

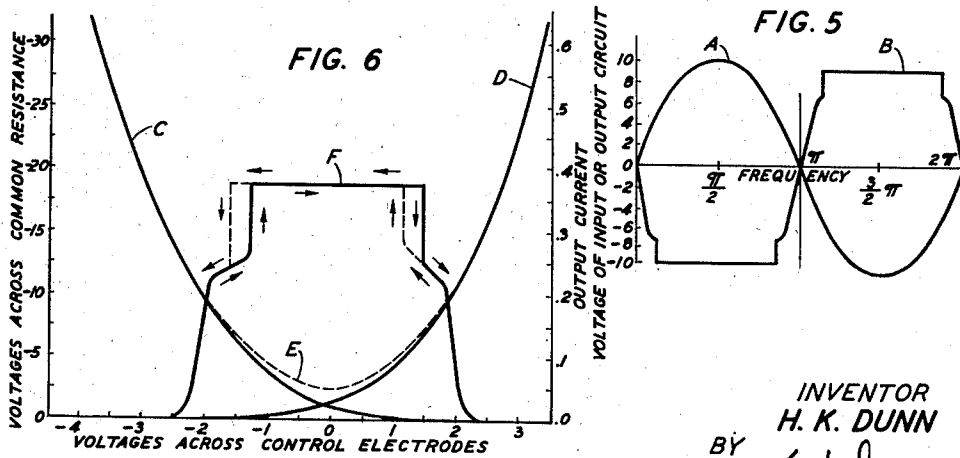
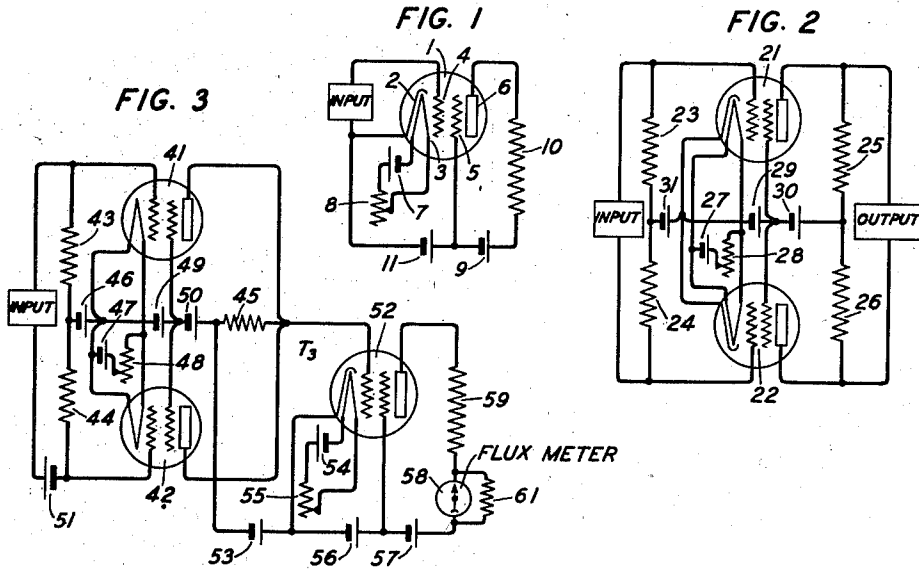
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WAVE SHAPING SYSTEM

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WAVE SHAPING SYSTEM

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5 Claims. (Cl. 178—69)

This invention relates to a wave shaping system and more particularly to a system for producing square-topped waves.

An object of this invention is to produce square-topped waves in certain electrical systems.

Another object of this invention is to facilitate a more accurate analysis of sound waves.

In many systems it is frequently desirable to produce a wave with a square-top. For example, in telegraph systems, the wave form of signals is considerably distorted after passing over long transmission lines. The production of a sharp, definite square-top wave would assist materially in the more accurate reception of these signals.

