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IRIS DIAPHRAGM

Filed Feb. 23, 1965

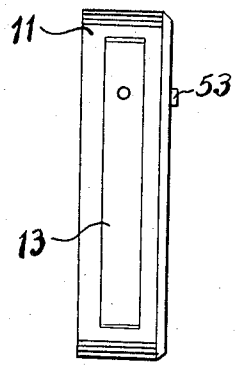


FIG. 2

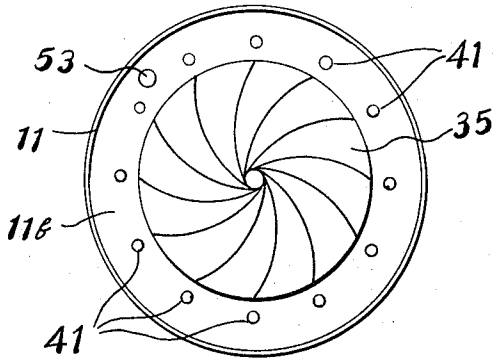


FIG. 1

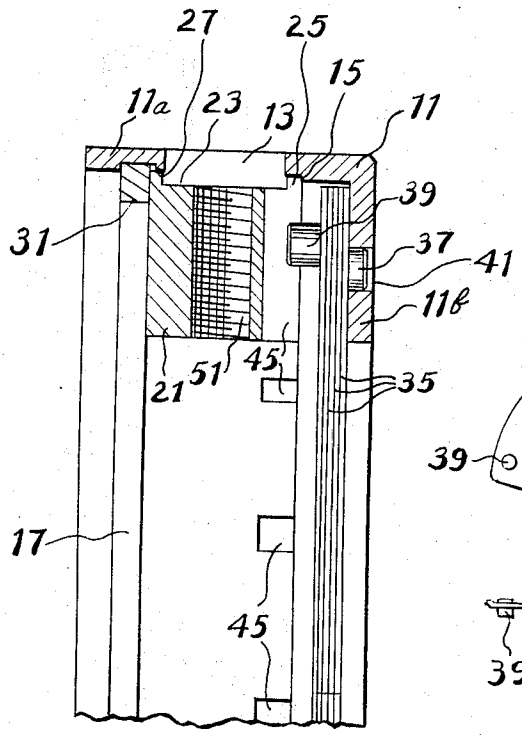


FIG. 3

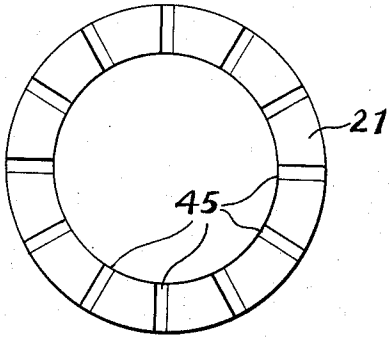


FIG. 4

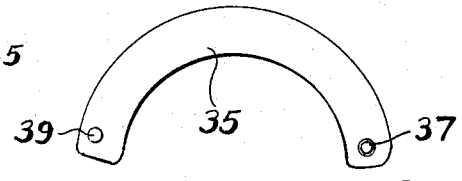


FIG. 5

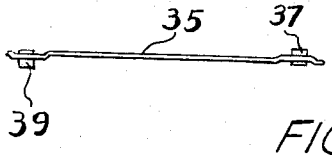


FIG. 6

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IRIS DIAPHRAGM

Richard J. Wollensak, Rochester, and Joel W. Graffley, West Henrietta, N.Y., assignors to Minnesota Mining and Manufacturing Company, St. Paul, Minn., a corporation of Delaware

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ABSTRACT OF THE DISCLOSURE

There is disclosed an iris diaphragm structure, especially suitable for locations subject to severe shock and impact, comprising an annular metal housing having a cylindrical flange and a radial flange projecting inwardly from one end of the cylindrical flange and formed integrally therewith, and an operating ring rotatable within the cylindrical flange and spaced axially from the radial flange. The diaphragm leaves are mounted between the radial flange and the operating ring, each leaf having near one end a pin projecting into a hole in the radial flange, and near the other end a pin projecting into a radial slot in the operating ring. Alternate leaves are made of different materials, e.g., brass and stainless steel.

