(No Model.)

C. J. VAN DEPOELE.

ALTERNATE CURRENT ELECTRIC RAILWAY TRAIN SYSTEM.

No. 434,685. Patented Aug. 19, 1890.

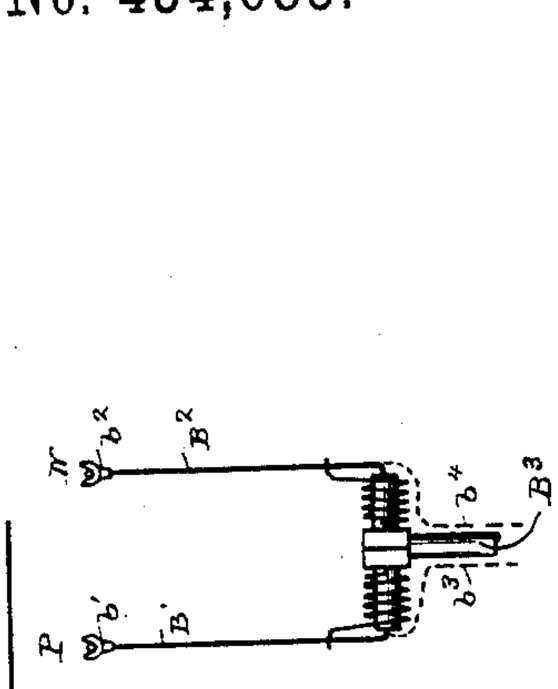

Fig. 2.

Fig. 1.

Witnesses.
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ALTERNATE-CURRENT ELECTRIC-RAILWAY-TRAIN SYSTEM.

SPECIFICATION forming part of Letters Patent No. 434,685, dated August 19, 1890.

Application filed August 16, 1889. Serial No. 320,934. (No model.)

To all whom it may concern:

Be it known that I, CHARLES J. VAN DEPOELE, a citizen of the United States, residing at Lynn, in the county of Essex and State of Massuchusetts, have invented certain new and useful Improvements in Alternate-Current Electric-Railway-Train Systems, of which the following is a description, reference being had to the accompanying drawings, and to the letters and figures of reference marked thereon.

This invention relates to improvements in electric-railway systems.

The invention comprises means for economically supplying currents of the alternating, intermittent, or discontinuous type over long lines of electrical conductors with little loss, means carried by the moving vehicles for utilizing said currents without danger to life or liability of injury to the apparatus on account of the tension of the supply-current where the circumstances may render necessary the use of a supply-current of high tension.

Many methods of conversion have been proposed but so far as I am aware it is entirely novel to transmit the supply-current from the source along the line of an electric railway upon an exposed working-conductor and at any potential necessary to carry the said current to the remotest parts of the line without wasteful loss. The disadvantages of employing such a current in the motor-circuits are many, among which are the danger to life by defective insulation, the danger of damage to the insulation of the apparatus, and the danger of leakage and waste by the escape of the current to the ground. I find, however, that according to my present invention these difficulties are entirely overcome, since the main working-conductor, carrying the relatively high-tension current, is usually suspended at such a height above the roadway as to be inaccessible to animal life and therefore free from danger thereto. The current is furthermore collected from said conductor by well-insulated apparatus, and although I may employ the rails as a return-conductor, it will in many instances, especially where the tension of the supply-current is quite high, be found desirable to employ a complete suspended metallic circuit, in which event the high-tension current is carried to the circuits of the motor-car and then back therefrom by well-insulated conductors to a return-circuit having no connection whatever with the rails and earth, and this is the preferable form of arrangement. Upon the motor-car is placed an inductional transformer or any desired number of inductional transformers, the primary circuit or circuits of which are in communication with the supply-circuit, the secondary circuit or circuits thereof feeding directly into a local circuit, which I have denominated the "train-circuit." The train-circuit extends by suitable couplings throughout the train, and a number of motor-cars are provided, sufficient to propel the said train at the desired rate of speed, the number being only limited by the capacity of the converter or converters.

