

United States Patent

[11] 3,564,343

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- [45] Patented **Feb. 16, 1971**
- [73] Assignee **Reliance Electric Company**

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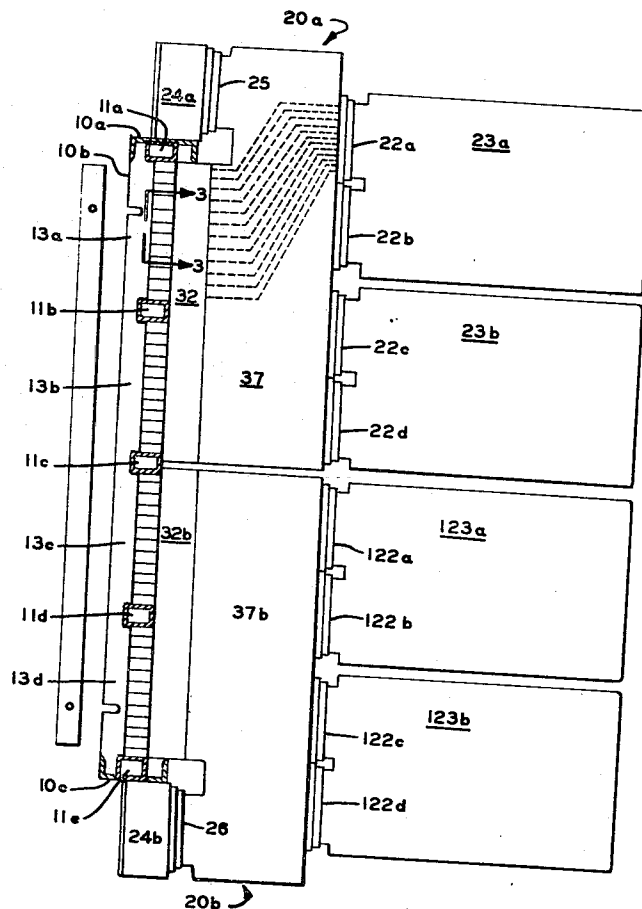
- [54] **COMPUTER PROGRAMMING APPARATUS**
16 Claims, 14 Drawing Figs.
- [52] U.S. Cl. 317/101;
339/17; 339/217
- [51] Int. Cl. H02b 1/02,
H01y 13/42
- [50] Field of Search..... 339/18, 17,
217 (S), 217.1, 217.2; 317/101 (CB), 101 (D),
101 (DH)

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ABSTRACT: A computer patchbay formed by the front edges of a plurality of etched circuit boards spaced apart from each other in a plurality of planes parallel to each other, with resilient spring contacts adapted to snap on the front edges of the circuit boards and extend forwardly therefrom. Each resilient spring contact includes a cylindrical bar with a plurality of slots which facilitate accurate alignment and uniform alignment of the contacts. Improved techniques for shielding conductors connected to the spring contacts from each other are disclosed.



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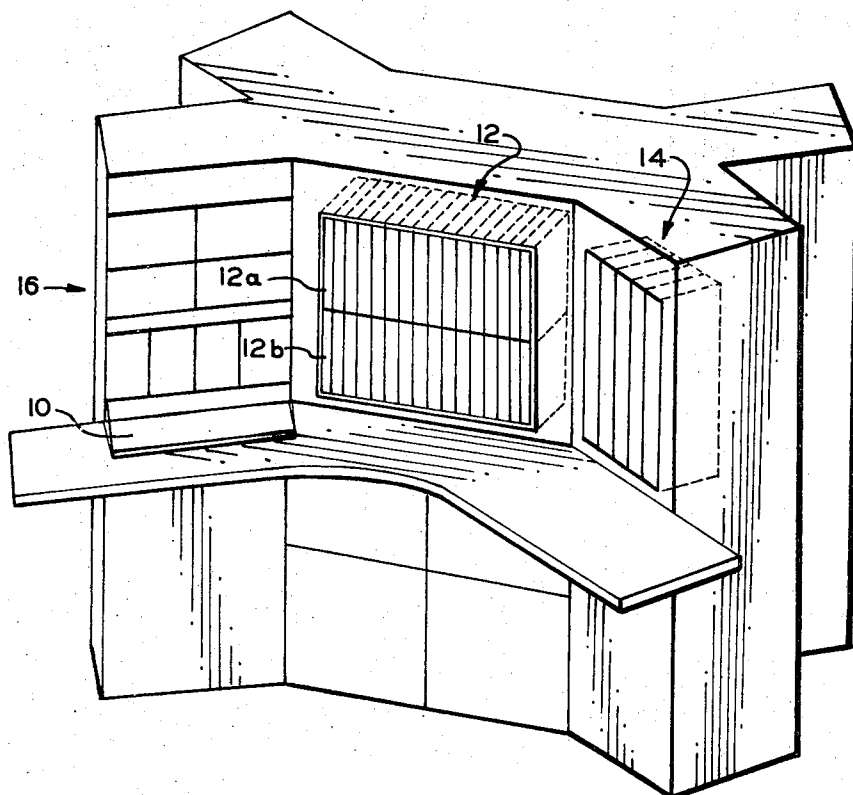


