(No Model.)

5 Sheets—Sheet 1.

G. LOWRY.

CRUSHER FOR STONE, ORE, &c.

No. 576,519. Patented Feb. 2, 1897.

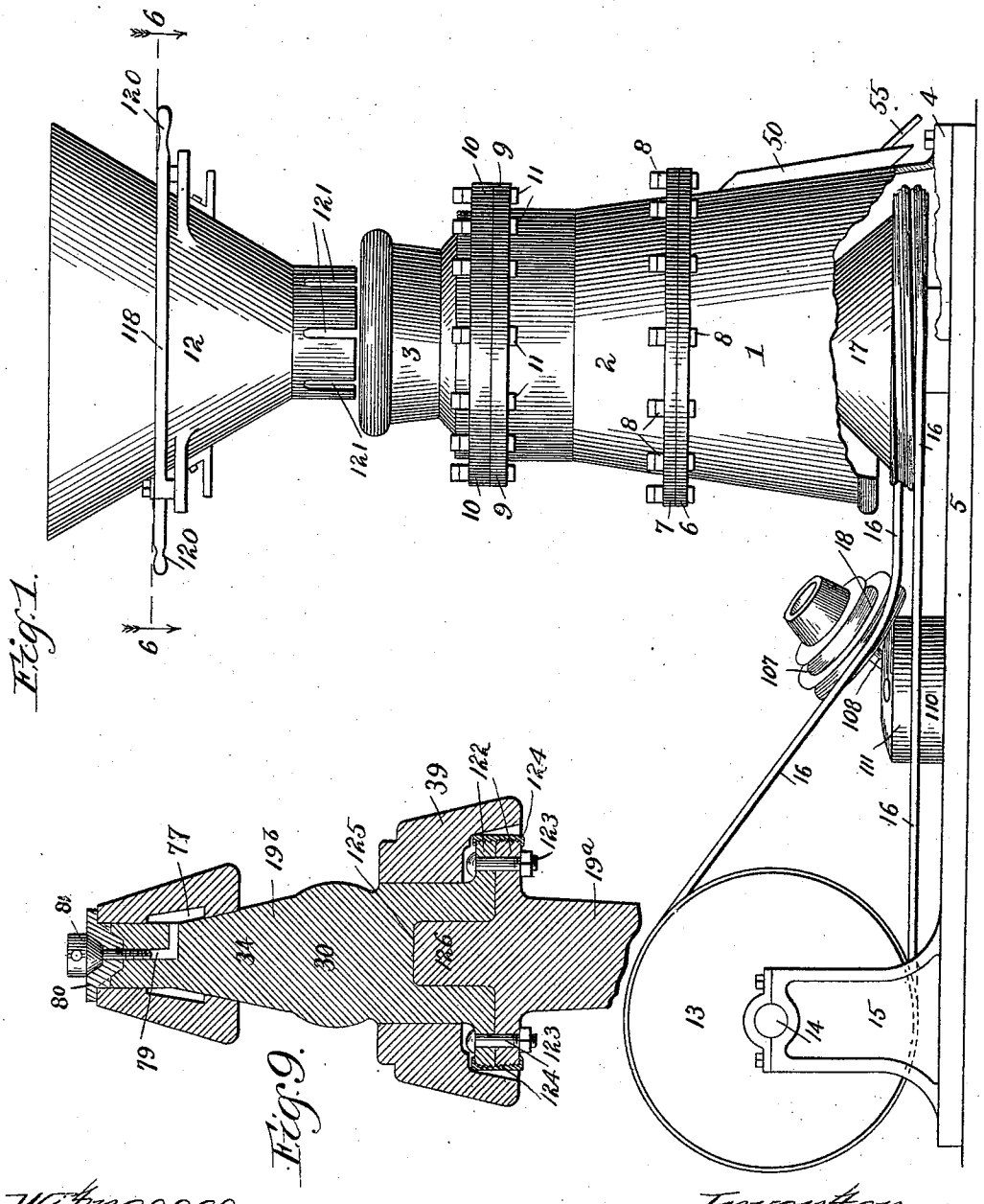


Fig. 1.

Fig. 2.

Witnesses:
Wm. M. Rheem.
Jno. L. Condon.

Inventor:
George Lowry
By Raymond & Quackenbush Attys.

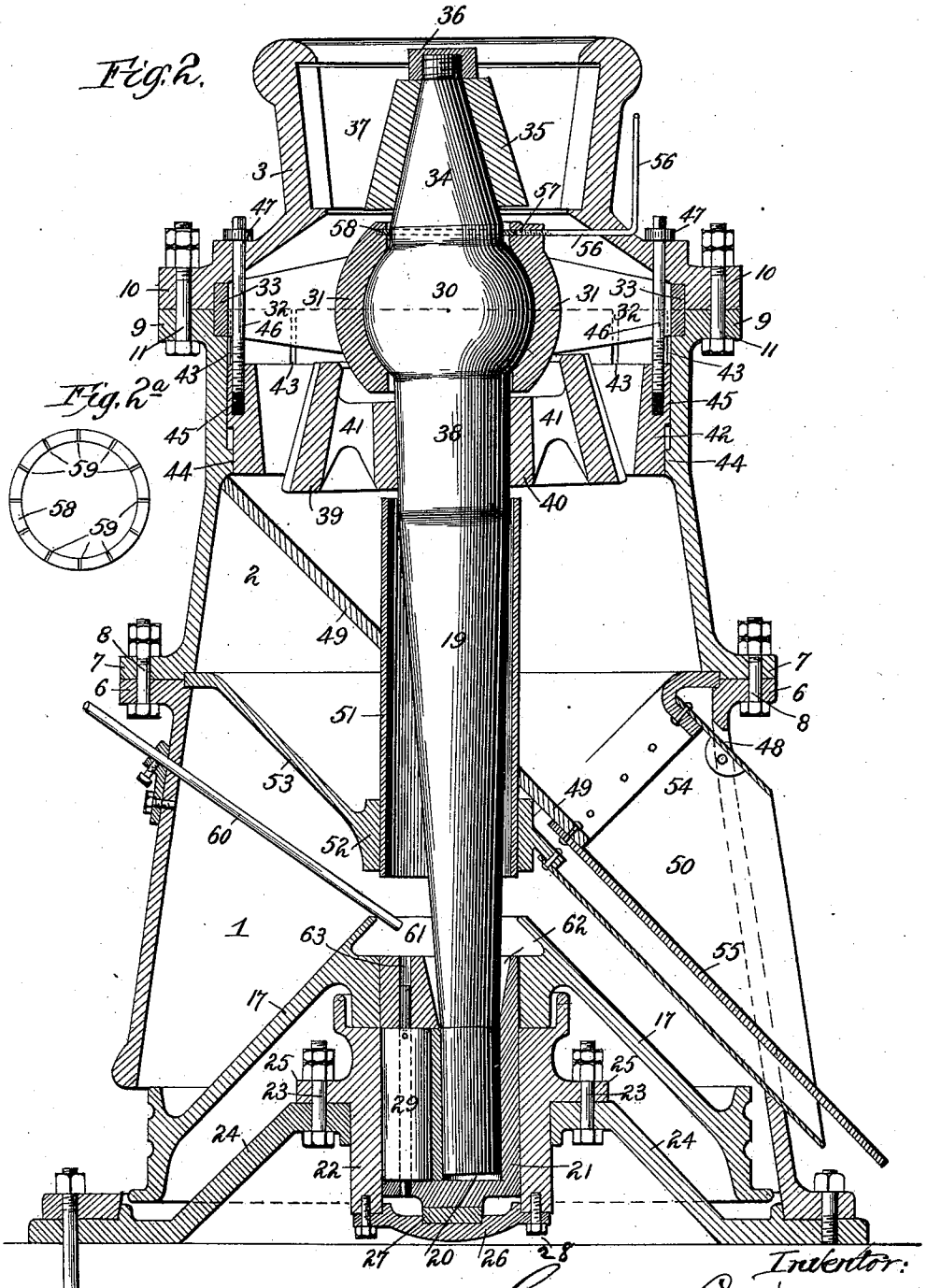
(No Model.) 5 Sheets—Sheet 2.

