

Feb. 26, 1946.

E. L. KENT

2,395,744

FREQUENCY CHANGING APPARATUS AND METHOD

Filed July 8, 1943

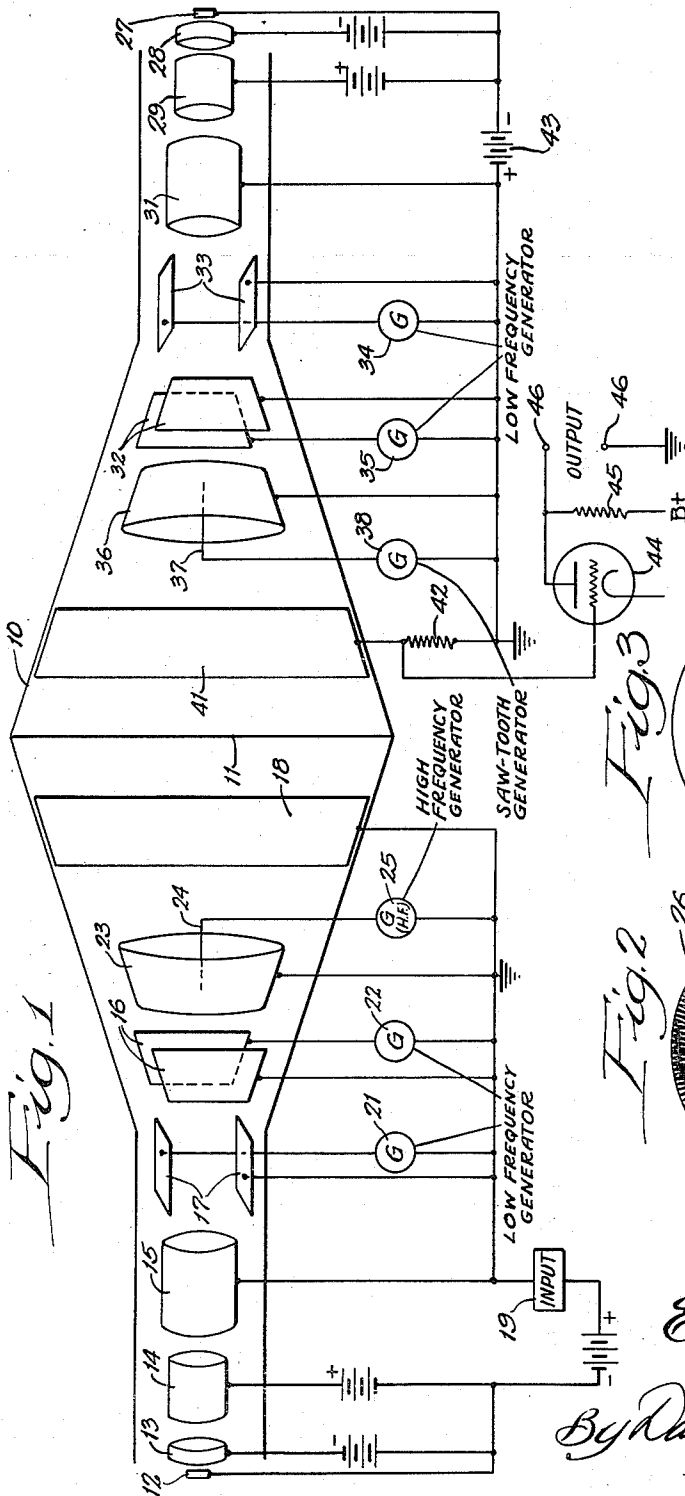
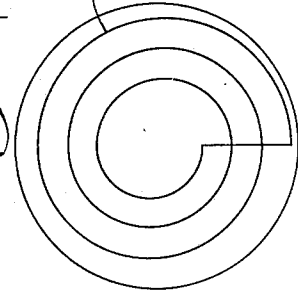
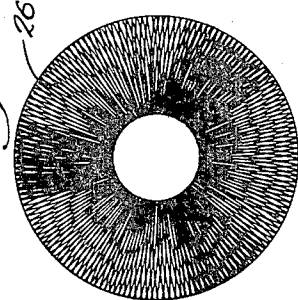


Fig. 1

Fig. 2

Fig. 3



Inventor:
 Earle L. Kent,
 By Ransom, Ooma and Bortle
 Attorneys.

