Oct. 23, 1945. L. J. MURRAY 2,387,525

TELEPHONE OR LIKE SYSTEM

Filed June 2, 1944 5 Sheets-Sheet 1

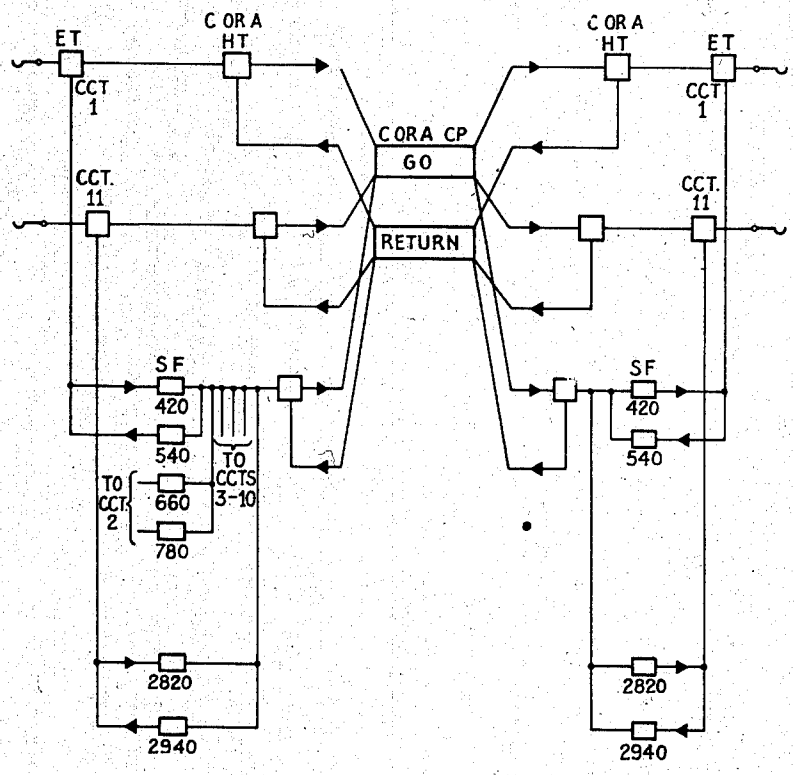


Fig. 1

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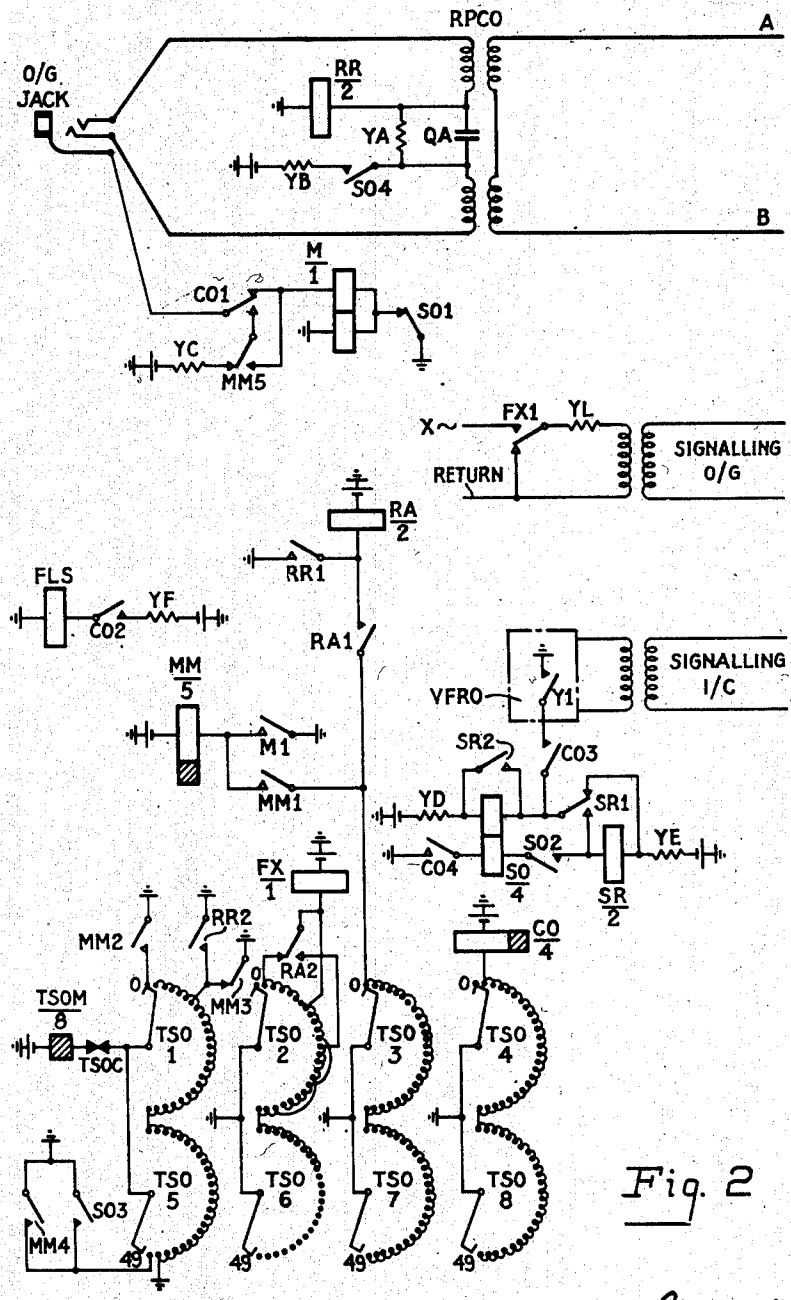


