

March 23, 1948.

H. A. TOULMIN, JR

2,438,239

BALL GRINDING MACHINE

Filed July 23, 1946

4 Sheets-Sheet 1

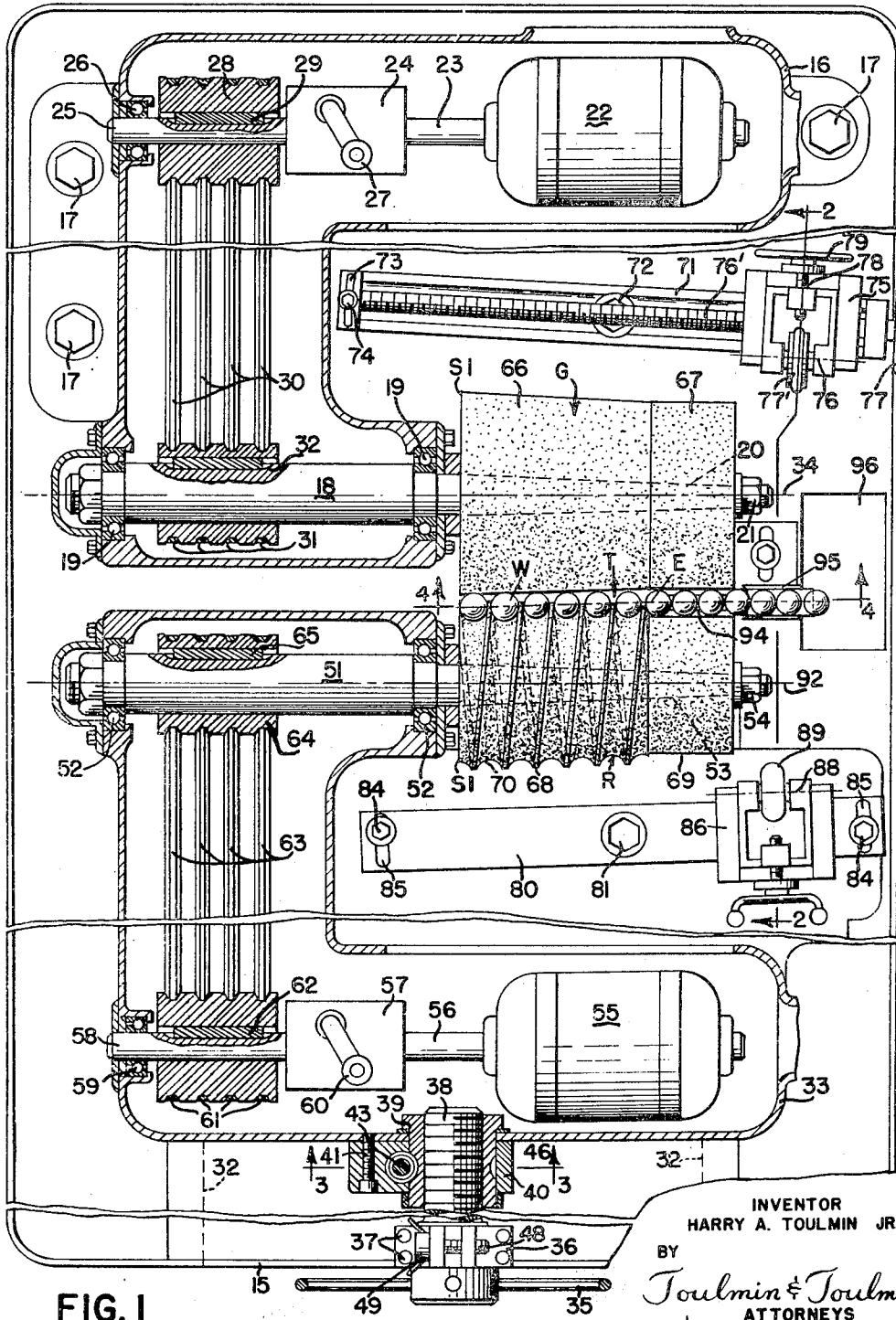


FIG. 1

INVENTOR
HARRY A. TOULMIN JR.

