

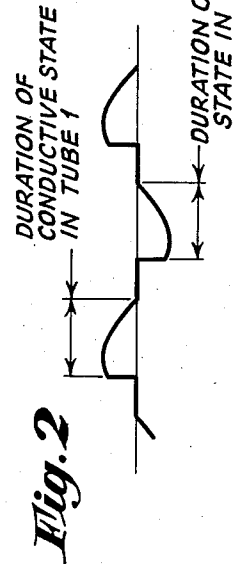
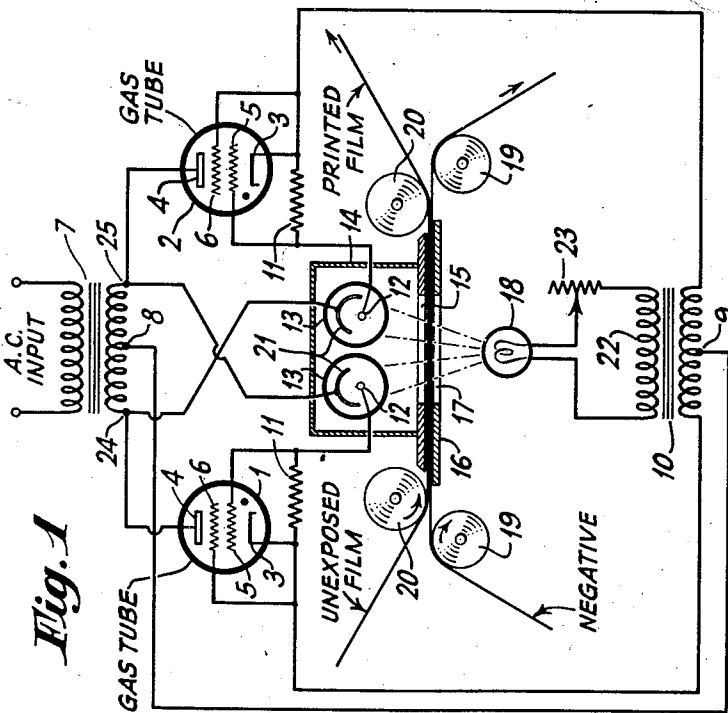
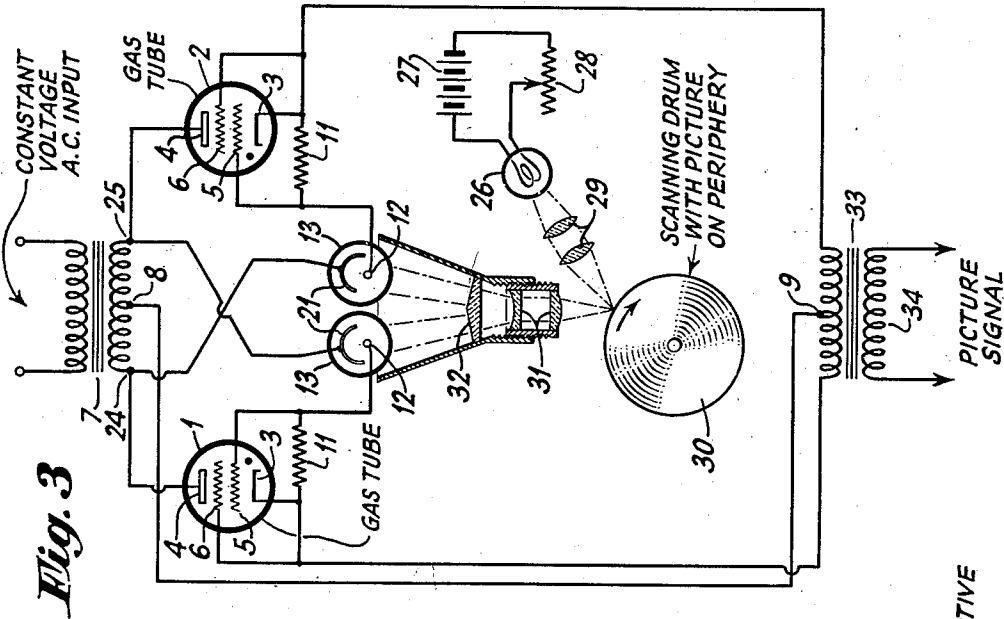
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POWER REGULATOR

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POWER REGULATOR

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This invention relates to power regulators and more particularly to a device which is enabled to provide either variable power regulation or constant power regulation, depending upon the use to which the device is to be put.