In referring to the converter throughout this specification it must be understood that I propose to use one or a number of inductional transformers, sufficient to produce the desired volume of current in the train-circuit. Alternate-current motors of any desired type are employed to propel the motor-cars, said motors being all connected in the train-circuit, and consequently all controlled from the point where the output of the converter can be reached. The flow of current in the train-circuit is readily controlled by a resistance or reactive coil in the primary circuit of the converter, and the motors can be stopped and started by decreasing or increasing the flow of supply-current in the primary circuit of the converter. Furthermore, all the motors can be reversed by the use of a single switch in the train-circuit, desirably on the motor-car near the converter, and by means of which the direction of rotation of the motors can be controlled by the person in charge of the motor-car. The train-circuit will under any circumstances be so comparatively short that its resistance will be low, and the cost of the additional conductor so small as to be of no importance. A car in each train, hereinafter referred to as the "motor-car," is provided with the current-collecting devices, and also with an inductional transformer or transformers for reducing the tension of the main current.

A principal feature of the invention con-

sists in collecting the high-tension supply-current from the conductors extending from the generating-station along the line of the railway and converting the same into current of lower potential and then supplying said secondary current to a local-train circuit traveling with the motor-car and provided with any desired number of motors of the best form for the purpose.

Several very advantageous type of alternating-current motors have been invented by me, which, owing to the fact that they require more than a two-wire circuit for their successful operation, would under some circumstances be commercially impracticable on account of the great cost of so many circuit-wires. By means of the present invention, however, not only is that objection entirely overcome, but the said motors are found to be specially adapted to the purpose, and a safe, practical, and convenient way is provided for subdividing the power necessary to propel a long train of cars, thereby doing away with the necessity for a large heavy locomotive, while at the same time the control of all the motors on the train is located at a single point, as though a single locomotive were used. While I find it desirable to employ more than two conductors in the motor-circuit, said circuit is only required to traverse the train, and the cost thereof will be inconsiderable.

The simplest form of my invention comprises a single converter upon the motor-car, a local circuit traveling therewith, and suitable motors in the local circuit. Having shown a particular form of motor in the present instance, the same being well adapted to the purpose, I have shown a double-converter system, since by means thereof the desired difference in phase necessary to produce the best results in the motor is secured.

In the accompanying drawings, which illustrate a form of my invention, Figure 1 is a diagrammatic view showing the application of the system to an electric railway. Fig. 2 is a detail end view of the supply-circuit and current-collecting devices.

As indicated in the drawings, A is the motor-car, desirably attached at the front of the train and provided with current-collecting devices and other mechanism, as will appear. The motor-car may be of any desired size, shape, or construction, and will in most instances be occupied by the operator in charge of all the propelling mechanism of the train and the tension-reducing apparatus supplying the local circuit. The train is in the present instance indicated by a second car B, attached to the motor-car A, and provided with circuit-conductors and a propelling-motor.

It will be understood without further illustration that any desired number of cars may be attached to the motor-car and operated and controlled thereby.

As here shown, the supply-circuit consists of two suspended conductors P N, which form a complete metallic circuit extending over the entire line of way, and the motor-car is provided with duplex traveling contact devices engaging the said conductor and connected with the primary converter-circuit upon the said motor-car.

B′ B^2 represent upward-pressure contact-carrying arms sustained upon the top of the car A, and provided at their free extremities with one or more contact-shoes b' b^2, by which traveling connection with the said supply-circuit is established and maintained, suitable conductors b^3 b^4 extending from said traveling contacts to the terminals of the converter circuit or circuits. A convenient form of apparatus for this purpose is shown and described in my patents, No. 394,038, dated December 4, 1888, and No. 409,156, dated August 13, 1889. It should be understood, however, that the particular arrangement of the supply-conductors or the form or nature of the traveling contact devices forms no essential part of the present invention, and therefore the same may be arranged in any desirable or convenient manner.

The cars A B are mounted upon carrying-wheels a a', which move upon the track A′. Obviously the track A′ might be electrically connected and used as a return-conductor, in which event one side of the supply-circuit would be dispensed with.

C C′ are alternate-current motors of any desired type or construction, and said motors are mounted upon suitable supporting-frames C^2, connected with or forming part of the trucks upon which the cars are mounted. The motor C is similar to the machine shown, described, and claimed in my pending application filed March 8, 1889, Serial No. 302,544. The motor C′ resembles the motor C in principle, but differs slightly therefrom in actual construction, which, however, is immaterial, since both are operated in the same circuit.

Both motors here shown are what I have termed "double-circuit" motors—that is to say, the field-magnet systems of each are included in one circuit of conductors. A second circuit of conductors is provided for energizing what I have termed an "inducing" system, which is placed over or in inductive relation to the armature, and the armatures are of the wire-wound type, the conductor thereof being connected in one or more closed circuits.

M represents the field-magnets of both motors, and O the armatures.

