WIRE HANDLING APPARATUS

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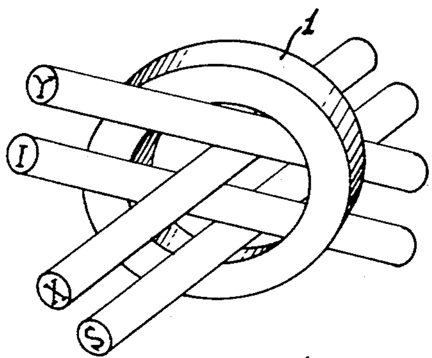

Fig. 1.

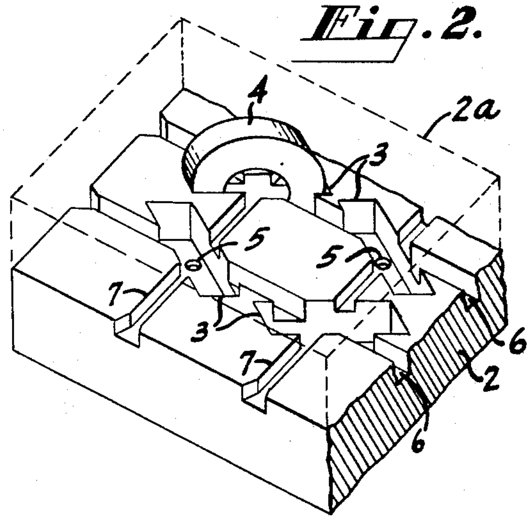

Fig. 2.

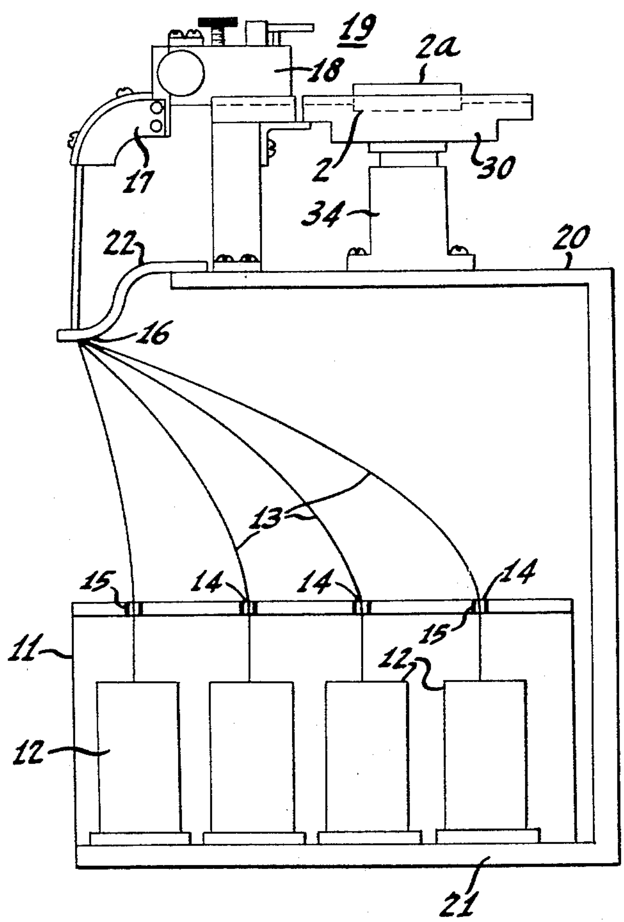

Fig. 3.

