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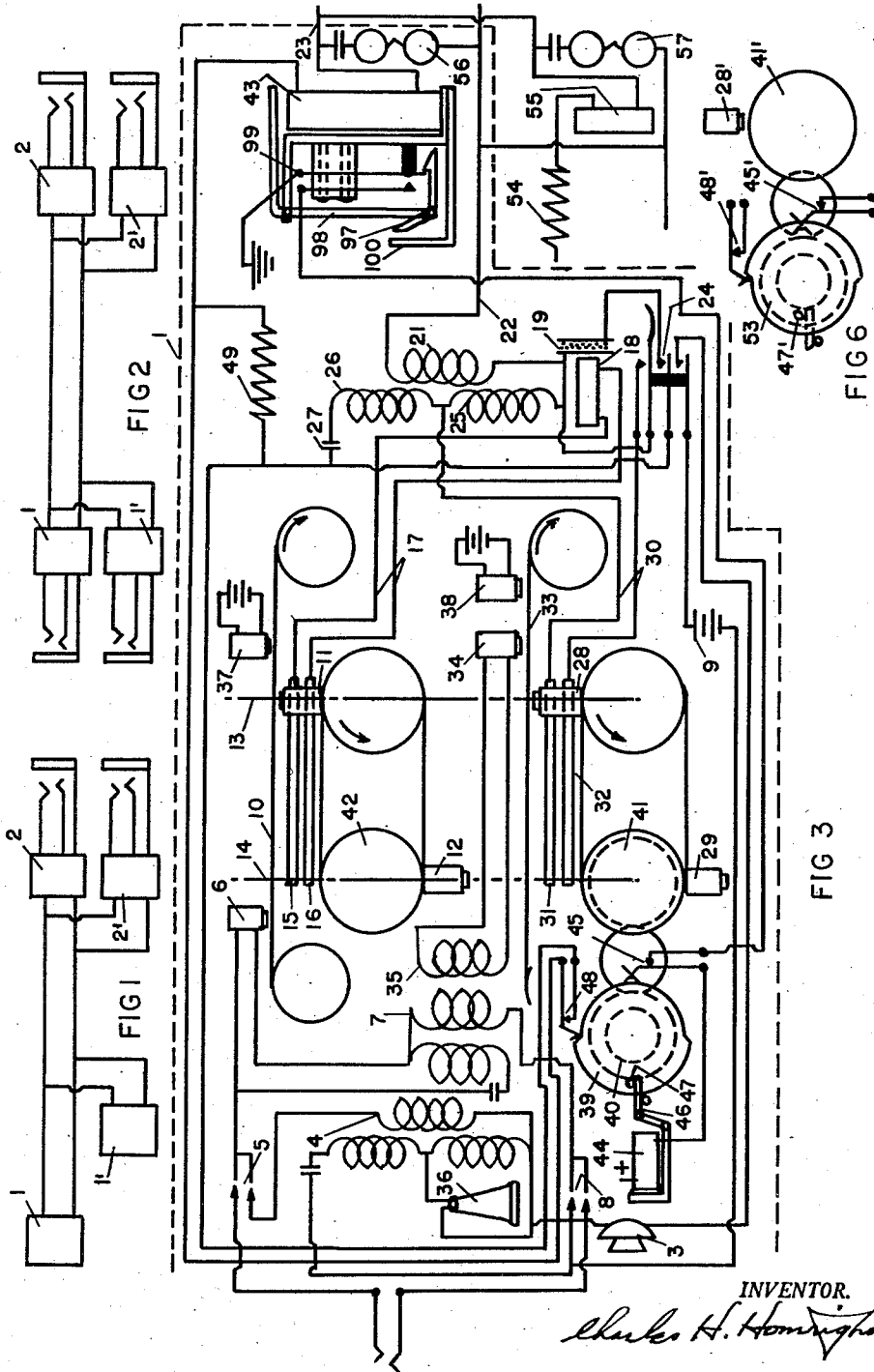
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TIME DIVISION MULTIPLEX TELEPHONE SYSTEM

