

May 28, 1940.

R. E. COLLIS
TELEPHONE SYSTEM

2,201,986

Filed June 17, 1938

4 Sheets-Sheet 1

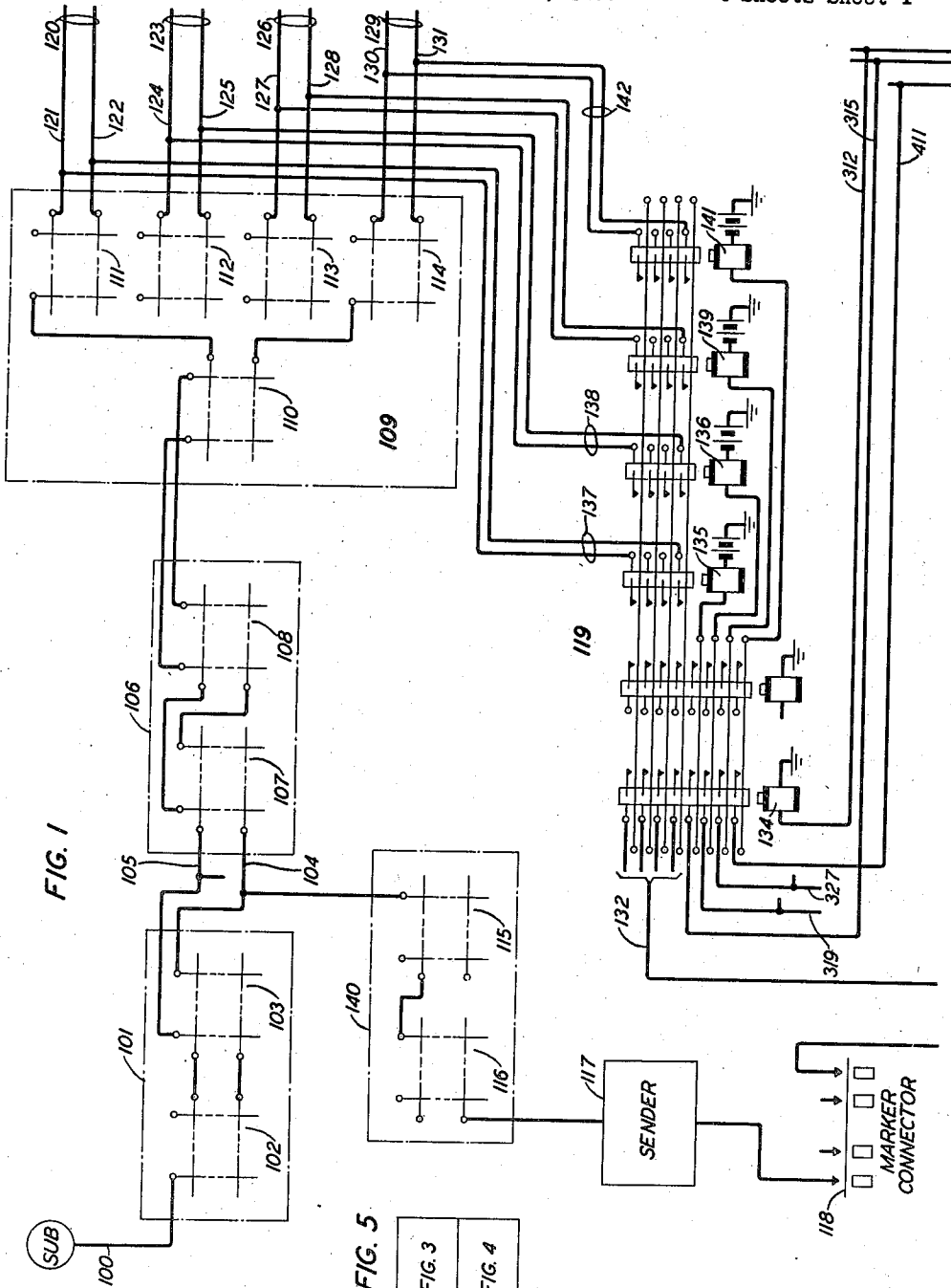


FIG. 1	FIG. 2	FIG. 3	FIG. 4
FIG. 5			

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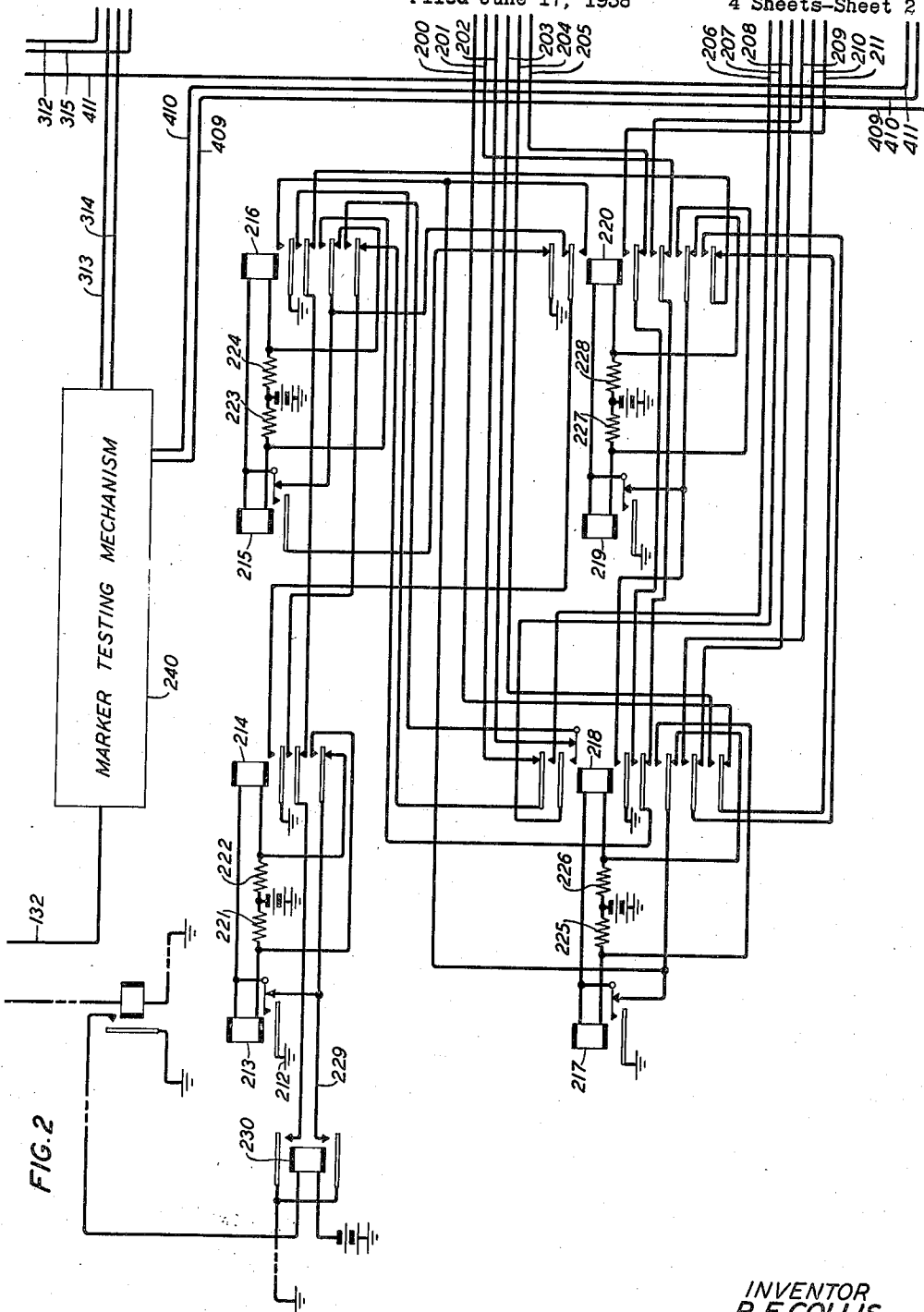
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4 Sheets-Sheet 2



