May 7, 1968 R. J. BILLINGSLEY ET AL 3,381,357

FERROMAGNETIC CORE WIRING FIXTURE

Filed Dec. 9, 1965 2 Sheets-Sheet 1

FIG. 1

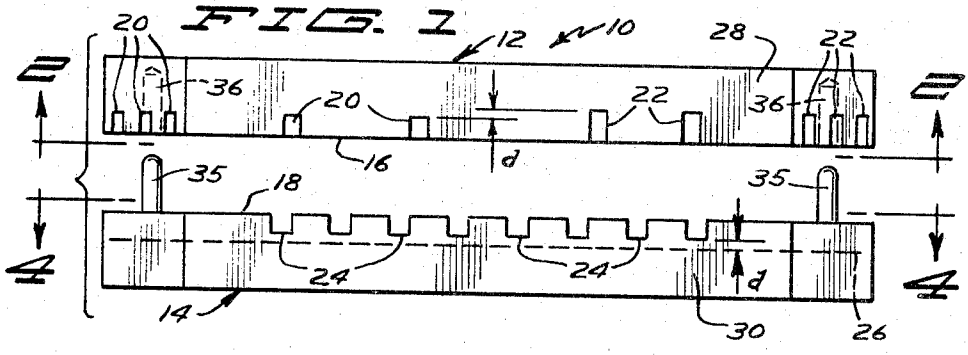


FIG. 2

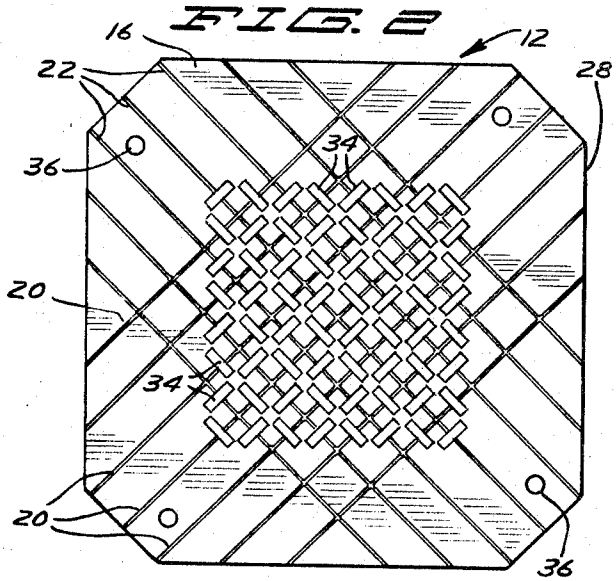
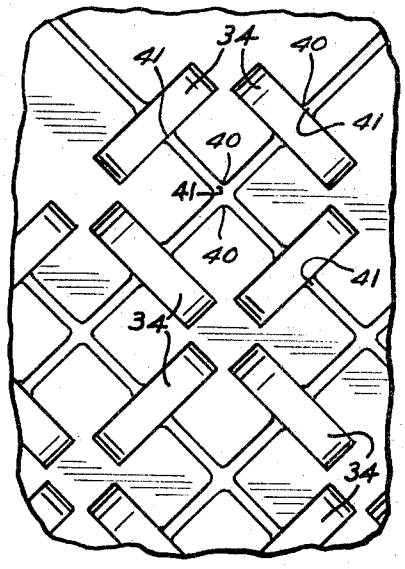


