July 21, 1925. 1,547,143

F. B. COX

VARIABLE RESISTANCE

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FIG. 1.

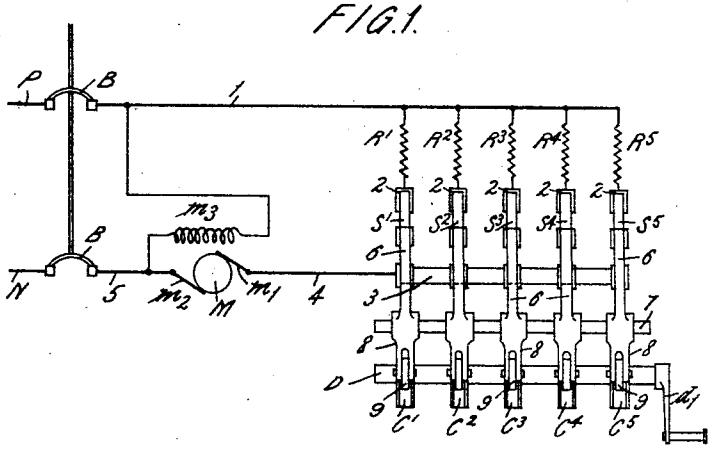


FIG. 2.

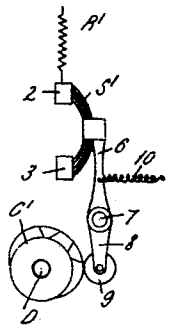


FIG. 3.

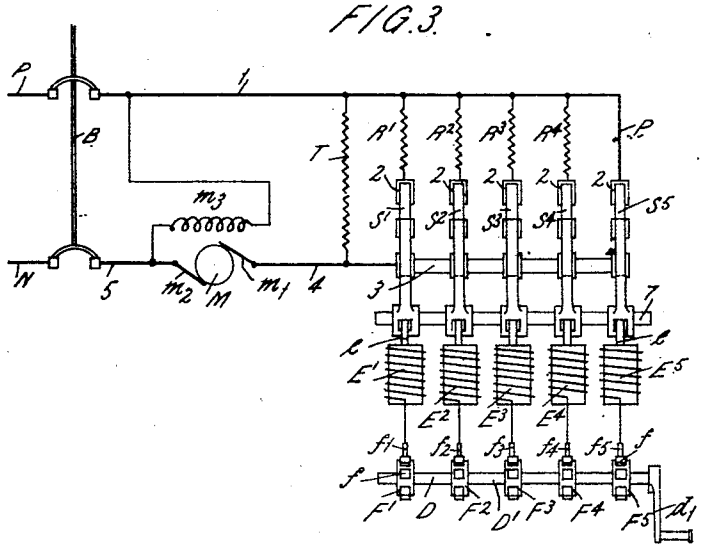
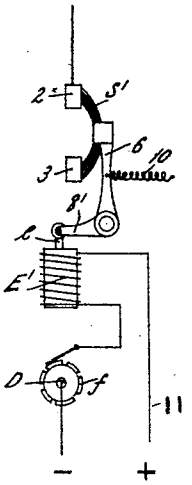


FIG. 4.



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FIG. 5.

