(No Model.) 2 Sheets—Sheet 1.

W. P. CARSTARPHEN, Jr.

ELECTRICAL RECIPROCATING TOOL.

No. 476,225. Patented May 31, 1892.

Fig. 1

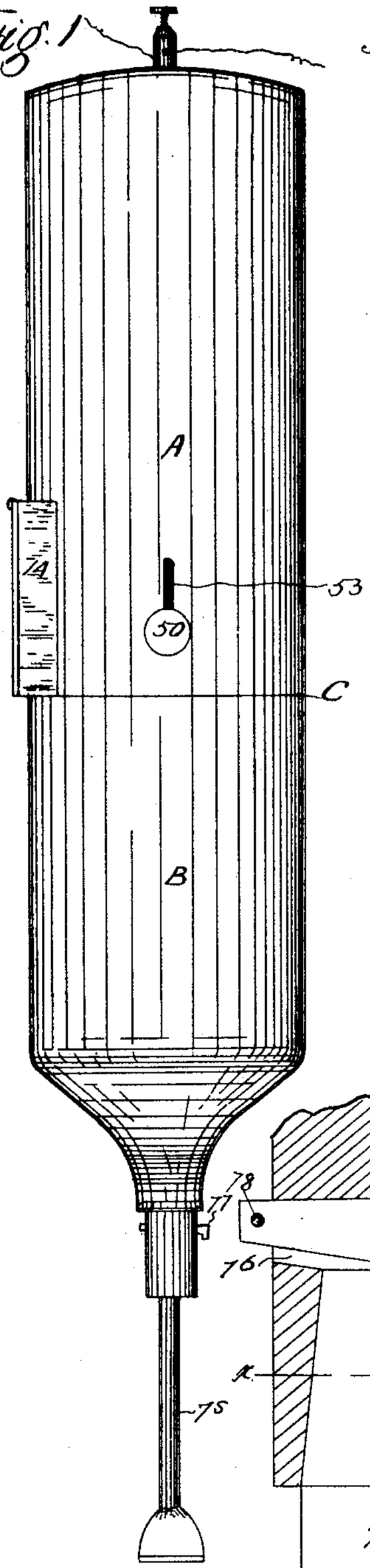

Fig. 2.

