

Oct. 7, 1941.

H. S. OGDEN

2,258,259

CONTROL SYSTEM

Filed Oct. 11, 1939

Fig. 2.

STEP	CONTACTORS CLOSED								UP	DOWN	UP	DOWN
	20	21	22	23	24	25	27	28				
1	.	.	.	.	.	.	.	.	.	.	.	.
2	.	.	.	.	.	.	.	.	.	.	.	.
3	.	.	.	.	.	.	.	.	.	.	.	.
4	.	.	.	.	.	.	.	.	.	.	.	.
5	.	.	.	.	.	.	.	.	.	.	.	.
6	.	.	.	.	.	.	.	.	.	.	.	.
7	.	.	.	.	.	.	.	.	.	.	.	.
8	.	.	.	.	.	.	.	.	.	.	.	.
9	.	.	.	.	.	.	.	.	.	.	.	.

Fig. 1.

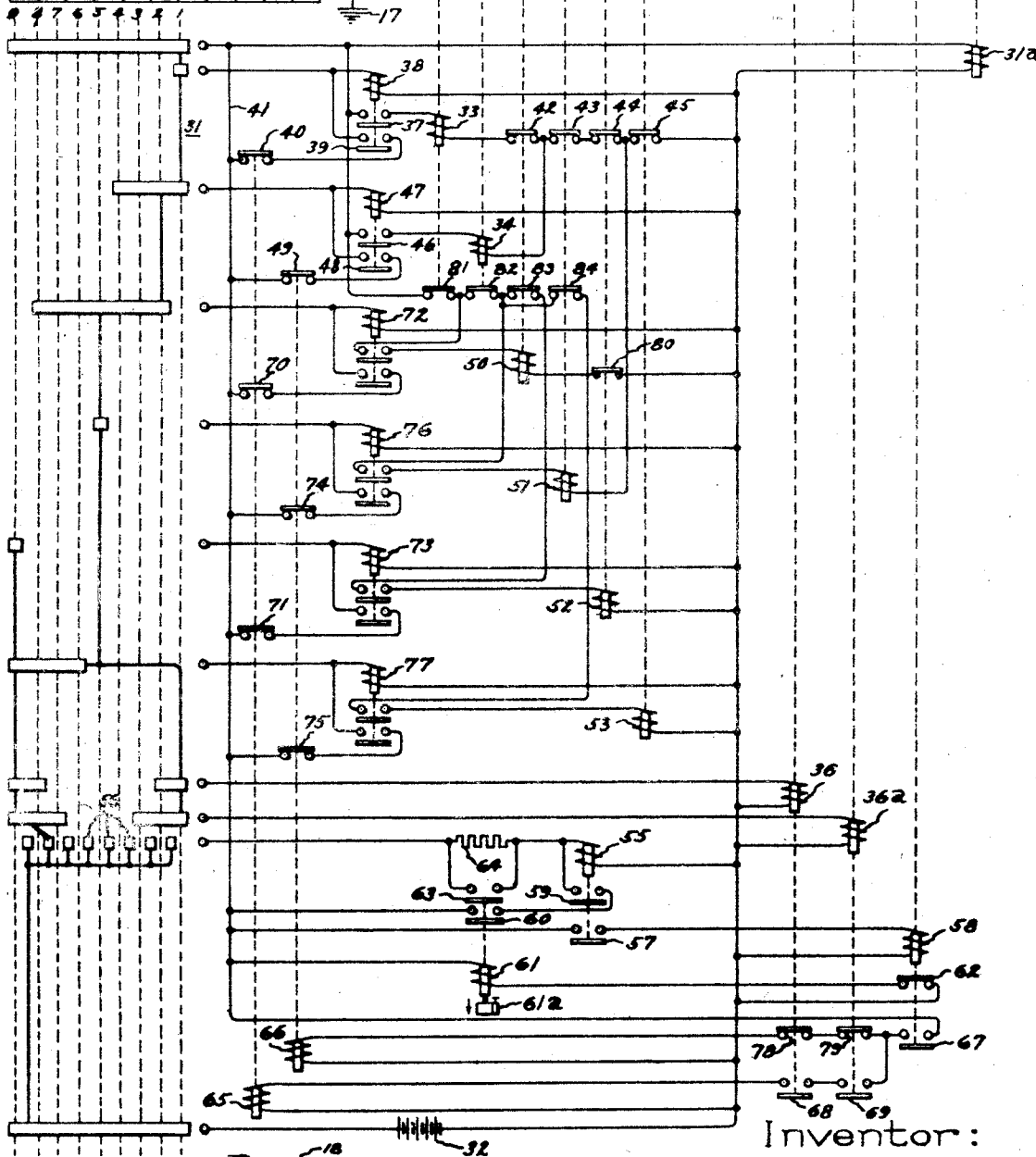
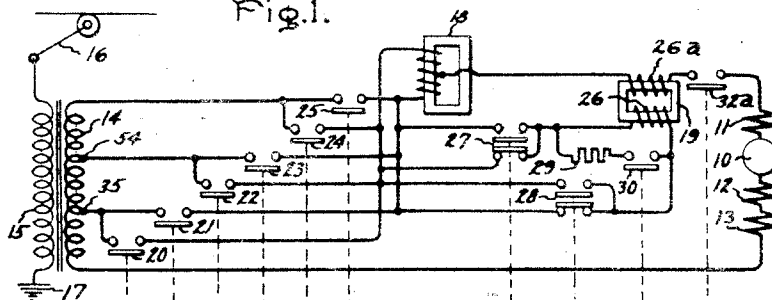


