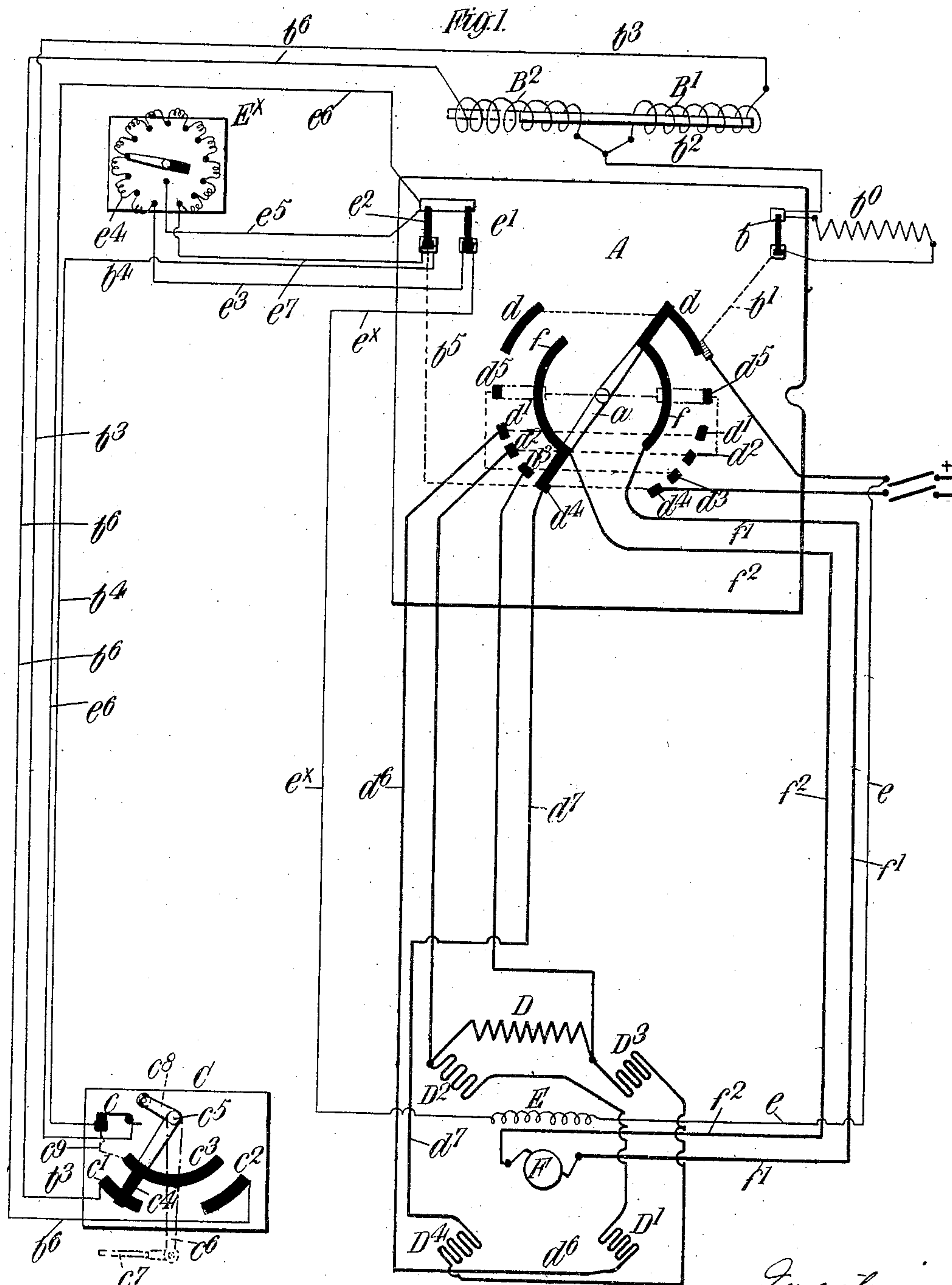


A. D. WILLIAMSON.
ELECTRICAL APPARATUS FOR WORKING PLANING MACHINES AND OTHER RECIPROCATING TOOLS.
919,411.
APPLICATION FILED DEC. 11, 1908.
Patented Apr. 27, 1909.
4 SHEETS—SHEET 1.



Witnesses:
L. B. Barlow
E. A. Van Kuren

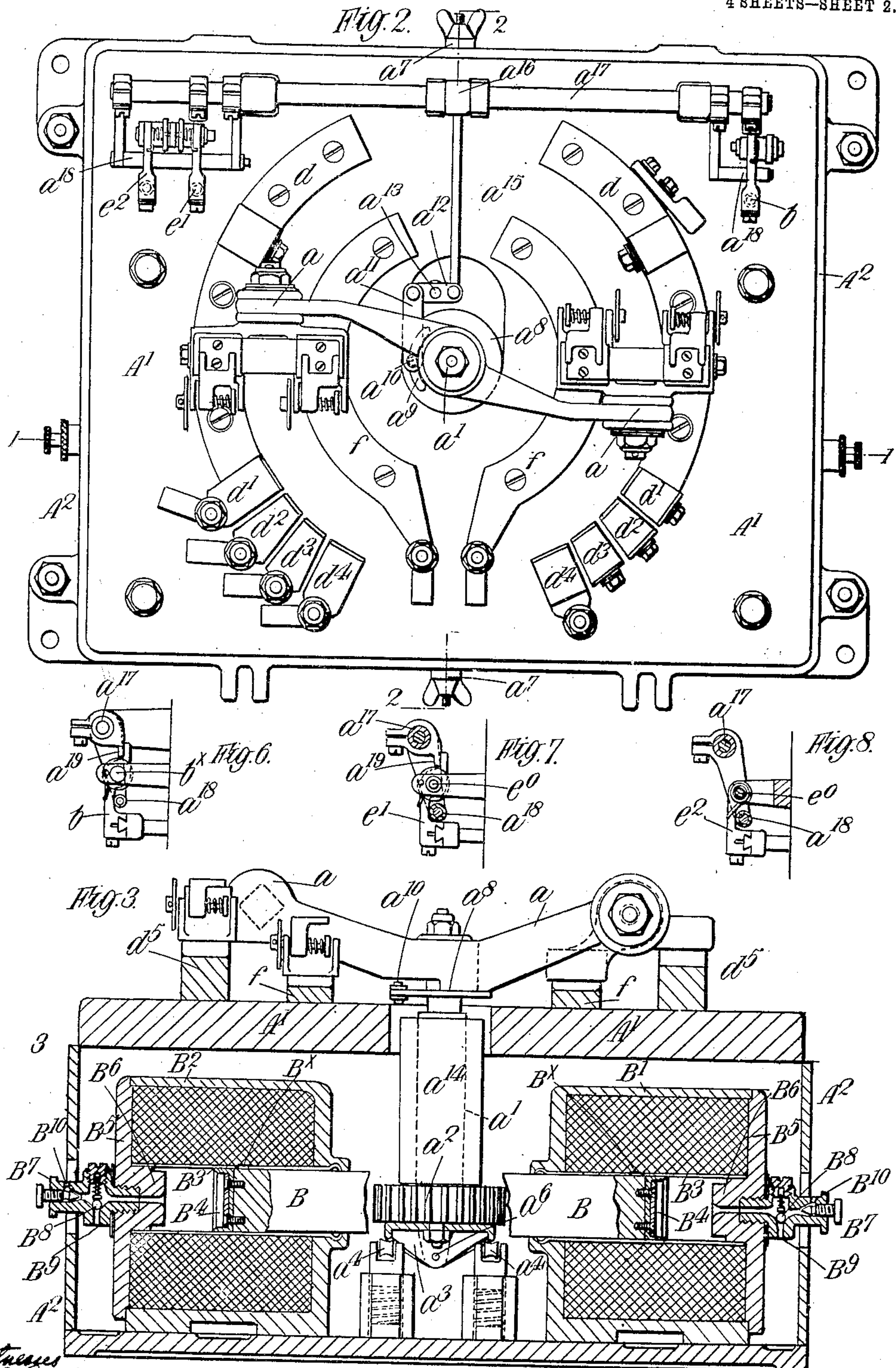
Inventor.
Alfred David Williamson
by Lewis Goldsborough
his Attorneys

