(No Model.)

W. VON SIEMENS.

DISTRIBUTION OF ALTERNATING ELECTRIC CURRENTS.

No. 502,682. Patented Aug. 1, 1893.

Fig. 1.

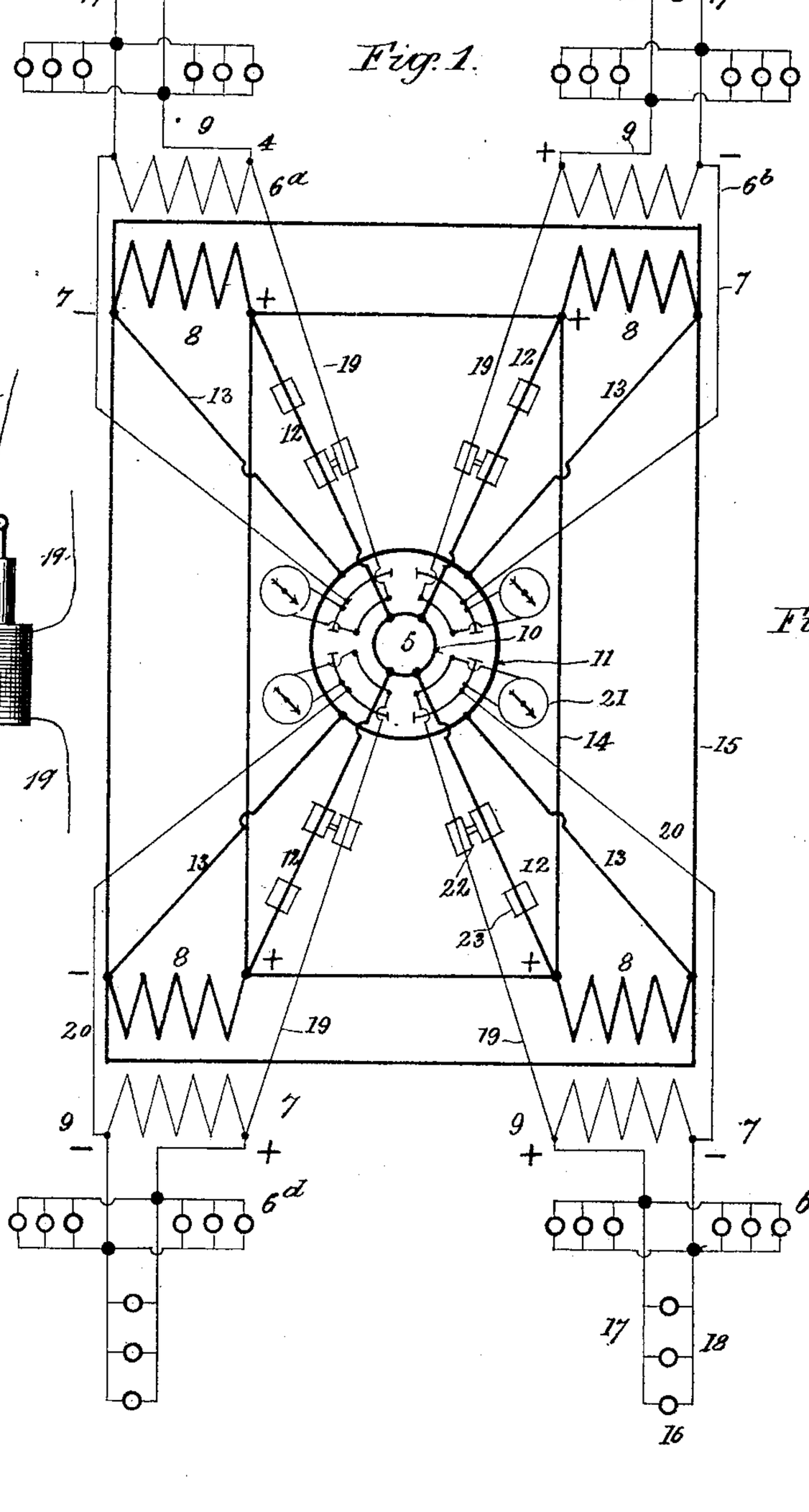


Fig. 2.

