June 11, 1935. F. SCHRÖTER 2,004,587

GLOW DISCHARGE TUBE CIRCUIT

Filed April 19, 1930

Fig. 1.

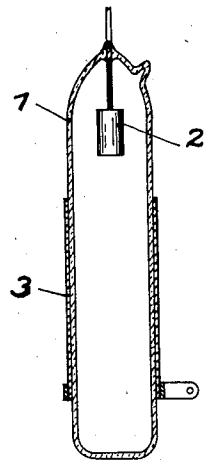
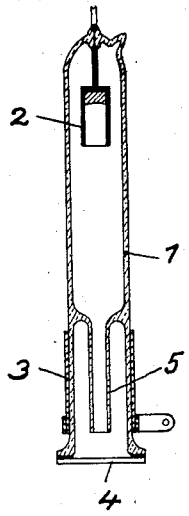


Fig. 2.



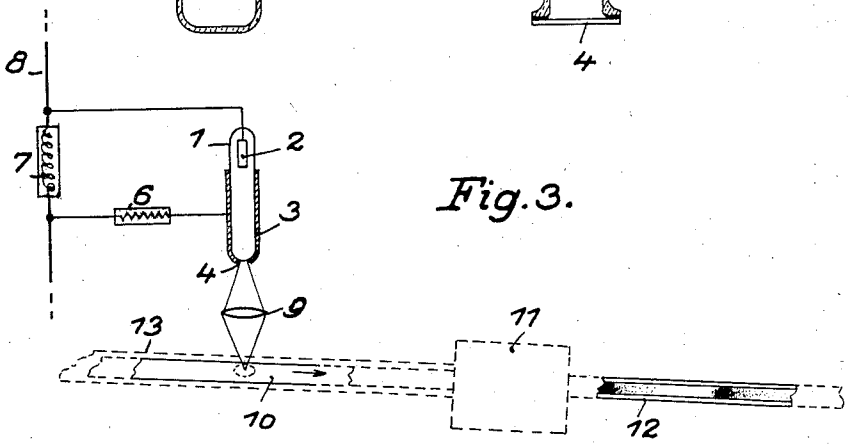


Fig. 3.

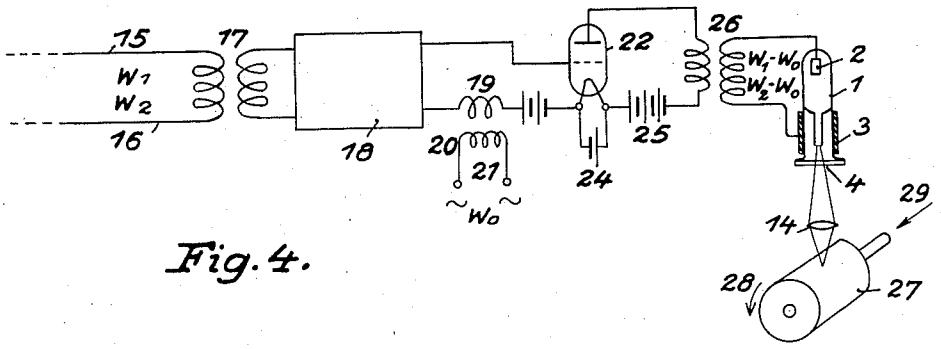


Fig. 4.

Inventor:
Fritz Schröter

By Samuel Astrolink
ATTORNEY

Patented June 11, 1935 2,004,587

UNITED STATES PATENT OFFICE

2,004,587

GLOW DISCHARGE TUBE CIRCUIT

Fritz Schröter, Berlin-Schmargendorf, Germany, assignor to Radio Patents Corporation, New York, N. Y.

Application April 19, 1930, Serial No. 445,790
In Germany July 11, 1929

10 Claims. (Cl. 178—7)

This invention relates to a glow discharge tube filled with rare gases or mixtures of rare gases at low pressures, which tube can be traversed by electric alternating current voltages beyond certain values producing ionization and illumination, whilst it does not allow a continuous current to pass through. Such a tube supplies a discharge current which is not dependent only upon the value of the applied alternating current voltage but also upon the frequency thereof, so that the strength of the current or the brightness of the light which is emitted is a measure for the amplitude and the frequency of the said voltage. The effective current passing through a condenser with a capacity C is $i=C.\omega.E$, wherein E is the effective alternating current voltage and ω the periodicity of the cycle. If the discharge tube according to the present invention is constructed as shown in Figure 1, wherein one electrode is in the interior of the vessel whilst the second electrode forms the condenser armature on the outside of the vessel, a glow discharge flows through the gas, the effective current E and ω of which are proportional, that is to say it increases and decreases at constant voltage with the frequency and at constant frequency with the voltage.

