Dec. 6, 1966 TORU OHNO 3,290,447

MEANS FOR SPLITTING CROSSPOINTS OF A CROSSBAR SWITCH

Filed April 23, 1963 7 Sheets-Sheet 1

Fig. 1

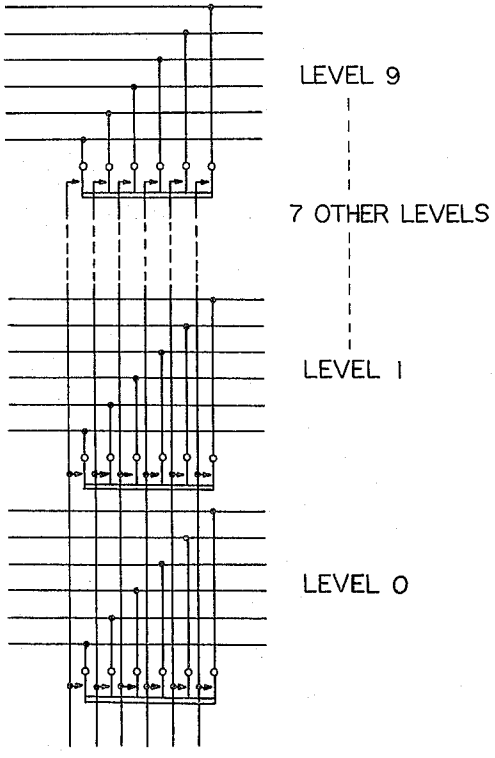
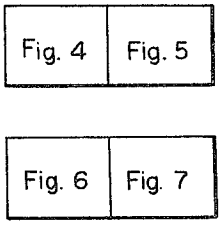


Fig. 8



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MEANS FOR SPLITTING CROSSPOINTS OF A CROSSBAR SWITCH

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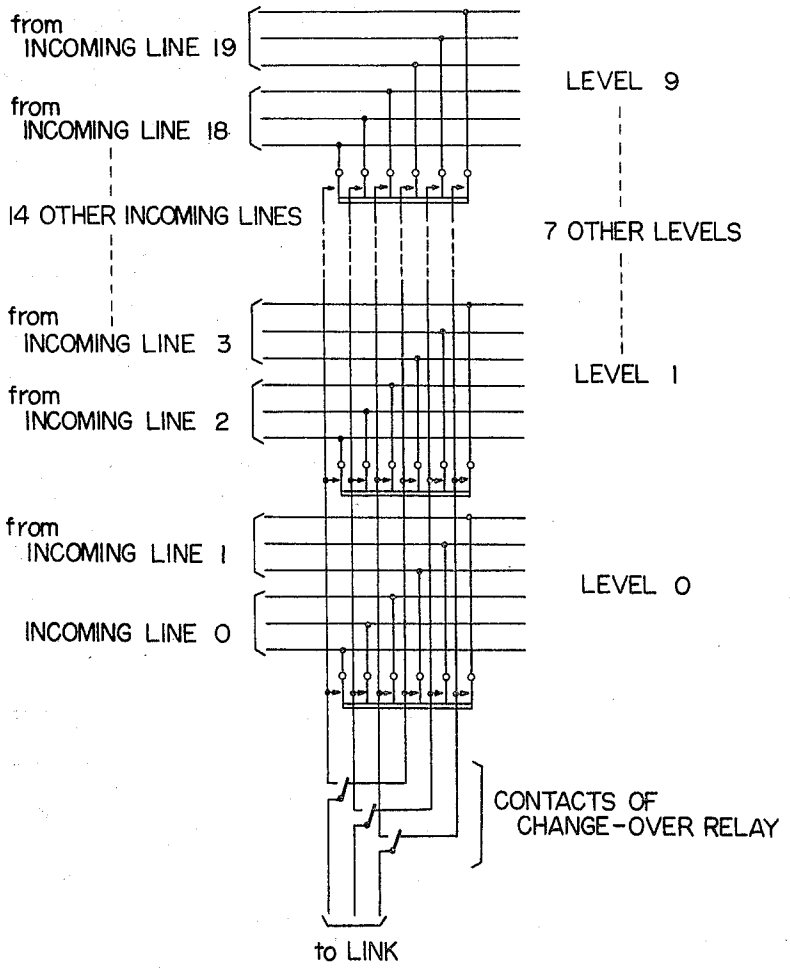
Fig. 2



