

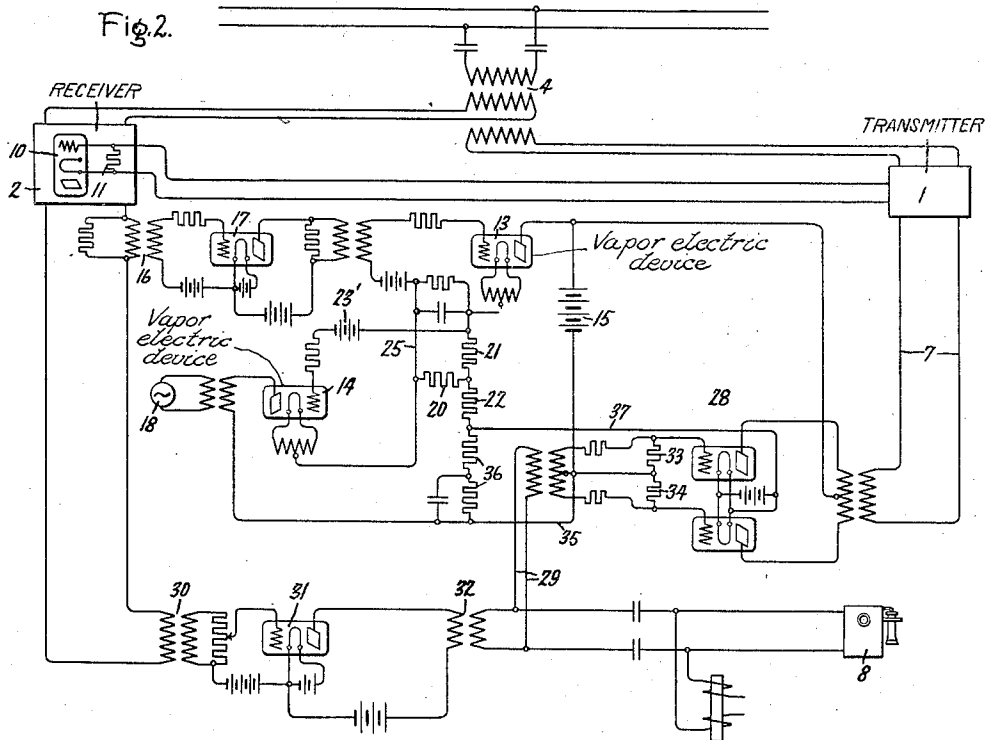
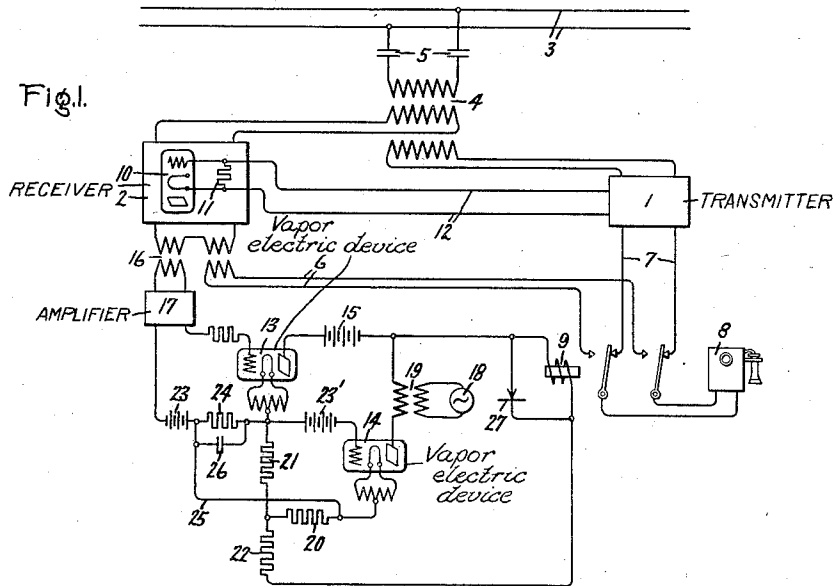
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SIGNALING SYSTEM

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SIGNALING SYSTEM

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My invention relates to signaling systems and more particularly to signal systems arranged for duplex communication.

