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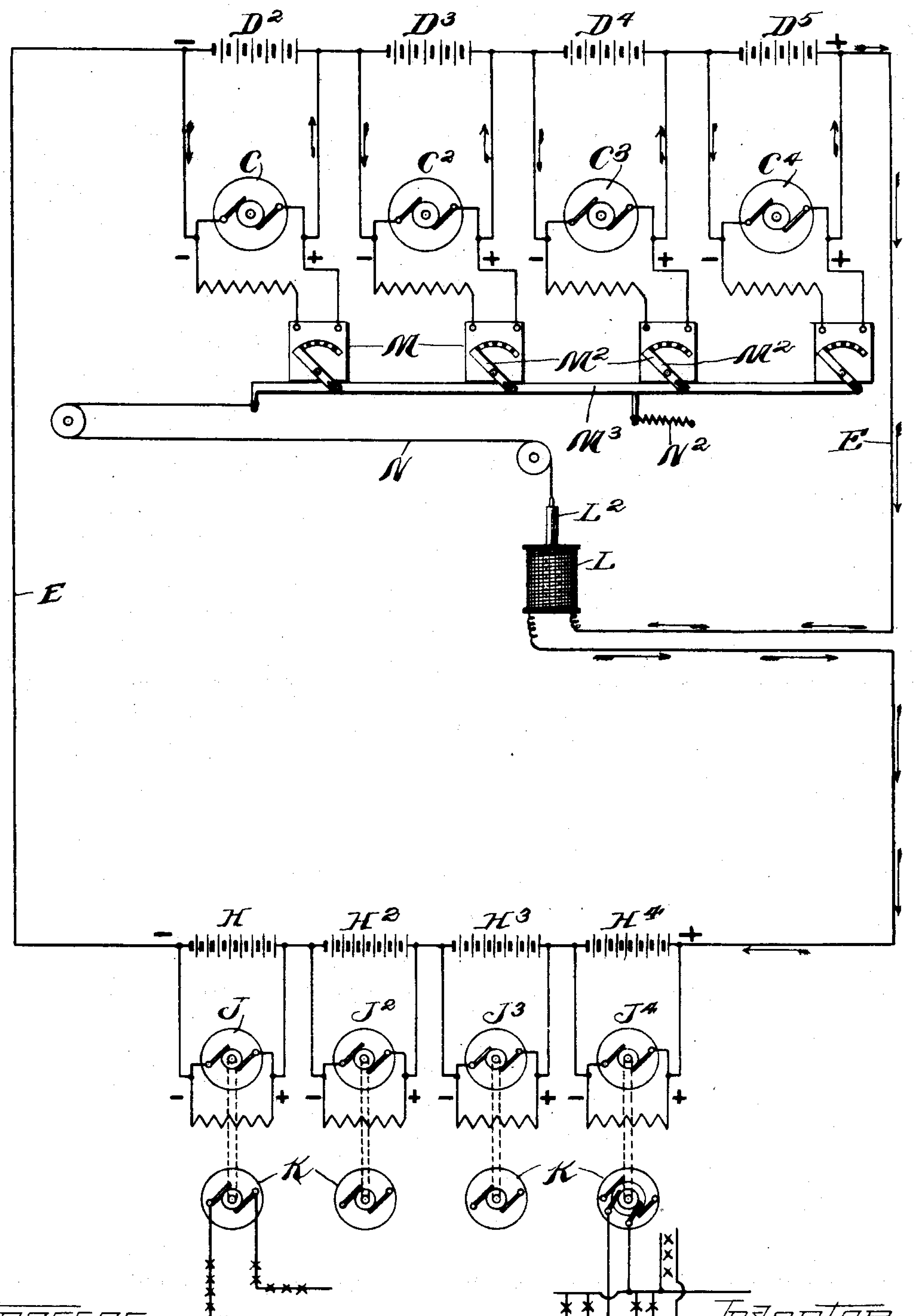
N. G. WARTH.

ELECTRICAL POWER TRANSMISSION SYSTEM.

(Application filed Feb. 11, 1901.)

