United States Patent

Wilson

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[54] APPARATUS FOR CONTROLLING A PLURALITY OF LIGHT SOURCES

[72] Inventor: **James F. Wilson**, Palatine, Ill.

[73] Assignee: **Bell & Howell Company**, Chicago, Ill.

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Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 779,817, Nov. 29, 1968.

[52] **U.S. Cl.** .....**178/5.4 R**, 200/16 R, 200/6 A

[51] **Int. Cl.**.....**H01h 19/58**, H01h 21/78, H04n 9/48

[58] **Field of Search**.....178/5.4, 5.2; 240/44.27; 200/16 R, 16 F, 6 A, 11 D, 166 PC, 17 R

[56] **References Cited**

UNITED STATES PATENTS

2,866,124	12/1958	Giuffrida et al.	178/5.4 R
2,877,293	3/1959	Loughren	178/5.4 R
3,059,140	10/1962	Heuer	178/5.4 R
3,383,460	5/1968	Pritchard	18/5.4 BD

Primary Examiner—Robert L. Griffin
Assistant Examiner—John C. Martin
Attorney—William F. Pinsak, John E. Peele, Jr., Kenneth W. Greb and William K. Serp

[57] **ABSTRACT**

Three variable, addable factors are controlled simultaneously from a single manual setting of the apparatus to produce a resultant having a constant characteristic.

