July 17, 1928. 1,677,337

T. E. GROVE

ANTRUM DRILL

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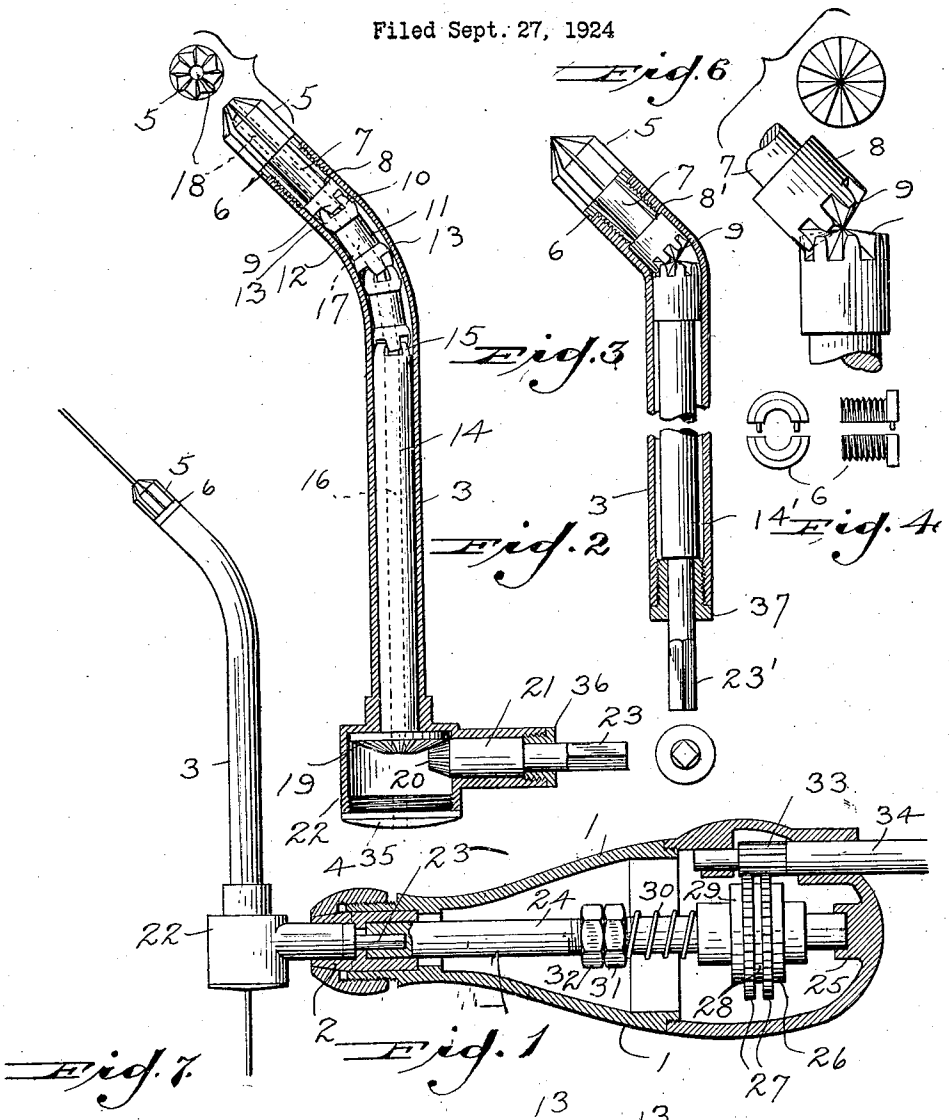

Fig. 1

Fig. 7

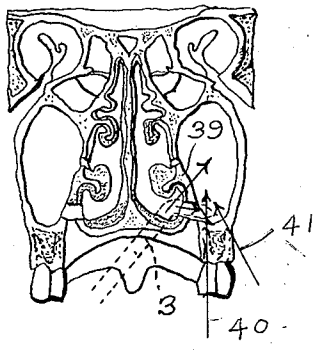

Fig. 2

Fig. 3

Fig. 4

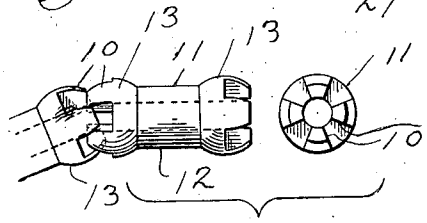

Fig. 5

Fig. 6

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UNITED STATES PATENT OFFICE.

