No. 676,254. Patented June 11, 1901.

C. HOFMANN.

BALL GRINDING MILL.

(Application filed Sept. 17, 1898.)

(No Model.) 3 Sheets—Sheet 1.

Fig. 1.

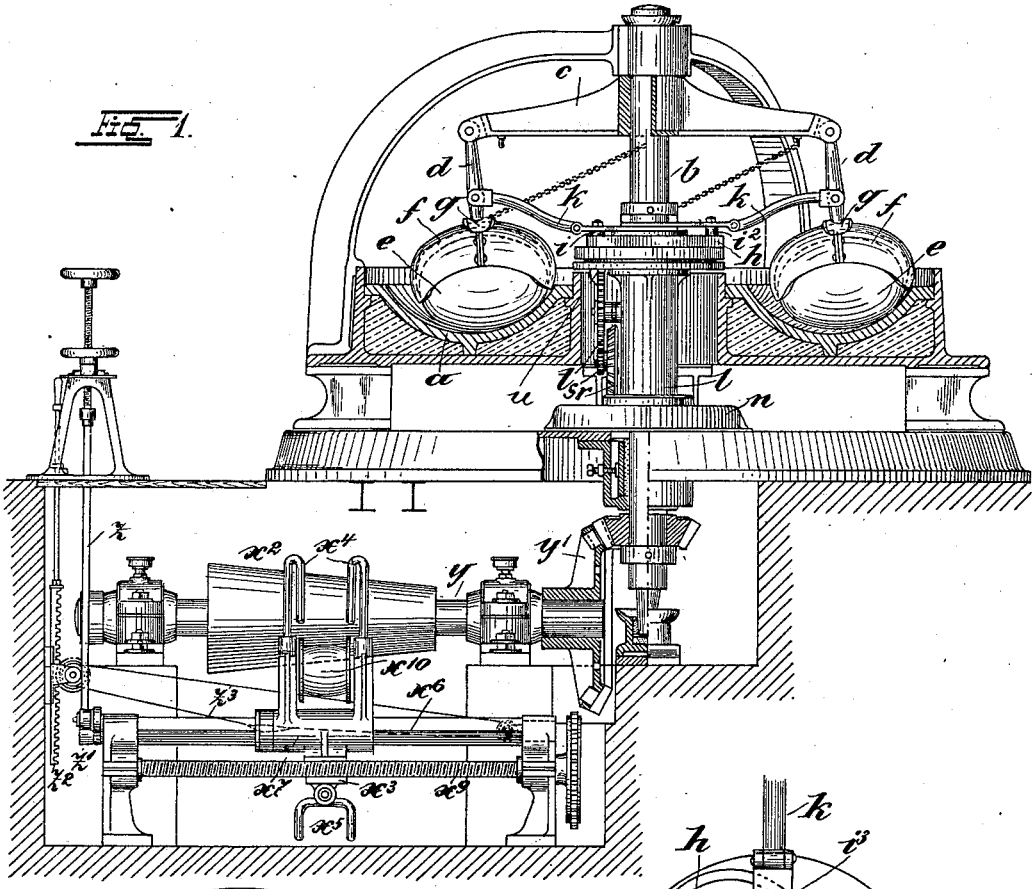
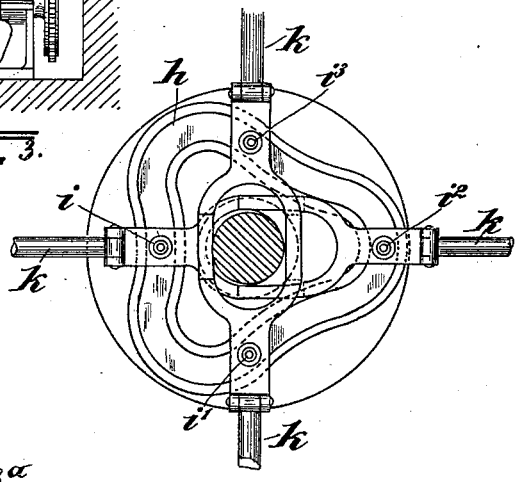


Fig. 3.



