Aug. 19, 1958 L. R. NIXON 2,848,656

WINDINGS FOR ELECTROMAGNETS

Filed March 25, 1955

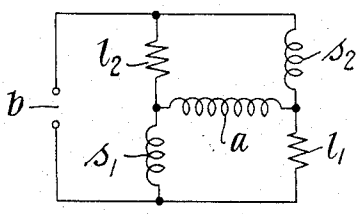


FIG. 1.

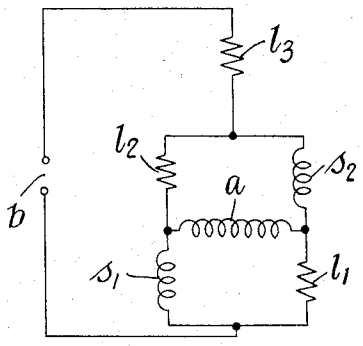


FIG. 2.

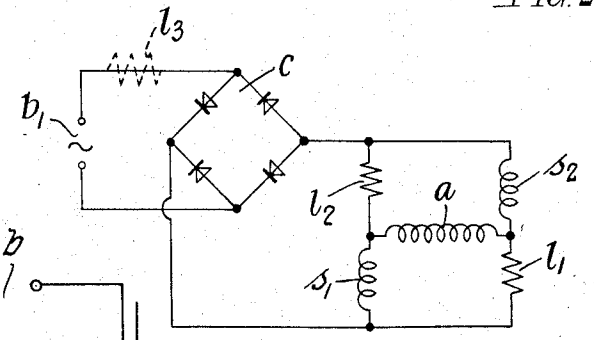


FIG. 3.

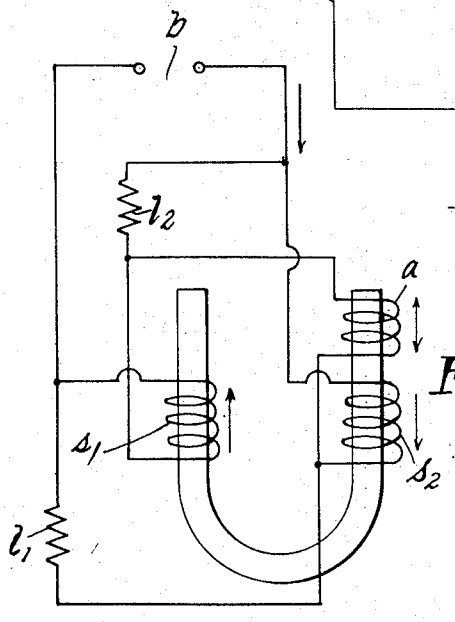


FIG. 4.

Inventor
Leslie Reginald Nixon, deceased,
by Edith Maude Nixon, Executrix,
by Sommers & Young
Attorneys

United States Patent Office 2,848,656 Patented Aug. 19, 1958

2,848,656

WINDINGS FOR ELECTROMAGNETS

Leslie Reginald Nixon, deceased, late of Catford, London, England, by Edith Maud Nixon, executrix, Catford, London, England, assignor to J. Stone & Company (Deptford) Limited, London, England

Application March 25, 1955, Serial No. 496,876

Claims priority, application Great Britain March 31, 1954

5 Claims. (Cl. 317—131)

This invention concerns exciting windings for electromagnets, particularly such for automatic regulators, relays and the like, and has for its object to provide by simple means effective compensation for variation of the resistance of such windings with variation of temperature.

According to the invention, an electromagnet comprises, in addition to a main winding, an auxiliary winding connected in one diagonal of a bridge circuit across whose other diagonal the source of supply of current is to be connected and whose pairs of opposite limbs comprise two parts of a divided main winding, or the main winding and a resistance, and two ballast resistances respectively, the bridge circuit being arranged to be balanced at a normal mean temperature and, on unbalance due to temperature change, to produce in the auxiliary winding a magneto-motive force opposite to and substantially equal to the variation, produced by the temperature change, in the magneto motive force of the main winding. Thus the magneto-motive force of the auxiliary winding can alternatively oppose or assist that of the main winding so as to provide an effective magneto-motive force which remains substantially constant over a range of temperature change.

Various ways of carrying the invention into effect will now be described by way of example and with reference to the accompanying drawing in which:

Figures 1 to 3 are circuit diagrams showing different arrangements.

Fig. 4 is a diagram illustrating the relative disposition on the magnet of the windings shown in the circuit diagram of Fig. 1.

In all of the arrangements illustrated, the magnet is provided with a main winding divided into two equal parts s_1 and s_2 and with an auxiliary winding a. The latter is connected in one diagonal of a bridge circuit of which one pair of opposite limbs comprises the two parts s_1 and s_2 of the main winding and the other pair comprises two equal ballast resistances l_1, l_2. The other diagonal of the bridge is connected to the source b of current. The ballast resistances are made substantially insensitive to temperature variation. The magnet windings are preferably all of copper.

