(No Model.) 4 Sheets—Sheet 1.

W. DUFFIELD & W. R. TAYLOR.

MILL FOR CRUSHING AND GRINDING.

No. 563,145. Patented June 30, 1896.

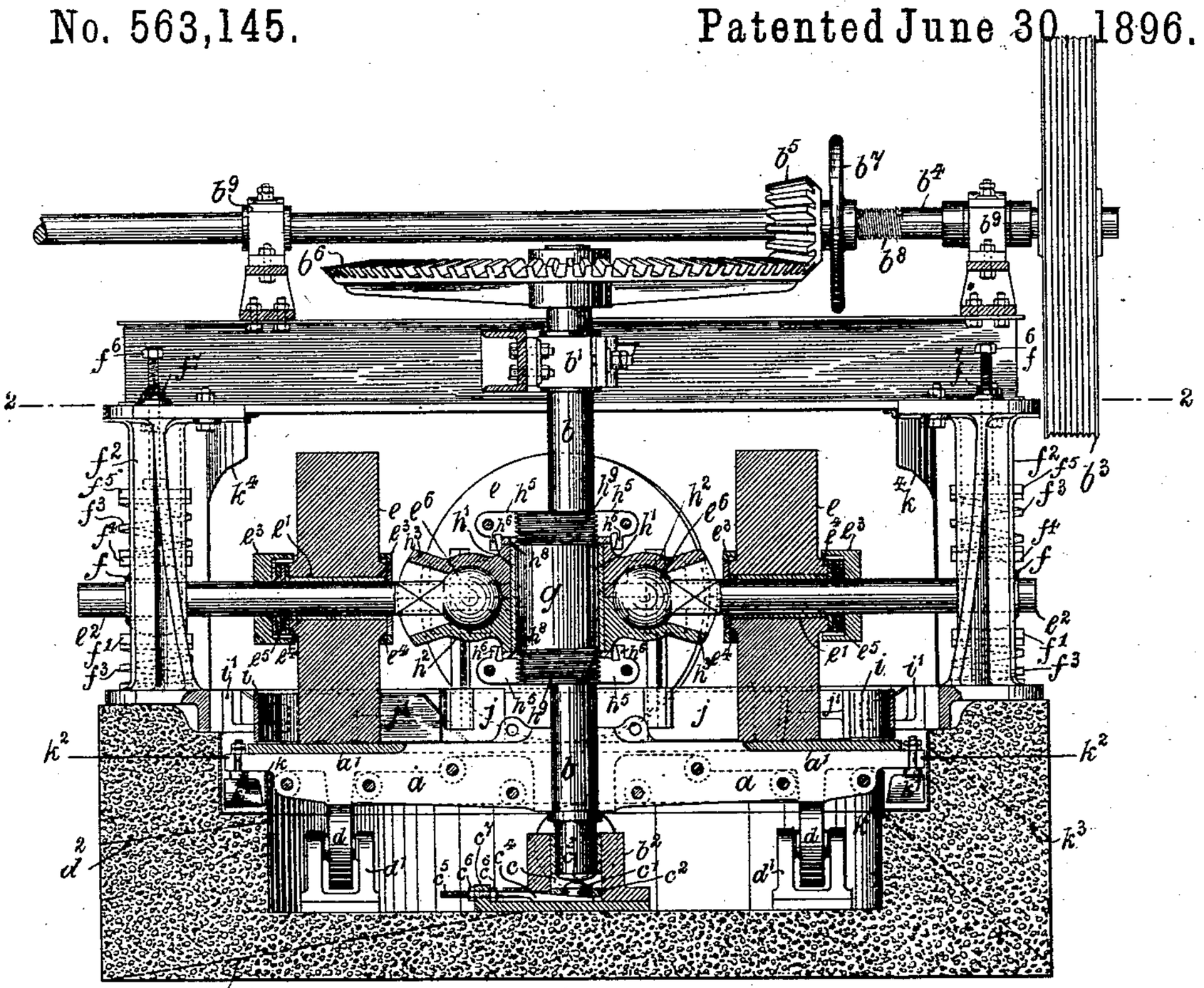

Fig. 1.

