No. 720,436. PATENTED FEB. 10, 1903.

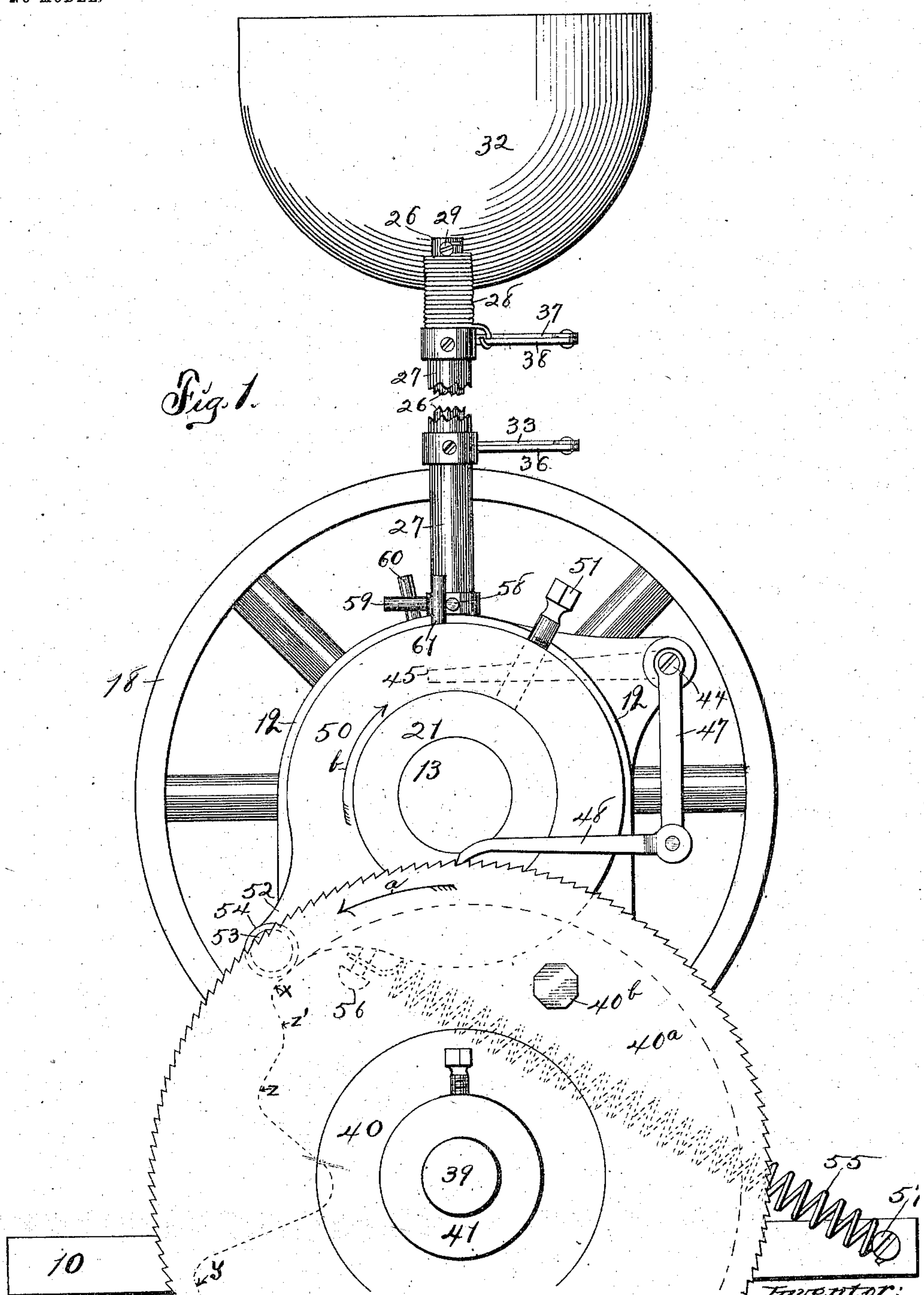
A. JOHNSTON.

MACHINE FOR REDUCING AND FINISHING HOLLOW BEARING BALLS.

APPLICATION FILED MAY 31, 1902.

NO MODEL. 4 SHEETS—SHEET 1.

Fig. 1.



