No. 706,102. Patented Aug. 5, 1902.

J. H. PENDLETON.

CENTRIFUGAL GRINDING MILL.

(Application filed July 9, 1901.)

(No Model.) 2 Sheets—Sheet 1.

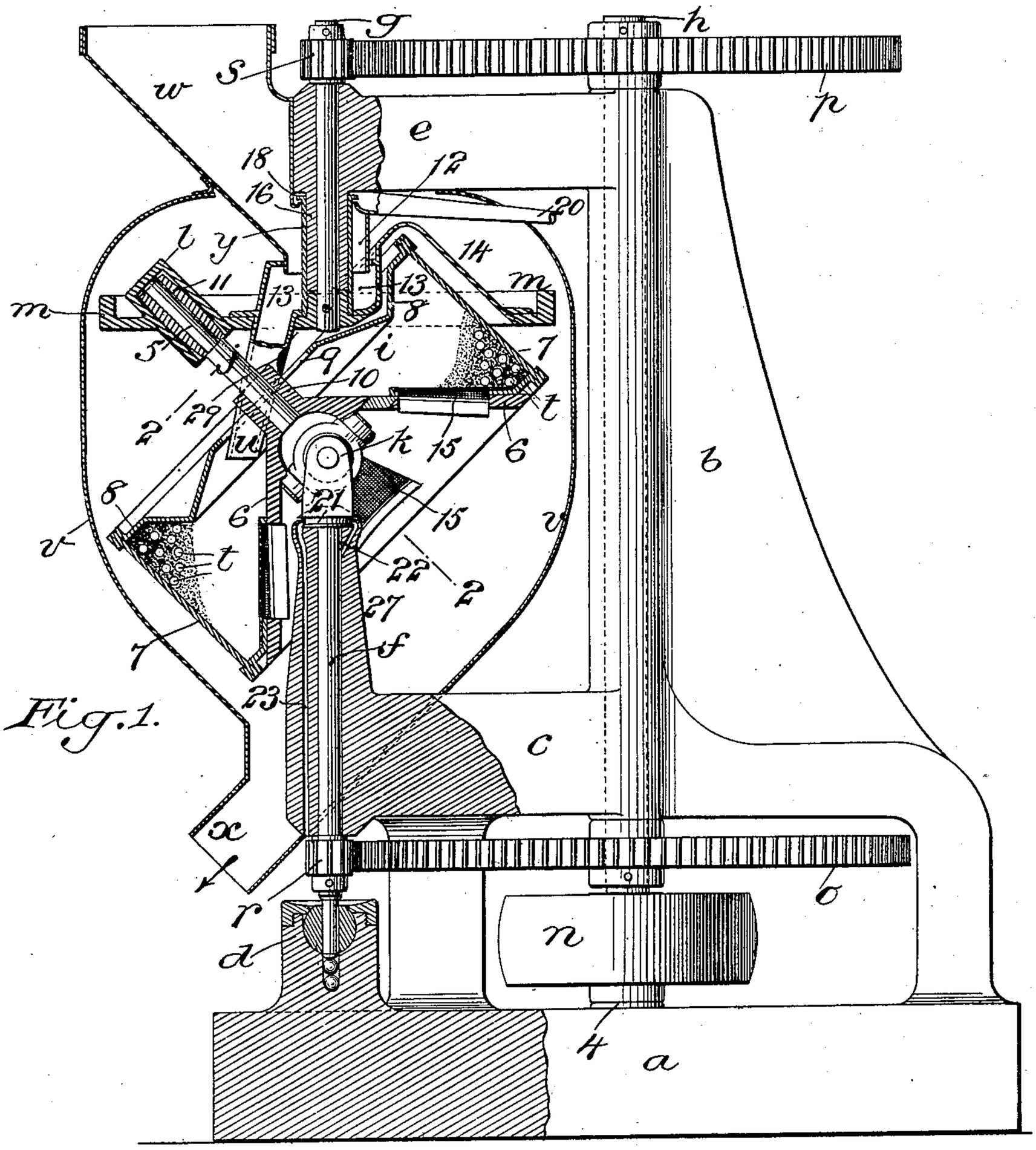

Fig. 1.

Fig. 2.

