A general object of this invention is to expedite the manufacture of apparatus comprising wired assemblies of small, apertured articles by eliminating the necessity for using needles or similar devices to guide the wires through the apertures in the articles.

Another object is to provide economical means for enabling a large number of thin, flexible wires to be threaded simultaneously through several rows of apertured articles whose holes are too small to permit the passage of hollow needles or similar wire guiding means.

Still another object is to enable the hole diameters in apertured magnetic memory elements to be reduced substantially below the minimum diameter which now is considered feasible when the conventional methods for manufacturing such apparatus are employed.

A further object is to expedite the manufacture of magnetic core memories by eliminating the hand-wiring operations which customarily are employed in threading certain of the wires through each core plane assembly and substituting therefor a multiple wire feeding operation by mechanical means.

A still further object is to introduce the desired skews or zigzags in the wiring by a simple mechanical motion instead of requiring a skilled hand threading operation for that purpose.

The invention features a novel method of mechanically pretreating a multiplicity of parallel wires by simultaneously stretching their forward end portions until these portions break, thereby causing the remainder of each wire to have a leading end portion which has been reduced and hardened by the tensile working of the wire in the vicinity of its break point. The hardened end portion on each wire, having a point that resembles the muzzle of a miniature bullet, then serves as an integral needle for guiding the remainder of the wire into and out of the successive aligned apertures in the cores or other apertured elements as the several wires are fed therethrough. The tensile stressing of the wires also serves to eliminate any ripples or bends in the stressed portions thereof.

Another feature of the invention involves the provision of a novel matrix for supporting the apertured elements while they are being wired, said matrix having adjoining fixed and movable portions which can be indexed with respect to each other for thereby skewing certain of the wires that have been threaded through these elements, the skewing action taking place on the lines where the fixed and movable portions of the matrix adjoin.

The foregoing and other objects, features and advantages of the invention will be apparent from the following more particular description of a preferred embodiment of the invention, as illustrated in the accompanying drawings.

In the drawings:

FIG. 1 is a plan view of an exemplary apparatus embodying the invention, said apparatus being utilized in this instance to insert a third set of coordinate wires into a core plane assembly which already contains two other sets of coordinate wires.

FIG. 2 is a fragmentary, enlarged plan view, partially in section, showing the novel mechanical pretreatment which is given to the wires by the apparatus of FIG. 1 just before said wires are inserted into the core assembly.

FIG. 3 is a partially schematic plan view of the respective portions of the core supporting matrix in their initial relative position, with the first two sets of coordinate wires positioned in the core assembly.

FIG. 4 is a plan view showing one of the matrix sections displaced relative to the other so as to impart a skew to one of the two sets of wires in the assembly, just before the insertion of the third set of wires therein. Fragmentary portions of the adjacent wire guiding means also are shown in this view.
FIG. 5 is a vertical section along the line 5-5 on FIG. 4. FIG. 6 is a fragmentary plan view, partially in section, showing the positions of some of the wires in the third coordinate set before the same are inserted into the core assembly.

FIG. 7 is a fragmentary vertical section showing one of the wires in the third set after it has been threaded through the first few cores in its respective row of cores. FIG. 8 is a fragmentary plan view which shows some of the wires in the third set after they have progressed through the assembly to positions above the skewed portions of the wires in the second set.

As indicated in the drawings, the principles of this invention may be applied very advantageously to the manufacture of core planes (planar core assemblies) which are used in magnetic core memories. This can be done in several ways. Thus, the invention may be utilized for inserting all of the coordinate wires into the core plane by multiple wire inserting operations performed without the use of needles. Even where some of the coordinate wires are inserted by means of hollow needles, however, as is done in the conventional partially mechanized wiring procedure, the invention still may find useful application in eliminating the slow and laborious hand-wiring operations that have been necessary in threading the remaining coordinate wires through the cores according to conventional practice. Not only are the hand-wiring operations intricate and time-consuming, but there is also the danger that the manipulations of the needles may damage the cores or the wires. These hand-wiring operations have been further complicated by the fact that in the conventional design, those wires which are inserted by hand are also the wires which must be skewed or zigzagged by hand. The present invention simplifies this procedure greatly by making provision for mechanically skewing or zigzagging certain of the wires which have been mechanically inserted into the core plane, thereby providing the desired noise cancelling effect without any hand-wiring operations.

In describing the embodiment of the invention disclosed herein, it is assumed that two of the three sets of coordinate wires employed in the assembly (namely, those sets conventionally designated the X wires and Y wires) already have been inserted into the core plane by a suitable technique, whether this be a conventional technique as disclosed in United States Patent No. 2,958,126, issued on November 1, 1960, in the name of W. P. Shaw et al., or by some other method such as the one herein disclosed. It will be assumed also (in accordance with conventional practice) that the coordinate wires in the third set, known as the inhibit-sense wires, have diameters such that these wires could not be fed through the cores by means of hollow needles. It is not hereby intended to limit the application of the invention to such a condition, however, for it will be obvious to those skilled in the art that the principle of the invention can be utilized for inserting any or all of the coordinate wires into an assembly of cores or like elements, regardless of whether or not such wires could or could not be inserted by other means.

Referring now to the drawings, FIG. 1 shows the general plan layout of an illustrative apparatus for inserting coordinate wires into a planar assembly of toroidal magnetic cores in accordance with the invention. The principal parts of the apparatus comprise a core supporting unit 10, a wire feeding unit 12 (movable to the left and to the right as viewed in FIG. 1), a wire clamping unit 14 (movable along a transverse path as indicated by the solid-line and broken-line positions thereof in FIG. 1), and a wire receiving unit 16 (movable to the right and to the left as in FIG. 1). The core supporting unit 10 has a matrix therein adapted to support the toroidal magnetic cores which are to be threaded by the coordinate wires. This matrix consists of a stationary section 18 and an adjacent movable section 20, which is capable of being shifted or indexed transversely of the wire path from the position thereof illustrated in FIG. 3 to the position thereof illustrated in FIG. 4, the purpose of this arrangement being described presently. In executing this movement, the matrix section 20 slides between the stationary matrix section 18 and another stationary member 21 on the core supporting unit 10, as will be described more fully hereinafter.