Gaseous discharge tubes of the trigger-acting type have been used in various ways for power control in alternating current systems. Such systems are used, for example, for controlling illumination in theaters and in similar applications. The method generally adopted is one which employs so-called "thyatron" tubes, where a greater or lesser value of negative bias on the grid of the tube causes the conduction of electrical energy to start at a point nearer to or farther from the positive peak of each cycle.

It is an object of the present invention to provide a system of power regulation suitable for any one of a variety of different uses, depending upon the load conditions which are to be served.

It is another object of my invention to provide a suitable current regulator for use in connection with a photographic film printer whereby the density of the negative film is caused to control a current supply system for the energization of a printing light source.

It is another object of my invention to provide a variable power supply dependent upon the action of a photo-electric device, such as used in facsimile picture transmission systems, for producing a variable amplitude picture signal.

Other objects akin to those already recited are contemplated and will be apparent upon reviewing the description to follow. The invention itself will best be understood by reference to the accompanying drawing, in which—

Figure 1 shows diagrammatically and schematically a circuit arrangement in combination with apparatus units intended primarily for use as a film printer.

Fig. 2 shows a curve characteristic of the output energy from the current regulator, and

Fig. 3 shows another application of my invention to a use in facsimile picture transmission systems.

Referring first to Fig. 1, I show therein a pair of gaseous discharge tubes 1 and 2, each tube comprising a cathode 3, an anode 4, a control grid 5 and, if desired, a suppressor grid 6. Within the envelope of the tube is a low pressure gaseous atmosphere. Such tubes are commonly termed "thyatron" tubes. Other types of gaseous tubes, however, may be used in my invention without departing from the spirit thereof.

The anodes 4 of the tubes 1 and 2 are connected respectively to different secondary winding terminals 24 and 25 of a transformer 7. The primary of this transformer is fed with energy from any suitable alternating current source. The secondary of the transformer 7 has a mid-tap 8 which is connected to a mid-tap 9 on the primary winding of a transformer 10. The terminals of the primary winding on transformer 10 are connected respectively to the two cathodes 3 and to the suppressor grids 6 of the tubes 1 and 2. Interposed between each cathode 3 and its associated control grid 5 is a bias resistor 11. Each control grid 5 is also connected to an appropriate anode 12 in a photo-electric tube 13. The two photo-electric tubes are preferably housed in a container 14 having an opening 15 disposed in back of a film gate. This gate has a front plate 16 with an opening 17 therein which serves to admit light from a lamp 18 for printing purposes. Any suitable arrangement of film guides may be provided such as rollers 19 for the negative film and rollers 20 for the film to be printed.

Each of the photo-electric tubes 13 possesses a cathode 21, having a proper connection to one of the terminals 24 and 25 on the secondary of the transformer 7. The energizing circuit for the lamp 18 comprises the secondary winding 22 on the transformer 10 and a rheostat 23 for adjusting the normal light intensity with respect to the speed at which the films are to be moved for printing purposes.

The system as exemplified in Fig. 1 is intended to function so as to vary the light intensity of the printing lamp 18 in dependence upon variations of negative film density occurring at or near the position of printing exposure. Some of the light from the lamp 18 penetrates both the negative film and the film to be printed. This light acts upon the photo-electric cathodes 13 to vary the electronic emission therefrom. If desired, the photo-electric tubes can be placed in advance of the printing exposure window 17 so as to receive light through the negative film only.

