Sept. 6, 1966 D. R. HARNER ETAL 3,271,747

MAGNETIC CORE PACKAGE

Filed Aug. 22, 1961

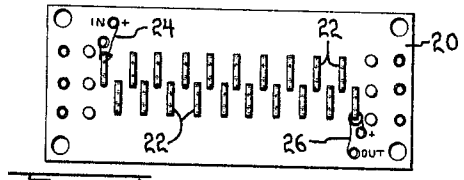


Fig. 1

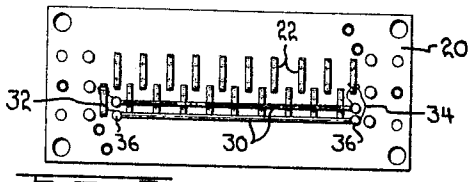


Fig. 2

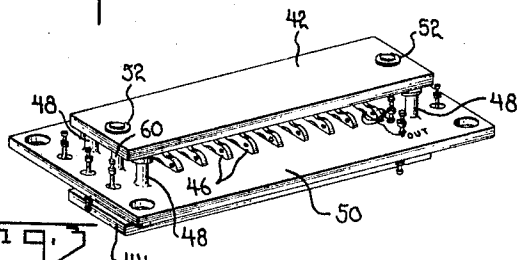


Fig. 3

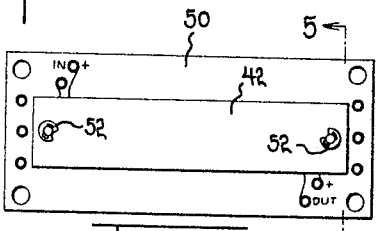


Fig. 4

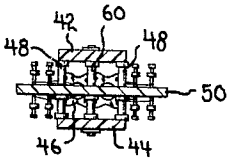


Fig. 5

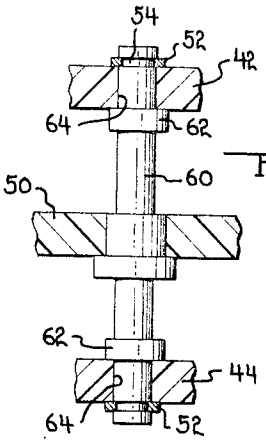


Fig. 6

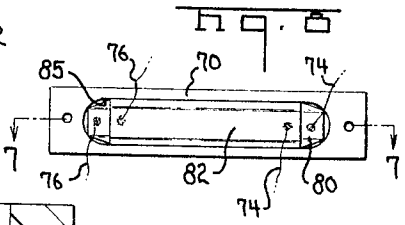


Fig. 8

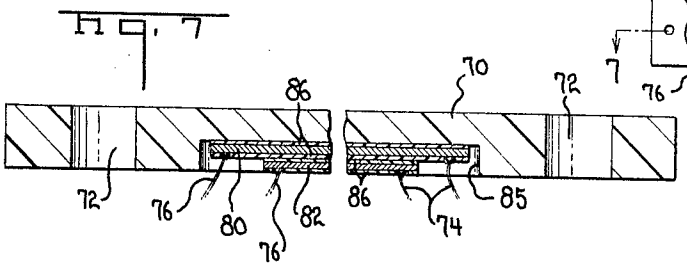


Fig. 7

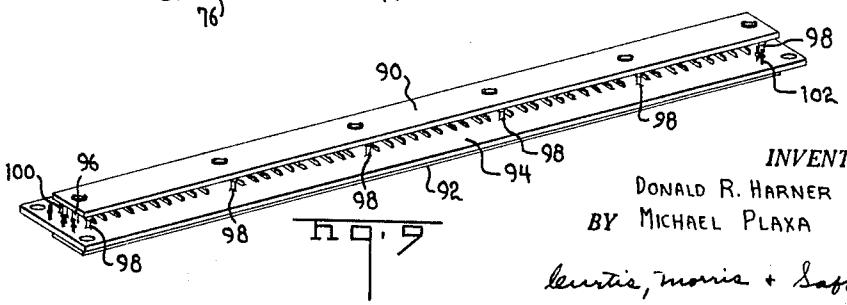


Fig. 9

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MAGNETIC CORE PACKAGE

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Filed Aug. 22, 1961, Ser. No. 133,118
1 Claim. (Cl. 340—174)

This invention relates to a magnetic core device assembly.

