Feb. 16, 1954 C. E. BASTON 2,669,682

HAND CONTROLLER FOR PLURAL DRIVE MOTORS

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Fig. 1.

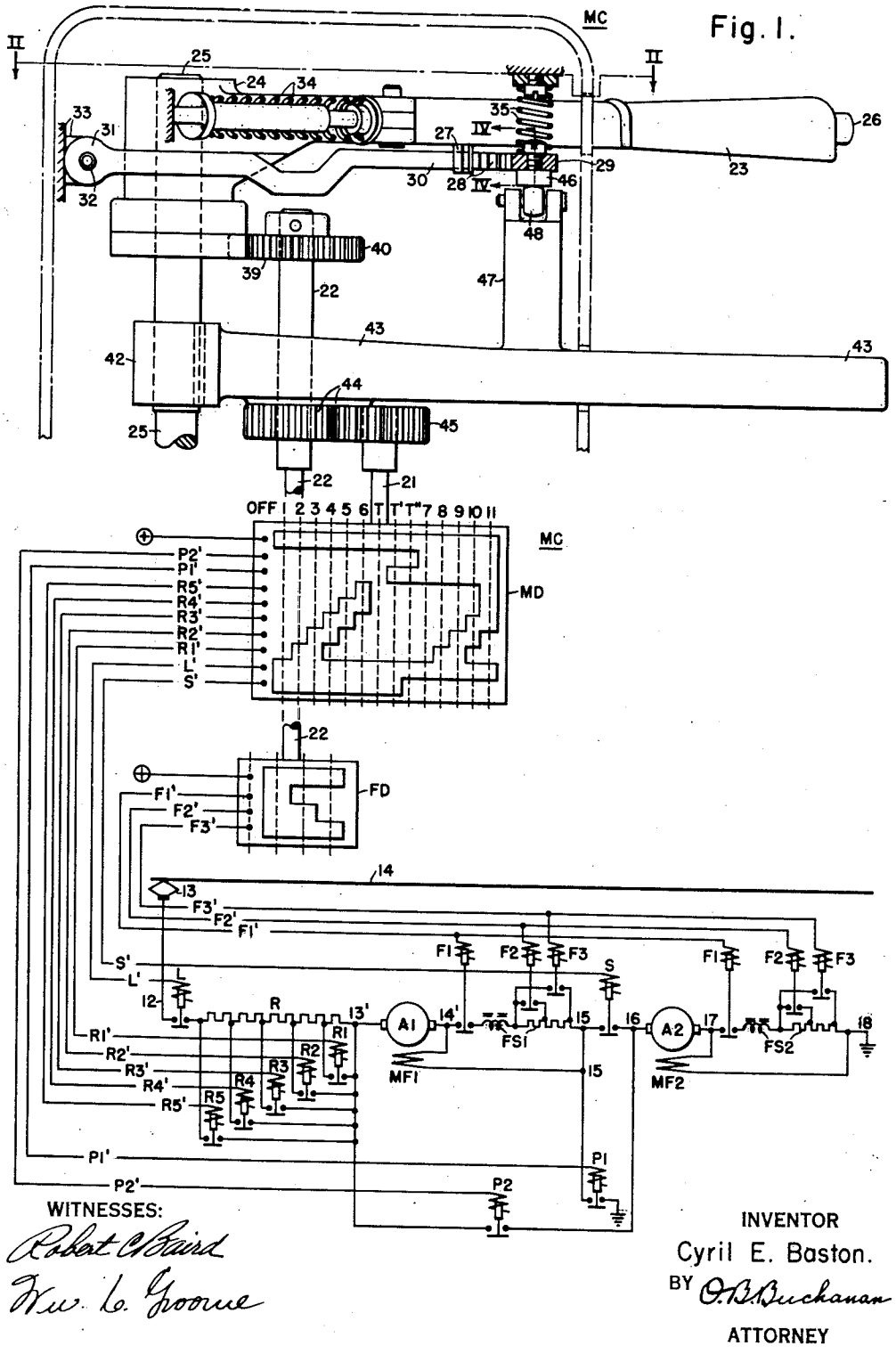

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Fig. 2.

