

No. 712,618.

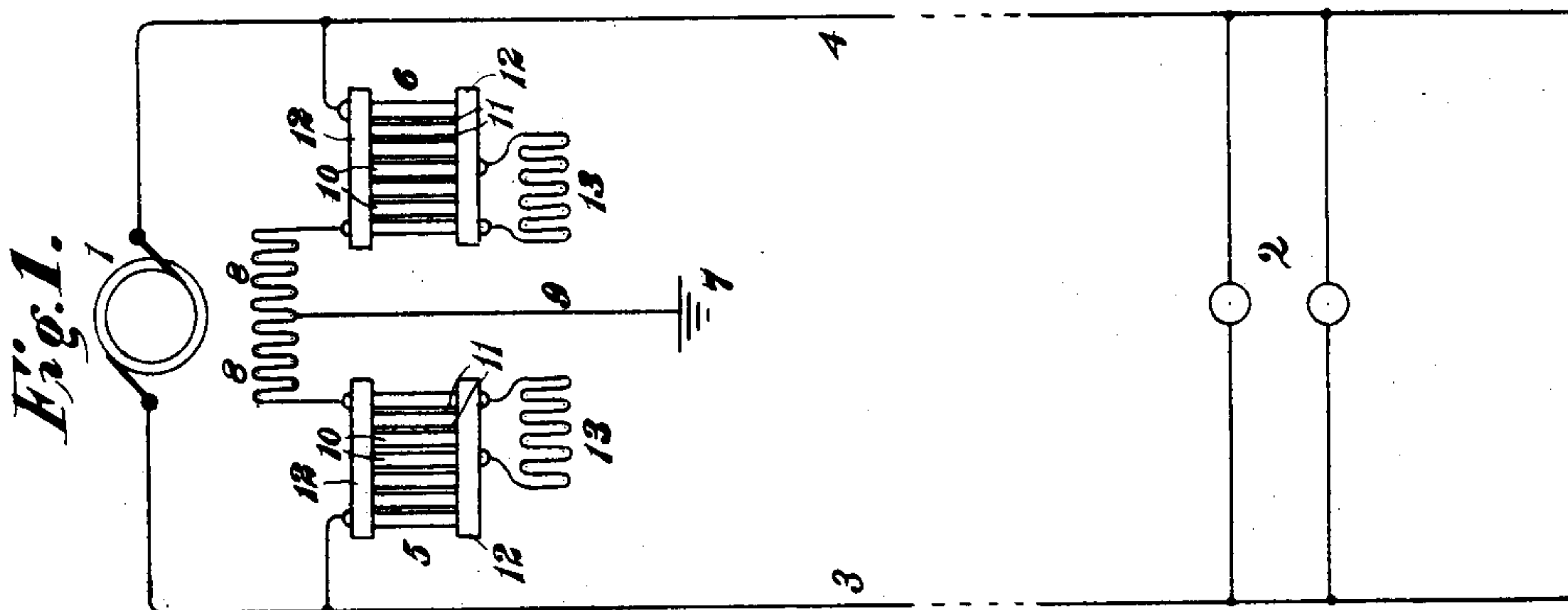
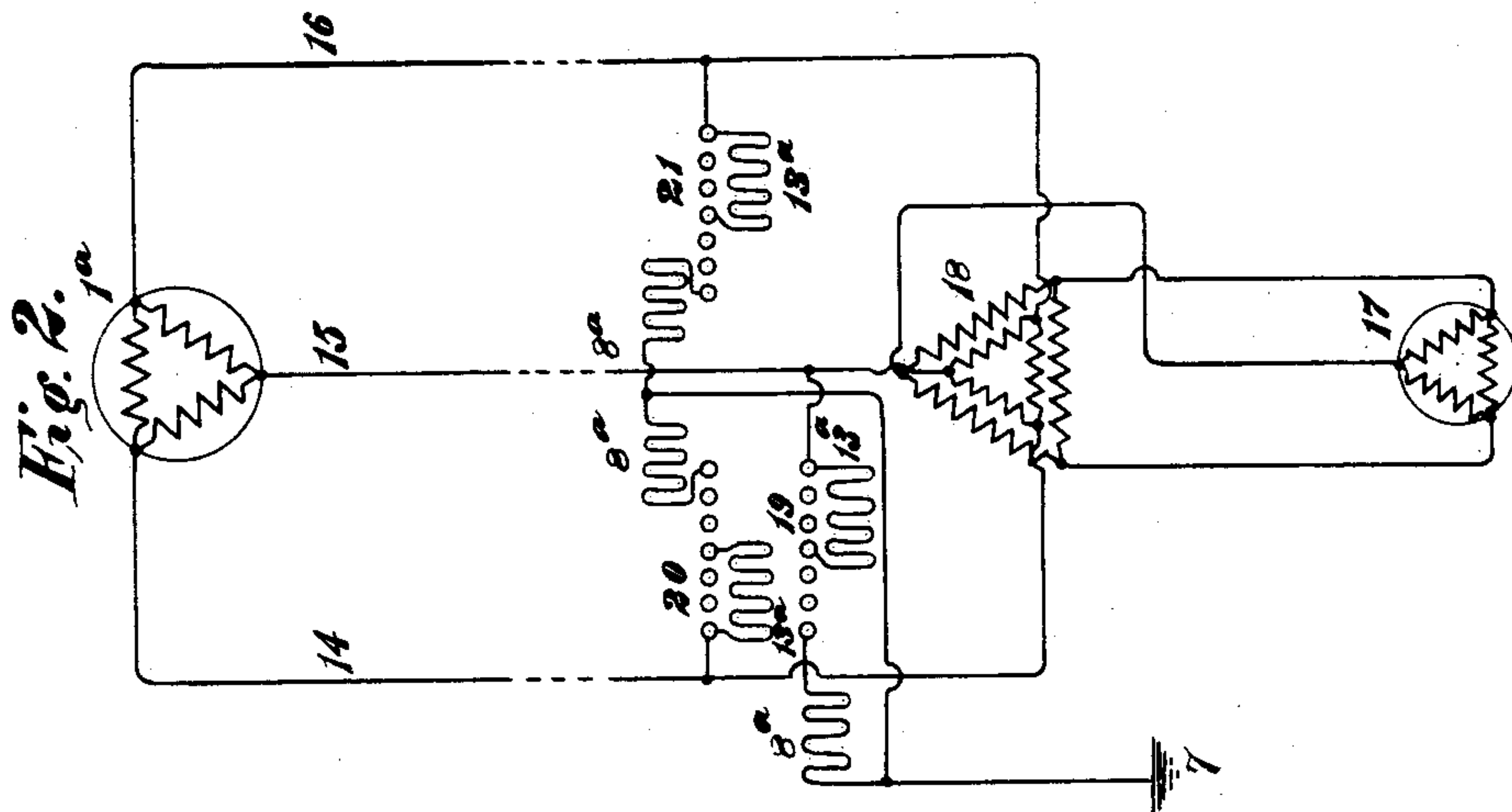
