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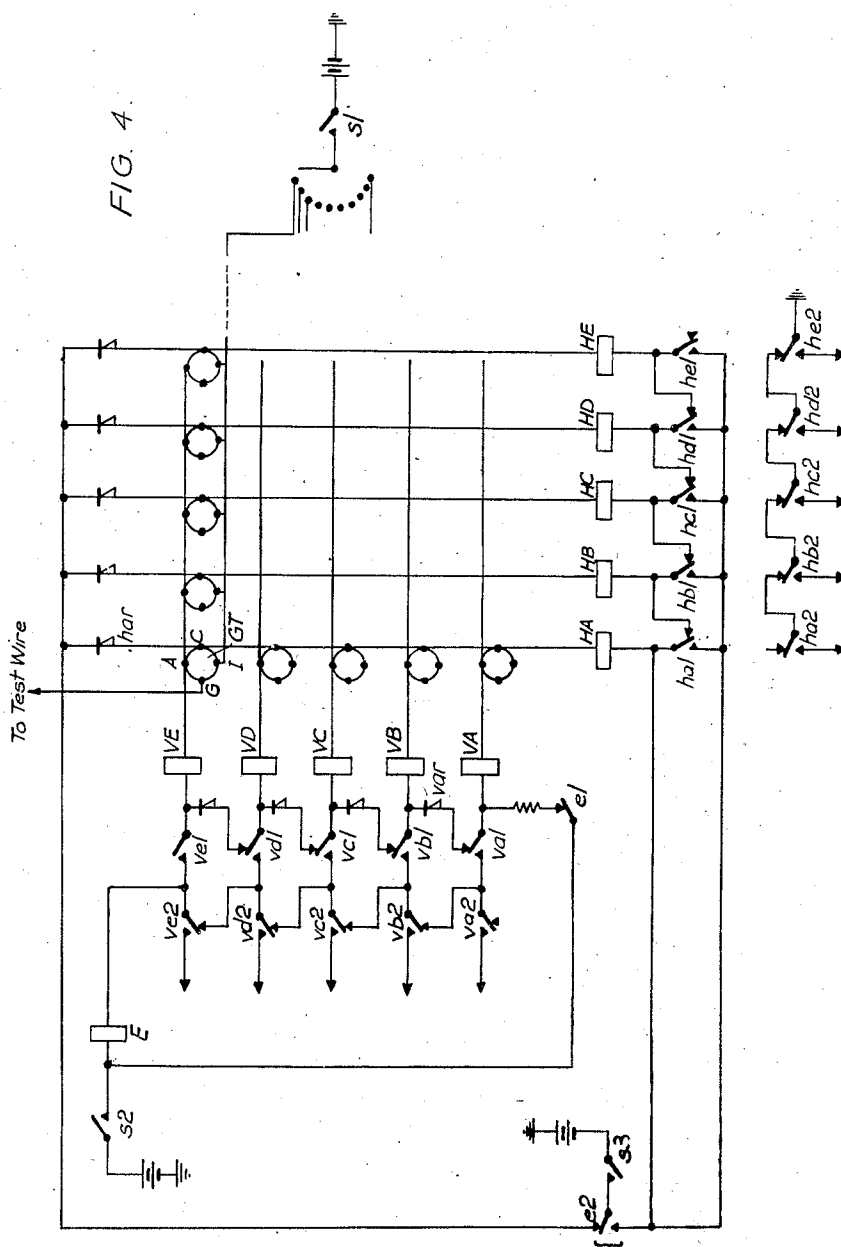
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HIGH SPEED SEARCHER USING GAS DISCHARGE TUBES

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HIGH-SPEED SEARCHER USING GAS
DISCHARGE TUBES

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This invention relates to searching arrangements in telephone systems.

In the setting up of a telephone connection at an exchange occasions arise when it is necessary to select a free line or link out of a group of lines or links and in the search for a free line in a group it is also frequently desirable that the lines should be searched in a predetermined order.

