(No Model.)

3 Sheets—Sheet 1.

E. THOMSON.

ELECTRIC LIGHTING SYSTEM.

No. 321,461. Patented July 7, 1885.

Fig. 1.

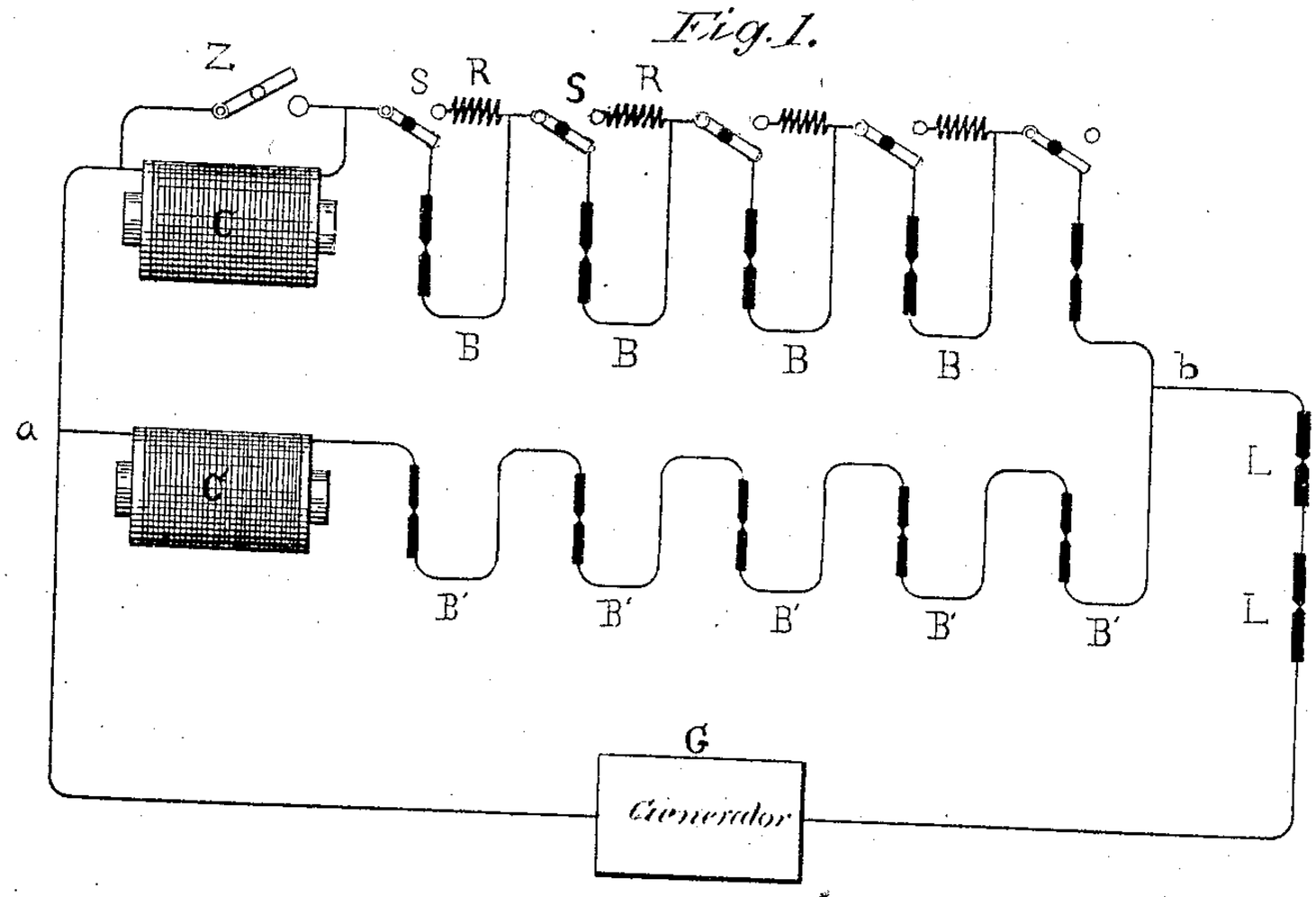


Fig 2.

