(No Model.) 3 Sheets—Sheet 1.

J. C. BOOTH & G. AMBORN, Jr.

ROTARY CUTTER.

No. 599,680. Patented Mar. 1, 1898.

Fig. 1.

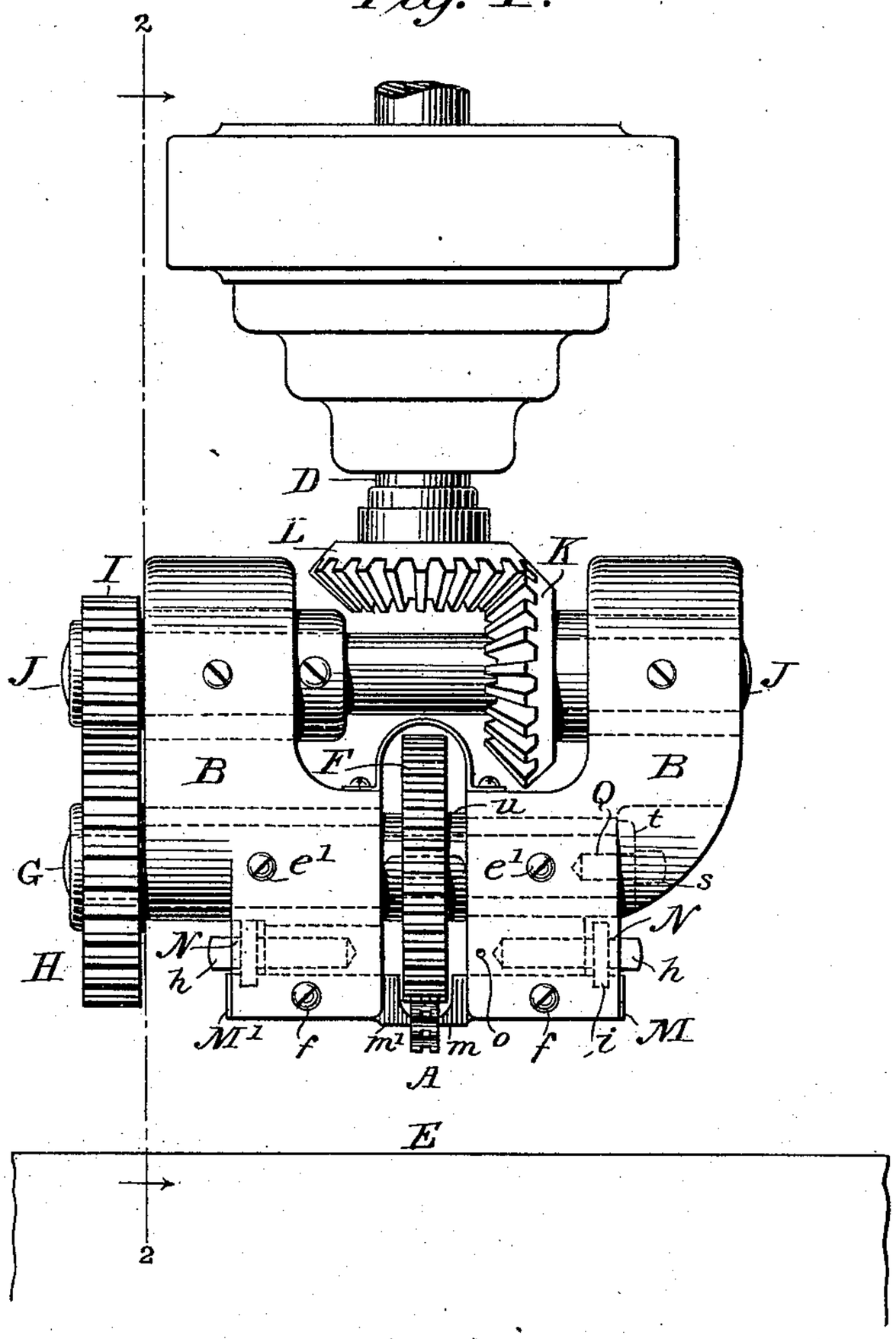
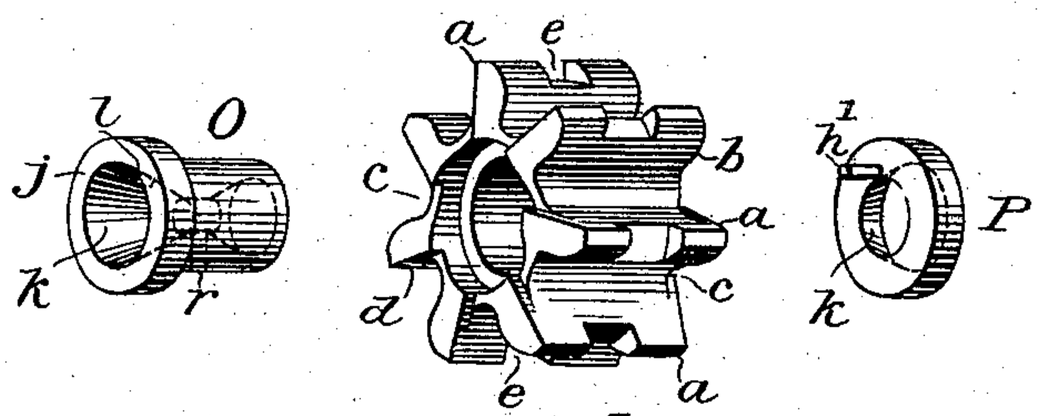


Fig. 5. *Fig. 4.* *Fig. 6.*



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(No Model.) 3 Sheets—Sheet 2.

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ROTARY CUTTER.

No. 599,680. Patented Mar. 1, 1898.

