Feb. 9, 1971 J. A. RAICKLE 3,561,088

MATRIX CORE THREADING APPARATUS

Filed Dec. 16, 1968 8 Sheets-Sheet 1

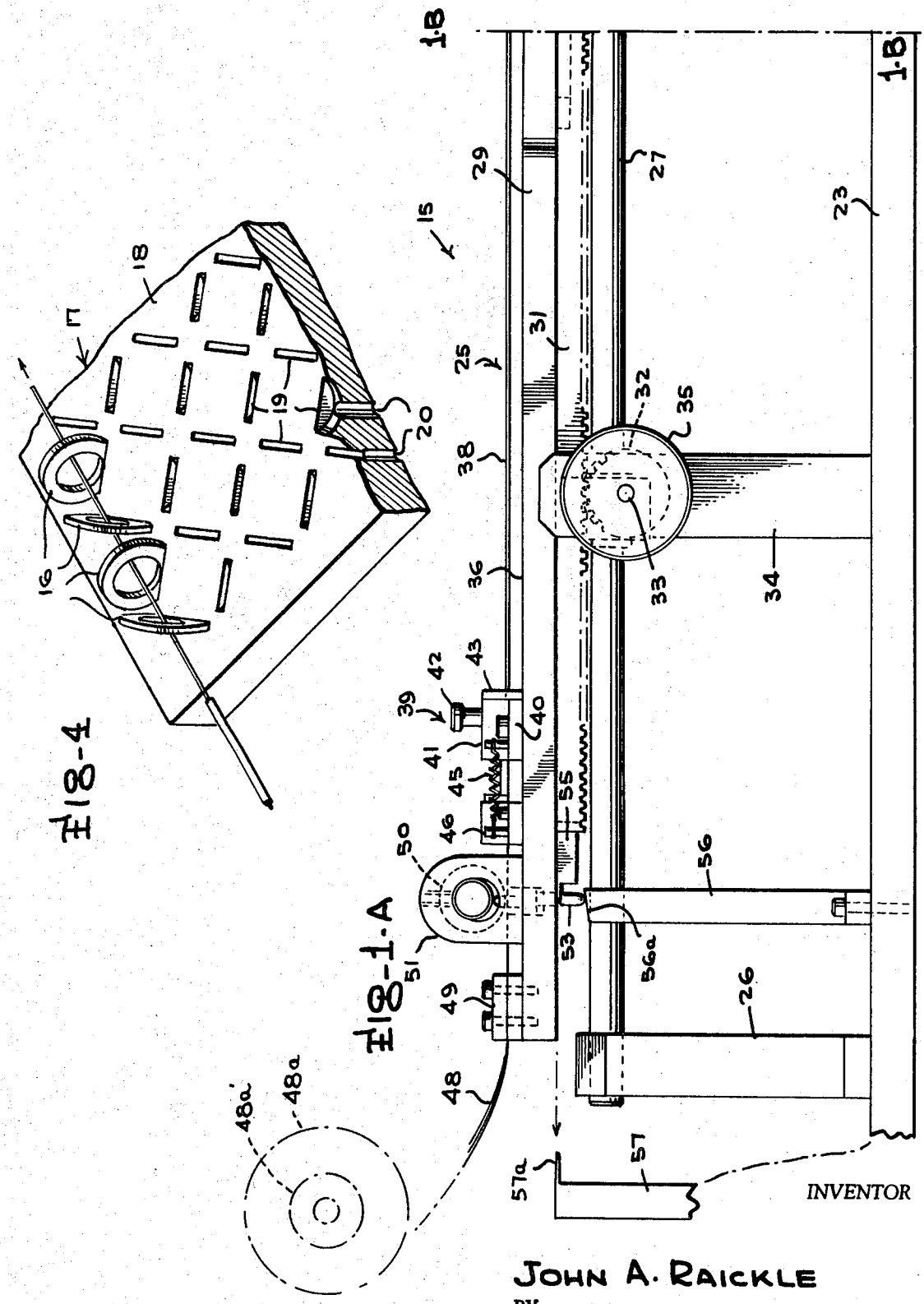


FIG 18-4

FIG 18-1-A

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MATRIX CORE THREADING APPARATUS

Filed Dec. 16, 1968 8 Sheets-Sheet 2

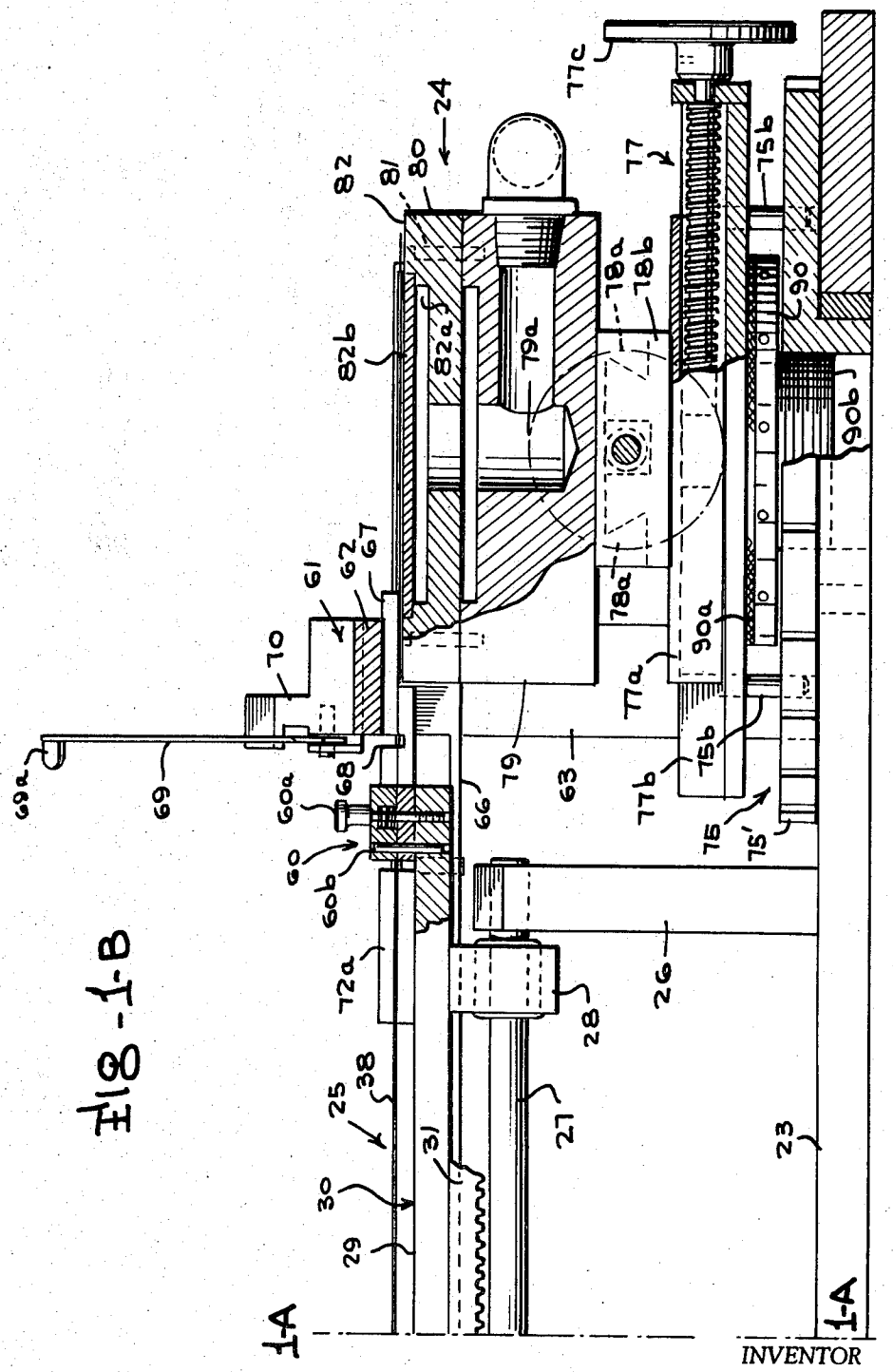


FIG. 1-B

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MATRIX CORE THREADING APPARATUS

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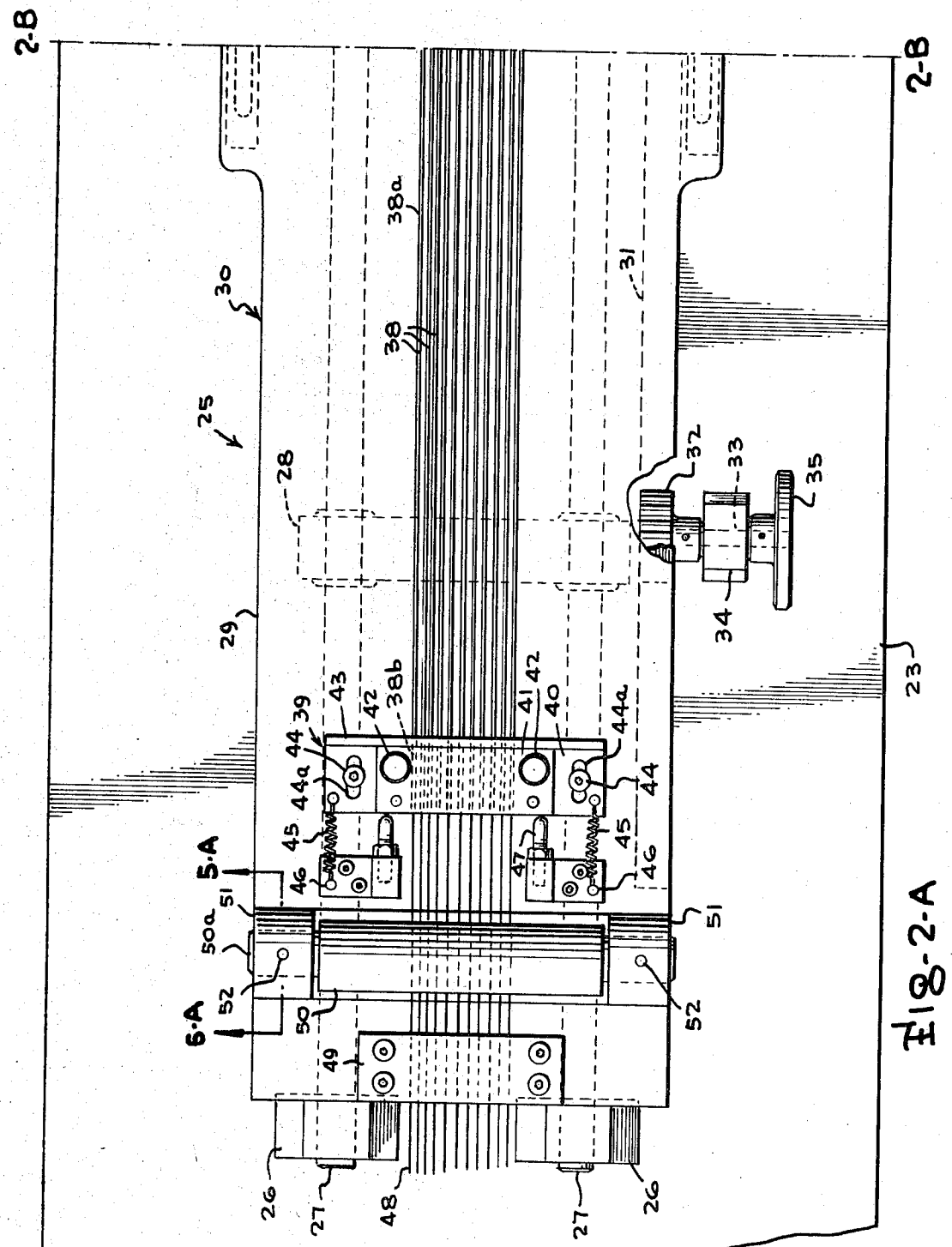


