Feb. 21, 1939. J. C. BATCHELOR 2,148,007

ILLUMINATION CONTROL SYSTEM

Filed Sept. 9, 1937 2 Sheets-Sheet 1

Fig. 1.

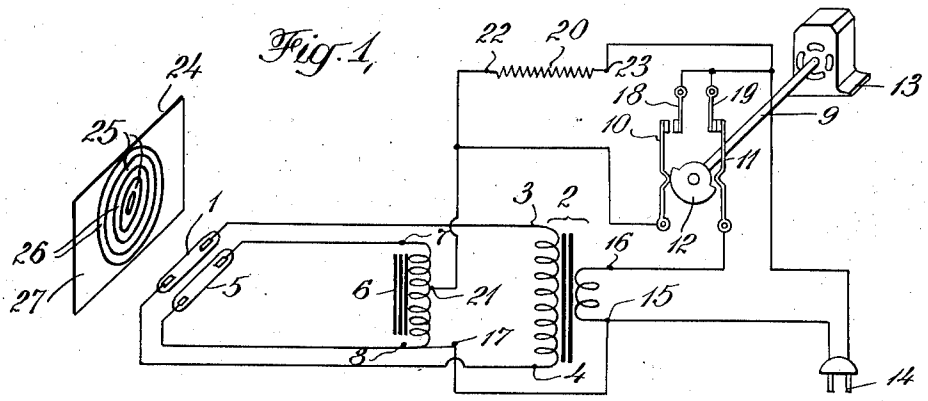
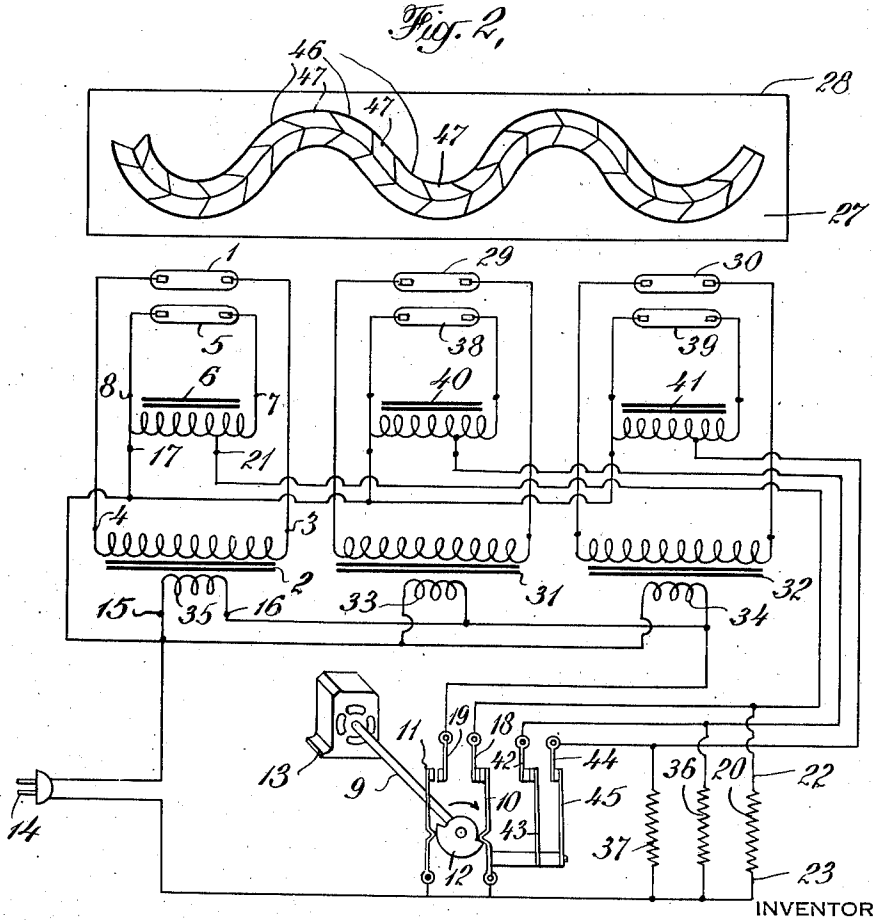


Fig. 2.



