No. 637,327. Patented Nov. 21, 1899.

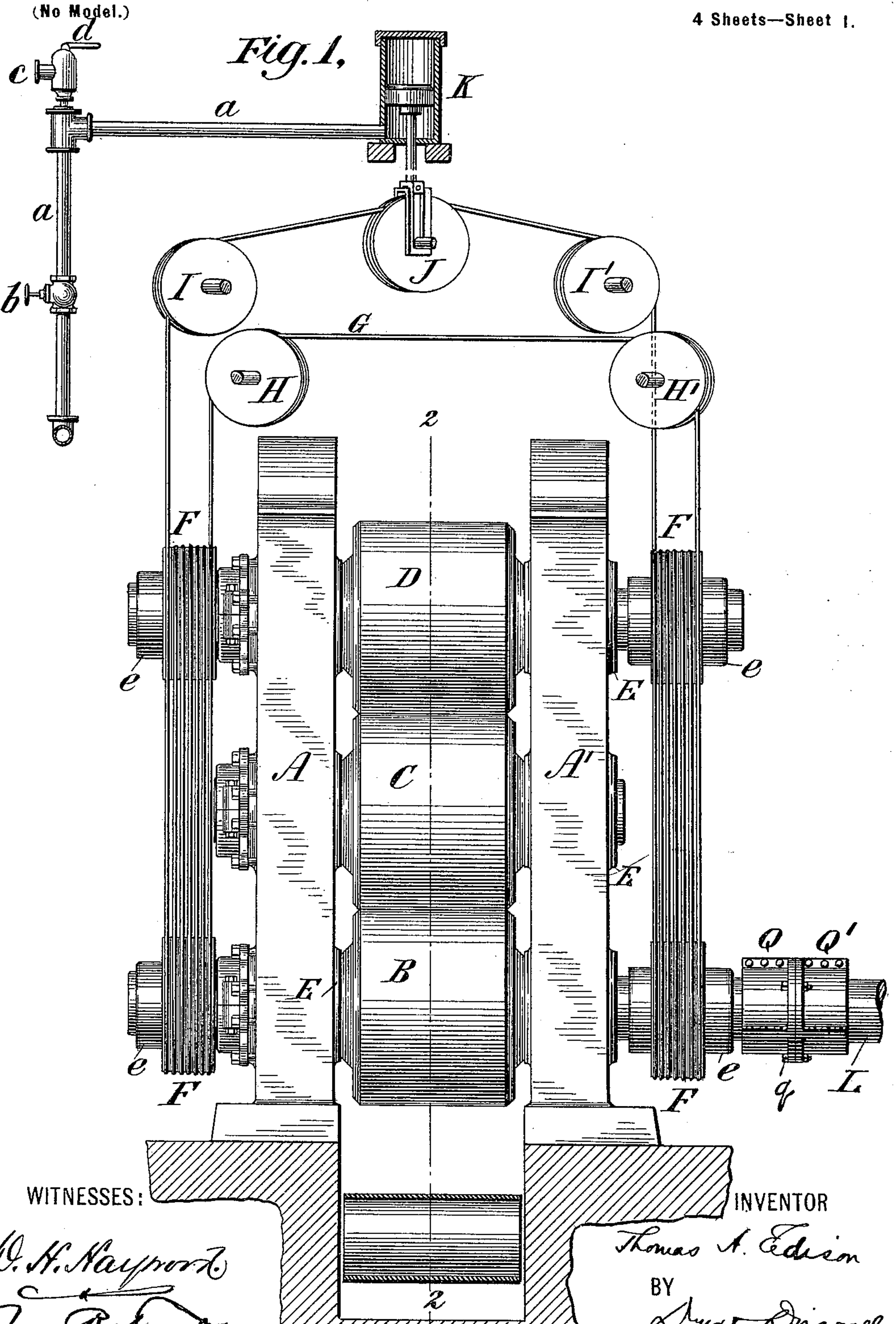
T. A. EDISON.

ROLLS.

(Application filed July 16, 1897.)

(No Model.) 4 Sheets—Sheet 1.

