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COUNTER ELECTROMOTIVE FORCE MOTOR STARTER CONTROL SYSTEM

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Fig. 1

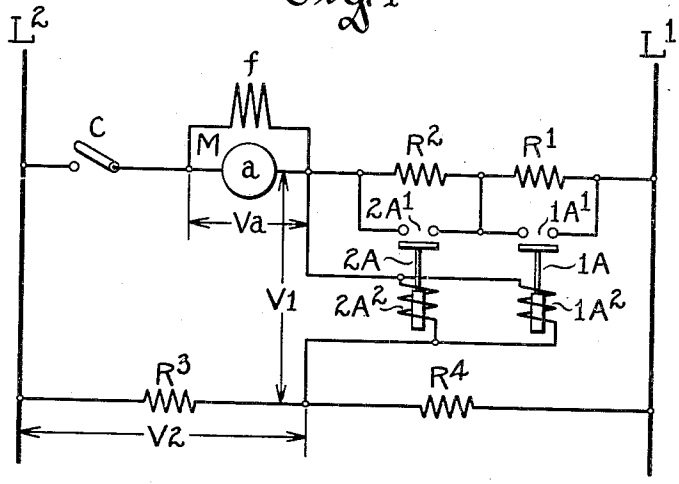
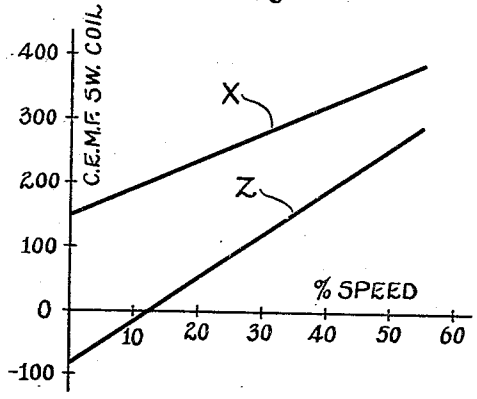


Fig. 2



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COUNTERELECTROMOTIVE FORCE MOTOR STARTER CONTROL SYSTEM

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5 Claims. (Cl. 318—394)

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This invention relates to improvements in controllers for electric motors and is particularly applicable to the so-called C. E. M. F. type starter.

Such starters commonly comprise one or more electroresponsive accelerating switches each having its control winding connected directly across the motor armature for response at a given value of C. E. M. F. of the motor, and such starters have been found very advantageous except for certain weaknesses. Each such accelerating switch requires a given setting and fluctuations in line voltage have resulted in premature or belated response of the switch. Also it has been found that the desired action of the switches has been adversely affected by rise in temperature of the switch windings. Also it has been found that due to the small change in voltage across the motor armature between that required to start the motor and that for which the first accelerating switch is preferably set to respond is so small and effects such a small change in ampere turns of the switch winding as to render it difficult to make the first accelerating switch reliable in responding at the selected value of motor C. E. M. F.

The present invention has among its objects to provide an improved C. E. M. F. starter and more particularly to provide such a starter overcoming the aforementioned weaknesses to at least very substantial extent in each instance.

Another object is to effect substantial rectification of such weaknesses of the conventional starter with a minimum of change from the conventional form of starter.

Another object is to provide a controller susceptible of various modifications.

Other objects and advantages of the invention will hereinafter appear.

One embodiment of the invention is diagrammatically illustrated in the accompanying drawing which will now be described, it being understood that the invention is susceptible of various modifications without departing from the scope of the appended claims.

In the drawing,

Figure 1 shows diagrammatically a simple form of control, and

Fig. 2 is a chart showing certain characteristic curves, one for the control illustrated, and the other for the conventional form of control.

Referring to the accompanying drawing there is illustrated a direct current motor M having an armature a and a shunt field winding f to be connected by a switch C across lines L^1, L^2 through resistors R^1 and R^2 for starting. As

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will be understood, the starting resistor may comprise any desired number of sections to be removed from circuit progressively for gradual acceleration of the motor.

As shown in the drawing, the resistors R^1 and R^2 are under the control of electroresponsive accelerating switches 1A and 2A, respectively, comprising normally disengaged sets of contacts 1A1 and 2A1, respectively, and windings 1A2 and 2A2, respectively. As in the conventional form of C. E. M. F. starter each of these accelerating switches is designed and adjusted to respond at a given value of current supplied thereto as a function of motor C. E. M. F. but the windings of these switches are not connected directly across the motor as in the conventional form.

