

Sept. 14, 1937.

J. L. HYSKO ET AL
TELETYPEWRITER SYSTEM

2,093,080

Filed Oct. 6, 1934

6 Sheets-Sheet 1

FIG. 3

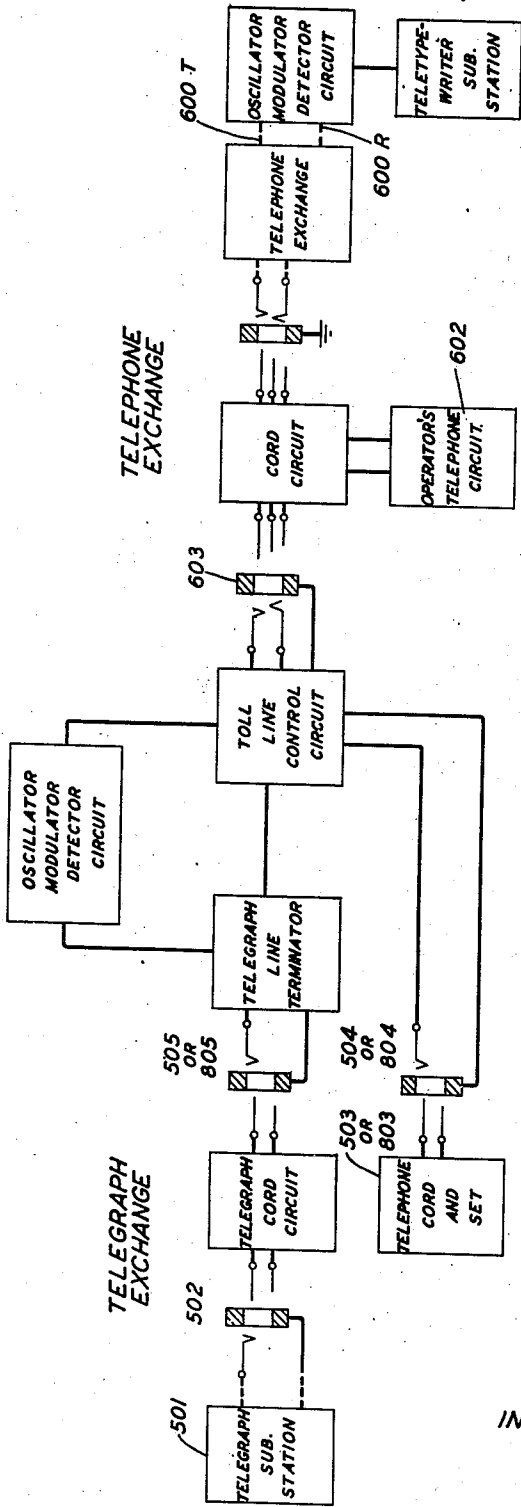


FIG. 1

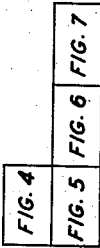
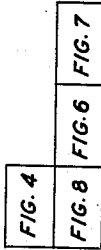


FIG. 2



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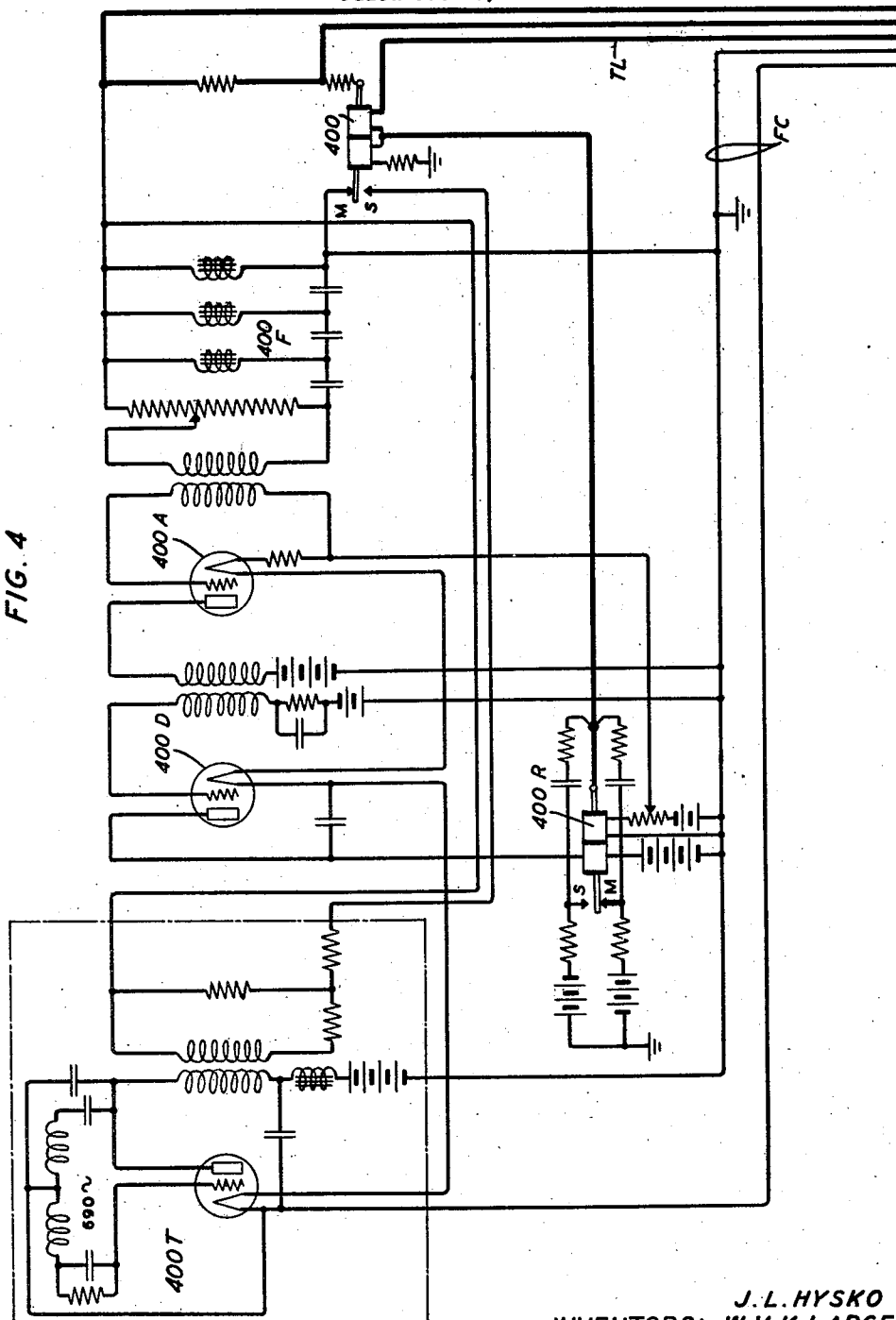
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6 Sheets-Sheet 2