BY

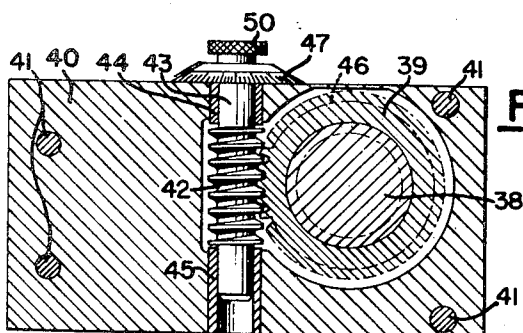
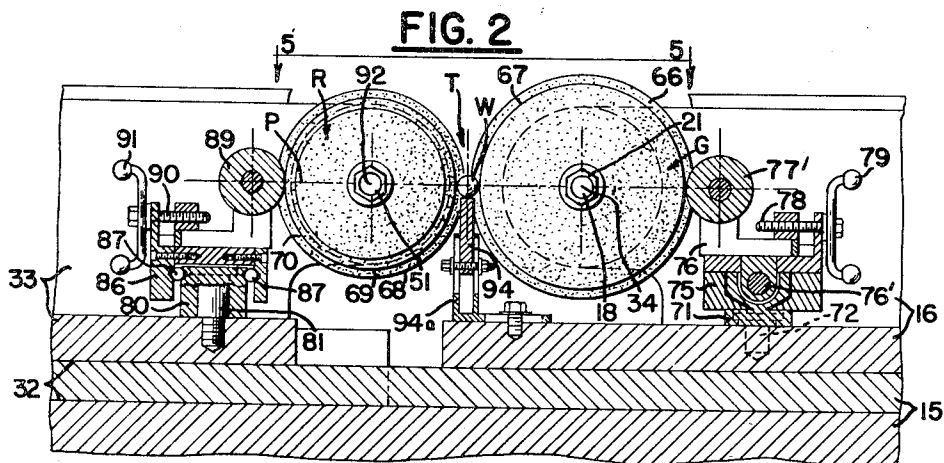
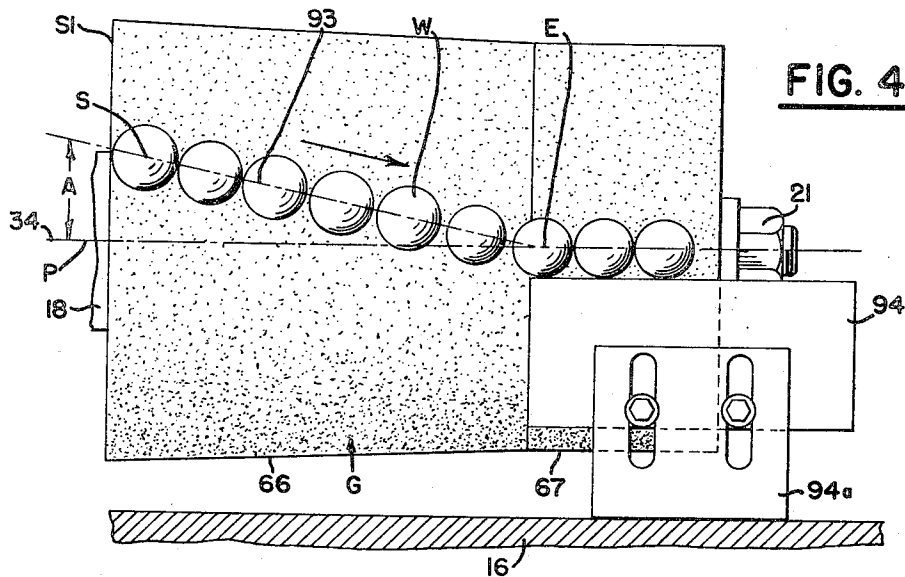
Toulmin & Toulmin
ATTORNEYS

2,438,239

BALL GRINDING MACHINE

Filed July 23, 1946

4 Sheets-Sheet 2



INVENTOR
HARRY A. TOULMIN JR.
BY
Toulmin & Toulmin
ATTORNEYS

March 23, 1948.

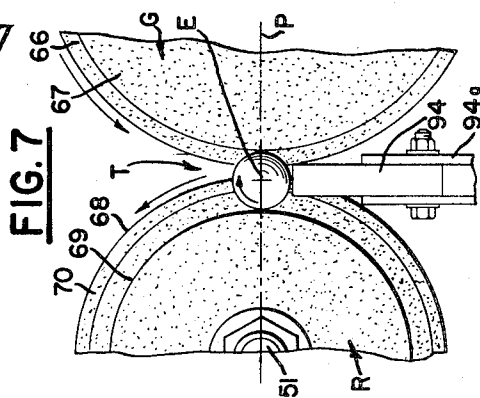
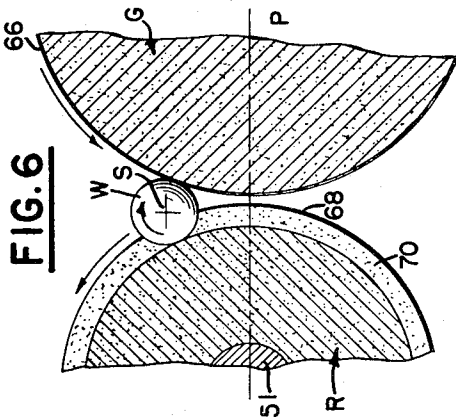
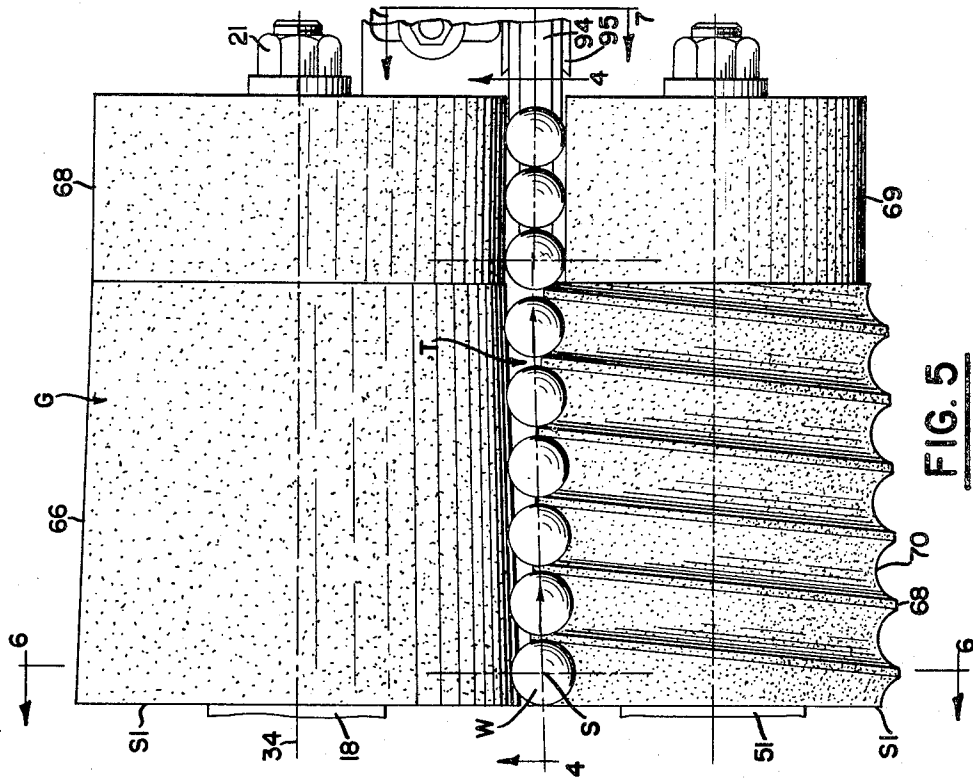
H. A. TOULMIN, JR

