April 6, 1926. 1,579,836

W. T. POWELL

AUTOMATIC TELEPHONE SYSTEM

Filed March 14, 1922 3 Sheets-Sheet 1

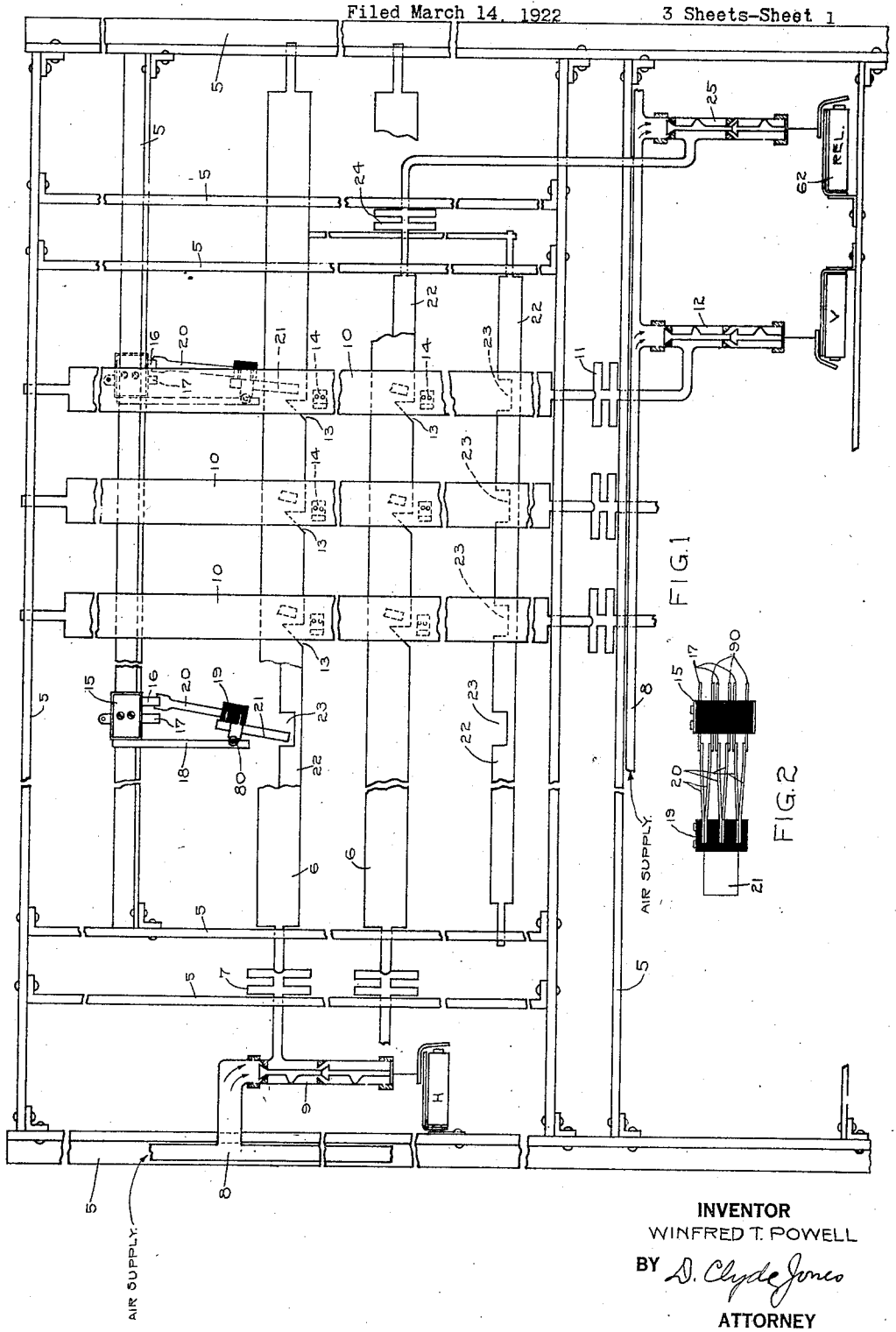


FIG. 1

FIG. 2

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Filed March 14, 1922 3 Sheets-Sheet 2