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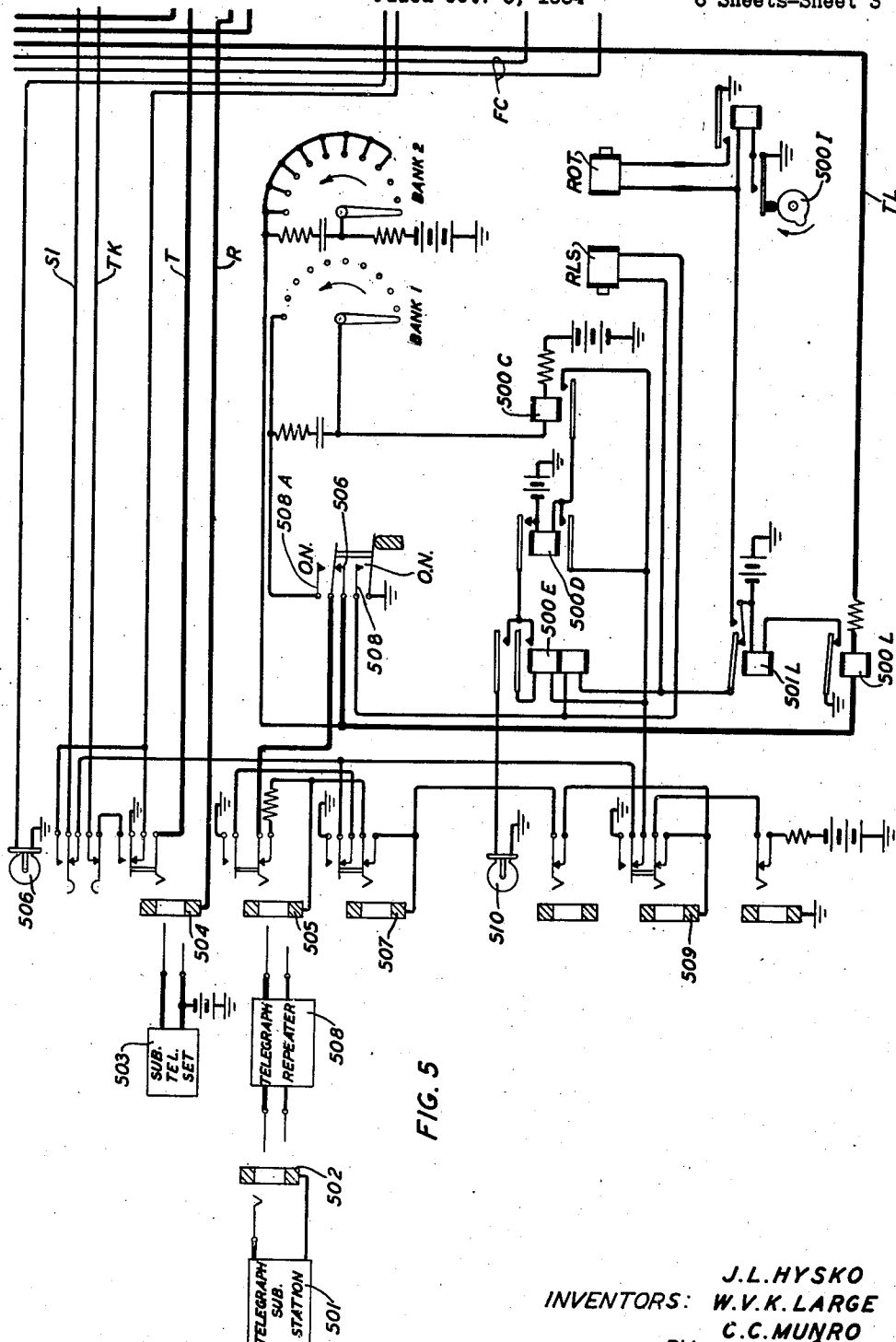


FIG. 5

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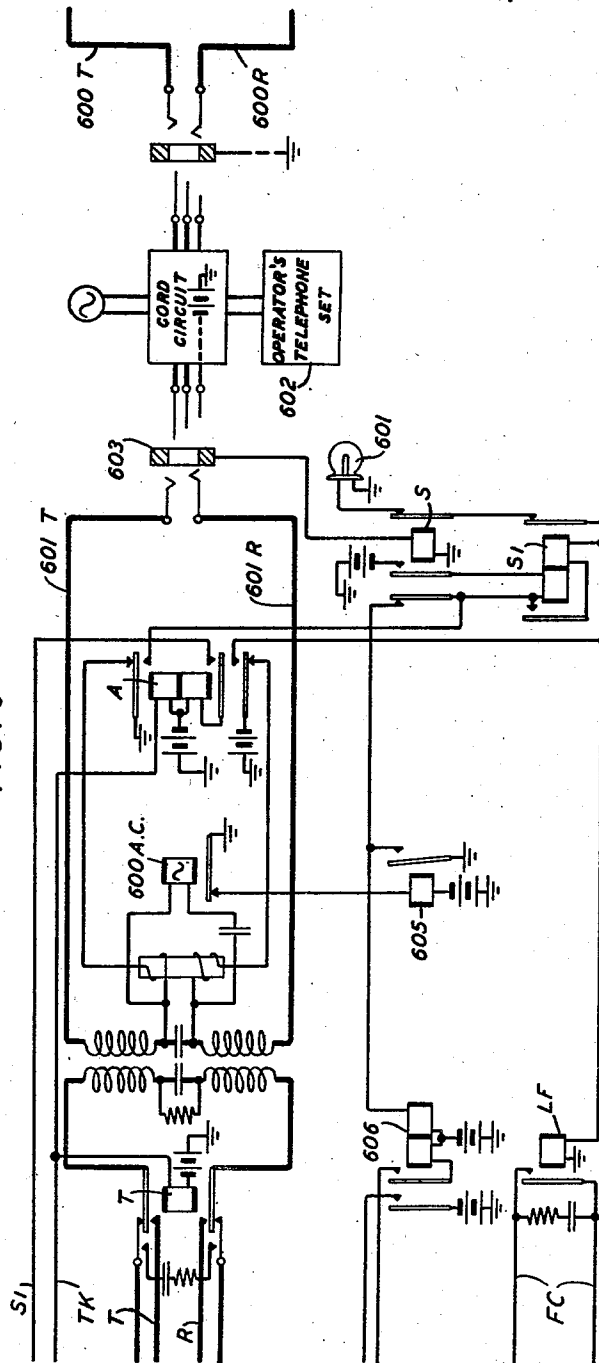
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FIG. 6