The wires 22, FIG. 1, which are to be inserted into the core plane are fed generally from right to left, as viewed in FIG. 1, by the wire feeding unit 12. During the mechanical pretreatment phase of the wire feeding operation, however, the wires may be pulled to the right, as viewed in FIG. 1, in order to break off their forward end portions which are held by the clamping unit 14. In performing this wire breaking step, the wire feeding unit 12 is moved slightly to the right. FIG. 1 shows the unit 12 in a position intermediate its extreme right-hand and left-hand positions, just prior to the breaking of the wires.

Referring now to FIGS. 1 and 3, the stationary matrix section 18 and the movable matrix section 20 are provided with individual core holding recesses (some of which are shown in FIG. 7) for holding the toroidal cores C in positions to be wired. These recesses 24 communicate through socket ports as 26, FIG. 7, with an exhaust channel such as 28 in the matrix sections 18 and 20, as the case may be. The exhaust channel in each of the sections 18 and 20 communicates with a suction pipe 30, FIG. 1, connected to a suitable air exhausting means (not shown). The suction maintained in the core receiving apertures 24, FIG. 7, helps to maintain the cores C firmly in place during the subsequent wire inserting operations. This core holding technique is well known and will not be described in further detail herein. Covers 82 for the matrix sections 18 and 20 are provided with wire slots as 25, FIGS. 6 and 7, to receive the wires 34 and 36.

It is assumed herein that the illustrated apparatus is being employed to insert a third set of coordinate wires 22, FIG. 1, into a core array which already contains two other sets of coordinate wires, the latter respectively comprising the X wires 34 and the Y wires 36, FIG. 3. As mentioned hereinabove, conventional means may be employed for threading the coordinate wires 34 and 36, respectively, through the cores C. This core holding technique is well known and will not be described in further detail herein. Covers 82 for the matrix sections 18 and 20 are large enough to accommodate the hollow needles that are used for guiding the wires 34 and 36 in conventional practice. However, the principles of the present invention have been extended to the threading of these X and Y wires, too, thereby eliminating all conventional wire threading techniques in the manufacture of core planes.

The instant description will be concerned specifically with the insertion of the third set of coordinate wires 22 (commonly known as the "inhibit-sense" wires) into the core plane as an example of the manner in which such wire threading operations can be performed according to the invention. As shown in FIGS. 6, 7 and 8, the wires 22 are considerably thicker than the wires 34 and 36 and could not be threaded through the cores C by means of hollow needles. In conventional practice the wires 22 would be inserted through the cores by hand, using solid needles welded to the wires, giving the same result.

As shown in FIG. 3, the toroidal cores C are positioned diagonally with respect to the X and Y wires 34 and 36 on which they are strung, as is customary in this type of apparatus. The wires 34 and 36 are secured at their outer ends to an open, rectangular, supporting frame 38 of insulating material, FIGS. 3, 4, 5 and 7, which carries individual metallic contacts (FIGS. 3, 4, and 7, and 42, FIGS. 3 and 4) to which the respective wires 34 and 36 are individually secured. Thus, the core array, prior to insertion of the third set of coordinate
wires 22 therein, consists of the open, rectangular frame 38 to which is secured a gridwork of intersecting ordinate wires 34 and 35 on which the cores C are strung, these cores being positioned at the individual bit storage positions respectively defined by the intersections of the X and Y coordinate wires 34 and 36. The upper edge portions of the stationary support members 18 and 21 are appropriately secured to receive the core frame member 38, as indicated in FIGS. 5 and 7, and the movable matrix section 20 is suitably recessed to receive said frame member and still permit the requisite sliding movement of the matrix section 20. If desired, fastening devices such as the screws 43, FIG. 3, may be utilized for holding the members in the support members 18 and 21 during the wire threading operation herein described.

It has been explained hereinabove that in order to provide the desired noise cancellation effect in a magnetic core memory plane, certain of the wires are skewed or zigzagged at predetermined places in the assembly. Customarily this is done at the time when the sense wires (or the combination inhibit-sense wires, where such are employed) are inserted into the core plane. In accordance with the present method of wiring a core plane, however, the desired skewing is imparted to one of the other sets of sense wires (this is shown in the X wires 34, FIGS. 3, 4, 5, and 4) before the third set of wires 22 is threaded through the array. Such skewing of the X wires 34 is accomplished very conveniently in the present apparatus by means of the movable matrix section 20, which is capable of sliding for a limited distance transversely of the direction in which the wires 34 extend. This will be explained in detail presently.

The partially wired core plane, consisting of the frame 38, ordinate wires 34 and 36 and the cores C, appears initially as shown in FIG. 3 (some of the wires and cores being omitted from this view for clarity). The X wires 34 initially extend in straight lines through the array and are suitably secured at their outer ends to the individual contact pieces 40 on the ends of the frame 38. The Y wires 36 respectively are secured to individual contact pieces 42 mounted on the sides of the core frame 38. For reasons which will be explained presently, transverse rows of anchor pins 44, 46, 48 and 50 are provided on adjacent edge portions of the matrix sections 18 and 20, and similar transverse rows of anchor pins 44, 46, 48 and 50 respectively are provided on adjacent edge portions of the matrix section 20 and the stationary member 21. These pins 44, 46, 48 and 50 initially help to locate the members 24 on the core wiring unit 10. Subsequently, when the matrix section 20 is moved from the position thereof shown in FIG. 3 to the position thereof shown in FIG. 4, these pins serve to anchor and support the skewed and unskewed portions of the wires 34 and to prevent stress from being exerted upon the cores C and upon the joints between the wires 34 and their contact pieces 40.

