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Vincent, Andrew W.

[11] **3,774,518**

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[54] **LARGE DIAMETER PHOTOGRAPHIC SHUTTER**

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[52] **U.S. Cl.** ..... **95/56,** 95/53 E, 95/53 EA, 95/53 EB

[51] **Int. Cl.** **G03b 9/40**

[58] **Field of Search** ..... 95/55, 56, 62, 53 E, 95/53 EA, 53 EB

[56] **References Cited**

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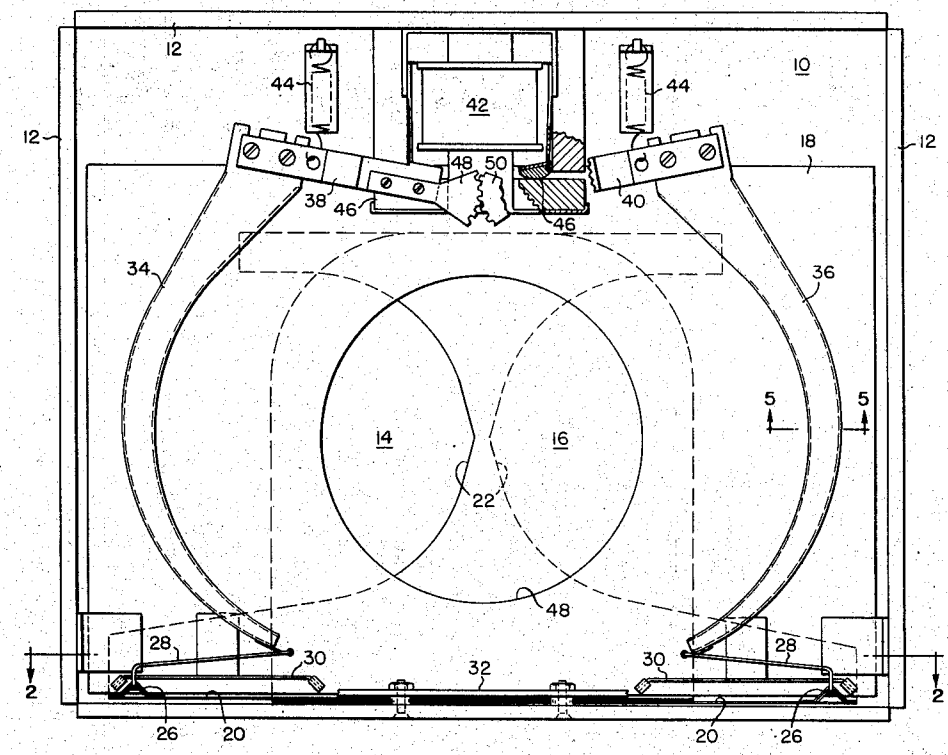
Primary Examiner—Monroe H. Hayes
Attorney—Hoffman Stone

[57] **ABSTRACT**

A photographic shutter having a large aperture (about 2½ inches) that can be driven at relatively high speed by an electromechanical actuator. The shutter has two blades of very thin sheet material that are reciprocated in opposition to each other in translation only. The blades have integrally formed flanges that stiffen them and provide the strength needed to keep them from buckling. The actuator is connected to the blades through relatively long levers to achieve the desired length of travel with adequate allowance for the rotational output motion of the actuator.

