April 28, 1936. F. W. SCHRAMM 2,038,683

PULSATING DIRECT CURRENT GENERATOR

Filed Sept. 8, 1932

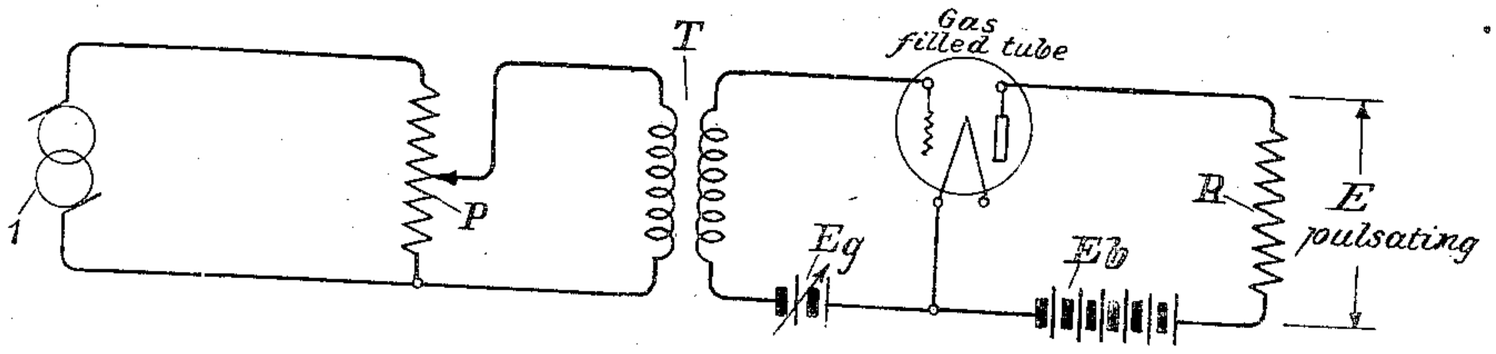

Fig. 1

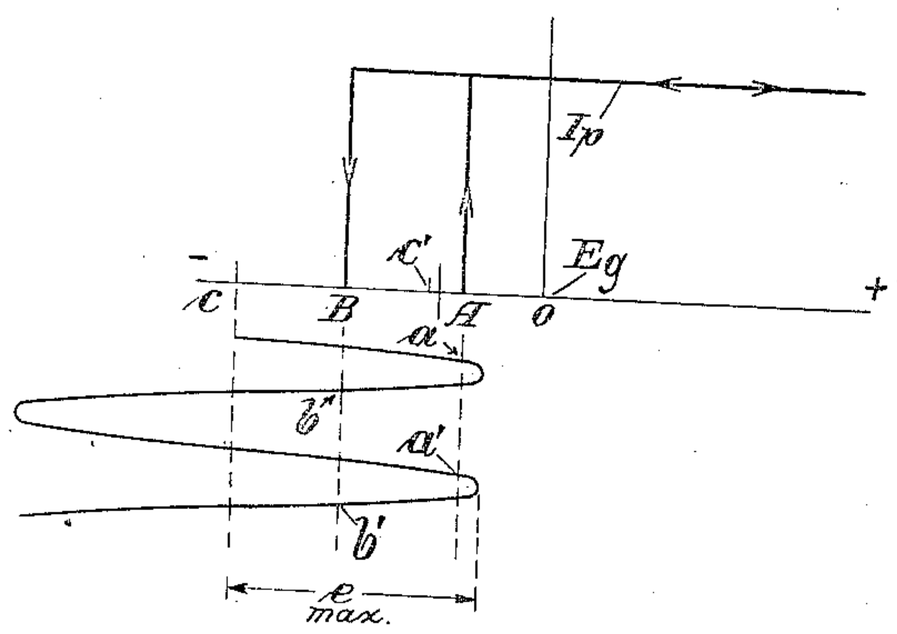

Fig. 2

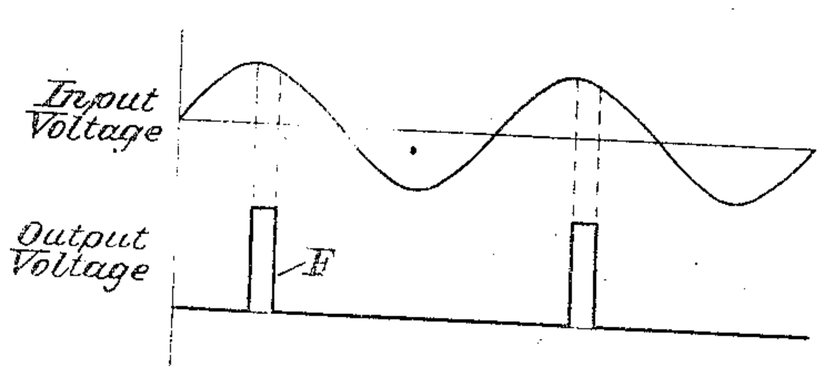

Fig. 3

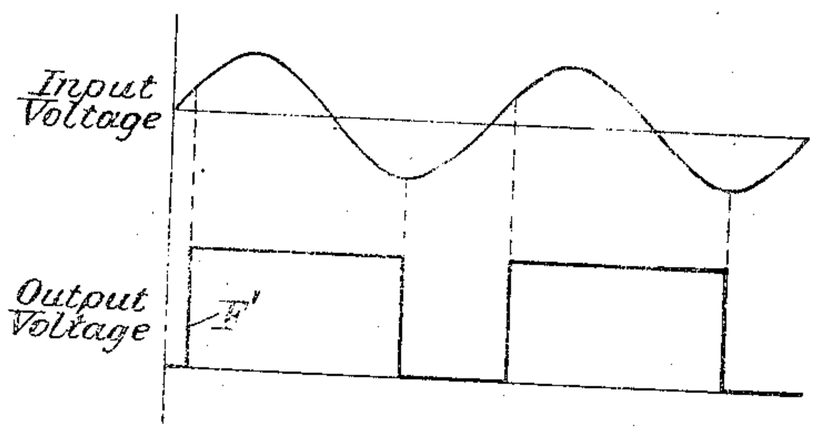

Fig. 4

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PULSATING DIRECT CURRENT GENERATOR

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2 Claims. (Cl. 175—373)

This invention relates to electrical circuits and more particularly to a device for producing a pulsating direct current. More specifically, this invention relates to the application of a gas-filled tube and associated equipment for the production of the aforementioned pulsating direct current.

In certain types of telephone signaling, a pulsating direct current is employed. The pulsating direct current mentioned above is generally obtained by means of mechanical interrupters or commutator devices which periodically open a source of direct current. These mechanical methods of obtaining the required current are subject to wear and require considerable maintenance of the moving parts in order to assure dependable operation. One of the objects of this invention is to devise a means of producing such signals as have been herein mentioned through the use of a gas-filled tube of the proper design containing some suitable gas such as argon or helium at the correct pressure. Such a device involves no mechanical motion or contacts, provides a simple adjustment of the pulse intervals and requires a relatively small amount of energy for control. Such a device may find various uses other than those relating to telephone circuits. It may be used to flash lamps, relays or other indicating devices.

