

March 28, 1944.

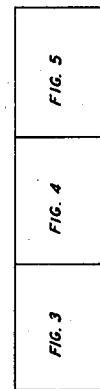
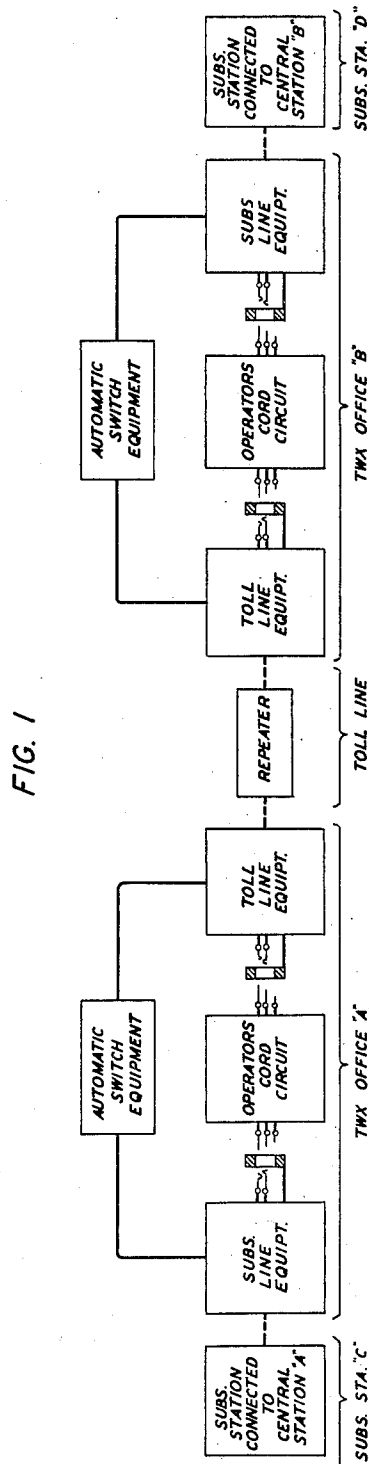
R. S. BAILEY

2,345,316

THROUGH AND INWARD TELEGRAPH EXCHANGE SYSTEM

Filed May 17, 1941

4 Sheets-Sheet 1



INVENTOR
R.S. BAILEY
BY *J. W. Schmied*
ATTORNEY

March 28, 1944.

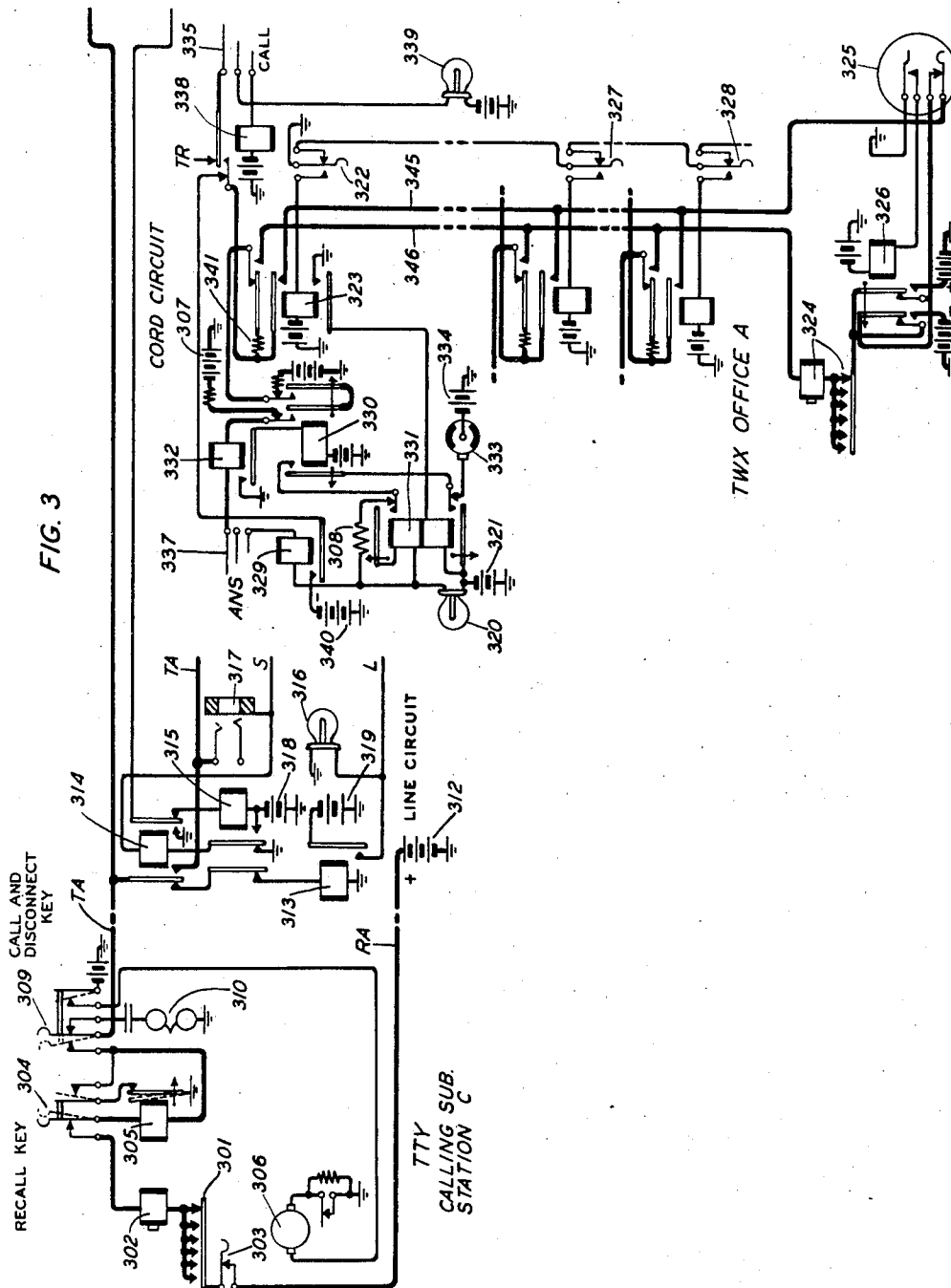
R. S. BAILEY

2,345,316

THROUGH AND INWARD TELEGRAPH EXCHANGE SYSTEM

Filed May 17, 1941

4 Sheets-Sheet 2



INVENTOR
R. S. BAILEY
BY *J. W. Schmied*
ATTORNEY

March 28, 1944.

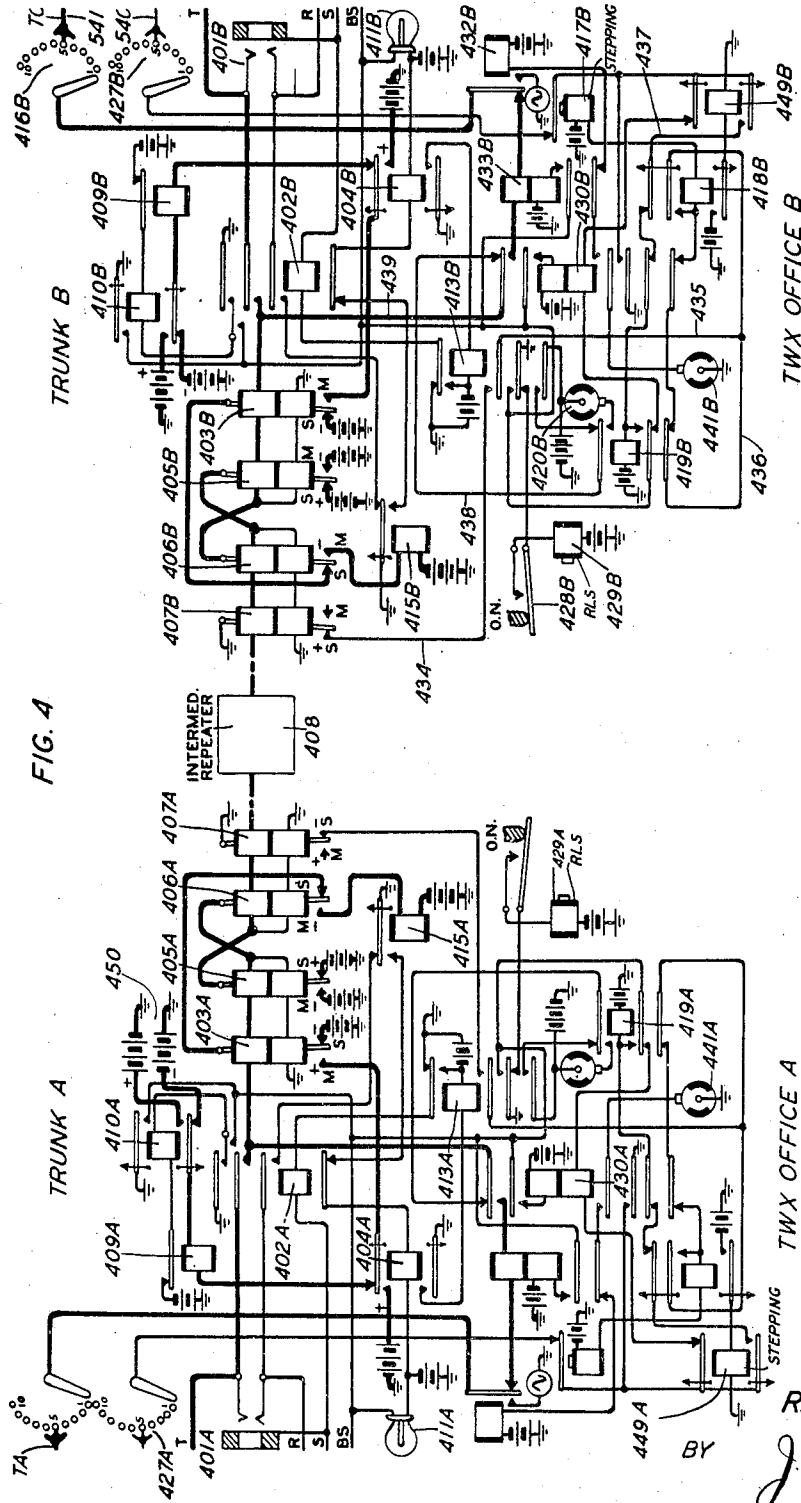
R. S. BAILEY

2,345,316

THROUGH AND INWARD TELEGRAPH EXCHANGE SYSTEM

Filed May 17, 1941

4 Sheets-Sheet 3



INVENTOR
R. S. BAILEY

BY *J. W. Schmied*
ATTORNEY

March 28, 1944.