FIG-2-A

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MATRIX CORE THREADING APPARATUS

Filed Dec. 16, 1968 8 Sheets-Sheet 4

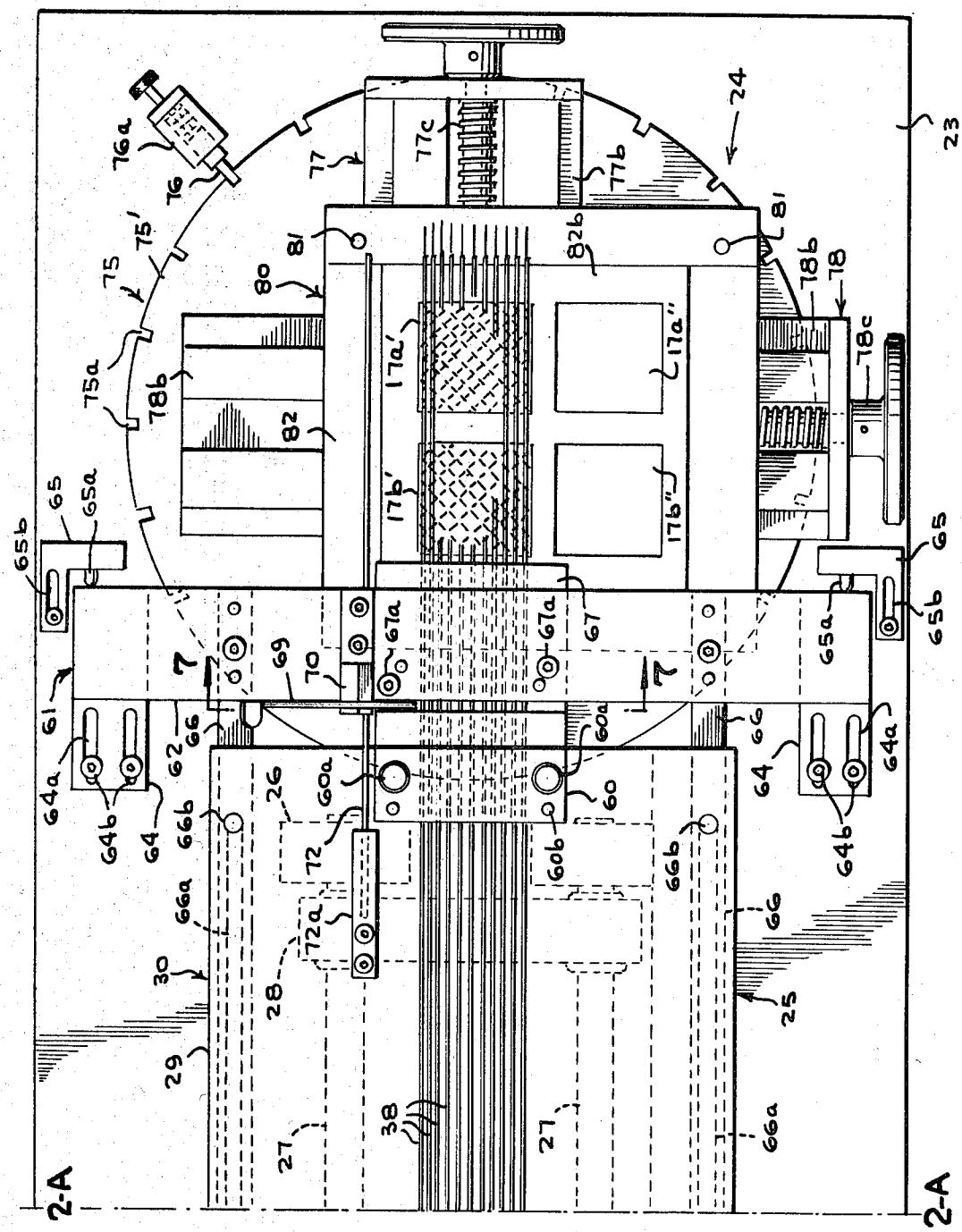


FIG-2-B

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MATRIX CORE THREADING APPARATUS

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Fig-5

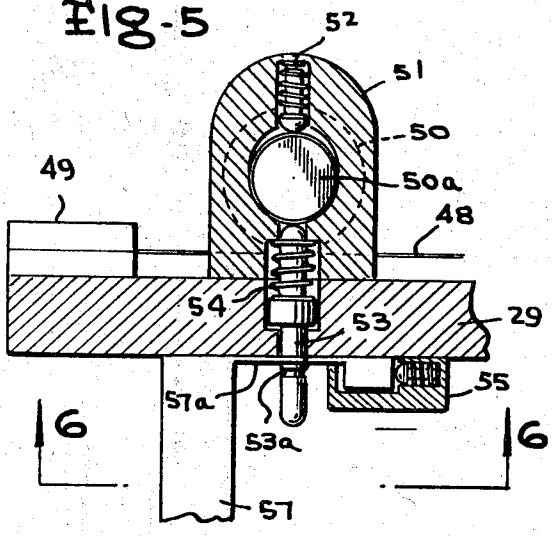


Fig-6

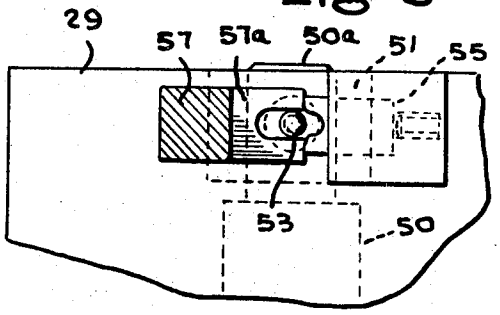
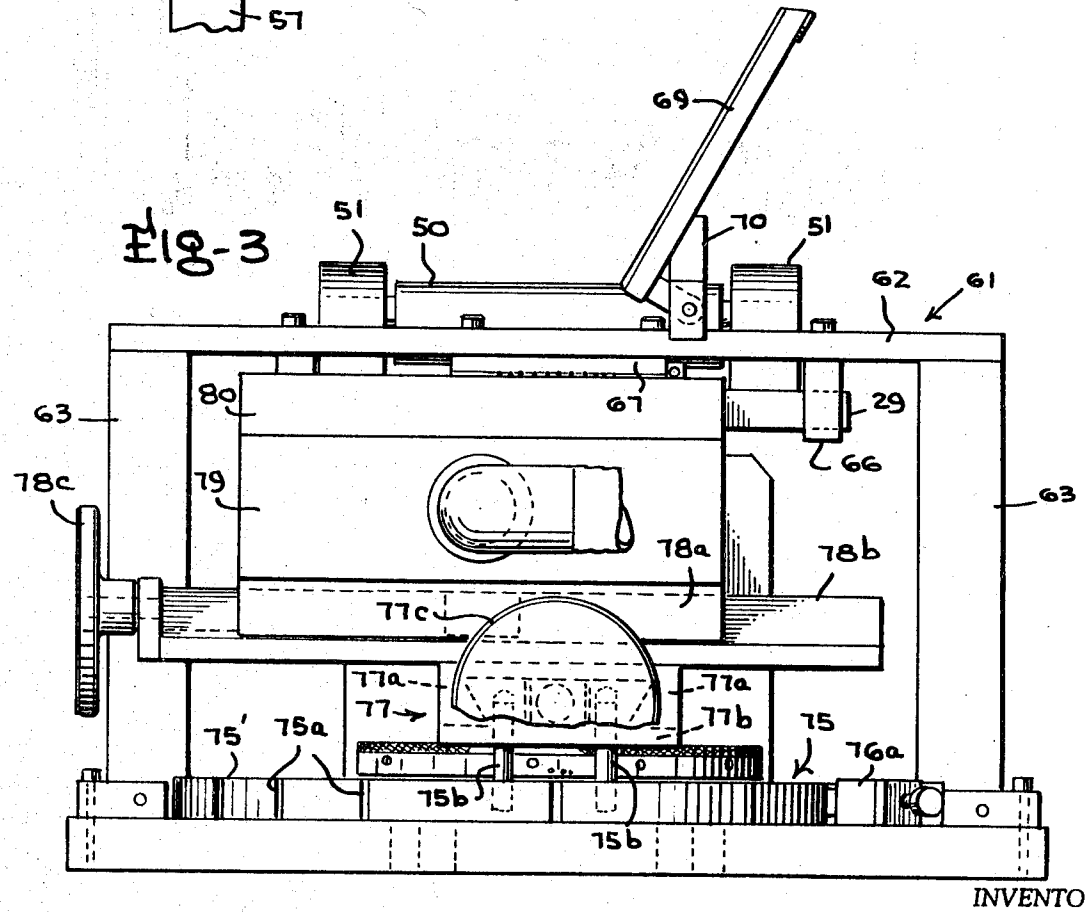


