

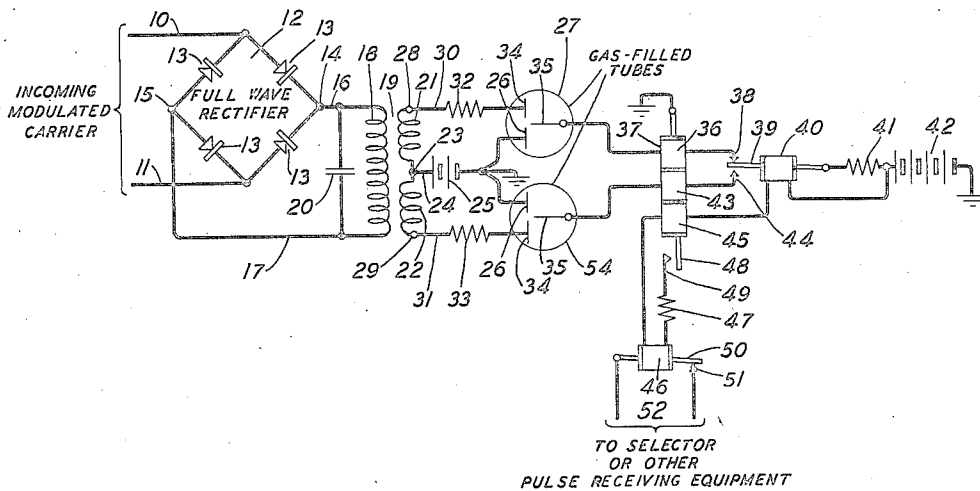
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SIGNAL TRANSMISSION CIRCUIT

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SIGNAL TRANSMISSION CIRCUIT

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This invention relates to signal transmission circuits, and more particularly, to pulse-receiving circuits.

Heretofore, in modulated carrier wave pulse-receiving circuits, it has been the practice to impress the rectified modulated carrier wave, for instance, through a filter, directly upon a relay or relays controlling the circuit to be operated in accordance with the received pulses. It has been found, however, that with variation in the transmission level of the incoming wave, considerable distortion resulted because, filters having relatively narrow band limits, the envelope of the resultant wave impressed on the relay or relays was substantially a sine wave rather than a series of pulses having an abrupt initiation and an abrupt cessation.

An object of this invention, therefore, is to improve modulated carrier wave pulse-receiving circuits, and, more particularly, to prevent or avoid distortion therein, resulting, for example, from carrier level variation.

A feature of the invention comprises the use of a gas-filled tube as a relay control means in a pulse-receiving circuit.

Another feature comprises the use of a plurality of gas-filled tubes as relay control means in a pulse-receiving circuit, one of the tubes causing the energization or operation of one or more relays, and another their deenergization or release.

Still another feature comprises the use of cold cathode tubes as relay control means in a pulse-receiving circuit.

A further feature comprises a pulse-receiving circuit comprising an incoming line, a rectifier, transformer, a pair of cold cathode gas-filled tubes, and a plurality of relays for operating upon a pulse-controlled circuit associated with the pulse-receiving circuit.

In accordance with this invention, the incoming modulated carrier wave is rectified, and the modulation frequency with harmonics is transmitted to the cathodes of a pair of gas-filled cold cathode tubes through a suitable transformer. One tube is caused to ionize and to cause the operation of a relay that holds itself operated and causes the operation of additional relays, one of which transfers potential from the anode of the tube to the anode of the second, and the other of which opens the circuit to a pulse-controlled circuit or apparatus. The reverse half of the wave causes ionization of the second tube and the release of the various relays to place the pulse-receiving circuit and pulse-controlled circuit or ap-

paratus in condition for the reception of the next pulsing wave.

A more complete understanding of the invention will be obtained from the detailed description which follows, taken in conjunction with the single figure of the accompanying drawing, which shows a signal transmission circuit in accordance with this invention.

In accordance with the invention, the accompanying drawing, in general, shows an impulse-receiving circuit employing a pair of cold cathode, neon-filled tubes, intended primarily for use in a transmission system in which a carrier wave is interrupted, i. e., modulated, at dialing speeds, at the sending end of the system and is transmitted through band pass filters on other networks such that the envelope of the modulated carrier incoming to this receiving circuit is approximately sine wave in form, and in which the level of incoming carrier may vary considerably.

