(No Model.) 4 Sheets—Sheet 1.

W. MEISSNER.

SYSTEM OF ELECTRICAL DISTRIBUTION.

No. 497,755. Patented May 16, 1893.

Fig. 1. *Fig. 3.*

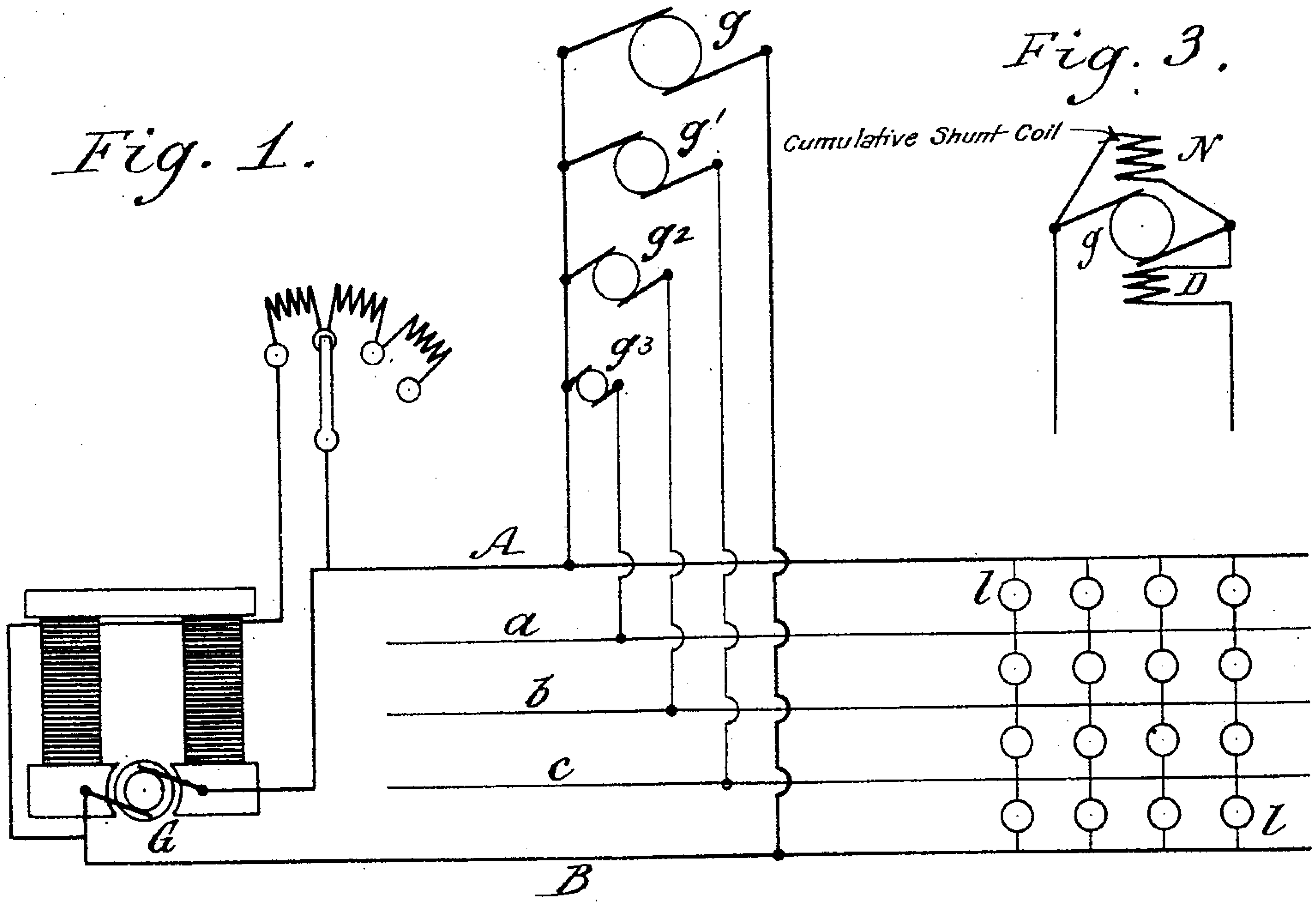

Fig. 2. *Fig. 4.*

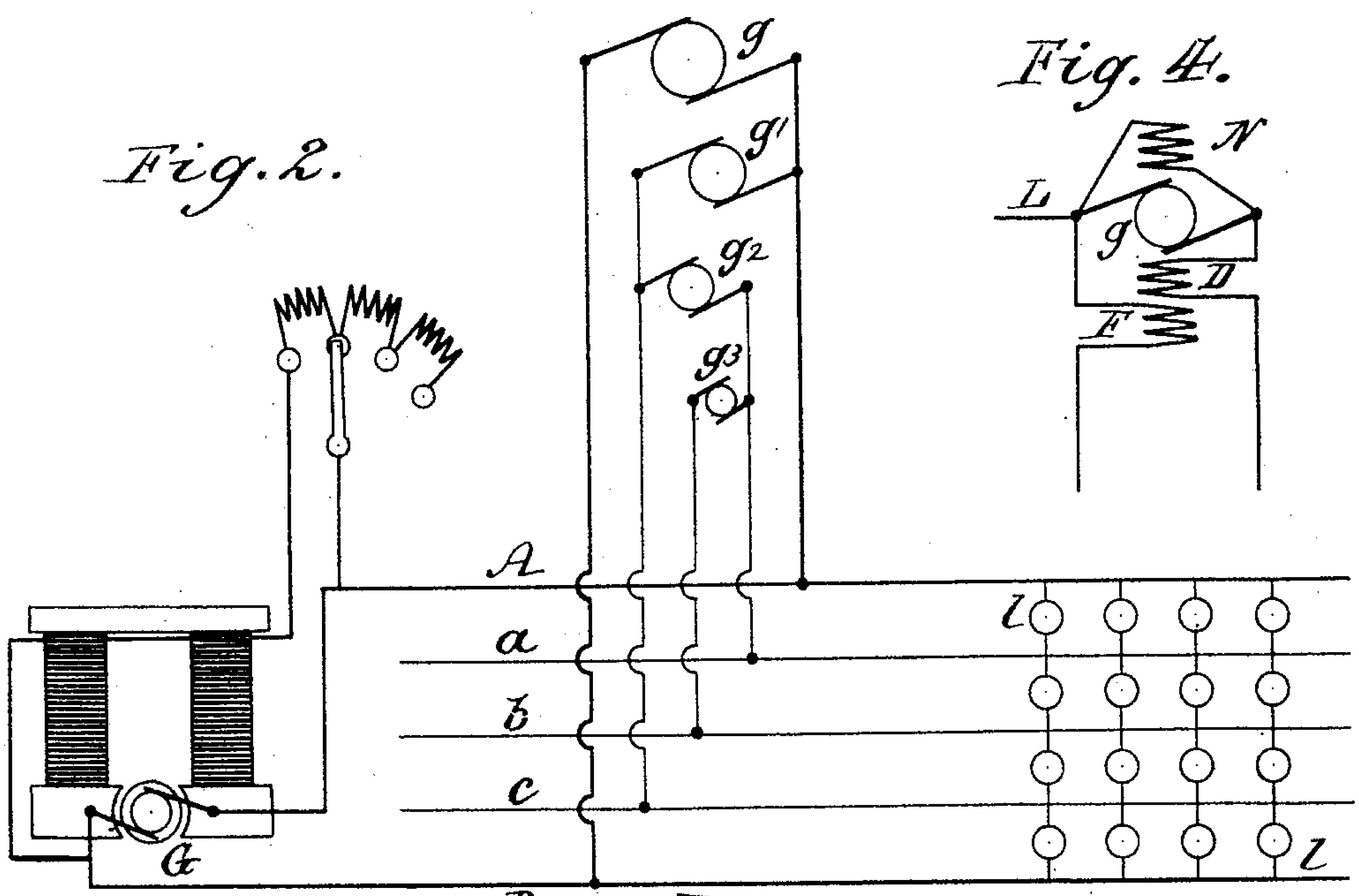

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Fig. 5.

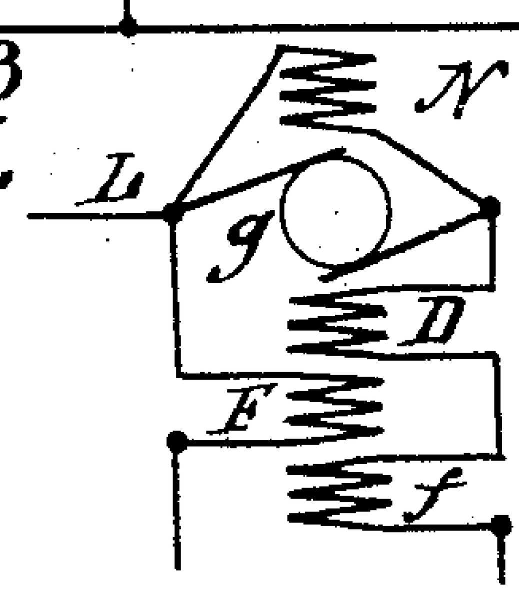

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Fig. 6.

