March 23, 1937. A. S. FITZ GERALD 2,074,835

ELECTRIC ELEVATOR INDICATING SYSTEM

Filed Dec. 5, 1933 2 Sheets-Sheet 1

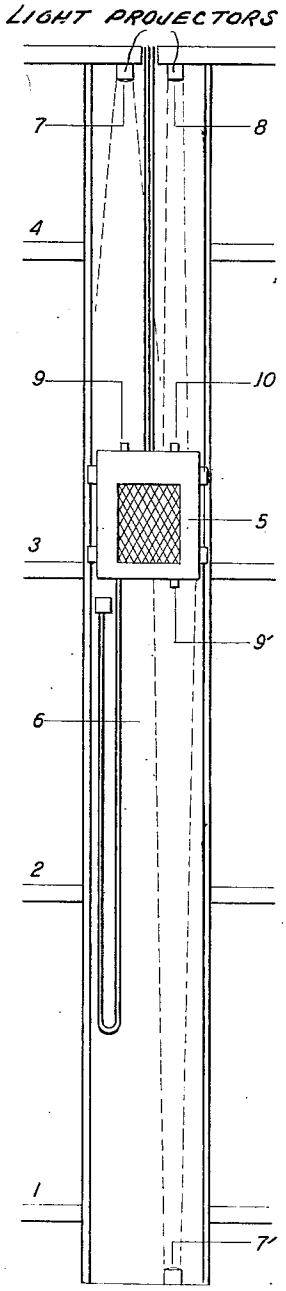


FIG 1

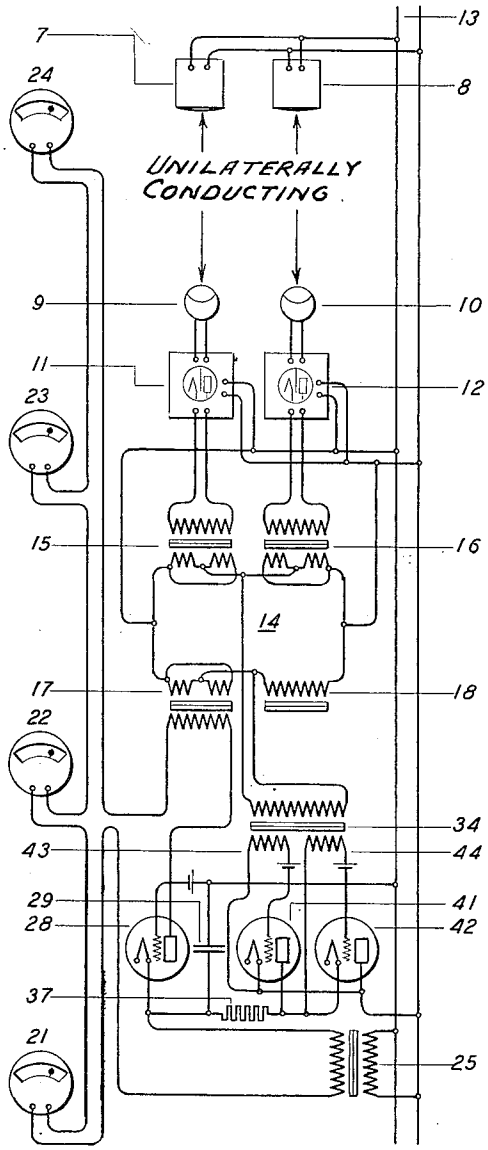


FIG 2

INVENTOR

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ELECTRIC ELEVATOR INDICATING SYSTEM

