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(54) IMPROVEMENTS IN OR RELATING TO TELECOMMUNICATIONS EXCHANGE SYSTEMS

(71) We, SIEMENS AKTIENGESELLSCHAFT, a German Company, of Berlin and Munich, Federal Republic of Germany, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:

This invention relates to telecommunications exchange systems, and in particular to a telephone exchange system comprising a switching network having inverse grouping.

The telecommunications exchange system includes a switching network comprising switching network sections each of which is constructed from multiple switches arranged in a plurality of switching stages which are connected to one another via intermediate lines. The switching network sections may comprise switching network sections of a first type all of which are of similar construction to one another and whose inputs are exclusively connected to subscriber lines, and switching network sections of a second type all of which are of similar construction to one another and whose inputs are connected to connection lines and connection devices required for connections.

Such a system can be very easily extended by the addition of switching network sections, until the number of multiple connections becomes insufficient to handle the traffic load which arises. In addition, the individual assignment of sub-control units to the switching network sections provides the possibility, when the switching network sections are suitably limited in size, of dispensing with a duplication of common control units. As is known, it is necessary to duplicate common control units for reasons of safety in those cases in which a breakdown of the common control unit would temporarily render inoperable either the entire exchange system or an impermissibly large part thereof. By suitably limiting the size of the switching network sections it is possible to avoid the need to duplicate each of the sub-control units.

This invention seeks to provide an improved telecommunications exchange system.

According to this invention there is provided a telecommunications exchange system including a switching network comprising a plurality of groups of switching network sections each of which is constructed from multiple switches arranged in a plurality of switching stages which are connected to one another via intermediate lines and the inputs of the switching network sections being for connection to subscriber lines, connection lines and connection devices required for connections, the switching network sections being assigned respective sub-control units, each switching network section having a given number of outputs, the outputs of all the switching network sections, which outputs have corresponding switching addresses in the respective switching network sections, being connected to one another by a multiple connection, the number of multiple connections being equal to said given number, the number of switching network sections forming each group of switching network sections being smaller than the maximum number of switching network sections which could be used to form the group of switching network sections without exceeding the maximum traffic loading capacity of the multiple connections of the group of switching network sections, and the multiple connections of different ones of the plurality of groups of switching network sections being interconnected in groups.

Expediently the multiple connections of each group of switching network sections are divided equally into a number of groups which number is one less than the number of groups of switching network sections, and the multiple connections of each group of

multiple connections of each group of switching network sections are connected individually to the multiple connections of a group of multiple connections of at least one other group of switching network sections thereby to form a plurality of different sets each of a plurality of groups of switching network sections groups of multiple connections of which are interconnected.

The total number of switching network terminals can be increased without this causing an impermissible overshooting of the traffic loading capacity of the multiple connections because the number of switching network sections in each group of switching network sections is smaller than the maximum permissible number of switching network sections which is determined by this maximum traffic loading capacity. If all the multiple connections of all the groups of switching network sections were connected to one another, this results in an arrangement corresponding to that disclosed in patent No. 1,511,918. However, in accordance with this invention the interconnection of the multiple connections in groups results in these interconnections being arranged in a staggered fashion as is known in principle from Fig. 3 of German Specification AS 1 562 133. It is thus possible to provide considerably more interconnections than multiple connections can be provided in the case of the parent application. For this reason, and because the traffic loading is distributed among a larger total number of interconnections, it is also possible to provide a larger total number of switching network sections with the consequent increase in the total number of switching network terminals. However an advantage is achieved in that the size of each of the switching network sections does not need to be increased so that in the event of the breakdown of a sub-control unit due to a disturbance the breakdown affects the operation of only a stricly limited number of subscriber terminals or connection devices; consequently it is not necessary to provide each sub-control unit in duplicate.

It is expedient for the switching network to have inverse grouping; as is known this facilitates the establishment of connections via short paths and results in a saving of crosspoints. In the context of this invention it is pointed out in particular that for short path connections within a switching network section between two switching network terminals of two different multiple switches of the first switching stage, all the outputs of this switching network section are available, although for normal path connections between switching network terminals of different groups of switching network sections in each case only some of the interconnections between these groups and accordingly only some of the outputs of the relevant two switching network sections of the different groups of switching network sections are available. As the establishment of connections via short paths is given precedence over the establishment of connections via normal paths, it is particularly expedient that a greater number of paths is available for the establishment of connections via short paths than for the establishment of connections via normal paths.