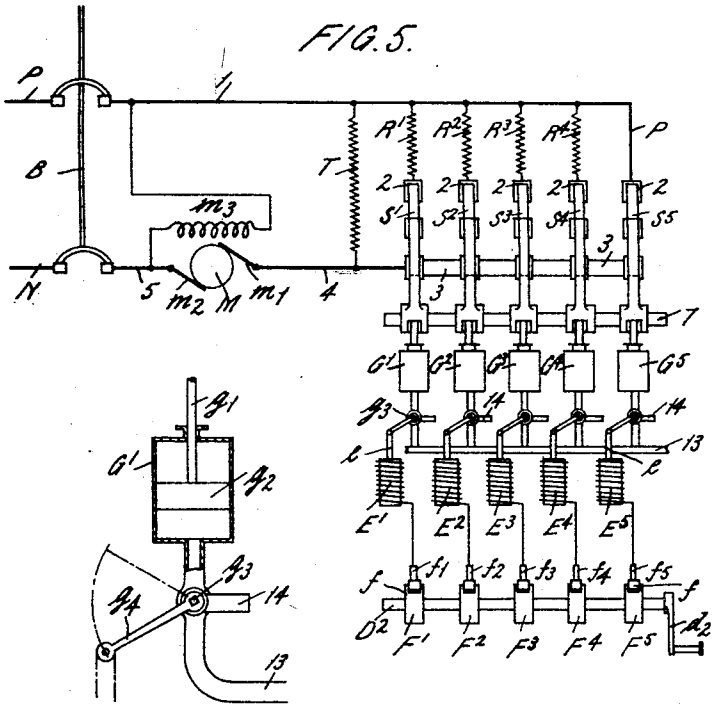


FIG. 6.

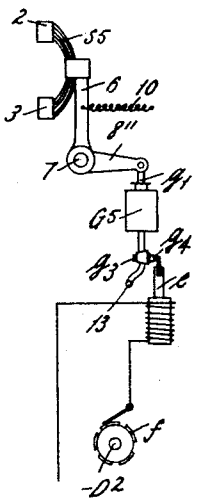


FIG. 7.

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UNITED STATES PATENT OFFICE.

FRANK BRIMSON COX, OF LIVERPOOL, ENGLAND.

VARIABLE RESISTANCE.

Application filed July 9, 1924. Serial No. 725,092.

To all whom it may concern:

Be it known that I, FRANK BRIMSON COX, a subject of the King of Great Britain, residing at Liverpool, in the county of Lancaster, England, have invented certain new and useful Improvements Relating to Variable Resistances, of which the following is a specification.

This invention relates to variable electric resistances and control switches therefor, and is specially applicable to switchgear for electric motors.

According to the present invention the resistance comprises several unit resistances usually of differing magnitudes arranged in parallel, and a control switch in the circuit of each resistance, the magnitude of the resistance as a whole being varied by varying the combinations of individual resistances in parallel, whereby, with a comparatively small number of individual resistances, a comparatively large number of combinations of resistances may be obtained by selective action of the switches controlling the respective resistances; for example, with four separate resistances of differing magnitudes, each controlled by its own control switch in such manner that any desired combination of these, singly or in parallel groups may be obtained, I am able, by selective action of the control switches, to obtain fifteen values of the resistance as a whole, varying from a minimum value when all the resistances are in parallel, through intermediate values to a maximum value when the highest resistance alone is in circuit.

In carrying out the invention a number n of resistances of unequal magnitude are adapted by switch connections and common operating means therefor to be introduced into a circuit in such manner that the resistance so introduced may be varied in a number of steps up to 2^n-1 steps from a maximum value equal to that of the greatest resistance to a minimum value equal to that of all the resistances connected in parallel.

I have illustrated my invention in the accompanying drawings, which are mainly of a diagrammatic character, and in which the invention is shown as applied for the purpose of varying the resistance in series with the armature of an electric motor, the several modifications illustrating the various ways in which the desired combinations of switches can be operated in succession.

Figs. 1 and 2 show the arrangement when the switches are closed by mechanical means;

Figs. 3 and 4 show the arrangement when the switches are closed by electro-magnetic means.

Figs. 5, 6 and 7 show the arrangement when the switches are closed by pneumatic means electrically controlled.

Referring first to Fig. 1:—

R^1, R^2, R^3, R^4 and R^5 are resistances of unequal magnitude; one end of each is connected to the conductor 1, and the other ends are connected to respective contacts 2; the contacts 2 are adapted to be connected to a common contact 3 by selecting switches S^1 . . . S^5; the common contact 3 is connected by a conductor 4 to the terminal m^1 of a motor M, the other terminal m^2 of which is connected to a conductor 5; the respective conductors 4 and 5 being adapted to be connected by a circuit breaker B to the positive and negative supply mains P and N.

m^3 is the shunt winding of the motor.

Each selecting switch S is carried by an arm 6, and the arms are mounted on a common spindle 7; and in the case of each switch an arm 8 connected to the arm 6 carries a cam roller 9. The cam roller 9 is adapted to be operated by respective sets of cams C^1, C^2, C^3, C^4 and C^5 mounted on an operating shaft D and adapted to be rotated by a handle d^1.