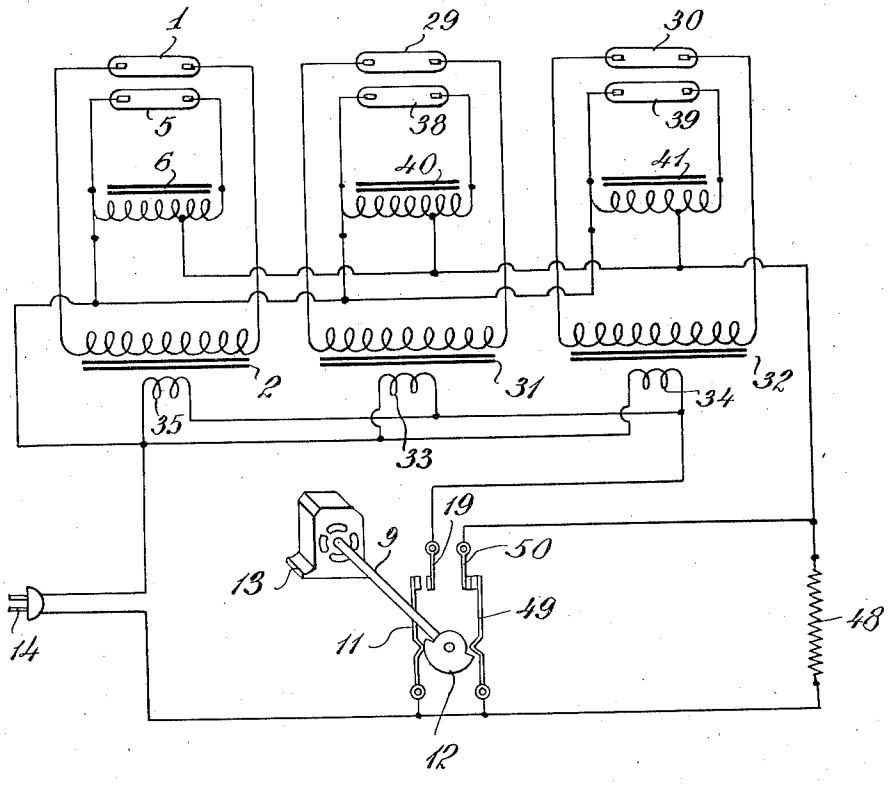
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Fig. 3,



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2,148,007

ILLUMINATION CONTROL SYSTEM

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15 Claims. (Cl. 40—130)

This invention relates generally to a method and apparatus for producing alternate and successive pulses of light which may differ from one another in one or more of the characteristics, color, intensity, duration, and location of the sources thereof. More particularly, the invention provides a method and apparatus for controlling electric lights of different colors to alternately and successively illuminate a surface containing representations or figures in complementary colors, to create an illusion of motion or animation of such representations, without the annoying accompaniment of color flicker.

The invention may be used to great advantage in connection with advertising displays, signs, and the like, for the production of illusions of motion in fixed pictorial or graphical representations in complementary colors in a plurality of positions on a neutral-colored background. By illuminating such representations alternately and successively with light pulses of different colors chromatically related to the colors of the representations, effects may be obtained which are both striking and pleasing to the eye.

Heretofore, in the illuminated advertising sign art employing one or more pairs of complementary colored light sources to illuminate chromatically related representations on a sign, it has been customary to effect complete modulation of each source between total extinction and full luminosity. To accomplish this mode of operation with gas discharge tube light sources, it has been the universal practice to employ exclusively tubes of the low-pressure type. Such tubes, although easily re-started, are known to be of relatively low efficiency as light sources, as compared with high-pressure gas discharge tubes, such as mercury vapor tubes. High-pressure gas discharge tubes, however, can be re-started after extinction only with difficulty. This is due to the fact that whereas such a tube is initially started as a glow discharge tube, the mercury within the tube soon becomes vaporized, and the discharge thereafter continues as an arc discharge at relatively high pressure. If the discharge be momentarily extinguished, it cannot be restarted as an arc without the use of a prohibitively high voltage; nor can it be restarted as a glow discharge, on account of the high pressure of the mercury vapor. Such condition continues until the pressure is once more reduced by cooling and consequent condensation of the mercury.

The devices heretofore known, therefore, are far less efficient than they would be were it possible to employ high-pressure tubes.

