No. 730,379. PATENTED JUNE 9, 1903.

J. S. LETORD, W. W. ALEXANDER & H. LETORD.

CIRCUIT CONTROLLER FOR SURGICO-DENTAL ENGINES.

APPLICATION FILED JULY 7, 1902.

NO MODEL. 4 SHEETS—SHEET 1.

Fig. 1.

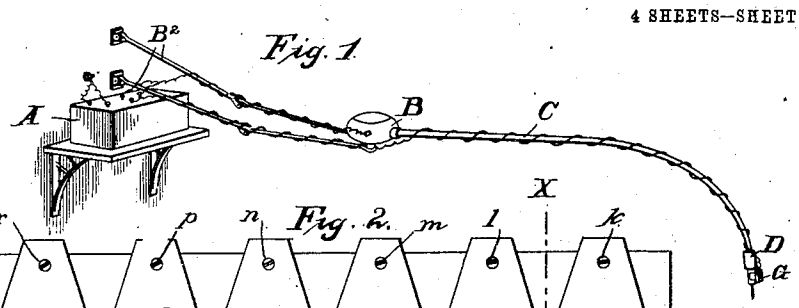



Fig. 2.

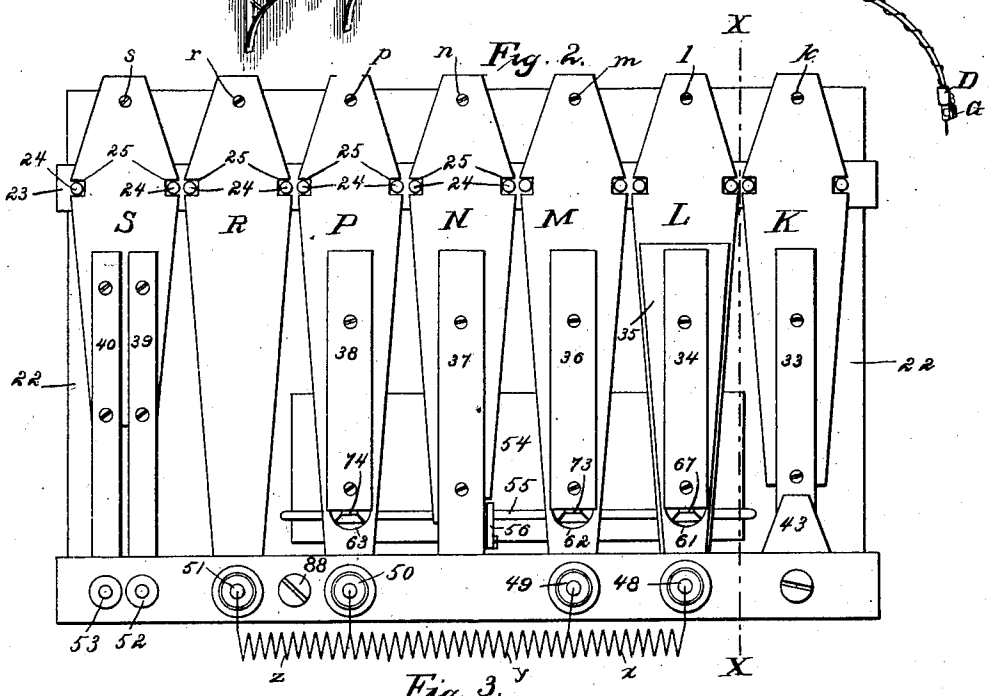
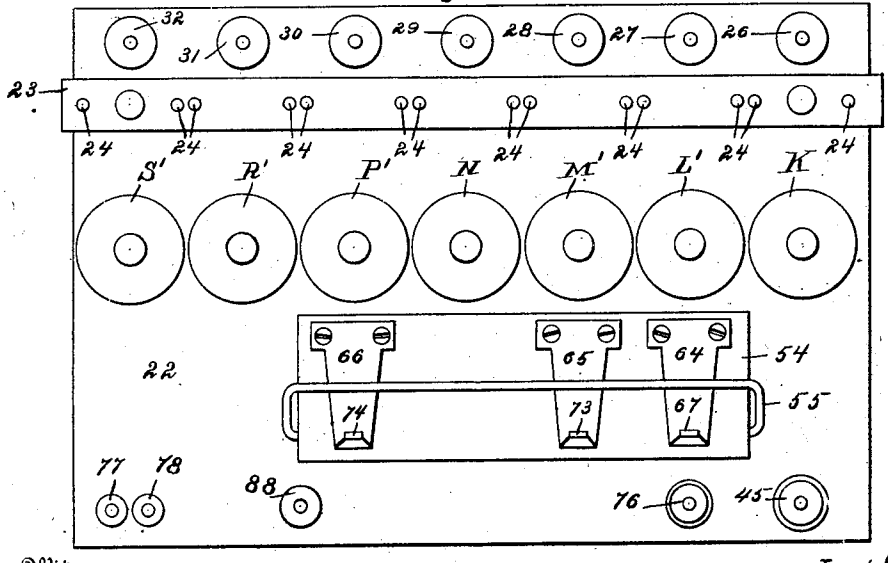



Fig. 3.




Witnesses

R. H. Storm.

L. J. Masson

Inventors

By Joseph S. Letord
William W. Alexander
Henri Letord.

E. E. Masson Attorney

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

No. 730,379. PATENTED JUNE 9, 1903.

J. S. LETORD, W. W. ALEXANDER & H. LETORD.

CIRCUIT CONTROLLER FOR SURGICO-DENTAL ENGINES.

APPLICATION FILED JULY 7, 1902.

NO MODEL. 4 SHEETS—SHEET 2.

