April 11, 1950 J. D. KARLE 2,504,075

TREPHINE

Filed March 12, 1946 3 Sheets-Sheet 1

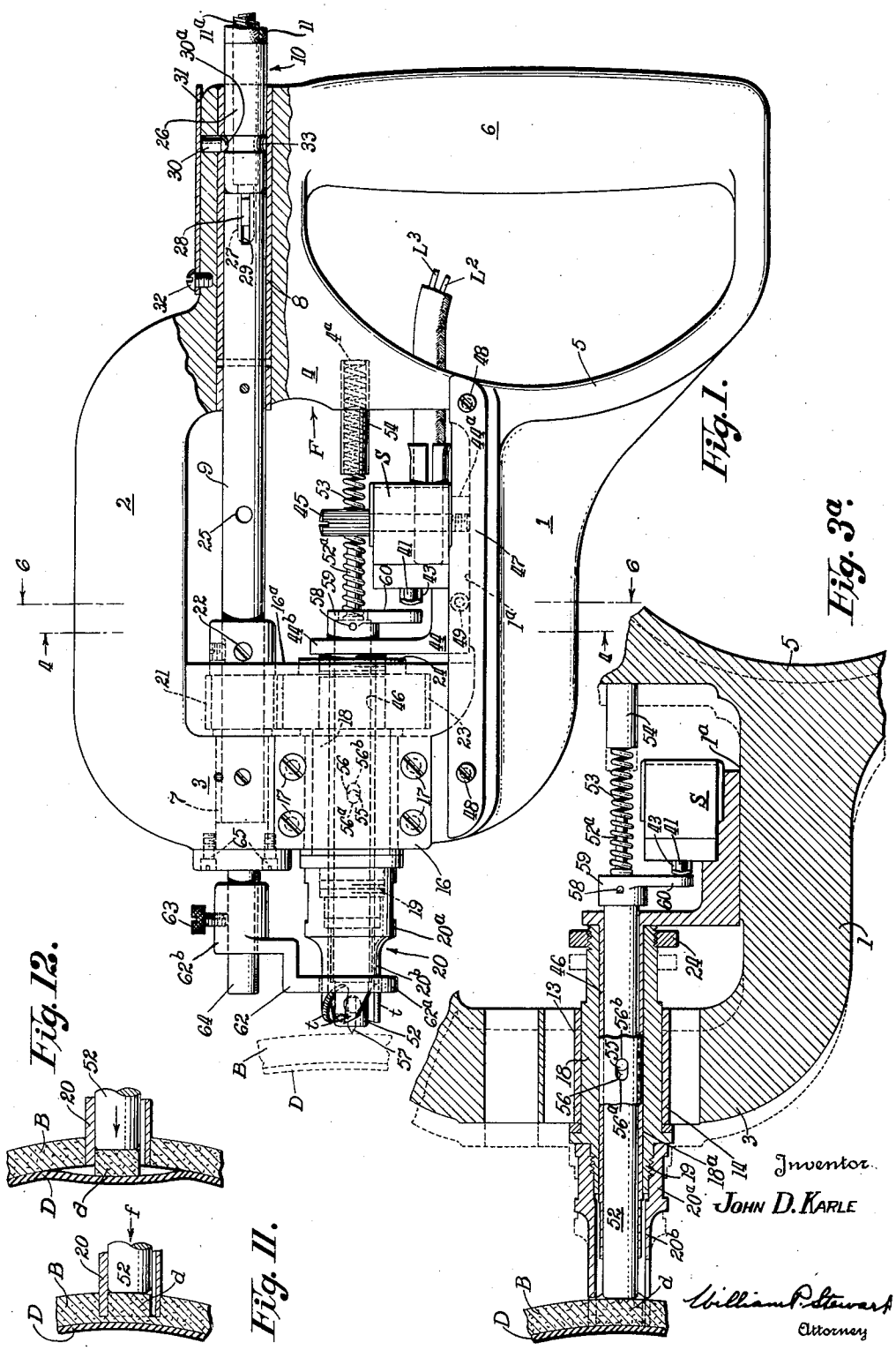

Fig. I.

