Nov. 10, 1942. M. B. WILEY ET AL 2,301,837

TESTING ARRANGEMENT FOR TRUNKS TO COMMUNITY DIAL OFFICES

Filed Feb. 25, 1941 2 Sheets-Sheet 1

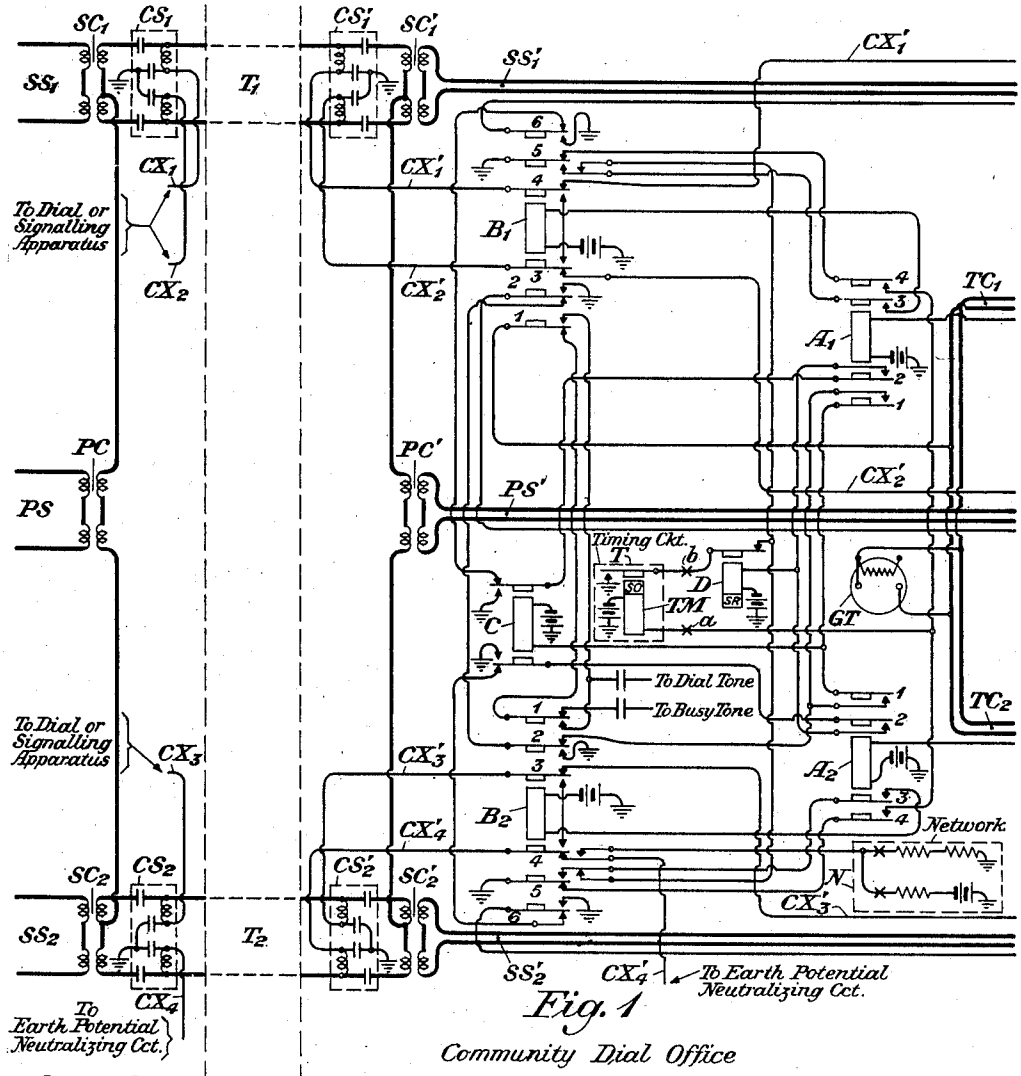


Fig. 1

Community Dial Office

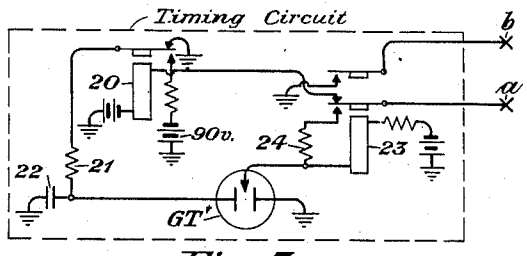


Fig. 3

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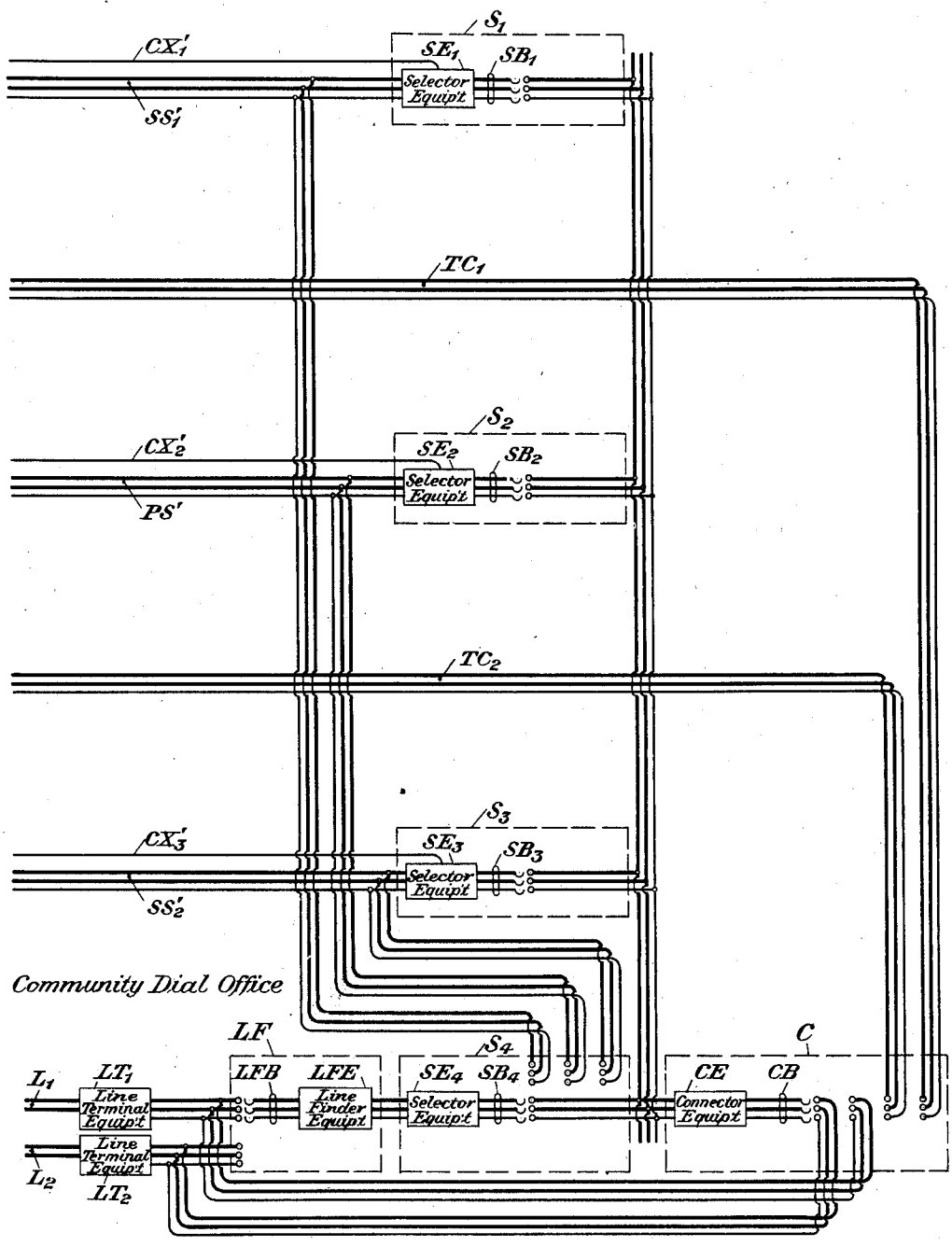


Fig. 2

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TESTING ARRANGEMENT FOR TRUNKS TO COMMUNITY DIAL OFFICES

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Application February 25, 1941, Serial No. 380,466

19 Claims. (Cl. 179—175.2)

This invention relates to community dial telephone systems and more particularly to arrangements for testing trunks extending between a telephone exchange and a community dial office.

It sometimes happens that a community or hamlet too small to justify an ordinary manual exchange is located near a larger town or city provided with a regular telephone exchange or exchanges. Frequently in such cases the outlying hamlet or community is too far away from the city to justify direct connections from each subscriber to a central office in the city. Under such circumstances it is usually the practice to provide the outlying hamlet with telephone service by means of a so-called community dial office. This is a small office located in the local community and provided with relatively simple, automatic switching machinery by which the local subscribers may dial each other. A relatively few trunks extend between the community dial office and the exchange in the nearby city to take care of calls from the local community to the larger telephone area. An operator in the city may establish a direct connection over one of these trunks to any desired subscriber coming into the community dial office, and any local subscriber desiring a city connection can by dialing, connect his line to one of the trunks leading to the city. These community dial offices are unattended, except at such times as maintenance and inspection employees make temporary visits.

Where such a situation exists and toll circuit troubles arise in connection with the trunks leading to the community dial office a somewhat elaborate procedure for clearing troubles is involved. It is frequently found necessary to send a lineman man from the testing office at the city exchange to the outlying community dial office to open and cross out circuits in order to measure or locate line troubles which are often found to be only a short distance from the testing office. This, of course, results in an excessive loss of time on trunk circuits, and in addition there is the expense of the unnecessary miles traveled.

