

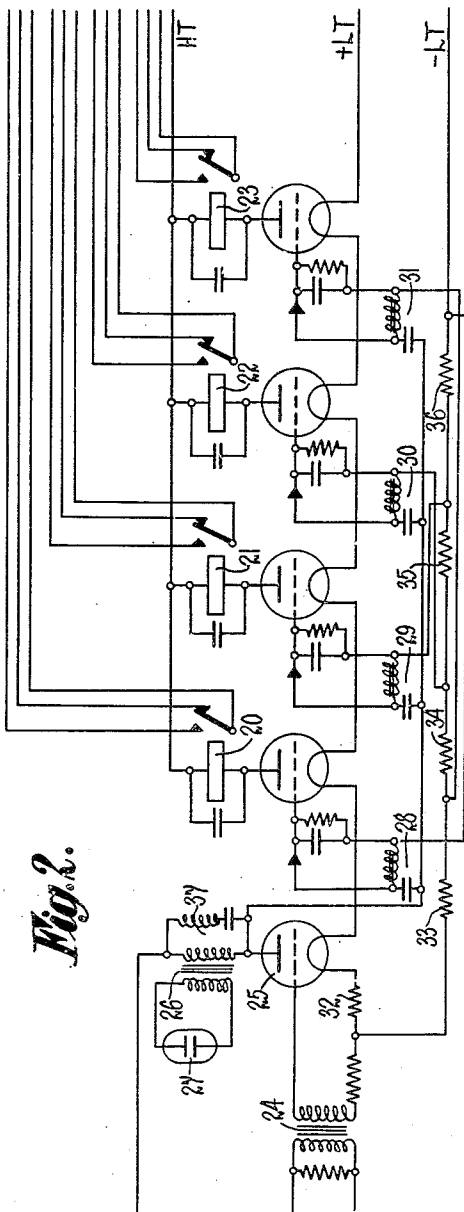
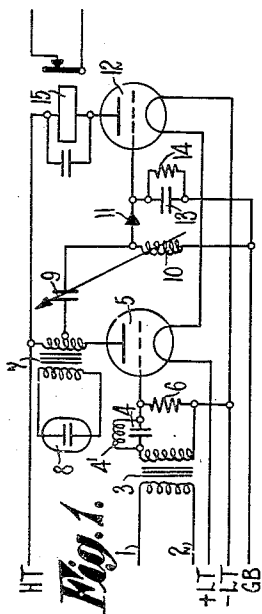
Oct. 31, 1933.

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1,932,679

ELECTRICAL SIGNALING SYSTEM

Filed March 16, 1932



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UNITED STATES PATENT OFFICE

1,932,679

ELECTRICAL SIGNALING SYSTEM

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Application March 16, 1932, Serial No. 599,221,
and in Great Britain March 17, 1931

3 Claims. (Cl. 179—84)

The present invention relates to audio or high frequency signaling systems and is more particularly concerned with selective receivers for use with such systems.

5 It is often desirable to transmit signals of a definite speech frequency or frequencies over circuits normally employed for the transmission of ordinary speech signals. The signals of the definite frequencies will be required to operate
10 receiving apparatus, but the receiving apparatus should not be operated by speech signals, although the latter may have components of one or more of the definite frequencies. It is further desirable that the receiving apparatus should
15 be capable of responding to a signal of one of the definite frequencies, although the signal is of short duration.

It is an object of the present invention to provide a signal receiver which will satisfy the above conditions while the method of operation remains comparatively simple.

It will be appreciated that since speech signals are complex in frequency, a speech signal of given voltage amplitude, while containing signals of the
25 definite frequencies will not contain such a large proportion as will a pure signal of those frequencies. Use is made of this fact and according to one feature of the invention in an alternating current signaling system having signaling currents of one or more definite frequencies trans-
30 mitted over a line the voltage amplitude of the incoming signals is limited by the association with the incoming signaling circuit of a gas discharge tube arranged to pass current when the voltage
35 of the incoming signals reaches a predetermined value.