Fig. 1,



WITNESSES:

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Fig. 2,

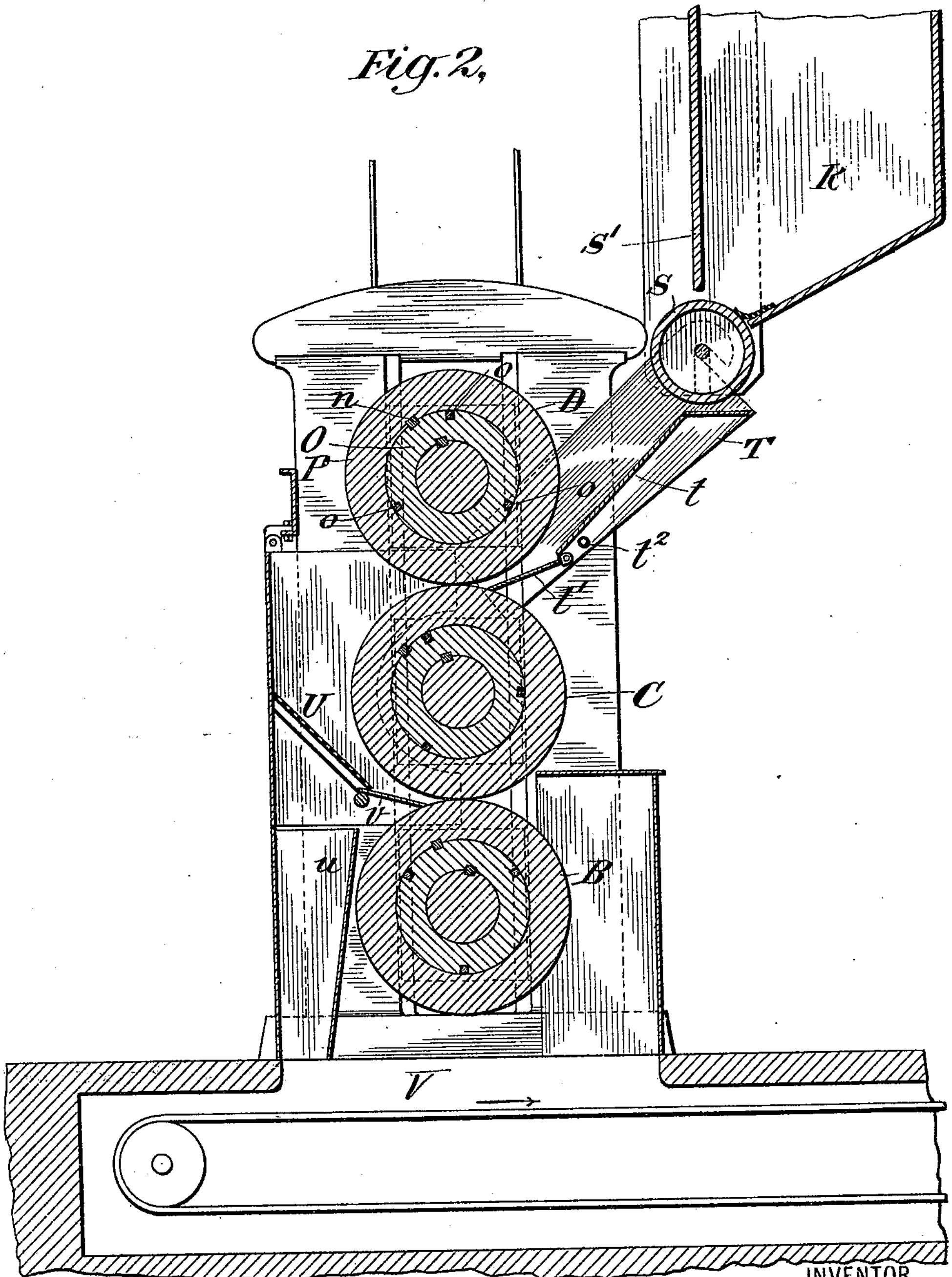

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Fig. 3,

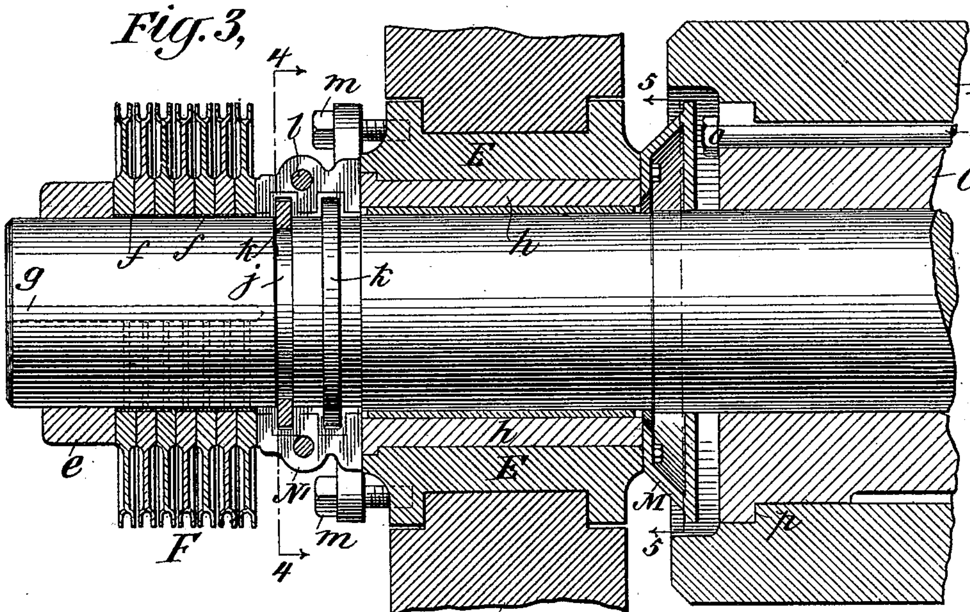

Fig. 4,

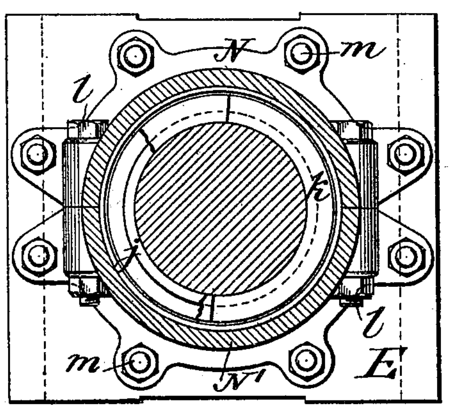

Fig. 5,

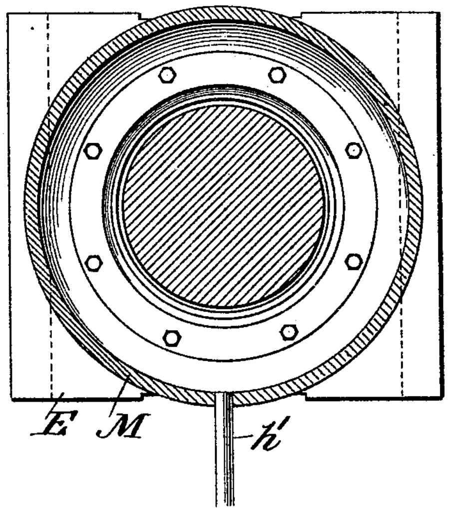

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Fig. 6,

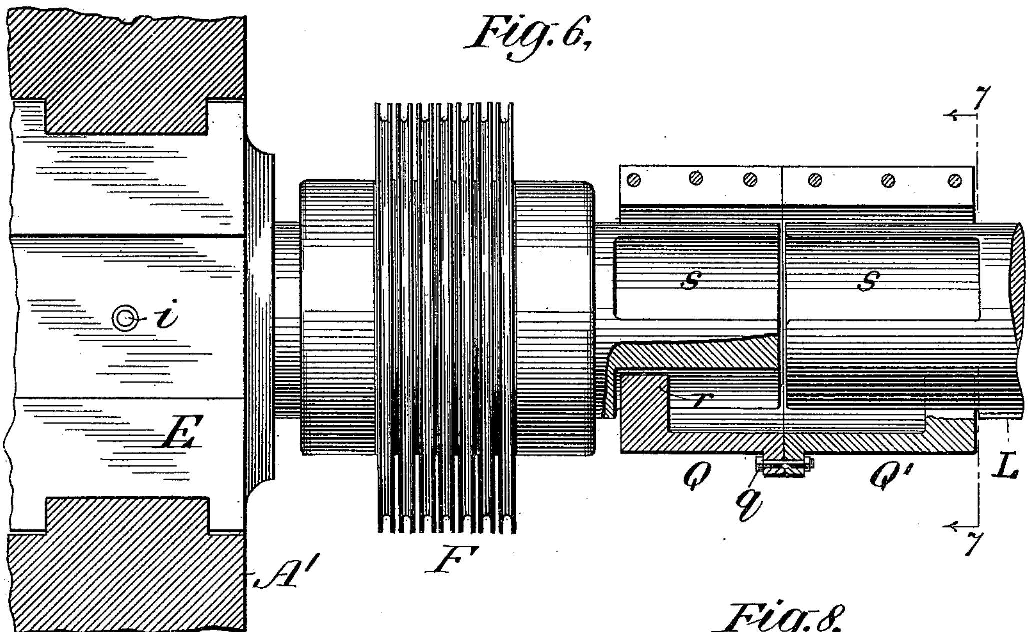
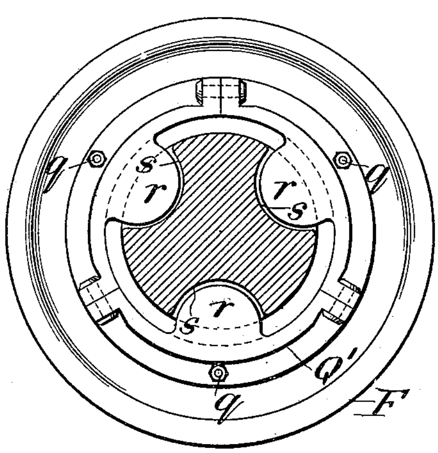
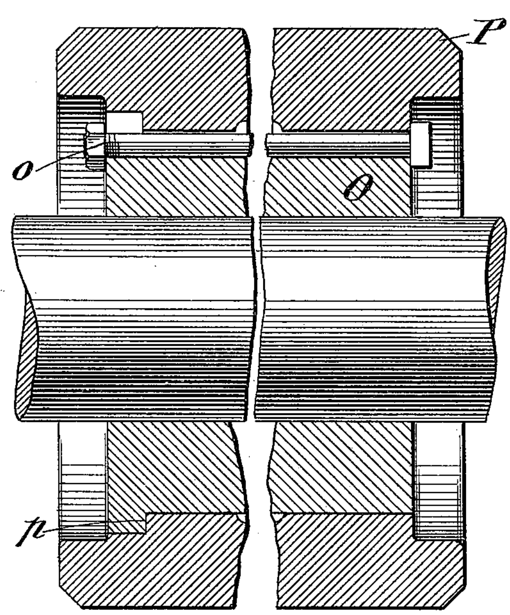


Fig. 8,

Fig. 7,





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UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF LLEWELLYN PARK, NEW JERSEY.

ROLLS.

SPECIFICATION forming part of Letters Patent No. 637,327, dated November 21, 1899.

Application filed July 16, 1897. Serial No. 644,746. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, a citizen of the United States, residing at Llewellyn Park, in the county of Essex and State of New Jersey, have invented a certain new and useful Improvement in Rolls, (Case No. 976,) of which the following is a specification.

This invention relates to that class of machinery called "rolls" and used for crushing ore, calendering paper, rolling iron, crushing sugar-cane, and for other similar purposes.

The principal object of the invention is to diminish the amount of power required to drive the rolls and increase the percentage of power utilized; further, to obtain more powerful pressures between the rolls than have heretofore been obtainable in practice, and, finally, to effect various improvements in matters of detail.