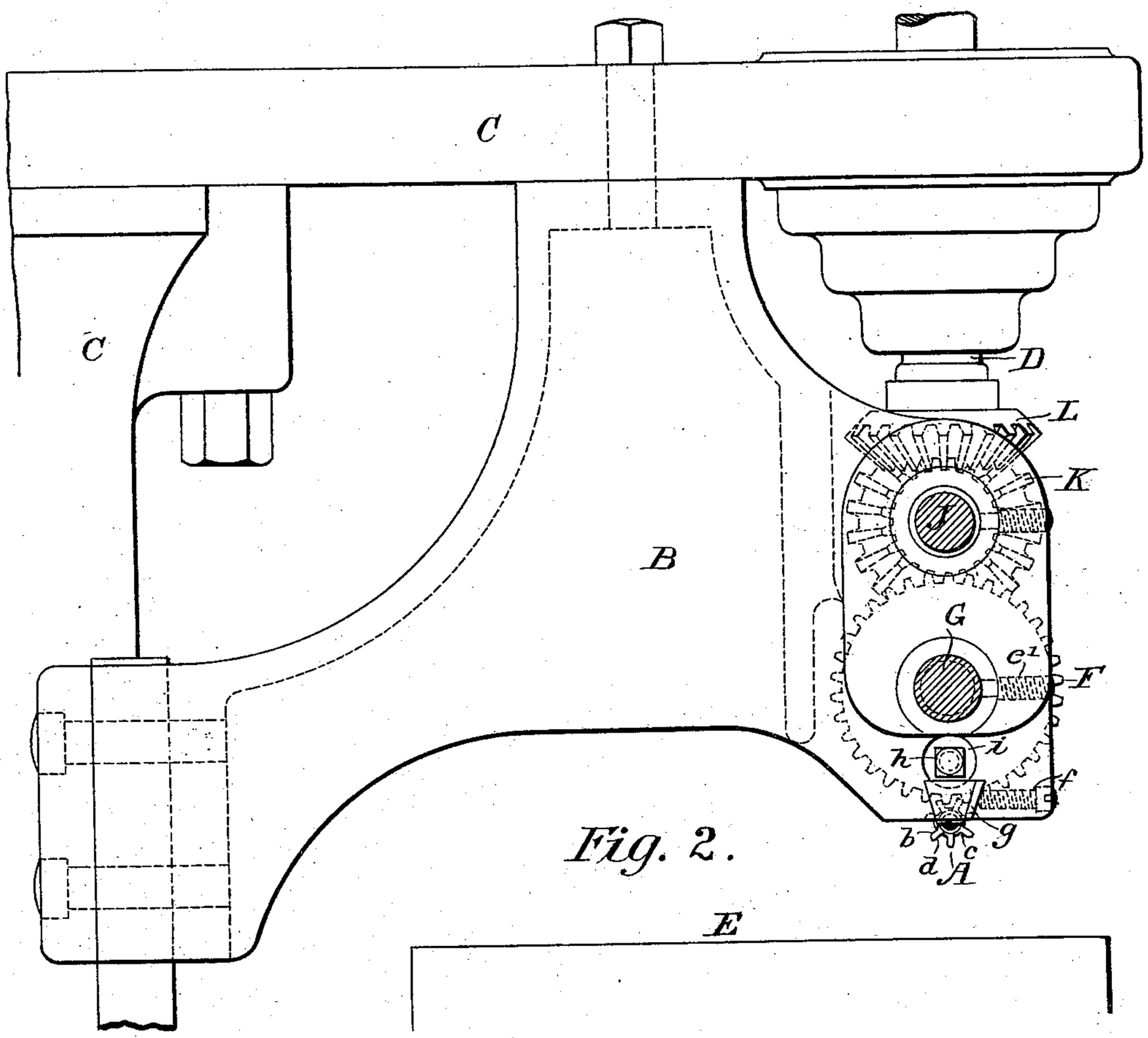


Fig. 2.

Fig. 8.