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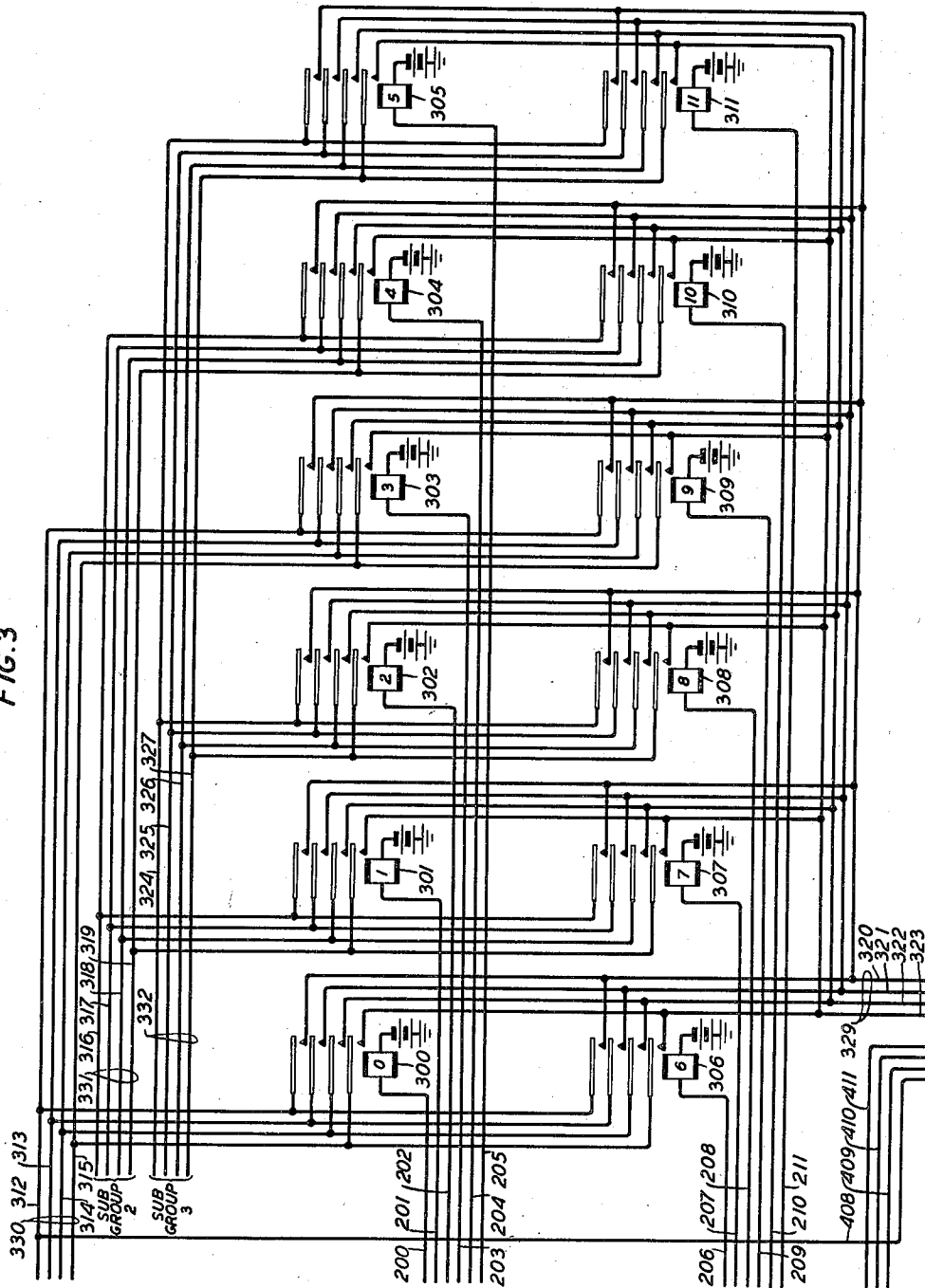
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FIG. 3



