(No Model.)

4 Sheets—Sheet 1.

D. CORNELL.

GRINDING MILL.

No. 418,168. Patented Dec. 31, 1889.

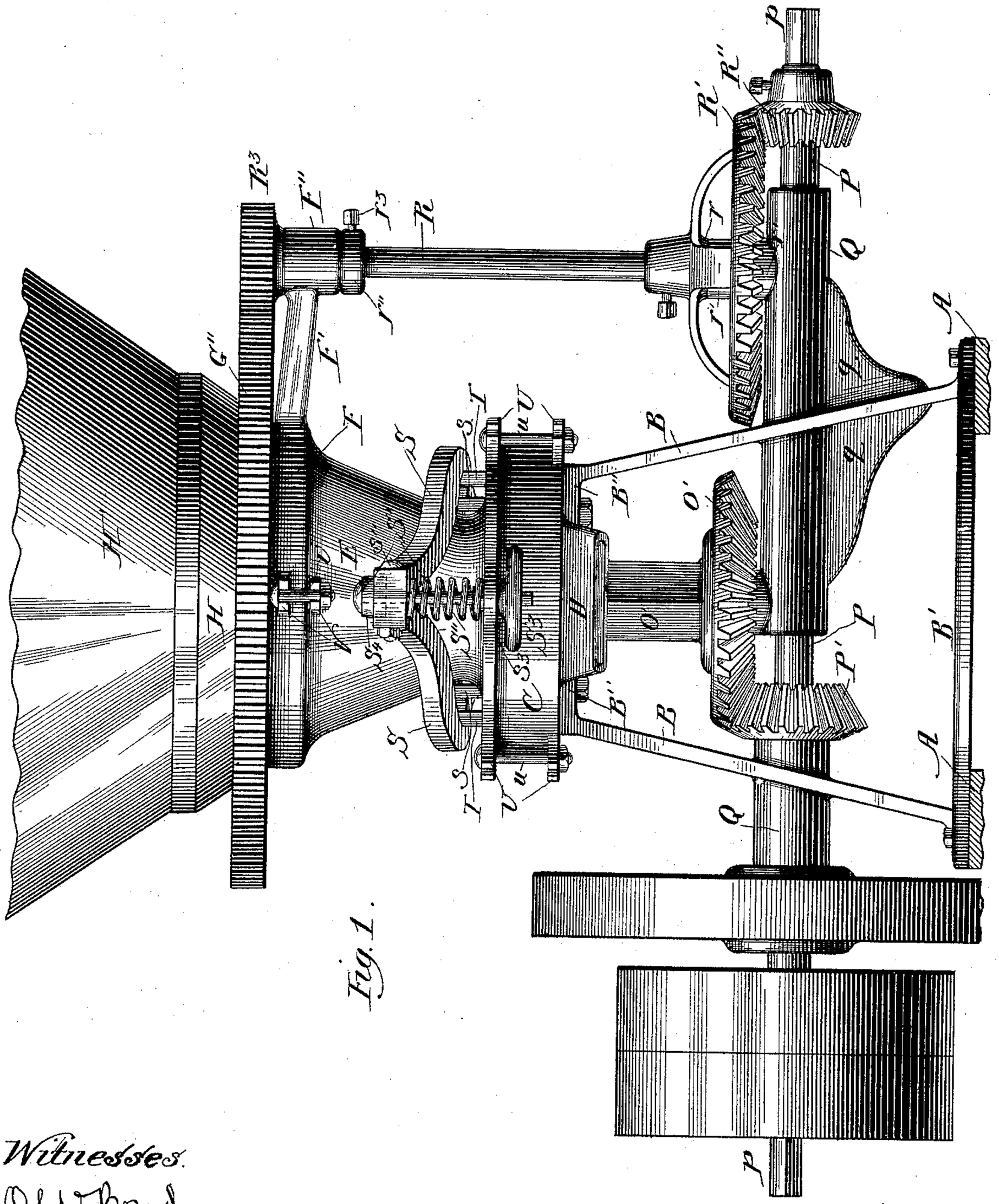

Fig. 1.

Witnesses.
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H. B. Hallock.

Inventor.
Delos Cornell.

(No Model.)

4 Sheets—Sheet 2.

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Fig. 3.

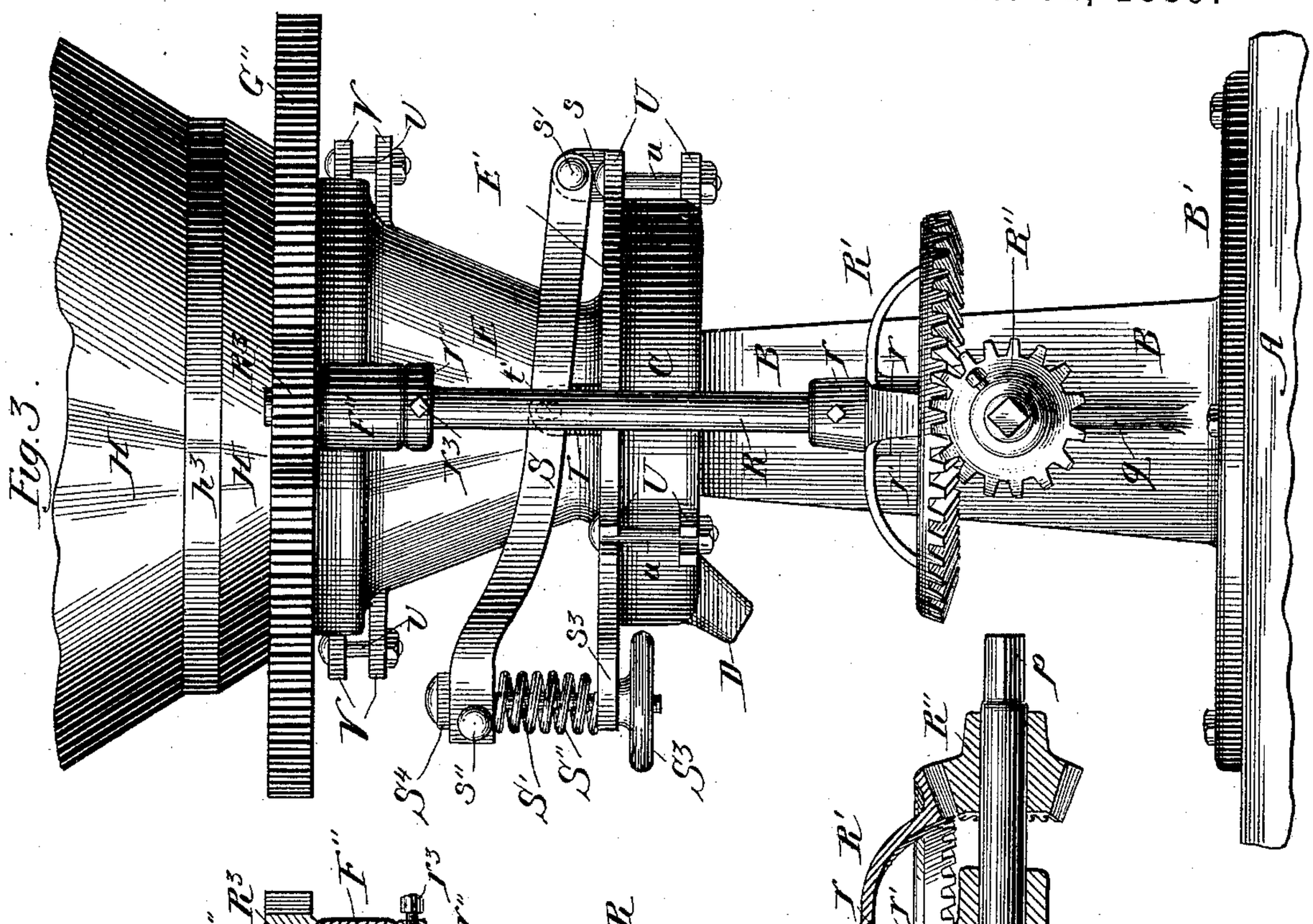
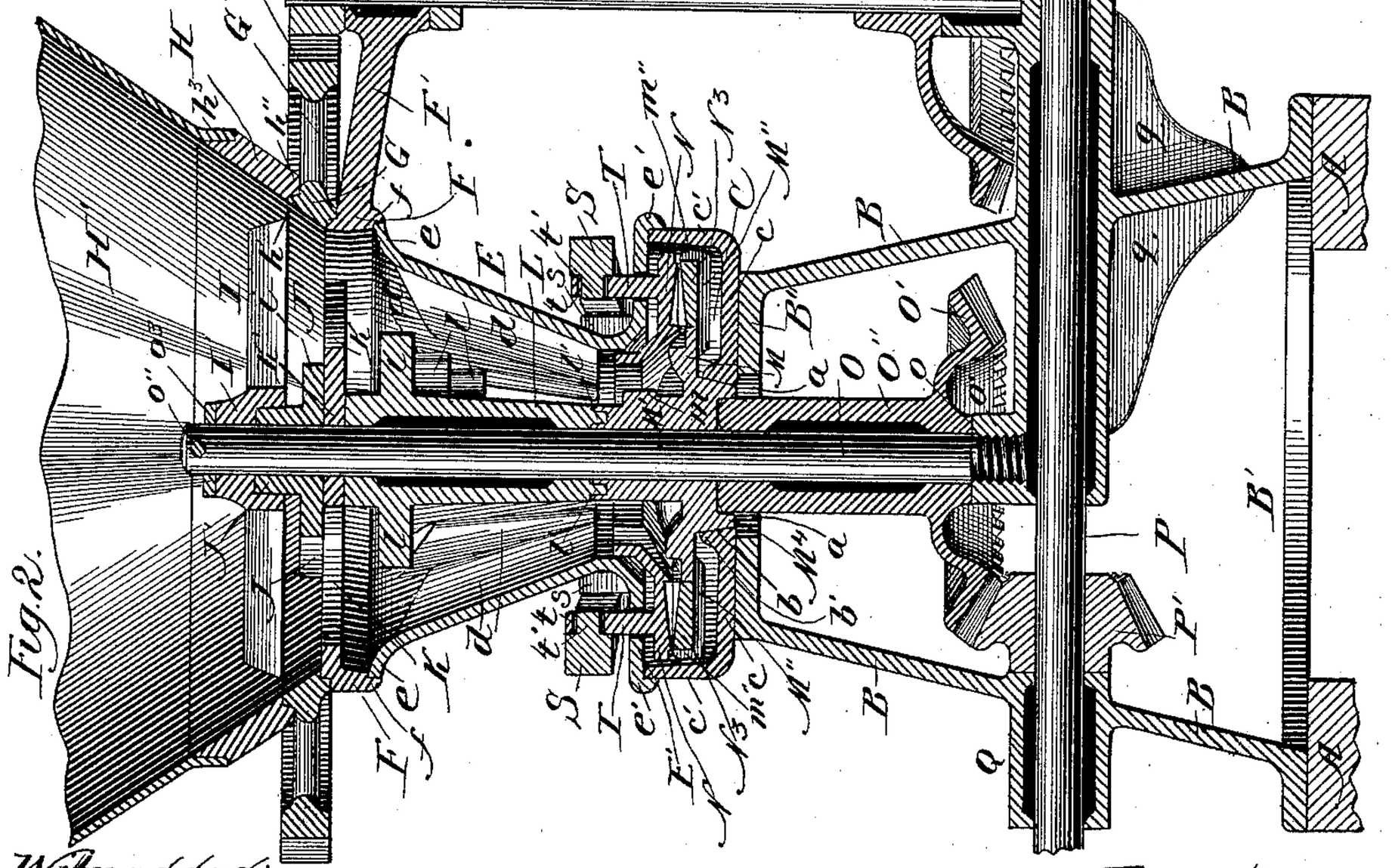