A primary object of invention is to provide a magnetic core package of a simple, compact and sturdy construction.

A further object of invention is to provide a magnetic core package which, while adequately protecting cores and windings from damage incident to handling, will permit access to cores and windings for inspection and/or alteration.

A still further object of invention is to provide a magnetic core package of a construction readily adaptable to core arrays of considerable length.

An additional object of invention concerns the provision of a core package having incorporated therein recirculating conductors of improved transmission characteristics.

In U.S. Patent No. 2,995,731 to J. P. Sweeney there is disclosed a magnetic core device comprising an array of multi-aperture magnetic cores arranged in two columns and connected to produce a shift register function. The construction of the unit of that application simplifies production by facilitating core winding. The core arrangement, wiring and operation of the device of the present invention may be similar to that of the Sweeney patent with the advantages obtained thereby.

In handling units of the type shown in the above-mentioned application, certain problems have arisen due to damage of cores and windings. While potting of the assembly generally eliminates core and coil mis-alignment due to handling it does not preclude fracture of a core by reason of tools or other objects being dropped thereon and, in fact, increases the likelihood of winding breakage in the event of bending or twisting of the core mounting panel. Moreover, potting makes it impossible to either inspect or alter cores or windings once the potting material has hardened. The present invention contemplates a construction completely covering the cores and windings with a hard but resilient cover thereby eliminating damage from objects dropped on the assembly or from other cause incident to handling. Additionally, the package of the invention substantially strengthens and rigidifies the core mounting board and permits core and winding inspection and/or alteration during the life of the unit.

Many computer applications require a relatively large number of digit columns, thereby necessitating core arrays of 50 to 100 core bit length. It will be readily perceived that core assemblies of such length, mounted on a single board, greatly increase the bending and twisting moment placed upon the unit during handling. With the present invention, magnetic core devices of large bit lengths can be packaged in a manner precluding bending or twisting of the core mounting board.

In magnetic core assemblies of the type disclosed in the Sweeney patent it is frequently desirable and in certain instances necessary to provide recirculating conductors linking the output of such units to the input thereof. The installation of recirculating conductors poses a problem both as to placement on the core mounting board and with respect to transmission line considerations. The present invention provides a solution to these problems by incorporating into the core package thin, flat copper conductors having an ideal transmission characteristic for magnetic core devices of the parallel row type.

Other objects and attainments of the present invention will become apparent to those skilled in the art upon a reading of the following detailed description when taken in conjunction with the drawing in which there is shown and described an illustrative embodiment of the invention; it is to be understood, however, that this embodiment is not intended to be exhaustive nor limiting of the invention but is given for purposes of illustration in order that others skilled in the art may fully understand the invention and the principles thereof and the manner of applying it in practical use so that they may modify it in various forms, each as may be best suited to the conditions of a particular use.

In the drawing:

FIGURE 1 is a plan view of a prior art ten-bit core array with windings removed for clarity.

FIGURE 2 is a reverse plan view of the unit of FIGURE 1.

FIGURE 3 is a perspective of a ten-bit core array packaged in accordance with the invention.

FIGURE 4 is a plan view of the unit of FIGURE 3.

FIGURE 5 is a section of the unit of FIGURE 4 taken along lines 5—5.

FIGURE 6 is an elevation of the center post employed in the unit of FIGURES 3–5.

FIGURE 7 is a longitudinal section of the bottom panel of one embodiment of the invention taken along the lines 7—7 of FIGURE 8 and enlarged for clarity.

FIGURE 8 is a reverse plan of the panel of FIGURE 7.

FIGURE 9 is a perspective of a unit exemplifying the adaptability of the invention for core array packages of considerable length.

The magnetic core device shown in FIGURE 1 is included principally to further explanation of the invention. This unit includes a core mounting panel **20**, carrying in slots a plurality of vertically disposed magnetic ferrite cores **22** in a staggered relationship. Control and coupling windings are omitted for clarity but, as heretofore mentioned, could be as disclosed in the Sweenly patent for a shift register function. It is understood that the invention has utility with any similar array of cores having various and other functions and wiring schemes. Input and output windings **24** and **26** are shown coupling the end cores of the core array. FIGURE 2 represents the device of FIGURE 1, rotated 180°, top to bottom, and shows the cores **22** protruding through the panel **20** with recirculating conductors **30**, of a prior known type, supported by posts **36** in an overlying relationship to one row of cores **22**. The winding **34** is connected to the last core of the core array through a minor aperture thereof, so as to produce a signal output representative of the core magnetic remanence condition via conductors **30** to winding **32**, coupling the major and minor aperture of the first core of the array. In this manner the output of the core array is recirculated.