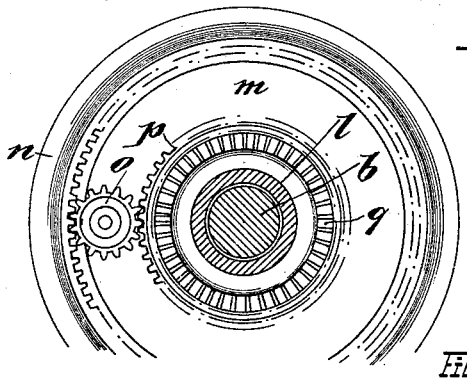


Fig. 3a.

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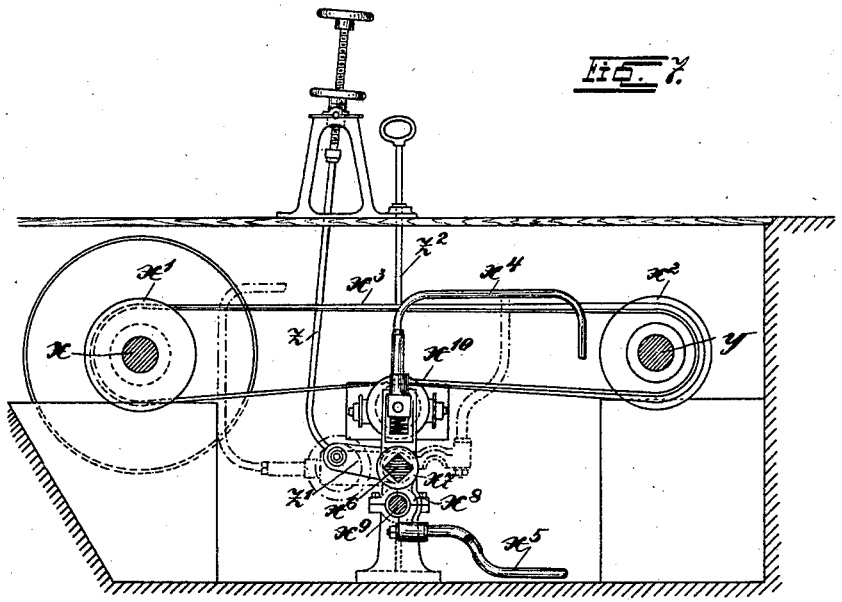
FIG. 1.



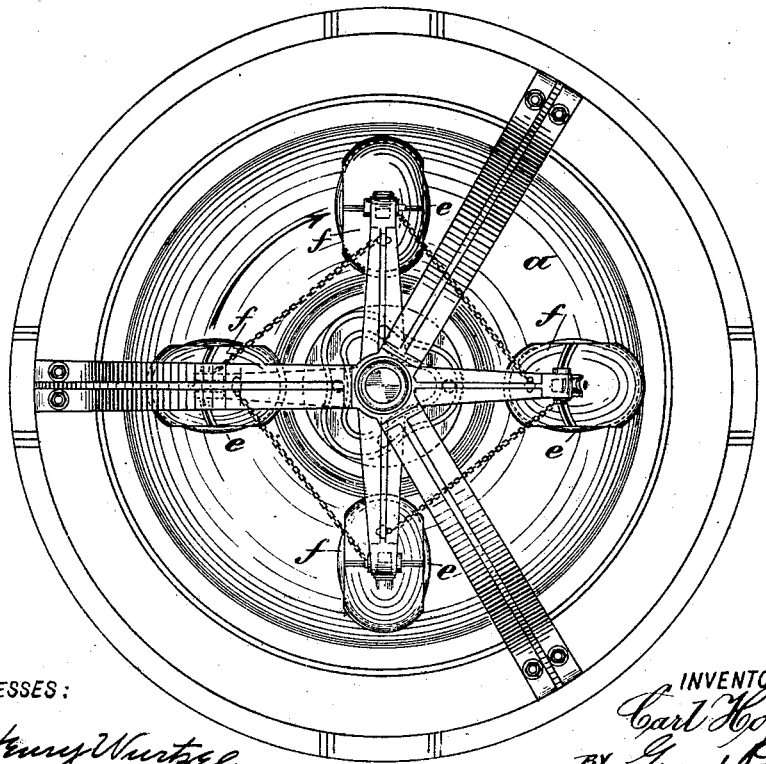


FIG. 2.

