

No. 609,251.

Patented Aug. 16, 1898.

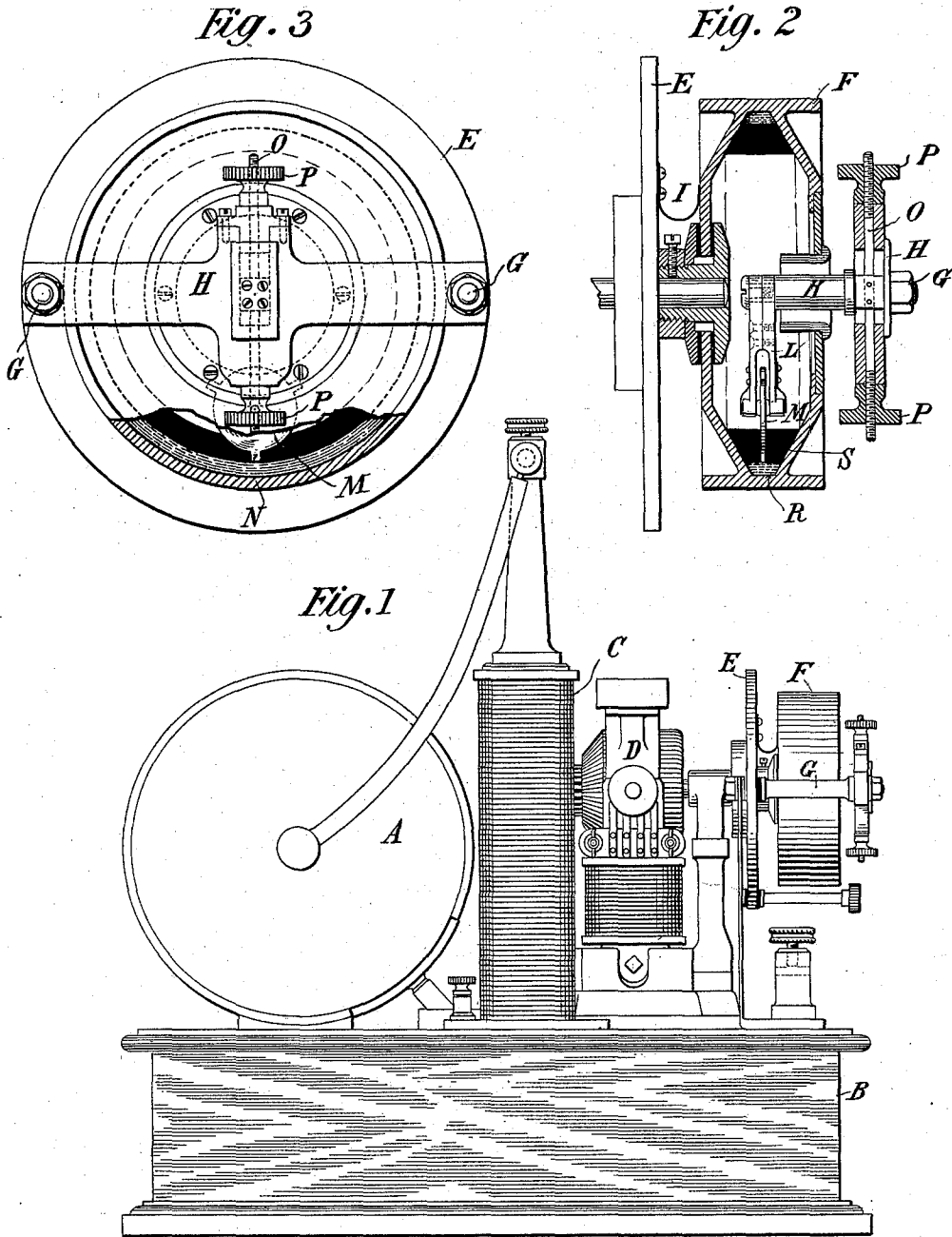
N. TESLA.

ELECTRIC CIRCUIT CONTROLLER.

