

Aug. 3, 1937.

C. WHITE

2,088,733

PRINTING TELEGRAPH SYSTEM

Filed Jan. 31, 1936

7 Sheets-Sheet 1

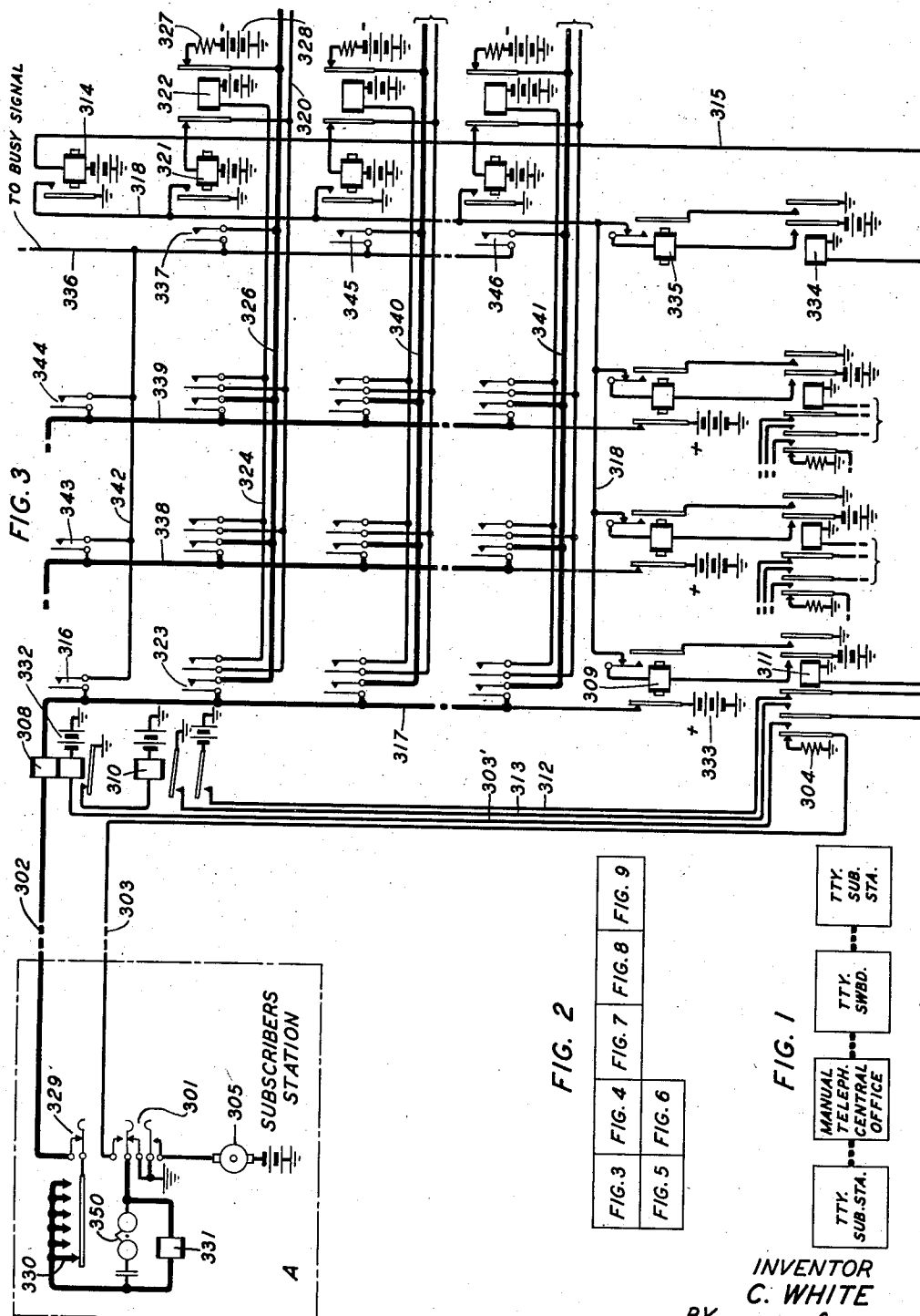
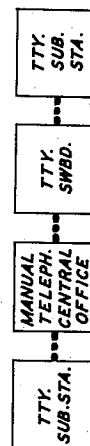


FIG. 2

FIG. 3	FIG. 4	FIG. 7	FIG. 8	FIG. 9
FIG. 5	FIG. 6			

FIG. 1



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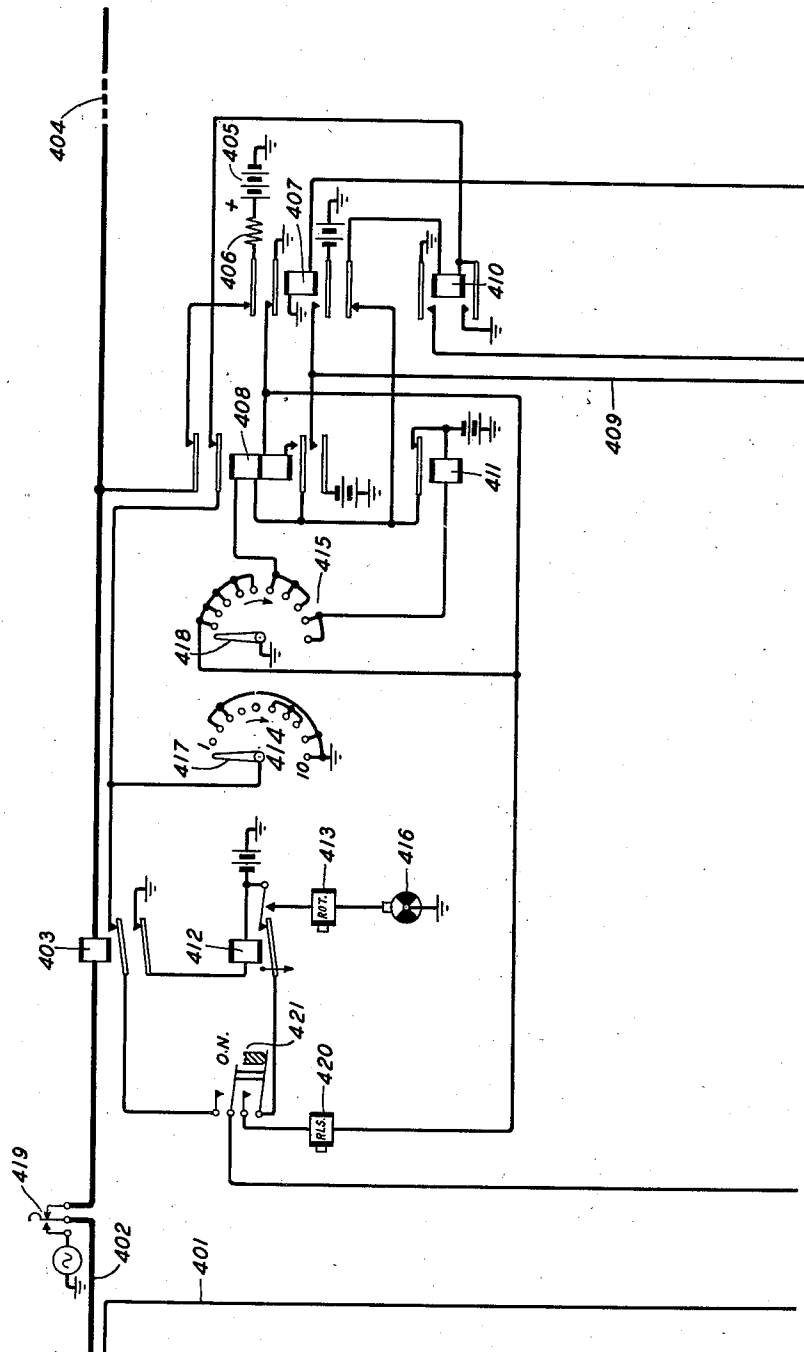
2,088,733

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FIG. 4



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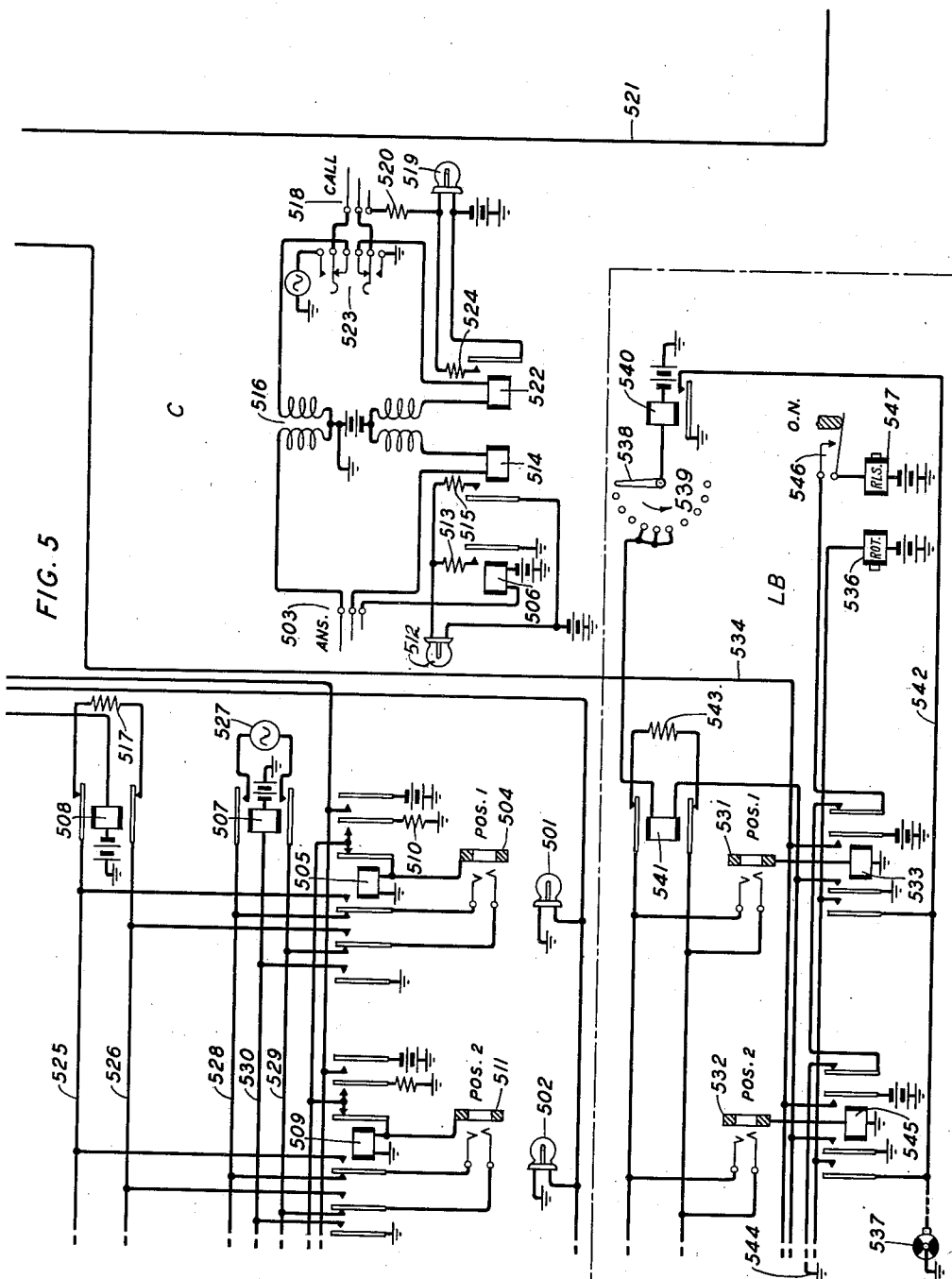
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PRINTING TELEGRAPH SYSTEM

