March 7, 1933. W. E. BOWER 1,900,038

OSCILLATION GENERATOR

Filed April 15, 1930

FIG. 1

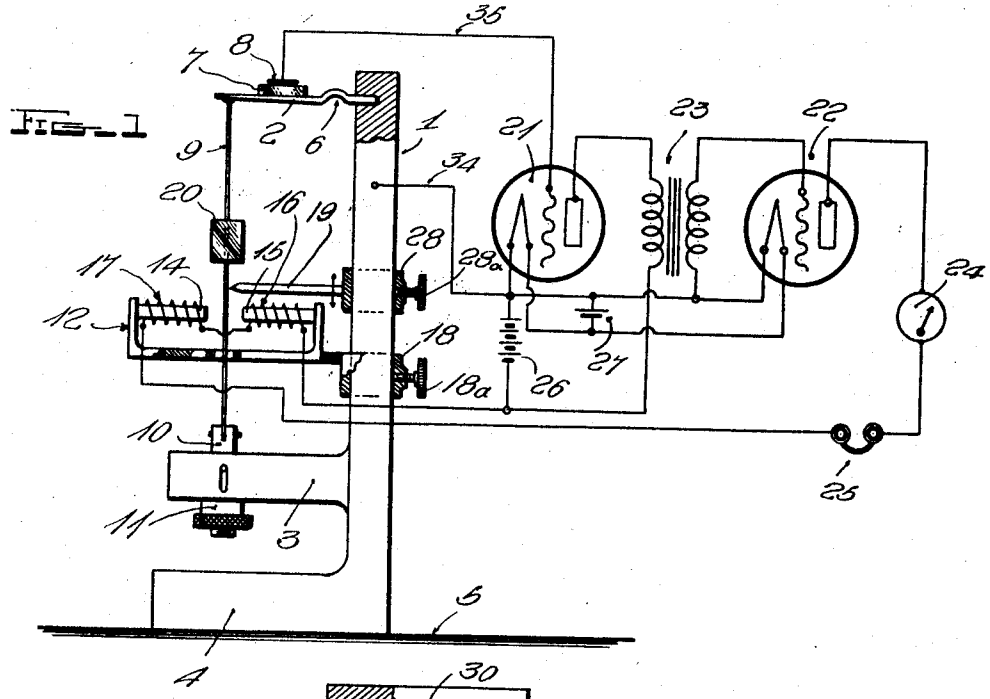
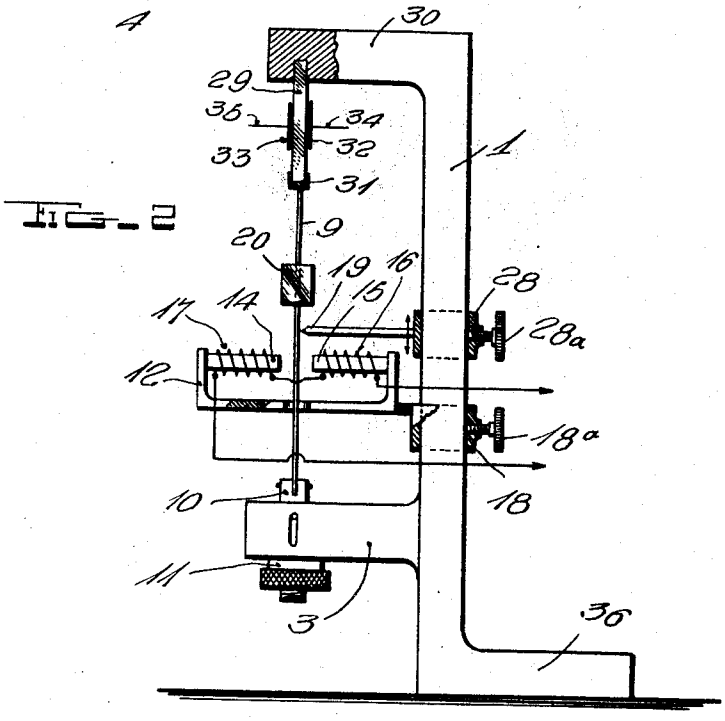


FIG. 2



INVENTOR.

Ward E. Bower,

BY Harold Dodd.

