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MIXER TUBE CIRCUIT

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Fig. 1

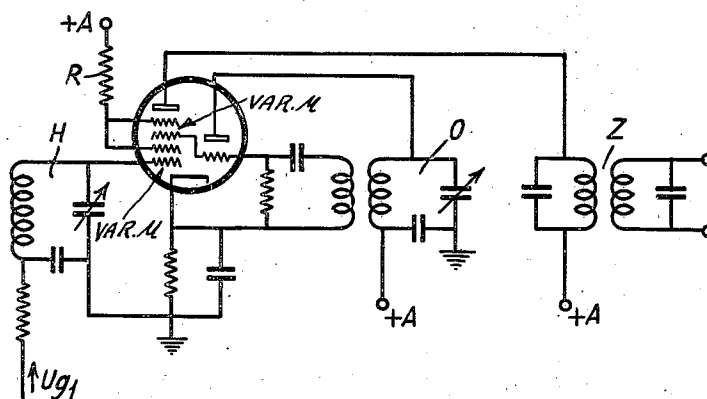


Fig. 2

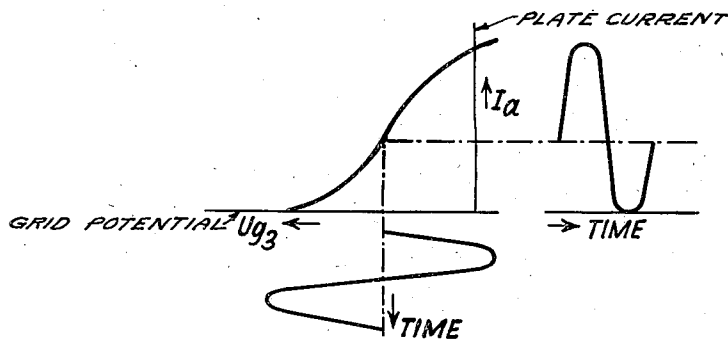
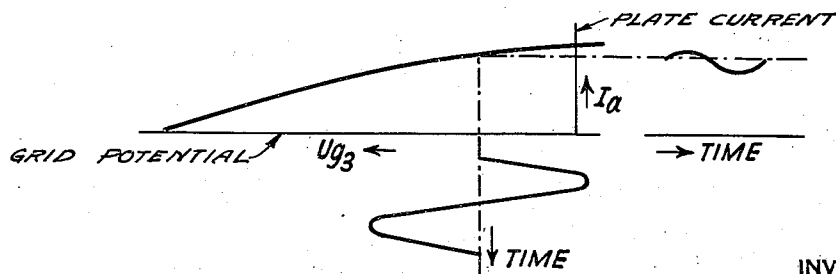


Fig. 3



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MIXER TUBE CIRCUIT

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3 Claims. (Cl. 250—27)

As is known, the grid of a multi-grid mixer tube and to which the alternating input potential (high-frequency potential) is applied can be adapted for variable amplification control, and more especially as exponential grid just as in the case of an exponential tube. It is desirable to increase the limited controllability of such a mixer tube, i. e. to decrease the requirement in control potential. This would be possible if, aside from the control at the input grid, also the amplitude of the superposed alternating potential applied to the grid of the local oscillator, or the grid biasing potential of the grid of the local oscillator would be controlled. Both types of control are complicated as regards the circuits and difficult to realize since frequency distortions occur at the control performance. Of the two types of control the control at the grid of the local oscillator appears to be simpler but still more difficult than at the input grid since the grid of the local oscillator carries current. Furthermore the change of the grid current causes a change of the damping of the oscillatory circuit of the local oscillator and hence, a frequency distortion.

The invention affords a new and simpler way without any particular requirement in circuit means and which resides substantially in a different design of the tube. Underlying the invention is a known mixer tube with a grid for the alternating input potential which grid is so designed for variably controlling the amplification and this mixer tube also has a non-controlled grid for the alternating potential of the local oscillator. In accordance with the invention the mixer tube is so designed and/or so operated that when the grid biasing potential of the input grid becomes more negative, the alternating potential of the local oscillator which remains constant controls but partially the plate current.

In one of the modes of construction the invention resides in that the control affected by the grid for the alternating potential of the local oscillator is different throughout the length of the grid in the same manner in which the control by the input grid differs.

Before elucidating another mode of construction according to the invention in which the so-called gliding screen grid potential is used, the first mode of construction according to the invention will now be explained in reference to the figures, wherein Figure 1 shows a mixer tube circuit in accordance with the invention, and Figures 2 and 3 are oscillator grid potential-plate

current curves for two conditions of operation which will serve to explain the invention.

Referring now to Figure 1 the circuit is shown to utilize a tube having four grids. The incoming high-frequency is impressed across the high-frequency circuit H upon the grid situated next to the cathode. The second grid and fourth grid are screen grids having constant direct potential (in place of the series resistor R a voltage divider may at first be considered). The third grid has applied thereto from the grid of the built-in oscillator, with the oscillatory circuit O, the alternating potential of the local oscillator. The anode lead-in contains the band filter Z for the intermediate frequency.