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(No Model.) 3 Sheets—Sheet 3.

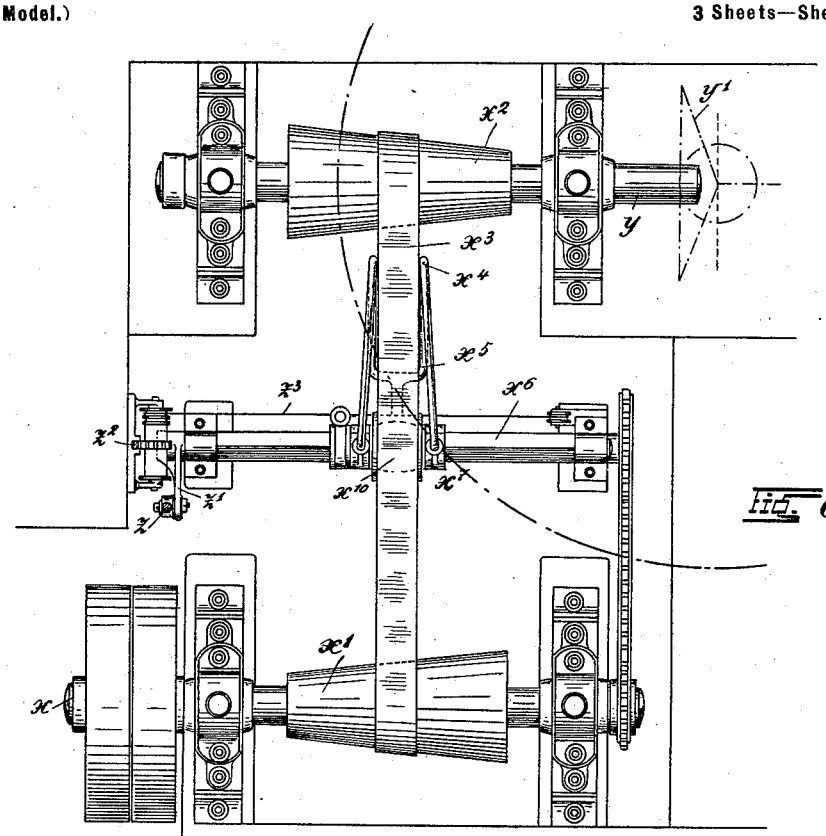

Fig. 6.

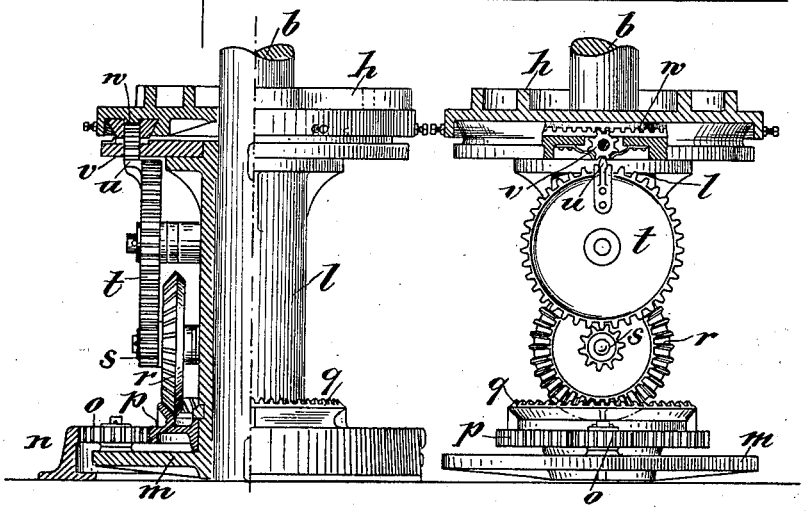

Fig. 4. Fig. 5.