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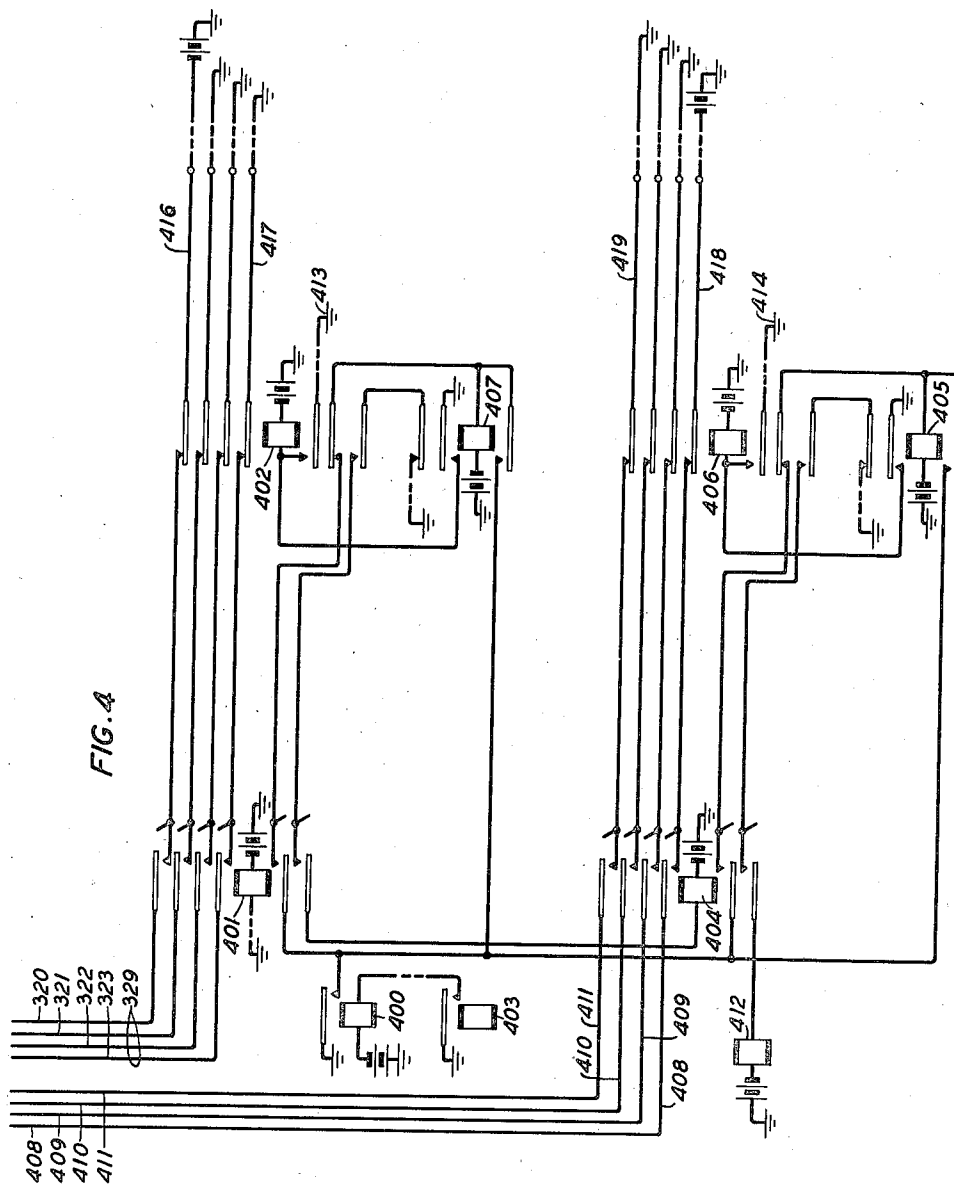
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TELEPHONE SYSTEM

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4 Sheets-Sheet 4



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2,201,986

TELEPHONE SYSTEM

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Application June 17, 1938, Serial No. 214,351

8 Claims. (Cl. 179—18)

This invention relates to telephone systems and particularly to those employing automatic switching equipment for establishing connections.

The objects are to increase the accessibility of trunk groups; to obtain a more uniform distribution of the load over the trunks of a group; and in other respects to enable a more efficient use of the trunk groups and of other parts of the system.

It has been proposed in the past, where large trunk groups are involved, to subdivide the trunks into smaller groups and to test these subgroups successively until an idle trunk is found. If, however, the total group contains a large number of trunks, the time required to test all of the several subgroups may be considerable, and consequently other calls for the same group may be required to wait correspondingly.

According to a feature of the present invention it is possible to make efficient use of a large trunk group by dividing it into a plurality of first-choice subgroups and a single second-choice subgroup and providing means whereby each call for the group causes a preferred one of the first-choice subgroups to be tested for an idle trunk, followed by a test of the second-choice subgroups in case the first-choice subgroup is busy. Following each call for one of the trunks in a group, the preference is shifted from one first-choice subgroup to the next, so that each new call causes a different one of the first-choice subgroups to be tested, followed always by a test of the single second-choice subgroup in case no idle trunk is found in the preferred subgroup. This arrangement makes it possible to utilize the trunk groups and the controlling equipment to best advantage. By repeatedly shifting the preferred first-choice subgroup, each new call coming in has a favorable chance of finding an idle trunk in the preferred subgroup, and, if all trunks of the preferred subgroup are busy, the probability is even greater than an idle trunk, if there is one anywhere in the entire group, will then be found in the second-choice subgroup. By omitting to test successive subgroups after having tested the preferred subgroup, the holding time of the equipment is reduced considerably, and the waiting time of other calls is not increased unduly.

Another feature of the invention is a system in which a plurality of switch-controlling mechanisms, such as markers, have common access to the trunk groups, in which each of the markers is arranged to test first the preferred subgroup and then the second-choice subgroup on each particular call, and in which each marker auto-

matically shifts the preference so that when it receives the next call for the same or another trunk group, it will test the succeeding first-choice subgroup and then the common second-choice subgroup.

The foregoing and other features of the invention will be described more fully in the following detailed specification.

In the drawings accompanying this specification:

Figs. 1 to 4, when arranged in the order illustrated in Fig. 5, disclose a portion of a central office telephone system.

Fig. 1 illustrates diagrammatically the subscriber's line and automatic switches for extending the line to outgoing trunk circuits. This figure also illustrates a central office sender and certain connecting mechanism.

Figs. 2, 3 and 4 disclose a part of a switch-controlling marker.

Fig. 2 illustrates diagrammatically the trunk testing mechanism of the marker and shows in detail a stepping or allotting circuit for shifting the preference from one subgroup of trunks to another;

Fig. 3 shows a grouping circuit, controlled by the allotting circuit of Fig. 2, for shifting certain control conductors in accordance with the allotment of the trunk subgroups; and

Fig. 4 shows certain control relays and circuits cooperating with the circuits of Fig. 3.