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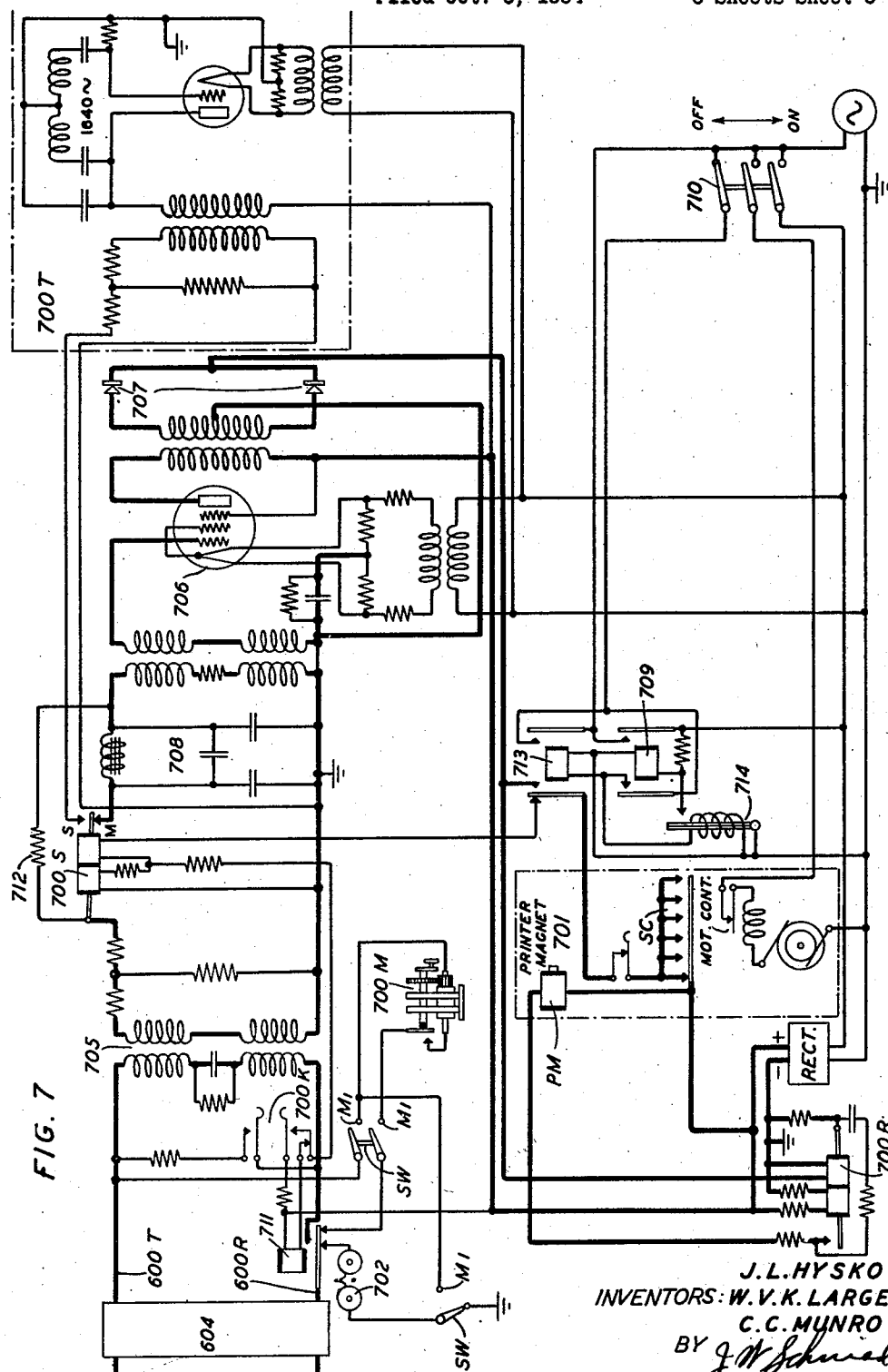
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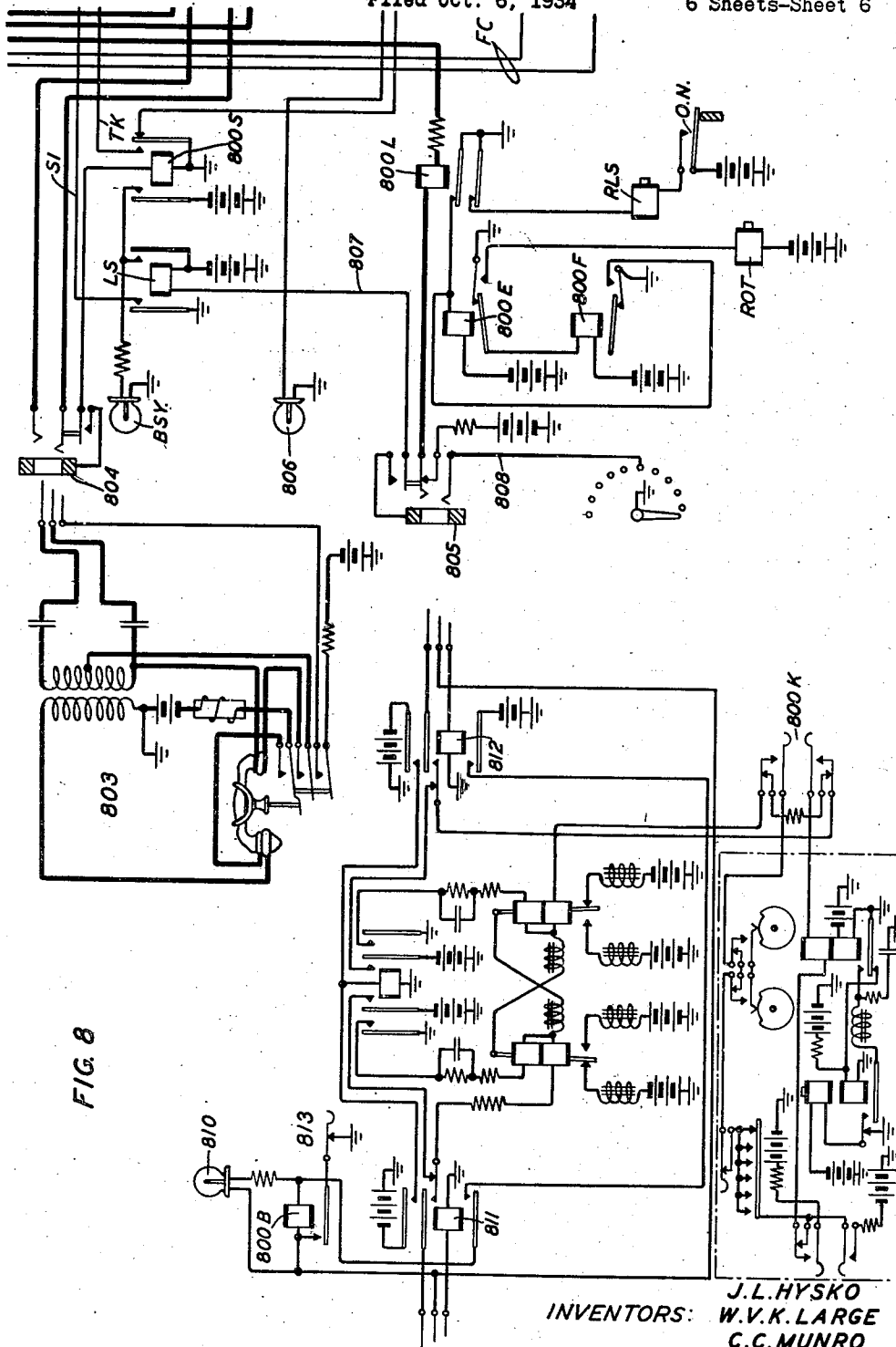
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TELETYPEWRITER SYSTEM

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UNITED STATES PATENT OFFICE

2,093,080

TELETYPEWRITER SYSTEM

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Application October 6, 1934, Serial No. 747,136

23 Claims. (Cl. 179-4)

This invention relates to teletypewriter communication circuits whereby exchange service may be rendered to one or more subscribers at outlying points from the nearest teletypewriter switching point over available telephone lines to the subscriber's or subscribers' station or stations.

An object of the invention is to provide circuit arrangements whereby teletypewriter subscribers may be connected up to a widely extended network by circuit arrangements which are economically feasible.

Among the subsidiary objects are to provide transmission of teletypewriter signaling impulses by modulated carrier current over circuits consisting in part of a teletypewriter network and in part of a telephone network and to provide supervisory and disconnect signals in connection therewith.

Various other features and objects will appear from the general statement of the nature of the invention and the detailed description of the operation of the various parts thereof.

Preliminarily to a detailed description, assume a teletypewriter exchange network and a subscriber, who, in the general case, may represent a plurality of subscribers in the same general locality but not necessarily upon the same local telephone exchange, said subscriber or subscribers being located so far from the nearest teletypewriter exchange switching point that it is not expedient to extend individual teletypewriter trunk lines to them. At a suitably near teletypewriter exchange switching point, which, in the general case, may be a regular teletypewriter exchange provided with toll line equipment, such as is disclosed in the patent of Lane-Locke, No. 1,979,273, granted Nov. 6, 1934, or similar apparatus located at a suitably modified telegraph test board, there is provided a switching point from which the outlying subscriber may be given teletypewriter exchange service over telephone lines. The telephone lines may extend through the local telephone exchange adjacent the subscriber and then through one or more telephone toll exchanges, if necessary. At the teletypewriter switching point is a teletypewriter jack circuit extending to a normally idle circuit consisting of an oscillator, a modulator and demodulator equipment, which will herein on occasion be called a teletypewriter carrier terminal circuit. The carrier channel therefrom extends to multiple jacks at a telephone toll board through a teletypewriter control circuit and thence through any number of

telephone exchange offices to the office at which the subscriber's line terminates and thence to an oscillator-modulator-demodulator circuit at the subscriber's office which may, by suitable arrangements, be connected to an ordinary subscriber's telephone line in lieu of his telephone subset.

