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[54] **SWITCHING SYSTEM USING DIVIDED CROSSBAR SWITCH**
6 Claims, 6 Drawing Figs.

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 340/147 T, 340/147
 [51] Int. Cl. H04q 9/00,
 H04q 3/54
 [50] Field of Search 340/166,
 147 T, 147, 147 C; 179/18, 22; 178/6 PD

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UNITED STATES PATENTS

3,045,209 7/1962 Pomerene 340/166 X
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ABSTRACT: In a switching system for connecting any one of a number of given lines to any selected one of a large number of available lines, a crossbar switch is used having its hold columns divided into two groups with each given line having assigned to it one hold column of each group. In the making of a selection, one hold column assigned to a given line selects a group of available lines, from the total of such lines, and connects the selected group to the other hold column assigned to the given line. The other hold column is then used to select an individual available line from the selected group. Preferably, the crossbar switch is so wired that both of the two hold columns assigned to a given line actually make both a group selection and an individual selection and a separate two-position auxiliary switch is used to select from the two individual available lines selected by the two hold columns.

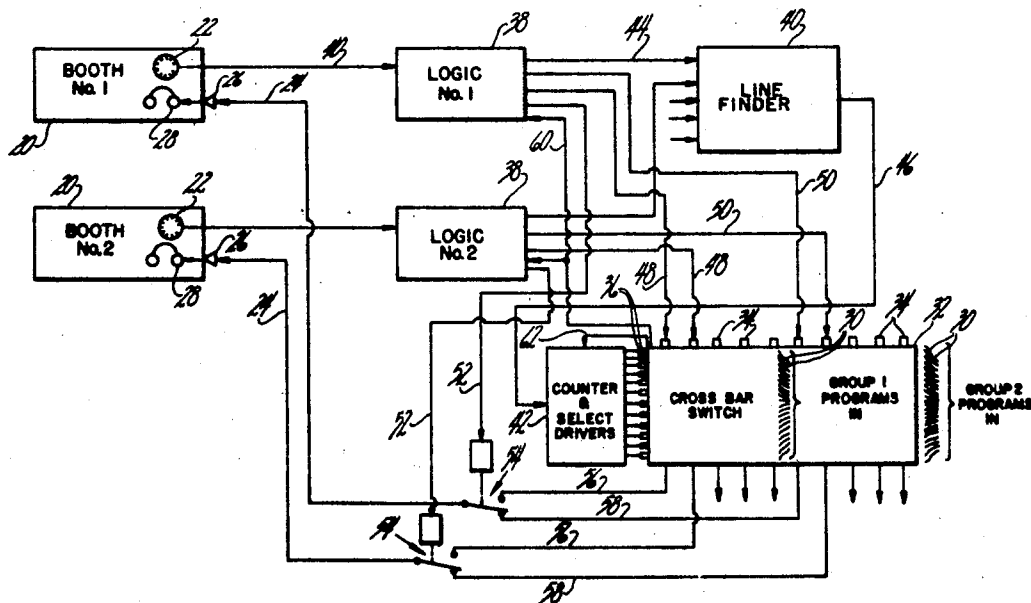


Fig. 1

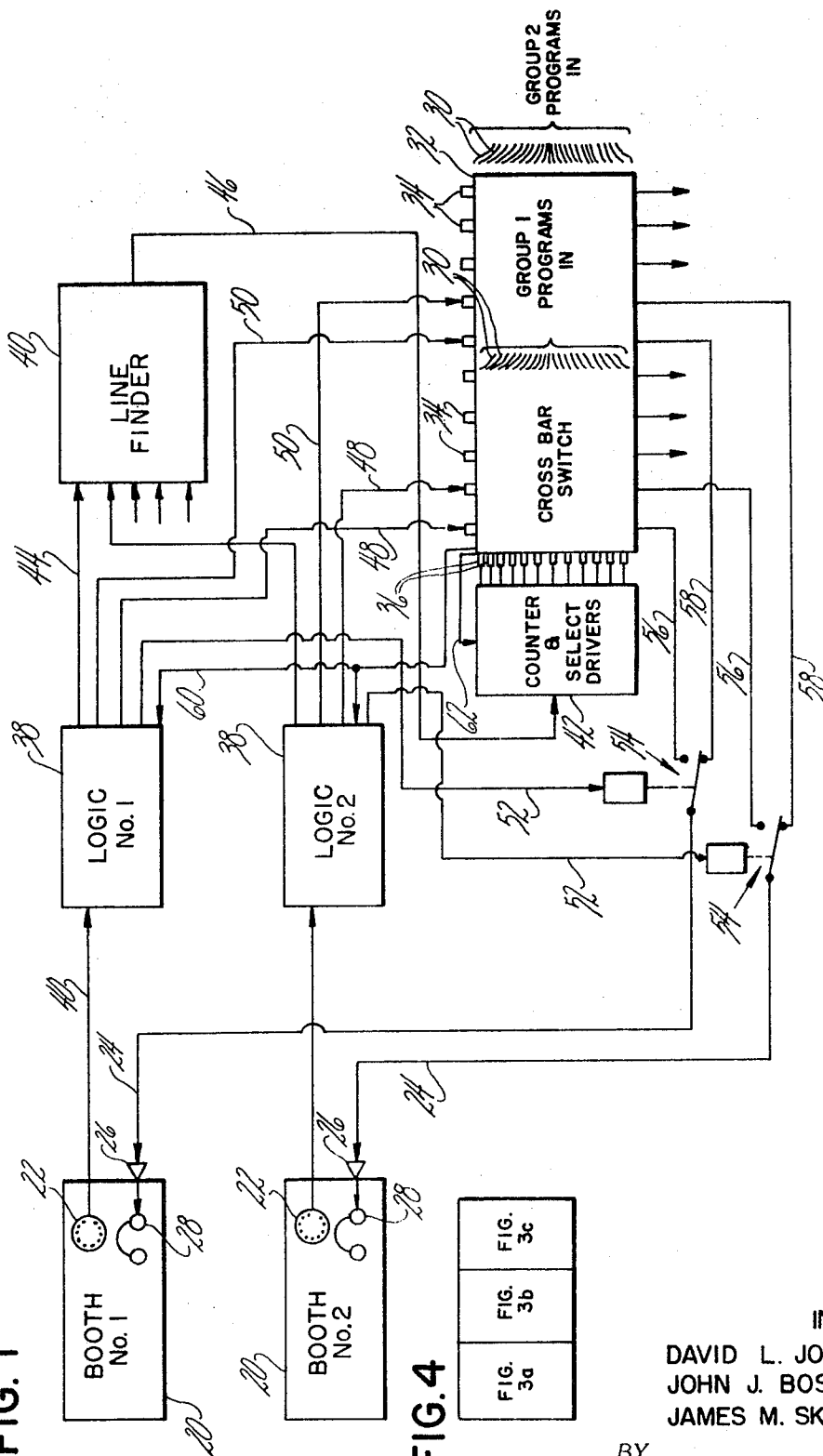


FIG. 4

FIG. 3a	FIG. 3b	FIG. 3c
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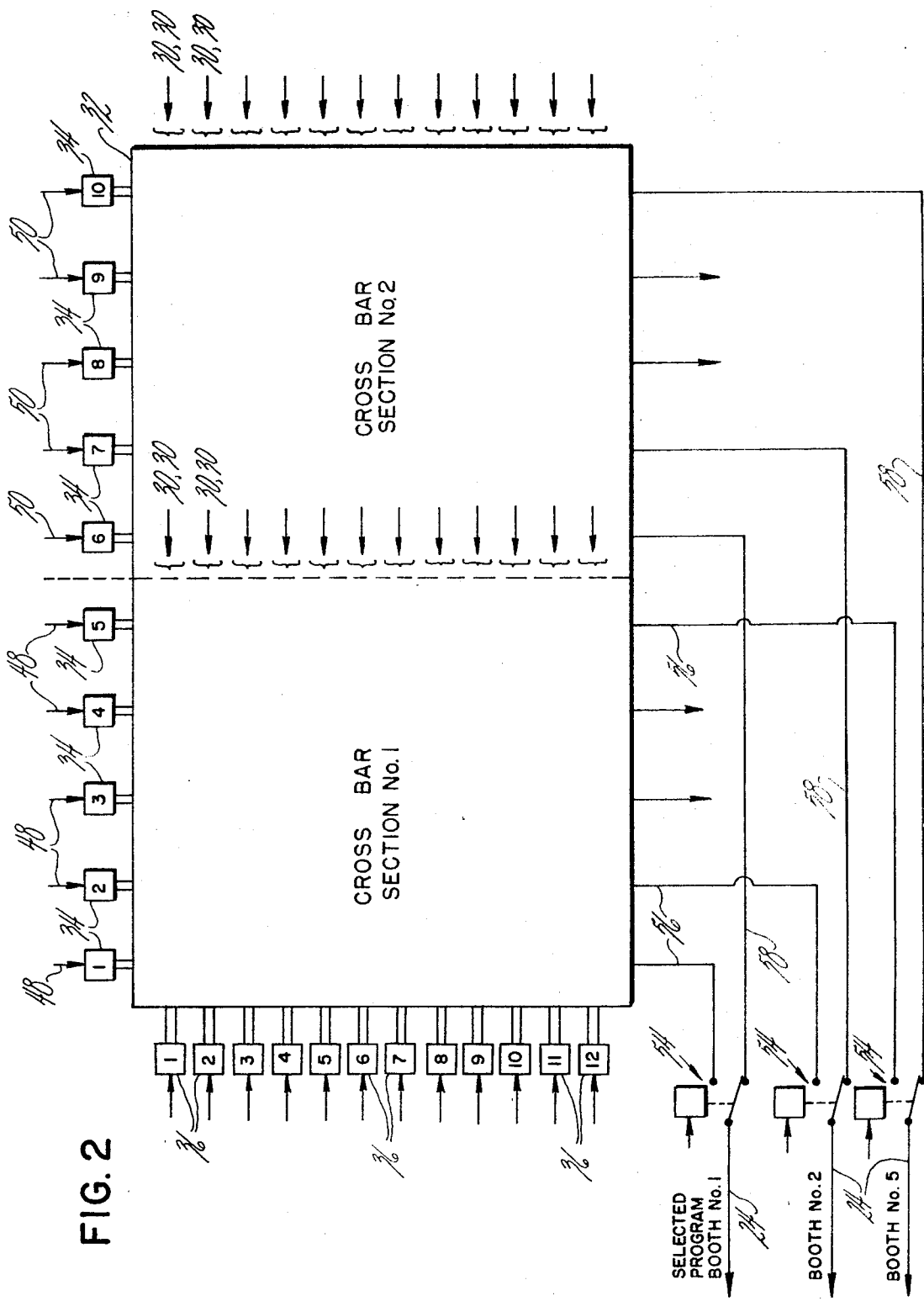