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ANTRUM DRILL.

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My invention relates to surgical instruments and more particularly to a drill for intranasal opening of the facial sinus or antrum, and the frontal sinus, as well as other bone drilling operations.

The facial sinus or antrum of Highmore is a large cavity of somewhat pyramidal form, located within the superior maxillary bone. The frontal sinus is an irregular cavity which extends upwardly and outwardly between the two tables of the skull, immediately above the superorbital arches and communicates with the nose thru the infundibulum. These cavities are subject to numerous surgical diseases, the most common being infection, followed by suppuration necessitating drainage.

The interior walls of the antrum are comparatively thin, particularly that portion of the interior wall which separates the antrum from the interior meatus of the nasal fossæ. The extreme thinness of the internal wall and its accessibility thru the nares renders the intranasal route desirable for surgical operations. However, due to lack of facilities and suitable instruments for puncturing the internal antrum wall, surgical preference has been given to operations by the dental route, which method necessitates the sacrifice by extraction of a molar tooth and the drilling thru the alveolar process, or the entrance to the antrum thru the lower exterior wall just above the apices of the tooth roots.

The sole means heretofore of intranasal operations for entrance into the antrum or into the frontal sinus has been by use of a trocar or cannula. The tortuous passage thru the nasal fossæ does not readily accommodate a straight trocar. A curved trocar or cannula adaptable to the passage is unsuitable since direct driving pressure is necessary and more or less twisting or boring movement is required to penetrate the antrum wall or enlarge the opening into the frontal sinus. In such method there is no way of controlling the extent of bone breakage, and the wall may be fractured or splintered thru a greater area than intended. In case the entrance opening thus formed by a pressure operated trocar is too small the use of a trocar must be followed by that of a rasp.

By the use of the present implement, entrance to the antrum thru the nasal route is achieved by drilling thru the wall between the antrum and interior meatus, at a point coincident with the bottom of the antrum cavity. Since this point of operation cannot be approached directly on a straight line thru the nares, there is employed an instrument having an arcuate or curvilinear shaft or cannula provided with a burr at its extremity, operated by drive means extending thru the hollow stem or cannula.

In prior Patent, No. 1,630,239, there is described a nasal drill having a stem or cannula of uniform curvature upon a comparatively large radius. The drill burr at the extremity of the cannula in the construction disclosed in such application is driven by means of a flexible wire, or flexible shaft extending thru the hollow stem or cannula. While the construction shown in such earlier Letters Patent is quite efficient and practical for certain conditions of use, it has been found that a cannula extending substantially straight thruout the major portion of its extent and having a rather abrupt lateral bend, adjacent to its extremity whereby the drill burr is disposed at a decided angle with the general extent of the cannula, affords a more practical and efficient construction, enabling the entrance to the antrum to be drilled at a lower point, and also permitting the implement to be employed for opening the passage from the nasal fossæ into the frontal sinus. While the flexible wire or continuous driving cable illustrated in the earlier application is quite suitable for the arcuate form of cannula there shown, such driving element does not accommodate itself to the abrupt change of direction of the cannula necessary to reach the preferred point of operation. To this end, the present construction embodies in lieu of the flexible wire or cable, successive inflexible driving sections within the hollow cannula, which sections have positive driving interengagement with each other by means of intermeshing teeth on their adjacent extremities. It is frequently desirable to employ a guide or lead element, which may be introduced in advance of the drill and employed to probe and locate the point of operation to which the drill burr will be subsequently guided. To this end the driving sections and drill burr are formed with hollow bores coinciding with each other, thru which may be introduced a silver probe or director. Such passage

also serves for relief and drainage at the time of operation.

The object of the invention is to simplify the structure as well as the means and mode of operation of such surgical drill instruments, whereby they will not only be cheapened in construction, but will be more efficient in use, positive in operation, uniform in action and unlikely to get out of repair.