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7 Sheets-Sheet 3



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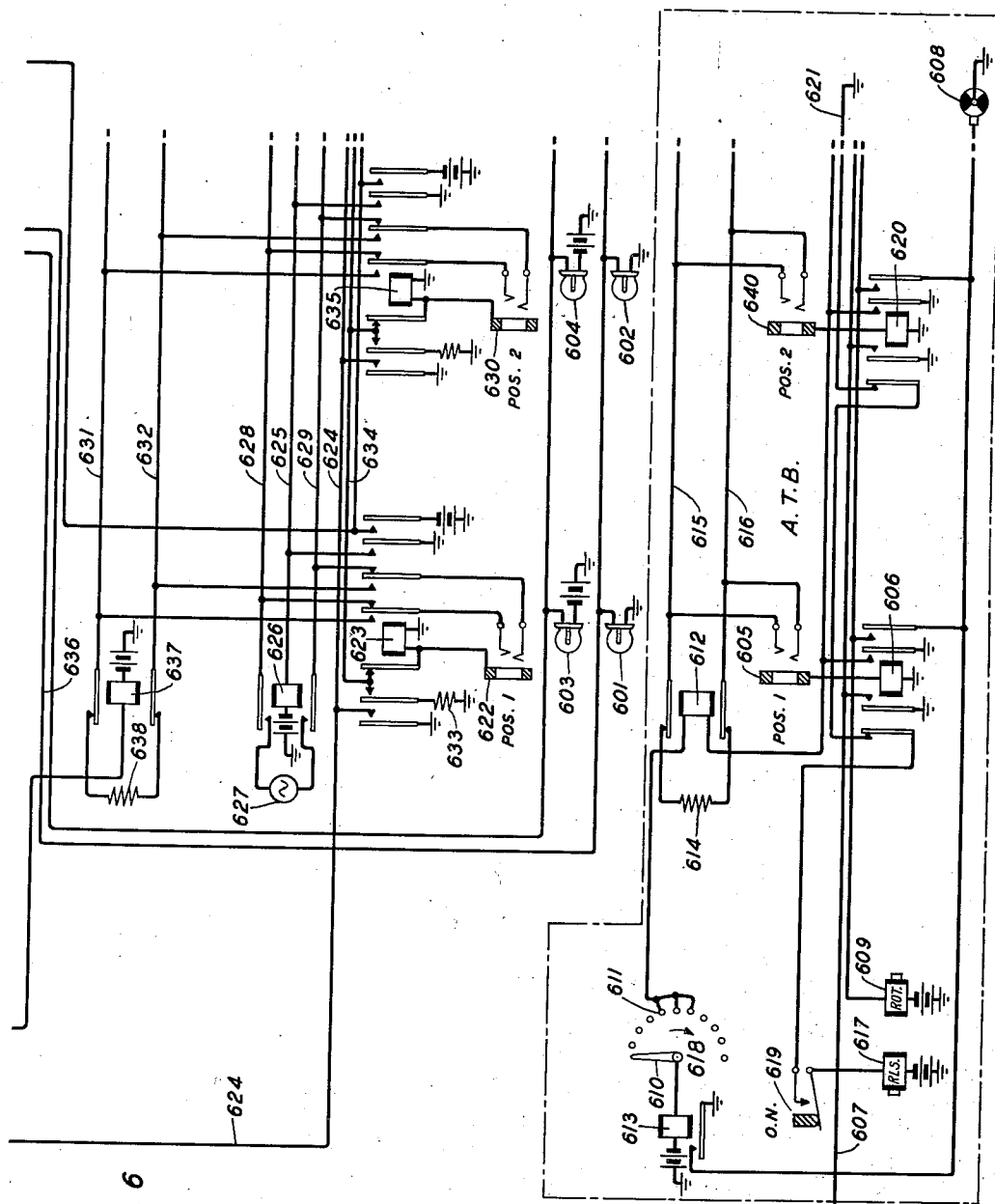
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PRINTING TELEGRAPH SYSTEM

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7 Sheets-Sheet 4



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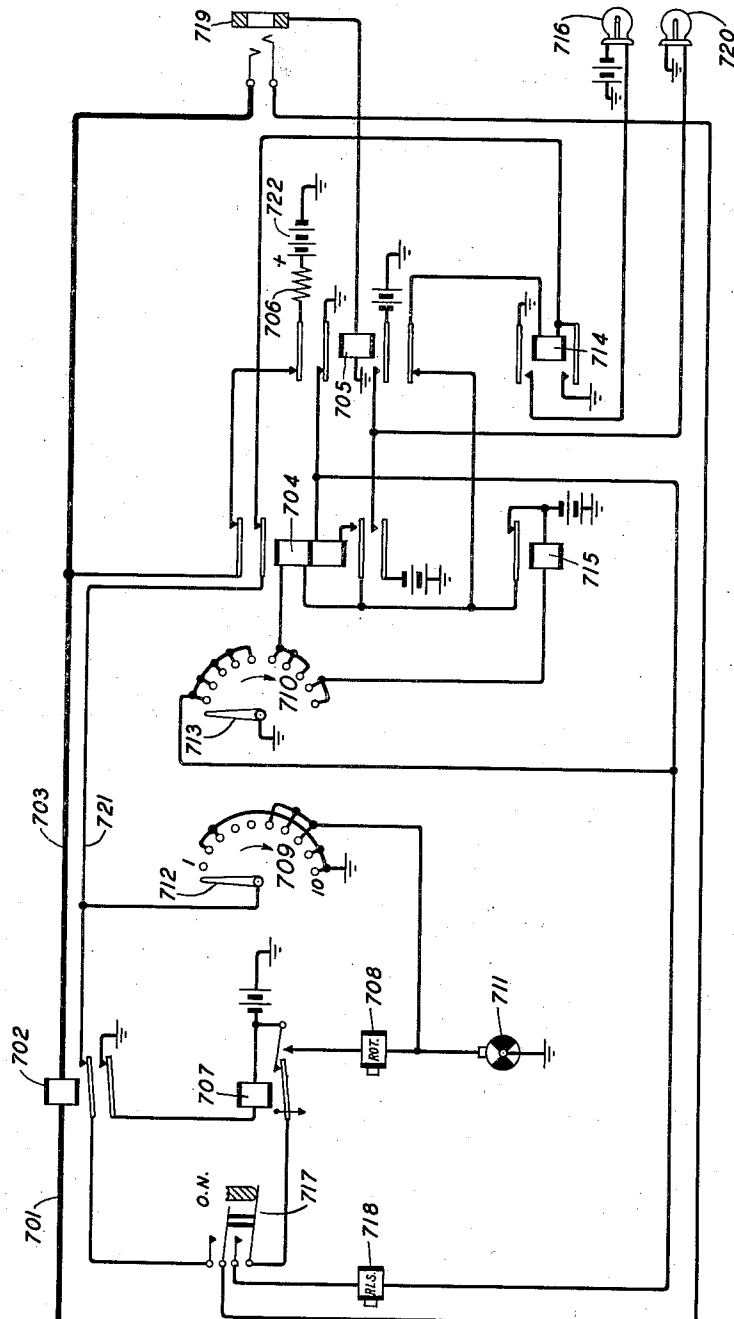
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FIG. 7