Fig. 2.



Witnesses:
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Delos Cornell

(No Model.) 4 Sheets—Sheet 3.

D. CORNELL.

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Fig. 4.

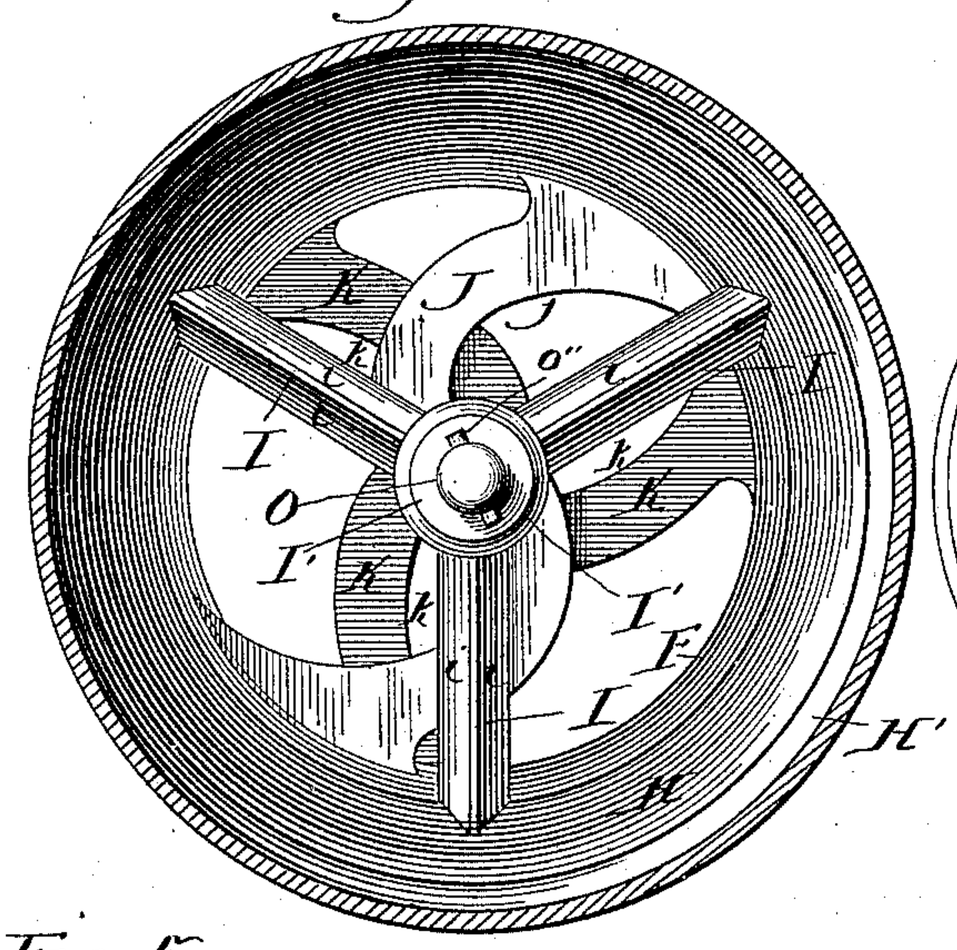


Fig. 6.