At the teletypewriter switching circuit, a jack is connected to a conductor, lead or line extending, in general, to a teletypewriter exchange system. Means are provided whereby supervisory conversations between the teletypewriter and the telephone toll operators relative to putting through a teletypewriter call proceed to the telephone toll board circuit over a voice circuit but when the operator at the teletypewriter exchange switching point plugs a teletypewriter cord circuit into the teletypewriter trunk thereat, the telephone toll line circuit is seized for the transmission of the voice frequency carrier waves modulated in accordance with teletypewriter signaling impulses to the outlying subscriber. Operation of the toll circuit for the purpose of calling therethrough to establish a teletypewriter communication circuit energizes the filaments of the oscillator-modulator-demodulator circuit so that the filaments are heated up and the circuits prepared for communication without delay.

Circuit arrangements and equipment in accordance with an embodiment of the invention are disclosed in the appended drawings wherein:

Fig. 1 indicates an arrangement of sheets of the drawings showing how the principal figures are to be put together to make a complete system;

Fig. 2 discloses an arrangement of sheets of the drawings to make a modified complete system;

Fig. 3 is a diagram showing the general outline of the system;

Fig. 4 is a simplified circuit arrangement of the oscillator-modulator-demodulator unit which is connected at times in a telegraph trunk channel between a direct current telegraph line and the voice frequency telephone system;

Fig. 5 is a simplified diagram of the operating circuits of a teletypewriter trunk terminating equipment;

Fig. 6 is a simplified diagram of a trunk control circuit;

Fig. 7 is a simplified diagram of the remote subscriber's equipment and circuits;

Fig. 8 is a simplified circuit diagram of a modified form of circuits and apparatus at a tele-

typewriter switchboard, this apparatus in the telegraph portion being in and of itself substantially identical with equipment utilizable for ordinary teletypewriter communication through switchboards over lines not employing carrier frequencies.

A comprehensive view of the various components of the system may be gained by considering each principal component circuit thereof and its principal functions.

The teletypewriter trunk carrier circuit or oscillator-modulator-demodulator circuit accomplishes the following functions:

(1) The generation of carrier current of a suitable fixed frequency in the voice range.

(2) Modulation of the carrier current in accordance with printer signals supplied by the teletypewriter switching equipment connected to and associated with the telegraph switching point, which carrier current is to be transmitted over telephone lines to the outlying subscriber.

(3) Demodulation of carrier current received over telephone lines from the outlying subscriber.

(4) Repetition of the signal impulses, resulting from the demodulation, into the teletypewriter switching equipment looking towards the teletypewriter exchange network.

(5) Transmission of break signals through the circuit in either direction.

The carrier teletypewriter trunk control circuit accomplishes the following functions:

(1) The production of a visible indication of an outgoing call at the telephone toll switchboard.

(2) The giving of a visible and audible indication of an incoming call.

(3) Switching from telephone communication to telegraph communication.

(4) The production of suitable supervisory signals at the toll switchboard.

(5) The reception of incoming signals when the teletypewriter cord circuit is connected into circuit.

(6) Suitable termination of the carrier telegraph circuit when the telephone network part of the system is used for telephone communication.

(7) Closure of the filament heating circuit of the carrier oscillator-modulator-demodulator equipment whenever the telephone circuit is utilized at the telephone toll switchboard.

(8) Production of signal to the teletypewriter switching operator in case of an erroneous disconnect made by the telephone toll operator.

The carrier teletypewriter trunk jack circuit performs the following functions:

(1) Gives a suitable signal proceeding from telephone toll operator.

(2) Provides a talking channel to the telephone toll switchboard.

(3) Provides switching and supervisory facilities for teletypewriter communication.

(4) Distinguishes between the lengths of spacing impulses used for supervision on the teletypewriter circuits.

(5) Furnishes supervisory signals back to the telephone toll operator.

The subscriber's set circuit performs the following functions:

(1) Operates as a switching and interconnecting instrumentality to connect the subscriber's teletypewriter set to his local telephone office.

(2) Permits the subscriber's station operator to call the teletypewriter operator by teletypewriter signals, to transmit and receive teletype-

writer signals and to send recall or disconnect signals to the teletypewriter operator.

(3) Permits the subscriber's station operator to operate his station locally without interfering with a call from the central office operator.

(4) Amplifies and demodulates carrier telegraph signals impressed upon the circuit terminals to produce from carrier telegraph signals of a level lying within the working range of the circuit direct current impulses suitable for operating the teletypewriter.

(5) Provides a suitable source of carrier frequency current preferably different from that used for reception and modulates this carrier current in accordance with the teletypewriter impulses.

(6) Furnishes power through suitable circuit arrangements to operate the subscriber's set and the teletypewriter.

Fig. 3 is a block diagram of the system with the several parts labeled. The object of the equipment is to enable a subscriber at the extreme left of the system of Fig. 3 to communicate telegraphically with a subscriber at the extreme right over a path leading to his nearest telephone exchange.

Systems in accordance with the invention may assume a variety of forms. In one form the teletypewriter call for communication with an outlying subscriber, or vice versa from the outlying subscriber for connection to a teletypewriter network, is assumed to arrive over or to the terminating point of a suitable telegraph line, which terminating point constitutes a station commonly known in telegraph parlance as a telegraph test board. With some modification the equipment at such a board is organized to perform the additional functions necessary to constitute a component part of a system to extend the call to the outlying subscriber. Such modified test board circuits are shown at the central portion of Fig. 5.

Let the telegraph subscriber's station 501 of Fig. 5 represent any subscriber upon a telegraph line however extended and which through one or more teletypewriter exchanges or not ultimately terminates at the jack 502. A suitable signal lamp, not shown, is associated with jack 502 in accordance with test board practice for informing the telegraph test board operator that a call is awaiting on the line connected to the jack 502. It may be considered that the call arrives at the test board over another circuit from another subscriber's station connected to the test board by a circuit of the same kind that leads to subscriber's station 701. The telegraph operator plugs an operator's teletypewriter circuit into the jack 502 and inquires telegraphically what is desired. The desired information may be received from a subscriber at station 501 or from an intermediate operator. We shall suppose that the call is for the subscriber at the station of Fig. 7 having a telegraph equipment 701 associable with a line which terminates at his nearest telephone office in a jack and supervisory lamp which is in all respects similar to a telephone line except that it has a line lamp of a special color for the information of the operator. (The call might be for any other subscriber having similar equipment.)

Having received the information the telegraph operator plugs into the jack 504 an operator's cord circuit 503 equipped with a telephone. Upon doing this ground upon the upper spring of the jack is supplied over the lead TK to relay A. The relay A operates and supplies battery to the lamp

601 which lights. The relay T also operates over the lead TK which connects the leads T and R to the telephone toll operator who plugs her cord circuit into the jack 603 and connects her telephone set 602. The telegraph operator then passes orally to the telephone toll operator the information concerning the wanted subscriber who puts the call through the line 600T, 600R, which line may include none or any number of telephone exchanges 604. The last operator calls the subscriber at the set 701 by the ringer 702 in the manner common in telephone practice. If the subscriber is upon a magneto exchange the switches SW will be closed upon the points M1 which may be assumed to be closed in the case of a magneto exchange to connect magneto generator 700M to the line. Upon the ringing of the bell the subscriber is informed that he is wanted for a teletypewriter communication. The operation of the switch 710 to the "on" position by the subscriber will actuate the relay 711 and perform other functions which will be hereinafter described. Actuation of the relay 711 connects the input circuit of the amplifier tube 706 through the lower contact of the relay 700S which is normally in its lower position. The subscriber's apparatus will then be connected to the line to his telephone exchange to receive telegraphically modulated voice frequency current through repeating coil 705.