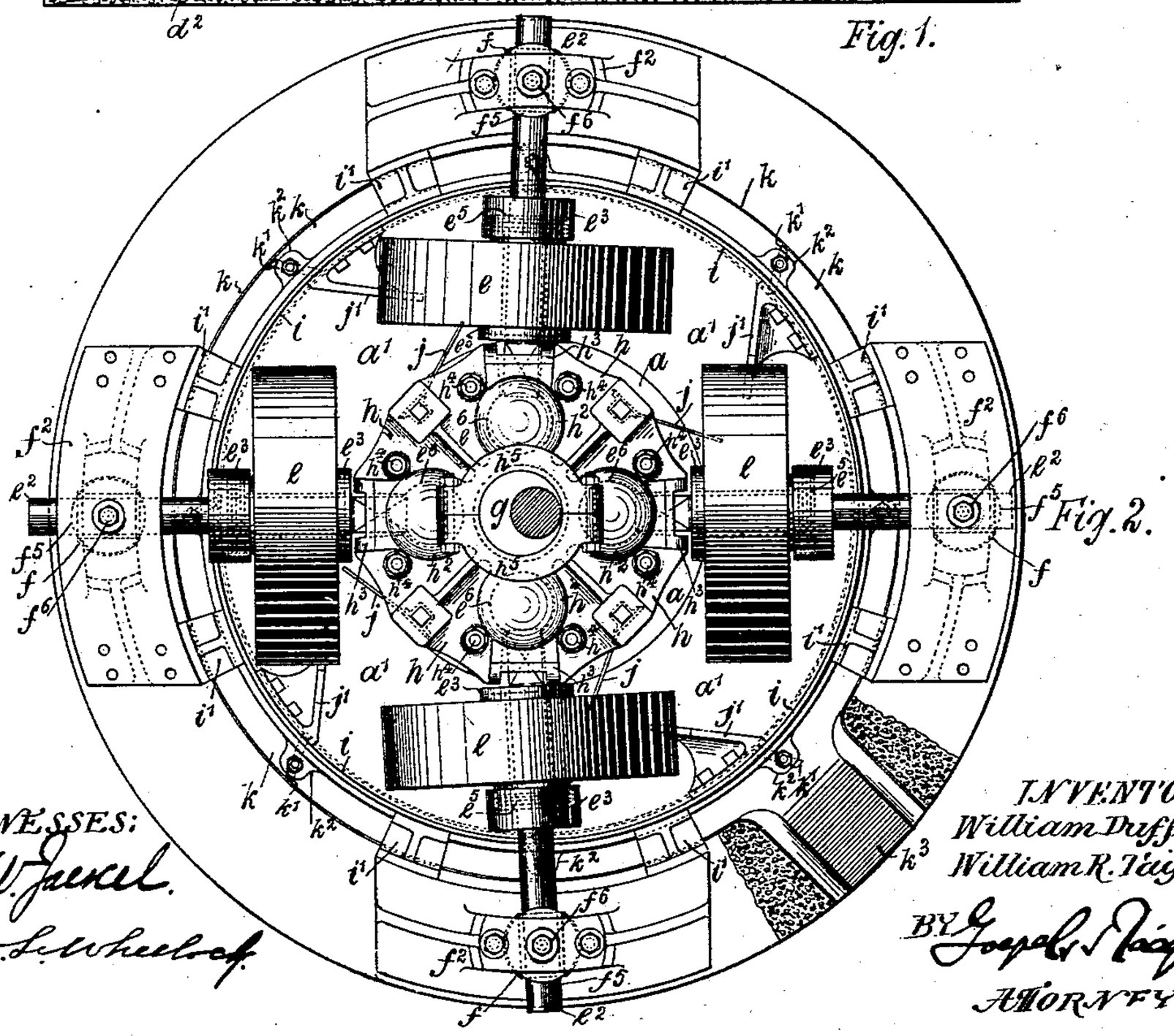

Fig. 2.

WITNESSES:
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Geo. L. Wheelock.

INVENTORS
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ATTORNEYS.

(No Model.)

4 Sheets—Sheet 2.

W. DUFFIELD & W. R. TAYLOR

MILL FOR CRUSHING AND GRINDING.

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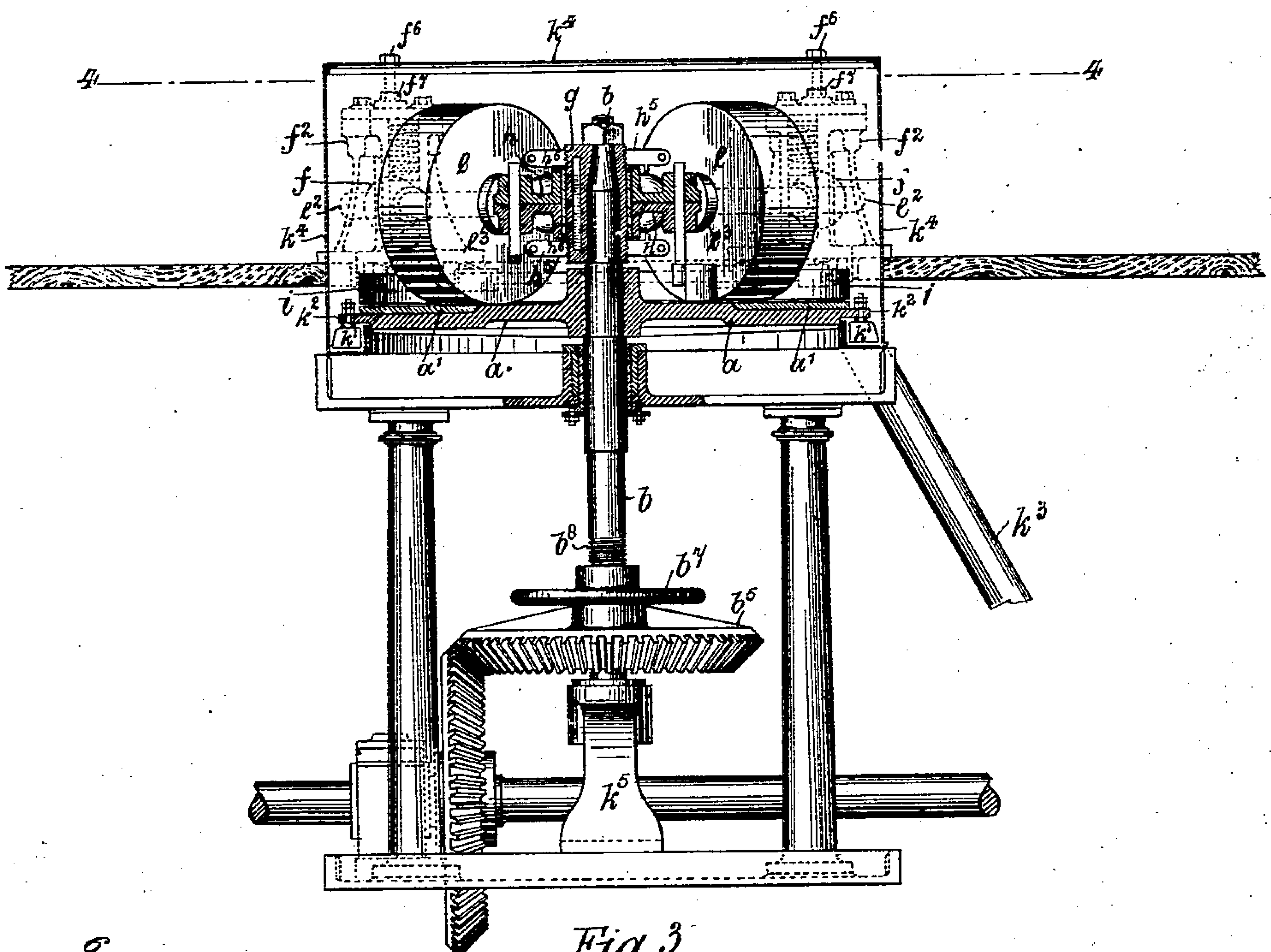

