July 31, 1934. W. A. KNOOP 1,968,457

TRANSMISSION OF INTELLIGENCE OVER WIRES

Filed Feb. 20, 1932 3 Sheets-Sheet 1

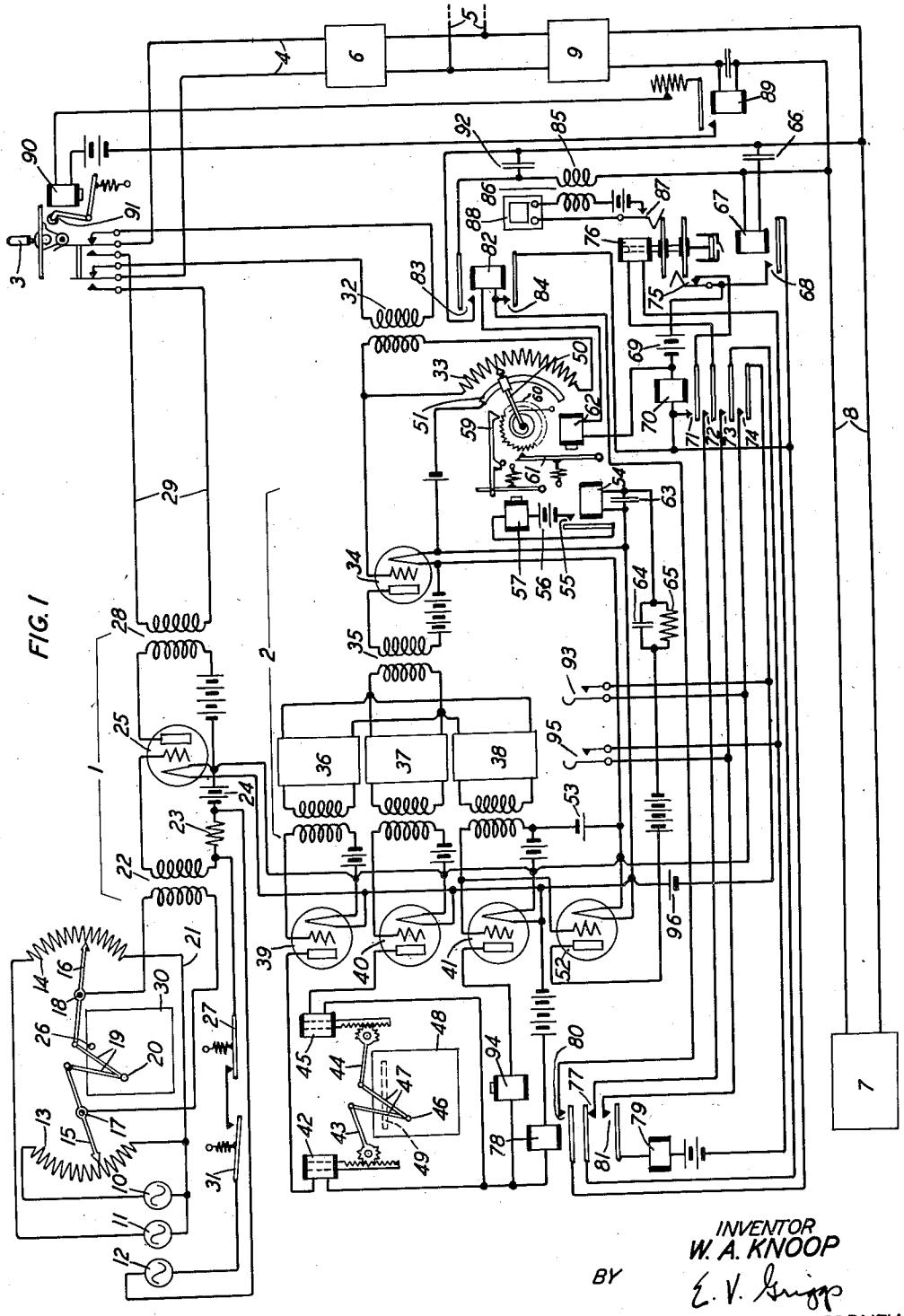

FIG. 1

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