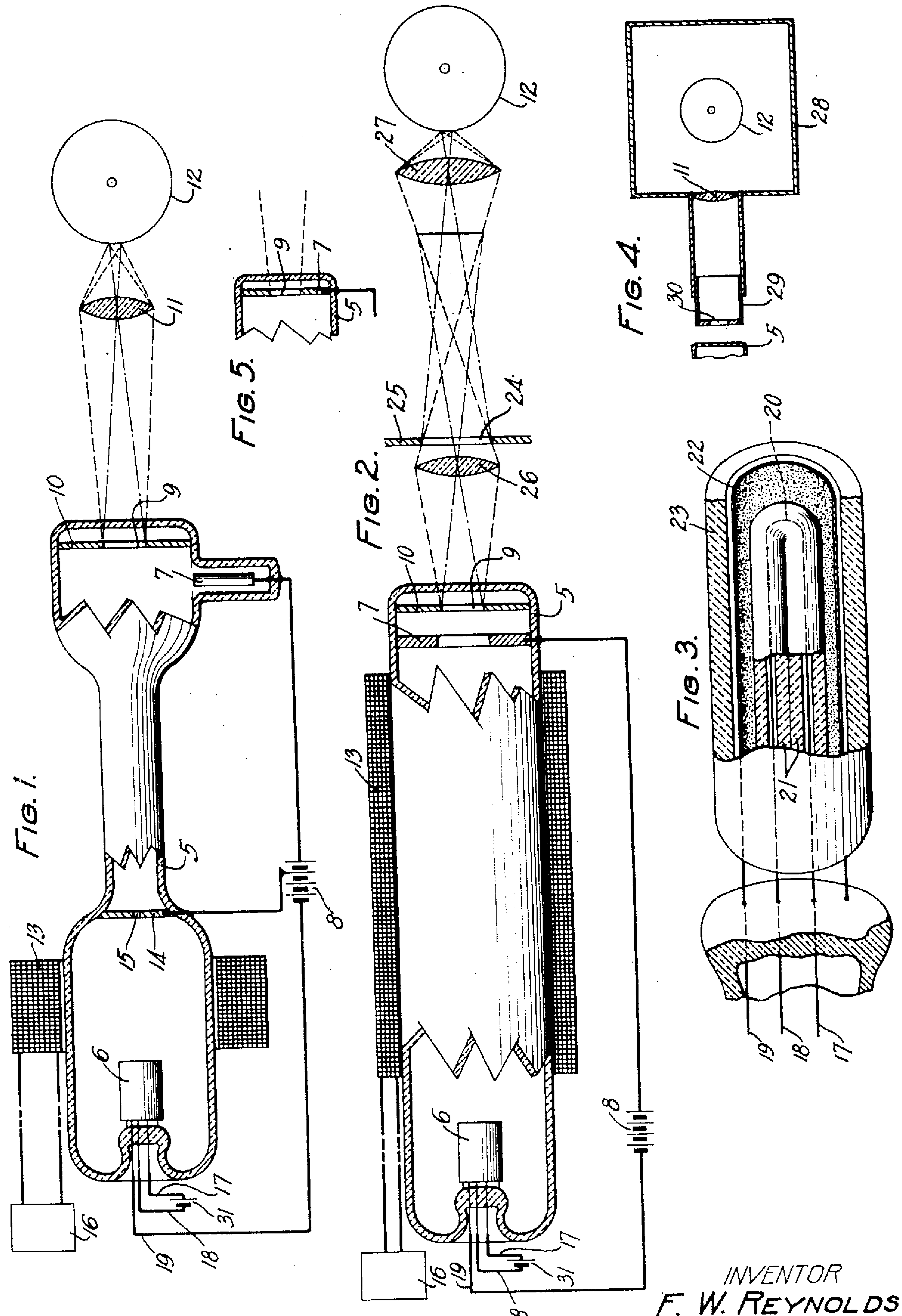
April 10, 1934. F. W. REYNOLDS 1,954,025

ELECTROOPTICAL SYSTEM

Filed Jan. 22, 1929



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Patented Apr. 10, 1934

1,954,025

UNITED STATES PATENT OFFICE

1,954,025

ELECTROOPTICAL SYSTEM

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Application January 22, 1929, Serial No. 334,337

11 Claims. (Cl. 176—122)

This invention relates to electro-optical systems and more particularly to a variable light source for such systems.