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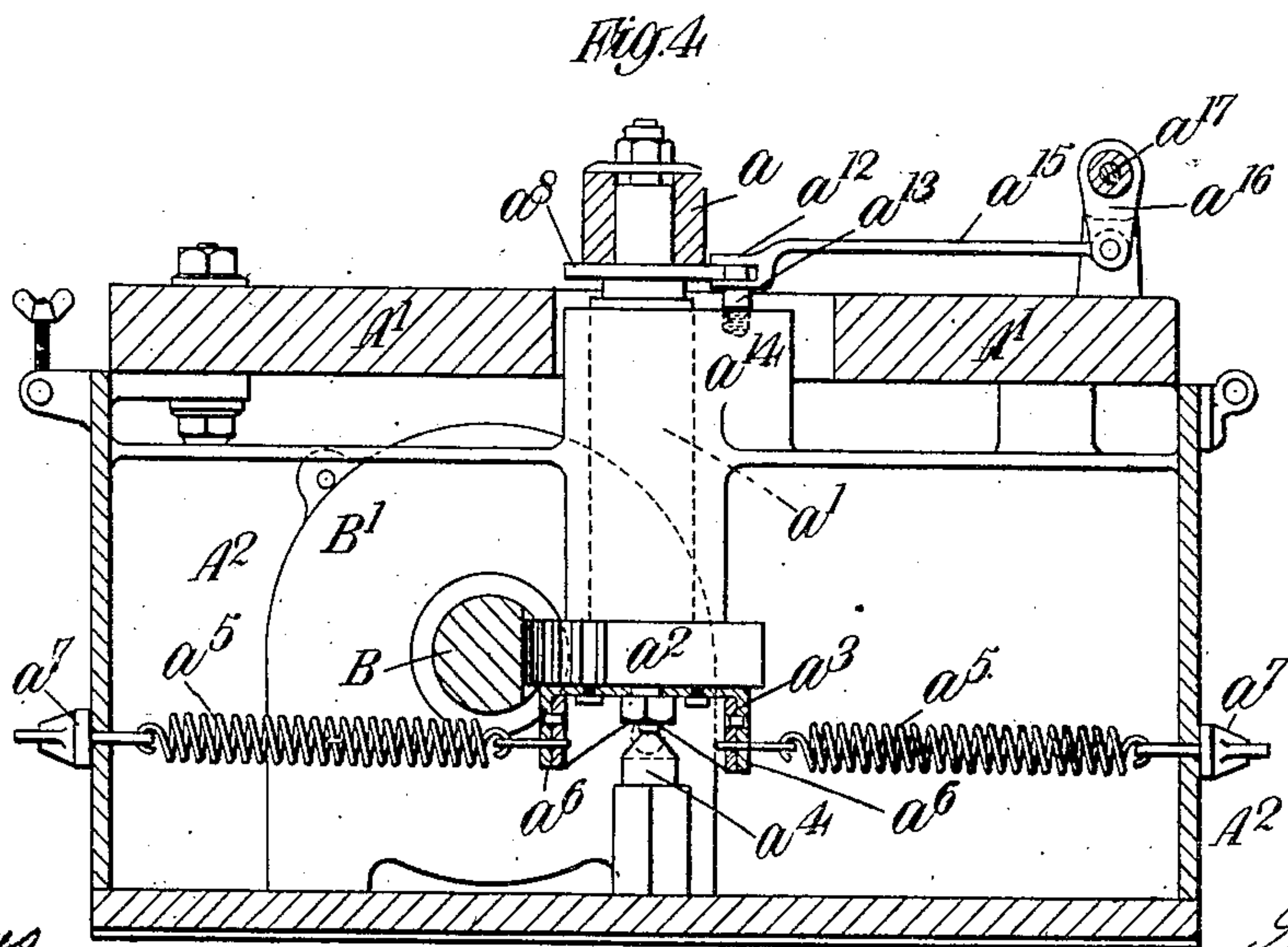
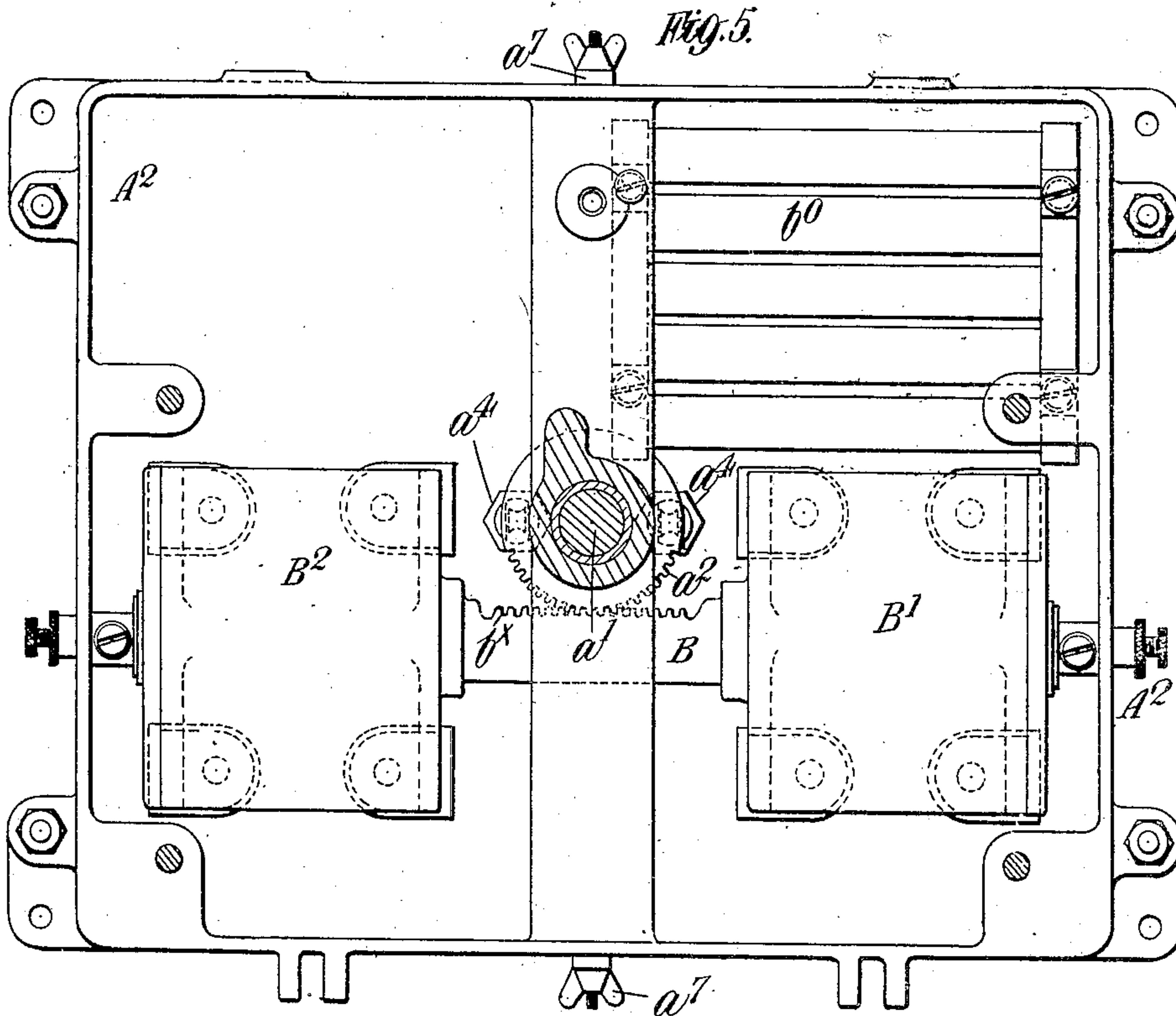
Inventor: Alfred David Williamson
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4 SHEETS—SHEET 3.