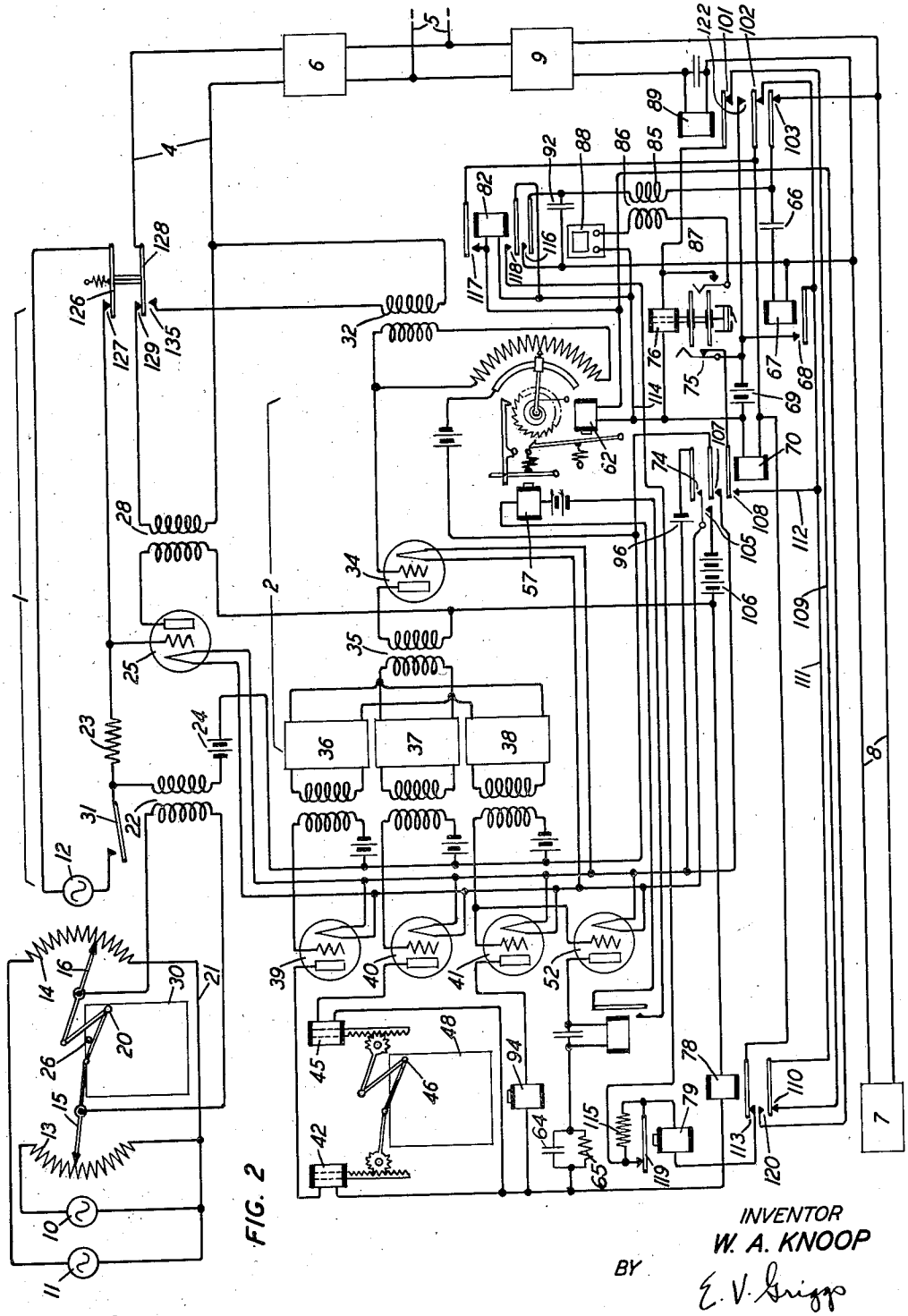

FIG. 2

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FIG. 3

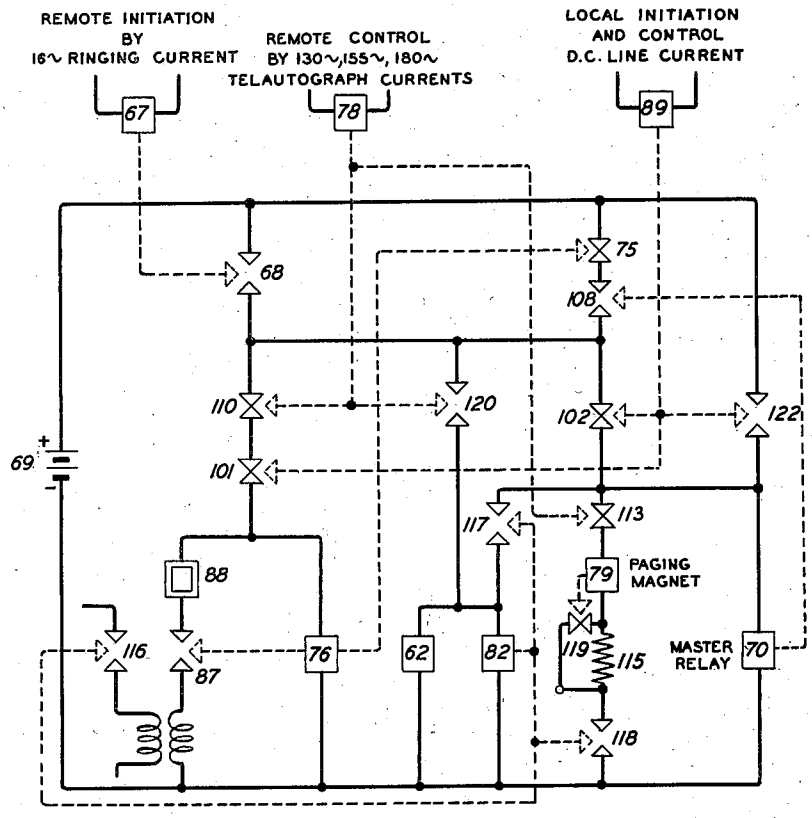
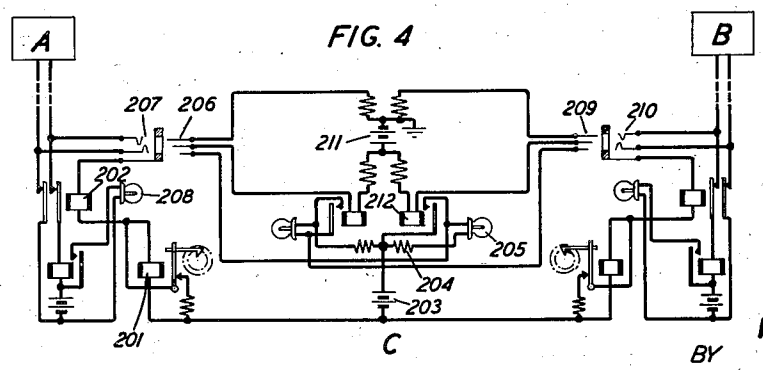