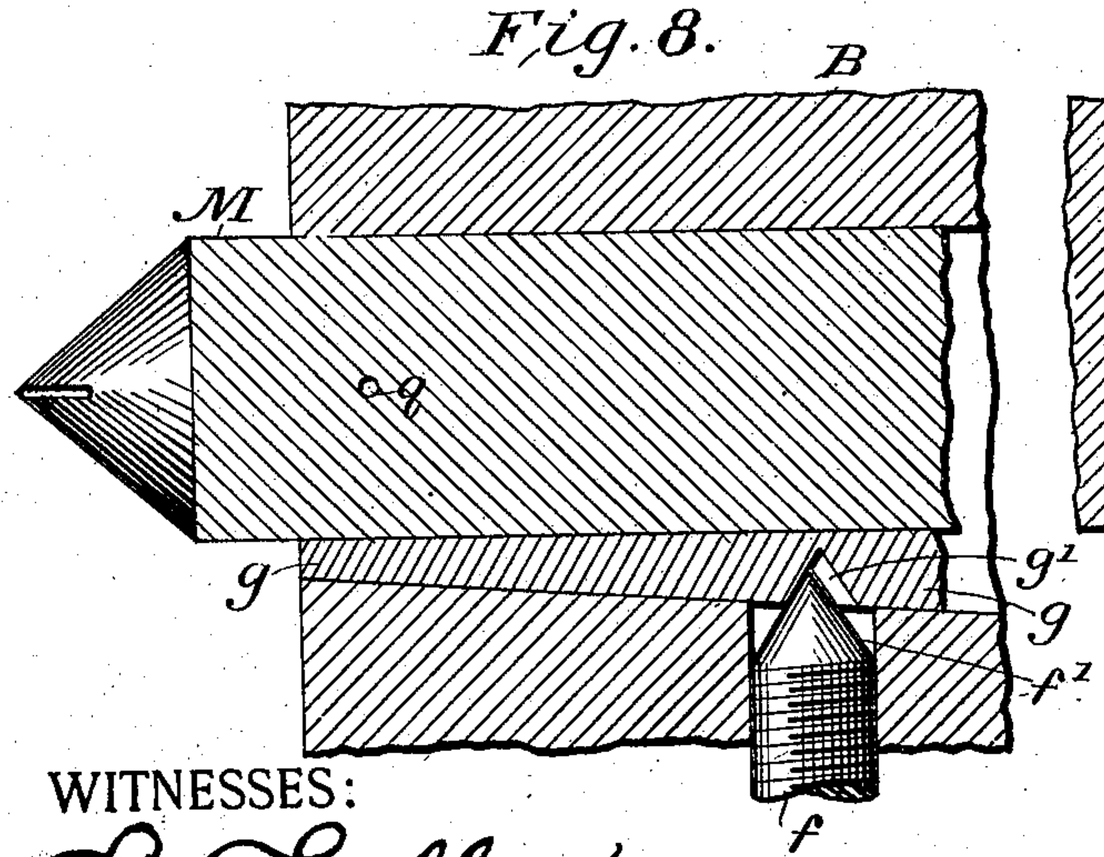
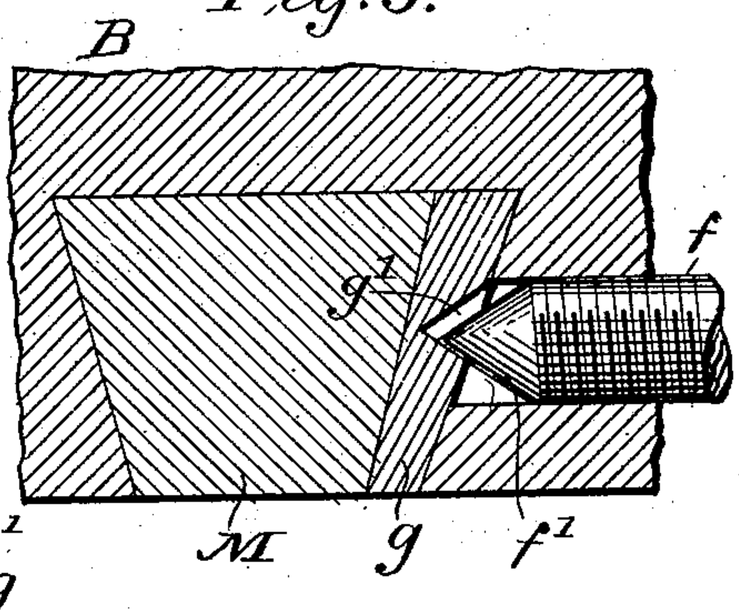


Fig. 9.



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(No Model.) 3 Sheets—Sheet 3.

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ROTARY CUTTER.

No. 599,680. Patented Mar. 1, 1898.

Fig. 3.