(No Model.)



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ELECTRICAL POWER-TRANSMISSION SYSTEM.

SPECIFICATION forming part of Letters Patent No. 682,300, dated September 10, 1901.

Application filed February 11, 1901. Serial No. 46,767. (No model.)

To all whom it may concern:

Be it known that I, NATHANIEL G. WARTH, a citizen of the United States, residing at Indianapolis, in the county of Marion and State of Indiana, have invented certain new and useful Improvements in Electrical Transmission of Power, of which the following is a specification.

In the early development of systems of electrical distribution the inherent alternating currents set up in the generator were straightened out or "commutated" into direct currents, and thus distributed through the conductors. In such systems it was found practically impossible to obtain long-distance transmission of current because of the drop in tension caused by the resistance of the conductors, and to apply the system through any considerable distance or to any practical extent it was found necessary to employ conductors of great cross-section, which were expensive and heavy. Owing to the limitations of the generating-machine in commutating its inherent alternating currents it has been impossible to generate straight or direct currents of a sufficiently high tension to overcome this drop of tension in the conductors, and consequently distribution systems which employ direct or continuous currents are circumscribed in the area fed by the current.

Conspicuous among the comparatively recent discoveries and improvements which have brought long-distance distributive systems into common use is the transformer or alternating-current system, whereby the electric current is transmitted from the generating-station to a very great distance at an extremely high pressure and is converted at the points of distribution into the low-pressure currents required by incandescent lamps and other low-capacity mediums of current utilization; but this system of transmission has serious disadvantages, principally because of the loss of energy involved in the conversion of the currents through the transformers. With alternating-current machines the safe voltage is quite limited, being not much in excess of the commutator-machine; but by reason of the currents generated being alternating in character use can be made of "step-up" converters whose insulation can be maintained for extreme voltages quite satisfactorily, and the resulting high-voltage currents of alternating character can be economically transmitted to considerable distances. At the receiving end of the circuit the high-potential current is reduced in voltage by means of "step-down" transformers to safe-voltage currents of quantity, and if the same are to be utilized as or for direct-current use it is necessary to employ direct-current rotary-motor generators to get the proper transformation. A considerable loss is thus sustained in this roundabout method by its four transformations—viz., original generation, step-up generation, transmission, step-down generation, and transformation to direct currents. Another serious effect of alternating-current transmission is the well-known harmonic stresses produced to break down the insulation of the converters and transmission-line. Another undesirable feature of alternating-current transmission is the inductive effects upon circuits and objects along the line, which produce a loss in the actual transmission and detrimental conditions in neighboring circuits. For the foregoing and other reasons which might be specified it may be said that the great desideratum in the transmission of great currents for power, &c., is a direct or continuous current having sufficient voltage to transmit to a considerable distance with small conductors and without great drop in tension and consequent loss of energy. Dynamos for direct currents on account of insulation restrictions and sparking at their commutators are impracticable for voltage in excess of about five thousand volts or difference of potential from pole to pole or across the "terminals" of the machine; but by reason of the far greater simplicity, efficiency, and economy of direct overalternating-current generation, transmission, and utilization its superiority, could but the objections above specified be eliminated or overcome, has long been recognized, and numerous attempts have been made to overcome these objections and make the use of the direct or continuous current for high voltages and long distance practicable. Among the proposed solutions may be mentioned that set forth in the patent to Charles S. Bradley, No. 491,465, dated February 7, 1893, in which a number of generators are coupled in series thoroughly insulated and their combined electromotive force transmitted through the machines themselves to line, the energy being distributed in a precisely similar way through a series of highly-insulated motors at the other end of the line. Another proposed solution is presented in the patent to Müller, No. 614,571, dated November 22, 1898, in which is shown a storage battery the cells of which are connected in series and are charged and then discharged in a low-tension current-charging circuit while the dynamo is disconnected, one machine having a capacity to charge the entire battery and the latter being big enough to carry the load during the time it is discharging with the charging-machine off, a rotating switch being employed to automatically switch the battery on and off the charging-machine, and another multiple-cell battery being employed in the discharging-circuit, which is charged in parallel and discharges in series.

