July 10, 1934. W. VAN B. ROBERTS 1,966,046

STABLE AMPLITUDE OSCILLATOR

Filed March 30, 1929

Fig. 1

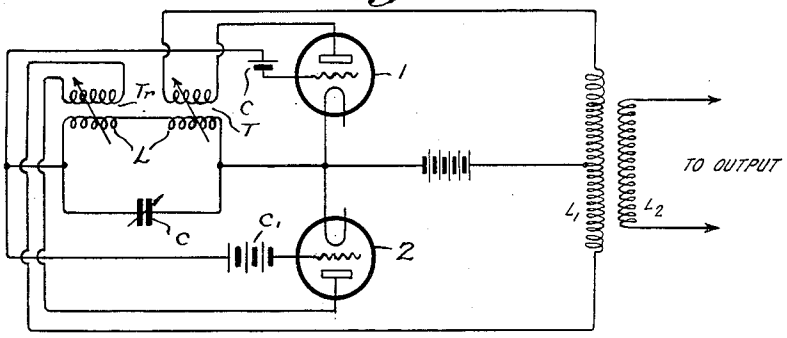
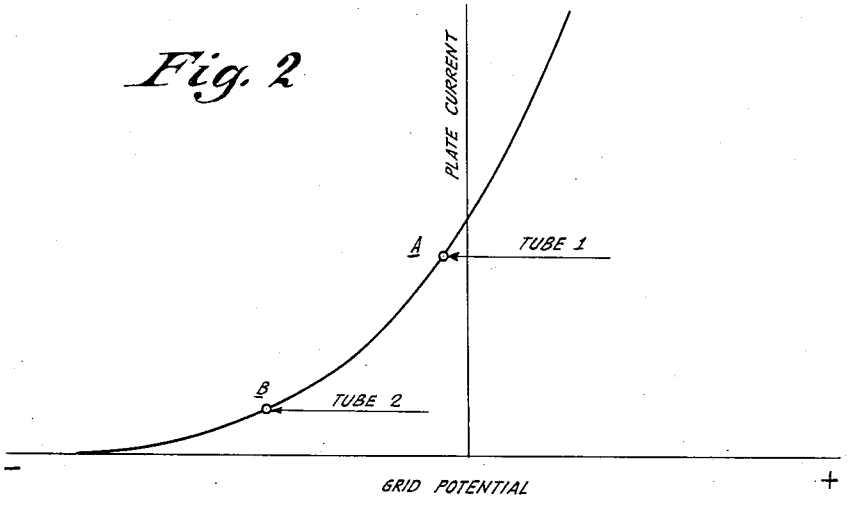


Fig. 2



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STABLE AMPLITUDE OSCILLATOR

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15 Claims. (Cl. 250—36)

This invention relates to oscillators, and more particularly, to a method and means for producing stable amplitude oscillations.

It is known that regeneration in a triode could be carried to extremes, if it had a straight line characteristic. Also if a small departure from the operating point on the characteristic of a triode made the average slope of the characteristic curve thereof less, then small oscillations could occur without building up any finite amount. Practically, it is impossible to work on such an inflection of the characteristic curve, and if the operating point is anywhere else, the average slope for moderate amplitude oscillations is greater than for infinitesimal oscillations, so that if oscillations begin at all they build up to a finite amplitude.

Now, I have discovered a method for permitting definite control of amplitude of oscillations, and devised means for securing micro-oscillations, or, stable amplitude oscillations of very small amplitudes. The arrangement utilized by me in the present invention employs a reversed tickler in addition to the usual regenerative tickler, and the essential feature of the invention consists in working the reversed coupling where the curvature of the characteristic curve is greatest.

Accordingly, one of the main objects of the present invention is to provide a micro-oscillator or stable amplitude oscillator which allows definite control of amplitude of oscillation, or in case of regeneration prevents "spilling over".

Another important object of the invention is to provide a regenerative circuit including a pair of triodes, the triodes having a common, parallel resonant circuit in their input circuits and a "tickler" or feedback coil in each of their plate circuits, the tickler in one of the plate circuits being reversed relative to the tickler in the other plate circuit, and the triode connected to the reversed tickler being operated at a point on its characteristic curve where curvature is pronounced.

