

March 13, 1962

W. R. SMITH ET AL

3,024,739

INDEPENDENT CONTROL OF MODEL TRAINS ON THE SAME TRACK

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3 Sheets-Sheet 1

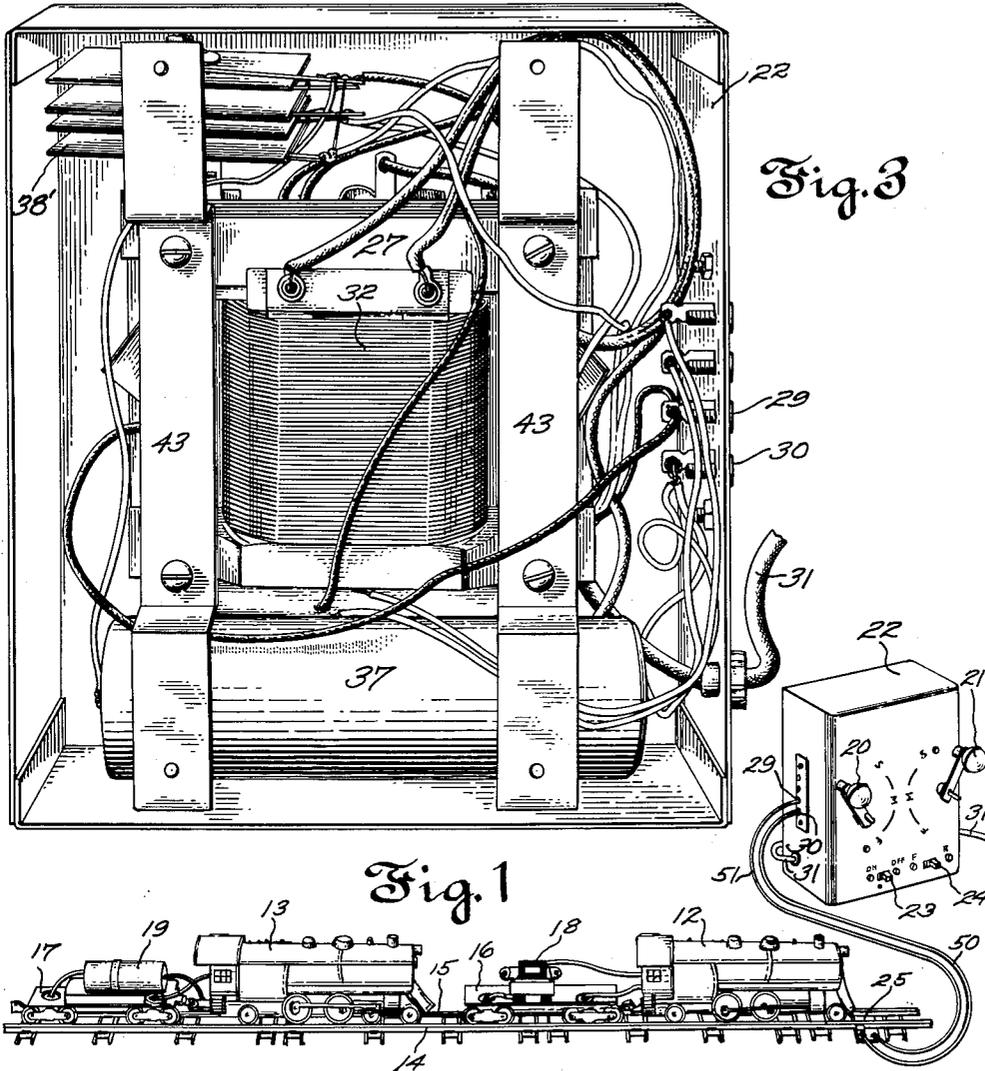


Fig. 1