G. LOWRY.

CRUSHER FOR STONE, ORE, &c.

No. 576,519. Patented Feb. 2, 1897.

Fig. 2.



Witnesses:
Wm. M. Sheem.
Jno. L. Condron.

Inventor:
George Lowry
By Raymond & Quackenbush
Atty's.

(No Model.) 5 Sheets—Sheet 3.

G. LOWRY.

CRUSHER FOR STONE, ORE, &c.

No. 576,519. Patented Feb. 2, 1897.

Fig. 3.

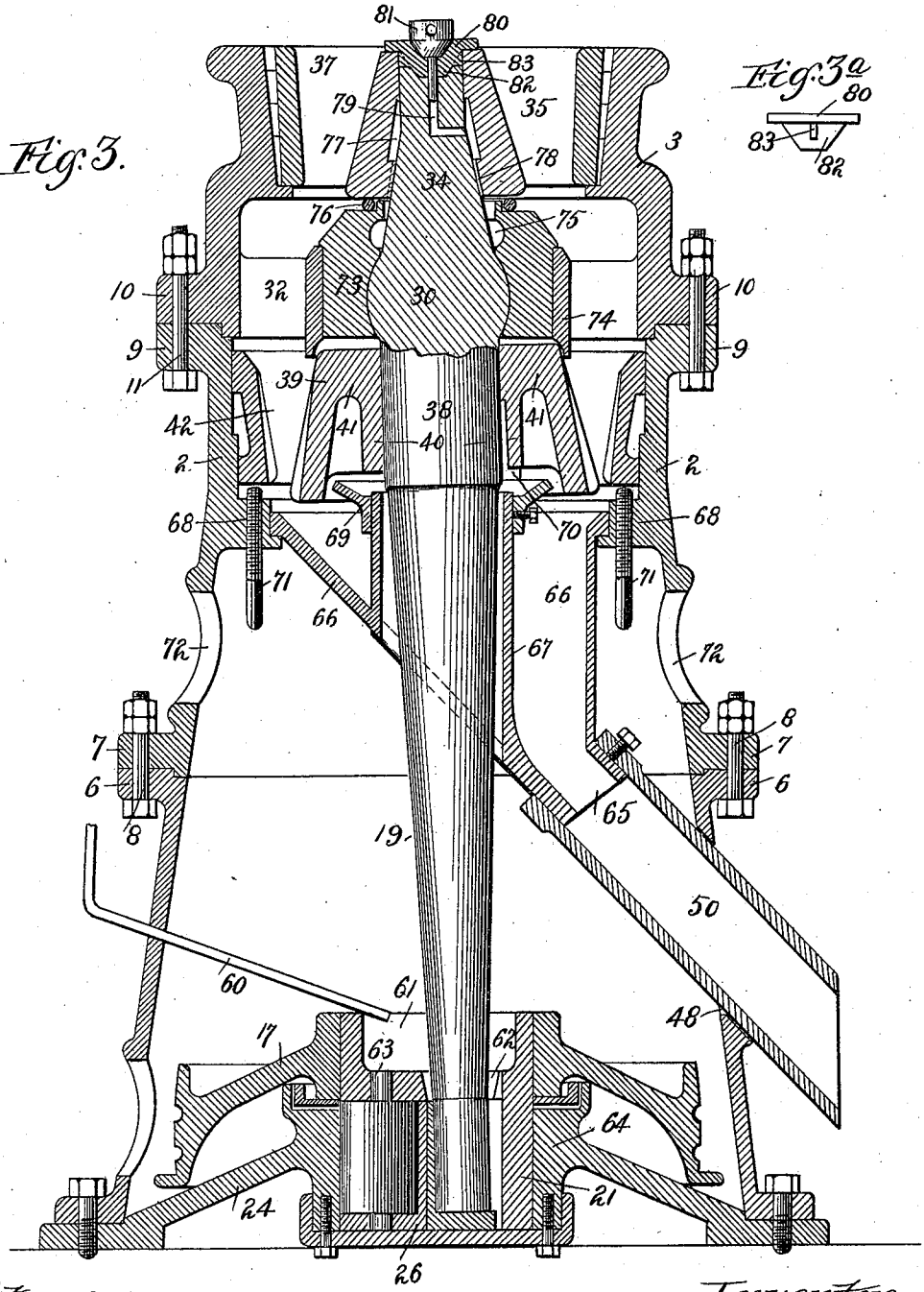


Fig. 3a

Witnesses.
Wm. M. Sheem.
Jno. L. Condron.

Inventor.
George Lowry
by Raymond & Quackenbush
Att'ys.

