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E. KLOTZ ET AL

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OSCILLATION GENERATOR

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Fig. 1

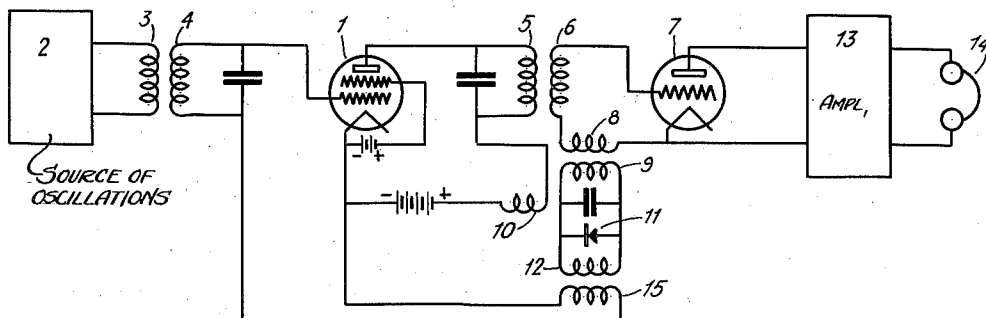


Fig. 2

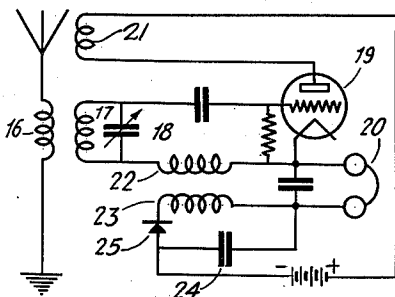


Fig. 3

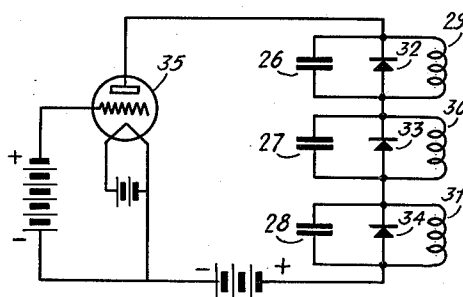


Fig. 5

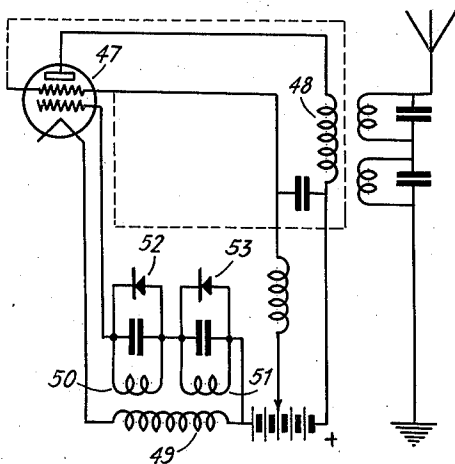
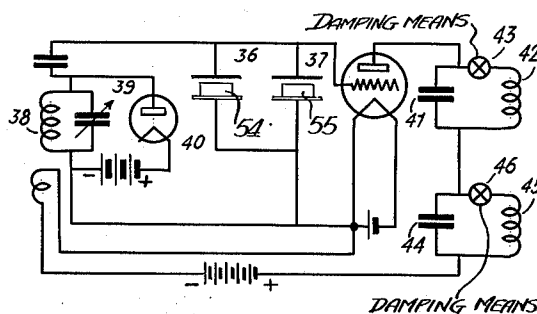


Fig. 4



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OSCILLATION GENERATOR

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In Germany February 8, 1933

2 Claims. (Cl. 250—36)

It is known in the art that in one tube two or more alternating currents of unlike frequency may be amplified at one and the same time. In this way, one or more tubes may be saved. However, the combination of several functions in a single tube is generally attended with difficulties in such arrangements as are known in the prior art, if one of these functions consists in the production of an electric oscillation. It is known that an electric oscillation gradually builds itself up in a tube practically always to such a point where the growth in damping caused by the knee in the characteristic tube occasions a limitation of the amplitude. As a result of this property the curved portions of the characteristic are essential for the tube acting as a generator, but on the other hand, they produce combination frequencies as soon as the tube has to fulfill another function in addition to the generation of a wave, such as the amplification or production of another frequency. Experiments have shown that with the customary means it is neither possible to amplify another wave in an oscillating tube in a satisfactory manner, nor feasible to excite such a wave simultaneously with the first produced frequency.