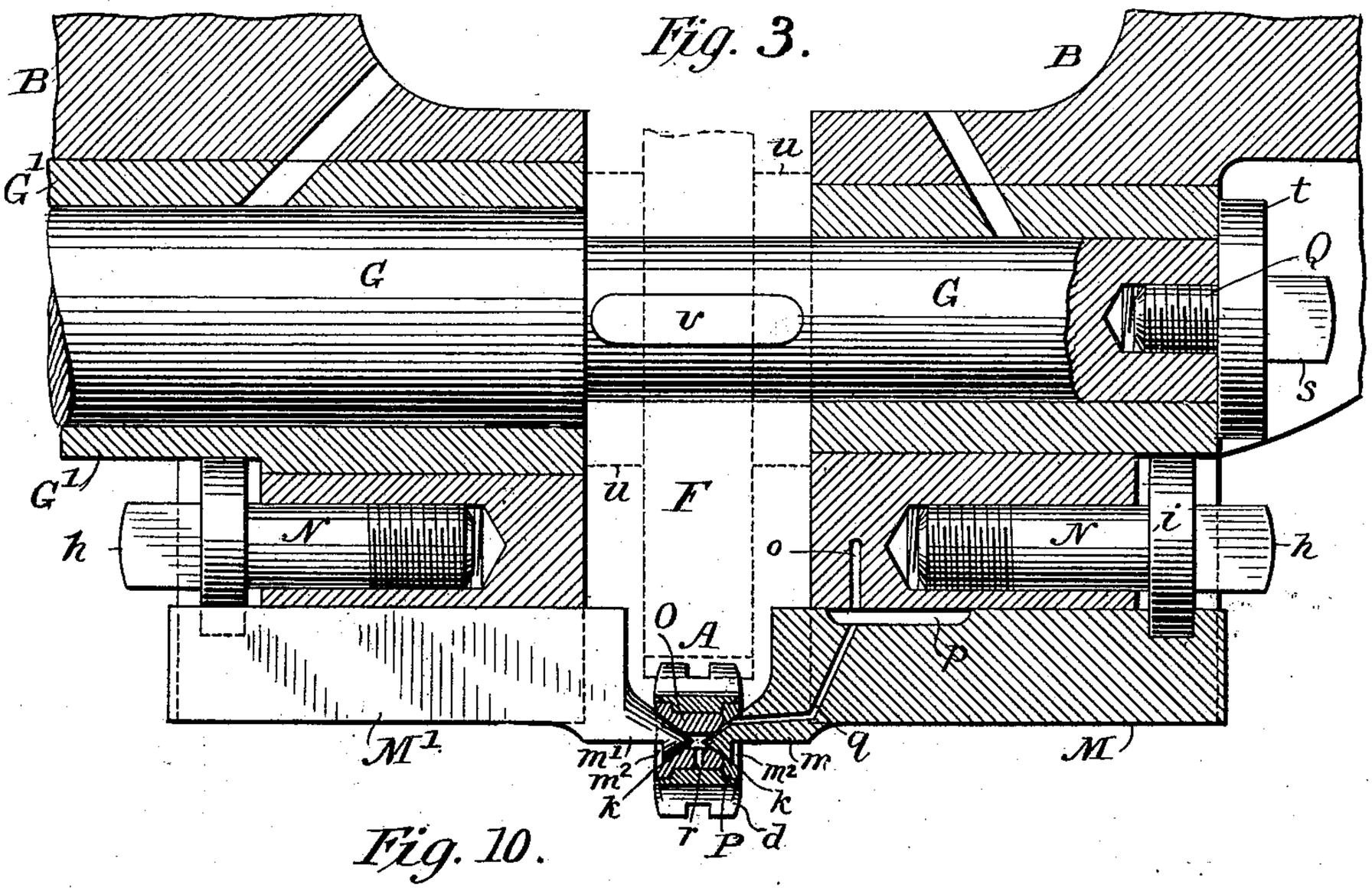


Fig. 10.

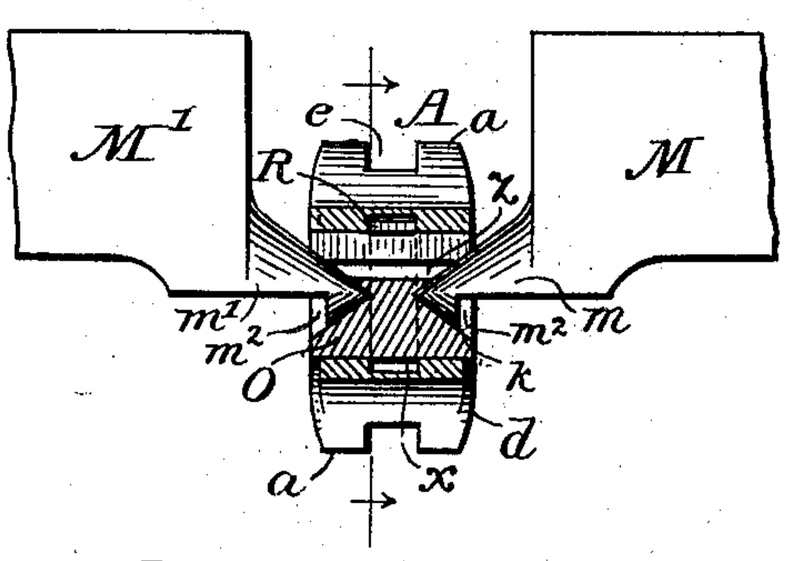


Fig. 7.

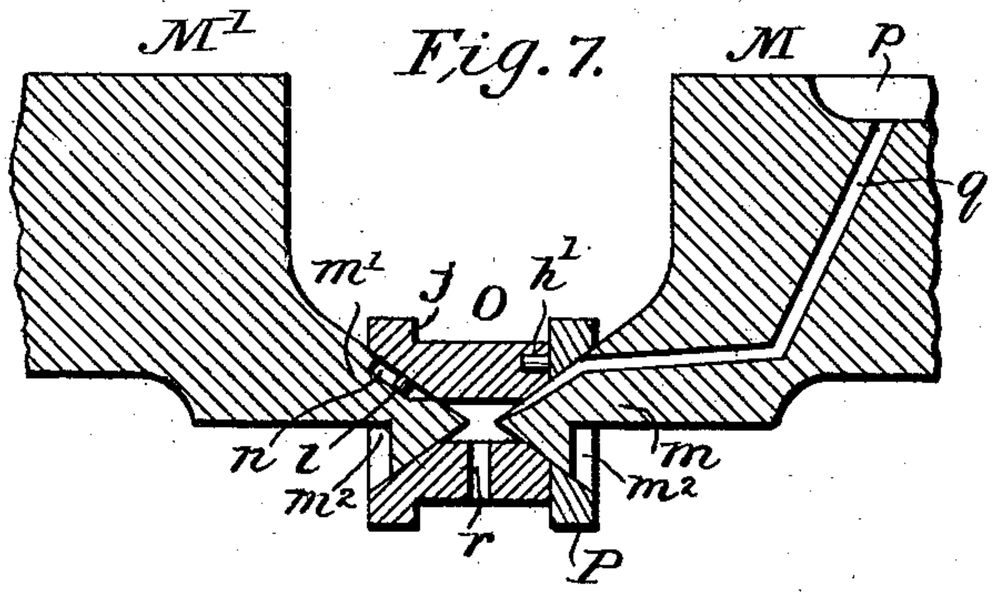


Fig. 11.

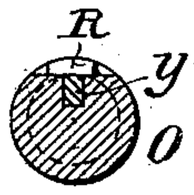


Fig. 12.

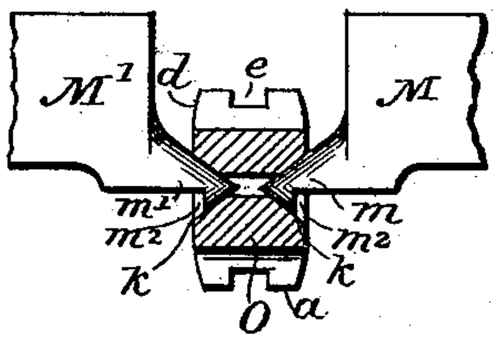
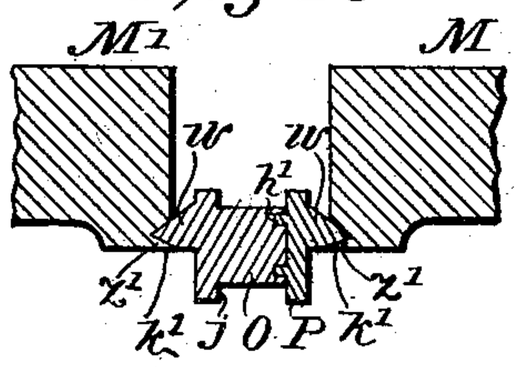


Fig. 13.