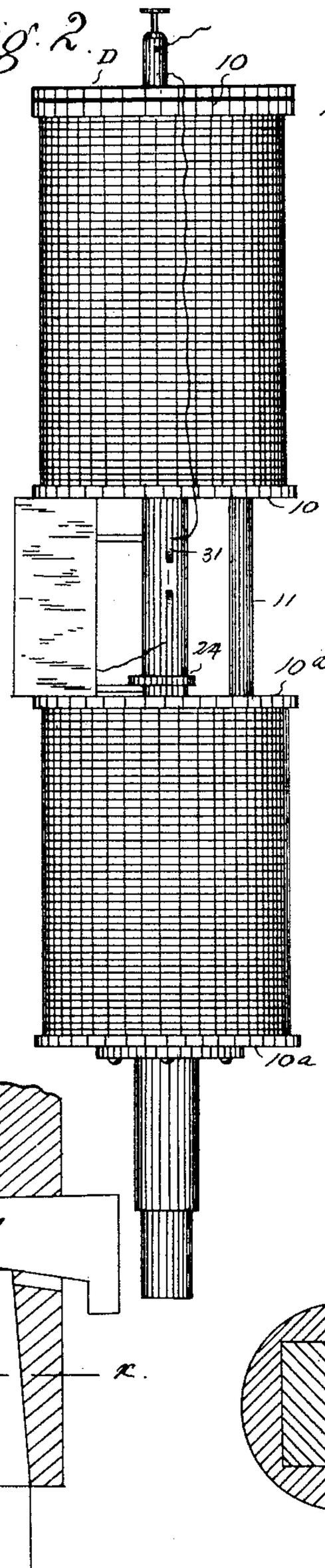

Fig. 3

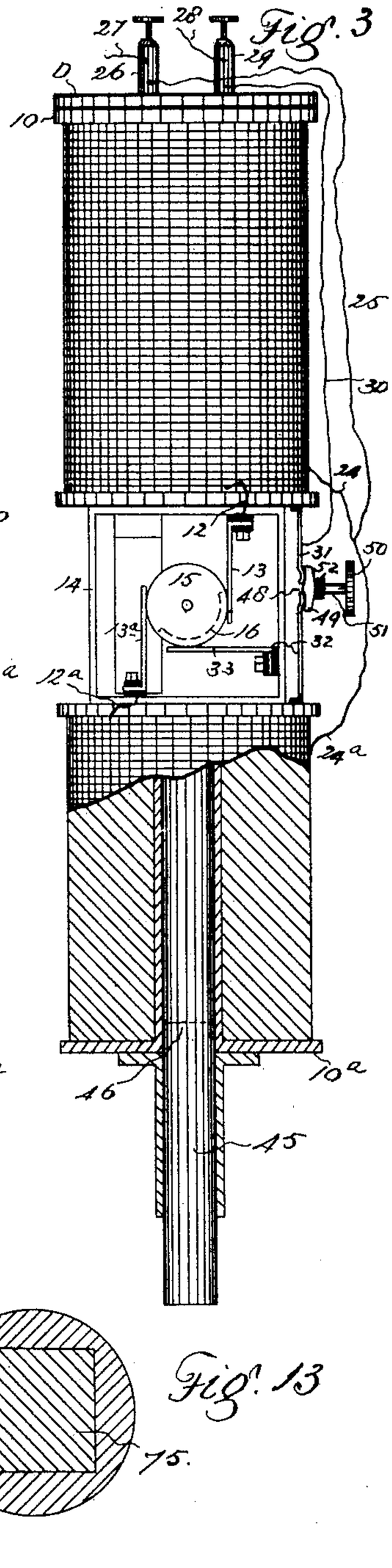

Fig. 13

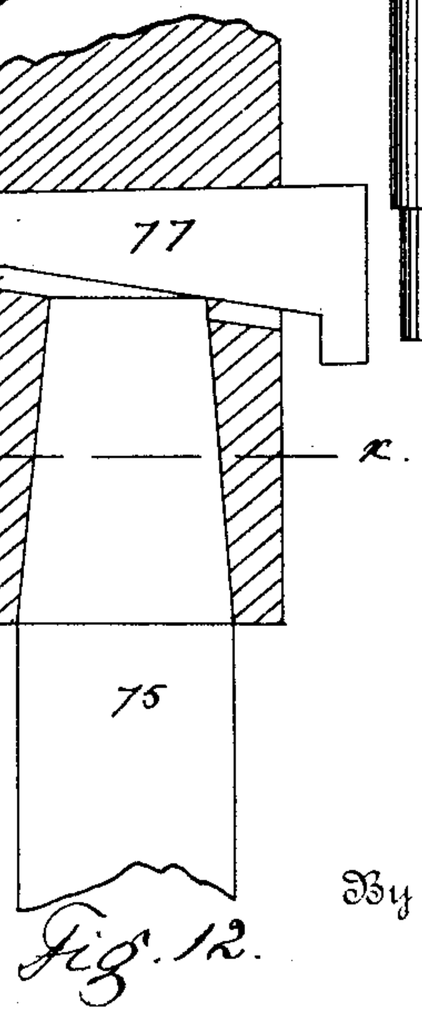

Fig. 12.

Witnesses
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(No Model.) 2 Sheets—Sheet 2.

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ELECTRICAL RECIPROCATING TOOL.

No. 476,225. Patented May 31, 1892.

Fig. 1.

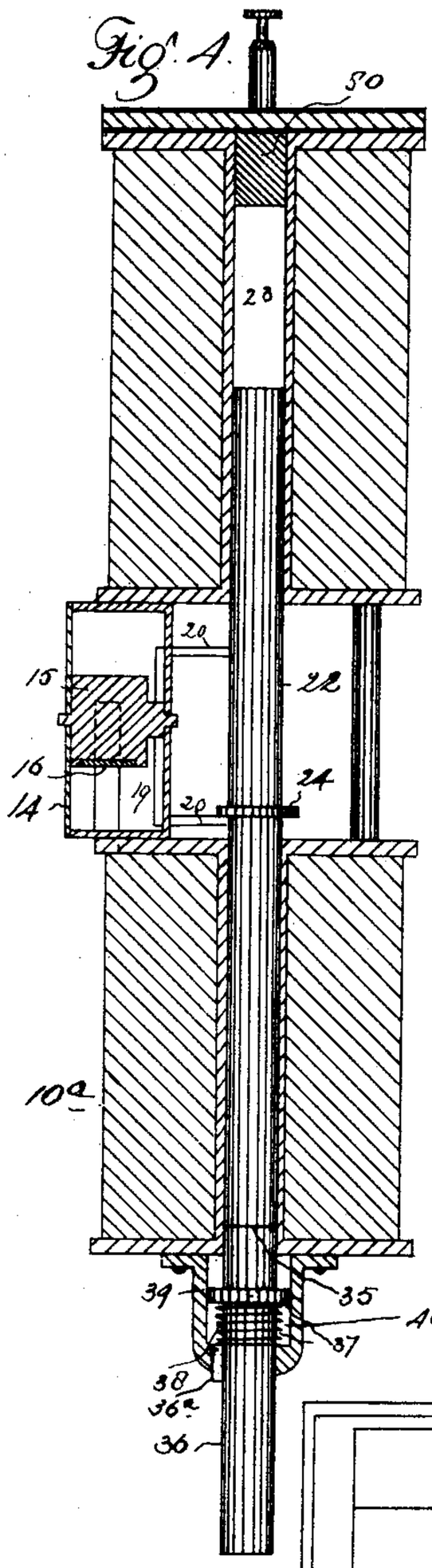

Fig. 5.

