July 31, 1934. G. F. LAMPKIN 1,968,528

COMMUNICATION SYSTEM

Filed April 17, 1929

Fig. 1.

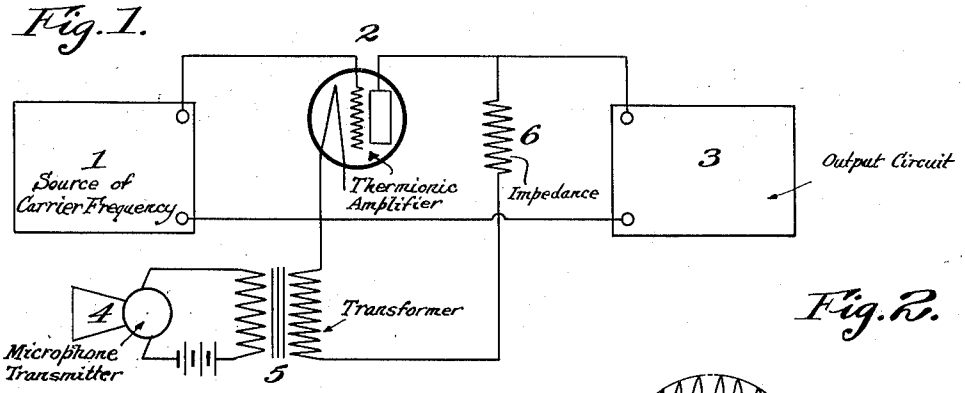


Fig. 2.

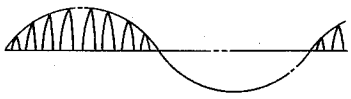


Fig. 3.

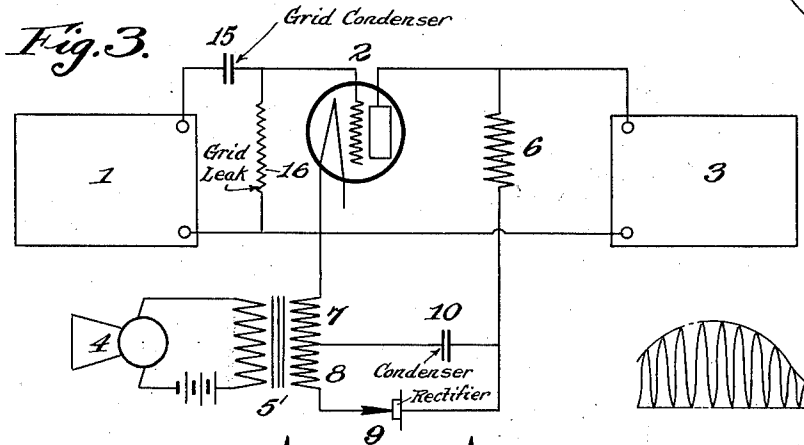


Fig. 4.

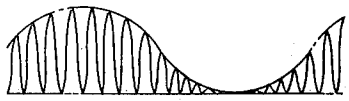


Fig. 7.

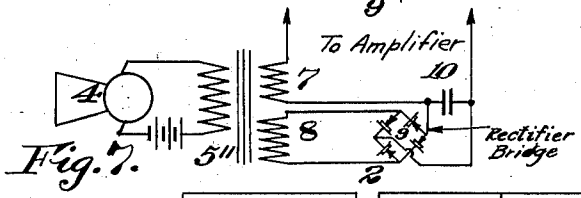
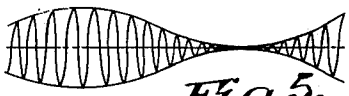


Fig. 5.



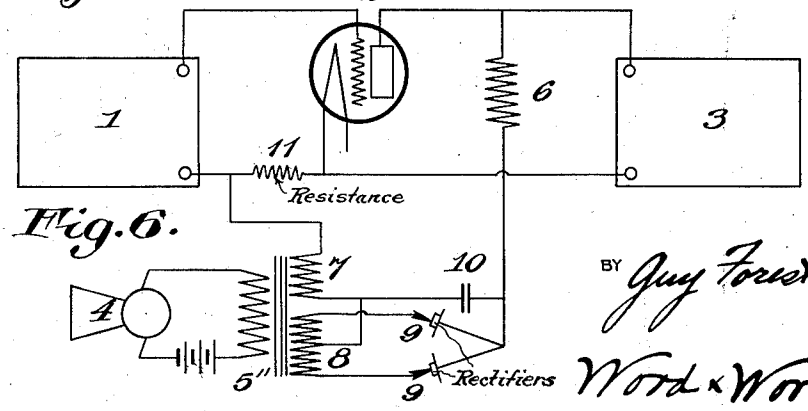


Fig. 6.

