

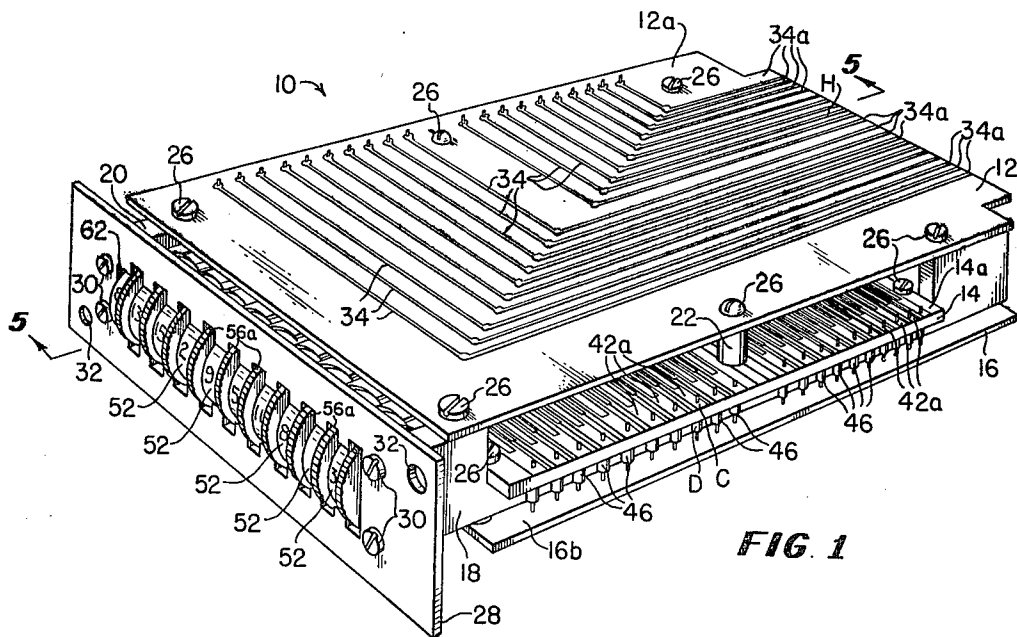
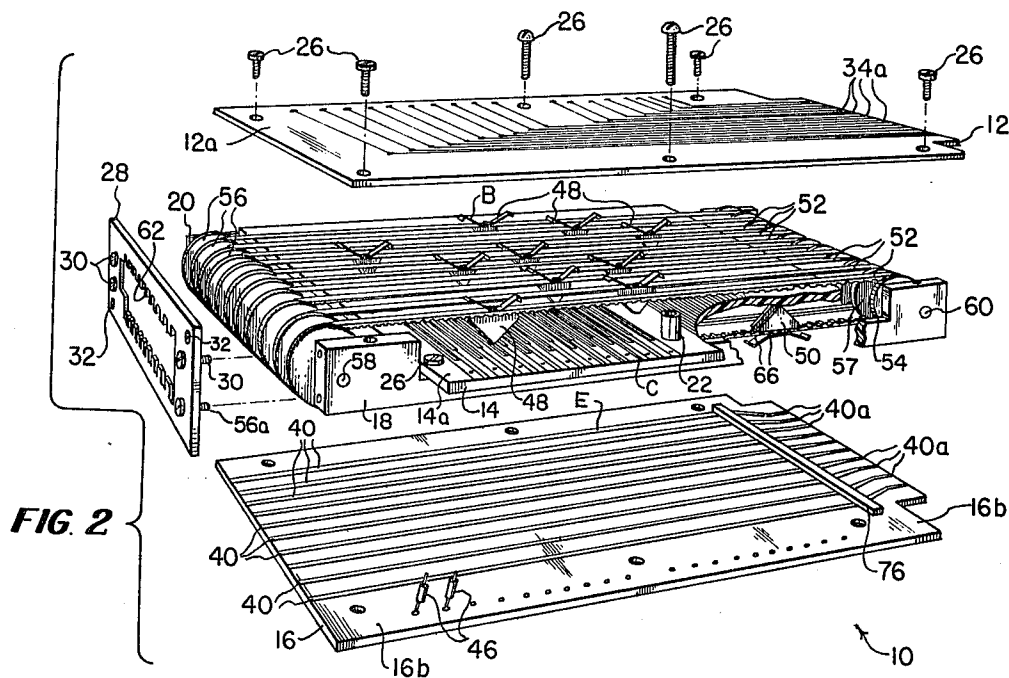
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H. E. TAUSCHER