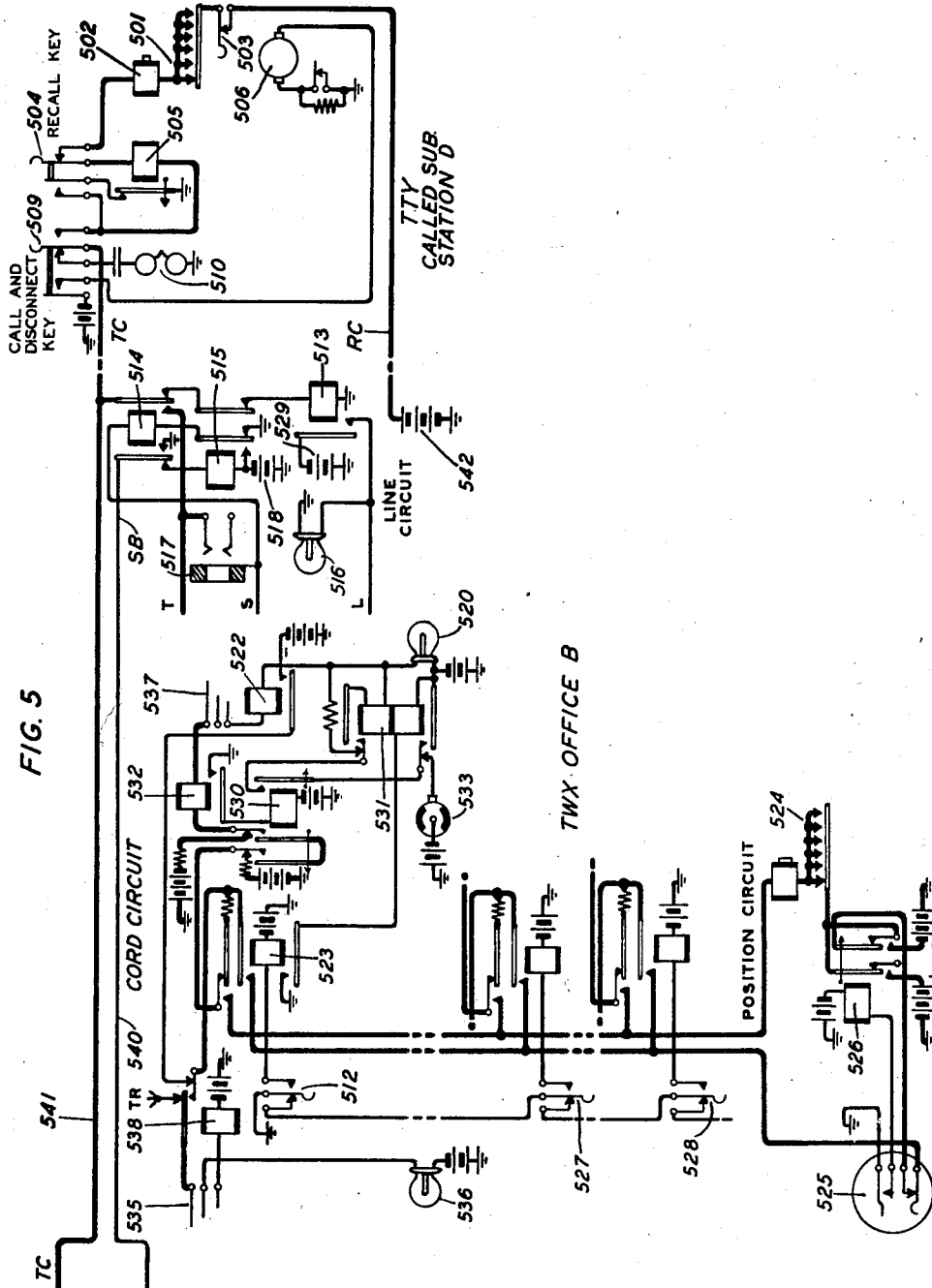
R. S. BAILEY

2,345,316

THROUGH AND INWARD TELEGRAPH EXCHANGE SYSTEM

Filed May 17, 1941

4 Sheets-Sheet 4



INVENTOR
R. S. BAILEY
BY *J. W. Schmied*
ATTORNEY

UNITED STATES PATENT OFFICE

2,345,316

THROUGH AND INWARD TELEGRAPH
EXCHANGE SYSTEMRand S. Bailey, Glen Ridge, N. J., assignor to Bell
Telephone Laboratories, Incorporated, New
York, N. Y., a corporation of New York

Application May 17, 1941, Serial No. 393,863

35 Claims. (Cl. 178—2)

This invention relates to teletypewriter systems and more particularly to automatic switching for establishing and maintaining connections in teletypewriter systems.

This application is in part a continuation of application Serial No. 223,431, filed August 6, 1938, and relates to the subject-matter and system originally disclosed in Figs. 1 to 5, inclusive, thereof, with added subject matter.

An object of this invention is to provide a system wherewith to establish automatically under control of one operator a connection between subscribers' stations over a toll line.

Another object of this invention is to furnish a teletypewriter exchange office operator with full supervision of the line of a calling and a called subscriber at the initial toll line exchange center. The teletypewriter toll exchange center will be referred to hereinafter as TWX office.

Prior to the present invention numerous types of teletypewriter switching systems have been patented, disclosed in publications or utilized in actual practice to a greater or lesser extent. In general, these fall into two classes, the first of which is the mechanical or selective type in which a calling station by some automatic means under the control of the attendant or operator at the calling station establishes connection with a remote station for one-way communication or for intercommunication. Various technical difficulties are involved in the use of such systems and, in addition, there is the further difficulty that when a charge must be made for the call some special arrangement must be made for establishing the charge. Another type of system extensively used for the giving of satisfactory service is one in which all line interconnections and disconnections are made manually by operators using suitable cord or key circuits. A feature of this type of system as generally employed is that a call involves the intervention of an operator at each switching point for setting up and disestablishing a communication circuit. Thus, in a call over a trunk the services of an operator at the calling end of the trunk as well as another operator at the called end of the trunk are engaged. This has the disadvantage of slowing up the service and also of increasing the cost thereof. In order to expedite the service and, in particular, to reduce the cost by enabling an operating routine in which a call over a single trunk engages the services of one operator only at the outgoing end of the trunk, the system herein disclosed has been devised.

A fundamental operating feature in accord-

ance with this invention is that a calling subscriber's station is connected automatically by an operator at one TWX office to a desired called subscriber connected to another TWX office without the intervention of an operator at the latter office. The operator at the originating TWX office has complete control of the circuit set up and complete supervision of the lines extending to the calling and called subscribers, the trunk, and the equipment required for automatic switching. In addition, the call initiating with the TWX operator can at all times ascertain the condition of the subscribers' stations and the lines connecting these stations.

A feature of the invention is the use of a trunk which is so terminated that calls may be extended in either direction thereover.

Features of the invention are the provision of trunks terminating both in selectors and in terminals for manual connection of link circuits thereto, such as jack terminals, for example, busy tests or lamps whereby seizure of a trunk by an operator at one end renders it busy at both ends; a busy test arrangement whereby a subscriber or branch line connected to a link circuit tests busy at terminals adapted to seize it for an incoming message; an operator's link circuit containing a teletypewriter and a dial of the numerical type for remotely controlling the selection of a subscriber line; a repeated trunk which may be of the differential duplex type typifying the general case of a two-way telegraphic impulse transmission channel; a trunk which transmits dial pulses with the same marking and spacing elements as used for telegraphic communication; a trunk normally spacing in the idle condition; a trunk in which a marking condition is used to indicate a call; a trunk over which call, mark, space, break, call and recall indications or any of them may at appropriate times be transmitted; use of break limiting recall keys; an operator's cord circuit including a break limiter; a trunk including a break limiter; a trunk terminating in multiple jacks; and other useful features.

