

July 20, 1965

D. A. BAKER

3,196,278

AREA TYPE PHOTO-ELECTRIC CONTROL DEVICE

Filed Sept. 12, 1961

2 Sheets-Sheet 1

Fig. 1

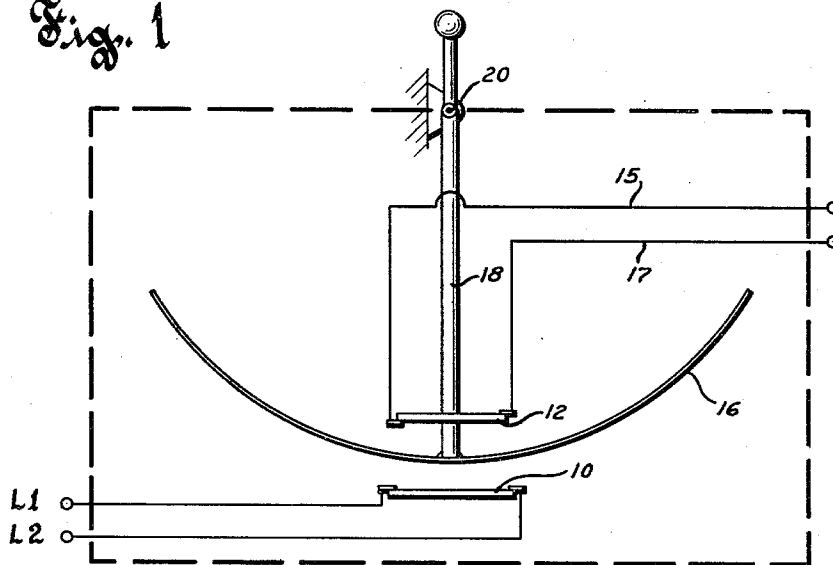


Fig. 2

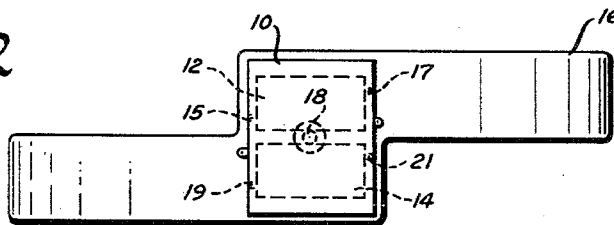


Fig. 3

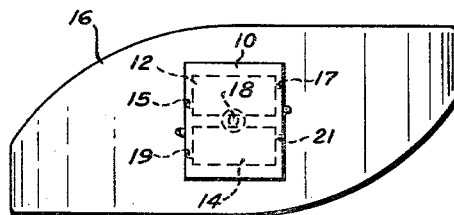
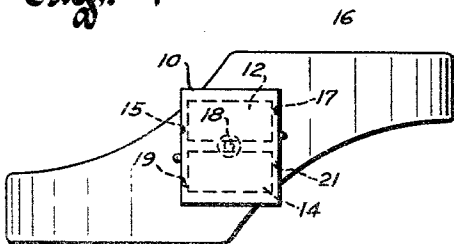


