

May 31, 1960

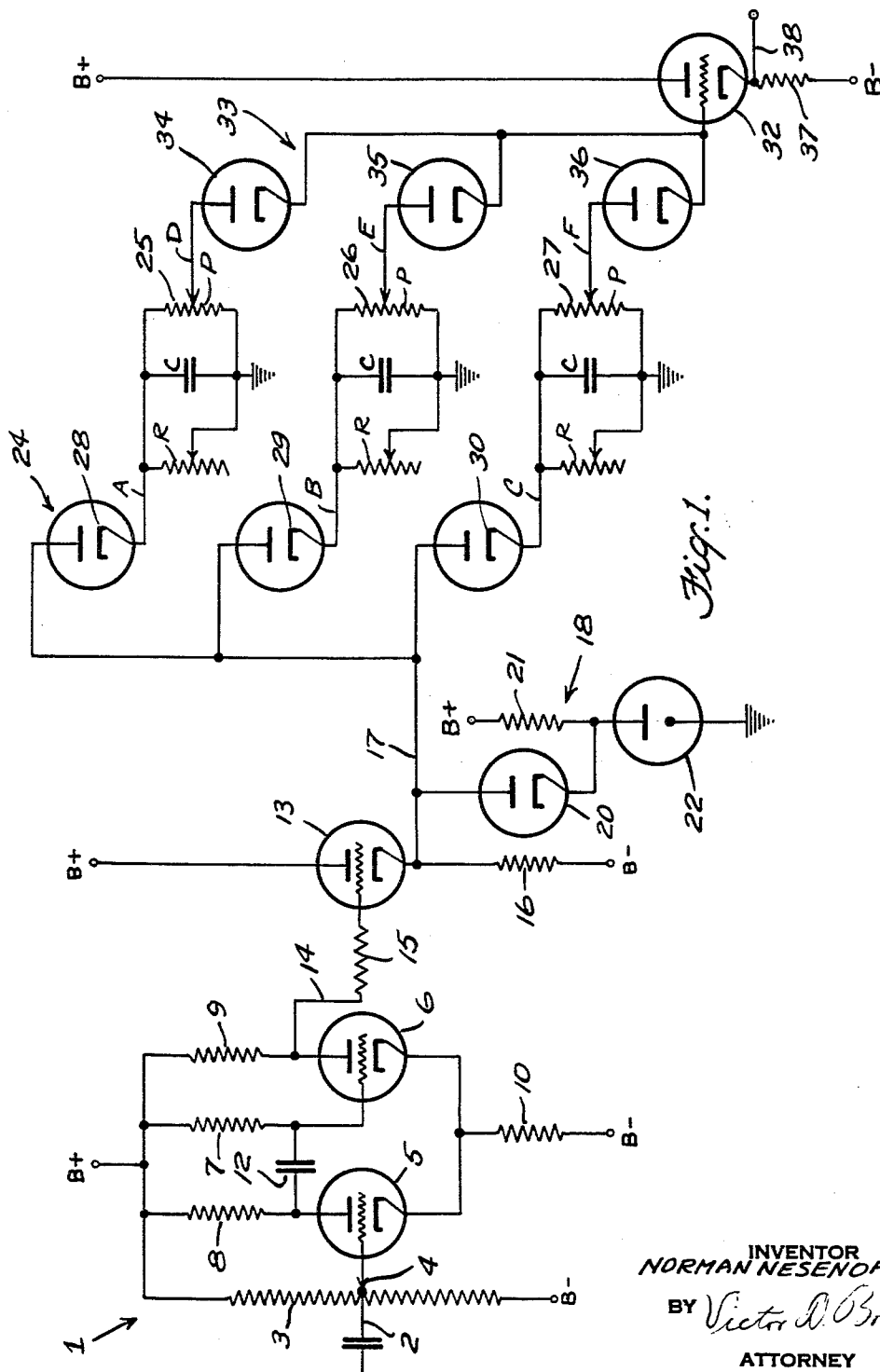
N. NESENOFF

2,939,082

ELECTRONIC FUNCTION GENERATOR

Filed June 10, 1958

2 Sheets-Sheet 1



May 31, 1960

N. NESENOFF

2,939,082

ELECTRONIC FUNCTION GENERATOR

Filed June 10, 1958

2 Sheets-Sheet 2

Fig. 2.

