March 23, 1965 D. P. DAVIS 3,174,214

APPARATUS FOR ASSEMBLING MEMORY MATRIX COMPONENTS

Filed Dec. 14, 1962 3 Sheets-Sheet 1

Fig. 1.

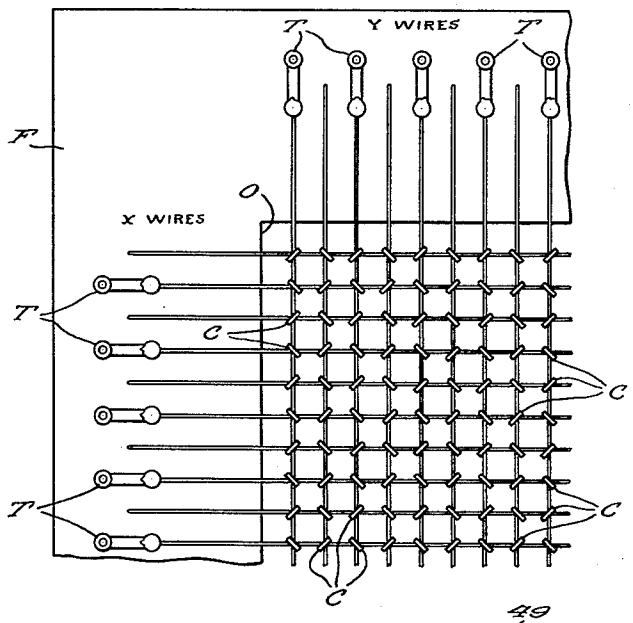


Fig. 2.

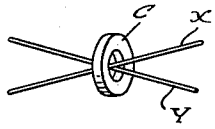


Fig. 6.

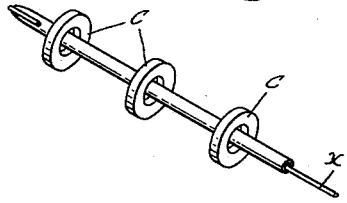


Fig. 3.

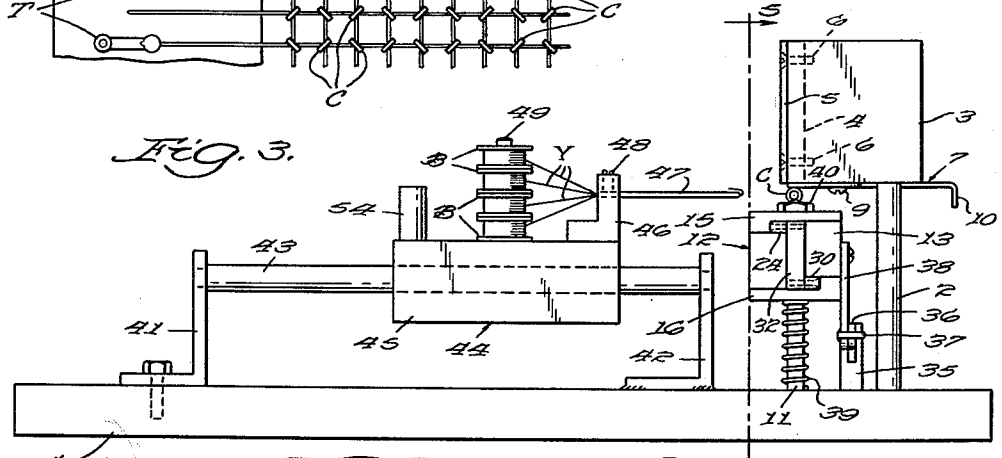
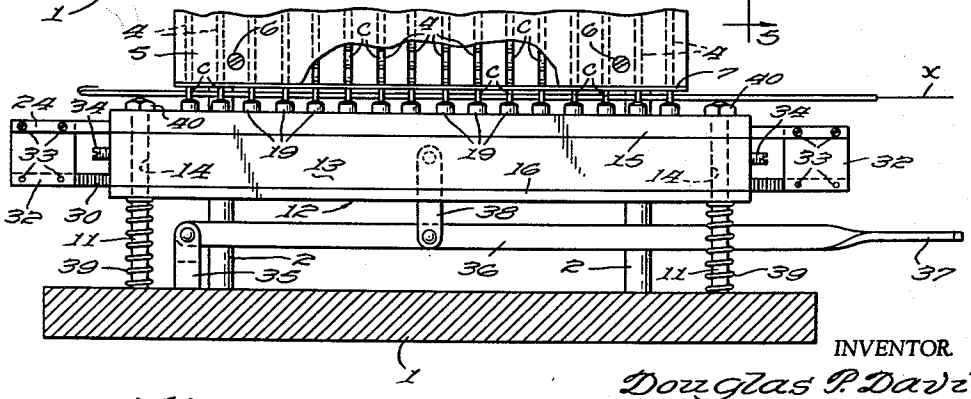


Fig. 5.