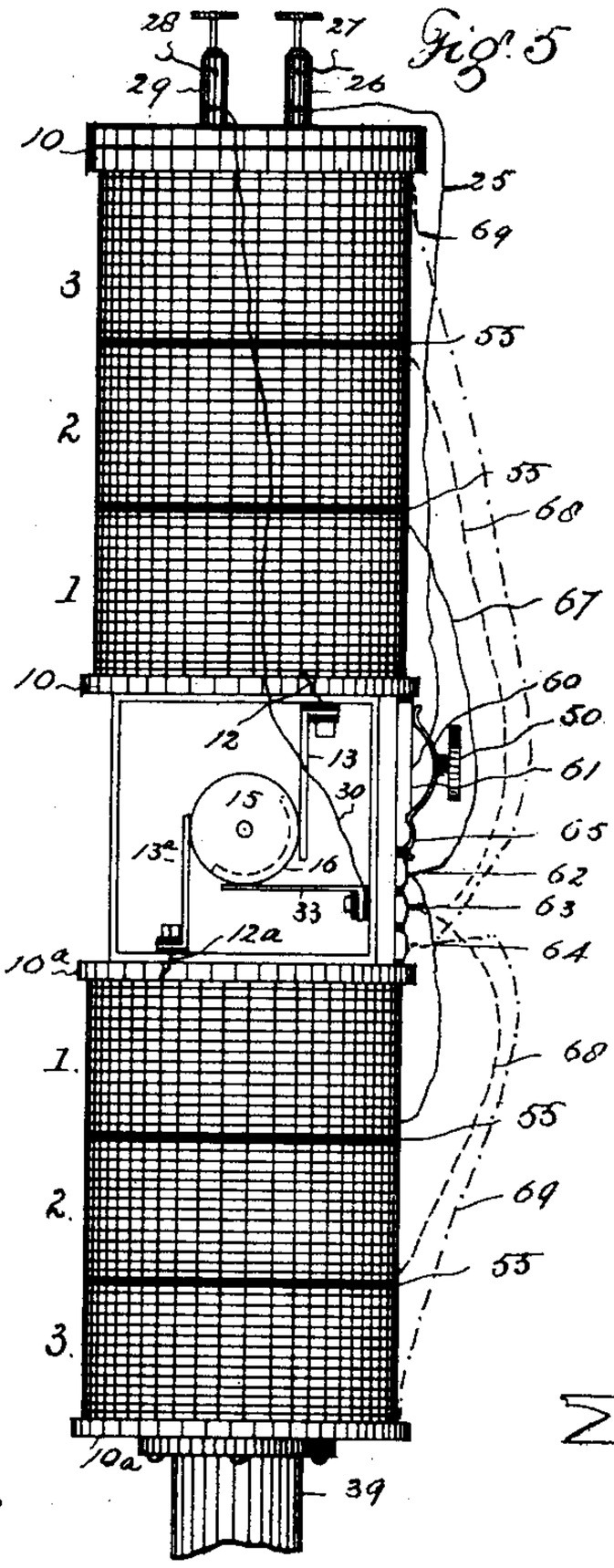

Fig. 7

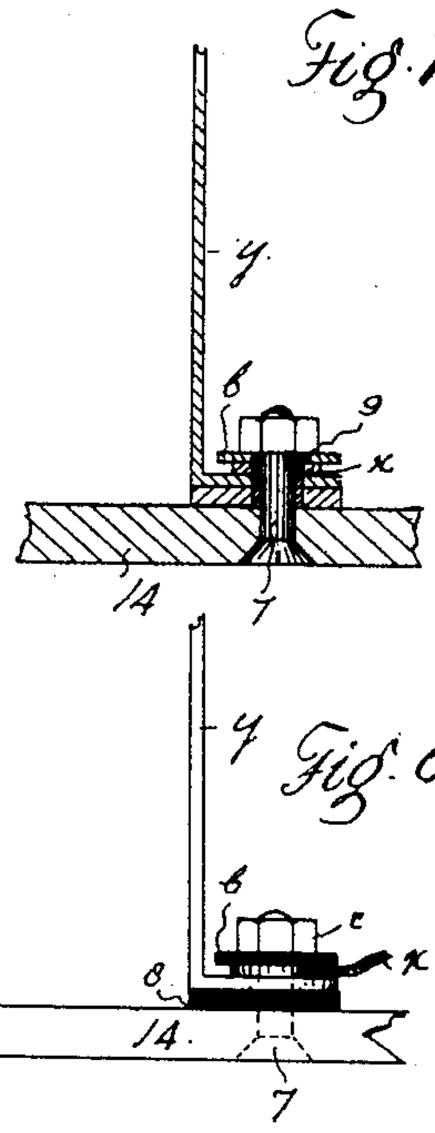

Fig. 6

Fig. 8

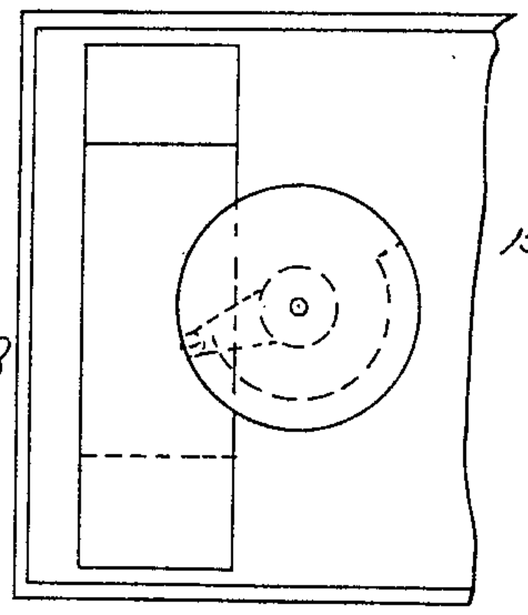

Fig. 9.

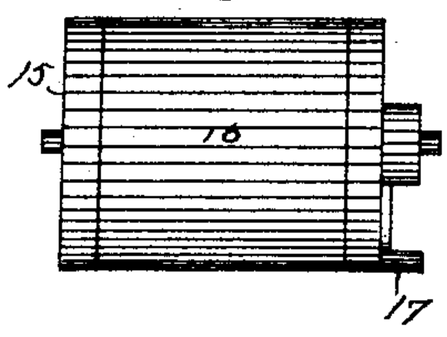

Fig. 10

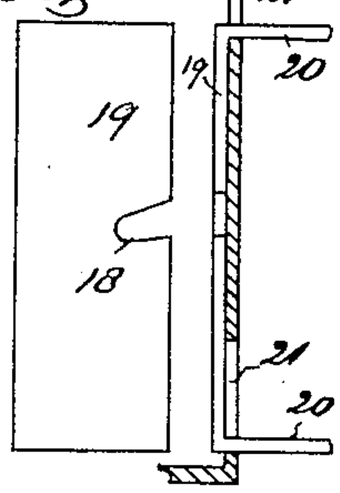

Fig. 11.

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By his Attorney
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UNITED STATES PATENT OFFICE.

WILLIAM P. CARSTARPHEN, JR., OF DENVER, COLORADO, ASSIGNOR TO THE ELECTRIC RECIPROCATING COMPANY, OF SAME PLACE.

ELECTRICAL RECIPROCATING TOOL.

SPECIFICATION forming part of Letters Patent No. 476,225, dated May 31, 1892.

Application filed June 1, 1891. Serial No. 394,671. (No model.)

To all whom it may concern:

Be it known that I, WILLIAM P. CARSTARPHEN, Jr., a citizen of the United States of America, residing at Denver, in the county of Arapahoe and State of Colorado, have invented certain new and useful Improvements in Electrical Reciprocating Tools; and I do declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same, reference being had to the accompanying drawings, and to the letters and figures of reference marked thereon, which form a part of this specification.

My invention relates to an improved electrical tool provided with a reciprocating plunger located and moving within the tubular spools of two coils or sets of coils of insulated copper wire through which a direct current of electricity is alternately passed. This reciprocating plunger is preferably constructed of pure soft iron because of its great capacity for conducting the magnetic lines of force or its permeability to these lines. The hollow or tubular cores of the helices should be constructed of some non-magnetic material possessing the requisite durability. I prefer to construct these spools of brass, which possesses in a satisfactory degree the qualities stated.