Other objects and features will be readily understood from the following description and appended claims when taken in conjunction with the accompanying drawings of which:

Fig. 1 illustrates in block diagram a teletypewriter system in which a calling station associated with a first toll, or TWX, office is connected by an operator to a called station associated with a second toll, or TWX, office, or vice versa, without the intervention of the operator at the toll,

or TWX, office nearer the called subscriber's station. A subscriber's station C is connected by means of a line to the subscriber's line equipment at TWX office A. The subscriber's line equipment is terminated in a jack at the TWX office A and is also connected to automatic switching equipment also located at the TWX office A. Trunk line equipment at the TWX office A is connected to a toll line. The automatic switching equipment is connected to the toll line equipment and serves as an automatic switching path from the toll line to the subscribers' stations connected to TWX office A when the subscribers' stations connected to TWX office A are the called stations. The toll line equipment at TWX office A terminates in a jack. A cord circuit at TWX office A serves to connect manually any subscriber's line connected to that office with the toll line equipment when the subscribers' stations, connected to TWX office A, originate the calls. The toll line connects to the toll line equipment at TWX office B. One or several repeaters, as required, are interposed in the toll line. The toll line may include carrier channels, radio channels or any usual type of duplex telegraph facility. Like the toll line equipment at TWX office A, the toll line equipment at TWX office B terminates in a jack and is connected to automatic switching equipment capable of connection with any one of several subscribers' line equipments connected to TWX office B when the subscribers' stations, connected to TWX office B, are the called stations. Both the toll line equipment and TWX office B and the subscribers' line equipments at TWX office B are provided with jacks for connection between the toll line and any subscriber's line connected to central station B. A cord circuit at the TWX office B serves to connect manually the toll line through the toll line equipment with the subscriber's line equipment at TWX office B, when the subscribers' stations connected to TWX office B originate the calls. "Subscriber's line" as used herein is a convenient designation for any line to an outlying station; operator is a name for any person who carries on the switching or other operations to which reference is made. All the parts of the system are indicated by labeled block diagrams in Fig. 1;

Fig. 2 shows the relative positions of Figs. 3, 4 and 5;

Fig. 3 shows in detail a teletypewriter subscriber's station set at station C connected to the subscriber's line equipment at the TWX office A and an operator's cord circuit for connecting the subscriber's line set to the operator's position circuit at TWX office A;

Fig. 4 shows the toll line equipment at TWX office A for connecting to the toll line the subscriber's station equipment either manually by means of the cord circuit, or automatically by means of automatic switching equipment, an intermediate repeater in the toll line and toll line equipment at TWX office B; and

Fig. 5 shows an operator's cord circuit at TWX office B for connecting the toll line equipment at the TWX office B, a subscriber's line equipment at TWX office B and a teletypewriter subscriber's set at station D directly connected to TWX office B. The teletypewriter subscriber's station set at station D is arranged for connection to the toll line equipment at TWX office B by means of the cord circuit shown in Fig. 5, or under the control of the automatic switching equipment shown in Fig. 4.

The intermediate repeater typifies any repeating means adapted to supply to each terminal the potentials indicated as available for direct supply if the repeater were omitted.

The system in Figs. 3, 4 and 5 utilizes normally open loop telegraph toll lines and may be operated with automatic signaling and full supervision. In Figs. 3, 4 and 5 is illustrated a comparatively simple form of TWX dial switching system, which may be extended to larger systems in accordance with established principles.

Station C initiates a call

A call is initiated from station C upon the operation of call key 309. The operation of this key energizes motor 306, causing it to operate during the entire time that the key is in an operated position. Key 309 in being operated also closes a circuit extending from grounded positive battery 312, conductor RA, break key 303, transmitting contacts 301, magnet 302, left spring and contact of recall and disconnect key 304, through the winding of slow-release relay 305, operated spring and contact of call key 309, tip conductor TA, left armature and contact of relay 314, outer armature and contact of relay 315, through the winding of line relay 313 to ground. Relay 313, in operating, closes an obvious circuit for lighting lamp 316. The lighting of lamp 316 indicates to the operator at TWX office A that a call is waiting on this line.

Operator answers

The operator answers by inserting a plug such as that designated 337 into jack 317, and operating the typing key 322.

Assuming that the plug has been inserted before the typing key 322 is operated, two circuits are completed, one from grounded battery 321, through lamp 320, through the winding of relay 329, sleeve conductors of plug 337 and jack 317, through the winding of cut-off relay 314, inner armature and back contact of relay 315, to ground. This circuit lights lamp 320 and operates relays 329 and 314. Relay 314, in operating, disconnects at its right armature, relay 315 from its associated terminal on the lower bank 427A of a rotary selector switch and applies ground to that terminal making the line busy to incoming calls. At its left armature and front contact, relay 314, in operating, completes a circuit extending from grounded positive battery 312, through station C, the left armature and front contact of relay 314, tip conductors of jack 317 and plug 337, through the winding of relay 332, to grounded negative battery 307. Relay 332, in operating, closes an operating circuit for relay 330. Relay 330 operates and at its inner make-before-break contact removes grounded negative battery 307 from the subscriber's line and replaces it by grounded negative battery 340, via the contacts of relays 329, 338 and 323. Relay 330, in operating, connects at its left-hand armature and contact an interrupter 333, via the lower and the upper make-before-break contact of relay 331, in shunt across lamp 320. At each closure of the interrupter, lamp 320 will be extinguished and on each opening it will light. This flashing of lamp 320 is an indication that key 322 has not been operated.

When the operator operates key 322, which is assigned to the cord circuit shown in detail, it will operate relay 323. Relay 323, in operating, will insert the operator's teletypewriter set consisting of magnet 326, transmitting and receiving

equipment 324 and dial 325 in series with the subscriber's line in place of resistance 305. Relay 323, in operating, also operates relay 331. Relay 331, in operating, cuts off at its lower armature interrupter 333 and locks up through its upper winding, its upper and lower armatures and front contacts, and the armature and contact of relay 330 to grounded battery 321 thereby applying a permanent shunt across lamp 320. By shunting lamp 320, the lamp is extinguished as long as relays 330 and 331 are operated, and also after key 322 is released.

If key 322 was operated before plug 337 was inserted into jack 317, relay 331 would have been operated and interrupter 333 would not have been cut in.

The operator may have at her disposal a number of cord circuits, but the operator's set can be cut in only on one circuit depending upon which one of keys 322, 327, 328, etc., is operated.

The operator indicates her answer and presence on the circuit to the calling subscriber C by typing "OPR" and subscriber C then types the code number of the desired subscriber's station which number appears at the operator's teletypewriter set.

Operator completes to a toll line

Assuming that the called party is in a distant city, the operator inserts plug 335 into a trunk jack of an idle trunk, such as jack 401A, which terminates a trunk circuit extending to another TWX office to which the called party's station is connected. Repeater relays 403A, 405A, 406A, 407A, 403B, 405B, 406B and 407B are differential polar relays and are normally held, in their idle condition, that is, on their spacing contacts, as shown, by current in their lower windings, the voltage polarity and direction of the flow being such as to hold them in the spacing positions.

When plug 335 is inserted in jack 401A, an operating circuit for relays 402A and 338 is closed from ground on back contact and upper armature of relay 413A, through the winding of relay 402A, sleeve conductors of plug 335 and jack 401A, through the winding of relay 338 to grounded battery, causing relays 338 and 402A to operate. Relay 402A, in operating, closes a circuit from grounded battery, through lamp 339, ring conductors of plug 335 and jack 401A, innermost upper armature and contact of relay 402A, back contact and armature of relay 415A, to ground. This latter circuit will cause lamp 339 to light to indicate that the line has been connected through but that the answering equipment has not as yet been associated. Relays 338 and 402A, being operated, will extend the communication circuit of the subscriber's station C through the upper winding of relays 403A and 405A, armature and spacing, or right, contact of relay 406A and armature and spacing, or right, contact of relay 403A to grounded negative battery. The communication circuit, which has grounded positive battery 312 connected to it at station C, will when closed cause relays 403A and 405A to move to their respective marking, or left, contacts. At the left contact of relay 403A, grounded negative battery 450 will again be established for holding operated relays 403A and 405A, via the upper armature and back contact of relay 404A, through the winding of relay 409A, lower armature and back contact of relay 410A to negative grounded battery 450. Relay 409A will operate and maintain open the operating circuit for relay 410A. Relay 410A might have operated previous to this

but its operation would not affect the operation of relays 403A and 405A and upon the operation of relay 409A, relay 410A would release. Relays 409 and 410 are brought into use in an established communication circuit so as to reduce the continuance of long spacing signals received from the direction of the called station over the toll line to one-half second. Relay 410A may be operated inadvertently on a slow plug-in by the initial incoming spacing signal but this is of no moment as relay 409A operates in response to the release of relay 403A, and relay 403A remains released, so as soon as relay 410A releases, open signals can be sent from the cord circuit to relays 405A and 403A.

Signal reaches office D

The operation of relay 405A to its left, or marking, contact applies grounded negative battery to the line via the upper winding, in series, of relays 406A and 407A, repeater 408, the upper winding, in series, of relays 407B and 406B to meet grounded positive battery on the spacing, or left, contact of relay 405B, thus causing relays 406B and 407B to move to their respective marking, or right, contacts. Relay 415B will operate via a circuit to ground through the lower windings, in series, of relays 403B and 405B.

Relay 415B, in operating, will operate relay 404B via the lower armature and contact of relay 402B. Relay 404B will remain operated during "break" signals, i. e., unless a spacing signal of over one-half second duration is received from office A, that is, a disconnect signal, since both relays 415B and 404B are of the slow-to-release type and the time required for these relays to release in succession is such that they will hold 413B operated for any break which the calling subscriber can produce. Relay 404B may be of a very slow-release type.