Fig. 2

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TELEPHONE OR LIKE SYSTEM

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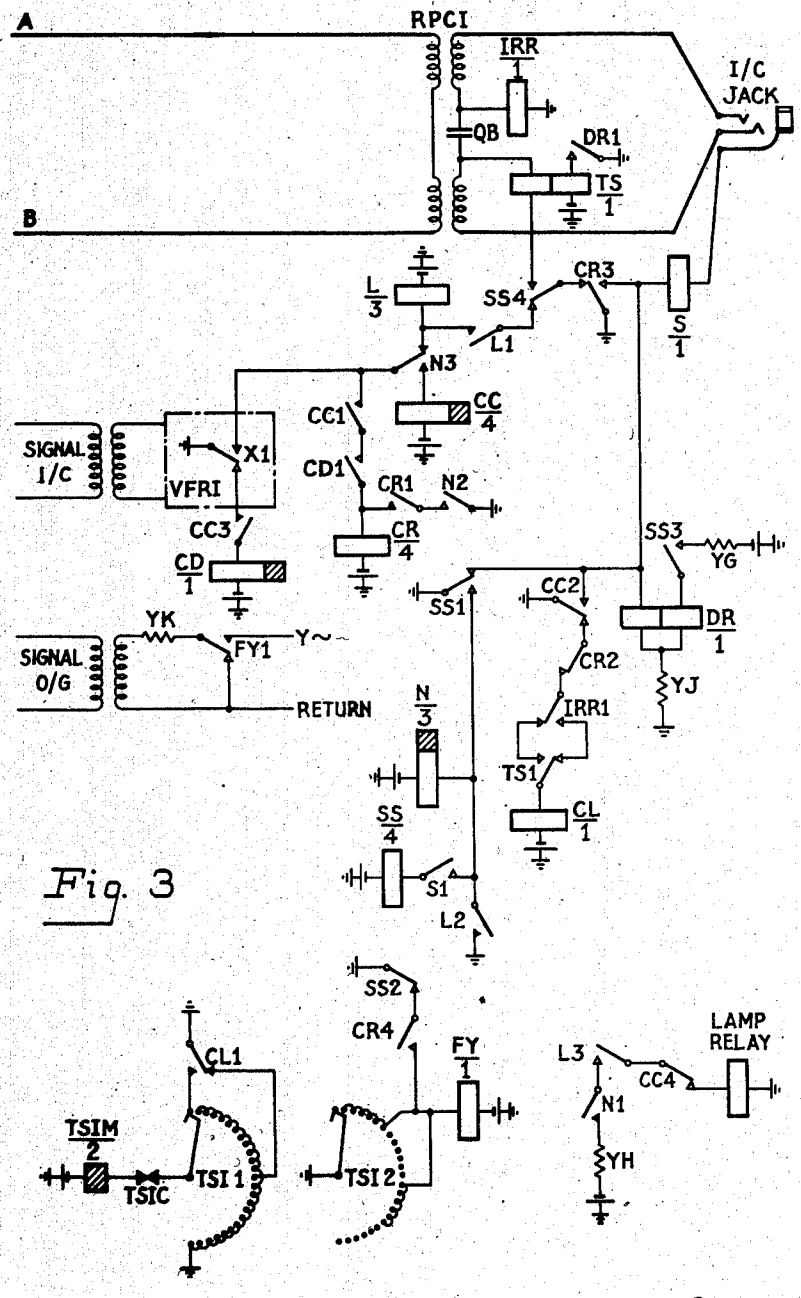


Fig. 3

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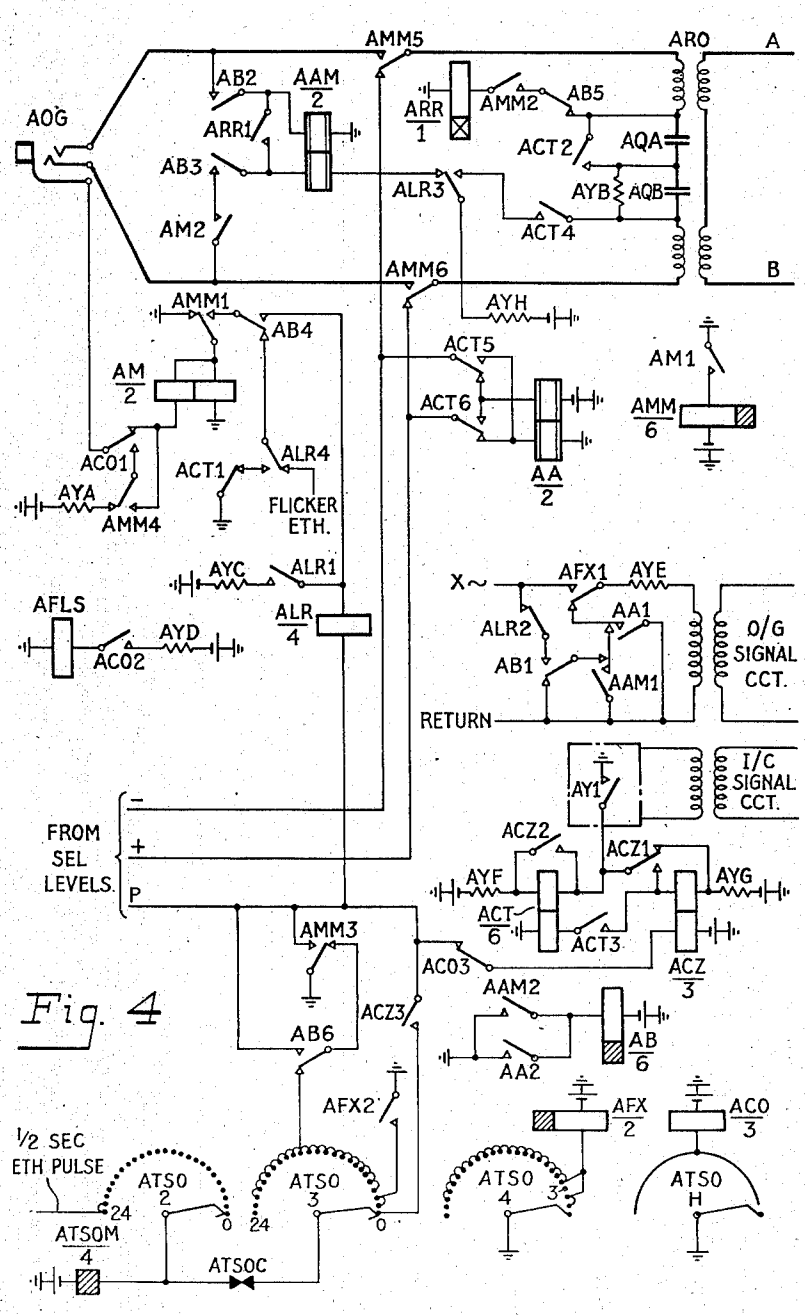