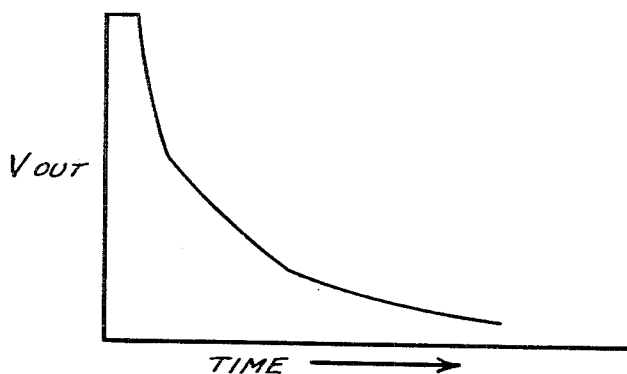
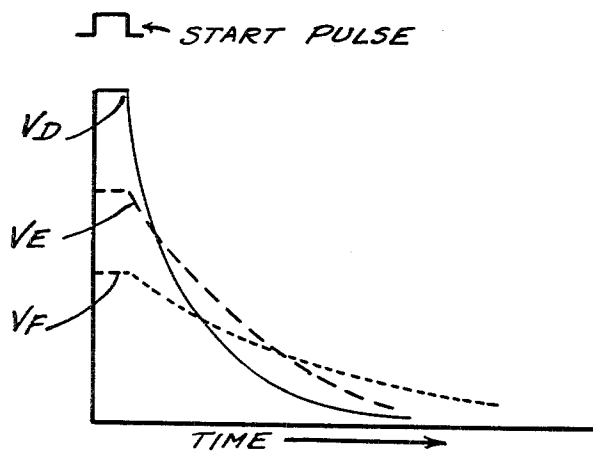


Fig. 3.

INVENTOR
NORMAN NESENOFF

BY *Victor N. Bross*
ATTORNEY

1

2,939,082

ELECTRONIC FUNCTION GENERATOR

Norman Nesenoff, Flushing, N.Y., assignor to Sperry Rand Corporation, Ford Instrument Company Division, Long Island City, N.Y., a corporation of Delaware

Filed June 10, 1958, Ser. No. 742,464

6 Claims. (Cl. 328—143)

This invention relates to a function generator and particularly to a device which is capable of generating a function proportional to the reciprocal of time. Hitherto means for generating functions according to time were either mechanical or electrical means, such means including diode switching devices for making linear approximations, cams and potentiometers.

According to this invention, there is provided an all-electronic device which generates functions of time by making exponential approximations with portions of waveforms obtained from the discharging of impedance combinations. Preferably, these impedance combinations comprise resistor-capacitor networks which desirably, but not necessarily, are arranged in parallel. The accuracy of the generated function is largely dependent upon the number of the networks employed.

One object of the invention is to provide a compact economically constructed electronic circuit for generating time functions.

Another object of the invention is to provide a fast acting function generator, the accuracy of which is assured through the provision of means for supporting starting pulses of uniform and constant duration and through the elimination of loading factors which would distort the exponential waveforms from which the generated function is selected.

The invention may be better understood on reading the following detailed description of one embodiment thereof which is taken in conjunction with the accompanying drawing in which

Fig. 1 illustrates schematically the circuitry of the function generator,

Fig. 2 is an approximating voltage versus time graph, and

Fig. 3 is a generated output voltage formed from the approximating voltages of Fig. 2 versus time graph.

Referring to the drawing, there is provided a monostable multivibrator 1, the operation of which is started on the appearance of a pulse on its grid lead 2. The grid of the multivibrator is also connected to a potentiometer 3 by means of a potentiometer wiper 4. The potentiometer 3 is energized through the B+ voltage source which also biases the plates of the cathode coupled triodes 5 and 6. The grid of the triode 6 is similarly biased from the B+ voltage source, a grid resistor 7 being provided in the grid biasing connection. The triodes 5 and 6 have plate resistors 8 and 9 in their respective plate to voltage source leads. A cathode resistor 10 connects the common cathode element of the two triodes to the negative B voltage terminal to which one end of the potentiometer 3 is also joined. A capacitor 12 couples the plate of the triode 5 to the grid of the triode 6. Capacitor 12 operates to discharge at the grid of triode 6 and fires triode 6 at the predetermined period of time after its cut-off.

The output of the multivibrator is fed to the grid of cathode follower 13 on output lead 14 which includes a

2

resistor 15. The plate of the cathode follower 13 is biased by a B+ voltage source and its cathode resistor 16 is connected to the negative B voltage terminal.

The voltage output on follower lead 17 of the cathode follower is regulated by a voltage clamping device 18 which consists of a diode 20, the cathode element of which is connected between a plate resistor 21 and the plate of voltage regulation tube 22 which is arranged to discharge to ground. The plate resistor 21 is connected to the positive terminal of a B voltage source.

The regulated voltage appearing on the follower lead 17 is placed into a parallel combination 24 of RC networks 25, 26 and 27 through diodes 28, 29 and 30, respectively. Each of the RC networks comprise a parallel combination of units which include capacitor C, variable resistor R and potentiometer P whose wiper output receives an attenuated portion of the charged capacitor voltages appearing across the resistor.

The potentiometer outputs are placed on the grid of cathode follower 32 through a diode configuration 33 comprising diodes 34, 35 and 36 which are separately connected to the potentiometers. The plate of the cathode follower 32 is biased by a B+ voltage source and its cathode resistor 37 is connected to the negative B voltage terminal. The generator function output of the function generator is introduced to the follower lead 38 of the cathode follower 32.

