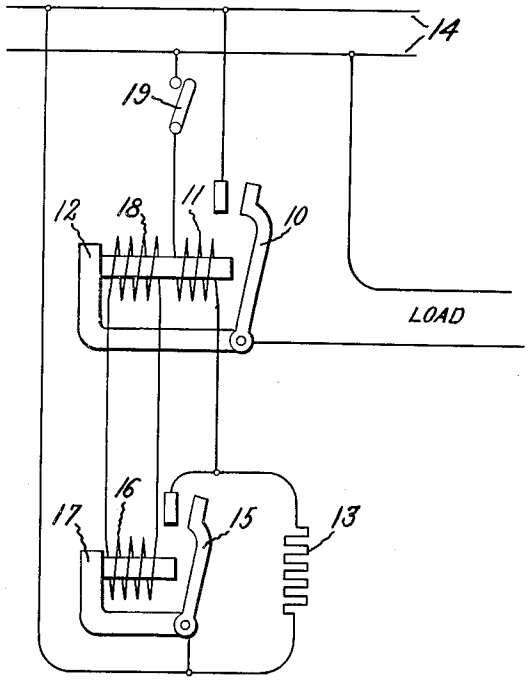
May 1, 1923. 1,453,555

G. E. STACK

ELECTROMAGNET AND CONTROL THEREFOR

Filed Dec. 21, 1920



Inventor:
George E. Stack,
by. Albert G. Davis
His Attorney.

Patented May 1, 1923. 1,453,555

UNITED STATES PATENT OFFICE.

GEORGE E. STACK, OF BALLSTON SPA, NEW YORK, ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

ELECTROMAGNET AND CONTROL THEREFOR.

Application filed December 21, 1920. Serial No. 432,331.

To all whom it may concern:

Be it known that I, GEORGE E. STACK, a citizen of the United States, residing at Ballston Spa, in the county of Saratoga, State of New York, have invented certain new and useful Improvements in Electromagnets and Control Therefor, of which the following is a specification.

My invention relates to improvements in electromagnets and the control of the same, and in particular to improved means for automatically reducing the current in the magnet winding when the movable element of the electromagnet has reached the full limit of its stroke.

My invention has a particular application in the control of electromagnetic switches, although it is not necessarily limited thereto, since it is applicable generally to the control of electromagnetic devices. The energy required to maintain the movable element of an electromagnet in its attracted position is considerably less than the energy required to attract the movable element to its operated position. The large amount of current initially required to operate the electromagnet is apt to cause overheating of its coil if continued. A well known arrangement for reducing the current in the coil circuit of the electromagnet after it has responded, is that of an auxiliary switch connected in any suitable manner to the movable element of the electromagnet, so that the final movement of the movable element operates the auxiliary switch and introduces a resistance in the circuit of the magnet coil. Such an arrangement has the disadvantage that the auxiliary switch must be operated before the movable element of the electromagnet has completed its stroke, and the movable element is liable to be either not attracted to the full extent of its movement or else will finally complete its movement after objectionable vibrating or telegraphing thereof. This vibrating or telegraphing is due to the premature reduction of the magnetic attraction by the insertion of the protective resistance.

One of the objects of my invention is to insure that the current in the electromagnet coil will be reduced after the movable element of the electromagnet has completed its movement, but not before. In carrying my invention into effect, I take advantage of the fact that when the electromagnet coil is first connected to the supply circuit there is a substantially definite rate of change of the magnetic flux in the magnet structure, and I cause a protective resistance to be inserted in series with the electromagnet coil responsively to the rate of change of the magnetism in the magnet structure of the electromagnet. At the instant the electromagnet is connected to a source of supply, the rate of change of the magnetization of the electromagnet is comparatively great, but after the movable element of the electromagnet has completed its movement, the magnetization will become substantially constant after a brief interval. In carrying my invention into effect in one form, I provide a coil on the magnetic structure of the electromagnet which is inductively related to the main coil and which acts as the secondary of a transformer (the main coil of the electromagnet acting as the primary) and energizes an auxiliary switch which controls a resistance in the main coil circuit. The potential applied to the coil of the auxiliary switch will be sufficient to cause the auxiliary switch to close its contacts and short-circuit the resistance in series with the main or operating coil of the electromagnet to be controlled when the operating coil is connected to a source of supply, but when the electromagnet has operated and the magnetization of its magnet structure becomes substantially constant, the potential applied to the coil of the auxiliary switch will be reduced to a negligible value. The auxiliary switch will thereupon be permitted to open and insert the resistance in series with the electromagnet coil after the electromagnet has operated.

For a better understanding of my invention, reference is had to the accompanying drawings wherein I have illustrated one form of my invention as applied to the control of an electromagnetic switch for purposes of illustration, and in which the main electromagnetic switch is provided with a movable switch member 10, and an operating electromagnet comprising an operating coil 11 properly disposed on the magnet structure 12 of the switch. A resistor 13 is provided for reducing the current in the

coil 11 after the switch member 10 has completed its movement to the attracted position, that in which the load is connected to the source of supply 14. This resistor 13 is controlled by means of an auxiliary electromagnetic switch having a movable switch member 15 and an operating electromagnet comprising a coil 16 suitably disposed upon a magnet structure 17. The coil 16 receives its energy from the auxiliary coil 18 disposed on the magnet structure of the main switch in such a way that the main coil 11 serves as the primary of a transformer and the auxiliary coil 18 serves as the secondary of the transformer.

