

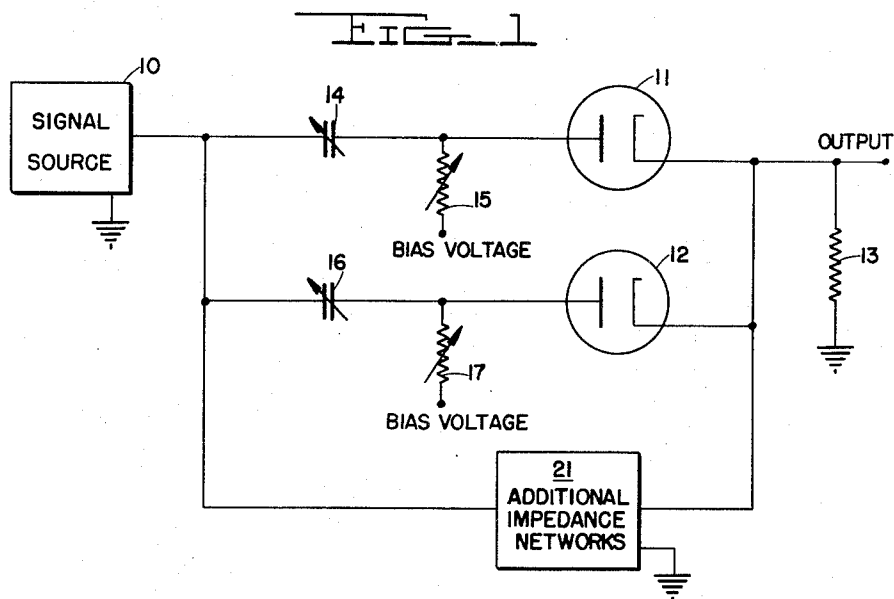
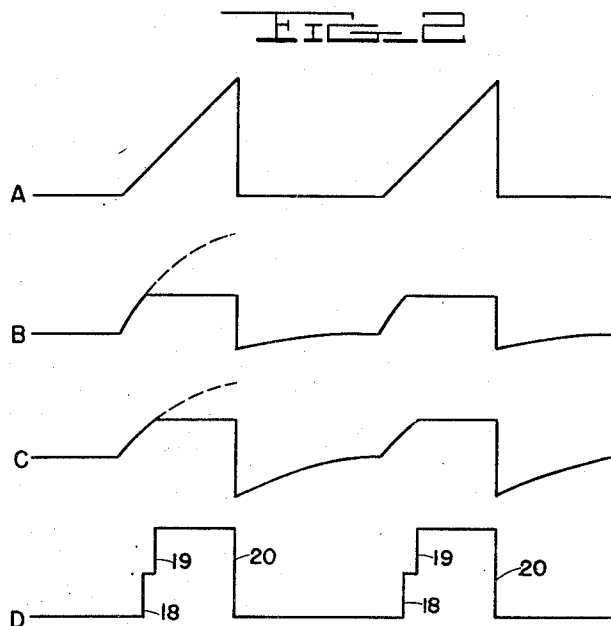
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SIGNAL GENERATOR

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SIGNAL GENERATOR

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This invention relates to signal generating systems and in particular to a voltage-generating system for producing a stepwise changing voltage waveform having selectable numbers and positions of steps.

In many applications it is desirable to produce a stepwise changing signal. Systems for producing stepwise changing signals have been available in the past, however, such systems are generally complex and require considerable power for their operation.

Accordingly, it is an object of the present invention to provide a stepwave signal generator of simple construction and having low power requirements.

Another object of the present invention is to provide a generating system for producing a stepwave signal having a plurality of steps of selectable time occurrence. Other and further objects and features of the present invention will become apparent upon a careful consideration of the following detailed description when taken together with the accompanying drawing which illustrates a typical embodiment of the features of the invention and the manner in which that embodiment may be considered to operate.

In order that the invention may be clearly understood and readily carried into effect, it will now be described more fully by way of example with reference to the accompanying drawings, in which:

Fig. 1 is a schematic diagram, partly in block, of a specific circuit designed to produce stepwise changing voltage signals.

