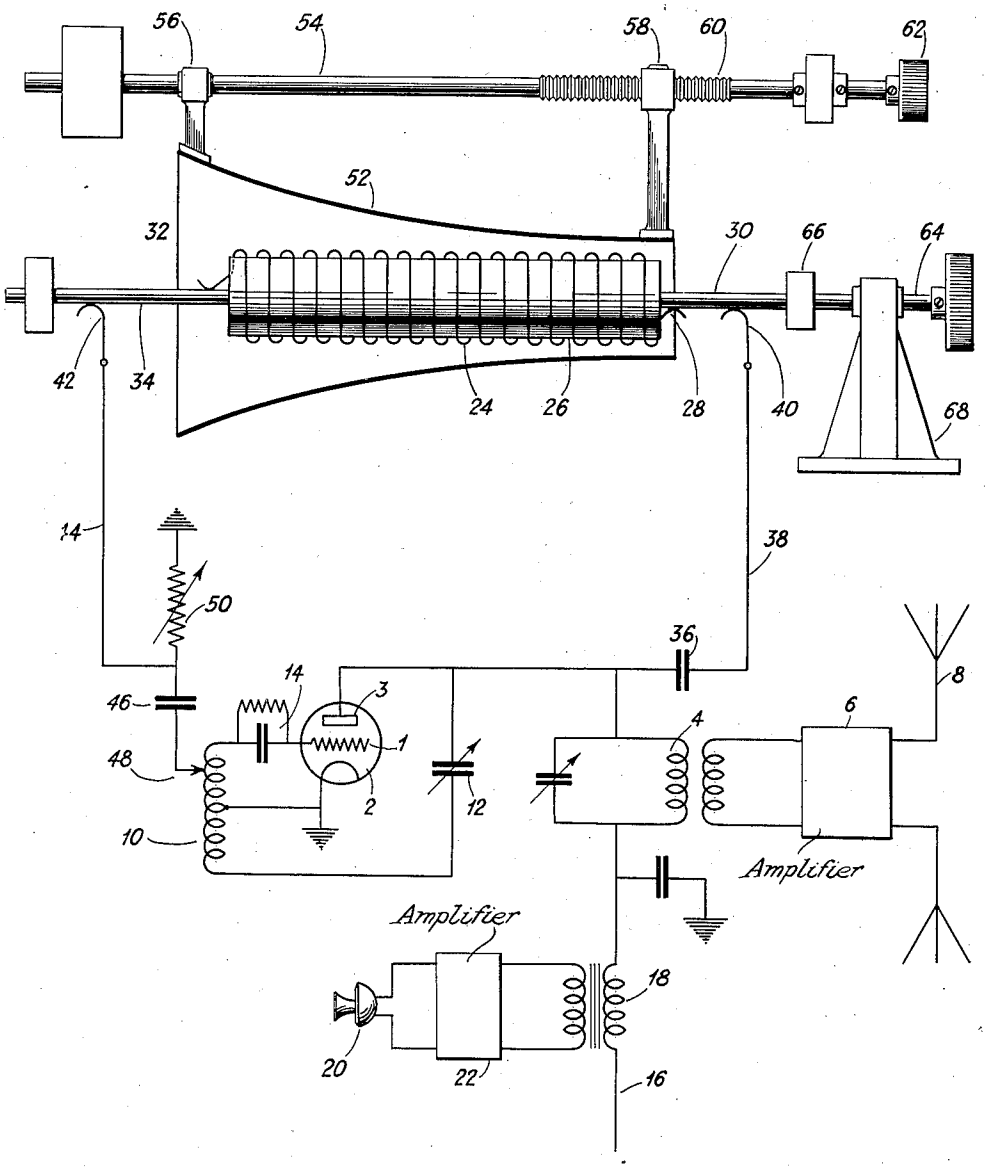
Aug. 21, 1934. J. W. CONKLIN 1,970,952

LINE CONTROLLED APPARATUS

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Fig. 1



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Fig. 2

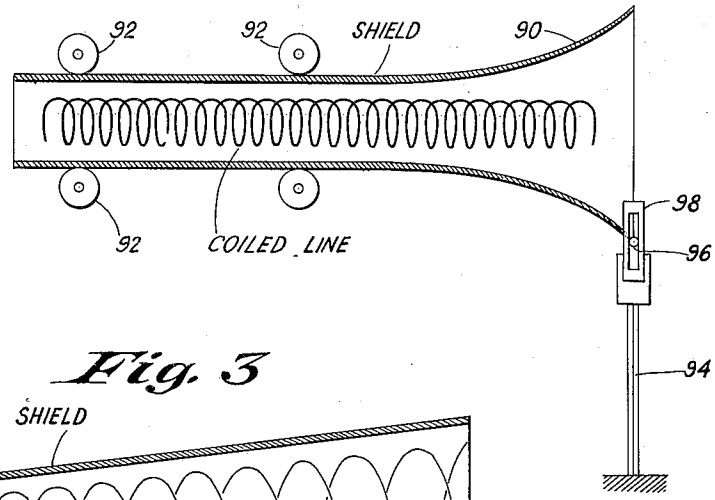


Fig. 3

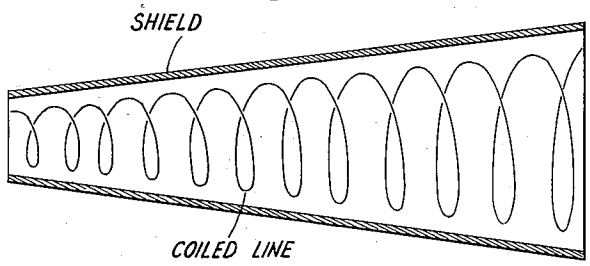


Fig. 4

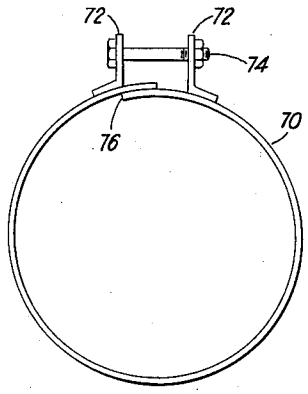
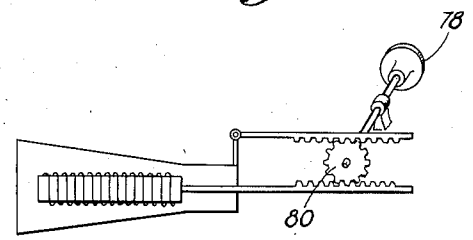


Fig. 5



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LINE CONTROLLED APPARATUS

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Application March 24, 1932, Serial No. 600,848

9 Claims. (Cl. 250—36)

This invention relates to an artificial transmission line controlled electron discharge device oscillator.

Transmission lines have been used with considerable success for the control of frequency of electron discharge device oscillators, the lines ordinarily having either traveling or standing waves thereon. In the former case the line is used to control regeneration, the length of the line being such that for a particular frequency, the line will apply out of phase potentials to the control electrode from the anode of an electron discharge device oscillator, which incidentally is a correct condition for oscillation generation at a particular frequency; and, in the latter case, standing waves on the line are used to pull the control electrode-anode potentials into step therewith whereby the frequency of oscillations generated is again controlled by the length of the line, for, the length of the line fixes the wave length of the standing waves. In both cases, any tendency for a shift in oscillator frequency is accompanied by a shift in phase directly proportional to the number of wave lengths on the line, and, by judicious choice of length of the line a large change in phase for a slight shift in frequency may be obtained thereby insuring frequency stability.

A prime desideratum in connection with transmission line controlled oscillators is the provision of a line readily adjustable in length, and for this purpose, heretofore, adjustable taps were provided. However, by such means exact adjustments in length are somewhat difficult to obtain and, to overcome this difficulty and to provide in combination with an electron discharge device oscillator, a transmission line which may be smoothly and continuously adjustable over a considerable range, are the prime objects of the present invention.