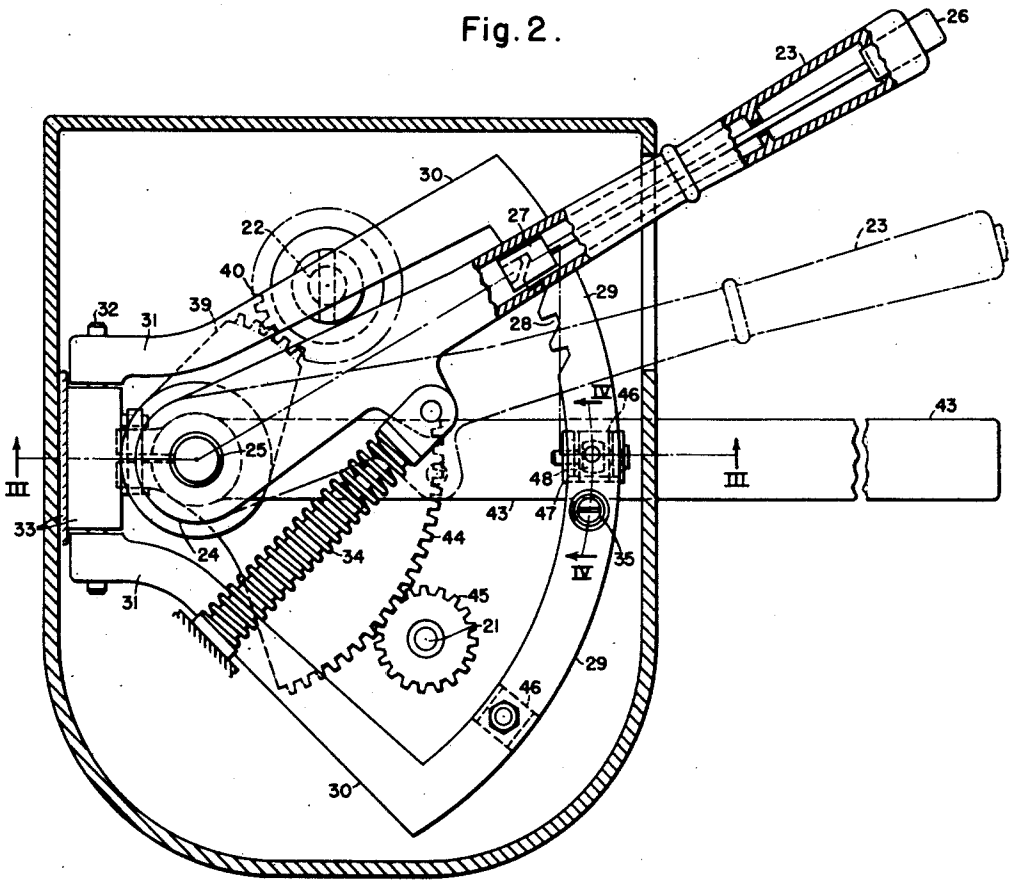

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Fig.3.