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MEANS FOR SPLITTING CROSSPOINTS OF A CROSSBAR SWITCH

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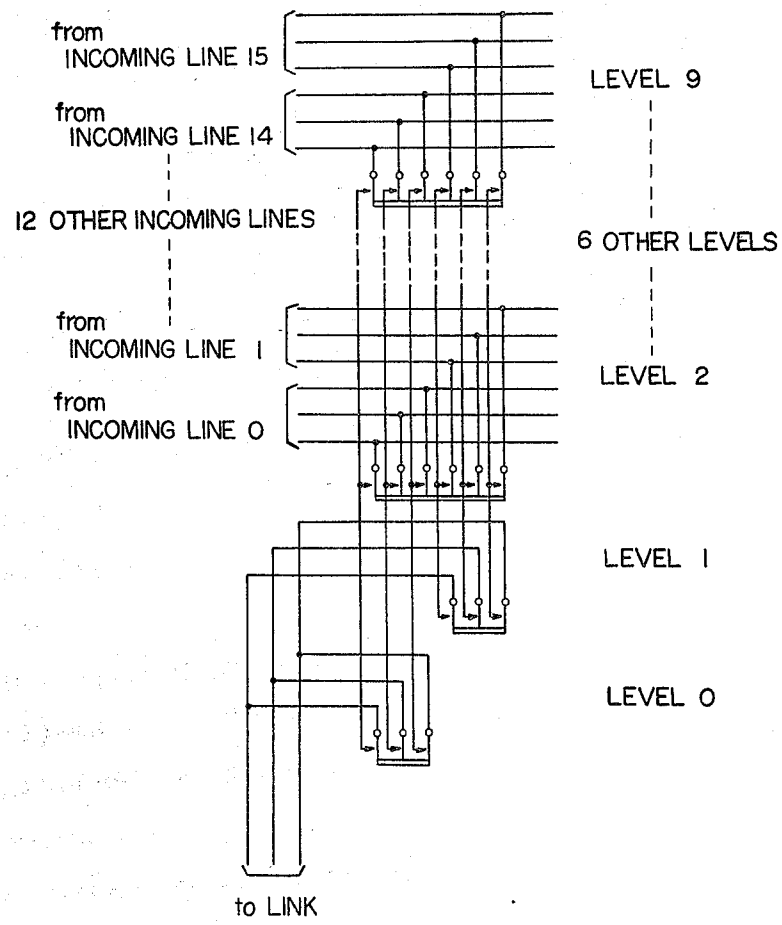
Fig. 3



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MEANS FOR SPLITTING CROSSPOINTS OF A CROSSBAR SWITCH

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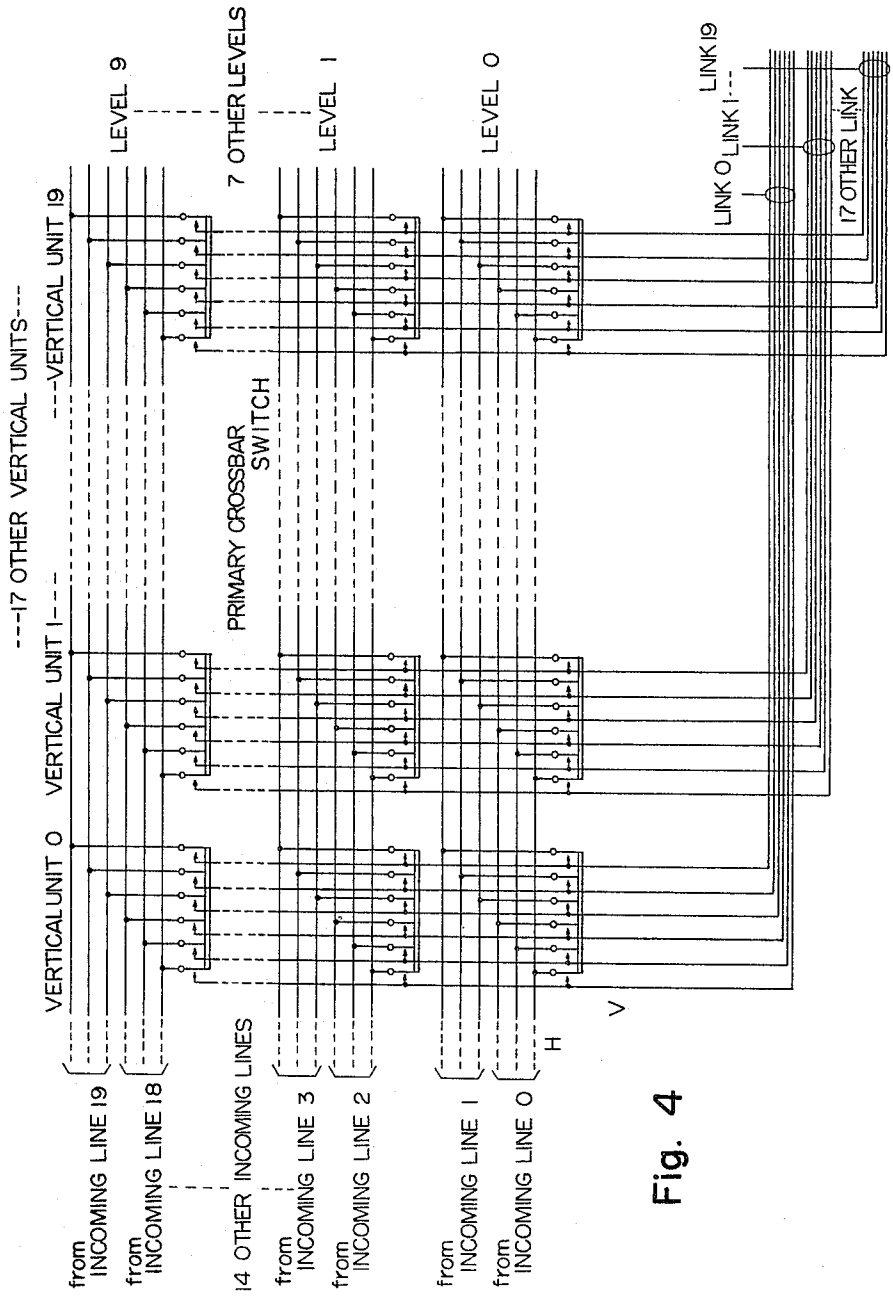