FIG. 3B

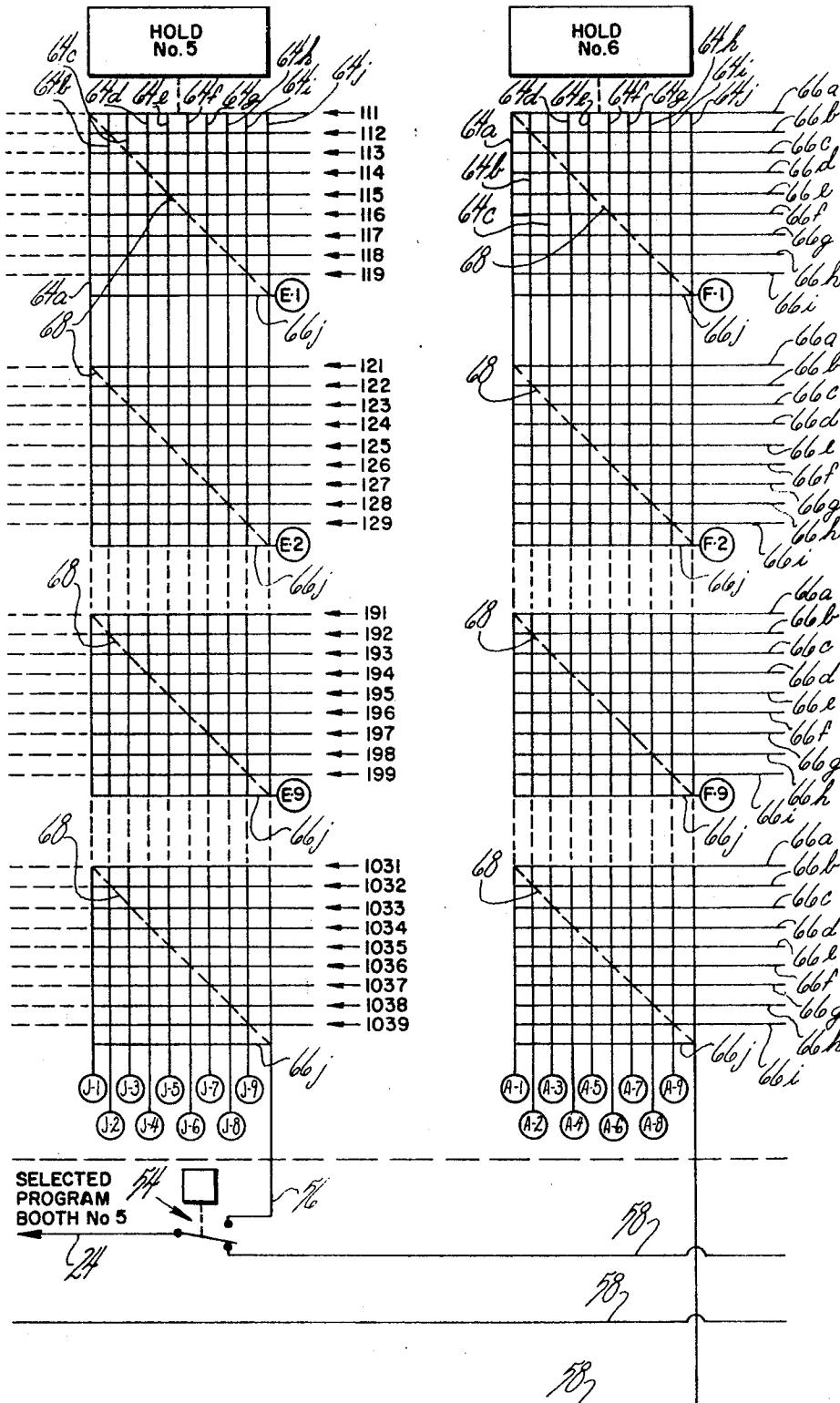
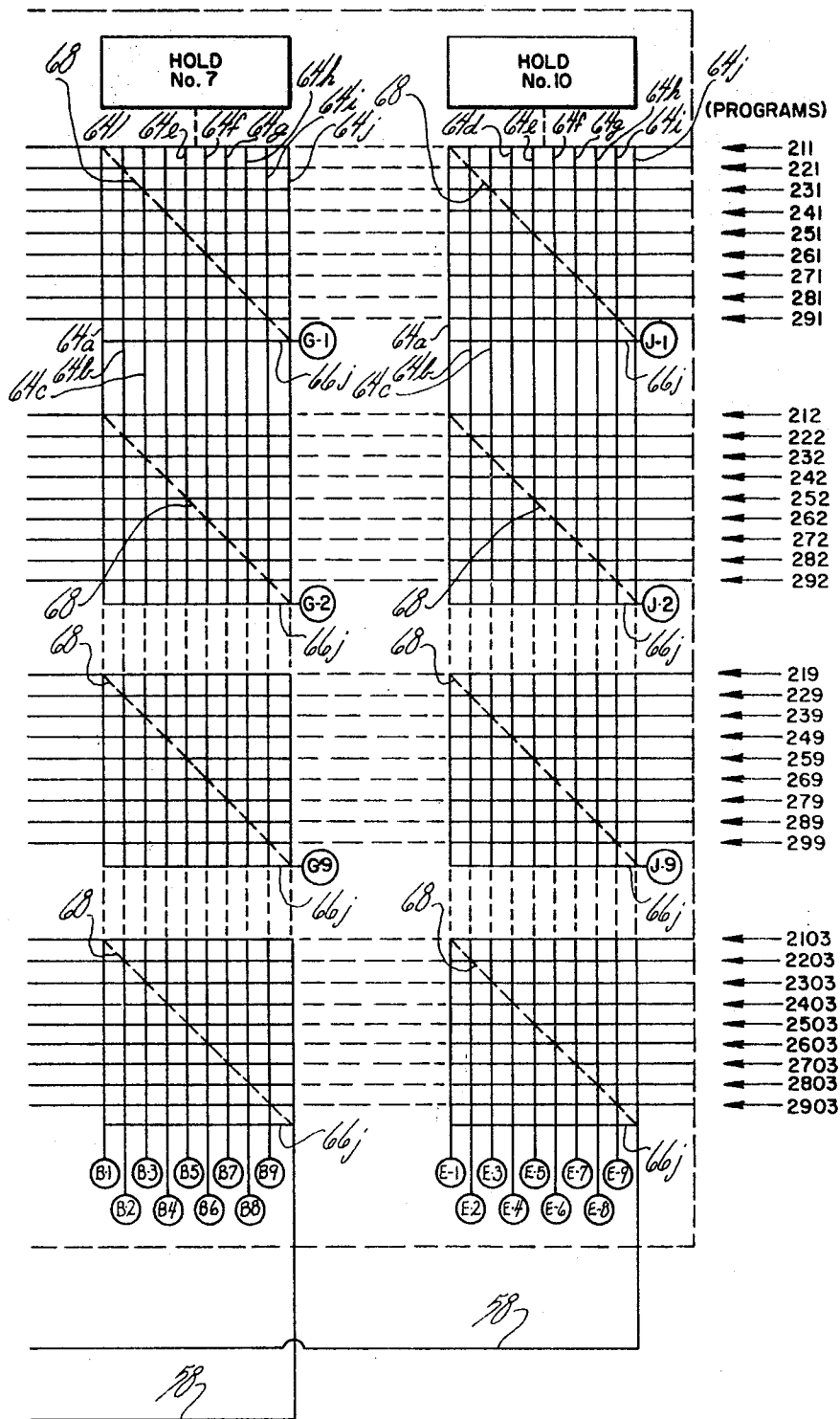