The novel features which I believe to be characteristic of my invention are set forth in particularity in the appended claims, the invention itself, however, as to both its organization and method of operation will best be understood by reference to the following description taken in connection with the drawing in which:

Figure 1 illustrates diagrammatically one circuit organization whereby my invention may be carried into effect; and,

Figure 2 is a graphic representation of the characteristic curve, and the operating points of the tubes.

Referring to Figure 1 there is shown a circuit comprising a pair of triodes 1, 2, the plate of triode 1 being connected to a tickler coil T, the plate of triode 2 being connected to a reversed tickler T_r. The input circuits of the triodes have a common parallel resonant circuit L, C connected thereto. The grid of triode 1 is biased by battery "C", the grid of triode 2 being biased by a battery "C_1". Instead of using the battery "C" a leaky condenser might be used.

The ticklers are both connected to a common coil L_1, the latter being coupled to a second coil L_2 which may be part of any desired output circuit. The ticklers T, T_r are so designed and arranged that the effect of the reversed tickler is less than that of the tickler T. If oscillations commence however, the reversed tickler T_r gains effectiveness with increased amplitude faster than the tickler T gains effectiveness.

Hence, the negative resistances introduced into the grid circuit is greatest for zero amplitude, and falls off with increasing amplitude without any other amplitude of maximum feedback. Hence, any amplitude of oscillations, produced by adjustment of the tickler, is stable. Figure 2 graphically shows the above operation of the circuit. It will be observed that the tube 1 is operated at the point A on the characteristic curve and the tube 2 at the point B on the characteristic.

It will, thus, be seen, that by means of the above arrangement it is quite possible to secure a definite control of the amplitude of oscillations. The circuit disclosed herein allows two or more oscillations to be produced by the same tubes when resonant networks of more than one degree of freedom are employed, without amplitude of the oscillations at any one frequency building up and reducing the feedback at the other frequencies, as is the case in the ordinary oscillator which tends to oscillate at only one frequency when circuits having several degrees of freedom are employed, although the several frequencies may be present during the building up of oscillations. These features are useful in "autodyne" frequency changing, or wherever several separate frequencies must be generated.

While I have indicated and described only one system for carrying my invention into effect, it will be apparent to one skilled in the art that my invention is by no means limited to the particular organization shown and described, but that many modifications in the circuit arrangement, as well

as in the apparatus employed, may be made without departing from the scope of my invention as set forth in the appended claims.

What I claim is:

1. The method of controlling an oscillation generator circuit so as to obtain oscillations of any desired amplitude which comprises damping the oscillation circuit both positively and negatively, the positive damping effect on the circuit being such that it increases with increasing amplitude of oscillations at a greater rate than the rate at which the negative damping effect on the oscillation circuit increases with increasing amplitude of oscillations.

2. The method of controlling an oscillation generator circuit so as to obtain oscillations of any desired amplitude which comprises subjecting said oscillator to a negative resistance and also to a positive resistance whose damping effect on the oscillation generator circuit increases with increasing amplitude of oscillations at a higher rate than the undamping effect of the negative resistance.

3. An oscillation generator comprising a pair of space discharge devices of like characteristic having anode, cathode and control electrodes said space discharge devices being arranged substantially as a push-pull circuit having a resonant circuit common to both devices connected in the input circuit thereof, a regenerative feed back coil in the anode circuit of one of said space discharge devices and a reversed feed back coil in the anode circuit of the second space discharge device and means for operating said space discharge devices along different portions of their characteristic the second space discharge device being operated along a portion thereof having the greater curvature.

4. An oscillation generator comprising a pair of space discharge devices having similar characteristics, arranged so as to form substantially a push-pull circuit, a common resonant circuit connected in the input circuit thereof, means for regeneratively coupling the output of one of said space discharge devices to said resonant circuit, means for degeneratively coupling the output of the other space discharge device to said resonant circuit, and means for operating said space discharge devices along different portions of their characteristic the second space discharge device being operated along a portion thereof having the greater curvature.