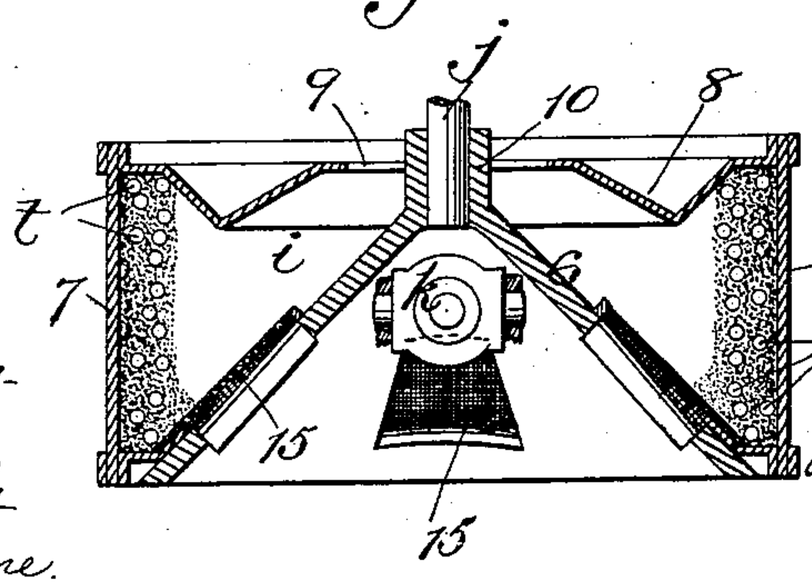

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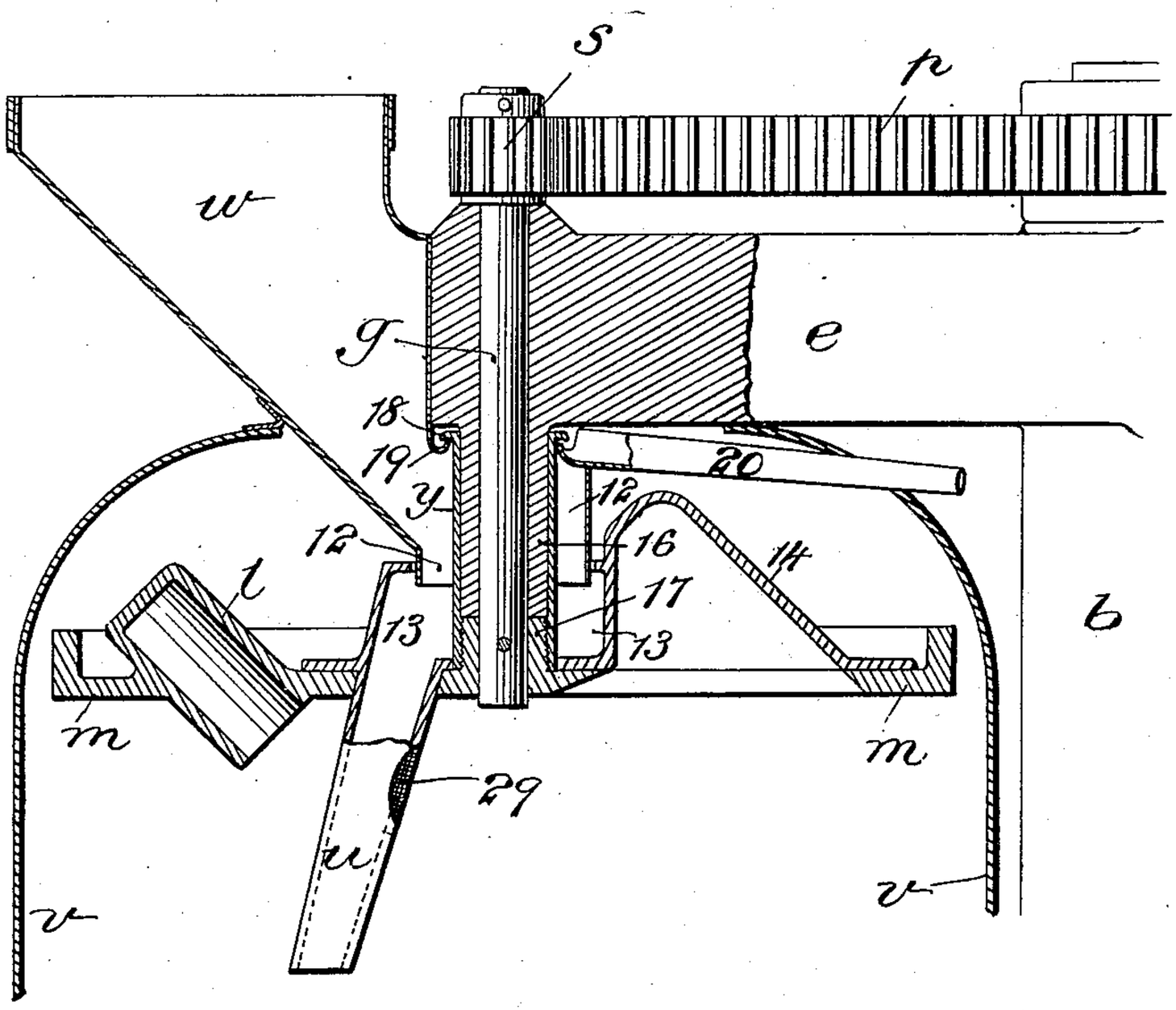
Fig. 3.