The purpose of skewing the wires 34, as represented in FIG. 4, is to provide the desired noise cancellation effect in the finished core plane. As mentioned hereinabove, such noise cancelling property customarily is provided by skewing the inhibit-sense wires of the array, but in the present instance it is preferred to accomplish this objective by skewing the X wires and leaving the inhibit-sense wires straight. In order to effect the desired wire skewing action, the matrix section 20 is actuated by a thumb screw 51, FIGS. 4 and 46, FIGS. 5, 4 and 46, which engages a tapped opening in a stationary supporting bracket 54 to bear against one side of the movable matrix section 20. It is assumed that the matrix section 20 is provided with suitable motion limiting means (not shown) for accurately locating it in either of its extreme positions. By turning the knob 52 on the side of the matrix section 20, the position thereof shown in FIG. 3 is moved from the position thereof shown in FIG. 4, during which movement the pins 46 and 48 thereon bear against the respective wires 34 and cause them to be skewed as represented in FIG. 4. The portions of the wires 34 disposed between the pins 44 and 46, and also between the pins 48 and 50 are stretched with the bending, leaving them with a permanent set so that they maintain the skewed positions thereof shown in FIG. 4 after the completed core plane assembly is removed from the apparatus. In practice the pins 44, 46, 48 and 50 are made retractable in order to facilitate the removal of the core plane from the apparatus upon completion of the wiring operation. The actual amount of indexing movement imparted to the movable matrix section 20 is on the order of .07 inch in a specific model of the illustrated apparatus which has been constructed. The displacement of the section 20 always will be a whole number of the row spacings between wires 34.

With the X wires 34 properly skewed as represented in FIG. 4, the core array now is ready to receive the third set of ordinate wires comprising, in this instance, the inhibit-sense wires 22, FIG. 1. Before these wires 22 are inserted into the array, however, their forward end portions thereof are given a mechanical pretreatment, in accordance with the principle of the invention, to provide needle-like leading ends on these wires 22. As a first step in this pretreatment process, the wire clamping unit 14 is moved from the broken-line position thereof, FIG. 1, to the position thereof represented by solid lines in FIG. 1, where it is adapted to grip or clamp the wires 22 near their forward ends. During the pretreatment operation on the wire clamping unit 14 is intermediate the core supporting unit 10 and the wire feeding unit 12 as shown in FIG. 1. The wires 22 extend from a source thereof (not shown) at the right of FIG. 1 and are passed beneath a wire clamping device 60 (presently in its raised position) on the wire feeding unit 12, thence beneath a feed roller 62 and finally beneath the raised clamping device 66 on the wire clamping unit 14. The feed roller 62 is provided with a hand wheel or knob 64, FIG. 1, and is positioned between two wire guide members or housings 68 and 70 mounted on the wire feeding unit 12. The members 68 and 70 have suitable wire guiding channels or grooves therein, the channels 72 in the guide member 70 being clearly shown in FIGS. 2, 6 and 7. Preferably the members 68 and 70 are made of clear plastic so that the wires 22 will be visible therethrough.

In performing the mechanical pretreatment, the wires 22 first are clamped in three places. The forward portions thereof are gripped by the clamping device 66, which is operated by suitable actuating means (not shown). The feed roller 62 is clamped by an associated clamping means operated by the hand wheel 76, FIG. 1, causing the roller 62 to be secured against rotation and pressing it firmly against the wires 22 beneath it. The means for clamping the wire feeding roller 62 is not shown in detail, but it is similar to a well-known mechanism for clamping the needle feeding roller in a conventional wire threading machine as shown, for example, in the aforesaid Shaw et al. Patent No. 2,958,126. The third point at which the wires 22 are clamped is beneath the clamping device 60, FIG. 1, which is operated by a handle 78. With the wires 22 first gripped by the clamps 60 and 66 and by the clamped feed roller 62, the mechanical pretreatment of these wires may commence.

Referring to FIGS. 1 and 2, the pretreatment is administered by retracting the feed unit 12 to the right, as viewed in these figures, until the wires 22 break as indicated in FIG. 2, leaving the forward end portion 22a of each wire disconnected from the remainder of its wire 22. It will be assumed that suitable means are employed for retracting the feed unit 12 to accomplish such breakage of the wires 22, the specific means employed not being pertinent to this invention. With the wires 22 being clamped as indicated in FIG. 1, and with the retracting force being applied gradually by movement of the feed unit 12, the portions of the wires 22 intermediate the
clamp 66 and the clamped feed roller 22 will be stretched gradually beyond their elastic limits and then will break at their weakest points. By experiment it has been found that all of the parts will tend to break within a space of less than 2 inches between the clamping unit 14 and the forward end of the wire guide housing 70 on the feed unit 12.

The wires 22 are made of a suitable material such as copper or copper alloy which tends to harden under tensile stress beyond its elastic limit. Such tensile working of the material in each of the wires 22 therefore causes the stressed portion of this wire to become hard and straight for a substantial distance. Moreover, as each wire 22 breaks, the leading end on the unbroken remainder of the wire 22 is reduced to a miniature "bullet nose" 80, as shown in FIGS. 2, 6, 7 and 8. Hence, by applying tensile stress to the wires 22 until the forward portions of 22a thereof are broken as shown in FIG. 2, the remainder of each wire 22 is left with a hardened leading end portion terminating in a pointed nose 80, and this hardened end portion is equivalent to a solid needle integral with the wire 22 and having a diameter no greater than that of the trailing portion of such wire.

After the forward end portions 22a have been separated from the remainder of their respective wires 22 as shown in FIG. 2, the clamping unit 14 is withdrawn to the broken-line position thereof indicated in FIG. 1. The handles 76 and 78 then are turned to release the clamping roller 62 and the clamping device 60, respectively. The knob 64 is turned sufficiently in the proper direction to retract the clamped wires 22 within the guide member 70 of the feed unit 12. As indicated in FIG. 2, the wires 22 break at various points in the gap between the clamping unit 14 and the guide member 70, so that the handle 64 must be turned through a sufficient angle for retracting the longest protruding length of wire 22 back within the guide member 70. The wire supply means (not shown) is assumed to take up the slack when the wires 22 are thus retracted into the guide member 70.