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APPARATUS FOR ASSEMBLING MEMORY MATRIX COMPONENTS

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Fig. 4.

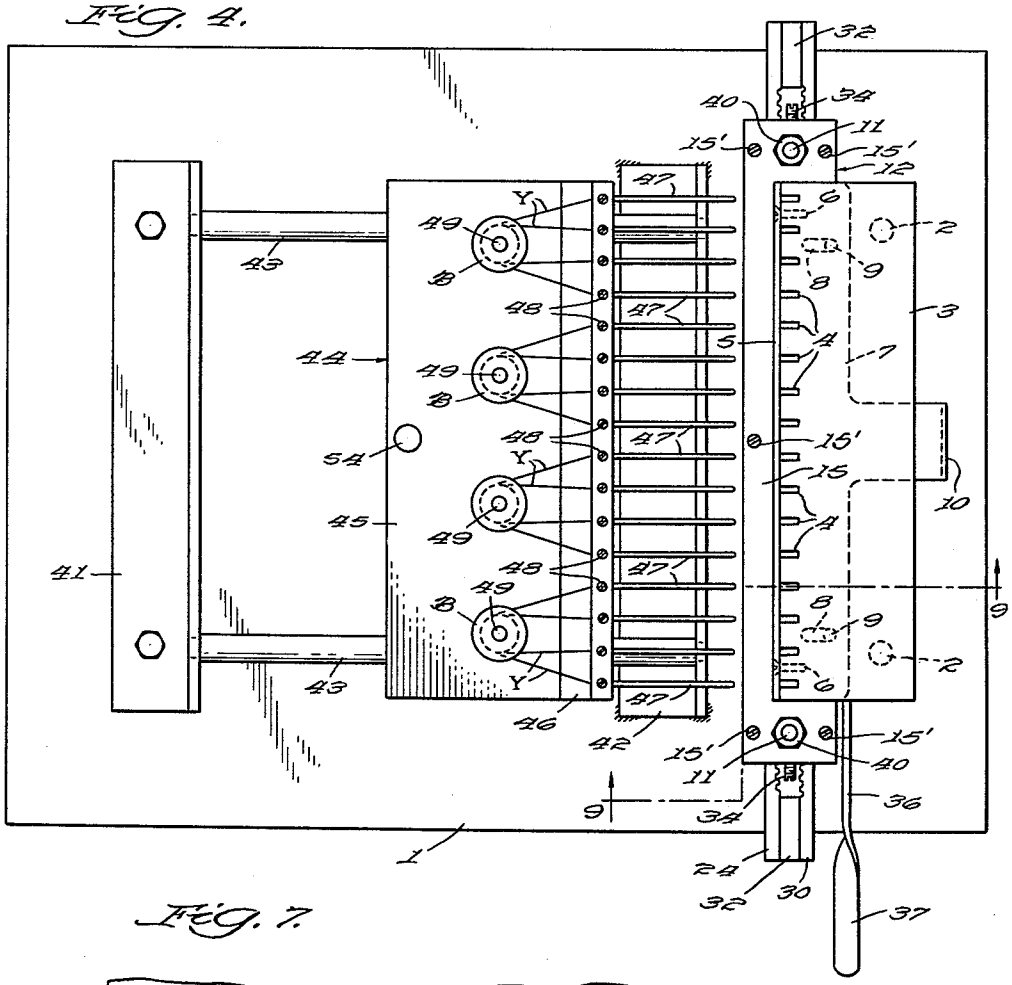


Fig. 7.