4 Claims, 5 Drawing Figures



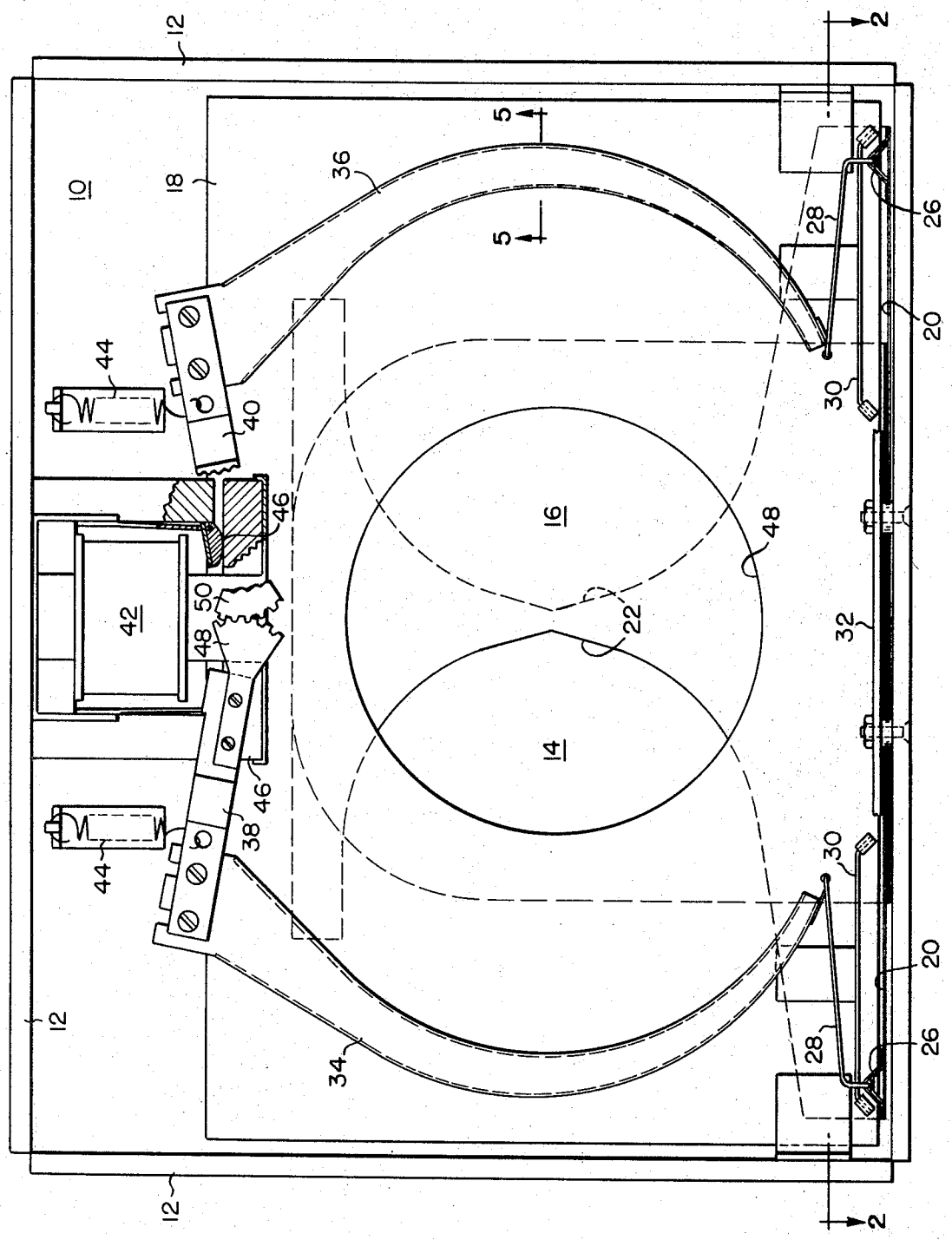

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FIG. 1

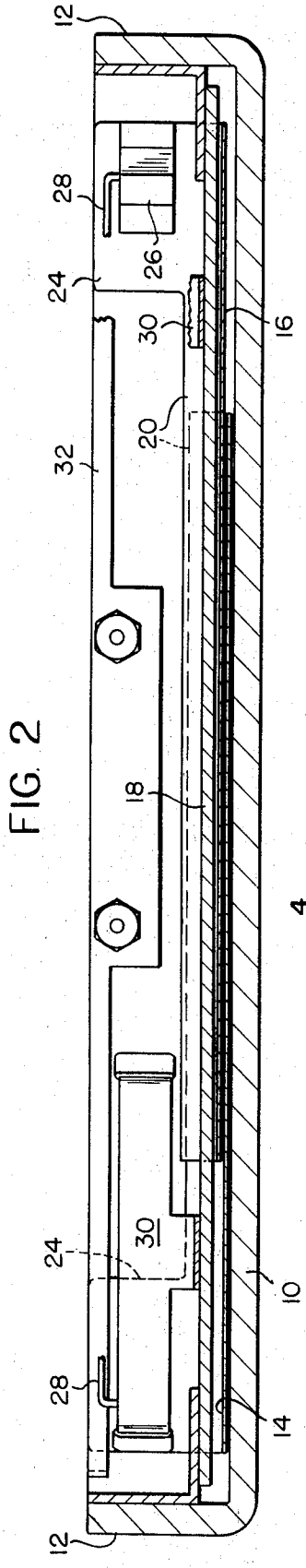

FIG. 2

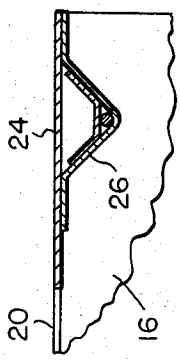

FIG. 4

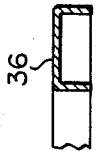

FIG. 5

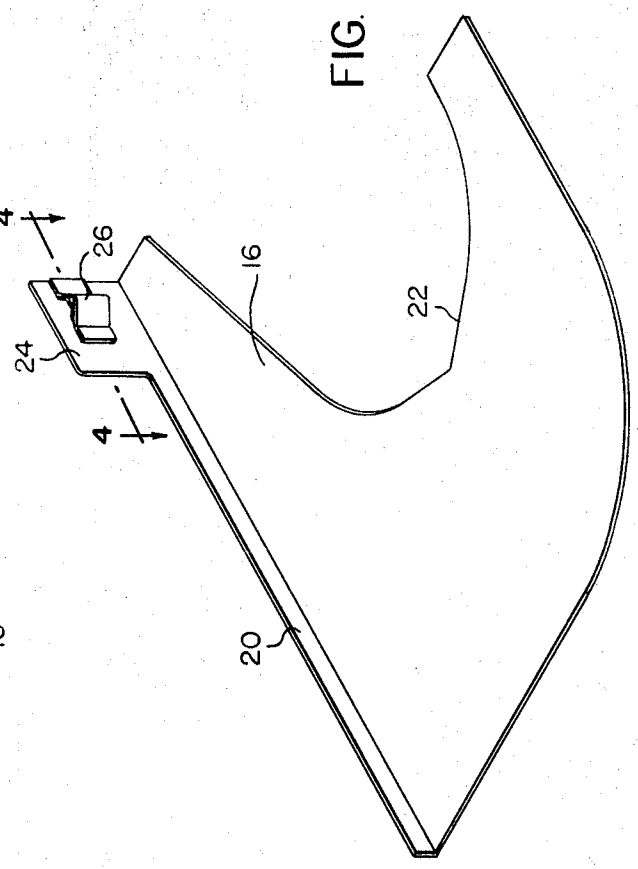

FIG. 3

LARGE DIAMETER PHOTOGRAPHIC SHUTTER

BRIEF SUMMARY

This invention relates to a novel photographic shutter capable of relatively rapid operation even though it may be of relatively large size.

The invention arose in the course of efforts to build a shutter having when open an aperture at least 64 mm. in diameter, and which is dependable, rugged, long lasting, and capable of rapid operation. shutter shown and claimed in my previous U.S. Pat. No. 3,595,553 has proven highly successful in sizes of up to about 1 inch diameter aperture. It includes a Pair of shutter blades mounted on beams that are reciprocated in rotation by an electromagnetic actuator. Several practical problems were encountered, however, in attempting to build it in a size much larger than about 1 inch aperture. The blades had to be of very thin material to minimize their mass, else too much energy would be required to move them rapidly, and when they were made thin enough they tended to buckle. Also, in the larger sizes, the swinging motion of the blades tended to cause them to twist, and their rotation about a pivot center fairly close to them made the unsymmetrical shape of the aperture during the intermediate travel of the blades more of a problem than in shutters of smaller size. A new approach seemed to be called for.