Fig. 4

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TELEPHONE OR LIKE SYSTEM

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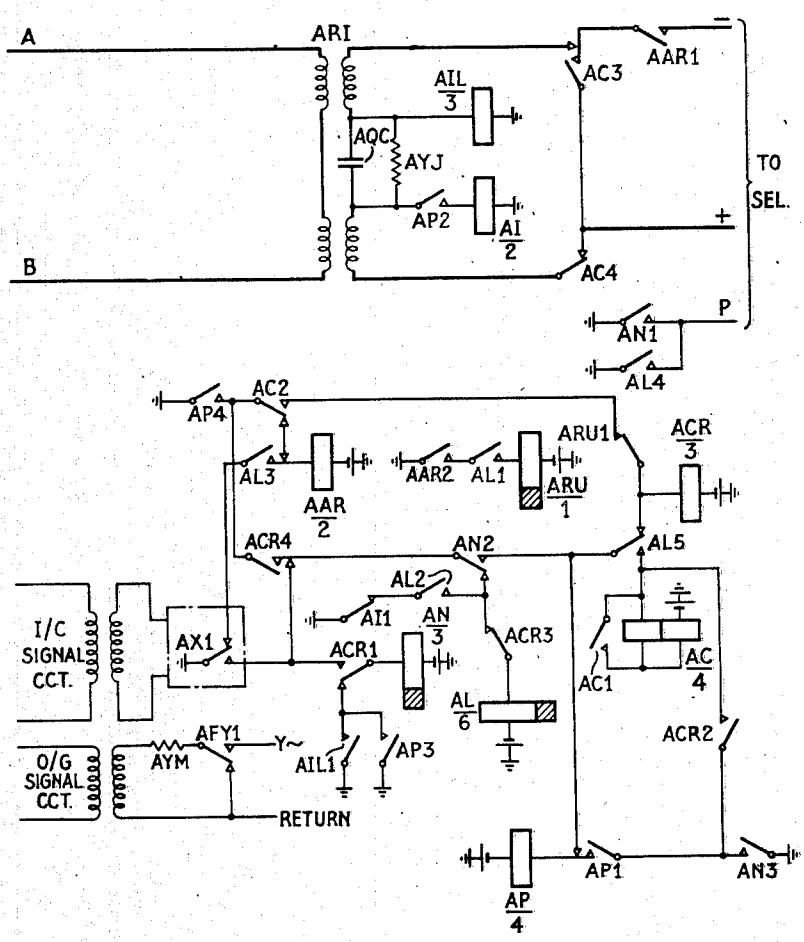
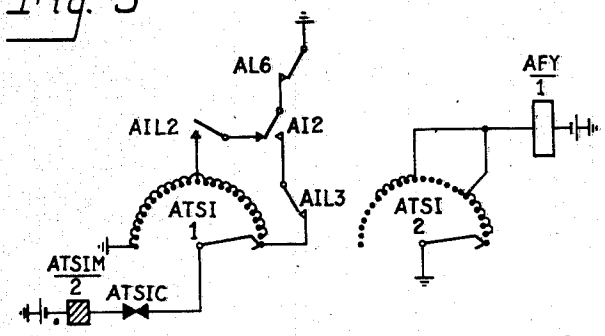


Fig. 5



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Patented Oct. 23, 1945 2,387,525

UNITED STATES PATENT OFFICE

2,387,525

TELEPHONE OR LIKE SYSTEM

Lawrence John Murray, Liverpool, England, assignor to Automatic Telephone & Electric Company Limited, Liverpool, England, a British company

Application June 2, 1944, Serial No. 538,449
In Great Britain July 21, 1943

8 Claims. (Cl. 179—43)

The present invention relates to telephone or like signalling systems and particularly those using alternating currents for signalling purposes. In such systems and more particularly those using alternating currents within the voice frequency range considerable difficulty is encountered in discriminating between signalling currents and currents of the same frequencies which are produced by speech or extraneous means and numerous expedients have been proposed for achieving the required discrimination to enable such systems to be operated successfully.