FIG. 3



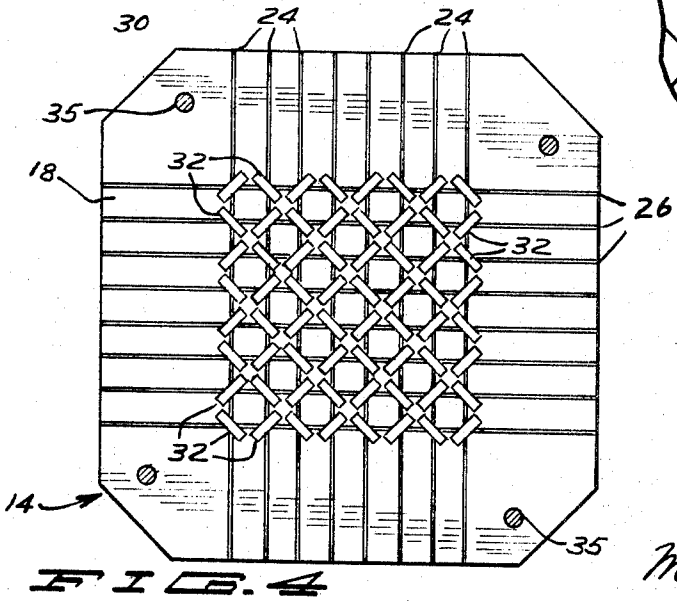


FIG. 4

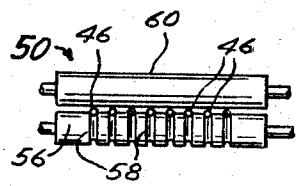


FIG. 5

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FIG. 5

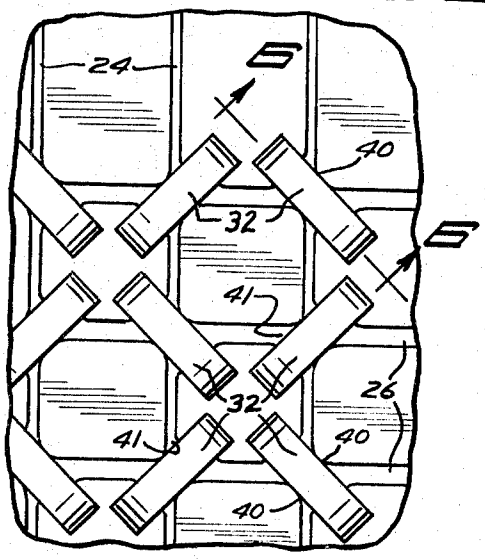
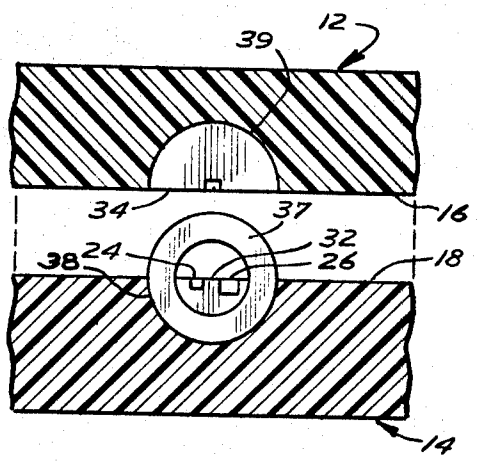


FIG. 6



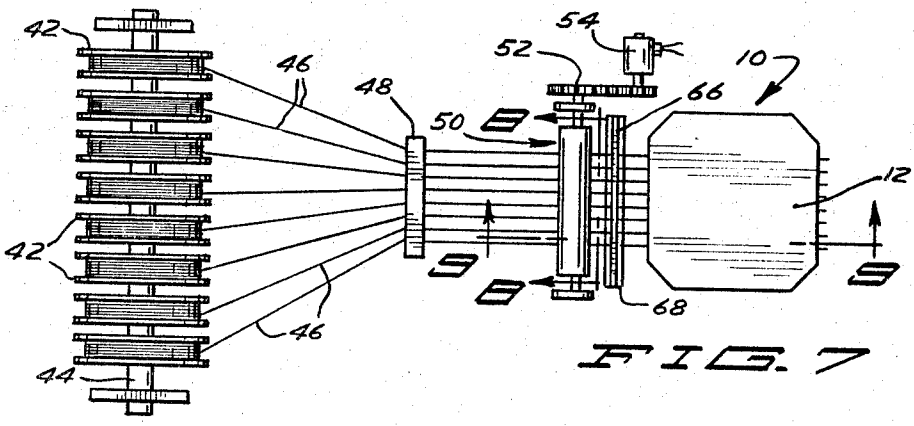


FIG. 7

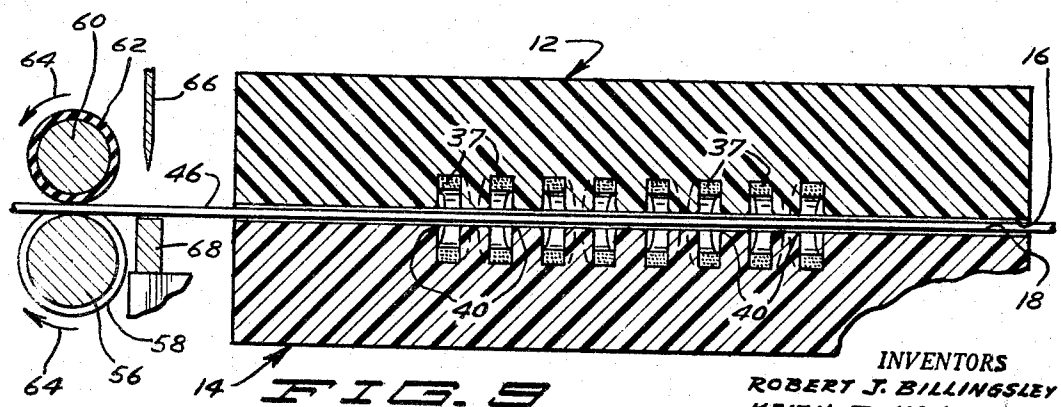


FIG. 8

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FERROMAGNETIC CORE WIRING FIXTURE

