No. 746,353. PATENTED DEC. 8, 1903.

W. M. MORDEY & A. G. HANSARD.

ALTERNATE CURRENT TRACTION SYSTEM.

APPLICATION FILED NOV. 12, 1903.

NO MODEL. 2 SHEETS—SHEET 1.

Fig. 1

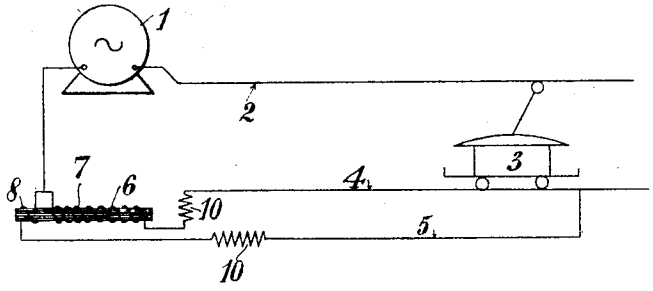


Fig. 2.

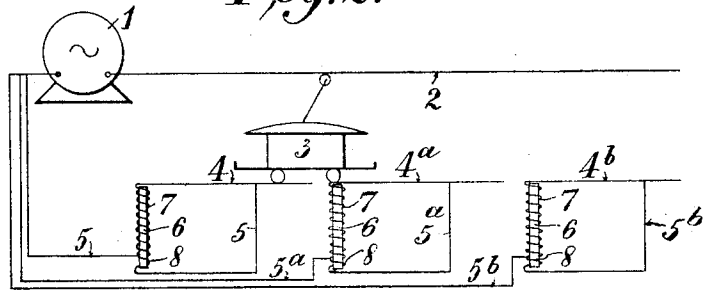
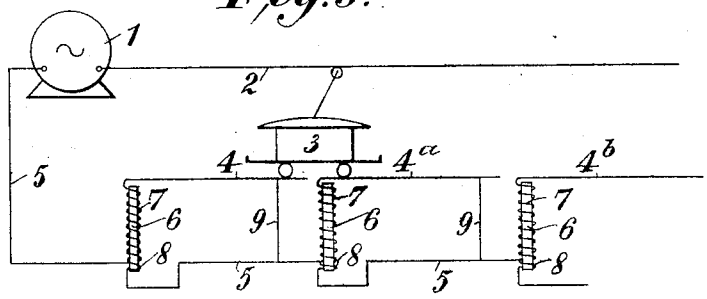


Fig. 3.



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NO MODEL. 2 SHEETS—SHEET 2.

Fig. 4.

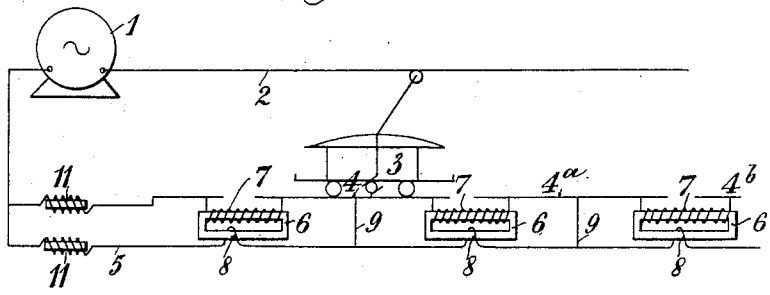


Fig. 5.

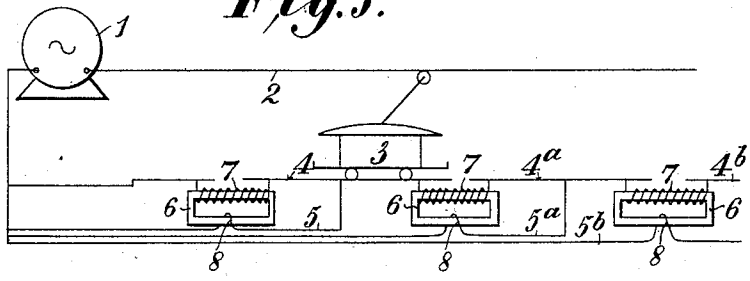
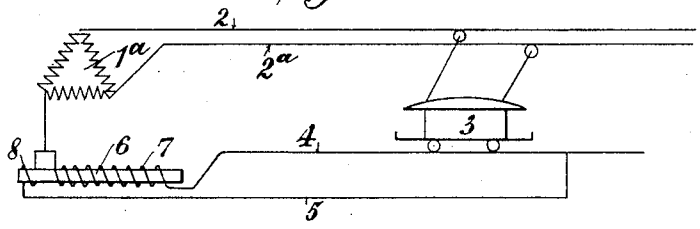


Fig. 6.