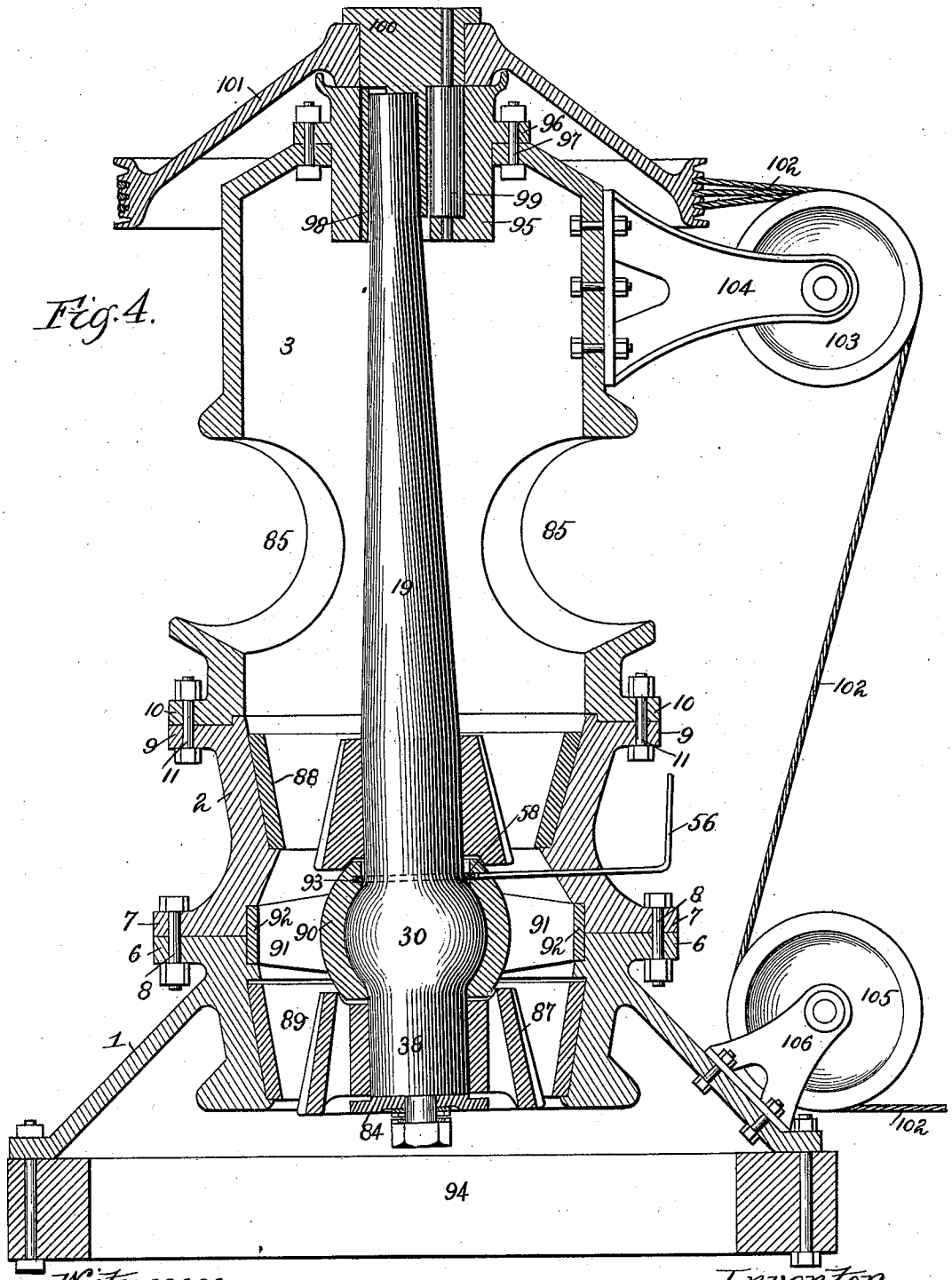
(No Model.) 5 Sheets—Sheet 4.

G. LOWRY.

CRUSHER FOR STONE, ORE, &c.

No. 576,519. Patented Feb. 2, 1897.

Fig. 4.



Witnesses.
Wm. M. Sheem.
Jno. L. Condron

Inventor.
George Lowry
By Raymond & Quackenbush Atty's

(No Model.) 5 Sheets—Sheet 5.

G. LOWRY.

CRUSHER FOR STONE, ORE, &c.

No. 576,519. Patented Feb. 2, 1897.

Fig. 7.

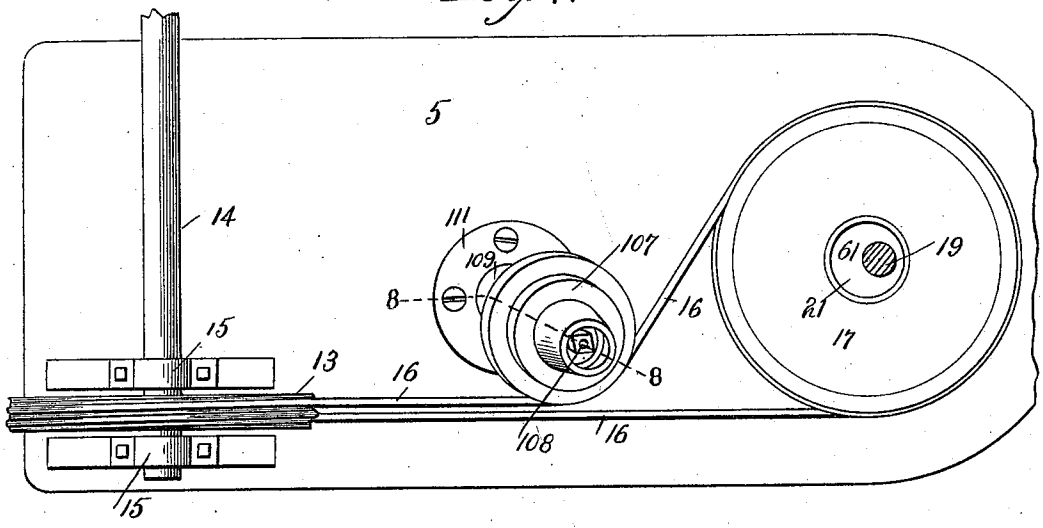


Fig. 5.

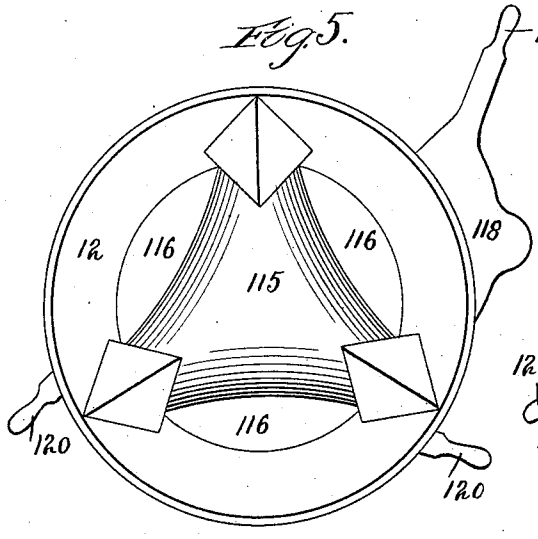


Fig. 6.

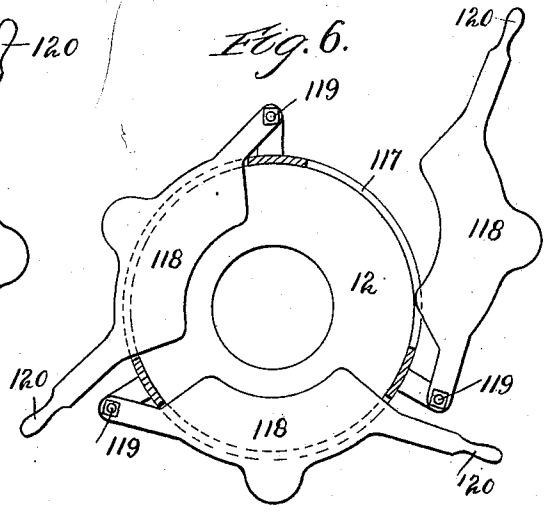
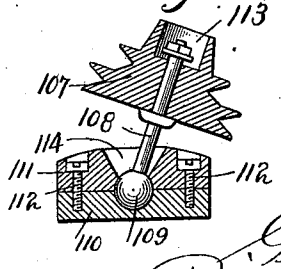


Fig. 8.



Witnesses:
Wm. M. Rheem.
Jno. L. Condon.

Inventor:
George Lowry
By, Raymond Ives Quackenbush Attys.

UNITED STATES PATENT OFFICE.