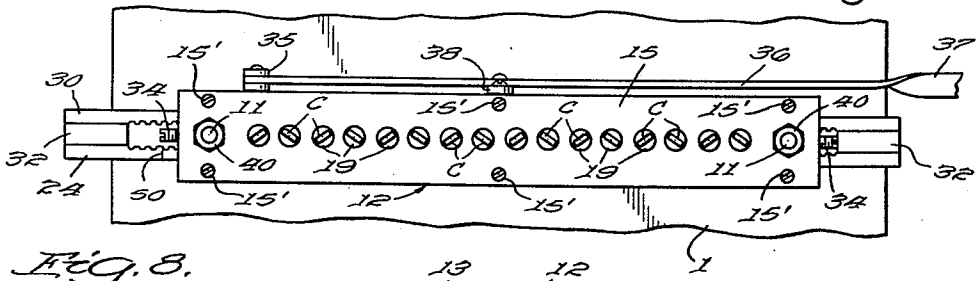
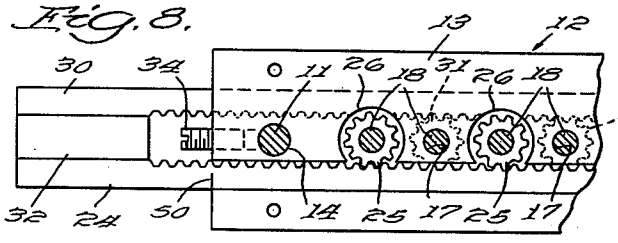


Fig. 8.



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APPARATUS FOR ASSEMBLING MEMORY MATRIX COMPONENTS

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Fig. 9.

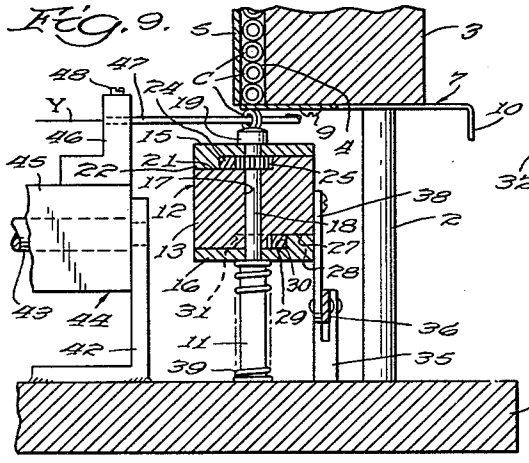


Fig. 11.

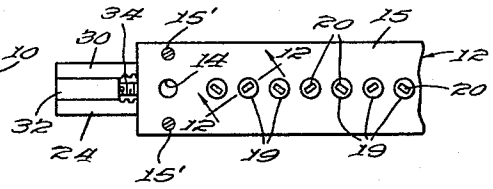


Fig. 12.

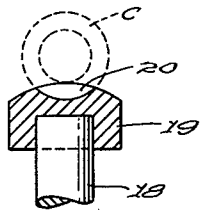


Fig. 10.

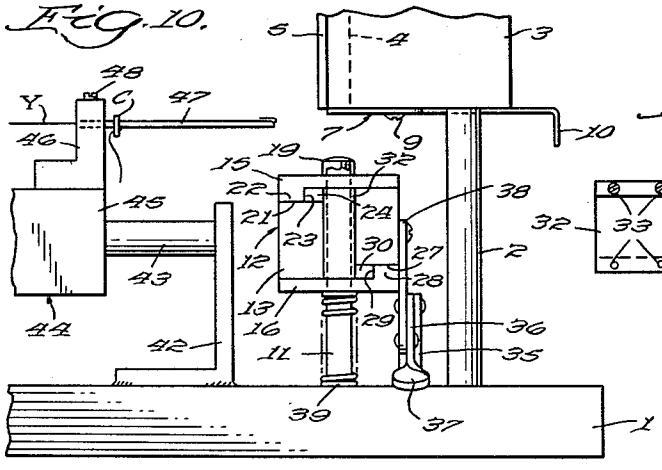
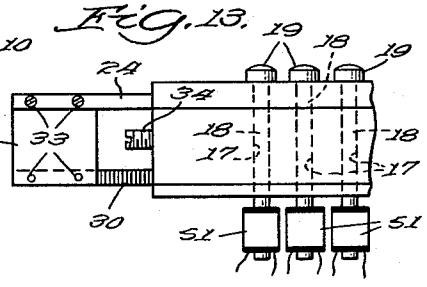


Fig. 13.