It is a well known fact that whereas low-pressure gas discharge tubes having a red color characteristic, such as neon tubes, give the impression of a substantial amount of rich red light, low-pressure gas-discharge tubes having a minus-red or cyan color characteristic give the impression of a pale or weak light. Hence when the two types are used in combination, the observer receives an impression of unbalance and color flicker, and a paucity of rich purples in the neutral portions of the representation. The strong cyan light of high-pressure tubes or mercury vapor tubes, on the other hand, is not open to this objection.

My invention is based largely on the discovery that more striking and more pleasing results can be obtained by controlling a first light source of one color and of a certain full luminosity, to effect periodic or intermittent modulation thereof from total extinction to full luminosity, and alternately therewith, controlling a second light source of a different color and of a substantially greater full luminosity than that of the first, to effect modulation thereof from partial luminosity to full luminosity. The intermittent decrease in luminosity of the second source is preferably so selected as to be of the order of the full luminosity of the first source.

Without definitely subscribing to a particular theory of operation, I believe that the results obtained as described above depend primarily upon the contrast in luminosity of the representations between the two phases of the operating cycle, and only secondarily upon the absolute value of the luminosity.

Furthermore, I have observed that when exactly equal quantities of light of substantially complementary colors are employed, as produced by methods heretofore known, a substantial amount of color flicker is produced from and upon the portions of the display which are intended to be neutral. This is believed to be due primarily to the change of the sensation value of the light with change of color, due to a shifting of the stimulus from one set of light-sensitive elements within the human eye to another. And this phenomenon may occur although the actinic value of the light on the neutral background is substantially constant.

As the result of my discovery that one of the colored light sources may be continuously excited and illuminated, it becomes possible to use a high-efficiency, high-pressure gas discharge tube, a mercury vapor tube, for example, as one of the sources of colored light in the illumination system

under discussion, since it is no longer necessary to start such tube from a totally extinguished condition. Thus, it is merely necessary to effect modulation of such high-pressure tube from partial luminosity to full luminosity, preferably substantially instantaneously.

To practice the invention with a specific embodiment, at least two gas discharge tubes are provided, including a low-pressure tube and a high-pressure tube. Suitable sources of electric energy are provided, and the tubes are arranged to be energized or excited in associated electric circuits by appropriate control equipment. The low-pressure tube is operated to effect modulation thereof from total extinction to full luminosity, and the high-pressure tube is operated alternately with the low-pressure tube to effect modulation of the high-pressure tube from its full luminosity to substantially less than its full luminosity. Thus, the high-pressure tube is continuously excited and never totally extinguished.

The invention will be more fully understood from the following description, considered with the accompanying drawings. In these drawings:

Fig. 1 illustrates schematically a pair of tubes and associated electric control circuits and apparatus, arranged to produce alternate and successive pulses of light;

Fig. 2 illustrates schematically an arrangement similar to that of Fig. 1, but in which more than one pair of luminous tubes is employed;

Fig. 3 illustrates schematically an arrangement employing more than a pair of luminous tubes, with certain modifications of the control circuits.

Referring to Fig. 1, I have provided the low-pressure luminous discharge tube 1 connected to the output terminals 3 and 4 of the transformer 2. The high-pressure luminous discharge tube 5 is connected to the output terminals 7 and 8 of the autotransformer 6.

A mechanical contactor 9 is provided having two sets of contacts 10, 18 and 11, 19, adapted to be alternately and successively closed by the operation of the cam 12 driven by the motor 13. A source of alternating current energy indicated by the plug 14 has one side connected directly to the input terminal 17 of the transformer 6, and to the input terminal 15 of the transformer 2. The other side of the plug 14 is connected through the resistor 20 to the remaining input terminal 21 of the autotransformer 6. The latter side of the plug 14 is also connected through the contacts 19 and 11 of the contactor 9 to the input terminal 16 of the transformer 2. The contacts 10 and 18 are connected respectively to the terminals 22 and 23 of the resistor 20 in such fashion that the resistor 20 is effectively short-circuited at such times as the contacts 10 and 18 are closed.

