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THERMIONIC MODULATION SYSTEM

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Fig. 1

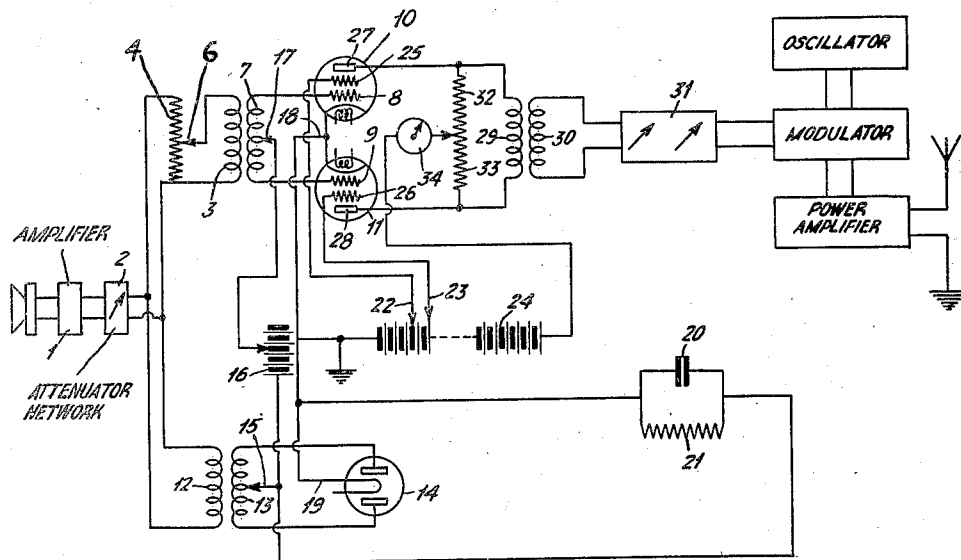
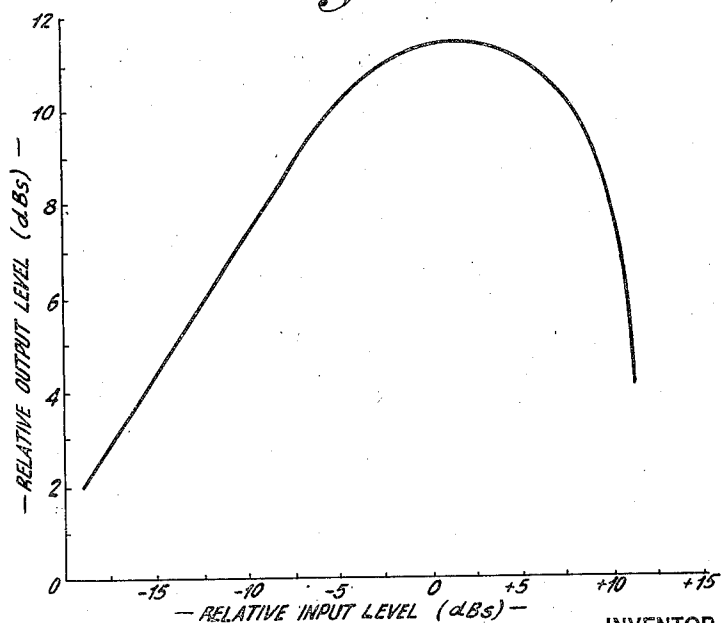


Fig. 2



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THERMIONIC MODULATION SYSTEM

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2 Claims. (Cl. 179—171)

This invention relates to thermionic modulation systems and more particularly to modulation systems for use in short wave radio transmission.

One of the principal difficulties met with in short wave radio transmission is that known as fading.

The principal object of the present invention is to provide a modulation system whereby the results of fading shall be to a large extent reduced.