Fig. 3.



Inventor:

Harold S. Ogden,
by *Harry C. Dunham*
His Attorney.

UNITED STATES PATENT OFFICE

2,258,259

CONTROL SYSTEM

Harold S. Ogden, Erie, Pa., assignor to General Electric Company, a corporation of New York

Application October 11, 1939, Serial No. 298,956

12 Claims. (Cl. 171-119)

My invention relates to control systems for electric motors, more particularly to systems for controlling the acceleration of single-phase alternating current railway motors of the type using preventive coil and a buck-boost transformer means for obtaining various voltage steps, and has for its object a simple and reliable means for preventing momentary sag or decrease in the tractive effort of the motor while the voltage connections are being changed.

In accordance with my invention, I connect the buck-boost transformer across the preventive coil and I connect also across the preventive coil a suitable resistance during the interval in which the connections are being changed between the preventive coil and the different voltage taps on the supply transformer.

I also connect the resistor across the exciting winding of the buck-boost transformer during the interval that the buck-boost transformer is being switched independently of the preventive coil.

For a more complete understanding of my invention, reference should be had to the accompanying drawing, Fig. 1 of which is a diagrammatic representation of an alternating current railway motor control system embodying my invention; Fig. 2 is a sequence chart for various positions of the switches or contactors; while Fig. 3 is a simplified diagram of connections during the transfer from one tap connection on the main transformer to the next.

Referring to the drawing, I have shown my invention in one form as applied to the control of a single-phase alternating current series motor 10 provided with an exciting field winding 11, a compensating field winding 12 and an interpole field winding 13. The motor is energized from taps on the secondary winding 14 of a supply transformer having a primary winding 15. As shown, the primary winding 15 has one terminal connected to a suitable alternating current source such as a trolley wire by means of a trolley 16 and its other terminal connected to a ground 17.

As shown, four terminals or taps only are provided on the secondary winding 14 although, of course, more may be provided if desired. However, by means of an iron core preventive coil 18 and an iron core buck-boost transformer 19 a multiplicity of voltages are obtained from the four transformer taps. As shown, the lower tap or terminal of the transformer secondary winding is connected directly to one side of the motor.

The connections between the three upper taps of the secondary winding 14 and the preventive coil 18 are controlled by electromagnetically operated switches or contactors 20 to 25 inclusive. Also the connections between one of the windings 26 of the buck-boost transformer 19 and the

preventive coil are controlled by two switches 27 and 28. Thus with the two switches 27 and 28 in their uppermost or lowermost positions the winding 26 is connected with one polarity or the other across the preventive coil, but with one of the switches 27 or 28 in its upper position and the other in its lower position, the winding 26 is short circuited.

Also I have provided a suitable impedance shown as a resistor 29 which may be connected across the winding 26 by a switch 30.