Each switch is provided with a spring 10, which tends normally to open it, and the respective cams tend to close the switches in opposition to the springs.

The action is as follows:—

With the five resistances shown 31 different resistance magnitudes may be interposed in the circuit, by the combinations obtained by closing the individual switches, or by closing all the switches, or by closing various combinations of 2, 3, 4 of the switches; the resistance interposed in the circuit varying in 31 steps from the maximum value equal to that of the highest individual resistance when its switch only is closed, to a minimum value, when all the switches are closed, equal to that of all the resistances when connected in parallel. Usually it is not necessary to have as many as 31 steps, but it will be seen that a number of combinations considerably greater

than the number of resistances employed may be obtained.

In Figs. 3 and 4 the arrangement is substantially similar to that described except that four resistances R^1 to R^4 only have switches attached to them, a resistance T being permanently connected across the circuit, and one of the switches S^5 being employed to short circuit all the resistances through a short circuiting bar P'.

In this arrangement the arms 8' of the switches, instead of being operated by cams and cam rollers, are operated by electromagnets E^1, E^2, E^3, E^4, E^5, the plungers *e* of the solenoids being connected to the respective arms 8'; the solenoids are energized by contacts *f* carried on respective discs F^1, F^2, F^3, F^4 and F^5, or on a common drum carried on the shaft D' adapted to be operated by the handle d^1; the windings of the solenoids are connected at one end by a wire 11 to one pole of a source of electric supply, and the other ends are respectively connected to a series of brushes f^1, f^2, f^3, f^4 and f^5, which brushes make contact with the groups of contacts *f*, each of the latter being connected to the other pole of the said supply.

It will be seen that by rotating the shaft d^1 various combinations of the switches can be closed whereby the individual resistances R^1—R^4 or various combinations of them in parallel are connected in the circuit; fifteen such combinations being possible with the four resistances.

The resistance T is introduced so as to provide a steadying effect, and the short circuiting conductor P is employed to connect the motor directly across the mains in the full-on position. The resistance T, and the short circuiting conductor P may, of course, be employed in the arrangement shown in Figs. 1 and 2.

The arrangement illustrated in Figs. 5, 6 and 7 is substantially similar to the one last described except that the operation of the switches is effected by electro-pneumatic means. The arms 8'' of the respective switches are connected by the rods g^1 to the pistons g^2 of the pneumatic cylinders G^1 to G^5, and the action of each pneumatic piston is controlled by valves g^3 adapted to connect the under side of the piston to, say, a vacuum through the pipe 13, or to the atmosphere through the pipes 14. The valves are provided with arms g^4 which are connected to the plungers *e* of a series of electro magnets E^1 to E^5, the energizing current of the electromagnets being controlled in the manner described in connection with Figs. 3 and 4, that is to say by brushes f^1 to f^5 making contact with contacts *f* mounted on discs F^1 to F^5 carried by a shaft D^2 operated by a handle d^2.

In the drawings I have shown the invention as applied to a variable electric resistance for starting an electric motor; it is to be understood however that the invention is applicable generally to variable resistance devices employed for any purpose.

Having now fully described my invention I declare that what I claim and desire to secure by Letters Patent is:—

1. A rheostat comprising, in combination, a plurality of resistances of different magnitudes having one end of each permanently connected together and to one terminal of the circuit to be controlled, an individual switch for connecting the other end of each resistance to the other terminal of the circuit to be controlled, electromagnetic means for actuating said switches, and manually controlled means including a rotary commutator for selectively energizing said electromagnetic means to cause the operation of said switches in predetermined groups.

2. A rheostat comprising, in combination, a plurality of resistances of different magnitudes having one end of each permanently connected together and to one terminal of the circuit to be controlled, an individual switch for connecting the other end of each resistance to the other terminal of the circuit to be controlled, pneumatic means for actuating said switches, electromagnetic means for controlling said pneumatic means, and manually operated means including a rotary commutator for selectively energizing said electromagnetic means to cause the actuation of said switches by said pneumatic means, in predetermined groups.

In witness whereof I have hereunto set my hand in presence of two subscribing witnesses.

FRANK BRIMSON COX.

Witnesses:
JOSEPH E. HIRST,
MARGUERITA JONES.