In order to overcome this difficulty, it is proposed in accordance with the present invention to provide arrangements in the dial office whereby the tester by dialing from the distant office can remove the office trunk equipment from the trunk conductors at the community dial office and short-circuit the trunk conductors so as to make measurement for faults. One of the features of the invention is to provide arrangements for preventing interference with calls in progress over the trunks. As illustrated, the invention is shown applied to trunk units involving two side circuits and a phantom provided with composite circuits for signaling over the trunks, but it will be understood that the principle of the invention may be applied equally well to simple telephone trunks.

Considering the invention in its more specific aspects, the side circuits and phantom of each phantom group are provided with connections leading to switching apparatus for establishing connections to local subscriber circuits, as well as multiple connections appearing in the banks of selector switches whereby connection may be established from local subscriber circuits to the trunks. In addition to these connections, the side circuits of the phantom combination are provided with special terminals for testing purposes, and the apparatus is so arranged that when a direct connection is established from the distant office to one of these testing terminals, the composite signaling leads of the corresponding side circuit are disconnected and the side circuit is short-circuited. At the same time the side circuit and the phantom trunk (but not the other side circuit of the group) are arranged to test busy at the dial office.

An arrangement is also preferably provided to delay the opening and shorting of the trunk conductors, as above described, for a short interval. This interval is made available, so that if a local subscriber should by error dial the number assigned to one of the special testing terminals, he will be able, upon hearing a warning tone, to hang up without disturbing the trunk.

In accordance with the invention, provisions are also made to trip the ringing apparatus and to place a busy tone on the special testing terminal to serve as the signal for a subscriber to hang up in case he dials through error a number assigned to a testing terminal. At the end of the delay period the busy tone is changed to a dial tone. Where the connection has been established to the special terminal by the tester at the distant office, this change to the dial tone indicates to the tester that the circuit has functioned and he may, therefore, proceed with his test.

The test circuit is also preferably so arranged as to prevent the opening and shorting of the trunk conductors, if either the desired side circuit or the phantom superposed thereon is busy, or becomes busy during the delay period. After the delay period is over, if either the desired side circuit or the associated phantom remains busy, the opening and shorting of the trunk conductors will be held up until both the side circuit and

the phantom circuit become idle. Since the other side circuit is not interfered with by the testing operation, the busy or idle condition of such other side circuit need not affect the establishment of the testing connection to the desired side circuit.

