(No Model.) 3 Sheets—Sheet 1.

# T. VON ZWEIGBERGK.

## SERIES MULTIPLE CONTROLLER.

No. 583,273. Patented May 25, 1897.

Fig. 1.

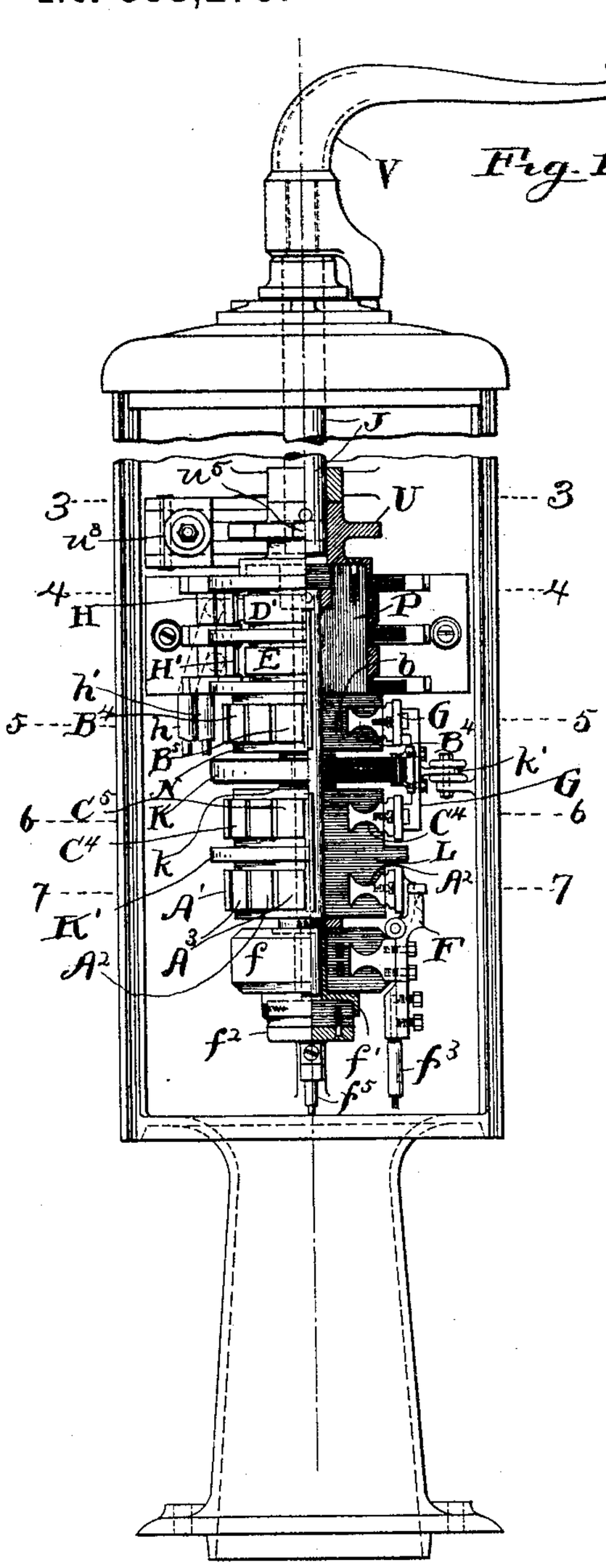



Fig-2

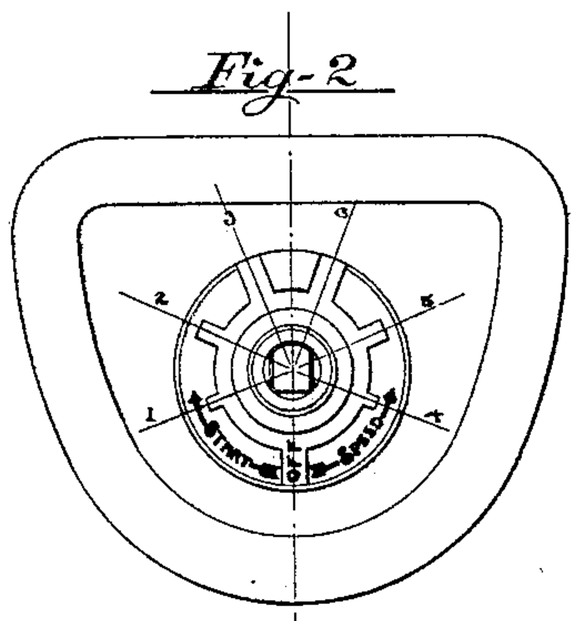



Fig-3

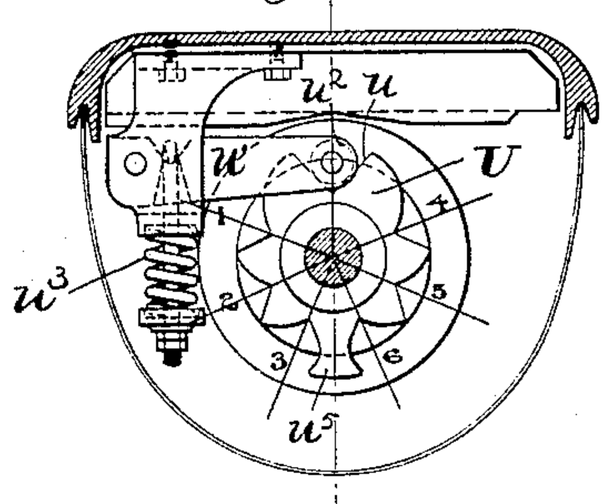
