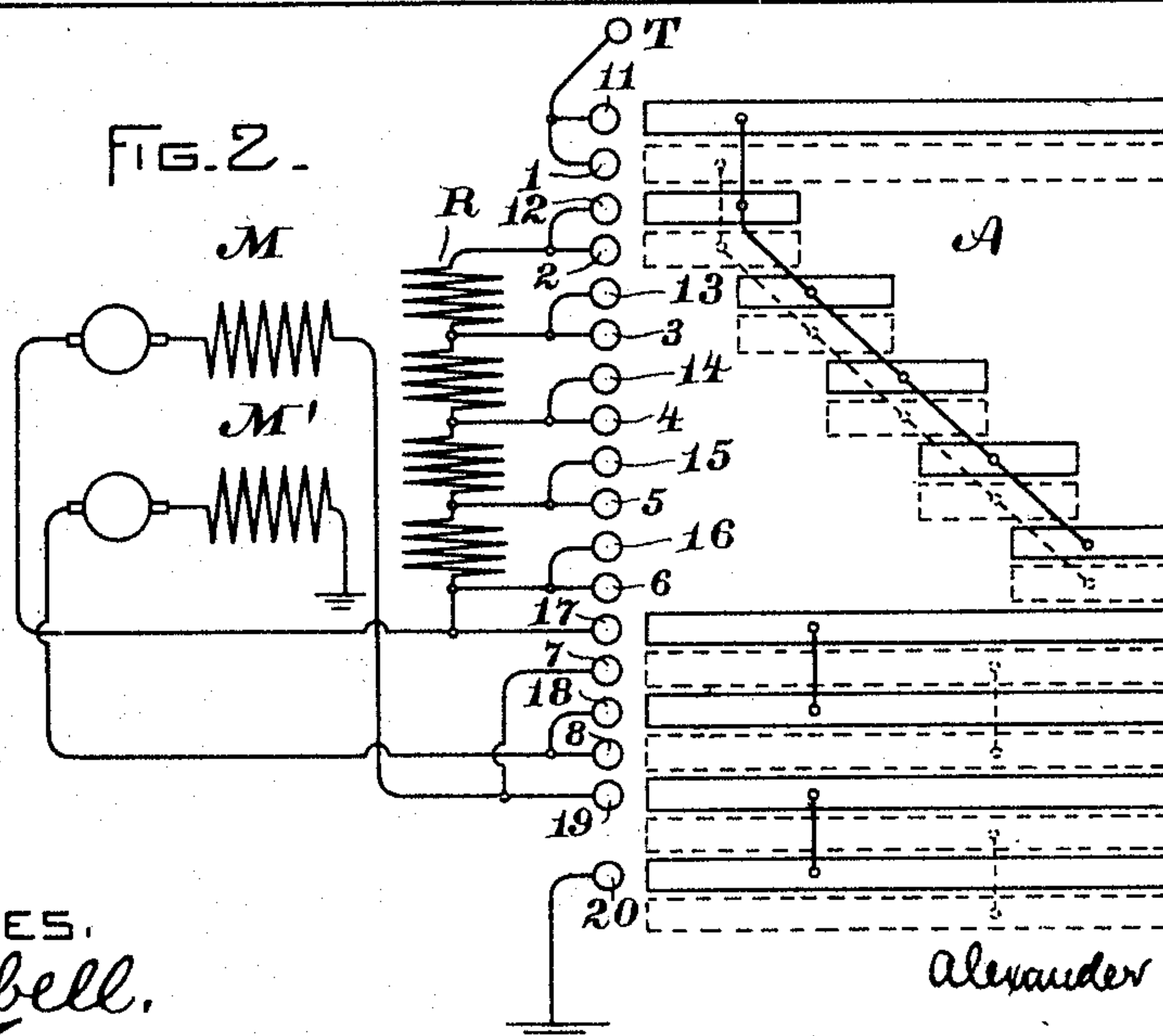
