

Sept. 7, 1954

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METHOD OF HEAT TREATING MAGNETIC IRON
TO RESTORE ITS MAGNETIC PROPERTIES
Filed Nov. 13, 1950

2,688,573

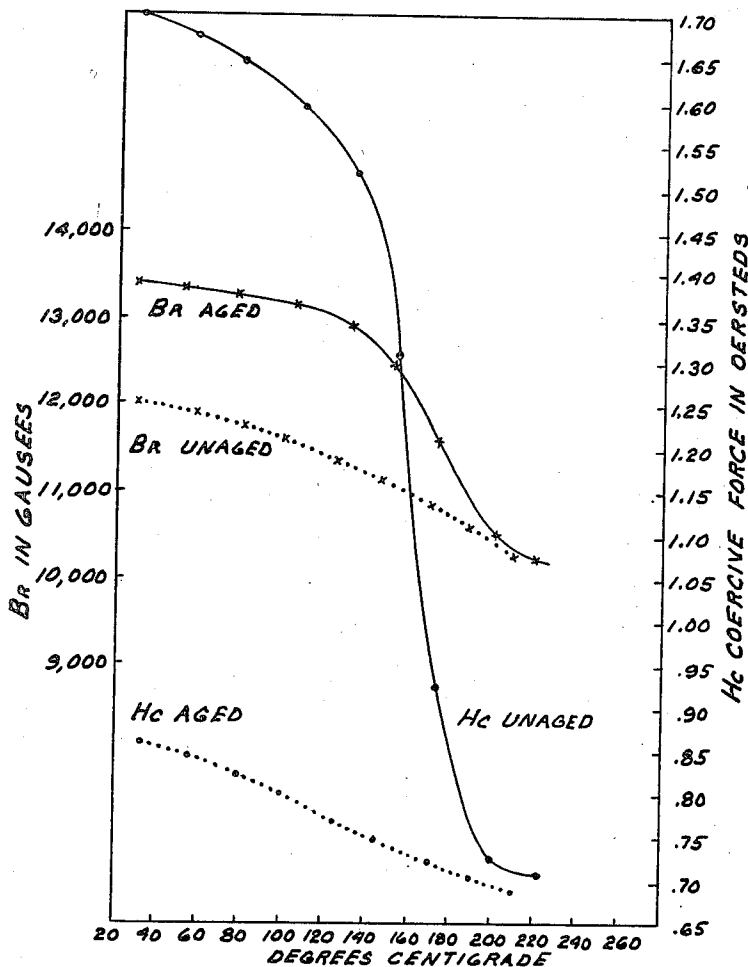


FIG. 1

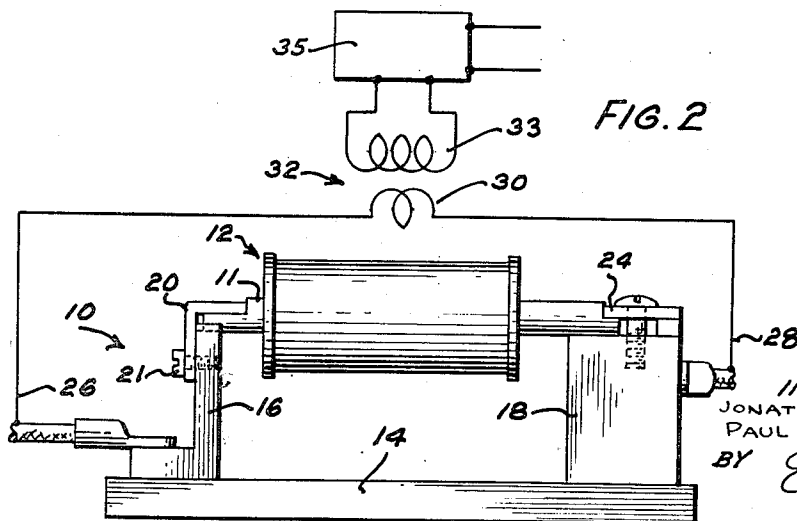


FIG. 2

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2,688,573

METHOD OF HEAT TREATING MAGNETIC IRON TO RESTORE ITS MAGNETIC PROPERTIES

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Application November 13, 1950, Serial No. 195,206

3 Claims. (Cl. 148-10)

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The present invention relates to a method of treating aged magnetic iron to improve the magnetic quality thereof and more particularly to a method of heat treating aged magnetic iron to restore the magnetic quality thereof to its pre-aged condition.

