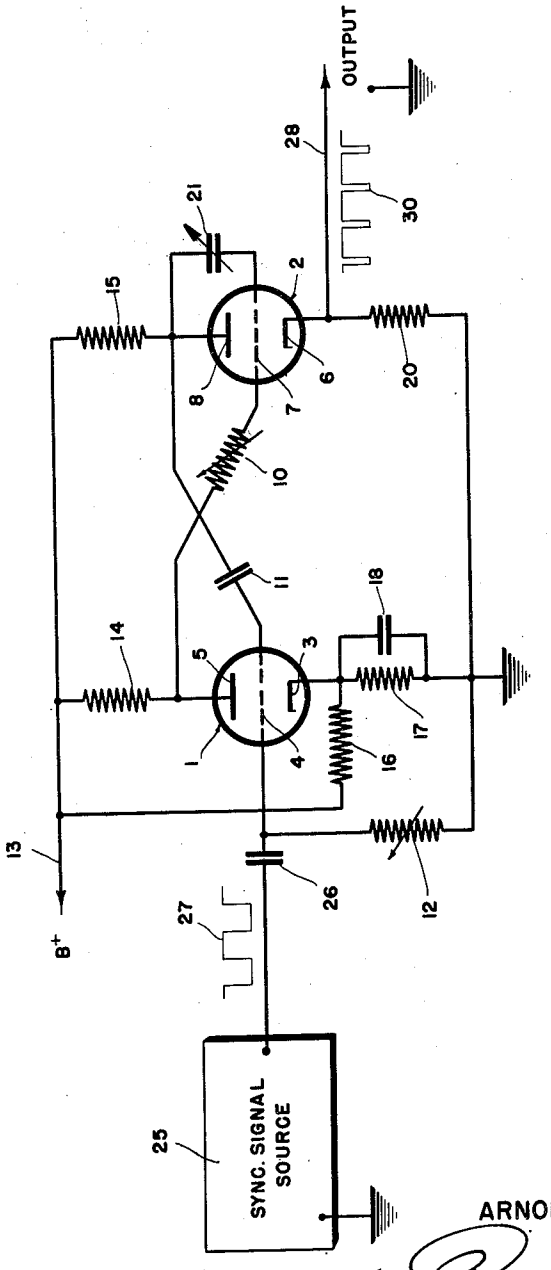
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A. H. BARTELS

PULSE GENERATOR

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INVENTOR
ARNOLD H. BARTELS

BY

ATTORNEY

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PULSE GENERATOR

Arnold H. Bartels, Fort Wayne, Ind., assignor, by mesne assignments, to Farnsworth Research Corporation, a corporation of Indiana

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1 Claim. (Cl. 250—36)

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This invention relates generally to pulse generators, and particularly relates to a foreign-driven multivibrator circuit arranged to develop output pulses of short duration.

A multivibrator is an oscillator comprising two thermionic tubes having their plates cross-connected by impedances to their grids. In a conventional multivibrator condensers are utilized for cross-connecting the plates to the grids of the two tubes. A multivibrator of this type is usually self-oscillating, although it can be arranged not to be self-oscillating in which case driving impulses are required from an external source for determining the frequency of the output signal. A circuit similar to a multivibrator has also been suggested where the plates are cross-connected to the grids by means of series resistors. When one of the tubes is conducting, the other tube is non-conducting. This condition is maintained until a driving impulse causes the space current in the conducting tube to cease, whereupon the previously non-conducting tube will conduct space current. Accordingly, two driving impulses are required for each operating cycle of the circuit.

Multivibrators have been widely used in the television and related fields for deriving square waves or pulses which may be employed, for example, for timing the scanning beams of television picture signal generating and reproducing tubes. In particular, multivibrators have been utilized for developing blanking and synchronizing pulses required for the transmission and reproduction of television pictures. For these purposes it is very desirable to utilize a pulse generator which develops pulses of short and controllable duration because the horizontal blanking pulses and the horizontal synchronizing pulses occupy only approximately 15% and 8%, respectively, of the time period of an entire deflection cycle. Pulses of this type can be obtained from conventional multivibrators with difficulty only because both tubes of the multivibrator conduct space current at alternate times and each tube conducts space current for substantially the same period of time. When an output pulse of short duration is required one of the tubes of the multivibrator must be conductive for a short period of the entire cycle only which can not be conveniently effected with conventional circuits.

It is an object of the present invention, therefore, to provide a pulse generator for developing output pulses of short duration.

A further object of the invention is to provide a novel foreign-driven multivibrator circuit for developing an output signal consisting of pulses of short controllable duration.