The problems were successfully overcome by the present invention, according to which the shutter includes a pair of very thin blades that are moved in translation only, and that are reinforced against twisting and buckling by integrally formed flanges. The blades are driven by an actuator of the kind disclosed and claimed in my U.S. Pat. No. 3,427,576 through relatively long, structurally shaped, cantilever beams, which magnify the motion of the actuator and reduce the sharpness of the rotation that must be accommodated between the swing of the output lever of the actuator and the translation of the driven blades.

In practice, a shutter according to the invention has been operated at speeds faster than 1/100th second exposure time, and further improvement in speed is expected when more experience is gained with it.

The present invention is not intended to be limited to the use of the particular actuator described in the hereinabove identified patent, although that actuator is presently believed to be the best driving means now known. The invention contemplates that the shutter may be driven by any desired means, even though high speeds may not be achievable.

DETAILED DESCRIPTION

A presently preferred embodiment of the invention will now be described in detail in connection with the accompanying drawings, wherein:

FIG. 1 is a front elevational view of a shutter according to the invention with the cover of its mounting box removed;

FIG. 2 is a horizontal sectional view taken along the line 2 — 2 of FIG. 1, with the scale enlarged and distorted to bring out certain details, especially in respect of thicknesses;

FIG. 3 is an isometric view of one of the shutter blades;

FIG. 4 is a sectional view taken along the line 4 — 4 of FIG. 3; and

FIG. 5 is a cross-sectional view of one of the cantilever beams, taken along the line 5 5 of Fig. 1.

The principal operating parts of the shutter are mounted in a box-like panel **10**, which is rigidified by integrally formed flanges **12** along all four sides. The two blades **14** and **16** stand, one against the other, between the major surface of the panel **10** and a retainer plate **18**. The plate **18** is rigidly secured to the panel **10** in spaced relation to its major face, leaving adequate space for the blades **14** and **16** to clear each other. The blades are enantiomorphic, but otherwise identical to each other. It will, therefore be sufficient to describe in detail only the single blade **16** shown in Fig. **3**.

The blade **16** is made of thin sheet material such as, for example, stainless steel sheet 0.001 inch thick, and is preferably covered with a thin coating of an antifriction material such as polytetrafluoroethylene. It has an integrally formed flange **20** extending along its lower edge to rigidify it, and a large notch **22** to define one side of the opening of the shutter.

The flange **20** is enlarged at one end into a tab **24** for mounting an attachment and abutment bracket **26**. The bracket **26** is V-shaped in section, and a connecting rod **28** (Fig. **1**) is fitted into its apex to connect the blade to its driving beam **30**. The ridge (not separately designated) of the bracket **26** extends normally from the main face of the blade **16**, and the sloping sides face the direction of travel of the blade. A spring detent **30** (Fig. **1**) is fixed to the cover plate **18** for engagement by the bracket **26** at both ends of the travel of the blade **16**. The action of the detent in cooperation with the bracket is described in my hereinabove identified U.S. Pat. No. 3,595,553, and claimed in the division thereof, U.S. Pat. No. 3,664,251, and will not be described in detail herein. It operates to absorb the energy of the blade 16, bringing it to a stop quickly and smoothly.

A horizontally extending retainer plate **32** is fixed to the main panel **10** overlying the flanges **20** of the blades to restrain them against vertical displacement.

The blades **14** and **16** are preferably shaped as shown, particularly with respect to the notches **22** that define the opening of the shutter. The bights of the notches **22** are not flat or circularly curved, but are of generally ogive shape, and the outer ends of the notches are open, not closed. The arrangement very much reduces the chance of interference between the blades relative to blades having simple circular openings. The factor is of importance when the shutter is driven at high speeds. In preliminary experimental work with blades having circular openings it was found that in high speed operation a slight buckling of one or both of the blades could cause the edges of the openings to interfere, with consequent damage to the delicate material they are made of.