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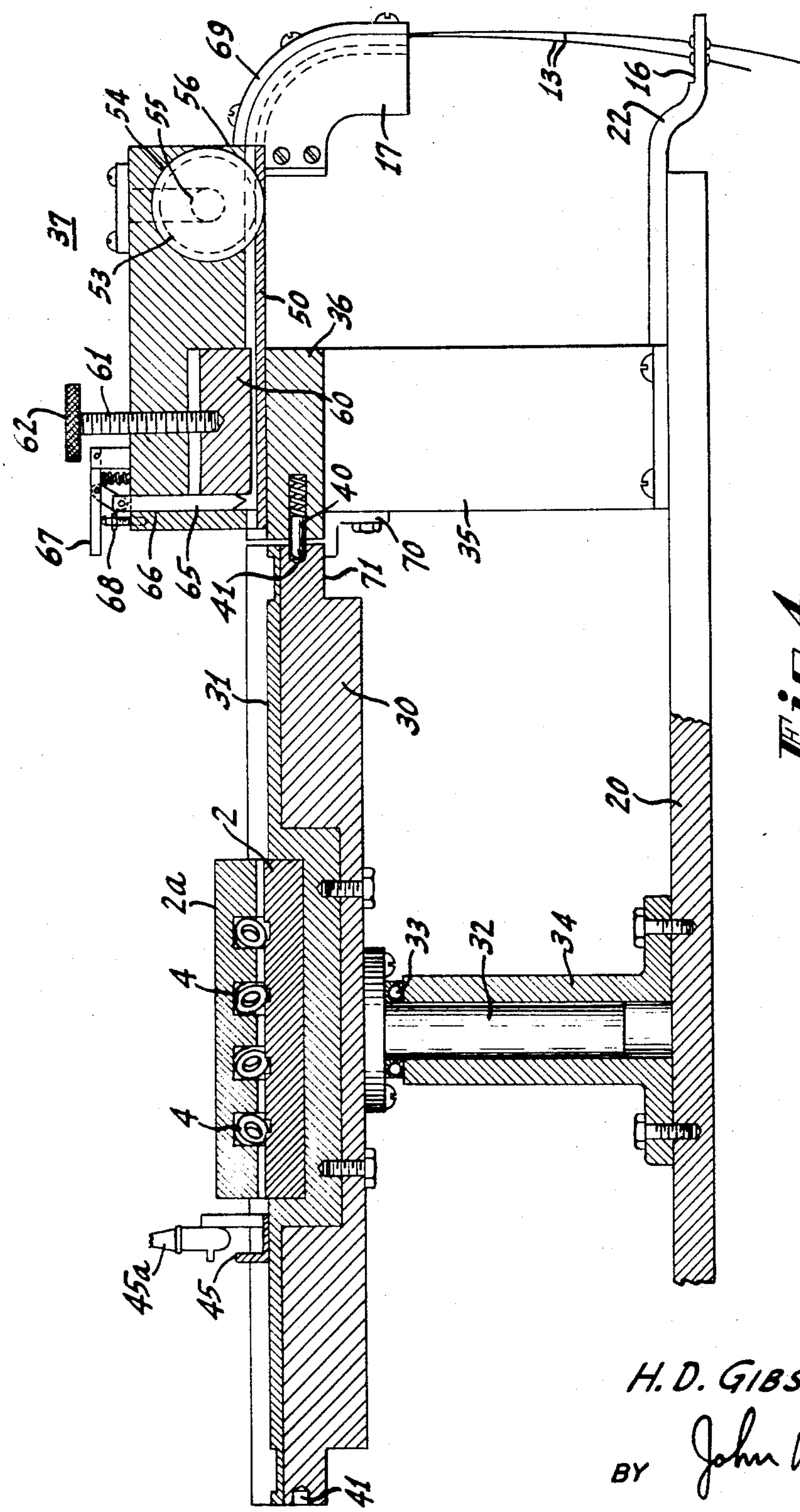

Fig. 4.

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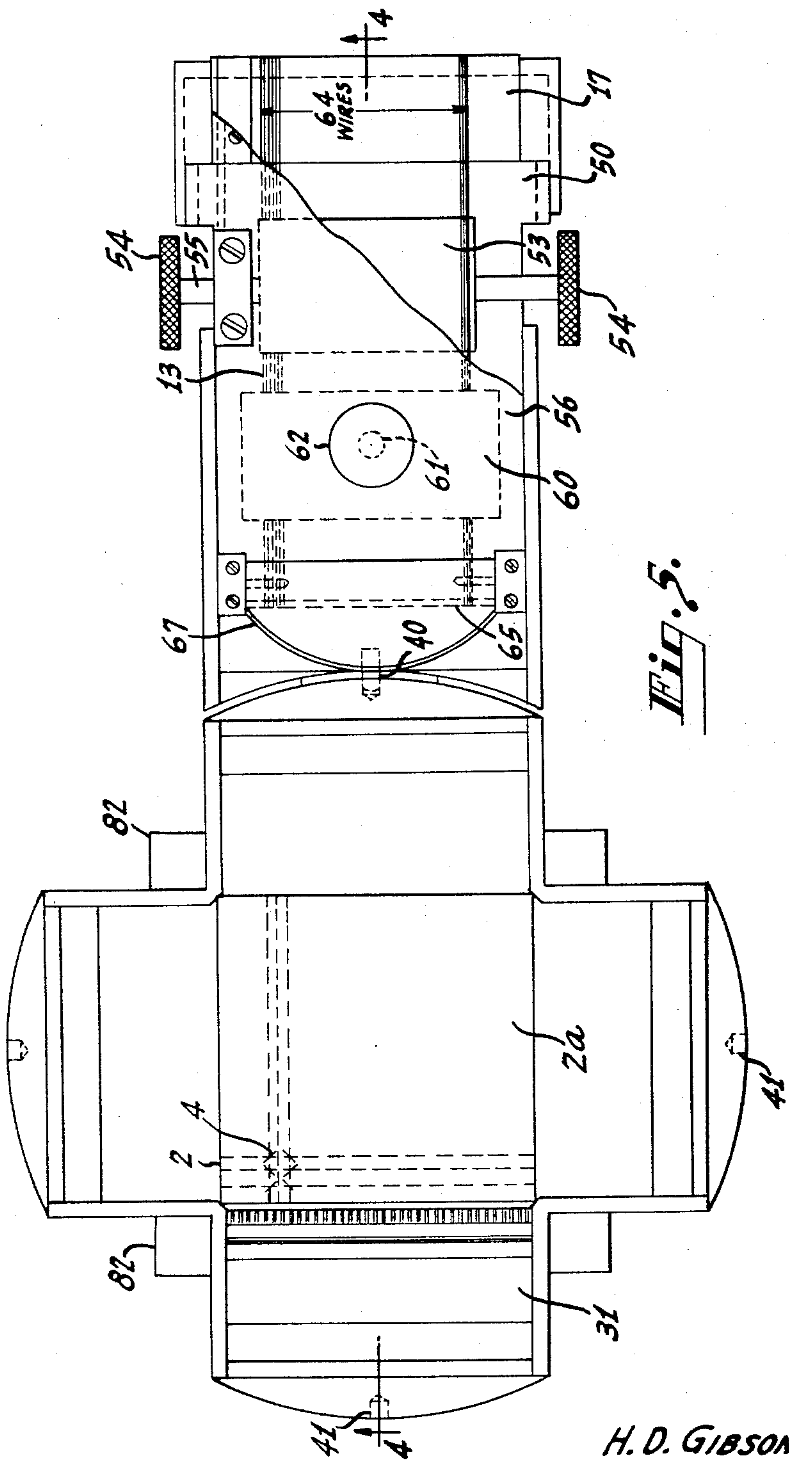

Fig. 5.