In an embodiment of the invention the switching network comprises a further switching stage comprising the same number of groups of multiple switches as there are said different sets each of a plurality of groups of switching network sections, and the interconnected multiple connections of each of said sets are connected each to arespective one of the inputs of the multiple switches of a respective group of multiple switches of the further switching stage. In this embodiment it is expedient if each multiple switch in each group of multiple switches of the further switching stage has the same number of inputs as the final switching stage of each switching network section has mutliple switches, each group of multiple switches of the further switching stage consists of a number of multiple switches which number is equal to the number of multiple connections of each switching network section divided by the product of said number of groups into which the multiple connections of each group of switching network sections are divided and said number of inputs of each multiple switch in each group of multiple switches of the further switching stage, and the inputs of each multiple switch in each group of multiple switches of the further switching stage are connected via the multiple connections each to an output of a respective one of the multiple switches in the final switching stage of each switching network section of the groups of switching network sections in the relevant set of such groups.

The invention will be further understood from the following description by way of example of embodiments thereof with reference to the accompanying drawings, in which:

Fig. 1 schematically illustrates parts of a telephone exchange system as described and claimed in U.K. Patent Specification No. 1,511,918, the switching network of which is hereinafter referred to for clarity as a group of switching network sections;

Fig. 2 schematically illustrates a switching network, including a plurality of groups of switching network sections, of a telephone exchange system in accordance with an embodiment of this invention;

Fig. 3 schematically illustrates a switching network arrangement forming part of a telephone exchange system in accordance with another embodiment of this invention and

comprising a plurality of switching networks as illustrated in Fig. 2; and

Fig. 4 schematically illustrates an alternative switching network to that illustrated in Fig. 2.

Fig. 1 illustrates a group I of switching network sections, of which sections referenced A, B, and N are shown, each of which is illustrated as having two stages KA and KB. It is equally possible for each of the switching network sections to have three or more stages. All of the switching network sections have the same number of multiple switches in the second, i.e. final, switching stage KB and all of these multiple switches possess the same number of outputs.

The switching network sections A to N may be differentiated into two types, determined by the connections of their inputs. The switching network sections A and B have their inputs connected exclusively to subscriber stations T1 to T4, whereas switching network sections such as the switching network section N have their inputs connected exclusively to connection lines and connection devices required for the establishment and monitoring of connections, i.e. line connection sets (e.g. VLO and VLF) for local connection lines (e.g. OVL) and trunk connection lines (e.g. FL), dial receiving sets (e.g. WS), and internal connection sets (e.g. JV).

Due to this differentiation of the switching network sections into switching network sections of a first type, whose inputs are connected exclusively to subscriber stations, and switching network sections of a second type, whose inputs are connected exclusively to connection line sets, dial receiving sets, and internal connection sets, it is possible to dimension the switching network sections of the two different types in different ways in dependence upon the differing traffic loading of the subscriber stations and of the aforementioned various connection devices required in different ways for each connection.

As already stated, the number of multiple switches in the second switching stage is the same in all the switching network sections. Also the number of outputs of each multiple switch of the second switching stage is identical in respect of all the multiple switches in each second switching stage. On the other hand the number of inputs of the multiple switches of the second switching stage can be greater in the case of the switching network sections A and B of the first type than in the case of the switching network sections e.g. N of the second type. The number of multiple switches in each first switching stage is equal to the number of inputs per multiple switch of the second switching stage of the same switching network section. Accordingly the switching network sections of the first type may each possess a greater number of multiple switches in the first switching stage than the switching network sections of the second type N. Since the number of outputs of each multiple switch of the first switching stage is always equal to the number of multiple switches in the second switching stage of the same switching network section, in all the switching network sections the multiple switches of the first switching stage possess the same number of outputs. However, the number of inputs per multiple switch in the first switching stage can differ for the switching network sections of the two types. Thus the multiple switches of the first switching stage can have a larger number of inputs in the switching network sections of the second type. The switching network sections of the first type can thus differ from the switching network sections of the second type both in respect of the number of multiple switches of the first switching stage of each switching network section and in respect of the number of inputs of each multiple switch. The precise numbers of inputs and outputs per multiple switch and of multiple switches per switching network section are determined in known manner in accordance with the traffic values of subscriber stations and connection devices required for connections.