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No. 746,353. Patented December 8, 1903.

UNITED STATES PATENT OFFICE.

WILLIAM MORRIS MORDEY AND ARNOLD GREAVES HANSARD, OF WESTMINSTER, ENGLAND.

ALTERNATE-CURRENT TRACTION SYSTEM.

SPECIFICATION forming part of Letters Patent No. 746,353, dated December 8, 1903.

Application filed November 12, 1903. Serial No. 180,935. (No model.)

To all whom it may concern:

Be it known that we, WILLIAM MORRIS MORDEY and ARNOLD GREAVES HANSARD, subjects of the King of Great Britain and Ireland, residing at Westminster, in the county of London, England, have invented Improvements in or Relating to Alternate-Current Traction Systems, of which the following is a specification.

This invention has reference to improved means for diverting the return-current of alternate-current railway and tramway lines from the return rail or conductor to the return feeder or feeders connected thereto, so as to thereby reduce or avoid fall of pressure in the return rail or conductor. According thereto there is employed, in conjunction with the return rail or conductor (hereinafter called the "return-rail") and the return-feeder connected in parallel thereto in the ordinary way or with each return-rail and its return-feeder, a transformer provided with two windings, one of which is arranged in series with the return-rail and the other is arranged in series with the return-feeder, the arrangement being such that the return-currents in the two windings will be in opposite directions to each other. By giving the winding connected to the return-rail a suitably greater number of turns than that of the other winding the return-current can be diverted from the return-rail into the return-feeder in any desired ratio by reason of the electromotive force set up by the first winding in the second winding.

In the case of long lines the return-rail may be divided into a number of separate sections, each of which is connected to its corresponding return-feeder through one winding of a transformer, the other winding of which is in the circuit of the return-feeder, or each section of return-rail may be connected through a winding of one of a number of transformers to a common return-feeder in which is the other winding of each transformer, or the sections of the return-rail may be connected together in series with each other through one of the windings of a series of transformers, the other windings of which are arranged in a common return-feeder or in separate return-feeders.

The invention is applicable to single or multiphase systems of electric railways and tramways.

In the accompanying illustrative drawings, Figures 1 to 5, inclusive, are diagrams showing various ways of applying the invention to single-phase electric railways or tramways. Fig. 6 is a diagram showing the application of the invention to a three-phase system of electric traction.

Referring to Fig. 1 of the said drawings, 1 is a single-phase alternator; 2, the conductor through which current is supplied from the alternator to one or more cars 3 or trains, wherein it is utilized either directly or indirectly for propelling purposes, as well understood; 4, the return-rail connected to the alternator 1, and 5 the insulated return-feeder connected to the alternator 1 and to the return-rail, these parts being all arranged for use in the ordinary manner. 6 is the laminated-iron core of a transformer having two windings 7 and 8, of which 7 is in series with the return-rail 4 and 8 is in series with the return-feeder 5. The two windings extend in opposite directions around the core, the number of turns in the winding 7 being greater than that in the winding 8 and such as to produce in the latter winding an electromotive force such as will divert return-current from the return-rail 4 into the return-feeder 5 in any desired ratio. For example, supposing a total current of five hundred amperes has to be returned to the alternator 1, by arranging that the number of turns in the two windings 7 and 8 are in the ratio of nine to one the electromotive force produced in the winding 8 will be such that the current passing through the return-rail will be approximately fifty amperes, while that passing through the return-feeder will be approximately four hundred and fifty amperes, and this without making the return-feeder 5 of expensively large cross-section.

Fig. 2 shows an arrangement suitable for use with long lines and where the return-rail is divided into a number of sections 4 4^a 4^b, respectively connected to separate return-feeders 5 5^a 5^b. In this case each section of rail is connected through the winding 7 of a transformer to the corresponding return-

feeder in the circuit of which the winding 8 of the corresponding transformer is placed, the number of turns in the two windings being suitably proportioned, as before, to give the required result.