According to the present invention, the foregoing objects are effected by providing a shielded coiled transmission line wherein the relative positioning of the shielding and coil is alterable. In other words, according to the present invention, by varying the shielding of the coil, the effective length of the line may be varied at will. That this necessarily follows is apparent from the fact that the velocity along the line is proportional to the square root of the product of inductance per unit of the length of the line, multiplied by the capacitance per unit of the length of the line. Therefore variation in capacity along the line, or its equivalent-line shielding, will change the time required for an electrical impulse to travel between two points on the line. Consequently, as the time of travel is altered, the length of the line between two points is effectively changed as is also, the stable frequency of the line controlled tube oscillator.

It is a further object of this invention to provide various combinations of relatively movable shields and coils, to be used preferably in combination with electron discharge devices for obtaining constant frequency operation thereof at any desired frequency, both the shields and coils being appropriately shaped as will be described more fully hereinafter.

A further object is to provide a line controlled tube system that is self correcting as regards temperature changes.

In accordance with the patent laws of the United States, the present invention is defined in the appended claims, but, it may best be understood as to its method of operation and structural organization by referring to the more detailed description which follows hereinafter and to the accompanying drawings wherein;

Figure 1 illustrates a signal transmission systen utilizing a long line frequency controlled oscillation generator, special means being provided in accordance with the present invention for effectively altering the length of the long transmission line included in the generator circuit,

Figures 2 and 3 diagrammatically illustrate relative forms which may be taken by the long coiled transmission lines and shields therefor,

Figure 2 also indicating, diagrammatically, a temperature independent or self correcting line,

Figure 4 is a cross sectional view of another form of adjustable shielding for a long coiled transmission line and,

Figure 5 illustrates diagrammatically means for simultaneously moving both coil and shield.

Turning to Figure 1, an electron discharge device oscillator tube 2 supplies modulated energy through its tunable output or tank circuit 4 to a power amplifier 6, which may be omitted if desired and then to a suitable radiating antenna 8. The tank circuit 4 having inductance and capacity, exhibits or experiences parallel resonance effects. This circuit furthermore roughly or approximately fixes or controls the frequency of operation of electron discharge device 2 to a desired value.

To prevent the effects of inter-electrode feed back or oscillation at an undersired frequency, electron discharge device oscillator 2 is neutralized by the action of a split input coil 10 and neutralizing condenser 12 as is well known in the art. Correct control electrode polarizing po-

tential for the control electrode of electron discharge device 2 may be provided by the action of a properly chosen condenser and resistance arrangement 14. Anode potential for tube 2 may be supplied, together with modulating potentials through lead 16, modulating potentials being supplied through the action of microphone 20, amplifier 22 and transformer 18.

After neutralization of tube 2 by adjustment of condenser 12, feed back is established by the connection of a long coiled artificial transmission line 24 mounted upon a suitable insulating base 26, the line being electrically connected at point 28 to conducting rod 30 and at point 32 to conducting rod 34, the rods 30, 34 being electrically independent and suitably fastened to insulating support 26. The input end 28 of the line is connected to the output or anode electrode of tube 2 or to the output circuit thereof through blocking condenser 36 conductor 38 and through a yieldable or springlike contact 40 making slidable contact with conducting member 30.

The output end 32 of long line 24 is coupled to the input circuit or to the control electrode of tube 2 through conducting rod 34, slidable contact 42, conductor 44, blocking condenser 46 and tap 48 suitably coupled to the input coil 10 for applying suitable potentials to the control electrode of tube 2.

The line is grounded on its output end by an impedance, here in the form of a resistance 50, equal in value to the surge impedance of the line so that reflections will not be set up thereon.

As a result of the foregoing construction, high frequency potentials on the control electrode 1 and anode 3 of tube 2 will be out of phase for a frequency corresponding to that for which the line is substantially an odd number of half wave lengths long. Oscillation generation at other frequencies will not occur since potentials at the other frequencies will not be applied in the correct phase relationship to the anode and control electrode of tube 2 for sustained oscillation generation. Of course, as the line may be an odd number of half wave lengths long for a number of frequencies, suitable adjustment of tuned circuit 4 to approximately that frequency desired, will serve to eliminate the generation of all but the one desired frequency.