Attest:
W. E. Ellis
A. B. Prior

Inventor:
Allen Johnston,
By J. H. Sweet Att'y

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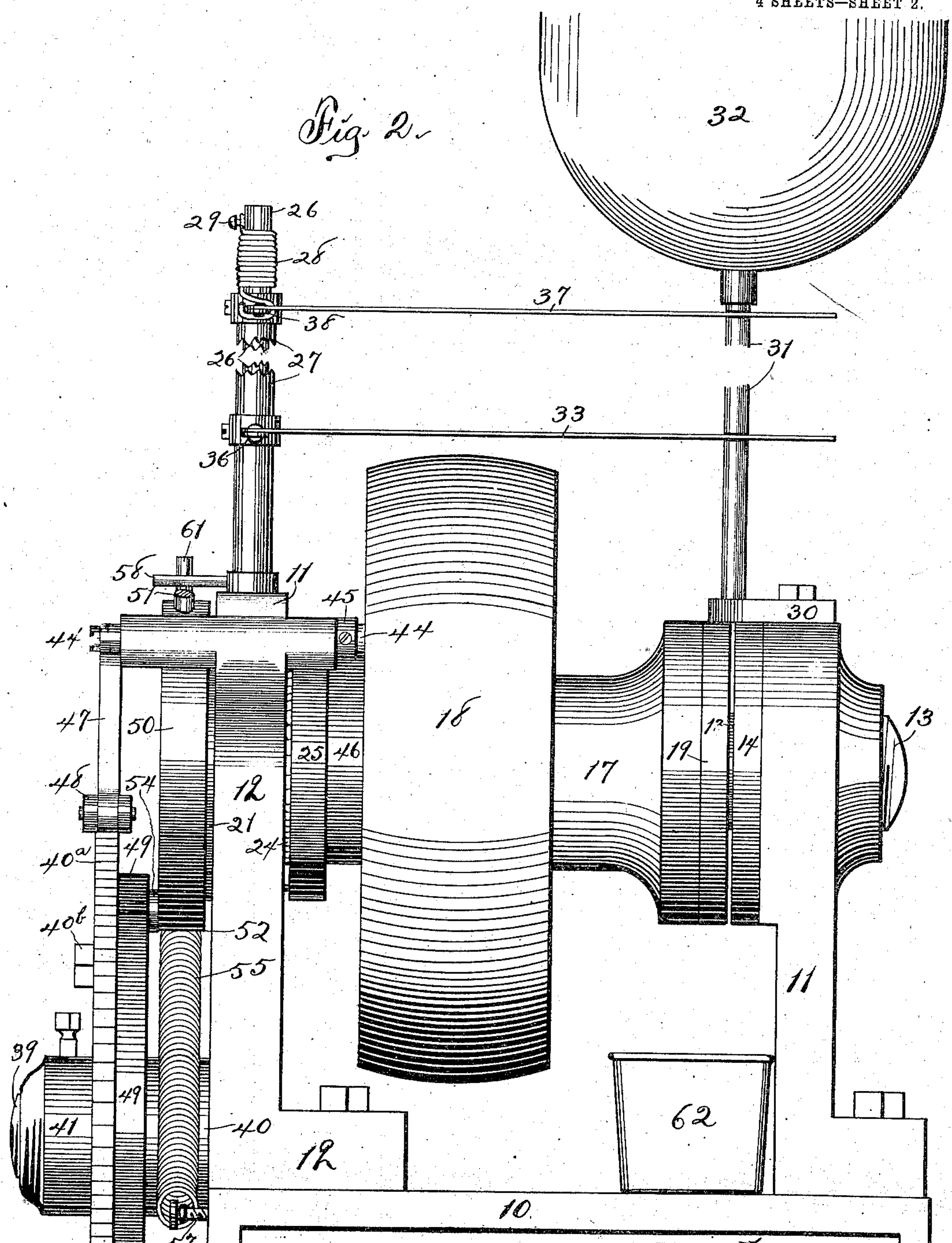
NO MODEL. 4 SHEETS—SHEET 2.

Fig. 2.



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NO MODEL. 4 SHEETS—SHEET 3.

Fig. 3.

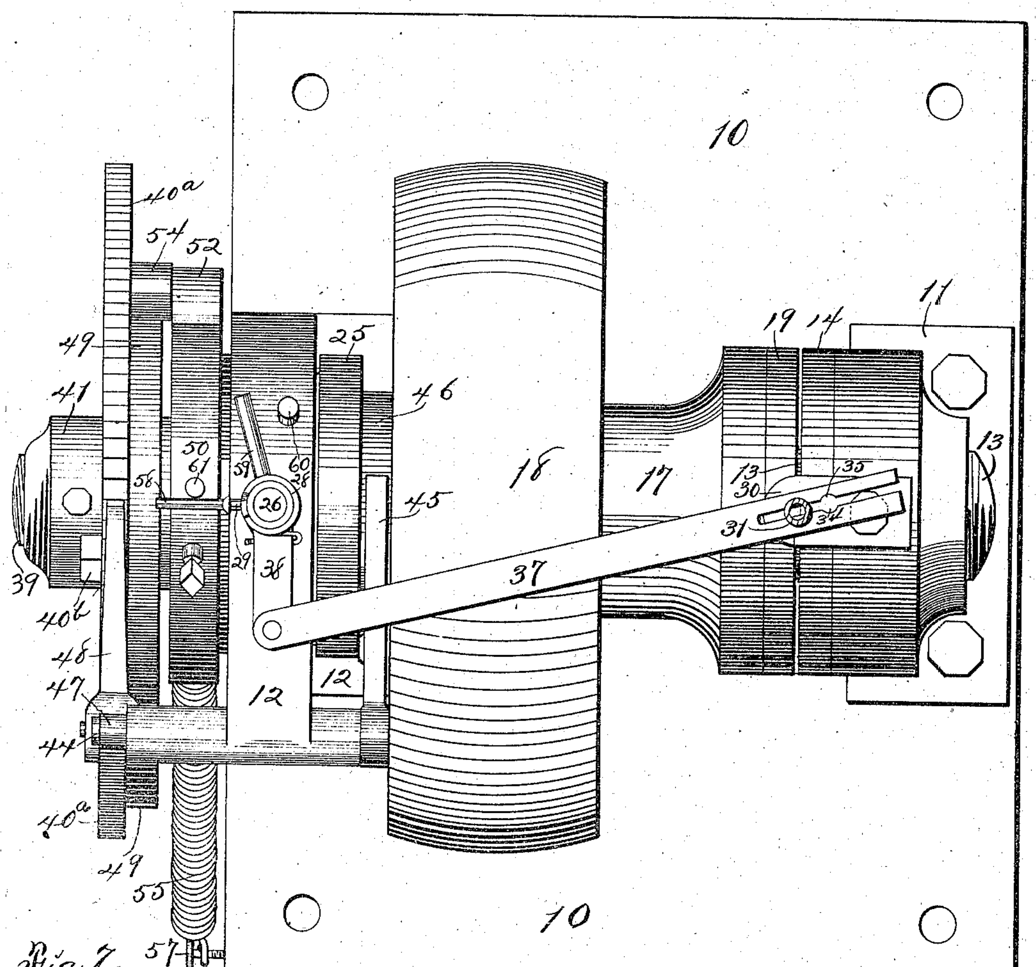


Fig. 7.

