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Draving et al.

[11] 3,772,755

[45] Nov. 20, 1973

[54] **APPARATUS FOR WIRING CORE MEMORY CORES**

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[73] Assignee: **Micro-Miniature Parts Corporation,** Willow Grove, Pa.

[22] Filed: **June 14, 1972**

[21] Appl. No.: **262,783**

Related U.S. Application Data

[62] Division of Ser. No. 2,165, Jan. 12, 1970, Pat. No. 3,694,913.

[52] **U.S. Cl.** ..... **29/203 MM,** 29/241, 29/604

[51] **Int. Cl.** **H05k 13/04,** B23p 19/04

[58] **Field of Search** ..... 29/203 MM, 604, 241; 140/92.1

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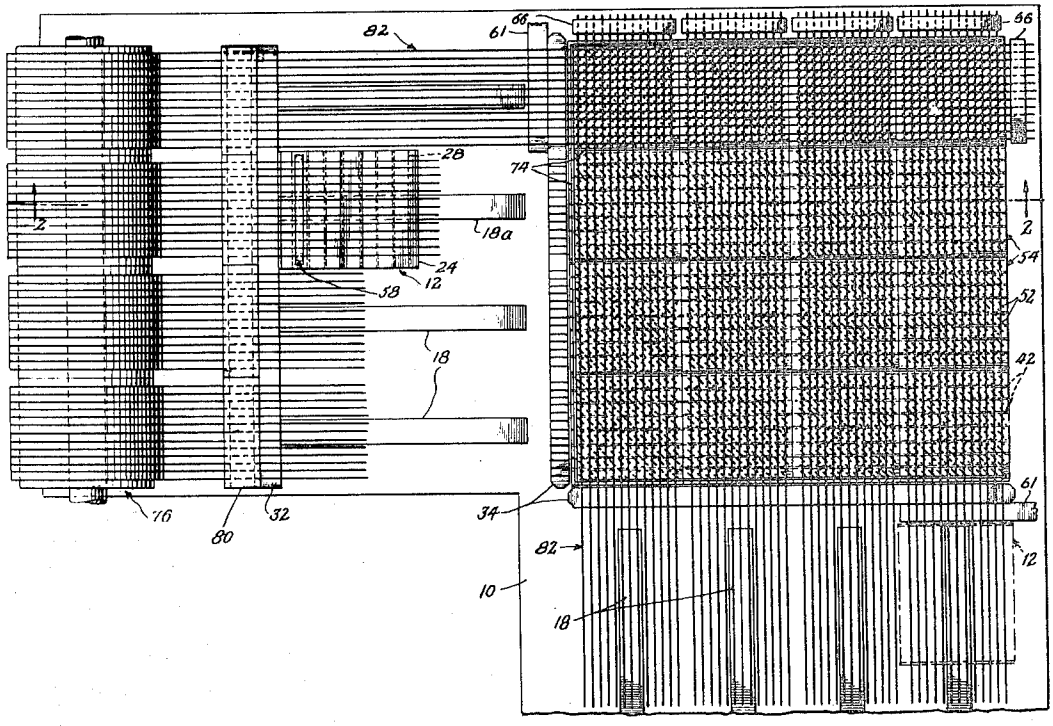
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[57] ABSTRACT

An apparatus for wiring the apertured cores of a core memory which includes placing the cores in a magnetic field and translating the wires through the apertures by means of magnetic needles.