The invention may be more fully understood from the following description together with the accompanying drawing in the Figures 1, 2, 3, and 4 of which the invention is illustrated. Figure 1 is a circuit diagram embodying a preferred form of the invention. Figs. 2, 3, and 4 are graphical illustrations of certain principles of operation of the arrangements of the invention.

A gas-filled tube may be so designed structurally that the grid does not lose complete control of the anode current. In the type of tube which is contemplated for use in this invention the grid may be, for example, of the ladder type with the grid wires spaced sufficiently close so that the anode current may be stopped by a grid potential which is more negative than the value at which ionization takes place. Hence in this type of tube the operation and release of the tube may be controlled by the potential applied to the grid.

Fig. 2 of the drawing is the grid voltage plate current characteristic curve I_p of the tube which is designed to be used in this invention. For all grid potentials more negative than OB, no anode current will flow. When the negative potential applied to the grid is decreased to the value OA, the tube will operate and the anode current will rise suddenly as shown on curve I_p of Fig. 2. As the potential applied to the grid is decreased toward and to O or as this potential is made positive, the tube will remain operated and the anode current will not change. Now as the positive potential applied to the grid is decreased towards O and then a negative potential is applied to the grid, the tube will remain operated until the negative potential OB is reached. When this potential is reached, the tube will release and the anode current will be completely cut off.