Meantime the telegraph operator has placed a telegraph repeating cord into the jacks 502 and jack 505 and thereafter pulled out the telephone cord from the jack 504. Relay T releases. Ground is then supplied over the upper spring of the jack 505 to the lead S1 which closes a holding circuit for the relay A. In operating, the relay A had previously operated the relay S1 over an obvious circuit. When the telephone operator plugs into the jack 603 the relay S operated thereby locking up the relay S1 over the front contact of the relay S to ground on the upper inner contact of relay A. The relay LF operated and closed the filament circuit of the three tubes of the oscillator-modulator-demodulator circuit of Fig. 4. This allows the filaments to become heated so that by the time the subscriber at station 701 answers the tube circuit is ready for communication. The subscribers at stations 501 and 701 are now connected for telegraph communication by means of their respective teletypewriter machines over the circuits connecting them including the circuits of Fig. 4.

Oscillator-modulator-demodulator set between telegraph and telephone lines

Fig. 4 includes the sending oscillator tube 400T, an amplifier tube 400A and a detector tube 400D. When the filaments are heated by a circuit FC which is closed when the relay LF is actuated the oscillator generates current of a suitable frequency in the voice range, for example 690 cycles per second. When a teletypewriter machine in the operator's circuit or a telegraph repeater 508 is plugged into the jack 505 battery is applied to one of the windings of the polar relay 400 over a path from the tip of the jack 505 to the normal selector contact 506, the relay 500L and conductor TL and winding of relay 400 through the other winding of relay 400 to ground. This current cooperating with that supplied from the marking contact of relay 400R actuates the armature of relay 400 to its upper position. Whenever the teletypewriter machine connected directly or indirectly to the jack 505 is operated to produce a

spacing impulse upon the line the relay 400 is actuated back to its lower position. Alternating current of 690 cycle frequency is therefore impressed upon a telephone line to represent spacing impulses and no current on the telephone line represents marking impulses. This current is received in the demodulating circuit of the subscriber provided with machine 701 as will be further discussed hereinafter. When signals are not being transmitted by the relay 400 it is at a standstill in the upper position and received impulses of alternating current of a suitable different frequency, for example, 1640 cycles per second may arrive over the line from the oscillator 700T. This alternating current energizes the input circuit of the amplifier tube 400A and after amplification the energy is supplied to the detector tube 400D which is so adjusted that the rectified current in the output circuit actuates the receiving relay 400R to shift the armature thereof and supply marking and spacing conditions corresponding to marking and spacing current arriving in the detector tube over the tip of the jack 505 to the telegraph line or operator's instrument connected thereto. During the sending process a portion of the carrier current sent out on the line may be reflected back into the carrier terminal equipment due to imperfect balance at repeater points and for possible other reasons. If the time of return of the reflected current should be sufficiently long after the sending of the current into the line the part of the current sent during the spacing interval would be received when the relay 400 was connected to the receiving circuit during the marking interval. False operation might thus result and in order to prevent such false operation the input circuit is tuned or otherwise suitably provided with a filter 400F to prevent the passage of current of the frequency of 690 cycles per second but to pass freely received current of the frequency of 1640 cycles per second.

Reception and transmission by outlying subscriber

Alternating current arriving at the station of the subscriber having the teletypewriter 701 is transformed by the repeating coil 705 and supplied, through a circuit 708 tuned to 690 cycles per second, to the input circuit of a five-electrode tube 706 of a conventional type by means of which the energy is amplified and impressed upon copper-oxide or other suitable full wave rectifying devices 707 from which direct current is supplied to operate the relay 700R. The relay 700R is normally in the upper position when the subscriber's circuit is energized for operation but spacing impulses represented by carrier current upon the line cause its armature to be actuated downwardly. Marking impulses energize the printer magnet PM over an obvious circuit under the control of the relay 700R and spacing impulses cause its release, thereby recording the received signals upon the teletypewriter machine. For the purpose of sending the oscillator 700T is normally producing oscillations of 1640 cycles per second. When the teletypewriter sending contacts SC are opened current will flow through the left-hand winding of relay 700S and operate the relay armature to its spacing contact. This provides two paths for the flow of the alternating current from the oscillator 700T. One path is through the high resistance 712 which will supply alternating current to the receiving amplifier tube 706 and thence to operate the printer

magnet PM in the same manner as it is operated for received signals, in consequence of which the transmitted message is printed locally upon the subscriber's machine. The principal portion of the energy of the transmitted carrier wave is induced into the line circuit through the repeating coil 705 and conveyed through the telephone network to the oscillating-modulating-demodulating circuit of Fig. 4. It is contemplated that all carrier teletypewriter systems in a given exchange area will operate over the same circuit equivalents between the subscriber's set and the local telephone office so that all subscribers' loops, such as 600R, 600T, will be adjusted by means of suitable pads to have the transmission equivalents of the longest subscribers' loops in the area. Reverting again to the operation of the machine 701 in sending, when the sending contacts SC are closed the right-hand winding of relay 700S is connected in shunt to the series combination of the left-hand winding and a resistance with the result that the current in the left-hand winding drops to about three milliamperes while the current in the right-hand winding becomes about thirty-three milliamperes. The direction of these currents through the windings is such as to actuate the armature of the relay to its marking contact and thus connect the line circuit directly to the input circuit of the receiving amplifier through the selective network 708.

If the subscriber wishes to operate his local teletypewriter equipment for test or practice purposes and at the same time be ready to receive a call, the key 700K is operated. This prevents relay 711 from operating and leaves the local circuit ready for operation and his line circuit ready for ringing.

Preparation for call by outlying subscriber

The method by which the subscriber at station 701 originates a call or prepares his circuit for receiving a call will now be discussed. Assuming that the subscriber wishes to make a call he puts the switch 710 into its on position. The relay 709 operates and locks up over a circuit from a blade of switch 710 through a resistance, winding of relay 709 and back to ground of the common alternating current source. The motor of the set 701 is started into operation over an obvious circuit and the relay 711 operated over a circuit extending from the positive side of the rectifier 712 through the relay 711, left-hand winding of relay 700S and back to ground. The filaments of the oscillator tube and amplifier tube 706 are directly energized from transformers connected to the alternating current source. The 1640 cycle current produced by the oscillator is supplied to the line through the upper contact of the relay 700S when the said upper contact is closed. Actuation of the relay 711 closes the ring side R of the line to the repeating coil 705 and likewise lights a line lamp at the central office in the manner customary in telephone practice. In order to indicate to the telephone operator that this is a teletypewriter call, the line lamp may be of a special color or the operator may be specially instructed or directed through other means. The telephone toll operator establishes communication with the teletypewriter operator (in the case of a call from the outlying subscriber) in the following manner:

The telephone toll operator plugs her cord circuit into the jack 503 and rings on the circuit toward the teletypewriter operator with alternating ringing current in the usual manner

common in telephone practice. This actuates the relay 600AC which in turn releases the relay 605 and operates the relay 606 which locks up to ground on the upper spring of jack 504 and lights the teletypewriter toll lamp 508. The teletypewriter operator plugs her telephone cord circuit 503 into the jack 504. This removes ground from the locking winding of the relay 606 which releases and extinguishes lamp 508. The relays A and T operate. In operating, the relay A operates the relay S1 and the relay LF. The relay LF closes a circuit which lights the filaments of the tubes 400T, 400D and 400A. The relay S1 locks up under control of the relay A. The relay T transfers the leads T and R to the talking jack 504 and places a terminating impedance including a resistance and a condenser across the carrier circuit extending from Fig. 4. The telephone operator now gives orally to the telegraph operator the calling subscriber's number. The telegraph operator plugs an operator's teletypewriter cord circuit into the jack 505 and thereafter removes the plug from the jack 504. This releases the relay T but the relay A is held operated through its secondary winding and ground over the lead S1. The telegraph operator then receives from the calling subscriber at the station 701 information as to the party with which the subscriber at said station wishes to communicate. The telegraph operator plugs into the jack 502 which is connected to a line extending, in the general case, to a teletypewriter switchboard of any suitable type or, in the simplest case, directly to a teletypewriter subscriber's station and after the call is answered the connection is completed when the telegraph repeater 508 is plugged up between the jacks 502 and 505. The subscribers then communicate by teletypewriter.