Fig. 2 shows a series of waveforms which are taken to illustrate the operation of the circuit of Fig. 1.

In accordance with the fundamental concepts of the present invention, a stepwise changing voltage signal is produced by the successive initiation of conduction in each of a plurality of unilateral impedance elements. With proper selection of the sizes of certain elements in associated time constant circuits, the unilateral impedance elements are enabled to produce stepwise voltages of selectable time positions having minimum requirements as to numbers of circuit components and operational power required.

With reference to Fig. 1, a periodic, linearly changing waveform as exemplified by the recurrent sawtooth voltage of waveform A of Fig. 2 is obtained from a signal source 10 and applied to a plurality of diode electron tubes typified by 11, 12 having a common load impedance circuit 13.

By way of example, the linearly changing waveform is applied to the electron tube 11 through a differentiating type coupling circuit such as capacitance 14 and resistance 15. The differentiating action of this coupling circuit alters the sawtooth waveform A of Fig. 2 to produce a rising voltage of reduced amplitude. When the rising potential at the anode of electron tube 11 exceeds the cathode potential, conduction by that tube is initiated. Thus a current flow occurs and a charge is developed across the coupling capacitance 14. The point of initiation of conduction by tube 11 may be adjusted by selection of a biasing voltage applied thereto through resistance 15. The voltage developed on the coupling capacitance 14 as a result of conduction by tube 11 serves as an additional biasing voltage on said tube to supplement the biasing voltage applied through resistance 15. In recurrent operation the biasing voltage developed across capacitance 14 may be the sole biasing voltage applied to tube 11 in which case the biasing voltage would be zero.

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When conduction by the electron tube 11 is initiated, the resulting current flow through impedance path 13 produces a stepwise change in the potential at the cathode connection. Thereafter, the potential across resistance 13 does not follow the differentiated rising potential of the sawtooth voltage indicated by dotted line on waveform B but remains at a steady potential. To achieve this result, it is necessary to select certain of the circuit elements with respect to the characteristics of the linearly changing input signal of waveform A. The time constant of the circuit including capacitance 14 and the combination of resistance 15, electron tube 11, and impedance path 13, when tube 11 is conducting, must be short compared with the rise time of the linearly changing waveform. When such a situation exists the rate of change of voltage across capacitance 14 is the same as the rate of change of the linearly changing voltage and the charging current is constant. This results in the production of a constant amplitude voltage across impedance path 13. This constant voltage is approximately equal to the product of the time constant of the aforementioned circuit and the rate of change of the input voltage. In a similar manner the time constant of the circuit including capacitance 16 and the combination of resistance 17, electron tube 12, and impedance path 13 must also be short compared with the rise time of the linearly changing waveform.

When it is desired to obtain a multiple stepwise voltage having equal amplitude steps, the time constant of each of the circuits associated with the conducting electron tubes 11 and 12 must be equal. Since this time constant is determined primarily by the respective capacitance 14 or 16 and the impedance path 13 it follows that, in such a condition, capacitances 14 and 16 would be equal in size. The resistance of the conducting electron tube is usually small compared to the impedance path 13 which in turn is small compared to either resistance 15 or 17, therefore the time constants are determined primarily by the capacitance (14 or 16) and impedance path 13. It then follows that capacitances 14 and 16 would be equal in size.

The time displacement of the initiation of conduction by each of electron tubes 11, 12 is determined primarily by the associated coupling circuits comprising elements 14, 15 and 16, 17 which control the amount of differentiation of the signal applied to the respective electron tube, and the biasing voltage applied through resistances 15, 17. Thus by adjusting resistances 15 or 17 it is possible to alter the time occurrence of the step voltage produced by conduction of the associated electron tube.

When it is desired to obtain a stepwise changing waveform having a plurality of steps of different amplitude, the product of the time constant of the circuit associated with each conducting electron tube and the rate of change of the linearly changing voltage for the circuit of tube 11 must be different from that of the circuit of tube 12. Since the impedance path 13 is common to both circuits and large compared to the resistance of the conducting electron tube, capacitances 14 and 16 will be of unequal sizes.