Filed Sept. 28, 1943

2 Sheets-Sheet 1



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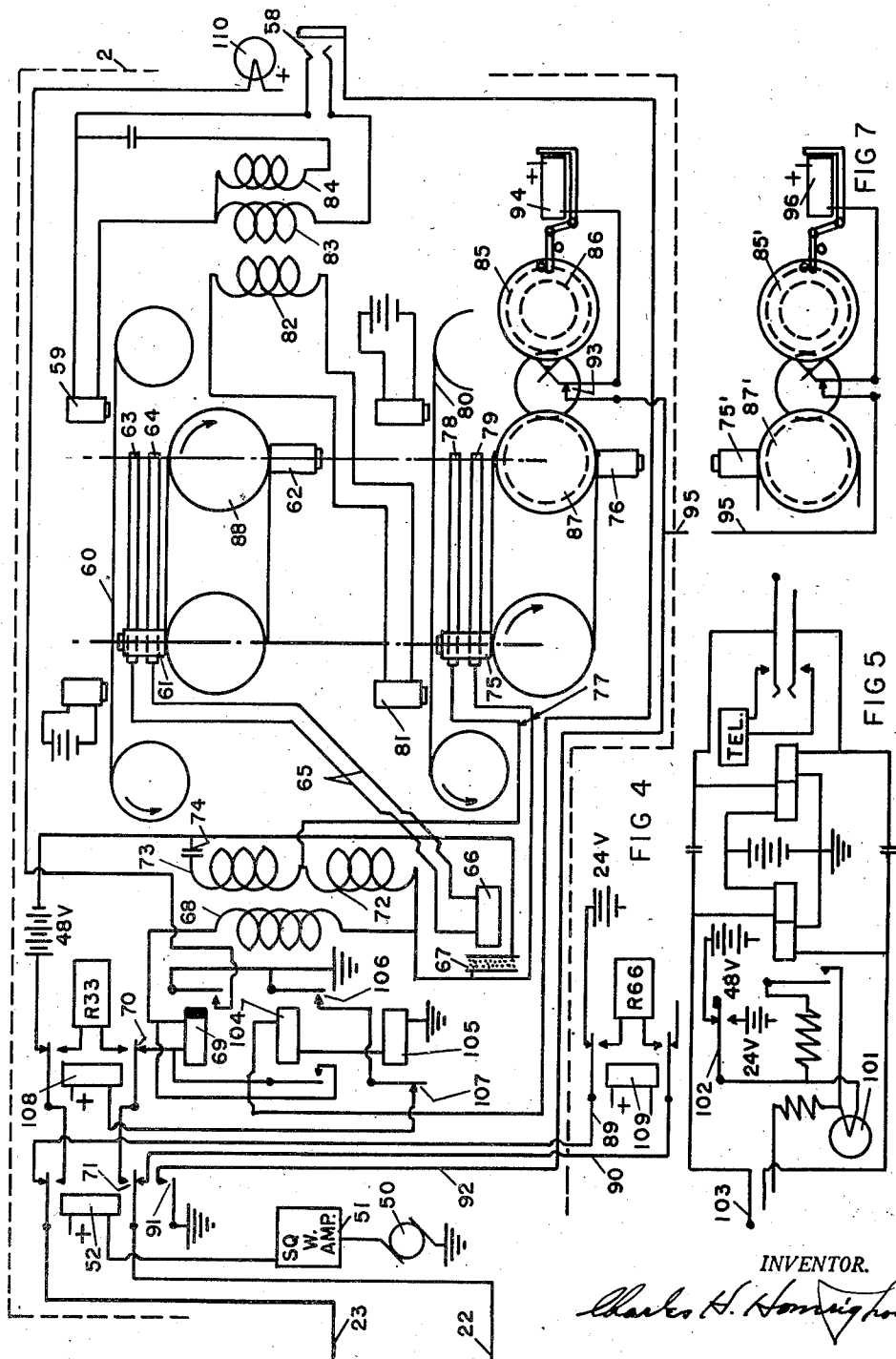
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UNITED STATES PATENT OFFICE

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TIME DIVISION MULTIPLEX TELEPHONE
SYSTEM

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9 Claims. (Cl. 179—15)

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This invention relates to a telephone system for transmitting two two-way telephone messages over a line at the same time.

