No. 676,718. Patented June 18, 1901.

C. C. HILL.

BALL GRINDING MACHINE.

(No Model.) (Application filed Jan. 2, 1900. Renewed Nov. 23, 1900.)

4 Sheets—Sheet 1.

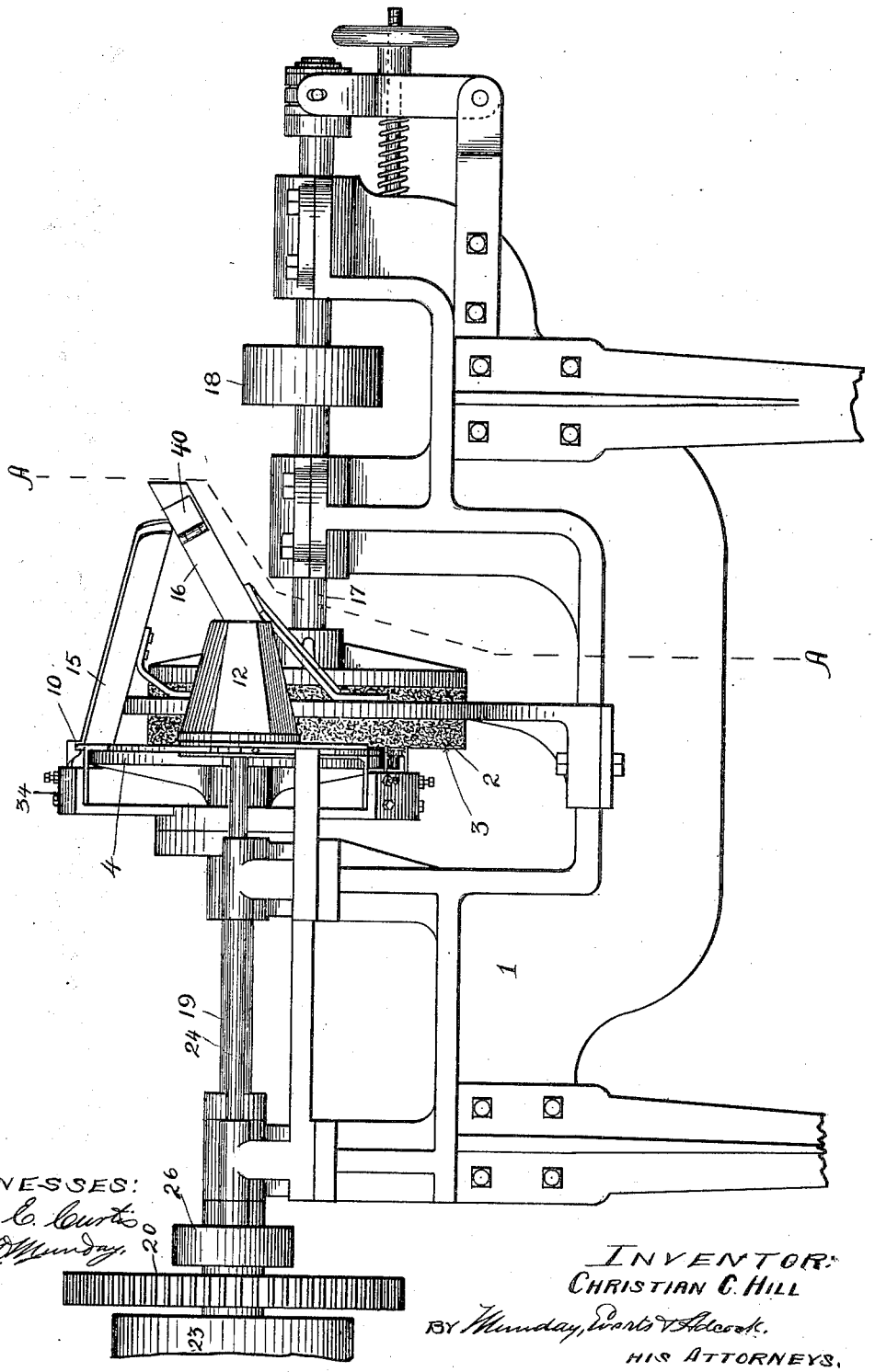

FIG. I

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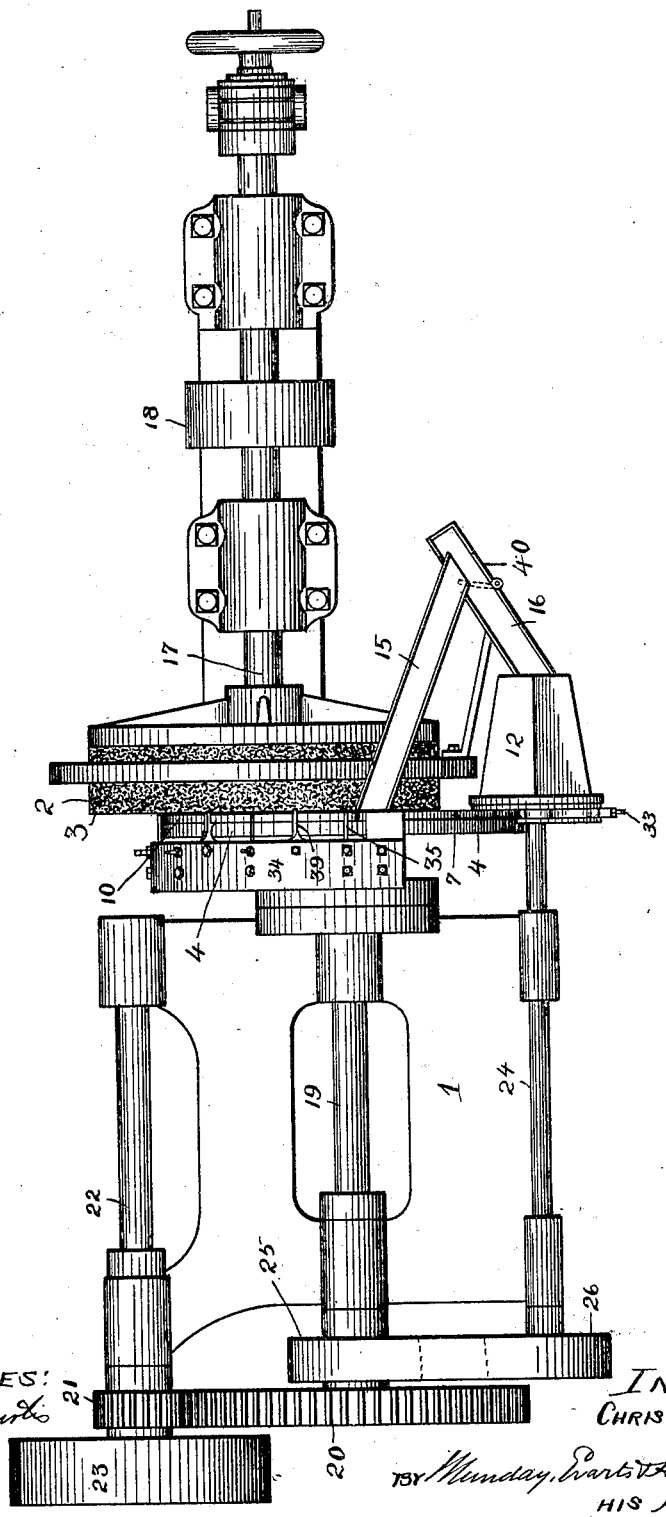

FIG. II.