It has for one of its objects to provide an improved means for use in duplex communication circuits to avoid undesirable effects resulting from reception in the receiver of currents from the associated transmitter and also resulting from currents received in the receiver reaching the input circuit of the associated transmitter. My invention has for one of its objects to provide means whereby somewhat more complete and satisfactory protection against these undesirable results may be had.

A further object of my invention is to provide a protection system whereby these results are accomplished and which is adapted for rapid response to signal currents. In accordance with my invention means are provided whereby the receiver of a duplex communication system is rendered operative and the transmitter inoperative in response to received signals. One of the objects of the invention is to provide improved means whereby this result is effected and which operates with sufficient rapidity to avoid loss of any appreciable portion of the signal currents received in the receiver.

My invention relates further to the use of vapor electric devices and one of its objects is to provide a novel circuit arrangement employing vapor electric devices which is particularly adapted for use in connection with the alternate operation of duplex communication channels.

The novel features which I believe to be characteristic of my invention are set forth with particularity in the appended claims. My invention itself, however, both as to its organization and method of operation, together with further objects and advantages thereof, may best be understood by reference to the following description taken in connection with the accompanying drawing in which Figs. 1 and 2 represent different embodiments of my invention.

Referring to Fig. 1 of the drawing I have shown therein a duplex carrier current communication system employing a transmitter 1 and a receiver 2, the input to the receiver and the output from the transmitter being coupled together and to the communication channel 3 by means of a transformer 4. The communication channel 3 may for example comprise the conductors of a high tension power transmission line to which one of the windings of the transformer 4 is connected through coupling condensers 5. The output 6 from the receiver and

also the input 7 to the transmitter are arranged for alternate connection to a signal device 8 by means of the contacts of the relay 9. The signal device 8 may comprise any suitable telephone instrument located near the transmitter and receiver or at a distant point, the connections thereto being effected over any suitable type of extension circuit. Relay 9 is normally de-energized whereby signal device 8 is normally connected to the input of transmitter 1 and accordingly the system is normally in condition to transmit signals.

The transmitter 1 is suitably of the type shown in Patent 1,696,566, to Emmett F. Carter and includes a normally inoperative carrier wave generator which is rendered operative only by the application of current from the signal device 8 to the transmitter. The receiver 2 may be of any suitable well known form but includes means whereby it is rendered inoperative by operation of the transmitter 1. This result may be effected, for example, by means of a discharge device having its anode and cathode connected in shunt to the receiver and which is arranged to have its grid bias controlled by means of a resistor connected between the grid and cathode thereof, this resistor being arranged to carry the anode current of the carrier wave generator employed in the transmitter. A receiver of such construction is shown for example in Patent 1,696,593 to Emmett F. Carter and Patent 1,739,384 to Lester F. Bird. This result may also be effected by similarly controlling the bias upon one or more of the amplifiers of a radio receiver. Such an arrangement is shown in copending application Serial No. 437,562, entitled Signaling system, filed March 20, 1930, by F. M. Rives, and which is assigned to the same assignee as my present application. For the purposes of simplicity of the drawing, this means for rendering the receiver inoperative during operation of the transmitter is conventionally indicated by means of a discharge device 10 arranged in the rectangle 2 having a resistance 11 connected between the grid and cathode thereof, said resistance being connected by conductors 12 to the transmitter 1. This discharge device may, of course, be connected in the receiving circuit in any desired way to render the receiver inoperative in response to potential on resistance 11.

In the operation of systems of the type described the output 6 from the receiver and the input 7 to the transmitter are ordinarily connected together in conjugate relation with respect to

the signal device 8 by means of a hybrid coil which when properly adjusted prevents the transmission of current from the output circuit 6 to the input circuit 7. It has been found, however, that the adjustment of such a hybrid coil offers considerable difficulty, particularly in cases where the line extending to the signal device 8 comprises a complicated extension circuit. Accordingly, to avoid the use of such a hybrid coil means are provided in accordance with my invention including the relay 9 and vapor electric devices 13 and 14 whereby in response to currents received in the receiver the transmitter 1 is disconnected from the signal device 8 and at the same time the signal device 8 is connected to the output circuit of the receiver. As thus arranged there is no connection between the circuits 6 and 7 with the result that any possibility of currents from the circuit 6 causing operation of the transmitter 1 is avoided.