Fig. 4

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MEANS FOR SPLITTING CROSSPOINTS OF A CROSSBAR SWITCH

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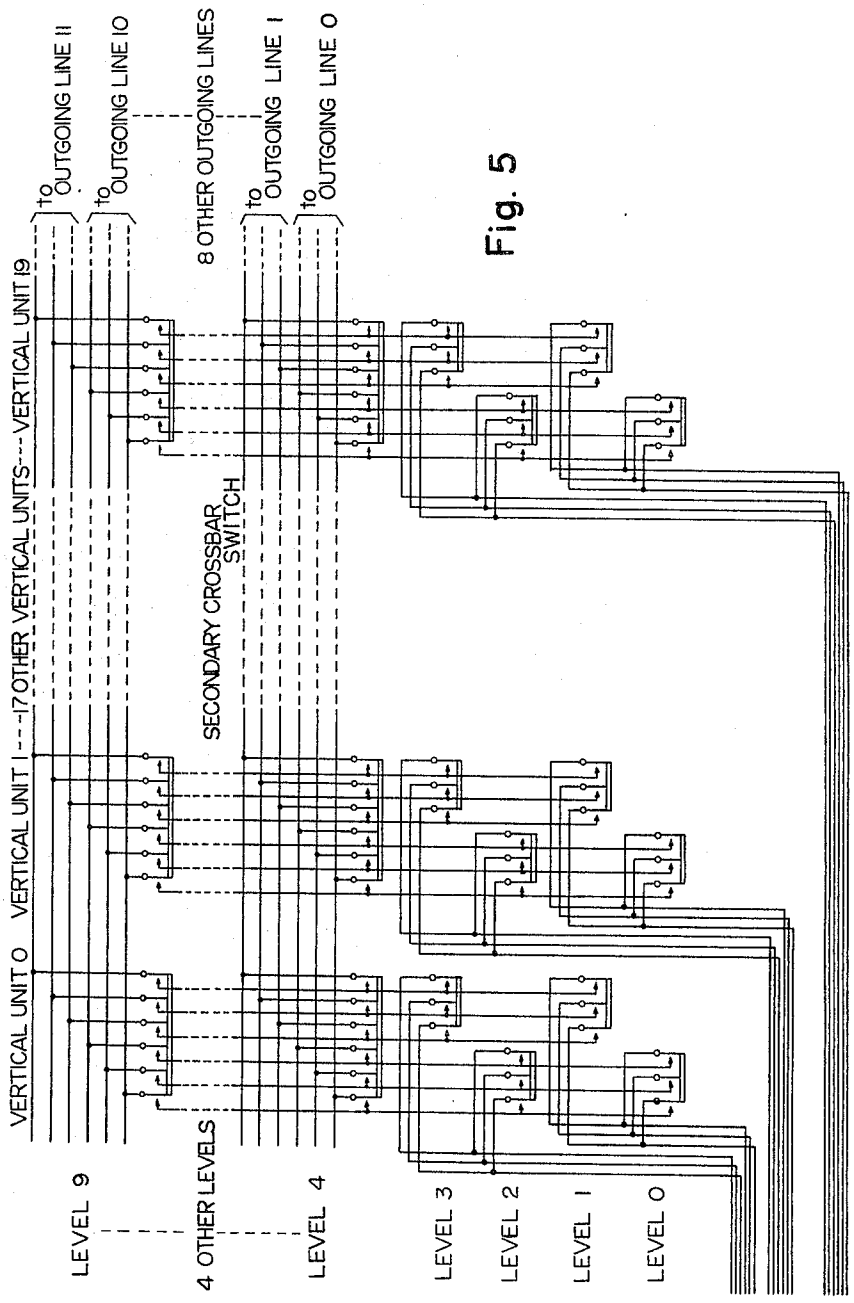