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3,174,214

APPARATUS FOR ASSEMBLING MEMORY MATRIX COMPONENTS

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Filed Dec. 14, 1962, Ser. No. 244,617
8 Claims. (Cl. 29—203)

This invention relates to methods and devices for assembling small parts and more particularly to the assembly of memory matrices employed in electrical and electronic computer devices. Such matrices comprise a series of very small paramagnetic rings hereinafter referred to as "cores" arranged in a configuration (usually rectangular) and having wires running through them in at least two directions normal to each other constituting, respectively, the so-called "X" and "Y" axes of the matrix. A common size of these cores is .050" O.D., .030" I.D. and .016" thick and a complete matrix usually comprises 64 rows of 64 each of these cores or 4,096 cores having .005" wires running through the holes thereof in both directions, the cores in each row being positioned diagonally to the wires and being arranged in alternate diagonal relation to each other in the said rows. Hand assembly of these matrices is a most tedious and exacting work and under the best conditions, a skilled worker requires anywhere from 10 to sometimes as much as 40 hours to complete the assembly of the wires and cores for a single matrix. This time excludes other time thereafter required to connect the wires to a supporting frame construction.

An object of the invention is to provide means for positioning successive pluralities of cores for simultaneous entry thereof by one of the axis wires and including means for simultaneously reversing the positions of the cores of each successive plurality thereof relative to the preceding plurality of cores.

Another object of the invention is to provide a means for simultaneous positioning of the plurality of cores employed in the formation of a complete matrix in position to receive the wires constituting the "X" axis and the "Y" axis of the matrix.

Still another object of the invention is to provide a machine for assembling the cores and axis wires of matrices characterized by capacity to project the wires of at least one of the matrix axes through a plurality of cores in a single step or portion of a cycle of operation of a machine.

With the foregoing objects in view, together with such additional objects and advantages as may subsequently appear, the invention resides in the hereinafter described method of assembling electronic matrices and in the parts and the construction, combination and arrangement of parts of certain devices useful in the practice of the said improved methods, all of which is disclosed, by way of example, in the following specification of a device constituting a presently preferred embodiment of the invention, reference being had to the accompanying drawings which form a part of said specification and in which drawings:

FIG. 1 is a fragmentary plan view, greatly enlarged, of one corner of a typical matrix of the type with which the present invention is concerned,

FIG. 2 is a perspective view, further enlarged of a single core and the "X" and "Y" axes wires passing therethrough,

FIG. 3 is a side elevational view of a machine constituting one embodiment of the novel apparatus for assembly of matrices using the method of the present invention,

FIG. 4 is a top plan view of a machine shown in FIG. 3,

FIG. 5 is a sectional view taken on the line 5—5 of FIG. 3; a portion of a cover plate element being broken away to show the magazine means for the cores and also

showing the mode of insertion of an "X" axis wire through a plurality of cores,

FIG. 6 is a greatly enlarged view showing the method of inserting the "X" axis wires through a plurality of cores,

FIG. 7 is a top plan view of the core holding means of the machine with the core holding means positioned for insertion of the "Y" axis wires in the plurality of cores held thereby,

FIG. 8 is an enlarged fragmentary plan view of the core orienting or positioning means with the cover plate removed to show details concealed thereby,

FIG. 9 is a further enlarged scale, sectional side elevational view taken on the staggered line 9—9 of FIG. 4 and particularly showing the core magazine means and the mode of inserting the "Y" axis wires through the cores,

FIG. 10 is a view similar to FIG. 9 but showing the cores stacked on the "Y" axis needle means,

FIG. 11 is a fragmentary top plan view of the core holding means showing the orientation of the plurality of cores for entry of the individual "Y" axis wire inserting needles therethrough,

FIG. 12 is an enlarged scale, sectional view of the core holders as viewed on the line 12—12 of FIG. 11 and

FIG. 13 is a side elevational view of the holding means for the cores particularly showing as a modification, the use of electromagnets for retaining the cores in the holding means therefor.

Referring first to FIGS. 1 and 2, each matrix comprises a frame or base F of rigid, non-conductive sheet material, usually having the sides thereof defining a rectangular opening O and across which opening the "X" axis wires extend in parallel spaced relation in one direction while the "Y" axis wires extend across the opening in a direction at right angles to the "X" wires in a corresponding spaced relation, alternate ones of each group of wires having terminals T at opposite sides of the opening. At each intersection of an "X" axis wire with a "Y" axis wire, they both pass through a core C causing the core to be positioned diagonally with respect to the two axes. These cores are so positioned that the axes of adjacent cores along any one wire extending in directions normal to each other. The invention is concerned only with the initial assembly of the cores and the wires and not with the step or steps of mounting the assembled matrix cores and wires upon the supporting frame.