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FIG. IV

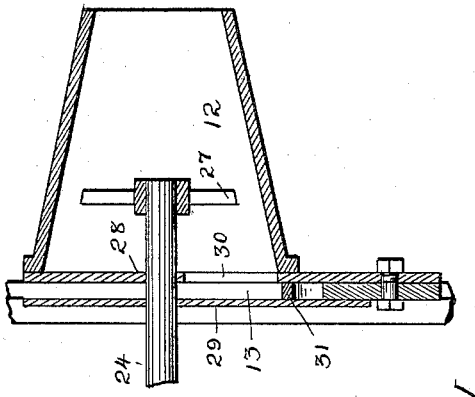


FIG. V

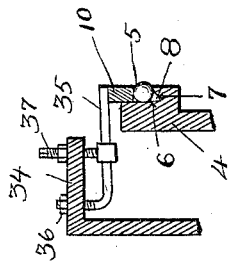
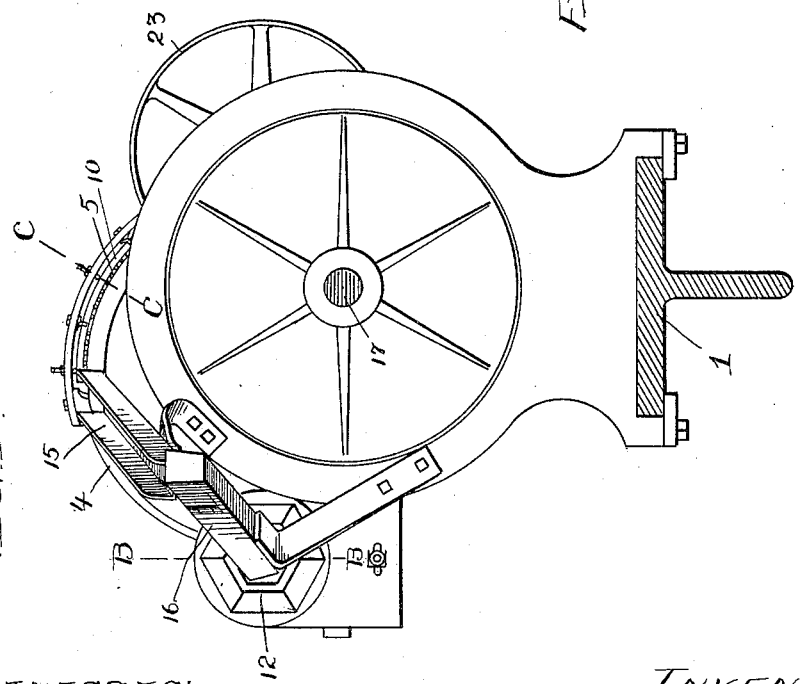


FIG. III



WITNESSES:
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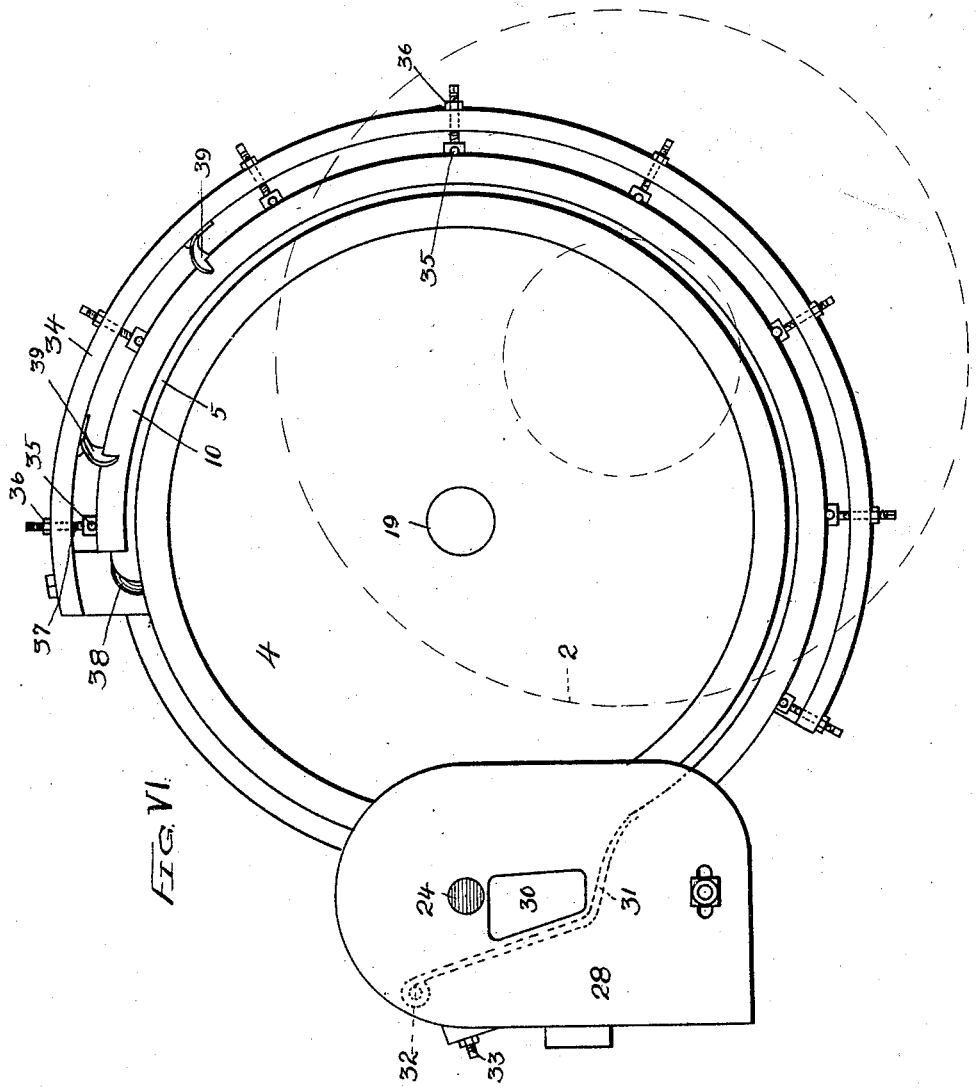