The object of my invention is to generate direct currents of electricity of exceedingly high potential and to accomplish this result by utilizing the output of a plurality of direct-current generators without causing the generated current to pass through each generator.

My invention broadly consists in a plurality of direct-current generators, a plurality of sets of secondary batteries, a local circuit for each set of secondary batteries, and its direct-current generator, said sets of secondary batteries being connected serially with one another and with the transmission-line, whereby each generator locally delivers its output into its corresponding set of secondary batteries and each set of serially-arranged secondary batteries delivering its current to the transmission-line, said apparatus and circuit arrangement constituting the generating end of the system. Sets of secondary batteries, included serially with one another and with the transmission-line, are also provided at the reception end of the circuit system, having local circuits for each set of serially-arranged batteries, which local circuits each includes a translating device or devices whereby the transmitted current is reduced in potential through the serially-connected sets of secondary batteries.

Referring to the drawing, the figure is a diagrammatic representation of the circuit arrangement and apparatus of a complete system.

I have illustrated and shall describe a circuit arrangement and arrangement of apparatus whereby to accomplish the results hereinbefore generally outlined.

As illustrated in the drawing, I have shown a metallic transmission-line E, but which may be grounded at either end. This transmission-line, starting from the upper end, is first connected with the coils of the first one of the plural number of generators designated at C.

I provide a number of sets of secondary batteries, designated, respectively, at D^2, D^3, D^4, and D^5, as shown, each set of said batteries being connected in a local circuit with its respective direct-current generator. Thus the first set of secondary batteries D^2 is connected in a local circuit with the generator C, the second set of secondary batteries D^3 is connected in a local circuit of its own with the generator C^2, the third set of secondary batteries D^4 is connected likewise in a local circuit of its own with the generator C^3, and the fourth set of secondary batteries is also connected in a local circuit of its own with the generator C^4. For the sake of clearness in illustration I have shown only four of such generators connected, respectively, in local circuit with their respective sets of secondary batteries; but it will be apparent that any number of such generators may be so connected. Each one of the respective sets of secondary batteries is connected serially one with the other and serially with the transmission-circuit, which is designated at E.

Having thus described the generating end of the transmission and utilizing system, I will now proceed to describe the receiving end of said system. At this end of the transmission-circuit I also employ independent sets of secondary batteries, designated, respectively, as shown at H, H^2, H^3, and H^4, these sets of secondary batteries being also serially connected one with the other and in the transmission-line. One of these sets of secondary batteries is also connected in a local circuit with a translating device, such as a motor or other translating device. Thus the set of secondary batteries H is connected in a local circuit with the motor J, the set of secondary batteries H^2 is connected in a local circuit of its own with the motor J^2, the set of secondary batteries H^3 is also connected in a local circuit of its own with the motor J^3, and the set of secondary batteries H^4 is connected in a local circuit of its own with the motor J^4, it being readily apparent that the number of translating devices at the receiving-end of the circuit and their corresponding sets of secondary batteries may be increased or reduced, as may be convenient or necessary in practice. I have also illustrated the specific application in this instance of electric motors, which are illustrated as directly connected with secondary generators K, respectively, as shown, and generating-current to supply an incandescent-lighting system and an arc-lighting system, respectively.