In operation, an input pulse is applied to the monostable multivibrator 1 which yields a pulse of constant duration. This pulse is then applied to the cathode follower 13 which provides a low impedance driving source to charge the capacitors. The cathode follower output pulse is acted upon by the voltage clamping circuit 18, so that the output voltage is stabilized. The regulated voltage which appears at points A, B and C is initially at some voltage less than that of the input pulse. When the regulated voltage appears on the plates of the diodes 28, 29 and 30 they will conduct and the voltages at A, B and C are made equal to the input voltage. When the input voltage is removed, the diodes will cease to conduct and the voltages at A, B and C will decrease in an exponential fashion as determined by the individual RC time constants. The voltages at D, E and F are attenuated at different rates according to said RC time constants and are initially determined by the setting of the potentiometers P. These voltages are then placed on the plates of the diodes 34, 35 and 36. Because the cathode elements of these latter diodes are joined, the diode which received the highest voltage will cut off the other diodes preventing them from conducting which is due to the fact that the diode which is first to conduct assumes a positive potential on its cathode which is shared by the other cathodes, the plate potentials of which are insufficient to cause them to conduct. The generated voltage of the circuit will, therefore, be a composite voltage comprising the largest portions of the voltages appearing on the latter diodes. The outputs of these diodes decrease exponentially with time and are shown on the voltage time graph of Fig. 2. The approximated function voltage selected from the largest of the several diode voltages as they decrease exponentially is shown in the voltage output versus time graph of Fig. 3. It is noted that the generator function is clamped to a constant value for the duration of the input pulse.

Obviously the accuracy of the approximation can be increased by using a greater number of exponential RC combinations within the precisions and variations of its components. The RC combinations are not necessarily restricted to parallel combinations as shown and described and the impedance elements, which are shown to be capacitors, may be inductor elements which are capable of charging and discharging and hence generating

the approximating waveform portions shown in Fig. 2. Accordingly, various modifications of the function generator may be effected by a person skilled in the art without departing from the scope and principle of the invention as defined in the appended claims.

What is claimed is:

1. An electronic function generator comprising a plurality of resistor impedance networks in electrically connected combination, a single input means through which uniform pulses of constant duration are imparted to said networks, said networks being adapted to be charged by said constant pulses and exponentially discharged on the removal of said pulses and means for selecting the largest of the exponentially discharging voltages of said networks and transmitting said selected voltage to the output of said generator as the desired generated function.

2. An electronic function generator comprising a plurality of resistor-capacitor networks in electrically connected combination, a single input means through which uniform pulses of constant duration are imparted to said networks, said networks being adapted to be charged by said constant pulses and exponentially discharged on the removal of said pulses and means for selecting the largest of the exponentially discharging voltages of said networks and transmitting said selected voltage to the output of said generator as the desired generated function.

3. An electronic function generator comprising a plurality of resistor-capacitor networks connected in parallel combination, a single input means through which uniform pulses of constant duration are imparted to said networks, said networks being adapted to be charged by said constant pulses and exponentially discharged on the removal of said pulses and means for selecting the largest of the exponentially discharging voltages of said networks and transmitting said selected voltage to the output of said generator as the desired generated function.

4. An electronic function generator comprising a plurality of resistor-capacitor networks connected in parallel combination, a monostable multivibrator by which uniform pulses of constant duration are imparted to said networks in accordance with input pulses applied to said multivibrator, said networks being adapted to be charged by said constant pulses and exponentially discharged on the removal of said pulses and means for selecting the largest of the exponentially discharging voltages of said

networks and transmitting said selected voltage to the output of said generator as the desired generated function.

5. An electronic function generator comprising a monostable multivibrator to which input pulses from a single source are applied, a cathode follower connected to the output side of said multivibrator, a voltage clamping device arranged to stabilize the voltage output of said cathode follower, means connected to the output of said cathode follower for generating a plurality of exponential voltages, said generating means including voltage adjusting devices for attenuating each of said plurality of exponential voltages and means for selecting the largest of said attenuating exponential voltages and transmitting said selected voltage to the output of said generator as the desired function generator voltage.

6. An electronic function generator comprising a monostable multivibrator to which input pulses from a single source are applied, a first cathode follower connected to the output side of said multivibrator a second cathode follower having the output side thereof connected to the output of said generator, a voltage clamping device arranged to stabilize the voltage output of said first cathode follower, a plurality of parallel branches connected between the output of said first cathode follower and the grid of said second cathode follower, each of said branches including in series a diode, a resistor-capacitor parallel network, a voltage attenuating potentiometer connected across said network and a second diode, the cathodes of said second diodes being connected to each other and to the grid of said second cathode follower, whereby said second diodes in conjunction with said second cathode follower are adapted to select the largest of the attenuated network output voltages and transmit said selected voltage to the output of said generator as the desired function generator voltage.

References Cited in the file of this patent

UNITED STATES PATENTS

2,570,431	Crosby	Oct. 9, 1951
2,683,807	Paxson	July 13, 1954
2,763,840	Pfleger	Sept. 18, 1956
2,831,107	Raymond et al.	Apr. 15, 1958
2,831,108	Barditch	Apr. 15, 1958
2,890,832	Stone	June 16, 1959
2,899,550	Meissinger et al.	Aug. 11, 1959