June 22, 1954 G. W. ELMEN 2,682,021

SHREDDED MAGNETIC CORE AND METHOD OF MAKING SAME

Filed Dec. 16, 1949

FIG. 1.

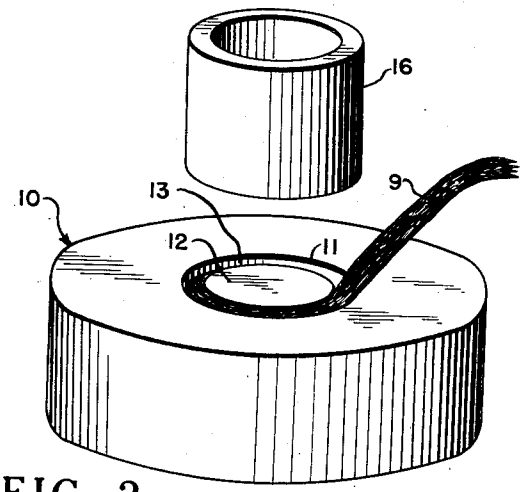


FIG. 2.

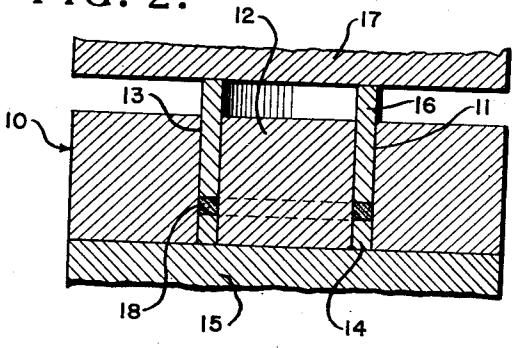


FIG. 3.

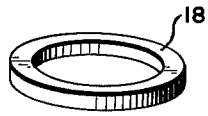


FIG. 4.

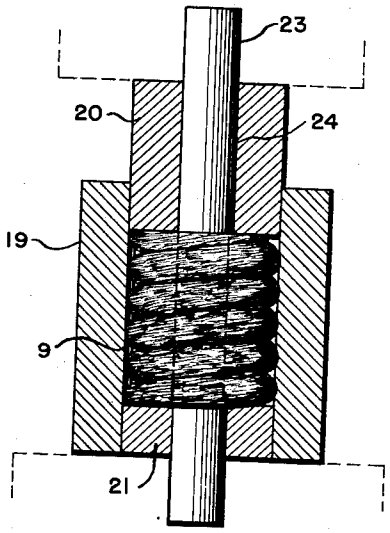


FIG. 5.

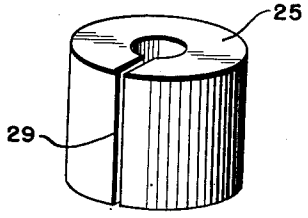


FIG. 6.

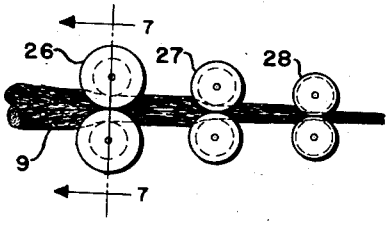
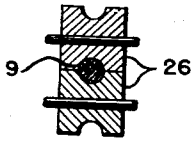


FIG. 7.



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SHREDDED MAGNETIC CORE AND METHOD OF MAKING SAME

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3 Claims. (Cl. 317—227)

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The present invention relates to new and improved magnetic cores for use with changing magnetic fluxes and methods of making the cores. More particularly the invention relates to magnetic cores formed of shredded magnetic material and methods of forming the material into cores having a desired conformation and desired electrical and magnetic characteristics.

Related prior art cores for use with changing magnetic fluxes are divided into three general varieties: those made of magnetic dust particles compressed at high pressure or held by a shellac or phenol binder, those made of magnetic wire, and those made of magnetic tape.

A particular disadvantage in forming cores of magnetic dust is the difficulty of producing suitable dust from many of the magnetic alloys, it being difficult in many instances to produce dust from such alloys without the introduction into the melt of impurities which interfere with the performance characteristics of the cores produced therefrom. A further disadvantage in the use of dust in the production of magnet cores is that it is difficult to produce dust particles of uniform size. Usually, after the metal is reduced to dust, it is passed through a screen to remove the larger particles which process produces a mixture of dust particles ranging from the largest particles passing through the screen down to the smallest particle of dust present in the mixture. It is apparent that with such a mixture of various sizes of dust the points of contact between the grains vary, thus producing an uneven distribution of the flux density throughout the core. Since both the hysteresis and eddy current energy losses vary in accordance with the maximum flux density it will be apparent that the performance characteristics of such a core would be adversely affected by the heterogeneous composition of the core mixture.