One of the main objects of my invention is to double the number of messages that may be transmitted over trunk lines between telephone offices.

Another object of my invention is to provide a system for intermittently transmitting two telephone messages over a subscriber's telephone line.

Another object of my invention is to provide a two message two-way trunk having means for allotting each message different recurring periods of time.

Another object of my invention is to provide a two message two-way trunk with means for signalling in either direction.

Another object of my invention is to provide in a party telephone line means for transmitting at least two private two-way telephone messages simultaneously.

Still another object of my invention is to provide in a party telephone line means for notifying the operator which party is calling.

Several telephone messages may be transmitted simultaneously over a pair of conductors by providing a different carrier wave for each telephone message. In the instant invention I separate the sound signals for two messages into equal portions or fragments and by reducing the period of time for each fragment approximately one half, the two messages may be transmitted in rotation over a pair of conductors.

The various objects and features of my invention will be clear from the following description taken in accordance with the accompanying drawing in which:

Figure 1 is a simplified diagram of a private two party subscriber's line.

Figure 2 is a simplified diagram of a two message two-way trunk line.

Figure 3 shows the interval reducing and expanding mechanism with associated circuits that may be used at the subscriber's station.

Figure 4 shows the interval reducing and expanding mechanism with associated circuits that may be used at the switchboard.

Figure 5 shows accord circuit that may be used with this invention.

Figures 6 and 7 are detail views.

Figure 1 represents a two party subscriber's telephone line having means at the switchboard terminal whereby an operator may individually signal each station on the line, also means whereby either station may signal the operator at the switchboard, indicating which subscriber is calling. The numeral 1 represents subscriber's station mechanism and associated circuits for separating the outgoing sound signals into equal portions or fragments and then reducing the pe-

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riod of time of each portion of signals to approximately one half to transmit the signals for one message in alternate periods of time. The mechanism also combines the incoming sound signals by expanding or doubling the interval of time for each portion of incoming signals. The numeral 1' represents similar equipment for a second party on the same line, to be fully explained later.

The mechanism 2 and 2' and their associated circuits at the telephone office are similar to the subscriber's station equipment and may function to separate and combine two different telephone messages.

Figure 2 shows a two conductor trunk line extending between two telephone offices and terminating in two jacks at each office for two secret telephone conversations at the same time.

Figure 3 shows the mechanism and associated circuits represented by the numerals 1 and 1' in Figures 1 and 2. Speech currents representing a conversation are produced as a result of speaking into the microphone 3. The speech current or sound signals from the microphone 3 are applied through the transformer winding 4, junction contact 5, recording coil 6, transformer winding 7, junction contact 8 and battery 9. The recording coil 6 will impress magnetic variations in the endless telegraphophone wire 10 traveling at a uniform speed beneath the coil in accordance with the speech currents produced by the microphone 3. Beneath the wire 10 are two reproducing coils 11 and 12 traveling on a belt in an opposite direction to the moving wire and at approximately the same speed that the wire is moving. The message variations are reproduced in the coil 11 traveling between lines or points 13 and 14. Therefore the sound signal frequency will be approximately doubled or the period of time for the portion or fragment of the message will be reduced by one half. The coils 11 and 12 are spaced so that message variations will be reproduced in alternate periods of time; that is, after coil 11 reproduces one portion of the message an equal period of time will elapse before coil 12 starts to reproduce the message variations from the wire 10.

The current variations produced in coils 11 and 12 are applied through brushes not shown contacting the bars 15 and 16, conductors 17, to the electromagnet 18, thereby actuating the microphone 19 to redevelop speech current in the line circuit to the telephone office, through winding 21 of anti-side tone transformer, line conductor 22, telephone office equipment of Figure 4, line conductor 23, relay 43, resistor 49, and switch hook contacts 24. Thus the speech currents produced by the microphone 3 will be reproduced and transmitted over the line circuit in alternate periods of time.

