Oct. 18, 1938. P. BAKKER 2,133,682

TELEPHONE SYSTEM

Filed March 3, 1937 10 Sheets-Sheet 1

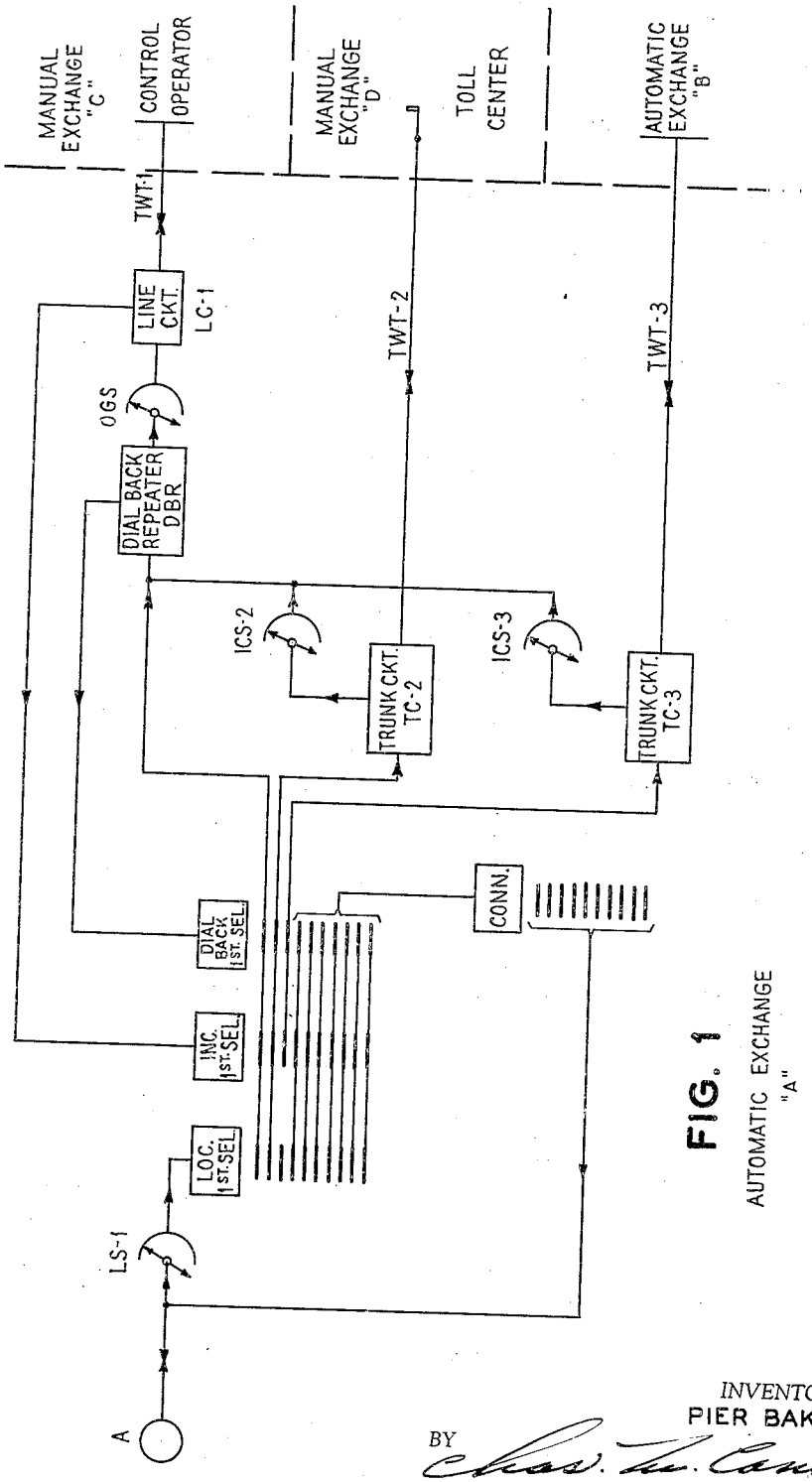


FIG. 1

AUTOMATIC EXCHANGE "A"

INVENTOR.
PIER BAKKER

BY Chas. Tu. Candy.

ATTORNEY.

Oct. 18, 1938. P. BAKKER 2,133,682

TELEPHONE SYSTEM

Filed March 3, 1937 10 Sheets-Sheet 2

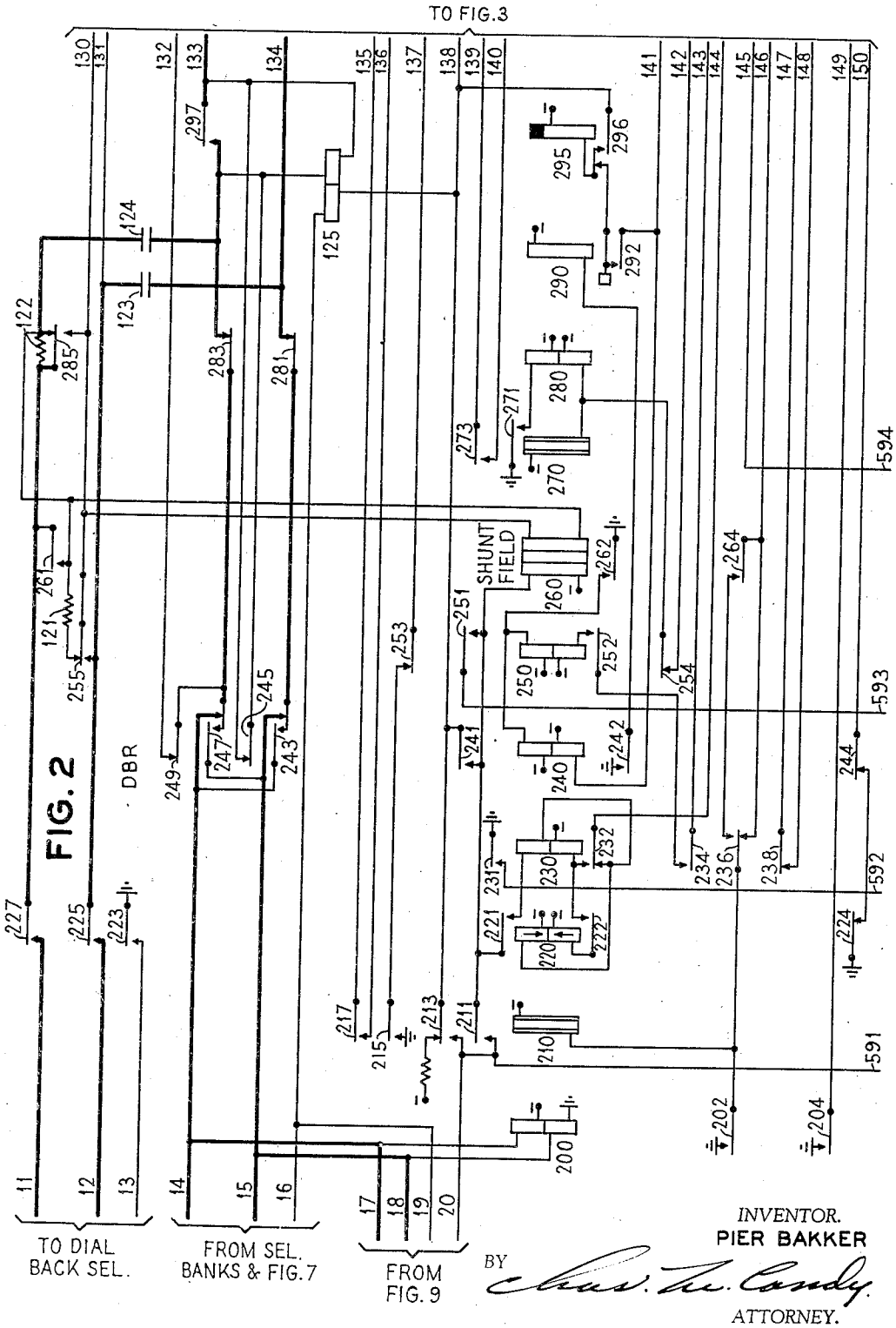


FIG. 2

INVENTOR.
PIER BAKKER
BY
ATTORNEY.