Fig. 3.

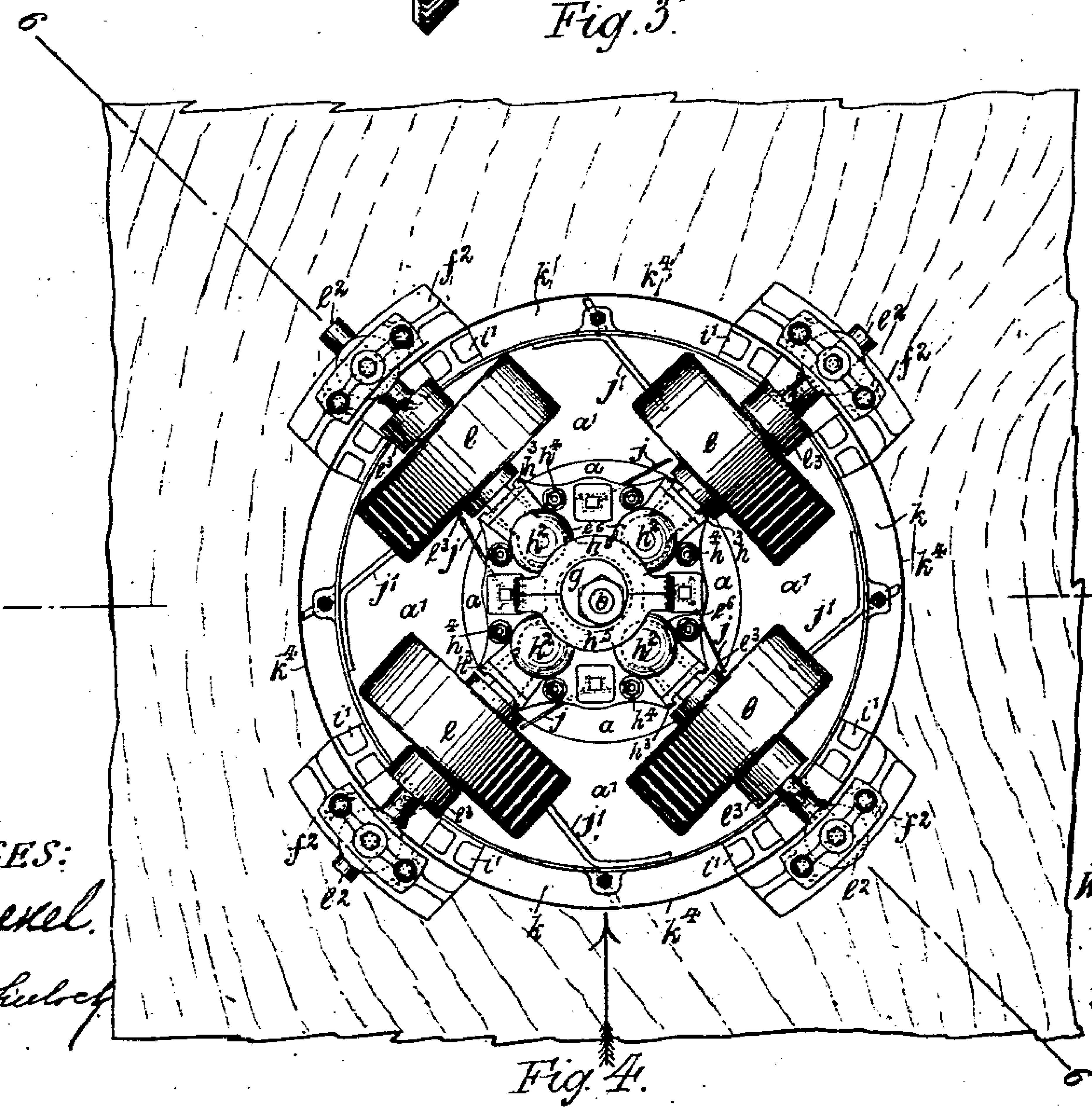

Fig. 4.

WITNESSES:
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Geo. Silvoheuloef

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W. DUFFIELD & W. R. TAYLOR.

