J. P. SMYTHE.

ORE MILL.

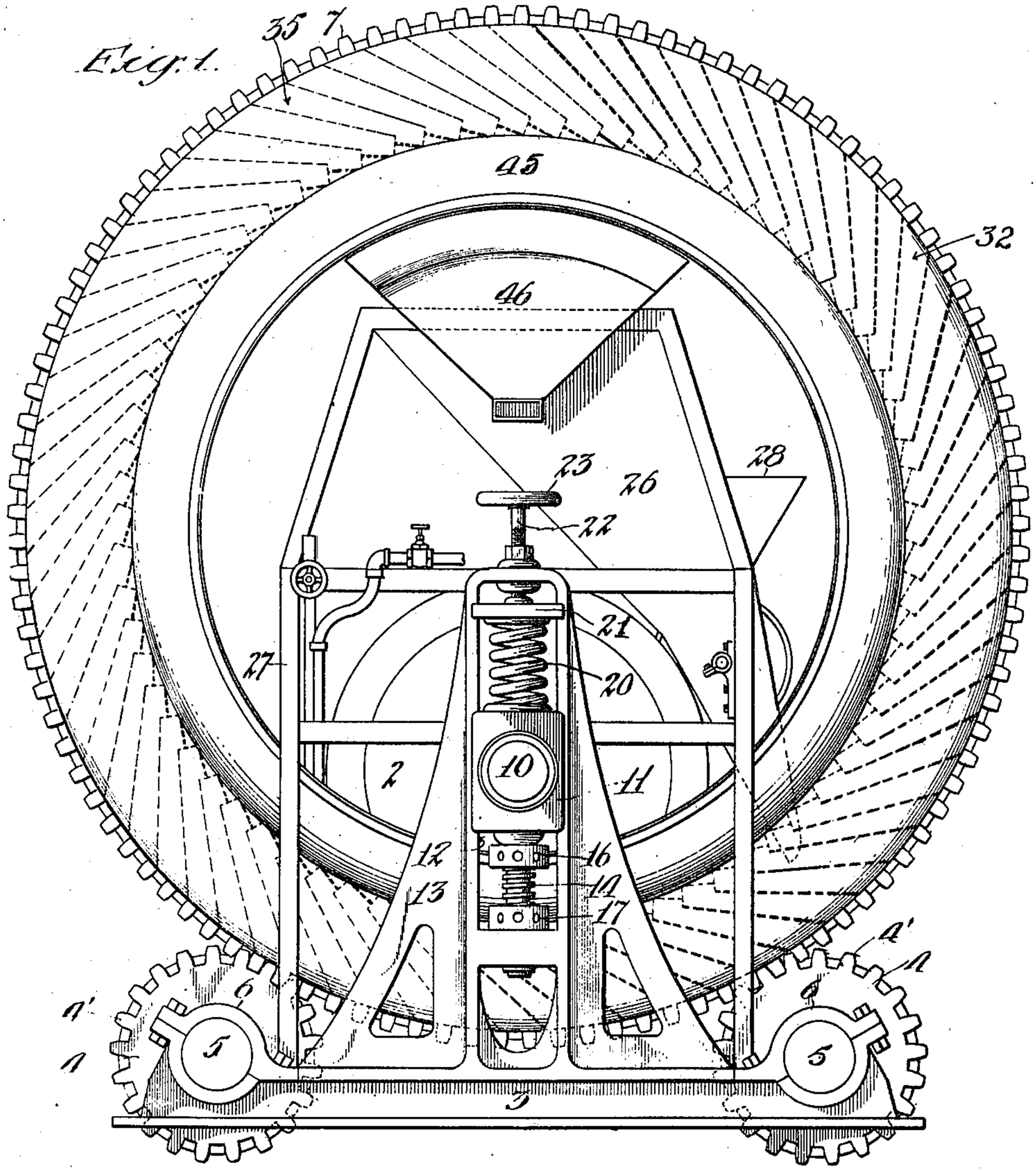
APPLICATION FILED SEPT. 20, 1909.

989,819.

Patented Apr. 18, 1911.

3 SHEETS—SHEET 1.

Fig. 1.



