Sept. 15, 1953 D. A. GRIFFIN 2,652,519

GASEOUS DISCHARGE TUBE CIRCUIT

Filed April 20, 1945

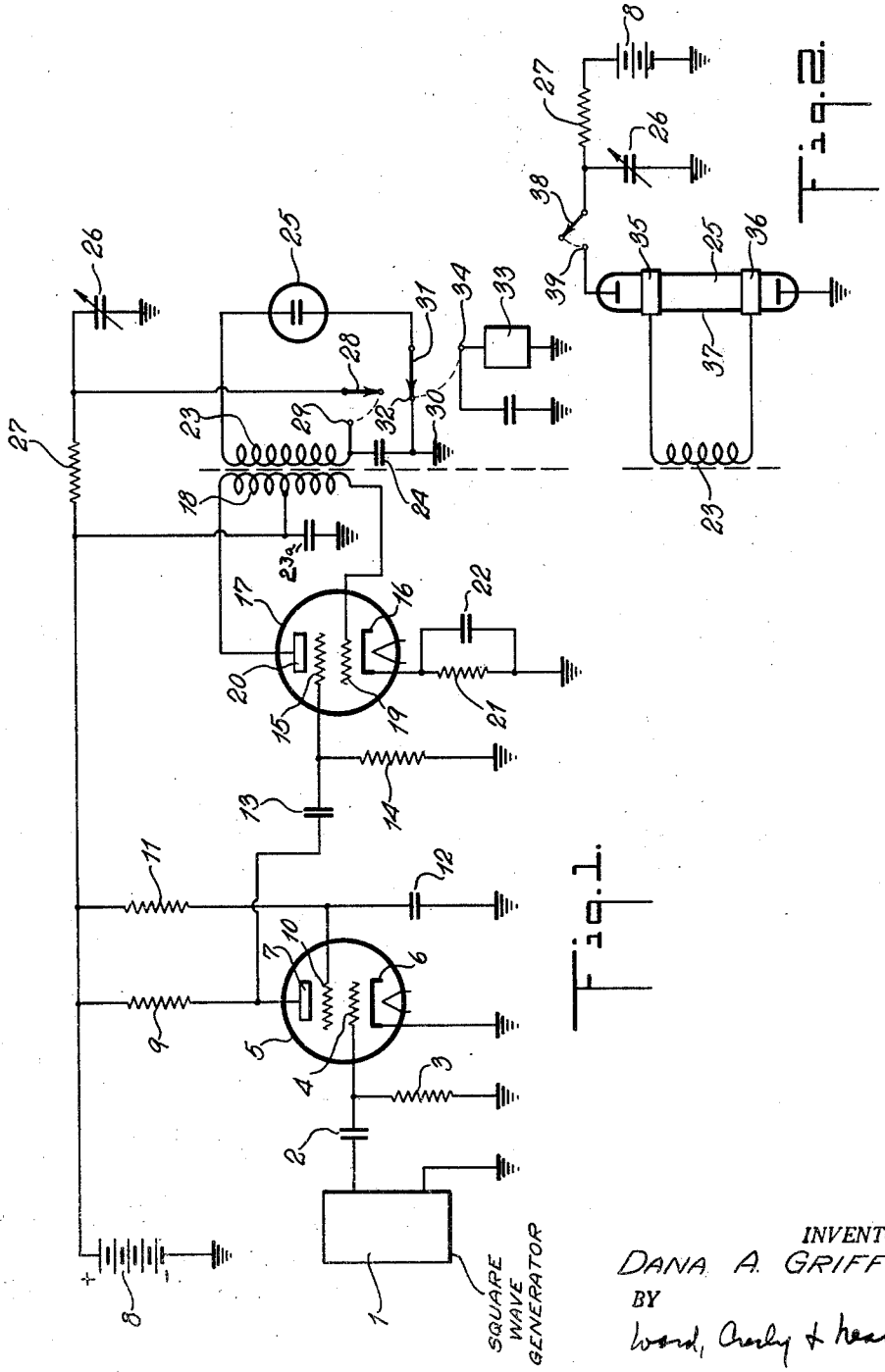


Fig. 2

Fig. 1

INVENTOR.
DANA A. GRIFFIN
BY
Wood, Cooley & Head
ATTORNEYS

Patented Sept. 15, 1953 2,652,519

UNITED STATES PATENT OFFICE

2,652,519

GASEOUS DISCHARGE TUBE CIRCUIT

Dana A. Griffin, North Plainfield, N. J., assignor to Dana A. Griffin, William J. Hammond, and Brunson S. McCutcheon, copartners, doing business as Communication Measurements Laboratory, New York, N. Y.

Application April 20, 1945, Serial No. 589,323

5 Claims. (Cl. 315—170)

1

This invention pertains to electrical circuits and apparatus for the accurate firing of gaseous discharge tubes at a desired repetition rate.

An object of the invention is to provide means whereby the gaseous discharge tube, such as a "glow discharge" tube, may be fired with great precision a desired number of times per second, thus causing the tube to become a source of stroboscopic light.

Another object is to provide means for maintaining the output of stroboscopic light at a high and relatively constant level over a wide range of firing frequencies.

Still another object is to provide a source of accurately timed, unidirectional pulses of high amplitude.

Other objects will be apparent from the following detailed explanation, having reference to the drawings in which:

Fig. 1 shows, in circuit diagram form, a preferred modification of the invention in which the firing pulses are applied directly to the electrodes of the gaseous discharge tube; while

Fig. 2 shows an alternate modification in which the firing pulses are applied indirectly to said tube.

Attempts to use two-electrode, gas-filled tubes, such as a "glow discharge" tube, as a source of stroboscopic light, have heretofore proved rather unsatisfactory, due to the fact that the firing voltage of such a tube does not remain constant. That is to say, if the tube is fired by permitting a condenser to charge through a resistance once every cycle, unavoidable