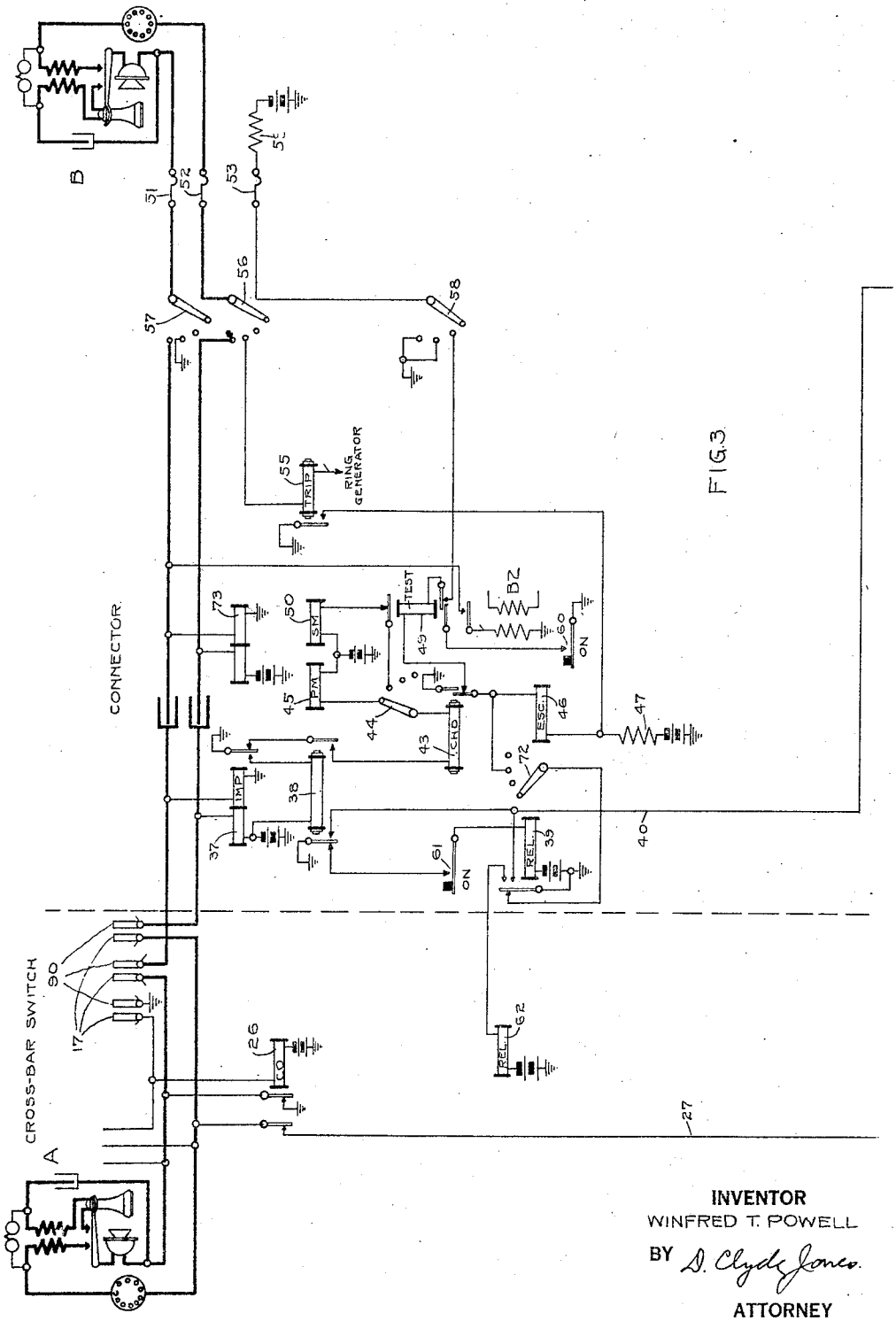


FIG.3

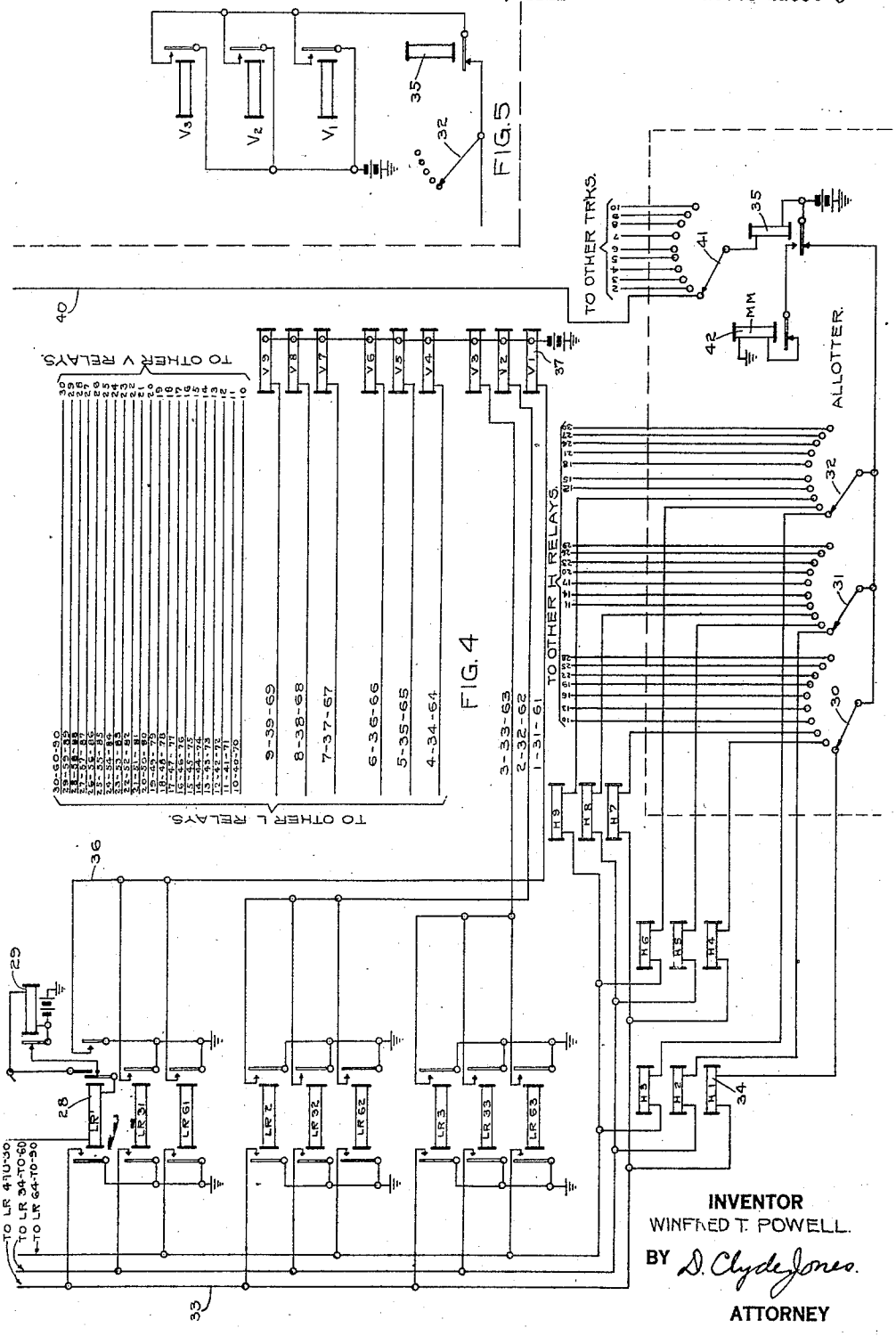
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UNITED STATES PATENT OFFICE.

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AUTOMATIC TELEPHONE SYSTEM.

Application filed March 14, 1922. Serial No. 543,696.

To all whom it may concern:

Be it known that I, WINFRED T. POWELL, a citizen of the United States, residing at Rochester, in the county of Monroe and State of New York, have invented certain new and useful Improvements in Automatic Telephone Systems, of which the following is a full, clear, concise, and exact description.

This invention relates to telephone systems and more particularly to telephone systems employing automatic switches in completing some part of a telephone connection.

The purpose of the present invention is to provide novel and inexpensive means for interconnecting a calling subscriber's line with an idle trunk or for connecting a selected trunk with another idle trunk.

