Dec. 21, 1937. A. B. RYPINSKI 2,103,019

SLOW ELECTROMAGNETIC DEVICE

Filed March 21, 1935

FIG. 1

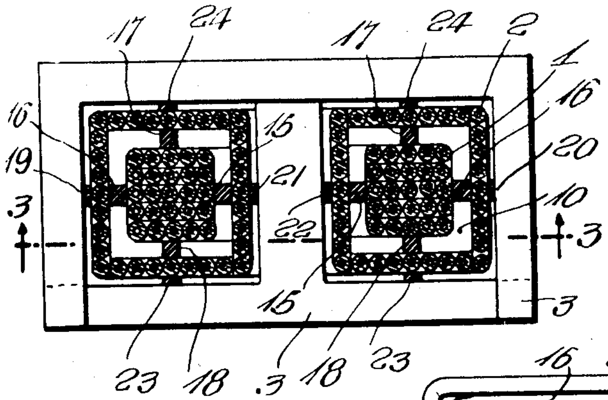


FIG. 2

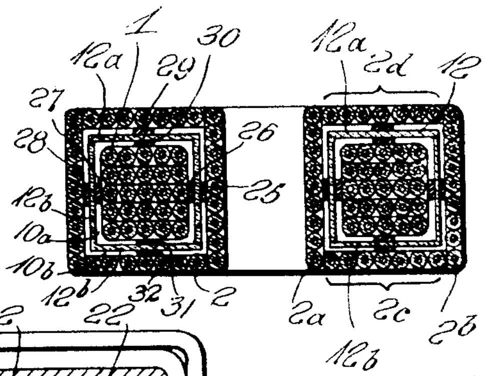
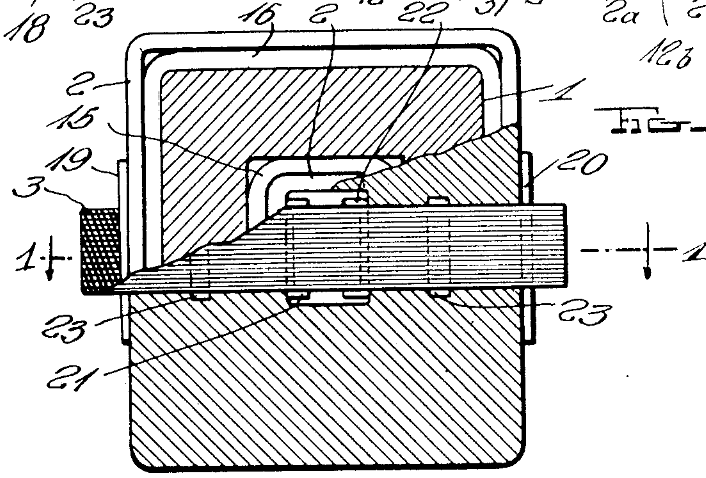


FIG. 3



INVENTOR.

Albert B. Rypinski,

BY John B. Brady

ATTORNEY.

UNITED STATES PATENT OFFICE

2,103,019

SLOW ELECTROMAGNETIC DEVICE

Albert B. Rypinski, Laurelton, Long Island, N. Y.

Application March 21, 1935, Serial No. 12,292

3 Claims. (Cl. 171—242)

This application is a continuation-in-part of my application Serial No. 671,767, for Slow electromagnets having the same or similar temperature coefficients of resistance materials in differential windings, filed May 18, 1933.

My invention relates generally to that class of slow electromagnetic devices, shown in the following patent and copending patent applications:

S. N. 416,877—filed Dec. 27, 1929—for Slow magnetic regulating devices;

S. N. 699,616—filed Nov. 24, 1933—for Motor starting systems;

S. N. 699,617—filed Nov. 24, 1933—for Signaling systems;

S. N. 699,618—filed Nov. 24, 1933—for Motor control system;

S. N. 699,619—filed Nov. 24, 1933—for Distribution system;

S. N. 699,620—filed Nov. 24, 1933—for Arc welding apparatus;

S. N. 703,313—filed Dec. 20, 1933—for High temperature slow electromagnetic devices;

S. N. 705,466—filed Jan. 5, 1934—for Slow electromagnetic devices having different temperature coefficient of resistance materials in assistant windings;

Patent No. 1, 972,319, dated September 4, 1934.

S. N. 671,768—filed May 18, 1933—for Coils for slow electromagnets and reactors.

The invention herein is directed to means for providing substantially complete flux interlinkage between the parallel connected windings shown generally in these various cases.

One of the objects of my invention is to construct a slow electromagnetic device in which the means for providing complete flux interlinkage between the parallel connected windings consist in surrounding one winding with the other.

Another object of my invention is to provide a construction of slow electromagnetic device which comprises a pair of inductively coupled and opposed windings connected in parallel one with respect to the other and formed of materials having the same temperature coefficients of resistance other than zero, and being associated with each other and with a magnetic core in such manner that all magnetism originating in either winding threads the other.

Still another object of my invention is to provide a construction of slow electromagnetic device in which a pair of cooperative windings are arranged one within the other and insulation members maintaining the windings in predetermined spacial relation.