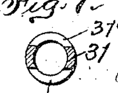


Fig. 5.

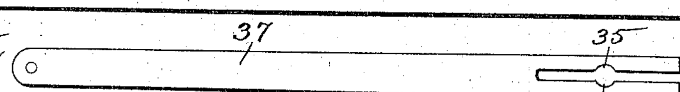
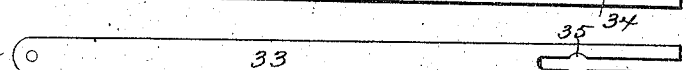


Fig. 6.



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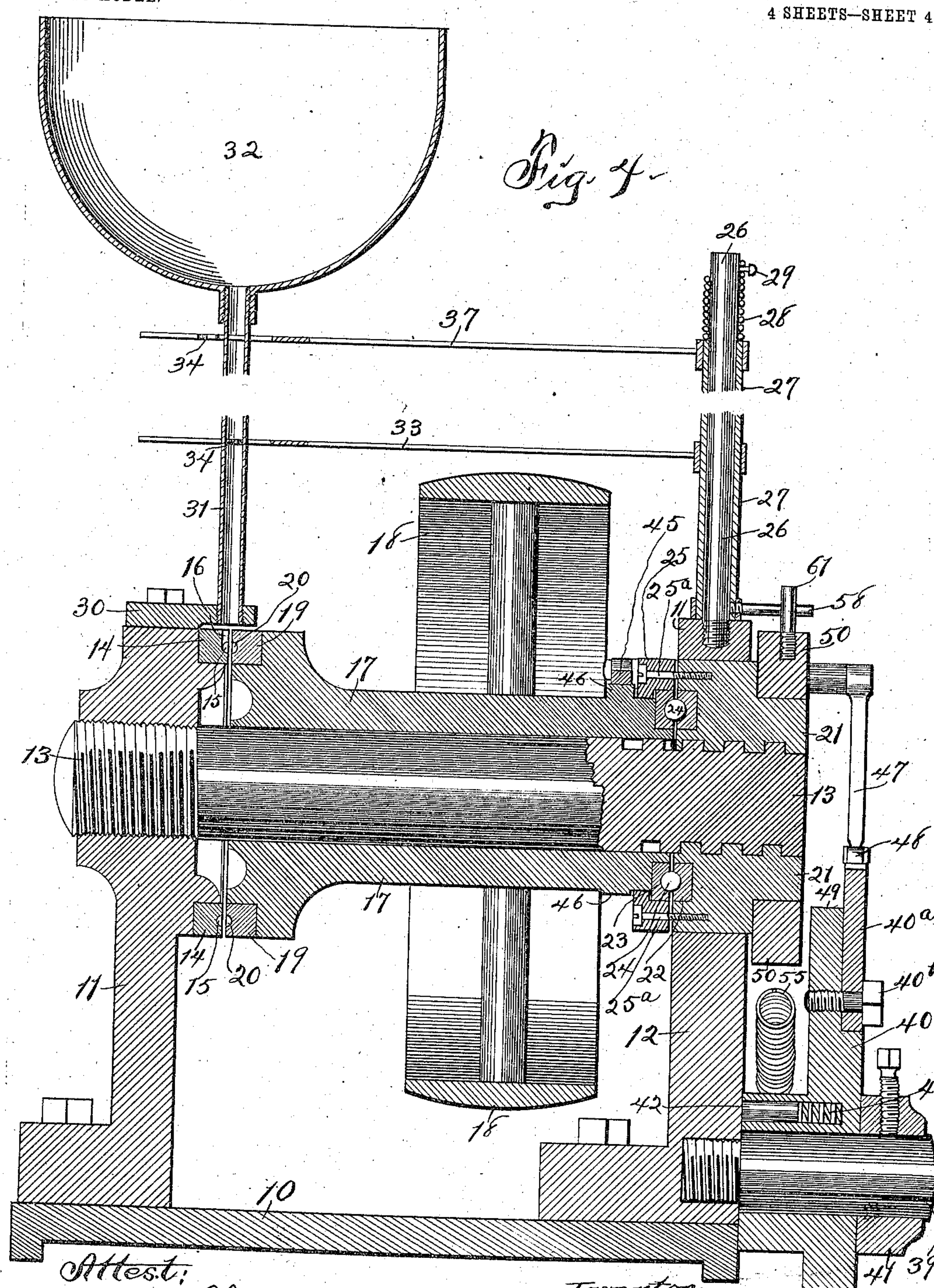
NO MODEL.

4 SHEETS—SHEET 4.



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UNITED STATES PATENT OFFICE.

ALLEN JOHNSTON, OF OTTUMWA, IOWA.

MACHINE FOR REDUCING AND FINISHING HOLLOW BEARING-BALLS.

SPECIFICATION forming part of Letters Patent No. 720,436, dated February 10, 1903.

