April 6, 1948. J. C. DUNN 2,439,245

RESISTANCE-CAPACITANCE TYPE OSCILLATOR

Filed June 2, 1945

FIG. 1.

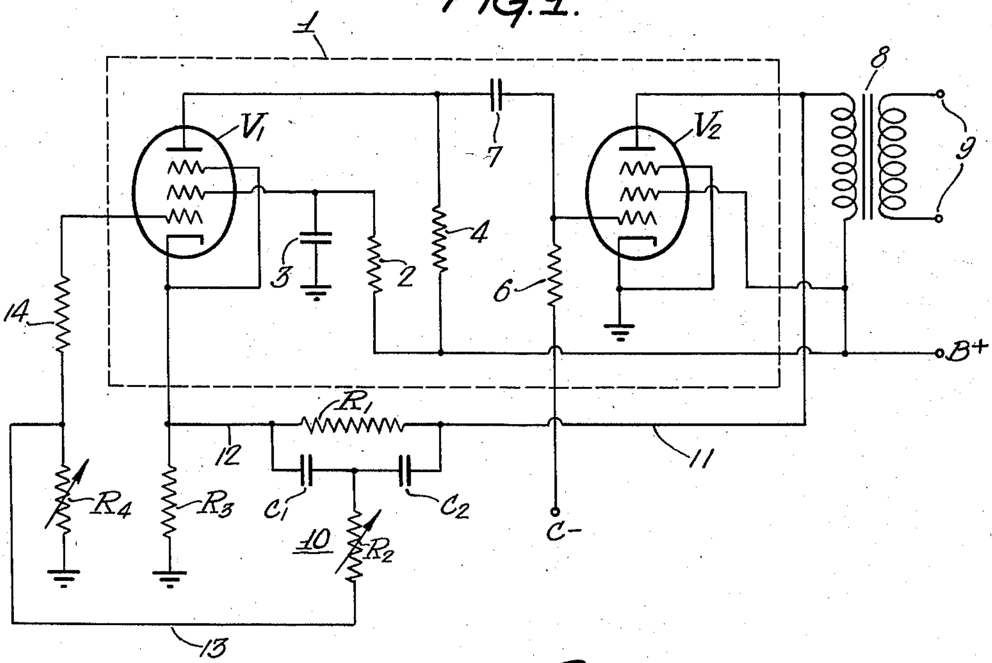
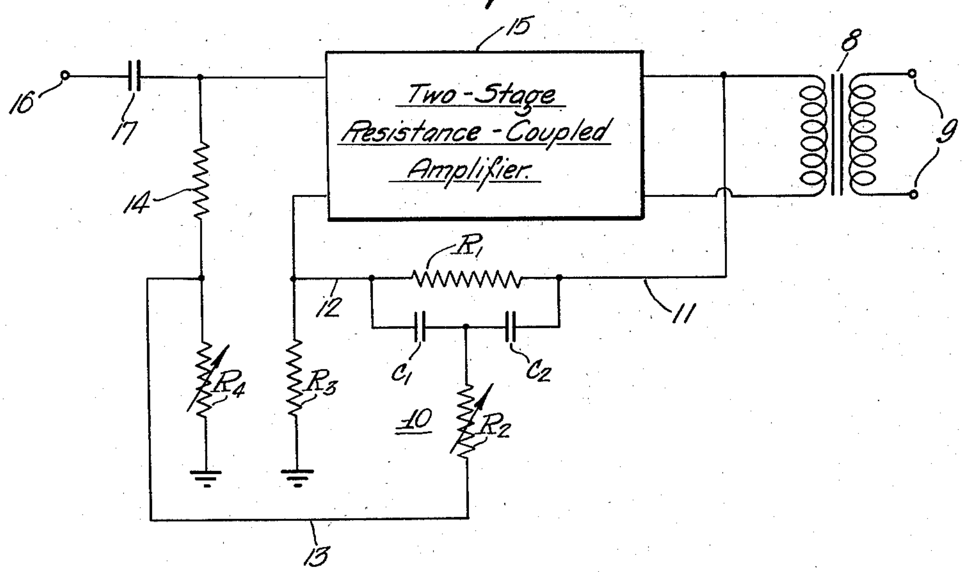


FIG. 2.