In the drawings Fig. 1 represents a side elevation of a non-numerical switch structure herein referred to as a cross-bar switch. Fig. 2 is a detailed view of the movable brushes of said cross-bar switch. Figs. 3 and 4 when taken together, and with Fig. 4 placed below Fig. 3 diagrammatically represent a portion of a telephone system in which the cross-bar switch of Fig. 1 is used. The circuits at the left of the dotted line of Fig. 3 as well as all the circuits at the left and above the dotted lines of Fig. 4 represent the operating circuits of the cross bar switch. In the lower right hand corner of Fig. 4 there is diagrammatically shown an allotter switch which functions to allot idle trunks for use in succession and also prevents the operation of more than one horizontal relay, thereby insuring the interconnection of only one subscriber's line with a trunk circuit. At the right of the dotted line of Fig. 3 there is diagrammatically represented a numerical switch or connector, as well as the line and substation circuits of a called line. Fig. 5 shows a modified form of circuit for the horizontal magnets which insures the operation of a vertical magnet before any horizontal magnet is energized.

The system.

For purposes of this disclosure it has been assumed that the cross-bar switch is of such size as to interconnect ninety subscribers' lines with any one of ten trunks. It will be understood, however, that if the size of the cross-bar switch is increased a greater number of subscribers' lines and trunk circuits may be extended through this operation. For systems of relatively large size, the subscribers' lines will be divided into groups of ninety lines with a cross-bar switch for each group, in this case the trunks will terminate in selector switches instead of connector switches. Each group of ninety subscribers' lines are further sub-divided into subgroups of thirty lines each and each trunk has branches accessible to each of the subgroups. Each subscriber's line terminates in multiple contacts associated with a contact of each of the ten trunks common to the group of lines.

The cross bar switch.

The cross bar switch shown in Figs. 1 and 2 consists of a rigid frame 5, in which the various parts of the switch structure are supported. In this frame there are mounted thirty horizontal bars such as 6 arranged for longitudinal or horizontal movement under control of expansive air chambers 7 which are commonly sold under the trade name of "Sylphons". As is well known these expansive air chambers are made of flexible metal which expands under the force of compressed air or any other fluid under pressure. For purposes of this disclosure the compressed fluid is assumed to be compressed air and the source of compressed air is brought to the switch through a supply pipe 8. At 9 there is represented a valve structure which is controlled by the energization of relay H to admit a supply of air to the expansive air chamber 7. This chamber when expanded forces the horizontal bar 6 longitudinally towards the right. In the present arrangement there are also provided thirty vertical bars designated 10, each of which is arranged for longitudinal or vertical movement under the control of its expansive air chamber 11, to which compressed air is admitted from the supply pipe 8 under the control of a valve 12 which valve in turn is controlled by a relay such as *v*. By reference to Fig. 1 it will be noted that the horizontal bars are provided with notches 13 located at the intersections of the horizontal bars with the vertical bars. The vertical bars are each provided with flexible springs 14, extending towards the rear of the switch structure. One of these

flexible springs is located near the intersection of a vertical bar, with its associated horizontal bar in such position that when the vertical bar 10 is elevated its vertical springs 14 are elevated into such position that they rest in the notches 13 of unoperated horizontal bars. If a horizontal bar has been operated a spring 14 moves up and to the right on the inclined surface of the notch. It should be stated here that the spring 14 is flexible for lateral movement but is substantially rigid against any vertical movement so that it is immaterial whether the vertical bars or the horizontal bars operate first. Mounted on the cross bars of the frame 5 near each intersection of the vertical bars with the horizontal bars are sets of rigid contacts such as 15 insulated from the frame. Each set of contacts includes a normal contact 16 which has no electrical connection and the sets of terminals 17 which are connected to a telephone line and trunk terminals 90. On an extension 18 of the frame there is mounted a brush block 19 pivoted at 80 which includes the sets of brushes 20 and a rigid extension 21. The rigid extension 21 is so placed that its normal position is at the right of its associated flexible spring 14 on the vertical bar such as 10, when these members have been raised to their highest position. The release bar such as 22 which is provided with notches 23, one for each brush block functions to return any associated operated brush block to its normal position. In the present arrangement the release bars such as 22 are operated in sets of three, that is, one expansive air chamber such as 24 functions to restore the operated brush blocks of any one of three horizontal bars. This is due to the fact that each trunk is common to three different groups of lines of thirty each. Valve 25 operating under the control of a release relay 62 controls the admission of air into the expansive air chamber 24.