FIG. 1

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FIG. 2

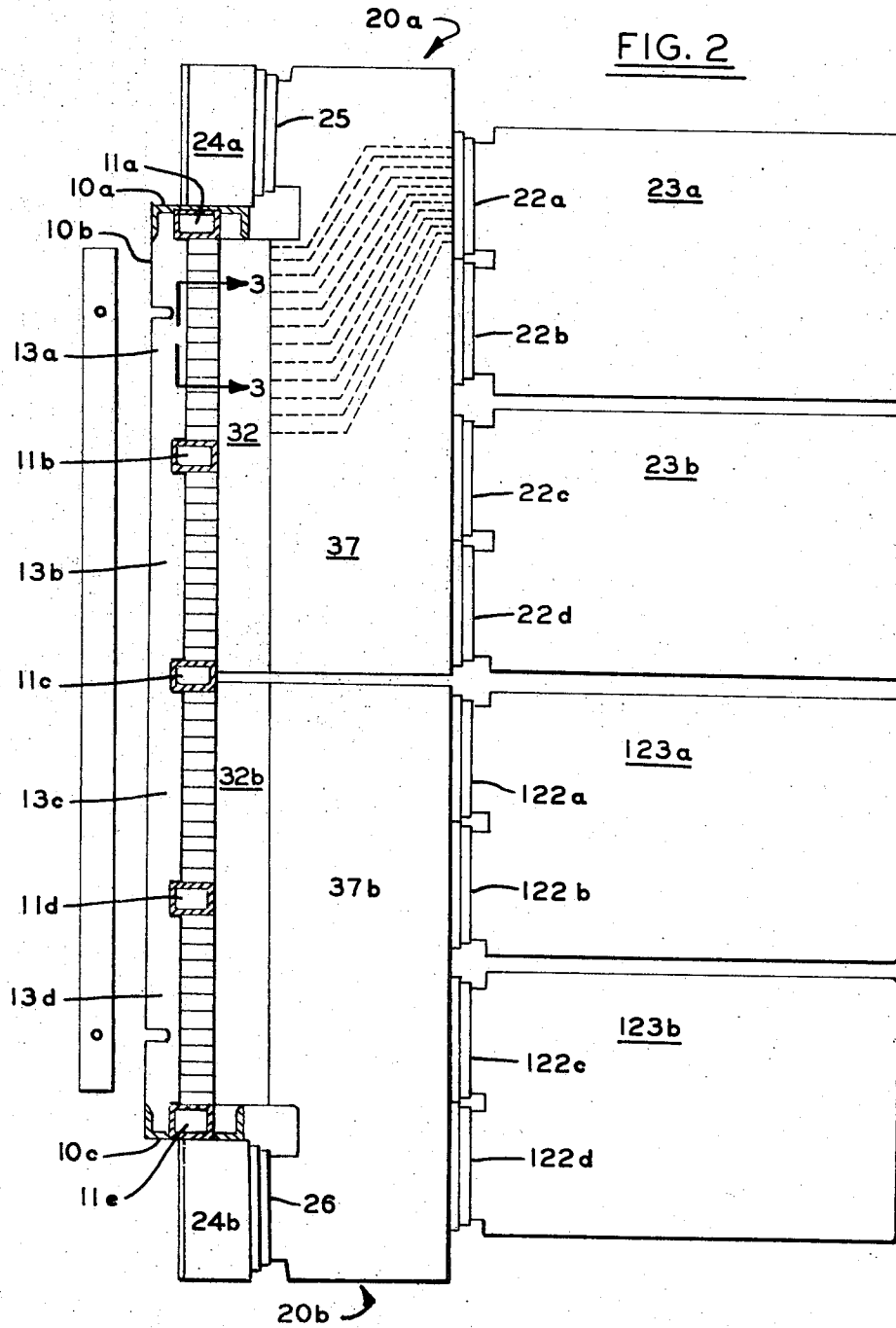
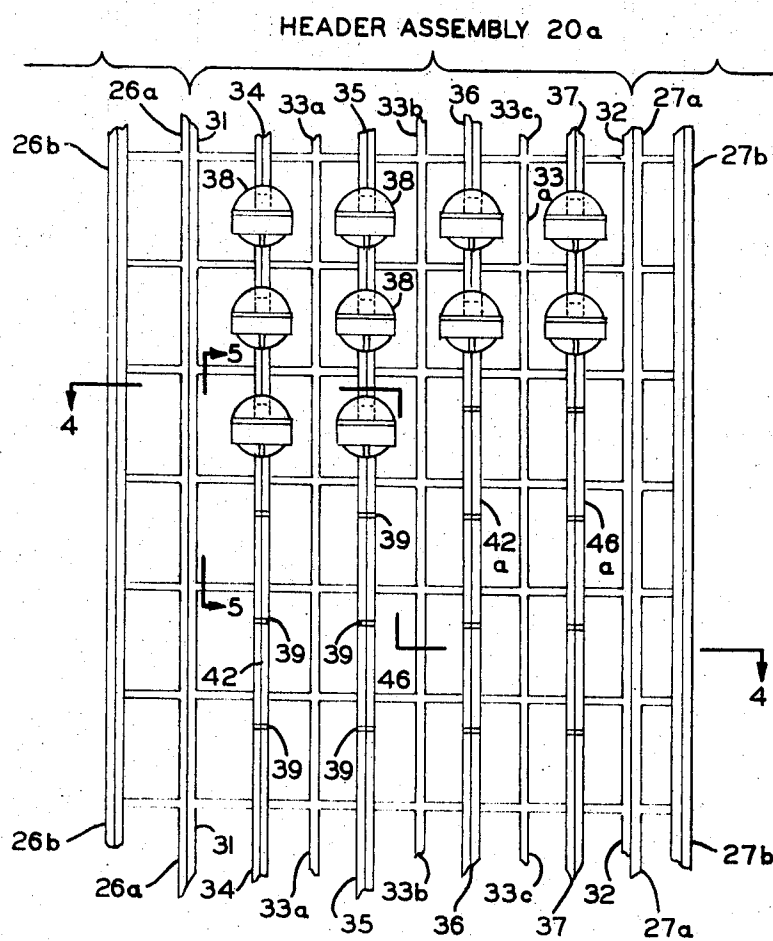