It has already been appreciated that if a separate channel or channels can be provided for signalling as distinct from the conversational circuit the problem of discriminating between voice and signalling currents of the same frequency no longer arises and the equipment used for responding to the signals can therefore be considerably simplified. The chief object of the present invention is to provide a simplified signalling system operating on this basis and suitable for giving both manual-to-manual and manual-to-automatic working.

According to the invention, in a telephone or like signalling system employing supervisory signals of alternating current transmitted over a channel which is common to a plurality of speech channels, each supervisory signal is transmitted once only and comprises one or more pulses of a single frequency and predetermined length.

The invention will be better understood from the following description of two methods of carrying it into effect, reference being had to the accompanying drawings.

Fig. 1 shows by way of example a twelve-channel carrier systems in which there are eleven speech channels, while the twelfth channel is sub-divided into twenty-two sub-channels to provide both-way signalling facilities for the eleven speech channels. It will be understood that although this arrangement may find its most advantageous application in carrier systems, it may also be used for ordinary audio circuits if separate cable circuits can be allocated to form a signalling circuit for a number of audio circuits.

Figs. 2 and 3 when arranged side by side show the circuit arrangements of jack-ended outgoing and incoming trunk circuits arranged according to the invention, and providing manual-to-manual working between operators situated at opposite ends of a trunk line.

Figs. 4 and 5 when arranged side by side show the circuit arrangements for outgoing and incoming trunk circuits terminating opposite ends of a trunk line and providing manual-to-automatic working or automatic-to-automatic working.

Referring now to the trunking arrangement, Fig. 1, this shows schematically the channel components involved in a carrier system arranged according to the invention providing eleven speech channels and using a twelfth channel to provide signalling facilities for the other eleven. This figure could be read with equal facility on to an audio cable system using separate cable circuits to provide the speech and signalling facilities.

The rectangle marked ET CCT1 represents the exchange termination of one of the channels, the rectangle marked C OR A HT represents the carrier or audio 4-wire hybrid termination, the rectangle marked C OR A CP for "go" and "return" represent the single carrier cable pair in either direction, or alternatively, the multiple audio cable pairs using a single pair each for "go" and "return" to provide a number of signalling channels for a group of speech channels. The smaller rectangles marked collectively SF and individually with frequency numbers such as 420, 540, etc. represents the signal filters which split up the "go" and "return" signalling pairs into a number of signalling channels.

If it be assumed that the diagram is to read on to a twelve channel carrier system using one of the channels for signalling, it will be seen that the twelfth "go" and "return" channels are split up into twenty-two sub-channels using signalling frequencies which are 120 cycles apart between the limits of 420 and 2940. Eleven of the frequencies are used for signalling in the "go" direction and eleven in the "return" direction. Thus two signalling frequencies are allotted to each speech channel, one in each direction. The twenty-two V. F. signal filters may be of a type similar to that used on V. F. telegraphs and the signalling receivers which respond to these frequencies need not be provided with guard circuits against voice operation because, as previously mentioned, conversation is not allowed to pass over the signalling circuits.

As will be appreciated, the outstanding advantage of this method of signalling is the avoidance of difficulties due to speech interference with the signalling. Furthermore, signalling

can take place independently and simultaneously in both directions.

In circumstances where multi-channel systems may have to form groups of wide band (coaxial) systems, it is inadvisable to have the signalling current flowing for long durations, since this may overload the line amplifiers and filters. According to the present invention therefore, the signals are composed of short pulses of frequency, and as there is no danger of jamming these signals by speech or by signals coming in the opposite direction, there is no necessity for them to be repeated.

Referring now to the circuit operation of Figs. 2 and 3, when the operator plugs into the outgoing jack to originate a call, relay M operates over the sleeve circuit and brings up relay MM. Relay MM at contacts MM2 causes switch TSO to step from its home position and it then continues to operate from earth over bank TSO1 until it reaches position 6. During this movement relay FX is operated and at contacts FX1 applies X frequency to the outgoing signalling circuit. The wipers come to rest in position 6 and relay FX releases to terminate the pulse which will have lasted for approximately 100 m. s. Relay CO is operated on the first step of the switch and at contacts CO2 energises relay FLS which causes the free line signal lamps appropriate to the next idle multiple circuit to light.

At the distant incoming relay set the pulse of X frequency operates relay X in the valve receiver VFR1 and this relay at contacts X1 operates relay L. Relay L locks up at contacts L1 and at contacts L2 operates relay N. This relay at contacts N1 in conjunction with relay L operates the lamp relay to light a lamp adjacent to the incoming jack to indicate to the operator that a call has been initiated on this circuit. Relay N also at contacts N2 prepares a locking circuit for relay CR and at contacts N3 opens the initial circuit of relay L and prepares a circuit for relay CC.

When the incoming operator answers the call by plugging into the jack, relay S is operated over the sleeve circuit to earth at contacts SS1 and relay SS is then energised. Relay SS at contacts SS1 completes a locking circuit for itself and removes the short-circuit from the left-hand winding of differential relay DR, at contacts SS2 opens a point in a circuit for relay FY, at contacts SS3 connects up the right-hand winding of differential relay DR which is not operated at this time since its two windings now neutralise one another, and at contacts SS4 connects relay TS to the ring conductor and releases relay L which thereupon disconnects the lamp relay so as to extinguish the lamp.

