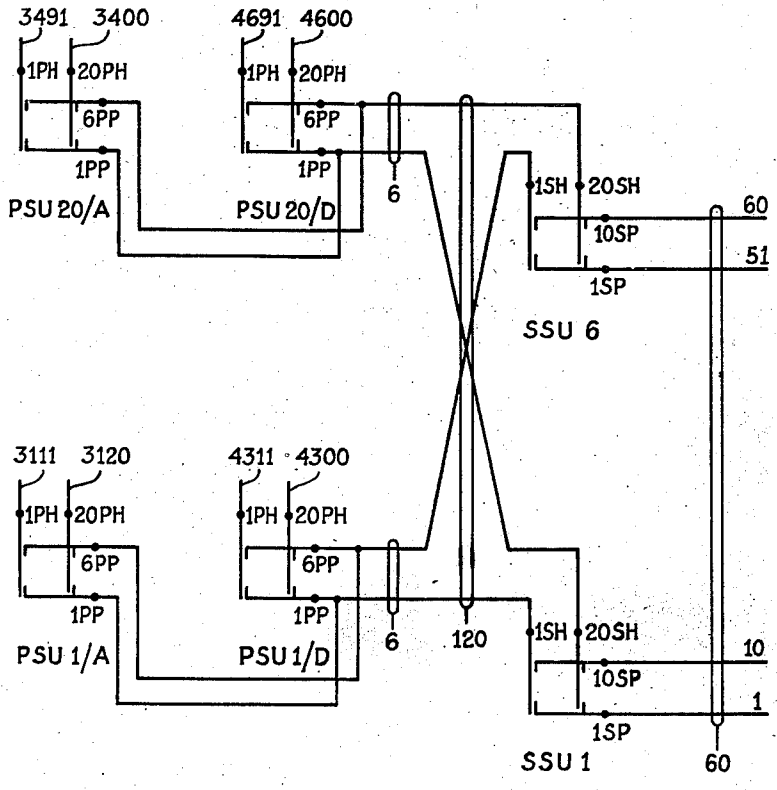
April 23, 1946. C. GILLINGS ET AL 2,398,826

TELEPHONE OR LIKE SYSTEM

Filed Feb. 3, 1944 6 Sheets-Sheet 1

Fig. 1



INVENTORS
CHARLES GILLINGS
LAWRENCE JOHN MURRAY

BY Chas. Tu. Cundy

ATTORNEY

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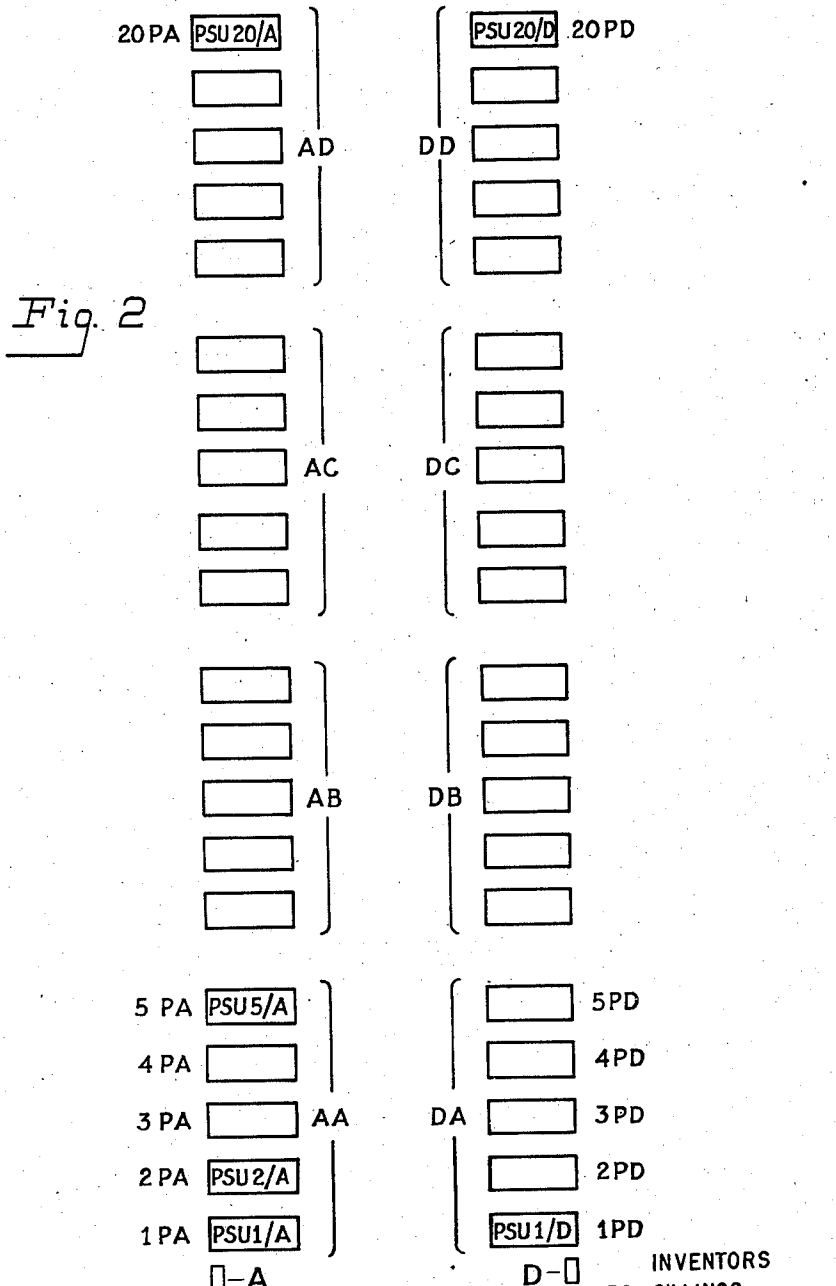