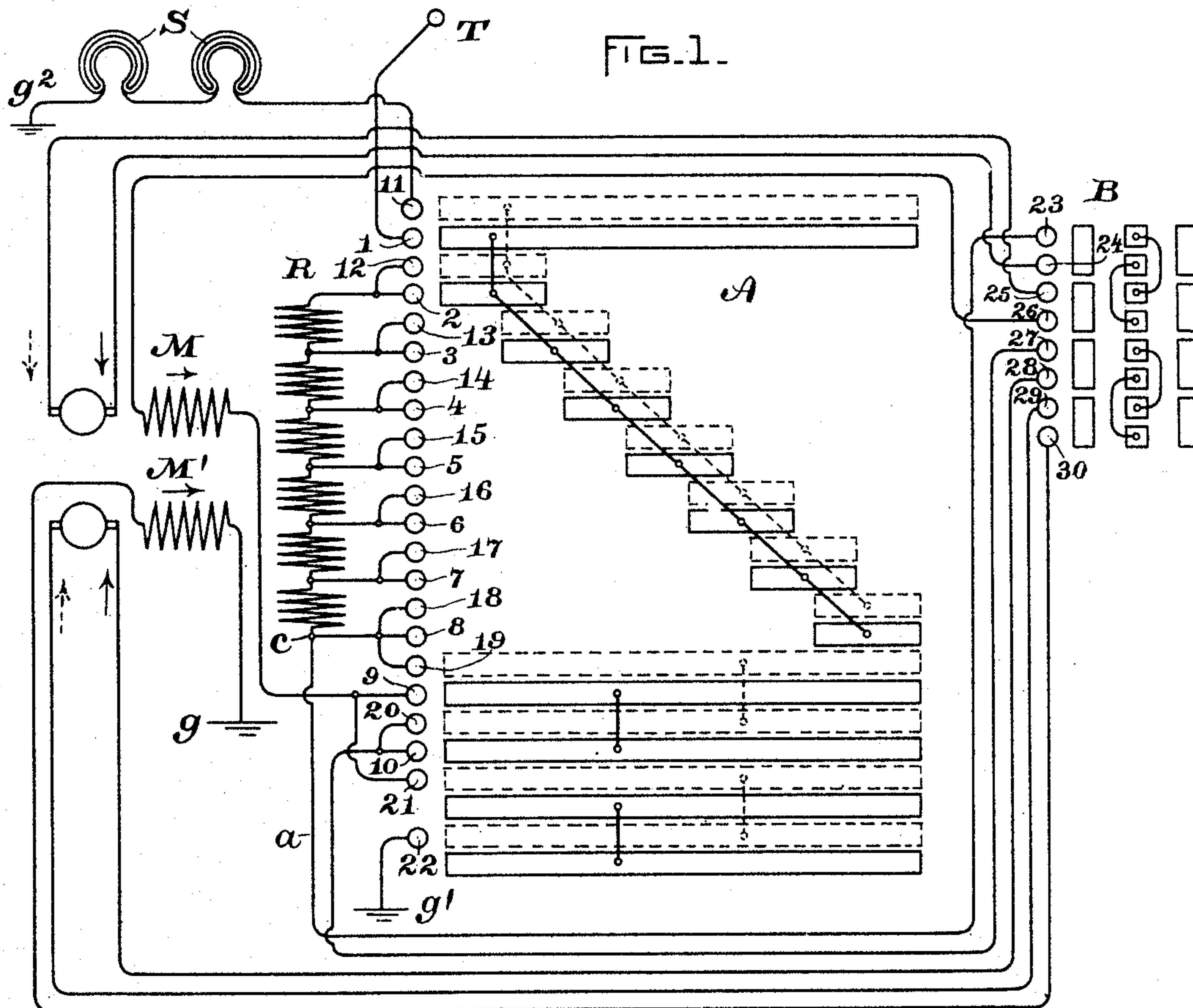