In accordance with the present invention an improved gaseous discharge device is provided to produce light flux varying in accordance with a variable magnetic field.

An arrangement illustrative of the invention comprises a gas filled tube of the arc discharge type having a hot cathode in which the arc discharge and therefore the intensity of the useful illumination of the positive column is controlled by focusing the emitted electrons with the magnetic field of an external concentric coil. In one specific form of the invention the control coil is located at the end of the tube adjacent to the cathode. A baffle or first anode is located between this coil and the anode and contains a small hole through which the electrons pass before entering the positive column. The light emerging from the anode end of the tube varies with the current through the control coil. In a modified arrangement the control coil extends substantially the whole length of the tube. An indirectly heated oxide coated cathode is preferably employed with low values of cathode to anode voltage so that the control coil field strength may be kept small.

These devices are particularly adapted to serve as the light sources at the receiving terminals of picture or image producing systems, the varying image currents being impressed upon the control coils.

A more detailed description of the invention follows having reference to the accompanying drawing. Identical elements in the several figures are identified by the same reference characters.

Figure 1 illustrates one form of an electro-optical system according to this invention.

Fig. 2 illustrates a modified form of the invention.

Fig. 3 shows more in detail an indirectly heated hot cathode suitable for use in the discharge tubes of Figs. 1 and 2.

Fig. 4 illustrates another modification of the invention in which an aperture external to the tube is employed.

Fig. 5 illustrates a further modification wherein the anode serves also as an apertured screen.

In the arrangement of Fig. 1 an enclosing vessel 5 is provided with a cathode 6 and an anode 7. The cathode 6 is heated by current from a battery 31 and a discharge between the cathode 6 and the anode 7 is maintained by battery 8. The vessel 5 is filled with a suitable gas at such a pressure that a luminous discharge occurs throughout substantially the whole length of the tube except for a short cathode dark space. This discharge illuminates an aperture 9 in an opaque screen 10. For recording purposes, as in a picture transmission system, for example, an image of the aperture 9 is formed by a lens 11 on a drum mounted light sensitive record blank 12. Helium gas preferably is used within the chamber 5 at a pressure of between 2 and 5 millimeters of mercury.

The intensity of illumination of the aperture 9 is controlled by the magnetic field produced by a coil 13 cooperating with a baffle 14 containing a small hole 15 through which electrons from the cathode 6 pass before producing the positive column to the right of the baffle 14. The baffle 14 may also serve as a first anode, in which case a portion only of the voltage of battery 8 is impressed thereon. Separate sources may of course be used. In an image or picture producing system the energizing current for the coil 13 is supplied by image or picture current producing apparatus 16.

It is not necessary to describe in greater detail the apparatus 16 and its cooperation with the drum mounted light sensitive record blank 12 for image or picture production in view of the Horton-Ives-Long Patent No. 1,606,227, issued November 9, 1926 with which the apparatus of Fig. 1 is readily combinable.

The aperture 15 in the baffle 14 should be small, compared to the diameter of the tube, in order that the baffle may be effective in screening most of the electrons from the positive column, when no current is applied to the focusing coil. There will be some tendency for the electron beam to be self-focusing due to the sheath of positive gas ions which will be present, although this effect is much less with helium and neon gases than with heavier gas ions such as argon. The magnetic field produced axially along the tube by the control coil will cause more electrons to enter the positive column to the right of baffle 14, thus localizing the ionization near the axis of the tube. This action of the control coil causes electrons which are moving in directions other than axially along the tube to follow a helical path of diminishing radius of curvature, thus directing the motion of the electrons and to some extent the positive ions along the axis of the tube and coil. The resultant illumination of the aperture 9 at the anode end of the tube will therefore vary with the current through the control coil. The function of the hot cathode is to supply the necessary number of electrons for maintaining the discharge. This permits of reducing the cathode potential drop to the minimum required for ionization of the particular gas used, since for visible as well as for useful photographic illumination from gas filled tubes such as helium, the velocities of the electrons need correspond to only a few volts.