Fig. 2

INVENTORS
CHARLES GILLINGS
LAWRENCE JOHN MURRAY

BY Chas. Tu. Cundy
ATTORNEY

April 23, 1946. C. GILLINGS ET AL 2,398,826

TELEPHONE OR LIKE SYSTEM

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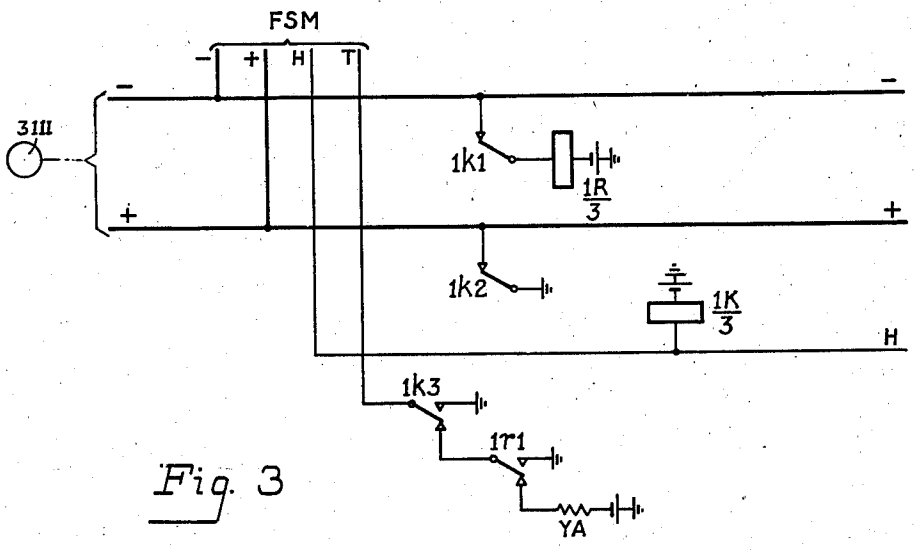
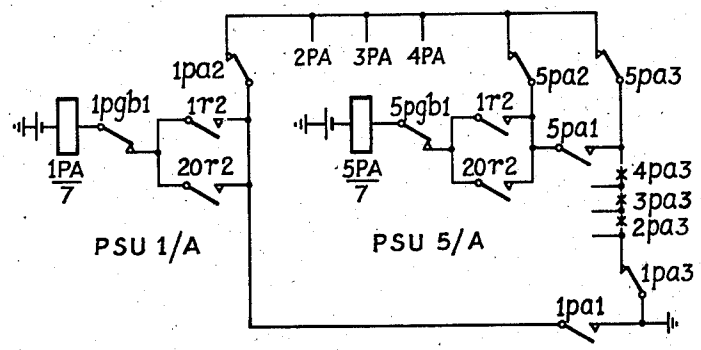
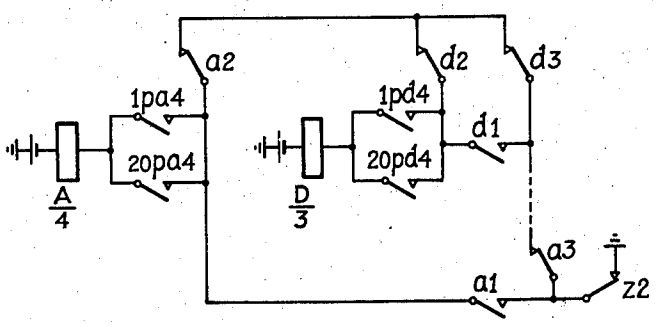


Fig. 3





INVENTORS
CHARLES GILLINGS
LAWRENCE JOHN MURRAY

BY

ATTORNEY

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TELEPHONE OR LIKE SYSTEM

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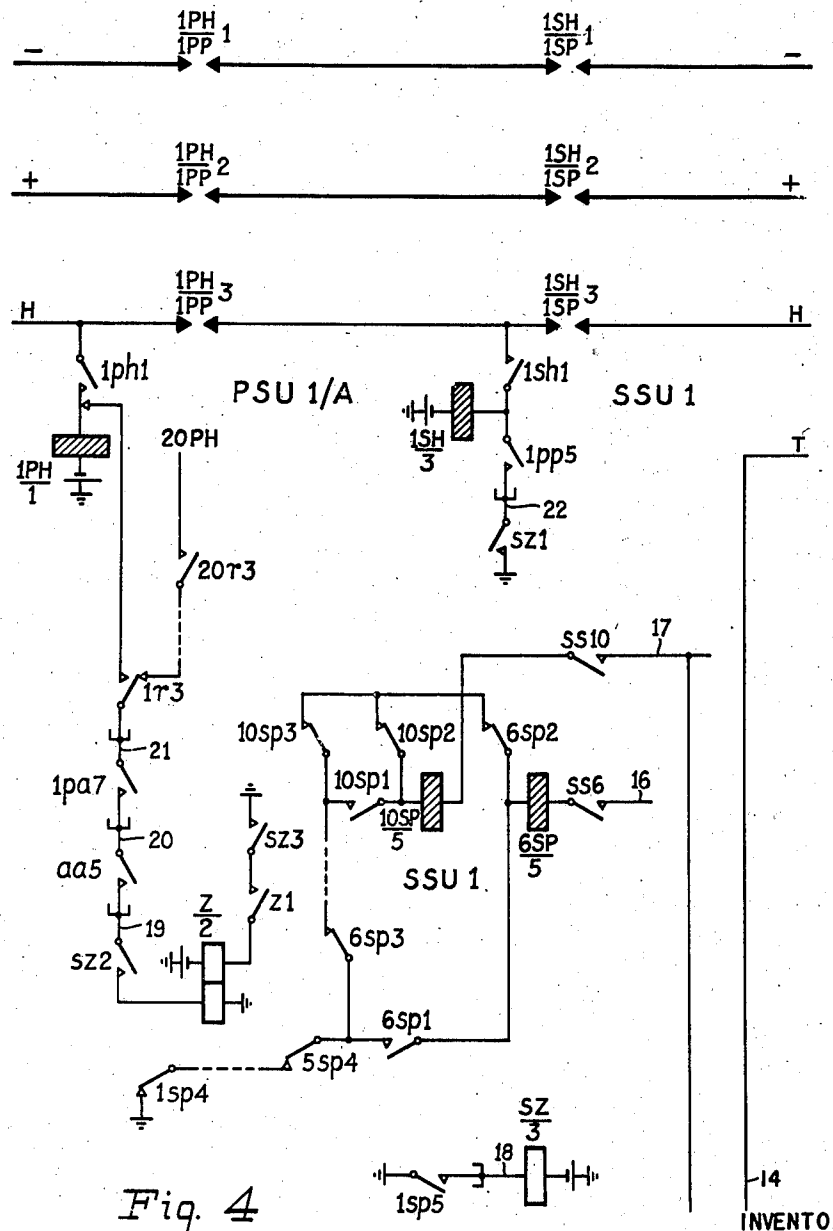


