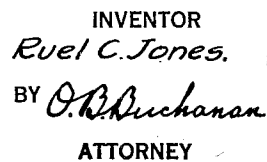


Filed Aug. 31, 1943



135

Patented Dec. 10, 1946

2,412,514

UNITED STATES PATENT OFFICE

2,412,514

ELECTRIC CATAPULT CONTROL

Ruel C. Jones, Pittsburgh, Pa., assignor to Westinghouse Electric Corporation, East Pittsburgh, Pa., a corporation of Pennsylvania

Application August 31, 1943, Serial No. 500,639

18 Claims. (Cl. 172-290)

1

The present invention relates to the control of linear motors and the power plants therefor, in a manner suitable for energizing towing-car catapults for launching aircraft. The general type of apparatus to which the present invention applies constitutes the subject-matter of the description and claims of an application of Frank B. Powers, Serial No. 473,843, filed January 28, 1943, for Electric towing-car catapult for aircraft assigned to the Westinghouse Electric & Manufacturing Company.

An object of the invention is to provide a control-system for a linear-motor towing-car in which a timing switch is utilized to apply braking-power in reverse phase-sequence to the car for a precisely preselected period of time, and to automatically cut off the power-supply to the car at the expiration of that time, so that the car may not accelerate to too great a speed in its reversed movement back toward its starting point, after having completed its ship-launching or accelerating run.

A further object of the invention is to provide means on the towing-car for responding to a reversal of the car-movement, and for either flashing a signal of such fact, or initiating an automatic control-board response to such fact, so that the reversed phase-sequence power may be promptly cut off from the towing-car, before the towing-car reaches a high rate of speed, in its return-movement back toward its starting point, after a ship-launching run.

A further object of the invention is to provide a specially desirable control-circuit arrangement whereby, shortly after the initiating of the accelerating run of the towing-car, in the process of launching a ship, a control-circuit is partially completed for closing the power-switches in the reversed direction, so that, as soon as the towing-car motor is deenergized, at the end of its accelerating, ship-launching run, a back-contact or contacts on the power-switch or switches may be utilized for completing the reverse-movement power-switch energization, so as to instantly commence to decelerate the towing-car.

With the foregoing and other objects in view, the invention consists in the systems, combinations, apparatus, parts, circuits, and methods, hereinafter described and claimed and illustrated in the accompanying drawing, the single figure of which is a simplified diagrammatic view of circuits and apparatus illustrating the invention in a preferred form of embodiment.

As diagrammatically illustrated in the drawing, an electric catapult involving the present in-

2

vention includes a linear-motor towing-car, a track therefor, and electrical supply-means and control-means therefor. The towing-car is diagrammatically represented, at the bottom of the figure, by the three-phase primary windings WA, WB, WC of the linear-motor and a car-wheel W, the winding being illustrated as a star-connected winding having a star-point O.

The track is diagrammatically represented as comprising two track-rails 1 and 2, two third-rails 3 and 4, and a linearly disposed secondary core-member 5 carrying a squirrel-cage secondary-winding, which is represented by the numerals 6 and 7. As described and claimed in an application of Maurice F. Jones, Serial No. 506,197, filed October 14, 1943, the track is preferably fabricated in a plurality of sections T1 to T35, suitably joined together, any desired number of sections being utilized, according to the desired length of run. A certain number of track-sections (seven, as illustrated), at each end of the track, have high-resistance squirrel-cage windings, as indicated by the bent or folded end-connections 6 in the drawing. The large intermediate group of track-sections, represented by the twenty-one sections T8 to T28 in the drawing, have low-resistance squirrel-cage windings, as represented by the low-resistance end-connections 7.

Three-phase electric power is supplied to the track, and thence to the car-motor WA, WB, WC, by means of line conductors L1, L2 and L3, the specific arrangement of which, to suitably reduce the reactance which might otherwise be excessively high, being the subject-matter of an application of Maurice F. Jones and Lee A. Kilgore, Serial No. 506,197, filed October 14, 1943. Two of the phases of the power-supply are connected to the third-rails 3 and 4, while the third phase, represented by the line-conductor L2, is connected to the two track-rails 1 and 2, by means of connectors 8, there being a separate connection for each section of track.