This invention relates to a diaphragm, and more particularly to an iris diaphragm for controlling the passage of light in an optical system.

An object of the invention is the provision of a generally improved and more satisfactory diaphragm.

Another object is the provision of a diaphragm which is particularly rugged and sturdy, and able to withstand severe shocks and impacts without damage to the parts and also without substantial deflection of the diaphragm leaves.

A further object is the provision of a diaphragm sufficiently simple to be capable of production at minimum expense, and sufficiently rugged to be satisfactory for use under the severe requirements of military service.

A still further object is the provision of a diaphragm meeting the above mentioned requirements, and yet so constructed that the diaphragm leaves can be adjusted to a different aperture by application of an extremely small force, so that the diaphragm is adapted to use with optical instruments in which the diaphragm is to be adjusted quickly and accurately by application of forces such as those available from photocells or other automatic light controlling appliances which commonly have a very small output of force.

These and other desirable objects may be attained in the manner disclosed as an illustrative embodiment of the invention in the following description and in the accompanying drawings forming a part hereof, in which:

FIG. 1 is a face view of a diaphragm assembly according to a preferred embodiment of the invention;

FIG. 2 is an edge view of the same;

FIG. 3 is a fragmentary radial section through the same;

FIG. 4 is a face view of a slotted operating ring constituting part of the assembly;

FIG. 5 is a face view of one of the diaphragm leaves; and

FIG. 6 is an edge view of the diaphragm leaf.

Many kinds of iris diaphragms are well known in the art. Most of those already known are designed, however, for use on cameras, enlargers, and similar instruments in locations where they are not expected to be subject to any great amount of shock or impact, and consequently they can be and often are rather delicate in construction.

As distinguished from the diaphragms of the prior art, the diaphragm of the present invention is especially intended for locations where it is subject to great shock and impact, and is so designed that it can withstand such shock and impact repeated a great many times, without permanently springing or distorting any of the parts of the diaphragm, or otherwise damaging it. Thus the present diaphragm is particularly adapted and useful for military installations, where the diaphragm may, for example, constitute part of optical apparatus which is mounted either directly on or closely adjacent to the barrel of a large caliber gun. In such a location, each time the gun is fired, there is a severe shock and impact transmitted to the diaphragm and other parts of the optical apparatus mounted on or near the gun.

For a military installation such as this, extreme reliability is required. In addition, in certain types of military optical apparatus it is essential that the temporary deflection of the adjustable leaves of the diaphragm in an axial direction, as a result of a shock or impact, shall not exceed a predetermined very small amount, because the diaphragm assembly may be mounted in a location where the leaves of the diaphragm are very close, in an axial direction, to some other delicate part of the optical system in which the diaphragm is used. Each time the gun is fired the leaves of the diaphragm will tend to deflect in an axial direction, but this deflection must be so small that the leaves will not engage the closely adjacent parts of the optical apparatus. All of these requirements above outlined are satisfied by the diaphragm of the present invention.

The diaphragm comprises a housing or casing indicated in general at **11**, preferably integrally made from a single piece of stainless steel and having a circular cylindrical flange portion **11***a* at its periphery, and an annular flange portion **11***b* extending radially inwardly from one end of the cylindrical portion **11***a*. The end of the housing at which the annular flange **11***b* is located may, for convenience of description, be called the front of the housing, although obviously the diaphragm assembly may be faced in either direction, depending upon the requirements of the optical system in which it is used.

A slot **13** extends through the thickness of the cylindrical part **11***a* of the housing, as shown in FIG. 3, and is elongated in a circumferential direction as shown in FIG. 2. An internal radial shoulder **15** is formed in the cylindrical flange **11***a*, near the front thereof (that is, near the right hand end of the flange, when viewed as in FIG. 3) so that the internal diameter of the cylindrical part is slightly smaller to the right of the shoulder **15** than it is to the left of such shoulder. Near the rear end (or left hand end when viewed as in FIG. 3) an internal groove **17** is formed in the flange **11***a*. As will be observed in FIG. 3, the shoulder **15** is a little to the right or forwardly of the forward edge of the slot **13**, and the groove **17** is a little to the rear or left of the rear edge of the slot **13**.