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In accordance with the present invention, there is provided a pulse generator comprising a first electric discharge device arranged to be normally non-conducting and a second electric discharge device arranged to be normally conducting, each discharge device having a cathode, a grid and an anode. A resistor is provided for coupling the anode of the first discharge device to the grid of the second discharge device and a condenser is provided for coupling the anode of the second discharge device to the grid of the first discharge device. Means are provided for periodically rendering the first discharge device conducting and for simultaneously reducing the space current in the second discharge device. Finally, means are provided for deriving output pulses of short duration from the pulse generator.

For a better understanding of the invention, together with other and further objects thereof, reference is made to the following description, taken in connection with the accompanying drawing, and its scope will be pointed out in the appended claims.

In the accompanying drawing, the single figure shows a pulse generator comprising a multivibrator circuit embodying the present invention.

Referring now more particularly to the single figure of the drawing, there is illustrated a multivibrator comprising two thermionic tubes 1 and 2. Although, thermionic tubes 1 and 2 have been illustrated with separate envelopes they may also be enclosed in a common envelope in the manner of a duplex triode. Tube 1 includes cathode 3, control grid 4 and anode 5, while tube 2 is provided with cathode 6, control grid 7 and anode 8. Anode 5 of tube 1 is conductively connected to grid 7 of tube 2 through series resistor 10 which may be variable as shown. Anode 8 of tube 2 is coupled to grid 4 of tube 1 through coupling condenser 11. Variable grid leak resistor 12 is provided for connecting grid 4 to ground.

Anodes 5 and 8 are supplied with positive potential from a suitable source indicated at B+ through lead 13. Lead 13 is connected to anodes 5 and 8 through anode resistors 14 and 15, respectively. Cathode 3 is connected to lead 13 and hence to the anode supply voltage through resistor 16. Resistor 17 connects cathode 3 to ground. Condenser 18 bypasses resistor 17 to ground and provides a low impedance path for alternating current. The current flowing from

the anode supply through resistors 16 and 17 to ground will cause a voltage drop across resistor 16 which will normally keep cathode 3 positively biased with respect to ground. Accordingly, it will be seen that grid 4 is normally maintained at a negative potential with respect to cathode 3. Cathode 6 is connected to ground through cathode resistor 20. Condenser 21, which may be variable as shown, may be provided for coupling grid 7 to anode 8. Although condenser 21 may be used for controlling the duration of the output pulses, it is not essential for the operation of the multivibrator and may be omitted.

The input signal is developed by synchronizing signal source 25 coupled to control grid 4 through coupling condenser 26. The input signal impressed upon grid 4 includes pulses of positive polarity with respect to ground as indicated at 27. The output signal may be obtained across cathode resistor 20 from lead 28. The output signal indicated at 30 consists of short pulses of negative polarity with respect to the normal potential of cathode 6, that is, when tube 2 is conducting.

At the present time no definite theory of operation of the multivibrator of the invention can be offered. It will be realized that it is very difficult to measure experimentally the voltage and current waves which may be present, for instance, on the electrodes of tubes 1 and 2. This is due to the fact that any instrument such as a cathode ray oscilloscope which may be used for measuring the electric waves will introduce changes of the circuit constants of the multivibrator and thus change the operation thereof. The following tentative theory of operation is presented here with the understanding that it may not be correct in all details.

Let us assume that tube 2 has just been rendered conducting, for example, by connecting line 13 to the anode supply voltage B+. Consequently, control grid 7 will assume a positive potential equivalent to the anode supply voltage impressed through resistors 14 and 10. Thus, grid 7 is positive with respect to cathode 6 and space current begins to flow through anode resistor 15 and tube 2. This causes a voltage drop across anode resistor 15 which will depress the potential of anode 8. Thus, it will be seen that grid 7 assumes momentarily a higher potential than anode 8 and, accordingly, grid 7 will draw grid current which flows from line 13 through resistors 14 and 10 through tube 2 to ground. The grid current flowing through resistors 14 and 10 will depress the potential of control grid 7 until the anode current through tube 2 as well as the grid current have adjusted themselves to an equilibrium value so that the potential of grid 7 is below that of the anode supply voltage.

The depressed potential of anode 8 is impressed upon control grid 4 through coupling condenser 11, thus biasing tube 1 beyond cutoff. However, the charge of coupling condenser 11 is gradually dissipated to ground through grid leak resistor 12. Therefore, the blocking potential impressed upon control grid 4 is removed after a period of time determined by the time constant of coupling condenser 11 and grid leak resistor 12. However, tube 1 should be normally non-conducting and, therefore, a suitable biasing potential is supplied to tube 1 which will normally bias it beyond cutoff. This is effected through the potential drop of the current flowing from the anode supply B+ through resistors 16 and 17 to ground. Thus, cathode 3 is maintained at a potential that is positive with respect to ground and consequently control grid 4 is maintained negative with respect to cathode 3 because the potential of control grid 4 can not drop below ground potential.