(Application filed June 3, 1897. Renewed June 15, 1898.)

(No Model.)

2 Sheets—Sheet 1.



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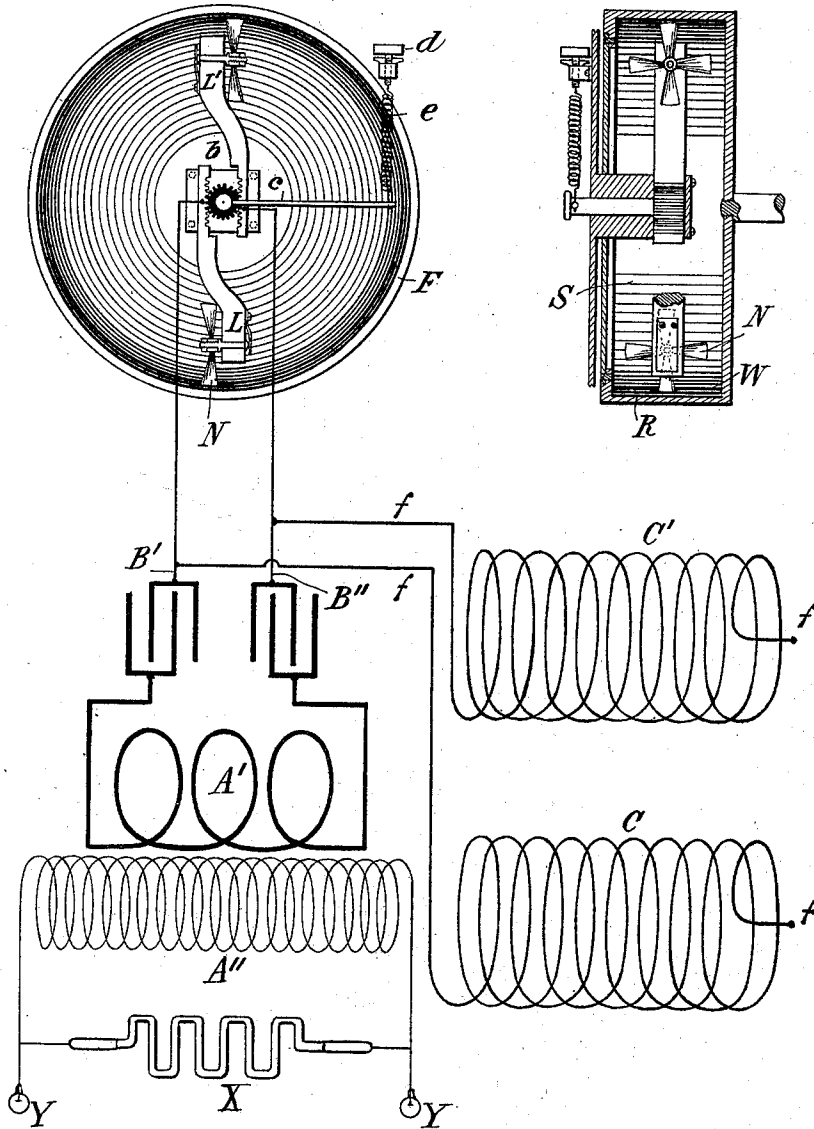
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2 Sheets—Sheet 2.

Fig. 4

Fig. 5



WITNESSES

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# UNITED STATES PATENT OFFICE.

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## ELECTRIC-CIRCUIT CONTROLLER.

SPECIFICATION forming part of Letters Patent No. 609,251, dated August 16, 1898.

Application filed June 3, 1897. Renewed June 15, 1898. Serial No. 683,525. (No model.)

*To all whom it may concern:*

Be it known that I, NIKOLA TESLA, a citizen of the United States, residing at New York, in the county and State of New York, have invented certain new and useful Improvements in Electric-Circuit Controllers, of which the following is a specification, reference being had to the drawings accompanying and forming a part of the same.