In the motor C an inductional coil Q is placed over the armature in inductive relation thereto, while in the motor C′ a pair of secondary or auxiliary field-magnets R R′ are provided, and have their polar extensions in inductive relation to the armature, the said secondary field-magnets acting to the same effect as the induction-coil in the motor C. Both inducing systems—the induction-coil Q

in motor C and the secondary field-magnets R R′ in motor C′—are connected in one circuit of conductors and both field-magnets in another circuit. The magnetic cores of the several parts of the several motors are laminated or subdivided to an extent depending upon the rapidity of current phase, and the said motors are operated by supplying currents to the several circuits alternately—that is to say, displacing the current phases, so as to produce a magnetizing effect in the armature-circuit and a magnetizing effect in the field-magnet circuit timed to react upon the armature-poles.

It will be understood that while I have described specifically the motors herein shown said description is merely for the purpose of necessary illustration, the particular form of motor forming no essential part of the present invention, except in that the said motors are operated without the use of sectional commutators and commutator-brushes, thereby eliminating one great source of trouble in the operation of electric-railway motors, and such motors I have referred to as being commutatorless.

Any form of alternate or discontinuous current motor might be substituted in the train-circuit for those herein shown, although I prefer to employ motors of the type of some of the various types shown and described in pending applications for Letters Patent.

The apparatus for transforming or modifying the supply-current for use in the local train-circuit is carried upon the motor-car A. As here shown, the converter system is duplex, this being one of the methods of providing currents in separate circuits, said currents being displaced in phase. As previously stated, however, the invention is not limited to the particular arrangement herein referred to.

The transformer D is provided with a primary coil *d*, which is connected to the supply-conductor P through conductor *b*, conductor b^3, carried by the trolley-arm, and the current-collecting devices, whether shoes *b′*, as shown, or grooved wheels. A reactive coil E is introduced between the conductor *b* and the primary circuit *d*, by means whereof, or any other suitable device, the currents flowing in said primary coil may be regulated and controlled. The other end of the coil *d* is connected by conductor *d′* with the conductor b^4, also carried by the trolley-arm and connected to the contact devices b^2 of the supply-conductor N. The transformer D is provided with a secondary coil *e*, the terminals of which are closed upon a coil *f*, constituting the primary of a second transformer F. The transformer F is provided with a secondary coil *f′*, the ends of which are connected to conductors 1 2 of the local train-circuit.

The train-circuit comprises four conductors—viz., 1 and 2 representing the secondary of transformer F, and 3 and 4 connected to the secondary of the transformer D. The train-circuit is complete in each vehicle, and each vehicle is provided at its extremity with couplings G G′, by which the said circuits are rendered continuous throughout the train. The induction system Q R R′ of the motors, whatever the number thereof employed to propel the train, are connected by branch conductors 7 8 in the circuit 1 2, representing the secondary of one of the transformers. By means of any convenient form of circuit-changing switch, as I, the direction of the flow of current in the said inductional systems of the motors can be changed at will, and said systems being independent of the field-magnet circuits proper it follows that if the direction of the flow of current therethrough be changed without affecting the field-magnet circuit the direction of the rotation of all the armatures upon the train will be reversed. The field-magnet coils of the several motors are supplied by branches 5 6 from train-conductors 3 4, which represent the secondary of the other converter.

It will be obvious that the means here shown for supplying the motor-circuits will produce in a very convenient and desirable manner the necessary difference in phase between the currents in the said local circuits, and this I claim as a special feature of the invention.

It will readily be understood that all the propelling mechanism of the train is under the control of the operator in the motor-car through the reactive coil E of the device, by which the flow of current in the primary-converter circuit is determined according to circumstances.

While I have referred to the converters upon the motor-car as a means for reducing the tension of the current in the supply-circuit, I wish it to be distinctly understood that that is not their only purpose or function, nor is it the only use of which they are capable according to my invention, since it may be desirable under some circumstances to utilize them as a means of producing separate currents in a number of separate circuits, whether two or more, and the tension of the secondary currents may be substantially the same or lower than that of the supply-current, as desired.

Having described my invention, what I claim, and desire to secure by Letters Patent, is—

1. An electric-railway system comprising a circuit of working-conductors along the line of travel, a source of alternating or discontinuous currents connected to said conductors, a traveling vehicle provided with current-collecting devices engaging the said working-conductors and with a system of inductional transformers and means for controlling the current therein, and suitable electric motors arranged to propel the vehicle and connected in the secondary circuit of the transformer system.

