SWITCHING GRID MATRIX WITH CROSSPOINT ELEMENTS, CONTROLLED BY MARKING PULSES BEING VERY SHORT COMPARED TO THEIR RESPONDING PERIOD

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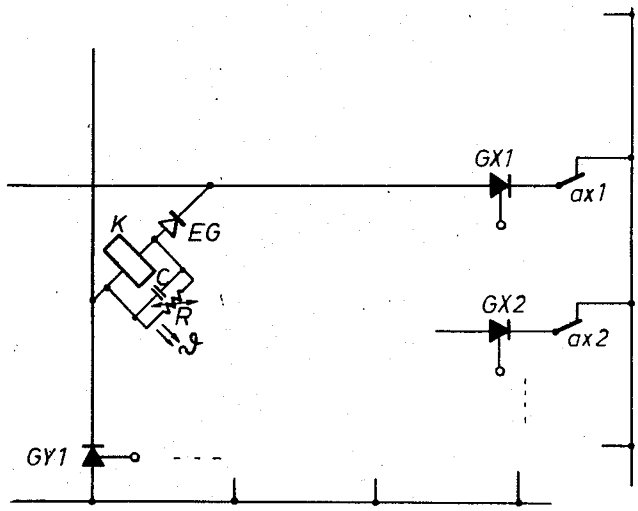

Fig.1

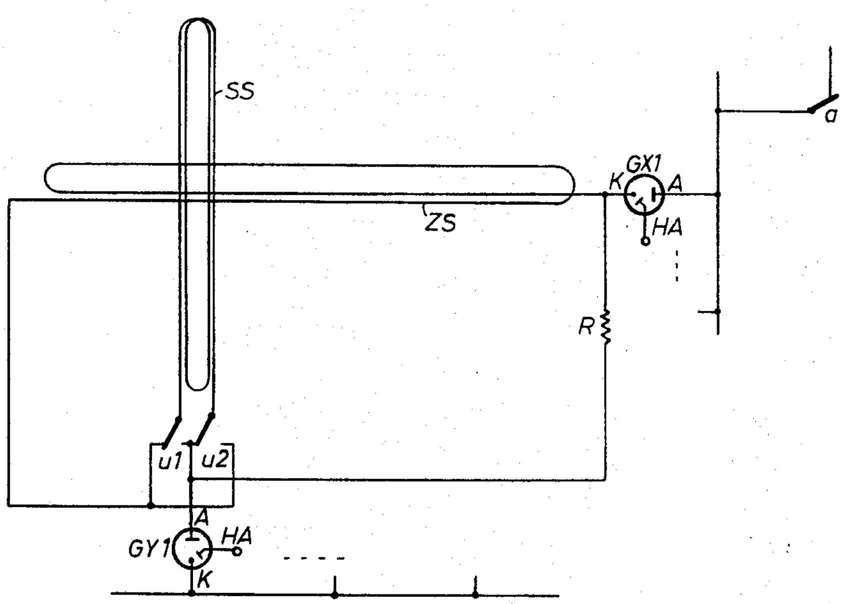

Fig.2

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SWITCHING GRID MATRIX WITH CROSSPOINT ELEMENTS, CONTROLLED BY MARKING PULSES BEING VERY SHORT COMPARED TO THEIR RESPONDING PERIOD

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U.S. Cl. 340—166 9 Claims

ABSTRACT OF THE DISCLOSURE

A storage switch is provided for each row and for each column of a switching matrix. The storage switches are controllable by relatively shorter pulses than are needed to operate crosspoint elements of the matrix. Resistors are placed in parallel with the crosspoint elements to provide a current path over which the storage switches can be kept operative until the crosspoint elements have had time to react and complete a circuit.

The invention relates to the marking of electro-mechanical crosspoint elements by means of electronic control devices.

In telecommunication systems with crossbar switches, in which the switching stages are controlled electronically, the mechanical switching elements have relatively long responding periods, while only relatively short control pulses of the quick acting central control facilities are available. The electro-mechanical crosspoint elements must safely be transferred into the through-connection status, despite the extremely short marking period, to which end they require a substantially longer responding period. Arrangements known to the art therefore use switchable magnets as storages for the respective operating condition, known under the designation "Ferreed." These crosspoint elements only need to be energized or marked a few microseconds, but the excitation current must be the higher, the shorter the excitation period shall last, but, if high current intensities are used, difficulties occur at mechanical contact making for selection of the rows and columns to be connected, of a matrix consisting of such crosspoint elements, if the contact-transfer resistance cannot safely be kept at its nominal value. This was hitherto possible only with contacts, coated with mercury.

It is the object of the invention to provide a switching grid matrix consisting of crosspoint elements capable of being controlled by a marking pulse which is very short compared to its responding period, being free from those disadvantages and constructed of the conventional crosspoint elements. Moreover, rows and columns shall be selectable with the aid of uncoated metal contacts. Such a switching grid matrix is characterised by the fact that a storage switch is associated with each row and each column of the matrix, controlled by short pulses, and that the crosspoint elements are bridged by resistors through which upon marking of a crosspoint element, currents flow for keeping the storage switches in the conductive condition during the responding period of the crosspoint elements.

In a further embodiment of the invention the crosspoint elements may also be bridged by timing circuits, consisting of capacitance and ohmic resistance, or else by an element with a positive temperature coefficient (PTC resistor).

A further embodiment of the invention provides that

release contacts are provided, either for all rows and/or columns, or that only one release contact is provided for the entire switching grid.

