Jan. 3, 1967 H. NERWIN 3,295,428

PHOTOGRAPHIC APERTURE REGULATING DEVICE

Filed Jan. 10, 1964 2 Sheets-Sheet 1

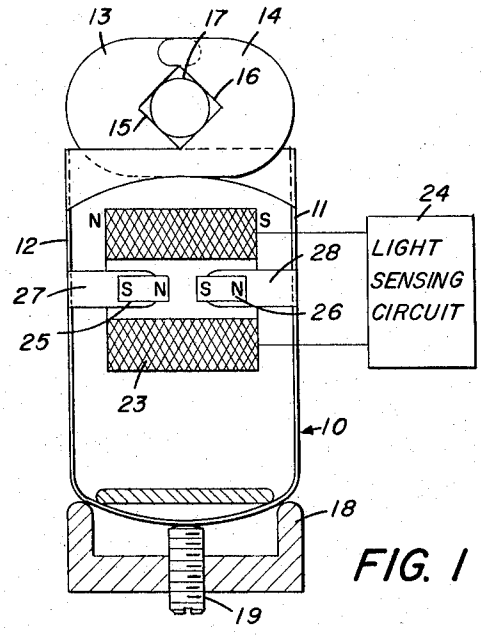


FIG. 1

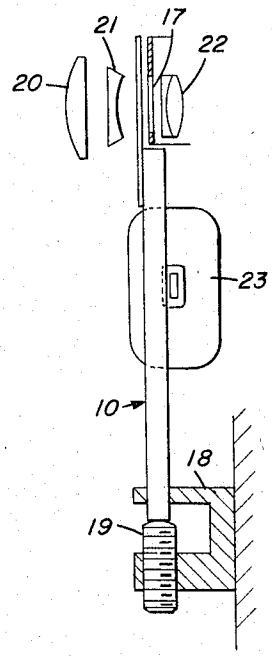


FIG. 3

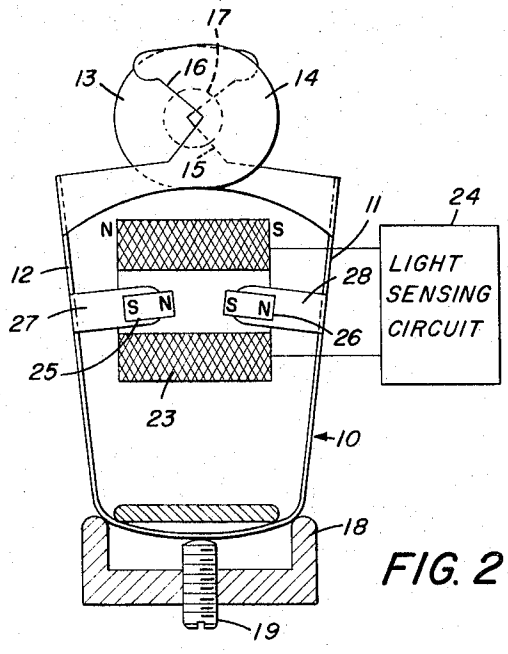


FIG. 2

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Jan. 3, 1967 H. NERWIN 3,295,428