Referring next to FIGS. 3 through 13, there is shown a device for practice of the method of the invention, it being understood from the dimensions of the matrix components previously set forth, that the figures show the machine in greatly enlarged scale. The illustrated machine comprises a rectangular base 1 having a pair of posts 2, 2 rising therefrom adjacent to the rear edge thereof and also adjacent the side edges of said base. Mounted on these posts in spaced relation above the base 1 is an elongated rectangular block 3 constituting a magazine for spaced pluralities of cores, each plurality of cores being maintained in edge to edge vertical relation spaced vertical slots 4 in the front face of the block 3 as best shown in FIGS. 4, 5 and 9, the said front face of the block 3 carrying a cover plate 5 secured thereto by screws 6 to complete the enclosure of the magazine slots 4.

Manually operable means for opening and closing the lower ends of the slots 4 is provided and comprises a metal plate 7 having parallel slots 8, 8 extending therethrough adjacent each end of the block 3 and through which slots screws 9, 9 extend to secure it to the bottom surface of the block 3 with capacity to be moved forwardly and rearwardly by the handle 10 to open the lower ends of the slots 4 or to cover said lower ends as required.

The base 1 carries a second pair of vertical posts 11, 11 disposed beneath the forward edge of the block 3 and slidably mounted on said posts is the core holding and positioning means generally indicated by the numeral 12. The core holding and positioning means comprises an elongated metal body 13 having bores 14, 14 extending therethrough for sliding movement on the posts 11, 11 and further having top and bottom cover plates 15 and 16 to which further reference will be made. Screws 15' secure the top plate to the body and corresponding screws (not shown) similarly secure the bottom plate 16 to the body member 13. Additionally, the body 13 is provided with a plurality of parallel vertical bores 17 extending therethrough in the same laterally spaced relation as the core magazine slots 4 and said bores are positioned directly under one each of said slots. Rotatably mounted in each of said bores 17 is a shaft 18 said shafts extending above the top cover plate 15 and each of said shafts carrying a head element 19 having an arcuate, core receiving slot 20 in the upper face thereof adapted to hold a core therein in a vertical edgewise position with the hole in the core exposed and with the vertical diametral line of a core in said slot substantially aligned with the shaft axis.

The top surface of the body 13 of the core positioning means 12 is provided with a longitudinally extending downwardly offset surface portion 21 extending from the front surface of the body member 13 rearwardly to a point presently to be identified. The top plate 15 is provided with a complementary downwardly extending surface portion 22 of less width than the surface portion 21 and combines with said surface portion 21 to define a longitudinally extending, rectangular slot 23 disposed forwardly of the vertical plane containing the axes of the shafts 18 and which slot affords guidance for a rack 24 having teeth meshing with gears 25 carried by alternate ones of the shafts 18; the upper surface of the body 13 being provided with counterbores 26 surrounding the gears except for the point of engagement with the rack 24 as best shown in FIG. 8, it being noted that the rear wall of the slot 23 is engaged by the ends of the rack teeth. The bottom cover plate 16 and the bottom surface of the body member 13 are provided with complementary offset portions comprising upwardly offset bottom surface portion 27 on the body member 13 extending from the rear face of said body member to a point adjacent the bores for the shafts 18 and the bottom plate 16 is provided with an upwardly extending rear portion 28 meeting the rearmost portion of the surface 27 which combines therewith to form a longitudinally extending rectangular slot 29 in which a rack 30 is slidable; the teeth of said rack meshing with gears 31 on the lower ends of the alternate ones of the shafts 18 which do not carry the gears 25 and the gears 31 being disposed in counterbores in the body member 13 corresponding to the counterbores 26 in the top surface of the body member.

The racks 24 and 30 extend beyond the opposite ends of the body member 13 and are connected to move in unison by blocks 32, 32 extending between the opposed faces of the racks and secured to the ends of the racks by screws 33; the distance between the blocks and the length of the body members being such as to limit the extent of reciprocation of the racks. Abutmen screws 34, 34 in the opposite ends of the body member 13 engageable by the adjacent end faces of the blocks 32 afford means of limiting the extent of travel of the racks. Having reference to FIGS. 2, 7, 8, 11 and 13, it will be seen that as the rack unit comprising the interconnected racks 24 and 30 is moved from left to right, the shafts 18 carrying the gears 25 and which mesh with the rack 24 will be caused to turn in a counterclockwise direction as viewed in top plan view while the alternate shafts having the gears 31 meshing with the rack 30 will be caused to turn in a clockwise direction. Obviously, movement of the rack unit from right to left will reverse the direction of turning of the shafts 18. The abutment screws 34, 34 serve to limit the extent of turning movement that can be imparted by the racks and thus determine the rotative position to be occupied by cores that are seated in the heads 19.