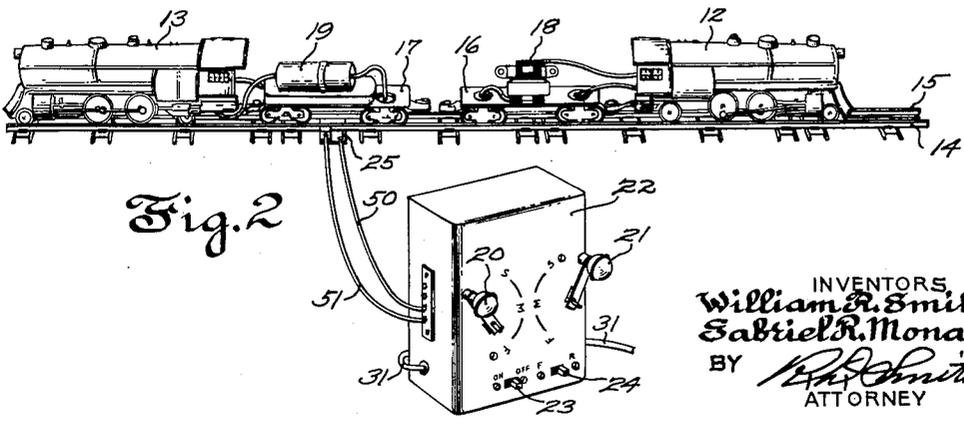


Fig. 2

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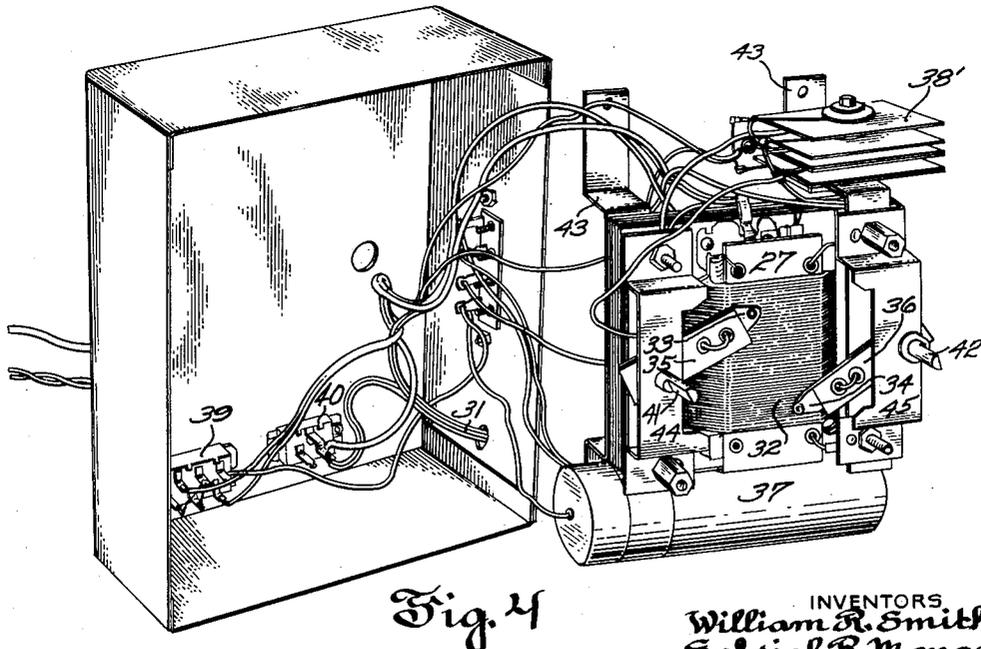
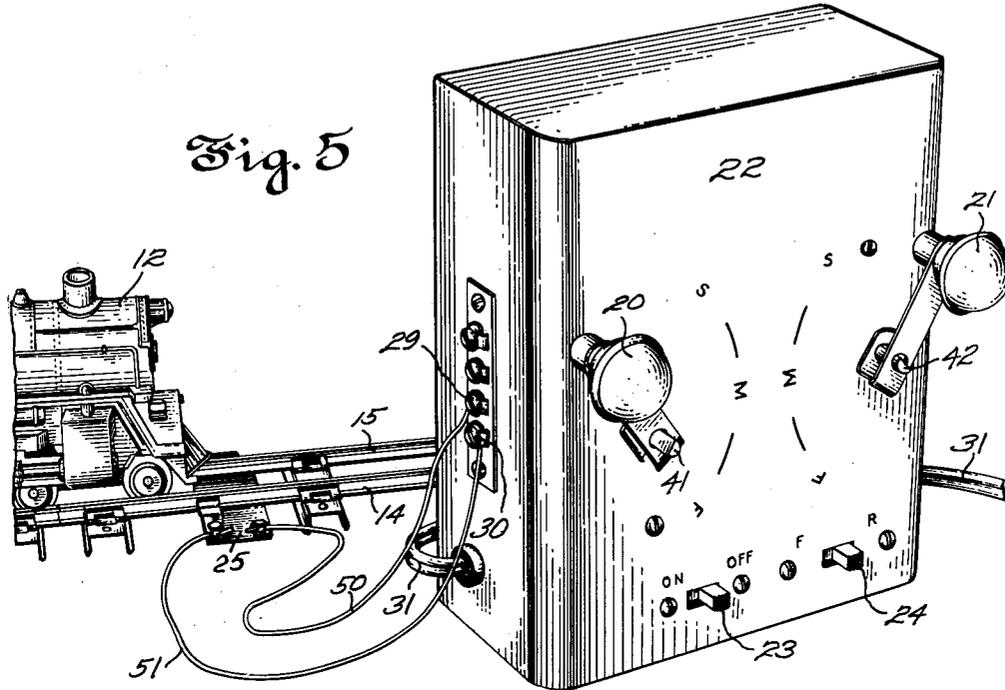
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3 Sheets-Sheet 3