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3 SHEETS—SHEET 2.

Fig. 2.

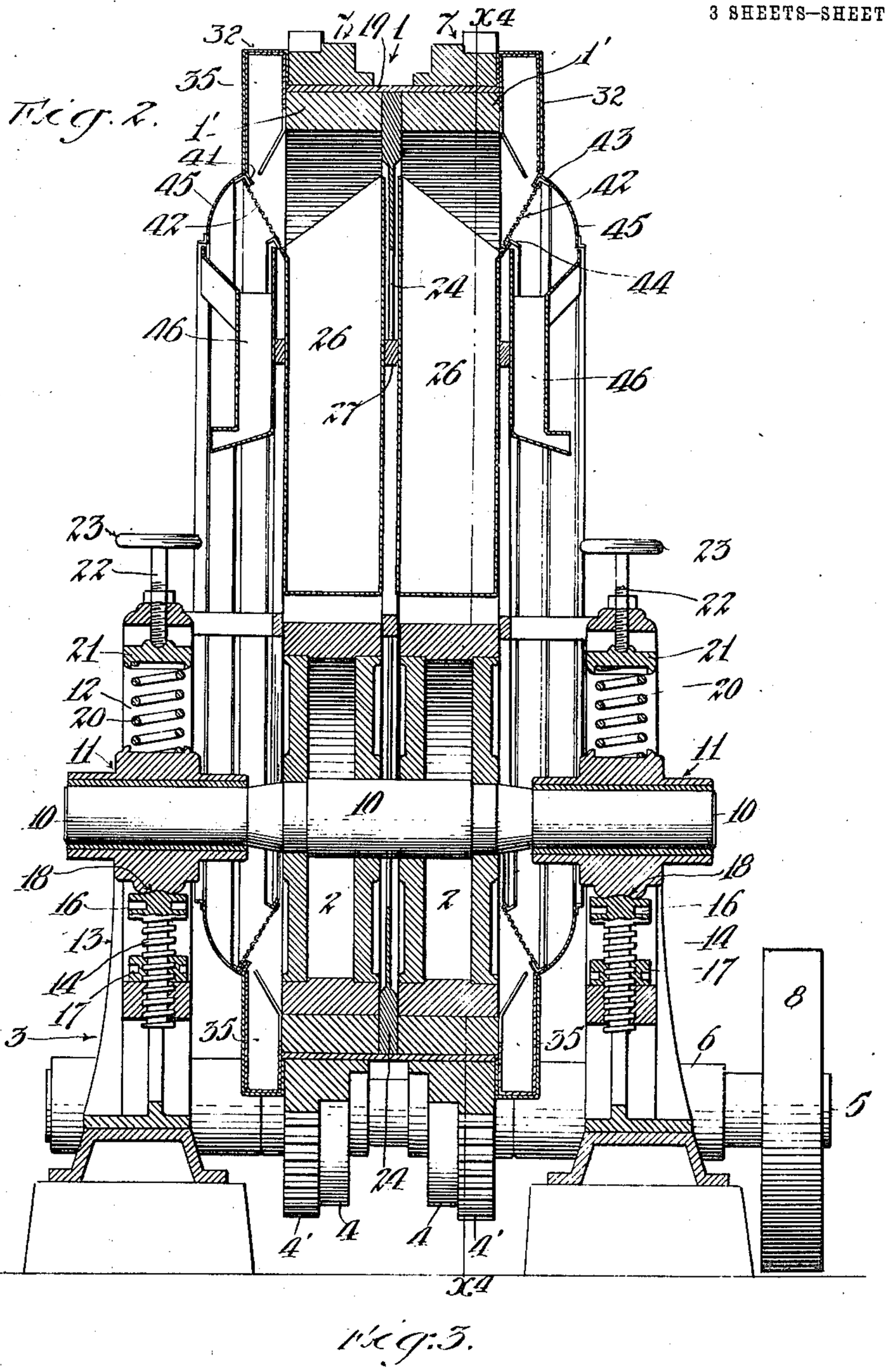
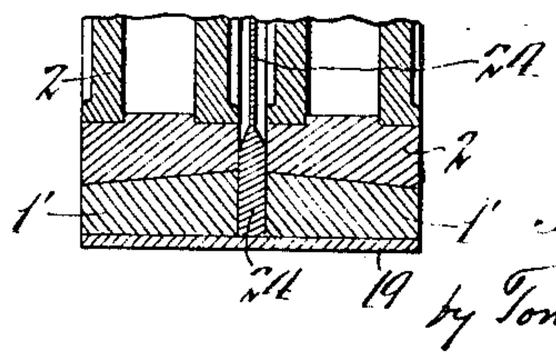


Fig. 3.