MILL FOR CRUSHING AND GRINDING.

No. 563,145. Patented June 30, 1896.

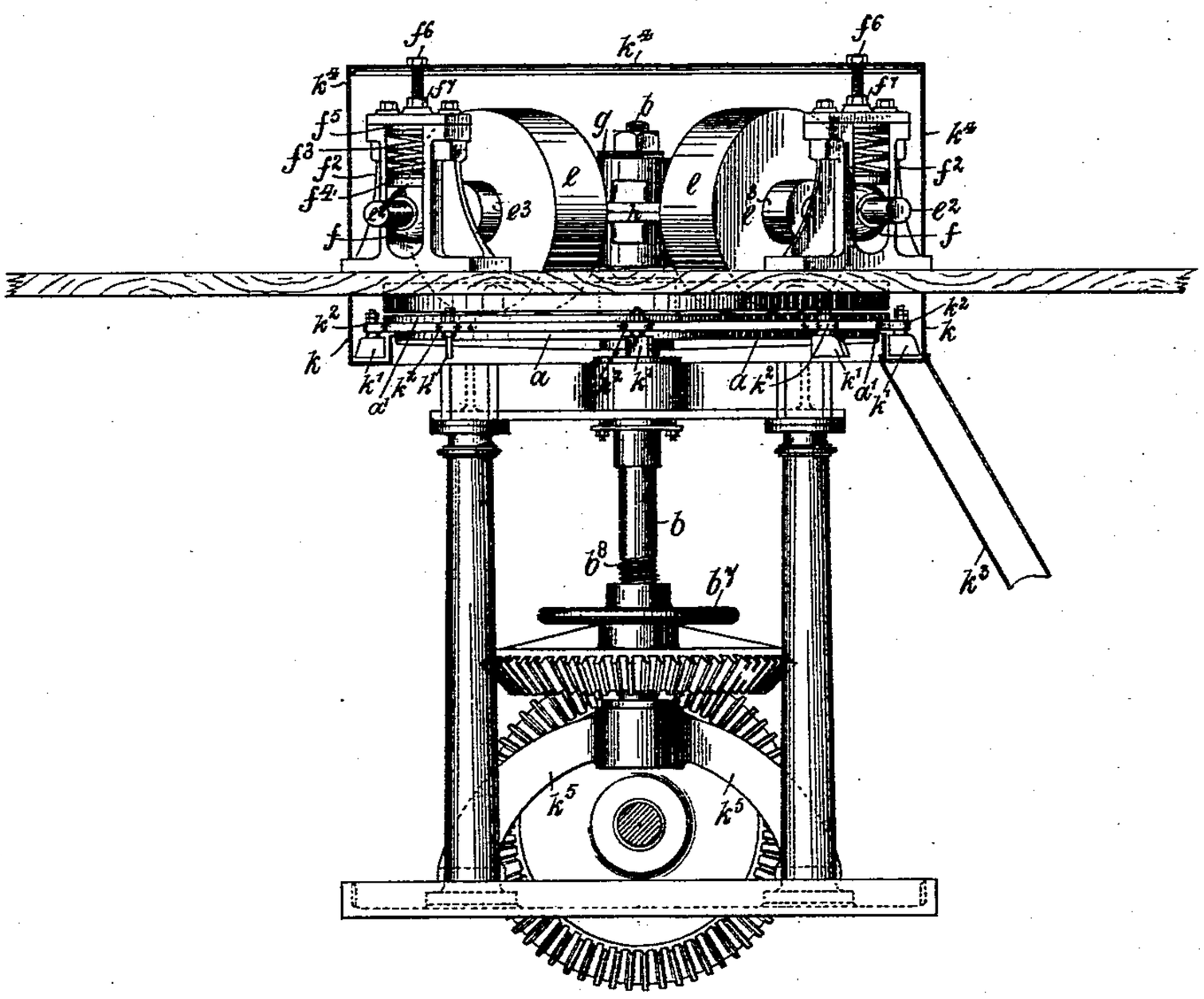

Fig. 5.