UNITED STATES PATENT OFFICE

2,395,744

FREQUENCY CHANGING APPARATUS AND METHOD

Earle L. Kent, Elkhart, Ind., assignor to C. G. Conn, Ltd., Elkhart, Ind., a corporation of Indiana

Application July 8, 1943, Serial No. 493,888

4 Claims. (Cl. 250—27)

This invention relates to frequency changing apparatus and method and more particularly to changing the frequency of electrical waves without changing their shape or other characteristics.

One of the objects of the invention is to provide a frequency changing apparatus and method in which the frequency of a wave may be increased or decreased without changing its shape.

Another object of the invention is to provide a frequency changing apparatus and method in which a pattern is produced according to the shape of an input wave and is scanned at a rate proportional to the desired output frequency.

Still another object of the invention is to provide a frequency changing apparatus and method in which an annular pattern is produced by a cathode ray apparatus and is scanned by a second cathode ray at a rate proportional to the desired output frequency.

A still further object of the invention is to provide a double ended tube, one end producing a pattern and the other end scanning the pattern to produce a wave having the same shape as the input wave and any desired frequency.

The above and other objects and advantages will be more readily seen when read in connection with the accompanying drawing, in which—

Figure 1 is a diagrammatic view of one form of apparatus embodying the invention;

Figure 2 is a diagrammatic illustration of the pattern produced by the input side of the apparatus; and

Figure 3 is a diagrammatic view of the scanning pattern.

In carrying out the invention a pattern is produced which varies in intensity in accordance with the shape of an input wave which may be an electrical wave, an audible wave or a supersonic wave of any desired character. The pattern is then scanned at a frequency which may vary substantially from the input frequency to produce an output wave having the same shape and general characteristics as the input wave but whose frequency is changed to the desired value. The pattern may be a light pattern produced from film or in any other desired manner but is preferably produced by a cathode ray beam on a mosaic screen which is capable of holding a charge and will be described herein in connection with an apparatus of this type.

The apparatus as shown in Figure 1 comprises a double ended tube 10 divided in its central part by a double sided mosaic screen 11 made up of a fine screen which serves to insulate tiny metallic plugs from each other. Screens of this

type have heretofore been used in other apparatus and will not be illustrated or described in detail herein.

A pattern is impressed on one side of the screen 11 by a cathode ray mechanism in one end of the tube including a cathode 12, a grid 13, a first anode 14, a second anode 15, horizontal deflector plates 16 and vertical deflector plates 17. The second anode 15 is connected to a collector ring 18 adjacent the screen. The input wave which may be derived from any desired source is applied at 19 and is impressed on the second anode and collector ring to vary the velocity of the cathode ray beam in accordance with the wave shape. The horizontal deflector plates 16 are connected to a generator 21 which is so arranged as to apply thereto an alternating voltage equal to

$$A \sin 2\pi f_1 t$$

and a similar voltage is impressed on the vertical deflector plates by a generator 22 which is equal to

$$A \cos 2\pi f_1 t$$

While separate generators at 21 and 22 have been shown it will be understood that the same generator might be used with suitable circuits to produce the desired function of the fundamental frequency. These two deflector plates will cause the beam to be deflected to travel in a circle on the screen to produce a circular pattern thereon.

If the device were to be used only as a delay device, this pattern could be scanned from the opposite side of the screen by a second cathode ray beam traveling in a circle of the same radius and not more than one revolution behind the first beam. However, if the frequency of the input wave is to be changed a different type of pattern must be produced and for this purpose the input cathode ray beam is biased by an alternating voltage causing it to travel radially back and forth in an annulus to form a pattern as shown in Figure 2. Preferably the biasing is accomplished by providing a biasing ring 23 in the path of the beam having a central anode 24 and connected to a high frequency generator 25. The generator 25 impresses a voltage on the biasing ring which is equal to

$$\sin 2\pi f_2 t$$

where f_2 is substantially in excess of f_1 . With this construction the beam will move rapidly back and forth along radial lines and will travel relatively slowly around the annulus to produce a pattern as indicated at 26 in Figure 2. Since the velocity of the beam is modulated in accord-

ance with the shape of the input wave the intensity of the pattern will vary around the annulus in accordance with the shape of the input wave.