PHOTOGRAPHIC APERTURE REGULATING DEVICE

Filed Jan. 10, 1964 2 Sheets-Sheet 2

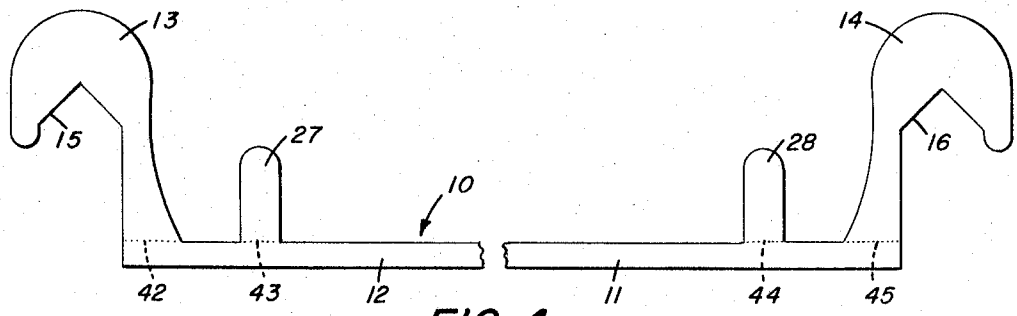


FIG. 4

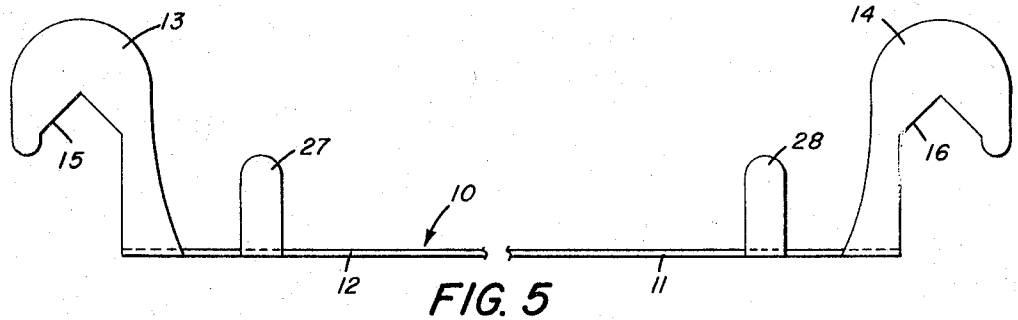


FIG. 5

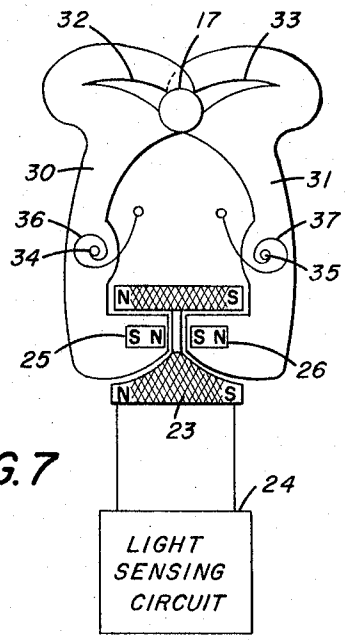


FIG. 7

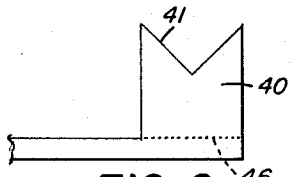


FIG. 6

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PHOTOGRAPHIC APERTURE REGULATING DEVICE

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8 Claims. (Cl. 95—64)

This invention relates to a device for regulating the effective size of a photographic aperture, and more particularly to an adjustable diaphragm vane device and method of making such a vane device that is positionable in accordance with interaction between permanent magnet means and solenoid means variably energized as a function of sensed illumination.

It is an object of this invention to regulate the effective size of a photographic aperture by means of a simple device that is electromagnetically positionable.

Another object of the invention is to reduce the manufacturing costs of a photographic aperture regulating device.

Another object of the invention is to form a diaphragm vane means from a single piece of material.

Another object of the invention is to eliminate the effects of hysteresis on an electromagnetic diaphragm vane adjusting mechanism.

Another object of the invention is to position a diaphragm vane by means of an electromagnetic actuator that is non-linear in its response to sensed illumination.

Another object of the invention is to regulate the effective size of a diaphragm aperture by means of a device that is reliable and accurate in operation, and to make such a device by a method that is simple and economical.

Another object of the invention is to eliminate the multiplicity of parts and reduce the relative movements of parts forming a diaphragm aperture size adjusting device.

These and other objects of the invention are accomplished by forming from a piece of bendable material an elongated member having longitudinally spaced notched vanes arranged so that when the member is bent into a U-shape, the notched vanes overlap and form an adjustable aperture the effective size of which varies as a function of the overlap of the vanes. Such a U-shaped or equivalent diaphragm vane device is positioned by the magnetic repulsion between solenoid or coil means variably energized as a function of sensed illumination and permanent magnet means, no other magnetic material being present within the effective magnetic field of the solenoid means. The invention will be more clearly understood by reference to the following description and the accompanying drawings wherein:

FIGS. 1 and 2 show partially schematic, partially sectioned front plan views of a diaphragm aperture adjusting device according to the invention.

FIG. 3 shows a partially schematic, partially sectioned side view of the device of FIGS. 1 and 2.

FIGS. 4 and 5 show steps in the method of fabricating the diaphragm vane illustrated in FIGS. 1–3.

FIG. 6 shows a plan view of an alternate vane configuration suitable for a single piece diaphragm vane device.

FIG. 7 shows a partially schematic, partially sectioned front plan view of a two vane diaphragm aperture adjusting device according to the invention.

As shown in FIGS. 1–3, a U-shaped diaphragm vane member 10 has leg portions 11 and 12 integral with vanes 13 and 14 that have respective notches 15 and 16 for regulating the effective size of photographic aperture 17 as a function of the overlap of the vanes. The overlap of the vanes 13 and 14 is in turn regulated by the position of leg portions 11 and 12 of U-shaped member 10. U-shaped member 10 is supported in a holder 18 having an adjusting screw 19 for calibrating the overlaps of vanes 13 and 14.

To incorporate the aperture adjusting member 10 into a photographic camera, holder 18 is fixed to the camera so as to position notches 15 and 16 over a camera taking lens aperture 17 for varying its effective size. To facilitate such an arrangement, camera taking lenses 20–22 can be associated with aperture 17 as shown in FIG. 3.