6 Claims, 18 Drawing Figures



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SHEET 1 OF 4

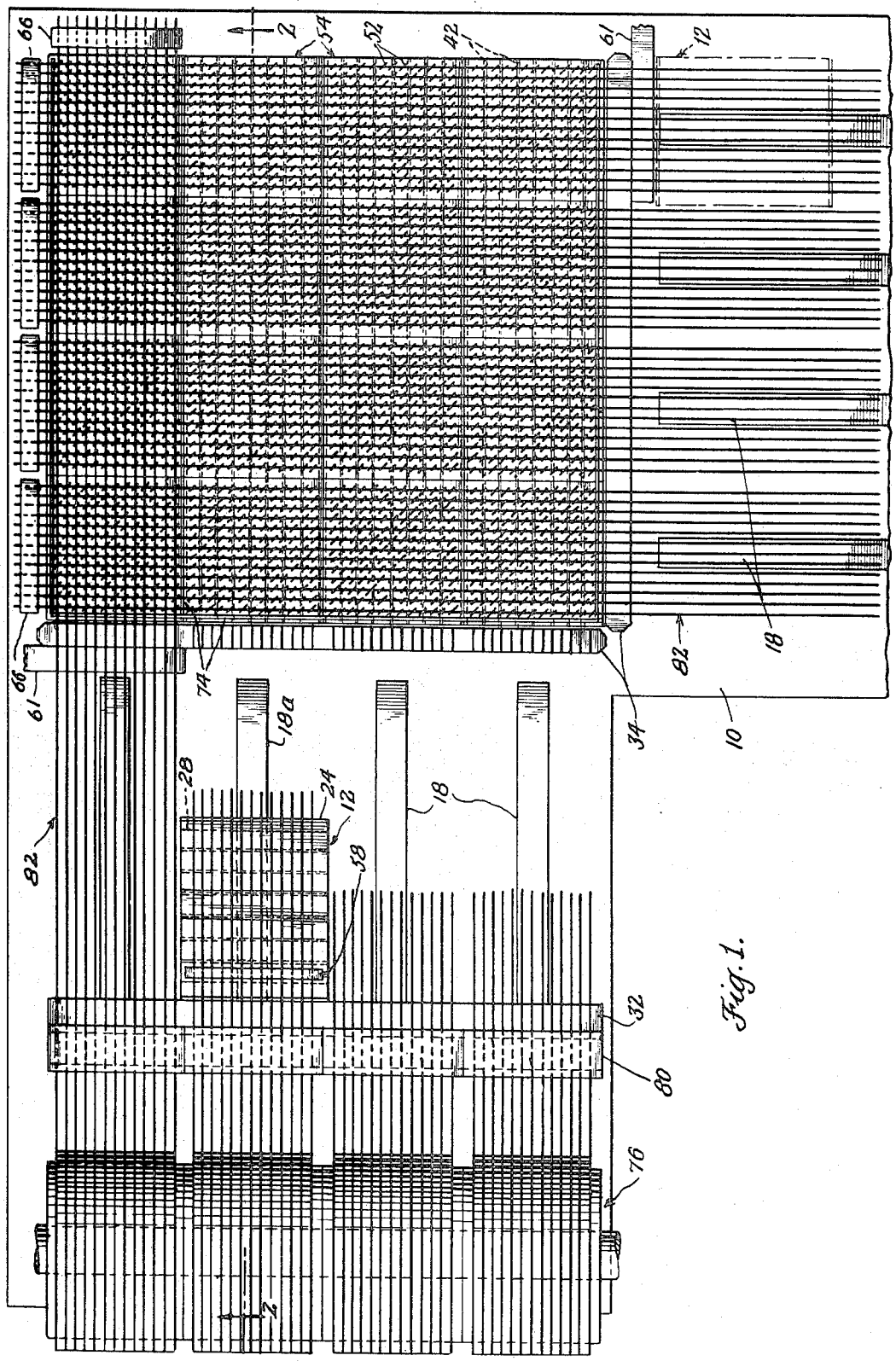
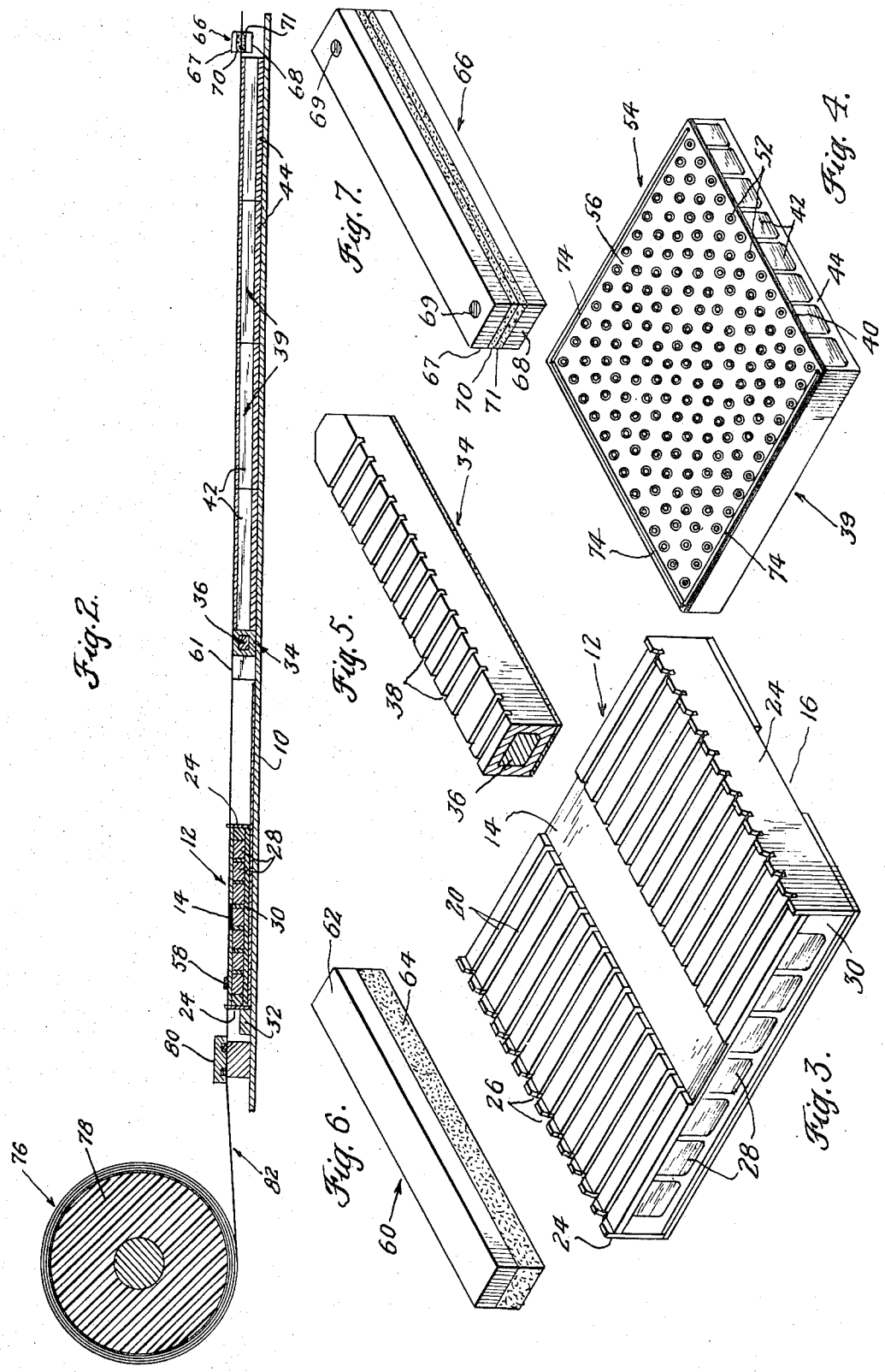


Fig. 1.