Electrical power is supplied to the line-conductors L1, L2, and L3, in the one phase-sequence or the other, by means of two groups of electrically operated power-switches A, B, C and D, E, F. The power-switches A, B, and C energize the car-windings WA, WB, WC in the phase-sequence for operation toward the left, while the power-switches D, E, and F are for acceleration toward the right. The power-switches A, B, C, or D, E, F, supply power to the line-conductors L1, L2, L3 from a three-phase bus T1, T2, and T3.

In the form of embodiment of the invention,

3

as illustrated, three-phase power is supplied to the bus T1, T2 and T3 by means of three generators G1, G2 and G3, or other sources of three-phase power.

As described in an application of Maurice F. Jones and myself, Serial No. 500,640, filed August 31, 1943, twenty-one electrically energized track-relays TR8 to TR28 are provided, one for each of the low-resistance track-sections T8 to T28, these track-relays being energized by current-transformers 8T in the individual track-section leads 8 which supply energy to the track-rails 1 and 2 of the corresponding track-sections. The design is preferably such that any track-relay Tr will be energized in response to the power-current which is fed into the towing-car at about the time when the center of the towing-car is near the center of the corresponding track-section Tr, or at any other predetermined point in the travel of the car, responsive to the point, along the track, at which current is being fed into the car at the moment.

Cooperating with the twenty-one track-relays TR8 to TR28 are twenty selector-switches which are diagrammatically illustrated at S9 to S28, these switches being preferably of the retained-contact type, or any type or kind whereby a predetermined one of these switches may be selected and closed by the operator, in order to pre-select the point in the track at which the towing-car will be deenergized, so as to pre-select the length of run, in accordance with the weight of the aircraft (not shown) to be launched, and with due regard to the prevailing direction and velocity of the wind at the time.

In accordance with my present invention, the towing-car is provided with friction-means which responds to the direction of movement of the car, so as to at least give a signal, and preferably also initiate an automatic operation, at the control-station at which the car-movement is being controlled. Any suitable means may be utilized for these purposes.

By way of illustration, which is intended to be symbolic of any equivalent signalling or intelligence-transmitting means or automatic control, I have illustrated one or more signal-lights L, of any desired color or color-combination, mounted on the towing-car, and energized from a small transformer TL carried by the car, and illustrated as being energized across the WB phase of the car-winding. The lights L are controlled by means of a reversible friction-switch FS in the form of a contact-brush which frictionally bears upon a car-wheel W, or other rotating part of the car, so as to be dragged around through a short arc, in the one direction or the other, so as to make contact with either one of two terminal contacts TCL or TCR, according to whether the car is moving toward the left or toward the right. Advantageously, the friction-switch FS is associated with a reversing-switch RS on the car, so that the signal-lights L will be energized only in response to a pre-selected direction of car-movement. The positions of the reversing-switch RS and the friction-switch FS may be initially pre-selected by any means such as handles H1 and H2, prior to the initiation of the launching-operation.

The signal-lights L, under the control of the friction-switch FS, are to be regarded, in a general sense, as representative of any means, located on the towing-car, for transmitting intelligence, in regard to a commencement of a reversed car-movement, to a stationary control-

4

station at which the car-movement is being controlled, such as the station at which the track-relays TR8 to TR28 and the selector-switches S9 to S28 are located. Disposed, preferably one at either end of the track, are suitable means for automatically responding to the reversed-movement signal which is transmitted by the signal-lights L or equivalent signal-means on the towing-car. By way of illustration, this signal-receiving means is illustrated in the form of two photoelectric-cells PC1 and PC2, one at each end of the track, each one pointing toward the towing-car, so as to respond, with proper selectivity, to the signal-lights L, so as to energize an auxiliary relay PCA, which is utilized in the automatic control of the car-movement.

Preferably, the track-relays TR8 to TR28 and the signal-responsive relay PCA are of the latched type, or other retained-contact type, so that, when once actuated, each will remain in its actuated position until it has been reset, as by means of a reset coil 12.

In accordance with my invention, a timer-relay T is provided, as shown at the upper right-hand portion of the drawing. This relay is energized, through a suitable transformer TT, from conductors 13 and 14 which are connected to the bus-terminals T2 and T3. The timer-relay T has contacts which can be sensitively adjusted to be closed at the expiration of any pre-selected time after the initial energization of the relay. The energization of the timer-relay T is under the control of an auxiliary relay TA. A second auxiliary relay or contactor-switch TB is controlled by the timer-relay T, at the end of its pre-selected time-setting.