INVENTOR

BY Guy Forest Lampkin

Wood & Wood ATTORNEYS

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1,968,528

COMMUNICATION SYSTEM

Guy Forest Lampkin, Cincinnati, Ohio

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3 Claims. (Cl. 179—171)

This invention relates to improvements in the system of electrical communication employing a high-frequency carrier wave. The desirable results accomplished by the invention are (1) transmission of the carrier wave is effectively prevented during the absence of a modulating signal; and (2) the amplitude of the carrier wave is automatically adjusted at all times to the requirements of the modulating signal. These results are in sharp contrast to the usual method of carrier-frequency transmission, in which the carrier wave is always present whether or not there be a modulating signal while at all times the amplitude of the carrier wave is approximately constant, independent of the amount of modulating signal. These two results have been accomplished in a variety of ways, as will be described in this specification.

The importance of the first result is illustrated in the application to a multiplex carrier-frequency telephone system. In order that each station of such a system shall be able to communicate with each of the other stations of the system it is necessary that all the stations be adjusted to transmit and receive on a single carrier frequency. In order to prevent interference it is then necessary that all but one of the transmitters be completely de-energized during the transmission of a signal. Therefore rapid communication between two or more stations which utilize a constant carrier is impossible; or, complicated and expensive switching arrangements are required, These difficulties are obviated in the system herein described, in which any number of transmitters may be in operation simultaneously on the same carrier frequency, with no interference whatever between the carrier waves, since the carrier wave is entirely suppressed in the absence of a modulating signal.

The second result has an important application in the field of radio broadcasting of popular programs. It is now common practice to transmit a carrier wave whose intensity is considerably greater than is needed for the average modulating signal, in order to prevent the possibility of over-modulation on the extremes or peaks of the modulating signal. It is found then that the carrier wave of a broadcasting station can be detected in a suitable receiver at a distance from the transmitter considerably greater than that over which the modulated signal can be received. Thus interference may be made and is produced by the carrier wave of a station at points lying outside of its own range of useful transmission. This is prevented by the system described below, in which the strength of the carrier wave is always adjusted automatically to the requirements of the modulating signal, and no surplus is ever produced.

The system has the further advantage that the amount of power required to produce a signal of given strength in the distant receiver is less than with the methods of signal transmission now in use.

The reception and detection of the signals emitted by transmitters using this system may be accomplished by receivers of ordinary design and construction. In this respect it is superior to transmitting systems in which the carrier wave is completely eliminated at all times, since in such systems it is essential that a local oscillation of exactly carrier frequency be produced at the receiver to render the signals intelligible.

The method by which these results have been attained is shown in the following figures, which are, however, merely illustrative. Many modifications of these arrangements may be used without departing from the content of my invention, as will be evident to any one skilled in the art.

In Figure 1 is shown the simplest arrangement of the system. 1 is an oscillator supplying a steady voltage of carrier frequency; 2 is a thermionic amplifier; 3 is the output translating device, which may be a transformer or network feeding a transmission line or radiating system, or another amplifier; 4 is a source of modulating potential, which in the usual application may be a microphone with associated batteries and speech amplifiers; 5 is a modulation transformer; and 6 is an impedance of suitable value to prevent the carrier-frequency output of the amplifier 2 from passing through the windings of the transformer 5.

The amplifier 2, while of ordinary design and construction, nevertheless has a special function, which is novel to my invention. In each of the arrangements exhibited in this specification, this amplifier is used as the modulating element of the device, and it also serves to limit the amount of carrier-frequency output to the requirements of the modulating signal, and to reduce the carrier-frequency output to zero when there is no modulating signal present. This amplifier will be known as the "modulating amplifier" in this specification. The modulating amplifier must by no means be construed as being limited to a three electrode vacuum tube. Four or five electrode tubes, in which the additional elements are used for space charge reduction, or grid-plate capacity reduction, or both, come within this definition of the modulating amplifier.

In operation, the anode current of the modulating amplifier 2 is zero as long as the source 4 and transformer 5 do not supply a modulating potential, and therefore the output into 3 is also zero. When a modulating potential is produced at 4, the anode of amplifier 2 is subject to this potential, modified by transformer 5, and during the parts of the cycle when this potential is positive there will be a flow of anode current. This

current will have a wave form such as shown in Figure 2, where the envelope of the curve is approximately of the same form as the modulating potential.

A certain amount of distortion is introduced by this system, as is evident since the negative loops of the modulating potential have no effect in the modulation. I have found by actual use, however, that ordinary speech introduced by microphone and amplifier is completely intelligible in the receiver when using this system.