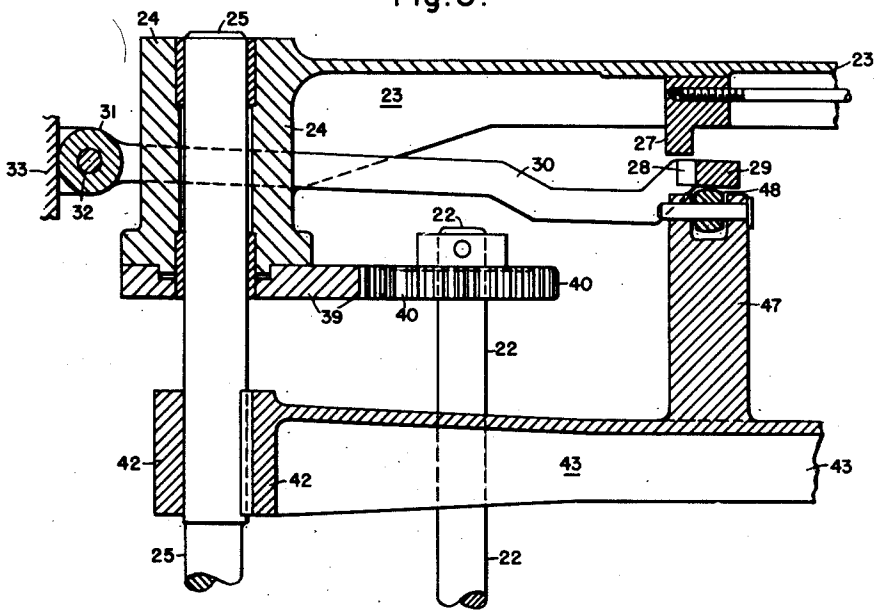
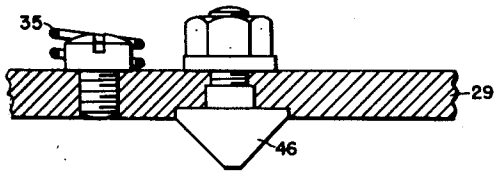


Fig.4.



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HAND CONTROLLER FOR PLURAL DRIVE MOTORS

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Application August 27, 1952, Serial No. 306,703

6 Claims. (Cl. 318—92)

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My invention relates to motor control equipments, particularly such as are adapted for use in high-voltage direct-current electric locomotives having a plurality of series driving-motors which are adapted to be reconnected in a plurality of different series-parallel motor-combinations, such as are shown, for example, in my application Serial No. 188,003, filed October 2, 1950, now Patent No. 2,626,374. More particularly, my invention relates to a form of embodiment of such locomotives, in which the engineman may operate his control-equipment so as to pass directly from the first motor-combination to the second, after having varied the effective motor-voltage from a minimum value to a maximum value, in the first motor-combination, and in which a separate field-control handle is provided, whereby the engineman, if he so desires, can shunt the motor-fields, in a plurality of successive steps or stages, while operating, at full motor-voltage, in the first motor-combination, or for that matter in any other motor-combination.

In such control-equipments, particularly when using high-voltage series direct-current motors, it is usually necessary or desirable to provide some means for returning the field-control handle to its off position, before the engineman can operate his controller so as to proceed into the next motor-combination. In the past, it has been the practice, for many years, to provide an arm on the main controller-handle or shaft, engaging a cam on the field-control handle or shaft, so that, if an attempt is made to move the main controller-handle forward, after the field-control handle has been moved, the arm engages the cam and physically moves the field-control handle back to its off, or full-field, position. This must be done before the main shaft reaches its next notch; and since the field-control shaft may have been moved three notches, for three successive stages of field-shunting, this entails a 3-to-1 mechanical disadvantage, with the result that the engineman must brace himself, and pull with both hands on the main controller-handle, in order to move it. In spite of the obvious criticism of the operators, and in spite of the complicate and expensive construction which has been required, this 3-to-1 mechanical disadvantage has perforce been tolerated, because nothing better has been available.

My present improvement consists in replacing the arm and cam with a handle-returning spring, to return the field-control shaft to its full-field position, in combination with a field-control notch-plate which is mounted so as to drop downward, under the force of gravity and a light

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spring, away from the latch which is carried by the field-control handle. This notch-plate is raised by a roller which is carried by the main handle, immediately below the notch-plate, so as to engage cams which are provided on the bottom of the notch-plate so as to lift the notch-plate into the plane of the latch, but only when the main handle is on a full-voltage running-notch, in one of the several motor-combinations. Thus, if the main handle is moved forward another notch, after the field-control handle has been moved to one of its weak-field positions, the notch-plate drops away from the latch, and the spring returns the field-control handle to its full-field position. The energy for returning the field-control handle to its off position is thus stored in the handle-returning spring, and the work is performed by the engineman when he advances the field-control handle in the first place, so that no additional work is required when the main handle is again advanced.