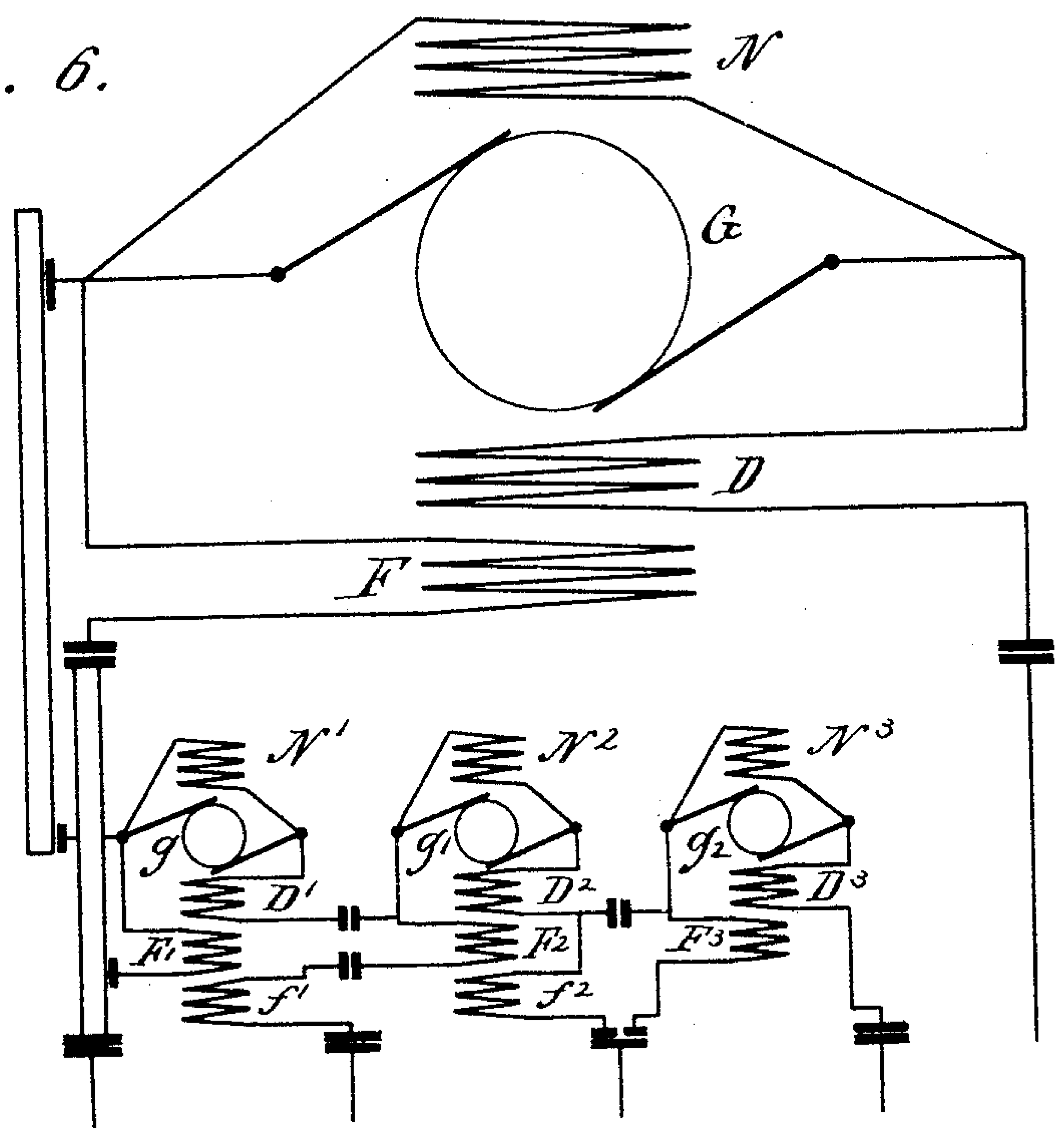
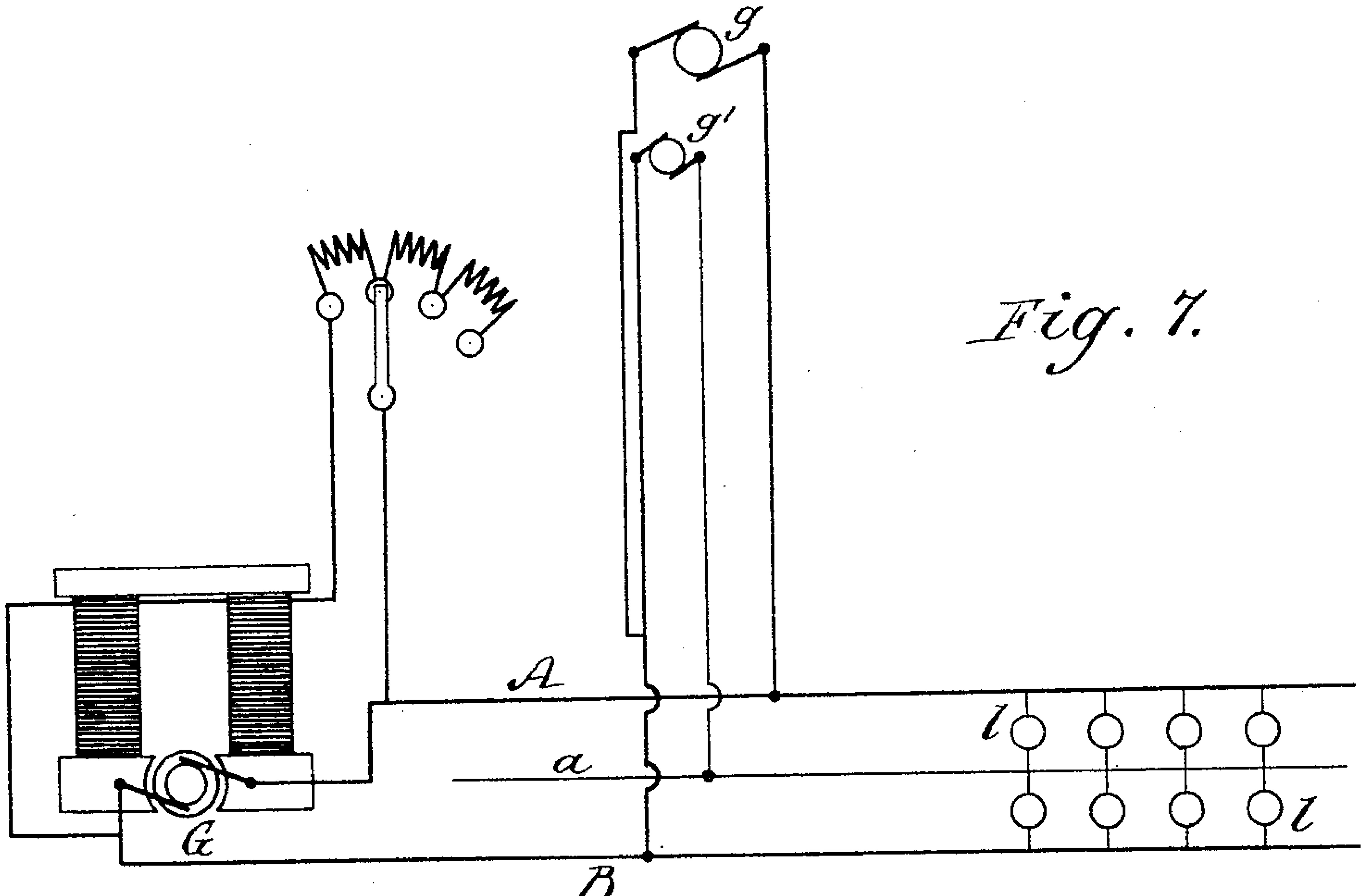


Fig. 7.



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SYSTEM