Dec. 27, 1927. 1,654,196

A. H. TAYLOR

THREE-PHASE OSCILLATOR

Filed Nov. 30, 1925

FIG. 1

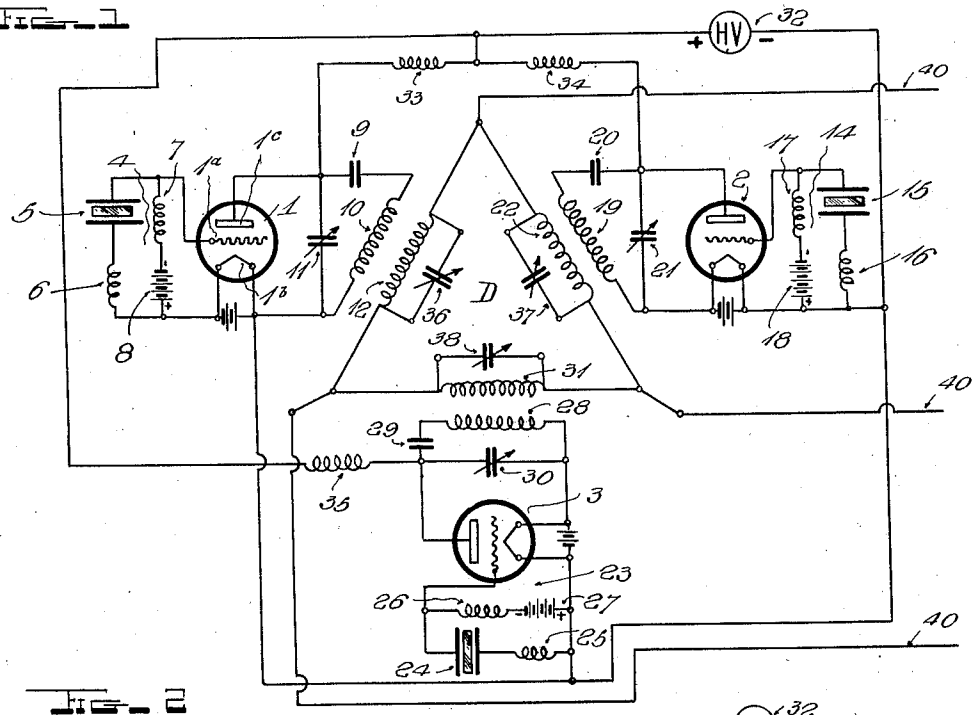


FIG. 2

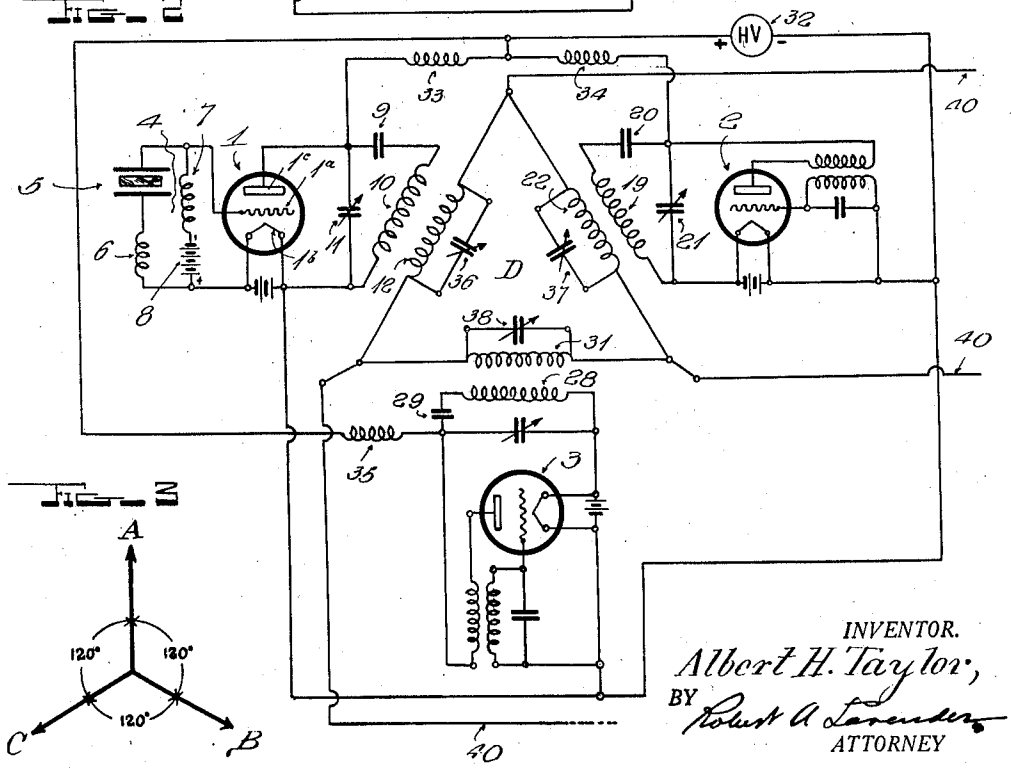


FIG. 3

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UNITED STATES PATENT OFFICE.