Fig. 3 shows another arrangement wherein each of the sections 4 4^a 4^b of the return-rail is connected through the winding 7 of a transformer to a common return-feeder 5, in which is arranged the other winding, 8, of each of the corresponding transformers and which is connected to each section of the return-rail by a cross connection 9.

Fig. 4 shows another arrangement wherein the several sections 4 4^a 4^b of the return-rail are connected together in series through the windings 7 of a number of transformers, the windings 8 of which are arranged in the circuit of a single return-feeder 5, the several sections of rail being connected to the common return-feeder 5 at intervals, as by the cross connections 9.

Fig. 5 shows a further-modified arrangement in which the sections 4 4^a 4^b of the return-rail are connected together in series through the windings 7 of a number of transformers, the other windings, 8, of which are arranged each in circuit with one of several return-feeders 5 5^a 5^b, connected, respectively, to the rail-sections 4 4^a 4^b.

In Fig. 6 a three-phase alternator 1^a is connected to the three main conductors 2, 2^a, and 4, of which 4 is the return-rail and has connected to it a return-feeder 5, the return-rail and return-feeder having, respectively, in circuit therewith the windings 7 and 8 of a transformer constructed and arranged as in Fig. 1. Each of the arrangements shown in Figs. 2 to 5, inclusive, would serve also for use as a three-phase system by using a three-phase alternator instead of a single-phase one and connecting thereto an additional supply-conductor, such as 2^a in Fig. 6.

An important advantage of the invention hereinbefore described is that whether it be applied to single-phase or polyphase working the transformer or transformers used has or have only relatively low tension windings as compared with other arrangements in which one or more transformers is or are used for diverting the current from the return-rail to the return feeder or feeders, and one of the windings of the transformer or each transformer is in circuit with the live or supply conductor.

A further advantage of the invention is that in applying the same to polyphase systems of working the transformer or each transformer requires only two windings.

In order to increase, decrease, or regulate the effect of the transformers in alternate-current systems according to this invention, resistances 10, Fig. 1, or inductance-coils 11, Fig. 4, may be arranged in circuit either with the return-rail or the return-feeder or with both the return-rail and return-feeder. Such arrangements will be obvious to those skilled in the art.

What we claim is—

1. In an alternate-current traction system, the combination with a return-rail and a return-feeder connected thereto, of means whereby the return-current flowing through the return-rail will set up an assisting electromotive force in the return-feeder.

2. In an alternate-current traction system, the combination with a return-rail and a return-feeder connected thereto, of a transformer having a winding in series with the return-rail and another winding in series with the return-feeder.

3. In an alternate-current traction system, the combination with the return-rail and a return-feeder connected thereto, of a transformer having two windings one of which is arranged in series with the return-rail and the other is arranged in series with the return-feeder, the two windings being wound in opposite directions and the number of turns in the winding connected to the return-rail be- being greater than that in the winding connected to the return-feeder.

4. In an alternate-current traction system, the combination with a section of a return-rail and a return-feeder connected thereto of a transformer having a winding in series with the return-rail and a winding in series with the return-feeder, the first winding having a greater number of turns than the second.

5. In an alternate-current traction system, the combination of a return-rail made in sections, and a return-feeder connected to each rail-section, of a number of transformers each having a winding connected in series with a rail-section and a winding connected in series with the return-feeder.

6. In an alternate-current traction system comprising an alternate-current generator, electric supply and return conductors, a vehicle adapted to be electrically propelled, an electric translating device carried by said vehicle and connected to said supply and return conductors, and supplementary current-returning means connected to the return conductor and generator, of transformers having windings connected in series with the return-conductor, and windings connected in series with the supplementary current-returning means and wherein an assisting electromotive force will be set up by the windings connected to the return-conductor.

7. In an alternate-current traction system, the combination with a return-rail made in sections, and a return-feeder common and connected to said rail-sections, of a number of transformers each having a winding in series with one of said rail-sections and a winding in series with the return-feeder, the first-mentioned winding having a greater number of turns than the other.

8. In an alternate-current traction system, the combination with a return-rail made in

sections, and a return-feeder common with and connected to said rail-sections, of a number of transformers, each having two windings, the rail-sections being connected together in series through one of the windings of the several transformers and the other windings of the transformer being arranged in series with the common return-feeder.

Signed at London, England, this 3d day of November, 1903.

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