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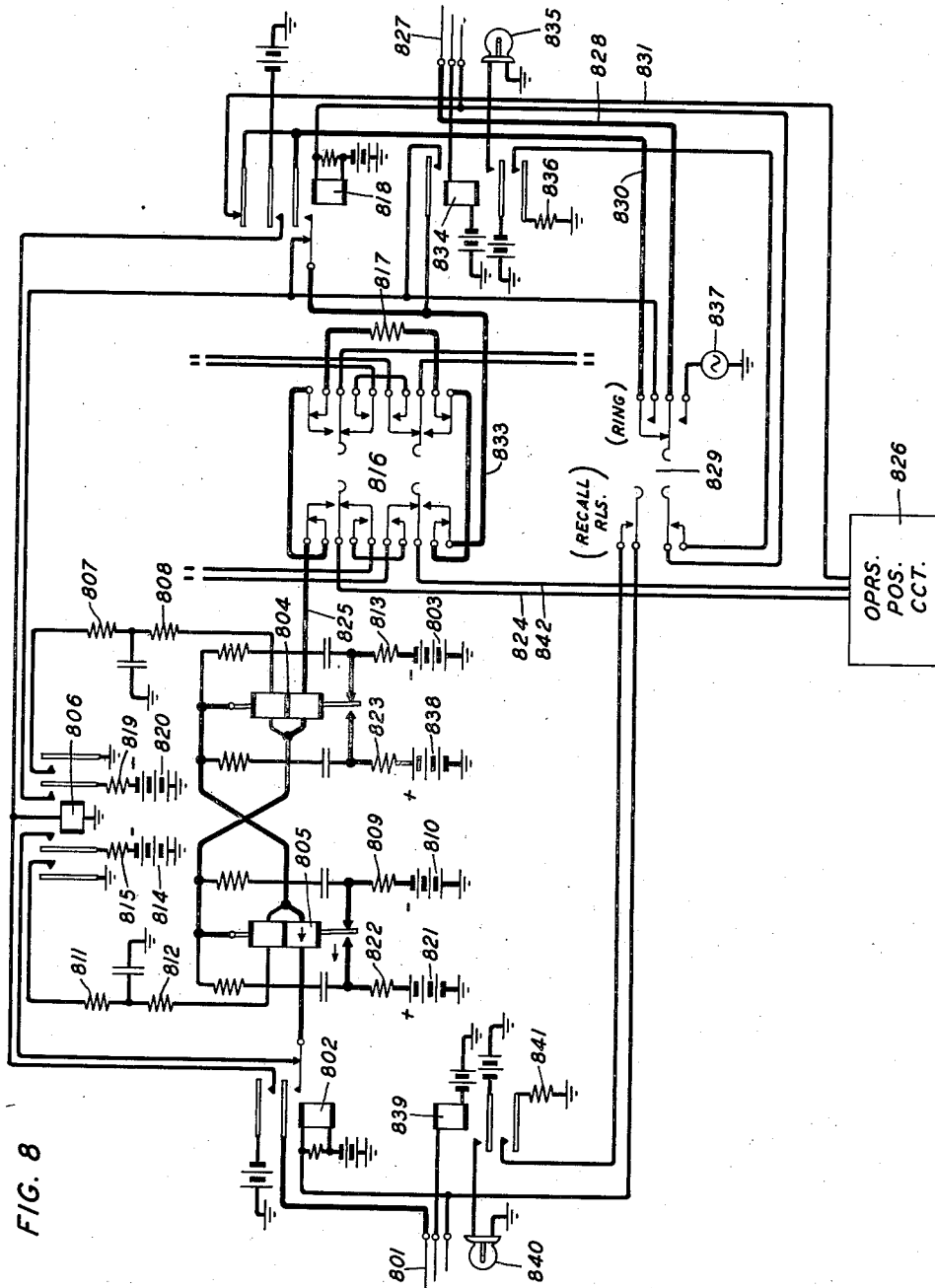
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PRINTING TELEGRAPH SYSTEM

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7 Sheets-Sheet 6



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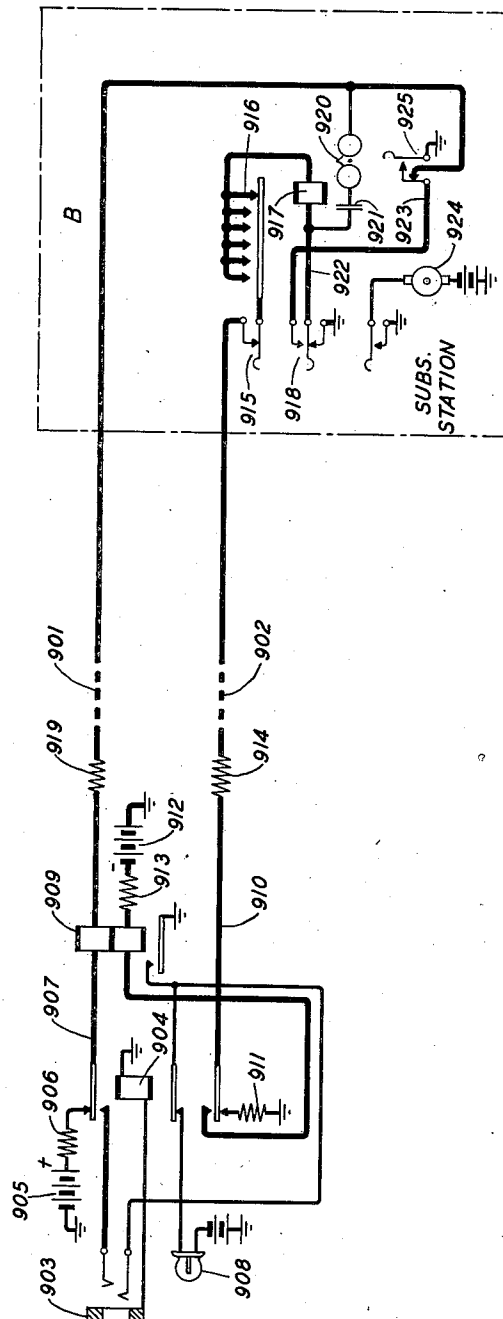
2,088,733

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FIG. 9



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UNITED STATES PATENT OFFICE

2,088,733

PRINTING TELEGRAPH SYSTEM

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Application January 31, 1936, Serial No. 61,663

6 Claims. (Cl. 179-4)

This invention relates to printing telegraph systems and more particularly to those systems which furnish teletypewriter exchange service.

An object of this invention is to provide teletypewriter exchange service in areas having a small number of subscribers, at a minimum cost.

Another object of this invention is to furnish service whereby a teletypewriter subscriber's station may be connected through a regular telephone switchboard to a teletypewriter switchboard located at a distant point.

Another object is to multiple the line and trunk circuits through several telephone operators' positions without causing interference during communication.

The invention is particularly adaptable for use in areas where the number of teletypewriter exchange service subscribers is so small that it is not economical to provide a teletypewriter switchboard for this service alone.

According to the present invention, one or more areas wherein the number of teletypewriter subscribers is small, may be connected to a teletypewriter switchboard which is at a considerable distance from the individual areas without the expense of extending the individual subscribers' lines for the entire distance between the subscribers' stations and the teletypewriter switchboard. The invention provides for connecting any one of the subscribers' stations to a telephone switchboard by operating a key at the subscriber's station to light a lamp at the telephone switchboard. The telephone operator may, upon observing the lighted lamp, connect by means of a telephone cord circuit, the calling teletypewriter subscriber's line, or line associated with the lighted lamp, to a trunk circuit extending to a teletypewriter switchboard at a distant point. The connection of one end of a cord circuit to a jack associated with the calling line circuit and of the other end to a jack associated with an idle trunk circuit effects the operation of a cross-bar switch whereby the calling telegraph line circuit is connected through the closed contact of the switch directly to the selected idle telegraph trunk circuit. The spring contacts of the trunk circuit jack may be connected in engageable relation to a circuit extending to a source of signaling current for supervision, which connection is controlled from the teletypewriter switchboard. Calls from the teletypewriter switchboard may be originated by causing the lamp associated with the trunk jack at the telephone switchboard to light and in response to the lighted lamp, one end

of a cord circuit is connected to the calling trunk. The number of the called teletypewriter subscriber's station is then transmitted to and recorded on a registering device at the telephone switchboard and the other end of the cord circuit is then connected to the line circuit corresponding to the recorded number. The linking of the cord circuit between a trunk and a line circuit causes the telegraphic circuit between the teletypewriter switchboard and the teletypewriter subscriber's station to be established over operated contacts of the cross-bar switch at the telephone subscriber's office. If all the trunk circuits to the teletypewriter subscriber's switchboard are in use when the teletypewriter subscriber initiates a call, or the called subscriber is busy when the teletypewriter switchboard operator attempts to establish a connection, the telephone operator will connect the calling line circuit or trunk circuit, as the case may be, to a busy-back jack for transmitting to the originating end of the connection busy-back interruption.

The objects and advantages of the invention will be better understood from the following detailed description thereof when read in connection with the accompanying drawings in which:

Fig. 1 is a block diagram showing a general layout of the system of the invention;

Fig. 2 is a block diagram showing the circuit arrangement of Figs. 3 to 9, inclusive;

Fig. 3 shows a teletypewriter station connected by a line which terminates at a telephone central office on a cross-bar switch mechanism which is used to connect said line over a trunk circuit to a teletypewriter central office;

Fig. 4 shows a circuit termination of the said trunk circuit at the telephone central office;

Fig. 5 illustrates a telephone cord circuit and associated circuit means, whereby in cooperation with Figs. 3, 4 and 6 the teletypewriter station aforesaid may be connected with the trunk to the teletypewriter central office;

Fig. 6 illustrates a circuit arrangement which in cooperation with Figs. 3, 4 and 5 may be used to establish a connection with an idle trunk extending to the teletypewriter office;

Fig. 7 illustrates an arrangement of terminal apparatus located at the teletypewriter office for the trunk incoming from the telephone central office;

Fig. 8 is a telegraph repeater cord circuit at the teletypewriter central office;

Fig. 9 shows a teletypewriter station with an associated line extending to and connecting with

terminal apparatus located at the teletypewriter central office.

In the drawings there are illustrated in comparative detail two teletypewriter stations A and B. Station A is connected to the telephone central office by two line conductors 302 and 303. Conductor 303 is connected over the outermost left-hand armature of relay 311, through a resistance 304 to ground, and conductor 302 through the upper winding of line relay 308 to conductor 317 to grounded positive battery at the left armature of magnet 309. Conductor 317 is a vertical member of a cross-bar switch mechanism which is used to connect the line of station A over the trunk conductor 404 to the teletypewriter central office at which is located the apparatus of Fig. 7, Fig. 8 and Fig. 9. A detailed description of the said cross-bar switch is given in U. S. Patent 2,021,329, granted to J. N. Reynolds on November 19, 1935.

Other incoming lines from teletypewriter subscribers' stations, not shown, are connected to other vertical members as 338 and 339. The trunk from the teletypewriter central office terminates on a horizontal conductor 326. Other trunks, now shown, terminate on other horizontals as 340 and 341. The connection of the line of station A is made to the trunk connected with conductor 326 by the operation of springs 323. In like manner, the line of any station may be connected to any trunk by operating the springs found at the intersection of the line vertical with the trunk horizontal. In order to provide for an all-trunks-busy condition for the line of station A, springs 316 are operated which connect vertical 317 to busy signal horizontal 342 which connects with a busy signal conductor 336. In like manner other line verticals, 338 and 339 may be connected by springs 343 and 344, respectively, to the horizontal 342. To provide for a line busy condition which may be encountered by a call incoming over a trunk from the teletypewriter office, the busy signal vertical 336 is associated with contacts such as 337, 345 and 346, which connect with trunk horizontals 326, 340 and 341 respectively.

In order to effect the above described functioning of the cross-bar switch mechanism regular telephone cord circuits illustrated by the cord circuit C of Fig. 5 are used. This cord circuit cooperates with the multiple line jacks 504 and 511 and the multiple trunk jacks, 622 and 630. Each multiple line jack circuit is identified with a line vertical and each multiple trunk jack circuit with a trunk horizontal of the cross-bar switch. For instance, multiple jacks 504 and 511 are identified with the vertical 317; multiple jacks 622 and 630 are identified with the horizontal 326. Other line jacks not shown would be identified with other verticals as 338 and 339; other trunk jacks not shown would be identified with horizontals 340 and 341.