Fig. 5

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MEANS FOR SPLITTING CROSSPOINTS OF A CROSSBAR SWITCH

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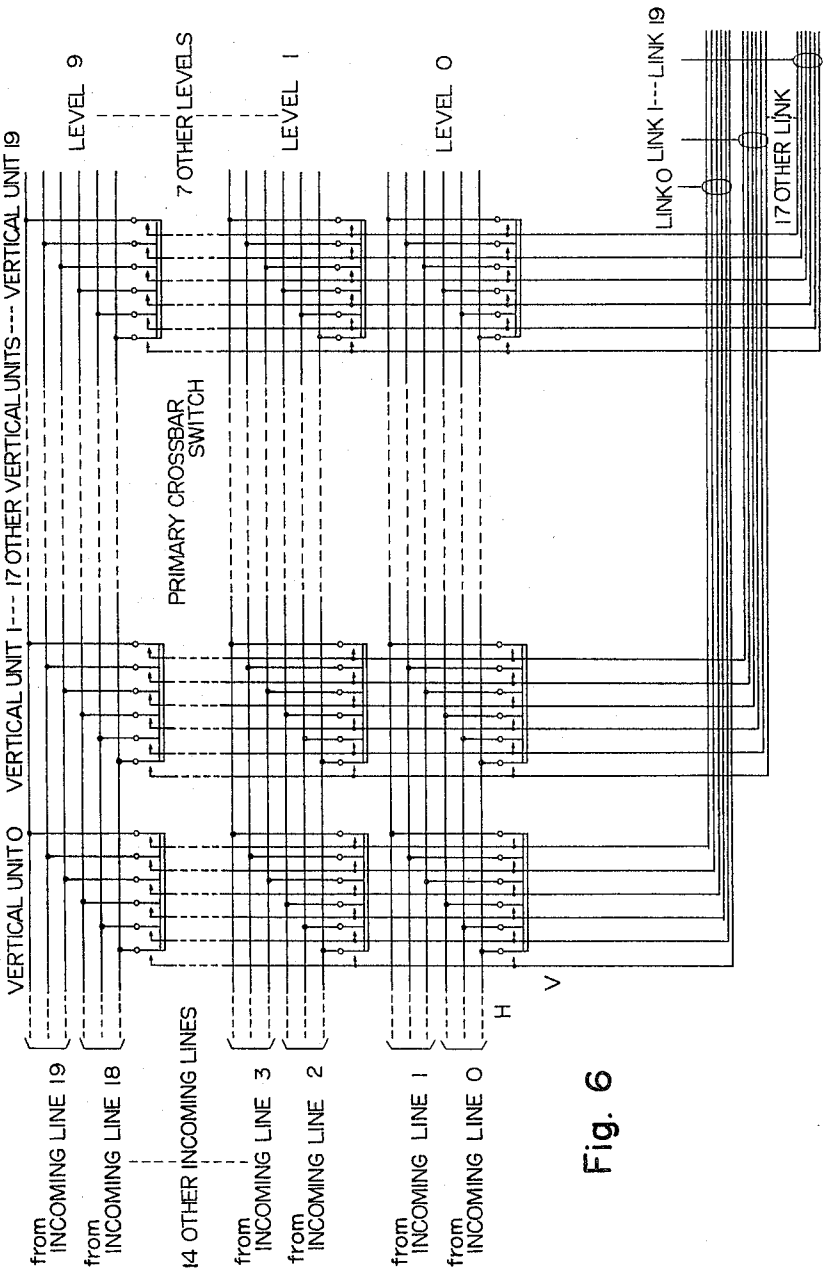