3,495,052

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2 Sheets-Sheet 1



INVENTOR:
HEINRICH E. TAUSCHER
By *Macon, Kolchmainer,
Rathburn & Wyss*
Attorneys

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H. E. TAUSCHER

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MATRIX SWITCH

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2 Sheets-Sheet 2

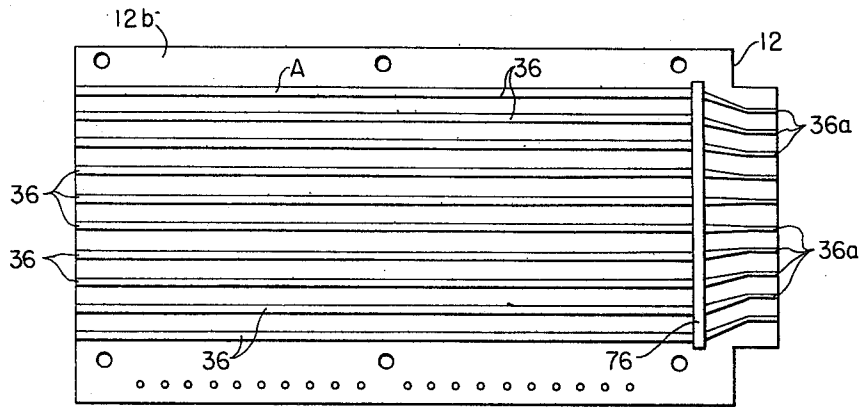


FIG. 3

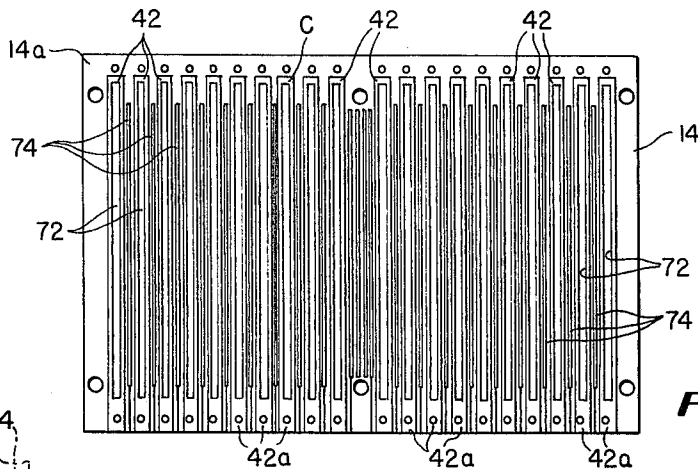


FIG. 4

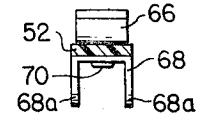


FIG. 7

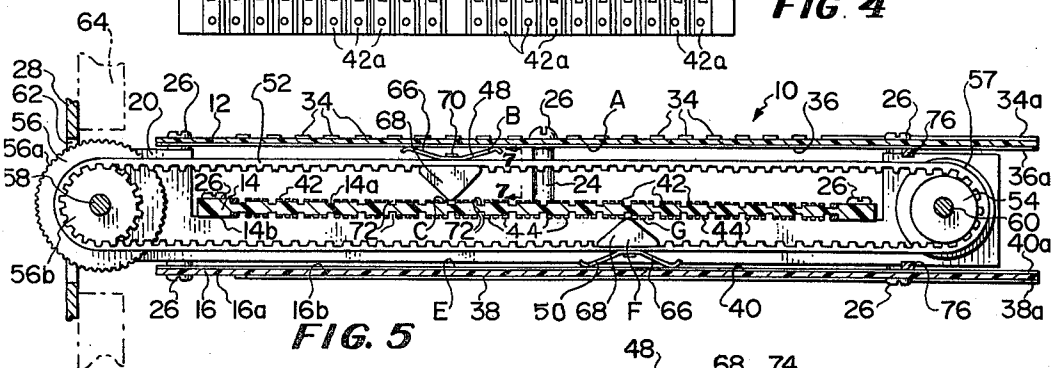


FIG. 5

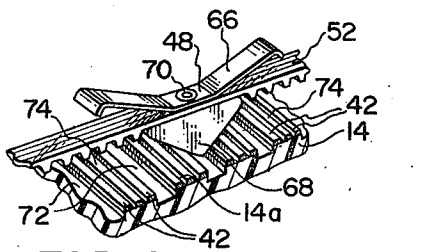


FIG. 6

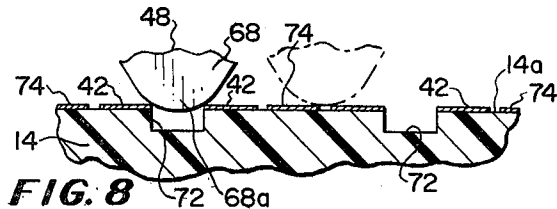


FIG. 8

INVENTOR
HEINRICH E. TAUSCHER
By *Mason, Kohnmainen,*
Ratliff, Wyse
Attorneys

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MATRIX SWITCH

Heinrich E. Tauscher, Chicago, Ill., assignor to Comtech Corporation, Broadview, Ill., a corporation of Illinois
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15 Claims

ABSTRACT OF THE DISCLOSURE

A matrix or crossbar switching unit includes interfacing surfaces supporting transverse conductors. A series of endless flexible belts driven by thumb wheels located at a small area at one edge of the unit move contactors between the surfaces to establish selected interconnections between conductors of the two groups. The contactors include resilient portions held in compression, and indexing is accomplished by means of recesses in one surface detachably engageable with protuberances on the contactors. The surfaces and conductors may conveniently be in the form of printed circuit boards.

The present invention relates to switch apparatus, and more particularly to an improved matrix switch for establishing selected interconnections between conductors of different groups.

Matrix or crossbar type selector switches may be used in various programming applications in conjunction with data processing equipment, communication systems, process control apparatus and the like. Such switches customarily include pairs of conductor groups together with manually operated contactor structure for interconnecting selected conductors from different groups. Known crossbar selector switches are subject to disadvantages including the necessity for a large panel area to accomplish the switching operation, complexity, expense and inconvenience in operation.

An important object of the present invention is to provide an improved matrix switch and to overcome difficulties encountered with known devices.