The function of the impulse-receiving circuit is to reproduce by relay contacts, the pulses of the dial at the sending end, such that negligible pulse distortion occurs, in spite of narrow band transmission and variation in carrier level. By "pulse distortion" is meant the amount by which the per cent "make" or "break" of the contacts of the pulse-reproducing relays in the receiving circuit differs from the per cent "make" and "break" of the dial contacts at the sending end.

Referring to the drawing, the modulated carrier is received over the incoming line wires 10, 11 and is rectified by a Wheatstone bridge type, full-wave rectifier 12, preferably employing rectifier units 13 of the dry type, for instance, copper-cuprous oxide units, connected across the line. The output terminals 14, 15 of the rectifier are connected through conductors 16, 17 with the terminals of the primary winding 18 of a transformer 19. The current passed by the rectifier comprises a direct current component and an alternating current component corresponding to the envelope of the modulated carrier. A condenser 20 is bridged across winding 18 to absorb the carrier ripples in the rectifier output current.

The transformer secondary comprises two windings 21, 22 serially connected, the common terminal 23 being connected through conductor 24 with biasing battery 25 and one cathode 26 of each of the two gas-filled tubes 27, 28, which may be of the cold cathode, neon-filled type, and to ground. The other terminals 29, 30 of the transformer secondary are connected through conductors 31, 32 and resistances 33, 34 with another cathode 35 of each of the tubes.

The anode 35 of tube 27 is normally connected through the winding 36 of a three-winding polar relay 37, the contact 38 and armature 39 of a second relay 40, and a resistance 41, with battery 42. The anode of tube 54 is normally connected through a second winding 43 of the relay 37 wound in opposition to winding 36, to the contact 44 of relay 40. The third winding 45 of relay 37 is serially connected with the winding of relay 40, and the winding of a third relay 46, the battery 42 and a resistance 47, the circuit being normally open at the armature 48 and contact 49 of relay 37. Normally, armature 50 of relay 46 engages with contact 51 to close the circuit of line 52 leading to a selector or other pulse-receiving equipment to be controlled in accordance with the signal pulses received by the pulse-receiving circuit.

Voltages induced in transformer windings 21, 22 are dependent upon the rate and amount of variation of current in the primary 18. For example, when primary current flows from conductor 16 to conductor 17 and is increasing in magnitude, voltages are induced in the secondary windings in directions 29-23 and 23-28. Voltage of winding 21 is added to that of the biasing battery 25, while that of winding 22 is subtracted, the potential between the cathodes in tube 27 is increased and that between the cathodes in tube 30 54 decreased, as long as the voltage of winding 22 is less than that of battery 25. When the primary current is decreasing, the secondary winding voltages are reversed and the cathode-to-cathode potential of tube 27 is decreased and that in the other tube is increased, as long as the voltage in the winding 21 is less than that of battery 25.

In the first case, i. e., when the primary current is increasing, when the sum of winding 21 voltage and battery voltage exceeds the cathode breakdown potential, tube 27 ionizes between cathodes, while in the second case, when the sum of the winding 22 voltage and battery voltage exceeds the cathode breakdown potential of tube 45 54, the latter ionizes between cathodes. In either case, when the secondary winding voltage drops to zero, ionization of the gas path ceases since the maximum potential of battery 25 is maintained at less than the required sustaining potential. Battery 25, therefore, acts to increase the sensitivity of the circuit, and to prevent both tubes from ionizing on the same half cycle, this type of tube having a non-polar breakdown characteristic.

The voltage of battery 42 must be less than the anode-cathode breakdown potential of the tube but greater than the necessary sustaining voltage. For the relay armature positions shown, when an increase in primary current induces sufficient voltage in the secondary to produce breakdown between the cathodes of tube 27, anode-to-cathode ionization occurs, causing a flow of current in winding 36 of relay 37. In operating, relay 37 locks itself through its winding 45, an operating circuit for relays 40 and 46 being closed. The operation of relay 40 transfers battery 42 from the anode of tube 27 to that of tube 54.