OF ELECTRICAL DISTRIBUTION.

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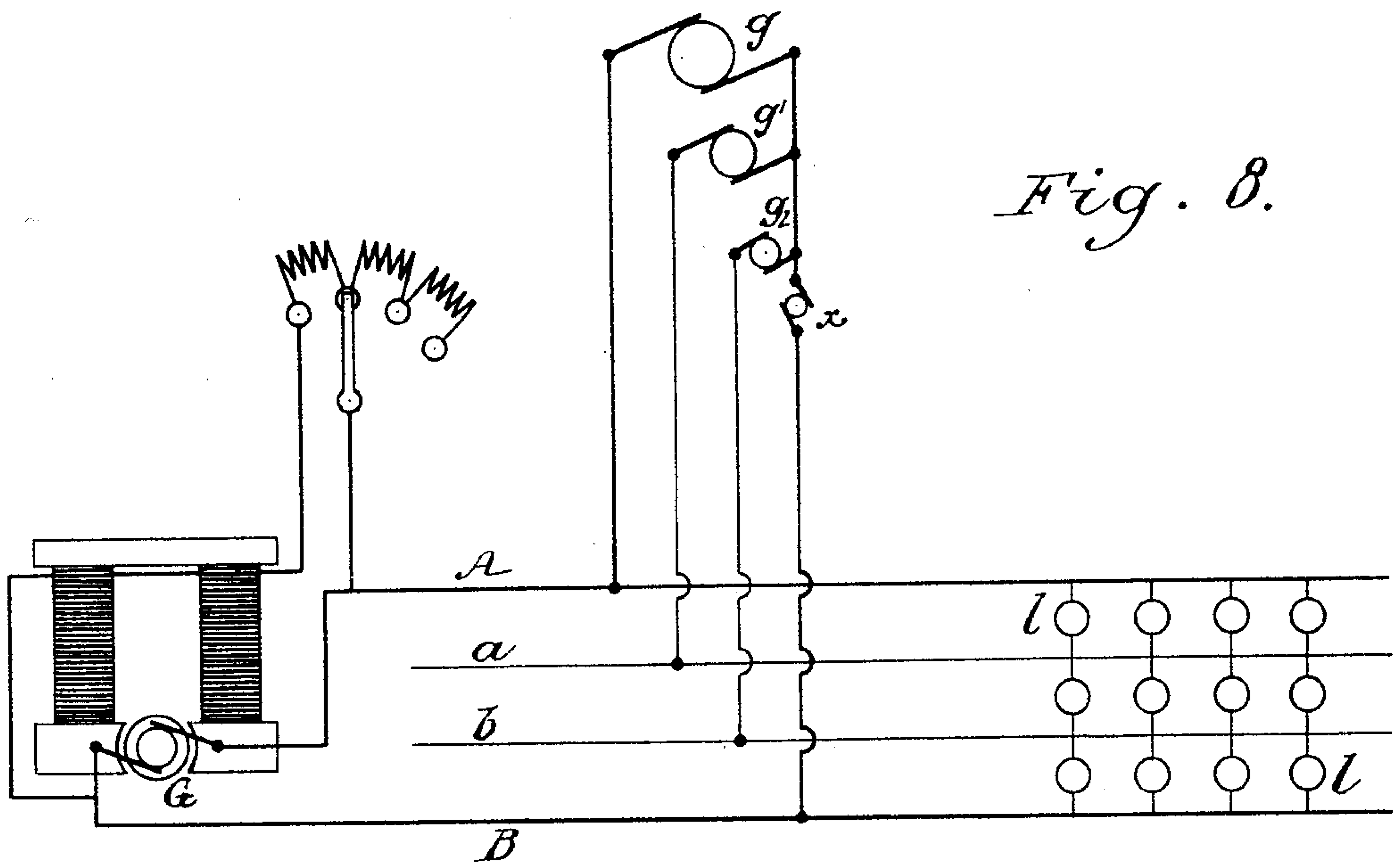