It is possible to replace each intermediate line between the first and second switching stages by two or more intermediate lines in parallel, in which case the number of inputs of each multiple switch of the second switching stage is twice or a greater number of times the number of multiple switches in the first switching stage of the relevant switching network section.

As can be seen from Fig. 1, the switching network section A possesses its own sub-control unit TA. Each other switching network section also posses its own sub-control unit, these not being represented in the drawing. All the sub-control units are connected to a common central control unit which is not shown. The mode of functioning of the sub-control units can be confined to that of intermediate store and/or recoding devices. Details in this respect are represented and described in German Patent Specification No. 1 537 849.

The connection devices can be commonly assigned control units, which can be individually provided for each of the different types of connection devices.

The size of each switching network sections is contrived to be such that in the event of breakdown of a sub-control unit, e.g. TA, assigned to a switching network section, e.g. A, only a relatively small part of the exchange system temporarily goes out of operation, i.e. all but a relatively small number of the subscribers and connection devices are unaffected. Devices whose

breakdown would result in too large a part of an exchange system being temporarily out of operation must be provided in duplicate and must operate in parallel in order that on the breakdown of one of the two parallel-operating devices, e.g. due to a disturbance, the other can continue the exchange operation. For this reason, the size of each of the switching network sections is contrived to be such that its sub-control unit does not need to be provided in duplicate. The sub-control units are thus provided individually for each switching network section.

Outputs of the different switching network sections, which outputs correspond to one another in respect of switching network parameters, are connected to one another by means of multiple lines V1, V2, to V*x*, thus forming the group I of switching network sections. The number of these multiple lines remains unchanged when the group of switching network sections is extended, one or more additional switching network sections being connected additionally to the multiple lines V1 to V*x* in the same manner as that shown in Fig. 1 for the switching network sections A to N. As in all the switching network sections, thus both in the switching network sections of the first type and in the switching network sections of the second type, the numbers of multiple switches in the second switching stage and outputs of each of these multiple switches are equal, no connection problems occur in the event of such extension. The outputs of the additional switching network sections, are simply additionally connected to the already existing multiple lines individually.

A possibility exists of increasing the number of multiple lines V1 to V*x*, when the number of the switching network sections becomes so large that the multiple lines available at that time can no longer handle the prevailing traffic load. For this situation it is provided that in all the already existing switching network sections, all the multiple switches of the second switching stage be connected in parallel at their inputs with a multiple switch. If the outputs of the original and the supplemented multiple switches in the second switching stage are equal, this measure doubles the number of outputs per switching network section. Thus if the number of switching network sections exceeds a degree which is permissible for the traffic loading of the multiple lines V1 to V*x*, in the manner described above it is possible to double the number of multiple lines and thus the traffic load capacity thereof.

Fig. 2 illustrates a switching network KT comprising four groups I to IV of switching network sections as illustrated in Fig. 1, the switching network sections of which are referenced AI. to NI., AII. to NII.,AIII to NIII.,and AIV. to NIV. For clarity in Fig. 2 in each group of switching network sections only those of the multiple connections V1 to V*x* which are connected to the outputs of the first multiple switch of the second switching stage KB in each switching network section are shown. It is assumed here that each such multiple switch has nine outputs the nine multiple connections connected to which are represented in Fig. 2 by three lines referenced, for example in the group I of switching network sections, I.V1, I.V4, and I.V7 each of which lines represents three of the multiple connections. References II.V1, II.V4, II.V7, III.V1,... to IV.V7 denote the corresponding lines in the other groups of switching network sections. All of the groups of switching network sections contain further multiple connections between the other multiple switches in the switching stage KB, as described above with reference to Fig. 1, but for simplicity and clarity these are not shown in Fig. 2.