Fig. 2.
Fig. 3.
Fig. 4.
Fig. 5.
Fig. 6.
Fig. 7.

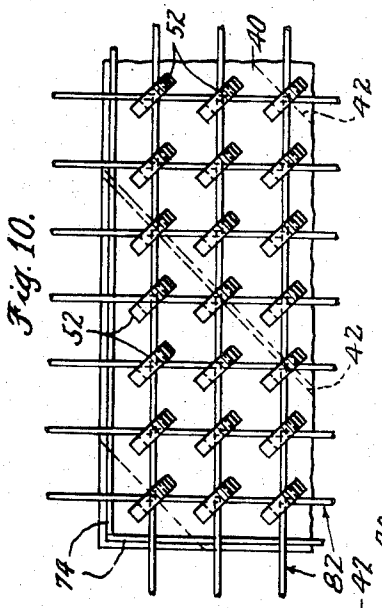


Fig. 10.

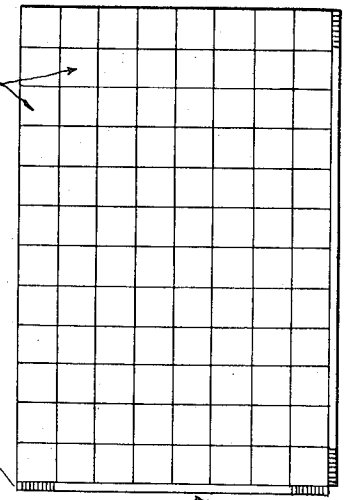
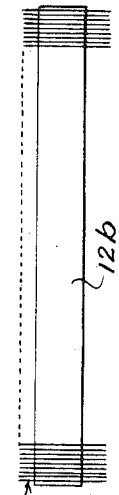


Fig. 11.



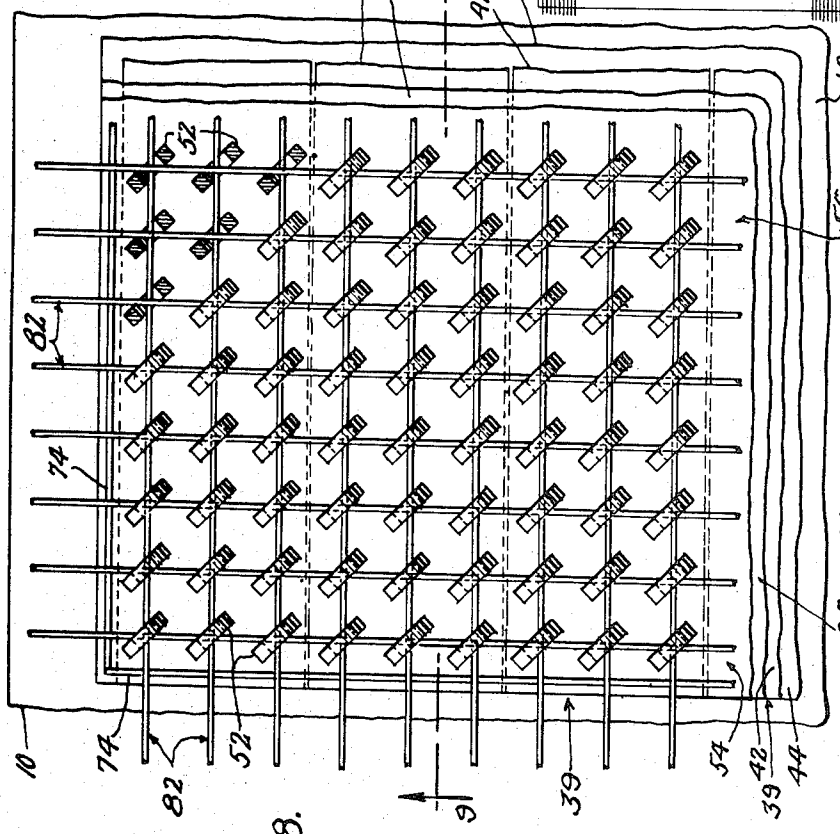


Fig. 8.

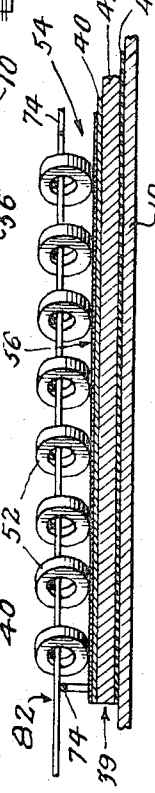


Fig. 9.