When the incoming operator throws her speaking key, the resistance in the sleeve circuit is altered and relay DR is sufficiently unbalanced to cause its operation. It thereupon at contacts DR1 energises relay TS which in turn operates relay CL. Contacts CL1 then cause the switch TSI to step from its home position and it then self-drives from earth over bank TSI1 to position 12. During the movement over contacts 1—6 relay FY is operated and at contacts FY1 connects up a pulse of Y frequency to the outgoing signalling circuit which pulse also has a duration of approximately 100 m. s.

At the outgoing relay set the pulse of Y frequency operates relay Y in the valve receiver VFRO and contacts Y1 complete a circuit for the upper winding of relay SO which accordingly operates. Relay SO at contacts SO1 alters the resistance of the sleeve circuit to dim the supervisory lamp, at contacts SO2 prepares a circuit for relay SR which is at present short-circuited, at contacts SO3 connects earth to the 49th contact in bank TSO5 and at contacts SO4 applies battery to the ring conductor to repeat the supervisory condition to the preceding circuits. At the end of the Y pulse relay Y releases and the short-circuit is removed from relay SR which operates in series with the lower winding of relay SO and at contacts SR1 re-arranges the circuits so that the next Y pulse will maintain relay SR and short-circuit relay SO, while at contacts SR2 the upper winding of relay SO is short-circuited.

When the incoming operator restores the speaking key after having received the details of the connection required, the resistance of the sleeve circuit is again altered so as to restore the balance of relay DR which releases. Relay TS is accordingly released followed by relay CL whereupon at contacts CL1 the switch TSI is again set in operation and returns to its home position. During this movement relay FY is again operated over contacts 13—18 and a pulse of Y frequency is again sent back over the outgoing signalling circuit.

At the outgoing relay set this pulse of Y frequency again operates relay Y which short-circuits relay SO and causes it to release, thereby at contacts SO1 again bringing in the operator's supervisory lamp. At the end of the Y pulse relay Y releases and permits relay SR to fall away so that relays SO and SR are now restored to normal in readiness to respond to the next pair of Y pulses.

When the connection has been completed to the called subscriber by either manual or automatic means, he is signalled in the usual manner and when he replies, battery is connected back over the ring conductor to operate relay TS over its left-hand winding. Relay TS as before operates relay CL and the switch TSI moves to its mid-position and causes a 100 m. s. pulse of Y frequency to be transmitted back. This as before operates relays SO and SR to give the outgoing operator answering supervision.

The subscribers may now converse and when the called subscriber clears, battery is removed from the ring conductor to release relay TS in the incoming relay set. Relay CL accordingly falls away and a further pulse of Y frequency is sent back while the switch TSI is moving to its home position. This results in the release of relays SO and SR and the lighting of the outgoing operator's supervisory lamp.

In response to this signal the operator removes the plug from the jack thereby releasing relays M and MM. At contacts MM5 battery guarding potential is applied to the sleeve of the jack until the equipment is restored to normal and at contacts MM3 earth is applied to the sixth contact in bank TSO1 to cause the switch to resume its movement. It thereupon steps to position 49 and during this period relay FX is operated from the bank commoning to cause two 100 m. s. pulses of X frequency to be applied to the outgoing signalling circuit, these pulses being separated by a gap of 100 m. s.

At the incoming relay set the first pulse of X frequency operates relay X in the valve receiver VFR1 and this causes operation of relay CC. This relay at contacts CC1 prepares a circuit for relay CR, at contacts CC2 short-circuits the left-hand

winding of relay DR and thus alters the resistance of the sleeve circuit so as to light the supervisory lamp, at contacts CC3 prepares a circuit for relay CD and at contacts CC4 opens a point in the circuit of the lamp relay. During the pause between the two pulses relay X releases and completes a circuit for relay CD. Relay CC has a longer hold period than 100 m. s. so that upon the receipt of the second X pulse relay CR is operated and locks up at contacts CR1. Relay CR also at contacts CR2 opens another point in the circuit of relay CL, at contacts CR3 connects a further earth to the sleeve circuit and at contacts CR4 prepares a circuit for relay FY.

When the incoming operator notes from the lighting of the supervisory lamp that the outgoing operator has cleared, she removes the plug from the jack whereupon relays S and SS release followed by relays N and CR. During the slow release period of relay N, relay CR is held up and completes a circuit for relay FY for approximately 200 m. s. Accordingly a Y pulse of this length is sent back over the signalling circuit and thereupon energises relays SO and SR. At contacts SO3 the switch TSO is caused to step to its home position whereupon relay CO is disconnected but remains operated for a short period owing to its slug in order to ensure that the guard on the multiple shall not be removed prematurely. Relays SO and SR are released at contacts CO4 when relay CO falls away.

If the outgoing operator wishes to flash the distant incoming operator, she depresses the ringing key which causes battery to be applied to the tip conductor and operates relay RR. Thereupon at contacts RR1 relay RA is energised and at contacts RR2 the switch TSO is caused to resume its stepping. Relay RA completes a locking circuit for itself at contacts RA1 and at contacts RA2 alters the connection of relay FX to the contacts of banks TSO2 and TSO6. Since relay MM is operated at this time, switch TSO will make a complete revolution and if the ringing key is still operated will again pass contact 6 and make a further revolution. During this movement relay FX is operated for approximately 560 m. s. and is released for 440 m. s. so that X pulses of this timing and spacing are applied to the outgoing signalling circuit. If the ringing key is released while the switch TSO is in an intermediate position, relay RA is held operated in order to ensure that the signal is not mutilated. At the incoming relay set the 560 m. s. X pulse operates relay CC and when the pulse terminates relay CD is operated. Relay CC however cannot hold up throughout the space period of 440 m. s. and consequently no circuit is completed for relay CR on the next pulse. The pulse is repeated by contacts CC2 which alter the resistance in the sleeve circuit and thus bring about the flashing of the operator's supervisory lamp.