Fig. 7.

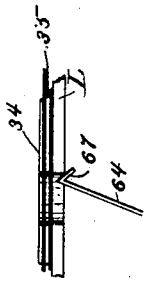


Fig. 4.

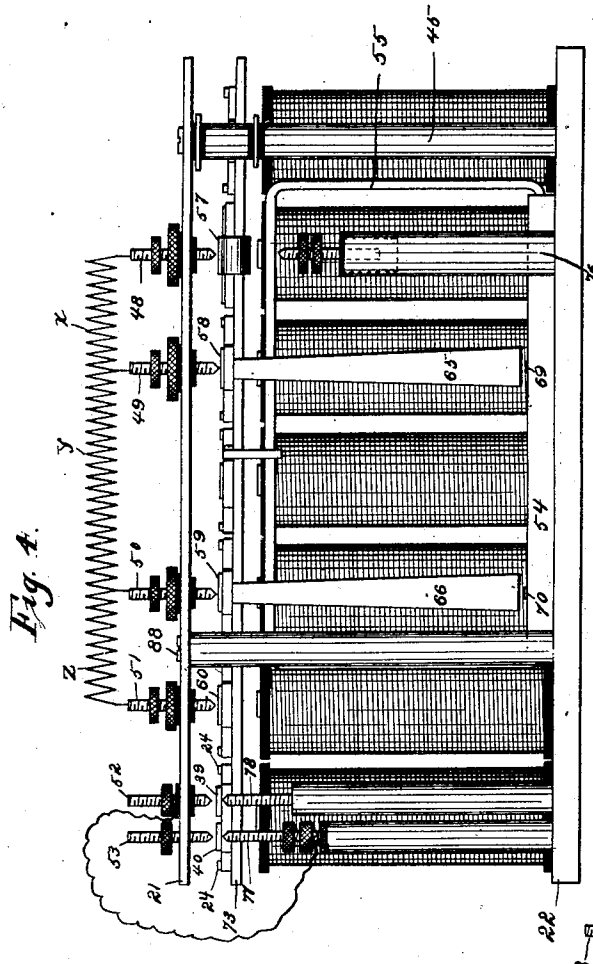


Fig. 5.

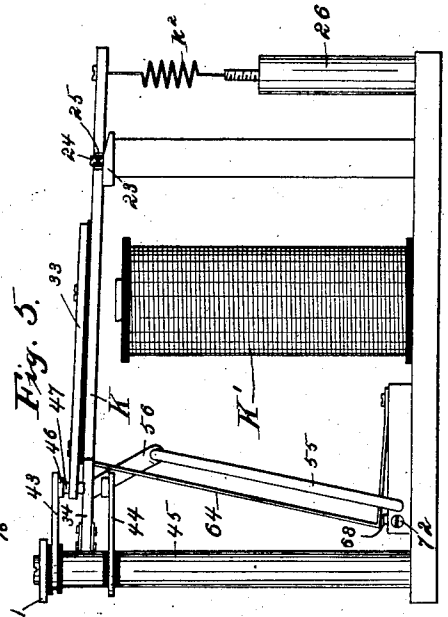
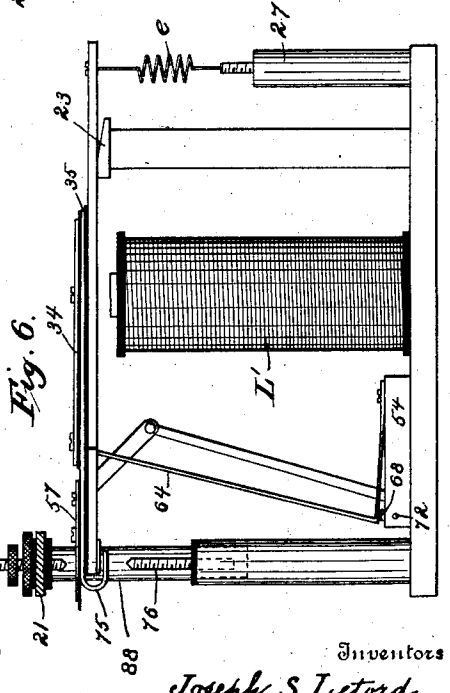


Fig. 6.



Witnesses

P. H. Storm.

L. J. Masson

Inventors

Joseph S. Letord

William W. Alexander

Henri Letord.

By

E. E. Masson Attorney

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

No. 730,379. PATENTED JUNE 9, 1903.

J. S. LETORD, W. W. ALEXANDER & H. LETORD.

CIRCUIT CONTROLLER FOR SURGICO-DENTAL ENGINES.

APPLICATION FILED JULY 7, 1902.

NO MODEL. 4 SHEETS—SHEET 3.

Fig. 8.