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UNITED STATES PATENT OFFICE.

CARL HOFMANN, OF BRESLAU, GERMANY.

BALL GRINDING-MILL.

SPECIFICATION forming part of Letters Patent No. 676,254, dated June 11, 1901.

Application filed September 17, 1898. Serial No. 691,157. (No model.)

To all whom it may concern:

Be it known that I, CARL HOFMANN, merchant, of Klosterstrasse 66, Breslau, in the Province of Silesia, German Empire, have invented certain new and useful Improvements in Mills, of which the following is a full and clear description.

This invention relates to grinding, crushing, and similar machines of the ball-and-ring type; and its object is to improve the efficiency of such machines.

In a machine constructed to embody these improvements the balls are preferably oval and have an oscillatory motion imparted to them in addition to their rotary motion around the ring.

The accompanying drawings illustrate a machine constructed according to this invention.

Figure 1 illustrates the machine in longitudinal section. Fig. 2 shows it in plan. Figs. 3, 3ª, 4, and 5 are representations of the devices for imparting oscillatory motion to the balls. Figs. 6 and 7 are respectively a plan and a side elevation of the mechanism whereby the speed of the machine may be varied. This mechanism is also shown in front elevation in Fig. 1.

Referring to Figs. 1 and 2, *a* represents the trough-shaped ring, in which the material to be crushed is placed. *b* is a vertical rotary shaft carrying the four projecting arms *c*, the outer extremity of each of which is furnished with a pivoted link or arm *d*, capable of moving toward or away from the central shaft *b*. The lower ends of the links *d* are movably secured to the cups or shells *f*, which loosely contain the balls *e*. As shown, these balls are preferably oval. The cups *f* are so connected to the links *d* at the points *g* that they may give and enable the balls to surmount and pass any unusual obstacle contained within the ring.

The device for causing the balls to oscillate across the ring during their rotation therein is illustrated most clearly in Fig. 3. A grooved cam *h* surrounds the shaft *b*, and with the groove are engaged the bolts $i\,i'\,i^2$, which are carried by the arms *k*. These arms are suitably jointed in their lengths and are connected to the links *d*. Thus upon the rotation of the shaft *b* the arms *c* and the balls *e* are carried around the ring *a* and cause also the rotation of the arms *k*. These latter by their engagement with the grooved cam are also reciprocated and cause the oscillation of the balls across the ring.

The cam *h* may either be fixed or caused to rotate slowly, the latter being preferred, as with a stationary cam the balls would always move across the ring at the same points and unequal wear would result. With a slowly-rotating cam, however, all parts of the ring will be equally worn.

The devices by means of which the desired rotation of the cam may be effected are shown in Figs. 3, 3ª, 4, and 5. Fixed to the shaft *b* is a sleeve *l*, the lower part of which is formed into or is provided with a disk or plate *m*, carrying the pinion *o*. This pinion gears with internal teeth formed within a surrounding casing *n* and also with a wheel *p*, which is free to rotate upon the sleeve *l*. This wheel is in one piece with a bevel-wheel *q*, which in its turn gears with a bevel-wheel *r*, to which the pinion *s* is secured. This pinion engages with the wheel *t*, which is provided with an additional projecting tooth *u*. Once during every revolution of the wheel *t* this tooth comes into contact with and gives a partial rotation to the pinion *v*, mounted on plate *v'*, carried by the sleeve *l*, and which also engages with the wheel *w*, secured to the grooved cam *h*. In this manner a slight angular motion is imparted to the cam during the working of the machine.