Another object of the invention is to provide a compact and conveniently operated matrix switch.

A further object is to provide a matrix switch requiring a minimum of panel space so that a large switching capability can be accommodated in a small space.

Another object of the invention is to provide improved switching apparatus in which much of the structure of the switch may be in the form of printed circuits to the end that the expense of manufacture and the complexity of the apparatus is reduced.

A further object of the invention is to provide a matrix switch in which two wire parallel switching for communications use or the like is easily accommodated.

Yet another object of the invention is to provide improved indexing structure in a matrix switch.

A further object of the invention is to provide an improved contactor structure for use with matrix switches.

In brief, an improved matrix switch constructed in accordance with the principles of the present invention may comprise a pair of spaced printed circuit boards including transverse groups of conductors. Contactors slidable between the interfacing board surfaces are selectively engageable between conductors of the two groups. An important aspect of the invention resides in the use of flexible belts trained around paths extending between the board surfaces for moving the contactors to desired positions. The belts are all driven from an edge of the unit so that a minimum of panel area is required.

The term "belt" as used herein is intended to encompass all types of endless driving elements such as bands, chains,

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cords and the like. In the illustrated embodiment of the invention, toothed bands are used, and the bands are drivingly engaged with toothed hub portions of thumb wheels to the end that precise registry without slippage is attained.

The improved contactors of the present invention include first and second portions slidably engaging the opposed board surfaces for registry with selected conductors. One of the portions is in the form of a spring held in compression for holding the contactor between the surfaces. The other portion of the contactor includes protuberances or nose means releasably detained in recesses in a board surface for indexing the contactor in selected positions. Suitable indicia on the belts are visible from the board edge and provide an indication of the contactor positions.

