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MODULATOR

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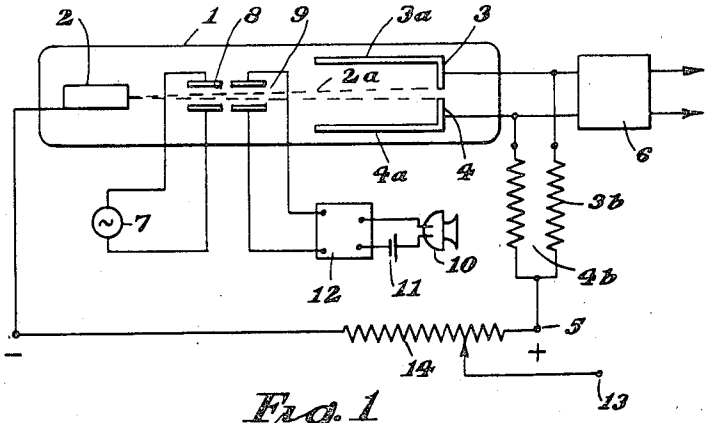


Fig. 1

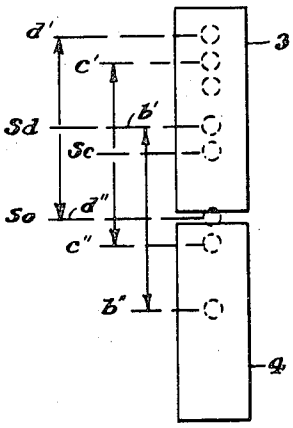


Fig. 2

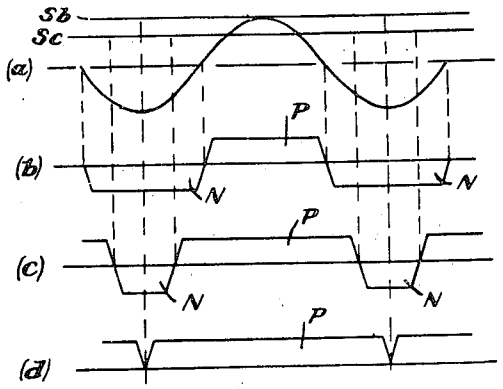


Fig. 3

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MODULATOR

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3 Claims. (Cl. 332—13)

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This invention relates to modulators of the type employing an electron beam tube.

An object of the invention is to devise an arrangement for modulating the output current of an electron beam relay in which the beam is alternately deflected between two spaced anodes or targets by means of a carrier wave.

A further object of the invention is to devise a modulator in which the modulated current is formed of positive and negative pulses of the same amplitude but of varying duration.

A further object of my invention is to devise an electron beam type modulator in which the output of the modulator consists of a series of pulses having a fixed pulse frequency but of variable pulse-duration.

The objects of my invention are attained by employing a cathode ray tube provided with two spaced anodes or targets between which the beam is alternately deflected by means of a carrier wave applied to suitable beam deflecting means. The modulating wave or signal is applied to vary the mean position of the beam with respect to its normal or neutral position. The arrangement is such that a small deflection of the beam from its neutral position causes the output wave to reach its maximum value quickly and remain at this value throughout an oscillatory excursion.

My invention may be explained by reference to the accompanying drawing in which

Figure 1 is a schematic circuit diagram of one embodiment thereof;

Figure 2 is a developed view of the two targets for explaining the action of the modulator; and

Figure 3 is a series of four curves which illustrate the operation of the invention.

Referring to Figure 1, 1 indicates the envelope of an electron beam tube having an electron gun 2 for producing a concentrated electron beam 2*a* which is normally directed along an axis passing between two spaced anodes 3 and 4 located in the other end of the tube. These anodes are provided with extensions 3*a* and 4*a* extending back towards the gun 2 in substantially parallel relation, and these extensions are for the purpose of intercepting the beam at all angles of deflection.

Anodes 3 and 4 are connected through suitable resistance elements 3*b* and 4*b* to the positive terminal 5 of a suitable source of space current. These anodes are also connected to a suitable load circuit, preferably through an amplifier 6. The gun 2 is connected to the negative terminal of the space current supply.

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A suitable source of carrier wave represented by the generator 7 is applied to deflecting means, such as the pair of plates 8, for deflecting the electron beam alternately between the anodes 3 and 4. A second deflecting system, such as the pair of plates 9, is also arranged to deflect the beam in the same plane as the plates 8, and these plates are energized from a suitable signal source represented in the drawing by the microphone 10 which is energized from battery 11, and the voice currents from the microphone are applied to the plates 9 after being amplified at 12. It is obvious that magnetic deflecting systems may be employed for the carrier and signal waves if desired.

In Figure 2 I have shown the two anodes 3 and 4 in developed position for the purpose of illustrating the extent of deflection of the beam under different conditions of applied signal.