Fig. 8.

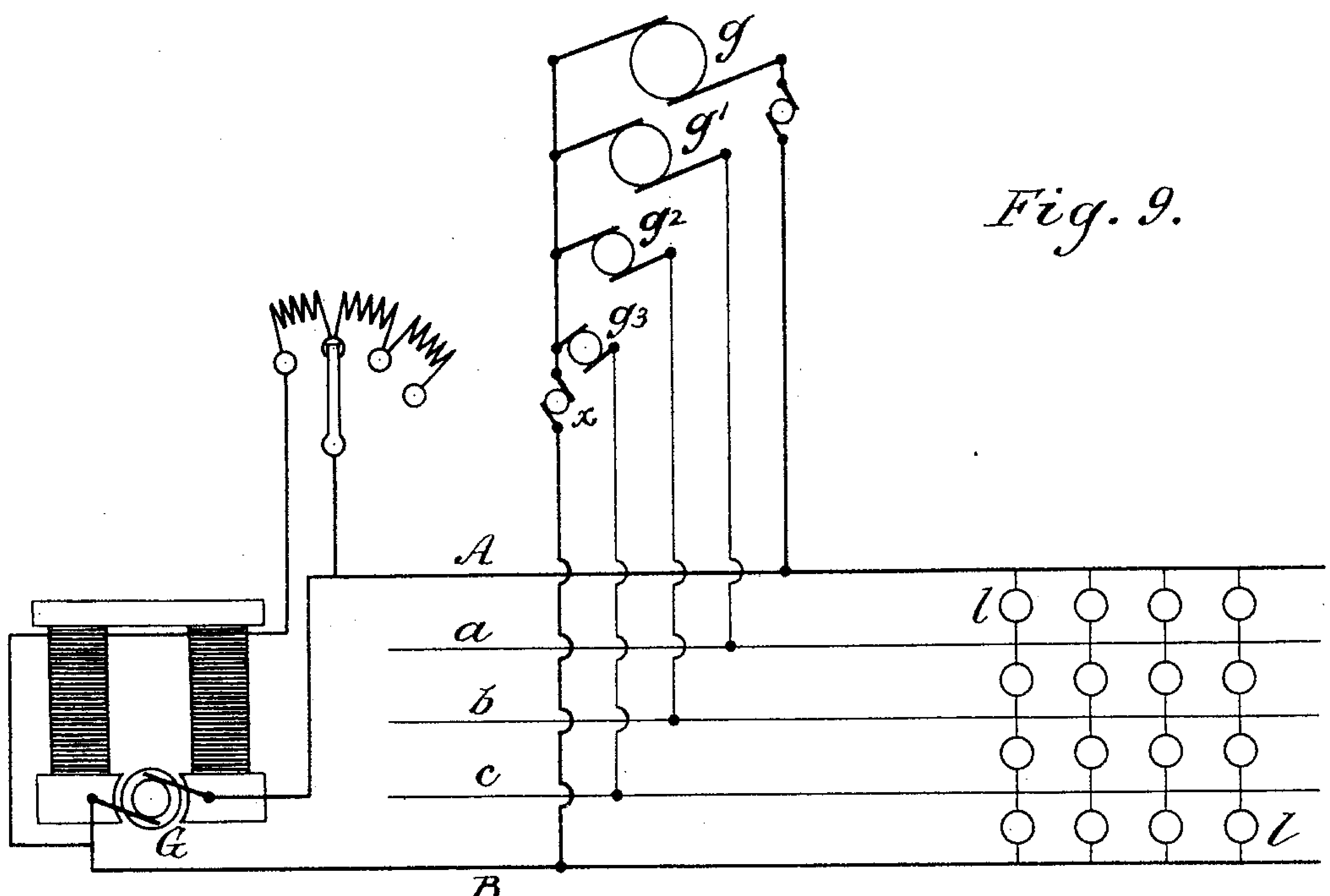

Fig. 9.

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SYSTEM OF ELECTRICAL DISTRIBUTION.

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Fig. 10.

Fig. 11.