FIG. 3



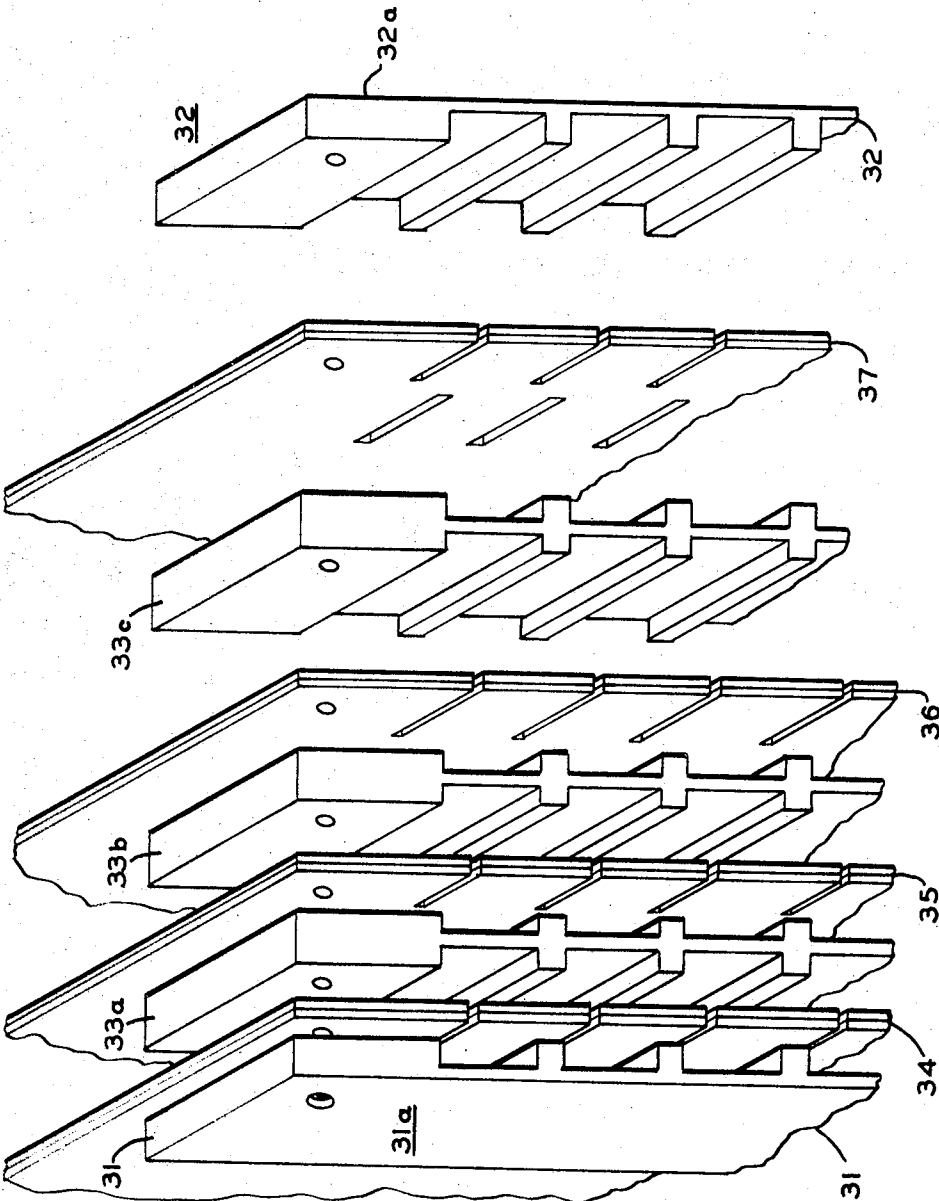


FIG. 3a

FIG. 4

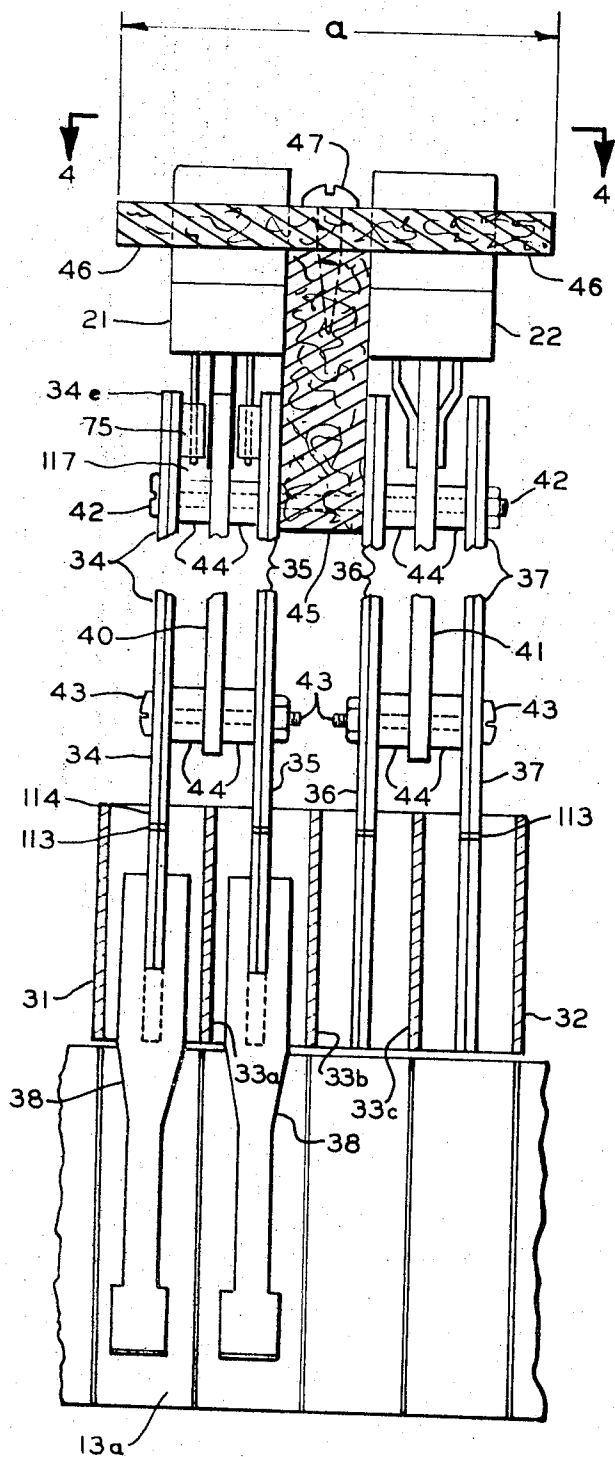
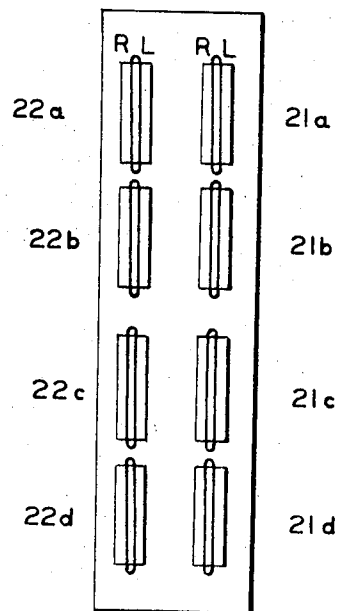


FIG. 4a



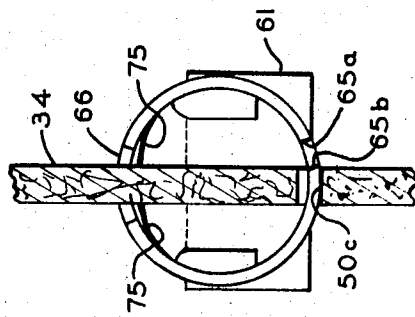
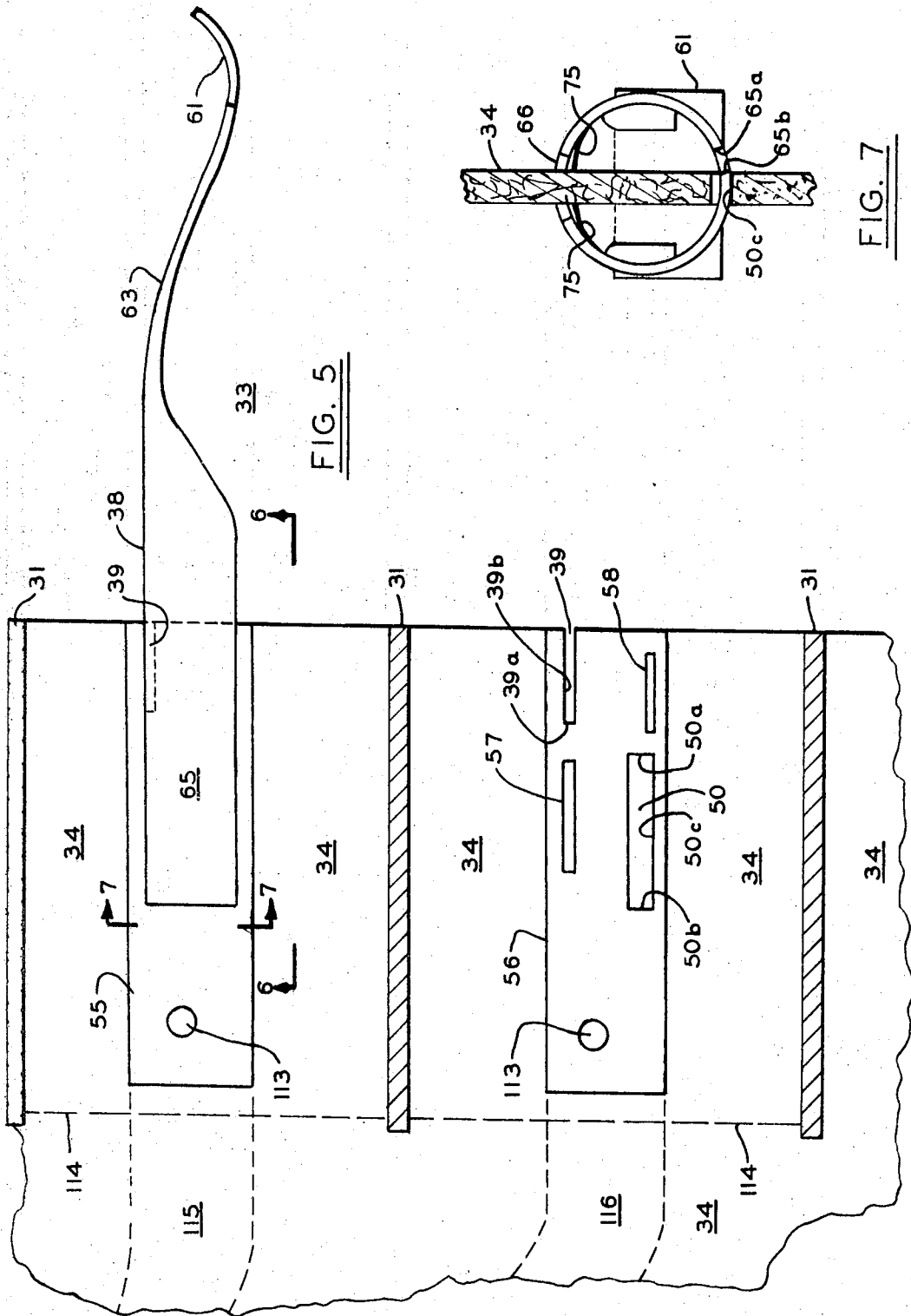