If the first grid of the mixer tube has a variable μ or amplification factor, the amplification of the mixing performance can already be controlled by varying the biasing potential U_{g1} of this grid. Since in view of freedom from distortion certain conditions exist for the bend of the characteristic such a method affords controlling of the amplification only at the ratio of about 1:50. But it is aimed at a control ratio of 1:300 at a possibly low control potential and this shall be accomplished in accordance with the invention in the following manner:

The amplification in the mixer stage aside from depending on the steepness in regard to the control grid carrying the high-frequency, also depends on the modulation by the frequency of the local oscillator of the high-frequency current produced by the input grid. In principle two limit cases are conceivable whereby this influence can be varied. On the one hand, the value of the alternating potential of the local oscillator could be varied but which involves considerable technical difficulties, and on the other hand, the modulation ratio of the local frequency can be varied. The last mentioned measure could be carried out again in two different ways, namely in shifting the working point for the local alternating potential likewise on a suitable characteristic, or and this was found to be most suitable and represents the feature of the first mentioned mode of construction according to the invention, in that solely through proper dimensioning of the tube employed it is accomplished that simply by varying the biasing potential of the first grid the modulation ratio of the third grid is so varied at the same time that at lower grid biasing potential of the first grid (high steepness) the modulation ratio becomes as high as possible, and at high grid biasing potential (small steepness) of

the first grid said modulation ratio becomes as low as possible.

In order to understand the ways and means in technically accomplishing this the tube is conceived as being divided into two or a greater number of partial systems such as is usually done in the case of tubes having a variable μ or amplification factor whereby the said partial systems are considered as being arranged side by side along the cathode. When figuring for instance with but two part systems, then in the exponential tube there is a system having a high amplification factor and high steepness and a second part system having a low amplification factor and a small steepness.

Exactly the same conditions are assumed to exist in connection with the first grid of the mixer tube herein considered. The additional possibility of control demanded of the new tubes and which control is to be such that no additional circuit means are used, is achieved in that the alternating potential of the local oscillator at the third grid in the partial system having high steepness and a high amplification factor, produces a highly modulating effect as regards the plate current while in the part system having a low amplification factor and a small steepness it causes but a weak modulation. This varying modulation on the third grid is obtained in that at a given alternating potential of the local oscillator the control ranges in regard to the potential U_{g3} of the third grid are different. If at a given alternating potential of the local oscillator the control range is fully utilized by the said alternating potential, a modulation degree of 100% will be attained. Figure 2 shows for this case at the left the dependence of the plate current I_a on the grid potential U_{g3} at the bottom the figure shows the alternating grid potential and at the right is the corresponding alternating plate current. If the control range is substantially greater, only a low modulation degree will be attained (Figure 3).

The different control ranges are obtained, in the manner known in the case of variable μ or exponential tubes, by designing the third or oscillator grid to possess a variable μ or amplification factor, and in practice the simplest way is to provide such grid with different pitches just as in the case of exponential tubes.

In accordance with this explanation regarding the principal functioning of the control method the technical features of the tubes employed are the following ones: A tube which in view of the dimensionings of the control factors thereof can be divided into several part systems similar to an exponential tube is adapted such that the part system with the high amplification factor on the first grid has also a relatively high amplification control factor and hence also a narrow control range on the third grid, while the part system having the low amplification factor on the first grid also has a low amplification factor and hence a wide control range on the third grid. In accordance with the technically customary establishment of a variable amplification factor on the first grid by cutting out one or several grid turns the control range on the third grid can likewise be obtained by cutting out one or several grid turns and in accordance with the above that turn is to be cut out at the place of the electron path which corresponds with the gap on the first grid.

In the above explanations mention was made only of the amplification control through the local oscillator grid and of its control range and

nothing was said about the steepness such as is customary in the case of exponential grids. In fact it is not advisable to count upon the steepness in the case of the local oscillator grid because the oscillator amplitude is so large that it covers ranges in which the steepness differs greatly such as indicated in Figure 2. The introduction of the meaning of the control range of the local oscillator grid is understandable when bearing in mind the pertinent points of the mixer amplification. As regards the mixer steepness it is essential that the steepness of the characteristic "plate current in function of the alternating input potential" will be varied within limits as wide as possible by the alternating potential of the local oscillator. This is accomplished in that the direct plate current of the local oscillator grid is controlled between the zero value and its maximum.

Also other possibilities of obtaining a varied control throughout the length of the local oscillator grid exist which are known from the control tubes. For instance the distance between the local oscillation grid and the adjacent grid may be rendered different throughout the length of the grid. Generally it can be remarked that relative to the place at which the input grid has a larger pitch for the grid turns, the effective potential is to be increased in the plane of the local oscillation grid.