For positioning vanes 13 and 14 so as to regulate the effective size of aperture 17, a coil or solenoid 23 is in circuit with schematically illustrated light-sensing circuit 24 so that solenoid 23 is variably energized as a function of sensed illumination. Many well-known photocell circuits including unassisted selenium cells, photoconductive cells with batteries, and amplified photocell outputs may be used as light-sensing circuit 24. Typically such photocells are arranged for accepting illumination from a scene to be photographed.

Interacting with the variable field of solenoid 23 are two permanent magnets 25 and 26 fixed respectively to arms 27 and 28 so as to extend into the hollow center of solenoid 23 as shown in FIG. 1 whenever solenoid 23 is unenergized. Diaphragm adjusting member 10 including legs 11 and 12 and arms 27 and 28 is preferably formed of nonmagnetic material so as not to be affected by the magnetic field of solenoid 23. Magnetic material within the effective variable field of solenoid 23 such as soft iron that is subject to the effects of hysteresis would introduce inaccuracies into the functioning of diaphragm aperture vanes 13 and 14. In other words, such magnetic material would retain some residual magnetism after a cycle of operation of coil 23 depending on previous induced magnetism and thus would start each aperture regulating cycle with variable and unknown conditions of induced magnetism. This results in inaccuracies in the positioning of vanes in response to the energization of coil 23. By eliminating from the effective magnetic field of solenoid 23 all magnetic material other than permanent magnets 25 and 26, the errors produced by hysteresis are eliminated. Permanent magnets 25 and 26 retain their fixed values of induced magnetism so as not to be subject to any variation from hysteresis effect. Once the inaccuracies from variable magnetic reactions from hysteresis are eliminated, a simple device such as illustrated in FIGS. 1–3 can function accurately to regulate the effective size of aperture 17 as a function of the illumination sensed by light-sensing circuit 24.

The interaction between the variable magnetic field of solenoid 23 and permanent magnets 25 and 26 is one of magnetic repulsion. This has the advantage of positioning vanes 13 and 14, as a function of a non-linear response to sensed illumination. Since the magnetic field strength within the hollow core of solenoid 23 for any given value of energization is uniform from the center to the edges of the coil, and is strongest throughout such a zone, magnets 25 and 26 react to the greatest repulsive

forces available for the lower values of illumination and to relatively decreased repulsive forces for increases in illumination from higher values of light intensity. Thus, when sensed illumination is at low values, magnets **25** and **26** are relatively strongly repulsed toward the ends of coil **23** and for intense illumination and relatively high energization levels of solenoid **23**, magnets **25** and **26** begin to withdraw from the ends of coil **23** and increased illumination produces relatively weaker increases in repulsive forces. This is desirable for approximating the log-linear conversion of sensed light intensity to mechanical movement.

Of course, the relative positions of solenoid and permanent magnets could be interchanged. Thus, two hollow solenoids could move over the ends of a fixed permanent magnet. Also, solenoid **23** could be formed in two connected coils and arms **27** and **28** could be located in another position, for example, bent outwardly of legs **11** and **12** for interacting with separate solenoid coils. Alternatively, the solenoid could be fixed to one leg of member **10** and a permanent magnet fixed to the other leg.

In FIG. 7 is illustrated an alternative embodiment of the invention using two pivoted diaphragm vanes **30** and **31** having respective falcate or sickle-shaped openings **32** and **33** co-operating to define photographic aperture **17** that is variable as a function of the overlap of vanes **30** and **31**. Vanes **30** and **31** are mounted for rotation about pivot points **34** and **35** respectively. Respective springs **36** and **37** operate to return vanes **30** and **31** from any deflected position to the position illustrated in FIG. 7 in which the vane openings **32** and **33** provide maximum effective size for aperture **17**. Permanent magnets **25** and **26**, fixed respectively to vanes **30** and **31**, interact repulsively with coil **23**, and light sensing circuit **24** variably energizes coil **23**—both as described above for FIGS. 1–3.

One advantage of the diaphragm aperture adjusting member **10** illustrated in FIGS. 1–3 is that it can be manufactured from a single piece of material by an advantageous method, steps of which are illustrated in FIGS. 4–6. A piece of bendable and preferably non-magnetic material should be selected, suitable materials including non-magnetic metals such as aluminum and various plastics. To make the diaphragm vane member **10** illustrated in FIGS. 1–3, the elongated member **10** illustrated in FIG. 4 is cut from a flat piece of bendable material. Such member has leg portions **11** and **12** and vanes **13** and **14** having respective notches **15** and **16**. Arms **27** and **28** also extend from leg portions **12** and **11** respectively. Although arms **27** and **28**, and vanes **13** and **14** may extend from either or alternate sides of member **10**, it is preferred that vanes **13** and **14** extend from the same lateral side of elongated member **10** as illustrated in FIG. 4.