Witnesses
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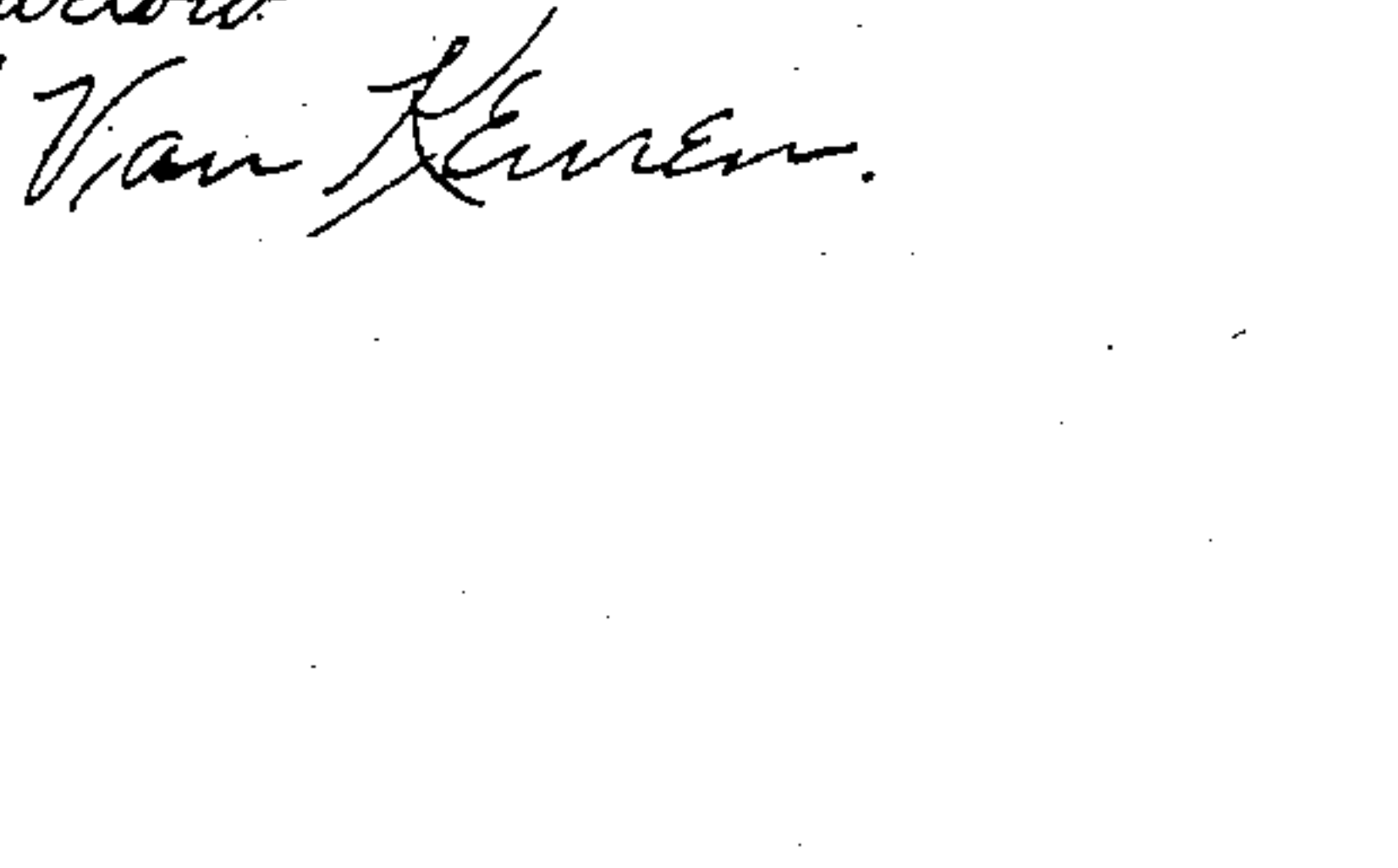
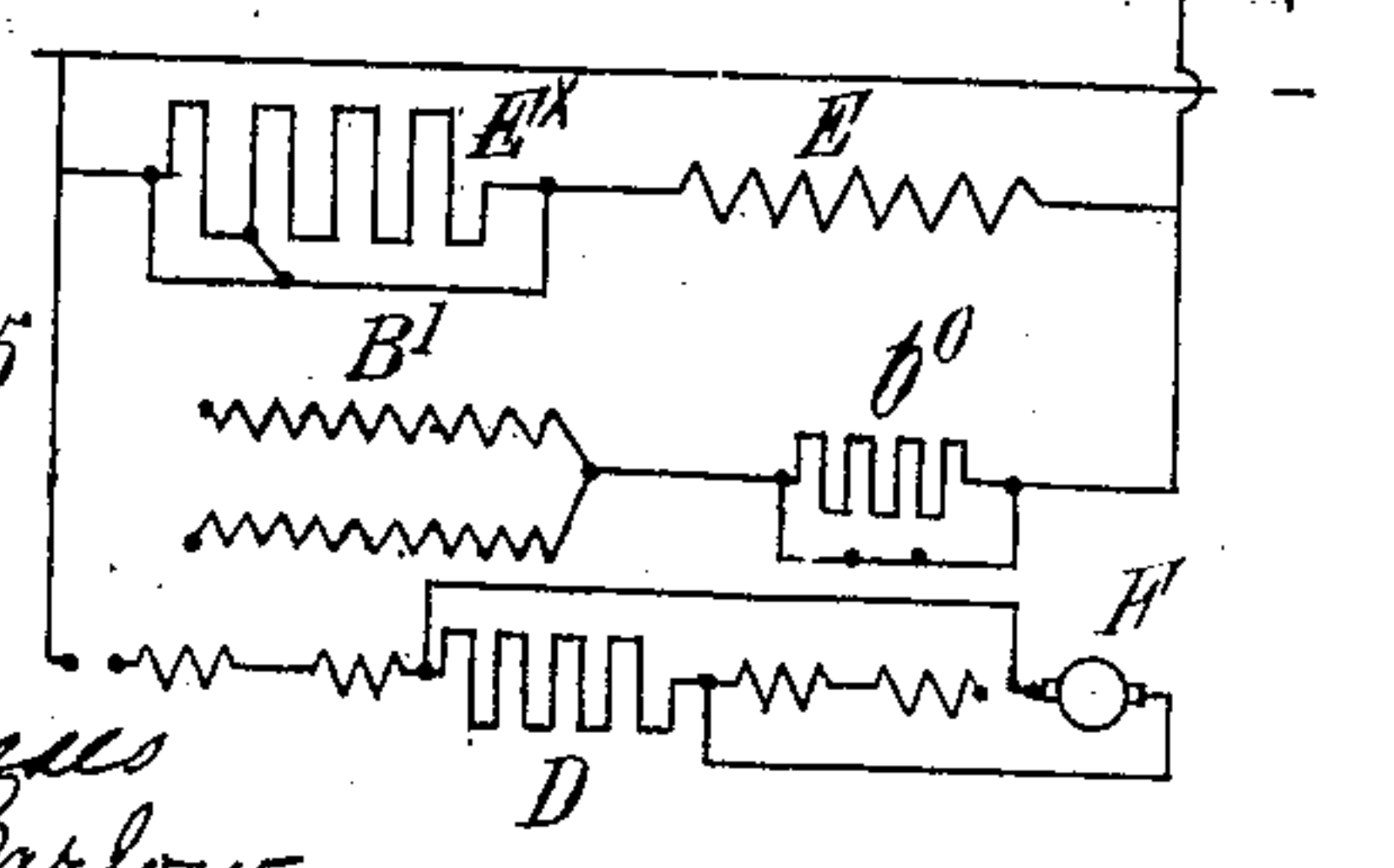
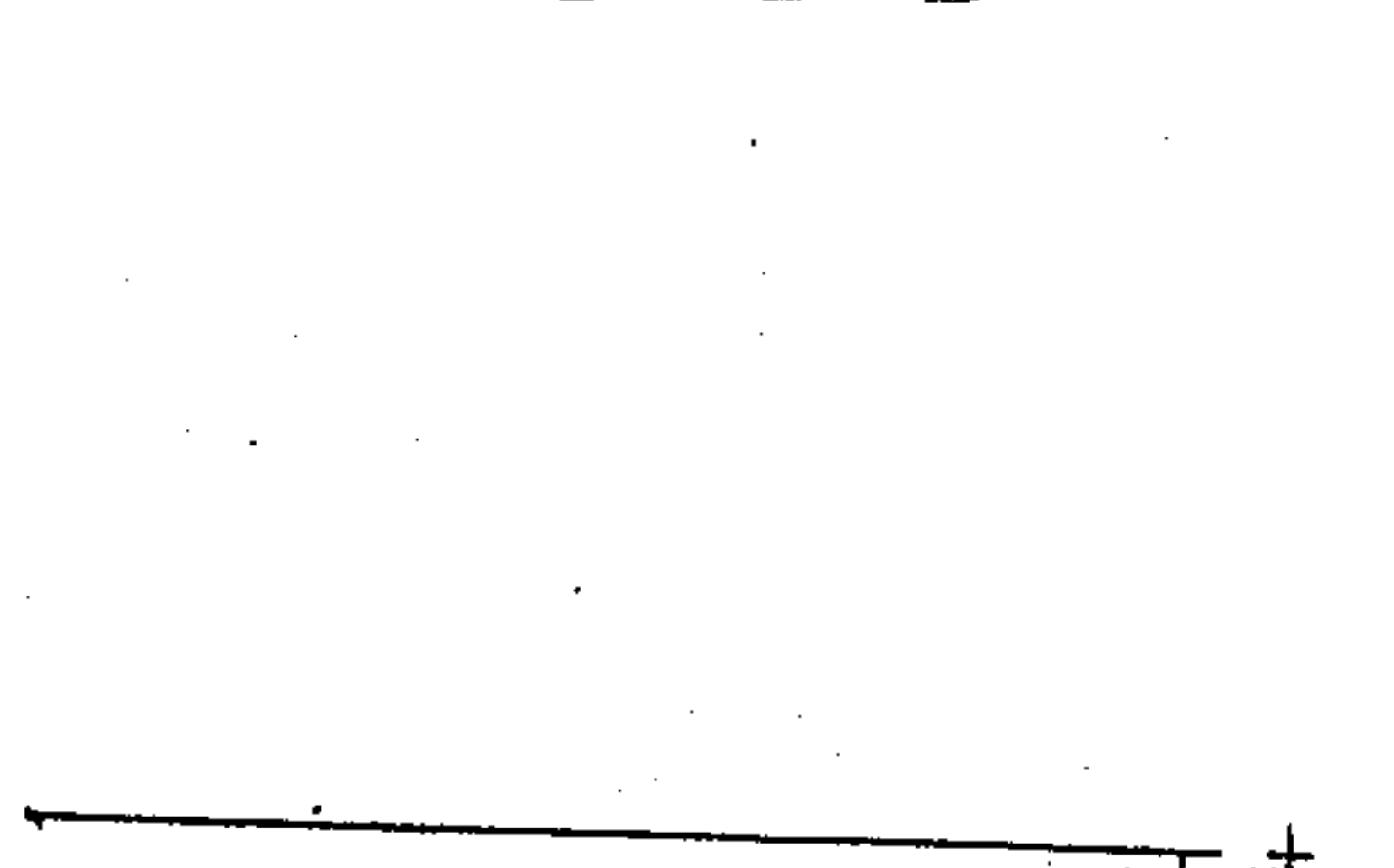
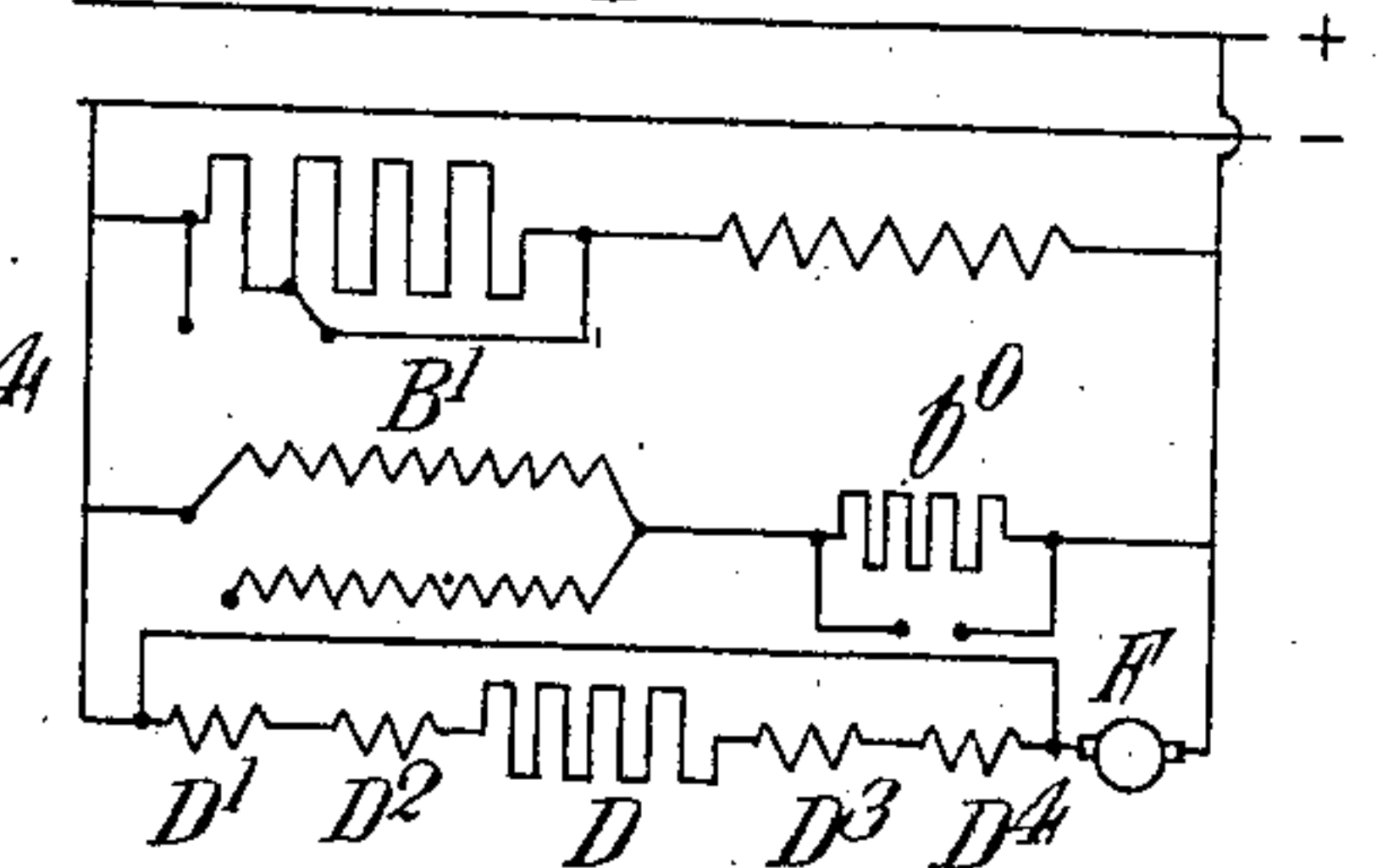