If the incoming operator wishes to flash the outgoing operator, she throws the speaking key and then intermittently operates the ringing key which is common to all the cord circuits. The operation of the speaking key produces the effects previously described, viz. the operation of relays DR, TS and CL so that a 100 m. s. pulse of Y frequency is sent back over the signalling circuit. When the ringing key is operated relay IRR energises and at contacts IRR1 opens the circuit of relay CL so that a further pulse of Y frequency is transmitted. The switch TSI thus makes half a revolution each time the key is operated or released and the relays SO and SR respond as previously described so that the outgoing operator's supervisory lamp is flashed.

The arrangement shown in Figs. 4 and 5 for working into an automatic exchange operates in substantially the same manner with suitable modifications to take care of the somewhat different conditions.

When the outgoing operator plugs into the jack AOG, relay AM operates over the sleeve circuit and at contacts AM1 energises relay AMM. This relay at contacts AMM1 connects flicker earth to the sleeve circuit, at contacts AMM2 and AMM5 connects up relay ARR to the tip conductor, and at contacts AMM3 applies earth to the P conductor extending to the selector levels to guard the circuit from seizure over this means of access and energises relay ACZ by way of its lower winding. Relay ACZ at contacts ACZ3 extends the earth from contacts AMM3 over the home position contact of wiper ATSO3 to cause switch ATSO to step, whereupon relay AFX is operated and at contacts AFX2 provides a circuit to drive the switch to position 3. Relay AFX also at contacts AFX1 applies X frequency to the outgoing signalling circuit so that during the stepping of the switch and the slow release time of relay AFX a pulse of approximately 100 m. s. duration is transmitted forward. Relay ACO is operated as soon as switch ATSO steps off-normal and at contacts ACO2 operates the lamp relay AFLS which causes the free line signal lamps appropriate to the next idle circuit to light while at contacts ACO3 relay ACZ is released.

At the incoming relay set at the distant exchange, the 100 m. s. pulse of X frequency operates relay X in the voice frequency receiver which then energizes relay AL. Relay AL at contacts AL1 prepares a circuit for relay ARU, at contacts AL2 completes a locking circuit for itself, at contacts AL3 prepares a circuit for relay AAR, at contacts AL4 earths the P conductor extending to the associated incoming selector, at contacts AL5 prepares a circuit for relay AC and at contacts AL6 opens a point in the driving circuit for the switch ATSI. At the end of the X pulse contacts AX1 operate relay AAR which at contacts AAR1 energises the line relay of the selector in series with relay AIL which also operates, and at contacts AAR2 energises relay ARU. Contacts ARU1 prevent the premature operation of relay ACR and relay AIL energises relay AN which at contacts AN1 supplements the earth on the P conductor, at contacts AN2 further prepares the circuit of relay AC and at contacts AN3 prepares a locking circuit for relay AP.

When the outgoing operator throws the dialling key, resistance battery is connected to the tip conductor and operates relay ARR which at contacts ARR1 energises relay AAM. This relay thereupon at contacts AAM1 prepares the circuit for transmitting setting pulses of X frequency and at contacts AAM2 energises relay AB. The latter relay at contacts AB1 further prepares the impulsing circuit, at contacts AB2 and AB3 connects relay AMM to the tip and ring conductors, at contacts AB4 disconnects the flicker earth from the sleeve circuit and prepares a circuit for relay ALR, at contacts AB5 releases relay ARR and at contacts AB6 opens a point in the driving circuit for switch ATSO. When the operator dials the wanted number relay AAM responds accordingly and at contacts AAM1 repeats pulses of X frequency over the outgoing signal circuit, the line being properly terminated

during the make periods over the operated contacts AAM1.

At the incoming end the first pulse releases relay AAR which at contacts AAR1 repeats the pulse to the incoming selector. The operation of relay AX also energises relay AC which at contacts AC1 short-circuits its left-hand winding to make itself slow to release, at contacts AC2 prepares a circuit for relay ACR and at contacts AC3 and AC4 provides an impedance-free impulsing circuit thereby releasing relay AIL. Relay AP is also operated and at contacts AP1 locks up to contacts AN3, at contacts AP2 connects up relay AI to the positive conductor, at contact AP3 provides a further circuit for relay AN and at contacts AP4 closes another point in the circuit of relay ACR. The remaining impulses are repeated by relay AAR in similar manner and at the end of the train relay AC releases and again connects up relay AIL which re-operates. Further trains of impulses produce similar effects to set up the automatic switch train and any tones which may be received during the setting up of the connection are transmitted back to the operator.

When the operator restores the dialling key, low resistance battery is connected to the sleeve circuit and brings about the operation of relay ALR and after a short interval depending upon the release of certain relays in the position circuit, relay AAM also releases and brings down relay AB. Relay ALR at contacts ALR1 locks up, at contacts ALR2 opens the impulsing circuit to prevent the transmission of a further X pulse on the release of relay AAM, at contacts ALR3 prepares to connect battery to the ring conductor and at contacts ALR4 connects direct earth to the sleeve circuit to light the supervisory lamp.