Fig. 4

INVENTORS
CHARLES GILLINGS
LAWRENCE JOHN MURRAY

BY Chas. H. Gandy

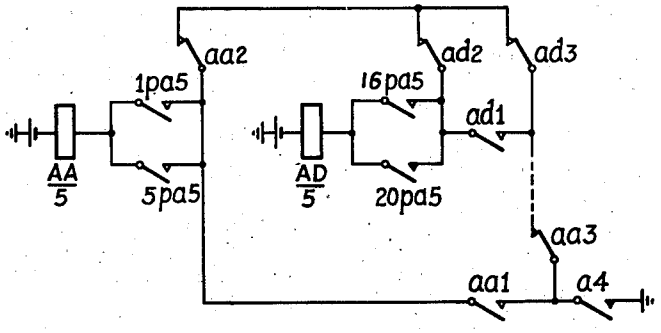
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TELEPHONE OR LIKE SYSTEM

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Fig. 5



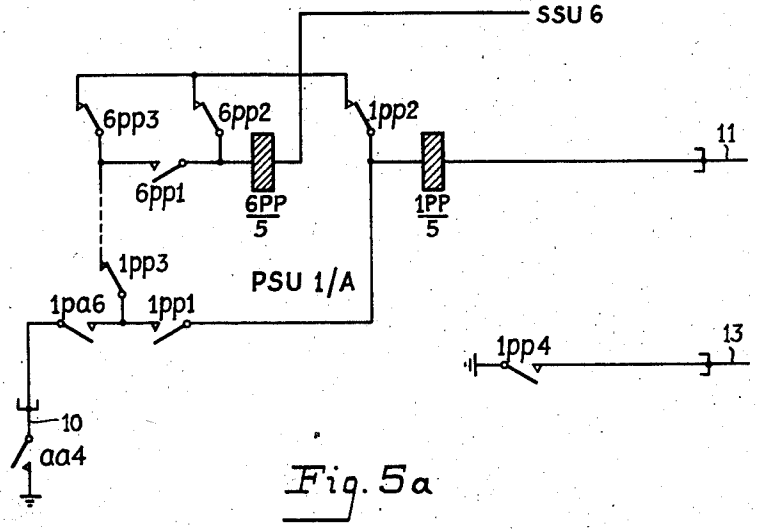


Fig. 5a

3	4
5	6

INVENTORS
CHARLES GILLINGS
LAWRENCE JOHN MURRAY

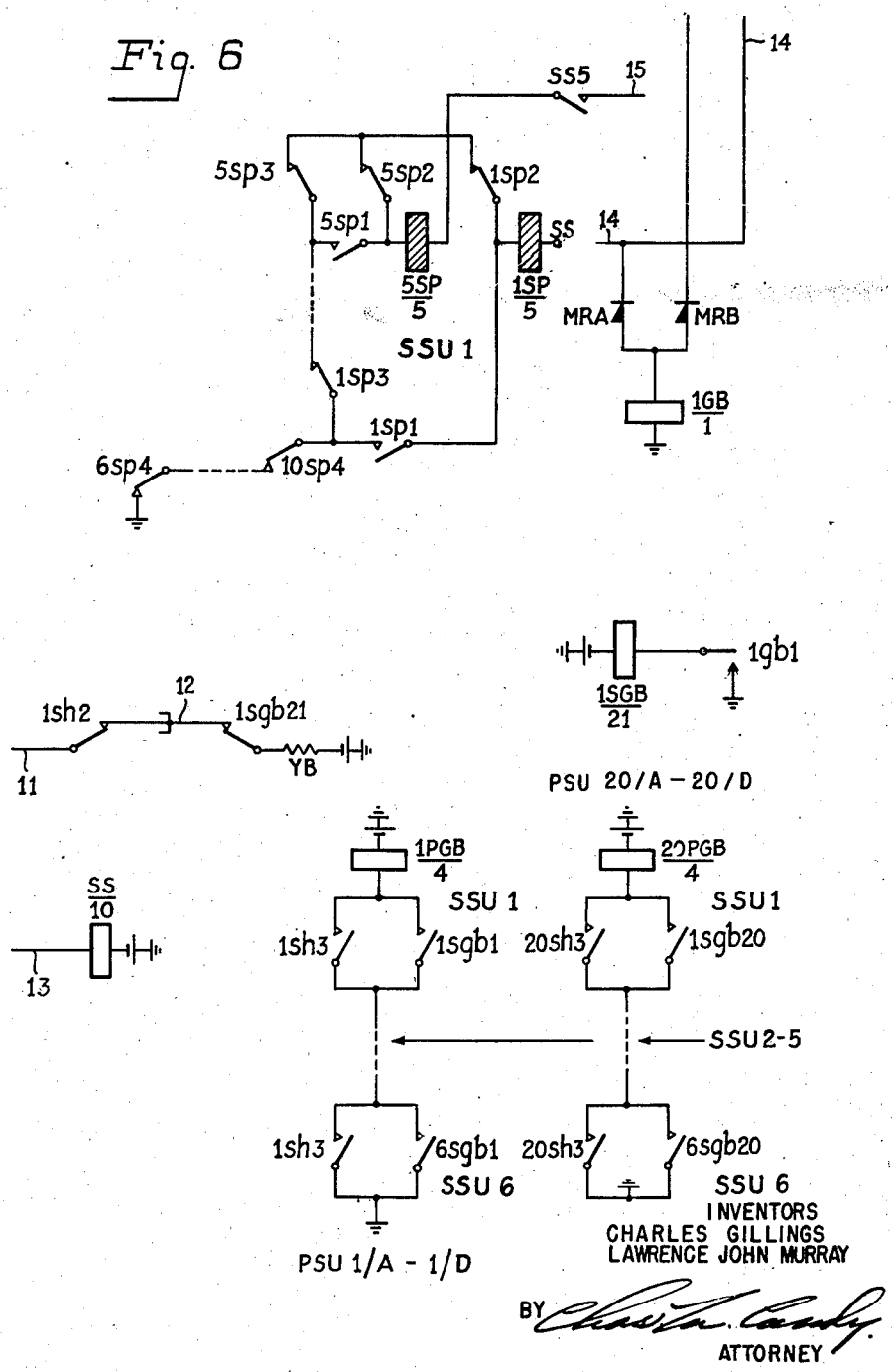
BY Chas. Tu. Cundy.
ATTORNEY

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Fig. 6



INVENTORS
CHARLES GILLINGS
LAWRENCE JOHN MURRAY

BY Charles Gilliings

ATTORNEY

Patented Apr. 23, 1946 2,398,826

UNITED STATES PATENT OFFICE

2,398,826

TELEPHONE OR LIKE SYSTEM

Charles Gillings and Lawrence John Murray, Liverpool, England, assignors to Automatic Electric Laboratories, Inc., Chicago, Ill., a corporation of Delaware

Application February 3, 1944, Serial No. 520,910
In Great Britain March 8, 1943

10 Claims. (Cl. 179—22)

The present invention concerns improvements in or relating to telephone or like systems and is more particularly concerned with crossbar switches as described for instance in our application Serial No. 513,370, filed Dec. 8, 1943.