12 Claims, 8 Drawing Figures

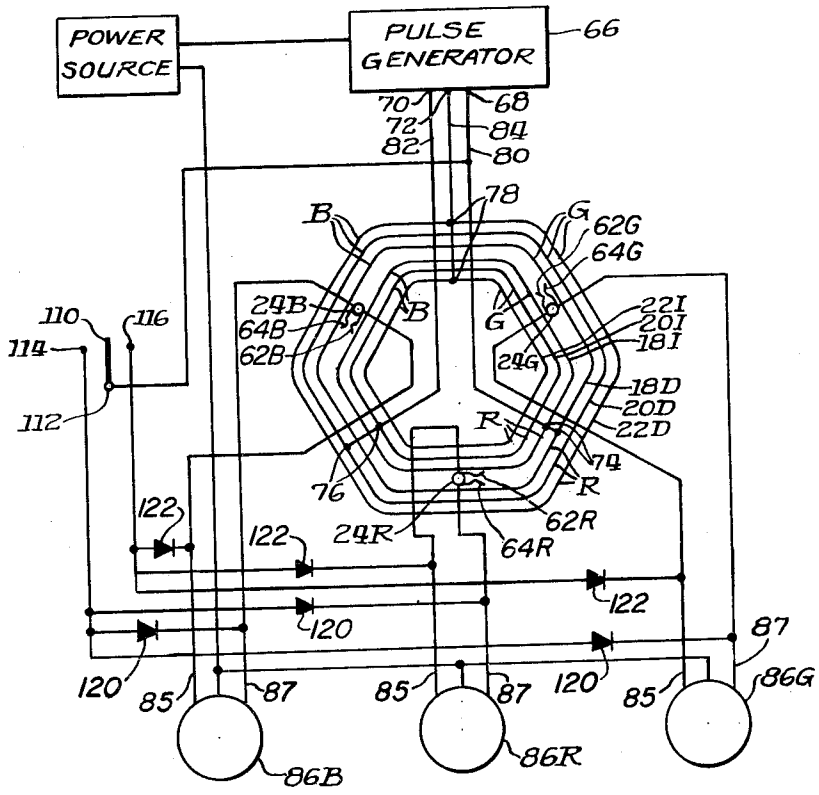


Fig. 1

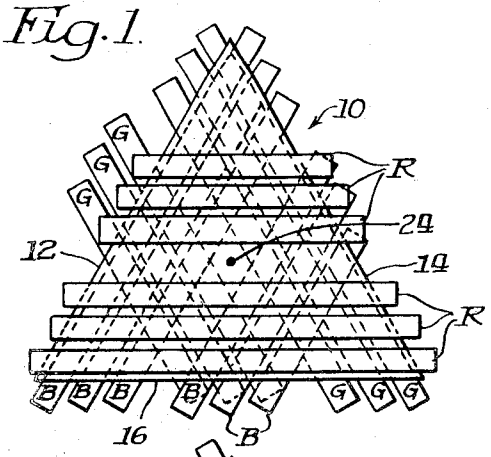


Fig. 2

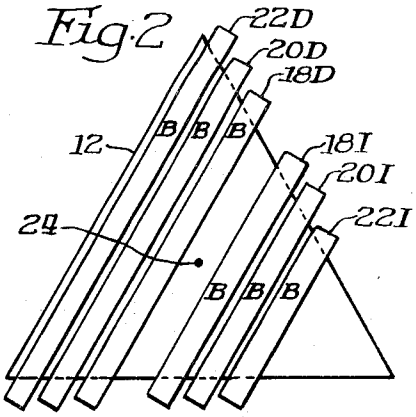


Fig. 3

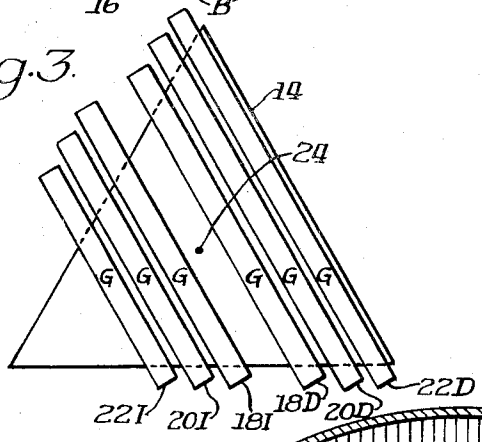


Fig. 4

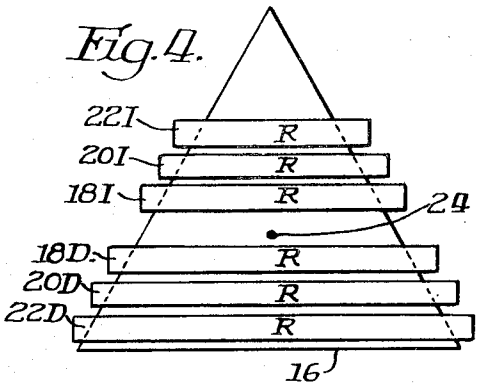
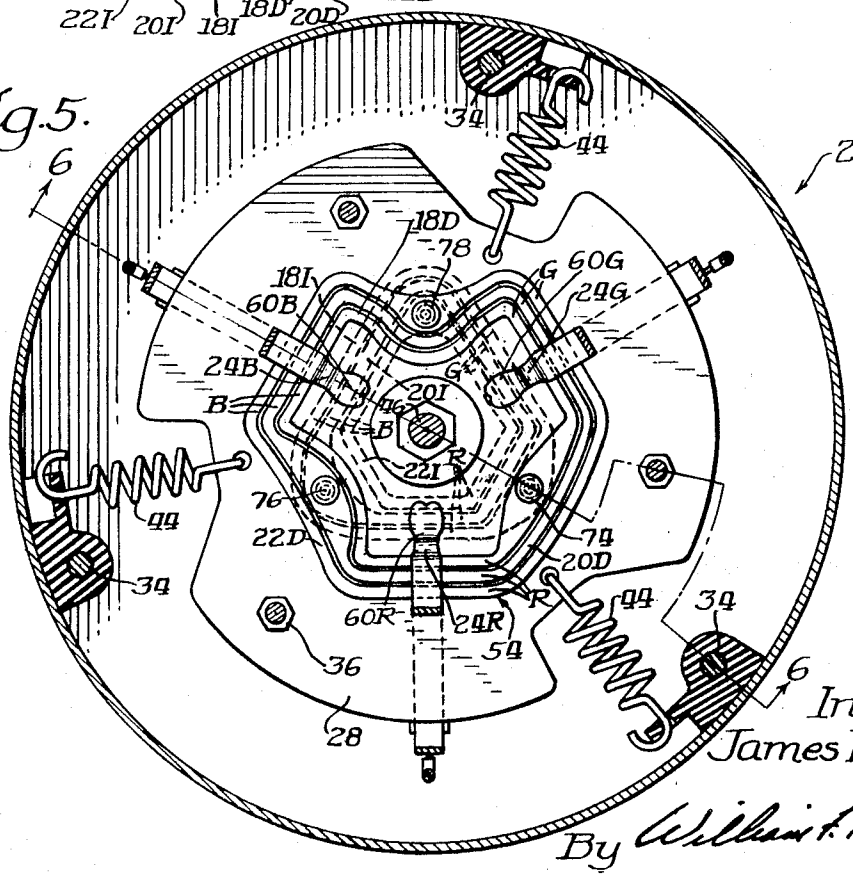


Fig. 5



Inventor:
James F. Wilson

By William L. Lovick
Atty

Fig. 6.