Oct. 18, 1938. P. BAKKER 2,133,682

TELEPHONE SYSTEM

Filed March 3, 1937 10 Sheets-Sheet 3

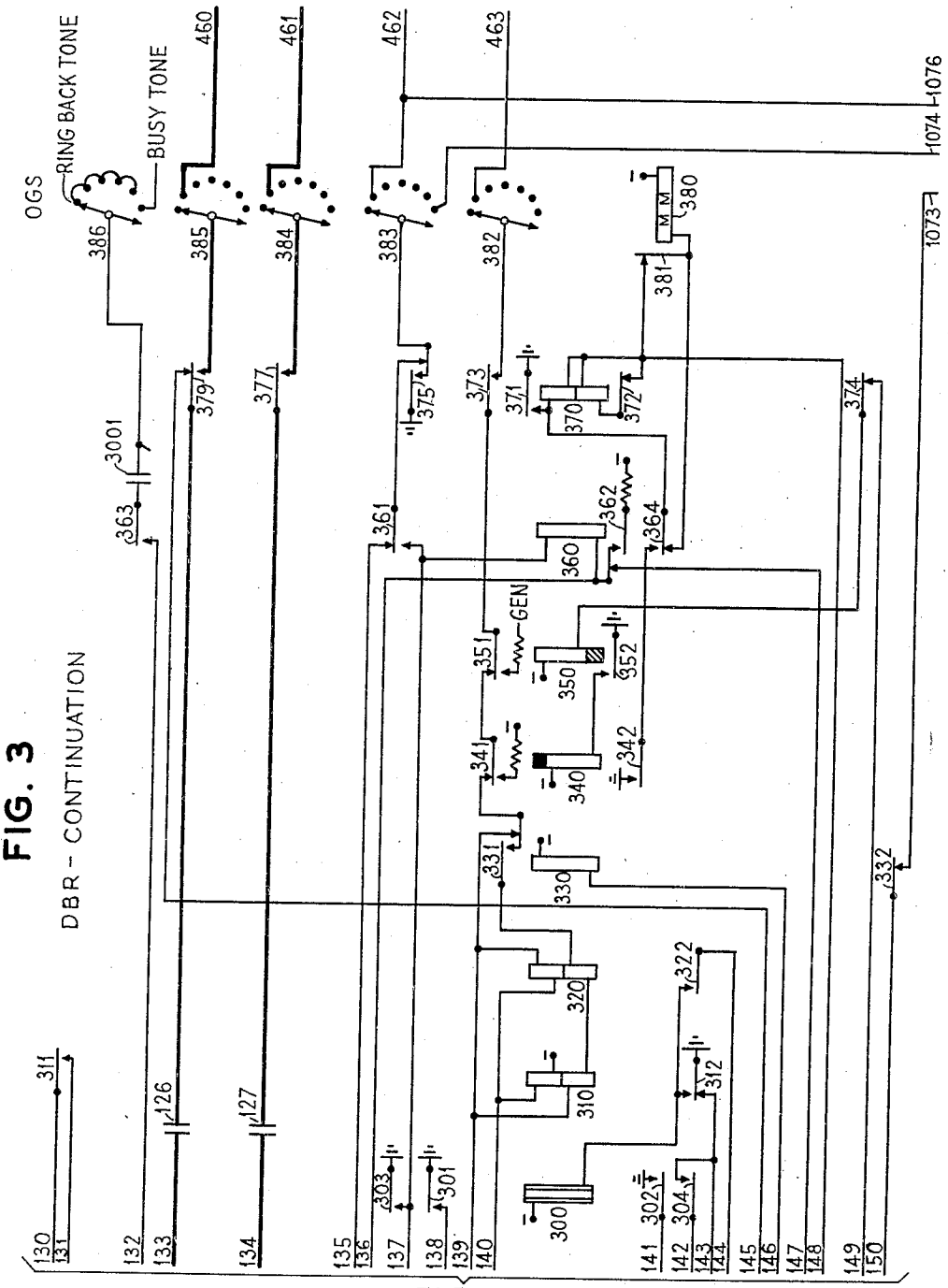


FIG. 3

DBR - CONTINUATION

TO FIG. 2

INVENTOR.
PIER BAKKER

BY Chas. L. Candy

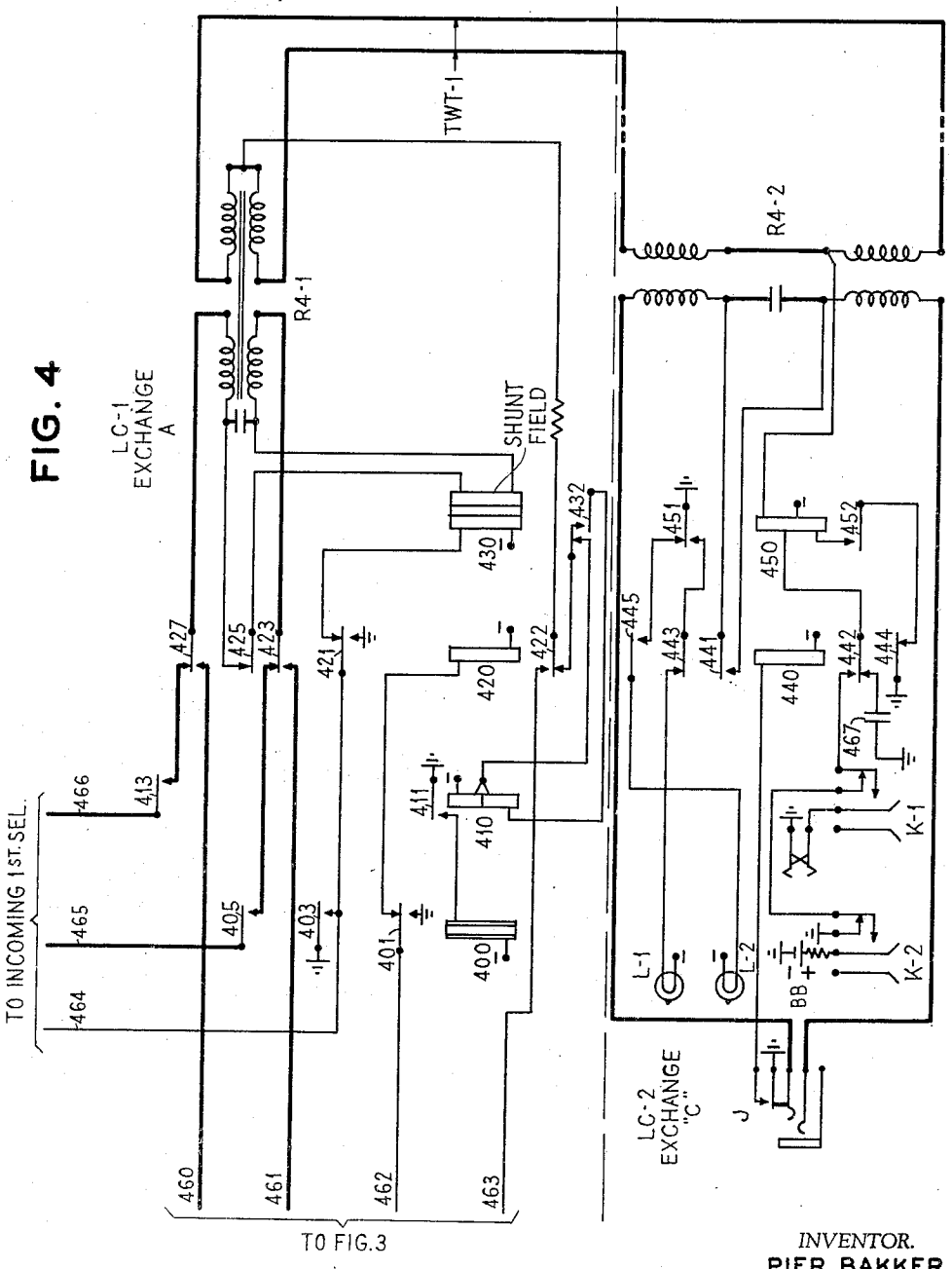
ATTORNEY.

Oct. 18, 1938. P. BAKKER 2,133,682

TELEPHONE SYSTEM

Filed March 3, 1937 10 Sheets-Sheet 4

FIG. 4



INVENTOR.
PIER BAKKER

BY Chas. Tu. Candy.

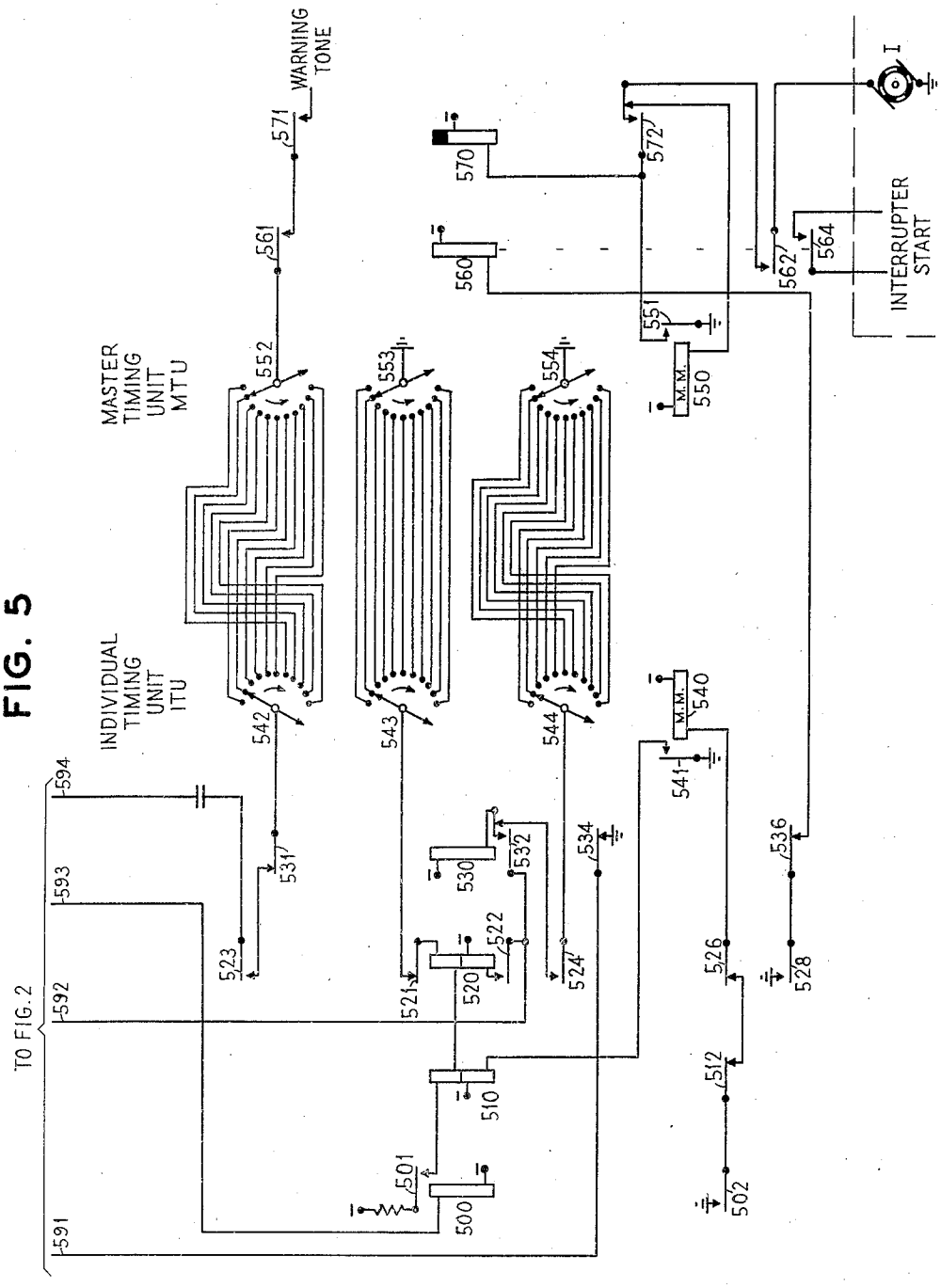
ATTORNEY.

Oct. 18, 1938. P. BAKKER 2,133,682

TELEPHONE SYSTEM

Filed March 3, 1937 10 Sheets-Sheet 5

FIG. 5



INVENTOR.
PIER BAKKER

BY Chas. Tu. Candy.
ATTORNEY.

Oct. 18, 1938. P. BAKKER 2,133,682

TELEPHONE SYSTEM

Filed March 3, 1937 10 Sheets-Sheet 6

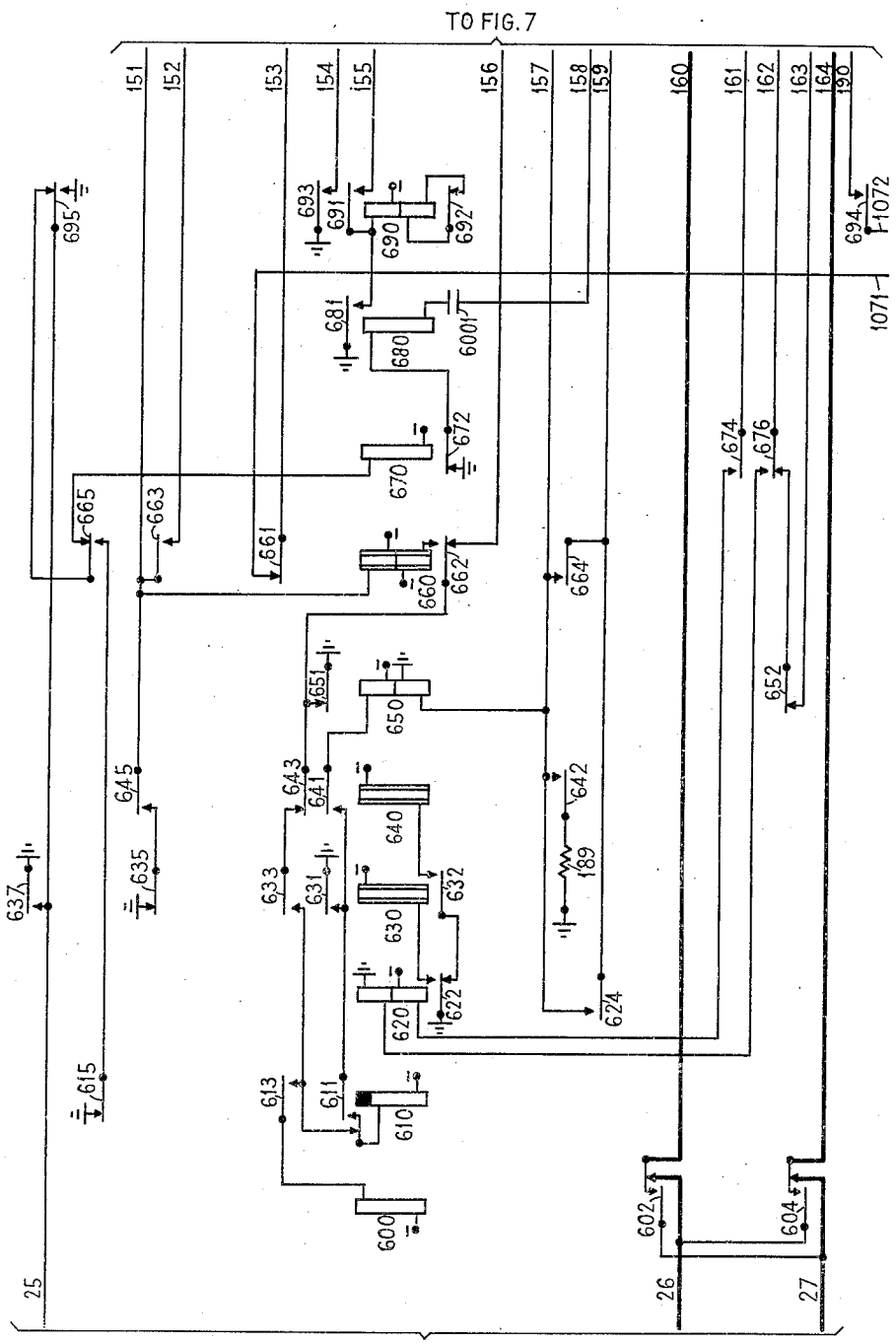


FIG. 6

TC-3

INVENTOR.
PIER BAKKER

BY Edward Lee Cady

ATTORNEY.