In the present invention a searching equipment is provided which is adapted to be associated with a group of lines when occasion demands. The searching equipment comprises grid controlled gas discharge tubes associated with the several lines to be searched in such a manner that when search is to be effected a number of tubes are immediately brought to a threshold or active condition and the presence of a potential indicative of a free or marked line on an electrode of a tube causes that tube to ignite and complete a circuit for bringing about an indication of that line. In order to prevent confusion due to a number of free or marked lines bringing about the ignition of a number of tubes it is preferably arranged that the ignition of one tube in a row of tubes prevents the operation of any other tube in the row from becoming effective. The tubes may be arranged in rows and columns and a group of lines may be associated with a plurality of rows of tubes. On the other hand a row of tubes may be associated with more than one group of lines, suitable means being provided for ensuring search in the desired group.

Where a large group is concerned the rows of tubes may be actively connected up in succession testing a plurality of lines simultaneously until a free or marked line is found and owing to the nature of the arrangements the time of search is the time taken to switch over successively from one row to the next. Switching between rows of tubes will be effected if there is no free line in a row actively connected up for the time being and will be carried out so that the several rows of tubes are actively connected up in turn in a predetermined order. Since there is likely to be more than one free or marked line in a row the arrangements will provide for identifying the first of the free lines in the row in sequential order and preventing identification of the other lines.

The identification may be performed conveniently by relays, one for each row and one for each column. The ignition of a tube will bring about the operation of the two relays indicative of the position of the tube and the relay ap-

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propriate to the column in which the ignited tube is situated may prevent operation of or effect release of the relays of later columns in the sequence. Similar arrangements may be provided for the relay appropriate to the row in which the ignited tube is situated. It may be arranged for the relay appropriate to a column and/or row to lock up after operation independently of the other column or row relays. For switching from one row to another a relay may be provided for each row and be so connected that its operation will be dependent on the failure of a column relay to operate. Obviously the references to rows and columns can be reversed and this is to be understood throughout this specification. Although it has been stated that rows of tubes may be actively connected up in succession it may be arranged, when the characteristic of the tubes and relays permit, for all the tubes to be actively connected to the outlets of a group at the same time.

The use of a searcher according to the invention is especially advantageous in cases where large groups of outlets are to be searched. The identification may take any suitable form convenient to the arrangements made for taking into use an identified outlet. For instance, an outlet may be indicated to an operator by lighting a lamp indicative of the outlet or, by means of a suitable signalling circuit indicating the number of an identified outlet on an indicator. The searcher may also be used for bringing about a connection with an outlet by an automatic selecting switch and in this connection the arrangements are especially suitable for use with switching arrangements of the kind in which connection is made directly with an outlet of the intersection of two conductors without the necessity of wipers having to traverse rows of contacts in one or more planes, an example of such arrangements being a switch of the kind commonly referred to as a cross-bar switch. Since the identification is performed by a co-ordination of the function of two relays it may be arranged for this co-ordination to be effected in the switch itself, one relay bringing about the operation of a member controlling connection with one co-ordinate and the other relay bringing about the operation of a member controlling connection with the other co-ordinate so that connection is actually made only at the point of intersection of the co-ordinates.

The outlets of the searcher are conveniently arranged on the co-ordinate principle and they may be so arranged that of a number of free

outlets selection is made in a predetermined order. If the outlets are outlets from an automatic switch of the type referred to their position in the switch may differ from that in the searcher since the order of selection is determined by the searcher and would be signalled to the switch, the connection between the two pieces of apparatus being flexible so far as selection is concerned.

Embodiments of the invention are illustrated by way of example in the accompanying drawings of which the following is a description. Fig. 1 of the drawings shows the arrangements of a searcher suitable for use with a single group of outlets. Fig. 2 shows a modification of Fig. 1 to deal with different groups of outlets. Fig. 3 shows a modification of the connections of the set of column relays of Fig. 1 and Fig. 4 shows a further modification of the general arrangements of Fig. 1.