In the accompanying drawings, which illustrate my invention applied to a set of rolls especially arranged for crushing ore, Figure 1 is a front elevation of the rolls with the casing, hopper, &c., removed and showing above the rolls the rope-wheels, the supports for which are omitted for clearness of illustration. Fig. 2 is a central vertical section on the line 2 2 in Fig. 1, the casing and hopper being shown. Fig. 3 is a horizontal section through a portion of either the top or the bottom roll and outwardly through the housing to the end of the shaft, the shaft being shown in full lines. Fig. 4 is a sectional view on the line 4 4 in Fig. 3 and looking in the direction of the arrows which terminate that line. Fig. 5 is a section on the line 5 5 in Fig. 3 looking in the direction of the arrows which terminate that line. Fig. 6 is a horizontal section above the block at the driven end of the lowermost roll, showing, partially in section, the wabbling coupling connecting the roll-shaft with the driving-shaft. Fig. 7 is a sectional view on line 7 7 in Fig. 6 looking in the direction indicated by the arrows which terminate that line; and Fig. 8 is a section through one of the rolls, which is broken away at the center to diminish the length.

A A′ represent the housings, which may be of ordinary construction.

B, C, and D are three rolls placed one above the other and having their shafts passing through bearing-blocks E, sliding in the housings. The bottom and top rolls B D have their shafts extended beyond the bearing-blocks and outside of the housings, and upon each end of these shafts are mounted a number of grooved wheels or sheaves F, which are mounted so as to be capable of independent rotation upon the shafts. A wire rope G passes around the four sets of sheaves, the two bights of the rope being carried by four wheels H H′ I I′. Considering the rope as commencing at a point midway between the wheels H H′, its course is as follows, (see Fig. 1:) It passes over the wheel H and then downwardly to the innermost sheave on the left-hand end of the shaft of the bottom roll B and around that sheave and upwardly to the innermost sheave on the left-hand end of the shaft of the top roll D, then around that sheave and down again to the second sheave below, and so on until the outermost sheave of the lower shaft is reached, when the rope after passing around that sheave extends upwardly and over the wheel I, from which it passes to the wheel I′ and then downwardly around the sheaves on the right-hand ends of the shafts of the bottom and top rolls, when it returns over the wheel H′ to the point of starting. In this way the sheaves at each end are coupled together like the sheaves in a compound block and tackle, while the sheaves at both ends are connected together through the same wire rope. The bight of the wire rope between the wheels I and I′ passes over another wheel J, which is carried by a piston-rod from a piston located in a long cylinder K. From the lower end of this cylinder a pipe *a* extends to a source of elastic fluid under pressure, such as air or steam, this pipe being provided with a throttle-valve *b*, a gage *c*, and a safety-valve *d*. The description so far given is sufficient to enable the more comprehensive features of the invention to be understood.

The pressure between the coacting surfaces of rolls being a fixed condition or static effect should not require, theoretically, any expenditure of power to maintain it; but as rolls are now made it is usual to transmit the pressure from the pressure-producing devices through moving frictional surfaces at the bearings, and hence when great pressures are required, as in crushing ore or rolling iron, the work performed on the material is but a small fraction of the total work performed, the loss in rubbing friction at the bearings under the great pressures necessary being the principal loss. The three rolls B, C, and D being in contact with each other, the total weight of these rolls is carried by the bearings of the bottom roll B in the lowermost block E. The pressure between rolls B and C is that produced by the weight of the rolls C and D, and the pressure between the rolls C and D is that produced by the weight of the roll D. These pressures are entirely insufficient to do the work, as dead-weight in the rolls is not desirable, and they are made as light as possible, so as not to obtain pressure in this manner, as the whole of this pressure must be taken on the bearings of the lower roll, and any increase of this pressure results in an increase of the loss by friction.