Fig-3



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MATRIX CORE THREADING APPARATUS

Filed Dec. 16, 1968 8 Sheets-Sheet 6

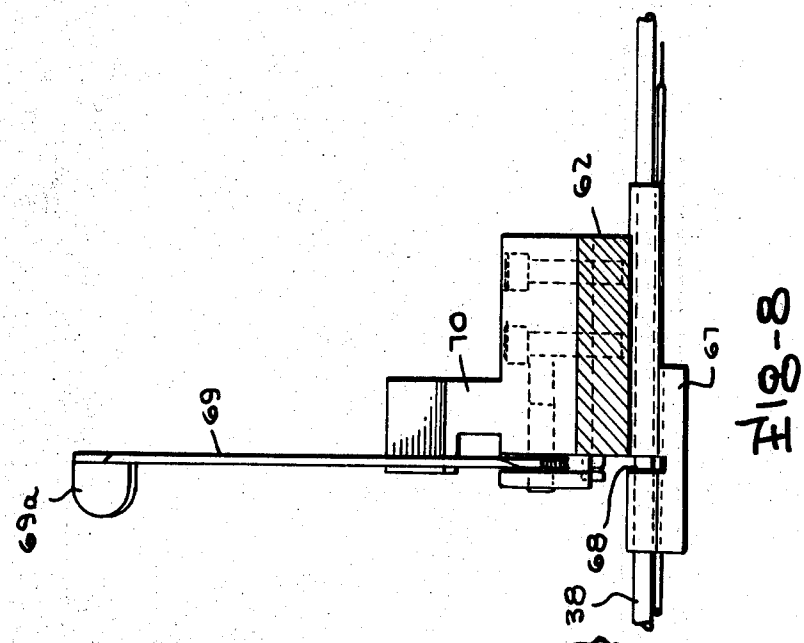


FIG. 8-8

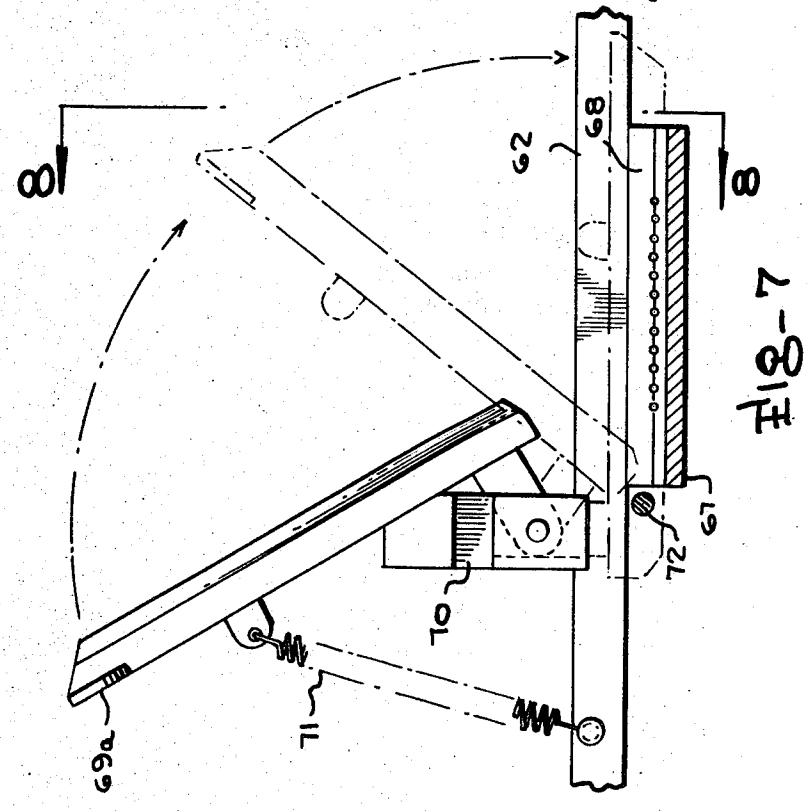


FIG. 8-7

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MATRIX CORE THREADING APPARATUS

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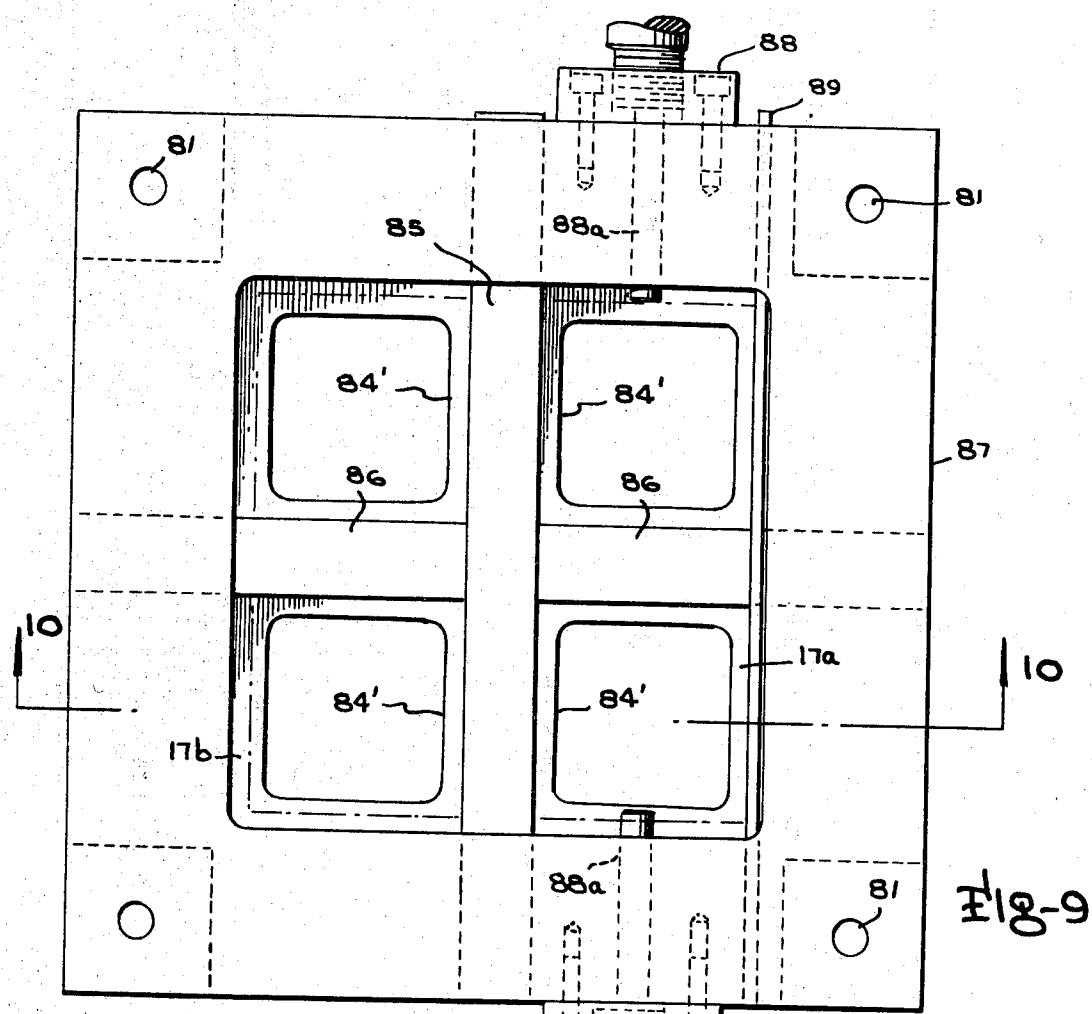


Fig-9

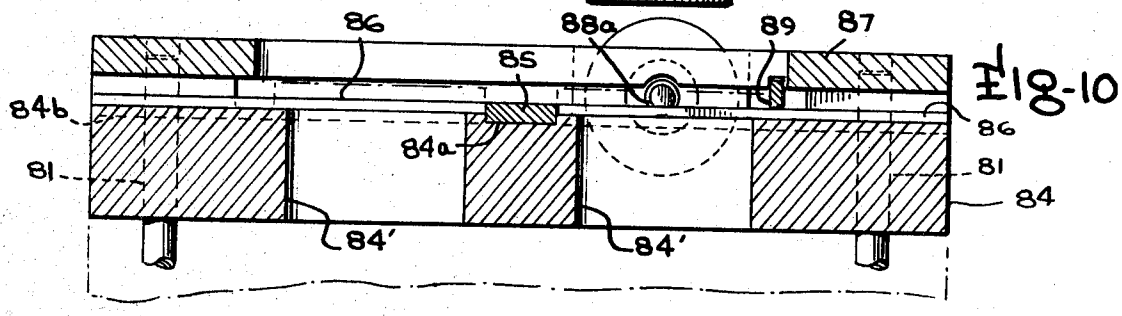


Fig-10

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MATRIX CORE THREADING APPARATUS