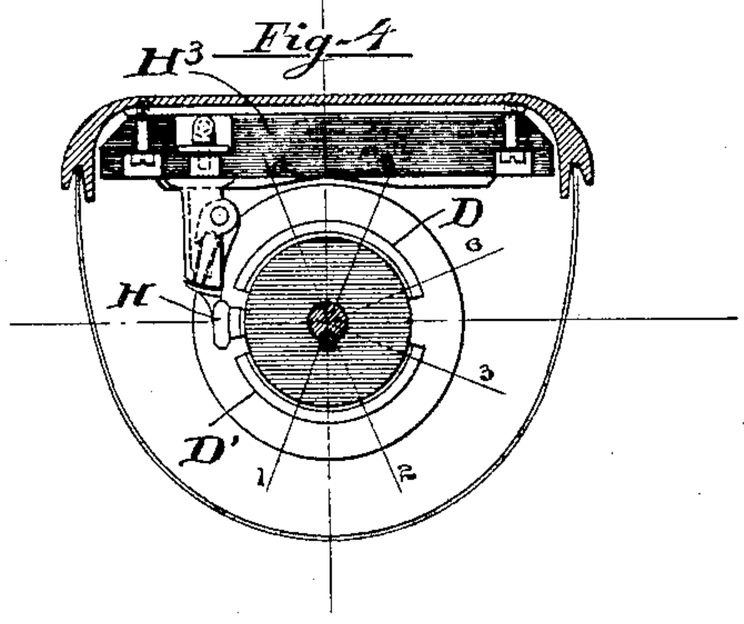



Fig-4




Witnesses
E. B. Gilchrist
Albert H. Bates.

Inventor
Thorsten von Zweigbergk
By his Attorney
E. L. Thurston

(No Model.) 3 Sheets—Sheet 2.

# T. VON ZWEIGBERGK.

## SERIES MULTIPLE CONTROLLER.

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Fig. 5.