An illustrative form of embodiment of my invention, in a much simplified form, is indicated in the accompanying drawings, wherein:

Figure 1 is a much simplified front-elevational and partially diagrammatic representation of a portion of a master controller embodying my invention, with the top of the controller-housing indicated in phantom, and with a diagrammatic representation of the two control-drums, together with the essential electric circuits and apparatus of a locomotive embodying the general principles of my invention in a very much simplified form of embodiment, to avoid unnecessary complications in the illustration;

Fig. 2 is a plan view of the simplified master-controller mechanism, as seen on the section-plane II—II in Fig. 1;

Fig. 3 is a partial section view on the two planes indicated by the broken line III—III in Fig. 2, one of said section-planes passing through the off-positions of both the field-control handle and the main accelerating handle; and

Fig. 4 is a fragmentary detailed elevation of the notched segment of the notch-plate, as seen from the section-plane which is indicated at IV—IV in Figs. 1 and 2.

In Fig. 1, the parts are shown with the main handle in its full-voltage position for the series-motor connection, corresponding to notch No. 6, in the simplified control-diagram which I have indicated, to show the raising of the field-control latch-plate in this position of the main handle, whereas, in Figs. 2 and 3, both handles are in their off-positions.

Referring first to the electric circuit diagram

in Fig. 1, I have illustrated an electric locomotive in its simplest possible form, as comprising two series direct-current motors having armatures A1 and A2, and series mainfield windings MF1 and MF2, which are energized from a power-conductor 12 which is connected to a pantograph 13 or other current-collector which engages a high-voltage direct-current trolley-wire 14 or third-rail.

From the power-conductor 12, a circuit extends through an electrically controlled line-switch L to an accelerating-resistor R to a conductor 13', thence through the motor-armature A1 to a conductor 14', and thence through the field-winding MF1 to a conductor 15. From the conductor 15, a circuit continues, through an electrically controlled series-connection contactor S, to a circuit 16, and thence through the second motor-armature A2 and a circuit 17, and finally through the second motor-field MF2 to a ground-connection 18. Two electrically controlled parallel-connection contactors P1 and P2 are also provided, the first for connecting the circuit 15 to ground, and the second for joining the two circuits 13' and 16 together.

Means are provided for progressively cutting out the accelerating resistor R in a large number of steps, which are typified by five simple steps under the control of five electrically controlled resistor-shunting contactors R1 to R5. In this way, the voltage which is effective across the motor-terminals can be progressively increased from a minimum value to a maximum value, for either the series-motor combination in which the contactor S is closed, or the parallel-motor combination in which the contactors P1 and P2 are closed.

Each of the motor-fields MF1 and MF2 is provided with its own field-shunt FS1 and FS2, respectively, and these field-shunts are adapted to be applied, in a plurality of successive stages, by means of electrically controlled field-shunt contactors F1, F2 and F3, respectively.

The traction-motors A1 and A2 of the locomotive are under the control of one or more master-controllers MC. Each of the electrically controlled contactors of the motor-circuits is provided with a control-wire which is given the same designation as the contactor, with a prime added. The master-controller MC has two control-drums, namely a main drum MD, which is carried by a main shaft 21 of the controller, and a field-control drum FD, which is carried by a jack-shaft 22 of the controller.

The main drum MD controls all of the contactors except the field-control contactors F1, F2 and F3. This main drum is illustrated as having an off-position, eleven consecutively numbered running-positions, and three transition-positions T, T' and T''. The first notch or position of the main drum MD closes the contactors L and S, thus establishing the series-motor connection with all of the accelerating-resistance R in service, so that a minimum voltage is applied to the motor-armatures. In successive main-drum positions 2 to 6, the accelerating-resistance R is progressively cut out, until, at point 6, the full-voltage motor-energization is made, with the motors in their series-motor combination.