Filed Dec. 5, 1933 2 Sheets-Sheet 2

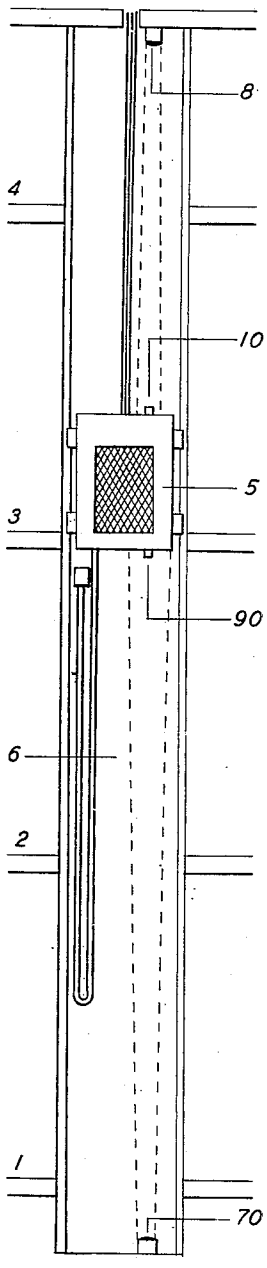


FIG. 3

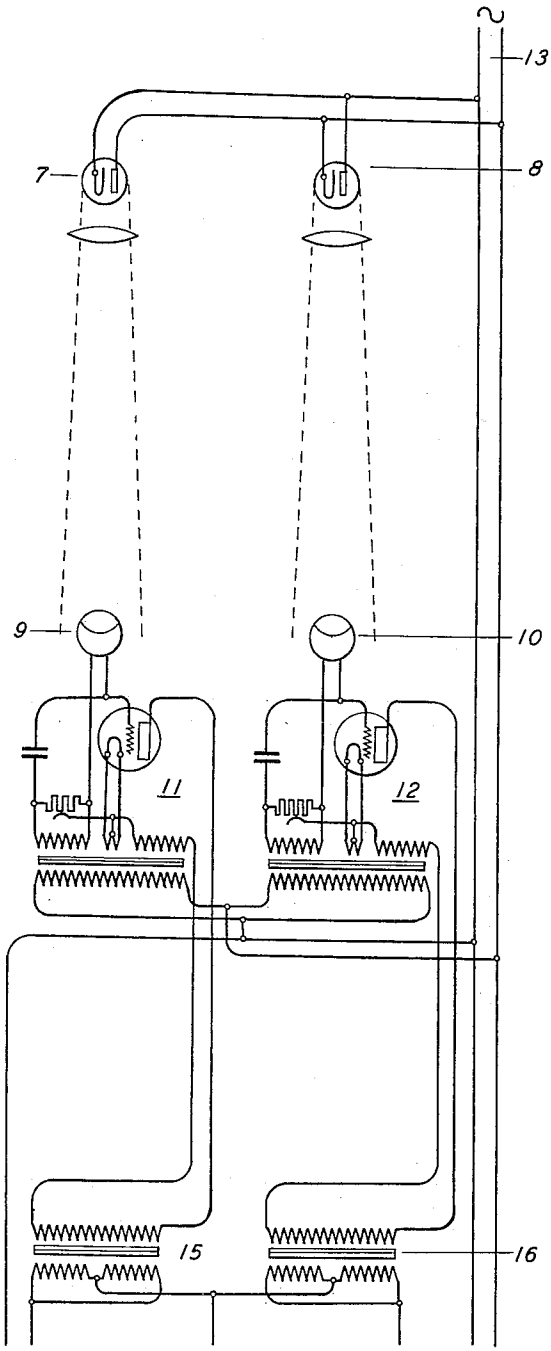


FIG. 4

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UNITED STATES PATENT OFFICE

2,074,835

ELECTRIC ELEVATOR INDICATING SYSTEM

Alan S. Fitz Gerald, Wynnewood, Pa.

Application December 5, 1933, Serial No. 700,957
In Great Britain December 6, 1932

8 Claims. (Cl. 177—336)

This invention relates to electric indicating systems and more particularly to systems for indicating the position of an elevator car during its travel.

Various mechanical devices have hitherto been used for indicating, to passengers waiting at the different floors served by the elevator, the location of the various cars. Usually a special pulley cable is attached to the car for operating these devices. Owing to slipping or creepage or other irregular circumstances, such apparatus often requires resetting from time to time.