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UNITED STATES PATENT OFFICE.

JOHN C. BOOTH AND GEORGE AMBORN, JR., OF BROOKLYN, NEW YORK, ASSIGNORS TO THE J. H. WILLIAMS & COMPANY, OF SAME PLACE.

ROTARY CUTTER.

SPECIFICATION forming part of Letters Patent No. 599,680, dated March 1, 1898.

Application filed July 31, 1897. Serial No. 646,672. (No model.)

To all whom it may concern:

Be it known that we, JOHN C. BOOTH and GEORGE AMBORN, Jr., of Brooklyn, in the county of Kings and State of New York, have invented certain new and useful Improvements in Rotary Cutters, of which the following is a specification.

The present improved rotary cutter, while not limited in its application to such purposes, is nevertheless more particularly designed for die-sinking, since when so used its merits and advantages are most conspicuously displayed. The invention and improvement will therefore be described with reference to such use.

In sinking dies—that is to say, in forming an intaglio or female die by cutting into the metal of which the die is formed—it is a tedious matter to form die depressions or recesses which are semicircular in cross-section, such as are repeatedly necessary in case the article to be made in the die-press is cylindrical in shape at any point. In the usual way of making such dies it is necessary to first rough out the die-depressions to approximately the desired shape by a roughing-cutter driven by power in the manner common to the ordinary die-sinkers, and the die thus partly made is completed by handwork. This handwork is tedious and requires workmen of very high skill.

The chief object of the present improvement is to provide a rotary cutter which will enable the desired operation to be performed entirely by machine, thus dispensing altogether with subsequent hand-finishing, except, perhaps, in some cases to a very limited extent. This object is achieved by the employment of a rotary wheel-cutter having cutting edges on its periphery, the cutter being so mounted and driven that it is able to sink throughout its entire axial extent clear to the center or axis of rotation in the material operated upon, thus enabling a full semicircular recess to be formed in the die-stock or other material operated upon, the surface of which that is acted upon by the cutter is greater in both directions than the axial and diametric extents, respectively, of said cutter.

It will be obvious that if the improved cutter thus briefly referred to has cutting edges only on its periphery it would be necessary to furnish separate cutters for different lengths of semicylindrical depressions to be cut, and hence in any establishment a large number of expensive cutters would be required. In addition, it is to be noted that in metal-working the power required to drive the cutter would increase in proportion to the length of the cutter, so that the permissible length of the cutter is limited. To avoid these difficulties a second feature of the present invention is to provide the cutter with cutting edges on its faces, which enable the die-groove to be cut out lengthwise. In the ordinary die-sinkers the work is carried by a universally-movable bed, and hence the lateral movement of the work to enable the side cutting faces to operate and perfect their work is provided for. This operation, however, requires that the rotary cutter should be so mounted as to be incapable of lengthwise movement on its axis during its cutting operation, and the mounting of the cutter in this respect constitutes one of the features of the present invention.

The invention comprises also features in detail, auxiliary to the main features, which will be hereinafter more specifically described.

In order that the present improvements may be readily understood, we have shown them in the accompanying drawings as applied to an ordinary die-sinker, and hence the gearings shown are such as to enable the rotary cutter to be driven from the usual vertical shaft of such machines. It is to be understood, however, that the drawings simply show one selection of means of carrying out and embodying the invention.

In the accompanying drawings, Figure 1 is a front view of so much of a die-sinking machine, with the present improvements applied thereto, as is necessary to enable the present invention to be clearly understood. Fig. 2 is a side view of the mechanism shown in Fig. 1, being partly in vertical section in the plane indicated by the line 2 2 in Fig. 1. Fig. 3 is a vertical cross-section, on an enlarged scale, of the rotary cutter and the means for mounting it. Fig. 4 is a perspective view of the rotary cutter detached. Fig. 5 is a perspective view of the hub on which the rotary cutter turns. Fig. 6 is a perspective view of a thrust-collar

for the rotary cutter. Fig. 7 is an enlarged vertical longitudinal section of the hub and the centers on which it is mounted. Fig. 8 is a longitudinal section of one of the center-slides and a portion of the cutter-head. Fig. 9 is a vertical cross-section of the parts shown in Fig. 8. Figs. 10 and 11 are detail views of a modified form of rotary cutter. Fig. 12 is a detail view of a still further modified form of rotary cutter. Fig. 13 is a detail view of a modified arrangement of hub and centers.

Referring first to Figs. 1 and 2, A is the rotary cutter. B is the cutter-head, in which the mechanism constituting the present improvements are mounted. C is part of the framework of an ordinary die-sinking machine. D is the usual vertical power-driven rotary drive-shaft of an ordinary die-sinking machine, and E indicates the universally-movable work-bed of an ordinary die-sinking machine, as is usual in such machines, which is capable of being moved vertically and in two horizontal planes perpendicular to each other by the usual appliances for that purpose.