FIG. VI.

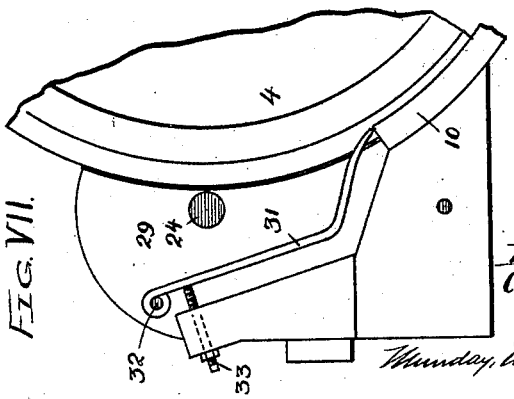

FIG. VII.

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UNITED STATES PATENT OFFICE.

CHRISTIAN C. HILL, OF CHICAGO, ILLINOIS, ASSIGNOR TO THE STEEL BALL COMPANY, OF SAME PLACE.

BALL-GRINDING MACHINE.

SPECIFICATION forming part of Letters Patent No. 676,718, dated June 18, 1901.

Application filed January 2, 1900. Renewed November 23, 1900. Serial No. 37,457. (No model.)

To all whom it may concern:

Be it known that I, CHRISTIAN C. HILL, a citizen of the United States, residing in Chicago, in the county of Cook and State of Illinois, have invented a new and useful Improvement in Ball-Grinding Machines, of which the following is a specification.

My invention relates to improvements in machines for grinding steel balls for ball-bearings.

The object of my invention is to provide a machine of a simple, efficient, and durable construction by means of which steel balls may be rapidly and cheaply ground to a uniform size or diameter and to a truly round or spherical shape.

Heretofore great difficulty has been experienced in the practical operation of many machines formerly in use for grinding steel balls for ball-bearings owing to the failure of the machines to grind the balls of a true spherical shape and of uniform size or diameter and owing to the fact that the emery or grinding surfaces are in some machines generally in use speedily cut out or worn out by reason of the dancing or chattering movements of the balls while undergoing operation in the machine, and the operation heretofore has generally been comparatively slow, laborious, and expensive.

