

Feb. 21, 1950

J. Q. ADAMS
SATURABLE MAGNETIC CORE

2,498,475

Filed May 6, 1948

Fig. 1.

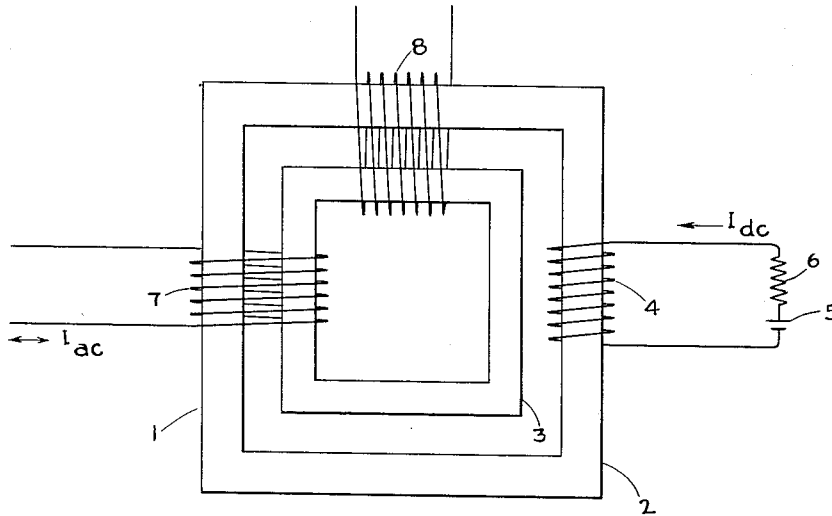
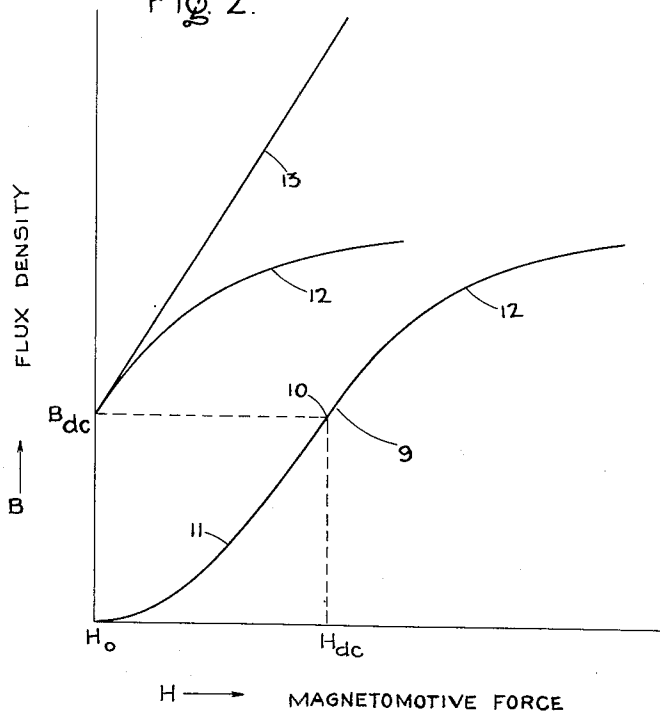


Fig. 2.



Inventor:
John Q. Adams,
by *Ernest H. Britton*
His Attorney.

UNITED STATES PATENT OFFICE

2,498,475

SATURABLE MAGNETIC CORE

John Q. Adams, Schenectady, N. Y., assignor to
General Electric Company, a corporation of
New York

Application May 6, 1948, Serial No. 25,349

6 Claims. (Cl. 323—89)

1

This invention relates to magnetic cores and more particularly to magnetic cores having a constant permeability.

In the case of a transformer or reactor having a core constructed of a ferro-magnetic material, due to the effect of saturation and the non-linear relationship between flux density and magneto-motive force, there may be introduced into the circuit variations of the voltage or current wave shape which are very often undesirable. Particularly in the case of a reactor used in connection with a capacitor an undesired resonant circuit might result from the introduction of higher harmonics. To prevent any distortion of the wave shape of current or voltage or both it would be necessary to have a magnetization curve for the ferro-magnetic material comprising the magnetic core which exhibits a linear relationship between flux density (B) and mmf. (H).