Now, the present invention obviates these drawbacks by providing an additional non-linear resistance which prevents the gradual building up of the generated wave to the amplitude for which the knee of the tube characteristic plays a part. Such non-linear resistances may consist of detectors, glow discharge tubes, electron tubes, etc., adapted to introduce in the oscillation circuit a markedly increased damping upon the exceeding of a certain amplitude of the wave in question so that a further growth of the oscillations is precluded with the result that the amplitudes of the oscillations will not extend as far as the more markedly curved portions of the characteristic of the tubes. In the presence of such a resistance the tube will act as a perfectly linear element on which several frequencies may be superposed without causing incidental combination frequencies or other actions between the various frequencies.

Figures 1-5 illustrate various modifications embodying the principles of the present invention.

Fig. 1 shows an arrangement according to this invention which is designed to be employed as a radio frequency amplifier and for the simultaneous generation of a heterodyne frequency as required for super-heterodyne reception. Referring to Fig. 1, 1 denotes the tube which is fed from the input stage 2 by way of the coupling

3, 4, with the radio frequency energy to be amplified. Through the plate coupling 5, 6, the amplified oscillations are fed to the mixer tube 7. The latter is supplied by way of the coupling 8, 9, with an auxiliary oscillation generated by the tube 1, and which in mixer tube 7 results in the formation of an intermediary frequency. The latter is then further handled, as known, by the amplifier 13, and after audio frequency demodulation it is fed into the loudspeaker 14. Now, the idea underlying the invention, in an arrangement of the kind illustrated in Fig. 1, consists in keeping the heterodyne frequency produced in the radio frequency tube 1 by way of the regeneration path 10, 9, and 12, 15, at an amplitude which is so low that the tube may be regarded practically as a perfectly linear element for this oscillation by the provision of a supplementary non-linear resistance 11. Arrangements of this kind, when used in super-heterodyne receivers, offer the advantage that the harmonics generated by the heterodyne will practically be free from a disturbing action because of their low intensity. Moreover, by special means, for instance, by the loose coupling as shown between the circuit 9, 11, 12, of the heterodyne wave and the rest of the equipment conditions may be made so that the overtones produced by the non-linear element 11 will be transferred to the equipment or assembly only to a very reduced degree. Especially by the insertion of a filter complete suppression of the harmonics of these heterodyne frequencies is attainable.

In the light of what precedes it will be evident that the described solution is useful not only for tube type generators, but similarly also for arc-generators, gas discharge generators, and the like systems capable of being used as negative resistances.

Another use for generators as here disclosed is in connection with an oscillating detector (autodyne). In the standard or normal oscillating audion, the phenomenon known as the "pulling" or entrainment action of the autodyne oscillations by the incoming oscillation has been felt to be disturbing. The range of entrainment, to be sure, is greatly reduced if the regenerative coupling is tightened considerably, but then the audion action is mostly very low because of the large amplitude of the local waves.

Now, by application of the basic idea of the invention it is possible to operate with low wave amplitudes, if the feedback coupling is close, so that the audion reaction of the receiver will be practically unaffected and unimpaired. A cir-

cuit scheme where this is accomplished is shown, for instance, in Fig. 2. The incoming signal is fed from the aerial by way of the coupling 16, 17 into the audion oscillation circuit 17, 18 whereupon after amplification as known by the audion 19 it is fed to the headset 20 or the audio frequency amplifier. By the feedback 21, 17, normal increase in sensitiveness is attained. The generated oscillation is due to the feedback 22, 23 of the grid circuit with an oscillatory structure 23, 24, 25, included in the plate circuit. This circuit may here be tuned to half the signal frequency. The amplitudes which are set up are limited by the non-linear resistance 25 in a way as has above been set forth. At the same time, owing to the non-linear distortion by the resistance 25, harmonics are produced in this circuit, and the second one of these harmonics may be caused to undergo beating with the incoming 20 signal.

Another application of the basic idea of the invention is concerned with generators which serve for the simultaneous generation of two or more frequencies. The tests so far made with generators of this sort have demonstrated that by the presence of an oscillation, the other possible kinds of oscillation in a circuit scheme are suppressed so that the intended purpose of simultaneous production of several frequencies is obtained not at all or only in an unstable manner. However, by the aid of generators of the kind here disclosed it is feasible to generate such frequencies simultaneously without their interfering with one another. But for this end it is necessary to provide in the circuit scheme non-linear damping means working substantially separately for the generated waves. It is possible by the damping means to separately act upon the amplitudes arising in the various frequencies, and to keep them so low that the characteristic graph of the generator producing the various frequencies may still be regarded as linear for such amplitudes as may arise. Since under these circumstances the circuits of the different frequencies do not have any non-linear parts in common, there exists no mutual linking or coupling, so that the difficulties referred to at the outset are non-existent.