Speech current incoming from the line conductors 22 and 23 during alternate periods of time pass through transformer windings 24, 25 and 26 in series and condenser 27. The variable currents in winding 25 are applied to the recording coils 28 and 29, over conductors 30, bars 31 and 32. The coils 28 and 29 travel on a belt beneath the telegraph wire 33 in a direction opposite to the movement of the wire. This mechanism is similar to the mechanism described above, both mechanisms being connected together and driven by a single motor, except that the problem now is to expand the intervals for portions of the incoming messages. The rotating coils 28 and 29 will impress magnetic variations in the wire 33 between the points or lines 13 and 14 during alternate periods of time. Therefore, since the coils 28 and 29 and the wire 33 are moving in opposite directions the message variations reproduced in coil 34 are expanded to approximately equal their original intervals.

The current variations in coil 34 are applied to the transformer winding 35, producing a variable current in the telephone receiver 36. Coils 37 and 38 are erasing coils.

The signal separating and combining devices comprising the telegraph wires 10 and 33 which may be the same wire and the coils 11, 12, 28 and 29 are driven by a single motor at the subscriber's station. The motor, not shown, drives the cam wheel 39 through a friction clutch indicated by the dotted circle 40. The cam wheel 39 through an intermediate gear drives the pulley 41 which is directly connected to the pulley 42. Thus both the sending mechanism and receiving mechanism are driven at the same speed. The speed for the wheels 39 and 41 is approximately ten R. P. S.

The line circuit is supplied with twenty-four and forty-eight volts from the telephone office batteries (Figure 4) in successive rotation and during equal periods of time to be fully explained later. The armature of relay 43 will be operated only during the time that forty-eight volts are connected to the line. The energization of relay 43 places ground potential on the control relay 44 through cam controlled contacts 45. The operation of the armature of relay 44 draws the holding bar 46 out of engagement with the pin 47, thus allowing the wheels 39, 41 and 42 to rotate, whereby a portion or fragment of a conversation may be sent over the line circuit during one half revolution of the wheel 39. Whereupon the cam controlled contacts 48 are opened for the remaining one half revolution of the wheel 39. Opening the contacts 48 places the resistance 49 in series with the anti-side tone transformer during the 24 volt period. It is also to be noted that the coils 11 and 28 have traveled from line 13 to line 14 during one half revolution of wheels 41 and 42 and during the remaining half revolution of the wheels none of the rotating coils are engaging or coacting with the continuously moving wires 10 and 13.

The generator 50 (Figure 4) develops ten cycles per second sine wave current which is applied to the device 51 for producing square waves. The positive pulse of the square wave is applied to the relay 52 for energizing the relay during one half of each cycle, thereby interchanging from twenty-four to forty-eight volt transmission during each cycle of generated current, or forty-eight volts during one half revolution of the wheel 39 and twenty-four volts during the other one half revolution of the wheel.

The subscriber's station equipment for the second party 1' on the line extending to the control office is exactly like that described above except for the wheel 39 which would be replaced by a wheel 53 Figure 6 having the location of the holding pin 47' on the opposite side of the wheel and the cam for opening the contacts 48' on the opposite side of the wheel so that the contacts 48' for the station 1' will be open to include resistance 54 in series with the transformer at station 1' during the time that the contacts 48 in station 1 are closed. The coil 28' would be as shown in Figure 6 at start of forty-eight volt transmission. Therefore, station 1 will transmit on forty-eight volts and station 1' will transmit on twenty-four volts. The relay 55, like relay 43, operates only on forty-eight volts and controls a relay similar to 44 in station 1.

The ringer 56 in station 1 may be for thirty-three cycle current and the ringer 57 in station 1' may only respond to sixty-six cycle current.

Figure 4 shows the mechanism and associated circuits represented by the numerals 2 and 2' in Figures 1 and 2. The mechanism and associated circuits in Figure 4 are similar to those in Figure 3 and the operation is practically the same.