In Figure 3 is shown an arrangement of parts in which the distortion inherent in the method of Figure 1 is eliminated. Here the numbers have the same significance as in Figure 1, and in addition 5' is one form of a special transformer with double secondary windings 7 and 8, 9 is a rectifier of any type, 10 is a condenser for the separation of alternating from unidirectional current. A grid leak resistor 16 and condenser 17 are also shown, which combination serves to bias the amplifier in conventional manner, and thereby improve the linearity between input and output of the amplifier.

This combination acts as above described for Figure 1, except that when a modulating potential is produced at 4, the secondary winding 8, in conjunction with the rectifier 9 and filter condenser 10, produces a unidirectional current flow in the anode circuit of the modulating amplifier 2, to which is added the alternating anode current due to the potential induced in secondary winding 7. If the windings 7 and 8 and the condenser 10 are properly proportioned relative to each other, the effect on the anode current will be as shown in Figure 4. If the component of modulation-frequency current is subtracted from this output current, as can be done by well-known methods in the translating device 3, the form of variation shown in Figure 5 is obtained. This is clearly a modulated carrier-frequency wave with complete modulation.

I do not wish to imply that it is essential or even important to have the adjustment of windings 7 and 8 and condenser 10 so made as to produce exactly the result of Figure 4. The unidirectional component may be made either larger or smaller relatively than there indicated without impairing the result materially. The relation shown is desirable, since it provides best reproduction with maximum economy.

There is still another element of distortion remaining in the improved arrangement. This is due to the fact that anode current is not strictly proportional to anode potential, particularly at low values of anode potential; therefore the envelope of the modulated signal will not be of exactly the same form as the input modulation potential. I have overcome this drawback as shown in Figure 6. Here the resistance 11 has been inserted in the input circuit to the modulating amplifier, in such wise that the anode-current component of modulation frequency is forced to flow through said resistance. This introduces a variable grid bias potential in addition to any constant bias potential already present, and the variable bias is directly proportional to the low-frequency component of anode current. If the value of the resistance 11 is suitably chosen, the effect of the variable bias will be, as I have found by test, to produce an anode current which is substantially proportional to the anode potential.

I have also shown in Figure 6 another improvement in that the unidirectional component of anode current is supplied by a full-wave rectifier of conventional form. This greatly simplifies the filtering of the output. The same effect may be produced by means of any other full-wave rectifier device, as for example in Figure 7, where the rectifier 9 is arranged in the well-known "bridge" form of connection.

All the above arrangements may be grouped into a single statement of the ground which my invention covers, as follows: In modulating a carrier-frequency voltage wave, a tube is used which has grid (or grids) and anode excited in any one of a variety of ways by a carrier-frequency potential and a modulation-frequency potential, in combination with such unidirectional potentials as may be required. The characteristic feature of the operation is that the anode current of the amplifier tube is forced to be zero in the absence of modulation potential, and the anode current has a component in the form of a modulated carrier-frequency wave when modulation potential is present.

Having described my invention, I desire to be limited only by the following claims:

1. A device for producing modulated carrier-frequency signals, said device comprising a modulating amplifier of thermionic type, an independent source of carrier-frequency oscillations associated with the grid of said amplifier, a source of modulating potential, a transformer whose primary winding is energized by said modulating source, said transformer provided with two secondary windings, a rectifier and filter associated with one of said secondary windings in such wise that the rectifier-filter potential together with the modulation-frequency potential of the other secondary winding constitute the only potentials supplying the anode of said amplifier, and a suitable output circuit.

2. A device for producing modulated carrier-frequency signals, said device comprising a modulating amplifier of thermionic type, an independent source of carrier-frequency oscillations associated with the grid of said amplifier, a source of modulating potential, a transformer whose primary winding is energized by said modulating source, said transformer provided with two secondary windings in such wise that the rectifier filter potential together with the modulation-frequency potential of the other secondary winding constitute the only potentials supplying the anode of said amplifier, a full wave rectifier and filter associated with one of said secondary windings, and a suitable output circuit.

3. In an electrical communication system employing a high frequency carrier wave, a device for transmitting said wave only contemporaneously with modulating signals, said device comprising means for producing a wave of carrier frequency, a thermionic amplifier, the grid of which is connected to said means, a transformer, a full wave rectifier connected to a part of the secondary of the transformer to rectify part of the secondary output, a condenser adapted to lessen the pulsations of said rectified wave, the other part of the secondary of the transformer being proportioned to provide an output of amplitude slightly less than the value of the rectified current, a connection between the anode of the thermionic amplifier and said secondary outputs, a source of direct current and a signaling device connected to the primary of said transformer, and an output device connected to the thermionic amplifier, said device adapted to transmit the resultant wave of amplified and modulated carrier frequency current.

GUY FOREST LAMPKIN.