

Sept. 14, 1937.

J. A. KRECEK

2,093,084

SYSTEM FOR GIVING TELETYPEWRITER SERVICE OVER TELEPHONE LINES

Filed April 30, 1935

5 Sheets-Sheet 1

FIG. 2

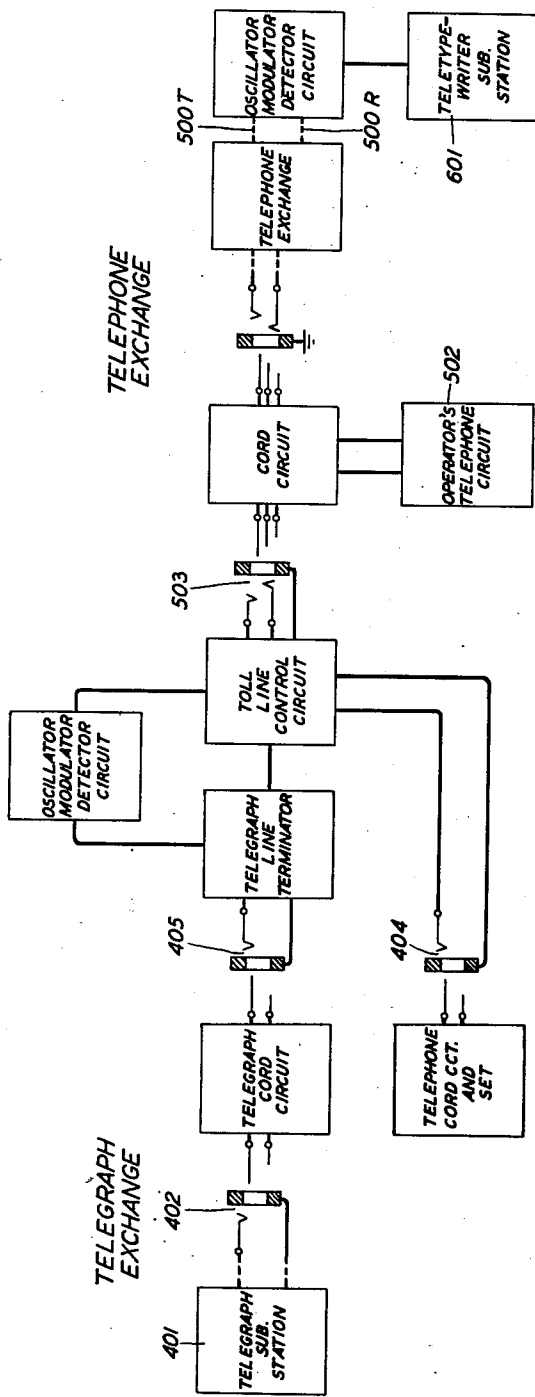
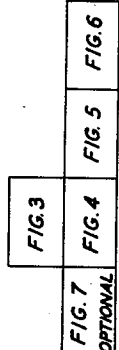


FIG. 1



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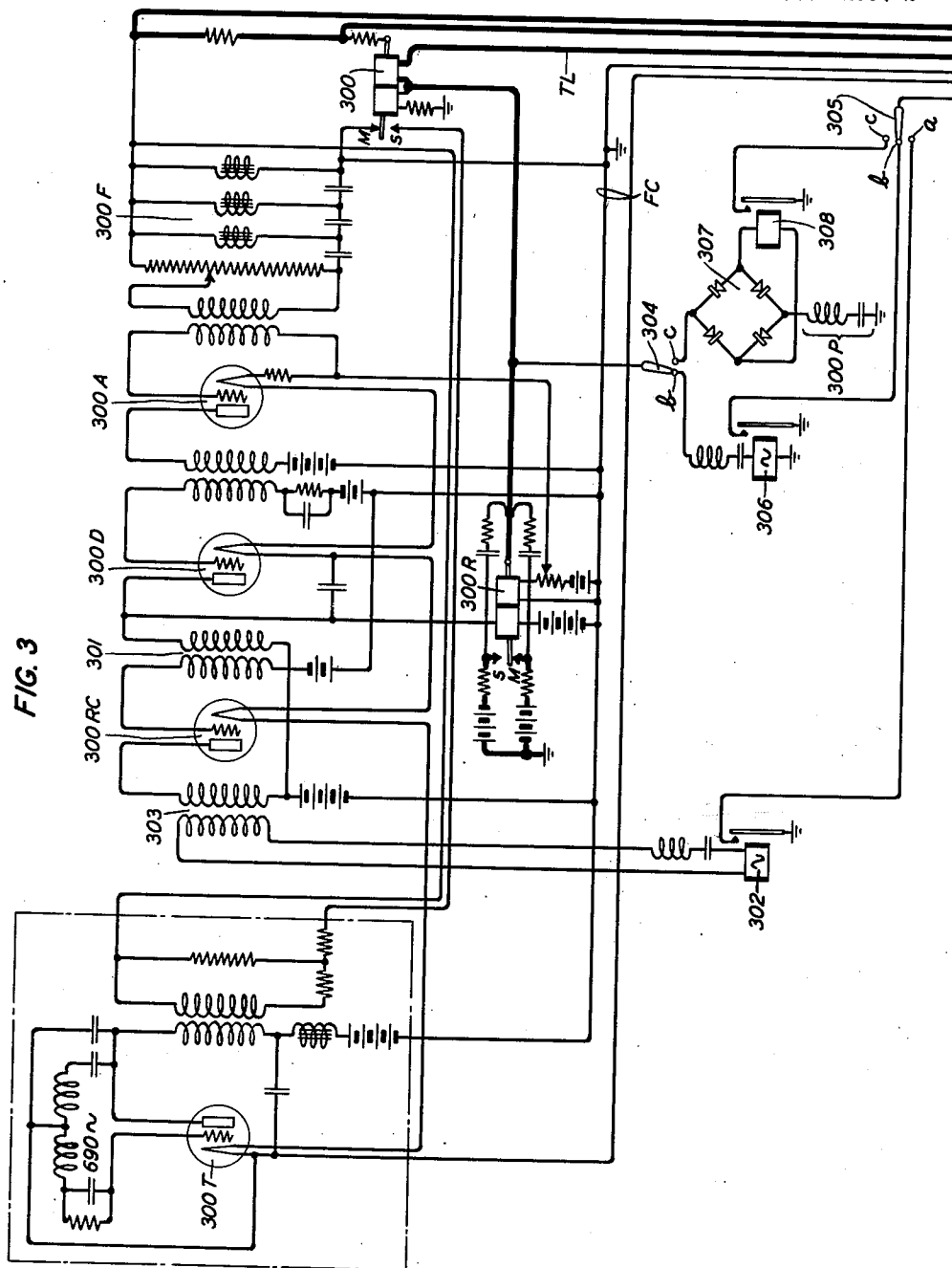
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5 Sheets-Sheet 2



