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C. W. LUFKY ET AL

2,999,215

MAGNETIC CORE AND METHOD OF MANUFACTURE

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*Fig. 1.*

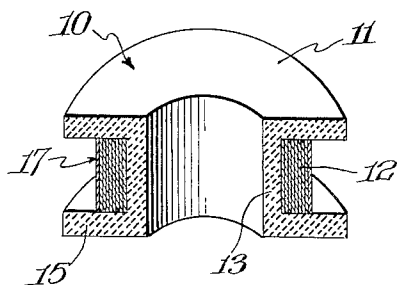


*Fig. 2.*

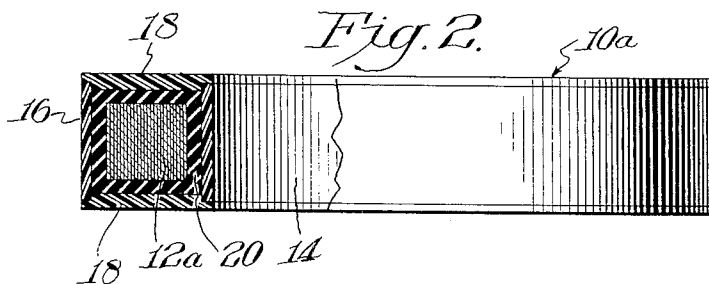
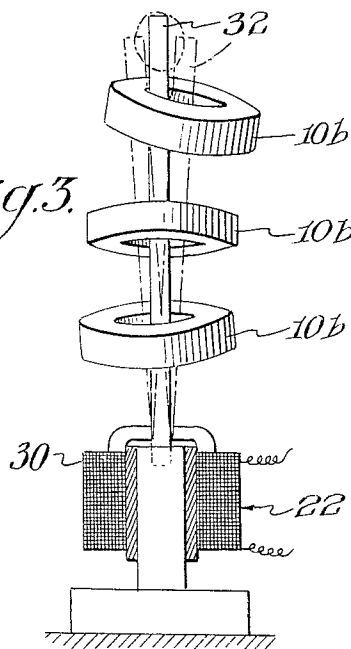


*Fig. 3.*



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**MAGNETIC CORE AND METHOD  
OF MANUFACTURE**

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11 Claims. (Cl. 336-213)

This application relates to magnetic cores which are substantially insensitive to ordinary mechanical shock and to a novel method of manufacturing them, and more particularly relates to the manufacture of tape-wound magnetic cores by this novel method.

Conventional tape-wound cores are highly sensitive to mechanical shock. The slightest jar abruptly changes their magnetic characteristics. In fact, even the most careful handling during fabrication and assembly will not uniformly prevent alteration and distortion of their magnetic characteristics. This sensitivity to strain and mechanical shock has made it extremely difficult to mass produce magnetic cores having uniform magnetic characteristics, and has concomitantly resulted in an extremely high rejection rate in the production of tape-wound magnetic cores.

An objection of this invention is to provide a tape-wound magnetic core whose magnetic characteristics are substantially uniform and insensitive to ordinary mechanical shock and to provide a method of manufacture which is capable of consistently producing such cores.

In accordance with this invention, magnetic cores whose magnetic characteristics are uniform and insensitive to ordinary mechanical shock, are produced by applying to the cores after they are annealed at high temperatures a succession of mechanical shocks of a predetermined force and duration which stabilizes their magnetic characteristics and relieves residual strains without straining or damaging the cores. This succession of mechanical shocks may be applied, for example, by means of vibration for a brief period of time. Determination of optimum force and duration of vibration is accomplished experimentally. The cores must be shaken enough to relieve all residual strains, but they must not be shaken hard or long enough to introduce equally or even more deleterious mechanical strains.