The distance between the cathode 6 and the first anode 14 which serves also as a baffle, may be such that in combination with the voltage applied and the mean free path of the electrons at the pressure of the gas used, no appreciable ionization occurs until the electrons reach the space between the first anode 14 and the anode 7. The ionization in this latter portion of the tube 5 and therefore the illumination of the aperture 9 will increase with the number of electrons entering this space which number is determined by the focusing action of the external concentric coil 13. The intensity of illumination as viewed from the end of the tube will also be greater the longer the column of ionized gas. At pressures from 1 to 5 millimeters of mercury using a gas such as helium, the potential gradient in this portion of the tube will be from 1 to 2 volts per centimeter depending upon the gas pressure and diameter of the tube. The total anode voltage applied will, of course, depend upon the length of the tube and the gas pressure, and for tubes 30 to 40 centimeters long may be as great as 50 to 75 volts without causing disintegration of the electrodes or cathode sputtering. Luminous outputs as great as several thousand lumens may therefore be obtained.

Another advantage of using a hot cathode is that it is possible to use a cathode to anode voltage well below that which causes disintegration of the cathode by sputtering. A useful tube life of several thousand hours is therefore possible.

The preferred form of cathode 6 is illustrated in Fig. 3 and is an indirectly heated oxide coated cathode. A heated filament 20 located within a capillary tube 21 has external terminals 17 and 18. Surrounding the filament 20 is a hollow cylindrical metallic member 22, the inside surface of which is coated with the oxides of alkali earth metals in a well known manner to produce an electron emitting surface when heated. The hollow cylinder 22 is surrounded by a tube 23. The capillary tube 21 and the tube 23 are made of refractory material, such as fused quartz.

An advantage of this type of cathode resides in the fact that substantially no light flux from the electron emitting surface is incident upon the aperture 9 to affect the intensity of illumination thereof.

In the alternative arrangement of Fig. 2 the control coil 13 is applied to substantially the entire length of the tube 5. A more efficient control of the ionization in the positive column results since very few of the emitted electrons travel far from the cathode before causing ionization and are deflected by collisions with gas atoms and ions. The presence of the magnetic field throughout the length of positive column has a greater influence upon the nature of the discharge, resulting in a concentration of ionization near the axis of the tube proportional to the current throughout the control coil. Magnetic fields of the order of a few gausses are sufficient to obtain sufficient variation in the degree of illumination in the aperture 9 for ordinary image or picture producing purposes and such fields can be obtained without introducing an objectionable amount of inductance into the control circuit.

In the arrangement of Fig. 2 the anode 7 is ring shaped, the central opening being somewhat larger than the aperture 9 in screen 10. The type of anode shown in Fig. 1 may, however, be used. Likewise the type of anode shown in Fig. 2 may be used in Fig. 1.

The illuminated aperture 9 at the anode end of the tube 5 may or may not be suitable for imaging upon the light sensitive record blank 12. If it is not suitable, a second aperture 24 in a screen 25 located near a lens 26 may be used. A lens 27 forms an image of the aperture 24 on the light sensitive record blank 12 while the lens 26 forms an image of the aperture 9 at some point between the shield 25 and the lens 27, preferably nearer the lens 27. By this arrangement efficient gathering of the light flux passing through the aperture 9 is effected and a suitable spot of uniform intensity over its cross section is produced on the light sensitive record blank 12.

The lens system of Fig. 2 may, of course, be embodied in the system of Fig. 1 or vice versa. The system of Fig. 2 may be used for the same purposes as that of Fig. 1.

In Fig. 4 there is shown a system in which an aperture 30 in a tube 29 external to the discharge tube 5 is adjustable in a casing 28 within which the lens 11 and drum mounted light sensitive record blank 12 is located. The lens system of Fig. 2 may be used in the arrangement of Fig. 4. In some instances the arrangement of Fig. 4 may be preferable to those of Figs. 1 and 2.

In Fig. 5 the ring shaped anode 7 serves also as the apertured light screen. It is preferably located as close as possible to the end of the tube 5 in order to obviate the production of a luminous discharge to the light of the screen.