In the system illustrated herein the invention is applied to one of the switch-controlling markers which are used particularly for controlling switches of the cross-bar type. The subscribers' lines, such as line 100, in a system of this kind appear in frames of cross-bar line switches. One of these frames 101 is illustrated, comprising a number of primary cross-bar switches 102 and a number of secondary cross-bar switches 103. The line switches have access by way of district trunk circuits 104 and 105 to frames of district selector switches. One of these frames 106 is illustrated, comprising primary cross-bar switches 107 and secondary cross-bar switches 108. The district frames in turn have access to office selector frames, such as frame 109. The office frame 109 comprises a plurality of primary cross-bar switches 110 and secondary cross-bar switches 111, 112, 113, 114.

The outgoing trunk groups over which calling lines are extended, either to terminating equipment in the same exchange or to distant exchanges, appear in the terminals of the secondary office selector switches. These trunk groups are

divided into a number of subgroups, and the switch-controlling markers, one of which is illustrated in Figs. 2, 3 and 4, are provided with testing mechanism for making a test of the trunks of the subgroups to determine an idle one.

The calling subscribers' lines also have access by way of the district selector trunks 104, 105 to frames of sender selector switches. One of these frames 146, comprising primary cross-bar switches 115 and secondary cross-bar switches 116, is illustrated. The sender selector switches serve to extend the calling lines automatically to idle senders, such as the sender 117. The senders in turn have access to the markers by way of marker connector mechanisms 113.

Since the marker serves to test the trunks of the desired outgoing group to locate an idle one and also causes the selective operation of the district and office selector switches, it is necessary to provide connecting means for associating the marker with the outgoing trunk groups and with the district and office selector frames. This is effected by connecting devices, such as the frame connector 112 shown partially in detail in Fig. 1.

When a calling subscriber removes his receiver to make a call, his line 100 is automatically extended by the line switches 102 and 103 to an idle district trunk 104 terminating in primary district switch 107 and also appearing in the sender selector frame 146. The initiation of the call also causes the operation of the sender selector switches to extend the calling line through to an idle register sender 117. The subscriber dials the wanted number, which is recorded on the sender 117. Thereupon the sender causes the operation of a marker connector 112 to connect the sender to an idle one of the switch-controlling markers. The recorded information in the sender is transferred to the registers of the marker, and the marker makes use of this information to determine which one of the trunk groups is to be used in extending the subscriber's call.

Assume that the desired trunk group outgoing from the office switches is subdivided into four subgroups. Assume also that the first subgroup 120 is represented by the trunks 121 and 122; that the second subgroup 123 is represented by trunks 124 and 125; that the third subgroup 126 is represented by trunks 127 and 128; and that the fourth subgroup 129 is represented by trunks 130 and 131. These subgroups may comprise any convenient number of trunks, and they may be distributed in any suitable manner over the secondary switches of the office frames. As soon as the marker determines the desired trunk group, it causes the operation of the frame connector 112 to connect the marker testing mechanism 240 to the test conductors of the particular one of the subgroups that happens to be preferred at the time. After an idle trunk has been found the marker will proceed to test the link circuits of the district and office frames 106 and 109 to extend the district trunk circuit 104 through to the chosen idle outgoing trunk. The marker is then released, and, if the sender has not already been released, it will restore to normal as soon as it has completed its further functions in connection with the extension of the call.

Inasmuch as the invention relates particularly to the marker, much of the entire system has been omitted, and only those parts of the marker itself are shown which are necessary to an understanding of the invention. In the following descriptions reference will be made to numerous

operations which are not fully disclosed in all of their details. Wherever such references occur, it will be understood that the circuits and equipment so referred to are already known, and in particular reference is made hereby to the following for a detailed description of all operations and equipment referred to herein but not specifically disclosed: Carpenter Patent 2,093,117, September 14, 1937; and Carpenter application Serial No. 214,356, filed June 17, 1938.

The cross-bar switches employed in this system may be of any suitable type, such as the one disclosed in the patent to Reynolds, No. 2,021,329 of November 19, 1935.

The marker is provided with a relay 230 that operates and releases each time the marker is taken in use to serve a call. Also the marker is equipped with four pairs of control relays 213 and 214, 215 and 216, 217 and 218, 219 and 220, the function of which is to connect ground consecutively, after each call to each of the conductors 200, 201, 202, 203, 204, 205, 206, 207, 208, 209, 210 and 211 in the order named, thereby causing the consecutive operation, respectively, of the grouping relays 300, 301, 302, 303, 304, 305, 306, 307, 308, 309, 310 and 311. One of the control relays, 213 or 214, responds to each operation and each release of relay 230, and these relays in turn control the functioning of the other control relays, as will be hereinafter described. The grouping relays are connected as shown to provide for three first-choice subgroups of trunks. This is obtained by connecting in multiple the armatures of relays 300, 303, 306 and 309, relays 301, 304, 307 and 310, and relays 302, 305, 308 and 311. Connections for the three subgroups are brought out over conductors 312, 313, 314 and 315; 316, 317, 318 and 319; and 320, 321, 322 and 323. Two of the conductors of each subgroup extend as shown to the frame connector 112, and the other two conductors to the testing mechanism 240 of the marker. Conductors 320, 321, 322, 323 are energized through contacts of the ground supply relay 402 and route relay 401. These conductors are multiplied, as indicated, to the make contacts of the grouping relays 300 to 311, inclusive, and the contacts of route relay 401 are multiplied, as indicated, to corresponding contacts of other route relays, not shown, which are associated with relay 402.

With this arrangement, when relay 300 operates in response to the engagement of the marker for a call, conductors 320, 321, 322, 323 are connected respectively to conductors 312, 313, 314, 315, to establish the test for the first subgroup of trunks 120. In like manner, when relays 301 and 302 operate, the test connections for the second and third subgroups respectively are established. When relays 303, 306 and 309 operate subsequently, a test connection for the first subgroup is again made. Similarly, relays 304, 307, 310 and 305, 308, 311 operate to again make connection to the second and third subgroups. With this arrangement the control conductors for the same subgroup of trunks are connected at the operation of every fourth relay. With a total of twelve grouping relays, three subgroups of trunks may be connected to the grouping circuit as shown. It is to be understood that the grouping relays may be connected also to provide for grouping a different number of subgroups, as for example, four, six or twelve subgroups. For four subgroups, the make contacts of every third relay would be multiplied; for six subgroups, the contacts of every second relay; for twelve subgroups none of the make con-

tacts would be multiplied, each set of contacts controlling a different subgroup of trunks.

