May 16, 1961 E. C. CARLSON 2,984,241

POWERED OSTEOTOME

Filed Nov. 6, 1958 3 Sheets-Sheet 1

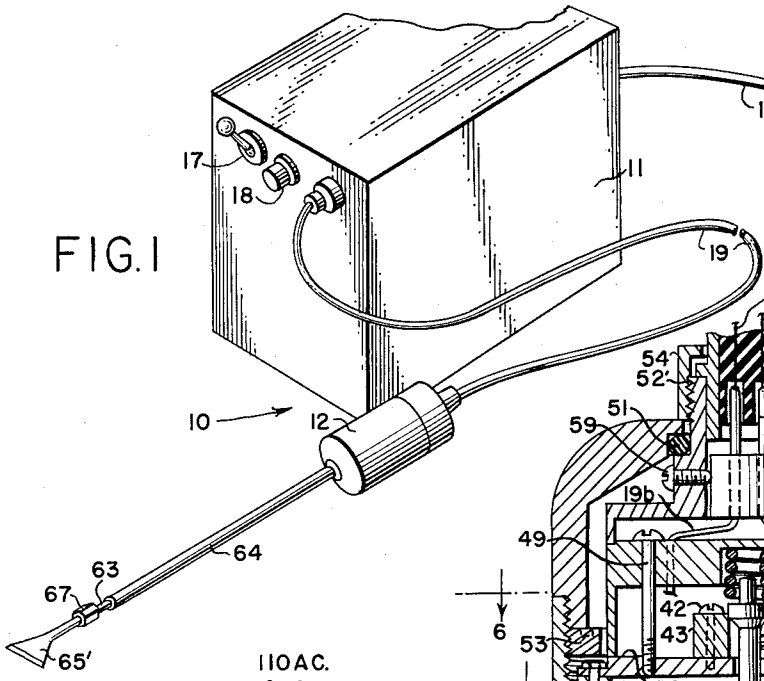


FIG. 1

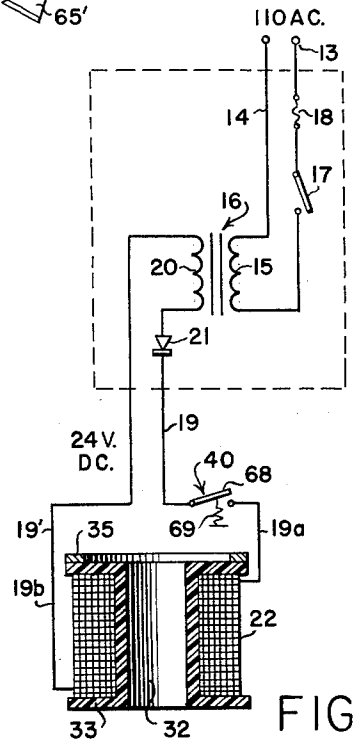


FIG. 2

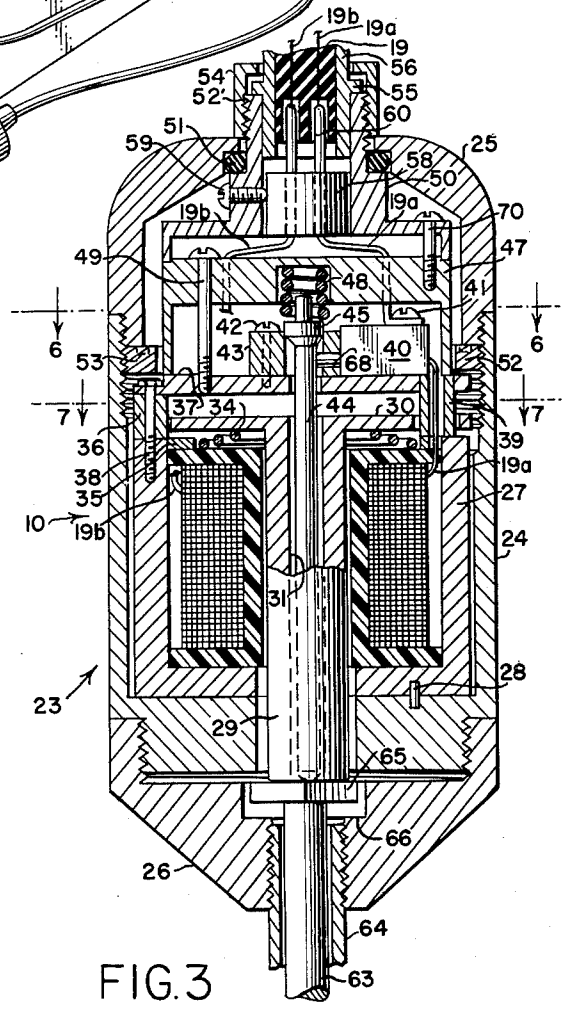


FIG. 3

INVENTOR

ELMER C. CARLSON

BY Wm. E. Ford

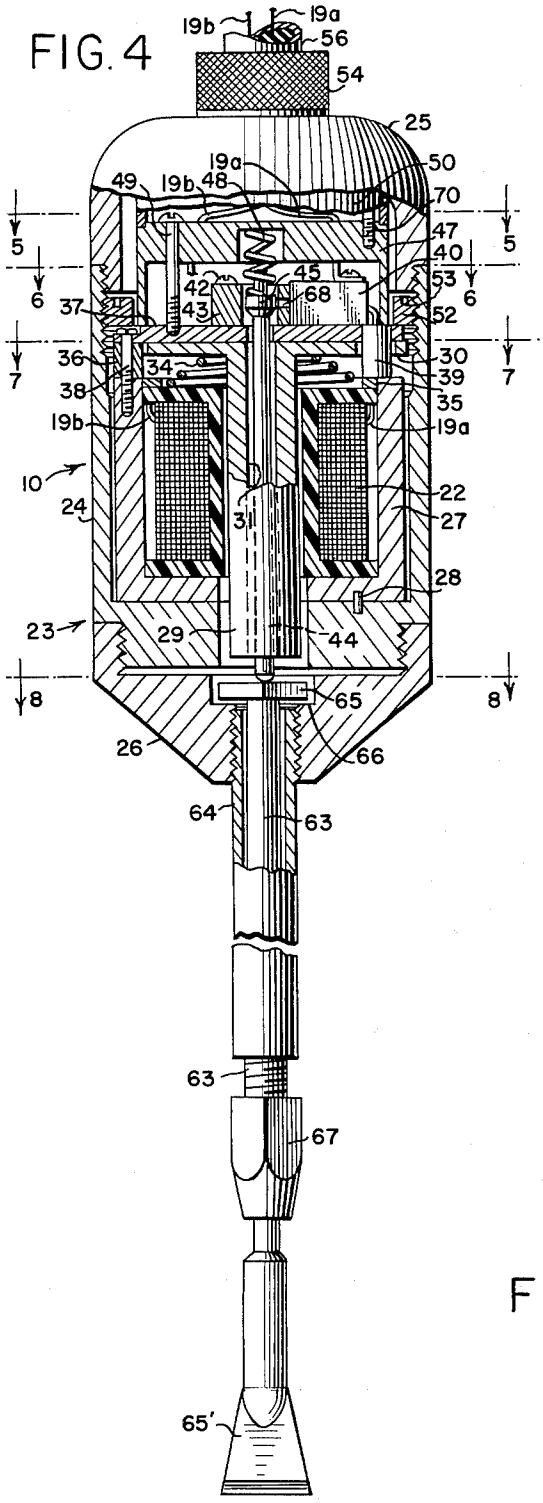
ATTORNEY

May 16, 1961 E. C. CARLSON 2,984,241

POWERED OSTEOTOME

Filed Nov. 6, 1958 3 Sheets-Sheet 2

FIG. 4



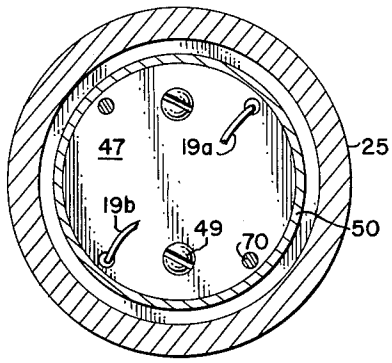


FIG. 5

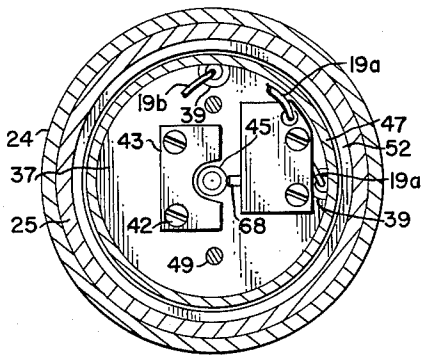


FIG. 6

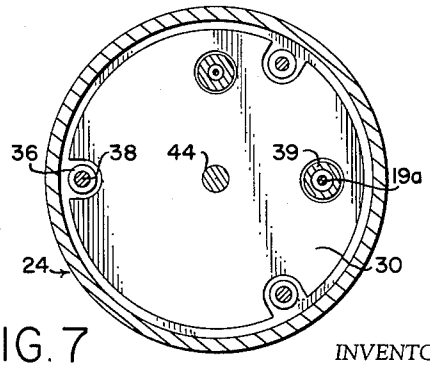


FIG. 7

INVENTOR

ELMER C. CARLSON

BY Wm. E. Ford

ATTORNEY

May 16, 1961 E. C. CARLSON 2,984,241

POWERED OSTEOTOME

Filed Nov. 6, 1958 3 Sheets-Sheet 3

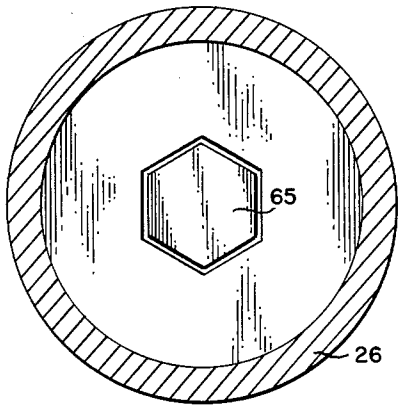


FIG. 8

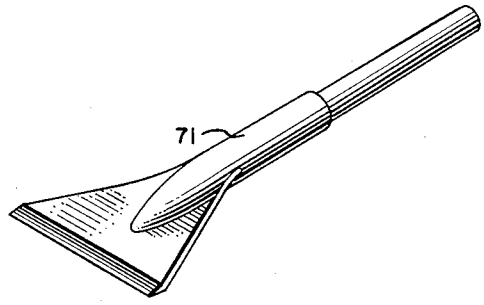


FIG. 9

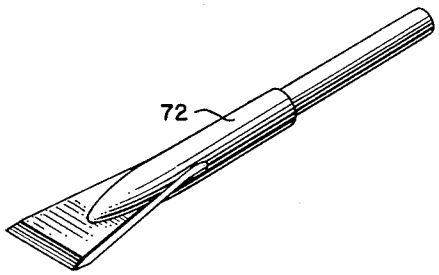


FIG. 10

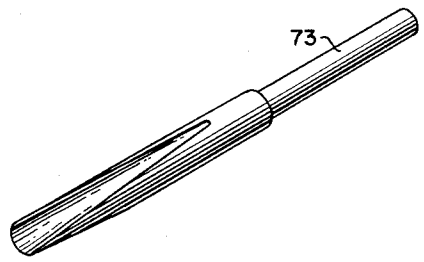


FIG. 11

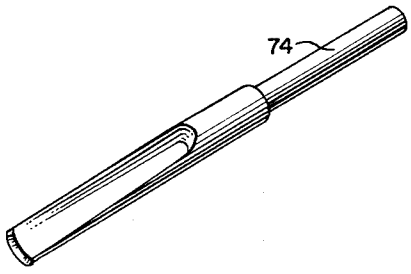


FIG. 12

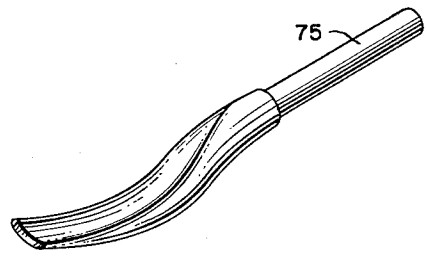


FIG. 13

INVENTOR

ELMER C. CARLSON

BY Wm. E. Ford