GEORGE LOWRY, OF TIFFIN, OHIO.

CRUSHER FOR STONE, ORE, &c.

SPECIFICATION forming part of Letters Patent No. 576,519, dated February 2, 1897.

Application filed October 14, 1893. Serial No. 488,163. (No model.)

To all whom it may concern:

Be it known that I, GEORGE LOWRY, a subject of the Queen of Great Britain, and a resident of Tiffin, in the county of Seneca and State of Ohio, have invented certain new and useful Improvements in Crushers for Stone, Ore, &c., of which the following is a full, clear, and exact description, reference being had to the accompanying drawings, forming a part of this specification.

My invention relates to machines for breaking or crushing stone, ore, coal, and various hard and bulky substances into particles of smaller sizes, and more particularly to that type of crushers or breakers in which the crushing operation is performed principally by a gyratory crushing-head as distinguished from such crushers as utilize rocking jaws, rollers, and other or analogous devices for effecting the crushing or breaking operation.

Among the primary objects of my invention is included that of producing a crusher in which the stone, ore, coal, or other material shall be subjected to a succession of crushing or breaking operations whereby the capacity of any given machine is greatly increased and the quality of crushed material produced is greatly improved in respect to uniformity of grade, and whereby also the maximum power of the machine is fully and effectively utilized; furthermore, to have the gyratory crushing-head actuated by a minimum expenditure of power and with a minimum development of friction by the actuating devices; also to produce a machine in which the belt transmission of power from a prime motor to the crusher shall involve the use of but few parts and at the same time properly direct and deflect the course of the transmitting-belt in such manner as to avoid all possibility of running off or unshipping the belt, and which shall also utilize a maximum proportion of the power delivered to the belt.

A still further primary object of my invention is to greatly facilitate and bring under the complete voluntary control of an attendant the feeding of the material to the machine, so that such material shall be uniformly and effectively distributed to the crushing-head without possibility of choking the head or unduly crowding the feed, and at the same time so as to develop the maximum capacity of the machine.

Another primary object of my invention is to provide improved means for insuring a perfectly free discharge of crushed material from the machine and a perfect exclusion of all dust, dirt, or other objectionable substances from contact with the driving-gear and such other operative parts of the machine as would be injured or impeded by such substances.

Another primary object of my invention is to insure a thorough and easy lubrication of all of the frictional surfaces of the machine and to prevent all possibility of the entrance of dust or dirt into the lubricating-channels; furthermore, to facilitate the adjustment of the crushing-ring, so as to insure a perfect regulation of the size of the crushed material and so as to enable the sizes of the crushed material to be readily varied, as described.

A still further primary object of my invention is to enable all of the principal driving appliances to be placed wholly external to the machine, so as to further insure such appliances against injury or impediment by dust or dirt, and, furthermore, to dispense in certain instances with the usual interior diaphragm or hopper.

To the above purposes my invention consists in certain peculiar and novel features of construction and arrangement, as hereinafter described and claimed.

The more precise nature of my invention will be better understood when described with reference to the accompanying drawings, in which—

Figure 1 is a side elevation of a crusher and a belt-gearing therefor embodying my invention, the lower part of the crusher-casing being partly broken away. Fig. 2 is an enlarged central transverse vertical section of one form of crusher embodying my invention. Fig. 2ª is a detached plan view of the lubricator-distributing ring shown in Fig. 2. Fig. 3 is an enlarged central transverse vertical section of a modified form of crusher also embodying my invention. Fig. 3ª is a detached view, in side elevation, of the cap or washer used in the machine shown in Fig. 3. Fig. 4 is an enlarged central transverse section of a further modified form of crusher also

embodying my invention. Fig. 5 is a detached and enlarged plan view of the feed-regulating hopper shown in Fig. 1. Fig. 6 is an enlarged horizontal section of the feed-regulating hopper, taken on the line 6 6 of Fig. 1, the direction of view being downward, as indicated by the arrows applied to the section-line. Fig. 7 is an enlarged and detached plan view of the belt-gearing embodying my invention. Fig. 8 is a detached sectional view of the inclined belt-deflecting pulley, taken on the line 8 8 of Fig. 7. Fig. 9 is a detached view, in central vertical section, of a sectional crusher-shaft adapted for use in connection with either form of machine embodying my invention.

For the sake of clearness, I will first describe the structure shown in Fig. 1, then in sequence the structure shown in Figs. 2, 3, and 4, and, finally, the attachments shown in detail in Figs. 5, 6, 7, and 8.

In Fig. 1 the external shell or casing of the crusher is shown as composed of a lower section 1, an intermediate section 2, supported upon the upper end of the lower section, and an upper section or crown-feeder 3, resting upon the upper end of the intermediate section 2. The lower section 1 is preferably of frusto-conical form, as shown, (although such precise form may be varied without departing from my invention,) and is shown as bolted at its lower end to a base-plate 4, which rests upon a suitable bed or foundation, such, for example, as is shown at 5, the lower casing section 1 thus standing vertically. The lower part of the intermediate casing-section 2 is preferably of frusto-conical form, so as to constitute an upward prolongation of the lower section 1; but the upper part of said intermediate section is preferably of cylindrical form, either both externally and internally, as shown, or in any event internally. The lower and intermediate sections 1 and 2 are preferably detachable from each other and may be secured together in any sufficiently strong and rigid manner. For example, the upper end of the lower section 1 is shown as provided with an external flange 6, and the lower end of the intermediate section 2 is shown as provided with an external flange 7. Bolts 8 are shown as passed vertically through the flanges 6 and 7, so as to strongly connect the two sections together, each bolt 8 having, of course, a suitable retaining nut or nuts.

The lower part of the upper section or crown-feeder 3 is preferably flared outwardly and downwardly, while the upper part of said section is preferably flared upwardly and outwardly, after the fashion of a hopper-mouth, these two parts being preferably united together integrally. This upper section or crown-feeder 3 is preferably also detachable from the intermediate section, and may be secured to the latter in any suitably strong and rigid manner. For example, I have shown the upper end of the intermediate section 2 as provided with an external flange 9 and the lower end of the upper section 3 as provided with a similar external flange 10. Bolts 11 are passed vertically through these flanges 9 and 10 and are provided with the usual retaining-nuts, so as to strongly connect the two sections together.

Upon the top of the upper section or crown-feeder 3 is supported a feed-regulating hopper 12, which, together with its attachments, will be hereinafter fully described; also, upon the bed or foundation 5 of the machine, and at one side of the latter, I have shown a driving-pulley 13, mounted upon a horizontal shaft 14 so as to turn therewith. The shaft 14 is shown as journaled in suitable bearing-standards 15, rising vertically from the bed 5, and a rope belt or cable 16 is shown as trained from over the periphery of the driving-pulley 13, the lower strand of said belt or cable extending directly to and around the periphery of a pulley 17 in the lower part of the crusher-casing and the upper strand of the belt or cable being trained beneath an inclined pulley 18, interposed between the driving-pulley 13 and the pulley 17 within the crusher-casing. Inasmuch as this driving-gearing constitutes a part of my present invention, it will be fully and completely described at such point in the ensuing description as shall render such description perfectly clear.