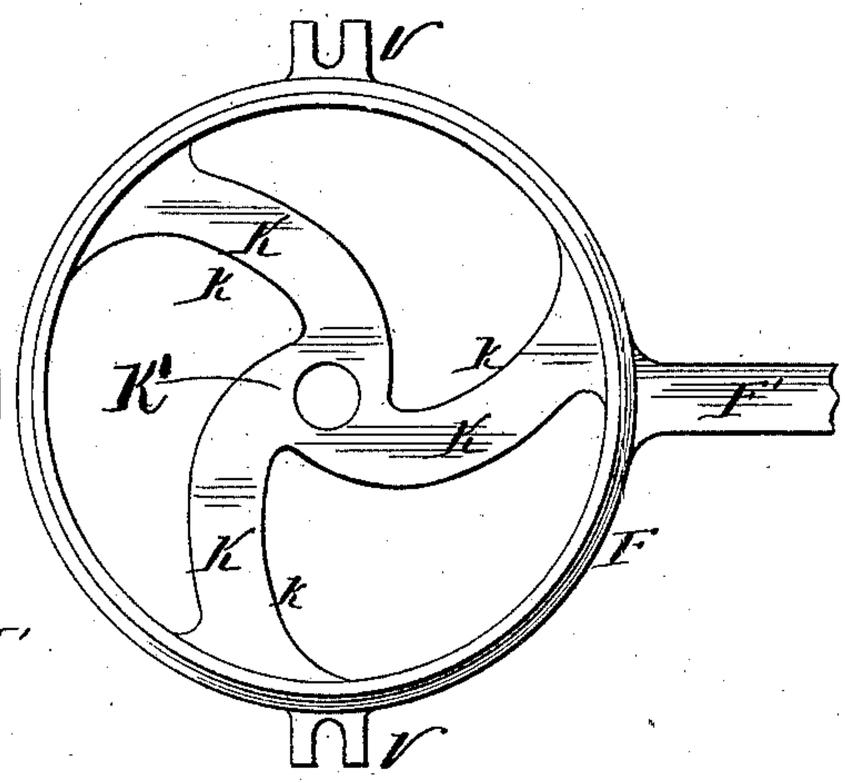


Fig. 5

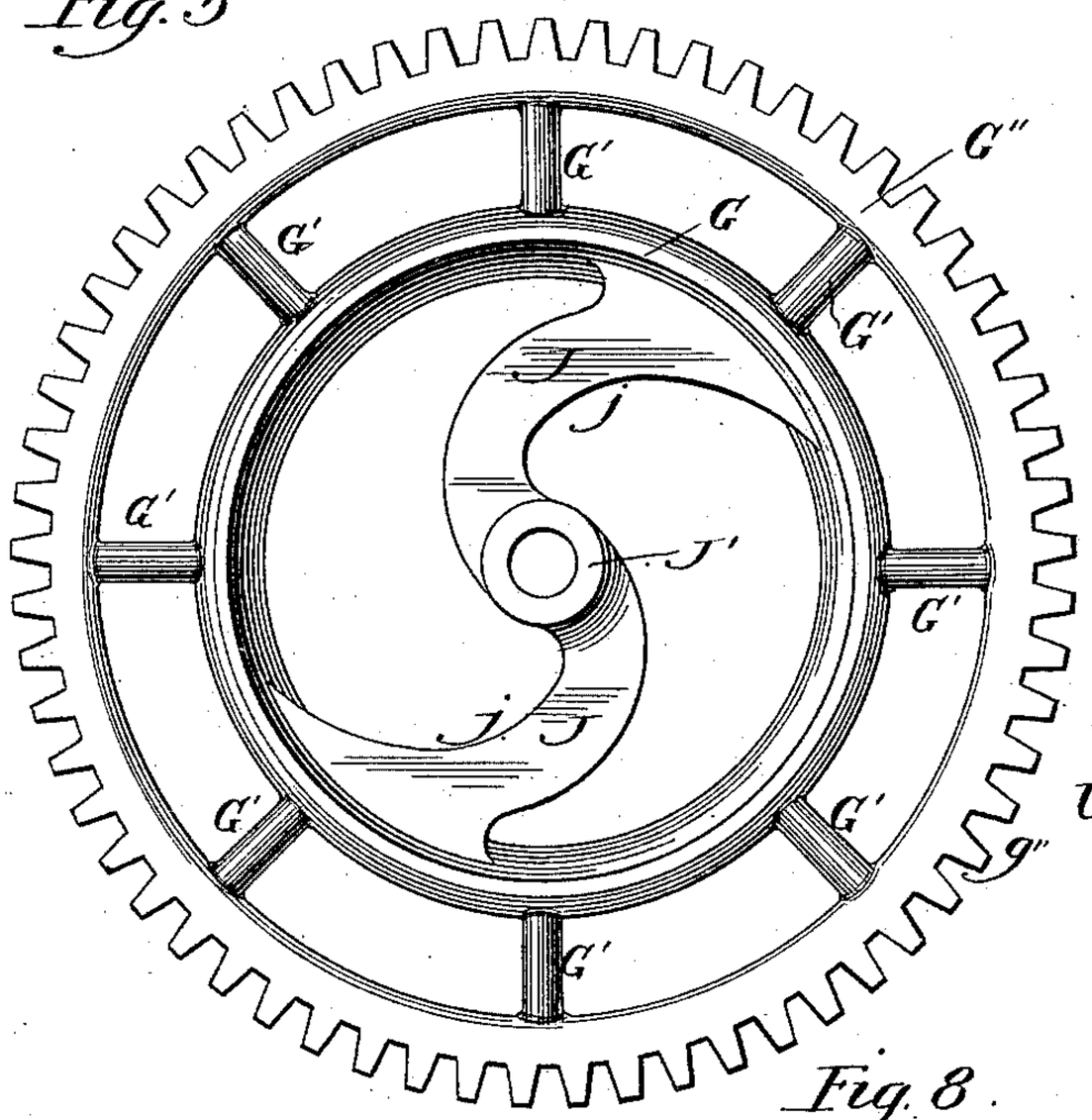


Fig. 7.

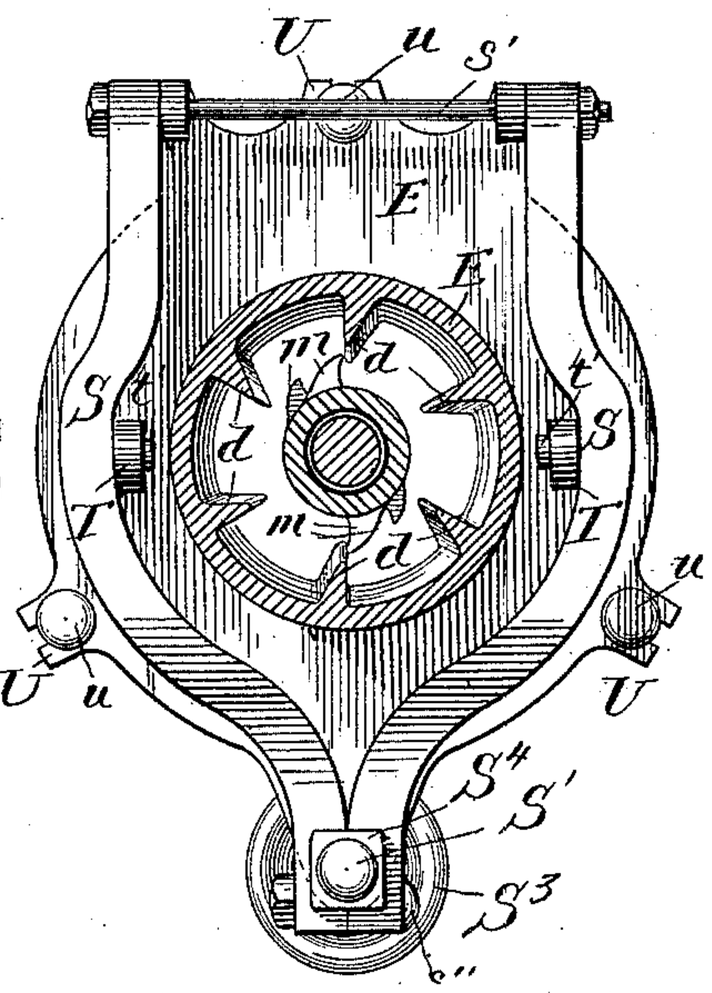
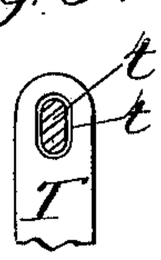


Fig. 8.



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Inventor:
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(No Model.)

4 Sheets—Sheet 4.

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Fig. 9.

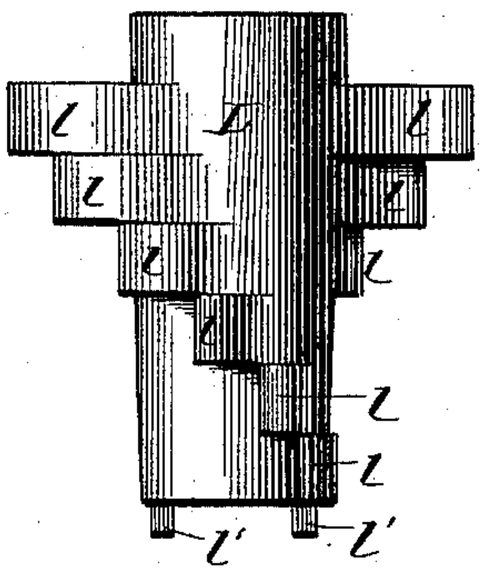


Fig. 10.

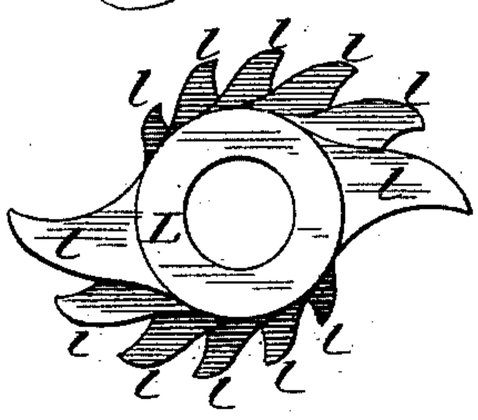


Fig. 11.