ATTORNEY

United States Patent Office 2,984,241 Patented May 16, 1961

2,984,241

POWERED OSTEOTOME

Elmer C. Carlson, 7225 Knob Hill, Houston, Tex., assignor of fifty percent to Esar R. Wren, Houston, Tex.

Filed Nov. 6, 1958, Ser. No. 772,340

8 Claims. (Cl. 128—312)

This invention relates to a powered osteotome of the type which reciprocates a hammer blade at a fast rate of speed to cut or chip bone, as human bone, the efficiency of its operation being obtained by a unique arrangement for reciprocating the hammer or cutting tool and a unique structural arrangement permitting full and complete control of the engagement of the tool by its operator.

It is consequently an object of this invention to provide a powered osteotome which is reciprocatory in action, which is positively engageable and disengageable, and which attains a high rate of reciprocatory speed by a novel application of the principle of converting alternating current to pulsating direct current.

It is also an object of this invention to provide a powered osteotome of this class which is normally inoperative until action is desired at which time the tool can be set in action simply by the contact thereof with the object on which cutting is to be done.

It is a further object of this invention to provide a powered osteotome of this class which is adapted to serve in carrying out a number of services where its principle of cutting by reciprocatory movement can be employed to greatest advantage.

It is also another object of this invention to provide a powered osteotome of this class which may be economically constructed, requiring a minimum number of working parts and an uncomplicated arrangement of electrical equipment.

Other and further objects will be apparent when the specification herein is considered in connection with the drawings in which:

Fig. 1 is a view of the various parts of the invention in assembled relation;

Fig. 2 is an electrical wiring diagram of the invention;

Fig. 3 is a sectional elevation through the osteotome drive of the invention showing the drive in contact to reciprocate the hammer or blade carrier;

Fig. 4 is an elevation through the osteotome drive and the hammer or blade carrier, part in section, showing the switch which actuates the device open and the hammer head out of driving contact;

Fig. 5 is a sectional plan view taken along line 5—5 of Fig. 4;

Fig. 6 is a sectional plan view taken along line 6—6 of Fig. 4;

Fig. 7 is a sectional plan view taken along line 7—7 of Fig. 4.

Fig. 8 is a sectional plan view taken along line 8—8 of Fig. 4;

Fig. 9 is an isometric view of a wide, flat blade;

Fig. 10 is an isometric view of a narrow flat blade;

Fig. 11 is an isometric view of a flat gouge;

Fig. 12 is an isometric view of a deep gouge; and

Fig. 13 is an isometric view of a curved gouge.

Referring in detail to the drawings in which like reference numerals are assigned to like elements in the various views, a powered osteotome 10 is shown including a transformer box 11 and an osteotome drive 12. The electrical power which actuates the invention is shown as 110 volts alternating current. A plug 13 connects into the source of electrical power and a conductor cord 14 extends from the plug to the transformer box 11.