Fig. 4



Inventor
Dale H. Baker
By *Wm. A. Autio*
Attorney

July 20, 1965

D. A. BAKER

3,196,278

AREA TYPE PHOTO-ELECTRIC CONTROL DEVICE

Filed Sept. 12, 1961

2 Sheets-Sheet 2

Fig. 5

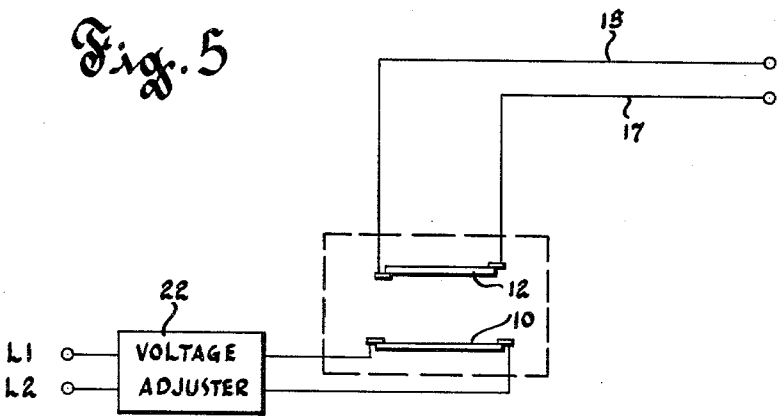


Fig. 6

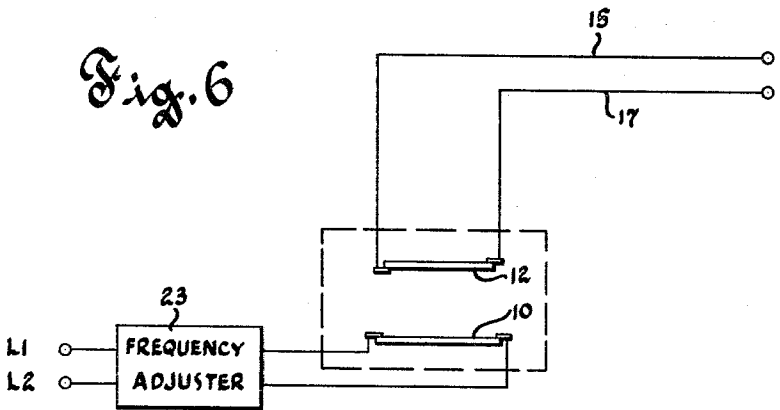
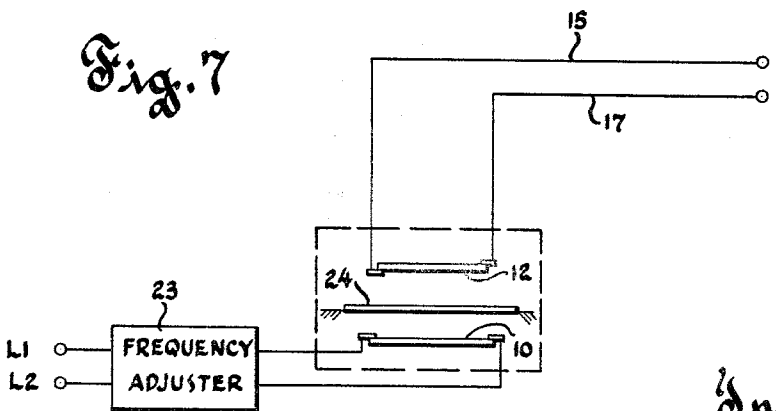


Fig. 7



Inventor
Dale S. Baker
By *Wm. A. Curtis*
Attorney

1

3,196,278

AREA TYPE PHOTO-ELECTRIC CONTROL DEVICE

Dale A. Baker, Waukesha, Wis., assignor to Cutler-Hammer, Inc., Milwaukee, Wis., a corporation of Delaware

Filed Sept. 12, 1961, Ser. No. 137,653

12 Claims. (Cl. 250-237)

This invention relates to a control device for a regulator and particularly to a position-to-voltage type transducer with an output voltage suitable for use as a reference signal for a regulator.

Photo-electric type devices have been used previously to produce a reference signal for a regulator in response to variations in the intensity of light on the photo-electric cells. A point light source will produce uniform illumination on the interior surface of a concentrically located sphere. Any surface which does not consist of a portion of such a concentrically located sphere will be unevenly illuminated by a point light source. Any mechanical device which modulates the light emanating from a point source and falling upon a plane surface must be compensated for this uneven illumination. In contrast a true area light source will cause uniform illumination of a plane of the same size as the area light source if such plane is located parallel to the area light source and with the spacing between the receiving plane and the area light source small with respect to the small dimension of the receiving plane.