Reference will first be made to Fig. 1. A number of cold cathode gas discharge tubes GT, twenty-five in the present example, are arranged in co-ordinate fashion, there being five rows and five columns of tubes. With each row is associated a pilot tube PT and relays L and V and with each column a column relay H. The gas discharge tubes GT are of the kind in which each has four electrodes, there being an anode A, a cathode C, a control electrode G and a starting electrode I. The pilot tubes are of the kind in which each has three electrodes, an anode A, cathode C and starting electrode I. There is also a starting relay (not shown) which is operated when the searcher is to function, contacts s1, s2 and s3 of this relay being shown, and which connects up the several sources of potential to the searcher for its operation. The function of the relays L is to connect up the several rows of tubes in succession while the functions of the row relays V and column relays H are by their co-ordination to identify or signal a particular outlet in the group. The row and column relays are preferably of the high speed type. The row relays are connected in the circuits for the cathodes of the tubes, relay VA being connected in the circuit for the cathodes of the tubes in the uppermost or first row, relay VB being connected in the circuit for the cathodes of the tubes in the second row and so on. The column relays are connected in the circuits for the anodes of the tubes relay HA being connected in the circuit for the anodes of the tubes in the left hand or first column, relay HB being connected to the second column and so on. It will be noticed that the column relays are connected to a chain contact circuit of these relays, the circuit for relay HB and subsequent column relays including break contacts of the preceding relays to prevent more than one column relay remaining operated. The starting electrodes of the tubes GT and pilot tube PT of a row are connected to a source of ionising potential over a contact of the relevant L relays, the operating windings (I) of the relays being connected in the anode circuits of the several pilot tubes. The control electrodes of the tubes GT are connected individually to the test wires of the outlets the searcher is arranged to test, the test wire of a free outlet being marked by the presence of positive potential over the winding of a relay while if the outlet is engaged the test wire will be at earth potential. For the operation of the tubes two batteries are employed one with its positive

pole earthed and the other with its negative pole earthed or a single battery may be employed the connections of the points indicated by the earth symbol being made to a suitable point on the battery which may or may not be earthed.

The operation of the searcher is as follows. When the searcher is required for use the starting relay is operated and contact s1 connects ionising potential to all the starting electrodes of the five tubes in the first row and charges up condenser QA over resistance YA; contact s2 connects the positive pole of battery over the column relays to the anodes of all the tubes in the five columns and over the operating winding of the L relays to all the pilot tubes; contact s3 connects the negative pole of battery to the cathodes of all the pilot tubes and over the row relays to the cathodes of all the tubes in the five rows. By the connection of ionising potential to the starting electrodes of the first row of tubes these tubes are brought to a threshold condition of ionisation and those tubes connected to the test wires of free outlets will ignite due to the presence of positive potential on their control electrodes. The presence of earth potential or the potential of a tapping point on the battery hereinafter termed earth, negative with respect to the free potential on the control electrode of a tube will prevent that tube igniting. All the tubes in the first row that are connected to free outlets will ignite and their anode-cathode circuits will become conductive and relay VA will operate over the tube circuits in series with the corresponding column relays. The operation of the column relay in the earliest column containing a tube in the first row connected to a free outlet will prevent a later column relay from operating fully or remaining operated by opening its contact in the chain circuit to which the column relays are connected. If, for example, the outlets connected to the first row tube in the first column and to other tubes in the first row are free relay VA will operate in series with relay HA and contact ha1 opening will prevent other column relays from becoming fully operated or from remaining operated. Thus, the row relays and the tubes in the row have identified free outlets in the row and the column relay has identified a particular outlet amongst the free outlets. Contacts of the row and column relays would be connected in circuits for indicating in a suitable manner the identified free outlet, i. e., in the example the outlet connected in the first column of the first row of tubes in the searcher. The seizure or taking into use of this outlet causes earth potential to be connected to the test wire as indicated by the contacts bp and consequently to the control electrode of the first tube thereby marking it engaged for subsequent search and the starting relay will be released. Contacts of this relay opening disconnect the potentials on the anode, cathode and starting electrodes and the tube is extinguished. It will be appreciated that so far as the outlets connected to the first row are concerned these are tested simultaneously. Should there be no free outlet connected in the first row condenser QA will become charged and a gradually increasing positive potential will be applied to the starting electrode of the pilot tube. This affords a slight delay period covered by the capacity of the condenser and the value of the resistance YA before the pilot tube can strike, giving time for the operation of the column relay