From the above description of the circuit arrangements and connections, it is evident that when the cam 12 is driven by the motor 13, the full voltage of the source 14 is applied through the contacts 19 and 11 to the primary winding of the transformer 2 during one half of each revolution, and that during the other half revolution, when the contacts 11 and 19 are open, no voltage is applied to the transformer 2. It is further evident that during the first half revolution of the cam 12, when the contacts 10 and 18 are open, the voltage of the source 14 is applied through the resistor 20 to the terminals 17 and 21 of the autotransformer 6, the voltage at the transformer 6 being thus reduced below the source voltage by the voltage drop in the resistor 20; and that during the succeeding half revolution, when the contacts 10 and 18 are closed, the voltage of the source 14 is applied directly to the terminals 17 and 21 of the autotransformer 6. Thus, due to the connections of the gas discharge tubes 1 and 5 to the transformers 2 and 6 respectively, as above described, the tube 1 is subjected to successive and intermittent excitation, varying substantially instantaneously from a zero value to a predetermined value; whereas the tube 5 is subjected to successive and intermittent excitation varying substantially instantaneously from a greater predetermined value to a lesser predetermined value, the intermittent decrease being determined by choice of the resistor 20. Since the function of the resistor 20 is to provide a voltage drop, any other form of impedance, such as a choke coil, may equally well be employed.

A display surface or area is shown at 24, having a neutral background 27 and having, for example, a plurality of concentric rings 25 and 26 in complementary colors; for example, the rings 25 may be cyan, otherwise known as minus red, and the rings 26, concentric and alternate with the rings 25, may be red. The tube 1 in the embodiment shown may be a conventional low-pressure luminous gas discharge tube containing a gas having a characteristic red or red-orange glow; the gas neon, for example. The luminous discharge tube 5 is preferably of the high-pressure high-efficiency type of mercury vapor tube which may be filled, for example, with argon at a relatively low pressure, and may contain a measured quantity of mercury such that, when normal operating temperature has been reached, the pressure of the mercury vaporized within the tube may be of the order of, for example, one-half atmosphere.

Fig. 2 represents a modification of the apparatus of Fig. 1 in that a relatively large display surface 28 is provided having a length greater than that which can be illuminated conveniently by a single pair of discharge tubes 1 and 5. Three similar luminous discharge tubes 1, 29 and 30 are provided, connected to the secondary windings of the transformers 2, 31 and 32, respectively. The primary windings 35, 33 and 34 of the transformers 2, 31 and 32 are connected in parallel, and the three primaries 35, 33 and 34 are adapted to be excited intermittently by energy derived from a source indicated by the plug 14 through the contacts 11 and 19 of the contactor 9.

The transformer 6, which supplies the tube 5, is adapted to receive continuous partial excitation from the plug 14 through the resistor 20 during the time when the contacts 10 and 18 are open, and full excitation through the contacts 10 and 18 in parallel with the resistor 20 when those contacts are closed. Energy is supplied to the luminous discharge tubes 38 and 39 by the transformers 40 and 41, the tubes 38 and 39 being similarly connected and similar to the tube 5, and the transformers 40 and 41 being similarly connected and similar to the transformer 6. The transformers 40 and 41 are likewise adapted to receive continuous partial excitation through the resistors 36 and 37, respectively, and intermittent full excitation through the contacts 42, 43 and 44, 45, respectively.

The display surface 28 is provided, for example, with the neutral background 27, the cyan representation 46 and the red representation 47 comprising alternate blocks of the respective colors

disposed in a manner such that the illusion of continuous motion is created along their length.

Under certain conditions, it is desirable that the cyan illumination be intermittently reduced to as low a value as possible. Such conditions may arise when, for example, the greater part, geometrically, of the surface representations are cyan but it is desired that the dominant color of the display be red. In the embodiment shown in the figures, this requires that the mercury vapor tube **5** of Fig. 1, or the tubes **5**, **38**, and **39** of Fig. 2, have their luminosities intermittently decreased as nearly to the point of extinction as possible. It is for such case that the separate control circuits of Fig. 2 are provided, including particularly the separate contact pairs **10—18**, **43—42**, and **45—44**; and the separate resistors **20**, **36**, and **37**, connected as shown. This separation of the control circuits prevents any irregularity in the operation of any one of the cyan tubes from being reflected as an inverse irregularity in another of those tubes.