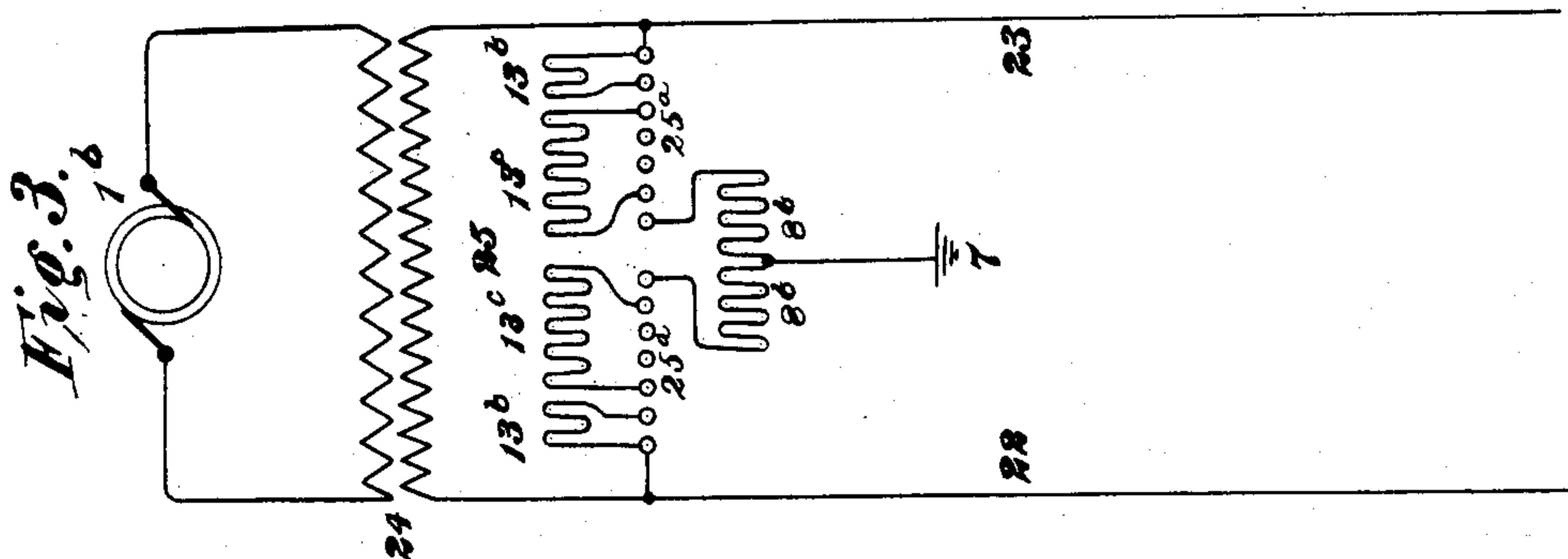
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P. H. THOMAS.

