

(No Model.)

J. & E. HOPKINSON.

METHOD OF SYNCHRONIZING ALTERNATE CURRENT GENERATORS.

No. 412,186.

Patented Oct. 1, 1889.

Fig. 1.

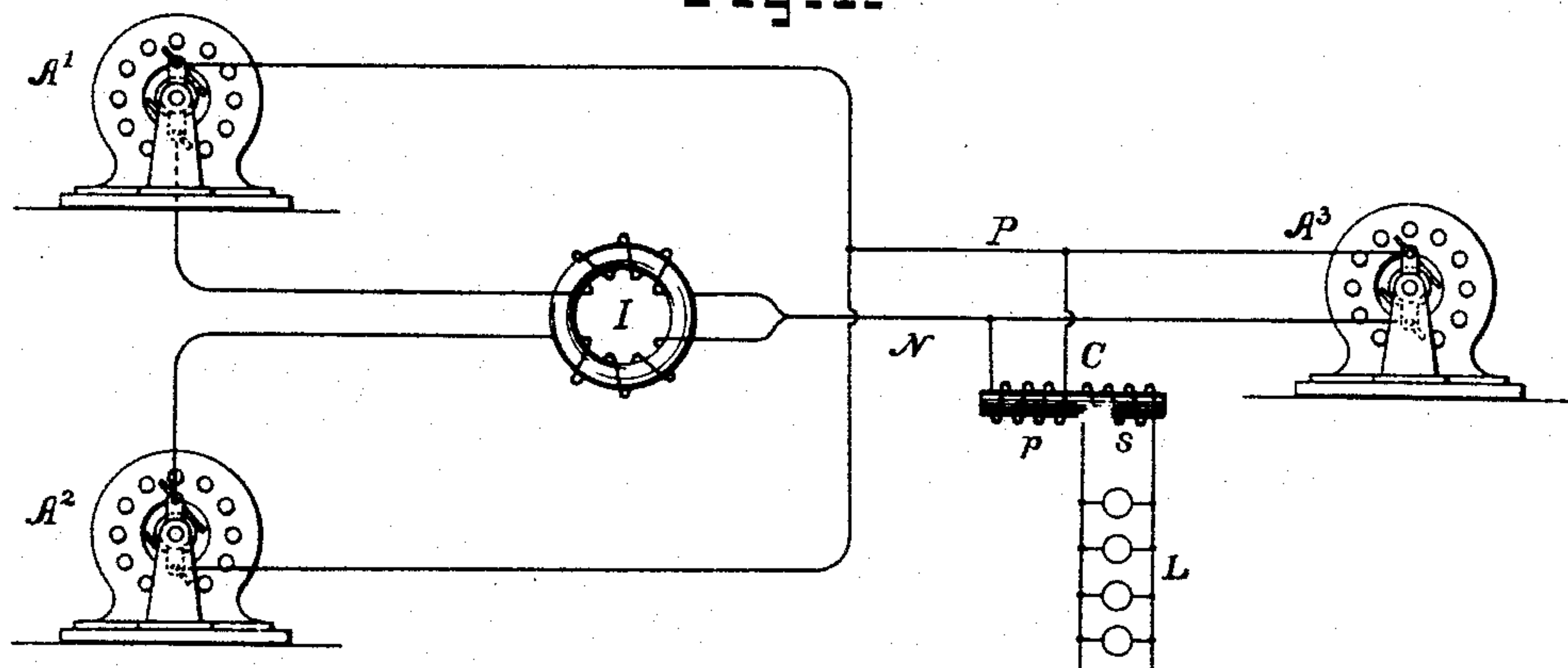
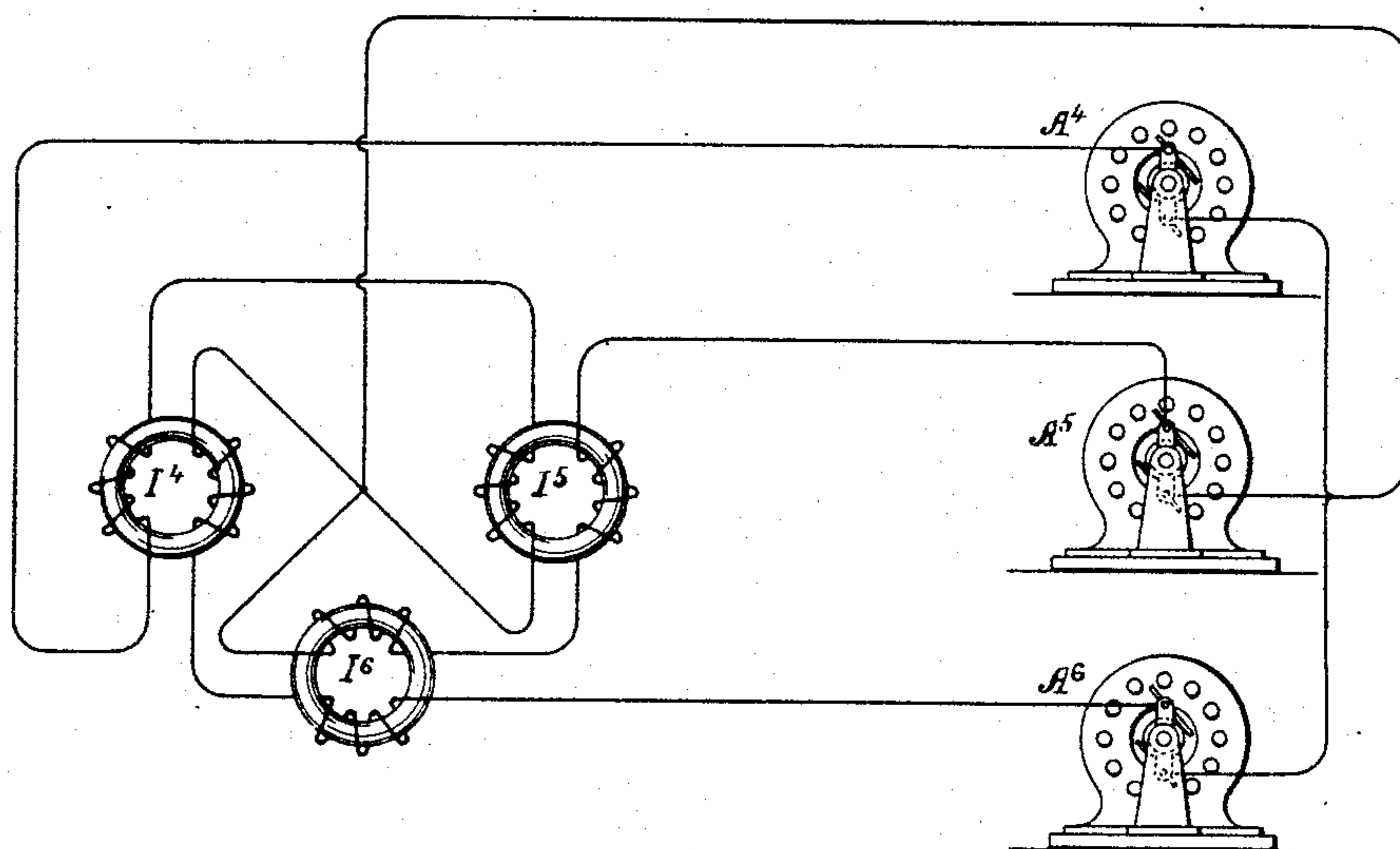