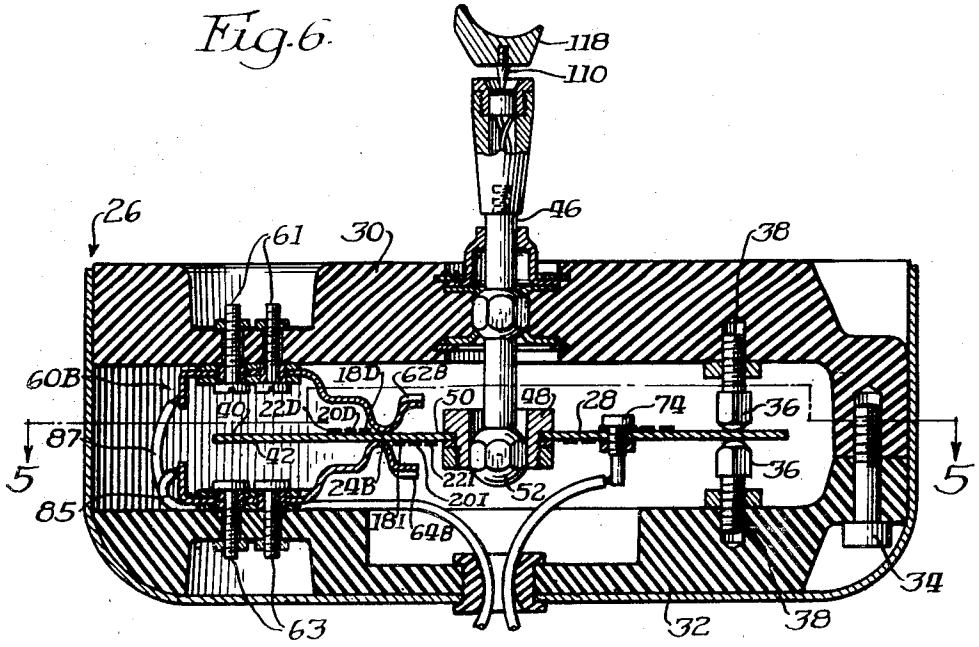
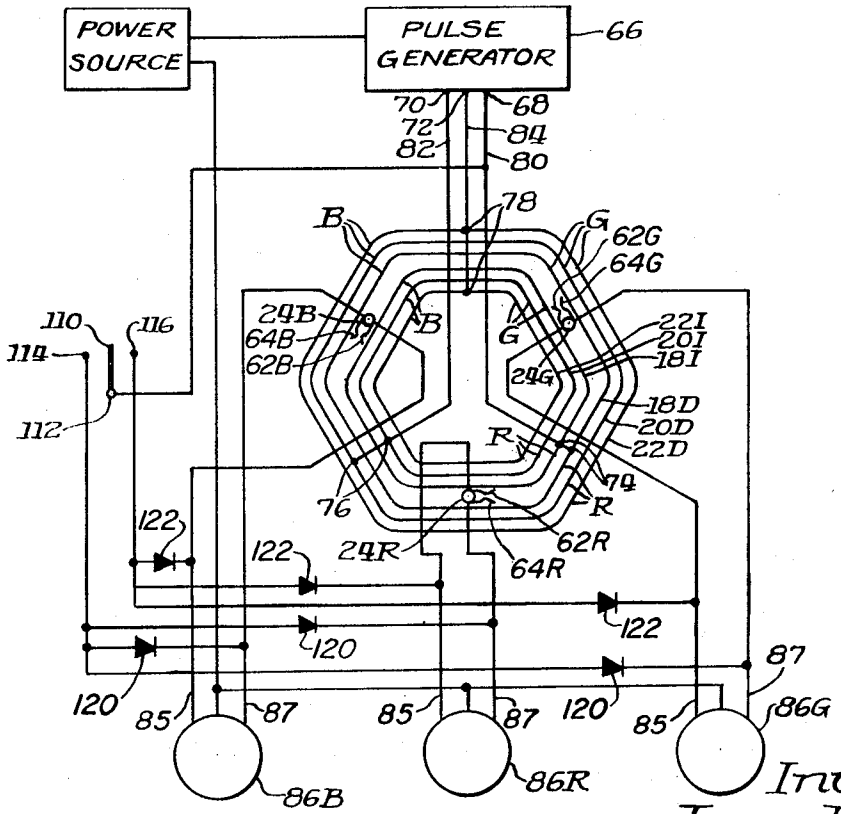


Fig. 8.