The above and other objects and advantages of the invention will appear from consideration of the following detailed description of an embodiment of the invention illustrated in the accompanying drawings in which:

FIG. 1 is a perspective view of a matrix switch unit embodying the features of the present invention;

FIG. 2 is an exploded perspective view, partly broken away, of the matrix switch unit;

FIG. 3 is a bottom plan view of a printed circuit board forming one element of the matrix switch unit;

FIG. 4 is a top plan view of another printed circuit board forming one element of the matrix switch unit;

FIG. 5 is a sectional view of the matrix switch unit taken along the line 5—5 of FIG. 1;

FIG. 6 is a fragmentary, enlarged view of one portion of the matrix switch unit;

FIG. 7 is an enlarged, sectional view taken along the line 7—7 of FIG. 5 and illustrating one of the contactors of the matrix switch unit; and

FIG. 8 is a greatly enlarged view illustrating the engagement between a contactor and one of the board surfaces of the matrix switch unit.

Referring now to the drawings, there is illustrated a matrix switch unit designated as a whole by the reference numeral 10 and constructed in accordance with the principles of the present invention. As shown most clearly in FIGS. 1, 2 and 5, the structural components of the unit 10 include three board members 12, 14 and 16 held in spaced and stacked relationship by a pair of frame members 18 and 20 and a pair of spacers 22 and 24. These elements are held together in a rigid unit by means of fasteners 26 extending through the boards 12, 14 and 16 and threaded into the frame members 18 and 20. In order to support the unit 10 behind a panel or the like, the unit includes an end panel 28 firmly mounted to the unit by means of fasteners 30 connected to the frame members 18 and 20. Conveniently the entire unit 10 may be mounted in a very small panel area by means of the end panel 28 which is provided with suitable openings 32 for this purpose.

In accordance with one important feature of the present invention, the board members 12, 14 and 16 are printed circuit boards serving to provide not only much of the structure of the unit 10, but also serving to provide in a convenient and economical form the conductors required for the switching assembly. More specifically and referring first to the board member 12, the board 12 includes an upper surface 12a (FIG. 1) and a lower surface 12b (FIG. 3). The upper surface 12a is provided with a plurality of spaced apart conductors 34 each including a terminal portion 34a disposed at an edge of the board. The surface 12b of the board member 12 (FIG. 3) includes a group of spaced apart longitudinal conductors 36 spanning the length of the surface 12b and including terminal portions 36a disposed on the opposite side of

the board surface from the terminal portions 34a of the conductors 34.

The board member 16 in the illustrated embodiment of the invention is identical to the board member 12, except that it is mounted in an upside-down position. The board 16 includes a lower surface 16a (FIG. 5) including a group of conductors 38 identical to the conductors 34 and including terminal portions 38a at an edge of the board. An upper surface 16b of the board 16 (FIG. 2) is provided with a group of conductors 40 identical to the conductors 36 and including terminal portions 40a on the opposite side of board 16 from the terminal portions 38a of the conductors 38.

The edge terminal conductor portions 34a, 36a, 38a and 40a can conveniently be used to electrically interconnect the matrix switch unit 10 with other electrical equipment to be controlled or programmed by the unit. Since the terminal portions 34a, 36a, 38a and 40a are all disposed at one end of the unit, electrical connections to these terminal portions can be completed conveniently with suitable frictional connecting apparatus.

The board member 14 includes an upper surface 14a (FIG. 4) and a lower surface 14b (FIG. 5), which surfaces may be identical to one another. The upper surface 14a, best illustrated in FIG. 4, includes a group of conductors 42 spanning the width of the surface 14a and arranged transversely of conductors 36 carried on surface 12b of board 12 so that each conductor 42 crosses each conductor 46. The conductors 42 include end portions 42a disposed at an edge of the board 14. Although not illustrated in detail in the drawings, the underside 14b of the board member 14 includes a group of conductors 44 (FIG. 5) traversing the surface 14b and crossing each of the conductors 40 on the surface 16b of the board member 16. The conductors 44 include end portions (not shown) at the opposite edge of the board 14 from the end portions 42a of conductors 42.