The trunk testing circuit 240 is arranged to test a maximum of forty trunks, twenty trunks appearing on one office frame of a pair and twenty trunks on the other frame. Assuming that the grouping relays of Fig. 3 are multiplied to provide for twelve first-choice subgroups, the maximum number of trunks is 480. With a maximum of forty trunks in an associated second choice subgroup the maximum total number of trunks for a group of trunks extending to a called destination is 520.

Relay 401 is the route relay corresponding to the first-choice subgroups of trunks which extend to the called office. It operates after the office code is dialed and connects the four control conductors 320, 321, 322 and 323 to the ground supply relay 402. One conductor is used to operate the proper pair of frame connectors, such as connector 119, to effect the connection of the marker to the pair of office frames on which is located the subgroup of trunks extending to the called office. Two other conductors are used to mark the beginning and the end of the trunk subgroup in relation to its connection with the trunk testing circuit 240. A fourth conductor is used for the operation of the trunk level relays associated with the frame connectors 119 of the pair of office frames upon which is located the subgroup of trunks extending to the called office. These relays connect the marker test leads 132 to the test conductors associated with certain horizontal levels of the office switches. On these levels are located the subgroups of trunks leading to the called destination. To recapitulate, one conductor determines the frame location of the trunk subgroup, a second and third conductor the limits of the trunk subgroup, and a fourth conductor the horizontal levels to which the subgroup is connected, thereby completely determining the trunk subgroup.

When all the trunks of a first-choice subgroup of trunks are found busy, trunk busy relay 400 is operated, causing the operation of relays 401 and 402. Relay 402 opens the circuit of the control conductors 320, 321, 322 and 323 and effects the operation of the second-choice route relay 404. This relay connects conductors 408, 409, 410 and 411, to determine the second-choice subgroup in the same manner as the first-choice subgroups were determined. In this case the control conductors are connected directly to the office frame and trunk testing circuit without going through the grouping circuit of Fig. 3. If all trunks of the second-choice subgroup are busy then relay 406 is operated, disconnecting control conductors 408, 409, 410 and 411 and effecting the operation of a route relay 412, which may be associated with an alternate route group, or with an overflow group of trunks.

The operation of the system will not be described in detail. It should be stated here that any one of the relays 213, 214, 215, 216, 217, 218, 219 and 220 may, in the course of the regular functioning of the marker, be left operated after a call; for this description, however, it is assumed that all relays at first are normal. When relay 230 operates due to the marker's engagement for a call, relay 213 operates in a circuit traced from battery through resistance 221, winding and normally closed contacts of relay 213, and lower contacts of relay 230 to ground. Relay 213 locks to ground 212, on its make contacts. Relay 230 also, with its upper contacts, connects ground

to conductor 200, through middle break contacts of relay 214, break contacts of relays 216, 220 and 218. Relay 300 operates in this circuit and connects the group of conductors 329, including conductors 320, 321, 322 and 323, to the group 330, comprising conductors 312, 313, 314 and 315, respectively. Since the group 330 relates to the first subgroup of trunks, the selection of this group of conductors determines that the first subgroup of trunks 120 are preferred for this call.

Route relay 401 also operates, selectively, at this time in response to the office code dialed at the calling station and connects conductors 329 through upper contacts of relay 402 to sources of battery and ground as indicated. The multiple straps shown connected to contacts of relay 401, indicate that other route relays that may be used for other trunk destinations are also connected to the upper break contacts of relay 402. The operation of route relay 401 completes circuits to establish the testing connection for the first-choice subgroup of trunks 120 that extends to the called office. One of these circuits extends from battery over conductor 416, contacts of relay 402 and 401, conductor 320, contact of relay 300, conductor 312, multi-contact relay 134 of frame connector 119 to ground and also through the corresponding relay of the mate frame connector. Another circuit leads from ground over conductor 417, contacts of relays 402 and 401, conductor 323, contact of relay 300, conductor 315, contact of operated relay 134, relay 135 to battery. A multiple of this circuit extends to the mate frame connector. The remaining two conductors 321 and 322 of group 329 are extended through relay 300 and over conductors 313 and 314 to the testing mechanism 240 to determine which of the testing relays thereof are needed to test the subgroup of trunks 120. With relays 134 and 135 of connector 119 operated, the test leads 137 associated with subgroup 120 are extended over conductors 132 to the marker testing mechanism 240. And the same is true of the other half of subgroup 120 that appears on the mate frame. If an idle trunk is found in subgroup 120, the marker connects itself to district frame 106 and operates the district and office switches 107, 108, 110, and 111 to extend calling line 100 to the selected idle trunk. The marker is then released as well as all other common equipment.

With the marker released, relays 401, 300, and 230 are deenergized. Relay 213, however, remains operated and relay 214 operates. The operating circuit for relay 214 may be traced from battery through resistance 222, winding of relay 214 and operated make contacts of relay 213 to ground. Before relay 230 released, ground on conductor 229, through lower outermost break contacts of relay 214, kept this relay shunted. When relay 214 operates it closes a circuit for operating relay 215, which circuit may be traced from ground on the inner make contacts of relay 214, through upper inner break contacts of relay 220, normally closed contacts and winding of relay 215, and resistance 223 to battery. Relay 215 locks to ground on the upper, outermost break contacts of relay 220. Relay 216 does not operate now due to the shunt connection through its own break contacts. At the end of the first call, with relay 230 released, relay 300 is released, and relays 213, 214 and 215 are operated.