A. F. MACDONALD.
ELECTRIC CONTROLLER.

No. 585,772.

Patented July 6, 1897.



WITNESSES.
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Alexander S. Macdonald,
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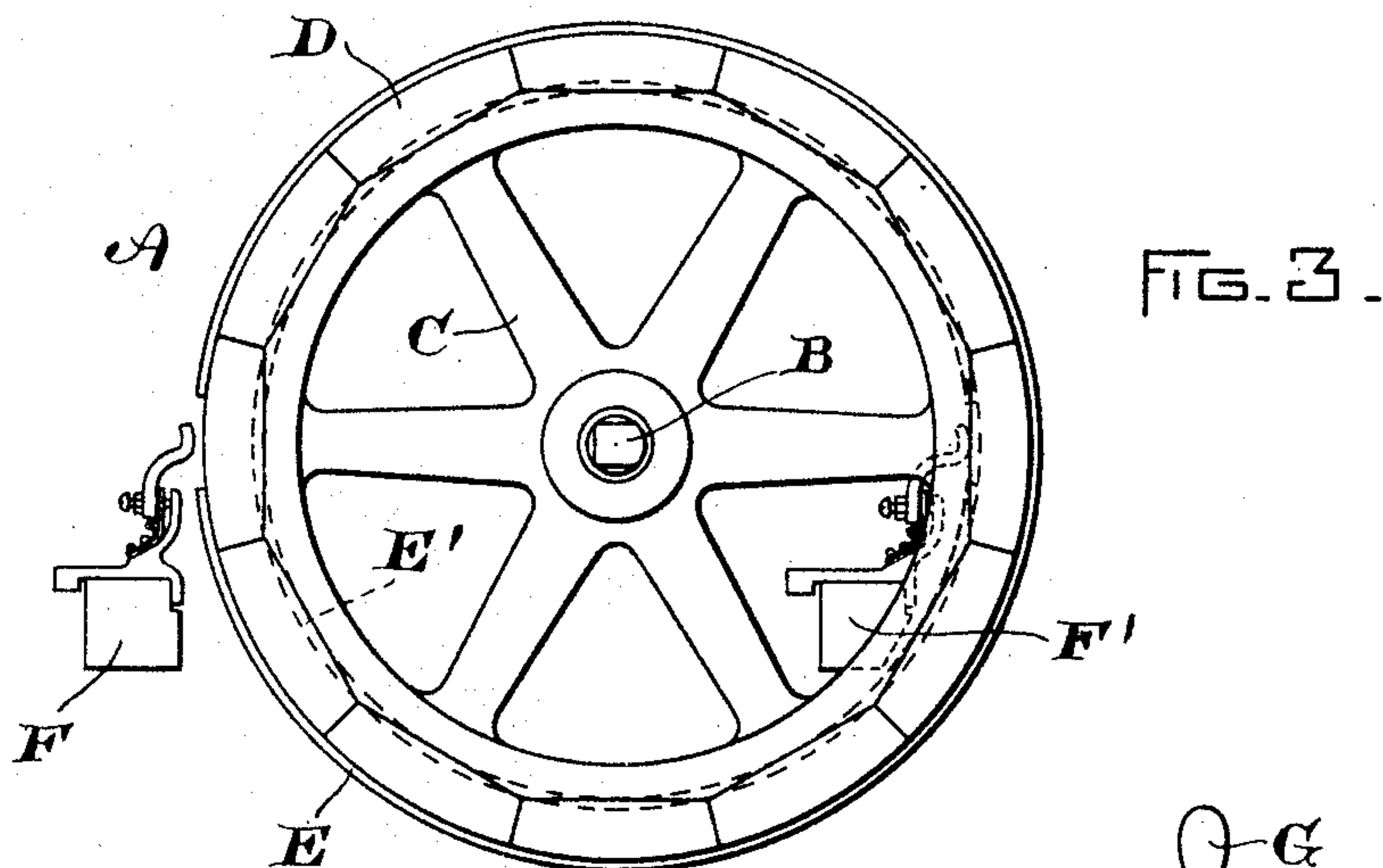


FIG. 3.