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3 SHEETS—SHEET 3.

Fig. 4.

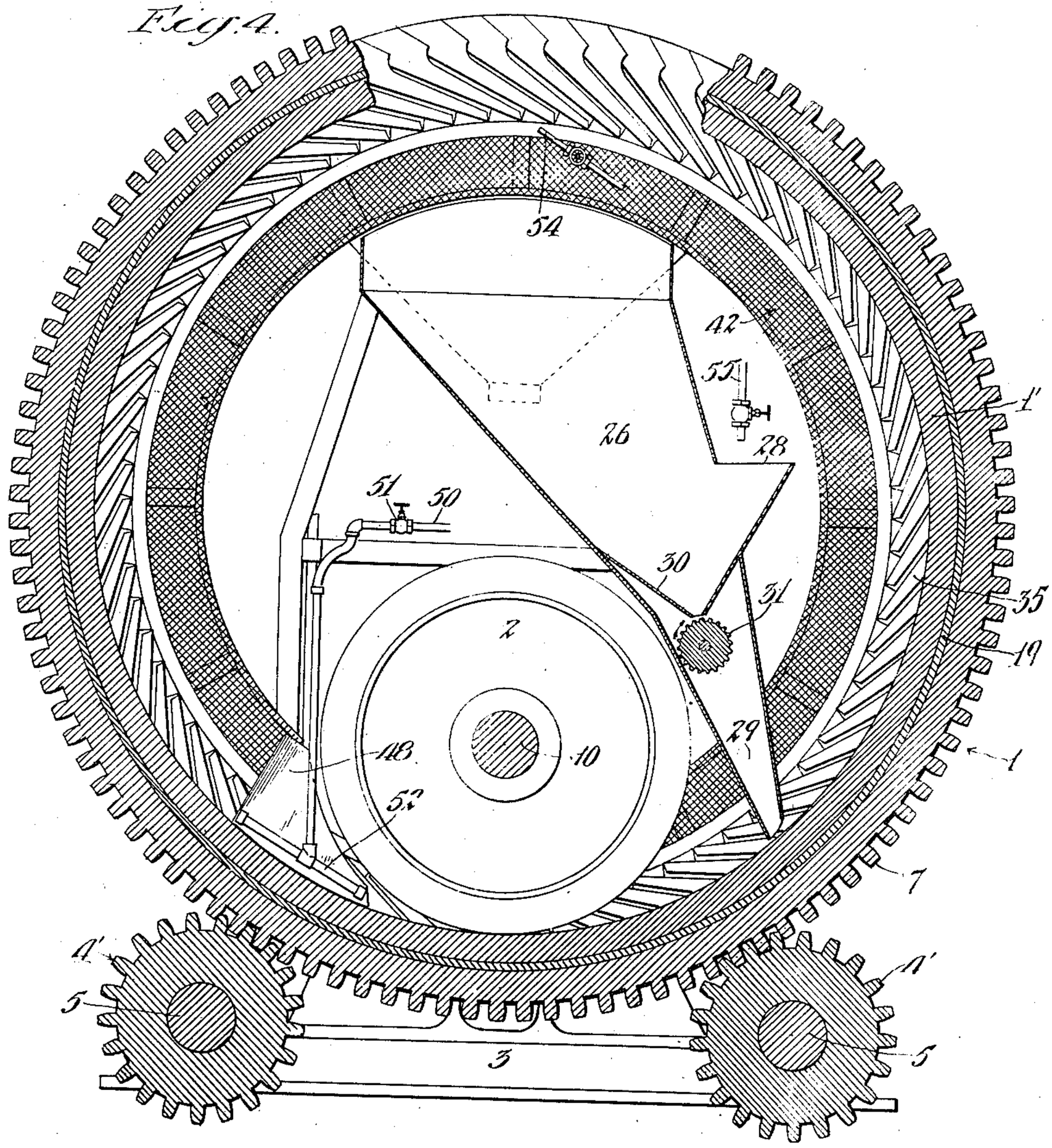
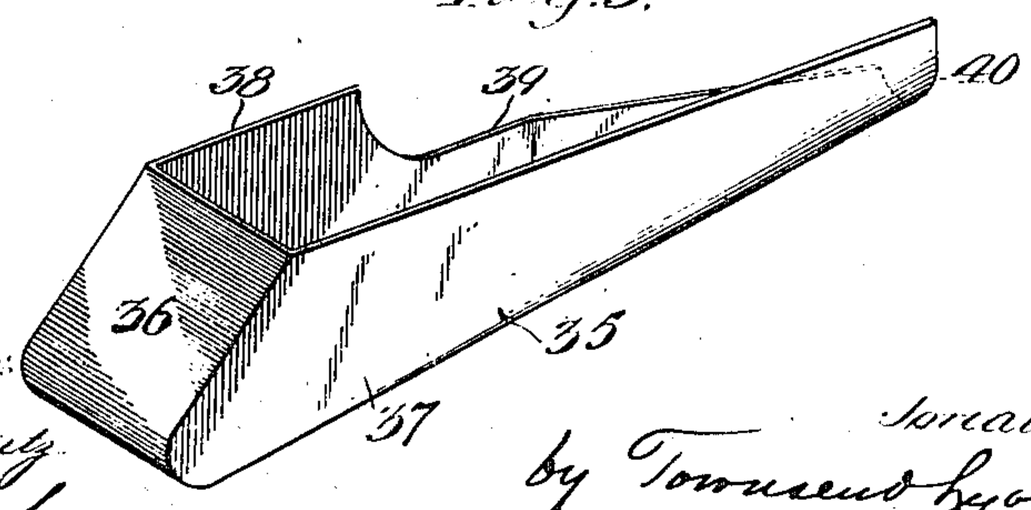