FIG. 4



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Patented July 31, 1934 1,968,457

UNITED STATES PATENT OFFICE

1,968,457

TRANSMISSION OF INTELLIGENCE OVER WIRES

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Application February 20, 1932, Serial No. 594,285

14 Claims. (Cl. 179—4)

This invention relates to systems for the transmission of intelligence over wires and particularly to a facsimile telegraph system wherein the movements of a transmitting stylus are recorded in facsimile at a distant receiving station.

An important feature of the invention is its coordination of a telephone circuit and a telautograph system to permit ordinary telephonic conversation and transmission of facsimile information to proceed simultaneously at the pleasure of the communicating parties. This enables the talking party to supplement his oral message by a simultaneously transmitted facsimile message, or a speaker to illustrate his remarks while he talks.

An additional feature of the invention is its provision for recording of facsimile messages at the station of a called subscriber thus permitting the calling subscriber to leave a message record at the station of the called subscriber irrespective of whether or not the latter answers the call.

According to the invention, each telephone subscriber's station is provided with auxiliary apparatus comprising a telautograph transmitter and receiver. The telautograph apparatus is operated by alternating currents transmitted over the telephone circuit and lying outside the essential speech frequency band. These alternating currents operate mechanism to perform the usual functions of lifting and positioning the recording stylus at the receiving apparatus in accordance with the motions of the stylus at the remote transmitting station. They also serve to regulate the amplification of the received telautographic current and to give return indications to the calling subscriber that the receiving apparatus is in operative condition. The telautographic receiving apparatus is normally connected to the line and upon receipt of the usual telephone ringing current is conditioned thereby to receive telautographic messages from the calling party's telautographic transmitter. Should the called party answer and desire to transmit a facsimile message to the calling party in the course of the conversation, he will disconnect his telautograph receiver and connect his telautograph transmitter. The calling party correspondingly disconnects his telautograph transmitting apparatus and connects his receiving apparatus. During the entire communication the telephone apparatus is available for oral communication in the usual manner. Upon the conclusion of the communication both parties restore their apparatus to normal position thus informing the central station operators that their lines may be disconnected.

The novel features which are characteristic of the invention are set forth with particularity in the appended claims. The invention itself both as to its organization and method of operation may best be understood by reference to the following description taken in connection with the accompanying drawings, in which:

Fig. 1 shows diagrammatically a terminal station circuit of a two-way system for enabling two persons to communicate with each other by means of simultaneously transmitted speech and graphical messages;

Fig. 2 illustrates a modification of the terminal station circuit of Fig. 1;

Fig. 3 is an explanatory diagram of a portion of the circuits of Fig. 2; and

Fig. 4 shows a message register circuit.

Referring to Fig. 1 a telautograph transmitter indicated comprehensively by numeral 1 and a telautograph receiver similarly indicated by 2 are by means of a manually operated transmit-receive switch 3 associated one at a time with a two-way telautograph circuit 4. Circuit 4 is in turn connected to a two-way transmission line 5 through a band-pass filter 6 designed to transmit freely a band of currents outside the essential speech range but to exclude both telephonic ringing currents and currents within the essential speech frequency range. Filter 6 may, for example, pass currents within the band of frequencies lying between 100 cycles and 200 cycles and may exclude currents of lower than 100 cycles or higher than 200 cycles.

A two-way telephone station 7, such as the usual common battery subscriber's station, is connected by conductors 8 to a band suppression filter 9 which transmits in each direction between circuits 8 and 5 ringing currents and currents of essential speech frequencies but suppresses currents of the telautograph frequency band as, for example, those between 100 cycles and 200 cycles.

Telautograph transmitter

The telautograph transmitter 1 includes three sources 10, 11 and 12 of alternating currents which, by way of example, may be respectively of 130 cycles, 180 cycles and 155 cycles. Sources 10 and 11 supply currents to telautograph potentiometers 13 and 14 with which are associated contact arms 15 and 16 pivoted respectively at 17 and 18 and associated by means of insulating link members 19 with transmitting stylus 20 in such manner that the positions of the contact arms are