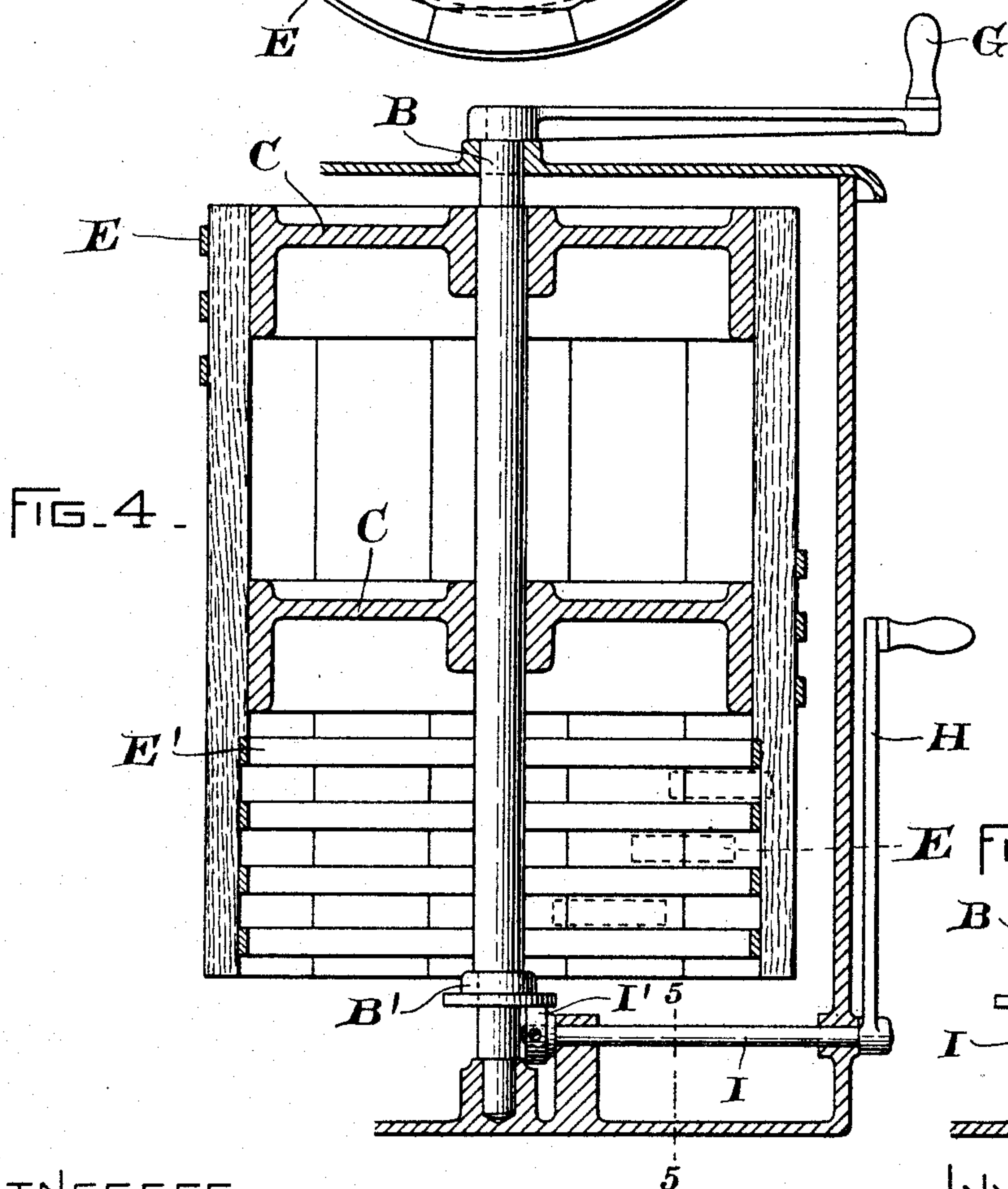
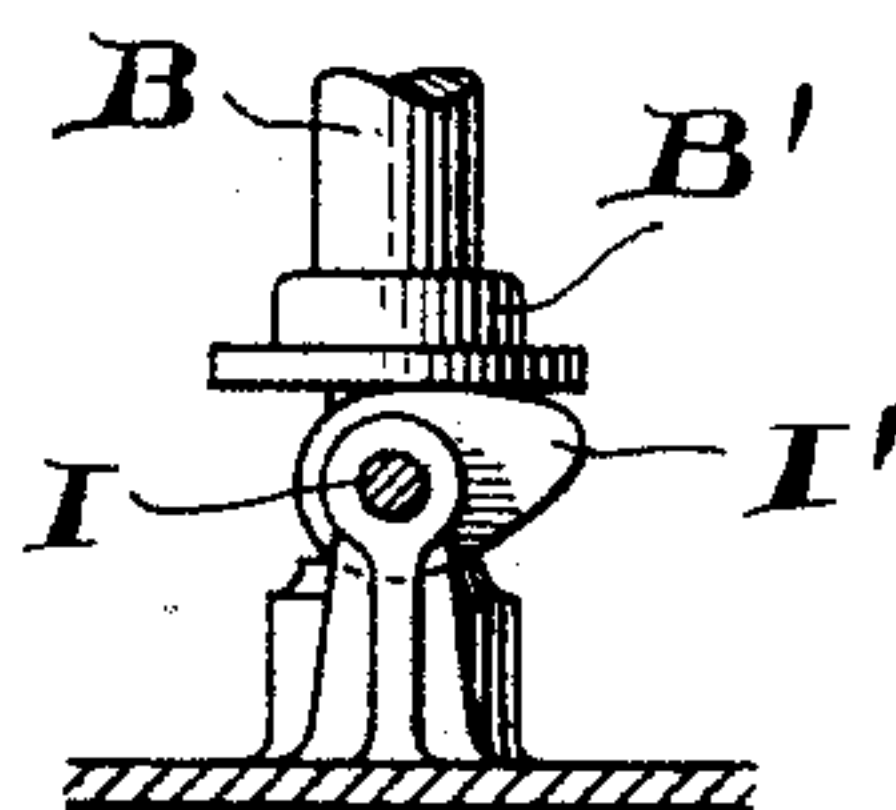


