

Oct. 20, 1942.

R. B. DOME

2,299,571

HARMONIC TRANSMISSION SYSTEM

Filed May 10, 1941

Fig. 1.

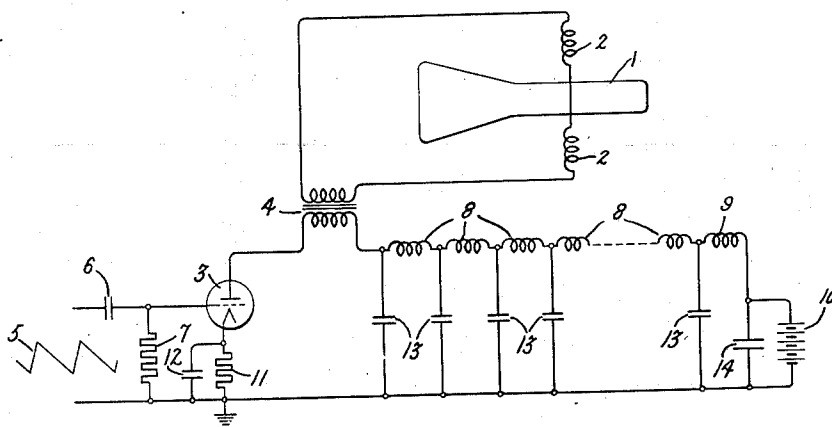


Fig. 2.

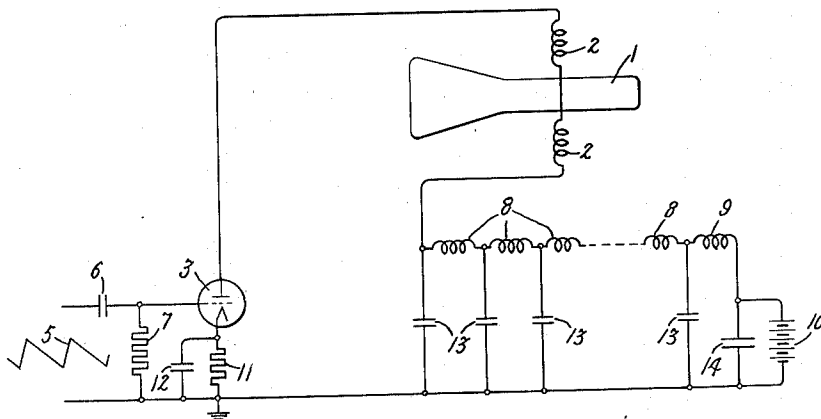


Fig. 3.

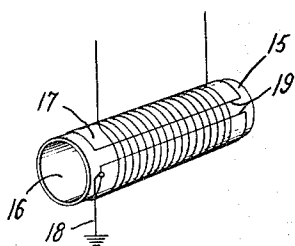
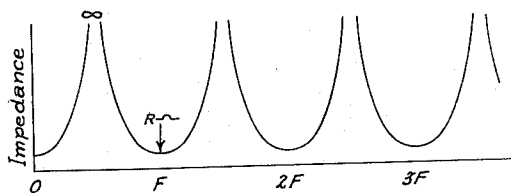


Fig. 4.



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UNITED STATES PATENT OFFICE

2,299,571

HARMONIC TRANSMISSION SYSTEM

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Application May 10, 1941, Serial No. 392,933

7 Claims. (Cl. 250-27)

My invention relates to electrical circuits capable of transmitting efficiently currents of irregular wave form, such as sawtooth waves, in which currents of frequencies which are harmonics of the fundamental frequency are of importance. It has for one of its objects to improve the efficiency of such systems.

Such systems are employed commonly in connection with cathode ray apparatus. Waves of sawtooth wave form are commonly employed for controlling the deflection of the cathode ray across a fluorescent screen, the sawtooth wave being supplied to a magnetic deflection coil surrounding the cathode ray device. Such deflection coils have high inductance and to produce sufficient current therein of the fundamental and different harmonic frequencies, a source, which may be an amplifier, of adequate capacity must be provided. An object of my invention is to reduce the capacity required of such a source, or amplifier.

The novel features which I believe to be characteristic of my invention are set forth with particularity in the appended claims. My invention itself, however, both as to its organization and method of operation together with further objects and advantages thereof may best be understood by reference to the following description taken in connection with the accompanying drawing in which Fig. 1 represents an embodiment of my invention; Fig. 2 represents a modification thereof; Fig. 3 represents a detail, and Fig. 4 represents a characteristic pertaining to the operation of the elements shown in Figs. 1 and 2.