According to a further feature of the invention in an alternating current signaling system having signaling currents of one or more definite frequencies transmitted over a line also employed
40 for the transmission of other signals of frequencies including the definite frequencies the voltage amplitude of the incoming signals is limited to a predetermined value and the limited
45 signaling currents are fed to one or more circuits tuned respectively to each of the definite frequencies, each tuned circuit having associated therewith a rectifying valve provided with such grid bias voltage that appreciable current only
50 flows in the plate circuit when the voltage amplitude of the applied signal closely approaches the limited value.

According to another feature of the invention in an alternating current signaling system having signaling currents of a definite frequency

within the voice frequency range transmitted over a line also employed for the transmission of speech, the incoming signals are applied to a thermionic valve amplifier constructed so as to amplify inefficiently currents of the signaling frequency, the amplified signals being then limited as regards voltage amplitude to a predetermined maximum value.

The general method of operation of the system will now be explained. Signals incoming to the
65 receiver are applied to a thermionic valve amplifier, the plate circuit of which is inductively connected to a gas discharge tube, for instance a neon tube over a transformer. The function of the neon tube is to limit the voltage amplitude
70 of all the incoming signals to a predetermined maximum value so that in the output circuit of the amplifying valve there will be no signals having a voltage amplitude greater than this maximum value. This action is due to the fact that
75 when the voltage between the electrodes of the neon tube is sufficient to cause it to strike an appreciable current flows and the additional load thus introduced into the circuit prevents any further increase in the voltage amplitude of the signals which are applied to the receiving equipment.
80 It will be seen, therefore, that in the case of ordinary speech signals incoming to the receiver the voltage amplitude of the definite frequency or frequencies contained in the speech signals will be considerably less than the maximum value. In the case of a pure signal of the definite frequency, however, the voltage amplitude after limitation will be that of the predetermined maximum value. The output circuit from the ampli-
90 fying valve is connected to the input circuit of a rectifying valve which is so biased that it will only operate when the voltage amplitude of the signals applied to it is that of the maximum value. Hence, further discrimination is effected between
95 a pure signal of a definite frequency and a signal of the definite frequency which is merely a component of ordinary speech signals.

This arrangement can be made use of in a number of signaling arrangements. Since it is possible to distinguish signaling current of a definite frequency from speech currents which may include such a frequency one suitable application is in connection with telephone repeater working for the purpose of sending ringing or supervisory signals over the same circuits as speech currents. It may also be used in connection with signaling systems in which a plurality of different frequencies are to be sent in variable combinations; in this case the invention ensures that there shall
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be a more definite selectivity than is otherwise possible. Further, the invention may be used for the purpose of distinguishing the number of signals which may be transmitted at once. It will be understood, of course, that where a signal of one definite frequency only is sent the receiving apparatus, usually a relay, can be adjusted so that it just responds when the maximum output allowed by the current limiting device is received.

Where, however, there are two signals of different frequency sent simultaneously, then the presence of the two signals will mean that the maximum output of either signal will be reduced and the adjustment of each delay or equivalent device must be such that it is capable of operating under these conditions, while not being responsive to currents of less value than those obtained when two signals are sent simultaneously. The transmission of various combinations of frequencies may be employed for signaling from an operator's position in accordance with the digits of a wanted number, such frequencies being translated into impulses for operating automatic switches or like devices. Preferably in such cases the signals would be combinations including the least number of frequencies possible to produce the required number of signals. For the purpose of transmitting the signals, for instance, from an operator's keyboard at a private branch exchange it may be undesirable to originate currents of the various frequencies at the place from which they are transmitted but to originate them at a place remote from the signal circuit, for instance in a main exchange and transmit them to the transmitting end of a signal circuit over a common transmitting channel. Then at the transmitting end they would be separated by means of electrical filters prior to their subsequent connection to the signal circuit. Such a common transmitting channel might be, for instance, a phantom or simplex circuit superimposed on the telephone lines or a phantom circuit superimposed on a battery feed line. By the invention the degree of separation of the signals need not be large since, even if an unwanted signal is present in a transmitted signal to a considerable extent, no false operation of the signal receiver will occur. Accordingly it is possible to use very simple electrical filters to separate the signals to be transmitted. These filters, for instance, may be simple parallel tuned circuits, each tuned to one of the signal frequencies. The various signals are then obtained from across the appropriately tuned circuits, being conveniently connected through a rectifier to a direct current relay or its equivalent.