The charge pattern impressed on the screen 11 by the cathode ray beam on the input side of the tube is scanned by a cathode ray beam in the output side of the tube which is produced by a cathode 27 controlled by a grid 28 and first and second anodes 29 and 31. The output beam is deflected by horizontal deflector plates 32 and vertical deflector plates 33 supplied with alternating voltage from generators 34 and 35 respectively. The generator 34 supplies a voltage equal to

$$\cos 2\pi f_3 t$$

and the generator 35 supplies an alternating frequency equal to

$$\sin 2\pi f_3 t$$

where f_3 is the desired output frequency. The beam is biased by a biasing ring 36 having a center anode 37 and supplied with a saw tooth wave of frequency f_4 by a generator 38. The frequency supplied by the generator 38 is less than the frequency of f_3 and is preferably equal to the frequency f_1 so that the beam will be biased to travel in a spiral pattern as indicated at 39 in Figure 3. A collector ring 41 is connected to the grid of a amplifier tube 44 whose plate circuit is connected across a resistance 45 to output terminals 46 as shown.

As the cathode ray beam in the output side of the tube travels in a spiral path over the pattern 26 of the mosaic screen 11, the plugs in the screen will be driven to equilibrium by secondary emission to cause a varying current between the screen and the collector ring 41. Due to the spiral path of the beam it sweeps over a fresh part of the screen in each revolution so that the frequency f_3 may, if desired, be greater than the frequency f_1 and so that the variation in current between the screen and the collector ring 41 will follow the pattern produced by the input wave. The output wave at the terminals 46 will, therefore, have the same shape as the input wave and will have a frequency proportional to the frequency f_3 .

The device of the present invention may be used in substantially any place where it is desired to change the frequency of a wave without altering its shape. For example, a musical tone of constant pitch may be impressed on the input side of the tube at 19 and may be taken out at the terminals 46 at a different frequency proportional to the frequency f_3 . If the fre-

quency f_3 is supplied by a variable generating system through a keyboard or the like, any desired tone could be produced having the qualities of the input wave. Another desirable use is in the field of secret communication in which frequencies of an input wave could be multiplied or divided to become unintelligible and could later be multiplied or divided by the same number to restore the original wave. Various other applications will occur to those skilled in the art.

While one embodiment of the invention has been shown and described in detail herein, it will be understood that this is illustrative only and is not intended as a definition of the scope of the invention, references being had to the appended claims for this purpose.

What is claimed is:

1. The method of changing the frequency of a wave which comprises producing from the wave an annular pattern varying in intensity annularly in accordance with the shape of the wave, and scanning the pattern in a spiral path at a rate proportional to the desired output frequency.

2. The method of changing the frequency of a wave which comprises deflecting a focused cathode ray beam to travel in a circle, biasing the beam at a high frequency to cause it to travel in closely spaced radial lines around the circle, varying the effective intensity of the beam in accordance with the wave shape producing a charge pattern from the beam, and scanning the pattern at a rate proportional to the desired output frequency.

3. Frequency changing apparatus comprising a screen, means for producing on the screen an annular pattern varying annularly in intensity in accordance with the shape of an input wave, and means for scanning the pattern in a spiral path at a rate proportional to the desired output frequency.

4. Frequency changing apparatus comprising a double ended tube, a double sided mosaic screen in the central part of the tube, means in one end of the tube to direct a focused cathode ray on one side of the screen and to cause the ray to move over the screen in closely spaced radial lines in an annulus, means to vary the effective intensity of the beam in accordance with the shape of an input wave to form an annular pattern on the screen, and cathode ray means in the other end of the tube to scan the pattern in a spiral at a rate proportional to the desired output frequency.

EARLE L. KENT