In order to complete the conductor paths of the matrix switch unit 10, there are provided a plurality of diodes 46 (FIGS. 1 and 2) extending between the end portions 42a of conductors 42 of board 12 and superimposed end portions of the conductors 38 of board 16. As shown most clearly in FIG. 1, the board member 16 overhangs the frame 18 at one side of the unit, as does the edge of the board member 14. The diodes 46 extend through holes in the board members 14 and 16 and are soldered to the respective conductors 42 and 38. If desired, resistances or conductors could be used in place of the diodes, depending upon the circuit requirements. Similarly, other diodes which do not appear in the drawings are connected between each of the conductors 44 and each of the conductors 34 at the opposite edge of the unit 10 in order to interconnect these conductors. Thus it can be seen that the terminal portions 34a correspond in a one-to-one relationship with each of the conductors 44 on the surface 14b of the board member 14. In a similar manner each of the terminal portions 38a corresponds in a one-to-one relationship with each of the conductors 42 on the board member 14.

The matrix switching unit 10 includes a pair of two-dimensional matrices formed of conductors supported on the interfacing surfaces of the board members 12, 14 and 16. More specifically, the conductors 42 and 36 form one matrix on the interfacing surfaces 12b and 14a. Similarly, the conductors 44 and 40 form another matrix on the interfacing surfaces 16b and 14b.

In accordance with a feature of the present invention, there is provided improved apparatus for selectively interconnecting conductors of the switch matrices. In order to interconnect selected ones of the conductors 36 and 42, there are provided a plurality of contactors 48, and in order to connect interconnected selected ones of the conductors 40 and 44 there are provided a plurality of identical contactors 50. Another important feature of the present invention resides in the provision of novel apparatus for controlling the positions of the contactors

48 and 50 from one edge of the unit 10. This novel construction makes it possible to use a small amount of panel space in order to control the matrix switching so that a large amount of switching capability can be incorporated into a relatively small panel.

More specifically, each contactor 48 and each contactor 50 is attached to an endless flexible belt in the form of a band 52 having inwardly directed teeth. As appears most clearly in FIG. 5, the bands 52 are trained around closed paths extending between the interfacing surfaces 12b and 14a and the interfacing surfaces 16b and 14b. Each belt is supported upon an idler pulley 54 at one end of the unit 10 and on a driving element or thumb wheel 56 at the other end of the unit 10. The driving elements 56 each include a knurled flange portion 56a and a toothed hub portion 56b drivingly related to the corresponding band 52. Spacers 57 may be located between the pulleys 54 for holding the bands 52 in position. One contactor 48 and one contactor 50 are mounted on each band 52 at substantially opposite points on the band so that they move in synchronism over the length of the unit 10 when the driving element 56 is rotated. The pulleys 54 and the thumb wheels 56 are mounted for rotation on a pair of shafts 58 and 60 extending between the frames 18 and 20.

Referring to FIGS. 1 and 2, it can be seen that the end panel 28 of the unit 10 is provided with a recess 62 through which the flange portions 56a of the thumb wheels 56 are easily accessible for adjustment of the switching unit 10. In addition, the recesses 62 are such as to render visible the portions of the bands 52 lying over the hubs 56b of the driving elements 56. In accordance with a feature of the invention, suitable indicia are provided on the outer surfaces of the bands for indicating the positions of the corresponding contactors 48 and 50.

When the switching unit 10 is mounted upon a suitable panel such as shown in broken lines and as designated as 64 in FIG. 5, a minimum of panel space is required. Since the driving elements 56 are easily accessible through the end panel 28, the switching unit can be operated without the necessity for access to a large surface of the switching unit as has been required in known crossbar type selector switches. It should be understood that several of the units 10 may be mounted on a panel in stacked relationship and several of the units 10 can be accommodated in a panel of the size which heretofore could accommodate only a single switching unit.