A further object of my invention is to provide a construction of slow electromagnetic device including a pair of cooperative windings in which one winding is enclosed by conjugate cover members arranged to insulate one winding from the other.

A still further object of my invention is to provide a construction of slow electromagnetic device including a pair of cooperative windings arranged one within the other and associated with a magnetic core structure and having a pair of conjugate cover members embracing opposite sides of one winding with insulation means spacing the conjugate cover members from each of the windings and serving to insulate the windings one from the other.

Other and further objects of my invention are set forth more fully in the specification hereinafter following by reference to the accompanying drawing, in which:

Figure 1 is a sectional view of a coil with one winding surrounded the other taken on line 1—1 of Fig. 3; Fig. 2 shows another form with the core omitted; and Fig. 3 is an end view of the device of Fig. 1.

The term "leakage reactance" is used to measure the leakage magnetism in a two coil transformer or other magnetic device, i. e., the magnetism originating in one coil but not linking with the other. In slow electromagnetic devices of my invention it is generally important to keep this as low as practicable.

One means for accomplishing this is shown in my Patent 1,972,319 for Coils for slow electromagnets and reactors, issued September 4, 1934, where I wind one conductor in spiral or other formation over the other. A second means is shown in my application 416,877, listed above, where I wind the two insulated wires in as a twin conductor.

It is not essential for the purposes of my invention that the windings be of different or the same temperature coefficients of resistance, be connected to oppose or assist one another, be self-contained or with series resistors, or have any one of a number of heating means for producing the differential effects. It is essential that the two windings be inductively coupled and connected in parallel one with respect to the other.

To accomplish the purpose of substantially complete flux interlinkage between the paralleled windings I may entirely surround one winding with the other as illustrated in Fig. 1 where an inner winding 1 is shown surrounded by an air space 10 and an outer winding 2 forming a complete enclosure for the inner winding. The core is designated at 3. Strips of insulation material 15 and 16 may be disposed about the inside and outside of the coil 1 for centering coil 1 with respect to coil 2. The space 10 may be left open except at points of support provided by strips 15 and 16. In order to properly center the sides of coil 1 with respect to coil 2, I arrange annular strips of insulation material, as represented at 17 and 18. The turns of coil 2 are spaced from core 3 by means of strips 19 and 20 and strips 21 and 22. The sides of coil 2 are spaced from core 3 by means of annular strips of insulation material represented at 23 and 24.

The space 10 may be divided as shown in Fig. 2 into two spaces 10a and 10b by the heat insulating barrier 12. In this modification, the heat insulating barrier is constructed of a pair of conjugate annular cover members 12a and 12b which are interfitted on opposite sides of the coil 1 to provide a heat insulation casing for coil 1 and the coil 2. Provision is made for a proper air gap between the walls of the heat insulation casing 12 and coils 1 and 2 by means of insulated spacing strips 25, 26, 27, and 28. These strips permit the coils 1 and 2 to be positively spaced from the walls of the heat insulating barrier. To insure evenly balanced construction, annular strips of insulation material are mounted at the sides of coil 1 and the annular cover members 12a and 12b constituting the heat insulating barrier 12, as represented at 29, 30, 31, and 32, serving to center coil 1 with respect to the side portions of coil 2 with the heat insulating barrier therebetween, as shown. The coil structure illustrated in Fig. 2 is preformed in four parts, that is, two concentrically disposed cylindrical coils, one coil represented at 2a and one outer coil represented at 2b with two identical flat pancake coils 2c and 2d located on the sides in the arrangement shown. In the assembly, coil 1 is enclosed in the coacting heat insulating barriers 12a and 12b with the centering strips of insulating material properly disposed in position and the heat insulated coil 1 introduced into the enclosing coil 2 while one of the side pancake coils, such as 2d, is removed. The pancake coil 2d is then placed in position thus completing the coil structure preparatory to assembly of the core 3 with respect to the assembled core structure. The magnetism will pass into the core 3 as before but heat exchange between the windings 1 and 2 will be largely prevented. Where design conditions require it, the air space 10 may be vented to the outside air, or in extreme cases, a forced draft of air may be introduced to keep winding 1 at a low temperature while winding 2 rises to a higher temperature.

It is standard practice in transformer and other constructions to wind one coil over another, but not to surround one with the other on all sides. With a slow electromagnetic device constructed as disclosed herein, it is not ordinarily essential that all flux originating in one winding thread the other, but in cases where the result is hard to attain due to a relatively small temperature difference, a low amount of energy available for operation, or any other cause, it is desirable to employ all available magnetism in producing the difference between the cold and hot condition. In such a case, the spacers 15, 16, 17, and 18, Fig. 2, may be omitted and the outer coil wound in close contact with the inner one.

Windings known as "non-inductive" windings are in common use, where the magnetic effects of current in the winding are undesirable.

With windings of the slow magnetism type it is sometimes desirable to have the coil non-inductive at one range of current values and highly inductive, after heating, at another range of current values.