Within the transformer box 11 the supply circuit is connected across the terminals of the primary windings 15 of a transformer 16, such circuit having a switch 17 therein in series with the primary windings 15, and there being a fuse 18 also connected in such series. A conductor 19 is connected across the terminals of the secondary windings 20 of the transformer 16, and by means of the transformer the alternating current voltage is substantially reduced as to say 24 volts. This voltage is rectified by a silicon rectifier 21 installed in the conductor in series with the secondary windings 20.

This silicon rectifier is well known in the art as set forth in the Sarkes Tarzian Catalogue No. 68 of May 1, 1958, attached, the type specifically employed being designated ST type 20J2 having a maximum peak inverse volt capacity of 200 and a root means square voltage rating of 140 with a corresponding maximum D.C. load current rating of 10 at 100 degrees centigrade with a maximum recurrent peak rating of 50 amperes at this temperature and a surge 4 means square maximum current rating of 80 at such temperature. The JETEC number corresponding to this type of silicon rectifier is 1N1622.

Such rectifier when employed in single phase connections has the following output voltages under the conditions hereinbelow set forth: With half wave at 10 D.C. amperes the maximum input root mean square voltage is 140 and the approximate output D.C. voltage is 65. With full wave bridge at 20 amperes D.C. (4 required) the maximum input root mean square voltage is 140 and the approximate output D.C. voltage is 125. With full wave center tap at 20 amperes D.C. (2 required) the maximum input root mean square voltage is 140 and the approximate output D.C. voltage is 65. This type of silicon rectifier is classified in the J series as J–2, page 8 of the Sarkes Tarzian catalogue above identified and introduction, theory of operation, manufacturing process, and characteristics are set forth on pages 3–6, inclusive, of such catalogue. Additionally electrical engineering data and circuit diagrams are set forth on pages 28–39, inclusive, of this Sarkes Tarzian catalogue.

The conductor 19 extends from the transformer box 11 to the osteotome drive 12 and within the drive housing it is connected across the windings of a solenoid 22. The characteristics of the solenoid are such that the voltage drop across the rectifier is 1.6 and the pulsation or ripple frequency in half waves is approximately 60 per second with the consequence that the solenoid is energized and de-energized approximately 60 times per second.

The osteotome drive 10 includes a housing 23 comprising a case or central housing member 24, a top case cover or closure cap 25, and a case bottom or drive end closure 26. In assembly an outside pole piece or cup 27 is fitted within the case or housing member 24 and connected thereto by means of a dowel 28 which fits in communicating upper and lower bores with the upper bore being provided in the bottom of the pole piece or cup 24, and with the lower bore being provided within a counterbore providing the shoulder or seating surface within the case or housing member 24 upon which the pole piece or cup 27 seats.

A plunger 29 having a flange or hammer 30 on the head thereof, and a bore 31 therethrough, extends through a bore 32 through an insulative coil form or spool 33 about which is wound the winding of a solenoid 22 between the upper and lower flanges thereof.

A spring 34 of the volute type and termed the hammer spring seats with base coil upon the upper flange of the spool 33 and such spring is restrained between such flange and the hammer or flange 30 of the plunger 29. A metallic ring 35 seats upon the top flange of the spool and extends around the base coil of the volute spring 34 to serve as a spacer, and as a retainer for the spring. Spacer blocks 36 seat upon the top of the pole piece 27 and extend through slots in the hammer 30 and support a transverse top plate 37. Assembly is effected between this plate 37 and the pole piece 27 by means of machine screws 38 which extend through bores provided in the spacer blocks 36 and through bores tapped into the pole piece 27, the heads of such machine screws seating in recesses provided in the plate 37.