The electrical control equipment for the catapult comprises two control-drums DD and TD, which are shown at the top of the figure, a control-switch CS which is shown between them, and a spotting-switch SS which is shown underneath the drum TD. As indicated, the control-switch has an "on" position and a "reset" position. The drum DD is a direction-selecting drum having an "off" position and two operating positions marked "left" and "right," corresponding to the desired direction of aircraft-launching. The drum TD is a take-off drum which is illustrated as having an "off" position, an "idling" position, and a "take-off" position. The drawing has been simplified by omitting the "test" position and contacts of the drum TD, for testing out the various circuits. The spotting-switch SS can be moved to either the left or the right, according to the direction of acceleration or movement desired to be imparted to the car while it is being returned to its starting point. The two control-drums DD and TD, the control-switch CS, and the spotting-switch SS, cooperate with the power-switches A, B, C and D, E, F to constitute relatively stationary located control-means, by which I mean that the control-means is stationary or non-movable with respect to the towing-car while the towing-car is moving, without intending to imply that the control-means may not be portable or movable independently of the towing-car.

The operating-control connections may be traced from the control switch CS. When this switch is in its normal or "on" position, a circuit is completed from the positive terminal of a suitable source of relaying energy, indicated as a positive bus (+), and a conductor 20, to a conductor 21, which is connected to a corre-

2,412,514

5

spondingly numbered contact-point on the drum DD.

It will first be assumed that the towing-car is at the left-hand end of the track, at or near the track-section T1, and is to be moved to the right for the purpose of accelerating some aircraft (not shown), for the purpose of launching the same. The direction-selecting drum DD is first moved to its right-hand position, to pre-condition the control-circuits for a right-hand run, and the drum DD will be assumed to be in this position. At the drum DD, the conductor 21 is connected to a conductor 22 which extends to a correspondingly numbered contact-point on the take-off drum TD.

When, now, the signal is given for take-off, the operator moves the take-off drum TD to the "take-off" position, which connects the conductor 22 to the contact-points 23 and 24 of the take-off drum TD. The conductor 23, which is connected to the contact-point 23 of the drum TD, is connected to a correspondingly numbered contact-point of the drum DD, but no contact is made with this point, in the right-hand position of the drum DD. The conductor 23 also extends to a back-contact of the last track-relay TR28, this relay-contact being sufficiently identified by reference to the relay-designation TR28. A relaying circuit is thereupon completed in series through the back-contacts of all twenty-one of the track-relays TR28 to TR8. As only certain illustrative track-relays have been shown, this relaying-circuit can be traced, from the conductor 23 at the relay TR28, through the conductors 25, 27 and 29, and the various relay-contacts, to a correspondingly numbered top contact-point 29 on the drum DD.

A pre-selected one of the selector-switches S9 to S28 also was pre-selected, prior to take-off, the usual interlocks being omitted for the sake of clarity. For purposes of illustration, it will be presumed that the selector-switch Sx was closed. This makes a bypassing-connection from the conductor 27 of the track-relay TRx, through the Sx contact to a conductor 30, which extends to a correspondingly numbered contact-point on the drum DD, where a connection is made to the conductor 29, the drum being in its right-hand position. This bypassing-connection thus short-circuits all of the track-relay contacts which are interposed between the conductor 29 and the conductor 27, so that the relaying circuit will not be broken, during the movement of the car, as subsequently described, until the car reaches the track-section Tx and energizes the track-relay TRx, which will thereupon break the connection between the conductor 23 and the conductor 29.

The conductor 29 continues, from the correspondingly numbered top contact-point of the drum DD to a correspondingly numbered lower contact-point 29 on the drum DD. In its right-hand position, the drum DD connects this conductor 29 to a conductor 34 which extends down to the power-switches D, E, F to energize the same, in series with back-contacts on the power-switches A, B, and C, the circuit being completed at the negative terminal (—) at the operating-coil of the relay F. In this manner, the power-switches D, E, and F are energized, closing their main contacts which energize the leads L1, L2, and L3 from the bus-terminals T1, T3, and T2, respectively, thus energizing the car-windings WA, WB, WC in the phase-sequence suitable for driving the car toward the right. This causes

6

the car to start and to rapidly accelerate in its right-hand run, or the run from its starting point at the track-section T1.