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and the opening of its contact in the chain circuit which cuts off the anode potential for the pilot tube. If there is no free outlet connected in the first row the pilot tube will strike after the short delay period and relay LA will be operated in the circuit of the tube. The relay will lock up over its winding (II) and contacts *la1* and *s1* and the ionising potential over contact *s1* will be applied to the tubes of the second row and the outlets connected in this row will be tested in a similar manner. If no free outlet is found the pilot tube of this row will ignite after the short delay period and relay LB will operate and lock up extending the ionising potential to the tubes of the third row. Operations will continue in this manner until if no free outlet is found all the outlets connected to the searcher will have been tested whereupon relay LE will be operated and will lock temporarily. By the connection of contact *le2* in the circuit for the locking winding of relay LA all the L relays can be released and the ionising potential again applied to the tubes of the first row and a retest of the outlets may be commenced.

The column relays are preferably of the high speed type which will operate in 1 millisecond or less and the L relays may operate in 1.5 milliseconds so that if the searcher comprises ten rows of 10 columns 100 outlets can be tested in about 20 milliseconds.

Referring now to Fig. 2 it will be seen that there are contacts of additional starting relays for applying the starting potential to the starting electrodes. These contacts are designated *1s1*, *2s1* and *3s1* and are to be assumed to be controlled by relays 1S, 2S, and 3S respectively. The tubes are shown in outline only their starting electrodes being included and the pilot tubes and row and column relays and their connections are not shown neither are the connections to the test wires of the outlets to be tested. The pilot tubes may be assumed to be connected together with their L relays in the manner shown in Fig. 1 and the connections of the electrodes of the tubes which are not shown are to be assumed to be connected in a similar manner to that shown in Fig. 1. The figure shows by way of example three groups of outlets, the first row of tubes comprising one group of outlets, the second group of outlets being connected to all the tubes in the second row and the earlier tubes in the third row. The third group of outlets is connected to the later tubes in the third row and to tubes in the fourth row. If a search is to be made in the first group of outlets contact *1s1* will be closed to apply ionising potential to the starting electrodes in the tubes of the first row. Test is made of the outlets connected in this row in the manner previously described and if no free outlet should be found relay LA is operated and locked up. Since, in the example given no switching from one row to another is required relay LA may be omitted together with the pilot tube for this row. If search is to be made in the second group contact *2s1* is closed and the outlets connected in the second row are tested and if no free outlet is found relay LB is operated and locked up and the ionising potential is transferred to the earlier tubes in the third row. Search of the outlets of the third group commences with the later outlets connected in the third row and if no free outlet should be found therein relay LC will be operated to extend the ionising circuit to the tubes in the fourth row with which relay LD may be associated.

It will be seen from the description that has

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already been given that outlets are tested simultaneously in groups, or sub-groups and that the groups and the outlets therein are taken into use in a predetermined order so that an order of preference may be had.

The arrangement of the connection of the column relays to the chain circuit shown in Fig. 3 ensures that once an outlet has been selected by the operation of a column relay it cannot be released in favour of an earlier choice outlet if one should become free before the selected outlet is taken. As in the arrangement illustrated in Fig. 1 the circuit for a column relay includes break contacts of relays connected earlier in the chain and when a relay operates it connects a holding circuit for itself over its contact *1* independently of contacts of earlier relays. Thus relay HB on operation opens the operating circuit for relays HC, HD and so on at its early opening contact *hb1* and at the same contact closes a holding circuit for itself independent of contact *ha1* so that should relay HA tend to operate before the outlet indicated by the operation of relay HB has been taken it cannot bring about the release of relay HB. The devices designated MA, MB and so on in this figure which represent suitable devices for co-ordinating the columns of outlets are connected up over a chain of contacts of the column relays in reverse order to that in the column relay chain. Thus, device MA, is connected up over the front contacts of relay HA and back contacts of relays HB, HC and so on. Assuming relay HB to have operated, device MB is connected up over front contact *hb2* and back contacts *hc2* and *hd2* and so on. If relay HA should operate before the outlet in the column identified by relay HB has been taken it cannot release relay HB as before explained and its closure of contact *ha2* will be without effect as the circuit over it has already been opened at contact *hb2*, i. e., by a relay later in the chain.