Fig. 3a.

Fig. 12.

Fig. II.

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TREPHINE

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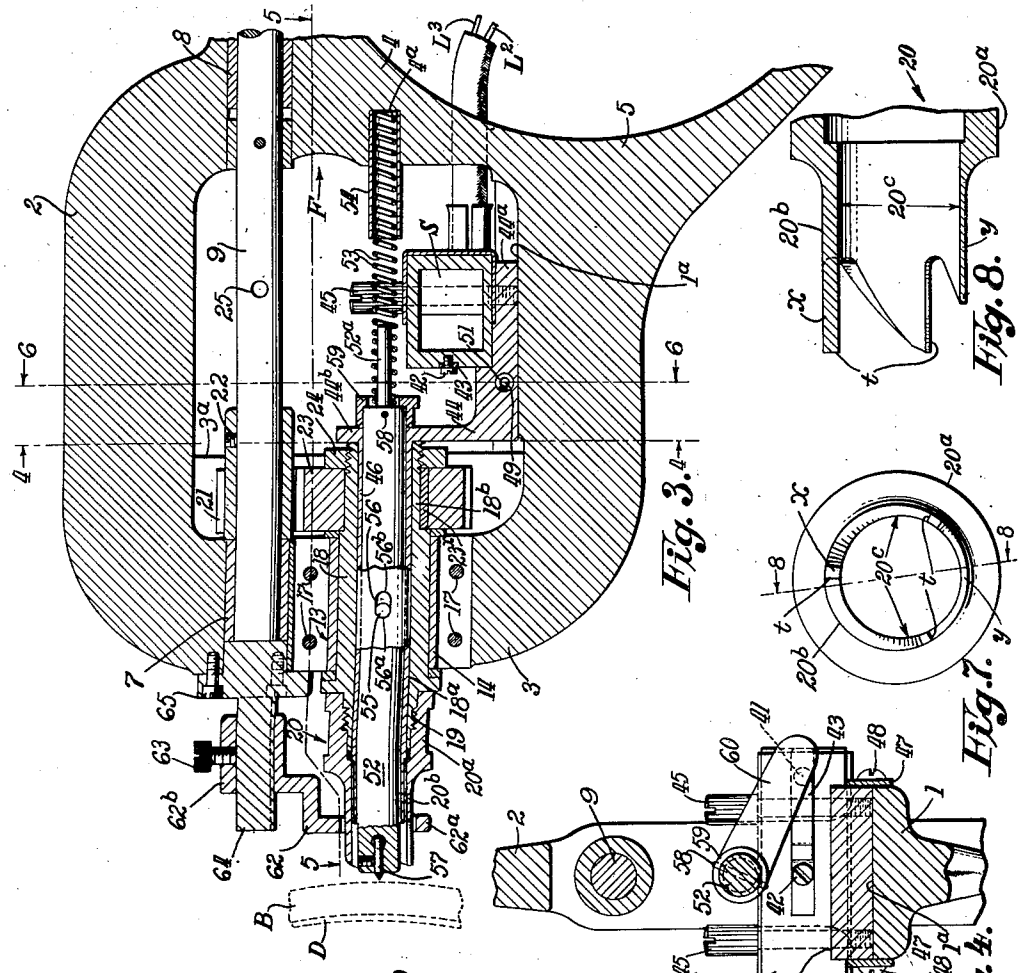

Fig. 3.

Fig. 8.

Fig. 7.

Fig. 4.