FIG. 6a

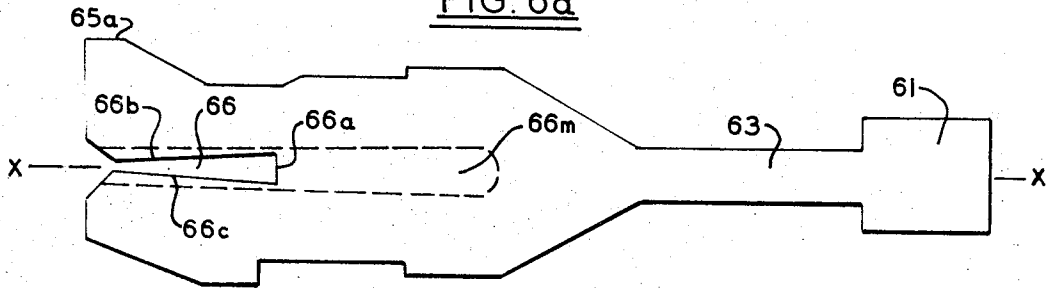


FIG. 6b

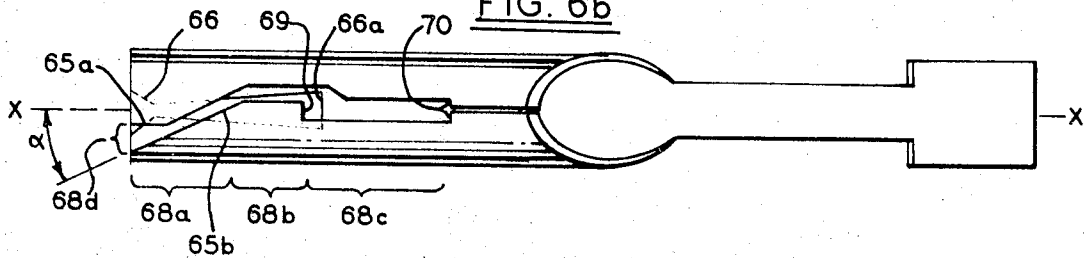


FIG. 6c

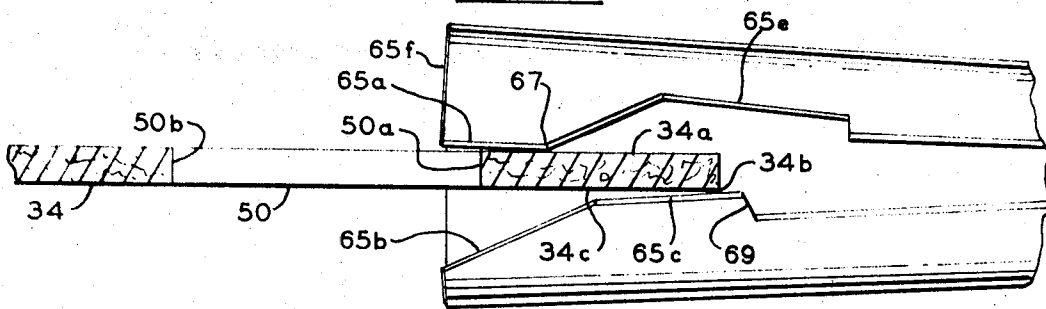


FIG. 6d

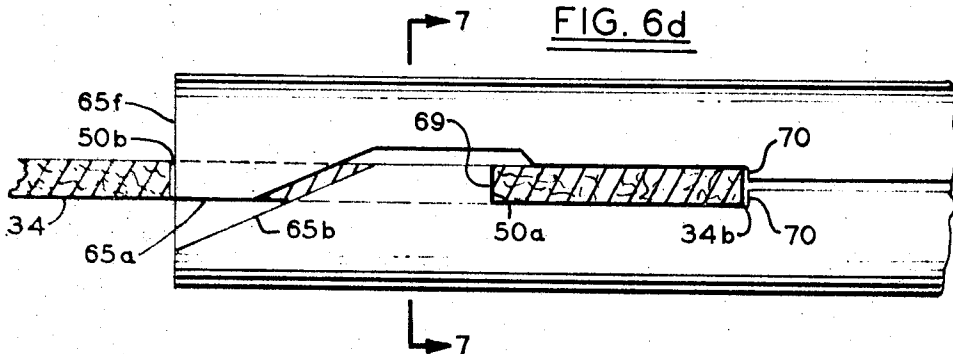


FIG. 8a

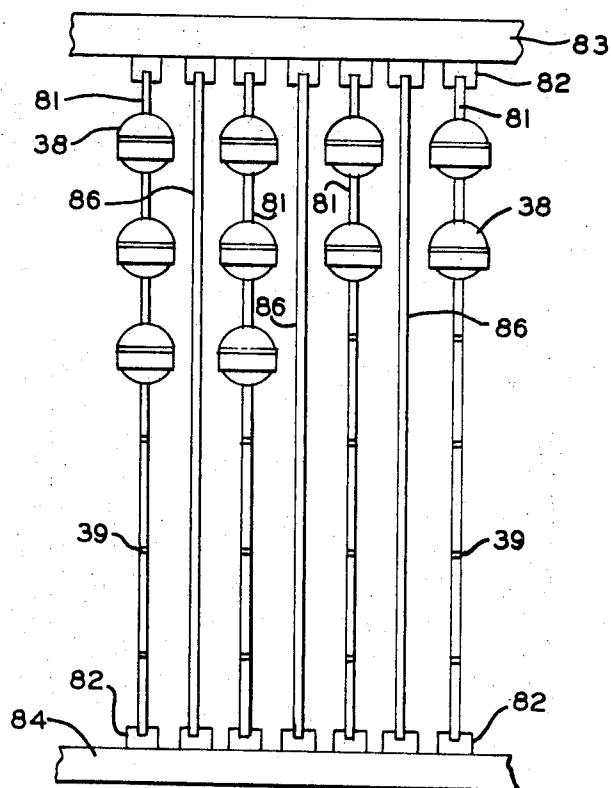
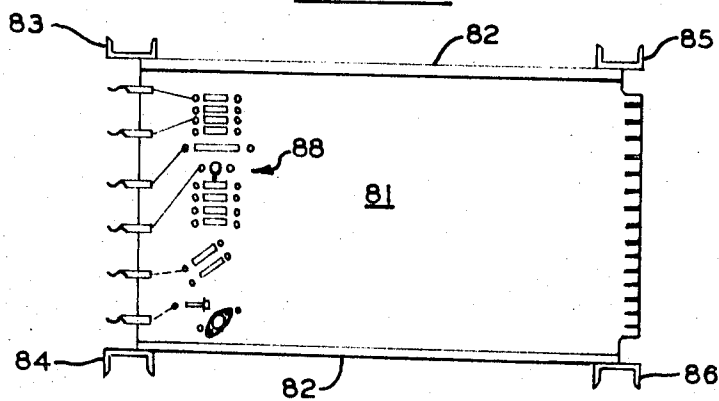


FIG. 8b



COMPUTER PROGRAMMING APPARATUS

A variety of electronic devices, and particularly electronic computers, require that a large number of circuit terminals be selectively connected together in order to program a machine to solve a desired problem, and many computers, including digital types, analogue types and hybrid analogue-digital types, utilize removable patchboards or plugboards having matrices (rows and columns) of contact holes which may be interconnected by patchcords and plugs to establish a desired program. After the desired number of patchcords and plugs have been appropriately plugged into a removable patchboard, the patchboard itself is ordinarily plugged into the computer patchbay, so that each of the patchcord tips or plug tips extending through one of the patchboard contact holes is electrically and mechanically contacted by a spring contact fixedly installed in the computer patchbay. The spring contacts of the patchbay are connected to various computing elements such as amplifiers and logic circuits mounted within the computer. Typical patchbays may have a large number of contacts, as, for example, 3840 contacts arranged in 60 rows and 64 columns on perhaps three-eighth inch centers, so that the patchbay and each patchboard cover an area of roughly one square yard. In many computers the nature of the electrical signals at various contacts requires that the contacts be effectively shielded from each other. In many prior computers the patchbay has consisted of a honeycomblake group of individually shielded rectangular recesses, with a spring contact mounted within each recess to be engaged by a patchcord which extends within the recess when the patchboard is plugged into the patchbay. The rear end of each spring contact most commonly terminates in a bar to which an electrical connection may be made either by means of a connector or through use of a wire-wrap connection.

U.S. Pat. No. 3,443,161 issued to Jay B. King discloses an improved form of patchbay construction in which a patchbay is formed by the front edges of a group of multilayer etched circuit board assemblies, termed "headers." Each header comprises a plurality (e.g. six) of etched circuit boards sandwiched together to form a rigid unit having a height and depth considerably greater than its width, a typical header unit having a width of three-quarters inch so as to receive two columns of a patchboard having patchholes on three-eighths inch centers, a height of about two feet and a depth of perhaps one foot. Placing 32 such headers side by side forms a patchbay having 64 columns of holes. Etched circuit conductors on various of the circuit boards extend from the front edges of the boards to other edges of the boards and allow the connections to be fanned out to provide much more space within which connections may be made. Many of the conductors terminate in connectors at the rear edges of the header assemblies, and various circuits such as amplifiers may be plugged directly in the connectors. The arrangement not only overcomes the need for making a large number of wire-wrap connections to the rear of a patchbay, but also provides a rigid wiring assembly having known or predetermined electrical characteristics between each computer element and each patchbay contact to which it is connected. Each header preferably includes metal or metal-coated plastic shielding along its front edges, with recesses milled or otherwise formed in the shielding to provide two columns of shielded recesses, and a spring contact is mounted within each such recess near the front edge of one of the etched circuit boards. In the King application each spring contact is shown riveted on a circuit board and soldered to an etched circuit conductor.