Application filed May 31, 1902. Serial No. 109,740. (No model.)

To all whom it may concern:

Be it known that I, ALLEN JOHNSTON, a citizen of the United States of America, and a resident of Ottumwa, Wapello county, Iowa, have invented a new and useful Machine for Reducing and Finishing Hollow Bearing-Balls, of which the following is a specification.

The object of this invention is to provide improved means for reducing, truing, finishing, and polishing the surfaces of bearing-balls, and especially hollow bearing-balls made from sheet metal.

A further object of my invention is to be found in the provision of means for feeding bearing-balls automatically to and discharging the same from the finishing-machine, the feeding means being operated by the finishing-machine.

A further object of my invention is to be found in the provision of means for automatically increasing pressure upon a series of bearing-balls simultaneously contained in a finishing-machine.

My invention consists in the machine for finishing bearing-balls comprising grooved rings, one of which is mounted for rotation, means for automatically separating the rings to receive and discharge the balls, means for automatically closing the rings gradually to a predetermined point as the balls are being rolled, and means for automatically feeding the balls to said machine.

My invention consists, further, in the rolling-machine comprising grooved rings mounted in opposition to each other and means for automatically separating and approximating said rings relative to each other.

My invention consists, further, in the combination, with a rolling and finishing machine, of means for automatically feeding a predetermined number of balls to said machine.

My invention consists, further, in the construction, arrangement, and combination of elements hereinafter set forth, pointed out in my claims, and illustrated by the accompanying drawings, in which—

Figure 1 is an end elevation of the complete machine. Fig. 2 is a front elevation of the complete machine. Fig. 3 is a plan of the machine, the ball-receptacle being removed. Fig. 4 is a vertical section of the machine axially of its shaft. Figs. 5 and 6 are detail views of the valves. Fig. 7 is a detail cross-section of the feeding-tube.

In the construction of the machine and its mounting, as shown, the numeral 10 designates a table on which are mounted and fixed machine heads or standards 11 12. A shaft 13 is secured at one end in a horizontal aperture or screw-seat of the machine-head 11 and projects horizontally therefrom through a materially larger aperture in the machine-head 12. A ring 14, preferably made of hardened steel, is mounted on the inner face of the machine-head 11 concentric with the shaft 13, and a groove 15 of annular form and preferably concaved on an arc in cross-section is formed in one face of said ring and also is arranged concentric with the shaft 13. The ring 14 preferably is mounted stationary or fixed to the machine-head 11, and a notch 16 is formed in the uppermost portion of said ring and communicates with the groove 15 therein. A sleeve 17 is mounted for revolution on the shaft 13 between the machine-heads 11 12, and a driving-pulley 18 is formed on or fixed to said sleeve and is arranged to revolve the sleeve when driven by belting to a prime mover. (Not shown.) A ring 19, preferably made of hardened steel, is mounted rigidly in one end portion of the sleeve 17 concentric with the shaft 13, and a groove 20 is formed in one face of said ring and is of annular form and preferably concaved on an arc in cross-section. The groove 20 also is concentric with the shaft 13 and is located in direct opposition to the groove 15 and is designed to coöperate with said groove in the formation of a raceway or annular seat for balls.

As above stated, one end portion of the shaft 13 is threaded and secured in the machine-head 11. This is for the purpose of fixing said shaft rigidly, yet detachably, in the machine-head. The opposite end portion of the shaft 13 is threaded with a very coarse screw, the threads of which, preferably, are angular in cross-section, and a feeding-nut 21, interiorly screw-threaded to match the coarse thread on the shaft, is mounted loosely for rotation in the large aperture of the machine-head 12, surrounding and concentric with said shaft. Raceway-rings 22 23 are mounted, respectively, in the inner face of the feeding-nut 21 and the adjacent end portion of the sleeve 17, and bearing-balls 24 are mounted in the raceway groove or annulus formed by said rings. It is the function of the bearing-balls 24 and rings 22 23 to receive and resist the thrust of the sleeve 17 endwise or longitudinally of the shaft 13, and a ball-bearing is employed in this place to minimize the friction between the sleeve and the feeding-nut 21 and avoid rotation of said feeding-nut by direct contact of the sleeve. The raceway-ring 23 is of greater diameter than the sleeve 17, and a retaining-ring 25, rabbeted on its inner surface, is mounted around the sleeve and engages said ring. The retaining-ring 25 is fixed to the feeding-nut 21 by screws 26 and serves to retain the sleeve against endwise movement independent of the feeding-nut.

A post or standard 26 is mounted in and rises from the apex of the machine-head 12, and a sleeve 27 is mounted loosely for revolution or oscillation on said post. A torsional spring 28 is mounted around the upper end portion of the post 26 and has one of its ends in contact with the sleeve 27, while its other end is in engagement with a pin 29, fixed to and projecting from the post.