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ABSTRACT OF THE DISCLOSURE

A first plate having a plane surface contains a number of core-positioning recesses and a plurality of wire-guiding channels intersecting these recesses. By means of the channels, the wires are threaded into the apertures contained in the cores. A second plate having core-positioning recesses and wire-guiding channels is adapted to be assembled with the first plate with the plane surfaces of each plate confronting the other. The guiding channels are of different depth in order to locate the threaded wires at the requisite levels within the various cores. The ends of the wire-guiding channels are flared so as to provide enlarged entrances for the introduction of the various wires. Through the agency of upstanding posts, the plates are accurately positioned with respect to each other when assembled.

This invention relates to an assembling jig or fixture for use in the fabrication of ferromagnetic core memory matrices for computers. More particularly, the invention relates to a device for holding a plurality of ferromagnetic cores in a desired geometrical pattern and for guiding a plurality of conductors through apertures in the cores to couple them for subsequent use in a digital computer.

It is well known in the computer art to arrange storage elements, such as apertured ferromagnetic cores, in a regular pattern with their apertures disposed in aligned relationship with respect to rows and columns, for example. The various cores are typically interconnected by conductors which are manually threaded through the apertures in the cores, the ends of the wires being secured to the frame to complete the device. The number of cores in the matrix, the structure of the individual cores, and the number of wires interconnecting each core will vary, depending upon the particular electrical function or operation that the matrix is intended to perform. Generally, however, there are an extremely large number of very small core elements involved. A typical array will contain thousands of cores of only a few hundredths of an inch in size, for example.

It will be appreciated that the manual wiring of a memory matrix of the type here under consideration is difficult, cumbersome and subject to errors and nonuniformities. Cores are sometimes missed or damaged during the threading process and the wire is often kinked or otherwise displaced from its desired position and arrangement.

Accordingly, it is an object of this invention to provide a device for facilitating the wiring of magnetic core matrices. Stated more particularly, it is an aim of the invention to provide a device which eliminates the problems of hand-wiring techniques and which will permit mechanized assembly of magnetic core matrices.

Another object of the invention is to provide a fixture for accurately positioning the magnetic cores to be wired and for providing accurate control of the location of each of the individual wires with respect to the cores, and for accurately positioning the wires with respect to each other. By such accurate positioning of the cores and wires, optimum electrical characteristics are achieved.

It is another object of the invention to provide a wiring fixture for magnetic core matrices which will permit assembly of a matrix in much less time and at much less cost than is now required using manual wiring methods.

Still another object of the invention is to provide a mechanism for use in wiring a magnetic core matrix in which the quality of the finished matrix is appreciably better than that normally obtained with manual wiring methods.

Briefly described, the magnetic core matrix wiring fixture provided by the present invention includes a body of plate having a plane surface in which are formed a plurality of core-positioning recesses and a plurality of wire-guiding channels. The core-positioning recesses are arranged to support the cores to be wired in the proper orientations and positions with respect to the desired pattern of the matrix. The wire-guiding channels are each arranged to communicate with a plurality of the core-positioning recesses so as to guide a wire through the apertures in the cores positioned therein.

Preferably, the wiring fixture of the invention further includes a second plate having a plane surface containing core-positioning recesses and wire-guiding channels, the two plates being adapted to be assembled with their plane surfaces in abutting relation and with their respective core-positioning recesses in registry. Means are provided in the guiding channels to guide the various wires into separate planes so that a network of accurately positioned wires may be obtained.