The invention will now be more fully understood from the following detailed description when read in connection with the accompanying drawings. In the drawings, Figure 1 shows a phantom trunk combination extending from a central office to a community dial office, together with the testing equipment at the latter office whereby the trunks may be tested from the central office; Fig. 2 shows a schematic layout of the switching equipment at the community dial office to indicate how connections are established between subscribers at the community dial office, how connections are made from subscribers' lines to the trunks, and also how connections may be established to the special testing connections of the side circuits; and Fig. 3 shows an alternative type of timing circuit which may be substituted for the simple timing circuit illustrated in connection with Fig. 1.

In Fig. 1 the central office of a city shown at the left is connected to an outlying community dial office shown at the right by means of three trunks comprising two side circuits and a superposed phantom. For this purpose a pair of conductors T_1, extending from the central office to the community dial office, serves as one side circuit and is connected through side circuit coils SC_1 and SC'_1 to the side circuit terminals SS_1 and SS'_1 at the central office and the community dial office, respectively. Similarly another pair of conductors T_2 serving as the other side circuit is associated through side circuit coils SC_2 and SC'_2 with side circuit terminals SS_2 and SS'_2 at the central office and community dial office, respectively. From the midpoints of the primary windings of the side circuit coils above referred to phantom connections extend to the primaries of phantom coils PC and PC' associated with the phantom terminals PS and PS' at the central office and community dial office, respectively.

The apparatus above referred to comprises one unit of three talking trunks extending between a central office and a community dial office. As many additional such units may be provided as are necessary to take care of the traffic between the central office and the community dial office.

The switching apparatus for the community dial office is schematically indicated in Fig. 2. Here two line circuits L_1 and L_2 extending to subscribers' equipment (not shown) are illustrated and are intended to be representative of a larger number of similar subscriber circuits. Each subscriber's line has associated therewith line terminal equipment such as LT_1 and LT_2 of a well-known character, and terminates in multiple, tip, ring and sleeve contacts appearing at various line finder switches such as LF. Each of the lines also has multiple connections, consisting of a tip and ring for talking purposes and a sleeve for testing purposes, extending to the terminal banks of connector switches such as C. Throughout the drawings where similar groups of three conductors appear on the drawings, the upper wire will represent the tip conductor, the middle wire, the ring conductor and the lower wire the sleeve conductor. The talking conductors are drawn in heavy lines in order that they will stand out more clearly from the associated circuits.

If the subscriber of one of the lines such as L_1 should take his receiver off the hook, the closing of the circuit would in a well-known manner condition the line terminal equipment LT_1 to set the line finder equipment LFE of an idle finder LF into operation, thereby causing the brushes LFB of the line finder to hunt the calling line. As soon as the test brush of the line finder comes in contact with the test terminal associated with the line L_1, the line finder will come to rest because it finds battery voltage appearing upon the sleeve terminal of the line. A connection is now established from the line L_1 to a selector S_4 associated with the line finder LF. The selector is illustrated as an up-and-around switch of the step-by-step or Strowger type. While the description herein refers more particularly to this type of switch, it will be understood that the various line finder, selector and connector switches may be of other known types, such as relay switches, cross-bar switches, etc.

To complete a connection to another subscriber the calling subscriber will first dial the hundreds digit of the wanted subscriber's number. This will step the brushes SB_4 of the selector S_4 to a particular level. In this level are contacts connected to connector switches such as C, adapted to establish connections to any subscriber of the group in which the wanted subscriber is located. Upon being stepped to this level, the brushes are then rotated automatically to the various contacts in this level until one is found whose sleeve terminal is not busy, i. e. not grounded. Assuming that the connector C is not busy, the brushes SB_4 will then stop on the contacts connected to the connector C. The subscriber then dials the tens digit of the wanted subscriber's number to directively step the brushes CB of the connector C to the proper level. Next the dialing of the units digit causes the connector equipment CE to directively step the brushes CB around over the contacts of that bank to the particular group of three contacts multipled to the terminals of the wanted subscriber's line, which it may be assumed is the line L_2.

If the line L_2 is not busy, it will not have ground applied to the sleeve conductor of its line terminal. In such case the connector equipment of the connector C will complete the talking connection through to the subscriber, apply ringing current to the subscriber's line, and apply a busy ground to its sleeve conductor in a well-known manner. As soon as the called subscriber answers, the ringing apparatus of the connector equipment CE is tripped so that ringing ceases and the two subscribers may now converse.

In order to establish connections from the distant central office over one of the trunks to a subscriber at the community dial office, the switching equipment is similar, except that ordinarily no line finders are provided because the number of trunks is too small to justify the use of line finders. Instead each of the trunks SS'_1, PS' and SS'_2 has associated with it, as shown in Fig. 2, its own individual selector such as S_1, S_2 and S_3. These selectors are also provided with selector equipment such as SE_1, SE_2, etc. An operator at the distant office may dial the number of a wanted subscriber's line whereupon the associated selector steps its brush in response to the hundreds digit to a particular level leading to a certain group of final connectors such as C. The final connector is then directively operated

to establish the connection to the wanted subscriber's line. The dialing arrangements for the trunk circuits are of a somewhat different character than those employed for the local subscriber's line and will be described in more detail later.

Since any local subscriber can use any one of the trunks which is not busy to establish a connection to the distant central office, the trunks are not given special numbers like those assigned to the subscriber's lines. They are not, therefore, reached through final connectors. Instead, when a community dial subscriber wishes to make a connection to the distant central office, he takes his receiver off the hook whereupon a line finder such as LF seeks out his line and connects it to the associated selector S_4. The subscriber then dials some especially assigned digit, which causes the selector equipment SE_4 of the selector to step the brushes SB_4 to the level at which the terminals of the various central office trunks appear.