Between the shoulder **15** at the front and groove **17** at the back, the inner surface of the flange **11***a* is smooth and of uniform diameter, except for the presence of the circumferential slot **13**. In this smooth portion of the flange **11***a*, there is rotatably mounted a diaphragm operating ring **21**, made preferably of stainless steel. This ring is of annular form, and the outer peripheral surface is relieved or cut away in a continuous circumferential band extending through most of the axial length of the ring, as shown at **23**, but leaving a rim portion **25** of the full diameter of the ring at the forward end thereof, and another similar rim portion **27** of the full diameter of the ring at the rear end thereof, as well seen in FIG. 3. The rim portions **25** and **27** ride rotatably on the inner face of the cylindrical flange **11***a* of the casing or housing, throughout the entire periphery of the inner face.

In those portions of the periphery where the slot 13 is located, the bearing rim 25 is slightly forwardly of the slot 13, and the bearing rim 27 slightly to the rear thereof. Between the bearing rim portions 25 and 27, where the ring 21 is relieved or cut away as at 23, it is slightly spaced from the inner face of the housing flange 11*a*, to provide clearance so as to minimize any friction which might be caused by slight irregularities of the surfaces of the parts.

To the rear of the operating ring 21 is a resilient split retaining ring 31, preferably of stainless steel, seated in the circumferential groove 17. The split ring extends around most of the circumferential length of the groove 17, but with enough clearance between the ends of the ring so that the ring may be contracted enough to pass through the opening at the rear end of the cylindrical flange 11*a*, and it will then expand resiliently to seat itself in the groove 17, thereby holding the operating ring 21 in place. The dimensions of the various parts are such that the operating ring 21 has a snug but freely rotatable fit within the housing, held against forward displacement in the housing by the shoulder 15 and held against rearward displacement by the split ring 31.

In the space between the front face of the operating ring 21 and the rear face of the annular flange 11*b*, the diaphragm leaves (sometimes called blades) are mounted. In the present construction, the leaves may be of any desired even number. A convenient number of leaves is 12, as here shown, individual leaves being shown at 35. As best seen in FIG. 5, each leaf is of arcuate shape, approximately semi-circular in extent, and each has at one end a forwardly extending pivot stud 37, and at the other end a rearwardly extending operating stud 39.

The stud 37 of each leaf extends forwardly into snug but rotatable engagement with a circular hole 41 formed through the thickness of the front flange 11*b* of the housing. There are several such holes 41, one for each of the individual iris diaphragm leaves 35, so that if there are 12 leaves, there will be 12 of these holes 41 spaced evenly around the flange 11*b* as seen in FIG. 1.

The operating stud 39 on each leaf 35 extends rearwardly and engages snugly but slidably in a slot 45 formed radially in the front face of the operating ring 21. Just as in the case of the holes 41, there is an individual slot 45 for each diaphragm leaf, so that if there are 12 leaves, there will be 12 of these slots 45, spaced evenly around the ring 21 as seen in FIG. 4. For ease of manufacture, these slots 45 extend radially through the entire radial thickness of the ring 21, from its outer peripheral edge to its inner edge.

Those familiar with iris diaphragms will readily understand that rotation of the ring 21 within the housing or casing 11 will move the respective ends of the respective iris diaphragm leaves 35 which have the pins 39 extending into the slots 45, swinging the respective leaves on their pivots 37 at their opposite ends, with the result that the aperture formed collectively by the inner curved edges of the overlapping iris diaphragm leaves is made larger or smaller, as the case may be, depending upon the direction of rotation of the control ring 21. FIG. 1 illustrates the leaves adjusted to give minimum aperture. When the operating ring 21 is turned to its opposite limit of motion, to give maximum aperture, the inner curved edges of the various leaves are substantially flush with the inner edges of the operating ring 21 and of the front flange 11*b*, so that the aperture defined by the leaves when adjusted for maximum aperture is of substantially the same size as the inner edge of the flange 11*b* and of the operating ring 21.