Fig. 6

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MEANS FOR SPLITTING CROSSPOINTS OF A CROSSBAR SWITCH

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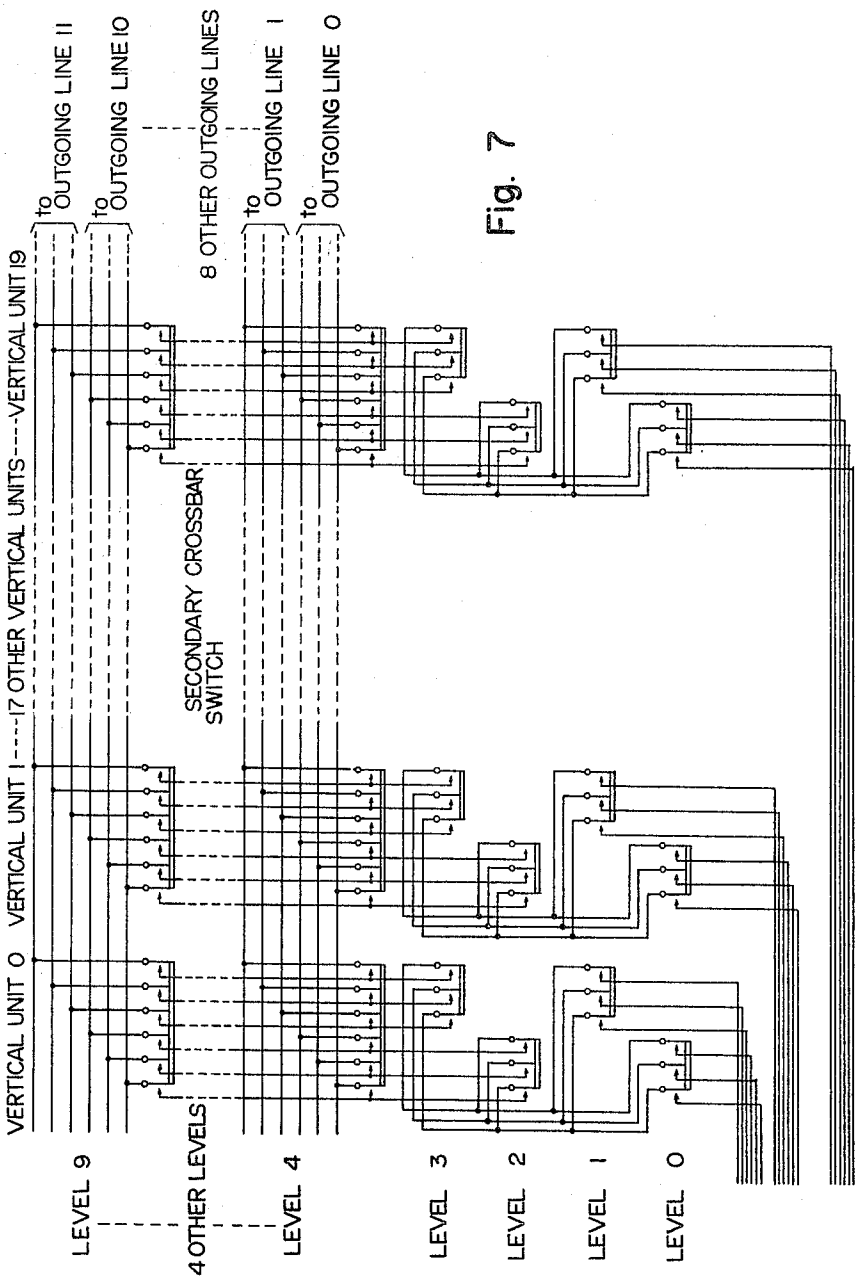

Fig. 7

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MEANS FOR SPLITTING CROSSPOINTS OF A CROSSBAR SWITCH

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Claims priority, application Japan, May 25, 1962, 37/20,916
6 Claims. (Cl. 179—25)

The present invention relates generally to automatic switching systems and particularly to such systems of the so-called crossbar type. As will be apparent from the following description, etc. the invention is readily adaptable not only to the telephone switching system, but also to any other switching system of the same general character.

In the crossbar switching system, many crossbar switches are combined together to form talking paths and to carry calls through the switching system. Therefore, the method of combining crossbar switches has a great effect on overall economy of the switching system.

The present invention is designed to provide a new and useful means for combining crossbar switches in crossbar switching systems more economically than heretofore. Most crossbar switches now in common use are three-wire or six-wire crossbar switches having three or six "make" contacts at each crosspoint. For two-wire exchanges such as local and short distance toll exchanges, which usually necessitate only three-wires for each talking path, three-wire crossbar switches may be used intact, but six-wire crossbar switches cannot be used unless the six make contacts at each crosspoint are split into two groups each of three make contacts.

Despite this, the six-wire crossbar switches are also widely used because their cost of manufacture per contact is generally lower than that of the three-wire type.

The main object of the present invention is to provide an entirely novel means for splitting crosspoints of a crossbar switch, by connecting another crossbar switch to the first-mentioned crossbar switch and arranging some of the horizontal paths of the second-mentioned crossbar switch so as to split the remaining horizontal paths of the second-mentioned crossbar switch and the horizontal paths of the first-mentioned crossbar switch.

In two-wire exchanges, six-wire crossbar switches have previously been employed with the six wires in each horizontal path split into two groups each of three wires. The splitting between the two groups of the three-wire paths has generally been effected by the following two methods. In one method a changeover relay is used for each vertical unit of the six-wire crossbar switch, and in the other method some of the horizontal paths are made use of for performing the splitting.

In either method, the number of horizontal paths is in effect increased but some difficulties have remained particularly in some applications. Namely, in the first method, not only changeover relays and a controlling circuit for operating them are required but also the holding power for these relays during each conversation is required. In the second method, some inconvenience occurs in accommodating necessary input or output lines in case ten-level crossbar switches are used, since the total number of effective horizontal paths is not an integer multiplied by ten.