The current for operating my improved tool may be supplied from any suitable electrical source, as the ordinary galvanic battery or dynamo-electric machine, and this current is automatically switched from one coil or set of coils to the other by the use of a mechanism located between the two coils and controlled by the reciprocation of the plunger. The reciprocating action of this plunger results from alternately producing a strong magnetic field at different points in its path in the manner heretofore intimated.

The principle of the improvement and the mechanism by which it is applied will be fully understood by reference to the accompanying drawings, wherein is illustrated an embodiment of the invention.

In the drawings, Figure 1 is a side elevation of the tool ready for use. Fig. 2 is a similar view with the casing and bit removed. Fig. 3 is a side view partially in section. This view is obtained by giving the tool a quarter-turn toward the right from the position illustrated in Figs. 1 and 2. Fig. 4 is a longitudinal section taken through the center of the tool without cutting the plunger. In Fig. 5 the tool is shown with the casing removed and several coils wound on the spool, which is divided into sections by insulating-disks. Fig. 6 is an enlarged view in detail of one of the switch-brushes, and Fig. 7 is a horizontal section of the same. Fig. 8 is an outline top view of the switch without the brushes. Fig. 9 is a side view of the cylindrical contact-breaker forming an element of the switch. Fig. 10 is a plan view of a sliding plate located in the bottom of the switch-box; and Fig. 11 is a side view of the same, the box or casing being shown in section. Fig. 12 is a longitudinal section taken through the chuck and showing the manner of fastening the tool. Fig. 13 is a transverse section taken on the line $x\,x$, Fig. 12.

