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LOW FREQUENCY OSCILLATOR

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FIGURE 1

FIGURE 2

FIGURE 3

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2,190,078
This invention relates to oscillating space discharge devices and has particular reference to their use at low frequencies such as at audio frequency.

One object of the invention is to provide an improved oscillation generator of unusual frequency stability.

Another object of the invention is to provide an oscillation generator capable of furnishing a pure sine wave.

Another object of the invention is to provide an improved combination of oscillation generator and lag circuit keying system, said combination providing an output signal which builds up gradually and stops gradually.

Another object of the invention is to furnish an oscillation generator, the output of which builds up gradually and stops gradually on being “keyed” and without requiring the usual choke, condenser and resistor components of the ordinary lag circuit as known to the art.

Other objects and advantages of the invention will become apparent as the specification proceeds.

With the aforesaid objects in view, the invention consists in the novel combinations and arrangements of parts hereinafter described in their preferred embodiments, pointed out in the subjoined claims, and illustrated in the annexed drawing, wherein like parts are designated by the same reference characters throughout the several figures.

In the drawing:

Fig. 1 shows a space discharge oscillator embodying the frequency stabilizing phase of the invention.

Fig. 2 shows an oscillator embodying both the frequency stabilization and the lag circuit.

Fig. 3 shows the invention as applied to a "Hartley" type oscillator.

The advantages of the invention as here outlined are best realized when all of its features and instrumentalities are combined in one and the same structure, but, useful devices may be produced embodying less than the whole.

It will be obvious to those skilled in the art to which the invention appertains, that the same may be incorporated in several different constructions. The accompanying drawing, therefore, is submitted merely as showing the preferred exemplification of the invention.

This application is a continuation in part of my application for radio tube oscillators filed October 27, 1937 now U. S. Letters Patent No. 2,140,267.

Generally described the invention provides a very stable oscillation generator of the space discharge type. The principles upon which this stabilization is based are similar to those contained in the aforementioned patent, which invention, however, specifically refers to oscillators of the "Hartley" class whereas the present invention deals with oscillators of the "Collette" group. These principles, however, may be applied to any oscillator, the frequency of which is controlled by a parallel connected inductance, capacity combination. As in my Letters Patent No. 2,140,267, the stability of the oscillator is improved to a marked degree by selecting that size of capacity in parallel with the inductance, which is so large but desirably short of the size at which the oscillations of the space discharge device cease. In order to provide a lag in the buildup and disappearance of the output of an oscillation generator of the type described it is only necessary to shunt a resistor across the keying means.

The size of this resistor determines the amount of "lag" of the oscillator. The lowest resistance it is possible to use is that size unit whose resistance is so low but desirably greater than that resistance at which the tube will oscillate. By using this size resistor the "lag" is very marked. By increasing the resistance the lag effect becomes less noticeable until it practically disappears. Obviously with this system key clicks may be eliminated entirely.

Another important point is that the lag increases as the frequency decreases due to the loading effect of the L C constants of the oscillation circuit. The result is that if these oscillators are used as the ultimate tone source for an electrical musical instrument such as an electric organ the response or attack of the notes may very easily be made to simulate that of pipes or reeds. Hereuntofore lag circuits consisted of condenser, inductance combines which were relatively expensive. To my knowledge this is the first time that the frequency control circuit of an oscillator is made to form part of the lag circuit. Moreover, the combination of this lag or voltage buildup with an extremely stable oscillator is important because the output can be depended upon to be constant in frequency during the period of varying voltage. In this connection it is well to remark that (assuming a fairly low resistance oscillatory circuit) the oscillation frequency of this type oscillator is practically impervious to changes caused by supply voltage changes which assume even very extraordinary proportions.

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The word "lag" as used throughout this specification and as generally used in radio parlance means the gradual build-up and decaying of the oscillator signal whenever it is keyed. See the 1938 edition of the American Radio Relay League Amateur Radio Manual, page 209, for the explanation under the diagram.

The importance of the lag of an oscillation tone generator is especially important when considering that the tone of recognizability of a musical sequence is as much dependent on the response or attack of the notes as upon the overtone content or phase relationship of the various harmonics of a given tone may be composed. As was pointed out in the aforementioned patent the operation of an oscillator in accordance with the details of that invention enables one to secure a sine wave with relative ease and minus the usual by-pass condensers or filters. This principle also holds true in the present invention. The term audio frequency as used in this specification refers to frequencies up to about 30,000 cycles.

Referring in detail to the drawing Fig. 1 denotes an oscillator of the Colpitts type which embodies the invention. The same may include a space discharge device that includes cathode, anode and grid. An inductor 2 may be connected between the grid 12 and the anode 13 through a source of direct current 3. Two condensers 4 and 5 are connected in series with each other but the series combine being connected in parallel with the inductance 2 as shown. The cathode 11 may be connected to the junction of the condensers as indicated at 16 and a choke 6 is connected between the cathode and grid. An output pick-up coil 10 may lead to any suitable load.