The means whereby the operation of relay 9 is controlled, however, should be such that very rapid operation of this relay is effected in response to received signal currents, thereby to avoid loss of any appreciable portion of the received signal such, for example, as the first syllable of a spoken word. At the same time the relay 9 should be of rugged construction capable of operating a plurality of movable contacts which cooperate alternately with fixed contacts. Accordingly the system must be capable, in response to the relatively small electromotive force received from the receiver 2, of supplying a comparatively large control current to the winding of relay 9, this current being supplied quickly in response to the received signal current. For this purpose relay 9 is connected in circuit with a source of unidirectional electromotive force 15 and the anode and cathode of the vapor electric device 13. Signal currents from the receiver 2 are supplied between the grid and cathode of the vapor electric device 13 through a transformer 16 and an amplifier 17. The vapor electric device 13 normally has a negative bias impressed upon the grid thereof by means of a source of electromotive force 23 and is normally non-conductive with the result that the relay 9 normally is deenergized. When signal currents are received through the amplifier 17 the vapor electric device 13 becomes conductive and the relay 9 is energized to connect the circuit 6 to the device 8.

Since the anode circuit of vapor electric device 13 is energized with unidirectional potential it is continually in readiness to pass current and accordingly it immediately upon reception of signal voltage from the grid thereof breaks down and causes the energization of relay 9.

Vapor electric devices, however, have the property that when rendered conductive by means of electromotive force applied to the grid thereof they remain conductive after said electromotive force is interrupted. Accordingly, in the circuit described additional means are necessary automatically to deenergize relay 9 after signal currents are removed from the grid of vapor electric device 13. This means comprises a second vapor electric device 14 which is connected in parallel circuit relation with the device 13. The anode of the device 14 is supplied with alternating electromotive force from the source 18 through a transformer 19, the upper terminal of which transformer is connected to the negative side of the source of potential 15.

The cathode of this device is connected through a resistance 20 to a point upon the anode circuit of the device 13. Between the grid and cathode of device 14 is connected a resistance 21 which is also connected in series with the anode and cathode of vapor electric device 13 and in a portion of the circuit which is individual to that device. A resistance 22 is also connected in series with relay 9 and in a portion of the circuit which is common to the two vapor electric devices.

As thus arranged the operation of the device is as follows: As previously stated, the device 13 is normally non-conductive. Device 14 is also normally non-conductive since its grid is biased negative by source of electromotive force 23'. When signal currents are received on the grid of device 13 this device becomes conductive and causes energization of relay 9. Current flowing in the device 13 causes an electromotive force to be produced across resistance 21 which overcomes the negative bias on the grid of device 14 produced by source 23' and causes the voltage on the grid of this device to be sufficiently varied in a positive direction to render this device conductive when the anode thereof is positive with respect to the cathode, that is, during a portion of alternate half cycles of the alternating current wave produced by the source 18 when the voltage across the secondary winding of transformer 19 sufficiently exceeds the voltage across relay 9 and resistance 22. Thus, during these alternating half cycles, current flows through the device 14 and resistances 20 and 22, causing energization of relay 9. The potential produced on resistance 22 and relay 9 due to current flowing through device 14, however, so reduces the voltage between the anode and cathode of device 13 that this device is immediately rendered non-conductive and current in the resistance 21 ceases. During the next half cycle of source 18 the vapor electric device 14 is also rendered non-conductive when its anode becomes negative with respect to the cathode. If signal currents are still impressed upon the grid of device 13, this device again immediately becomes conductive and causes device 14 likewise to become conductive, which in turn renders the device 13 non-conductive, this cycle of operation repeating as long as signal currents are supplied to the grid of device 13. When these signal currents are removed, however, and device 13 is rendered non-conductive by device 14, it remains non-conductive and in turn causes the device 14 to become non-conductive as soon as its anode becomes negative with respect to the cathode. The negative bias on the grid of device 14 then causes this device to remain non-conductive with the result that the relay 9 is deenergized.

It will thus be seen that since the vapor electric device 13 is of high current carrying capacity, a large amount of current is supplied to the relay 9 in quick response to the impressed signal voltage, with the result that relay 9 may be of inexpensive and rugged construction and may carry as many contacts as is necessary to effect the desired control operations.