When the main drum MD is further rotated, in the motor-accelerating direction, the low-voltage connections for the next motor-combination are established. In this case, only two motor-combinations are illustrated for the sake of

simplicity, and the second motor-combination is a parallel-motor combination. The transition from the series to the parallel motor-combination may be made in a number of different ways; for example, as shown on notches T, T' and T'', by first opening all of the resistance-shorting contactors R1 to R5, then closing the first parallel-connection contactor P1, then opening the series-connection contactor S, and finally, on notch 7 of the main controller-drum MD, closing the second parallel-connection contactor P2. Thereafter, as the main drum MD is further advanced, through positions 8 to 11, the accelerating-resistor R is again cut out in any desired number of steps, until, in the controller-position 11, the full-voltage conditions are reached for the parallel-motor connection.

The field-control drum FD is a separate drum, having an off-position, corresponding to the full-field operation of the motors, and three consecutively numbered on-positions, wherein any one of three progressive stages of field-shunting may be applied to the series-motor fields, by successively controlling the field-controlling contactors F1, F2 and F3.

In the ordinary operation of the equipment, it is desired that the field-control drum FD shall be in its off-position at all times except when the main drum MD is in one of its full-voltage positions 6 or 11 (in the illustrated example), according to the number of different motor-combinations which are being used in achieving successively higher motor-speeds. It is desired that the engineman shall be able to vary the operation, after reaching his first full-voltage controller-position 6, with full field-strengths in the motors, either by proceeding on to the next motor-combination, by moving his controller from point 6 to point 7, without using any field-control, or, if the engineman desires to operate, for a while, with a reduced motor-speed, but desires a little more speed than is obtained in the full-voltage, full-field, series-motor connection, the engineman can leave his main drum on the full-voltage series-connection point 6, and operate the field-control drum FD to any one of its successive on-positions, for short-field operation, causing the motors to increase their speed.

If, after thus operating on a full-voltage short-field series-motor connection, the engineman desires to increase the motor-speed, and if, to that end, he proceeds to advance his main drum MD through the transition-points T, T' and T'' to the next running-notch 7, without having first returned the field-controller drum FD to its off-position, it is very desirable, usually amounting to a necessity, to provide some sort of means for quickly automatically returning the field-control drum FD to its off-position, when this further movement of the main control-drum MD is made. In order to accomplish the quick automatic return of the field-control drum FD, under the conditions just named, I have provided a new and much simplified form of construction for the master controller MC, as shown at the top of Fig. 1, and in Figs. 2 and 3.

At the top of the master controller MC there is an arcuately movable auxiliary or field-control handle 23, having a hub 24 which is mounted for free rotation or pivotal movement about a vertical stub-shaft 25. The grip of this field-control handle 23 is provided with a button 26 which can be depressed to release a yieldable latch 27 which is carried by the field-control handle, and which is adapted to engage in any one of a plu-

rality of notches 28 in the notched segment 29 of a field-controller notch-plate 30.

The field-controller notch-plate 30 is necessarily mounted so as to hold the field-control handle 23 in any one of its notches or positions, so that the field-control handle is restrained against backward rotating or arcuate movement when the yieldable latch 27 is engaged in one of the notches 28. In accordance with my present invention, however, this notch-plate 30 is mounted so that it has some freedom for a small amount of vertical movement, so that the notched segment 29 may be moved into an upper position in which its notches 28 are in the same plane as the latch 27, so as to be engaged thereby as the field-control handle 23 is advanced to its various positions, as shown in Fig. 1. On the other hand, the notch-plate 30 can be depressed into a lower position in which the notched segment 29 is out of engagement with the field-controller latch 27, as shown in Fig. 3. To this end, the portion of the field-control notch-plate 30 opposite to the segment 29 is bifurcated, as shown at 31, and this bifurcated end is pivoted on a horizontal pin 32 which passes through, or is carried by, a fixed support 33.

