

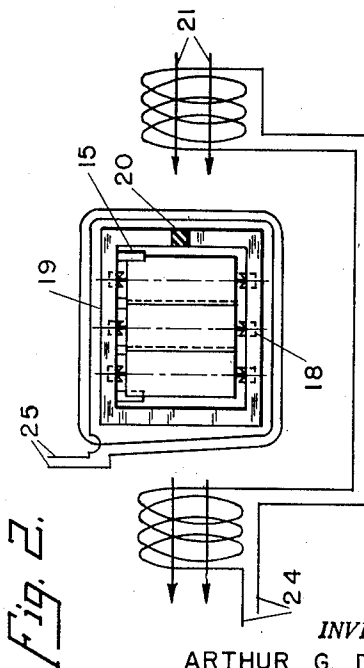
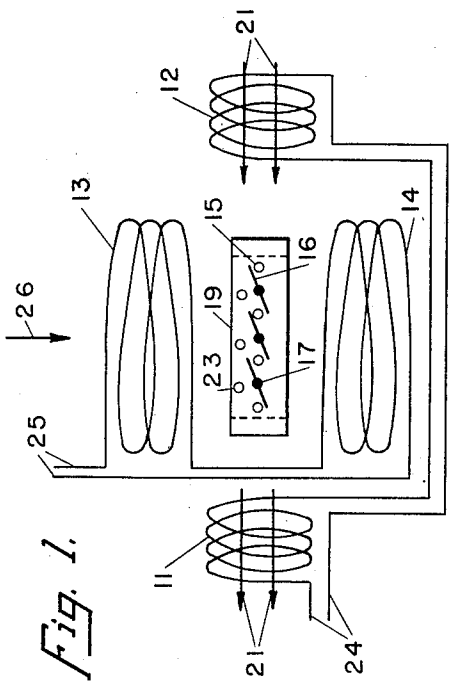
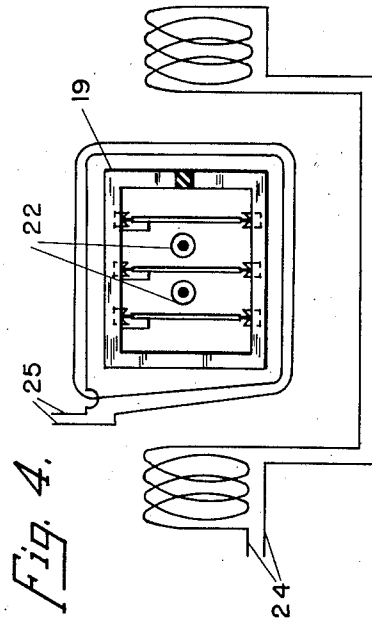
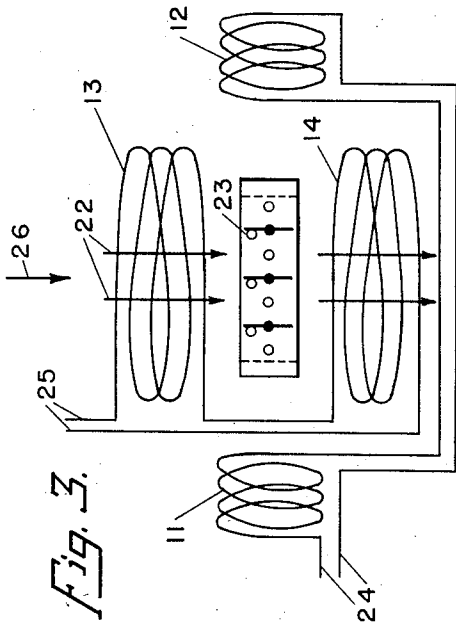
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2,702,500

DIRECT ACTION MAGNETIC SHUTTER

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1

2,702,500

**DIRECT ACTION MAGNETIC SHUTTER**

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1 Claim. (Cl. 95—58)

(Granted under Title 35, U. S. Code (1952), sec. 266)

The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

The present invention relates to a magnetic shutter and more particularly to a magnetic shutter that is directly actuated by a magnetic field.

Previously used shutters are actuated by means of a solenoid acting on an armature which in turn acts on the shutter blades through gear linkages and other mechanical movements. The disadvantages of these methods employing mechanical linkages are:

- (1) Uncertainties in the exact acting time of the shutter due to mechanical play and lag;
- (2) Uncertainties in the duration of the shutter opening due to play, lag and friction in mechanical movement;
- (3) Relative slowness in action due to inertia of heavy moving parts.

The disadvantages encountered in prior art shutters are overcome by the present invention in which the butterfly vanes of the shutter are made to move as desired by the application of a magnetic field. The vanes are mounted on pivots and pivot bearings and are free to turn as soon as they are acted upon by the magnetic field. Since the vanes have no mechanical linkages the shutter will act, by either opening or closing, at a definitely determined time so as to admit light to a photographic, optical, or similar system, during a precisely controlled interval of time.

An object of the present invention is to devise a magnetic shutter that will accurately operate at a specifically desired moment.

Another object of the present invention is to devise a magnetic shutter that will operate for a precisely determined interval of time.

A further object is to devise a magnetic shutter that has a rapid response.

A still further object of the present invention is to provide a magnetic shutter that can be operated in whatever sequence of exposures is desired.

A final object of the present invention is to provide a magnetic shutter that may be quickly regulated by simple adjustments to its electrical circuit.

Other objects and many of the attendant advantages of this invention will be readily appreciated as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings wherein:

Fig. 1 illustrates a plan view of a preferred embodiment of the present invention in the closed position.