A further object of the invention is to provide such a drill for surgical purposes, mounted on a cannula having a rather short and abrupt bend, with driving means operable thru the interior of the cannula, capable of accommodating itself to the abrupt change of direction, without distortion and without twisting or breakage.

A further object of the invention is to provide in such surgical drill instrument, a construction permitting the preliminary introduction of a director probe or guide wire by which the point of operation may be definitely located and the drill instrument guided thereto. To this end the instrument is provided with hollow driving sections for the drill burr, and a hollow burr.

A further object of the invention is to provide a bone drill or the like, the parts of which are easily and readily accessible for sterilization, but which are so interengaged and assembled as to prevent accidental disconnection and loss when in use.

A further object of the invention is to provide an instrument of improved shape and contour to more readily accommodate it to various sizes of nares and to enable the puncture of the antrum wall at a lower level and also to provide a drill instrument adaptable to the opening of the passage into the frontal sinus, for which the construction shown in Patent No. 1,630,239 heretofore referred to is not suitable.

With the above primary and other incidental objects in view as will more fully appear in the specification, the invention consists of the features of construction, the parts and combinations thereof, and the mode of operation or their equivalents as hereinafter described and set forth in the claims.

Referring to the drawings, Fig. 1 is a longitudinal sectional view of the surgical drill forming the subject matter hereof. Fig. 2 is an enlarged sectional view of the cannula disclosing the driving sections enclosed therein, and the drill burr at its extremity. Fig. 3 is a modification of the construction shown in Fig. 2. Fig. 4 is a detail view of the split bushing for removably securing the rotary drill burr in the end of the cannula. Fig. 5 is a detail view of one of the driving sections shown in Fig. 2. Fig. 6 is a detail view of the interengaging faces of the driving sections shown in Fig. 3. Fig. 7 is a diagrammatic view showing the relative location of the maxillary antrum and indicating different directions in which the antrum may be entered, in comparison with the present drill method through the nares.

Like parts are indicated by similar characters of reference thruout the several views.

In the drawings, wherein have been shown the preferred, but obviously not necessarily the only forms of embodiment of the invention, the various parts have been illustrated upon a very much enlarged scale. It will be understood that the length and diameter of the cannula and the size of the burr as well as the handle or mounting containing the driving mechanism will be appropriate to the anatomical conditions to which it is applied.

In the drawings, 1 is a hollow handle, within which is contained frictional driving mechanism for the burr or drill. Detachably secured at the extremity of the handle 1 by means of clutch jaws 2 is a hollow cannula or stem 3. To accommodate the instrument to the nasal passages thru which it must be introduced, the cannula in the present instance is rather abruptly bent adjacent to its extremity in a lateral direction, inclined to the general axis of the main portion of the cannula, which is substantially straight. The chuck jaws 2 may be of any suitable form or construction. In the present instance, they consist of a slotted or tapered sleeve carried by the handle section 1 and surrounding the end of the cannula 3. The jaws are contracted by a tapered collar 4, screw threaded upon the handle section 1. The particular mode of attachment is immaterial, and obviously, other forms of attaching the cannula to the mounting or handle may be substituted. On the outer extremity of the laterally bent or inclined portion of the cannula or hollow stem 3 is mounted a drill burr 5. Such drill burrs are made in various shapes and sizes to meet various conditions of use. For illustrative purposes the drill or burr 5 in the present instance has been shown of substantially cylindrical form terminating in a conical or tapered end. This preferred form of drill burr is a combined drill and side mill, by which a hole may not only be drilled thru the antrum wall or other bony structure, but may be enlarged by side cutting to any desired size. The burr 5 is revolubly mounted in a spit bushing 6, screw threaded in the end of the curvilinear cannula 3. To prevent accidental disengagement of the burr, the shank 7 of the burr is provided at its inner end with a head or shoulder 8 which prevents its withdrawal axially from the bushing 6. The shank 7 is positioned intermediate the two halves of the split bushing 6 shown in detail in Fig.

4. This bushing is then screwed into the end of the hollow stem or cannula 3. The bushing is threaded right or left according to the direction of rotation of the burr, so that it is screwed into the cannula in the same direction that the burr rotates. Thus the tendency of the rotating drill or burr will be to tighten the split bushing 6 in place. Obviously, when the shank of the burr is enclosed within the split bushing 6 with the shoulder or head 8 at one end, and the drill head at the other end, it cannot become dislodged or accidentally disconnected and lost in the antrum cavity or in the nasal fossæ.