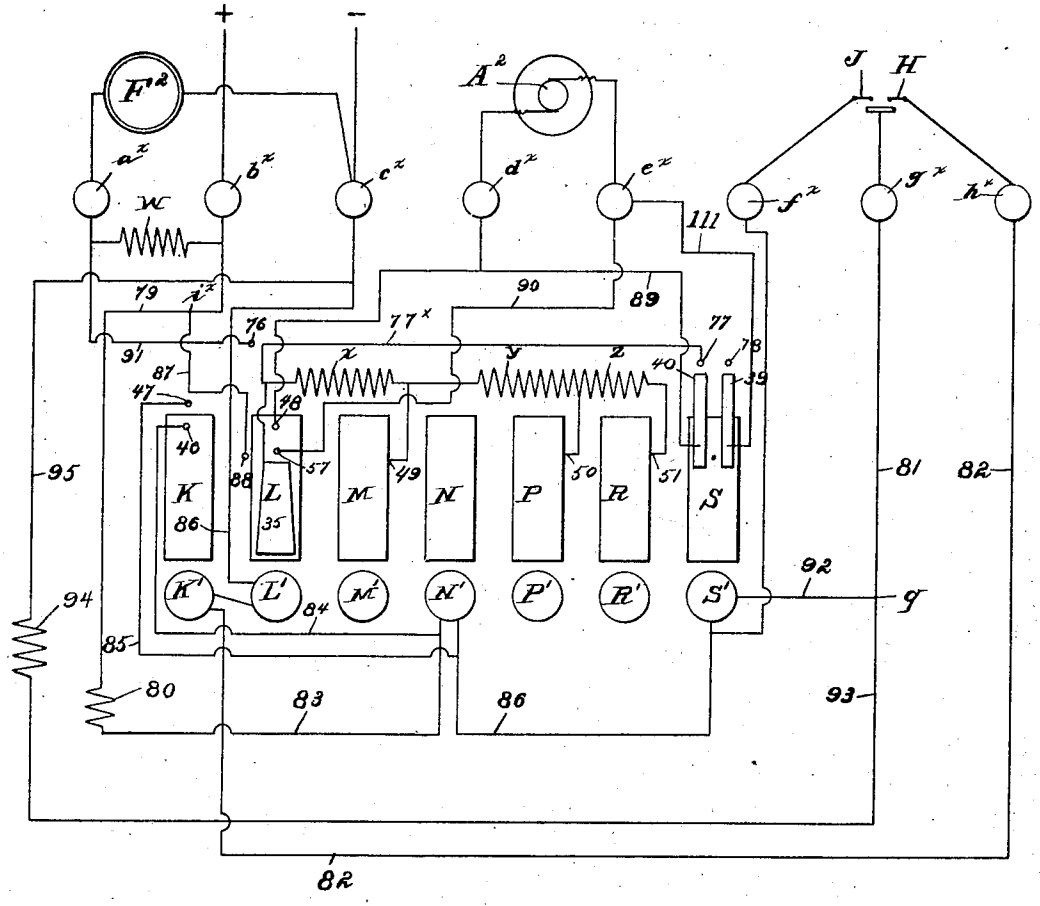
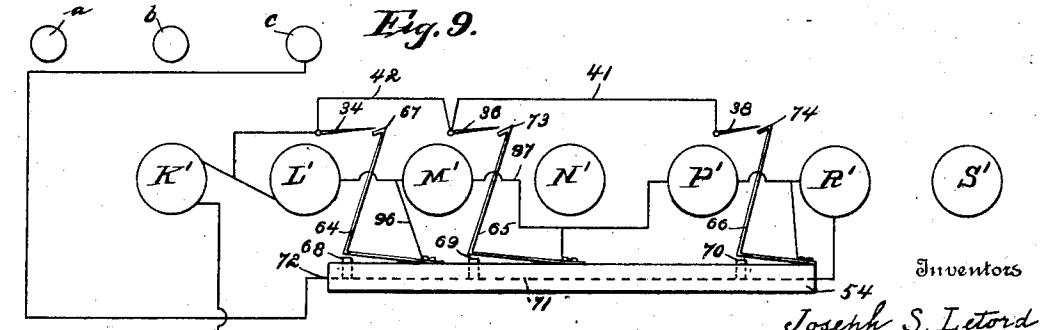



Fig. 9.




Witnesses

P. H. Stone

L. J. Masson

Inventors

Joseph S. Letord

William W. Alexander

Henri Letord.

By E. E. Masson Attorney

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

No. 730,379. PATENTED JUNE 9, 1903.

J. S. LETORD, W. W. ALEXANDER & H. LETORD.

CIRCUIT CONTROLLER FOR SURGICO-DENTAL ENGINES.

APPLICATION FILED JULY 7, 1902.

NO MODEL. 4 SHEETS—SHEET 4.

Fig. 10.

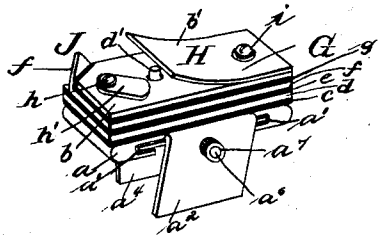



Fig. 11

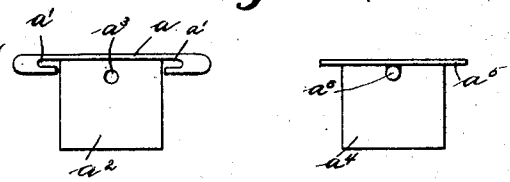



Fig. 12.

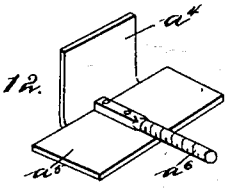



Fig. 13.

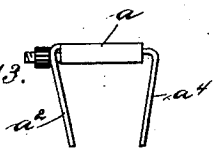



Fig. 14.

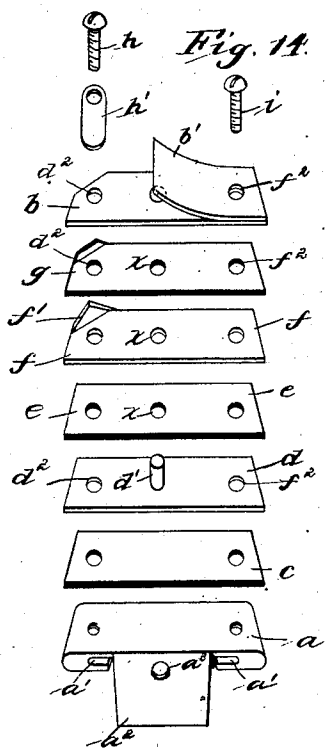



Fig. 15

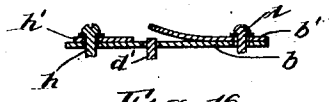
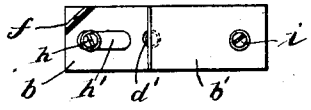



Fig. 16.