If a travelling wave with an inclined front acts upon such a tube, the starting displacement current and therewith the brightness of the tube momentarily emitted, is proportional to the inclination of the wave, thus the observation or registering of the illumination can serve for arriving at a conclusion as regards the value and the inclination of the excess voltage. As the brightness can be continuously registered on a movable photographic surface, the form and the strength of voltage waves in conducting systems with which the tube is connected directly by a capacity or through an inductance, can be continuously supervised by such photograms.

The construction according to Figure 2 makes it possible to obtain a sharp and well defined spot-like luminous source which may be disposed close against the window 4, thus making it possible to dispense with special collecting lenses and thereby decreasing the cost of the equipment. Furthermore, a tube of the type shown embodying an external electrode, and a narrow channel 5 for producing a sharp spot-like light source enables the arrangement of an extended electrode 3 on the outside wall of the main vessel 1 with a corresponding large capacity surface resulting in a decrease of the effective impedance of the gap.

Moreover, the tube according to the invention may be used for observing or registering signals which are transmitted in the form of modulated alternating current, more especially when the frequency of the said current is modulated. In this case the property of the arrangement with an outer electrode of automatically preventing a continuous current to pass through is an advantage, as it is no longer necessary to prevent the continuous current component of the signal from reaching the circuit of the tube.

In the case just referred to, it is preferable to make the tube according to Figure 2 very narrow and to observe the discharge through a window 4 in the longitudinal direction of the tube, or to allow the discharge to act through the said window. In this way a well-defined point of light of great brightness is obtained. The inner electrode is in this case constructed as a hollow cathode containing a store of strongly electropositive metal, for instance potassium, sodium, cæsium, barium or magnesium, or which it can develop from a suitable reaction mixture under the influence of the heat due to the discharge. The vapours of these metals keep the gas filling pure and therefore the electric properties of the tube remain constant.

Referring to the accompanying drawing,

Figures 1 and 2 show constructions of tubes which can be used according to the invention.

Figure 3 is a diagram of connections of a registering device used in power lines, and

Figure 4 is a diagram of connections used with picture transmission according to the invention.

Referring to Figures 1 and 2, 1 is a glass, quartz, or like tube, 2 is an inner electrode and 3 an outer electrode. In the form of construction shown in Figure 2, there is also arranged inside the tube a separate narrow part 5, which can be seen from the front end 4 of the tube, the said part 5 being preferably made of the same material as the tube, viz, glass, quartz, or the like, through which the glowing displacement current can pass and thus be concentrated so that the light effect through the window 4 can be increased.

In the diagram illustrated in Figure 3, 8 is a portion or branch of a power installation also containing overhead lines, on which therefore electric charges are accumulated, which are propagated in the form of waves. In the part 8 a separate branch 7 is inserted which may, for instance, consist of a choking coil or any other member producing a potential difference at its two ends. The glow tube 1 according to the invention is connected to the two sides of the said branch 7 in such a manner that the inner elec-

trode 2 lies on the one side and the outer electrode 3 on the other side of the branch 7. 6 is a resistance for limiting the strength of the current in the glow tube. If a travelling wave strikes on the branch 7 owing to the suitable dimensions of the latter, a sufficient potential difference is produced at its two ends in order to light up the tube 1. The light which passes through at 4 is projected, preferably after passing through a condensing lens 9, on a light-sensitive strip 10 at a point at which the latter is uncovered by the light-protecting cover 13. The light-sensitive strip is fed in the direction of the arrow into the container 11 in which it can be developed and fixed so that when it comes out at 12 into the open, it shows darkened points which correspond to the voltage reaching the tube and which give an indication of the inclination of the travelling wave.

In the diagrammatic example illustrated in Figure 4, a picture transmission with frequency modulation is shown. Let white correspond to the frequency w_1 and black to the frequency w_2. Then the tones between black and white are transmitted by frequencies which are different from one another. Let these frequencies be transmitted over the lines 15, 16, which may be connected to an aerial or a wire line and reach the amplifier 18 over the transformer 17, from which amplifier they pass to the grid circuit of the rectifying tube 22. The said grid circuit also contains the grid bias battery 23 and the transformer 19, 20 to the terminals 21 of which a local oscillator (not shown) having a constant frequency w_0 is connected. 24 is a source of current for heating the filament and 25 an anode battery for the rectifier 22. Owing to the superposition and rectification, the frequency w_1 minus w_0 will operate in the anode circuit of the rectifier when white is transmitted, whilst the frequency w_2-w_0 operates therein when black is transmitted. Let us assume that the frequency differences are as follows (when w_1 is 6500 cycles, w_2=2,000 periods, and w_0=1,500 cycles:

$$w_2-w_0=500 \text{ cycles}$$

$$w_1-w_0=5000 \text{ cycles}$$

These frequency differences are transmitted over the transformer 26 to the glow tube 1, which in the case of lower frequency glows less than in the case of higher frequency, so that the tones between white and black are reproduced by the different degrees of brightness of the tube and therefore can be reproduced photographically. The light which passes through the window 4 of the tube and is collected by the lens 14, is projected in the form of a spot of light on the drum 27 on which the film or photographic paper is mounted.