Inventor:
James C. Dunn
by his Attorneys
Howson & Howson

Patented Apr. 6, 1948 2,439,245

UNITED STATES PATENT OFFICE

2,439,245

RESISTANCE-CAPACITANCE TYPE OSCILLATOR

James C. Dunn, Philadelphia, Pa., assignor, by mesne assignments, to Philco Corporation, Philadelphia, Pa., a corporation of Pennsylvania

Application June 2, 1945, Serial No. 597,226

11 Claims. (Cl. 250—36)

1

This invention relates to vacuum tube circuits, and more particularly to circuits employing feedback connections.

The principal object of the invention is to provide a novel feedback arrangement in a vacuum tube circuit, which arrangement may be employed to adapt the circuit for use either as an audio oscillator or as a selective audio amplifier.

A more specific object of the invention is to provide a novel feedback arrangement employing a bridged T network.

One aspect of the invention, therefore, has to do with the provision of a novel audio oscillator circuit. Conventional resistance-capacitance tuned audio oscillators have generally required at least two ganged, matched, variable resistors or condensers in order to provide for continuous variation of frequency over the operating frequency range. In its application to an audio oscillator, the present invention has for a further object the provision of a novel audio oscillator circuit in which continuous variation of frequency over a predetermined range may be effected by means of a single variable element.

As applied to the purpose of audio amplification, the invention has for a further object the provision of a novel selective audio amplifier having a sharp cut-off characteristic for frequencies above and below the desired operating frequency.

Other objects and features of the invention will be apparent as the description proceeds. In the accompanying drawing,

Fig. 1 is a diagrammatic illustration of a tuned audio oscillator embodying the invention; and

Fig. 2 is a similar illustration of a selective audio amplifier embodying the invention.

Referring to Fig. 1, the audio oscillator circuit illustrated comprises a conventional audio amplifier represented generally by the broken line rectangle 1, and a novel feedback arrangement which will be described hereinafter. While the audio amplifier may be of any suitable form, it is preferred to employ at least a two-stage amplifier, as illustrated, comprising vacuum tubes V_1 and B_2 which may be either pentodes, as shown, or triodes with appropriate circuit modifications. The input tube V_1 may be provided with the usual screen grid resistor 2 and associated by-pass condenser 3, and the usual plate resistor 4. The output tube V_2 may be provided with the usual grid resistor 6 and may be coupled to tube 1 through the usual coupling condenser 7. Suitable plate voltages for the tubes may be supplied from a source designated B+, and a

2

suitable grid biasing voltage for the tube V_2 may be supplied from a source designated C—. The output of the amplifier may be supplied to an audio transformer 8, and the audio oscillations generated by the circuit may be derived from the secondary of the said transformer across terminals 9.

In accordance with the present invention, there is provided a novel feedback arrangement including a bridged T network designated generally reference character 10. This network comprises capacitance arms C_1 and C_2 bridged by a resistor R_1, and a variable resistance R_2 forming the upright of the T. One arm of the network 10 is connected to the anode or plate circuit of tube V_2 by means of the conductor 11, so as to derive a portion of the audio output of the amplifier 1. The other arm of the network 10 is connected through a conductor 12 to the ungrounded end of a resistor R_3 which is included in the cathode circuit of tube V_1. The upright element R_2 of the network 10 is connected through a conductor 13 to the ungrounded end of a variable resistor R_4 which is included in the grid circuit of the tube V_1. The latter circuit also includes a grid resistor 14.