After the hardened leading end portions of the wires 22 have been retracted as just described, and the wire is withdrawn from the wire path, the entire wire feeding unit 12 now is advanced bodily to the left as viewed in FIG. 1, bringing the forward end of the guide member 70 into proximity with the stationary matrix section 18, as shown in FIGS. 6 and 7. The guide member 70 is adapted to overlap as a part of the matrix section 18 extending past the nearest end of the core frame member 38 to within a short distance of the first column of magnetic cores C on the matrix section 18.

To assist in holding the cores C in place, a suitable cover 82, FIGS. 2, 4, 5 and 7, is placed on each of the matrix sections 18 and 20, each of these covers 82 having individual recesses in its under surface for receiving the cores C and also being provided with channels or wire slots 25 therein for receiving the wires 22 as the latter are fed through the array. With the wire feeding unit 12 in its extreme left-hand position, the gap between the guide member 70 and the cover 82 is quite small. The cover 82, like the guide member 70, may be made of clear plastic in order to facilitate viewing the wires 22 as they are fed through the core array.

FIG. 6 shows, on an enlarged scale, the leading end portions of the wires 22 after they have been retracted back into the guide housing 70 and the housing 70 has been advanced to within a short distance of the first column of cores C. The wires 22 are led into the core plane by turning the knob 64, FIG. 1, to rotate the feed roller 62. As the wires 22 are being fed, the hardened leading end portions of the wires 22 serve to guide these such parts of the structure as the guide slots 72, the inner edges of the cores C, and the guide pins such as 44 and 46, FIGS. 6, 7 and 8. The arrangement preferably is such that the greatest distance between successive wire guiding points during the travel of each wire 22 will be on the order of 0.15 inch. The reduced nose portions 80 on the leading ends of the wires 22 enhance the self-guiding action afforded by the hardened leading end portions of these wires. FIG. 8 represents the leading end portions of the wires 22 as the latter leave the first part of the core plane, which is positioned on the stationary matrix section 18, and enter the second part of the core plane, FIGS. 20. It will be noted that the nose portions 80 of the wires 22 are not transversely aligned with each other in view of the fact that the wires 22 usually do not break in corresponding places when these wires are mechanically pretreated as above described.

The wire receiving unit 16, FIGS. 1 and 4, is adapted to receive the leading ends of the wires 22 after the same have emerged from the core plane. The unit 16 includes a guide member or housing 90, preferably made of clear plastic, which is appropriately grooved to receive the respective wires 22. The wire receiving unit 16 is movable from a position thereof shown in FIG. 1 to the position thereof schematically represented in FIG. 4, in order to receive the leading wire ends after they pass between the final guide pins 59 and out of the core plane assembly.

Briefly summarizing the operation of the illustrated apparatus, a partially wired core plane, containing the X wires 34, the Y wires 36 and the toroidal cores C strung on the intersections thereof, is placed on the core supporting unit 19 as shown in FIG. 3. The movable matrix section 20 then is indexed by turning the knob 52, causing the matrix section 20 to move from the position thereof shown in FIG. 3 to the position thereof shown in FIG. 4. This displaces those portions of the wires 34 which are disposed on the matrix section 20 relative to those portions of the same wires which are disposed on the matrix 18, the amount of displacement being a whole number of the row spaces between adjacent wires 34. The portions of the wires 34 disposed between the anchor pins 44 and 46, and between the anchor pins 48 and 50, respectively, are skewed as shown in FIG. 4 so that the final core memory array will have the desired noise canceling property.

The core plane now is ready to receive the third set of coordinate wires 22, which are assumed herein to be the inhibit-sense wires of the core plane. However, these wires 22 first must be pretreated mechanically so that they can be threaded through the cores without the aid of needles. To do this, the forward end portions of the wires 22 are clamped by the wire clamping unit 14, FIG. 1, whereupon the wire feeding unit 12 is retracted to the right as viewed in FIG. 1, causing the forward end portions 22a of the wires 22 to break off as indicated in FIG. 2. All of these wire breakages occur within the gap that now exists between the units 12 and 14. The wire clamping unit 14 now is retracted out of the wire path, while the broken ends of wires held thereby are released and disposed of. The tensile working of the wires 22 causes the material therein (principally copper) to become hardened, and it also removes any ripples in the end portions of the wires 22 so that the leading ends of these wires are hard and straight, thereby adapting them to perform a function comparable to that of the solid needles which are employed in the conventional hand-wiring practice to thread the inhibit-sense wires through the core array. The hardening of the wires 22 occurs principally in the tensioned portions thereof that are disposed in advance of the clamping device 60. However, it is believed that some tensioning and consequent hardening of the material occurs also in the portions of the wires 22 between the roller 62 and the wire clamping device 60, inasmuch as the clamped roller 62 probably does not completely restrain the wires 22 against movement relative thereto.
After being pretreated as just described, the wires 22 temporarily are retracted within the guide housing 70 (as indicated in FIG. 6) by rotating the now-released feed roller 62. The wires 22 then are brought to a point near the core plane by moving the wire feeding unit 12 to the position thereof shown in FIGS. 4, 5 and 6, following which these wires are advanced through the core array by turning the feed roller 62. As illustrated in FIG. 7, the wires 22 pass above the wires 34 in parallel relation therewith and cross over the wires 36 at right angles thereto. Due to the preliminary skewing of the wires 34, as described above, each wire 22 will overlie different ones of the wires 34 in the two sections of the core array that are respectively positioned on the matrix sections 18 and 20. This is clearly indicated in FIG. 8. After the wires 22 have advanced through the core plane and into the wire receiving unit 16, FIG. 1, they are trimmed by a cutting means (not shown). Following this, the wires 22 may be bonded to individual contact pieces (not shown) mounted on the core plane frame 38. Assembly of the core plane with its three sets of coordinate wires now is completed.