Inventor:
James F. Wilson

By William F. Pinsk Atty

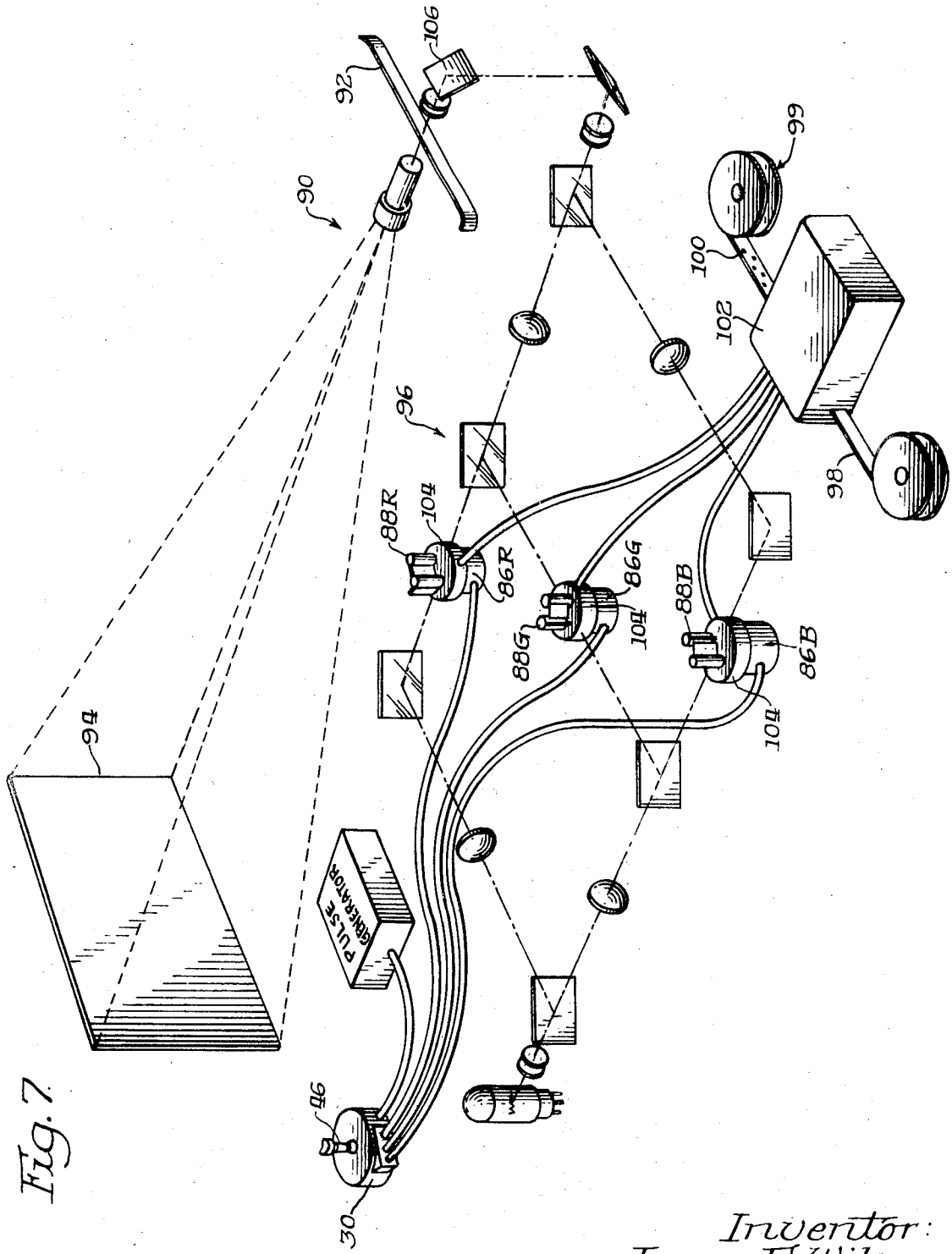


Fig. 7

Inventor:
James F. Wilson.

By William F. Lunde Atty

APPARATUS FOR CONTROLLING A PLURALITY OF LIGHT SOURCES

This is a continuation-in-part of U.S. application Ser. No. 779,817, filed Nov. 29, 1968.

The present invention relates to remote control. Particularly, the invention relates to control of at least three variable factors. Specifically, the invention relates to adjustment of color balance in color picture production.

Prior to the present invention, no means was known for simultaneously controlling from a single control setting three variable factors having values which total to a constant. While having wide application which will be apparent to persons skilled in various arts, means for effecting such control and the concept upon which such means are hypothecated are readily understood when related to balancing three principal or primary colors for reproduction of images in color, as for example, in the production of a colored picture on a television screen or in color printing of motion picture film.