In order that any patchcord tip make good electrical contact with its mating patchbay contact, patchbay contacts commonly include a blade portion which extends at an angle to the direction in which the patchboard is inserted, so that insertion of a patchboard tends to flex the spring contacts as the patchboard is inserted. To insure good electrical contact between each patchcord tip and a spring contact, patchboards are usually arranged to be translated vertically upwardly slightly beyond their normal operating position and then moved slightly downwardly to their operating position. Ini-

tially moving the patchboard past its operating position insures that contact area portions of each tip and contact which ultimately engage when the patchboard is in its final operating position will have been wiped. Because the large number of spring contacts can apply a large spring force to the patchboard, levers or electrical motors are sometimes used to accomplish the vertical shifting of the patchboard. It will be apparent that patchbay contacts may be arranged, if desired, so that sidewise translation instead of vertical translation of the patchboard causes similar wiping action.

While a patchbay formed with header assemblies as disclosed in the mentioned King application offers great advantages over predecessor arrangements and eliminates much of the wire-connecting required in prior systems, it still requires that a large number of spring contacts be riveted or otherwise affixed in rows along the front edges of each header assembly forming the patchbay. One object of the present invention is to provide an improved spring contact mounting arrangement for such a patchbay using a spring contact which need not be riveted or soldered to an etched circuit card, but which may be merely forced onto the edge of an etched circuit card and thereafter held in place automatically by its own resiliency. An attendant object of the invention is to provide a spring contact arrangement in which electrical contact between the spring contact and the etched circuit conductor is reliable, and which will not be disturbed as the spring contact is flexed by the patchcord tip.

Due to careless installation of a patchboard or due to mishandling of the computer when a patchboard is not in place various of the spring contacts of patchbays sometimes become bent, so that they do not make reliable electrical contact with patchcord tips. Replacement of patchbay spring contacts has been extremely difficult and expensive to accomplish in most patchbays prior to that of the King application, and even with the latter arrangement, replacement of a patchbay spring contact has been tedious and time-consuming, and has required that each header assembly having a faulty spring contact be unplugged and removed from the computer and then dismantled, so that replacement of even a single patchbay contact involves several hours. A primary object of the present invention is to provide a patchbay similar to that of the King application in that it is formed by the front edges of a plurality of sandwiched etched card assemblies, but in which faulty spring contacts may be easily removed and replaced individually from the front of the computer, so that no dismantling or removal of the assemblies is necessary in order to replace faulty patchbay contacts. While the spring contacts of the present invention are removable and replaceable, it is vitally important, of course, that they not be susceptible to misalignment as they are flexed by the patchboard tips. It is also vitally important that each spring contact, when installed, be precisely aligned in the same direction as all of the other spring contacts, so that substantially uniform contact pressure exist, and that similar contact wiping occur, on all of the contacts. A further object of the invention is to provide an improved patchbay which is economical to manufacture, assemble and repair.

Other objects of the invention will in part be obvious and will, in part, appear hereinafter.

The invention accordingly comprises the features of construction, combination of elements, and arrangement of parts, which will be exemplified in the constructions hereinafter set forth, and the scope of the invention will be indicated in the claims.

For a fuller understanding of the nature and objects of the invention, reference should be had to the following detailed description taken in connection with the accompanying drawings in which:

FIG. 1 is an isometric view of a typical hybrid analogue-digital computer embodying two patchbays constructed in accordance with the invention.

FIG. 2 is a side view taken in cross section through one form of patchbay constructed in accordance with the present invention.

FIG. 3 is an enlarged view of a portion of the front of the patchbay of FIG. 2 taken at lines 3-3 in FIG. 2.

FIG. 3a contains isometric cutaway views of three shield plates which form the front edge of the header assembly of FIG. 2 and cooperate to form two rows of recesses having a rectangular cross section.

FIG. 4 is a cross section view taken downwardly at lines 4-4 in FIG. 3.

FIG. 4a is a rear view of a header assembly taken at lines 4-4 in FIG. 4.

FIG. 5 is a cross section view taken at lines 5-5 in FIG. 3.

FIG. 6a is a plan view showing the outline of a flat metal stamping from which one form of spring contact may be formed.

FIG. 6b is a bottom view of a spring contact which has been formed by rolling the contact stamping of FIG. 6a about a cylindrical die.

FIGS. 6c and 6d are bottom views of the rear end of patchbay contacts; FIG. 6c showing the contact as it is being installed on an etched circuit board, and FIG. 6d being a similar view with the contact shown completely installed and locked in place.

FIG. 7 is a cross section view taken at lines 7-7 in FIG. 6d.

FIGS. 8a and 8b are front and side views of an alternative arrangement in which electronic circuit components are mounted on the same etched circuit boards as patchbay spring contacts, so that connections are made by etched circuit conductors from the patchbay contacts directly to electronic circuits, such as amplifiers, without the need for intervening connectors or plugs.

FIG. 1 shows a hybrid analogue-digital computer comprising a plurality of interconnected cabinets and drawers containing a wide variety of electronic analogue and digital computing elements such as amplifiers, multipliers, gates, counters and the like. The computer is controlled from the front side visible in FIG. 1, by operation of a number of switches, push-buttons and dials (not shown) located at control center 16 and control panel 10, and various data indicating computed results and conditions within the computer is displayed on a number of indicators (not shown) located at control center 16. Frequently, the computer is interconnected by cables (not shown) to one or more additional computers or computer peripheral devices such as printers and magnetic tape units and the like.

The basic operation of the computer of FIG. 1 is determined by making selective electrical connections between various ones of a large number of electrical terminals by means of patchcords and plugs which plug into a patchboard having many rows and columns of holes. In order that given programs or connection arrangements may be used at different times without requiring a patchboard to be wired each time, and in order that different programs may be executed rapidly in succession, it is common to provide a number of patchboards with each computer, with each patchboard being capable of being quickly plugged into and removed from the patchbay of the computer. In FIG. 1 the computer is shown as including two patchbays 12 and 14, each comprising generally a plurality of sandwiched etched circuit board assemblies. Main patchbay 12 is shown as including 32 sandwiched etched circuit board assemblies or "headers" mounted adjacent each other, side by side, in an upper row of 16 headers indicated at 12a and a lower row of 16 headers indicated at 12b, while patchbay 14 is shown as including a single row of five generally similar headers. Each of the headers of patchbay 12 presents four half columns (24 rows) of patchbay spring contacts near its front edge and engages the patchcord tips or patch plug tips in four half columns of a patchboard when the latter (not shown) is plugged into patchbay 12. Thus patchbay 12 is provided with 64 times 24 or 1536 spring contacts. Each of the five headers of patchbay 14 presents four full columns of patchbay spring contacts near its front edge and engages tips in four columns of a patchboard when one is plugged into patchbay 14. Header-assemblies may be made to engage single columns of patchboard contacts, or two, three or more

than four columns, if desired, and individual headers may be constructed to extend horizontally instead of vertically, to cover rows of contacts instead of columns. The overall shape and arrangement of the particular computer shown in FIG. 1 forms no part of the present invention and FIG. 1 merely serves to illustrate one typical header assembly arrangement with which the present invention may be used.