It is well known that the magnetic properties of magnetic iron parts in electrical apparatus change with time due to the magnetic aging thereof and that the rate of aging of the magnetic iron parts increases with a rise in temperature which in most electrical equipment occurs as a result of the frequent use thereof. In the magnetic iron cores and armatures in telephone relays, aging detrimentally affects the magnetic qualities of the iron, as for example, by progressively increasing the coercive force and residual magnetism therein, which necessitates the frequent adjustment of the contact springs of the relay in order to maintain the relay in an operative condition. Aging may continue to the extent where the changes in the magnetic qualities of the iron exceed the point where the springs can be adjusted to compensate for it, as for example, the residual magnetism in the iron parts may increase to the point where the armature after being attracted to the core sticks thereto even after the magnetizing current has been interrupted, thus rendering the relay unsatisfactory for further use.

It is an object of the present invention to provide a method of treating aged magnetic iron to improve the magnetic properties thereof.

A further object is to provide a simple method of heat treating the magnetic iron core of an assembled relay which has aged to restore the magnetic quality of the core to its pre-aged values without removing the core from the relay.

In accordance with one method of practicing the present invention to improve the magnetic properties of aged magnetic iron, the magnetic iron is subjected to heat and the temperature thereof is raised to a value of between 150° and 221° C., preferably 221° C. for a short period of time to effect the restoration of the magnetic properties of the iron to its pre-aged condition. The magnetically aged iron core of the relay in an assembled condition may be connected in series with a secondary of a welding transformer and a relatively high current passed through the core for a short time to heat the core to approximately 200°-220° C. to restore the magnetic properties of the core substantially to their original value without removing the core from the relay and without damaging the relay.

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Other objects and advantages will become apparent by reference to the following detailed description of the invention and the accompanying drawing in which

Fig. 1 is a graph showing in dotted lines the effects of temperature on residual induction B_r and coercive force H_c in an un-aged sample of magnetic iron, and in full lines the effects of temperature on B_r and H_c in an aged sample of magnetic iron; and

Fig. 2 is a diagrammatic view of a device for electrically heating the core of a relay.

With the object of devising ways of overcoming the detrimental magnetic effects of aging and of restoring the magnetic properties of aged magnetic iron to their pre-aged condition, experiments were conducted to determine the effect of temperature upon the magnetic qualities of magnetic iron. An annealed ring sample of un-aged magnetic iron having a low carbon content of less than .04% was measured to determine the values of various magnetic properties thereof in its un-aged condition.

The ring sample of magnetic iron was then placed in an oven and subjected to successively increasing temperatures and by means of a test set connected to the ring, readings of magnetic induction B , in gaussses, residual induction B_r , in gaussses, and coercive force H_c in oersteds (at 27 oersteds), were taken at various temperature levels at and above room temperature and at various magnitudes of magnetizing field H in oersteds. The value 11970 of B_r at room temperature or 30° C. progressively decreased with progressive increases in temperature to a value of 10280 at approximately 210° C. as indicated in the dotted curve B_r in Fig. 1. The value of H_c of the ring sample decreased from .869 to 30° C. to .698 at 210° C. as indicated in the dotted curve H_c in Figure 1. The ring sample was then allowed to cool to room temperature and the values of B_r and H_c were again measured and found to be the same as they were before being subjected to the elevated temperatures.

The ring sample of magnetic iron was then artificially aged by subjecting it to a temperature of approximately 100° C. for a period of 216 hours which artificial aging effect is equivalent to the natural aging occurring at normal room temperatures over a period of from three to six years. The sample was then cooled to room temperature and remeasured as before to determine the values of the various magnetic characteristics thereof after aging. It was found that the values of B_r of the aged sample at 30° C. had

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risen to 13390 and the value of H_c at 30° C. had risen to 1.70. The sample ring of magnetic iron was then placed in the oven and again heated to progressively increasing levels of temperature and again the readings of the furnace temperature were taken at these levels and the values of the magnetic characteristics were determined. The ring sample was demagnetized immediately before taking readings at each temperature level and it was permitted to remain fifteen minutes at the next temperature level to insure that all parts of the sample were uniformly heated to the desired temperature before measurements were made at the new level. As the ring sample was heated to progressively higher temperature levels the values of both B_r and H_c fell to progressively