2,438,239

BALL GRINDING MACHINE

Filed July 23, 1946

4 Sheets-Sheet 3



INVENTOR
HARRY A. TOULMIN JR.
BY

Toulmin & Toulmin
ATTORNEYS

March 23, 1948.

H. A. TOULMIN, JR

2,438,239

BALL GRINDING MACHINE

Filed July 23, 1946

4 Sheets-Sheet 4

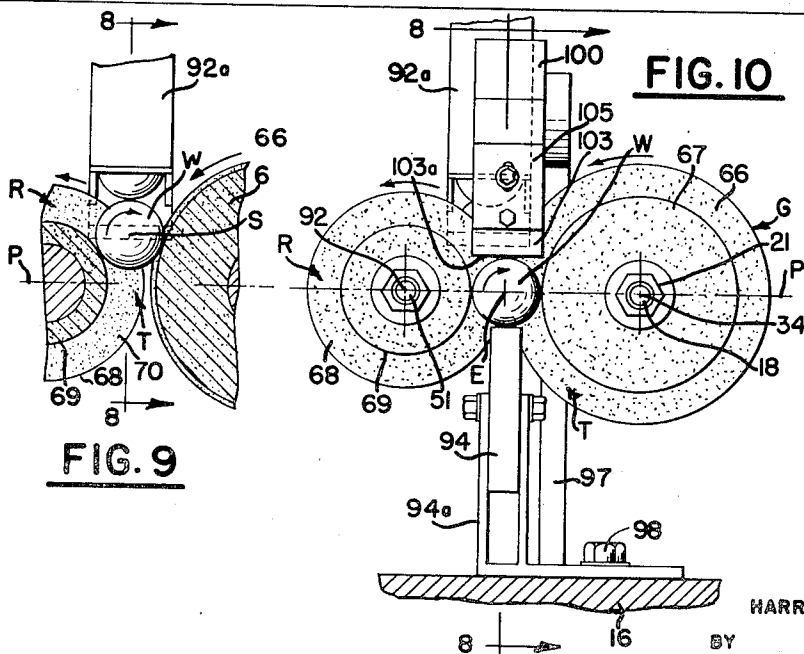
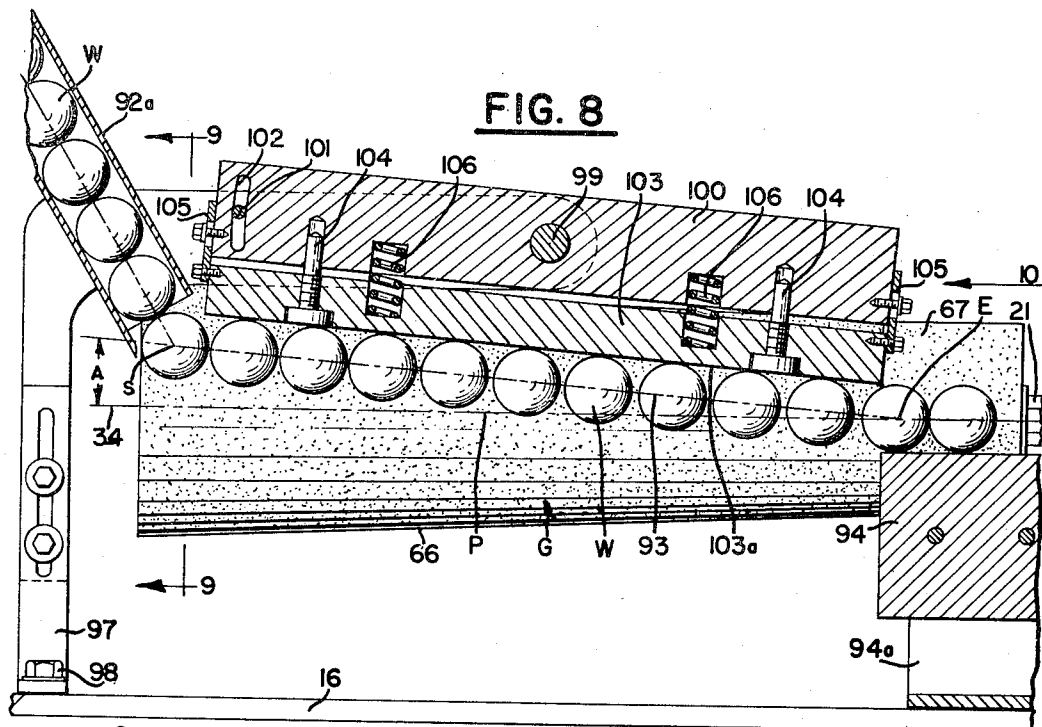
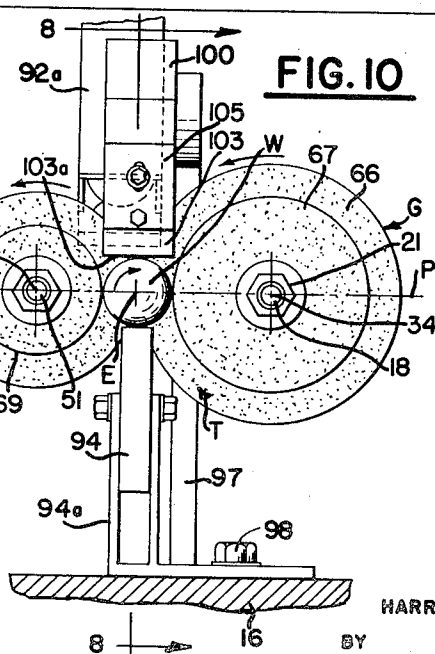