Filed Dec. 16, 1968 8 Sheets-Sheet 8

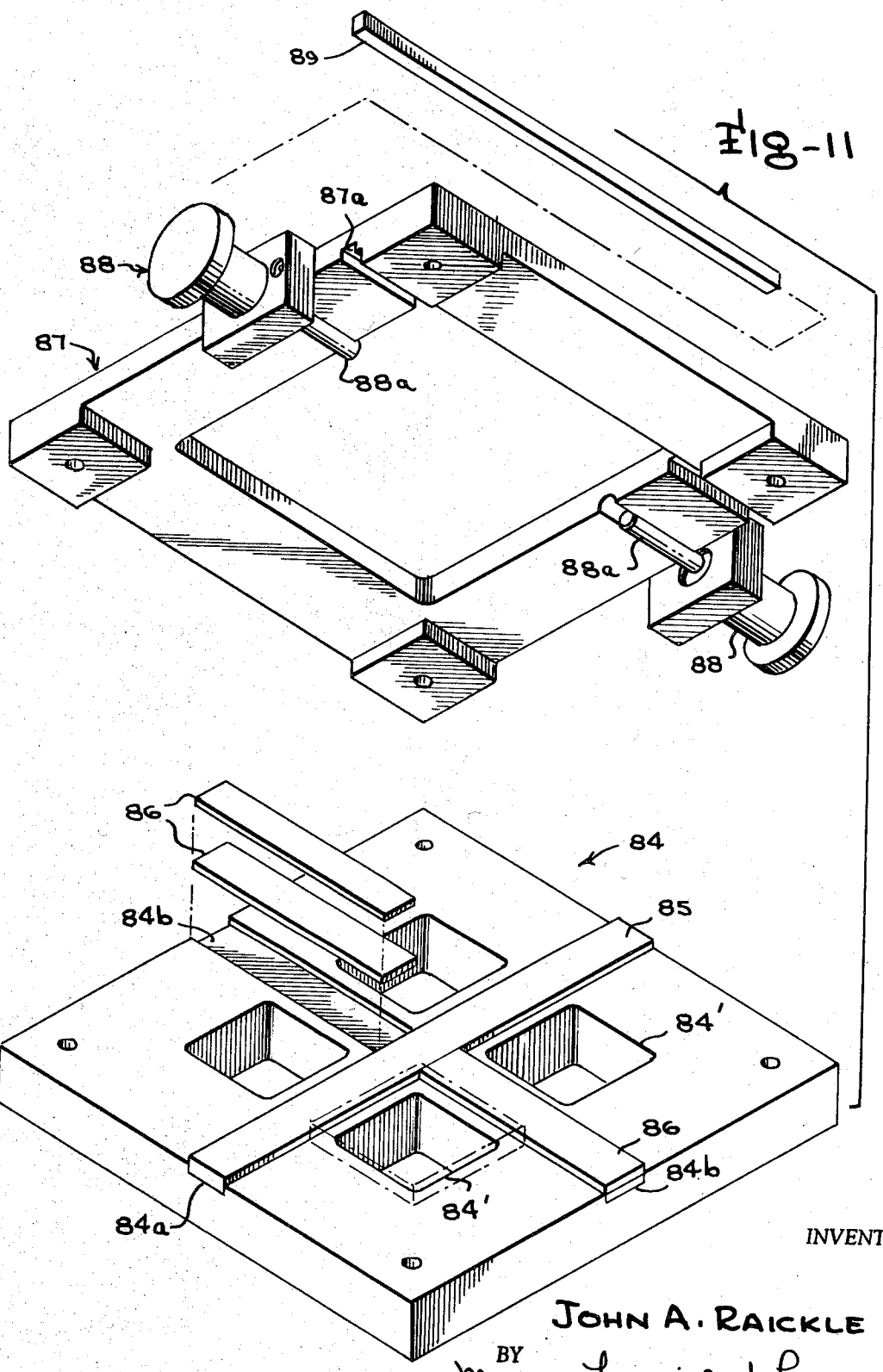


Fig-11

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United States Patent Office 3,561,088
Patented Feb. 9, 1971

3,561,088

MATRIX CORE THREADING APPARATUS

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Filed Dec. 16, 1968, Ser. No. 783,966
Int. Cl. B23p 19/04; H05k 13/04
U.S. Cl. 29—203 23 Claims

ABSTRACT OF THE DISCLOSURE

A machine for threading wires through an array of magnetic cores on filler plates to form a memory matrix having a rectilinearly reciprocative carriage on which plural hollow needles are firmly held in tensioned condition with portions of the needles adequate to span the filler plates projecting beyond the carriage. The wires extend through and protrude a short distance beyond the needles and are moved unitarily with the needles and carriage through an advance stroke feeding both the needles and wires through parallel rows of the cores, after which the wires are held in tension while the needles are retracted, leaving the wires threaded through the cores, and the wires are cut adjacent the proximal edge of the array. Means are provided for supporting the needles against deviation from their assigned paths during reciprocation, for automatically clamping and releasing the wires relative to the carriage, and for minute relative displacement of portions of the array transversely of the needle path and for angular and vertical adjustment of the array.

BACKGROUND AND OBJECTS OF THE INVENTION

The present invention relates to apparatus for concurrently threading wires along a plurality of parallel rectilinear paths through aligned holes of small matrix memory cores arranged in parallel rows of plural cores to produce memory matrices for use in electrical and electronic computer devices.

The memory matrices employed in electrical and electronic computer devices comprise a plurality of very small paramagnetic rings, usually referred to as "cores", arranged in a common plane so that the openings in the cores are aligned along a set of parallel first axis rows and also along a set of parallel second axis rows perpendicular to the first axis rows, frequently referred to as the X and Y axes of the matrix. The cores are located at the intersections of their respective associated first and second axis rows and arranged perpendicular to the common plane of the matrix, with the cores inclined at an angle of about 45° to the axes of their respective associated first and second axis rows. One or more wires are threaded through these cores in each of the X and Y axis directions to complete the assembly of the matrix, and frequently, in the so-called "bootstrap" wired matrices, each of the wires in one direction must be threaded through some of the cores in one row and then through the remainder of the cores in the adjacent parallel row. As the miniaturization of electronic circuit components has progressed, the size of the elements making up such matrices has also been reduced, so that it is not uncommon to have matrix cores wherein the diameter of the hole in the core is approximately .020 inch, and each such hole may have four wires threaded therethrough, each having a diameter of about .003 inch. Ordinarily, each matrix comprises thousands of such cores.

It has been customary in the past to hand assemble these matrices by manually feeding the wires through the individual cores, using tweezers or guide needles of

various constructions. For example, aligned rows of cores have been threaded by passing a hooked needle through the cores, attaching a wire to the hook end of the needle and then withdrawing the needle along a reverse path with the wire attached, or by attaching a wire to the trailing end of a needle, passing the needle through the cores, and drawing the wire through after the needle. Obviously, such hand assembly of these matrices is an extremely slow, tedious, exacting and costly procedure under the best circumstances, and highly skilled workers are required to perform this work.

Considerable effort has been devoted to development of apparatus which will facilitate the threading of such matrix magnetic cores and reduce the degree of worker's skill, time and cost involved in assembling the matrices. Typical of efforts to solve this persistent problem are the devices shown in U.S. Patent No. 2,958,126, to Shaw et al., and No. 3,174,214, to Davis. In both of these patents, elongated hollow needles or needle-like tubes having the wires led through the bores of the needles are advanced with the wires from a proximal end of the core array to the distal end thereof, after which the lead end portions of the wires are secured at the distal end against movement and the needles are retracted relative to the wires to withdraw them from the cores. In the Davis device, a single needle feeds the wire through one row of cores along one axis, for example, the X axis, of the matrix, and a plurality of needles thereafter concurrently feed wires through the plurality of cores which were threaded by the single X axis wire to feed Y axis wires through these cores. The lead end of the wire projecting beyond the lead end of each needle must be bent rearwardly over the adjacent exterior surface portion of the needle to permit it to be fed with the needle through the cores, and this bent lead end of the wire must be held in some manner while the tube is withdrawn from the cores to leave the wire inserted in the cores. Obviously, considerable manual manipulation of the wires must occur in the use of this device to bend the lead end of the wire back over the leading end portion of its associated needle before each advancement of the needle through the cores and to hold the hooked end of the wire when the needle is retracted.

In the device of the earlier patent to Shaw et al., the plurality of hollow needles or needle-like tubes are concurrently advanced through the cores while the lead ends of the wires are located entirely inside the bores of the needles, and after the needles have been advanced fully through the cores, the wires are then advanced through the needles to a position whereby their feed ends protrude from the lead ends of the needles, after which the protruding ends of the wires are gripped and the needles are retracted to their original positions.

In the Davis apparatus, the needles are supported at their ends remote from the cores by a reciprocated carrier spaced from the lead end of the needle a distance greater than the axial length of one of the matrix rows, leaving a long expanse of unsupported needle which can be readily distorted out of the very precise position and alignment in which it must be maintained to properly register with the very small diameter bores in the cores. In the Shaw et al. apparatus, the needles are axially driven by limited surface engagement between a vertically spaced pair of rubber rollers which slide the needles axially along a support surface, and which engage and drive the wire through the needles after the needles have been advanced across the array and their trailing edges have passed beyond the rollers. This arrangement does not provide adequate protection against bowing or distortion of the elongated needles or of the wire, particularly as the needles are able to undergo some rotation

about their axes during movement along the support surface, and thus preservation of needle alignment with the cores cannot be insured with the required high degree of precision.

An object of the present invention is the provision of novel apparatus for rapidly and reliably assembling magnetic core matrices by inserting wires into the plurality of parallel rows of magnetic cores.

Another object of the present invention is the provision of novel apparatus for rapidly assembling magnetic core matrices by inserting wires into the plurality of parallel rows of magnetic cores which is capable of threading wires in a wide variety of matrix wiring patterns in both X and Y axis directions, including bootstrap wiring of matrices, and which insures reliable proper feeding of the wires through the matrix cores over long periods of use.

Another object of the present invention is the provision of apparatus for threading wires through matrix cores, wherein the major portions of the wires are housed in hollow elongated needles during advancement through the cores and are maintained in proper alignment with the cores with an extremely high degree of precision during advancement through the cores.

Other objects, advantages and capabilities of the present invention will become apparent from the following detailed description, taken in conjunction with the accompanying drawings illustrating a preferred embodiment of the invention.