FIG. 4.

FIG. 5.



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UNITED STATES PATENT OFFICE.

ALEXANDER F. MACDONALD, OF SCHENECTADY, NEW YORK, ASSIGNOR TO
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ELECTRIC CONTROLLER.

SPECIFICATION forming part of Letters Patent No. 585,772, dated July 6, 1897.

Application filed January 5, 1897. Serial No. 618,031. (No model.)

To all whom it may concern:

Be it known that I, ALEXANDER F. MACDONALD, a citizen of the United States, residing at Schenectady, in the county of Schenectady, State of New York, have invented certain new and useful Improvements in Electric Controllers, (Case No. 455,) of which the following is a specification.

The present invention relates to controllers for controlling electric motors. I have aimed to simplify the construction of the controllers by lessening the number of necessary moving contacts and in certain cases arranging the contacts on the controller-drum so as to economize space.

The improvement herein set forth may be embodied in controllers for a number of different purposes. I show it applied to controllers used for braking and regulating electric motors on electric tramways, and also applied to controllers for low and high speed combinations, such as are used for heavy traffic, since both of these types of controllers are now especially notable instances in which simplification is desirable in order to keep down the size and weight of the apparatus.

In a combined regulating and brake controller I dispense with the extra set of moving contacts heretofore employed for establishing the brake-circuit, and I utilize in their stead the moving contacts normally employed in establishing and controlling the power-circuit, thereby reducing the number of moving contacts and the cost of maintenance to a minimum. In carrying out this particular feature of the invention a single set of contacts is mounted on a cylinder in the usual manner. Situated in such a position that they will make contact with the moving cylinder are two sets of stationary brushes arranged in alternation, the contacts on the cylinder bearing such a relation to the stationary sets of brushes that only one set can be in engagement with the cylinder at a given time. To move the cylinder in a vertical direction, so that the contacts thereon may be opposite the desired set of brushes, a lever is provided, so arranged that a movement in one direction will move the contacts on the

cylinder to a point where they will engage with one set of brushes, and when in the other direction the contacts will be in a position to engage with the other set of brushes. One set of stationary brushes is connected to the dynamo-electric machines in such a manner that when current is supplied thereto by moving the contact-cylinder into engagement with the brushes the dynamo-electric machines will act as motors and propel the vehicle. The second set of brushes is so connected that when the contacts on the cylinder are moved to a position opposite them and the circuit closed the dynamo-electric machines, having been converted into generators by suitable means, will supply current for braking purposes, and by varying the position of the contact-cylinder the resistance of the circuit may be regulated.