Fig. 5.



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UNITED STATES PATENT OFFICE.

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ORE-MILL.

989,819. Specification of Letters Patent. Patented Apr. 18, 1911.

Application filed September 20, 1909. Serial No. 518,695.

To all whom it may concern:

Be it known that I, JONATHAN P. SMYTHE, a citizen of the United States, residing at Longbeach, in the county of Los Angeles and State of California, have invented a new and useful Ore-Mill, of which the following is a specification.

This invention relates to a mill for crushing or granulating ore or rock to any desired degree of fineness and especially to the regrinding of middling or tailing products of concentration or ore-dressing operations.

The main object of the invention is to provide means for crushing the ore, as far as possible, to a definite fineness or size without producing an undue amount of slimes, so called, or without subjecting the ore to repeated and unnecessary crushing and grinding. In many metallurgical operations it is desirable to have the ore of a definite size or fineness and the presence of slimes (or ore of greater fineness than is required) is a detriment because of the loss or escape of the values that takes place when too much slime is present. Moreover, after the ore has been brought to the required degree of fineness the expenditure of power in recrushing such ore is an additional source of loss. In this connection, an object of the invention is to eliminate such waste and produce a material of uniform fineness and nearly free from slimes or unnecessary fine admixture.

Another object of the invention is to provide an ore grinder or granulator in which a minimum amount of water will be required in the crushing operation.

In the ordinary construction and equipment of concentration or reduction works, preference is usually given to what is known as roll-crushing as the method mainly giving the most desirable form of granulated product. This usually necessitates the erection of expensive and troublesome elevators and revolving screens or other means of "sizing" the product, hence the preference of many metallurgists and mill-men for some one of the varied types of so-called "self contained" crushing or granulating devices—from gravity stamps to the wellknown Chilian or Huntington Mills, with their more or less uncertain method of delivery of granulated product and their certain production of too much slimes—as well as their great consumption of water. It is the intention in this invention to combine all of the good features of roller-granulation with minimum consumption of water (where it is desired to crush the ore wet); minimum production of slimes (by elevating and screening the crushed mass after each passing of the material under the rolls); automatic and positive elevation and discharge of the finished product from a point in the machine higher than where received and that without the use of either elevator-belts or a sand-pump and at a point whence the granulated product can readily be conveyed by ordinary means to points upon the same floor-level for subsequent treatment.