In the operation of the system as shown in Fig. 1 it will be understood that the gaseous tubes 1 and 2 are rendered conductive in a push-pull manner, each upon the approach of a positive voltage peak of the alternating current impressed on its anode 4. The ionizing voltage is varied in dependence upon the bias applied to the control grid 5.

Let it be assumed that the potential at the

terminal 24 is rising on a positive half cycle of current. Let it be assumed also that the portion of the negative film in back of the window 17 is so dense that very little light penetrates the two films so as to reach the photo-electric cathodes 21 of tubes 13. Under these conditions substantially no current flows through the bias resistors 11 and consequently the grids 5 are held at substantially cathode potential. The thyatron tube 1 almost immediately becomes conductive. The thyatron tube 2 acts in the same manner upon reversal of current across the transformer terminals 24 and 25. Considering the action of tube 1, however, current is passed from the terminal 24 of the transformer 7 through the space discharge path of the tube 1 to the cathode 3 and thence to the left-hand terminal of the primary winding on the transformer 10 and back through the center tap 9 to the center tap 8 of the transformer 7. As this action continues energy will be supplied to the lamp 18. The duration of the conductive state will be greater in this case than in the case now to be described.

Assume now that a more translucent portion of the negative is to be printed and is in back of the window 17. Under these conditions photo-electric action will take place in the tubes 13. Considering only the left-hand tube 13, however, a negative potential derived from the terminal 25 of the secondary on transformer 7 will produce a conductive state in the tube 13, which is intensified by the light impressed on the cathode 21, and this operation will draw current through the bias resistor 11, thereby rendering the control grid 5 more negative than the cathode 3. It follows that a period of cut-off bias on the tube 1 will be prolonged, and the duration of the conductive state when the anode potential eventually reaches the ignition point will be shortened. The reduced time of conductivity of the tube results in the application of less power to the transformer 10, and accordingly the lamp 18 will be somewhat dimmed to compensate for the more translucent area of the negative.

Referring to Fig. 2, I show diagrammatically how the wave form of an alternating current may be modified by the control process above described. Here the outline of a sine wave can be observed over a certain portion thereof, but this outline is broken by certain periods of non-conductance of the thyatron tubes. The duration of the conductive state in tube 1 is shown between the two vertical dimension lines at the extremities of a positive peak. The duration of the conductive state in tube 2 is correspondingly indicated by dimension lines at the extremities of a subsequent peak which is positively impressed on the anode of tube 2, although it represents a half cycle of opposite phase. It will be understood that by varying the instant of ionization of the gas in each thyatron tube under control of the grid bias potentials derived from the photo-electric tubes 13, these moments of duration of the conductive state may be correspondingly varied.

It will be clear from the above description that I have provided a combination of gaseous tubes and photo-electric tubes which cooperate for varying the intensity of a light source in dependence upon the density of a negative film from which a printing operation is to be performed on an unexposed film. The variation in the conductive time interval of the gaseous tube during each positive half cycle applied to its

anode circuit corresponds with a variation in the R. M. S. voltage of the output energy. Hence the device operates as an output power modulator. Various modifications in the structural parts of the film printer may be made, of course, without departing from the spirit of the invention.

Referring now to Fig. 3, I show another application of my invention as it may be used in connection with a facsimile transmitter. Parts corresponding to those in Fig. 1 have been given like reference numbers.

In the embodiment shown in Fig. 3 a different set of conditions is met compared with those set forth in connection with the embodiment of Fig. 1. For facsimile picture signal transmission it is essential that a constant light source 26 be employed. The lamp 26 may be excited from any suitable direct current source 27. The intensity of the light may be controlled by a rheostat 28.

A suitable optical system consisting of lenses 29 may be employed to focus a light spot upon an elemental area of a picture to be scanned for facsimile signal transmission requirements. A scanning drum is shown at 30 and will be understood to have wrapped around it a picture which is to be used for picture signal transmission. As the drum is rotated at a constant speed it is also moved axially with respect to the light spot so as to form a helical scanning path which eventually covers the entire picture.