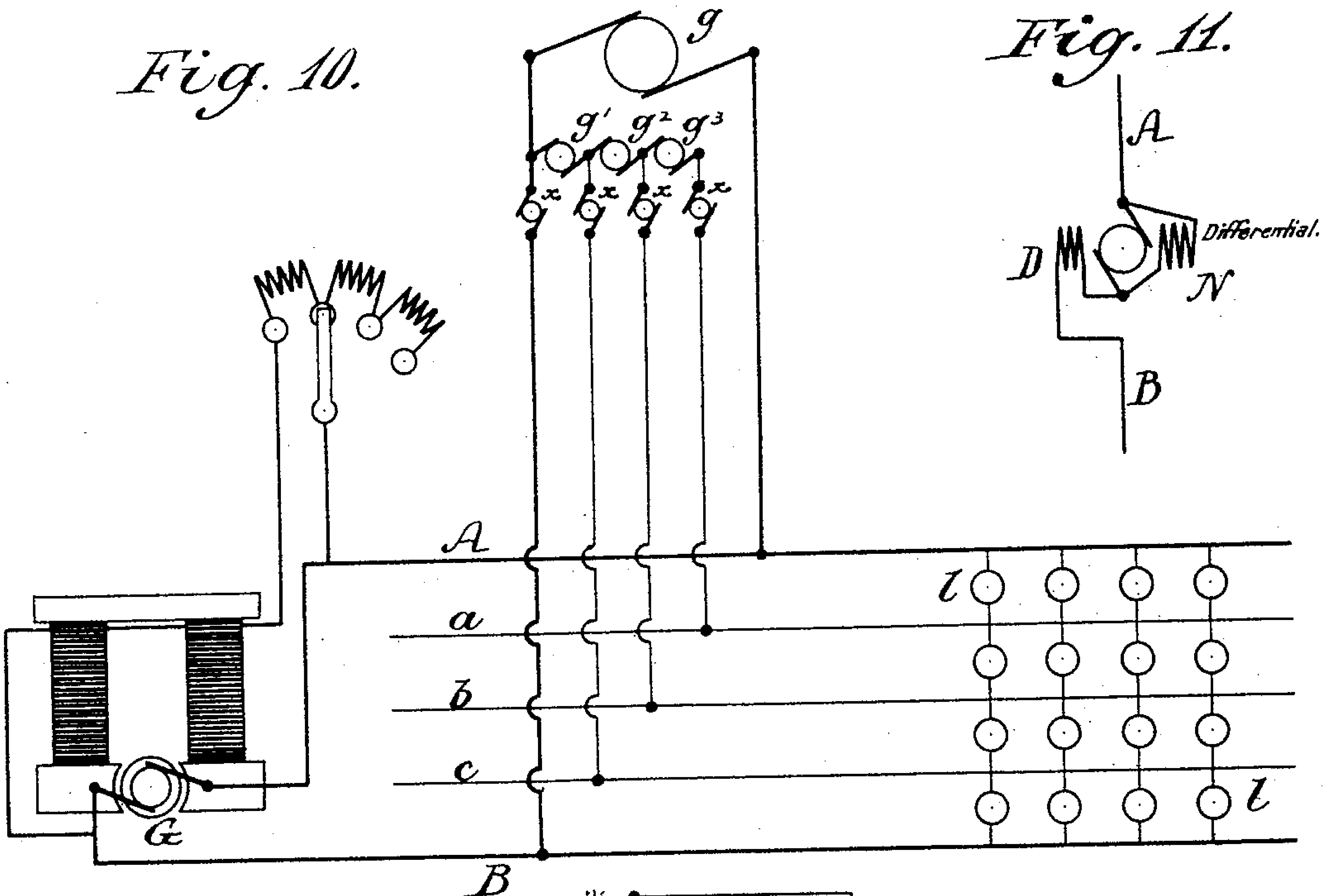
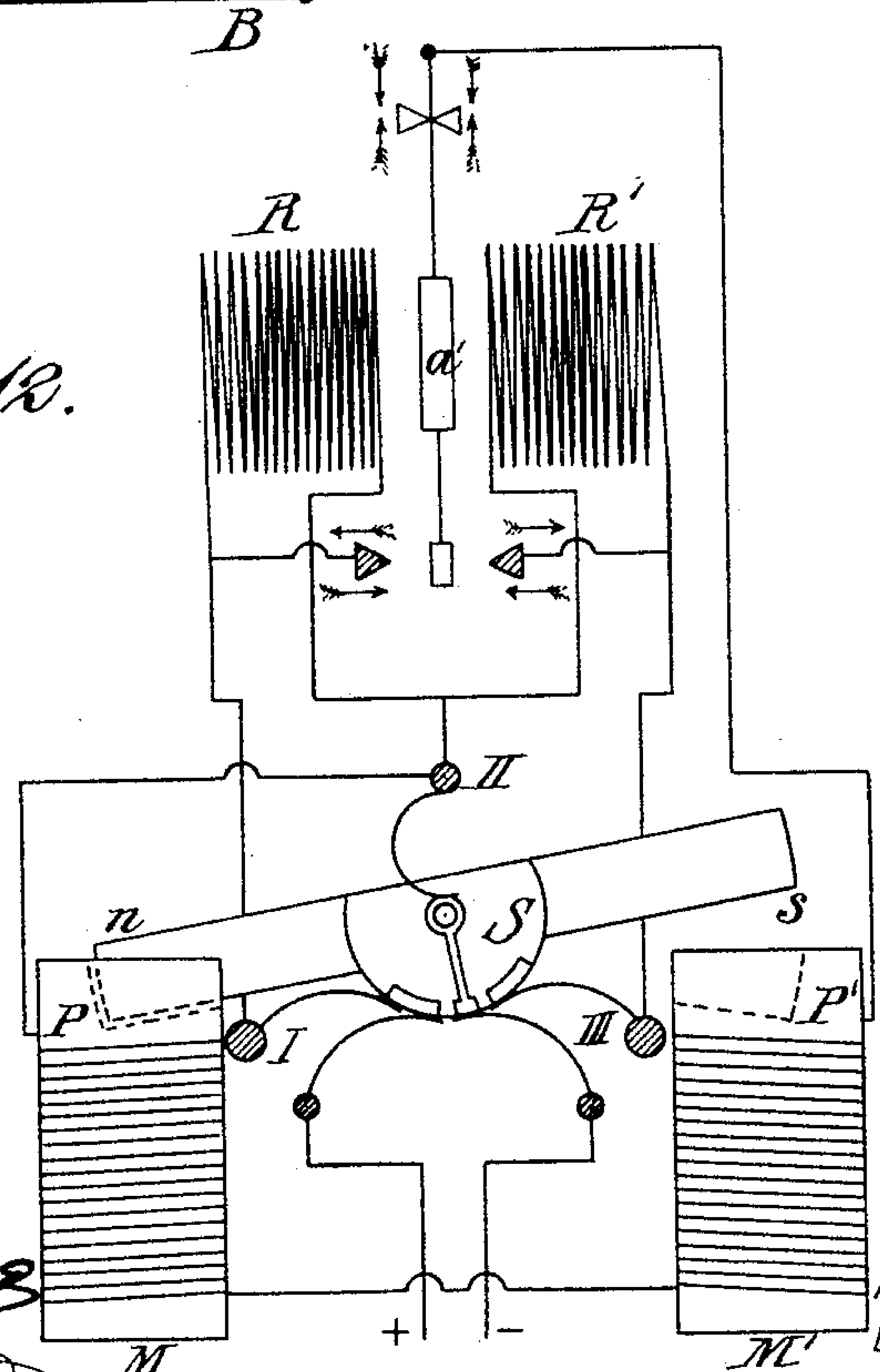


Fig. 12.