determined by the movements of stylus 20. Accordingly, currents of 130 cycles and 180 cycles are transmitted from potentiometers 13 and 14, the output portions of which are connected in series by conductor 21, to the primary winding of transformer 22, the secondary winding of which with series resistance 23 and polarizing source 24 forms the input circuit of transmitting amplifier 25 which may be of the usual three-element electron discharge type. At the zero or rest position of stylus 20 indicated by the circle 26 the arms 15 and 16 make contact with the zero potential ends of the potentiometers thus reducing the stylus controlled currents to zero. In its normal zero position at 26 the stylus 20 rests upon circuit closer 27 thus holding open the circuit of source 12. When the stylus is removed from its rest position circuit closer 27 operates to close the circuit of source 12 and as platen switch 31 is closed current of 155 cycles frequency flows from source 12 to resistance 23 and amplifier 25 accordingly supplies to transformer 28 and circuit 29 amplified currents from the source 12. As stylus 20 is moved laterally arms 15 and 16 will move along the potentiometers and currents of 130 cycles and 180 cycles will also be transmitted. The currents from sources 10 and 11 vary in strength with the movement of stylus 20 while the 155 cycle current from source 12 remains unvarying in amplitude. When the stylus 20 is lowered into contact with platen 30 the pressure thereon causes the platen to depress platen switch 31 thus opening the circuit of source 12 as is indicated in the drawings and terminating the train of waves of 155 cycles which was initiated when the stylus was lifted from its rest position. It will, therefore, be evident that the 155 cycle current transmitted to the amplifier persists during the interval that the stylus is lifted from the circuit closer 27 and from the platen 30 and disappears when the stylus is supported by either of these two members. When switch 3 is thrown to the right any telautograph currents supplied to circuit 29 from sources 10, 11 and 12 are transmitted by way of the left-hand contacts of the switch over circuit 4, filter 6 and line 5 to the telautograph receiving circuit of the station which, at the particular time under consideration, is associated with line 5 at its remote terminal.

Telautograph receiver

The telautograph apparatus at the remote station is similar to that at the station of Fig. 1 and the effect of the transmitted telautograph currents may be understood by reference to the operation of the telautograph receiving apparatus 2 shown in Fig. 1. Assuming that the transmit-receive switch 3 at the remote station is in the normal or receiving position as shown in Fig. 1, currents of 130, 180 and 155 cycles received at the remote station from line 5 will pass by way of filter 6, circuit 4, normal contacts of switch 3 to input transformer 32 associated through gain control potentiometer 33 with the input circuit of gain regulating amplifier 34. The amplified received currents are next impressed through transformer 35 upon the parallel input circuits of selectors 36, 37 and 38, preferably narrow band-pass filters, designed to select respectively currents of 130, 180 and 155 cycles and to impress them upon their respective amplifiers 39, 40 and 41. The varying strength currents of 130 cycles in the output circuit of detector-amplifier 39 cause solenoid 42 and its rack gear to produce a motion of pivoted arm 43 corresponding to that given the left-hand contact arm 15 by the transmitting stylus 20 at the transmitting station at the opposite end of the line 5. In similar fashion the right-hand arm 44 is caused by operation of rectified currents of 180 cycles in the output circuit of amplifier 40 acting upon solenoid 45 to follow the movements of the contact arm 16. The receiving stylus 46 associated through links 47 with arms 43 and 44 will, therefore, reproduce the motion of transmitting stylus 20 and will record the desired graphical message on a sheet of paper placed on platen 48.

Amplifier 41 supplies to pen lifting magnet 94 rectified currents of 155 cycles which it will be recalled are transmitted only while stylus 20 is lifted. The pen lifting magnet 94 operating upon the pen lifting bar 49 indicated in dotted lines will lift the receiving stylus 46 together with its operating links 47 in a manner well known in the art, the links 47 being pivoted to permit them to swing both in a horizontal plane under control of arms 43 and 44 and in vertical planes in response to vertical motion of lifting bar 49.

Gain control

Since the magnitude of motion of the arms 43 and 44 is dependent upon the strength of the received currents of 130 and 180 cycles it is desirable in order to record the graphical message without distortion and with a definite scale that these currents be supplied to the solenoids 42 and 45 with magnitudes which are independent of the length or the attenuation characteristics of the transmission line 5. To accomplish this, a gain control device is provided and is made responsive only to the pen lifting currents from source 12. It will be recalled that these currents are transmitted only during the interval between lifting of the transmitting stylus 20 from its rest position at 26 on switch 27 and placing of the stylus upon the platen 30 to begin the message transmission and open platen switch 31. Accordingly, the gain regulation is effected during this interval and is completed before actual transmission of the graphical message begins.

The gain control apparatus operates to vary the position of a rotary potentiometer arm 50 which carries a contact element in electrically conducting engagement with both an arcuate segment 51 and potentiometer 33. This increases or diminishes the electromotive force of the 155 cycle current applied by the potentiometer 33 to the input circuit of amplifier 34 in such manner as to maintain substantially constant the electromotive force of the pen lifting current of 155 cycles applied by filter 38 to the input circuit of amplifier 41 and consequently also to the parallel-connected input circuit of a gas-filled tube relay 52, e. g. of the thyratron type, which preferably has a grid biasing voltage applied by source 53 of a magnitude somewhat greater than required to normally render the space current of the relay substantially zero. Should the applied electromotive force of the 155 cycle current increase space current will begin to flow in the plate circuit of the gas-filled relay 52. The characteristic of this tube is such that when the space current begins to flow the impedance rapidly decreases thus permitting a large current to flow through the tube. The series resistance 65 is of relatively high magnitude. Consequently, the heavy pulse of space current will cause condenser 64 to become charged. The pulse of charging current energizes relay 54 causing it to close its contacts 55, in the local circuit of source 56

and stepping relay 57. As the potential difference across the terminals of the condenser 64 rises the charging current will decrease until finally a point is reached at which the effective potential between the anode and the cathode of the gas-filled relay 52 is insufficient to maintain the discharge. The discharge thereupon ceases. Relay 54 and stepping magnet 57 consequently deenergize permitting the armature of the magnet 57 to release and under the actuation of its retracting spring to carry pawl 59 back with it preparatory to initiation of the next step. The ratchet wheel 60 is retained in position to which it has been stepped by an armature detent 61 under the control of a retracting spring and a holding magnet 62. Associated with an armature of magnet 57 is a stepping pawl 59 which operates upon a ratchet wheel 60 mechanically connected to arm 50 to step the arm 50 around to such a position that the electromotive force of 155 cycle current applied to the input of relay 52 is so reduced that current no longer flows through the magnet 54.