Oct. 18, 1938. P. BAKKER 2,133,682

TELEPHONE SYSTEM

Filed March 3, 1937 10 Sheets-Sheet 7

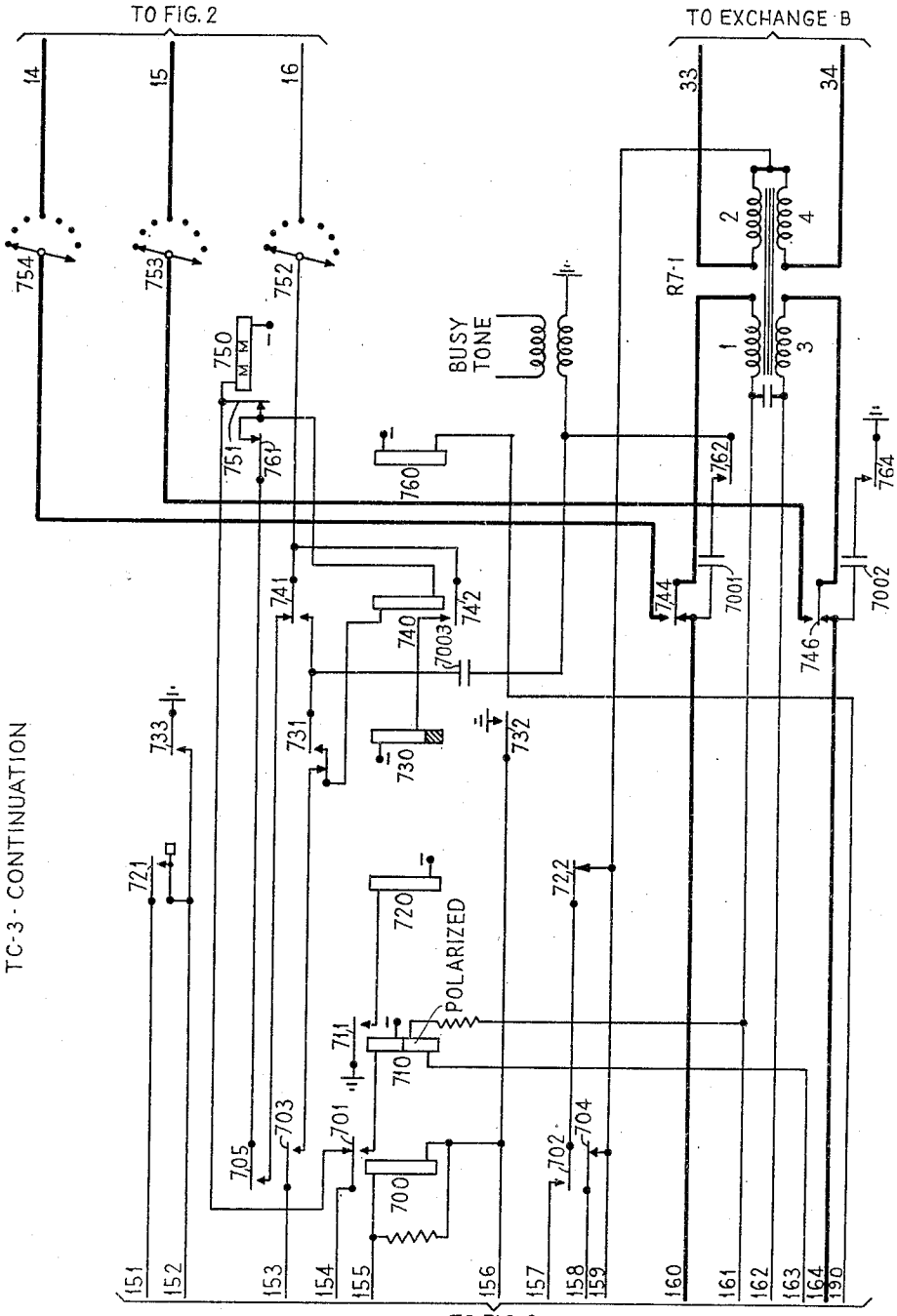


FIG. 7

INVENTOR.
PIER BAKKER

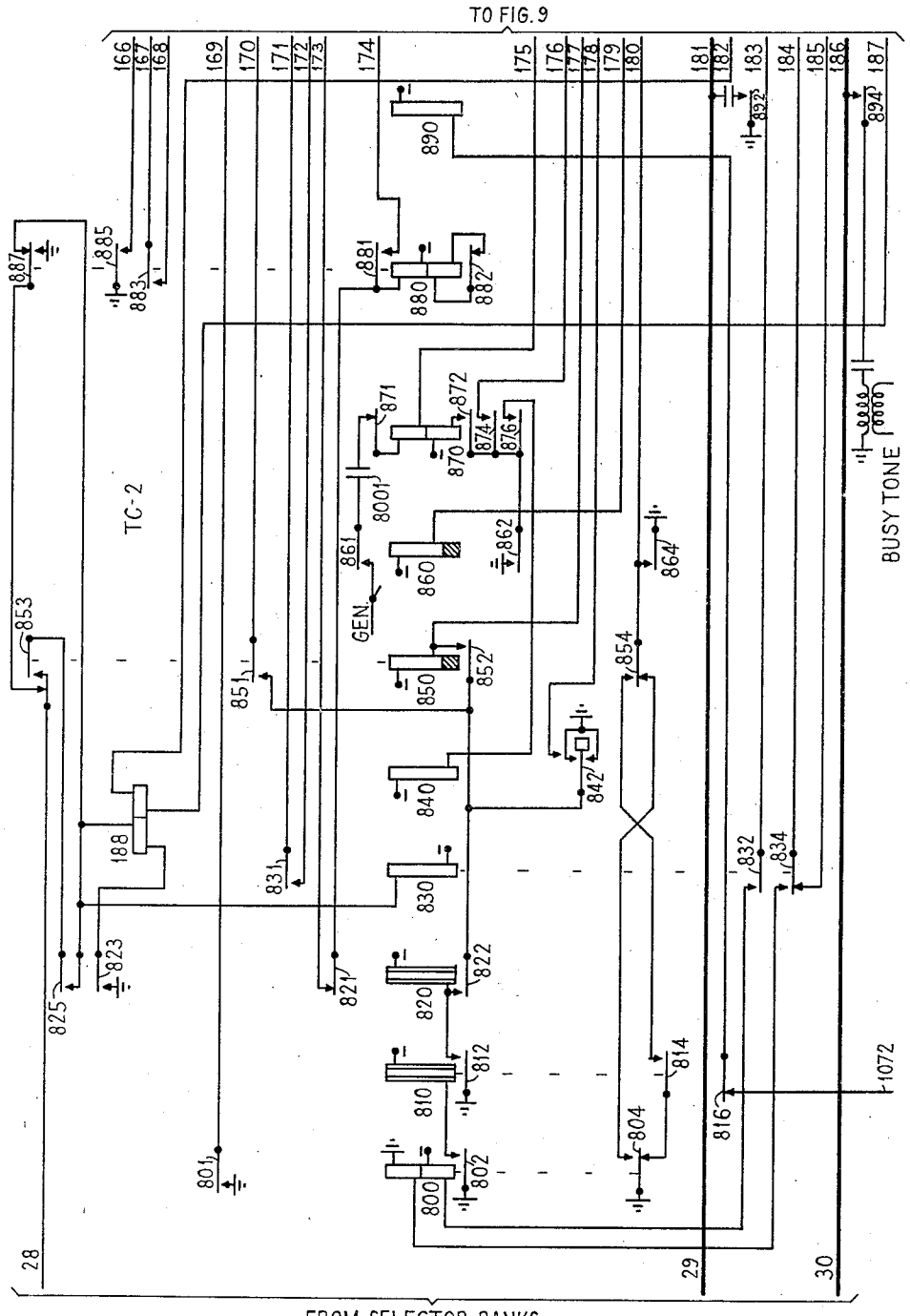
BY Chas. Tu. Candy.
ATTORNEY.

Oct. 18, 1938. P. BAKKER 2,133,682

TELEPHONE SYSTEM

Filed March 3, 1937 10 Sheets-Sheet 8

FIG. 8



INVENTOR.
PIER BAKKER

BY Chas. Tu. Candy.

ATTORNEY.

Oct. 18, 1938. P. BAKKER 2,133,682

TELEPHONE SYSTEM

Filed March 3, 1937 10 Sheets-Sheet 9

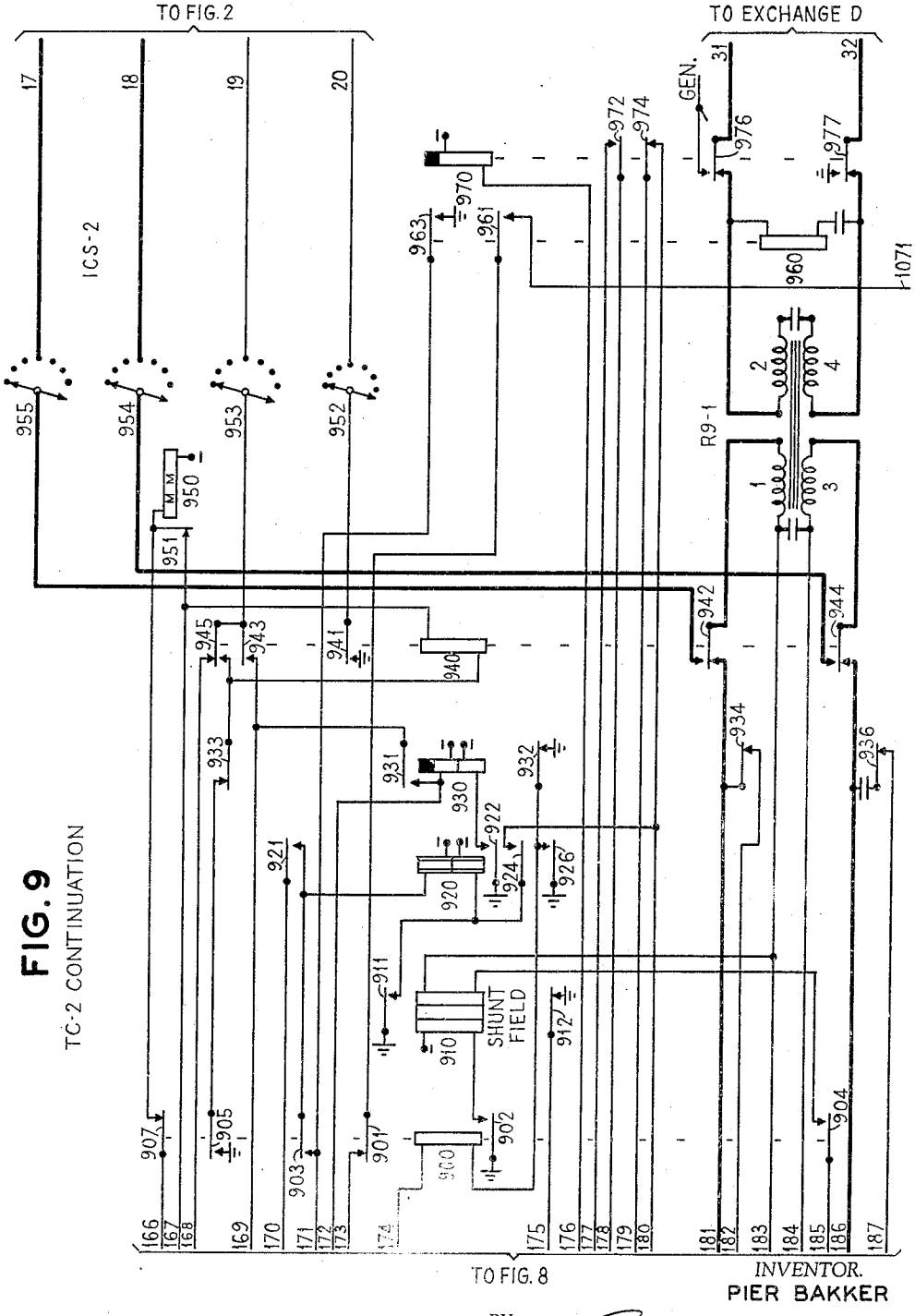


FIG. 9

TC-2 CONTINUATION

INVENTOR.
PIER BAKKER

BY

ATTO

Oct. 18, 1938. P. BAKKER 2,133,682

TELEPHONE SYSTEM

Filed March 3, 1937 10 Sheets-Sheet 10

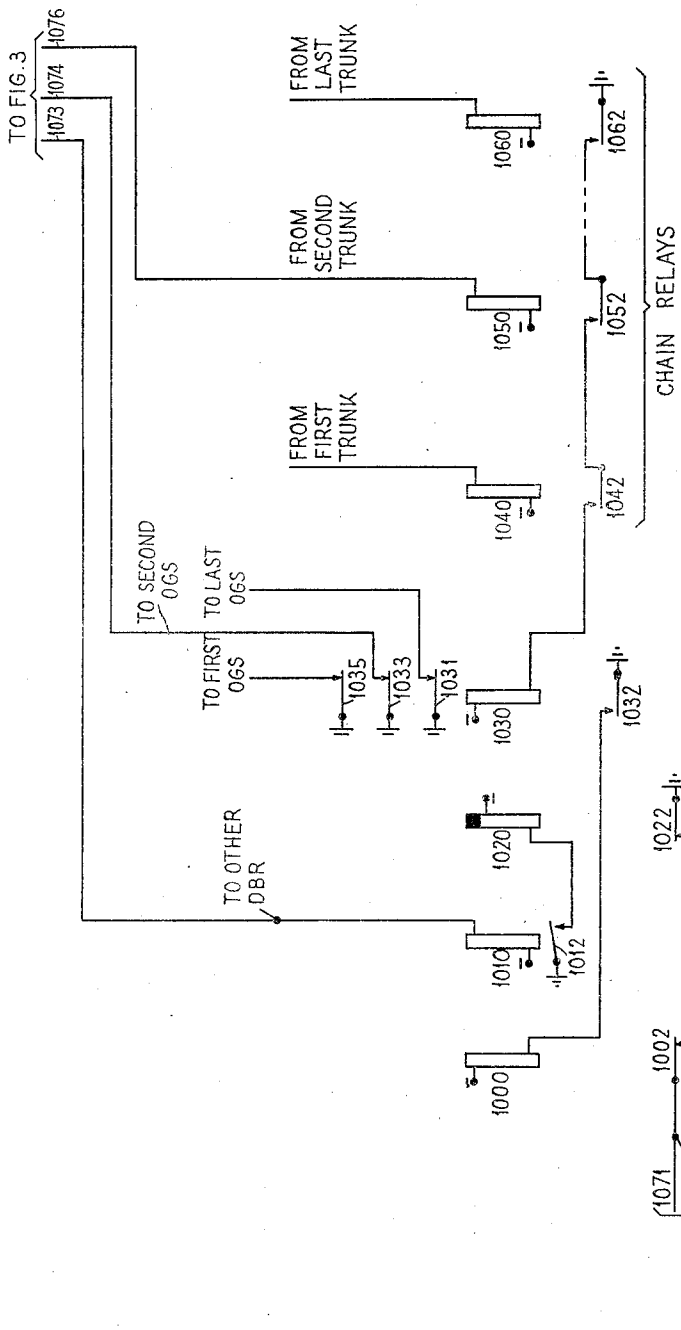


FIG. 10

ALL TRUNKS BUSY EQUIP.