A manually operated drum controller 31 is provided for suitably controlling the tap switches 20 to 25, the reversing switches 27 and 28 and the switch 30 to control the speed of the motor. In its first position, the controller energizes from a suitable auxiliary control supply source, shown as a storage battery 32, a coil 31a which closes the starting switch 32a in the motor circuit. Also energized in this position are the coils 33 and 34 which close their switches 20 and 21. These last-mentioned two switches connect both terminals of the preventive coil 18 to the same tap 35 of the transformer and, consequently, the voltage of the tap 35 is applied to the motor circuit. Also, in the first position of the controller 31, the coils 36 and 36a are energized whereby the switches 27 and 28 are lifted to their uppermost positions to connect the coil 26 with a predetermined polarity across the preventive coil 18. At this time, however, since the preventive coil is short circuited by the switches 20 and 21, no voltage is applied to the coil 26 and the voltage of tap 35 is the voltage applied to the motor.

A suitable relay interlocking system is provided for the coils of the switches. The coil 33 is energized through a switch 37 operated by a coil 38 which is directly energized from the controller 31. Also the coil 38 closes a switch 39 which closes a holding circuit for the coil 38 through a relay switch 40 to the conductor 41 leading to the upper contact of the controller 31 and connected through the conductors of the controller and the lower controller contact to one side of the battery 32. The circuit of the coil 33 also includes normally closed interlock switches 42, 43, 44 and 45 which are connected to the switches 22 to 25 inclusive.

The coil 34 is similarly energized through a switch 46 operated by a coil 47. In a similar manner this coil 47 closes a switch 48 in a holding circuit for itself leading through an interlock switch 49. The coil 34 is interlocked through the switches 43, 44 and 45.

It is believed that the connections and operation of the coils 50, 51, 52 and 53 will be clear from the preceding description with the help of the sequence chart. Thus in the second position of the controller 31 with the switch 20 open the switch 21 closed and the switch 22 closed, the

preventive coil 18 is connected across the transformer taps 35 and 54 so as to give a voltage half-way between these taps which voltage is reduced for the motor by the action of the buck-boost transformer 19.

In position 3 of the controller 31, the coil 36 is deenergized whereby the switch 27 drops to its lower position and short circuits the buck-boost coil 26. This gives a motor voltage half-way between the taps 35 and 54, the buck-boost transformer being inactive.

In position 4 the coil 36a is deenergized whereby the switch 28 drops to its lower position thus connecting the coil 26 across the preventive coil 18 with a polarity which is reversed with respect to its polarity in position 2. This causes the buck-boost transformer to boost the transformer voltage.

In the fifth position of the controller, the coil 34 is deenergized and the switch 21 opens while the coil 51 is energized to close the switch 23. The opening of the switch 21 also deenergizes the buck-boost transformer coil 26. At this time the motor is supplied with the full voltage of the tap 54.

It is believed that the connections established in the remaining positions of the controller 31 will be clear from the preceding description.

For the purpose of assuring a predetermined momentary closure of the switch 30 to connect the resistor 29 across the coil 26 between the various positions of the controller 31, a coil 55 is provided which is energized momentarily between positions by the controller contacts 56. This coil closes a switch 57 which energizes the coil 58 for the resistor switch 30. Also the coil 55 closes an interlock switch 59 which establishes a holding circuit for the coil 55 through the relay switch 60 held closed by its coil 61. It will be observed that the coil 61 is energized through a normally closed switch 62 operated by the coil 58. Also the coil 61 closes a switch 63 to short circuit the resistance 64 in the circuit of the coil 55 whereby the coil is given a tremendous pick-up force. Preferably the coil 55 is wound for continuous operation on a lower voltage than that of the supply source 32 to obtain increased pickup force.

When the coil 58 closes the switch 30 and opens the switch 62, the coil 61 is deenergized and the switch 60 opens after a time interval determined by the inherent operating time of coil 61 (requires time to open its contacts) or of a timing device 61a to deenergize the coil 55. The coil 55 then releases its switch 57 which drops open and deenergizes the coil 58 to again open the switch 30. In the event that the controller is held in a mid-position, it will be observed that the deenergization of the coil 61 and opening of the switch 63 inserts the resistance 64 in circuit with the coil 55 to prevent overheating of the coil. This interlocking arrangement assures the momentary closure of the switch 30 when the controller 31 is moved rapidly from one position to the next.