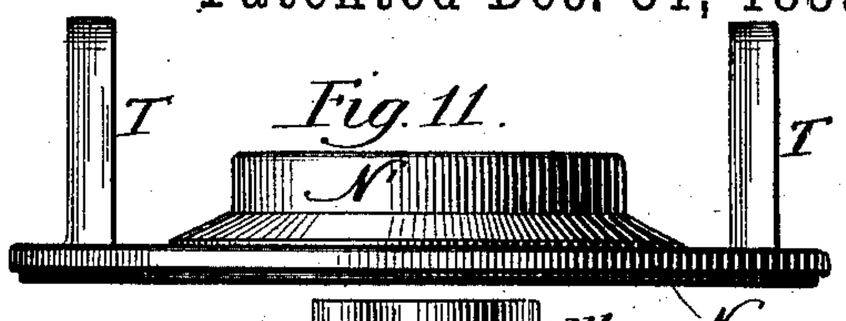


Fig. 12.

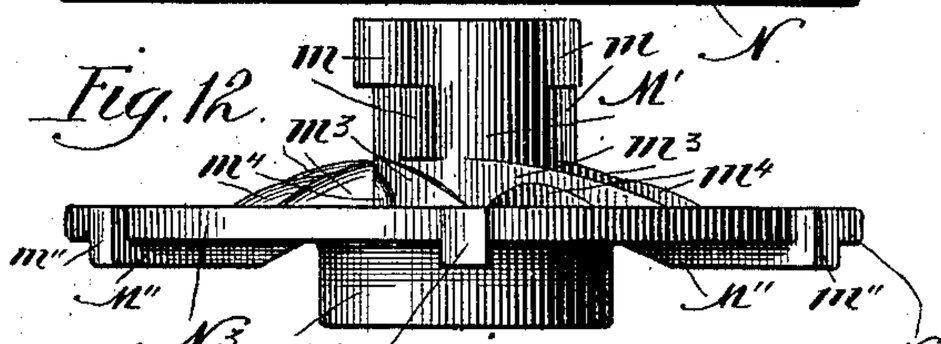


Fig. 13.

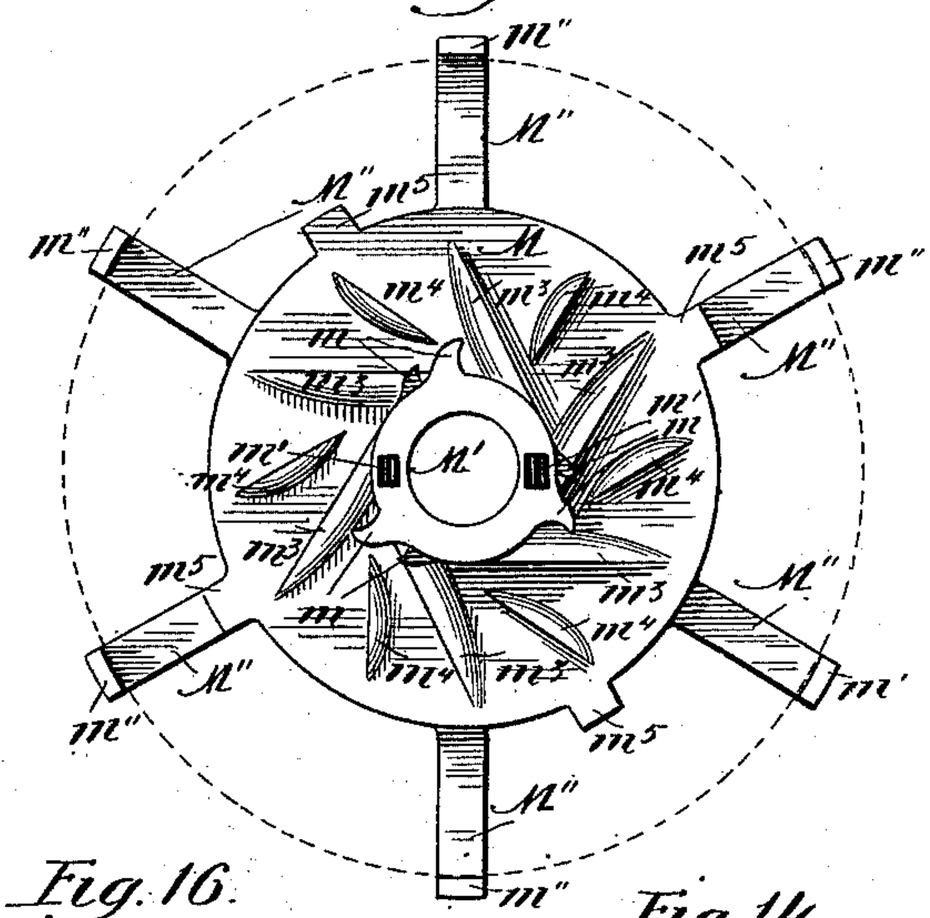


Fig. 15.

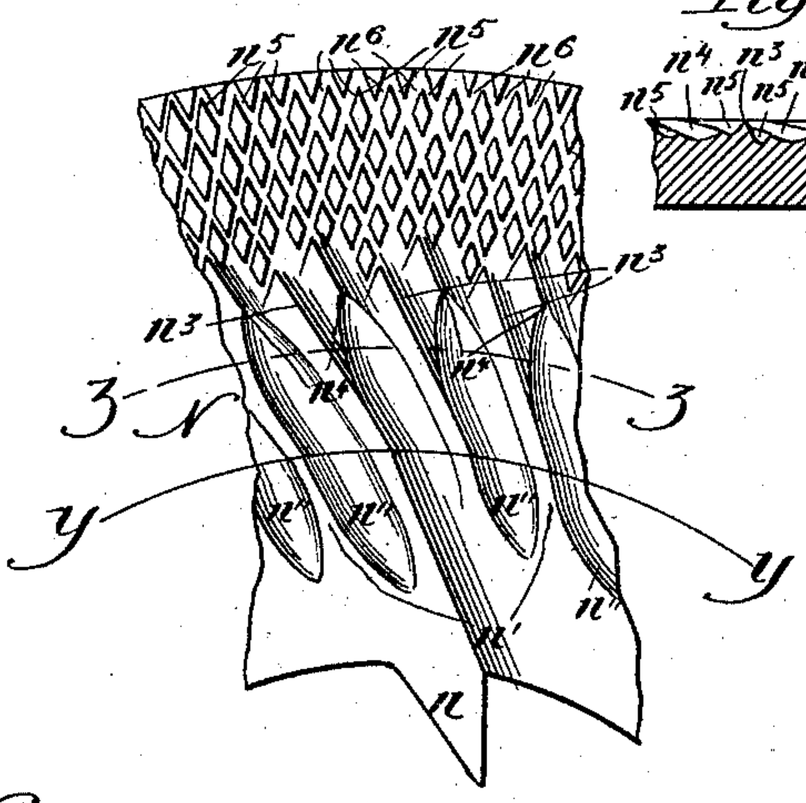


Fig. 16.