The lines I.V1 to IV.V7 are interconnected as shown in Fig. 2 by six multiple links Wa to Wf each of which represents three lines. Thus for example in the group 1 of switching network sections the three multiple connections represented by the line I.V1 are connected individually via the three lines of the multiple link Wa to the three multiple connections in the group II of switching network sections represented by the line II.V1. The multiple links Wb to Wf effect similar groups of three inter-connections. Further multiple links (not shown) interconnect in exactly the same way the other multiple connections (not shown) of the groups of switching network sections which other multiple connections are connected to the outputs of the other multiple switches in the switching stage KB in the various groups of switching network sections. Thus the groups I to IV of switching network sections are combined to form six different pairs of groups of switching network sections, corresponding to the six multiple links Wa to Wf, the multiple connections in each particular group of switching network sections being connected in equal numbers via the multiple links to multiple connections of the three groups of switching network sections with which the particular group forms pairs. Thus the multiple connections of each group of switching network sections are divided equally into three (one less than the number of groups of switching network sections) groups.

It is possible to form other than pairs of groups of switching network sections, for example as shown in Fig. 4 the switching network may be formed alternatively from the four groups I to IV of switching network sections by combining the groups of switching network sections to form four different sets each of three groups of switching network sections.

In Fig. 4 in each of the groups of switching network sections only one switching network section I.A, II.A, III.A, and IV.A is shown. The multiple connections connected to the switching network sections of each group of switching network sections are again interconnected by multiple links as in the switching network of Fig. 2, but in the switching network of Fig. 4 in respect of each multiple switch, per switching network section, in the second switching stage there are only four multiple links W1 to W4 (replacing the six multiple links Wa to Wf in Fig. 2) each of which again represents three lines. Each line of each multiple link, however, connects together corresponding multiple connections of three (instead of two) groups of switching network sections. For example the three lines of the multiple link W1 individually interconnect the multiple connections connected to the first three outputs of the first multiple switch in the second switching stage of each switching network section of the group I of switching network sections and the corresponding multiple connections in the groups II and III of switching network sections.

Although the following description refers only to the switching network illustrated in Fig. 2, it will be appreciated that corresponding comments apply in respect of the alternative switching network illustrated in Fig. 4.

The number of switching network sections forming each group of switching network sections is selected to be smaller than the maximum number of switching network sections which could be used to form the group of switching network sections without exceeding the maximum traffic loading capacity of the multiple connections of the group of switching network sections. Thus referring to Fig. 1 the number of switching network sections A to N is less than the number of switching network sections which is permitted by the maximum traffic loading capacity of the multiple lines V1 to V*x*. With the multiple connections of various groups of switching network sections interconnected as described above with reference to Fig. 2, it is possible to increase substantially the total number of switching network sections in the switching network and hence also the total number of switching network terminals, in comparison to a group of switching network sections which is merely as illustrated in Fig. 1.

The switching stages KA and KB of the switching network KT illustrated in Fig. 2 constitute a switching network with inverse grouping, via which as is known it is possible to establish connections both via so-called normal paths and via so-called short paths. Thus a normal path connection can be established between two switching network terminals of different groups of switching network sections via one of the lines of the multiple links interconnecting the groups of switching network sections and via the switching stages KA and KB in the relevant switching network sections of each of the two groups of switching network sections. For example a terminal of the switching network section AI. in the group I can be connected to a terminal of the switching network section AII. in the group II via the switching stages KA and KB in these two switching network sections and via one of the lines of the multiple link Wa. A considerably larger number of connection path possibilities exist for a short path connection between two terminals of the same switching network section or of different switching network sections in the same group, for which all the outputs of the switching stage KB of the switching network section(s) are available. Thus the switching network achieves a preference for connection establishment via short paths.