The total capacity of condensers 4 and 5 in series is made so large that it is just desirably short of the point at which the space discharge device stops oscillating. The critical point for stable operation may easily be determined in the following manner. The capacity of the series combination, condensers 4 and 5 are increased by steps. As this is done the output will begin to gradually drop but when the maximum capacity is approached it will be noticed that there is a sharp drop which is larger in proportion than the previous drops. This is the beginning of the region of stable operation although nearer the maximum capacity is approached the more stable is the operation. The aforementioned point of critical capacity is usually within about 5 to 15 percent of the maximum capacity or that capacity at which the tube stops oscillating. However, no exact data can be given as it depends upon various circuit constants such as type of tube, operating voltage, or circuit resistance, etc. It suffices to say that with any given set of conditions the condenser capacity cited will result in unusual frequency stability. The advantages of this invention are obtained at audio frequency.

In order to obtain a lag when controlling this oscillator, as by a contact 8, it is merely necessary to shunt the contact with a resistor 7 as shown in Fig. 2. As previously stated the lag is controlled by the resistance of the unit 7 and the greatest lag is obtained when the resistance of 7 is so small but desirably greater than that resistance at which unit 7 will pass enough voltage to allow the tube to oscillate. Although in this drawing a Colpitts type oscillator is shown it is to be understood that this principle applies to any oscillator the frequency of which is controlled by the combination of a condenser in parallel with an inductance. The capacitance of said condenser being so large but somewhat smaller than that capacity at which the space discharge device stops oscillating. In the drawing the circuit breaker is shown in the negative anode return circuit; however it might be placed in the positive anode branch of the circuit or even in series with the grid or cathode. The purpose of resistor 7 is to provide a means whereby the oscillations will decay in a damped manner upon the opening of said circuit breaker.

Fig. 3 illustrates this principle as applied to an oscillator of the "Harley" class. Here, the inductance is connected between the anode 13 and the grid 12 and an intermediate point of the inductance is connected to the cathode 11 as indicated at 15. The condenser 14 is connected in parallel with the inductance. The capacity of condenser 14 is so large but desirably short of that capacity at which the space discharge device 1 stops oscillating. The positioning of contact 8 and resistor 7 is self evident from the drawing. Contact 8 is a circuit breaker connected between the plate supply 3 and inductance 2 in Fig. 2 and inductance 4 in Fig. 3. The resistor 7 is connected across the contact 8.

Having thus described my invention what I claim is:

1. An oscillator of high degree of frequency stability comprising a space discharge device having a cathode, anode, and grid, an oscillatory frequency control circuit associated with said space discharge device, said circuit including an inductance connected between said anode and grid, a capacity means connected in parallel with at least a substantial portion of said inductance, the value of said capacity means being so large that it is just short of that point which would prevent oscillation, means for connecting said cathode to said control circuit whereby feed-back is produced, a plate supply circuit for said oscillator, a circuit breaker in said plate supply circuit, a resistor across said grid, the value of this resistance being so low that it is just greater than that resistance which will allow the tube to oscillate, whereby the oscillations will decay in a damped manner upon opening of said circuit breaker, said oscillator being constructed and arranged to operate at audio frequency.

2. An oscillator in accordance with claim 1, wherein the means for connecting said cathode to said control circuit comprises a connection from said cathode to an intermediate point on said inductance.

3. An oscillator in accordance with claim 1, wherein said capacity means comprises two capacity means in series and wherein the means for connecting said cathode to said control circuit comprises a connection from said cathode to a point between said capacities in series.

4. An oscillator of high degree of frequency stability comprising a space discharge device having a cathode anode and grid, an oscillatory frequency control circuit associated with said space discharge device, said circuit including an inductance connected between said anode and grid, a capacity means connected in parallel with at least a substantial portion of said inductance, the value of said capacity means being so large that it is just short of that point which would prevent oscillation, means for connecting said cathode to said control circuit whereby feed-back is produced, a plate supply circuit for said oscillator, a circuit breaker in said plate supply circuit, a resistor across said grid, the value of this resistance being so low that it is just greater than that resistance which will allow the tube to oscillate, whereby the oscillations will decay in a damped manner upon opening of said circuit breaker, said oscillator being constructed and arranged to operate at audio frequency.

5. An oscillator in accordance with claim 1, wherein said capacity means comprises two capacity means in series and wherein the means for connecting said cathode to said control circuit comprises a connection from said cathode to a point between said capacities in series.
cathode to said control circuit whereby feedback is produced, a plate supply circuit for said oscillator, means for applying between said cathode and anode a voltage sufficient to cause said circuit to oscillate and means for interrupting said voltage and means for applying during said interruptions a voltage between said cathode and anode great enough to maintain oscillation for a relatively short period of time, but not great enough to maintain continuous oscillation, said oscillator being constructed and arranged to operate at audio frequency.

5. An oscillator in accordance with claim 4, wherein the means for connecting said cathode to said control circuit comprises a connection from said cathode to an intermediate point on said inductance.

6. An oscillator in accordance with claim 4, wherein said capacity means comprises two capacities in series and wherein the means for connecting said cathode to said control circuit comprises a connection from said cathode to a point between said series capacities.

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