The ball-grinding machine which I have invented obviates difficulties and objections heretofore experienced and enables me to grind balls very rapidly and cheaply and to a true spherical shape and to a uniform size or diameter, while at the same time the machine itself is durable, so that no great expense is occasioned by the cutting or wearing out of the emery grinding-surface, and the machine operates automatically and requires but little attention from the operator or attendant, so that a number of machines may be under the charge of a single operator.

My new ball-grinding machine comprises in combination and herein my invention consists in, first, a rotating disk having its emery or grinding surface on its flat side or face; second, a rotating ball-carrier disk mounted parallel to the emery-disk and eccentric thereto and provided with a ball-carrying channel or groove, one face of which is parallel to the grinding-surface of the grinding-disk to serve as a fixed and rigid holder for the balls against the grinding-disk, and thus cause the balls to be ground to a uniform size or diameter; third, a yielding segmental ball-holder band, which operates to yieldingly hold the balls in the channel or passage-way between the grinding-disk and the ball-carrier disk, and thus prevent all tendency of the balls to dance or chatter while being operated upon, and which by its segmental character permits the balls after being once conveyed across the face of the grinding-disk to be again returned to the hopper which contains a large number of balls and from which the balls are promiscuously delivered again to the channel of the carrier-disk, so that all the balls in the hopper will in time be uniformly operated upon by the machine, and thus be uniformly ground to a uniform size or diameter, and, fourth, a hopper which is preferably a rotary one or provided with means for stirring or mixing the balls therein and from which the balls are fed promiscuously or by chance into the channel of the carrier-disk at one end of the segmental ball-holding band and into which the balls are again and again returned from said channel at the other end of the segmental ball-holding band.

My invention also consists in the novel construction of parts and devices and in the novel combinations of parts and devices herein shown and described, and specified in the claims.

In the accompanying drawings, which form a part of this specification, Figure I is a side elevation of a machine embodying my invention; Fig. II, a plan view; Fig. III, a section on line A A of Fig. I; Fig. IV, a section on line B B of Fig. III; Fig. V, a section on line C C of Fig. III. Fig. VI is a face view of the ball-carrier disk and ball-band and adjacent parts, showing the grinding-disk or emery-wheel in dotted lines; and Fig. VII is a detail view similar to Fig. VI with the plate removed.

Like figures of reference indicate like parts in the different views.

In the drawings, 1 represents the frame of the machine.

2 is the rotating emery-wheel or grinding-disk, having its emery or grinding surface 3 on the flat face of the disk.

4 is the rotating ball-carrier disk, the same being driven in the opposite direction from the grinding-disk 2 and mounted parallel thereto and eccentric to the grinding-disk. The ball-carrier disk 4 is provided at its periphery with a channel or passage-way 5 for the balls. One face 6 of this ball-channel is parallel to the grinding-face 3 of the emery-wheel 2, and its other face 7 is at an acute angle to said parallel face 6, as will be readily understood from Fig. V of the drawings, so that while the parallel face 6 of the ball-channel remains or is held positively at a fixed distance from the grinding-face 3 of the emery-wheel in order to grind the balls to a uniform diameter or size the groove 8, formed by the acute-angled face 7, will permit the smaller balls, or those that have been ground sufficiently, to drop back out of engagement or contact with the grinding-face of the emery-wheel.

10 is the segmental ball-holder band, the same having preferably a slightly-curved inner face and serving to hold the balls in the channel of the ball-carrier disk and to press and hold them yieldingly against the parallel face and the inclined or angle face of the carrier-disk while being operated upon by the emery-wheel or grinding-disk. As the balls are thus held yieldingly by this segmental band in the channel or groove of the ball-carrier disk, the balls are free to rotate when engaged by the grinder-disk, but are prevented from dancing or chattering, so that the grinding-surface of the emery-wheel will not be cut or worn in spots or the balls themselves injured. As the rotary carrier-disk is eccentric to the rotating grinding-disk, the path of the balls extends entirely across the face of the grinding-disk, so that the whole emery surface of the emery grinding-disk is utilized, and as the balls have a curved path across the face of the grinding-disk and as this curved path extends from the periphery of the disk near to the center and from a point near the center again to the periphery, and as the grinding-disk and carrier-disk rotate in opposite directions, it will be seen that the effect is to vary the speed of rotation of the ball and also its direction of rotation as it is carried across the face of the grinder-disk, thus causing all portions of the periphery of the ball to be exposod to the surface of the grinding-disk, and thus insuring a uniform and proper grinding. This curved eccentric path of the balls across the face of the grinding-disk also prevents the face of the grinding-disk being worn in channels or spots by the balls.