Relay 404B, in operating, will by its upper armature and front contact apply grounded positive battery to the marking, or right, contact of relay 403B and will also maintain open the operating circuit for relay 409B. At its lower armature and contact, relay 404B will operate relay 413B. Relay 413B, in operating, will apply at its upper armature and front contact, grounded negative battery to a circuit extending through the winding of relay 402B to the sleeve conductor of jack 401B, thereby making the sleeve busy, that is, jack 401B is busy to the operator at office B. Also, relay 413B, in operating, will condition at its inner lower armature and contact the dialing circuit which, during dialing, will extend from ground, armature and spacing contact of relay 407B, conductor 434, contact and inner lower armature of relay 413B, conductors 435 and 436, outer lower armature and contact of relay 419B, outermost lower armature and back contact of relay 430B, through the winding of relay 418B, through the winding of stepping magnet 417B of the banks 416B and 427B of a rotary selector switch at office B, to grounded battery. Also, relay 413B, in operating, will at its middle armature and front contact close an operating circuit for busy lamp 411B and maintain open the operating circuit for release magnet 429B, the latter circuit extending over off-normal contacts 428B of the rotary selector switch. Another function of relay 413B, when operated, is to close at its lowermost armature and contact the called station loop to grounded positive battery, thereby causing relays 403B and 405B to operate to their respective marking positions due to current now

flowing in their upper windings. The release of relay 405B sends back a negative voltage or marking signal to office A and relays 407A and 406A operate to marking position due to the flow of current in their respective upper windings. Relay 406A, upon releasing, causes the release of relay 409A and relay 410A consequently operates to prepare the limited time "break circuit" to function on the next long spacing signal received from the direction of the cord circuit of Fig. 3. Slow-release relay 415A operates and thereby extinguishes cord lamp 339, as a signal to the operator at office A that the equipment is prepared to receive the dialing pulses. The operator at office A could dial with lamp 339 lighted, that is, against the original space signal, since the operated 409A and released relay 410A have provided marking instead of spacing battery toward the selected cord circuit at office A in spite of the incoming space signal received from the toll line.

Dialing

It is not necessary to give the operator at office A a dialing signal since the very fact that the operator has possession of an idle trunk gives her complete control over all required apparatus as no other apparatus need be brought into play. Each trunk is equipped at the receiving teletypewriter exchange office with a conventional dial controlled selector switch, a ten point rotary selector switch consisting of banks such as those designated 416B and 427B, a stepping magnet such as that designated 417B, an off-normal contact such as that designated 428B and a release magnet such as that designated 429B being illustrated. The operator at office A dials by moving her dial 325 off-normal to the number required. The upper contacts of the dial will operate relay 326 which will split the cord circuit, applying grounded negative battery to the subscriber's line and grounded positive battery to the trunk, thus preventing the dialing pulses from interrupting or affecting the subscriber's circuit at station C. Relay 326 will remain operated until the dial returns to normal.

The automatic return of the dial to normal will cause a train of pulses, consisting of openings and closures, to be transmitted over the trunk thereby operating relays 403A and 405A, in accordance with the pulses. Relay 405A, in operating, in accordance with the pulses causes relays 407B and 406B to operate in accordance with the pulses. Relay 406B, in operating, in accordance with the pulses will not affect relay 415B inasmuch as the latter relay is of the slow-to-release type. Relay 415B will, therefore, remain operated during the reception of the train of pulses. The first open pulse, causing relay 407B to go to its spacing, or left-hand, contact, will complete a circuit from ground on the armature of relay 407B in engagement with its left-hand contact, conductor 434, contact and inner lower armature of relay 413B, conductors 435 and 436, outer lower armature and contact of busy relay 419B, outermost lower armature and contact of relay 430B, through the winding of relay 418B, through the winding of stepping magnet 417B to grounded battery. Relay 418B operates in response to the first opened pulse and will, therefore, lock up in a path which shunts the outer lower armature and contact of relay 419B and the outermost lower armature and contact of relay 430B. Relay 418B is of the slow-to-release type and will, therefore, hold over for the duration of the train of pulses. Relay 418B, in op-

erating, will close an obvious operating circuit for relay 449B, which is also of the slow-to-release type and will remain operated for the duration of the train of pulses. Relay 449B, in operating, will open at a second point the circuit for operating relay 430B and will condition the circuit for operating busy relay 419B which is opened at relay 418B.

The train of pulses will operate stepping magnet 417B a successive number of times corresponding in number to the pulses of each train. The successive operation of stepping magnet 417B causes the wipers of banks 427B and 416B to rotate one step for each pulse. Now if it is assumed that there is transmitted a train of five pulses, the wipers of banks 427B and 416B will be on terminals No. 5 of their respective banks at the end of the train, and the final closure of the line circuit after the train of pulses has been transmitted, will cause the armature of dialing relay 407B to remain engaged to its right-hand contact, thereby opening both the operating and the holding circuits for relay 418B. Slow-release relay 418B after a short time will release thereby opening the operating circuit for relay 449B, which being also slow to release is subsequently released. The line which terminates on terminals No. 5 of switch banks 416B and 427B is multiplied, as indicated, to the corresponding terminals of other switch banks, not shown but respectively associated with other trunk circuits of the system.

Called line busy

If the called line, that is, the line which terminates on terminal No. 5 of switch banks 427B and 416B is busy, ground will be present on conductor 540 because of the operated condition of cut-off relay 514. When stepping magnet 417B releases after the last pulse of a train and the release of this magnet is followed shortly by the release of relay 418B, a circuit is closed extending from ground on conductor 540, wiper in engagement with terminal No. 5 of bank 427B, contact and armature of stepping magnet 417B, contact and lower armature of relay 449B, outer upper armature and contact of relay 418B, contact and next to the outermost lower armature of relay 430B, through the winding of busy relay 419B to grounded battery. Busy relay 419B, whose function is to cause a busy signal to be sent back to the office A, operates and at its contact and inner lower armature closes for itself a locking circuit extending to ground at the outer lower armature and front contact of relay 413B. Busy relay 419B, in operating, connects at its upper armature and contact, grounded positive battery through interrupter 420B, conductor 438, back contact and outer upper armature of relay 430B, conductor 439, through the upper windings, in series, of relays 403B and 405B, armature and right-hand contact of relay 406B through the winding of relay 415B to grounded negative battery. Alternate open and closed pulses are therefore being transmitted by the armature of relay 405B, through the upper windings, in series, of relays 406B and 407B, through the intermediate repeater 408, through the upper windings, in series, of relays 407A and 406A to the armature and left contact of relay 405A to grounded negative battery. Relay 406A, upon operating its armature to its right-hand position, closes an operating circuit for relay 409A which extends from grounded positive battery at the front contact and lower armature of relay 410A,

through the winding of relay 409A, back contact and upper armature of relay 404A, left contact and armature of relay 403A, right contact and armature of relay 406A, through the lower windings, in series, of relays 405A and 403A to ground. Relays 406A and 409A operate for an interval sufficiently long, as determined by the cuttings of interrupter 420B, to permit slow-release relays 410A and 415A to release. These alternate open and closed pulses are greater than one-second duration and are sufficient to release relay 415A after each closed pulse. The alternate operation and release of relay 415A causes the alternate opening and closing of the operating circuit for supervisory lamp 339 so that the lamp gives a flashing signal to the operator at office A.

This flashing lamp is an indication to the operator at office A that the called subscriber's line is busy. The operator then notifies the calling subscriber at station C who, upon receiving such information, will disconnect. The operator then removes plug 335 from jack 401A. The plug may be removed from the jack during either a closure or an opening of the circuit of interrupter 420B. If the line is closed the removal of plug 335 will effect the release of relays 402A and 338. The release of relay 338 will close the line circuit extending to subscriber's station C and the operator will receive a disconnect signal from the subscriber at calling station C in a manner to be hereinafter described. The release of relay 402A will open the upper winding of relays 403A and 405A whereby relays 403A and 405A will operate to their respective space, or right, positions. The application of grounded positive battery by the armature of relay 405A to the trunk circuit will cause relays 406B and 407B to operate to their respective space, or left, positions. The operation of relay 406B to its space position will cause the release of relay 415B which in turn will release relay 404B. Relay 404B, in releasing, will operate relay 409B in a circuit traceable from grounded negative battery, back contact and lower armature of relay 410B, through the winding of relay 409B, back contact and upper armature of relay 404B, mark, or right, contact and armature of relay 403B, space, or left, contact and armature of relay 406B, through the upper and lower windings, in parallel, of relays 405B and 403B, the path including the upper windings being extended over conductor 439 to the outer upper armature and back contact of relay 430B, conductor 438, upper armature and contact of relay 419B, interrupter 420B to grounded positive battery. The release of relay 404B releases relay 413B also. Relay 413B, in releasing, removes at its upper armature the grounded battery from jack 401B which battery had heretofore served as an indication to the operator at office B that the trunk circuit shown in Fig. 4 was busy. Also relay 413B, in releasing, opens at its outer middle armature and front contact the locking circuit for busy relay 419B, which releases to thereby remove interrupter 420B. Also relay 413B, in releasing, will close at its middle lower armature and back contact an operating circuit for release magnet 429B which circuit extends over the closed contacts of off-normal switch 428B. Release magnet 429B, in operating, causes the wipers of rotary selector switch banks 416B and 427B to return to normal and the off-normal switch 428B is thereby also restored to normal in which position the contacts are opened. The removal of interrupter 420B, whereby relays 406B

and 407B were operated periodically to their spacing positions, will result in grounded negative battery being applied to the lower winding of relays 403B and 405B and the latter relays will consequently operate to their respective spacing, or left, positions. The operation of relay 403B to its spacing position will cause the release of relay 409B. The operation of relay 405B to its spacing position causes relays 406A and 407A to operate to their respective spacing, or right, positions, thereby releasing relays 415A and 404A. Relay 413A then releases. Relay 402A, in releasing, extinguishes busy lamp 411A and the release of relay 413B extinguishes lamp 411B. The circuit is now normal.

If the line is open when plug 335 is removed from jack 401A, the same procedure as just described will be followed except relays 403B and 405B will not have to wait for the removal of interrupter 420B, to operate to their respective spacing, or right, positions.