As a necessary part of my invention, the field-control handle 23 is provided with a suitable handle-biasing means, such as a compression-spring 34, for returning the field-control handle to its illustrated off-position. Furthermore, the vertically movable field-control notch-plate 30 is provided with a biasing means, such as a light compression-spring 35, bearing on the top of the segment 29, preferably somewhere near the center of the segment, for supplementing the force of gravity and biasing the notch-plate 30 to its lowermost position, in which the notched segment 29 is out of the plane of the latch 27 which is carried by the field-control handle 23.

Next underneath the notch-plate 30, the hub 24 of the field-control handle 23 carries a gear-segment 39, which drives a jack-shaft pinion 40 which is mounted on the top of the previously mentioned jack-shaft 22 which carries the field-control drum FD.

Keyed and clamped firmly to the stub-shaft 25 on which the field-control handle 23 pivots, and disposed at a point below the gear-segment 39, is the hub 42 of a main or accelerator-handle 43, which moves arcuately with the stub-shaft 25. On its underside, this accelerating handle 43 carries a gear-segment 44 which engages a main-shaft pinion 45 at the top of the previously mentioned main shaft 21, which carries the main or accelerator-drum MD. This gear-drive makes it possible for the main or accelerator drum MD to be rotated through an arc of anywhere from about 180° to close on toward 360°, whereas the main or accelerator-handle might have an angular movement of usually not more than 60° or 70°, in order to provide an easily handled controller, which does not require the engineman to get into awkward positions. In general, the main or accelerator-handle 43 has an arcuate movement through a considerably larger arc than the field-control handle 23. In the illustrated form of embodiment of my invention, these two controller-handles 23 and 43 are arcuately movable about the same axis, or at least substantially the same axis.

In accordance with my invention, the field-control notch-plate 30 is made so that its notched segment 29 has an arcuate extent commensurate with the arcuate movement of the main handle

43 which is located somewhat below said notched segment 29. It will be understood, of course, that the latch-engaging notches 28 of this notched segment 29 extend over only a small arc of the segment 29, corresponding to the small arc of the arcuate movement of the field-control handle 23. In accordance with my invention, the underside of this segment 29 has two or three downwardly directed segment-elevating cam-projections 46 (Figs. 2 and 4), located at points corresponding to the successive high-voltage positions or notches of the main accelerator-handle 43, corresponding to the full-voltage running-positions 6 and 11, respectively, of the main accelerator drum MD, in each of the successive motor-combinations. In the simple illustrated equipment, there are only two such motor-combinations. In more elaborate control equipments, there may be three or more; as illustrated, for example, in my previously mentioned application.

The main or accelerator-handle 43 is provided with an upstanding projection-engaging arm or portion 47, terminating, at its top, in a roller 48 which engages the cam-projections 46 on the underside of the notched segment 29, thus lifting said notched segment 29 of the field-control notch-plate 30 when the main handle 43 is at any one of a small number of predetermined selected positions at which it is desired to cause the notched segment 29 to be raised into the plane of the yieldable latch 27 which is carried by the field-control handle. Thus, when the notched segment 29 of the notch-plate 30 is thus raised or elevated, it is possible for the engineman to notch forward the field-control handle 23, into any one of its three on-positions, for shunting the motor-fields in three successive stages. Under such circumstances, when the engineman releases the control-button 26 after having advanced the field-control handle 23, latch 27 will engage one of the notches 28 in the segment 29 and hold the field-control handle 23 in its selected on-position, against the bias of the handle-biasing spring 34.

The cam-projections 46 underneath the notched segment 29 have such a limited arcuate extent that the roller 48 of the main handle 43 rolls out from under these projections before the main handle 43 is moved forward to its next notch or position, in the motor-accelerating direction of movement, thus releasing the field-control handle 23 from any advanced position, so that its handle-biasing spring 34 will promptly return said field-control handle 23 to its off-position.

It will thus be understood that I have provided a mechanism which is simple and rugged, and which stores up the handle-returning energy in the handle-biasing spring 34 during the time when the engineman is notching up the field-control handle 23, so that when the engineman wishes to advance the accelerator-handle 43 beyond the position of its full-voltage notch 6, for the series motor combination (or other intermediate-speed combination), the field-control notch-plate 30 snaps back down, out of engagement with the latch 27, and permits the field-control handle 23 to snap back to its off position, without imposing any additional drag which would make the further advancing movement of the accelerating-handle 43 more difficult.