The charge on condenser 64 discharges through the shunt resistance 65. The potential difference across terminals of the condenser 64 thus gradually falls and at the same time the effective potential between the anode and cathode of the gas-filled relay 52 rises until it again reaches the break-down point when another charging pulse energizes relay 54. This sequence of impulses continues so long as the incoming carrier wave potential applied to the grid of the relay 52 is sufficient to reduce the impedance of the tube to a point at which the space current source is enabled to cause the tube impedance to break down. Accordingly, the gain control device will be operated step by step to reduce the amplification to such a point that a standard level of voice frequency currents will be applied to the telautograph apparatus.

The calling operation

A call is initiated in the usual manner by removal of the telephone receiver of apparatus 7 from its switchhook or cradle to inform the operator that a connection is desired. Upon ascertaining the number of the desired party the exchange operator causes ringing currents to be applied to the line 5 with which the called station 7 is associated. These ringing currents may be of the low frequency usually employed for telephone bell ringing purposes or they may be of higher voice frequencies as are often employed in toll transmission but in any event it is desirable that they should fall well outside the band reserved for telautographic currents. In the system illustrated they may be assumed as of 16 cycle frequency. The filter 9 may pass currents of all frequencies below 100 cycles or above 200 cycles.

Ringing current received at the called station is transmitted by filter 9 and circuit 8 to the usual bell ringing circuit of station 7. Bridged across circuit 8 is a shunt path tuned to the ringing current and including a condenser 66 and a relay 67 which responds to ringing current to close its armature contacts 68 thus completing through battery 69 an energizing circuit for master relay 70.

Relay 70 upon energization closes four sets of armature contacts 71, 72, 73 and 74. Contacts 71 complete a holding circuit for relay 70 by way of the normally closed contacts 75 of slow acting dash pot relay 76.

Contacts 73 in closing prepare an energizing circuit for paging magnet 79.

Contacts 74 close the circuit of filament heating source 96 to enable it to supply filament heating current to the cathodes of each of the tubes 25, 34, 39, 40, 41 and 52.

Contacts 72 close the circuit of slow acting relay 76 by way of normally closed contacts 77 of relay 78. Shortly after the slow acting relay 76 begins to operate it closes contacts 87 to complete the circuit of buzzer 88 which produces an audio frequency tone and transmits it by way of transformer 86 through condenser 92 and filter 9 over the transmission line 5 to inform the calling party that the telautographic receiver is in condition to record a graphic message.

If during the time that elapses before slow acting relay 76 pulls up its lower solenoid bar to open contacts 75, the calling subscriber should lift his transmitting stylus, pen lifting currents of 155 cycles will be received and transmitted to amplifiers 34 and 52 so that the gain control device will be operated. Pen lifting currents are also transmitted to amplifier 41 to operate pen lifting magnet 94 and hold the receiving stylus 46 out of contact with the platen. Simultaneously therewith relay 78 is energized and closes its contacts 80 and 81 and opens its contacts 77. Opening of contacts 77 causes slow acting relay 76 to deenergize. Closing of contacts 81 completes the circuit of paging magnet 79 to advance paper feeding apparatus with respect to the sheet of paper on platen 48 so that upon release of magnet 79 the paper will be advanced by an amount sufficient to prepare for the recording of the next line. Closing of contacts 80 closes a path which is in parallel to master relay 70 and which includes holding pawl magnet 62 and relay 32 in series. Consequently magnet 62 is energized and holds pawl 61 in close proximity to ratchet wheel 60 as long as any telautograph currents are received to maintain relay 78 energized. Relay 82 in energizing closes its contacts 83 and 84. Closing of contacts 83 completes a direct current path across line 8 through the inductance 85 which constitutes the secondary winding of transformer 86 permitting direct current to flow from the central office battery and operating in well known manner to register the call and remove the automatically applied ringing current from the line. Relay 82 by holding closed the contacts 84 in shunt to contacts 80 serves to prevent the relay 78 from "flashing" the lamp at the central station. Each time the calling subscriber returns his transmitting stylus 20 to its rest position all telautographic currents are cut off from the transmission line, relay 78 releases, and paging magnet 79 deenergizes to step the receiving station record paper up another line.

Should the called subscriber respond by removing his telephone receiver from its hook the consequent flow of direct current will energize line relay 89, the armature and contact of which operate to close the circuit of holding magnet 90 of the transmit-receive key 3. If he thereafter shifts transmit-receive switch 3 to the transmit position magnet 90 with its associated armature, latch 91 will hold switch 3 in that position against the tendency of its biasing springs to return it to normal until such time as the telephone receiver is again placed on its hook thus cutting off the direct current line current and deenergizing relay 89.

