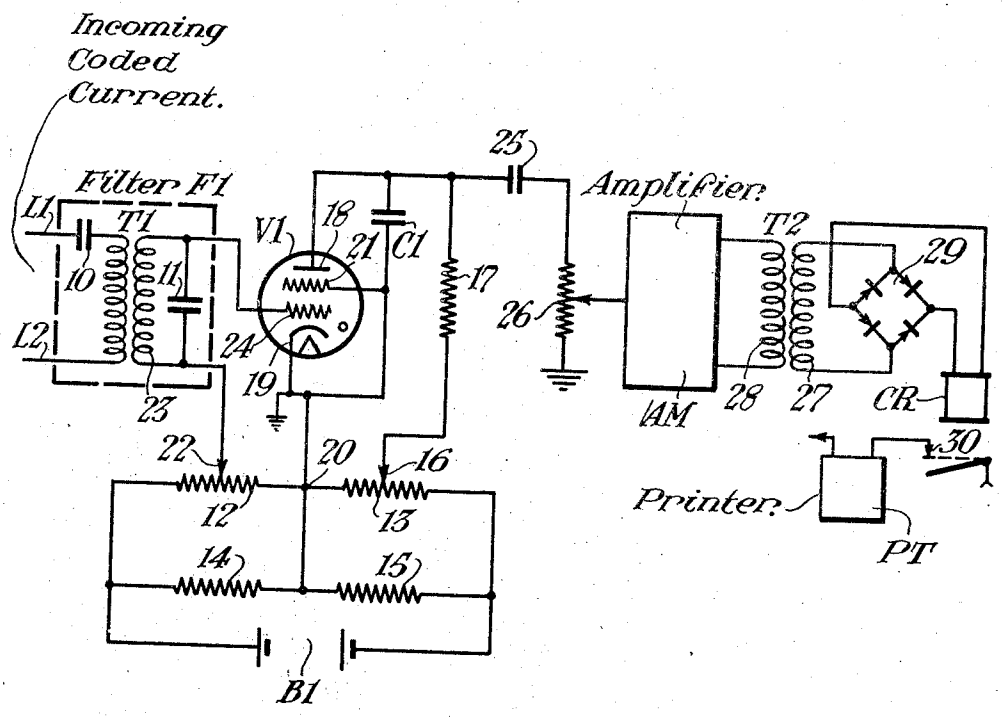
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PULSE GENERATING RECEIVER FOR CODED CARRIER SIGNALS

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PULSE GENERATING RECEIVER FOR CODED CARRIER SIGNALS

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Our invention relates to signaling apparatus, and more particularly to apparatus for receiving coded current.

In the reception of coded current the distortion and attenuation of the code pulses due to variations of the transmitting medium may adversely affect the operation of the decoding unit which usually includes a code following relay and the code may be not properly interpreted. For example, in printing telegraph systems distortion and attenuation of the code pulses occurs because of variations in the line circuit due to variations in weather conditions, such as rain and sleet. Such distortion may cause the code following relay to fail to follow the code and the code message or signal is not correctly reproduced. Because of such distortion the length of the line circuit must be limited to that through which satisfactory reception can be accomplished under all conditions of transmission. This means that repeaters and similar facilities must be provided for relatively long circuits and when transmission is difficult.

Accordingly, a feature of our invention is the provision of signaling apparatus incorporating novel and improved means to receive coded current.

Another feature of our invention is the provision of an improved method of reception of coded current which is subject to distortion to effect a substantially uniform energization of a code responsive device irrespective of such distortion of the received current.

Again, a feature of our invention is the provision of improved receiving apparatus to effect substantially uniform energization of a code following or controlling relay over relatively large variations of received energy.

Still another feature of our invention is the provision of signaling apparatus incorporating novel means for locally generating oscillations in step with the coded current and which oscillations are of substantially uniform amplitude irrespective of the amplitude of the coded current.

A specific feature of our invention is the provision of high speed printing telegraph apparatus incorporating novel means for triggering a relaxation oscillator by a carrier telegraph current and for operating a telegraph printer or recorder by the generated oscillations.

Other features, objects and advantages of our invention will appear as the specification progresses.