When, on the other hand, a substantial continuous residual cyan light is either unobjectionable or desirable, it is feasible to maintain the continuous cyan luminosity, and therefore the continuous excitation of the mercury vapor tubes, at a relatively high level. In such case, the effect of reflection of irregularities in the operation of one tube into another is relatively small, and the contact pairs **10—18**, **43—42**, and **45—44** may safely be replaced by a single contact pair, the resistors **20**, **36**, and **37** being similarly replaced by a single resistor of appropriate value. This arrangement is shown in Fig. 3, wherein the transformers **2**, **31** and **32** for the tubes **1**, **29** and **30**, respectively, are excited and controlled by energy from the source **14** through the contacts **11** and **19**. The transformers **6**, **40** and **41** for the tubes **5**, **38** and **39** are similarly connected in parallel and are adapted to receive continuous partial excitation through the single resistor **48** and intermittent full excitation through the contacts **49** and **50**, in parallel with the resistor **48** and actuated by the cam **12** of the contactor **9**.

By employing the arrangements of my invention it becomes possible to take advantage of the relatively low illuminating and atmospheric penetrating power of light of the general hue cyan. Thus, though the tube **5** is at all times excited to a point safely above the extinction point, its luminosity, when reduced in intensity by excitation through the resistor **20**, may be made of such low value that the visible illumination of the display surface **24** is substantially negligible.

On the other hand, it is sometimes desirable to employ a reduction of the cyan light different from the amount of added red light in order that, at a particular distance from the display, the degree of visibility of the display during the two phases of the cycle shall be equal.

One of the uses for which the arrangements and methods of my invention are well adapted, is to reduce as far as possible the color flicker on the neutral portion **27** of the surface **24**, and I have found it possible to reduce the amount of this color flicker very materially below the level possible by methods heretofore known. To this end I employ a relatively large quantity of cyan light to illuminate the cyan concentric rings **25**, and intermittently reduce the amount of this cyan light approximately to one-third its value at full luminosity, providing at the same time red light in approximately the amount by which the cyan light is reduced; that is to say, the maximum value of the red light is about two-thirds the maximum value of the cyan light or about twice its reduced value. By this choice of light values I have found that a neutral portion **27**, capable of reflecting substantially equally both cyan and red light, will present the appearance of substantially constant illumination.

I may still further vary the lighting effects obtainable by controlling the illumination from the two sources, and therefore the luminosity in the two colors, in other ways. For example, I may place the cyan source at one distance from the surface representation and the red source at a different distance. I may likewise place these sources at different angles with respect to the surface. Furthermore, I may alter the duration of the different-colored pulses. This may most easily be accomplished by the use of a long-arc cam for one set of contacts and a short-arc cam for the other set of contacts.

Though I have described my invention in connection with gas discharge tubes, it is obvious that certain of its advantages may be achieved by the use of different-colored light sources of other types. Furthermore, while I have described the invention in connection with a display system, it is, of course, applicable to any system in which two or more sets of light pulses, differing in any particular, are alternately and intermittently produced.

Having now described my invention, I claim:

1. In a system of illumination utilizing at least two electrically actuated light sources, one of said sources being of the high-pressure discharge-tube type and the other of said sources being of a different type, the method of producing alternate and successive pulses of light which comprises continuously exciting said high-pressure tube source to effect continuous illumination thereof at at least partial luminosity, exciting said high-pressure tube source to effect periodic modulation thereof from said partial luminosity to its full luminosity, and alternately therewith exciting said other light source to effect periodic modulation thereof from total extinction to its full luminosity.

2. In a system of illumination utilizing at least two electrically actuated gas-discharge tube light sources, one of the high-pressure type and another of the low-pressure type, the high-pressure tube source having a substantially greater intensity at full luminosity than the low-pressure tube source at full luminosity, the combination which comprises means for successively and intermittently exciting the low-pressure tube source to effect modulation thereof from total extinction to its full luminosity, means for continuously exciting the high-pressure tube source to effect continuous illumination thereof at at least partial luminosity, and means for exciting said high-pressure tube source, alternately of the excitation of said low-pressure tube source, to effect modulation of said high-pressure tube source from said partial luminosity to its full luminosity.

3. In a system of illumination utilizing at least two electrically actuated gas-discharge tube light sources, one of the high-pressure type and another of the low-pressure type, the high-pressure tube source having a substantially greater intensity at full luminosity than the low-pressure tube source at full luminosity, the combination which comprises means for successively and intermittently exciting the low-pressure tube source to effect periodic modulation thereof from total extinction to its full luminosity, means for con-

tinuously exciting the high-pressure tube light source to effect continuous illumination thereof at at least partial luminosity, and means for exciting said high-pressure tube source, alternately of the excitation of said low-pressure tube source, to effect periodic modulation of said high-pressure tube source from said partial luminosity to its full luminosity, the intermittent change in luminosity of said high-pressure tube source from said partial luminosity to said full luminosity being of the order of the full luminosity of said low-pressure tube source.