Thus, it will be seen that tube 2 is normally conducting, while tube 1 is normally non-conducting. The multivibrator of the invention, therefore, is not self-oscillating and must be driven by a foreign source. For the purpose of developing one output pulse it is necessary to initiate the conduction of space current in tube 1 by some suitable means. This may be effected, for instance, by synchronizing signal source 25 which develops positive driving pulses 27 impressed through coupling condenser 26 upon control grid 4. Driving pulses 27 should be of such a magnitude to overcome the negative bias between control grid 4 and cathode 3 sufficiently to render tube 1 conducting. Thus, upon the arrival of a positive driving pulse 27 space current begins to flow in tube 1.

The space current of tube 1 flows through anode resistor 14 causing a voltage drop thereacross. The depressed potential of anode 5 is now impressed through resistor 10 upon control grid 7. The depressed potential of anode 5 is of such a value to drive control grid 7 sufficiently negative to either terminate space current through tube 2 entirely or to reduce it to a low value. Accordingly, either no space current or much less space current will flow through cathode resistor 20. As long as tube 2 is conducting space current a voltage drop is developed across cathode resistor 20 which will maintain cathode 6 at a positive potential with respect to ground. When the space current flowing through cathode resistor 20 is either terminated or considerably reduced, the potential of cathode 6 will approach ground potential. Accordingly, control grid 7 now assumes a less negative or even a positive potential with respect to cathode 6 so that space current is again initiated in tube 2.

The space current flowing through anode resistor 15 again causes a potential drop thereacross which is impressed through coupling condenser 11 upon control grid 4, thus biasing it beyond cutoff. In the meantime we may assume that the positive charge of condenser 26 due to the driving pulses 27 has been partly or entirely dissipated through grid leak resistor 12. The termination of the space current through tube 2 causes the potential of anode 5 to rise. This increased potential of anode 5 is impressed through resistor 10 upon control grid 7 which, in turn, increases the current flow through tube 2 still further. At this instant tube 2 conducts space current while tube 1 is non-conducting, and the cycle of operation repeats again upon the arrival of another positive driving pulse impressed upon control grid 4. Thus it will be seen that the multivibrator of the invention develops but one output pulse at a time in response to the arrival of a driving pulse from synchronizing signal source 25.

The output pulses may be derived across cathode resistor 20 through output lead 28. It has been found experimentally that the duration of the output pulses is very short. This may easily be understood from the previous explanation of the operation because the space current through tube 2 is reduced or terminated only for a short

period of the operating cycle. It has also been found experimentally that the duration of the output pulses may be controlled by adjusting grid leak resistor 12 and coupling resistor 10. It will be evident that grid leak resistor 12 in combination with coupling condenser 11 controls the time constant of tube 1. The value of coupling resistor 10 determines the potential of control grid 7. Furthermore, it has been found that the duration of the output pulses may be controlled by adjusting coupling condenser 21 arranged between control grid 7 and anode 8.

While it will be understood that the circuit specifications of the multivibrator of the invention may vary according to the design of any particular application, the following circuit specifications for a multivibrator are included, by way of example only, suitable for a pulse frequency of the order of 14 kilocycles and using a duplex triode of the 6SN7 type:

Positive potential of anode supply B+ volts	300
Condenser 11 micro-microfarads	100
Condenser 18 microfarads	.06
Condenser 23 micro-microfarads	100
Variable condenser 21 do	10
Resistor 14 ohms	10,000
Resistor 15 do	10,000
Variable resistor 10 do	1,000,000
Resistor 20 do	1,000
Resistor 16 do	100,000
Resistor 17 do	4,700
Variable resistor 12 do	250,000

The pulse width obtained with the multivibrator of the invention having the above circuit specifications was approximately 7% of the operating cycle.

While there has been described what is at present considered the preferred embodiment of the invention, it will be obvious to those skilled in the art that various changes and modifications may be made therein without departing from the invention, and it is, therefore, aimed in the appended claim to cover all such changes and modifications as fall within the true spirit and scope of the invention.

What is claimed is:

A pulse generator comprising a first electric discharge device and a second electric discharge device, each having a cathode, a grid and an anode, and adjustable resistor for coupling the anode of said first device to the grid of said second device to control the duration of output pulses, a condenser for coupling the anode of said second device to the grid of said first device to control the time constant of said first discharge device, resistors connected to said anodes, means for supplying through said anode resistors a potential to said anodes that is positive with respect to ground, an adjustable grid leak resistor for connecting the grid of said first device to ground, means for normally maintaining the grid of said first device negative with respect to the cathode of said first device, an adjustable condenser for coupling grid and anode of said second device to control the duration of output pulses, another resistor for connecting the cathode of said second device to ground, means for periodically rendering said first device conducting, and means for deriving output pulses of short duration across the cathode resistor of said second device, said adjustable resistors and said adjustable condenser controlling the duration of said output pulses.

ARNOLD H. BARTELS.

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