Assume now that the marker is again engaged on a second call. When relay 230 operates, it

connects ground with its contacts to conductor 229, thence through lower outermost make contacts of relay 214 to the left terminal of resistance 221, thereby shunting relay 213 which releases. Relay 214 remains operated, however, in a circuit completed through the normally closed contacts of relay 213 to conductor 229. By reason of the continuity contacts of relay 213, the transfer from ground 212 to conductor 229 is made without opening the circuit of relay 214. A circuit is now closed for grounding conductor 201 and operating relay 301. This circuit is traced from ground through the upper make contacts of relay 230, lower middle make contacts of relay 214, lowermost break contacts of relay 216, lower break contacts of relay 218, lower break contacts of relay 220 to conductor 201. Relay 301 now operates, and, assuming that relay 401 has functioned as before described, conductors 329 are now connected to the respective conductors 216, 217, 218 and 219 of group 331, which prepare for testing the second first-choice subgroup of trunks 123. In this case a circuit is extended from battery on conductor 416, over conductor 320, contacts of relay 301, conductor 315, thence to relays, such as relay 134 on the pair of office frame connectors individual to the frames in which the subgroup 123 appears. As illustrated, this subgroup appears in frame 109 and its mate frame (not shown); hence relay 134 and the corresponding relay of the mate connector are operated. The circuit from ground over conductor 417, however, now leads through contacts of relay 301, conductor 319, thence through contacts of relay 134 (Fig. 1), winding of relay 135 to battery. With relays 134 and 135 operated, test leads 138 associated with subgroup 123 are extended to the marker testing relays 240. In due time the marker is released. When this occurs, relay 230 releases for the second time, and relays 301 and 214 release. Relay 214 in releasing removes the shunting ground for relay 216 which now operates and operates relay 217 in a circuit from battery through resistance 225, winding and normally closed contacts of relay 217, and upper inner make contacts of relay 216 to ground. Awaiting the operation of relay 230 for a third call, relays 213, 214, 216, 218, and 220, are normal, and relays 215, 216 and 217 are operated.

When the marker is next seized and relay 230 operates for the third time, relay 213 operates as before described. A circuit is now closed for grounding conductor 202, which circuit may be traced from ground on the upper contacts of relay 230, middle break contacts of relay 214, make contacts of relay 216, uppermost break contacts of relay 218 to conductor 202. Relay 302 operates and connects conductors 329 to conductors 324, 325, 326 and 327 of group 332, thereby establishing a testing connection for the third first-choice subgroup of trunks, relay 401 again operating as before described. In this instance circuits over conductors 324 and 327 cause the operation of relays 134 and 139, respectively, to associate the marker testing mechanism with subgroup 125.

When the marker is again released and relay 230 releases for the third time, relay 302 releases, relay 214 operates and closes a circuit for shunting relay 215. This circuit is traced from ground on the innermost contacts of relay 214, upper inner break contacts of relay 220, make contacts of relay 216 to the lower winding terminal of relay 215. Awaiting the fourth operation of re-

lay 230, relays 213, 214, 216 and 217 are operated, and relays 215, 218, 219 and 220 are normal.

When the marker is next seized and relay 230 operates for the fourth time, relay 213 is shunted as before, and a circuit is closed for operating relay 303, which may be traced from the upper contacts of relay 230, through middle make contacts of relay 214, lower outer make contacts of relay 216, and upper normally closed contacts of relay 218, over conductor 203 to the winding of relay 303. Relay 303 in operating, by reason of the multiple connection of its armatures with those of relay 300, establishes again a testing connection for the first subgroup of trunks 120. When relay 230 releases for the fourth time, relay 303 releases, relay 214 releases as before, relay 216 releases due to the removal of the holding ground on the inner contacts of relay 214, and relay 218 operates due to the removal of the shunting ground connected through the inner contacts of relay 216 and the lower middle break contacts of relay 218. Relay 218 in operating closes a circuit for operating relay 219 which is traced from ground on the lower, innermost contacts of relay 218, through normally closed contacts and winding of relay 219, and resistance 227 to battery. Awaiting the fifth operation of relay 230, relays 213, 214, 215, 216 and 220 are normal and relays 217, 218 and 219 operated.

When relay 230 operates for the fifth time, relay 213 operates as before and at the same time a circuit is closed for operating relay 304. This circuit is traced from ground on the contacts of relay 230, through middle break contacts of relay 214, break contacts of relays 216 and 220, lower outermost make contacts of relay 218, over conductor 204 and through the winding of relay 304 to battery. Relay 304 in operating, establishes the testing connection for the second subgroup of trunks 123, in the same manner as did relay 301, due to the multiple connection of the armatures of the two relays. When relay 230 releases for the fifth time relay 214 operates as before and closes a circuit for operating relay 215, which may be traced from ground on the innermost contacts of relay 214 through upper inner break contacts of relay 220, normally closed contacts and winding of relay 215, and resistance 223 to battery. Awaiting now the sixth operation of relay 230, relays 213, 214, 215, 217, 218 and 219 are operated and relays 216 and 220 are normal.

When relay 230 operates for the sixth time, relay 213 releases as before described, and a circuit is closed for operating relay 305, which circuit is traced from ground on the contacts of relay 230, through middle make contacts of relay 214, lowermost break contacts of relay 216, lower make and break contacts of relays 218 and 220, respectively, over conductor 205 and through winding of relay 305 to battery. Relay 305 operates and connects the third subgroup of trunks 126, as did its multiplied relay 302. When relay 230 releases for the sixth time, relay 305 releases. Relay 214 releases as before described and causes the operation of relay 216 by removing the ground connected through the upper break contacts of relay 220, and the break contacts of relay 216. Relay 216 in operating causes the release of relay 217. The shunting circuit effecting this release may be traced from ground on the inner make contacts of relay 216, through make contacts of relay 216 to the winding of relay 217. Awaiting now the seventh operation of relay 230, relays 215, 216, 218 and

219 are operated and relays 213, 214, 217 and 220 are normal.

When relay 230 operates for the seventh time, it causes the operation of relay 213 as before described and closes a circuit for operating relay 306, which circuit may be traced from ground on the contacts of relay 230, through middle break contacts of relay 214, make contacts of relay 216, uppermost make contacts of relay 218, over conductor 206 and through the winding of relay 306 to battery. Relay 306 in operating connects conductors 330 associated with the first subgroup of trunks to conductors 329. When relay 230 releases for the seventh time, relay 306 releases, and relay 214, as before described, operates. The operation of relay 214 connects a shunting ground to the winding of relay 215, through the circuit before traced after the third release of relay 230. Relay 215 releases, and now relays 213, 214, 216, 218 and 219 are operated and relays 215, 217 and 220 are released, awaiting the eighth operation of relay 230.