Fig. 1 of the drawing is a circuit diagram of the equipment employed to accomplish the purposes of this invention. An alternating potential of the correct frequency is applied from the generator I through potentiometer P to transformer T and thence to the grid circuit of the gas-filled tube. Battery E_g supplies the necessary bias to the grid of the tube. The anode voltage of the tube is supplied by battery E_b through resistance R. When an alternating potential is applied to the grid circuit, the effective potential resulting from the bias supplied by battery E_g plus the applied alternating potential at certain portions of the cycle may be so adjusted as to cause the tube to operate in the desired manner.

The periodicity of the pulsating potential which is delivered by the above described equipment is dependent upon the frequency of the alternating potential applied to the grid circuit. By a proper choice of the applied alternating potential and bias battery, the length of the pulses may be varied within limits as will be demonstrated hereinafter.

Fig. 2 illustrates the method in which the fixed grid bias and the alternating potential applied to the grid combine to cause the tube to operate and release thus delivering a pulse of unidirectional potential across resistance R. In the steady state with no alternating potential applied to the grid, the negative bias on the grid is shown as OC. Assume an alternating potential of approximately sine wave form to be supplied to the grid circuit. The maximum value of the alternating potential is designated as e_{max}. As the alternating potential increases from zero to the maximum positive value, the resultant negative potential applied to the grid will decrease until it reaches the value shown at *a*. At this point, the resultant potential applied to the grid will be of such a value that the tube will break down. As the applied alternating potential increases further in the positive direc-

tion from a to its maximum value e_{max}, there will be no change in the operation of the tube and the anode current will remain constant.

After the applied alternating potential has passed its maximum positive value e_{max}, it will decrease in value and there will be no change in the operation of the tube until the point b is reached at which time the tube will release and stay released until the applied alternating potential completes the cycle to the point a' at which time the tube will reoperate and remain so operated until the point b' is reached. This manner of operation and release will be repeated for each cycle of the impressed potential.

The time during which the gas-filled tube is operated is that time which elapses between points a and b. This time interval may be varied by varying the value of the fixed bias. If the negative bias potential supplied to the grid of the tube is reduced to a value OC', then the tube will be unoperated for only the short interval of time during which that part of the negative cycle adds sufficient negative potential to the grid bias supplied by battery E_g to produce a net negative potential on the grid of a value OB or larger. Figs. 3 and 4 illustrate the effect produced by shifting the bias supplied to the grid of the tubes. For example, the line F of Fig. 3 might show the operating characteristic of the tube when the fixed grid voltage was OC and the line F' of Fig. 4 might show how the tube would operate when the fixed grid voltage was OC'. Therefore by proper adjustment of the bias potential and the maximum value of the impressed alternating potential, the length of the pulse of unidirectional potential may be varied to that value which is desired.

While the invention has been disclosed as embodied in certain specific forms which are deemed desirable, it is understood that it is capable of embodiment in many and other widely varied forms without departing from the spirit of the invention as defined in the appended claims.

What is claimed is:

1. A device for producing a pulsating direct current comprising a gas-filled discharge tube, an adjustable grid biasing battery for said tube for applying to the grid a voltage sufficiently negative to be below that needed to cause the tube to discharge and below that needed to maintain the tube in a discharging condition after breakdown, a source of alternating current of constant amplitude, means for applying alternating potentials from said source to the grid of said tube to cyclically raise said grid biasing voltage above that needed to cause the tube to discharge and to restore said grid voltage to its original condition whereby a pulsating direct current will flow in the plate circuit of said tube under control of the grid voltage whereby an adjustment of said grid biasing battery may vary the duration of said produced direct current pulses.

2. A device for producing a pulsating direct current comprising a gas-filled discharge tube, means for applying to the grid of said tube a fixed biasing voltage sufficiently negative to be below both the breakdown voltage of the tube and below the voltage needed to maintain the tube in a discharging condition after breakdown, and means for applying to the grid of said tube an alternating potential of constant amplitude and of sufficient magnitude to cyclically raise said grid biasing voltage above the breakdown voltage of said tube and to restore said grid voltage to its fixed value whereby said tube will have discharging and non-discharging conditions under control of the grid voltage and means for varying the amplitude of said alternating current applied to said tube whereby the duration of the produced direct current pulses may be varied.

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