PROTECTING DEVICE FOR ELECTRIC CIRCUITS.

(Application filed Nov. 27, 1899.)

(No Model.)



WITNESSES:

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PROTECTING DEVICE FOR ELECTRIC CIRCUITS.

SPECIFICATION forming part of Letters Patent No. 712,618, dated November 4, 1902.

Application filed November 27, 1899. Serial No. 738,338. (No model.)

To all whom it may concern.

Be it known that I, PERCY H. THOMAS, a citizen of the United States, residing at Pittsburgh, in the county of Allegheny and State of Pennsylvania, have invented a new and useful Improvement in Protecting Devices for Electric Circuits, (Case No. 850,) of which the following is a specification.

My invention relates to devices employed for protecting electrical circuits and apparatus from injuries due to the so-called "electrostatic" disturbances. By "electrostatic" or "static" phenomena are meant those changes in electric potentials or charges occurring in connection with electric work-circuits that are not directly produced by the generating apparatus. Generally such charges cause a flow of energy from place to place which is not directly maintained by the prime mover of the system, and hence is of comparatively small amount. Such flow of energy may be in the form of electricity at very high potential and may be produced by many causes—*e. g.*, lightning discharges, grounding of circuits, switching, resonance in cables, &c.

The object of my invention is to provide a device which shall be adapted for alternating-current circuits and which shall embody an effective means of facilitating the passage of current rushes due to dangerously high potentials, while preventing the dynamo-current from following the static current, and this without materially impeding the static discharges and without rendering the apparatus employed either complicated or expensive in construction.