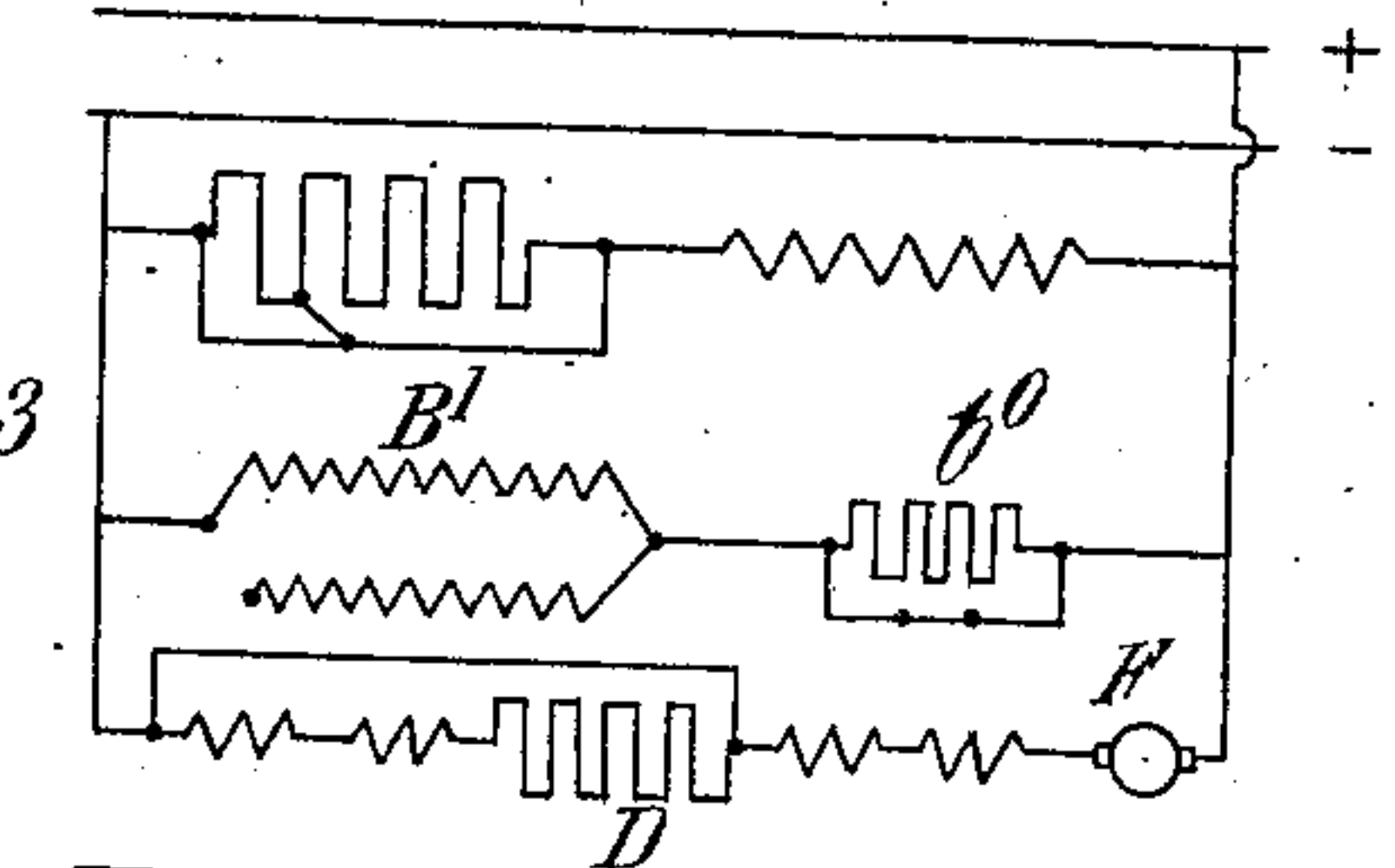
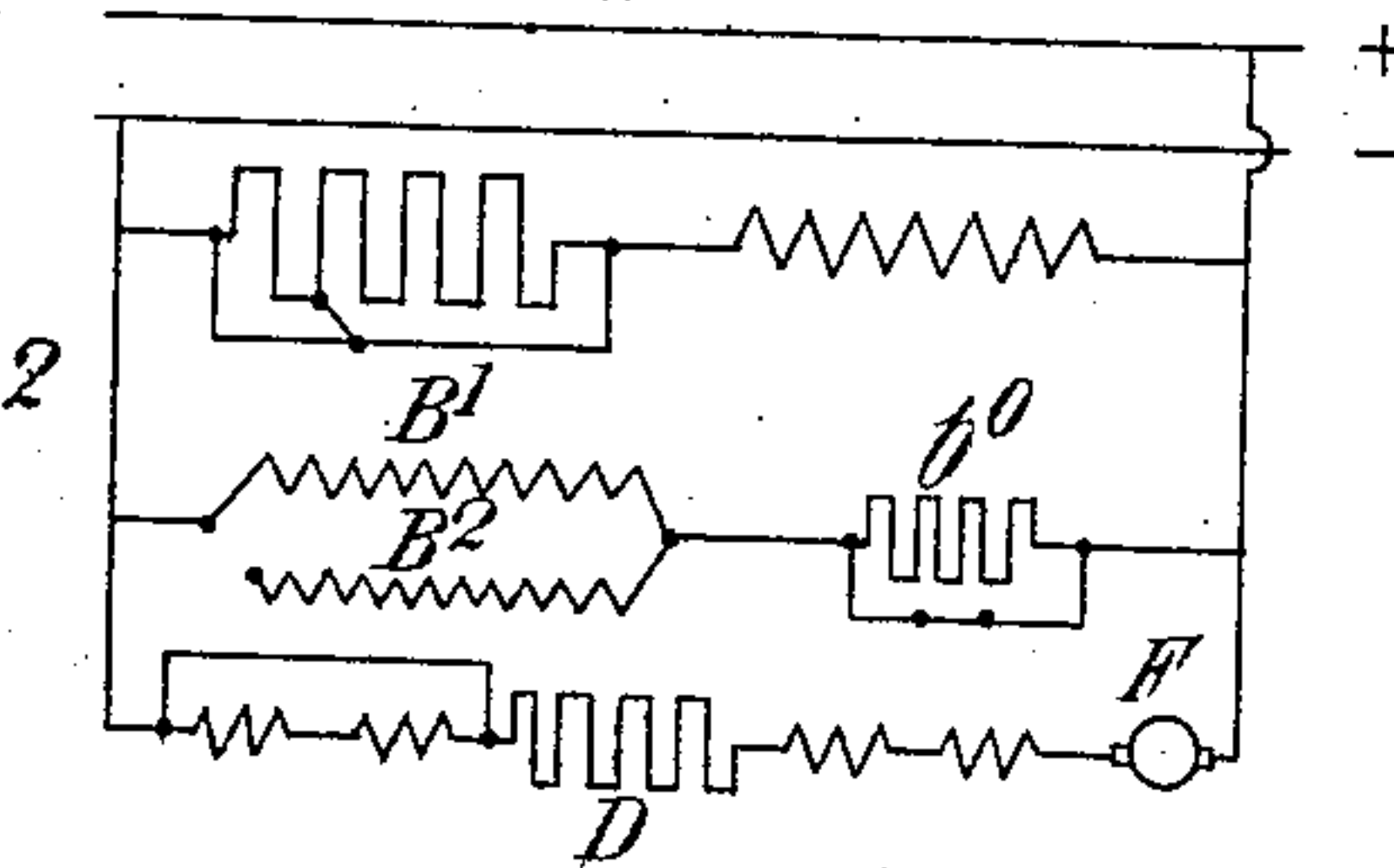
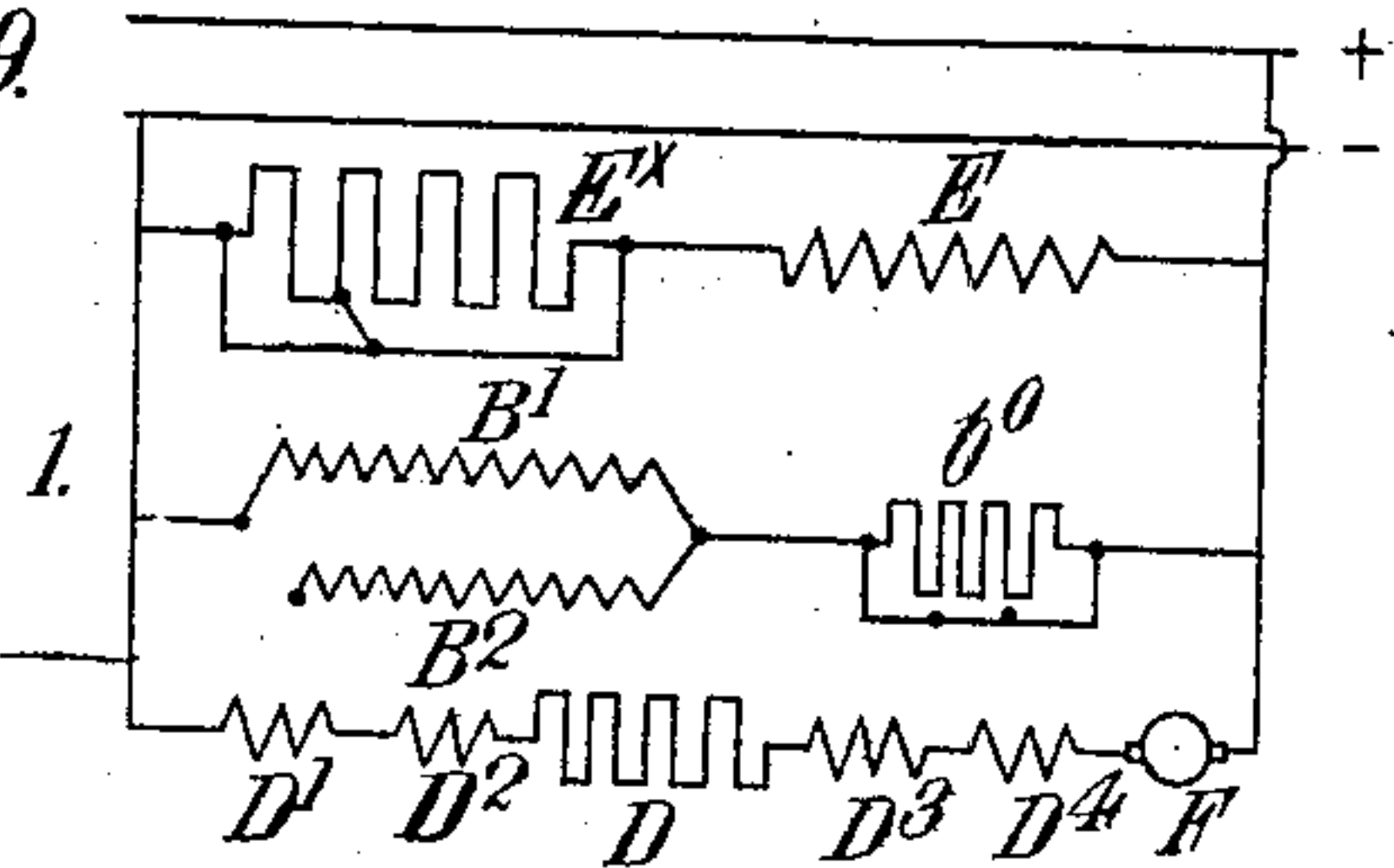
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4 SHEETS—SHEET 4.