Called line idle

If the called line is idle grounded negative battery 518 will be present on a circuit including the winding of relay 515, back contact and left armature of relay 514, conductor 540, terminal No. 5 of switch bank 427B at the time the wipers of the rotary selective switch are operated to their respective No. 5 terminals. When therefore relay 418B releases at the end of the train of dialing pulses, busy relay 419B will not operate. When relay 449B releases subsequent to the release of relay 418B and stepping magnet 417B a circuit is closed extending from ground at the middle lower armature and front contact of relay 413B, inner lower armature and back contact of relay 419B, through the lower winding of relay 430B, contact and upper armature of relay 449B, contact and armature of stepping magnet 417B, wiper in engagement with terminal No. 5 of switch bank 427B, conductor 540, left armature and back contact of relay 514 through the winding of relay 515 to grounded battery. Relay 515 operates and connects at its front contact and inner left armature grounded negative battery to a circuit extending through winding of cut-off relay 514 to the sleeve conductor of jack 517 whereby the line circuit of subscriber's station D is provided with a busy potential upon the sleeve of the jack. Relay 430B operates and closes at its inner upper armature and contact a locking circuit for itself, which extends to ground at the middle lower armature and front contact of relay 413B. Relay 430B, in operating, will at the next to its innermost lower armature and contact apply ground to terminal No. 5 of switch bank 427 thereby making the terminal busy to other calls and serving as a holding ground for operating relay 515. The operation of cut-off relay 514 opens the line circuit to line relay 513 thereby preventing the lighting of the call lamp for the line of subscriber's station D. Also, relay 430B, in operating, will at its innermost lower armature and contact close a circuit extending from ground, interrupter 441B, innermost lower armature and contact of relay 430, outer lower armature and contact of relay 433B, through the winding of ringing relay 432B to grounded battery. Relay 432B alternately operates and releases in response to interrupter 441B and thereby applies at its armature and contact ringing current to a circuit extending over the wiper in engagement with terminal No. 5 on selector switch bank 416B, conductor 541, over the normally

closed contact of switch 509 to ringer 510. The ringer 510 will be actuated intermittently to notify the subscriber at station D that an incoming call is on the line.

Subscriber answers

When the subscriber at station D answers by operating key 509 and during the non-ringing interval of interrupter 441B a circuit is closed from grounded positive battery 542, through the apparatus at subscriber's station D, conductor 541 connected to terminal No. 5 in engagement with wiper of bank 416B, armature and back contact of relay 432B, through the upper winding of relay 433B, outer upper armature and front contact of relay 430B, through the upper winding, in series, of relays 403B and 405B, armature and right-hand contact of relay 406B, through the winding of relay 415B to grounded negative battery. Relay 433B operates and closes at its inner upper armature and contact a locking circuit for itself, extending to ground at the outer lower armature of relay 413B. Relay 433B, in operating, will at its outer lower armature and contact open the operating circuit for ringing relay 432B and thereby cut off the ringing. The closing of the subscriber's line of station D will energize the upper windings of relays 403B and 405B which will operate to their respective marking, or right, positions, causing in turn, relays 406A and 407A to operate to their respective marking, or left, positions. Relay 406A, in its marking position, will operate relay 415A. Relay 415A, in operating, opens a circuit extending from ground, upper armature and back contact of relay 415A, contact and innermost upper armature of relay 402A, ring conductors of jack 401A and plug 335, through lamp 339 to grounded battery and lamp 339 is therefore extinguished. Relay 406A, in operating to its marking position, will at its spacing, or right, position open the operating circuit for relay 409A. Relay 409A releases and thereby closes at its armature and contact the operating circuit for relay 410A. Relay 410A, which is of the slow-to-release type to the amount of one-half second, operates. The connection is now complete and communication may take place from subscriber at station C to subscriber at station D. The operator at office A retires by restoring key 322.

Transmission

The method of transmission is of a well-known type and will not be described here. Subsequent spaces of telegraph code or subscribers' "breaks" proceeding from the direction of office B will cause relay 409A to release but relay 410A will remain operated to apply positive battery space signals back to the direction of station A or the calling line of station C. However, a long "recall" or "disconnect" space from the direction of the called subscriber of station D will allow relay 410A to release in about one-half second and limit such spacing signals to one-half second duration toward the calling line. The release of relay 415A at the end of a long break signal will light supervisory lamp 339 but the light will go out again on closure of the break and, moreover, the relay may be of a design as slow as desired.

Telegraph code and short break signals from the calling subscriber are repeated by relays 403A, 405A, 407B and 406B, but longer open line signals employed for disconnect or recall coming from the direction of station C are prevented

from continuing on the trunk circuit beyond station A after one-half second by the release of relay 330 in the cord circuit, which relay releases to close the calling loop toward the toll line. Relay 330, upon releasing, also removes the shunt path closed at its left-hand armature and contact and permits lamp 320 to light. If the subscriber recalls, the reoperation of relay 330 will now shunt lamp 320 intermittently as a recall in the well-known manner. Relay 331 which cooperates in providing the recall is also slow to release since relay 332 and hence relay 330 may be released not only by the calling subscriber but by called subscriber "breaks" as well; relay 331 protects the long signal until relay 410A has had an opportunity to release and reclose the calling loop. In other words, if a break is received from station D upon a call originated at station C, the release time of relay 330 should be longer than that of relay 410A so that upon a break proceeding from station D it is limited at relay 410A to a shorter time than it would be limited at relay 330 so that disconnect lamp 320 is not lighted to give an erroneous indication of a disconnect from station C. A desirable but not absolutely essential condition, therefore, is that relays 330 and 530 may require more release time by an ample margin than all relays 410A and 410B. Such relative times of one second and one-half second have been assigned whereas the sum of the releasing times of relays 415B and 404B may be above one second.

The relays 409 and 410 are not required to function and do not function to limit "breaks" on the inward end of a toll line, as the relay corresponding to those designated 332, 532, etc. and the relay corresponding to those designated 330, 530, etc. in the cord circuit restrict the duration of the calling subscriber's "breaks." The disconnect signal sent by the "A" operator, that is, the operator at the outgoing end of the connection, need not be and is not limited. The operation of the relay corresponding to relays 404A, 404B, etc., therefore, disconnects the armatures of relays 410A or 410B, respectively, and its sources of potential from the associated line and substitutes positive, or spacing, battery for retransmission of all spacing signals received from the toll line to the called loop subscriber.

Calling subscriber disconnects

The calling subscriber can disconnect by restoring key 309 to normal. The restoration of key 309 to its normal position will open the operating circuit for motor 306 and remove grounded positive battery 312 from the line circuit, whereby relay 332 is deenergized after a time interval of one second. Relay 332, in releasing, will open the operating circuit for relay 330 which also releases. Relay 330, in releasing, will split the line at its right-hand armatures so that the subscriber's loop is maintained closed at the inner right make-before-break contact of relay 330 to grounded negative battery 307 and the tip conductor of the trunk circuit is maintained closed at the outer right make-before-break contact of relay 330 to grounded positive battery 307. Also, relay 330, in releasing, opens at its left armature contact the locking circuit for relay 331, thereby causing lamp 320 to light in a circuit to grounded negative battery 321 to lamp 320 through the winding of relay 329, sleeve conductors of plug 319 and jack 317 through the winding of cut-off relay 314 to ground at the inner left armature and back contact of relay 315. The lighting

of lamp 320 at this time notifies the operator at office A that the subscriber at station C has disconnected.

Calling subscriber recalls

If the subscriber at station C desires to recall the operator at office A before plug 339 is removed from jack 317, the subscriber reoperates 309 and relays 332 and 330 will operate in sequence, as heretofore described, and relay 331 will not reoperate because at this time relay 323 is released and typing key 322 is in its normal position. The operation of relay 330 at a time when relay 331 is released closes a shunt path around lamp 320, said path extending from grounded negative battery 334, interrupter 333, lower make-before-break contact of relay 331, contact and left-hand armature of relay 330, upper make-before-break contact of relay 331, resistance 308 which is of a comparatively low value, through the winding of relay 329, sleeve conductors of plug 337 and jack 317, through the winding of relay 314 to ground at the inner left armature and back contact of relay 315. The shunt path to grounded negative battery 334 extinguishes lamp 320 during the intervals of closed circuit effected by interrupter 333 and lighted during the open interval thereby causing lamp 320 to flash. The operator at office A observing the flashing of lamp 320 will operate key 322 to close the operating circuit for relay 323. Relay 323, in operating, closes the operating circuit for relay 331 which now operates to extinguish lamp 320 and the subscriber's teletypewriter set at station C is connected as heretofore described to the teletypewriter set of the operator at office A.