My invention consists of a spark gap or gaps so chosen as to be broken down by any voltage considered dangerous, but able to withstand the normal voltage from the generating apparatus between the parts of the circuit connected by the gap or gaps, a current-limiting body or device that is non-polarizable, that is of such character and dimensions as to restrict the flow of current without producing a magnetic field of any considerable amount, and that is indestructible under normal conditions of operation and may therefore be termed "infusible," in series

with the gaps, and a similar body also in series therewith, but shunted by one or more additional spark-gaps.

The effectiveness of the device results from the fact that the unshunted current-limiting body so limits the first rush of dynamo-current that the shunted current-limiting body may withdraw a sufficient amount of current from the shunting-gaps to enable them to suppress arcs which tend to form between them. The current strength is thus reduced by the two current-limiting bodies, acting as stated, to such a degree as to enable the unshunted gaps to suppress the current-flow. When properly proportioned, the shunted current-limiting body prevents that extreme rise of potential on the shunting gap or gaps that otherwise obtains in generating-circuits containing self-induction by reason of the collapse of magnetic lines linked with such circuits. Without the shunted current-limiting body this extreme rise of potential (an illustration of which is found in the high voltages obtained by suddenly opening the field-circuit of a large dynamo) would cause the current to continue across all the gaps. It is found also that in circuits capable of supplying energy in large amounts the current strength will be so great that no practicable number of gaps can suppress it in the absence of a current-limiting body connected in series. The object of the gap or gaps which shunt the second current-limiting body is to provide a path of discharge for the static current which would otherwise be impeded to such an extent as to seriously impair, if not to actually destroy, the effectiveness of the device. The impedance of the first current-limiting body is so small that in practice no dangerous check to the flow of static current will result.

I am aware that impedance-bodies have been used heretofore in connection with devices for protecting electric circuits; but without the presence of the second impedance-body shunted by a gap or gaps the first body must, to be successful, be so great as to introduce a very serious check to the static discharge.

I here employ the term "current-limiting

body" to designate any conductor of such form or composition as to reduce the volume of current-flow, it being either inductive or non-inductive and with or without material ohmic resistance. The term "ohmic" resistance is used to designate such current-limiting bodies as have a comparatively small or negligible amount of inductance and the term "inductive" resistance to designate such current-limiting bodies as have comparatively little or a negligible ohmic resistance.

No additional opposition is presented to the static current by the addition of the second current-limiting body shunted by the gaps, for on account of the shunt the series gaps are first broken down and afterward the gaps shunting the second current-limiting body, which, like the series gaps, are proportioned to be broken down by any dangerous potential.

It is obvious that two or more shunting current-limiting bodies may be used instead of one without departing from my invention. In fact, some advantage may be gained by shunting different gaps by current-limiting bodies of different dimensions or composition, since the current-limiting value of each successive body may be increased by reason of the work performed by the preceding body or bodies. It is true, likewise, that a greater number of gaps may be employed without increasing the voltage necessary to break them down by using a plurality of shunted current-limiting bodies.

The shunting current-limiting body may evidently be used to enable approximately double the number of gaps to be used to suppress dynamo-arcs in a gap-protector, for by means of the shunt the full voltage of the static potential to be discharged is impressed upon the series gaps, which will consequently break down, and after their resistance has been practically reduced to zero by the current-flow the static current, provided the current-limiting body be of proper magnitude, will break down the shunting gap or gaps. A plurality of shunted bodies of different value will when properly proportioned allow a still further increase of gaps, which, if they be properly proportioned, will require no more voltage than the series gaps.

In the accompanying drawings, Figure 1 is a diagram of a single-phase alternating-current circuit equipped with my invention. Fig. 2 is a diagram of a three-phase alternating-current circuit provided with my invention, and Fig. 3 is a diagram of a single-phase circuit embodying a modification of my invention.