In the views, wherein similar reference characters indicate corresponding parts of the mechanism, let the numerals 10 and 10^a designate two hollow spools placed end to end and suitably connected, the inner end flanges being sufficiently separated from each other to permit the intermediate location of the automatic switch mechanism and allow the plunger the required length of stroke. Besides the switch-box, which is secured to the adjacent extremities of the spools 10 and 10^a, these spools are otherwise connected by strengthening bars or stays 11. The brass spools 10 and 10^a are wound with suitable copper wire, which may form a single coil or several coils, as may be desired.

In the single-coil construction shown in Figs. 2 and 3 one end 12 of the coil-wire leads to a metal brush 13, secured to a rectangular metal frame 14, having two opposite sides made fast to the adjacent ends of the spools. The free extremity of brush 13 engages a rotating cylindrical circuit-breaker 15, centrally pivoted in the bottom plate of casing 14. The corresponding extremity 12^a of the opposite coil leads to a similar metal brush 13^a, secured to the switch-box on the opposite side from brush 13. Brushes 13 and 13^a engage the circuit-breaker 15 at diametrically-opposite points. This circuit-breaker is provided with a metal contact-plate 16, partially encircling

its body portion, which is composed of suitable insulating material. Plate 16 is shown by dotted lines in Figs. 3, 5, and 8. The circuit-breaker 15 is provided with a wrist 17, formed in its lower end to one side of its center or pivotal point and engaging a recess 18, formed in a sliding plate 19, supported upon the bottom of the switch-box and provided with downwardly-projecting arms 20, which pass through slots 21 21, formed in the bottom of the box.

The reciprocating plunger 22 is located in the central space 23 of the hollow spools and crosses the space between the spools just below or to one side of the switch mechanism. Centrally located upon this plunger is a circumferential shoulder 24, adapted to engage arms 20 of plate 19 as the plunger reciprocates, thus moving said plate sufficiently to give the circuit-breaker a partial rotation. This movement alternately makes and breaks the connection between the metal contact-plate 16 and the brushes 13 and 13ª. Hence these brushes never simultaneously engage said contact-plate. The other extremities 24 and 24ª of the respective coils lead to a circuit-wire 25, connected with a binding-post 26, and thence with one pole of the electrical source through the medium of a wire 27. A wire 28 leads from the opposite pole of the battery or other source of electricity to the binding-post 29, and thence through a wire 30 to a metal conductor 31, having its extremities secured to the spools, but insulated therefrom. A wire 32 leads from conductor 31 to a third metal brush 33, secured on one side of the switch-box and having its free extremity constantly in engagement with the metal contact 16 of the circuit-breaker. The binding-posts are insulated from spool 10 by an insulating-plate D. It will thus be seen that the electric current is always completed through one of the coils on the spools 10 10ª, and that these coils are alternately in the circuit. In following the current I may say that it passes from one pole of its source through wire 28, binding-post 29, wire 30, conductor 31, wire 32, to brush 33, and thence to the contact-plate 16. Now if brush 13 is in contact with plate 16 the current passes through this brush through the coil wound on spool 10, thence to wire 24, wire 25, binding-post 26, and wire 27 to the opposite pole of its source, completing the circuit; or, if brush 13ª is in contact with plate 16 the current passes thence through said brush through the coil wound on spool 10ª, thence to wire 24ª and wire 25 to the binding-post 26, completing the circuit, as last described. Since the circuit is always completed through conductor 31, I divide this post so as to form a narrow space 48 between its parts, and I bridge this space by a sliding contact 49, manipulated by the use of a button 50, connected with 49 by a neck 51, insulated from the contact, as shown at 52. This contact-breaker is manipulated at pleasure by the user of the tool, the button 50 being located on the outside of the casing and the neck moving in a slot 53, formed therein. The ends of part 31 on each side of space 48 are slightly raised, while the under surface of the contact 49 is correspondingly concaved. By virtue of this construction the parts are held securely in contact when space 48 is bridged, and the contact 49 may be easily moved to one side of the space when it is desired to break the circuit.

While the tool is in operation the electric current alternately traverses the two paths just described, one coil lying in each path. As the current passes through one of the coils the attraction resulting from the lines of force induced by the current draws the reciprocating plunger 22 into the hollow of the spool to the limit of its stroke. This action of the plunger shifts the contact-breaker by virtue of the construction heretofore described and cuts the coil last traversed by the current out of the circuit and completes the current through the other coil. Again, the attraction resulting from the induced lines of magnetic force acts on the reciprocating plunger and draws it back into the hollow of the other spool, when the contact-breaker is again shifted and the reciprocation continues.

The manner of insulating the switch-brushes from the parts to which they are attached is shown in Figs. 6 and 7. Let *y* designate the brush, which may be either that designated as 13, 13ª, or 33 when occupying their proper position in the mechanism. One extremity of the brush being bent to lie parallel with the surface to which it is to be secured is placed upon an insulating-plate 8, engaging one side of the switch-box. A screw 7, having its head countersunk in the opposite side of the switch-casing, is passed through apertures formed in plate 8 and the engaging extremity of the brush, these apertures being large enough to receive an insulating rubber sleeve 9 surrounding the screw. Let *x* designate the conductor leading to the brush, which conductor may be that designated as 12, 12ª, 30, or 32 in those views wherein the parts are assembled. This conductor surrounds the insulating-sleeve and engages the brush. Above the conductor is placed an insulating-washer *b*, and these parts are all secured in place by a small nut *c*, which the outer extremity of the screw is fashioned to receive.