INVENTOR.
PIER BAKKER

BY Chas. Tu. Candy

ATTORNEY.

Patented Oct. 18, 1938 2,133,682

UNITED STATES PATENT OFFICE

2,133,682

TELEPHONE SYSTEM

Pier Bakker, Chicago, Ill., assignor to Associated Electric Laboratories, Inc., Chicago, Ill., a corporation of Delaware

Application March 3, 1937, Serial No. 128,736

13 Claims. (Cl. 179—26)

The invention relates in general to telephone systems but more particularly to inter-exchange calls in which an operator is required to complete connections between automatic subscribers' lines over trunk lines connecting two automatic exchanges.

The main object of the invention consists in the provision of improved circuits whereby an automatic subscriber in one exchange in order to call an automatic subscriber in another exchange must first call a control operator over a trunk extending from the automatic exchange to the manual control exchange, after which the control operator dials back over this same trunk to operate the automatic switches to complete the desired connection. When such connection is complete the control operator may disconnect and free her trunk leaving the connection between the two automatic subscribers established over one of the trunk lines connecting the two automatic exchanges. The switching system herein disclosed is an improvement over those previously developed, an example of which is shown in the Saunders application, Serial No. 45,845, filed October 21, 1935.

An additional feature of the invention relates to the provision of automatic timing equipment which affords a means of releasing an interoffice connection after a predetermined time interval.

Other features relate to the circuit refinements in the dial back repeater which enables this type of service to be given.

The drawings, Figs. 1 to 10, inclusive, show by means of the usual circuit diagrams, a sufficient amount of apparatus to enable the invention to be described and understood.

Fig. 1 shows a trunking diagram of a telephone network employing the principles of this invention. The network consists of the automatic exchange A, a second automatic exchange B, a manual exchange C which houses the control operator, and a second manual exchange D which may be considered as a toll center and in which, incidentally, the operators' positions are not provided with dials. Automatic exchange A is connected with each of the other exchanges by a plurality of two way trunks.

The two way trunk TWT—1 terminates in exchange A upon the line circuit LC—1, and an incoming first selector; and is accessible from banks of the outgoing secondary line switch OGS. In exchange C this trunk terminates in line equipment usually found in a manual switchboard, and in addition means are provided whereby a dial may be associated therewith.

The two way trunk TWT—2 terminates in exchange A upon the trunk circuit TC—2 and the incoming secondary line switch ICS—2; and at exchange D upon line equipment usually found in a manual switchboard.

The two way trunk TWT—3 terminates in exchange A upon the trunk circuit TC—3 and the incoming secondary line switch ICS—3; and at exchange B may be considered as terminating upon a simplex to loop repeater of the general type shown in the Wicks Patent No. 1,682,100, issued August 28, 1928, but with a circuit arrangement such that the local seizure of the repeater causes a splash of generator to be impressed upon the simplex of the trunk.

Each station in exchange A terminates in a line switch (such as LS—1), which has access to trunks leading to local first selectors. The tenth level in the banks of the local, dial back, and incoming first selectors are multipled and trunked to dial back repeaters. These same trunks are also multipled to the banks of incoming secondary line switches ICS—2 and ICS—3.

Each dial back repeater is connected to an outgoing secondary line switch (such as OGS), which has access to trunks leading to line circuits (such as LC—1), which are the terminus of two way trunks (such as TWT—1), connecting exchange A with exchange C. Each dial back repeater has in association a dial back first selector, which is operable only by the control operator at exchange C.

The ninth level in the banks of the local, dial back, and incoming first selectors is multipled and carried to trunk circuits (such as TC—2), which are the terminus of two way trunks (such as TWT—2), connecting exchange A with exchange D. Each trunk circuit is connected to an incoming secondary line switch (such as ICS—2) which has access to trunks leading to the dial back repeaters.

The eighth level in the dial back and incoming first selectors is multipled and carried to trunk circuits (such as TC—3), which are the terminus of two way trunks (such as TWT—3) connecting exchange A with exchange B. Each trunk circuit is connected to an incoming secondary line switch (such as ICS—3) which has access to trunks leading to the dial back repeater. Attention is directed to the fact that there are no trunks connected to the eighth level in the banks of the local first selectors.

Trunk circuit TC—3, when seized from ex-

change A, functions as an automatic to automatic impulse repeater. The circuit to this repeater employs loop pulsing, and the repeater repeats pulses over the simplex of the trunk to exchange B. The supervision from exchange B is the well known high resistance supervision used on simplex dialling circuits, and is repeated as standard reverse battery supervision to the switches of exchange A.

Trunk circuit TC—3 functions as a line circuit when a subscriber in exchange D dials the digit representative of exchange A. A splash of ringing current on the simplex of the trunk causes the circuit to be extended by way of the incoming secondary line switch ICS—3 to an idle dial back repeater. The dial back repeater then extends the call by way of the outgoing secondary line switch OGS to an idle line circuit (such as LC—1) and thence to the control operator at exchange C.

Trunk circuit TC—2, when seized from exchange A, functions as an automatic to manual ring down repeater to signal the operator at exchange D.

Trunk circuit TC—2 functions as a line circuit when the operator at exchange D plugs into the jack associated with trunk TWT—2. A ring on the trunk causes the circuit to be extended by way of the incoming secondary line switch ICS—2 to an idle dial back repeater. The dial back repeater then extends the call by way of the outgoing secondary line switch OGS to an idle line circuit (such as LC—1) and thence to the control operator at exchange C.

The dial back repeater, when seized from either first selectors or incoming secondary line switches, functions to extend the call by way of the outgoing secondary line switch OGS to an idle trunk to exchange C. The control operator may extend the call manually, or may complete the call by dialling back over the same trunk. The associated dial back first selector is seized by momentarily placing booster battery on the simplex of the trunk.

When a call has been reverted by the control operator, the operator on receiving answering supervision may disconnect from the control trunk or supervise the call as the conditions may require. In the event that the operator disconnects, the dial back repeater will free the two way trunk thus making it available for other calls. The release of the dial back repeater is now under control of the calling party, or of the automatic timing equipment when it is used.

The automatic timing equipment provides a means of releasing an established call after a predetermined time interval, and is brought into operation when the called party answers. The automatic timing equipment is not effective so long as the control operator supervises the connection, nor is it effective when the call is originated at a toll board.

Line circuit LC—1, when seized by an outgoing secondary line switch, functions as a ring down repeater to signal the operator at exchange C.

Line circuit LC—1 functions, as the name implies, when the control operator at exchange C plugs into the jack associated with trunk TWT—1, and extends the connection to the associated incoming first selector.

It is evident that calls involving the control operator at exchange C would fail in the event of either of two busy conditions. Provision has been made such that the outgoing secondaries will cease to hunt, and will give the calling party the busy tone, should all the trunks to exchange C be in use. Likewise the incoming secondaries will cease to hunt, and will give the calling party the busy tone, should all the dial back repeaters be in use.

Fig. 2 shows a portion of the circuit of the dial back repeater DBR. Conductors **11**, **12** and **13** represent the three conductor trunk leading to the individual dial back first selector associated with this dial back repeater. Conductors **14**, **15** and **16** represent the three conductor trunk from the banks of the first selectors and from the bank of the incoming secondary line switches associated with the trunks to exchange B. Conductors **17**, **18**, **19** and **20** represent the four conductor trunk from the banks of the incoming secondary line switches associated with the trunks to exchange D. Conductors **591**, **592**, **593** and **594** lead to the individual timing unit associated with this dial back repeater.

Fig. 3 shows a continuation of the circuit of the dial back repeater DBR, and the outgoing secondary line switch OGS associated therewith. Conductors **460**, **461**, **462** and **463** represent the four conductor trunk leading to line circuit LC—1. Conductors **1073**, **1074** and **1076** lead to the "all trunks busy" equipment.

Fig. 4 shows the line circuit LC—1 located in exchange A, conductors **460**, **461**, **462** and **463** represent the four conductor trunk from the banks of the outgoing secondary line switches, such as OGS of Fig. 3. Conductors **464**, **465** and **466** represent the three conductor trunk leading to the individual incoming first selector associated with this line circuit. Line circuit LC—2 represents the equipment upon which trunk TWT—1 terminates in exchange C.

Fig. 5 shows the individual timing unit associated with the dial back repeater of Fig. 2 and the master timing unit common to exchange A.

Fig. 6 shows a portion of the trunk circuit TC—3. Conductors **25**, **26** and **27** represent the three conductor trunk from the bank of the first selectors. Conductors **1071** and **1072** lead to the "all trunks busy" equipment.

Fig. 7 shows a continuation of trunk circuit TC—3, and the incoming secondary line switch ICS—3 associated therewith. Conductors **14**, **15** and **16** represent the three conductor trunk leading to the dial back repeater of Fig. 2. Conductors **33** and **34** represent the two conductor trunk to exchange B.

Fig. 8 shows a portion of the trunk circuit TC—2. Conductors **28**, **29** and **30** represent the three conductor trunk from the banks of the first selectors. Conductor **1072** leads to the "all trunks busy" equipment.

Fig. 9 shows a continuation of trunk circuit TC—2, and the incoming secondary line switch ICS—2 associated therewith. Conductors **17**, **18**, **19** and **20** represent the four conductor trunk leading to the dial back repeater of Fig. 2. Conductors **31** and **32** represent the two conductor trunk to exchange D. Conductor **1071** leads to the "all trunks busy" equipment.

Fig. 10 shows the "all trunks busy" equipment. This equipment includes a relay chain (**1040**, **1050** and **1060**), comprising one relay for each trunk between the outgoing secondary line switches and the line circuits to exchange C, and a normally energized relay (**1010**) whose circuit is multipled to all dial back repeaters.

The various relays diagrammatically shown throughout the drawings are of the general type

ordinarily employed in automatic telephone systems. The secondary line switches are of the well known single motion pawl and ratchet type arranged to advance their wipers upon each de-energization of the motor magnet.

It is believed that a most thorough understanding of the invention can be obtained by describing the various circuit operations of the dial back repeater in the following order:—

1. Call from exchange A to exchange C.
   1. Seizure of the dial back repeater.
   2. Selection of an idle trunk to exchange C.
   3. Seizure of first idle trunk to exchange C.
   4. Control operator answers.
   5. All trunks busy.
2. Reverted call from exchange C to exchange A.
   1. Seizure of dial back selector.
   2. Repeating impulses to the dial back selector.
   3. Control operator receives answering supervision.
   4. Control operator disconnects.
   5. Timing equipment releases connection.
3. Call from exchange C to exchange A.
4. Call from exchange A to exchange D.
   1. Seizure of TC—2 by automatic subscriber.
   2. Signalling operator at exchange D.
5. Call from exchange D to exchange A.
   1. Seizure of TC—2 by operator at exchange D.
   2. ICS—2 selects trunk to idle DBR.
   3. Operator at exchange C answers.
   4. All trunks to exchange C busy.
   5. All dial back repeaters busy.
6. Call from exchange C to exchange B.
   1. Seizure of TC—3 by first selector.
   2. Repeating impulses to exchange B.
   3. Called party answers.
7. Call from exchange B to exchange A.
   1. Seizure of TC—3 by automatic subscriber.
   2. ICS—3 selects trunk to idle DBR.
   3. Release of the connection.
   4. All trunks to exchange C busy, or all dial back repeaters busy.