A circuit arrangement adapted to the simultaneous independent generation of three different frequencies according to the idea underlying this invention is illustrated in Fig. 3. In this figure comprising three oscillation circuits there are indicated at 26, 27, 28, the three capacities of these oscillation circuits, at 29, 30, 31, the inductances thereof, while 32, 33, 34, are the damping means, designed to separately influence the amplitudes of the waves generated in the said three oscillation circuits. For the production of the waves there is provided, for instance, a dynatron tube 35. The damping means are so designed that they themselves rather than the knee of the characteristic of the tube will limit the amplitudes of such oscillations as are generated.

Fig. 4 shows another exemplified embodiment of the invention and its fundamental idea. This figure shows a triode-type generator which generates simultaneously three frequencies independent of one another, two of which are governed by the fixed natural frequencies of the crystals 54 and 55, whereas the third one is governed by the variable tuning of the circuit 38, 39, 40. In order to determine the excitation of oscillations by the crystals there are provided in the plate circuits, as known in the art, the circuits 41, 42, 43, and 44. 45, 46, tuned to the crystal fre-

quencies. In these circuits, 43 and 46 constitute again the damping means limiting the amplitudes of the frequencies, which, in the case of crystals involving very low damping, may consist of metal-filament glow-lamps (incandescent lamps), which, in the presence of incipient oscillation (resonance), i. e., when the current in the oscillation circuit is relatively large, will cause a higher resistance as a result of the heating of the filament and thus a limitation of the amplitude of the wave. Limitation of the amplitude of the wave generated by the oscillation circuit 38, 39, 40 is insured by a non-linear resistance 40, which consists in the present instance of a diode furnished with a negative biasing voltage.

Generators of this invention, inter alia, are useful in radio centrals for the production of all of the frequencies used in the central station in a common amplifier input stage, for instance, in a combination of an arrangement as shown in Fig. 4 and a one or two stage amplifier whose output end is connected with the end stages of each transmitter. Using an aperiodic amplifier a system capable of wide development is obtained which may remain unaltered if the number of frequencies to be sent out from the central is to be enlarged.

In Fig. 5 is shown, for instance, a combination of the basic idea of this invention with a circuit scheme for load-independent frequency or wave generation by the aid of a regenerated screen-grid tube 47 of the kind disclosed in United States patent application Serial No. 668,957, filed May 2, 1933, in which the load impedance 48 or the load circuit is disposed between anode and screen grid, and where the tickler (feedback) coil 49 is included in the series connection with the cathode. By means of two tuned grid circuits 50, 51, which contain the damping elements 52, 53, according to this invention, two independent frequencies are produced.

Also in heterodyne receivers comprising two or more local oscillation generators, of the kind disclosed, for instance, in German Patent 564,600, the invention may be useful insofar as one or more heterodynes may be saved in that all of the required waves are produced in a single heterodyne in a way as described.

We claim:

1. In combination, an electron discharge device having an anode, cathode, and a control electrode, an input circuit comprising a first inductance coil connected to said control electrode and an output circuit comprising second and third coils serially connected to said anode, an oscillatory circuit comprising fourth and fifth coils, a capacitance and a non-linear conductor all connected in parallel with respect to one another, a utilization circuit having an input circuit including sixth and seventh coils serially connected together, said sixth coil being coupled to said second coil in the output circuit of said electron discharge device, and said seventh coil being coupled to said fourth coil in said oscillatory circuit and to said third coil in said output circuit, means to couple said input and output circuits of said electron discharge device together, said means including an inductance which is coupled to said fifth coil of said oscillatory circuit.

2. In combination, an electron discharge device amplifier and oscillation generator comprising input and output circuits, said input circuit having a first and a second coil connected in series, a condenser connected directly in parallel

across said first coil only, said output circuit having a third and fourth coil connected in series, a condenser connected in parallel across said third coil only, a circuit coupling said second and
5 fourth coils together, said last circuit including in shunt therewith a two terminal non-linear conductor arranged to absorb energy at a rate which

increases as amplitude increases in comparison to the rate at which energy would be absorbed by a linear conductor, and a source of oscillations coupled to said first coil.

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