Fig. 9.



Witnesses
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UNITED STATES PATENT OFFICE.

ALFRED DAVID WILLIAMSON, OF SHEFFIELD, ENGLAND, ASSIGNOR TO VICKERS SONS & MAXIM LIMITED, OF SHEFFIELD, ENGLAND.

ELECTRICAL APPARATUS FOR WORKING PLANING-MACHINES AND OTHER RECIPROCATING TOOLS.

No. 919,411.

Specification of Letters Patent.

Patented April 27, 1909.

Application filed December 11, 1908. Serial No. 467,005.

To all whom it may concern:

Be it known that I, ALFRED DAVID WILLIAMSON, a subject of the King of Great Britain, residing at River Don Works, Sheffield, in the county of York, England, have invented certain new and useful Improvements in Electrical Apparatus for Working Planing-Machines and other Reciprocating Tools, of which the following is a specification.

This invention relates to electrically actuated planing machines and other reciprocating tools that work with a comparatively slow cutting stroke and a quick return stroke. I have already used machines of this kind in which the electrical apparatus comprised a reversible variable speed electric motor controlled by a reversing switch and a starting switch which were mechanically operated from the reciprocating member or table of the planing machine and controlled circuits by which the motor was successively worked at a suitable slow speed for effecting the cutting stroke of the machine, was retarded and reversed at the end of such stroke, was restarted and worked at a quick speed for effecting the return stroke of the machine, was retarded and again reversed at the end of such stroke and restarted at the slow speed to effect another cutting stroke and so on, the reversal and restarting of the motor being always made in a strong magnetic field and the various operations taking place automatically in proper sequence so long as the machine continued at work.

According to my present invention I still employ a reversible variable speed electric motor which performs the various functions mentioned above, but instead of using switches operated by mechanical means from the reciprocating table of the planing machine I employ a combined reversing and starting switch which is controlled electrically by means of two solenoids which are alternately energized by current passing in circuits controlled by a master switch that receives its movement from the reciprocating table of the planing machine. The said combined reversing and starting switch has an oscillatory contact arm which under the influence of spring pressure or equivalent means tends to assume an intermediate position for short circuiting the armature through the starting resistance and which under the

influence of the solenoids moves from its intermediate position in alternately opposite directions for controlling the series field windings and the direction of current in the armature. The oscillatory contact arm on the completion of its movement from the intermediate position in either direction also operates suitable mechanism for inserting a speed regulating resistance in the shunt field winding during the quick return stroke and for removing said resistance or the main part of it during the cutting stroke.

I will describe my invention more fully with reference to the accompanying drawings, in which:—

Figure 1 is a diagrammatic view showing the various circuits and connections of the electrical apparatus. Figs. 2 to 8 illustrate in detail the construction of the combined starting and reversing switch; Fig. 2 being a plan; Fig. 3 a horizontal section on the line 1, 1; Fig. 4 a vertical section on the line 2, 2; Fig. 5 a horizontal section on the line 3, 3 of Fig. 3; and Figs. 6, 7 and 8 detail views of certain hammer switches herein-after referred to. Fig. 9 is a diagram illustrating the condition of the circuits at the various steps in the operation of the apparatus.

Referring first more particularly to Fig. 1; A is the combined starting and reversing switch. B¹ B² are the solenoids controlling said switch. C is the master switch controlling the solenoid circuits. D¹ D² D³ D⁴ are the series field windings of the motor and D is the starting resistance. E is the shunt field winding, and F is the armature. E^x is the speed regulating resistance which is adapted to be set into the desired position for introducing more or less resistance in the shunt winding E of the motor according to the speed at which the cutting stroke of the machine is to be effected. The said combined starting and reversing switch comprises the oscillatory contact arm *a* and two concentric series of fixed contacts symmetrically arranged on either side of a vertical line, the starting contacts on the left coming into action when the planing machine is working in one direction and those on the right coming into operation when the planing machine is working in the other direction. The inner series of contacts consist of two segmental pieces *f* connected with the motor

armature F. The outer series consist of various segmental pieces of which those marked $d^1 d^2 d^3 d^4$ are connected with the series field windings, the contact pieces d^4 being also connected with the negative main (-); the contact pieces d are connected with the positive main (+) and those marked d^5 are connected with the starting resistance D through the contacts $d^2 d^3$.

10 The solenoids $B^1 B^2$ have the contiguous ends of their windings connected with a hammer switch b , the fixed contact of which is connected with the fixed contacts d of the combined starting and reversing switch A; 15 this hammer switch b is actuated mechanically by the combined starting and reversing switch and controls a resistance b^0 forming part of the solenoid circuits. The outer ends of the solenoid windings are respectively connected with the fixed segmental contacts $c^1 c^2$ of the master switch C. This master switch 20 also has another fixed segmental contact c^3 which is connected with the fixed contact of a mechanically actuated hammer switch c . 25 This master switch has a switch arm c^4 which is mounted on an axle c^5 that carries another arm c^6 . This latter arm is coupled to a sliding block on the planing machine by a rod c^7 and as this sliding block is moved to 30 and fro by the action of tappets on the reciprocating table of the planing machine as is well understood, the said arm c^6 (together with the switch arm c^4) is caused to oscillate about the axis of the axle c^5 . A 35 short arm c^8 is also provided on the axle c^5 for lifting the hammer switch c when the switch arm c^4 moves toward the right, the said hammer switch closing again under the influence of a spring when the said switch 40 arm moves toward the left. The core of the solenoids $B^1 B^2$ is connected mechanically with the contact arm a of the combined starting and reversing switch, so that when one of the solenoids is energized the said 45 core moves the contact arm a in one direction away from its intermediate position in which it lies on a horizontal line joining the two fixed contacts d^5, d^5 , and when the other solenoid is energized the core moves the said 50 contact arm in the opposite direction from its intermediate position. The said contact arm returns promptly to its intermediate position under the influence of springs when the solenoids are not energized. The move- 55 ment of the said contact arm when under the influence of either of the solenoids, is retarded by a dash pot device which however does not interfere with the prompt return of the contact arm to the intermediate 60 position when the solenoids are not energized.

$e^1 e^2$ are other hammer switches which are also actuated mechanically by the combined starting and reversing switch and control 65 the speed regulating resistances E^x that are

inserted at the proper times in the shunt winding E of the motor. These hammer switches $e^1 e^2$ and the other hammer switch b are all opened at the completion of the movement of the contact arm a in one direction 70 (corresponding with the quick return stroke of the reciprocating table of the planing machine), but only the hammer switches e^1 and b are opened at the completion of the movement of the contact arm a in the opposite di- 75 rection, (corresponding with the slow cutting stroke of the reciprocating table) as will be hereinafter more fully explained.