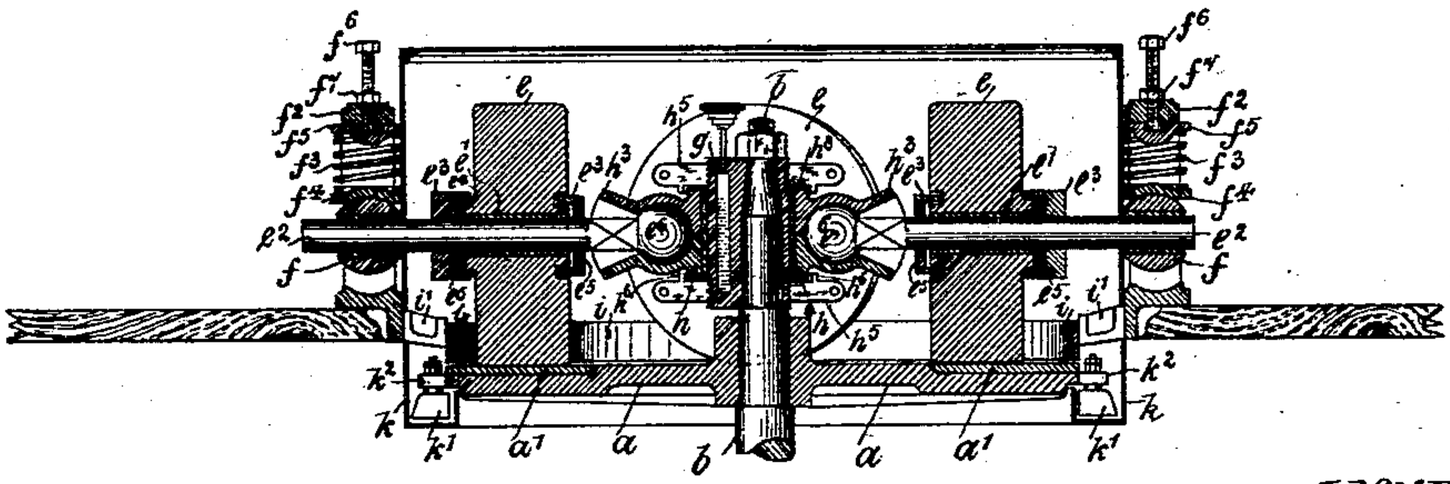

Fig. 6.

WITNESSES:
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(No Model.) 4 Sheets—Sheet 4.

W. DUFFIELD & W. R. TAYLOR.

MILL FOR CRUSHING AND GRINDING.

No. 563,145. Patented June 30, 1896.

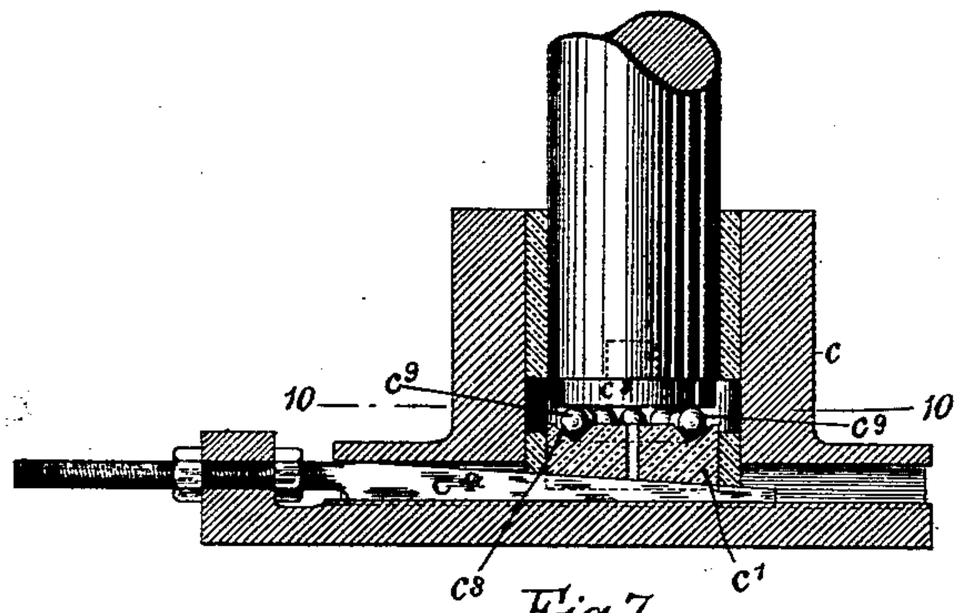

Fig. 7.

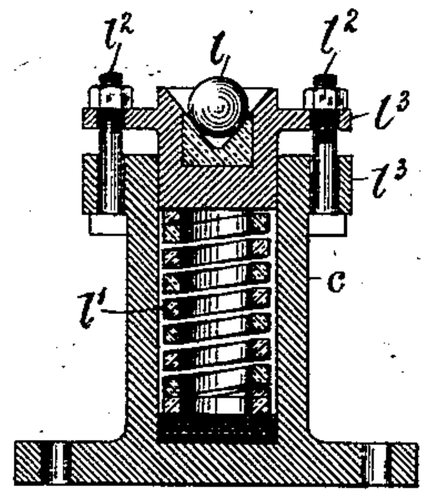

Fig. 9

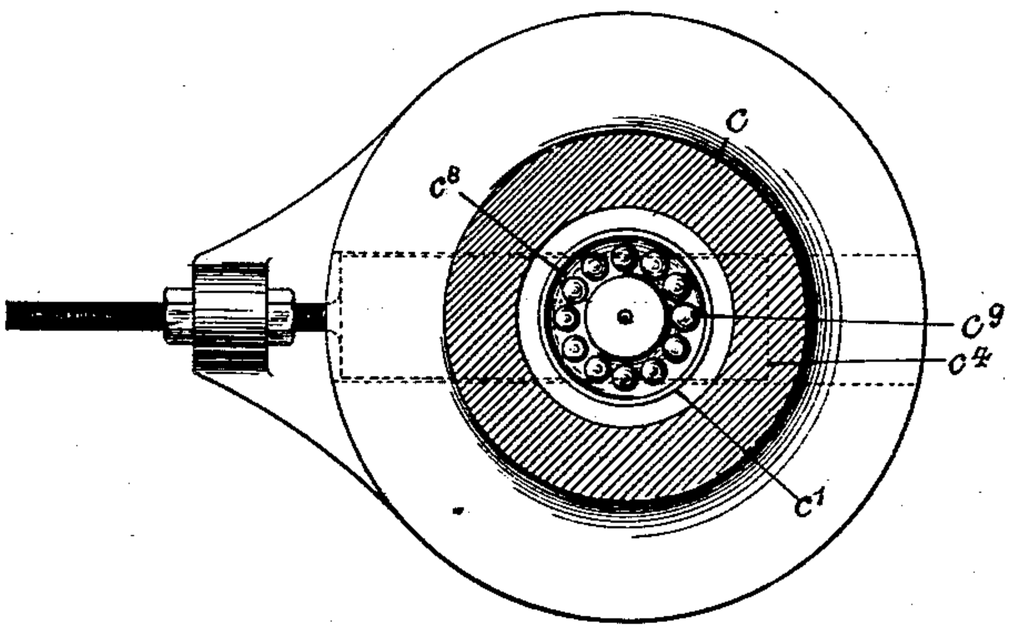

Fig. 8.