In the prior specification control equipments are provided involving relays and simple unidirectional switch mechanisms or uniselectors in association with each of the various switching stages.

It is an object of the present invention to provide arrangements for selecting an idle line in the group, for instance, preselecting arrangements which employ control equipment including only relays but it must be understood that the invention is not particularly limited to arrangements disclosed in the above system.

According to the invention, in a telephone system employing crossbar type switches, the connection of any one of a number of lines to an idle line of a second group of lines is effected by exciting a plurality of relay chains, the relays of one of which chains correspond to the individual lines, and the relays of another of which chains correspond to the individual groups of lines into which the said first lines are divided, which relay chains cause crossbar switching mechanism, for instance primary and secondary crossbar selecting units, to be operated substantially instantaneously to connect a line of said first group to an idle line of said second group. The invention is particularly applicable for the connection of subscribers' lines to an idle line leading to the first numerical switching stage.

The invention will be better understood from the following description of one method of carrying it into effect, reference being had to the accompanying drawings comprising Figs. 1 to 6.

Of these figures Fig. 1 shows the essential trunking arrangements of an all-relay primary/secondary preselection stage of a four-digit automatic telephone system of the above-mentioned type, the stage concerned being assumed to serve the sixteen hundred subscribers numbered 3111–4600.

Fig. 2 shows two out of the possible four columns of primary crossbar switching units which together form the primary part of the primary/secondary preselection stage of Fig. 1, while it also indicates the relays of the associated control equipment which are representative of the columns, of the sub-columns and of the primary switching units. These control equipment relays are arranged in a number of chain circuits, selected ones of which are included in the circuits of the primary/secondary preselection stage shown in Figs. 3–6 when arranged in the manner indicated in Fig. 5*a*.

Referring now to the trunking diagram, the primary/secondary preselection stage, which comprises a number of relatively small capacity primary and secondary crossbar switching units such as PSU1/A and SSU1, enables a subscriber, on removal of his receiver, to be automatically connected to a first numerical group selecting crossbar switching unit. As will be appreciated later, a preselection stage may serve between two hundred and sixteen hundred subscribers' lines according to the traffic involved, and it connects with a group of six first numerical group selecting units, each of which is capable of handling up to ten connections and so has ten links incoming thereto.

Each of the primary switching units is ordinarily arranged to accommodate twenty subscribers and to have access to six outlets, each of which is linked with a secondary switching unit. Up to twenty primary units may be arranged in a column and from one to four columns, according to the traffic density involved, has or have access to a group of six secondary units SSU1—SSU6, each of which terminates twenty links from the primary units and has access to ten links to first group selecting units. The first and twentieth primary units PSU1/A and PSU20/A of the first column and units PSU1/D and PSU20/D of the fourth column are shown in the drawings.

A group of six first group selecting units thus serves up to four columns of primary units. If the traffic density is light, then the maximum of four columns will be provided and twenty subscribers will be accommodated per primary unit so that under these conditions the six first selecting units will be serving sixteen hundred subscribers' lines. Under very heavy traffic conditions each primary unit might be adapted only to accommodate ten subscribers, and only one column might be provided so that the six selecting units would now be serving two hundred subscribers only. By altering the number of columns, the number of primary switching units in a column and the number of subscribers' lines per primary switching unit, the preselection stage may be adapted to accommodate a suitable number of lines in accordance with the traffic involved.

In the drawings where the maximum of sixteen hundred subscribers is assumed to be served by the preselection stage, the subscribers' numbers involved are assumed to range from 3111–4600 inclusive.

As regards the construction of the crossbar primary units, these each comprise three two-way horizontal selecting or prepare bars together with three pairs of associated bar controlling relays 1PP, 2PP, . . . 6PP, which connect with the six outlets concerned. In addition there are twenty vertical holding bars and associated controlling relays 1PH—20PH which connect with the twenty subscribers' lines concerned, and by means of

which a connection can be completed between a calling line and any one of the six outlets available to a primary unit. Similar remarks apply as regards the secondary units with the exception that in this instance there are five two-way horizontal bars and ten horizontal bar controlling relays 1SP, 2SP; . . . 10SP.

Referring now to Fig. 2 which depicts the first and fourth of the four possible columns of primary units, a control relay A is associated with the first column, relay B (not shown) with the second column, relay C (not shown) with the third and relay D with the fourth. For circuit convenience each of the columns is divided up into four sub-columns, the four sub-columns of column 1 employing control relays AA—AD respectively, the four sub-columns of column 2 employing the relays BA—BD (not shown) and so on. For each primary unit there is provided a control relay; for the first column, relay 1PA serves unit PSU1/A, relay 2PA serves unit PSU2/A and so on up to relay 20PA. In the fourth column the relays will be designated 1PD to 20PD for the primary units PSU1/D—PSU20/D.

The primary unit relays of each sub-column, the sub-column relays of each column, and the column relays are arranged in a number of chain circuits, the general operation of which is as follows, when one or more subscribers in the primary/secondary preselection stage originates a call.

If a call is originated on, say, unit PSU1/A, the chain circuit involving the five relays 1PA—5PA in the sub-column concerned comes into operation and relay 1PA associated with unit PSU1/A operates to pick out the calling unit PSU1/A.

Similar operations can be taking place simultaneously for each of the sixteen sub-columns in the primary/secondary group if calls are being originated in these sub-columns.

The chain circuit involving the column relays A—D now comes into operation to pick the calling column out of the group of four such columns. Where more than one column is calling, then one column only will be picked out.