The frequencies w_1+w_0 and w_2+w_0 which are produced by heterodyning are kept away from the glow tube, preferably by filter circuits (not shown) in the output circuit of the rectifying tube or input circuit of the glow tube.

It is to be understood that the drum 27 must run in the direction of the arrow 28 at the same speed as the transmitting drum at the transmitting end, on which transmitting drum the picture (or facsimile) to be transmitted is mounted. In the same way the drum 27 must be moved axially in the direction of the arrow 29 at the same speed as the transmitting drum at the transmitting end.

What I claim is:—

1. In a signalling system a receiving circuit; means for transforming signals of constant amplitude and variable frequency into signals of variable amplitude consisting of a glow discharge tube, a first electrode within said tube, a second electrode on the outside of said tube; said electrodes forming a condenser therebetween, and means for impressing signals from said receiving circuit, across said electrodes, of constant current amplitude and variable frequency.

2. In a picture transmitting system; means for transmitting picture signals of constant current amplitude and varying in frequency in accordance with the light and shades of a picture, a receiver comprising means for transforming constant amplitude variable frequency signals into signals of variable amplitude consisting of a glow discharge tube having an internal electrode and an external electrode directly inserted in said receiver to be controlled by said variable frequency signals.

3. In combination with a signal receiving circuit of means for translating signals of constant amplitude and varying frequency into corresponding signals of varying amplitude consisting of a glow discharge tube having an external and an internal electrode directly inserted in said circuit, and means for utilizing light variations of said tube in accordance with said varying frequency.

4. In combination with a signal receiving circuit of means for translating signals of constant amplitude and varying frequency into corresponding signals of varying amplitude consisting of a glow discharge device, an internal and external electrode of said device, means for applying input signals to said electrodes, and means deriving output signals in accordance with light variations of said tube produced by said input signals.

5. In combination with a signalling system, a receiving circuit; means for transforming constant amplitude variable frequency signals into corresponding variable amplitude signals comprising a glow discharge device consisting of a vessel of insulating material filled with a gaseous atmosphere, a narrow tube within said vessel having one end connected to said vessel and having its other end open to divide said vessel into two communicating chambers; a first electrode within said vessel; a second electrode on the outside wall of said vessel, said electrodes forming an electrical condenser with said vessel acting as a dielectric and said gas as a current conductor; means for impressing signals from said receiving circuit across said electrodes; and further means for utilizing light variations within said tube in accordance with the signals applied to said electrode.

6. In a signal receiving device; as claimed in claim 5, provided with a window, the open end of said tube being disposed close against said window.

7. In combination with a signalling system, a receiving circuit; means for transforming constant amplitude variable frequency signals into corresponding variable amplitude signals comprising a glow discharge device consisting of a vessel of insulating material of substantially cylindrical shape filled with a gaseous atmosphere; a narrow concentric tube of insulating material having one end connected to and integral with said vessel and having its other end open to divide said vessel into two communicating chambers; a first electrode within said vessel; a second electrode on the outside wall of said vessel, said electrodes forming an electrical condenser with

said vessel acting as a dielectric and said gas as a conductor; means for impressing signals from said receiving circuit across said electrodes and further means for utilizing light variations within said tube in accordance with signals applied to said electrodes.

8. In a signal receiving device as claimed in claim 7 in which said discharge vessel is provided with a window, the open end of the tube being arranged close against said window.

9. In combination with a signalling system, a circuit for receiving signalling currents; means for translating said currents comprising a glow discharge device consisting of a vessel of insulating material filled with a gaseous atmosphere; a narrow tube disposed within said vessel having one end connected to said vessel and having its other end open to divide said vessel into two communicating chambers; a first electrode within said vessel; a second electrode on the outside wall of said vessel, said electrodes forming an electrical condenser with said vessel acting as a dielectric and the gas as a current conductor; means for applying signalling currents to said electrodes; a window for said vessel, the open end of said tube being arranged close against said window; and further means for utilizing light variations within said tube in accordance with the signals applied.

10. In combination with a signalling system, a circuit for receiving signalling currents; means for translating said currents comprising a glow discharge device consisting of a vessel of insulating material of substantially cylindrical shape filled with a gaseous atmosphere; a narrow concentric tube of insulating material within said vessel having one end connected to and integral with said vessel and having its other end open to divide said vessel into two communicating chambers; a first electrode within said vessel; a second electrode on the outside wall of said vessel, said electrodes forming an electrical condenser with said vessel acting as a dielectric and the gas as a current conductor; means for applying signalling currents to said electrodes; a window for said vessel, the open end of said tube being arranged close against said window; and further means for utilizing light variations within said tube.

FRITZ SCHRÖTER.