CALL FROM A TO C

Seizure of dial back repeater

Assume that a subscriber in exchange A desires to call exchange C; he will first remove his receiver, whereupon his line switch will extend the connection to an idle local first selector. The calling subscriber then dials the digit O, with the result that the first selector will proceed to select a trunk leading to an idle dial back repeater. Referring now to Fig. 2, it will be assumed that the trunk so selected is that represented by conductors **14**, **15** and **16**.

Relay **200** operates; over conductor **14** and **15** and the calling subscriber's loop; closes relay **210** at **202**; closes relay **330** by way of **202**, **236** and conductor **146**; and closes relay **350** by way of **204**, conductor **149** and **374**.

Relay **330** operates; and removes a multiple ground, by way of **224**, **244**, **150**, **332** and **1073**, from the all trunks busy relay **1010**.

Relay **210** operates; supplies holding ground to the preceding switches by way of **534**, conductor **591**, **213**, impedance **125** and conductor **16**; prepares the operating circuit of relay **360** at **215**; and at **217** closes the circuit from test wiper **383** to the motor magnet **380**.

Relay **350** operates; prepares a circuit to signal the distant operator at **351**; and closes the circuit of relay **340** at **352**.

Relay **340** operates; prepares the circuit to relay **370** at **342**; and at **341** connects battery through a resistance to the dial lead.

CALL FROM A TO C

OGS selects trunk to idle LC—1

If the wipers of the outgoing secondary line switch are resting on a busy trunk, relay **360** is shunted by a circuit extending from ground on the bank contact occupied by test wiper **383**, by way of **375**, **361**, conductor **135**, **217**, conductor **136**, **362**, conductor **147**, **238**, conductor **148**, **381** to the motor magnet **380**.

Motor magnet **380** operates, and at **381** cuts the high resistance upper winding of relay **370** in series with its own circuit.

Motor magnet **380** restores as a result of the reduced current flow; advances the associated wipers one step, and again shunts relay **370** at **381**. Motor magnet **380** will continue to act in this fashion until an ungrounded bank contact is reached by wiper **383**. Relay **370** is slow to operate because of its normally short circuited lower winding, and will not operate when its circuit is only momentarily closed in series with the motor magnet **380**.

CALL FROM A TO C

OGS seizes the first idle trunk

When the rotary switch wipers engage the first idle trunk, assumed to be that represented by conductors **460**, **461**, **462** and **463**, the absence of ground at wiper **383** will render effective a circuit from ground at **215**, **253**, conductor **137**, relay **360**, **362**, conductor **147**, **238**, conductor **148**, **381**, through motor magnet **380**. The motor magnet will not energize at this time because of the high resistance of relay **360**.

Relay **360** operates; locks itself to battery at **362**, thus opening the circuit of motor magnet **380**; extends busying ground forward by way of **215**, **253**, conductor **137**, **361**, **375** to wiper **383** and the contact upon which it is standing, and thence to relay **420** by way of conductor **462** and **491**; closes the circuit of relay **370** in series with motor magnet **380** at **364**; and impresses ring back tone on the calling line by way of wiper **386**, condenser **3001**, **363**, conductor **132**, **249**, **247** and conductor **14**.

Relay **420** operates; extends talking conductors **460** and **461** to the left side of the repeating coil R4—1; and connects conductor **463** to the simplex of the line at **422**.

The motor magnet **380** will not energize in series with the upper winding of relay **370**, but the latter relay will operate and lock itself up at **371**; remove the short circuit from its lower winding at **372**; open the circuit of relay **350** at **374**; completes the signalling circuit at **373**; and replaces the previous ground on wiper **383** by that at **375**. Following the operation of relay **370**, and prior to the restoring of relay **350**, a splash of generator signals exchange C by way of **351**, **373**, wiper **382**, conductor **463**, **422**, simplex of the trunk TWT—1, relay **450**, **442** and condenser **467**.

Relay **450** operates; locks its second winding at **452**; and brings in the line lamp L—1 by way of **451** and **443**.

Relay **350** restores and opens the circuit of relay **340**. Following the restoration of relay **350**, and prior to the falling away of relay **340**, it will be noted that the simplex of the trunk is drained of any possible condenser charge by being connected to battery at **341**.

Relay **340** restores and extends the simplex

of the trunk by way of 341, 331, through the lower windings of relays 320 and 310, and thence through the upper windings of relays 320 and 310 to battery.

CALL FROM A TO C

Control operator answers

The control operator at exchange C responds to the lighted line lamp by inserting the plug of an idle cord circuit into the jack J, whereupon relay 440 energizes and completes a circuit from ground at key K—2, through key K—1, 442, relay 450, simplex of trunk TWT—1, 422, conductor 463, wiper 382, 373, 351, 341, 331 through the lower windings of relays 320 and 310, thence through the upper windings of relays 320 and 310 to battery. Relay 320 does not operate on normal exchange voltage, but relay 310 operates and closes the circuit of relay 300 at 312.

Relay 300 operates; supplies a multiple ground to conductor 16 at 301, thus placing the release of the connection under control of the operator; closes a multiple circuit to relay 360 at 303; and by way of 302 and conductor 141 closes a circuit to the lower winding of relay 240.

Relay 240 operates; removes the ring back tone from the calling line at 240, removes the normal short circuit from the right hand winding of impedance 125 at 245; reverses battery on the calling line by way of 243 and 247; closes the circuit of relay 290 at 242; and at 241 closes the circuit to the left hand winding of relay 260, but without effect at this time.

Relay 290 operates and closes an intermittent circuit to slow to operate relay 295 through the weighted spring contact 292.

If the calling line is a pay station line, a tone, superimposed on conductor 16, flows through the left hand winding of impedance 125 and induces a tone in the second winding thereof which is audible to the control operator.

Relay 295 does not operate when first energized by relay 290, but as the vibration of the weighted spring 292 decreases in amplitude, the circuit to relay 295 is closed for longer and longer intervals. Finally relay 295 operates; closes its locking circuit at 296 and short circuits the right hand winding of impedance 125 at 297, thus removing the pay station tone from the trunk.

Transmission battery is supplied to the calling subscriber through the windings of relay 200, and voice currents pass to the trunk by way of condensers 126 and 127.

CALL FROM A TO C

All trunks busy

With reference to Fig. 10, it will be noted that the second chain relay 1050 has been connected via conductor 1076 to conductor 462 of the trunk extending to LC—1, Fig. 4. Other chain relays are connected in a similar manner, it follows then that a circuit will be completed for relay 1030 each time all trunks in the group become busy.

Relay 1030 operates; and by way of 1033 and conductor 1074 removes ground from the last bank contact accessible to wiper 383. Other springs on relay 1030 likewise remove ground from similar last bank contacts in the remaining outgoing secondary switches.

We will now assume that all the trunks accessible to OGS are busy when the dial back repeater DBR is seized from the local first selector. In this event wiper 383 will engage grounded contacts, and the switch will continue to search, until wiper 383 engages the contact to which conductor 1074 is connected, whereupon relay 360 energizes.

Relay 360 operates; closes relay 370 in series with motor magnet 380 at 364; transfers its own circuit at 362; and extends busy tone to the calling subscriber by way of the last contact in the bank and wiper 385, 363, conductor 132, 249, 247 and conductor 14.

Relay 370 operates; closes its locking circuit at 371; and opens the circuit to relay 350 at 374.

Relay 350 restores; and opens relay 340 at 352.

Relay 340 restores; but without effect.

When the calling party restores his receiver, the release of the connection will take place as previously described.

REVERTED CALL C TO A

Seizure of a dial back selector

The control operator may extend the call through exchange C, in which case no further operation occurs in the circuits under discussion until the calling subscriber disconnects.

We will now assume that the calling subscriber desires a number which necessitates that the control operator revert the call back over trunk TWT—1. The operator momentarily depresses key K—2, thereby inserting the booster battery BB in the simplex circuit of the trunk.

Relay 320 operates because of the increased current flow and closes a circuit by way of 312, 322, conductor 144, 232, through the upper winding of relay 220.

Relay 220 operates; prepares a holding circuit for itself through the upper winding of relay 230 at 221; prepares its own releasing circuit at 222; and effects the seizure of the dial back selector by completing a circuit from conductor 11, 227, resistance 122 (now shunted by 285), right hand winding of relay 260 (now shunted by 255 and resistance 121), conductor 130, 311, conductor 131, 225 and conductor 12.

When booster battery is removed from the simplex of the trunk, relay 320 will restore and at 322 will remove the short circuit from the upper winding of relay 230, thus allowing the latter relay to operate in series with relay 220.

Relay 230 operates; opens the operating circuit of relay 360 at 238, and of the upper winding of relay 220 at 232; opens the circuit of relay 330 at 236; prepares a holding circuit to relay 250 at 234; prepares a holding circuit for itself and a releasing circuit for relay 220 at 232; and extends holding ground to the timer equipment by way of 231 and conductor 592.

Relay 330 restores; removes the lower windings of relays 310 and 320 from the simplex of the trunk and extends that circuit through the upper windings of relays 320 and 310 to battery. Relay 320 will not operate on normal exchange battery. The simplex of the trunk is now in readiness for the operator to dial back over the same.

REVERTED CALL C TO A

Repeating pulses to the dial back selector

The control operator at exchange C now depresses key K—1 and dials the number of the called station, the impulse springs interrupting the simplex of the trunk in accordance therewith.

Relay 310 follows the impulses as received; and at each deenergization opens the circuit of slow to release relay 300; closes a circuit by way of 312, 304, conductor 142, 254, through relay 270 in parallel with the lower winding of relay 280; and opens the loop to the dial back selector at 311.

Relay 270 operates at the beginning of each

series of impulses and remains energized throughout the series; short circuits the upper winding of relay **320**, by way of **273** and conductors **139** and **140**, to prevent the possibility of its operating during impulsing; and at **271** closes a circuit to the upper winding of relay **280**.

Relay **280** operates; shunts the right hand winding of relay **260** and resistance **121** at **285** to improve dialling; and opens the transmission circuit at **281** and **283** to prevent dial clicks from being heard by the calling subscriber.

Relays **270** and **280** deenergize after each series of impulses and restore the previously discussed circuit to the dial back selector. The non inductive resistance **122** prevents completely opening the loop circuit to the dial back selector during the transfer from the direct loop to the loop in series with the right hand winding of relay **260**. The non inductive resistance **121** reduces the impedance of the loop to the dial back selector.

REVERTED CALL C TO A

Operator receives answering supervision

We will now assume that the control operator has dialled the number of the called subscriber and, when he answers, the connector in use will reverse battery in conductors **11** and **12**. The resulting reversal of current flow through the right hand winding of relay **260** will cause the two windings of that relay to oppose each other and bring about the operation of the relay.

Relay **260** operates; closes the upper windings of relays **240** and **250** at **262**; closes the circuit of relay **330** by way of **202**, **236**, **264**, and conductor **146**; and short circuits the resistance **122** at **261**.

Relay **250** operates; opens the operating circuit to relay **360** at **253**; removes the resistance **121** at **255** to improve transmission; opens the circuit of relays **270** and **280** at **254**; connects the right hand winding of relay **260** directly across conductors **11** and **12** at **255** to prevent an interruption of the loop to the dial back selector when relay **310** restores; prepares a holding circuit for its lower winding at **252**; and closes timer relay **500** by way of **251** and conductor **593**.

Relay **330** operates and at **331** inserts both windings of relays **310** and relay **320** in the simplex of the trunk. The resulting reduction in current flow causes relay **450** at exchange C to restore and bring in disconnect lamp L—2 by way of **451** and **445**.

The control operator may supervise the call by retaining the connections to the trunk. The operator can be recalled by either the calling or called parties since relay **330** is under control of both relay **200** and relay **260**. The calling party cannot release at this time because ground is maintained on conductor **16** by way of **125**, conductor **138** and **301**.

REVERTED CALL C TO A

Control operator disconnects

Upon receiving answering supervision the control operator may disconnect by withdrawing the plug from jack J, thereby opening the simplex of the trunk.

Relay **310** restores; opens the circuit of relay **300** at **312**; and closes the locking circuit to relay **250** by way of **312**, conductor **143**, **234**, and **252**.

Relay **300** restores; removes ground at **301** from conductor **16**, thereby placing the release of the connection under control of the timing equipment; opens the circuit of relay **240** at **302**; and opens the circuit of relay **360** at **303**.

Relay **360** restores and shunts out the upper winding of relay **370** at **364**. The motor magnet **380** operates and opens the circuit to relay **370** at **381**.

Relay **370** restores and opens the circuit to motor magnet **380** at **371**. The motor magnet **380** restores and advances the associated wipers one step.

Relays **350** and **340** operate at this time but without effect.

Voice currents complete the circuit for transmission from the calling and called lines by way of condensers **123** and **124**.

REVERTED CALL C TO A

Timing equipment releases connection

With reference to Fig. 5, it may be said that the individual timing unit ITU is in association with the dial back repeater of Fig. 2, and that the master timing unit MTU is common to exchange A.