In accordance with this invention the characteristics of a space discharge device having at least four elements are utilized to produce a square-top wave. Unlike three-element space discharge devices, variation in the grid potential of devices having at least four elements under certain conditions result in a non-uniform rate of increase of current in the anode circuit. This non-uniformity in the rate of increase of anode current is influenced markedly by the constants of the circuit with which the device is associated. The circuit constants may be chosen so that a voltage applied to the device causes a current to be produced that is approximately zero for a voltage below a critical value, that rises rapidly to a maximum as the potential of the grid exceeds this value, and that remains substantially constant at that maximum for additional increases in voltage. For example, a circuit containing a space discharge device having at least four elements with a relatively large impedance comprising chiefly resistance in the output circuit of the device exhibits this characteristic. The potential bias of the control electrode of the device, the voltage of the supply for the anode of the device and the value of the output circuit impedance may be such that when the voltage impressed on the input circuit is below a predetermined critical value, the current in the output circuit is substantially zero, that when the voltage increases above this value, the current in the output circuit rises rapidly to a maximum and remains substantially at that maximum for additional increases in input voltage. This characteristic of the circuit results in the production of a wave having a square top when a voltage which fluctuates above and below this value is impressed on the input circuit.

In another modification a square-top alternat-

ing current is obtained. The potential bias of the control electrode, the voltage of the anode supply and the impedance comprising chiefly resistance of the output circuit are also factors in the determination of the wave shape of the current produced. Two space discharge devices having at least four elements arranged in push-pull relation are employed with a relatively large resistance in the output circuits of both devices.

In a specific example illustrating the invention a sound wave is analyzed to determine the portion of the wave which lies within a predetermined amplitude range. The waves to be analyzed are applied to the input of a circuit having two space discharge devices in push-pull relation. A resistance in the output of the circuit is associated with a four-element space discharge device. When the amplitude of the wave applied to the input of the circuit is within the desired predetermined range, a low potential below a certain critical value exists across the resistance in the output of the circuit. For all other amplitude values a higher potential results across the resistance. The four-element space discharge device associated with this resistance is responsive to a potential below this critical value. A relatively large resistance in the output circuit of the space discharge device causes a constant current to flow in the output circuit of the device when a potential below the critical value is impressed on the control electrode of the device. When the potential increases above this value, no appreciable current flows in the output circuit of the device. Accordingly, a constant current results when the amplitude of the sound wave is within a predetermined range of limits, but remains approximately zero for either higher or lower amplitudes. A measuring device indicates the period during which the current flows.

A more comprehensive understanding of this invention may be obtained by reference to the drawing in which:

Fig. 1 is a schematic of a generic form of circuit embodying this invention;

Fig. 2 is a schematic of a circuit embodying this invention for the production of an alternating electromotive force having a square-top characteristic;

Fig. 3 shows an amplitude filter circuit in which this invention is embodied.

Fig. 4 is a graphic representation of the characteristics of the current produced in the anode circuit with varying control electrode potentials in the circuit shown in Fig. 1;

Fig. 5 illustrates graphically the production of an alternating electromotive force by the circuit shown in Fig. 2;

Fig. 6 is a curve showing the characteristics of current passing through or voltage existing across parts of the circuit with varying applied voltages as obtained experimentally using the amplitude filter shown in Fig. 3.

In Fig. 1, the numeral 1 represents a four-element vacuum space discharge device. The device comprises a heated cathode element 2, filament 3 for heating the cathode element 2, the control electrode 4, the shield grid 5 and the anode 6. The filament 3 is supplied with current by the unidirectional current source 7 through the variable resistance 8. The cathode and control electrode are connected to the input circuit. Between the shield grid and the anode a relatively large resistance 10 and a unidirectional source 9 for supplying the anode with current are inserted in series. A difference of potential between the cathode and shield grid is provided by the battery 11 connected between these two elements. The electromotive forces of unidirectional source 9 and the battery 11, the magnitude of resistance 10 and the characteristics of the device 1 are such that when the electromotive force impressed across the terminals of the input circuit is below a predetermined critical value, the current in the output circuit is substantially zero. When the electromotive force increases above this value, however, the current in the output circuit rises rapidly to a maximum and remains substantially at that maximum for additional increases in input voltage.