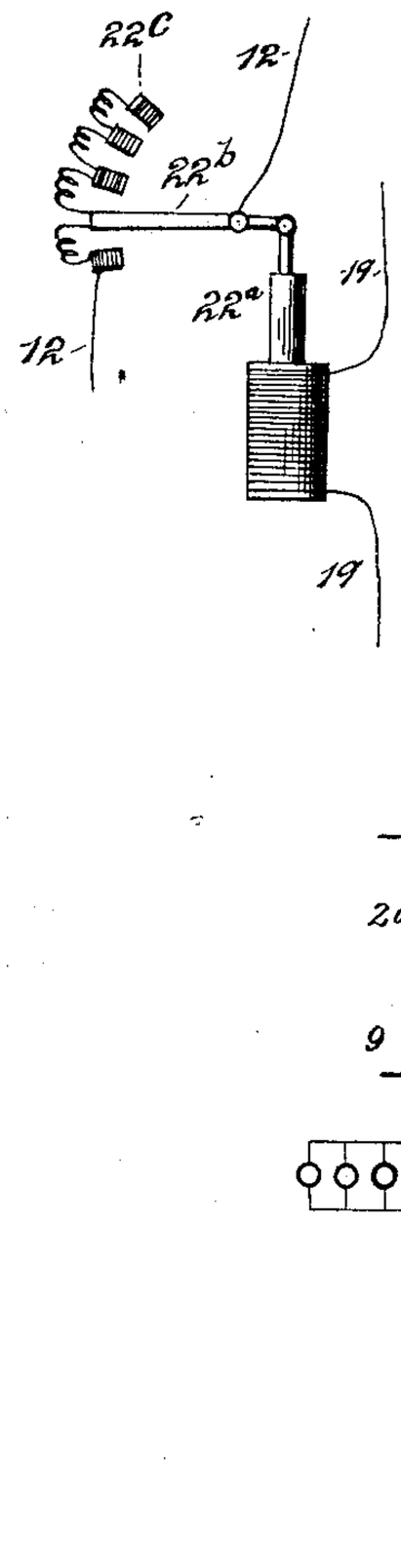
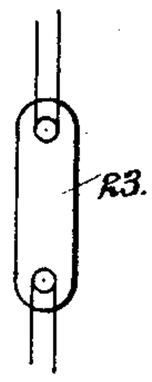


Fig. 3.



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WILHELM VON SIEMENS, OF BERLIN, GERMANY, ASSIGNOR TO SIEMENS & HALSKE, OF SAME PLACE.

DISTRIBUTION OF ALTERNATING ELECTRIC CURRENTS.

SPECIFICATION forming part of Letters Patent No. 502,682, dated August 1, 1893.

Application filed July 16, 1892. Serial No. 440,255. (No model.) Patented in Austria-Hungary December 28, 1885, Nos. 768 and 36,918 and 17,243 and 20,890; in England December 30, 1885, No. 16,038; in Belgium July 15, 1886, No. 73,585; in France October 20, 1886, No. 176,794; in Italy December 30, 1886, Nos. 20,191 and 381; in Germany January 14, 1887, No. 38,880; in Sweden April 15, 1887, No. 814, and in Norway June 30, 1887, No. 51.

To all whom it may concern:

Be it known that I, WILHELM VON SIEMENS, a subject of the Emperor of Germany, and a resident of Berlin, German Empire, have invented certain new and useful Improvements in the Distribution of Alternating Electric Currents, (for which I have obtained Letters Patent in Germany, No. 38,880, dated January 14, 1887; in France, No. 176,794, dated October 20, 1886; in Belgium, No. 73,585, dated July 15, 1886; in Great Britain, No. 16,038, dated December 30, 1885; in Austria-Hungary, Nos. 768 and 36,918 and 17,243 and 20,890, dated December 28, 1885; in Italy, Nos. 20,191 and 381, dated December 30, 1886; in Sweden, No. 814, dated April 15, 1887, and in Norway, No. 51, dated June 30, 1887,) of which the following is a specification.

My invention relates to a method of distributing alternating electric currents of electricity to different distant points of consumption within a defined district, and through the instrumentality of current transforming devices; and also to the method and means employed for regulating or equalizing the currents transmitted to the transformers at the distributing stations.

In the distribution of alternating currents through a number of transformers, independently located at a distance from the main generating station, it is essential to maintain the potential at the secondary terminals of the transformers as nearly uniform as possible, for the reason that the translating devices usually included in the secondary circuit are adapted to work at a fixed potential: and further, to regulate the current flowing in the primary of each transformer in proportion to the work done in each secondary distributing circuit.