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UNITED STATES PATENT OFFICE.

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SYSTEM OF ELECTRICAL DISTRIBUTION.

SPECIFICATION forming part of Letters Patent No. 497,755, dated May 16, 1893.

Application filed October 23, 1889. Serial No. 327,892. (No model.) Patented in Germany May 23, 1889, No. 55,203, and November 18, 1889, No. 54,728; in Austria-Hungary September 19, 1889, No. 2,470 and No. 40,667; in Switzerland September 19, 1889, No. 1,659; in Norway September 19, 1889, No. 1,626; in England September 19, 1889, No. 14,783; in France September 19, 1889, No. 201,287; in Belgium September 19, 1889, No. 87,791; in Sweden September 19, 1889, No. 2,797, and in Italy September 19, 1889, Nos. 453 and 26,179.

To all whom it may concern:

Be it known that I, WALDEMAR MEISSNER, a subject of the King of Prussia and German Emperor, residing at Königsberg, in the Kingdom of Prussia and German Empire, have invented certain new and useful Improvements in the Distribution of Electric Currents, (for which I have obtained Letters Patent in Germany, No. 55,203, dated May 23, 1889; in England, No. 14,783, dated September 19, 1889; in Belgium, No. 87,791, dated September 19, 1889; in Italy, No. 26,179, dated September 19, 1889; in France, No. 201,287, dated September 19, 1889; in Switzerland, No. 1,659, dated September 19, 1889; in Norway, No. 1,626, dated September 19, 1889; in Sweden, No. 2,797, dated September 19, 1889; in Austria-Hungary, No. 40,667 and No. 2,470, dated September 19, 1889;) 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.

My invention relates to systems of electrical distribution, and especially to means whereby a large number of translating devices are supplied with energy of considerable amount with economy of conductors and a high efficiency of regulation.

It is well known, as for instance in the three wire system of distribution, that when translating devices are placed in series with each other, an economy of main line conductors is thereby attained; because the translating devices being arranged in series are capable of receiving, and of necessity must receive a current of higher tension than when they are placed in parallel arc, and as high tension currents require conductors of smaller cross section, it is obvious that less copper is used per unit of length in said system. At the same time, in many systems of distribution it is preferable, if not necessary, to arrange (especially in the case of incandescent lamps) the translating devices in parallel, because devices arranged in parallel are capable of very efficient regulation.

The Hopkinson three wire system is an example of the advantages to be gained from a combined series and parallel arrangement, and in that system conductors of small sizes are capable of being used, and the translating devices are also capable of independent, and therefore highly efficient regulation. However, in the Hopkinson three wire system it is necessary, in order that the regulation shall be complete, to have the intermediate or compensating conductors carried back to the source of energy, namely,—the generators—and this obviously necessitates an additional use of wire.

My system is intended to embody all the advantages of the three wire system, and at the same time the cheapness of main line wires attained in high pressure series systems. I attain this by arranging the translating devices in a number of equal groups, and joining the said devices in each group in parallel, while the groups themselves are joined in series by means of intermediate or compensating conductors.

To the advantages of the simple multiple conductor system is opposed the difficulty of keeping the tension constant in the different groups when the consumption of current is unequal or varying in them; that is, there is a difficulty in providing each translating device with a normal current. It can be proved by calculation that this cannot be attained by variable resistances arranged in the distant conductors. Even if an arrangement, such as shown in Fig. 1, is used with secondary batteries in place of the generators, only small differences in the tension could be compensated for, as the potential of a battery decreases when the intensity of the current increases.

I attain my object of keeping the tension constant in the different groups, when the absorption of current is varied among the groups, by using, in addition to the principal dynamo or dynamos which are connected to the main conductors, intermediate or compensating generators, which keep the potential constant in the various groups; although the consumption of energy in the different groups may vary: that is, I regulate the consumption of energy in the groups with relation to the entire system. The positive (or else the negative) terminal or terminals of the compensating generator or generators are all connected to one of the main conductors as a common conductor, and the terminals of the other sign of each of the other dynamos are connected to one of the other conductors, either an intermediate or the other main conductor.

Referring to the accompanying drawings: Figures 1, 2, 7, 8, 9, and 10 show various modifications of my system in diagrammatic outlines. Figs. 3, 4, and 5 show in diagram the windings and connections of the generators, especially the compensating generators; that is, especially the series and shunt field magnet windings and the regulating windings in addition. Fig. 6, shows one of these generators connected with my system. Fig. 11, shows also the windings for one of my generators. Fig. 12, shows the switching device, somewhat in detail.

Referring to Fig. 1: G indicates the main generator which, as shown, is of the ordinary continuous current type (for example the Siemens type) such as is used with multiple systems of distribution; but it is obvious that any other suitable form of generator may be used. The compensating and auxiliary generators may be of the same or similar type. A, B are the main line wires; g, g', g^2 are the intermediate or compensating generators which are used between the various groups to regulate the potential; l, l, l, l, are the incandescent lights, or other similar translating devices (for example, electric motors) arranged in parallel series with each other by means of the main conductors A, B, and the intermediate conductors a, b, c.

Now, when any group between A, B, and a, b, c, has a varied number of lamps in action, or when the devices require different amounts of energy, it is obvious, without some means of regulation between the various groups that some of the translating devices would receive more than their normal amount of current, and others would receive less. Now to obtain an efficient regulation between the various groups, so that each particular device may receive its normal amount of current under all circumstances, I connect the compensating generators (preferably smaller than the main generator) to one of the main conductors in common, their other terminals being connected one to each of the other conductors, either an intermediate conductor or the other main conductor. These generators are so related to each other as to act, according as a load varies in different groups, either as a generator or a motor, or a device capable of transferring energy. By this means the potential of the various groups with relation to the translating devices is kept normally constant and in proper relation to the other groups, and that independent of the load. The armatures of these compensating generators may of course be mounted on the same shaft with each other; and the same may be true of the auxiliary dynamo generators, which are mentioned later on. As these compensating generators are thus connected and related to each other, it appears, when one of the groups of devices requires a less amount of energy than normal owing to the fact that a smaller number of devices than normal are in action, that the compensating generator, which is connected to this group, is called upon to do less work, and that the said compensating generator will receive part of the current which formerly would have been supplied to the translating devices from the main generator; and thereby it acts as a motor driving or helping to drive the other generators, and in this way turns current into the other groups composing the rest of the system. On the other hand, when one of the groups requires more than its normal supply of energy, then as the potential falls in that particular group there will be an increased demand on the entire system, which will cause the current in the other groups to operate the compensating generators in these groups as motors to bring up the current on the heavily loaded group. In other words, when any group needs less than the normal amount, the compensating generator in that group receives an increased amount of current, which causes it to run as a motor and help feed current to the other groups of the system, thereby calling for less energy from the main generator. While on the other hand, if a group is more heavily loaded than normal, a greater amount of current is required, and that is attained by either calling on the main generator for a greater amount of current for the entire system, when the other groups are normally loaded; or else, when some of the other groups are loaded less than normal, current is derived from these groups by having the generators therein run as motors which actuate the generators in the other groups. The action in Figs. 2, 6, and 7 is substantially the same, with the obvious variations which are apparent from the modified arrangements shown therein. As the necessary constant distant tension of the compensating machines working together excludes the employment of ordinary compound dynamos, which have a constant pressure at the terminals of the shunt windings, I may use what I call super-compound dynamos, that is, those which have a constant pressure at the ends of the outer resistance at the points where the distant conductors join the circuit proper. In other words, my super-compound machines differ from ordinary compound machines in the proportion of ampère turns of their field magnet windings.