The parts s_1 and s_2 of the main winding are arranged to assist each other. The auxiliary winding a may be unexcited or may assist or oppose the main winding depending upon conditions in the bridge. The resistances of the limbs s_1, s_2 and l_1, l_2 are designed so that the bridge will be balanced and the auxiliary winding unexcited approximately at the normal mean temperature in the working range of the electromagnet. If the resistance of the winding parts s_1, s_2 rises, so that the magneto-motive force of the main winding decreases, due to increase of temperature above the value at which the bridge is balanced, a current will flow in one direction in the auxiliary winding a. The winding is so arranged on the magnet that current in this direction will produce a magneto-motive force which boosts the magneto-motive force of the main winding. The former magneto-

motive force can be made substantially to compensate for the decrease in the magneto-motive force in the main winding. If the resistance of the winding parts s_1, s_2 falls, due to decrease of temperature, there will be a current in the opposite direction through the winding a and a magneto-motive force opposing that of the main winding. In either case, the effective magneto-motive force will remain substantially unaltered.

The relative directions of the aforesaid magnetizing forces produced by the currents in the windings are indicated in Fig. 4.

As illustrated in Figure 2, a further ballast resistance l_3 may, if desired, be connected in series with the whole bridge.

If the windings s_1, s_2 and a require to be excited by direct current and the source of supply is alternating current, a rectifier may be provided. An arrangement of this kind is shown in Figure 3 in which a full-wave rectifier c is interposed between the source b_1 and the bridge circuit described with reference to Figure 1. The additional ballast resistance l_3 may be provided in this case also, as indicated in broken lines.

If the same compensation is required for variation of winding temperature due to self heating as for that due to ambient changes, it may be advantageous to interleave the main and auxiliary windings. On the other hand, if desired, compensation for the two effects may be made unequal by arranging for unequal temperature rises in the windings due to self heating.

Such arrangements can be advantageously applied to electro-magnetic regulators, for example to the carbon-pile regulator described in the specification of the patent application No. 399,974. In such an application, the said arangements have certain advantages over compensating arrangements utilising, for example, a bimetal element acting on the control spring of the regulator: For one thing, the compensation is independent of the setting of the control spring. Moreover, as the net magneto-motive force is substantially unaffected by temperature, undesirable effects due to changes in the force/deflection characteristic of the magnet system are obviated: For instance, a change in the cut-in voltage with temperature is avoided. Transitory errors due to sudden changes of ambient temperature can also be avoided, as the thermal time constants of the two windings can be made similar. This is of particular benefit in applications used on aircraft.

For some purposes, instead of dividing the main winding of the electromagnet between two limbs of the bridge circuit, the undivided main winding may be arranged in one limb and an equivalent resistance in the opposite limb of the said circuit, whereby a similar temperature-compensation effect can be obtained.

However, the invention is applicable with similar advantages to magnet windings of apparatus other than regulators, for instance relays saturable chokes, motor and generator fields, and generally, to any winding whose magneto-motive force requires to be temperature-compensated.

What is claimed is:

1. An electromagnet comprising a magnet and, in addition to a main winding divided into two parts disposed on said magnet and, an auxiliary winding disposed on said magnet and connected in one diagonal of a bridge circuit across whose other diagonal the source of supply of current is to be connected and whose pairs of opposite limbs comprise the two parts of the main winding and two ballast resistances respectively, the bridge circuit being arranged to be balanced at a normal mean temperature and, on unbalance due to temperature change, to produce in the auxiliary winding a magneto-motive force opposite to and substantially equal to the

variation, produced by the temperature change, in the magneto-motive force on the main winding.

2. An electromagnet comprising a magnet and in addition to a main winding disposed on said magnet, an auxiliary winding disposed on said magnet connected in one diagonal of a bridge circuit across whose other diagonal the source of supply of current is to be connected and whose pairs of opposite limbs comprise the main winding and a resistance and two ballast resistances respectively, the bridge circuit being arranged to be balanced at a normal mean temperature and, on unbalance due to temperature change, to produce in the auxiliary winding a magneto-motive force opposite to and substantially equal to the variation, produced by the temperature change, in the magneto-motive force of the main winding.

3. An electromagnet as claimed in claim 1, wherein a further ballast resistance is connected in series with the bridge circuit.

4. An electromagnet as claimed in claim 1, wherein a rectifier is interposed between the source of supply and the bridge circuit.

5. An electromagnetic carbon-pile regulator provided with a temperature-compensated electromagnet comprising a magnet and, in addition to a main winding divided into two parts disposed on said magnet, an auxiliary winding disposed on said magnet connected in one diagonal of a bridge circuit across whose other diagonal the source of supply of current is to be connected and whose pairs of opposite limbs comprise the two parts of the main winding and two ballast resistances respectively, the bridge circuit being arranged to be balanced at a normal mean temperature and, on unbalance due to temperature change, to produce in the auxiliary winding a magneto-motive force opposite to and substantially equal to the variation, produced by the temperature change, in the magneto-motive force of the main winding.

References Cited in the file of this patent

UNITED STATES PATENTS

2,448,843	Thomas	Sept. 7, 1948
2,476,384	Razek	July 19, 1949