To operate the switch mechanism for the line busy condition, a line busy circuit LB of Fig. 5 is provided. When the called line is found to be busy and the calling plug of a cord circuit C is inserted in one of the multiple jacks 531 or 532 the springs 337, 345 or 346 are operated so as to connect to the busy signal vertical 336, the calling trunk corresponding to the horizontals 326, 340 or 341.

To operate the switch mechanism for the all trunks busy condition an all trunks busy circuit ATB of Fig. 6 is provided. When all trunks extending to the teletypewriter office are found

busy and the calling plug of a cord circuit C is inserted in one of the multiple jacks 605 or 640, the springs 316, 343 or 344 are operated so as to connect the busy signal horizontal 342 (connected to vertical 336) to the calling line corresponding to verticals 317, 338 or 339.

In order to initiate a call to the teletypewriter office, the switch 301 at station A is operated and the telephone operator in response to the lighted lamp 501 or 502, which identifies the line of the calling subscriber, extends the connection over trunk conductor 404 in the manner hereinbefore outlined. A key 419 which is arranged to open the circuit for approximately two seconds is then operated. This causes the apparatus of Fig. 7 at the teletypewriter office to function so as to light a line lamp 716 in response to the operation of a relay 714 which operates and locks. After the operator answers by plugging into the line jack 719, relay 714 releases extinguishing lamp 716. For recalling the teletypewriter operator the key 419 is held open for approximately seven seconds which causes the selector brushes of Fig. 7 to step around to the seventh contact so as to connect an interrupter 711 which flashes a lamp in the cord circuit of Fig. 8. To give a disconnect signal key 419 is held open for approximately ten seconds. This causes the brushes 712 and 713 to step around to the tenth contact so as to cause the supervisory lamp of the cord circuit of Fig. 8 to be lighted steadily as a disconnect signal.

Fig. 8 is a preferred form of a standard teletypewriter repeater cord circuit which can be used advantageously in connection with this invention. It is provided with a typing key 816, with which the cord circuit may be connected to an operator's position circuit 826 in which is located a teletypewriter which the operator may use in communicating with either the called or calling subscriber. For supervisory purposes lamps 840 and 835 are provided. A key 829 is shown which when operated to the right is used to ring the line of the subscriber B; when operated to the left, to cause the release of a locked-in recall signal in Fig. 7.

Fig. 9 illustrates in conventional manner a standard station circuit of a teletypewriter subscriber who is signaled by the operation of a ringer 920. The line circuit which is shown is of the open circuit type. The subscriber calls the operator by operating the switch 918, thereby causing the lighting of the line lamp 908 and the starting of the teletypewriter motor 924.

When the teletypewriter operator wishes to call the station of subscriber A whose line terminates at the telephone office the calling plug of the cord circuit of Fig. 8 is inserted in the jack 719 of a trunk extending to the telephone office. By means of a key on the operator's teletypewriter an open calling interval of approximately two seconds is transmitted over the line conductor, releasing relay 403, which causes a selector switch to function and effect the lighting of multiple line lamps 603 and 604. The telephone operator answers by plugging into a corresponding jack 622 or 630, depending upon the positional location of the operator. This causes the operation of a cut-off relay 407, which extinguishes the lamps 603 and 604. The number of the line of the called subscriber is then transmitted over a circuit, not shown, to the telephone office, where it is received on a register.

The connection is then completed through the cross-bar switch mechanism by the operator's

plugging into a jack 504 or 511, or some other jack, not shown, which corresponds to the vertical which identifies the line of the called subscriber.

A detailed description of the operation of the invention will now be given. Assuming that the subscriber of station A desires to establish a connection with station B, switch 301 is operated which starts the teletypewriter motor 305 from a circuit closed through its lower contacts. The upper contacts of switch 301 transfer the winding of the teletypewriter, or printer magnet 331 from ground to line conductor 303. The circuit for line relay 308 which is normally operated, is now traced from ground, resistance 304, back contact and outermost left armature of relay 311, over conductor 303, through operated upper contacts of switch 301, winding of printer magnet 331, normally closed transmitting contacts 330 of the teletypewriter, or printer, at station A, contacts of break key 329, over line conductor 302, upper winding of line relay 308, left-hand contacts of holding magnet 309 to positive battery 333. Line relay 308 releases due to resistance 304 and opens the circuit extending through the winding of relay 310, which also releases, closing a circuit for lighting the line lamps 501 and 502 which are connected in multiple, and appear, each at a different operator's position. This circuit may be traced from grounded battery through the lower armature and back contact of relay 310, back contact and innermost left-hand armature of relay 311 and lamps 501 and 502 to ground. The operator in control of the cord circuit C, who by assumption is located at the position at which one of the lamps, say lamp 501 appears, observing the lighted lamp 501, now inserts plug 503 into the associated jack 504 thereby operating sleeve relays 505 and 506 through a circuit from ground, through the winding of relay 505, sleeve contacts of jack 504 and plug 503 and winding of relay 506 to battery. Relay 505 operates relay 311 from grounded battery on its right-hand outermost armature and front contact, through an obvious circuit and also transfers with its left-hand innermost armature the tip conductor of jack 504 from multiple conductor 528 to multiple conductor 525 and with its left-hand middle armature the ring conductor of jack 504 from multiple conductor 529 to multiple conductor 526. Relay 505 also operates with ground on its left-hand outermost contacts relay 507 which connects the source of audible tone 527 to the conductors 528 and 529 so that, if another operator should now plug into another jack, such as jack 511, a busy indication will be received. Relay 505 also opens with its right-hand innermost contacts the normal multiple connection of its winding with the winding of the corresponding relay 509 of the adjacent position. This multiple connection is through the innermost right-hand armature and contact of relay 509 and may be extended to corresponding relays of other positions not shown. Relay 505 also connects ground through resistance 510 with its right-hand middle armature and contact to the winding of relay 509, through the innermost right-hand armature and contact of relay 509. This resistance acts as a low resistance shunt across the winding of relay 509 which accordingly does not operate if another operator should plug into jack 511 at another position, thereby avoiding interference with the circuit of jack 504.

When relay 311 operated it disconnected at its innermost left-hand armature and contact con-

ductor 312 from lamps 501 and 502, which are thereby extinguished. Relay 311 also connects with its left-hand middle armature and front contact the winding of relay 508 to conductor 313, but relay 508 operates only for the short interval during which relay 308 is in an unoperated position. Relay 308 reoperates when its lower winding is energized by the transfer of conductor 303 at the outermost left-hand armature of relay 311, from its associated back contact to its associated front contact. Relay 310 then reoperates. Relay 311 also connects at its right-hand inner armature and contact, battery to the winding of cross-bar switch holding magnet 309, which however, does not operate at this time since there is no ground on conductor 318. When relay 506 operated as hereinbefore described it closed an obvious circuit through supervisory lamp 512 and resistance 513. Assuming that key 301 was held operated for only a short interval, lamp 512, however, did not light as supervisory relay 514 operated when plug 503 was inserted into jack 504, and connected a low resistance shunt 513 in multiple with lamp 512. The operating circuit for relay 514 extends from ground through the upper left-hand winding of repeating coil 516, tip contacts of plug 503 and jack 504, left-hand, innermost armature and front contact of relay 505, upper armature and contact of relay 508, resistance 517, lower armature and contact of relay 508, front contact and left-hand middle armature of relay 505, ring contacts of jack 504 and plug 503, winding of relay 514, and left-hand lower winding of repeating coil 516 to grounded battery. The operator now selects an outgoing trunk to the teletypewriter central office which serves the called station B. The terminal apparatus for one of these trunks is shown by Fig. 4 and Fig. 6. For the purpose of the immediate description it is now assumed that all of these trunks are busy. This will be indicated by the lighted condition of all busy lamps of position 1, only one of which, lamp 501 is shown. The functioning of the apparatus of Fig. 4 which effects the lighting of lamp 501 will be hereinafter described in connection with the description for a completed call.

The operator finding that no trunks are available now inserts plug 518 of cord circuit C into the busy jack 605 of position 1. Busy relay 606 now operates in a circuit traced from grounded battery through supervisory lamp 519, resistance 520, sleeve contacts of plug 518 and jack 605 and winding of relay 606 to ground. Relay 606 in operating connects ground with its left-hand inner armature and contact to the winding of busy signal selecting magnet 314, over conductors 607, 521 and 315. Magnet 314 in operating, operates holding magnet 309 in a circuit that may be traced from ground on the armature and contact of magnet 314 over conductor 318 through right-hand normally closed contacts and winding of holding magnet 309 to grounded battery on the operated right-hand inner armature and contact of relay 311. Holding magnet 309 operates and locks through its right-hand armature and contact to ground on the outer right-hand armature and contact of operated relay 311 and in cooperation with selecting magnet 314 effects the closure of cross-bar switch contacts 316, thereby connecting the winding of relay 308 and line conductor 302 to a busy signal circuit, not shown, but which is connected to conductor 336. When magnet 309 operated it also removed grounded positive battery 333 at its left-hand ar-