Fig. 2 also illustrates that the switching network KT may include a third switching stage KC. This third switching stage KC consists in this example of six (the number of multiple links Wa to Wf) groups KCa to KCf each of three (the number of lines in each multiple link Wa to Wf) multiple sections KCa1 to KCa3 to KCf1 to KCf3 each having as many inputs as there are multiple switches in the switching stage KB of each of the switching network section AI. to NIV. For simplicity in Fig. 2 only some of the connections to the switching stage KC are shown. The three lines of the multiple link Wa are connected to the first inputs of the three multiple switches KCa1, KCa2, and KCa3 respectively, and the three lines of each of the other multiple links Wb to Wf are similarly connected to the first inputs of the three multiple switches in each of the groups of multiple switches KCb to KCf respectively. These connections are in respect of the first multiple switch in the switching stage KB in the switching network sections, and corresponding connections are effected to the second and subsequent inputs of each multiple switch in the switching stage KC in respect of each of the second and subsequent multiple switches in the switching stage KB in the switching network sections.

Again in such a switching network including the switching stage KC connections can be established via normal paths and via short paths. A normal path connection consists of two sub-connections which run from the relevant switching network terminals of two different groups of switching network sections to different inputs of a multiple switch in the switching stage KC, where they are connected to one another by interconnecting the two multiple switch inputs to an output of the multiple switch. Short path connections run between switching network terminals of

different groups of switching network sections each via a line of the multiple links such as Wa to Wf, or between switching network terminals of different switching network sections within a group of switching network sections each via a multiple connection of that group, or between switching network terminals of the same switching network section.

Fig. 3 illustrates a switching network arrangement comprising a plurality of switching networks KT1, KT2, to KTx each of which is as described above with reference to Fig. 2, outputs of the multiple switches in the switching stage KC of which are interconnected systematically as shown in Fig. 3 via further intermediate lines. In such a switching network arrangement the normal path and short path connections already described above with reference to Fig. 2 constitute short paths, and normal path connections can be established between switching network terminals of different switching networks each via one of the further intermediate lines.

WHAT WE CLAIM IS:

1. A telecommunications exchange system including a switching network comprising a plurality of groups of switching network sections each of which is constructed from multiple switches arranged in a plurality of switching stages which are connected to one another via intermediate lines and the inputs of the switching network sections being for connection to subscriber lines, connection lines and connection devices required for connections, the switching network sections being assigned respective sub-control units, each switching network section having a given number of outputs, the outputs of all the switching network sections, which outputs have corresponding switching addresses in the respective switching network sections, being connected to one another by a multiple connection, the number of multiple connections being equal to said given number, the number of switching network sections forming each group of switching network sections being smaller than the maximum number of switching network sections which could be used to form the group of switching network sections without exceeding the maximum traffic loading capacity of the multiple connections of the group of switching network sections, and the multiple connections of different ones of the plurality of groups of switching network sections being interconnected in groups.

2. A system as claimed in Claim 1 wherein the multiple connections of each group of switching network sections being divided equally into a number of groups which number is one less than the number of groups of switching network sections, the multiple connections of each group of multiple connections of each group of switching network sections being connected respectively to the multiple connections of a group of multiple connections of at least one other group of switching network sections thereby to form a plurality of different sets each of a plurality of groups of switching network sections, groups of multiple connections of which are interconnected.

3. A system as claimed in Claim 2 wherein the switching network comprises a further switching stage comprising the same number of groups of multiple switches as there are said different sets each of a plurality of groups of switching network sections, and wherein the interconnected multiple connections of each of said sets are connected each to a respective one of the inputs of the multiple switches of a respective group of multiple switches of the further switching stage.

4. A system as claimed in Claim 3 wherein each multiple switch in each group of multiple switches of the further switching stage has the same number of inputs as the final switching stage of each switching network section has multiple switches, wherein each group of multiple switches of the further switching stage consists of a number of multiple switches which number is equal to the number of multiple connections of each switching network section divided by the product of said number of groups into which the multiple connections of each group of switching network sections are divided and said number of inputs of each multiple switch in each group of multiple switches of the further switching stage, and wherein the inputs of each multiple switch in each group of multiple switches of the further switching stage are connected via the multiple connections each to an output of a respective one of the multiple switches in the final switching stage of each switching network section of the groups of switching network sections in the relevant set of such groups.

5. A telecommunications exchange system including a switching network arrangement comprising a plurality of switching networks each as recited in Claim 3 or Claim 4, wherein outputs of the multiple switches in the groups of multiple switches of the further switching stage in the various switching networks are systematically interconnected via intermediate lines each of which extends between outputs of different switching networks.

