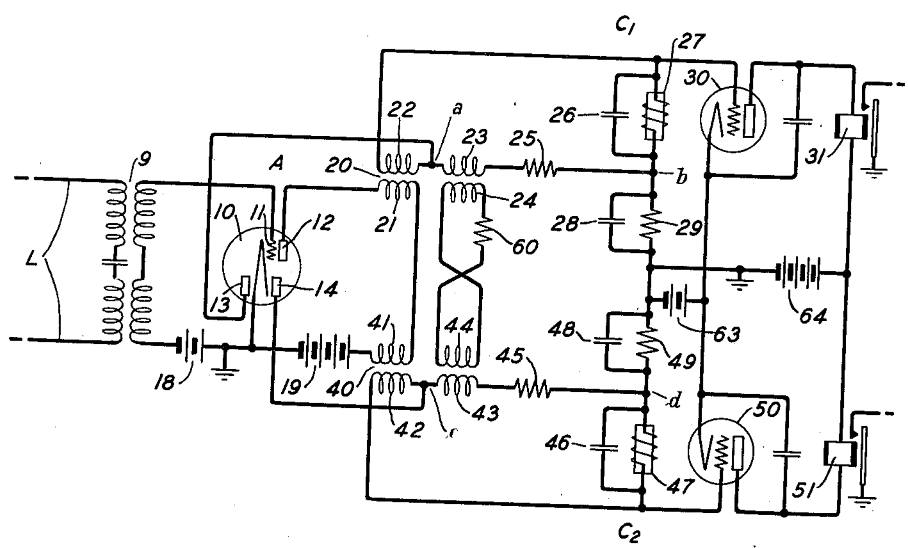
Nov. 29, 1938. H. M. PRUDEN 2,138,613

SIGNALING SYSTEM

Filed May 14, 1937



INVENTOR
H. M. PRUDEN
BY W. P. McKenney
ATTORNEY

Patented Nov. 29, 1938

2,138,613

UNITED STATES PATENT OFFICE

2,138,613

SIGNALING SYSTEM

Harold M. Pruden, Maplewood, N. J., assignor to Bell Telephone Laboratories, Incorporated, New York, N. Y., a corporation of New York

Application May 14, 1937, Serial No. 142,619

5 Claims. (Cl. 179—84)

This invention relates to signaling systems and particularly to signal receivers adapted to respond to signaling currents of a particular frequency.

It is the object of the invention to provide a more reliable signal receiver adapted to respond to signaling currents of each of a plurality of frequencies without responding to non-signaling currents of the same or other frequencies.

It is, of course, known to use alternating current for signaling over telephone lines and moreover to signal with current within the voice frequency range. It is necessary in such signaling arrangements to provide means for preventing false operation of the signal device in response to voice currents which include the particular voice frequency which is being used for signaling. When two or more different types of signals are required, a different frequency may be used for each type of signal.

This invention is a multi-channel signal receiving circuit arrangement comprising two signal receivers, amplifier-coupled to an incoming line, each of the signal receivers comprising a thermionic tube and an impedance bridge connecting the tube to the output of the amplifier. The bridge of each receiver is balanced to current of a different particular frequency and unbalanced to currents of all other frequencies and is directly connected to the grid of the tube in such a manner that the signal device is operated only when the current in the signaling circuit is of the particular frequency and does not include other frequencies. A feature of the invention is the provision of rectifying elements in the thermionic amplifier for controlling the potential applied to the grid element of the thermionic tube of each of the signal devices.

Further explanation of the invention will be made by considering a circuit arrangement in which the invention is embodied, such an arrangement being shown schematically in the drawing which forms a part of this specification. The invention is, of course, not limited to the specific arrangement shown in the drawing and is, in general, applicable to all signaling systems comprising a signal receiver responsive to signaling current of a particular frequency.

The drawing which consists of a single figure shows a multi-channel signal receiver which comprises an amplified A and two differently tuned signal receivers C1 and C2.

The incoming signaling circuit includes the line L and the primary windings of an input transformer 9. The thermionic tube 10 of amplifier A comprises a filament, a grid 11, a grid-controlled anode, or plate, 12 and two rectifier plates 13 and 14. The secondary windings of the input transformer 9 are connected in the grid-filament circuit of tube 10 which circuit also includes the grid biasing battery 18. The circuit for heating the filament of tube 10 is not shown but includes any suitable source of current. The output of the amplifier is divided by means of a hybrid coil group comprising transformers 20 and 40 and the balancing resistor 60. The balancing resistor 60 has a high resistance and is connected in series with the balancing winding 24 of transformer 20 and the balancing winding 44 of transformer 40. The anode-filament circuit of tube 10 includes the primary winding 21 of transformer 20 of signal receiver C1 and the primary winding 41 of transformer 40 of signal receiver C2 and the battery 19. The voltage ratio of the input transformer 9 and the grid biasing potential are so related that signaling current received at the highest normal level will not cause overloading of tube 10.