A plate 30 is mounted on the apex of the machine-head 11 and projects across the vertical planes of the rings 14 and 19, and a screw-threaded aperture is formed in said plate immediately above and in registration with the notch 16 in the ring 14. A stand-pipe or feeding-tube 31 is secured at its lower end in the threaded aperture of the plate 30 and rises perpendicularly therefrom. A hopper or receptacle 32 is mounted on the upper end portion of the stand-pipe or feeding-tube 31 and is designed to contain a quantity of bearing-balls to be fed to the machine and rolled, finished, reduced, and polished therein. At a little distance above the plate 30 notches are formed in the stand-pipe or feeding-tube 31, which notches intersect the bore of the tube and are on opposite sides of the center thereof. A valve or gate 33 is provided, preferably of sheet metal forked at one end, to embrace those portions of the stand-pipe or feeding-tube between the notches above mentioned and mounted for rectilinear reciprocation through said notches. The slot forming the fork at the end of the valve 33 is of less width than the bore of the stand-pipe or tube 31, and said valve is notched at 34 35, opening to the slot, the combined diameter of the notches and slot being equal to or greater than the bore of the tube. The valve 33 is connected at its opposite end to a crank-arm 36, fixed to and extending horizontally from the sleeve 27, and the notches of the stand-pipe are elevated just sufficiently to permit the valve 33 to clear the pulley 18 and belt thereon in extending to the sleeve. Normally the torsional spring 27 holds the sleeve 27 in such position that the notches 34 35 of the valve 33 are in registration with the bore of the stand-pipe or tube 31 and permit the passage of the balls downwardly through said tube. At a material distance above the valve 33 the stand-pipe or tube 31 is again notched in like manner, and a valve 37, also forked at one end, is mounted for rectilinear reciprocation through said notches and across the plane of the stand-pipe. The valve 37 has notches 34 35 in its end portion, bordering on the slot therein and arranged to register at times with the bore of the stand-pipe. The valve 37 extends from the stand-pipe and has its other end pivotally connected to a crank-arm 38, fixed to and projecting horizontally from the sleeve 27. Normally the torsional spring 28 holds the sleeve 27 in such position that the crank-arm 38 retains the valve 37 with its notches 34 35 out of registration with the bore of the stand-pipe or tube 31, and portions of said valve bordering the slot therein intersect and prevent the passage of the balls through said tube toward the valve 33. Thus normally the balls are retained in the hopper 32 and in that portion of the stand-pipe 31 above the valve 37 until in the operation of the machine, hereinafter described, said valve 37 is adjusted into a position to permit the feeding of the balls through the tube to a seat on the valve 33.

A stub-axle or pin 39 is mounted in and extends horizontally outward from the machine-head 12 below the shaft 13. A ratchet-wheel 40 is mounted loosely for revolution on the pin or stub-axle 39 and is retained thereon by a collar 41, attached to said pin outside the ratchet-wheel. It is desirable to brake or apply a tension to the ratchet-wheel 40 to prevent too free movement of said ratchet-wheel on the pin 39, and to this end a pin 42 is seated in the hub of the ratchet-wheel and held in contact with the machine-head 12 by an expansive coil-spring 43, also contained in the hub of the ratchet-wheel and bearing against said pin. A rock-shaft 44 is mounted for oscillation in a bearing fixed to the machine-head 12, and a crank-arm 45 on said rock-shaft extends across the vertical plane of the shaft 13 and contacts with an eccentric boss or cam-rib 46 on the sleeve 17 adjacent the retaining-ring 25. A crank-arm 47 on the opposite end portion of the rock-shaft 44 extends downward approximately at right angles to the crank-arm 45 and carries a gravity-operated feeding-pawl 48 on its lower end. The feeding-pawl 48 is pivoted on the lower end portion of the crank-arm 47 and extends horizontally to and contacts with one or another of the teeth of the ratchet-wheel 40 in such manner that when said crank-arm is moved in one direction the pawl will feed or revolve the ratchet-wheel predetermined distances. A cam-shaped shoulder 49 is formed on the ratchet-wheel 40 within the pitch-line of the teeth of said ratchet-wheel. The cam-shaped shoulder 49 is approximately circular throughout a major portion of the circumference of the shoulder 49. Its eccentricity to the axis of the ratchet-wheel is not great, being sufficient only to raise a traveler riding thereon to the degree necessary to perform the useful function hereinafter defined; but at one point in its periphery said shoulder is recessed or depressed a considerable and material distance, as illustrated by dotted lines in Fig. 1. A collar 50 is mounted on the feeding-nut 21 and secured thereto by a set-screw 51. The collar 50 preferably is approximately circular, and an arm 52 is formed on and radiates from said collar and is provided with a lateral stud or pin 53, extending over or across the face of the cam-shaped shoulder 49. An antifriction-roller 54 is mounted for revolution on the pin 53 and rides on the periphery or face of the cam-shaped shoulder 49. A retractile coil-spring 55 is fixed at one end to a pin 56 on the collar 50 and at the other end is attached to a pin 57 on the table 10. It is the function of the spring 55 to hold the roller 54 in contact with the cam-shaped shoulder 49 and at the same time retain the collar 50 in a variable position governed by the eccentricity of said shoulder relative to the axis of the ratchet-wheel 40. When the ratchet-wheel in its rotation under the influence of the step-by-step movement of the feeding-pawl 48 shall have performed almost a complete revolution, the retractile coil-spring 55 draws the roller 54 into the depression or offset portion of the shoulder 49 and in so doing rotatably moves the collar 50 a considerable distance. A pin 58 is fixed to and projects horizontally from the lower end portion of the sleeve 27 and extends across the face of the collar 50. A pin 59 is fixed to and projects laterally from the lower portion of the sleeve 27 and extends along the uppermost portion of the machine-head 12. The pin 59 normally engages a pin 60, seated in the machine-head 12, and limits the movement of the sleeve in opposition to the expansion of the torsional spring 28. A pin 61 is fixed in and projects radially from the collar 50 and is arranged to engage at times with the pin 58 and move the sleeve 27 rotatably in opposition to the pressure of the torsional spring 28.