The timing equipment is placed in operation when the called party answers on a connection established over the dial back switch train. ITU searches for and finds the present location of the wipers of MTU, thereby establishing the start of a predetermined time interval during which the connection will be maintained. A warning tone will be placed on the transmission circuit one half minute before the expiration of the time interval, thus giving the subscriber an indication that the connection is about to be released. The connection will be released at the end of the time interval even though the calling subscriber is still on the line. A detailed circuit explanation of the timer equipment will now be given.

Relay **230** operates when the control operator prepares the circuit of Fig. 2 for dial back operation, and at **231** places holding ground on conductor **592**.

Relay **250** operates when the called party answers on a dial back connection, and at **251** closes a circuit by way of conductor **593** to relay **500**.

Relay **500** operates; prepares the stopping circuit at **501**; and closes a circuit to motor magnet **540** by way of **502**, **512**, and **526**.

Motor magnet **540** operates and at **541** closes the circuit of relay **510**.

Relay **510** energizes; and at **512** opens the circuit of motor magnet **540**.

Motor magnet **540** restores; advances the associated wipers one step, and at **541** opens the circuit of relay **510**.

Relay **510** restores; and at **512** again closes the circuit of motor magnet **540**.

Motor magnet **540** operates; and again at **541** closes the circuit of relay **510**. This cycle of operation continues until wiper **543** finds a grounded bank contact, thereby aligning ITU with the position occupied by MTU at the moment. When alignment results, a circuit is closed by way of wiper **553**, wiper **543**, **521**, through the upper windings of relays **520** and **510** to battery at **501**. Because of this circuit relay **510** will not restore and again complete the circuit of motor magnet **540**.

Relay **520** operates; locks its lower winding at **522** to conductor **592**; opens its own operating circuit at **521**; opens at **526** the incomplete circuit to motor magnet **540**; at **524** prepares the circuit of relay **530**; and closes the circuit of **560** by way of **528** and **536**.

Relay **560** operates; starts the interrupter I at **564**; prepares the warning tone circuit at **561**; and connects motor magnet **550** to the interrupter

circuit by way of 562 and 572. For the purpose of explanation it may be assumed that the interrupter I delivers ground pulses at one half minute intervals and that each pulse has a duration of one fourth second.

Motor magnet 550 operates at the next pulse and closes the circuit of relay 570 at 551.

Relay 570 operates; locks up to the pulse at 572 and opens the circuit of motor magnet 550.

Motor magnet 550 restores and advances the associated wipers one step.

Relay 570 restores at the end of the pulse and again extends the interrupter circuit to motor magnet 550. Relay 570 and the motor magnet 550 will operate as described so long as relay 560 remains operated.

It will be noted that the banks associated with wipers 543 and 553 have been connected "tail to tail" and contact for contact; the banks associated with wiper 542 and 552 have been connected with a "slip" of six; and the banks asociated with wipers 544 and 554 have been connected with a "slip" of seven. We will assume that the position of the switches and wipers was as shown in Fig. 5 at the instant that ITU aligned itself with MTU. It follows then that on the fifth interrupter pulse thereafter (representing approximately a three minute time interval) a warning tone will be placed on the dial back transmission circuit by way of 571, 561, wiper 552, wiper 542, 531, 523, conductor 594, conductor 145, 379, 126, conductor 133, 297, and 283. This tone will advise the subscribers that the connection is about to be released, and at the next step of wiper 554 a circuit is closed by way of wiper 544, 524, and 532 to relay 530.

Relay 530 operates; locks itself to conductor 592 at 532; opens the circuit of relay 560 at 536; and removes ground from conductor 591 at 534.

The release of the dial back repeater and all associated switches takes place when ground is removed from conductor 591; it being remembered that relay 300 restored when the control operator disconnected from the trunk.

The control of the connection, following the disconnect of the control operator, is in the hands of the calling subscriber; for he at any time may restore his receiver and bring about the restoration of relay 200, followed by that of relay 210, thus disconnecting the dial back repeater from grounded hold conductor 591 at 211.

Call From C to A

When the operator at exchange C wishes to establish a call through exchange A she will insert the plug of an idle cord circuit into the jack J, Fig. 4, thereby energizing relay 440.

Relay 440 operates; and closes relay 410 by way of key K—2, key K—1, 442, relay 450, simplex of trunk TWT—1, 442 and 432.

Relay 410 operates; connects the upper left hand winding of repeating coil R4—1 to the incoming first selector trunk at 413; and closes the circuit of relay 400 at 411.

Relay 400 operates; ground conductor 462 at 401, thus making the trunk busy in the banks of the outgoing secondary line switches; closes the circuit of the left hand winding of relay 430 at 403 but without effect at this time; and completes the loop to the incoming first selector associated with LC—1, by way of conductor 465, 405, 423, lower left hand winding of repeating coil R4—1, right hand winding of relay 430, 425, upper left hand winding of repeating coil R4—1, 427, 413 and conductor 466. Relay 430 will not energize at this time because its two windings now aid each other.

The operator will now dial the number of the desired station. Relay 411 follows the impulses received over the simplex of the trunk, and when at normal opens the circuit of relay 400 at 411, and the loop to the incoming first selector at 413. The switches in exchange A follow the repeated impulses and complete the desired connection. Relay 400 remains operated during each series of impulses.

When the called party answers, battery will be reversed over conductors 465 and 466, thus causing the operation of relay 430. The latter relay connects the bottom (high resistance) winding of relay 410 in series with the simplex of the trunk at 432. The reduced current flow therein results in the required supervision at exchange C.

When the called party disconnects, the current flow through relay 430 is again reversed and the latter relay functions to remove the high resistance winding of relay 410 from the simplex of the trunk, disconnect supervision is thus given the operator at exchange C.

When the operator withdraws the plug from jack J the simplex circuit is opened to direct current flow, with the result that relay 410 restores; opens the loop at 413 to allow the release of the incoming switches; and opens the circuit of relay 400 at 411, thus removing busying potential in the banks of the outgoing secondary line switches.

Call From A to D

Seizure of TC—2 by subscriber

Assume that a subscriber in exchange A desires to call exchange D; he will first remove his receiver, whereupon his line switch will extend the connection to an idle local first selector. The calling subscriber then dials the digit 9 with the result that the first selector will proceed to select an idle trunk circuit leading to exchange D. Referring now to Fig. 8, it will be assumed that the trunk so selected is that represented by conductors 28, 29, and 30.

Relay 830 operates; by way of 887, 853, and conductor 28 from ground supplied by the selector seizing TC—2; and bridges relay 800 across the calling loop by way of conductor 29, conductor 181, 942, windings 1 and 3 of R9—1, 944, conductor 186, and conductor 30.

Relay 800 operates; closes relay 810 at 802; and closes relay 860 by way of 804, 854, conductor 180, 974, and conductor 179.

Relay 810 operates; closes relay 820 at 812; and disconnects relay 890 from the all trunks busy equipment 816.

Relay 820 operates; extends ground by way of 823, impedance 188, 887, 853 to conductor 28 to hold the preceding switches; prepares its own holding circuit at 822; and opens the incomplete circuit to relay 880 at 821.

Relay 860 operates; closes its locking circuit at 864; and connects generator to the upper winding of relay 870 by way of 861 and condenser 8001.

Call From A to D

Signalling operator at D

Generator by way of 861, 871, upper winding of relay 870, conductor 175 and 912 causes an energization of said relay sufficient to energize make first contacts 872.

Relay 870 operates; locks through its lower

winding at 872; closes relay 970 by way of 874 and conductor 176; and closes relay 840 at 876.

Relay 840 operates, but without effect at this time.

Relay 970 operates; opens relay 860 at 974; closes relay 850 by way of 842, conductor 178, 972, and conductor 177; and at 976 and 978 impresses generator upon trunk conductors 31 and 32.

Relay 850 operates; locks itself at 852; and transfers the operating circuit of relay 860 by way of 854 to break springs of relay 800.

Relay 860 restores; opens its incomplete locking circuit at 864; and at 862 opens the circuit of relays 870, 840 and 970.

Relay 840 restores, but without effect at this time.

Relay 970 restores; prepares the operating circuit to relay 860 at 974; and removes generator from trunk conductors 31 and 32 at 976 and 978. The slow release characteristics of relays 860 and 970 determine the length of the ring sent out on conductors 31 and 32.

The splash of generator impressed on trunk conductors 31 and 32 will actuate the usual ring down equipment at exchange D and, when the operator answers, transmission will occur. Transmission battery is supplied to the calling party through relay 800.

If the calling line is a paystation line, a tone, superimposed on conductor 28, flows through the left hand winding thereof which is audible to the operator at exchange D by way of conductors 182 and 187, and contacts 934 and 936. The operator cuts off the tone by ringing on the trunk, thus actuating relay 960.

Relay 960 operates; and closes relay 930 by way of 963, conductor 171, 831, and conductor 172.

Relay 930 operates; locks itself at 931; and removes the second winding of impedance 188 from the talking conductors at 934 and 936.

The calling party may re-signal the operator by momentarily operating the hookswitch or dialling another digit. In either event relay 800 will momentarily restore and close relay 860.

Relay 860 operates and locks itself at 864 whereupon relays 870, 840, 970 and 860 function as before explained to impress a splash of generator on conductors 31 and 32.

The operator, upon answering, must again ring to remove the paystation tone, for relay 800 opened the locking circuit of relay 930 at 801.

The weighted spring 842 of relay 840 will vibrate following the restoration of that relay, thus maintaining an intermittent circuit to relays 820 and 850 so that the latter will not restore as the result of the deenergization of relay 810, should the subscriber delay unduly in releasing the hookswitch when resignalling the operator.

The release of the connection is under control of the calling party, and the restoration of the receiver to the hookswitch will open the circuit of relay 800.

Relay 800 restores; opens relay 810 at 802 and relay 930 at 801; and closes relay 860.

Relay 860 operates; locks itself at 864 and causes relays 870, 840 and 970 to operate and send "ring-off" generator over trunk conductors 31 and 32.

Relay 810 restores; and opens relay 820 at 812 and relay 860 at 814.

Relay 860 restores; and opens relays 840, 870, and 970.

Relay 840 restores; and its weighted spring 842 vibrates, thus opening and closing the circuit to relays 820 and 850. The latter relays are slow to release and do not restore immediately, but as the vibrations of 842 decrease in implitude relays 820 and 850 are opened for longer and longer periods until restoration finally occurs.

Relay 820 restores; and opens relay 830 at 825 and impedance 188 at 823, thus causing the release of the preceding switches.

Relay 850 restores; and again connects relay 830 to conductor 28 in order that TC—2 may be available from the selector banks.

Call From D to A

Seizure of TC—2 by operator

The operator at exchange D may ring on trunk conductors 31 and 32, thereby bringing about the energization of relay 960.

Relay 960 operates; and closes relay 880 by way of 1022, 1002, conductor 1071, 961, 901, conductor 173 and 821. The short circuited lower winding of relay 880 makes said relay slow to energize, thus it will not operate should relay 960 momentarily respond to a surge or condenser discharge on the trunk.

Relay 880 operates; prepares its locking circuit by way of 881, conductor 174, relay 900 and 932; places ground on conductor 28 by way of 887 and 853 to make TC—2 busy in the banks of the selectors; closes motor magnet 950 by way of 885, conductor 166 and 907; and connects wiper 953 of ICS—2 by way of 945, conductor 168, 883, conductor 167 to relay 940.

Relay 960 restores when the operator removes generator from the trunk, and opens the operating circuit of relay 880 at 961, whereupon relay 900 energizes in series with relay 880.

Relay 900 operates; opens the operating circuit of relay 880 at 901 to prevent the release of relay 900 should the operator again ring in the trunk; opens motor magnet 950 at 907; prepares the circuit of relay 940 at 905; and closes the left hand winding of relay 910 at 902, but without effect at this time.

Motor magnet 950 restores and advances the associated wipers one step. If ICS—2 is now resting on a trunk to a busy dial back repeater, wiper 953 will be grounded, thus shunting out relay 940 and closing motor magnet 950 by way of 945, conductor 168, 883, conductor 167 and 951.

Motor magnet 950 operates; opens its own circuit at 951, and advances the associated wipers one step upon deenergizing. This cycle of operations will continue until an idle dial back repeater is found.

Call From D to A

ICS—2 selects trunk to idle DBR

When the rotary switch wipers engage the first idle trunk, assumed to be that represented by conductors 17, 18, 19 and 20, the absence of ground at wiper 953 will render effective a circuit from ground at 905, 933, relay 940, 951 and motor magnet 950. The motor magnet will not energize at this time because of the high resistance of relay 940.

Relay 940 operates; closes the loop to DBP by way of conductor 17, 955, 942, winding 1 of R9—1, right hand winding of relay 910, 904, conductor 185, 834, conductor 184, winding 3 of R9—1, 944, 954 and conductor 18; and places ground on conductor 20 by way of 941 and 952; thus rendering inoperative the time release equipment of Fig. 5.