The term "wire" as employed herein is intended to denote a thin, normally flexible filament, especially one made of copper, copper alloy or other suitable material which has the property of becoming related hard, rigid or stiff when subjected to a tensile stress beyond its elastic limit. The tensile working of such material which occurs upon stretching and breaking off a portion of the wire tends to straighten any ripples in the wire and conveniently provides it with a needle-like end portion which is relatively hard or stiff for a substantial distance back of the breakage point. After receiving such pretreatment, the wire can readily be fed by a roller through the aligned holes in a row of toroidal cores in the array, the hardened leading portion of the wire being of sufficient length to bridge the greatest distance between successive wire guiding points in the path of the wire and to maintain the desired direction thereof, from the feeding unit 12 to the receiving unit 16. Wires having a diameter as small as 0.0022 inch (No. 44 wire) have been successfully used in accordance with the disclosed method.

This invention makes it feasible to insert all of the coordinate conductors into a magnetic core plane by mechanized, multiple wire threading operations, thereby eliminating the slow handwiring techniques that must otherwise be employed. The instant method also eliminates the damage that may be caused to the cores or to the wiring of the array by unskilful hand threading. Furthermore, it enables the core memory designer to choose which set of coordinate wires will be skewed to provide the desired noise cancelling effect, rather than limiting this choice to one particular set of wires, the only requirement now being that the set of wires to be skewed must be inserted into the plane before the superposed set of straight wires (if any) is inserted.

To practice the present novel method of inserting coordinate wires into a planar assembly of apertured articles, one is not necessarily limited to the specific type of apparatus herein disclosed. In an equivalent model of this invention adapted to operate on the same principle, but without the refinements of the later improved design, good results were obtained by using a conventional needle and wire feeding apparatus of the type disclosed in the above-mentioned Patent No. 2,959,126, such apparatus being modified only to the extent of enabling the forward ends of a set of wires to be clamped for pretreatment purposes before such wires enter the core plane rather than being clamped after leaving the core plane as disclosed in said patent. In the particular adaptation just described, all of the feed rollers cooperated directly with the wires, since no needles were used when feeding the mechanically pretreated wires.

While the invention has been particularly shown and described with reference to a preferred embodiment thereof, it will be understood by those skilled in the art that changes in form and details may be made therein without departing from the spirit and scope of the invention.

What is claimed is:

1. A method of threading a row of aligned apertured articles with a wire made of material that normally is flexible but which is capable of being hardened by the application thereto of tensile stress in excess of its elastic limit, said method comprising the steps of:

   a) subjecting a leading portion of the wire to tension which causes the material in said portion of the wire to be stressed in excess of its elastic limit, thereby hardening the stressed material in a substantial length of the wire extending from the leading end thereof, and feeding the wire through the aligned apertures in said row of apertured articles in such manner that the hardened leading portion of the wire maintains the wire in the desired direction as it moves through said row of articles.

2. A method of threading a row of aligned apertured articles with a wire made of material that normally is flexible but which is capable of being hardened by the application thereto of tensile stress in excess of its elastic limit, said method comprising the steps of:

   a) subjecting an end portion of the wire to a tensile stress which causes a forward part thereof to break away from the remainder of the wire, thereby causing the stressed material in a leading end portion of said remainder to be hardened for a substantial length of the wire behind the point of breakage, and feeding said remainder of the wire through the aligned apertures in said row of apertured articles in such manner that the hardened leading portion of the wire maintains the desired direction of the wire as it moves through said row of articles.

3. A method of threading a wire of cuprous material through a substantially straight guide path at least part of which is defined by a succession of spaced apertured articles having their apertures aligned on said path, said method comprising the steps of:

   a) applying to said wire tensile stress sufficient to harden said cuprous material in a leading portion of the wire the length of which is at least equal to the maximum distance between successive wire guiding points in said path, and

   b) feeding the wire through said path in such manner that the hardened leading portion of the wire serves to maintain the desired direction of the wire as it passes between successive wire guiding points in said path.

4. A method of threading a wire of cuprous material through a substantially straight guide path at least part of which is defined by a succession of spaced apertured articles having their apertures aligned on said path, said method comprising the steps of:

   a) applying to said wire tensile stress sufficient to break a forward portion of the wire away from the remainder of the wire and cause the leading end portion of said remainder to become hardened by the tensile working of the cuprous material therein throughout a length of the wire at least equal to the maximum distance between successive wire guiding points in said path, and

   b) feeding said remainder of the wire through said path in such manner that the hardened leading portion thereof serves to maintain the desired direction of the wire as it passes between successive wire guiding points on said path.

5. A method of threading a row of aligned apertured articles with a wire made of material that normally is flexible but which is capable of being hardened by the application thereto of tensile stress in excess of its elastic limit, said method comprising the steps of:

   a) subjecting an end portion of the wire to a tensile stress which causes a forward part thereof to break away
from the remainder of the wire, thereby reducing the wire in the vicinity of the break to form a substantially pointed end on said remainder and causing the leading portion of said remainder to be hardened for a substantially length behind said pointed end thereof, and

feeding said remainder of the wire through the aligned apertures in said row of apertured articles in such manner that the hardened leading portion of the wire maintains the desired direction of the wire as it moves through said row of articles.

6. A method of threading a wire of cuprous material through a substantially straight guide path at least part of which is defined by a succession of spaced apertured articles having their apertures aligned on said path, said method comprising the steps of:

applying to said wire tensile stress sufficient to break a forward portion of the wire away from the remainder of the wire, thereby reducing the wire in the vicinity of the break to form a substantially pointed end on said remainder and causing the leading portion of said remainder to be hardened for a substantially length behind said pointed end thereof, and

feeding said remainder of the wire through said path in such manner that the hardened leading portion thereof serves to maintain the desired direction of the wire as it passes between successive wire guiding points on said path.