ALBERT H. TAYLOR, OF WASHINGTON, DISTRICT OF COLUMBIA, ASSIGNOR TO WIRED RADIO, INC., OF NEW YORK, N. Y., A CORPORATION OF DELAWARE.

THREE-PHASE OSCILLATOR.

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My invention relates broadly to the generation of three phase high frequency current and more particularly to an electron tube circuit arrangement for the generation of three phase high frequency current with means for regulating the currents in the several phases of the high frequency system.

One of the objects of my invention is to provide a simplified construction of electron tube generator of three phase high frequency current, where the current in the several phases is maintained in 120 degree phase relationship.

Another object of my invention is to provide a delta connected three phase generator of high frequency current, in which one or more of the phases is controlled by constant frequency oscillators such as piezo electric crystals arranged in one or more of the phases for maintaining the currents of each of the phases at a 120 degree relationship.

My invention provides a source of three phase high frequency current which may be utilized in the systems set forth in Letters Patent 1,560,505 dated November 3, 1925 and granted to Robert D. Duncan, Jr., and in the systems in co-pending application filed by Robert D. Duncan, Jr., Serial No. 35,212, filed June 5, 1925, which became patent 1,592,085, July 13, 1926, entitled Three phase wired radio receiving circuits; application Serial No. 45,131, filed July 21, 1925, by Robert D. Duncan, Jr., for Three phase high frequency system; application Serial No. 45,132 filed July 21, 1925, by Robert D. Duncan, Jr., Samuel Isler and Salvatore A. Barone, for Three phase high frequency system; and application Serial No. 45,948, filed July 24, 1925, which became Patent 1,591,025, July 6, 1926, by Robert D. Duncan, Jr., for Duplex radio telephone system.

My invention will be more fully understood by reference to the following specification and the accompanying drawings, in which:

Figure 1 illustrates a delta connected electron tube oscillator system in which the currents in the several phases are controlled by piezo electric crystals; Fig. 2 illustrates a modified arrangement of delta connected oscillators in which currents for two of the phases are delivered by self-excited tube oscillators, while the three phase is controlled by a constant frequency piezo electric crystal oscillator; and Fig. 3 is a vector diagram illustrating the angular displacement of the currents in the three phase system.

The necessity for a simplified arrangement for the generation of constant frequency three phase currents has become increasingly important with the development of the three phase high frequency communication systems set forth in the aforementioned references. The three phase high frequency generator of the present invention may be compactly constructed utilizing single phase electron tube oscillators and integrating the currents in the several phases in a common output circuit from which may be derived the three phase current. In order to control the frequency of the three phase current, piezo electric crystals are arranged in the input circuits of one or more of the tubes which form the single phase generators in each of the phases of the three phase system and the oscillators automatically fall into step and keep in synchronism at 120 degrees apart, thereby generating three phase current in the delta connected circuit.

Referring to the drawings in more detail reference characters 1, 2 and 3 represent electron tubes, each arranged in single phase oscillation circuits. Each tube is provided with grid, filament and plate electrodes, which I have designated in the case of electron tube 1 by reference characters 1^a, 1^b, and 1^c. Each tube has an input and output circuit arranged for the generation of oscillations. The input circuit of tube 1 between grid electrode 1^a and filament electrode 1^b, is represented at 4 containing a frequency determining element or piezo electric crystal 5 in series with sensitizing choke 6, which circuit is shunted by a radio frequency choke coil 7 in series with a source of negative potential 8, by which the piezo electric crystal oscillator is operated at substantially no load. The output circuit of electron tube 1 includes condenser 9, and inductance 10 tuned by variable condenser 11. The inductance 10 is coupled with inductance 12 in one side of a delta connected system designated at D.

The second phase is made up by the circuits of electron tube 2, the input circuit 14 of which is completed through piezo electric crystal 15 and sensitizing choke 16, the control circuit being shunted by radio fre-

quency choke 17 and source of negative potential 18. The output circuit of electron tube 2 includes inductance 19, and stopping condenser 20 shunted by tuning condenser 21. Inductance 19 is coupled with inductance 22 of the delta connected system.

The three phase is formed by electron tube generator 3 having an input circuit 23 which is closed through constant frequency piezo electric crystal oscillator 24 connected in series with sensitizing choke 25 and shunted by radio frequency choke 26 and source of negative potential 27. The output circuit of electron tube 3 includes inductance 28, stopping condenser 29 and tuning condenser 30. The inductance 28 is coupled with inductance 31 in the delta connected system.