variations in the ignition voltage required by the tube, from time to time, will cause it to fire at different parts of the condenser charging cycle, for the different cycles, thus producing light pulses which are unevenly spaced in time, with obviously unsatisfactory results when viewing objects in motion, by intermittent or stroboscopic light effects.

I have discovered, in accordance with one aspect of my invention, that if the tube is fired by a radio frequency pulse which takes only about a millionth of a second to build up to the maximum firing voltage, any irregularities in the firing voltage required by the tube, from time to time, will produce negligible errors in firing times, even though the repetition rate may be relatively high, for example, on the order of ten thousand cycles per second or more.

Referring now to Fig. 1, the block diagram 1 represents a square wave generator, such as a relaxation oscillator, the output of which is impressed across a "peaker" circuit, comprising

2

series capacity 2 and resistance 3, thereby to produce for each square wave of input a sharply peaked positive pulse and a sharply peaked negative pulse, of extremely short time duration.

The upper terminal of resistance 3 is connected to the control grid 4 of a screen grid electronic tube 5, the lower terminal of this resistance being grounded as shown. Also, the indirectly heated cathode 6 of the tube is directly grounded, as shown, whereby the positive and negative voltage impulses, developed as aforesaid, across resistance 3, are impressed upon the input to tube 5. The anode 7 of screen grid tube 5 is energized from a source of direct current voltage 8, having its negative terminal grounded as shown, and its positive terminal connected through a resistance 9 to anode 7. Likewise, positive voltage from source 8 is supplied to the screen grid 10 of the tube through another resistance 11. In addition, the screen grid is connected to the ground through a by-pass condenser 12 for filtering off high frequency components.