We attain the foregoing features, objects and advantages of our invention by utilizing the properties of a controlled ionization by utilizing the properties of a controlled ionization or gas tube which allows it to oscillate as a relaxation oscillator if the anode voltage is applied through a resistor of such value as to cause the voltage of

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the tube anode to drop below the critical firing voltage when the tube conducts. The tube is normally biased to a non-conductive condition and is fired when a control voltage is applied to a control electrode of the tube to oppose the normal bias. Since the tube ceases to conduct at the end of each operation cycle, the tube functions as an oscillator as long as the control voltage is applied and ceases to oscillate when the control voltage is interrupted. Thus on and off code periods of the control voltage are reproduced by corresponding on and off code periods of the locally generated oscillations. The amplitude of these oscillations is governed by the proportioning of the anode circuit and is independent of the amplitude of the control voltage, the only criterion being that the control voltage is large enough to fire the tube. Consequently, a coded control voltage which may vary in amplitude over a relatively wide range creates a corresponding code in locally generated oscillations of substantially uniform amplitude.

By proper proportioning of the parts the operating cycle of the tube, that is, the frequency of the locally generated oscillations, is made equal to the frequency of the carrier of the control voltage. By such locking in of the oscillator with the incoming coded carrier the locally generated oscillations are substantially in phase with the carrier and faithfully reproduce codes of relatively high code rates. This locking-in feature although desirable is not essential to satisfactory operation of the apparatus.

The locally generated oscillations are used to control a code following relay. Preferably the oscillations are rectified and the resultant unidirectional current supplied to a direct current code following relay. The generated oscillations may be first amplified in the usual manner if a higher energy level for energization of the relay is needed. It is to be seen therefore that substantially uniform energization of a code following relay is obtained irrespective of amplitude variations of the control voltage and substantially non-distorted operation of the relay is effected, although code distortions in the incoming code pulses may exist.

The normal bias of the tube is made just under the critical firing condition of the tube and a relatively weak or low control voltage, such as prevails under adverse transmitting conditions is sufficient to fire the tube. The higher values of the control voltage prevailing under good transmitting conditions do not over-energize the code following relay. We have found that a code following relay can be satisfactorily operated at code speeds up to 100 cycles per second with a ten to one amplitude variation of the control voltage. In other words, we have found that a code following relay can be satisfactorily oper-

ated through a relatively long line circuit, such as, for example, a line circuit of the order of 300 miles in length.

We shall describe one form of apparatus embodying our invention and shall then point out the novel features thereof in claims.

The accompanying drawing is a diagrammatic view showing one form of apparatus embodying our invention when used with a printing telegraph system. It is to be understood that our invention is not limited to printing telegraph systems and this one application serves to illustrate the many places where the apparatus is useful.

Referring to the drawing, the reference characters L1 and L2 designate wires forming the two sides of a transmitting circuit through which a coded carrier current is transmitted from a remote station, transmitting apparatus suitable for supplying such coded current being provided at this remote station. These two wires L1 and L2 may be the two line wires of a line circuit, or they may represent a line circuit including one wire and ground or the circuit may be an antenna circuit and transmission effected through radio principles.

To aid in understanding the invention, we shall assume that the line wires L1 and L2 represent a two wire line circuit and that a carrier current is used, the carrier being of the frequency of the order of say 5000 cycles per second, and the code being effected by periodically interrupting the carrier current at code rates of 25 to 100 cycles per second. It is to be noted, of course, that other frequencies can be used and other code rates provided.

In the case here assumed for illustration, the current is received from the line circuit through a filter F1, which includes a transformer T1 and two capacitors 10 and 11, this filter being tuned to pass a carrier current of 5000 cycles and substantially suppress currents of other frequencies.

An electron tube V1 is controlled by the energy received from the line circuit through the filter F1. Tube V1 may be any one of several types and is shown as an indirectly heated tetode gas tube. The filament of this tube would be heated in any convenient manner for the tube to be constantly active. Power for exciting the tube V1 is obtained from a battery B1. To facilitate the obtaining of desired anode and bias voltages from battery B1, a resistance network is connected across the battery. This network comprises two parallel branches, one of which branches includes resistors 12 and 13 in series, and the other of which branches includes resistors 14 and 15 in series. The junction terminal of resistors 12 and 13 is connected to the junction terminal of resistors 14 and 15. The resistors are proportioned so that predetermined voltages with respect to the junction terminal are obtained at intermediate terminals of resistors 12 and 13.