The windings of switches 1A and 2A are connected in parallel across the armature through a resistance R^3 and line L^2, and through a resistance R^4 to line L^1. In other words, the windings are connected in parallel in a bridge wherein the resistors R^3 and R^4 are connected directly across lines L^1 and L^2.

With such connections it will be apparent that the starter shown will function in generally the same manner as the conventional starter to effect response of the switches 1A and 2A sequentially to exclude resistors R^1 and R^2 progressively as the motor accelerates and its C. E. M. F. increases to the values at which the switches are set to respond. On the other hand, the action of the starter illustrated is distinctive from that of the conventional type of starter in important respects now to be set forth, and for purposes of discussion let it be assumed that Va represents the armature voltage at which any one of the switches is responsive, that V1 represents the switch winding voltage at which the switch is responsive, and that V2 represents the corresponding voltage across the resistor R^3.

The bridge circuit shown is distinctive in greatly reducing the aforementioned effects of variations in line voltage. V1 will be unaffected by changes in line voltage. V2 will be relatively unaffected by the current through the coils but will tend to rise and fall proportionately to the line voltage and since Va equals V1 plus V2 any line voltage change causing a change in V2 will cause a similar change in Va, wherefore the armature voltage at which the accelerating switches will respond will increase and decrease with the line voltage.

Also the action of the starter illustrated is distinctive in minimizing the effect of temperature rise of the switch windings. The resistors R^3 and

R^4 because of the low temperature coefficient of the resistor material are at most only affected negligibly by temperature change. The switches will respond at the current value for which they are designed and adjusted regardless of temperature of their windings, or in other words, the pull of the magnets of these switches is proportional to the current flowing through their windings and is not affected by temperature change. Thus since the resistance of R^3 and R^4 and the current flowing through them do not change with temperature change V2 is not affected by temperature change and since V*a* equals V*f* plus V2 and V*f* equals only a small part of V*a* the variation in V*a* as the result of a substantial change in V*f* will be small. Hence the circuit illustrated is much less affected by temperature change than is the conventional circuit.

Additionally the circuit illustrated is distinctive in affording an increased change in ampere turns of each switch winding for a given change in motor speed, as will be apparent from the curves of Fig. 2. The curve X depicts the change in ampere turns with change in speed of the motor in the case of the conventional form of starter, whereas curve Z depicts the corresponding characteristic of the starter of Fig. 1, and it will be noted that the curve Z is considerably steeper than the curve X. As will be obvious, this characteristic of the starter illustrated will tend to insure a very much more consistent response of each switch where for one reason or another it is a little erratic.

What I claim as new and desire to secure by Letters Patent is:

1. The combination with a motor, of a supply circuit therefor and control means for said motor comprising resistors connected in series across the supply circuit, and also comprising an electroresponsive switch having a control winding connected in a loop with the armature of said motor and certain of said resistors for response to motor C. E. M. F., other of said resistors being interposed between said loop and said supply circuit.

2. The combination with a motor, of a supply circuit therefor and control means for said motor comprising resistors connected in series across the supply circuit, and also comprising an electroresponsive switch having a control winding connected in a loop with the armature of said motor and certain of said resistors for response to motor C. E. M. F., other of said resistors being interposed between said loop and said supply circuit and the bridge connections thus afforded said winding constituting for said winding stabilizing means compensating for changes in line voltage and increase in temperature of said winding and augmenting the change in ampere turns of said winding for a given change in speed of said motor.

3. The combination with a motor, of a supply circuit therefor and starting means for said motor comprising a starting resistor, an electroresponsive control switch for said resistor, and resistors connected in series across said supply circuit, said switch having an operating winding connected in a loop with the armature of said motor and certain of the last recited resistors for response to C. E. M. F. of said motor, other of said last recited resistors being interposed between said loop and said supply circuit.

4. The combination with a motor, of a supply circuit therefor and starting means for said motor comprising a starting resistor, an electroresponsive control switch for said resistor, and resistors connected in series across said supply circuit, said switch having an operating winding connected in a loop with the armature of said motor and certain of the last recited resistors for response to C. E. M. F. of said motor, other of said last recited resistors being interposed between said loop and said supply circuit and the connections thus afforded said winding constituting a bridge circuit for said winding to minimize certain of the influences, including changes in line voltage, which tend to render action of said switch erratic.

5. In combination, a motor, a supply circuit therefor, resistors, certain of said resistors being in circuit with said motor and other of the same being in a circuit extending across said supply circuit, and electroresponsive accelerating switches controlling said resistors in circuit with said motor and having individual control windings connected in parallel and connected across the armature of said motor through a resistor included in said circuit extending across said supply circuit, said switches being responsive in sequence under control by the C. E. M. F. of said motor.

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