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Dec. 8, 1931. F. A. PEARSON 1,835,612

ELECTRICAL SHUTTER

Filed Feb. 2, 1928

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Fig. 1,

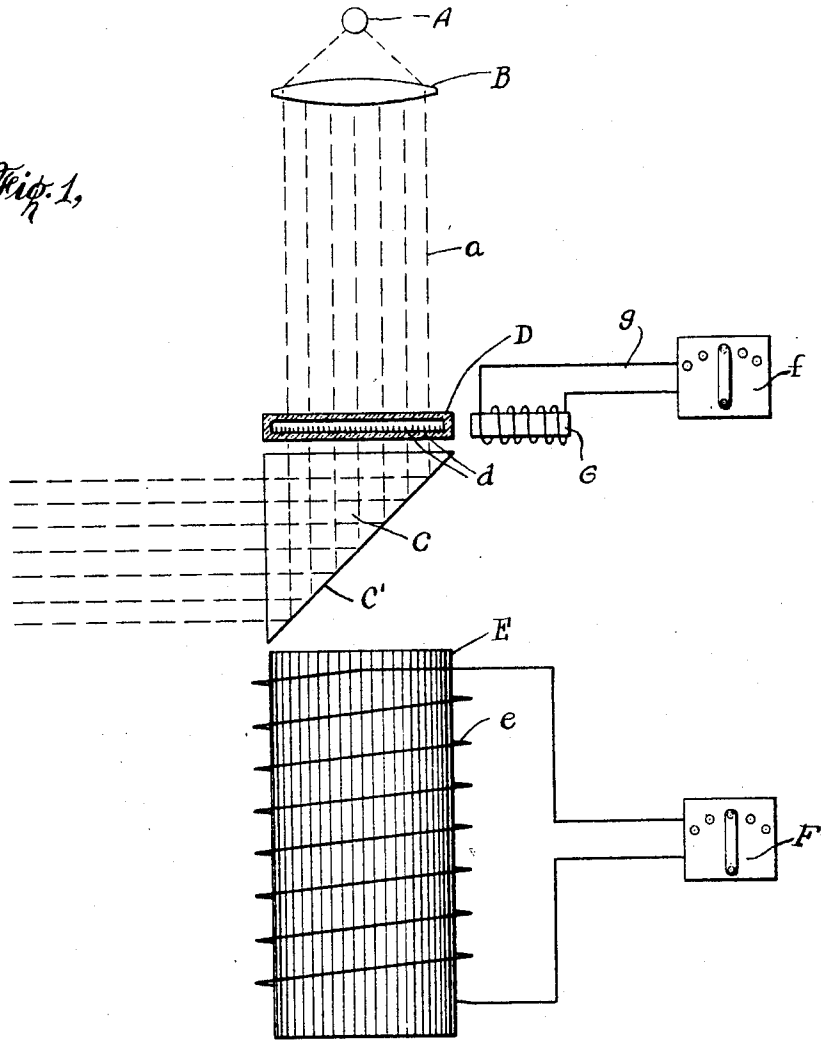


Fig. 2,

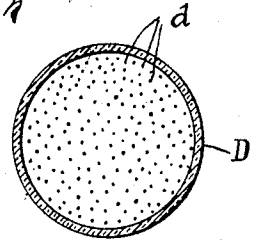
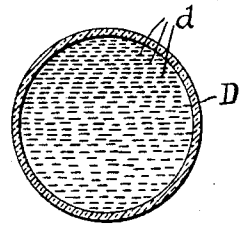


Fig. 3,



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Patented Dec. 8, 1931 1,835,612

UNITED STATES PATENT OFFICE

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ELECTRICAL SHUTTER

Application filed February 2, 1928. Serial No. 251,348.

The general object of the present invention is to provide an improved method of, and improved apparatus for rapidly increasing and decreasing the intensity of a beam or ray of light as is required for television and analogous purposes. A more specific object of my invention is to provide an electro-magnetically actuated shutter of extreme sensitivity and rapidity.

My improved shutter was primarily devised and is especially adapted for use in such optical electrical devices as those used in the transmission of pictures by electrical impulses and in the recording of sound vibrations upon sensitive films, but the invention is adapted for use wherever it is desired to interrupt or partially obstruct a beam of light proportionately or synchronously with the changes in a varying electrical current.

