

PATENT SPECIFICATION

DRAWINGS ATTACHED

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COMPLETE SPECIFICATION

Improvements in or relating to Telecommunication Switching Systems

I, HER MAJESTY'S POSTMASTER GENERAL, of The General Post Office, London, E.C.1., do hereby declare the invention, for which I pray that a patent may be granted to me, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to telecommunication switching systems and in particular to systems employing switches each having a number of inputs and outputs. Each output of each switch is interconnected with an output of one or more other switches, the switches being arranged in a matrix of rows and columns. The term "matrix of rows and columns" is used herein only as a means of identifying the respective switches which are not necessarily disposed in this manner in a practical layout.

With some existing telephone systems for example, an incoming circuit, i.e. a subscriber's line is connected to one input of a line switch giving access via a group of outlets to other selectors, the outlets being shared by a number of subscribers, greater in number than the number of outlets in the group, according to specified traffic requirements. The subscribers sharing the outlets are so arranged as to assure as far as possible that all groups of outlets are equally loaded, i.e. where subscribers are known to originate large volumes of traffic they do not share the same outlets leaving other outlets to be shared by subscribers generating less traffic. This entails constant checks on traffic loading and the moving of subscribers from one group of outlets to another.

The object of the invention is to reduce the possibility of "blocking", i.e. the condition when all the outputs of a particular switch are engaged, and to permit an incoming

circuit to be connected to one input of any switch, without the need to consider the amount of traffic originated by the incoming circuit.

According to the present invention, a telecommunication switching system has a number of first terminal points and a greater number of second terminal points and comprises a plurality of switches each having first terminals shared via the switch by a number of second terminals, the number of first terminals being the same for all switches, each switch second terminal being connected to a different one of the second terminal points, each first terminal point being connected to one first terminal of each switch of a different combination of switches, the switches being disposed schematically in a matrix of rows and columns, the number of columns being equal to the number of first terminals per switch, each first terminal point being connected to one of the terminals of at least one switch in each row of switches, and in which the first terminals of each switch are numbered sequentially in that switch, each first terminal of a switch in one row and column being connected to the correspondingly-numbered first terminal of a switch in a different row and in a column ($x-p$) relative to the one column, x being the number of the first terminal of the switch in the one row and column and p being an integer of value from 0 to N where N is the number of columns.

Conveniently, the matrix consists of equal numbers of columns and rows and in this Specification such a matrix is referred to as a "block". A switching arrangement may comprise a number of such blocks each of which may have its own unique first and second terminal points, or the corresponding first

terminal points of the blocks may be commoned. Again, the arrangement may comprise one or more blocks having their own unique first and second terminal points and other blocks of which corresponding first terminal points are commoned. Within each block the same method of interconnecting the first terminal points with the switch first terminals is used, but different methods may be used for different blocks although the use of a common method clearly facilitates the wiring-up of the first terminal points and switch first terminals.

A block may be enlarged by the addition of one or more switches.

Interconnection of the first terminals of each switch in a block is arranged so that each first terminal point of the block is connected to a first terminal of at least one switch in each row.

In a preferred embodiment of the invention, the number of rows and columns is a prime number. In such an embodiment, the interconnection method of a particular first terminal point will involve, in each row, a switch in a different column except for the terminal $x=p$. Alternatively, if the number of rows and columns is not prime, the interconnection method for some of the first terminal points of a given block will involve the use of more than one switch in some columns other than for the terminal $x=p$.

By way of example only, embodiments of the invention will now be described with reference to the drawings accompanying the Provisional Specification and of which:—

Fig. 1 is a block schematic of a first embodiment, and,

Figs. 2, 3, 4, 5 and 6 are explanatory tables of connections.

Fig. 1 is a block schematic of a first embodiment and shows switches A1 . . . A5, B1 . . . B5, C1 . . . C5, D1 . . . D5 and E1 . . . E5. Each switch may be a crossbar switch, several unisector switches, a co-ordinate array of cross-point switches or any other suitable form of switch enabling a number of first terminals to be connected to an equal number of second terminals.

