

May 14, 1946.

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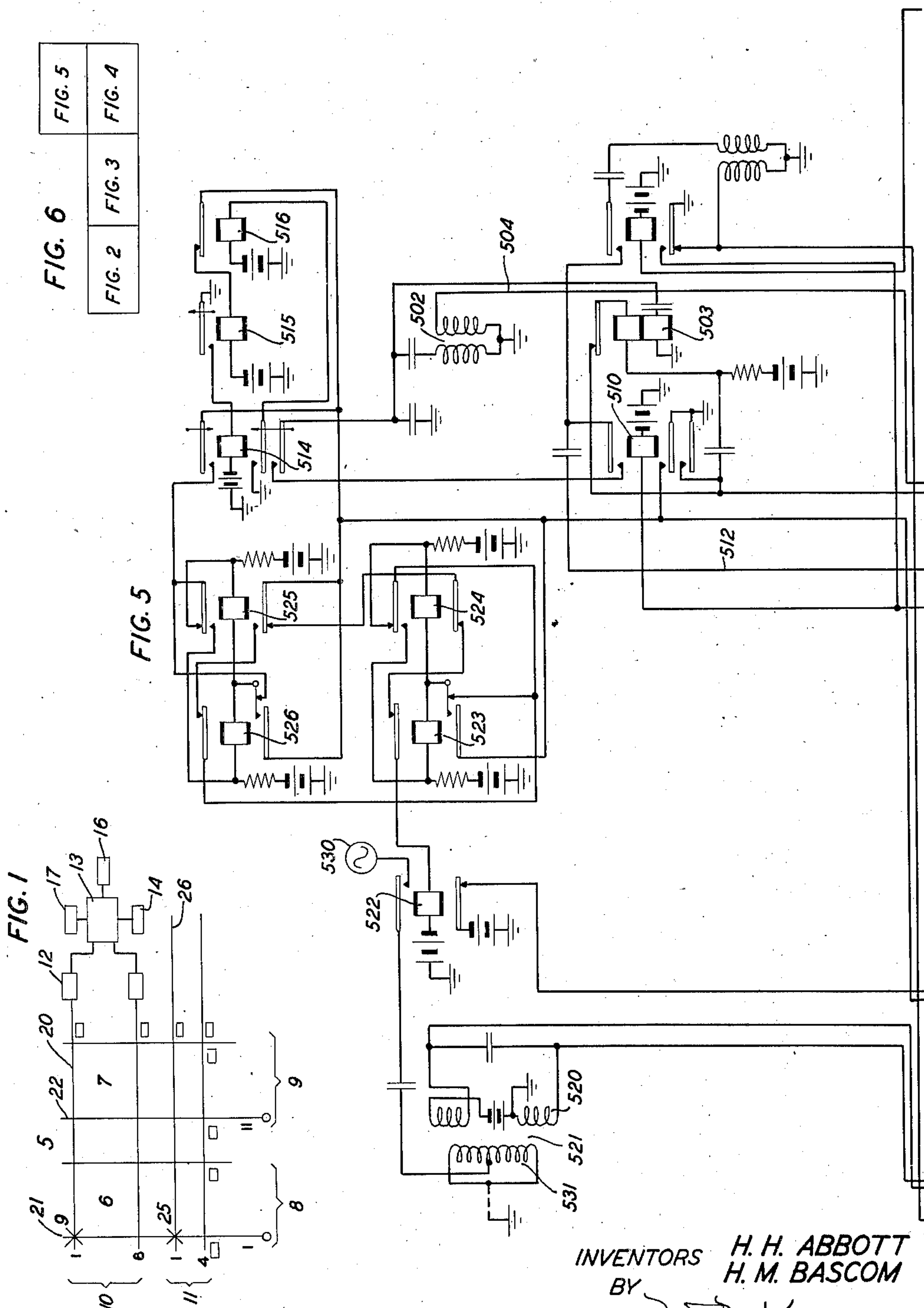
2,400,061