The chain circuit involving the sub-column relays of the selected column now comes into operation to determine the calling sub-column. If more than one sub-column is calling then one only of the sub-columns will be picked out. It may be mentioned that the reason why a particular calling primary unit is not picked out by connecting all the relevant PA relays in a chain circuit or why a particular one out of the sixteen possible calling sub-columns is not picked out by connecting the sixteen relevant relays AA—DD in a single chain circuit, is that it is desirable not to have too many relays in a single simultaneous outlet testing chain circuit of the type to be employed since the first one of a chain in operating may have to break operating circuits for all the other relays of the chain. With too many relays in the chain arcing will occur at the relay contacts with serious results.

The three above stages of chain selection are effected almost instantaneously and as a result there will be operated one column relay, one of the sub-column relays in that column and one of the primary unit relays in that sub-column; in addition there may be a primary unit relay operated in other sub-columns.

With sub-column relay AA operated in dependence upon column relay A and with primary unit relay 1PA operated, then primary unit PSU1/A will be picked out as the unit which is to be connected through to a secondary unit.

If calls have also been originated on other primary units, then in cases where these units are in sub-columns other than the sub-column selected, the operation of one of the set of relevant primary unit relays will be without avail, while in the case where these units are in the sub-column selected the relevant primary unit relays will not be allowed to operate in view of the operation of relay 1PA which in so doing disconnects their operating circuits.

When primary unit PSU1/A is picked out in the above described manner, then the six prepare relays 1PP—6PP on this unit which are also connected up in a chain circuit are caused to test for an idle one of the six available outlets to a secondary unit. When a secondary unit is taken into use its ten prepare magnets 1SP—10—SP which are connected in a chain circuit are caused to test for an idle one of the ten possible outlets to first numerical selectors, and when a free outlet is found the calling party is switched through to the selector. At the same time the control equipment is released, whereupon, if a further call is waiting to be put through, the cycle of operations is repeated.

The operation of the various chain circuits will be appreciated from the ensuing circuit description of a call originated by a subscriber No. 3111 on primary unit PSU1/A, the line circuit concerned being shown in Figure 3. For convenience it will be assumed that when this subscriber removes his receiver he will be automatically connected through to the first of the sixty available selectors over the first vertical internal link of primary unit PSU1/A over the first of the six available external links to secondary units and then via the first vertical internal link of secondary unit SSU1.

In the circuits the number of contact units carried by each relay is shown beneath its designation, as for instance

$$\frac{A}{4}$$

(Fig. 3) for relay A, the contact units being designated individually in small letters which in this instance will be *a1*, *a2*, *a3* and *a4*.

As regards the crossbar vertical and horizontal relays, these are indicated by a hatched rectangle, the contact units individual thereto being indicated in the same manner as for ordinary relays. The set of crossbar switch contacts proper which are closed at the intersection of any given pair of vertical and horizontal bars, say the contacts controlled by magnets 1PH and 1PP on primary switching unit PSU1/A, are designated

$$\frac{1PH_1}{1PP}, \frac{1PH_2}{1PP}$$

according to the set of contacts involved.

When subscriber No. 3111 on primary unit PSU1/A originates a call, the loop placed by his telephone across the left-hand set of negative and positive conductors (Fig. 3) operates line relay 1R which in so doing at contacts *1r1* disconnects the standing idle marking battery via resistance YA and extends a guard earth on to the incoming test lead T from the final selector multiple FSM or its equivalent. At contacts *1r2* it starts up the so-called "primary control" chain circuit involving relays 1PA—5PA, associated respectively with the sub-column of primary units

PSU1/A—PSU1/D, so as to determine whether the primary unit PSU1/A concerned or whether another calling primary unit in the same sub-column shall be picked out as the one through which a call is to be extended to a selector at this time, it being appreciated that only one call can be dealt with at a time by the control equipment. In addition to this chain circuit there are fifteen similar circuits for the fifteen other sub-columns in the four columns of primary units and in each of these one of the primary unit relays may be operated if calls are originated at this time.

It should be explained that corresponding contacts 1*r*2—20*r*2 of the relays 1R—20R allocated to primary units PSU1/A—PSU5/A are given the same references in Fig. 3 for the purpose of convenience. It will readily be seen from their location in the chain circuit to which relays they belong.

Referring again to the primary control chain involving relays 1PA—5PA, and assuming that none of the units PSU2/A—PSU5 are originating a call at this time, then relay 1PA will operate over the following circuit: earth, chain connected contacts 1*pa*3—5*pa*3, contacts 1*pa*2, 1*r*2 and 1*pgb*1, winding of relay 1PA to battery. In connection with the contacts 1*r*2 it will be understood that in parallel with these contacts are the contacts 2*r*2—20*r*2 of the nineteen other line relays 2R—20R of the nineteen other subscribers on unit PSU1/A. Relay 1PA in operating locks over its make-first light contacts 1*pa*1, at contacts 1*pa*2 opens its initial operating circuit and at contacts 1*pa*3 opens the operating path for any of the other relays 2PA—5PA. Had another PA relay, say relay 2PA of unit PSU2/A, attempted to switch at the same time as relay 1PA, it will be seen that the latter in operating would have disconnected relay 2PA since the operating circuit for this other relay is completed over contacts 1*pa*3. Unit PSU2/A would then have had to wait until the call on unit PSU1/A had been put through. Relay 1PA thus has precedence over relay 2PA; relay 2PA over relay 3PA and so on.

Returning now to the operation of relay 1PA, this relay in operating at its contacts 1*pa*4 (Fig. 3) starts up the column chain circuit involving relays A—D and it will be noted that the contacts 1*pa*4—20*pa*4 of the relays 1PA—20PA are associated with the column 1 relay A. If at this time relay 1PA is the only one calling, then relay A will operate and will lock over its contacts *a*1, disconnect its operating circuit at contacts *a*2 and at contacts *a*3 will prevent any of the other relays B—D from coming in. In the event of there being simultaneous calls from two or more columns, it will be seen that relay A will have preference over relay B, relay B over relay C, and so on.

With relay A operated it is now possible due to the closure of contact *a*4 to determine which of the four sub-columns in column 1 shall be put through and this is effected by the sub-column discriminating chain shown in Fig. 5 and involving relays AA—AD. Associated with sub-column relay AA are the contacts 1*pa*5—5*pa*5 of the relays 1PA—5PA and assuming that a call has originated only from the first sub-column, relay AA will operate and at its contacts *aa*1 will lock and at its contacts *aa*2 and *aa*3 will open its own operating circuit and will prevent any of the other relays AB—AD from coming in.

