according to the invention in that to two discs, receiving the balls between them and one of which rotates while the other remains stationary, a ceramic grinding disc is coordinated in such a manner that it cooperates with the rotating disc on a portion of the path over which the balls travel.

Consequently the machine according to the invention grips the balls between two superposed discs, the upper of which for example, is stationary while the lower one rotates. The lower disc is provided with a plurality of concentric grooves for receiving the balls. Owing to the V-shape of these grooves, the balls are held at three points so that they are positively moved forward in accordance with the rotation of the lower disc. It must also be stated that the two discs are pressed the one towards the other by a suitable pressure.

The invention can be applied with particular advantage

if the grinding disc is mounted eccentrically to the rotary disc and projects into a circular recess in the stationary disc. As already mentioned, it is advisable to drive the grinding disc and the rotary disc in the same direction, for example in counterclockwise direction.

The upper disc preferably has a divided aperture on one side serving as inlet and outlet for the balls and a recess on the opposite side in which the grinding disc rotates at the normal cutting speed usually employed.

If the balls are now carried forward by means of the lower grooved disc they will be fed under the rotary grinding disc in the recess in the upper disc. This in turn tends to impart movement to each ball. This ball, however, owing to the kinetic course of its movements—on running in under the disc—is at first supported by one of the flanks of the groove of the lower guide disc supporting it, whereas in the middle or intermediate stage of the grinding process it runs tangentially to the guide groove in the lower disc to be then supported by the opposite flank of the groove. About in the middle stage of the process one ball bears against another and is braked by the other ball, that is by the preceding ball due to the rotary movement initiated by the grinding. By this continuously changing bearing position of each ball during its rotation—supported sometimes on one side, sometimes by the other balls and sometimes on the other side—the balls are, on the one hand, subjected to a certain braking effect which enables regular cutting or chipping of the balls to be carried out with a standard grinding disc running at an economical cutting speed, that is the grinding can be effected in a rational manner. On the other hand, by this procedure a certain changing in the movement of the balls takes place which is due to the above mentioned shifting of the position of the balls. This changing of position of the balls also produces a certain braking effect on their travel. The peripheral speed of the rolling balls is therefore not the same as the surface speed of the rotating grinding disc. This also prevents the balls from being milled or crushed and ensures in fact that they are properly ground or abraded.

Another advantage of the invention consists in that, owing to the fact that the balls are supported in the V-shaped grooves in the lower guide disc and by the level surface of the upper disc, they are of necessity engaged in a three-point grip which again ensures the production of a geometrically spherical ball. Moreover the invention enables the balls to be taken over for grinding immediately after they have been pressed, because, due to the manner in which the balls are gripped, projecting burrs and the like are so-to-speak rolled flat under strong pressure and then ground off on reaching the grinding disc. Thus the expensive rough-grinding or filing of the balls, which was hitherto customary, becomes unnecessary. Moreover the grinding process is rendered economical and the output of the machine many times greater as compared with the grinding machines hitherto known.

According to another invention a grinding disc is used which is not in one piece, but is composed of a plurality of concentric rings corresponding in number to the number of grooves in the rotary disc. A further feature of the present invention consists in that these grinding rings are of different abrasive hardness, preferably in such a manner that the product of abrasive hardness multiplied by the cutting speed is everywhere substantially the same. According to the invention therefore the abrasive hardness of the rings of the grinding disc changes according to the diameter and therefore to the cutting speeds of the rings. This presents the advantage that the balls are subjected to the same grinding effect at every working point, that is in each guide groove, because the diameter at each working point is in proportion to the hardness of the abrading ring.

An embodiment of the invention is illustrated diagrammatically by way of example in the accompanying drawings, in which:

Fig. 1 shows a section through the working discs of a ball grinding machine;

Fig. 2 is a top plan view of Fig. 1;

Fig. 3 is a part section taken on the plane of the arrow A of Fig. 2 showing the direction of movement of the balls on being gripped by the grinding disc;

Fig. 4 is a part section taken on the plane of the arrow B of Fig. 2 showing the direction of movement of the balls in the guide groove;

Fig. 5 is a part section taken on the plane of the arrow C of Fig. 2 showing the direction of movement of the balls on leaving the grinding disc;

Fig. 6 shows a guide groove of dove-tailed cross-section;

Fig. 7 shows a construction wherein the grooves are formed by rails.