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Table 2.—Sample at 30° C. after aging had the following characteristics:

H	B
1.0	498
1.5	2,340
1.9	5,260
2.4	8,230
3.6	11,670
10	14,980
15	15,580
27	16,270
B_r	13,390
H_c	1.70

Table 3.—Aged sample at various temperature levels had the following characteristics:

H	B								
	30° C.	57° C.	77° C.	105° C.	134° C.	152° C.	173° C.	200° C.	221° C.
1	498	569	569	618	739	1,160	3,340	6,260	6,400
1.5	2,340	2,510	2,630	2,850	3,340	4,830	7,850	9,480	9,600
1.9	5,260	5,480	5,620	5,900	6,530	7,830	9,840	10,840	10,820
2.4	8,230	8,470	8,400	8,650	9,020	9,920	11,240	11,800	11,780
3.6	11,670	11,710	11,730	11,780	11,920	12,300	12,610	13,160	13,090
10	14,980	14,920	14,900	14,870	14,830	14,870	14,940	14,940	14,820
15	15,580	15,550	15,500	15,430	15,400	15,400	15,430	15,350	15,280
27	16,270	16,220	16,190	16,120	16,070	16,030	16,030	15,960	15,900
B_r	13,390	13,320	13,190	13,090	12,930	12,500	11,570	10,500	10,210
H_c	1.70	1.67	1.65	1.60	1.525	1.31	.928	.718	.707

lower levels until the temperature reached the range of substantially 210°–225° C. at which range the values for B_r and H_c of the aged and the un-aged ring samples substantially coincided, indicating that the magnetic characteristics of B_r and H_c in the aged ring sample of magnetic iron had been restored to the values of the un-aged ring sample of magnetic iron. The sample ring was then cooled to room temperature and the magnetic properties of the de-aged ring sample were again measured and compared with those of the un-aged ring sample at room temperature and were found to be substantially the same. The heating of a ring sample was not continued beyond the point where the magnetic properties of the heated aged sample were substantially the same as those of heated un-aged sample because further heating to higher temperatures would be of no avail.

In checking the parts measurements were made of the magnetic induction of a sample at various temperatures and for different magnetizing forces as follows:

Table 1.—Un-aged sample at various temperatures.

H	B								
	30° C.	55° C.	81° C.	100° C.	125° C.	145° C.	168° C.	188° C.	210° C.
1	4,980	5,300	5,520	5,610	5,980	6,050	6,340	6,370	6,480
1.5	9,040	9,230	9,320	9,360	9,530	9,575	9,620	9,660	9,650
1.9	10,740	10,820	10,880	10,910	11,100	11,030	11,000	10,960	10,880
2.4	11,910	11,950	11,930	11,900	11,980	11,960	11,940	11,870	11,840
3.6	13,460	13,420	13,040	13,380	13,380	13,380	13,310	13,240	13,170
10	15,380	15,330	15,290	15,200	15,170	15,140	15,080	15,020	14,900
15	15,800	15,770	15,680	15,650	15,620	15,570	15,530	15,460	15,350
27	16,380	16,340	16,280	16,220	16,190	16,150	16,090	16,030	15,940

Since 27 oersteds is considered by most of those working in the field as a satisfactory saturation point, the residual induction B_r , and the coercive force H_c , were taken at 27 oersteds and are as follows:

B_r	11,970	11,860	11,710	11,580	11,370	11,120	10,870	10,620	10,280
H_c	.869	.858	.828	.808	.771	.752	.733	.718	.688

Table 4.—De-aged sample at 30° C. had the following characteristics:

H	B
1.0	4,760
1.5	8,950
1.9	10,670
2.4	11,820
3.6	13,370
10	15,320
15	15,800
27	16,350
B_r	11,960
H_c	.88

With a knowledge of the laws discovered as a result of the above investigation, it is a relatively simple matter to improve the magnetic qualities of aged magnetic iron and restore the magnetic properties thereof to their pre-aged values by merely heating the magnetic iron to a temperature of approximately 221°. The heating of the magnetic iron may readily be done in a suitable oven when the magnetic iron parts are by themselves and disassociated from other components of the electrical equipment, but the problem is

more complex where the magnetic iron parts are in assembled relation with other parts of electrical apparatus and it is not feasible to remove the magnetic iron parts from the apparatus. After some investigation, however, it has been

found that some of the magnetic iron parts forming components of electrical apparatus may be heated to the desired temperature by passing an electrical current therethrough without damaging the other parts such as the insulation on the wire and other components associated therewith. For example, aged magnetic iron cores of telephone relays may be de-aged to restore the electrical properties to their pre-aged condition by passing an electrical current of predetermined intensity and duration through the cores to heat the cores to a temperature of approximately 200°-220° as previously mentioned.

