CLAMP TUBE MODULATION— AND HOW IT WORKS

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MOBILE transmitters always seem to take more power from the battery than desirable, and unless a charger is taken along, the worry of keeping the battery charged can become a problem. In order to conserve battery power, various systems of modulation are tried, and some sort of ratio obtained between power drawn from the battery to supply a modulator and final, and the power developed in the aerial. Some of these ratios can be quite staggering.

TYPES OF MODULATION

For example, consider Heising modulation, an inefficient and out-dated method, which is still used. Assume a power amplifier, having 300 volts on the plate at 50 mA., which represents a power input to the p.a. of 15 watts. To modulate this, we will require 7.5 watts of audio. Using a class A modulator, having an efficiency (we will be generous) of 30%, means that the power input to the modulator will be 100 ÷ 30 × (15 ÷ 2), or 25 watts.

Remember that a valve operating class A has no grid current at any part of its cycle, so the plate current drain will be constant at all times. Only its efficiency will vary. So now (neglecting, for the sake of clarity, the necessary dropping resistor between modulator and p.a., and also to save lots of figures, we will assume the efficiency of the p.a. to be 100%) we will require 25 watts plus 15 watts, a total of 40 watts, from the power supply to deliver a modulated input to the p.a. of 22.5 watts. This will give us an efficiency rating of power used, to power delivered, of 22.5 ÷ 40 × 100%, or 55% for a typical Heising modulation system.

Now consider a class B modulator with the same final. Once more we have 15 watts input to the p.a., and we will require 7.5 watts of audio to modulate it. Now the efficiency of class B is a lot better than Heising, but as we are mainly concerned with power used when the p.a. is 100% modulated, we will consider the modulator drain when it is delivering 7.5 watts. From a typical valve table this is 16 watts. So our figures now are, drain from power supply, 15 plus 16 watts, or 31 watts, for a modulated power input to the p.a. of 15 watts plus 7.5 watts, or 22.5 watts. This gives us an efficiency of 22.5 ÷ 31 × 100, or 72.5%.

Of course, to keep the record straight, the modulation transformer and choke used in above examples, are regarded as having no insertion or other losses.

The next type we will consider is Reference Shift. This is an excellent modulator, but I am afraid that a great number of Amateurs who use it, labour under the false impression that its efficiency is astronomical. In actual fact, there is less than 10% difference, and this occurs when the p.a. is not modulated. In this case Reference Shift is approx. 6% better than class B.

Don't think for one moment that I am decrying Reference Shift, which I have been using since 1952 in various transmitters. If I were building a plate modulated rig and did not have a modulation transformer, I would use Reference Shift. As for Grid, Suppressor, or straight Screen Grid Modulation, none of these would even compare with Single Choke Heising, because we would have to take the plate efficiency of the p.a. into consideration and quite a lot of design care is needed, not to mention adjustment for best results.

CLAMP TUBE MODULATION

Some months back I became the owner of a Type A Mk. III. transmitter, and as there is practically no room to fit a modulation choke, or for that matter, no more than a couple of small valves, I had to think of some system of modulation that did not require much room. As I did not want to exceed the ratings of its power supply, this was quite a problem. So out came my accumulation of years of "A.R's." to see what could be used. Clamp tube modulation seemed to be very popular but not enough information was given as to how it worked.

I like to fully understand anything I am associated with, for example, I have been married for 20 years, and my wife thoroughly understands me, and I am still finding new facets regarding her. Wonderful people, women. But this article is on modulators regretably, so much as I would like to talk about these wonderful creatures, we must push on to more uninteresting things.

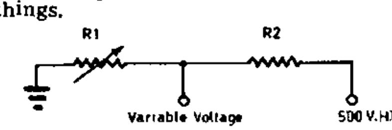

Fig.1.

Clamp tube modulation at first sight seemed to be comparable with the efficiency of grid modulation, but such is not the case. To digress from modulators for a moment, let us examine the action of a clamp tube. It is generally a triode. Now if sufficient negative bias is applied, the plate current will drop to a very low value, and if the bias were made positive the plate current would rise to a comparatively high value. This variation depends on the type of valve used and what amount of reference bias voltage (if required) is developed across the cathode resistor, if fitted. Now bearing in mind this important fact, it is obvious that the tube can, in effect, be used as a variable resistor to vary the voltage in a resistive network. This is shown in Fig. 1.

Now if this network was altered to a clamp tube set-up, we would replace R1 with a clamp tube as in Fig. 2.

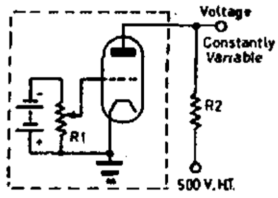

Fig.2.

By varying the potentiometer across the bias battery, the conductance of the tube can be varied at will and the resultant voltage at the plate of the tube would also vary. Now this is the "intestinal fortitude" of clamp tube modulation. So now we can actually get to designing this modulator, and for the moment, it will take the form as shown in Fig. 3.

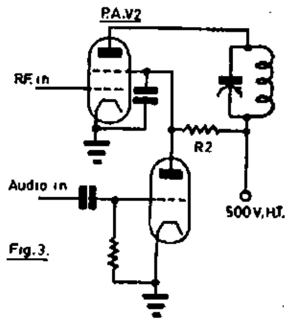

Fig.3.

Now if audio is fed into the grid of VI, it will be rectified and appear as bias. This bias, when negative, will decrease the conductance of the tube and increase its resistance and, in turn, raise the voltage at the screen of V2. Now if you are doubtful of this occurring, put a diode in series with the grid of V1 and this will prove to you that only a varying voltage will appear on the grid. In short, if a syllabic voltage (speech) is applied to the grid of VI, the voltage on the screen of V2 will vary at a syllabic rate. Remember this, as there are a few traps.

Remembering that if sufficient bias is applied to the grid of VI, it will cease to conduct and allow the normal voltage (dropped through R2) to appear at the grid of V2; and if no bias voltage was applied, the tube V1 would conduct and reduce the voltage on the screen of V2.

We now have a system whereby we can vary the voltage on the screen of V2 at a syllabic rate. This system can be likened somewhat to single choke Heising, and calls for the screen voltage of V2 to swing between zero and twice its applied voltage.

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