TELEPHONE SYSTEM

Filed March 22, 1944

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FIG. 6	FIG. 5
FIG. 2	FIG. 4



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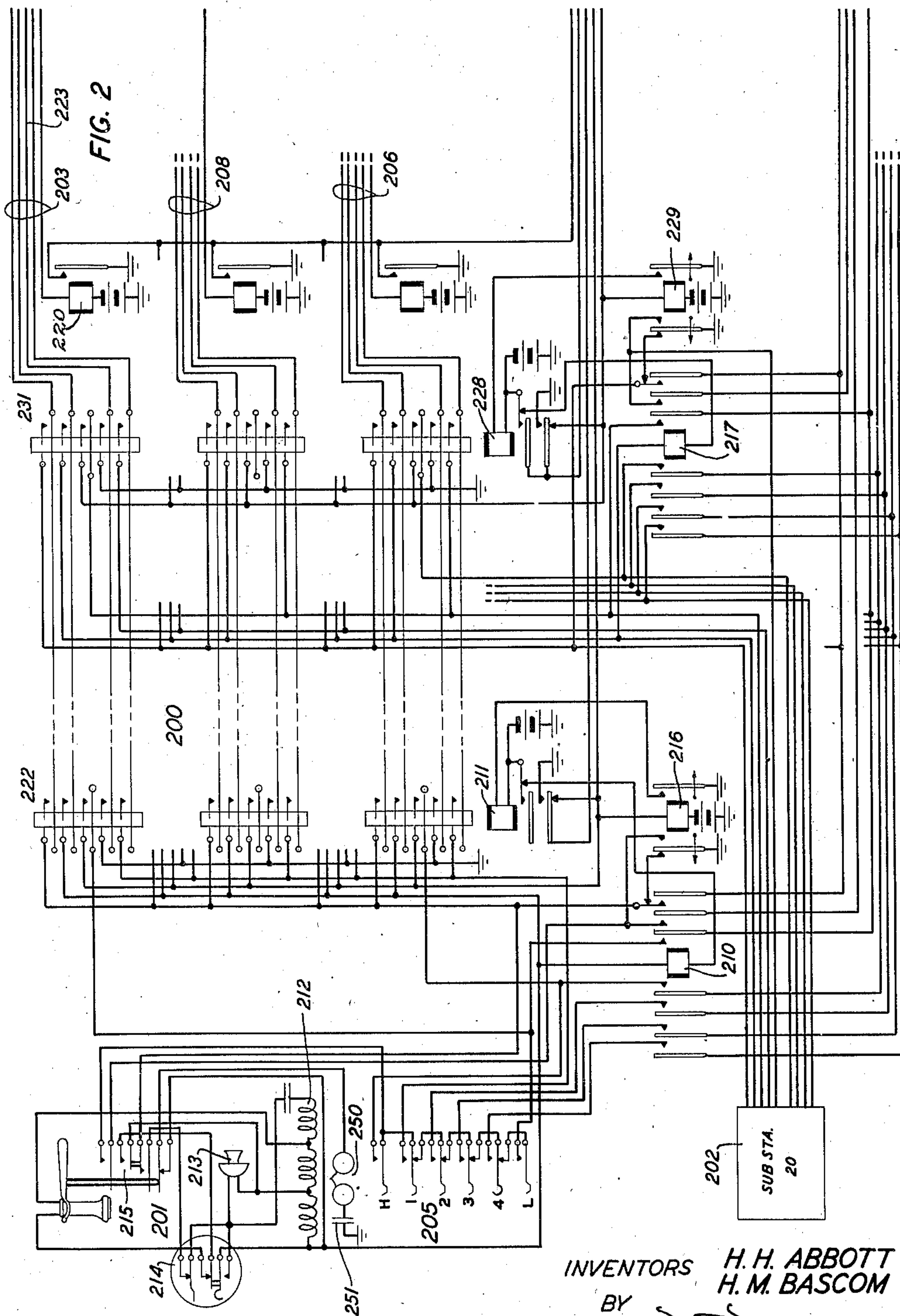
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4 Sheets-Sheet 2



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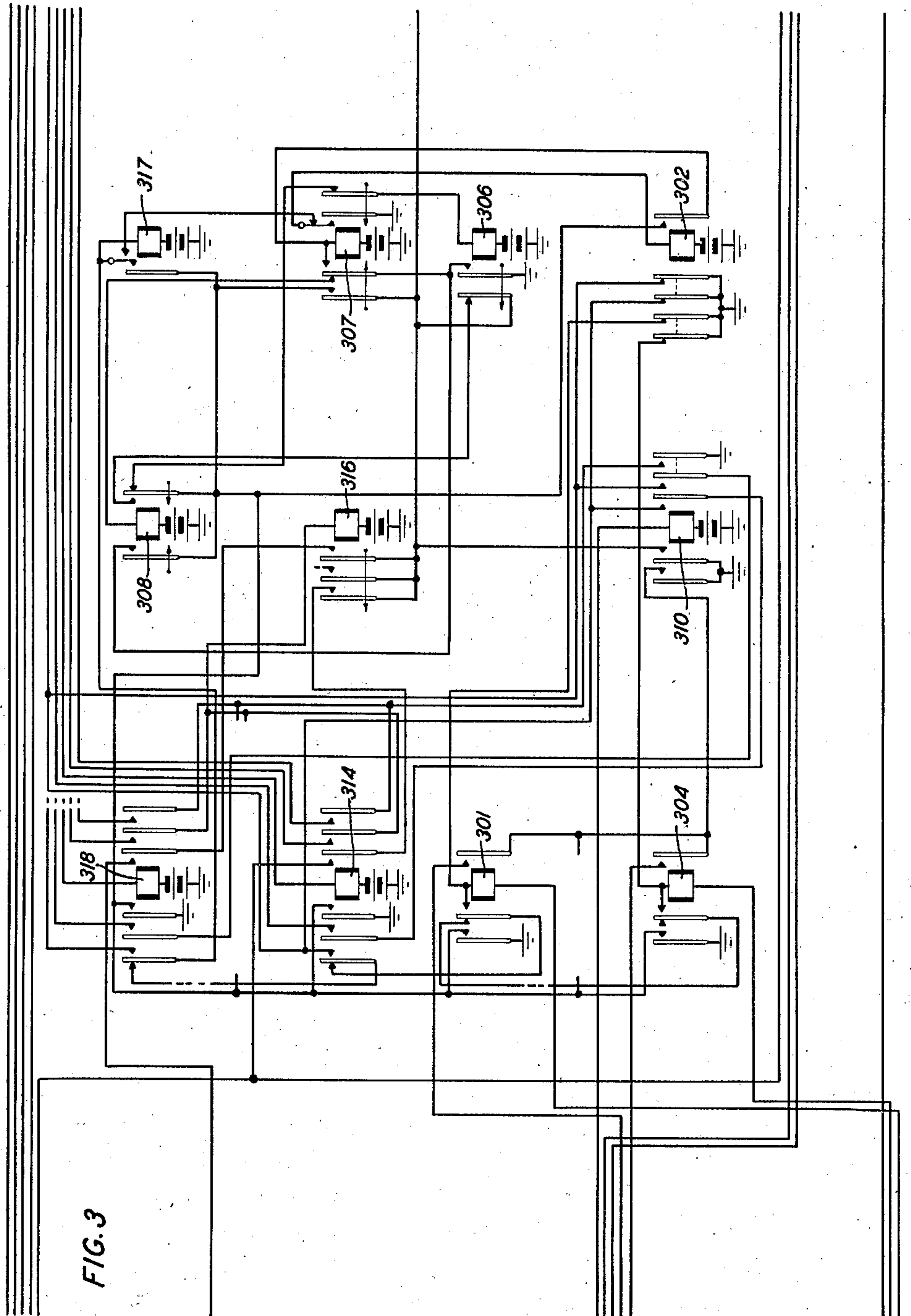
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TELEPHONE SYSTEM