To explain the circuit action more fully, reference is now had to the waveforms of Fig. 2 which were chosen for a condition of equal sizes of capacitances 14, 16 and the time constant circuit including capacitance 14 and resistance 15 longer than that including capacitance 16 and resistance 17. Thus the initial rising portion of the waveform B which represents the anode voltage of electron tube 11 follows more closely the rising waveform A from signal source 10 than does the initial rising portion of waveform C which represents the voltage at the anode of electron tube 12. As a result, tube 11 is brought to initial conduction at a point on the rising portion of waveform B to produce the step 18 of waveform D which represents the potential of the common cathode connection. Subsequently, tube 12 is brought to conduction to produce the second step 19 in waveform D. At the conclusion of the linearly rising portion of waveform A a drop in potential is produced at the common cathode connection as conduction by both electron tubes 11 and 12 is terminated. This drop is indi-

cated by numeral 20 on waveform D. A signal waveform is thus produced having a plurality of steps of selectable amplitude and position with respect to the initiation of the linearly rising portion of the input waveform, depending upon the time constant of the input coupling circuit. The number of steps can be fixed by the number of electron tubes such as 11, 12 which are employed. If a greater number of steps are required, a plurality of input coupling networks and electron tubes may be employed as indicated in general by block 21 of Fig. 1.

From the foregoing discussion it is apparent that considerable modifications of the features of this invention are possible, and while the device herein described and the form of apparatus for the operation thereof constitutes a preferred embodiment of the invention it is to be understood that the invention is not limited to this precise device and form of apparatus, and that changes may be made therein without departing from the scope of the invention as defined in the appended claims.

The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

What is claimed is:

1. A signal generating system for producing a stepwise changing signal, comprising; a plurality of impedance networks having input and output connections, each of said impedance networks including a differentiator type coupling circuit and a unilateral impedance element, a common impedance means connected to the unilateral impedance elements operative to provide a continuous direct current return path for the unilateral impedance elements, and means connected to said impedance network supplying a linearly changing input signal thereto.

2. A signal generating system for producing a stepwise changing signal, comprising; a plurality of electron tubes having at least anode and cathode electrodes, signal generator means delivering a substantially linearly changing signal, individual time constant coupling means modifying and supplying said substantially linearly changing signal individually to one electrode in each of said electron tubes at a different rate whereby each of said electron tubes is rendered conducting at a selected level of said substantially linearly changing signal, a common output terminal connected to another electrode in each of said tubes, and an impedance means connected to said out-

put terminal and forming a part of the individual time constant circuit of any tube that is conducting.

3. A generating system for producing a stepwise signal, comprising; means supplying an input signal changing substantially linearly with time, a plurality of impedance networks, each of said impedance networks including a normally non-conducting diode electron tube having anode and cathode electrodes and a short time constant coupling circuit including a reactive element for supplying the linearly changing signal to a first electrode of the diode electron tubes whereby the diode electron tubes are rendered conducting at a selected point of the linearly changing input signal, said short time constant coupling circuit further forming, with the associated diodes in a conductive state, a circuit whose time constant is short with respect to the changing time of the input signal, and a common impedance means connected to the second electrodes of said diode electron tubes providing a continuous direct current return path for the electron tubes for combining the conduction current through the diode electron tube impedance elements.

4. A signal generating system for producing a stepwise changing signal, comprising; a plurality of electron tubes having at least anode and cathode electrodes, signal generator means delivering a substantially linearly changing signal, a plurality of bias voltage sources of selected different amplitudes, separate and distinct time constant coupling means each coupling said generator voltage and one of said bias sources to an electrode of a different one of said tubes, whereby each of said electron tubes is rendered conducting at a selected level of said substantially linearly changing signal, a common output terminal connected to another electrode in each of said tubes, and an impedance means connected to said output terminal and forming a part of the individual time constant circuit of any tube that is conducting.

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