The structures shown in Figs. 2 and 3 are mounted in sectional casings similar to those just described and the casing-sections and their appurtenances are designated by similar numerals of reference in Figs. 1, 2, and 3. In a general way it may be stated that the lower section 1 incloses the "actuating-gearing," (so termed in distinction from the external transmitting or belt gearing,) while the upper section incloses the crushing mechanism, the intermediate section inclosing the gyratory crusher-shaft. This is not strictly true, since the crushing mechanism is shown as partly inclosed by the upper end of the intermediate section and since the gyratory shaft is inclosed partly by both the lower and intermediate casing-sections, but the description sufficiently discloses the principal purposes of the three sections.

Referring now to Fig. 2, 19 designates the gyratory crusher-shaft, which is preferably of gradually-increased diameter from its lower end to its ball-fulcrum, and which is also of such length as to extend from the bottom of the lower section 1 to the top of the upper section 3. The lower end of this shaft is stepped into a socket-bearing 20, formed eccentrically in a bearing-sleeve 21, which is surrounded by a tubular boss 22, passing centrally through a web-plate 24, forming the bottom of the lower section 1. As to its body portion this web-plate is of concavo-convex form, placed with its concave surface downward, and said web-plate is preferably bolted marginally to the lower end of the lower casing-section 1. The tubular boss 22 may be

connected in any suitable manner to the center of the web-plate, and a desirable form of connection is shown as consisting of a flange 25, formed externally upon the sides of the boss and resting upon the upper surface of the web-plate, bolts 23 being passed vertically through the flange and through the middle of the web-plate, and having suitable retaining-nuts, so as to strongly attach the boss to the web-plate. The lower end of the detachable boss 22 is closed by a cap 26, detachably secured to the lower end of said boss by screws 28 or in any suitably strong and rigid manner. The lower end of the tubular sleeve 21 may rest directly upon the upper surface of the cap 26, but it preferably rests upon a cross-bar 27, suitably supported in the lower part of the section 1 and interposed between the sleeve and the cap, so as to take the wear. In order to further reduce the wear resulting from the axial movement of the sleeve 21 in the boss 22, the sleeve may be provided with one or any suitable number of vertical rollers 29, placed in a laterally-recessed portion at one side of the sleeve and interposed between the wall of such recess and the inner surface of the sleeve, the ends of the roller or rollers 29 being journaled in the upper and lower parts of the sleeve.

Upon the upper end of the sleeve 21 is keyed or otherwise secured, so as to turn with the sleeve, the pulley 17, previously referred to, this pulley being desirably of frusto-conical form in cross-section, so as to extend obliquely outward and downward from its hub or center to its periphery. The arrangement of these parts is such that as the pulley 17 revolves it rotates the sleeve 21 with it, causing the lower end of the shaft 19 to describe a circle eccentric to the center of the pulley and also causing said shaft to revolve axially, the purpose of the eccentric and axial movements being hereinafter explained.

At its upper portion the gyratory crusher-shaft 19 is formed or provided in any suitable manner with a spherical enlargement 30, which has its bearing in an internally-spherical bearing-socket 31. This socket is formed or otherwise suitably provided with radial outwardly-extending spider-arms 32, the outer extremities of which are suitably connected to or united to a horizontal supporting-ring 33, which rests in rabbets in the upper end of the intermediate section 2 and the lower end of the upper section 3, the spaces between the spider-arms 32 affording free passage downward for the partly-crushed material.

The upper extremity 34 of the crusher-shaft is of conical form and is surrounded by a conical primary crusher-head 35, said head being retained upon the upper end of the shaft by a nut 36, screwed upon the upper extremity of said shaft. The crusher-head 35 may, however, be secured to the shaft in any manner which will permit the crusher-head to be detached from the shaft, but which will also prevent the crusher-head from moving independently of the shaft.

The primary crusher-head 35 is surrounded by a crusher-ring 37, which is shown as set in the recessed inner surface of the crown-feeder 3, so as to be incapable of movement therein. This crusher-ring 37 may be either in the form of a single piece or it may be composed of sections, as preferred, and the same is true also of the crusher-head, and, furthermore, the crusher-ring may be bolted or secured in any suitably firm manner within the crown-feeder 3, while the outer surface of the crusher-head and the inner surface of the crusher-ring may either be chilled in casting or be covered with suitable hardened facings. Again, these surfaces may be roughened or corrugated, if desired, in any suitable manner to facilitate their crushing action. In any event the outer surface of the primary crusher-head extends obliquely downward and outward, while the inner surface of the crusher-ring extends obliquely downward and inward, easy entrance thus being afforded for the uncrushed material, and such material being successively broken into smaller and smaller particles as it works downward between the head and the ring.

For a comparatively short distance downward from the spherical enlargement 30 the shaft 19 is shown at 38 as of cylindrical form, and surrounding this cylindrical portion 38 is a secondary or auxiliary crusher-head 39. The shaft 19 may or may not be formed with the cylindrical portion 38, but in any event the auxiliary or secondary crusher-head 39 is so secured to the shaft, at a point below the spherical enlargement thereof, as to move always with the shaft. As a desirable construction this secondary crusher-head is shown as composed of a conical outer or body portion and an inner portion or hub 40, united to the body portion by radial arms 41. The outer surface of the secondary head inclines downward and outward and may be chilled in casting and suitably roughened or corrugated, or it may be covered with a suitable hard facing. The hub 40 may be keyed, bolted, or otherwise firmly secured to the shaft 19, and the body portion of the head may be either of integral form or built up of separate sections suitably secured together, as preferred. In any event this secondary crusher-head 39 is surrounded by a secondary crusher-ring 42, which fits within the upper cylindrical portion of the intermediate casing-section 2 in such manner as to be movable upward and downward therein, but immovable axially in said section. These results may be accomplished in a great variety of ways. For example, the inner surface of the cylindrical upper portion of the casing-section 2 may be formed with any desired number of vertical grooves 43, the lower ends of which terminate at an inwardly-extend-

ing horizontal shoulder 44, formed on the lower part of said inner surface, the upper ends of said grooves opening at the upper margin of the section 2. Corresponding vertical ribs 45 are in such instance formed upon the outer surface of the secondary crusher-ring 42, each rib entering one of the grooves, and said ribs being so placed that when the ring is in its lowest position the lower ends of the ribs 45 rest upon the shoulder 44, and thus support the ring, and the ribs and grooves thus also preventing any axial movement of the ring.

As a means for raising and lowering the secondary crusher-ring 42, so as to regulate the fineness of the secondary crushing, adjusting-screws 46 may be used, such screws being inserted downwardly through the lower part of the crown-feeder 3 and having on their upper end portions collars or shoulders 47, which rest upon the crown or section 3. The lower ends of these screws are threaded and enter threaded sockets in the upper part of the ring 42, and the arrangement is such that by turning the screws 46 in one or the opposite direction the secondary crusher-ring will be raised or lowered, as desired. The inner surface of this crusher-ring inclines downwardly and inwardly and may be chilled and roughened or corrugated, or it may be provided with a hardened facing; and, furthermore, the ring may be either a single piece or in sections, as preferred. In any event the partially-crushed material from the primary crusher head and ring falls through the spaces between the arms 32 of the ball-socket bearing 31 and enters the space between the secondary crusher-head and crusher-ring, and working downward through the latter is effectively crushed. This double-crushing action greatly increases the capacity of the machine and also the uniformity of the product. After passing through the secondary crushers the material falls into the lower casing-section 1 and is directed outward therefrom, through a discharge-opening 48 in one side thereof, by an oblique chute or diaphragm 49 and spout 50, the crushed material being subsequently screened and graded, as required.