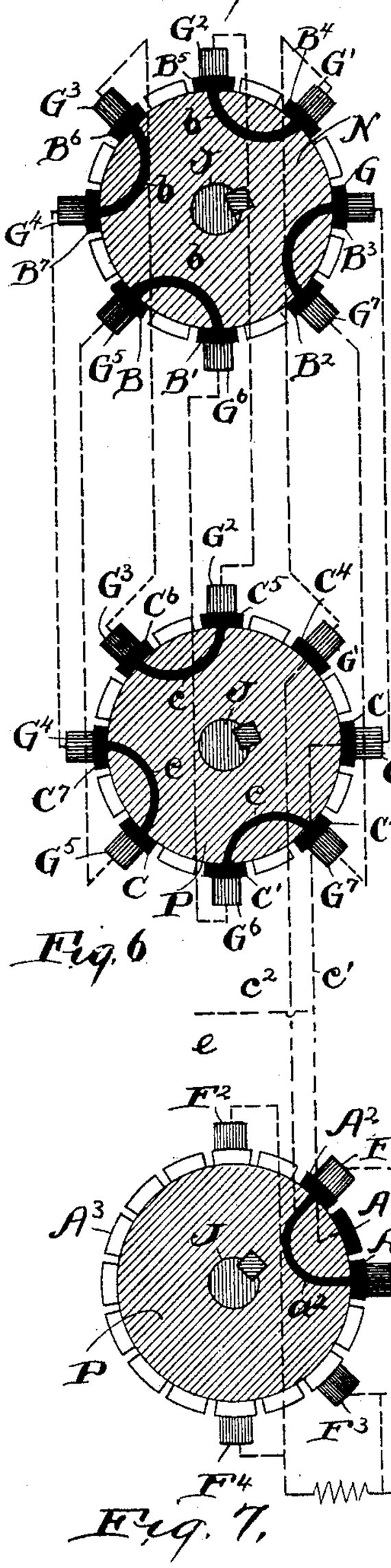


Fig. 6

Fig. 5a.

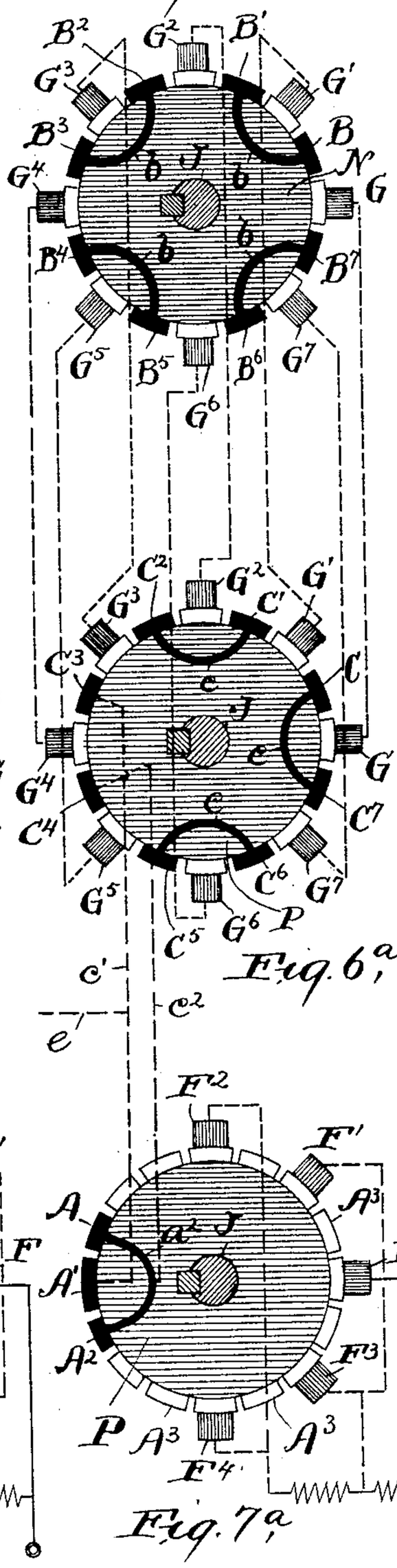


Fig. 6a

Fig. 5b.