It will be understood that I have attempted to illustrate only the general principles of my invention, in a simple form of embodiment, so as to avoid unnecessary complications. It will thus

be understood that my invention is not limited to the illustrated simple form, as more traction-motors could be used, more motor-combinations, more and differently arranged accelerator-notches, and numerous mechanical and electrical interlocking-means and safeguards, for preventing erroneous operations. It will further be obvious that various details such as reversers, over-current and undervoltage contactors and relays, and many other features, could be used without departing from the essential spirit of my invention.

I claim as my invention:

1. A master-controller having, (*a*) a main drum having a relatively large number of operating positions, and including a main operating-handle, (*b*) an auxiliary drum having an off-position and a plurality of on-positions, and including an auxiliary operating-handle, (*c*) a handle-biasing spring for returning said auxiliary handle to its off-position, (*d*) a yieldable latch carried by said auxiliary handle and including a latch-releasing member carried by said auxiliary handle, (*e*) a notch-plate including a notch-segment having a separate notch for holding said auxiliary handle, against the bias of said handle-biasing spring, in at least each of the on-positions of the auxiliary handle, when the corresponding notch is engaged by said latch, (*f*) said notch-plate including a mounting-means which permits said notch-segment to be axially moved into positions in and out of engageability with said latch on the auxiliary handle, (*g*) a notch-segment biasing-means, for biasing said notch-segment toward a position wherein said notches are not engageable by said latch, and (*h*) a means, operable at any one of a relatively small number of predetermined selected positions of the main handle, for moving said notch-segment, against its biasing-means, into a position for cooperative engagement with the latch of said auxiliary handle.

2. Control-equipment including the combination, with (*a*) a plurality of series motors for driving a common load-device, said motors having series main-field windings, (*b*) a motor-connection switching-means, for connecting said motors in any one of a plurality of different motor-combinations, for driving said load-device at progressively higher speeds, (*c*) a voltage-changing accelerating-means, for progressively increasing the voltage which is effective on the motors, from a low-voltage value to a high-voltage value, in each of said motor-combinations, and (*d*) a plural-step field-shunting means, for applying any one of a plurality of progressive stages of field-shunting, to the series main-field windings of said motors, of (*e*) a master-controller for the foregoing elements, said master-controller comprising, (*f*) a main drum having a plurality of progressively higher-voltage positions for each of the successive motor-combinations, said main drum including a main operating-handle, and including a control-means, controlled by said main drum, for controlling said voltage-changing accelerating-means (*c*) and said motor-connection switching-means (*b*), (*g*) a field-control drum having an off-position and a plurality of on-positions, corresponding to the off-position and the several successive stages of said field-shunting means (*d*), said field-control drum including a field-control handle, and including a control-means, controlled by said field-control drum, for controlling said field-shunting means (*d*), (*h*) a handle-biasing spring for returning said field-control handle to its off-position, (*i*) a yieldable latch carried by said field-control handle and including a latch-releasing member carried by said field-control handle, (*j*) a notch-plate including a notch-segment having a separate notch for holding said field-control handle, against the bias of said handle-biasing spring, in at least each of the on-positions of the field-control handle, when the corresponding notch is engaged by said latch, (*k*) said notch-plate including a mounting-means which permits said notch-segment to be axially moved into positions in and out of engageability with said latch on the field-control handle, (*l*) a notch-segment biasing-means, for biasing said notch-segment toward a position wherein said notches are not engageable by said latch, and (*m*) a notch-plate actuating-means, operable at the high-voltage positions of the main handle, in each of the successive motor-combinations, for moving said notch-segment, against its biasing-means, into a position for cooperative engagement with the latch of said field-control handle.

3. The invention as defined in claim 2, characterized by said notch-plate actuating-means (*m*) being operable only when the main drum is in one of its high-voltage positions.

