

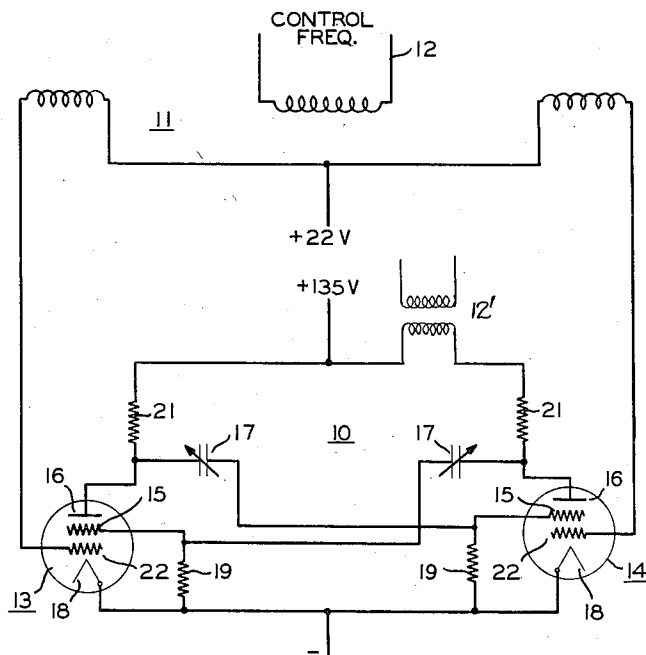
April 2, 1935.

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1,996,403

FREQUENCY CONTROL

Filed Jan. 23, 1932



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## UNITED STATES PATENT OFFICE

1,996,403

## FREQUENCY CONTROL

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Application January 23, 1932, Serial No. 588,479

5 Claims. (Cl. 250—36)

This invention relates to a system for maintaining a local frequency constant by controlling it from a source of standard frequency.

It is an object of this invention, therefore, to provide means for controlling a local circuit which is oscillated at a harmonic of a standard frequency source by means which will absorb a minimum amount of power from said source and which will exert the minimum amount of reaction thereupon.

It is well known that, having a source of constant or standard frequency of a predetermined value, if a frequency of some other value is desired, which is a harmonic of the standard frequency, it may be obtained by setting up a local circuit to oscillate substantially at the harmonic desired and then suitably coupling the local circuit to the standard source. Such an arrangement will act to maintain the frequency of the local circuit at an exact ratio of the standard frequency.

Heretofore the local oscillating circuit or oscillation generator has been provided by the use of the ordinary three electrode tube or triode having two external circuits which connect with the tube. The circuit is maintained in oscillation by some type of feed back or control coupling between the anode and the grid circuit of the tube. The control of the local frequency is then obtained by coupling the anode circuit of the tube to the standard frequency source.

According to this invention it is proposed to employ, instead of the ordinary triode tube in the local frequency circuit, a tube having an additional separate control element through which the standard frequency source controls the local circuit. This provides an arrangement which will very effectively couple the local oscillating circuit to the source of standard frequency and at the same time have the minimum amount of reactive effect upon the latter circuit.

The invention will be further understood from the following description taken in connection with the accompanying drawing forming a part of this application.

Referring to the drawing, the preferred embodiment of this invention is shown. It comprises a local operating circuit 10 coupled through a transformer arrangement 11 to a source of standard frequency 12. The local circuit is in turn connected through transformer 12' to devices to which frequency is to be supplied. The local circuit comprises a common form of oscillating circuit embodying, instead of triodes, two four element vacuum tubes 13 and 14 of the

double grid type having grids 15 and 22. One of the grids of each tube, preferably the grid 15 nearest the plate 16 of the tubes, is coupled through variable condensers 17 to the plate of the other tube. The grids 15 are coupled also to the cathodes 18 of the respective tubes through resistances 19. The plates are coupled to a source of positive potential through resistances 21 or other suitable type of impedances, the whole arrangement acting in such a manner that oscillations are generated in the local circuit by the interaction of the tubes upon each other through the feed-back means provided by the coupling condensers above described. The local circuit is adjusted as closely as is practical to operate at the desired frequency by varying the capacity of the condensers 17, the value of the resistances or other impedances in the circuit having been properly chosen.

For a more particular description of the type of oscillation circuit or oscillation generator set forth above, reference may be had to the description by Abraham and Bloch, in Annales de Physique, vol. 12, p. 237 (1919).

This type of generator is now well known and in common use. The arrangement produces, instead of a sinusoidal waveform, oscillations of substantially "square-topped" waveform. Such oscillations are rich in harmonics, which makes it an excellent harmonic generator.

This arrangement is however more or less unstable but may be stabilized by impressing some standard accurately controlled frequency upon the circuit.

The frequency of the local oscillating circuit should be chosen as some harmonic or multiple of the available standard frequency. The standard frequency may be from a clock controlled source or any other suitable source of constant frequency. As is well known if a circuit is oscillating substantially at a harmonic of a standard frequency source, the two frequencies may be maintained in step by suitably coupling the local circuit to the source of standard frequency. Circuits so coupled follow the laws of harmonic vibration and may be considered as being locked together. That is, the number of frequency oscillations occurring in the local circuit will be in exact proportion or ratio to that of the standard circuit.

In the arrangement set forth the local circuit 10 is to be understood as the portion of the device in which the local oscillations are generated. It includes the negative leads from the source of potential to the cathodes 18, the electron path

of the tube to the plates 16, the resistances 21, the positive leads to the potential source, and the feed-back means including the leads connecting the plate of one tube to the grid of the other.