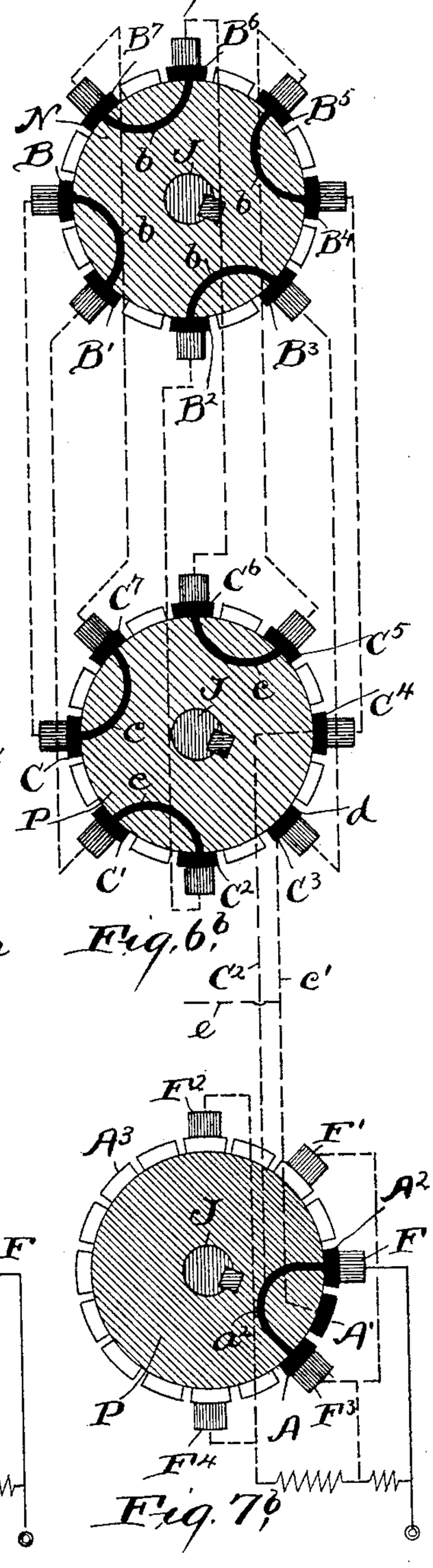


Fig. 6b

Fig. 7.




Fig. 7a.




Fig. 7b.




Witnesses
E. B. Gilchrist
Albert H. Baker.

Inventor
Thorsten von Zweigbergk
By his Attorney
E. L. Thurston

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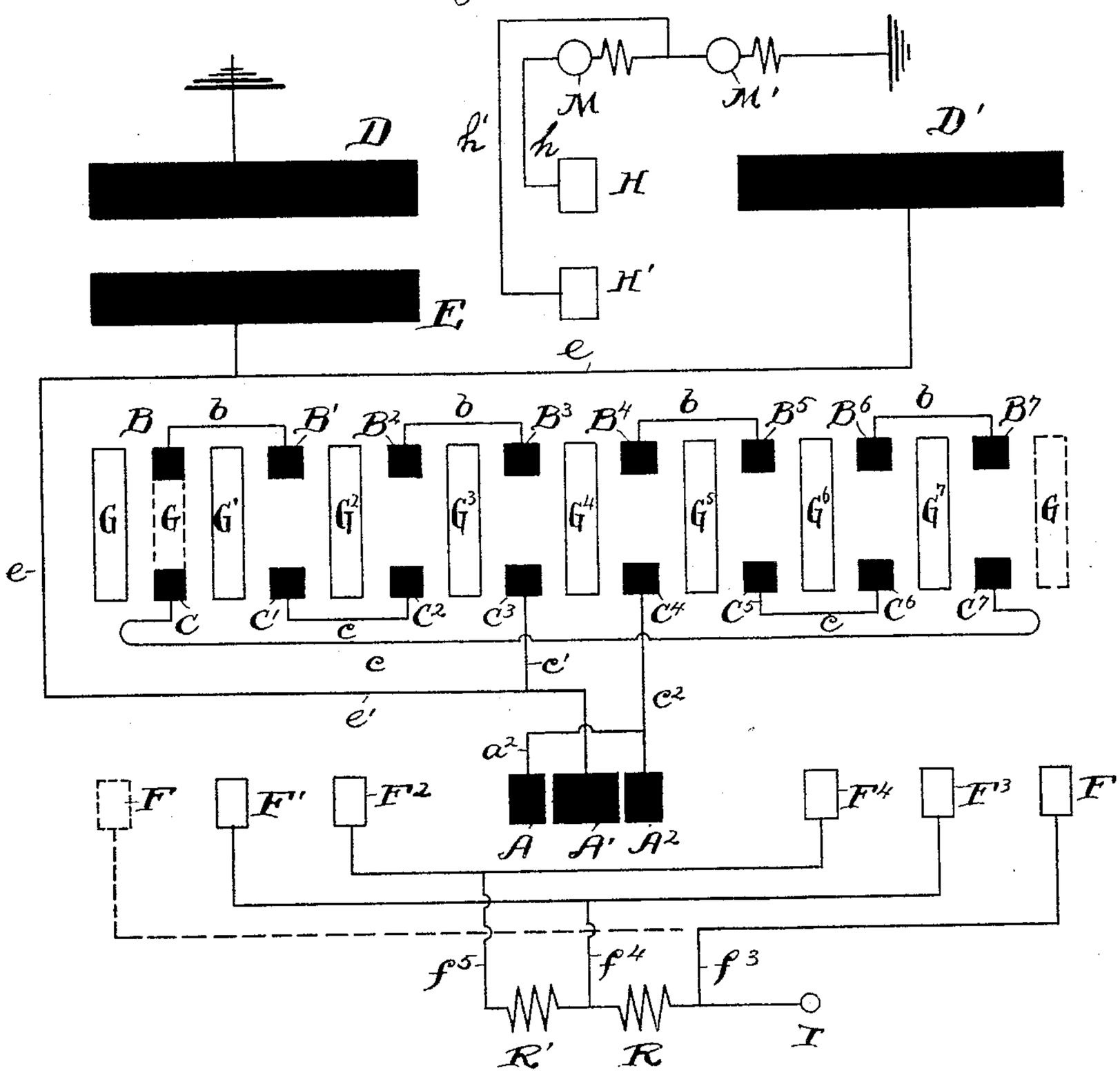
# T. VON ZWEIGBERGK.