The operation of this circuit is illustrated graphically in Fig. 4. This figure shows the control electrode electromotive force or the voltage impressed by the input circuit between the cathode and the control electrode with the resulting current obtained in the anode circuit. With the resistance 10 having a value of 500,000 ohms, unidirectional source 9 and battery 11 having electromotive forces respectively of 105 volts and 75 volts, no current passes in the anode circuit until the control electrode potential rises in a direction toward positive potential above -14 volts. From input voltages above -14 volts, the current in the anode circuit rapidly increases until it reaches a maximum at approximately -5½ volts as indicated by the arrows pointing toward the right. With additional increase in input voltage, the current in the anode circuit remains substantially constant. When the voltage impressed on the control electrode decreases from zero, that is, tends to become more negative, the current in the anode circuit remains at the maximum until the control electrode voltage drops to approximately -7 volts along the dotted line as indicated by the arrows pointing toward the left. At this point, the current in the anode circuit suddenly drops. The current then follows the same curve but in an opposite direction to that resulting from increases in the control electrode voltage until at -14 volts the current in the anode circuit is zero. The slight deviation in the curve indicated by the dotted line when the voltage is decreasing from above the critical value is due to the characteristics of the four-element space discharge device. This hysteresis effect can partially be obviated by the use of a five-element device.

Fig. 2 shows a circuit for the production of an alternating electromotive force having a square-

top characteristic. Two four-element vacuum space discharge devices 21 and 22 are arranged in push-pull relation. Both devices 21 and 22 are of the equipotential cathode type. The control electrodes of devices 21 and 22 are connected to their respective cathodes by the resistances 23 and 24 respectively. Two resistances 25 and 26 are connected across the output circuit of devices 21 and 22 respectively. The biasing potentials for devices 21 and 22 are supplied by unidirectional current source 31 through resistances 23 and 24 respectively. The current for the filaments for heating the cathodes of devices 21 and 22 is supplied by the battery 27 through the variable resistance 28. A battery 29 impresses an electromotive force between the shield grids of devices 21 and 22 and their respective cathodes. Battery 30 supplies anode current to devices 21 and 22 through resistances 25 and 26 respectively. One of the terminals of the input circuit is connected to the control electrode of device 21, while the other terminal of the input circuit is connected to the control electrode of device 22. The output circuit is connected to the anodes of devices 21 and 22.

Fig. 5 shows the relationship between the input and output voltages obtained with the use of the circuit shown in Fig. 2. Curve A shows the input voltage over one complete cycle, while curve B is the output voltage over the same cycle shown in curve A. The values of the various parts of the system employed in obtaining the alternating electromotive force shown in curve B were as follows: resistances 25 and 26—500,000 ohms, battery 31—10 volts, battery 29—75 volts, battery 30—105 volts.

As shown in curves A and B with a slight increase in the voltage impressed on the input above zero, the voltage in the output circuit rapidly increases in a negative direction (i. e. the voltage in the output tends to become more negative or changes rapidly from zero to approximately -9 volts) until it reaches a maximum at about one-fifteenth of a completed cycle. It remains at this maximum for additional increases in voltage until the applied voltage again approaches zero. At this point, the voltage in the output circuit rapidly decreases in a negative direction to zero (i. e. the voltage in the output circuit tends to become less negative or change from approximately -9 volts to zero rapidly). In the next half cycle when the applied voltage increases in a negative direction from zero, the voltage in the output circuit increases in a positive direction rapidly until a maximum is attained (i. e. the voltage of the output tends to become more positive or to change rapidly from zero to approximately +9 volts). The output voltage remains at this maximum until the input voltage again approaches zero when the output again rapidly decreases to zero. Accordingly, an alternating voltage having a square-top characteristic is produced in the output circuit.

Fig. 3 illustrates a circuit by which sound waves may be analyzed to determine the portion of the wave which lies within a predetermined amplitude range. Two four-element space discharge devices 41 and 42, preferably of the high vacuum tube type, are connected in push-pull relation. Resistances 43 and 44 are connected between the cathodes and control electrodes of devices 41 and 42, respectively. A resistance 45 is connected in series with the anode circuits of both devices 41 and 42 and is common to both anode circuits. A battery 46 furnishes the bias-

ing potential for devices 41 and 42 through resistances 43 and 44 respectively. The cathode of devices 41 and 42 are heated by the battery 47 through the variable resistance 48. A battery 49 provides potential between the shield grids and the cathodes of devices 41 and 42. The current for the anode of devices 41 and 42 is supplied by the unidirectional source 50 through the common resistance 45. One terminal of the input circuit is connected to the control electrode of device 41, while the other terminal of the input circuit is led to the control electrode of device 42. A battery 51 is connected in series with one of the terminals of the input circuit and the control electrode of one of the devices 41 or 42. The function of battery 51 is described hereinafter.