ATTORNEY.

Patented Mar. 7, 1933 1,900,038

UNITED STATES PATENT OFFICE

WARD E. BOWER, OF WASHINGTON, DISTRICT OF COLUMBIA

OSCILLATION GENERATOR

Application filed April 15, 1930. Serial No. 444,481.

My invention relates broadly to oscillation generators and more particularly to a construction of oscillation generator capable of forming a secondary standard of frequency.

One of the objects of my invention is to provide an oscillation generator which may form a secondary standard of frequency and which may be readily transported for comparing various forms of oscillator circuits with the primary frequency standard with a high degree of accuracy.

Another object of my invention is to provide a construction of a secondary standard of frequency which includes a piezoelectric crystal device which may be set into vibration by operation of a mechanical vibratory system for generating oscillations of constant frequency comparable with the frequency of the primary standard, the construction of the secondary standard being such that it is capable of transportation from place to place for reproducing oscillations of the desired frequency.

Still another object of my invention is to provide an oscillation generator in which a mechanical system is operated under control of the generated oscillations for mechanically flexing a piezoelectric crystal element and producing thereby oscillations of constant freqency.

A still further object of my invention is to provide a construction of secondary frequency standard in which a piezoelectric crystal element is mounted in relation to a mechanical vibratory system which maintains the piezoelectric crystal element in a state of mechanical flexure for the generation of electrical oscillations of constant frequency.

A further object of my invention is to provide an arrangement of piezoelectric crystal system and mechanical vibrating system associated therewith by which the piezoelectric crystal may be subjected to compressional and rarefactional forces in step with the natural frequency thereof for generating constant frequency oscillations.

Other and further objects of my invention reside in the mechanical arrangement of driving system and piezoelectric generating system as set forth more fully in the specification hereinafter following by reference to the accompanying drawing, in which:

Figure 1 is a diagrammatic view showing the circuit arrangement for the secondary frequency standard of my invention; and Fig. 2 illustrates a modified form of mounting for the piezoelectric crystal element employed in the secondary frequency standard of my invention.

The primary frequency standard is generally erected in a laboratory where provision may be made for the maintenance of an exact temperature with constant humidity condition in the vicinity of the frequency fixing device. An elaborate system of temperature control is generally employed and other precautions are taken to carefully maintain constant conditions in the vicinity of the frequency fixing device. The primary frequency standard is generally erected in the laboratory and is a permanent fixture therein. A secondary standard of frequency on the other hand is a portable apparatus which simulates as closely as possible the characteristics of the primary frequency standard, the secondary frequency standard being readily transportable for the comparison of many different forms of oscillator circuits with the frequency which is developed by the secondary standard of frequency.

My invention provides means for fixing the frequency of oscillations and maintaining the circuits associated with the apparatus in continuous oscillation. I provide a vibratory system which is operated in step with the oscillation circuit for mechanically flexing the piezoelectric crystal element which is connected in the oscillation circuit and establishing constant frequency oscillations.

Referring to the drawing in more detail reference character 1 indicates a massive framework supported on base 4, the framework being constructed to withstand the tension of a stretched magnetic wire 9 which extends between the extremity of the flat spring 2 and the laterally projecting supporting arm 3. The spring 2 is provided with a resilient bowed portion 6 thereon which adds to the resiliency thereof. The laterally pro-