In order to protect the driving-gear within the lower end of the casing-section 1 and also the shaft 19 from injury by the dust and smaller fragments of material, the diaphragm 49 is of such form as to fit closely against the inner surfaces of the lower part of the upper section 2 and the lower section 1, and said diaphragm also closely surrounds a cylindrical thimble 51, which is of such length as to extend vertically considerably above and below the diaphragm. Calkings, of lead, solder, oakum, or any other suitable material, may be used to pack the joints between the sides of the sections 1 and 2 and the edges of the diaphragm 49, and also between the opening of said diaphragm and the thimble 51. The lower end of this thimble is tightly inserted into a hollow boss or hub portion 52, preferably integral with a concave partition 53, said partition being supported at its upper margin upon the upper end of the casing-section 1 and having at one side an opening 54, through which the crushed material passes on its way out of the machine. The inner end of the spout 50 is shown as tightly embracing and as riveted to the opening 54 of the concave partition 53 and as protruding somewhat out of the discharge-opening 48, provided in section 1, and an extension-plate 55 is shown as also protruding outward through said discharge-opening 48 and as riveted at its inner end to the partition-opening 54. It will be observed that the chute or diaphragm 49 not only tightly surrounds the thimble 51 and materially assists in retaining the same in its proper position with respect to the sections 1 and 2, but also directs the crushed material outward to the spout 50, which is carried by the concave partition 53, the latter also tightly embracing and supporting said thimble through the medium of the hollow boss or hub portion 52. Thus the driving-gear and the shaft 19 are doubly and effectually protected from injury by dust or dirt and a free course of discharge is provided for the crushed material. The diameter of the thimble 51 is of course to be amply sufficient to permit the unobstructed gyratory movements of the crusher-shaft 19.

In order to provide for the easy and effective lubrication of the working parts of the machine, I provide attachments, which I will now proceed to describe. The ball-joint bearing of the gyratory crusher-shaft 19 is lubricated by oil fed to the bearing-socket 31 through one or any suitable number of feed-pipes 56, each of which is connected at its inner end to the upper part of the bearing-socket, so as to communicate with a horizontal oil-channel 57, formed in the upper part of the inner surface of said socket and opening into the interior of the socket. Within this channel 57 is placed an oil-distributing ring 58, which is of somewhat less external diameter than the greatest diameter of the channel, and also of somewhat less thickness from its lower to its upper surfaces than the channel, the diameter of the opening of the distributing-ring being somewhat greater than the diameter of the adjacent part of the crusher-shaft, and these dimensions being such as to permit a gradual rotation of the ring in its channel. The distributing-ring 58 is formed, either on its under surface only or on both its under and upper surfaces, with radial channels 59, which, as the ring gradually moves or shifts and rotates in the channel 57, feed the oil inward to the cavity of the bearing-socket 31. Each feed-pipe 56 extends outward through the crown-feeder 3 and at its outer end is connected to a suitable oil-cup or to an oil-reservoir sufficiently elevated above the bearing-socket 31 to insure an effective gravity feed of oil.

The bearing of the lower end of the crusher-

shaft 19 in the bearing-sleeve 21 is lubricated by oil fed through one or more feed-pipes 60, each of which is shown as extending obliquely inward and downward through the upper part of the lower casing-section 1, and the outer end of each of which is connected to a suitable oil-cup or to an oil-reservoir sufficiently elevated above the bearing-sleeve 21 to insure an effective gravity feed of oil. The inner end of each feed-pipe 60 delivers into a cavity 61, formed in the upper side of the middle portion or hub of the pulley 17, and the oil descends from said cavity 60 into the bearing-socket of the sleeve 21 through the expanded upper end 62 of said cavity. The upper journal-bearings 63 of the rollers 29 also open into the cavity 61, so that some of the oil flows downward over the rollers and even enters and lubricates their lower journal-bearings, in addition to lubricating the rollers themselves. It will also be seen that the oil is permitted to work downward between the bearing-sleeve 21 and the inner surface of the boss 22 and also between the lower end of the sleeve and the cap 26, so that all parts of the bearing-surfaces in the lower part of the machine are thoroughly lubricated.

In the structure shown in Fig. 3 many of the parts are precisely similar to those shown in Figs. 1 and 2 and such similar parts are designated by the same reference-numerals as are used in said preceding figures. This structure, however, involves certain modifications in the form and arrangement of the primary and secondary crusher heads and rings, in the devices for protecting the driving-gearing from dust and for discharging the crushed material from the machine, and also in the means for lubricating the ball-fulcrum bearing and the bearings for the lower end of the crusher-shaft and of the devices connected therewith, and, furthermore, certain modifications in the devices for securing the upper or primary crusher-head. In this instance the detachable boss 22 of the web-plate 24 is dispensed with, and in lieu thereof a boss 64, formed integrally with the web-plate, is employed, this integral boss in its general form and functions being similar to the separable boss 22, before described. The lower end of the boss 64 is closed by a removable cap 26, as before, said cap being here shown as flanged upward marginally, so as to embrace the lower end of the boss, and such upward flanging being desirable (although not essential) in either form of construction, since it insures a tighter joint between the cap and the boss. The bearing-sleeve 21 is in this instance made somewhat longer than before, so that the upper end of said sleeve shall come up flush with the upper surface of the center or hub of the pulley 17, the oil-cavity 61 being here formed directly in the upper end of the sleeve instead of in the hub, as before. The partition 53 and diaphragm 49 are in this instance dispensed with, and the inner end of the chute or spout 50 is secured around an outlet-opening 65 at one side of the lower part of a discharge-hopper 66, which may be supported in any suitable manner within the intermediate casing-section 2. As a desirable way of supporting this discharge-hopper its upper margin is shown as resting upon an internal horizontal ledge or flange 67, formed with the intermediate section 2, and said hopper is also shown as formed integrally with a thimble 67, rising from the bottom of the hopper and surrounding the crusher-shaft 19, said thimble being of sufficient internal diameter to permit the shaft 19 to gyrate unobstructedly. A flaring guard 69 may, if desired, be secured to the upper end of the thimble 67 so as to prevent dust or particles from flying inward from between the secondary crusher head and ring and entering between the thimble and shaft, but such guard is not essential and may be dispensed with if not desired. The secondary crusher-head 39 is here shown as secured to the shaft 19 by a key 70, inserted between the cylindrical portion 38 of the shaft and the hub 40 of the head, but, as before stated, the secondary crusher-head may be rigidly, but detachably, secured to the shaft in any suitable manner. The secondary crusher-ring 42 is here shown as adjustable upward and downward within the upper part of the intermediate casing-section 2 by means of adjusting-screws 71 of which there may be two or any desired number, and each of which is screwed upwardly through the flange or shoulder 68. The upper ends of these adjusting-screws impinge against the under side of the secondary crusher-ring and the lower angular ends extend adjacent to openings 72, formed through the casing-section 2, the arrangement being such that a wrench may be successively introduced through the openings 72 and applied to the lower ends of the screws 71, so as to turn said screws in one direction or the other and thus raise or lower the crusher-ring 42, as required. The ball-joint cavity for the crusher-shaft is in this instance formed in a socket-piece 73, resting removably in a supporting-ring 74, united to the inner ends of the spider-arms 36, the outer ends of said arms being here shown as formed integrally with the crown-feeder section 3. It is to be understood that the socket-piece 73 may either be formed of a single piece or that it may be composed of sections, as preferred. In any event the upper part of the socket-piece contains an oil-cavity 75, which opens at the top of the socket-piece, so as to receive oil from the primary crusher-head, as will be presently described. A packing-ring 76, of oakum, rope, or any other suitable material, is preferably placed upon the top of the socket-piece 73, around the opening of the oil-cavity 75 thereof, so as to close the space between the socket-piece and the primary crusher-head 35, and thus prevent dust and dirt from working inward between the socket-piece and the spherical portion 30 of the crusher-shaft. In its general form the pri-