A general object of the invention is to provide an improved photo-electric type of control device which affords a controllable output signal.

The primary object of this invention is to provide a simple electronic device for controlling the speed of an electric motor in response to the position of a master control.

A further object of this invention is to provide improved means affording an electric motor speed control reference signal that is pure D.C.

Other objects and advantages will be pointed out in or be apparent from the specification and claims, as will obvious modifications of the embodiments shown in the drawings, in which:

FIGURE 1 is a side view of a first embodiment of the control device;

FIG. 2 is a bottom view of the control device of FIG. 1;

FIG. 3 is a bottom view of a modified type shade for the control device of FIGS. 1 and 2;

FIG. 4 is a bottom view of another modification of the shade for the control device of FIGS. 1 and 2;

FIG. 5 is a side view of a second embodiment of the control device wherein the output voltage is controlled by adjustment of the supply voltage;

FIG. 6 is a side view of a third embodiment of the control device wherein the output voltage is controlled by adjustment of the supply frequency; and

FIG. 7 is a side view of a modification of the control device of FIG. 6 wherein the light is filtered.

Referring to the drawings, the control device is shown in FIGS. 1 to 4 generally as including an area type primary light source 10, such as an electroluminescent panel, connected to an A.C. source of power L_1 , L_2 . A pair of area type photo-electric cells 12 and 14, such as self-generating selenium cells, of equal size are positioned above the light source parallel and very close to the light source and in a light-tight enclosure (shown in broken lines in FIG. 1). The area of the panel for the light source is shown as being slightly greater than the combined areas of the photo-electric cells so that the light intensity will be assured of being equal over the

2

entire surface of the photo-electric cells. The cells are independently connected to the motor regulator by respective pairs of conductor 15, 17 and 19, 21 to provide pure D.C. voltages to control the speed of the motor. The motor regulator can be constructed so that the rotation of the motor depends upon which cell is exposed to the source of light and this can obviously be coordinated with the direction of motion of the handle.

An arcuate opaque shade 16 is secured to the end of a control rod 18 pivoted at 20 and is movable between the light source and the photo-electric cells upon movement of the control rod. Since the output from the light source is constant and the voltage output of the cells is directly proportional to the intensity of light on their surfaces or the amount of such surface exposed to light of constant intensity the shade is cut to expose an increasing amount of surface of one cell or the other to the light as the shade is rotated to the right or left. The increase in light applied on the cell will produce a low power pure D.C. voltage that increases in a manner directly related to the contour of the shade. In FIG. 3 the shade is designed to provide a dead band when the control rod is initially rotated in either direction with a slowly increasing light exposure while the shade in FIG. 4 allows a small amount of light to reach the cells when the control rod is at neutral and increases the light exposure rapidly. It should be apparent that the same result could be accomplished by either contouring the light source or the cells to change the characteristic of the output of the cells.

In a practical application of this device, such as in a crane, the light source is connected across power supply lines L_1 and L_2 and the photocells are connected to control the speed and direction of rotation of the crane lift motor. Since the D.C. voltage output of the cells will increase as the total amount of light on the cells increases, the farther the shade is rotated in either direction the larger will be the reference signal to the regulator which can cause the motor to run faster. It can be seen that as the control rod is rotated clockwise (FIG. 1), cell 14 will be exposed to the light. The farther the rod is rotated, the greater the area of exposure. The position of the rod, therefore, determines the output of the photocells and this output is used to control both the direction of rotation and speed of the motor. The intensity of the light source is determined by the A.C. voltage which can be varied with respect to a second parameter if desired. Some phosphors used in electroluminescent light sources will produce a light the wave length of which is somewhat dependent upon the frequency of the applied A.C. voltage. Therefore, the use of colored filters between the electroluminescent panel and the photocells can make the output of the photocells somewhat dependent upon the frequency of the A.C. voltage applied to the electroluminescent light source which may then be made a function of a third parameter.