Witnesses
P. H. Storm.
L. J. Masson

Inventors
Joseph S. Letord
William W. Alexander
Henri Letord.

By
E. E. Masson Attorney

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

No. 730,379. Patented June 9, 1903.

# UNITED STATES PATENT OFFICE.

JOSEPH S. LETORD, WILLIAM W. ALEXANDER, AND HENRI LETORD, OF KANSAS CITY, MISSOURI, ASSIGNORS TO THE L. A. RHEOSTAT CO., OF KANSAS CITY, MISSOURI.

## CIRCUIT-CONTROLLER FOR SURGICO-DENTAL ENGINES.

SPECIFICATION forming part of Letters Patent No. 730,379, dated June 9, 1903.

Application filed July 7, 1902. Serial No. 114,613. (No model.)

*To all whom it may concern:*

Be it known that we, JOSEPH S. LETORD, WILLIAM W. ALEXANDER, and HENRI LETORD, citizens of the United States, residing at Kansas City, in the county of Jackson and State of Missouri, have invented certain new and useful Improvements in Circuit-Controllers for Surgico-Dental Engines, of which the following is a specification.

The invention relates to circuit-controllers for surgico-dental electric motors or engines; and an object, among others, is to improve and simplify the construction of such appliances in general, and more particularly the circuit-controller for which Letters Patent No. 661,742 have been granted to Henri and Joseph S. Letord.

The first part of our invention comprises a regulator that is electrically connected with the motor and with a circuit-closing key and involves means to open and close the motor-circuit, thus starting and stopping the motor; means for cutting in and out of circuit a variable resistance, thus regulating the speed of the motor; means for reversing the polarity of the motor's armature, thus reversing its direction of rotation, and means for short-circuiting the armature of the motor when current is cut off from the latter, whereby to overcome the armature's momentum, so as to stop it instantly.

The second part of the invention comprises a handpiece attachment consisting of a double circuit-closing key combined with a clamp for fastening it upon a handpiece.

The nature, characteristic features, and scope of the invention will be readily understood from the following detailed description, taken in connection with the accompanying drawings, forming a part hereof, wherein—

Figure 1 is a perspective view of a surgico-dental electric engine mounted on an adjustable bracket connected up with circuit-controlling mechanism designed in accordance with our invention. Fig. 2 is a top view of the regulator, showing the general arrangement of the armatures and contact-points. Fig. 3 is a similar view with the armatures and rod carrying the contacts removed. Fig. 4 is a front elevational view. Fig. 5 is an end view; Fig. 6, a sectional view on line $x\,x$ of Fig. 2. Fig. 7 is a detail. Fig. 8 is a diagrammatic view of the regulator and its circuits. Fig. 9 is a diagrammatic view of the magnet-circuits. Fig. 10 is a perspective view of the handpiece attachment. Fig. 11 shows elevational views of the respective clamp members. Figs. 12 and 13 are detail views of the clamp. Fig. 14 is a perspective view of the respective members of the handpiece attachment detached, but in proper order for assembling. Fig 15 is a sectional view of the upper plate of the attachment. Fig. 16 is a top view of the complete attachment.

We shall first consider the "regulator," reference being had to Figs. 2 to 9, inclusive.

K, L, M, N, P, R, and S are seven armatures mounted above the electromagnets K′, L′, M′, N′, P′, R′, and S′, respectively.

22 is a rectangular piece of metal, (preferably soft iron,) which, acting as a base-plate, supports all the other parts.

The armatures K, L, M, N, P, R, and S rest upon the beveled bar 23 and are held in their proper places by the pins 24, which fit into notches 25 in the sides of the armatures, thus permitting the armatures to rock seesaw fashion across 23, but preventing their movement laterally. The poles of their respective magnets limit the downward motion of the armatures, and the contact-points arranged in the flat bar 21 limit their upward movement. Retractile springs $k$, $l$, $m$, $n$, $p$, $r$, and $s$ serve to hold the front ends of the armatures normally away from the respective poles K′ L′ M′ N′ P′ R′ S′ and in contact with their several contacts in the bar 21, as shown in Figs. 5 and 6. The springs $k$, $l$, $m$, $n$, $p$, $r$, and $s$ have their lower ends adjustably secured to the upright pieces 26, 27, 28, 29, 30, 31, and 32.

33, 34, 35, 36, 37, 38, 39, and 40 are strips of conducting material—for instance, brass—which are fastened to the armatures, but are insulated electrically therefrom.

41 and 42 are insulated conductors electrically connecting plates 34 and 36 and 38.

43 is a metallic strip or arm arranged between the bar 21 and the post 45 and insulated therefrom and carrying the contact 46.

On the end of conductor 33 is a contact 47, normally held in contact with contact 46 by means of the spring $k^2$.

44, Fig. 5, is a stop to limit the downward motion of armature K.

48, 49, 50, 51, 52, and 53 are contact-pieces set into the bar 21, all being insulated from the frame electrically.

54 is a rectangular piece of insulating material having a rectangular wire 55 secured to it, something like the bail of a bucket, so as to be free to swing backward and forward.

56 is a piece of insulating material pivotally mounted upon conductor 37 at one end and having a hole through the other end for the passage of the bar or wire 55.