In the embodiment of Fig. 1, each switch is in the form of a co-ordinate array of cross-points having 5 first and second terminals, the switches being arranged in a matrix of rows and columns, having 5 switches per row and 5 rows per block, making a total of 25 switches per block. Thus, the first column comprises switches A1 . . . A5, the second B1 . . . B5, the third C1 . . . C5, the fourth D1 . . . D5 and the fifth E1 . . . E5. The first terminals of a switch are designated 1A1, 2A1 . . . 5A1 and so on. The block has a total of 125 second terminal points 1 . . . 125 but because of the interconnection arrangement described below it has only 25 first terminal points 1 . . . 25. These 25

first terminal points are divided into 5 groups, i.e. 5 for each switch in the top row, and in accordance with the interconnection arrangement, each of these first terminal points is available to a different combination of 25 second terminal points out of the 125 second terminal points.

In Fig. 1 only the interconnection for the first terminals 1A1 . . . 5A1 from the A1 switch and the first terminal 1B1 of the B1 switch are shown.

The interconnections shown are of a standardised pattern such that if x designates the number of a switch first terminal, it will be connected to the corresponding first terminal x of a switch in the next row and in a column ($x-p$) in advance which is defined as the direction A1—B1—C1—D1—E1—A1—B1 . . . , p is a factor called the advance factor and has a value of from 0 to N, where N is the number of columns. The embodiment of Fig. 1 uses an advance factor p of 1. In Fig. 1, the first terminal points are at the top of the matrix and connections are made to the first terminals of switches in successive rows moving downwardly. If the first terminal points were at the bottom of the matrix, connections would be made to the first terminals of switches in successive rows moving upwardly.

Thus, for switch A1, when x , the number of the first terminal, is 1, ($x-p$)=1-1=0, i.e. no advance, and the first terminal 1A1 is connected to the first terminal 1A2 of switch A2.

When x is 2, $x-p$ =2-1=1 so that the first terminal 2A1 of the switch A1 is joined to first terminal 2B2 of switch B2, i.e. an advance of one.

When x is 3, $x-p$ =3-1=2, so that the first terminal 3A1 of switch A1 is joined to the third, first terminal 3C2 of switch C2, i.e. an advance of two.

When x is 4, $x-p$ =4-1=3, so that the first terminal 4A1 of switch A1 is joined to the fourth, first terminal 4D2 of switch D2, i.e. an advance of three.

When x is 5, $x-p$ =5-1=4, so that the first terminal 5A1 of switch A1 is joined to the fifth, first terminal 5E2 of switch E2, i.e. an advance of four.

The connections of the other switches follow in like manner. The interconnections are set out in Fig. 2 which lists in columns the inter-connected switch first terminals.

The block shown in Fig. 1 can be enlarged to accommodate extra second terminal points by adding further switches. The extra switches have their first terminals connected to the first terminal points of the block by repeating the interconnection method of the block. The first terminal 1A6 of an extra switch A6 schematically disposed beneath switch A5 is joined to first terminal 1A5 of switch A5, first terminal 2A6 is joined to first terminal

2E5 of switch E5, first terminal 3A6 is joined to first terminal 3D5 of switch D5, first terminal 4A6 is joined to first terminal 4C5 of switch C5, and first terminal 5A6 is joined to first terminal 5B5 of switch B5. These connections ensure that first terminal 1A6 is joined to the first terminal point 1, and first terminals 2A6, 3A6 are joined to first terminal points 2 . . . 5 respectively. Fig. 1 shows a further row of switches A6 . . . E6 but only the connections to first terminals 1 . . . 5 of switch A6. Further rows of switches could be added, interconnection then simply repeating the pattern of switches A1 . . . E5.

Further self-contained blocks of switches could be added to that shown in Fig. 1 to enlarge the capacity of the switching system. Thus, the addition of another block similar to that shown in Fig. 1 would add a further 25 first terminal points shared between another 125 second terminal points. In this case, the blocks are quite separate although preferably the same interconnection method is used.

In the matrix shown in Fig. 1, connections are made from the first terminals of the switches in one row of those of the switches in the next adjacent row which, in Fig. 1, is the next lower row.