7. A method of threading a row of aligned apertured articles with a wire made of material that normally is flexible but which is capable of being hardened by the application thereto of tensile stress in excess of its elastic limit, said method comprising the steps of:

longitudinally moving the wire in a forward direction to a position near the row of apertured articles, restraining a forward portion of the wire against further movement, longitudinally moving the remainder of the wire in a reverse direction to stretch it and break it away from the restrained forward portion thereof, thereby causing a leading portion of said remainder to be reduced and hardened by the tensile working of the material therein, removing the broken forward portion of the wire, and longitudinally moving the remainder of the wire forwardly through the row of apertured articles in such manner that the hardened leading portion thereof maintains the desired direction of the wire as it moves through the aligned apertures in said articles.

8. A method of threading a wire of cuprous material through a substantially straight guide path at least part of which is defined by a succession of spaced apertured articles having their apertures aligned on said path, said method comprising the steps of:

longitudinally moving the wire in a forward direction to a position near the row of apertured articles, restraining a forward portion of the wire against further movement, longitudinally moving an adjoining portion of the wire in a reverse direction to stretch it and break it away from the restrained forward portion thereof, thereby causing the stretched portion of the wire to be hardened by the tensile working of the cuprous material therein for a distance at least equal to the maximum distance between successive wire guiding points in said path, removing the broken forward portion of the wire, and longitudinally moving the remainder of the wire forwardly through the row of apertured articles with the hardened portion thereof in the lead for maintaining the desired direction of the wire as it passes through the aligned apertures in said articles.

9. A method of simultaneously threading several parallel rows of aligned apertured articles with wires each made of a material that normally is flexible but which is capable of being hardened by the application thereto of tensile stress in excess of its elastic limit, said method comprising the steps of:

simultaneously subjecting the several wires to tension which causes the material in the leading portion of each wire to be stressed in excess of its elastic limit, thereby hardening the stressed material in a substantially length of the wire extending from the leading end thereof, and
simultaneously feeding the wires respectively through said rows of apertured articles in such manner that the hardened leading portion of each wire maintains the wire in the desired direction as it moves through its row of articles.

10. A method of simultaneously threading a plurality of wires of cuprous material respectively through a plurality of parallel guide paths each defined in part by a succession of spaced apertured articles aligned on the respective path, said method comprising the steps of:

simultaneously applying to said wires tensile stress sufficient to harden the cuprous material in a leading portion of each wire, the length of such leading portion being at least equal to the maximum distance between successive wire guiding points in the respective one of said paths, and

feeding the wires simultaneously through said paths in such manner that the hardened leading portion of each wire serves to maintain the desired direction of the wire as it passes between successive wire guiding points in its respective path.

11. A method of threading a plurality of parallel rows of apertured articles respectively with wires made of material that normally is flexible but which is capable of being hardened by the application thereto of tensile stress in excess of its elastic limit, said method comprising the steps of:

longitudinally moving the wires simultaneously in a forward direction to positions near the respective rows of apertured articles, simultaneously restraining the forward portions of the respective wires against movement, longitudinally moving the adjoining unrestrained portions of the respective wires simultaneously in a reverse direction to stretch them and break them away from the restrained forward portions thereof, thereby causing the leading portion of the remainder of each wire to be reduced and hardened by the tensile working of the material therein, removing the broken forward portions of the wires, and longitudinally moving the remainder of the respective wires forwardly simultaneously through the rows of apertured articles in such manner that the hardened leading portion of each wire maintains the desired direction of such wire as it moves through the aligned apertures in its respective row of articles.

12. A method of threading a plurality of wires of cuprous material respectively through substantially parallel guide paths each defined in part by a succession of spaced apertured articles aligned on the respective path, said method comprising the steps of:

longitudinally moving the wires simultaneously in a forward direction to positions near the respective rows of apertured articles, simultaneously restraining the forward portions of the respective wires against movement, longitudinally moving the adjoining unrestrained portions of the respective wires simultaneously in a reverse direction to stretch them and break them away from the restrained forward portions thereof, thereby causing the stretched portion of each wire to be hardened by the tensile working of the cuprous material therein for a distance at least equal to the maximum distance between successive wire guiding points in its respective path.
removing the broken forward portions of the wires, and
longitudinally moving the remainders of the respective wires forwardly simultaneously through the rows of apertured articles with the hardened portion of each wire being in the lead to maintain the desired direction of the wire as it passes through the aligned articles in its path.

13. In the manufacture of a magnetic core memory plane which contains rows and columns of magnetic cores threaded by sets of coordinate wires, the wires in one of said sets extending generally parallel to the wires in another of said sets through the several rows of cores in said plane, a method of producing a partially offset relationship between the wires of said one set and the wires of said other set to provide for noise cancellation in the completed core plane, said method comprising the steps of
shifting the position of one group of magnetic cores in said plane relative to the position of another group of magnetic cores in said plane through a limited distance equal to a whole number of row spacings transversely of the general direction in which said one set of wires extends, thereby causing the portions of the wires threading said one group of cores to be offset by one or more rows with respect to the portions of the same wires threading the other group of cores in said plane and concurrently imparting a skew to the portions of such wires intermediate the relatively offset portions thereof, and advancing the wires of said other set along substantially straight paths for threading the same through the newly aligned rows of cores in the relatively shifted groups thereof, whereby the relatively offset portions of each wire in said one set are positioned respectively adjacent to different wires of said other set.

14. A method as set forth in claim 13 wherein the intermediate portions of the wires in said one set are stretched as they are skewed, thereby imparting a set to these skewed intermediate portions.

15. In the manufacture of a magnetic core memory plane which contains rows and columns of magnetic cores threaded by sets of coordinate wires made of cuprous material, the wires in one of said sets extending generally parallel to the wires in another of said sets through the rows of cores in said plane, the fabrication steps comprising
shifting the position of one group of magnetic cores in said plane relative to the position of another group of magnetic cores in said plane through a limited distance equal to a whole number of row spacings transversely of the general direction in which said one set of wires extends, thereby causing the portions of those wires threading said one group of cores to be offset by one or more rows with respect to the portions of the same wires threading the other group of cores in said plane and concurrently imparting a skew to the portions of such wires intermediate the relatively offset portions thereof, and advancing the wires of said other set along substantially straight paths for threading the same through the newly aligned rows of cores in the relatively shifted groups thereof, whereby the relatively offset portions of each wire in said one set are positioned respectively adjacent to different wires of said other set.