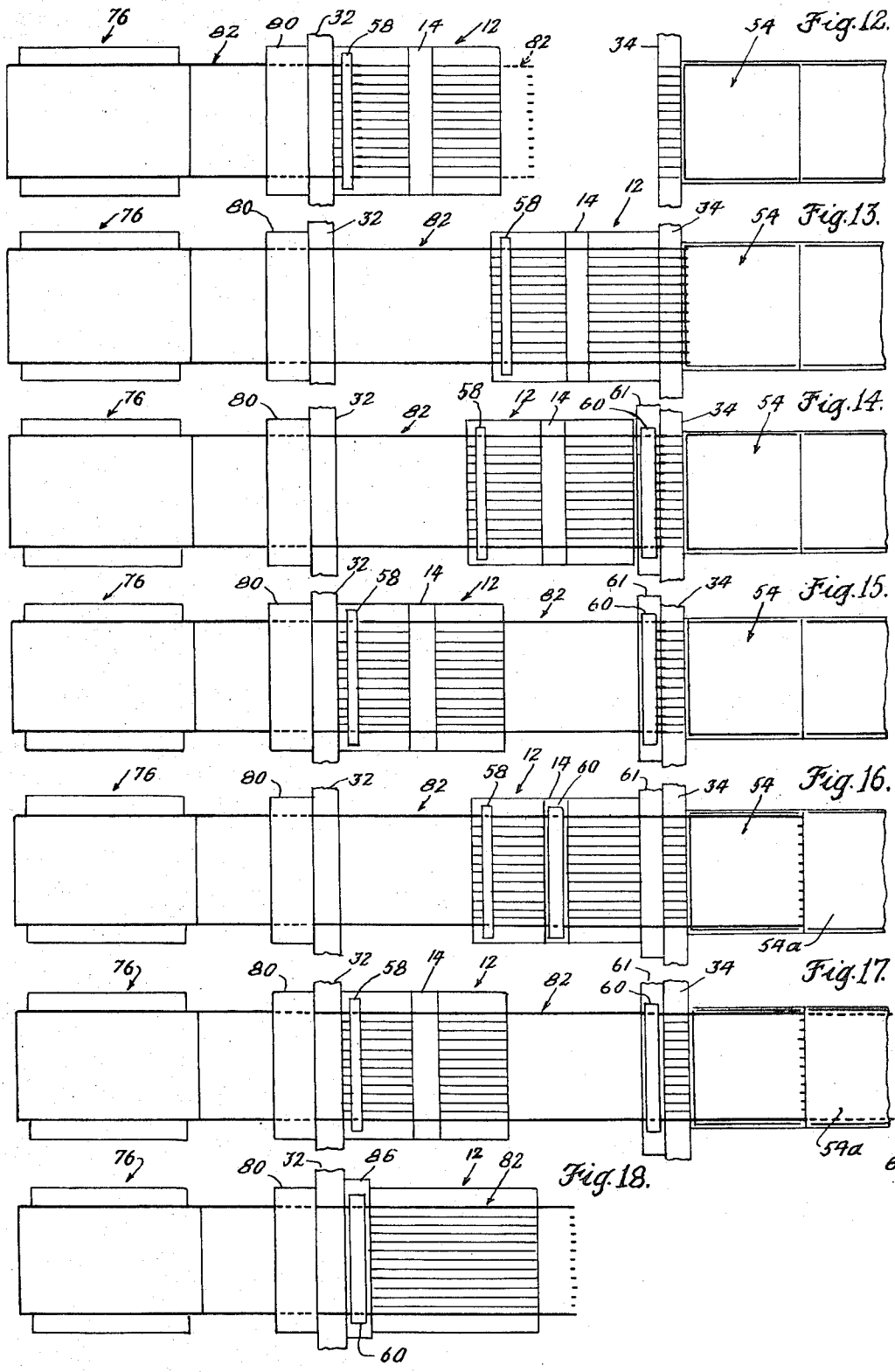


Fig. 12.
Fig. 13.
Fig. 14.
Fig. 15.
Fig. 16.
Fig. 17.
Fig. 18.

APPARATUS FOR WIRING CORE MEMORY CORES

This application is a division of U. S. Ser. No. 2,165, filed January 12, 1970, U.S. Pat. No. 3,694,913.

The invention relates in general to core memories for computers, and more particularly to an apparatus for wiring of the apertured cores used in these memories.

In a core memory (for example, a 2-D core memory), a large number of ferrite cores are arranged in a single plane in rows, the axes of which intersect at right angles in a grid pattern, the plane of each core being set at a position of approximately 45° with respect to the axes of the rows. In a memory, these cores are grouped together (to facilitate wiring) in a number of core patches. A typical mass memory may contain 96 core patches, each core patch containing more than 16,000 cores. The details of these cores are not perceivable by the naked eye, a typical core having a diameter of approximately 12 mils.

The cores, in order to attain the desired data storage and data output from a mass memory, are provided with wires which pass through openings or apertures in each core in each row. With rows of cores extended at right angles to each other and with the cores at 45° to the axes of the rows, the opening or aperture in each core contains an intersection of two wires. In each opening or aperture, the wires extended in one direction must assume a predetermined relationship to the wires extended at right angles thereto. For example, in one preferred pattern, the wires of the first group must be either above the wires of the second group in each and every opening or aperture, or below the wires of the second group in each and every opening or aperture. If the desired predetermined relationship does not exist, the memory will not function properly.

At the present time, wiring the cores is expensive and time-consuming. Also, cores are damaged in the course of wiring a core patch, as well as when wiring a mass memory. When a core is damaged, this necessitates that the core be removed, discarded, and replaced and that the rows of which that core was a part have to be rewired. This unnecessarily adds to the total cost of the wiring.

An object of this invention is the easy, inexpensive, and expeditious wiring of core memory cores, especially the cores of a mass memory.

Another object of this invention is a reduction in the number of cores which must be rewired because of damage during the wiring process.