12 is the hopper for holding a quantity of balls and from which the balls are delivered through the feed-chamber 13 to the channel of the ball-carrier disk at one end (preferably the lower end) of the segmental yielding flexible ball-holding band 10, and to which hopper the balls are again returned by the connecting troughs or passage-ways 15 and 16. This hopper is preferably a rotary hopper, so that the balls contained therein may be conveniently and thoroughly stirred and intermingled, and as the ball-holder band 10 is segmental, so that a series of balls after being carried once across the face of the grinding-disk may be again returned to the hopper and mixed with the mass of balls therein, and as the construction, combination, and arrangement of the grinding-disk, ball-carrier disk, and segmental yielding ball-holding band are such as to cause the grinding-disk to act selectively upon the larger balls, the operation of the machine is necessarily to reduce all the balls in the hopper to a uniform size and diameter and to a true spherical shape.

The emery-wheel or grinding-disk 2 is secured to a rotating shaft 17, journaled on the frame of the machine and which is provided with a driving-pulley 18 for rotating it at the required speed from any suitable belt or source of power.

The ball-carrier disk 4 is mounted on a shaft 19, which is furnished with a gear 20, meshing with a gear 21 on a counter-shaft 22, which is furnished with a driving-pulley 23, so that the ball-carrier disk may be driven independently of the grinding-disk and at any speed required.

In order to rotate the hopper 12, I mount it on the end of a shaft 24, which is journaled on the frame of the machine and is provided with a pulley 26, receiving power from the pulley 25 on the shaft 19 of the ball-carrier disk.

The rotary ball-hopper 12 is preferably of a polygonal shape, larger at one end than at the other, and it is secured by arms 27 to its shaft. This hopper is open at its outer end to receive the balls from the connecting spout or trough 16, and it is closed at its inner and larger end by a stationary plate 28, forming one side of the feed-chamber 13, the other side of which feed-chamber is formed by a similar plate 29. The plate 28 has an aperture 30 to permit the balls to pass from the rotating hopper into the feed-chamber. The back of the feed-chamber is formed of a movable spring-piece 31, fitting between the plates 28 and 29 and extending to the lower end of the segmental ball-holding band 10. This spring-back 31 of the feed-chamber is preferably hinged at its upper end at 32 and is supported by an adjusting-screw 33. The front of the feed-chamber is open to the ball groove or channel 5 in the ball-carrier disk 4. In other words, the ball-carrier disk forms the front of the feed-chamber. This adjustable spring-back 31 for the feed-chamber prevents clogging of the feed by yielding and permitting the balls to go by on their path into the ball channel or groove formed by the carrier-disk, the segmental yielding ball-holding band, and the grinding-disk.

The segmental yielding flexible ball-holding band 10 is attached at one end to the frame of the machine. It preferably extends about two-thirds around the ball-carrier disk. It is held yieldingly in a position from a curved supporting-bar 34 by flexible fingers 35, which rest against the periphery of the band 10 at their outer ends and which are attached at their inner ends to the supporting-bar 34 by nuts 36. The tension of these spring-fingers against the segmental yielding ball-holding band 10 is regulated by adjusting-screws 37. 39 indicates retaining-clamps for the band 10. At or near the point where the segmental band 10 terminates a deflector 38 is located in the path of the balls to insure the removal of the balls from the ball-channel between the ball-carrier disk and the grinding-disk. The deflector is in the ball trough or channel 14, leading to the trough 15 and trough 16, which conveys the balls back to the rotating hopper. The ball-trough 16 is provided with a movable gate 40, through which when all the balls in the hopper have been sufficiently ground the batch of balls may be discharged from the machine.