Referring now to the rotary cutter A, as best shown in Fig. 4, it will be noted that the cutter has a plurality of cutting edges *a* on its periphery, which extend substantially parallel with each other and, if a cylindrical die depression is to be made, parallel with the axis of rotation of the cutter. These cutting edges are at the outer edge of ribs *b*, which are separated by spaces *c*. This construction virtually makes a gear-wheel or pinion out of the cutter, which enables it to be directly driven by a gear-wheel F, directly meshing therewith, as shown in Fig. 2, the ribs *b*, carrying the peripheral cutting edges *a*, constituting the gear-teeth. The cutter likewise has cutting edges *d* on its side faces along the gear-teeth *b*, which constitute the cutting means whereby a groove of greater length than that of the cutter may be formed. It will be noted, as shown in Fig. 4, that the peripheral cutting edges *a* do not extend continuously across the teeth *b*, but are interrupted at the middle thereof by spaces *e*. The purpose of this interruption is to enable the cutter to have sufficient length to operate effectively as a gear-wheel or pinion without increasing the cutting extent so far as to incur the expenditure of an undue amount of power in driving the same while working. Since the cutters so formed are intended more especially for cutting a groove or recess of greater length than the width of the cutter, the relative lateral movement between the work-support and cutter permitting this to be done, the presence of the spaces *e e* does not result in cutting a groove or recess with a corresponding inwardly-projecting rib. The pitch-line of the cutter A, considered as a gear-wheel, is nearer the axis of rotation than the bottom of the spaces *e*, so that the presence of said spaces does not unduly weaken the teeth *b*.

It will be noted from an inspection of Fig. 3 that the face cutting edges *d* may be curved if the configuration of the die-groove to be formed renders such configuration desirable or expedient; but any form may be given thereto, depending upon the desired configuration of the finished die.

Passing by for the moment the mounting of the rotary cutter A, it is immediately driven by the directly intermeshing gear-wheel F. This gear-wheel F is keyed to a horizontal shaft G, journaled in cutter-head B. Preferably the shaft G is not journaled directly in the cutter-head, but in a separate sleeve or bushing G′, inserted in the cutter-head and firmly held therein by screws *e′ e′*. By reason of this construction the bushings may be replaced when worn without replacing the entire cutter-head. The said shaft G at one of its outwardly-projecting ends carries a pinion H, which meshes with a pinion I, carried by a second horizontal shaft J, which is journaled in the cutter-head B above the shaft G and carries a beveled gear K, which meshes with a beveled gear L on the vertical shaft D. In this way the rotary cutter is driven by the usual vertical shaft D. This gearing, however, is not an essential part of the invention in its broader aspects, but may be varied or modified at will, being, in so far as many of its features are concerned, merely incidental to the use of the rotary cutter on an existing type of machine carrying a vertical drive-shaft. There are, however, in connection with the gear-wheel F some features relating to its mounting and its engagment with the rotary cutter A of importance, though of an auxiliary character, which will hereinafter be more particularly referred to.

Now it is obvious that if the rotary cutter A turned upon an ordinary cylindrical shaft it would be impossible for the cutter to sink in the material operated upon sufficiently far to cut a semicylindrical die-groove, since the depth of the cut would be limited by the diameter of the shaft. To enable the rotary cutter to cut a true semicircle, it is obvious that it is necessary for the cutter to be so mounted as to sink in the material operated upon clear to its center or axis of rotation, and hence a special mounting therefor is rendered necessary. This special mounting will accordingly be described with special reference to Figs. 1 to 7, inclusive. The cutter-head B has a vertically-extending recess in which the rotary cutter A and the gear F are located. On either side of this recess and at the bottom of the cutter-head are located two bearing-slides M M′, which are alike except in the particulars hereinafter specified. These slides are mounted horizontally in the cutter-head, so as to slide to and from each other. Each slide is dovetailed in shape in cross-section, as indicated in Figs. 2 and 9, and slides in a correspondingly dovetail-shaped longitudinal groove or passage in the cutter-head. Each slide is clamped in place by means of a

clamping-screw *f*, which taps into the cutter-head and may seat immediately against the front side of the slide. Preferably, however, the clamping-screw *f* seats against a separate clamping-gib *g*, interposed between the same and the front side of the slide and extending lengthwise of the slide and alongside the outer inclined side thereof. This clamping-gib is preferably slightly wedge-shaped longitudinally, with its narrowest portion toward the inner end of the slide, so as to more certainly prevent any accidental outward movement of the slide, and is also preferably wedge-shaped laterally, with its widest end at the top to hold the slide solidly against upward pressure, all as shown in Figs. 8 and 9. On its outer face or side the clamping-gib has a conical recess *g'*, into which enters the conical inner end *f'* of the clamping-screw, said conical end seating against the inner and lower margins of the said conical recess, so that said clamping-gib is seated tightly and solidly into the gap between the cutter-head and the center-slide, thereby firmly wedging the slide in place in contact with the inner inclined wall of the passage in the cutter-head and holding it solidly against outer longitudinal and upward movement. In order to adjust either slide M or M' in and out, an adjusting-screw N is employed. This adjusting-screw screws into an immovable part of the cutter-head B, its head *h* being squared for the application of a wrench for this purpose. The adjusting-screw N has a circular flange *i* thereon, which closely engages a recess in the upper side of the slide M or M', as shown in Fig. 3. Consequently as the adjusting-screw N is turned in or out the slide is moved correspondingly, the clamping-screw *f* being of course loosened when this is to be done. The independent endwise movement of the slide is prevented by the close engagement of its recess with the flange *i* of the adjusting-screw.

Each slide M M' has on its inner end a center *m m'*, respectively. Each of these centers is preferably conical in shape. The lower half of each conical center terminates in a vertical shoulder m^2, which extends upwardly at least as far as the center or axis of the cone, and no part of the center-slide exterior to said shoulder is in a plane as low or lower than the said axis. These two conical centers constitute the bearings on which the rotary cutter mediately or immediately turns.