## SERIES MULTIPLE CONTROLLER.

No. 583,273. Patented May 25, 1897.

Fig. 8.




Witnesses
E. B. Gilchrist
Albert H. Bates

Inventor
Thorsten von Zweigbergk
By his Attorney
E. L. Thurston

# UNITED STATES PATENT OFFICE.

THORSTEN VON ZWEIGBERGK, OF CLEVELAND, OHIO, ASSIGNOR TO THE WALKER COMPANY, OF SAME PLACE.

## SERIES-MULTIPLE CONTROLLER.

SPECIFICATION forming part of Letters Patent No. 583,273, dated May 25, 1897.

Application filed January 21, 1897. Serial No. 620,160. (No model.)

*To all whom it may concern:*

Be it known that I, THORSTEN VON ZWEIGBERGK, a citizen of the United States, residing at Cleveland, in the county of Cuyahoga and State of Ohio, have invented certain new and useful Improvements in Series-Multiple Controllers; and I do hereby 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.

One object of my invention is to provide novel mechanism for subdividing the arcs incident to breaking or reducing an electric current, whereby the destructive energy of said arcs is diminished.

Another object is to provide a novel and simple construction of the controller device for trolley-cars, whereby the different connections of the motors and resistances may be made quickly and with certainty.

Another object is to provide a construction whereby the movement of the switch in one direction results in the trolley being connected with the motors in series and the movement of the switch in the other direction results in the trolley being connected with the motors in multiple arc.

The invention consists in the novel controller apparatus hereinafter described, and pointed out definitely in the claims.

The apparatus, as shown, is especially adapted to control the current of a motor-car carrying two motors and two resistances. By the movement of the switch in one direction the motors in series are connected with the trolley and the circuit is made to include neither or one resistance, or both resistances, as desired, and by the movement of the switch in the opposite direction the motors in multiple arc are connected with the trolley, and the connection includes neither or one resistance, or both resistances, as desired.

In the drawings, Figure 1 is a front elevation, partly in section, of the controller device, the contact-fingers on the unsectioned side of the figure being removed. Fig. 2 is a plan view thereof. Fig. 3 is a sectional plan view on line 3 3 of Fig. 1. Fig. 4 is a sectional plan view on line 4 4. Figs. 5, $5^a$, and $5^b$ are sectional plan views on line 5 5 when the switch-cylinder is in three different positions. Figs. 6, $6^a$, and $6^b$ are sectional plan views on line 6 6 when the switch-cylinder is in three different positions. Figs. 7, $7^a$, and $7^b$ are sectional plan views on line 7 7 when the switch-cylinder is in three different positions. Fig. 8 is a diagrammatic view of the controller apparatus, the black patches representing the contact-strips on the switch and their connections and the white blocks representing the contact-fingers.

Referring to the parts by letters, K represents a movable switch. It is shown in the form of a cylinder which is mounted upon a vertical axis. The particular construction of the cylinder is not material to the invention. It is only necessary that the various contact-strips carried by it shall be insulated from each other. In the construction shown the switch consists of a central vertical shaft J, upon which are rigidly secured the three fiber (insulated) rings L, N, and P.