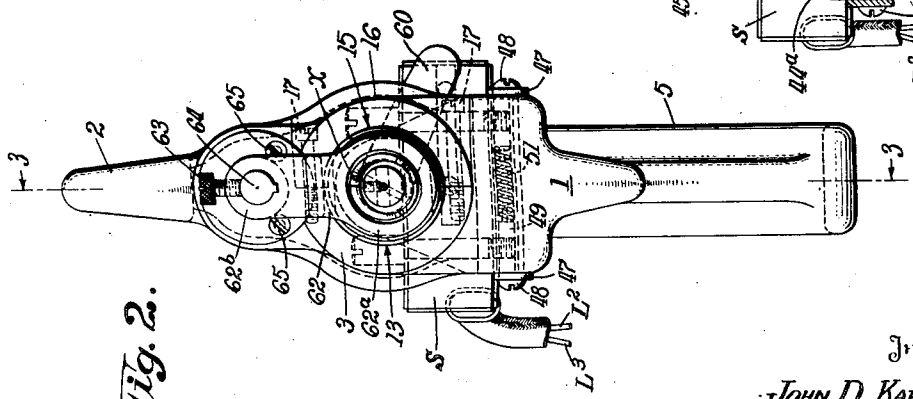

Fig. 2.

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2,504,075

TREPHINE

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Application March 12, 1946, Serial No. 653,900

14 Claims. (Cl. 128—310)

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This invention relates to surgical instruments and more particularly to trephining instruments, designed to remove a disk or plug of bone from a skull, to produce a hole in the skull as a preliminary step in the removal of a skull-section to permit a brain operation. The invention also relates to an improved method of trephining.

The invention has as a primary object to provide an improved, automatically controlled power driven trephining instrument which is easy and convenient to manipulate, which is rapid in its action and safe in operation.

Another object of the invention is to provide an automatically controlled trephining instrument which does not start its cutting action until the cutter has been accurately located relative to the spot where the hole is to be made; which is started by pressure of a portion of the instrument on the skull; and which is stopped automatically the instant the disk of bone has been severed from the skull, thus protecting the dura and the brain therebeneath from accidental injury.

A further object is to provide, in an instrument of this nature, automatically actuated means for forcing the dura out of the path of the rotating cutter.

Another object of the invention is to provide, in a power driven trephining instrument, an adjustable stop to limit the inward movement of the cutter so that the cutting edge thereof cannot be forced materially beyond the inner surface of the skull bone.

Still another object is to provide conveniently actuated means for disconnectibly connecting the instrument to a flexible power drive-shaft.

A further object of the invention is to provide an improved cutter, for an instrument of this nature, which gives ample room for chip disposal, which affords clearance between the outer wall of the bone disk removed and the inner wall of the cutter to prevent jamming of the disk in the cutter, and in which a plurality of cutting teeth of unequal widths, spaced apart circumferentially about the cutter, act simultaneously on the bone being drilled.

These objects have been attained by the provision of a hand-supported and hand-manipulated instrument, generally similar to a portable hand drill, having a frame affording a hand grip at one end, a rotary cutter spindle journaled in the frame substantially perpendicular to the hand grip, a remotely located electric driving motor, and power means in the form of a flexible drive shaft adapted to connect the motor and the instrument to drive the cutter spindle. The improved instrument also includes a switch and control means therefor whereby the switch is closed and the motor (and consequently the cutter spindle) are set in motion by pressure of a portion of the instrument on the skull. Means, in the form of a plunger which is put under spring tension during the trephining operation and which is released by the severance of the bone disk by the trephining cutter, is provided for automatically opening the switch, thereby stopping the rotation of the cutter, when the cutting operation has been completed.

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With the above and other objects in view, as will hereinafter appear, the invention comprises the devices, combinations, and arrangements of parts hereinafter set forth and illustrated in the accompanying drawings of a preferred embodiment of the invention, from which the several features of the invention and the advantages attained thereby will be readily understood by those skilled in the art.

In the drawings,

Fig. 1 is a side elevation, partly in section, of a surgical instrument embodying the present invention.

Fig. 2 is a left end view of the instrument illustrated in Fig. 1.

Fig. 3 is a longitudinal vertical section, substantially on the line 3—3 of Fig. 2, through the central and left end portions of the instrument shown in Fig. 1, the parts being shown in the positions which they occupy prior to the beginning of a trephining operation.