As shown in the modification illustrated in Fig. 12, the rotary cutter may turn directly upon the conical centers. This, however, would involve wear on the conical centers, which it is desirable to avoid. Hence we prefer a construction similar to that shown in Figs. 1 to 7, inclusive. As here shown, the rotary cutter turns directly upon a stationary hub O, (see Figs. 5 and 7,) which has a fixed flange *j* at one end. This hub O fits within a cylindrical bore in the rotary cutter, its flange *j* fitting in a circular recess within the rotary cutter. The thrust-collar P (shown in Fig. 6 in detail) is of the same diameter as the flange *j* of the hub and fits within a corresponding recess in the other side or face of the rotary cutter, all as shown in Fig. 3. The thrust-collar P may be considered as a separable flange of the hub O, and when the hub is thus regarded as having a fixed and a separable flange it is constructed with two conical recesses *k k* at either end, which conform in shape to the conical centers. The thrust-collar P has a projecting stud *h'*, which fits in a corresponding aperture in the hub, so that said collar cannot turn independently of the hub.

As shown in Fig. 3, the two conical centers *m m'* enter and fit in the two conical recesses *k k* in the hub with its flanges. In the case of the separable flange or thrust-collar P it will be noted that a portion of the conical seat *k* on that side of the hub is formed in the separable flange or thrust-collar itself. The conical seats in the hub are of such size that when the conical centers are in place the outer end faces of the cutter extend outwardly as far or farther than the shoulders m^2 of the centers, so that the lower halves of said centers are wholly within the said seats. To prevent the rotation of the hub upon the bearings *m m'*, it is provided with a key *l*, which fits in a key-slot *n* in one of the conical centers, as *m'*. (See Fig. 7.) Owing to this construction the hub remains stationary and the rotary cutter turns thereon, and consequently wearing friction does not occur upon the conical centers. The flange *j* and thrust-collar P prevent any endwise movement of the rotary cutter, and thus enable its face cutting edges *d* to operate, since any working pressure brought to bear upon said face cutting edges *d* is resisted by either said flange or said thrust-collar, which themselves are prevented from axial movement by reason of the rigid mounting of the slides M M' and the close fit which is permissible between the conical centers *m m'* and the conical seats *k k*.

It will be noted that the progressive cutting into the die-stock is caused by the upward movement of the work-bed E when the peripheral cutting edges are considered and by the lateral movement of the work-bed when the face cutting edges are considered, so that the cutter is, in effect, a milling-cutter. A less desirable but permissible arrangement would be to employ a stationary bed-plate and a universally-movable cutter-head or to distribute the relative movements between the bed and head.

In order to oil the rotary cutter, the cutter-head B is provided with an oil-channel *o*, opening out at any convenient point, as in the front of the cutter-head, as indicated in Fig. 1. At its lower end this oil-groove *o* communicates with an elongated oil-groove *p* in the upper side of the slide M, the elongation of the same being necessary to compensate for the horizontal movement of the said slide, which horizontal movement is neces-

sary both to enable the rotary cutter to be put into place and to enable cutters of different widths to be employed. An oil-duct q in the slide M leads from the oil-slot p to the conical center and terminates in communication with one of the conical seats k. From thence the oil is conducted to the wearing-surfaces of the hub O and rotary cutter A by oil-duct r, leading from a central passage in the hub O. It will be noted, as best shown in Fig. 7, that the opening of the duct q is wholly within the seat k and hence within the outer side face of the hub, so that dust, &c., are excluded.

In order that semicircular die-grooves of different diameters may be cut, it is necessary to employ rotary cutters of different diameters, and since the rotary cutter is in itself a gear-wheel this involves as the preferable arrangement the employment of gears F of correspondingly-varying diameters. Less desirably the center-slides might be vertically adjustable. The arrangement of the slides M M′, as already described, permits the insertion and removal of rotary cutters of varying diameters and widths. In order that the gear F may be removed and replaced, its shaft G is made removable. To this end said shaft G coöperates with a fastening-screw Q, which taps into one end of the shaft G, said screw Q having a squared head s to enable it to be turned by a wrench, and a flange t, which seats against a ribbed portion of the cutter-head B, thus firmly maintaining the shaft G in place. On removing the fastening-screw Q the shaft G is free to be moved endwise until it is entirely free from the gear F. Thereupon the gear F can be removed and another one put in its place. It will be noted that the portion of the shaft G at the left in Fig. 3 is larger in diameter than the portion at the right, which passes through the hub u of the gear F. The reason of this arrangement is to permit the key v, which engages the hub u of gear F, to slip out during endwise movement of the shaft G in whatever circumferential position the shaft G may be.

Figs. 10 and 11 show a modification of the hub O and rotary cutter A. In this instance the hub O is not provided with flanges j and P, but is provided with an automatic key R on its upper side, which engages with a peripheral groove x in the central bore of the rotary cutter A. This key R has a tongue y, which rises and falls in a slot z, extending longitudinally of the hub O on its upper side. When the hub O is detached from the centers m m', the key R and its tongue y drop down into the position shown in Fig. 11, where the key R is disengaged from the rotary cutter A. Consequently the rotary cutter may be slipped on and off. In this position, however, the ends of the tongue y project into the conical seats k in the hub O, and consequently when the rotary cutter A is in position on the hub and the conical centers m m' are brought into position they encounter the ends of the tongue y and thereupon elevate the key R into engagement with the peripheral groove k of the rotary cutter A. Consequently the rotary cutter A, while free to turn on the hub O, is nevertheless prevented from endwise movement.

As shown in Fig. 13, the arrangement of seats and centers can be reversed. As here shown the hub is provided with semiconical centers w, which fit in semiconical seats k' in the slides. To prevent the hub (and cutter) from dropping out, one (or both) of the slides has a tongue z' fitting the cut-away end of the corresponding center w.