The invention will be better understood from the following description taken in conjunction with the accompanying drawing comprising Figs. 1 and 2, in which Fig. 1 shows the invention applied to a signal receiver adapted to respond to signals of a single definite frequency only, while Fig. 2 shows a signal receiver adapted to be used in a system employing four signal frequencies.

Referring now to Fig. 1 the incoming line is connected to the terminals 1 and 2 and the incoming signals are applied to the grid of the amplifying valve 5 over a transformer 3. The grid circuit of the valve 5 also contains a low capacity condenser 4, an inductance 4' and a high resistance 6, the purpose of which will be pointed out later. In the plate circuit of the valve 5 is the primary winding of a transformer 7, having a step up secondary winding across which is connected a neon lamp 8.

Now it is a well-known property of a neon tube

that no current will pass until the voltage across the electrodes reaches a definite value, when a considerable current will flow without the voltage across the electrodes increasing. The step-up ratio of the transformer is so chosen that the neon tube will flash when the voltage amplitude of the amplified signal currents in the plate circuit of the valve 5 reaches the predetermined value which has been chosen as the limit. The consequent increase in the load on the circuit when the neon lamp flashes will prevent the voltage across the transformer winding from increasing above the predetermined value.

The received signals having been limited to a constant maximum voltage amplitude are now applied to a resonant circuit comprising a condenser 9 and an inductance 10. This circuit is tuned to the definite signal frequency which for the purpose of description will be denoted by F. The alternating currents of frequency F are applied by way of a metal rectifier 11 to the grid circuit of a thermionic valve 12, the circuit also including the condenser 13 which is shunted by a high resistance 14. During the positive half-wave the grid of the valve 12 will be charged with a positive potential and current will flow through the rectifier 11 to charge the condenser 13. During the negative half-wave no current will flow through the rectifier but the charge in the condenser which leaks away through the resistance 14 will tend to maintain a positive potential on the grid of the valve. It is found that this arrangement facilitates the operation of the receiving relay 15 located in the plate circuit of the valve 12, since it produces a continuous and comparatively steady plate current in place of the isolated pulses produced by ordinary half wave rectifications.

The valve 12 is biased so that it only operates if the voltage amplitude of the grid swing is substantially that of the limited voltage amplitude. Assume that speech signals containing a signal of frequency F are applied to the receiver. These currents are limited in voltage amplitude and since the signal comprises a number of frequencies the voltage amplitude of the signal of frequency F selected by the tuned circuit will not approach the limited voltage amplitude and hence the voltage amplitude of the grid swing of the valve 12 will not be sufficient to cause the operation thereof and consequently the receiving relay 15 remains unoperated.

When, however, a pure signal of frequency F is applied to the receiver the current after limitation will consist of current of frequency F only whose voltage amplitude is that of the limited value. The grid swing will then be sufficient to operate the valve 12 and cause the operation of the receiving relay 15.

As a further precaution against false operation of the receiving relay when speech signals containing currents of frequency F are applied to the receiver, the amplifying valve 5 is so arranged that the amplification of signals of frequency F is less efficient than that for signals of other frequencies. This is effected by the parallel tuned circuit comprising condenser 4 and inductance 4' which are tuned to the signal frequency and are of such value as to produce suitable attenuation of currents of this frequency. Hence in the plate circuit of the valve 5 the ratio of the voltage of signals of frequencies other than F to the voltage of signals of frequency F is increased. This decrease in amplification as regards signals of fre-

quency F has no deleterious effect when the incoming signals are pure signals of frequency F, since the amplification is sufficient to bring them up to the limited value, but if the incoming currents are speech currents containing the frequency F, the decrease in amplification reduces the proportion and so ensures that the grid swing of the valve 12 will not be sufficiently great to cause its operation.