It will be observed that the switches 27, 28 and 30 are controlled to connect the buck-boost transformer coil 26 and the resistor 29 in parallel with each other across the preventive coil 18 during the time that the preventive coil 18 is open circuited and one terminal only connected to a transformer tap. This condition occurs when the controller 31 is moved between positions 1—2, 4—5, 5—6, and 8—9. Thus, when the controller 31 is moved from the fourth position to the fifth position, the switch 21 is first opened which

leaves the upper half only of the preventive coil 18 connected through the switch 22 to the transformer tap 54. This upper half of the preventive coil, unless means were provided to prevent it, would momentarily under these conditions introduce an appreciable reactance voltage drop in the motor circuit whereby the voltage applied to the motor would be correspondingly reduced. This is undesirable because of the resulting irregular and jerky operation of the motor by reason of its momentarily reduced voltage and torque.

With the resistor and coil 26 connected in parallel with the preventive coil, however, in accordance with my invention, the motor current divides equally between the preventive coil on the one hand and the resistor and winding 26 on the other hand. As shown diagrammatically in Fig. 3, indicating the momentary conditions existing in passing from the fourth to the fifth position of the controller 31, one-half of the motor current passes through the upper half of the preventive coil, as indicated by the arrow 64a, while the other half of the motor current passes through the lower half of the preventive coil, as indicated by the arrow 64b. This latter half of the motor current divides equally between the resistor 29 and the winding 26, the preventive coil acting as an autotransformer. This division of motor current is brought about by using a 4:1 transformer 19 whereby its primary winding 26 has one-fourth motor current induced in it, and by using a resistance 29 of such value that it will not have a voltage across it high enough to saturate or over-excite the preventive coil and buck-boost transformer. As a result of this action, the currents in the upper and lower halves of the preventive coil flowing in opposite directions inductively neutralize each other so that substantially no inductive voltage drop appears across the preventive coil. Therefore, no decrease in the motor voltage takes place during the momentary existence of this condition.

When the switches 27 and 28 are operated independently of the switches 20 to 25 inclusive, by controller movement between positions 2—3, 3—4, 6—7, and 7—8, the resistor 29 is connected across the winding 26 of the buck-boost transformer momentarily during the interval in which the switch 27 or 28 is open and the winding 26 is thereby open-circuited. The resistor 29 is thus connected across the winding 26 so that the current induced in the winding 26 by the primary winding 26a exactly neutralizes the ampere turns of the winding 26a. The value of the resistor is such as to practically short-circuit the winding 26. This prevents any appreciable impedance drop across the winding 26a during these intervals and thereby prevents resulting momentary sag or decrease in motor voltage and at the same time prevents excessive voltages being induced in winding 26.

Additional interlock means is provided by the relay interlock switches operated by the coils 65 and 66. When the coil 65 is deenergized and its interlock switches 40, 70 and 71 thereby closed, these interlock switches assure respectively that any one of the coils 38, 72 and 73 which may be energized when these switches close is maintained closed by a holding circuit through its interlock switch respectively and, therefore, cannot be opened so long as the coil 65 is deenergized, by movement of the controller 31 to any operating position. These coils control the group of tap switches 20, 22 and 24, which control the

connection of the upper terminal of the preventive coil to the transformer taps. Likewise, when the coil 66 is deenergized and its interlock switches 49, 74 and 75 are closed, these switches respectively establish a holding circuit for any one of the coils 47, 76 and 77 that may then be energized. Consequently, these coils operating the group of tap switches 21, 23 and 25 cannot be deenergized by the controller 31 so long as these interlock switches remain closed. This means that the tap switches 20 to 25 inclusive, which are closed respectively when the coils 38, 47, 72, 76, 73 and 77 are energized, cannot be opened by the movement of the controller 31 to any other operating position when the coils 65 and 66 are deenergized. In other words, the tap connections remain as they are until one or the other of the coils 65 or 66 is energized.

The coils 65 and 66 are energized from the conductor 41 through a common interlock switch 67 operated by the coil 58. In addition, the coil 65 is energized through two normally open interlock switches 68 and 69 operated by the coils 36 and 36a while the coil 66 is energized through two normally closed interlock switches 78 and 79 operated by the coils 36 and 36a.