Referring now to FIG. 2, patchbay 12 includes a main frame comprising a rectangular opening comprising four structural channels 10a-10d, the two vertical channels 10b and 10d not being shown in FIG. 2, and five horizontal crossbars 11a-11e best seen in FIG. 2, which are shown extending across the entire patchbay. Four sections of "eggcrate" shielding 13a-13d are shown mounted between and fastened to each adjacent pair of crossbars. Each section of eggcrate shielding comprises a matrix of rows and columns of thin strips of electrically-conductive material, such as metal or plated plastic. Each section of eggcrate shielding provides 64 columns and 12 rows of rectangular recesses having open front faces into which patchcord tips protrude when a patchboard is installed, and having open rear faces into which the front portions of spring contacts mounted on the header assemblies protrude, none of the spring contacts being shown in FIG. 2. Thus each header carries four half-columns of spring contacts, with 24 contacts in each half column.

The typical upper and lower header assemblies 20a and 20b shown in FIG. 2 each comprise a plurality (e.g. six) of sandwiched etched circuit cards rigidly mounted together, with certain of the cards of each header carrying a large number of etched circuit conductors which extend from the spring contacts at the front edge of a header to one or more of the other edges of the header, in a manner to be shown in detail. The right-hand outside card of upper header 20 is shown at 37, and the right-hand outside card of lower header assembly 20b is shown at 37b. As will be explained below, the sides of cards 37 and 37b visible in FIG. 2 are largely covered with ground foil in many applications. In FIG. 2, 12 conductors assumed to be located on one of the inside cards of upper header assembly 20a are shown in dashed lines leading from a column of spring contacts (not shown) mounted within the recesses of shielding 13a, rearwardly to connector 22a to connect to circuits on card 23a. Header assemblies 20a and 20b are each shown provided with a plurality of rear-edge ribbon-type circuit card connectors 22a-d and 122a-d, and a plurality of computer circuit cards 23a, 23b and 123a, 123b plug directly into such connectors. Various conductors on one or more of the cards of upper header 20a extend to connectors located above the patchbay area at 25, and various conductors on one or more cards of lower header assembly 20b extend to connectors located below the patchbay at 26. Cables and/or bus wires (not shown) extend along upper and lower raceways 24a, 24b across the computer normal to the planes of the header assemblies to connect to the conductors at 25 and 26.

The front faces of both of the headers shown in FIG. 2 butt against the rear edges of the eggcrate shielding and include further shielding having a plurality of rectangular recesses which register with the recesses defined by the eggcrate shielding, a portion of the shielding of upper header 20a being shown at 32, and a portion of that of lower header 20b being shown at 32b.

FIG. 3 is a front view looking into a portion of the patchbay. The front face of header assembly 20a is defined by left and right outer shield plates 31 and 32, three center shield plates 33a, 33b, 33c and the front edges of four double-layer etched circuit cards 34, 35, 36 and 37. The right-hand shield plate and one double-layer circuit board of a similar header assembly mounted to the left of header assembly 20a are shown at 26a and 26b, respectively, and the left-side shield plate and one double-layer circuit board of a further header assembly mounted to the right of header assembly 20a are shown at 27a and 27b, respectively. The cross sections of the shield plates are illustrated in FIG. 3a, the cross sections of inner shield plates 33a, 33b and 33c all being the same. It will be seen that

the outer shield plates 31 and 32 (which are mirror images of each other) each have a flat outer surface (31a, 32a), and a plurality of inwardly-extending slots milled, cast or molded on one side. The flat surface 31a of left-side shield plate 31 will be seen to lie against the similar flat surface of right-hand shield plate 26a of an adjacent header assembly, while flat surface 32a of right side shield plate lies against the flat side of left-hand shield plate 27a of another adjacent header assembly. It will be seen that each slot in each outer shield plate registers horizontally with a slot in an adjacent center shield plate to provide eight columns of rectangular recesses across header assembly 20a, with the four double-layer circuit boards each extending between an adjacent pair of recesses, and with each recess being open on its front and rear sides. Each recess may be closed at its rear to provide better shielding, if desired. A spring contact 38 is mounted in each adjacent pair of recesses on the circuit board between the pair in the manner shown for contacts 38, 38 in FIG. 3, and each spring contact 38 extends forwardly outside the recesses, into a registering rectangular recess provided in eggcrate shielding 13a. In FIG. 3 various of the contacts are shown removed to afford a view of upper location slots 39, 39 provided in the front edges of each of the multilayer etched circuit cards.

In the top view of FIG. 4 header assembly 20a is shown including six phenolic etched circuit boards, including the four previously-mentioned multilayer circuit boards 34-37, together with two singlelayer circuit boards 40, 41 sandwiched therebetween, with all six boards tightly bolted together as by means of machine screws 42 and 43, 43, with fiber spacers used between various of the boards, as illustrated at 44, 44. While multilayer circuit boards 34-37 which carry spring contacts extend all the way to the front edge of the shielding, circuit cards 40 and 41 terminate near the rear edge of the shield pieces. While only a single circuit board (40 or 41) is shown sandwiched between a pair of spring contact-carrying boards in FIG. 4, it will be apparent that further such boards also could be sandwiched therebetween by using shorter spacers, or no spacers at all. The eggcrate shielding 13a into which various of the spring contacts extend is also shown in FIG. 4, with the shielding 13a shown moved slightly forwardly from the header assembly for sake of clarity. When the header assembly is installed, the front edges of the shield plates of each header are adapted to engage the rear edges of the eggcrate shielding, thereby completely shielding each spring contact from other adjacent spring contacts.

Each spring contact 38 grips the outer sides of a respective multilayer circuit board, and etched circuit conductors extend from where each contact grips the outer sides of the board rearwardly to a plated-through hole 113. Each plated-through hole 113 serves to transfer the electrical path from outer sides of a multilayer board to in-between two layers of the multilayer board. The electrical path for each spring contact then extends between two layers of a given multilayer board back to a location near the rear edge of the board, at which location a respective box contact 75 is stapled to the board. From a position slightly rearwardly from each plated-through hole 113 the outer sides of each multilayer board are covered with ground foil, and hence each conductor leading rearwardly inside each multilayer board is completely shielded from conductors leading rearwardly on other boards of the header assembly, and from conductors on adjacent header assemblies. At each box contact a further plated-through hole through one or more layers of the multilayer board reroutes the conductive path from between layers of the multilayer board to the outer side upon which the box contact is located.

In FIG. 4 the ground foil on the left-hand outer side of board 34 extends from a point 114 just rearwardly of hole 113 all the way to the rear edge 34e of board 34, while the ground foil on the right-hand outer side of board 34 extends from just rearwardly of hole 113 to point 117 just forward of box contact 75. Ground foil (preferably covered with thin strips of insulation) extends from connector 21 forwardly on both sides of single-layer board 40, to a point slightly forwardly from point

117, thereby insulating and shielding the box contact from other contacts in the same horizontal row.

A fiber or other rigid block 45 is shown spaced between circuit boards 35 and 36 near the rear edge of the assembly, and a cross-piece 46 affixed to spacer block 45 by means of screw 47 not only acts as a support for circuit board connectors 21, 22 but also extends laterally on each side so that the width of the rear edge of the assembly (dimension *a* in FIG. 4) corresponds to the distance between the flat outside surfaces of outer shields 31 and 32. When a plurality of header assemblies are mounted adjacent each other, the outside edges of piece 46 abut the edges of similar pieces near the rear edges of similar assemblies.

In the rear view of header 20a shown in FIG. 4a the header is shown as including eight connectors 21a-d and 22a-d. Circuit board 23a plugs into connectors 22a and 22b, and circuit board 23b plugs into connectors 22c and 22d as shown in FIG. 2. A similar part of circuit boards (not shown) plug into connectors 21a, 21b and 21c, 21d. Thus header 20a connects to 96 patchbay spring contacts and to four circuit boards. Of the eight connectors shown on header 20a, four connectors (21a, 22a, 21c and 22c) connect to patchbay spring contacts, while the other four connectors (21b, 22b, 21d and 22d) connect power and control lines to the four circuit boards plugged into the header. The lines routed from the 96 patchbay spring contacts are all treated as sensitive signal circuits and are shielded by routing them in the manner described between layers of the four multilayer circuit boards 37-40 included in header 20a. The power and control lines are unshielded and are carried on both sides of the two singlelayer circuit boards (40, 41) of header 20a.