Fig. 3a is a view similar to Fig. 3, with certain elements omitted and with the parts shown in full lines in the positions which they occupy at the beginning of a trephining operation and, in dotted lines, in the positions which they occupy at the completion of the operation and immediately before the motor control switch is opened to discontinue the rotation of the motor and the cutter spindle.

Fig. 4 is a transverse vertical sectional view taken on the line 4—4 of Figs. 1 and 3.

Fig. 5 is a longitudinal horizontal section taken substantially on the line 5—5 of Fig. 3.

Fig. 6 is a transverse vertical sectional view taken on the line 6—6 of Figs. 1 and 3.

Fig. 7 is an enlarged end view of the improved cutter forming a part of the trephining instrument.

Fig. 8 is a longitudinal section taken on the line 8—8 of Fig. 7.

Fig. 9 is an enlarged sectional view of the cutter, disclosing it as part way through a skull bone and showing the clearance afforded between the inner surface of the cutter and the outer surface of the bone disk being removed.

Fig. 10 is a section taken on the line 10—10 of Fig. 9, also showing the clearance between the cutter and the disk.

Fig. 11 is a detail sectional view of the cutter

United States patent to McGall, No. 1,960,020, May 22, 1934. Inasmuch as the specific construction of this switch forms no part of the present invention, detailed illustration and description thereof is deemed unnecessary. Suffice it to say that it is embodied in an electrical circuit (see Fig. 14) comprising a line L^1 which extends from any suitable source of power to a coupling block 40 and thence directly to the motor M. The line L^2 extends to the coupling block 40 thence to the switch S carried by the instrument. The switch is normally open but is adapted to be closed by the inward endwise movement of a plunger 41 forming a part of the switch. When the switch is closed, line L^2 is connected back to the coupling block 40 and then to the motor M through line L^3 thereby completing the circuit from the lines L^1 and L^2 to the motor and causing it to rotate and turn the flexible cable 11, shaft 9, gears 21, 23, cutter spindle 18 and cutter 20.

Secured to the side of the switch block, by a screw 42, is a spring arm 43 adapted to engage the outer end of the plunger 41 thereby to shift it inwardly to close the circuit.

The switch S is secured, by screws 45, upon the base portion 44a of an L-shaped saddle member 44. The saddle member has an upstanding portion 44b formed integrally with a horizontally disposed sleeve 46 slidingly fitted within the axial bore 18a in the cutter-driving spindle 18. The base 44a of the saddle 44 is slidingly mounted upon an upper flat bearing surface 1a provided by the portion 1 of the frame of the instrument, and between guide-bars 47 secured to opposite sides of the portion 1 by screws 48. A pair of plungers 49, slidingly mounted in a transverse bore 50 formed in the base 44a are urged outwardly by a spring 51 and frictionally engage the inner faces of the guide-bars 47 to retard the sliding movement of the saddle 44 for a purpose hereinafter to be described.

Slidingly mounted within the sleeve 46 is a plunger 52 having a reduced rear end 52a which is surrounded by one end of a compression coil spring 53, the other end of which is housed in a sleeve 54 and bears against an abutment wall 4a provided by the end wall 4. The spring 53 normally urges the plunger 52 outwardly, the outward movement of the plunger being limited by contact of a pin 55 carried by the plunger, with the front end walls 56a of slots 56 formed in the opposite sides of the sleeve 46, as shown in Figs. 1, 3 and 5. The outer end of the plunger 52 normally projects beyond the cutting face of the teeth *t* of the cutter 20 and has secured therein a pin 57 having a pointed end adapted to be inserted into the skull bone at the point where the hole is to be trephined. This pin and plunger afford locating and guiding means for the cutter and insure that the hole will be drilled at the intended point by preventing side slipping of the cutter.

Secured to the rear end of the plunger 52, by a pin 58, is the hub 59 of an outwardly and downwardly extending arm 60. The outer end portion of this arm is adapted, upon rearward movement of the plunger 52, to engage the spring arm 43 of the switch S and cause the latter arm to close the switch.