In certain types of controllers with which I am familiar, particularly designed for heavy work, a commutating-switch is employed for establishing a series or parallel relation of the motors and a separate rheostatic switch or cylinder for closing the circuit and regulating the motors when so connected.

By my present invention the commutating-switch is dispensed with and a double set of stationary brushes provided, so connected with the motors that when one set of brushes is in engagement with the contacts on the moving cylinder a series relation of the motors is established and when with the second set a parallel relation, the cylinder being so arranged that the resistance of the circuit in either case may be varied as desired.

A further object of the invention is to reduce the height of the contact-cylinder, (which in controllers designed for heavy work is an important advantage,) at the same time maintaining suitable insulation between contacts. The invention also has for its object to utilize the inner periphery of the cylinder, which as ordinarily constructed is unemployed.

In carrying out the last-named feature of my invention certain of the contacts are placed on the inner periphery of the cylinder and preferably staggered with respect to those on the outer periphery, thereby reduc-

ing the liability of short-circuiting by the screws or bolts employed in securing the contacts to the cylinder. Extending upward inside of the cylinder in a direction parallel to the actuating-shaft is a suitable insulating-support, to which are secured the sets of brushes, the cables or connections therefrom being brought out in any suitable manner which will permit the free operation of the cylinder. A second set of brushes would also be mounted for engagement with the other set of moving contacts.

In the accompanying drawings, attached to and made a part of this specification, Figure 1 is a diagrammatic view of my invention with the circuits arranged for propelling and braking purposes. Fig. 2 is a diagrammatic view in which the circuits are arranged for high and low speed combinations. Fig. 3 is a plan view of the contact-cylinder. Fig. 4 is a sectional view of the same, and Fig. 5 is a section on line 5 5 of Fig. 4.

The cylinder A is provided with contacts mounted thereon in any desired manner and adapted for rotary movement. Situated at one side of the cylinder are two sets of stationary brushes arranged in alternation, those numbered from 1 to 10 being employed when the motors M and M' are employed for propelling the vehicle and those from 11 to 22 when the motors M and M' have been converted into generators and are supplying current to the brakes S. A reversing-switch B is located in any convenient part of the controller-casing and is so arranged that the direction of rotation of the motors may be reversed, and also the relation of the field and armature of the motors at the time it is desired to convert the motors into generators and supply current to the brakes S. I prefer to employ for this purpose the switch mechanism shown in the patent to E. A. Sperry, No. 566,426, dated August 25, 1896. As the particular construction of the reversing-switch forms no part of this invention, further reference to the operating mechanism will be omitted.

In Figs. 3, 4, and 5 I have shown the mechanical construction of the switch. A central shaft B is provided on which are mounted the spiders C C, provided with spokes and a flange which on its outer periphery is polygonal, thereby furnishing a good bearing-surface for the insulating-pieces D, which form the barrel of the controller. Mounted on the insulating-pieces D are the contacts E, which are divided in any suitable manner to give the desired electrical connections. At the lower portion of the cylinder or barrel and on the inside are a number of contacts E'. These are similar in construction to those on the outside and are preferably staggered with respect thereto. This reduces to a minimum the liability of short-circuiting between the contacts by the screws or bolts employed in their construction. Engaging with the con-

tacts E and E' are rows of brushes mounted on insulating-supports F F'. These brushes are provided with springs, permitting them to make good contact with the moving cylinder.