Each of the several constructions illustrated enables a recess with closed sides and ends, semicircular in cross-section, to be cut in a mass of material which presents to the action of the cutter a surface greater in length than the axial extent of the cutter and greater in width than the diametric extent of the cutter. The cutter in each case sinks or embeds itself throughout its entire axial extent in the mass of the material operated upon.

It is obvious that numerous changes and modifications can be made in the detail construction and arrangement selected for illustrating the principles of the invention without departing from the same, and hence we do not wish to be confined or limited to the details shown and described.

What we claim as our invention is—

1. The combination of the rotary cutter, a cutter-head, and means supported by said cutter-head upon which said cutter is mounted which permit it to sink to its axis of rotation throughout its entire axial extent into the mass of material operated upon when said mass has its surface acted upon by said cutter greater in both directions than the axial and diametric extents respectively of said cutter, substantially as set forth.

2. The combination of the rotary cutter, and a cutter-head having centers upon which said cutter is mounted which permit it to sink to its axis of rotation throughout its entire axial extent into the mass of material operated upon when said mass has its surface acted upon by said cutter greater in both directions than the axial and diametric extents respectively of said cutter, substantially as set forth.

3. The rotary cutter having conical seats, in combination with the conical centers which adapt the cutter to sink in the material operated upon to its axis of rotation, substantially as set forth.

4. The rotary cutter constructed as a gear-wheel and capable of sinking to its axis of rotation in the material operated upon, in combination with a directly-engaging driving-gear, substantially as set forth.

5. The rotary cutter constructed as a gear-wheel with peripheral cutting-teeth and ca-

pable of sinking to its axis of rotation in the material operated upon, in combination with a directly-engaging driving-gear, substantially as set forth.

6. The cutter-head having longitudinally-movable centers, in combination with the rotary cutter mounted on said centers so as to sink in the material operated upon to its axis of rotation, substantially as set forth.

7. The cutter-head having longitudinally-movable conical centers, in combination with the rotary cutter having conical seats which adapt it to sink in the material operated upon to its axis of rotation, substantially as set forth.

8. The rotary cutter constituting in itself a gear-wheel, whereby rotary motion may be communicated thereto, and having on its gear-teeth both peripheral and face cutting edges, in combination with a work-support, there being a relatively lateral movement between the cutter and work-support, substantially as set forth.

9. The rotary cutter constituting in itself a gear-wheel, whereby rotary motion may be communicated thereto, and having peripheral cutting-teeth which are interrupted so as not to extend the full width of the cutter, in combination with a gear-wheel engaging said cutter, and a work-support, there being a relatively lateral movement between said work-support and cutter whereby an elongated groove may be cut, substantially as set forth.

10. The rotary cutter constituting also a gear-wheel, whereby rotary movement may be imparted to it, and having peripheral cutting edges with central spaces therein so that each cutting edge is not continuous throughout its length, in combination with a gear-wheel engaging said cutter, and a work-support, there being a relatively lateral movement between said work-support and cutter whereby an elongated groove may be cut, substantially as set forth.

11. The combination of the cutter-head having conical centers, the hub having conical seats, and the rotary cutter turning on said hub, substantially as set forth.

12. The combination of the cutter-head having conical centers, the hub having conical seats, the rotary cutter turning on said hub, and means for preventing the endwise movement of the rotary cutter on the hub, substantially as set forth.

13. The combination of the cutter-head having conical centers, the hub having conical seats, and projecting flanges at either end, and the rotary cutter turning on said hub between said flanges, substantially as set forth.

14. The combination of the conical centers, the hub having conical seats, the rotary cutter turning on said hub, and means for preventing the rotation of the hub, substantially as set forth.

15. The combination of the centers, the hub having seats, and the rotary cutter turning on said hub, substantially as set forth.

16. The combination of the centers, the hub having seats, the rotary cutter turning on said hub, and means for preventing the endwise movement of the rotary cutter on the hub, substantially as set forth.

17. The combination of the centers, the hub having seats, and projecting flanges at either end, and the rotary cutter turning on said hub between said flanges, substantially as set forth.

18. The combination of the centers, the hub having seats, the rotary cutter turning on said hub, and means for preventing the rotation of the hub, substantially as set forth.

19. The combination of the centers, the hub having central passage, and an oil-duct leading therefrom, the rotary cutter turning on said hub, and the oil-passage leading through one of said centers to the central passage in said hub, the outlet of said oil-passage being within the outer side face of said hub, substantially as set forth.

20. The combination of the rotary cutter, the movable centers therefor, the removable gear immediately engaging said rotary cutter, and the removable shaft of said gear-wheel, substantially as set forth.

21. The cutter-head, in combination with the center-slide, the wedge-shaped clamping-gib extending lengthwise of said slide, and the clamping-screw seating against the outer side of said gib, substantially as set forth.

22. The cutter-head, in combination with the center-slide, the doubly-wedge-shaped clamping-gib extending lengthwise of said slide having a conical seat in its outer side face, and the clamping-screw having a conical point entering said seat, substantially as set forth.

23. The combination of the cutter-head having longitudinal passage dovetailed in cross-section, the center-slide dovetailed in cross-section entering in said longitudinal passage and seating against the inner inclined wall thereof, and the clamping-gib inserted in said passage longitudinally alongside one inclined face of said slide, said gib being wedge-shaped both longitudinally and laterally, and means for holding said gib in place, substantially as set forth.

In testimony that we claim the invention above set forth we affix our signatures in presence of two witnesses.

JOHN C. BOOTH.
GEORGE AMBORN, JR.

Witnesses:
JOHN LEE,
A. M. TILTON.