The vapor electric device 13 also has the property that when its anode voltage is reduced a more positive grid voltage is necessary in order to render the device conductive. Accordingly it is desirable after the discharge device 14 has broken down to reduce the bias voltage on the grid of device 13 in order that signal currents

supplied to the grid of device 13 before current has stopped flowing through device 14 may still render device 13 conductive. This result is effected by means of resistance 20 which is connected in the portion of the parallel circuit individual to the device 14 and by resistance 24 connected in the grid circuit of device 13, the cathode terminal of resistance 20 being connected to the grid terminal of resistance 24 by conductor 25. In this way when current flows in device 14 a positive electromotive force is supplied to the grid of device 13 in series with the electromotive force produced upon the source 23 with the result that the grid of device 13 is rendered less negative with respect to the cathode. It is thus assured that the device may be rendered conductive by the received signal current notwithstanding that its anode and cathode voltage is reduced by operation of device 14. A condenser 26 is connected across the resistance 24 to smooth out the voltage which is supplied to the grid of device 13 from resistance 20.

The use of resistances 20 and 24 and condenser 26 is advantageous in that it insures that when the received signal currents are just sufficient to cause device 13 to break down it will continue to break down on succeeding cycles of operation of devices 13 and 14 notwithstanding some reduction in the intensity of the received signals. In this way the operation of the system is rendered less erratic in case of slight fluctuations in the received signal intensity.

I have also shown at Fig. 1 a rectifier 27 connected in shunt with the winding of relay 9. This rectifier may be one of the copper oxide contact type such as is shown in Patent No. 1,640,335, issued Aug. 23, 1927 to Lars O. Grondahl. This rectifier may or may not be employed, but is desirable to insure against chattering of the relay 9 due to momentary interruptions in current through the relay winding such as occur between the syllables of speech, or between rapidly spoken words. Any diminution of current in the winding of relay 9 causes current to flow through the rectifier 27 in such a direction as to tend to maintain the energization of relay 9. This rectifier also has the effect of reducing the transient voltage across the winding of relay 9 and thereby preventing this voltage from breaking down tube 13 when no signal is received.

The modification of my invention shown in Fig. 2 is similar to that shown in Fig. 1, but differs therefrom in that in place of the mechanical relay 9 an electron discharge relay is employed, this electron discharge relay being constructed in the form of a push-pull amplifier 28 having its input 29 connected to the signal device 8 and its output connected to the input 7 of the transmitter. The output from the receiver 2 is also connected through a transformer 30, audio amplifier 31, and transformer 32 to the signal device 8 and to the input 29 of amplifier 28. This push-pull amplifier 28 comprises a pair of electron discharge devices having grids which are connected to the cathode through resistances 33 and 34 respectively, conductor 35, resistance 36, and conductor 37. Resistance 36 is common to the anode and grid circuits of the devices and the anode current normally flowing in this resistance is sufficient to produce a proper operating bias upon the grids. Thus, these discharge devices are normally in condition to transmit signals from the device 8 to the input circuit of

the transmitter. They are prevented, however, from transmitting signals from the output circuit of the receiver 2 to the input circuit of the transmitter 7 by means of the vapor electric devices 13 and 14.

This operation may be described as follows: When signal currents are received in the receiver they are supplied through transformer 16 and audio amplifier 17 to the grid of device 13, thereby rendering that device conductive as previously described. The resistance 36 is connected in the anode circuit of this device and also in the grid circuit of the discharge devices of the push-pull amplifier 28 in such a way that when the device 13 is conductive a strong negative potential is impressed upon the grids of the push-pull amplifier, thereby rendering those devices inoperative to amplify the electromotive forces received from the circuit 29. In other respects the vapor electric devices 13 and 14 function as previously described in connection with Fig. 1.

While I have shown particular embodiments of my invention it will of course be understood that I do not wish to be limited thereto since many modifications, both in the circuit arrangements and in the instrumentalities employed may be made and I contemplate by the appended claims to cover any such modifications as fall within the true spirit and scope of my invention.

What I claim as new and desire to secure by Letters Patent of the United States, is:—

1. In a high frequency signaling system, a receiver, a transmitter, a vapor electric device, means responsive to said receiver for rendering said vapor electric device conductive when received signal currents are of relatively weak intensity, means responsive to current in said vapor electric device to render said transmitter inoperative, and means including an additional vapor electric device to render said transmitter operative.