In this manner, the tap switch combinations are interlocked with the switches 27, 28 and 30. A tap switch combination existing before the controller 31 is moved is maintained until the switches 27, 28 and 30 assume their proper positions for the next tap change. Thus, a tap switch change cannot be made until, first the switch 30 is closed to close the interlock switch 67 which closure of the switch 30 is effected by movement of the controller 31 between steps and, second, a tap switch change can be made only when the switches 27 and 28 are in their positions to give the correct polarity of the winding 26 as connected to the preventive coil 18, this latter interlocking previously noted being effected by the interlock switches 68, 69 and 78, 79. It will be noted, for example, from the sequence chart, Fig. 2, that in the positions 4, 5 and 6, the tap switches 21, 23 and 25 are closed and opened in sequence, this being possible because the coil 66 is energized between steps or positions of the controller 36. At this same time, however, the coil 65 is deenergized continuously.

Short circuits across sections of the transformer winding 14 and the possibility of the application of overvoltage to the preventive coil are prevented by the normally closed interlock switches 42, 43, 44, 45, 80, 81, 82, 83 and 84. For example, it will be observed that the coil 33 cannot be energized if any one of the tap switches 21 to 25 inclusive is closed which might cause a short circuit or overvoltage condition. The closure of each tap switch opens its corresponding interlock switch referred to above.

While I have shown a particular embodiment of my invention, it will be understood of course that I do not wish to be limited thereto since many modifications may be made and I therefore contemplate by the appended claims to cover any such modifications as fall within the true spirit and scope of my invention.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. A motor control system comprising a supply transformer having a plurality of voltage taps, a preventive coil, two groups of tap switches for connecting respectively the terminals of said preventive coil to selected ones of said taps, a buck-boost transformer having a winding arranged for

connection in a motor circuit and a second winding inductively associated with said first winding, reversing switches for connecting said second winding across said preventive coil, said switches being normally in positions to connect said second winding across said preventive coil for one polarity and movable to second positions for reversed polarity, means operated by movement of said reversing switches to one of said positions for maintaining closed a predetermined group of said tap switches, means operated by movement of said reversing switches to said normal positions for maintaining closed the other of said groups of tap switches, and interlocking means between the tap switches of each group preventing the closure of more than one of the switches of each group at any one time.

2. A motor control system comprising a supply transformer having a plurality of voltage taps, a preventive coil, two groups of normally open electromagnetic tap switches operable to connect respectively the terminals of said preventive coil to selected ones of said voltage taps, a buck-boost transformer having a winding arranged for connection in a motor circuit and a second winding inductively associated with said first winding, electromagnetically operated reversing switches for connecting said second winding across said preventive coil, a resistor, a normally open electromagnetically operated resistor switch for connecting said resistor across said second winding of said buck-boost transformer, a controller movable to a plurality of positions to control said switches, and means selectively operated by said reversing switches and said resistor switch for holding closed one of said tap switches of one of said groups independently of said controller and for opening said one tap switch upon operation of said resistor switch and said reversing switches to other positions.

3. A motor control system comprising a supply transformer having a plurality of voltage taps, a preventive coil, two groups of tap switches for connecting respectively the terminals of said preventive coil to selected ones of said taps, a buck-boost transformer having a winding arranged for connection in a motor circuit and a second winding inductively associated with said first winding, reversing switches for connecting said second winding across said preventive coil, said switches being normally in positions to connect said second winding across said preventive coil for one polarity and movable to second positions for reversed polarity, interlock means operated by movement of said reversing switches to each of said positions for maintaining closed a predetermined group of said tap switches, interlock means between the tap switches of each group preventing the closure of more than one of the switches of each group at any one time, a resistor, resistor switching means for connecting said resistor across said second winding, and switching means operated by said resistor switching means for operating said interlock means to release said predetermined group of tap switches.

4. A motor control system comprising a supply transformer having a plurality of voltage taps, a preventive coil, two groups of tap switches for connecting respectively the terminals of said preventive coil to selected ones of said taps, a buck-boost transformer having a winding arranged for connection in a motor circuit and a second winding inductively associated with said first winding, reversing switches for connecting said second winding across said preventive coil, said

switches being normally in positions to connect said second winding across said preventive coil for one polarity and movable to second positions for reversed polarity, a resistor, resistor switching means for connecting said resistor across said second winding, a controller movable to predetermined positions to control said tap and reversing switching means and to close said resistor switching means in moving from one of said positions to another, interlock means operated by movement of said reversing switches to each position for maintaining closed a predetermined group of said tap switches independently of movement of said controller while providing for selective operation of the other group of said tap switches by said controller, means operated by said resistor switching means for disabling said interlock means, and interlock means between the tap switches of each group preventing the closure of more than one of the switches of each group at any one time.