In an alternative embodiment switches comprising a co-ordinate array having 7 first and second terminals are used. Using a designation the same as that used above for the 5x5 switches, Fig. 3 shows the interconnections for the first terminals of the A1 switch. Other first terminals of other switches are interconnected in like fashion.

Fig. 4 shows similar interconnections for 9x9 switches.

In Figs. 3 and 4 an advance factor of 1 is used.

It should be understood that the advancement from column to column may take place as just described when $p=1$ to the right, from A through B, C, D to E, or alternatively it may be made to the left, from A through E, D, C to B, although for the sake of clarity the first is preferred.

When p equals any other number but 1, it must be decided that advancement in one direction shall be termed positive and in the other direction negative, and although it does not matter which is used, for the sake of clarity, positive to the right and negative to the left is preferable.

For example, consider switch A1 of Fig. 1 and an advance factor $p=2$. Then

when x is 1, $x-p=1-2=-1$ so that the first terminal 1A1 is joined to the first terminal 1E2 of switch E2,

when x is 2, $x-p=2-2=0$ so that the first terminal 2A1 is joined to the first terminal 2A2 of switch A2,

when x is 3, $x-p=3-2=1$ so that the first terminal 3A1 is joined to the first terminal 3B2 of switch B2.

Again, consider switch A1 of Fig. 1 and an advance factor p of value 5. Then

when x is 1, $x-p=1-5=-4$ so that the first terminal 1A1 is joined to the first terminal 1B2 of switch B2,

when x is 2, $x-p=2-5=-3$ so that the first terminal 2A1 is joined to the first terminal 2C2 of switch C2,

when x is 3, $x-p=3-5=-2$ so that the first terminal 3A1 is joined to the first terminal 3D2 of switch D2,

when x is 4, $x-p=4-5=-1$ so that the first terminal 4A1 is joined to the first terminal 4E2 of switch E2,

when x is 5, $x-p=5-5=0$ so that the first terminal 5A1 is joined to the first terminal 5A2 of switch A2.

Again, for switch A1 of Fig. 1 and an advance factor p of value 3, then

when x is 1, $x-p=1-3=-2$ so that the first terminal 1A1 is joined to the first terminal 1D2 of switch D2,

when x is 2, $x-p=2-3=-1$ so that the first terminal 2A2 is joined to the first terminal 2E2 of switch E2,

when x is 3, $x-p=3-3=0$ so that the first terminal 3A1 is joined to the first terminal 3A2 of switch A2,

when x is 4, $x-p=4-3=1$ so that the first terminal 4A1 is joined to the first terminal 4B2 of switch B2,

when x is 5, $x-p=5-3=2$ so that the first terminal 5A1 is joined to the first terminal 5C2 of switch C2.

Fig. 5 shows the interconnections of the first terminals of switch A1 of Fig. 1 using an advance factor of 4. Fig. 6 shows similar interconnections using an advance factor of 5.

The decision as regards the value of p and the positive and negative directions of advancement must be maintained throughout a block but can be different for other blocks.

It will be appreciated that, in any one block, in the embodiments described above, the interconnection of the first terminals of switches B1, C1, D1 and E1 is similar to that of the first terminals of switch A1 and that the interconnections between switches in adjacent rows is likewise similar. Thus, the interconnections take on a standard pattern and, in practice, a standard preformed connection field would be used.

A switching system embodying the invention is suitable for use as a switching stage in an automatic telephone exchange and may be so connected that the second terminal points are connected to subscribers and the first terminal points might be joined to other switching stages. The system might also be used as the final selector in an automatic telephone exchange in which case the first terminal points might be junctions from a preceding switching stage and the second terminal points might

be outgoing points to subscribers, other exchanges, etc.

5 In a single block, the traffic from one switch carrying a high traffic level cannot "busy" all the first terminal points available to other switches in the same column as the one switch. Further, it will be apparent that the security of the system is relatively high because faults in a block of switches can occur whilst maintaining a minimum grade of service to all or the majority of second terminal points connected to the block.

10 The control equipment to be used with the switching system embodying the invention can take any one of the well known forms and for this reason will not be described further in this Specification.

