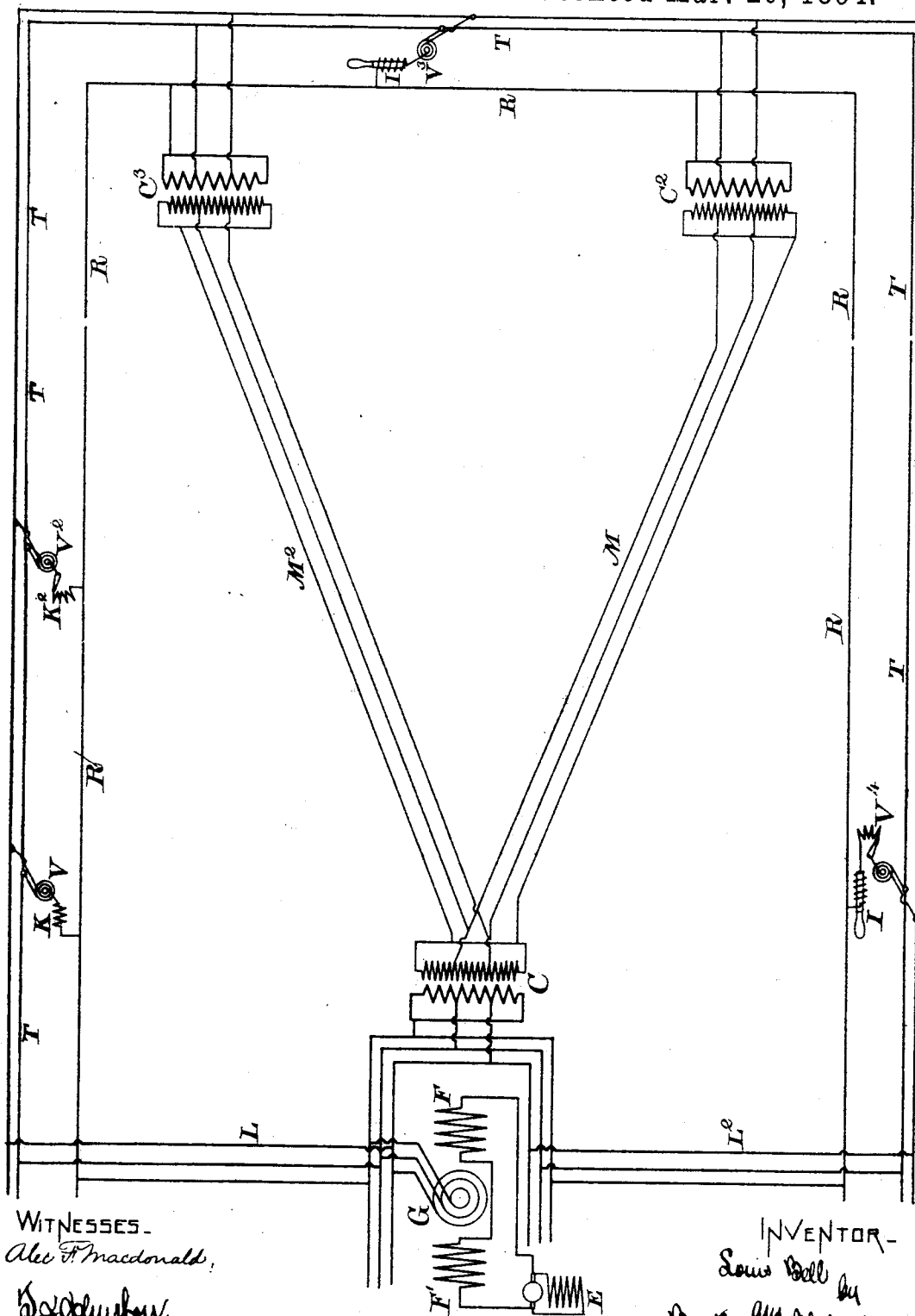


(No Model.)

L. BELL.
REGULATION OF MULTIPHASE SYSTEMS.

No. 516,796.

Patented Mar. 20, 1894.



WITNESSES.

Alec F. Macdonald,

J. J. Johnston.

INVENTOR-

Louis Bell

by
Bentley and Blodgett,
Attys.

UNITED STATES PATENT OFFICE.

LOUIS BELL, OF BOSTON, MASSACHUSETTS, ASSIGNOR TO THE GENERAL ELECTRIC COMPANY, OF SAME PLACE.

REGULATION OF MULTIPHASE SYSTEMS.

SPECIFICATION forming part of Letters Patent No. 516,796, dated March 20, 1894.

Application filed June 15, 1893. Serial No. 477,653. (No model.)

To all whom it may concern:

Be it known that I, LOUIS BELL, a citizen of the United States, residing at Boston, in the county of Suffolk and State of Massachusetts, have invented a certain new and useful Improvement in Regulation of Multiphase Systems, of which the following is a specification.