By reference to Fig. 5 it will readily be seen that when armature K is in its raised position the bar or wire 55 and non-conductor 56 have arrived at an obtuse angle with respect to each other and that bar 55 is therefore carried forward by the upward movement of armature N. Likewise the downward movement of N carries 55 backward. The object of this will be discussed presently.

57, 58, 59, and 60 are flat springs in common electrically with the armatures L, M, P, and R, respectively, and serve to make a firm but cushioned and noiseless contact with contact-pieces 48, 49, 50, and 51.

61, 62, and 63 are holes through L, M, and P, respectively.

64, 65, and 66 are three L-shaped pieces of brass or other spring metal fastened at the ends of their horizontal portions to the block of insulating material (hard rubber) 54 and having their vertical portions terminating in hooks 67, 73, and 74, Figs. 7 and 9. Near their angles these pieces rest upon contact-points 68, 69, and 70, Figs. 4 and 5, which project upward from the (hard rubber) insulating-block 54. Contacts 68, 69, and 70 are connected in common electrically by a conductor 71, Fig. 9, which passes along a groove in the bottom of the block 54. Conductor 71 terminates under a screw 72, which serves as a binding-post for connecting 68, 69, and 70 with other parts, as will be hereinafter described. Hooks 67, 73, and 74 normally lie in the openings 61, 62, and 63, respectively, in such a manner that when armatures L, M, and P (or any one of them singly) are brought downward by their electromagnets the hooks catch on the edges of conducting-pieces 34, 36, and 38 and hold the armatures down after the discharge of the magnets until mechanically released, (as will be presently explained,) and at the same time electrical connection is established between 64, 65, and 66 and 34, 36, and 38, respectively.

As the armatures L, M, and P are alike in the main in their construction and functions, a description of one, L, will answer for all three. As L has some features not shared by armatures M and P, these particulars of armature L will be described afterward. L normally has its contact-piece 57 held by the retractile spring $l$ in contact with the insulated post 48. When its electromagnet L′ is charged, the armature is pulled downward and the contact between post 48 and contact-piece 57 is broken. At the same time the hook 67 catches over 34, establishing electric connection between 64 and 34. When magnet L′ is discharged, spring $l$ tends to restore L to its normal position, but is prevented by the hook 67 of the L-shaped piece 64. However, the relative strengths of spring-piece 64 and the spring $l$ are so proportioned that while spring $l$ is unable to restore the armature L to its normal position against the action of 64 it is strong enough to bend the horizontal portion of 64 sufficiently to break electrical connection between 68 and 64. This condition—that is to say, contacts between 64 and 34 made—continues until the hook 67 is released, as will be described presently. Similarly, contacts between 49 and 58 and 50 and 59 and 65 and 69 and 66 and 70 are broken, and contacts between 73 and 36 and 74 and 38 are established by the movements of M and P. The means of releasing hooks 67, 73, and 74 (or any one of them singly) will now be described.

It will be remembered how the horizontal portion of the rectangular wire or bar 55 is made to swing backward and forward by the charge or discharge of the magnet N′ acting upon the armature N. The horizontal portion of bar 55 passes behind the vertical parts of the L-shaped pieces 64, 65, and 66, so that when the former is carried forward by the upward movement of armature N it collides with and pushes forward the upright portions of members 64, 65, and 66, thus disengaging the hooks and permitting armatures L, M, and P to return to their normal positions. L, M, and P being in their normal positions, contacts between 48 and 57, 49 and 58, 50 and 59, 64 and 68, 65 and 69, 66 and 70 are established, and contacts between 64 and 34, 65 and 36, 66 and 38 are broken. The conducting-plate 35, superimposed upon the armature L and insulated therefrom, terminates at 75, so as to make a spring contact with the insulated contact-piece 76. Contact between 60 and 51 is made and broken by the action of electromagnet R′ upon the armature R, as will be readily seen by reference to the drawings. Let it be understood that spring-contacts 58, 59, and 60 are in common electrically with their armatures, and hence in common with the frame of the whole appliance. Between contacts 48 and 49, 49 and 50, 50 and 51 there is a series of graduated resistances X, Y, and Z. 39 and 40 are two insulated conducting-strips forming part of the circuit of the armature of the motor with which the regulator may be connected, and constructed to make contact with 53 and 52 or 77 and 78, according to the position of armature S. Contact-posts 53 and 78 are in common with the frame of the appliance, and 52 and 77 are completely insulated therefrom.

If the frame of the regulator be positive and the other two posts 52 and 77 negative, it is obvious that the direction of a current flowing between 39 and 40 through the armature of the motor will be in one direction or the other according as 39 and 40 are in contact with 53 and 52 or with 77 and 78. If the frame be negative and 52 and 77 be positive, the result will be the same. As the frame of the regulator and the posts 52 and 77 are actually charged oppositely or negatively, as will be shown later, it will appear that the direction in which the motor's armature rotates is controlled by the armature S, since the position of S determines the direction of the current through the motor's armature.

We will now describe the circuit-closing key. The key described herein is one specially designed to be attached to the handpiece of a dento-surgical electric engine; but it will be understood that any kind of a circuit-closing key which permits the handling of two circuits may be used instead of the one described when our regulator is to be used in connection with electric engines other than dento-surgical engines or when for any cause a key separate from the handpiece is desirable in the case of dento-surgical engines. The circuit-closing key will hereinafter be referred to as the "handpiece" attachment and will now be described. The handpiece attachment consists of a double circuit-closing key combined with a clamp for fastening it upon a handpiece. One key, H, has one of its contacts on a spring, so as to automatically break the circuit when the pressure holding the contacts together is removed, and the other key, J, of the handpiece attachment has a short pivoted switch-lever which may be moved into or out of contact with its corresponding contact point. For the sake of clearness farther on we will here say that key H is the controller for the motor's speed and that key J is the controller for the direction of the armature's rotation.