Novel features and advantages of the present invention will become apparent to one skilled in the art from a reading of the following description in conjunction with the accompanying drawings wherein similar reference characters refer to similar parts and in which:

FIG. 1 is a perspective view partially in cross-section of a tape-wound core which is one embodiment of this invention;

FIG. 2 is a view in elevation partially broken away in cross-section of another tape-wound core which is another embodiment of this invention; and

FIG. 3 is a perspective view of the practice of a novel method which is a further embodiment of the present invention.

In FIG. 1 is shown a tape-wound magnetic core 10, for example of the type generally designated as a bobbin type magnetic core. Core 10 includes a bobbin 11, for example, of a ceramic material. Bobbin 11 may also be made of other nonmagnetic materials such as stainless steel. Tape 12 of ferro-magnetic material is wound about the cylindrical hub 13 of bobbin 11 between flanges 15 extending from the ends of hub 13. This tape is quite thin and ranges in thickness, for example, from 0.000125 inch to 0.002 inch. The tape in the smaller tape-wound cores referred to as "bobbin" cores is very thin and ranges from 0.001 inch to 0.000125 inch in thickness. After winding, the ferro-magnetic tape is

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firmly secured into position, for example, by means of an adhesive-coated paper tape 17.

Upon visual inspection core 10 appears to resemble any standard bobbin type core but it nonetheless incorporates this present invention by virtue of subjection to a novel method or process, later described in detail, which is a critical feature of this present invention.

Another type of tape-wound magnetic core is shown in FIG. 2. Core 10a, for example, is of the type shown in FIG. 8 of U.S. Letters Patent 2,569,468. This core 10a is also an embodiment of this present invention by virtue of having been subjected to the aforementioned novel method.

As shown in FIG. 2, the tape-wound core assembly 10a is made up of a wound tape core 12a of ferro-magnetic material encapsulated in a container of plastic material, Bakelite for example, including an inner annular ring 14, an outer annular ring 16, and suitably indented or notched covers 18. This container may also be made of metal, aluminum for example, or of any other suitable material. Tape wound core 12a is embedded or potted within a body of cushioning material 20. This cushioning material is unvulcanized rubber which does not include a vulcanizing agent, for example, or it may also be an unvulcanized silicone material, such as Silastic.

The illustrative tape-wound magnetic cores shown in FIGS. 1 and 2 have had their magnetic characteristics made substantially uniform and insensitive to ordinary mechanical shock, after they have been annealed at high temperatures, by application of a succession of mechanical shocks of a predetermined force and duration which stabilizes these characteristics without straining or damaging the cores. This method is carried out, for example, by the vibratory apparatus 22 shown in FIG. 3. Apparatus 22, for example, includes vibration generator 30 which may be a conventional vibratory generator of the type described, for example, in U.S. Letters Patents 2,187,717 and 2,305,943. In an apparatus of this type a rod 32, for example, is mounted upon vibration generator 30 which vibrates, for example, at the rate of 3600 cycles per minute upon standard 60 cycle alternating current. This frequency is convenient because standard 60 cycle A.C. current is readily available, but any conceivable frequency would probably be operative. Frequencies over the entire audio range, for example, from 20 to 20,000 cycles per second could probably be conveniently utilized.

One or more magnetic cores 10b are placed upon rod 32, for example, and vibrated at a predetermined amplitude and duration. As previously mentioned the frequency is not critical and may depend upon a particular combination of amplitude and duration which proves advantageous.

The predetermined amplitude and duration of vibration is empirically or experimentally determined. Experiments are carried out on sample cores of each particular type to determine the amplitude and duration of vibration necessary to stabilize and strain relieve the particular core without straining or damaging it. A too violent or too prolonged vibration introduces deleterious, mechanical strains in the core which may permanently damage them. The amplitude and duration of vibration should be just great enough to insure that all residual strains in the core are relieved. However, insufficient amplitude will require an undue length or duration of vibration.

After the cores are vibrated, their magnetic characteristics are tested by any standard magnetic test which indicates that they uniformly meet specifications. Bobbin type cores, for example, may be tested by passing a sharp pulse through them and ascertaining on an oscilloscope whether they are capable of switching rapidly from one condition of polarization to the other.