The speech currents from the operator's or called subscriber's microphone are applied through the cord circuit (Figure 5), jack 58 to the recording coil 59. The recording coil 59 will impress magnetic variations in the endless telegraph wire 60 traveling at a uniform speed beneath the coil. Beneath the wire 60 are two reproducing coils 61 and 62 traveling on a belt in the opposite direction to the moving wire and at approximately the same speed as the speed of the wire. The message variations reproduced in the coils 61 and 62 will have their frequency practically doubled or the period of time for each fragment of a message will be reduced by one half. The coils 61 and 62 are spaced so that message variations will be produced in alternate periods of time as described above for the subscriber's station. The current variation produced in coils 61 and 62 are applied through brushes contacting bars 63 and 64, conductors 65, to the electromagnet 66 for actuating the microphone 67 to develop speech current in the line circuit to the subscriber's station through windings 68 of the anti-side tone transformer, contact 70, contact 71 when relay 52 is energized, line conductors 22 and 23, to forty-eight volt battery. Thus the speech produced at the operator's microphone or at a called subscriber's station will be reproduced and transmitted over the line circuit during alternate periods of time.

Speech currents incoming from the calling subscriber's station during alternate periods of time flow through the transformer windings 68, 72 and 73, condenser 74. The variable current in winding 72 is applied to the recording coils 75 and 76 alternately through conductors 77 and bars 78 and 79. The coils 75 and 76 travel on a belt beneath the continuously moving wire 80 in a direction opposite to the movement of the wire. This mechanism is similar to the mechanism associated with coils 61 and 62, both mechanism being connected together and driven by a single motor at the telephone office.

The rotating coils 75 and 76 will impress magnetic variations in the wire 80 during alternate periods of time. The wire 80 and coils 75 and 76 travel in opposite directions, therefore the message variations reproduced in coil 81 are expanded to approximately equal their original interval.

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The current variations in coil 81 are applied to the transformer winding 82 producing a variable current through the windings 83 and 84 and the operator's cord circuit (Figure 5) to the called subscriber's station.

A motor not shown drives the cam wheel 85 through a friction clutch indicated by the dotted line 86. The wheel 85 through an intermediate gear drives the pulley 87 which is directly connected to the pulley 88; thus both the sending mechanism and receiving mechanism are driven at the same speeds. The speed of the wheel 85 should be the same as the speed of the wheel 39 in the subscriber's station.

Figure 7 shows the arrangement of the wheels 85' and 87' for the equipment 2'. The coil 75' would be in the location shown at the start of the 48 volt transmission period.

From the above description it has been shown that a conversation between two stations may be transmitted over the two conductor line during alternate periods of time.

The telephone office equipment for the second station 2' in Figures 1 and 2 is exactly like the office equipment described in Figure 4 except that twenty-four volt current is supplied to the line over conductors 89 and 90 during the intermediate periods of time, whereby a second conversation may be transmitted during the periods intervening the first message.

To synchronize the subscriber's station mechanism with the mechanism at the telephone office: The relay 52, which upon energizing, places 48 volts on the line, actuating the relay 43 to in turn actuate the control relay 44 and a similar control relay 55 in station 1' is actuated in unison with relay 43 as previously described. Relay 52 upon energizing also places ground through its contacts 91 over conductor 92 and cam controlled springs 93, to the control relay 94, thereby releasing the rotating mechanism at the telephone office at the same instant that the mechanism at the subscriber's station is released. The conductor 95 places ground potential on the control magnet 96 in the office equipment 2' Figure 7.

The wheel 39 Figure 3 is driven at a slightly greater speed than ten R. P. S. so that the holding bar 46 will have a tendency to snub or slow down the speed of the wheel at the end of each revolution. Assuming that a calling subscriber removes the receiver from the switch hook some time after the start of 48 volt transmission the relay 44 would be operated as previously described, which would release the wheel 39 after the start of transmission.