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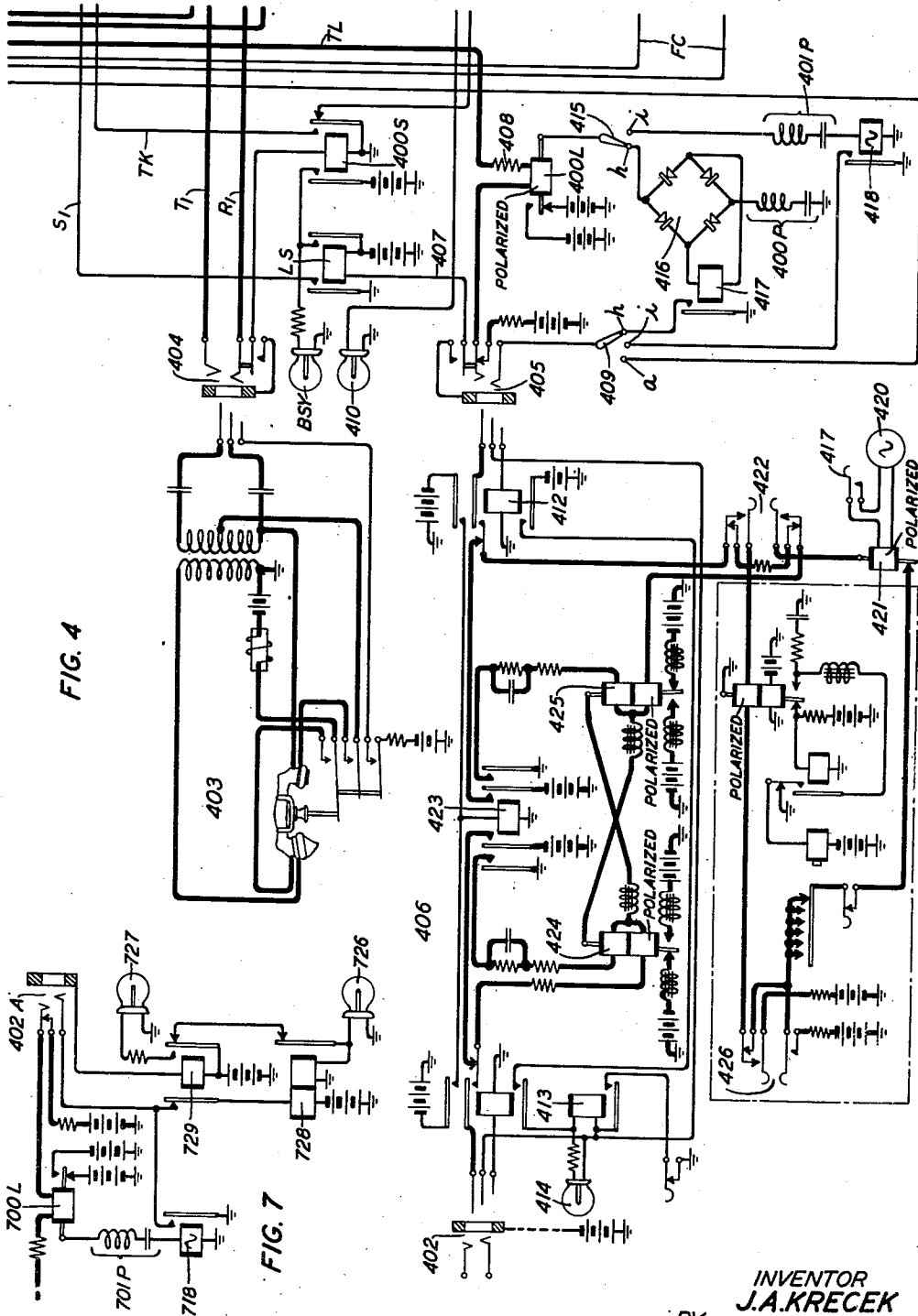
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SYSTEM FOR GIVING TELETYPEWRITER SERVICE OVER TELEPHONE LINES