The original contact-strips A A′ $A^2$, or "trolley-strips," as I will call them, are arranged in one horizontal row upon the surface of the ring L. The surface of the switch in the same horizontal plane with the trolley-strips is built out by strips $A^3$, having no electrical connections, the surface of all of said strips being parts of the same cylindrical surface.

C, C′, $C^2$, $C^3$, $C^4$, $C^5$, $C^6$, and $C^7$ represent a row of arc-spanning strips which are secured upon the ring L. All of them except the two middle strips $C^3$ $C^4$ are connected together in pairs by the wires *c*. The strip $C^3$ is connected by wire *c′* with the middle trolley-strip A′, while the strip $C^4$ is connected by wires $a^2$ $c^2$ with the two other trolley-strips A $A^2$. Another horizontal row of arc-spanning strips B, B′, $B^2$, $B^3$, $B^4$, $B^5$, $B^6$, and $B^7$ are secured to the ring N, and they are connected in pairs by the wires *b*.

One motor-strip E is secured to the face of the ring P, and the two other motor-strips D D′ are secured in a row to the same ring. The two motor-strips E and D′ are connected by a wire *e* to the trolley-strip A′ and consequently with arc-spanning strip $C^3$. The motor-strip D is grounded.

M M′ represent the two motors, which, as shown, are permanently connected together, and the motor M′ is grounded.

The trolley contact-fingers, of which there are five, F F′ $F^2$ $F^3$ $F^4$, are fastened to the edges of an insulated ring *f*. This ring is secured to a sleeve *f′*, which embraces the shaft J loosely, and is fastened to a fixed base $f^2$. These contact-fingers are connected with the trolley T and the resistances R R′ as follows: Both resistances are included in the connection $f^5$ between the trolley and the fingers $F^2$ $F^4$. One resistance R is included in the connection $f^4$ between the trolley and the two fingers F′ $F^3$. The connection $f^3$ between the trolley and finger F does not include either resistance.

G, G′, $G^2$, $G^3$, $G^4$, $G^5$, $G^6$, and $G^7$ represent arc-spanning fingers which are arranged in an annular row around the cylinder and are supported by an insulated fiber ring K. This ring is secured to a sleeve *k*, which loosely embraces the shaft J, and the ring is prevented from revolving by an arm *k′*, which is fastened to it and to the fixed casing O. The ends of these fingers respectively lie in the planes of the two rows of arc-spanning strips. When the current is cut off entirely, these fingers lie between the arc-spanning strips of these two rows; but when any connection is made each of the said fingers contact with an arc-spanning strip in the upper row and one in the lower row, as indicated by the dotted representation of finger G in the diagrammatic view.

H and H′ represent two spring-actuated contact-fingers which are pivoted one above the other to a fixed insulated support. One finger H′ is in the plane of the motor-strip E, while the other is in the plane of the motor-strips D D′. The finger H is connected by wire *h* with both motors in series, while a wire *h′* connects the finger H′ with both motors in multiple arc.

When the switch is in the shut-off position, the two strips D D′ are on opposite sides of the finger H, as shown by Fig. 4. The strip E is just below strip D and consequently on the same side of finger H′. The three trolley-strips A A′ $A^2$ lie between the two fingers $F^2$ $F^4$, as shown in Fig. $7^a$, and the fingers G, &c., lie between the arc-spanning strips, as shown in Figs. $5^a$ and $6^a$.

The switch may be turned in either direction nearly half a revolution. If turned to the left, the motors are connected in series; if to the right, in multiple arc. If turned by its handle V one notch to the left, to the position indicated by the line 1 of Fig. 2, all of the arc-spanning strips are brought into contact with the corresponding fingers G, &c., the trolley-strip A contacts with finger $F^2$, and the motor-strip D′ contacts with finger H. The current then flows through both resistances R R′ to finger $F^2$, strip A, all of the arc-spanning strips and fingers to strip D′, to finger H, and both motors in series. If moved another notch to the left, all of the arc-spanning strips simultaneously break connection with the arc-spanning fingers and immediately make new connection with the next pair of fingers. The trolley-strip A makes contact with the finger F′, while before this last contact is made trolley-strip A′ makes contact with finger $F^2$. The motor-strip D′ remains in contact with finger H. The current momentarily flows direct from strip A′ to strip D′, over wire *e*, and thence as before; but when all of the contacts are made as described the current passes through one resistance R to finger F′, to strip A, and thence through the arc-spanning strips, &c., as before. When the switch moves another notch to the left, the arc-spanning strips break the old and make new connections with the fingers G, &c. The motor-strip A contacts with finger F, while the strip A′ contacts with finger F′. The current flows through both motors in series and neither of the resistances, the then existing connections being indicated by Fig. 7.