The cylinder K is preferably a long cylinder, and by introducing the elastic-fluid pressure beneath the piston the piston is forced upwardly and tightens the ropes around the sheaves, producing a pressure which may be increased up to the breaking-point of the wire rope. This pressure is multiplied at the rolls on the principle of the compound block and tackle. If, for instance, there are ten turns of the rope over the sheaves at each end of the machine and if there is a pressure of six thousand pounds upon the piston, there will be a stress of three thousand pounds on the rope on each side of the wheel J and throughout the length of the rope. Since in the illustration assumed there are forty ropes at the sheaves, this stress will tend to press the three rolls together with a pressure of forty times three thousand pounds, or one hundred and twenty thousand pounds. A smaller or greater number of the loose sheaves will give a smaller or greater pressure at the rolls for the same cylinder-pressure. Since the pressure at the cylinder can be varied at will by the valve and can be regulated in accordance with the indications of the pressure-gage, the powerful pressures produced in this way can be changed and regulated to any extent instantly and while the rolls are in motion. It will be observed that this device for producing pressure on the coacting surfaces of the rolls does not consume any considerable amount of power, as the pressure does not pass through any of the rubbing surfaces in the bearing-blocks, as it does in rolls in general use. This will be clearly seen if we imagine the rolls supported in mid-air by the ropes themselves. The pressure between the rolls might be hundreds of tons and yet none would or could pass through bearing-boxes on the shafts. The ore, iron bar, or sugar-cane passing continuously between the rolls does not change the pressure.

The object of having the sheaves all separate from each other and capable of independent rotation is to permit the gang of ropes holding the rolls together to shorten or lengthen as more or less ore is fed between the rolls. The sheaves rotating upon the lubricated shaft at a smaller surface velocity produce less strain upon the ropes than would be the case if the sheaves were all fixed to the shafts and the ropes were made to slip in the grooves of the sheaves at a greater surface velocity. Again, the rolls by wear or purposely may have variations in diameter. If the diameter of the rolls B and D is the same and the feed of the material between the rolls is of constant thickness, the sheaves have no motion of rotation upon the shafts, but travel with them. If, however, the roll D, for instance, should be smaller by ten per cent. than the roll B, the sheaves will rotate upon the shaft of D one revolution for every ten of the shaft. The lowermost roll B is driven by a shaft L through a coupling, which will be presently described. The other two rolls are driven entirely by friction between the coacting surfaces and not through the pressure-rolls, as the sheaves carrying these are loose on the shafts and mearly serve to produce pressure. An elastic fluid under pressure, such as air or steam, is used to give the pressure instead of weights, for the reason that variations in the thickness of the material passing through the rolls occur in very small fractions of a second and the inertia of weights would be so great that no rope could be made to stand the excessive strains. With an elastic-fluid pressure, however, and a light piston-rod and movable sheave (the weight of these parts being reduced to a minimum) these rapid changes are taken care of without danger of breaking the rope. Again, in rolling iron it is desirable to change the pressures as the ingots lose their heat, and the elastic-fluid cylinder, with valve and gage, gives the means of instantly and accurately doing this. I prefer to use compressed air instead of steam on account of the condensation of the steam; but excellent results can be obtained with steam.

It will be observed that I employ a single endless rope and one pressure-cylinder for producing the pressure at both ends of the rolls. I prefer this arrangement to one in which a separate rope and pressure-cylinder are employed for each end of the rolls, (as might be done within the scope of my invention,) because with the single point of pressure common to both ends of the rolls the pressure is always the same at both ends of the rolls, and in case the single rope breaks no damage will occur, because the rolls will be freed at both ends simultaneously.

In using this invention for rolling iron the upward movement of the bearing-blocks of the top roll D must be limited by suitable stops, so as to permit the work to be sized accurately, as is done in all iron-mill rolls; but the pressure upon the ropes should be so gaged that the pressure upon the limiting-stops will not be more than a small fraction of the total pressure, since all pressure exerted on the bearings, as in regular rolls, wastes power. Another advantage which this invention gives is that the journals of the rolls may be of any diameter without appreciable loss of power. Indeed, these journals may have the same diameter as the rolls themselves, thus preventing the great breakage which occurs at the neck of rolls as now generally used. In ordinary rolls the journals are necessarily smaller in diameter than the rolls to save excessive loss by friction. I have shown three rolls, but five, seven, or any odd number may be used, the top and bottom rolls being connected by the wire rope, or, indeed, an even number of rolls might be employed, in which case it would be necessary to cross the ropes between the sheaves in order to permit the rotation of the rolls in opposite directions without the turning of the sheaves on the rolls except to allow for variation in the separation of the rolls and to compensate for differences in diameter.