The springs of relay 43 are controlled by a ratchet 97 pivoted on the end of the armature 98. As the armature is attracted to the pole of the coil the springs are closed by the ratchet engaging the bottom of spring 99; further movement of the armature causes the ratchet arm to engage a pin 100, thereby releasing the spring 99, but still maintaining its armature in an operated position. Therefore, the relay 43 upon energizing after the wheel 39 has rotated less than a complete revolution will have no effect on the control relay 44, since contacts 45 are open and the springs of relay 43 are only closed when the relay is first energized. The wheel 39 will then come to rest with the holding bar 46 engaging the pin 47 until the start of the next period of 48 volt transmission and from this time on the wheel 39 will rotate in synchronism with the wheel 85. The mechanism for station 1' is similarly synchronized.

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Figure 5 shows a conventional cord circuit provided with a signal lamp 101 to indicate when the calling party hangs up his receiver, and a ringing key 102 for signalling a called subscriber. The operator, upon inserting the plug 103 in the jack 58, places 48 volt battery over the sleeve conductor to energize relay 104 and 105 in series. Assuming that the operator desires to ring station 1, she depresses key 102 placing twenty-four volts on the sleeve conductor instead of forty-eight volts. Whereupon relay 105 will release and close a circuit from ground through contacts 106 and 107 to ringing relay 108. Relay 108 upon energizing causes thirty-three cycle alternating current to be applied to the line actuating the harmonic ringer 56 at station 1. The ringer 57 will not respond to thirty-three cycle current. However relay 109 in the office equipment 2' controlled by the ringing key in the cord circuit will upon energizing cause sixty-six cycle alternating current to be applied to the line for actuating the ringer 57.

The subscriber at station 1 upon removing the receiver from its hook closes a circuit intermittently as previously described, through relay 69. This relay is designed for slow release and will maintain its contacts closed during the interruptions of the circuit by relay 52 to bring in the visual signal 110 in front of the operator. The operator upon answering the call by plugging into the jack 58 will cause relay 104 to be energized to close its contacts, thereby short circuiting relay 59 to retire the signal. Likewise a subscriber from station 1' can signal the operator at 2'.

From the above description it has been shown that two secret conversations may be transmitted over a pair of conductors from subscriber's station to the telephone office at the same time.

The equipment of Figure 3 and Figure 4 may be used in the trunk line between two central offices shown in Figure 2. In Figure 3 a jack may be connected at contacts 5 and 8 in place of the subscriber's telephone and the ringers 56 and 57 may be replaced with ringing current drop signals in the switchboard.

Equipment at subscriber's station 1 and office terminal equipment 2 are arranged for forty-eight volt transmission; station 1' and office terminal equipment 2' are arranged for twenty-four volt transmission. In other words, station 1 always operates over forty-eight volt line, and station 1' always operates over twenty-four volt line.

In the various circuits shown and described I have simplified the drawings by indicating the source of potential as a positive sign. I have also indicated certain similar apparatus by primed numerals.

The embodiments of the invention which have been given herein are illustrations of how the various features may be accomplished and of the principles involved. It is to be understood that the invention contained herein is capable of embodiment in many other forms and adaptations, without departing from the spirit of the invention and the scope of the appended claims.

Having thus described my invention, I claim:

1. In a telephone system, a subscriber's line, sources of high and low potential direct current, means for connecting said sources of current in successive rotation to said line, a supervisory lamp, means for closing a circuit from said source of high potential current over said line during certain alternate periods of time to cause said lamps to glow, means for varying the high po-

tential current in said line in accordance with a telephone message during other alternate periods of time, and means for varying the low potential current in said line in accordance with another telephone message.

2. In a telephone system, a trunk line, sources of direct current, means for supplying current from said sources in successive rotation to said line during substantially equal periods of time, a plurality of supervisory lamps, means for closing a circuit from a first one of said sources of current over said line during certain alternate periods of time to cause one of said lamps to glow, means for closing a circuit from a second one of said sources of current over said line during certain intermediate periods of time to cause another one of said lamps to glow, means for varying the current in said line from said first one of said sources during other alternate periods of time in accordance with one telephone message, and means for varying the current in said line from said second one of said sources during other intermediate periods of time in accordance with another telephone message.