In previous patents granted to me I have shown and described methods and apparatus for the conversion and utilization of electrical currents of very high frequency based upon the principle of charging a condenser or a circuit possessing capacity and discharging the same generally through the primary of a transformer, the secondary of which constituted the source of working current and under such conditions as to yield a vibrating or rapidly-intermittent current.

In some of the forms of apparatus which I have heretofore devised for carrying out this invention I have employed a mechanism for making and breaking an electric circuit or branch thereof for the purpose of charging and discharging the condenser, and my present application is based upon a novel and improved form of device for this purpose, which may be generally styled a "circuit-controller."

In order that the full advantages of my system may be realized and the best practical results secured, the said circuit-controller should be capable of fulfilling certain requirements, the most important among which is the capability of effecting an extremely-rapid interruption and completion of the circuit. It is also of importance that such makes and breaks, and more especially the former, should be positive and abrupt, and from considerations of economy and practicability it is essential that the apparatus should be cheaply constructed, not liable to derangement, and capable of prolonged use without attention or adjustment. With the object of attaining these results, which have never heretofore been fully attained in any form of mechanical circuit-controller of which I am aware, I devised and developed the circuit-controller which forms the subject of my present application and which may in general terms be described as follows:

The device in its typical embodiment comprises as essential elements two terminals—one with peripheral contacts alternating with insulating-spaces, such as is exemplified in a stelliform disk and which is capable of rotation, and the other a rotatable receptacle containing a fluid in which more or less of the first-named terminal is immersed.

In the preferred construction of the apparatus the receptacle contains both a conducting and a non-conducting fluid, the former being the heavier, and I maintain the terminals in such relations that the electrical connection between them is made and broken by the successive immersion of the contact-points into and their withdrawal from the conducting through the non-conducting fluid. These relations are best maintained by such construction of the receptacle that the distribution of the two fluids necessary for the proper operation of the device may be preserved by centrifugal action and the rotation of the other terminal effected by the movement of the fluid or fluids relatively thereto.

To secure the conditions necessary for the accomplishment of the objects of the invention, various mechanical expedients may be resorted to; but the best and most practicable device for the purpose of which I am aware is a hollow wheel or drum mounted so as to be rotated at any desired speed and containing a conducting fluid, such as mercury or an electrolyte, which by the rotation of the drum is thrown by centrifugal force outward to the inner periphery of the same, and a sufficient quantity of a lighter non-conducting or poorly-conductive fluid, such as water or oil, which by the centrifugal action is maintained on the surface of the heavier conducting fluid and tends to prevent the occurrence of arcs between the contact-points and the conducting fluid.

A central opening is formed in one side of the drum, through which enters an arm carrying a disk with peripheral projections or vanes which when the drum is rotated project to a sufficient extent toward or into the conducting fluid to effect the makes and breaks of the circuit.

The motion of the fluid within the drum causes the disk to rotate and its projections or vanes to make and break the circuit with

a rapidity which may be very great. In fact, when the drum is rotated at a high rate of speed the fluid conductor may become in its effect similar to a solid body, upon which the conducting-disk rolls, so that the conducting fluid might be dispensed with, although I find it preferable to use it.

In order to insure the proper immersion of the projections into the fluid to compensate for wear and at the same time to secure a yielding pressure between the fluid and the disk, it is desirable to employ for the disk some form of spring connection or support which will exert a force tending to force it in contact with the fluid.

I have also devised certain details of construction which add to the efficiency and practicability of the apparatus which will be more conveniently described by reference to the accompanying drawings.

Figure 1 is a side elevation of a complete apparatus for producing currents of high frequency and to which my present invention is applied. Fig. 2 is a central vertical section of the improved circuit-controller of Fig. 1; Fig. 3, an end view of the same; Fig. 4, a modified form of the circuit-controller, showing it in connection with the remaining parts of the apparatus illustrated diagrammatically; and Fig. 5, a side view of the same with the receptacle in section.

As the apparatus as a whole is now well known, a brief description of the same will suffice for an understanding of its character.

