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F. CONRAD.

ALTERNATING CURRENT SYSTEM OF CONTROL.

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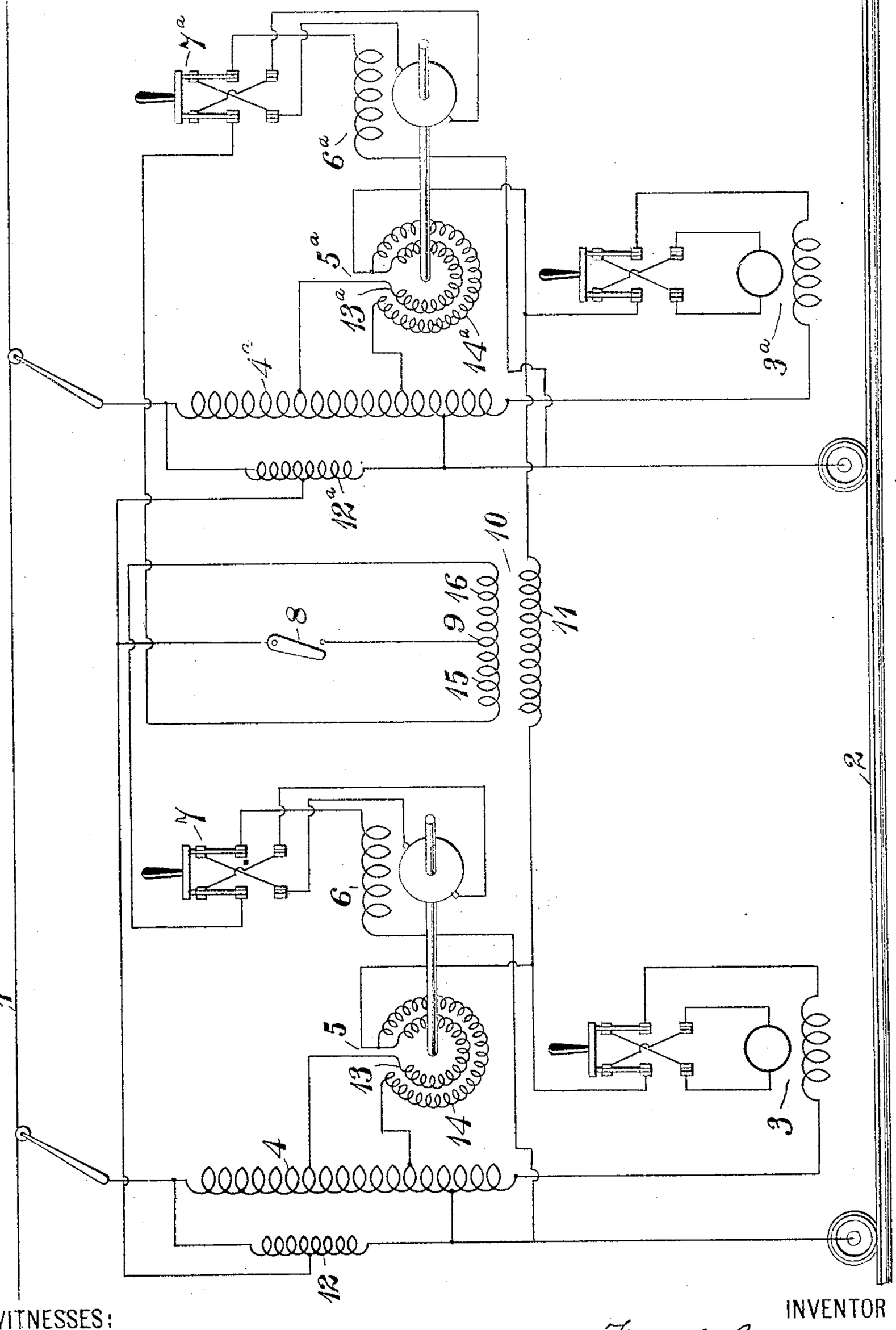

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ALTERNATING-CURRENT SYSTEM OF CONTROL.

No. 803,213. Specification of Letters Patent. Patented Oct. 31, 1905.

Application filed April 3, 1905. Serial No. 253,642.

To all whom it may concern:

Be it known that I, FRANK CONRAD, a citizen of the United States, and a resident of Edgewood Park, in the county of Allegheny and State of Pennsylvania, have invented a new and useful Improvement in Alternating-Current Systems of Control, (Case No. 1,417,) of which the following is a specification.

My invention relates to systems of control for electric motors, and particularly to alternating-current systems that embody voltage-regulating devices.

The object of my invention is to provide means for causing two or more voltage-regulators to operate simultaneously and synchronously—that is, so that all of the regulators will supply approximately the same voltage to the motors or other translating devices.

When two or more railway-vehicles that are each provided with motors and voltage-regulators are connected to form a train or when it is expedient or necessary to provide a single vehicle with two voltage-regulators, it is desirable that all the motors be supplied with approximately the same voltage in order that they may operate at the same speed and develop the same torque.