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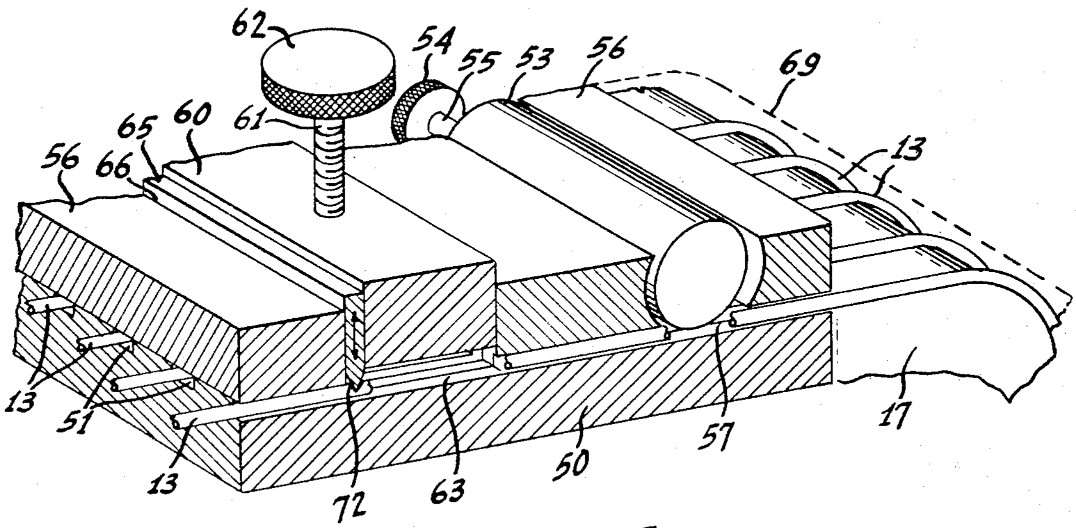

Fig. 6.

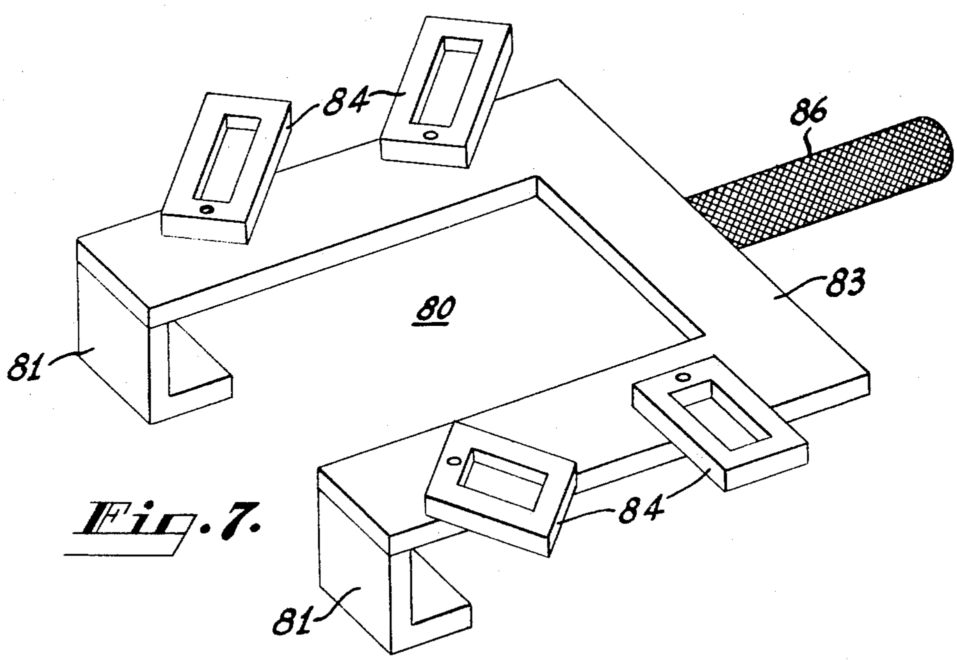

Fig. 7.