The base 1 forwardly of and adjacent the left hand post 2 is provided with a short, vertically extending yoke member 35 serving as the fulcrum point for one end of a hand lever 36 extending parallel to, in rear of, and below the core positioning means 12; said lever terminating in a hand engaging distal end 37 adjacent the right hand end of the base 1. A link 38 pivotally connects the lever with the body member 13 at the mid-length of said body member. Compression springs 39, 39 surrounding the posts 11, 11 tend constantly to urge the body member 13 upwardly to the extent permitted by the nuts 40, 40 on the upper ends of the posts 11, 11; the distance being such as to permit cores to drop into the arcuate slots 20 in the shaft heads 19 while allowing the slide 7 to pass between the cores so deposited and the lowermost cores in the magazine slots 4 whereby the delivery of a single core to each shaft head is effected. The lever 36 is employed to move the core holding and positioning means downwardly against the bias of the springs 39, 39 for a purpose presently to be described.

Fixed to the top of the base 1 adjacent the forward edge thereof is a transversely extending vertical bracket member 41 and also mounted on said base slightly forwardly of the core positioning means 12 is a corresponding vertical rear bracket 42; said brackets serving to support, respectively, the front and rear ends of a pair of laterally spaced guide rods 43, 43 disposed above the top surface of the base 1 and extending parallel to each other and to the top surface of the base. Slidably mounted on the rods 43, 43 is the "Y" axis wire inserting means 44 comprising a body member 45 carrying an upstanding bracket 46 extending transversely along the rear edge thereof and supporting the rear ends of a plurality of hollow needles 47 secured therein by set screws 48; said needles being disposed at the elevation of the axial line of cores C disposed in the grooves 20 of the core holding heads 19 when the core holding and positioning means 12 is at the upper position thereof established by the nuts 40. Rearwardly of the bracket 46, the body member 45 is provided with a series of vertical posts 49 on each of which a plurality of spools or bobbins B each carrying a supply of the wire employed to form the "Y" axes of the matrix to be formed and the wire from each bobbin is led through one each of the needles 47 and is then bent back over the rearwardly extending end of the needle.

Assuming that the magazine slots 4 are filled with pluralities of cores C and that each of the needles 47 has been supplied with a "Y" axis wire extending therethrough, the operation of the device is as follows:

The rack unit is first positioned at its mid-travel position determined, for example, by the registry of a line 50 on the rack 24 with the end of the body member 13 and this positions all of the shafts 18 so that the slots 20 in the heads 19 carried by said shafts are disposed in alignment with the magazine slots 4. The plate or gate 7 is then withdrawn rearwardly allowing the cores in the magazine slots to move downwardly to the extent permitted by the arcuate slots 20; the nuts 40, 40 being so adjusted that when the plate 7 is then moved forward again to close off the magazine slots 4, it will hold the cores C which have entered the slots in the heads 19 against removal therefrom. Incidentally, since the cores are formed of paramagnetic material, the shafts 18 may be formed as permanent magnets or, as shown in FIG. 13, each of said shafts may extend below the bottom plate 16 and carry a solenoid coil 51 to supply magnetic force tending to hold the core seated in the slot 20 in the head 19 of the shafts.

After the plate or gate 7 has been moved forward, the

cores occupy the position thus shown in FIGS. 3, 5 and 6 with the axes thereof substantially coincident with each other in a horizontal line. An "X" axis wire is then inserted through all of the aligned cores as best shown in FIGS. 5 and 6, the wire first being inserted through a fine hollow tube or needle 47' with the end thereof bent over the inserted end of the tube. For the very small sizes of cores above described, the metal tubing employed for forming the smaller sizes of hypodermic needles is satisfactory. When the tube has been inserted through all of the aligned cores as shown in FIG. 5, the hooked end of the wire is held and the tube is withdrawn from the cores leaving the "X" axis wire inserted in the cores. A considerable length of the said wire is left at each end of the cores.