Recalling the teletypewriter operator from the telephone toll position

If the telephone toll operator wishes to recall the teletypewriter operator, she may do this by ringing upon the circuit with her ringing key. The relay 600AC operates and lights the lamp 506 which stays lighted because the relay 606 locks up when no telephone set is in jack 504. When communication between the subscribers ends, the teletypewriter operator will be informed by a disconnect signal on the line connected to jack 502 or by other means as will be hereinafter described and will remove the plug from jack 505. When the teletypewriter cord is taken down from jack 505, the circuit relay A releases which places battery on the ring conductor 601R and ground on the tip conductor 601T which lights the usual cord supervisory lamp (not shown) in the toll telephone operator's cord circuit. Such supervisory lamps and operating circuits therefor are disclosed in numerous patents and are well known to those skilled in the art. The operator takes down the cord circuit 602 which clears the telephone circuit in the usual manner.

Operation of the oscillator-modulator-demodulator conversion unit of Fig. 4

Fig. 4 comprises the oscillator tube 400T and its associated circuits, the detector 400D and the amplifier 400A with an input filter 400F tuned to pass the carrier frequency to be received and to exclude the carrier frequency to be transmitted. The polar sending relay 400 normally stands on its marking contact during the operative condition of the circuit and the relay 400R

likewise normally stands on its marking contact. The polar relay 400 is controlled from the teletypewriter or teletypewriter circuit connected to the jack 505 over a path extending from the tip of the plug, tip of the loop, contact 506, relay 500L, lead TL to the right-hand winding of relay 400, and thence to positive battery on the contact of relay 400R. When the teletypewriter interrupts the path just traced during a spacing impulse, the relay 400 is actuated to its spacing contact and high frequency current is applied thereover to the tip and ring T, R of the voice frequency channel. Thus voice frequency carrier waves are transmitted to the line, the carrier waves being on the line for spacing signals and off the line for marking signals.

For reception from the outlying station 701 the receiving circuit is connected to the line through the armature and marking contact of relay 400. Received waves traverse the filter 400F, are amplified by the amplifier 400A and rectified or detected by the detector 400D. The detector tube 400D is adjusted to such a negative grid potential that the anode current thereof is substantially zero when no alternating current input is received. During the spacing impulse, i. e. carrier on the line, the current in the output circuit of the detector 400D rises sufficiently so that the relay 400R is actuated to its spacing contact and negative battery is impressed upon conductor TL. Because the conductor TL is connected to negative battery at its other end, the telegraph circuit is effectively open thereby causing the telegraph repeater to transmit a spacing impulse through the circuit connected to the jack 502. The battery polarities connected to relay 400R and the line at the repeater may be selected and the windings of relay 400 arranged in accordance with any well known repeater practice.

During sending by actuation of the relay 400, a portion of the carrier current sent out upon the line may be reflected back into the sending circuit due to imperfect balance at repeater points and to other possible causes. Where the time of return of the reflected current is appreciable due to transmission delay in the circuits, a part of this reflected current may arrive after the beginning of a marking interval during which the receiving circuit is connected to the line by the sending relay. If this reflected current reaches the detector, false operation of the receiving relay 400R might occur which would produce errors at both the sending and receiving teletypewriter instruments. This is one of the reasons for the inclusion of the filter circuit 400F which is designed to pass current of the frequency of 1640 cycles per second produced by the oscillator 700T but to attenuate and suppress current of the frequency of 690 cycles per second produced by the oscillator 400T.

As stated before, the receiving relay 400R has on its spacing contact battery of the same polarity as that which is applied to the other end of the circuit to which the lead TL is connected and upon its marking contact is battery of the opposite sign.

As will be readily seen, a break signal can be transmitted in either direction from the break key upon the teletypewriter instrument or by other suitable means. If printing telegraph signal impulses are being transmitted to the outlying station the outlying station may send a break signal by impressing carrier current on the line continuously for one or two seconds. This causes the receiving relay 400R to be operated to

its spacing contact at any time the sending relay 400 is on its marking contact. When this occurs, it is impossible for the sending relay to be operated from marking to spacing and hence the receiving relay remains on its spacing contact as long as the continuous carrier current is being received. During this condition current in the circuit connected to lead TR remains zero whether the loop is open or closed and the break signal is transmitted to the circuit connected to the lead TL. In order to prevent the transmission of break signals long enough to operate the supervisory signals, the station operator may be specially instructed or provided with a device limiting the duration of break signals from the break key of the teletypewriter.

Disconnecting the subscriber's station

To disconnect, a subscriber at the station 701 operates the switch 710 to the "off" position. This will bring up the supervisory signal at the teletypewriter operator's position in the manner hereinafter described. By leaving the switch 710 in the "off" position, the thermal element will function in approximately ten seconds and shunt the relay 701 after which all power is cut off at the subscriber's station and the circuit is returned to normal.

Incoming call at outlying subscriber's station

In the case of an incoming call, ringing current from the switchboard at the outlying telephone office will operate the ringer 702 which will call the attention of the station operator. The operator will operate the switch 710 to the "on" position which will energize the station equipment in the same manner as when a subscriber at station 701 makes a call.

Operation of subscriber's circuit for recalling or disconnecting

Assume that a complete communication circuit has been set up and that the subscriber at station 501 is in communication with the subscriber at station 701. The subscriber at station 701 wishes to recall the teletypewriter operator to remedy a line trouble or for some other reason. The station operator operates the switch 710 to the "off" position momentarily and then back to the "on" position. The relay 709 remains locked by the switches in the "off" position but the relay 713 is operated while the switch is in the "off" position and locks up in series with the contacts of relay 709. The thermal element 714 is thus energized and after a predetermined time which we may assume to be ten seconds, the thermal element is operated to close its contact. This shunts the relay 709 which releases and the relay 713 which also releases.

Operation of the teletypewriter trunk jack circuit

The operation just described will place continuous carrier current upon the line for approximately ten seconds which will actuate the circuit devices of Fig. 5 to produce a supervisory signal at the teletypewriter operator's position. The operation by which this takes place will now be described:

One of the features is a time-limiting circuit whereby spacing signals sent to the telegraph network by the outlying subscriber cannot exceed a predetermined duration, for example, in the present case, five seconds. Upon reception of a spacing signal from the operator at the station 701, the relay 500L (Fig. 5) releases. One

reason why this is desirable is that the telegraph network may include exchanges whereat seven and ten second break signals may produce automatic recall and disconnect signals, respectively.

Ground is removed from the relay 501L which also releases but it is a slow release relay and upon normal signaling impulses it does not release before relay 500L reoperates. In the case of a long spacing signal, relay 501L releases and battery is put on a rotating magnet ROT in series with interrupter 500I which operates at 120 interruptions per minute. On the first step of the rotary switch, the contact 500 is opened and contacts 500 and 500A which are the off-normal contacts of the switch are closed. The brush of bank 2 upon the third step of the switch supplies negative battery of signaling voltage over the brush through the winding of relay 500L to the lead TL which replaces the battery normally supplied for the telegraph repeater and provides battery to release the circuit when the marking condition is restored. If the circuit is held opened for five seconds or more, the brush of bank 1 steps to the tenth point and supplies battery through relay 500C toward jack 505 at the telegraph operator's position. The relay 500C, upon operating, operates the relay 500D if a cord is plugged into the jack 505 or the jack 507. The relay D locks up over contacts on the jack 509 if a cord is plugged into the jack 505 or the jack 507 and the telegraph lamp 510 is lighted. When the circuit closes, the relay 500L reoperates which reoperates the relay 501L. The circuit is then closed to the release magnet RLS from battery over the back contacts of relay 501L. In the meantime, the relay 500E has operated from battery on the make contact of relay 501L and it locks up under control of the relay 500D from battery over the upper make contact of relay 500D, inner make contact of relay 500E to ground on jack 505 or 507 over a contact of jack 509. The operator observes the lighted lamp 510 and challenges on the circuit by plugging a monitoring teletypewriter circuit into the jack 509. This releases the relays 500D and 500E and extinguishes the lamp 510. The operator then challenges upon the circuit and in the case of a recall signal she receives the necessary information transmitted from the subscriber's teletypewriter.