With reference to the latter, known color printing apparatus comprises a light modulating system which adds and subtracts selected amounts of light of selected principal or primary colors to a field about an initially developed negative film in order to produce desired color balance in a color print or film printed from raw stock exposed to the negative under the balanced light. Preparatory to printing, the negative film is projected for review by a skilled color technician. He may judge successive exposure to determine the brightness or colored light requirement in each successive field about the negative film for producing a print having suitable color balance and brightness, for example, to provide uniform light throughout a relates exposure. Indicia representing the technician's color selections are recorded on a control member such as a punched tape. The condition of a plurality of valves for passing light of each of the principal or primary colors in controlled quantities is determined by the punched tape in the printing apparatus. Light passed by the valves is combined for projection through the negative for exposing raw stock to make a print.

The hue of printing light is conventionally a resultant of three variable factors, namely light of each of three principal or primary additive colors. But in addition to hue, the resultant is characterized by brightness. Although adding or subtracting light of a given color, to effect color balance for printing, will effect hue, brightness will also be correspondingly effected by, and as a function of, the quantity of light regardless of color, which is added or subtracted. In conventional color printing, hue and brightness evaluations are independently made by an operator; and his skill is a factor in effecting precise compensating changes in each. By providing a less subjective basis or reducing the number of subjective considerations for light color balancing in color printing, the likelihood of a poor color print can be reduced.

It is an object of the present invention to remotely control at least three variables.

It is another object of the invention to remotely control simultaneously three variable factors having a constant resultant.

It is a further object of the invention adjustably to control from a single control setting at least three addable variable factors having a resultant with a constant characteristic.

It is an additional object of the invention to provide an improved color additive system.

It is still a further object of the invention to improve color balancing in the production of images in color.

Moreover, it is an object of the invention to provide improved printed color films and the like.

Still a further object of the invention is to minimize subjectivity in color balancing in a color additive system for colored image production.

To effect the foregoing objects, remote control apparatus for at least three factors which are combinable to a resultant comprises a pattern. A plurality of loci within the said pattern corresponds to different values in said factors. Sensor means

are arranged with said pattern for relative movement to any selected of said loci. Moreover, means develop an effect in each factor corresponding to the condition of said sensor means relative to said pattern and with a resultant having a characteristic of constant value.

Further and other objects will be apparent from the description of the accompanying drawings in which like numerals refer to like parts.

In the drawings:

FIG. **1** is a scheme for illustrating the principle for simultaneously controlling a plurality of variable factors which add to a resultant having a constant characteristic and upon which the present invention is hypothecated.

FIGS. **2**, **3** and **4** comprise schemes illustrating the principal for control of said factors, respectively.

FIG. **5** is a sectional view of a device embodying the invention, a switch plate being shown in plan, and parts shown in dotted line for the purpose of illustration.

FIG. **6** is a sectional view taken on the broken line **6—6** of FIG. **5** and showing a lower end portion of a manual control rod in elevation.

FIG. **7** is a perspective of apparatus employing the device of FIG. **5** to produce a control member for operating the color valves of a color additive printing system.

FIG. **8** is a wiring scheme of said apparatus.

Referring now to FIG. **1**, a geometric form **10**, has a plurality of sides **12**, **14** and **16** which correspond, respectively, to a plurality of addable related variable factors control of which is desired. The sides are equiangularly disposed, of equal length, and regularly spaced from the center **24** of said geometric form. While the latter is shown herein as an equilateral triangle, neither the invention nor the principle upon which the invention is hypothecated is limited to three variable factors. Any number of at least three factors may be controlled according to the present invention simultaneously and from a single setting and station. Accordingly, if there are, for example, four factors the geometric figure to which apparatus embodying the invention will be related will be a square.

It is observed that form **10** comprises an infinite number of loci, each of which is definable in terms of coordinates comprising its perpendicular distance from each side of the figure. Moreover, the sum of the perpendicular distances from the sides of form **10** to any point or locus therewithin is equal to a constant.

In accordance with the predication of one aspect of the invention, an arbitrary quantity of each of three principal or primary colors, namely, blue, green and red, of a color additive system is represented or corresponds, respectively, to one of the sides **12**, **14** and **16**. The relationship of the selected colors is such that equal amounts of each develops gray, or some level of brightness on a gray scale; and a combination of equal amounts of any two complements a like amount of the other. Within form **10**, the perpendicular distance from each side represents the brightness of a respective color. In consequence of the foregoing, each locus or point within the triangle represents or corresponds to a distinctive resultant or hue according to a definition of the locus in terms of its perpendicular distances to the sides. However, the brightness of the resultant is a constant. That is to say, the brightness of each of the infinite hues (corresponding to the infinite loci within form **10**) is the same as the brightness for each of the other hues.