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4 Sheets-Sheet 3



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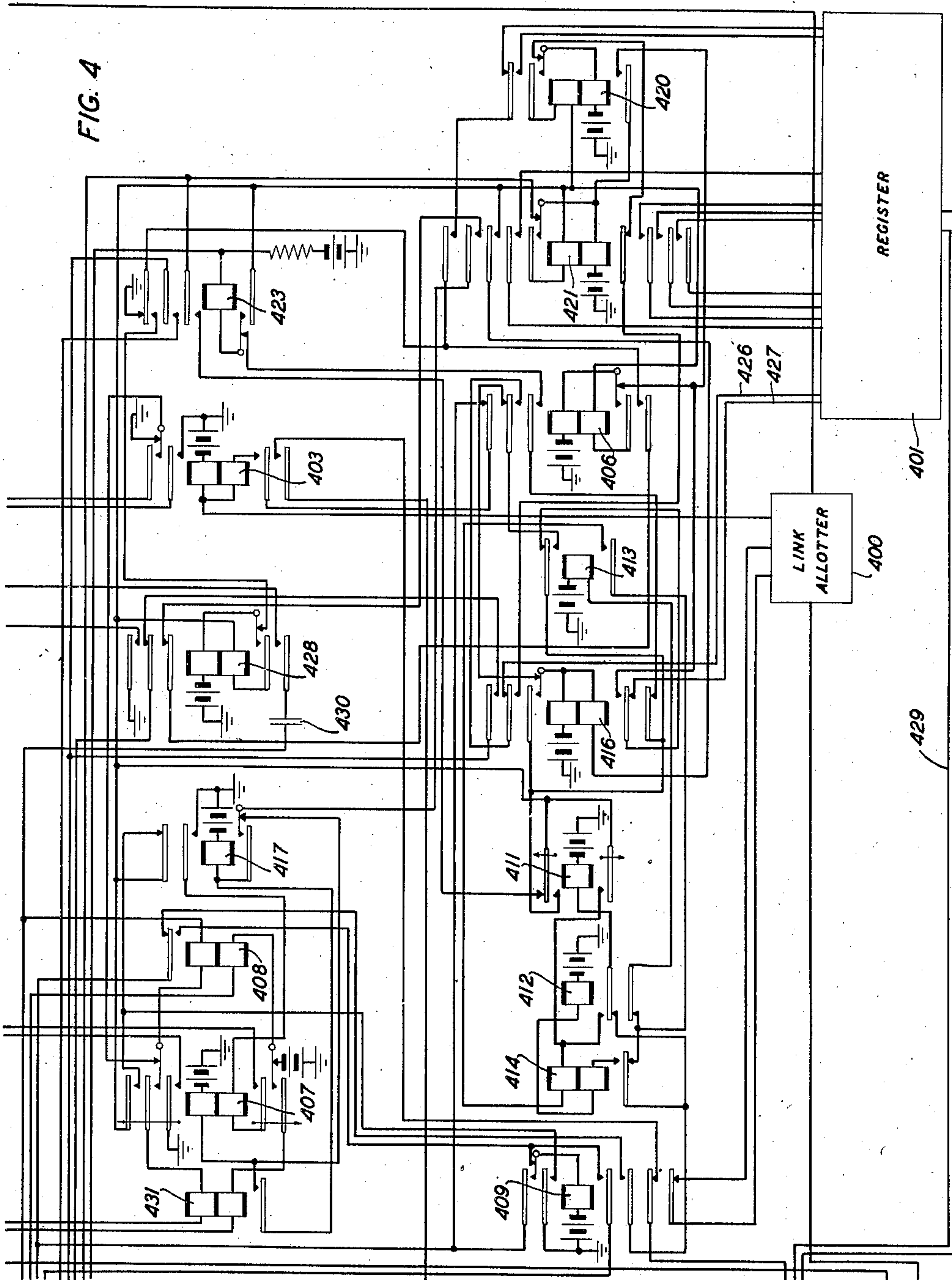
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TELEPHONE SYSTEM

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4 Sheets-Sheet 4



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2,400,061

TELEPHONE SYSTEM

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Application March 22, 1944, Serial No. 527,636

10 Claims. (Cl. 179—22)

This invention relates to telephone systems and particularly to systems in which automatically operated switches are employed to establish connections between subscribers' lines.

An object is to simplify the automatic equipment and to economize in the use of such equipment.