4. In a system of illumination utilizing at least two electrically actuated gas-discharge tube light sources, one of the high-pressure type and another of the low-pressure type, the high-pressure tube source having a substantially greater intensity at full luminosity than the low-pressure tube source at full luminosity, the method of producing alternate and successive pulses of light, which comprises continuously exciting the high-pressure tube source to effect continuous illumination thereof at at least partial luminosity, successively and intermittently exciting the low-pressure tube source to effect modulation thereof from total extinction to its full luminosity, and alternately therewith exciting the high-pressure tube source to effect modulation thereof from said partial luminosity to its full luminosity.

5. In a system of illumination utilizing at least two electrically actuated gas-discharge tube light sources, one of the high-pressure type and another of the low-pressure type, the high-pressure tube source having a substantially greater intensity at full luminosity than the low-pressure tube source at full luminosity, the method of producing alternate and successive pulses of light, which comprises continuously exciting the high-pressure tube source to effect continuous illumination thereof at at least partial luminosity, successively and intermittently exciting the low-pressure tube source to effect periodic modulation thereof from total extinction to its full luminosity, alternately therewith exciting the high-pressure tube light source to effect periodic modulation thereof from said partial luminosity to its full luminosity, and limiting the intermittent decrease in luminosity of the high-pressure tube source to the order of the full luminosity of the low-pressure tube source.

6. In the art of alternate and successive illumination of objects by at least two light-sources of different characteristics, the method of utilizing a high-efficiency high-pressure discharge tube as one of said light-sources and a low-pressure gas-discharge tube as another of said light-sources, which comprises successively exciting said low-pressure tube to effect modulation of the light thereof from extinction to full luminosity thereof, continuously exciting said high-pressure tube at at least partial luminosity of the light thereof, and successively exciting said high-pressure tube, alternately of the excitation of said low-pressure tube, to effect modulation of the light thereof from said partial luminosity to the full luminosity thereof.

7. In the art of alternate and successive illumination of objects by at least two light-sources of complementary colors, the method of utilizing a high-efficiency high-pressure mercury-vapor discharge tube of cyan color characteristic as one of said light sources and a low-pressure neon gas-discharge tube of red color characteristic as another of said light-sources which comprises successively exciting said neon gas-discharge tube to effect modulation of the red light thereof from extinction to full luminosity thereof, continuously exciting said mercury-vapor tube at at least partial luminosity of the cyan light thereof, and successively exciting said mercury-vapor tube, alternately of the excitation of said neon gas-discharge tube, to effect modulation of the cyan light thereof from said partial luminosity to the full luminosity thereof.

8. In the art of alternate and successive illumination of representations having at least two different visual characteristics by at least two light-sources of characteristics corresponding to the characteristics of said representations, the method of utilizing a high-efficiency high-pressure discharge tube as one of said light sources and a low-pressure gas-discharge tube as another of said light-sources which comprises successively exciting said low-pressure tube to effect periodic modulation of the light thereof from extinction to full luminosity thereof, continuously exciting said high-pressure tube at at least partial luminosity of the light thereof, successively exciting said high-pressure tube, alternately of the excitation of said low-pressure tube, to effect periodic modulation of the light thereof from said partial luminosity to the full luminosity thereof, and illuminating said representations with the light from said light-sources.

9. In the art of alternate and successive illumination of representations in at least two complementary colors by at least two light-sources of corresponding complementary colors, the method of utilizing a high-efficiency mercury-vapor discharge tube of cyan color characteristic as one of said light sources and a low-pressure neon gas-discharge tube of red color characteristic as another of said light-sources which comprises successively exciting said neon gas-discharge tube to effect periodic modulation of the red light thereof from extinction to full luminosity thereof, continuously exciting said mercury-vapor tube at at least partial luminosity of the cyan light thereof, successively exciting said mercury-vapor tube, alternately of the excitation of said low-pressure tube, to effect periodic modulation of the cyan light thereof from said partial luminosity to the full luminosity thereof, and illuminating said representations with the light from said mercury-vapor tube and said neon tube.