When the contact arm a is in its intermediate position which it assumes when the circuit through the solenoids is broken by the master switch C, the armature is short-circuited through the starting resistance D, the shunt field winding E is fully excited, the hammer switches $e^1 e^2$ are closed, and the series field windings $D^1 D^2 D^3 D^4$ are cut out of 80 circuit. 85

When the master switch C is actuated by the quick return movement of the reciprocating table of the planing machine, and 90 moved toward the left into the position shown in Fig. 1, its switch arm c^4 connects the fixed contacts $c^1 c^3$ and thus permits current to pass from the positive main through the wire b^1 to the hammer switch b (which at this time 95 is closed) and thence, through the wire b^2 , to the winding of the solenoid B^1 , whence the current passes, by the wire b^3 , to the contact c^1 and through the switch arm c^4 to the contact c^3 ; from this contact the current passes 100 through the short wire c^9 to the fixed contact of the hammer switch c , thence, by the wire b^4 , to the fixed contact of the hammer switch e^2 and thence, through the wire b^5 , to the negative main. The solenoid B^1 being 105 thus energized causes the contact arm a to commence moving away from its intermediate position and to act upon the four left-hand contacts $d^1 d^2 d^3 d^4$ in succession. On 110 reaching the first of these contacts viz: d^1 , the circuits and connections are as shown in Diagram 1 of Fig. 9; that is to say current passes from the positive main through the right hand contacts d, f , the wire f^1 , the armature F, the wire f^2 , the left hand con- 115 tacts $f d^1$, the wire d^6 , the series field windings $D^1 D^2$, the starting resistance D, the series field windings $D^3 D^4$, the wire d^7 , the left hand contact d^4 and thence to the negative main. At this time current from the posi- 120 tive main also passes from the wire e through the shunt field winding E, the wire e^x and the hammer switches $e^1 e^2$ (which are closed) to the wire b^5 and thence to the negative main. The shunt field winding is thus at 125 this time fully excited, no resistance being inserted in its circuit. The said switch arm a in continuing its movement moves slowly over the next three left hand contacts $d^2 d^3 d^4$ and by so doing cuts out from the armature 130

circuit, first the two series field coils D^1 D^2 (see Diagram 2 of Fig. 9), then the starting resistance D (see Diagram 3 of Fig. 9) and finally the remaining two series field coils D^3 D^4 (see Diagram 4 of Fig. 9). The switch arm a then occupies the position in which it is shown in Fig. 1 in which the armature is connected directly across the mains and the machine performs the slow cutting stroke. As the said switch arm a reaches this position it causes the two hammer switches b and e^1 to open. The effect of opening the switch b is to insert the resistance b^0 in the winding of the solenoid B^1 , so as to reduce the heating effect of the current after the said solenoid has performed the work of moving the said switch arm. The opening of the switch e^1 has the effect of inserting in the shunt field circuit E the proper amount of initial resistance to which the speed regulator E^x has been previously set for obtaining the required degree of speed for the slow cutting stroke of the machine depending upon the nature of the work under treatment. When this switch e^1 is thus opened, the current passes from the positive main through the wire e , the shunt winding E and the wire e^x , to the fixed contact of the said switch e^1 , thence through the wire e^2 , the small amount of resistance e^4 , the wire e^5 , the hammer switch e^2 (which is closed), the wire b^5 and thence to the negative main.

The contact arm a remains in this position (Fig. 1) until the cutting stroke is nearing completion, when the tappet mechanism on the reciprocating table of the planing machine moves the arm c^4 of the master switch C toward the right. As the said arm c^4 in performing this movement reaches a neutral position between the two contacts c^1 c^2 in which these contacts are broken, the circuit through the winding of the solenoid B^1 is also broken. The said contact arm a being therefore no longer held by the influence of the solenoid in the position in which it is shown in Fig. 1, promptly returns under the influence of its springs or equivalent means to the intermediate position in which it joins the contacts f and d^5 , thus short-circuiting the armature F through the resistance D and stopping its rotation by the braking effect of the strong magnetic field. As the said contact arm a resumes this intermediate position, it also permits the hammer switches b and e^1 to close again, thus cutting out the resistance b^0 from the solenoid circuit and the speed regulating resistance e^4 from the shunt field circuit and obtaining the maximum strength of magnetic field for stopping the rotation of the armature as aforesaid, prior to the reversal of its direction of rotation (see Diagram 5 of Fig. 9). The said arm c^4 of the master switch in continuing its aforesaid movement to the right reaches a position in which the contacts c^2 c^3 are joined, where-

upon the current passes from the positive main through the wire b^1 , the hammer switch b (which is closed) and the wire b^2 , thence through the winding of the left hand solenoid B^2 , the wire b^0 , the contacts c^2 c^3 , the short wire c^9 , the fixed contact of the hammer switch c (which has been previously opened by the short arm c^8 of the arm c^4 acting on the tail thereof), the wire b^4 , the fixed contact of the hammer switch e^2 , and the wire b^5 back to the negative main. The contact arm a then moves under the influence of the left hand solenoid B^2 in the opposite direction to that aforesaid and travels slowly over the two left hand contacts f and d and the four right hand contacts d^1 d^2 d^3 d^4 . The current through the armature circuit is thus reversed, passing from the positive main to the left hand contacts d , f , then through the wire f^2 , the wire f^1 , the right hand contact f and to the contacts d^1 d^2 d^3 and d^4 in succession, and back to the negative main, thus cutting out the series field coils and the starting resistance as before (see Diagrams 6, 7 and 8 of Fig. 9). As the said contact arm a completes this movement it opens the three hammer switches b , e^1 and e^2 . The opening of the hammer switch b causes the resistance b^0 to be inserted in the winding of the solenoid B^2 as in the case when the right hand solenoid was energized. The opening of the two hammer switches e^1 e^2 has the effect of causing the current in the shunt field circuit to pass from the positive main through the wire e , the shunt winding E , the wire e^x , the fixed contact of the hammer switch e^1 , the wire e^3 , the whole of the speed regulating resistances of the speed regulator E^x , thence through the wire e^7 , the fixed contact of the hammer switch e^2 , and the wire b^5 back to the negative main. The whole of the resistance being thus inserted in the shunt circuit of the motor, it runs at its maximum speed for the quick return stroke of the machine (see Diagram 9 of Fig. 9). The said contact arm a remains in the aforesaid position until the reciprocating table of the planing machine approaches the completion of its quick return stroke, whereupon the arm c^4 of the master switch C is moved toward the left by the tappet mechanism and in so moving first permits the hammer switch c to close, then breaks the contacts c^2 c^3 and the circuit through the left hand solenoid B^2 and closes the contacts c^1 c^3 for recommencing a fresh cycle of operations. The effect of closing the hammer switch c is to cut out the bulk of the speed regulating resistance from the shunt field circuit, by reason of the current being then able to pass from the wire e^x of the shunt field circuit through the fixed contact of the hammer switch e^1 , the wire e^3 , the small portion e^4 of the speed regulating resistance E^x , the wire e^5 , the wire e^6 , the closed hammer switch c , the wire b^4 , the fixed con-

tact of the hammer switch e^2 to the wire b^5 and thus to the negative main. This operation takes place a fraction of time in advance of the return movement of the contact arm a , and occurs when the arm c^4 of the master switch leaves the contact c^2 and breaks the circuit through the solenoid B^2 , and therefore just before the hammer switches b , e^1 , e^2 close again under the action of the said contact arm a . An earlier strengthening of the shunt field of the motor is thus obtained and consequently a more ready reversal of the motor, than would otherwise be the case (see Diagram 10 of Fig. 9). As the said contact arm a thus returns to its intermediate position joining the contacts f and d^5 , and permits the hammer switches b , e^1 and e^2 to again close, the circuit through the armature F is short-circuited through the resistance D as before and the armature comes to rest in a strong magnetic field preparatory to being reversed, whereupon the said contact arm a moves in the opposite direction to cause a fresh cutting stroke of the machine (see Diagram 11 of Fig. 9).

I will now describe the constructional form of the combined starting and reversing switch shown by Figs. 2 to 8. It comprises a spindle a^1 upon the outer end of which is mounted the contact arm a . This arm carries at its extremities holders for the carbon contacts which bear upon the aforesaid two series of stationary contacts that are fixed to the plate A^1 of slate or other insulating material. This plate A^1 is situated above a box or casing A^2 within which are arranged the two solenoids B^1 , B^2 and the resistance b^0 (Fig. 5). The inner end of the said spindle a^1 carries a toothed wheel or segment a^2 which gears with rack teeth b^x formed on the middle part of the solenoid core B . To the lower side of the said toothed segment a^2 , is attached a cam plate a^3 which is in the form of a flanged ring having in its flanged portion two inclined or inverted V-shaped recesses against the walls of which bear a pair of spring rollers a^4 , a^4 , whose function is to cause the said spindle a^1 and its contact arm a to always assume the proper intermediate position hereinbefore stated, when the solenoids are inactive and the said spindle is being returned by the springs a^5 , a^5 (Fig. 4). These springs are connected at their inner ends to the opposite sides of the said cam plate at a^6 , a^6 and at their outer ends are connected to the box or casing A^2 by means of adjustable eyes a^7 , a^7 . The aforesaid solenoids B^1 , B^2 have tubular barrels B^3 (Fig. 3) fitted therein and the ends of the core B are furnished with cup leathers B^4 that work in said barrels like pump pistons. The end covers B^5 of the solenoids have inwardly projecting bosses B^6 that fit into the outer ends of the said barrels B^3 . These bosses are perforated and have screw-threaded cavities to receive air