In FIGS. 5, 6 and 7, reference characters like those in FIG. 1 have been employed for like elements. The embodiment in FIG. 5 differs from that in FIG. 1 in that the shade has been omitted. Also, a voltage adjuster 22 is connected in power supply lines L_1 and L_2 or to the power supply source to enable adjustment of the magnitude of the alternating voltage applied to light source 10. Increase or decrease in the voltage magnitude respectively increases or decreases the intensity of the light emitting from source 10. The embodiment in FIG. 6 differs from that in FIG. 5 in that a frequency adjuster 23 is used in place of the voltage magnitude adjuster. Increase or decrease in the supply frequency respectively increases

or decreases the intensity of the light emitted from source 10. The modification in FIG. 7 differs from FIG. 6 in that a colored filter 24 has been mounted between light source 10 and photo-cells 12 and 14. Since the wave length of the light is dependent on the frequency of the alternating current source L_1-L_2 , filter 24 may be employed to block all or part of the light at one source frequency and to vary the passage of light therethrough as the frequency is adjusted.

A significant feature provided by this system is that the output voltage produced by the photo-electric cells is a pure D.C. voltage which does not require filtering before use as a reference signal in a fast response regulator. This transducer also has neither the counter-torque type of force feedback such as produced by the magnetic type transducer nor a friction type force feedback such as produced by a potentiometer type transducer.

Although several embodiments of the present invention have been illustrated and described, it will be apparent to those skilled in the art that various changes and modifications may be made therein without departing from the scope of the appended claims.

I claim:

1. A selectively adjustable control device for providing an electrical signal having a magnitude which is proportional to adjustment of the control device comprising:
 - area-type photo-electric means responsive to variable light to provide a proportionally variable electrical output signal;
 - an area-type primary luminescent source spaced closely parallel to said photo-electric means so that unit areas of said photo-electric means are exposed to light emitted from corresponding unit areas of said luminescent source;
 - and means for continuously adjusting the amount of light impinging on said photo-electric means directly from said luminescent source proportionally to adjust the magnitude of said output signal.
2. The invention defined in claim 1, wherein said means for continuously adjusting the amount of light impinging on said photo-electric means from said luminescent source comprises:
 - an opaque shade positioned in the small space between said luminescent source and said photo-electric means; and means for steplessly moving said shade to adjust the area of said photo-electric means that is exposed to light from said luminescent source.
3. The invention defined in claim 1, wherein said primary luminescent source comprises:
 - an electro-luminescent member; and
 - an alternating current power supply source connected to said member to cause light emission therefrom; and said means for continuously adjusting the amount of light impinging on said photo-electric means from said luminescent source comprises means for adjusting the magnitude of voltage applied to said electro-luminescent member thereby proportionally to adjust the intensity of light emitted therefrom onto said photo-electric means.
4. The invention defined in claim 1, wherein said primary luminescent source comprises:
 - an electro-luminescent member; and
 - an alternating current power supply source connected to said member to cause light emission therefrom; and said means for continuously adjusting the amount of light impinging on said photo-electric means from said luminescent source comprises means for adjusting the frequency of the voltage applied to said electro-luminescent member thereby proportionately to adjust the intensity of light emitted therefrom onto said photo-electric means.
5. The invention defined in claim 4, together with:
 - a stationary colored filter between said electro-luminescent member and said photo-electric means for pass-

ing light therethrough as a function of the wavelength of such light.