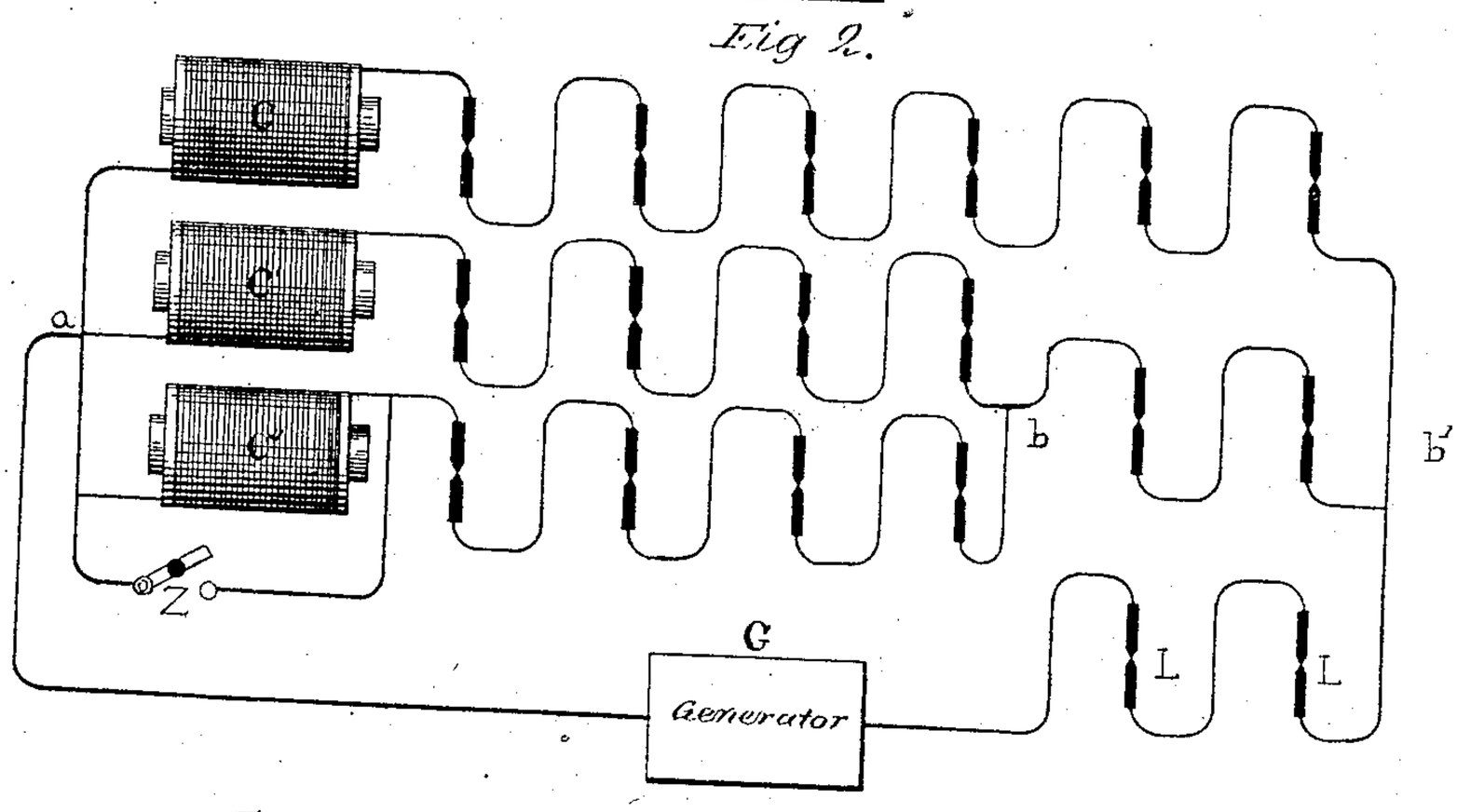
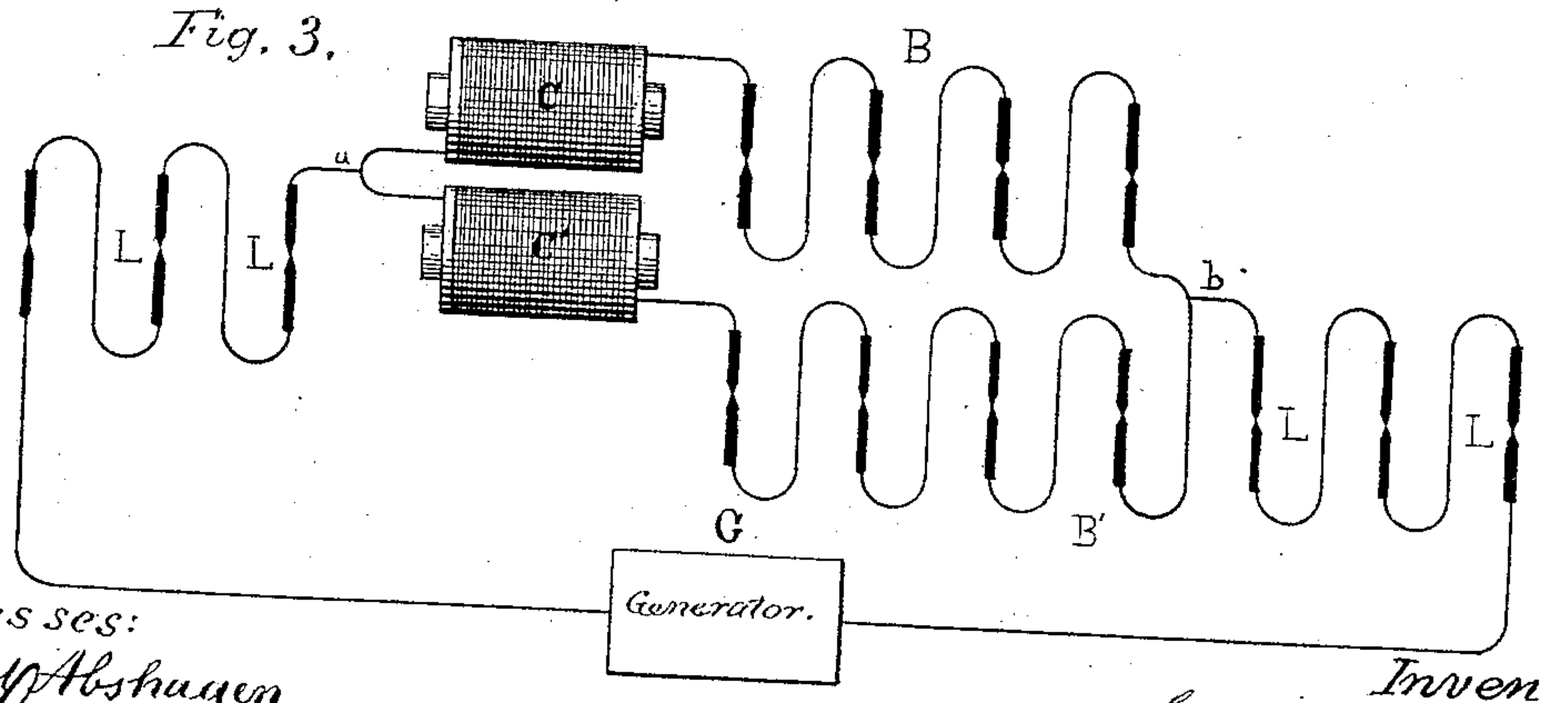


Fig. 3.