Any number of balls may be operated upon in my machine at a time, either a more or less number than sufficient to fill the ball-channel formed by the segmental ball-holding band, the ball-carrier disk, and the ball-grinding disk or a number sufficient to fill the feed-hopper, which is the preferable way. The rotation of the hopper keeps the balls mixed up together and they roll by gravity, one by one, from the hopper and feed-chamber into the groove 5, so that if a sufficient number of balls has been placed in the hopper the groove 5 is filled and the balls, passing around the groove, are delivered to the troughs and back to the hopper in a constant succession, so that whatever quantity of balls is in the hopper they are sure to receive each one the same treatment in the machine and be continuously treated until removed. From time to time the person supervising the machine may easily pick up one of the balls from the troughs as they flow and caliper it or examine it with the assurance that the condition in which he finds the one ball will represent the condition of the whole charge or contents of the machine, and to do this it is unnecessary to stop the machine.

The operation of the flexible segmental yielding ball-holding band 10 is to hold the balls yieldingly in contact with the rotary ball-carrier disk in the groove thereof and to prevent the balls from chattering or dancing under the action of the emery-wheel, while at the same time the balls are caused to revolve on their own centers by contact of one side with said segmental band and of the other side with the moving ball-carrier disk, which latter rotates, it will be noticed, in a direction opposite to the direction of rotation of the emery-wheel, the center of the rotating emery-wheel being eccentric to the center of the rotating disk and the ball-groove, and consequently the sweep of the balls over the face of the emery-wheel is a long one, as will be seen by reference to Fig. VI, and, moreover, the relative speed of the disk and emery-wheel, so far as the balls are concerned, is constantly varied, and for this reason the direction of action of the emery-wheel upon the ball is constantly varying, and for the same reason the surface of the emery-wheel receives an equal amount of wear throughout its entire face.

When the charge of balls is first placed in the hopper, they are of different sizes, of course, the variation, however, not exceeding a few thousandths of an inch, though sometimes this amount of difference is exceeded considerably and the blanks or balls are not all of them true spheres, or even approximately such. It is the object of the machine to reduce them all to the exact same size and turn them out all true spheres ready for the finishings. Now when the balls enter the groove in this condition, some large and some small, the flexible segmental ball-holding band 10 yields and springs out against its holding-fingers to accommodate the largest one of the balls which it has received, and the machine proceeds to grind this ball selectedly and any others of its size until they are reduced to a point where the machine can act upon the balls of the next smallest size until all are reduced to the same size, the flexible band creeping or pressing in by reason of its flexibility and the spring action of its holding-fingers and assisted by the direction of movement of the disk, which because of the contact between the band and the balls and the balls and the disk tends to draw the flexible band around and in until a common size has been reached by all of the balls, continuing until the operation is complete. The inclined face 7 of the ball-channel 5 in the carrier-disk 4 also tends to permit the smaller balls to roll or fall back out of contact with the grinding-disk.

The machine is simple in construction and continuous and certain in its action. It works without chattering or dancing of the balls, and therefore produces a uniform and perfect product without any excessive wear of the grinding-wheel, thereby greatly reducing the cost of the operation, and the whole apparatus is so constructed that a charge of balls may be placed in it and left until completed, usually a charge being supplied sufficient to employ the machine for fifteen minutes or more, depending upon the size of the hopper, and it being necessary only to watch the machine at work and examine the balls from time to time without stopping the machine or to adjust the grinding-surface of the emery-wheel forward from time to time as it is consumed, so that a single attendant may operate a number of machines.

I claim—

1. In a ball-grinding machine, the combination of a rotary grinding-disk having a flat grinding-face, with a rotary ball-carrier disk furnished with a peripheral channel or groove for the balls, said channel having a face parallel to the grinding-face of the grinding-disk, and a segmental ball-holding band, said ball-carrier disk being eccentric to the grinding-disk, substantially as specified.