If, for example, the digit zero is used, the terminals of the central office trunks will appear in the tenth level, this being the upper group of terminals shown in connection with selector S_4. Each of the trunks such as SS'_1, PS', SS'_2 have separate connections to terminals corresponding to tip, ring and sleeve. As soon as the brush is stepped to the tenth level, the brushes automatically rotate until the sleeve brush comes in contact with the sleeve terminal of a trunk which is not busy, this fact being indicated by the absence of ground. The brushes are brought to rest upon the tip, ring and sleeve terminals of the trunk, and the selector equipment SE_4 applies a busy ground to the sleeve terminal of the seized trunk. If the seized trunk is the trunk SS'_1, apparatus associated with the selector equipment SE_1 associated with that trunk will cause a supervisory signal to be sent over the composite circuit CX'_1 to signal the operator at the central office. The composite circuit will be described in more detail later.

Returning to Fig. 1, it will be noted that transformers such as SC_1, SC'_1 are included in the various trunk circuits so that it is not possible to send dial signals or other supervisory signals over the trunks in the same manner as with ordinary subscribers' lines. Each of the two side circuits is therefore provided with composite sets to furnish composite or CX circuits for dialing and supervisory purposes. For example, the side circuit T_1 has a composite set CS_1 at the central office by means of which dial current or low frequency signals may be sent to or from the composite conductors CX_1 and CX_2. The composite sets are similar to those employed for superposing telegraph circuits upon telephone pairs. Each set includes series condensers for passing the higher frequency telephone currents over the side circuits. Shunt coils serve to pass the dial and other supervisory signals to the composite conductors CX_1 and CX_2, while substantially preventing telephone currents from being diverted into these channels. Shunt capacities to ground are also provided to further prevent telephone currents from being diverted into the composite circuits CX_1 and CX_2.

A similar composite circuit CS'_1 is associated with the side circuit T_1 at the community dial office whereby composite conductors CX'_1 and CX'_2 may be extended from the side circuit. These may be used for dialing and other purposes as will be described later. Likewise the trunk T_2 is provided with composite sets CS_2 and CS'_2 similar to those already described at the central office and community dial offices respectively. These sets provide the composite circuits CX_3 and CX_4 at the central office and CX_4 and CX'_4 at the community dial office.

It will thus be seen that four CX or composite circuits are provided. For example, a CX circuit extends from conductor CX_1 at the central office through the composite set CS_1, over the upper conductor of the side circuit T_1, thence through the composite set CS'_1 to the conductor CX'_1 at the community dial office. Conductor CX'_1 extends over a contact of the relay B_1 to the selector equipment SE_1 of the selector S_1 associated with the side circuit SS'_1 at the community dial office. This circuit enables an operator at the central office to dial the switch S_1 associated with the trunk SS'_1 and thereby establish a connection to any desired subscriber at the community dial office. This circuit also enables various supervisory signals identified with the side circuit SS_1—SS'_1 to be transmitted between the central office and the community dial office during the establishment of connections. It also serves, as already described, when a subscriber by dialing zero at the community dial office selects an idle trunk, to establish a supervisory signal over the trunk SS_1—SS'_1 (if that trunk is idle and happens to be selected) to notify the operator at the central office that a call has come in over the trunk.

In a similar manner a second composite circuit is established over the conductors CX_2 and CX'_2 for various dialing and supervisory signal operations in connection with the phantom circuit PS—PS'. So also a third composite circuit is established over conductor CX_3, the upper conductor of the side circuit pair T_2 and the conductor CX'_3, to serve for signaling and dialing in connection with the side circuit trunk SS_2 and SS'_2. A fourth composite circuit is also provided extending from the conductor CX_4, over the lower conductor of the pair T_2 to the conductor CX'_4 at the community dial office. This fourth conductor is not needed for supervisory signal or dialing purposes, and is, therefore, used as an earth potential neutralizing circuit. As this circuit has nothing to do with the invention herein described, the apparatus associated therewith is not illustrated.

As has already been pointed out, when a subscriber at the community dial office desires a connection over one of the trunks to the distant central office, such connection is not obtained by a directive action of a connector switch but by stepping the brushes of a selector switch up to a level at which all of the trunks appear. An idle trunk is then picked out by a testing action, and hence each trunk is provided with a terminal at each of the selector switches used by the subscriber's lines. In order that access may be had by an attendant at the distant central office to the side circuits to measure for faults, each side circuit is also provided with a special terminal which is reached through a connector.

For example, the connector C is provided with sets of contacts which are connected to special testing circuits TC_1 and TC_2 associated with the side circuit pairs T_1 and T_2, respectively. The sleeve conductors of the special connections TC_1 and TC_2 are led to relays A_1 and A_2, the former of which performs certain operations in connection with the side circuit pair T_1, and the latter of which performs similar functions with respect to the side circuit pair T_2. Relays B_1 and B_2 are re-

spectively associated with the side circuit pairs T_1 and T_2 and are controlled by the relays A_1 and A_2, respectively, to disconnect the CX circuits from the side circuit pairs and short-circuit said pairs, as will be described in more detail later.

A timing circuit T is provided to delay the action of the relays B_1 or B_2 as the case may be. The interval thus provided enables a subscriber at the community dial office, who may have dialed one of the circuits TC_1 or TC_2 by error, to hang up. It will be understood, of course, that the circuits TC_1 and TC_2 are given numbers just as are subscribers' lines so that they may be dialed from the distant central office through selector and connector switches in the usual manner. A relay D is provided which operates whenever the side circuit which is wanted for testing purposes is busy. This holds up the operation of relays B_1 and B_2 until the wanted side circuit becomes free. Should the phantom circuit be busy, a relay C is operated to hold up the operation of the relay B_1 or B_2 as the case may be, thereby preventing the establishment of a testing connection until the phantom is free. Thus it will be seen that when a particular side circuit is wanted for testing purposes it cannot be obtained until both the wanted side circuit and the superposed phantom are free.