It is now well understood that in all properly constructed transformers (when the secondary circuit is open), the counter electro motive force of the core will approximately balance the current flowing in the primary, and that, as translating devices such as lamps are cut into the secondary circuit, the counter electro motive force of the core will decrease until it is nearly, if not entirely, lost,—at which point such a number of translating devices will have been cut into the secondary circuit as require the full inducing power of the primary to operate them. This balancing action in the transformer itself serves in a measure to bring about the regulating conditions required in practice,—especially when the potential at the terminals of each primary coil can be maintained uniform,—as for instance, in the case where the transformers are located in the generating station and immediately under the eye of the attendant, and not so far removed from the generator as to be subjected to line disturbances. In the case, however, where the current is carried a considerable distance from the generating station, through a single pair of conductors to transformers independently located at different distances from said station, it is difficult to so proportion the size of the conductors connecting the separate transformer stations to the source of energy, as to provide for the various disturbing conditions which tend to affect their resistances. Hence, in practice, it is found difficult, when the transformers are connected in series (Gaulard & Gibbs system) or in multiple (Zipernowsky, Deri & Blathy system) of a single pair of conductors, even with the best of regulating devices at the generating station, to maintain a given potential at the primary terminals of transformers located at different distances from the source of energy.

The object of my invention is to overcome this objection, and to supplement the regulating action occurring within the transformer itself by appropriate means, and so bring about the practical regulation or equalization of the current through the distributing system as a whole. This I accomplish in the manner I will now describe, in connection with the diagram, which shows the relation of the different circuits and parts composing my improved system of distribution.

In the accompanying diagrams which illustrate my invention, similar figures of reference indicate like parts.

Figure 1 serves to show, generally, how my invention may be carried into effect. Fig. 2 illustrates the mechanism employed for cutting resistance into and out of the primary circuit. Fig. 3 is a view of an automatic circuit rupturing device.

In the diagram, 5 indicates a generator of alternating currents. The generator may be a single machine, or it may consist of a number of machines connected in multiple. The machines are located in a main generating station which should be situated as nearly as possible in the center of the district to be supplied.

6^a, 6^b, 6^c, 6^d, are current transforming and distributing stations, which are supposed to be located at different distances from the generating station.

7, are current transforming devices of the usual type provided with primary coils 8, secondary coils 9, and laminated cores (not shown.) A number of transforming devices may be coupled in the usual way. The generator, or generators have their terminals connected to the feeder conductors 10 and 11. The primary coils 8 of the transformers are connected in multiple through separate pairs of primary conductors 12 and 13, which are connected to the feeder conductors 10 and 11. It will be observed that by this arrangement of separate conductors, each transformer is normally fed independently of the other transformers of the system, which arrangement in practice is found to be of great advantage.

14 and 15 represent conductors which respectively connect all of the positive and negative terminals of the primary coils of the transformers together. The primary coils of all the transformers are respectively in multiple of the conductors 14 and 15.

The conductors 14 and 15 serve as a means for equalizing the currents between all of the transformers of the system, and in the following manner: If, for instance, the resistance of the several primary circuits 12 and 13 from the generator is the same, and the full complement of translating devices 16 are cut into each of the secondary distributing circuits 17 and 18, little or no current will flow in the conductors 14 and 15. If, however, several lamps are cut out of, say one of the secondary circuits 17 and 18, as for instance at 6^a, the core of the transformer at that station will at once set up a counter electro motive force which acts in the nature of a resistance introduced into the primary of the transformer. The current therefore flowing to the station 6^a, from the main source of energy, will divide between the primary of the transformer at that station and the equalizing conductors 14 and 15, and be distributed by these conductors to the other transformers in circuit of the equalizing conductors. This arrangement will accomplish the equalizing or balancing result desired, but is objectionable for the reason that the equalizing conductors must be of such a size as to carry the greatest current which may be diverted without heating,—thus a large outlay of copper would be required. In order to overcome this objection, I have devised a means for limiting the current flowing in any primary circuit in proportion to the needs of its secondary circuit, and this I accomplish in the following manner: 19 and 20 represent controlling conductors connected respectively to the positive and negative terminals of the secondary of each transformer. These conductors are carried to the main generating station and closed through a suitable current indicating device 21,—thus furnishing the attendant at the station means for knowing the actual potential at the terminals of each secondary distributing circuit of the system. Included in the conductor 19 is an electrically actuated device 22, by means of which resistance may be put into or taken out of a primary conductor 12; such a device, for instance, may consist of an electro-magnet 22^a carrying a contact lever 22^b, adapted to sweep over a series of resistances 22^c in the primary conductor 12. The device 22 is so adjusted that when the potential at the secondary terminals of the transformer is that determined as the working potential of the translating devices 16 in the secondary distributing circuits 17 and 18, no resistance other than that normal to the primary circuits 12 and 13 will be included, but which as the potential of the secondary terminals rises or falls, as translating devices are cut out of circuit, will cut such a resistance into or out of the primary conductor 12, between the main generating station and the primary terminal of the transformer to again restore the potential at the secondary terminals to their normal value. By the use of this or a similar device, the conductors 14 and 15 may be made quite small,—as it can never happen that any considerable current will be diverted through them.