It will be recalled that when the take-off drum TD was first moved to its "take-off" position, it also energized a contact-point 24 from the conductor 22. From the contact-point 24, a conductor 24 extends to the back-contact of the TB relay; and thence to a conductor 36.

The conductor 36 extends to the auxiliary photo-electric-cell relay PCA, which has a back-contact joining the conductor 36 to a conductor 37.

The relay-conductor 37 is thus energized from the contact-point 24 of the take-off drum TD, through the back-contacts of the auxiliary timing-relay TB and the back-contacts of the auxiliary photoelectric-cell relay PCS. In accordance with my present invention, a circuit from the conductor 37 extends to the operating coil of the other auxiliary timer-relay TA, and thence to a conductor 44, which is connected to a make-contact of the first track-relay TR8, corresponding to the first track-section T8 having a low-resistance squirrel-cage winding 7. At an early part of the run of the towing-car, when it reaches the track-section T8, the track-relay TR8 picks up, and connects the conductor 44 to a conductor 45 which leads to a correspondingly numbered contact-point on the drum DD, where this conductor is connected to a conductor 46. The conductor 46 leads down to the left-hand, or reversing, power-switches A, B, and C, through back-contacts of the right-hand, or ship-launching, power-switches D, E, and F.

Thus, at an early stage in the movement of the towing-car, a partial relaying-circuit is set up, energizing the reversing power-switch conductor 46 from the positive relaying-bus (+), starting with the conductor 20 at the control-switch CS, and extending through the contact-point 24 of the take-off drum TD. The reverse-phase-sequence power-switches A, B, and C are not immediately energized, however, because the other three power-switches D, E, and F had previously been energized in order to cause the car to move toward the right along the track.

The right-hand power-switches D, E, and F are deenergized, in general, in response to the selector-switch selection Sx, which preselects the length of car-run. As soon as all three of the right-hand power-switches D, E, and F are open, the previously partially energized relaying-circuit 46 comes into play, to instantly energize the three left-hand power-switches A, B, and C, so as to immediately apply power to the car in the reverse phase-sequence, producing a force tending to move the car toward the left.

The energization of the left-hand, or reversing, power-switches A, B, and C causes current to flow through the operating-coil of the first auxiliary timing-relay TA, because this operating-coil is connected between the conductors 37 and 44. This picks up the first auxiliary timing-relay TA, which, in accordance with my present invention, energizes the timer T, thus initiating the movement of the timer T, which, at the end of a pre-selected time-interval, will close its contact and energize the auxiliary timing-relay TB.

The reverse-phase-sequence energization of the towing-car continues, in general, until either one of two things happens—either until the expiration of the pre-selected time-period of the timer T, at which time the auxiliary timing-relay TB picks up, seals itself in, and breaks the contact

7

between the conductors 24 and 36—or until the actuation of means for automatically responding to a commencement of the car-motion in the reverse direction, such as the photoelectric-cell relay PCA, which breaks the contact between the conductors 36 and 37. The timer T is set to discontinue the reversed excitation of the car-motor WA, WB, WC before the car attains a high velocity in its return-trip to its starting point, and it serves as a sort of back-up protection to safeguard against a failure of the photoelectric-cell relay PCA. Since the reversing power-switch conductor 46 is energized from the conductor 37, a breaking of the circuit, either at 36—37, or at 24—36, results in deenergizing the reversing power-switches A, B, and C, thus deenergizing the towing-car, and leaving it coasting back towards its starting point.

As soon as the signal-light or lights L light up on the towing-car in response to a commencement of the return-journey of the car, the operator at the take-off drum TD should immediately move said drum to the "idle" position thereof. This does several things. It deenergizes the conductors 24—36, from which the reversing power-switch conductor 46 receives its energization. However, the reversing power-switches A, B and C are already deenergized, as described. The "idle" drum-position energizes a contact-point 47 of said drum TD, from the conductor 22, thereby energizing the spotting-switch SS. It also connects two other contact-points 48 and 49 of the aforesaid drum TD to each other, thus electrically connecting the correspondingly numbered conductors 48 and 49.