According to my invention I utilize light beams and photo-electric devices for indicating the position of the elevator car. Stationary light sources are mounted in the hatchway impinging upon photo-electric cells attached to the elevator car. Alternatively, the light sources may be mounted upon the car and the photo-cells may be stationary, these being mounted in the hatchway. The light sources are so placed in relation to the photo-electric cells that the ratio between the intensity of the illumination directed upon the photo-cells, by the light sources varies in accordance with the position of the elevator car in the hatchway.

Thus, two photo-electric currents are generated and the ratio of the magnitude of these two currents is a function of the position of the elevator car.

Any suitable method, therefore, which gives an indication in accordance with the ratio between these two currents will furnish an indication of the position of elevator car.

Since the indication of the elevator car position should be reproduced at each floor, and in view of the fact that indicating instruments actuated by a single electric current are cheaper and more readily obtainable than ratio-instruments, according to a further feature of my invention I provide a novel automatic regulating electric circuit which furnishes a single electric current proportional to the ratio of the photo-electric currents. A circuit carrying this current may be taken to each indicating station and the position of the elevator car shown by a simple current-operated indicating instrument.

It is an object of the present invention to provide an entirely electrical system for indicating the position of an elevator car and which avoids the installation of any mechanical apparatus, pulleys, cable or other similar gear in the hatchway.

It is another object of my invention to provide an improved method of indicating the position of an elevator car which avoids the use of any mechanical engagement between the car and the hatchway and which, accordingly, is simple, economical and easy to install and maintain.

It is a further object of my invention to provide an electric floor indicating system capable of giving an indication of the position of an elevator car either at the elevator floor-gates on the various floors, within the car, or at any other point to which an electric circuit may be taken and which requires only two conductors irrespective of the number of floors to be indicated.

It is yet a further object of my invention to provide, in order to accomplish the above purposes, an electric circuit which will generate a current proportional in magnitude to the ratio of the magnitudes of two other currents.

These and other novel features which I believe to be characteristic of my invention will be set forth with particularity in the appended claims. My invention itself, however, both as to its organization and method of operation, together with further objects and advantages thereof, may best be understood with reference to the following description taken in connection with the accompanying drawings, in which

Figure 1 is an embodiment of my invention;

Fig. 2 is an electrical circuit diagram relating to the embodiment of my invention shown in Fig. 1;

Fig. 3 shows a modification of the embodiment of my invention in Fig. 1; and

Fig. 4 is an electric circuit diagram showing in greater detail a portion of the arrangement illustrated in Fig. 2.

In Fig. 1, I show an elevator car 5 operating in a hatchway 6 serving four floors 1, 2, 3 and 4, respectively. At the top of hatchway 6, I show two light sources 7 and 8 which may constitute projecting lanterns comprising lenses and/or reflectors for projecting two beams of light downwards in the hatchway. On the roof of car 5, I show two photo-cells 9 and 10, which may be mounted in suitable housings and which are directed upwards so as to receive illumination from the light sources 7 and 8.

As an alternative, the light source 7 may be mounted in the bottom of the hatchway, as shown in Fig. 3 at 70, the corresponding photo-cell being mounted on the bottom of the car, as shown at 90.

If, for example, the latter arrangement be adopted, and if it be assumed that the lanterns 70 and 8 are similar and have like refractive properties, it will be readily apparent that the

relative illumination impinging, respectively, on the photo-cells 90 and 10 will depend on the position of the car. Obviously, when the car is halfway down the intensity of illumination falling on 90 and 10 will be equal. When the car is at the top, the light falling upon 10 will be a great deal more intense than that which reaches 90; likewise, when the car is at the bottom, a stronger light will be directed on 90 and a weaker light upon 10.

Obviously any suitable or convenient means giving an indication in accordance with the ratio of the respective photo-electric currents will show the position of the car.

While I have shown the lanterns 70 and 8 mounted in the hatchway and the photo-cells 90 and 10 mounted upon the car, it will be obvious to those skilled in the art that the relative locations of the photo-cells and the light sources is immaterial so far as the principle of the operation of my invention is concerned. Clearly, if it should be more convenient, the lanterns may be mounted on the car and the photo-cells in the hatchway.