In computer applications requiring large digit columns, the board **20** and conductors **30** must be extended many times the bit length shown in FIGURE 1, to provide for the increased function. One method of accomplishing this has been to connect a plurality of ten-bit stages together. Another method employed has been to mount the cores and windings on a single central board, such as **20** in FIGURE 1, with recirculating conductors **30** extending the length of the core columns. The former of these approaches requires an additional mounting frame and the latter is not sufficiently resistant to bending without a center panel so thick as to interfere with core winding.

In both of the foregoing arrangements, general operational utility is reduced due to damage incident to core and winding breakage. With the use of parallel wire recirculating conductors, as shown in FIGURE 2, difficulties in operation are encountered proportional to the length of a core array. These difficulties are due to the low characteristic impedance of a typical core array relative to the characteristic impedance of parallel wire recirculating conductors. The difference in match between core array and recirculating conductors results in a loss proportional to the mis-match factor times the loss present in a properly terminated line of the same length. This loss is such, that in a 50 bit length shift register having parallel wire recirculating conductors, it has been necessary in the past to regenerate the output signal to avoid malfunction. This increases unit cost and reduces reliability due to the inclusion of the additional non-magnetic components necessary to regenerate the recirculated core output signal.

The device of FIGURES 1 and 2, while quite satisfactory in operation in ten-bit core lengths, exposes cores, windings and recirculating conductors to damage during handling and permits tampering. Potting material bedded over the cores and windings does not provide a completely satisfactory solution to this problem for the reasons heretofore mentioned.

FIGURES 3–6 show an embodiment of the package contemplated by the invention overcoming the foregoing problems. In FIGURE 3, the general feature of the package includes a central core mounting board panel **50** similar to that of panel **20** of FIGURE 1 and the aforementioned Sweeney patent carrying a plurality of ferrite magnetic cores **46** extending through the panel. Mounted proximate the ends of panel **50** are two central posts **60** and four side posts **48** extending through the panel to support top and bottom panels **42** and **44**. The panels **50**, **42** and **44** and the posts **60** and **48**, in a preferred embodiment, consist of epoxy glass material approximately $\frac{1}{16}$ of an inch thick. It is contemplated, however, that any insulating non-magnetizable material sufficiently strong to resist bending can be employed. It will be apparent that the panels **42** and **44** provide an area facilitating handling of the unit and an additional area whereon identification markings and instructions may be printed.

FIGURE 4 indicates that the panel member **42** extends to protectively cover the cores and windings from contact with objects such as cables or tools dropped or rested on the unit. Panel **44** of a similar dimension is mounted to cover the cores on the other side of the unit and both panels are supported and held by the cooperative action of center posts **60**, carrying locking e-rings **52**, which operate to snug down the panels on side posts **48** as more clearly shown in FIGURES 5 and 6. The combination of panels and posts form a structurally strong unit capable of resisting both bending and twisting moment.

In situations wherein it is desirable to lock panels **42** and **44** to prevent tampering, phenolic or epoxy cement may be spotted over the posts **60** in place of e-rings **52**. The posts **48** and **60** may also be spotted with cement at their juncture with the panel **50** to insure rigidity of the package.

In FIGURE 5, the relationship of panels **42**, **44** and **50** to the posts **48** and **60** is shown with the panels **42** and **44** resting upon the posts **48** and locked into place by e-rings **52** fitted under the flange **54** of post **60** (as shown in FIGURE 6). Flange **62** serves to support the panels in proper vertical alignment and to further brace the assembly. For inspection and/or alteration of the cores and windings of a core assembly, the panels **42** and **44** may be removed by removing the e-rings **52** and lifting off the panels.