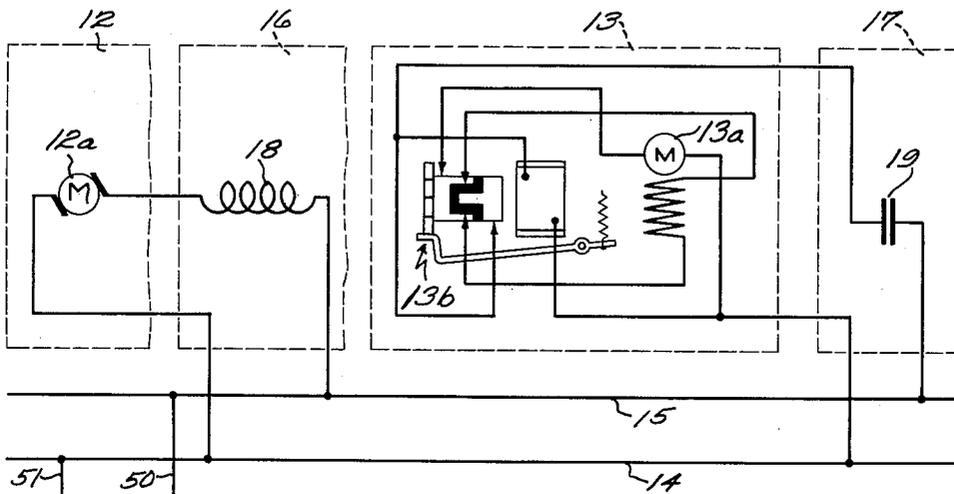


Fig. 6

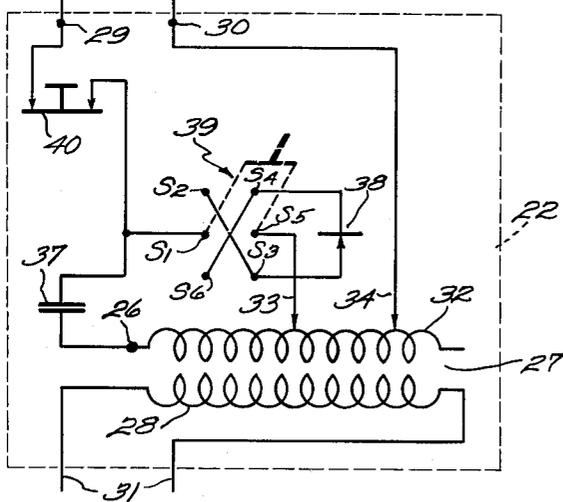
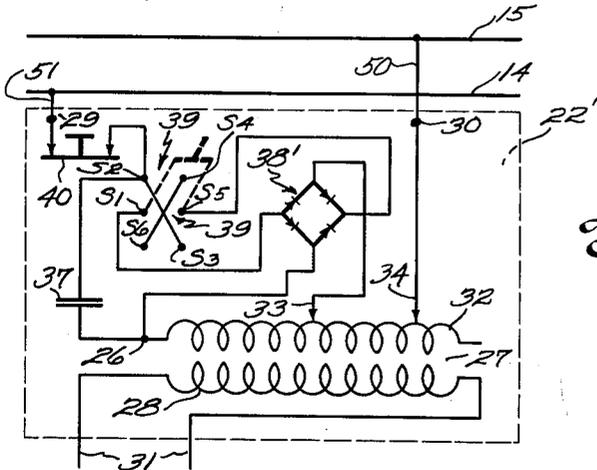


Fig. 7



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INDEPENDENT CONTROL OF MODEL TRAINS
ON THE SAME TRACK

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5 Claims. (Cl. 104—149)

This invention relates to electrical systems for controlling independently by means of a single remote control unit the running of a plurality of model trains rolling on a common course of track in a miniature or toy railroad.

Various earlier systems proposed to that end have involved cumbersome accumulations of control equipment whose total functioning has failed to achieve the complete variety of control operations made possible by these improvements.

The present invention solves the problem of how to control the speed of travel of either train independently of the speed of travel of the other train at all times.

It solves the problem of how to cause either train to run in forward or reverse direction at all speeds and regardless of the direction in which, or the speed at which, the other train may be running. In fact, the other train may be left standing still.

It enables the propulsion motor of one train to operate with good efficiency under all circumstances while energized by alternating current and enables the propulsion motor of the other train to be run with good efficiency while energized by unidirectional current.

The invention further enables the motor that is energized by alternating current to be reversed in conventional manner by the automatic action of an electromagnetic step switch carried on the rolling stock, and enables the motor that is energized by unidirectional current to be reversed merely by reversing the electrical polarity of the track rails.

A further object of the invention is to derive all current, for the aforedescribed wide variety of ways of running A.C. and D.C. propelled trains on the same track, from the same secondary winding of a single step-down transformer under manual control respectively of separately operable handles with which the transformer is equipped.

A further object is to block the transmission of unidirectional current from the track to the motor that is intended to run on alternating current and to screen out alternating current which otherwise would be transmitted from the track to the motor intended to run on unidirectional current.