In the operation of the cross bar switch just described when the subscriber initiates a call after the allotter switch hereinafter described has allotted a trunk, the vertical relay such as V actuates the valve 12 to admit air into the expansive chamber 11 and this chamber on expanding elevates the vertical bar 10. This bar when elevated positions its sets of flexible springs 14 in the notches such as 13 of the horizontal bars such as 6. Also at this time the relay such as H operates to open valve 9 and admits air to the expansive chamber 7. This chamber forces its horizontal bar 6 towards the right causing the inclined edge of the notch 13 to engage the flexible spring 14 and since the spring is flexible only for horizontal movement it engages the extension 21 of the brush block and forces the set of brushes 20 from their normal set of contacts 16 into engagement with the line contacts 17 and trunk contacts 90. Each line terminates in several line contacts 17 located in a vertical row and are multipled together while each trunk terminates in multiple terminals 90 located in one or more horizontal rows.

At the termination of a connection circuits become effective, as will be pointed out, to actuate the relay 62. This relay opens the valve 25 and permits compressed air to enter expansive chamber 24. This chamber on expanding moves the release bars 22 towards the left and since the extension 21 of the brush blocks are always located in a notch 23 of the release bars, each brush block 17 which is in an off-normal position is rotated into the position shown in Fig. 1.

In the modified circuits of Fig. 5, the operating circuits of the horizontal relay 5 are held open until a vertical relay operates, to assure the positioning of the springs 14 in the notches 13 of the horizontal bars.

Operation of the system.

It is believed that the operation of this switch in a telephone system will best be understood by describing the method of extending a telephone connection from a calling subscriber indicated at A to a called subscriber indicated at B.

When the subscriber at A removes his receiver from its switch hook, a circuit is completed from ground at the inner back contact and armature of the cut-off relay 26, over the upper side of the calling line and through the substation circuits at A in series over the lower side of the calling line, armature and back contact of relay 26, conductor 27, winding of the line relay 28, through its continuity spring and back contact, back contact and armature of relay 29, which is common to ninety subscribers' lines to grounded battery. The line relay 28 is energized in this circuit and is held energized in a substitute circuit differing from that just described by reason of the fact that it extends from the continuity spring and armature of relay 28, winding of relay 29 to grounded battery. In this system the allotter normally has preselected an idle trunk for use.

Let it be assumed that the allotter is standing with its brushes 30, 31, 32 and 41 in engagement with the contacts as shown in Fig. 4. Under this assumption when the line relay 28 is energized it closes a circuit from ground, its left hand armature and front contact, conductor 33, winding of the horizontal relay 34, allotter brush 30, back contact and armature of relay 35 to grounded battery. At the outer right hand armature and front contact of line relay 28 a circuit is closed from ground over conductor 36, winding of vertical relay 37 to grounded battery. Vertical relay 37 actuates a ver-

tical bar in the manner already described and the horizontal relay 34 actuates a horizontal bar to move the brush block 19 so that the brushes 20 connect terminals 17 and 90. As soon as the sets of contacts 17 and 90 are in engagement, the cut-off relay 26 operates in the well known manner to disconnect line relay 28 from further control of the calling line, also at this time the impulse relay 37 of the connector switch is energized over the two sides of the selected trunk and calling line in series. The connector switch referred to may be similar in structure to that shown in the patent to Keith et al. #815,176 issued March 13, 1906.

The impulse relay when thus energized attracts its armature and closes an operating circuit for the slow releasing relay 38. This relay at its right hand armature and front contact closes an operating circuit for the operating magnets of the connector switch as will be described, while at its left hand armature and back contact it opens an operating circuit of the release magnet 39 of the connector switch and at its left hand armature and front contact closes a circuit from ground over conductor 40, allotter brush 41, winding of relay 35 to grounded battery. The relay 35 is energized in this circuit and closes an operating circuit for the motor magnet 42 of the allotter, which advances brushes 30, 31, 32 and 41 until the test brush 41 engages a terminal of an idle trunk which is characterized by the absence of ground potential. At this time relay 35 deenergizes to open the operating circuit for the motor magnet 42 to stop the allotter in position to preselect an idle trunk. The circuits of the connector switch are now in condition to receive the directive impulses from the calling subscriber's dial sender.