Other objects, advantages and novel features of the invention will become apparent from a reading of the following detailed description when considered in conjunction with the accompanying drawings, wherein:

FIGURE 1 is an exploded elevational view of a fixture according to the invention, with the size of the wire-guiding channels exaggerated somewhat to illustrate their dimensional relationships to each other and without any magnetic cores in place in the fixture;

FIGURE 2 is a plan view of the top plate of the fixture, taken on the line 2—2 of FIGURE 1;

FIGURE 3 is a detailed view of a portion of the surface of the top plate of the fixture, the scale being considerably greater than that of FIGURE 2;

FIGURE 4 is a plan view of the bottom plate of the fixture, taken on the line 4—4 of FIGURE 1;

FIGURE 5 is a greatly enlarged detailed view of a portion of the bottom plate, similar to FIGURE 3;

FIGURE 6 is a partial vertical sectional view taken on the line 6—6 of FIGURE 5, but including the top fixture plate in slightly spaced relation above the bottom plate and illustrating a toroidal core in place;

FIGURE 7 is a top view of a wire-feeding apparatus and the fixture of the invention, showing the relative arrangement of these devices in the practice of the invention;

FIGURE 8 is a detailed view of a portion of the wire-feeding apparatus taken on the line 8—8 of FIGURE 7; and

FIGURE 9 is a sectional view through the fixture and part of the wire-feeding apparatus of FIGURE 7, taken along line 9—9 of FIGURE 7.

In the illustrated embodiment of the invention, the core wiring fixture is generally indicated at **10** throughout the several views of the drawings. As seen in FIGURE 1, for example, the fixture **10** consists of a top plate **12** and a bottom plate **14**, the top plate **21** having a plane surface **16** and the bottom plate **14** having a plane surface **18**, which surfaces are adapted to be brought into abutting relation when the parts are assembled. Surface **16** contains a first set of parallel channels **20** and a second set of parallel channels **22** arranged as best seen in FIGURE 2, and surface **18** contains a set of channels

24 and a set of channels 26, as seen in FIGURE 4. The various channels open through the peripheral edges 28 and 30 of the plates 12 and 14, respectively, so that wire may be inserted therein from the sides of the fixture 10.

Each of the plates 12 and 14 has a plurality of core-positioning pockets or recesses arranged in the desired pattern, which, for illustrative purposes, has been shown as an 8 x 8 square matrix. This pattern is typical of arrangements now in use, although usually a larger matrix with many more cores is employed. The several recesses in the plate 14 have been designated at 32 in FIGURE 4, while those in plate 12 are designated by reference numeral 34, FIGURE 2. As is apparent in FIGURES 2 and 4, the recesses 32 and 34 are arranged in rows and columns.

Means are provided for collocating the fixture plates 12 and 14 to bring the core-positioning recesses 32 and 34 into accurate registry when the surfaces 16 and 18 are in abutting relation. To this end, a plurality of upstanding dowel pins or posts 35 are provided on plate 14, posts 35 being adapted to enter correspondingly located bores 36 in plate 12. At least two sets of such posts and bores are required for collocation, but in the preferred embodiment shown, four posts are employed to give added strength to the assembled fixture.

FIGURES 6 and 9 further illustrate the relationship of the core-positioning recesses 32 in the fixture plate 14 to the recesses 34 in the fixture plate 12 when fixture 10 is assembled. In the exemplary embodiment shown, the core-positioning recesses 32 and 34 are adapted to hold toroidal cores 37 which are rectangular in cross section, that is, which consist of flat circular discs with cylindrical apertures. Thus, the core-positioning recesses are rectangular, when viewed as in FIGURES 2 and 4, to cooperate with the side faces of the cores to align their axes in the desired directions. The surfaces 38 and 39 of the recesses 32 and 34, respectively, are circular to conform to the peripheral shape of the cores 37 and are cut to such a depth that when the cores 37 are in place in the recesses, the planes of the surfaces 16 and 18 will intersect the apertures in the cores. The recesses 32 and 34 will thus position the various cores 37 with their axes parallel to the channels 20 and 22 in the fixture plate 12, and with their axes at 45° positions with respect to the channels 24 and 26 in the bottom plate 14. Thus, it will be apparent that each core is traversed in at least three directions, that is, its axial direction and the two directions at 45° to either side thereof.

Provision is made to guide each set of parallel wires into a plane separate from the planes occupied by the other sets so that a network of wires can be inserted through the cores in the three directions shown. It will be noted in FIGURE 1, for example, that the channels 24 and 26 in the fixture plate 14 have the bottoms thereof spaced from each other by the distance indicated as *d*, that is, the channels 26 are deeper by the distance *d* than the channels 24. The distance *d* is made larger than the diameter of the wire which is to be passed through hte guide channels, so that wires lying in the bottoms of the channels 26, for example, will lie wholly below the bottoms of the channels 24. In this manner, wires can be passed through the channels 24 to overlie wires which have previously been passed through the channel 26.