FIG. 10



INVENTOR
HARRY A. TOULMIN JR.

BY
Toulmin & Toulmin
ATTORNEYS

UNITED STATES PATENT OFFICE

2,438,239

BALL GRINDING MACHINE

Harry A. Toulmin, Jr., Dayton, Ohio, assignor to
The Thompson Grinder Company, Springfield,
Ohio, a corporation of Ohio

Application July 23, 1946, Serial No. 685,714

21 Claims. (Cl. 51-79)

1

This invention relates to improvements in grinding machinery and has particular reference to a machine adapted to the grinding of balls or similar contoured articles.

An object of this invention is the provision of a positively controlled ball grinder which shall be substantially continuous in operation and therefore give maximum production.

A further object of the present invention is the provision of an improved mechanism for operation on spherical articles in a continuous stream, which shall cause said articles to be subjected to a maximum of grinding action during the period of their passage through the machine.

A further object of this invention is to provide for a continuous feeding operation on the work pieces or balls in a manner to insure gradual stock removal and permit final proper sizing of the pieces during the continuous progress thereof.

Another object of this invention is the elimination of fixed work supporting members and the utilization of the work pieces themselves as a sole means to produce proper relative movement of work and grinding wheel to effect proper movement and grinding action on the work pieces.

A further object of the invention is the provision of a mechanism for the grinding of balls which will positively and definitely regulate and control the rotating action of the blanks during grinding.

Another object of the invention is the provision of a machine which will automatically operate continuously on a series of spherical articles to successively reduce the work pieces down to the same predetermined size and accurate to fractional thousandths of an inch, both as to diameter, contour, and surface.

Another object of the invention is the provision of a machine particularly adapted for the production of spherical articles which will automatically impart a gyratory or twisting movement to the work pieces to insure proper presentation of its entire surface to the abrasive member.

A further object of this invention is to provide a ball grinding machine with a novel grinding and regulating wheel arrangement serving as the sole means for continuously feeding the work pieces over the grinding wheel to automatically effect a continuous grinding operation on a series of work pieces.

2

Still another object of this invention is to provide a novel grinding machine adapted to spherical grinding which is of simple construction and operation, requiring a minimum of special adjustments and setting of the various grinding and regulating wheel spindles.

Further features and advantages of this invention will appear from a detailed description of the drawings in which:

Figure 1 is a fragmentary diagrammatic view, partly in section, showing the general arrangement of the ball grinding machine incorporating the features of this invention.

Figure 2 is a fragmentary vertical transverse section on the line 2-2 of Figure 1.

Figure 3 is an enlarged section on the line 3-3 of Figure 1.

Figure 4 is an enlarged view on the line 4-4 of Figures 1 and 5 showing the relationship of work and grinding wheel.

Figure 5 is an enlarged fragmentary plan view, indicated by the line 5-5 in Figure 2.

Figure 6 is an enlarged fragmentary section on the line 6-6 in Figure 5.

Figure 7 is an enlarged fragmentary section on the line 7-7 of Figure 5.

Figure 8 shows a modified form of work control mechanism for the machine indicated by the line 8-8 in Figures 9 and 10.

Figure 9 is a fragmentary transverse section on the line 9-9 of Figure 8.

Figure 10 is a transverse sectional view on the line 10-10 of Figure 8.

As illustrative of apparatus incorporating the features of this invention, there is shown a machine comprising a base or frame 15, Figure 1, to which is fixed the grinding wheel housing 16 by suitable screws 17. On the grinding wheel housing 16 is journaled the grinding wheel spindle 18 on suitable antifriction bearings 19. The grinding wheel G is mounted by suitable taper means 20 on the spindle 18 and held in place by a nut 21.

A grinding wheel driving motor 22 is mounted on the grinding wheel housing 16 and has a shaft 23 connected to drive a variable speed unit 24 which in turn has an output shaft 25 supported in a bearing 26 in the housing 16. Adjustment of the control lever 27 of the unit 24 effects variable speeds in the output shaft 25. A pulley 28

is suitably keyed at 29 to the output shaft 25. Belts 30, operated over the pulley 28 and the pulley 31, fixed by a suitable key 32 to the grinding wheel spindle shaft 18, connect power from the motor 22 to drive the grinding wheel spindle 18 and grinding wheel G.