Figs. 3, 4, and 5 represent in diagram the field windings of a super-compound dynamo provided with a short shunt, which latter may, however, be replaced by a long shunt. N here refers to the shunt winding, and D to the series. The winding on the field magnet may be wound on either or both limbs of the magnet, and it may be either started from the terminals of the generator, or direct from the brushes.

When more than one conductor is connected to the generator, it is necessary, in addition to the ordinary two windings on the field magnet of the generators, to have a third or fourth winding, according to whether one or both of the dynamo terminals are connected with the conductors; that is, besides the shunt and series windings, there may be a part of the conductor at the local point of distribution carried around the field magnet in such a manner that all the windings magnetize in the same direction with a normal amount of current. It can be shown that with proper calculation or measurement in this case the tension at the local group remains constant, no matter what quantity of current is fed to, or is abstracted from, the machine by the working conductors; and this is true, independent of the direction of the current passing through the working conductors and the armature.

In some cases, as represented in Fig. 11, the auxiliary dynamo may be provided with a subordinate shunt winding N, which acts differentially to the direct or series windings, thereby causing the magnetism after the cessation of the current from A, B, to be brought to zero, even before the direction of the current is reversed.

The diagram of the windings and connections of a triple or quadruple compound generator is represented in Figs. 4 and 5. The lines L represent the conductors or connections; the windings carrying the local working current are marked F and *f*. In case an additional or reserved compensating dynamo is to be switched in instead of the principal dynamo, a switching arrangement on one of the well known principles may be employed to change the connections; which arrangement may be a graduated switch device having rheostat, or a quick acting device, such as a snap switch.

When the machines are not connected together at the station, but only in circuit, the machines having double super-compound windings can be used; and for this purpose a separate conductor may lead from each pole of the machine to the respective joining point of the circuit. Such arrangement is shown in Fig. 7. When the machines are connected in series, it is sometimes necessary to increase the tension on a line by an additional electro-motive force, which may be attained by the use of auxiliary dynamos, as shown in Figs. 8, 9 and 10 at *x*.

Fig. 12 shows one form of my switch device. This represents a simple, and at the same time, a most effective form of switch, by means of which a change of poles or lamps connected in a circuit is avoided. The electro-magnets M and M′ of the switch are supplied with current by the differential tension relay R, R′ which has high resistance coils. This relay has a soft iron armature *a′* suspended between the cores of the two coils R and R′. As shown in the drawings, R is permanently connected with the conductors I and II and R′ is connected with the conductors II and III. The armature *a′*, however, forms a terminal of a circuit which begins at the binding post II, and which supplies the electro magnets M and M′. This circuit is not closed as long as *a′* remains in the middle between R and R′, that is to say, so long as the two relay coils are excited with equal intensity. If, however, the tension in one of the groups rises above the normal, one of the relay coils becomes more strongly excited than the other, and so it attracts the armature. By this means the above mentioned circuit is closed as the armature is provided with a contact piece, which in this case happens to touch one or the other of the contacts connected with the binding posts I or III, shown in the drawings below the relay coils. If now the arrangement of the connection is such that the tensions in the conductors connect to binding posts I, II, and III (II having the medium tension), it follows that the current starting from II and passing through the electro-magnets must have either the one or the other direction, according as it flows through the armature of the relay to the binding post I or III. Each movement of the relay thus causes the currents to flow through the electro-magnets in opposite directions, and consequently effects the switching of the lamps in the one group or the other.

Places are shown at P and P′ in the drawings for receiving the poles *n*, *s*, an arrangement which has the effect of increasing the magnet's action as much as possible. The switching in or out of the different groups of lamps takes place in this manner with such rapidity that the breaking of the current is practically unnoticeable, and thus the employment of an instantaneous switch is hardly necessary.

My system, as before described, has the translating devices equally distributed in the groups, each having substantially equal resistance or power consuming capacities; but if the translating devices are not distributed equally, but only symmetrically, then the separate compensating machines have to be constructed of different capacities or powers, in order that the proper ratio between the groups may be preserved. The size of the driving machine, of course, is calculated according to the distribution of the translating devices on easily recognized principles. If, in consequence of the local conditions, a proper loss of tension takes place in the outer conductors with average consumption, then the intermediate conductors, acting only as compensating conductors, do not require to be of as large size as the main conductors.

It will be noticed, in accordance to the above described apparatus, that by having compensating generators of different sizes I am enabled to supply currents of different tensions to my translating devices by using the compensating generators of different capacities in connection with my switching devices. In some cases this is a very important feature, because I can supply currents of any different potential, say from one hundred and ten to six hundred or eight hundred volts, according to the requirements of my translating devices, and thus be able to supply the demands of a system within very wide variations.

I do not desire to confine myself to any particular arrangement of apparatus, as I consider myself to be broadly the inventor of so connecting compensating generators in a multiple series system in such a way as to cause the said compensating generators to take from, or supply to, any one of the groups electricity, said electricity being in the respective cases either supplied to the entire system or taken therefrom according as its load is lighter than, or heavier than the normal load, said supply of energy being taken from or added to the remainder of this system. In this way I attain all the advantages of small conductors used with high pressure systems, and also the advantages of great efficiency due to high regulation incident to the parallel arrangement of devices, such as incandescent lamps and motors, and even arc lamps.