In the use of wire in the production of magnetic cores it has been found that production costs are prohibitively high, particularly where extremely small diameter wire is required. It is also pointed out that because of the poor space factor for the wire, this arrangement is seldom employed for cores arranged for use in high frequency coils.

Cores constructed of magnetic tape, particularly those having a very thin cross sectional area are very costly to produce. The convolutions of the tape have a tendency, under certain conditions, to shift relative to each other thus causing changes in the air gap of the core and as a result thereof changes in the effective magnetic constants.

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In the core of the present invention such difficulties are, to a considerable extent, eliminated, the core being constructed of elongated filaments of shredded magnetic material such, for example, as steel wool or similar material made from any of the well known metal alloys in common use in magnetic cores. The elongated shreds or filaments are arranged generally parallel to the path of magnetic flux within the core whereby the magnetic circuit through the core is substantially continuous, the only air gaps therein being those which occur between overlapping portions of adjacent filaments. With this arrangement, the reluctance of the magnetic circuit of the core is reduced to a low value and a high effective permeability is obtained. Moreover, this core construction has the further advantage that the filaments of the core may be twisted sufficiently to vary the effective permeability to specific values suitable for different applications of the core material.

By reason of the small cross sectional area of the filaments, the eddy current losses in the core are reduced to a low value and may be limited to specific values in accordance with the density of the core, i. e., the number of filaments in the cross sectional area of the core, which, in turn, is controlled by the degree of pressure applied in the molding of the filaments into the solid mass of the core. The eddy current losses in the core may also be controlled by insulating the individual filaments in a well known manner such, for example, as by oxidizing the filaments or by applying a coating of a suitable insulating material thereto.

Whereas several methods of fabricating cores from the core material will occur to those skilled in the art to which this invention relates or most closely appertains, the shredded metal material is well adapted for use in fabricating toroidal cores, or closed cores of various shapes, wherein the shredded material is first formed into a rope with the filaments extending generally along the length thereof and with the rope twisted or untwisted, as the case may be. The rope is then formed into a coil and pressure applied axially thereof in an amount sufficient to compress the coil to a toroid of the desired thickness, suitable apparatus being employed to maintain the desired toroidal configuration of the core.

According to another method of fabrication, in the construction of cylindrical cores, the shredded material is formed into a rope, as before, and the rope thereafter is passed in succession between pairs of rollers having peripheral grooves which are semi-circular in cross section and

which decrease in diameter in succeeding pairs of rollers whereby the rope is compressed into the solid mass of the core of desired diameter upon emergence from the last pair of compression rollers.

An object of the present invention is to provide a magnetic core having improved electrical and magnetic characteristics.

Another object is to provide a new and improved magnetic core in which the electrical and magnetic characteristics may be varied during the manufacture thereof to suit a wide range of conditions of use.

Another object resides in the provision of magnetic cores having increased effective permeability and low eddy current loss.

Another object is to provide methods and apparatus for fabricating magnetic cores from shredded magnetic material.

Still another object is to provide a new and improved compressed magnetic core for use with changing magnetic fluxes in which the shredded magnetic material of which the core is composed may be arranged prior to compression thereof in such a manner as to vary the electrical and magnetic characteristics of the finished core.

A further object is to provide a magnetic core fabricated of shredded material which is economical to manufacture, durable in use, and capable of retaining its electrical and magnetic characteristics.

Other objects and many of the attendant advantages of this invention will be readily appreciated as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawing wherein:

Fig. 1 is a perspective view of a plunger, mandrel and die in the respective positions prior to compressing a coil of metallic wool placed in the die;

Fig. 2 is a sectional view of the plunger, mandrel and die and illustrating the metallic wool compressed in the form of a toroidal core;

Fig. 3 is a perspective view of a completed toroidal core as formed by the plunger, mandrel and die of Figs. 1 and 2;

Fig. 4 is a sectional view of a slightly modified form of plunger, mandrel and die;

Fig. 5 is a perspective view of a core produced by the apparatus of Fig. 4;

Fig. 6 is a view in elevation of a further modification; and

Fig. 7 is a sectional view taken along line 7—7 of Fig. 6.

Referring more particularly to the drawing in which like numerals of reference indicate like parts throughout the several views a mold or die indicated generally at **10** has a central bore **11**. Axially mounted in bore **11** is a mandrel **12** which is concentrically spaced by a spacer ring **14** to form a chamber **13**.