With relays AA and 1PA operated the calling primary switching unit PSU1/A is now caused to test over the six available outgoing links to the secondary switching units and this is done by means of the prepare relays 1PP—6PP of this unit which are connected up in a chain circuit as shown in Fig. 5. For each sub-column there are five such chain circuits, the particular one in question being picked out by virtue of the particular primary unit relay which is operated. Hence with relays AA and 1PA operated earth will be extended over contacts *aa*4 on to lead 10, which is common to the prepare relay chain circuits of the five primary units PSU1/A—PSU5/A, and then via contacts 1*pa*6 to start up the chain circuit of unit PSU1/A. The test lead for the first of the six available outlets from this unit is designated 11, and if this is free, battery via resistance YB (Fig. 6) will be encountered thereon and relay 1PP will operate. This relay in operating locks at its contacts 1*pp*1, and at its contacts 1*pp*2 and 1*pp*3 opens its own energizing circuit and also any operating circuit for any of the other five relays 2PP—6PP. Relay 1PP in operating also actuates its horizontal bar. If two or more outlets are free, say the first and second, relay 1PP will have preference over relay 2PP and so on.

From Fig. 1 it will be seen that the first outgoing link from unit PSU1/A gives access to secondary unit SSU1 and hence relay 1PP in operating, at its contacts 1*pp*4 (Fig. 5) will extend earth over common lead 13 to energise the start relay SS of secondary unit SSU1.

As explained in connection with Fig. 1, unit SSU1 serves twenty incoming links from the primary units, and each link may be shared by up to four primary units so that the common start lead 13 will therefore be common to the contacts 1*pp*4 of the relays 1PP on all the primary switching units (up to eighty) in the primary/secondary group. As regards test lead 11, this will be common to the relays 1PP in the four primary units sharing access to the first vertical internal link on secondary unit SSU1, while as regards lead 12, this is common to the contacts 1*sh*2—20*sh*2 of the vertical holding relays 1SH—20SH on unit SSU1, common leads equivalent to 11 terminating on the other side of each of the contacts 2*sh*2—20*sh*2 in the same manner as for contacts 1*sh*2. The link busying function of the contacts 1*sh*2—20*sh*2 will be dealt with later.

Returning now to the operation of the start relay SS for secondary unit SSU1, in order to gain access to a free first numerical selecting unit it is now only necessary to pick out one of the ten outgoing leads from unit SSU1. Relay SS in operating, at its contacts SS1—SS10 (Figs. 6 and 4) closes chain circuits for the ten relays 1SP—10SP on unit SSU1, and these relays each test for a free outlet. To avoid having all the ten SP relays in one chain they are divided up into two interlinked chain circuits, the arrangements of each chain circuit being the same as those already described in that the first relay of the chain gets preference over the second, the second over the third, and so on. The interlinking arrangements between the two chain circuits are such that if any of the relays in the chain involving relays 1SP—5SP operate, then the second chain circuit will be disconnected at one or other of the contacts 1*sp*4—5*sp*4 and vice versa. Considering the operation of the first chain, on operation of relay SS, earth is connected up over the chain-connected contacts 6*sp*4—10*sp*4 and 1*sp*3—5*sp*3, contacts 1*sp*2, relay 1SP, contacts *ss*1 and lead 14 which connects up with the test lead T of the first of the ten links

extending from the unit SSU1. The other relays 2SP—5SP are connected up to similar test leads of other links, 15 designating the test lead for the fifth available link, while in Fig. 4 leads 16 and 17 respectively designate the sixth and tenth available test leads.

If the first of the available ten links is free, then relay 1SP will operate in series with the idle marking resistance battery which will be normally connected at the terminating group selecting unit to lead T, and at contacts *1sp1*, will lock, while at its contacts *1sp2*—*1sp4* it will open any operating circuit for all other relays both in its own chain circuit and in the other chain circuit of Fig. 4; in operating it also actuates its horizontal bar. At contacts *1sp5* (Fig. 4) an earth is extended on to lead 18 which is common to the contacts *1sp5*—*10sp5* of all ten SP relays on the unit SSU1, and relay SZ operates.

Relay SZ in operating at contacts *sz1* (Fig. 4) extends earth on to common lead 22 which is equivalent to the start lead 13 (Fig. 6) in that it is common to the contacts *1pp5* of the relays 1PP on all (eighty) of the primary units in the primary/secondary group, the contacts *1pp5* on primary units PSU1/A—PSU1/D connecting on their other side with relay 1SH, the corresponding contacts on units PSU2/A—PSU2/D connecting with relay 2SH and so on up to contacts *1pp5* on units PSU20/A—PSU20/D which connect with relay 20SH. Only one PP relay can be operated, however, at this time, in this instance relay 1PP on primary unit PSU1/A, and hence only the first vertical hold relay 1SH on unit SSU1 will be operated. Relay 1SH in operating, at its contacts *1sh1* prepares a locking circuit on to the hold lead H and actuates its associated first vertical bar on unit SSU1, so that the set of contacts at the intersection of the vertical and horizontal bars in question will be operated; these are shown as

$$\frac{1SH}{1SP}-3$$

in Fig. 4. Relay SZ in operating also at contacts *sz2* (Fig. 4) extends earth via the low resistance lower winding of relay Z on to lead 19 which is common to the contacts *aa5*—*dd5* of the sixteen subcolumn relays AA—DD. In this instance relay AA is operated so that the circuit will be extended through to common lead 20 which is common to the contacts *1pa7*—*5pa7* of the five relays 1PA—5PA of the primary units in the sub-column served by relay AA. In this instance relay 1PA is operated so that the circuit is extended through to common lead 21 which is common to the contacts *1r3*—*20r3* of the line relays 1R—20R of the twenty subscribers numbered 3111—3120 served by primary unit PSU1/A. In this instance contacts *1r3* are operated, signifying a call from subscriber No. 3111, so that the circuit is extended through to the vertical hold relay 1PH associated with this subscriber. If relay 20R had been operated instead of relay 1R signifying a call from subscriber No. 3120, then the circuit would have been established to relay 20PH. In case two or more line relays are operated, line relay 1R will receive preference over line relay 2R, relay 2R over relay 3R and so on up to 20R.