I also consider myself to be the first to use pairs of conductors carrying different amounts of tension with my switch devices, to connect translating devices to the various groups in various ways, so as to take in difference of potential within wide limits from the supply conductors, for the use of my translating devices.

I claim—

1. In a system of electrical distribution, the combination of main conductors, an electric generator connected to said main conductors, groups of translating devices arranged in parallel series between said main conductors, intermediate conductors between the groups, and compensating generators directly connected by one terminal to one of the main conductors as a common conductor, and having their other terminal individually connected to one of the other conductors substantially as described, in such a way as to maintain constant potential in the various groups of devices, irrespective of their load.

2. In a system of electrical distribution, the combination of main conductors, an electric generator connected to said main conductors, groups of translating devices arranged in parallel series between said main conductors, intermediate conductors between the groups, and compensating generators directly connected by one terminal to one of the main conductors as a common conductor, and having their other terminal individually connected to one of the other conductors, said compensating generator or generators having means of regulation, substantially as described, so that constant potential is maintained in the various groups of devices irrespective of their load.

3. In a system of electrical distribution, the combination of main conductors, an electric generator connected to said main conductors, groups of translating devices arranged in parallel series between said main conductors, intermediate conductors between the groups, and compensating generators directly connected by one terminal to one of the main conductors as a common conductor, and having their other terminal individually connected to one of the other conductors, said compensating generator or generators having super-compound windings, substantially as described, so that constant potential is maintained in the various groups of devices, irrespective of their load.

4. In a system of electrical distribution, the combination of main conductors, an electric generator connected to said main conductors, groups of translating devices arranged in parallel series between said main conductors, intermediate conductors between the groups, and compensating generators directly connected by one terminal to one of the main conductors as a common conductor, and having their other terminal individually connected to one of the other conductors, all of said compensating generators being mutually related, substantially as described, so that constant potential is maintained in the various groups of devices, irrespective of their load.

5. In a system of electrical distribution, the combination of main conductors, an electric generator connected to said main conductors, groups of translating devices arranged in parallel series between said main conductors, intermediate conductors between the groups, and compensating generators connected by one terminal to one of the main conductors as a common conductor, and having their other terminal individually connected to one of the other conductors, said compensating generators being mechanically connected together, so that constant potential is maintained in the various groups of devices, irrespective of their load.

6. In a system of electrical distribution, the combination of main conductors, an electric generator connected to main conductors, groups of translating devices arranged in parallel series between said main conductors, intermediate conductors between the groups, and compensating generators connected by one terminal to one of the main conductors as a common conductor, and having their other terminal individually connected to one of the other conductors, said compensating genera-

tors having normally different electro-motive forces from the main generators, so that constant potential is maintained in the various groups of devices, irrespective of their load.

7. In a system of electrical distribution, the combination of main conductors, an electric generator connected to said main conductors, groups of translating devices arranged in parallel series between said main conductors, intermediate conductors between the groups, and compensating generators directly connected by one terminal to one of the main conductors as a common conductor, and having their other terminal individually connected to one of the other conductors, said compensating generators being provided with means for regulating their electro-motive force, so that constant potential is maintained in the various groups of devices, irrespective of their load.

8. In a system of electrical distribution, the combination of main conductors, an electric generator connected to said main conductors, groups of translating devices arranged in parallel series between said main conductors, intermediate conductors between the groups, and compensating generators directly connected by one terminal to one of the main conductors as a common conductor, and having their other terminal individually connected to one of the other conductors, said compensating generators being provided with means for regulating their electro-motive force, and means whereby they can be operated either as a generator or a motor, depending upon the demands of the groups of the system, so that constant potential is maintained in the various groups of devices, irrespective of their load.

9. In a system of electrical distribution, the combination of main conductors, an electric generator connected to said main conductors, groups of translating devices arranged in parallel series between said main conductors, intermediate conductors between the groups, and compensating generators connected by one terminal to one of the main conductors as a common conductor, and having their other terminal individually connected to one of the other conductors, and auxiliary generators connected directly in the shunt circuit to bring up the electro-motive force of said branch circuits, substantially as described, so that constant potential is maintained in the various groups of devices, irrespective of their load.

10. In a series multiple system of distribution, the combination of the translating devices with directly connected compensating generators having compound windings and also additional super-compound windings, so that constant potential is maintained in the various groups of devices, irrespective of their load.

11. In a system of electrical distribution, and combination of main conductors, an electric generator connected to said main conductors, groups of translating devices arranged in parallel series between said main conductors, intermediate conductors between the groups, and compensating generators directly connected by one terminal to one of the main conductors as a common conductor, and having their other terminal individually connected to one of the other conductors, said compensating generators having compound windings and series super-compound windings, substantially as described, so that constant potential is maintained in the various groups of devices, irrespective of their load.

12. In a system of electrical distribution, the combination of main conductors, an electric generator connected to said main conductors, groups of translating devices arranged in parallel series between said main conductors, intermediate conductors between the groups, and compensating generators directly connected by one terminal to one of the main conductors as a common conductor, and having their other terminal individually connected to one of the other conductors, all of said generators, both main and compensating, having additional regulating means for super-compounding, substantially as described, so that constant potential is maintained in the various groups of devices, irrespective of their load.

13. In a system of electrical distribution, the combination of main conductors, an electric generator connected to said main conductors, groups of translating devices arranged in parallel series between said main conductors, intermediate conductors between the groups, and compensating generators directly connected by one terminal to one of the main conductors as a common conductor, and having their other terminal individually connected to one of the other conductors, and a suitable switching device whereby the connections of the circuits are interchanged to compensate for the loads, in such a way as to maintain constant potential in the various groups of devices, irespective of their load.

14. In a system of electrical distribution, the combination of main conductors, an electric generator connected to said main conductors, groups of translating devices arranged in multiple series between said main conductors, intermediate conductors between the groups, and compensating generators connected to the said conductors, said compensating generators being of different electric capacity so as to supply currents of different tension, and switching devices whereby the translating devices are enabled to be connected to the various conductors in such a manner as to receive currents of varying tension.

15. In a system of electrical distribution, the combination of main conductors, an electric generator connected to said main conductors, groups of translating devices arranged in multiple series between said main conductors, intermediate conductors between the groups, and compensating generators connected to the

said conductors, said compensating generators being of different electric capacity so as to supply currents of different tension, and switching devices whereby the translating devices are enabled to be connected to the various conductors in such a manner as to receive currents of varying tension, said compensating generators having means of regulation whereby their electric capacity may be further varied.

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

WALDEMAR MEISSNER.

Witnesses:

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LUDVIG OLSEN.