The sheaves F are held on the rolls by collars *e*, these sheaves being preferably bushed with phosphor-bronze rings *f*, Fig. 3. To lubricate the bearing of the sheaves, a hole *g* is bored centrally into the shaft from its outer end, and from this central hole radial holes pass outwardly to the surface of the shaft, as shown in dotted lines in Fig. 3. By attaching a grease-cup to the end of the shaft over the hole *g* the bearing of the sheaves on the shaft will be lubricated. The bearing-blocks E where the shafts pass through them are provided with suitable removable bearings *h*, which are babbitted, as shown. These bearings are lubricated in the usual manner by oil-cups mounted on top of the bearing-blocks, the oil-hole being shown at *i* in Fig. 6. To the inner end of each bearing-block and surrounding the shaft is a dust-cap or oil-casing M. This dust-cap is an annular chamber through which the shaft passes and which is secured at its inner wall to the bearing-block and at its outer wall makes a close fit with the shaft, as shown in Fig. 3. A drip-pipe *h'*, Fig. 5, extends from the lower side of the dust-cap. This dust-cap prevents the dust from entering the bearing of the shaft in the bearing-block, a matter of considerable importance when the rolls are used for crushing ore. The oil is allowed to work freely out of the bearing into the dust-cap, from which it is withdrawn by the drip-pipe. At one end of each of the roll-shafts is provided a centralizing-bearing similar in principle to the thrust-bearings used on the propeller-shafts of steamships, but especially constructed to adapt it for use on rolls, and when so used to act as the centralizing-bearing, which resists the thrust in both directions and prevents the rolls from rubbing against the housings or bearing-blocks. The shaft of each roll at the point where the thrust-bearing is applied has two grooves *j*. In these grooves are placed steel rings *k*, forming ribs on the shaft, each ring being divided into two parts, so that it can be placed upon the shaft. These rings are surrounded by a split collar N N', which is secured together by bolts *l* and has a flange which is bolted by bolts *m* to the bearing-block E. The collar N N' is provided with grooves embracing the rings or ribs *k*, which grooves are suitably babbitted. The divided collar incloses the bearing and enables it to be lubricated.

Another novel feature is employed by me in the construction of the rolls themselves, and is shown particularly in Figs. 2, 3, and 8 of the drawings. Upon the shaft is mounted and permanently keyed a cast-iron cylinder O, and over this is placed the crushing-shell P, which forms the wearing-surface of the roll. This shell is prevented from rotating on the cast-iron cylinder by a removable key *n*, and the shell is held against longitudinal displacement on the cylinder by bolts *o*, which extend through channels in the surface of the cylinder and engage by their heads and nuts the adjacent edges of the cylinder and shell. The cylinder is also preferably provided with a shoulder *p* at one end, and the shell has a corresponding shoulder, the shell being slipped onto the cylinder from one end and the shoulders being held solidly together by the bolts *o*. This construction enables the crushing-shell to be readily removed from the roll for turning it true or replacing it.

For connecting the driving-shaft L with the shaft of the lower roll, so as to make unnecessary the establishing and maintaining of an exact alinement, I employ a wabbling coupling. This coupling consists of two cylinders Q Q, which are secured together by brass bolts *q*, passing through flanges on the adjacent ends of the two cylinders. These brass bolts are made of such a size that when the rolls become clogged by some obstacle the brass bolts will be sheared off and the two parts of the coupling separated before damage is done to the machine. Each cylindrical section of the wabbling coupling is made in three parts, (see Fig. 7,) and at the outer end of each of these three parts there is provided an internally-projecting rounded lug *r*. The adjoining ends of the shafts are provided with corresponding rounded grooves *s*, in which the lugs *r* play. The parts fit loosely together, and the motion is transmitted through the coupling without binding, even if the alinement of the shafts is not exact. By having the wabbling coupling made in six parts it can be readily taken apart and removed from the adjoining ends of the shafts without disturbing the position of the shafts.