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5 Sheets-Sheet 3



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SYSTEM FOR GIVING TELETYPEWRITER SERVICE OVER TELEPHONE LINES

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5 Sheets-Sheet 4



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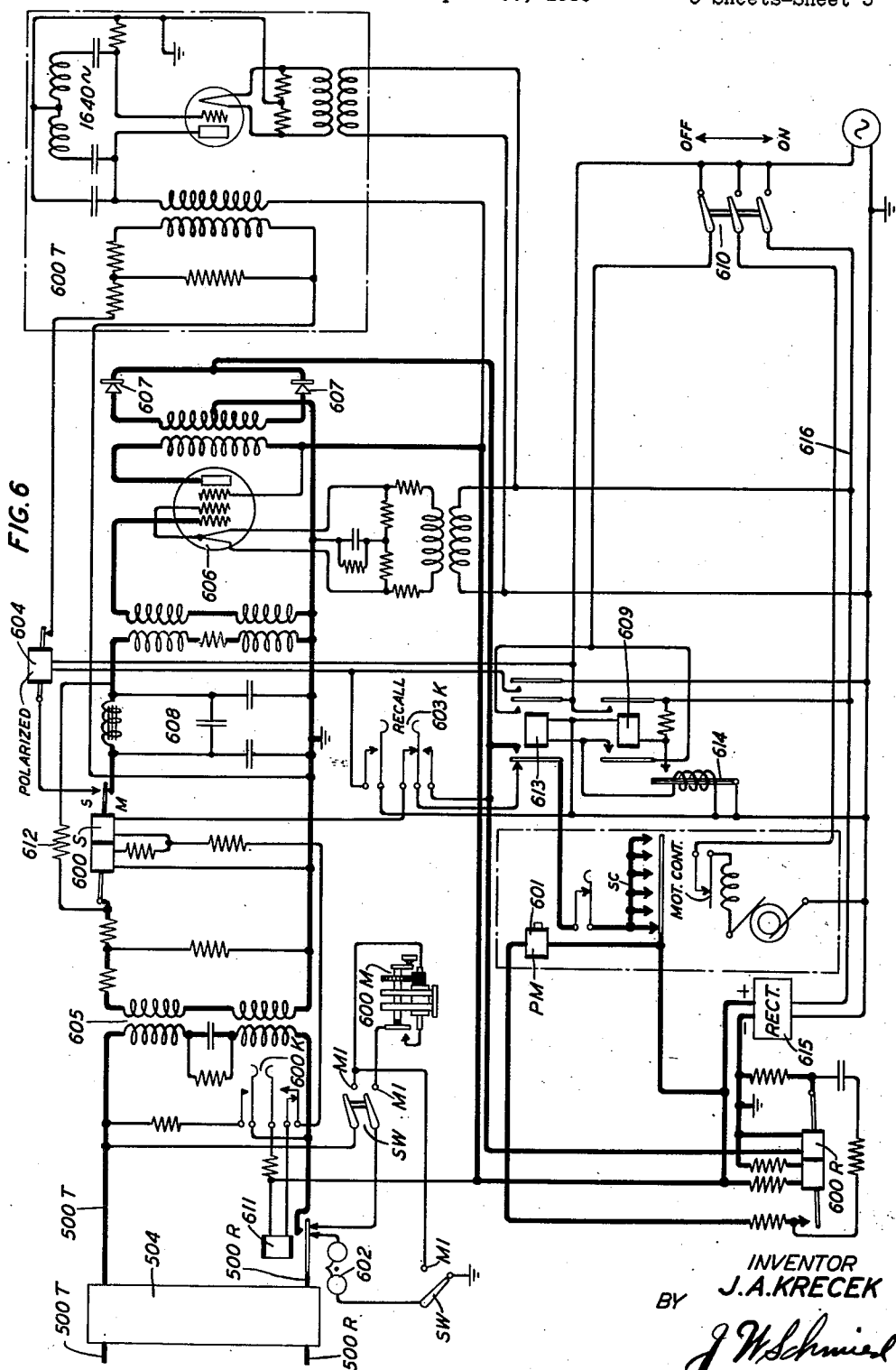
2,093,084

SYSTEM FOR GIVING TELETYPEWRITER SERVICE OVER TELEPHONE LINES

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5 Sheets-Sheet 5

FIG. 6



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UNITED STATES PATENT OFFICE

2,093,084

SYSTEM FOR GIVING TELETYPEWRITER
SERVICE OVER TELEPHONE LINESJoseph A. Krecek, Brooklyn, N. Y., assignor to
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Application April 30, 1935, Serial No. 18,991

13 Claims. (Cl. 178—2)

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 telegraph 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 application of Lane-Locke, Serial No. 631,016, filed August 30, 1932, patented Nov. 6, 1924, No. 1,979,273, 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 oscillator-modulator-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.