Referring now to Fig. 2, this shows the invention applied to a signal receiver comprising four receiving relays 20, 21, 22 and 23 adapted to be operated by pure signals of four different frequencies. The operation of the circuit is similar to that described above. The incoming signals are applied over a transformer 24 to an amplifying valve 25 in the plate circuit of which is the primary winding of a step-up transformer 26, the secondary winding of which is connected in series with a neon lamp 27. The plate circuit of the valve is connected to four resonant circuits 28, 29, 30, 31, each tuned to one of the signal frequencies. These resonant circuits separate the currents flowing in the plate circuit of the valve 25 and select those signals of frequencies to which they are tuned and apply them to the grid of the associated thermionic valve over a metal rectifier in the manner described in connection with Fig. 1. In the case of pure signals the receiving relay in the plate circuit of the valve will be operated as described above.

Filament current is applied in series to all the valves employed in the receiver over the resistances 32, 33, 34, 35 and 36 and tapings are taken from these resistances to provide grid bias to the rectifying valves.

It was found that with an arrangement of this type, false operation of the receiving relays occasionally occurred. This is probably due to cross modulation of the harmonics of the originally applied signals which are liable to be produced if the amplifier prior to the limiting device should be overloaded unless the signaling frequencies are very carefully chosen. These cross modulation products or their harmonics may at times correspond to one of the signal frequencies to which the signal received is arranged to respond but which is not actually one of the signal frequencies originally received by the receiver. To obviate this defect the primary winding of the transformer 26 may be shunted by a circuit 37 comprising inductance and capacity so chosen that the harmonics of the originally applied signals are suppressed.

I claim:—

1. In a signaling system, a circuit over which signaling currents are received, an amplifier coupled to said circuit, a voltage limiting device in the plate circuit of said amplifier, a resonant circuit coupled to said plate circuit, a second ampli-

fier, means including a rectifier for coupling the grid of said second amplifier to said resonant circuit, and a responsive device in the plate circuit of said second amplifier.

2. In a signaling system, a circuit over which speech currents are received and also signaling currents of a definite frequency within the voice frequency range, means for amplifying currents received over said circuit, means for limiting the voltage amplitude of the output from the amplifying means to a predetermined maximum value, a second amplifier, a rectifier, means including a tuned circuit for passing on to the second amplifier through said rectifier that component of the output of the first amplifier which has the aforesaid definite frequency, and an electromagnetic responsive device in the plate circuit of said second amplifier.

3. A signaling system as set forth in claim 2, in which the circuit of the first amplifier is provided with means which cause currents of the definite frequency to be amplified less than currents of other frequencies.

4. A signaling system as set forth in claim 2, in which the grid circuit of the second amplifier is shunted by a condenser and grid leak so as to minimize the fluctuations of voltage applied to the grid through the rectifier and thus improve the operation of the responsive device.

5. A signaling system as set forth in claim 2, in which the voltage limiting device includes a transformer having its primary winding connected in the plate circuit of the first amplifier, and a neon lamp connected in series with the secondary winding.

6. In a selective signaling system, a circuit over which signaling currents of different predetermined frequencies are received, means for amplifying such currents, means for limiting the voltage of the output from said amplifying means to a predetermined maximum value, a plurality of tuned circuits connected in parallel for receiving the output from said amplifying means, each circuit being tuned to one of said predetermined frequencies, individual amplifiers for amplifying the currents beyond said tuned circuits, respectively, and a plurality of responsive devices controlled by said individual amplifiers, respectively.

7. A selective signaling system as set forth in claim 6, in which the voltage limiting device includes a neon lamp, and a circuit for said lamp inductively connected with the output circuit of said first amplifying means.

8. A selective signaling system as set forth in claim 6, in which the output circuit of the first amplifying means is provided with means for suppressing the harmonics of the predetermined frequencies.

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