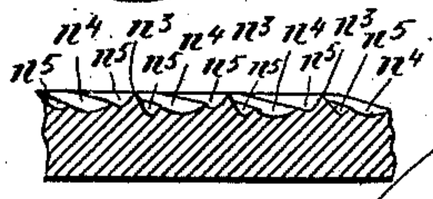
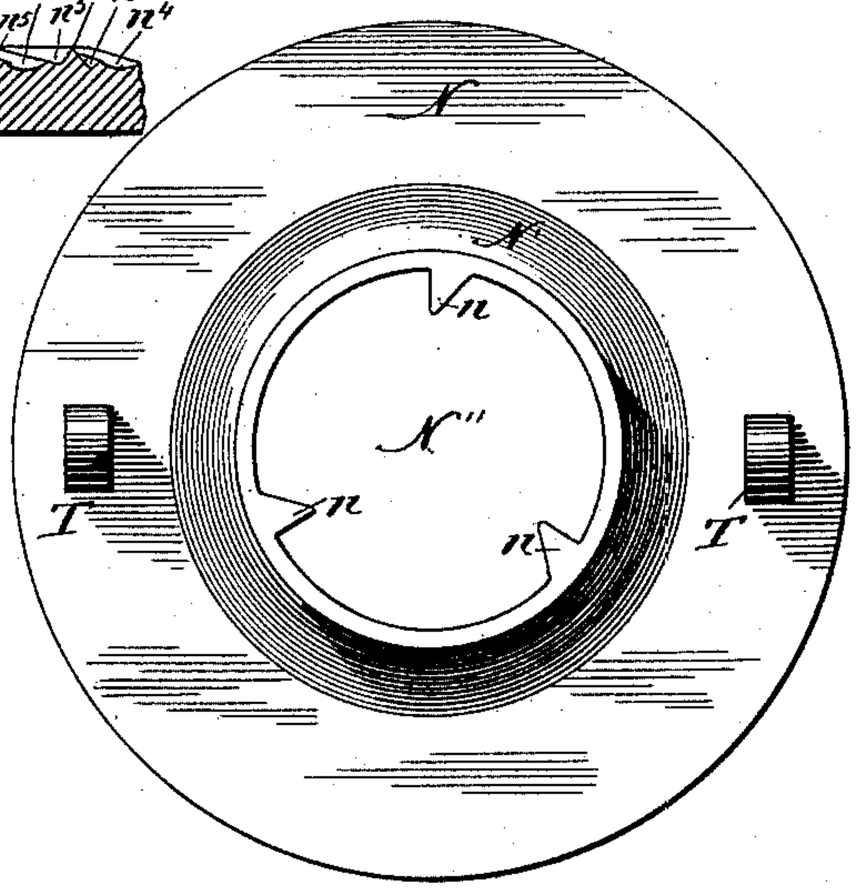


Fig. 14.



Witnesses:
C. W. Bond.
H. B. Hallock

Inventor:
Delos Cornell.

UNITED STATES PATENT OFFICE.

DELOS CORNELL, OF BOON GROVE, INDIANA.

GRINDING-MILL.

SPECIFICATION forming part of Letters Patent No. 418,168, dated December 31, 1889.

Application filed April 7, 1888. Serial No. 269,899. (No model.)

To all whom it may concern:

Be it known that I, DELOS CORNELL, a citizen of the United States, residing at Boon Grove, in the county of Porter and State of Indiana, have invented certain new and useful Improvements in Grinding-Mills; and I do hereby declare that the following is a full, clear, and exact description of the invention, which will enable others skilled in the art to which it pertains to make and use the same, reference being had to the accompanying drawings, forming a part hereof, in which—

Figure 1 is a side elevation of the mill; Fig. 2, a vertical central section; Fig. 3, a side elevation of the parts shown; Fig. 4, a top or plan view with the hopper in section; Fig. 5, a plan view of the rotating crusher and cutter; Fig. 6, a plan view of the lower stationary crusher; Fig. 7, a cross-section taken on a line above the adjusting-arms, looking down; Fig. 8, a detail, partly in section, of the connection between the upper grinding-ring and its supporting-arms; Figs. 9 and 10, a side elevation and a plan view, respectively, of the crushing and feeding cone; Fig. 11, a side elevation of the upper grinding-ring; Fig. 12, a side elevation of the lower grinding-ring; Fig. 13, a top or plan view of the center of the lower grinding-ring; Fig. 14, a top or plan view of the upper grinding-ring; Fig. 15, a detail showing the ridges and drifts for the grinding-rings; Fig. 16, a section on line *z z* of Fig. 15, looking toward the periphery of the ring.

This invention relates to that class of grinding-mills designed for grinding corn and cob; but it can also be used for grinding shelled corn or other grain without any change in the parts, thereby enabling the grinding of different grain in one and the same mill, as well as the grinding of corn and cob.

The object of the invention is to improve the construction and operation of the crushing and cutting devices by which the ears of corn are broken sufficiently to be fed to the grinding-burrs; to improve the construction and operation of the devices by which the corn and cob, after the first crushing of the ears, are fed to the grinding-burrs; to improve the construction and operation of the grinding-burrs and the means for adjusting the burrs to grind coarse, medium, or fine, as may be required, and to improve generally the construction and operation of the mill as a whole; and its nature consists in the several parts and combinations of parts hereinafter described, and pointed out in the claims.

In the drawings, A represents supporting-pieces or a frame on which the mill is mounted.

B represents the standards or uprights connected at the bottom by an annular ring or flange B′, by which and suitable bolts or otherwise the uprights are fastened to the frame A and connected at the top by an annular flange or rim B″, having a central circular opening *a*, and, as shown, two uprights B are used, arranged in line—one with the other—so as to leave a clear space on the sides for the discharge on one side of the ground material; but the uprights can be arranged otherwise and be varied in construction so long as they furnish a support for the operating parts of the mill.

C represents an annular chamber formed of a bottom plate *c* and a side or wall *c′*, the bottom having a central opening *b* in line with the central opening *a*, around which opening *b*, as shown, is a bead or flange *b′*, above which the lower grinding ring or burr is supported.

D represents a discharge-spout leading from the chamber C on one side thereof.

E represents an annular cone-shaped receiver having at the lower end a plate E′, with a lip *e′* to receive the upper end of the wall *c′*, so that the plate E′ forms a cover for the chamber C, and the upper end *e* of the receiver E is flared or rounded out to insure the passage of the crushed ears of corn into the receiver from the crushing devices. This receiver E is smallest at the bottom, and its interior face is provided with a series of crushing and grinding ridges *d*, the upper end of each ridge being formed on a downward incline *d′*, as shown in Fig. 2.

F represents a ring having on its lower edge a recess *f* to receive the end *e* of the receiver E, and having on its upper side, at its outer edge, a groove forming on the inner edge a tongue or bead. An arm F′ extends out from the ring F on one side, and at its outer end is provided with a journal-box F″, as shown in Figs. 1 and 2.

G represents a ring, the inner face of which is formed on an incline and the lower face of which has a groove to receive the tongue or bead of the upper face of the ring F, and this lower face of the ring G, at its inner edge, has a tongue or bead to enter the groove in the upper face of the ring F, connecting the rings F and G together, so that the ring G has a bearing on the ring F.

H represents a ring having its inner face formed on an incline to correspond to the incline of the inner face of the ring G, and having at its lower face, at the inner edge, a groove to receive a tongue or bead h' on the upper face at the inner edge of the ring G, and the lower face of the ring has a tongue or bead h'' to fit over the tongue h', and the upper face of the ring H, at the outer edge, is cut away to form a square face h^3, in the form shown, for the reception of the lower end of the hopper H′.

The ring G has extending out therefrom arms or spokes G′, connecting the ring G″ with the ring G, and this ring G″ has around its periphery cogs or leaves to form a driving-gear by which the ring G is rotated, and, in rotating, the ring G is held at the bottom by the tongues on the bottom face of the ring G and on the upper face of the ring F and is held at the top by the tongues h' and h'', so as to revolve freely.

I represents bars extending from a center or hub I′ to the ring H, and each arm I is formed beveled or inclined on two sides to produce a cutting-edge i at the bottom, and these arms I and the hub I′ are formed integral with the ring H and are located at the bottom of the latter.

J represents curved arms or bars running from a center or hub J′ to the ring G and formed integral with said ring, and each arm or bar J has a crushing or acting edge j to coact with the acting edge i of each bar I and cut and crush the ears of corn, and, as shown, the bars I are straight to leave a wider space between them for the dropping in of large ears of corn, to allow the end of the ear to pass into the opening between the acting edges j of the arms J and the acting edges i of the bars I to be broken, cut, and crushed, and the arms J, formed and arranged as shown in Fig. 5, have their acting edges curved to draw the ears toward the center in operation, and these arms J rotate with the ring G, while the arms I are stationary.

K represents arms or bars running from a center K′ to the ring F and formed integral with the latter, so as to lie adjacent to the arms or bars J when the parts are together, and these arms K are curved in an opposite direction to the curve of the arms J and have an acting edge k to coact with the acting edge j and still further crush and break the cob. Three arms or bars K are provided, and the curvature of the acting edge k of each arm or bar, in connection with the curvature of the acting edges j of the arms or bars J, is one that draws the partly-crushed material toward the center.