As may be seen from the illustration, the bridged T network 10 and the associated resistors R_3 and R_4 provide degenerative and regenerative paths in the feedback arrangement. The degenerative or negative feedback path extends through the bridged arms of the network to the cathode resistor R_3, while the regenerative or positive feedback path extends through the upright element R_2 of the network to the variable grid resistor R_4. The variable resistor R_2 constitutes the tuning element by which the frequency of oscillation may be continuously varied over the operating frequency range. If the elements C_1, C_2 and R_2 and the associated positive feedback path were removed, negative feedback would take place through the resistors R_1 and R_3, and the magnitude of such feedback would be substantially independent of frequency. With the aforementioned frequency selective elements and the positive feedback path present, however, there is less negative feedback at the frequency to which the circuit is tuned. The variable resistor R_4 serves to control the magnitude of the positive or regenerative feedback, and by proper adjustment of this resistor the circuit may be caused to oscillate at the frequency to which it is tuned. In accordance with the usual procedure for operating oscillators of this general type, the regeneration control element R_4 should be adjusted to the lowest setting necessary to sustain oscillations in order to maintain the calibration of the usual frequency dial and to insure an output of good wave form.

By means of the circuit illustrated, it is possible to effect operation over frequency bands whose maximum and minimum frequency values are related by ratios as high as ten-to-one or greater. The particular frequency band or range over which the circuit is adapted to operate in any instance will depend upon the values of the elements of the bridged T network and the feedback resistors R_3 and R_4. With a given set of values, the frequency may be varied over the permissible range by varying the resistor R_2 from its minimum value to its maximum value, or vice versa. If desired, provision may be made for band switching by changing the values of the condensers C_1 and C_2. As will be apparent to those skilled in the art this could be accomplished by substitution of various condensers by means of a suitable switching arrangement.

By employing a large resistor as the frequency control element R_2, the frequency range may be substantially increased, but at the same time the use of a linear resistor tends to crowd the frequencies at the end of the band where a large change in frequency is effected by a small change in resistance. In such case, it may be necessary to employ logarithmic resistance variation to spread the frequencies. While a smaller linear resistance affords a lesser frequency range, it gives a better spread of frequencies at the high frequency end of the band.

It is also characteristic of the circuit illustrated that the frequency control element R_2 tends to affect the amplitude of the generated oscillations as the frequency is varied. Such variations in amplitude as may be thus caused, may be substantially eliminated by employing a suitable A. V. C. arrangement.

While, as previously stated, the particular form of the audio amplifier 1 is not a feature of the present invention, the two-stage amplifier illustrated may comprise a 7W7 input tube, and a 6K6 output tube, and the circuit elements may have the following values:

Resistor 2	megohms	2.7
Condenser 3	microfarads	.4
Resistor 4	ohms	470,000
Resistor 6	do	470,000
Condenser 7	microfarads	0.1
Resistor 14	megohms	1.2

By way of example, the elements of the feedback circuits may be as follows:

Resistor R_1	ohms	240,000
Resistor R_2	do	5,500
Resistor R_3	do	680
Resistor R_4	do	100
Condensers C_1 and C_2, each	microfarad	.002

A circuit employing values as set forth above has an operating frequency range extending from 2.2 kc. to more than 22 kc.

In Fig. 2 there is shown a similar circuit which is adapted for use as a selective audio amplifier. In this instance, the rectangle 15 corresponds to the broken line rectangle 1 of Fig. 1, and is intended to represent a two-stage resistance-coupled amplifier such as shown in Fig. 1. The other elements of Fig. 2 corresponding to those of Fig. 1 are designated correspondingly. In this instance, however, an audio signal to be amplified is supplied to the amplifier by way of the in-

put terminal 16 and the coupling condenser 17. In operation, the regeneration control element R_4 is adjusted to a point just below that at which oscillation will take place. In this instance, the control element R_2 serves, together with the associated elements, to control the frequency of maximum response. The feedback arrangement effects frequency-selective regenerative action which improves the response or gain at the resonant frequency and also produces a sharp cut-off above and below the resonant frequency. By adjustment of the resistor R_2, the band resonant frequency may be varied over a substantial range. In this embodiment of the invention, a suitable A. V. C. system may be employed to maintain the amplifier gain just below the point of oscillation.

It is also possible by means of this circuit to change the frequency range or band by changing the values of the elements in the feedback circuits.

Although certain embodiments of the invention have been illustrated for the purpose of disclosure, the invention is not limited thereto, but is capable of other embodiments and modifications.