5. A motor control system comprising a supply transformer having a plurality of voltage taps, a preventive coil, two groups of normally open electromagnetic tap switches operable to connect respectively the terminals of said preventive coil to selected ones of said voltage taps, a controller movable to a plurality of predetermined positions selectively to close said tap switches, normally closed holding switches in holding circuit for said tap switches, a coil for opening said holding switches for the tap switches of each group, a buck-boost transformer having a winding arranged for connection in a motor circuit and a second winding inductively associated with said first winding, two electromagnetically operated reversing switches for connecting said second winding across said preventive coil, said controller being arranged to operate said reversing switches in conjunction with said tap switches, a normally closed interlock switch operated by each of said reversing switches, connections connecting said normally closed interlock switches in series with each other in the circuit of one of said coils, a normally open interlock switch operated by each of said reversing switches, and connections connecting said normally open interlock switches in series with each other in the circuit of the other of said coils.

6. A motor control system comprising a supply transformer having a plurality of voltage taps, a preventive coil, two groups of normally open electromagnetic tap switches operable to connect respectively the terminals of said preventive coil to selected ones of said voltage taps, a controller movable to a plurality of predetermined positions selectively to close said tap switches, normally closed holding switches in holding circuits for said tap switches, a coil for opening said holding switches for the tap switches of each group, a buck-boost transformer having a winding arranged for connection in a motor circuit and a second winding inductively associated with said first winding, two electromagnetically operated reversing switches for connecting said second winding across said preventive coil, switching means operated by said reversing switches connected in circuits with said coils, said controller being arranged to operate said reversing switches in conjunction with said tap switches, a resistor, a normally open electromagnetically operated resistor switch for connecting said resistor across said second winding of said buck-boost transformer, a normally open interlock switch operated with said resistor switch connected in circuit with

both of said coils, and means including said controller for operating momentarily said resistor switch to its closed position between said predetermined positions.

7. A motor control system comprising a supply transformer having a plurality of voltage taps, a preventive coil, two groups of normally open electromagnetic tap switches operable to connect respectively the terminals of said preventive coil to selected ones of said voltage taps, a controller movable to a plurality of predetermined positions selectively to close said tap switches, normally closed holding switches in holding circuits for said tap switches, a coil for opening said holding switches for the tap switches of each group, a buck-boost transformer having a winding arranged for connection in a motor circuit and a second winding inductively associated with said first winding, two electromagnetically operated reversing switches for connecting said second winding across said preventive coil, said switches being in normally closed positions to connect said second winding across said preventive coil for one polarity and movable to a second position for reversed polarity, said controller being arranged to operate said reversing switches in conjunction with said tap switches, a normally closed interlock switch operated by each of said reversing switches, connections connecting said normally closed interlock switches in series with each other in the circuit of one of said coils, a normally open interlock switch operated by each of said reversing switches, connections connecting said normally open interlock switches in series with each other in the circuit of the other of said coils, a resistor, a normally open electromagnetically operated resistor switch for connecting said resistor across said second winding of said buck-boost transformer, a normally open interlock switch operated with said resistor switch connected in circuit with both of said coils, and means including said controller for operating momentarily said resistor switch to its closed position between said predetermined positions.

8. A control system comprising a supply transformer having a plurality of different voltage taps, a preventive coil provided with two end terminals and with a substantially central tap dividing said preventive coil into two portions, tap switching means for connecting in one position the said terminals of said preventive coil to a selected pair of said taps, a transformer having a winding arranged for connection in a motor circuit and a second winding inductively associated therewith, reversing switching means for connecting in one position said second winding across said preventive coil with one polarity and movable to short-circuit said second winding and to connect said second winding across said preventive coil with reversed polarity, said reversing switching means open circuiting said second winding in moving from one position to another to effect each change in its connections, an impedance, normally open impedance switching means movable to a closed position to connect said impedance across said second winding, and a controller having a plurality of positions for controlling said tap switching means, and for controlling said reversing switching means and said impedance switching means to connect said impedance across said second winding during the time interval that said second winding is open circuited by said reversing switching means and then open said impedance switching means after

said reversing switching means has operated either to connect said second winding across said preventive coil or to short-circuit said second winding.