6. A telephone exchange system substantially as herein described with reference to Figures 1 and 2 or Figures 1 and 4 of the accompanying drawings.

7. A telephone exchange system substantially as herein described with reference to Figures 1, 2 and 3 or Figures 1, 4 and 3 of the accompanying drawings.

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1565058 COMPLETE SPECIFICATION
4 SHEETS *This drawing is a reproduction of the Original on a reduced scale*
Sheet 1

Fig.1

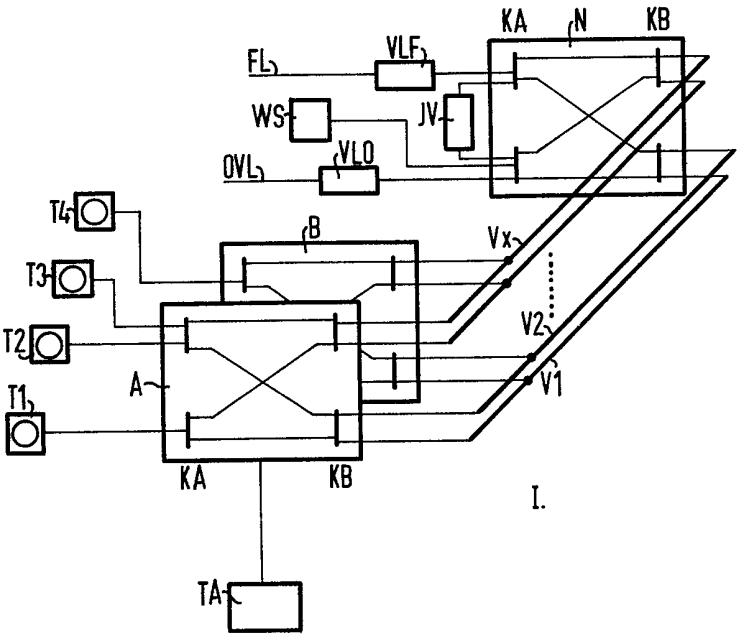
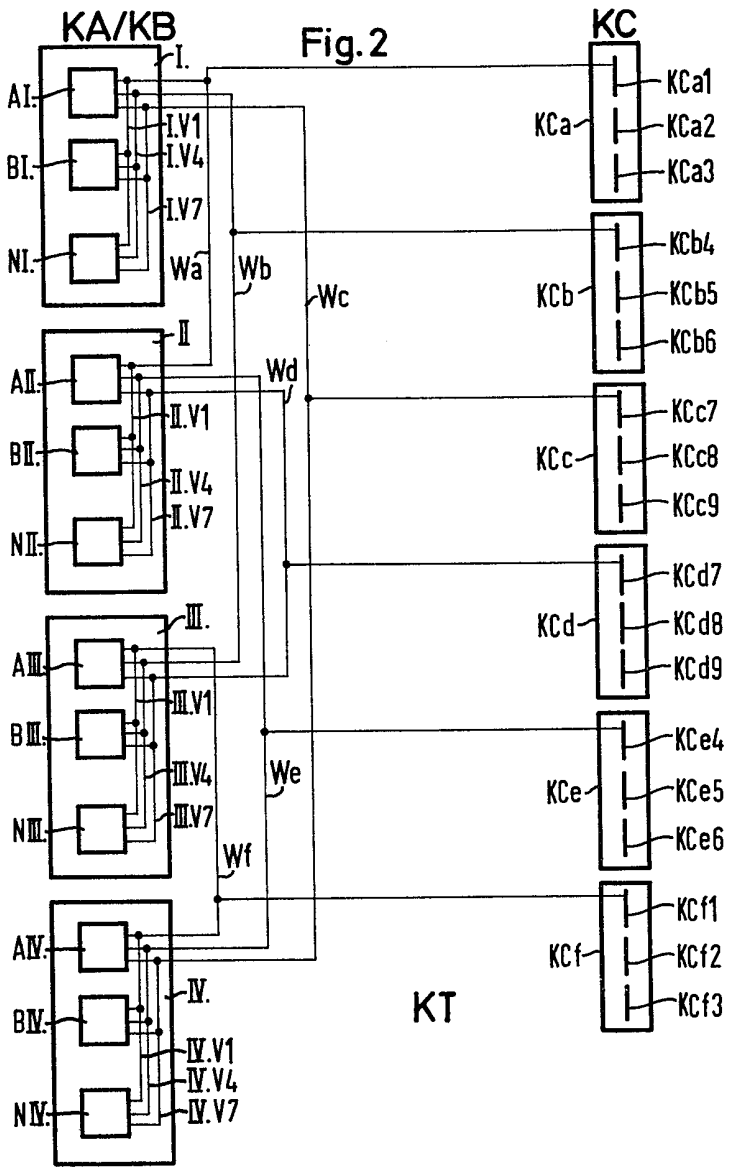