Heretofore so-called cross bar switching systems have been used in various forms to establish automatic connections between subscribers' lines. For example in small capacity systems of the order of from 1 to 200 subscribers' lines, a single cross bar switch was used in which each subscriber's line terminated in a separate row of contacts such as in a vertical row, while links for connecting the subscribers terminated in the horizontal rows. The arrangement was such that a calling subscriber's line was connected at the crosspoint of his vertical row of contacts with an outgoing branch of an idle link in a horizontal row and the called subscriber's line was connected at the crosspoint of his vertical row of contacts with an incoming branch of this seized link in another horizontal row so that the connection extended from the calling subscriber's line through this two-ended link to the called subscriber's line. These connections were established by the usual means of select magnets and hold magnets operating on intersecting bars in a manner well known in the art.

It is a feature of the applicants' invention to employ instead of such two-ended links, means whereby a connection between a calling subscriber's line and a called subscriber's line is extended over a single-ended link in the same horizontal row of contacts. That is, the calling line is connected at the crosspoint of his vertical row of contacts and the contacts of an idle horizontal row of link contacts and the called subscriber's line is connected at the crosspoint of his vertical row and contacts of the same horizontal row of said seized link.

Another feature of the applicants' invention is to provide a ringing equipment for ringing the called line over one conductor of the line from the single-ended link and the called line through the called subscriber's ringer to ground and through a ringing trip relay connected in series with a ringing source and so arranged that this relay is energized while ringing is taking place and released when the called subscriber answers as a result of the opening of the ringing path to the called subscriber's ringer to ground. The release of said relay disconnects the ringing source and establishes the talking

connection. This arrangement also provides that the ringing is tripped only during a ringing interval and thereby prevents any loud clicks in the calling subscriber's receiver while tripping takes place which would occur if the tripping would take place during a silent interval.

The applicants' invention has been illustrated in the accompanying drawings in which:

Fig. 1 shows in schematic form a typical layout of the applicants' invention in connection with a cross bar switch; and

Figs. 2, 3, 4 and 5 arranged in the order as shown in Fig. 6 disclose in detail the circuit arrangement for carrying out the applicants' invention in a small capacity system.

Referring now to the drawings and particularly to Fig. 1, the arrangement shown may consist of a single cross bar switch 5 divided into two sections 6 and 7 having a capacity of ten subscribers each. That is, in section 6 there are ten vertical rows of contacts for ten subscribers' lines as indicated at 8 and in section 7 there are another ten subscribers' lines terminating in ten vertical rows of contacts indicated at 9. The horizontal rows of contacts may be divided in six single-ended links shown at 10 and four outgoing trunks shown at 11. These links may be provided with a separate group of control relays such as 12 for link No. 1 and common control relays indicated by the box 13, while a common register as indicated at 14 and an idle link allotter arrangement at 16 with a common ring arrangement at 17. If a connection is desired, for example, from a subscriber No. 1 to a subscriber No. 11, the subscriber No. 1, removing his receiver from the switchhook causes a connection to be established over, for example, the link 20, allotted by the allotter 16, through crosspoint 21 to the register 14 over the individual relays 12 and the common relays 13. He then after receiving dial tone dials the number of the desired subscriber's line which requires a first digit determining whether the calling subscriber's line is in group 8 or in group 9 and a second digit determining the individual subscriber's line. When the dialing has been completed the register 14 operates these mechanisms to establish a connection at the crosspoint 22 between the called subscriber's line and the link 20 and the ringing equipment 17 is then operated to ring the called subscriber over the chosen link. When the called subscriber answers, the ringing equipment 17, the common relays 13, the register 14 and the allotter 16 are released for common use and the talking circuit is established

from the calling subscriber No. 1 through the crosspoint 21 over link 20 to the called subscriber No. 11 through crosspoint 22. A trunk connection is established by, for example, a subscriber No. 1 by a single connection at a crosspoint such as, for example, 25 between the subscriber's line No. 1 and the first trunk 26 or if this trunk is busy at a different crosspoint to the next succeeding idle trunk. The trunk may extend to a distant office, central office or a private branch exchange.

Referring now to Figs. 3 to 5, a call will be traced from a calling subscriber's line to a called subscriber's line over these circuits followed by a description of a call to a trunk from a calling subscriber's line.

In Fig. 2 the cross bar switch 200 has been shown with the connections for one subscriber's line with his station equipment as shown at 201. In this switch have also been shown the connections terminating in the box 202 which would contain the same station equipment for another subscriber's line. The individual control equipment for one link 203 has been shown in Fig. 2 and the common control circuit arrangement as been shown partially in Figs. 3 and 4; the allotter has been indicated by a box 400 and similarly the standard register by a box 401 while the ringing equipment has been shown in Fig. 5.

It should be noted that a subscriber's station equipment consists of a series of hand-operated keys indicated at 205, the key parts 1, 2, 3 and 4 are for the purpose of selecting outgoing trunks one of which has been shown at 206, while the key marked L is for the purpose of starting the operations to establish connection between a calling subscriber and the register and the common equipment over a link such as a link 203 which is the first link while 208 represents the sixth link. Key H is provided for holding purposes but is of no importance as far as the present invention is concerned.