I have represented independent batteries for heating the electrodes of each of the electron tubes, in the separate phases, but it will be understood that a common cathode heating battery may be employed for all of the tubes of the system. The various plate electrodes for all of the tubes are supplied with high potential from direct current source 32, through radio frequency choke coils 33, 34, and 35, with a return lead to the several cathode circuits. The inductances 12, 22 and 31, in the delta connected system, are each independently tuned by means of condensers 36, 37 and 38. Each of the electron tube systems may be independently adjusted by the separate tuning condensers 11, 21 and 30 for starting oscillations in each of the tube circuits. These oscillations, when impressed upon the delta connected circuit, will cause a circulating current in the delta circuit, unless the phases of the oscillators are angularly separated by 120 degrees, which will result in drawing power out of certain of the tubes and the returning of power into others of the tubes. The result of this will be to advance the phase of one or more tubes to the phase of such tubes as supply power for this circulating current in the delta. The tubes will, therefore, automatically adjust themselves to a normal three phase relationship, 120 degrees apart.

Between points A and B, between C and B, and C and A, voltages are therefore developed which are in three phase relationship, 120 degrees apart. Between these points, therefore, the load of any nature may be connected. Preferably before going to an antenna system or to a wire distributing system one or more stages of amplification may be provided, one set of amplifiers being between A and B, one between B and C, and one between A and C. The grids of these amplifiers would therefore be excited with three phase current in the proper phase relationship.

The quartz or piezo electric crystals 5, 15 and 24 are ground to the same frequency of oscillation and the crystals so arranged in each of the phases that the currents are maintained in phase with 120 degrees relationship, as represented in Fig. 3.

In some instances it is desirable that the frequency of one or more of the phases may shift above or below a pre-determined value fixed by the frequency of another phase, in order to automatically adjust the normal three phase relationship of the several currents. Accordingly, in Fig. 2, I have shown electron tubes 2 and 3 arranged for self-excitation and the generation of oscillations without piezo electric crystal control, while the electron tube 1 is controlled by a piezo electric crystal. In this manner the piezo electric crystal 5 fixes the frequency of the system, while the arrangement of the delta connected tubes is such that the currents are spaced 120 degrees apart.

The three phase generator may work into a line wire system which I have designated generally by reference character 40 and deliver the three phase energy to any suitable load. While I have shown only single electron tubes in each of the phases of the high frequency system, it will be understood that a multiplicity of tubes may be used and arranged to deliver their common output to the delta connected system.

While I have described my invention in certain preferred embodiments, I desire that it be understood that modifications may be made and that no limitations upon the invention are intended other than are imposed by the scope of the appended clams.

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

1. In a system for generating three phase oscillations, the combination of a set of three independent single phase oscillators, a delta connected circuit connected with said oscillators, and a piezo electric crystal arranged in circuit with a selected one of said single phase oscillators for controlling the phase displacements of the currents in said delta connected circuit.

2. In a system for generating three phase high frequency oscillations, the combination of three independent sets of single phase oscillators, a common output circuit to which all of said oscillators are connected, and a mechanically vibrating element capable of sustaining constant frequency oscillations connected with the input circuit of one of said oscillators for maintaining the currents generated by said three independent oscillators at 120 degrees phase displacement.

3. In a three phase system for the generation of high frequency currents, the combination of three independent sets of high frequency oscillators, a common output circuit into which the oscillations from each of said oscillators are delivered, at least two of said oscillators being capable of a shift in

frequency from a predetermined limit and a piezo electric crystal connected in circuit with one of said independent oscillators for facilitating the maintenance of the phase relationship of the currents delivered to said common output circuit.

4. A three phase high frequency oscillator comprising in combination a set of three independent electron tubes each having grid, filament and plate electrodes, input and output circuits interconnecting said electrodes, a delta connected circuit, connections between each of said output circuits and said delta connected circuit, and a mechanically vibratile element capable of sustaining constant frequency oscillations connected in a selected one of said input circuits for controlling the output of each of said electron tubes for displacing the currents supplied to said delta connected circuit 120 degrees apart in phase.

5. In a system for generating three phase high frequency current, the combination of a delta connected circuit, means for tuning each branch of said circuit, a set of three independent electron tubes each having grid, filament and plate electrodes, an output circuit interconnecting said plate and filament electrodes, an input circuit interconnecting said grid and filament electrodes, means coupling the output circuit of each of said electron tubes with a tuned branch of said delta connected circuit, a constant frequency generator of oscillations connected in a selected one of said input circuits, and a common source of high potential connected with each of said output circuits whereby the effects of each of said electron tubes are integrated upon said delta connected circuit and the currents supplied thereto positively spaced 120 degrees apart in phase under control of said constant frequency generators in said selected input circuit.

6. In a system for generating three phase high frequency current, the combination of a delta connected circuit, means for tuning each branch of said circuit, a set of three independent electron tubes each having grid, filament and plate electrodes, an output circuit interconnecting said plate and filament electrodes, an input circuit interconnecting said grid and filament electrodes, means coupling the output circuit of each of said electron tubes with a tuned branch of said delta connected circuit, at least one of said electron tubes having its input and output circuits mutually coupled for sustaining oscillations shiftable in frequency above or below a predetermined limit, a piezo electric device connected in the input circuit of the other of said electron tubes for sustaining oscillations at said predetermined frequency limit in the circuits of said last mentioned electron tube whereby the currents in said delta-connected circuit are automatically adjusted in phase through an angular displacement of 120 degrees.

ALBERT H. TAYLOR.