WHAT I CLAIM IS:—

20 1. A telecommunication switching system having a number of first terminal points and a greater number of second terminal points comprising a plurality of switches each having first terminal shared via the switch by a number of second terminals, the number of first terminals being the same for all switches, each switch second terminal being connected to a different one of the second terminal points, each first terminal point being connected to one first terminal of each switch of a different combination of switches, the switches being disposed schematically in a matrix of rows and columns, the number of columns being equal to the number of first terminals per switch, each first terminal point being connected to one of the terminals of at least one switch in each row of switches and in which the first terminals of each switch are numbered sequentially in that switch, each first terminal of a switch in one row and column being connected to the correspondingly-numbered first terminal of a switch in a different row and in a column ($x-p$) relative

to the one column, x being the number of the first terminal of the switch in the one row and column and p being an integer of value from 0 to N where N is the number of columns.

2. A system as claimed in claim 1 in which each row and each column contain the same number of switches, that number being a prime number.

3. A system as claimed in claim 2 in which each row and each column contain the same number of switches, that number being a number which is not a prime number, and in which each first terminal point is connected to one of the first terminals of at least two switches in some column.

4. A telecommunication switching arrangement having first and second switching systems as claimed in claim 1 and in which each first terminal point of the first system is connected to one first terminal of each switch of a different combination of switches of the second system.

5. An arrangement as claimed in claim 4 in which the method of interconnecting the first terminal points with the said one first terminals of the combinations of switches of the first plurality is identical with that used to interconnect the first terminal points with the said one first terminals of the combinations of switches of the second plurality.

6. A telecommunication switching system substantially as described with reference to and as illustrated by Figs. 1 and 2, or Fig. 3 or Fig. 4 or Fig. 5 or Fig. 6 of the drawings accompanying the Provisional Specification.

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be outgoing points to subscribers, other exchanges, etc.

In a single block, the traffic from one switch carrying a high traffic level cannot "busy" all the first terminal points available to other switches in the same column as the one switch. Further, it will be apparent that the security of the system is relatively high because faults in a block of switches can occur whilst maintaining a minimum grade of service to all or the majority of second terminal points connected to the block.

The control equipment to be used with the switching system embodying the invention can take any one of the well known forms and for this reason will not be described further in this Specification.

WHAT I CLAIM IS:—

1. A telecommunication switching system having a number of first terminal points and a greater number of second terminal points comprising a plurality of switches each having first terminal shared via the switch by a number of second terminals, the number of first terminals being the same for all switches, each switch second terminal being connected to a different one of the second terminal points, each first terminal point being connected to one first terminal of each switch of a different combination of switches, the switches being disposed schematically in a matrix of rows and columns, the number of columns being equal to the number of first terminals per switch, each first terminal point being connected to one of the terminals of at least one switch in each row of switches and in which the first terminals of each switch are numbered sequentially in that switch, each first terminal of a switch in one row and column being connected to the correspondingly-numbered first terminal of a switch in a different row and in a column ($x-p$) relative

to the one column, x being the number of the first terminal of the switch in the one row and column and p being an integer of value from 0 to N where N is the number of columns.

2. A system as claimed in claim 1 in which each row and each column contain the same number of switches, that number being a prime number.

3. A system as claimed in claim 2 in which each row and each column contain the same number of switches, that number being a number which is not a prime number, and in which each first terminal point is connected to one of the first terminals of at least two switches in some column.

4. A telecommunication switching arrangement having first and second switching systems as claimed in claim 1 and in which each first terminal point of the first system is connected to one first terminal of each switch of a different combination of switches of the second system.

5. An arrangement as claimed in claim 4 in which the method of interconnecting the first terminal points with the said one first terminals of the combinations of switches of the first plurality is identical with that used to interconnect the first terminal points with the said one first terminals of the combinations of switches of the second plurality.

6. A telecommunication switching system substantially as described with reference to and as illustrated by Figs. 1 and 2, or Fig. 3 or Fig. 4 or Fig. 5 or Fig. 6 of the drawings accompanying the Provisional Specification.

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