To bring the car to standstill, at the starting-point, at the precise spot desired, the spotting-switch SS is utilized. The car is now moving to the left toward the starting-point. To brake the car, the spotting-switch SS is moved to the right, connecting the conductor 47 to the conductor 34 which energizes the power-switches F, E, D. This applies a small braking-force to the car, and this braking-force is discontinued, at any moment desired, by returning the spotting-switch to its central or neutral position. If the spotting-switch should be left too long on its right-hand position, so that the car starts back again toward the right, the spotting-switch may be touched momentarily on its left-hand position, connecting the conductor 47 to the conductor 46, which momentarily energizes the power-switches A, B, and C.

In the "idling" position of the take-off drum TD, it has been noted that the conductor 48 is joined to the conductor 49. The conductor 48 is connected to the "reset" position of the control-switch CS, so that, after the car has been brought, with the spotting-switch SS, to its desired position, at either end of the track, the control-switch CS can be moved from its "on" position momentarily to its "reset" position, thus momentarily energizing the conductor 48 from the conductor 20 and the positive relay-bus (+). The conductor 48 is connected, in the "idling" position of the take-off drum TD, to the conductor 49, which energizes all of the reset coils 12 in series, thereby resetting all of the track-switches TR8 to TR28, and the auxiliary photoelectric-cell relay PCA. As soon as these relays are reset (which takes but a moment), the control-switch CS is returned to its "on" position, ready for another launching.

In the preceding explanation, it has been assumed that the car started from track-section T1 and operated toward the right. An important

8

feature of the design, however, is that the car can be operated for take-off in either direction, with equal facility.

Thus, if the car should initially be standing at the other end of the track, or on the track-section T35, so that it would be necessary to take off in a direction toward the left, the direction-selecting drum DD would be moved first to the "left" position. The effect of this drum-setting would be as follows. The contact-point 21 would again be connected to the contact-point 22. The contact-point 30 would be connected to the contact-point 23 rather than the upper contact-point 29. The contact-point 34 would be connected to a conductor 65, instead of the conductor 29, and the contact-point 46 would be connected to the conductor 29 instead of the conductor 45.

The changing of the conductor 30 from contact with the conductor 29 to contact with the conductor 23 results in making the selected selector-switch, such as $S(x+1)$, short-circuit the back-contacts of the track-relays between TR x and the conductor 23, rather than between TR x and the conductor 29, so that the conductor 29 remains energized until the selected track-relay TR x is actuated, whereupon the conductor 29 is deenergized, and the accelerating movement of the towing-car is discontinued.

The effect of connecting the contact-point 46 to the conductor 29 instead of the conductor 45 is to make the initial energization of the power-switches an energization of the switches A, B, and C for left-hand operation, under the control of the conductor 29, thus setting up the control-circuits for operation of the car in the left-hand direction.

The effect of connecting the conductor 34 to the conductor 65 instead of the conductor 29 will be seen from observing that the conductor 65 is connected to a make-contact of the track-relay TR28, which corresponds to the first track-section T28 having a low-resistance squirrel-cage winding 7 to be encountered by the car, in its travel toward the left. When the track-relay TR28 picks up, it thus closes its make-contact and connects the conductor 65 to the conductor 44, thus setting up a partial energizing-circuit, through the coil of the auxiliary timing-relay TA, from the conductor 37 to the conductor 44, thence to the conductor 65, and thence to the conductor 34, which is ready to energize the right-hand power-switches D, E, F as soon as the left-hand power-switches A, B, and C drop out.

Since the operation of the apparatus has been carefully described, in the process of the description, it is believed that no further summary of the operation is necessary. While a single form of embodiment of the invention has been illustrated, it is to be understood that the invention is not limited, in its broader aspects, to any particular form of embodiment, as many changes of addition, omission, and substitution may be made, without departing from the essential features of the invention. It is desired, therefore, that the appended claims shall be accorded the broadest construction consistent with their language.

I claim as my invention:

1. An electrically controlled system, comprising a reversible polyphase motor, power-switch means for controlling the polyphase energy-supply to the motor in either sequence of phases, control-means, associated with said power-switch means, for initiating and terminating a forward-

driving polyphase energization of the motor for a forward run in a selected phase-sequence, means responsive to the termination of the forward-driving polyphase energization of the motor, at the end of the forward run, for automatically and promptly thereafter initiating a reverse-phase-sequence energization of the motor and also initiating a timing operation, and means responsive to a preselected time-period of the timing operation for discontinuing said reverse-sequence energization of the motor.