Called subscriber disconnects

The called subscriber at station D can disconnect by restoring key 509 to normal whereby grounded positive battery 542 is disconnected from conductor 541 and a trunk circuit including the wiper in engagement with terminal No. 5 on switch bank 416B, armature and back contact of relay 432B, winding of 433B, front contact and outer upper armature of relay 430B, conductor 439, upper windings, in series, of relays 403B and 405B, armature and right contact of relay 406B, winding of relay 415B, and grounded negative battery. Relays 403B and 405B release to their respective spacing, or left, positions. Relay 405B in releasing to its left-hand position connects grounded positive battery to a circuit extending over the upper windings, in series, of relays 406B and 407B, intermediate repeater 408, upper windings, in series, of relays 407A and 406A, armature and marking, or left, contact of relay 405A to grounded negative battery. Relays 407A and 406A release to their respective spacing, or right, positions. Relay 406A closes an operating circuit for relay 409A extending from grounded positive battery 450, front contact and lower armature of relay 410A, through the winding of relay 409A, back contact and upper armature of relay 404A, marking, or left, contact and armature of relay 403A, spacing, or right, contact and armature of relay 406A, through the biasing windings, in series, of relays 405A and 403A. Relay 409A operates and relay 410A releases in about one-half second. Relay 409A, in operating, opens the operating circuit for relay 410A and the latter relay releases; upon its release it extends marking battery toward the cord circuit of Fig. 3 to prevent relay 330 from releasing at this time. Relay 75

406A, in operating to its spacing, or right, position opens the operating circuit for relay 415A which releases to close at its armature and back contact an operating circuit for lamp 339, which circuit extends over the contact and innermost upper armature of relay 402, ring conductors of jack 401A and plug 335, through lamp 339 to grounded negative battery. Lamp 339 lights to indicate to the operator at office A that the subscriber at station D has disconnected. The release of relay 410A prepares for the extinguishment of trunk busy lamp 411A upon removal of plug 335 from jack 401A.

Called subscriber recalls

The called subscriber at station D may reoperate switch 509 or he may have used recall key 504 which restores a marking condition before the operator at office A has removed plug 335 from jack 401A and thereby connects grounded positive battery 542 through the subscriber's teletypewriter apparatus at station D, conductor 541 to the trunk circuit which extends over the armature and back contact of relay 432 through the upper winding of relay 433, front contact and outer upper armature of relay 430B, conductor 439, through the upper windings, in series, of relays 403B and 405B, armature and marking, or right, contact of relay 405B, through the winding of relay 415B to grounded negative battery. Relays 403B and 405B operate to their respective marking, or right, positions and subsequently effect the operation of relays 407A and 406A to their respective marking, or left, positions. Relay 406A in operating to its marking position reoperates relay 415A to extinguish lamp 339. The subscriber at station D in sending a recall signal may alternately operate and release key 509 to thereby cause lamp 339 to flash indicating to the operator at office A that a recall signal is being transmitted by the subscriber at station D. More properly he should use key 504 for recalling which automatically recloses the line after a short interval.

Operator disconnects

The "A" operator at office A recognizes a disconnect signal by removing plug 335 from jack 401A. Relays 403A and 405A operate to their respective spacing, or right, positions and, consequently, relays 406B and 407B operate to their respective spacing, or left, positions. The operation of relay 406B to its spacing position opens the operating circuit for relay 415B which releases. Relay 415B, in releasing, opens the operating circuit for relay 404B which in turn releases. Relay 404B, in releasing, opens at its lower armature and contact, the operating circuit for relay 413B which releases and causes at its outer lower armature and front contact, the opening of the locking circuits for relay 430B and relay 433B. Relays 430B and 433B are released. Relay 413B, upon releasing, closes at its outer lower armature and back contact an operating circuit for release magnet 429B which, in operating, causes the wipers in engagement with terminals No. 5 on switch bank 416B and 427B, respectively, to return to normal. When the wipers of the rotary selective switch return to normal the off-normal contact 428B automatically closes. Relay 406B upon being released, that is, operated to its spacing, or left, position, closes a circuit extending from grounded negative battery, the back contact and lower armature of relay 410B, through the winding of relay 409B, back contact and upper armature of relay

404B, spacing, or right, contact and armature of relay 403B, spacing, or left, contact and armature of relay 405B through the lower windings, in series, of relays 405B and 403B to ground. Relays 405B and 403B release, that is, operate to their respective left-hand positions. The operation of relays 405B and 403B to their left-hand positions operates relays 405A and 406A to their spacing, or right-hand, positions and the circuit is again normal.

Cut-off

If the "A" operator at office A should, in error, disconnect at the toll line end of the cord circuit, that is, by withdrawing plug 235 from jack 401A, the disconnection would become effective after an interval of about one-second duration and the called subscriber's connection would then be transferred to the "A" switchboard associated with the called subscriber's station D and appear as a call by operation of relay 529 and lighting of lamp 516. Jack 517 represents the calling and answering jack at "A" switchboard for subscriber's station D.

A cut-off towards the calling subscriber, that is, by withdrawing plug 337 from jack 317 would be displayed at the originating operating position and could be detected immediately.

Reseizure of toll line before previous disconnection is effective

The busy lamp 411A at the outgoing end of a toll line will register idle, that is, become extinguished, as soon as the cut-off relay 402A and relay 410A have released, usually an interval of time of one-second duration after the physical disconnection, while the incoming end of the same toll line will not be free for another second. A reseizure during this interval would block the release of the previous connection.

The outgoing jack, such as jack 401B, which is used only when the call is originating at station D, is definitely guarded against intrusion until the toll line equipment at TWX office A which is in operated condition due to a previous call originating at station C is free.

Double seizure at same end of toll line

In the event that two operators simultaneously seize one and the same trunk at the same terminal and proceed to dial a wrong number or other error may result. The operators or the subscribers would quickly become aware of this condition and the subscribers would recall or the operators would correct the situation without notice; in a small board such an event would not occur.

Double seizure at opposite ends of toll line

In this case the calling supervisory lamps at the switchboard positions of the operators who are establishing calls at opposite ends of the toll line simultaneously would be extinguished instantly and stay extinguished until one or both operators withdrew their respective calling plugs whereupon normal conditions would again prevail. Such should be a rare occurrence because common practice requires selection of an idle trunk from the lowest number in a sequence at one terminus and a reverse sequence at the other terminus.

A call originating at station D

If the subscriber at station D desires to call and establish a connection with a subscriber's station C which is connected to TWX office A, the operation of the system is identical to that

heretofore described. In that event, the operator at TWX office B answers the call by means of a cord circuit shown in Fig. 5 which is identical with the cord circuit shown in Fig. 3. The parts of the cord circuit shown in Fig. 5 and numbered with the prefix "5" correspond to and have the same functions as those of the cord circuit shown in Fig. 3 having the prefix "3." If the subscriber at station D is the calling subscriber, the toll line equipment located at TWX office B operates in the same manner as the toll line equipment located at TWX office A in the call heretofore described in which the subscriber's station C was the calling station. The toll line equipment located at TWX office B is identical to that located at TWX office A. Similar parts of the toll line equipment shown in Fig. 5 have the same numerals with a suffix "A" or "B" to correspond to the TWX offices A and B, respectively. When the subscriber at station D calls the subscriber at station C the call is established without the intervention of the operator at TWX office A, the call being established from TWX office A by means of the automatic switching equipment as herebefore described for a call being established in the opposite direction when the automatic switching equipment at TWX office B functions.

Teletypewriters used in a system of this kind may be of conventional start-stop character. A calling subscriber should not transmit breaks of over one-half second as this would produce a disconnect indication but breaks generated by the recall key 304 are automatically limited. No break long enough to disconnect a switch can pass from a cord circuit into a trunk circuit from a calling subscriber because of the break limiting effect of relay 330. Breaks from called subscribers may be of any length and will produce recall or disconnect indications but because of the break limiting effect of relay 410A upon signals passing the calling end of a trunk will not effect relay 332 long enough to cause the release of relay 330. The supervisory operator's machine need not transmit breaks and no break key therefor is shown. By special instruction a called subscriber will recognize the desirability of sending only limited breaks in order to prevent the production of false supervisory signals. Repeated short breaks may be used with the same general effect upon a sending correspondent as an undesirable and unused long break. The system is guarded throughout against initiating the improper disconnection of a switch by breaks sent from break keys normally provided.

What is claimed is:

1. A printing telegraph exchange system comprising a plurality of groups of subscribers' telegraph stations, printing telegraph signal transmitting and receiving mechanism at each of said stations, a plurality of switching offices, break signal limiting means at each of said offices, a trunk circuit interconnecting said switching offices, a normally deenergized line circuit connected between each of the stations of one of said groups and one of said switching offices, a normally deenergized line circuit connected between each of the stations of the other of said groups and another of said offices, means controlled from either of said offices for establishing a connection for communication purposes between a station of one of said groups and a station of the other of said groups over said trunk circuit, and means at one of said switching offices for through supervision, independently of the other of said offices, of a connection between a station

of one of said groups and a station of the other of said groups.

2. A printing telegraph exchange system comprising a plurality of groups of subscribers' telegraph stations, printing telegraph signal transmitting and receiving mechanism at each of said stations, means in said mechanisms for sending normal break signals, a plurality of switching offices, a trunk circuit interconnecting said switching offices, a normally deenergized line circuit connected between each of the stations of one of said groups and one of said switching offices, a normally deenergized line circuit connected between each of the stations of the other of said groups and another of said offices, means controlled from either of said offices for establishing a connection for communication purposes between a station of one of said groups and a station of the other of said groups over said trunk circuit, means at one of said switching offices for through supervision, independently of the other of said offices, of a connection between a station of one of said groups and a station of the other of said groups, and break signal limiting means comprising a slow-release relay at each of said stations and said switching offices for automatically regulating the duration of an open period in an energizing one of said line circuits before disconnect and recall signals become effective.