The present invention is designed to obviate the above difficulties. The means for splitting crosspoints of a crossbar switching system according to the present invention can be applied to the so-called multi-stage crossbar switch link arrangement which has other preceding or succeeding crossbar switches connected to the crossbar switch to be split.

The main feature of the present invention is that, in case the preceding or succeeding crossbar switch connected to the crossbar switch to be split has surplus horizontal paths, the crossbar switch to be split can accommodate two lines in each of its horizontal paths by using the said surplus horizontal paths of the preceding or succeeding crossbar switch for splitting the crossbar switch to be split.

Another feature of the present invention is that a simplified control circuit can be employed because the number of lines to be accommodated in the horizontal paths of the crossbar switch will be some multiple of ten as long as the switch is of the ten-level type.

A further feature of the present invention is to provide a method for splitting crosspoints of crossbar switches which does not necessitate any changeover relays and hence any control circuit therefor and thus is operable with reduced power consumption.

Yet another feature of the present invention is to use a crossbar switch which can split not only its own horizontal paths but also those of any preceding or succeeding crossbar switch by using four surplus horizontal paths of the first crossbar switch for the splitting purpose.

A still further feature of the present invention is to use a crossbar switch which can split not only its own horizontal paths but also those of any preceding or succeeding crossbar switch by using four surplus horizontal paths of the first crossbar switch for the splitting purpose, and by dividing its vertical multiple into two parts.

The above and other objects and features of the invention may be more readily understood from an examination of the following detailed description and attached drawings, in which:

FIG. 1 is a typical circuit diagram of a vertical unit of a six-wire crossbar switch;

FIGS. 2 and 3 are circuit diagrams illustrating the conventional method of splitting crosspoints of a vertical unit of a six-wire crossbar switch;

FIGS. 4 and 5 are circuit diagrams illustrating an embodiment of the method of splitting crosspoints of a crossbar switch according to the present invention;

FIGS. 6 and 7 are also circuit diagrams illustrating another embodiment of the present invention; and

FIG. 8 discloses the manner in which FIGS. 4 and 5 and FIGS. 6 and 7 are arranged relative to each other.

Referring first to FIG. 1, the six-wire crossbar switch illustrated has ten horizontal paths (or levels) and the fixed contacts springs in each crosspoint are connected in multiplicate in the same vertical. As is understood, the crossbar switch includes a plurality of vertical units (only one of which is shown).

The vertical units may alternatively be wired in horizontal multiple connection if so desired. In use of such six-wire crossbar switch where only three wires are required to form a talking path, the switch may desirably be used on a three-wire basis to increase the number of horizontal paths available.

The splitting method shown in FIG. 2 includes a six-wire crossbar switch and changeover relays there being one set of relays for each vertical unit thereof. Each of the horizontal paths (or levels) includes two groups of three wires either of which is selectively utilized depending upon whether the associated changeover relay is thrown to the right or left as shown in FIGURE 2. In this case, it will be recognized that the number of available horizontal paths is in effect doubled forming a crossbar switch having twenty horizontal paths.

In FIG. 3, two horizontal paths of a six-wire crossbar switch are made use of for the splitting purpose. A talking path is formed by closing crosspoints of one of splitting horizontal levels and crosspoints of one of remaining horizontal levels. In this case, it will be recog-

nized that the crossbar switch has an increased number, 16, of horizontal paths and in effect operable as a sixteen-level switch.

For a detailed explanation of the mechanical structure and control of crossbar switches, reference may be made to "The Design of Switching Circuits" by Keister et al., 1951, page 194.

As is well known, crossbar switching systems include plural vertical units. Usually, a vertical unit is provided with ten sets of contacts, each set consisting of three or six pairs of "make" type contact springs. The interconnections of these springs are indicated, for example, in FIG. 4. For descriptive reasons, one contact spring of each pair will be referred to hereinafter as V spring, and the other H spring, and in every vertical unit there are three or six V and H springs at each crosspoint. The V springs are usually formed from a single metal strip, and the H springs are extended in soldering strips at the rear of the switch. After the plural vertical units, usually ten or twenty, have been assembled in a frame, the corresponding H terminals of all the vertical units are connected together by horizontal wires.

In FIG. 4, the primary crossbar switch has 20 vertical units, and each vertical unit has six V springs and six H springs in each crosspoint. Two incoming lines are connected to the horizontal multiple that connects the H springs together, two lines for each level, so that the switch provides for connection to twenty incoming lines altogether. The links are connected to the six V strips of each of the twenty vertical units. There are thus two incoming lines associated with each crosspoint, and when a selecting and a holding bar are operated, one incoming line will be connected to the three left V strips, and the other to the three right V strips of the vertical unit. To select the particular incoming line wanted of the two that have been connected to the V strips, the crosspoints of the secondary crossbar switch in FIG. 5 are used.