The present invention relates particularly to supervisory signal arrangements. In a previous arrangement, several seconds were required to send a recall or disconnect signal from the outlying subscriber's station to the teletypewriter operator. This not only tied up the telegraph circuit for the required several seconds but also tied up the telephone trunk connection for the required several seconds. Inasmuch as both the telegraph circuit and the telephone trunk circuit include expensive equipment and lines, their more effective utilization is economically desirable.

To this end, recall and disconnect signals may be sent by the outlying subscriber by applying his outgoing voice frequency carrier source to the line and then modulating it with a suitable lower frequency alternating current such as 60 cycles or any other suitable readily available frequency. Suitable equipment at the teletypewriter operator's position may then be energized by other selective equipment connected to the oscillator-modulator-demodulator circuit to energize and display the required recall or disconnect signal within a fraction of a second.

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 is a diagram showing the general outline of the system;

Fig. 3 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. 4 is a simplified circuit diagram of a modified form of circuits and apparatus at a teletypewriter switchboard, the principal portion of this apparatus in the teletypewriter portion being in and of itself substantially identical with equipment utilizable for ordinary teletypewriter communication through switchboards over lines not employing carrier frequencies;

Fig. 5 is a simplified diagram of a trunk control circuit;

Fig. 6 is a simplified diagram of the remote subscriber's equipment and circuits; and

Fig. 7 is an optional line terminating equipment which may or may not be used with other features disclosed.

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 modulated in accordance with printer signals supplied by the teletypewriter at location of the outlying subscriber and transmitted over telephone lines from said subscriber's location.

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.

6—Demodulation of carrier current modulated in accordance with 60 cycle alternating current or other low frequency current at the location of the outlying subscriber and transmitted over telephone lines from said subscriber's location, said modulated current being transmitted in order to send an instantaneous recall or disconnect signal to the telegraph switching point.

The carrier teletypewriter trunk jack circuit performs the following functions:

1—Gives a suitable signal proceeding from the telephone toll operator.

2—Provides a talking channel to the telephone toll switchboard.

3—Provides switching facilities for teletypewriter communication.

4—Provides for the teletypewriter switching operator a recall and disconnect signal actuated in response to carrier current, modulated in accordance with 60 cycle alternating current, or other low frequency current at the location of the outlying subscriber and transmitted over telephone lines from said subscriber's location.

5—Furnishes supervisory signals back to the telephone toll operator.

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 signals to the teletypewriter switching operator in case of an erroneous disconnect made by 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 teletypewriter 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—Provides for modulating, with 60 cycle alternating current or other low frequency current, the carrier current regularly used for the transmission of teletypewriter signals and for transmitting the modulated current to the teletypewriter switchboard to actuate thereat a recall or disconnect signal.

7—Furnishes power through suitable circuit arrangements to operate the subscriber's set and the teletypewriter.

Fig. 2 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. 2 to communicate telegraphically with a subscriber at the extreme right over a path leading to his nearest telephone exchange.

In order to describe the operation of the invention, the establishment of a teletypewriter connection between two teletypewriter stations will now be discussed.

Let it be assumed that the subscriber at the teletypewriter station indicated at the extreme left of Fig. 2 desires to establish communication with the subscriber at the teletypewriter station

indicated at the extreme right of Fig. 2. The operator in control of the teletypewriter cord circuit 406 of Fig. 4 responds to the call from the teletypewriter network as described in the hereinbefore mentioned patent of Lane and Locke, No. 1,979,273. The cord circuit 406 is essentially in accordance with the disclosure of the said patent. 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 404 and a teletypewriter jack 405. In Figs. 1, 2 and 3 of said patent 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 teletypewriter apparatus 601 of Fig. 6. It will also be understood that the exchange includes trunk lines of the type referred to in said patent for connecting to a subscriber through other exchanges. (The subscribers' lines are not shown herein inasmuch as they are fully disclosed in said patent.)