2. In a ball-grinding machine, the combination of a rotary grinding-disk having a flat grinding-face, with a rotary ball-carrier disk furnished with a peripheral channel or groove for the balls having a face parallel to the grinding-face of the grinding-disk, and a segmental ball-holding band, said ball-carrier disk being eccentric to the grinding-disk, a feed-hopper for delivering the balls to the ball-carrier disk at one end of said ball-holding band, and receiving the balls therefrom at the other end of said band, substantially as specified.

3. In a ball-grinding machine, the combination of a rotary grinding-disk having a flat grinding-face, with a rotary ball-carrier disk furnished with a peripheral channel or groove for the balls having a face parallel to the grinding-face of the grinding-disk, and a segmental ball-holding band, said ball-carrier disk being eccentric to the grinding-disk, a feed-hopper for delivering the balls to the ball-carrier disk at one end of said ball-holding band, and receiving the balls therefrom at the other end of said band, and connecting ball-carrying troughs or passage-ways between said hopper and ball-carrier disk, substantially as specified.

4. In a ball-grinding machine, the combination of a rotary grinding-disk having a flat grinding-face, with a rotary ball-carrier disk furnished with a peripheral channel or groove for the balls having a face parallel to the grinding-face of the grinding-disk, and a segmental ball-holding band, said ball-carrier disk being eccentric to the grinding-disk, a feed-hopper for delivering the balls to the ball-carrier disk at one end of said ball-holding band, and receiving the balls therefrom at the other end of said band, said ball-hopper being a rotary one to mix and intermingle the balls, substantially as specified.

5. In a ball-grinding machine, the combination of a rotary grinding-disk having a flat grinding-face, with a rotary ball-carrier disk furnished with a peripheral channel or groove for the balls having a face parallel to the grinding-face of the grinding-disk, and a segmental ball-holding band, said ball-carrier disk being eccentric to the grinding-disk, a feed-hopper for delivering the balls to the ball-carrier disk at one end of said ball-holding band, and receiving the balls therefrom at the other end of said band, and a deflector near the ball-discharge end of said ball-holding band to free the balls from the groove or channel of the ball-carrier disk, substantially as specified.

6. In a ball-grinding machine, the combination of a rotary grinding-disk having a flat grinding-face, with a rotary ball-carrier disk furnished with a peripheral channel or groove for the balls having a face parallel to the grinding-face of the grinding-disk, and a segmental ball-holding band, said ball-carrier disk being eccentric to the grinding-disk, the ball-channel of said ball-carrier disk having a bottom face or wall at an acute angle to its said parallel face, substantially as specified.

7. In a ball-grinding machine, the combination of a rotary grinding-disk, with a rotary ball-carrier disk, and a segmental yielding ball-holding band, substantially as specified.

8. In a ball-grinding machine, the combination of a rotary grinding-disk, with a rotary ball-holding disk and yielding ball-holding band, said yielding band being secured to the machine at one end and free at the other end, substantially as specified.

9. In a ball-grinding machine, the combination of a rotary grinding-disk, with a rotary ball-holding disk, and yielding ball-holding band, said yielding band being secured to the machine at one end and free at the other end, and held at intervals throughout its length by adjustable spring-fingers, substantially as specified.

10. The combination of the rotary grinding-disk, with a rotary ball-holding disk, a yielding ball-holding band, and a deflector in the path of the balls, a trough from the said deflector to a hopper, and said hopper; whereby the balls are continuously operated upon and may be examined from time to time without stopping the machine.

11. The combination of an upright grinding-disk, with an upright rotary disk having a ball-holding groove, a deflector for turning the balls out of the groove, a trough and the hopper, the deflector being placed at a point above the hopper so that the balls return to the hopper by gravity, substantially as specified.

12. The combination of the rotary grinding-disk, the rotary ball-holding disk, a yielding ball-holding band, a deflector, a trough and a rotary hopper, substantially as specified.

13. In a ball-grinding machine, the combination of a rotary grinding-disk having a flat grinding-face, with a rotary ball-carrying disk eccentric thereto furnished with a channel for the balls, and a ball-holding band extending part way around said carrier-disk, substantially as specified.

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