The curves of Figure 3 illustrate the wave form obtained across the anodes 3 and 4 under different conditions of applied signal.

Operation of the arrangement shown in Figure 1 is as follows: It will be understood that the signal wave may be a periodic wave or a varying potential of either polarity, but its rate of change will normally be quite low with reference to the frequency of the source 7. Normally, the electron beam 2*a* will be directed between the two anodes 3 and 4 by suitable beam concentrating and directing means not shown. With the beam in its neutral or normal position, an equal quantity of electrons will impinge upon the anodes 3 and 4 and there will be no difference of potential applied to the output circuit. The normal position of the beam is shown at So in Figure 2. Assume that a sine wave shown in curve *a*, Figure 3, is applied to the deflection plates 8, the beam will be deflected alternately from one anode to the other at the frequency of the carrier wave. Where the positive and negative alternations of the wave are the same, the beam will be deflected to the same extent on the two anodes, and this is shown in Figure 2 by the deflection of the beam from the normal position So to the position *b'* on the anode 3 for the positive carrier pulse and down to the position *b''* for the negative carrier pulse. While the beam is impinging upon the anode 3 the output circuit will receive a positive pulse P as shown in curve *b*, Figure 3, and while the beam impinges upon anode 4 the output circuit will receive a negative pulse N. When the mean position of the beam is at the point So in Figure 2, the positive and negative pulses of the output wave will have

the same amplitude and will be of the same duration, see curve b.

Assume now that the signal source applies a potential to deflection plates 9 to move the mean position of the beam from the point So up to the point Sc in Figure 2 so that the beam normally strikes the anode 3. The value of the signal potential applied to the deflection plates 9 is represented by the line Sc in Figure 3. The wave shape of the output wave will be determined by the points at which the value Sc of Figure 3 just cancels the value of curve *a* of Figure 3 representing the carrier wave. As will be seen from curve *c* of Figure 3, the application of the signal potential Sc in a direction to shift the mean position of the beam onto anode 3 causes a lengthening of the positive pulses P and a corresponding shortening of the negative pulses N.

When the applied signal has a greater value to deflect the mean position of the beam to the point *Sd* as shown in Figure 2, the duration of the positive pulses will be still further increased. When the deflecting force of the signal wave is equal to the deflecting force of the carrier wave as shown by the line *Sd* in Figure 3, the positive pulses P will be of maximum duration and the negative pulses will have disappeared. Under this condition, the position of the beam oscillates about the point *Sd* in Figure 2 and the extreme positions of the beam are represented by the points *d'* and *d''*. It will be obvious that the action of the tube will be the same when the applied signal tends to deflect the mean position of the beam onto the anode 4, except that the change in the duration of the positive and negative pulses will be reversed.

The amplifier 6 of Figure 1 will repeat the wave form shown in Figure 3. If the output wave is to be formed of positive pulses only, one side of the output circuit would extend from the anode 3 while the other side would extend from terminal 5. If the output wave is to include negative pulses only, one side of the output circuit will extend from the lead of anode 4 and the other side from terminal 5.

For steep wave-forms at the point of transition from positive to negative, and vice versa, the gap between the two anodes should be small with respect to the length of the anode or the maximum swing of the beam, and the transverse dimension of the beam in the direction of swing should also be small with respect to the maximum swing.

In the annexed claims the term "plane of said anodes" refers to the plane which includes, or is parallel with, the longitudinal axes of the anodes.

I claim:

1. In combination, an electron tube including means for establishing an electron beam along a given axis, a pair of anodes arranged on opposite sides of said axis, an output circuit connected to said anodes in push-pull relation, a deflecting system arranged to deflect said beam in the plane of said anodes, a source of alternating current of fixed frequency, means for energizing said deflection system from said source to alternately deflect the beam from one anode to another at the frequency of said source and at a constant amplitude, a second deflection system arranged to deflect said beam in the plane of said anodes, and a source of signal current for energizing said second deflecting system to shift the mean position of said beam to one side or the other of said axis in the plane of said anodes, and said anodes having a dimension in the direction of deflection of said beam relatively large with respect to the transverse dimension of said beam in the same direction.

2. A combination according to claim 1 wherein said anodes are elongated in their common plane and serve to intercept said beam at all angles of deflection.

3. In combination, an electron tube including means for establishing an electron beam along a given axis, a pair of anodes arranged on opposite sides of said axis, an output circuit connected to said anodes in push-pull relation, means for alternately deflecting said beam from one anode to the other at fixed frequency and constant amplitude, and signal control means for shifting the mean position of said beam in the plane of said anodes, said anodes having a dimension in the direction of deflection of said beam relatively large with respect to the transverse dimension of said beam in the same direction.

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