6. An adjustable control device for providing an electrical signal having a magnitude which is proportional to adjusted position of the control device comprising:
 - area-type photo-electric means responsive to variable light to provide a proportionally variable electrical output signal;
 - area-type luminescent source means spaced closely parallel to said photo-electric means so that portions of said photo-electric means are exposed to light emitted from corresponding portions of said luminescent source means;
 - area-type opaque shade means mounted for lateral stepless movement in the small space between said luminescent source means and said photo-electric means; and one of said means being provided with a configuration which operates in conjunction with movement of said shade to cause the magnitude of said output signal to change proportional to such movement.
7. The invention defined in claim 6, together with:
 - an opaque housing completely enclosing said photo-electric means and said luminescent source means and said shade means;
 - and control means extending from the exterior of said housing therewithin for moving said shade means.
8. The invention defined in claim 6, wherein said one of said means is provided with a configuration which comprises a straight edge so that uniform incremental movements of said shade means cause respective directly and linearly proportional changes in the magnitude of said output signal.
9. The invention defined in claim 6, wherein said one of said means is provided with a configuration which comprises an edge of progressively increasing curvature so that uniform incremental movements of said shade means cause successively larger increments in the magnitude of said output signal.
10. The invention defined in claim 6, wherein said one of said means is provided with a configuration which comprises an edge of progressively decreasing curvature so that uniform incremental movements of said shade means cause successively smaller increments in the magnitude of said output signal.
11. An adjustable control device for providing a direct current electrical signal having a magnitude which is proportional to adjustment of said control device comprising:
 - a planar photo-electric element responsive to variable light to provide a direct current signal having a proportionally variable magnitude;
 - a planar electro-luminescent member having an area at least as large as the area of said photo-electric element and having its light emitting surface spaced closely parallel to the light responsive surface of said photo-electric element so that unit areas of the latter are in direct light exposure relation with corresponding unit areas of said electro-luminescent member;
 - an opaque shade;
 - means mounting said opaque shade for movement in the small space between said electro-luminescent member and said photo-electric element;
 - an opaque enclosure for the aforementioned parts to prevent other light from impinging on said photo-electric element;
 - means on the exterior of said enclosure and extending into the latter for affording continuous movement of said shade to adjust the amount of light passing from said electro-luminescent member directly onto said photo-electric element;
 - and an alternating current power supply source and conductors extending therefrom into said enclosure and being connected to said electro-luminescent member for energizing the latter with an alternating current field.
12. A selectively adjustable control device for provid-

5

ing a selected one of a plurality of electrical signals and a magnitude therefor which are functions of the adjustment of said control device comprising:

- a plurality of area-type photo-electric elements arranged in side-by-side relation, each said element being responsive to variable light exposure to provide a proportionally variable output signal and having a pair of terminals for connecting the same to a device to be controlled; 5
- an area-type luminescent source having an area at least as large as the combined areas of said photo-electric elements and having its light emitting surface spaced closely parallel to the light responsive surfaces of said photo-electric elements; 10
- an opaque shade mounted for continuous lateral movement in the small space between said luminescent source and said photo-electric elements; 15
- and said shade being provided with a configuration comprising a plurality of cutout portions whereby movement thereof in a selected direction causes exposure of an increasing amount of surface of a selected photo-electric element to said luminescent source. 20

6

References Cited by the Examiner

UNITED STATES PATENTS

2,030,854	2/36	Calver	250—229 X
2,740,901	4/56	Graham	250—212 X
2,753,487	7/56	Bone	250—229 X
2,780,731	2/57	Miller	250—213
2,858,449	10/58	Burr	250—105 X
2,879,405	3/59	Pankove	250—211
2,896,086	7/59	Wunderman	250—211
2,904,697	9/59	Halsted	250—213
3,015,731	1/62	Van Santen et al.	250—213
3,033,073	5/62	Shuttleworth	250—211
3,046,540	7/62	Litz et al.	250—213
3,093,741	6/63	Meyer	250—212
3,121,795	2/64	Marvin	250—212
3,134,907	5/64	Volberg	250—237

FOREIGN PATENTS

223,728	7/59	Australia.
---------	------	------------

RALPH G. NILSON, *Primary Examiner.*ARCHIE R. BORCHELT, *Examiner.*