A further object is to interpose between the track and a common source of simultaneously supplied alternating and rectified current, a circuit making and breaking switch through which both the alternating and the rectified current passes, and also a polarity reversing switch through which only the rectified current passes to the track.

Another object is to incorporate in circuit with such polarity reversing switch either a half-wave or a full-wave rectifier so connected as to convert alternating current into pulsating unidirectional current.

A still further object is to provide the single aforesaid current source transformer with independently operable, double take-off control wipers, both collecting current separately from the same secondary winding of the transformer, one of said wipers feeding unrectified alternating current to the track and the other of said wipers feeding current to the track through the intervention of a rectifier.

As an example of one practical embodiment of the im-

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provements, the foregoing and related objects of the invention may be obtained by a combination of apparatus and electrical circuitry one form of which is disclosed in the following description of a successful two-train control system, said description having reference to the appended drawings wherein:

FIG. 1 shows a portion of a continuous course of two-rail miniature railroad track with plural units of rolling stock placed thereon to head in the same direction and to be individually and independently controlled, both as to speed and direction of travel, by manipulating separate control handles of a trackside remote control unit in accordance with the invention.

FIG. 2 is like FIG. 1 showing the units of rolling stock heading in opposite directions.

FIG. 3 is a view on a much larger scale showing the rear of the trackside remote control unit with its casing wall removed.

FIG. 4 on a somewhat smaller scale shows the operating parts of the control unit removed from the casing and turned about so as to expose two voltage varying take-off wipers which collect current from the same secondary winding of the transformer.