The light at the scanning spot is reflected from the surface of the picture in greater or lesser intensity, according to the light and dark elemental areas of the picture. The reflected light shines upon an optical system which may, if desired, comprise lenses 31 and a prism 32, so as to be impressed upon the photo-electric cathodes 21 of the two photo-electric tubes 13.

The operation of the gaseous tubes 1 and 2 as shown in Fig. 3 will be readily understood from the description which has been given of these tubes in Fig. 1. However, the output energy which results from controlling the duration of the conductive state in each of the tubes 1 and 2 is impressed upon the primary winding of a transformer 33. This transformer has a secondary winding 32 which delivers a picture signal, preferably for radio or wire transmission purposes.

In the operation of the system shown in Fig. 3 it will be understood that a relatively dark elemental area, when it comes beneath the light spot projected from the lamp 26, will produce very little light reflection through the optical system of lenses 31 and prism 32 to the cathodes 21 of the photo-electric tubes 13. Consequently these photo-electric tubes will be substantially non-conductive and there will be little, if any, negative bias on the thyatron control grids 5, since no current will pass through the bias resistors 11.

Under the condition, however, where the elemental picture area that is scanned is relatively white, then considerable light will be reflected into the optical system 31, 32 and will reach the photo-electric cathodes 21 so as to render these tubes sufficiently conductive to draw current across the bias resistors 11. The grids 5 in the gaseous tubes will then be rendered more negative and the duration of the conductive state in each of the tubes 1 and 2 will be shortened. Under these conditions a reduced amplitude of signal will be impressed upon the output circuit

from the secondary winding 34 of the transformer 33. It will be seen from this description that the system as shown is one wherein maximum amplitude of the picture signal represents a black area and minimum amplitude represents a white area. This relationship between the amplitude and light intensity may, however, be reversed by reversing the action of the photo-electric tubes 13 so as to render the grids 5 of the thyatron tubes more positive with increase in light intensity.

My invention has still another group of applications which may well be understood by considering Fig. 1 without the inclusion of the films. Assume, for example, that it is merely required that the device be used as a voltage regulator. The secondary winding 22 of the transformer 10 may then be used to deliver energy to any required load. In parallel with this load is the circuit for exciting the lamp 18. Without the negatives in the light path between the lamp 18 and the photo-electric tubes 13, it will be seen that variations in the load or variations in the input voltage on the transformer 7 may be compensated. The compensating action results from variations in the light intensity of the lamp 18 due to a fluctuating load or to a fluctuating input voltage. However, this light fluctuation from the lamp 18 operates upon the photo-electric tubes 13 so as to vary the bias across the resistors 11, and thus to vary the duration of the conductive state in each of the tubes 1 and 2. The portion of each cycle of the alternating current which is lost will be subtracted from the total power available at the terminals 24 and 25 of the transformer. Regulation of the R. M. S. voltage thus results. Assuming that, for a given period, the load is substantially constant, an equilibrium will be reached when the power passed by the Thyatron tubes is just sufficient to produce a constant value of illumination from the lamp 18. If, after this equilibrium is established, the load increases so as to reduce the output voltage across the secondary winding 22, then the brilliance of the lamp 18 will be reduced, the conductance of the photo-electric tubes 13 will be reduced, and the negative bias on grids 5 of the Thyatron tubes will be reduced so as to lengthen the conductive state in the tubes 1 and 2. Thus, R. M. S. voltage compensation will be provided to meet the added load.

Various other applications of my invention will suggest themselves to those skilled in the art upon considering the exemplified applications herein shown and described. The invention is, therefore, limited only in accordance with the scope of the claims.

I claim:

1. A power control system for use between an alternating power supply source and a load, said system comprising at least one trigger-acting gaseous discharge tube having its discharge path determined by a cathode and an anode, said discharge path being in circuit between said source and said load, a control grid in said discharge path, a bias resistor interconnecting the control grid and the cathode, a photo-electric device having one electrode connected to said source and a second electrode directly connected to the control grid of said gaseous tube, and means including a light source acting upon said photo-electric device for varying the electronic discharge therein, thereby to control the bias on said control grid, said means being solely effective to vary the interval of the conductive state of said gaseous tube during a half cycle of current from said source.

