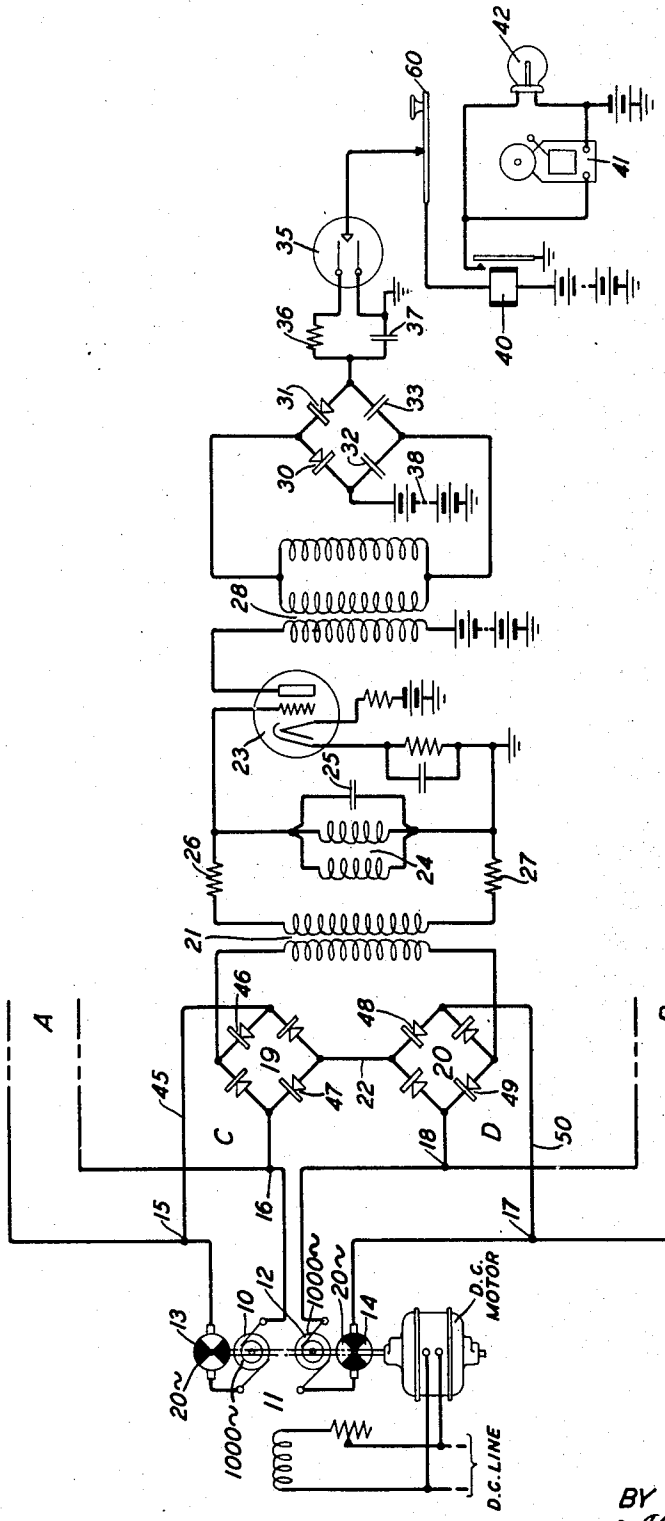
April 5, 1938. G. A. PULLIS 2,113,221

SIGNALING SYSTEM

Filed Oct. 31, 1935



INVENTOR
G.A.PULLIS

BY

ATTORNEY

Patented Apr. 5, 1938

2,113,221

UNITED STATES PATENT OFFICE

2,113,221

SIGNALING SYSTEM

George A. Pullis, New York, N. Y., assignor to Bell Telephone Laboratories, Incorporated, New York, N. Y., a corporation of New York

Application October 31, 1935, Serial No. 47,598

4 Claims. (Cl. 177—311)

This invention relates to high frequency signaling over telephone toll lines and particularly to a system for indicating frequency and voltage variations in the high frequency signaling source utilized for signaling purposes.