mary crusher-head 35 is similar to the primary crusher-head previously described, but in this instance the head is formed with an internal oil-cavity 77, surrounding the shaft 19, and from said cavity lead downward any desired number of oil-channels 78, which conduct the lubricating-oil from said cavity 77 to the opening of the oil-cavity 75 in the socket-piece 73. Oil is fed into the cavity 77 of the head 35 through an L-shaped oil-channel 79, the upper end of which opens out of the upper extremity of the shaft 19 and the lower end of which opens through one side of said shaft, so as to communicate with the oil-cavity 77. In this instance also the retaining-nut 36 (shown in Fig. 2) is dispensed with and a cap or washer 80 and retaining-screw 81 are used in lieu of the nut. The body 82 of the cap or washer 80 is shown as of less width than the top thereof and as of inverted frusto pyramidal or conical form. One or any suitable number of ribs or fins 83 are formed upon the outer part of the body portion 82 of this cap, and said body portion is inserted into a correspondingly-shaped cavity in the upper end of the shaft 19. The fins 83 enter lateral recesses in the upper end of the shaft, and the arrangement is such that the cap 80 cannot be turned by any rotation of the primary crusher-head 35 on the shaft. The screw 81 is threaded into the upper end of the oil-channel 79, and as the cap or washer 80 is prevented by its fins 83 from turning it prevents this screw 81 from being unscrewed by any revoluble play of the head 35 on the shaft. In this respect the arrangement is advantageous over the retaining-nut 36, because there is a possibility of the revoluble play of the head 35 working the retaining-nut 36 loose. At the same time the retaining-screw 81 also prevents the entrance of dust into the oil-channel 79.

The structure shown in Fig. 4 involves, essentially, a reversal of the relative positions of the crushing and actuating mechanisms, the crushing mechanism being located in the lower part of the casing, while the actuating mechanism is located in the upper part of said casing. The casing is shown as of essentially similar character to those of the structure above described, and the crushing mechanism is also of similar essential character to those previously described. The gyrating crusher-shaft 19 is in this instance shown as of gradually-increased diameter from its upper toward its lower end, and the spherical enlargement 30 is shown as located near the lower end of the shaft. The lower extremity of the crusher-shaft is shown as supported upon a horizontal cross-bar 84, which is supported in any suitable manner in the lower part of the lower casing-section 1. The upper casing-section 3 is formed at its sides with two or any desirable number of openings 85, through which the material to be crushed is to be introduced in any preferred manner, and the primary crusher-head 86 is located just above the spherical enlargement 30, while the secondary crusher-head 87 is located just below said enlargement. The primary and secondary crusher-heads are shown as similar in form to the primary and secondary crusher-heads shown in Fig. 2, and the socket-piece 90 is also shown as of similar form to the socket-piece 31 in Fig. 2, said socket-piece being supported by spider-arms 91, extending radially inward from a supporting-ring 92, and the spider-arms and ring being similar to the arms 32 and ring 33 in Fig. 2. The primary crusher-ring 88 is secured in the upper part of the intermediate casing-section 2 in generally similar manner as the crusher-ring 37 is secured in the crown-feeder 3, and an oil-distributing ring 93 is inserted into the upper part of the socket-piece 90 similarly as the ring 58 is inserted into the socket-piece 31, one or more oil-feeding pipes 56 conducting oil to the ring from cups or reservoirs, as before, but in this instance extending through the intermediate casing-section 2. It is to be understood, however, that crushing devices similar in general form to those shown in Fig. 3 may be placed in the lower part of the casing in Fig. 4, and that various other changes in details of construction and arrangement may be adopted without departing from the essential spirit of my invention so long as a primary and a secondary crushing apparatus are employed. The machine is shown in Fig. 4 as supported upon an open base-piece 94, through which the crushed material may fall and be carried to any suitable point. In the top of the upper casing-section 3 is supported a removable bearing-boss 95, similar in general form to the bearing-boss 22, (shown in Fig. 2,) this boss 95 having an extended flange 96, similar to the flange 25 of the boss 22, and resting upon the top of the upper casing-section 3, and also secured thereto by bolts 97, passing vertically through the flange 96 and the top of said casing-section 2. Through the boss 95 extends a bearing-sleeve 98, similar in general form to the bearing-sleeve 21 in Fig. 2, the upper end of the gyratory crusher-shaft entering an eccentric socket-opening at the under side of the sleeve, and said sleeve being provided with bearing-rollers 99, similar to the bearing-rollers 29 of Fig. 2. The upper end 100 of this bearing-sleeve 98 is, however, closed in this instance and is surrounded by the tightly-fitting hub of a driving-pulley 101, the upper extremity of the end 100 being shown as extended laterally over the upper side of the pulley-hub, and the sleeve being so connected to the pulley as to turn always therewith. Three strands 102 of rope or cable belting are trained around the periphery of the driving-pulley 101 and lead them over two idle-pulleys 103, journaled side by side in brackets 104, extending from one side of the upper part of the casing-section 3; but one pulley 103 is shown, but as the companion pulley is precisely like the one shown and is simply placed

beside it the arrangement is believed to be obvious. From the idle-pulleys 103 the strands of rope 102 extend downward and then outward beneath a pair of parallel idle-pulleys 105, (one of which is shown,) journaled in brackets 106, projecting outward from the corresponding side of the casing-section 1. From the idle-pulleys 105 the rope strands 102 extend outward to a belt-wheel of a suitable prime motor. It is to be understood that, if preferred, bearing attachments similar to those shown in Fig. 3 may be employed in this instance, with such minor modifications in form and arrangement as may be necessary to adapt the devices to their inverted position, and also that any form of bearing devices may be employed, (such as will impart the required gyratory motion to the crusher-shaft,) without departing from the essential spirit of my invention.