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(No Model.)

3 Sheets—Sheet 2.

E. THOMSON.

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Fig. 4.

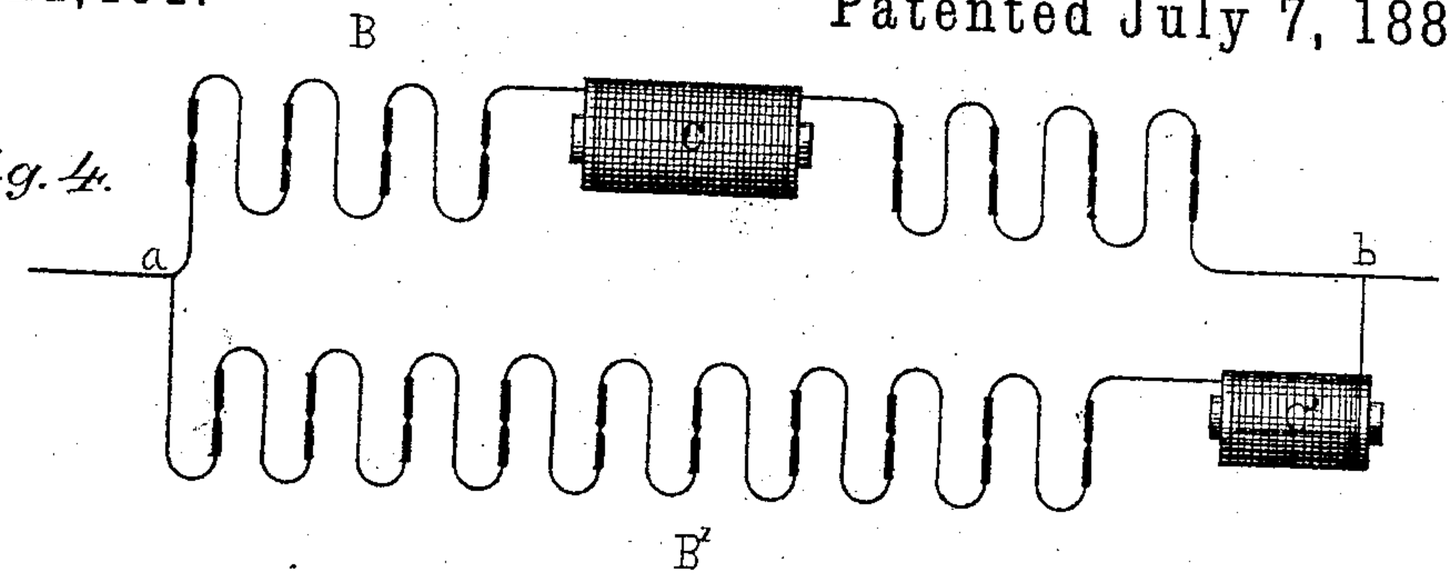


Fig. 5.