The teletypewriter operator having been informed telegraphically of the identity of the called subscriber, inserts the plug of the cord of the telephone set 403 in the jack 404. This operates the relay 400S which connects ground to lead TK, thereby causing the operation of relay A. Relay A, in operating, supplies battery to the lamp 501 which lights. The relay T also operates over the lead TK which connects the leads T and R to the circuit terminating on jack 503, into which the telephone toll operator plugs her cord circuit to which is connected her telephone set 502 thereby operating over the associated sleeve circuit relay S, extinguishing lamp 501 and operating relay S1 through its left-hand winding. The teletypewriter operator then passes orally to the telephone toll operator the information concerning the wanted subscriber who puts the call through the line 500T, 500R, which line may include none or any number of telephone exchanges 504. The last operator calls the subscriber at the set 601 by the ringer 602 in the manner common in telephone practice. If a 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 600M to the line. Upon the ringing of the bell, the subscriber recognizes that he is wanted for a teletypewriter communication. The operation of the switch 610 to the "on" position by the subscriber will actuate the relay 611 and perform other functions which will be hereinafter described. Actuation of the relay 611 connects the input circuit of the amplifier tube 606 through the lower contact of relay 600S which is normally in its lower position. The subscriber's apparatus will then be connected over the line to his telephone exchange to receive telegraphically modulated voice frequency current through repeating coil 605.

Meantime the teletypewriter operator has placed the plug of a teletypewriter cord 406 into the jack 405 and thereafter pulled out the telephone cord 403 from the jack 404. Ground through the winding of relay 412 over the sleeve of cord circuit 406 operates the relay LS which provides a holding ground over lead S1 for relay A in the trunk control circuit of Fig. 5. Relay S1, in operating as heretofore described, locks up through its left-hand contacts and right-hand winding under control of relay A independently

of relay 3. The relay LF operates through an obvious circuit and closes the filament circuit of the four tubes of the oscillator-modulator-demodulator circuit of Fig. 3. This allows the filaments to become heated so that by the time the subscriber at station 601 answers, the tube circuit is ready for communication. The subscribers at stations 401 and 601 are now connected for telegraph communication by means of their respective teletypewriter machines over the circuits connecting them including the circuits of Fig. 3. The operator at the cord circuit 406 may, however, split the circuit and communicate with either subscriber individually either prior to or after they have commenced to communicate with each other.

Oscillator-modulator-demodulator set between telegraph and telephone lines

Fig. 3 includes the sending oscillator tube 300T, an amplifier tube 300A, a detector tube 300D, and a tube 300RC which is arranged, according to a particular feature of this invention, to provide an instantaneous recall or disconnect signal under the control of the subscriber 601. Said feature will be hereinafter described. 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 the teletypewriter cord 406 is plugged into the jack 405, battery is applied to the right-hand winding of the polar relay 300 over a path from the tip conductors of cord 406 and jack 405, through the winding of relay 400L, resistance 408, right-hand and left-hand windings of relay 300 in series to ground. This current cooperating with that supplied from the marking contact of relay 300R actuates the armature of relay 300 to its upper position. Whenever a teletypewriter machine is operated to produce a spacing impulse upon the line, the relay 300 is actuated to its lower position. Alternating current of 690 cycle frequency is, therefore, impressed upon the telephone line to represent spacing impulses and no current on the telephone line represents marking impulses. This current is received in the demodulating circuit provided with machine 601 as will be further discussed hereinafter. When signals are not being transmitted by the relay 300 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 600T. This alternating current energizes the input circuit of the amplifier tube 300A and after amplification the energy is supplied to the detector tube 300D which is so adjusted that the rectified current in the output circuit actuates the receiving relay 300R 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 405, to the tip of the teletypewriter cord 406. During this 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 300 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 300F 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 601 is transformed by the repeating coil 605 and supplied through a circuit 608 tuned to 690 cycles per second, to the input circuit of a five-electrode tube 606 of a conventional type by means of which the energy is amplified and impressed upon the copper-oxide or other suitable full wave rectifying devices 607 from which direct current is supplied to operate the relay 600R. The relay 600R 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 selector magnet PM over an obvious circuit under the control of the relay 600R and spacing impulses cause its release, thereby recording the received signals upon the teletypewriter machine. For the purpose of sending, the oscillator 600T 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 600S and operate the relay armature to its spacing contact. This provides two paths for the flow of the alternating current from the oscillator 600T. One path is through the high resistance 612 which will supply alternating current to the receiving amplifier tube 606 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 605 and conveyed through the telephone network to the oscillating-modulating-demodulating circuit of Fig. 3. It is contemplated that all carrier teletypewriter systems in a given exchange will operate over the same circuit equivalents between the subscriber's set and the local telephone office so that all subscribers' loops, such as 500R, 500T 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 601 in sending when the sending contacts SC are closed, the right-hand winding of relay 600S 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 608.