mature and contact from conductor 317, thereby leaving conductor 302 free to receive the busy signal impulses, which cause the printing of a distinctive signal at the station A which may be interpreted to indicate the busy condition encountered. Relay 606 when it operated also connected through its right-hand outer armature and contact a grounded busy back interrupter 608 operating at the rate of approximately sixty interruptions per minute to the winding of selector rotary magnet 609, which operates in response to the interruptions and causes the associated selector brush 610 to be stepped around the associated contact arc in the direction indicated by the arrow. After approximately three seconds, brush 610 will have made contact with the fourth terminal 611 closing a circuit from ground on the right-hand inner, operated contacts of relay 606 through the winding of relay 612, contact 611, selector brush 610, and winding of relay 613 to battery. Relay 613 in operating short-circuits the interrupter 608, thereby preventing further stepping of the brush 610. When relay 612 operated it disconnected resistance 614 from the multiple tip and ring conductors 615 and 616, thereby opening the circuit through the winding of supervisory relay 522. This circuit was established when plug 518 was inserted in jack 605 and may be traced from battery through the lower right-hand winding of repeating coil 516, relay 522, lower normally closed contacts of ringing key 523, ring contacts of plug 518 and jack 605, lower normally closed contacts of relay 612, resistance 614, upper normally closed contacts of relay 612, tip conductors of jack 605 and plug 518, upper normally closed contacts of ringing key 523 and upper right-hand winding of repeating coil 516 to ground. Relay 522 operated in this circuit and connected resistance 524 in shunt with lamp 519, preventing its illumination. Now when the operating circuit of relay 522, before traced, is opened by the operation of relay 612, relay 522 releases and the shunt 524 being disconnected, permits lamp 519 to be lighted. When busy contacts 316 on the cross-bar switch were closed a circuit was closed through the busy signal circuit for holding the upper winding of relay 308 energized. Relay 210 having reoperated maintains open the circuit extending through the left-hand middle armature and front contact of relay 311, and winding of relay 508 to battery. Relay 508 in releasing connects resistance 517 to the multiple conductors 525 and 526, thereby closing the circuit hereinbefore traced through the winding of relay 514, which operates and connects resistance 515 thereby shunting supervisory lamp 512 which is extinguished. The operation of relay 612 also causes through circuit means not shown, the disconnection of the aforesaid busy signal circuit from the conductor 336 which effects the release of supervisory relay 514 and the lighting of supervisory lamp 512. Since several operators have access to the multiplied busy jacks it is necessary that the supervisory lamp 519 should be dark when the operator plugs in to assure that relay 612 has not been previously operated, cutting off the busy signal circuit. The operator now observing that lamps 512 and 519 are lighted will understand that this is a disconnect signal and will withdraw plugs 503 and 518 from the jacks 504 and 605, respectively. On withdrawing plug 503, relay 505 releases, which disconnects battery at its right-hand outermost armature and contact from the winding of relay 311, which releases and disconnects battery on

its right-hand inner contacts from the winding of holding magnet 309, which releases, opening switch contacts 316. Magnet 309 in releasing also connects positive battery 333 at its left-hand armature and contact to conductor 317 reestablishing the original operating circuit for relay 308 and the key 301 at station A is restored to normal by the subscriber. Relay 505 in releasing dis connects ground from the multiple conductor 530 releasing relay 507 which disconnects the source 527 of busy tone from the multiple conductors 528 and 529. On withdrawing plug 518, relay 606 releases, opening the operating circuit for the selecting magnet 314, which releases, and the circuit through relays 612 and 613, which also release. A circuit is now closed from battery through the winding of release magnet 617, closed off-normal contacts 619 of the selector switch illustrated by the contact arc 618 and the brush 610, left-hand outer contacts of relay 606 and of relay 620 of position 2, thence through corresponding contacts of corresponding relays in other positions, not shown, to the ground 621 associated with the relay of the last position. The selector switch and all apparatus are now restored to normal.

The operation of the invention will now be discussed for a completed call from station A to station B. The description for an uncompleted call, hereinbefore given, applies up to the point at which the operator observed that all trunks were busy. Finding now that the trunk which terminates on jack 622 in position 1 is not busy as indicated by the non-lighted condition of the corresponding busy lamp 601, the operator inserts plug 518 of cord circuit C into jack 622, which establishes a circuit through the winding of sleeve relay 623 which may be traced from battery through supervisory lamp 519, resistance 520, sleeve contacts of plug 518 and jack 622 and winding of relay 623 to ground. Relay 623 operates and connects ground with its left-hand outermost contacts to multiple conductor 624 which connects with conductor 401 leading to conductor 320 of the cross-bar switch. Ground on conductor 320 operates through the left-hand break contacts of relay 322, selecting magnet 321 which connects a ground to conductor 318 operating horizontal magnet 309 as before described. Spring combination 323 is accordingly operated, connecting conductor 320 to conductor 324, and conductor 317 to conductor 326, which connects with conductor 402. When conductor 320 is joined to conductor 324 as before described, relay 322 operates and opens with its left-hand armature and contact the circuit of selecting magnet 321 which releases, and also disconnects with its right-hand armature and contact negative battery 328 through resistance 327 from conductor 326, which connects with conductor 402. The tip line conductor 302 from station A is now extended through to positive battery 722 at the teletype-writer central office through contacts of key 419, the winding of relay 403, over line conductor 404, conductor 701, through winding of relay 702, over conductor 703, through the upper outer armatures and their respective contacts of relays 704 and 705, and resistance 706. Relay 403 is normally held operated in a circuit from positive battery 405 through resistance 406, the upper outer armatures and their respective contacts of relays 407 and 408, winding of relay 403, contacts of key 419, over conductors 402 and 326, through right-hand armature and contact of relay 322, resistance 327 and negative battery 328.

When relay 623 operated, as before described, relay 407 operated in a circuit from battery on the right-hand outermost armature and contact of relay 623 and disconnected positive battery 405. Relay 403 remains operated on positive battery 722 through the circuit hereinbefore traced. When relay 623 operated it connected, with its right-hand armature and contact next to the outermost, ground to multiple conductor 625, thereby operating relay 626, which connects a busy tone 627, to multiple conductors 628 and 629, so that, if another operator should plug in at another position, into jack 630, for instance, a busy tone will be received, indicating that the plug should be withdrawn. Relay 623 also connects the tip and ring conductors of jack 622, over its right-hand innermost armature and front contact and the right-hand next-to-innermost armature and front contact to multiple conductors 631 and 632. A shunting resistance 633 is also connected with the left-hand middle armature and contact of relay 623 to multiple conductor 634, which connects with the left-hand innermost armatures and their respective contacts of the sleeve relays of the other positions as relay 635, for instance. This prevents the operation of sleeve relays if the operator should plug in improperly, after another sleeve relay associated with the same trunk, has been previously operated.

Relay 407 in operating also connects battery at its lower inner armature and contact to conductors 409 and 636, thereby operating busy lamps 601, 602 and busy lamps, not shown, of other positions. Relay 407 also opens at its lower outer armature and contact, the operating circuit of relay 410 thereby preventing its improper subsequent operation when the telephone operator signals out over the trunk to the teletypewriter office as will be hereinafter described. The operator will now open key 419 for approximately two seconds, which will release relay 403, thereby releasing slow-releasing relay 412 which connects battery through its back contacts to the winding of rotary magnet 413 of the selector switch having contact arcs 414 and 415. An interrupter 416 furnishing impulses at a rate of approximately sixty per minute is connected to the magnet 413 and causes the brushes 417 and 418 to step around in the direction indicated by the arrows. After approximately two seconds brushes 417 and 418 will be resting on either the second or third terminals of arcs 414 and 415. When key 419 is restored to normal, relay 403 reoperates, reoperating relay 412, opening thereby the circuit of magnet 413, preventing further stepping of the selector switch. A circuit is now closed through the winding of release magnet 420, which may be traced from battery through front contact and armature of slow-release relay 412, lower operated contacts of off-normal springs 421 which were operated when the selector switch moved off-normal, winding of magnet 420, second or third contact of arc 415, and brush 418 to ground. This causes the selector switch to release, to restore brushes 417 and 418 and springs 421 to normal, thereby opening the circuit of magnet 420.

When the key 419 was operated relay 702 at the teletypewriter office also released, releasing the slow-releasing relay 701, thereby connecting battery to the winding of rotary magnet 703 of the selector switch having rotary arcs 709 and 710. Rotary magnet 708 is also connected to the interrupter 711, which causes the switch brushes

712 and 713 to step around in the direction of the arrows at the rate of sixty steps a minute. After approximately two seconds, when the key 419 has been restored to normal, relay 702 reoperates, reoperating relay 701 and deenergizing magnet 708, thereby preventing further stepping of the aforesaid selector switch, brushes 712 and 713 of which now rest on the second or third terminals of the contact banks. This closes a circuit for operating relay 714 which may be traced from ground on the second or third contact of arc 709, through brush 712, upper inner armature and contact of relay 704, winding of relay 714, and normally closed lower and upper armatures and contacts of relays 705 and 715, respectively, to battery. Relay 714 in operating closes an obvious circuit through line lamp 716, and locks to ground through its lower armature and contact, under control of relays 705 and 715. When relay 707 reoperates a circuit is closed from battery on its armature and front contacts through lower contacts of off-normal contacts 717, winding of release magnet 718, second or third contacts of arc 710, and brush arm 713 to ground. Magnet 718 being thus energized causes the restoration of the selector switch to normal. The teletypewriter operator observing the lighted line lamp 716, inserts plug 801 of the teletypewriter repeater cord into jack 719. Relay 705 now operates through a circuit from ground through the winding of relay 705, sleeve contacts of jack 719 and plug 801 and winding of relay 802 to battery, releasing relay 714 and thereby extinguishing lamp 716. A circuit is closed for lighting busy lamp 720, traced from battery on the lower inner contacts of relay 705 through lamp 720 to ground. Relay 705 in operating also disconnects with its upper outer contacts positive battery 722 and resistance 706 from the upper outer contacts of relay 704 and line conductor 703. It also removes ground with its upper inner contacts from the winding of release magnet 718. When relay 802 operated it also operated from battery on its outer upper contacts, relay 806, which closes local circuits through the windings of repeater polarized relays 804 and 805, which cause these relays to operate to their armatures and left-hand, or marking, contacts as will now be described. A circuit is closed from ground on the right-hand outer armature and contact of relay 806 through resistances 807 and 808, upper and lower windings in series of relay 804, left-hand and right-hand uppermost and normally closed contacts of typing key 816, resistance 817, right-hand and left-hand lowermost and normally closed contacts of key 816, inner normally closed contacts of relay 818, right-hand inner armature and contact of relay 806, resistance 819 to negative battery 820. Another circuit is closed (momentarily before relay 805 operates) in multiple with the lower winding of relay 804 which is traced from negative battery 819 (which is identical with battery 820) through resistance 809, armature and right-hand contact of relay 805 to the junction point of the upper and lower windings of relay 804. These windings are so connected that they effect the operation of relay 804 to its left-hand contacts. When relay 805 operates to its left-hand contact as will be hereinafter described, positive battery 821 is connected through resistance 822, left-hand contact and armature of relay 805 to the junction point of the upper and lower windings of relay 804. Under this condition current flows from

positive battery 821 through the lower winding of relay 804 toward negative battery 820, and through the upper winding of relay 804 toward ground on the right-hand outer armature and contact of relay 806. The upper and lower windings of relay 804 have each the same number of turns and the same resistance and are connected so that when current from positive battery 821 flows as described there is a differential action between the two windings. The electrical constants of the circuits of the respective windings are such, however, that a much greater current flows in the lower than in the upper winding so that the magnetic effect of the lower winding predominates. The direction of current flow in this winding is such as to operate the armature of relay 804 to its left-hand, or marking, contacts, that is, relay 804 remains operated to its left-hand contacts with the armature of relay 805 operated to either its left-hand or right-hand contacts.