In order to adjust the length of the line and therefore the oscillation frequency of oscillator 2, it was heretofore proposed to mechanically tap on to the line at various points along its length. However, this does not give as smooth and continuous adjustment as desired, and for this purpose the line is made adjustable within a tapered shield 52 supported upon a rod 54 by brackets 56, 58 the latter of which is screw threaded on to screw threaded portion 60 of rod 54. Rotation of knob 62 will, therefore, cause motion of the shielding 52 relative to the coiled line 24. This relative change in position may also be brought about by movement of rod 64 fixed to rod 30 by means of insulator 66, the rod 64 being mounted in a suitable bearing 68.

By virtue of the change in shielding along the length of the coil by changing or altering the relative positioning of the coil and shield, electrical velocity along the coil is altered thereby changing the effective length of the line and therefore the frequency at which tube 2 will produce oscillations of constant frequency.

Tapering in the diametrical ratio of the coil to the shield along the axis of the coil whereby the impedance of the coil and the velocity there along will vary gradually along the axis of the coil may not only be accomplished as shown in Fig. 1, but may be accomplished equally as well by the arrangements shown diagrammatically in Figures 2 and 3.

The coil and shield construction of Figure 2 differs from that shown in Figure 1, wherein a straight coil and a tapered shield are illustrated, in that the shield is tapered for only part of its length, the coil being maintained straight or of uniform diameter throughout its length. In Figure 3 both the coil and shield are tapered, and, as in Figure 1, relative movement or changes in positioning of the coil and shields shown in Figures 2 and 3 will vary the effective length of the coiled transmission line.

Tapering of the line may, of course, be so chosen as to make the rate of change of impedance uniform, or it may be so chosen that the rate of change follows any desired law. In any case, the impedance changes should be made sufficiently gradual so that reflections arising therefrom become self-cancelling throughout the line.

Another form of shielding is shown in Figure 4 wherein the shielding 70, by virtue of brackets 72 and bolt 74 is made compressible either partially or totally so as to reduce or increase its diameter with respect to the coil. Preferably an air gap is left at point 76 to reduce eddy current loss. If desired, the shield shown in Figure 4 may be given any of the shapes described in connection with Figures 1, 2 and 3.

For the simultaneous movement of both coil and shield, the gear and rack arrangement diagrammatically illustrated in Figure 5, may be used to good advantage. In Figure 5, motion of knob 78, imparts, through gear 80, opposite simultaneous movement of the coil and shield. A dial or other indicating device, may, of course, be provided for all modifications described to indicate the effective length of line in circuit.

Relative movement between shields and coils may be made responsive to temperature variations in such a way that the effective electrical length of line may be made independent of, or in other words, self correcting for changes in ambient temperature. Such an arrangement is illustrated diagrammatically in Fig. 2 wherein the shield 90 is slidably mounted between grounded rollers 92.

A bi-metallic strip 94 moving a pin 96 acts through slotted member 98, fastened to the shield to move it relative to the coil dependent upon ambient temperature variations. The arrangement should be so designed that the effects of temperature variations are compensated. It is obvious that the temperature responsive adjusting means 94 may be used to move the coil rather than the shield.

In the light of what has been said hereinbefore, various modifications will, of course, readily suggest themselves to those skilled in the art and consequently the present invention is to be limited not by the illustrations given in the drawings, but solely by the width of the appended claims.

Having thus described my invention, what I claim is:

1. In apparatus for undulatory electrical currents, an electron discharge device having a plurality of electrodes, a circuit having inductance and capacity and experiencing parallel resonance effects, coupled to a pair of electrodes of said device, for roughly fixing the frequency of operation of said device; a transmission line coupled to a plurality of electrodes of said device for accurately fixing the frequency of operation of said device, and temperature responsive means for

varying the effective electrical length of said line whereby the frequency of operation of said device is maintained constant despite variations in ambient temperature.