The input circuit of a four-element vacuum space discharge device 52 is connected across the resistance 45. The device 52 is of the equipotential cathode type. A battery 53 supplies biasing potential for the control electrode of the device 52. The current for the filament for heating the cathode of device 52 is furnished by a battery 54 through a variable resistance 55. A potential between the shield grid and cathode of device 52 is supplied by a battery 56. The current for the anode of device 52 is provided by a unidirectional source 57 through a flux meter 58 and a resistance 59. The flux meter 58 preferably has its restoring torque reduced to a low magnitude and has large electromagnetic damping so that its deflections represent the integral of current over a definite period of time. A resistance 61 shunted across the fluxmeter provides this electromagnetic damping. The resistance 59 has a relatively high value. The device 52 with its input and output circuits corresponds to and serves the same function as the device 1 and circuit shown in Fig. 1.

Fig. 6 shows the operating characteristics of the circuit shown in Fig. 3. The values of the parts of the circuit shown in Fig. 3 employed in compiling the data for the curves shown in Fig. 6 were as follows: resistances 43 and 44—100,000 ohms each; resistance 45—1 megohm; resistance 59—500,000 ohms; battery 49—45 volts; battery 50—135 volts; battery 56—75 volts; battery 57—180 volts.

Curve C represents the voltage existing across the common resistance 45 when varying input voltages are impressed upon the control electrode of device 41. Curve D shows the voltage across the common resistance 45 resulting from varying voltages being impressed on the control electrode of space discharge device 42. The curve E shows the resulting voltage generated across the resistance 45 by the devices 41 and 42 with varying input voltages. The curve F represents the current passing through resistance 59 or the output of device 52 with varying input voltages. The voltage of battery 51 is the arithmetic mean of the intensity of the predetermined amplitude range to be ascertained. The battery 51 is so arranged in the circuit that when the electromotive force produced across the output circuit equals the arithmetic mean of the intensity of the predetermined amplitude range, the electromotive force generated by the battery 51 neutralized the electromotive force across the input circuit and no electromotive force is impressed on the control electrodes of devices 41 and 42.

When the potential having a value corresponding to the arithmetic mean of the intensity of the predetermined amplitude range exists

across the input circuit, zero potential is impressed on the control electrodes of devices 41 and 42 since the input potential is neutralized by the electromotive force generated by the battery 51. The potential impressed on the control electrodes of devices 41 and 42 is the difference in voltage between the negative value of battery 51 and that existing across the input terminals. The potential across resistance 45, shown on the left scale of the axis of the ordinate in Fig. 6, resulting from the varying voltages impressed on the control electrodes of devices 41 and 42 is indicated by the composite curve E. When the potential impressed on the control electrodes of devices 41 and 42 increases from below -2.5 volts toward zero potential, the potential across the resistance 45 decreases in a negative direction (i. e. the potential across resistance 45 tends to become less negative or approach zero potential) until when zero potential is impressed on the control electrodes, the potential across the resistance 45 approaches zero as represented by the curve E. When the potential impressed on the control electrodes of devices 41 and 42 increases in a positive direction from zero potential, the potential across resistance 45 increases negatively (i. e. tends to become more negative).