2. An electrically controlled system, comprising a reversible self-propelling polyphase-motored movable body, power-feeder means for feeding polyphase electrical energy to said polyphase-motored movable body, a relatively stationarily located power-switch means for controlling the polyphase energy-supply to the polyphase-motored movable body in either sequence of phases, control-means, associated with said power-switch means, for initiating and terminating a forward-driving polyphase energization of said polyphase-motored movable body for a forward run in a selected phase-sequence, control-means, associated with said power-switch means and responsive to the termination of said forward-run energization, for automatically and promptly thereafter initiating a reverse-phase-sequence energization of the polyphase-motored movable body, and means on said movable body for responding to a reversal of the movement thereof and for producing a signal of such fact.

3. The invention as defined in claim 2, in combination with control-means, associated with said power-switch means, for responding to said signal and for automatically and promptly thereafter discontinuing said reverse-sequence energization of the polyphase-motored movable body.

4. The invention as defined in claim 2, in combination with means, responsive to the termination of the forward-run energization, for also initiating a timing operation, control-switch means, associated with said power-switch means, for discontinuing said reverse-sequence energization of the polyphase-motored movable body in response to a preselected time-period of said timing operation, and control-switch means, associated with said power-switch means, for also discontinuing said reverse-sequence energization of the polyphase-motored movable body in response to the signal.

5. An electrically controlled system, comprising a reversible self-propelling polyphase-motored movable body, power-feeder means for feeding polyphase electrical energy to said polyphase-motored movable body, a relatively stationarily located, electrically controlled, power-switch means for controlling the polyphase energy-supply to the polyphase-motored movable body in either sequence of phases, control-means, associated with said power-switch means, for initiating and terminating a forward-driving polyphase energization of said polyphase-motored movable body for a forward run in a selected phase-sequence, means operating shortly after the initiating of said forward run of said polyphase-motored movable body, in either direction of run, for partially completing a control-circuit for closing the power-switch means in the reversed phase-sequence, and control-means, associated with said power switch means and responsive to the termination of said forward-run energization, for automatically and promptly thereafter completing the aforesaid control-circuit.

6. An electrically controlled system, comprising a reversible self-propelling polyphase-motored movable body, a track therefor, power-feeder means for feeding polyphase electrical energy to said polyphase-motored movable body, a relatively stationarily located, electrically controlled, power-switch means for controlling the polyphase energy-supply to the polyphase-motored movable body in either sequence of phases, control-switch means, associated with said power-switch means, for initiating and terminating the forward-driving polyphase energization of the polyphase-motored movable body for a forward run in a selected phase-sequence, a track-relay for responding to the position of the polyphase-motored movable body close to, but removed from, the starting point of said forward run, means responsive to a response of said track-relay for partially completing a control-circuit for closing the power-switch means in the reversed phase-sequence, and control-means, associated with said power-switch means and responsive to the termination of said forward-run energization, for automatically and promptly thereafter completing the aforesaid control-circuit.

7. An electrically controlled system, comprising a reversible self-propelling polyphase-motored movable body, a track therefor, power-feeder means for feeding polyphase electrical energy to said polyphase-motored movable body, a relatively stationarily located, electrically controlled, power-switch means for controlling the polyphase energy-supply to the polyphase-motored movable body in either sequence of phases, a plurality of position-responsive means for responding to the position of the polyphase-motored movable body on different portions of the track, control-switch means, associated with said power-switch means, for initiating and terminating the forward-driving polyphase energization of the polyphase-motored movable body for a forward run in a selected phase-sequence and for rendering effective a preselected position-responsive means close to, but removed from, the starting point, means responsive to the preselected position-responsive means for partially completing a control-circuit for closing the power-switch means in the reversed phase-sequence, and control-means, associated with said power-switch means and responsive to the termination of said forward-run energization, for automatically and promptly thereafter completing the aforesaid control-circuit.