My invention provides means for causing equalization of the potentials at the terminals of all of the motors.

The single figure of the accompanying drawing illustrates a system embodying my invention.

Alternating-current energy is supplied from a trolley-conductor 1 and a track-rail 2 to motors 3 and 3ª through lowering transformers 4 and 4ª and voltage-regulators 5 and 5ª, that are operated by means of motors 6 and 6ª, the circuits of which are controlled by means of reversing-switches 7 and 7ª and a master-switch 8. One terminal of the master-switch 8 is connected to the middle or an intermediate point of the secondary winding 9 of a transformer 10, the terminals of the primary winding 11 of which are connected to corresponding terminals of the motors 3 and 3ª or to corresponding points in the motor-circuits. The terminals of the secondary winding 9 are connected to reversing-switches 7 and 7ª, and the remaining terminal of the master-switch 8 is connected to intermediate points in the transformers 12 and 12ª, that are supplied directly from the trolley-wire 1 and the track-rail 2. The transformers 12 and 12ª may in a more complete system of control than that here shown serve an additional purpose to that here indicated—such, for instance, as supplying the lights of the train.

The voltage-regulators 5 and 5ª comprise primary windings 13 and 13ª, that may be adjusted in position with respect to secondary windings 14 and 14ª by means of the motors 6 and 6ª, the inductive relations of the primary and secondary windings being thereby modified and the voltage supplied to the motors 3 and 3ª varied.

If the regulators 5 are not adjusted synchronously, different voltages may be supplied to the motors 3 and 3ª, and a difference of potential may be caused to exist between the terminals of the motors, and consequently between the terminals of the primary winding 11 of the transformer 10. The motors 6 and 6ª are ordinarily supplied with energy from the transformers 12 and 12ª through the master-switch 8 and through the parts of the secondary winding 9 of the transformer 10 in opposite directions, so that the inductances of the two parts of the windings neutralize each other. When, however, current traverses the primary winding 11, electromotive forces are induced in the portions of the secondary winding 9, one of which is added to the normal voltage derived from the transformers 12 and 12ª and the other of which is opposed to that derived from the transformers 12 and 12ª.

The circuits are so arranged that whenever the voltages supplied to the main motors differ those supplied to the regulator-operating motors are also caused to differ and the regulator which is delivering the lowest voltage is accelerated, while the other is retarded in its operation until the voltages are equalized. For example, it may be supposed that the motors 6 and 6ª are normally supplied with current at one hundred volts and that the regulators 5 and 5ª do not occupy corresponding positions and that consequently the voltage supplied to the motor 3 is higher than that supplied to the motor 3ª by ten volts. The difference of potential, then, between the terminals of the primary winding 11 of the transformer 10 is ten volts, and it may be assumed that an electromotive force of twenty volts is induced in the secondary winding 9, one-half of which pertains to each part of such

winding. In the part 15 the ten volts will be added to the one hundred volts supplied from the circuit, and consequently the voltage supplied to the motor 6^a will be one hundred and ten, while the ten volts induced in the part 16 will be opposed to the one hundred volts derived directly from the circuit, and therefore the voltage supplied to the motor 6 will be ninety. The regulator 5^a will then be operated at an increased speed and the regulator 5 at a decreased speed until there is no difference of potential between the terminals of the primary winding 11 of the transformer 10—that is, until the motors 3 and 3^a are supplied with the same voltage.

The arrangement and circuit connections of the main and auxiliary transformers, of the voltage-regulators, their operating-motors, and the main motors may be varied considerably from what is here specifically shown and described, and the transformers may also be of the two-winding form rather than of the single-winding form, as here shown, and many other of the details of the arrangement may be modified without departing from the scope of my invention.

I claim as my invention—

1. The combination with a plurality of translating devices and voltage-regulators therefor, of motors for operating the regulators, and a transformer the primary winding of which is connected between corresponding terminals of the translating devices and the secondary of which is connected to the regulator-operating motors by means of its end terminals and an intermediate connection.

2. The combination with a plurality of translating devices and voltage-regulators therefor, of motors for operating the regulators and a transformer for governing the speeds of the motors and thereby equalizing the voltages supplied by the regulators to the translating devices.

3. The combination with a supply-circuit, a plurality of main electric motors and a plurality of motor-operated voltage-regulators for varying the speed of said main motors, of an adjusting-transformer the primary winding of which is connected between corresponding points in the circuits of the main motors and the secondary winding of which has its end terminals respectively connected to the terminals of the regulator-operating motors and an intermediate point connected to the supply-circuit.

4. The combination with a supply-circuit, a plurality of main electric motors and a plurality of motor-operated voltage-regulators for varying the speed of said main motors, of an adjusting-transformer the primary winding of which is connected between corresponding points in the circuits of the main motors and the end terminals of the secondary winding of which are connected to terminals of non-corresponding regulator-operating motors and an intermediate point of which is connected to the supply-circuit.

In testimony whereof I have hereunto subscribed my name this 31st day of March, 1905.

FRANK CONRAD.

Witnesses:
S. E. JOHANNESEN,
BIRNEY HINES.