FIG. 5 is a perspective front view of the encased current supply transformer shown connected to the two-rail track solely by two transmission wires.

FIG. 6 is a simplified circuit diagram showing the entire electrical system hooked up to make use of a half-wave rectifier.

FIG. 7 shows the circuitry within the control unit altered to accommodate a bridge type of rectifier substituted for the half-wave rectifier of FIG. 6.

As in common practice, current for propelling two locomotives 12 and 13 is collected from the track rails 14 and 15 by relatively insulated conductive wheels on respectively opposite sides of a tender 16 drawn by locomotive 12 and on respectively opposite sides of a tender 17 drawn by locomotive 13. Each locomotive and tender constitutes a unit of rolling stock which may be made into a longer train by attaching as many cars as are to be hauled. Tender 16 carries a choke coil 18 for holding back alternating current which otherwise would be collected from the track by locomotive 12 and tender 17 carries a condenser 19 for blocking off direct current which otherwise could be collected from the track by locomotive 13. For convenience of reference 12 will be referred to as the D.C. locomotive because herein propelled by a permanent magnet motor 12a (see FIG. 6) capable of running on pulsating unidirectional current and which is reversible in direction of running by reversing the polarity of the track rails 14, 15. Motor 12a may be of the universal type and capable of running on alternating current if such were supplied thereto. Also for convenience of reference 13 will be referred to as the A.C. locomotive because propelled by an alternating current motor 13a contained therein and reversible through the automatic action of an electromagnetic stepping relay 13b in a conventional hookup such as disclosed, for instance, in United States Patent No. 2,708,885.

The track is supplied with alternating current from secondary 32 through takeoff wiper 34 and the non-polarized condenser 37 at voltage varying between zero and 15 volts, and is supplied with pulsating unidirectional current derived through take-off wiper 33 from the same secondary 32 through a circuit branch which contains in series with each other, but in parallel relation to condenser 37, a rectifier 38 or 38' and a polarity reversing or double throw switch 39. The circuit to track rail 14 from both the condenser 37 and the rectifier 38 normally is closed but can be opened and reclosed at will by the momentary contact switch 40.

Without implication of limitation thereto, successfully

operative electrical ratings for the components in the above described two-train control system may be about as follows. The propulsion motor 12a in locomotive 12 operates on pulsating unidirectional current at from lower than 7 volts to 15 volts and draws about ¾ amperes. A.C. propulsion motors 13a in locomotive 13 operates at from lower than 7 volts to 15 volts and draws alternating current of about 1½ amperes. Condenser 19 on the tender 17 is rated 1000 mfd. nonpolarized Nonpolarized condenser 37 in the control box 22 is rated 1000 to 3000 mfd. The specified motors 13a and 12a operate advantageously when energized respectively by alternating and by pulsating unidirectional currents for which purpose they are differently wound and constructed. Hence, neither motor needs be penalized as to efficiency by having to perform on any kind of current other than that for which it is specifically intended. This is of utmost importance where track conveyed low voltage current must support not only the simultaneous running of two trains but also such extraneous loads as apparatus carried by the rolling stock for whistle blowing, generating imitative "Choo Choo" sounds and visible puffing of smoke, "Choo Choo" being a register trademark of The A. C. Gilbert Company.

Each of the aforesaid contrasting kinds of current is delivered to the track at variable voltage determined selectively by manipulation of two separate controller handles 20 and 21 on a unitary control box 22 from which there also projects the operating handle 23 of a momentary circuit making and breaking or stop and start switch 40 and the separate independently operable handle 24 of a quick acting, double-throw or polarity reversing switch 39. A pair of single conductors 50 and 51 connect binding posts 29 and 30 of the control box respectively with the track rails 15 and 14. The insulative binding post plate 25 underlying the track separates rail 14 from conductive relation to lead 50. A supply of 60-cycle alternating current at the usual 110 volts is furnished to the primary winding 23 of transformer 27 within control box 22 by an ordinary two-wire attachment cord 31.