In voice frequency signaling systems as applied to telephone toll lines interconnecting widely separated telephone exchanges, it is customary to utilize interrupted voice frequency currents for transmitting signals of various characters over the toll lines. The correct functioning of such systems depends, to a considerable degree, upon the faithfulness of the voltage and frequency output of the signaling current source. It is, therefore, essential, in order to insure the accurate transmission of signals over the toll lines, that any departure in the voltage or frequency, from predetermined limits, of the signaling current source, be immediately detected so that means may be resorted to to bring the signaling source back within the permissible limits.

It is accordingly an object of this invention to provide a simple, inexpensive and dependable off-frequency and low-voltage alarm circuit which functions in a reliable manner in detecting small changes in the frequency and voltage generated by a source of alternating current.

A feature of the invention resides in inductively coupling each of a plurality of signaling channels with a common amplifier in the indicating circuit in such a manner that interaction between the several channels is eliminated.

This and other features of the invention will be readily understood from the following detailed description made with reference to the accompanying drawing which illustrates an off-frequency and low-voltage alarm circuit embodying the features of this invention.

A pair of telephone toll lines are shown at A and B, the first line A being supplied with voice frequency signaling current from the winding 10 of the 1000 cycle generator 11 and the line B being furnished with signaling current of the same frequency from the generator winding 12. Interposed between the generator windings 10 and 12 and their respective toll lines A and B are interrupters 13 and 14 which are shown to be 180 degrees out of phase with each other and are adapted to set up interruptions in the signaling current source at the rate of 20 cycles per second. The lines A and B are accordingly alternately supplied with 1000 cycle current interrupted at 20 cycles which is utilized in the well-known manner in effecting the operation of signaling equipment (not shown) associated with the lines A and B.

The input terminals of a balanced bridge type rectifier 19 are connected across the generator winding 10 at the points 15 and 16 while the input terminals of a similar rectifier 20 are connected across the generator winding 12 at the points 17 and 18. One of the output terminals of rectifier 19 is connected to an output terminal of rectifier 20 by way of the primary winding of transformer 21, the other output terminals of the rectifiers being connected directly by the conductor 22.

The windings 10 and 12 of generator 11 supply 1000 cycle current which is interrupted at the rate of 20 cycles per second by means of the interrupters 13 and 14. However, the interruptions of winding 10 are exactly 180 degrees out of phase with the interruptions of winding 12 with the result that steady rectified 1000 cycle current is applied to the primary winding of transformer 21. This rectified current appears as 2000 cycle current on the secondary side of the transformer 21 and is impressed on the grid electrode of the amplifier 23.

A retard coil 24 and a condenser 25 constitute a tuned circuit connected across the transformer secondary by way of the resistances 26 and 27, which is tuned anti-resonant to 2000 cycles and attenuates all frequencies other than 2000 cycles.

The plate circuit of amplifier 23 includes the primary winding of transformer 28, the secondary of which is associated with the voltage doubling combination comprising rectifiers 30, 31 and condensers 32, 33. The amplified current, or output of the amplifier 23 is accordingly impressed on the rectifiers 30 and 31 which, as above indicated, are arranged with condensers 32 and 33 for voltage doubling.

The rectified voltage, or output of the rectifier-condenser combination, is impressed on the control gap of the cold cathode gas-filled tube 35 by way of resistance 36 with such a polarity as to oppose the normal voltage applied to the control gap by battery 38 and with a voltage of sufficient value to reduce the normal control gap voltage below the breakdown or ionization point of the gap. The tube 35, under these conditions, does not fire and the alarm relay 40 accordingly remains unoperated. The normal biasing potential of battery 38 is applied to the ungrounded cathode of tube 35 by way of the two rectifiers 30 and 31 and the resistance 36, it being understood that, in this instance, the rectifiers

merely act as high resistances. Though shown poled to oppose the flow of current from the battery 38 the rectifiers do not present an infinite resistance. The condenser 37 serves to shunt out the high frequency components of the rectified voltage thereby preventing the breakdown of the tube on the peaks of these high frequencies and the consequent untimely operation of the alarm. The condenser also prevents the tube from breaking down on other transient currents.