In a similar manner relay 805 which is identical with relay 804 operates from negative battery 803 connected to the central junction point between the windings of relay 805 and from negative battery 814 in series with resistance 815 through the left-hand inner armature and contact of relay 806, resistances 811 and 812 and momentarily before relay 802 has operated completely, through the inner normally closed contacts of relay 802 to the lower winding of relay 805. After relay 804 operates positive battery 838 is connected through resistance 823 and the left-hand contact and armature of relay 804 to the junction point of the upper and lower windings of relay 805. Under this condition the greater current in the lower winding prevails over the smaller current in the opposing upper winding. With relay 802 operated, the lower winding terminal of the lower winding of relay 805 is transferred by the continuity contacts of relay 802 from negative battery 814 to the tip conductors of plug 801 and jack 719, over conductor 703, through winding of relay 702, over conductors 701 and 404, through winding of relay 403, key 419, over conductor 326, left-hand contacts of cross-bar switch spring combination 323, winding of relay 308, over line conductor 302, contacts of break key 329, normally closed sending contacts 330 of the teletypewriter, winding of relay 331, left-hand operated contacts of switch 301 over line conductor 303, through the outermost left-hand armature and front contact, conductor 303', through the lower winding of relay 308 to negative battery 332. Under this condition the current through the line or lower winding of relay 805 also predominates and is so directed that the armature of relay 805 remains operated to its left-hand contacts.

The teletypewriter operator in control of the cord circuit of Fig. 8 will now operate typing key 816 so that its left-hand uppermost front contacts connect conductor 825 to conductor 824 which extends to the operator's position circuit 826, which is represented conventionally by a box. In this position circuit is a teletypewriter, with which the operator now answers the calling station A telegraphically by actuating relay 804, which repeats the telegraphic impulses through the lower winding of relay 805. The subscriber of station A now types the number of the desired station, causing the operation of the relay 805, and the operator, before whom the number is printed, now proceeds to complete the call. Let it be assumed that the line of the called teletype-

writer station B is served by the line jack 903, which it is understood, may be joined by multiple connections not shown, with other jacks at other operators' positions. The operator will now make a busy test to determine the idle or busy condition of the called line, by touching the sleeve conductor of jack 903 with the tip conductor of plug 827. If the line of station B is busy, a potential will be present on the sleeve conductor of jack 903, which will be extended over conductor 828, through normally closed contacts of ringing key 829, over conductor 830, through uppermost contacts of sleeve relay 818, over conductor 831 to the position circuit 826, associated with which is a busy lamp, not shown, which lights in response to the aforesaid busy potential. If the test indicates that the line is not busy then the operator inserts plug 827 into jack 903 thereby causing the operation of relay 818, which disconnects the busy circuit conductor 831 from conductor 830, connects battery through its middle armature and contact to the winding of relay 806, and transfers conductor 833 from its connection with battery 820 to the tip conductor 830 which extends through ringing key 829 to conductor 828. The operating circuit for relay 818 may be traced from battery through the winding of relay 818, sleeve conductors of plug 827 and jack 903 and winding of relay 904 to ground. Relay 904 also operates in this circuit and transfers at its upper armature and contact, conductor 907, from its connection with positive battery 905 through resistance 906, to the tip conductor of jack 903; disconnects at its lower innermost armature and contact, line lamp 908 from the armature and contact of line relay 909; transfers with its outer lower armature and contact, line conductor 910 from grounded resistance 911 to a connection with the lower winding of line relay 909. A circuit is also closed for operating the line relay 909 that may be traced from negative battery 912 through resistance 913, lower winding of relay 909 and outer lower armature and front contact of relay 904, over conductor 910, through resistance 914, over line conductor 902, through break key 915, normally closed contacts 916, winding of printing magnet 917 to ground at the normally closed middle contacts of key 918. Relay 909 in operating connects ground to the ring conductor of jack 903, thereby causing the operation of relay 834 in a circuit traced from battery through the winding of relay 834, ring contacts of plug 827 and jack 903 to ground at the armature and contact of relay 909. Relay 834 operated lights the supervisory lamp 835 from battery on its lower inner armature and contact; also connects negative battery 820 through its upper armature and front contact to conductor 833, to replace the battery connection opened by the inner normally closed contacts of relay 818. This is done so as to maintain negative battery on the line conductor until the called subscriber of station B answers. Relay 834 also connects with its lower outer contacts ground through resistance 836 to the lower left-hand springs of key 829, but this serves no useful purpose at this time.

With the connection established to the line of station B as before described the teletypewriter operator now rings on the tip of the line by operating the right-hand springs of ringing key 829, which transfers tip conductor 830 from its connection with conductor 828 to a connection with conductor 833 via upper contacts of relay 834 thereby maintaining negative battery on conductor 833. A source of grounded ringing cur-

rent 837 is now connected through the lower right-hand make springs of key 829 to tip conductor 828, thence through tip contacts of plug 827 and jack 903, upper operated front contacts of relay 904 and winding of relay 909, resistance 919, over line conductor 901, through ringer 920, and condenser 921 to ground on the right-hand contacts of key 918.

Answering the ringer the subscriber of station B operates key 918 transferring with its upper springs conductor 922 to conductor 923, thereby short-circuiting ringer 920 in series with condenser 921, and closing with its left-hand contacts a circuit to start the teletypewriter motor 924. Line relay 909 is now in a circuit from positive battery 821 through resistance 822, left-hand contact and armature of relay 805, lower winding of relay 904, uppermost normally closed contacts of key 816, resistance 817, lowermost normally closed contacts of key 816, over conductor 833, through innermost armature and front contact of relay 818, over conductor 830, through right-hand normally closed contacts of key 829, over conductor 828 through tip contacts of plug 827 and jack 903, front contact and upper armature of relay 904, upper winding of relay 909, resistance 919, over line conductor 901, through break contacts of key 925 at station B, over conductor 923, through upper operated front contacts of key 918, through winding of magnet 917, transmitting contacts 916, normally closed contacts of break key 915, over line conductor 902, through resistance 914, lower outer armature and front contact of relay 904, lower winding of relay 909 and resistance 913 to grounded negative battery 912. Since the two windings of relay 909 are now connected in a series differential relation, relay 909 releases, opening the operating circuit hereinbefore traced, of relay 834, which releases, extinguishing the supervisory lamp 835, thereby indicating to the operator that the called station B has answered. The subscribers of station A and station B are now connected for teletypewriter operation through the repeater cord of Fig. 8.

When station A transmits a spacing or open impulse the circuit hereinbefore traced through the lower winding of repeater relay 805 is opened, thereby leaving relay 805 energized locally by only its upper winding from grounded positive battery 838 through the left-hand contacts of repeater relay 804. The direction of current flow through the upper winding of relay 805 is now such as to operate relay 805 to its right-hand contacts, thereby transmitting a negative impulse from grounded negative battery 810, through resistance 809 and lower winding of repeater relay 804 over the circuit of station B until it meets grounded negative battery 912, which is equivalent to an open circuit or spacing impulse. During the transit of the armature of relay 805 from contact with grounded positive battery 821 to contact with grounded negative battery 810, relay 804 is energized through upper and lower windings in series aiding from ground on the right-hand outer contacts of relay 806 over the line of station B to grounded negative battery 912. The current flow is so directed that relay 804 remains on its left-hand contacts during this transitory period. When the armature of relay 805 reaches its right-hand contacts, then grounded negative battery 810 energizes the upper winding of relay 804 so as to cause this relay to continue on its left-hand contacts.

to a marking impulse, grounded negative battery 332 is reconnected over the line of station A and acting in series with grounded positive battery 838 reenergizes the lower winding of relay 805, causing the armature of this relay to reoperate to its left-hand or marking contact. In this way the spacing and marking impulses necessary for the teletypewriter message are transmitted from station A, received by relay 805 and repeated to station B. If the subscriber of the calling station A should desire to recall the teletypewriter operator, this is done by opening the line at station A by means of a timing key, not shown, which maintains an open circuit for some predetermined interval of time, say seven seconds. During this interval relay 308 releases because the energization of its lower winding is insufficient to maintain it operated in a circuit extending to ground at an operated contact on the timing key. Relay 310 releases and relay 508 operates. The operation of relay 508 disconnects resistance 517, causing the release of supervisory lamp relay 514 and the lighting of supervisory lamp 512. At the end of this interval the circuit will be closed again and the lamps 512 extinguished indicating to the telephone operator that the momentary lighting of the lamp was a recall signal. The opening of the line as aforesaid also effects the release of line relay 403, which opens the circuit of slow-release relay 412, which releases and connects battery to the winding of rotary magnet 413, thereby causing the selector brushes 417 and 418 to be stepped around in response to the grounded impulses of the interrupter 415, which operates at a predetermined rate of approximately sixty interruptions per minute. At the end of the seven-second open period brushes 417 and 418 will have stepped around over approximately seven contacts and relay 403 will reoperate, reoperating relay 412 and leaving the brushes 417 and 418 on the contact to which they were stepped. Brush 417 is stopped on an open circuit contact and accordingly has no circuit effect. Brush 418 on the seventh contact closes a circuit from ground through the upper winding of relay 408 to grounded battery on the armature and contact of relay 411. Relay 408 in operating disconnects with its upper outer armature and contact conductor 404 from the upper outer armature and contact of relay 407, disconnects at its upper inner armature and contact the winding of relay 410 from brush 417, and connects at its lower outer contacts grounded battery to conductor 409. In Fig. 7 relay 702 releases and thereby releases slow-releasing relay 707 which closes a circuit from sixty interruptions per minute interrupter 711 through the winding of rotary magnet 708 associated with the selector of contact banks 709 and 710. When relay 702 reoperates after approximately seven seconds, brush 712 will then be on the seventh terminal of bank 709 and brush 713 on the seventh terminal of bank 710. A circuit is closed from ground through interrupter 711, seventh contact of bank 709, brush 712, inner operated contacts of relay 702, upper closed contacts of ON combination 717, ring conductors of jack 719 and plug 801 and winding of relay 839 to grounded battery. Relay 839 operates in unison with the interruptions of interrupter 711, causing supervisory lamp 840 to flash as a recall signal. A circuit is also closed for operating relay 704 which is traced from ground on brush 713, seventh contact of bank 710, upper winding of relay 704 and through the armature and con-

When station A now changes from a spacing

tact of relay 715 to battery. Relay 704 in operating at its upper outer armature and contact disconnects the upper outer armature and contact of relay 705 from conductor 703 and at its upper inner armature and contacts disconnects the winding of relay 714 from conductor 721. Relay 704, also in operating, connects at its lower outer armature and contacts battery to busy lamp 720. In response to the flashing lamp 840 the operator will operate the left-hand springs of the recall release key 829. This will connect a low resistance 841 in shunt with the winding of relay 705. This shunted circuit is traced from ground through resistance 841, lower outer armature and contact of relay 839, left-hand upper contacts of key 829, thence through the sleeve contacts of plug 801 and jack 719 to the winding of relay 705, which releases. Relay 705 in releasing connects ground through its upper inner armature and contact to the lower winding of relay 704 which is held operated through its lower winding, lower inner armature and contact, to grounded battery on the armature and contact of relay 715, thereby maintaining busy lamp 720 lighted while relay 705 is released. Relay 705 released also connects ground on its upper inner armature and contact to the winding of release magnet 718, thence through lower operated contacts of ON combination 717 and operated contacts of relay 707 to grounded battery. The brushes 712 and 713 are accordingly restored to normal and relay 839 releases. When relay 839 releases, the shunting resistance 841 is removed from connection with the winding of relay 705, which reoperates and releases relay 704.