The arrangement of the channels 20 and 22 in the fixture plate 12 is similar to the arrangement of the channels 24 and 26. Thus, the channels 22 are deeper, with respect to the surface 16, than the channels 20 so that, with the entire assembly inverted from the relationship shown in FIGURE 1, wires lying in the bottoms of the channels 22 will underlie wires lying in the bottoms of the channels 20.

The electrical arrangements of some memory matrices require that two wires pass in the same direction through a row or column of cores. In the present embodiment, the channels 26 have been constructed to permit the insertion of two wires simultaneously into each of the channels. Thus, as shown in FIGURE 5 for example, the channels 26 are substantially twice as wide as the channels 24, which are intended to accommodate only a single wire.

One other feature of the wire-guiding channels 20, 22, 24 and 26 remains to be pointed out, that being the flaring of the intersections of the various channels with the core-receiving recesses and with other channels, to facilitate the passage of the wires through the fixture. The rounding or flaring is indicated best in FIGURES 3, 5 and 9, for example, where it can be seen that the rounded edges of the intersections of the channels with the walls of the various fixture recesses and intersecting channels are indicated at 40 and the enlarged entrances which are formed thereby are designated at 41. For convenience, the flared entrances 41 are provided at both sides of a core positioning recess or an intersecting channel, as shown, so that wire may be passed through the channels in either direction selectively. As stated, this arrangement is provided for convenience and it will be understood that if it is desired to pass wire through the fixture from one side only, then only the entrances to the channels on the sides of core-positioning recesses and intersecting channels which are remote from the starting end would be provided with the rounded edges 40.

In order to aid in the understanding of the use of the present invention, FIGURES 7 to 9 have been provided to illustrate diagrammatically an apparatus for feeding the various conductors or wires through the fixture and the relationship of the fixture to the feeding apparatus. Thus, in FIGURE 7, a bank of spools 42 supported on a suitable shaft 44 has been shown for supplying a plurality of wires 46. From the spools 42, the various wires 46 are passed through an apertured plate 48 to provide the desired spacing between the wires and are then passed through a set of advancing rollers generally designated 50 which are rotated through suitable gearing 52 by a motor 54.

The structure of the advancing rollers 50 is illustrated in FIGURES 8 and 9, where it will be seen that a bottom roller 56 is provided which has a plurality of peripheral grooves 58 to aid in the positioning of the wires 46. A top roller 60 is provided with a peripheral surface 62 of rubber or other resilient material and the arrangement is such that the resilient surface 62 frictionally engages the wires and holds them in the grooves 58. Rotation of the rollers in the direction of arrows 64, FIGURE 9, will thus advance the wires to the right, as seen in FIGURES 7 and 9.

A knife 66 is provided for cutting off the wires after they have been inserted through the fixture, the knife cooperating with an anvil 68 located below the set of wires, as suggested in FIGURE 9. The knife and anvil arrangement is located between the advancing rollers 50 and the fixture 10, so that when it is actuated the ends of the wires will be retained in the advancing rollers 50.

The manner of using the fixture of the invention should now be clear. First, the fixture plates 12 and 14 are separated and the cores 37 are inserted into the core-positioning recesses 32 in the lower plate 14. After all of the cores are in place, the upper fixture plate 12 is superimposed on the lower plate 14 and is brought down so that the surfaces 16 and 18 are in abutting relationship. The cores are now properly positioned to be wired.

The assembled fixture 10 is then placed in position in front of the advancing rollers 50 and the knife 66, in the desired position to have a set of wires passed therethrough. The actual wiring sequence is not material, but, for purposes of illustration, let it be assumed that the first wiring operation is to be the feeding of a set of eight wires simultaneously through the channels 24 in the bottom fixture plate 14. First, the feeding apparatus is set up with eight wires in the feeding rollers 50, as shown. The

fixture **10** is then placed in position with the channels **24** parallel to the feeding direction of the wires. The advancing rollers are actuated to feed the wire into the channels **24** and to pass the wire completely therethrough to the opposite side of the fixture **10**. After the wires emerge from the opposite side of the fixture, the knife **66** is actuated to cut them off and the first wiring operation is then complete.