In the operation of such works and more particularly in the crushing of very friable materials like, for instance, lead or copper sulfids, it is desirable to eliminate as far as practicable, the production of material (commonly termed "slimes") so finely comminuted as to be carried either in suspension in or borne upon the surface of the water used in the subsequent operation of concentration or separation of the mineral particles from the granulated mass of ore. In order to accomplish this result it is necessary to remove the broken particles just as soon as they are fine enough to pass the desired mesh of screen; and this invention provides a combination of rolls, deflector, elevator, and annular screen, in a single machine.

Other objects and advantages of the invention will appear hereinafter.

The accompanying drawings illustrate the invention, and referring thereto: Figure 1 is a side elevation of the machine. Fig. 2 is a longitudinal section thereof. Fig. 3 is a partial section showing a different form of the crushing faces. Fig. 4 is a transverse section on the line x^4—x^4 in Fig. 2. Fig. 5 is a perspective of one of the buckets for conveying the crushed ore to the screening means.

The machine comprises an outer crushing ring 1 and an inner rotary crushing means 2, these parts being rotatably mounted on a frame 3. The crushing ring 1 is peripherally supported on pairs of wheels 4 carried by shaft 5, and journaled in bearings 6 on the frame 3, one or both of said pairs of wheels being provided with gear teeth 4′ to engage gear rims 7 or circular series of gear teeth on the periphery of the ring 1. Driving means, such as a pulley 8, is secured to one or both of the shafts 6, whereby the

corresponding wheels 4 are rotated and the crushing ring 1 is thereby caused to rotate.

The machine is shown as constructed in duplicate, the inner crushing means comprising two crushing rolls 2 secured on a shaft 10 journaled in bearing blocks 11 which are mounted so as to be vertically slidable in ways 12 in standards 13 at the respective sides of the machine, a screw 14 working in the bottom of the standard and engaging at its upper end with the bearing block or pillow block 11 serving to adjust the height of the roll shaft 10, said screw having a capstan head 16 and a capstan lock nut 17 for adjustment thereof. The bearing of the head of the screw against the bearing block 11 is preferably rounded as shown at 18 to permit of automatic adjustment or alinement of the bearing to the shaft. A spring 20 extends between bearing block 11 and a follower plate 21 engaged by a pressure screw 22 with a hand wheel 23 to produce an adjustable yielding pressure on the top of the bearing block at each end of the shaft 10.

The machine being in duplicate, a partition wall or ring 24 extends inwardly from the crushing ring, the crushing ring being preferably made in two parts 1′ separated by said partition ring and the ring extending inwardly to form a flange for separating the contents of the two sides or ends of the crushing ring. The two parts are secured in a cylindrical shell 19, and the gear rims 7 are secured on the outside of said shell.

A hopper 26 extends within each portion of the crushing ring, and is supported on a suitable frame or standard 27, the top of said hopper being below the top of the crushing ring and its lower end or spout extending adjacent to the inside of the crushing ring, somewhat in front of the point of contact with the crushing roll, this point of contact being at the bottom of the roll and of the inner face of the crushing ring. Said hopper is open at the top and has an opening or feed spout 28 at one side into which the ore to be crushed is supplied by any suitable means, not shown. Above the delivery spout 29 of the hopper an interior spout or false bottom 30 is provided, feeding the ore to a feed roll 31 which is rotated by any suitable means, to cause the ore to pass in graduated and regulated amount through the spout 29 to the crushing surfaces. On the outside of the crushing rings buckets 35 are provided for receiving the crushed ore and carrying it up and discharging it upon or over the screening means. These buckets are fastened to an annular casing 32, of sheet steel, which is secured to the shell 19 and to the rim 7, the buckets being placed in close order in a circular series. Each bucket 35, see Fig. 5, comprises a pocket portion 36, outside wall 37, and inside wall 38 extending forwardly from said pocket portion, the inside wall being cut-away as at 39 to form an inlet mouth and the forward end of the bucket being opened as at 40 to form a delivery spout or mouth. When the buckets are arranged in circular order, the side walls 37 are close together, and the wider portion of wall 38 and the walls of pocket 36, together with these outer walls 37 form a continuous series of receptacles for the ore.