Also mounted on suitable guideways 32 on the frame 15 is the regulating wheel housing 33. The guideways 32 are so arranged that the housing 33 moves in a perpendicular direction relative to the axis of rotation 34 of the grinding wheel spindle 18. The regulating wheel housing 33 may be moved on the guideways 32 and accurately positioned relative to the grinding wheel spindle 18 and the grinding wheel G by manipulating the hand wheel 35, Figure 1, which is attached to an adjusting screw 38 journaled against axial movement in a suitable bracket 36 fixed to the base 15 by suitable screws 37. The screw 38 operatively engages in a nut 39 journaled in a block 40 fixed to the housing 33 by suitable screws 41. The nut 39 is adjustably positioned against rotation by the mechanism best shown in Figure 3 comprising a worm 42 formed on a shaft 43 journaled against axial movement in suitable bearings 44 and 45 in the block 40, the worm 42 meshing with a worm gear 46 cut on the outside diameter of the nut 39. An indicating dial 47, connected to the shaft 43, serves to indicate the amount of rotation of the shaft 43 and the nut 39 for the final accurate vernier positioning of the regulating wheel housing 33. Rotation of the hand wheel 35 effects the coarse positioning and rapid movement of the housing 33 to and from the grinding wheel G. A clamping screw 48 operated by a hand wheel 49 serves to clamp the main screw 38 in its position while allowing the final fine adjustment to be effected by rotating the knob 50 and vernier dial 47 on the shaft 43.

On the regulating wheel housing 33 is journaled the regulating wheel spindle 51 on suitable bearings 52, this spindle having appropriately mounted on its taper portion 53 the regulating wheel R which is held in place by the nut 54. The regulating wheel spindle 51 is driven from the regulating wheel drive motor 55 which is mounted on the regulating wheel housing 33 and has a shaft 56 connected to drive the variable speed unit 57 which in turn has the output shaft 58 supported at its outer end in a suitable bearing 59 in the regulating wheel housing 33. Manipulation of the control lever 60 of the variable speed power unit 57 effects variable output speeds in the shaft 58. A pulley 61 fixed by a suitable key 62 to the output shaft 58 is connected by belts 63 to a pulley 64 fixed by the key 65 to the regulating wheel spindle 51.

The grinding wheel G is dressed so that it has a frusto-conical portion 66 and a straight cylindrical portion 67. The regulating wheel is similarly dressed with a frusto-conical portion 68 and a straight cylindrical portion 69. The grinding wheel G and the regulating wheel R are placed on the respective spindles 18 and 51, Figure 1, with the large diameters or base portions of the frusto-conical portions 66 and 68 in alignment and with the smaller diameter portions at the other end of the frusto-conical portions in alignment. With this arrangement, a variable width grinding throat T is formed between the wheels increasing in width from left to right as shown in Figures 1 and 5. The straight cylindrical portions 67 and 69 are also arranged adjacent one another and at the widest part of the throat T.

In the conical portion 68 of the regulating wheel R is formed a spiral or helical feed groove 70 which is preferably made with a radius of curvature equal to the work pieces or balls W to be ground.

Both the grinding wheel G and the regulating wheel R are maintained in proper condition by crush dressing apparatus. The grinding wheel G is dressed by a crush dressing device comprising a guide bar 71 pivotally mounted about a trunnion 72 fixed to the grinding wheel housing 16. On the outer ends of the guide bar 71 are formed elongated slots 73 through which pass clamping screws 74 into the housing 16, the screws 74 when tightened serving to lock the guide bar 71 in any desired angular or straight position relative to the grinding spindle axis 34 to conform to the desired angles or cylindrical straight portion desired on the grinding wheel G. Slidably mounted on suitable guideways on the guide bar 71 is the carriage 75 which is appropriately moved along the guide bar by a suitable screw 76' rotated by a hand wheel 77. Rotation of the hand wheel 77 traverses the carriage longitudinally of the grinding wheel G. On the carriage 75 is a cross slide 76 upon which is journaled the crush dressing wheel 77', the cross slide being actuated by a screw 78 upon rotation of the hand wheel 79. Thus, by properly setting the guide bar 71 and adjusting the cross slide and then feeding the carriage 75 longitudinally of the grinding wheel by the hand wheel 77, a crush dressing operation may be performed on the grinding wheel to properly condition it for carrying out the required grinding operation.

Similarly the regulating wheel R is dressed by a crush dressing apparatus comprising the guide bar 80 mounted on the pivot screw 81 on the regulating wheel housing 33 and locked in any desired angular position by means of the clamp screws 84 in the elongated slots 85 in the ends of the guide bar 80. A carriage 86 is mounted on antifriction guideways 87, Figure 2, for substantially friction-free sliding movement along the guide bar 80. A cross slide 88 is mounted on the carriage 86 and contains the crush dressing wheel 89 suitably journaled thereon. A cross feed screw 90 serves to adjust the cross slide on the carriage 86 by manipulation of the hand wheel 91.

With the guide bar 80 set in the correct angular position and the crush dressing wheel 89 moved in to the previously formed helical groove 70 of the regulating wheel, the lead of the helical groove will automatically feed the carriage 86 along the guide bar 80 to effect the proper crush dressing of the helical groove 70. The bar 80 may be adjusted to a straight position parallel to the axis of rotation 92 of the regulating wheel spindle when it is desired to crush dress the straight portion 69 of the regulating wheel R.

The operation of the machine is as follows: The grinding wheel drive motor 22 and the regulating wheel drive motor 55 are energized and their respective variable speed units 24 and 57 adjusted so that the grinding wheel G and the regulating wheel R will be rotated at the correct predetermined speeds relative to one another. Usually the grinding wheel G is rotated at a relatively fast grinding rate while the regulating wheel R is rotated in the same direction at a slower feed rate. Having properly adjusted the position of the regulating wheel relative to the grinding wheel by the hand wheel 35 and the vernier adjusting knob 50 as described, the work

5

or balls W are then continuously fed to the throat T formed between the grinding and regulating wheels. The balls are started into this throat at the larger diameter end portions S of the grinding and regulating wheels, that is, the narrower portion of the variable width throat T. Preferably, a suitable hopper (not shown) connected through a feed tube 92a serves to continuously supply the work or balls W to the throat T beginning at the edges S1 of the grinding and regulating wheels.