jecting arm 3 is rigid and is provided with an insulated chuck member 10 which extends upwardly therethrough and engages the lower end of the magnetic wire 9, an adjusting screw device 11 being operated to move chuck 10 for imparting to the magnetic wire 9 the desired tension. The piezoelectric crystal element 7 is supported upon the flat spring 2 in such manner that flexing of the flat spring 2 imparts mechanical forces to the piezoelectric crystal element 7. An upper electrode 8 contacts with the top surface of the piezoelectric crystal element 7 and connects through lead 35 with the input system of the thermionic tube 21. The thermionic tube 21 is coupled through transformer 23 with the input circuit of amplified tube 22. The output circuit of amplifier tube 22 includes the ammeter 24, head telephones 25, and the magnet windings 16 and 17 which are wound upon the oppositely directed magnet poles 14 and 15. The pole pieces 14 and 15 are carried by a frame structure 12 which is adjustably positioned along the vertical standard 1 by means of the slidable collar 18 which fits around the standard 1 and is secured in selected position thereon by means of set screw 18*a*. By the vertical adjustment of the magnets 14 and 15, I am able to selectively apply the magnetic forces to the magnetic wire member 9 for setting the wire into a state of vibration. In order to produce certain frequencies of vibration of the magnetic wire 9, I provide an adjustable member 19 which projects laterally from the collar 28 which is vertically adjustable along standard 1 and which may be selectively set in position thereon by means of set screw 28*a*. The member 19 contacts with magnetic wire member 9 and determines the position of a vibratory node along the magnetic wire 9. If the member 19 engages the wire 9 midway between the ends thereof then the frequency of vibration will be twice the fundamental frequency of the wire 9. A limited number of integral frequencies are obtainable by selectively positioning the magnetic system 14—15 and laterally projecting member 19 along the wire 9. The plate potential for the electron tubes constituting the oscillator and amplifier system is supplied from battery 26. The cathodes of the electron tubes are heated from battery 27.

There are thus two separate mechanical vibrating elements which will have different individual natural frequencies, in the vibrating system on which the crystal is mounted, the spring 2 and the magnetic wire 9 which are mechanically coupled together, and this coupled vibrating system will have a plurality of resonant frequencies and a broad response curve as contrasted with the narrow mechanical resonance peak of a single mechanical vibrating element.

For purposes of scanning in systems of television or picture transmission, a small mirror 20 may be carried by the magnetic wire member 9 in such a position that a beam of light may be reflected over a given angular displacement. By reason of the control which is offered by the piezoelectric crystal element, the vibratory movement of the mirror 20 may be maintained at extremely constant amplitude.

In Figure 2, I have shown a modified form of mounting for the piezoelectric crystal element. In this arrangement the frame 1 is provided with an angular base mounting 36 and an upper horizontally extending portion 30 from which depends the piezoelectric crystal element 29. The free end of the piezoelectric crystal element 29 is coupled through jaw member 31 with the wire member 9 whereby vibrations developed along wire member 9 are imparted to the piezoelectric crystal element 29 so that a compressional and rarefactional force is applied to the piezoelectric crystal generating electrical oscillations which are supplied to the electron tube circuits through leads 34 and 35 which connect to the electrodes 32 and 33 on the piezoelectric crystal element.

The piezoelectric voltage alternates between its maximum and minimum values in phase with the displacement of the magnetic wire 9. In Figure 1, the transverse vibrations of the wire are sinusoidal. As these vibrations are applied to the piezoelectric crystal element, voltages generated thereby set up oscillations in the electron tube circuit 21 which are transferred to electron tube amplifier 22 and amplified thereby. The electromagnetic windings 16 and 17 in operating upon magnetic wire 9 continue the cycle of subjecting the piezoelectric crystal element in mechanical flexure thus generating the oscillations of constant frequency. In the oscillation generator which I have described, synchronized undulated currents are fed back in phase with the elastic displacement of the wire, and oscillations may be maintained throughout the entire audio frequency range, that is, from the lowest audible frequency up to 5000 cycles or more.

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 my invention are intended other than are 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 as follows:

1. In a generator of oscillations of controlled frequency, a support, a resilient strip projecting from said support, a piezoelectric crystal carried by said strip, a tensioned magnetic wire held between said strip and a portion of said support, electromagnetic means mounted upon said support for oper-

ating upon the wire and being adjustable in position upon the support along the length of said wire, a fret to engage said wire mounted upon said support and being adjustable upon the support to a desired point along the length of said wire whereby the resonant frequency of the oscillator is controlled, and an electron tube amplifier having its input connected to said crystal and its output connected to said electromagnetic means.

2. In a generator of oscillations of controlled frequency, a support, a piezoelectric crystal carried by said support, a tensioned magnetic wire having one end connected to said crystal, electromagnetic means carried by said support for acting upon said wire to impart vibrations to the wire and crystal and being adjustable whereby the resonant frequency of the oscillator is controlled, and an electron tube amplifier having its input connected to said crystal and its output connected to said electromagnetic means.

WARD E. BOWER.