Another object and a more complete understanding of the invention may be had by referring to the following description and claims, taken together with the accompanying drawings, in which:

FIG. 1 is a plan view of a plurality of core patches resting on an apparatus embodying the invention. The cores are shown far larger than they are in fact;

FIG. 2 is a longitudinal section taken along the line 2—2 in FIG. 1;

FIG. 3 is an isometric view of a shuttle employed in the apparatus;

FIG. 4 is an isometric view of a core patch resting on a support as provided according to the invention;

FIG. 5 is an isometric view of a grooved guide also employed in the apparatus;

FIG. 6 is an isometric view of a needle-holding pad employed;

FIG. 7 is an isometric view of a drawing clamp employed;

FIG. 8 is an enlarged plan view of a portion of a core patch resting on a portion of an apparatus embodying the instant invention;

FIG. 9 is a longitudinal section taken along the line 9—9 of FIG. 8;

FIG. 10 is a fragmentary plan view similar to FIG. 8 but illustrating an alternative arrangement for positioning the cores for wiring;

FIG. 11 is a diagrammatic view illustrating a mass memory consisting of 96 core patches and showing a modified shuttle arrangement;

FIGS. 12–17 are diagrammatic representations of a sequence of wiring steps as carried out by apparatus of the kind shown in FIG. 1; and

FIG. 18 is a diagrammatic representation of a modified shuttle and related parts.

In FIGS. 1 and 2, a preferred embodiment of the invention is illustrated. The apparatus there shown has a base 10. Movably mounted on this base 10 is the shuttle 12, also shown in FIG. 3, which shuttle has a transverse channel 14 in it. On the underside of the shuttle 12 is a trackway 16 which is adapted to receive any one of the tracks 18 on the base 10. When the shuttle 12 is placed on a track 18, and the track is fitted into the trackway 16, the shuttle 12 may be moved back and forth on and is guided by that track 18. This structure establishes a path of translational motion for the magnetic wiring needles, to be described later.

The shuttle 12 has a plurality of longitudinal grooves 20 in its upper side, adapted to receive the wiring needles. The end walls 24 'f the shuttle project upwardly from the body of the shuttle and have V-slots 26 in their upper edges. These V-slots are aligned with the longitudinal grooves 20 in the upper sides of the shuttle.

It is contemplated that the shuttle comprises or incorporates material having the properties of a magnet so that the wiring needles, when placed in the grooves, will be retained therein. Preferably, the body of the shuttle is formed of a non-magnetic material, such as aluminum, and the properties of a magnet are contributed to the shuttle by the use of magnets positioned within the body.

In the preferred embodiment, the body of the shuttle 12 is made of aluminum and has positioned therein a plurality of magnet strips 28. These magnet strips are transversely positioned within and extend from side to side of the shuttle 12, and are fixed in place by epoxy 30. An adhesive other than epoxy, or some other fastening means, may be used.

The magnet strips 28 may be formed of magnetized material of a variety of types. In the preferred embodiment, they are a flexible strip magnet marketed under the brand name ECLIPSE, and according to the container in which they are sold, they originate from James Neill and Company (Sheffield) Limited.

The travel of the shuttle is restricted at one end by the bar 32 and at the other end by the guide 34, shown in FIG. 5, as well as in FIGS. 1 and 2.

Like the shuttle, it is contemplated that the guide 34 comprises or incorporates material having the properties of a magnet. Preferably, the body of the guide is made of a non-magnetic material, such as aluminum, and the properties of a magnet are contributed to it by the use of a magnet positioned within the body.

In the preferred embodiment, the body of the guide **34** is made of aluminum, and positioned within it is a magnet **36.** In the preferred embodiment, this magnet is an ECLIPSE strip, like those used in the shuttle, but it should be understood that any material having the properties of a magnet may be used.

The guide **34** has grooves **38** in its top, which grooves are adapted to receive the wiring needles. As in the shuttle, the wiring needles are positioned in the grooves **38** and are held there by the attraction of the magnet **36.**

The cores to be wired are mounted on the base **10,** adjacent to the guide **34,** and for this purpose a support structure **39** is provided for each core patch to be wired. One such support is shown in FIG. **4** and a plurality of these appear in FIG. **1.** It is contemplated that this core support **39** also comprises or incorporates materials having the property of a magnet. Preferably, the top plate of the support is made of a non-magnetic material, such as aluminum, and the properties of a magnet are contributed to it by the use of magnets positioned beneath it.

In the preferred embodiment, the surface plate **40** is made of aluminum and has positioned beneath it a plurality of magnet strips **42.** As illustrated in FIGS. **2** and **4,** these magnets **42** are positioned along the longitudinal axis of the apparatus. These magnets are held in place by epoxy **44,** which in turn is in contact with the base **10.**

The magnets **42** may be formed of magnetized material of a variety of types. In the preferred embodiment, they, like the magnets in the shuttle and the guide, are flexible strip magnets marketed under the brand name ECLIPSE.

In the embodiment shown in the drawings, each core patch **54** is shown as having a separate support **39.** It should be understood that the surface plates **42** may be integrated into one sheet.

To facilitate wiring, a plurality of cores are brought together in a core patch **54,** shown in FIG. **4.** A core patch has a base **56.** The cores, which as previously stated are aligned in rows and are positioned at a 45° angle to the axes of the rows, are attached to the base **56** by a suitable adhesive. Each core **52** is positioned on edge, i.e., is positioned in a plane which is substantially normal to the place of the base **56.** After the cores are wired, the base **56** is peeled away from them and discarded. A typical core patch for a 2-D memory has 128 rows in each direction.