Relay 230 operating for the eighth time operates relay 307 in a circuit traced from ground on the contacts of relay 230, middle make contacts of relay 214, make contacts of relay 216, upper inner make contacts of relay 218, over conductor 207 and through the winding of relay 307 to battery. Relay 307 functions to connect the associated conductors of the second subgroup of trunks. Relay 230 in operating also effects the release of relay 213 as before described. When relay 230 releases for the eighth time, then relay 214 releases as before and releases relay 216. Relay 216 in releasing releases relay 218 by opening its holding circuit which extends from ground on the inner contacts of relay 216, through normally closed contacts of relay 217, winding of relay 218 and resistance 226 to battery. Relay 218 in releasing removes a shunting ground from the winding of relay 220, which operates. This ground extends from the lower, innermost contacts of relay 218 through break contacts of relay 220 and resistance 228 to battery. Awaiting the ninth operation of relay 230, only relays 219 and 220 are now operated.

When relay 230 operates for the ninth time, a circuit is closed for operating relay 308, which circuit may be traced from ground on the contacts of relay 230, through middle break contacts of relay 214, break contacts of relay 216, lowermost make contacts of relay 220, break contacts of relay 218, over conductor 208 and through winding of relay 308 to battery. Relay 308 in operating functions the same as did relays 302 and 305, connecting the control conductors of the third subgroup to Fig. 4. Relay 230 in operating operates relay 213 as before, and in releasing for the ninth time releases relay 308 and effects the operation of relay 214. Relay 214 in operating operates relay 217 in a circuit from ground on the inner make contacts of relay 214, through upper inner make contacts of relay 220, normally closed contacts and winding of relay 217 and resistance 225 to battery. Awaiting the tenth operation of relay 230 relays 213, 214, 217, 219 and 220 are operated and relays 215, 216 and 218 are released.

When relay 230 now operates for the tenth time, a circuit is closed for operating relay 309, which is traced from ground on the contacts of relay 230, through middle make contacts of relay 214, lowermost break contacts of relay 216,

lower break contacts of relay 218, lower make contacts of relay 220, over conductor 209 and through winding of relay 309 to battery. Relay 309 in operating effects the necessary connections for the first subgroup of trunks. Relay 230 in operating causes relay 213 to release as before described, and when relay 230 releases for the tenth time relay 309 releases and, as hereinbefore described relay 214 again releases. The release of relay 214 causes relay 218 to operate, due to the removal of the shunting ground from its winding. Relay 218 in operating causes relay 219 to release due to a shunting ground from the lower inner make contacts of relay 218, through make contacts of relay 220 to the winding of relay 219. Awaiting now the eleventh operation of relay 230, relays 213, 214, 215, 216 and 219 are normal, and relays 217, 218 and 220 are operated.

When relay 230 operates for the eleventh time, ground on the make contacts of relay 230 is connected through middle break contacts of relay 214, break contacts of relay 216, lowermost make contacts of relay 220, lower make contacts of relay 218, over conductor 210 and through the winding of relay 310 to battery. Relay 310 in operating connects the control conductors of the second subgroup of trunks to Fig. 4. Relay 230 in operating also operates relay 213 as before. When relay 230 releases for the eleventh time, relay 310 releases, and relay 214 operates as before. Relay 214 in operating shunts the winding of relay 217, causing this relay to release. Awaiting now the twelfth operation of relay 230, relays 213, 214, 218 and 220 are operated and relays 215, 216, 217 and 219 are normal.

Relay 230 in operating for the twelfth time closes a circuit for operating relay 311 which may be traced from ground on the contacts of relay 230, through middle make contacts of relay 214, lowermost break contacts of relay 216, lower make contacts of relays 218 and 220, over conductor 211 and through the winding of relay 311 to battery. Relay 311 in operating connects the control conductors, associated with the third subgroup of trunks, to Fig. 4. Relay 230 in operating also shunts down relay 213. When relay 230 releases after its twelfth operation, relay 311 releases and also relay 214. Relay 214 in releasing, releases relay 218 and relay 218 releases relay 220. All relays 213 to 220 inclusive are now normal, having completed one cycle of operation. When relay 230 again operates, another cycle, similar to that hereinbefore described begins.

With the arrangement just described it is seen how the various first-choice subgroups of trunks of any group are connected in rotation on successive calls. If all the calls in an office were handled by one marker and the relays 300 to 311 were used only for one group of trunks, then there would always be a consecutive use of the subgroups. Relays 300 to 311, however, may be provided with additional sets of four contacts, not shown, to handle subgroups of other trunk groups.

Assume now, using the same marker, that relay 300 operates to connect subgroup No. 1 of a trunk group extending to an office A, and then on the next call relay 301 operates and connects subgroup No. 2 of another trunk group extending to another office B, using, as aforesaid, an additional set of four contacts. Under this condition on the next call relay 302 will operate and now

if the call is to be directed to the office A associated subgroup No. 3 will be connected, the connection of subgroup No. 2 being skipped for this cycle of operation. Subgroup No. 2 for office

5 A might also be skipped at this time, when another marker is connected to handle a call and its corresponding control circuit of Fig. 2 should be set by chance, to operate its relay 301, or some succeeding relay of the series. However, in the
10 consecutive use of the various trunk subgroups, over a considerable period of time the number of times each subgroup is used will be equal approximately to the average use of all the subgroups.

The arrangement before mentioned, whereby,
15 if the trunks of a first-choice subgroup are all found busy the marker immediately engages a single second-choice group of trunks extending to the called office, will now be described in detail.

20 Assuming now that the test of the trunks of a first-choice subgroup, which was made following the operation of the first-choice route relay 401 indicates that all trunks of this subgroup were busy, then relay 400 is operated from ground on the contacts of relay 403. This latter relay operated when the marker found all trunks of the first-choice subgroup busy. The operation of relay 400 effects the release, through a circuit not shown, of the district link connection established
30 for the aforesaid first-choice subgroup of trunks. Relay 400 also closes a circuit for operating relay 407, which circuit may be traced from ground on the contacts of relay 400, through lower inner contacts of first-choice route relay 401, lower
35 break contacts of relay 402 and winding of relay 407 to battery. Relay 407 operates and locks through its lower contacts to ground on the contacts of relay 400. Relay 407 operates relay 402, which locks to ground 413. The lower make contacts of relay 407 are arranged to close before its upper contacts close, to insure that the operating circuit of relay 407 is not opened by relay 402 before the locking circuit of relay 407 is closed. The operation of relay 402 disconnects the four
45 control conductors 329 which were used in establishing the testing arrangement for the first-choice subgroup of trunks. Opening these conductors releases the connection to the pair of office switch frames and releases the group start and group end relays of the trunk testing circuit, not shown, which is thus restored to normal. At this time relay 403 releases which in turn releases relay 400, thereby releasing relay 407; this closes a circuit for operating the second-choice route
55 relay 404. This circuit may be traced from battery through the winding of relay 404, lower outer contacts of relays 401 and 402 to ground through the break contacts of relay 407.