A limit stop or depth gauge 62 serves as means for limiting the depth to which the cutter-teeth *t* may enter the skull. This limit stop comprises a ring-like skull-engaging portion 62a surrounding the cutter 20 and a shank portion 62b adjustably secured, by a set screw 63, upon a stud 64 secured to the end wall 3 of the instrument, by screws 65. Prior to the trephining operation, the thickness of the skull is determined, as accurately as possible, as for example, by X-ray photographs, and the stop 62 is so set that the teeth of the cutter may enter only slightly beyond the inner surface of the skull. It is impossible to so accurately determine the thickness of all parts of the skull that the stop may be set with sufficient precision to stop the inward movement of the cutter the instant the inner surface of the skull has been reached. The limit stop transmits to the outer surface of the skull the thrust applied to the instrument after the hole has been trephined and prevents accidental forcing of the cutter into the dura or the brain therebeneath.

Operation

Having thus described the construction of the improved instrument, the operation thereof in connection with the removing of a plug or disk from a skull will now be explained.

Having determined where the hole is to be made in the bone B of the skull and having determined the approximate thickness thereof and set the limit stop 62 accordingly, the surgeon connects the instrument to the electric motor M and to the electric circuit, as illustrated in Fig. 14. The motor is then at rest because of the fact that the motor control switch S is normally open.

The surgeon then grasps the hand grip 6 of the handle and places the pointed end of the pin 57 at the point where the hole is to be made, and applies initial pressure to the handle in line with the longitudinal axis of the instrument. This initial pressure forces the pointed end of the pin 57 into the outer surface of the skull sufficiently to hold the plunger 52 and the cutter 20 against lateral movement. Further pressure applied to the handle causes the plunger 52 to be forced rearwardly in the sleeve 46 of the saddle 44 in opposition to the spring 53. During this movement the arm 60, carried by the plunger 52, engages the switch arm 43 which, in turn, acts on the plunger 41 and closes the switch S, thereby starting the motor and consequently effecting rotation of the cutter spindle 18 and the cutter 20 carried thereby. During the closing of the switch S, the saddle 44 is held against rearward movement, relative to the frame, by the pressure of the plungers 49 on the guide-bars 47. Continued pressure on the handle moves the cutter 20 substantially into contact with the outer surface of the skull as indicated in full lines in Fig. 3a and causes further retraction of the plunger 52, relative to the sleeve 46, and takes up the lost motion between the plunger and sleeve until the pin 55 carried by the plunger engages the rear end walls 56b of the slots 56 in the sleeve 46 after which there is no further relative movement between the plunger 52, sleeve 46, saddle 44 and the switch S carried by the saddle. The cutter 20 is now rotating and ready to start its cutting operation on the skull bone B.

Continued pressure on the handle moves the instrument toward the work and causes the cutter 20 to cut an annular channel in the skull bone while the plunger 52 is maintained in pressure contact with the outer face of the plug or disk *d* being removed. Inasmuch as the instrument as a whole is advanced toward the skull

while the plunger 52, saddle 44 and switch S remains stationary, the relative movement therebetween causes the compression of the spring 53 to be increased. Fig. 11 discloses the cutter 20 as part way through the skull bone B while the plunger 52 exerts a pressure (under the influence of the spring 53 as represented by the arrow *f*) on the outer face of the disk *d*.

Fig. 3ª shows, in dotted lines, the cutter 20 as having completely penetrated the bone B and having reached the dura D, the disk *d* now being completely severed from the surrounding bone B. When this condition has been reached, the spring 53 acts instantly to force the plunger 52 forwardly thus pushing the disk *d* and the underlying dura D inwardly of the skull to a position substantially as illustrated in Fig. 12. This forward movement of the plunger 52 shifts the arm 60 out of contact with the switch controlling arm 43 which thereupon permits the plunger 41 to move outwardly thereby breaking the circuit and discontinuing the rotation of the motor M and cutter 20. The pressure of the spring plungers 49 on the bars 47 temporarily prevents the saddle 44, and the switch S carried thereby, from following the plunger 52 and arm 60. This automatic stopping of the motor is an important feature of the present invention.