If both lanterns be mounted at the top of the hatchway, directing the light downwards, as shown at 7 and 8, both photo-cells being mounted on the roof of the car, as shown at 9 and 10, the position of the car may be indicated by the ratio of the photo-electric currents if the refractive properties of the lanterns 7 and 8 be made dissimilar.

For example, 7 may be focused so that there is a substantial change in the intensity of the light reaching 9 as the car goes up and down. On the other hand, 8 may be focused in such a way that the change in the intensity of the light falling upon the photo-cell 10, with the car at different heights, may be substantially different. It is, of course, quite possible to provide reflecting and/or refracting arrangements in the lantern 8 such that an image of the light source is arranged to come to a focus when the car is at the bottom of the hatchway and with such an arrangement the intensity of the light falling upon 10 may be arranged to increase as the car descends and decrease as the car is raised.

I wish to make it clear that it is immaterial, so far as my invention is concerned, whether the variation in the intensity of the photo-electric currents takes place in accordance with the law of inverse squares, in a linear manner, or in accordance with any other law; all that is necessary is that the relative intensities shall vary with different positions of the car in accordance with some definite, even though empiric, relation.

The photo-electric currents derived from 9 and 10, which may be amplified by suitable amplifying apparatus to any required extent, may be arranged to give a visual indication of the position of the car by any one of a number of suitable means, known to those skilled in the art, for giving an indication in accordance with a ratio. For example, the system I have shown and described in my pending U. S. application bearing Serial No. 682,421, filed July 27, 1933, now Patent Number 2,021,099, shows a method of lighting any one of four lights in accordance with the ratio between two electric currents and is accordingly especially suitable for indicating the position of an elevator car in accordance with the ratio of two photo-electric currents.

Direct indicating instruments of the ratio type are well-known in the art and instruments of this type may be used, if desired, for carrying into effect the present invention. However, such instruments are not readily procurable and are somewhat expensive, which may be inconvenient if it is desired to furnish indications of the position of an elevator car at a number of different floors.

I have, therefore, devised a novel electric circuit which I show in Fig. 2 and which has for its object the provision of a single electric current, the magnitude of which is proportional to the ratio between the two photo-electric currents and is substantially independent of the absolute magnitude of either of these currents. By means of this circuit any number of cheap and simple indicating instruments, of the type which is actuated by a single electric current, may be connected in series so as to form a single loop circuit.

In Fig. 2, I show lanterns 7 and 8 and photo-electric cells 9 and 10 which may be located in accordance with either of the alternative positions indicated in Fig. 1. The photo-electric currents from 9 and 10 are amplified by means of amplifiers 11 and 12. The lanterns 7 and 8 and amplifiers 11 and 12 are energized from an alternating source 13.

I show also in Fig. 2 a bridge circuit 14 comprising three saturating reactors 15, 16, 17 and an impedance of substantially constant value 18. The bridge circuit 14 is also energized from the source 13. The saturating windings of the reactors 15 and 16 are connected to receive uni-directional current from the amplifiers 11 and 12, respectively. The saturating reactors 15 and 16 are, therefore, variably saturated, respectively, in accordance with the intensity of the light falling upon photo-cells 9 and 10.

A current of adjustable value is caused to flow in the saturating winding of the reactor 17.

A transformer 34 is connected between the junction of reactors 15, 16 and the junction of reactor 17 and fixed impedance 18.

Operation of the bridge circuit 14 is as follows:

Assuming any given relation between light intensities impinging, respectively, on the photo-cells 9 and 10, the saturating reactors 15 and 16 being correspondingly saturated variably, it will be obvious that by varying the current in the saturating winding of the reactor 17, a condition may be found at which the bridge circuit 14 balances, under which condition transformer 34 will be de-energized.