In turning the switch to the right connections are made by means of which the motors are connected in parallel arc. By thus moving the switch one notch the trolley-strip $A^2$ is made to contact with the finger $F^4$, and both motor-strips D and E will contact with the fingers H H′, respectively. Now, as always, when any connection is made the fingers G′, &c., are contacting with the arc-spanning strips B, &c., C, &c. The current now flows through both resistances, the arc-spanning strips, and fingers to strip E, finger H′, to a point between the motors. It flows through one motor M′ to the ground and through the other motor to finger H, to strip D, to ground. In the further movement of the switch in this direction the path of the current is changed only by cutting out one and then both resistances as the strip $A^2$ contacts successively with fingers $F^3$ and F. The last position is indicated by Fig. $7^b$. In moving to the second notch the strip A′ passes momentarily into contact with finger $F^4$, and in moving to the third notch the strip A′ is momentarily brought also into contact with finger $F^3$, and during the period of time when said fingers are in contact with strip A′ the current passes directly from said strip to motor-strip E.

It will be noticed that the distance between the strip A′ and both strips A $A^2$ is less than the width of the fingers F, &c., wherefore the said fingers temporarily make contact with both strips as the switch is moved to carry one out of and the other into contact with one of the fingers. It will also be noticed that in moving the switch from one position to another in either direction all of the arc-spanning strips break contact with all of the fingers G, &c., at the same instant that the strips A or $A^2$ break contact with the respective fingers.

If the switch is in either position shown by Figs. $7^a$ or $7^b$ and it is moved to make a new connection to reduce the current flowing, the

circuit is simultaneously broken in seventeen places—viz., when the trolley-strip A or $A^2$ breaks contact with the finger F and when all of the arc-spanning strips break contact with the several contact-fingers. Thereafter and until the strips A or $A^2$ make contact with the fingers F′ or $F^3$, as the case may be, the current flows through one resistance to one or the other of said fingers to trolley-strip A′, thence over wire *e* to motor-strip E or D′, as the case may be, and thence to the motors. The reduced circuit is now formed, and in being formed the old circuit was, as above stated, broken simultaneously in seventeen places, thereby diminishing the length of the incidental arcs to the extent well understood. The switch does not stop in this position, but continues to move until one of the strips A $A^2$ (depending upon the direction of movement) contacts with the corresponding finger F′ $F^3$ and until the arc-spanning strips again make contact with the fingers G, &c., both of which connections are made before the strip A′ finally breaks contact with the finger F′ or $F^3$. The circuit is not changed by this additional movement except that the arc-spanning system of strips and fingers is connected into it, and this change is made without any break in the circuit.

When the current is entirely cut off, all of the motor-strips and arc-spanning strips and trolley-strips simultaneously break contact with the fingers with which they are in contact, making eighteen or nineteen breaks, as the case may be.

Associated with the switch is an indicator-wheel U, secured to it and having six notches (indicated by 1 2 3 4 5 6) in addition to the notch *u*, Fig. 3. A spring-actuated arm *u′*, pivoted to a fixed support, is provided with a friction-roller $u^2$, which is held in contact with the periphery of said indicator-wheel by the spring $u^3$. The indicator-wheel moves with the switch and can only stop when the roller $u^2$ is in one or the other of said notches—that is to say, it may stop in one of the seven positions before explained. The notches 3 and 6 are separated by a long tooth $u^5$, which engages with the roller $u^2$ and prevents further movement of the switch in either direction after the said engagement takes place. The switch may therefore be moved only three notches from the shut-off point in either direction. If the motors are connected in series or multiple arc and it is desired to reverse the connection in this particular, it is necessary to first entirely shut off the current.