L represents a crushing and feeding cone, the larger end being at the top, and located, when the parts are together, within the receptacle E, with its upper end in contact, or nearly so, with the under face of the center K′. This cone L is provided with two rows of crushing and feeding ridges l, each row being formed of a series of separate teeth, and each row winding partly around the body of the cone in such shape as to have each tooth clear and distinct from the adjoining tooth, as clearly shown in Figs. 9 and 10. These ridges l grade from the top to the bottom to correspond in pitch to that of the ridges d on the receptacle E, and so as to coact with the ridges d and crush the material after it leaves the breaking, crushing, and cutting devices I, J, and K, and also act to feed the material down to enter between the grinding-rings. The cone L at its lower end is provided with lugs or projections l' for locking the cone to the lower grinding-ring to be rotated therefrom in the form of construction shown.

M represents the center portion of the lower grinding-ring, having at its center a hub or enlargement M′, in which are mortises or openings m' to receive the lugs l', and the exterior of this hub M′ is provided with crushers and feeders m, which, when the parts are together, form a continuation of the crushing and feeding ridges l, and are arranged on the same incline and wind as are the teeth of l. The upper face of the center M is provided with feeding and grinding ridges m^3 and m^4, the ridges m^3 extending from the hub M′ outward on a tangent and being inclined on their upper edge, as shown in Figs. 12 and 13, and the ridges m^4 lying between the ridges m^3 and having a curved side against the direction of the run of the ring to insure the throwing out of the material to enter the final outer grinding-faces of the upper and lower grinding-rings. The center M is provided with a series of radial arms M″, having their outer ends m'' turned up, and these arms M″ are in a lower plane than the under face of the center M, and form wipers or cleaners for carrying the ground material around to be discharged at the spout D, and these arms M″ form a support for the outer portion of the lower grinding-ring, which is made detachable from the center M in the construction shown; but, if desired, the center and the outer grinding portion could be formed of a single disk, and, as shown, two of the arms M″ are provided with lugs m^5, and two similar lugs m^5 project out from the edge of the center M, by means of which lugs and recesses in the outer portion of the grinding-ring the two parts of the ring are locked together.

N represents the upper grinding-ring, having a hub or center N′ to lie within the lower end of the receptacle E when the parts are together with a close enough fit to prevent

the crushed material from passing between the receptacle and ring at that point, and this ring has a central hole or eye N″ to receive the hub M′ of the center M, and the interior of the eye N″ is provided with ridges *n* to coact with the cutters and crushers *m* in the operation of the mill to reduce the material in its passage to the grinding-faces of the upper and lower grinding-rings. The acting face of the grinding-ring N is provided with a series of ridges *n′*, leading from the eye or hole N″ in an oblique direction to the periphery of the center, as shown in Figs. 15 and 16, and between these ridges *n′* are intermediate hollows which form intermediate ridges *n*, as shown in Figs. 15 and 16, and from the terminal point of the ridges *n′* and *n″* at the line *y* the hollows are continued outward at a different angle, forming ridges n^4, between which, at the terminus of the hollows, are short ridges n^3, and from the terminal points of the ridges n^3 and n^4 are drifts n^5 and n^6, which form a fine grinding-surface, as shown in Fig. 15. The acting face of the outer portion N^3 of the lower grinding-ring is formed with ridges and drifts corresponding to those of the upper grinding-ring from the point beginning with the curved line *y y*, Fig. 15, and extending to the periphery of the ring, and this ring N^3 is supported upon the arms M″ and lies directly under the corresponding portion of the upper grinding-ring N, so that the corresponding ridges n^3 and n^4 and the feed-drift n^5 and n^6 will form grinding-faces, between which the material will be reduced to the required degree of fineness, and the ridges *n′* and n^3 act to feed the material outward, and the hollows between the ridges *n″* and n^4 furnish a means for the escape of the material, by which clogging will be prevented, and the material, as it is acted upon by the grinding-faces formed by the feed-drifts n^5 and n^6, will be reduced, and at the same time these drifts act to carry the material, as fast as it is ground, out to be discharged around the periphery of the grinding-rings and be deposited in the receiver C, in which the grinding-rings are located, and the ground material, falling to the bottom of this receptacle, will be swept around by the arms M″ to enter the spout D and be discharged.

O represents a shaft passing through the hub of the lower grinding-ring, the cone L, and the hubs or centers I′, J′, and K′ of the arms or bars I, J, and K, and the lower grinding-ring has its hub or center fitted somewhat closely around the shaft O, so that the shaft will furnish a support and prevent any wabbling of the ring, and, as shown, a pin *o″* and a washer o^3 are provided at the top for holding the parts against end movement, and when fitted together the hub J′ enters a countersink in the hub I′, so as to bring the arms I J K sufficiently close to each other to perform the work of breaking, crushing, and cutting and to give a bearing for the arms J on the shaft O to prevent wabbling in use. The lower end of the shaft O, as shown, is screw-threaded and enters a screw-threaded hole in a bearing *o′*, and around the lower end of the shaft is a sleeve O″, formed with or suitably secured to a beveled gear O′, by which the sleeve O″ is driven, and this sleeve O″, at its upper end, receives the center or hub M^4 of the lower grinding-ring M to connect the sleeve and the grinding-ring, for which purpose the sleeve is formed square in cross-section, and the hub M^4 has a square recess fitting the sleeve.

P represents the main driving-shaft, on which is a beveled pinion P′, which meshes with the bevel-gear O′ for rotating the gear O′, and this shaft at each end may be squared to form an end *p* for the attachment of a tumbling-rod or other driving-gear, and one end of the shaft is to be provided with a fly-wheel and a pulley, if so desired, the pulley furnishing a means for driving the shaft by a belt from an engine or other motive power.

Q represents sleeves formed integral with or suitably secured to the standards B, and arranged so as to leave a space for the location of the driving-pinion P′ on the shaft P, and, as shown, flanges *q* are provided, extending from the standard B to the longer sleeve to give an increased strength and support therefor.

R represents a shaft, the upper end of which passes through the journal-box F″, and is locked, when adjusted, by a sleeve *r″*, which abuts against the end of the journal-box and is secured to the shaft by a set-screw r^3. The lower end of this shaft enters a journal-box *r′* on the sleeve Q, on which sleeve is also located the boss *o′* for the shaft O, and the lower end of the shaft R has secured thereto a bevel-gear R′, which meshes with a driving-pinion R″, secured to the shaft P. The bevel-gear O′ has a hub *o* to form a bearing in connection with the boss *o′*, and the bevel-gear R′ has a hub *r* to form a bearing in connection with the journal-box *r′*, and the shaft O is stationary and the sleeve O″ revolves around the shaft, while the shaft R is revolved from the bevel-gear R′, and this shaft R, at its upper end, has a pinion R^3, which meshes with the cogs or leaves of the ring G″, which drives the ring G″ and rotates the ring G to drive the arms or bars J.

S represents arms, each of a similar shape and each having a straight portion at each end and a curved portion at the center to pass around the receptacle E. Each arm, at one end, is attached to an ear *s*, projecting up from the plate E′ by a common bolt *s′*, extending from ear to ear, and the free ends of the arms S receive a bolt S′, around which is a spring S″, located between the under face of the arms S and an ear s^3, projecting out from the plate E, and at this end the arms are secured together by a bolt *s″*. The screw-threaded end of the bolt S′ passes through the ear s^3 and receives a hand-

nut S^3, by means of which the bolt can be shortened to draw down the arms S at this end, and the arms are carried back when the nut S^3 is loosened by the action of the spring S''. The bolt S' is encircled by a rubber bumper S^4, which lies between the head of the bolt S' and the top of the arms S and forms a cushion to allow of a slight yield of the arms when required.

T represents ears projecting up from the upper grinding-ring N and passing through the plate E', and arranged on opposite sides of the grinding-ring in line one with the other, and at a distance apart to lie between the arms S, to which they are connected by means of a projection *t'* on each arm, which enters a slot *t* in the ear adjacent to the arm, as shown in Figs. 2 and 8.

The arms S, in connection with the ears T, carry the upper grinding-ring, and by means of the bolt S' and the hand-nut S^3 this grinding-ring can be adjusted up or down, as required, to bring the grinding-faces of the upper and lower grinding-ring in position for grinding coarse or fine or medium, as may be required, the drawing down of the arms S, through the bolt S' and hand-wheel S'', bringing the grinding-faces close together for fine grinding, and the release of the arms by the unscrewing of the hand-nut S^3 carrying the rings farther apart by the action of the spring S'', which raises the arms S, and in case a hard substance enters between the grinding-rings the cushion formed by the rubber bumper S^4 allows of a sufficient yield for the hard material to pass without breaking or doing serious injury to the grinding-rings.