8. An electrically controlled system, comprising a reversible self-propelling polyphase-motored movable body, a multi-sectional track therefor, power-feeder means for feeding polyphase electrical energy to said polyphase-motored movable body, at least one phase of said electrical energy being fed to the various sections of the track and thence to the polyphase-motored movable body, a relatively stationarily located, electrically controlled, power-switch means for controlling the polyphase energy-supply to the polyphase-motored movable body in either sequence of phases, control-switch means, associated with said power-switch means, for initiating and terminating the forward-driving polyphase energization of the polyphase-motored movable body for a forward run in a selected phase-sequence, a track-relay, means for controlling said track-relay in response to the flow of electrical energy into one of the track-sections close to, but removed from, the starting point of said forward run, means responsive to a re-

11

sponse of said track-relay for partially completing a control-circuit for closing the power-switch means in the reversed phase-sequence, and control-means, associated with said power-switch means and responsive to the termination of said forward-run energization, for automatically and promptly thereafter completing the aforesaid control-circuit.

9. An electrically controlled system, comprising a reversible self-propelling polyphase-motored movable body, a multi-sectional track therefor, power-feeder means for feeding polyphase electrical energy to said polyphase-motored movable body, at least one phase of said electrical energy being fed to the various sections of the track and thence to the polyphase-motored movable body, a relatively stationarily located, electrically controlled, power-switch means for controlling the polyphase energy-supply to the polyphase-motored movable body in either sequence of phases, a plurality of position-responsive means, associated with a plurality of sections of said track, for responding to the position of the polyphase-motored movable body on different sections of the track, each position-responsive means being energized in response to the flow of electrical energy into its corresponding track-section, control-switch means, associated with said power-switch means, for initiating and terminating the forward-driving polyphase energization of the polyphase-motored movable body for a forward run in a selected phase-sequence and for rendering effective a preselected position-responsive means close to, but removed from, the starting point, means responsive to the preselected position-responsive means for partially completing a control-circuit for closing the power-switch means in the reversed phase-sequence, and control-means, associated with said power-switch means and responsive to the termination of said forward-run energization, for automatically and promptly thereafter completing the aforesaid control-circuit.

10. An electrically controlled system, comprising a reversible polyphase motor, power-switch means for controlling the polyphase energy-supply to the motor in either sequence of phases, control-means, associated with said power-switch means, for initiating and terminating a forward-driving polyphase energization of the motor for a forward run in a selected phase-sequence, means responsive to the termination of the forward-driving polyphase energization of the motor, at the end of the forward run, for automatically and promptly thereafter electrically energizing the motor to stop and reverse its motion and also initiating a timing operation, and means responsive to a preselected time-period of the timing operation for discontinuing said reverse energization of the motor.

11. An electrically controlled system, comprising a reversible self-propelling polyphase-motored movable body, power-feeder means for feeding polyphase electrical energy to said polyphase-motored movable body, a relatively stationarily located power-switch means for controlling the polyphase energy-supply to the polyphase-motored movable body in either sequence of phases, control-means, associated with said power-switch means, for initiating and terminating a forward-driving polyphase energization of said polyphase-motored movable body for a forward run in a selected phase-sequence, control-means, associated with said power-switch means and responsive to the termination of said

12

forward-run energization, for automatically and promptly thereafter electrically energizing the polyphase-motored movable body to stop and reverse its motion, and means on said movable body for responding to a reversal of the movement thereof and for producing a signal of such fact.

12. The invention as defined in claim 11, in combination with control-means, associated with said power-switch means, for responding to said signal and for automatically and promptly thereafter discontinuing said reverse energization of the polyphase-motored movable body.

13. The invention as defined in claim 11, in combination with means, responsive to the termination of the forward-run energization, for also initiating a timing operation, means for discontinuing said reverse energization of the polyphase-motored movable body in response to a preselected time-period of said timing operation, and means for also discontinuing said reverse energization of the polyphase-motored movable body in response to the signal.

14. An electrically controlled system, comprising a reversible self-propelling polyphase-motored movable body, power-feeder means for feeding polyphase electrical energy to said polyphase-motored movable body, a relatively stationarily located, electrically controlled, power-switch means for controlling the polyphase energy-supply to the polyphase-motored movable body in either sequence of phases, control-means, associated with said power-switch means, for initiating and terminating a forward-driving polyphase energization of said polyphase-motored movable body for a forward run in a selected phase-sequence, means operating shortly after the initiating of said forward run of said polyphase-motored movable body, in either direction of run, for partially completing a control-circuit for the power-switch means, for controlling a decelerating electrical energization of the polyphase-motored movable body, and control-means, associated with said power-switch means and responsive to the termination of said forward-run energization, for automatically and promptly thereafter completing the aforesaid control-circuit.