In the smaller styles of my improved device, where a short stroke is always desirable, the reciprocating plunger should always be separate and distinct from the chuck-stem, as shown in Fig. 4. This division is indicated by the line 35 in said figure, and 36 is the chuck-stem, which is provided with a collar 37, located in a small chamber 38, inclosed by a cup-shaped casing 39, secured to one end of the spool 10ª. The stem 36 is provided with a feather or spline 36ª, engaging a corresponding groove formed in the casing 39. This construction allows the stem a free lon-

gitudinal movement, but prevents any rotating action.

Between the collar 37 and the outer extremity of the casing is located a coil-spring 40, which normally holds the chuck-stem at its backward limit of movement. As the reciprocating plunger engages the inner extremity of stem 36 the latter is driven forward, compressing spring 40. As soon as the plunger releases the chuck the latter is returned to its normal position by the recoil of the spring. The chuck should be constructed of non-magnetic material, so that it will neither adhere to the plunger nor to external paramagnetic objects.

Experience has shown that the adjacent extremities of the plunger and chuck manifest little or no wear after use for a considerable length of time. This condition results from the fact that the plunger in its rapid reciprocation compresses the air in the hollow of the spool 10^a and forms an air-cushion between its extremity and the adjacent extremity of the chuck. Hence this cushion or column of compressed air prevents, it is believed, the actual engagement of the adjacent parts of the plunger and chuck between which it lies and accounts for the absence of wear between these parts.

In Fig. 3 the chuck-stem is shown formed continuous and integral with the plunger. In the larger style of tools for mining purposes this form would undoubtedly be preferable. In this case the bit of course moves the entire length of the stroke. The outer portion 45 of this continuous plunger, beginning about at a line 46, should be formed of non-magnetic material to prevent magnetization and consequent trouble from its adhering to external paramagnetic objects, and for the further purpose of utilizing to the best advantage the lines of force induced by the current circulating through the coils.

As heretofore stated, the plunger proper should be of pure soft iron, which is delicately sensitive to the induced magnetic action, since it has a high coefficient of electromagnetic conductivity or is readily permeable to the lines of magnetic force. It is obvious that the magnetic action induced by the current in passing through the convolutions of one coil will continue to draw the plunger until the inner entrance to the hollow spool is equidistant between the extremities of the plunger, when the magnetic action will cease to be efficacious in continuing the movement, since the poles of the plunger are equally acted upon by the polarity induced at the inner entrance of the hollow spool whose coil is in the circuit, which polarity repels one pole of the plunger and attracts the other. Hence in order to get the best results the length of the permeable portion of the plunger should be so regulated that the extremity lying in the direction toward which it is moving will, when at its forward limit of movement, be nearer the inner entrance to the hollow of the magnetizing-coil than the opposite extremity of the plunger. This is illustrated in Fig. 4, and though in Fig. 3 the part 45 is continuous with the permeable soft-iron bar the line of demarkation between the non-magnetic portion 45 and the permeable portion should be located to correspond with line 35 in Fig. 4, when the bar 22 and the chuck-stem are in contact. I will assume that 46 designates this line in Fig. 3.

In many cases it will be found desirable in a tool of this class to change the speed without altering the current which induces the magnetic energy. I accomplish this by the use of the construction illustrated in Fig. 5.

Instead of winding the spool from end to end, layer upon layer, forming a single coil, as shown in Figs. 2 and 3, I divide the spools 10 10^a into several sections, spaces, or compartments by the insulating-disks 55. As shown in the drawings, I use two disks on each spool and form three compartments or sections 1 2 3. Compartment 1 is first wound full and then compartments 2 and 3 successively in the order named, the three coil-sections being composed of a continuous wire, but each section wound full before the wire is carried to the next. The innermost sections are wound first and then the others in their order toward the outer extremities of the spools. The ends 12 and 12^a of the coils are connected with the brushes 13 and 13^a, respectively, as heretofore described, while the circuit-wire 30 is carried directly from the binding-post to brush 33 and the wire 25 to a bar 61, secured to the adjacent extremities of the spools, but insulated therefrom. About one-half of this bar is formed into ridged sections 62, 63, and 64, insulated from each other and from the other portion of the bar, as shown at 65. The last convolution of coil 1 is connected by a wire 67 with ridge 62, which is located nearest the circuit-breaker 60. The last convolution of each coil 2 is connected with the central ridge 63 by a wire 68, and the last turn of each coil 3 with the outer ridge 64 by a wire 69.