16. Apparatus for causing an alignment of apertured articles to be threaded with a wire made of material that normally is flexible but which is capable of being hardened by the application of tensile stress thereto beyond its elastic limit, said apparatus comprising means for applying longitudinal stresses in opposite directions respectively to adjoining portions of the wire, thereby to break a forward portion of the wire away from the remainder of the wire and leave said remainder with a hardened leading portion, and means for longitudinally advancing said remainder of the wire through said apertured articles with the hardened leading portion thereof being directed along the line of apertures therein.

17. Apparatus for threading a row of aligned apertured articles with a wire made of material that normally is flexible but which is capable of being hardened by the application of tensile stress thereto beyond its elastic limit, said apparatus comprising means for applying to a forward portion of the wire tensile stress sufficient to break the wire, thereby producing a hardened leading end portion on the remainder of the wire, means for feeding the wire with its hardened leading end through the aligned apertures in the row of apertured articles, and a guide means for giving at least partial guidance to the wire as the same is fed through the row of apertured articles.

18. Apparatus for threading a wire of cuprous material through a substantially straight guide path at least part of which is defined by a succession of spaced apertured articles having their apertures aligned on said path, said apparatus comprising means for applying to said wire tensile stress sufficient to break a forward portion of the wire away from the remainder of the wire and cause the leading end portion of said remainder to become hardened by the tensile working of the cuprous material therein throughout a length of the wire at least equal to the maximum distance between successive wire guiding points in said path, and a feeding means for longitudinally advancing said remainder of the wire through said path in such manner that the hardened leading portion thereof serves to maintain the desired direction of the wire as it passes between successive wire guiding points on said path.

19. Apparatus for threading a wire of cuprous material through a substantially straight wire guiding path including a succession of spaced apertured articles having their apertures aligned on said path, said apparatus comprising
feeding means for longitudinally moving the wire along said path,
first clamping means for clamping a forward portion of the wire at a point intermediate the apertured articles and said feeding means, and second clamping means for causing the wire to be clamped at a point substantially spaced from the point at which the wire is clamped by said first clamping means, said first and second clamping means being relatively movable for causing the wire to be stretched and broken between them and being so spaced from each other that the main portion of the wire is hardened by the application of the tensile stress thereto for a
distance at least equal to the maximum distance between successive wire guiding points in said path, said feeding means being adapted to feed the wire along said path through the aligned apertures in said articles with the hardened part thereof in the lead for maintaining the desired direction of the wire as it passes through the successive apertures in the articles.

20. Apparatus for threading a wire of cuprous material through a substantially straight wire guiding path which includes a succession of spaced apertured articles having their apertures aligned on said path, said apparatus comprising feeding means including a feed roller engaged with said wire and normally rotatable for longitudinally moving the wire along said path, first clamping means for clamping a forward portion of the wire at a point intermediate the apertured articles and said feeding means, second clamping means for restraining rotation of said feed roller and thereby causing the wire to be clamped by said roller at a point longitudinally spaced from the point at which the wire is clamped by said first clamping means, third clamping means for clamping the wire at a point still further spaced from said first clamping means, and means for bodily moving said feed roller and said second and third clamping means away from said first clamping means to stretch and break the wire between said first and second clamping means, thereby causing the wire to become hardened by the tensile working of the cuprous material therein for a substantial distance from the point of breakage, said feeding means being effective upon release of said second and third clamping means for feeding the unbroken remainder of the wire along said path through said apertured articles with the hardened portion of the wire in the lead for maintaining the desired direction of the wire as it passes through said articles.

21. Apparatus for threading a plurality of parallel rows of apertured articles respectively with wires made of a material that normally is flexible but which is capable of being hardened by the application thereto of tensile stress in excess of its elastic limit, said apparatus comprising means for subjecting the end portions of the respective wire simultaneously to tensile stresses which cause the material in such end portions to be hardened by the tensile working thereof, and means for simultaneously feeding the wires respectively through said rows of apertured articles with the hardened end portions thereof in the lead for maintaining the desired directions of the wires as they advance.

22. Apparatus for threading parallel rows of apertured articles respectively with wires made of material that normally is flexible but which is capable of being hardened by the application thereto of tensile stress in excess of its elastic limit, said apparatus comprising means for subjecting the end portions of the wires simultaneously to tensile stresses which cause the forward parts of the wires to break away from the remainder of the wires, thereby causing the stressed material in the leading portion of the remainder of each wire to be hardened for a substantial distance from the point of breakage, and means for simultaneously feeding the remainder of the wires respectively through the rows of apertured articles with the hardened leading portions of these wires serving to maintain them in the desired directions as they pass through said articles.

23. Apparatus for threading wires of cuprous material respectively through parallel rows of apertured articles, comprising means for simultaneously applying to the forward portions of the respective wires longitudinal stresses in opposite directions for breaking the wires and thereby providing the remainder of each wire with a hardened leading portion terminating in a substantially pointed end, and means for simultaneously feeding these wires respectively through the rows of apertured articles with the hardened leading ends of such wires serving to maintain them in the desired directions as they pass through the apertured articles.

24. Apparatus for threading parallel rows of apertured articles respectively with wires made of a material that normally is flexible but is capable of being hardened by the application of tensile stress thereto beyond its elastic limit, said apparatus comprising means for simultaneously applying to the forward portions of the wires tensile stress sufficient to break such portions away from the remainder of the respective wires, thereby producing a hardened end portion on the remainder of each wire, means for simultaneously feeding the wires with their hardened end portions in the lead through the aligned apertures in the respective rows of apertured articles, and guide means effective in cooperation with said apertured articles for guiding the respective wires as they advance through the respective rows of apertured articles, the hardened portion of each wire being at least equal in length to the maximum distance between successive guide points in its path.