In FIG. **1,** 16 core patches **54** are shown resting on the aluminum plate **40.** A selection of 16 core patches for the mass memory shown in FIG. **1** was done for illustrative purposes only. As previously stated, a typical 2-D mass memory contains 96 core patches, eight in one direction and twelve in the other direction. Such a mass memory is diagrammatically shown in FIG. **11.**

In FIG. **1,** it may be observed there are four tracks **18** paralleling the longitudinal axis of the apparatus and four more tracks **18** paralleling the transverse axis of the apparatus. These numbers correspond to the number of rows of core patches **54** in each direction.

For the mass memory depicted in FIG. **11,** there would be eight tracks **18** paralleling the longitudinal axis of the apparatus and twelve more tracks **18** paralleling the transverse axis of the apparatus. The shuttle modification illustrated in FIG. **11,** which does not require the plurality of tracks **18,** will be described later.

In addition to the items described above, the preferred embodiment of the invention includes a strip **58.** This strip **58** is made of a magnetic material (a "magnetic" material as used herein refers to a material which has or may assume the properties of a magnet or is attracted by a magnetic field), and lies transversely across the longitudinal grooves **20** in the shuttle. This strip **58** assists in retaining the wiring needles in the grooves **20** of the shuttle.

The preferred embodiment also includes a holding pad **60,** which is shown in FIG. **6.** This pad **60** fits into the transverse channel **14** in the shuttle **12,** and is also adapted to cooperate with the bar **61.** The upper portion **62** is preferably metallic. The lower portion **64** is made of a spongy material in order to provide good frictional engagement with the wiring needles when used in the manner described below.

Also for use with the preferred embodiment are the drawing clamps **66,** shown in FIGS. **1, 2,** and **7.** A drawing clamp comprises two portions **67** and **68.** These two portions may be fastened together with separable connectors **69.** The mating surfaces **70** and **71** of each portion preferably are made of a material having a high coefficient of friction so that when wiring needles are placed between the two portions and the portions are fastened together, the wiring needles will not with the application of a normal force pull out of the drawing clamps **66.**

Extending along the edges of three sides of the plate **40** are guide wires **74.** These guide wires also extend between the core patches, as shown in FIG. **1.** They establish the level at which the wiring needles will start to enter the rows of cores.

Copper wire is used to wire the cores of a core memory. This wire is deformed very easily. In order to facilitate translating this wire through the openings or apertures in the cores, the wire is butt welded to spring steel needles, thereby providing needle-wire assemblies **82.** These needles are more rigid than the wire, and therefore it is more difficult to deform them. After a strand of wire is drawn through the openings or apertures in a row of cores by these needles, the needles are detached from the wire and discarded.

Such needle-wire assemblies are packaged in multi-feed-wire packages, numbered generally as **76.** Such a package is disclosed in U.S. Pat. No. 3,450,359.

These feed wire packages include a rotatable spool **78** and a mounting block **80,** which is positioned upon the base **10.** Strands of the needle-wire combinations **82** are wrapped around the spool **78.** The needle ends of these combinations extend through the mounting block **80,** which has grooves in it to space the needles apart from each other.

To understand the operation of the apparatus described heretofore, it is helpful first to consider the translation of needles through the rows in one core patch. A diagrammatic representation of this is shown in FIGS. **12-16.**

Before considering FIGS. **12–16** in detail, recall that the cores of the core patch **54** are aligned in rows. Each core **52** is positioned edgewise to the base of the core patch **56.** The cores are positioned at a 45° angle with respect to the axes of the rows of the cores. Each row is positioned so that a pre-determined axis extending longitudinally of the apparatus goes through the opening or aperture in each core. And, a pre-determined axis extending transversely of the apparatus goes

through the opening or aperture in each core. This positioning is accomplished when the cores are assembled to make up the patches. This takes place before the cores are mounted on the supports 39 for wiring.

In FIG. 12, the needles of the needle-wire assemblies 82 have been drawn from the mounting block 80 of the multi-feed-wire package 76. One needle 82 has been placed in each longitudinal groove 20 of the shuttle 12. The number of needles 82 and the number of grooves 20 correspond to the number of rows of cores 52 in the core patch 54. The magnetic strip 58 is in place to help to retain the needles 82 in place in the grooves 20. Since both the needles 82 and the strip 58 are made of a magnetic material, they are attracted toward the bottom of the grooves by the magnet strips 28 in the shuttle 12. Observe that the needles 82 are depicted as extending beyond the edge of the shuttle 12.

In FIG. 13, the shuttle has been translated and has come into contact with the guide 34, the grooves of which are extended in the direction of the predetermined axes. The needles 82 have been extended through the grooves 36 in the guide 34 and over the guide wire 74. The guide 34 now magnetically holds the needles 82 in position to be inserted into and translated serially through the cores in each row of the core patch 54.

In FIG. 14, the shuttle has been retracted a distance sufficient for insertion of the bar 61 between the end of the shuttle and the guide 34. The holding pad 60 has been placed on the bar 61.

In FIG. 15, a force has been applied to the holding pad 60, which in turn frictionally engages the needles 82 between it and the bar 61. The shuttle 12 has been retracted, and has been again brought into contact with the bar 32.

In FIG. 16, the holding pad 60 has been removed from the bar 61 and has been placed in the transverse channel 14 in the shuttle 12. A force has been applied to the holding pad 60, the shuttle has been translated away from the bar 32, and again has been brought into contact with the bar 61. The force on the holding pad 60 prevents movement of the needles 82 with respect to the shuttle 12 while the shuttle 12 is being translated to the bar 61. This in turn rotates the spool 78 and unwinds more of the needle-wire combination 82. The needles are thereupon translated along one of the predetermined axes through the rows of cores 52 in the core patch 54. Observe that the needles 82 have passed through the core patch 54 and are ready for translation through the second core patch, here indicated as 54*a*.