According to this invention means are provided at a transmitter for maintaining the level of modulation at a comparatively "deep" value even when the intensity of the signals themselves is small and means are also provided for preventing overloading of the transmitter when the signal input becomes strong. It is found that this maintenance of comparatively deep modulation considerably lessens the effects of fading at the receiver and although, as will be understood, a system in accordance with this invention will result in the ratio of loud and soft passages at the receiver being less than the original ratio, this difficulty is for many purposes not of any very great importance.

The invention is illustrated in and explained in connection with the accompanying drawing.

Referring to Figure 1, which shows one way of carrying out the present invention, input from a microphone or microphone amplifier 1 is passed through a variable attenuator network or other similar control device 2 and is fed through a further variable attenuator to the primary 3 of a transformer. As illustrated the further attenuator consists of a potentiometer which may conveniently have a resistance of about 600 ohms value and one end of which is connected to one end of the primary of the transformer. The movable point of the potentiometer is connected to the other end of the transformer primary and the secondary 7 of the said transformer is connected between the control grids, 8, 9, of a pair of so-called "variable mu" tubes 10, 11, connected in push-pull. The so-called variable mu tube is a modified screen grid tube, the mutual conductance of which varies substantially with applied control grid voltage. An example of such tube now in common use is the Marconi valve, known under the trade designation VNS4. This tube has a mutual conductance which varies between about 1.1 MA/volt and about 0.005 MA/volt, the impedance being about 450,000 ohms. Shunted across the potentiometer resistance is the pri-

mary 12 of a second transformer, the ends of whose secondary 13 are connected to the anodes of a pair of low impedance rectifiers whose cathodes are connected together or, as shown, to the anodes of a full wave rectifier tube 14. The center point 15 of the secondary 13 is connected through a suitable bias battery 16 to the center point 17 of the secondary 7 of the input transformer to the variable mu tubes 10, 11. The common cathode point 18 of the variable mu valves is earthed and is connected to the cathode point 19 of the full wave rectifier, which point is also connected through a condenser 20 of from .01 to .1 microfarads capacity, e. g., of .08 microfarads, which is shunted by a very high resistance 21, which may be variable from about .1 to 50 megohms, to the center point 15 of the secondary 13.

The rectified speech currents appearing in the output of the rectifier are of an intensity determined by the amplitude of the speech currents. The control bias on the grids of the tubes 10 and 11 is in part determined by the intensity of the direct current in the output of the rectifier 14. It follows therefore that the control bias and, consequently, the operativeness of tubes 10 and 11 is a function of the amplitude of the speech frequencies.

Suitable values of direct current potential are applied from tapping points 22, 23 on a battery 24 to the outer grids 25, 26 of the variable mu tubes, the plates 27, 28, of which are connected together through the primary 29 of an output transformer, from whose secondary 30 the output is passed through a variable gain amplifier 31 and then utilized for modulation. The secondary 30 may in practice conveniently be designed to feed into a load resistance of about 600 ohms. The anodes 27, 28 are also connected through a pair of resistances 32, 33 in series, say, of 5,000 ohms each, the junction point of these resistances being taken through an indicating milliammeter 34 to a source of anode potential—the battery 24. It will be seen that with this arrangement part of the modulation input is diverted through the low impedance rectifiers, and is utilized to control the grid bias of the variable mu tubes.

The operation and adjustment of the device will be understood from the following:

So long as the output impedance of a variable mu tube is low in comparison with the tube impedance, the amplification obtained will vary with the value of the amplification factor divided by the internal resistance. Now the curve con-