3. A printing telegraph exchange system comprising two switching offices arranged to be used interchangeably for outward and inward toll calls, a toll line circuit normally in spacing condition at each terminus interconnecting said offices, groups of printing telegraph stations, a calling device and a printing telegraph signal transmitting and receiving mechanism at each of said stations, a plurality of line circuits for respectively connecting said stations of one of said groups to one of said offices, a second plurality of line circuits for respectively connecting the stations of the other of said groups to the other of said offices, a dialing and a printing telegraph signal transmitting and receiving mechanism at each of said switching offices; means at each of said switching offices for indicating the operation of said calling device of any one of said stations of its associated group, means at each of said switching offices for interconnecting a line circuit extending from any one of the stations of one group at which the call originates and said toll line circuit whereby said printing telegraph signal transmitting and receiving mechanism at the calling station is connected to the dialing and printing telegraph signal transmitting and receiving mechanism at one of said switching offices conditioned for an outward call, a switching device at each of said switching offices, and means included in the switching device at said switching office conditioned for an inward call, adapted in response to the operation of the dialing mechanism at said office conditioned for an outward call to complete a connection for communication purposes to any one of the line circuits extending to a station in said other group.

4. A printing telegraph exchange system comprising two switching offices arranged to be used interchangeably for inward and outward toll calls, a normally energized toll line circuit interconnecting said offices respectively arranged for inward and outward toll calls, groups of printing telegraph stations, a calling device, and a printing telegraph signal transmitting and receiving mechanism at each of said stations, a plurality of

normally deenergized line circuits for respectively connecting the stations of each of said groups to its associated one of said offices, manually operated means at one of said offices conditioned for an outward call for interconnecting any one of said normally deenergized line circuits of one group and said normally energized toll line circuit, an automatically operated switch at said office conditioned for an inward call, said automatically operated switch including means responsive to the operation of the calling device at said office conditioned for an outward call for connecting said normally energized toll line circuit to one of said normally deenergized line circuits extending to one of the stations of the other group, and means at one of said offices conditioned for an outward call for supervising the complete connection between the two interconnected stations of different groups.

5. A printing telegraph exchange system comprising a switching office, a second switching office, a trunk channel interconnecting said offices, a group of printing telegraph stations connected to each of said switching offices, means in one of said switching offices for establishing a connection between any one of said stations of one group and any one of said stations of another group over any one of said trunk channels, means in one only of said switching offices for supervising any one connection established between any two stations of different groups, and a "break" limiting device included in a connected channel of transmission between said stations to prevent the release of said connection by "break" or spacing conditions of long duration.

6. A printing telegraph exchange system comprising a toll line switching office, a second toll line switching office, toll lines interconnecting said offices, a group of printing telegraph stations connected to each of said switching offices, manually operable means in one of said switching offices and automatically operated means controllable from said one switching office but in the other of said switching offices for establishing connections between any one of said stations of one group and any one of said stations of the other group over said toll line, and means in one only of said switching offices having the manually operable means for supervising all connections established between any two interconnected stations of different groups.

7. A printing telegraph exchange system comprising a switching office, a second switching office, said switching offices including means adapted to interchange said offices for outward and inward toll calls, and equipment responsive to both inward and outward toll calls in each of said offices, said equipment for outgoing calls including a manually operated cord circuit and said equipment for incoming calls including an automatically operated selector switch, and means in one only of said switching offices for supervising all connections established upon outgoing calls between any two interconnecting stations of different groups.

8. A teletypewriter switching system comprising two central offices with an interconnecting trunk for the transmission of marking and spacing code impulses and including telegraphic impulse repeaters, subscriber lines terminating at each of said offices, signal means associated with each line to notify an operator of a call upon one of said lines, and means whereby either of said operators may extend said line over said trunk to said other office, and means including a nu-

merical code dialing device whereby said operator may transmit over said trunk dial pulses to select a required subscriber line at said other offices and connect it to said trunk thereat for telegraphic transmission between said subscriber lines.

9. In a system according to claim 8, a conductor associated with each subscriber line having a normal condition, means for establishing thereupon a busy condition, means controlled by said busy condition whereby the selection of said line as in claim 7 controls the generation of busy indicating pulses, and means for transmitting said impulses over said telegraphic impulse repeaters to the station of the calling operator, and a busy signal thereat energized by the receipt of said impulses.

10. A telegraphic system having a subscriber's line, a jack having a tip, ring and sleeve for connecting a cord circuit to said line, a tip, ring, and sleeve in said cord circuit, a plug for connecting a trunk to said cord circuit, a selector having wipers connected to said trunk and terminals connected to said line, means whereby interconnection of said line to said trunk through said cord circuit for communication is ineffective upon said selectors, a telegraphic impulse repeater in said trunk having marking and spacing conditions, and means for operating said selector from a distant point over said trunk through said impulse repeater to connect said line to said trunk.

11. In a system according to claim 10, a release means for said selector, means for causing said release means to operate comprising a path controlled by said telegraphic impulse repeater, said means being effective upon an element of said repeater assuming a spacing condition for greater than a predetermined time.

12. A printing telegraph exchange system comprising a two-way trunk equipped for transmission of telegraphic code impulses, said trunk having at each end terminals for the manual connection of a link circuit whereby a call originating line terminating at one end may be associated with said trunk through said link circuit, means in each link circuit for controlling over the trunk at the remote end of the trunk, independently of the link circuit at the remote end thereof, the connection of a line terminating at said remote end to said trunk whereby said lines are connected together for communication by telegraphic code impulses over said trunk.

13. A system for telegraphic switching of the automatic through and inward type comprising a telegraphic trunk channel of transmission, said trunk having associated therewith at each terminus thereof selective means controllable from the remote terminus to select and seize a called channel of transmission to said trunk, and a link circuit at each terminus normally disconnected from but associable with said trunk, said link circuit containing elements operable to initiate pulses to control the actuation of the aforesaid selective means at the remote terminus selectively.

14. A system for telegraphic switching of the automatic through and inward type comprising a telegraphic trunk channel of transmission, said trunk having associated therewith at each terminus thereof selective means controllable from the remote terminus to select and seize a called channel of transmission to said trunk, and a link circuit at each terminus normally disconnected from but associable with said trunk, said link circuit comprising means for associating a channel of transmission with said trunk for in-

tercommunication independently of the selective means at the trunk terminus adjacent said link circuit, said link circuit containing elements operable to control the actuation of the aforesaid selective means at the remote terminus selectively.

15. A system for telegraphic switching of the automatic through and inward type comprising a telegraphic trunk channel of transmission, said trunk having associated therewith at each terminus thereof selective means controllable from the remote terminus to select and connect a called channel of transmission to said trunk, terminals including a test terminal associable with each terminus of said trunk, a link circuit associable with said terminals comprising elements operable to control the actuation of the aforesaid selective means at the remote terminus selectively, and means operable by association of said link circuit with one terminal of said trunk to create a busy condition on said test terminal at the remote terminus of said trunk.

16. A system for telegraphic switching of the automatic through and inward type comprising a telegraphic trunk channel of transmission, said trunk having associated therewith at each terminus thereof selective means controllable from the remote terminus to select and connect a called channel of transmission to said trunk, terminals including a test terminal associable with each terminus of said trunk, a link circuit associable with said terminals comprising elements operable to control the actuation of the aforesaid selective means at the remote terminus selectively, means operable by association of said link circuit with one terminal of said trunk to create a busy condition on said test terminal at the remote terminus of said trunk, and means associated with said called channel of transmission whereby connection of said link circuit thereto establishes a busy condition individual to said channel whereby the functioning of said selective means to control the selection and seizure of said channel is prevented during the continuance of said busy condition.

17. A telegraph station, a telegraph line from said station to an operator's position, a telegraphic trunk adapted for the transmission of combinations of impulses constituting codes, said line at the station of said operator's position being provided with terminals for manual connection of a link circuit therewith and with terminals upon a selector adapted for remote selective control by impulses transmitted over said trunk, and means whereby one of said terminals for manual connection is caused to test busy upon selection of said terminals upon said selector.

18. A telegraph station, a telegraph line from said station to an operator's position, a telegraphic trunk adapted for the transmission of combinations of impulses constituting codes, said line at the station of said operator's position being provided with terminals for manual connection of a link circuit therewith and with terminals upon a selector adapted for remote selective control by impulses transmitted over said trunk, and means whereby one of said terminals upon said selector has a busy test condition imposed thereupon to prevent selection of said line by said selector upon connection of said link circuit to said terminals provided for manual connection.

19. A telegraph station, a telegraph line from

said station to an operator's position, a telegraphic trunk adapted for the transmission of combinations of impulses constituting codes, said trunk having a marking and a spacing condition as defined in teletypewriter transmission but when idle being in the spacing condition, said line at the station of said operator's position being provided with terminals for manual connection of a link circuit therewith and with terminals upon a selector adapted for remote selective control over said trunk, and means whereby one of said terminals for manual connection is caused to test busy upon selection of said terminals upon said selector.

20. A telegraph station, a telegraph line from said station to an operator's position, a telegraphic trunk adapted for the transmission of combinations of impulses constituting codes, said trunk being normally changed, in the direction away from the terminus of seizure, upon seizure, from spacing to marking condition, said line at the locus of said operator's position being provided with terminals for manual connection of a link circuit therewith and with terminals upon a selector adapted for remote selective control over said trunk, and means whereby one of said terminals for manual connection is caused to test busy upon selection of said terminals upon said selector.

21. A telegraph station, a telegraph line from said station to an operator's position, a telegraph trunk having relaying telegraphic repeaters adapted for the transmission of combinations of impulses constituting codes, said repeaters being normally in spacing condition but changed in the transmission path away from the point of seizure to marking condition upon seizure, said line at the locus of said operator's position being provided with terminals for manual connection of a link circuit therewith and with selector terminals adapted for remote selective control over said trunk, and means whereby one of said terminals for manual connection is caused to test busy upon selection of said selector terminals.