The lines marked 1, 2, 3, 4, 5, and 6 in Fig. 2 indicate the positions of the handle V when the roller $u^2$ is engaging with the correspondingly-numbered notches in the indicator-wheel.

The lines marked 1, 2, 3, 4, 5, and 6 in Fig. 4 represent the parts of the motor-strips which are in engagement with the finger H when the roller $u^2$ is engaging with the correspondingly-marked notches in the indicator-wheel.

Having described my invention, I claim—

1. In a series-multiple controller, in combination, two motors, contact-fingers with which the motors are respectively connected in series and in multiple arc, a switch movable in both directions from the "shut-off" position, motor contact-strips thereon, on opposite sides of said contact-fingers when the switch is in said shut-off position, and adapted to contact with said contact-fingers, trolley-strips thereon, connections between the motor-strips and trolley-strips, and fixed contact-fingers which connect the trolley-strips with the source of current, whereby the movement of the switch in one direction causes the current to pass through the motors in series, and the movement of the switch in the opposite direction causes the current to pass through the motors in multiple arc, substantially as and for the purpose specified.

2. In a controller device, in combination, two motors, two contact-fingers, one of which is connected with the two motors in series, and one with said two motors in multiple arc, a switch movable in both directions from the shut-off position, and means for connecting one finger with the trolley when the switch is moved in one direction, and for connecting said finger with the ground and the other finger with the trolley when the switch is moved in the opposite direction, substantially as and for the purpose specified.

3. In a controller device, in combination, two contact-fingers H, H′, a switch relatively movable in both directions, two motor-strips D, D′ in line upon said switch and on opposite sides of the finger H, the strip D being connected with the ground, a motor-strip E upon said switch on one side of finger H′, means for connecting and disconnecting both strips E and D′ with the trolley, and two motors which are connected with finger H in series, and with finger H′ in multiple arc, substantially as and for the purpose specified.

4. In a controller device, in combination, a switch movable in both directions from its shut-off position, two motor contact-fingers, two motors respectively connected with said fingers in series and in multiple arc, two strips D D′ on the switch in line with and on opposite sides of one of the said fingers, the strip D being grounded, a strip E in line with the other motor-finger, the two rows of arc-spanning strips, all of the strips in one row being connected in pairs, and all of the strips in the other row except two being similarly connected, permanent electrical connections between one of the said two arc-spanning strips with the motor-strips E and D′, means for connecting the other of said arc-spanning strips with the current-supply, and a plurality of arc-spanning fingers for severally connecting the strips in one arc-spanning row with strips in the other row, substantially as and for the purpose specified.

5. In a controller, in combination, a switch movable in both directions from the shut-off

position, three trolley-strips thereon, fixed contact-fingers for contacting with said strips, said fingers being connected with the source of current by connections which include different amounts of resistance, a row of arc-spanning strips which are connected together in pairs, another row of arc-spanning strips, all but two of which are connected together in pairs, permanent electrical connections between one of the said two arc-spanning strips referred to and both of the end trolley-strips, permanent electrical connections between the other of said arc-spanning strips, the middle trolley-strip and two of the motor-strips, motor-strips, their contact-fingers, electrical connections between the motor contact-fingers and the motors, and arc-spanning contact-fingers, substantially as and for the purpose specified.

6. A controller consisting of a switch having thereon a row of trolley-strips comprising the strips A, A′, $A^2$, and the two rows of arc-spanning strips, the strips of each row (except two in one row) being connected in pairs as described, and two rows of motor-strips, one row containing one strip E and the other row two strips D, D′ on opposite sides of the corresponding contact-finger, permanent electrical connections between both strips A, $A^2$, and one of the unconnected arc-spanning strips, permanent electrical connections between the strip A′ and the other unconnected arc-spanning strip and the motor-strips E and D′, permanent electrical connections between the strip D and the ground, the trolley-fingers, permanent electrical connections between said fingers and the trolley, which connections include different amounts of resistance, arc-spanning fingers for connecting the strips in the two arc-spanning rows, the two motor-fingers, and two motors connected in series with the ground, and permanent electrical connections between one motor-finger and both motors in series, and between the other motor-fingers and both motors in multiple arc, substantially as and for the purpose specified.

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

THORSTEN VON ZWEIGBERGK.

Witnesses:
E. L. THURSTON,
E. B. GILCHRIST.