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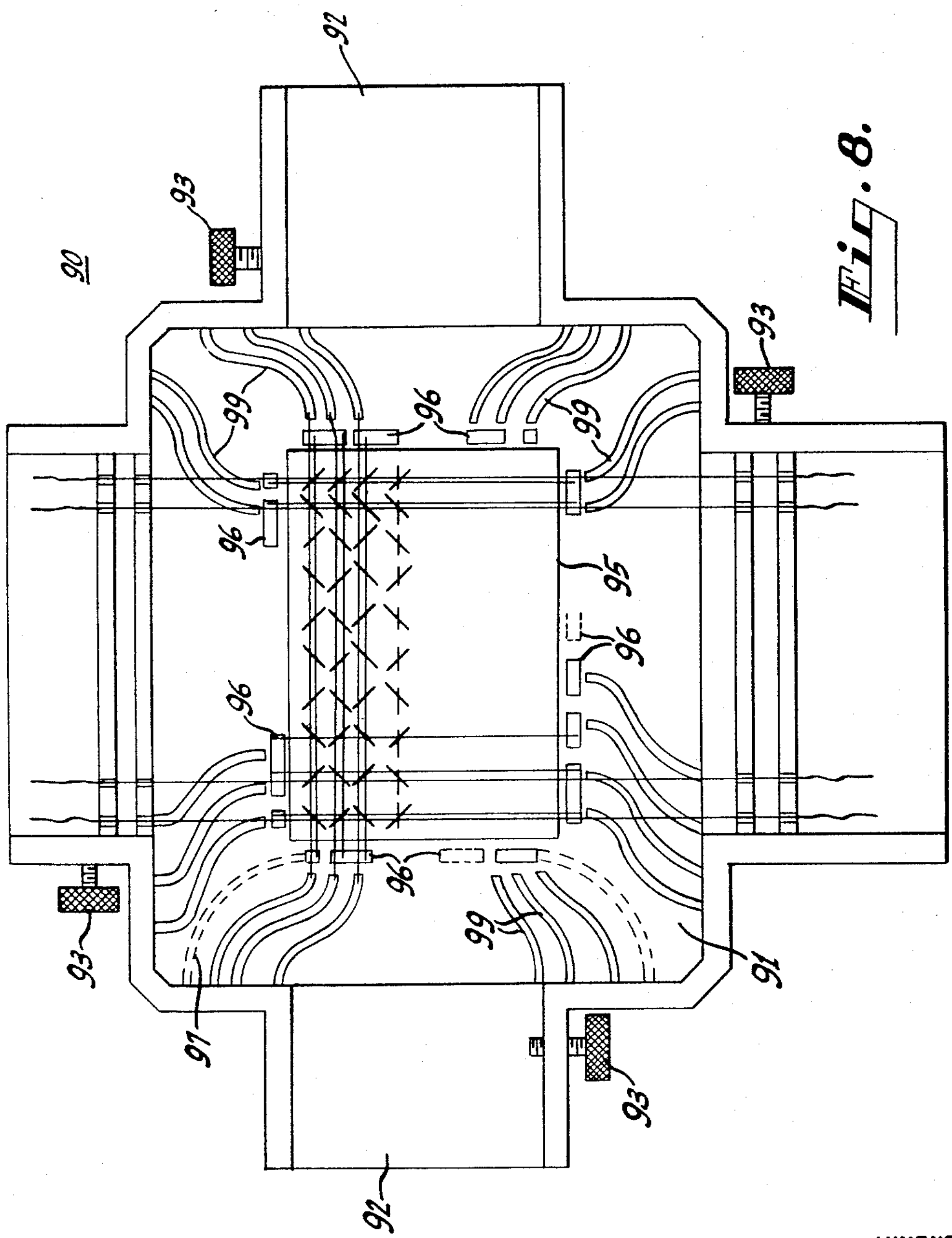

Fig. 8.

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3,438,403
WIRE HANDLING APPARATUS

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U.S. Cl. 140—1 **7 Claims**

ABSTRACT OF THE DISCLOSURE

A method and apparatus for producing wires with integral leaders. The arrangement is particularly adapted to the concurrent formation of integral leaders in a large number of fine wires such as those used for stringing a magnetic core memory matrix.

Background of the invention

The convention prior art stringing of magnetic core matrices has been largely a manual operation wherein the fine wires are individually hand fed through the cores using needles which are, for example, butt welded to the wire ends to function as wire leaders. Such prior art core stringing techniques are slow, tedious and, more importantly productive of core damage. This core damage is the result of abrasion of the cores with the attached leader particularly the so-called plated leaders which generally have a rough surface resulting from the plating operation. This rough surface combined with the projecting weld bead used to connect the leader to the wire gives rise to unavoidable core damage during the prior art core stringing operations. In practice, the correction of these errors may consume approximately three times as much time as the actual core stringing. The present invention is operative to concurrently form integral leaders in a plurality of wires which is effective to avoid the use of an attached leader.

Brief summary of the invention

The present invention relates to a wire preparing method and machine. More specifically, the present invention is directed to an integral leader forming method and apparatus for concurrently forming an integral leader in each of a plurality of wires.

The present invention will be described in the environment of a core stringing machine which is the subject matter of a copending application entitled "Wire Stringing Machine" and filed concurrently herewith by the present applicant and assigned to the same assignee. According to the invention, a method and apparatus of concurrently forming integral wire leaders in a plurality of wires involves locking one end of each of the wires, tensioning each of the wires, concurrently deforming a section of each of the wires adjacent to wire locking points, concurrently nicking all of the wires along a line between the wire locking points and the deformed sections and breaking the wires at the nick to produce individual leader points.

Brief description of the drawing

A better understanding of the present invention may be had when the following detailed description is read in connection with the accompanying drawings, in which:

FIGURE 1 is a pictorial view of a typical core and the signal wires passing therethrough as found in a prior art core plane;

FIGURE 2 is an enlarged cross-section of a corner of a support plate for supporting cores in the wire stringing machine of the present invention;

FIGURE 3 is a pictorial side view of a wire stringing machine embodying the present invention;

FIGURE 4 is a view of an enlarged cross-section of a portion of the machine shown in FIGURE 3;

FIGURE 5 is a top view of the apparatus shown in FIGURE 4;

FIGURE 6 is an elongated cross-section of a portion of the apparatus shown in FIGURE 4;

FIGURE 7 is a pictorial illustration of a transfer tray used during the stringing of multiple sets of wires and for handling the completed core plane; and

FIGURE 8 is a pictorial illustration of a jig used to connect the core plane to a printed cirucit board.