Fig. 4 shows a searcher in which the circuit arrangements shown in Fig. 3 are applied both to rows and columns. In Fig. 4 twenty-five cold cathode gas discharge tubes GT are shown arranged in co-ordinate fashion in the manner shown in Fig. 1 but for convenience the electrodes themselves are not shown but they are connected to the points indicated at A, C, G and I for the anode, cathode, control electrode and starting electrode respectively. These positions do not correspond to those shown in Fig. 1 but are arranged to suit the drawing. The first row in this figure is the lowermost and the first column is the left hand column. As in Fig. 1 the row relays are designated VA, VB and so on and the column relays HA, HB and so on and contacts *s1*, *s2*, and *s3* are contacts of a starting relay. There is an additional relay E the purpose of which is to disconnect the anode potential of earlier rows after a row relay has operated and to connect up the column relays. When the searcher is required for use the starting relay is operated and contact *s1* applies ionising potential to the starting electrodes. This may be applied to a particular row or rows as indicated over a wiper and contact bank of a stepping switch. Contact *s2* applies the anode potential from the positive pole of battery over back contact *e1* of relay E and a resistance to a chain circuit to which the row relays are connected and over the row relays to the anodes of the tubes, the anodes of all the tubes of a row being connected to the relevant row relay. Each anode circuit therefore includes break contacts of the row relays of earlier rows,

there being no such contacts in the anode circuit of the first row. Contact *s3* connects the negative pole of battery over back contact *e2* and dry metal rectifiers *har* and so on to the several cathodes, the cathodes of all the tubes in a column being connected over a rectifier and all such circuits being connected in parallel. The control electrodes of the several tubes are connected individually to the test wires of the outlets available to the searcher. For the sake of description it will be assumed that only one large group of outlets is concerned and that the searcher can test all of these if necessary in the search for a free outlet, ionising potential being connected to the starting electrodes of all the tubes. All the outlets of all the rows are tested simultaneously and it may be that more than one row relay tends to operate. Let it be assumed that relays VB, VC, VD, VE all tend to operate and that there is no free outlet in the first row. The circuit for relay VB is from the positive pole of the battery over contacts *s2*, *e1*, the resistance, back contact *val*, rectifier *var*, relay VB, through the tubes of the second row connected to free outlets from anode to cathode, the rectifiers *har* and so on, back contact *e2*, contact *s3* to the negative pole of battery. There will also be circuits through the other row relays, all these circuits including back contact *vb1*, and similar contacts of later relays in the chain that are earlier in the order than the row relay tending to operate. Obviously the partial operation of relay VC and later relays will have no effect on the operating circuit for relay VB so that relay VB will operate and by changing over its contact *vb1* will break the chain circuit to which the later row relays are connected so that these will not operate. A locking circuit for relay VB independent of relay VA is now closed over contact *s2*, the winding of relay E and front contact *vb1*. Since the later relays are now in a de-energised condition the reverse order chain of contacts of the row relays, will extend the positive potential over the second contacts of the later relays and front contact *vb2* for operating a co-ordinating device such as that represented at MB in Fig. 3. Relay E operates in the previously traced circuit and at contact *e1* disconnects anode potential from the tubes of the first row or more generally from the tubes of rows earlier than that associated with the operated row relay. Contact *e2* which is of the make-before-break type disconnects the original cathode circuit over the rectifiers *har* and so on and connects up the column relays. Let it be assumed that there are free outlets in the second row in the columns connected to relay HC, HD and HE. These relays will tend to operate in series with relay VB and the tubes in the respective columns, the circuit including break contacts of relays HA and HB but on the operation of relay HC contact *hc1* will open the chain and prevent the later relays from operating fully. Relay HC locks up over front contact *hc1* independently of contacts *hb1* and *ha1*. Contact *hc2* in the reverse order chain of contacts closes and operating circuit for a co-ordinating device to determine the column in which the free outlet has been identified and the co-ordination of the two operated devices completes identification of the free outlet found by the searcher. Even if an outlet situated in the selected row of the searcher but in an earlier column should become free before the indicated outlet is taken and the corresponding earlier column relay operates, it will be without effect so far as the indication is concerned as the reverse

order chain of contacts will be open at the contact of the later relay. The method of indication may be carried out over a signalling circuit, the indication given being one resulting from a code formed by the combination of the row and column relays operated.