I claim:

1. In a vacuum tube circuit, a vacuum tube amplifier whose input elements comprise a control grid and a cathode, a feedback connection between the amplifier output and said cathode, said connection including a resistor and a pair of serially-connected capacitors in parallel with said resistor, and an auxiliary feedback connection between the junction of said capacitors and said grid, said auxiliary connection including a variable resistor.

2. In a vacuum tube circuit, a vacuum tube amplifier whose input elements include a control grid and a cathode, a variable resistor connected between said grid and ground, a second resistor connected between said cathode and ground, a bridged T network including an adjustable element, means connecting the arms of said T network between the output of said amplifier and the cathode end of said second resistor, and means connecting the upright of said T network to the grid end of said first resistor.

3. An oscillator circuit, comprising an amplifier including at least two vacuum tubes each having a control grid and a cathode, a variable resistor connected between the grid of the first tube and ground, a second resistor connected between the cathode of the first tube and ground, a bridged T network including an adjustable element, means connecting the arms of said T network between the output of said amplifier and the cathode end of said second resistor, and means connecting the upright of said T network to the grid end of said first resistor.

4. An oscillator circuit as defined in claim 3, wherein said network includes capacitance arms bridged by a resistor, and the upright of the T is a variable resistor.

5. In combination, a vacuum tube amplifier having grid and cathode input elements, and a feedback coupling network connected between the output and input of said amplifier, said network being of the bridged T type and being arranged to provide negative and positive feedback paths, the bridged arms of the T network being included in a feedback connection extending to said cathode element, and the upright of the T network being included in an auxiliary feedback path extending to said grid element, one of the elements of said network being adjustable to rel-

atively vary the negative and positive feedback actions.

6. An oscillator circuit, comprising a vacuum tube amplifier having grid and cathode input elements, and feedback coupling means between the output and input of said amplifier, said coupling means including a bridged T network arranged to provide negative and positive feedback paths, said T network including capacitance arms bridged by a resistor, said arms being connected to the amplifier output and to said cathode element, respectively, and the upright of said T network being connected to said grid element, said upright including a variable resistor adapted to relatively vary the negative and positive feedback actions and to effect oscillation of the circuit at a desired frequency.

7. A frequency-selective audio amplifier circuit, comprising a vacuum tube amplifier having grid and cathode input elements, and feedback coupling means between the output and input of said amplifier, said coupling means including a bridged T network arranged to provide negative and positive feedback paths, said T network including capacitance arms bridged by a resistor, said arms being connected to the amplifier output and to said cathode element, respectively, and the upright of said T network being connected to said grid element, said upright including a variable resistor adapted to relatively vary the negative and positive feedback actions.

8. In combination, a vacuum tube amplifier having at least an output electrode and a pair of input electrodes, a bridged T network, means including said network for coupling said output electrode and one of said input electrodes in degenerative phase relation, means including said network for coupling said output electrode and the other of said input electrodes in regenerative phase relation, and means for varying a parameter of said network.

9. In combination, a vacuum tube amplifier

having at least grid and cathode input electrodes and an output anode, a bridged T network, means including said network for coupling said anode and said cathode in degenerative phase relation, means including said network for coupling said anode and said grid in regenerative phase relation, and means for adjusting a circuit element of said network.

10. An oscillator circuit, comprising a vacuum tube amplifier having at least an output electrode and a pair of input electrodes, a bridged T network, means including said network for coupling said output electrode and one of said input electrodes in degenerative phase relation, means including said network for coupling said output electrode and the other of said input electrodes in regenerative phase relation, and means for varying a parameter of said network.

11. An oscillator circuit, comprising a vacuum tube amplifier having at least grid and cathode input electrodes and an output anode, a bridged T network, means including said network for coupling said anode and said cathode in degenerative phase relation, means including said network for coupling said anode and said grid in regenerative phase relation, and means for adjusting a circuit element of said network.

JAMES C. DUNN.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,897,639	Kreer	Feb. 14, 1933
2,173,427	Scott	Sept. 19, 1939
2,186,571	Beale	Jan. 9, 1940
2,268,872	Hewlett	Jan. 6, 1942
2,298,177	Scott	Oct. 6, 1942
2,319,965	Wise	May 25, 1943
2,386,892	Hadfield	Oct. 16, 1945