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SIGNALING SYSTEM

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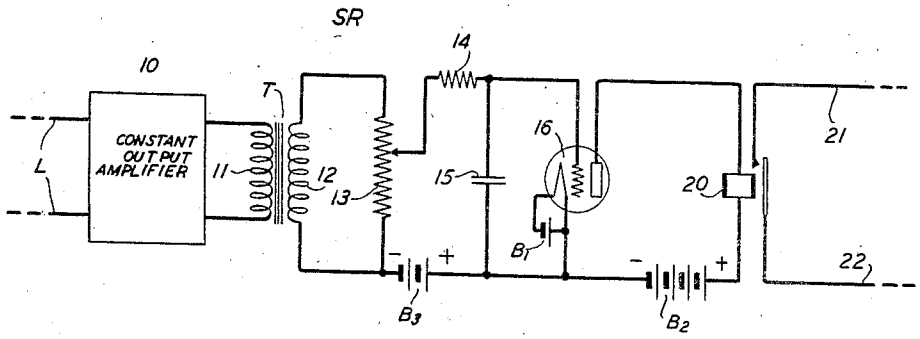

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SIGNALING SYSTEM

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This invention relates to signaling systems and particularly to systems employing voice frequency currents for transmitting signals.

Objects of the invention are an increase in the reliability of alternating current signaling and the prevention of false operation in response to interference currents.

In signaling systems in which current of one or more voice frequencies is used for signaling, the signal receiver must respond to signaling current without being responsive to voice currents or interference currents of signaling frequency. It is known in such systems to employ frequency selective or time delay arrangements for preventing false signal operations.

This invention is a signal device which is operatively responsive to application of signaling currents of sinusoidal wave form and which is operatively non-responsive to application of currents of other wave forms.

According to a feature of the invention, false signal operation is prevented in a voice frequency signaling system by distinguishing between signaling currents which are of sine wave form and voice currents which have a relatively high peak factor. That is, the ratio of the maximum to the root-mean-square amplitude of sine wave signaling current is low enough compared with the ratio of the maximum to the root-mean-square amplitude of voice currents, so that this difference may be used to prevent false signal operation in response to voice currents.

Another feature of the invention is a signal receiver subjected at times to voice currents and at other times to voice frequency signaling currents of substantially sine wave form, the receiver comprising a constant output amplifier, connected to a line through which the voice and signal currents are transmitted, and a biased detector for effecting the operative energization of a signal relay in response to signaling current without effecting operation of the relay when voice currents are being transmitted.

A signal receiver arranged in accordance with the invention is shown in the drawing which consists of a single figure. Referring to the drawing, the signal receiver SR is connected to a line L through which signals are transmitted in the form of current of one or more voice frequencies or voice frequency bands and through which speech currents may be transmitted.

The signal receiver SR consists of a constant output amplifier **10**, a transformer T, potentiometer **13**, resistor **14**, condenser **15**, detector **16**, and signal relay **20**. Three batteries are shown, battery B1 for energizing the cathode of tube **16**, battery B2 supplying the plate voltage for tube **16**, and battery B3 supplying the grid bias for tube **16**. The amplifier **10** which is designed to give a constant root-mean-square output may be similar to that disclosed in Fig. 7 of the patent to H. S. Black No. 2,209,955 of August 6, 1940. Although the detector **16** is shown as a half-wave detector, it is understood that a full-wave rectifier may be used. The voltage of the grid biasing battery B3 is such that tube **16** is biased to the cut-off point; and the potentiometer **13** is set so that, with a sine wave input, the peak voltages applied by transformer **12** to the grid of tube **16** just fail to effect a grid-cathode current. The signal relay **20** is designed and adjusted to be barely operated by the current in the anode-cathode circuit of tube **16** when a sine wave signaling current is transmitted over line L. When currents having a high peak factor, such as voice currents, are transmitted over line L, the peak potentials applied to the gride of tube **16** are much higher and the resulting grid-cathode current causes a drop in potential through resistor **14** which increases the grid bias to a value which just permits grid current during the peaks; and, therefore, only the peaks of the speech waves are rectified and the current in the anode circuit is insufficient to energize the signal relay **20**. The operation of relay **20**, responsive to signaling current, closes a circuit through conductors **21** and **22** to effect any desired result.

The performance of such a signal receiving arrangement may be analyzed by assuming that the signaling currents have a pure sine wave form and that the voice currents consist of rectangular impulses of alternate polarity, each impulse having an amplitude h and lasting for a small fraction k of a half cycle. The output of the detector **16** in response to such a rectangular wave having a high peak factor will be compared to the output in response to a sine wave. The characteristics of the two waves are as follows:

	Sine wave	Rectangular wave
Root-mean-square value	$\frac{A}{\sqrt{2}}$	$h\sqrt{k}$
Peak amplitude	A	h
Peak factor	$\sqrt{2}$	$\frac{1}{\sqrt{k}}$

and the ratio of peak factors

$$R=\frac{1}{\sqrt{2k}}$$

Assuming further that the constant root-mean-square value of the output of the amplifier **10**, of either wave, is B, then for the sine wave,

$$\frac{A}{\sqrt{2}}=B \text{ or } A=\sqrt{2}B$$

and for the rectangular wave

$$h\sqrt{k}=B \text{ or } h=\frac{B}{\sqrt{k}}$$

Since, from the ratio of the peak factors,

$$R=\frac{1}{\sqrt{2k}},\ k=\frac{1}{2R^2}$$

and therefore

$$h=\sqrt{2}RB$$

Now assume that the detector 16 is a linear full wave rectifier. The current through signal relay 20, responsive to a sine wave input, is

$$I_s=\frac{1}{\pi}\int_0^{\pi}\sqrt{2}B\sin\alpha d\alpha=\frac{2\sqrt{2}B}{\pi}$$