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 600K is operated. This prevents relay 611 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 601 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 610 into its "on" position. The relay 609 operates over a circuit from a blade of switch 610 through a resistance, winding of relay 609 and back to ground of the common alternating current source. The motor of the set 601 is started into operation over an obvious circuit and the relay 611 operated over a circuit extending from the positive side of the rectifier 615 through the winding of relay 611, left-hand winding of relay 600S, and back to ground. The filaments of the oscillator tube and amplifier tube 606 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 600S when the said upper contact is closed. Actuation of the relay 611 closes the ring side R of the line to the repeating coil 605 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 one end of her cord circuit into the jack 504 in response to the call from the subscriber 601, and then the other end of said cord circuit into jack 503. She then rings on the circuit toward the teletypewriter operator with alternating ringing current in the usual manner common in telephone practice. This actuates the relay 500AC which in turn releases the relay 505 and operates the relay 506 which locks up to ground on the back contact of relay 400S and lights the teletypewriter toll lamp 406. The teletypewriter operator plugs her telephone cord circuit 403 into the jack 404. This operates relay 400S, thereby releasing relay 506, extinguishing lamp 406, lighting busy lamp BSY and operating relays A and T, Fig. 5. In operating, the relay A operates the relays S1 and LF. The relay LF closes a circuit which lights the filament of the tubes 300T, 300RC, 300D and 300A. The relay S1 locks up under control of the relay A. The relay T transfers the leads T and R connected to the talking jack 404 and places a terminating impedance including a resistance and a condenser across the carrier current extending from Fig. 3. The telephone operator may or may not now give orally to the telegraph operator the calling subscriber's number. The telegraph operator plugs an operator's teletypewriter cord circuit 406 into the jack 405 and thereafter removes the plug from the jack 404. This releases the relay T but the relay A is held operated through its lower winding over lead S1 to ground on the left-hand contacts of relay LS which operated in series with relay 412 when the cord 406 was plugged into jack 405. The telegraph operator may then transmit to and receive from the

calling subscriber at the station 601 information as to the party with which the subscriber at said station wishes to communicate. The telegraph operator plugs into the jack 402, 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's subscriber's station. After the call is answered, the subscribers communicate by teletypewriter through the cord circuit 406, the operating details of which are described in the hereinbefore mentioned Lane-Locke patent.

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 500AC operates and causes the lighting of the lamp 410, which remains lighted because the relay 506 is locked up to ground on the back contacts of relay 400S. When the teletypewriter operator answers the recall signal by plugging into jack 404, relay 400S operates releasing relay 506, thereby extinguishing lamp 410. Communication with the toll operator is now established as hereinbefore described. When communication between the subscribers ends, the teletypewriter operator will be informed by a disconnect signal, actuated by means of a circuit arrangement which is a particular feature of this invention and which will be hereinafter described. In response to the disconnect signal, the teletypewriter operator removes the plugs of cord 406 from jacks 402 and 405. Relays 412 and LS release. Relay LS in releasing releases relay A which places battery on the ring conductor 501R and ground on the tip conductor 501T 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.

Operation of the oscillator-modulator-demodulator conversion unit of Fig. 3.

Fig. 3 comprises the oscillator tube 300T and its associated circuits, the detector tube 300D, the amplifier tube 300A, and the recall-disconnect tube 300RC, with an input filter 300F tuned to pass the carrier frequency to be received and to exclude the carrier frequency to be transmitted. The polar sending relay 300 normally stands on its marking contact during the operative condition of the circuit and the relay 300R likewise normally stands on its marking contact. The polar relay 300 is controlled from the teletypewriter or teletypewriter circuit connected to the jack 405 over a path extending from the tip of the plug of cord circuit 406, tip contacts of jack 405, winding of relay 400L, resistance 408, and right-hand winding of relay 300 to positive battery on the contacts of relay 300R. When the teletypewriter interrupts the path just traced during a spacing impulse, the relay 300 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 601, the receiving circuit is connected to the line through the armature and marking contact of relay 300. Received waves traverse the filter

300F, are amplified by the amplifier 300A and rectified or detected by the detector 300D. The detector tube 300D 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 300D rises sufficiently so that the relay 300R is actuated to its spacing contact and negative battery is impressed on 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 jack 402. The battery polarities connected to relay 300R and the line at the repeater may be selected and the windings of relay 300 arranged in accordance with any well-known repeater practice.

During sending by actuation of the relay 300, 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 300R 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 300F which is designed to pass current of the frequency of 1640 cycles per second produced by the oscillator 600T, but to attenuate and suppress current of the frequency of 690 cycles per second produced by the oscillator 300T.

As stated before, during telegraph communication the receiving relay 300R 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. This causes the receiving relay 300R to be operated to its spacing contact at any time the sending relay 300 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, the break signal is transmitted to the circuit connected to the lead TL. It is not necessary to guard against a prolonged break signal to avoid the improper actuation of the supervisory signal at the teletypewriter position, as is usual in other systems. The supervisory signal is actuated only when carrier current modulated by 60 cycles or other low frequency current is connected to the line, as will appear from the hereinafter given description.