The terminal face of the spindle head 8 is provided with a series of radially disposed spaced lugs or teeth, resembling clutch teeth rather than gear teeth. The teeth 9 of the head 8 engage with corresponding teeth or lugs 10 upon a short driving section 11 located within the cannula. This driving section 11 is medially reduced at 12, the extremities of the section bearing teeth 10 being formed into spherical heads 13. Any number of such sections may be provided as may be necessitated by the extent of the bend or arcuate configuration of the cannula. In the present instance there are two such intermediate short driving sections 11, each having at its opposite ends terminal clutch teeth or driving lugs 10. The diameters of the spherical heads 13 at the opposite ends of the sections 11 corresponding with the internal diameter of the cannula enables the driving sections 11 to accommodate themselves to the curvature of the cannula and to freely rotate therein. Extending thru the major straight portion of the cannula is a revoluble stem or shaft 14, having at its extremity clutch teeth or driving lugs 15, interengaging with the driving lugs or teeth 10 of the first short section 11 of the series. This drive shaft or spindle 14 may be provided with a polygonal terminal at its opposite end for direct engagement with the main drive shaft of the mounting or transmission mechanism as is shown in Fig. 3. However, to accommodate a lead wire or guide probe, the spindle 14 and intermediate driving sections 11, as well as the burr or drill are provided with registering longitudinal bores 16, 17 and 18 respectively, thru which such guide wire or lead may be introduced and projected beyond the extremity of the drill or burr. The intercommunicating bores 16, 17 and 18 form a vent or drain passage during the period of operation. In order that the entrance orifice of such passage may be unobstructed for the introduction and manipulation of the probe or lead wire the spindle 14 is connected in offset relation with the power transmission devices enclosed in the handle 1. To this end the spindle 14 is provided at its extremity with a gear pinion 19, meshing with a corresponding gear pinion 20 on a stub shaft 21. These gear pinions are enclosed within a housing or coupling enclosure 22, having therein a bearing for the stub shaft 21. The stub shaft 21 is provided with the polygonal extremity 23 engageable with the main shaft of the power transmission mechanism.

As before mentioned the power transmission mechanism is enclosed within the hollow handle 1. The polygonal extremity 23 of the stub shaft 21 is received in a corresponding socket in the end of the drive shaft 24. This shaft 24 extends axially within the handle section 1, and is provided with a bearing in a lug 25, in one end of the handle mounting, and has a loose journal bearing in the inner end of the clutch sleeve 2 at the opposite end of the handle section. Fixedly secured to the drive shaft 24 is a friction drive collar 26, adjacent to which are loosely journaled upon the drive shaft two driving gears 27 spaced apart and between which is interposed a friction drive disc 28. The disc 28 is keyed upon the shaft 24 for unison rotation therewith, and is free for axial adjustment. Bearing upon the gear 27 on the side opposite the fixed collar 26 is a second friction collar 29, also keyed upon the shaft 24 for unison rotation, but slidingly adjustable in an axial direction and exerting pressure upon the gears 27, under the influence of a spring 30. The spring 30 is of helical formation, bearing at one end upon the sliding friction collar 29, and abutting upon its opposite end upon a stop nut 31, adjustable upon the shaft 24 to vary the tension of the spring and secured in its adjusted position by means of the lock nut 32. The construction is such that while the gears 27 are loosely journalled upon the shaft 24 for independent rotation they are clamped between the friction collar 26 and 29, and the interposed friction discs 28, under spring pressure to afford the necessary driving power. The gears 27 intermesh with a driving gear pinion 33, upon a counter shaft 34 suitably journalled in the handle section 1 in parallel relation with the main drive shaft 24, and extending beyond the handle section where it is connected to a driving motor or other suitable source of power. The frictional engagement of the collar 26, 28 and 29 with the driving gear 27 is sufficient to drive the shaft 24 and with it the burr or drill 5 in any ordinary operation. However, should the resistance to the burr or drill become sufficiently great to endanger either the patient or the instrument or to be such as to be likely to cause breakage of the burr, the frictional driving engagement between the collars and the gear will be overcome and more or less slippage will occur.