When a rectangular wave is impressed on the detector, and the grid bias is increased to the point where the peak of the wave just causes a grid current, only a portion A of the upper part of the wave is rectified. Therefore, the current through the signal relay 20, responsive to a rectangular wave input, is

$$I_r=Ak=\frac{B}{\sqrt{2R^2}}$$

From this

$$\frac{I_s}{I_r}=\frac{4R^2}{\pi}$$

and this is the factor by which the current through relay 20 is reduced when a rectangular wave, whose peak factor is R times that of a sine wave, is applied instead of a sine wave. For instance, if R=2.5,

$$\frac{I_s}{I_r}=8$$

Or expressing it differently, if the rectangular wave has a peak factor 8 decibels higher than that of a sine wave, the relay current is 18 decibels less. This indicates that there is an ample margin between the operating current through relay 20 responsive to signaling current and the non-operating current through this relay responsive to voice current.

The invention is not limited in its application to voice frequency signaling but is generally applicable to any signaling system in which signal operation is desired in response to sinusoidal signal currents but not in response to currents having a different wave form. Although the specific arrangement shown in the drawing comprises an amplifier having a constant root-mean-square output and a detector responsive to the peak value of the applied currents, the arrangement might alternatively comprise an amplifier of constant peak output and a detector responsive to the root-mean-square value of the applied currents.

What is claimed is:

1. In a signaling system including a line subjected to voice currents and to signals consisting of voice frequency currents, the wave form of the signaling currents being that of a sine wave, a signal receiver, said receiver comprising a signal relay, means including a detector and a constant output amplifier in series connecting said relay to said line for response to incoming signals, said line being connected to the input conductors of said amplifier and the output conductors of said detector being connected to said relay, and means for biasing the detector and for increasing the bias when the input voltage exceeds the maximum voltage applied thereto by sine wave signal currents, thereby to prevent the operation of said signal relay in response to voice currents.

2. In a signaling system, a signal receiver operatively responsive to signals consisting of alternating currents the wave form of which is such that the ratio of the peak amplitude to the root-mean-square amplitude does not exceed a certain value and operatively non-responsive to alternating currents the wave form of which is such that the ratio of the peak amplitude to the root-mean-square amplitude does exceed said certain value, said receiver comprising an amplifier for receiving the signaling currents, said amplifier having a constant output, a detector whose sensitivity is in inverse relation to the amplitude of the applied voltage, said detector being connected to the output conductors of said amplifier, and a signal responsive device connected to the output terminals of said detector.

3. In a signaling system, a signal receiver subjected to voice currents and to signals consisting of voice frequency current of substantially sine wave form, said receiver comprising a constant output amplifier to which voice currents and signal currents are applied, a relay, and a detector connecting said relay to said amplifier for operation in response to signal currents, said detector comprising an anode, a cathode and a control grid, means biasing said detector to just prevent current in its grid-cathode circuit when signal current is being applied to said amplifier, and means for increasing the grid bias when voice currents are applied to said amplifier thereby to prevent the operation of said relay.

4. In a signaling system, a signal receiver subjected to voice currents and to signals consisting of voice frequency current of substantially sine wave form, said receiver comprising a constant output amplifier to which voice currents and signal currents are applied, a detector comprising an anode, a cathode and a control grid, a signal responsive relay in the output circuit of said detector, means comprising a transformer and a potentiometer connecting the output of said amplifier to the grid-cathode circuit of said detector, a biasing battery, means comprising said potentiometer and said battery for just preventing grid-cathode current in said detector when signal currents are applied, and means comprising a resistor in series with the grid of said detector for increasing the grid bias when voice currents are applied, thereby to permit only the peaks of voice currents to be applied to said relay, said relay being adjusted to be responsive to the current in the output circuit of said detector resulting from the application of signal current but non-responsive to the current in the output circuit of said detector resulting from the application of voice current.

5. A signal receiver comprising a constant output amplifier having an input circuit for receiving signals, a signal relay for operation responsive to sine wave signaling currents, a detector operatively connecting said amplifier to said relay, means normally biasing said detector to prevent operation of said relay and to permit operation of said relay responsive to sine wave signaling current, and means for automatically increasing the bias of said detector whenever the voltage applied to the input terminals of said detector exceeds the maximum voltage applied thereto by sine wave signaling currents, thereby to prevent the operation of said signal relay in

response to current other than signaling current in the input circuit of said amplifier.

6. A signal receiver comprising an amplifier having an input circuit for receiving signals, said amplifier being arranged to have a constant root-mean-square output, a signal relay for responding to sine wave signaling currents, means comprising a biased detector for operatively connecting said amplifier to said relay, the current in the output circuit of said detector being normally ineffective to operate said relay and effective when the current in the input circuit of said amplifier is sine wave signaling current to operate said relay, and means increasing the bias of said detector when there is current of wave form other than sine wave form in the input circuit of said amplifier, thereby to prevent the operation of said relay.

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