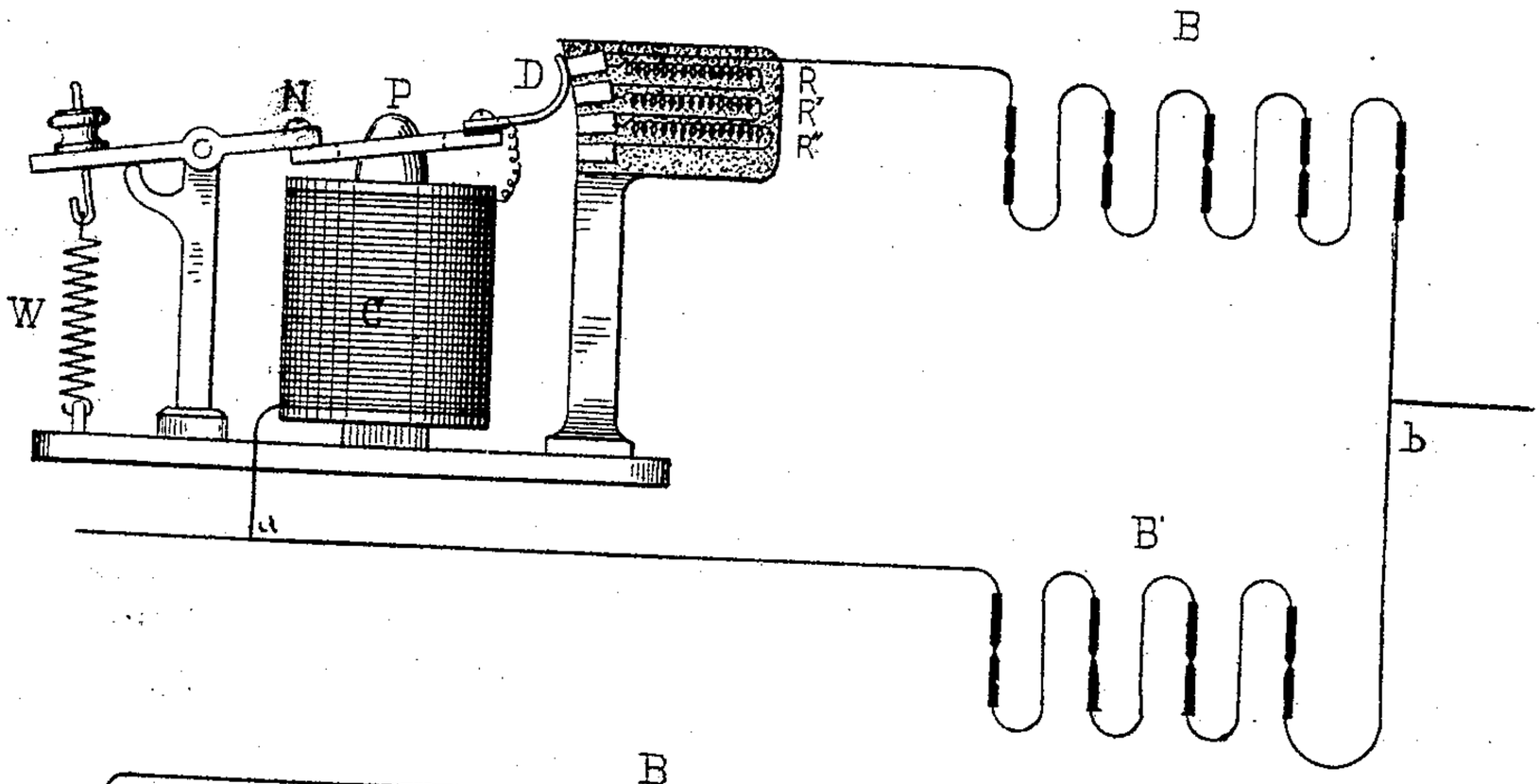


Fig. 6.

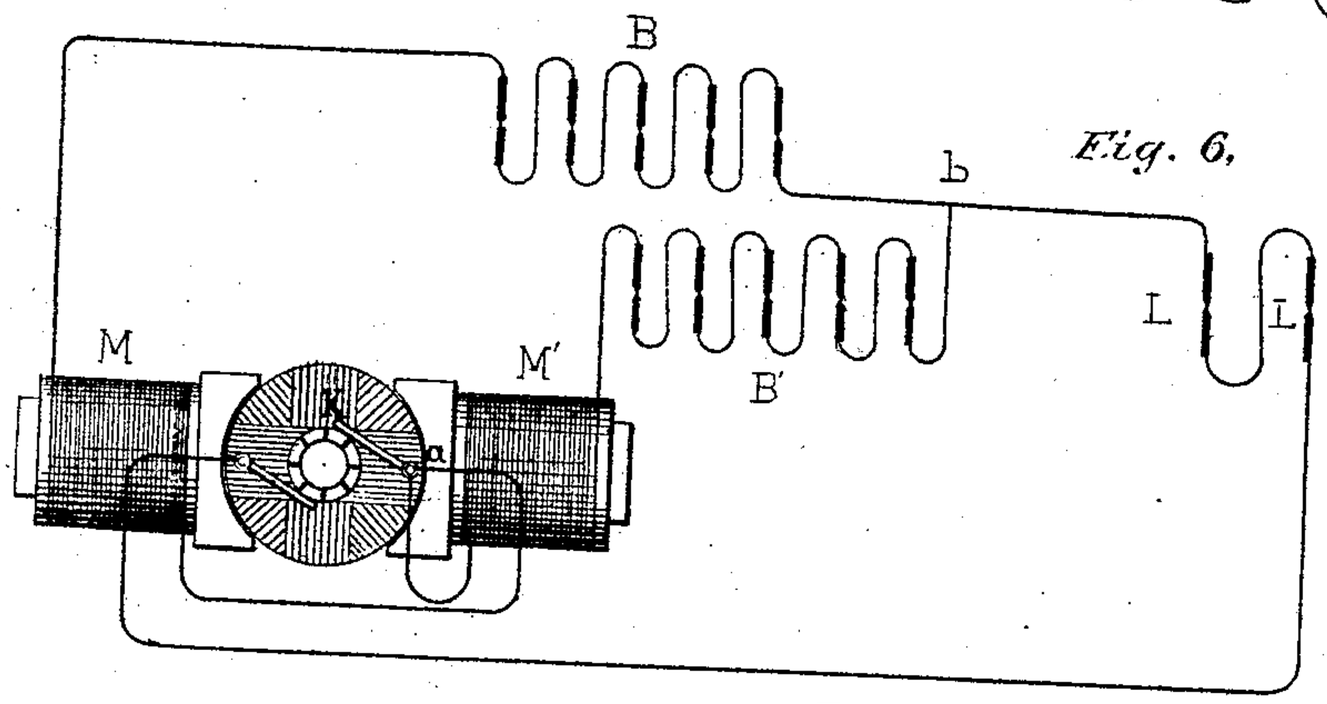
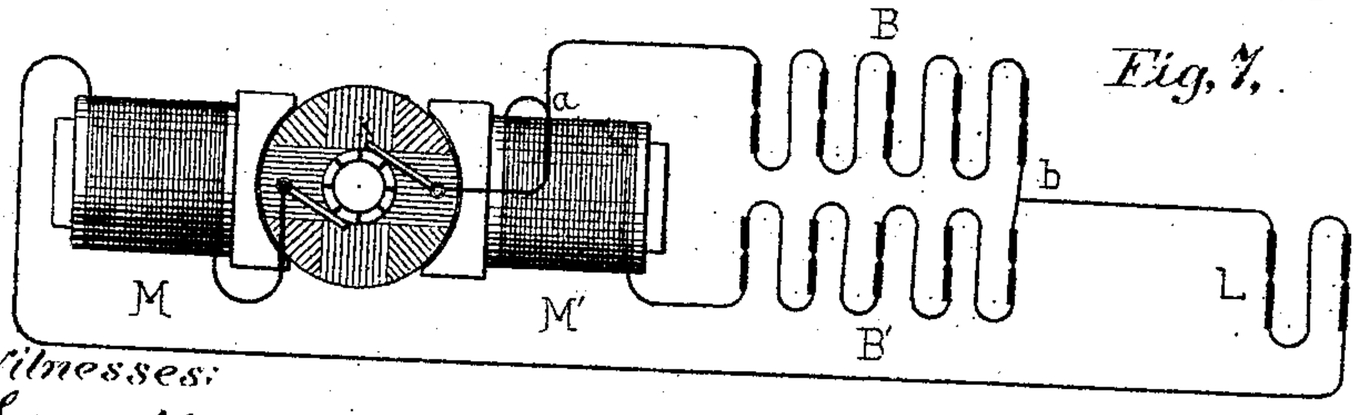