The tube V1 is provided with an anode circuit extending from an intermediate terminal 16 of resistor 13 through a resistor 17, anode 18 and tube space to cathode 19 of the tube, and to the junction terminal 20 of the resistance network. A capacitor C1 is connected between anode 18 and cathode 19 and a control electrode 21 of the tube is also connected to the cathode. A control circuit for the tube includes intermediate terminal 22 of resistor 12, winding 23 of transformer T1, control electrode 24, cathode 19 and to the junction terminal of the resistance

network. Thus, there is impressed upon the tube, a bias voltage of a value predetermined by the position of the intermediate terminal 22, and an anode voltage of a value predetermined by the position of the intermediate terminal 16. Also, a control voltage obtained from the line circuit through the filter F1 is impressed upon the control electrode 24. The parts are so proportioned that the normal bias voltage applied to the control electrode 24 biases the tube V1 to a condition that the voltage applied to the anode from terminal 16 of the resistance network is insufficient to fire the tube, but that a relatively low control voltage from the line circuit to oppose the bias voltage and drive the control electrode 24 in a positive direction causes the tube to be fired. That is, the positive half cycles of the carrier control voltage received from the line circuit through the filter F1 fires the tube. The parts are arranged that the carrier control voltage received under adverse transmission conditions of the line circuit will be sufficient to fire the tube. This means that the line circuit may be relatively long and the received control voltage still fire the tube without an excessive high voltage at the transmitting or remote station.

The resistor 17 is made of sufficient value that the voltage drop across the resistor 17 when the tube V1 is conducting reduces the anode voltage to a value below the critical firing voltage of the tube, and the tube is deionized and a new firing of the tube must be effected by the next positive half cycle of the control voltage. Again, the capacitor C1, resistor 17 and the voltage of terminal 16 are preselected so that the tube oscillates at the carrier frequency. That is, the oscillations of the anode circuit are locked in and in phase with the carrier line circuit current. This last characteristic of the apparatus is not required for proper operation thereof but it improves the operation and efficiency. It follows that the line circuit current causes oscillations of the anode circuit current of tube V1, and when such line circuit current is interrupted or ceases the oscillations of the anode current immediately cease, with the result the code of the line circuit current is reproduced in the oscillations.

The amplitude of the oscillation generated by tube V1 is the same irrespective of the amplitude of the received control voltage because the amplitude of the anode circuit current is governed by the circuit elements, and these circuit elements once predetermined they remain constant.

The anode circuit of tube V1 is coupled to the input side of an amplifier AM through capacitor 25 and resistor 26. Amplifier AM is shown conventionally for the sake of simplicity since its specific structure forms no part of our invention and it may be any one of several well-known amplifier arrangements. It is sufficient for this application to point out that the oscillations of the anode circuit current of tube V1 are applied to the input terminals of amplifier AM and cause a corresponding oscillating electromotive force to be induced in a secondary winding 27 of an output transformer T2, a primary winding 28 of which is included in the output circuit of the amplifier. The electromotive force of secondary winding 27 is applied to a code following relay CR through a full wave rectifier 29. Relay CR is a direct current code following relay suitable for relatively high speed operation. It is to be seen therefore that a pulse of unidirectional current is supplied to the operating winding of relay CR in step with the code pulses of the carrier line circuit current.

Also, the magnitude of the energizing pulse supplied to the code following relay CR is substantially uniform irrespective of variations in the amplitude of the coded line circuit pulse. Relay CR is used to control any suitable device, and as here shown it governs a telegraph printer PT through an obvious circuit including contact 30 of the relay. The printer PT is shown conventionally for the sake of simplicity because its specific structure forms no part of our invention and it may be of standard structure.

Normally, that is, when no coded carrier current is present in the line circuit, the tube V1 is nonconductive and relay CR is deenergized and inactive. Also, capacitor C1 is charged at a voltage substantially equal to the anode voltage of tube V1.