Detailed description of the invention

Referring to FIGURE 1 there is shown a pictorial illustration of a typical prior art core **1** with the signal wires threading the core as found in a core plane having an X wire, a Y wire, an INHIBIT wire and a SENSE wire. Each core in the plane has all of these wires passing through its center opening. A small core commonly used in current core matrices would have an approximate outer diameter of .030 and an inner diameter of .018. Such a core could be referred to as a 30/18 core. The wires used to string such a core could be a so-called No. 42 wire having a nominal outside diameter of .0030 inch including the insulating layer on the wire. In a core plane having 64 cores on each side, there would be 4096 cores, each with the aforesaid four wires passing therethrough. It is to be noted that the method and apparatus of the present invention is suitable for use with smaller cores and thinner wires without departing from the teachings of the present invention.

FIGURE 2 is an enlarged pictorial illustration of a corner portion of a core support plate **2**. The plate **2** is provided with a plurality of recesses **3** which are arranged to hold half of a ferrite core. A typical core **4** is shown in one of the recesses **3**. The recesses **3** are arranged to hold the cores **4** in a suitable predetermined configuration, which is well-known in the prior art, to enable the aforesaid wires to be passed through the cores **4** in a straight line from one side of the core matrix to the other. A hole **5** may be provided in the bottom of each recess **3** in order to enable a vacuum loading technique to be used to fill the recesses **3** with the cores **4**. Such loading techniques are well-known in the prior art and comprise a means for applying vacuum to the underside of the plate **2** while the cores **4** are brushed or vibrated into the recesses **3**. The vacuum which is communicated into each of the recesses **3** by the holes **5** is effective to induce a core **4** to enter the recess **3** and to retain the core **4** while the other cores are being positioned in the other ones of the recesses **3**.

A plurality of row wire guide grooves **6** are provided in the surface of the plate **2** with the grooves **6** being coaxially aligned with the center opening of the cores **4** across the plate **2**. Similarly, a plurality of column wire guide grooves **7** are provided in the face of the plate **2**. The column grooves **7** are also axially aligned with the cores **4** and are arranged to intersect the row grooves **6** at the center of the recesses **3** to provide separate levels for the wires threading the cores. The width of the row and column grooves **6, 7** is arranged to accommodate respective wires which are to be guided through the cores **4**. A cover plate **2***a* shown in dotted outline, having an internal configuration similar to the support plate **2** is positioned on top of the plate **2** after the plate **2** is filled with the cores **4**. The recesses in the cover **2***a* and the support plate **2** are arranged to mate to form closed boxes holding the cores **4** therein. Also, the row and column grooves in the cover plate are longitudinally aligned with the grooves 6, 7 in the support plate 2. The total height of the mated grooves is arranged to accommodate the number of layers of wires which are to be positioned in each row and column. For example, each of the row grooves 6 would be arranged to hold two layers of wires which would be the Y and INHIBIT wires shown in FIGURE 1. The grooves 6 and 7 may, also, be outwardly tapered at their ends at the outside faces of the plate 2 to facilitate the guiding of a wire into one of the grooves 6, 7.

The complete core assembly comprising the support plate 2, the cover 2*a* and the cores 4 positioned in their individual recesses are placed in a precisely predetermined position on a wire stringing apparatus shown generally in FIGURE 3 and in more detail in enlarged cross-section in FIGURES 4, 5 and 6.

Referring to FIGURE 3 in more detail, there is shown a pictorial representation of wire stringing apparatus embodying the present invention. A wire storage box 11 is arranged to store a plurality of individual containers of insulated wire 12, e.g. 64, which wires are used in the stringing of a core matrix. The insulated wires 13 are brought out of the box 11 through individual ports 14 which may be fitted with smooth guide bushings 15 to prevent damage to the insulating coating on the wires 13. The wires 13 are, next, directed to a wire stringing apparatus starting with a support plate 16 having guide holes therein corresponding in number to the number of the wires 13. After emerging from the guide plate 16, the wires 13 are arranged in individual grooves in a curved transition plate 17 whereby their individual location is precisely determined. From the curved transition plate 17, the wires 13 enter a wire handling apparatus 18, described fully hereinafter, having individual wire grooves for supporting the wires 13, drive means operative to move the wires 13 out of the storage box 11, and means for forming integral leaders in each of the wires 13.

A support structure 19, also described hereinafter, is provided at the exit side of the apparatus 18 to support a core matrix support plate 2 having the cores 4 to be strung individually positioned therein to receive the insulated wires 13 as previously discussed. Thus, the wires 13 are extracted from their individual containers 12 within the storage box 11 by the wire drive means within the apparatus 18 and are introduced into the core support assembly supported by the turntable 19. A bench 20 with a shelf 21 is provided to support the wire storage box 11, and the wire guiding assembly in an operative relationship as shown in exemplary form in FIGURE 3. A support arm 22 is attached to the base of the apparatus 18 to rigidly support the guide plate 16.