4. A master-controller having, (*a*) an arcuately movable main handle having a large number of operating positions, (*b*) an auxiliary handle which is arcuately movable, on substantially the same axis as said main handle, in a plane which is axially displaced with respect to said main handle, said auxiliary handle having an off-position and a plurality of on-positions, (*c*) a handle-biasing spring for returning said auxiliary handle to its off-position, (*d*) a yieldable latch carried by said auxiliary handle and including a latch-releasing member carried by said auxiliary handle, (*e*) a notch-plate including a notch-segment having a separate notch for holding said auxiliary handle, against the bias of said handle-biasing spring, in at least each of the on-positions of the auxiliary handle, when the corresponding notch is engaged by said latch, (*f*) said notch-plate including a mounting-means which permits said notch-segment to be axially moved into positions in and out of the plane of said latch on the auxiliary handle, (*g*) a notch-segment biasing-means, for biasing said notch-segment toward a plane wherein said notches are not engageable by said latch, (*h*) said notch-segment having a relatively small number of segment-moving cam-projections, located at points corresponding to predetermined selected positions of the main handle, and (*i*) said main handle having a projection-engaging portion, adapted to engage one of said notch-segment cam-projections, at any one of a relatively small number of predetermined selected positions of the main handle, for axially moving said notch-segment, against its biasing-means, into a position for cooperative engagement with the latch of said auxiliary handle.

5. Control-equipment including the combination, with (*a*) a plurality of series motors for driving a common load-device, said motors having series main-field windings, (*b*) a motor-connection switching-means, for connecting said motors in any one of a plurality of different motor-combinations, for driving said load-device at progressively higher speeds, (*c*) a voltage-changing accelerating-means, for progressively increasing the voltage which is effective on the

motors, from a low-voltage value to a high-voltage value, in each of said motor-combinations, and (*d*) a plural-step field-shunting means, for applying any one of a plurality of progressive stages of field-shunting, to the series main-field windings of said motors, of (*e*) a master-controller for the foregoing elements, said master-controller comprising, (*f*) an arcuately movable main accelerating-handle, having a plurality of progressively higher-voltage positions for each of the successive motor-combinations, and control-means, controlled by said main handle, for controlling said voltage-changing accelerating-means (*c*) and said motor-connection switching-means (*b*), (*g*) a field-control handle which is arcuately movable, on substantially the same axis as said main handle, in a plane which is axially displaced with respect to said main handle, said auxiliary handle having an off-position and a plurality of on-positions, corresponding to the off-position and the several successive stages of said field-shunting means (*d*), and a control-means, controlled by said field-control handle, for controlling said field-shunting means (*d*), (*h*) a handle-biasing spring for returning said field-control handle to its off-position, (*i*) a yieldable latch carried by said field-control handle and including a latch-releasing member carried by said field-control handle, (*j*) a notch-plate including a notch-segment having a separate notch for holding said field-control handle, against the bias of said handle-biasing spring, in at least each of the on-positions of the field-control handle, when the corresponding notch is engaged by said latch, (*k*) said notch-plate including a mounting-means which permits said notch-segment to be axially moved into positions in and out of the plane of said latch on the field-control handle, (*l*) a notch-segment biasing-means, for biasing said notch-segment toward a plane wherein said notches are not engageable by said latch, (*m*) said notch-segment having a relatively small number of segment-moving cam-projections, located at points corresponding to the high-voltage positions of the main handle, in each of the successive motor-combinations, and (*n*) said main handle having a projection-engaging portion, adapted to engage one of said notch-segment cam-projections, when the main handle is in any one of its high-voltage positions, for axially moving said notch-segment, against its biasing-means, into a position for cooperative engagement with the latch of said field-control handle.

6. The invention as defined in claim 5, characterized by all but the last of the cam-projections (*h*) of said notch-segment having such limited arcuate extent that the projection-engaging portion (*n*) of the main handle rides off of any such cam-projection before the main handle is moved forward into the lowest-voltage position of the next following motor-combination.

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