U represents ears formed on the plate E' and the receptacle C, by means of which and bolts *u* the plate E' is secured to the receptacle.

V represents ears formed on the receptacle E and the ring F, by means of which and bolts *v* the ring F is firmly secured to the receptacle.

The head or flange *b'* forms a guard against the discharge of the ground material at the opening *b* when the mill is together. The cone crusher L, when in place, has its ridges *l* in line with the ridges *m* of the center M' to form a continuous winding ridge. The interior walls of the rings G and H line with each other and with the interior wall of the hopper to form a continuous incline for the passage of the material. A fly-wheel and a fast and loose pulley for driving purposes are attached to the end of the shaft P, as shown in Fig. 1.

In use the mill is attached to a frame A or other support by the ring B', or in any other suitable manner, and is located at any place where it is desired to be used, and so that a connection can be had by a tumbling-rod from a horse or other power with the shaft P, or by a belt and pulley with a motive power to drive the shaft P. The corn (on the cob) is placed in the hopper H', and the shaft P is driven from its motive power, driving the beveled pinions P' and R'', and the pinion P' drives the gear O', rotating the sleeve O'' and driving the lower grinding-ring, and this ring, by the connection of the crusher-cone L therewith, also drives the crushing-cone in unison with the rotation of the lower grinding-ring, and at the same time the pinion R'' drives the beveled gear R', rotating the shaft R, which drives the pinion R^3, which pinion drives the gear-ring G'', rotating the ring G, carrying around the arms J, so that the driven parts are all operated from the same driving-shaft. The corn on the ear in the hopper feeds down by gravity, and the ears falling in the spaces between the stationary arms I are caught by the rotating arms J and broken, crushed, and cut by the acting edges *i* of the arms I and the acting edges *j* of the arms J, and the caught portion first broken passes down and is caught between the rotating arms J and the stationary arms K to be broken, crushed, and cut by the action of the acting edges *j* of the arms J and the acting edges *k* of the arms K, and, after being operated upon by the arms I, J, and K, the crushed and broken pieces pass down and enter between the cone L and the receptacle E, where the broken pieces are still further reduced in size as they descend by the action of the crushing-ridges *l* and the crushing-ridges *d;* and a further reduction is had in the broken pieces as they enter the eye N'' of the upper grinding-ring N by the action of the crushing-ridges *m* on the hub M' and the crushing-ridges *n* in the eye of the grinding-ring N, and by the action of these ridges *m* and *n* the particles are reduced in size sufficiently to pass between the grinding and crushing ridges m^3, m^4, and *n'*, by which ridges the material is reduced in size and fed outward to enter the outer grinding-faces of the rings N and N^3 for the final reduction; and the ridges on the upper and lower grinding-rings, in connection with the feed-drifts between the ridges by reason of their tangential arrangement act both to reduce the material and feed it toward the periphery of the grinding-rings, and in order to leave a clear space for the outward feed of the material the upper grinding-ring adjacent to the eye thereof is inclined so as to leave an open space between the first series of grinding and crushing ridges to insure a proper feed, and the feed of the material to the grinding-ring is insured by the wind of the ridges *l* and *m* of the cone L and the hub M'; and it will be further seen that by the inward drawing action of the crushing and breaking arms I, J, and K a positive feed is provided for the material after the first crushing to pass to the crushing and feeding cone L, and after the material is fed to this cone a positive feed is had by the action of the ridges *l* and *m*, and after the material reaches the grinding-faces of the upper and lower ring a positive feed is had to throw the ma-

terial to the outer periphery of the rings by the action of the ridges and drifts on the acting faces of the upper and lower grinding-rings. The upper grinding-ring is raised or lowered, as required, for coarse or fine grinding, by the arms S, the raising of the arms by the spring S″, when the hand nut or wheel S is unscrewed, raising the grinding-ring N through the ears T, and the drawing down of the arms S, by turning up the hand nut or wheel S^3, carries down the grinding-ring N through the ears T, and by means of this hand nut or wheel S^3 and the bolt S′ the arms S can be adjusted so as to bring the grinding or acting faces of the upper and lower grinding-rings in adjustment to operate and reduce the material to any degree required; and in case of a hard substance entering between the grinding-rings the yield of the rubber cushion S^4 will allow the upper grinding-ring to rise for the hard material to be thrown out by the action of the feeding ridges and drifts of the rings without breaking or producing injurious effects. The ground material is thrown from the rings at the periphery thereof and falls into the receptacle C, in which the ground material is swept around by the action of the arms M″, which act as wipers to carry the ground material to the discharge-spout D to be discharged into any suitable receptacle.

The grinding of shelled corn or other grain is performed in the same manner, except that but little, if any, crushing action is had on the grain by the arms I, J, and K as the grain passes from the hopper through the spaces of the arms to enter the space between the cone L and receptacle E to be fed forward by the action of the ridges *l* and *m* to enter the eye of the upper grinding-ring and pass between the grinding-faces of the upper and lower grinding-rings, where it is reduced by the action of the grinding-ridges of such rings to any degree required, the rings being adjusted by the arms S, as already described; and, if desired, the cone L, with the crushing and breaking arms I, J, and K, can be removed when grinding shelled corn or other grain, in which case the grain will pass from the hopper directly to the grinding-rings, passing through the eye of the upper grinding-ring and entering between the grinding-faces of the rings and when grinding shelled corn or other grain a hopper H′ can be used having therein a feed-gate by which the quantity of corn or grain passing from the hopper can be regulated to suit the feed for the action of the grinding-rings.

The shaft P drives both the grinding-ring and the crushing and breaking arms; but the speed of the grinding-ring and of the breaking-arms is not the same, as the ratio between the driving-gears for these parts is one that will give a slow speed for the breaking-arms as compared with the speed of the grinding-ring, and a speed that will perform the required functions for the crushing and breaking arms and the grinding-ring is one in which the speed of the crushing and breaking arms will be one revolution to ten of the grinding-ring per minute, or approximately to such ratio, and, as the speed of the crushing and feeding cone L is the same as that of the grinding-rings, it will be seen that after the first or coarse crushing of the corn in the ear by the action of the crushing and breaking arms I, J, and K the feed of the partly broken material will be one that will carry away the broken pieces from the breaking and crushing arms as fast as required to keep the arms clear of the broken pieces, and at the same time this speed is one that will give a feed for the material to the grinding-rings to a degree corresponding with the feed of the grinding-rings in reducing the material to the degree of fineness required. The ridges n' of the upper grinding-ring N extend from the eye N″ across the inner face of the ring to the line *y*, and each fourth ridge coincides with a breaking or crushing ridge *n* in the eye of the ring, and between the grinding-ridges n' are the grinding-ridges n'', separated one from the other and from the ridges n' by hollows or depressions, which form wide drifts for the passage of the material, and from the line *z*, where the ridges n^3 and n^4 run into the outer grinding-face, the drifts n^5 start, running on the same tangent as the ridges n^3 and n^4, two drifts being formed between each ridge n^3 and n^4, and the cross-drifts n^6 run on an opposite tangent from the drifts n^5, so as to form grinding-faces of a diamond shape between the drifts n^5 and n^6, as clearly shown in Fig. 15, and the grinding-ridges n', which are continued to the eye of the grinding-ring, are formed on a slightly-different angle to that of their continuations of the grinding-ridges n^3, commencing at the line *y*, and these eye grinding-ridges n' coact with the grinding-ridges m^3 to perform the first crushing and grinding as the material enters between the rings, and also to feed the material outward, and for this purpose the tangent of the ridges m^3, m^4, and n' is one which has a tendency to throw the material away from the eye of the upper grinding-ring, and the upper grinding-ring is inclined upward at the eye, so as to leave room for the passage of the ridges m^3 of the lower grinding-ring, and these ridges m^3 are inclined on their upper edge from the hub downward to the meeting point on the face of the center M, and their acting side has a straight wall and their non-acting side a rounded or inclined wall to insure a positive cut and a clear discharge or outward throw of the material.