Fig. 7.



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(No Model.)

3 Sheets—Sheet 3.

E. THOMSON.

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Fig. 8.

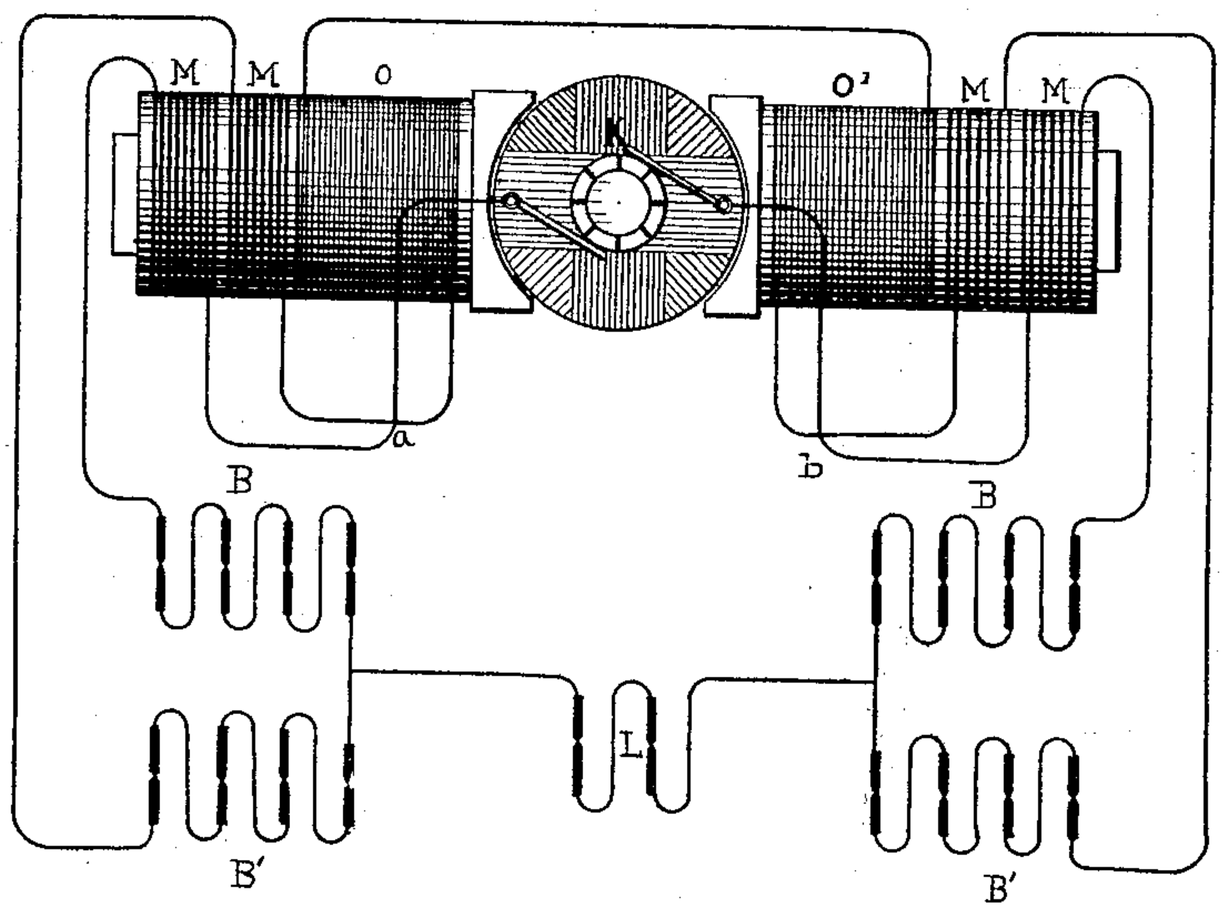
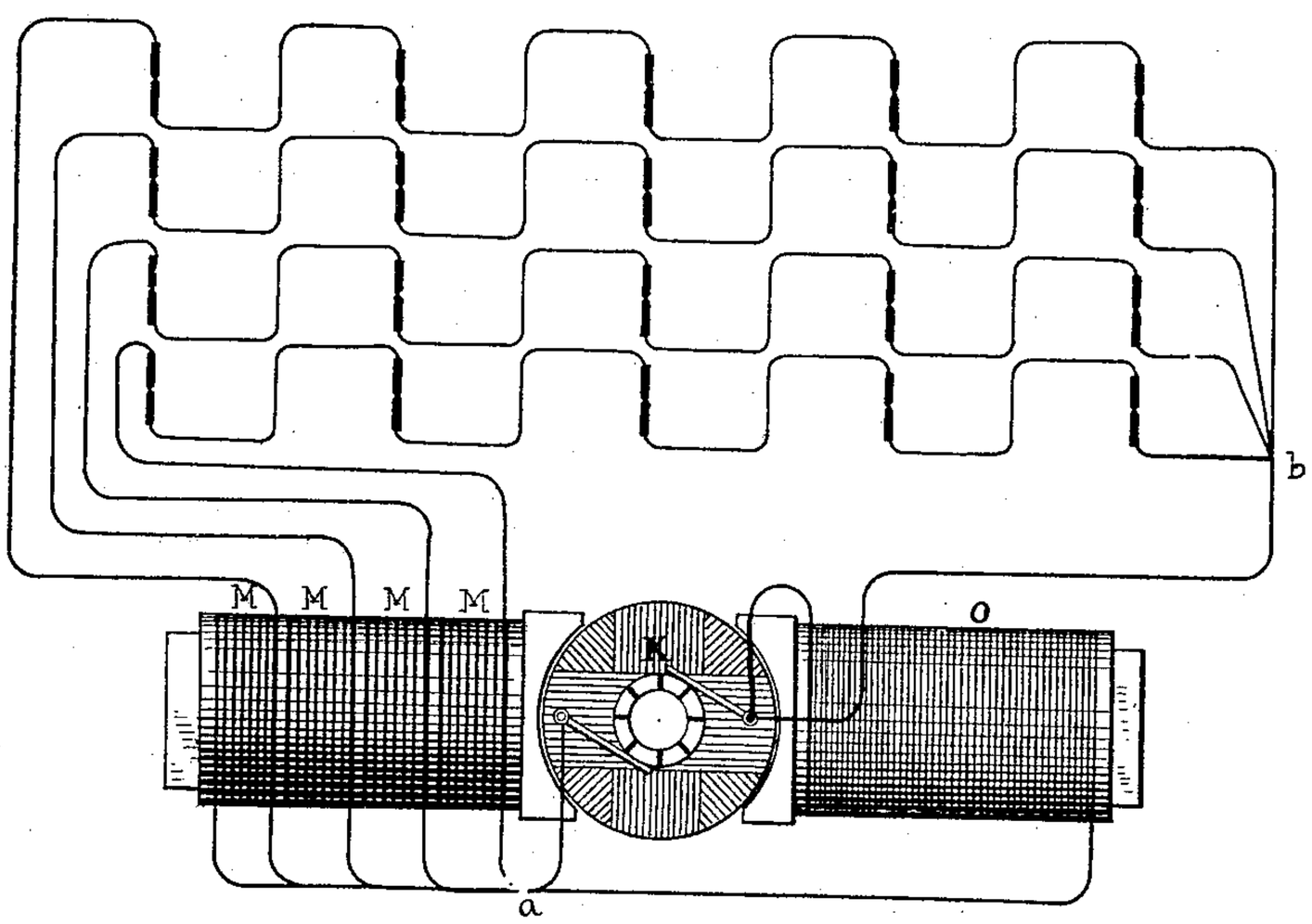