G designates the handpiece attachment, which, as illustrated in Fig. 14, is made up of alternate sheets or laminæ of conducting and non-conducting material, as follows: $a$ and $b$ are respectively base and top plates and are of sheet metal. $c$ is a layer of insulating material, as fiber; $d$, a conducting-strip, as copper, served with a contact-point $d'$, projecting upwardly centrally of said strip. $e$ is a non-conductor, $f$ a conductor, and $g$ a non-conductor. The top or surface plate $b$ is provided with a short upwardly-bent flat spring $b'$, which may be brass, arranged for contact with pin $d'$, as clearly to be seen in Figs. 10 and 14. The respective laminæ or strips are suitably apertured to receive the screws $h$ and $i$, which are properly insulated and serve to secure the whole. The strips $e$, $f$, $g$, and $b$ are centrally apertured to accommodate the contact-pin $d'$. $h'$ is a switch pivotally mounted on screw $h$ and movable on the surface of $b$. It should be observed that apertures $d^2$ and $f^2$ are large enough to permit the passage of screws $h$ and $i$ without contact therewith, so that plates $d$ and $f$ are perfectly insulated from the other metallic parts, except at $f'$ and $d'$. The screw $h$ is provided with a shoulder to permit the switch to be brought into contact with the upwardly-turned lug or edge $f'$ of strip $f$, the corresponding corners of strips $g$ and $b$ being clipped to accommodate the lug $f'$. The apertures $a'$ of plate $a$ are tapped for the reception of screws $h$ and $i$. It will be understood that the exposed ends of insulated conductors are inserted between plates $a$ and $c$ and $d$ and $e$, and through these conductors electrical connection is had between the handpiece and the regulator. The aperture $x$ in plates $e$, $f$, and $g$ are sufficiently large to avoid contact with the pin or projection $d'$. Thus it will be seen that we have a double circuit-closing key from $a\ i\ b\ d'$ to $d$, constituting controller H, and from $a\ i\ b\ h\ f'$ to $f$, constituting controller J, combined with a clamp for attaching it to a handpiece. The clamp comprises the base-plate $a$, having corresponding slots or ways $a'$, and depending jaw $a^2$, provided with an opening $a^3$. Coöperating with member $a$ there is a second clamp member consisting of plates $a^4$ $a^5$, bent at right angles to each other and the latter plate provided with a threaded bar or rod $a^6$, which is arranged for reception in the opening $a^3$, the part $a^5$ being received in the slots or ways $a'$. It will thus be seen that by using a turn-nut $a^7$ the jaws $a^2$ and $a^4$ can be readily adjusted toward and away from each other.

A in Fig. 1 indicates a box which in practical operation will contain the regulator and accessories. B indicates any suitable surgico-dental electric motor, supported by brackets $B^2$. C indicates the usual flexible shafting carrying at its outer end the usual handpiece D, to which our improved handpiece attachment G is detachably received by means hereinbefore described.

The method of connecting the machine up will now be described, reference being had to diagram of circuits, Fig. 8. The small circles $a^\times$, $b^\times$, $c^\times$, $d^\times$, $e^\times$, $f^\times$, $g^\times$, and $h^\times$ represent binding-posts on the most convenient place of any box which may be used to contain the regulator. All below this line of circles belongs to the regulator proper and that above represents the connections of the regulator with the handpiece attachment H and J, the motor-armature $A^2$, the source of power plus and minus, and the motor-field $F^2$ and the resistance W. Resistance W is made high, so that this current-flow is very slight, and the purpose of it is to keep the field charged after the main path through it is broken in order that the motor may temporarily be connected into a generator by short-circuiting its armature after its current is shut off. By converting the motor into a generator whatever momentum its armature may have acquired by running is overcome by the load thrown upon it,

and consequently the moter is stopped instantly. The manner of short-circuiting the armature $A^2$ will appear later.