Referring now to FIGURES 4 and 5, there are shown detailed pictorial representations of the wire handling portion of the present invention. A turntable 30 is provided with a jig surface 31 for precisely locating the core assembly. The turntable 30 is rotatably mounted by means of a center support spindle 32 having a bearing 33 mounted thereon. The bearing means 33 is arranged to space the turntable 30 from a spindle sleeve 34 attached to the base 20. The jig surface 31 is arranged to hold the plate 2 with the cores 4 and the top cover 2*a* in a predetermined location in the center of the turntable 30. A clamp mechanism may be provided to further retain the plate 2 and cover 2*a*. In FIGURE 5, there is shown a partial cross-sectional top view of the apparatus shown in FIGURE 4. The jig turntable 30 and jig surface 31 are shaped to form a cross with equal length arms having depressed center areas to form a pair of similar intersecting channels. The intersection of these channels is arranged to hold the plate 2, core 4 and cover 2*a* in a precise location with respect to the edges of the aforesaid channels.

Adjacent to the jig surface 31 and the turntable 30 is a wire feeding mechanism including a support bracket 35 mounted on the base 20 and a guide channel member 36 mounted on the bracket 35. A wire driving apparatus 37 is positioned in the channel of the guide member 36. This channel is arranged to be the same size as the channels in the jig surface 31 to enable the drive apparatus 37 to slide from the guide member 36 to the jig surface 31. The alignment of the channels in the jig surface 31 with the channel in the guide member 36 is effected by a spring-loaded indexing pin 40 which is arranged to cooperate with recesses 41 in the ends of the arms of the turntable 30. The drive apparatus 37 is arranged to have a sliding fit in the aforesaid channel to enable it to be moved from the guide member 36 to a precise location next to the facing side of the core plates 2, 2*a* wherein the wires 13 are aligned with the grooves 6, 7. In the latter position, the wires 13 are driven by the drive apparatus 37 through the cores 4 in a manner hereinafter described.

A J-shaped wire locking comb 45 is positioned in the channel of the jig surface 31 adjacent to the side of the plates 2, 2*a* opposite to that facing the drive apparatus 37. The spaces between the teeth of comb 45 on the long leg of the J are arranged to form a continuous wire channel with the respective wire slots in the plates 2, 2*a*. Thus, a wire driven by the drive apparatus 37 is ultimately positioned in the teeth of the comb 45 and sufficient wire is fed to straddle the gap across the J. A wire locking member 45*a* in the form of a bar fitting between the legs of the comb 45 is inserted into this gap to lock the wires in the comb and to equalize the tension in the individual wires. The comb 45 may be temporarily retained against the plates 2, 2*a* by any suitable means which allows free movement of the wires through the comb 45 during the stringing operation.

Referring now to FIGURE 6, an enlarged view of the drive apparatus 37 is shown with a bottom wire guide plate 50 having longitudinal grooves 51 of approximately square cross-section therein to accommodate individual ones of the wires 13. The depth of these grooves 51 is arranged to accommodate the diameter of the wires 13 with cross-cut slots of predetermined locations to allow the drive mechanism of the apparatus 37 to exert a driving force thereon and for other reasons explained fully hereinafter. The wire drive means is a spring-loaded transverse resilient roller 53 positioned in contact with the wires 13 near the entrance end of the plate 50. The roller 53 is provided with a pair of drive knobs 54 attached to respective ends of an axle 55 supporting the roller 53. The axle 55 is journaled in a cover housing 56 forming an upward extension of the guide plate 50. A cross-cut arcuate slot 57 is provided across the grooves 51 under the roller 53 to expose the wires 13 to the roller 53 with a small portion of the grooves 51 being retained to guide the wires 13.

A transverse clamp block 60 is centrally located in the cover block 56 and spaced from the roller 53. A screw 61 is attached to the top of the block 60 and is threaded into the housing 56. The other end of the screw 61 is attached to a knob 62 positioned above the housing 56. The block 60 has a flat bottom surface and substantially the same width as the roller 53 to enable all of the wires 13 to be clamped upon the plate 50 by a rotation of the clamp knob 62. A second cross-cut slot 63 is provided under the block 60 to expose the wires 13 to the bottom surface of the block 60. The slot 63 is arranged to expose approximately 30 percent of the diameter of the wires 13 to the block 60.

A transverse knife edge 65 is positioned in a slot 66 in the housing 56 adjacent to the exit side of the guide plate 50 and spaced from the clamp block 60. The knife edge 65 is connected to a spring-biased actuating lever 67 positioned above the housing 56. The slot 66 is continued to the bottom of the grooves 51 to prevent damage to the knife-edge 65. The depth of the cut is controlled by a stop 68 shown in FIGURE 4. The knife edge 65 is arranged to be normally out of contact with the wires 13. A matching cover **69** is provided on the transition guide plate **17** to restrain the wires **13** in the grooves of the plate **7**.

Since, as previously discussed, the wires entering a side of the core plates **2**, **2*a*** are on two levels, the bottom surface of the jig surface channels **31** must have a depth which will place the exit side of the wire grooves in the wire drive apparatus **37** in alignment with the spatial position of the desired wire location in the core assembly. In other words, the vertical location of the wires **13** exiting from the drive apparatus **37** with respect to the bottom of the guide plate **50** is fixed by this mechanical dimension. Additionally, the position of the core plates **2**, **2*a*** is fixed on the jig surface **31**. Accordingly, the depths of the various channels in the jig surface **31** are effective to vertically locate the wires **13** in the various wire layers in the slots of the plates **2**, **2*a***. However, it is desirable to have the bottom face of the operative channel in the jig surface **31** and the guide channel in the support **36** in alignment to facilitate movement of the drive apparatus **37**. Thus, for a deeper channel in the jig surface **31**, the jig surface **31** must be raised slightly to align the aforesaid channel bottoms. This vertical motion is accommodated in the movement of the shaft **32** in the cylindrical housing **34**. The extent of the vertical movement is determined by a camming action between the bottom of the turntable **30** and a fixed cam plate **70** attached to the support **35** under the index pin **40**. The cam plate **70** is arranged to contact a bottom edge **71** of the outer periphery of the turntable **30**. The thickness of the turntable **30** at this point for each of the four jig guide channels is arranged to provide the necessary positioning action of the jig surface **31**.