When the frequency of the generator falls below 980 cycles or exceeds 1020 cycles the antiresonant circuit, comprising retard coil 24 and condenser 25, attenuates the voltage applied to the grid of the tube 23 with the result that the voltage output of the transformer 28 is decreased. The lower value of rectified voltage which is now applied to the control gap of the tube 35 is not of a sufficient magnitude to reduce the normal voltage, applied by battery 38, below the ionization point of the control gap of the tube. The tube control gap accordingly ionizes and the main gap also ionizes as a result of the breakdown of the control gap. Relay 40, which is included in the output circuit of the tubes 35 accordingly operates completing an obvious circuit for the audible and visual signals 41 and 42 respectively. To restore the relay 40 the lead to the relay from the plate electrode of tube 35 may be carried through the contacts of key 60, operation of the key 60 restores the relay and deionizes the tube.

Since any departure in frequency from the predetermined frequency of the source 11 results in a corresponding drop in voltage across the input of amplifier 23 due to the attenuation effect of the tuned circuit including retard 24 and condenser 25 with the result that an alarm signal is brought in, it follows that any drop in voltage at the generator terminals will effect the same result. The system so far described, therefore, functions not only as an off-frequency indicator but also as a low-voltage indicator.

It will be noted that during the period in which the generator winding 10 and interrupter 13 are functioning to transmit signaling current over the line A, the signaling current in the channel C traverses a path extending from the point 15, conductor 45, rectifier element 46, primary winding of transformer 21, thence through the four balanced arms of rectifier 20 in parallel, conductor 22, rectifier element 47 and back to the point 16. Due to the fact that the bridge 20 is balanced there will be a zero difference of potential across the channel D, it being also understood that when the interrupter 13 is in such a position as to permit the signaling current to pass, the interrupter 14 is in a position to prevent its passage; in other words, during the transmission of signaling current over one of the channels C, or D, the other channel experiences a silent interval. It is evident, therefore, that during the effective interval on channel C, the channel D is rendered immune to any disturbance which might otherwise be caused by the leakage of the 1000 cycle current from the channel C by way of the primary winding of transformer 21.

During the silent interval on channel C, signaling current from generator winding 12 traverses a path from the point 17, conductor 50, rectifier element 48, conductor 22, the four balanced arms of the bridge 19, primary winding of transformer 21, rectifier element 49 to the point 18. Under this condition, due to the balanced condition of bridge 19, the 1000 cycle current transmitted from the generator winding 12 is prevented from leaking back into the channel C. Such leakage, if not eliminated, would cause undue disturbances on the toll lines A and B and other circuits associated therewith.

What is claimed is:

1. In a signaling system, a plurality of signal channels, a balanced bridge for each of said channels having input and output terminals, each of said channels being connected to the input terminals of its respective bridge, an amplifier and a transformer inductively coupling said channels with said amplifier, the output terminals of said balanced bridges being connected in a series circuit including a primary winding of said transformer.

2. In a signaling system, a plurality of signal channels, a source of signaling current, means for transmitting current of a predetermined frequency from said source alternately over said signal channels, an amplifier, means for inductively coupling said amplifier to all said signal channels and means for rendering one of said channels immune to leakage current from another of said channels by way of the coupling means, said means comprising a balanced bridge type rectifier for each of said channels having their input terminals connected across their respective signal channels and their output terminals connected in a series circuit including a portion of the coupling means.

3. In an electric circuit arrangement, a signaling channel terminating at the input terminals of a balanced bridge, a second signaling channel terminating at the input terminals of a second balanced bridge, an amplifier common to said channels and a transformer for coupling said amplifier to said signaling channels, an output terminal of said first bridge being directly connected to an output terminal of said second bridge and the other output terminal of said first bridge being connected to the other output terminal of said second bridge by way of a winding of said transformer.

4. In a signaling system, a pair of current conducting channels alternately carrying current from a signaling current source and each of said channels terminating in a balanced bridge, an amplifier common to said channels and a transformer for coupling said channels to said amplifier, the path for the current transmitted over one of said channels from said source including the four arms of the bridge in which the other of said channels terminate.

GEORGE A. PULLIS.