Fig.2


KA/KB
KC
I.
AI.
BI.
NI.
I.V1
I.V4
I.V7
Wa
Wb
Wc
II
AII.
BII.
NII.
II.V1
II.V4
II.V7
Wd
III.
AIII.
BIII.
NIII.
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III.V4
III.V7
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Wf
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IV.V4
IV.V7
KT
KCa
KCa1
KCa2
KCa3
KCb
KCb4
KCb5
KCb6
KCc
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KCc9
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KCf1
KCf2
KCf3

Fig.3

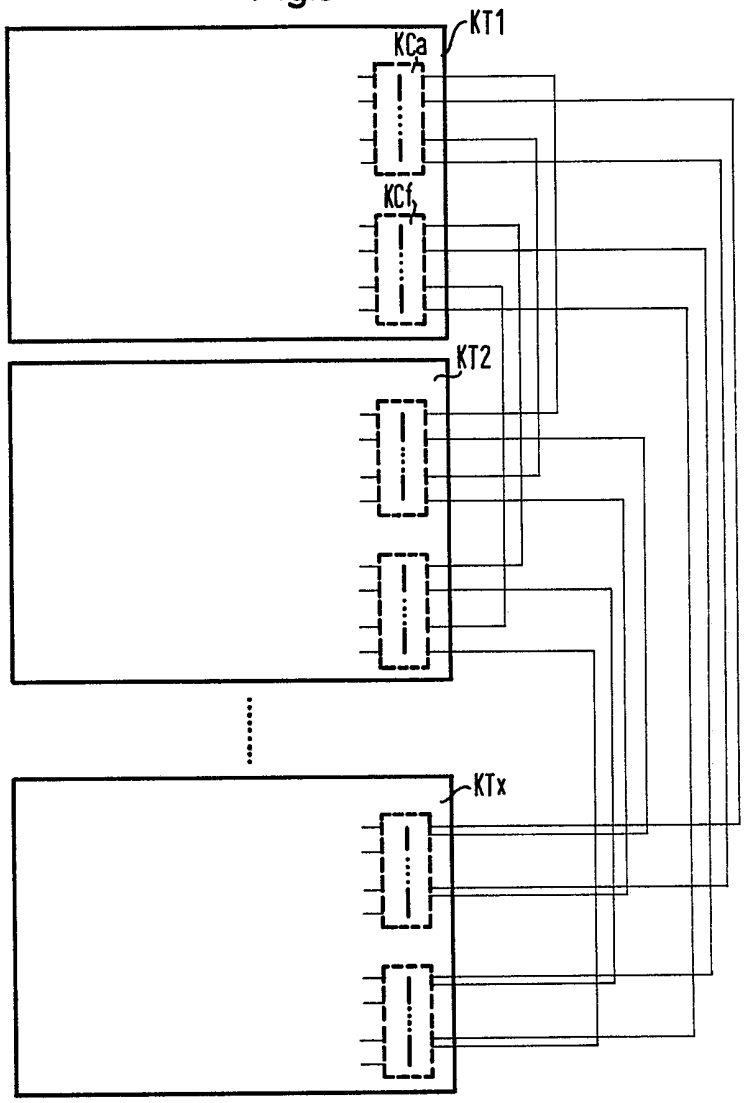

Fig. 4