BRIEF DESCRIPTION OF THE FIGURES

FIGS. 1A and 1B collectively form a side elevation of matrix core threading apparatus embodying the present invention, with parts broken away to reveal details thereof;

FIGS. 2A and 2B collectively form a top plan view of the apparatus;

FIG. 3 is an end view of the apparatus as viewed from the right of FIG. 1;

FIG. 4 is a fragmentary perspective view of one of the filler plates in which the cores are supported during threading thereof;

FIG. 5 is a vertical section view through one of the pinch roll bearings, taken along the line **5—5** of FIG. 2A;

FIG. 6 is a section view, taken along the line **6—6** of FIG. 5;

FIG. 7 is a fragmentary section view of the cutting knife assembly, taken along the line **7—7** of FIG. 2B;

FIG. 8 is a section view, taken along the line **8—8** of FIG. 7;

FIG. 9 is a top plan view of another form of head and a spider usable therewith;

FIG. 10 is a vertical section view taken along the line **10—10** of FIG. 9; and

FIG. 11 is an exploded perspective view of the head of FIG. 9 and the spider employed therewith during adjustment of filler plate positions.

DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT

Referring to the drawings, wherein like reference characters designate corresponding parts throughout the several figures, the apparatus of the present invention, indicated in general by the reference character **15**, is designed to facilitate the rapid production of a magnetic core matrices by advancing wires along X axis rows and then along Y axis rows through a plurality of annular magnetic cores, indicated **16**, in FIG. 4, when the cores have been supported in a common matrix plane on a suitable core supporting base, such as the filler plate **17**. The filler plate **17** is formed of rigid, non-conductive material such as an insulative or dielectric plastic, having a substantially rectangular perimeter and an upper surface **18** provided with a plurality of concave cavities or recesses **19**, corresponding in number and location to the magnetic cores **16** to be present in the final matrix assembly. The cavities **19** have the configuration of a shallow

cylindrical segment to receive a lower portion of the magnetic cores **16** and support them in planes perpendicular to the plane of the surface **18**. The upper surface **18** of the filler plate **17** may be otherwise flat, or may have a plurality of guide grooves of selected depth extending parallel to the X axis of the matrix and a second group of parallel guide grooves extending parallel to the Y axis of the matrix and having a somewhat greater depth than the X axis guide grooves intercepting the cavities to assist in guiding the wires and needles. The cavities **19** being oriented so as to dispose the cores **16** at an angle of about 45° to the X and Y axes of the matrix, the top surface of the plate, or the base surface of each guide groove, if used, is spaced a sufficient distance above the lowermost points of the cavities **19** to register wires being fed along these surfaces with the hole or central opening in each of the cores. Each cavity has a vacuum port **20** extending from its lowermost point through the filler plate **17** to the bottom side thereof, so that upon application of vacuum or suction pressure to the bottom side of the filler plate **17**, as will be later described, the cores **16** will be held within their respective cavities **19**.

The matrix core threading apparatus **15**, which is generally illustrated in FIGS. 1A and 1B, 2A and 2B, and 3, comprises a base plate **23** having a filler plate supporting assembly, generally indicated at **24**, located near one end thereof, and a needle reciprocating assembly, generally indicated at **25**, arranged in selected lateral alignment with the filler plate supporting assembly for feeding hollow needles and wires into the cores **16** disposed on the filler plate **17**. The assembly **25** comprises upright posts **26** supporting a pair of elongated rectilinear guide rods **27** in a horizontal plane above the base plate **23**, which extend through and form supporting tracks for slidable bearing members **28** depending from a base platform or carriage plate **29** of an elongated needle carriage **30**. Depending from the bottom side of the base platform **29** along one edge thereof is an elongated rack **31**, the teeth of which mesh with a drive pinion **32** on a shaft **33** journaled in and extending through an upright bearing post **34** and having a manual operating knob **35** fixed to the shaft **33** and outwardly of the bearing post **34** for reciprocating the needle carriage **30** through advance and return strokes along a precise rectilinear path governed by the guide rods **27**.

The base platform **29** has a flat horizontal upper surface **36** which is spaced downwardly a slight distance below the plane of the horizontal upper surface of the filler plate **17**. A plurality of elongated hollow needles **38**, corresponding in number to the number of rows in one filler plate **17**, are firmly held on the carriage platform **29** at locations spaced apart a major portion of the length of the needles, with the needles **38** arranged in parallelism in a plane aligned with the plane of the upper surface of filler plates **17** and extending from a location adjacent the left hand or trailing end of the carriage plate **29**, as viewed in FIGS. 1A and 1B, and 2A and 2B, to a projected position beyond the right hand or leading end thereof. The needles **38** form elongated hollow tubes whose internal diameter corresponds closely to the outer diameter of the wire to be threaded through the cores **16**, for example, wire having a diameter of .003 inch, and in the preferred embodiment may be formed of stainless steel tubing **38***a* having a length of about 2 feet, and inside diameter of about .004 inch and an outside diameter of about .006 inch and having a tubular stainless steel shank **38***b* of about .006 inch internal diameter, about .015 inch outer diameter, and an axial length of 1¼ inches shrunk or otherwise secured to the trailing end portion of the tubing portion **38***a* in a partially telescoped or overlapped relation thereon.

The needle shank **38***b* is located on the carriage plate **29** by a clamping block assembly **39** formed of a lower block member **40** having grooves in the upper surface thereof to receive the lower surface portions of the shanks **38***b* and an upper block member **41** secured to

the lower block member by knurled head screws **42** and precisely aligned therewith by such screws and by adjacent alignment pins. A stop plate **43** is secured to the face of the block members **40, 41** facing toward the assembly **24**, having apertures sized to pass the needle tubes **38***a* but not the shanks **38***b*. The assembly of the upper and lower block members **41, 40** is supported for limited longitudinal movement on the top plate **36** by mounting screws **44** extending through elongated slots **44***a* in the lateral end portions of the lower block member and into the carriage plate **29**, and is biased toward the trailing end of the plate **29** by tension springs **45** connected to the lower block member **40** and to laterally spaced posts **46** on the carriage plate. These posts **46** also have stop pins **47** threaded therein for adjustment longitudinally of the plate **29**, which may be fixed at desired adjusted positions by nuts on the pins **47** and bear at their free ends against confronting surface portions of the upper block member **41**.

The wires, indicated collectively at **48**, to be fed through the bores of the hollow needles **38** are led through a wire guide block **49** fixed to the carriage plate **29** at the trailing end thereof and beneath overlying pinch roll **50**, into the bores of the needles **38** at the shank ends thereof from suitable supply spools, diagrammatically indicated at **48***a* having conventional clutch discs **48***a'* for applying a selected frictional force to the spools to maintain the wires under slight tension. A sufficient length of wire is paid off the spools through the wire guide block **49** and between the pinch roll **50** and a block or elevated surface portion of plate **29** therebeneath into each of the needles and project a very short distance beyond the leading ends of the needles through which they are fed. The upper pinch roll **50** is journaled in upright bearing members **51** having slightly vertically elongated journal openings for the trunnions of the pinch roll **50** to accommodate a slight amount of vertical movement of the pinch roll. A resiliently biased bearing pin **52** is housed in a suitable recess in each of the bearing members **51** above the trunnions **50***a* of the pinch roll **50** to bear downwardly upon the trunnions and bias the pinch roll **50** downwardly to driving surface engagement with the wires leading to the needles. A vertically movable cam pin **53** extends through a vertical axis bore in each of the bearing members **51** communicating with the journal openings to bear upwardly against the lower portion of the trunnions **50***a*. This cam pin **53** is resiliently biased by spring **54** within the bore to a downward position and the lower end portion of the cam pin projects below the bottom of the base platform **29** and has a circumferential groove **53***a* therein. Mounted against the underside of the platform **29** and alongside the lower portion of the cam pin **53** is a spring loaded slide lock **55** having a nose portion which terminates in a concave surface adapted to interfit in a portion of the groove **53***a* when the groove registers therewith. Stationary tripping blocks **56** fixed on the base plate **23** and having inclined cam surfaces **56***a* at the upper end thereof are so located along the line of travel of the cam pins **53** as to engage the cam pins when the carriage **30** reaches the forwardmost limit of its advance stroke and lift the cam pins, to thereby raise the pinch roll **50** out of engagement with the wires and align the grooves **53***a* with the slide locks **55** which then enter the grooves **53***a* and latch the cam pins in raised position until the carriage **30** returns fully to the retracted limit position at the end of its return stroke. At this retracter limit position, release blocks **57** likewise fixed on the base plate **23**, have tongue portions **57***a* which engage the slide locks **55** and force them out of the grooves **53***a* of the cam pins **53** and release these pins to their lower positions, allowing the pinch roll **50** to again bear on the wires **48**.

A fixed clamping block **60** for the needles **38** is mounted on the carriage plate **29** at the lead end thereof, by means of knurled head screws **60***a* and alignment pins **60***b*, and comprises upper and lower blocks having concave recesses in their confronting surfaces designed to receive portions of the needles therein and provide an interference fit with the needles to securely clamp them on the plate **29** at positions spaced a selected distance back from the leading ends of the needles. Since the trailing end portions of the needles are securely clamped by the clamping block assembly **39**, which is movable on the plate **29** by virtue of the slots **44***a* through which the mounting screws **44** extend and is resiliently biased toward the left or trailing end of the plate **29** by the springs **45**, the needles are firmly gripped at these widely spaced locations and continuously held under tension when mounted on the carriage plate **29**.

Adjacent the leading end portion of the needle carriage plate and overlying a portion of the filler plate supporting assembly **25** is a bridge structure **61** comprising an upper horizontal cross piece **62** extending transversely across the apparatus and vertical supporting posts **63** at the opposite ends thereof having foot plates **64** secured to their lower ends and slidably bearing on the upper surface of the base plate **23**. The foot plates **64** project towards the trailing end of the carriage **30** from the posts **63** and have elongated slot **64***a* therein through which mounting screws **64***b* extend into the base plate to support the bridge structure **61** for a limited range of movement, for example, about 1 inch, longitudinally of the base plate. The forward or extended position of the bridge structure **61** is determined by adjustable stop members **65** adjacent the posts **63** having stop pins **65***a* projecting therefrom to be engaged by the posts of the bridge structure at the forward limit position of the bridge and having slots **65***b* through which mounting screws extend into the base plate to adjust the stop members **65**. The bridge structure **61** is linked to the base platform **29** for movement of the carriage **30** relative thereto while maintaining proper alignment of these components relative to each other by rigid elongated straps **66** fixed to the cross piece **62** of the bridge structure and extending toward the trailing end of the carriage **30** immediately beneath the latter, having elongated slots **66***a* therein whose length corresponds to the length of the desired stroke of the carriage **30** plus the range of movement of the bridge structure permitted by the slots **64***a*, in which fixed pins **66***b* depending from the carriage track during movement of the carriage.