2. An electric-railway system comprising a circuit of working-conductors along the line of travel, a source of alternating or discontinuous currents connected to said conductors, a motor-car provided with current-collecting devices engaging the said working-conductors and with a system of inductional transformers, one or more vehicles attached to the motor-car, a local circuit extending through the vehicles and constituting the secondary circuit of the transformer system on the motor-car, and suitable electric motors arranged to propel the vehicles, and all connected in the said local circuit.

3. An electric-railway system comprising a source of alternating or intermittent currents, working-conductors connected thereto and extending along the line of travel, a motor-car provided with current-collecting devices engaging said conductors, and an inductional transformer system for modifying the supply-current, vehicles moving with the motor-car and carrying conductors in circuit with the transformer system, electric motors for propelling the vehicles and in circuit with the modified current of the said transformer or transformers, and means for controlling the speed, power, and direction of rotation of all the motors simultaneously.

4. An electric-railway system comprising a source of alternating or intermittent currents of relatively high potential, exposed working-conductors extending along the line of travel and connected to said source of current, a motor-car or train of cars, an inductional transformer carried by one of said cars, current-collecting devices extending from the primary circuit of the transformer-circuit to the supply-conductors, commutatorless motors upon one or more of the cars, a train-circuit receiving alternating current from the secondary circuit of the transformer, and means for controlling the speed, power, and direction of rotation of all the motors simultaneously.

5. An electric-railway system comprising a circuit of main supply-conductors extending along the line of travel and connected to a source of alternating, intermittent, or pulsating electric current, a moving vehicle carrying inductional transformers, a traveling connection between the transformers and the supply-circuit, and one or more local circuits moving with the vehicle and supplied with current of suitable tension from the said tranformers, and one or more commutatorless motors for propelling the vehicle, said motors being all supplied with alternating, intermittent, or pulsating currents from the local circuits.

6. An electric-railway system comprising a circuit of exposed working-conductors along the line of travel, a source of alternating or discontinuous currents connected to said conductors, a traveling vehicle provided with current-collecting devices engaging the said working-conductors and with a duplex system of inductional transformers, and suitable electric motors arranged to propel the vehicle and connected in the secondary circuits of the transformer system.

7. An electric-railway system comprising a circuit of exposed working-conductors along the line of travel, a source of alternating or discontinuous currents connected to said conductors, the motor-car provided with current-collecting devices engaging the said working-conductors and with a system of inductional transformers, one or more vehicles attached to the motor-car, a duplex local circuit extending through the vehicles and constituting the secondary circuit of the transformer system, the several parts of the local circuit being supplied with currents differing in phase, and suitable electric motors arranged to propel the vehicles, and all connected in the said moving circuit.

8. An electric-railway system comprising a circuit of exposed working-conductors connected to a source of alternating or discontinuous currents and extending along the line of travel, a motor-car provided with contact devices for maintaining a moving contact with said conductors, one or more cars moving with the motor-car, two separate circuits extending between the connected car and inductional transformers supplied with current through the said traveling contact devices and arranged to supply currents of the desired tension to the said separate train-circuits in alternation, and electric motors arranged to propel said cars and to be operated by the currents in the respective circuits.

9. An electric-railway system comprising a circuit of exposed working-conductors connected to a source of alternating or discontinuous currents and extending along the line of travel, a motor-car provided with contact devices for maintaining a moving contact with said conductors, one or more cars moving with the motor-car, two separate circuits extending between the connected cars, an inductional transformer having its primary circuit connected to the traveling contact devices and connections between its secondary circuit and one of the train-circuits, a second transformer having its primary in circuit with the secondary of the first transformer and its secondary supplying current to the second train-circuit, and means for reversing the current in one of the train-circuits.

10. An electric-railway system comprising a circuit of exposed working-conductors connected to a source of alternating or discontinuous currents and extending along the line of travel, a motor-car provided with contact devices for maintaining a moving contact with said conductors, one or more cars moving with the motor-car, two separate circuits extending between the connected car, an inductional transformer having its primary circuit connected to the traveling con-

tact devices and connections between the secondary circuit and one of the train-circuits, a second transformer having its primary in circuit with the secondary of the first transformer and its secondary supplying current to the second train-circuit, means for reversing the current in one of the train-circuits, and means for controlling the flow of current from the traveling contact to the primary of the first converter, and thereby controlling the current in both the train-circuits.

In testimony whereof I hereto affix my signature in presence of two witnesses.

CHARLES J. VAN DEPOELE.

Witnesses:
JOHN W. GIBBONEY,
CHARLES L. OECHSNER.