With the regulating and grinding wheels rotating in the same direction, counterclockwise in Figures 2 and 10, and with the spiral feed groove 70 so arranged (as a left-hand thread) as shown in Figures 1 and 5, it will be noted that the balls will automatically be guided in feeding and grinding motion longitudinally of the grinding and regulating wheels. As seen in Figures 4 and 8, the path of travel 93 of the balls through the throat is angularly related to the plane P defined by the axes of rotation 34 of the grinding wheel and the axis of rotation 92 of the regulating wheel. In other words, the balls start in at the point S and gradually move down a path 93 angularly related by the angle A, Figures 4 and 8, to the common plane P defined by the axes of the grinding and regulating wheels.

As the balls W emerge from the throat between the frusto-conical portions of the grinding and regulating wheels at the point E, they then pass through the straight cylindrical portions 67 and 69 supported on a guide blade 94 carried on a support 94a fixed to the housing 16 for final sizing and polishing of the balls. The balls then proceed outwardly into the discharge trough 95 and through an opening 96 in the base 15 where they drop into a suitable container in finished condition.

It is to be clearly noted that not only do the balls proceed downwardly along the line 93 in angular relationship to the axes of rotation 34 and 92 of the grinding and regulating wheels but there is no other guiding support for the balls during this operation since the angular frusto-conical portions, together with the spiral feed groove formed on the regulating wheel R, provides the sole means for controlling the feeding grinding and in continuously rotating the balls to effect a thorough and accurate uniform grinding of the work over their entire spherical surface. Thus, a continuous process of feeding the work pieces through the feed tube 92a into the throat at the point S and the automatic movement of the balls through the widening throat along the line 93 to the point E and then the final sizing and polishing up operation by the straight portions 67 and 69 of the grinding and regulating wheels provides a continuous uniform and efficient process for finishing spherical pieces.

As a modification, there is shown in Figures 8, 9, and 10 an arrangement to hold down and steady the balls in proper operative contact with the grinding and regulating wheels. This apparatus consists of a bracket 97 rigidly fixed to the housing 16 by suitable screws 98 and which carries a pivot pin 99 upon which is pivotally mounted the bar 100. A pin 101, fixed to the bracket 97 and operating in the elongated slot 102, serves to limit the pivotal motion of the bar 100. A work contacting strip 103, carried on guide screws 104 and guide strips 105 and yieldingly urged normally downwardly by springs 106, has a surface 103a adapted to lightly contact the work or balls W and maintain a predetermined

6

pressure between the work and the grinding and regulating wheels for more efficient operation of the machine at a high speed.

While the apparatus herein disclosed and described constitutes a preferred form of the invention, it is to be understood that the apparatus is capable of mechanical alteration without departing from the spirit of the invention and that such mechanical arrangements and commercial adaptations as fall within the scope of the appended claims are intended to be included herein.

Having thus fully set forth and described this invention, what is claimed as new and desired to be secured by United States Letters Patent is:

1. The method of grinding spherical work pieces comprising rotating a pair of frusto-conical abrasive wheels on parallel axes adjacent one another so as to form a grinding throat of varying width between said wheels, and feeding a continuous series of spherical work pieces to said throat in a path angularly related to the plane defined by the axes of said abrasive wheels.

2. The method of grinding spherical work pieces comprising the steps of: rotating a pair of frusto-conical abrasive wheels on parallel axes to form a variable width grinding throat; driving one of said wheels more rapidly than the other and both in the same direction; and continuously feeding a series of spherical work pieces through said throat from the narrower width to the wider width thereof.

3. The method of grinding spherical work pieces in a continuous manner comprising the steps of rotating a grinding and a regulating wheel on parallel axes lying in a horizontal plane, said wheels being shaped to provide a tapered grinding throat therebetween, rotating said wheels in the same direction and one more rapidly than the other, and feeding a series of spherical work pieces into the narrower end of said throat while causing said spherical work pieces to move at a downwardly inclined path of travel toward the wider end of said throat to perform a grinding operation on said work pieces.

4. The method of grinding spherical work pieces comprising rotating a frusto-conically shaped grinding wheel on a horizontal axis at grinding speed, rotating a frusto-conically shaped regulating wheel on a horizontal axis parallel to said grinding wheel axis, positioning said grinding and regulating wheels relative to one another to form a grinding throat of increasing width extending longitudinally of said axes, and continuously feeding a series of spherical work pieces into the narrower end of said throat and causing said work pieces to move through said throat from a position above a plane defined by said axes in inclined downward movement into said plane at the completion of the grinding operation.

5. The method of grinding spherical work pieces comprising rotating a frusto-conically shaped grinding wheel on a horizontal axis at grinding speed, rotating a frusto-conically shaped regulating wheel on a horizontal axis parallel to said grinding wheel axis, positioning said grinding and regulating wheels relative to one another to form a grinding throat of increasing width extending longitudinally of said axes, and feeding a spherical work piece into the narrower end of said throat and causing said work piece to move through said throat from a position above a plane defined by said axes in inclined downward movement into said plane at the comple-

tion of the grinding operation, and effecting longitudinal movement of said work piece by said regulating wheel in a direction substantially parallel to said axis of rotation of said grinding and regulating wheels.