As shown in Fig. 5, one extremity of circuit-breaker 60 engages an insulating-division 65 and the circuit is broken. Part 60 is concave on its under side, its extremities only being in contact with other parts, and is adjusted by sliding back and forth. For this purpose it is provided with a button 50, connected with the main part by a suitable neck adapted to move in slot 53. (Shown in Fig. 1.) One extremity of part 60 is in contact with the body of the bar 61, while the other extremity is fashioned to engage the ridges 62, 63, and 64, and is sufficiently yielding to permit of its being easily moved from one of the contact-ridges to the other, and when in place it grips the ridge tightly enough to prevent possible displacement, which otherwise might result from jars or vibrations of the parts when the tool is in action.

I will suppose the cylindrical circuit-

breaker 15 to occupy the position shown in Fig. 5—that is, with the contact-plate 16 engaging brush 13. Now if part 60 is so adjusted that its contact extremity engages ridge 62 the current may be said to pass from one pole of the electric source through wire 28, binding-post 29, wire 30, brush 33, contact-plate 16, and brush 13 to one extremity 12 of the coils 1 2 3 of spool 10, and thence back and forth through all the convolutions of each layer of coil 1, and out through conductor 67 to contact-ridge 62 through parts 60 61, and wire 25, binding-post 26, and wire 27 to the other pole of the electric source, completing the circuit. It will thus be observed that when part 60 engages contact-ridge 62 the current only passes through section 1 of the coil. Now if part 60 be moved to engage contact-ridge 63 the current passes through section 1 of the coil, as before; but as the circuit cannot now be completed *via* wire 67 the current passes to and through the next coil 2, and thence out through conductor 68 to contact-ridge 63, and thence completing the circuit through part 60, as before. Again, if part 60 is shifted to engage contact-ridge 64 the circuit cannot be completed *via* wire 68. Hence after the current has traversed coil-sections 1 and 2 it will pass through coil 3 and thence out through conductor 69 to contact-ridge 64, completing the circuit *via* part 60, as before. It will be observed that by reason of its arched shape part 60 when engaging contact-ridges 63 or 64 spans 62 or 62 and 63, as the case may be, thus being never in contact with more than one ridge at the same time.

The cutting-bit 75 is secured within a suitable socket formed in the chuck. As shown in the drawings, this socket is rectangular in cross-section and tapers gradually from the outside to its inner extremity, where it communicates with a transverse keyhole 76. The bit-stem is fashioned to correspond with the shape of the socket and made of such size as to wedge tightly therein and extend into the keyhole. The key 77 is located immediately in the rear of the bit and engages the same. The surface of the key engaging the bit is inclined, while the opposite face lies in a vertical or horizontal plane, according as the tool occupies a vertical or horizontal position. The head of the key is larger than the opening for its reception, being provided with a projecting lip which prevents its falling through the opening before it is engaged by the bit. Its smaller extremity is provided with a pin 78 to prevent the key from slipping out in the opposite direction.

When it is desired to remove the bit, it may be easily loosened by tapping the head of the key with a hammer.

Within the rear extremity of the central opening in spool 10 is located a resilient buffer 80, which is engaged by bar 22 when at its backward limit of movement during each reciprocation. This buffer reduces the concussion or jar to a minimum, and by its recoil action gives the stem a forward impetus and thus assists in the return movement.

The mechanism is incased by a cylindrical casing, preferably formed in two sections A and B, as shown in Fig. 1. These sections are united in any suitable manner, preferably by a screw-joint. C indicates the line of demarkation between the body portions of these sections of the casing. These two parts may overlap by telescoping the one into the other sufficiently tight to be held together by frictional contact, or one may be interiorly threaded and provided with a shoulder and the other correspondingly exteriorly threaded, thus forming a screw-joint.

I have found by experiment that it is advantageous to have this external shell constructed of some material having a high coefficient of magnetic induction, as soft iron. The button 50 projects from one side of this outer shell, as shown in Fig. 1, while the binding-posts 26 and 29 protrude from one end thereof. This shell is insulated from the binding-posts and from all parts of the mechanism lying within the circuit. The switch-box 14 also projects from one side of the casing and is closed by a cover secured in place in any suitable manner.

From the foregoing description the construction and operation of my improved electric tool will be understood.

This instrument may be constructed of small size, so that it can be easily held in the hand when used. This small-sized tool will be found highly advantageous in cutting marble and other stone, and specially so in cutting inscriptions on tombstones, monuments, &c. It is also believed that it will prove a valuable acquisition to the sculptor's tools and greatly facilitate all fine stone-cutting work.

The tool can be cheaply operated for light work, since a battery consisting of a few cells will supply current of ample strength, and when once set in motion its action is thoroughly automatic.

Having thus described my invention, what I claim is—

1. In an electrical tool, the combination, with two hollow coils, of a movable bar supported therein, a circuit, a commutator located between the coils and consisting of a box or frame connecting the two coils and provided with a bottom located just above the movable bar and a top covering the working parts, a movable plate supported upon said bottom and provided with depending arms projecting through slots formed in the bottom of the box and into the path of the bar, which is provided with a shoulder adapted to alternately engage said arms as the bar reciprocates, a cylindrical circuit-breaker pivoted in the bottom of the frame or box and provided with a wrist or projection located to one side of its center and engaging a slot formed in the movable plate, a single contact-plate secured to said circuit-breaker and partially surrounding the same, the upper ex-

tremity of the circuit-breaker being pivoted in the top plate of the box, and three brushes one constantly in engagement with the contact-plate and the other two alternately in contact therewith, the brushes and coils being arranged and connected in the circuit, substantially as described, and for the purpose set forth.