The cross piece **62** of the bridge structure **61** in the middle region thereof rigidly supports a needle guide member **67** fixed therebeneath, designed to span the space between the leading end of the carriage **30** and the filler plate supporting assembly **24** to support the leading end portions of the needles **38** over the space between these components against distortion or deviation from their assigned rectilinear axes while permitting axial reciprocative movement of the needles during the advance and return strokes. The needle guide member **67** is supported in depending relation from the cross piece **62** by bolts and alignment pins, indicated generally at **67***a*, and have cylindrical bores therethrough aligned with the needles **38** and sized to support the needles in proper alignment in sliding engagement with their exterior surfaces. It will be noted from FIGS. 7 and 8 that the needle guide member **67** has an upwardly opening vertical slot **68** therein extending from its uppermost surface to a position immediately below the needle path and aligned vertically with the edge of the cross piece **62** confronting the leading end of the carriage **30**, with a portion of the needle guide member underlying this slot to support the entrance portion of the needle guide member which abuts the leading end of the carriage **30** at the forwardmost limit of the advance stroke thereof. This slot **68** is designed to accommodate a knife **69** having one end pivotally supported on a mounting block **70** fixed on the cross piece **62** spaced to one side of the paths of the needles. The knife has a handle portion **69***a* at the free end thereof and is spring loaded to the raised position illustrated in the FIG. 7 by spring **71**, and is normally maintained in the raised

position by abutment with an inclined stop surface portion of the mounting block **70**. The relative disposition of the pivot axis of the knife **69** and the spring **71** is such as to provide an over-center arrangement whereby the knife is resiliently maintained in either the raised or the lowered position to which it is manually adjusted.

To insure against accidental manipulation of the knife to the lower or cutting position while any of the needles **38** occupy the knife slot **68**, an elongated safety bar **72** is fixed to the underside of the base platform **29** of carriage **30** by mount **72***a* and extends longitudinally of the carriage through an opening sized to slidably accommodate the safety bar in the needle guide member **67** to one side of the needle path, but located in the path of movement of the pivoted end portion of the knife **69** to abut the knife end portion and prevent further downward movement thereof before the knife reaches the cutting position in its downward stroke. This safety bar **72** has a length correlated to the stroke of the needle carriage **30** and the location of the leading ends of the needle at the retracted limit position of the carriage to maintain the safety bar in such intercepting relation to the knife whenever the carriage is so displaced from its retracted limit position as to locate any portions of the needles within the knife slot **68** and to withdraw the free end of the safety bar **72** toward the trailing end of the carriage from the knife path when the carriage is sufficiently retracted to withdraw all portions of the needles from the knife slot **68**.

The filler plate supporting assembly **24**, which is located in the right hand region of the apparatus as viewed in FIG. 2B is designed to support four filler plates **17**, as illustrated in FIG. 2B and provide for precise angular adjustment and vertical adjustment, as well as translation of the filler plate along the X and Y axes, and also to optionally provide for micrometer controlled displacement of the pair of filler plates, for example, the plates **17***a'*, **17***a''*, to one side of the transverse center axis of the assembly **24** relative to the other pair of filler plates **17***b'*, **17***b''*. This supporting assembly **24** comprises a rotatably stage unit **75** having a stage plate **75'** journaled in the base plate **23** for rotation about a vertical center axis and having a series of locating notches **75***a* in the periphery thereof, positioned, for example, at 15° increments, adapted to removably receive therein a spring loaded locating pin **76** supporting for axial retroactive movement on the base plate in a suitable holder **76***a*. Supported on the rotatable stage unit **75** is a first axis guide frame **77** having parallel guide members **77***a* whose inwardly confronting faces define a dovetail groove slidably supported on a dovetail guide block **77***b* which is coupled to a stage unit **75** for rotation therewith by coupling pins **75***b*. The frame guide members **77***a* are driven along the guide block by a manually rotatable lead screw and knob **77***c* for rectilinear reciprocative movement parallel to one edge of the filler plates **17**. Supported on the frame guide members **77***a* is a second axis guide frame **78** having similar guide members **78***a* slidably supported on a guide block **78***b* fastened to guide members **77***a* with members **78***a* driven by a lead screw and knob **78***c* for rectilinear reciprocative movement along an axis perpendicular to the axis of movement of the guide members **77***a*.

Surmounted on the guide members **78***a* is a vacuum box **79** having internal fluid ducts therein, indicated at **79***a*, terminating at one end in a vacuum inlet port for communication to a conduit leading to a suction source (not shown) and opening at the other end through the top surface of the vacuum box **79**. Removably mounted on the vacuum box **79** is any one of a plurality of interchangeable heads, generally indicated at **80**, properly positioned on the vacuum box by locating pins **81**, for example, at the four corners thereof, extending through vertical openings in the head **80** and aligned sockets in the vacuum box **79**. The reason for making the heads **80** interchangeable is to permit heads of various types to be mounted on the vacuum box **79** to support filler plates in different ways for different types of operation.

One form of head which may be used is illustrated in FIGS. 1B and 2B and designated by the reference character **82**, and has an upwardly opening cavity **82***a* opening through the upper face thereof substantially rectangular configuration of an appropriate size to extend beneath four filler plates **17** spaced in the manner illustrated in FIG. 2B and having a port communicating the cavity **82***a* with the ducts **79***a* of the vacuum box **79**. A rabbet is formed along the perimeter of the cavity **82***a* to receive and support the edges of a removable panel **82***b* having four rectangular openings therein, which may also have rabbeted perimeters, to receive and support the filler plates **17** and communicate the vacuum ports **20** thereof with the cavity **82***a* to permit application of suction from the vacuum box **79** thereto. As will be observed from FIG. 2B, with the head **82**, the four filler plates **17** are arranged in a pattern which forms two X axis rows and two Y axis rows. With this arrangement, the respective filler plates **17** cannot be displaced along the X or Y axes relative to each other but must be moved as a group by adjustment of the knobs **77***c*, **78***c* and their associated guide frame members.

Another form of head, indicated by the reference character **83**, is illustrated in FIGS. 9, 10 and 11, and comprises a head member **84** having four openings **84'** therein of generally rectangular configuration slightly smaller than the filler plates **17** to support the perimeters thereof and communicate their vacuum ports **20** with the ducts **79***a* of the vacuum box **79**. The upper surface of the head member **84** is provided with a first elongated groove **84***a* extending in the Y axis direction across the head member at the center thereof and a second groove **84***b* extending in the Y axis direction across the head member at the center thereof and intersecting the first groove **84***a*. The groove **84***a* is designed to receive a solid locating guide **85** having a length to extend entirely across the head member and the two sections of the groove **84***b* flanking the guide **85** in the groove **84***a* are each designed to receive either a solid locating guide of the same cross section as the guide **85** or a stack of two coextensive guides having a plane of separation located flush with the top surface of the head member, both types of guides for the groove **84***b* being indicated by the reference character **86**. The guides **86**, either of the solid or two piece type, and the guide **85**, are of such total thickness as to dispose their upper surfaces spaced slightly above the plane of the top surface of the head member **84** so that the edges of the locating guides form abutment surfaces for two adjoining edges of each of the filler plates **17** for properly locating the filler plates on the head member **84**. The one piece solid locating guides **86** are used when aligning the filler plates in two precisely aligned rows of two plates each, while the two piece locating guides **86** are used when moving the right or left hand pair of filler plates **17***a*, **17***b* to form bootstrap wiring and like operations, as will be later described.

To facilitate precise transverse displacement of the right hand pair of filler plates **17***a'*, **17***a''* to effect bootstrap wiring, a removable spider **87** is provided, which fits over the head member **84** and is located in precise relation thereto by apertures in depending pad formations at the corners of the spider for receiving upwardly protruding portions of the locating pins **81**. Mounted on opposite edge portions of the spiders **87** in axial alignment with each other along the common axis of the two right hand filler plates **17***a'*, and **17***a''* are a pair of micrometers **88** having micrometer shafts **88***a* which extend through suitable recesses in the lower surface of the spider to abut the outer edges of the two right hand filler plates **17***a'*, **17***a''* opposite the edges thereof which contact the locating guides **86**. When the two piece locating guides **86** are used,

it will be apparent that coordinate adjustment of the micrometers **88** to shift the two right hand filler plates **17***a'*, **17***a''*, when the vacuum to the box **79** is turned off, will effect movement of these two filler plates as a unit along the Y axis as the uppermost piece of the two piece guide **86** abutting the edges of these filler plates is free to move along the upper surface of the head member **84**. To maintain these two filler plates in precise alignment with each other along the wire axis during each adjustment an elongated guide groove **87***a* paralleling the axis of the locating guide **85** is provided in the lower surface of the spider to removably receive a guide bar **89** which extends downwardly to the top surface of the locating guides **86** and abuts the edges of the filler plates **17***a'*, **17***a''* opposite the edges abutting the locating guide **85**. After adjustment of the filler plates **17***a'*, **17***a''* to the desired offset position, the vacuum to the box **79** is again turned on to securely hold the filler plates in their newly adjusted positions, and the guide bar **89** is then removed so as to avoid interference with the travel of the wires and needles during the threading stroke.

Duplicate micrometers and a second guide bar may be provided to the left of the center of the spider, if desired, for displacing the left hand pair of filler plates **17***b'*, **17***b''* or the spider may merely be removed and reassembled on the head member **84** after rotation of the spider through 180° to effect micrometer adjustment of the left hand filler plates. Of course, the size of the openings in the head member **84** below the filler plate stations is made sufficient to provide communication between the vacuum box and the vacuum ports **20** of the filler plates for all such positions of adjustment of the filler plates. It will be appreciated that following manual location of the filler plates in their assigned positions by disposition of their appropriate edges in abutment with the guide **85** and one piece guides **86**, or following micrometer adjustment of the filler plates in selected transversely offset relation to the other filler plates, the filler plates will be securely held in proper position by the vacuum conditions applied to their lower faces through the head from the vacuum box **79**.