In FIG. 5, the secondary crossbar switch has also twenty vertical units, but they differ from those which are used in the primary crossbar switch shown in FIG. 4. The vertical units of the secondary crossbar switch have also six V strips. However, six sets of H springs are provided only for the upper six levels, and the lower four levels have only three sets of H springs the three for levels 1 and 3 being associated with the three V strips on the right, and the three for levels 0 and 2 being associated with the three V strips on the left. With this arrangement, each of the upper six levels will accommodate two outgoing lines, so that the switch provides for connection to twelve outgoing lines altogether. There are thus two outgoing lines associated with each crosspoint, and when a selecting and a holding bar are operated, one outgoing line will be connected to the three left V strips, and the other to the three right V strips of the vertical unit. To connect a particular outgoing line wanted of the two, which have been connected to the V strips, with the particular incoming line, the four lower sets of crosspoints are used. The links, instead of being connected to the V terminals, are connected to the H terminals of the four lower levels, as shown in FIG. 5. Since there is no horizontal multipling between the vertical units on these four levels, each of the twenty vertical units represents a different link.

One example of connection between a particular incoming line and a particular outgoing line will be explained hereinafter. The operation of the selecting bar of the primary crossbar switch, say that for level 9, places selecting fingers across the back of all of the contact sets in level 9, and when the holding bar is subsequently operated, say that of the vertical unit 0, the contacts at the crosspoint of the level 9 of the vertical unit 0 are closed. As evident in FIGURE 4, this would connect incoming lines 18 and 19 to link 0. With the selecting bar of the secondary crossbar switch for level 9 operated, for example, outgoing lines 10 and 11 will both be connected to V strips when the holding bar of the vertical unit 0 of the secondary crossbar switch is operated. If the selecting bar for level 0 of the secondary crossbar switch has also been operated, however, the operation of the holding bar will connect outgoing line 10 to link 0, and consequently outgoing line 10 to incoming line 18. While if selecting bar for level 1 of the secondary crossbar switch had been operated instead of level 0, outgoing line 11 would have been connected to incoming line 18. Similarly, selecting bar for level 2 had been operated, outgoing line 10 would have been connected to incoming line 19. And if selecting bar for level 3 had been operated, outgoing line 11 would have been connected to incoming line 19. In this way the four lower crosspoints of the secondary crossbar switch permit a choice to be made of the four possible combinations between the two incoming lines associated with any level of the primary crossbar switch and the two outgoing lines associated with any level of the secondary crossbar switch.

In this embodiment, it will be observed that the level 0 crosspoints of the secondary crossbar switch are used for connection between the even-numbered incoming lines and the even-numbered outgoing lines. The level 1 crosspoint of the secondary crossbar switch are used for connection between the even-numbered incoming lines and the odd-numbered outgoing lines. The level 2 crosspoints of the secondary crossbar switch are used for connection between the odd-numbered incoming lines and the even-numbered outgoing lines. And the level 3 crosspoints of the secondary crossbar switch are used for connection between the odd-numbered incoming lines and the odd-numbered outgoing lines.

Another embodiment of the present invention will next be explained with reference to FIGS. 6 and 7. In this embodiment, the primary crossbar switch, shown in FIG. 6, is quite similar to the primary crossbar switch of the former embodiment shown in FIG. 4, but the secondary crossbar switch differs from the former secondary crossbar switch primarily with respect to the vertical units. In this new vertical unit as shown in FIG. 7, the six V strips are divided into two parts at the point between level 1 and level 2. Six sets of H springs are provided only for the upper six levels, and the lower four levels have only three sets of H springs the three for level 1 and level 3 being associated with the three V strips on the right, and the three for level 0 and level 2 being associated with the three V strips on the left. In the lower four levels, corresponding H terminals of the same vertical unit are connected together by three lead wires, as shown in FIG. 7. Moreover, the links between the primary crossbar switch vertical units and the secondary crossbar switch vertical units are connected to the lower six V strips of the secondary crossbar switch vertical units. With this arrangement, each of the upper six levels will accommodate two outgoing lines so that the switch provides for connection to twelve outgoing lines altogether. There are thus two outgoing lines associated with each crosspoint of the upper six levels, and when a selecting and a holding bar are operated, one outgoing line will be connected to the three left V strips, and the other to the three right V strips of the vertical unit. To connect a particular outgoing line wanted of the two, which have been connected to the V strips, with a particular incoming line, the four lower sets of crosspoints are used.