In the case of a disconnect signal there will be no answer upon the circuit and the circuit will be pulled down and released.

Modification terminating directly at a teletypewriter switchboard

In a modified circuit arrangement which is preferred for use if the outlying subscriber or subscribers are sufficiently near to a teletypewriter exchange, a circuit arrangement in accordance with Fig. 8 will replace that of Fig. 5. Fig. 8 consists of two parts, namely, a cord circuit and a line terminating circuit. The cord circuit is essentially in accordance with the disclosure of the above mentioned Patent 1,979,273, to which reference is made for a full disclosure. The line terminating equipment appears at the exchange as a trunk circuit termination especially identified to the operator. This line termination includes a talking jack 804 and a teletypewriter jack 805. In Figs. 1, 2, and 3 of said application there are disclosed forms of subscribers' lines and line terminating equipment which are understood to be a part of the exchange and to or from which connections may be made to communicate with a subscriber whose station includes the apparatus

701. It will also be understood that the exchange includes trunk lines of the type referred to in said application for connecting to a subscriber through other exchanges. (The subscribers' lines are not shown herein inasmuch as they are fully disclosed in said application.) The particular exchange disclosed in said application is illustrative of exchanges at which lead TL may terminate.

Operation for incoming call

When a telephone toll operator receives a request for teletypewriter service from a distant telephone operator, she will insert the trunk and toll cord 802 into the jack 803 and ring on the circuit. This will operate the relay 800AC which will release the relay 805 and operate the relay 806. This will cause the lamp 806 to light and the teletypewriter switchboard operator plugs into the jack 804 with the telephone set 803 with which the teletypewriter switchboard is equipped. Battery over the sleeve and cord of the jack operates the relay 800S which in turn removes ground from the locked-up relay 806 in the trunk control circuit and extinguishes the lamp 806 but lights the busy lamp BSY. Operation of relay 800S also supplies ground for the operation of the relays T and A in the trunk control circuit. The relay T connects the tip and ring of the trunk to the talking jack 804. The operators may then converse and the teletypewriter operator secures the calling subscriber's number from the originating telephone operator. The teletypewriter operator then inserts the answering plug of the teletypewriter cord circuit into the jack 805 and thereafter takes down the cord that is plugged into the jack 804. This releases the relay 800S which removes ground from the lead TK and allows the relay T to release. The trunk is then in condition for telegraph communication. When the teletypewriter cord is plugged into the telegraph line, the relay LS operates from ground over the sleeve of the cord and jack of the telegraph line over the lead 807. It will be noted that the sleeve of the answering plug is grounded. The operation of the relay LS places ground on the conductor S1 to maintain the relay A operated and hold the trunk circuit in a condition for telegraph communication. The busy lamp BSY is maintained lighted by relay LS. The operator now operates the monitoring or listening key 800K and places her teletypewriter instrument in the cord circuit for communication with the subscriber having a teletypewriter 701. The call is then completed to a called line by the answering jack in the same manner as teletypewriter calls are completed by means of the system disclosed in the application of Lane and Locke above referred to. If the telephone toll operator wishes to recall the teletypewriter operator she can ring on the circuit which operates the relay 800AC in the trunk control circuit and causes the lamp 806 to be lighted. With a cord plugged into the telegraph toll line the lamp 806 is lighted over the locked-up relay 806. It will be assumed that the telephone toll operator goes into the circuit with her monitoring key operated in order to avoid mutilating the telegraph signals. When a disconnect signal is received over the telegraph toll line and the teletypewriter cord, the operator will take down the teletypewriter cord. Removal of the teletypewriter cord will release the relay LS which in turn causes the relay A in the trunk control circuit to release which lights the usual cord circuit supervisory lamp (not shown)

in the telephone toll operator's cord circuit. Release of relay LS extinguishes the busy lamp BSY. The telephone toll operator then takes down the cord from the associated jacks in accordance with customary routine.

In case the toll operator disconnects in error, the relay S in the trunk control circuit will release. Ground on the upper make contact of relay A will operate the relay 806 and light the lamp 806. Relay S will not light the lamp 801.

Outgoing call

When a call is received from the teletypewriter network for a subscriber to be reached by a carrier operated loop the teletypewriter operator inserts the plug of the cord of the set 803 in the jack 804. This operates the relay 800S and causes relays in the trunk control circuit to operate in an obvious manner to connect the leads T and R of the trunk circuit to the jack 804 and to light the lamp 801 at the toll switchboard. The teletypewriter operator passes verbally the information necessary to identify the called subscriber and the operator then plugs a teletypewriter into the telegraph toll line. Ground over the sleeve of the cord operates the relay LS which provides holding ground for the relay in the trunk control circuit. For a disconnect in error, the mode of operation is the same as for a call passing in the opposite direction. If a disconnect is received over a line connected to the left end of the cord circuit in Fig. 8, the operator challenges with her teletypewriter. If the call is finished, she pulls down the connection of the answering plug of the cord or jack 805 which releases the relay LS. The release of the relay LS opens a holding path for the relay A and lights the cord supervisory lamp in the telephone toll operator's cord circuit. The telephone toll operator then clears the circuit in the usual manner.

Let us suppose that a circuit has been set up between two subscribers and that their communication has ended or that the subscriber at the station 701 desires to recall the teletypewriter operator. The subscriber at station 701 sends a break signal of ten seconds duration as described. At the teletypewriter operator's station of Fig. 8 the relay 800L releases. This causes the release of the slow-acting relay 800E which causes energization of the selector rotating magnet ROT which steps one step and at the same time the off-normal contact is closed. The relay 800F releases which operates the relay 800E which again releases the relay 800F. Upon every release of the relay 800E the selector steps for another point. The lead 808 is wired to a terminal of the selector at which the brush of the selector will arrive in a predetermined time, for example, five seconds. Assuming that the chosen time is five seconds and that the brush reaches the fifth terminal in five seconds then at the expiration of such time the lead 808 is connected to ground over the selector brush and this establishes a circuit to the ring at the jack, ring of the plug, relay 800B and disconnect lamp 810 in parallel through the lower make contacts of sleeve relays 811 and 812 which are closed when the cord is plugged into two jacks, to battery. The relay 800B locks up to ground through the key 813. When the line closes, the operator connects her teletypewriter machine to her cord circuit and challenges. If the subscriber wishes to recall the operator he answers the challenge and gives the desired information but if there is no answer the operator pulls the plug from the jack.

When the line closes at the end of the ten second break the relay 800L reoperates and the release magnet RLS is operated. This restores the circuit to normal. When the operator pulls the plug from the jack 805, the relay LS releases thereby putting out the busy lamp and the circuit of Fig. 8 is returned to normal.

In the foregoing description and in the drawings numerous auxiliary devices and features, such as current limiting resistances, fuses, testing jacks, variable features of elements, night alarms, multiple connections to jacks and lamps, spark killers and numerous other features employed in commercial practice have been omitted to simplify the description, but it is understood that all such customary features may be used if and when desired.