necting the amplification factor divided by the internal resistance (ordinates) and grid voltage (abscissæ) of a variable mu tube of the kind in question is approximately hyperbolic and asymptotic to the ordinate and abscissa lines. For the tube known as VMS4 the curve is approximately asymptotic between an ordinate value of about 1.2 milliamperes per volt and an abscissa value of about -40 volts. The apparatus is adjusted by varying the grid bias until the anode current corresponding to value of about .7 milliamperes per volt is obtained. The curve connecting the output level in decibels (ordinates) and the input level in decibels (abscissæ) of the arrangement described will, owing to the described characteristics of the variable mu tube, rise to a maximum and then fall away with increasing values of input level, this curve being of approximately inverted U shape with a fairly flat top. A typical curve obtainable with an arrangement as described is shown in Figure 2, wherein the ordinates are decibels (relative output level) and the abscissæ are decibels (relative input level). As will be seen from Figure 2, for a level of -20 decibels input the output level is about 1.5 decibels rising to a level of about 10 decibels for an input level of about -5 decibels. This value marks the beginning of what may be termed the "flat top" of the curve, for at zero input level the output level in decibels is only about 11.5, while when the input level has risen to about +7 decibels the output level has fallen to about 10 decibels. It will be seen therefore that between values of about -5 decibels and +7 decibels input level, the output level is approximately constant irrespective of input, lower inputs being magnified in greater proportion than larger inputs. When, moreover, the input level increases above somewhere about +7 decibels, the output level rapidly falls away. It follows therefore that the level will be maintained substantially constant over a wide range of different input strengths while over-loading and "blasting" of the transmitter is automatically prevented.

In order the better to understand the action and manner of operation of the arrangement shown in Figure 1, a description of a practical method of securing the necessary adjustments will now be described, the description applying to a transmitter such as ordinarily employed for broadcasting purposes and wherein a so-called "tuning note", i. e., an audio frequency modulation of substantially constant amplitude and frequency, is transmitted prior to the commencement of a programme.

From the description which follows it will be seen that this tuning note is utilized for the necessary preliminary adjustments and checking, although, of course, it is possible to employ any other constant "test" signal for the same purposes.

It will be obvious that the reading obtained on the milliammeter 34 will be principally effected by the control bias applied from the rectifier unit 14 and the attenuating potentiometer which feeds into the transformer 3 may be so adjusted that the maximum output, as given by the top of the flat part of the curve of Figure 2, is obtained when the reading of the milliammeter 34 is some convenient value, say half way along the scale. In an actual case wherein the curve of Figure 2 was obtained the milliammeter was an instrument reading up to 3 milliamperes and the maximum value corresponding to the top of the flat portion of the curve in Figure 2 was 1.3

milliamperes. The potentiometer control is then left at this position of adjustment and with the tuning note present, the attenuator device 2 is set to bring the control milliammeter 34 to the reference mark—i. e. half scale reading. The variable gain amplifier 31 is then adjusted to secure full control of the transmitter. Any further control found to be necessary when the programme is being transmitted is obtained by adjusting the attenuator device 2. It will be apparent that with this adjustment it will not be possible to "blast" the transmitter since the control settings have been made for the maximum output condition and the control milliammeter 34 will give readings indicating the part of the curve of Figure 2 which is operative. If the control at 2 is so adjusted that the modulation keeps the needle of the instrument 34 near the reference mark the flat part of the curve of Figure 2 will be operative and the "peak" output will be substantially constant. This adjustment condition secures the maximum possible over-all level. If the movements on the instrument 34, due to relatively weak input signals, are small, i. e. near what is normally the full scale reading, (the reading with no signal present would be full scale) the first or rising part of the curve is being worked over, while if, as a result of relatively strong input signals, the reading on the instrument 34 is reduced to well under half, the apparatus is working over the drooping part of the curve of Figure 2 and under both these conditions the full output of the transmitter will not be reached. At times, however, when "light and shade" effects are required, it may be desirable to adjust the apparatus to work on the rising part of the curve and preferably so that the needle of the instrument 34 occasionally reaches the reference mark which is half way along the scale. Obviously a specially marked control instrument 34 may be employed, if desired, and so as more clearly to indicate to an operator the working conditions. The time period governing the bias control given by the rectifier 14 can be adjusted by altering the values of the condenser 20 and resistance 21 since large values of resistance and condenser will produce a very slow leakage of the control bias while small values will result in a more rapid leakage. The effect obtained can be checked by watching the readings on the milliammeter 34. When the values in this line control circuit 20, 21 are too large a sudden peak modulation will be indicated by the readings being reduced to well under half and then slowly returning, the result obtained being to reduce the control of the transmitter when the peak occurs. If the return of the needle during leakage is too slow the time taken to restore the modulation to full control, as indicated by the half scale reading on the meter, will be excessive. If on the other hand the time period is too short, the control will follow the modulation employed too rapidly and a "jerky" transmission will be produced. Careful initial adjustment can be made in such manner that the control allows very full modulation with safety while any accidental high peak modulation will only result in a momentary reduction in output due to the transmitter working over the drooping portion of the curve of Figure 2. The adjustments for the attenuating device 2 after the initial adjustments have been made are quite uncritical and generally will only need to be made at all when the character of the pro-