Each fourth ridge n' coincides with an eye-ridge *n*, and each ridge n' joins a ridge n^3 for each fourth ridge n', so that the coinciding ridges n' n^3 form a continuous ridge from the eye to the terminal line *z*, and the ridges n'' coincide with the ridges n^3, and the wide drifts between the ridges n'' continue and join the ridges n^4, forming a clear space for the pas-

sage of the material from the eye n^3 to the ridges n^4, and the drifts n^5 are wider at the inner end between the ridges n^3 and n^4 and gradually decrease in width and depth to the periphery of the ring. The acting face of the grinding-ring N is divided into three sections or portions—an inner, a middle, and an outer one—the inner portion commencing at the eye N^3 and extending to the line y, the middle commencing at the line y and extending to the line z, and the outer commencing at the line z and extending to the periphery. The ridges n' and n'' are formed in the inner portion, the ridges n^3 and n^4 on the middle portion, and the drifts n^5 and n^6 on the outer portion, with the drifts n^5 extending into the middle portion, and in use the inner grinding portion breaks and grinds the material coarsely, the middle grinding portion reduces it still finer, and the outer grinding portion completes the grinding process.

The curved arms J and K are not arranged exactly radially, as will be seen. Their curves do not conform to arcs of circles, but to arcs of ellipses, thereby causing the arms to lie substantially at a tangent to the hubs. Thus the outer ends of the arms are in advance of the inner ends and the abrupt portion of the curve of each arm is adjacent to the hub, whereby the ears of corn are drawn inward toward the hubs, where the leverage (and consequently the power) is greatest.

What I claim as new, and desire to secure by Letters Patent, is—

1. In a mill for cutting, crushing, and breaking corn on the ear, the combination, with the hopper, of the stationary radial arms I, disposed therein, the stationary curved arms K, arranged below the plane of the arms I, with an intervening space, and the elliptically-curved tangential arms J, arranged in said intervening space and connected at their outer ends to a ring which is geared to a suitable drive-shaft, substantially as specified.

2. In a grinding-mill, the combination, with the hopper having stationary cutting and crushing arms arranged therein, of the rotary arms arranged in a plane parallel with and adjacent to the stationary arms and having elliptically-curved edges, whereby the ears of corn are drawn toward the center of the hopper, said rotary arms being connected at their outer ends to a ring which is geared to a suitable drive-shaft, whereby the power is applied to the outer ends of the arms, substantially as specified.

3. In a grinding-mill, the combination, with a suitable receptacle, of an inverted conical crusher provided with two or more series of spirally-arranged teeth l, diminishing in size toward the bottom of the crusher and winding from top to bottom in the direction of the rotation of the same, substantially as specified.

4. In a grinding-mill, the combination, with a suitable receptacle provided on its inner surface with spirally-arranged ridges, of an inverted conical crusher provided with two or more series of spirally-arranged independent integral teeth l, diminishing in size toward the bottom of the crusher, and each tooth receding from the plane of the tooth above, said teeth being rounded at their free ends, substantially as specified.

5. In a grinding-mill, the combination, with an upper stationary disk, of the lower rotary disk comprising the central portion M, provided with radial arms M″, having upturned ends, and also provided with circumferential projections m^5, and the removable annular portion N^3, surrounding the central portion resting on the arms M″, and provided in its inner edge with recesses engaged by projections m^5, substantially as specified.

6. In a grinding-mill, the casing comprising the interlocking rings H G F, carrying crushing-arms I J K, respectively, having central hubs, the intermediate ring G being free to rotate, and the hopper H′, fitted on the upper edge of the upper stationary ring H, combined with a vertical shaft arranged axially in the casing and fitting in the hubs of the crushing-arms, whereby it forms a journal for the arms J, and the rotary grinding-disk mounted on the said shaft below the crushing-arms with its surface in contact with a stationary grinding-disk and geared to the rotary ring G, substantially as specified.

7. In a grinding-mill, the combination, with a suitable casing, of the upper stationary grinding-disk having vertical ears T, the lever S, pivoted at one end to the casing and connected at intermediate points to the said ears, the adjusting-bolt mounted on the casing and connected to the free end of the lever, the spring coiled on the said bolt and bearing against the end of the lever, and the rotary grinding-disk arranged below said stationary disk, substantially as specified.

8. In a grinding-mill, the casing having horizontal journal-boxes Q, the driving-shaft P, mounted in said boxes and carrying a pinion P′, and the vertical shaft O, located centrally in the casing and threaded at its lower end in the box Q, in combination with a rotary grinding-disk mounted on the vertical shaft and coacting with a stationary grinding-disk, and the gear-wheel O′, mounted on the vertical shaft, meshing with the pinion P′, and provided with an upper squared portion which fits in a corresponding socket in the lower side of the rotary grinding-disk, substantially as and for the purpose specified.

9. In a grinding-mill, the combination, with the stationary breaking-arms and the coacting rotary arms G, carrying a large gear-ring G″, of the driving-shaft carrying pinions P′ and R″, the rotary grinding-disk coacting with a stationary grinding-disk and provided with a gear-wheel O′, which meshes with the pinion P′, and the vertical shaft R, provided at one end with a large pinion to mesh with the pinion R″, and provided at the other end with a small pinion to mesh with the larger

gear-ring G″, whereby the arms G are driven at a lower rate of speed than the rotary grinding-disk, substantially as specified.

10. The receiver C, receptacle E, mounted on the receiver C, the ring F, attached to the receptacle E and having a series of breaking-arms K, the rotating ring G, having a series of breaking-arms J and supported by the ring F, and ring H, having a series of breaking-arms I and attached to the hopper, in combination with the arm F′, formed with the ring F and having at its outer end the journal-box F″, gear-ring G″, connected with the ring G, shaft R, mounted in the box F″, driving-gear R′ for the shaft R, and driving-pinions R″ and R³, for supporting and driving a breaking mechanism, substantially as specified.

11. A grinding-disk having an acting face consisting of ridges n', leading from the eye of the disk outwardly in an oblique direction, intermediate ridges n'' between the ridges n', formed by hollows, ridges n^4, constituting continuations of the ridges n'' and formed by changing the angle of inclination of the hollows, ridges n^3 between the ridges n^4, at the terminal of each hollow, drifts n^5, leading to the periphery of the disk from the line of termination of the ridges n^3, and cross-drifts n^6, forming with the drifts n^5 a fine grinding-face, substantially as specified.

12. A lower grinding-disk having a center M, provided with ridges m^3, and an outer grinding-ring having hollows forming ridges n^4, between which are ridges n^3 at the termini of the hollows, and having drifts n^5, leading from the ridges n^3 and n^4 to the periphery of the ring, and cross-drifts n^6, forming with the drifts n^5 a fine grinding-face, in combination with an upper grinding-disk having an acting face corresponding to that of the lower grinding-disk, substantially as and for the purposes specified.

13. A grinding-disk consisting of a center M, provided with ridges m^3, and an outer ring portion N³, having hollows forming ridges n^4, between which are ridges n^3 at the termini of the hollows, and having drifts n^5, leading from the ridges n^3 and n^4 to the periphery of the ring, and cross-drifts n^6, forming with the drifts n^5 a fine grinding-face, substantially as specified.

14. A grinding-disk having an eye or center and an acting face consisting of three divisions, the inner provided with ridges n' and n'', leading from the eye or center across the grinding-face, the middle provided with hollows forming ridges n^4, between which are ridges n^3 at the termini of the hollows, and the outer ring provided with drifts n^5 and cross-drifts n^6, forming a fine grinding-face, substantially as described.

15. An upper grinding-disk having on opposite sides, in line with each other, ears T, each provided with an opening t, and a receptacle C for the grinding-disks, having a cover provided with openings for the passage of the ears T, in combination with the pivoted arms S, one for each ear T, each having a lug t' entering the opening t, a bolt S′, common to both arms S, a spring S″, encircling the bolt S′, a support s^3 for the spring, and a hand-wheel S³, for adjusting the run of the grinding-ring, substantially as specified.

16. An upper grinding-disk having on opposite sides, in line with each other, ears T, each provided with an opening t, and a receptacle C for the grinding-disks, having a cover provided with openings for the passage of the ears T, in combination with the pivoted arms S, one for each ear T, a bolt S′, common to both arms S, a spring S″, encircling the bolts S′, a support s^3 for the spring S″, a hand wheel S³, and a yielding bumper S⁴ between the head of the bolt S′ and the arms S, substantially as and for the purposes specified.

DELOS CORNELL.

Witnesses:
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