The signal receiver C1, which comprises a thermionic detector 30 and signal relay 31, is operatively responsive to signaling current of one particular frequency, such as 1200 cycles; and the signal receiver C2, which comprises a thermionic detector 50 and signal relay 51, is operatively responsive to signaling current of another particular frequency, such as 1800 cycles. The grid of tube 30 is inductively coupled through secondary windings 22 and 23 of transformer 20, and the grid of tube 50 is inductively coupled through secondary windings 42 and 43 of transformer 40, to the output circuit of amplifier tube 10. The battery 63 furnishes the normal grid bias for tubes 30 and 50. The circuit or circuits for heating the filaments of tubes 30 and 50 are not shown but include any suitable source of current. The output, anode-filament circuit of tube 30 includes the winding of signal relay 31 and plate battery 64; and the output, anode-filament circuit of tube 50 includes the winding of signal relay 51 and battery 64.

The secondary windings 22 and 23 of transformer 20 constitute adjacent branches of an impedance bridge, the third branch of which is the resistor 25 and the fourth branch of which is a tuned network comprising the condenser 26 in parallel with the induction coil 27. Across the junction point *a* between windings 22 and 23 and the junction point *b* between resistor 25 and the branch 26—27, is bridged the rectifier plate 13 and filament of amplifier tube 10 in series with condenser 28 and resistor 29 connected in parallel. Due to the rectifier elements, condenser 28 can be charged only in the direction which increases the negative potential of the grid of tube 30. The resistor 29 has a high resistance and serves as a grid leak resistance. The windings 22 and 23 are alike and have the same impedance at all frequencies; the resistor 25 is non-inductive and has a high and constant impedance at all frequencies; and the condenser 26 and coil 27 are tuned to offer a high impedance to current of 1200 cycles. Therefore, the impedance of network 26—27 to signaling current of 1200 cycles is substantially equal to the impedance of resistor 25, so that little or no difference in potential exists between points *a* and *b* of the bridge when signaling current of 1200 cycles and no other frequency is being received. But the bridge is unbalanced to current of all other frequencies and a drop in potential exists between points *a* and *b* when current of a frequency other than 1200 cycles is being received because the impedance of network 26—27 decreases rapidly with only a small change in the frequency above or below 1200 cycles. The drop in potential across network 26—27 is impressed on the grid of tube 30; and, when signaling current of 1200 cycles and no other is being received over line L, the filament-anode current causes the operation of signal relay 31. But when signaling current of a frequency other than 1200 cycles is being received the difference in potential between points *a* and *b* is effective during one half of each cycle to charge condenser 28 in a direction to increase the negative bias on the grid of tube 30 and thereby prevent the operation of signal relay 31.

The secondary windings 42 and 43 of transformer 40, the resistor 45 and the network comprising condenser 46 and induction coil 47 also constitute an impedance bridge. The condenser 46 and coil 47 are tuned to offer a high impedance to current of 1800 cycles. The resistor 45 is non-inductive and has a high and constant impedance, so that the bridge is balanced to current of 1800 cycles and unbalanced at all other frequencies. The rectifier plate 14 and filament of amplifier tube 10 are connected in series with condenser 48 and grid leak resistor 49 across points *c* and *d* of the bridge. No potential difference is created across points *c* and *d* by current of 1800 cycles and signaling current of this frequency and no other causes operation of signal relay 51; but current of other frequencies causes the charging of condenser 48 in a direction which increases the negative bias of tube 50 and the operation of signal relay 51 is thereby prevented if the current received over line L consists of or includes frequencies other than 1800 cycles.

When, therefore, a 1200 cycle signaling current is received over line L and there are no other frequencies being received, the detector tube 30 causes the operation of signal relay 31 but tube 50 is ineffective to operate signal relay 51. When an 1800 cycle signaling current is received over line L and there are no other frequencies being received, the detector tube 50 causes the operation of signal relay 51 but tube 30 is ineffective to operate relay 31. And when current of both of these frequencies, or of either of these frequencies and also current of other frequencies, is being received over line L, both of the tubes 30 and 50 are ineffective to cause the operation of signal relays 31 and 51.

Such an arrangement is adapted for use in selectively responding to dial impulse signals and to supervisory signals, transmitted over toll lines, only one of these types of signals being transmitted at a time.