The machine in either of the forms shown in Figs. 2 and 3 may obviously be driven by various forms and arrangements of gearing adapted to transmit power from a prime motor to the driving-pulley 17, but I have shown and will now describe a form of transmitting-gearing which is peculiarly adapted to the requirements of the machines shown in Figs. 2 and 3 on account of its simplicity and directness of operation and of its ability to transmit the maximum power applied to the belt, and also on account of its adaptitude for location wholly outside of the machine itself.

The shaft 14, previously referred to, upon which the belt-wheel 13 is mounted is placed horizontally at one side of and away from the machine and may be connected directly by a crank to an engine, or it may be geared or bolted in any suitable manner to a motor of any desired type. The belt-wheel 13 of this shaft stands vertically, while the driving-pulley 17 of the machine lies horizontally, and in order to properly deflect the belt 16 from over the periphery of the vertical pulley 13 to the periphery of the horizontal pulley 17 in the simplest and most direct manner I employ an inclined intermediate pulley 107. This pulley 107 is shown as journaled upon the upper end of a shaft 108, the lower end of which is provided with a spherical enlargement 109. The spherical enlargement 109 fits within a divided spherical bearing-cavity formed partly in the upper surface of a base-piece 110 and partly in the under surface of a cap-piece 111, the base 110 being suitably secured to the bed 5 of the machine at a point between the pulleys 13 and 17, and the cap 111 being connected to the base in such manner as to be clamped downward forcibly upon the spherical enlargement 109, and thus retain the shaft or arm 108 in any desired position of inclination. In order to effect this clamping of the shaft or arm 108, I have shown set-bolts 112 as passed downwardly through the cap 111 and as threaded into the base 110; but although this is a simple and desirable way of clamping the arm 108 I desire it to be understood that various other means may be adopted for this purpose without departing from the essential spirit of my invention.

Thus it will be seen that the lower strand of the cable 16 runs directly from the lower part of the periphery of the pulley 13 to the periphery of the pulley 17, while the other strand of said cable leads from the upper part of the periphery of pulley 13 downward beneath the periphery of the intermediate or deflecting pulley 107 and thence obliquely and horizontally to the periphery of the pulley 17, there obviously being no possibility of the belt running off of any of the pulleys, and all necessity for an objectionable multiplicity of deflecting-pulleys being avoided. Lubrication of the pulley 107 may be provided for by an oil-cavity 113 in the upper side of the pulley-hub, and lubrication of the ball-and-socket bearing of the arm 108 may be provided for by an oil-cavity 114 in the upper side of the cap 111.

With the machines shown in Figs. 2 and 3 it is desirable to insure a gradual distribution of the uncrushed material into the space between the primary crusher-head and crusher-ring in order to avoid choking of the feed and stoppage of the machine or injury to the head or ring. I have provided effectively for such a distributive feed by means which I will now proceed to describe. The hopper 12 above referred to contains in its interior, throat, or lower part a horizontal guard or shield 115, (shown as of approximately triangular form, so as to leave entrance-openings 116 at its sides, through which the uncrushed material may pass.) Through the sides of the hopper are formed horizontal slots 117, through each of which works a horizontal cut-off gate 118. Each of these gates 118 is pivoted at one end, as at 119, to the side of the hopper, and the opposite end of the gate is preferably provided with a handle 120 to be grasped by an attendant. Through the sides of the lower part or throat of the hopper 12 are formed any desired number of vertical slots 121, and the purpose of said slots is to permit a suitable bar to be inserted by the attendant, so as to stir the material in the hopper in the event of any possible choking of the material therein, and thus to free such material.

I desire it to be clearly understood that, while I have in each instance shown the outer shell or casing of the crusher as composed of three detachable sections, I do not desire to be understood as limiting myself exclusively either to such precise number of sections, nor to a sectional form of casing, since the casing may be of any desirable form without departing from the essential spirit of my invention. A sectional casing is, however, advantageous for ease in shipment and transportation, and for the same reasons a sectional crusher-shaft, such as I have shown in Fig. 9, is also a desirable feature of these machines. This shaft

consists of two longitudinal sections 19^a and 19^b, the adjacent ends of such sections being formed each with a transverse external flange 122, through which are inserted bolts 123 for connecting the two shaft-sections together. After such connection has been made a ring 124 is screwed upon the externally-screw-threaded margins of the flanges, so as to effectively secure said flanges together, and the edges of the ring are bent under and over the flanges, as shown. The shaft-section 19^b carries the spherical enlargement 30 and has at the end adjacent to the section 19^a a longitudinal socket 125 to receive a longitudinal extension 126 of the end of the section 19^a, such socket and extension being preferably angular in cross-section. Thus a strong connection is made between the shaft-sections, while such such sections are rendered readily detachable for shipment and transportation. Obviously this shaft is adapted for use in either of the machines above described, such minor changes in its attachments as may be required being evidently apparent.

I desire it to be understood that while I have shown ropes or cables 16 and 102 as employed with the machines and have also shown grooved pulleys 13, 17, 101, 103, 105, and 107 to receive said ropes or cables belts or sprocket-chains may be substituted for either or both of the cables and belt or sprocket pulleys may be substituted for the cable-pulleys without departing from the essential spirit of my invention.

After the machine is started the attendant pulls one of the gates 118 outward, so as to open the corresponding feed-passage 116. A charge of uncrushed material is now dumped into the hopper and is partly sustained by the shield 115 and the closed gates 118, so as to remove the weight of the entire charge from the primary crushing head and ring. A certain amount of the uncrushed material falls through the open feed-passage 116, and as soon as such material has been easily received by the primary crusher-head the corresponding gate 118 is closed and another gate is opened, so as to permit more of the material to enter the machine. This opening and closing of the gates is continued during the operation of the machine, (one gate or another being always open,) and thus no choking of the crushing devices can occur. By the use of suitable spouts or chutes entering the feed-openings 85 of the machine shown in Fig. 4 this distributive feed can be readily applied to said machine.

Having thus described my invention, what I claim as new therein, and desire to secure by Letters Patent, is—

1. The combination with a case constructed as described, of a gyratory shaft having a ball-fulcrum, the bearing for said shaft firmly supported within the frame, the upper crusher-ring held in the upper flanged portion of the case, the upper crusher-section detachably mounted upon the shaft above the fulcrum, the lower crusher-ring, the screws secured to the upper portion of the ring and projected through the case for adjustably supporting said ring, and the lower crusher-section firmly mounted upon the shaft below the fulcrum, and means for revolving said shaft, substantially as shown and described.

2. The combination with the case and gyratory shaft having a ball-fulcrum, of the tubular boss, the sleeve located in said boss, said boss receiving the lower end of said shaft, a friction-roller mounted in said sleeve, the top of the sleeve being formed with a chamber to receive a lubricant, a drive wheel or gear mounted upon the upper portion of the sleeve, and the upper and lower crusher-sections mounted on said shaft above and below the fulcrum respectively, substantially as shown and described.

3. In a crusher or breaker, a gyratory shaft made in sections, one of which has a socket and the other an extension fitting said socket, both of said sections having flanges bolted together and threaded upon their periphery, and a collar screwed upon said flanges, substantially as shown and described.

GEORGE LOWRY.

Witnesses:
JNO. L. CONDRON,
OTTO R. BARNETT.