March 30, 1948. G. C. SZIKLAI 2,438,586

COLOR ANALYZING CIRCUIT

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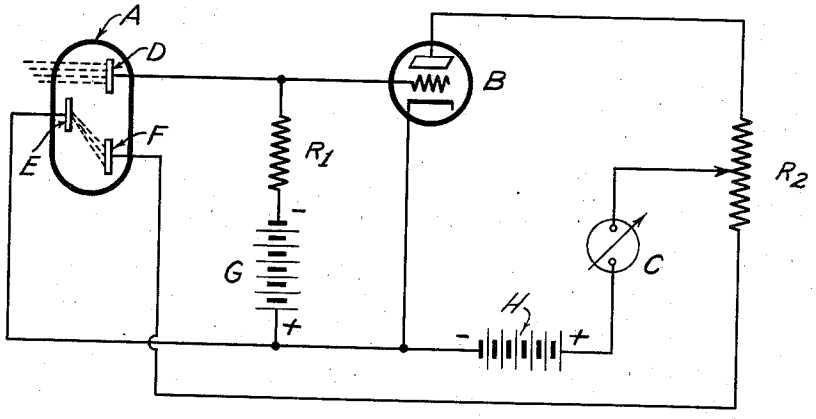


Fig. 1

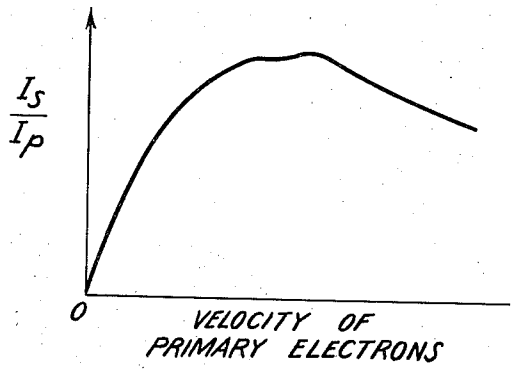


Fig. 2

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COLOR ANALYZING CIRCUIT

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9 Claims. (Cl. 250—41.5)

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This invention relates to color analyzing devices which are utilized to determine hue or color, and has for its principal object the provision of an improved color analyzer and method of operation which involve less complication than previous devices of this character.

The operation of this improved color analyzer is based on the fact that the energy of an electron emitted from a photoelectric surface, and hence its velocity, is dependent on the frequency of the light applied to the photoelectric surface.

It is well known that the electrons emitted from a photoelectric surface are affected by the characteristics of the light applied to such surface. Thus, the number of emitted electrons increases as the intensity of the light is increased and the energy and velocity of the emitted electrons increase as the frequency of the applied light is increased from the infra-red to the ultra-violet end of the spectrum. Otherwise stated, the hue or color of light is determined by its frequency, and the more nearly the color approaches the ultra-violet end of the spectrum the greater the energy of the electrons which it causes to be emitted from a photoelectric surface.

The relation between light frequencies (hue or color) and electron emission is given by the Einstein equation as

$$hf - hf_0 = \frac{mV2}{2}$$

where f is the frequency of the emission producing light f_0 is the lowest frequency that will enable an electron to leave the photoelectric surface, h is Planck's constant $=6.55\times10^{-27}$ erg.-sec., m is the mass of the electron and V is the speed of the electron.

According to the relation, the electron velocity is proportional to the frequency of the light producing the electron emission. If these primary electrons are caused to strike a secondary electron emissive surface, the number of secondary electrons per primary electron varies with the velocity of the primary electrons in a well known manner. In accordance with the present invention, the current of these secondary electrons is utilized to determine the color of the light by which the primary electrons are released from the photoelectric surface.

Important objects of the invention are the provision of a color analyzer which functions to indicate or determine color in response to the frequency of the applied light, and the provision of means whereby the output of an electron multiplier may be rendered independent of the intensity

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of the light applied to its photoelectric cathode.

The invention will be better understood from the following description considered in connection with the accompanying drawings and its scope is indicated by the appended claims.

Referring to the drawings:

Fig. 1 is a wiring diagram of a color analyzer constructed in accordance with the invention, and

Fig. 2 is a curve illustrating the number of secondary electrons emitted for each primary electron at different velocities of the primary electron.

The device of Fig. 1 includes an electron multiplier A, an amplifier B, and a meter C which responds to the current of the secondary electrons of the device A and is calibrated in terms of color.

Light falling on the photoelectric surface D of the electron multiplier A enables some electrons to overcome the surface potential barrier and leave it with a speed determined by the relation set forth by the above equation. These primary electrons travel to an electrode E.

The electrode E is of the type producing high secondary electron emission. The number of secondary electrons that leave it in response to each primary electron varies with the velocity of the primary electron as indicated by the curve of Fig. 2. If the potential applied to the electrode E is maintained at a value low enough to keep the velocity of the secondary electrons below its maximum value, the current between the electrodes E and F is proportional (1) to the speed of the primary electrons striking the electrode E and (2) to the number of primary electrons.

Since the device is required to respond only to the velocity of the primary electrons, some means must be provided for neutralizing the effect otherwise produced by variation in the intensity of the light applied to the electrode D.