FIG. 3c



SWITCHING SYSTEM USING DIVIDED CROSSBAR SWITCH

BACKGROUND OF THE INVENTION

This invention relates to switching systems for selectively electrically connecting a given line to any one of a plurality of available lines, and deals more particularly with such a system utilizing a generally conventional crossbar switch as a part thereof.

The switching system of this invention may be used in many varied applications, but for convenience of description is disclosed herein as used as part of a so-called teaching machine or language laboratory wherein individual students located at booths or study areas may, by operation of a telephone-type dial, select for hearing through a pair of earphones at each booth any one of a large number of prerecorded programs supplied by continuously running tape decks or other sources. The switching system of this invention is of particular utility in such an application as it, among other things, increases substantially the number of programs which may be made available to a single student through a single crossbar switch and reduces the amount and complexity of the auxiliary switching mechanisms required.

SUMMARY OF THE INVENTION

In the switching system of this invention, a crossbar switch is provided having a plurality of vertical conductors grouped into a plurality of hold columns and also for each hold column having a plurality of horizontal conductors grouped into a plurality of select levels. For each given line to which an available line is to be connected, the crossbar switch includes two hold columns. At least some of the available lines are connected to the horizontal conductors of the first of these two hold columns and this first hold column has its vertical conductors connected in one-to-one relationship to those horizontal conductors of the second hold column associated through the contacts of such second hold column to one particular vertical conductor of the second hold column. Therefore, when one cross point of the first hold column is selected or closed, the group of available lines connected to the horizontal conductors of such cross point are connected to a respective one of the select levels of the second hold column so that when a cross point of the second hold column is thereafter selected or closed, one of the group of available lines connected to said second hold column by said closed cross point of said first hold column is selected and connected to said one particular line of said second hold column. Preferably, the other vertical conductors of the second hold column are connected to those horizontal conductors of the first hold column associated with one particular vertical conductor of the first hold column, and other available lines are connected to the other horizontal conductors of the second hold column, in the same manner as described above so that when one cross point is selected or closed in each of the two hold columns, two connections are made to two available lines, one connection being made through a particular one of the vertical conductors of the first hold column and the other connection being made through a particular one of the vertical conductors of the second hold column, and an auxiliary two-position switch is provided for connecting the given line to a selected one of these two particular vertical conductors.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a schematic block diagram illustrating a teaching machine employing a switching system embodying this invention.

FIG. 2 is a generally schematic view showing in enlarged form the crossbar switch of FIG. 1.

FIGS. 3a, 3b, and 3c, when placed side by side in the manner shown in FIG. 4, constitute a single figure showing schematically the crossbar switch of FIG. 1 and the manner in

which various conductors of said switch are connected to one another and to the incoming available lines.

FIG. 4 is a diagram showing the manner in which FIGS. 3a, 3b, and 3c are to be arranged to form a single composite figure.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Turning to the drawings, and first considering FIG. 1, this figure shows a portion of a language laboratory for supplying a number of students at individual booths or study areas with audio instructional material. Two of the booths are shown at 20, 20, and each includes a telephone-type dial 22 through the use of which the student at the booth may make a selection from a large number of available programs supplied by continuously running tape decks or other sources. The selected program is transmitted to the booth by a program line 24. It is amplified by an amplifier 26 associated with the booth and is finally reproduced by a pair of earphones 28 or other sound reproducer in the booth. The available programs are supplied a plurality of lines 30, 30 hereafter referred to as available lines or program input lines. That is, each line 30 is connected to an individual program source (not shown), such as one channel of a tape deck, and carries a signal representing one individual audio program. As shown, and as explained in more detail hereinafter, the various available lines 30, 30 are divided into two groups, both of which are connected to different sections of a single crossbar switch 32.

The crossbar switch 32 constitutes a major part of the switching system for selectively connecting any one of the available lines 30, 30 to the program line 24 of any one of the booths, and may be of generally conventional construction. For example, it may, except for the specific wiring details hereinafter described, be of the type manufactured by North Electric Company of Galion, Ohio, and described both in their Industrial Bulletin No. 204-52 and in their publication No. ED-2-61 entitled "Crossbar Switch Maintenance and Adjustment Handbook." The illustrated crossbar switch 32 is one having 10 hold columns, represented by the 10 hold magnets 34, 34 of FIG. 1, and 12 select levels, represented by the 12 level select magnets 36, 36 of FIG. 1.