By disengaging the chuck collar 4, the curvilinear cannula or stem 3 may be disen-

gaged from the handle and with it the intermediate driving connection between the main power shaft 24 and the burr or drill. By unscrewing the bushing 6 the burr may be disengaged. The intermediate driving sections 11 which are interposed between the burr and the spindle 14 can then be removed thru the end of the cannula. The coupling or housing 22 is provided with a removable bushing 36, and a removable head 35, which upon disengagement permit the withdrawal of the stub shaft 21 with its gear pinion 20 and the spindle 14 with its gear pinion 19. The head 35 is provided with a central orifice registering with the bore 16 of the spindle 14, thru which the lead wire or guide probe may be introduced.

In the event that a guide or lead wire is not to be employed and the registering bores thru the spindle and burr are to be omitted, the spindle is directly connected with the power shaft of the transfitting mechanism by means of a polygonal head 23′, formed directly upon the extremity of the spindle as shown in Fig. 3. In the event that the curvature or lateral deflection of the cannula is abrupt, so that intermediate driving sections 11 are unnecessary to accommodate the power transmission devices to the curvature of the cannula the extremity of the spindle may have direct driving engagement with the burr or drill as also shown in Fig. 3. In this figure the spindle 14′ is formed with a series of radial teeth on its terminal face. The head 8′ of the burr or shank is formed with similar teeth intermeshing with those of the spindle. By this means power is transmitted directly from the spindle 14′ to the shank of the drill burr, whereas in the construction shown in Fig. 2 because of the more extended curvature of the cannula, making direct connection of the spindle and burr impossible, the intermediate short driving sections 11 are interposed, which sections because of their spherical heads at each end readily accommodate themselves to the curvature of the cannula and freely rotate therein.

In Fig. 3 a bushing 37 at the end of the cannula opposite the burr forms a bearing for the spindle 14′ and removably secures the spindle within the cannula. The bushing 6 at one end of the cannula and bushing 37 at the opposite end thereof are reversely threaded, one being right hand and one being left hand threaded, the threading agreeing in direction with that of the rotation of the spindle and burr, so that the tendency of such rotation will be to tighten both bushings, thereby entirely obviating any tendency to loosen in use.

In the diagrammatic view, Fig. 7, the application of the present instrument to antrum purposes has been illustrated. By its use the entrance orifice may be approximately at the bottom of the nasal fossæ and somewhat lower than when using the nasal trocar. The drill burr operated as described will cut its way thru the wall of the antrum quickly and with minimum pain. By lateral motion the initial opening may be enlarged and extended as desired. If the bone is dense or hard there is no danger of fracture as sometimes occurs under the heavy pressure required to force a trocar thru the wall. Moreover, the use of the rasp for the enlargement of the opening is eliminated.

In Fig. 7 external routes as present employed are indicated at 40 and 41 respectively. Obviously, the route 40 necessitates the sacrifice of a molar tooth in order to enter the antrum.

It is obvious that the instrument herein shown and described may be applied to many other bone drilling operations, as will readily occur to the skilled surgeon. For different purposes the cannula carrying the burr may be made of various degrees of curvature or of greater or less length. To meet unexpected or unusual conditions for emergency operations, the tubular stem or cannula may be made of material capable of being flexed or bent into various shapes at the time of its use to enable operations in otherwise inaccessible locations. Obviously, such curvatures of the cannula would be readily permitted by the employment of a succession of short driving sections 11. The instrument is adaptable to dental drilling operations or surgery for which purpose a variety of interchangeable cannulæ or tubular stems of different extent and curvature will be provided. The advantage of the instrument for intranasal operations is illustrated in Fig. 7, wherein the thicker portion of the internal wall of the antrum is shown being penetrated at a much lower level than is possible with the use of a nasal trocar. In using the trocar the surgeon necessarily selects the higher and thinner walled area 39 as the point of entrance, with sacrifice of drainage facilities because of its accessibility and the impossibility of forcing the trocar thru the thick lower wall.