Since it has been assumed for purposes of description that the present system is of small capacity, the first series of impulses corresponds to the tens digit of the wanted number. In response to each of these impulses the impulse relay 37 vibrates its armature to close a circuit from ground, armature and back contact of relay 37, armature and front contact of relay 38, winding of the change-over relay 43, side switch wiper 44 in its first position, winding of the primary motor magnet 45 to grounded battery. In response to each of these impulses the primary motor magnet 45 advances the brushes 51, 52 and 53 in their primary or group selecting movement. As soon as the operating circuit for the primary motor magnet 45 is completed, as just described, the change-over relay 43 is energized and at its continuity spring and armature completes a circuit from ground, through the winding of the escape magnet 46, resistance 47 to grounded battery to hold the escape magnet operated.

At the close of the tens series of impulses the impulse relay 37 holds its armature attracted for a relatively long interval which causes the change-over relay 43 to deenergize and interrupt the circuit which has held the escape magnet 46 operated during this series of impulses. The escape magnet on deenergization moves the side switch wipers into their second position.

In response to the units series of impulses the impulse relay 37 again vibrates its armature but this time completes a circuit from ground, its armature and back contact, armature and front contact of relay 38, winding of the change-over relay 43, side switch wiper 44 in its second position, armature and back contact of test relay 49, winding of the secondary motor magnet 50 to grounded battery. In response to each of the impulses repeated to the secondary motor magnet 50, this magnet advances brushes 51, 52, and 53 of the connector switch one step in their secondary direction to select a wanted line in the selected group. On the first closure of the operating circuit of the secondary motor magnet 50 the change-over relay 43 is energized in series therewith and attracts its armatures, completing an energizing circuit for the escape magnet 46 extending from grounded battery resistance 47, winding of this magnet, continuity spring and contact of the change-over relay to ground. Under the control of this circuit the escape magnet is held operated during the units series of impulses but at the close of this series of impulses the change-over relay 43 deenergizes and if the wanted line is idle, the escape magnet 46 deenergizes and advances the side switch wipers into their third position.

At this time the escape magnet 46 is energized from grounded battery, resistance 47, winding of magnet 46, side switch wiper 72, back contact and armature of release magnet 39 to ground. Ringing current is supplied to the wanted line in a circuit completed from the ringing generator (not shown), winding of the trip relay 55 side switch wiper 56, connector brush 52 and through substation circuits and call bell in series, connector brush 51, side switch wiper 57 in its third position to ground. Ringing current is applied over this circuit until the called party responds at which time the trip relay 55 is operated to short circuit the escape magnet 46, which magnet deenergizes and advances the side switch wipers into their fourth or talking position. Talking battery is supplied to the calling line through the windings of impulse relay 37 and talking battery is supplied to the called line through impedance coil 73.

Let it be assumed that the wanted line is busy at the time when it is tested by the test brush 53 of the connector switch, while

the side switch wipers are in their second position. This test takes place immediately after the close of the units series of impulses when the change-over relay 43 deenergizes. If the wanted line is busy at this time the escape magnet 46 is held operated from grounded battery, resistance, winding of this magnet, continuity spring and back contact of relay 43, winding of the test relay 49, its continuity spring and back contact, side switch wiper 58 in its second position, test brush 53, the test terminal with which it is in engagement, through a multiple terminal, a test brush similar to 53 of the connector switch that has already seized the wanted line, a side switch wiper similar to 58 in its third position to ground. The test relay is energized in this circuit and closes a locking circuit for itself from grounded battery, resistance 47, escape magnet 46, continuity spring and back contact of change-over relay 43, winding of test relay 49, its continuity spring and armature, off normal contacts 60 to ground. The escape magnet 46 thus holds the side-switch wipers in their second position and the source of busy tone current is applied through the lowermost armature and front contact of the test relay to the calling line to inform the subscriber thereon that the wanted line is not selectable.