In accordance with this invention, the hold columns of the crossbar switch 32 are divided into two groups, with each student booth or program line 24 having assigned to it one hold column of each group. Therefore, the illustrated switch 32 is capable of servicing five student booths, although only two such booths have been shown in FIG. 1 for convenience. The number of programs or available lines 30, 30 capable of being handled by the crossbar switch 32 is dependent on the number of circuits provided for each cross point. In the case where 10 circuits are provided per cross point, as illustrated in FIG. 3, the switch is capable of handling a maximum of 216 available lines. This compares with a total of 120 available lines capable of being handled by the same switch when used in previous switching systems such as the one shown in prior U.S. Pat. No. 3,199,226.

Still referring to FIG. 1, the language laboratory or teaching machine there illustrated also includes a logic circuit 38 associated with each booth 20 for controlling the program selection process in response to dial pulses transmitted thereto over an associated line 40 from the associated dial 22. All booths serviced by the crossbar switch 32 are also serviced by a single linefinder 40 and by a circuit 42 constituting a counter and drivers for energizing the level select magnets 36, 36 of the crossbar switch. Each logic is connected to the linefinder by a line 44 and the linefinder is in turn connected to the counter and select driver circuit 42 by a line 46. Each logic is also connected to its two associated hold column magnets 34, 34 of the crossbar switch 32 by two lines 48 and 50. Each logic also has connected thereto another line 52 for controlling the energization of an associated switch 54 for selectively connecting the associated program line 24 to one or the other of two output lines 56 and 58 from the crossbar switch 32, each as-

sociated with a respective one of the two hold columns associated with the particular booth in question.

The logic circuit 38, linefinder 40 and the counter and select driver circuit 42 by themselves form no part of this invention and may take various different forms. Their nature and function may best be described by considering the operation of the system shown in FIG. 1. In doing this, assume first that a student in booth No. 1 wishes to be connected to a given program supplied by one of the available lines 30, 30. To do this, he dials a program number, corresponding to the desired program and consisting of a set of subnumbers, on the dial 22 of this booth. The first subnumber dialed should be either a one or a two. In response to the receipt of this number, the associated logic 38 does two things. First, by a signal transmitted to the linefinder 40 over the line 44, it causes the linefinder to assign itself to the No. 1 logic, to the temporary exclusion of all other logics, so that subsequent dial pulses transmitted from the No. 1 logic to the linefinder over the line 44 are transmitted to the counter and select driver circuit through the line 46. Second, the logic 38, in response to the first number dialed also controls state of the associated auxiliary switch 54. That is, if the first number dialed is a one, the associated switch 54 is conditioned to connect the program line 24 to the associated crossbar switch output line 58, as shown. If the first number dialed is a two, then the switch 54 is conditioned to connect the program line 24 to the other associated crossbar switch output line 56. The state of the switch 54 selected by the first number dialed is maintained throughout the remainder of the dialing process and is also thereafter maintained until a new complete program number is dialed.

When the second subnumber is thereafter dialed on the dial 22, the dial pulses generated by the dial are transmitted through the logic 38, through the linefinder 40, which is now tied to the dialing booth, and to the counter and select driver circuit 42 through the line 46. The counter in the circuit 42 counts the number of received pulses and at the end of the pulse train energizes the one level select magnet 36 which corresponds to the number of pulses counted. Since the dial 22 is capable of generating only a maximum of 10 pulses for each dial train, and since the crossbar switch 32 includes 12 level select magnets 36, 36, the counter 42 is so connected to the crossbar switch that no level select magnet is energized upon the count of 10. Instead, the number 10 level select magnet is energized when the counter contains a count of 11, the number 11 level select magnet is energized when the counter contains a count of 12, and the number 12 level select magnet is energized when the counter contains a count of 13. Therefore, the first nine level select magnets are energized by dialing the corresponding digit on the dial 22. The number 10 level select magnet is energized by dialing the subnumber 01 (the digit 0 followed by the digit 1), the number 11 level select magnet is energized by dialing the subnumber 02 and the number 12 level select magnet is energized by dialing the subnumber 03. During the receipt of a train of dial pulses, the counter 42 and its associated drivers are held from energizing any one of the level select magnets 36, and after the dial train is completed the level select magnet corresponding to the count of the counter is energized through its associated driver, none, of course, being energized if the count is 10. After a level select magnet is energized, an off-normal contact associated with it transmits a signal back to the logic 38 through the line 60, and in response to this signal the logic 38 transmits a signal through the line 48 energizing the left-hand one of the two hold magnets 34, 34 associated with booth No. 1. The energization of this hold magnet in turn closes an off-normal contact associated with it and produces a signal transmitted to the counter of the circuit 42, through the line 62, which resets the counter for use with a new train of dial pulses. The previously activated level select magnet 36 is also deenergized, but the hold magnet remains energized to maintain the contacts at the selected cross point closed.

The third subnumber of the program number is now dialed. In response to the dialing of this number, the system of FIG. 1

operates similarly to its operation during the dialing of the second subnumber except that at the end of the sequence of events, and following the energization of the select magnet the logic 38 operates to energize, through the line 50, the right-hand hold magnet 34 assigned to booth No. 1 rather than the left-hand hold magnet. Both the right-hand hold magnet and the left-hand hold magnet thereafter remain energized to maintain closed circuits through the respectively selected cross points until such time as the student in the associated booth again operates his dial to select a new program. Also, at the end of the dialing of the third subnumber, the linefinder 40 and the associated counter and select driver circuit 42 are released for use with another one of the five booths associated with the crossbar switch 32.

As will be evident from the more detailed description which follows concerning the wiring of the crossbar switch 32, the energization of both the hold magnets associated with one booth causes one of the available or program input lines 30, 30 to be connected to the associated crossbar output line 56 and to cause another one of the available or program lines 30, 30 to be connected to the other associated crossbar output line 58. One of these two output lines is then connected to the program line 24 through the associated switch 54 which, as mentioned above, is controlled by the first subnumber dialed on the dial during the program selection process. As shown in FIG. 1, the various available lines 30, 30 are divided into two groups and the action of the crossbar switch is such that when the two hold magnets of the booth are energized, one program of the first group of available lines 30, 30 is connected to the associated output line 56 and one line from the second group of available lines 30, 30 is connected to the associated output line 58.