As is well known, the dura has a certain adherence to the inner surface of the skull which adherence tends to resist inward movement of the dura from the position shown in Fig. 11 to that shown in Fig. 12. Likewise the brain which underlies the dura affords resistance to inward movement of the dura. The spring 53 therefore is so constructed and arranged that its strength bears a definite relation to the resistance to inward movement of the dura, whereby when the disk *d* is severed from the skull bone, the spring will force the disk inwardly to a position substantially as shown in Fig. 12 but not materially further. In this position the force of the spring and the resistance to movement of the dura are balanced and the disk holds the dura out of the path of rotation of the cutter, should the teeth thereof pass beyond the inner surface of the skull before the limit stop 62 engages the outer surface thereof. When the pressure on the handle 6 is relieved the spring 53 overcomes the resistance to movement afforded by the spring plungers 49 bearing on the guide-bars 47 and returns the saddle 44, sleeve 46, switch S, plunger 52, and arm 60 to the positions shown in Fig. 1.

In practice, the disks *d*, of which several are removed as an initial step in the opening of the skull, are placed in a sterile solution and, after the operation on the brain has been completed, are replaced in the openings from which they were removed and in a relatively short time are firmly knitted to the adjacent skull bone.

While the improved method of trephining has been described in connection with the instrument disclosed in the drawings and described in the specification, it is to be understood that the method may also be performed by hand or by other tools; the essential feature being the protection of the dura and the underlying brain by rendering the cutter ineffective to cut the dura after the disk *d* has been completely severed from the skull bone. This may be effected in either of two ways (*a*), by causing the disk to shift the dura out of the range of the cutter or, (*b*) by automatically stopping the rotation of the cutter the instant the trephining of the skull bone has been completed. The specific instrument disclosed in this application embodies both of these safety features but obviously both are not essential.

Having thus set forth the nature of the invention, what I claim herein is:

1. A surgical instrument comprising a frame, a handle at one end of the frame, a rotary cutter-spindle journaled in said frame, a cutter carried by said spindle and having a cutting face projecting beyond the opposite end of said frame, electric power means to rotate said spindle and cutter, a yielding member supported within said cutter-spindle and having a portion normally projecting beyond the cutting face of the cutter and adapted to engage the work in advance of the cutter, a power control switch carried by said frame, and means actuated by the movement of said yielding member under the pressure of the work for closing said switch to render said electric power driven means effective to rotate said spindle and cutter.

2. A trephining instrument comprising a frame, a trephining cutter carried thereby, electric power driven means to rotate said cutter to effect a trephining operation, a spring-pressed plunger mounted within said cutter and having a portion thereof adapted to bear on the bone disk being cut from the skull bone during the trephining operation, said plunger being designed to be moved axially by the spring pressure thereon to force said disk inwardly of the skull when the disk is severed from the surrounding skull bone, and an electric switch connected with said electric power driven means and actuated by and simultaneously with said axial movement of the plunger to discontinue the rotation of the cutter.

3. A surgical instrument comprising an open frame having a hand-grip portion, a rotary cutter-spindle journaled therein, a hollow cutter carried by said spindle and having its cutting face projecting beyond said frame, electric power means to rotate said spindle and cutter, a work-contacting member slidingly mounted in said spindle, spring means acting on said work-contacting member and shifting it in one direction to a position in which one end thereof projects beyond the cutting face of said cutter, said member being adapted to be shifted in the opposite direction in opposition to said spring means by pressure of the member on the work, and a power control switch slidingly mounted in said open frame and actuated by the movements of said member alternately to render said electric power means effective and ineffective.

4. A surgical instrument comprising a frame, a cutter spindle journaled therein, a cutter secured upon said spindle, means, including a shaft journaled in said frame and adapted to be driven by a flexible drive cable from a remotely located motor, for rotating said spindle and cutter, a motor control switch carried by said frame, a switch controlling member slidingly mounted in said frame, spring means urging said member in one direction to a position in which said switch is open and the motor is at rest and with the forward end of said member projecting beyond the working face of said cutter, and means actuated by the movement of said member in the opposite direction under the pressure of the work thereon for closing said switch to start said motor.