From the above description it will be apparent that there is thus provided a device of the character described possessing the particular features of advantage before enumerated as desirable, but which obviously is susceptible of modification in its form, proportions, detail construction and arrangement of parts without departing from the principle involved or sacrificing any of its advantages.

While in order to comply with the statute the invention has been described in language more or less specific as to structural features it is to be understood that the invention is not limited to the specific details shown, but that the means and construction herein dis-

closed comprises the preferred form of several modes of putting the invention into effect and the invention is, therefore, claimed in any of its forms or modifications within the legitimate and valid scope of the appended claims.

Having thus described my invention, I claim:

1. In a surgical drill for entering the maxillary antrum through the nares or the like, the combination with a mounting including a revoluble drive shaft, of a tubular cannula laterally bent adjacent to its extremity, a revoluble cutting burr mounted in the end of the bent portion of the cannula, the cannula being shaped and proportioned to follow the burr into any passage traversed by such burr, a shank for said burr, a head on the inner end of the shank having a plurality of radially disposed teeth, a spindle revolubly mounted in the cannula with its axis angularly disposed in relation with that of the burr, said spindle having at its extremity teeth operatively connected with those of the burr, the other end of the spindle being operatively engageable with the power shaft of the mounting.

2. In a surgical drill, the combination with a mounting including a revoluble power shaft, of a tubular cannula of curvilinear form, a revoluble drill burr mounted at the extremity of the cannula, the cannula being so shaped and proportioned to enable its entrance into the passage traversed by said burr and means for operatively connecting the burr with the power shaft thru the interior of the cannula including a succession of independent power transmission sections arranged end to end within the cannula, successive sections of the series being arranged with their axes inclined to each other.

3. In a surgical instrument, a cannula comprising two angularly disposed portions, a revoluble cutter mounted at the extremity of the cannula which is shaped and proportioned to follow the cutter into a restricted passage traversed by the cutter, a positive driving connection extending thru the interior of the cannula including a succession of inflexible sections having intermeshing terminal teeth, and means for rotating such sections.

4. In a surgical instrument, a tubular stem bent at a mid-length point to afford a substantially straight portion, and a portion inclined thereto of substantially uniform diameter throughout, a drill burr revolubly mounted at the extremity of the inclined portion and at least as great in diameter as that of the tubular stem, driving means for the drill burr located within the tubular stem and means for rotating the driving means.

5. In a surgical instrument of the character described, a tubular stem, comprising two substantially straight relatively inclined portions joined by an intermediate bend, a revoluble cutter at the extremity of one of said portions capable of providing an orifice through which the adjacent portions of the tubular stem may be projected, an actuating mechanism at the end of the other portion, and an intermediate driving connection extending thru the interior of the tubular stem from the actuating mechanism to the cutter.

6. In a surgical instrument, a tubular stem, a cutter mounted upon the extremity of said stem, said stem being shaped and proportioned to follow said cutter into a restricted passage, a succession of intergeared driving elements extending thru the interior of the tubular stem and transmitting motion positively to said cutter, and an actuating mechanism for said driving elements connected to the other end of said tubular stem.

7. In a surgical instrument, a tubular stem, a cutter mounted thereon having an axial passage therethru, a tubular drive shaft for said cutter enclosed within the tubular stem and actuating means for the drive shaft, the passages thru the drive shaft and cutter coinciding one with the other to form a continuous passage for the introduction of a lead wire.

8. In a surgical instrument, a hollow drill burr, a stem on which the burr is carried, hollow driving elements for the drill burr within the tubular stem, the passages thru the drill burr and driving elements affording a continuous passage for the introduction of a guide wire.

9. In a surgical instrument, a revoluble cutter having an axial passage therethru, a drive shaft for said cutter also having an axial passage therethru and a lead wire introducible thru the said passages to a point beyond said cutter as a guide for the advance movement of the cutter, and means for actuating the drive shaft.

10. In a surgical instrument, a bent tubular stem, a cutter revolubly mounted upon the end of said stem, actuating mechanism. a driving connection between the actuating mechanism and the cutter extending thru the interior of the tubular stem, and a guide adjustably projected beyond the cutter.