Turning now to FIG. 2 and to the composite figure formed by joining FIGS. 3a, 3b, and 3c in the manner indicated in FIG. 4, FIG. 2 shows, in slightly greater detail than FIG. 1, the manner in which the available or program input lines 30, 30 are connected to the crossbar switch 32 and the manner in which the various hold columns are assigned to the student booths. More particularly, the crossbar switch may be considered to be divided into two sections with the left-hand section, section No. 1, containing the five left-hand columns and the right-hand section, section No. 2, containing the five left-hand hold columns. A given group of available lines are connected to Section No. 1 and another group of available lines are connected to Section No. 2. Within each group, the available lines are divided into subgroups with each subgroup being connected to a respective one of the 12 select levels. As will be more evident hereinafter, the number of available lines which may be connected to either section at any one of the select levels is one less than the total number of circuits provided at each cross-point. Therefore, if the crossbar switch is of the illustrated type which includes 10 circuits for each cross-point, then a total of nine available lines may be connected to each of the two sections at each select level. Therefore, the illustrated switch is capable of handling nine times 12 or 108 available lines for each section for a total of 216 lines for the entire switch. It should be noted from FIG. 1 that if the hold magnets are numbered 1 to 10 as indicated, hold columns 1 and 6 are assigned to booth No. 1, hold columns 2 and 7 are assigned to booth No. 2, hold columns 3 and 8 are assigned to booth No. 3, hold columns 4 and 9 are assigned to booth No. 4, and hold columns 5 and 10 are assigned to booth No. 5.

The composite figure made up of FIGS. 3a, 3b and 3c shows schematically a portion of the crossbar switch 32 with various ones of the select levels and hold columns being omitted for clarity. In this figure, each hold column, in addition to its hold magnet 34, is shown to comprise a set of 10 vertical conductors 64, 64 with the individual ones of the conductors being individually identified by the suffixes a to j. Each hold column also includes a plurality of horizontal conductors 66, 66 which are grouped into the various select levels with there being 10 horizontal conductors for each select level. In the drawing,

each individual horizontal conductor of each select level is individually identified by the suffixes *a* to *j*. It will, of course, be understood that although the vertical conductors 64, 64 and the horizontal conductors 66, 66 are herein for convenience merely described as "conductors," in the actual crossbar switch they are in the form of physical elements which may take various shapes and orientations. For example, the vertical conductors 64, 64 of each hold column commonly consist essentially of a set of spaced parallel plates or contact strips and the horizontal conductors 66, 66 of each select level commonly consist essentially of parallel-spaced contact-carrying springs or fingers. It should also be understood that the terms "vertical" and "horizontal" as applied to the conductors, herein and in the claims which follow, are used for the purpose of description only and that the crossbar switch need not necessarily be placed in such position that the conductors 64, 64 are actually oriented vertically and the conductors 66, 66 horizontally. The term "cross point" is used to refer to each point at which the vertical conductors 64, 64 of one hold column cross the horizontal conductors 66, 66 of one select level. Therefore, in the illustrated switch each hold column includes a total of 12 cross points, making a total of 120 cross points for the entire switch. At each cross point is a set or pileup of contacts which is operable to connect the vertical conductors of the cross point to the horizontal conductors of the cross-point in a one-to-one relationship. In the composite figure comprised of FIGS. 3a, 3b, and 3c, the connections made by these contacts, when closed, at each cross point are indicated by the lines 68, 68. Therefore, it will be noted that when the contacts of a particular cross point are closed, the horizontal conductor 66a is connected to the vertical conductor 64a, the horizontal conductor 66b is connected to the vertical conductor 64b, the horizontal conductor 66c is connected to the vertical conductor 64c, etc. The closing of the contacts at a particular cross point is accomplished by first energizing the select magnet of the cross point and then energizing the hold magnet of the cross point while the select magnet is energized. After the hold magnet is energized, the select magnet may be deenergized and the contacts will remain closed for so long as the hold magnet is maintained in an energized state.

In further accordance with this invention, the various conductors of the crossbar switch are so connected to one another that when a selection of an available line is made, one of the two hold columns associated with the program line 24 to which the connection is made makes a selection of a group of available lines and the other one of such two hold columns makes a selection of an individual one of the lines from the selected group. In order to achieve this type of operation, the crossbar switch is wired as shown in the composite figure. In this figure, various connecting lines have been omitted for clarity and have been replaced instead by circled terminals designated A-1, A-1, B-1, B-1, etc., with each pair of like-designated terminals representing the two ends of an omitted line. That is, the one terminal A-1 is connected to the other terminal A-1 by an omitted line, the one terminal B-1 is connected to the other terminal B-1 by an omitted line, etc. Also, the various incoming or available lines 30, 30 are represented by their program numbers, that is the numbers that have to be dialed in the system of FIG. 1 to make a connection to the program represented by the number. For example, to the right of the upper portion of the No. 5 hold column, the numbers 111 to 119 represent nine different available lines 30, 30 connected to the top nine horizontal conductors of the No. 1 select level of the No. 5 hold column.

In considering first the left-hand or No. 1 section of the crossbar switch of FIGS. 3a, 3b and 3c, it should first be noted that in each of the 12 select levels of each hold column, the top nine horizontal conductors 66a to 66i are connected in one-to-one relationship to the corresponding lines of the corresponding select levels of the other four hold columns, and also the nine available lines associated with such select level. Therefore, the No. 111 available line is connected to the top

horizontal conductor 66a of all five hold columns of the left-hand section, No. 112 available line is connected to the second horizontal conductor 66b of all five hold columns, etc. It should be further noted, however, that the bottom horizontal conductor 66j of each cross point is unconnected to all other horizontal conductors.