If it is assumed that the subscriber at station 201 desires to establish a connection to another subscriber such as 202, for example, this subscriber will remove his receiver from the switchhook and press his key L. This closes a circuit for the operation of line relay 210 from battery, contacts of the hold magnet 211, which is used for establishing connections for this calling subscriber's lines in the switch 200, through the winding of relay 210, a winding of the repeating coil 212, transmitter 213, contacts of the dial 214, switchhook contacts 215, contacts of relay 210 to ground at contacts of cut-off relay 216. This closes a circuit for the individual relay 301 for the calling subscriber's line in series with a start relay 403 from battery over a winding of this relay 403, through a circuit in the link allotter 400 over a start lead, contacts of relay 210, contacts of the operated key L and the closed contacts of keys 4, 3, 2 and 1, switchhook contacts 215, contacts of relay 210, winding of relay 301 to ground at relay 302, causing the operation of these relays 403 and 301. The relay 301 represents the first subscriber's lines in the first group of ten, that is, subscriber No. 1 in group 6, while the relay such as 304 represents the first subscriber's lines in the second group of ten and it is understood that eighteen other similar relays not shown represent individually 2 to 10 and 12 to 20 subscribers' lines. These relays are interconnected in various ways as will be described hereinafter. On the other hand, the start relay 403 is located in the control circuit for link 203 and this relay and the

corresponding start relay in the other links may be connected in succession through the allotter 400 to the common start lead and through the contacts of all line relays such as 210 and 217 for lines 1 and 20, respectively. The direct result of operation of relay 301 is that relay 306 is operated from battery through the winding of this relay, contacts of relays 307, 308, contacts of relay 301 to ground. Relay 306 closes a circuit for the operation of relay 308 from battery through the winding of this relay, contacts of relays 307 and 306 to ground. Relay 308 opens the circuit for relay 306 which now releases slowly and relay 308 locks over a circuit through its winding, contacts of relays 307, 308 and 301 to ground. When relay 306 releases a circuit is now completed for the select magnet for the link chosen, in this case link 203, and consequently the select magnet 220 is operated from battery winding of this magnet, contacts of relays 409, 403, 306, 308, 301 to ground. The operation of this select magnet prepares connections for extension over links 203 and closes an obvious circuit for the operation of relay 310 which in operating closes a circuit for the cut-off relay 216 of the calling subscriber's circuit from battery through the winding of this relay, contacts of relays 301 and 310 to ground. Cut-off relay 216 closes an obvious circuit for the operation of the hold magnet 211 which now connects the calling subscriber's line at the crosspoint 222 to the link 203. Hold magnet 211 opens the circuit for the relay 210 which now releases. Relay 210 in releasing releases relay 301, while the start relay 403 remains operated from battery over its two windings and its own contacts through the contacts of relay 406 over the ground supplied at the crosspoints 222 over the lead 223. Relay 301 in releasing releases relay 308 and also the select magnet 220 while cut-off relay 216 is maintained operated over the connection through the crosspoint 222 to ground over the connection through keys L, 1, 2, 3 and 4, switchhook contacts 215 and contacts of cut-off relay 216 to ground. Dial tone is now transmitted to the calling subscriber's line from the dial tone circuits in Fig. 5 from ground through one of the windings of the repeating coil 502, the circuits for starting the dial tone being completed on the operation of relay 403. That is, this relay 403 applies ground at its contacts to operate relay 503 alternately through its self-interrupting contacts. The dial tone is induced thereby through the windings of repeating coil 502 to the tip side of the subscriber's line over lead 504, contacts of relays 403 and 407 and a winding of relay 408.

The calling subscriber may now dial the desired subscriber's number which consists of two digits, one to determine the group of ten subscribers in which the called subscriber's line is located and the second to determine the number of the subscriber's line in this group. As the connection is established from the calling subscriber by the operation of the dial 214 through the switch 200, the relay 403 is operated through both windings over the tip and ring conductors. When this relay is first energized, a circuit is completed for the relay 409 from battery, the make-before-break contacts of this relay, contacts of relays 408 to ground over crosspoint 222 in switch 200. Relay 409 in operating closes a locking circuit for itself through its upper outer armature and front contact to this ground in switch 200. This relay also opens at its lower armature and back contact a connection to the link allotter 400 to release it to allot another link for a succeeding call.

That is, the allotter now extends the start lead to another start relay in another link corresponding to start relay 403 in link 203. On the first release of relay 408, relay 411 operates from battery through the winding of this relay, contacts of relays 409 and 408 to ground at switch 200. Relay 413 is also operated from battery through the winding of this relay, contacts of relays 412, 414, 409 and 408 to ground. Relay 413, in operating, closes a circuit for the operation of relay 416 from battery through a winding of this relay, make-before-break contacts thereof, contacts of relays 406, 413, 411, 417 and 409 to ground. Then when relay 408 operates at the end of the first impulse, relay 414 operates from battery through the winding of relay 413, contacts of relay 412, 413, upper winding of relay 414, contacts of relays 411, 417 and 409 to ground and as relay 408 releases at the beginning of the second impulse, relay 412 is operated from battery, winding of this relay, the lower winding of relay 414, contacts of this relay, contacts of relays 409 and 408 to ground, so that now relay 414 is held in series with relay 412, while relay 413 releases. Relay 413 in releasing operates relay 406 from battery, a winding of this relay and its make-before-break contacts, contacts of relays 416, 413, 411, 417 and 409 to ground. Relay 416 opens the holding circuit for relay 403. Then when the relay 408 operates at the end of the second impulse, relays 412 and 414 are released. If only two impulses are received, it indicates that the called subscriber's line is located in the first group of ten subscribers, that is, the same group in which the calling subscriber's line is located. On the other hand, if a third impulse is received, the release of the relay 408 in response to this impulse would operate relay 413 which now would operate relay 420 over a circuit from battery, a winding of this relay and its make-before-break contact, contacts of relays 421, 416, 406, 413, 411, 417 and 409 to ground. Relay 420 would in this case transfer certain leads through the register to indicate that the called subscriber's line is located in the second group of ten subscribers' lines. No further impulses can have any effect on the circuit as far as the selection of a group of subscribers' lines is concerned as a fourth impulse would prevent this by the operation of the relay 421 on the release of relay 413.