2. In a high frequency signaling system, a carrier current transmitter, a carrier current receiver, a signal device, a double throw switch arranged normally to connect said signal device to said transmitter for transmission of signals and arranged upon operation thereof to connect said signal device to said receiver for reception of signals, and means comprising a vapor electric device responsive to signals received in said receiver of relatively small intensity for operating said switch.

3. In a high frequency signaling system, a transmitter, a receiver, a signal device, a relay having a control element, said relay being arranged normally to render said transmitter operative to transmit signals from said signal device, and operable in response to a predetermined electromotive force supplied to said control element to render said transmitter inoperative, a vapor electric device having an anode, a cathode, and a grid, said control element being connected between said anode and cathode, means to supply signal currents received in said receiver to said grid and cathode whereby said predetermined electromotive force is supplied to said control element, and means including a second vapor electric device responsive to current flowing between said anode and cathode to interrupt said electromotive force.

4. In a high frequency signaling system, a pair of signal channels, means to render one of said channels inoperative when the other channel is operative, said means comprising a source

of unidirectional electromotive force, a vapor electric device having an anode, a cathode, and a grid, said anode and cathode being connected across said source, means responsive to the impedance between said anode and cathode to render said one channel inoperative, means to supply signal currents from said other channel to said grid and means including a second vapor electric device responsive to current flowing between said anode and cathode to render said one channel operative when said signal currents cease.

5. In a high frequency signaling system, a pair of signal channels, means to render one of said channels inoperative when the other channel is operative, said means comprising a source of unidirectional electromotive force, a vapor electric device having an anode, a cathode, and a grid, said anode and cathode being connected across said source, said device normally having high impedance between said anode and cathode, means for supplying signal currents from said other channel to said grid thereby to reduce said impedance, means responsive to said reduced impedance to render said one channel inoperative, and means responsive to current flowing between said anode and cathode to reduce the unidirectional voltage between said anode and cathode sufficiently to render said vapor electric device of high impedance when the signal currents supplied to said grid cease, said means comprising a second vapor electric device, and means for supplying alternating energizing potential to the anode thereof.

6. In a system for automatically conditioning a signaling channel in response to applied signal currents, a vapor electric device having a grid, an anode, and a cathode, a source of unidirectional potential connected between said anode and cathode, means to supply signal currents from said signal channel to said grid and cathode, said vapor electric device having the property of breaking down, and passing substantially full anode current in response to comparatively weak signal currents, means responsive to said anode current to condition said channel to transmit said signal, and means whereby said device is rendered intermittently conductive during the presence of signal currents having at least said comparatively weak intensity, said means comprising means responsive to said anode current to interrupt the conductivity of said vapor electric device.

7. The combination, in a high frequency signaling system comprising a pair of signal chan-

nels, of means for rendering one of said channels inoperative in response to signal currents in the opposite channel, said means comprising a vapor electric device having an anode, a cathode, and a grid, means to supply signal currents from said opposite channel to said grid and cathode, said vapor electric device having the property of breaking down and passing substantially full anode current in response to comparatively weak signal currents, means to render said vapor electric device intermittently conductive during the period when signal currents are present on said grid having at least said comparatively weak intensity, and means responsive to said anode current to render said one channel inoperative.

8. In a system for conditioning a signal channel in rapid response to supplied signal electromotive force comprising a vapor electric device having an anode, a cathode, and a grid, means to supply said signal electromotive force to said grid and cathode, means to supply an electromotive force to said anode, said vapor electric device having the property of breaking down and passing substantially full anode current in response to supplied signal electromotive force of relatively small intensity, means responsive to said anode current to reduce said anode voltage and to supply an electromotive force between said grid and cathode tending to reduce the signal electromotive force at which said vapor electric device breaks down, and means responsive to said anode current to control said channel.

9. In combination, a signal channel, means responsive to signal waves to maintain said channel in a predetermined condition during the presence of signal waves and in another condition during the absence of signal waves, said means comprising a vapor electric device having an anode and a grid, means to supply unidirectional energizing potential to said anode, means to supply signal currents to said grid to cause said device to break down and pass current, a second vapor electric device having an anode, means to supply alternating energizing potential to said anode of said second vapor electric device, means responsive to current passed by said first vapor electric device to cause said second vapor electric device to break down and pass current, means responsive to current passed by said second vapor electric device to interrupt current in the first device, and means responsive to current in said first device to control the condition of said signal channel.

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