When the connection between the calling and called stations is established by the operator and

the operation of slow acting relay 76 is initiated by the ringing currents that operation continues if uninterrupted until relay 76 opens its contacts 75 thus causing release of the master relay 70 and consequent restoration of the telautographic receiving apparatus to normal. As long as ringing currents are received the cycle of operations of relay 76 is repeated. If after ringing current has ceased and relay 76 has operated to restore the telautograph apparatus to normal the calling and called parties are in talking communication and desire to use the telautographic apparatus they may do so by closing switch 93 to energize the vacuum tubes.

At any time when no telautographic currents are being received a paging operation may be performed by closing and opening switch 95.

In this system no changes or additions are necessary in the central office equipment or in the method of handling calls in either dial or manual switching.

The Figure 2 circuit

Fig. 2 illustrates a modified circuit in which the functions of the transmit-receive switch and the rest position circuit closer of Fig. 1 are combined. In Fig. 2 similar parts are designated by the same characters as in Fig. 1. A spring biased switch 126 on which the stylus 20 bears when at the rest position 26 has upper contacts 127 which serve to close the circuit of alternating current source 12 and to initiate the train of 155 cycle oscillations in the same manner as the contacts 27 of the rest position circuit closer of Fig. 1. Switch 126 is provided with a transfer armature 128 which with its upper or transmitting contact 129 and its lower or receiving contact 135 serves to normally associate two-way telautograph circuit 4 with the local telautograph receiver while the transmitting stylus is at rest at position 26. When the transmitting stylus 20 is lifted from its rest position, switch 126 is operated by its biasing spring to close contacts 127 thus initiating the train of 155 cycle oscillations. At the same time its armature 128 transfers the connection of two-way circuit 4 from the telautograph receiver to the telautograph transmitter.

The selective networks, amplifiers, stylus control arms, pen lifter and gain control apparatus of Fig. 2 require no description. The key to an understanding of the relay control circuits is the operation of master relay 70 which applies power to the tubes and conditions the principal local telautograph circuits. There are several different circumstances under which the master relay operates. At the calling station it is energized by direct current and locks up when the calling subscriber takes his telephone receiver from its hook to initiate a call. At the called station, the master relay is initially energized by ringing currents and maintained energized for a limited time after ringing ceases when it deenergizes. If, during the period of energization, telautograph currents are received the relay remains energized until the telautograph message ceases or, if the called subscriber responds by removing his own receiver from its hook, his master relay is thereafter maintained energized by direct current line current in the same manner as the master relay at the calling station.

The relay circuits for conditioning and controlling the telautograph receiver may be readily understood by considering the operations attendant upon a call. When a calling subscriber lifts his receiver from its hook direct current from the central office exchange flows over his line circuit and through winding of relay 89. Relay 89 in responding opens its upper armature contacts 101, opens the normally closed lower armature contact 103, and actuates a third armature to open contacts 102 and close contacts 122. Closure of contacts 122 completes an energizing circuit for master relay 70. Relay 70 closing its upper contacts 74 causes energy to be supplied to the cathodes of all of the vacuum tubes. At the same time it closes auxiliary contacts 105 to complete the space current circuits of the various tubes through the common space current source 106. Contacts 107 close the grid polarizing circuits of the various tubes. Slow acting relay 76 and buzzer 88 are prevented from operating since their circuits are held open at contacts 101 by the energized line relay 89.

In the meantime, the central exchange operator proceeds to ascertain the number of the desired subscriber's line and to initiate application of ringing current to that line. The ringing currents traversing line 5, selective network 9 to line 8 and the called subscriber's station are partly diverted through the bridged path comprising relay 67, condenser 66 and contacts 103 of line relay 89. Energization of relay 67 by the ringing currents causes contacts 68 to be closed thus closing the energizing circuit of master relay 70 at the called station. Relay 70 establishes its own holding circuit by closing contacts 108 to complete a circuit extending from source 69 through contacts 75 of relay 76, contacts 108 of relay 70, conductor 112, contacts 102, winding of relay 70 back to source 69. Relay 70 also causes all the tubes at the called station to be energized. Slow acting relay 76 is also energized when the ringing relay 67 closes its contacts 68 over a circuit comprising winding of relay 76, contacts 101 of line relay 89, conductor 109, lower contacts 110 of relay 78, conductor 111, conductor 112, contacts 108 of relay 70, contacts 75 of relay 76 and source 69 back to winding of relay 76. Should the ringing currents continue without response from the called subscriber, relay 76 will first operate a wiping contact to momentarily connect a shunt path across itself including contacts 87, primary winding of transformer 86, buzzer 88 and conductor 114 back to relay 76. During the short period that the shunt path is closed, the buzzer 88 transmits a tone back over the line 5 as described in connection with the operation of Fig. 1 to inform the calling subscriber that the called station apparatus is energized and prepared to receive a graphical message. Should the called subscriber respond at this time, energization of his line relay 89 opens the circuit of the slow acting relay cutting off its further control of the circuit. Line relay 89 establishes a direct energizing path for master relay 70 by way of the upper contact of armature 102 thus maintaining the various tubes energized until line relay 89 is again deenergized at the termination of the communication.

If, now, the calling subscriber should transmit telautographic currents the stylus 46 and the gain control apparatus will be operated as previously described. As long as master relay 70 remains operated whenever telautograph waves are received, relay 78 will be energized to open its upper armature contacts 113. Upon cessation of the train of telautograph waves, relay 78 releases to permit contacts 113 to fall back thus closing the circuit of paging magnet 79 which responds to advance the sheet of paper on receiving platen 48.