One example of the connection between a particular incoming line and a particular outgoing line will be explained hereinafter. The operation of the selecting bar of the primary crossbar switch, say that for level 9, places the selecting fingers across the back of all of the contact sets in level 9, and when the holding bar is subsequently operated, say that of the vertical unit 0, the contacts at the crosspoint of the level 9 of the vertical unit 0 are closed. As evident in FIG. 6, this would connect incoming lines 18 and 19 to link 0. With the selecting

bar of the secondary crossbar switch for level 9 operated, for example, outgoing lines 10 and 11 will both be connected to the upper V strips of the vertical unit 0 when the holding bar of the secondary crossbar switch vertical unit 0 is operated. If the selecting bars for levels 0 and 2 of the secondary crossbar switch have also been operated, however, the operation of the hodling bar will connect the outgoing line 10 to the incoming line 18 via link 0. While of the selecting bars for levels 1 and 3 of the secondary crossbar switch had been oeprated instead of level 0 and level 2, outgoing line 11 would have been connected to incoming line 19 via link 0. In this way the four lower crosspoints of the secondary crossbar switch permit a choice to be made of the four possible combinations between the two incoming lines associated with any level of the primary crossbar switch and the two outgoing lines associated with any level of the secondary crossbar switch.

The level 0 crosspoints are used for even-numbered incoming lines, the level 1 crosspoints are used for odd-numbered incoming lines, the level 2 crosspoints are used for even-numbered outgoing lines, and the level 3 crosspoints are used for odd-numbered outgoing lines.

It is to be understood that the above-described embodiments are merely illustrative of the application of the principles of the invention. Various other modifications may be made by those skilled in the art without departing from the spirit and scope of the invention.

What is claimed is:

1. In a crossbar switching system comprised by first and second sets of crossbar switches with the second set of crossbar switches providing a crosspoint splitting function and wherein the total number of vertical switching units in the second set of crossbar switches is equal to the total number of vertical switching units in the first set of crossbar switches, the improvement comprising means of connecting four horizontal level switching units in each vertical unit of said second set of crossbar switches for splitting of crosspoints, means for connecting the remaining horizontal level switching units in the second set of crossbar switches for ordinary crossbar switching connection, means for connecting each one of the vertical units of said first set of crossbar switches to a corresponding vertical unit of the second set of crossbar switches, and means for splitting crosspoints of each crossbar switching unit of said first set of crossbar switches as well as crosspoints of each crossbar switching unit of the remaining horizontal level switching units in the second set of crossbar switches by selective operation of one of the four horizontal level switching units.

2. The combination set forth in claim 1, wherein the crossbar switching units are six wire units and wherein three wires of each vertical unit of the first set of crossbar switches are connected to the first and second horizontal level switching units in the corresponding vertical unit of the second set of crossbar switches for splitting of crosspoints, and the remaining complementary three wires of each vertical unit in the first set of crossbar switches are connected to the third and fourth horizontal level switching units in the same vertical unit of the second set of crossbar switches for splitting of crosspoints.

3. The combination set forth in claim 1, wherein the crossbar switching units are six wire units and wherein three wires of each vertical unit of the first set of crossbar switches are connected to the first horizontal level switching unit in the corresponding vertical unit of the second set of crossbar switches for splitting of crosspoints, and the remaining complementary three wires of each such vertical unit in the first set of crossbar switches are connected to the second horizontal level switching unit in the same vertical unit of the second set of crossbar switches for splitting of crosspoints, the third and fourth horizontal level switching units in said vertical unit of the second set of crossbar switches being connected respectively through said first and second horizontal level switching units to all six wires of the said vertical unit of the first set of crossbar switches for splitting of crosspoints.

4. The combination set forth in claim 1, wherein the first set of crossbar switches comprises six wire-ten horizontal switching levels by twenty vertical switching units and the second set of crossbar switches comprises six horizontal levels of six wire-twenty vertical switching units and four crosspoint splitting horizontal levels of three wire-twenty vertical switching units with the three wire units of the four crosspoint splitting horizontal levels being alternately staggered between right and left hand groups of three wire conductors.

5. The combination set forth in claim 4, wherein three wires of each vertical unit of the first set of crossbar switches are connected to the first and second horizontal level switching units in the corresponding vertical unit of the second set of crossbar switches for splitting of crosspoints, and the remaining complementary three wires of each such vertical unit in the first set of crossbar switches are connected to the third and fourth horizontal level switching units in the same vertical unit of the second set of crossbar switches for splitting of crosspoints.

6. The combination set forth in claim 4, wherein three wires of each vertical unit of the first set of crossbar switches are connected to the first horizontal level switching unit in the corresponding vertical unit of the second set of crossbar switches for splitting of crosspoints, and the remaining complementary three wires of each such vertical unit in the first set of crossbar switches are connected to the second horizontal level switching unit in the same vertical unit of the second set of crossbar switches for splitting of crosspoints, the third and fourth horizontal level switching units in said vertical unit of the second set of crossbar switches being connected respectively through said first and second horizontal level switching units to all six wires of the said vertical unit of the first set of crossbar switches for splitting of crosspoints.

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