For practical operation this machine is first set with the sleeve 17 adjusted slightly away from the machine-head 11, such adjustment being effected by unscrewing the feeding-nut 21, the degree of separation being sufficient only to permit the passage of balls from the feeding-tube or stand-pipe 31 through the notch 16 into the annular space formed by the grooves 15 and 20 in the rings 14 and 19. Thus a sufficient quantity of rough balls is introduced through the tube 31 into the annular space between the rings 14 and 19 to fill said space. Then the valve 33 is opened and the valve 37 is closed, and the hopper and uppermost portion of the stand-pipe 31 are filled or supplied with rough balls. Then the feeding-nut is adjusted to cause the ring 19 to bear slightly upon the balls, which contact at their opposite portions with the ring 14, and the ratchet-wheel 40 is adjusted so that the roller 54 is at the initial point *x* of the cam-shaped shoulder 49. The pawl 48 is positioned on and in contact with a tooth of the ratchet-wheel 40, and the machine is started by gearing to the prime mover. (Not shown.) In the rotation of the pulley 18 and sleeve 17 in either direction the rough balls are revolved, rolled, and worn between the rings 14 and 19, inasmuch as the ring 14 is stationary and the ring 19 revolves with the sleeve. In the revolution of the sleeve 17 the cam-rib 46 revolves and acts upon and vertically oscillates the crank-arm 45. The vertical oscillation of the crank-arm 45 results in an oscillation of the rock-shaft 44 and a consequent horizontal oscillation of the crank-arm 47. The horizontal oscillation of the crank-arm 47 effects a rectilinear reciprocation of the feeding-pawl 48, and said pawl in turn engages successive teeth of the ratchet-wheel and rotatably moves said wheel step by step in a given direction. In the rotation of the ratchet-wheel in a given direction (indicated by the arrow *a* in Fig. 1) the roller 54 rises slightly on the incline or cam-shaped periphery of the shoulder 49, and in rising said roller 54 raises the pin 53 and arm 52 and rotatably moves the collar 50 and feeding-nut 21 in a given direction, (indicated by the arrow *b* in Fig. 2.) In the rotation of the feeding-nut, as indicated by the arrow *b* in Fig. 2, said nut engages by its screw with the coarse screw of the shaft 13 and operating through the ball-bearing, consisting of the rings 22, 23, and balls 24, tends to move and does move the sleeve 17 endwise and approximates or brings closer the ring 19 to the ring 14. It will be perceived that the endwise movement of the sleeve 17 coincident with any one step of advance of the ratchet-wheel 40 is infinitesimal, but of a positive and measurable quantity, and that such endwise movement supplies a slightly-increased pressure to the rough balls being treated between the rings 14 and 19. The relative diameters of the rings 14 19 and the ratchet-wheel 40 are such that when the ratchet-wheel has almost completed a revolution and the terminal portion *y* of the cam-shaped shoulder 49 is in contact with the roller 54 the balls being treated between said rings have received a considerable and material reduction of diameter and have been turned and pressed on their various axes and polished, worn, smoothed, and finished to the desired degree of perfection. Thereafter in the further operation of the machine and continued rotation of the ratchet-wheel the roller 54 moves inward toward the axis of the ratchet-wheel and along the surface of the depressed portion of the shoulder 49, being impelled by the retractile resilience of the spring 55. It is apparent that as the roller 54 enters the depressed portion of the shoulder 49 its movement is accelerated and it rapidly unscrews the feeding-nut 21 and withdraws the sleeve 17 and separates the ring 19 from the ring 14. Such degree of separation of the ring 19 from the ring 14 permits the discharge of all the balls contained between said rings into a receptacle 62, provided to receive them. Such reversed and accelerated movement of the roller 54 and collar 50 is arrested when the roller reaches the limit of depression in the shoulder and is overcome and inverted by the rise of said roller on the opposite incline of the shoulder. When the collar moves rapidly in a direction opposite to that indicated by the arrow *b* in Fig. 2 by reason of the roller 54 entering the depression of the shoulder 49, the feeding-nut 21 is rapidly unscrewed and separates the rings 14 and 19 for the deposit of the balls in the receptacle 62. As the roller 54 rises on the opposite incline of the depressed portion of the shoulder 49 the feeding-nut 21 is again screwed upon the shaft and moves the sleeve 17 sufficiently to approach the ring 19 toward the ring 14 enough to prevent the escape of the balls from the space between the reducing-rings. When the collar 50 moves in a direction opposite to that indicated by the arrow *b* in Fig. 1 by reason of the roller 54 entering the depressed portion of the shoulder 49, said collar removes the pin 61 from the pin 58 and permits the sleeve 27 to move rotatably under the resilience of the torsional spring 28 exerted on the crank-arm 38, such movement of rotation of the sleeve continuing until it is arrested by contact of the pin 59 with the pin 60. In such movement of rotation of the sleeve 27 the crank-arms 36 and 38 move away from the stand-pipe or feeding-tube 31 and in so doing move the valves 33 and 37 longitudinally until the feeding-port of the valve 33 is closed and the feeding-port of the valve 37 is opened, whereby a quantity of the balls may flow from the receptacle 32 into and fill the space between said valves. As the roller 54 rises on the opposite incline of the depressed portion of the shoulder 49 toward the point *z* it moves the collar 50 rotatably in the direction of the arrow *b* until the pin 61 contacts with the pin 58 and moves said pin 58 to the right, thus establishing a movement of rotation of the sleeve 27 against the resilience of the torsional spring 28. While the ratchet-wheel is traveling from the point *z* to the point *z'* the valve 33 is opened and the valve 37 is closed, thus permitting the deposit of the quantity of balls measured between said valves into the annular space formed by the grooves 15 and 20 in the rings 14 and 19, said balls entering the annular space through the notch 16. As the roller 54 rises from the point *z'* to the point *x* and gradually from the point *x* to the point *y* the valves are held with the lower one open and the upper one closed by contact of the pin 61 with the pin 58 against the resilience of the torsional spring 28. The abrupt elevation of the cam between the point *z'* and the point *x* is provided to enter the feeding-nut 21 quickly in such position as will move the sleeve 17 and reducing-ring 19 endwise until such reducing-ring contacts with the balls in the grooves and causes said balls to contact with the reducing-ring 14. This operation also closes the rings sufficiently that the balls may not thereafter escape through the notch or entrance-port 16. Further operations of the machine are repetitions of those just described and are continued until the quantity of balls in the receptacle 43 is exhausted or the machine is stopped by disengagement from the prime mover.