If the called subscriber fails to respond, the calling subscriber upon hearing the answer back tone from buzzer 88 at the called station may begin to transmit a telautograph message. The telautograph currents will energize relay 78 at the called station to open its contacts 110 thus disabling dash pot relay 76 and preventing interruption by relay 76 of the holding circuit of master relay 70 so long as telautographic currents continue. The relay 76 may again be momentarily energized if the transmitting stylus is brought back to its rest position for dipping it into an inkwell or for purely paging purposes but its slow action permits the calling subscriber to resume the message before the slow acting relay has time to interrupt the holding circuit of the master relay.

A message register is provided which depends upon flow of unidirectional current over both the calling subscriber's line and the called subscriber's line. In order that a message charge may be registered when the called subscriber does not respond but the calling subscriber transmits a telautograph message, relay 82 is provided with contacts 116 to close a direct current path bridged across the called subscriber's circuit through coil 85 of transformer 86 and contacts 103 of line relay 89.

Relay 82, which energizes whenever relay 78 closes normally open contacts 120, locks up both itself and its parallel connected holding pawl magnet 62 by closing at its contacts 117 a path in parallel to master relay 70. At its contacts 118, relay 82 prepares an energizing path for paging magnet 79. This path is in parallel to master relay 70 and includes contacts 118, a resistor 115, winding of paging magnet 79 and contacts 113 of relay 78. Current is permitted to flow in this path to energize paging magnet 79 only during cessation of telautograph currents which permits relay 78 to deenergize and thus to close its contacts 113. It follows that the paging magnet is for the most of the time without current and receives a brief actuating impulse of a duration corresponding to the absence of telautograph currents. However, even when paging magnet 79 is energized it draws full current only until it completes its actuating stroke at which time it interrupts the contact between its armature 119 and one terminal of a series resistance 115. This connects resistance 115 effectively in the circuit and reduces the current traversing the magnet from its operating value to the minimum amplitude required to hold the magnet energized.

Condenser 92 permits answering tone to be applied to line 8 by buzzer 88. When speech currents are being transmitted this circuit is disconnected at 103 in consequence of the energization of relay 89.

Fig. 3 is a simplified schematic of a portion of the control relay circuits of the telautograph receiver of Fig. 2. The arrows represent circuit closing contacts in the circuits represented by solid lines. The dotted lines indicate which relays and contacts are associated and lead in each instance from the relay to a terminating arrow head at the contacts which are actuated by that relay. When two of the arrows are shown in contact in the figure this means that the circuit is normally established at that point. When they are separated it means that the circuit is normally open. As an illustration of the use of this figure in following the operation of the circuits, the response of master relay 70 to the local subscriber's line current relay 89 may be noted. When relay 89 energizes, it closes normally open contacts 122. The master relay is thereupon energized over a circuit from source 69 through the now closed contacts 122.

The response of master relay 70 to incoming ringing currents may likewise be readily traced. Ringing currents energize relay 67 which operates to close contacts 68 establishing a circuit from source 69 via contacts 68, normally closed contacts 102 through winding of relay 70 and back to source 69. Relay 70 thereupon closes its contacts 108 establishing a holding circuit from source 69 via normally closed contacts 75, contacts 108 (now closed) normally closed contacts 102 and the winding of relay 70 back to source 69.

Fig. 4 shows a schematic of the message register circuits employed at the central office together with the essential portions of the subscriber's circuit which cooperate therewith. A and B represent two stations to be connected and C indicates generally the central station apparatus. This circuit corresponds essentially to that of McBerty Patent 690,453, January 7, 1902, to which reference may be made for details. The service meter or message register 201 at the central station associated with the line from station A, is connected in a local circuit in series with the usual cut off relay 202, a local source 203, resistance 204, and lamp 205. Assume that station A is calling the central office to request a connection with station B. Upon inserting the plug 206 into the jack 207 to answer the call, the operator closes the circuit of the cut off relay 202 by way of sleeve of the jack 207 thus energizing the cut off relay to extinguish line lamp 208 of station A in the usual manner. At this time, the message register 201 does not receive sufficient current to cause it to operate because of the presence of the series resistance 204. Having ascertained that station B is desired, the operator inserts the plug 209 into jack 210 and by means of the calling key (not shown) rings the bell at station B. When the subscriber at station B responds by taking down his receiver hook thus closing a direct current path for the central office battery 211, relay 212 of the operator's cord circuit energizes short-circuiting series resistance 204 and lamp 205 permitting sufficient current to flow through the service register 201 to cause the register to operate. It will be understood that the same result takes place if in the event that the called subscriber fails to respond, the calling subscriber transmits voice frequency current over the circuit to cause relay 82 at station B to close its contacts 116.

What is claimed is:

1. A communication system comprising a two-conductor transmission line, stations adapted to be connected to each other over said transmission line and means at said stations whereby simultaneous oral and written communication may be maintained between said stations over said transmission line by currents transmitted wholly over one of said two conductors as an outgoing path and the other of said conductors as a return path, said currents lying entirely within a band having a frequency range not materially exceeding that of ordinary speech sounds.

2. A communication system comprising two separate telephone stations, a two-conductor transmission circuit connecting said stations and means at said stations for simultaneously carrying on two-way conversation between said stations and for sending a written message from one

of said stations over said transmission circuit and for recording its facsimile at said other station by currents transmitted wholly over one of said two conductors as an outgoing path and over the other of said two conductors as a return path.