The operator will now operate the typing key 816 to the left, thereby connecting the teletypewriter of the operator's position circuit 826 to the line conductor over conductor 824 and will then announce the connection by typing OPR or some other appropriate indication.

If the subscriber of station B desires the attention of the operator the non-locking key 925 is operated which connects ground at its make contact to line conductor 902, thereby energizing line relay 909 through its lower winding alone, since conductor 901 is disconnected by the break contacts of key 925. As the differential action between the upper and lower windings of relay 909 is accordingly no longer effective relay 909 operates and connects ground to the ring conductors of jack 903 and plug 827, operating relay 834, which lights supervisory lamp 835 from battery at its lower inner contacts.

When the subscriber of station A has completed the transmission of the message to station B a disconnect signal is transmitted to the telephone and teletypewriter operators by the operation of a timing key, not shown, which holds open the line for approximately ten seconds. At the end of this period the selector brushes 417 and 418 will have stepped around to the ninth or tenth terminal. Brush 417 closes a circuit from ground on the ninth or tenth terminal through inner operated contacts of relay 403, upper operated ON contacts 421 and winding of relay 637 to battery. Relay 637 in operating disconnects resistance 638 from the tip and ring conductors causing the release of supervisory relay 522 and the lighting of supervisory lamp 519. Simultaneously with the action just described selector brushes 712 and 713 also step around to the ninth or tenth terminal of their associated banks, due to the release of relays 702 and 707. When relay 702 reoperates a circuit is closed from ground

on the ninth or tenth terminal of bank 709 over brush 712, through operated inner contacts of relay 702, upper operated ON contacts 717, ring conductors of jack 719 and plug 801 and winding of relay 839 to battery. Relay 839 operates and lights supervisory lamp 840 steadily as a disconnect signal. After the incoming message has been received at station B, the key 918 is reoperated to the off-position, thereby stopping motor 924, transferring conductor 922 from connection with conductor 923 to ground, and reconnecting ringer 920 so as to be available for another incoming call. Under this circuit condition line relay 909 is energized through its lower winding alone, the circuit of the upper winding being open, and accordingly operates, connecting ground to the ring conductor of jack 903 and plug 827. Relay 834 now operates lighting supervisory lamp 835 from grounded battery on its lower inner armature and contacts. The operator observing the lighted lamp 835, withdraws plug 827 from jack 903, restoring to normal the line of subscriber B.

The opening of the line of subscriber A for ten seconds as hereinbefore described, releases relays 308 and 310. The release of relay 310, operates relay 508, disconnecting resistance 517 from the tip and ring conductors and causing the release of supervisory relay 514 and the lighting of supervisory lamp 512. The telephone operator observing the lighted supervisory lamps now withdraws plug 503 from jack 504 and plug 518 from jack 622. When plug 503 is withdrawn relay 505 releases, releasing relay 311, which releases holding magnet 399, restoring the cross-bar switch to normal, which, in turn, removes ground from conductor 324, releasing relay 322. The release of relay 505 also releases the busy tone relay 507. When plug 518 is withdrawn, relay 623 releases, releasing relay 407. Relay 407 in releasing extinguishes busy lamps 601 and 602; connects ground through its upper inner armature and contact, winding of release magnet 420, lower operated contacts of ON combination 421 to battery on the armature and front contact of relay 412. The selector switch now releases. The release of relay 623 also releases the busy tone relay 626 and removes ground from conductor 401. The teletypewriter operator observing the lighted supervisory lamp 840 withdraws plug 801 from jack 719. The withdrawal of plug 801 releases relays 705, 802 and 839 extinguishing lamps 720 and 840 and closing a circuit through release magnet 718, which may be traced from ground on the upper inner armature and contact of relay 705, through winding of release magnet 718, lower operated contacts of ON springs 717 to battery on the armature and front contact of relay 707. The brushes 712 and 713 are restored to normal. All apparatus is now ready for another call.

The operation of the system of the invention will now be discussed for a call transmitted from station B to station A. The subscriber of station B initiates a call by operating the switch 918 closing a circuit with its left-hand contacts for the starting of teletypewriter motor 924, and with its right-hand contacts for completing the circuit of line conductors 901 and 902. Line relay 909 operates through its upper winding in a circuit from positive battery 905, through resistance 906, back contact and upper armature of relay 904, upper winding of relay 909, resistance 919, over line conductor 901, normally closed contacts of switch 925, over conductor

923, through right-hand operated contacts of switch 918, winding of relay 917, normally closed contacts 916 and 915, over line conductor 902, through resistance 914, over conductor 910, through outer lower armature and contact of relay 904 and resistance 911 to ground. Relay 909 in operating closes a circuit for lighting line lamp 908 traced from grounded battery through lamp 908, back contact and lower inner armature of sleeve relay 904 to ground on the front contact and armature of relay 909. The teletypewriter operator observing the lighted lamp 908 inserts plug 827 into jack 903 thereby operating sleeve circuit relays 818 and 904. Relay 904 in operating disconnects at its upper armature and contact positive battery 905, and effects the release of line relay 909 by the establishment of a series differential connection between its upper and lower windings. This circuit was hereinbefore discussed in connection with the operation of the invention for a call originating at station A and terminating at station B. Relay 909 in releasing removes ground from the ring conductor of jack 903, thereby preventing the operation of ring conductor supervisory relay 834. Lamp 908 is extinguished, and is disconnected from the contacts of relay 909 by the operation of relay 904. The operation of relay 818 closes a circuit from grounded battery through its middle armature and contact and the winding of relay 806, which operates and causes the operation of the armatures of repeater relays 804 and 805 to their left-hand or marking contacts as hereinbefore described. Relay 804 is maintained on its marking contacts due to the predominating effect of the current in its lower winding, over that of the current in its upper winding.

After plug 827 is inserted into jack 903 as before described the operator operates the left-hand lowermost contacts of typing key 816 and thus connects conductor 842, from the operator's position circuit 826, to the tip conductor of plug 827. This circuit is traced from conductor 842 through left-hand lowermost make contacts of key 816, front contact and innermost armature of relay 818, over conductor 830, normally closed contacts of key 829, tip contacts of plug 827 and jack 903, thence over the circuit of the associated line circuit of station B to grounded negative battery 912. The operator now communicates by teletypewriter with the subscriber of station B. The telegraphic current impulses pass through the windings of line relay 909, which, however, does not operate due to the differential action of its windings. Having ascertained that the subscriber of station B desires to communicate with the subscriber of station A, the teletypewriter operator will select an idle trunk to the telephone central office at which the line circuit of station A terminates. The jack 719 of such a trunk is arranged to be multiplied before several operators' positions. The necessary multiple connections, however, are not shown. Assuming that the trunk of jack 719 is not busy as shown by the non-lighted condition of busy lamp 720, the operator inserts plug 801 into jack 719, operating sleeve circuit relays 802 and 705, as before described. Relay 802 connects the lower winding of repeater relay 805 through to tip conductor 703. Relay 705 lights busy lamp 720, disconnects grounded positive battery 722 from the uppermost outer armature and contact of relay 704 and tip conductor 703; removes ground 75 from the lower winding of relay 704; and opens

the operating circuit of relay 714. The teletypewriter operator will now transmit by means of a key associated with the position circuit 826 an open period of approximately two seconds. Relay 702 now releases releasing relay 707 and thereby closing a circuit through the winding of selector rotary magnet 708 and sixty interruptions per minute interrupter 711. Brushes 712 and 713 are now stepped around to the second or third contacts of banks 709 and 710, respectively. When the circuit through the winding of relay 702 is closed again after the aforesaid two second interval relay 707 reoperates and closes a circuit from battery through the operated contacts of relay 707, lower operated ON contacts 717, winding of release magnet 718, through second or third contacts of bank 710 to ground on brush 713. Magnet 718 is energized and causes the release of the associated selector switch, restoring Fig. 7 to the condition existing prior to opening the line for the aforesaid two second interval.

The transmission of the open interval as before described also causes simultaneously the release of relay 403, which releases relay 412 and closes a circuit through the winding of selector rotary magnet 413, causing the selector brushes 417 and 418 to be stepped around to the second or third contacts of banks 414 and 415, respectively. When the line circuit is reclosed relay 403 operates, operating relay 412, which opens the circuit of magnet 413 stopping further rotary motion. A circuit is now closed for operating relay 410, which may be traced from grounded battery through the armature and contact of relay 411, contact and lower outer armature of relay 407, winding of relay 410, contact and upper inner armature of relay 408, brush 417 and ground on the second or third contacts of bank 414. Relay 410 locks to ground on its lower armature and contact and at its upper armature and contact closes a circuit from ground through the multiple line lamps 603 and 604, each of which are located at a different position. When relay 403 reoperates a circuit is also closed from ground on the upper inner armature and contact of relay 407, through the winding of release magnet 420, lower operated ON contacts 421 to grounded battery on the armature and front contact of relay 412. Brushes 417 and 418 are now restored to the normal position shown on the drawing of Fig. 4.