When the called subscriber replies, battery is reversed back over the calling side of the circuit so that relay AIL is released and relay AI is operated. Relay AI at contacts AI1 releases relay AL and a circuit is then completed over contacts AL6, AI2 and AIL3 to cause the switch ATSI to step from its home position and thereafter to drive to position 12. While it is passing over the first six contacts relay AFY is operated and at contacts AFY1 transmits a pulse of Y frequency of approximately 100 m. s. over the outgoing signalling circuit. Relay AY at the outgoing end responds to this pulse and energises relay ACT by way of its upper winding. This relay at contacts ACT1 disconnects direct earth from the sleeve circuit to dim the supervisory lamp, at contacts ACT2 short-circuits condenser AQA in the repeating coil bridge which has been in circuit to minimise distortion during dialling, at contacts ACTS prepares a locking circuit for itself in series with the upper winding of relay ACZ and at contacts ACT4 connects through signalling battery to the ring conductor. At the end of the Y pulse the short-circuit is removed from relays ACZ and ACT and the former now operates while the latter holds. Relay ACZ at contacts ACZ1 prepares a circuit for short-circuiting the lower winding of relay ACT and at contacts ACZ2 short-circuits the upper winding of this relay. Conversation may now proceed.

When the called party clears at the end of the conversation, battery is reversed back to normal so that relay AI releases and relay AIL again operates. The switch ATSI is then caused to advance over the other half of its bank to cause the transmission of a further 100 m. s. pulse of Y frequency. This energises relay AY and at contacts AY1 the lower winding of relay ACT is short-circuited while relay ACZ is held over its upper winding until the end of the pulse. The release of relay ACT causes the supervisory signal to be repeated to the operator and when she removes the plug from the jack in response thereto, relays AM and AMM restore. The latter relay at contacts AMM3 provides a circuit to drive switch ATSO to position 23 and during this operation relay AFX is energised to apply a pulse of X frequency of approximately 400 m. s. duration to the outgoing signalling circuit. The switch ATSO is then restored to its home position over wiper ATSO2 which picks up half-second earth pulses over contacts 23 and 24 so as to maintain the circuit guarded during the release time of the equipment at the distant exchange.

At the distant end the effect of the long X pulse is to operate relay ACR which at contacts ACR1 connects up relay AN to contacts AX1 so as to be dependent upon the incoming pulse, at contacts ACR2 energises relay AC, at contacts ACR3 opens a point in the circuit of relay AL and at contacts ACR4 completes a locking circuit for itself. The operation of relay AC releases relay AAR which thereupon opens the outgoing circuit. When relay AX falls away at the end of the pulse, relay AN releases after its slow period and releases relays AP and AC. Relay ACR falls away on the release of relay AP and the circuit is then completely restored to normal. The release of relay AN disconnects earth from the P conductor to release the automatic switch train.

If a busy connection has been encountered, there will have been no reversal to bring about the release of relay AL and the circuit conditions are therefore somewhat different. In these circumstances the operation of relay AX releases relay AAR and operates relay AC. Relay ARU is now released and a circuit is then completed for relay ACR over contacts AP4, AC2 and ARU1. Relay ACR now disconnects relay AL and transfers the holding circuit for relay AN to contacts AX1 and provides a holding circuit for relay AC. At the end of the X pulse, relay AN falls away and releases the remaining equipment as previously described. If the circuits are such that busy flash is returned, battery over the two speaking conductors operates both relays AIL and AI and causes the release of relay AL but in these circumstances there is no circuit for setting the switch ATSI in operation so that a false answer signal is not transmitted.

The case will now be briefly considered in which the circuit is taken into use from the levels of automatic switches rather than from an operator's position. In this case when the circuit is seized relay AA is operated over the speaking conductors and operates relay AB. Thereupon at contacts AB6 earth is applied to the P conductor to hold the preceding train of switches and to maintain relay ACZ which was energised by the earth originally fed forward. Relay ACZ causes a seizing pulse of X frequency of 100 m. s. duration to be transmitted to the distant exchange in the manner previously described whereupon the equipment thereat is prepared in the usual manner. The operation of relay ACO when the switch ATSO moves off normal connects guarding battery to the sleeve of the jack to indicate to the operator that the circuit is busy. Incoming trains of impulses are received on relay AA which at contact AA1 repeats them

in the form of X pulses over the outgoing signalling circuit. During the setting up of the connection any tones which may be encountered are transmitted back over contacts AMM5 and AMM6 since relay AMM is not operated under these conditions.

When the called subscriber answers, the 100 m. s. pulse of Y frequency brings about the operation of relay ACT as before and this relay at contacts ACT5 and ACT6 reverses battery over the speaking conductors to repeat the supervision to the preceding switches. When the called subscriber clears, the transmission of the further pulse of Y frequency causes the release of relay ACT which reverses battery back to normal and thus repeats the supervisory signal to the preceding train of switches. When the calling party releases, the loop circuit for relay AA is opened and it falls away thereby bringing down relay AB. This at contacts AB6 completes a driving circuit for the switch ATSO which then rotates to contact 23 to effect the transmission of a 400 m. s. clearing pulse over the signalling circuit. This effects the release of the equipment at the incoming end in the manner previously described.

What I claim as new and desire to secure by Letters Patent is:

1. A telephone system including in combination a transmission line, means for dividing said line into a plurality of speech channels and a single signalling channel, means for dividing said signalling channel into a number of sub-channels individual to each of said speech channels, means individually associated with each of said speech channels for transmitting a single signal of predetermined voice frequency and of predetermined length over one of the associated sub-channels to the outgoing end of said line to indicate the reply of the called party in a connection extended over the corresponding speech channel, first self-locking means at the outgoing end responsive to said signal, means for transmitting a single signal of predetermined voice frequency and of predetermined length over one of the associated sub-channels to the outgoing end of said line to indicate the clearing of the called party and second self-locking means at the outgoing end responsive to said signal to give a clearing indication.