Another feature of the invention relates to the feeding of the material and is especially applicable to the crushing of ore. R, Fig. 2, is the ore-hopper, from which the ore is fed in a stream of even thickness by means of a roller S, the thickness of the stream being adjusted by moving the board S', which controls the opening over the top of the roller, and in this way the material may be fed to the rolls only as fast as the rolls can take care of it. The stream of material falls from the roller S onto an inclined board t and from there to a pivoted plate t', resting on the upper surface of the middle roll C. The board t and plate t' are carried by side pieces T, which are hung on the shaft of the roller S and are held in position by bolts t^2, by the removal of which the side pieces T may be swung away from the rolls to enable the rolls to be cleared. The material passes from the plate t' between the top roll D and the middle roll C and then falls upon an inclined screen U, through which the fine material escapes. A chute u delivers this fine material to a conveyer-belt V, which carries away the crushed material from the rolls. From the screen U the material which does not pass through the screen slides onto a plate v, which rests on the bottom roll B, and which plate delivers the material to the opening between the bottom roll and the middle rool. After passing through this opening the material falls upon the belt V and is carried away.

By running the stream of material continuously between the two sets of rolls I secure double the amount of crushing with the same pressure.

The screening of the material after it passes between the top and middle rolls and before it passes between the middle and bottom rolls is a matter of considerable importance in the crushing of ore, because it enables me to remove from the stream the fine material, which if allowed to pass between the middle and bottom rolls would fill the spaces between the larger pieces and would prevent the effective crushing of the larger pieces. By clearing the steam of the material already sufficiently crushed open spaces are left between the larger pieces in passing the second time through the rolls, giving room to accommodate the material by lateral displacement as it is crushed.

What I claim is—

1. The combination with a set of rolls, of supporting means affording moving relatively frictionless bearings therefor, independent of rotation of the rolls, and independent means for driving the rolls, substantially as set forth.

2. The combination with a set of rolls, of a power connection for driving one of said rolls, the other roll or rolls being driven from the first by friction at their coacting surfaces, and supporting means affording moving relatively frictionless bearings for the rolls independent of rotation thereof, substantially as set forth.

3. The combination with a set of rolls, of sheaves mounted loosely on the axes of the rolls, an encircling rope or band connecting the sheaves, and means for tightening the rope or band, substantially as and for the purpose set forth.

4. The combination with a set of rolls, of a number of independent sheaves mounted loosely on each end of the axes of two rolls, ropes encircling the sheaves and means for tightening the ropes, substantially as and for the purpose set forth.

5. The combination with a set of crushing-rolls, of a compound block and tackle connecting both ends of the rolls together, a single endless rope passing over the sheaves of both tackles, and a piston moved by an elastic fluid under pressure acting to tighten the rope, substantially as set forth.

6. The combination with a set of rolls, of a compound block and tackle connecting both ends of the rolls, a single endless rope passing over the sheaves of both tackles, wheels for guiding the rope from one tackle to the other, a movable wheel acting on the bight of the rope, and a piston moved by an elastic-fluid pressure carrying the movable wheel, substantially as set forth.

7. The combination with a set of rolls composed of an odd number of rolls, of a number of independent sheaves mounted loosely on each end of the shafts of the top and bottom rolls, a rope directly encircling the two sets of sheaves at each end, and means for tightening the ropes, substantially as set forth.

8. The combination with a roll, the housings and bearing-blocks, of a centralizing-bearing for the roll-shaft consisting of one or more removable rings laid in a groove or grooves in the shaft, each ring being divided whereby it may be removed and an encircling and inclosing divided collar attached to a bearing-block, substantially as set forth.

9. In a set of rolls, the combination with a roll-shaft and a bearing-block, of grooves in the shaft, divided rings in said grooves, and an inclosing and encircling divided collar secured to the bearing-block, substantially as set forth.

This specification signed and witnessed this 14th day of May, 1897.

THOMAS A. EDISON.

Witnesses:

JNO. R. TAYLOR,
EUGENE COURAN.