Relative to each of the sides **12**, **14** and **16**, a plurality of gradient strips **18I**, **18D**, **20I**, **22I** and **22D** are arranged in spaced and parallel relationship from each other and an associated side. Each of said strips has three segments B, G and R which correspond in the exemplary disclosure, respectively, to colors blue, green and red. The segments associated with each color are parallel to each other and to the side of form **10** related to a corresponding color. FIGS. **2**, **3** and **4**, respectively, graphically isolate groups of parallel B, G and R segments of said gradient strips. FIG. **1** illustrates them combined.

The center 24 of geometric form 10 may be employed as a reference or zero point because it is perpendicularly equidistant from each of the sides 12, 14 and 16. Accordingly, a coordinate of a locus will have a value more or less than zero depending on whether it is farther or closer to a side than is center 24.

A remote control device 26 (FIGS. 5 and 6) hypothecated on the aforeannunciated principles has a housing comprised of an upper casing member 30 and a lower casing member 32 which are secured together by suitable fasteners, such as screws 34. A switch 28 in the form of a plate of nonconductive fabrication is arranged with the housing for movement in a horizontal plane. Means for supporting switch 28 comprises a plurality of vertically arranged pairs of upper and lower holding members 36 regularly spaced about switch 28. Outer portions 38 of the holding members of each pair are adjustably secured in adjacent casing members for spacing the inner bearing portions in slidable association with upper and lower surfaces 40 and 42 of said switch. Means, such as a plurality of expansion springs 44 are arranged for urging switch 28 to a center, or inactive condition. To that end, said springs may be regularly spaced about said switch with inner portions connected to the switch and outer portions anchored to the housing.

A control handle or joy stick 46 comprises means for manually moving switch 28 from its centered position to any of selected positions in a horizontal plane radially from the center of the switch to any position within its range in a plane about its center. To that end, a bearing hub 48 is rigidly secured by any suitable means to an inner marginal annulus 50 formed about the center of the switch. The innermost end portion 52 of the joy stick 46 bearingly seats in hub 48 for motivating said switch in a horizontal plane.

A pattern 54 corresponding to the triangle comprising geometric form 10 is defined on switch 28 by strips 18I, 20I, 22I, 18D, 20D and 22D which are electrical conductors. While said strips are shown segmented in FIGS. 1–4, in the practical form, each strip is endless (FIG. 5). Each group of segments B, G and R is spaced in the pattern from the other groups; and the segments of each group are arranged parallel one to another and to an imaginary side of a triangle. In consequence of such arrangement, each strip has an electrically conductive segment corresponding to each of the variables, namely a primary color. Any point on one of the segments B, G and R of pattern 54, provided it is overlapping the other strips from the standpoint of disposition in form 10, has a corresponding point on each of the other segments such that a value associated with any point has a pair of corresponding values associated with the corresponding points which values when added together produce a constant.

Strips 18I and 18D are first magnitude strips. Strips 20I and 20D are second magnitude strips. Strips 22I and 22D are third magnitude strips. Strips 18I, 20I and 22I are secured to the top surface 40 of switch plate 28; while the strips 18D, 20D and 22D are secured to its bottom surface 42. Moreover, the color segments B, G and R of strips 18I, 20I and 22I are spaced horizontally from respective color segments B, G and R of strips 18D, 20D and 22D to provide, between the segments of the I strips and the segments of the D strips, a plurality of nonconductive centers 24B, 24G and 24R, corresponding respectively, to the B, G and R segments and analogous to center 24.

Fixed secured electrical contact assemblies 60B, 60G and 60R are associated, respectively, with the groups B, G and R of color segments. Each of said assemblies preferably has the same construction as the others and comprises respectively a pair of vertically aligned upper and lower electric contacts 62B, 64B; 62G, 64G and 62R, 64R (FIG. 6 and 8). Upper contact 62 of each contact assembly is disposed adjacent upper surface 40 and secured by fasteners such as screws 61 to casing member 30 for engagement with a corresponding group of color segments B, G and R of strips 18D, 20D and 22D as switch plate 28 is appropriately shifted. Lower contact 64 of each contact assembly is disposed adjacent lower surface 42 and secured by fasteners such as screws 63 to casing member 32 for engagement with a corresponding group of color segments B, G and R of strips 18I, 20I and 22I as switch plate 28 is suitably shifted.