In operation, the present invention is initially used to prepare the ends of the wires **13** to allow leaderless stringing of the wires through the cores **4**. In this operation, the knife edge **65** is used to produce a notch **72** in each of the wires **13** with the stop **68** serving to limit the depth of the notch **72**. The clamp block **60**, on the other hand, is positioned by the knob **62** on the wires **13** in the cross-cut slot **63** behind the notch produced by the knife edge **65**. The block **60** is forced down on the wire **13** until it reaches the top of the slot **63**. This squeezing, or flattening of the top and bottom, of the wires **13** is effective to work-harden a substantial length of each insulated wire behind its respective notch.

An exemplary sequence of operations to produce leaderless wires ready for core stringing is now described for an initial state without a preceding core stringing operation. A locking comb similar to comb **45** is positioned and clamped by any suitable means in front of the drive apparatus **37** which would be positioned on the guide support **36**. The feed roller **53** is operated to drive the wires **13** into the comb **45**. The locking bar **45*a*** is inserted in the comb **45** to lock the wires **13** in place. The wire **13** is then placed in a taut condition by reverse rotation of the feed roller **53**. The clamp block **60** is lowered on the wires **13** and is effective to work-harden the wires **13** by a controlled deformation wherein they are taken past their yield point in the taut condition. The knife edge **65** is then used to produce the notches **72** in each of the wires. The drive apparatus **37** is then moved slightly backwards away from the locking comb **45** and the wires **13** are broken at the notches **72**. This wire breaking step is effective to form a cone-shaped end on each of the wires since they neck down at the notches **72** just before the actual break takes place. The clamp **60** is released, and the wires **13** and the points may then be fed back under the clamp block **60** to work-harden the point by repeating the clamping and unclamping operations. The comb **45** and the locking bar **45*a*** are removed and the short pieces of wire therein are discarded.

The wire feeding apparatus **37** is now slid along the support channel **36** and into the waiting arm of the jig surface **31** until the exit end of the guide plate **50** is adjacent to the pre-positioned face of the core plates **2**, **2*a***. As previously discussed, the edges of the jig surface **31** are effective to transversely align the wire grooves **51** with the slots in the core plates **2**, **2*a***, while the cam plate **70** positions the grooves **51** at the proper height. The feed roller **53** is then operated to propel the wires **13** along the grooves **51**, through the cores **4** and through the comb **45**. A locking bar is inserted in the comb **45** to lock the wires **13**. The comb **45** is then repositioned and clamped at the end of its channel in the jig surface **31**. The feed apparatus **37** is restored to its original position on the support channel **36** by a reverse rotation of the feed roller **53**. A second comb is inserted beneath the wires **13** which are in a taut condition as a result of the reverse movement of the roller **53** while the ends are locked by the comb **45**. The second comb is positioned and clamped adjacent to the exit face of the guide **50** with the wires **13** passing through wire slots in the comb. A locking bar is inserted in this comb to lock the wires **13**, and the point forming operation described above is repeated.

After the new point is formed, the turntable **30** is rotated to position a second arm of the jig surface **31** in alignment with the guide channel **36**. This movement is effective to remove the ends of the wires **13** strung through the cores **4** from the grooves **51**. The above-described operation is now repeated to insert a second set of wires **13** in the cores **4** perpendicular to the first set of wires. These two sets of wires may be designated as the X and Y wires shown in FIGURE 1. The point forming operation is repeated and the turntable **30** is again rotated to position a third arm of the jig **31** facing the wire drive apparatus **37**. Since this arm and its counterpart on the other side of jig surface **31** have a set of wires and locking combs from the first threading operation, these parts must be displaced from their present locations on both sides of the jig surface **31** before a second set of wires and locking combs can be introduced on these arms of the jig surface **31**.

In FIGURE 7 there is a transfer jig **80** which is used to hold the locking combs and wires of a preceding wire layer in a non-interfering position during multiple wire threading on a single axis and to transfer the wired core matrix to other locations for subsequent operations. In order to position this jig **80** on the jig surface **31**, the jig **80** may be provided with two L-shaped clips **81** which are arranged to fit on support pads **82**, shown in FIGURE 5, located at the inside corners of the jig surface **31**. The jig **80** is arranged as a U-shaped member **83** having a suitable opening to clear the core assembly and to allow the wire feed mechanism **37** to approach the core plates **2**, **2*a*** during the threading of the aforesaid third set of wires. A plurality of comb-carrying arms **84** are mounted on swivel pins on the top of the member **83**. Additional comb-holding arms or similar devices may be provided in the arms of the U-shaped member **83** to enable additional locking combs to be carried. A handle **86** is supplied at the closed end of the member **83** to transport the jig **80**.