11. In a surgical drill, a revoluble hollow cutter, a bent tubular stem at one end of which the cutter is revolubly mounted, a hollow drive shaft extending thru the bent tubular stem, the passage of said drive shaft communicating with that of the hollow cutter to permit the introducion of a guide wire, and means to actuate the drive shaft.

12. In a surgical instrument, a revoluble cutter, a bent tubular stem at one end of

which the cutter is revolubly mounted, a series of clutch teeth upon the inner end of the cutter, a drive shaft extending within the tubular stem, having upon its extremity a plurality of clutch teeth, and a plurality of intermediate clutch elements each comprising an intermediate cylindrical portion of less diameter than the interior diameter of the tubular stem and integral terminal heads of spherical form having diameters substantially equal to the interior diameter of the stem and comprising the bearing surfaces upon which said clutch elements rotate within the stem, said clutch elements having clutch teeth formed on their extremities for interengagement with the cutter and drive shaft and with each other.

13. A surgical instrument wherein a revoluble cutter mounted upon the extremity of an unalined tubular stem is actuated by driving means extending thru the interior of the stem, characterized by a driving element comprising a dumbell shaped member having spherical terminal heads forming bearing surfaces upon which the driving element rotates and an intermediate portion of reduced thickness, the spherical heads being intersected to form a succession of clutch teeth at each end of the driving element, driving and driven elements at opposite ends of such driving element with which the clutch teeth interengage to transmit motion thru an unalined portion of the tubular stem to the cutter, and means for driving said elements.

14. In a surgical instrument of the character described, a cannula, a cutting burr mounted at one end thereof, the cannula being shaped and proportioned to follow the cutter into a restricted orifice formed thereby, means for rotating the cutting burr, and a handle portion connected in angular relation to the cannula whereby the end of the cannula opposite the cutting burr is open for access through the cannula to the area of operation of the burr.

15. In a surgical instrument of the character described, a cannula, a cutter carried at one end thereof, the cannula being shaped and proportioned to follow the cutter into a restricted orifice formed thereby, and driving means for the cutter connected in offset relation with the cannula whereby access is permitted to the end of the cannula opposite the cutter and thence through said cannula to the area of operation of the cutter.

16. In a surgical instrument of the character described, a cannula, a cutter carried at the end thereof capable of forming an opening to receive the cannula, means for driving the cutter, the end of the cannula opposite the cutter being accessible for communication through the cannula with the area of operation of the cutter.

17. As an article of manufacture a drill burr including a shank having therein a peripheral groove forming a trunnion upon which the burr rotates and spaced shoulders defining the peripheral groove, said burr having an axial bore extending therethrough and open at its opposite ends.

18. In a surgical instrument, a cannula, a hollow cutter mounted at the end of the cannula and capable of forming an opening into which the cannula will follow, the hollow interior of the cutter communicating with the interior of the cannula to afford a continuous passage through the cannula and cutter into the recess entered by the cutter.

19. As an article of manufacture a cutter having a cylindrical cutting face and a terminal cutting face, including a shank having therein a peripheral groove forming a trunnion upon which the cutter rotates and spaced shoulders defining the peripheral groove.

20. As an article of manufacture a cutter having a cylindrical cutting face and a terminal cutting face, including a shank having therein a peripheral groove forming a trunnion upon which the cutter rotates and spaced shoulders defining the peripheral groove, said cutter having an axial opening therethrough from one end to the other.

21. In a drill of the character described, a revoluble burr, a mounting therefor, a drive shaft operatively connected with the burr, a drive gear loosely journaled on the drive shaft, a pair of spaced collars one of which is fixedly secured upon the drive shaft, the other of which is axially adjustable thereon but engaged therewith for unison rotation, and between which the gear is mounted, and a spring urging the movable collar toward the fixed collar to yieldingly clamp the drive gear therebetween.

22. In a drill of the character described, a revoluble burr, a mounting therefor, a drive shaft operatively connected with the burr, a counter shaft, intermeshing gears operatively connecting the drive shaft and countershaft one with the other, one of said gears being loosely mounted on its shaft, and friction discs on opposite sides of the loosely mounted gear, mounted for rotation with the shaft and yieldingly engaging the shaft under spring pressure.

In testimony whereof, I have hereunto set my hand this 23rd day of September, A. D. 1924.

THOMAS E. GROVE.