6. In a ball grinding machine, a conically shaped grinding wheel and conically shaped regulating wheel located adjacent one another to form a variable width throat therebetween, means for rotating said grinding wheel at grinding speeds, means for rotating said regulating wheel at feeding speeds, and means formed on said regulating wheel to move a spherical work piece when placed in the narrower end of said throat toward the wider portion of said throat.

7. In a grinding machine for spherical work pieces, a grinding wheel having a frusto-conical portion and a straight cylindrical portion mounted on a power driven grinding wheel spindle, a regulating wheel having a frusto-conical portion formed with a helical groove therein and a straight cylindrical portion, means for mounting said regulating wheel on a power driven spindle so that said conical and cylindrical portions are aligned with like portions of said grinding wheel, means for feeding a series of spherical work pieces into the throat formed between said abrasive wheels, and means for rotating said grinding and regulating wheels at predetermined relative speeds to effect a through feeding movement of said work pieces in a diagonally downward direction between said abrasive wheels and to feed said work pieces in a horizontal direction past said cylindrical portions of said wheels to complete a grinding operation on said work pieces.

8. In a ball grinding machine, a frame, a grinding wheel spindle journaled for rotation about a horizontal axis on said frame, a regulating wheel spindle journaled on said frame for rotation about a horizontal axis lying in the same plane as said first mentioned axis, a conical grinding wheel on said first mentioned spindle, a conical regulating wheel on said second mentioned spindle, means for relatively positioning said spindles so as to form a variable width grinding throat between said wheels, and means for feeding a series of spherical work pieces into the small end of said throat so as to cause said work pieces to move in downwardly inclined direction from a position above said mentioned plane to a position lying in said plane to complete a grinding operation on said work pieces.

9. In a ball grinding machine, a frame, a grinding wheel spindle journaled for rotation about a horizontal axis on said frame, a regulating wheel spindle journaled on said frame for rotation about a horizontal axis lying in the same plane as said first mentioned axis, a conical grinding wheel on said first mentioned spindle, a conical regulating wheel on said second mentioned spindle, means for relatively positioning said spindles so as to form a variable width grinding throat between said wheels, and means for feeding a series of spherical work pieces into the small end of said throat so as to cause said work pieces to move in downwardly inclined direction from a position above said mentioned plane to a position lying in said plane to complete a grinding operation on said work pieces, cylindrical portions formed on said grinding and regulating wheels at the wide end of said throat, and guide means for receiving and supporting said work pieces while moved parallel to said axes out

of said grinding throat by the preceding work pieces passing through said variable throat.

10. In a ball grinding machine, a grinding wheel and a regulating wheel rotatable on parallel horizontal axes lying in a common horizontal plane, both of said wheels comprising frusto-conical portions and straight cylindrical portions adjacent the conical portions said wheels being adjacent with their cylindrical portion extending in the same direction so as to provide a variable width grinding throat between said wheels, means for continuously feeding a series of spherical work pieces to the narrowest end of said throat, means for rotating said wheels at predetermined relative rates and directions of rotation to cause said work pieces to feed longitudinally of the axes of rotation of said wheels in a downwardly inclined direction from a position above said plane into said plane upon arrival of said work pieces at said cylindrical portions of said wheels, and means including a supporting blade for guiding said work pieces, as pushed by the preceding work pieces coming from said conical portions of said wheels, out past the end of said cylindrical portions to complete the grinding operation on said work pieces.

11. In a ball grinding machine, a grinding wheel and a regulating wheel rotatable on parallel horizontal axes lying in a common horizontal plane, said wheels comprising frusto-conical portions and straight cylindrical portions adjacent the conical portions on both of said wheels, said wheels having their respective conical and straight portions adjacent so as to provide a variable and straight grinding throat between said wheels, means for continuously feeding a series of spherical work pieces to the narrowest end of said throat, means for rotating said wheels at predetermined relative rates and directions of rotation to cause said work pieces to feed longitudinally of their axes of rotation of said wheels in a downwardly inclined direction from a position above said plane into said plane upon arrival of said work pieces at said cylindrical portion of said wheels, means including a supporting blade for guiding said work pieces as pushed by the preceding work pieces coming from said conical portions of said wheels out past the end of said cylindrical portions to complete the grinding operation on said work pieces, and means on said regulating wheel comprising a helical groove formed on the conical portion thereof to facilitate the feeding movement of said work pieces between said grinding and regulating wheels.

12. In a ball grinding machine having a grinding wheel and a regulating wheel, each of said wheels having complementary conical and straight cylindrical portions and said regulating wheel having a spiral groove thereon, means for rotating both of said wheels so that work pieces may be fed through the throat formed between said wheels by the said groove, said wheels forming the sole means for guiding, feeding, and sizing the work pieces as they pass through said throat toward said cylindrical portions.

13. In a ball grinding machine having a grinding wheel and a regulating wheel, each of said wheels having complementary conical and straight cylindrical portions and said regulating wheel having a spiral groove thereon, means for rotating both of said wheels so that work pieces may be fed between the throat formed between said wheels by said groove whereby said wheels form the sole means for guiding, feeding, and sizing the work pieces as they pass through said

throat toward said cylindrical portions, and guide bar means associated with said cylindrical portions to assist in guiding said work pieces when being operated upon by said cylindrical portions of said wheels.

14. In a ball grinding machine having a conical grinding wheel, a conical regulating wheel including a helical feed groove formed thereon, means for rotating said wheels in predetermined grinding and feeding relationship, and means for continuously supplying a series of spherical work pieces into the grinding throat formed between said wheels, whereby said work pieces feed through said throat in a diagonal direction relative to the axes of rotation of said grinding and regulating wheels.