If it is assumed that only two impulses have been sent, relay 411 which is slow in releasing will release on the operation of relay 408 at the end of the second impulse and this relay in turn releases relay 416, which connects the odd and even leads for the register for the control thereover by the second digit. Now when the second digit is dialed on the first release of relay 408, relay 411 will again be operated which in turn will operate in this case relay 423 from battery through the winding of this relay and its make-before-break contacts, contacts of relays 406, 416, 411, 417 and 409 to ground. Relay 413 will also operate from battery through the winding of this relay, contacts of relays 412, 414, 409 and 408 to ground and an impulse will be sent to the register for recording this first digit from ground at contacts of relay 409, contacts of relays 417, 411, 413, 406, 416 to the odd lead 426. As relay 408 is operated at the end of the first impulse, relay 414 is operated to hold relay 413. If a second impulse is received then on the release of relay 408, relay 412 will operate and hold relay 414 while relay 413 is released and ground will now be applied to the even lead 427 from ground through contacts

of relays 409, 417, 411, 413, 416, lead 427. This ground operates other relays in the register to record the second digit. If it is, however, assumed that only one impulse is received, relay 411 will release on the operation of relay 408 at the end of this impulse. This causes the operation of relay 421 from battery through the lower winding of this relay and its make-before-break contacts, contacts of relays 423, 411, 417 and 409 to ground. This connects the busy relay 428 to the lead, for example, 429 for the called subscriber's line which subscriber in this case would be the first subscriber in the second group such as the one whose equipment is shown at 202. A test will now therefore be made to determine whether this line is busy or not. This connection extends from battery through the upper winding of the busy test relay 428, its make-before-break contacts, contacts of relays 423, 421 and 420 through the register to the unit and test lead 429, contacts of the hold magnet 228 of the desired subscriber's line connection at switch 200 through the winding of the cut-off relay 229 to battery, that is, provided this line is idle. If the line is busy a ground will be found applied at the contacts of the hold magnet 228 which will be operated in this case. Relay 428 will therefore operate from this ground and apply a busy tone to the calling subscriber's line by first closing an obvious circuit for the relay 510 which closes an obvious circuit for the operation of relay 503. Relay 503 alternately operates and releases through its self-interrupting contact and thereby induces the busy tone through the transformer 502, while relay 510 also closes an obvious circuit for relay 515 which operates relay 514 which in turn operates relay 516. Relay 516 releases relay 515 which releases relay 514 and these operations are repeated at intervals depending on the slow-to-close characteristics of these relays to send busy tone signals from repeating coil 502 over lead 512 through contacts of relays 514, 510, 428, condenser 430 over the tip conductor to the calling subscriber's line.

On the other hand, if the called line is idle as indicated by the released condition of the hold magnet 228, and relay 428 is not operated, relay 416 closes a connection for the operation of the relay 314 from battery, winding of this relay, contacts of relays 428, 416, 423, 302 to ground. Relay 314 is one of six relays for operating the select magnets in the switches 200 representing six links, this relay being the one associated with the chosen link. This relay 314 operates relay 316 from battery, winding of this relay, contacts of relays 314, 423, 411, 417, 409 to ground and also relay 306 from battery, winding of this relay, contacts of relays 308 and 314 to ground. Relay 317 is also operated from battery, winding of this relay, through the chain circuit of relay 318 and the intermediate relays in the group to which relay 314 belongs, contacts of relay 314 to ground at relay 302. Relay 317 locks over its own contacts to ground at the contacts of relay 314. Relay 302 is then operated from battery through the winding of this relay, contacts of relay 307, contacts of relay 317 to the same ground at contacts of relay 314. This ground also furnishes a holding circuit for relay 314 through contacts of relay 317. Relay 306 closes an obvious circuit for relay 308 over contacts of relay 307. Relay 302 closes a circuit for the operation of relay 307 from battery through the winding of this relay, contacts of relays 302, to ground at relay 314. A circuit is now completed for the operation of the select magnet 220 of the chosen link 203 from

battery, winding of this magnet, contact of relays 314, 316, 307 to the ground at contacts of relay 314, while relay 307 releases relays 306 and 308, the latter releasing relay 307. These relays 306, 308 and 307 are slow in releasing to permit select magnet 220 to remain energized long enough to perform its functions. The select magnet 220 closes an obvious circuit for the operation of relay 310 which latter relay holds this select magnet operated for an instant. Relay 310 applies a ground at its outer right-hand armature and front contact which causes relay 423 to release. This causes the operation of the cut-off relay 229 from battery through the winding of this relay, contacts of hold magnet 228 over the unit lead 429 which represents the first subscriber's line in the second group and through the register 401, contacts of relays 420, 421 to ground at contacts of relay 423. Relay 229 in operating closes an obvious circuit for the operation of the hold magnet 228 which now closes a connection between the link 203 at the crosspoint 231 to the called subscriber's line 202. Relay 229 is now locked over the sieve connection at crosspoints 231 and crosspoint 222, keys L, 4, 3, 2 and 1 at the calling subscriber's line, the switchhook contacts to ground at the cut-off relay 216. Relay 423 also causes the release of relays 314, 316 and 317, while relay 314 releases the select magnet 220 and the relay 317 causes the release of relay 302.