Connectors 21a, 22a, 21c and 22c which carry the shielded conductors from the patchbay spring contacts each include two rows of 24 contact bars. In each of the connectors the odd-numbered contact bars of one row and the even-numbered contact bars of the other row are all connected together and grounded. Hence each ungrounded contact bar is situated in between two grounded contact bars in the same row, and across from a grounded contact bar in the other row, and hence effectively shielded from each other ungrounded contact bar.

The 12 ungrounded contact bars in row L of connector 21a connect via box contacts and 12 shielded lines inside multilayer board 34 to the upper 12 of the 24 spring contacts carried at the front edge of board 34. The 12 ungrounded contact bars in row R of connector 21a connect via box contacts and 12 shielded lines inside multilayer board 35 to the upper 12 of the 24 spring contacts on board 35. The 12 ungrounded contact bars in row L of connector 21c connect via box contacts and 12 further shielded lines inside multilayer board 34 to the lower 12 of the 24 spring contacts on board 34, and the 12 ungrounded contact bars in row R of connector 21c connect via box contacts and 12 further shielded lines inside multilayer board 36 to the lower 12 of the 24 spring contacts on board 35. The L rows of contact bars of connectors 21b and 21d all connect to one side of singlelayer board 40, and through printed conductors on board 40 up to connection located above the patchbay, as shown at 25 in FIG. 2. The R rows of contact bars of connectors 21b and 21d all connect to the other side of board 40, and via printed conductors on board 40 up to further connectors located above the patchbay.

The 12 upper spring contacts carried by boards 36 and 37 similarly are connected via shielded lines within multilayer boards 36 and 37 to contact bar rows L and R, respectively, of connector 22a, the 12 lower spring contacts on those boards being similarly connected via shielded lines to rows L and R respectively, of connector 22c, and groups of power and control lines on opposite sides of board 41 being routed from respective rows of contact bars of connectors 22b and 22d to connectors above the patchbay at 25.

In the side cross-sectional view of FIG. 5, a spring contact 38 is shown mounted in only one of the two recesses shown for sake of illustration. Multilayer circuit card 34 includes a plu-

ality of inwardly-extending upper location slots 39, 39 along its front edge, with each such slot open at the front edge of the card, and includes a lower clamping slot 50 through the board shown spaced rearwardly and downwardly from upper slot 39, with the front edges 50a of each of the lower slots 50 being closed. In FIG. 5 etched circuit conductors are shown leading rearwardly on card 34 from the front edge of the double-layer card to a location within each shielded recess where a plated-through hole 113 is located. Such conductors preferably extend on both outer sides of each multilayer circuit board from each spring contact 38 back to a respective plated-through hole 113. Each plated-through hole serves to connect the electrical path for each spring contact from the two outer sides of the multilayer board to a location between layers of the multilayer boards, and an etched circuit conductor plated on the inside of one layer then extends rearwardly toward one of the rear-edge connectors 21, 22. In FIG. 5 conductors extending rearwardly from holes 113, 113 between the layers of circuit board 34 are shown in dashed lines at 115, 116. The outer surfaces of circuit board 34 are covered with ground foil at areas at the left of line 114 in FIG. 5. Thus the electrical path from each spring contact is completely shielded from the paths from other spring contacts in the same row. The locations at which a spring contact such as 38 resiliently grips the etched conductor 56 are shown generally at 57 and 58 in FIG. 5.

It is a feature of the invention that only simple slots such as those shown at 39 and 50 need be provided in order to attach the spring contacts in a precisely aligned manner. Slots 39 and 50 may be punched along and near the front edges of circuit cards with accurate spacing easily and rapidly prior to assembly of each header.

Each spring contact 38 is shown including a widened front contact pad portion 61 adapted to present a diagonal or angularly-extending plane surface to a patchcord tip when the patchboard is inserted into the patchbay. Pad portion 61 is connected by resilient blade portion 63 to a generally cylindrical rear portion or barrel 65. Each spring contact may be fabricated easily and economically by punching flat stampings having a shape such as that shown in FIG. 6a, rolling the rear portion of each stamping about a cylinder to form the rear portion of the stamping to a generally cylindrical shape, and bending the blade portion and contact pad portions to the shapes shown in FIG. 5. A portion indicated within a dashed line at 66m in FIG. 6a of the top of the cylindrical barrel of the contact is preferably also flattened or depressed for a reason to be explained below. When formed into such a shape each spring contact will be seen to have a rear end slightly-tapering upper slot 66 shown slightly flared at the rear end of the contact, and a complex-shaped bottom slot 68 of the nature best seen in FIG. 6b. When the spring contact is in a relaxed condition such as is shown in FIG. 6b, bottom slot 68 formed by the irregular rearward edges of the stamping will be seen to include a rearmost portion 68a which extends angularly (at the angle α in FIG. 6b) with respect to the longitudinal axis x-x of the contact and the center line of upper slot 66, a further portion 68b parallel to axis x-x, and a widened third portion 68c also extending parallel to axis x-x, with portion 68c radially offset from portion 68b, and with the ends 69, 70 of the widened portion extending normal to the longitudinal axis. It should be noted that the rear end or opening 68d of bottom slot 68 lies entirely on one side of the plane defined by axis x-x and the center line of upper slot 66.

In order to install a patchbay spring contact on the forward edge of a circuit board, the contact is merely urged rearwardly until it snaps in place and locks itself in place. Upper slot 66 of the spring contact engages upper locating slot 39 at the front edge of the board. When the contact has been pushed fully back and into place, front edge 66a of upper slot 66 will abut inner edge 39a (FIG. 5) of slot 39, and edges 66b and 66c of slot 66 (FIG. 6a) will resiliently grip the board, with edge 66b thereby contacting the portion of etched conductor 56 generally shown at 57 in FIG. 5, and with edge 66c pressing against the board 34 on the other side. If an etched conductor

(not shown) similar to conductor 56 (and electrically connected to conductor 56) is provided on the other side of board 34 opposite conductor 56, edge 66c then will contact areas of such other conductor opposite area 57, doubling the contact area at the top of the spring contact.

As the spring contact is pushed rearwardly on the circuit board the open rear end (68d, FIG. 6b) of bottom slot 68 initially engages the edge of the board. As the contact is urged rearwardly, side 34a (FIG. 6c) of the board will be seen to lie flat against longitudinally-extending edge 65a of the contact, and corner 34b of the board will slide upwardly on angularly-extending ramp edge 65b of the contact, thereby tending to spread or widen the bottom slot of the contact against the resilience of the contact. Because the resilience of the contact tends to grip the board between flat edge 65a and corner 34b, it will be seen that the longitudinal axis x-x of the contact tends to be swung parallel and then to remain parallel with the plane of the board, and does not tend to cock in one direction or the other as the contact is installed. The use of the angularly-extending ramp portion 65b opposite the axially-extending edge 65a does allow some side-to-side angular tolerance as the contact initially engages the edge of the board, making it unnecessary to precisely align the contact with the board during initial contact between the two. As the contact is pushed further onto the board, corner 34b and then face portions 34c of the board located rearwardly from corner 34b will be seen to ride along edge 65c (FIG. 6c). During that time the board will be seen to be gripped on opposite sides by edges 65a and 65c, and because both of these edges extend parallel to the x-x axis, the resilience of the contact will be seen to continue to align the contact with its axis parallel to the plane of the board. Such conditions will be seen to pertain during most of the travel of the contact onto the board.