The magnetic core construction which is the subject of this invention achieves this linear relationship by employing a compound core prepared in two sections from a single ferro-magnetic material, and establishing, preferably by means of a direct current polarizing coil, a specific flux density within one section of the core. The polarizing effect of the direct current coil is such that the resulting magnetization curve, the algebraic sum of the magnetization curves of the polarized and unpolarized core sections, is a straight line.

Therefore, it is an object of this invention to provide a magnetic core construction which possesses the characteristic of constant permeability over a specified range of magnetomotive force.

This invention will be better understood from the following description taken in connection with the accompanying drawing and its scope will be pointed out in the appended claims.

In the drawing Fig. 1 is a semi-schematic diagram of a particular embodiment of the invention as applied to the construction of a reactor. Fig. 2 is a graph showing the magnetization curve for the material used in the construction of the reactor shown in Fig. 1, and also showing other curves useful in the explanation of the subject invention.

Referring now to the drawing there is shown in Fig. 1, by way of example, a reactor core 1 which is constructed in accordance with this invention. The reactor core 1 is prepared in two sections 2 and 3 from a single ferro-magnetic material A. Around core section 2 is wound a polarizing coil 4 which carries a current, I_{dc} , supplied by the direct current source 5 and whose magnitude is determined by the resistance of the coil 4 and the external resistor 6. Around both sections 2 and 3 of the reactor core 1 is wound a

2

coil 7 which is the reactor coil and is connected to an external alternating current circuit having a current I_{ac} . If I_{ac} varies in such a manner that the current reverses direction (i. e., the current is first positive and then negative) another polarizing coil 8, which is wound around both sections 2 and 3 of the reactor core 1, must be used to prevent a reversal of magnetization when the current I_{ac} becomes negative. Coil 8 may be eliminated if I_{ac} remains positive at all times during its cyclic variation, as would be the case if it had a large enough direct current component.

The magnetization or B—H curve of a material A is given by curve 9 in Fig. 2. The current I_{ac} which flows through the polarizing coil 4 is of such a magnitude that the flux density B_{dc} set up within the core section 2 due to I_{dc} is the same as the flux density which corresponds to the point of inflection 10 of the magnetization curve 9. It can be seen from the curve 9 that, starting at the origin (i. e., point of zero mmf. and zero flux density) the slope of that part of the curve 9 labeled 11 increases and when point 10 is reached the slope of the curve 9 starts to decrease; the section of the curve 9 having a decreasing slope is labeled 12. Thus, point 10 corresponds to the point of maximum slope of the magnetization curve 9. The algebraic sum of curve 11 and curve 12 for a specific mmf. region, in Fig. 2 from H_0 to H_{dc} , if the material A is chosen properly will be a straight line, and is shown as curve 13. Therefore, if the polarizing current through coil 8 is such that the magnetomotive force resulting from I_{ac} flowing in coil 7 remains in the region from H_0 to H_{dc} the shape of the flux density wave will be substantially the same as the shape of current I_{ac} wave and no distorting harmonics will be introduced into the circuit. For full utilization of the core the magnetomotive force of coil 8 should be $\frac{1}{2} H_{dc}$.

In a particular application of this invention the core 10 is constructed from an iron cobalt alloy composed of 50 per cent iron and 50 per cent cobalt. H_{dc} has a value of two oersteds. With a direct current through coil 8 corresponding to a magnetomotive force of one oersted the current in coil 7, I_{ac} , produces a magnetomotive force varying from zero to 2 oersteds. It is found that a constant permeability of 10,000 is obtained for this specific range of magnetomotive force.