It will be observed that no negative biasing voltage is applied to the control grid 4 of tube 5, so that the space current which flows between cathode 6 and anode 7 is determined principally by the potential of the high voltage plate supply 8, and by the value of the resistor 9 in the plate circuit. When no pulses are being applied to the control grid 4, the plate 7 will be at a relatively low positive potential, owing to the relatively high plate current voltage drop across resistor 9. For the positive input pulses impressed on the control grid by the peaker circuit, the plate 7 will assume an even lower positive potential, owing to the increased plate current flowing through resistor 9. On the other hand, for negative input pulses applied to the control grid, by the peaker circuit, the space current in tube 5 will be cut off and hence the potential of plate 7 will rise to the full positive potential of the high voltage plate supply 8.

The instantaneous plate voltage of tube 5, developed as aforesaid, is impressed through a blocking condenser 13 and across a grounded resistor 14 between the screen grid 15 and the cathode 16 of a screen grid tube 17 arranged to operate as a high frequency oscillator by virtue of a coil 18 connected between the control grid 19 and the anode 20 of tube 17. The cathode 16 is maintained positive with respect to the control grid 19 by means of a plate current biasing resistor 21, connected between the cathode and ground, and shunted by a by-pass condenser 22. Coil 18 is tapped to ground, at an interme-

diate point thereof, through a blocking condenser 23*a*, whereby said intermediate point of coil 18 is effectively tapped to the cathode, through condensers 22 and 23*a*, for arranging the circuit to provide sustained oscillations. The plate 20 of tube 17 is connected through the upper half of coil 18 to the positive terminal of the direct current high voltage source 8, for energizing the plate circuit of the tube.

With the circuit as thus arranged, coil 18 is preferably of such size as to cause tube 17 to oscillate at about two million cycles per second, when appropriate direct current potentials are applied to the plate and screen grid electrodes. It will be observed, in this connection, that the screen grid 15 is normally at ground potential, owing to its connection to ground through resistance 14. Under such conditions, the tube 17 is arranged to oscillate very feebly. When, however, tube 5 goes to cut-off, under the influence of a negative pulse applied thereto by the peaker circuit as above explained, a large instantaneous positive potential is applied through blocking condenser 13 to the screen grid 15 of tube 17, whereby this tube oscillates strongly for the duration of such positive pulse. In other words, during this interval, a short pulse of high amplitude, radio frequency energy is generated by tube 17.

The coil 18 in the output circuit of oscillator tube 17 constitutes the primary winding of a transformer, the secondary winding 23 of which is connected through a blocking condenser 24 between the electrodes of a two-electrode, gas-filled or "glow discharge" tube 25. Accordingly, when the oscillator tube 17 is pulsed, in the manner above explained, strong radio frequency oscillations flow in the transformer primary 18 and are picked up by the transformer secondary 23 and applied to the terminals of the glow discharge tube 25, causing the gas path of said tube to ionize, thereby to produce a resultant pulse of light.

The invention, as described thus far, is capable of producing satisfactory stroboscopic light, so long as a high repetition pulsing rate is employed. When, however, the repetition rate is low, the light is emitted by tube 25 during such a small fraction of time that its average intensity is too low for effective stroboscopic illumination. This difficulty is overcome, in accordance with a further aspect of the invention, by means of a resistance-capacity, or RC circuit, consisting of variable condenser 26 and resistance 27 connected between ground and the positive terminal of voltage source 8. Condenser 26 is thus charged from voltage source 8 through resistance 27, and the charge accumulating on the condenser is applied through a switch 28, when operated to the upper position 29, to an electrode of the gaseous discharge tube 25. With the circuit as thus arranged, the blocking condenser 24 is required to prevent grounding of the voltage source 8 at the grounded point 30 of the discharge tube circuit.