Fig. 9.



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UNITED STATES PATENT OFFICE.

ELIHU THOMSON, OF LYNN, MASSACHUSETTS, ASSIGNOR TO THE THOMSON-HOUSTON ELECTRIC COMPANY, OF CONNECTICUT.

ELECTRIC LIGHTING SYSTEM.

SPECIFICATION forming part of Letters Patent No. 321,461, dated July 7, 1885.

Application filed May 21, 1884. (No model.)

To all whom it may concern:

Be it known that I, ELIHU THOMSON, a citizen of the United States, and a resident of Lynn, in the county of Essex and State of Massachusetts, have invented certain new and useful Improvements in Electric Lighting Systems, of which the following is a specification.

My invention has for its object the division of a continuous-current electric circuit into two or more branches for feeding arc lights upon each branch.

Heretofore no means has existed for successfully working two or more arc-light circuits in parallel or multiple arc from the same circuit conveying continuous straight electric current. The nearest approximations thereto have been where the arcs have been very short. In fact only semi-incandescent lights have thus been worked. By my invention it is feasible to divide a circuit supplied with a continuous or straight electric current—that is, one constantly of the same polarity—through two or more arc lights or series of arc lights, reunite the branch circuits for larger lights, and again divide through two or more lights or series of lights. Wherever it has been attempted previously so to divide only very irregular action has been obtained, a rapid alternate transfer of current from one circuit to the other being the only result when two or more arc lights or series of arc lights have been connected in parallel arc. With my invention a current of ten ampères can be subdivided to feed two circuits of five ampères each, or can be divided so as to give unequal current, as six to one and four to another branch. Currents of any volume may be subdivided to traverse two or more sets or series of arc lamps. Thirty ampères, for instance, may feed a circuit of fifteen ampères, another branch of ten, and another branch of five, giving arc lights of power corresponding thereto, while the united circuit may have lights demanding thirty ampères upon it. In all cases I suppose that the arc lights used have been adjusted to the volume of current to be supplied and work normally with such volume.