Assuming next that a coded carrier current is supplied to the line circuit at the remote station, the first positive half cycle of the first code pulse of the line circuit is passed by filter F1 and applied to the control electrode 24 of tube V1 to oppose the normal bias voltage applied from terminal 22 of the resistance network, and the tube V1 is fired. Capacitor C1 discharges through the tube and the conduction current from battery B1 creates a drop in voltage across resistor 17 of such value that the anode voltage of the tube is reduced below the firing value of the tube and the tube is extinguished during the following negative half cycle of the incoming carrier current. This action is repeated each cycle of the coded pulse of the carrier current with the result oscillations are generated in the anode circuit as long as the code pulse exists, the oscillations starting and stopping in step with the code pulse. These oscillations are of an amplitude predetermined by the circuit elements of the anode circuit and by the voltage derived from the intermediate terminal 16 of the resistance network. The capacitor C1 serves to determine the period of operation of tube V1 and in turn the cycle of the oscillations. Preferably the cycle period of the oscillation is made equal to the cycle period of the carrier current. The anode and bias voltages of the tube are adjusted so that a relatively weak control voltage of a value just above the noise energy of the line circuit is sufficient to fire the tube. Thus the code of the code pulses transmitted through the line circuit under adverse transmitting conditions is faithfully reproduced in the locally generated oscillations to the same degree that the code of code pulses transmitted under the most favorable transmitting condition is reproduced. Any voltage variation of the battery B1 tending to vary the operating characteristics of the tube V1 can be compensated by adjustment of the intermediate terminals 16 and 22 of the resistance network.

The oscillations thus generated by the tube V1 are applied to the amplifier AM and a corresponding electromotive force is induced in the secondary winding 27 of the output transformer T2. The electromotive force of the secondary winding 27 is rectified by rectifier 29 and unidirectional current applied to relay CR to energize and operate that relay. It is clear that a code pulse of unidirectional current is supplied to the relay in step with the code pulse of the line circuit current and the amplitude of the code pulse supplied to relay CR is substantially uniform and independent of amplitude variations of the incoming code pulse from the line circuit. It is to be noted that the amplifier AM may not be required and the rectifier 29 connected to the

anode circuit of tube V1 for operation of the code following relay by the generated oscillations. Relay CR in turn controls the printer PT at which the code of the line circlit current is recorded and printed.

Apparatus such as here disclosed has the advantages that a badly distorted and attenuated coded current of a line circuit is faithfully decoded without the use of expensive repeater facilities. Also relatively high speed code rates can be satisfactorily transmitted.

Although we have herein shown and described but one form of signaling apparatus embodying our invention, it is understood that various changes and modifications may be made therein within the scope of the appended claims without departing from the spirit and scope of our invention.

Having thus described our invention, what we claim is:

1. In combination, means to receive a coded carrier signaling current, an electron tube of the controlled ionization type, a non-inductive anode circuit including a current source and a resistor connected across an anode and cathode of said tube but normally ineffective to fire the tube, said receiving means connected to a control electrode of the tube to fire the tube in response to each positive half cycle of said carrier current, a capacitor connected across said anode and cathode to cooperate with said non-inductive anode circuit to extinguish the tube whereby oscillations coded according to the code of the carrier current are created in said anode circuit, and decoding means coupled to said anode circuit excited by said oscillations to interpret the code thus formed by the oscillations.

2. In combination, means to receive a carrier current coded according to a given signal, a controlled ionization electron tube, a non-inductive anode circuit including a power source and a resistor connected across an anode and cathode of said tube but normally ineffective to fire the tube, said resistor proportioned to reduce the anode voltage below the critical firing voltage of the tube when the tube is conducting, a capacitor connected to said anode circuit to govern the operating cycle of the tube, said receiving means connected to a control electrode of the tube to fire the tube each positive half cycle of said carrier current to generate in said anode circuit oscillations substantially in phase with said carrier current to provide oscillations of the anode circuit current coded according to said given signal, and decoding means coupled to said anode circuit excited by said oscillations to reproduce said signal.

3. In receiving apparatus for receiving from a transmitting medium a carrier current which has been coded to convey a signal, the combination comprising; a gas tube having an anode, a cathode and at least one control electrode; a source of direct current connected across said anode and cathode, through a resistor to form a non-inductive anode circuit, said current source normally ineffective to fire the tube, said resistor of a value that its voltage drop reduces the anode voltage below the voltage required to maintain the tube fired when the tube is conducting, said transmitting medium coupled to said control electrode and cathode to fire the tube each positive half cycle of said carrier current to generate oscillations coded according to the signal conveyed by the carrier current, and decoding means including a rectifier and a relay coupled to said anode circuit to op-

erate said relay according to the coding of said oscillations.