When the bridge circuit 14 is balanced, the ratio of the reactance of the reactor 17 to that of impedance 18 will be identical with the ratio of the impedances of 15 and 16, respectively. Since 18 is of substantially constant value, the impedance of 17 will be a function of the ratio of the impedances of 15 and 16. It follows, therefore, that there will be a definite relation between the saturating current flowing in 17 when the bridge is balanced, and the ratio of the saturating currents of 15 and 16. Thus, the saturating current in 17, so long as the bridge is balanced, is a measure of the ratio between the saturating currents applied to 15 and 16 and, therefore, an indication of the light intensity ratio.

Accordingly the saturating current in 17, when the bridge is balanced, is a function of the position of the elevator in the hatchway.

I therefore provide means for automatically regulating the saturating current of 17 so as to maintain in the bridge 14 in a balanced condition.

This regulated current which, as explained above, is an indication of the position of the car, may be caused to flow around a loop circuit,

through the flexible control cable which connects the car to the electrical system, including indicating instruments 21, 22, 23, 24, situated on the several floors of the building.

For automatically regulating the indicating current, any one of a number of systems well-known to those skilled in the art may be employed. For example, there may be used an arrangement which avoids the use of contacts and moving apparatus such as I have shown in my United States Patent No. 1,893,768, Fig. 3, and which forms no part per se of my present invention. This arrangement consists of a balanced bridge circuit and a system of electric valves adapted to control the current in a saturating reactor so as to maintain the bridge in a condition of balance.

According to my preferred system, illustrated in Fig. 2, the saturating winding of the reactor 17 is energized by a transformer 25 in series with an electric valve 28. The grid of the electric valve 28 is excited with the voltage across a capacitor 29. The grid circuit is provided with a suitable negative bias voltage since, with this method of control, the grid should be maintained negative at all times. The capacitor is arranged to be charged, through a high resistor 37, by means of two electric valves 41 and 42 which are reversely connected in parallel so that the capacitor 29 may be charged to either polarity, by means of the transformer 34, from the source 13. The transformer 34 is provided with two secondary windings 43, 44 which are connected to the grids of the valves 41 and 42. The transformer 34 is energized, as described above, across the diagonal of the bridge circuit 14.

Thus, when the bridge circuit is exactly balanced, the transformer 34 will be de-energized. When the bridge is unbalanced, the transformer 34 will be energized with an alternating voltage which will either be in phase with, or out of phase with the voltage of the source 13, from which the valves 41 and 42 are energized, according to whether the impedance of the reactor 17 be too high or too low.

For a detailed explanation of the operation of the electric valve control system, reference may be had to my aforesaid U. S. Letters Patent No. 1,893,768. Briefly, when the bridge circuit 14 is in a balanced condition, no voltage is applied to the grids of 41 and 42 and the voltage across the capacitor remains at a constant positive value. When the bridge becomes unbalanced, the action of valves 41, 42 modifies the charge of the capacitor 29, increasing or decreasing the voltage across 29, as may be necessary, until the saturating current supplied by electric valve 28 to the saturating reactor 17 is adjusted to such a value that the bridge is again balanced.

In utilizing the arrangements in which both light sources are situated at the top of the hatchway, as shown in Fig. 1, at 7 and 8, it will be realized that possibly both of the photo-cells 9 and 10 may, at times, come under the influence of one light source. This, however, will not vitiate the functioning of the indicating system since, even if this occurs, there will still be a substantial variation in the ratio of light intensities. For instance, let it be assumed that the light source 7 is arranged to give a rather wide beam so that the light falls off in intensity as the car descends, and that the light source 8 is adapted to furnish a narrow concentrated beam. The sharply focused beam emitted by 8 can be focused so as to be concentrated throughout the travel of the car on the photo-cell 10, none of it at any time impinging on photo-cell 9. If, at the bottom portion of the travel of the car, the wider beam from the light source 7 embraces 10, as well as 9, its intensity in comparison with the intensity of the stronger beam from 8 will be such that no substantial change in the light intensity ratio will result from this circumstance. In any case, even if there should be interaction of the above nature between the two beams, this effect will be a function of the travel of the car. It is not essential that the indicating current be precisely proportional to the travel of the car, as has been indicated above; all that is necessary is that there shall be a finite relation between the position of the car and the value of the indicating current. This, in accordance with the principles of my invention, will clearly be provided.