In the practical operation of a system such as described, it sometimes happens that all the transforming devices in any secondary circuit are cut out of circuit, or the secondary circuit is accidentally closed upon itself. Where either of these two conditions occur, they are apt to act destructively upon the primary of the transformer. I therefore provide in the primary circuit a device 23 for automatically rupturing the primary circuit when the current transmitted through it reaches the limit of safety.

I may use any approved form of device for automatically rupturing the primary circuit 12, such for instance as a fusible plug, as shown in Fig. 3, or an electrically operated device may be employed.

I do not limit myself to the employment of any special construction of electrically actuated device for cutting resistance into or out of the primary circuit, as any well known device may be used for the purpose.

In addition to the automatically operating device for cutting resistance into and out of circuit, I may provide at the main generat-

ing station hand resistances which can be operated by the attendants in accordance with the readings of the current indicating devices 21. I may also provide at the station means for automatically varying the potential of the current generated in proportion to the needs of the system.

Having thus described my invention, I claim—

1. In a system of electrical distribution, the combination of a source of alternating currents, a plurality of independently located transformers, and an independent and separate supply circuit for each tranformer from the source of energy.

2. In a system of electrical distribution, the combination of a source of alternating currents, a plurality of independently located transformers, an independent supply circuit for each transformer, and a pair of equalizing conductors connecting the like poles of all of the transformers.

3. In a system of electrical distribution, the combination of a source of alternating currents, a plurality of independently located transformers, an independent supply circuit for each transformer, resistance devices in each supply circuit, and devices energized by variations of current in the secondaries of the respective tranformers to vary the resistance in the supply circuits.

4. In a system of electrical distribution, the combination of a source of alternating currents, a plurality of independently located transformers, an independent supply circuit for each transformer, a pair of equalizing conductors connecting the like poles of all of the transformers, and independent consumption circuits for each of said transformers.

5. In a system of electrical distribution, the combination of a source of alternating currents, a plurality of independently located transformers, an independent supply circuit for each transformer, resistance devices in each supply circuit, mechanism energized by variations of current in the secondaries of said transformers to vary the resistance in the supply circuits, and automatic circuit rupturing devices in the supply circuits.

6. In a system of electrical distribution, the combination with the primary coils of a plurality of current transforming devices, of means substantially as described for equalizing the current in said primary coils, resistance devices in the primary coils of said devices, and mechanism actuated by variations in the secondary coils of said transformers and which serve to vary the resistance of the primary circuits, and thereby modify the current transmitted to the primary coils of the separate transformers in proportion to the work done in the respective secondary circuits.

7. In a system of electrical distribution, the combination of a source of alternating currents, a pair of main conductors, a plurality of distributing conductors connected in multiple to and branching in different directions from points of same potential on said main conductors, and a plurality of independently located transformers, each transformer connected in multiple of one pair of distributing conductors.

8. In a system of electrical distribution, the combination of a source of alternating currents, a pair of main conductors closed upon themselves leading therefrom, and a plurality of independently located transformers connected in multiple, but independently of each other, to said main conductors.

9. The herein described method of distributing electrical energy throughout an alternate current distribution system constructed and arranged substantially as described, which consists in dividing the generated current between the sub-districts, transferring the surplus of energy from that district or districts in which the work required is the smallest to such district or districts where the work required is the largest, and at the same time varying automatically the resistance of the supply conductors to the district or districts where the work done is the smallest.

10. The herein described method of distributing electrical energy, which consists in dividing the generated current between a number of transforming stations at which are located inductional transformers, and in varying automatically the current fed to the respective stations in proportion to the demand in the local distribution circuits from such stations.

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

WILHELM VON SIEMENS.

Witnesses:

GUSTAV STENZEL,

MAX WAGNER.