As the calling and called subscribers' lines are now connected to the same link 203 and as relay 423 is released, the ringing of the called subscriber will commence by the operation of the relay 407 over a circuit from battery through the upper winding of this relay, contacts of relays 417, 421, 428, 406 and 423 to ground. The operation of relay 407 transfers the tip and ring conductors from the battery and ground through the windings of relay 408 through the windings of the relay 431 through the two windings 520 of the repeating coil 521 to battery and ground in the ringing circuit and also starts the ringing by closing a circuit for the operation of relay 522 from battery, winding of this relay, contacts of relay 523, 524, 525 to ground at the contacts of relay 407. Relay 522 in operating applies alternating ringing current from the source 530 through contacts of this relay to the opposite winding 531 of the repeating coil 521 to ground. This applies a ringing voltage from ground through repeating coil 521 to both sides of the called subscriber's line. As the called subscriber's ringer is connected through a condenser to ground as shown, for example, at the calling subscriber's line where the ringer is marked 250 and the condenser 251, the circuit for ringing is extended from ground and battery through the upper of the two windings 520, through the lower winding of relay 431, contacts of relay 407, lower winding of relay 408 over the ring conductor through the ringer and condenser to ground at the called subscriber's station, that is, the ringer and condenser corresponding to the ringer 250 and condenser 251 of the calling subscriber's station. It should be observed that the tip and ring conductors are closed at the calling subscriber's line for this connection through the upper winding of relay 408 and the upper winding of relay 431 through the lower right-hand winding of the repeating coil 521 to ground, but that there is no connection for the tip conductor at the called subscriber's station. Consequently, due to the low resistance path through the ringer to ground at the called subscriber's station

through the lower winding of relay 431 and due to the fact that the windings of this relay are wound in opposite directions this relay will operate at this time. This causes the operation of relay 417 from battery through the winding of this relay, contacts of relay 431, make-before-break contacts of relay 417, contacts of relays 421, 428 and 406 to ground at relay 423. Relay 417 in operating closes a locking circuit for itself over the circuit to ground at relay 423 independent of the connection of the contacts of relay 431. Thus relay 407 is held operated while the ringing current is transmitted to the called line due to the operation of relay 431.

It should now be observed that when relay 407 was operated, it closed a circuit for the operation of relay 515 which closes a circuit for relay 514, which relay in turn operated relay 516. Relay 516 releases relay 515 and this relay releases relay 514. This cycle of operations is repeated to close ground connections from relay 407 through contacts of relay 514 alternately for the relays 525, 526, 524 and 523 for their ultimate operation and release. When this ground is first applied, it causes the operation of the relay 526 from battery through a resistance, winding of relay 526, its make-before-break contacts, contacts of relay 514 to ground at relay 407 and when relay 514 releases, relay 525 operates with relay 526 locked to this ground at relay 407. When relay 514 again operates, relay 526 releases, which causes relay 523 to operate from battery through a resistance, winding of this relay, contacts of relays 523, 526 and 525 to ground at relay 407. When relay 514 releases relay 525 releases causing the operation of relay 524 from battery through a resistance, contact of relay 523, to ground at relay 407. When relay 514 operates, a third time, relay 526 operates, when relay 514 releases relay 525 operates, when relay 514 is again operated, relays 526 and 523 release and when relay 514 releases, relays 525 and 524 release. These operations are repeated so as to alternately release and operate relay 522 at intervals as determined by the time release characteristics of relays 514, 515 and 516. That is, relay 522 releases on the first operation of relay 525 and operates on the first release relay 524. These operations are in the nature of one second for the application of ringing and three seconds for a silent period. Therefore when relay 522 releases for the first time, that is, on the operation of relay 525, relay 407 is held operated over a circuit from battery through contacts of relay 522, contacts of relay 407 and the lower winding thereof to ground at contacts of relay 417 while relay 431 releases due to the cutting off of the ringing current, then when relay 522 again operates on the first release of relay 524, relay 431 operates and holds relay 407 operated. These operations continue as long as ringing is continued. Then when the called subscriber answers, the ringing is released only during a ringing period, that is, when relay 522 is operated. When the called subscriber answers under these circumstances, by removing the ringer through the condenser to ground at his station, relay 431 releases due to the opening of the path through the ringer to ground. The holding circuit for relay 407 at this time is opened at the contacts of relay 522. Relay 407 in releasing removes the operating ground from the relay 515 and the associated relays and consequently prevents relay 522 from again operating. Should the subscriber answer during the silent period no release operations are possible since relay 407

will still be maintained operated due to the released condition of relay 522 which maintains the holding circuit for this relay and not until ringing is applied will ringing be discontinued. Thus the ringing will be tripped only during the ringing period. However, the calling and called subscribers will be able to talk before the ringing is tripped and no loud clicks will be caused by the tripping although the transmitter current will temporarily be less than normal as the resistance of the windings of the repeating coil 521 through which ringing is transmitted to the line will be in series with the talking battery supply circuit until after the ringer is tripped. The talking current supply is through the windings of relay 408. As 407 releases the common holding ground at contacts of relay 409 is removed causing the release of relays 406, 421, 420 and 416.