The wiring of the other channels follows similarly. Again, the fixture would be positioned in the proper direction with respect to the feeding direction of the wires, the wires are passed through the fixture and the cut-off operation is performed. It will be understood, of course, that when it is desired to feed the wire in pairs, as was discussed above with respect to channels **26**, a feeding apparatus, now shown, capable of handling the wires in pairs, would be employed. For threading the seven wires through the openings **20** and **22**, one of the wires **46** may simply be omitted from the feeding apparatus shown.

The wires can be passed through the openings **20** in the top plate **12** of the fixture without inversion thereof, since the surface **18** will define a bottom of the guide channels **20** when the two plates **12** and **14** are assembled. When it is desired to pass a set of wires through the channels **22** in overlying relationship to the channels **20**, the entire fixture **10** is inverted so that the bottoms of the channels **22** are lowermost. The wire can then be advanced through the channels **22** and will pass beneath the wires which have already been inserted into the channels **20**. After the wire has been inserted into the channels **22**, the knife **66** is again actuated to cut off the wires. The fixture is then opened and the completely wired core matrix is lifted out of the fixture **14**.

It should not be apparent that a wiring fixture has been described which fully meets the objects of the invention set forth hereinabove. In particular, the device allows for a completely mechanized threading of conductors through magnetic memory cores and because of the accurate positioning of the cores and the wires therethrough, the various advantages of savings in time and expense and increased quality of the product are provided.

Of course, the invention is not limited to the structure shown. For example, the number, structure and arrangement of the core-positioning openings and guide channels may be varied to accommodate the desired structure of the finished matrix. Accordingly, it is to be understood that within the scope of the appended claims, the invention may be practiced otherwise than herein specifically described.

We claim:

1. A wiring fixture for use in assembling magnetic core matrices having a plurality of apertured magnetic cores arranged in a predetermined pattern in which the apertures in said cores are aligned with respect to rows and columns and said cores are joined by a network of wires passing through the apertures therein comprising a fixture plate having a plane surface, means defining a plurality of core-positioning recesses in said plane surface, said recesses being arranged in said predetermined pattern so that said cores are held in said predetermined pattern with the plane of said surface intersecting the apertures therein, means defining a plurality of wire-guiding channels in said plane surface, said wire-guiding channels extending from the periphery of said plate and each communicating with a plurality of said core-positioning recesses, said wire-guiding channels being arranged in parallel sets traversing said rows and columns in predetermined intersecting directions with respect to said rows and columns, one set of said wire-guiding channels being deeper with respect to said plane surface than another set of said wire-guiding channels whereby wires may be inserted into said wire-guiding channels to be guided thereby through the apertures in said cores and certain of said wires disposed adjacent the bottoms of one set of said wire-guiding channels will occupy a plane space from the plane occupied by other of said wires disposed adjacent the bottoms of the other set of said wire-guiding channels.

2. A magnetic core matrix wiring fixture as recited in claim **1**, further comprising a second plate having a plane surface, means defining a plurality of core-positioning recesses arranged in said predetermined pattern in said surface of said second plate, means defining a plurality of wire-guiding channels in said surface of said second plate, and means for collocating said plates with their said plane surfaces in abutting relation and their core-positioning recesses in registry.

3. A magnetic core matrix wiring fixture as defined in claim **2**, wherein said wire-guiding channels in said second plate are arranged in parallel sets traversing said rows and columns in predetermined intersecting directions other than the directions of said wire-guiding channels in said first-mentioned plate, one set of said wire-guiding channels in said second plate being deeper with respect to said plane surface of said second plate than another set of said wire-guiding channels therein.

4. A magnetic core wiring fixture as defined in claim **3**, wherein each of said wire-guiding channels in each of said plates is adapted to have a wire passed therethrough in at least one direction from an entrance end thereof, each wire-guiding channel being flared to provide an enlarged entrance thereto adjacent each of its cooperating core-positioning recesses and each of its intersecting wire-guiding channels on the sides thereof remote from said entrance end of said wire-guiding channel.

5. A magnetic core matrix wiring fixture as recited in claim **4**, each said wire-guiding channel being flared adjacent both sides of its cooperating core-positioning recesses and its intersection wire-guiding channels, whereby passage of wire in either direction through said wire-guiding channel is facilitated.

6. A magnetic core matrix wiring fixture as defined in claim **5**, each of said core-positioning recesses in both of said plates being adapted to support cores of predetermined size and shape, said core-positioning recesses conforming to the shape of said cores.

7. A magnetic core matrix wiring fixture as recited in claim **6**, wherein said collocating means comprises at least two posts upstanding from said plane surface on one of said plates and means defining correspondingly positioned openings in the other of said plates.

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