The alternative wiring diagrams in FIGS. 6 and 7 show circuit connections forming an electrical "hook-up" of the physical apparatus shown in FIGS. 1-4. The source transformer 27 is shown removed from control box 22 in FIG. 4 and turned about. It includes a primary winding 28 (not shown in FIGS. 3 and 4) energized through attachment cord 31. A secondary winding 32 has two arcuate paths bared of insulation, to be conductively swept by two separate current take-off wipers 33, 34. These wipers are carried respectively by insulative arms 35, 36 which swing in unison with controller handles 20, 21, respectively, on shafts 41, 42.

The operation will best be understood by reference to the schematic showing of circuit connections in FIGS. 6 and 7 which differ mainly by the fact that a half-wave rectifier 38 is used in FIG. 6 and a bridge-type rectifier is used in FIG. 7.

For convenience of reference locomotive 12 with its tender 16 and whatever cars may be pulled or pushed thereby will be termed the D.C. unit of rolling stock while locomotive 13 with its tender 17 will be termed the A.C. unit of rolling stock, it will not matter whether both of these units are headed in a common direction on a circuitous course of track 14-15 as in FIG. 1 or headed in opposite directions as in FIG. 2 inasmuch as each unit is individually controllable at will as to direction of travel and also as to starting and stopping and individual speed of travel.

Operating handle 20 of control box 22 is swung clockwise in FIGS. 1, 2 and 5 to cause current take-off wiper 33 to sweep downward from the low voltage end 26 of transformer secondary 32 toward the higher voltage end thereof. The other control box operating handle 21 is swung counterclockwise in the same figures of the draw-

ings to cause current take-off wiper 34 to sweep downward from the same end 26 of the same secondary 32 to higher voltage positions therealong. In each instance this increases the voltage impressed upon the track circuit.

But the D.C. locomotive 12 is immune to the swinging of control handle 21 because the latter's take-off wiper 34 is capable of varying the voltage of only the alternating current that is delivered to the track through the circuit 26, 32, 34, 30, 50, 15, rolling stock, 14, 51, 29, 40, 37, 25. Such alternating current is choked at the train carried coil 18 and it furthermore cannot pass the rectifier 38 as alternating current in FIG. 6, or 38' in FIG. 7. Likewise the A.C. locomotive 13 is immune to the swinging of control handle 20, which can have no effect upon the speed of running of A.C. locomotive 13 because of the train carried condenser 19.

From the foregoing it follows that the voltages of alternating current and pulsating unidirectional current that may be separately or compositely impressed upon the same two-rails of track can be varied both simultaneously and independently in whatever relationship desired by chosen manipulation of the two control handles 20 and 21.

A reversal of direction in which each of the two units of rolling stock will travel is at the operator's command at all times through separate manipulation of the two switches 40 and 39. In FIG. 6 switch 40 will be seen to cause reversal of the A.C. locomotive 13 each time it is opened and closed to cut off and restore alternating current to the track through the conventional circuit reversing action of the locomotive carried electromagnetic step switch 13b as is well understood in the art and fully explained in the aforesaid Patent No. 2,708,885.

Also in FIG. 6 switch 39 causes reversal of the D.C. locomotive 12 by merely reversing the polarity of the track rails 14, 15. When the blades of the reversing switch 39 are swung to uppermost position into contact respectively with 52 and 54 unidirectional current, which in the diagram can pass rectifier 38 only in upward direction, courses through switch 39 in the direction of current flow from the transformer and indicated as the circuit elements S1, S2, S3, 38, S4, S5, 33 thereby to polarize rail 14 negative and rail 15 positive. When the blades of switch 39 are swung to lowermost position, rail 14 is polarized positive and rail 15 negative by the opposite direction of current flow from the transformer and indicated as the circuit elements 33, S5, S3, 38, S4, S6, S1.

In FIG. 7 corresponding reversal of the flow of unidirectional current in the track rails 14, 15 is effected through the bridge-type rectifier 38' when the blades of double-throw switch 39 are shifted from upward to downward position. This changes the direction of current flow from the direction S2, S1, 38', 33 to the direction 33, 38', S5, S3, S2.