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UNITED STATES PATENT OFFICE.

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CENTRIFUGAL GRINDING-MILL.

SPECIFICATION forming part of Letters Patent No. 706,102, dated August 5, 1902.

Application filed July 9, 1901. Serial No. 67,605. (No model.)

To all whom it may concern:

Be it known that I, JOHN H. PENDLETON, a citizen of the United States, and a resident of Jamesburg, in the county of Middlesex and State of New Jersey, have invented a new and useful Improvement in Centrifugal Grinding-Mills, of which the following is a specification.

A mill embodying this invention comprises a mortar and grinding-balls therein, a central shaft which carries said mortar and which may be termed the "mortar-shaft," two other shafts alined with each other and with the adjacent ends of which the opposite ends of the mortar-shaft are connected by a universal joint and crank-like connection in such manner as to keep it oblique to said alined shafts, which, being driven at different speeds in the same direction, cause the mortar-shaft and the mortar to rotate more or less slowly about their own oblique axis while revolving more or less rapidly around the axis of the alined shafts. I will describe a mill with reference to the accompanying drawings and afterward point out its novelty in claims.

Figure 1 is a vertical sectional view of the mill; Fig. 2, a sectional view taken transversely to Fig. 1 in the line 2 2 of the latter figure; Fig. 3, a vertical sectional view, on a larger scale, of parts of the mill imperfectly represented in Fig. 1.

a b c d e designate the parts of a framing containing suitable bearings for three upright rotary shafts *f g h*. The shafts *f g* are in line with each other, with a space between them, the lower one being represented as supported in a step-bearing *d* on the bed-plate *a* and working in a bearing in a bracket *c*, and the upper one, *g*, as supported by and working in a bearing in the bracket *e*. The shaft *h* is represented as supported in a step-bearing at 4 in the bed-plate and working in bearings in the standard *b*.

i is the grinding-mortar, fast on a shaft *j*, with which it is concentric, the said shaft *j* being arranged in a position oblique to the common axis of the shafts *f g* and being retained in such position partly by a joint *k*, which is flexible in all directions, represented as a gimbal, and which connects the lower end of said shaft and the mortar with the upper end of the shaft *f*, and partly by having the pivot or journal 5 on its upper end fitted to a journal bearing or box *l*, carried by a rotary disk *m*, which is affixed to the lower end of the shaft *g*. This disk constitutes the rigid arm of a crank, the other arm and wrist of which are flexibly constituted by the oblique mortar-shaft *j* and its journal 5 and the gimbal-joint *k*. The mortar *i* contains any number of grinding-balls *t* of any suitable material, as chilled iron or steel, and of any desirable size and number, according to the nature of the matter to be ground.