2. A telephone system including in combination a transmission line, means for dividing said line into a plurality of speech channels and a single signalling channel, means for dividing said signalling channel into a number of sub-channels individual to each of said speech channels, means individually associated with each of said speech channels for transmitting a single signal of predetermined voice frequency and of predetermined length over one of the associated sub-channels to the outgoing end of said line to indicate the reply of the called party in a connection extended over the corresponding speech channel, first self-locking means at the outgoing end responsive to said signal, means for transmitting a single signal of the same predetermined voice frequency and length over one of the associated sub-channels to the outgoing end of said line to indicate the clearing of the called party and second self-locking means at the outgoing end responsive to said signal to give a clearing indication.

3. A telephone system including in combination a transmission line, means for dividing said line into a plurality of speech channels and a single signalling channel, means for dividing said signalling channel into a number of sub-channels equal to twice the number of said speech channels, two of said sub-channels being individually associated with each of said speech channels, means individually associated with each of said speech channels for transmitting signals of predetermined voice frequency over one of said associated sub-channels from the outgoing end of said line to control the settng up of a connection, means individually associated with each of said speech channels for transmitting a single signal of predetermined voice frequency and of predetermined length over the other of said associated sub-channels to the outgoing end of said line to indicate the reply of the called party in a connection extended over the corresponding speech channel, first self-locking means at the outgoing end responsive to said signal, means for transmitting a single signal of predetermined voice frequency and of predetermined length over the said other sub-channel to the outgoing end of said line to indicate the clearing of the called party and second self-locking means at the outgoing end responsive to said signal to give a clearing indication.

4. A telephone system including in combination a transmission line, means for dividing said line into a plurality of speech channels and a single signalling channel, means for dividing said signalling channel into a number of sub-channels equal to twice the number of said speech channels, two of said sub-channels being individually associated with each of said speech channels, means individually associated with each of said speech channels for transmitting signals of a first predetermined voice frequency over one of said associated sub-channels from the outgoing end of said line to control the setting up of a connection, means individually associated with each of said speech channels for transmitting a single signal of a second predetermined voice frequency and of predetermined length over the other of said associated sub-channels to the outgoing end of said line to indicate the reply of the called party in a connection extended over the corresponding speech channel, first self-locking means at the outgoing end responsive to said signal, means for transmitting a single signal of said second predetermined voice frequency and of predetermined length over said other associated sub-channel to the outgoing end of said line to indicate the clearing of the called party and second self-locking means at the outgoing end responsive to said signal to give a clearing indication.

5. A telephone system including in combination a transmission line, means for dividing said line into a plurality of carrier speech channels and a single carrier signalling channel, means for dividing said signalling channel into a number of sub-channels equal to twice the number of said speech channels, two of said sub-channels being individually associated with each of said speech channels, means individually associated with each of said speech channels for transmitting a single signal of predetermined voice frequency and of predetermined length over one of said associated sub-channels to the outgoing end of said line to indicate the reply of the called party in a connection extended over the corresponding speech channel, first self-locking means at the outgoing end of each speech channel responsive to said signal, means for transmitting a single signal of the same predetermined frequency and length over the same sub-channel to the outgoing end of said line to indicate the clearing of the called party, and second self-

locking means individually associated with each speech channel and responsive to said signal to give a clearing indication.

6. A telephone system according to claim 4 in which timing of the predetermined length of said signals is effected by the stepping operation of an electromagnetically-operated step-by-step rotary switch arranged to operate by self-interruption.

7. A telephone system including in combination a transmission line, means for dividing said line into a plurality of carrier speech channels and a single carrier signalling channel, means for dividing said signalling channel into a number of sub-channels equal to twice the number of said speech channels, two of said sub-channels being individually associated with each of said speech channels, means individually associated with each of said speech channels for transmitting a single signal of predetermined voice frequency and of predetermined length over one of said associated sub-channels to the outgoing end of said line to indicate the reply of the called party in a connection extended over the corresponding speech channel, a relay individually associated with each speech channel and arranged to be operated in response to the receipt of said signal, a second relay cooperating with said first relay and arranged to be operated on the termination of said signal, means for transmitting a single signal of the same predetermined frequency and length over the same sub-channel to the outgoing end of said line to indicate the clearing of the called party, circuit arrangements for causing said first relay to de-energize on receipt of said second signal and circuit arrangements for causing said second relay to de-energize on the termination of said second signal.

8. A telephone system including in combination a transmission line, means for dividing said line into a plurality of carrier speech channels and a single carrier signalling channel, means for dividing said signalling channel into a number of sub-channels equal to twice the number of said speech channels, two of said sub-channels being individually associated with each of said speech channels, an operator's position at the outgoing end of said line, means for extending a connection from said operator's position over one of said speech channels to a second operator's position at the incoming end of said line, means for transmitting a single signal of predetermined voice frequency and of predetermined length over the appropriate one of said associated sub-channels on the reply of said second operator, self-locking means responsive to said signal to give a supervisory indication, means for transmitting a single signal of the same predetermined frequency and length over said signalling sub-channel on the withdrawal of said second operator, means responsive to said signal to unlock said self-locking means and cancel said supervisory indication, means for extending a connection from said second operator's position of a called party, means for transmitting a single signal of the same predetermined frequency and length over said signalling sub-channel on the reply of said called party to re-operate said self-locking means and means for transmitting a single signal of the same predetermined frequency and length over said sub-channel on the clearing of the called party to again unlock said self-locking means.

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