The dial back repeater will extend the connection over an idle trunk to exchange C, in the manner previously explained. In the event that the call is not answered by the operator at exchange C, the operator at exchange D may release the connection by again ringing on the trunk, thereby energizing relay **960**.

Relay **960** operates; and closes relay **920** by way of **963** and **903**.

Relay **920** operates; provides a holding circuit for relays **900** and **880** at **926**; and closes relay **930** at **922**.

When the ringing current is removed from the trunk, relay **960** will restore and open the circuit of relay **920**.

Relay **920** restores; opens the circuit to relays **900** and **880** in series; and to relay **930**. Due to its slow to release characteristics, relay **930** remains operated long enough to allow the release of relay **880**.

Relay **900** restores; opens the loop to DBP at **904**; and causes the release of ICS—**2** by opening the circuit of relay **940** at **905**.

Call From D to A

Operator at exchange C answers

When the control operator answers, the associated dial back repeater reverses battery over conductors **17** and **18**, thus causing the energization of relay **910**.

Relay **910** operates; opens the incomplete circuit of relay **870** at **912**; and closes relay **920** at **911**.

Relay **920** operates; prepares its holding circuit by way of **842**, **851**, conductor **170** and **921**; closes relay **860** by way of **911**, **924**, **974**, and conductor **179**; closes relay **930** at **922**; and provides holding ground for relays **900** and **880** at **926**.

Relay **860** operates; but without effect at this time.

Relay **930** operates; removes ground from relay **940** at **933**, but without effect as relay **940** is held from ground on conductor **19**; closes a holding circuit for itself at **931**; and opens the original holding circuit of relays **900** and **880** at **932**, thus placing the release of this switch under control of relay **920**.

The control operator at exchange C will now extend the call over the dial back switch train in the manner previously explained. When the called party answers, the control operator can disconnect from the control trunk, thus placing the release of the entire switch train under control of the called subscriber.

The called subscriber can recall the operator at exchange D by momentarily operating his hookswitch. Such action, as heretofore explained, will cause the dial back repeater to momentarily reverse battery on conductors **17** and **18**, thereby causing the deenergization of relay **910**.

Relay **910** restores; and completes the circuit of the upper winding of relay **870** at **912**; whereupon relays **870**, **840**, **970**, **850** and **860** function as before explained to impress generator on trunk conductors **31** and **32**, thereby signalling the operator at exchange D. The vibrations of the weighted spring of relay **840** prevents the release of relays **850** and **920**, so that TC—**2** will not release as a result of the momentary reversal of current on conductor **17** and **18**.

When the called party restores his receiver at the end of the conversation a splash of "ring off" current is impressed upon conductors **31** and **32**, in the manner just described. And, as the vibrations of relay **840** decrease in amplitude, the circuit to relays **920** and **850** are open for a longer period during each oscillation until finally the aforementioned relays deenergize.

Relay **920** restores; and opens the circuit of relays **880**, **900** and **930**.

Relay **900** restores; and at **904** opens the loop across conductors **17** and **18**, thus causing the release of the dial back repeater and switch train. The release of DBR removes ground from conductor **19**, thus causing the deenergization of relays **940** and **930**.

Relay **850** restores; and again connects relay **830** to conductor **28**, thus making TC—**2** available to calls from the selector banks.

Call From D to A

All trunks to C busy

In the event that all the trunks from exchange A to exchange C are busy it is desirable that the operator at D receive a busy indication without needlessly tying up a dial back repeater. As before explained, this busy condition results in the energization of relay **1030**, which in turn closes the circuit of relay **1000**. A circuit is thereby closed by way of **1004** and conductor **1072** to all trunk circuits incoming to the dial back repeaters of exchange A. In the case of TC—**2** the circuit extends through **816** to relay **890**.

Relay **890** operates; and impresses busy tone on conductors **29** and **30** by way of **892** and **894**. The busy tone is induced in the line side of repeating coil R**9**—**1** and is audible to the operator at exchange D when she plugs into the jack associated with trunk conductors **31** and **32**.

The busy condition just described does not prevent a subscriber in exchange A from making a call to exchange D, for relay **810**, which operates on a local connection, opens the circuit of relay **890** at **816**.

The operation of relay **960** is rendered ineffective, should the operator ring on trunk conductors **31** and **32** during an all trunks busy period, by the removal of ground from conductor **1071** at **1002**.

Call From D to A

All DBR's busy

In the event that all dial back repeaters are in use, it will be impossible to complete a call from exchange D to exchange A, even though trunks are available from exchange A to exchange C.

Conductor **1073** connects the normally energized relay **1010** to all dial back repeaters in exchange A, in the case of DBR this conductor is normally grounded by way of **332**, conductor **150**, **244**, and **222**. It follows then that relay **1010** will deenergize when all dial back repeaters are in use.

Relay **1010** restores; and closes the circuit of relay **1020** at **1012**.

Relay **1020** operates; removes ground from conductor **1071** at **1022**; and grounds conductor **1072** at **1024**.

As a result of the foregoing, the operator at exchange D will receive a busy indication and the trunk circuit will be protected as previously explained.

Call From C to B

Seizure of TC—3 by first selector

As indicated by the trunking diagram Fig. 1, exchange B can only be called by the control

operator at exchange C, through the medium of a dial backfirst selector or an incoming first selector.

We will assume that the control operator reverted a connection to a dial back first selector, and now dials the digit eight, with the result that the dial back selector will proceed to select an idle trunk circuit leading to exchange B. Referring now to Fig. 6, it will be assumed that the trunk so selected is that represented by conductors 25, 26 and 27.

Relay 670 operates; by way of 665, 695 and conductor 25 from ground supplied from the selector seizing TC—3; bridges relay 620 across the calling line by way of 676, conductor 162, winding 3 of R7—1, 746, conductor 164, and 604 to conductor 27, and by way of 674, conductor 161, winding 1 of R7—1, 744, conductor 160 and 602 to conductor 26; and opens the circuit of relay 680 at 672.

Relay 620 operates; closes relay 630 at 622; and completes a dial lead to exchange B by way of relay 650, 624, conductor 159, and the midpoint of windings 2 and 4 of repeating coil R7—1.

Relay 650 operates; and opens the incomplete circuit to relay 610 at 651.

Relay 630 operates; and at 637 supplies ground to conductor 25 to hold the preceding switches.

CALL FROM C TO B

Repeating impulses to exchange B

Trunk circuit TC—3 is now prepared to repeat impulses to exchange B. Relay 620 follows the impulses of each series and, when at normal, opens the dial lead at 624 and closes the circuit of relay 640 by way of 622 and 632.

Relay 640 operates; opens the incomplete circuit to relay 610 at 643; closes relay 650 by way of 631 and 641 to maintain the latter during the impulsing period; and at 642 connects resistance 189 in parallel with relay 650 to improve pulsing.

Relay 650 restores momentarily, following the deenergization of relay 620 and prior to the operation of relay 640, but without effect as relay 610 is slow to operate.

Due to their slow release characteristics relays 630 and 640 remain operated during impulsing.

The opening and closing of the simplex of the trunk causes the switches in exchange B to operate and complete the dialled connection.

CALL FROM C TO B

Called party answers

When the called party answers, the equipment at exchange B places a high resistance in the simplex of the trunk thereby causing relay 650 to deenergize and close the circuit of relay 610 by way of 651, 643, 633 and 611.

Relay 610 operates; locks itself to ground at 631 and opens its originating circuit at 611; and closes relay 600 at 613.

Relay 600 operates; and reverses battery to conductor 26 and 27 at 602 and 604.

The circuit is now complete for transmission. Transmission battery is supplied to the calling party through relay 620. The transmission circuit to and from the called party is by way of the repeating coil R7—1.

The called party can recall the operator at exchange D (assuming that the connection originated thereat) by momentarily depressing this hookswitch. The equipment at exchange D follows the hookswitch and places the high resistance out and in the simplex of the trunk. Relay 650 will follow the supervision received over the simplex and will cause relay 600 to send reverse battery supervision back over the calling switch train.

The release of the connection is under the control of the calling party and, when the receiver is restored, the circuit of relay 620 will be opened.

Relay 620 restores; opens relay 630 at 622; opens relay 650 at 624; and closes relay 640 at 622.

Relay 630 restores; opens relays 610 and 650 at 631; opens relay 640 at 632; causes the release of the preceding switches by removing ground from conductor 25 at 637; and closes relay 660 at 635.

Relay 600 operates; prepares its locking circuit at 662; and closes relay 650 at 664.

Relay 610 restores; and grounds conductors 25 at 615, thus making TC—3 busy in the selector banks.

The operation now depends upon whether or not the called subscriber has restored his receiver to the switch hook. In the event that he has restored, relay 650 will remain operated by virtue of its lower winding which is energized over the simplex of the trunk.

Relay 640 restores; and opens relay 660 at 645.

Relay 660 restores; removes ground from conductor 25 at 665 and connects relay 670 thereto; and opens relay 650 at 664.

Relay 650 restores; whereupon TC—3 is again at normal.

In the event that the called party had not restored, relay 650 will restore when its upper winding is opened at 631 because the current flowing through its lower winding and the simplex of the trunk is limited by the high resistance at exchange B, and is not sufficient to maintain the relay in an energized position. The restoration of relay 650 affords a locking circuit for relay 660 by way of 651 and 662. Thus the trunk to TC—3 is made busy in the selector banks until such time as the called party restores.

When the called party restores, the high resistance will be cut out of the simplex of the trunk, whereupon relay 650 will operate and open relay 660 at 651.

Relay 660 restores; removes ground from conductor 25 at 665; and connects relay 670 thereto; and opens relay 650 at 664.

Relay 650 restores; whereupon TC—3 is again at normal.

CALL FROM B TO A

Seizure of TC—3 by automatic subscriber

Assuming now that a subscriber in exchange B desires to call a subscriber in exchange A, he will first remove his receiver, whereupon his line switch will extend the connection to an idle local first selector. The calling subscriber than dials the digit required to select an idle trunk to exchange A. Referring now to Fig. 7, it will be assumed that the trunk so selected is that represented by conductors 33 and 34.

The equipment at exchange B will next impress generator upon the simplex of the trunk, thereby energizing relay 680 by way of 672, condenser 6001, conductor 158, 704 and windings 2 and 4 of R7—1 in parallel to conductors 33 and 34.

Relay 680 operates; and closes relay 690 at 681.

Relay 690 operates; grounds conductor 25 at 695, thus making TC—3 busy in the selector banks; closes motor magnet 750 by way of 693, conductor 154, and 701; and prepares the operating circuit of relay 700 at 691. The normally short circuited lower winding of relay 690 causes that relay to be slow to operate, and as a result it will not energize should relay 680 operate momentarily as the result of a line surge.

Relay 680 restores; when generator is removed from the simplex of the trunk; and removes the short circuit from relay 700 at 681. The energizing circuit of relay 700 extends from ground at 651, 562, conductor 156, relay 700, conductor 155, 691 and relay 690.

Relay 700 operates; opens relay 680 at 704, connects relay 650 to the simplex of the trunk at 702; closes relay 710 by way of 693, conductor 154, and 701; connects wiper 752 to motor magnet 750 by way of 741, 705, 761, and 751; prepares the circuit of relay 740 at 703; and opens motor magnet 750 at 701.

Motor magnet 750 restores and advances the associated wipers one step. If ICS—3 is now resting on a trunk to a busy dial back repeater wiper 752 will be grounded, thus shunting out relay 740 and closing motor magnet 750 by way of 741, 705, 761 and 751.

Motor magnet 750 operates; opens its own circuit at 751, and advances the associated wipers one step upon deenergizing. This cycle of operations will continue until an idle dial back repeater is found.

Call From B to A

ICS—3 selects trunk to idle DBR

When the rotary switch wipers engage the first idle trunk, assumed to be that represented by conductors 14, 15, and 16, the absence of ground at wiper 752 will render effective a circuit from ground at 1022, 1002, conductor 1071, 661, conductor 153, 703, 731, relay 740, 751 and motor magnet 750. Motor magnet 750 will not energize in series with the high resistance relay 740.

Relay 740 operates; closes the loop to the dial back repeater by way of conductor 14, 754, 744, winding 1 of R7—1, relay 710, conductor 163, 652, 676, conductor 162, winding 3 of R7—1, 746, 753, conductor 15; prepares its own holding circuit at 741; and connects relay 730 to wiper 752 at 742. The dial back repeater associated with trunk conductors 14, 15, and 16 now returns ground on conductor 16, thus energizing relay 730 by way of 752 and 742.

Relay 730 operates; prepares a holding circuit for relay 690 in series with relay 700 at 732, thus placing the release of TC—3 under control of the dial back repeater; and transfers the holding circuit of relay 740 to conductor 16 at 731.

The dial back repeater and associated outgoing secondary lineswitch function as before described to signal the control operator at exchange C. When the control operator answers, battery is reversed over conductors 14 and 15, thus reversing the current in the operating winding of polarized relay 710.