For instance, in a slow impeder for connection in series with a circuit to afford overload or short circuit protection to that circuit, it is highly desirable that there be no choking action and as little impedance voltage drop as possible from no load to full load. By means of the interlinkage of the fluxes produced by the windings shown in the structure of my invention I am enabled, where the magneto-motive forces are in opposition, to produce substantially zero net flux with currents in the windings.

By reason of the paralleled, inductively coupled and opposed windings of my invention, I am enabled, on alternating or pulsating currents, to produce a coil in which, while the resistances of the paralleled paths and currents therein are passing through a range of values, the magnetism of the coil and the induced voltage in one winding pass through zero. The effect of the magnetism and induced voltage changes is as follows:

Assume two windings 1 and 2, the resistances of whose parallel paths are such that when they are in parallel and opposition, winding 1 overbalances winding 2 magnetically and sets up a slight flux in core 3. As the parallel paths change in resistance, assume that winding 1 weakens and winding 2 strengthens magnetically. A point is reached, as this continues, at which there is zero flux in core 3. As the action continues past this point winding 2 becomes stronger magnetically than winding 1 and produces flux in core 3 of the opposite instantaneous polarity to that in the core when winding 1 overbalanced winding 2.

It will be seen that the flux in one instantaneous direction must induce in the windings it cuts, voltages opposite to those induced when it has passed zero to the opposite instantaneous direction. Since the windings are in opposition the same flux cutting both must set up opposite voltages in the two. In the stronger winding the induced voltage tends to choke the current flow, while in the weaker winding it tends to assist the current flow. Thus, in the weaker winding, the induced voltage tends to offset the IR voltage drop through that winding at some critical point, and the impedance voltage drop is therefore substantially reduced through that winding. If this point is reached very close to zero magnetization in the core and the other winding has a very low resistance, which can usually be arranged, a slow electromagnetic device results in which the impedance drop through the coil as a whole is very low with considerable current in the circuit.

If the core steel has the proper characteristics and the heating and resistance values are carefully worked out, this range of low impedance may be extended over most of the range from no load to full load. If desired the inductive drop may be caused to decrease slightly as the load builds up to full load, to be substantially zero at full load.

For values beyond full load the heating curves and magnetization curve of the core will largely determine the rise in impedance. By allowing the temperature to rise rapidly beyond a critical load point, which is the usual characteristic of a temperature curve on electrical apparatus, and using high permeability steel, the magnetism and consequent inductive voltage may be made to rise on a steep slope and produce a radical rise in impedance.

I may employ windings part of which are closely interlinked magnetically and the rest not. For example, in my co-pending application 703,313 parts of the windings are designed for relatively low temperature operation and the other parts for very high temperature operation in an evacuated vessel. In windings of this type, and others, I may employ the various methods disclosed for producing substantially 100% flux interlinkage in the low temperature windings only or in the high temperature windings only.

My invention herein may be utilized in solenoids, electromagnets with or without moving cores, electromagnets to attract or repel other electromagnets, reactors or impeders without cores, with stationary or movable cores, transformers of any type without cores, with stationary or movable cores and for any use disclosed in the various patents and patent applications listed above.

I have described my invention in certain preferred embodiments, but I desire that it be understood that modifications may be made and no limitations upon my invention are intended other than are imposed by the scope of the appended claims.

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

1. An electromagnetic device comprising a pair of inductively coupled and opposed windings connected in parallel one with respect to the other, said windings being formed of materials having the same temperature coefficients of resistance other than zero, said windings mounted on a core of magnetic material, one winding constituting an inner winding and the other an outer winding, said outer winding surrounding said inner winding at every point of said windings, said second winding having pancake sections bridging the gap at the ends of said first winding between said circumferential winding and said core, so that when energized, substantially all magnetism originating in either winding threads the other, and conjugate cover members enclosing said inner winding and insulating said inner winding from said outer winding.

2. An electromagnetic device comprising a pair of inductively coupled and opposed windings connected in parallel one with respect to the other, said windings being formed of materials having the same temperature coefficients of resistance other than zero, said windings mounted on a core of magnetic material, one winding constituting an inner winning and the other an outer winding, said outer winding surrounding said inner winding at every point of said windings, said second winding having pancake sections bridging the gap at the ends of said first winding between said circumferential winding and said core, so that when energized, substantially all magnetism originating in either winding threads the other, conjugate cover members conforming in contour with said inner and outer windings and enclosing said inner winding, and insulation strips disposed between said conjugate cover members and said outer winding for insulating said windings one from the other.

3. An electromagnetic device comprising a pair of inductively coupled and opposed windings connected in parallel one with respect to the other, said windings being formed of materials having the same temperature coefficients of resistance other than zero, said windings mounted on a core of magnetic material, one winding constituting an inner winding and the other an outer winding, said outer winding surrounding said inner winding at every point of said windings, said second winding having pancake sections bridging the gap at the ends of said first winding between said circumferential winding and said core, so that when energized, substantially all magnetism originating in either winding threads the other, conjugate cover members conforming in contour with said inner and outer windings and enclosing said inner winding, and insulation strips spacing said cover members from both said inner and outer windings for insulating said windings one from the other.

ALBERT B. RYPINSKI.