FIGURES 7 and 8 exemplify a form of outer panel which may be used in lieu of the solid plastic panels **42** and **44** above when recirculating conductors are required. The panel **70** of FIGURE 7 is enlarged to show the conductor strips. The panel **70** of FIGURE 8 approximates dimensionally the actual size of a panel constructed for a ten-bit length shift register. In FIGURE 7 element **70** represents a stiff plastic non-magnetizable panel having mounting holes **72** at each end similar to holes **64** shown in FIGURE 6 to accommodate center posts **60**. Recessed within the panel **70** are two flat copper strips **80** and **82** separated as indicated by strips of insulation **86** and connected to each conductor at each end thereof by leads **76** and **74**. In FIGURE 8, the conductors **80** and **82** are shown as of different lengths to facilitate the solder connection of leads **74** and **76**. The leads **74** and **76**, representing the ends of the conductors wound on the input and output core of a core array similar to windings **32** and **34** shown in FIGURE 2, should be of a length sufficient to permit removal of the panel **70** without breaking the solder connection to the conductors **80** and **82**. The groove **85** shown in FIGURES 7 and 8 may be either molded with the panel or cut therein after the panel has been formed.

It is contemplated that the panel **70** can serve as either a top or bottom panel of a core package, but for the usual wiring scheme, a bottom placement is preferred. It is further contemplated that the conductors **80** and **82** can be made to extend the full width of the panel with alternate layers of dielectric of a thickness to form in combination a structure of sufficient strength to prevent breaking or twisting of the central core mounting board.

An embodiment of the invention typifying the advantages set forth above is shown in FIGURE 9 representing a 50 length core array. A single piece central core mounting board **94** and single piece top and bottom panels **90** and **92** are connected as heretofore disclosed by the cooperating engagement of side post **98** and center post **96** provided at each decade bit length. Input terminals **100** and output terminals **102** are provided at each end of the assembly.

In an actual prototype 50 bit length package similar to the unit shown in FIGURE 9, the panels were constructed of $\frac{1}{16}$ inch epoxy glass sheet drilled and slotted to accommodate core central and side posts and terminal posts. The bottom panel of the unit, panel **92** of FIGURE 9, was cut to a depth of approximately $\frac{1}{32}$ of an inch in the manner shown by recess **85** in FIGURE 8 and two strips of preinsulated copper sheet, 6 mils thick and 200 mlis wide, known commercially as "Tape-Cable," were cemented therein. The cores of the unit were wound with the end cores including recirculating windings soldered to the conductors in the bottom panel. The panels were installed and locked by e-rings as shown in FIGURE 4 above. The unit showed substantial resistance to either bending or twisting and the panels adequately resisted physical shock applied thereto. Under test, the unit operated with excellent results using the standard core output signal achieving low recirculation loss without requiring regeneration of the core output signal.

A core package constructed in accordance with the foregoing disclosure lends itself to economic mass production and provides a sturdy and reliable magnetic core device capable of manufacture in various lengths. The use of flat copper strips in lieu of parallel wire conductors so improves the impedance match between the recirculating transmission line and the core array that substantial core lengths may be operated with normal voltage and current parameters. It is, of course, understood that the factors controlling the characteristic impedance of the recirculating conductors, such as, conductor spacing and/or dielectric material and conductor cross sectional area and shape, can be variously manipulated to achieve a sufficiency of match for various types of core arrays. It will be apparent to those skilled in the art that use of flat conductors in addition to improving impedance match also reduces the possibility of

intra-inductive coupling with cores and windings by reason of the increased skin area of the conductor and its physical shape.

It will be further apparent to those skilled in the art that the foregoing package can be employed to protect a core assembly and/or provide improved recirculating conductors in core devices, wherein the cores are mounted parallel to the core mounting board on one side only or on both sides thereof.

Changes in construction will occur to those skilled in the art and various apparently different modifications and embodiments may be made without departing from the scope of the invention. The matter set forth in the foregoing description and accompanying drawing is offered by way of illustration only. The actual scope of the invention is intended to be defined in the following claim when viewed in their proper perspective against the prior art.

We claim:

In a magnetic core device of the type utilized to store and shift intelligence the combination comprising a core mounting panel, a series of magnetic cores mounted thereon, windings linking said cores including an input and an output winding linking the first and last of said plurality of cores and coupling windings linking adjacent cores to transfer intelligence stored in said cores between

cores, at least another panel secured to said first mentioned panel in an overlying protective relationship to said cores, a recirculating loop linking the last core to the first core through the said output and input windings to recirculate intelligence transferred through said register, the said recirculating loop being comprised of flat conductors insulated from each other secured in said other panel to form a flat strip transmission line matched in impedance to the input and output impedance characteristics of the input and output cores and windings whereby to transmit recirculated intelligence with minimum signal loss.

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