The various parts or devices are preferably mounted on a base B, which contains the condenser, and comprise a transformer A with primary and secondary coils, one or more self-induction coils C, a small electromagnetic motor D, and the circuit-controller, which is driven by the motor. The circuit connections will be described in connection with Fig. 5.

In general plan of construction and arrangement the apparatus is essentially the same as that described and shown in a patent granted to me September 22, 1896, No. 568,176.

The shaft of the motor D extends through a stationary disk E, and to its end is keyed a hollow wheel or drum F, which rotates with it. Two standards G are secured to the disk E and connected by a cross-bar H, from which extends an arm K into the interior of the drum F through a central opening in its side.

To the end of the arm K is secured an arm L, carrying at its free end a disk M with peripheral teeth or projections N, as shown in Fig. 3. The disk is mounted on any suitable bearings in the arm L, so as to be capable of free rotation.

It is desirable that the disk should admit of adjustment with respect to the inner peripheral surface of the drum, and for this purpose I secure the arm K to a rod O, which passes through supports in the cross-bar H and is adjustable therein by means of threaded nuts P.

The interior of the drum F is formed by preference in substantially the manner shown

in Fig. 2—that is to say, it is tapered or contracted toward the periphery so as to form a narrow trough in which the fluid is confined when the drum is rotated.

R designates the conducting fluid, and S the lighter non-conducting fluid, which are used in the drum. If the proper quantities and proportions of these fluids be introduced into the drum and the latter set in rapid rotation, the two fluids will distribute themselves under the action of centrifugal force around the drum in the manner indicated in Fig. 2. The arm K is adjusted so that the teeth or projections on the disk M will just enter the conducting fluid, and by the action of either or both the disk will be rapidly rotated. Its teeth are so arranged that no two are simultaneously in contact with the conducting fluid, but come into the same successively. If, therefore, one part of the circuit be connected to the drum, as by a contact strip or brush T, and the other part to the disk M, or to any part, as the standards G, which are insulated from the frame of the apparatus and in metallic connection with the disk M, the circuit will be made and broken with a rapidity which may obviously be made enormously high. The presence of the non-conducting fluid on the surface of the other operates to prevent the occurrence of sparks as the teeth N leave the latter and also to prevent the current from leaping across the space between the teeth and the conductor as the two approach.

In illustration of the modifications of which the improvement is susceptible I now refer to Figs. 4 and 5, in which also certain novel and useful details of construction applicable generally to the invention are shown.

In the modification shown in Figs. 4 and 5 two rigid arms L and L', each carrying a disk M, are shown, and this number may be increased, if so desired. The rotating disks in this case are mounted on spindles at right angles to the axis of rotation of the drum F, and the contact points or projections are formed as vanes, with faces inclined to the plane of rotation, so as to be rotated by the movement of the fluid in the manner of turbine wheels.

In order to provide a means for automatically adjusting the disks to compensate for any wear and keep the ends of the vanes or points properly immersed in the fluids, each disk-carrying arm is impelled by a spring or weight in the direction of the periphery of the drum. A convenient way to accomplish this is to form racks on the arms L L' and to provide a pinion *b* in engagement therewith. From the shaft of the pinion extends an arm *c*, the end of which is connected to an adjustable stop *d* by a spiral spring *e*, the tendency of which is to turn the pinion and force both arms L and L' toward the periphery of the drum.

In some applications of the invention it is practicable to prevent the occurrence of arcs

still more effectively or even entirely by using in addition to the non-conducting fluid a somewhat heavier fluid W, which is a comparatively poor conductor and which takes up a position between the conducting and non-conducting fluids.

When two or more disks or equivalent devices are used, they may be connected either in series or multiple. In the present illustration they are shown as in series, and as the arms L and L' are insulated from each other and each connected with a terminal of the source of current the circuit is completed only when a vane of each disk is immersed in the conducting fluid and interrupted at all other times.