In accordance with another feature of the invention, the improved contactors 48 and 50 provide stable and resilient frictional support of the contactors between interfacing board surfaces. Referring now more specifically to FIGS. 6 and 7 wherein one of the contactors 48 is shown in detail, each contactor includes a first portion 66 and a second portion 68, these portions being slidably engageable with two opposed interfacing board surfaces. The portion 66 comprises a leaf spring having diverging angled legs with reverse curved ends providing smooth sliding contact with a board surface. The portion 68 comprises a somewhat U-shaped bracket member having opposed end portions or feet 68a providing two-point sliding engagement with the opposite board surface. Since the portions 66 and 68 each engage the corresponding board surfaces at two spaced points, the entire contactor 48 or 50 is held firmly in its properly orientated position by a four-point engagement between the surfaces. Furthermore the relaxed condition of the leaf spring 66 is such that when the contactor 48 or 50 is mounted in position, the leaf spring portion 66 is held in compression, thereby to provide a resilient frictional force holding the contactor in place. The two portions 66 and 68 are held together by means of a fastener 70 also passing through the corresponding band 52 so that the position of the contactor on the band is fixed.

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In accordance with another feature of the present invention, there is provided a novel indexing arrangement for releasably detaining the contactors 48 and 50 in properly orientated positions along their paths of travel. Referring now more specifically to FIGS. 4-6 and 8, each of the conductors 42 and the conductors 44 on opposite surfaces of the board member 14 is provided with a central groove or recess 72 extending substantially the length of the conductor. Furthermore, the end or feet portion 68a of the contactor element 68 are in the shape of a nose or protuberance detachably engageable within the grooves 72 as best shown in FIG. 8. Accordingly, whenever a band 52 is moved to bring its contactors 48 and 50 into position to engage selected conductors 42 and 44, the nose portions 68a of the contactor segments 68 descend into the corresponding groove 72 releasably to hold the contactors in position. In addition to providing a releasably locking action giving a desirable "feel" to the operator, this arrangement provides a low resistance electrical connection between the contactor and the conductors due to the corner engagement between the edges of the conductors 42 and 44 and the nose portion 68a.

In order to allow the contactors 48 and 50 to move smoothly between their proper positions engageable with the grooves 72, the space on the surfaces of the panel 14 between each of the conductors 42 and between each of the conductors 44 is filled with a spacer or dummy conductor 74. The spacers 74 are not connected to any external circuitry but merely serve to fill the region between the switch conductors so that the nose portions 68a move smoothly between properly aligned positions.

In order to limit movement of the belts 52 so that the contactors 48 and 50 cannot become jammed on the driving elements 56 or idler pulleys 54, the boards 12 and 16 are each provided with a stop member 76 (FIGS. 2, 3 and 5). At the opposite ends of the range of movement of the bands 52, the stop members 76 are engaged by the leaf spring portions 66 of the contactors 48 and 50 to prevent further movement.

As can best be seen from a comparison of FIGS. 2 and 3, there is a one-to-one correspondence between the bands 52 and the conductors 36 and 40. Each of the contactors 48 is in sliding engagement with one of the conductors 36 while each of the contactors 50 is in sliding engagement with one of the conductors 40. Since the contactors 48 and 50 are slidably movable over the surfaces 14a and 14b, each of the conductors 36 and 40 may be selectively interconnected to any of the corresponding conductors 42 or 44 by the corresponding contactors 48 and 50. Thus by manipulation of the thumb wheels 56, any selected electrical interconnections may be made between the terminal portions 34a of the conductors 34 and the terminal portions 40a of the conductors 40. At the same time, corresponding interconnections are made between the terminal portions 38a of the conductors 38 and the terminal portions 36a of the conductors 36.

The operation of the switching unit 10 may be more readily understood through reference to a specific example. Referring now to the electrical circuit completed by the driving element 56 on the left as illustrated in FIGS. 1 and 2 of the drawings, one of the conductors 36, designated by the letter A, is in frictional contact with the corresponding contactor 48, labeled B (FIGS. 2 and 5). This contactor is also in engagement with one of the conductors 42, labeled C (FIGS. 1, 2, 4 and 5). This conductor 42 is connected by one of the diodes 46, labeled D, to one of the conductors 38 on the underside 16a of the board member 16.

Simultaneously, a corresponding connection is made between one of the conductors 40, labeled E, by one of the contactors 50, labeled F (FIG. 5) to one of the conductors 44, labeled G. This conductor is coupled by one of the diodes at the edge of the unit 10 to a conductor 34, labeled H (FIG. 1).

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Since manipulation of each of the driving elements 56 serves to close corresponding switch points in each of the pair of matrices of the switching unit, the switching unit 10 is particularly well suited for two wire parallel switching operations such as may be required in some audio communication systems and the like. However, if desired, one half of the switching capability may be omitted from the unit through elimination of one of the sets of contactors and the associated conductors.