According to a further embodiment of the invention bistable crosspoint elements are provided at the crosspoints, the switching condition of which can be reversed by changing the direction of current flow in the associated row- or column-coil.

Finally, a further embodiment of the invention provides that controlled rectifiers, four-layer diodes or cold-cathode thyratrons are provided as storage switches, i.e. as switches for selecting the rows and columns there are used e.g. controlled rectifiers with a storage characteristic, corresponding to their current-voltage characteristic, assumed to be known per se.

These storage switches respond to very short control pulses and remain in the switched-over condition until being switched off. Due to their amplifying effect a very valuable switching power transfer can be obtained, besides the storage of the marking, until the through-connection becomes effective.

The use of controlled rectifiers in a matrix consisting of crosspoint elements arranged at the points of intersection between the row and column leads, does not represent an increased expenditure compared to a matrix with "Ferreed" switches at the crosspoints, because in such a matrix, due to the high current intensities required for the marking, there is required the same number of semiconductor switches for connecting the rows and columns, as rows and columns are provided in the matrix.

The invention is described with reference to FIGS. 1 and 2 of the accompanying drawing, wherein:

FIG. 1 shows the inventive arrangement in a switching grid, and

FIG. 2 shows an arrangement for crosspoint elements having a bistable behavior.

The controlled rectifiers GX1, GX2 and GY1 for the row- and column-selection purpose are shown in FIG. 1. As disconnecting contacts *ax1*, *ax2*, etc. there are used metal contacts. The cross point element K, inserted always between rows and columns, is bridged, according to the invention, by a resistor R. The rectifier EG serves for mutual decoupling.

For reversing the rectifier into the conductive switching condition, current pulses of a short duration and low intensity are sufficient only if the current in the coil of the crosspoint element K has increased already during this short period of the marking pulse, i.e. beyond the value of the rectifier holding current, but since this will not be the case due to the inductance of the crosspoint element K, the resistor R is inserted according to the invention. After the rectifiers have operated the current in this resistor rises substantially quicker than the current in the coil of the crosspoint element K and, as long as the rectifiers are conductive, remains at a value which is determined by the circuit arrangement. An auxiliary current, therefore, flows through the resistor in such a way that the controlled rectifier is kept in the conductive condition after the marking pulse is over, so that sufficient time is available before the field in the coil is established, i.e. until the crosspoint element is fully excited. By this resistor the connecting rectifier relay combination is provided with an adhesive character.

Since the marking causes the through-connection of the crosspoint element, after the lapse of the responding period, with the aid of current intensities which are low compared to those of conventional switching elements, metal contacts may be used as switch-off contacts *ax1*, *ax2* . . . .

In order to make sure that the current flow upon operating the controlled rectifiers GX1 and GY1 according to FIG. 1, will immediately assume the full value, a capacitor C is still connected across the resistor R parallel in relation to the crosspoint element K. The current flow via this circuit decreases subsequently to the charging of the capacitor C, i.e. all the more if there is used a resistor R whose resistance variation extends in the same sense as the temperature. ϑ. This is indicated by the two small arrows with the reference symbol ϑ at the resistor R, whereas the double arrow extending through the resistor symbol indicates that this resistance variation is effected automatically.

In FIG. 2 there is shown a switching grid whose not shown bistable crosspoint elements are actuated electro-magnetically via row coils ZS and column coils SS. The switch-over contacts *u***1** and *u***2** thereby serve to reverse the direction of current flow in the row- and column-coils. The one direction of current flow serves to actuate the crosspoint elements, while the other direction of current flow serves to release the bistable crosspoint elements.

As may be taken further from the showing of FIG. 2, also cold cathode tubes may be used as controlled storage switch means GX1 and GY1 which, with their cathode-anode section A–K are looped into the column or row conductors and are controlled via the auxiliary anode HA.

In the example of embodiment according to FIG. 2 the disconnection of the switching grid may be performed by the action of one single contact *a*.

I claim:

1. A switching matrix comprising a rectangular array of vertical and horizontal groups of multiples, a plurality of current controlled electronic switch means, one of said switch means being coupled to each of said multiples at the matrix inlet and at the matrix outlet, crosspoint means shunted by a resistance element at each intersection of said horizontal and vertical multiples, and means responsive to a switching pulse for firing the electronic switch associated with each of the desired inlet and outlet multiples, whereby current flows through said resistance to hold said fired switches in an on condition while the crosspoint operates.

2. The matrix of claim **1** wherein said resistance element is inclined with a capacitor as part of a timing circuit.

3. The matrix of claim **1** wherein said resistive element has a positive temperature coefficient.

4. The matrix of claim **1** and contact means coupled in series with each of at least one of the groups of multiples, and means for selectively opening said contact means to release a connection.

5. The matrix of claim **1** wherein there are a plurality of matrix stages connected in cascade, and a single stage having contact means therein for releasing a path completed through said cascade.

6. The matrix of claim **1** wherein said crosspoint means comprises a first winding associated with a horizontal multiple and a second winding associated with a vertical multiple, and means for changing the switching condition of said crosspoints by reversing the direction of current flow.

7. The matrix of claim **1** wherein each of said electronic switch means comprises a controlled rectifier.

8. The matrix of claim **1** wherein each of said electronic switch means comprises a four layer diode.

9. The matrix of claim **1** wherein each of said electronic switch means comprises a cold cathode tube.

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179—18; 340—147, 167