Referring now to Fig. 1 of the drawings, the alternating-current generator 1, which supplies translating devices 2 with energy by means of the conductors 3 and 4, constitutes the apparatus to be protected, this being illustrated as merely one of a considerable variety of machines and apparatus which my invention is designed to protect from the injurious effects of sudden changes in static

potential. As shown in this figure, two lightning-arrester units 5 and 6 are respectively connected to the conductors 3 and 4 by means of their outer terminals and to the ground 7 through a current-limiting body 8 by means of their inner terminals and a conductor 9. Each of the units 5 and 6 comprises a series of metal cylinders 10, separated from each other by gaps 11 and supported by non-conducting plates 12. The cylinders 10 are preferably formed of non-arcing metal, and at least one of the gaps 11 is in shunt to a current-limiting body 13. As shown, three gaps of each unit are in shunt to the corresponding current-limiting body 13. The current-limiting bodies 8 and 13 are here shown as in the form of wire of comparatively high resistance so coiled or disposed as to be non-inductive.

In Fig. 2 I have shown a three-phase alternating-current generator 1^a, supplying transmission-lines 14, 15, and 16 with three-phase currents of high voltage, the energy of these lines being shown as supplied to a three-phase motor 17 by means of a three-phase step-down transformer 18. The transformer 18 is protected by means of three protecting devices 19, 20, and 21, each of which has one terminal connected to a corresponding line conductor, the other terminal being connected to ground through an impedance-body 8^a. Three of the gaps of each device are connected in shunt to a second current-limiting body 13^a. In Fig. 3 an alternating-current generator 1^b supplies the transmission-circuit 22 23 through a step-up transformer 24, the latter being protected by the protecting device 25. As shown, the latter comprises two lightning-arrester units 25^a, each having six gaps and each connected to ground through an impedance-body 8^b. In this case I have shown the gap adjacent to the line conductor as in shunt to a comparatively small current-limiting body 13^b and three of the gaps nearer the ground-terminal as in shunt to an impedance-body 13^c of greater value. This arrangement is intended merely to illustrate the use of current-limiting bodies in shunt to different gaps of the series, the number and value of such shunted bodies being varied within such limits as may be found desirable in any particular case.

As regards my invention, the form and number of gaps are immaterial, provided there be at least one unshunted and one shunted gap. The location of the series and shunt current limiting bodies is also immaterial, the only condition being that the current rushes shall pass through the former and either through the latter or through the gaps in shunt thereto.

The number of phases of current carried by the line in connection with which my invention is used may be anything desired, and the number, size, and location of parts may also be varied within considerable limits.

I claim as my invention—

1. A protecting device for electric circuits

comprising one or more series gaps, one or more gaps shunting one or more infusible and non-polarizable, current-limiting bodies and a non-polarizable, current-limiting body in series with all the gaps.

2. A protecting device for electric circuits comprising a series of conducting-pieces separated by gaps, one or more comparatively high ohmic resistance bodies shunted by one or more of said gaps, and an ohmic resistance body connected in series with the gaps.

3. A protecting device for electric circuits comprising a plurality of conducting-pieces separated by gaps, a plurality of infusible and non-polarizable current-limiting bodies severally shunted by one or more of said gaps, and one or more infusible and non-polarizable current-limiting bodies in series with all of said gaps.

4. A protecting device for electric circuits comprising a series of spark-gaps between the conductor to be protected and the ground, a plurality of impedance bodies of different

values, each of which is connected in shunt to one or more of said gaps, and one or more impedance-bodies connected in series with all of said gaps.

5. A protecting device for electric circuits comprising a series of conducting-pieces separated by gaps, one or more infusible resistance bodies in shunt-circuit to a number of said conducting-pieces, and a current-limiting body in series with said conducting-pieces.

6. A protecting device for electric circuits comprising one or more series gaps, one or more gaps shunting one or more infusible and non-polarizable, current-limiting bodies, and an infusible and a non-polarizable, current-limiting body in series with the gaps.

In testimony whereof I have hereunto subscribed my name this 25th day of November, 1899.

PERCY H. THOMAS.

Witnesses:

WESLEY G. CARR,
H. C. TENER.