Reference to the drawings will disclose that the ratchet-wheel is made in two parts, the ratchet proper being formed on a rim 40^a, secured by screws 40^b to the plate portion, the cam-shaped shoulder 49 forming the periphery of the plate portion. Such construction is adopted in consideration of shaping and truing the periphery of the plate portion of the cam-shaped shoulder.

It will be observed that the balls in the annular space between the rings 14 and 19 are acted upon or revolved or carried about in their orbit a very large number of times while confined in the machine and before being discharged therefrom. Such repeated and multiplied treatment of the balls is desirable in order to produce that smoothness and uniform circularity of surface as is required for the attainment of the most satisfactory results and is provided for by arranging a high speed of the pulley 18 relative to the slow feed of the sleeve 17 endwise under the influence of the ratchet-wheel and cam-shaped shoulder acting upon the feeding-nut 21. It will be observed that in the treatment of a quantity of balls by the reducing-rings 14 and 19 the pressure applied thereto by endwise thrust or feed of the sleeve 17 is very gradual and uniformly progressive—that is to say, the feed of the sleeve endwise can progress no faster than the rotation of the ratchet-wheel and the shape of the cam-shaped shoulder 49 will permit, and yet at each revolution of the pulley 18 and sleeve 17 an endwise movement of the sleeve is effected in some degree. The product resulting from the treatment of the balls is an object of truly spherical character, having material homogeneity of substance and uniformly hard and polished surface.

I do not wish to be understood as limiting myself to the use of a tube or stand-pipe in vertical position for feeding the rough balls to the rolls, since my invention is of broader scope and compasses a large variety of ball feeding or supplying mechanisms. Neither do I wish to be limited to the use of the precise form of sleeve-feeding mechanism employed, as various screw-operated feeding devices or step-by-step mechanisms may be devised to effect an endwise movement of the revolving sleeve or the head in opposition thereto.

I claim as my invention—

1. In a machine for rolling hollow balls, grooved rings, one of which is mounted for rotation, automatic mechanism for separating the rings to allow the balls to travel into the grooves thereof, and automatic mechanism to close the rings gradually to a predetermined point as the balls are being rolled.

2. In a machine for rolling hollow balls, grooved rings, one of which is mounted for rotation, automatic mechanism for separating the rings to allow the balls to drop out, an automatic mechanism to close the rings partially to allow the balls to pass into the grooves thereof and then gradually to close the rings to a predetermined point as the balls are being rolled.

3. In a machine for rolling hollow balls, counterpart grooved rings, one of which is stationary and the other revolves, and means for automatically reciprocating the revolving ring longitudinally of its axis synchronous with its rotation.

4. In a machine for rolling hollow balls, a shaft, counterpart grooved rings, one of which revolves around said shaft, mechanism arranged to reciprocate the revolving ring longitudinally of its axis synchronous with its rotation, and a feeder consisting of a tube and a gate therein and arranged to allow the balls to enter said grooved rings at predetermined intervals.

5. In a machine for rolling hollow balls, a shaft, counterpart grooved rings, one of which revolves around said shaft and is arranged for endwise reciprocation longitudinally of the shaft synchronous with its revolution, and a feeder provided with feeding mechanism automatically to allow a plurality of balls to enter said grooved rings at predetermined intervals.

6. In a machine for rolling hollow balls, counterpart grooved rings, one of which revolves, and automatic mechanism to reciprocate the revolving ring longitudinally of its axis synchronous with its revolution.

7. In a machine for rolling hollow balls, a receptacle for the balls, a feeder arranged to receive the balls from the receptacle by gravity, gates arranged to hold back the balls from the machine a predetermined length of time, and mechanism acting on said gates to pass the balls to the machine in predetermined numbers, and feed the balls within the machine, together with automatic discharging mechanism whereby the balls may be discharged from the machine after they have been rolled.

8. In a machine for truing and condensing hollow metal balls, a shaft, counterpart grooved rings, one of which revolves around the shaft, a receptacle for holding balls mounted above said machine, a feeder arranged to carry the balls by gravity to said machine, and means arranged to retain the balls within the grooves of the rings and means for automatically discharging the balls after they have been rolled.

9. In a machine for rolling hollow balls, a shaft, counterpart grooved rings, one of which revolves around said shaft, and arranged to roll a plurality of balls a predetermined length of time and at the same time by peripheral friction revolve said balls in different directions that they may be rolled upon all their axes, in combination with driving mechanism for automatically and synchronously rotating and reciprocating one of said rings.