In order to accommodate for variations of load in the transmission-circuit, I provide a current-regulating device or controller in the transmission-circuit, which is operated under variations of current to in turn establish conditions in one or more of the local circuits, whereby to control the output of any one or more of the generators. This controller, as shown, consists in a solenoid L, having a movable core L^2, which solenoid is connected in the transmission-circuit E. As illustrated, the output of the generators of each local circuit is regulated by rheostats M, the levers M^2 of which are operated by means of a connecting-rod M^3, to which each lever is shown as attached. The core L^2 of the solenoid L is connected by a flexible connector N with the connecting-rod M^3, and a retractile spring N^2 at the other end of the rod restores the levers M^2 of the rheostat M to a normal position. When the demand for current at the receiving end of the transmission-circuit varies and is increased, for instance, the attractive effect of the solenoid L upon its core L^2 is increased, thus imparting a pull upon the connector N and the connecting-rod M^3 and operating the levers M^2 of the rheostat to decrease the resistance in the local circuits of the fields of the generators. When the current decreases in the transmission-line, the pull of the solenoid L upon its core L^2 is relaxed, permitting the retractile spring N^2 to pull the connecting-rod M^3 to such an extent as is necessary to provide conditions of resistance in the generator-fields to compensate for that decrease of current in the transmission-line. It is apparent that any one of the well-known means of regulating the output of a generator may be employed in this connection, and I do not desire to limit my invention to the specific means which I have herein shown; but my invention consists in this particular in the provision of a controller included in the transmission-circuit which operates in response to variations of current in the line to regulate the output of one or more of the generators in a local circuit with respective sets of secondary batteries.

In the ordinary practice of charging secondary batteries the total voltage of the batteries is proportioned to the voltage of the charging-generator, and in this system it is evident that the same rule maintains. It is further evident that the ultimate voltage which is applied to the transmission-line is the sum of the voltage of the sets of serially-connected secondary batteries.

It will be observed that instead of connecting the generators in series one with the other and delivering current from one generator into the next succeeding generator and so on until the accumulated current of the serially-arranged generators is applied to the line I provide a local circuit about each generator, having therein a set of secondary batteries, and deliver the current from each generator into its set of secondary batteries, which latter are connected together in series in such a way that the accumulated current has a voltage which is the sum of the voltage of the respective sets of secondary batteries then applied to the line. This current of exceedingly high voltage is transmitted to the receiving end of the line and there is received through a similar arrangement of secondary batteries, to which the translating devices are connected in local circuits similar to those at the generating end of the system, whereby it is converted at the points of distribution into the low-potential currents required at such points.

Having thus described my invention, what I claim as new, and desire to secure by Letters Patent, is—

1. In an electric generating and transmitting system, a multiple number of direct-current generators operated simultaneously in connection with a multiple number of groups or sets of secondary batteries, which latter are in series connection with the transmission-line for generating and transmitting direct currents of high potential.

2. In a generation system, a plurality of direct-current primary generators, a plurality of sets of secondary batteries, serially connected with each other and with the transmission-line, and a local circuit for and including each said set of batteries and its generator.

3. A system of high-potential direct-current generation and transmission wherein each of a number of direct-current generators delivers its generated direct currents locally to a suitable set of secondary batteries, the plural sets of said batteries being connected in series relative to each other and to the transmission-line, the generation of current and transmission of same being practically simultaneous.

4. In an electric direct-current generating and transmitting system, the combination with a transmission-line, of a multiple number of groups or sets of secondary batteries in series in the line at the transmitting and receiving points, a multiple number of direct-current generators connected simultaneously operating with the secondary batteries at the transmission-points of the line, translating apparatus connected with the secondary batteries at the receiving point or points, whereby direct high-potential currents may be generated, transmitted and utilized.

5. In a high-tension direct-current-transmission system, a plurality of direct-current generators, sets of secondary batteries, each set connected with each generator, sets of secondary batteries at the receiving end of the system, a translating device connected with each set of secondary batteries, an electromagnetic controller in the transmission-line and means for controlling or regulating the output of the current of the generators, actuated by the electromagnetic controller, in response to the current demand.

6. In an electric direct-current generating and transmitting system, the combination with a transmission-line, of a multiple number of groups or sets of secondary batteries in series in the line at the transmitting and receiving points, a multiple number of direct-current generators at the transmitting-points, local circuits including each such generator

and group or set of batteries, translating devices at the receiving end of the line, and local circuits connecting each such device with a group or set of said secondary batteries according to the potential differences desired whereby direct currents of high potential may be generated, transmitted and utilized at lower tensions.

Signed by me at Indianapolis, Marion county, Indiana, this 1st day of February, 1901.

NATHANIEL G. WARTH.

Witnesses:
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