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MAGNETIC DEMAGNETIZING DEVICES

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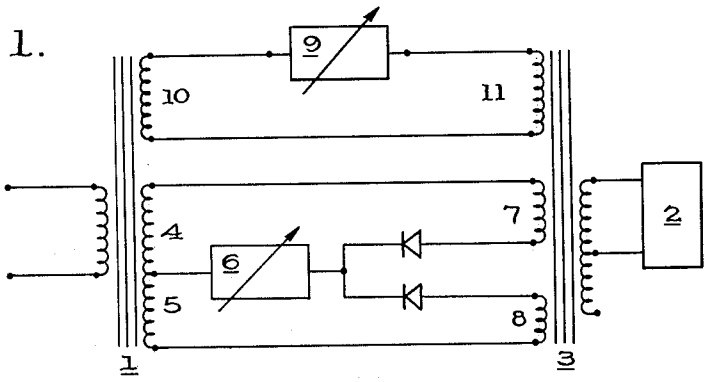
FIG. 1.



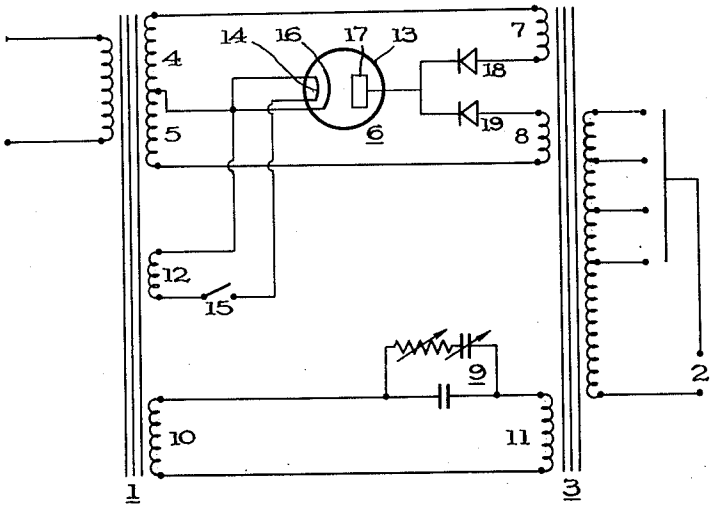


FIG. 2.

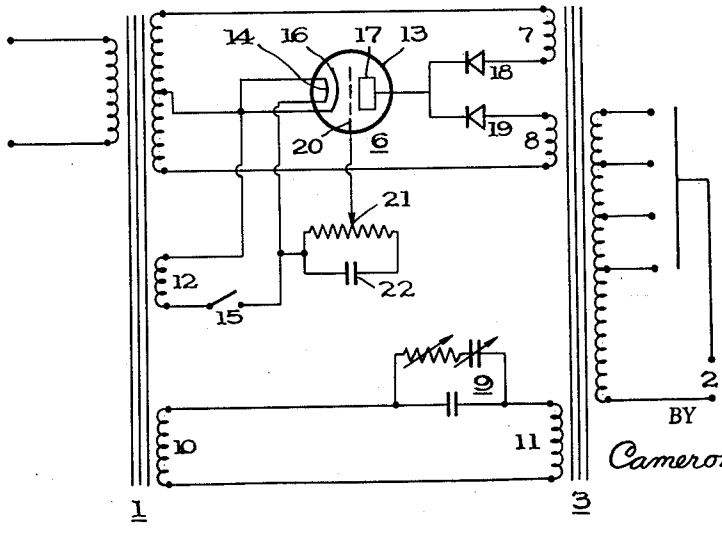


FIG. 2a.

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MAGNETIC DEMAGNETIZING DEVICES

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This invention relates to demagnetizing techniques of ferro-magnetic substances.

Ferro-magnetic substances may, under certain well known conditions, present a so-called residual magnetization which must sometimes be removed for scientific or industrial purposes. The demagnetization has for its object to render the intensity of magnetization as close as possible to zero.