In the present instance relay 1PH in operating actuates its associated vertical bar, whereupon since relay 1PP has already operated, the cross-bar contacts

$$\frac{1PH}{1PP}\ 1—3$$

are closed and extend the calling subscriber's loop through to the first of the six selecting units available from unit SSU1. Relay 1PH in operating, at its contacts *1ph1* completes a temporary locking circuit for itself over contacts

$$\frac{1PH_3}{1PP}$$

and contacts *1sh1* and *1pp5* to earth via contacts *sz1*. This earth is also extended back to operate the calling subscriber's cut-off relay 1K whereupon line relay 1R releases and releases relay 1PA in the primary control chain, unless one or more of the line relays 2R—20R on primary unit PSU1/A are operated at this time. In the control equipment relay Z (Fig. 4) will have operated in series with relay 1PH and in so doing will have locked over its upper winding so that at contacts *z2* (Fig. 3) the column chain circuit involving relay A—D is opened to release the previously operated relay A and at the same time to prevent the chain circuit again coming into operation or being maintained in operation in response to other calls originated at this time. Relay A in releasing releases the operated subcolumn discriminating chain for column 1, involving relays AA—AD, and relay AA in releasing, at contacts *aa4* (Fig. 5) releases the secondary unit test chain involving the relays 1PP—6PP of primary unit PSU1/A. Relay 1PP in releasing, at contacts *1pp4* (Fig. 5) opens the start circuit to relay SS of unit SSU1 and also at contacts *1pp5* (Fig. 4) opens the local holding circuits for relays 1SH, 1PH and 1K. By this time, however, a guarding and holding earth will have been returned over the H lead from the selecting unit taken into use so that these relays will remain held throughout the connection. Relay SS in releasing opens the secondary unit outlet test chains involving relays 1SP—5SP and 6SP—10SP, whereupon the previously operated relay 1SP releases and in so doing at contacts *1sp5* (Fig. 4) releases relay SZ. Relay SZ in releasing, at contacts *sz3* (Fig. 4) releases relay Z, whereupon the earth feed to the column chain (Fig. 3) is restored at contacts *sz2*, and the equipment is now ready to handle the connection of another calling party to a free one of the sixty selectors available to the primary/secondary stage.

On release of the prepare relays 1PP and 1SP, the associated horizontal bars which were operated will have released, but the pins or their equivalents which were engaged by the actuated vertical bars remain held without appreciably restraining the restoration of the horizontal bars.

Relay 1SH in remaining operated, at its contacts *1sh2* (Fig. 6) marks the first vertical internal link on unit SSU1 as busy so that subsequent calls through this unit must be routed through one or other of the links 2—20 via their corresponding vertical hold relays 2SH—20SH. At the same contacts unit SSU1 is busied as far as a subsequent call from any of the units PSU1/A—PSU1/D are concerned, since these units have access only to the first vertical link on unit SSU1 via the first of the six available links to secondary units.

From the foregoing description it will be seen that of the up to sixteen hundred subscribers accommodated in the primary/secondary stage only one call at a time can be handled by the all-relay chain switching control equipment, other calls originated at this time having to wait till they can be picked out one by one by the control

equipment. The connecting process for each call is, however, almost instantaneous so that the waiting time for any calling subscriber before a dialling tone is received from a first numerical selector or its equivalent will never become excessive.

Referring again to the trunking diagram of Fig. 1, and again considering a call originated by subscriber No. 3111 on unit PSU1/A, connection with a group selecting unit cannot be effected, firstly if all the six available links to secondary units are directly busied due to the operation of the relays 1SH in each of the six secondary units SSU1—SSU6, while furthermore, any one of the links can be indirectly busied owing to the fact that on the associated secondary unit all ten outlets therefrom to first numerical selecting units are already in use.

In the first instance, with the relays 1SH in all the units SSU1—SSU6 in an operated condition, the series-connected contacts *1sh*3 (Fig. 6) on each of these relays will bring up the busy relay 1PGB associated with the six links available to the four units PSU1/A—PSU1/D. Relay 1PGB in operating, at its contacts *1pgb*1 (Fig. 3) disconnects any circuit to relay 1PA thus preventing further calls from subscribers 3111—3120 on primary unit PSU1/A from being dealt with, while in addition other contacts *1pgb*2—*1pgb*4 (not shown) will disconnect relays 1PB—1PD from their relevant primary control chain circuits so as to prevent the subscribers on the units PSU1/B—PSU1/D from setting up connections. Any one of these eighty subscribers must therefore wait until one of the six links, available in common to their primary units, becomes free.

Similar remarks apply to the sets of six links available to other primary units, relay 20PGB (Fig. 6) serving the units PSU20/A—PSU20/D.

In the second instance, if all ten outlets from secondary unit SSU1 are engaged, all links thereto from the primary switching units are busied in the following manner. For each secondary switching unit a group busy relay is provided, relay 1BG (Fig. 6) serving unit SSU1. This relay is connected via rectifiers such as MRA or MRB to the outgoing test lead of all ten outlets of the secondary unit. If any of the ten outlets are free, then relay 1GB will remain operated to the relevant idle marking resistance battery and will maintain its contacts *1gb*1 (Fig. 6) in the operated position as shown. If all ten outlets become busy, then relay 1GB will release. It may be mentioned here that rectifiers such as MRA and MRB are provided to prevent mutual interference between the outgoing test leads to which relay 1GB is connected.

Relay 1GB in releasing at its contacts *1gb*1 brings up relay 1SGB which is individual to the unit SSU1 and this relay in operating, at its contacts *1sgb*21 disconnects the idle marking resistance battery from common lead 12 so as to mark all twenty of the incoming link test leads as busy. At contacts *1sgb*1—*1sgb*20 it simulates the operation of all the relays 1SH—20SH on unit SSU1 to prepare for the operation of one or other of the busy relays 1PGB to 20PGB when the requisite conditions obtain.

What we claim as new and desire to secure by Letters Patent is:

1. In a telephone system, a plurality of groups of crossbar switches each having a plurality of subscribers' lines and a plurality of trunks terminating therein, a relay chain for each group of switches, each of said relay chains containing a plurality of relays corresponding respectively to the different crossbar switches in the associated group of switches, a further relay chain containing a plurality of relays corresponding respectively to the different groups of switches, means operated responsive to a calling condition on any one of said subscriber's lines for operating a relay in said last chain and a relay in one of said other chains, and means controlled conjointly by said two operated relays for operating a particular one of said crossbar switches to connect the calling subscriber's line to one of the trunks terminating in that switch.