Alternatively, vane **40** having notch **41** as illustrated in FIG. 6 may be substituted for the vane configuration of vanes **13** and **14** as illustrated in FIGS. 4 and 5.

Right angle bends are formed at dotted lines **42–45** or **46** that are located where vanes and arms project laterally from elongated member **10**. Such right angle bends are made so that vanes **13** and **14** extend from the same face of leg portions **12** and **11** respectively as illustrated in FIG. 5. In such position vanes **13** and **14** are coplanar in a plane normal to the plane of leg portions **11** and **12**. Arms **27** and **28** are similarly bent at right angles so as to project from the same face of leg portions **11** and **12**, but, as indicated above, arms **27** and **28** could be bent in opposite right angles so that either one or both of arms **27** and **28** extended in a direction 180 rotational degrees from the direction illustrated in FIG. 5. The determining factor for the bends of arms **27** and **28** is the desired location and number of solenoids or permanent magnets.

When the member, **10** formed as illustrated in FIG. 5, is bent into a U-shape as illustrated in FIGS. 1–3, vanes **13** and **14** overlap to define the effective size of aperture **17**. With the fixing of permanent magnets **25** and **26** to arms **27** and **28** respectively, diaphragm aperture adjusting member **10** is ready for insertion into holder **18**. Adjustment of screw **19** calibrates member **10** for operation.

The advantages of the above-described vane manufacturing method include simplicity, economy of parts, elimination of assembly operations, and reduction of the possibilities for manufacturing errors, all of which contribute to economy of manufacture.

The invention has been described in detail with particular reference to preferred embodiments thereof but it will be understood that variations and modifications can be effected within the spirit and scope of the invention as described hereinabove and as defined in the appended claims.

I claim:

1. A device for regulating the effective size of a photographic aperture as a function of the illumination of a photoresponsive element, comprising: movable adjusting means the position of which determines the effective size of said aperture; and a solenoid actuator comprising hollow coil means and permanent magnet core means movable relative to one another and one of which is movable with said adjusting means, said coil means being in circuit with said photoresponsive element and variably energized as a function of said illumination, and said coil means and said permanent magnet means being relatively arranged so that whenever said coil means is unenergized, said permanent magnet means extends into the hollow of said coil means, and whenever said coil means is energized, said coil means and said permanent magnet means are urged apart so as to position said adjusting means as a function of the strength of the magnets field of said coil means, said permanent magnet core means being adapted to be at least partially withdrawn from said hollow coil means when said aperture is at its smallest size.

2. The device of claim **1** wherein said adjusting means comprises a pivotally mounted vane having a falcate opening therein.

3. The device of claim **1** wherein the portions of said adjusting means arranged in the vicinity of said coil means are formed of non-magnetic material.

4. A device for regulating the effective size of a photographic aperture as a function of the illumination of a photoresponsive element, comprising: a coil in circuit with said photoresponsive element and variably energized as a function of said illumination; a U-shaped, resilient, aperture-size-adjusting member having notched vanes integral with each leg of said member, said vanes partially overlapping each other so that their respective notches cooperate to define an aperture that is variable in size in response to the relative positions of the legs of said U-shaped member; and two permanent magnets, each one of which is fixed to a respective leg of said U-shaped member, said magnets being arranged for moving away from the coil in response to the increase in magnetic field of said coil for positioning the legs of said U-shaped member as a function of the strength of the magnetic field of said coil, said permanent magnets being adapted to be at least partially remote from said coil when said aperture is at its smallest size.

5. The device of claim **4** wherein said U-shaped member is formed of non-magnetic material.

6. The device of claim **4** wherein said coil is hollow and said magnets extend into said coil whenever the latter is unenergized.

7. A device for regulating the effective size of a photographic aperture as a function of the illumination of a photoresponsive element, comprising: solenoid means in circuit with said photoresponsive element and variably energized as a function of said illumination; a pair of pivotally mounted diaphragm vanes having respective falcate openings that co-operate to vary the size of said aperture as a function of the rotational positions of said vanes; and two permanent magnets, each fixed to a respective

one of said vanes, said magnets being arranged for moving away from said solenoid means in response to the increase in strength of the magnetic field of said solenoid means for positioning said vanes, said magnets being adapted to be at least partially remote from said solenoid means when said aperture is at its smallest size.

8. The device of claim 7 wherein said solenoid means comprises a hollow coil, and said permanent magnets extend into opposite ends of said coil whenever the latter is unenergized.

References Cited by the Examiner

UNITED STATES PATENTS

2,206,086	7/1940	Galyon	95—64
2,973,699	3/1961	Nerwin	95—64
3,082,674	3/1963	Bagby	95—64

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