The rack unit is then moved to one or the other of its extremes of movement as, for example, to the left resulting in rotation of the shafts **18** and the cores carried thereby in opposite directions for slightly less than a quarter turn whereby the axial lines of the cores are disposed at acute angles to a horizontal line normal to the first identified horizontal line. The "Y" axis wire inserting means is then moved forwardly on the guide rods **43** by grasping the handle **54** on the base **45** thereof with the result that each needle **47** with its "Y" axis wire is inserted through one of the cores in the core holding means. While the needles are still penetrating the cores as shown in FIG. 9, the lever **36** is moved downwardly pulling the cores out of the slots in the heads **19** and leaving the row of cores with the inserted "X" axis wires hanging on the needles **47**. The subassembly unit comprising a row of cores with an "X" axis wire extending therethrough is pulled back on the needles **47** as far as it will go and the "Y" axis wire inserting means is then moved back on the rods **43** away from the core holding and positioning means. The core holding and positioning means **12** is then allowed to resume its normal upward position, the rack unit is then centered to bring the slots in the heads **20** again in alignment with the magazine slots **4**, the plate **7** is withdrawn and replaced to allow a second series of cores to be delivered to the holding heads **19**. An "X" wire is inserted through this second series of cores and the needle by which the wire was inserted is withdrawn leaving the "X" wire in this second series of cores. The rack unit is then moved in the opposite direction to the limit permitted by the stop screws **34** with the result that the cores held in the slots **20** are rotated less than a quarter revolution in the opposite directions, whereupon the "Y" axis wire inserting means is again advanced to project its wires to the second subassembly of cores and "X" wire. The core positioning means is again depressed by the lever and the second series or subassembly of cores and "X" axis wire is pressed back on the needles **47**. The reason for thus rotating the cores preferably less than 90° is to avoid the possibility of rupturing any core by reason of the bending of the previously inserted "X" axis wire.

This cycle of operations is continued until the required number of cores is thus assembled on the various wires. The ends of the various wires with a great deal of excess wire are temporarily interconnected and the thus formed assembly of the cores and wires is ready for mounting on the supporting frame or base "F" as shown, for example, in FIG. 1.

As before related, the usual dimensions of a matrix is that of 64 rows of these cores of 64 cores each. The device shown in these figures accommodates a lesser number of cores but this has been done purely by way of illustration of the invention. It being believed to be obvious that following the principles of the specification suitable apparatus for accommodating any desired number of cores may be provided.

Thus there has been provided an apparatus by which the interlaced cores and "X" and "Y" axis wires of computer memory matrices may be more readily and economically assembled by persons having a lesser degree of skill than has heretofore been necessary.

While the foregoing specification discloses a presently preferred embodiment of the invention, the invention is not to be deemed to be limited to the precise details of such disclosure. For example, while the foregoing disclosure contemplates the attachment of the axis wires to the various hollow needles prior to the insertion of the needles through the cores, it will be obvious that the needles can first be inserted and the wires then be passed through the needles, wherefore, it will be understood that the invention includes as well all such changes and modifications in the parts and in the construction, combination and arrangement of parts as shall come within the purview of the appended claims.

I claim:

1. In an apparatus for assembling computer memory matrices, a base, a plurality of core supporting means on said base for supporting one each of a plurality of matrix cores in a horizontal row and disposed either in a first position in which the axial lines of said plurality of cores are substantially coincident with each other for reception of an axis wire extending through the thus aligned cores or in a second position in which the axial lines of said plurality of cores are disposed at such angular relations to said first position as will accommodate separate entry through each core of one each of a plurality of other axis wires extending in spaced parallel relation to each other in a direction normal to the direction of said first-named wire in the completed matrix, means for simultaneously moving said core supporting means and the cores supported thereby to and from said first and second positions, means for supporting a plurality of said other axis wires in spaced parallel relation in a horizontal plane containing the openings in cores in said core supporting means and aligned one each with the opening in one each of the cores in said supporting means, and means for effecting relative movement between said core supporting means and said plurality of other axis wires in a direction parallel to said wires effective to project the ends of said plurality of other axis wires simultaneously through the aligned ones of the cores held by said core supporting means when in said second position thereof.