To effect vertical indexing of the filler plate supporting assembly **24** between successive threading strokes of the carriage, the lower guide frame **77** is made to be vertically movable relative to the stage plate **75'** and pins **75***b*. Interposed between the upper surface of the stage **75'** and the lower surface of the frame guide block **77***b* is a jack nut **90** having an enlarged head **90***a* and a precisely threaded, constricted lower portion **90***b* threaded into a threaded center bore in the stage plate **75'**. The perimeter of the head **90***a* is knurled at its top, for ease of initial assembly, and has incremental graduations thereon, marked or calibrated in terms of thousandths of an inch elevation changes and outwardly facing openings for receiving parts of a spanner wrench or tool for angular adjustment of the jack nut to align different graduation marks thereon with an index mark on the stage **75'** to raise and lower the frame unit **77** through incremental steps equal to or slightly greater than the diameter of the wires to be threaded through the cores. Thus, the plane in which the cores lie can be shifted vertically appropriate distances for second, third, fourth, or more, threading strokes of the wires and needles through the holes in the cores by angularly adjusting the jack nut **90** to vertically change the level of the cores between each stroke so that the wires and needles for subsequent strokes will not be intercepted by wires already threaded through the cores during preceding strokes.

In the operation of the apparatus, the filler plates **17** with cores seated in their cavities **19** are positioned in the appropriate stations therefor on the head **80** of the filler plate supporting assembly **24**, vacuum is applied to their lower surfaces through vacuum box **79** to hold them securely in place on the head, and the first or upper row of filler plates **17***a'*, **17***b'*, as viewed in FIG. 2B, are properly aligned with the needle path by adjustment of the knobs **77***c* and **78***c*. The needles **38** are assembled on the needle carriage **30** by inserting them in the openings in the clamping bar assembly **39** from the direction of the trailing end of the carriage until the leading edge of the shanks **38***b* abut the stop plate **43** of the clamping block assembly, and the tubing portions **38***a* of the needles are led into and clamped in the fixed clamping block **60** at a location along the needles such that the leading ends of the needles will be positioned slightly to the right of or beyond the right hand edge of the right hand filler plate **17***a'*, as viewed in FIG. 2B, when the carriage is at the forward or advanced limit position. The nuts **47***a* are adjusted so that the stop pins **47** limit rearward movement of the clamping block **39** by the springs **45** to a position imparting appropriate tension to the needles **38** to maintain the needles in precise rectilinear condition. The wires **48** are inserted through the openings in the wire guide bar **49** and beneath the pinch roll **50**, with the pinch roll in raised condition, and are led through the needles **38** until their leading ends project a selected short distance beyond the leading ends of the needles, after which the pinch roll **50** is lowered to hold the wires against the carriage plate **29** for travel with the carriage and needles toward the assembly **24**.

With the filler plates **17***a'*, **17***b'* precisely aligned with the needles **38** so that the needles will pass through the openings in the cores forming the respective X axis rows, the carriage **30** is moved through its advance or threading stroke from its retracted limit position to its advanced limit position by manipulation of the knob **35**, the pinion **32** connected therewith driving the rack **31** and the carriage **30** through the advance stroke. The needles are effectively maintained against deviation or distortion from their prescribed rectilinear paths over the distance between the leading end of the carriage **30** and the filler plate supporting assembly **24** by the tension stresses applied to the needles at points spaced apart a major portion of their axial length and by the sliding support given by the needle guide member **67** mounted on the bridge cross piece **62**. When the carriage **30** reaches its advance limit position projecting the needles through the cores of the X axis rows of the filler plates aligned with the needle path, the protruding leading end portions of the wires **48**, which overlie the right hand border region of the head **80**, as viewed in FIG. 2B are then secured in any suitable manner, as by applying a strip of pressure sensitive tape over the protruding wire portion and against the adjacent surface of the head, and the carriage **30** is then withdrawn to the retracted limit position by reverse manipulation of the knob **35**.

It will be noted that when the carriage **30** reached the projected limit position, the cam pins **53** associated with the crimp roll bearings **51** engaged the inclined ramp surfaces **56***a* of the tripping blocks **56**, raising the pinch roll **50** out of contact with the wires **48** and thus releasing the wires so that they will not be withdrawn by movement of the carriage in the carriage return direction during the return stroke. The slide locks **55** engaging the grooves **53***a* in the cam pins maintain the cam pins in raised position throughout the return stroke of the carriage. When the carriage **30** reaches the retracted limit position, however, the slide locks **55** are engaged by the tongue portions **57***a* of the release blocks **57** to withdraw the slide locks from the grooves **53***a* and the cam pins **53** are spring returned to their lower position allowing the pinch roll **50** again to fall into engagement with the wires **48** to clamp them against the top plates **36** and cause them to be led through the advance stroke with the needles **38** during the next advance stroke of the carriage.

When the carriage **30** assumes the retracted limit position, the leading ends of the needles are spaced toward the trailing end from the slot **68** in the needle guide member **67** a distance corresponding to the desired wire length to be left protruding from the leading ends of the

needles, while the leading ends of the needles are still located in the guide bores of the needle guide member **67**. The knife **69** is then lowered to cut the wires, and the bridge **61** is manually retracted toward the trailing end of the carriage **30** to expose the proximal end portions of the wires which have already been threaded through the cores to permit them to be secured to the head **80** by pressure sensitive tape or other suitable securing means.

The knob **77***c* associated with the guide frame **77** may then be rotated to translate the head in the Y axis direction to locate the next X axis row of filler plates **17***a*'', **17***b*'' in alignment with the needle path and the previously described procedures repeated to thread the cores on this row of filler plates.

If the head **83** is used, the bootstrap wiring operations are desired, the spider **87** is placed over the head **83** and the micrometers **88** adjusted in the manner previously described to displace the filler plates **17***a*', **17***a*'' in the Y axis direction from the normal aligned relation with the plates **17***b*', **17***b*'' so that, for example, the first X axis row of cores of the plates **17***a*', **17***a*'' is aligned with the second X axis rows of cores of **17***b*', **17***b*'' respectively, thus causing the needles to be fed through the respective aligned X axis rows of filler plates **17***a*', **17***a*'' and **17***b*' and **17***b*'' in whatever relation is determined by the Y axis displacement which has been effected upon adjustment of the micrometers.

Following threading of the bores in the X axis direction, cutting of the wires, and taping of the Y ends to the head, the rotation stage **75** is then rotated through 90° or other desired angles and the jack nut **90** is angularly adjusted relative to the stage **75**' to vertically lower the head **80** through one vertical indexing increment of a distance appropriate to displace the wires that have already been threaded through the cores below the plane along which the next set of wires and needles will be advanced during the next threading stroke of the carriage and thus avoid contact of the needles during such subsequent stroke with the wires already in the cores. Then, the carriage advancing and retracting procedure previously described is repeated in the Y axis direction relative to the filler plates to complete threading of the matrix cores.

It will be apparent that a machine like that herein disclosed but having only a single needle **38** on the platform **29**, can be used to thread a wire in any desired pattern through the cores along diagonal axis inclined 45° to the X and Y axes by rotating the stage **75**' to the appropriate 45° position and adjusting the knobs **77***c* or **78***c* to shift different groups of cores aligned with each other along the diagonal axes into alignment with the single needle and reciprocating the needle through its advance and return stroke. The wire can be cut when the carriage is returned to its retracted limit position, or can be taped down without cutting and the filler plates shifted transversely to align other diagonally aligned sets of cores with the needle for a subsequent threading stroke, as may be desired.

What is claimed is:

1. Apparatus for threading wires through annular cores in a core array to form a memory matrix, comprising core support means for supporting a plurality of the cores in an array at a selected horizontal plane with the cores disposed in a first set of parallel rows and a second set of parallel rows intersecting the first rows, each core being common to two intersecting rows, an elongated horizontal carriage platform spaced laterally from said array having leading and trailing ends respectively adjacent and remote from said array and supported for rectilinear reciprocative movement through advance and return strokes relative to the array along a stroke axis paralleling one of said sets of rows, a plurality of elongated hollow axially rectilinear needles for threading wires through the cores, needle support means for supporting said needles in axial parallelism on said platform in respective axial alignment with the rows of one of said sets with leading end portions of said needles projecting beyond said platform toward the array a distance to span the length of the row aligned therewith, said needle support means including holding means securing each needle to said platform for axial movement therewith and against rotation thereon at axially separated holding stations spaced apart a major portion of the needle length and maintaining them against deviation from axially rectilinear condition between said stations, means for supplying a continuous wire through each of the respective needles to occupy feed positions wherein their leading ends protrude a selected extent from the needles toward the array, releasable wire clamping means on said platform for clamping the wires at said feed positions against movement relative to the platform to be advanced with the platform and needles during the advance stroke and for releasing the wires for movement of the platform and needles relative thereto during the return stroke, and means for moving said platform through said advance and return strokes over a distance progressing the leading ends of the needles through the length of said rows.

2. Apparatus as defined in claim **1**, wherein said holding means includes a first holding member for fastening the needles at a first longitudinal portion thereof against movement relative to the platform and a second holding member movable in the stroke axis direction on said platform and resiliently biased away from said first holding member for gripping the needles at a second longitudinal portion thereof and applying tension to the needle portions lying between said first and second holding members.

3. Apparatus as defined in claim **1**, wherein said needles have externally enlarged trailing end portions opposite the leading end portions thereof; and said holding means includes a first holding block fixed on said platform adjacent the leading end of the platform for securing the adjoining needle portions against movement relative to the platform, a second holding block spaced toward the trailing end of the platform a major portion of the needle length supported on the platform for limited movement along the stroke axis having stop surfaces engaging and restraining said enlarged trailing end portions against withdrawal from said second holding block toward said first holding block, and spring means connected between said second holding block and said platform for biasing the former away from said first holding block and applying tension to the needle portions lying between said blocks.