The upright shaft *h*, which is the driving-shaft, is represented as furnished with a pulley *n* for the reception of a driving-belt and as carrying a larger and a smaller spur-gear *o p*, gearing, respectively, with smaller and larger spur-gears *r s* on the shafts *f* and *g*, respectively, so that by the rotation of *h* the two shafts *f* and *g* are driven in the same direction, but *f* is driven faster than *g*. By this mounting of the mortar and this system of gearing the oblique shaft *j* and the mortar are carried around with the shaft *f* and caused to revolve around the axis thereof, revolution for revolution, and the mortar and its shaft *j* are also caused to rotate about their own axis at a speed depending upon the difference in the speed of the shafts *f* and *g*. Thus if *g* makes nine revolutions to ten of *f* the shaft *j* and mortar will make one revolution about their oblique axes.

The mortar is represented as having an internally-concave bottom 6 in order to bring the center of the universal joint *k* as nearly as possible in the center of the entire mass of the mortar and its contents. Its sides 7 are represented as cylindrical and without opening. Its top or cover 8 has a central opening 9 around its shaft for the reception of the material to be ground and for the entrance of air, the said opening being large enough for the entrance also of a rotating feeding-spout *u*, which is carried by the crank-disk *m*, the lower end or nozzle of the said spout entering the lower part of said opening 9 and there being a lateral opening 29 in said

spout opposite to the upper part of said opening 9 for the entrance of air to the mortar. This opening 29 is fitted with a screen to prevent the passage through it of any of the material to be ground. The bottom 6 of this mortar and its central hub 10, which receives the shaft *j*, may be of one casting. The sides and top or cover may be of steel plate. In the bottom there are provided a number of screens 15, the fineness of whose mesh corresponds with the fineness to which the matters are to be ground. The journal 5 of the shaft *j* is represented as fitted with a sleeve 11, the exterior of which, fitting to the journal-box *l*, is of spheroidal profile to permit it to oscillate within the box sufficiently to accommodate the shaft to any want of truth in the parts that may result from wear.

In Fig. 1 the mortar is represented as surrounded by and entirely inclosed within a stationary casing *v*, at the upper end of which is affixed a feeding-hopper *w* and at the bottom of which is a delivery-spout *x*. The throat 12 of the hopper surrounds the shaft *g* and the tubular part 16 of its bearing and is entirely surrounded by the hopper-like receiving-mouth 13 of the rotating spout *u*. The crank-disk *m* is constructed or provided with a hood 14, which covers the upper part of the hopper. This hood 14 and the spout *u* are represented in Figs. 1 and 3 of one piece secured on the top of the crank-disk *m*.

In order to prevent the oil which is employed for lubricating the shaft *g* from escaping around the bottom of its bearing and so getting into the feeding-spout *u* and into the matter to be ground, the said bearing is prolonged, as shown at 16 in Figs. 1 and 3, below the said bracket in tubular form, and a flanged sleeve *y* which fits the exterior of the tubular prolongation 16 and is screwed tightly onto the exterior of the hub 17 of the crank-disk *m*. This sleeve *y*, which forms an oil-cup, receives any of the lubricating-oil which may escape around the shaft *g* at the bottom of the prolongation 16 of its bearing, such oil passing up through the said cup and over the flange 18 of its upper end into a little annular trough 19, which is formed around the throat 12 of the hopper *w* and from which a small spout 20 passes through the casing *v* to deliver the escaping oil outside of the latter.

In order to prevent any of the oil which is used to lubricate the shaft *f* from escaping at the top of the bearing 27, provided on and in the bracket *c* for said shaft, and running into the ground material within the casing *v*, a channel 21 is provided, as shown in Fig. 1, in and around the said shaft above the said bearing, and with this channel 21 two channels 22 23 communicate, the channel 22 coming from the interior of the bearing and the channel 23 running downward outside of the bearing and having an outlet below the bearing outside of the delivery-spout *x*.