2. In an electrical tool, the combination, with two hollow coils, of a movable bar supported therein, a circuit, a commutator located between the coils and consisting of a box or frame connecting the coils and provided with a bottom located just above the movable bar and a top covering the working parts, a movable plate supported upon said bottom and provided with depending arms projecting through slots formed therein and into the path of the bar, which is provided with a shoulder adapted to alternately engage said arms as the bar reciprocates, a cylindrical circuit-breaker consisting of a block of insulating material having an exposed metallic contact-plate partially surrounding the same, said circuit-breaker being pivoted in the bottom of the frame and provided with a wrist or projection located to one side of its center and engaging a slot formed in the movable plate, the upper extremity of the circuit-breaker being pivoted in the top plate of the box, and three metallic brushes, one continually in direct engagement with the contact-plate of the circuit-breaker and the other two alternately in direct contact therewith, the brushes and coils being arranged and connected in the circuit, substantially as shown and described, whereby as the movable bar reciprocates a partial rotation in reverse directions is imparted to the circuit-breaker, as and for the purpose set forth.

3. The combination, with two hollow coils inclosed by a suitable metallic shell or case, each coil being wound in a plural number of distinct sections by the use of a continuous wire, of a movable bar supported in said coils, a circuit and automatic switch mechanism connected with the coils and lying within the circuit, and a movable spring-plate suitably supported upon the tool and located within the shell or case, said plate having one extremity continually in electrical contact with one pole of the source of electricity, metallic contacts lying in the same plane and equal to the number of sections of each coil, these contacts being insulated from each other and each connected with a single corresponding section of both coils by a continuous conductor, said contacts forming a series of corrugations which the spring-plate is fashioned to engage, and means connected with the movable spring-plate and protruding through a slot formed in the inclosing case, whereby said plate may be shifted at will from the outside of the shell independently of the movement of the reciprocating bar, according as it is desired that the current shall pass through one or more of the coil-sections, substantially as described.

4. In an electrical reciprocating tool, the combination, with two hollow energizing-coils, of a movable bar supported in said coils, a circuit, switch mechanism located between the coils and projecting into the path of the movable bar, which acts directly thereon, said switch mechanism consisting of a circuit-breaker composed of a solid cylindrical block of insulating material and a single exposed metallic contact-plate partially surrounding said block, and three metallic brushes, two of the brushes being respectively connected with the coils and alternately in engagement with the contact-plate of the circuit-breaker, the third brush being connected with one pole of the electrical source and constantly in engagement with the contact-plate of the circuit-breaker, whereby the current is alternately passed through the coils and a reciprocating movement imparted to the bar, substantially as described.

5. In an electrical tool, the combination, with two hollow energizing-coils, of a movable iron bar supported therein, a circuit in which the coils lie, a commutator located between the coils, which are suitably separated therefor, said commutator consisting of a cylindrical circuit-breaker composed of a solid block of insulating material partially surrounded by a single exposed metallic contact-plate and three metallic brushes, two of the brushes being respectively connected with the coils and alternately in direct engagement with the contact-plate of circuit-breaker, the third brush being connected with one pole of the electrical source and constantly in direct engagement with the contact-plate of the circuit-breaker, and a sliding plate connected with the circuit-breaker and having arms projecting into the path of the movable bar, said bar being provided with a ring or shoulder adapted to engage these arms and actuate the circuit-breaker, whereby the current is alternately passed through the coils and a reciprocating movement imparted to the bar, substantially as described.

6. In an electrical reciprocating tool, the combination, with two hollow energizing-coils, of a movable iron bar supported therein, a circuit in which the coils lie, a switch mechanism located between the coils, which are suitably separated therefor, said mechanism consisting of a circuit-breaker composed of a cylindrical insulating-block partially surrounded by a single metallic contact-plate, and three metallic brushes, two of the brushes being respectively connected with the coils and alternately in direct engagement with the contact-plate of the circuit-breaker, the third brush being connected with one pole of the electrical source and constantly in direct engagement with the contact-plate of the cir-

cuit-breaker, and a sliding plate connected with the circuit-breaker and having arms projecting into the path of the movable bar, said bar being provided with a shoulder centrally located thereon and adapted to engage these arms and actuate the circuit-breaker, giving the same a partial rotation in reverse directions, whereby the current is alternately passed through the coils and a reciprocating movement imparted thereto, substantially as described.

In testimony whereof I affix my signature in presence of two witnesses.

WILLIAM P. CARSTARPHEN, JR.

Witnesses:
WM. MCCONNELL,
G. J. ROLLANDET.