valves B^7 adapted to admit air to the interior of the barrels B^3 more freely than it can escape, thus constituting the dash pot device for causing the solenoid core B to move slowly while the contact arm a is moving to one or other side of its intermediate position and to move quickly when returning to that position under the action of the springs a^5 . In the intermediate position of the contact arm a , the core B lies in the position shown in Fig. 3, with a space at each of its ends. On the said core moving say to the right under the influence of the solenoid B^1 , the said core sucks in air through the left hand valve by the lifting of the ball B^8 and the consequent opening of the passage B^9 , but as the ball B^8 of the right hand valve remains closed during this movement the air at the right hand end of the core B can only pass slowly through the right hand valve by way of the contracted passage B^{10} . When the action of the solenoid B^1 ceases, the springs a^5 quickly return the core to its original position by reason of the fact that the air in front of the left hand end of the core can freely pass out by the hole B^x and that air can at the same time enter freely in front of the right hand end of the core, through the lifting of the ball B^8 of the right hand valve. If the core be moved toward the left by the influence of the solenoid B^2 , the ball B^8 of the left hand valve remains closed so that the air has to be forced slowly through the contracted passage B^{10} of this valve, while air is able to enter freely through the right hand valve by lifting the ball B^8 of such valve. When the solenoid B^2 becomes inactive the said core returns quickly under the action of the springs a^5 because the air in front of the right hand end of the core can freely pass out by the hole B^x and air can at the same time enter freely in front of the left hand end of the core through the lifting of the ball B^8 of the left hand valve. Near the outer end of the said spindle a^1 is fixed a disk a^8 having therein a segmental slot a^9 (Fig. 2) with which a pin a^{10} engages. This pin is carried by a link a^{11} which is hinged to one end of a lever a^{12} . This lever is mounted on a stationary pivot a^{13} carried by the socket a^{14} in which the spindle a^1 works. To the other end of the said lever a^{12} is hinged an arm a^{15} which is coupled to a crank a^{16} carried by a transverse rocking shaft a^{17} mounted in bearings on the insulated plate A^1 . At its opposite ends this rocking shaft has stirrup pieces a^{18} which lie beneath the aforesaid hammer switches e^1 , e^2 , and b . The hammer switches e^1 , e^2 are hinged to a shaft e^0 and the hammer switch b is hinged to a shaft b^x . When the rocking shaft a^{17} is rocked in one direction, it will, by means of the stirrup pieces, lift all of the said hammer switches against the resistance of springs with which the latter are provided. When the said shaft a^{17} is rocked in the oppo-

site direction it will lift the hammer switches e^1 and b without affecting the hammer switch e^2 , this result being obtained by providing the said hammer switches e^1 and b with tail pieces that lie beneath corresponding fingers or lugs a^{10} (Figs. 6 and 7) on the said rocking shaft. The rocking motion of the said shaft is effected by the ends of the slot a^9 in the disk a^8 acting upon the pin a^{10} of the link a^{11} .

10 The said slot occupies a central position with respect to the said pin when the contact arm a is in the intermediate position and acts upon the pin as one or other of its ends comes against the said pin, when the arm a completes its angular movements in either direction.

What I claim and desire to secure by Letters Patent of the United States is:—

1. In electrical apparatus for automatically working planing machines and other reciprocating tools; the combination with a reversible variable speed electric motor, of a combined reversing and starting switch controlling the circuits by which the motor is caused to change its revolution and speed for effecting in one direction the slow cutting stroke and in the other direction the quick return stroke, electrical means for actuating the aforesaid combined reversing and starting switch, and a master switch receiving its movement from the reciprocating table of the planing machine for controlling the circuits appertaining to the aforesaid electrical means.

2. In electrical apparatus for automatically working planing machines and other reciprocating tools; the combination with a reversible variable speed electric motor, a starting resistance and a speed regulating resistance, of a combined reversing and starting switch having an oscillatory contact arm, means tending to cause said contact arm to assume an intermediate position for short circuiting the armature through the starting resistance, electrical means for causing said contact arm to move from its intermediate position in alternately opposite directions for controlling the series field windings and the direction of the current in the circuit of the armature of the aforesaid motor, means actuated on the completion of the movement of the aforesaid arm from its intermediate position in either direction for inserting the speed regulating resistance in the shunt field winding of the motor during the quick-return stroke and for removing said resistance or the main part thereof during the cutting stroke, and a master switch receiving its movement from the reciprocating table of the planing machine for controlling the circuits appertaining to the aforesaid electrical means.

3. In electrical apparatus for automatically working planing machines and other reciprocating tools; the combination with a re-

versible variable speed electric motor, a starting resistance and a speed regulating resistance, of a combined reversing and starting switch having an oscillatory contact arm, springs tending to cause said contact arm to assume an intermediate position, electrical means for causing said contact arm to move from its intermediate position in alternately opposite directions, means actuated on the completion of the movement of the aforesaid arm from its intermediate position in either direction for inserting the speed regulating resistance in the shunt field winding of the motor during the quick return stroke and for removing said resistance or the main part thereof during the cutting stroke, and a master switch receiving its movement from the reciprocating table of the planing machine for controlling the circuits appertaining to the aforesaid electrical means.

4. In electrical apparatus for automatically working planing machines and other reciprocating tools; the combination with a reversible variable speed electric motor, a starting resistance and a speed regulating resistance, of a combined reversing and starting switch having an oscillatory contact arm, a spindle to which said contact arm is secured, springs attached to oppositely situated points relatively to said spindle and tending to cause said contact arm to assume an intermediate position, electrical means for causing said contact arm to move from its intermediate position in alternately opposite directions, means actuated on the completion of the movement of the aforesaid arm from its intermediate position in either direction for inserting the speed regulating resistance in the shunt field winding of the motor during the quick return stroke and for removing said resistance or the main part thereof during the cutting stroke, and a master switch receiving its movement from the reciprocating table of the planing machine for controlling the circuits appertaining to the aforesaid electrical means.

5. In electrical apparatus for automatically working planing machines and other reciprocating tools; the combination with a reversible variable speed electric motor, a starting resistance and a speed regulating resistance, of a combined reversing and starting switch having an oscillatory contact arm, a spindle to which said contact arm is secured, a cam-plate attached to said spindle, springs attached at opposite points on said cam-plate and tending to cause said contact arm to assume an intermediate position, spring controlled rollers engaging with the cam plate for causing said cam plate, spindle, and contact arm, to assume their true intermediate position when moving under the influence of the aforesaid springs, electrical means for causing said contact arm to move from its inter-

mediate position in alternately opposite directions, means actuated on the completion of the movement of the aforesaid arm from its intermediate position in either direction for inserting the speed regulating resistance in the shunt field winding of the motor during the quick return stroke and for removing said resistance or the main part thereof during the cutting stroke, and a master switch receiving its movement from the reciprocating table of the planing machine for controlling the circuits appertaining to the aforesaid electrical means.

6. In electrical apparatus for automatically working planing machines and other reciprocating tools; the combination with a reversible variable speed electric motor, a starting resistance and a speed regulating resistance, of a combined reversing and starting switch having an oscillatory contact arm, means tending to cause said contact arm to assume an intermediate position, electrical means for causing said contact arm to move from its intermediate position in alternately opposite directions, means for enabling said contact arm to perform its oscillatory movements sluggishly in one direction and quickly in the other direction, means actuated on the completion of the movement of the aforesaid arm from its intermediate position in either direction for inserting the speed regulating resistance in the shunt field winding of the motor during the quick return stroke and for removing said resistance or the main part thereof during the cutting stroke, and a master switch receiving its movement from the reciprocating table of the planing machine for controlling the circuits appertaining to the aforesaid electrical means.

7. In electrical apparatus for automatically working planing machines and other reciprocating tools; the combination with a reversible variable speed electric motor, a starting resistance and a speed regulating resistance, of a combined reversing and starting switch having an oscillatory contact arm, means tending to cause said contact arm to assume an intermediate position, a pair of solenoids adapted to be alternately energized for causing said contact arm to move from its intermediate position in alternately opposite directions, means for enabling said contact arm to perform its oscillatory movements sluggishly in one direction and quickly in the other direction, means actuated on the completion of the movement of the aforesaid arm from its intermediate position in either direction for inserting the speed regulating resistance in the shunt field winding of the motor during the quick return stroke and for removing said resistance or the main part thereof during the cutting stroke, and a master switch receiving its movement from

the reciprocating table of the planing machine for controlling the circuits appertaining to the aforesaid solenoids.

8. In electrical apparatus for automatically working planing machines and other reciprocating tools; the combination with a reversible variable speed electric motor, a starting resistance and a speed regulating resistance, of a combined reversing and starting switch having an oscillatory contact arm, means tending to cause said contact arm to assume an intermediate position, a pair of solenoids adapted to be alternately energized for causing said contact arm to move from its intermediate position in alternately opposite directions, a movable core common to said solenoids, gearing connecting said core to the contact arm, means for enabling said core to move sluggishly when under the influence of the alternately energized solenoids and to move quickly in its return, means actuated on the completion of the movement of the aforesaid arm from its intermediate position in either direction for inserting the speed regulating resistance in the shunt field winding of the motor during the quick return stroke and for removing said resistance or the main part thereof during the cutting stroke, and a master switch receiving its movement from the reciprocating table of the planing machine for controlling the circuits appertaining to the aforesaid solenoids.

9. In electrical apparatus for automatically working planing machines and other reciprocating tools; the combination with a reversible variable speed electric motor, a starting resistance and a speed regulating resistance, of a combined reversing and starting switch having an oscillatory contact arm, means tending to cause said contact arm to assume an intermediate position, a pair of solenoids adapted to be alternately energized for causing said contact arm to move from its intermediate position in alternately opposite directions, a movable core common to said solenoids, gearing connecting said core to the contact arm, a dash-pot device for enabling said contact arm to perform its oscillatory movements sluggishly in one direction and quickly in the other direction, means actuated on the completion of the movement of the aforesaid arm from its intermediate position in either direction for inserting the speed regulating resistance in the shunt field winding of the motor during the quick return stroke and for removing said resistance or the main part thereof during the cutting stroke, and a master switch receiving its movement from the reciprocating table of the planing machine for controlling the circuits appertaining to the aforesaid solenoids.