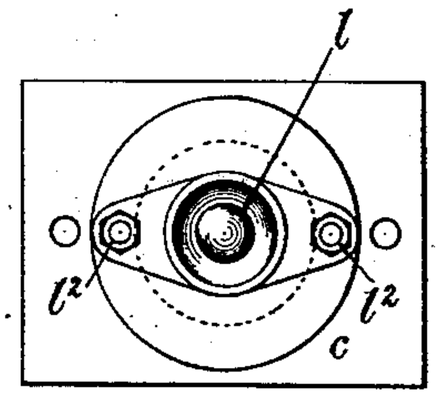

Fig. 10.

WITNESSES:
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Geo. L. Wrobleff.

INVENTORS
William Duffield
William R. Taylor
BY Joseph & Wagner,
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UNITED STATES PATENT OFFICE.

WILLIAM DUFFIELD AND WILLIAM ROWLAND TAYLOR, OF LONDON, ENGLAND.

MILL FOR CRUSHING AND GRINDING.

SPECIFICATION forming part of Letters Patent No. 563,145, dated June 30, 1896.

Application filed May 31, 1895. Serial No. 551,210. (No model.) Patented in England April 19, 1893, No. 7,926; in Germany June 7, 1894, No. 84,324, and in France June 16, 1894, No. 239,384.

To all whom it may concern:

Be it known that we, WILLIAM DUFFIELD, of No. 7 Nelson Road, Chatham, and WILLIAM ROWLAND TAYLOR, of No. 2 Star Hill Villas, Rochester, London, both in the county of Kent, England, subjects of the Queen of the United Kingdom of Great Britain and Ireland, have invented certain new and useful Improvements in Mills for Crushing and Grinding, (for which we have obtained the following patents: in Great Britain and Ireland, No. 7,926, April 19, 1893; France, No. 239,384, June 16, 1894, and Germany, No. 84,324, June 7, 1894;) and we do hereby declare that the following is a full, clear, and exact description of the invention, reference being made to the accompanying drawings, which are to be taken as part of this specification and read therewith, and one which will enable others skilled in the art to which it appertains to make and use the same.

This invention relates to improvements in mills for crushing and grinding Portland cement, clinker, or any other substance, wet or dry, by means of a revolving or fixed pan with two or more heavy runners revolving on axles, at and in suitable speeds and positions, whereby a combined increased grinding and crushing surface is obtained with considerably less power than by any other known mill for the same purpose.

In one form of mill made according to this invention a plate or pan is fixed to a vertical shaft running in a toe-step at the bottom and a bearing at the top, and power is imparted to it through any suitable gearing. This vertical shaft is fitted with cams or eccentrics which revolve in a center casting or mace. The latter is fitted with two or more receptacles for receiving the shafts which carry the runners or crushers. The shafts are made with spherical ends, which are fitted to suitable receptacles formed in the mace. The outer end of each of these shafts is carried in a spherical bearing, through which it can slide to and fro. Further, the bearing is held in a vertical slotted column between two springs—one above it, and one below it, and both within the slot—in such a way that it can rise or fall and turn about its center as the shaft changes its position. The motion is imparted to the said runners by the revolving pan coming in contact with them, and the vertical shaft, at the same time, imparts motion to the cams or eccentrics, which cause the mace to work in and out according to the amount of the throw of the cams. The runners revolve on their shafts and are kept in position by collars or the like. As they are fixed to the mace they work in and out at the same time, thereby causing a continuous scrubbing or grinding, in addition to the well-known crushing motion of the runners.

The runners are made of hard chilled iron, or any other suitable material, with flat or concaved faces, and revolve on a renewable path made of cast-steel, or any other suitably-hard material, with a flat or convex surface to correspond. The latter may be made in segments fixed to the pan.

The mill may be fed at any part, and the stuff to be ground may be distributed by means of adjustable scrapers fixed to the mace, by which means it is kept in constant agitation.

The stuff when ground will pass off the pan by centrifugal force and under an adjustable ring or other suitable device placed near the periphery of the pan. The latter is fitted with various scrapers for passing back to the runners the stuff not sufficiently ground. The ground stuff, after passing under the ring, passes over the edge of the pan and falls into a receptacle, from which it is collected or expelled by means of scrapers fixed to the under part of the outer edge of the pan.

Our invention includes the application of the cam or eccentric mechanism above described as for imparting the scrubbing or grinding motion and action to the pan instead of to the runners of an edge-runner grinding-mill.