The vertical conductors of each hold column of the left-hand or No. 1 section of the crossbar switch are connected to horizontal conductors of the associated hold column of the right-hand or No. 2 section in such a manner that each of said vertical conductors is assigned to a respective one of the select levels of the associated hold column and within such select level is connected with that one horizontal conductor which is associated through the cross point contacts to a particular one of the vertical conductors. More particularly, in the illustrated case, the vertical conductors 64a through 64i of hold column No. 1 are connected to horizontal conductors of hold column No. 6. The connection is such that the first vertical conductor 64a of hold column No. 1 is connected with the bottom horizontal conductor 66j of the first select level of hold column No. 6, the second vertical conductor 64b is connected to the bottom horizontal conductor 66j of select level No. 2 of hold column No. 6, etc. Only the first nine of the vertical conductors of hold column No. 1 are connected to hold column No. 6 and, therefore, connections are made only to the first nine select levels of hold column No. 6, the bottom three select levels of hold column No. 6 having no connections to the vertical conductors of hold column No. 1. Since all of the vertical conductors which are connected to hold column No. 6 are connected to those horizontal conductors 66j, 66j of hold column No. 6 which are associated through the contacts of hold column No. 6 to the vertical conductor 64j of hold column No. 6, it will, therefore, be seen that when the contacts of one cross-point of hold column No. 1 are closed, a group of available lines are connected to hold column No. 6 in such a manner that when the contacts of one cross-point of hold column No. 6 are thereafter closed, one of the lines of the selected group is connected to the vertical conductor 64j of hold column No. 6, which in turn is connected to the associated output line 58.

In order to better understand the manner in which a selected connection is made assume that in hold column No. 1 the contacts of the cross-point associated with select magnet No. 1 are closed and in hold column No. 2 the contacts of the cross-point associated with select magnet No. 2 are closed. The closing of the contacts at the Hold No. 1—Select No. 1 cross point connects programs 111 to 119 to the vertical conductors 64a to 64i of hold column No. 1. These nine programs are accordingly connected in one-to-one relationship to the bottom horizontal conductors 66j, 66j of the top nine select levels of hold column No. 6 and through one of the closed contacts of the Hold No. 6—Select No. 2 cross point the available line No. 112 is connected to the vertical conductor 64j and to the output line 58. The output line 58 leads to the switch 54, and since the switch 54 is in the state indicated in the drawing, which corresponds to the first divided subnumber of the program number being a one, the selected line 112 is connected to the program line 24.

In cases where the switching system need handle only a limited number of available or program input lines, the wiring of the crossbar switch 64 may consist of no more than that described above with all incoming available lines being connected to one section of the crossbar switch which section includes hold columns for making selections of groups of lines, the other section of the crossbar switch being used in association with such first section for selecting an individual line from the group selected by the first section. In this case, the connection to the selected line will always be made through the section of the switch and the two position selector switches 54, 54 may be eliminated.

Preferably, however, and as illustrated in the drawings, the crossbar switch is symmetrically wired as between its two sections so that each section may be used to make both a group

selection and an individual selection. To accomplish this, the previously unmentioned conductors of the hold columns, Nos. 6 to 10, of the second section are connected to the previously unmentioned conductors of the hold columns, Nos. 1 to 5, of the first section in the same but reverse manner as described above for the connections between the previously mentioned conductors of the two sections. That is, for example, the first nine vertical conductors 64a through 64i of hold column No. 6 are connected in one-to-one relationship with the bottom horizontal conductors 66j, 66j of the first nine select levels of hold column No. 1. Also, as indicated in the composite figure, the top nine horizontal conductors of each select level of each hold column of the second section are connected in common to the corresponding conductors of the corresponding select levels of the other four hold columns and to nine associated available lines.

From the foregoing it will, therefore, be seen that for booth No. 1, for example, when a cross point of hold column No. 1 is closed and a cross-point of hold column No. 6 is closed, two individual program lines are selected with the connection to one of such lines being made through the horizontal conductor 64j of hold column No. 1 and associated output line 56 and with the other connection being made through the horizontal vertical conductor 64j of hold column No. 6 and the associated output line 58. The final selection between these two output lines 56 and 58 is then made through the associated two-position selector switch 54.

As mentioned, the individual available lines shown in the composite figure have been assigned the numbers which are dialed on a dial 22 to obtain a connection to such line. In connection with an understanding of these program numbers, it should be mentioned that in the illustrated case, the system function is such that during the course of every program selection, the left-hand hold magnet assigned to the dialing booth is operated first and the right-hand hold magnet assigned to such booth is operated second. The available lines connected to the left-hand section of the crossbar, therefore, follow a generally regular numerical sequence; whereas the numbers of the lines connected to the right-hand section of the switch do not have as regular a numerical sequence.

We claim:

1. In a switching system for selectively connecting one given line to any one of a plurality of available lines, the combination comprising: a crossbar switch having a plurality of hold columns each including a plurality of vertical conductors and also for each hold column having a plurality of select levels each including a plurality of horizontal conductors, each of said select levels associated with each hold column crossing such hold column at a cross-point which includes a set of contacts for selectively connecting and disconnecting each horizontal conductor of said select level to and from a respective one of the vertical conductors of said hold column, said plurality of hold columns including a first hold column and a second hold column, means connecting different groups of said available lines to horizontal conductors of said select levels of said first hold column so that upon the closing of the contacts at one cross-point of said first hold column a group of available lines and connected to certain vertical conductors of said first hold column, means connecting each of said certain vertical conductors of said first hold column to a different one of said horizontal conductors of a different one of said select levels of said second hold column so that when the contacts of one of the cross-points of said second hold column are closed one available line from the group of available lines selected by said first hold column is connected to a particular one of the vertical conductors of said second hold column, means for connecting said given line to said particular one of the vertical conductors of said second hold column, means connecting other groups of said available lines to horizontal conductors of the select levels of said second hold column so that when the contacts of one cross point of said second hold column are closed a group of available lines is selected by said second hold column and connected to certain vertical conductors of

said second hold column, means connecting each of said certain vertical conductors of said second hold column to a different one of said horizontal conductors of said select levels of said first hold column so that when the contacts of one cross-point of said first hold column are closed one available line from the group of available lines selected by said second hold column is connected to a particular one of the vertical conductors of said first hold column, and means for connecting said given line to said particular one of the vertical conductors of said first hold column.