10. In an electrical display system having a surface bearing representations in complementary red and cyan colors, and illumined by a low-pressure gas-discharge tube source of light of a red color and a relatively high-pressure discharge tube source of light of a cyan color, the combination of means for successively exciting said low-pressure tube to effect modulation of the red light thereof from extinction to full luminosity of said tube, means for continuously exciting said high-pressure tube to produce continuous cyan light at at least partial luminosity of said tube, and means for successively exciting said high-pressure tube, alternately of the excitation of said low-pressure tube, to effect modulation of the cyan light thereof from said partial luminosity to full luminosity of said tube, said full luminosity being substantially greater than the full luminosity of said low-pressure tube.

11. In an electrical display system having a surface bearing representations in complementary red and cyan colors, and illumined by a low-pressure gas-discharge tube source of light of a red color and a relatively high-pressure gas-discharge tube source of light of a cyan color, the

combination of means for successively exciting said low-pressure tube to effect modulation of the red light thereof from extinction to full luminosity of said tube, means for continuously exciting said high-pressure tube to produce continuous cyan light at at least partial luminosity of said tube, and means for successively exciting said high-pressure tube, alternately of the excitation of said low-pressure tube, to effect modulation of the cyan light thereof from said partial luminosity to full luminosity of said tube, said full luminosity being substantially greater than the full luminosity of said low-pressure tube, and the intermittent change in luminosity of said high-pressure tube being of the same order as the full luminosity of said low-pressure tube.

12. In an electrical display system having a surface bearing representations of different color characteristics, and illumined by a low-pressure gas-discharge tube light-source and a relatively high-pressure discharge tube light-source, said sources having color characteristics corresponding to those of said representations, the combination of means for successively exciting said low-pressure tube to effect periodic modulation of the light thereof from extinction to full luminosity of said tube, means for continuously exciting said high-pressure tube to produce continuous light at at least partial luminosity of said tube, and means for successively exciting said high-pressure tube, alternately of the excitation of said low-pressure tube, to effect modulation of the light thereof from said partial luminosity to full luminosity of said tube, said full luminosity being substantially greater than the full luminosity of said low-pressure tube.

13. In an electrical display system having a surface bearing representations of different color characteristics, and illumined by a low-pressure gas-discharge tube light-source and a relatively high-pressure discharge tube light-source, said sources having color characteristics corresponding to those of said representations, the combination of means for successively exciting said low-pressure tube to effect periodic modulation of the light thereof from extinction to full luminosity of said tube, means for continuously exciting said high-pressure tube to produce continuous light at at least partial luminosity of said tube, and means for successively exciting said high-pressure tube, alternately of the excitation of said low-pressure tube, to effect modulation of the light thereof from said partial luminosity to full luminosity of said tube, said full luminosity being substantially greater than the full luminosity of said low-pressure tube, and the intermittent change in luminosity of said high-pressure tube being of the same order as the full luminosity of said low-pressure tube.

14. In an electrical system for alternately and successively operating at least two different gas-discharge tubes, the combination of a first transformer having input and output terminals, a circuit including said input terminals arranged for connection to a source of alternating current energy, a low-pressure gas-discharge tube connected in a circuit including said output terminals, a second transformer having input and output terminals, the second-named input terminals being arranged for connection to said source of alternating current energy, an impedance connected in series with the second-named input terminals and said source, a high-pressure gas-discharge tube connected in a circuit including the output terminals of said second transformer, means for periodically exciting said first transformer and low-pressure tube at predetermined intervals from said source, means for exciting said second transformer and said high-pressure tube from said source, and means for periodically short-circuiting said impedance during the periods of extinction of said low-pressure tube.

15. In an electrical system for alternately and successively operating gas-discharge tubes of at least two different types, the combination of a first plurality of similar transformers having input and output terminals, circuits including said input terminals arranged for connection to a source of alternating current energy, a plurality of similar low-pressure gas-discharge tubes arranged in circuits including the output terminals of said first-named transformers, a second plurality of similar transformers having input and output terminals, circuits including the input terminals of said second-named transformers arranged for connection to said source, a plurality of similar impedances arranged in series with the input terminals of said second-named transformers and said source, a plurality of similar high-pressure gas-discharge tubes arranged in circuits including said output terminals of said second-named transformers, means for periodically exciting said first-named transformers and low-pressure tubes at predetermined intervals from said source, and means for periodically short-circuiting said impedances during the periods of extinction of said low-pressure tubes.

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