I have, however, shown in Fig. 2 a method of eliminating this kind of interaction in the event that, for some very special application of this invention, it may be thought desirable to do so.

Many of the types of photo-electric cells in general use are of the uni-laterally conducting type. Light sources of the vapor-electric space discharge type are known in the art, such as for example sodium, mercury, neon, and the like. Some of these are unilaterally conducting; others may be operated in series with rectifiers. By making use of the property of uni-lateral conductivity, it is possible to operate two complete photo-electric systems, each comprising a light source and a photo-cell, in the same space, without mutual interference.

Referring to Fig. 2, it is to be supposed that the light sources 7 and 8 are both uni-laterally conducting devices having, for example, an anode and a cathode operating in a gas suitable for emitting rays to which the photo-cells 9 and 10 are sensitive. On referring to the connections in the figure, it will be observed that the light sources 7 and 8 are oppositely connected to the source 13, as are also the photo-cell amplifiers 11 and 12, from which the anode voltage of the photo-cells 9 and 10 is derived. Accordingly, 7 and 9 will be operated on one half-wave of the supply voltage derived from 13, and the light source 8 and photo-cell 10, independently of 7 and 9, will be operated on the opposite half-wave. Thus, the action of the two photo-electric systems is entirely independent even though the two optical systems be intermingled.

I show in Fig. 4, detailed electrical connections of the light sources 7 and 8 and the photo-electric amplifiers 11 and 12. In Fig. 4 I have shown light sources 7 and 8 as being uni-laterally conducting tubes of the hot-cathode type such as for example sodium vapor lights.

While the automatic regulating system embodying the bridge circuit 14, which I show in Fig. 2, is of particular utility in connection with the specific elevator indicating system shown, I wish it to be clearly understood that it is not to be restricted to this particular purpose, but that it has value and utility in connection with a large number of electrical and other systems and applications. Many other applications of photo-electric cells, known to those skilled in the art, embody the use of two or more photo-electric cells in such a manner that the desired effect is dependent upon the ratio of two photo-electric currents. For example, many photo-electric inspection and testing arrangements utilize the principle of comparing a light intensity derived from a specimen of material with the light intensity derived from a standard. Many other electrical

control and indicating systems embody functions dependent upon a ratio between two electrical effects as, for example, temperature, resistance and impedance measurements, compensation for varying line voltage, and other like purposes, in connection with which ratio type instruments are used. Difficulty is encountered in such systems, when it is desired to provide a graphic record, due to the fact that it is difficult and expensive to construct ratio meters having sufficient torque to drive a pen. In general, where ratio balance effects are involved, some sort of complicated motor-operated or other type of follower mechanism is employed such, for example, as is well-known to those skilled in the art in connection with furnace temperature indicating and recording apparatus.

Since high torque graphic type instruments, which are actuated by a single current, as distinguished from a ratio effect, are readily obtainable, the automatic regulating circuit embodied in my present invention is of particular value for the purpose of providing a cheap and simple method of obtaining a single current proportional to a ratio effect.

As exemplified in the present description and figures, this feature of my invention is of especial value when it is desired, as in a telemetering system, to transmit to a remote location an indication depending upon a ratio between two effects.

While I have shown in Fig. 2, by way of example, an automatically regulated bridge circuit comprising saturating reactors, I wish it to be clearly understood that the elements 15, 16 and 17 may consist of any other suitable variable impedance devices without departing from the spirit of my invention. It will be understood that the term "variable impedance device" is intended to refer to any device wherein the electrical resistance and/or reactance is variable in accordance with a controlling effect.

While I have described the operation of my invention with specific relation to an elevator, it is to be understood that it is not to be limited thereto, but may be utilized for indicating the position of any other object or device movable in a predetermined path, such as a crane or rail-borne vehicle.