At the termination of the connection the calling subscriber replaces his receiver on its switch hook, which operation opens the energizing circuit of the impulse relay 37 causing it to retract its armature. Shortly afterwards the slow releasing relay 38 deenergizes and thereby completes a release circuit from ground, its armature and back contact, off-normal contact 61, winding of the release magnet 39 to grounded battery. The release magnet operates in the well known manner to restore the connector switch to normal position, it also closes a circuit from ground, its armature and front contact, winding of the release magnet 62 to grounded battery. This last mentioned release magnet, it will be remembered effects the operation of the expansive chamber 25 of Fig. 1 which in turn operates the release bars 22 to restore the brushes 20 to their normal position.

What is claimed is:—

1. In a telephone system, a group of telephone lines, a group of trunks, multiple terminals of said lines and multiple terminals of said trunks placed in adjacent relation to each other, a relay individual to a subgroup of telephone lines, a second relay individual to a second subgroup of telephone lines but including one telephone line of said first subgroup, fluid-controlled means for closing the terminals of a trunk with the terminals of the line common to said subgroups, said fluid-controlled means being actuated by said relays, means controlled over a calling telephone line for operating a pair of said relays, and means for preventing the simultaneous operation of more than one pair of said relays.

2. In a telephone system, a group of telephone lines divided into subgroups, a group of trunks, an allotter for assigning trunks for use, a relay individual to a subgroup of telephone lines, a second relay individual to a second subgroup of telephone lines but including one telephone line of said first group, a circuit for one of said relays controlled by said allotter, fluid controlled means for connecting said telephone line to an allotted trunk, said fluid-controlled means being actuated by said relays, means controlled over said common telephone line for actuating a pair of relays, and means for preventing the operation of more than one pair of said relays at the same time.

3. In a telephone system, a group of telephone lines, a group of trunks, a relay individual to a subgroup of telephone lines, a second relay individual to a second subgroup of telephone lines but including one telephone line of said first group, fluid-controlled means for connecting a telephone line to a trunk, said fluid-controlled means being actuated by said relays, a line relay controlled over a telephone line for causing the actuation of said pair of relays, and means for preventing the simultaneous operation of more than one pair of said relays.

4. In a telephone system, a group of telephone lines, a group of trunks, an allotter for assigning trunks for use, a relay individual to a subgroup of said telephone lines, a second relay individual to a second subgroup of telephone lines but including one telephone line of said first subgroup, a line relay controlled over said common telephone line for actuating said relays, fluid-controlled means governed by said first mentioned relays for connecting a calling telephone line to an allotted trunk, a cut-off relay individual to said common telephone line and controlled by the connection of said line to said allotted trunk for disabling said line relay, and means for preventing the simultaneous operation of two line relays.

5. In a telephone system, a group of telephone lines, a group of trunks, an allotter for assigning trunks for use, a relay individual to a subgroup of telephone lines, a second relay individual to a second subgroup of telephone lines but including one telephone line of said first subgroup, a line relay controlled over said common telephone line for actuating said relays, fluid-controlled means for connecting a calling telephone line to an allotted trunk under the control of said pair of relays, and a cut-off

relay individual to said common line and controlled by the connection of said line to said trunk for disabling said line relay, the circuit of said cut-off relay having but one break point.

6. In a telephone system, a group of telephone lines, a group of trunks, an allotter for assigning trunks for use, a relay individual to a subgroup of said telephone lines, a second relay individual to a second subgroup of telephone lines, but including one telephone line of said first subgroup, a line relay individual to and controlled over each telephone line, a pair of said first and said second mentioned relays being actuated by the operation of each line relay, fluid controlled means for connecting a called telephone line to an allotted trunk under the control of said pair of relays, a cut-off relay individual to said common telephone line and controlled by the connection of said line to an allotted trunk for disabling its line relay, a relay common to said group of telephone lines, a circuit for said relay serially including the calling telephone line and its line relay, and means controlled by said common relay for preventing the operation of more than one line relay at a time.

In witness whereof, I hereunto subscribe my name this 10th day of March A. D. 1922.

WINFRED T. POWELL.