In each of FIGS. 6 and 7 it will be observed that the reversing switch 39 is contained in a circuit in series with the rectifier 38 or 38', which circuit is in shunt or parallel relation to the non-polarized condenser 37 in control box 22.

A theory of the electrical performance in the hook-up of circuits hereinbefore described is that alternating current may be considered as starting at the take-off wiper 34, passing to track rail 15 and then through the D.C. blocking capacitor 19 and A.C. motor 13a to track rail 14, thence back to the secondary 32 of the source transformer 22 at 26. Movement of wiper 34 toward the high voltage end of the transformer will increase the current through that circuit and therefore will increase the speed of the A.C. train unit. The condenser 19 in the A.C. train unit has a relatively low impedance to the flow of alternating current whereas the choke coil 18 in the D.C. train unit presents a relatively high impedance to the flow of alternating current.

During one half-cycle of the source alternating current the pulsating unidirectional current flow to which

D.C. motor 12a responds flows partly in a close circuit from take-off wiper 33 through the rectifier 38 and 38' and unidirectional current blocking capacitor 37 back to the secondary 32 of source transformer 27 at 26. This flow charges the blocking capacitor 37 to a potential that depends upon the distance of wiper 33 from 26 along secondary 32 and the impedance in the said close circuit. Simultaneously with the described flow in the said close circuit, current from the slider 34 will flow from the transformer secondary 32 to the track and through the A.C. motor 13a and train carried capacitor 19 back to the track returning to the source transformer through the blocking capacitor 37. This imposes a charge upon blocking capacitor 37 additional to and of the same polarity as the aforesaid charge derived through the close circuit 33, 38 (38') 37, 26, such additional charge depending upon the distance of wiper 34 from 26 along secondary 32 and all the impedance that is present.

During the following half cycle of the source alternating current, current flow from track 14 to the slider 33 in one or the other direction, depending on the position of reversing switch 39, is prevented by rectifier 38 or 38'. At the same time current is prevented from flowing from wiper 33 to the track because the voltage produced at 26 by the charge in capacitor 37 is as great or greater than the voltage that can be drawn from secondary 32 by wiper 33. To permit this performance blocking capacitor 37 must have sufficient transmitting capacity to pass the pulses of current without saturating. A current pulse will flow from 26 through blocking capacitor 37 to the track during the said following half cycle of the alternating source current and thus through both the A.C. and D.C. train propulsion motors thence back to the source transformer through wiper 34.

In the above described performance, that charge of potential which has been contributed to blocking capacitor 37 during a first half cycle of the source alternating current will pass through the A.C. propulsion motor 13a during the half cycle of alternating current that follows. The impedance of the A.C. motor itself limits the extent of current flow that can pass back to the transformer. The remaining portion of the above said charge which has been contributed by wiper 33 to blocking capacitor 37 during the said first half cycle of source alternating current will during the said following half cycle of source alternating current be forced through the D.C. propulsion motor. This theory accounts for there being a unidirectional charge of current forced through the D.C. propulsion motor during every other half cycle of the source alternating current.

The shafts 41 and 42 of the control handles 20 and 21 have rotary bearing in brackets 44 and 45 that are carried by the core body of the transformer 27. This body is mounted on the rear wall of control box 22 by bracket structure 43, so that when control handles 20, 21 are removed from their shafts the entire control apparatus comprising transformer 27, rectifier 38' and condenser 37, together with the back panel (not shown) which forms the rear wall of the control box 22, can be removed as a unit from the rest of box 22 for inspection or repair, leaving the switches 39 and 40 undisturbed. In the drawings the back panel also has been removed from the unit apparatus so as to expose and give access to both sides of the transformer.

The appended claims are directed to and intended to cover not only the particular circuit connections and structural arrangements of apparatus herein disclosed, but all variations thereof that are characterized by the novel aspects of this invention in the broadest sense of their recital in the following claims.