22. In a printing telegraph switching system of the through and inward type in which a trunk connects central office A with central office B, subscriber lines terminating at central office A, subscriber lines terminating at central office B, an operator's link circuit at central office A by which said operator may receive telegraphic instructions to and thereupon may link a subscriber line at station A to said trunk, means operably associable with said link circuit whereby the operator at station A may control the selection of an idle subscriber line at station B and connect the same to said trunk for intercommunication with the linked subscriber line at station A, an operator's link circuit at central office B whereby a subscriber line at station B may be linked to said trunk, and means operably associated with said link circuit at central office B whereby the operator thereat may control the selection of an idle subscriber line at station A and connect the same to said trunk for telegraphic intercommunication with the linked subscriber line at station B.

23. In a printing telegraph switching system of the through and inward type in which a trunk connects central office A with central office B, subscriber lines terminating at central office A, subscriber lines terminating at central office B, an operator's link circuit at central office A by which said operator may receive telegraphic in-

structions to and thereupon may link a subscriber line at station A to said trunk, means operably associable with said link circuit whereby the operator at station A may control the selection of an idle subscriber line at station B and connect the same to said trunk for intercommunication with the linked subscriber line at station A, an operator's link circuit at central office B whereby a subscriber line at station B may be linked to said trunk, means operably associated with said link circuit at central office B whereby the operator thereat may control the selection of an idle subscriber line at station A and connect the same to said trunk for telegraphic intercommunication with the linked subscriber line at station B, and busy test means associated with said trunk at either terminus whereby the seizure thereof by an operator at the one terminus places a busy test condition upon said trunk at the other terminus.

24. In a printing telegraph switching system of the through and inward type in which a trunk connects central office A with central office B, subscriber lines terminating at central office A, subscriber lines terminating at central office B, an operator's link circuit at central office A including means by which said operator may receive telegraphic instructions to and thereupon may link a subscriber line at station A to said trunk, means operably associable with said link circuit whereby the operator at station A may control the selection of an idle subscriber line at station B and connect the same to said trunk for intercommunication with the linked subscriber line at station A, an operator's link circuit at central office B whereby a subscriber line at station B may be linked to said trunk, means operably associated with said link circuit at central office B whereby the operator thereat may control the selection of an idle subscriber line at station A and connect the same to said trunk for telegraphic intercommunication with the linked subscriber line at station B, means whereby the connection of a linking circuit to a subscriber line places a busy condition upon the subscriber line, and means whereby selection of the terminals of such "busied" line under control of the remote terminus of said trunk returns a busy indication back to said terminus.

25. In a printing telegraph switching system of the through and inward type in which a trunk connects central office A with central office B, subscriber lines terminating at central office A, subscriber lines terminating at central office B, an operator's link circuit at central office A including means by which said operator may receive telegraphic instructions to and thereupon may link a subscriber line at station A to said trunk, means operably associable with said link circuit whereby the operator at station A may control the selection of an idle subscriber line at station B and connect the same to said trunk for intercommunication with the linked subscriber line at station A, an operator's link circuit at central office B whereby a subscriber line at station B may be linked to said trunk, means operably associated with said link circuit at central office B whereby the operator thereat may control the selection of an idle subscriber line at station A and connect the same to said trunk for telegraphic intercommunication with the linked subscriber line at station B, means whereby the connection of a linking circuit to a subscriber line places a busy condition upon the subscriber line, means whereby selection of the

terminals of such "bused" line under control of remote terminus of said trunk returns a busy indication back to said terminus, and means for causing said busy signal to be cyclically and repetitiously indicated until the calling operator separates the calling link circuit from the trunk.

26. In a printing telegraph switching system of the through and inward type in which a trunk connects central office A with central office B, subscriber lines terminating at central office A, subscriber lines terminating at central office B, an operator's link circuit at central office A including means by which said operator may receive telegraphic instructions to and thereupon may link a subscriber line at station A to said trunk, means operably associable with said link circuit whereby the operator at station A may control the selection of an idle subscriber line at station B and connect the same to said trunk for intercommunication with the linked subscriber line at station A, an operator's link circuit at central office B whereby a subscriber line at station B may be linked to said trunk, means operably associated with said link circuit at central office B whereby the operator thereat may control the selection of an idle subscriber line at station A and connect the same to said trunk for telegraphic intercommunication with the linked subscriber line at station B, means whereby any called subscriber line may create an answering condition, and means whereby said condition creates an indication significant thereof to the operator at the terminus of said trunk remote from the answering subscriber.

27. In a printing telegraph switching system of the through and inward type in which a trunk connects central office A with central office B, subscriber lines terminating at central office A, subscriber lines terminating at central office B, an operator's link circuit at central office A including means by which said operator may receive telegraphic instructions to and thereupon may link a subscriber line at station A to said trunk, means operably associable with said link circuit whereby the operator at station A may control the selection of an idle subscriber line at station B and connect the same to said trunk for intercommunication with the linked subscriber line at station A, an operator's link circuit at central office B whereby a subscriber line at station B may be linked to said trunk, means operably associated with said link circuit at central office B whereby the operator thereat may control the selection of an idle subscriber line at station A and connect the same to said trunk for telegraphic intercommunication with the linked subscriber line at station B, means whereby any called subscriber by creating a disconnect condition at his station causes impulse transmission over the trunk to the far terminus thereof, a signal thereat, and means controlled by the transmitted disconnect condition to produce an indication upon the signal before the operator thereat.

28. In a printing telegraph switching system of the through and inward type in which a trunk connects central office A with central office B, subscriber lines terminating at central office A, subscriber lines terminating at central office B, an operator's link circuit at central office A having means associable therewith by which said operator may receive telegraphic instructions to and thereupon may link a subscriber line at station A to said trunk, means

operably associable with said link circuit whereby the operator at station A may control the selection of an idle subscriber line at station B and connect the same to said trunk for intercommunication with the linked subscriber line at station A, an operator's link circuit at central office B whereby a subscriber line at station B may be linked to said trunk, means operably associated with said link circuit at central office B whereby the operator thereat may control the selection of an idle subscriber line at station A and connect the same to said trunk for telegraphic intercommunication with the linked subscriber line at station B, means whereby any called subscriber by creating a disconnect condition at his station causes the transmission of impulses over the trunk to the far terminus thereof, a signal thereat, means controlled by the transmitted disconnect condition to produce an indication upon the signal before the operator thereat, and means for releasing the selected subscriber line controlled by the unlinking of the link circuit from the trunk.

29. In a printing telegraph switching system of the through and inward type in which a trunk connects central office A with central office B, subscriber lines terminating at central office A, subscriber lines terminating at central office B, an operator's link circuit at central office A including means by which said operator may receive telegraphic instructions to and thereupon may link a subscriber line at station A to said trunk, means operably associable with said link circuit whereby the operator at station A may control the selection of an idle subscriber line at station B and connect the same to said trunk for intercommunication with the linked subscriber line at station A, an operator's link circuit at central office B whereby a subscriber line at station B may be linked to said trunk, means operably associated with said link circuit at central office B whereby the operator thereat may control the selection of an idle subscriber line at station A and connect the same to said trunk for telegraphic intercommunication with the linked subscriber line at station B, an operable device at a called subscriber station, and means controllable thereby to control over the trunk the production of a recall indication before the operator at the calling terminus of the trunk.

30. In a printing telegraph switching system of the through and inward type in which a trunk connects central office A with central office B, subscriber lines terminating at central office A, subscriber lines terminating at central office B, an operator's link circuit at central office A including means by which said operator may receive telegraphic instructions to and thereupon may link a subscriber line at station A to said trunk, means operably associable with said link circuit whereby the operator at station A may control the selection of an idle subscriber line at station B and connect the same to said trunk for intercommunication with the linked subscriber line at station A, an operator's link circuit at central office B whereby a subscriber line at station B may be linked to said trunk, means operably associated with said link circuit at central office B whereby the operator thereat may control the selection of an idle subscriber line at station A and connect the same to said trunk for telegraphic intercommunication with the linked subscriber line at station B, and means whereby upon physical disconnection of a link circuit from a trunk the terminals available to an operator

at the distant terminus thereof have applied thereto a guard busy condition until the trunk including the selective means associated therewith are fully freed.

31. In a telegraph switching system, a circuit having a source of selective pulses connected with said system at one terminus thereof, circuits to be selected thereby at another terminus, selective devices for accomplishing the selection under control of the pulses, means whereby a prior busy condition may be placed upon one of the circuits, a break limiter device in said circuit for normally limiting spacing conditions sent over said system, means for sending back pulses to indicate said busy condition, and means to lock out said break limiter during such sending.

32. A system including a spacing condition limiter, a sender of supervisory signals of duration inconsistent with said limiter, and means for locking out said limiter to permit said signals to be sent.

33. A system in which a channel of telegraphic impulse transmission is established for communication from one station to another, means for sending "break" signals thereover in a given direction, a "break" limiter device for limiting "break" signals traversing said channel, and another "break" limiter device between said means

and said first "break" limiter device for limiting breaks from said means to a shorter duration than said first limiter device.

34. A system in which a channel of telegraphic impulse communication between two points may be established, a device operable by "break" signals of a certain duration upon said channel but not by normal spacing signals for changing the condition of a supervisory signal device, a means associated with said channel between said device and a potential source of "break" signals to limit break signals proceeding toward said device to less duration than said certain duration.

35. In a telegraphic impulse transmission system, a numerical dial for setting up connections, said dial being located at one terminus of a main communication path, means for actuating a selective device at a remote terminus of said path by actuation of said dial to extend said path over a selected further path of transmission, means for sending a telegraphic "break" signal from said selected path toward the station of said dial, and means controllable over said main path from the locus of said dial to release and disconnect said selected path against and during the continuance of the "break."

RAND S. BAILEY.