Referring to Fig. 1 of the drawing, I have conventionally indicated at 1 a cathode ray device having a deflection coil, which may be represented at 2, to which a sawtooth wave is supplied from an amplifier 3 through a transformer 4.

The coils 2 may, for example, be the coils which produce the horizontal sweep of the cathode ray beam in a television transmitter or receiver. In television service, for example, the sawtooth wave employed for producing the horizontal sweep has a frequency, which, in present practice, is ordinarily 13,230 cycles per second. This sawtooth wave, which is indicated at 5 may be supplied from any convenient sawtooth generator through the coupling condenser 6 to the grid of the amplifier 3 between the grid and cathode of which is connected the grid resistor 7 in the usual way. The anode circuit, in accordance with my invention, includes the primary winding of the transformer 4, a series of induct-

ance coils 8 and 9, a source of operating potential 10 and a resistance 11, the resistance 11 being the usual cathode bias resistor for generating a suitable bias potential upon the grid of the discharge device 3. As usual, this resistance is by-passed at all the frequencies to be transmitted by condenser 12. Connected across the circuit between the ground or return conductor and the different coils 8 are condensers 13 and across the source 7 is connected a large by-pass condenser 14 having substantially zero impedance at the frequencies to be transmitted through the circuit. The coils 8 and 9 are proportioned relative to the condensers 13 and to the inductance which appears across the primary winding of the transformer 4 so that the impedance looking into the circuit from the amplifier 3 simulates the impedance of a transmission line short circuited at the far end and having a length equal to one-half the wave length corresponding to the fundamental frequency of the sawtooth wave. Such a transmission line presents an input impedance to the source, which is purely resistive at the fundamental frequency of the source and each of the different harmonic frequencies thereof, although at frequencies intermediate the fundamental and harmonic frequencies the impedance is highly reactive.

Thus with the elements 8, 9 and 13 so proportioned, the discharge device 3 works into a load which is purely resistive at all frequencies to be transmitted, this resistance being the resistance of the coil 2 as seen from the primary of transformer 4 plus the small series losses in coils 8 and 9, although the load may be highly reactive or highly resistive at other frequencies. This means that the discharge device 3 may be one of considerably smaller capacity than would be the case were the coils 8 and 9 and the condensers 13 omitted from the circuit. This will be appreciated when it is realized that the horizontal deflection coils 2 of the cathode-ray device are of extremely high inductance and that this inductance is connected effectively in the anode circuit of the device 3 through transformer 4 such that it appears directly across the primary terminals of this transformer. This means that unless other means were provided the discharge device 3 would have to be of sufficient capacity to produce current in this highly inductive load of sufficient intensity to produce the required effect upon the cathode ray device. Because of the high inductance, the discharge device 3 would have to be one of large capacity. By the use of my invention whereby the load

into which the device operates is purely resistive at all frequencies involved, the discharge device 3 may be one of very substantially reduced capacity.

In accordance with my invention the coil 9 should be of the same inductance as that which appears across the primary of transformer 4 and should be one-half of the inductance of the different coils 8.

Fig. 2 is similar to Fig. 1 with the exception that in Fig. 2 the coils 2, 8 and 9 are connected directly in the anode circuit of the discharge device 3 rather than to the secondary winding of a transformer 4 as in Fig. 1. Of course, either arrangement may be provided with equal facility but the transformer 4 may be preferable in certain situations.

If desired, the coils 8 and 9 may be lumped inductances connected in series and the condensers 13 may be small capacitors connected in shunt with the circuit.

Fig. 3, however, shows an arrangement whereby the inductance of the coils 8 and 9 is made up of a single cylindrical coil 15 wound upon a non-conducting form 16 having about it a conducting sleeve 17, which may be of suitable conducting material such as tinfoil, or copper, and which is grounded as at 18. The coil 15 may thus replace the inductances 8 and 9 of Figs. 1 and 2 and the capacitance between the different turns of coil 15 and the capacitance electrode 17 may replace the condensers 13 of Figs. 1 and 2. Thus the network may be conveniently constructed into a single unit of economical form capable of convenient and practical use. Of course, the capacitance electrode 17 should not be a complete cylinder but should be broken at at least one point in its circumference as indicated at 19 to prevent circulating currents therein.