As indicated in Fig. 1 of the drawing, insulated magnetic wool filaments **9** which have been loosely arranged into ropelike form with the filaments running substantially straight along the length thereof or twisted to various degrees, as the case may be, are placed spirally in chamber **13**. The die **10** is mounted on a bed plate **15** of a press (not shown), a plunger **16** of hollow cylindrical form is inserted in chamber **13** and pressure of a desired value is applied to the mandrel by means of a pressure plate **17** which is moved by any well-known mechanical, hydraulic or pneumatic arrangement (not shown) to obtain the desired

pressure. The metallic wool filaments are thus compressed to form a mass or core **18** having desirable magnetic and electrical qualities of particular advantage for use with changing magnetic fluxes.

It is to be noted that the filaments employed in the cores may be individually insulated by any well-known method such, for example, as by oxidation.

It is also to be noted that pressure applied during the forming of the core should not reach the point where a breakdown of the insulation of the individual filaments will result therefrom.

In order to permit expeditious removal of the formed core **18** from the die **10**, the plunger **16** and the mandrel **12** are removed prior to the extraction of the core **18**.

Figs. 4 and 5 illustrate a slightly modified form of core and pressure mold or die therefor, the mold comprising a hollow cylindrical outer member **19** and a spacer ring **21**. A rod or mandrel **23** is axially aligned in die **19** and is supported at one end by the spacer ring **21**.

As clearly shown in Fig. 4 of the drawing, mettalic wool filaments in the form of a loose rope are wrapped spirally around mandrel **23** and forced into the cavity defined by the die **19** and mandrel **23**. A plunger **20** havng a bore **24** therein for a sliding fit around mandrel **23** and an outer periphery arranged for a sliding fit in bore of die **19** is employed to compress the filaments in the same manner as the mandrel **16** of Figs. 1 and 2.

As shown in Fig. 5 the compressed filaments may be severed by cutting a slit **29** through one side of the finished core in order to introduce an air gap which will provide a desired effective magnetic permeability of the core.

As indicated in Fig. 6 the wool filaments may be formed into a solid cylinder by passing the filaments through a series of grooved pairs of compressing rolls **26**, **27** and **28**, the rolls having grooves of graduated size in successive order from large to small whereby the loosely formed filaments are compressed in successive stages as they are moved between a plurality of pairs of rolls to form a substantially solid mass or to produce the rope **9** employed in the apparatus and methods of Figs. 1 to 4, the rollers being caused to rotate about the axis of the rope, if desired, as the shredded material is fed therethrough to give a desired twist to the rope. This arrangement is particularly advantageous in the formation of solid cores for use with changing magnetic fluxes. It is, of course, understood, that the filaments may be arranged substantially straight along the length thereof as by combing the wood filaments, or the wool filaments may be employed with random alignment of the filaments or they may be twisted to varying degrees to produce a variety of magnetic and electric characteristics, as aforedescribed.

The shredding of the metal filaments for use in the present invention may be accomplished in any well-known manner such, for example, as by multiple cutters in a specially constructed lathe or shaper. The length and cross sectional area of the individual filaments may be regulated to provide for various conditions of use.

After the shredded filaments are formed they are subjected to any suitable well-known insulating process wherein the individual filaments are either coated with an insulating shellac or varnish or by oxidation.

It is also to be understood in practicing the

method of the present invention that it is generally preferable to anneal the magnetic filaments both prior to and after the compression thereof. The temperature employed for the first annealing operation should be sufficiently high to eliminate all characteristics which are detrimental to the production of the highest permeability obtainable from the particular material employed in the making of the filaments. In the final annealing operation the heat employed should be at a temperature sufficient to produce optimum electrical and magnetic characteristics in the cores. The heat employed should not be high enough to destroy the insulation of the filaments particularly where organic materials are used therefor. Under certain conditions it may be advantageous to perform the final annealing operation in hydrogen.

Obviously many modifications and variations of the present invention are possible in the light of the above teachings. It is therefore to be understood that within the scope of the appended claims the invention may be practiced otherwise than as specifically described.

The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

What is claimed as new and desired to be protected by Letters Patent of the United States is:

1. The method of fabricating a magnetic core which comprises the steps of reducing a quantity of filamentary magnetic wool to a rope-like configuration, twisting the filaments of the reduced wool as a group and variably in accordance with desired electrical and magnetic characteristics of the core, and reducing the diameter of the rope sufficiently to form a solid mass.

2. A magnetic core for use with changing magnetic fluxes comprising, a plurality of overlapping elongated magnetic filaments arranged generally parallel to the magnetic path of the core and compressed and twisted as a group to obtain a particular value of effective permeability and eddy current loss.

3. A magnetic core for use with changing magnetic fluxes comprising, a plurality of overlapping elongated magnetic filaments arranged generally parallel to the magnetic path of the core and twisted as a group to obtain a particular value of effective permeability and eddy-current loss, said group of filaments being wound in helical configuration and compressed to form a substantially solid mass in toroidal form.

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