What is claimed is:

1. In combination, a signaling circuit, a thermionic amplifier for amplifying signals incoming over said circuit, a signaling relay, a thermionic device for operating said relay in response to signaling current of a particular frequency, means comprising an impedance bridge balanced at said signaling frequency and unbalanced at other frequencies for coupling the output of said amplifier to said device, and a capacitor connected in series with the filament and a rectifier plate of said amplifier across points of said bridge which are at the same potential when the bridge is subjected to current of said signaling frequency and at different potentials when the bridge is subjected to current of other frequencies for preventing the operation of said relay when the incoming signaling current includes frequencies other than said signaling frequency.

2. In combination, a signaling circuit, a thermionic amplifier for amplifying signals incoming over said circuit, two signaling relays, a first thermionic device for operating one of said relays in response to signaling current of a first particular frequency, a second thermionic device for operating the other of said relays in response to signaling current of a second particular frequency, means comprising a first impedance bridge balanced at said first frequency and unbalanced at other frequencies for coupling the output of said amplifier to said first device, means comprising a second impedance bridge balanced at said second frequency and unbalanced at other frequencies for coupling the output of said amplifier to said second device, means comprising a capacitor and a rectifier connected across points of said first bridge which are at the same potential if the incoming signaling current is of said first frequency and at different potentials if this current includes any other frequency for preventing the operation of said first relay when the incoming signaling current includes frequencies other than said first frequency, and means comprising a capacitor and a rectifier connected across points of said second bridge which are at the same potential if the incoming signaling current is of said second frequency and at different potentials if this current includes other frequencies for preventing the operation of said second relay when the incoming signaling current includes frequencies other than said second frequency.

3. In combination, a line, a transformer, a thermionic amplifier, a signaling circuit including said line and a primary winding of said transformer, a secondary winding of said transformer connected to the grid of said thermionic amplifier, a second transformer, the plate circuit of said thermionic amplifier including a primary winding of said second transformer, an impedance bridge, two like secondary windings of said second transformer constituting adjacent branches of said bridge, a non-inductive resistor of low conductivity constituting a third branch of the bridge, a tuned network comprising a condenser and an induction coil connected in parallel constituting the fourth branch of said bridge, said tuned network having maximum impedance at a particular signaling frequency, a rectifier plate in said thermionic amplifier, a detector tube, a grid condenser and grid leak resistor for said detector tube, said grid condenser and grid leak re-

sistor in parallel being connected in series with the filament and rectifier plate of said thermionic amplifier across the junction point between the secondary windings of said secondary transformer and the junction point between said non-inductive resistor and said network, the grid of said detector tube being connected to the junction point between the secondary windings of said other transformer and said network, and a signal relay connected in the plate circuit of said detector tube for operation when the current in said signaling circuit is of said particular frequency and no other.

4. In a combination according to claim 3, a third transformer, a primary winding of said third transformer being included in the plate circuit of said thermionic amplifier, two like secondary windings of said third transformer constituting adjacent branches of a second impedance bridge, a second non-inductive resistor of low conductivity constituting a third branch of said second bridge, a tuned network comprising a condenser and an induction coil connected in parallel constituting the fourth branch of said second bridge, said second network having maximum impedance at a second particular signaling frequency, a second rectifier plate in said thermionic amplifier, a second detector tube, a grid condenser and grid leak resistor for said second detector tube, the grid condenser and the grid leak resistor of said second detector tube being connected in parallel with each other and in series with the filament and second rectifier plate of the thermionic amplifier across the junction point between the secondary windings of said third transformer and the junction point between said second non-inductive resistor and said second network, the grid of said second detector tube being connected to the junction point between the secondary windings of said third transformer and said second network, and a second signal relay, said relay being operatively controlled by said second detector tube.

5. In a signaling system, a signaling circuit, a thermionic amplifier, the grid of said amplifier being connected to said circuit, a plurality of signal receivers, one for each of a plurality of signaling frequencies transmitted in said circuit, a transformer for each of said receivers, a primary winding of each of said transformers being included in the plate circuit of said thermionic amplifier, a rectifier plate in said thermionic amplifier for each of said signal receivers, each of said receivers comprising a signal relay, a detector tube, a condenser, and an impedance bridge balanced at the particular signaling frequency to which it is desired that said relay be operatively responsive and unbalanced at all other frequencies, said condenser being connected in series with the associated rectifier plate and the filament of said thermionic amplifier across points of said bridge which are at equal potential when the current in said circuit is of said particular signaling frequency and at different potentials when the current is of any other frequency in such a manner as to prevent energization of the signal relay when the current in said circuit includes frequencies other than said particular frequency.

HAROLD M. PRUDEN.