The improved machine may also be furnished with mechanism for automatically increasing its speed as the crushing or grinding progresses. A form of apparatus which may be employed is represented in Figs. 1, 6, and 7. The main driving-shaft *x* is provided with fast and loose pulleys of the usual construction and with a coned pulley *x'*. From this latter pulley a belt x^3 passes to and around the inversely-coned pulley x^2, mounted upon the shaft *y*, the end of which carries the bevel-wheel *y'* for driving the machine. The belt x^3 passes through the belt-fork x^4, the lower end of which is formed with an extension x^5. The boss or support x^7 of the belt-fork is mounted upon and is capable of sliding along the square shaft x^6. Connected to the boss is the partial or half nut

x^8, capable of engaging with the rotary screw x^9, by the rotation of which the boss and the strap-fork may be moved along the shaft x^6. The belt is thus moved along the coned pulleys as the grinding proceeds, the movement being in such a direction as to increase the speed of the machine. x^{10} is a guide-bolt attached to the belt-fork. The screwed shaft x^9 may be rotated by means of a chain or the like from the main shaft x. When the belt reaches the end of the coned pulleys, the machine is automatically stopped. To return the belt to the other end of the pulleys, a slight angular motion is given to the square shaft x^6 by means of the rod z and the lever z'. By this motion the half-nut x^8 is moved away from the screwed shaft, the forks x^4 x^5 are swung into the position shown in dotted lines, and the belt-fork is free to move along the square shaft. A rack z^2 is arranged in gear with a pinion to which is attached a reel or drum having wound around it the cord or chain z^3. One end of this cord is attached directly to the belt-fork, and the other end passes around a pulley on the opposite side of the mechanism and is then in turn also attached to the fork. The rotation of the drum in one direction will draw the fork toward it, and its rotation in the other direction will cause the fork to move away. The rotation of the drum in the required direction may be effected by raising or depressing the rack z^2.

The dotted lines in Fig. 7 show the positions of the various parts when the belt is free to be moved from one end of the pulleys to the other. The extension x^5 of the fork is now in engagement with the belt, and the bolt x^{10}, which has before served to maintain tension in the belt, has now left it, so that the belt is slack.

The links d or the cups or casings f may advantageously be additionally connected to the arms c by means of chains or the like.

Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed, I declare that what I claim is—

1. In a ball grinding-mill, the combination of a trough-shaped ring, a rotary drive-shaft within the same, supporting-arms extending radially from said shaft, depending links pivoted to the said arms, grinding-balls suitably supported by said links, and means positively connecting the said links with the drive-shaft for imparting an oscillatory movement to the links and balls, substantially as set forth.

2. In a ball grinding-mill, the combination of a trough-shaped ring, a rotary drive-shaft arranged at the center of the ring, arms extending radially from said shaft, depending links pivoted to the said arms at points approximately above the middle of the cross-section of the ring, grinding-balls elongated transversely to the ring and suitably supported by said links, and means for imparting an oscillatory movement to the links and balls, whereby the latter are caused to travel in a serpentine path in the trough of the ring, substantially as set forth.

3. In a ball grinding-mill, the combination of a trough-shaped ring, a rotary drive-shaft, grinding-balls elongated transversely to the ring, means for imparting rotary motion from the drive-shaft to the balls so as to move them around upon the ring, and means for moving said balls in longitudinal direction, so that a compound movement is imparted to the balls, causing them to travel in a serpentine path around the ring, substantially as set forth.

4. In a ball grinding-mill, the combination of a trough-shaped ring, a rotary drive-shaft, grinding-balls in the trough of the ring, means for imparting rotary motion to the balls around the ring, means for moving the balls in a direction toward and from the shaft, whereby the same are caused to travel in a serpentine path, and means, acting on the latter means, for intermittently changing the path of movement of the balls, substantially as set forth.

5. In a ball grinding-mill, the combination of a trough-shaped ring, a rotary drive-shaft, grinding-balls in the trough of the ring, means for imparting rotary motion to the balls around the ring, means for moving the balls from side to side of the ring, causing them to move in a serpentine path, and means for gradually increasing the speed of the balls around the ring, substantially as set forth.

In witness whereof I have hereunto set my hand in presence of two witnesses.

CARL HOFMANN.

Witnesses:
HERMAN BORTSCH,
EDWIN WEISS.