Figure 1 is a front elevation, partly in section. Fig. 2 is a sectional plan taken on the line 2 2 of Fig. 1. Fig. 3 is a sectional front elevation taken on the line 3 3 of Fig. 4. Fig. 4 is a sectional plan taken on the line 4 4 of Fig. 3. Fig. 5 is a front elevation of Fig 4, looking at it in the direction of the arrow, showing the casing of the grinding mechan-

ism in section. Fig. 6 is a sectional elevation taken on the line 6 6 of Fig. 4. Fig. 7 is a sectional elevation of a substitute type of adjustable step-bearing. Fig. 8 is a horizontal section on the line 10 10 of Fig. 7. Fig. 9 is a sectional elevation of a modified form of ball-bearing. Fig. 10 is a plan thereof.

Referring to Figs. 1 and 2, the mill illustrated therein is an edge-runner with a revolving pan, constructed according to the present invention. The usual pan is replaced by a flat plate a, which may be of any suitable construction. It is shown as consisting of several segments bolted together. The annular surface upon which the crushing and grinding is effected is provided by a renewable ring a'. The plate a and ring a' are hereinafter referred to as the "pan." The pan is made fast in the horizontal plane, as heretofore, to a vertical shaft b, which is carried in suitable bearings. The top bearing b' is carried by the frame of the mill. The bottom one is described farther on. The driving-gear may be of any suitable kind. It is shown as consisting of a rope-pulley b^3 on a counter-shaft b^4, a miter-pinion b^5, and a crown-wheel b^6. The latter is fast on the top of the vertical shaft b. Provision is made for putting the mill in and out of work by connecting the pinion b^5 to a hand-wheel b^7 concentrically with it in such a way that either can be rotated independently of the other, but so that neither can be moved along the counter-shaft without the other. This hand-wheel is bored out and screwed to engage with a screw-thread b^8 on the counter-shaft. The latter is carried in bearings in pillow-blocks b^9 b^9, bolted on the top of the frame of the mill. The top bearing b' is supported by the said frame, while the bottom one b^2 is a step-bearing of special construction, standing upon the bed of the mill. c is the box of this step-bearing, and c' a toe held in a central position therein by a ring c^2.

The end of the shaft b is fitted with a convex button c^3, up to which the toe is kept by a wedge c^4, which can be moved longitudinally in either direction across the bottom of the box c and through its side by the wedge-shank c^5, which serves as a handle for that purpose. The function of the wedge c^4 being to provide for setting up the toe c', provision is made for holding the wedge in any given position with reference to the height at which it holds the toe by means of two lock-nuts c^6 on the shank c^5, one on each side of a tab c^7 through which the said shank passes.

d d are antifriction-rollers supported by pillow-blocks d', standing on the bed of the mill. Their function being to support the pan against the weight of the runners, they are placed centrally under the ring a'. Access to the step-bearing, as well as to the rollers d, is provided by a way d^2 in the bed. This way is indicated by dotted lines in Fig. 1.

e e e e are four edge-runners. They may be of any suitable material, and are fitted with bushes e'. e^2 e^2 e^2 e^2 are their shafts. A runner is held to its shaft by a pair of dust-collars e^3 e^3. These respectively embrace rings e^4 e^4 on the sides of the runner, and are made fast to the shaft by any suitable device.

e^5 e^5 are antifriction-collars inserted between the outer dust-collar e^3 and ring e^4. The outer end of each shaft e^2 has its bearing in a sphere f, which is carried between two plates f' f^4, both suitably concaved on their respectively-adjacent faces for it to fit in. This method of supporting the sphere provides for it being moved in any direction about its center. The sphere f and plates f' f^4 are capable of a vertical motion in either direction in a slot in the column f^2. The plates are kept up to the sphere, and all three returned to their normal position in the slot by a pair of spiral cushioning-springs f^3, one above and one below the sphere. The bottom spring f^3 acts between the base of the column f^2 and the under side of the plate f', and the top one between the upper side of the plate f^4 and a plate f^5.

f^6 is a set-screw adapted to work through the top of the standard down upon the plate f^5 for the purpose of regulating the tension of the pair of cushioning-springs. f^7 is the locking-nut of the said set-screw.

g is an eccentric fast upon the shaft b, the axis through the center from which it is struck being parallel with the axis of the said shaft. Its function is to, in combination with a special device by which the inner end of each runner-shaft is held to the shaft, make the runners grind or scrub the stuff upon the pan, in addition to crushing it, as it is carried under; and, provided that this grinding or scrubbing action is duly provided for, our invention does not limit us in respect of the detailed construction of such eccentric, or whether there is used an eccentric or a cam, or a combination of both. The ring or strap of the eccentric, as well as the bearings for the inner ends of the four runner-shafts, are all merged in the mace h. This latter is bored out to fit the periphery of the eccentric, a suitable bush h' being interposed.

h^2 h^2 h^2 h^2 are four cups formed in the mace at equal distances from the geometric center of the eccentric, and with their centers in the same horizontal plane as that of the axes of the runner-shafts e^2. The inner end of each shaft has a ball e^6 formed upon it of a proper size to fit and turn smoothly in its respective cup h^2. The opening into the cup, *i. e.*, the open side of the cup, is larger than the runner-shaft by about one-half for two reasons, first, in order that the shaft may pivot vertically as the inequalities in the thickness or consistence of the stuff on the pan cause the runners to rise and fall, and, second, in order that the inner end of the shaft may follow the eccentric. Each cup is provided with a flaring mouth h^3, which strengthens the opening into the cup and serves as a stop to the respective shaft. The mace is split centrally in the

horizontal plane to allow of its cups embracing the balls e^6, the two halves being held together by bolts h^4. It is further held at its working level on the eccentric by a pair of combined holding rings or nuts h^5 and dust-guards p^6. Each nut is made in two halves for convenience in fixing, and is held to the eccentric by a screw-thread h^9, in order that the position of the mace upon the cam may be adjusted. An antifriction-ring h^8 is interposed between each nut and the mace.

i is a vertical metal ring, rather smaller (if anything) in diameter than the pan a. It is held over the latter by brackets i', which are fixed either to the bed of the mill or to the columns f^2. Provision must be made for adjusting the distance at which the ring i stands clear of the surface of the pan, because it is that distance which will be the gage to which the stuff is to be milled. We do not confine ourselves to any particular device, but suggest the use of vertical slots in either the ring, or the brackets, and nutted bolts passed through both. Further, the ring i may be made either in one piece or in segments, as may be preferred.