gramme is changed, e. g., when an orchestral selection is followed by a programme item of much less volume, for example, a speech.

It is, of course, not necessary to employ two 5 variable mu tubes in push-pull, though this arrangement is preferred, since it is quite practical to employ only one variable mu tube, the grid bias thereof being controlled by a proportion of the input energy in manner analogous to 10 that already described for the push-pull arrangement. Similarly, though the use of a full wave rectifying arrangement for providing the bias for the tubes to be controlled is preferred, it is not necessary to employ full wave recti- 15 fication.

Though the main object of the present invention is, as above stated, to minimize the effects of fading, which effects are, of course, manifested mainly, if not exclusively, on the shorter 20 wave lengths, the invention is not limited by this object but may be applied advantageously in other cases where continuously "deep" modulation is required. For example, where a speech by a platform orator is being broadcast, the 25 difficulty is often met with that the speaker tends to vary his distance from the microphone and/or the direction of his voice. The present invention may advantageously be employed to meet this difficulty by maintaining the depth 30 of modulation more or less constant, and at the same time preventing transmitter overloading or "blasting", substantially independent of the intensity of sound picked up by the microphone. The novel utilization of the properties of a vari- 35 able mu tube with gain regulation as disclosed in the present invention results in exceedingly good control of modulation depth, etc., of a modulated carrier wave, thereby reducing fading. For applications such as this, of course, 40 the wave length of the carrier wave transmitted does not enter into the matter and the invention is thus applicable generally to radio systems and not merely to short wave systems.

Having thus described my invention and the 45 operation thereof, what I claim is:

1. A device for amplifying alternating current potentials from a source of alternating current potential comprising, a thermionic tube of the variable mu type having anode, cathode, control

grid and an additional grid-like electrode, a circuit including amplitude regulating means connected between said source of alternating current potential and the control grid and cathode 5 of said tube, a direct current source for energizing the anode electrode and the additional grid-like electrode, a rectifier having its input electrodes coupled to said source of alternating current potentials, a source of direct current connecting the output electrodes of said rectifier between the cathode and control grid of said tube, 10 said rectifier applying a mean biasing potential to said control grid such that said tube is operative upon a portion of its characteristic curve such that the output level of said tube is constant over a wide range of input levels and a time control device inserted in the output circuit of 15 said rectifier.

2. A device for amplifying alternating current potentials from a source of alternating current 20 potential comprising, a pair of thermionic tubes of the variable mu type each having anode, cathode, control grid and an additional grid-like electrode between the control grid and anode, a circuit including amplitude regulating 25 means connected between said source of alternating current potential and the control grids and cathodes of said tubes, said circuit including a transformer having its primary winding variably coupled to said source and its secondary 30 winding connected between the control grids of said tubes, a source of direct current connected between the anodes and cathodes of said tubes, a connection between each additional grid-like electrode and a point on said source, a thermionic rectifier of the full wave type having its input 35 electrodes coupled to said source of alternating current potentials, a source of direct current connecting the output electrodes of said rectifier between the cathodes of said tubes and 40 a point on said secondary winding, said direct current source and said rectifier applying a mean biasing potential to said control grids such that each tube is operated upon a portion of its characteristic curve such that the amplitude of 45 the alternating current potentials in the output of said tube is constant over a wide range of input potentials.

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