When the rate of decrease of primary current is sufficient to cause breakdown of tube 54, anode current in winding 43 of relay 37 produces sufficient ampere-turns to overcome that of winding 46, and the effective ampere-turns of a biasing spring if one is associated with the relay 37. The latter releases, thereby releasing relays 40

and 46, battery 42 is transferred back to the anode of tube 27 and the circuit is restored to its original condition, armature 50 and contact 51 which had been separated on energization of relay 46 again making contact, resulting in a transfer to the controlled circuit of the received pulse.

Since tube 27 ionizes during the portion of the cycle in which the primary current is increasing in value, and tube 54 ionizes when the primary current is decreasing, it is evident that, if the same wave form of the current be maintained, the interval between ionization of the tubes for a given pulsing frequency, will remain essentially constant, even though the carrier level may vary considerably; provided the maximum rate of carrier level fluctuation is less than the minimum rate of change necessary to cause ionization of the tubes. Since the length of make and break periods of relay 37 and, consequently, of relay 46 are controlled by the ionization intervals, it follows that, for a given speed, the make and break periods of relay 46 are independent of carrier level. The maximum level, assuming 100 per cent modulation in every case, is limited, for a given pulsing frequency, to the value which causes either secondary winding voltage plus the voltage of the source of anode potential to exceed the anode-cathode breakdown potential of either tube, or which causes the blasting voltage less the voltage of either secondary winding to have an absolute value greater than the cathode-to-cathode breakdown potential. Which of the two limiting conditions will determine the maximum level, depends upon the value chosen for the biasing voltage. In either case, the effect of exceeding this level will be that, at the beginning of a cycle of primary current, one tube will ionize as intended, but relay 40 may transfer battery to tube 54 quickly enough to allow it to break down during the same half cycle.

Resistances 32 and 33 are inserted to reduce the current drain on battery 25, and resistances 41 and 47 to reduce the current drain on battery 42 during the ionization and to regulate the relative biasing effects of windings 43 and 45 of relay 37; resistances 41 and 47 may be either external or included in the windings of relays 40 and 46. To be sensitive to low modulating frequencies, transformer 19 should have a reasonably high inductance. While any full wave rectifier might be used for rectifying the incoming modulated carrier, one employing copper-cuprous oxide units is preferred as the most suitable for working into the low transformer primary impedance. Furthermore, while tubes 27 and 54 have been described as cold cathode neon tubes, cold cathode argon tubes or hot cathode gas-filled tubes would function as satisfactorily after readjusting circuit battery potentials to the proper value. The cold cathode neon tubes have the advantage, however, that there is no filament or cathode-heater power loss.

While this invention has been disclosed with reference to a single embodiment, it is to be understood that it is not limited thereto, but is to be considered as comprehending that which is included in the terms and spirit of the appended claims.

What is claimed is:

1. A transmission circuit comprising an incoming line for signal impulses, a plurality of cold cathode gas-filled tubes, means including a rectifier and a transformer for impressing signal impulses first on the cathode of one tube and sub-

sequently on the cathode of another tube, each tube having a cathode connected to one output terminal of said transformer, a controlled circuit, and a plurality of relays associated with said tubes for controlling said controlled circuit in accordance with the rectified signal impulses and upon the ionization of said tubes thereby.

2. A transmission circuit comprising an input line, a pair of cold cathode tubes, means comprising a rectifier connected in said line and a transformer connected to the output of said rectifier for impressing signal impulses on said tubes to cause first one and subsequently the other to ionize, each tube having a cathode connected in the output circuit of said transformer, a controlled circuit, and means associated with said tubes to be operated upon the ionization of said tubes in accordance with pulses received over said input line, to interrupt and to close said controlled circuit.

3. A transmission circuit comprising an incoming line for a modulated carrier wave, a rectifier having its input terminals connected to said line, a transformer connected to the output terminals of said rectifier, a pair of gas-filled tubes of the cold cathode type, each being caused to ionize by a different half of the rectified wave and each having its cathode connected to an output terminal of said transformer, a controlled circuit, and a plurality of relays associated with said tubes for controlling said controlled circuit in accordance with the rectified modulated carrier wave.