5 In addition, the tubes may be considered to have two external grid circuits. One extends from the grid 15 through resistance 19 to the cathode, the other from grid 22 through transformer 11 and the source of potential.

10 Instead of locking the standard or control frequency to the local circuit through the plate circuit of the tubes, as has been the practice heretofore, the arrangement, according to this invention, is to connect the control frequency through 15 the external circuit including the transformer 11 to the second or control grids 22 of the tubes 13 and 14. These are the grids ordinarily disposed nearest the cathode of the tube. It is evident that such arrangement would provide a very sensitive means of influencing the local circuit and 20 that a control of the local circuit by such an arrangement may be accomplished with a minimum amount of power as compared with that necessary to influence the local circuit through the plate circuit of the tubes. Such an arrangement results in the minimum amount of power drained from the source of control frequency. It is evident that a small power drain from the standard frequency source facilitates the maintenance of 30 a constant frequency at such source.

A further advantage resides in the fact that when the local oscillating circuit is controlled through a second control element in the tube, the amount of feed back or reaction of the local circuit on the circuit of the standard frequency source is reduced to a minimum. Theoretically, 35 when two oscillating circuits are coupled together in the slightest degree, there is a minute reaction of one circuit upon the other. With the arrangement employed heretofore where the standard frequency source is coupled to the local circuit through the anode circuit of the tube in which flows relatively large amounts of power, the reaction between the local circuit and the frequency source is of a substantial amount and 45 often results in depreciatively influencing the stability of the circuit from which the standard frequency is supplied. On the other hand, when the coupling is accomplished through an extra control element of the tube, the reaction between 50 the two circuits is reduced to a minimum and the number of circuits which it is permissible to couple to the standard frequency circuit is thereby greatly increased.

55 It is obvious that the principles applied to the embodiment of the invention illustrated may be applied to other circuit arrangements for accomplishing substantially the same results. The same principles would apply for instance where a single tube was employed for maintaining the local oscillating circuit.

60 From the foregoing, it will be evident that an improved arrangement has been provided for coupling a local oscillating circuit or oscillation generator to a source of standard frequency so as to maintain the local circuit effectively and accurately locked to the source of standard or control frequency. Also because of the sensitivity of 65 the control a small amount of power is drained from the control source, which permits an increased number of local circuits to be connected to a source of constant frequency without the danger of power drainage from said source in 70 sufficient quantities to affect the stability of the

source. Likewise the feed-back or reaction from the local circuit is reduced to a minimum.

Although this invention has been illustrated in but one form, it will be apparent to those skilled in the art that it is not so limited but that various changes and modifications may be made without departing from the spirit thereof and it is desired, therefore, that only such limitations shall be placed thereon as are imposed by the prior art or as are specifically set forth in the appended 10 claims.

I claim:

1. In a frequency control system, a source of oscillations of a known standard frequency, an oscillation generator the frequency of which is to 15 be controlled by coupling the generator to said standard source, said generator embodying a pair of electronic tubes coupled in bridge circuit relation, said tubes embodying a cathode, an anode and an exciting grid, said bridge circuit including a local output circuit connecting the anodes with their respective cathodes, and a local input circuit connecting the exciting grids and the respective cathodes, and feed back means to couple the local output circuits with the local input circuits 20 for causing oscillations to be generated in said circuits, said tubes embodying a control grid, circuit means operating independently of said local circuits for coupling the control grids to their respective cathodes, and means for coupling said independent circuit to said source of oscillations, whereby the oscillations from said source will be impressed upon the local circuits solely through 25 said control elements.

2. In a frequency control system, a source of control frequency in which oscillations of a predetermined frequency are maintained and a local oscillation generator, the frequency of which is to be controlled, said local generator comprising 35 of a pair of electron tubes intercoupled through a local circuit including suitable impedances providing for said generator to be oscillatable substantially at a harmonic of said source, each of said electron tubes being provided with a cathode and anode and a pair of control elements, feed back means included in said local circuit and coupled to one of the control elements of each tube for exciting the local oscillations and circuit means independent of said local circuit connected 40 to the other control element of each tube or coupling the frequency source to the local circuit solely through the electron stream within said tubes.

3. In a frequency control system, a readily oscillatable circuit the frequency of which is to be 45 controlled, electronic means for impelling oscillations in said circuit, said means embodying a cathode, an anode, and two control elements, said means being coupled directly in said oscillatable circuit through the cathode and anode, feed-back means from said circuit to one of said control elements for exciting the oscillations, and a circuit independent of said oscillatable circuit in which a control frequency of a known value is 50 maintained, said independent circuit being connected to the other of said control elements for controlling the local oscillations solely through a control element of the electronic means.

4. In a frequency control system, an oscillation generator the frequency of which is to be 55 controlled, said generator comprising a pair of electron tubes provided with a cathode, an anode, and two control elements and an external circuit for each of the control elements, one of said ex- 60

ternal circuits for each tube being coupled through feed back means to the anode of the other tube and the other of said external circuits being coupled to a source of standard frequency, whereby the generator is caused to oscillate at an harmonic of said standard.

5 In a frequency control system, a source of control frequency of known value, a local oscillation generator the frequency of which is to be controlled, said local generator including a pair of electron tubes each having a cathode, an anode, and a pair of grids, a circuit organization for connecting said anode and grids to said cathode,

said organization including feed-back means for so coupling one of said grids of each tube to the anode of the other tube that oscillations will be set up in the anode-cathode circuit by the action of said grids, and said organization including means for impressing the control frequency upon the other grid of said tubes, whereby the source of control frequency is coupled to the local generator causing the latter to oscillate at an harmonic of said source and yield an output of a known frequency value.

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