There are many phases under which my invention can be employed, and I will briefly describe some of the more apparent.

My invention consists in placing a coil in one or more of the branches of the main circuit conveying a continuous electric current, which coil has a high self-induction, a large coil of copper wire wound around a mass of iron being sufficient. The resistance of the coil is made low, so as to avoid waste of energy. It is only necessary that it be constructed of sufficient proportion to exert a powerful tendency to reactive or extra current effects.

Figures 1, 2, 3, and 4 illustrate diagrammatically various arrangements of circuits and lights embodying my invention. Fig. 5 shows diagrammatically an arrangement in which an automatic resistance is combined with the apparatus for governing the flow of current in one of the branches. Figs. 6, 7, 8, and 9 show modifications of my invention, in which the coils of the field-magnet for the machine supplying current to the divided circuit are utilized as the reactive coils of my invention.

In Fig. 1 I have shown one of the more obvious arrangements that may be adopted in carrying out my invention.

G indicates a generator or current source of any ordinary or suitable construction—such, for instance, as a dynamo-electric machine—the current from which is made to branch, as at *a*, through two reactive or self-inductive coils, C C′, wound around suitable cores of iron, as before specified, and through two series of electric-arc lights (indicated at B and B′) one series being in a branch derivation or sub-circuit with the reactive coil C, and the other series in a branch derivation or sub-circuit with the coil C′, the combined current required for running both series of lights being equal to that supplied from the source G. The current of the two branches, after reuniting at a point, as *b*, may be carried through lamps L L, which are supposed to be such as to each require the full volume of current from the generator. After passing the lights L L the circuit is carried back to the machine in the usual or any proper manner. The direction

of current might be the opposite to that just supposed, and the results would be the same. The size of the coils C C′ will vary with every element in their construction. I find it generally sufficient in dividing a ten-ampère current into two branches of five each to have about fifty to one hundred pounds of No. 10 B. and S. gage in each coil, and have them wound around a mass of iron as a core, or bundle of iron wires of about equal weight. The adjustment of the lamps and many minor circumstances govern the size of the coil needed, and it is well to have ample size in the coils. An excess of size is no detriment, excepting that it adds unnecessary resistance. Neither is it necessary to employ two coils where two branches are used, as a single coil, C′, if large enough and in one branch only, suffices to steady or produce a constant equality in the division of current. It is, of course, to be understood that the current supplied is in one direction or continuous in character. A switch, Z, may be used to shunt out one of the coils C when desired; also switches S and resistance R, each equal to a lamp, may be placed around the lamps, so that the derivation or division of current will remain as before, even though a lamp is switched out. In Fig. 2 a derivation into three branches is supposed to be made at *a*, and the volume of current traversing each branch will accord with the relative adjustments for current given to the lamps, as when the ordinary differential regulating systems are used to regulate the carbons. At *b* a union of two branches is made for working lamps whose required current is equal to that of two of said branches combined, and at *b′* the three unite to feed lamps L L, demanding the full current. Ordinarily a full, perfect arc light demands from forty to forty-five volts, and even though the current be changed somewhat the demand is approximately the same. Hence in arranging circuits of lights, if it be desired that all the arcs should have forty volts, the number of lamps in a branch before reunion should be the same unless resistances are substituted. In any case, however, the union of the branches should be effected at equivalent potential points, and the electrical engineer, by observing such rule, may employ in any series, lamps adjusted to demand any desired electro-motive forces. The sums of the electro-motive forces demanded in any two parallel series between their points of division and reunion should be equal. Thus six lamps demanding forty volts each may be placed in parallel with eight lamps adjusted to demand only thirty volts each.

The coil introduced into any branch from the main circuit in accordance with my invention operates not by its resistance but by its power to give out extra currents, or, in other words, to add electro-motive force or exert a counter electro-motive force when needed. If the attempt is made to branch the main current through two series of arc lamps, the result is that a rapid transfer of the line-current takes place from one branch to the other. This is due to the fact that the least inequality of the resistance of the two branches causes the current to be diverted to that branch having the least resistance, because the resistance of arc is inversely proportional to the current strength. To prevent this rapid alternation of effect in the branches, the regulating mechanism of the lamp would require to work with inconceivable rapidity and to be without inertia in making such adjustments as to preserve the resistance of the branches equal. The introduction of the electro-reactive coil prevents the rapid transfers of current above described, by virtue of the fact that all changes of current in such a coil are opposed by counter forces set up. Thus should the current begin to increase, the coil opposes a kick or reaction or counter electro-motive force due to the energy absorbed in giving magnetism to its core. On the other hand, should the current begin to diminish, the coil tends to retard or prevent such diminution of current by developing an electro-motive force in the same direction, or an extra current due thereto, or a reaction tending to sustain the original flow of current unchanged—that is, there is a giving out of energy due to the loss of magnetism of the iron core. Now, in practice all such changes of current are anticipated by the actions brought about, and the result is that sufficient time is given for the mechanism of the lamp to either equalize or establish and preserve definite adjusted relations between the various branches of the current.

In Fig. 3 the derivation *a* is made at an intermediate point in the main circuit containing lights L L L L, the coils C C′ being the same as before. It is not necessary to place the coils C and C′ (whether one or both be used) at any definite point in the circuit, but they may be placed where convenient in the branch, as indicated by Fig. 4. In fact, several coils may be distributed along each branch, and they may be made so small that only their combined action would be sufficient.