Relay 404 extends conductors 408, 409, 410 and
60 411, which relate to the second-choice subgroup of trunks extending to the called office, these conductors being extended independently of the grouping relays of Fig. 3. These conductors now engage the same pair of office frames as before,
65 or another pair of frames, upon which the trunks of the second-choice subgroup of trunks may be located. Also, the proper trunk level relays are operated and the limits of the trunk group are indicated by operating the associated group start and group end relays. One of the circuits thus closed leads from battery over conductor 410, contact of relays 408 and 404, conductor 408, thence to the winding of frame connector relay 134, and to a similar relay on the mate connector.
70 It should be noted that conductor 408 would lead

to a different pair of frame connectors if the second-choice subgroup 129 were located on other frames. Another of the circuits closed by route relay 404 leads from ground on conductor 419, contacts of relays 406 and 404, conductor 411, 5 contact of relay 134, winding of relay 141 to battery. Relays 134 and 141 extend the test conductors 142 of the second-choice subgroup 129 to the testing mechanism 240. If this second-choice subgroup should also be found busy, then
10 relays 403 and 400 operate again and effect the operation of relay 405 through the lower inner make contacts of relay 404 and the lower break contacts of relay 406. Relay 405 operates relay 406, thereby opening the circuit established for
15 conductors 408, 409, 410 and 411, and locks to ground on the contacts of relay 400. Relay 406 locks to ground 414. When relay 400 finally releases, relay 405 releases and then a circuit is closed for relay 412, which circuit may be traced
20 from battery through the winding of relay 412, lower outer make contacts of relays 404 and 406 to ground on the break contacts of relay 405. Relay 412 is a route relay, with contacts not shown, which is used to establish connection to an alternate route of trunks or to an overflow route, if the alternate route is not provided. The additional relays necessary for the alternate and overflow groups of trunks are not shown. When these groups are subdivided the four control conductors
30 extending from the contacts of each corresponding route relay are carried through additional contacts, not shown, of the grouping relays of Fig. 3 so as to equalize the use of these subgroups in the same manner as the use of the first-choice
35 subgroups was equalized.

What is claimed is:

1. In combination, trunk groups, each of which is divided into a plurality of first-choice subgroups and one second-choice subgroup, a
40 marker, means effective when a call is made for one of said groups for causing the marker to test first the trunks of a preferred first-choice subgroup and then the second-choice subgroup to find an idle one for use, and means in the marker
45 for changing the preference from one first-choice subgroup to another each time the marker is used.

2. In combination, trunk groups, each of which is divided into a plurality of first-choice subgroups and one second-choice subgroup, a
50 marker, means effective when a call is made for one of said groups for causing the marker to test first the trunks of a preferred first-choice subgroup and then the second-choice subgroup to find an idle one for use, and a sequence circuit in the marker operative each time the marker is taken in use for advancing the preference from one first-choice subgroup to the next.

3. In combination, trunk groups, each of which is divided into a plurality of first-choice subgroups and one second-choice subgroup, a plurality of markers, any one of which may serve to extend calls to any of said groups, means effective when a marker is seized for a call in
65 one of said groups for causing the marker to test a particular one of the first-choice subgroups in preference to the others, and means in each marker operative each time the marker is used to shift the preference from one to another of the first-choice subgroups in each group.

4. In combination, trunk groups, each of which is divided into a plurality of first-choice subgroups and one second-choice subgroup, means effective when a call is made for one of said
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groups for testing the trunks of a particular one of the first-choice subgroups in preference to other first-choice subgroups, means effective to shift successively the preference from one to another of the first-choice subgroups of a group, and means operative if all the trunks of a preferred first-choice subgroup are found busy for causing a test to be made of the second-choice subgroup.

5. In combination, a group of trunks divided into a plurality of first-choice subgroups and a second-choice subgroup, a controlling device, means for seizing the controlling device for making calls in the trunks of said group, means responsive to a call for said group of trunks for connecting the controlling device to one of said first-choice subgroups in preference to others for making a test of the trunks in said preferred subgroup, means for causing the controlling device to release from the first-choice subgroup if all trunks are busy and for connecting it to said second-choice subgroup to test the trunks therein, and means operative each time the controlling device is taken in use for shifting the preference from one to another of said first-choice subgroups.

6. In combination, trunk groups, each of which is divided into a plurality of first-choice subgroups and one second-choice subgroup, the number of first-choice subgroups differing for different groups, means effective when a call is made for any one of said groups for testing a preferred first-choice subgroup, means operative each time a call is made for any group for shifting the preference from one first-choice subgroup to the next, and means effective if all trunks of the preferred first-choice subgroup are busy for causing a test to be made of the corresponding second-choice subgroup.

7. The combination in a telephone system of automatic switches, trunk groups appearing in said switches, each group being divided into a plurality of first-choice subgroups and a second-choice subgroup, a marker for controlling the selective operation of said switches to extend calls over said trunks, register means in said marker for receiving and registering the designation of a desired one of said trunk groups, means effective when the designation of one of said groups is registered in the marker for causing the marker to test first the trunks of a preferred first-choice subgroup and then the trunks of the second-choice subgroup to find an idle one for use, and means in the marker for changing the preference from one first-choice subgroup to another each time the marker is used.

8. The combination in a telephone system of automatic switches, trunk groups appearing in the terminals of said switches, each group being divided into a series of first-choice subgroups and a single second-choice subgroup, a marker common to said switches for controlling the selective operation thereof to extend calls over said trunks, means for transmitting and registering in said marker the designation of a desired group of said trunks, means effective when the designation of one of said groups is registered in said marker for causing the marker to test the trunks of a preferred first-choice subgroup and to select an idle one for use, means effective if all of the first-choice trunks are busy for causing the marker to test the trunks of the second-choice subgroup and to select an idle one for use, and means in the marker for changing the preference from one first-choice subgroup to another in said series each time the marker is used.

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