15. An electrically controlled system, comprising a reversible self-propelling polyphase-motored movable body, a track therefor, power-feeder means for feeding polyphase electrical energy to said polyphase-motored movable body, a relatively stationarily located, electrically controlled, power-switch means for controlling the polyphase energy-supply to the polyphase-motored movable body in either sequence of phases, control-switch means, associated with said power-switch means, for initiating and terminating the forward-driving polyphase energization of the polyphase-motored movable body for a forward run in a selected phase-sequence, a track-relay for responding to the position of the polyphase-motored movable body close to, but removed from, the starting point of said forward run, means responsive to a response of said track-relay for partially completing a control-circuit for the power-switch means, for controlling a decelerating electrical energization of the polyphase-motored movable body, and control-means, associated with said power-switch means and responsive to the termination of said forward-run energization, for automatically and promptly thereafter completing the aforesaid control-circuit.

13

16. An electrically controlled system, comprising a reversible self-propelling polyphase-motored movable body, a track therefor, power-feeder means for feeding polyphase electrical energy to said polyphase-motored movable body, a relatively stationarily located, electrically controlled, power-switch means for controlling the polyphase energy-supply to the polyphase-motored movable body in either sequence of phases, a plurality of position-responsive means for responding to the position of the polyphase-motored movable body on different portions of the track, control-switch means, associated with said power-switch means, for initiating and terminating the forward-driving polyphase energization of the polyphase-motored movable body for a forward run in a selected phase-sequence and for rendering effective a preselected position-responsive means close to, but removed from, the starting point, means responsive to the preselected position-responsive means for partially completing a control-circuit for the power-switch means, for controlling a decelerating electrical energization of the polyphase-motored movable body, and control-means, associated with said power-switch means and responsive to the termination of said forward-run energization, for automatically and promptly thereafter completing the aforesaid control-circuit.

17. An electrically controlled system, comprising a reversible self-propelling polyphase-motored movable body, a multi-sectional track therefor, power-feed means for feeding polyphase electrical energy to said polyphase-motored movable body, at least one phase of said electrical energy being fed to the various sections of the track and thence to the polyphase-motored movable body, a relatively stationarily located, electrically controlled, power-switch means for controlling the polyphase energy-supply to the polyphase-motored movable body in either sequence of phases, control-switch means, associated with said power-switch means, for initiating and terminating the forward-driving polyphase energization of the polyphase-motored movable body for a forward run in a selected phase-sequence, a track-relay, means for controlling said track-relay in response to the flow of electrical energy into

14

one of the track-sections close to, but removed from, the starting point of said forward run, means responsive to a response of said track-relay for partially completing a control-circuit for the power-switch means, for controlling a decelerating electrical energization of the polyphase-motored movable body, and control-means, associated with said power-switch means and responsive to the termination of said forward-run energization, for automatically and promptly thereafter completing the aforesaid control-circuit.

18. An electrically controlled system, comprising a reversible self-propelling polyphase-motored movable body, a multi-sectional track therefor, power-feeder means for feeding polyphase electrical energy to said polyphase-motored movable body, at least one phase of said electrical energy being fed to the various sections of the track and thence to the polyphase-motored movable body, a relatively stationarily located, electrically controlled, power-switch means for controlling the polyphase energy-supply to the polyphase-motored movable body in either sequence of phases, a plurality of position-responsive means, associated with a plurality of sections of said track, for responding to the position of the polyphase-motored movable body on different sections of the track, each position-responsive means being energized in response to the flow of electrical energy into its corresponding track-section, control-switch means, associated with said power-switch means, for initiating and terminating the forward-driving polyphase energization of the polyphase-motored movable body for a forward run in a selected phase-sequence and for rendering effective a preselected position-responsive means close to, but removed from, the starting point, means responsive to the preselected position-responsive means for partially completing a control-circuit for the power-switch means, for controlling a decelerating electrical energization of the polyphase-motored movable body, and control-means, associated with said power-switch means and responsive to the termination of said forward-run energization, for automatically and promptly thereafter completing the aforesaid control-circuit.

RUEL C. JONES.