The arrangement and proportioning of parts is such that the contacts 62 and 64 of each assembly will simultaneously engage corresponding of centers 24B, 24G and 24R, when switch plate 28 is in its normal condition. Furthermore, the contact assemblies 60B, 60G and 60R are arranged and proportioned so that a circuit may be completed at one time through only one contact of each contact assembly. Consequently, a circuit may not be completed through the contacts 62 and 64 of the same contact assembly. Moreover, simultaneously each contact assembly is disposed at an analogous position as the other assemblies, that is, the same locus when considered in relation to geometric form 10. This arrangement enables simultaneous and separate readout of corresponding values of each of the variable factors.

In the present embodiment, an electrical gradient is produced by means of a pulse generator 66 (FIG. 8) which has three output terminals 68, 70 and 72. The output at terminal 68 is X pulses per second, the output at terminal 70 is 2X pulses per second, and the output at terminal 72 is 3X pulses per second. In an exemplary device X may have a value of one, which is of 0.01 second duration at about 110 volts. It is intended, however, that neither the pulse rate nor the voltage is limiting on the present invention.

Terminal 68 is coupled to strips 18I and 18D, terminal 70 is coupled to terminals 20I and 20D, and terminal 72 is coupled to strips 22I and 22D by means of suitable conductive connectors 74, 76 and 78 (FIG. 5) which are suitably arranged at the ends of conductors 80, 82 and 84. To isolate the effects of the gradient strips, 18I, 20I, 22I, 18D, 20D and 22D each must be spaced from an adjacent strip by a distance such that they are out of direct electrical communication. On the other hand, the spacing of the strips should be such that each of the contacts 62 and 64 is able to engage two adjoining strips simultaneously to prevent dead spaces between adjoining B, G and R segments of the I strips and adjoining B, G and R segments of the D strips.

A plurality of reversibly drivable stepping motors 86B, 86G and 86R, respectively, are associated with the groups of segments B, G and R. From one side, each motor is connected to its segments of I strips through a conductor 85. From the other side, each motor is connected to its segments of D strips through a conductor 87. The arrangement is such that when a contact 62 engages an energized D strip, a circuit will be completed through a corresponding conductor 87 (FIGS. 6 and 8) to drive an associated motor in one direction. Whereas, when a contact 64 engages an energized I strip, a circuit will be completed through corresponding conductor 85 for driving an associated motor in an opposite direction. Stepping motors 86B, 86G and 86R are adapted for reversibly driving respective of the pairs of vanes of color valves 88B, 88G and 88R (FIG. 7). The valves may be of conventional construction. The arrangement is such that when a circuit is completed through a contact 62, an associated valve is driven to close; whereas, when a circuit is completed through a contact 64, a therewith associated valve will be motivated to open.

The aforesaid color valves comprise colored light control means of a color additive system embodying one aspect of the present invention for manufacturing a control member such as a punched tape 100. Said tape is of the type disclosed in copending application Ser. No. 641,532, now U.S. Pat. No. 3,502,409, assigned to the assignee of the present invention. In accordance with the present invention, an initially developed color film 92, from which it is desired to produce a print on other stock in a color conditioned or color balanced form, is moved through a projector 90 only sufficient of which is shown to facilitate understanding of the invention. Under combined primary colored lights developed in a light modulating system 96 of the type particularly described in said copending application, film 92 is projected onto a screen 94.

Unpunched tape 98 is supported on conventional tape handling apparatus 99 for movement through a coding punch 102 synchronously with movement of film 92 thereby to supply the punched tape 100. Punch 102 may be conventional and its details of construction including a reading mechanism do not limit the invention. Said reading mechanism is arranged for response to effects generated by vane position sensors 104 associated with said valves 88B, 88G and 88R and produces corresponding effects by conventional means for punched tape production.

Valves 88B, 88G and 88R are arranged for controlling the volume or amount of light of each of three primary colors comprising variable factors herein. These colored lights are combined in a resultant reflected from mirror 106 for projection of film 92. An operator can cause a desired color effect on screen 94 by simultaneously controlling the three variable factors through manipulation of handle 46. That is to say, assume a scene is projected on screen 94 which in the judgment of the operator is deficient in red, he can move handle 46 to shift switch plate 28 and cause engagement of an R segment of either strip 18I, 20I or 22I with an associated contact 64. Thereby, valve 88R will open to increase the red light. But opening red valve 88R not only increases the red colored light in the resultant but will increase picture brightness if all other factors are held constant.