5. A surgical instrument comprising a frame, a handle at one end of the frame, a shaft journaled lengthwise in said frame and transversely of said handle, a rotary cutter-spindle journaled

in said frame, a cutter carried by said spindle and having a cutting face projecting beyond the opposite end of said frame, a speed-reducing gear connection between said shaft and spindle, electric power means to rotate said shaft and thereby said spindle and cutter, a yielding member supported within said cutter-spindle and having a portion normally projecting beyond the cutting face of the cutter and adapted to engage the work in advance of the cutter, a power control switch carried by said frame, and means actuated by the movement of said yielding member under the pressure of the work for closing said switch and thereby rendering said power driven means effective to rotate said spindle and cutter.

6. A trephining instrument comprising a frame, a handle at one end of the frame, a shaft journaled in said frame transversely of said handle, a rotary cutter-spindle journaled in said frame, a cutter carried by said spindle and having a cutting face projecting beyond the opposite end of said frame, a gear connection between said shaft and spindle, electric power means to rotate said shaft and thereby said spindle and cutter, a yielding member supported within said cutter-spindle and having a portion normally projecting beyond the cutting face of the cutter and adapted to engage the work in advance of the cutter, a power control switch carried by said frame, means actuated by the relative movement between said yielding member and said switch under the pressure of the work for rendering said electric power driven means effective to rotate said spindle and cutter to effect a trephining operation, and spring means acting on said member at the completion of the trephining operation to shift said yielding member in the opposite direction to discontinue the rotation of the spindle and cutter.

7. The combination of an electric motor and a flexible drive shaft driven thereby; of a trephining instrument located remotely from said motor and actuated from said drive shaft, said instrument comprising a frame, a rotary spindle journaled therein, a trephining cutter carried by said spindle, a motor control switch slidingly mounted on said frame, spring means normally urging said switch in one direction on said frame, an electric circuit connected with said motor and switch, a spring-pressed work-engaging plunger carried by said instrument, and means carried by said plunger and responsive to pressure of the work on the plunger for closing said switch to effect starting of the motor, said switch being adapted to have a sliding motion relative to said frame in opposition to said spring means after the switch has been closed and during the trephining operation.

8. The combination set forth in claim 7 in which the switch is mounted upon a saddle which is slidingly mounted on said frame and spring urged in a direction opposite to that in which the work-engaging plunger is moved relative to the frame by the pressure of the work, and in which friction means is provided to retard the return movement of said saddle when the pressure of the work on the plunger is relieved.

9. The combination set forth in claim 7 in which the switch is mounted upon a saddle which is slidingly mounted on said frame between a pair of guide bars and spring urged in a direction opposite to that in which the work-engaging plunger is moved relative to the frame by the pressure of the work, and in which a pair of spring-pressed plungers are carried by said saddle and frictionally engage said guide-bars to retard the return movement of the saddle when the pressure of the work on the work-engaging plunger is relieved.

10. A surgical instrument comprising a frame, a rotary spindle journaled therein, a cutter carried by said spindle, an electric motor to rotate said spindle and cutter, a saddle slidingly mounted on said frame and having a sleeve portion within said spindle, a motor-control switch secured upon said saddle, a plunger slidingly mounted in said sleeve and having a work-engaging end, a spring acting on said saddle and plunger normally to force them to one extreme position with the work-engaging end of the plunger extending beyond the cutting face of said cutter, a pin-and-slot connection between said sleeve and plunger to permit limited endwise movement of the plunger in the sleeve by the resistance to movement of the work, and an arm carried by said plunger and rendered effective by said limited movement of the plunger to close said motor-controlling switch.