This undesired effect is neutralized or compensated by means of a direct current amplifier bridge circuit. The different arms of this bridge circuit consist of (1) the plate circuit of the direct current amplifier B, (2) opposite sections of a resistor R_2 and (3) the electrodes E and F of the device A. Connected across the diagonal of the bridge circuit are the meter C and a battery H polarized as indicated. The grid circuit of the amplifier B includes a resistor R_1 and a battery G polarized as indicated. The potential applied to the grid of the amplifier B is determined by the resultant difference between the voltage of the battery G and the voltage devel-

oped across the resistor R by the current flowing from the electrode D to the electrode E.

Under these conditions, the voltage developed across the resistance R_1 is directly proportional to the current between the electrodes D and E, and the resultant voltage applied to the grid of the amplifier B is inversely proportional to the current between the electrodes D and E. The plate current of the amplifier B, however, is directly proportional to the current between the electrodes D and E in the same way as the current between the electrodes E and F.

If the amplification factor Ip/Eg of the amplifier B is made such that the bridge is balanced when light of the threshold frequency f_0 is applied to the electrode D, no current flows through the meter C. The application of light of higher frequencies to the electrode D, however, produces in the circuit of the meter C a current which is proportional to the frequency and is independent of the intensity or amount of the applied light. The meter C may therefore be calibrated so as to indicate directly the hue or color of the light applied to the electrode D.

It is also within the purview of the invention to substitute for the meter C a device adapted to control other devices or processes in accordance with the frequency of the applied light. Other variations in the disclosed modification of the invention are easily recognizable by those skilled in the art.

I claim as my invention:

1. The combination of a device wherein primary electrons derived from a cathode are projected on an emissive electrode from which secondary electrons are applied to an output electrode, a pair of impedance elements having a terminal in common, means for supplying to said terminal through one of said elements a current which is proportional to the number of said primary electrons, and means for supplying to said terminal through the other of said elements component currents which are proportional respectively to the number of said primary electrons and to the speed of said primary electrons.

2. The combination of a device wherein primary electrons derived from a cathode are projected on an emissive electrode from which secondary electrons are applied to an output electrode, a pair of impedance elements having a terminal in common, means for supplying to said terminal through one of said elements a current which is proportional to the number of said primary electrons, means for supplying to said terminal through the other of said elements component currents which are proportional respectively to the number of said primary electrons and to the speed of said primary electrons, and means connected to said terminal for producing an indication proportional in value to said component current which is proportional to the speed of said primary electrons.

3. The combination of a device wherein primary electrons derived from a photoelectric electrode are projected on an emissive electrode from which secondary electrons are applied to an output electrode, a pair of impedance devices having a terminal in common, means including an amplifier responsive to said primary electrons for supplying current to said terminal through one of said elements, and means for supplying to said terminal through the other of said elements component currents which are proportional respectively to the number of said primary electrons and to the speed of said primary electrons.

4. The combination of a device wherein primary electrons derived from a photoelectric electrode are projected on an emissive electrode from which secondary electrons are applied to an output electrode, a pair of impedance devices having a terminal in common, means including an amplifier responsive to said primary electrons for supplying current to said terminal through one of said elements, means for supplying to said terminal through the other of said elements component currents which are proportional respectively to the number of said primary electrons and to the speed of said primary electrons, and means connected to said common terminal for detecting the value of said primary electron speed proportional current.

5. The combination of a device wherein primary electrons derived from a photoelectric electrode are projected on an emissive electrode from which secondary electrons are applied to an output electrode, a pair of impedance devices having a terminal in common, means for supplying to said terminal through one of said elements a current which is proportional to the number of said primary electrons, and means including said emissive and output electrodes for supplying to said terminal through the other of said elements component currents which are proportional respectively to the number of said primary electrons and to the speed of said secondary electrons.

6. The combination of a device wherein primary electrons derived from a photoelectric electrode are projected on an emissive electrode from which secondary electrons are applied to an output electrode, a pair of impedance devices having a terminal in common, means for supplying to said terminal through one of said elements a current which is proportional to the number of said primary electrons, means including said emissive and output electrodes for supplying to said terminal through the other of said elements component currents which are proportional respectively to the number of said primary electrons and to the speed of said secondary electrons, and means for detecting the resultant difference between the currents supplied through said elements to said terminal.

7. The combination of a device wherein primary electrons derived from a cathode are projected on an emissive electrode from which they are applied to an output electrode, and a bridge circuit including as two of its arms a pair of impedance elements having a terminal in common, as another of its arms said emissive and output electrodes and as still another of its arms means for producing a current proportional to the number of said primary electrons.

8. The combination of a device wherein primary electrons derived from a cathode are projected on an emissive electrode from which they are applied to an output electrode, and a bridge circuit including as two of its arms a pair of impedance elements having a terminal in common, as another of its arms said emissive and output electrodes and as still another of its arms an electron discharge device responsive only to the number of said primary electrons.

9. The combination of a device wherein primary electrons derived from a cathode are projected on an emissive electrode from which they are applied to an output electrode, a bridge circuit including as two of its arms a pair of impedance elements having a terminal in common, as another of its arms said emissive and output

electrodes and as still another of its arms an electron discharge device responsive only to the number of said primary electrons, and means connected between said terminal and a terminal common to said emissive electrode and the cathode of said electron discharge device for indicating a quantity proportional in value to the speed of said primary electrons.

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