Magnetic demagnetization consists in producing in the sample under treatment an alternating decreasing magnetic field. The following conditions must be fulfilled:

(*a*) The decrease of the amplitude of the magnetic field must be regular and considerable. The initial amplitude must be at least four times the value of the coercive field; for laboratory uses the final amplitude must be as weak as possible, in the presence of the coercive field. In effect, with regard to physical applications, the quality of demagnetization obtained increases with the ratio of the initial and final amplitudes.

(*b*) The mean value of the demagnetizing field must be nil to avoid an hysteretic magnetization phenomena, and the alternations of opposite sense must be identical, which implies perfect symmetry.

(*c*) Finally, it is advantageous in certain cases to allow the physicist to choose the law of decrease of the amplitudes of the curve of time variation of the magnetic field.

The alternating magnetic field is generally produced by a coil energized by an alternating current derived from an efficient, constant source of electromotive force. In order to decrease the amplitude of the field, laboratories commonly make use of mechanical systems (for instance, magnetic circuits of variable reluctance, or liquid rheostats). These systems are bulky, they lack flexibility, they are delicate to handle and generally they cannot be transported. Consequently they do not give rapid demagnetization or a fast rate of operation.

Automatic instruments based on the oscillating discharge of a condenser have been introduced in the industry. Due to the weakness of the energy accumulated, this principle does not result in sufficient physical demagnetization. In fact, the principle is used to determine the value of residual magnetization of permanent magnets with respect to attraction, which implies a small variation of the magnetization.

The present invention relates to improvements in magnetic demagnetization devices which fulfil simply the conditions mentioned above.

The invention is essentially characterized in that the transmission of alternating electric power, from the current source to the coil which creates the demagnetizing field, is effected through suitable electronic circuits which affect the transmission, and which comprise, on the one hand, a power network which transmits in nearly its totality the electric power, the alternations of opposite sense being transmitted in a perfectly symmetrical manner and, on the other hand, a compensating network which corrects the imperfections of the transmission, these networks both connecting the secondary of an entry transformer, whose primary is connected to the current source, to the primary of an exit transformer whose secondary is connected to the coil which creates the demagnetizing field.

A non-limiting embodiment of the improvements in

magnetic demagnetizing devices in accordance with the invention will be described hereafter with reference to the accompanying schematical FIGURES 1 and 2. The particular features described with reference to this embodiment are deemed to be part of the invention, it being understood that any equivalent features may also be employed within the scope of the invention.

FIGURE 1 is a diagram illustrating the principle on which are based the improvements in accordance with the invention.

FIGURE 2 is a diagram of the electronic system of a demagnetization device in accordance with the invention.

FIGURE 2*a* is a diagram of a modified electronic system of FIG. 2.

With reference to the diagram of FIGURE 1: the source of energy is an alternating generator, not shown, of suitable frequency and power, connected to the primary winding of the entry transformer **1**; the coil **2** which creates the magnetic demagnetizing field may, in accordance with its impedance, be connected to different points of the winding of the exit transformer **3**; the two half-windings **4** and **5** of the secondary of transformer **1** are connected through an electronic network **6** to the two half-windings **7** and **8** of the primary of transformer **3**. The network **6** controls the transmission of electrical energy between the transformers **1** and **3** and consequently the amplitude of magnetizing current of the coil **2**; when the transmission tends to zero at the end of demagnetization, an electronic network **9** which similarly connects a secondary winding **10** of the transformer **1** and a primary winding **11** of the transformer **3**, makes it possible to reach a final stage, by compensating the residual imperfections due to the wiring.

The advantages of the device are the following:

(*a*) The purely electrical regulation of power utilized makes possible a very high energy yield and minimum dimensions with respect to the initial power required.

(*b*) The operation is entirely automatic and makes possible uses by remote control or with programming.

(*c*) The speed of operation only depends on the sample, which imposes a limit frequency on the alternating magnetic field, which makes it possible to attain minimum demagnetization time.