The operation of the mill is as follows: Rapid rotary motion being given to the shaft *h* and through it to the shafts *f* and *g* at unequal velocities, the oblique mortar-shaft and the mortar are caused by the shaft *f* to revolve horizontally therewith about the common axis of the two alined shafts *f g* and at the same time to turn slowly about their own oblique axis. The matter to be ground, fed into the stationary hopper *w*, passes thence through the rotating spout *u* into the mortar, wherein it is subjected to the grinding action between the balls *t t* themselves and between the said balls and the sides of the mortar, such action resulting partly from the centrifugal force to which the balls and the said matters are subjected by the revolution of the mortar around the axis of the alined shafts and resulting partly from the constant interchange of position of the balls and said matters resulting from the slow rotation of the mortar about its own oblique axis by which every part of it is alternately brought to its highest and lowest positions. In this operation the grinding-balls and the matter to be ground are caused by the centrifugal action of the mortar to continually range themselves around the sides of the mortar, as shown in Figs. 1 and 2, in the form of a wall parallel with the axis of the alined shafts *f g*. As fast as the matter is reduced to the requisite degree of fineness the reduced particles, being the lightest, are subject to less intense centrifugal action, and consequently work gradually inward toward the center of the mortar and are sifted out through the screens 15, whence they pass into the lower part of the casing *v* and out through the delivery-spout *x*. This operation of sifting is effected in part by gravitation and in part by currents of air induced into the mortar through the hopper *w* and spout *u* and expelled therefrom through the delivery-spout *x* by the blower-like action of the mortar itself, which action might be assisted by suction applied at the delivery-spout *x*.

It is obviously immaterial which of the shafts *f g* should have the higher velocity, it only being necessary that their velocities should be different to produce the slow rotation of the mortar-shaft *h* about its own axis.

What I claim as my invention is—

1. In a mill, the combination of a mortar and grinding-balls therein, a shaft which carries said mortar, two shafts alined with each other and between the adjacent ends of which the first-named shaft is obliquely arranged and carried as part of a flexible crank connection, and means for rotating said alined shafts at different velocities, substantially as described.

2. In a mill, the combination of a mortar and grinding-balls therein, a shaft which carries said mortar, two shafts alined with each other and between the adjacent ends of which the first-mentioned shaft is obliquely arranged, a flexible connection between one of said alined shafts and one end of said obliquely-arranged shaft, a crank-arm on the

other of said alined shafts, a pivotal connection between said crank-arm and the other end of said obliquely-arranged shaft, and means for rotating the two alined shafts at different velocities, substantially as herein described.

3. In a mill, the combination of a mortar and grinding-balls therein, a shaft which carries said mortar, two shafts alined with each other and between the adjacent ends of which the first-mentioned shaft is obliquely carried, means for rotating said alined shafts at different velocities, and a rotary feeding-spout carried by one of said alined shafts and entering the mortar, substantially as herein described.

4. In a mill, the combination of a mortar and grinding-balls therein, a shaft which carries said mortar, two shafts alined with each other and between the adjacent ends of which the first-mentioned shaft is obliquely arranged, a gimbal-joint between one of said alined shafts and one end of said obliquely-arranged shaft, a crank-arm on the other of said alined shafts, a journal-bearing in said crank-arm receiving a journal on the other end of said obliquely-arranged shaft, and means for rotating the two alined shafts at different velocities, substantially as herein described.

5. In a mill, the combination of a mortar and grinding-balls therein, a shaft which carries said mortar, two shafts alined with each other and between the adjacent ends of which the first-mentioned shaft is obliquely arranged and carried as part of a flexible crank connection, means for rotating said alined shafts at different velocities, and a rotary feeding-spout carried by one of said alined shafts and entering the mortar, substantially as herein described.

6. In a mill, the combination of a mortar and grinding-balls and screens therein, a shaft which carries said mortar, two shafts alined with each other and by and between the adjacent ends of which the first-mentioned shaft is obliquely arranged as part of a flexible crank connection, means for driving the two alined shafts at different velocities, and a stationary casing surrounding the mortar and the crank connection and having a feeding-inlet above the mortar and a delivery-outlet below the mortar, substantially as herein described.

7. In a mill, the combination of a mortar and grinding-balls therein, a shaft which carries said mortar, two shafts alined with each other and between the adjacent ends of which the first-mentioned shaft is obliquely arranged and carried as part of a flexible crank connection, means for rotating said alined shafts at different velocities, a rotary feeding-spout carried by one of said alined shafts and entering the mortar, and a stationary casing surrounding the mortar and its crank connections and having a feeding-inlet in its upper part communicating with said rotary feeding-spout and a delivery-outlet in its lower part, all substantially as herein described.

In testimony that I claim the foregoing as my invention I have signed my name, in presence of two witnesses, this 12th day of April, 1901.

JOHN H. PENDLETON.

Witnesses:
FREDK. HAYNES,
L. M. EGBERT.