Operation for a recall or disconnect signal

A particular feature of this invention, hereinbefore mentioned, whereby an instantaneous re-

call or disconnect signal may be sent to the teletypewriter operator by the outlying station will now be discussed. Assume that a complete communication circuit has been set up and that the subscriber at station 401 is in communication with the subscriber at station 601. The subscriber at station 601 wishes to recall the teletypewriter operator to remedy a line trouble or for some other reason. The station operator operates the key 603K and thereby connects 60 cycle alternating current to the winding of polarized relay 604. This relay now vibrates at a 60 cycle rate. Operation of key 603K also opens the circuit through the right-hand winding of relay 600S which is thereby actuated to its spacing contact, closing the circuit of the oscillator 600T through to transformer 605 and line 500T and 500R. 1640 cycle current modulated at a 60 cycle rate by the armature and contacts of relay 604, is received at the teletypewriter switchboard over the incoming voice frequency carrier circuit, the circuits at which are illustrated by Fig. 3 and Fig. 4. Various optional arrangements whereby said modulated 1640 cycle current effects the display of a signal for the attention of the teletypewriter operator will now be described. The different arrangements are schematically illustrated by the use of movable arm contact switches 304, 305, 409 and 415.

One arrangement of the invention for actuating the recall signal employs a tube 300RC which is coupled to demodulating tube 300D by a transformer 301. Tube 300RC amplifies the 60 cycle output of transformer 301 and thereby operates through transformer 303, relay 302, the winding of which is connected in a circuit tuned to 60 cycles. Relay 302, in operating, connects ground to the ring conductor of jack 405, with switches 305 and 409 in position *a*. This causes the operation of relay 413 and the lighting of lamp 414 to which the operator responds as described in the aforesaid Lane-Locke patent.

Another arrangement for lighting the lamp 414, which does not require the use of tube 300RC and its associated apparatus is to make use of the response of relay 300R as it operates in unison with the incoming 60 cycle spurts of 1640 cycle current. This is shown when switches 304 and 305 are in position *b*, and switch 409 in position *a*. Relay 300R, in operating, connects alternately positive and negative battery to the tuned 60 cycle circuit of relay 306 which operates and grounds the ring conductor of relay 405, thereby lighting lamp 414. Still another plan is to use a full wave rectifier 307, tuned to 60 cycles by tuned path 300P, with switches 304 and 305 in position *c*, and switch 409 in position *a*. With this circuit relay 308 operates on direct current and effects the lighting of lamp 414 as before described. Another arrangement is to use a polarized relay 400L in lead TL. This relay responds to the operation of relay 300R and connects positive and negative battery alternately to full wave rectifier 416 tuned to 60 cycles by tuned path 400P, switches 415 and 409 being in position *b*. Relay 417 operates on direct current. Or, another plan is to use relay 418 in a 60 cycle circuit tuned by path 401P, with switches 415 and 409 in position *i*. Any of these alternative arrangements may be used or several of them may be incorporated in one system with appropriate switches for changing from one to the other.

To send a disconnect signal, power switch 610 is operated to the "off" position, thereby tempo-

rarily connecting 60 cycle current to bus bar 616 through the right-hand operated contacts of relay 609 and the upper blade of switch 610. Relay 613 operates through the upper blade of switch 610 in the "off" position and the left-hand operated contacts of relay 609. Relay 613, in operating, connects 60 cycle current with its right-hand outer contacts to the winding of relay 604, disconnects with its left-hand contacts the right-hand winding of sending relay 600S from positive direct current and closes a circuit through the winding of thermal element 614 with its right-hand inner contacts. Relay 604, as before, follows the 60 cycle alternations and immediately effects the display of the supervisory lamp 414. After a short interval which is required to be only sufficiently long for lamp 414 to light, the thermal element 614 functions, short-circuiting the winding of relay 609 which releases, causing thereby the release of relay 613. Relay 613, in releasing, effects the release of thermal element 614. All apparatus at station 601 is now restored to normal. It is to be understood that instead of a thermal element 614, any equivalent arrangement using a slow acting relay may be conveniently used. The single operation of the subscriber required to shut down his station apparatus therefore sends a disconnect signal automatically, i. e., with no attention on his part.

Alternating current supervision over telegraph trunks

In the foregoing description it has been assumed that supervisory communication between the operator at cord circuit 706 and any other operator connected at the far end of a line terminating at jack 402 would be by the method of the Lane-Locke application previously mentioned. However, the operator at cord circuit 706 can call or recall a distant operator or be called or recalled by alternating current transmitted over the telegraph line.

Fig. 7 discloses means for doing this. Let it be assumed that one or more lines terminating at and connected to a jack such as jack 402A is equipped with apparatus as shown in Fig. 7 at each end thereof. Two or more such lines may be connected in tandem. In this apparatus is included a line lamp 726 and a busy lamp 727, a tuned relay path 701P, a line relay 700L, and other elements which will be readily understood.

To send a call signal, the operator will plug either end of cord circuit 406 into jack 402A and operate keys 422 and 419 simultaneously and momentarily. A source 420 of alternating voltage of 60 cycles per second or other convenient frequency is connected by key 419 to polarized relay 421. Relay 421 oscillates at a 60 cycle rate and interrupts the current in a path beginning at battery, through armature of relay 424, winding of relay 425, lower operated contact of key 422, relay 421, teletypewriter contacts, upper make contact of key 422 and make contact of relay 412 to the tip of line 700L. If the other plug were used, the path just traced would have been varied to include repeater relay 424 or 425. Any telegraph repeaters on the line (assumed not to be regenerative repeaters) will relay the 60 cycle interruptions to the distant station.