Two guide discs *a* and *b* are provided which, in the example illustrated, are arranged coaxially one above the other. The lower disc *a* is rotatable by means of a carrier hub *c*. The upper disc *b* is stationary.

At least one of these two discs, in the example illustrated the disc *a*, is provided with concentrically arranged grooves *d* for guiding the balls *e* to be worked. As in each guide groove the contacting points f^1 and f^2 are at different distances from the axis, the balls are subjected to a continuous axial avertage independently of the fact that they roll forward in the V-shaped grooves as the disc *a* rotates.

According to the invention, a ceramic grinding disc *g* is coordinated to the discs *a* and *b*, this disc *g* being rotatable and, as shown particularly in Fig. 1, projects into a circular recess *h* in the stationary disc *b*. The axis of rotation *i* of the grinding disc *g* is arranged eccentrically to the axis of rotation *k* of the lapping disc *a*. The two discs *a* and *g* rotate in the same direction, in the example illustrated in counterclockwise direction as indicated by the arrow *x*. At the actual working points the grinding disc *g* moves at an angle to the disc *a*, the angle changing from 90° through 180° to 90°. As already mentioned, each ball first rests, as shown in Fig. 3, on one flank and later, according to Fig. 5, on the other flank of the V-groove, whereas in the intermediate stage of the grinding process it bears, as shown in Fig. 4, against the preceding and following balls.

According to Fig. 1, the grinding disc *g* may be composed of grinding or abrasive rings g^1, g^2, g^3, g^4, g^5 and g^6. These grinding rings have different abrasive hardnesses. The degree of hardness changes in the same ratio as the diameter of the rings. Consequently the outermost grinding ring g^6, although running at the highest speed, exerts the same grinding effect as the other grinding rings.

The stationary disc *b*, as can be seen particularly from Fig. 1, is utilized for forming the ball inlet *l* and ball outlet *m*. For this purpose a partition wall *n* is provided with a guide-in tongue *o*. This tongue extends across the passage *p* in which the balls are fed to the inlet *l* by the rotation of the tray *q* forming the bottom of the passage *p*, and are led off on passing out through the outlet *m*.

In the above mentioned form of construction the guide grooves *d* formed in the lower working disc *a* are of V-shaped cross-section. It is, however, possible to make these grooves with dove-tailed shape, as shown in Fig. 6, with a trapezoidal cross-section. But it is also evident that grooves of other cross-sectional shape may prove advantageous.

The grooves need not be formed in the lower working disc *a*. According to Fig. 7 they can be formed by guide rails *r* which are placed between the discs. These rails can be fixed either on the lower or on the upperworking disc.

The above-indicated examples of construction show that the proposal according to the invention is subject to many modifications, even as far as the guide grooves are concerned.

I claim:

1. Ball grinding machine, comprising in combination two superposed working discs receiving between them the balls to be ground, one of said discs being rotatable and the other stationary to effect a relative movement between the two discs, a plurality of concentric grooves for the balls provided in at least one of said discs, an inlet and an outlet leading to and from said grooves, and a ceramic grinding disc coordinated to said superposed working discs and cooperating with the rotary disc on a portion of the path over which the balls travel in said grooves, said grinding disk being mounted eccentrically to the rotary working disk and projecting into a recess in the stationary working disk conforming to the peripheral curvature of said grinding disk.

2. Ball grinding machine as set forth in claim 1, wherein the grinding disc rotates in the same direction as the rotary working disc.

3. Ball grinding machine as set forth in claim 1, wherein the grinding disc is composed of a plurality of concentric grinding rings corresponding in number to the number of grooves in the rotary disc.