In order to raise the cylinder A vertically when it is desired to establish new circuit connections, a collar B' is mounted on the shaft B, and engaging therewith is a cam I', mounted on the shaft I and actuated by means of the lever H. The cam and lever are so arranged that when the latter is in the extreme forward position the cylinder will be in the position shown, but when the lever H is moved to the left the cam I', engaging with the collar B', will lift the cylinder bodily to a position where its contacts will be opposite the second set of stationary brushes and in position to coöperate therewith. Surrounding the cylinder A is a suitable case provided with bearings for the shaft B and also for the cam-shaft I. The cylinder A can be actuated by any suitable means, a handle G being shown.

In electric controllers when employed for heavy work it is necessary to employ a large number of contacts which are suitably spaced one from the other to maintain good insulation. This involves the use of a contact-cylinder having a large number of rows of contacts, the number of contacts being at times so great that it is necessary to provide two cylinders and gear them together. In the present invention I reduce the vertical height of the cylinder by mounting certain of the contacts on the inner periphery of the cylinder, as described. It is immaterial which of these contacts are so placed. It is, however, desirable to place thereon contacts which are liable to the least amount of sparking, it being well known that in controllers sparking is less liable to occur at some points than others, due to the particular connection which the contact-brush at this point makes with the motor or motors.

Referring to Fig. 1, the operation of the controller will be described in connection with the electric brakes. Assuming, for example, that it is desired to propel the vehicle, the cylinder A is brought to the position shown in full lines, and current entering by the trolley T passes to brush 1, to the contact opposite it on the cylinder A, thence to the brush 2 by contacts and cross connection on the cylinder A, through the resistance R, wire *a*, to brush 23, by the contact on the cylinder B to brush 24, thence to armature of motor M, to brush 25, thence by contact on switch B to brush 26, to the field of motor M, to brush 9, to contact on cylinder A, by cross connection on the cylinder to brush 10, to brush 27, by contact on the reversing-switch B to brush 28, to the armature of motor M', to brush 29, by contact on switch B to brush 30, to the field of motor M', to ground *g*. This will establish the series relation of motors with full resistance in circuit. As the cylinder A is

rotated from right to left one section after another of the resistance R is cut out of circuit until the motors are connected directly between the trolley and ground.

5 If it is desired to brake the vehicle, the cylinder A, by means of the lever H and the mechanism previously described, will be raised to the position shown in dotted lines. At the same time by suitable mechanism the reversing-switch B will be moved so that the brushes 10 23 to 30, inclusive, will be in position to engage with the middle row of contacts, and the circuit will be as follows, assuming it to begin at the point *c* at the end of the resistance 15 R: by wire *a* to brush 23, to brush 25 by means of cross connection on the switch B, through the armature of motor M in the direction indicated by the dotted arrow, to brush 24, to brush 26 by means of the contacts on the reversing-switch, to the field of motor M, 20 the current flowing in the same direction as when used for propelling the vehicle, to brush 21, to the opposite contact on the cylinder A, by cross connection to the next lower contact, to brush 22, to ground *g'*. Starting again at point *c*, the second circuit is through brush 25 the second circuit is through brush 19, by cross-connected contacts on the cylinder A to brush 20, to brush 27, by cross-connected contacts on the reversing-switch to 30 brush 29, to armature of motor M', in the direction indicated by the dotted arrow, to brush 28, by cross-connected contacts on the reversing-switch to brush 30, to the field of motor M', and to ground *g*. The current then passes 35 from the grounds *g* and *g'* of both machines to the ground *g*², thence through the brake-magnets S in series to brush 11, thence by cross-connected contacts on the cylinder A to brush 12, through the sections of resistance 40 R to the starting-point *c*. It will be seen that the motors are connected in multiple and are supplying current to the brake-magnets S, which are connected in series. Further movement of the cylinder A to the left will 45 cut the sections of resistance R out of circuit step by step until it is entirely eliminated.