11. A trephining instrument comprising a frame, a rotary cutter spindle journaled therein, power driven means to rotate said spindle, a trephining cutter secured upon said spindle and including a cylindrical portion having an eccentric bore affording a wall of varying thickness, the axis of the bore being parallel to the axis of said cylindrical portion, and a plurality of cutting teeth formed in the free end portion of said wall, said teeth being of various widths.

12. A trephining cutter comprising, a hub, a cylindrical portion projecting from said hub and having an annular wall of varying thickness, and a plurality of cutting teeth formed in the free end portion of said wall.

13. A trephining cutter having a cylindrical portion provided with an eccentric bore affording a wall of varying thickness, the axis of the bore being parallel to the axis of said cylindrical portion, and a plurality of cutting teeth formed in one end of said cylindrical portion with one of said teeth in the thickest portion of the wall.

14. A skull-cutting surgical instrument, comprising a frame, a cutting tool carried thereby, an electric motor located remotely from said instrument, a driving connection between said motor and said instrument for actuating said cutting tool, an electric switch carried by said instrument and in circuit with said motor, a skull-engaging member carried by and movable relatively to said frame, and means rendered effective upon movement of said skull-engaging member relative to said frame for closing said switch to start said motor and thereby actuate said cutting tool.

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(1st addition to No. 412,052)

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WRITING INSTRUMENT CARRYING TELEPHONE NUMBERS

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Fig. 1.

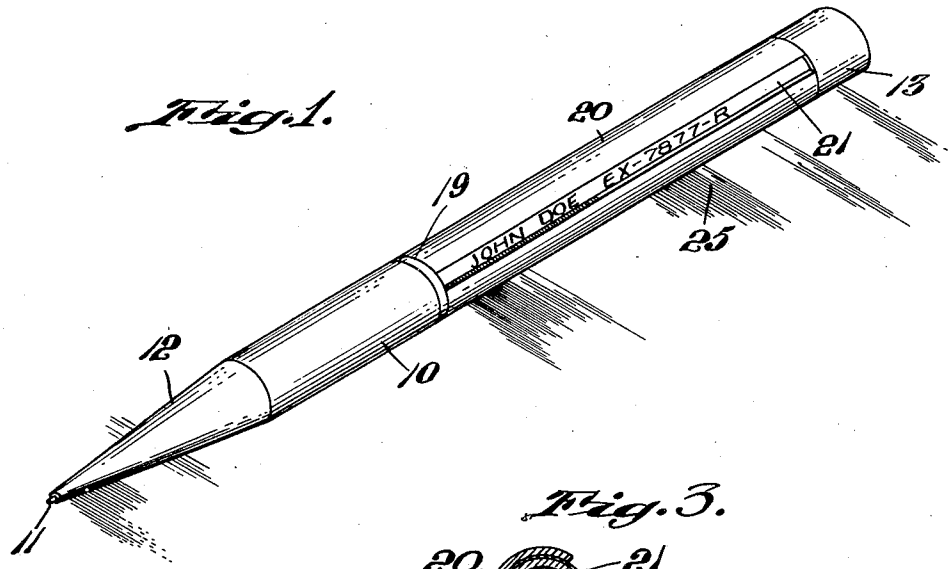


Fig. 3.

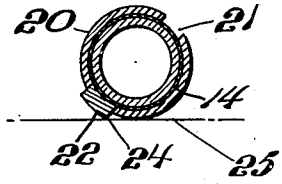
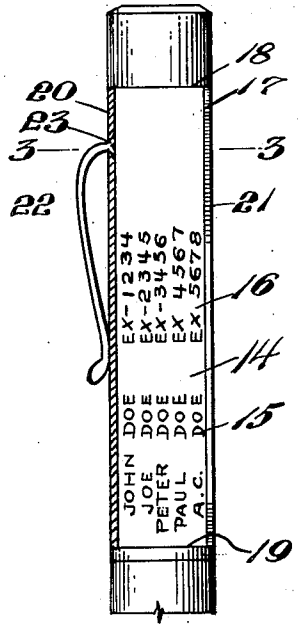


Fig. 2.



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