10. In a machine for rolling hollow balls, a shaft, counterpart grooved rings, one of which rings is mounted for automatic and synchronous rotation on and reciprocation longitudinally of said shaft, and driving mechanism arranged to control said rotation and reciprocation.

11. In a machine for rolling hollow balls, a shaft, counterpart grooved rings, one of which reciprocates endwise of said shaft, a cam arranged to control said reciprocation, and a timing-ratchet arranged to control the feeding of the balls with reference to the operation of the cam.

12. In a machine for rolling hollow balls, a feeder provided with a cam-operated controlling-gate, and a timing-ratchet arranged to control the operation of said gate.

13. In a machine for truing and condensing hollow metal balls, a shaft, counterpart grooved rings, one of which revolves around said shaft, means for distributing a plurality of balls within the grooves of said rings, and means for automatically discharging the balls after they have been trued.

14. In a machine for truing and condensing hollow metal balls, a shaft, counterpart grooved rings, one of which revolves around said shaft, means for automatically distributing and retaining a plurality of balls within said grooves, and means for discharging the balls after they have been rolled a predetermined length of time.

15. In a machine for rolling hollow balls, the machine-heads, the shaft fixed to one of said heads, the grooved ring mounted on said sleeve in opposition to the first grooved ring, and cam-operated screw mechanism arranged to feed said sleeve longitudinally of said shaft.

16. The combination of the reducing-machine, automatic mechanism arranged to open and close the reducing-machine for the reception and discharge of balls synchronous with the revolution thereof, the stand-pipe communicating therewith and arranged to feed balls thereto, the ball-containing receptacle on said stand-pipe, the valves controlling the number in each series of balls passing through said stand-pipe and the cam-operated mechanism arranged to move said valves for alternate opening and closing thereof.

17. The combination of the reducing-machine, the stand-pipe communicating therewith, the receptacle on the stand-pipe, the valves controlling said stand-pipe, and the cam-operated, spring-resisted mechanism

whereby the valves are moved to and fro in the operation of the machine.

18. The reducing-ring stationarily mounted, the reducing-ring mounted for rotation in opposition thereto, the feeding mechanism arranged to move said rotatable reducing-ring longitudinally of its axis, the cam acting on said feeding mechanism and the ratchet-and-pawl mechanism acting on said cam and operated by the rotation of the rotatable reducing-ring.

19. In a machine of the class described, the machine-head, the shaft fixed therein and having a coarse screw on its opposite end, the reducing-ring on the machine-head, the sleeve mounted for revolution on the shaft, the reducing-ring on the sleeve in opposition to the first reducing-ring, means for feeding balls to the space between said rings, the feeding-nut having a coarse screw in mesh with the coarse screw of the shaft, ball-bearings interposed between the feeding-nut and the adjacent end of the sleeve, a retaining-ring connecting the feeding-nut and sleeve, a cam arranged to move said feeding-nut rotatably, and ratchet-and-pawl mechanism acting on said cam and geared to the revoluble sleeve.

20. In a machine of the class described, the machine-head, the shaft fixed therein and having a coarse screw on its opposite end, the reducing-ring on the machine-head, the sleeve mounted for revolution on the shaft, the reducing-ring on the sleeve in opposition to the first reducing-ring, means for feeding balls to the space between said rings, the feeding-nut having a coarse screw in mesh with the coarse screw of the shaft, ball-bearings interposed between the feeding-nut and the adjacent end of the sleeve, a cam arranged to move said feeding-nut rotatably, and ratchet-and-pawl mechanism acting on said cam and geared to the revoluble sleeve, together with a rock-shaft, and a cam-rib on said sleeve acting on said arm.

21. In a machine for rolling a series of balls simultaneously, rolling mechanism consisting of counterpart grooved rings one of which revolves, automatic mechanism arranged to reciprocate the revolving ring longitudinally of its axis synchronous with its rotation, a receptacle for balls, a conductor and automatically-operated stops in said conductor to allow a series of a predetermined number of balls to pass to the rolling mechanism and to prevent passage of further balls through the conductor until said first series have been rolled through the entire length of the grooves of the rings a predetermined plural number of times and discharged.

22. In a machine for rolling hollow balls, grooved rings, one of which revolves, a conductor, gates on said conductor to allow a plurality of balls to pass in series to said rings at predetermined times and in predetermined numbers, feeding mechanism to automatically approach said rings as the balls are being rolled and also to separate said rings and discharge said balls after they have been rolled.

23. In a machine for rolling hollow balls, grooved rings, one of which revolves, a conductor and gates thereon to allow a plurality of balls to pass in series to said rings at predetermined times and in predetermined numbers, feeding mechanism to automatically approach said rings as the balls are being rolled and also to separate said rings and discharge said balls after they have been rolled, and timing mechanism to control said movements.

24. In a machine for rolling and reducing hollow balls, the grooved rings, one mounted for synchronous rotation and endwise reciprocation, ball-feeding mechanism and ring-feeding mechanism whereby the rotatable ring may be separated from the other ring, the balls fed in series to the grooves of the rings and the rotatable ring returned to ball-rolling relation with the other ring, successively and repetitiously simultaneous with the rotation thereof.

Signed by me at Ottumwa, Iowa, this 26th day of April, 1902.

ALLEN JOHNSTON.

Witnesses:

R. W. FUNK,

FRED DIMMITT.