5. In the operation of a regeneratively connected space discharge device, the method of obtaining stable amplitude oscillations which comprises applying an electronic braking effect to the regeneratively connected device increasing in effect with increasing amplitude of oscillations.

6. In the operation of a regeneratively connected space discharge device the method of obtaining stable amplitude oscillations in the output thereof which comprises applying a minimum braking effect sufficient to maintain the proper desired amplitude of oscillations and increasing said braking effect substantially proportionately to increases in amplitude of oscillations.

7. In a system of the kind described a pair of space discharge devices having a common input circuit, output circuits having a common portion said space discharge devices having substantially similar characteristic curves and differently coupled input and output circuits, means for operating said devices along different portions of their characteristic curves having respectively different curvature characteristics and means for coupling both said output circuits to said common input circuit in a reverse sense with respect to each other.

8. An oscillation generator comprising a regeneratively connected electron discharge device, and means for controlling the amplitude of oscillations generated by said generator comprising a biased degeneratively connected electron discharge device having its output circuit connected to the output circuit of said regeneratively connected device and an input circuit in common with the input circuit of said regeneratively connected device.

9. In a system of the kind described, a regenerative feedback system and biased electronic means for reducing the effect of the regenerative feedback with increasing amplitude of oscillations.

10. In a system of the kind described, the combination of a regeneratively connected space discharge device having means so as to be operated along a point of its characteristic curve at which the effectiveness of the device does not increase appreciably with increasing amplitude of oscillations, and a degeneratively connected space discharge device having means so as to be operated along a point of its characteristic curve at which the effectiveness of the second named device increases rapidly with increasing amplitude of oscillations said devices having at least portions of their input and output circuits common.

11. A relay circuit comprising in combination a regeneratively connected electron discharge device having means for adjusting said device for operation along a point of its characteristic curve at which its regeneration effectiveness does not incrcease appreciably with increasing amplitude of oscillations, a degeneratively connected electron discharge device having means for adjusting said last named device for operation along a point of its characteristic curve at which its degeneration effectiveness increases rapidly with increasing amplitude of oscillations and a utilizing circuit coupled to both said devices.

12. A relay circuit comprising in combination a pair of space discharge devices having a common input circuit adapted to have oscillations impressed thereon and output circuits having a common portion, one of said devices having means for adjusting said device for operation along a point of its characteristic at which its amplifying power does not vary substantially with changes in amplitude of oscillations in said input circuit, the other of said devices having means for adjusting said device for operation along a point of its characteristic at which its amplifying power increases rapidly with increasing amplitude of oscillations in said input circuit, a utilizing circuit and means for differentially coupling said two output circuits thereto.

13. A pair of electron discharge tubes having a fixed ratio of input voltages and a common load circuit to which energy is fed from the two tubes in opposing phase, the first of said tubes having plate and grid operating potentials so chosen that the amplifying power does not increase appreciably with increasing voltage input, the second of said tubes having grid and plate operating potentials so chosen that the amplifying power of said second tube increases considerably with increasing voltage input, the couplings between said tubes and said load circuit being so chosen that for weak input voltages the amplifying action of said first tube predominates, whereby the total amplification of the system, determined by the

difference between the amplifying power of the two tubes, decreases as the voltage input to the tubes increases.

14. In an oscillation relay circuit, a negative resistance having means for maintaining its effectiveness substantially constant irrespective of the amplitude of oscillations comprising a positive resistance in said circuit having means for rapidly increasing its effectiveness with increasing amplitude of oscillations.

15. In an oscillation relay circuit, a negative resistance device provided with means for maintaining its effectiveness substantially constant irrespective of the amplitude of oscillations in the relay circuit and a positive resistance device provided with means for determining its resistance characteristics to the extent that its effectiveness with relation to the relay circuit increases rapidly with increasing amplitude of oscillations in the relay circuit, said two resistances acting simultaneously to affect the relay circuit during operation thereof.

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