4. Ball grinding machine as set forth in claim 1, wherein the grinding disc is composed of a plurality of concentric grinding rings corresponding in number to the number of grooves in the rotary working disc, the abrasive hardness of said grinding rings differing in relation to their difference in diameter.

5. Ball grinding machine as set forth in claim 1, wherein the stationary working disc has a circular peripheral recess into which the grinding wheel projects and opposite said recess an aperture divided by a partition wall to form an inlet and outlet for the balls.

6. Ball grinding machine as set forth in claim 1, wherein the guide grooves for the balls are of V-shaped cross-section.

7. Ball grinding machine as set forth in claim 1, wherein the guide grooves for the balls are of dove-tail cross-section.

8. Ball grinding machine as set forth in claim 1, wherein the guide grooves for the balls are disposed in the lower working disc.

9. Ball grinding machine as set forth in claim 1, wherein the concentric guide grooves are formed by rails arranged between the two working discs and fixed to one of said discs.

10. A ball grinding machine having two superposed discs, at least one of said discs being provided with concentric guide grooves for the balls to be ground, said one of said discs being rotatable and the other of said discs being stationary, said stationary disc being provided with an eccentrically disposed recess, a rotating grinding disc projecting into said recess and coacting with a partial area of said rotatable disc in the grinding of said balls, said recess being arcuate and corresponding to the peripheral curvature of said grinding disk, said stationary disk being provided with inlet and outlet means, said inlet and outlet means comprising a partition wall disposed closely adjacent to the surface of said rotatable disk.

11. A ball grinding machine having two superposed discs, at least one of said discs being provided with concentric guide grooves for the balls to be ground, said one of said discs being rotatable and the other of said discs being stationary, said stationary disc being provided with an eccentrically disposed recess, a rotating grinding disc projecting into said recess and coacting with a partial area of said rotatable disc in the grinding of said balls, said rotating grinding disc having the same direction of rotation as the said other of said discs, said recess being arcuate and corresponding to the peripheral curvature of said grinding disc, said stationary disc being provided with inlet and outlet means, said inlet and outlet means com-

prising a partition wall disposed closely adjacent to the surface of said rotatable disc.

12. A ball grinding machine having two superposed discs, at least one of said discs being provided with concentric guide grooves for the balls to be ground, said one of said discs being rotatable and the other of said discs being stationary, said stationary disc being provided with an eccentrically disposed recess, a rotating grinding disc projecting into said recess and coacting with a partial area of said rotatable disc in the grinding of said balls, said recess being arcuate and corresponding to the peripheral curvature of said grinding disc, said stationary disc being provided with inlet and outlet means, said inlet and outlet means comprising a partition wall disposed closely adjacent to the surface of said rotatable disc, said rotating grinding disc being composed of a plurality of concentric grinding rings, the number of said rings corresponding to the number of said guide grooves on said other of said discs, the degrees of hardness of the respective rings varying inversely in accordance with their respective diameters.

13. A ball grinding machine having two superposed discs, at least one of said discs being provided with concentric guide grooves for the balls to be ground, said one of said discs being rotatable and the other of said discs being stationary, said stationary disc being provided with an eccentrically disposed recess, a rotating grinding disc projecting into said recess and coacting with a partial area of said rotatable disc in the grinding of said balls, said stationary disc being provided with an aperture opposite

said recess, said aperture being divided by a partition wall closely adjacent to the surface of said one of said discs to form an inlet and an outlet for said balls.

14. A ball grinding machine having two superposed discs, at least one of said discs being provided with concentric guide grooves for the balls to be ground, said one of said discs being rotatable and the other of said discs being stationary, said stationary disc being provided with an eccentrically disposed recess, a rotating grinding disc projecting into said recess and coacting with a partial area of said rotatable disc in the grinding of said balls, said recess being arcuate and corresponding to the peripheral curvature of said grinding disc, said stationary disc being provided with inlet and outlet means, said inlet and outlet means comprising a partition wall disposed closely adjacent to the surface of said rotatable disc, said concentric guide grooves being formed by annular rails arranged between said rotatable disc and said grinding disc, said rails being fixed to one of said two last-named discs.

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