

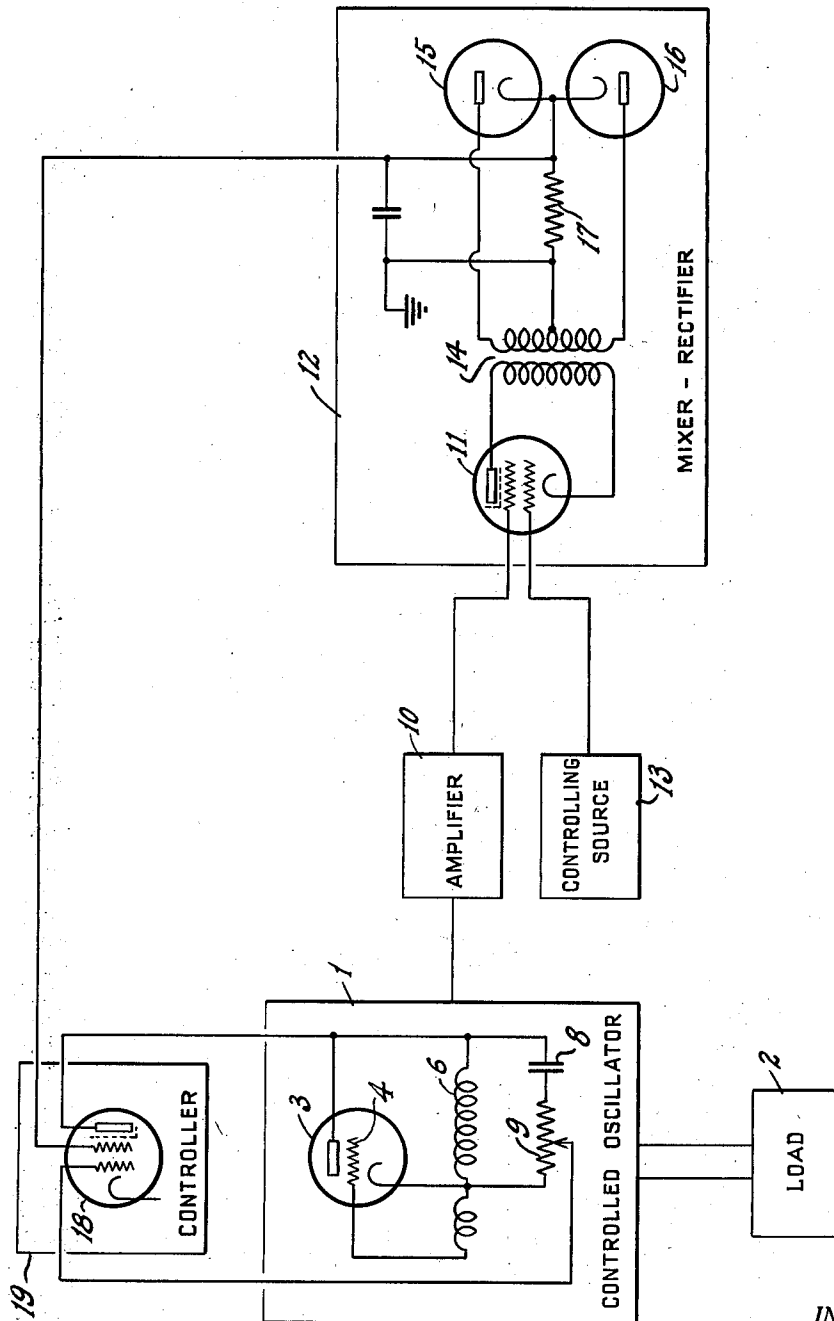
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ELECTRONIC SYNCHRONIZING SYSTEM

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ELECTRONIC SYNCHRONIZING SYSTEM

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3 Claims. (Cl. 250—36)

This invention pertains in general to frequency control systems and specifically relates to such a system employing electronically controlled circuits.

5 One of the objects of the invention consists in providing an electronic frequency control system for synchronizing the action of a plurality of sources of alternating current, particularly, though not exclusively, where one of said sources
10 may be of a frequency different from the other.

A further object of the invention consists in providing a system for controlling a source of oscillations with oscillations from a different source to produce a controlled frequency.

15 A still further object of the invention comprises providing a system for mixing frequencies to produce a controlling voltage proportional to the phase difference of the mixed frequencies to maintain the controlled generation of oscillations
20 of a desired frequency.

These and other objects will be apparent from the following, reference being had to the accompanying drawing which is a schematic representation of a preferred embodiment of the invention.

25 The invention contemplates the provision of an oscillator to be controlled and another source of controlling oscillations, it being desired to maintain the generated oscillations in strict relationship with the oscillations from the controlling
30 source. In accordance with the invention, the controlled and the controlling oscillations are introduced into a mixing circuit for producing a uni-directional voltage which is proportional to the phase relation between the voltages of the mixed
35 frequencies, and is therefore a resultant of the voltage vectors of such mixed frequencies. This uni-directional voltage is utilized to electronically control the original source of oscillations to produce a sustained frequency having a definite relationship with the controlling frequency.

40 Referring to the drawing in detail, there is provided a controlled oscillator 1 which, in accordance with the invention, provides sustained oscillations to be supplied to a utilization circuit represented by the load 2, and which may include
45 amplifiers for amplifying the oscillations. The oscillator 1 includes an electron tube 3 having a control electrode 4. The electron tube 3 is connected with an oscillation circuit including the inductance 6 and capacitor 8 as shown, the capacitor 8 being connected in series with a resistance
50 9. Other components of the oscillator unit 1 are of conventional arrangement for producing sustained oscillations.