(*d*) The network **6** makes it possible suitably to adapt the demagnetization to any exterior phenomenon and to realize for the envelope of the variation curve of the demagnetizing field, forms which are judged adequate.

(*e*) The entirely symmetrical constitution of the device gives identity of alternations of opposite sense, these alternations being regulated by the common network **6**. The traces of dissymmetry which may remain are suppressed by the addition of the compensating network **9**.

(*f*) There is a very large ratio between the initial and final values of the demagnetizing field.

The device makes it possible to perform any desired action on the residual magnetization of a ferro-magnetic body, ranging from fixing its value with respect to attraction, up to complete suppression, and from high laboratory performance to high power industrial applications.

Among the limitless number of possible embodiments of the transfer **6**, that represented in FIGURE 2 is one of the simplest.

The characteristics of the currents flowing in the various windings are as follows.

Transformer **1**:

Primary	50 Hz., voltage of the sector.
Secondary **4** and **5**	350 v. 300 ma.
Secondary **12**	6 v. 1 a.
Secondary **10**	50 v.

Transformer **3**:

Primaries **7** and **8**	330 v. 300 ma.
Primary **11**	50 v.
Secondary	according to charge.

The transfer system generally indicated at 6 is constituted by a tube 13, heating of whose filament 14 is effected by the winding 12. The switch 15 makes it possible to suppress the heating current. The cathode 16 is at the same potential as filament 14. The plate 17 is connected to germanium diodes 18 and 19. During one alternation the current passes through the windings 4 and 7 and through diode 18, and during the other alternation, through the windings 5 and 8 and diode 19.

Decrease of the amplitude of demagnetization current is obtained as follows.

The heating current of filament 14 is suppressed at the beginning of demagnetization by opening the switch 15. Cathode 16 cools and the internal resistance of tube 13 increases. The resulting decrease of current makes possible at the end of about 15 seconds a ratio of initial amplitude to final amplitude of the order of 10^5.

The compensating system 9 comprises variable resistances and condensers which compensate in phase and amplitude the parasite connections between the various windings. The optimum values depend on the material employed and on the construction.

In one specific embodiment of the invention the dimensions of the instrument are 150 x 150 x 270 mm.; the weight is 5 kilograms and the initial power is 50 watts.

Finally, in the modified embodiment of the invention shown in FIGURE 2*a*, decrease of the current in the tube is obtained by adding a common grid 20 to the tube 13, and regulating the potential of the grid by applying thereto a variable negative charge, by any known means, here shown as a variable resistance 21 and a condenser 22 connected in the grid control circuit between switch 15 and grid control 20.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. Magnetic demagnetizing device which provides in a simple manner regular and considerable decrease of the amplitude of the demagnetizing field, zero mean value of said field, and the possibility of choosing the decrease low, said device comprising a source of alternating current, a coil which creates a demagnetizing field, an entry transformer having its primary winding connected to said current source, an exit transformer having its secondary winding connected to said coil, and electronic circuits connected to the secondary winding of said entry transformer and connected to the primary winding of said exit transformer effecting and regulating the transmission of alternating electric power from said current source to said coil, the alternations of opposite sense being transmitted in a perfectly symmetrical manner, said electronic circuits comprising a power network transmitting almost the totality of the electric power and a compensating network producing a current component compensating for irregularities of the principal current component produced by the power network due to residual dissimilarities of the power network, said power network comprising an electronic tube having a filament, two diodes in two distinct and identical circuits having in common only said tube, the alternations of current of opposite sense passing each through one of said two circuits, the current through said tube having a constant sense, and means for suppressing the heating of the filament of said tube to thereby decrease the amplitude of current traversing said tube.

2. Magnetic demagnetizing device according to claim 1, a grid for said tube, and means to regulate the potential of said grid to thereby decrease the amplitude of current traversing said tube.

3. Magnetic demagnetizing device according to claim 1, wherein said compensating network comprises variable resistances and condensers compensating in amplitude and in phase any parasite connections between the several windings.

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