25. In an apparatus for threading parallel rows of apertured articles respectively with wires of cuprous material, the combination of a supporting unit for holding the rows of apertured articles in positions to be threaded by the wires, a movable member adapted to be moved toward or away from said supporting unit along a path parallel with the direction in which the rows of apertured articles extend, said member also being adapted to remain in a fixed position when desired, rotatable wire feeding means mounted on said movable member and operable to feed a plurality of wires simultaneously along paths respectively aligned with the rows of apertured articles, a wire clamping device movable into and out of the paths of the wires between said supporting unit and said movable member, said device being operable to grip the forward end portions of the respective wires and hold the same stationary, and a second wire clamping device mounted on said movable member for gripping the wires and substantially preventing movement thereof relative to said movable member, said movable member being operable when both of said wire clamping devices are engaged with the wires to impart reverse movement to the wires for stretching and breaking the same at points intermediate said first clamping device and said feeding means, thereby causing the cuprous material in the leading portions of the remaining lengths of wire to become hardened by the tensile working thereof prior to being advanced by said feeding means through the respective rows of apertured articles.

26. An apparatus as set forth in claim 25 including means for preventing rotation of said rotatable wire feeding means while said movable member is being operated to stretch and break the wires as aforesaid, thereby enabling said wire feeding means to exert a temporary clamping action upon the wires.

27. Apparatus for simultaneously threading wires of cuprous material through parallel rows of toroidal magnetic cores in a magnetic core plane comprising core supporting means for holding the cores of the plane in position to be wired, a movable member adapted to be moved toward or away from said core supporting means along a path
parallel with the direction in which the rows of cores extend, said member also being adapted to remain in a fixed position when desired, a feed roller on said movable member rotatable to feed a plurality of wires simultaneously along wire paths respectively aligned with the rows of cores, wire guiding means carried by said movable member for guiding the wires fed by said feed roller along said wire paths, a first wire clamping device movable into and out of the wire paths between said core supporting means and said movable member and operable to grip the forward ends of portions of the wires to prevent movement thereof, and a second wire clamping device carried by said movable member operable to engage the wires and substantially prevent movement thereof relative to said movably member, said movable member being capable of retrograde movement for stretching the portions of the wires intermediate said wire clamping devices sufficiently to break said wires at points between said first wire clamping device and said feed roller, thereby causing the cuprous material in the unbroken leading portions of the wire to become hardened by the tensile working thereof prior to being advanced by said feed roller through the respective rows of cores positioned on said core supporting means.

28. Apparatus as set forth in claim 27 including restraining means operable to prevent rotation of said feed roller while the wires are being stretched and broken and thereupon operable to release said feed roller so that the same may be rotated for retracting the hardened leading portions of the wires within said wire guiding means, said movable member thereupon being operable to advance said wire guiding means into proximity with the rows of cores which are to receive the respective wires fed by said roller.

29. In an apparatus for manufacturing a magnetic core memory plane assembly containing rows and columns of toroidal magnetic cores threaded by sets of coordinate wires, the wires of one set extending generally parallel to the wires of another set through the rows of cores in said assembly, the combination comprising a supporting unit for supporting two groups of cores in coplanar relationship, said unit including a stationary section having a portion thereof adapted to support one of said groups of cores, and a movable section for supporting the other of said groups of cores, said latter section being movable transversely of said core rows between predetermined positions respectively defining different alignments of the rows in said two groups of cores, means for shifting the position of said movable section from one predetermined position thereof to the other predetermined position thereof while said cores are threaded by said one set of coordinate wires, thereby causing the portions of those wires threading said one group of cores to be offset by one or more rows relative to the portions of those same wires threading said other group of cores, and wire feeding means for passing the wires of said other set along substantially straight paths through the newly aligned rows of cores in the relatively shifted groups thereof, whereby the relatively offset portions of each wire in said one set are respectively positioned adjacent to different wires of said other set for providing the core plane assembly with a desired noise cancelling property.

30. In an apparatus for manufacturing a magnetic core memory plane assembly containing rows and columns of toroidal magnetic cores threaded by sets of coordinate wires, the wires of one set extending generally parallel to the wires of another set through the rows of cores in said assembly and being secured at opposite ends thereof to fixed portions of said assembly, the combination comprising a supporting unit for supporting two groups of cores in coplanar relationship, said unit including a stationary section having a portion thereof adapted to support one of said groups of cores, and a movable section for supporting the other of said groups of cores, said latter section being movable transversely of said core rows between predetermined positions respectively defining different alignments of the rows in said two groups of cores, means for shifting the position of said movable section from one predetermined position thereof to the other predetermined position thereof while said cores are threaded by said one set of coordinate wires, thereby causing the portions of those wires threading said one group of cores to be offset by one or more rows relative to the portions of those same wires threading said other group of cores and concurrently imparting a skew to those portions of such wires intermediate the relatively offset portions thereof, sets of pins respectively positioned on the different sections of said supporting unit to apply bending and tensile stresses to said intermediate portions of the wires in said one set as said movable section is shifted, thereby preventing any substantial stress from being exerted upon the cores by such wires while they are being skewed and concentrating the resultant strain upon the skewed portions of these wires, wire feeding means for passing the wires of said other set along substantially straight paths through the newly aligned rows of cores in the relatively shifted groups thereof, whereby the relatively offset portions of each wire in said one set are respectively positioned adjacent to different wires of said other set for providing the core plane assembly with a desired noise cancelling property.

References Cited by the Examiner

UNITED STATES PATENTS

2,797,508 7/1957 Huyett ----- 29—203 X
2,958,126 11/1960 Shaw et al. ----- 29—433
3,111,651 11/1963 Foulkes ----- 29—155.5 X
3,177,368 1/1964 Bartik ----- 29—155.56
3,134,635 5/1964 Luhn ----- 29—205 X

JOHN F. CAMPBELL, Primary Examiner,
THOMAS H. EAGER, Examiner.