The current in the output circuit of device 52 due directly to the potential existing across resistance 45 and indirectly to the voltage impressed on the control electrodes of devices 41 and 42 is shown by curve F. The right hand scale of the ordinate axis indicates the current in the output circuit. The value of the resistance 59, the characteristic of the device 52 and the constants of the circuits associated with the device 52 are such that when the potential across the resistance 45 is below approximately -13 volts, no appreciable current passes in the output circuit of device 52. This result may be seen by comparing the composite curve E and curve F. When the potential across resistance 45 is decreased below the critical value of approximately -13 volts, (i. e. the potential across resistance 45 tends to become less negative or approach zero) the current in the output circuit rapidly increases to a maximum and remains at that maximum for additional decreases in the negative value of potential across resistance 45. When the potential across resistance 45 increases in a negative direction to the critical value, the current in the output circuit rapidly decreases to zero. The current passing through the output circuit is shown in curve F along the arrows pointing to the right.

The potential across resistance 45 is, as indicated by the composite curve E, the same for voltages of equal intensity above and below zero which are impressed on the control electrodes of devices 41 and 42. Accordingly, the current in the output circuit remains at substantially zero for voltages below -2.5 volts impressed on the control electrodes of devices 41 and 42, rises rapidly to a maximum as the impressed voltages are increased until at approximately +2 volts, the current drops rapidly to zero as shown by the curve F along the arrows pointing to the right. If the voltage impressed on the control electrode of devices 41 and 42 is decreased from above +2.5 volts a current passes in the output circuit in accordance with the curve F along the arrows pointing to the left. The slight deviation in the curve illustrated by the dotted line is due to the characteristics of the four-electrode space discharge device. A five-element space

discharge device corrects to some degree this hysteresis effect. The current passing through the output circuit of device 52 is indicated by the meter 58.

5 When the amplitude of a sound wave between predetermined limits is desired, it is converted in a well known manner to electrical energy. The electromotive force generated is impressed on the input of the circuit shown in Fig. 3. The con-
10 stants of this circuit are chosen so that when the amplitude of the sound wave is within the predetermined limits, a current having characteristics similar to that shown in curve F is generated in the output of device 52. The meter 58 accord-
15 ingly indicates when the sound wave is within the predetermined amplitude range.

Although this invention is not limited thereto, it is preferred to use space discharge devices of the high vacuum type in the embodiments de-
20 scribed in Figs. 1, 2 and 3. In Fig. 3, space discharge devices of Western Electric Co. manufacture have been found satisfactory. The manufacture's designated code numbers are for device 52 of Fig. 3—259A and for devices 41 and
25 42—246A.

While preferred embodiments of this invention have been shown and described, various modifications therein may be made without departing from the scope of the appended claims.

30 What is claimed is:

1. A system for producing a square-top wave comprising a space discharge device, said device comprising a cathode, an anode, a control elec-
35 trode and an auxiliary electrode, means for maintaining said auxiliary electrode at a potential different from the potential of said anode and said control electrode, an output circuit connected to said anode and said cathode and a large ohmic resistance in said output circuit.

0 2. A wave shaping device comprising two space discharge devices in push-pull relation, said devices comprising anode, cathode, control elec-

trode and auxiliary electrode, an output circuit connected to said devices, means for maintain-
ing said auxiliary electrodes at potentials different from the potentials of said anodes and said control electrodes, a large ohmic resistance in
5 said output circuit and means for indicating the current in said output circuit.

3. A system for analyzing sound waves comprising a resistance, means for impressing a low potential across said resistance when the ampli-
10 tude of a sound wave lies within a predetermined range, means connected to said resistance comprising a space discharge device having a cathode, an anode, a control electrode and an auxiliary
15 electrode responsive to said low potential for producing a substantially constant current and means for maintaining said auxiliary electrode at a potential different from the potential of said anode and said control electrode.

4. A system for producing an alternating volt-
20 age having a square-top wave form comprising two space discharge devices in push-pull relation, an output circuit connected to said devices, each of said devices comprising a cathode, an anode, a control electrode and an auxiliary electrode,
25 means for maintaining said auxiliary electrode at a potential different from the potential of said anode and said control electrode and a large impedance in each of said output circuits.

5. In combination, two space discharge devices
30 in push-pull relation, each of said devices comprising a cathode, an anode, a control electrode and an auxiliary electrode, input and output circuits connected thereto, means for maintaining
35 said auxiliary electrode at a potential different from the potential of said anode and said control electrode, and means in said output circuit for producing small increases in the current of said output circuit for large increases in the poten-
40 tial of said input circuit.

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