The conductor wires 19*a* and 19*b* extend from the ends of the solenoid windings through slots provided in the insulative spool 33 and the ring 35 and such wires pass upwardly through guide sleeves 39 which extend through bores provided in the hammer 30 and in the plate 37. The wire 19*a* is shown thus extending in Fig. 3 and making connection to a switch 40 which is supported on the upper surface of the plate 37. The other wire 19*b* is not shown in Fig. 3 except at its point of connection to the solenoid and at a point thereabove where it is shown broken off but such wire 19*b* is conducted through the spool 33, the ring 35, the hammer 30 and the plate 37 in the same manner as has been described hereinabove in the case of the wire 19*a*.

The switch 40 is connected to the plate 37 by means of machine screws 41 and similar machine screws 42 connect a guide block 43 to the plate 37. A switch actuating pin 44 extends through a bore in the guide block 43 and in the plate 37 therebelow and through the bore 31 in the plunger 29. Such pin 44 has a head 45 thereon with a tapered or cammed surface included as part thereof, such head sliding guidably in the bore in the guide block portion of the switch 40.

A spring termed an overtravel spring 48 bears upwardly in a bore or recess in an inverted cup shaped cap or switch cover 47 which seats upon the plate 37. Such cover 47 is connected to the plate 37 by the means of machine screws 49 which pass through bores provided in the cover 47 and bores tapped into the plate 37, while the conductor wires 19*a* and 19*b* pass through other bores provided in the cover 47. Above the cover 47 an adapter connection or junction box 50 is provided to seat on a turned down shoulder provided at the top corner of the cover 47, and machine screws 70 extend through bores in the junction box 50 and tapped bores in the cover 47 therebelow to connect these two elements. Such junction box 50 has a reduced diameter central portion and is turned down thereabove to provide a seat for an O-ring seal 51, of a material such as neoprene, the upper end of such junction box 50 being threaded at 52'. The wires 19*a* and 19*b* extend from the cover 47 into an insulative plug or cylinder 58 which is held within the junction box 50 by means of a set screw 59, and from the insulative plug the wires 19*a* and 19*b* extend through tubes 60 and make connection with corresponding conductors 19*a* and 19*b* in the cord 19.

In final assembly of the upper part of the device a lock ring 52 is threaded into the housing 24 above the plate 37, such ring 52 providing indentations or holes 53 in the upper surface thereof to receive the prongs of a spanner wrench by which the lock ring is threaded into the housing. After the lock ring 52 is in place the cap closure or case cover 25 is threaded into the case 24 to shoulder upon its upper end face, and then the nut 54, which is slid over the conductor cord 19, is brought to shoulder against the flange 55 on the connection member 56 of such cord. When the nut 54 is threaded until it is firmly shouldered, the junction box 50 and the closure cap 25 are in tightly assembled relation and the cord 19 is firmly connected to the osteotome drive 12.

The lower end of the osteotome drive 12 is assembled by inserting the lower end of a chisel carrier or drive shaft 63 through a sleeve 64 which is tightly threaded into the drive end closure or case bottom 26, the head 65 of the chisel carrier 63 being non-circular in cross-section and fitting into a recess of corresponding non-circular cross-section within the case bottom 26. The outer end of the chisel carrier 63 is tubular and externally threaded and has longitudinally or axially extending slots therein in accordance with conventional collet construction, and a conventional collet 67 is internally tapered at its outer end and internally threaded at its inner end for threaded engagement with the chisel carrier threaded end with its internally tapered surface to bear upon the externally tapered nose of the chisel carrier end whereby collet connection can be effected with any round ended type of tool which may be inserted into the tubular outer end of the chisel carrier. Thus whatever type of blade, chisel or tool 65 it may be desired to employ can be assembled to the collet as long as its connection end is insertable into the tubular end of the collet. Finally the switch 17 in the transformer box 11 may be turned on and the device may then be operated in the following manner:

With the various elements in the relative positions shown in Fig. 4, the chisel or blade 65' is brought into contact with the bone to be cut and such contact forces the chisel carrier 63 upwardly so that a head or flange 65 at the top of the chisel carrier 63 urges against the lower end of the switch pin 44 and pushes this pin upwardly against the pressure of the overtravel spring 48 to move its head 45 out of contact with the plunger or contact arm 68 of the normally closed switch 40. A spring 69 is provided, as indicated in Fig. 2, and such spring tends to maintain this switch 40 normally closed when the switch pin 44 and chisel carrier head 65 are in lower position, such closed position taking place when the contact arm 68 is in outermost position as indicated by contact with the pin 44 below the head thereof as shown in Fig. 3. When the switch 40 closes the solenoid is brought into circuit with the secondary winding of the transformer and thus the solenoid may be energized and de-energized, say 60 times per second, as hereinabove described, and the solenoid, when energized, moves the plunger 29 downwardly to compress the operating spring 34. Conversely when the solenoid is de-energized, the operating spring 34 returns the plunger head 30 upwardly to contact the stop plate 37.

The length of the switch actuating pin 44 is such with relation to the plunger 29, and the plunger is so positioned with relation to the switch 40 that when the pin head 45 is first moved above the switch plunger 68 there is still clearance between the chisel carrier head 65 and the end surface of the lower end of the plunger 29 with the consequence that the plunger may reciprocate responsive to the action of the solenoid but as yet no drive is imparted to the chisel carrier 63. However, when the osteotome is further pressed, as against the bone of the person under surgery, then the top surface of the carrier head 65 is brought into contact with the end surface of the plunger 29 and the action of the solenoid upon the plunger is imparted therethrough to reciprocate the hammer, such condition being shown in Fig. 3.

The invention is of particular importance to orthopedic surgeons as for use in spine fusions since it assures excellent control of the instrument, the drive handle being firmly grasped in one hand while the other hand grasps the sleeve or chisel housing 64 or the reciprocatory chisel carrier 63 to direct cutting. Cutting can be facilitated by imparting a rotary motion to the instrument as pressure is applied. Forward pressure is exerted by the hand grasping the drive while a braking action is exerted by fingers on the sleeve 64 or the chisel carrier 63 to guide the point.

The types of chisels, blades, or cutting tools are sub-

ject to variation over a wide range of usages. The wide flat blade **71** and the narrow flat blade **72**, shown respectively in Figs. 9 and 10, are employable in certain types of bone grafts. Also the flat gouge **73** shown in Fig. **11** is employable in preparation for bone grafts. Additionally the flat blades **71** and **72** are employable to model bone as for shaving or planing after a bunion has been removed. Also the deep gouge **74** and the curved gouge **75**, shown in Figs. 12 and 13, respectively, are employable in spine fusions. Furthermore all of the tools shown in Figs. 9–13, inclusive, can be used to roughen bones when necessary, as for instance around fresh fractures.

The invention is constructed for employment in usages other than orthepedic surgery and no limitation is placed on the invention by elaboration of this special usage. In effect the invention is not limited to the exact disclosure shown in the drawings and described in the specification but other modifications, variations, usages, and applications are considered as well as such may fall within the broad spirit of the invention and within the broad scope of interpretation claimed and merited for the appended claims.

What is claimed is:

1. A powered osteotome comprising a housing having stop means therein, a tool carrier extending through one end of the housing and having a flange on the inner end thereof, a hammer plunger having a flange as a hammer on one end thereof, a solenoid around the plunger bearing on a shoulder provided in the housing, a hammer spring based at one end against said hammer and at the other end on said solenoid, a bore through said plunger and a switch actuating pin extending therethrough having a head on one end thereof, an overtravel spring bearing at one end on said switch actuating pin head and at the other end against said housing, said osteotome including a transformer and a primary circuit from the primary winding of the transformer leading to a source of alternating current and including a starting switch in such circuit, a secondary circuit including a silicon rectifier and leading from the secondary windings of the transformer into said housing and to said solenoid and including a normally open switch in said housing, said rectifier converting alternating current to pulsating direct current to thereby interrupt the cyclic impression of electromotive force upon said solenoid at a fast predetermined rate per time interval, movement of said switch actuating pin inwardly compressing said overtravel spring to move said switch actuating pin head to let said normally open switch close and energize said solenoid to compress said hammer spring, upon said solenoid being de-energized said hammer spring then urging said hammer against said stop means, said carrier being forced in direction of said actuating pin when opposed by an object, as bone, to bring said carrier flange against said switch actuating pin to move the head thereof against the force of the overtravel spring to permit said normally open switch to close to supply pulsating direct current to said solenoid to alternately energize and de-energize said solenoid to actuate said hammer, the further opposing of said carrier, as by bone, as said housing is moved in direction thereof, bringing the end of said plunger in contact with said carrier flange thereby to reciprocate said carrier responsive to plunger operation.

2. A powered osteotome having therein stop means, a normally open switch, and a solenoid, a hammer plunger extending through said solenoid and having a hammer thereon, a hammer spring between said hammer and said solenoid, a switch actuating pin extending through said plunger and including a head and a shank, an overtravel spring urging said pin head into opening contact with said switch, a tool carrier with head in said osteotome and tool end extending therefrom, circuit means connecting said switch and said solenoid and including a rectifier whereby impressed alternating current is converted to pulsating direct current in said circuit means thereby to interrupt the energizing of said solenoid at a fast predetermined rate per time interval, movement of said pin inwardly by contact with said carrier head urging said pin head to compress said overtravel spring and out of contact with said switch to let said switch close against said shank whereby said plunger hammer alternately compresses said hammer spring upon solenoid energization and said hammer spring urges said hammer against said stop means upon solenoid de-energization, and further movement of said carrier inwardly bringing said carrier head and said plunger into driving abutment whereby said carrier is reciprocated with said plunger.

3. A powered osteotome as claimed in claim 2 in which said tool carrier includes a wide flat blade as the tool carried thereby as for the purpose of making large bone shavings.

4. A powered osteotome as claimed in claim 2 in which said tool carrier includes a narrow flat blade as the tool carried thereby as for the purpose of making small bone shavings.

5. A powered osteotome as claimed in claim 2 in which said tool carrier includes a flat gouge as the tool carried thereby as for use in conditioning bone for bone grafting.

6. A powered osteotome as claimed in claim 2 in which said tool carrier includes a deep gouge as the tool carried thereby for use upon bone in spin fusion.

7. A powered osteotome as claimed in claim 2 in which said tool carrier includes a curved gouge as the tool carried thereby for use upon bone in spine fusion.

8. A reciprocatory tool including a housing having therein stop means, a normally open switch, and a solenoid, a hammer plunger extending through said solenoid, a hammer spring between the hammer of said plunger and said solenoid, a pin extending through said plunger having means to open said switch, a tool carrier with head in said housing and extending therefrom, circuit means connecting said switch and said solenoid and including a rectifier whereby impressed alternating current is converted to pulsating direct current to interrupt the energizing of said solenoid at a fast predetermined rate per time interval, inward movement of said carrier head first urging said pin to let said switch close and further inward movement of said carrier head establishing its contact with said plunger for reciprocation therewith responsive to the alternate energization of said solenoid to urge said hammer to compress said hammer spring, and the de-energization of said solenoid whereby said hammer spring urges said hammer against said stop means, said housing when being constantly urged in direction of an object on which the tool engages causing effective reciprocation of said tool.

References Cited in the file of this patent

UNITED STATES PATENTS

557,159	Skinner	Mar. 31, 1896
1,483,085	Heidbrink	Feb. 12, 1924
2,542,695	Neff et al.	Feb. 20, 1951
2,588,006	Hufnagel	Mar. 4, 1952
2,655,921	Haboush	Oct. 20, 1953

FOREIGN PATENTS

414,676	Germany	June 9, 1925