3. In a telephone system, a trunk line provided with sources of relatively high and relatively low potential direct current intermittently applied, a pair of supervisory lamps, means for closing a circuit from said source of high potential over said line during certain high potential periods of time to cause one of said lamps to glow, means for closing a circuit from said source of low potential over said line during certain low potential periods of time to cause another one of said lamps to glow, devices associated with one end of the trunk line for grouping and combining received signals from different messages to vary the high and low potential current in the said trunk line above the original frequency for the said signals to transmit one message during other high potential periods and another message during other low potential periods, and other devices associated with the opposite end of the trunk line for separating and expanding the grouped signals for the different messages into substantially their original intervals.

4. In a telephone system, means to separate and group received sound signals in alternate periods of time, means to separate and group other received sound signals in intermediate periods of time, each of the said first and second means comprising a device for recording said signals on a movable member, and a movable device adapted to travel in a direction opposite to said member for reproducing said signals in spaced groups, a generator for producing spaced control signals, and means responsive to the control signals for controlling the movable devices to govern the starting time for each group of said signals, a subscriber's line, a number of different sources of direct current intermittently applied to one line terminal, means at the opposite line terminal to close a circuit from a first one of said sources of current over said line during said alternate periods of time, means to vary the current in said line in accordance with said sound signals grouped in said alternate periods, means at said opposite line terminal to close a circuit from a second one of said sources of current over said line during said intermediate periods of time, and means to vary the current in said line from said second source in accordance with said sound signals grouped in said intermediate periods.

5. In a telephone system, a trunk line provided with a source of direct current during alternate

periods of time, a supervisory lamp, means for closing a circuit from said source of current over said line in certain of said periods to cause said lamp to glow, a device associated with one end of the trunk line for grouping received signals to vary the current from said source in the trunk line during other of said periods, and another device associated with the opposite end of the trunk line for expanding the grouped signals to substantially their original interval.

6. In a secret telephone system, a party telephone line extending to a central office provided with at least a first subscriber's station and a second subscriber's station widely separated, two sources of direct current at the telephone office intermittently applied to said line during recurring periods of time, a station call indicating lamp at the central office for each of said stations, means at the first station to close a circuit from one of said sources of current over said line during certain alternate periods in said recurring periods to cause one of said lamps to glow, means at the second station to close a circuit from another one of said sources of current over said line during certain intermediate periods in said recurring periods to cause another one of said lamps to glow, means at each of said stations actuated by current from one of said sources to control the transmitting periods of both of said stations so that only one station transmits at a time, means at the first station and means at the second station to vary the current in said line in other of said recurring periods in accordance with two telephone messages without overlapping.

7. In a telephone system, a party line extending to a telephone office provided with a plurality of subscriber's stations, a source of direct current at the telephone office, means to connect said source of current to said line in spaced recurring periods of time, a call signal at each subscriber's station, a source of ringing current at the telephone office, means to disconnect said source of direct current and to connect said source of ringing current to said line during certain of said recurring periods to actuate the call signal at a first one of said stations, means at the said first station to close a circuit from said source of direct current over said trunk line during other of said recurring periods, means at the said first station to vary the direct current in said line during certain periods of time in accordance with a telephone message, and means at a second one of said stations under control of current from said source of direct current received over said line to control the transmitting period for said second station.

8. In a communication system, a subscriber's station having a line extending to a central office, a device at said station comprising movable mechanism under control of an electromagnet for selecting different portions of signals representative of an intelligence message to transmit over said line in recurring spaced periods of time, said magnet adapted upon energization to start said mechanism and upon deenergization to control its movement, a relay at said station, said relay provided with an armature and a pair of contact springs, for closing an energizing circuit to said electromagnet, one of said springs actuated to engage the other said spring by a relatively small movement of its armature and releasing means actuated upon full movement of its armature to disengage said springs for opening said energizing circuit, and means at said office to connect a source of current intermittently for said line to

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energizing said relay, thereby controlling the movement of said mechanism for transmitting said signals in predetermined periods of time.

9. A relay comprising a movable armature and an electromagnet to actuate said armature, a pair of contact springs, a ratchet secured to said armature adapted to engage one of said springs, whereby a relatively small movement of said armature causes said springs to contact, and means to actuate said ratchet upon substantially full movement of said armature to disengage said springs.

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