In a preferred practical mode of carrying out the present invention, I employ a shutter proper, comprising a multiplicity of minute bodies suitably responsive to variations in a magnetic field of force, and subject said bodies to the action of a magnetic field of force which is varied in its intensity, or in the direction of its lines of force as required to cause said bodies to shift between positions in which they intercept maximum and minimum portions of the light entering the shutter. A preferred shutter construction comprises iron filings or other minute magnetic bodies of needle-like form, located in a shallow transparent horizontally disposed container traversed by a vertical beam of light to be controlled, and means adapted to create magnetic lines of force passing vertically through said container and means adapted to create lines of force passing horizontally through the container. With such an arrangement, by suitable variations in the resultant magnetic field of force which may result from a variation in the intensity of the effect produced by either or both of said means, the magnetic bodies may be caused to alternately stand vertically on end, and lay horizontally alongside one another, accordingly as the resultant of the magnetic and gravitational forces acting on them varies. When standing vertically on end the intercepting effect of said bodies on a beam of light passing vertically through the container is at a minimum and much less than when the bodies extend transversely to the light.

Since the magnetic or analogous bodies responding to changes in the magnetic field of force passing through the shutter may be exceedingly minute and of correspondingly small inertia, the shutter of which they form a part may be very sensitive and rapid in action. As compared with prior methods of light control for purposes analogous to those for which it is especially adapted, my improvement is characterized by its extreme simplicity in construction and operation. Heretofore light control for purposes of the kind served by the present invention, have been effected by the crystal method of control, or by the revolving mirror method. My invention possesses important practical advantages over each of these prior methods.

The obstruction which my shutter, when in its open condition, offers to the passage of light, is materially less than that experienced with the open shutter condition of the crystal method of light control. The inertia of the individual particles employed in my improved shutter is much less than the inertia of a light controlling moving mirror, and consequently my improved shutter responds more rapidly to signal current changes, and may be actuated by smaller signal current changes than are required with the moving mirror method of control. Moreover, my improved shutter possesses important practical advantages over the moving mirror type of beam control in that it does not deflect or change the direction of propagation of the light controlled, and may be employed to control a larger beam than can be controlled in practice with the moving mirror method of control.

The various features of novelty which characterize my invention are pointed out with particularity in the claims annexed to and forming a part of this specification. For a better understanding of the invention, however, its advantages and specific objects attained with its use, reference should be had

to the accompanying drawings and descriptive matter in which I have illustrated and described preferred embodiments of the invention.

Of the drawings:—

Fig. 1 is a diagrammatic view representation of a preferred form of the invention;

Fig. 2 is a plan view of the shutter proper in its "open" position; and

Fig. 3 is a plan view of the shutter proper in its "closed" position.

In the apparatus illustrated diagrammatically in the drawings, A represents a source of light, B represents a condensing lens, and C represents a reflecting prism by the inclined face C′ of which the light rays *a* coming vertically downward from the source A are laterally deflected. Between the lens B and the prism C, I interpose my novel shutter element which comprises a container in the form of a horizontally disposed shallow box or disc of transparent material. Within the container D are small needle-like bodies *d* affected by magnetic lines of force traversing the container. An electro-magnet E having its core vertically disposed beneath the container D tends, when suitably energized, to create magnetic lines of force passing vertically through the container, and thereby cause the bodies to stand on end on the bottom wall of the container. The bodies *d* when thus magnetized, tend to repel one another, and in consequence they tend to assume a condition of uniform distribution, or at least they tend to assume such a condition when initially distributed with suitable uniformity over the bottom wall of the container. Owing to their elongated form, the bodies *d* obviously oppose less obstruction to the passage of light from the source A to the reflecting prism face C′ when standing on end than when horizontally disposed. By energizing and de-energizing the electro-magnet E, it is thus possible to "open" and "close" the shutter. As shown, the energization of the electro-magnet E is controlled by a suitable controller or current regulator F, to which the terminals of the winding *e* of the electro-magnet E are connected. The magnet E must be capable of producing a magnetic field of force of sufficient strength to overcome the effect of gravitation on the bodies *d* to the extent required to make the various bodies *d* stand on end.

In lieu of controlling the opening and closing of the electro-magnet E, I may advantageously associate with the latter means for creating a magnetic field of force modifying the magnetic field of force created by the electro-magnet E. In the arrangement shown in Fig. 1, the means for thus creating the modifying field of force comprises an electro-magnet G, the axis of which is horizontally disposed with regard to the shutter. As shown, the windings for the electro-magnets G are connected in series in a circuit *g*, the terminals of which are connected to controller or current regulator *f*.