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

1. In a telephone system, a group of outlets, a group of cold cathode gas discharge tubes one for each outlet, a pair of main electrodes in each of said tubes, a relay common to said tubes and connected to one of the main electrodes of each tube, a relay individual to each of said tubes and connected to the other main electrodes thereof, control electrodes in said tubes connected to said outlets, and means including said control electrodes for testing said outlets and for causing the simultaneous discharge of any tubes in said group associated with free outlets, said common relay and one of said individual relays being operated thereby to select one of said free outlets.

2. In a telephone system, a group of outlets, a group of cold cathode gas discharge tubes one for each outlet grouped in rows and columns, a pair of main electrodes in each of said tubes, a relay for each row connected to one of the main electrodes of each tube in said row, a relay for each column connected to the other main electrodes of the tubes in said column, control electrodes in said tubes connected to said outlets, means including said control electrodes for testing said outlets and for causing the simultaneous discharge of a plurality of tubes associated with free outlets, and means to cause the operation of one of said row relays and one of said column relays in response to said discharge of said plurality of tubes to select one of said free outlets.

3. In a telephone system, a group of outlets, a group of cold cathode gas discharge tubes one for each outlet connected in rows and columns, a pair of main electrodes in each of said tubes, a relay for each row connected to one of the main electrodes of the tubes in said row, a relay for each column connected to the other main electrodes of the tubes in said column, control electrodes in said tubes connected individually to said outlets, means including said control electrodes for simultaneously testing the outlets associated with a row of said tubes, means for causing the simultaneous discharge of any tubes in said row connected to free outlets, and means to cause the operation of the corresponding row relay and one of said column relays in response to said discharge to select a preferred one of said free outlets.

4. In a telephone system, a group of outlets, a group of cold cathode gas discharge tubes associated therewith arranged in rows and columns, a pair of main electrodes in each of said tubes, a relay for each row connected to one of the main electrodes of the tubes in said row, a relay for each column connected to the other main electrodes of the tubes in said column, other electrodes in said tubes, means including said other electrodes for testing the idle or busy condition of the outlets associated with a row of said tubes, means for causing the discharge of any tubes in said row associated with idle outlets, the corresponding row relay and one of said column relays being operated thereby to select one of said idle outlets, and a chain circuit controlled by said column relays to cause their operation in a preferred order by the disablement of relays later in the chain upon the operation of a relay earlier in the chain.

5. In a telephone system, a group of outlets, a group of associated gaseous discharge devices one for each outlet connected together in rows and columns, a row relay for each row and a column relay for each column, a cathode in each device, the cathodes of each row of devices being connected together and to the associated row relay, an anode in each device the anodes of each column of devices being similarly connected together and to the associated column relay, means for causing the simultaneous discharge of all devices associated with free outlets in one of said rows of devices, the corresponding row relay and one of said column relays being operated in response to said discharge to select one of said free outlets, a chain circuit controlled by said column relays whereby the operation of a relay early in said chain disables the succeeding relays to provide selection of free outlets in a preferred order, and a reverse chain circuit controlled by said column relays to prevent the subsequent operation of a still earlier relay from interfering with said selection.

6. In a telephone system, a plurality of outlets, a plurality of gaseous discharge devices individually associated therewith and arranged in rows and columns, a pair of main electrodes in each device, a row relay for each row and a column relay for each column said relays each connected respectively to one of the main electrodes of all the devices in the associated row or column, a control electrode in each device, a starting electrode in each device, means including said control and starting electrodes for simultaneously testing the outlets associated with a row of said devices, and means for causing any devices in said row associated with a free outlet to discharge across their main electrodes and operate the corresponding row relay and one of said column relays to select or identify a preferred one of said free outlets.

7. In a telephone system, a plurality of outlets, gaseous discharge devices individually associated with said outlets and grouped in rows and columns, a pair of main electrodes in each device, a row relay for each row and a column relay for each column each connected respectively to one or the other of the main electrodes of the devices in the associated row or column, a control electrode and a starting electrode in each device, means including said control and starting electrodes for testing the outlets associated with a row of said devices, means for causing any devices in said row associated with free outlets to discharge and operate the corresponding row relay and one of said column relays to select or identify one of said free outlets, and means operative in case no free outlet is available in said row for causing the other rows of devices to test similarly in succession until a free outlet is encountered.