For photographic purposes helium, mercury vapor, carbon monoxide or carbon dioxide, rather than neon gas is preferable due to its greater energy distribution in the shorter wave lengths of the visible spectrum. The greater portion of luminous energy from the neon discharge occurs in the red portion of the spectrum for which the ordinary photographic emulsion is comparatively insensitive. Neon is preferable, however, in certain forms of image producing systems, such as television.

Various modifications of the illustrated forms of the invention may be made without departing from the purview of the invention as defined in the appended claims.

What is claimed is:

1. A luminous gaseous discharge lamp comprising a gaseous discharge tube containing an anode and a cathode for producing a gaseous discharge having a luminous positive column, and a magnetic control coil concentric with the discharge path between said anode and cathode for varying the cross-section of said positive column.

2. A luminous gaseous discharge lamp comprising a gaseous discharge tube containing an anode and a cathode for producing a gaseous discharge having a luminous positive column, a magnetic control coil concentric with the discharge path between said anode and cathode for varying the cross-section of said positive column, and a secondary light field energized by light flux from said positive column, the intensity of the light flux emerging therefrom being a function of the cross-section of the positive column.

3. A luminous gaseous discharge lamp comprising a gaseous discharge tube containing an anode

and cathode for setting up a gaseous discharge having a luminous positive column, and a control coil located concentrically with the discharge path between said anode and cathode for varying the cross-section of said positive column and extending over the major portion of the whole distance therebetween.

4. An electro-optical device comprising a gaseous discharge tube having an anode and a cathode of the thermionic type for producing a gaseous discharge having a luminous positive column, said cathode being so shaped that the light therefrom in the direction of the positive column is negligible, and a magnetic control coil concentric with the discharge path between said anode and cathode to control the light flux emanating from the positive column.

5. An electro-optical device comprising a gaseous discharge tube containing an anode and a cathode for setting up a gaseous discharge having a luminous positive column, said cathode comprising a hollow cylinder coaxial with said positive column, a thermionic electron emitting layer on the inside surface of said cylinder, and a heating element within said cylinder, and a magnetic control coil concentric with the discharge path between said anode and cathode to control the light flux emanating from the positive column.

6. An electro-optical device comprising a gaseous discharge tube containing an anode and a cathode for setting up a gaseous discharge having a luminous positive column, said cathode comprising a hollow cylinder coaxial with said positive column, a thermionic electron emitting layer of the oxides of alkali earth metals on the inside surface of said cylinder, a filamentary heater element inside said cylinder but separated from said inner surface and a refractory insulating covering for said filament and the outside surface of said cylinder, and a magnetic control coil concentric with the discharge path between said anode and cathode to control the light flux emanating from the positive column.

7. A luminous gaseous discharge lamp comprising a gaseous discharge tube having an anode and a cathode for producing a gaseous discharge having a luminous positive column, ionizable gas at low pressure within said tube, the gas ions of which are lighter than those of argon, and a magnetic control coil concentric with the discharge path between said anode and cathode for varying the cross-section of said positive column.

8. A luminous gaseous discharge lamp comprising a gaseous discharge tube having an anode and a cathode for producing a gaseous discharge having a luminous positive column, a filling of helium gas at low pressure for said tube, and a magnetic control coil concentric with the discharge path between said anode and cathode for varying the cross-section of said positive column.

9. A luminous gaseous discharge lamp comprising a gaseous discharge tube containing an anode and a cathode for producing a gaseous discharge having a luminous positive column, a baffle between said anode and cathode comprising a small aperture through which said discharge takes place, and a magnetic control coil concentric with the discharge path between said cathode and said baffle to vary the cross-section of said positive column to control the light flux emanating from the positive column.

10. A luminous gaseous discharge lamp comprising a gaseous discharge tube containing an anode and an electron emitting cathode for producing a gaseous discharge having a luminous positive column, and a magnetic control coil concentric with the discharge path between said anode and cathode for varying the cross-section of said positive column.

11. A luminous gaseous discharge lamp comprising a discharge tube containing an anode and an lectron emitting cathode for setting up a gaseous discharge having a luminous positive column, and a control coil located concentrically with the discharge path between said anode and cathode for varying the cross-section of said positive column and extending over the major portion of the whole distance therebetween.

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