55 The output of the controlled oscillator 1 is directed through electronic amplifier 10 to one of the electrodes of a multi-electrode electron tube 11 which forms part of a mixer-rectifier 12. A controlling source 13 is connected with another of the electrodes of the tube 11. This controlling source 13 may be any means for providing oscillations or alternating current of a definite frequency to be utilized for controlling the frequency of the oscillations produced by the oscillator 1. For example, the controlling source 13 may be a source of commercial power such as 60 cycle 110 volt alternating current, or it may be a crystal controlled oscillator. If the source 13 is connected with the 60 cycle alternating current supply, it then includes a frequency multiplier to increase the frequency. On the other hand, if the source 13 comprises a crystal controlled oscillator, this crystal may be adapted to operate at a frequency much higher than the frequency of the oscillator 1 and in this event, a frequency sub-divider, such as a multi-vibrator, may be employed to sub-divide the frequency. At all events, and as far as the present invention is concerned, the source 13 comprises a source of sustained oscillations of frequency usually different from the frequency 1 but having a harmonic relationship with the intended frequency of the oscillations from the source 1. Similarly, when desired, and where operating conditions so indicate, the amplifier 10 may include a harmonic generation circuit or a frequency sub-divider, such as a multi-vibrator, to produce the desired oscillation frequency.

As before stated, the output of the controlling source 13 is connected with another of the controlling electrodes of the tube 11. The tube 11 includes an output circuit operating through a transformer 14. The secondary of the transformer 14 includes connections to the anodes of the rectifier tubes 15 and 16, as shown. The cathodes of the rectifiers 15 and 16 are interconnected and include a connection through resistor 17 to the mid-point of the secondary of the transformer 14. Connections are provided across the resistor 17 for a circuit extending to the suppressor electrode of an electron tube 18 forming part of a controller 19. The controller 19 provides means for producing a controlling voltage applied to the controlled oscillator. This voltage is supplied over a circuit including a circuit path extending to the control electrode of tube 18. It will be understood in the controller 19, as well as the other units of the system, that the showing of conventional circuits is reduced to a minimum for the sake of simplicity. The tubes 3, 11, and

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18 may be of the type 6A6, 6L7, and 6C6, respectively, by way of example.

In the operation of the system, the electrodes of the tube 11 are respectively energized by the controlled source 1 and the controlling source 13. Operating through the tube 11 and in conjunction with the rectifiers 15 and 16, a uni-lateral voltage is developed across the resistance 17 which is proportional to the phase relationship of the voltages respectively introduced into the tube 11 by the sources 1 and 13. This uni-lateral voltage then operates through the controller tube 18 to supply a voltage shifted 90 degrees to effect a controlling operation with respect to the tube 3 so that the oscillations produced by the source 1 are electronically maintained in synchronization or in step with the oscillations from the source 13. Although, as shown, the control electrode of tube 18 is connected with the controlled oscillator including tube 3 for controlling the oscillation circuit of the source 1, other equivalent arrangements may be employed without departing from the intended scope of the invention. For example, any suitable form of biasing control for the tube 3 would also produce the desired controlling effect.

In the foregoing, a preferred embodiment of electronic synchronizing system has been presented to illustrate the system for "locking in" one frequency with another. It will of course be understood that various modifications and changes can be made without departing from the spirit of the invention. Therefore, no limitation is intended other than as imposed by the scope of the appended claims.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. An electronic synchronizing system comprising, a source of controlled oscillations including an oscillator circuit, a source of controlling oscillations, an electron tube having a plurality of control electrodes respectively energized by said sources of oscillations, an output circuit for said tube, a rectifier system operatively connected with said output circuit, a second electron tube having a plurality of electrodes including a control electrode and anode, a circuit between said last-mentioned tube and said oscillator circuit and including a connection with said anode of

said tube, and a circuit extending between said control electrode of said second tube and said rectifier system for supplying thereto a uni-lateral phase shifted voltage proportional to the phase difference of the voltages from said different sources of oscillations introduced in said first-mentioned tube.

2. An electronic synchronizing system comprising, a source of controlled oscillations including an oscillator circuit having an electron tube connected therein, a source of controlling oscillations, a mixer electron tube having a plurality of control electrodes respectively energized by said sources of oscillations, an output circuit for said tube, a rectifier system operatively connected with said output circuit, a control electron tube including a plurality of control electrodes and an anode, a circuit between said control tube and the tube of said oscillator circuit including a connection between control electrodes of said tubes and a connection between the anodes of said tubes, and a connection between said rectifier system and the other of the control electrodes of said control tube for supplying thereto a uni-lateral phase shifted voltage proportional to the phase difference of the voltages from said different sources of oscillations introduced in said mixer tube whereby the anode circuit of said control tube functions as a variable capacitance at high frequencies to control the operation of said oscillator circuit.

3. An electronic synchronizing system comprising, a source of controlled oscillations including an oscillator circuit, a source of controlling oscillations, an electron tube having a plurality of control electrodes respectively energized by said sources of oscillations, an output circuit for said tube, a rectifier system operatively connected with said output circuit, an electron tube having a plurality of electrodes, one of said electrodes being connected with the output of said rectifier system, and another of said electrodes being connected with said oscillator circuit for supplying thereto a uni-lateral phase shifted voltage proportional to the phase difference of the voltages from said different sources of oscillations introduced in said first-mentioned tube.

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