While there has been shown and described a particular embodiment of this invention it will be obvious to those skilled in the art that various changes and modifications can be made therein without departing from the invention, and therefore, it is aimed in the appended claims to cover all such changes and modifications as fall within the true spirit and scope of the invention.

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

1. A substantially uniform permeability magnetic core comprising, in combination, two magnetically parallel closed loop sections of ferromagnetic material, means including an electric circuit linking both of said sections for magnetizing them with a variable magnetomotive force, said material having a conventionally shaped magnetization curve which as the flux density increases from zero is characterized by a lower zone in which the permeability increases separated by a point of inflection from an upper zone in which the permeability decreases by reason of saturation effects, and means for magnetizing one of said sections with a unidirectional flux having a density in the vicinity of said point of inflection.

2. A substantially uniform permeability magnetic core comprising, in combination, two magnetically parallel closed loop sections of ferromagnetic material, a variable current exciting circuit linking both of said sections, said material having a conventionally shaped magnetization curve which as the flux density increases from zero is characterized by a lower zone in which the permeability increases separated by a point of inflection from an upper zone in which the permeability decreases by reason of saturation effects, means for magnetizing one of said sections with a unidirectional flux having a density in the vicinity of said point of inflection, and means for magnetizing both of said sections in parallel with a unidirectional magnetomotive force of approximately half that corresponding to said point of inflection.

3. Stationary induction apparatus comprising, in combination, two magnetically parallel closed loop magnetic core sections of the same magnetic material, said material having a conventionally shaped magnetization curve which as the flux density increases from zero is characterized by a lower zone in which the permeability increases separated by a point of inflection from an upper zone from which the permeability decreases by reason of saturation effects, means for magnetizing one of said sections with a unidirectional flux having a density in the vicinity of said point of inflection, means for magnetizing both of said sections in parallel with a unidirectional magnetomotive force of approximately half that corresponding to said point of inflection, and a winding linking both of said core sections for magnetizing them with an alternating magnetomotive force whose amplitude between maximum positive and negative values is substantially equal to the magnetomotive force corresponding to said point of inflection.

4. A substantially uniform permeability magnetic core comprising, in combination, two magnetically parallel closed loop sections of ferromagnetic material, a common alternating current exciting circuit linking both of said sec-

tions, said material having a conventionally shaped magnetization curve which as the flux density increases from zero is characterized by a lower zone in which the permeability increases separated by a point of inflection from an upper zone in which the permeability decreases by reason of saturation effects, and means including a winding on one of said sections for magnetizing it with a unidirectional flux having a density in the vicinity of said point of inflection.

5. A substantially uniform permeability magnetic core comprising, in combination, two magnetically parallel closed loop sections of ferromagnetic material, a common alternating current exciting winding linking both of said sections, said material having a conventionally shaped magnetization curve which as the flux density increases from zero is characterized by a lower zone in which the permeability increases separated by a point of inflection from an upper zone in which the permeability decreases by reason of saturation effects, means for including a winding linking one of said sections for magnetizing it with a unidirectional flux having a density in the vicinity of said point of inflection, and means including a winding linking both of said sections for magnetizing them with a unidirectional magnetomotive force of approximately half that corresponding to said point of inflection.

6. Stationary induction apparatus comprising, in combination, two magnetically parallel closed loop core sections of the same magnetic material, said material having a conventionally shaped magnetization curve which as the flux density increases from zero is characterized by a lower zone in which the permeability increases separated by a point of inflection from an upper zone in which the permeability decreases by reason of saturation effects, means including a winding for magnetizing one of said sections with a unidirectional flux having a density in the vicinity of said point of inflection, means including a second winding linking both of said sections for magnetizing them with a unidirectional magnetomotive force of approximately half that corresponding to said point of inflection, and means including a third winding linking both of said sections for magnetizing them with an alternating magnetomotive force whose amplitude between maximum positive and negative values is substantially equal to the magnetomotive force corresponding to said point of inflection.

JAMES Q. ADAMS.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,357,197	Brooks	Oct. 26, 1920
1,835,209	Dowling	Dec. 8, 1931