The voltage of source 8 and the values of capacity 26 and resistance 27, of the RC circuit, are so chosen with reference to the desired pulsing rate, as to insure that capacity 26 will not charge to a potential high enough to fire tube 25 between successive radio frequency pulses supplied from the oscillator 17. When, however, the gaseous discharge tube 25 is fired by receiving a pulse of radio frequency energy from the oscillator tube 17, its resistance is lowered and capacity 26 discharges through it, thus causing tube 25 to emit a light pulse of high intensity. If a large change is made in the pulse rate of oscillator tube 17, a corresponding change must be made in the value of condenser 26 because, if this capacity is too low in relation to the pulse repetition rate, a sufficient charge may build up on it to fire tube 25 before the radio frequency triggering pulse arrives, thus causing irregular performance. If, on the other hand, the value of capacity 26 is too large in relation to the pulse repetition rate, the potential of the charge built up in it, between pulses, may be so low as to be below the extinction of the discharge tube 25, in which event the condenser will fail to discharge through tube 25, and the light produced by the radio frequency pulses from oscillator tube 17 will not be intensified by the discharge of the condenser 26.

An additional switch 31, which is normally closed to contact 32, to provide circuit operation as above explained, may be used to connect the discharge tube 25 to any desired load circuit 33, in series with tube 25, by operating switch 31 to contact 34, thus providing a convenient source of direct current pulses of high amplitude.

It will be observed that, in the modification of Fig. 1, the circuit including the transformer secondary winding 23 is directly connected to the electrodes of the gaseous discharge tube. Fig. 2 shows an alternative arrangement omitting any direct connection between the radio frequency circuits and the electrodes of the glow discharge tube. Thus, in the modification of Fig. 2, the gaseous discharge tube 25 is provided with external electrodes 35, 36 which may be metal, foil or the like, surrounding and affixed to the outside of the glass envelope 37 of tube 25. These outer electrodes 35, 36 are connected, respectively, to the upper and lower terminals of the transformer secondary winding 23, inductively coupled to the primary winding 18 of Fig. 1. The operation of the modified Fig. 2 circuit, therefore, is essentially the same as that of Fig. 1, in that the pulses of high frequency energy developed by tube 17 ignite the gaseous discharge tube 25 through the action of the external electrodes 35, 36. If the pulse repetition rate is high, the ignition thus produced produces sufficient glow discharge in tube 25 for stroboscopic purposes. If, however, the pulse repetition rate is low, the auxiliary RC circuit 26, 27, 8 of Fig. 2 is employed by operation of switch 38 to contact 39. The arrangement of Fig. 2 has the advantage of completely isolating the radio frequency and direct current circuits from each other with respect to the gaseous discharge tube 25.

What is claimed is:

1. A stroboscopic light source comprising: a gaseous discharge tube capable of emitting light of high intensity for short intervals of time, said tube having an envelope containing gas ionizable along a predetermined path and having ionizing electrodes mounted adjacent said path and said gas having a predetermined electromagnetic field ionization level; means external to said tube generating an electromagnetic energy ionizing field which exceeds said level for periodic intervals of time but which is less than said level between said intervals, said means generating said ionizing field comprising a low frequency electron tube oscillator generating pulses having time durations substantially equal to said intervals and having a predetermined spacing and frequency, a high frequency generator generating an elec-

tromagnetic field, said high frequency generator including an electron tube oscillator whose frequency of oscillation is higher than said predetermined frequency and having means which is responsive to said pulses controlling the output of said high frequency generator, and means coupling said low frequency oscillator to said means controlling the output of said high frequency generator; and coupling means directly applying the output of said high frequency generator to said ionizing electrodes.

2. A stroboscopic light source comprising: a gaseous discharge tube capable of emitting light of high intensity for short intervals of time, said tube having an envelope containing gas ionizable along a predetermined path and having a pair of ionizing electrodes mounted adjacent said path and said gas having a predetermined electromagnetic field ionization level; means external to said tube generating an electromagnetic energy ionizing field which exceeds said level for precisely spaced, periodic intervals of time, but which is less than said level between said intervals, said means generating said ionizing field comprising a low frequency electron tube oscillator generating pulses having time durations substantially equal to said intervals and having a predetermined spacing and frequency, a high frequency oscillator whose frequency of oscillation is higher than said predetermined frequency, said oscillator comprising a vacuum tube having a control electrode and an output electrode, and means coupling said low frequency oscillator to said control electrode; and coupling means connecting said output electrode to said ionizing electrodes.