We claim:

1. A miniature electric railway system for independent control through track conducted current of a plurality of model trains each with respect to speed and direction

of travel while rolling on a common course of track, comprising in combination with two rails of the track, a single source of alternating current of variable potential, a track feeding circuit line supplied with current at variable potential from said source and connecting said source to one of said two rails of the track, a circuit completing line connecting said source to the other of said two rails of said track including parallel branches, one of said branches being shiftable connected to said source in a manner to transmit unidirectional current therethrough at variable voltages, a current rectifier in said one of said branches operative to convert alternating current into pulsating unidirectional current, a polarity shifting double-throw switch in series with said rectifier in said one of said branches, the other of said branches being connected to said source and containing a direct current blocking capacitor operative to prevent flow of unidirectional current therethrough, a first unit of rolling stock on said track, a reversible A.C. propulsion motor on said first unit deriving current from said two rails of the track, an electromagnetic relay carried by said first unit electrically operative to reverse the direction of running of said A.C. motor, an electrical condenser on said first unit of rolling stock electrically interposed between one of said two rails of the track and said A.C. propulsion motor, a second unit of rolling stock on said track, inductive electrical translating means carried by said second unit electrically interposed between said two track rails and including a second propulsion motor adapted to operate on pulsating unidirectional current, and a make-and-break switch in one of said circuit lines in series with said capacitor, whereby opening and closing of said track feeding circuit by said make-and-break switch operates said relay to reverse the direction of said first unit of rolling stock, and polarity shifting operation of said double-throw switch reverses the direction of travel of said second unit of rolling stock.

2. A miniature electric railway system as defined in claim 1, in which the said source of alternating current is the secondary winding of a current transformer, and the said unidirectional current transmitting branch of the said circuit completing line contains a voltage varying current take-off wiper arranged to sweep conductively along said secondary winding.

3. A miniature electric railway system as defined in claim 1, in which the said source of alternating current is the secondary winding of a step-down transformer, and the said track feeding circuit line contains a voltage varying current take-off wiper arranged to sweep conductively along said secondary winding, and the said unidirectional current transmitting branch of the said circuit completing line contains another voltage varying current take-off wiper arranged to sweep conductively along the same said secondary winding.

4. A miniature electric railway system as defined in claim 1, in which the said second propulsion motor is reversible by reversal of track rail polarities and the said rectifier is a half-wave rectifier operative to transmit current therethrough in only one direction, together with a double-throw switch electrically connected between said rectifier and the said other rail of the said track to cause the unidirectional travel of the rectified current on one occasion to be toward one of said track rails and on another occasion to be away from said one of said track rails.

5. A miniature electric railway system for the independent control through track conducted current of a plurality of model trains each with respect to speed and direction of travel while rolling on a common course of track, comprising in combination with two rails of the track, a single source of alternating current of variable potential, a track feeding circuit line supplied with current at variable potential from said source and connecting said source to one of said two rails of the track, a circuit completing line connecting said source to the other of

said two rails of said track including parallel branches, one of said branches being shiftably connected to said source in a manner to transmit unidirectional current therethrough at variable voltages, a current rectifier in said one of said branches operative to convert alternating current into pulsating unidirectional current, a polarity shifting double-throw switch in series with said rectifier in said one of said branches, the other of said branches being connected to said source and containing a direct current blocking capacitor operative to prevent flow of unidirectional current therethrough, a first unit of rolling stock on said track, a reversible A.C. propulsion motor on said first unit deriving current from said two rails of the track, an electromagnetic relay carried by said first unit electrically operative to reverse the direction of running of said A.C. motor, an electrical condenser on said first unit of rolling stock electrically interposed between one of said two rails of the track and said A.C. propulsion motor, a second unit of rolling stock on said track, inductive electrical translating means carried by said second unit electrically interposed between said two track rails and including a second propulsion motor and a choke in series therewith adapted to operate on pulsating

unidirectional current, and a make-and-break switch in one of said circuit lines in series with said capacitor, whereby opening and closing of said track feeding circuit by said make-and-break switch operates said relay to reverse the direction of said first unit of rolling stock, and polarity shifting operation of said double-throw switch reverses the direction of travel of said second unit of rolling stock.

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