In FIG. 17, the needles 82 are shown as having been translated through the second core pad 54*a*. The holding pad 60 has been placed upon the bar 61, and a force has been applied thereto. The shuttle has been retracted and brought into contact with bar 32, which previously occurred in FIG. 15. The next step in this operation would be a removal of the holding pad 60 from the bar 61, again placing this holding pad 60 in the transverse channel 14 in the shuttle, and advancing the shuttle to the bar 61, as is shown in FIG. 16. This would translate the needles 82 serially through the cores in the next core patch.

The steps shown in FIGS. 16 and 17 are repeated until the needles 82 have been translated along the predetermined axis through all the cores in the core patch. Such a condition is illustrated in FIG. 1 with reference to all of the core patches 54 arranged along the transverse axis of the apparatus (running from the bottom to the top as shown in FIG. 1).

Also, the drawing clamps 66 have been applied to the leading portions of these needles to hold them in place and in preparation for drawing the wires connected with these needles through the cores after the insertion of the needles along the longitudinal axis in accordance with the description below.

Referring now to FIG. 1, this longitudinal wiring has been completed for the top row of core patches, and the needles 82 have been secured at the end of these core patches by the drawing clamp 66. These needles were drawn through by the sequence of steps described heretofore in connection with the discussion of FIGS. 12–17. The shuttle 12, which had been used to transmit the needles 82 through the top row of core patches along the longitudinal axis, as well as those aligned with the transverse axis, is put in place on the track here numbered 18*a* for translation of the needles through the second row of core patches along the longitudinal axis of the apparatus. The shuttle is shown in the same position as it is in FIG. 12. The translation of the needles through the second row of core patches along the longitudinal axis will take place by following the sequence of steps shown and described in connection with FIGS. 12–17. Needles will be translated sequentially through third and fourth rows of core patches along the longitudinal axis by a similar sequence of steps.

In FIGS. 8 and 9, needles 82 are shown in place as they are in each core patch in the top row of core patches in FIG. 1. This shows the relative positions of the needles 82 extending along the transverse axis to the needles extending along the longitudinal axis. Note that the needles extending along the transverse axis are above in each opening or aperture of a core the needles extending along the longitudinal axis.

This relationship is readily effected by use of the invention, and occurs in the following way:

When the needles which are to be translated along the transverse axis of the apparatus cross the guide wire 74, they are directed towards the upper half of the apertures in the first core in each row. These needles also are affected by the magnetic field of the magnet strips 42. Specifically, it has been found that with the preferred embodiment herein described, each needle is magnetically guided to a position adjacent the upper side of the opening or aperture of each core. If the guide wire 74 has a diameter of a size so that the needles are directed into the lower half of the apertures in the first core in each row, then each needle is magnetically guided to a position adjacent the lower side of the opening or aperture of each core. As the needles are translated serially through the cores in a core patch, they continue to be magnetically guided to this same position, and therefore pass through the cores with little, or no, interference. Not only does use of this invention in the preferred embodiment guide the needles through the cores, but also it decreases the friction between the needles and the cores, apparently because the magnetic field is acting in opposition to the force of gravity. This becomes progressively more important as the number of cores through which the needles have been translated increases.

Upon insertion into the cores of the needles to be translated along the longitudinal axis, they too are affected by the presence of the magnetic field of the mag-

nets **42.** Each needle, by virtue of the presence of the guide wire **74,** is inserted into the upper half of the aperture, is magnetically guided toward the upper side of the opening or aperture of each core, and comes into contact with the transverse needle already there. As the needles are translated serially through the cores, they too are magnetically guided through the opening or aperture in each core. As is the case with the transverse needles, the frictional resistance to the passage of these needles also is reduced.

It is important to realize that another important advantage is produced by the use of this invention. If, while it is being translated, a needle comes into contact with a core, the needle will bend. The person using the apparatus may observe this bending. At that point, that person may halt the shuttle and jostle or rotate the needle until it finally is translated through the aperture of that core. If the needle will not pass through the core, the shuttle and needles are drawn back slightly and the position of the core is corrected, or it is replaced. Then, translation of the needles is resumed. This assures proper wiring, and also greatly reduces breakage of the cores which could result if a continuous force were applied to the needle even after its leading edge came into contact with the core.

After needles have been translated along both the transverse and longitudinal axes through all core patches, and have been secured by application of them of the drawing clamps **66,** the drawing clamps are pulled. This draws the wires, attached to the needles, through the apertures in the cores in the desired manner. The needles then are severed from the wires and are discarded.

Translation of a needle **82** through cores may be facilitated by forming the end of the needle as a cone. The angle of the cone preferably corresponds to the angle at which the needle meets the cores. In a 2-D memory of the kind shown, this angle is 45°.

If a needle having such a cone formed at its leading end comes into contact with a cone before it enters the aperture thereof, the cone likely will cause the leading end of the needle to be deflected from the core and enter the aperture thereof.