The operation of testing a trunk is as follows:

Assuming that an attendant at the distant central office desires to test the side circuit pair T_1 for faults, he will order the operator to dial the test circuit TC_1 associated with the side circuit pair T_1 at the community dial office. In order to establish such a connection the operator may use any idle trunk other than the wanted side circuit and the phantom circuit superimposed thereupon. In other words, the operator can use the other side circuit pair T_2, if it is idle, or can use either side circuit or the phantom (if idle) of any other phantom group.

Let us assume that the side circuit pair T_2 is idle and is used for establishing the connection. The operator seizes the trunk SS_2—SS'_2 and dials the number of the testing circuit TC_1 over the composite conductor CX_3, the upper conductor of the pair T_2 and over the composite conductor CX'_3, which extends over the back contact of the third armature of the relay B_2 to the selector equipment SE_3 of the selector switch S_3 associated with the side circuit SS'_2. The selector equipment operates in a well-known manner in response to the hundreds digit to step the brushes SB_3 of the selector S_3 up to a level in which are located the contacts of circuits leading to connectors having access to the desired test circuit TC_1. The selector then hunts for an idle circuit in this level and finally picks out, say, the circuit leading to the connector C. When the operator dials the tens digit, the connector equipment CE operates to raise the brushes CB to the level in which the test circuit TC_1 is found. Then in response to the units digit the brushes are stepped around in that level to the particular set of contacts to which are connected the conductors of the testing circuit TC_1. As soon as the brushes CB rest upon said contacts, ground is applied from the connector equipment to the sleeve contact thereby completing a circuit over the sleeve connection of the testing circuit TC_1 to operate the relay A_1.

As soon as the connection is established by the connector C to the testing circuit TC_1, the operator at the central office or the testboard man, if he is listening, will hear a busy tone, for the busy tone is normally connected by a circuit extending over the back contact of the first armature of relay B_2, back contact of the first armature of relay B_1, to the common ring conductor of test circuits TC_1 and TC_2. So long as the busy tone is heard the operator and the testman know that the final operation of the testing circuits has not been completed, as will appear presently.

The operation of the relay A_1 completes a circuit at its fourth contact over the slow-operating relay TM of the timing circuit T, said circuit extending from ground over the back contact of the fifth armature of relay B_1, front contact of the fourth armature of relay A_1 and through the slow-operating relay TM to battery. At its third contact relay A_1 prepares a circuit for the relay B_1, but this circuit cannot be completed until the slow-acting relay TM operates. Relay TM is slow enough in its operation to delay the action of the relay B_1 for such an interval as will enable a subscriber who has dialed the test circuit TC_1 by mistake to hang up when he hears the busy tone.

At the front contact of its second armature, relay A_1 establishes a connection between the relay D and the sleeve conductor of the side circuit SS'_1. Said circuit extends over the back contact of the sixth armature of the relay B_1, upper back contact of the relay C, front contact of second armature of relay A_1, to slow-release relay D. If the side circuit SS'_1 is busy, ground will be applied to its sleeve conductor and the relay D will operate to hold open the operating circuit of the relay B_1, which is controlled by the timing relay TM, thus preventing any action of the relay B_1 so long as the side circuit SS'_1 is busy. At the front contact of its first armature relay A_1 establishes a connection between relay C and the sleeve conductor of the phantom PS'. Said circuit extends from said sleeve conductor over the back contact of the second armature of relay B_1, back contact of the second armature of relay B_2, front contact of the first armature of relay A_1 to the winding of relay C and thence to battery. If the phantom circuit PS' is busy, ground will appear on its sleeve conductor and the relay C will be operated. At its upper front contact relay C closes another circuit for the relay D which extends from ground over said contact of relay C and over the front contact of the second armature of relay A_1. Consequently no operation of the relay B_1 can take place until both the wanted side circuit SS'_1 and its superposed phantom PS' are both idle, so that the busy ground is removed from their sleeve conductors.

In this connection it should be noted that so far as testing on the side circuit SS'_1 is concerned, it does not matter whether the associated side circuit SS'_2 is busy or not, as the one side circuit does not affect the other. It is only the busy condition of the wanted side circuit and the superposed phantom that is important. The side circuit SS'_2 is at this time busy, of course, because the dialing circuit above described was established over this circuit to operate selector S_3, which applied ground to the sleeve conductor of circuit SS'_2. This does not affect the relay D, however, as the circuit from the sleeve conductor of the side circuit SS'_2 to the relay D is held open at the second armature of the relay A_2, which is, of course, not operated at this time.

In order that the relay B_1 may be operated, three conditions must obtain: (1) the relay TM of the timing circuit must have operated, and

this operation occurs a definite interval after the selection of the circuit TC_1 with the consequent operation of the relay A_1, said interval being determined by the design of the relay TM; (2) the wanted side circuit SS'_1 must not be busy, for if it is busy, the action of the relay B_1 cannot occur until it becomes idle; (3) the superposed phantom PS'_1 must not be busy, for if it is busy, operation of the relay B_1 cannot take place until the phantom likewise becomes idle.

Let us assume that the slow-operating relay TM has now operated. If the relay D is released at this time, as will be the case when both side circuit and phantom are free, the circuit for the relay B_1 will be completed at once. If, however, the relay D is operated, as it will be if either the side circuit SS'_1 or the phantom PS' is busy, the operation of the relay B_1 cannot take place. If we assume that the side circuit SS'_1 is still busy at the time the relay TM operates, the relay D will not be released until the side circuit becomes idle. Assuming the phantom circuit is idle, as soon as the side circuit SS'_1 becomes free the circuit previously traced over the grounded sleeve of the side circuit SS'_1 through the winding of the relay D will no longer be completed to ground, because the busy ground has been removed from the sleeve conductor of the side circuit SS'. Under these circumstances the circuit for the relay B_1 will be completed from ground over the front contact of the relay TM, over the back contact of the relay D, auxiliary back contact controlled by the fifth armature of the relay B_1, over the front contact of the third armature of the relay A_1, through the winding of relay B_1 to battery.