We will suppose the appliance all connected up and key H of the handpiece attachment closed and key J open. The current starting from positive (+) enters the binding-post $b^\times$ and divides, one part returning to negative (−) via resistance W and field $F^2$, the other re-dividing at $i^\times$. Leaving one branch at $i^\times$, to be considered later, we follow the other along conductor 79, through a suitable resistance 80, through conductor 83 and 84 to 46, thence to 47, then by conductors 85 and 86 to magnet S′. S′ brings down the armature S, and 39 is put into contact with 78 and 40 with 77. From S′ the current continues along conductor 92 to $q$, where it divides, one part taking the path through conductor 93, a suitable resistance 94, and conductor 95 to binding-post $c^\times$, the negative. Hence it will be seen that magnet S′ is normally kept charged and armature S, therefore, normally down, so that 39 and 40 are normally in contact with 78 and 77, respectively. By looking at the diagram it will be clearly seen that closing key J simply puts a short current on magnet S′, thus depriving it of its magnetic charge and allowing conductors 39 and 40 to be brought into contact with 52 and 53, respectively. As will be shown presently, this movement of armature S determines the direction of the current's flow through armature $A^2$, and therefore determines the direction of rotation of armature $A^2$. Thus it is seen key J operates to reverse the motor. From $q$ the other branch of the current continues via conductors 81, binding-post $g$, key H, binding-post $h$, conductor 82, to magnet K′. K′ brings down armature K, thus breaking contact between 46 and 47, which forces the current through N′. Magnet N′ brings down armature N, which pushes back the horizontal wire bar 55, leaving the hooks 67, 73, and 74 free. Continuing from K′ the current returns to negative via magnet L′, conductor 86, binding-post $c^\times$. As L′ is magnetized armature L is pulled down, thus breaking contact between contact-post 48 and contact-piece 57, Fig. 6, and at the same time contact is made between 75 and 76. By reference to the diagram it will be seen that the break between 57 and 48 is simply a break in a short circuit on the motor's armature $A^2$. The movement downward of L also results in the establishment of contacts between 35 (via 75) and 76 and between 64 (via hook 67) and 34 for purposes to be explained later. Returning to $i^\times$, where the current divides after leaving binding-post $b^\times$, we follow the current by way of conductor 87 to the frame of the appliance at any convenient place—as, for instance, the screw 88. From the frame two paths are open for the current—first, through the contact-piece 78, conductor 39, along conductor 111, to binding-post $e^\times$, via armature $A^2$, to binding-post $d^\times$, through conductor 89, to conductor 40, from 40 to insulated post 77, thence through the conductor $77^\times$, to the conducting-plate 35, when it again meets the current from which it separated at the frame; second, through the posts supporting bar 23 to bar 23, thence through armature M to insulated post 49, via resistance X, to conducting-plate 35, where it joins the first branch. It will be noticed here that between the frame and the conducting-plate 35 the current divides between the motor-armature $A^2$ and the resistance X. From conducting-plate 35 the current continues via contact 75 to 76 and thence by conductor 91 to binding-post $a^\times$, thence through the motor-field $F^2$ to negative. We will now suppose key H opened. Armature K returns to its normal position and 46 contacts with 47, thus putting a short circuit on magnet N′. Armature L remains down, although L′ has lost its charge by reason of the hook 67. The magnet N′ being discharged, the retractile spring $n$ returns armature N upward, which moves forward the wire bar 55, thus disengaging the hook 67 from plate 34. It will be noticed, however, that magnet N′ is short-circuited. By this arrangement the magnet's own inductive discharge is made to circulate through its own coils, and as a result the magnet holds its magnetic strength for a short time after being cut out from the main current. Consequently armature N is held down a short time after key H is opened, and this means that the hook 67 continues to hold down the armature L for an interval after key H is opened. If key H is left open a sufficient length of time, magnet N′ loses its magnetic strength, armature N releases the hook 67, and everything is restored to its normal condition; but let us suppose key H to be again closed before N′ discharges or, in other words, while hook 67 still holds down armature L. Magnet K′ will be charged, armature K will break connection between 46 and 47, which removes the short circuit from magnet N′, magnet N′ will be recharged and will continue to hold back the rectangular wire bar 55 so as to give 64, 65, and 66 free play. Furthermore, by an arrangement of circuits between magnet-coils L′, M′, P′, and R′, which will be described presently, L′ is cut out of the circuit and M′ is switched in in its place. Consequently upon opening key H and closing it again quickly magnet M′ will receive a charge and armature M will be pulled downward, thus breaking the contact at 49. The circuits will all remain as before, except the division of the current in shunt with the armature $A^2$ will go by way of insulated post 50 and resistances Y and X instead of by way of post 49 and resistance X alone. The effect of this will be to increase the strength of current in the armature $A^2$, and hence increase the speed of the motor. Armature M will of course be caught and held by the hook 73. Upon again opening and closing key H quickly armature P will be brought down and held in a manner like

that of armature M and contact at insulated post 50 will be broken, thus forcing the armature's (A′) shunt through resistance Z, as well as Y and X, by way of armature $A^2$ and insulated post 51. Cutting in Z again increases the motor's speed. Upon again opening and closing key H the contact at 51 will be broken as those at 50 and 49 were, and the current will have only the one path between the frame and the conducting-plate 35—namely, that through the motor-armature $A^2$—and the effect of this will be to send the entire strength of the current through the armature and field of the motor in series, thus giving the motor its maximum speed and power. We have here shown the regulator capable of giving the motor four speeds; but it is obvious that the number of speeds can be made anything desirable. Four is a convenient number and we have used it as a matter of convenience. We have previously shown how the downward movement of armature L breaks contact between contact-plate 57 and post 48. Naturally the upward movement of L restores this connection. It will be seen by the drawings that the making of this contact simply puts a short circuit on the motor-armature $A^2$. Suppose key H to be closed and the motor running. Armature L is down. The position of the armatures K, M, N, P, R, and S is immaterial. L being down, contact between insulated post 48 and plate 57 is broken, while that between plate 35 and insulated post 76 is made. It will be remembered that contact between 35 and 76 gives the motor its current principally, field $F^2$ partially, and armature $A^2$ entirely, $F^2$ having a separate circuit in series with the resistance W. Now suppose key H opened. Armature L returns to its raised position. Contact between 35 and 76 is broken, thus cutting off the current from the armature entirely. The field $F^2$ is still charged through resistance W. Contact is made at the same time between insulated post 48 and plate 57, which contact short-circuits the armature $A^2$, and the motor is temporarily converted into a generator, thus throwing a load upon the armature A, which at once exhausts the armature's momentum and brings it to an instant stop.