2. An apparatus as claimed in claim 1 in which said core supporting means includes a plurality of core holding head elements disposed in a horizontal line on the upper surface of a support and the top surface of each of said head elements having a first slot extending transverse to said horizontal line and a second slot disposed at least substantially parallel to said horizontal line; said slots having the bottom surfaces thereof conforming to the outer peripheries of the cores with a maximum depth substantially equal to the radial width of the cores and being of a width closely fitting the side surfaces of the cores and said solts intersecting each other at their midlength.

3. In an apparatus for assembling computer memory matrices including a plurality of matrix core elements each having an opening extending therethrough, a base, and a plurality of means on said base each provided with a slot for holding one each of a plurality of matrix cores in a common horizontal plane and disposed in a vertical, edgewise position in a row and with the openings in the cores exposed and the cores being disposed either with the axial lines thereof substantially coincident with each other in a first horizontal line for reception of an axis wire extending throuhg the aligned cores or in selected positions in which the axial lines thereof are disposed at acute angles to a second horizontal line normal to said first horizontal line for separate entry through each core of one each of a plurality of other axis wires which will extend in spaced, parallel relation to each other in a direction normal to the direction of said first-named wire in a completed matrix, a core supply magazine means mounted on said base and including separate magazines each holding a plurality of cores for an associated one of each of said

plurality of core holding means, and means associated with said magazine means manually operable for simultaneously feeding one core to each of said core holding means from the associated magazine and to simultaneously close all of said magazine means.

4. An apparatus as claimed in claim 3 in which said core component holding means includes a plurality of core holding head elements disposed one each beneath one each of the core supplying magazine means of said supply means and in which said feeding means for supplying cores to said core holding head elements cooperates with said head elements to maintain cores supplied thereto from being dislodged therefrom.

5. An apparatus as claimed in claim 3 in which all of said core holding means are mounted for rotation about vertical axes in a supporting element mounted on said base, in which said axes are each substantially coincident with a vertical diametral line of a core held thereby, and in which said supporting element further includes devices for simultaneously effecting rotation of said core holding means about said vertical axes between extreme positions in which a plurality of cores held one each in each of said holding means are disposed with the axial lines thereof extending at acute angles to said second horizontal line and an intermediate position in which said axial lines of said cores are substantially coincident with each other and with said first horizontal line.

6. An apparatus as claimed in claim 5 in which said devices for effecting rotation of said core holding means include interengaging components operative to cause simultaneous rotative movement of adjacent ones of said core holding means in opposite directions.

7. In an apparatus for assembling computer memory matrices, a base, a core supporting means mounted on said base including a supporting element carrying a plurality of core holding head elements disposed in a horizontal line on the upper surface of said supporting element and mounted on said supporting element for rotation about separate vertical axes lying in a common vertical plane and coincident with the vertical diametral line of a core held thereby; each of said head elements having a curved slot in the upper face thereof conforming to the outer periphery and thickness of the cores and having a maximum depth substantially equal to the radial width of a core, means on said supporting element for simultaneously effecting rotation of said core holding means about said vertical axes between extreme positions in which a plurality of cores held one each in each of said holding means are disposed with the axial lines thereof extending at acute angles to a second horizontal line extending at right angles to said first horizontal line and an intermediate position in which said axial lines are substantially coincident with each other and said first horizontal line, and other means mounted on said base for reciprocation in a horizontal plane in a path parallel to said second horizontal line operable to engage said plurality of cores for the insertion in one each of said cores of one each of a plurality of axis wires.

8. In an apparatus for assembling computer memory matrices, a base, a core supporting means mounted on said base including a supporting element carrying a plurality of core holding head elements disposed in a horizontal line on the upper surface of said supporting element and mounted on said supporting element for rotation about separate vertical axes lying in a common vertical plane and coincident with the vertical diametral line of a core held thereby; each of said head elements having a curved slot in the upper face thereof conforming to the outer periphery and thickness of a core and having a maximum depth substantially equal to the radial width of a core, means on said supporting element for simultaneously effecting rotation of said core holding means about said vertical axes between extreme positions in which a plurality of cores held one each in each of said holding means are disposed with the axial lines thereof extending at acute angles to a second horizontal line extending normal to said first horizontal line and an intermediate position in which said axial lines are substantially coincident with each other and said first horizontal line, other means mounted on said base for reciprocation in a horizontal plane in a path parallel to said second horizontal line operable to engage said plurality of cores for the insertion in one each of said cores of one each of a plurality of axis wires, and means for dislodging said plurality of cores from said holding means while retaining them on said last-named means for inserting axis wires therethrough.

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