Directly within the delivery spouts 40 of the circular series of buckets is provided a conical apron 41 and a screen 42, preferably extending in the same conical surface, tapering from the outside toward the mid length of the crushing ring, said screen being supported by annular members or angle irons 43, 44 and being preferably divided in a plurality of sections as shown in Fig. 4. A guard plate or deflector ring 45 extends from the upper supporting member 43 for the screen and a delivery hopper or chute 46 is supported on the framework of hopper 26 with its open upper end directly beneath the opening between this ring 45 and the lower supporting ring 44 for the screen, for the purpose of collecting the screened material and discharging the same at a given point.

A deflector or scraper 48 is provided adjacent to the inner face of the crushing ring 1, said deflector inclining forwardly and laterally with respect to the axis of rotation of the ring in the manner of a plowshare to scrape the material from the crushing ring laterally outward into the buckets at that side. A water supply pipe 50 provided with a valve 51 is connected to a spout or nozzle member 52 which jets or sprays water onto the scraper or deflector 48 adjacent to the scraping edge thereof and to facilitate the deflection or discharge of crushed material from crushing ring to elevator pockets.

The operation is as follows: The ore is supplied into the side inlet 28 of the hopper 26 and is fed by the feed roll 31 and spout 29 to the inside of the crushing ring 1 directly in front of the inner crushing rings or rolls 2, the crushing ring 1 is set in rotation by the driving means 8, 6, 4 and 7, carrying the ore beneath the crushing rolls 2. The height of the crushing rolls is adjusted by means of the screws 14 in accordance with the fineness of crushing desired, so that if any piece of ore passing between the roll and the ring is larger than the distance between these parts it will be subjected to a crushing strain and the pressure exerted by the springs 20 is adjusted by means of the screws 22, so that in general the crushing strain will be sufficient to crush the ore thus brought under the crushing rolls. In this operation the crushing rolls turn freely with shaft 10 within the bearings of said shaft, so that the action is one of rolling pressure

rather than of grinding pressure. The crushed material passes from beneath the crushing roll in front to the deflector which scrapes it off to one side whence it falls into the lateral inlets or openings of the series of buckets 35. This action is assisted by the water from the nozzle 52, and in some cases this water jet alone will suffice to carry the material into the buckets. In the rotation of the crushing ring these buckets are carried upwardly and forwardly, the buckets being presented at an angle to the radial direction as shown in Figs. 1 and 4, so that on this upwardly moving side or limb of the crushing ring the outlets of the buckets are presented upwardly and there is no tendency for the buckets to discharge their contents. As the buckets approach the uppermost position in the rotation of the ring they are tipped forwardly and eventually are inclined downward so as to discharge their contents through the outlet 40 at the forward ends thereof onto the annular or conical apron 41 where the material passes onto the conical screen 42. This screen is of proper mesh to permit passage of the material of the required standard of fineness and such material will pass therethrough and into the discharge chute 46 from which it is delivered to any suitable delivery means. The material which is too coarse to pass through the screen 42 falls off of the screen and is deflected by the screen into the upper inlet of the hopper 26 where it becomes mixed with the crushed material supplied to the hopper and passes again through the cycle of operations above described.

If it be desired to produce slimes or very finely comminuted material it can be done upon this machine by using the crushing ring shaped so as to slope from the center-flange toward the elevator pockets, as shown in Fig. 5, and having the roll-shells built to conform to same, as shown therein. Then, by running the crushing-ring and the rolls in, practically, direct contact, and by reason of the slight difference in speed of rotation of the surfaces, there will be a large percentage of slimes in the resultant product.

In crushing materials dry the operation is practically the same except for the elimination of the use of water.

Another feature of this device is that we can almost entirely eliminate the production of slimes by raising the roller slightly above the point of contact with the crushing-ring by means of the capstan-screws on each side of the machine, thus preventing any scouring effect in the rotation of the rolls.