The diagram of circuit connections will serve to illustrate the purpose and mode of operation of the device. Let  $f$  be the conductors from a source of current, each including a self-induction coil C C' and connected with the arms L and L' and with two conductors B' B'', respectively. Then during the periods when the circuit is completed between the two arms L L' the coils C C' store energy, which on the interruption of said circuit rushes into and charges the condensers. These latter during the periods when the circuit is closed between arms L and L' discharge through the primary A' and induce by such discharge currents in the secondary A'', which are utilized for any purpose for which they may be suited, as in operating vacuum-tubes X or suitable lamps Y.

It will be understood that the rotating drum may be mounted in a horizontal or other plane and from the nature and objects of the results which are attained by the particular apparatus described the construction of this apparatus may be very greatly varied without departure from my invention.

Without therefore limiting myself to the details of construction and arrangement shown herein in illustration of the manner in which my invention is or may be carried out, what I claim is—

1. A circuit-controller comprising, in combination, a receptacle containing a fluid, means for rotating the receptacle, and a terminal supported independently of the receptacle and adapted to make and break electric connection with the receptacle through the fluid, as set forth.

2. A circuit-controller comprising in combination a receptacle containing a conducting fluid and a non-conducting fluid, means for rotating the receptacle and a terminal adapted to make and break electrical connection with the conducting fluid within or under the non-conducting fluid, as set forth.

3. A circuit-controller comprising in combination a terminal capable of rotation and formed or provided with peripheral contacts, a receptacle comprising the opposite terminal and containing a fluid into which the said contacts extend, and means for rotating the receptacle, as set forth.

4. A circuit-controller, comprising, in combination, a terminal capable of rotation and formed or provided with peripheral projections, a receptacle containing a fluid conductor into which the points or projections of the said conductor extend, and means for rotating the said receptacle, as set forth.

5. A circuit-controller comprising, in combination, a terminal capable of rotation and formed or provided with peripheral projections, a centrifugal drum or wheel containing a fluid conductor into which the points or projections of the said conductor extend, and means for rotating the said drum, as set forth.

6. A circuit-controller comprising, in combination, a terminal capable of rotation and formed or provided with peripheral projections, a centrifugal drum or wheel containing a fluid conductor into which the points of the said terminal extend, and means for adjusting the latter with relation to the surface of the fluid, as set forth.

7. A circuit-controller comprising, in combination, a terminal having peripheral projections and capable of rotation, a centrifugal drum or receptacle containing a conducting and a lighter non-conducting fluid, the said terminal being arranged so that its points or projections extend through the non-conducting into the conducting fluid, when the fluids are distributed in the drum under the action of centrifugal force, as set forth.

8. The combination with a hollow centrifugal drum or wheel containing a conducting fluid, a motor for rotating the same, a support extending through an opening into the drum, and a rotatable terminal having peripheral projections, mounted on said support in position in which its projections extend into the fluid when displaced by centrifugal action, as set forth.

9. The combination with a receptacle containing a fluid and means for rotating the same, a terminal with peripheral projections capable of rotation, and a spring connection or support for said terminal tending to force it toward the periphery of the receptacle, as set forth.

10. The combination with a hollow centrifugal drum or wheel containing a conducting fluid and a lighter non-conducting fluid, means for rotating the said drum, a support extending through an opening into the drum, and a rotatable terminal having peripheral projections, mounted on said support in position in which the projections extend through the non-conducting into the conducting fluid when the fluids are displaced by centrifugal action, as set forth.

11. The combination with a centrifugal drum containing a conducting and a non-conducting fluid, means for rotating the drum, a terminal capable of rotation and having peripheral projections, mounted within the drum on a stationary support, and a spring or its equivalent acting on the said terminal

and tending to force its projections toward the inner periphery of said drum, as set forth.

12. The combination with a receptacle containing a conducting fluid, a lighter fluid of low conductivity and a non-conducting fluid lighter than the others, and means for rotating the receptacle, of a terminal adapted to make and break the circuit by movements be-

tween the conducting and non-conducting fluid through the intermediate fluid of low conductivity, as set forth.

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