The call signal will be received at a distant station by the oscillation of relay 700L thereat which will cause the excitation of circuit 701P and operation of relay 718 which will close its contact and energize relay 728. Relay 728, upon operating, will light calling lamp 726 and lock up 75

through its right contact over the back contact of relay 729. When the operator sees the lamp 726 lighted and plugs into jack 402A, relay 728 will be released and the lamp 726 will go out.

5 The sending of a recall signal will be the same as sending a call signal but the operator may send it in only one direction or in both directions by a suitable splitting key or other suitable means, such as key 426.

10 In receiving a recall signal it will be remembered that the cord circuit 406 has one end plugged into jack 402A and the other end in jack 405. The 60 cycle alternating current will arrive over the line and cause relay 424 to oscillate.

15 The repeated impulses will pass through the normal contacts of key 422 into the line and oscillate relay 400L. If we assume switch 415 to be on contact *h* and switch 409 on contact *h*, the relay 417 will be operated and close a path from ground

20 over the ring of the plug and jack to relay 413 and lamp 414 in parallel. The relay will lock up and hold the lamp lighted. Upon responding to the recall signal the operator will depress key 427 and extinguish lamp 414. It will be observed

25 that an operator at the station of Fig. 6, in sending a recall signal or a disconnect signal will not only energize lamp 427 but if trunk lines equipped similarly to Fig. 7 are in circuit, the signal will appear at all teletypewriter exchanges on the circuit which are so equipped. It will be understood that the arrangements of Fig. 7 are optional.

In the foregoing description and in the drawings, numerous auxiliary devices and features, 35 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. In a telegraph exchange system, a subscriber's station equipped with a telegraphic transmission and reception instrument, a central office equipped with apparatus for connecting said instrument for transmission to a distant station, a supervisory signal at the central office, 50 devices at the subscriber's station for modulating in a suitable distinctive manner a periodic current normally transmitted in unmodulated form for telegraphic signaling, and devices at the central office responsive to the reception of the component of the current due to said modulation to cause said supervisory signal to respond.

2. In a telegraphic system, means for transmitting marking impulses and spacing impulses, and means for modulating one variety of said impulses, a supervisory signal device not responsive to either marking or spacing impulses but responsive to currents produced by operation of said modulating means in modulating one variety of said impulses.

3. A system for communication between subscribers by means of 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 through the telephone operator's position without the knowledge or attention of the

telephone operator, said arrangement for operating said signal comprising means at the subscriber's station for modulating his outgoing carrier current at a suitable predetermined frequency, and means for detecting said carrier current and operating the supervisory signal at the telegraph operator's position under the control of said detecting means.

4. In a system for communicating by impulse telegraphy, devices for intercommunicating between different parts of the system by code combinations of impulses, devices for sending supplemental supervisory information over said system comprising an instrumentality for sending modulated carrier waves from one operator's position to another, a device at the second operator's position operated thereby as a supervisory indication, and other devices controlled thereby to transmit to a more distant point in the system sustained current variations of a frequency 20 other than that of said carrier waves.

5. In a teletypewriter cord circuit, a supervisory signal, a telegraph communication circuit to which said cord circuit may be connected by a jack, said signal being controlled by a relay operatively connected to said circuit, frequency selective means whereby said relay is non-responsive to normal telegraph signaling current but responsive to special non-telegraphic modulation of said current.

6. In a system in accordance with claim 5, a frequency selective rectifying instrumentality connected to control said relay under the influence of special non-telegraphic modulation of said current.

7. In a system in accordance with claim 5, a frequency selective relay, and instrumentalities connected to control said signal controlled relay under the influence of special non-telegraphic modulation of said current.

8. In a system in accordance with claim 5, a rectifying space discharge device and a tuned device controlled thereby for controlling said signal controlled relay.

9. A telegraph subscriber's station comprising a movable element in addition to telegraphic transmission and reception equipment, and operative connections between said element and said transmission equipment means for producing a variation of non-signal characteristic, and means whereby movement of said element to one position causes said equipment to transmit a long spacing impulse modified in accordance with said non-signaling characteristic.

10. A subscriber's telegraphic station, a central switching office and lines interconnecting said station and office, means at said station and office for transmitting telegraphic variations of current, said station having an idle condition and a working condition, a circuit varying element for placing said station in idle condition, a circuit changer controlled by moving said circuit varying element to idle position, and means actuated thereby to send to said switching office a current having a non-telegraphic variation of supervisory significance.

11. In a system according to claim 10, a time limiting device for limiting the duration of said current having a non-telegraphic variation and thereafter rendering said subscriber's station idle.

12. A system according to claim 10, including a signal device at said switching office, and means actuating said device solely under control of currents resulting from said non-telegraphic variation.

13. In a telegraph system, a link circuit for interconnecting two telegraph lines, means for communicating over one of said lines by application of direct current pulses thereto in code combinations representing intelligence, a repeater of such current in said cord circuit, repeating relays

in said repeater, a source of periodic ringing current, and means for actuating a relay of said repeater in accordance with current from said source.

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