Eventually the spring contact is pushed far enough onto the board that corner 67 reaches front edge 50a of clamping slot 50, after which further advancement of the contact allows edge 65a to enter slot 50 as the resilience of the contact causes its rear portion to assume its original cylindrical shape. Upon still further advancement of the contact to where perpendicular edge 69 reaches the front edge of slot 50, edge 65c is allowed to suddenly snap into slot 50. At that point the rear portion of the contact will be locked in position relative to the board in the manner illustrated in FIG. 6d. With normal or perpendicular end 65f of the contact abutting rear edge 50b of clamping slot 50, it will be seen that the contact cannot be pushed further onto the board. With perpendicular edge 69 abutting front edge 50a of clamping slot 50, it will be seen that the contact cannot be pulled forwardly off of the board. Furthermore, it will be seen that inward or outward forces imparted to the contact will not tend to rotate the contact on the board. With edges 65e and 65c, both of which extend parallel to the x-x axis, gripping the board, precise longitudinal alignment of the contact in a sidewise sense is assured. It also may be seen that the centerline of the contact desirably coincides with the center of the board, facilitating sidewise centering of the contacts in their respective recesses, which not only decreases the chances of bending a contact so as to short it to a wall of its respective recess, but also decreases the capacitance between the contact and its recess.

The vertical distance (FIG. 5) between the upper edge 39b of each front slot 39 and the lower edge 50c of each slot 50 is preferably arranged to be less than the outer diameter of the cylindrical barrel of each contact. When a contact 38 is fully installed on a board its flattened upper portion lies against the flat upper edge 39b and its lower edge against the lower edge 50c, with the dimensions chosen so that the contact is slightly vertical compressed between edges 39b and 50c, which helps prevent both rotation of the contact about any axis parallel to the board and any pitching of the contact about any axis perpendicular to the board. The flattened or depressed portion at the top of the contact barrel can be seen at 75 in FIG. 7.

Although the described specific embodiment of the invention has been illustrated as comprising a plurality of assem-

blies wherein plural mutually-parallel circuit boards are mechanically attached together, it is important to recognize that the spring contacts of the invention may be used as well on patchbay assemblies comprising groups of separate or individually-mounted circuit boards all arranged spaced from each other in mutually parallel planes.

FIGS. 8a and 8b show a portion of a patchbay formed by a plurality of individual etched circuit boards 81, 81 supported in slots in rearwardly extending upper and lower C-shaped guide bars 82, 82. Horizontal bars 83 and 84 support the front ends of guide bars 82, 82, and similar bars 85 and 86 (FIG. 8b) support the rear ends of the guide bars. Metal shield plates 86, 86 (which may be foil-covered phenolic boards) provide shielding between adjacent circuit boards. Eggcrate shielding (not shown) of the same type shown in FIG. 2 may be utilized at the front edges of the circuit boards if desired.

As best seen in FIG. 8b, the conductors leading rearwardly from the spring contacts of each board of FIG. 8a do not all extend to connectors at one or more other edges of the circuit boards, but instead, each circuit board carries a plurality of electronic components, 88, 88 such as transistors, resistors, capacitors, diodes, etc. to provide one or more electronic circuits, such as amplifier circuits, for example. A number of printed or etched conductors lead rearwardly from various of the components to the rear edge of the circuit board, and a conventional ribbon-type connector (not shown) engages the rear edge of each circuit board to connect power and control lines and input and output signal lines to the electronic circuit or circuits carried on each board. Each circuit board in the arrangement of FIGS. 8a and 8b may comprise a single-side circuit board, a double-side circuit board, or a 3 or more-layer circuit board. If desired, a circuit board connector may be permanently attached to the rear edge of one or more of the circuit boards.

In the foregoing specification and in the following claims, the term "etched circuit conductor" is intended to mean any of the common planar or foil-type circuit conductors commonly used on circuit boards, irrespective of whether it is formed on the board by etching or plating or separately formed such as a stamping and then adhered to the board.

It will thus be seen that the objects set forth above, among those made apparent from the preceding description, are efficiently attained, and since certain changes may be made in the above constructions without departing from the scope of the invention, it is intended that all matter contained in the above description or shown in the accompanying drawing shall be interpreted as illustrative and not in a limiting sense.

We claim:

1. A selective connection assembly adapted to resiliently engage a removable patchboard having rows and columns of patchholes with patchcord tips extending through a plurality of said patchholes, comprising, in combination: a row of circuit cards fixedly spaced from each other in mutually parallel planes with a front edge of each of said cards terminating in a front plane perpendicular to the plane of each of said cards, and with a plurality of etched circuit conductors extending rearwardly from a location adjacent the front edge of each card, each of said cards including a plurality of slots spaced along its front edge; and a plurality of resilient metallic spring contacts each comprising a resilient forwardly-extending contact arm having a contact portion adapted to be resiliently contacted and flexed by a patchcord tip, and a hollow generally cylindrical rear portion having a longitudinally-extending slot open at the rear cooperating with a slot on one of said cards, with the sides of said longitudinally-extending slot resiliently gripping said card within said contact slot.

2. An assembly according to claim 1 in which said longitudinally-extending slot extends parallel to the longitudinal axis of said generally-cylindrical rear portion, and having a second slot open at the rear edge of said cylindrical rear portion and extending forwardly therefrom, a first portion of said second slot extending at an acute angle to said longitudinal axis and a second portion of said second slot extending parallel to said longitudinal axis.

3. An assembly according to claim 1 in which each of said cards includes a plurality of holes, and in which each of said spring contacts has a further slot having an edge portion adapted to extend through one of said holes to rigidly affix each of said spring contacts on said cards.

4. An assembly according to claim 1 in which each of said circuit cards comprises a multilayer laminated card having electrical conductors on both of its outer sides adapted to be engaged by opposite edges of one of said spring contacts, and means connecting said electrical conductors to a further electrical conductor extending between the layers of said laminated card.

5. An assembly according to claim 1 in which each of said circuit conductors extends to a further edge of its respective circuit card to connect to a detachable connector means.

6. An assembly according to claim 1 in which at least one of said circuit cards carries a plurality of electronic circuit components and in which at least one of said circuit conductors extends to and connects to one of said circuit components.

7. An assembly according to claim 1 in which each of said circuit cards includes a second front edge portion adapted to engage a circuit card connector, and in which a plurality of said circuit conductors extend to said second front edge portion.

8. An assembly according to claim 1 in which each of said cards includes a plurality of holes, and in which each of said spring contacts includes a tubular portion having a slot, one side of which slot extends from the rear of said tubular portion for a first distance at an acute angle to the longitudinal axis of said tubular portion and then extends perpendicular to said axis.

9. An assembly according to claim 1 in which each of said resilient spring contacts includes a resilient forwardly-extending contact arm having a contact portion adapted to be contacted by a patchcord tip and a hollow tubular rear portion having first and second slots angularly spaced from each other substantially diametrically across from each other and extending forwardly from the rear end of said tubular rear portion, said second slot having a first edge portion which extends at an acute angle to the longitudinal axis of said tubular rear portion and a second edge portion which extends perpendicularly to said longitudinal axis.

10. An assembly according to claim 1 in which said longitudinally-extending slot in each of said spring contacts has a front edge portion substantially the same width as the thickness of the circuit card upon which a respective spring contact is mounted, and a rearward portion of lesser width than said thickness, whereby installation of each spring contact on its respective circuit cards causes said rearward portions of its respective slot to resiliently grip opposite sides of its respective circuit card.

11. An assembly according to claim 1 in which the front end of each of said contact slots is adapted to engage the rear end of a respective one of said slots on said cards to fixedly locate said spring contacts on said circuit cards.

12. An assembly according to claim 2 in which said first portion of said second slot extends from the rear end of the cylindrical rear portion to the second portion of said second slot, and in which said first portion includes a rearmost portion having one edge arranged at an acute angle to said longitudinal axis and an opposite edge extending parallel to said longitudinal axis.

13. An assembly according to claim 2 wherein the centerline of said second portion of said second slot is located diametrically across said cylindrical rear portion from the centerline of said first slot.

14. An assembly according to claim 2 wherein said second portion of said second slot includes a central portion laterally offset from a longitudinal plane extending through the centerlines of said first and second slots, and a front portion centered on said longitudinal plane.

15. An assembly according to claim 3 in which each of said closed holes comprises an elongated slot having at least one edge which extends rearwardly on its respective circuit card in

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a direction parallel to an edge of the slot along the front edge of the card which is engaged by the same spring contact.

16. An assembly according to claim 4 in which said outer

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sides of said laminated card facing a portion of said further electrical conductors are covered with electrical shielding to shield said further conductor.

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