Fig. 4 illustrates the relation between the frequency plotted as abscissa and impedance plotted as ordinates of the anode circuit of the discharge device 3 as measured between the anode and cathode of the discharge device. It will be seen that at the fundamental frequency F and at the harmonic frequencies $2F$ and $3F$, etc., the impedance is of minimum value and equal to the resistance of the circuit. At intermediate frequencies the impedance becomes very high, approaching infinity at a frequency midway between the fundamental and its second harmonic, or between different harmonics, such impedance being highly reactive, except that exactly midway the impedance is highly resistive, approaching infinity. This high impedance, however, at these frequencies, is not objectionable because it is necessary that only the fundamental and harmonic frequencies be supplied to the sweep coils 2, that is, no components are present which correspond to anything but the troughs of the curves shown in Fig. 4.

While I have shown particular embodiments of my invention, it will of course be understood that I do not wish to be limited thereto since different modifications, both in the circuit arrangement and in the instrumentalities employed may be made, and I contemplate by the appended claims to cover any such modifications as fall within the true spirit and scope of my invention.

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

1. In combination, a cathode ray device having a deflection coil, a source of deflection voltage connected across said coil, and additional

impedance effectively in circuit with said coil, said impedance being of such character that it, in combination with the impedance of said deflection coil, presents to said source an impedance simulating at all frequency components of said source the impedance of a transmission line having a length of a half of a wave length of voltage having the fundamental frequency supplied by said source to said deflection coil.

2. In combination, a cathode ray device having a deflection coil, an electron discharge amplifier having an input circuit including a source of deflection voltage, and an output circuit effectively including the impedance of said deflection coil, the impedance of said output circuit at said amplifier being equal at all frequency components of said source to the impedance of a transmission line having a length equal to half of a wave length of the wave of the fundamental frequency supplied by said source.

3. In combination, a cathode ray device having a deflection coil, an electron discharge amplifier having an input circuit including a source of deflection voltage comprising a fundamental wave and various harmonics thereof, and an output circuit effectively including said deflection coil and an impedance network comprising series inductance and shunt capacitance, said series inductance being proportioned relative to said shunt capacity and the inductance of said deflection coil to produce pure resistance at the terminals of said amplifier at the fundamental and harmonic frequencies of said source.

4. In combination, a source of voltage comprising a fundamental frequency wave and waves having harmonic frequencies of said fundamental wave, a highly inductive load supplied from said source requiring energy in said waves of both fundamental and harmonic frequencies and an inductance coil in series with said load, said inductance coil being wound in cylindrical form, and a capacitance electrode extending along said cylindrical form, in proximity to the turns of said coil and connected to the side of said load circuit opposite said coil, the capacitance between said electrode and said coil being so proportioned with relation to said coil and said coil being so proportioned relative to the inductance of said highly inductive load that pure resistance is presented to said source at each of said fundamental and harmonic frequencies.

5. In combination, a cathode ray device having a deflection coil, an electron discharge amplifier having an input circuit including a source of deflection voltage and an output circuit in which current of saw tooth wave form is produced by said source, said output circuit including a source of operating voltage connected between the output electrodes of said amplifier effectively through the inductance of said deflection coil and through a second inductance, said second inductance having distributed capacity proportioned relative to the inductance thereof such that the impedance of said output circuit as seen by said amplifier is that of a transmission line having a length equal to a half wave length and is purely resistive at each harmonic of the fundamental frequency of said saw tooth wave.

6. In combination, a cathode ray device having a deflection coil, and electron discharge amplifier having an input circuit including a source of deflection voltage and an output circuit in which current of saw tooth wave form is produced by said source, said output circuit including in series the effective inductance of said coil, a series of

other inductance elements, a return conductor, and capacitance from said return conductor to each of said other inductance elements of such value that the impedance of said output circuit as viewed from said amplifier simulates that of a transmission line having a length equal to half a wave length of the fundamental of said saw tooth wave, and which is short circuited at its remote end and said impedance being low at all harmonics of said saw tooth wave.

7. In combination, a cathode ray device having a deflection coil, an electron discharge amplifier having an input circuit including a source of deflection voltage and an output circuit in which current of saw tooth wave form is produced by

10 said source, said output circuit including in series the effective inductance of said coil, a series of other inductance elements, a return conductor and capacitance from said return conductor to each of said other inductance elements of such value that the impedance of said output circuit as viewed from said amplifier simulates that of a transmission line having a length equal to an integral multiple of a quarter of a wave length of the fundamental of said saw tooth wave and having low impedance at all harmonics of said saw tooth wave and high impedance at frequencies between said harmonics.

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