Fig. 2.



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UNITED STATES PATENT OFFICE.

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METHOD OF SYNCHRONIZING ALTERNATE-CURRENT GENERATORS.

SPECIFICATION forming part of Letters Patent No. 412,186, dated October 1, 1889.

Application filed May 24, 1889. Serial No. 311,970. (No model.)

To all whom it may concern:

Be it known that we, JOHN HOPKINSON and EDWARD HOPKINSON, residing, respectively, in Westminster, in the county of Middlesex, and Manchester, in the county of Lancaster, England, have invented certain new and useful Improvements in the Method of Synchronizing Alternating-Current Generators, (Case 233,) of which the following is a specification.

We have found that it is practicable to work two or more alternate-current dynamo-electric machines when coupled in parallel to each other (or, as it is sometimes termed, "in multiple arc") to a system of conductors common to both, and also that a similar alternate-current machine coupled in like manner and connected in parallel with the same system of conductors may under certain conditions be employed as a motor. These results are dependent upon the self-induction or counter electro-motive force of the dynamo-electric machines employed, and this in turn is dependent for its value upon the mass of iron in the armature, which is subject to inductive action. In many classes of machines, especially in those in which the armature is formed wholly of coiled conductors without iron cores, the coefficient of self-induction is too small to produce the desired result.

Our invention, which is designed to overcome this defect, consists in causing the current from such machines to traverse an independent self-induction coil or coils, which coil or coils are preferably constructed in such a manner that the core forms a complete magnetic circuit, as by this means the highest coefficient of induction is attained.

In the accompanying drawings, Figure 1 is a diagram illustrating the principle of our invention. Fig. 2 shows an arrangement applicable to a group of three dynamos.

A' and A² represent two alternate-current dynamo-electric machines, which are driven by power usually independently, having their terminals united in parallel or multiple arc to a pair of main conductors P N, common to both.

A³ is a third alternate-current dynamo-machine, which may be used as a motor, and this has its terminals likewise connected to the same conductors N P.

C is an induction coil or converter, which has the terminals of its primary coil *p* attached, respectively, to the conductor N P, while the terminals of its secondary coils *s* are connected with a system of incandescent or other electric lamps, as shown at L. In the circuit of the alternate dynamo-electric machines, as A' and A², a self-induction coil I is included, which may be of any desirable construction. We prefer to construct the same in such manner that the coiled copper conductors are surrounded by a mass of iron subdivided by insulating-spaces in a direction parallel to the general direction of the lines of the magnetic force, as set forth in the British Letters Patent No. 14,233, granted to us October 28, 1884, to which reference is had; but we do not desire to restrict ourselves to a self-induction coil of any particular construction. It is sometimes desirable to vary the co-efficient of self-induction of this coil, which may be effected in any convenient manner. We have found that when one or more independent self-induction coils are included in the circuit of two or more generators in which the mass of iron in the respective armatures is insufficient to maintain a continuous synchronism the effect is substantially the same as if the mass of iron forming the cores of the self-induction coils were a part of the armature and subject to the inductive action of the armature-coils.

Fig. 2 shows a group of three alternate-current dynamos A⁴, A⁵, and A⁶, grouped with three self-induction coils 14, 15, and 16 in such manner that either machine may be used either as a generator or as a motor, or any two of the group may be used as a generator and the other as a motor, or any one may be used as a generator and the other two as motors, as the conductors of each machine are brought into inductive relation with the conductors of the other two.

When the generators connected through the respective coils of any of the self-induction coils are in synchronism, then the electro-motive forces of these two oppose each other in the two portions of the coils, since the currents flow in the opposite directions. If, now, one generator lags behind the other, then the effect of its current upon the core will be less

than that of the other generator. The portion of the coil receiving the greater current then acts as the primary coil of a converter and induces current in the other portion.

- 5 This induced current tends to assist the lagging electro-motive force, and consequently assists in synchronizing the two generators.

In another application, Serial No. 240,225, filed June 4, 1887, the system of apparatus
10 here shown is claimed.

We claim as our joint invention—

- The hereinbefore-described method of synchronizing alternate-current electric generators, which consists in causing the excess of
15 current from one generator to induce an assisting current in the circuit of the other generator and thereby temporarily lessen the load of that generator.

In testimony whereof we have hereunto sub-

scribed our names this 2d day of May, A. D. 20
1889.

JOHN HOPKINSON.
EDWARD HOPKINSON.

Witnesses to the signature of John Hopkinson:

SAMUEL CRANSAR,
Clerk to Messrs. John Newton & Son, Public Notaries, of Birchin Lane, London.

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Witnesses to the signature of Edward Hopkinson:

JOSEPH HOWARTH,
J. WESLEY C. STAFFORD,
Clerks with Messrs. Ormerod & Allen, Solicitors and Notaries, Manchester.