In a preferred mode of operation of the apparatus shown in Fig. 1, the electro-magnet E is normally energized so as to maintain a field of force which, if not disturbed by the field of force created by the magnet G, is of a strength slightly in excess of that required to make the bodies stand on end. In consequence, when the magnet G is energized, the magnetic lines thereby created cause the bodies *d* to deflect all in the same direction toward a position of parallelism with the lines of force created by the magnet G.

With an arrangement of the character shown in Fig. 1, the light transmitting capacity of the shutter may be materially varied by such relatively small and rapidly occurring changes in value of the current flowing through either energizing circuit *e* or *g*, as are produced when the corresponding controller F or *f* forms part of a television apparatus or other automatic mechanism for producing small and rapid current changes. The change in resultant magnetic field required with properly designed apparatus is very small and the shutter mechanism is correspondingly sensitive in operation.

The bodies *d* may be formed of various materials and produced in various ways. They may be, for example, iron filing so produced or screened that the bodies are more or less uniform in their dimensions, and are elongated or of needle-like form. Advantageously, the vertical depth of the chamber space in the container D is but little greater than the length of the individual bodies *d*, so that the bodies have no opportunity to unite in end to end pairs. In an initial adjustment of the apparatus, the bodies *d* may advantageously be agitated to insure their tolerably uniform dispersion over the bottom wall of the container. When so initially dispersed the magnetization of the bodies causes the latter to be mutually repellent and thus insures the maintenance of the proper distribution of the bodies in the container.

Instead of making the bodies *d* of iron filings or other magnetic metal, they may be made of other materials affected by magnetic lines of force, either by virtue of their own nature or by virture of the electric charges which they may carry.

While in accordance with the provisions of the statutes, I have illustrated and described the best form of embodiment of my invention now known to me, it will be apparent to those skilled in the art that changes may be made in the form of the apparatus disclosed without departing from the spirit of my invention as set forth in the appended claims and that in some cases certain features of my invention may be used to advantage

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without a corresponding use of other features.

Having now described my invention, what I claim as new and desire to secure by Letters Patent, is:—

1. The method of varying the light intercepting effect of a multiplicity of small elongated bodies of magnetic material distributed across the path of a beam of light, which consists in directly subjecting said bodies to the action of a variable magnetic field of force to thereby cause said bodies to move toward and away from positions in which they extend parallel to the direction of said beam.

2. The method of variably intercepting more or less of a vertical beam of light through a transparent support, which consists in distributing a multiplicity of small elongated bodies over the transparent support, and causing said bodies to move toward and away from positions in which they stand on end on said support by subjecting them to a variable magnetic field of force.

3. The method of variably intercepting more or less of a beam of light, which consists in disposing a multiplicity of small elongated bodies in the path of said beam and creating a magnetic field of force acting on said bodies and thereby tending to set the latter into parallelism with the lines of force of said field by exerting an effect tending to create magnetic lines of force, the portions of which adjacent said bodies are parallel to said beam, and exerting an effect tending to create magnetic lines of force, the portions of which adjacent said bodies are transverse to said beam, and varying the relative intensities of said effects.

4. A light shutter for a beam of light, comprising a horizontally disposed transparent support, a multiplicity of small elongated bodies resting thereon and tending to move into parallelism with the lines of a magnetic field of force passing through said support, and means for creating such a field of force.

5. A light shutter, comprising a horizontally disposed box-like container of transparent material and a multiplicity of small elongated bodies therein and tending to move in parallelism with the lines of a magnetic field of force passing vertically through said container, and means for creating such a field of force.

6. A light shutter, comprising a horizontally disposed shallow box-like container and a multiplicity of small elongated bodies of magnetic material therein, and means for subjecting said bodies to a variable magnetic field of force tending to cause said bodies to stand on end in more or less erect positions as said field varies.

7. A light shutter, comprising a horizontally disposed shallow box-like container and a multiplicity of small elongated bodies of magnetic material therein, and means for subjecting said bodies to a variable magnetic field of force tending to cause said bodies to stand on end in more or less erect positions as said field varies, said box being too shallow to permit said bodies to stand erect when coupled in end to end pairs.

8. A light shutter, comprising a horizontally disposed box-like container and a multiplicity of small elongated bodies therein adapted to move into parallelism with the lines of a magnetic field of force of sufficient intensity traversing said container, means for creating vertical magnetic lines of force traversing said container, and means for creating magnetic lines of force passing horizontally through said container, said means being adjustable to vary the relative intensity of the effects thereby produced.

Signed at Great Barrington, in the county of Berkshire and State of Massachusetts, this 30th day of January, A. D. 1928.

FREDERICK AMBROSE PEARSON.