In Fig. 5 I have shown one way in which a current-regulator for automatically regulating or governing the flow of current in one of the derivations may be combined with my invention. The current-regulating device is here shown as consisting of a variable resistance governed in its action or position by an electro-magnet whose coils are in a branch or derivation. Any other device for regulating or governing the flow of current to the branch might be used in place of a rheostat or variable resistance.

R R′ R^2 indicate three coils of an adjustable resistance of well-known principle, and D a contact-spring adapted to slide over a series of contacts, to which the terminals of said coils are connected in such way that the number of

coils in circuit with one another and the lights B, and therefore the amount of resistance in circuit, will depend upon the position of the spring. The spring D is carried by the armature N of the regulating-magnet, which magnet is attracted to its pole P against the action of a retracting-spring, W. The armature is preferably perforated and the pole conoidal in form, as shown. The coils of the regulating-magnet are in the branch with the lights B, the spring D, and the adjustable resistance, and the movement of the spring under the action of the magnet adjusts the resistance. Any excess of current branching through the lights B will cause resistance to be introduced into the branch and the current flow in said branch to be maintained at the same amount. The regulating-coil is shown as consisting of the reactive coil C, and this is the preferable construction. The extinguishment or short-circuiting of a lamp, B, causes resistance at R R′ R^2 to be automatically introduced into the branch containing the lamps. The magnet C P should have a uniform effective attraction for a given normal current strength. The branch B′ is also preferably provided with a regulating-magnet like C P, although for simplicity I have left it out of the figure.

In certain cases I find a considerable advantage in making the field-magnets of a dynamo-generator act as a substitute for coils C C′. The coils of the field-magnet being wound on an iron core like the coils C C′, will obviously have, like the latter, a self-inductive capacity fitting them for use in accordance with my invention. Such an arrangement is indicated in Fig. 6, where the branches or derivations start from a commutator-brush of the dynamo and pass through the field-magnet coils M M′, respectively, and thence separately through the series of arc lights B B′, returning by L L. Where a simple coil only is desired to act as a self-induction coil, the evident modification shown in Fig. 7 may be adopted. In this instance one coil only of the field-magnet of the generator is in a branch or derivation, the other coil or coils being in the main or principal circuit, through which the current for both branches circulates.

Further modifications, such as indicated in Fig. 8, may be readily made. In this instance part of the field-magnet coils constitute a derived circuit of high resistance around the working circuit or circuits, other coils of said field-magnet being used as reactive coils according to my invention.

O O′ indicate such fine-wire coils of high resistance in a derived circuit about the resistances, while M M M M indicate field-magnet coils of coarse wire, assisting the fine-wire coils to produce the field-magnetism in the machine, and each acting as a reactive coil of my invention in a separate branch or derivation.

In Fig. 9 connections from the commutator K feed the magnet-coil O in derived circuit around the work, and the derivation at *a* is made into four circuits or other number when so constructed, the separate field-magnet coils M M serving, as before, to permit branching of current. The proportions are selected so that the electro-motive force of the generator at a constant speed shall be constant, whether the circuit is closed or not through the whole four series of lights. These proportions may be readily established in accordance with the methods of a former patent issued to me October 10, 1882, No. 265,937.

So constructed and with proper modifications, the generator may be made to furnish one, two, three, four, or more series of lights independently of each other from a single armature, and the extinction of one or more series by open-circuiting is possible without seriously affecting the remaining series.

Having now described my invention in its more obvious forms, I wish it to be understood that it has reference to a new art or method of operating, while the embodiment in special devices, though important, is subject to wide variations.

I am aware that it is not new to divide the field-magnet coils of a dynamo-machine into sections, each section being in a separate circuit from the armature to incandescent lamps fed in multiple arc, and I do not, therefore, make any broad claim to such an arrangement.

What I claim as my invention is—

1. The combination, with two or more multiple or parallel arc branches fed by a continuous-current dynamo-electric machine, of electric-arc lamps arranged in series in said branches, and a coil or coils of the dynamo included in one or more of said branches, as and for the purpose described.

2. In a system of electric distribution for electric-arc lamps in which said lamps are fed in multiple or parallel arc from a continuous-current main, the combination, with one or more of said multiple-arc branches, of one or more reactive coils constructed in the manner described to have a definite or positive electro-motive tendency suited to the current-supply, as and for the purpose described.

3. The combination, with two or more parallel or multiple arc branches fed from a continuous-current main, of electric-arc lamps arranged in series in said branches, and one or more reactive coils in one or more of said branches, said coil or coils being constructed in the manner described to have a positive or determinate counter-electro-motive force, according to the current-supply, as and for the purpose described.

4. The combination, with two or more multiple or parallel arc branches containing electric-arc lamps and fed from a common supply, of an automatic variable resistance for governing the flow of current to a branch, and a reactive coil or coils placed in one or more

of said branches and constructed to have a definite or positive counter-electro-motive force adapted to the current-supply.

5. The combination, with a dynamo-machine supplying two or more multiple or parallel arc branches, of derived or shunt field-magnet coils and accessory direct-circuit field-coils in circuit with branches containing arc lights.

6. The combination, in a generator, of a derived or shunt field-magnetizing coil, and a series of field-magnet coils or branches from the armature through separate arc-light circuits.

Signed at Lynn, in the county of Essex and State of Massachusetts, this 15th day of May, A. D. 1884.

ELIHU THOMSON.

Witnesses:
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E. B. DOEN.