3. A stroboscopic light source comprising: a gaseous discharge tube capable of emitting light of high intensity for short intervals of time, said tube having an envelope containing gas ionizable along a predetermined path and having ionizing electrodes mounted adjacent said path and said gas having a predetermined electromagnetic field ionization level; means external to said tube generating an electromagnetic energy ionizing field which exceeds said level for substantially only periodic intervals of time, said means generating said ionizing field comprising a low frequency electron tube oscillator generating a plurality of pulses having a predetermined frequency and having rapid build up times and precise spacing with respect to their build up edges, each pulse having a duration substantially equal to one of said intervals, a high frequency generator generating an electromagnetic field, said high frequency generator including an electron tube oscillator whose frequency of oscillation is higher than said predetermined frequency and having means which is responsive to said pulses controlling the output of said high frequency generator, and means coupling said low frequency oscillator to said means controlling the output of said high frequency generator; and coupling means directly applying the output of said high frequency generator to said ionizing electrodes.

4. A stroboscopic light source comprising: a gaseous discharge tube capable of emitting light of high intensity for short intervals of time, said tube having an envelope containing gas ionizable along a predetermined path and having a pair of ionizing electrodes mounted adjacent said path and said gas having a predetermined electromagnetic field ionization level; means external to said tube generating an electromagnetic energy ionizing field which exceeds said level for substantially only periodic intervals of time, said means generating said ionizing field comprising a low frequency electron tube oscillator generating a plurality of pulses having a predetermined frequency and having rapid build up times and precise spacing with respect to build up edges, each pulse having a duration substantially equal to one of said intervals, a high frequency generator generating an electromagnetic field, said high frequency generator including an electron tube oscillator whose frequency of oscillation is higher than said predetermined frequency and having means which is responsive to said pulses controlling the output of said high frequency generator, and means coupling said low frequency oscillator to said means controlling the output of said high frequency generator; coupling means directly applying the output of said high frequency generator to said ionizing electrodes; a source of unidirectional pulses having amplitudes insufficient to ionize said gas; and means coupling said source of unidirectional pulses to said ionizing electrodes.

5. A stroboscopic light source comprising: a gaseous discharge tube capable of emitting light of high intensity for short intervals of time, said tube having an envelope containing gas ionizable along a predetermined path and having a pair of ionizing electrodes mounted adjacent said path and said gas having a predetermined electromagnetic field ionization level; means external to said tube generating an electromagnetic energy ionizing field which exceeds said level for substantially only periodic intervals of time, said means generating said ionizing field comprising a low frequency electron tube oscillator generating a plurality of pulses having a predetermined frequency and having rapid build up times and precise spacing with respect to build up edges, each pulse having a duration substantially equal to one of said intervals, a high frequency generator generating an electromagnetic field, said high frequency generator including an electron tube oscillator whose frequency of oscillation is higher than said predetermined frequency and having means which is responsive to said pulses controlling the output of said high frequency generator, and means coupling said low frequency oscillator to said means controlling the output of said high frequency generator; coupling means directly applying the output of said high frequency generator to said ionizing electrodes; a direct current voltage source whose voltage is insufficient to ionize said gas; a condenser connected between said ionizing electrodes; a resistor; and means connecting said voltage source and said resistor in series between said ionizing electrodes.

DANA A. GRIFFIN.

References Cited in the file of this patent

UNITED STATES PATENTS

Number	Name	Date
1,951,294	Greeff	Mar. 13, 1934
1,961,749	Ewest	June 5, 1934
2,266,668	Tubbs	Dec. 16, 1941
2,342,257	Edgerton	Feb. 22, 1944
2,349,012	Spaeth	May 16, 1944
2,395,850	Colman	Mar. 5, 1946
2,413,182	Hollingsworth et al.	Dec. 24, 1946