In accordance with the present invention, this undesirable occurrence will be prevented because as the volume of light of any primary color is added to the resultant, like amount of light will be simultaneously subtracted by closing the valves controlling the colors of the complement to the added light color. Consequently, as the hue is changed, the brightness will be held to a constant level.

Immediately after a desired color effect has been produced on screen 94, stick 46 is released to permit return of the switch plate 28 to its normal condition. Such release does not affect the position of the light valves, and their condition may be registered on tape 100 by operation of the punch 102 in a customary manner. In consequence of the foregoing, each prior valve position is a reference position from which a next setting of the valves is developed.

By reason of the manner of energization of the conductive strips, a circuit through the strip 18I will cause a thereby controlled valve to open one third as quickly as a circuit through strip 22I and half as quickly as a circuit through strip 20I. Similarly, a circuit through strip 18D will cause a thereby controlled valve to close one third as quickly as a circuit through strip 22D and half as quickly as a circuit through strip 20D.

To enlarge the utility of the control apparatus herein described, means are provided for selectively changing the value of the constant resultant that is to change the brightness while maintaining a control hue. Translated into the apparatus for producing punched tape 100, a change of constant switch 110 (FIGS. 6 and 8) having a terminal pole 112 is coupled to generator 66. Herein the connection is shown through terminal 68. However, depending upon the speed requirement for changing the constant, connection of terminal 112 to the generator could be through another of terminals 70 and 72.

Switch 110 has an open and ineffective condition (FIG. 8) and a pair of effective conditions when it is disposed in engagement with selected terminals 114 and 116. Terminal 114 is coupled to one side of each of the stepping motors through steering diodes 120 while terminal 116 is coupled to the other side of each of the stepping motors through steering diodes 122. Accordingly, when the switch 110 completes a circuit through terminal 114 each of the valves will be closed a like extent. Whereas, when a circuit is completed through terminal 116, each of the valves will be opened a like extent. In the present embodiment, the condition of switch 110 may be controlled through a thumb knob 118 (FIG. 6) which can be suitably mounted on the upper end portion of handle 46.

What is claimed is:

1. An apparatus particularly adapted for controlling at least one light source comprising:

a support member of nonconductive material displaying two relatively continuous surfaces and adapted for movement along a substantially fixed path;

a plurality of conductors positioned upon said support member, said conductors being continuous linear conductors formed into equiangular figures of different sizes and concentrically located;

a plurality of electrically conductive contacts each of which is positioned to contact one of said conductors so as to complete a circuit between said conductors and said electrically conductive contacts, each of said contacts being related to a different side of said equiangular figure; and

means for varying the relative position between said support member and said contacts to selectively complete the circuit between said conductors and said electrically conductive contacts thereby controlling the operation of the light source.

2. The apparatus of claim 1, wherein at least two of said conductors are of similar shape but different size and arranged in nested position upon said support member.

3. The apparatus of claim 2, wherein said means for varying the relative position between said support member and said contact engages support member for imparting movement to said member relative to said electrically conductive contact.

4. The apparatus of claim 2, wherein at least one of said conductors is disposed on each of the surfaces of said support member.

5. The apparatus of claim 4 particularly adapted for controlling a plurality of light sources further comprising a plurality of said electrically conductive contacts wherein at least one electrically conductive contact corresponding to a selected light source is carried on each surface of said support member.

6. The apparatus of claim 5, wherein said support member is a substantially flat plate and bias means supporting said plate with respect to said electrically conductive contacts for movement in a fixed plane.

7. The apparatus of claim 3, wherein said means for varying the relative position between said support member and said contact is manually operable and comprises a joy stick suitable for grasping by the human hand, and a switch mounted upon said joy stick.

8. The apparatus of claim 7, wherein said switch serves to selectively connect at least two of said electrically conductive contacts.

9. The apparatus of claim 1, which further includes reversible stepping motors operatively connected to the light source and a generator so that upon engagement of said contact with said conductors said motors are actuated by said generator in a predetermined direction.

10. The apparatus of claim 9, which further includes a switch for directly connecting said motors with said generator so as to produce uniform motor actuation of the light source.

11. The apparatus of claim 10, wherein said switch is a single pole double throw center-off switch with the movable member connected to said generator, and a plurality of steering diodes connecting the fixed members of said switch with said motors.

12. The apparatus of claim 11, comprising at least one color valve connected to each of said motors whereby upon actuation of said varying means the hue of said color valves varies with relatively constant brightness and upon activation of said switch the brightness varies while maintaining relatively constant hue.

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