The operation of my invention as thus constructed and arranged is as follows: With the parts in the various positions shown in the drawing, the closing of the pilot switch 19 connects the coil 11 of the main switch to the source of supply 14 momentarily through the resistor 13. By reason of the inductive effect, the current in the main coil 11 will not be instantly established at the full value, but will increase at an approximately definite rate. The auxiliary coil 18 is disposed on the magnetic circuit 12 in such a way that it serves as the secondary of a transformer, and the voltage induced in this auxiliary coil will be responsive to the rate of change of the magnetism in the magnetic structure. Therefore, an instant after the closing of the pilot switch 19, the coil 16 on the auxiliary switch which controls the resistor 13 will be energized to such an extent that the switch member 15 will be attracted and short-circuit the resistor 13, thereby permitting full potential to be applied to the main coil 11. The short-circuiting of the resistor 13 produces a further change in the magnetization of the magnetic structure of the main switch, and the winding 16 of the auxiliary switch will be maintained energized temporarily to short-circuit the resistor. As the movable switch member 10 moves towards its attracted position, that in which the load is connected to the source of supply, the magnetization of the magnetic structure of the main switch will also correspondingly change, thereby inducing a potential in the secondary coil 18 which will energize the auxiliary switch to maintain the resistor 13 temporarily short-circuited. The resistor 13 will be maintained short-circuited until after the switch member 10 of the main switch has completed its movement to the attracted position, but after the switch member 10 has closed, the rate of change in the magnetic structure of the main switch will decrease to approximately zero. Since the auxiliary switch which controls the resistor 13 is energized responsively to the rate of change of the magnetism in the main switch, when the magnetism in the main switch becomes a substantially constant value, the winding 16 will be substantially deenergized, thereby permitting the switch member 15 to open and insert the resistor 13 in series with the main coil 11 of the main switch. The insertion of the resistor 13 will produce a change of the magnetism in the main switch, but this will be a minor change and the auxiliary switch will be designed so that it will not respond to this change. The resistor 13 will be maintained in series with the switch winding 11 until the pilot switch 19 is opened.

My invention, in the form illustrated in the drawings, has a particular application to large electro-magnets in which the operating current in the coil winding is a considerable value, but it is not necessarily limited to large electromagnets but is adapted generally where it is desirable to reduce the current in the operating winding of an electromagnet after the electromagnet has operated to perform the work for which it is provided.

In accordance with the provisions of the patent statutes, I have described the principle of operation of my invention, together with the apparatus which I now consider to represent the best embodiment thereof, but I desire to have it understood that the apparatus shown is only illustrative and that the invention can be carried out by other means.

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

1. The combination with an electromagnet and a movable member operated in response to the energization of the magnet winding, of means operated responsively to the rate of change of the magnetism of the electromagnet for automatically reducing the current in the magnet winding.

2. The combination with an electromagnet having an operating winding and an auxiliary winding inductively related thereto, of a movable member operated in response to the energization of the operating winding, and means operated responsively to the voltage induced in the auxiliary coil for automatically reducing the current in the operating winding.

3. The combination with an electromagnet and a movable member controlled thereby, of a resistor for reducing the current in the magnet winding, and means controlled responsively to the rate of change of the magnetism in the electromagnet for controlling the said resistor.

4. The combination with an electromagnetic switch having a movable switch member and an operating electromagnet therefor, of a resistor for reducing the current in the magnet winding, and means controlled responsively to the rate of change of the mag-

netism in the operating electromagnet for introducing the resistor in the coil circuit of the operating electromagnet.

5. The combination with an operating electromagnet having a movable member controlled thereby, of a resistor for reducing the current in the magnet winding, and an auxiliary electromagnetic switch for controlling the said resistor, the said auxiliary switch having a winding energized in accordance with the rate of change of the magnetism in the operating electromagnet.

6. The combination with an electromagnetic switch having a movable switch member and an operating electromagnet therefor having two coils, one of which is an operating coil and the other of which serves as a secondary of a transformer of which the operating coil is the primary, a resistor for reducing the current in the operating coil, and an electromagnetic switch energized from the said secondary coil for controlling the resistor.

7. The combination with an electromagnet having a movable member operated in response to the energization of the magnet winding, of a resistor normally in the circuit of the magnet winding, and means operated responsively to the rate of change of the current in the said winding for short circuiting the said resistor an interval after the winding is energized to operate the said member and then reinserting the resistor to reduce the current in the winding when the current in the winding becomes substantially constant.

In witness whereof, I have hereunto set my hand this 20th day of Dec., 1920.

GEORGE E. STACK.