Although I have chosen a particular embodiment of my invention for the purpose of explanation, many modifications thereof will be apparent to those skilled in the art to which it pertains. My invention, therefore, is not to be limited except insofar as it is necessitated by the prior art and the spirit of the appended claims.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. In combination, a plurality of objects relatively movable in a predetermined path, a light-emitting system comprising a plurality of light sources, a light-receiving system comprising a plurality of photo-sensitive elements, said systems being in operative relation with said objects so that their confronting axes substantially coincide in the direction of motion of said relatively movable objects, including means for varying the relation between the light intensities directed upon said photo-sensitive elements, by said light sources, in accordance with the relative position of said objects, and means, controlled by a relation between the photo-electric currents derived from said photo-sensitive elements, for indicating the relative position of said objects.

2. In combination, an object movable in a predetermined path, a light-emitting system comprising a plurality of light sources, a light-receiving system comprising a plurality of photo-sensitive elements, one of said systems being mounted upon said movable object and the other of said systems being stationary so that their confronting axes substantially coincide in the direction of motion of said movable object, said systems including means for varying the relation between the light intensities directed upon said photo-sensitive elements by said light sources in accordance with the position of said movable object, and means, controlled by a relation between the photo-electric currents derived from said photo-sensitive elements, for indicating the position of said object.

3. In combination, an elevator car, a hatchway in which said car is movable, a light-emitting system comprising a plurality of light sources, a light-receiving system comprising a plurality of photo-electric elements, one of said systems being mounted upon said elevator car and one of said systems being mounted in the hatchway so that their confronting axes substantially coincide in the direction of motion of said elevator car, said systems including means for varying the relation between the light intensities directed upon said photo-sensitive elements by said light sources in accordance with the position of the elevator car, and means, controlled by a relation between the photo-electric currents derived from said photo-sensitive elements, for indicating the position of said car.

4. In combination, an elevator car, a light source mounted in the hatchway above said car, a light source mounted in the hatchway below said car, a photo-sensitive element mounted upon said car and receiving light from said first-mentioned light source, a photo-sensitive element mounted on said car and receiving light from said second-mentioned light source, and means, controlled by a relation between the photo-electric currents derived from said photo-sensive elements, for indicating the position of said car.

5. In combination, an elevator car, a light source mounted in the hatchway, a photo-sensitive element mounted upon said elevator car and receiving light from said light source throughout the travel of said car, a second light source mounted in the hatchway, a second photo-sensitive element mounted on said car and receiving light from said second-mentioned light source throughout the travel of said car, means for causing the relative intensities of light received by said photo-sensitive elements to vary in accordance with the position of said car, and means, controlled by a relation between the photo-electric currents derived from said photo-sensitive elements, for indicating the position of said car.

6. In combination, an elevator car, a light source mounted in the hatchway, a photo-sensitive element mounted upon said elevator car and receiving light from said light source throughout the travel of said car, a second light source mounted in the hatchway, a second photo-sensitive element mounted on said car and receiving light from said second-mentioned light source throughout the travel of said car, means for causing said light sources to emit beams of light having different relative intensities at different distances therefrom so as to cause the relative intensities of the light received by said photo-sensitive elements to vary in accordance with the position of the car, and means, controlled by a relation between the photo-electric currents de-

rived from said photo-sensitive elements, for indicating the position of said car.

7. In combination, an elevator car, means including photo-electric devices for furnishing a plurality of electric currents having relative magnitudes which vary in accordance with the position of said elevator car, means for generating a single electric current varying in accordance with a relation between said currents, and means responsive to said single current for indicating the position of said car.

8. In an electric system, an alternating current source, a first photo-electric system comprising a light source and a photo-sensitive element, both uni-laterally conducting, a second light source and a second photo-sensitive element, likewise uni-laterally conducting, means for causing said light sources to emit beams of light having different relative intensities at different distances therefrom, said first light source and photo-sensitive element, and said second light source and photo-sensitive element being respectively connected to said alternating current source so as to operate on opposite half-cycles, so that said photo-electric systems may be optically commingled without mutual intereference, and means for giving an indication in accordance with a relation between the photo-electric currents derived from said photo-sensitive elements.

ALAN S. FITZ GERALD.