What is claimed is:

1. In a telephone system, a cross bar switch, lines terminating in said switch, single-ended links terminating in said switch, means responsive to the seizure of a calling line for connecting it to an idle one of said single-ended links, and means responsive to designation signals received over said calling line and connected link for connecting said link to a called line.

2. In a telephone system, a cross bar switch, lines each terminating in contacts in a single row in one coordinate direction of said switch, links each terminating in contacts in a single row in the other coordinate direction of said switch, means responsive to the seizure of a calling line for establishing a connection through the contacts at the intersecting point of said line and an idle link, and means responsive to dial pulses received over the calling line and the associated link for establishing a connection through the contacts at the intersecting point of said called line and said seized link.

3. In a telephone system, a cross bar switch, lines each terminating in contacts in a single row in one coordinate direction of said switch, links each terminating in contacts in a single row in the other coordinate direction of said switch, a source of current associated with each link, means responsive to the seizure of a calling line for establishing a connection between said line and an idle link through contacts at the intersecting point of said line, and link means responsive to dial pulses received over said calling line and the connected link for establishing a connection between said link and a corresponding called line through contacts at the intersected point of said called line and said link to complete a talking circuit over said seized link between said calling line and said called line with said source of current associated with said seized link serving as a common talking battery source.

4. In a telephone system, a cross bar switch, lines terminating in said switch, a single-ended link terminating in said switch, means responsive to the seizure of a calling line for connecting it to an idle link through said switch, means responsive to dial pulses received over said calling line and connected link for connecting said link to a called line, a relay in each of said links, means responsive to the seizure of said called line for transmitting ringing current to said called line and for operating the relay in the connected link, and means operative when the subscriber of the called line answers the ringing for releasing said relay to discontinue said ringing.

5. In a telephone system, a cross bar switch, lines each terminating in said switch in line con-

tact in a single row in one coordinate direction, links each terminating in said switch and link the contacts in a single row in the other coordinate direction, a source of current associated with each link, means responsive to the seizure of a calling line for establishing connections between contacts at the crosspoint of the associated row of line contacts and the row of link contacts of an idle link, means responsive to dial pulses received over the calling line and a seized link for establishing a connection at the crosspoint of the row of line contacts of a desired called line and a row of link contacts of said seized link, a common ringing circuit, means responsive to the seizure of said called line for causing said ringing circuit to transmit ringing signals to the calling line, a relay in said seized link operative in response to said ringing signals, means operative when the called subscriber answers for releasing said relay, and means operative on release of said relay for causing ringing signals to cease and for connecting said source of current across the conductor of said link to serve as a common talking battery for both parties.

6. In a telephone system, a cross bar switch having select bars arranged in one coordinate direction, a select magnet for each bar, hold bars associated in the other coordinate direction, a hold magnet for each hold bar, contacts at the intersecting point of said bars, a telephone line terminating in contacts controlled by each hold bar, a link circuit terminating in the contacts controlled by a select bar, means responsive to the seizure of a telephone line for actuating a select magnet of an idle link circuit and the actuation of the hold magnet associated with the calling telephone line to establish connections between the calling telephone line and said link circuit over the contacts at the intersecting point of the actuated bar and for thereafter releasing the actuated select magnet, and means responsive to impulses received over said calling telephone line and connect link circuit for reoperating associated select magnets and for actuating the hold magnets of a desired called telephone line for establishing a connection between said called telephone line and the seized link circuit over the contacts at the cross-point of the associated select bar and hold bar.

7. In a telephone system, a cross bar switch, lines terminating in said switch, single-ended links terminating in said switch, means responsive to the seizure of a calling line for connecting it to an idle link, means responsive to impulses received over said calling line and link for connecting said link to a corresponding called line, means responsive to the seizure of the called line for transmitting ringing current over one of the line conductors of the called line, and means operative when the subscriber of said called line answers the call for discontinuing the transmission of said ringing current.

8. In a telephone system, a cross bar switch, lines terminating in said switch, single-ended links terminating in said switch, means responsive to the seizure of a calling line for connecting it to an idle link, means responsive to impulses received over said calling line and link for connecting said link to a corresponding called line, an alternating current responsive relay in each link circuit, means responsive to the seizure of said called line for transmitting alternating current signals over one of the line conductors of the called line to said associated relay to cause said relay to operate and to signal the subscriber

of said called line, and means operating when the subscriber of said called line answers the call for transmitting the ringing current to said associated relay to cause it to release, and means responsive to the release of said relay for discontinuing the transmission of ringing current over said called line.

9. In a telephone system, a cross bar switch, lines terminating in said switch, links terminating in said switch, each line having access to each link through a single set of contacts in said cross bar switch, means responsive to the seizure of a calling line for connecting it to an idle link through the associated set of contacts, and means responsive to designating signals received over said calling line and the connected link for connecting said link to the corresponding called line over the associated set of contacts.

10. In a telephone system, a cross bar switch, lines each terminating in contacts in a single row in one coordinate direction of said switch, links each terminating in contacts in a single row in the other coordinate direction of said switch so that each link has access to each line through the contacts at the single intersecting point of said coordinate rows of contacts, means responsive to the seizure of a calling line for establishing a connection to an idle link at the corresponding single set of contacts, and means responsive to dial pulses received over the calling line and the connected link through the associated set of contacts for establishing a connection to a called line between said link and said called line at the corresponding single set of contacts.

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