As a result of the application of this method, the rejection rate of tape-wound cores has been reduced to as little as 5%. This is highly significant since the rejection rate, heretofore, has run as high as 90%. Furthermore, these vibrated cores are amazingly insensitive to ordinary mechanical shock. Any shock short of one great enough to physically damage the casing or the core tape material does not change or alter magnetic characteristics.

An absolutely certain theory explaining exactly how and why the aforementioned results are achieved is not fully established, but it is suspected that the application of this succession of mechanical shocks frees each successive convolution of the wound-tape which might be bound by slight welds formed at the high annealing temperatures or bound by residual strains incorporated while the core cools down to ambient temperature from these high annealing temperatures.

During prior manufacturing processes some cores might accidentally be free of residual strains or, by chance, have relieved themselves of any. However, as previously mentioned, the rejection rate in standard production has run as high as 90% which has resulted in exorbitantly high manufacturing costs. Practice of this invention not only minimizes the initial rejection rate, but also provides cores which are amazingly less susceptible to subsequent alteration in their magnetic characteristics during shipping, installation, and operation.

What is claimed is:

1. A tape-wound magnetic core incorporating a toroidal wrapping of thin magnetic tape whose magnetic characteristics are made uniform and insensitive with respect to mechanical shocks which do not subject the core material to a strain exceeding their elastic limit by means of the method which comprises the steps of annealing said cores, empirically determining an intensity and duration for a succession of mechanical shocks which will stabilize the magnetic characteristics of said cores without exceeding their elastic limit, and applying said empirically determined succession of mechanical shocks to said cores.

2. A tape-wound magnetic core incorporating a toroidal wrapping of thin magnetic tape whose magnetic characteristics are made uniform and insensitive with respect to mechanical shocks which do not subject the core material to a strain exceeding their elastic limit by means of the method which comprises the steps of annealing said cores, applying a succession of magnetic shocks to said cores which are sufficiently prolonged and strong enough to stabilize the magnetic characteristics of said cores without exceeding the elastic limit of said tape, electrically testing the magnetic characteristics of said cores after application of said shocks to make sure that their elastic limit has not been exceeded, and rejecting any cores which the electrical test shows to have been damaged by being taken past their elastic limit.

3. A method of manufacturing tape-wound magnetic cores incorporating a toroidal winding of thin magnetic tape which comprises the steps of annealing said cores,

empirically determining an intensity and duration for a succession of mechanical shocks which will stabilize the magnetic characteristics of said cores against distortion by subsequent mechanical shock without exceeding the elastic limit of the wound tape, and applying said empirically-determined succession of mechanical shocks to said cores.

4. A method as set forth in claim 3 wherein said cores are tested after application of said succession of shocks to determine whether any cores have been damaged by being taken past their elastic limit, and rejecting said damaged cores.

5. A method as set forth in claim 3 wherein said shocks are applied by vibrating said cores.

6. A method as set forth in claim 5 wherein said cores are vibrated within the audio range of vibration.

7. A method as set forth in claim 6 wherein said cores are vibrated at approximately 3600 cycles per minute.

8. A method of manufacturing tape-wound magnetic cores incorporating a toroidal winding of thin magnetic tape which comprises the steps of annealing said cores, applying a succession of mechanical shocks to said cores which are sufficiently prolonged and strong enough to stabilize the magnetic characteristics of said cores against distortion by subsequent mechanical shock without exceeding the elastic limit of said tape, electrically testing the magnetic characteristics of said cores after application of said shocks to make sure that the elastic limit of the wound tape has not been exceeded, and rejecting any cores which the electrical test shows to have been damaged by being taken past their elastic limit.

9. A method as set forth in claim 8 wherein said succession of shocks are applied by vibrating said cores.

10. A method as set forth in claim 9 wherein said cores are vibrated within the audio range of vibration.

11. A method as set forth in claim 9 wherein said cores are vibrated at approximately 3600 cycles per minute.

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