2. In a switching system for selectively connecting one given line to any one of a plurality of available lines, the combination defined in claim 1 further characterized by said means for connecting said given line to said particular one of the vertical conductors of said first hold column and said means for connecting said given line to said particular one of the vertical conductors of said second hold column comprising a switch for selectively connecting said given line to either one of said two particular vertical conductors.

3. In a switching system for selectively connecting any one of a number of given lines to any one of a plurality of available lines, the combination comprising: a crossbar switch having a plurality of hold columns divided into two sections, each of said hold columns having a plurality of select levels, each of said select levels associated with each hold column crossing such hold columns at a cross point which includes a set of contacts, and each of the hold columns also having one output line, means connecting different groups of said available lines to different ones of the select levels of the hold columns of the first of said sections so that when the contacts of one cross point of any one of the hold columns of said first section are closed a group of said available lines are selected from said plurality of available lines, means connecting certain ones of said cross points of one of said select levels of each of the hold columns of said first section to different levels in a respectively associated one of the hold columns of said second section in such a manner that when the contacts of one of the cross points of such section section hold column are closed one available line from the group of available lines selected by the associated hold column of the first section is connected to the output line of said second section hold column, means for connecting said latter output line to one of said given lines, means connecting other different groups of said available lines to different ones of the select levels of the hold columns of said second section so that when the contacts of one of the cross points of hold column of said second section are closed a group of available lines is selected, means connecting the select levels of each hold column of said second section to a predetermined select level of a respectively associated one of the hold columns of said first section in such a manner that when the contacts of one of the cross points of such first section hold column are closed one of the available lines selected by the hold column of said second section are connected to said output line of said first section hold column, and means for connecting said latter output line to said one of said given lines.

4. In a switching system for selectively connecting one given line to any one a plurality of available lines, the combination comprising: a crossbar switch having a plurality of vertical conductors grouped into a plurality of hold columns and also for each hold column having a plurality of horizontal conductors grouped into a plurality of select levels, each of said select levels associated with each hold column crossing such hold column at a cross point which includes a set of contacts for selectively connecting and disconnecting each horizontal conductor of said select level to and from a respective one of the vertical conductors of said hold column, said plurality of hold columns including a first hold column and a second hold column both assigned to said one given line, means connecting at least some of the vertical conductors associated with said first hold column in one-to-one relationship to at least some of those horizontal conductors of said second hold column associated through the sets of contacts at the various cross

points of said second hold column with a particular one of the vertical conductors of said second hold column, means for connecting said given line to said particular one of the vertical conductors of said second column, and means connecting at least some of said available lines in one-to-one relationship to at least some of said horizontal conductors of said first hold column.

5. In a switching system for selectively connecting one given line to any one of a plurality of available lines, the combination defined in claim 4 further characterized by those horizontal conductors of said first hold column to which at least some of said available lines are connected not including those horizontal conductors of said first hold column which are associated through the sets of contacts at the various cross points of said first column with a particular one of the vertical conductors of said first column, means for connecting other of said available lines in one-to-one relationship to at least some of said horizontal conductors of said second hold column other than those to which said vertical conductor of said first column are connected, and said means for connecting said given line to said particular one of the vertical conductors of said second column including a switch for selectively connecting said given line to either said particular one of the vertical conductors of said second column or to said particular one of the vertical conductors of said first column.

6. In a switching system for selectively connecting any one of a number of given lines to any one of a larger number of available lines, the combination comprising: a crossbar switch having a plurality of vertical conductors grouped into a plurality of hold columns which hold columns are in turn divided into first and second sections with each of said given lines having exclusively assigned to it one hold column from each of said sections, said crossbar switch also including for each hold column a plurality of horizontal conductors grouped into a plurality of select levels crossing such hold column at a cross-

point which includes a set of contacts for selectively connecting and disconnecting each horizontal conductor of said select level to and from a respective one of the vertical conductors of said hold column, each of said select levels of each hold column including a plurality of horizontal conductors which are electrically connected to the corresponding horizontal conductors of the corresponding select levels of the other hold columns of the same section and also including one horizontal conductor which is normally electrically unconnected to any other horizontal conductor, such normally unconnected horizontal conductors of the select levels of each hold column all being associated with one particular vertical conductor of said hold column through said sets of contacts at the various cross-points of said hold column, means connecting one group of said available lines in one-to-one relationship to the electrically connected horizontal conductors of said first section of hold columns, means connecting another group of said available lines in one-to-one relationship to the electrically connected horizontal conductors of said second section of hold columns, means connecting all but said particular one of the vertical conductors of each hold column of said first section in one-to-one relationship with the electrically unconnected horizontal conductors of the hold column of said second section assigned to the same one of said given lines, means connecting all but said particular one of the vertical conductors of each hold column of said second section in one-to-one relationship with the electrically unconnected horizontal conductor of the hold column of said first section of hold columns assigned to the same one of said given lines, and a switch for selectively connecting each of said given lines to either said one particular vertical conductor of the hold column assigned to it from said first section or to said one particular vertical conductor of the hold column assigned to it from said second section.

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