If on the other hand, after the side circuit becomes idle, the phantom PS' is still busy, the relay D will not yet be released. Its circuit will be held closed by the alternative ground connected over the upper front contact of the relay C, which is operated over the grounded sleeve conductor of the phantom circuit PS'. As soon as the phantom becomes idle, however, the ground is removed from the sleeve conductor of the phantom, thus releasing the relay C. This in turn releases the relay D, whereupon the relay B_1 is operated over the circuit above traced.

Relay B_1, by opening the back contact of its number one armature, disconnects the busy tone from the ring conductor of the test circuit TC_1, and at the front contact of said armature connects the dial tone to said ring conductor. The operator (or the testman) at the distant central office, upon hearing the dial tone, is at once informed that the relay B_1 has been operated, and the test connection to be later described has been set up. At the front contact of its second armature relay B_1 connects ground to the sleeve conductor of the phantom circuit PS' to render said phantom circuit busy during the testing operation of the side circuit SS'_1. This is necessary because obviously the phantom cannot be used while the side circuit conductors of the pair T_1 are being tested. At the front contact of its sixth armature relay B_1 similarly applies ground to the sleeve conductor of the side circuit SS'_1 to render it busy.

At its fifth armature relay B_1 opens the circuit of the timing relay TM extending from ground over the back contact of said armature, and over the front contact of the fourth armature of relay A_1 to the timing relay TM. The operation of said fifth armature of the relay B_1 also opens the original operating circuit of said relay B_1 (which was controlled by the timing relay TM), and locks up said relay B_1 over a circuit from ground, over the front contact of the fifth armature of relay B_1, over the front contact of the third armature of relay A_1 and through the winding of relay B_1 to battery. B_1 is, therefore, held locked up so long as the relay A_1 is energized. Consequently the relay B_1 will not be released until the testing circuit TC_1 is released with the consequent deenergization of the relay A_1.

At the back contacts of its third and fourth armatures relay B_1 opens the dialing and signaling circuits CX'_1 and CX'_2 associated with the side circuit SS'_1 and the phantom circuit PS', and at the front contacts of said third and fourth armatures, relay B_1 connects a short-circuit across the conductors of the pair T_1, through the two coils of the composite set CS'_1. The side circuit is now in condition to be tested for faults by the testman, during his test the side circuit and associated phantom will be held out of service by the busy ground applied to their sleeve conductors, as already described. Also during the testing operation the dial tone is continuously applied to the ring conductor of the test circuits TC_1 and TC_2. If a subscriber at the community dial office should dial the number of either the test circuit TC_1 or TC_2 through a mistake, he would hear the dial tone and would be warned thereby to hang up.

It will be observed that when the operator at the distant office established connections over the side circuit SS'_2 to the test circuit TC_1 by dialing, the connector switch C connected its talking brushes to the contacts to which the talking conductors of test circuit TC_1 are connected. Since the connector C is ordinarily used for establishing connections to subscribers, it is, of course, provided with ringing equipment, and as soon as the connection above described was established, ringing current would be applied over the talking conductors of the testing circuit TC_1. A gas tube GT has its electrodes bridged across the talking conductors TC_1 and TC_2, and the ringing potential applied to the former conductors TC_1 ionizes the gas in the tube GT and breaks down the resistance between its electrodes. This causes an effect similar to that produced when a subscriber takes his receiver off the hook and completes a direct circuit connection between the talking conductors. As is well known, such a connection trips a relay in the connector equipment CE to disconnect the ringing current from the circuit. Consequently when the resistance of the tube GT breaks down, the ringing current is cut off from the testing circuit TC_1. The gas tube GT is of a known type, and is provided with a heated filament which is heated over a circuit (not shown), to produce a sensitive condition of the gas in the tube so that it is easily ionized. As the nature of these tubes is well known, no further description is necessary. It will be understood, however, that a cold cathode tube arrangement may be substituted for the hot cathode tube circuit, if so desired.

It will be noted that the short-circuit across the conductors of the pair T_1 is established by means of contacts in the composite leads CX'_1 and CX'_2 instead of by means of contacts directly connected in the conductors of the pair T_1 themselves. This is a desirable arrangement, as it avoids any unbalance as between the conductors of the pair T_1 due to variations in contact resistance.

When the testing operation is completed, the

operator will cause the release of the connector switch C in the usual manner. This releases the relay A_1, which in turn releases the relay B_1 and restores the circuits, including the composite legs, to normal.

Should it be desired to test the pair T_2, the number of the test circuit TC_2 will be dialed over another trunk, thereby causing the operation of the relay A_2. The relay A_2 at its fourth armature completes a circuit for the timing relay TM, and if the side circuit SS'_2 and the phantom PS' are idle, so that their sleeve conductors are ungrounded, the relays C and D will not be operated. In such case relay A_2 in conjunction with the timing relay TM will complete a circuit for the relay B_2 from ground, over the front contact of the timing relay TM, back contact of the relay D, auxiliary back contact of the fifth armature of the relay B_2, front contact of the third armature of the relay A_2, and through the winding of the relay B_2 to battery.

Relay B_2 at its upper armature disconnects the busy tone from the ring conductor of the circuit TC_2, and applies dial tone over the front contact of said armature, and over the back contact of the number one armature of relay B_1, to said ring conductor. At its second and sixth front contact respectively, relay B_1 applies busy ground to the sleeve conductors on the phantom circuit PS' and the side circuit SS'_2. At its third and fourth armatures relay B_2 opens the composite circuit CX'_3 and CX'_4 and establishes a short-circuit between them, thus in effect short-circuiting conductors of the pair T_2. It will be noted that this disconnects the ground potential neutralizing circuit CX'_4 from the lower conductor of the pair T_2. In order to prevent improper action of the neutralizing circuit, the fourth armature of the relay B_2 is provided with an auxiliary front contact which, when the auxiliary circuit CX'_4 is opened, connects the network N to said auxiliary circuit.