We will now explain how magnets L′, M′, and P′ are in turn cut out and M′ switched in place of L′, P′ in place of M′, and R′ in place of P′ by successive openings and closings of key H. We have already shown how the first closing of key H brings down armature L, and it will be remembered that L becomes hooked down by the hook 67 on the end of the L-shaped piece 64. Looking at Fig. 9, we will examine these magnet-circuits. The insulated conductors 41 and 42, connecting the insulated plates 36, 34, and 38, and the L-shaped springs 64, 65, and 66, as well as the block of insulating material 54, with its contact-points 68, 69, and 70, will be readily recognized, as it will be remembered that contacts between 34 and 67, 36 and 73, and 38 and 74 are normally open and that those between 64 and 68, and 65 and 69, and 66 and 70 are normally closed. When key H is closed, armature L is brought down and the contact between 34 and 67 is made. Now if key H be opened magnet L′ loses its charge and the contact between 64 and 68 is broken, but armature L is still held by the hook 67 on the end of 64. Now if H be closed again before magnet N′ has time to discharge and release L from its hook a second electrical impulse will be sent through K′ and M′ (L being cut out by the break between 64 and 68) via 34 67 64 96 97 65 69. This current results in pulling down armature M where it is engaged by the hook 73. If key H be again opened and closed, the contact between 65 and 69 is broken, so that when H is again closed quickly (before N′ discharges) the current is forced through magnet P′ and in a like manner the next and all subsequent quick makes and breaks at key H sends or send the current through magnet R′. If at any step the key H is left open long enough for magnet N′ to discharge, armature N will fly up, carrying forward the wire-bar 55, and by so doing release any or all of the armatures in the series from their hooks and put the machine back at the starting place. As the downward movement of the armatures L, M, P, and R cuts in more and more resistance of the series X Y Z (which series is in parallel with the motor-armature $A^2$) the speed of the motor is advanced step by step, and as this movement of armatures L, M, P, and R is accomplished by closing, opening, and closing again, &c., according to the speed desired, the key H of the handpiece attachment it follows that the appliance described furnishes a means for starting, stopping, and regulating the speed of an electric motor by means of a key; and as key J furnishes means for reversing the direction of the current's flow through the motor-armature, and hence reversing the motor, the regulator in combination with a double circuit-closing key is seen to start, stop, regulate the speed of and reverse an electric motor.

It will be obvious to those skilled in the art to which the invention appertains that modifications may be made in detail without departing from the spirit and scope of the same. Hence we do not limit ourselves to the precise construction and arrangement of parts hereinabove described, and illustrated in the accompanying drawing; but,

Having described the nature and objects of the invention, what we claim as new, and desire to secure by Letters Patent, is—

1. The combination of an electric motor, a handpiece, a main-circuit closer a resistance-controller in the main circuit, a variable resistance, and an attachment to the handpiece for operating the controller and main-circuit closer, substantially as described.

2. The combination of an electric motor, a handpiece, a resistance-controller in the main

circuit, a variable resistance connected in parallel with the armature of the motor, and an attachment to the handpiece for operating the controller.

3. The combination of an electric motor, a handpiece, a main-circuit closer, a variable resistance, a resistance-controller in the main circuit, a pole-changer, and attachments to the handpiece for operating respectively the main-circuit closer and pole-changer, substantially as described.

4. The combination of an electric motor, a handpiece, a main-circuit closer, a variable resistance connected in parallel with the armature of the motor, a resistance-controller in the main circuit, and an attachment to the handpiece for operating the controller, substantially as described.

5. The combination of an electric motor, a handpiece, a main-circuit closer, a variable resistance connected in parallel with the armature of the motor, a resistance-controller in the main circuit, a pole-changer; and attachments to the handpiece for operating, respectively the main-circuit closer and pole-changer, substantially as described.

6. The combination with the electromagnets, of complemental supports having beveled edges and pins projecting therefrom, and armatures retained by said pins and arranged to rock on said supports.

7. The combination with the electromagnets, of complemental supports having beveled edges and pins projecting therefrom, and armatures arranged to rock on said supports and having notched portions, which coöperate with the pins, substantially as described.

8. The combination with the electromagnets and their circuits, of complemental supports having beveled edges and pins projecting therefrom, armatures arranged to rock on supports and having notched portions, which coöperate with the pins, and means for throwing the armatures in and out of circuit, substantially as described.

9. The combination with the circuits, a variable resistance, electromagnets, complemental supports having beveled edges and pins projecting therefrom, armatures arranged to rock on said supports and having notched portions, which coöperate with the pins, means for cutting in and out more or less of resistance, and restraining means for the armatures, substantially as described.

10. The combination with an electric motor and handpiece, of a circuit-closer, a variable resistance and means for controlling same, a pole-changer, means for short-circuiting the armature of the motor, and attachments to the handpiece for controlling said parts, substantially as described.

11. A handpiece attachment for an electric engine, comprising superimposed alternate plates of conducting and non-conducting material, a contact-pin extending upwardly therefrom, a spring member arranged for contact therewith, a switch-lever and means for moving the same into electrical contact with an intermediate conductor.

12. A handpiece attachment comprising superimposed top and bottom conducting-plates and alternately-arranged intermediate conducting and non-conducting plates, screws binding said plates together and insulated from all but the top and bottom plates, one of said intermediate conductors having a contact-pin projecting upwardly and insulated from the other plates, a spring member on said top plate movable with reference to the pin and a switch-arm on said top plate arranged to establish electrical connection with another intermediate plate.

13. A handpiece attachment comprising superimposed top and bottom conducting-plates and alternately-arranged intermediate conducting and non-conducting plates, screws binding said plates together and insulated from all but the top and bottom plates, one of said intermediate conductors having a contact-pin projecting upwardly and insulated from the other plates, a spring member on said top plate movable with reference to the pin, a switch-arm on said top plate arranged to establish electrical connection with another intermediate plate, and a clamp arranged to secure said attachment to the handpiece.

In testimony whereof we affix our signatures in presence of two witnesses.

JOSEPH S. LETORD.
WILLIAM W. ALEXANDER.
HENRI LETORD.

Witnesses:
JAMES G. SMITH,
MINNIE KRETSCHMAR.