The further stringing of wires in the core **4**, thus, is facilitated by the transfer jig **80** which is effective to provide a support for the locking combs and the attached wires of a prior threading operation. The third set of wires can, accordingly, be threaded through the cores **4** after the combs and wires of the first threading operation are supported on the transfer jig **80**. Additional sets of wires may be threaded through the cores **4** up to their inner diameter capacity by rotating the turntable **30** and repeating the aforesaid operations while the layers of wires in the cores **4** are positioned in separate layers while the wires in a preceding layer are held in an appropriate position by the jig **80**.

After all of the sets of wires have been threaded, the cover **2*a*** is removed from the cores **4**. The locking combs are all positioned on the transfer jig **80**, and the cores and wires are lifted out of the support plate **2** by the lifting of the transfer jig **80** with the locking combs **45**. The wired core plane is now ready to be connected to a printed circuit board or some means for providing terminals for the ends of the wires threading the cores **4**. In FIGURE 8, there is shown a jig **90** arranged to hold a printed circuit board **91** in a predetermined precise alignment with respect to a plurality of comb-holding slots **92** and comb clamps **93**. The spacing of the clamped combs from the center of the jig **90** is arranged to coincide with the clamped position of the combs **45** on the core threading jig **31**. Accordingly, when the combs **45** are clamped in the jig **90** the wires **13** threading the cores **4** are restored to the taut condition of the core threading operation from the slack state imposed during the transfer operation on the transfer jig **80**.

The printed circuit board is provided with two sets of wire attaching points on each edge of an inner opening **95** arranged to accommodate the wired core plane. A first set of attaching points comprises four groups of printed rectangular pads **96** adjacent to each edge of the opening **95**. The pads **96** are each arranged to underlie the spatial position of two wires coming from two adjoining columns in the core plane. Further, the pads on opposite sides of the opening **95** are staggered as a group with respect to each other so that the wires connected to a pad on one side of the opening **95** will be positioned for connection to two pads on the other side. Thus, the pads connect the wires in an appropriate layer into a continuous winding as may be required for the sense and inhibit wires. The ends of this "winding," i.e., the first and last wires may be connected to individual pads and printed wiring on the board **91**, shown in dotted form as printed segments **97, 98**.

A second set of attaching points on the board **91** may be four groups of printed wires **99** with each extending from a point behind a respective one of the pads **96** to a spaced location on the adjacent edge of the board **91**. The number of printed wires in each of the four groups is equal to the number wires coming from a corresponding side of the core matrix. The wires to be connected to the pads **96** are first positioned by inserting their combs into the slots **92**. In this position of the combs, the wires attached thereto are accurately positioned over the pads **96**. These wires are then soldered and the excess wire removed. The respective combs are removed from the slots **92**, and the combs for the wires to be connected to the printed wires **99** are inserted therein. These insulated wires pass over the previously soldered pads **96** and are also accurately positioned for soldering to the printed wires **99**. If desired, these wires may be anchored to the board **91** by an adhesive and a dip-soldering process may be used after the excess wires and combs are removed. The core matrix and the board **91** may, subsequently, be attached to individual input connectors or wired into a mass core memory having a plurality of similar core planes interconnected in a stack by any suitable prior art means.

What is claimed is:

1. A method of preparing an integral wire leader in a continuous wire comprising the steps of locking said wire against a fixed support, applying a tensile force to said wire at a point spaced from said support to place said wire in a taut state, permanently deforming a section of the taut wire between said support and said point of

applying tensile force by exceeding its yield point while in said taut state, momentarily pressing a knife edge against said taut wire at a point between said support and said deformed section to produce a nick in said wire, exerting a further tensile force on said wire to produce a break at said nick, and releasing the deformed section of said wire.

2. A method as set forth in claim **1**, which includes the additional step of work-hardening said wire at said break after producing said break.

3. An apparatus for producing an integral wire leader in a continuous wire comprising wire locking means operative to lock said wire against a fixed support, tensile force applying means spaced from said locking means and operative to apply a tensile force to said wire to place said wire in a taut state, clamp means operative to permanently deform a section of said taut wire between said support and said tensile force applying means by exceeding the yield point of said wire while in said taut state, knife-edge means operative to momentarily press a knife edge against said taut wire at a point between said support and said deformed section to produce a nick in said wire and means operative to break said wire at said nick.

4. An apparatus as set forth in claim **3**, and including a wire guide channel encompassing a portion of the thickness of said wire whereby said guide channel is operative to provide a stop for said clamp means and said tensile force applying means.

5. An apparatus as set forth in claim **4** wherein said portion of the thickness of said wire encompassed by said channel beneath said clamp means is approximately 30% of the thickness of said wire.

6. An apparatus for producing a separate integral wire leader in each of a plurality of continuous wires comprising wire locking means operative to lock said wires against a fixed common support, tensile force applying means spaced from said locking means and operative to apply a tensile force to said wires to place said wires in a taut state, clamp means operative to simultaneously permanently deform a section of each of said taut wires between said support and said tensile force applying means by exceeding the yield point of said wires while in said taut state, knife-edge means operative to momentarily press a knife-edge simultaneously against all of said wires along a line between said support and said deformed section to produce a nick in each of said wires and means operative to break each of said wires at said nick.

7. An apparatus as set forth in claim **5**, and including a wire guide channel for each of said wires wherein said wires are aligned prior to being deformed and broken and guided thereafter.

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U.S. Cl. X.R.

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