The timing circuit T, which depends upon the action of a simple slow-acting relay TM, is so designed that the relay TM operates in an interval of about fifteen to thirty seconds. If a more precise interval of time is desired to enable hanging up of his receiver by a subscriber who has dialed the testing circuit in error, a timing circuit T', such as shown in Fig. 3, may be substituted for the testing circuit T at the points *a* and *b*. This employs a gas tube GT' of a cold cathode type.

The operation of this circuit is as follows: When ground is applied to the point *a* in Fig. 3 in response to the operation of one of the relays A_1 or A_2 of Fig. 1, the relay **20** is operated. This connects 90 volt battery through a resistance **21** to charge a condenser **22**. This condenser is of such capacitance that after a predetermined interval the potential across it becomes sufficiently high to cause the gas in the tube GT' to be ionized and break down the resistance through the tube. This causes current to flow from the ground connected to one of the electrodes of the tube through the relay **23** to battery, thereby operating said relay **23**. Relay **23** at its upper front contact connects ground to the point *b* to operate the relay B_1 or B_2, as the case may be. At its lower armature relay **23** opens the circuit of relay **20** and completes locking circuit for its own winding from point *a*, through the resistance **24**, and through the winding of relay **23** to battery. Relay **20** upon releasing connects ground through the resistance **21** to the condenser **22** causing the latter to discharge and restore tube GT' to normal.

It will be obvious tha the general principles herein dislosed may be embodied in many other organizations widely different from those illustrated without departing from the spirit of the invention as defined in the following claims.

What is claimed is:

1. In a communication system, a central office, an unattended community dial office, a trunk extending between said offices, subscribers' lines entering said community dial office, dial operated switching apparatus at said community dial office to establish connections between subscribers' lines at said office and to establish connections between such lines and said trunk, a testing terminal for said trunk at said community dial office, and means whereby said terminal may be dialed from said central office, said means including means whereby said trunk is short-circuited to establish a testing condition on said trunk at said community dial office.

2. In a communication system, a central office, an unattended community dial office, a trunk extending between said offices, subscribers' lines entering said community dial office, dial operated switching apparatus at said community dial office to establish connections between subscribers' lines at said office and to establish connections between such lines and said trunk, a testing terminal for said trunk at said community dial office, and means whereby said terminal may be dialed from said central office and said trunk short-circuited for testing purposes at said community dial office.

3. In a communication system, a central office, an unattended community dial office, a trunk extending between said offices, subscribers' lines entering said community dial office, dial operated switching apparatus at said community dial office to establish connections between subscribers' lines at said office and to establish connections between such lines and said trunk, a testing terminal for said trunk at said community dial office, means whereby said terminal may be dialed from said central office to short-circuit said trunk to establish a testing condition on said trunk at said community dial office, and means to delay the establishment of such condition a predetermined time to permit a subscriber to hang up without interfering with the trunk in case the subscriber should erroneously dial the number of said test terminal.

4. In a communication system, a central office, an unattended community dial office, a trunk exending between said offices, subscribers' lines entering said community dial office, dial operated switching apparatus at said community dial office to establish connections between subscribers' lines at said office and to establish connections between such lines and said trunk, a testing terminal for said trunk at said community dial office, means whereby said terminal may be dialed from said central office to short-circuit said trunk to establish a testing condition on said trunk at said community dial office, means to delay the establishment of such condition a predetermined time to permit a subscriber to hang up without interfering with the trunk in case the subscriber should erroneously dial the number of said test terminal, and means to indicate to such subscriber that he has established a connection to a test terminal as distinguished from a line.

5. In a communication system, a central office,

an unattended community dial office, a trunk extending between said offices, subscribers' lines entering said community dial office, dial operated switching apparatus at said community dial office to establish connections between subscribers' lines at said office and to establish connections between such lines and said trunk, a testing terminal for said trunk at said community dial office, means whereby said terminal may be dialed from said central office to short-circuit said trunk to establish a testing condition on said trunk at said community dial office, and means to prevent the establishment of such test conditions when the trunk whose test terminal is dialed happens to be busy.

6. In a communication system, a central office, an unattended community dial office, a trunk extending between said offices, subscribers' lines entering said community dial office, dial operated switching apparatus at said community dial office to establish connections between subscribers' lines at said office and to establish connections between such lines and said trunk, a testing terminal for said trunk at said community dial office, means whereby said terminal may be dialed from said central office to short-circuit said trunk to establish a testing condition on said trunk at said community dial office, means to prevent the establishment of such test conditions when the trunk whose test terminal is dialed happens to be busy, and means to automatically establish said test condition when the trunk ceases to be busy.

7. In a communication system, a central office, an unattended community dial office, a trunk extending between said offices, subscribers' lines entering said community dial office, dial operated switching apparatus at said community dial office to establish connections between subscribers' lines at said office and to establish connections between such lines and said trunk, a testing terminal for said trunk at said community dial office, means whereby said terminal may be dialed from said central office to short-circuit said trunk to establish a testing condition on said trunk at said community dial office, and means to render said trunk busy when said testing condition has been established.

8. In a communication system, a central office, an unattended community dial office, a group of trunks including two side circuits and a phantom extending between said offices, subscribers' lines entering said community dial office, dial operated switching apparatus at said community dial office to establish connections between subscribers' lines at said office and to establish connections between such lines and any of said trunks, a testing terminal for each of said side circuits at said community dial office, and means whereby the testing terminal of any side circuit trunk may be dialed from the central office, said latter means including means to short-circuit any side circuit trunk dialed to establish a testing condition on said trunk at the community dial office.

9. In a communication system, a central office, an unattended community dial office, a group of trunks including two side circuits and a phantom extending between said offices, subscribers' lines entering said community dial office, dial operated switching apparatus at said community dial office to establish connections between subscribers' lines at said office and to establish connections between such lines and any of said trunks, a testing terminal for each of said side circuits at said community dial office, and means whereby the testing terminal of any side circuit trunk may be dialed from the central office and said trunk short-circuited for testing purposes at said community dial office.