4. A transmission circuit comprising an incoming line for a modulated carrier wave, a full wave copper-oxide rectifier having its input terminals connected to said line, a transformer connected to the output terminals of said rectifier, a pair of gas-filled tubes, each tube ionizing in response to a different half of the rectified wave and each having its cathode connected to an output terminal of said transformer, a controlled circuit, and a plurality of relays associated with said tubes for controlling said controlled circuit in accordance with the rectified modulated carrier wave.

5. In a pulse-receiving circuit, a pair of gas-filled tubes, each having a cold cathode, means for impressing a signal wave first on one cathode and subsequently on the second to cause the tubes to ionize, a plurality of relays, one of which has a plurality of windings, one winding being connected with the anode of one tube, a source of potential to be applied to said anode being normally in circuit with said winding, a second winding being connected with the anode of the second tube and being wound in opposition to the other windings on said relay, a third winding being connected in series with the windings of the other relays, one of said other relays upon the ionization of the first tube and the energization of the multi-winding relay being adapted to transfer the source of potential from the anode of the first tube to that of the second, and another of said other relays being adapted to interrupt and to close a pulse-controlled circuit in accordance with the signal impressed on the tubes, all relays deenergizing upon the ionization of the second tube.

6. A transmission circuit comprising an incoming line for a modulated carrier wave, a full-wave copper-oxide rectifier having its input terminals connected to said line, a transformer connected to the output terminals of said rectifier, a pair of gas-filled tubes each having its cathode

connected to an output terminal of said transformer, a controlled circuit, and a plurality of relays associated with said tubes for controlling said controlled circuit in accordance with the rectified modulated carrier wave, one of said relays controlling the circuits for the other relays and having windings one of which is connected to the anode of one tube and the other to the anode of the other tube, one winding being normally in series with a source of anode potential, and the other adapted to be connected to the same source of potential upon the ionization of the first tube, another of said relays transferring the source of anode potential from the anode of one tube to the other, and a third relay opening the controlled circuit upon the energization of the first relay, all of said relays being deenergized upon the ionization of the second tube.

7. A transmission circuit comprising an incoming line for a modulated carrier wave, a copper-oxide rectifier having its input terminals connected to said line, a transformer connected to the output terminals of said rectifier, said transformer comprising a primary winding and a secondary having two windings with a common terminal, a condenser shunted across said primary winding, a pair of gas-filled tubes each having two cathodes and an anode, a source of potential connected between said common terminal and one cathode of each tube, the other terminals of said secondary windings being connected with the other cathodes of said tubes, a controlled circuit, and a plurality of relays and a source of potential associated with the anodes of said tubes for controlling said controlled circuit in accordance with the rectified modulated carrier wave.

8. A transmission circuit comprising an incoming line for signal impulses, a rectifier connected in said line, a transformer connected in the output circuit of said rectifier and comprising a primary and a secondary, said secondary comprising two windings having a common terminal, a pair of cold cathode neon tubes having two cathodes and an anode, a source of potential connected between said common terminal and one cathode of each tube, the other terminals of the secondary windings being connected to the other cathodes, a controlled circuit, and means associated with anodes of said tubes to be operated upon the ionization of said tubes in accordance with pulses received over said input line to interrupt and close said controlled circuit.

9. A transmission circuit comprising an incoming line for signal impulses, a copper-oxide rectifier connected in said line, a transformer connected in the output circuit of said rectifier and comprising a primary and a secondary, means shunted across said primary to absorb the carrier ripples in the rectifier output current, said secondary comprising two windings having a common terminal, a pair of cold cathode neon tubes having two cathodes and an anode, a source of potential connected between said common terminal and one cathode of each tube, the other terminals of the secondary windings being connected to the other cathodes, a controlled circuit, and means associated with anodes of said tubes to be operated upon the ionization of said tubes in accordance with pulses received over said input line to interrupt and close said controlled circuit.

10. A transmission circuit comprising an incoming line for signal impulses, a rectifier connected in said line, a transformer connected in

the output circuit of said rectifier and comprising a primary and a secondary, said secondary comprising two windings having a common terminal, a pair of cold cathode neon tubes having two cathodes and an anode, a source of potential connected between said common terminal and one cathode of each tube, the other terminals of the secondary windings being connected to the

other cathodes, a controlled circuit, and relay means associated with the anodes of said tubes to be operated upon the ionization of said tubes in accordance with pulses received over said input line to interrupt and close said controlled circuit. 5

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