Relay 710 operates; and closes relay 720 at 711.

Relay 720 operates; opens the simplex of the trunk at 722, thus causing the restoration of a relay at exchange B in order that paystation tone may become audible on conductors 33 and 34; and closes an intermittent circuit to relay 660 by way of 733, weighted spring 721 and conductor 151. Relay 660 does not energize until the weighted spring 721 comes to rest.

Relay 660 operates; closes its locking circuit at 662; recloses the simplex of the trunk at 664, thus causing the removal of paystation tone from conductors 33 and 34 at exchange B; opens the original holding circuit of relays 690 and 700 at 662; and opens the incomplete circuit of relay 740 at 661.

Busy tone is placed on conductor 16 by way of condenser 7003, 741 and 752, thus affording a discriminating tone which becomes audible to the control operator in exchange C, and advises her that the call is from exchange B.

Call From B to A

Release of the connection

The control operator will now revert the call by way of a dial back first selector to the desired subscriber in exchange A, in the manner already described. If the control operator supervises the connection, the release of TC—3 is under the control of the last party to release, otherwise the release is under the control of the calling party, or of the timing equipment.

When the calling party releases, the equipment at exchange B removes the high resistance from the simplex of the trunk, thereby causing the energization of relay 650.

Relay 650 operates; opens relay 660 at 651; and opens the loop circuit to the dial back repeater at 652, thus giving the control operator disconnect supervision. When the dial back repeater releases, ground is removed from conductor 16, thus opening the circuit of relays 730 and 740.

Relay 730 restores; and opens the circuit of relays 690, 700 and 660. Relay 660 is made slow to release so that relay 690 will restore first and thereby open the operating circuit to relay 700.

Relay 660 restores; opens the simplex of the trunk at 664 thus allowing the release of the equipment in exchange B; and at 665 connects relay 670 to conductor 25, thus making TC—3 available from the selector banks.

In the event that the calling party remains on the line, the timing equipment will eventually remove ground from conductor 16, thereby opening the circuits of relays 740 and 730.

Relay 740 restores; opens the loop to the dial back repeater at 744 and 746, thus causing its release, as well as the deenergization of relays 710 and 720.

Relay 730 restores; and opens relays 690 and 700 at 732.

When the called party restores his receiver, the high resistance is removed from the simplex of the trunk, thus causing the energization of relay 650.

Relay 650 operates; and opens relay 660 at 651.

Relay 660 restores; opens the simplex of the trunk at 664, thereby releasing the repeater in exchange B; and at 665 connects relay 670 to conductor 25, thus making TC—3 available from the selector banks.

Call From B to A

All trunks to C busy or all dial back repeaters busy

As has been previously explained, relay 1000 operated when all of the trunks from exchange A to exchange C are busy, while relay 1020 operates if all of the dial back repeaters are in use. In either event ground is placed on all branches of conductor 1072, and ground is removed from all branches of conductor 1071.

If, during either busy condition, TC—3 is seized

from exchange B by a ring on the simplex of the trunk, relays 680, 690 and 700 will operate as previously explained.

Relay 690 operates; and closes relay 760 by way of grounded conductor 1072 and conductor 190.

Relay 760 operates; opens the motor magnet circuit at 761, to prevent further operation of ICS—2; and connects busy tone to the switch board side of repeating coil R7—1 by way of 762 and 764 and condensers 7001 and 7002. The busy tone completes a circuit through the line side of the repeating coil to give the calling party in exchange B an indication of the all trunks busy condition.

As there is no ground on conductor 1071, relay 740 cannot operate at this time.

When the calling party releases, the equipment in the exchange B removes the high resistance from the simplex of the trunk, thus causing the energization of relay 650.

Relay 650 operates; and opens relays 690 and 700 at 651. The non-inductive resistance around relay 700 makes the latter relay somewhat slow to release, and insures that relay 690 will restore first and open the circuit to relay 700 at 691.

Relay 700 restores; opens relay 650 at 702, thus freeing the equipment in exchange B.

The invention having been described, that which is believed to be new and for which the protection of Letters Patent is desired will be pointed out in the appended claims.

What I claim is:

1. In a telephone system, a local dial exchange, a distant dial exchange, a toll exchange, a control exchange, trunk lines connecting the distant and local dial exchanges, dial back repeaters in the local exchange, a hunting switch individual to each said trunk line having access to said repeaters, toll trunk lines connecting the toll and local exchanges, a hunting switch individual to each said toll trunk line having access to said repeaters, control trunk lines connecting the local and control exchanges, a selecting switch individual to each said repeater having access to said control trunk lines, automatic subscribers' lines terminating in said local exchange, local connectors in said local exchange having access to said local lines, and means whereby said local connectors are accessible from said subscribers' lines, said control trunk lines, said toll trunk lines, and said repeaters.

2. In a telephone system, a local dial exchange, a distant dial exchange, a toll exchange, a control exchange, trunk lines connecting the distant and local dial exchanges, dial back repeaters in the local exchange, a hunting switch individual to each said trunk line having access to said repeaters, toll trunk lines connecting the toll and local exchanges, a hunting switch individual to each said toll trunk line having access to said repeaters, control trunk lines connecting the local and control exchanges, a selecting switch individual to each said repeater having access to said control trunk lines, automatic subscribers' lines terminating in said local exchange, local first selectors in said local exchange accessible to said automatic subscribers' lines, incoming first selectors in said local exchange individual to said control trunks, dial back first selectors in said local exchange individual to said repeaters, connectors in said local exchange accessible to all selectors therein, and means for restricting said local selector from connecting with the trunk lines connecting the local exchange with one of the distant exchanges.

3. In a telephone system wherein subscribers' lines in two automatic exchanges connected by trunk lines complete local automatic connections in their respective exchanges but are restricted from completing inter-exchange calls to called subscribers' lines in the far exchange, a control trunk line connecting one of the exchanges with an operator's position at a control exchange, means for seizing the control trunk line and for signalling the operator thereover in response to a call by a subscriber in either automatic exchange initiating an inter-exchange call, means controlled by the operator for revertively extending the connection to the desired called subscriber's line over the said control trunk line, means for freeing said control trunk line for other uses while maintaining the connection between the calling and called lines, and means independent of said subscribers for releasing said connection at the expiration of a predetermined time.

4. In a telephone system wherein subscribers' lines in two automatic exchanges connected by trunk lines complete local automatic connections in their respective exchanges but are restricted from completing inter-exchange calls over said trunk lines to called subscribers' lines in the far exchange, a control trunk line comprising two talking conductors connecting one of the exchanges with an operator's position at a control exchange, means including a dial back repeater in one of the exchanges for seizing the control trunk line and for signalling the operator thereover in response to a call by a subscriber in either automatic exchange initiating an inter-exchange call, a dial back first selector individual to said repeater, local switches accessible to said selector, a relay in said repeater, means controlled over the two talking conductors of said control trunk line in parallel for operating said relay, a circuit for operating said selector to select an idle local switch closed by the operation of said relay, and means controlled over the two talking conductors of said control trunk line in parallel for operating said selector to further extend said inter-exchange call toward completion.

5. In a telephone system wherein subscribers' lines in two automatic exchanges connected by trunk lines complete local automatic connections in their respective exchanges but are restricted from completing inter-exchange calls over said trunk lines to called subscribers' lines in the far exchange, a control trunk line comprising two talking conductors connecting one of the exchanges with an operator's position at a control exchange, means including a dial back repeater in one of the exchanges for seizing said control trunk line and for signalling the operator thereover in response to the initiation of an inter-exchange call from a subscriber's line in either automatic exchange, a booster battery at said operator's position, a relay in said repeater responsive only to current from said booster battery, means controlled by said operator for connecting said booster battery to the two talking conductors of said control trunk in parallel for operating said relay, a circuit for further extending the said inter-exchange call closed by the operation of said relay, means controlled over the two talking conductors of said control trunk line in parallel by the operator for opening and closing said circuit, and automatic switches con-

trolled by the closing and opening of said circuit for completing the inter-exchange call to a called line.

6. In a telephone system, a local dial exchange, a distant dial exchange, a toll exchange, a control exchange, trunk lines connecting the distant and local exchanges, dial back repeaters in the local exchange, a hunting switch individual to each said trunk line having access to said repeaters, toll trunk lines connecting the toll and local exchanges, a hunting switch individual to each said toll trunk line having access to said repeaters, control trunk lines connecting the local and control exchanges, and means to give a busy indication on calls directed to the local dial exchange in the event that all of said repeaters or all of said control trunk lines are in use.

7. In a telephone network, two exchanges serving two groups of subscribers, said exchanges operating independently in the establishment of local connections, trunk lines connecting said exchanges, dial back repeaters in one exchange, a control operator, means responsive to the initiation of an inter-exchange call from either one of said exchanges for establishing a connection from the calling station to one of said repeaters and for placing said one repeater under the control of said operator, operator controlled means including said one repeater for extending said connection to the other exchange and promoting its completion to a called station in said other exchange, timing means associated with said repeater, effective upon the option of said operator, for releasing the connection if said connection is not abandoned by the subscribers within a predetermined interval of time after its completion, said timing means issuing a warning to said calling and called stations a predetermined length of time before releasing said connection.

8. In a telephone network, a first exchange, a second exchange, and a third exchange, each said exchange serving a group of subscribers and operating independently of the other exchanges in completing calls between subscribers within that group, trunk lines extending from said first exchange to each of the other exchanges, a control operator, a dial back repeater located in said first exchange having access to said operator, means including said repeater controllable from each of the exchanges for extending a connection from a subscriber's substation in that exchange to said operator, operator controlled means for completing said connection to a subscriber's substation in any of said exchanges, means associated with said repeater for limiting the time length of said complete connection, said timing means automatically rendered ineffective if the connection is originated in said third exchange, operator controlled means for optionally rendering said timing means ineffective if the connection is originated in the first or second exchange.

9. In a telephone network, an automatic exchange serving one group of subscribers, a manual exchange serving another group of subscribers, each exchange operating independently of the other in the establishment of local connections, trunk lines connecting said exchanges, selectors in said automatic exchange accessible to the local subscribers and having access to said trunk line, means including one of said selectors and a trunk line controllable by subscribers in said automatic exchange for establishing a connection to said manual exchange, a control operator, a dial back repeater in said automatic exchange having access to said operator and accessible to said trunk lines, connector switches in said automatic exchange accessible from said repeater and having access to the local subscribers' lines, means including one of said trunk lines and one of said repeaters for establishing a connection from said manual exchange to said operator, operator controlled means including said one repeater and one of said connectors for extending last said connection to a subscriber in said automatic exchange.

10. In a telephone network, an automatic exchange serving one group of subscribers, a manual exchange serving another group of subscribers, each exchange operating independently of the other in the establishment of local connections, trunk lines connecting each of said exchanges to a third exchange, a control operator, a dial back repeater in said third exchange having access to said operator and accessible from said trunk lines, selectors in said third exchange accessible to said repeaters and having access to said trunk lines, means including one of said repeaters and a trunk line from either one of first two said exchanges for establishing a connection from said one exchange to said control operator, operator controlled means including said one repeater, one of said selectors, and a trunk line to the other one of the first two said exchanges for extending said connection to said other exchange.

11. In a telephone system, a first station, a second station, a third station, a dial back repeater, means for establishing a connection from said first station to said repeater, means in said repeater responsive to the completion of said connection for establishing a connection from said repeater to said second station, a booster battery at said second station, means at said second station for momentarily connecting said booster battery to the conductors of said second connection, means in said repeater responsive to current from said booster battery for preparing a connection from said repeater to said third station, means controlled at said second station for completing said third connection, said connections comprising a three-way talking circuit.

12. In a telephone system, subscribers' substations of two classes, a control operator, dial back repeaters, means for establishing a connection from a calling station of one class to one of said repeaters, means in said one repeater responsive to the completion of said connection for establishing a connection from said one repeater to said control operator, a booster battery, operator controlled means for momentarily connecting said booster battery to the conductors of said second connection, means in said repeater responsive to current from said booster battery for preparing a connection from said repeater to a called station of the other class, operator controlled means for completing said third connection, said connections comprising a three-way talking circuit having said repeater as the point of junction, operator controlled means for releasing said second connection, means associated with said repeater effective upon the release of said second connection for releasing the remaining two connections a predetermined interval after the completion of said third connection if said connections are not previously released by the subscribers' substations.

13. In a telephone system, subscribers' substa-

tions, a dial back repeater and a control operator associated therewith, means for establishing a connection from a calling substation to said repeater, operator controlled means for extending said connection from said repeater to a called substation, timing means associated with said repeater, effective upon the option of said operator, for releasing the connection if said connection is not abandoned by the subscribers within a predetermined interval of time after its completion, said timing means issuing a warning to said calling and called substations a predetermined length of time before releasing said connection.

PIER BAKKER.