A telephone operator observing one of the lighted lamps, 603, for instance, inserts the answering plug 503 of cord circuit C into the associated jack 622, operating sleeve circuit relays 506 and 623 as before described. Relay 407 is operated from grounded battery on the right-hand outermost armature and contact of relay 623, and in operating opens the circuit of relay 410, which releases, extinguishing lamps 603 and 604. At the same time the multiple busy lamps 601 and 602 are lighted over conductors 409 and 636. The teletypewriter operator having selected the trunk of jack 719, is now ready to convey to the distant telephone operator the number of the line of the called station A. A preferred method for doing this is by associating with the selected trunk, an independent circuit, extending from the teletypewriter office to the telephone office, over which circuit, current impulses of a predetermined character are transmitted by the teletypewriter operator, using a dial or some other suitable pulsing mechanism. These impulses are received on a register circuit, which records the

number of the called line. Circuit details of a register circuit, suitable for the requirements of this invention are well known in the telephone art, are not necessary to describe this invention, and accordingly are not shown here.

The telephone operator having determined from a reading of the aforesaid register circuit that a connection with the line of station A is required will insert calling plug 518 into the associated jack 504 after touching the sleeve of jack 504 with the tip of plug 518 to determine whether or not the called line is busy. This is in accordance with usual telephone practice, and accordingly the circuit details whereby this is accomplished are not shown. A circuit is now closed for operating relay 311 which may be traced from grounded battery on the right-hand outer armature and contact of relay 505, through the winding of relay 311 to ground.

When relay 623 operated a circuit was closed for operating selecting magnet 321 of the cross-bar switch. This circuit is traced from ground on the left-hand outer armature and contact of relay 623 over conductors 624, 401, and 320, through left-hand armature and contact of relay 322 and the winding of selecting magnet 321 to grounded battery. Holding magnet 309 controlling the vertical in which is located spring combination 323 on which the line of station A terminates, now operates, as before described, and is held operated under control of relay 311.

When springs 323 are operated, ground on conductor 320 operates relay 322, releasing selecting magnet 321 and disconnecting grounded negative battery 328 from the trunk conductor 326. The normally closed circuit of station A is now extended over conductors 326 and 402, through key 419, winding of relay 403, over conductors 404 and 701, through winding of relay 702, over conductor 703, tip conductors of jack 719 and plug 801, inner upper armature and contact of relay 802, lower winding of repeater relay 805, operated contacts of repeater relay 804, and resistance 823 to grounded positive battery 838.

The telephone operator will now transmit a signal to the teletypewriter operator to signify that the connection of the line of station A has been completed. This may be done conveniently by flashing the calling key 419 for two second intervals as was described hereinbefore in connection with the call originating at station A. In Fig. 4 the brushes 417 and 418 will be stepped around to the second contact terminals of banks 414 and 415 causing relay 637 to operate momentarily and cord circuit supervisory lamp 512 to flash; causing also the momentary operation, due to the release of relay 702 of the supervisory relay 839 and the flashing of lamp 840. The teletypewriter operator knowing now that the connection has been extended to station A will operate the typing key 816 to the left and thereby connect the position circuit 826 for teletypewriter transmission and will call the subscriber of station A by operating the upper case S key of the position teletypewriter which will cause the ringer 350 on the teletypewriter of station A to ring.

Standard commercial teletypewriters are usually arranged to function in this manner. The subscriber of station A will respond by operating the switch 301 which disconnects the winding of printer magnet 331 from ground and connects it to line conductor 303 extending to the telephone central office, then over the outermost left-hand armature and front contact of relay 311, conductor 303', through the lower winding

of relay 308, to grounded negative battery 332. Switch 301 also closes a circuit through the teletypewriter motor 305, which starts. The subscribers of stations A and B are now ready for teletypewriter communication. When the sending of the message is completed, the subscriber of station B restores switch 918 to normal stopping the motor 924 and connecting ground to the winding of line relay 917. Line relay 909 now being energized through only its lower winding operates and causes the operation of relay 834 which lights the supervisory lamp 835. Likewise the subscriber of station A, operates the switch 301 to its normal position stopping motor 305 and connecting the winding of line relay 331 to ground. To send a disconnect signal to the telephone and teletypewriter operators the subscriber of station A will operate a disconnect or timing key holding the line circuit open for approximately ten seconds. This will cause, as before described, the apparatus of Fig. 4 to operate relay 637 and thereby effect the lighting of supervisory lamp 512 and the apparatus of Fig. 7 to cause the operation of supervisory relay 839 and the lighting of supervisory lamp 840. The telephone and teletypewriter operators observing the lighted supervisory lamps as aforesaid will remove all plugs from their associated jacks, which will result in all apparatus being restored to normal as before described.

In the description just given it was assumed that the line of station A was not busy when the telephone operator tested the line jack 504. When the line of the called station is found to be busy, plug 518 is then inserted into a busy jack 531, located in the same position with the line jack 504. Sleeve relay 533 operates in a circuit similar to that described for relay 505 and connects battery at its right-hand inner armature and contact to conductor 534 operating relay 334. Relay 334 closes a circuit for operating holding magnet 335 which may be traced from grounded battery on the inner armature and contact of relay 334, through winding and normally closed contacts of magnet 335 to ground on the armature and contact of selecting magnet 321. A busy signal circuit connected to conductor 336 is now connected to line conductor 326 through the operated cross-bar switch contacts 337, which causes the printing of a distinctive signal on the operator's teletypewriter at the teletypewriter office. When relay 533 operated it also connected the winding of a selector switch rotary magnet 536 to a sixty interruptions per minute interrupter 537. After approximately three seconds interrupter brush arm 538 will rest on the fourth terminal of selector bank 539 and then a circuit will be closed from grounded battery through the winding of relay 540, over brush 538, fourth terminal of bank 539, winding of relay 541 to ground on the left-hand inner armature and contact of relay 533. Relays 540 and 541 operate. Relay 540 in operating connects ground to lead 542 thereby closing a shunt path around the interrupter 537 and preventing a further movement of the brush arm 538. Relay 541 also operates and disconnects resistance 543 from the tip and ring conductors of jack 531, thereby opening the circuit through supervisory relay 522 and causing the lighting of supervisory lamp 519. The operation of relay 541 also disconnects through circuit arrangements not shown the busy signal circuit before mentioned from the conductor 336, thereby discontinuing the printing of the busy signal at the teletypewriter office. If, when the operator plugs into the jack 531, the

supervisory lamp 519 should immediately light, this will be an indication that another operator previously has plugged into another jack, such as the multiple jack 532. It will be necessary then for the operator to withdraw plug 518 from jack 531 so that with all jacks unoccupied a circuit will be closed from ground 544, through the right-hand outer armatures and contacts of all sleeve relays, including relays 545 and 533, the operated ON springs 546 and winding of release magnet 547 to grounded battery. Brush 538 is then restored to normal and when the operator inserts plug 518 into jack 531 the busy signal will be transmitted for approximately three seconds until disconnected by the operation of relay 541 as before explained.

What is claimed is:

1. In a printing telegraph switching system, a plurality of subscribers' stations, a central office, a manually operated telephone switchboard at said central office, link circuits at said switchboard, a plurality of circuits respectively connecting said subscribers' stations to said central office and terminating in said switchboard, a second central office, a telegraph switchboard at said second central office, a plurality of trunk circuits interconnecting said offices, characterized in this that an automatically operated means comprising a system of coordinate axes at said first-mentioned central office is arranged to interconnect any one of said subscribers' circuits and any one of said trunk circuits under the control of any one of said link circuits.

2. In a printing telegraph switching system according to claim 1 wherein the automatically operated means is a switch of the cross-bar type.

3. In a switching communication system, a plurality of subscribers' stations, a central office, a multi-position telephone switchboard at said central office, a plurality of line circuits each connected at one end to one of said subscribers' stations, a second central office, certain of said line circuits each connected at the other end to the first-mentioned central office and the other of said line circuits each connected to said second central office, a multi-position telegraph switchboard at said second central office, a plurality of trunk circuits interconnecting said telephone and said telegraph central office, a multi-contact switch having coordinately operable elements under the control of an attendant at said telephone switchboard, linking means at said telephone switchboard for effecting the connection of any one of said certain line circuits through the elements of said multi-contact switch to said trunk circuit, and linking means at said telegraph switchboard for effecting the connecting of each of said trunk circuits to any one of said other line circuits for communication purposes.

4. In a switching communication system, a plurality of subscribers' sets, a central office, a multi-

position telephone switchboard at said central office, a plurality of line circuits respectively connected to said subscribers' stations, a multi-contact switch having coordinately operable elements whereat certain of said line circuits are respectively terminated, a plurality of trunk circuits, respectively arranged, under the control of the operator at said switchboard, to be selectively connected through the coordinately operable elements of said multi-contact switch to said certain line circuits or vice versa, a second central office at which the other of said line circuits and said plurality of trunk circuits terminate, a multi-position teletypewriter switchboard at said second central office having link circuits for interconnecting any one of said other line circuits and any one of said trunk circuits for telegraphic communication between any two of said subscribers' stations.

5. In a switching communication system according to claim 4 wherein the multi-position telephone switchboard comprises a circuit arrangement for each of said line circuits and each of said trunk circuits terminating at said telephone switchboard, each of said arrangements being common to all the positions of said telephone switchboard, and provided with relay means operative in response to the establishment of a communication connection of any one of said line circuits or any one of said trunk circuits at any one position of said telephone switchboard and signaling means controlled by said relay means and effectively operable only when another communication connection is attempted at another position connected to an operated circuit arrangement to thereby insure an established connection against interference from any other position of said telephone switchboard.

6. A combined telephone and telegraph system comprising a relatively small number of telegraph subscribers' stations, a telephone central office, a line extending from each of said subscribers' stations and terminating at said telephone central office, a manually operated switchboard at said central office having in addition to the usual telephone equipment for handling telephone calls terminals of a plurality of telegraph trunks for extending calls from a calling telegraph subscriber, a telegraph central switchboard for receiving said extended calls, means including cord circuits whereby the telephone switchboard operator may answer an incoming telegraph call and may select an idle telegraph trunk terminal, and means responsive to the operation of the answering and selecting means and comprising a cross-bar switch associated with the telephone operator's position for connecting the calling telegraph subscriber's line directly to the selected trunk to thereby extend the call to the telegraph central switchboard.

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