What is claimed is:

1. A system for giving teletypewriter exchange service to a subscriber equipped with a teletypewriter over an exchange and line network otherwise usable for telephony comprising a line of telephone transmission characteristics extending from said subscriber's station to a telephone central office, a trunk circuit from an exchange on said exchange network to a teletypewriter switching position, means for intercommunicating by telephone between a teletypewriter operator at the teletypewriter exchange terminus of said trunk and a telephone operator at the telephone exchange terminus of said trunk, means under the control of the operator at the teletypewriter office for seizing said trunk for teletypewriter communication in combination with an oscillator-modulator-demodulator set operatively connected between said teletypewriter office and said trunk when said trunk is so seized and an oscillator-modulator-demodulator set operatively connected between said subscriber's teletypewriter and his line to said telephone central office, said oscillator-modulator-demodulator sets each including means for producing oscillations in the telephone frequency range, means for modulating said oscillations in accordance with teletypewriter code and means for detecting modulated oscillations to reproduce teletypewriter code.

2. In a communication system, a trunk circuit normally terminating at each end thereof in a jack, an operator's telephone set adjacent each jack for connection thereto for telephone communication thereover, another jack adjacent one of said jacks, a plug for insertion into said other jack, a carrier wave source and a modulating device for modulating the waves from said source, relay equipment effective upon the insertion of said plug into said second jack and removal of the telephone set from connection with the adjacent jack to interpose said carrier wave source and said modulating device for modulating the waves from said source between said second plug and the jack at the remote end of said trunk and to disconnect said one of said jacks from operative connection to said trunk.

3. In a system in accordance with claim 2, trunk terminating equipment adjacent the one of said two jacks terminating the trunk circuit which is adjacent the said other jack, said trunk terminating equipment including instrumentalities operable over said trunk to cause the operation of a disconnect signal.

4. A teletypewriter system, comprising a teletypewriter line network for switched teletypewriter intercommunication, a telephone system, including a subscriber's local office and a line for teletypewriter communication from said sub-

scriber to said local office, a telephone trunk from said office to a teletypewriter switching position, and means including carrier wave sending and receiving devices, said sending devices being under the control of instrumentalities at said teletypewriter switching position for telegraph communication, and means for seizing a termination of said trunk for teletypewriter communication and communicating by telegraphy thereover.

5. A system in accordance with claim 4, in which the carrier wave sending and receiving devices are at the junction of the telephone trunk and the teletypewriter network and are connected to means for energizing them preliminarily to a teletypewriter subscriber's connection by devices operative upon seizure of a trunk for voice communication between the teletypewriter operator and the telephone toll operator.

6. In a system in accordance with claim 4, devices whereby spacing and break impulses are represented upon the telephone trunk by presence of carrier waves and marking signals by absence of carrier waves.

7. In a system in accordance with claim 4, a signal at the teletypewriter operator's position, relay controlled devices whereby long impulses transmitted from the subscriber over the telephone network energize said signal.

8. In a system in accordance with claim 4, relay controlled devices whereby long impulses transmitted from the subscriber over the telephone network are limited to a predetermined duration at points on said teletypewriter network beyond the first teletypewriter switching point.

9. In a system in accordance with claim 4, jack equipment at the teletypewriter operator's position and a signal device associated with the multiple thereof showing said trunk connected with said jack equipment to be busy, and means causing said signal device to indicate busy when said trunk is seized by a teletypewriter operator for telephone communication and to continue busy so long as said trunk is continued in use for either telephony or telegraphy.

10. In a system in accordance with claim 4, a talking cord circuit and a teletypewriter cord circuit at the operator's position together with trunk jacks, and means whereby insertion of the talking cord circuit into a jack seizes said trunk for voice communication and then insertion of a teletypewriter cord circuit into a jack seizes said trunk for telegraph communication while maintaining the continuity of said trunk and busy signals thereon.

11. A system in accordance with claim 4 including a call signal device at a subscriber's station together with a teletypewriter and carrier frequency conversion equipment and a switch for energizing said teletypewriter and equipment, said switch also acting to remove said signal device from call-operative connection with the line when said equipment is energized.

12. A system for teletypewriter communication including, at the terminus of a subscriber's line, a teletypewriter, an oscillator device controlled by and a receiving tube controlling said teletypewriter, a device operable to energize and deenergize at least one of said oscillator device and receiving tube, and instruments whereby the actuation of said device to deenergize at least one of said oscillator and receiving tube sends a disconnect signal over said line to a teletypewriter central office.

13. A system otherwise in accordance with claim 12 in which actuation of said device for a predetermined short period to deenergize at least one of said oscillator and receiving tubes sends a recall signal to a teletypewriter central office operator.

14. A system for communication between subscribers by means including telegraph code sending and receiving devices in which part of the communication circuit is by carrier current of telephone frequency over a telephone channel through a telephone operator's position to a telegraph operator's position, said system including a supervisory signal at the telegraph operator's position and devices whereby the subscriber can operate said signal over a circuit through the telephone operator's position without the knowledge or attention of the telephone operator.

15. A system in accordance with claim 14 having disconnect signal means at a telephone operator's position and devices operable by a telegraph operator to energize said signal means.

16. A system of communication between teletypewriter subscribers in part by direct current impulses and in part by carrier waves over a telephone trunk, said system including a cord circuit at a telephone operator's position and a connecting link at a telegraph operator's position, a signal device at said telegraph operator's position normally non-indicating during telegraph communication, and devices to cause said device to give an indication if the telephone operator erroneously disconnects.

17. A system of communication comprising a subscriber's station having a carrier current supply source, telegraph sending and receiving equipment for modulating said source and adapted to be operated by the current products of demodulated received carrier waves, a channel of communication through normal telephone circuits over which said carrier waves may be transmitted, a trunk from a switching position on said telephone circuit to a switching position on a telegraph communication network, devices whereby an operator may operatively connect to said trunk an oscillator-modulator-demodulator circuit and switching equipment whereby direct current impulses from said network may be supplied to said oscillator-modulator-demodulator circuit for communication in one direction and carrier waves modulated according to direct current impulses supplied from said oscillator-modulator-demodulator circuit for communication in the other direction.

18. A subscriber station including a delayed action thermal device, an operator's station including a signal, a line over which said stations are connectable, means for energizing said thermal device, delayed action means for changing the condition of said signal, and interlock means for said delayed action means and said means for energizing said thermal device whereby said delayed action means and said thermal device are energized together.

19. In a telegraph system, operators' telephone subsets, a carrier wave source, a line terminating in jacks, means for connecting said subsets to two of said jacks, means controlled thereby for rendering said source active, and means for modulating said source according to telegraphic intelligence impulses.

20. A system comprising a line and two teletypewriter instruments connectable over said line for communication, a disconnect signal separate from said instruments, means for placing alter-

nating current of carrier frequency by means of said instruments for intercommunication therebetween, means for placing alternating current of carrier frequency continuously upon said line for at least a definite time, and means whereby said disconnect signal is energized thereby.

21. In a communication system, a trunk, means for connecting said trunk to a source of voice waves, means for connecting said trunk to a source of carrier waves, and impedance terminating means connectable to said source of carrier waves as a substitute for the impedance of said trunk upon connection of said trunk to said source of voice waves.

22. A communication system comprising a line and a source of carrier waves, means for applying waves from said source to said line, means for interrupting the application of said waves, a stepping switch connected to said line to be controlled by said waves and adapted to take suc-

cessive steps in predetermined intervals, and connecting means to cause said switch to step whenever the application of waves from said source to said line is not interrupted for the duration of such predetermined interval.

23. In a communication system for communicating telegraphically by means of start-stop permutation code teletypewriters over telephone operators' cord circuits by carrier waves telegraphically modulated, a source of carrier waves, circuits for transmitting said waves over a telephone operator's cord circuit, a start-stop permutation code machine stopping on a closed line condition, and circuits for impressing a no-current condition on said operator's circuit concomitantly with and as a result of said closed line condition.

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