3. A telephone system comprising a calling station, a remote called station, means for transmitting ringing currents to said called station, a recording device at said called station, means at said called station responsive to protracted ringing currents to condition said recording device, a facsimile transmitter at the calling station to enable a user thereof to produce and transmit messages in any written symbolic form at will and means at said calling station for controlling said remote recording device to cause it to record a facsimile of the message transmitted from the calling station.

4. In a combined telephone and visual writing transmission system, telautograph apparatus including transmitters which comprise a plurality of sources of carrier frequency waves within the voice frequency range, means for controlling waves derived from said sources for transmission of written messages comprising any graphic symbols produced at the will of the user, receivers which comprise vacuum tube detectors for rectifying the currents received from said sources of carrier frequency waves for recording the transmitted message, means for impressing speech currents upon said system simultaneously with the transmission of the written message and filter circuits for separating the speech currents from said carrier frequency currents so that both speech communication and written message communication can take place simultaneously without interfering with each other.

5. A communication system comprising a plurality of subscribers' stations, an exchange station for connecting said subscribers' stations, means at each subscriber's station for conducting two-way telephone communication with a connected station and separate means for enabling two-way telautograph communication between said connected stations either simultaneously with or independently of telephone communication therebetween.

6. A communication system comprising two-way telautograph apparatus, receiving circuits including amplifiers for supplying currents to said telautograph apparatus, remote controlled means for supplying energizing currents to said amplifiers when a call is received from a distant station and transmitting apparatus including locally controlled means to energize said amplifiers when a call is made from the local station to a distant station.

7. An alternating current telautograph system comprising a receiving stylus, a transmission circuit, sources of two different frequency alternating currents, means to vary the strength of said currents and to apply said varying strength currents to said circuit to operate said stylus, a stylus lifting device, means to transmit over said circuit alternating current of a third frequency to operate said stylus lifting device and means responsive to said third frequency currents to insure that the two different frequency stylus operating currents are received with their magnitudes substantially unaffected by random variations in the condition or characteristics of the circuit.

8. A transmission system comprising a line, recording apparatus connected thereto, means for supplying to said line for transmission thereover alternating currents of two different frequencies and of varying strengths and alternating current of a third frequency and of an unvarying strength, means associated with said line and responsive to the alternating currents transmitted thereover to control the operation of said recording apparatus and additional means responsive to said third frequency current to regulate the amplitudes of all three currents to insure proper operation of said apparatus.

9. A visual writing system comprising a transmitting stylus, sources of current the strength of which is controlled by means of said stylus, an additional source of current in a circuit having a circuit-closing device operated by raising and lowering said stylus from its idle rest position, a transmission line to one terminal to which all of said sources are connected, recording apparatus connected to the remote terminal of said line and means at the recording apparatus controlled by currents which are affected by raising and lowering the stylus for regulating the amplitudes of the currents supplied by said line to said recording apparatus.

10. A visual communication system comprising stations each having facsimile transmitting and facsimile receiving apparatus, a line connecting said stations, said receiving apparatus being normally electrically connected to said line and said transmitting apparatus including a stylus which, at its rest position, maintains said transmitting apparatus disconnected from said line and which, when displaced therefrom disconnects its local receiving apparatus from said line and connects its local transmitting apparatus thereto.

11. In combination, a plurality of stations, a central station, individual circuits extending from each of said plurality of stations to said central station, means at said central station to interconnect any two of said circuits for two-way telephone and telautograph communication between their respective stations, a message register at said central station and means responsive to currents transmitted over said connected circuits to register both two-way telephone and telautograph messages and one-way telautograph messages transmitted thereover.

12. In combination, a central station, a plurality of subscribers' stations each having an individual circuit extending to and terminating at said central station, a facsimile recording device at one of said subscriber's stations, a facsimile transmitter at another of said subscriber's stations having means for producing and transmitting a message comprising any graphic characters or symbols which the user of the calling station may arbitrarily portray, a source of ringing current at said central station, means whereby when the circuits of said two subscribers' stations are connected at said central station and ringing currents are applied to the circuit of the station provided with a recording device, an answer-back tone is received at the calling station to inform the calling subscriber that the recording apparatus is energized and in condition to respond to his facsimile transmitter.

13. A telautograph system comprising a transmission line, a transmitting station connected to one terminal of said line and having a transmitting stylus, a receiving station connected to the remote terminal of said line and having a recording stylus, a source of alternating current at said transmitting station, means for causing currents from said source to be transmitted over said line

to lift said recording stylus only while said transmitting stylus is lifted, and a gain control device at said receiving station to maintain substantially constant the amplitude of the alternating currents from said source as received over said line at said receiving station.

14. In a communication system for simultaneous communication by speech and by facsimile messages, means for two-way speech transmission, a line connected to said means, a facsimile transmitter associated with one terminal of said line for transmitting control currents thereover, a step-by-step gain control device associated with the remote terminal of said line whereby the facsimile portion of said communication is maintained at a definite scale, a three-element thyratron type relay having an anode, a cathode and an impedance control element, said anode and cathode being connected through a space current circuit including in series a space current source, a stepping magnet and a combination of parallel capacity and resistance, an input circuit connected to said line and to said cathode and impedance control element whereby upon transmission of control currents over said line said thyratron relay operates to transmit intermittent impulses to said stepping magnet to operate said gain control device.

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