4. In receiving apparatus for receiving from a line circuit a carrier current of a given frequency and coded at a preselected code, the combination comprising; a gas tube having an anode, a cathode and at least one control electrode; a source of direct current, a resistor, an anode circuit including said direct current source and resistor connected to said anode and cathode but normally ineffective to fire the tube, said anode circuit being substantially non-inductive said resistor proportioned to reduce the anode voltage below that required to maintain the tube ionized when the tube is conducting, a capacitor connected across said anode and cathode to govern the operating cycle of said tube, said line circuit connected to said control electrode and cathode to fire the tube each positive half cycle of said carrier current to create in said anode circuit oscillations coded at said preselected code, and means including a rectifier and a relay coupled to said anode circuit to operate said relay according to said preselected code due to the coding of said oscillations.

5. In combination; a gas tube having an anode, a cathode and a first and a second control electrode; a source of power and a resistor in series connected across said anode and cathode, said resistor of a value that its voltage drop reduces the anode voltage below that required to maintain the tube conductive when the tube is conducting, a capacitor connected across said anode and cathode and having connection to said second control electrode to govern the operation cycle of the tube, means including a bias voltage source and a winding connected to said first control electrode and cathode to bias the tube to be normally non-conductive, transmitting means coupled to said winding to supply at times a carrier voltage coded to convey a given signal, said carrier voltage of an amplitude sufficient for each positive half cycle to fire the tube for generating in the anode circuit oscillations coded according to said given signal and of substantially uniform amplitude due to the proportioning of said anode circuit, and decoding means including a rectifier and a relay coupled to said anode circuit through a capacitor to operate the relay according to the coding of said oscillations free from distortion due to the uniform amplitude of the oscillations.

6. In receiving apparatus for receiving a carrier current coded at different preselected codes, the combination comprising; a gas tube having an anode, a cathode and at least one control electrode; a source of direct voltage and a resistor in series connected to said anode and cathode to form a non-inductive anode circuit, a capacitor connected across said anode and cathode, a receiving element and a bias voltage source in series connected to said control electrode and cathode to form a control circuit, said bias voltage source to bias the tube to be normally extinguished and to be fired in response to a preselected positive voltage, means to at times supply said coded carrier current to said receiving element to fire the tube each positive half cycle of the carrier, said capacitor and anode circuit to extinguish the tube each negative half cycle of the carrier to create oscillations in the anode circuit, said oscillations being in phase with said carrier and of relatively large amplitude due to said non-inductive anode circuit and being coded according to the code of the carrier due to action of the tube, a code following relay, and circuit means coupled to said anode circuit to supply to said relay energy corresponding to the coding of said oscillations.

7. In receiving apparatus for receiving a carrier current of a given frequency and coded at a preselected code, the combination comprising; a gas tube having an anode, a cathode and at least one control electrode; a source of direct voltage and a resistor in series connected across said anode and cathode to form a non-inductive anode circuit, a capacitor connected across said anode and cathode, a bias voltage source, a filter in series with said bias voltage source connected across said control electrode and cathode to form a control circuit, said bias voltage to maintain said tube deionized, means connected to said filter to supply at times said coded carrier current to said control circuit, said filter tuned to pass current of said given frequency, said bias voltage source proportioned for each positive half cycle of said carrier to ionize said tube, said capacitor and resistor proportioned to deionize said tube each negative half cycle of said carrier whereby oscillations of said given frequency and code are created in said anode circuit, a code following relay, and circuit means to couple said relay to said anode circuit to operate the relay in step with said code due to the oscillations thus created in said anode circuit.

8. In receiving apparatus for receiving from a line circuit a carrier current of a given frequency and coded at a preselected code, the combination comprising; a gas tube having an anode, a cathode and at least one control electrode; a source of direct current, a first and a second resistor in series connected across said source, each said first and second resistors having an adjustable intermediate terminal and the junction terminal of the resistors being connected to said cathode, a third resistor connected between said anode and the adjustable terminal of said first resistor to form an anode circuit for the tube, a capacitor connected across said anode and cathode, means including a filter to connect said line circuit between said control electrode and the adjustable terminal of said second resistor to form a control circuit for the tube, said filter tuned to pass current of said given carrier frequency and said adjustable terminal of the second resistor set to bias the tube to maintain the tube normally non-conductive and to be fired in response to a relatively low voltage of the carrier passed by the filter, said third resistor and capacitor to cause the tube to function as a relaxation oscillator to create oscillations through said third resistor of said given carrier frequency and which oscillations are coded according to the code of the line circuit current, and a code following relay coupled to said anode circuit through a capacitor to operate the relay according to the coding of said oscillations.

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