It will be observed from the above that one set of the stationary brushes is so connected with the motor-circuits that when current is 50 supplied thereto through the cylinder A the motors are connected to perform one operation and that when the cylinder A is shifted to its upper position the brushes, which will then engage with the contacts on cylinder A, 55 establish a different set of circuit relations and in this case are employed for a different purpose—namely, that of braking the vehicle.

In Fig. 2 I have shown a modification of my invention, in which the circuits and contacts 60 are so arranged as to establish high and low speed combinations. The brushes 1 to 8, inclusive, are so arranged that when the circuit is established through the switch A a series relation of the motors is established, and 65 when the brushes 11 to 20 are in engagement with the contacts on the cylinder A a parallel relation is established. The cylinder A

in this figure is shown in its upper or parallel position, the dotted lines showing its lower or series position. The circuit through the 70 motors being readily traced, further description is unnecessary.

In a controller of this kind it is necessary to bring the cylinder A to the "off" position, which will interrupt the circuit, before shifting it to its upper position either for braking 75 or for high-speed purposes.

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

1. In an electric controller, the combination 80 of a single set of moving contacts, two sets of brushes mounted for dissimultaneous engagement therewith, the two sets of brushes establishing different circuit combinations of the dynamo-electric machines, and means for 85 changing the relation between the contacts and sets of brushes.

2. In an electric controller, the combination of a contact-cylinder mounted for rotary 90 movement, stationary brushes mounted for engagement therewith, means for imparting a rotary movement to the cylinder, and means for moving the cylinder in a direction parallel to its axis when it is desired to establish 95 a new relation of the motors.

3. In an electric controller, the combination of a cylinder mounted for rotary movement, a set of contacts mounted thereon, means for moving the cylinder parallel to its axis, two 100 sets of brushes mounted for engagement with the contacts on the cylinder, one set of brushes being arranged to establish one combination of circuits when in engagement with the cylinder-contacts, the other set of brushes establishing a different combination of circuits 105 when engaging with the same contacts.

4. In an electric controller, for electrically-propelled vehicles, the combination of a single set of moving contacts, a set of brushes so 110 connected to the motors that the latter will propel the vehicle when the power-circuit is completed by the cylinder-contacts, a second set of brushes so connected as to establish the brake-circuit when the circuit is closed by the 115 contacts on the cylinder.

5. In an electric controller, the combination of a contact-cylinder mounted for rotary 120 movement, means for moving the cylinder in a direction parallel to its axis, brushes mounted for engagement with the cylinder, certain of them engaging with the cylinder-contacts when the cylinder is in one position, the remainder after the cylinder has been moved to a new position.

6. In an electric controller, the combination 125 of a cylinder, a single set of contacts mounted thereon, a set of brushes so connected to the motors that the latter will propel the vehicle when the circuit is completed by the cylinder-contacts, a second set of 130 brushes normally out of engagement with the cylinder-contacts and so connected as to establish the brake-circuit when the latter is closed by the cylinder-contacts, and means

for moving the cylinder-contacts into a position for cooperating with the brushes connected to the brake-circuit.

7. In an electric controller, the combination of a cylinder provided with a single set of contacts permanently connected to give any desired motor combination, two sets of brushes mounted on a vertical support, the brushes of one set alternating with those of the second set, the stationary brushes and cylinder-contacts bearing such a relation to each other that only one set of brushes can be in contact at a given time, and means for moving the cylinder into position for engagement with either of the sets of brushes.

8. In an electric controller, the combination of a contact-cylinder provided with contacts mounted on the outer periphery of the drum, contacts mounted on the inner periph-

ery, stationary brushes engaging with the outer peripheral contacts and stationary brushes engaging with the inner peripheral contacts.

9. In an electric controller, the combination of a spider or support insulation mounted thereon forming the drum, contacts mounted on the inner periphery, the inner and outer peripheral contacts being staggered, stationary brushes engaging with the outer set of contacts, and stationary brushes mounted on a suitable support within the drum making contact with the inner contacts.

In witness whereof I have hereunto set my hand this 31st day of December, 1896.

ALEXANDER F. MACDONALD.

Witnesses:

A. C. SAVAGE,

B. B. HULL.