8. In a telephone system, a plurality of outlets, a plurality of gas discharge tubes individually associated with said outlets and grouped in rows and columns, an anode and a cathode in each tube, a row relay for each row of tubes and connected to the cathodes thereof, a column relay for each column of tubes and connected to the anodes thereof, a starting electrode in each tube, means for connecting starting potential to the starting electrodes of one of said rows of tubes, means for causing all tubes in said one row associated with free outlets to discharge simultaneously in response to the application of said starting potential and operate the corresponding row

relay and one of said column relays to select a preferred one of said free outlets, means operative in case no free outlets are found by said one row of tubes for connecting starting potential to successive rows of tubes in a preferred order, and timing means for causing said starting potential to be connected to each successive row of tubes only after the expiration of a definite time interval.

9. In a telephone system, a plurality of outlets, a plurality of gas discharge tubes connected together in a co-ordinate arrangement of rows and columns and to said outlets, an anode and a cathode in each tube, a row relay for each row connected to the cathodes of said row, a column relay for each column connected to the anodes of said column, a starting electrode in each tube, means for connecting starting potential simultaneously to all the starting electrodes of a preferred row of said tubes, means for causing any tubes in said row associated with a free outlet to discharge in response to the application of said starting potential and operate the associated row relay and a preferred one of said column relays to select a preferred one of said free outlets, means operative in case none of the outlets associated with said row are free for connecting starting potential to a succeeding row of tubes, and a timing device including an electrical network and an additional gas discharge tube associated with said row to cause said starting potential to be connected to said succeeding row only after a definite time interval.

10. In a telephone system, a plurality of outlets, a plurality of gas discharge devices one for each outlet connected in rows and columns, a main anode and a main cathode in each device, a row relay for each row connected to the main cathodes thereof, a column relay for each column connected to the main anodes thereof, a control electrode in each device connected to a test conductor of the associated outlet, a starting electrode in each device, means for connecting starting potential to the starting electrodes of one row of devices, means for causing one or more devices in said one row to discharge across their main electrodes in response to said starting potential and to the presence on their control electrodes of a potential indicating a free outlet, the associated row relay and one of the associated column relays being operated in response to said discharge to select one of said free outlets, means comprising an additional discharge device and a transfer relay associated with each row of devices except the last and operative in case no free outlets are available to said row for connecting starting potential to the next succeeding row of devices, and similar means associated with the last row of devices operative in case no free outlets have been found in any row for causing starting potential to be re-connected to the first row of devices to permit repeated tests to be made.

11. In a telephone system, a plurality of outlets, a plurality of associated gas discharge tubes arranged in rows and columns, an anode and a cathode in each tube, a control electrode in each tube for testing said outlets, a starting electrode in each tube, a relay common to each row of tubes and connected to the cathodes thereof, a relay common to each column of tubes and connected to the anodes thereof, means for connecting a starting potential to said starting electrodes, means including said starting and control electrodes for causing tubes associated with free outlets to discharge and cause the operation of a

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preferred row relay and a preferred column relay to select one of said free outlets, and means to cause said preferred column relay to operate only after said preferred row relay has operated.

12. In a telephone system; a plurality of outlets; a group of gas discharge tubes individually associated therewith and arranged in rows and columns; an anode and a cathode in each tube, a row relay for each row of tubes and connected to the cathodes thereof; a column relay for each column of tubes and connected to the anodes thereof; a starting electrode for each tube and means for connecting a starting potential to all of said starting electrodes simultaneously, means for causing any tubes in said group associated with free outlets to discharge responsive to said starting potential and energize the row relays connected thereto, means controlled by said row relays for causing the operation of a preferred one of said energized row relays to prepare the selection of a free outlet associated with a preferred row of said tubes, means also controlled

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by said operated row relay for causing the energization of those column relays connected to operated tubes, means controlled by said column relays for causing the operation of a preferred one of said energized column relays, and means controlled by said operated column relay to complete the selection of a preferred free outlet associated with said preferred row of tubes.

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