A water supply pipe 54 may be provided for washing out the buckets at the point of discharge, and in case a supply of water is required during the granulating operation, it may be furnished by a pipe 55 discharging into the feed hopper 28.

What I claim is:—

1. An ore mill comprising a rotatable crushing ring, a crushing roll operating against the inner periphery of the crushing ring, an annular screen in the form of a frustrated cone carried by the said ring at one side of the ring with the smaller diameter of the screen nearest the ring and communicating with the space within the ring, whereby material which is discharged upon the top of the screen and does not pass therethrough, rolls down the screen toward the ring and drops into the interior of the ring, a series of buckets carried by the said ring on the side thereof and arranged annularly outside of the said screen, said buckets being tangentially disposed and their spouts deflected at an angle laterally outward from the ring to guide material discharged from a bucket to a point near the outer diameter of the screen, whereby the said material so discharged is caused to travel the width of the screen before being discharged from the screen into the ring.

2. An ore mill comprising a rotatably mounted crushing ring, a crushing roll mounted within the crushing ring, the outer face of the crushing roll and the inner face of the crushing ring as coöperating crushing surfaces, means for supplying ore between the said roll and ring, an annular rotating conical screen, said ring being provided with elevating means at the edge of the crushing face of the crushing ring and in uninterrupted communication therewith for receiving the ore immediately after it has passed between the roll and ring, said elevating means moving with the ring to lift the ore in the rotation of the ring and to discharge it at the upper part of the ring, on the top of the screen, a delivery means extending beneath said screen, and means for receiving the ore passing over the screen and delivering the same to the feed means for the crushing ring and roll.

3. An ore mill comprising a crushing ring mounted to rotate on a horizontal axis, means for rotation of said crushing ring, a roll mounted to rotate on the horizontal axis, means for pressing said roll downwardly toward said ring, means for limiting the downward movement of the roll, feed means for supplying ore between the ring and roll, elevator means connected to the ring and moving therewith for receiving the ore after it has passed between the roll and ring and lifting the same to the upper part of the ring, and a conical screen with horizontal axis mounted to rotate and receive the discharge from said elevator means on the outer face of said conical screen, means for delivering the screened material, means for receiving the material passing over the screen and delivering the same to the aforesaid feed means.

4. An ore mill comprising a crushing ring mounted to rotate on a horizontal axis, means for rotation of said crushing ring, a roll mounted to rotate on the horizontal axis, means for pressing said roll downwardly toward said ring, means for limiting the downward movement of the roll, feed means for supplying ore between the ring and roll, elevator means connected to the ring and moving therewith for receiving the ore after it has passed between the roll and ring and lifting the same to the upper part of the ring, a screen mounted to rotate and receive the discharge from said elevator means on the top of said screen, means for delivering the screened material, means for receiving the material passing over the screen and delivering the same to the aforesaid feed means, said screen being formed as an annular conical member connected to the crushing ring, and a conical apron continuous with the screen to receive the discharge from the elevator means and convey it to the screen.

5. An ore mill comprising a crushing ring mounted to rotate on a horizonal axis, means for rotation of said crushing ring, a roll mounted to rotate on the horizontal axis, means for pressing said roll downwardly toward said ring, means for limiting the downward movement of the roll, feed means for supplying ore between the ring and roll, an annular screen mounted to rotate with said ring, elevator means connected to the ring and moving therewith for receiving the ore after it has passed between the roll and ring and lifting the same to the upper part of the ring, and discharge the crushed ore upon the upper part of the rotating screen, means for delivering the screened material, means for receiving the material passing over the screen and delivering the same to the aforesaid feed means, said elevator means consisting of buckets connected to the side of the ring, said buckets having lateral inlets opening toward the ring and outlets at their inner ends and being inclined in a radial direction to automatically discharge their contents at the upper part of the ring.

In testimony whereof, I have hereunto set my hand at Los Angeles California, this 13th day of September 1909.

JONATHAN P. SMYTHE.

In presence of—
ARTHUR P. KNIGHT,
FRANK L. A. GRAHAM.