4. Apparatus as defined in claim **1** including needle guide means occupying a stationary position during movement of the platform having guide surfaces in sliding engagement with the needles in a zone between said platform and the array to support the needles aainst deviation from their normal rectilinear paths.

5. Apparatus as defined in claim **2** including needle guide means occupying a stationary position during movement of the platform having guide surfaces in sliding engagement with the needles in a zone between said platform and the array to support the needles against deviation from their normal rectilinear paths.

6. Apparatus as defined in claim **1**, wherein said wire clamping means includes a clamping member on said platform transversely spanning and overlying the wires leading to said needles at a location between the needles and the trailing end of the platform and movable toward and away from the platform to clamp the wires thereagainst, means including a first stationary member located adjacent the path of said platform for automatically raising the clamping member to a release position relative to the wires when the platform reaches its advance limit position and maintain the clamping member raised throughout the return stroke, and a second stationary member adjacent said path for automatically lowering the clamping member into clamping engagement with the wires when the platform reaches its return limit position.

7. Apparatus as defined in claim **2**, wherein said wire clamping means includes a clamping member on said

platform transversely spanning and overlying the wires leading to said needles at a location between the needles and the trailing end of the platform and movable toward and away from the platform to clamp the wires thereagainst, means including a first stationary member located adjacent the path of said platform for automatically raising the clamping member to a release position relative to the wires when the platform reaches its advance limit position and maintain the clamping member raised throughout the return stroke, and a second stationary member adjacent said path for automatically lowering the clamping member into clamping engagement with the wires when the platform reaches its return limit position.

8. Apparatus as defined in claim 1, wherein said wire clamping means includes a pinch roll overlying and transversely spanning the wires leading to said needles at a location between the needles and the trailing end of the platform, bearing members on said platform supporting said pinch roll for movement toward and away from the platform, said pinch roll being normally biased toward the platform to clamp the wires thereagainst for feeding the wires coordinately with the platform and needles through the advance stroke, a vertically movable lifting member on the platform movable between upper and lower positions for lifting said pinch roll to a raised position spaced out of clamping engagement with the wires and having a contact portion extending from the platform, a stationary activating member located along the path of said contact portion during movement with said platform for automatically engaging the contact portion and elevating said lifting member to shift said pinch roll to said raised position when the platform reaches its advance limit position, releasable latch means for latching said lifting member in said upper position upon elevation thereof to hold the pinch roll in raised position throughout the return stroke, and a stationary release member located along said path to automatically release said latch means from said lifting member when said platform reaches its return limit position.

9. Apparatus as defined in claim 3, wherein said wire clamping means includes a pinch roll overlying and transversely spanning the wires leading to said needles at a location between the needles and the trailing end of the platform, bearing members on said platform supporting said pinch roll for movement toward and away from the platform, said pinch roll being normally biased toward the platform to clamp the wires thereagainst for feeding the wires coordinately with the platform and needles through the advance stroke, a vertically movable lifting member on the platform movable between upper and lower positions for lifting said pinch roll to a raised position spaced out of clamping engagement with the wires and having a contact portion extending from the platform, a stationary activating member located along the path of said contact portion during movement with said platform for automatically engaging the contact portion and elevating said lifting member to shift said pinch roll to said raised position when the platform reaches its advance limit position, releasable latch means for latching said lifting member in said upper position upon elevation thereof to hold the pinch roll in raised position throughout the return stroke, and a stationary release member located along said path to automatically release said latch means from said lifting member when said platform reaches its return limit position.

10. Apparatus as defined in claim 5, wherein said wire clamping means includes a pinch roll overlying and transversely spanning the wires leading to said needles at a location between the needles and the trailing end of the platform, bearing members on said platform supporting said pinch roll for movement toward and away from the platform, said pinch roll being normally biased toward the platform to clamp the wires thereagainst for feeding the wires coordinately with the platform and needles through the advance stroke, a vertically movable lifting member on the platform movable between upper and lower positions for lifting said pinch roll to a raised position spaced out of clamping engagement with the wires and having a contact portion extending from the platform, a stationary activating member located along the path of said contact portion during movement with said platform for automatically engaging the contact portion and elevating said lifting member to shift said pinch roll to said raised position when the platform reaches its advance limit position, releasable latch means for latching said lifting member in said upper position upon elevation thereof to hold the pinch roll in raised position throughout the return stroke, and a stationary release member located along said path to automatically release said latch means from said lifting member when said platform reaches its return limit position.

11. Apparatus as defined in claim 1, including means for cutting said wires adjacent the edge of said array nearest said platform when the platform is at its return limit position including a knife blade supported for movement in a prescribed plane transverse to the needle axes and located toward the array from the leading ends of the needles when occupying the return limit position a distance corresponding to said selected extent of protrusion of the wire leading ends, whereby said selected extent of wire protrusion is present upon cutting of the wires by said knife blade.

12. Apparatus as defined in claim 2, including means for cutting said wires adjacent the edge of said array nearest said platform when the platform is at its return limit position including a knife blade supported for movement in a prescribed plane transverse to the needle axes and located toward the array from the leading ends of the needles when occupying the return limit position a distance corresponding to said selected extent of protrusion of the wire leading ends, whereby said selected extent of wire protrusion is present upon cutting of the wires by said knife blades.

13. Apparatus as defined in claim 5, including means for cutting said wires adjacent the edge of said array nearest said platform when the platform is at its return limit position including a knife blade supported for movement in a prescribed plane transverse to the needle axes and located toward the array from the leading ends of the needles when occupying the return limit position a distance corresponding to said selected extent of protrusion of the wire leading ends, whereby said selected extent of wire protrusion is present upon cutting of the wires by said knife blade.

14. Apparatus as defined in claim 13, wherein said needle guide means comprises a stationary guide block having elongated bores therethrough for slidingly receiving said needles and supporting the same in selected paths during said advance and return strokes, said guide block having a knife slot therein, communicating with said bores transversely spanning and intercepting the paths traversed by said wires and needles, and said knife blade being movable in said prescribed plane from a first position spaced from said bores to a second position in said knife slot for cutting the wires extending through said bores.

15. Apparatus as defined in claim 11, including needle guide means between said platform and said array comprising a stationary guide block having elongated bores therethrough for slidingly receiving said needles and supporting the same in selected paths during said advance and return strokes, said guide block having a knife slot therein, communicating with said bores transversely spanning and intercepting the paths traversed by said wires and needles, and said knife blade being movable in said prescribed plane from a first position spaced from said bores to a second position in said knife slot for cutting the wires extending through said bores.

16. Apparatus as defined in claim 14, wherein said bores in said guide block have entrance portions confronting said platform spaced toward the platform from

said knife slot a sufficient distance to locate leading end portions of the needle in said entrance portions when said platform occupies its return limit position.

17. Apparatus as defined in claim 15, wherein said bores in said guide block have entrance portions confronting said platform spaced toward the platform from said knife slot a sufficient distance to locate leading end portions of the needle in said entrance portions when said platform occupies its return limit position.

18. Apparatus as defined in claim 14, including an elongated safety bar fixed to said platform and extending slidably through said guide block along a path to intercept movement of said knife blade toward the wire and prevent cutting thereof whenever the platform is displaced from its return limit position and having a length to locate said bar out of such intercepting relation to the knife blade when the platform occupies said return limit position.

19. Apparatus as defined in claim 1, wherein said core support means comprises a plurality of filler plates each having upwardly opening cavities for receiving portions of said cores to support the cores in said first and second rows, a support head for supporting a plurality of said filler plates in a common horizontal plane with a pair of said plates spaced along an axis paralleling said stroke axis, means for angularly adjusting said head about a vertical axis to selectively dispose said first rows and said second rows in parallelism with the stroke axis, and means for displacing said head transversely of said stroke axis at plural angular positions of the head to precisely align said first rows and said second rows respectively with the needle axes.

20. Apparatus as defined in claim 19, including means for displacing a first one of said pair of plates relative to a second one of said pair in a direction transverse to the axes of a corresponding set of rows of each of said pair of plates to variably align different respective rows of the first plate of said pair with selected first rows of the second plate of said pair along projected axes of the needles.

21. Apparatus as defined in claim 19, including vertical indexing means supporting said head for vertical movement relative to the axes of said needles in incremental steps correlated to the diameter of the wires to displace said head and cores downwardly between successive advance strokes of the carriage a distance adequate to space the wires threaded through said cores during one advance stroke out of intercepting relation to the needle paths traversed during the next succeeding advance stroke.

22. Apparatus as defined in claim 20, including vertical indexing means supporting said head for vertical movement relative to the axes of said needles in incremental steps correlated to the diameter of the wires to displace said head and cores downwardly between successive advance strokes of the carriage a distance adequate to space the wires threaded through said cores during one advance stroke out of intercepting relation to the needle paths traversed during the next succeeding advance stroke.

23. Apparatus for threading wires through annular cores in a core array to form a memory matrix, comprising core support means for supporting a plurality of the cores in an array at a selected horizontal plane with the cores disposed in a first set of parallel rows and a second set of parallel rows intersecting the first rows, each core being common to two intersecting rows, an elongated horizontal carriage platform spaced laterally from said array having leading and trailing ends respectively adjacent and remote from said array and supported for rectilinear reciprocative movement through advance and return strokes relative to the array along a stroke axis paralleling one of said sets of rows, at least one elongated hollow axially rectilinear needle for threading wire through the cores, needle support means for supporting said needle on said platform in axial alignment with a row of one of said sets with a leading end portion of said needle projecting beyond said platform toward the array a distance to span the length of the row aligned therewith, said needle support means including holding means securing the needle to said platform for axial movement therewith and against rotation thereon at axially separated holding stations spaced apart a major portion of the needle length and maintaining the needle against deviation from axially rectilinear condition between said stations, means for supplying a continuous wire through the needle to occupy a feed position wherein its leading end protrudes a selected extent from the needle toward the array, releasable wire clamping means on said platform for clamping the wire at said feed position against movement relative to the platform to be advanced with the platform and needle during the advance stroke and for releasing the wire for movement of the platform and needle relative thereto during the return stroke, and means for moving said platform through said advance and return strokes over a distance progressing the leading end of the needle through the length of said rows.

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