2. In apparatus for undulatory electrical currents, an electron discharge device having a plurality of electrodes, a circuit having inductance and capacity and experiencing parallel resonance effects, coupled to a pair of electrodes of said device, for roughly fixing the frequency of operation of said device; a transmission line coupled to a plurality of electrodes of said device for accurately fixing the frequency of operation of said device, a metallic capacity element coupled to said line, and temperature responsive means for varying the capacity between said element and said line in such a way that despite variations in ambient temperature, the frequency of operation of said device remains constant.

3. In apparatus for undulatory electrical currents, an electron discharge device having a plurality of electrodes, a circuit having inductance and capacity and experiencing parallel resonance effects, coupled to a pair of electrodes of said device, for roughly fixing the frequency of operation of said device; a transmission line, long, relative to a half wave length taken at a desired operating frequency, coupled to a plurality of electrodes of said device for accurately fixing the frequency of operation of said device, a metallic capacity element coupled to said line, and means for varying the capacity between said element and said line and hence the accurate frequency of operation of said device.

4. In apparatus for generating constant frequency electrical currents, a tube having a plurality of electrodes, a rough frequency determining circuit having inductance and capacity coupled to a pair of electrodes of said tube, a coiled transmission line coupled to a plurality of electrodes of said tube for accurately fixing the frequency of operation thereof, a shield about said coiled transmission line, and means for varying the relative longitudinal positioning of said coil and shield whereby the effective length of said line and hence the accurate frequency of oscillation of said tube is altered.

5. In combination a tube having an anode a cathode and a grid, means for reducing the effects of interelectrode capacity between said anode and grid, a circuit having inductance and capacity experiencing parallel resonance effects at a frequency roughly corresponding to a desired frequency of operation, connected to a pair of electrodes of said device, a transmission line a plurality of half wave lengths at a desired operating frequency connected between the anode and grid of said device for accurately fixing the frequency of operation thereof, a tapered metallic shield about said transmission line, and means for varying said shield with respect to said line and hence the frequency of operation of said electron discharge device.

6. An oscillation generator comprising a vacuum tube having an anode a cathode and a grid, means for neutralizing interelectrode capacity existing between the anode and grid, a parallel tunable circuit connected between the anode and cathode of said tube for roughly fixing the frequency of operation thereof, a coiled transmission line, long, relative to a half wave length taken at a desired operating frequency connected between the anode and grid of said tube, an impedance substantially equal in value to the surge impedance of said line connected between the grid end of said line and said cathode, a tapered metallic shield about said coiled transmission line, and means for varying the relative longitudinal positioning of said shield and coil in order to vary the effective electrical length of said line and hence the accurate frequency of operation of said tube.

7. In apparatus for undulatory electrical currents, an electron discharge device oscillator tube, a tunable circuit coupled to a pair of electrodes of said tube for roughly fixing the frequency of operation of said oscillator tube means for preventing the effect of inter-electrode feedback in said electron discharge device oscillator tube, a coiled transmission line for establishing feedback between the output circuit and the input circuit of said oscillator tube, said line being long relative to a half wave length taken at a desired operating frequency and for controlling the frequency of oscillations generated by said oscillator tube and variable shielding for said line and means for varying said shielding and hence the effective length of said line and consequently the frequency of oscillations generated by said oscillator.

8. Apparatus for undulatory electrical currents comprising an electron discharge device having a plurality of electrodes, a circuit having inductance and capacity and experiencing parallel resonance effects, coupled to a pair of electrodes of said device, for roughly fixing the frequency of operation of said device; a transmission line coupled to a plurality of electrodes of said device for accurately fixing the frequency of operation of said device, and temperature responsive means for varying the effective electrical length of said line to change the frequency of operation of said device.

9. In apparatus for undulatory electrical currents, an electron discharge device having a plurality of electrodes, a circuit having inductance and capacity and experiencing parallel resonance effects, coupled to a pair of electrodes of said device, for roughly fixing the frequency of operation of said device; a transmission line coupled to a plurality of electrodes of said device for accurately fixing the frequency of operation of said device, a capacity member, and temperature responsive means for varying the position of said member with respect to said line for changing the effective electrical length of said line and the frequency of operation of said device.

JAMES W. CONKLIN.