2. A system in accordance with claim 1 and having means for varying the intensity of said light source in dependence upon the R. M. S. voltage applied to said load.

3. A system in accordance with claim 1 and having a medium of variable translucence interposed between said light source and said photo-electric device.

4. A system in accordance with claim 1 and having a medium suitably disposed for reflecting light from said light source toward said photo-electric device, said medium having light and dark areas and being movable to vary the amount of light which it reflects.

5. A current regulator for use between an alternating power supply source and a load, said regulator comprising at least one trigger-acting gaseous discharge tube having a control grid in the discharge path thereof, said discharge path being in circuit between said source and said load, a lamp in the load circuit, and a photo-electric device arranged to receive light from said lamp, said device having connections between said power source and the control grid of said gaseous tube such that the duration of the conductive state of said gaseous tube within a half cycle of current from said source is controlled in dependence upon the amount of light reaching the photo-electric device from said lamp.

6. A voltage regulator comprising an input transformer, a pair of gas discharge tubes each having an anode, a cathode and a control grid, the two said anodes being connected respectively to opposed secondary terminals of said transformer, an output transformer having opposed primary terminals connected respectively to each said cathode, interconnected mid-taps on the secondary of said input transformer and on the primary of said output transformer, a load connected across the secondary of said output transformer, said load including a light source, bias resistors, each connected between the cathode and control grid of a respective discharge tube, and two photo-electric devices each having a discharge path in circuit between the control grid of one gas tube and the anode of the other gas tube respectively, said devices being arranged for photo-electric response to variations in the light impinging thereon from said light source.

7. A voltage regulator in accordance with claim 6 and having a variably translucent medium interposed in the light path between said light source and said photo-electric devices whereby the R. M. S. voltage applied to said light source is caused to be varied in dependence upon the translucence of said medium.

8. In a device of the class described, an input transformer, a pair of gas discharge tubes each having an anode, a cathode and a control grid, the two said anodes being connected respectively to opposed secondary terminals of said transformer, an output transformer having opposed primary terminals connected respectively to each said cathode, interconnected mid-taps on the secondary of said input transformer and on the primary of said output transformer, a light source connected across the secondary of said output transformer, bias resistors connected respectively between the cathode and control grid of each tube, two photo-electric devices each having a discharge path in circuit between the control grid of one gas tube and the anode of the other gas tube respectively, and means interposed in the light path from said light source to said photo-electric devices for varying the photo-response in

said devices thereby to control the grids of said gas discharge tubes and to vary the R. M. S. voltage derived therefrom.

9. A circuit arrangement comprising a pair of gaseous discharge tubes each having a cathode, 5 an anode and a control grid, two bias resistors each respectively interconnecting the control grid and the cathode of the same tube, two photo-responsive impedances each respectively in circuit between the control grid of one tube and the 10 anode of the other tube, an alternating current input circuit having push-pull connections to said anodes and oppositely phased connections to said cathodes, an output transformer having a center-tapped primary winding the respective halves of 15 which are separately connected to said cathodes, the center-tap of said primary winding being connected to a neutral point on said input circuit, and means for controlling the bias on said grids 20 by causing light of varying intensity to shine on said photo-responsive impedances.

10. A voltage regulator comprising the circuit arrangement according to claim 9, wherein the

bias controlling means comprises a light source connected across the terminals of said output transformer, said light source being arranged to act upon said photo-responsive impedances.

11. A power-compensating device comprising the circuit arrangement according to claim 9, wherein the bias controlling means comprises a light source connected across the terminals of said output transformer, and a variably translucent medium through which light rays from said light source impinge upon said photo-responsive impedances.

12. A modulator comprising the circuit arrangement according to claim 9, wherein the bias controlling means comprises a constant light source, a movable reflecting medium having light and dark areas thereon, means for focussing a beam of light from said light source on said reflecting medium, and means for causing varying amounts of light reflected from said medium to impinge upon said photo-responsive impedances.

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