$j\,j$ are the central and $j'\,j'$ the outside diverters. The former are supported by the mace and the latter by the ring i.

k is a circular trough under, and projecting beyond, the pan a. $k'\,k'$ are scrapers supported in the said trough by tabs k^2 on the periphery of the pan.

k^3 is the chute from the trough. It is constructed in the bed of the mill and is indicated by the dotted lines in Fig. 1. The trough opens into it through its floor and outer wall. k^4 is a casing provided for the purpose of keeping the dust in.

Our invention constructed as above described works as follows: The ring i is first adjusted. As soon as the pinion B^5 is in gear with the crown-wheel b^6 the pan a begins to revolve and to rotate the runners, as heretofore, but in addition to this motion of rotation on the part of each runner in a vertical plane about a horizontal axis—both plane and axis being stationary, relatively to each other—each runner is at the same time compelled to grind or scrub over the pan, the direction of the grinding or scrubbing motion being elliptical. The effect of the combination of the two motions is that the stuff, no matter what may have been its condition when it was fed into the pan, is first crushed and then ground and floured, (*i. e.*, scrubbed,) being thereby reduced to an impalpable powder or fine-grained paste. The production of the said elliptical motion between the two contacting, and therefore operative, surfaces of the mill is the distinguishing feature of the process of grinding as conducted in a mill made according to the present invention. By "contacting and operative surfaces of the mill" we mean the peripheries of the runners and the surfaces of the pan, or the corresponding surfaces of a pair of burstones or a pair of disks. Each runner makes one elliptical motion upon the pan during one revolution of the latter. It is the interposition of the eccentric and eccentric-strap (or their equivalents, respectively) between the central shaft on the one side and the sockets of the inner ends of the runner-shafts on the other side, that is the agent by which the novelty in the process is effected. As the pan revolves, a centrifugal motion is imparted to the stuff, and those solid portions of the latter which are reduced to the desired gage (which is the distance between the ring i and the pan a) pass under the ring and drop into the trough k, from which it is driven by the scrapers k' into the chute k^3.

We do not confine ourselves in respect of an edge-runner made according to the present invention to making the pan rotary and the runner-shafts non-rotary and moving elliptically, for it is evident that an edge-runner in which the runner-shafts e^2 are fast to the central shaft b, and the pan a to the eccentric-strap, is as much according to our invention and within it as the one illustrated in Figs. 1 and 2 and described therewith.

Figs. 3 to 6 illustrate a mill constructed according to the present invention and mounted on a Mill Hurst framing. The consequent modifications are unimportant and will be readily understood from an examination of the figures in question. The step-bearing of the shaft b is carried by an arch k^5. The hand-wheel b^7 and screw-thread b^8 are transferred from the counter-shaft to the vertical shaft. The pillow-blocks d' and antifriction-rollers d are dispensed with, because they are not required in the small sizes of mills, which will be made according to the modification now under specification. The chute k^3 takes the form of a spout.

Referring to Figs. 7 and 8, c is the box of the bearing, and c' its toe. The button c^3 is flat as to its bottom face instead of being convex, and the top face of the toe c' is also flat. Further, it has an annulus c^8 (of smaller diameter than that of the button c^3) and which is provided with balls c^9, thereby providing a ball—as distinct from a step—bearing. The base of the toe c' is slotted, as indicated by the dotted lines, to straddle the wedge c^4, and the box c is slotted through both sides.

Referring to Figs. 9 and 10, the ball l stands in a conical seating, the base of which stands within the box c and rests upon a spiral spring l' held within the said box and within which it can rise and fall. $l^2\,l^2$ are bolts, which, by engaging with lugs l^3, are adapted to hold the seating to the box without interfering with its vertical motion.

We claim—

1. The combination of a shaft, an eccentric fixed on the same, an eccentric strap or mace arranged on the eccentric, and provided with cups at the side having flaring mouths, radial shafts provided with spherical inner ends received in said cups, edge-runners mounted on

said radial shafts, bearings for the outer ends of the shafts, and a rotary pan, substantially as set forth.

2. The combination of a shaft provided with an eccentric, an eccentric strap or mace arranged on the eccentric, and provided with cups, radial shafts provided at their inner ends with spherical portions received in said cups, edge-runners mounted on the radial shafts, vertically-movable spherical bearings in which the outer ends of the radial shafts are journaled, and a rotary pan below the edge-runners, substantially as set forth.

In witness whereof we have hereunto affixed our signatures, in presence of two witnesses, this 26th day of April, 1895.

WILLIAM DUFFIELD.
WILLIAM ROWLAND TAYLOR.

Witnesses:
H. WILD,
JAMES TONKIN COLEGATE.