10. In electrical apparatus for automatically working planing machines and other reciprocating tools; the combination with a reversible variable speed electric motor, a

starting resistance and a speed regulating resistance, of a combined reversing and starting switch having an oscillatory contact arm, a spindle to which said contact arm is secured, a toothed wheel on said spindle, means 5 tending to cause said contact arm to assume an intermediate position, a pair of solenoids adapted to be alternately energized for causing said contact arm to move from its intermediate position in alternately opposite directions, a movable core common to said 10 solenoids and having rack teeth thereon gearing with the aforesaid toothed wheel, means for causing said core when moved under the influence of the alternately energized solenoids to perform its oscillatory movements 15 sluggishly in one direction and quickly in the other direction, means actuated on the completion of the movement of the aforesaid arm from its intermediate position in either direction for inserting the speed regulating resistance in the shunt field winding of the motor during the quick return stroke and for removing said resistance or the main part 20 thereof during the cutting stroke, and a master switch receiving its movement from the reciprocating table of the planing machine for controlling the circuits appertaining to the aforesaid solenoids.

11. In electrical apparatus for automatically working planing machines and other reciprocating tools; the combination with a reversible variable speed electric motor, a starting resistance and a speed regulating 35 resistance, of a combined reversing and starting switch having an oscillatory contact arm, means tending to cause said contact arm to assume an intermediate position, a pair of solenoids adapted to be alternately energized for causing said contact arm to move 40 from its intermediate position in alternately opposite directions, a movable core common to said solenoids, gearing connecting said core to the contact arm, tubular barrels situated within said solenoids and formed with 45 air holes, pistons on the portions of the aforesaid core where they work within said barrels, valves for retarding the movement of said core while moving under the influence 50 of the alternately energized solenoids and for allowing the return movement to take place quickly, means actuated on the completion of the movement of the aforesaid arm from its intermediate position in either 55 direction for inserting the speed regulating resistance in the shunt field winding of the motor during the quick return stroke and for removing said resistance or the main part thereof during the cutting stroke, and a 60 master switch receiving its movement from the reciprocating table of the planing machine for controlling the circuit appertaining to the aforesaid solenoids.

12. In electrical apparatus for working 65 planing machines and other reciprocating

tools; the combination with a reversible variable speed electric motor, a starting resistance and a speed regulating resistance, of a combined reversing and starting switch having an oscillatory contact arm, means 70 tending to cause said contact arm to assume an intermediate position, electrical means for causing said contact arm to move from its intermediate position in alternately opposite directions, an auxiliary switch which normally short circuits a part of the speed-regulating resistance, a second auxiliary switch 75 which normally short circuits the whole of the speed-regulating resistance, means for actuating the first-mentioned auxiliary switch as the contact arm completes its movement 80 from its intermediate position for the cutting stroke, means for actuating both auxiliary switches as the contact arm completes its movement for the quick return stroke, and 85 a master switch receiving its movement from the reciprocating table of the planing machine for controlling the circuits appertaining to the aforesaid electric means.

13. In electrical apparatus for automatically working planing machines and other reciprocating tools; the combination with a reversible variable speed electric motor, a starting resistance and a speed regulating 90 resistance, of a combined reversing and starting switch having an oscillatory contact arm, a spindle to which said contact arm is secured, a slotted disk fixed to said spindle, means tending to cause said spindle and contact arm to assume an intermediate position, 95 electrical means for causing said contact arm to move from its intermediate position in alternately opposite directions, a hammer switch which normally short-circuits a part of the speed regulating resistance, a second 100 hammer switch which normally short-circuits the whole of the speed regulating resistance, a rocking shaft, link mechanism connecting the slotted disk on the spindle of the contact arm with said rocking shaft, an 105 arm secured to said rocking shaft for actuating the first mentioned hammer switch as the contact arm completes its movement from its intermediate position for the cutting stroke, a stirrup piece also secured to said 110 rocking shaft for actuating both hammer switches as the contact arm completes its movements for the quick return stroke, and a master switch receiving its movement from the reciprocating table of the planing machine for controlling the circuits appertaining 115 to the aforesaid electrical means.

14. In electrical apparatus for automatically working planing machines and other reciprocating tools; the combination with a reversible variable speed electric motor, a starting resistance and a speed regulating resistance, of a combined reversing and starting switch having an oscillatory contact 120 arm, means tending to cause said contact 130

arm to assume an intermediate position, a pair of solenoids adapted to be alternately energized for causing said contact arm to move from its intermediate position in alternately opposite directions, a normally short-circuited resistance in the circuit of said solenoids, means actuated on the completion of the movement of the aforesaid arm from its intermediate position in either direction for inserting the speed regulating resistance in the shunt field winding of the motor during the quick return stroke and for removing said resistance or the main part thereof during the cutting stroke, means actuated on the completion of the movement of the contact arm from its intermediate position in either direction for inserting the resistance in the circuit of the solenoid that is for the time being energized, and a master switch receiving its movement from the reciprocating table of the planing machine for controlling the circuits appertaining to the aforesaid solenoids.

15. In electrical apparatus for automatically working planing machines and other reciprocating tools; the combination with a reversible variable speed electric motor, a starting resistance and a speed regulating resistance, of a combined reversing and starting switch having an oscillatory contact arm, means tending to cause said contact arm to assume an intermediate position, a pair of solenoids adapted to be alternately energized for causing said contact arm to move from its intermediate position in alternately opposite directions, a normally short-circuited resistance in the circuit of the said solenoids, an auxiliary switch which normally short circuits a part of the speed-regulating resistance, a second auxiliary switch which normally short circuits the whole of the speed-regulating resistance, a switch which normally short-circuits the resistance in the solenoid circuits, means for actuating the first mentioned auxiliary switch as the contact arm completes its movement from its intermediate position for the cutting stroke, means for actuating both auxiliary switches as the contact arm completes its movement for the quick return stroke, means for actuating the solenoid resistance switch as the contact arm completes its movement from its intermediate position in either direction, and a master switch receiving its movement from the reciprocating table of the planing machine for controlling the circuits appertaining to the aforesaid solenoids.

16. In electrical apparatus for automatically working planing machines and other reciprocating tools; the combination with a reversible variable speed electric motor, a starting resistance and a speed regulating resistance, of a combined reversing and starting switch having an oscillatory contact arm,

a spindle to which said contact arm is secured, a slotted disk fixed to said spindle, means tending to cause said spindle and contact arm to assume an intermediate position, a pair of solenoids adapted to be alternately energized for causing said contact arm to move from its intermediate position in alternately opposite directions, a resistance in the circuit of the said solenoids; a hammer switch which normally short-circuits a part of the speed regulating resistance, a second hammer switch which normally short-circuits the whole of the speed regulating resistance, a third hammer switch which normally short-circuits the solenoid circuit resistance, a rocking shaft, link mechanism, connecting the slotted disk on the spindle of the contact arm with said rocking shaft, arms secured to said rocking shaft for actuating the hammers of the first and third mentioned hammer switches as the contact arm completes its movement from its intermediate position for the cutting stroke, stirrup pieces also secured to said rocking shaft for actuating all the hammers of the hammer switches as the contact arm completes its movement for the quick return stroke, and a master switch receiving its movement from the reciprocating table of the planing machine for controlling the current in the aforesaid solenoids.

17. In electrical apparatus for automatically working planing machines and other reciprocating tools; the combination with a reversible variable speed electric motor, of a combined reversing and starting switch controlling the circuits by which the motor is caused to change its revolution and speed for effecting in one direction the slow cutting stroke and in the other direction the quick return stroke, electrical means for actuating the aforesaid combined reversing and starting switch, a master switch receiving its movement from the reciprocating table of the planing machine for controlling the circuits appertaining to the aforesaid electrical means, and an auxiliary switch actuated by said master switch for cutting out the greater part of the speed-regulating resistance immediately the aforesaid master switch commences to be actuated by the reciprocating table of the planing machine at the completion of the quick-return stroke.

18. In electrical apparatus for automatically working planing machines and other reciprocating tools; the combination with a reversible variable speed electric motor, a starting resistance and a speed regulating resistance, of a combined reversing and starting switch having an oscillatory contact arm, means tending to cause said contact arm to assume an intermediate position, electrical means for causing said contact arm to move from its intermediate position in alternately opposite directions, an auxiliary switch

which normally short-circuits a part of the speed-regulating resistance, a second auxiliary switch which normally short-circuits the whole of the speed-regulating resistance, a master switch receiving its movement from the reciprocating table of the planing machine for controlling the circuits appertaining to the aforesaid electrical means, and an auxiliary switch actuated by said master switch for cutting out the greater part of the speed-regulating resistance immediately the aforesaid master switch commences to be actuated by the reciprocating table of the planing machine at the completion of the quick return stroke.

19. In electrical apparatus for automatically working planing machines and other reciprocating tools; the combination with a reversible variable speed electric motor, a starting resistance and a speed regulating resistance, of a combined reversing and starting switch having an oscillatory contact arm, means tending to cause said contact arm to assume an intermediate position, electrical means for causing said contact arm to move from its intermediate position in alternately opposite directions, an auxiliary switch which normally short-circuits a part of the speed-regulating resistance, a second auxil-

iary switch which normally short-circuits the whole of the speed-regulating resistance, means for actuating the first mentioned auxiliary switch as the contact arm completes its movement from its intermediate position for the cutting stroke, means for actuating both auxiliary switches as the contact arm completes its movement for the quick return stroke, a master switch receiving its movement from the reciprocating table of the planing machine for controlling the circuits appertaining to the aforesaid electrical means, and an auxiliary switch actuated by said master switch for cutting out the greater part of the speed-regulating resistance immediately the aforesaid master switch commences to be actuated by the reciprocating table of the planing machine at the completion of the quick-return stroke and before the first and second mentioned auxiliary switches return to their normal short-circuiting positions.

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

ALFRED DAVID WILLIAMSON.

Witnesses:

JNO. R. HECKLEY,
W. G. MANN.