The beams **34** and **36** are curved so they will not extend over the opening of the shutter when the shutter is open. They are connected rigidly at their upper ends to the respective output levers **38** and **40** of the actuator **42**. Their lower ends are connected respectively to the blades **16** and **14** through the connecting rods **28**. The beams **34** and **36** are urged apart by respective return springs **44** and **45** which serve to drive the shutter closed when the actuator is deenergized.

The output levers **38** and **40** are preferably geared to each other through a pair of segment gears **48** and **50**, respectively, to keep the armature **46** always level. This is not significant for ordinary opening and closing of

the shutter, but is desirable when the shutter is held partly open as by a servo arrangement for a time exposure. In the latter case the armature may tend to wander out of level and drive the blades **14** and **16** unequally so that the opening defined by them goes off center. The interconnection between the output levers prevents this. One advantageous servo arrangement for controlling the shutter is shown and claimed in my copending application Ser. No. 143,386, filed May 14, 1971, entitled, "Timer Circuit for Magnetic Actuators," and now U.S. Pat. No. 3,706,011.

The bearing surfaces **47** of the levers **38** and **40** engaged by the armature **46** may be shaped as suggested in my previous U.S. Pat. No. 3,427,576 to provide any of a large number of different operating characteristics. For example, in some cases it may be desired to optimize operation of a servo arrangement for driving the shutter only partly open and holding it at a predetermined position. A special curve can be readily calculated for this, taking into account the characteristics of the magnetic circuit of the actuator, the strenth of the return springs **44** and the effective mass of the load. In other cases different curves may be calculated to optimize other features, such as, for example, the opening or closing time of the shutter, or its power consumption.

The shutter may be easily made as a normally open shutter, that is, open when the actuator **42** is deenergized and closed only when the actuator picks up. This is done simply by suitably shaping the blades **14** and **16** so that they cover the opening when the actuator **42** picks up and clear it when the actuator drops.

An important advantage of the shutter according to the invention stems from the restriction of the blades to translation only, and relates to the symmetry of the opening formed by the blades throughout their travel. When the blades are partly retracted, the opening they define is symmetrical about any axis taken through the center of the structure in the plane of the opening and is generally similar in shape to a cat's eye.

What is claimed is:

1. A photographic shutter of the kind having a pair of blades reciprocatable in translation and in mutual opposition between a first position in which the shutter is closed and a second position in which the shutter is open, said shutter comprising:

a. a pair of blades of a thin, flexible sheet material, each of said blades including an integral flange extending along one edge thereof for rigidifying it,

b. a mounting plate having an aperture,

c. a retainer plate having an aperture about the same size as the aperture in said mounting plate,

d. means securing said retainer plate to said mounting plate closely spaced and parallel thereto with the apertures of said plates in register with each other,

e. said blades lying free and in face to face contact with each other between said mounting plate and said retainer plate with their flanges extending along one edge of said retainer plate,

f. a retainer bar adjacent to said flanges and on the opposite side thereof from said retainer plate for retaining said flanges within a predetermined distance from the edge of said retainer plate, and

g. drive means for reciprocating said blades in opposition to each other,

h. said retainer bar, together with said retainer plate being the sole guide means for said blades in directions parallel to the plane of said mounting plate.

2. A shutter according to claim **1** wherein each of said blades is shaped to define a notch of generally ogive shape, the edges of said notches being arranged to move across said aperture during travel of the blades between said positions.

3. A shutter according to claim **1** wherein said drive means comprises an electromagnetic actuator.

4. A shutter according to claim **3** wherein said actuator includes output levers that move in rotation only, structural beams are cantilevered on said levers, and connecting rods are pivotted between the distal ends of said beams and respective ones of said blades for driving the blades responsively to motion of said output levers.

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