My invention relates to an application of multiphase systems to circuits in which the resistance and self-induction are variable; and has for its object to provide a method of compensating for such variations in one or another of the lines of such a system by balancing the resistance and self-induction of the currents in the respective lines, so as to artificially adjust their phases when they do not harmonize or follow each other in proper succession, in such manner as to bring them into harmony to suit the best working conditions.

In the operation of multiphase or three-phase systems, particularly as applied to railways, any great variation in the resistance or self-induction of the lines will tend to displace the phases and greatly diminish the efficiency of the apparatus in the system, both at the generating station and on the lines. This difficulty is peculiarly apparent in railway circuits, inasmuch as the resistance of the ground return is ordinarily very much less than that of the copper lines used for the other two branches of the circuit. To correct these evils I artificially adjust the resistance of the circuit of odd conductivity, so as to bring it to approximately the same amount as that of the other branches of the three-phase or multiphase circuits; and my invention consists broadly in the use of an auxiliary phase-adjusting or current-regulating apparatus in circuits leading to the operating devices of a three-phase or multiphase system.

The accompanying drawing shows a diagrammatic representation of a system embodying my invention. Therein G is a generator of three-phase currents, the field magnet coils F, F' of which are energized by the exciter E. Line wires L, L² are connected to the generating coils to convey the currents to the work, for example, the operation of a railway in which R, R, &c., represent the rail re-

turn and its connections to one of the lines L, L². The other lines are connected to overhead conductors T, T, &c., as in ordinary trolley systems; or they may be arranged upon an elevated structure between the rails, outside the rails, or in a conduit in any convenient manner.

V, V², V³, V⁴, represent motors or electric locomotives taking power through the trolleys from the lines T, T. The feeding of the lines T and R may be by circuit connections to the generator by the lines L, L²; and it may also, in case a distance is to be covered by transformation up, as at C, and transformation down as at C², C³, the high potential lines being shown at M, M², connecting the different transformers, the low potential lines of which are connected respectively to the generator lines and to the lines T and R of the railway system, care being taken not to confuse the phases in making the connections.

As further indicated at K, K², I provide in the line which has the least resistance proper apparatus to adjust the total resistance in such line to an approximate equality with that of the other lines of the system; in the case illustrated the rail return R, R, includes the resistance.

At K², a resistance is shown as variable, which is of advantage in adjusting on different parts of the line as the motion of the vehicle from one part to another causes a variation in the resistance of the ground return. A coil of strong self-induction having a movable core may be employed, as at V³, where I is such a coil serving to give sufficient self-induction or lag to the currents to bring them into proper relation of phase. It is also within the scope of my invention to use a variable resistance as at V⁴ in combination with the adjustable self-induction coil I. It is to be understood that these elements of variability are to be provided in the circuit where they may be needed; and it is also within my invention to apply them to one or more of the circuits, in which case resistance may be placed in one circuit at the time when self-induction is used in another. In the case of stationary motors the apparatus described may be installed near the motor, and in the

case of moving vehicles it is installed upon the car, where the operator may readily adjust it so that the phases of current are never greatly disturbed from the proper angular succession.

I am aware that resistances and self-inductive appliances may be used in electric circuits in many relations; I do not therefore claim broadly the application of a resistance or a self-inductive appliance to an electric circuit, but I do claim such a use of a resistance or self-inductive appliance as will balance the resistance and self-induction of the different sides of a three-phase or multiphase system, and such an application of the apparatus described I wish to claim broadly.

Having thus described my invention, what I claim as new, and wish to protect by Letters Patent of the United States, is—

1. The method of preserving the relative position of the phases in a multiphase system the lines of which vary in resistance or self-induction, which consists in artificially raising the resistance of the lower resistance lines to that of the higher resistance lines.

2. In a multiphase system of electric distribution, a generator, conductors leading therefrom, an earth-circuit forming one of such conductors, translating devices, and current-adjusting devices arranged to keep the resistance and self-induction of the earth-circuit in substantial accord with that of the other conductors; whereby the phases on the

lines are preserved in harmony and the efficiency of the translating devices maintained.

3. In a multiphase electric railway system, a generator, lines leading therefrom, the rails forming one of such lines, and current-adjusting means in the rail-circuit; whereby the resistance and self-induction of the track-circuit may be adjusted to an equality with those of the other lines, and the phases preserved in proper succession, substantially as described.

4. In a system of electric distribution employing multiphase currents, a generator, lines of unequal resistance or self-induction leading therefrom, translating devices taking current from such lines and current adjusting devices in branches from such leads to the operating devices, adapted to equalize the resistance and self-induction of the lines, and thereby preserve proper succession of phases.

5. In combination with an alternating current motor of multiphase type, a generator of multiphase currents, lines supplying current to the motor, and a variable resistance in one or another of such lines adapted to adjust the resistance of the lines and preserve harmony of phase.

In witness whereof I have hereunto set my hand this 13th day of June, 1893.

LOUIS BELL.

Witnesses:

A. M. CLINE,
F. A. DAILEY.