The second mode of construction in accordance with the invention resides in applying the screen grid potentials of the mixer tube across a series resistance and in so choosing the alternating potential of the local oscillator that at the increase of the control range of the local oscillation grid, due to an increasing screen grid potential during the downward control of the mixer tube at the input grid, the local oscillator potential only partially controls this control range. The use of a screen grid series resistance in place of a potentiometer gives the following result:

At an increase of the negative biasing potential of the input grid the current leaving the cathode decreases and hence, also the screen grid current so that the potential drop through the series resistor R in Figure 1 decreases and therefore the screen grid potential increases. In this way there is achieved a more favorable matching of the bend of the characteristic with the value of the alternating potential across the range of the control so that distortions, cross modulations and disturbances due to whistling noises become uniformly lower across the control range.

However, the disadvantage appears hereby that the increase in the screen grid potential acts against the decrease of the steepness of the characteristic of the input grid so that the possible control capacity of the tube will be detrimentally affected. In the earlier control tubes this decrease in the controllability was such that the rule has been of deriving the screen grid potential at a potentiometer. This reduction in the controllability is however not as great if the grid potential-plate current characteristic of the input grid descends in a steeper fashion than in the case of the earlier exponential tubes. In the earlier control tubes the characteristic showed at first a steep falling towards the negative grid potentials in order to enter across a highly curved part into a flat part. However this highly curved portion is undesirable and in accordance with the latest teachings therefore it is preferable to have an input grid characteristic which falls

steeply in a continuous curve and to utilize at the same time a gliding screen grid potential so that at a higher negative biasing potential of the input grid the control range of this grid increases owing to the higher screen grid potential.

Hence, there exists for the entire control range no longer a single characteristic but a flock of characteristics. This possibility was arrived at since the control hexodes have taught the operation with a flock of characteristics.

Since the application of the gliding screen grid potential reduces the controllability of a multi-grid mixer tube though not quite as effective as in the case of the earlier tubes it is desired to have a further reduction in control potential required and therewith an improvement in the controlling property of the tube which can be achieved with the second mode of construction according to the invention (or with the first one). At an increase of the screen grid potential (owing to a higher negative biasing potential at the input grid) the range of control of the local oscillation grid increases in fact. Now, if in accordance with the invention the alternating potential of the local oscillator is so chosen that at an increase in the range of control of the local oscillation grid the plate current is no longer completely controlled by the alternating potential of the local oscillator (such as in Figure 3), there appears at a downward control of the amplification at the input grid at the same time a reduced modulation property of the local oscillation grid and hence a further decrease of the mixer amplification. The controlling property hence, is increased.

Now, the third possibility resides in applying at the same time the two different modes of construction according to the invention, namely the special design of the local oscillation grid and the above-explained dimensioning of the alternating potential of the local oscillator in employing the gliding screen grid potential. In this case there is obtained in two respects a control of the range of control of the third grid. Therefore, the principle of the gliding screen grid potential can be applied without the necessity of a larger requirement as regards the control potential.

The invention may be applied not only to the mixer tube shown in Figure 1 but also to other types of multiple grid mixer tubes. Furthermore it may be practiced not only in connection with

superheterodyne receivers but generally in mixer tubes serving for the mixing of two frequencies. What I claim is:

1. In a frequency converter system, a tube provided with at least a cathode, a signal control grid, an oscillator grid and an anode, each of said grids being provided with low and high mu sections and corresponding sections of said grids being disposed in cooperative relation with one another, means for applying a variable bias to the control grid for controlling the amplification of the system, means for impressing a signal frequency on the control grid, a local source of oscillations for impressing a constant voltage of a predetermined frequency on the frequency oscillator grid, and a utilization circuit responsive to the combined frequency connected to the anode, the arrangement being such that with increased control grid bias to reduce the amplification the control action of the local oscillator grid becomes less effective in producing the conversion to the combined frequency.

2. In a frequency converter system as defined in claim 1, wherein a screen grid is interposed between the signal and oscillator grids and a voltage dropping resistor is connected to said screen grid, so that with increased bias on the control grid, the applied screen grid voltage is increased to render the control action of the oscillator grid more ineffective.

3. In a frequency converter system, a tube provided with at least a cathode, a signal control grid, a screen grid, an oscillator grid and an anode arranged in the order named, each of the control and oscillator grids having a variable mu factor, means for applying a variable bias to the control grid for controlling the amplification of the system, means for impressing a signal frequency on the control grid, a local source of oscillations for impressing a constant voltage of a predetermined frequency on the frequency oscillator grid, a utilization circuit responsive to the combined frequency connected to the anode, and means for applying operating voltage to the screen grid through a resistor, the arrangement being such that with increased control grid bias to reduce the amplification the control action of the local oscillator grid by reason of its variable mu factor and the increased screen grid potential becomes less effective in producing the conversion to the combined frequency.

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