2. In a switching system, a plurality of groups of crossbar switches, each of said switches having a plurality of incoming lines and a plurality of outgoing lines, a relay chain for each group of switches, each of said relay chains containing a plurality of relays corresponding respectively to the different switches in the associated group of switches, a further relay chain containing a plurality of relays corresponding respectively to the different groups of said switches, means controlled over any one of said incoming lines to operate a relay in said last chain and a relay in one of said other chains, and means controlled conjointly by said two operated relays to operate a particular one of said crossbar switches to connect said one incoming line to an idle one of the lines outgoing from that switch.

3. In a system as claimed in claim 1, means in each relay chain preventing the concurrent operation of any two relays in that chain, thereby to prevent connections from being completed simultaneously by any two of said cross-bar switches.

4. In a switching system, a plurality of crossbar switches arbitrarily divided into groups and subgroups, each of said switches having a plurality of incoming lines and a plurality of outgoing lines; a subgroup relay chain for each subgroup of switches, each of said subgroup chains containing a plurality of relays corresponding respectively to the different switches in the associated subgroup; a group relay chain for each group of switches, each of said group chains containing a plurality of relays corresponding respectively to the different subgroups in the associated group; a system relay chain containing a plurality of relays corresponding respectively to the different groups of switches; and means controlled over any one of said incoming lines for operating a relay in said system relay chain, a relay in one of said group relay chains and a relay in one of said subgroup relay chains, thereby to operate a particular one of said crossbar switches to connect said one incoming line to an idle one of the lines outgoing from that switch.

5. In a switching system, a plurality of groups of crossbar switches, each of said switches having a plurality of incoming lines and a plurality of outgoing lines, a plurality of primary relays corresponding respectively to the different ones of said switches, a plurality of secondary relays corresponding respectively to the different ones of said groups, means normally controlled by a calling condition on any one of said incoming lines for operating the primary relay corresponding to the particular crossbar switch in which that line appears and also operating the secondary relay corresponding to the group in which said particular switch appears, means controlled by said two operated relays for operating said particular crossbar switch to connect said calling line to one of the lines outgoing from said particular

switch, and means preventing the concurrent operation of primary relays which correspond to different switches in the same group and preventing the concurrent operation of different secondary relays.

6. In a switching system, a plurality of crossbar switches arbitrarily divided into groups and subgroups, each of said switches having a plurality of incoming lines and a plurality of outgoing lines; a plurality of primary relays corresponding respectively to the different ones of said switches; a plurality of secondary relays corresponding respectively to the different ones of said subgroups; a plurality of tertiary relays corresponding respectively to the different ones of said groups; means normally controlled by a calling condition on any one of said incoming lines for operating the primary relay corresponding to the particular crossbar switch in which that line appears, the secondary relay corresponding to the particular subgroup in which said particular switch appears, and the tertiary relay corresponding to the group in which said particular subgroup appears; means including said three operated relays for operating said particular crossbar switch to connect said calling line to one of the lines outgoing from said particular switch; means preventing the concurrent operation of any two primary relays which correspond to crossbar switches in the same subgroup; means preventing the concurrent operation of any two secondary relays corresponding to subgroups in the same group; and means preventing the concurrent operation of any two of said tertiary relays.

7. In a switching system, a crossbar switch having a plurality of incoming lines and a plurality of groups of outgoing lines, means for operating said switch to connect any one of said incoming lines to any one of said outgoing lines, said means including a plurality of magnets corresponding respectively to said outgoing lines, a plurality of chain circuits corresponding respectively to the different ones of said groups, each chain circuit including the magnets which correspond to the outgoing lines of one group, means in each chain circuit preventing the concurrent operation of any two of the magnets in that circuit, and means interlinking the different ones of said chain circuits to prevent concurrent operation of magnets in different chain circuits.

8. In a switching system, a plurality of primary crossbar switches arbitrarily divided into groups, a plurality of individual relays corresponding respectively to the different ones of said switches, a plurality of group relays corresponding respectively to the different ones of said groups, a plurality of secondary crossbar switches, a plurality of lines terminating in each of said primary and secondary switches, links extending from each primary switch to every secondary switch, means controlled by a calling condition on any line terminating in one of said primary switches for operating the individual relay corresponding to the particular primary switch in which the calling line terminates and also operating the group relay corresponding to the group in which that primary switch appears, means controlled by said two operated relays for selecting an idle link from said particular primary switch to any one of said secondary switches, and means for thereupon operating said particular primary switch and said one secondary switch to complete a connection over said selected link from said calling line to one of said lines terminating in said one secondary switch.

9. In a switching system, a plurality of groups of primary crossbar switches, a plurality of individual relays corresponding respectively to the different ones of said switches, a plurality of group relays corresponding respectively to the different ones of said groups, a plurality of lines terminating in each of said switches, a plurality of secondary crossbar switches, links extending from each primary switch to every secondary switch, means controlled by a calling condition on any one of said lines for operating the individual relay corresponding to the particular primary switch in which the calling line terminates and also operating the group relay corresponding to the group in which that primary switch appears, means controlled by said two operated relays for selecting an idle link from said particular primary switch to any one of said secondary switches, a plurality of lines outgoing from said one secondary switch, means for operating said particular primary switch and said one secondary switch to complete a connection over said selected link from said calling line to one of said outgoing lines, said last means including a plurality of magnets corresponding respectively to said outgoing lines and a chain circuit for preventing the concurrent operation of any two of said magnets.

10. In a switching system, a plurality of groups of primary crossbar switches, a plurality of individual relays corresponding respectively to the different ones of said switches, a plurality of group relays corresponding respectively to the different ones of said groups, a plurality of lines terminating in each of said switches, a plurality of secondary crossbar switches, links extending from each primary switch to every secondary switch, means controlled by a calling condition on any one of said lines for operating the individual relay corresponding to the particular primary switch in which the calling line terminates and also operating the group relay corresponding to the group in which that primary switch appears, means controlled by said two operated relays for selecting an idle link from said particular primary switch to any one of said secondary switches, a plurality of groups of lines outgoing from said one secondary switch, means for operating said particular primary switch and said one secondary switch to complete a connection over said selected link from said calling line to one of said outgoing lines, said last means including a plurality of magnets corresponding respectively to said outgoing lines, a plurality of chain circuits corresponding respectively to the different ones of said groups of lines, each chain circuit including the magnets which correspond to the outgoing lines of one group, means in each chain circuit for preventing the concurrent operation of any two magnets in that circuit, and means interlinking the different ones of said chain circuits to prevent concurrent operation of magnets in different chain circuits.

CHARLES GILLINGS.
LAWRENCE JOHN MURRAY.