15. In a ball grinding machine having a conical grinding wheel, a conical regulating wheel including a helical feed groove formed thereon, means for rotating said wheels in predetermined grinding and feeding relationship, means for continuously supplying a series of spherical work pieces into the grinding throat formed between said wheels, whereby said work pieces feed through said throat in a diagonal direction relative to the axes of rotation of said grinding and regulating wheels, and straight cylindrical portions formed on said wheels and a guide bar located between cylindrical portions of said wheels adapted to receive said work pieces coming from said conical portions to said cylindrical portions to effect the guiding of said work pieces as moved parallel to said axes out of said cylindrical portions of said wheels by the oncoming work pieces being ground on said conical portions of said wheels.

16. In a ball grinding machine, a conical grinding wheel, a conical regulating wheel, a helical feed groove formed on said regulating wheel, means for rotating said wheels in predetermined grinding and feeding relationship, means for continuously supplying a series of spherical work pieces into the grinding throat formed between said wheels whereby said work pieces feed through said throat in a diagonal direction relative to the axes of rotation of said wheels, and a hold-down bar positioned to bear downwardly on said work pieces during their passage between said wheels.

17. In a ball grinding machine, a conical grinding wheel, a conical regulating wheel, a helical feed groove formed on said regulating wheel, means for rotating said wheels in predetermined grinding and feeding relationship, means for continuously supplying a series of spherical work pieces into the grinding throat formed between said wheels whereby said work pieces feed through said throat in a diagonal direction relative to the axes of rotation of said wheels, and a hold-down bar positioned to bear downwardly on said work pieces during their passage between said wheels, said bar being pivotally supported intermediate its ends for alignment with the line of work pieces between said wheels.

18. In a ball grinding machine, a conical grinding wheel, a conical regulating wheel, a helical feed groove formed on said regulating wheel, means for rotating said wheels in predetermined grinding and feeding relationship, means for continuously supplying the series of spherical work pieces into the grinding throat formed between said wheels whereby said work pieces feed through said throat in a diagonal direction relative to the axes of rotation of said wheels, and a hold-down bar positioned to bear downwardly on said

work pieces during their passage between said wheels, said bar being pivotally supported for alignment with the line of work pieces between said wheels and including a yieldable pressure plate bearing directly on the said work pieces.

19. In a ball grinding machine having a conical grinding wheel, a conical regulating wheel including a helical feed groove formed thereon, means for rotating said wheels in predetermined grinding and feeding relationship, means for continuously supplying a series of spherical work pieces into the grinding throat formed between said wheels, whereby said work pieces feed through said throat in a diagonal direction relative to the axes of rotation of said grinding and regulating wheels, and straight cylindrical portions formed on said wheels, a guide bar located between cylindrical portions of said wheels adapted to receive said work pieces coming from said conical portions to said cylindrical portions to effect the guiding of said work pieces as moved parallel to said axes out of said cylindrical portions of said wheels by the oncoming work pieces being ground on said conical portions of said wheels, and a pressure bar bearing on the line of work pieces between the conical parts of said wheels to urge the said work pieces into working engagement with said wheels.

20. In a ball grinding machine having a conical grinding wheel, a conical regulating wheel including a helical feed groove formed thereon, means for rotating said wheels in predetermined grinding and feeding relationship, means for continuously supplying a series of spherical work pieces into the grinding throat formed between said wheels, whereby said work pieces feed through said throat in a diagonal direction relative to the axes of rotation of said grinding and regulating wheels, and straight cylindrical portions formed on said wheels, a guide bar located between cylindrical portions of said wheels adapted to receive said work pieces coming from said conical portions to said cylindrical portions to effect the guiding of said work pieces as moved parallel to said axes out of said cylindrical portions of said wheels by the oncoming work pieces being ground on said conical portions of said wheels, and a pressure bar bearing downwardly on the work pieces between the conical parts of said wheels and pivoted intermediate its ends for alignment with the line of said work pieces for urging the same into working engagement with said wheels.

21. In a ball grinding machine having a conical grinding wheel, a conical regulating wheel including a helical feed groove formed thereon, means for rotating said wheels in predetermined grinding and feeding relationship, means for continuously supplying a series of spherical work pieces into the grinding throat formed between said wheels, whereby said work pieces feed through said throat in a diagonal direction relative to the axes of rotation of said grinding and regulating wheels, and straight cylindrical portions formed on said wheels, a guide bar located between cylindrical portions of said wheels adapted to receive said work pieces coming from said conical portions to said cylindrical portions to effect the guiding of said work pieces as moved parallel to said axes out of said cylindrical portions of said wheels by the oncoming work pieces being ground on said conical portions of said wheels, and a pressure bar positioned over the throat between said wheels for bearing downwardly on the work pieces therein, said bar being

11

pivotally supported intermediate its ends for alignment with the work pieces and including a yieldable pressure plate bearing directly on the said work pieces.

HARRY A. TOULMIN, Jr.

Number
1,579,934
1,683,974
1,846,661
1,872,405
1,970,777
2,062,803
2,087,874
2,132,280
2,377,921
2,377,982
2,413,880

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
611,968	Kempster	Oct. 4, 1898

12

Name	Date
Heim	Apr. 6, 1926
Heim	Sept. 11, 1928
Vuilleumier	Feb. 23, 1932
Caster	Aug. 16, 1932
Smith	Aug. 21, 1934
Benedek	Dec. 1, 1936
Indge	July 20, 1937
Zimmerman	Oct. 4, 1938
Binns et al.	June 12, 1945
Theler et al.	June 12, 1945
Mason	Jan. 7, 1947