In Fig. 2 of the drawing there is shown a diagrammatic view of a fixture 10 for use in heating the magnetic iron core 11 of a telephone relay 12. The fixture comprises a base of insulating material 14 on which is mounted in spaced relation to each other a pair of metal mounting lugs or supports 16 and 18 which are adapted to engage opposite end portions of the core 11 for supporting the relay 12. An L shaped bracket 20, welded to one end of the core 11 is secured to the mounting lug 16 by a screw 21 and the opposite end of the core 11 is clamped to the mounting lug 18 by a clamp 24. Leads 26 and 28 connect the lugs 16, 18 and the core 11 in a heating circuit including a secondary 30 of a step down transformer 32. The primary 33 of the transformer is connected to a suitable source of alternating current through a control unit 35 which controls the duration of the current during the heating operation.

Thus when the magnetic core of a relay has become aged to a point where it is no longer useful, in order to de-age the core to restore the magnetic properties thereof to its pre-aged condition, it is merely necessary to apply the relay to the fixture 10 and connect the ends of the core 11 to the mounting lugs 16 and 18, after which the control unit 35 may be actuated to initiate a heating cycle of a predetermined duration to pass a predetermined relatively high current through the core 11 of the relay and raise the temperature thereof to approximately 200°-220° C. The heating of the core 11 of the relay is of such short duration as to leave the coil and spool parts associated therewith undamaged while effectively improving the magnetic properties thereof and restoring them to their pre-aged condition. It was found that heating the aged magnetic iron core of a relay for approximately two minutes at a temperature of approximately 205° C. without removing the core from the relay, was effective in restoring the magnetic qualities of the core to substantially their pre-aged or original values. It will be understood that the intensity and duration of the current applied to the core may vary to heat the core to the desired temperature without damaging the other parts of the relay.

It is to be understood that the above-described arrangements are simply illustrative of the application of the principles of the invention. Numerous other arrangements may be readily devised by those skilled in the art which will embody the principles of the invention and fall within the spirit and scope thereof.

What is claimed is:

1. A method of treating an iron core of an electro-magnetic relay which has lost some of its magnetic properties due to aging to restore the magnetic properties thereof to that of the core before aging without removing the core from the relay, which method consists of connecting the magnetic iron core to an electric circuit and passing a relatively high current therethrough to raise the temperature of the core to approximately 205° C., maintaining said core at 205° C. for approximately two minutes, and cooling the core to room temperature.

2. A method of treating an iron core of an electro-magnetic relay which has lost some of its magnetic properties due to aging to restore the magnetic properties thereof to that of the core before aging without removing the core from the relay, which method consists of connecting the magnetic iron core to an electric circuit and passing a relatively high current therethrough to raise the temperature of the core to approximately 205° C. for a length of time sufficient to insure that all parts of the core have attained said temperature, and cooling the core to room temperature.

3. A method of treating an iron core of an electro-magnetic relay which has lost some of its magnetic properties due to aging to restore the magnetic properties thereof to that of the core before aging without removing the core from the relay, which method consists of connecting the magnetic iron core to an electric circuit and passing a relatively high current therethrough to heat the core to a temperature of between 150° and 221° C. for a length of time sufficient to insure that all parts of the core have attained said temperature, and cooling the core to room temperature.

References Cited in the file of this patent

UNITED STATES PATENTS

Number	Name	Date
432,651	Thomson	July 22, 1890
1,378,969	Milton	May 24, 1921
1,715,713	Legg	June 4, 1929
2,944,763	Bouton et al.	June 23, 1936
2,401,730	Green	June 11, 1946

OTHER REFERENCES

Cleaves and Thompson: The Metal Iron published by McGraw-Hill Book Co., New York, 1935, page 431.