9. A control system comprising a supply transformer having a plurality of different voltage taps, a preventive coil provided with two end terminals and with a substantially central tap dividing said preventive coil into two portions, tap switching means for connecting in one position the said terminals of said preventive coil to a selected pair of said taps and movable to disconnect one of said terminals from said supply transformer and then connect said one terminal to a different one of said taps, a transformer having a winding arranged for connection in a motor circuit and a second winding inductively associated therewith, reversing switching means for connecting in one position said second winding across said preventive coil with one polarity and movable to disconnect said second winding from said preventive coil and connect said second winding across said preventive coil with reversed polarity, a resistor, resistor switching means for connecting said resistor across said second winding, a controller having a plurality of first positions for controlling said tap switching means to connect said preventive coil selectively to different taps, and means on said controller between said first positions for controlling said reversing switching means and said resistor switching means to connect both said second winding and said resistor across said preventive coil during the time interval that one terminal of said preventive coil is disconnected from said supply transformer.

10. A control system comprising a supply transformer having a plurality of different voltage taps, a preventive coil provided with two end terminals and with a substantially central tap dividing said preventive coil into two portions, tap switching means for connecting in one position the said terminals of said preventive coil to a selected pair of said taps and movable to disconnect one of said terminals from said supply transformer and then connect said one terminal to a different one of said taps, a buck-boost transformer having a secondary winding arranged for connection in a motor circuit and a primary winding inductively associated therewith, reversing switching means for connecting in one position said primary winding across said preventive coil with one polarity and movable to short-circuit said primary winding and to connect said primary winding across said preventive coil with reversed polarity, said reversing switching means disconnecting at least one terminal of said primary winding from said preventive coil and thereby open circuiting said primary winding in effecting each change in the connections of said primary winding, a resistor, resistor switching means for connecting said resistor across said primary winding, and a controller having a plurality of positions for sequentially controlling said switching means to connect said preventive coil selectively to different taps, to connect both said primary winding and said resistor across said preventive coil during the time interval that one terminal of said preventive coil is disconnected from said supply transformer and to connect said resistor across said primary winding when said primary winding is open circuited, said buck-boost transformer having a ratio between its windings to provide when one terminal of said preventive coil is disconnected 75

for substantially one-fourth motor current in said primary winding and for substantially equal currents in said two portions of said preventive coil.

11. A control system comprising a supply transformer having a plurality of different voltage taps, a preventive coil provided with two end terminals and with a substantially central tap dividing said preventive coil into two portions, tap switching means for connecting in one position the said terminals of said preventive coil to a selected pair of said taps, a transformer having a winding arranged for connection in a motor circuit and a second winding inductively associated therewith, a first reversing switch biased to one closed position to connect a first end of said second winding to a first terminal of said preventive coil and movable to a second closed position to connect said first end of said second winding to the second terminal of said preventive coil, a second reversing switch biased to one closed position to connect the second end of said second winding to the second terminal of said preventive coil and movable to a second closed position to connect said second end of said second coil to said first terminal of said preventive coil, an impedance, impedance switching means for connecting said impedance across said second winding, and a controller for selectively controlling said reversing switching means and said impedance switching means to connect said impedance across said second winding during the time interval that each one of said reversing switches is open while moving from one closed position to another.

12. A control system comprising a supply transformer having a plurality of different voltage taps, a preventive coil provided with two end terminals and with a substantially central tap dividing said preventive coil into two portions, tap switching means for connecting in one position the said terminals of said preventive coil to a selected pair of said taps and movable to disconnect one of said terminals from said supply transformer and then connect said one terminal to a different one of said taps, a buck-boost transformer having a winding arranged for connection in a motor circuit and a second winding inductively associated therewith, a first reversing switch biased to one closed position to connect a first end of said second winding to a first terminal of said preventive coil and movable to a second closed position to connect said first end of said second winding to the second terminal of said preventive coil, a second reversing switch biased to one closed position to connect the second end of said second winding to the second terminal of said preventive coil and movable to a second closed position to connect said second end of said second coil to said first terminal of said preventive coil, an impedance, impedance switching means biased to an open position and movable to a closed position to connect said impedance across said second winding, and a controller having a plurality of positions for selectively controlling said switching means to connect said preventive coil selectively to different ones of said taps, to connect said second winding across said preventive coil, to short-circuit said second winding, and to connect said impedance across said second winding during the time interval that each of said reversing switches is open while moving from one closed position to another.

HAROLD S. OGDEN.