10. In a communication system, a central office, an unattended community dial office, a group of trunks including two side circuits and a phantom extending between said offices, subscribers' lines entering said community dial office, dial operated switching apparatus at said community dial office to establish connections between subscribers' lines at said office and to establish connections between such lines and any of said trunks, a testing terminal for each of said side circuits at said community dial office, composite circuits for said trunks established over the conductors of said side circuits, one of said composite circuits being assigned to each trunk for dialing and signaling purposes, and means whereby the testing terminal of any side circuit trunk may be dialed from the central office to short-circuit the latter side circuit trunk to establish a testing condition on said trunk at the community dial office.

11. In a communication system, a central office, a community dial office, a group of trunks including two side circuits and a phantom extending between said offices, subscribers' lines entering said community dial office, dial operated switching apparatus at said community dial office to establish connections between subscribers' lines at said office and to establish connections between such lines and any of said trunks, a testing terminal for each of said side circuits at said community dial office, composite circuits for said trunks established over the conductors of said side circuits, one of said composite circuits being assigned to each trunk for dialing and signaling purposes, and means whereby the testing terminal of any side circuit trnuk may be dialed from the central office to disconnect said composite circuits from the trunk at the community dial office and short the conductors of the side circuit at the terminals of said composite circuits to put the trunk in condition for testing.

12. In a communication system, a central office, an unattended community dial office, a group of trunks including two side circuits and a phantom extending between said offices, subscribers' lines entering said community dial office, dial operated switching apparatus at said community dial office to establish connections between subscribers' lines at said office and to establish connections between such lines and any of said trunks, a testing terminal for each of said side circuits at said community dial office, means whereby the testing terminal of any side circuit trunk may be dialed from the central office to short-circuit said trunk to establish a testing condition on said trunk at the community dial office, and means to delay the establishment of such condition a predetermined time to permit a subscriber to hang up without interfering with the trunk in case the subscriber should erroneously dial the number of the test terminal of the trunk.

13. In a communication system, a central office, an unattended community dial office, a group of trunks including two side circuits and a phantom extending between said offices, subscribers' lines entering said community dial office, dial operated switching apparatus at said community dial office to establish connections between sub-

scribers' lines at said office and to establish connections between such lines and any of said trunks, a testing terminal for each of said side circuits at said community dial office, means whereby the testing terminal of any side circuit trunk may be dialed from the central office to short-circuit said trunk to establish a testing condition on said trunk at the community dial office, means to delay the establishment of such condition a predetermined time to permit a subscriber to hang up without interfering with the trunk in case the subscriber should erroneously dial the number of the test terminal of the trunk, and means to indicate to such subscriber that he has established a connection to a test terminal as distinguished from a line.

14. In a communication system, a central office, an unattended community dial office, a group of trunks including two side circuits and a phantom extending between said offices, subscribers' lines entering said community dial office, dial operated switching apparatus at said community dial office to establish connections between subscribers' lines at said office and to establish connections between such lines and any of said trunks, a testing terminal for each of said side circuits at said community dial office, means whereby the testing terminal of any side circuit trunk may be dialed from the central office to short-circuit said trunk to establish a testing condition on said trunk at the community dial office, and means to prevent the establishment of such test conditions when the trunk whose test terminal is dialed happens to be busy.

15. In a communication system, a central office, an unattended community dial office, a group of trunks including two side circuits and a phantom extending between said offices, subscribers' lines entering said community dial office, dial operated switching apparatus at said community dial office to establish connections between subscribers' lines at said office and to establish connections between such lines and any of said trunks, a testing terminal for each of said side circuits at said community dial office, means whereby the testing terminal of any side circuit trunk may be dialed from the central office to short-circuit said trunk to establish a testing condition on said trunk at the community dial office, means to prevent the establishment of such test conditions when the trunk whose test terminal is dialed happens to be busy, and means to automatically establish said test condition when the trunk ceases to be busy.

16. In a communication system, a central office, a community dial office, a group of trunks including two side circuits and a phantom extending between said offices, subscribers' lines entering said community dial office, dial operated switching apparatus at said community dial office to establish connections between subscribers' lines at said office and to establish connections between such lines and any of said trunks, a testing terminal for each of said side circuits at said community dial office, means whereby the testing terminal of any side circuit trunk may be dialed from the central office to establish a testing condition on said trunk at the community dial office, and means to prevent the establishment of such test conditions when either the trunk whose test terminal is dialed or a phantom trunk composited thereon happens to be busy.

17. In a communication system, a central office, a community dial office, a group of trunks including two side circuits and a phantom extending between said offices, subscribers' lines entering said community dial office, dial operated switching apparatus at said community dial office to establish connections between subscribers' lines at said office and to establish connections between such lines and any of said trunks, a testing terminal for each of said side circuits at said community dial office, means whereby the testing terminal of any side circuit trunk may be dialed from the central office to establish a testing condition on said trunk at the community dial office, means to prevent the establishment of such test conditions when either the trunk whose test terminal is dialed or a phantom trunk composited thereon happens to be busy, and means automatically to establish said test condition when both of said trunks cease to be busy.

18. In a communication system, a central office, an unattended community dial office, a group of trunks including two side circuits and a phantom extending between said offices, subscribers' lines entering said community dial office, dial operated switching apparatus at said community dial office to establish connections between subscribers' lines at said office and to establish connections between such lines and any of said trunks, a testing terminal for each of said side circuits at said community dial office, means whereby the testing terminal of any side circuit trunk may be dialed from the central office to short-circuit said trunk to establish a testing condition on said trunk at the community dial office, and means to render said side circuit trunk busy when said testing condition has been established.

19. In a communication system, a central office, a community dial office, a group of trunks including two side circuits and a phantom extending between said offices, subscribers' lines entering said community dial office, dial operated switching apparatus at said community dial office to establish connections between subscribers' lines at said office and to establish connections between such lines and any of said trunks, a testing terminal for each of said side circuits at said community dial office, means whereby the testing terminal of any side circuit trunk may be dialed from the central office to establish a testing condition on said trunk at the community dial office, and means to render said side circuit trunk and the phantom trunk composited thereon busy when said testing condition has been established.

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