In FIG. **10,** a different means for positioning the cores **52** for wiring is shown. The magnets **42** are here illustrated placed on an angle of 45° with respect to the axes of the rows of cores. When this structure is utilized, cores **52** may be placed upon the surface of plate **40** having 45° slots to receive the cores, and the cores will thereupon be magnetically aligned in the slots at a 90° angle to the axes of the magnets. Such a structure obviates the necessity to construct core patches before the cores are placed on the plate **40** within the magnetic field of the magnets **42.**

In FIG. **11,** a modified shuttle **12***a* is shown. In FIG. **1,** one shuttle **12** is moved from one track **18** to the next track **18** as sequential rows of core patches are wired. In FIG. **11,** one shuttle **12***a* is mounted on the base **10,** which shuttle is wide enough to translate needles not merely through the cores of a single core patch, but through the cores of all of the core patches. Likewise, the shuttle **12***b* is wide enough to translate needles simultaneously through the cores of all of the core patches.

In FIG. **18,** there is illustrated a different form of shuttle. This shuttle does not have a transverse channel **14** and does not have a strip **58.** It does have a base strip **86** which is placed beneath the needles **82** on the shuttle and is adapted to receive the holding pad **60.** By this arrangement, the needles both are retained in the grooves **20** on the surface of the shuttle and are frictionally held in place while the shuttle is being moved during use of the apparatus.

In the preferred embodiment, the needles which are translated along the transverse axis are translated while the cores are in the magnetic field. It certainly is within the scope of the invention to perform such operation before the cores are placed in the magnetic field. After the transverse needles have been installed outside the magnetic field, the cores then may be placed within that field. The transverse needles will be guided to a side of the apertures of the cores, and the longitudinally directed needles then may be translated as described heretofore.

In the preferred embodiment, the magnet strips **42** are positioned at such a distance from the cores **52** when these cores are resting upon the support **39** that the magnetic needles **82** are guided to the upper side of the apertures of the cores when these needles are inserted into the upper half of these apertures. Likewise, the magnetic needles are guided to the lower side of the apertures of the cores when the needles are inserted into the lower half of these apertures. If the cores, however, are positioned closer to the magnet strips **42,** at a certain distance the magnetic needles are always guided to the lower side of the apertures of the cores.

Of course, it is within the scope of the invention to use it to wire cores in a mass memory according to a predetermined pattern different than that described above as being one preferred pattern. For example, more than two wires may be passed through the aperture in each core. In order to accomplish this, the cores must be positioned so that more than two predetermined axes would pass through and in different directions the apertures in the cores. For a further example, not all the wires translated along the longitudinal axis of the apparatus need be above all the wires translated along the transverse axis of the apparatus. Every other two wires along the longitudinal axis may be above and the rest below the wires translated along the transverse axis. This pattern may be accomplished by selectively varying the diameter of the guide wire **74** and the depth of the grooves **38** in the guide **34.**

Although the invention has been described with a certain degree of particularity, it is understood that the present disclosure has been made only by way of example and that numerous changes in details may be resorted to without departing from its spirit and scope, as hereinafter claimed.

What is claimed is:

1. Apparatus for wiring a series of apertured cores positioned so that a predetermined axis passes through the aperture in each core, the apparatus comprising means establishing a path of translational motion for a magnetic needle having a wire attached thereto, which path is extended in the direction of said axis to provide for translation of the needle serially through the apertures in the cores, and magnetic means including said cores for guiding the needle into a position adjacent one side of the apertures of the series of cores as the needle is translated through said apertures.

2. Apparatus as defined in claim **1** in which the means establishing the needle path comprises a shuttle for the needle and means for guiding the shuttle in a

path extended in the direction of said predetermined axis.

3. Apparatus as defined in claim 1 in which the means establishing the needle path comprises a shuttle having a groove for receiving the needle and having magnetic means for holding the needle in said groove and means for guiding the shuttle in a path extended in the direction of said predetermined axis.

4. Apparatus as defined in claim 2 and further including a guide device for the needle positioned adjacent an end of the series of cores being wired, said guide device having a needle receiving groove extended in the direction of said predetermined axis, and magnetic means for retaining the needle in the groove of the guide device.

5. Apparatus for wiring memory cores comprising: a core patch, said core patch comprising a plurality of magnetic cores temporarily mounted on positioning means such that the cores are vertically positioned and have apertures therein axially aligned in plural directions to thereby enable needles of magnetically susceptible material to be readily threaded through the apertures of said cores from said plural directions, the improvement comprising various mechanical means for facilitating the threading of the cores including first guide means positioned transverse to the path of a first set of needles for threading the cores in a first axial direction, said first guide means being effective to guide said needles with wires attached thereto to one side of the apertures of the cores in the vicinity of said first guide means, and second guide means positioned transverse to the path of a second set of needles for threading said cores in a second axial direction, said second guide means being effective to guide said second set of needles with wires attached thereto to another side of the apertures of cores in the vicinity of said second guide means whereby all of said second set of needles pass through said apertures in contact with said another side of said apertures and on a common side of said first set of needles.

6. The apparatus of claim 5 wherein said needles and said cores are aligned with respect to each other such that once the first needle threads the first aperture the balance of the needles are so positioned with respect to the apertures of the corresponding cores of the core patch to be threaded that said balance of the needles are readily threaded therethrough.

* * * * *

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,772,755 Dated November 20, 1973

Inventor(s) Walter J. Draving, Robert C. Draving

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Col. 2, line 33, " 'f " should read -- of --;

Col. 2, line 36, "sides" should read -- side --;

Col. 5, line 65, "axis" should read -- axes --;

Col. 6, line 18, "put" should read -- now --;

Col. 7, line 28, "of" should read -- to --;

Col. 7, line 40, "cone" should read -- core--.

Signed and sealed this 30th day of July 1974.

(SEAL)
Attest:

McCOY M. GIBSON, JR.
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents

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