Fig. 2 is a front elevation of the present invention in the closed position.

Fig. 3 is a plan view of the present invention in the open position.

Fig. 4 illustrates a front elevation of the present invention in the open position.

Referring now to the drawing wherein like reference characters designate like or corresponding parts throughout the several views, there is shown in Fig. 1 through Fig. 4, a plurality of high permeability, ferromagnetic, butterfly vanes, 16, to alternatively obstruct light or allow it to pass, are actuated by means of a set of hollow shutter opening coils, 13, and 14, energized by a controlled electrical power supply, 25, which produces a magnetic field,

2

22, that is approximately parallel to the direction of light through the shutter, as illustrated by arrow 26; and a set of closing coils, 11, and 12, energized by a controlled electrical power supply 24, which produces a magnetic field, 21, that is essentially at right angles to the direction of light travel, as illustrated by arrow, 26, through the shutter. The vanes are supported by a rectangular metal frame, 19, provided with a non-conducting insert, 20, which forms an integral part of the frame so as to break the continuity of the metal frame structure thereby preventing said frame from acting as a short-circuited turn linked to the magnetic field, 22, produced by the opening coils, 13, and 14. The coils are internally dimensioned to match the external size of the frame so that when the shutter-opening coils are energized the frame and its contained vanes will be engulfed in the resulting flux stream. A frame constructed of non-conducting material may be used in place of the metal frame, in which case the non-conducting insert would be unnecessary. Pivots, 17, are secured to both ends of each vane, and are set in jeweled V-bearings, 18, which are non-conducting and have a low coefficient of friction. Stop pins, 15, secured to frame, 19, define the closed position of the vanes, while stop pins, 23, define the open position of the vanes, both of which thereby permit approximately 90° oscillation of the vanes. As is shown in Fig. 1, close stop pins, 15, are located in a line parallel to the direction of magnetic field, 21, and on centers with the pivots, 17, so as to place the vanes, 16, at a slight angle to the direction of the magnetic field, 21. Fig. 3, illustrates the location of open stop pins, 23, located with respect to each of the pivots, 17, in lines which are substantially parallel to the magnetic field, 22, thereby placing the vanes parallel to the direction of magnetic field, 22.

As alternatives to the use of the above described coils, an arrangement of permanent magnets may be set up to control the shutter; or by the use of core material of higher permeability than air, the coils may be placed in more convenient location.

As alternatives to the vane assembly, permanent magnets may be used as vanes thereby resulting in a reaction between their own magnetic fields and the magnetic fields provided by the coils or other external fields; or the vanes may be made of non-magnetic material with small permanent or induced magnets directly secured to them, or their pivots.

With the foregoing in mind and referring to Figs. 1 through Fig. 4, the operation of the device is as follows:

When the closing coils, 11, and 12, are energized to produce a magnetic field, 21, parallel to the axes of these coils, the vanes, 16, are lined up approximately parallel to the magnetic field, and approximately normal to the direction of light, 26, and are limited to this position by closed stop pins, 15. During this period when the vanes are obstructing the light, the shutter is considered closed, during which time the opening coils, 13, and 14, are not energized. At the end of the closed period, the current in the closing coils is diminished from maximum to zero value thereby diminishing the magnetic field, 21, produced by this current; at the same time the current in the opening coils, 13, and 14, is increased from zero to maximum value thereby increasing the magnetic field, 22, produced by this current. The increase in magnetic field, 22, parallel to coils, 13, and 14, and the decrease in magnetic field, 21, parallel to, 11, and 12, produce in effect a rotating magnetic field, which the magnetic axis of the vanes as seen in Fig. 1 and Fig. 3, tend to follow. The vanes rotate to their open position as defined by open stop pins, 23. The current in the opening coils, and the attendant magnetic field, 22, remain on during the open period. There is no current in the closing coils.

At the end of the open period the current in the opening coils is diminished from maximum to zero value while the current in the closing coils is increased from zero to its maximum value. These changes in current produce a rotating magnetic field which causes the vanes to rotate to the closed position where they set against close stop pins, 15. The shutter is now closed and the cycle may be repeated at will.

3

4

The open stop pins, 23, may be located on-center with the axis of pivot 17, thereby positioning the vanes, 16, at a slight angle to the magnetic field, 22. In such case the magnetic fields need not be synchronized to produce a rotating field; instead one of the fields may be utilized to rotate the vane without the aid of the other.

Obviously many modifications and variations of the present invention are possible in the light of the above teachings. It is therefore to be understood that within the scope of the appended claims the invention may be practiced otherwise than as specifically described.

Having thus described the invention what is claimed is:

A photographic shutter consisting of a centrally open non-magnetic frame, a set of hollow shutter-opening coils in axial alignment with the direction of light travel, said coils comprising serially connected components in confronting relationship to opposite open sides of the frame and being internally dimensioned to substantially match the external size of the frame thereby to engulf the frame in the flux stream when the coils are energized, a set of shutter-closing coils axially oriented at a right angle to the shutter-opening coils and comprising serially connected components confronting opposite ends of the frame, and a plurality of flat vanes made of magnetic material

pivotaly mounted in said frame to assume face-on relationship to the opening coils when the closing coils are energized and to assume edge-on relationship to the opening coils when said opening coils are energized, the pivot axes of said vanes being located in a common plane and normal to the axes of the opening and closing coils, said pivot axes being in the center of said vanes and parallel to each other and equally spaced, the distance between said axes being less than the width of one vane.

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