What is claimed and desired to be secured by Letters Patent of the United States is:

1. A matrix switch comprising a pair of spaced board members providing first and second interfacing surfaces, an array of spaced parallel first conductors on said first interfacing surface. An array of spaced parallel second conductors on said second interfacing surface and extending transverse to said first conductors, a plurality of flexible belts each disposed along a path having a segment extending between said interfacing surfaces and overlying one of said first conductors, a contact member fixed to each belt, each contact member having a first portion in sliding contact with the corresponding first conductor and having a second portion engageable with said second conductors, and belt drive means located outside of the region between said interfacing surfaces and engageable with said belts for moving said belts to establish selected interconnections between first and second conductors.

2. A matrix switch as claimed in claim 1, said board members being generally rectangular, said belt drive means being disposed along an edge of said board members.

3. A matrix switch as claimed in claim 2, said belt drive members comprising a row of independently rotatable thumb wheels each drivingly engaged with one of said belts.

4. A matrix switch as claimed in claim 3, indicia means on each belt means for indicating the positions of said contact members.

5. A matrix switch as claimed in claim 1, said first and second conductors comprising layers of metal printed upon said first and second surfaces.

6. A matrix switch as claimed in claim 1, said contact members including resilient means for producing frictional engagement between said contact members and said second conductors, and recesses in said second conductors for releasably detaining said contact members.

7. A matrix switch comprising a plurality of endless flexible belts trained around spaced paths, said paths including substantially linear parallel segments lying in a generally rectangular first plane, a group of conductors lying in a second plane generally parallel to and spaced from said first plane, said conductors extending transverse to said segments, a plurality of contactors movable by said belts along said segments for establishing connections with said conductors, and a plurality of rotatable drive members drivingly engaged with said belts and located along an edge of said generally rectangular first plane.

8. A matrix switch as claimed in claim 7, further comprising an additional group of conductors lying in a third plane spaced from and parallel to said first plane, said second and third planes being on opposite sides of said first plane, each conductor of said additional group being parallel to and overlying one of said segments, each of said contactors being in sliding engagement with one of said conductors of said additional group.

9. A matrix switch as claimed in claim 7, said drive members comprising thumb wheels rotatable around a common axis.

10. A matrix switch as claimed in claim 9, each said belt comprising a toothed band, and said thumb wheels including toothed hub portions engaged with said bands.

11. Switch apparatus comprising a pair of spaced interfacing surfaces, a first conductor supporter on one of the surfaces, a group of spaced-apart second conduc-

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tors on the other of said surfaces, a contactor disposed between said surfaces for establishing selected connections between said first conductor and said second conductors, and driving means for moving said contactor along a line overlying said first conductor, said contactor including a first portion in sliding engagement with said first conductor and including a second portion in sliding engagement with said other surface for sequential contact with said second conductors, at least part of said contactor being formed of resilient material held in compression between said surfaces.

12. Switch apparatus as claimed in claim 11, said second portion of said contactor including protuberance means engageable with said other surface, and recesses in said second conductors constructed and arranged to receive said protuberance means for releasably detaining said contactor in engagement with said second conductors.

13. Switch apparatus as claimed in claim 11, one of said first and second portions of said contactor comprising a spring.

14. Switch apparatus as claimed in claim 11, said first portion of said contactor comprising a leaf spring having spaced ends slidably engaged with said first con-

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ductor, the second portion of said contactor comprising a generally U-shaped member having spaced legs, said first and second portions providing stable four point support of said contactor between said surfaces.

15. Switch apparatus as claimed in claim 14, said legs terminating in generally nose-shaped feet, and means defining indexing recesses on said second surface for releasably detaining said feet.

References Cited

UNITED STATES PATENTS

Re. 24,586	1/1959	Davis	200—16
3,146,320	8/1964	Wang et al.	200—16 XR
3,193,630	7/1965	Shlesinger	200—16
3,308,250	3/1967	Field et al.	200—16
3,366,751	1/1968	Capellari	200—11

ROBERT K. SHAEFER, Primary Examiner

J. R. SCOTT, Assistant Examiner

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