The rotary movements of the operating ring 21, to adjust the size of the aperture, are caused in any suitable way, for example by force applied to a radial stud screwed into a radial threaded opening 51 in the ring 21 and extending out through the circumferential slot 13. Such a stud may be conventional, and is not shown in the present drawings because it is not necessarily part of the diaphragm assembly as supplied by the manufacturer of the assembly to the concern which is to mount it and use it in a suitable optical system. The circumferential length of the slot 13 is sufficient, of course, to allow the radial stud to move circumferentially to turn the ring 21 to the desired extent from maximum to minimum aperture and vice versa.

A locating stud 53 preferably projects from the front face of the flange 11*b* of the housing 11, in a predetermined position, in order that when the diaphragm assembly is mounted in the optical instrument with which it is to be used, the locating stud 53 may engage in an opening in the optical instrument, thus locating the diaphragm assembly in a particular position or orientation.

One of the important features of the present invention is that adjacent diaphragm leaves 35 are of materials which differ from each other for the sake of more easy manipulation. Preferably alternate diaphragm leaves 35 are of stainless steel, for example stainless steel of so-called type 303, while the other diaphragm leaves, alternating with the stainless steel ones, are of brass, for example brass of so-called type 70–30. Both the brass leaves and the stainless steel leaves are of the same shape and dimensions, having for example a thickness of 0.003 of an inch.

It has been found by test that this preferred construction of stainless steel leaves alternating with brass leaves provides a diaphragm which is particularly able to withstand the severe shocks and impacts above mentioned, and works smoothly with minimum power requirements for adjusting the diaphragm from one aperture to another. The alternating stainless steel leaves give the diaphragm leaves, as a whole, sufficient rigidity so that the leaves will not deflect to an undesirable extent in the direction of the optical axis passing centrally through the diaphragm assembly, so that even under severe shock in an axial direction there will not be a deflection which will momentarily carry the leaves into contact with a closely adjacent part of the optical apparatus. A diaphragm constructed as here disclosed, in which the housing has an external diameter of about 1.260 inch and the openings through the housing and through the ring 21 have internal diameters of about 0.850 of an inch, has proven particularly satisfactory. In tests, it has successfully withstood repeated impact shock loads of the magnitude of 500 G. No physical damage or permanent deformation of components has occurred, and the iris leaves have exhibited only very slight instantaneous axial deflection.

The alternating brass leaves prevent the stainless steel leaves from rubbing on each other, and prevent them from "seizing" or sticking to each other, the brass leaves moving over the adjacent stainless steel leaves more easily than two stainless steel leaves rubbing on each other, and more easily than two brass leaves rubbing on each other. Moreover, all of the leaves (both the brass ones and the stainless steel ones) are preferably lubricated, at the time of manufacture, by molybdenum disulphide, applied in the form of a dry powder rubbed onto the surfaces of each leaf and then excess powder removed. Sufficient powder remains on the surface of each leaf to lubricate it to an appreciable extent. It is found that the assembly of the various diaphragm leaves, when made of the alternating stainless steel and brass construction above described and when lubricated as above described, can be adjusted with extremely small exertion of circumferential force or torque to turn the operating ring 21. Hence the construction is well suited for use in optical apparatus where automatic operating means of relatively low power is connected to the ring 21 to turn the ring to adjust the diaphragm aperture from time to time to various different apertures.

It is seen from the foregoing disclosure that the objects and purposes of the invention are well fulfilled. It is to be understood that the foregoing disclosure is given by way of illustrative example only, rather than by way of limitation, and that without departing from the invention, the details may be varied within the scope of the appended claims.

What is claimed is:

1. An iris diaphragm for controlling passage of light, comprising a metallic casing having a substantially cylindrical portion and an inwardly extending radial flange at one end of said cylindrical portion, means forming an internal circumferential groove in said cylindrical portion at a location spaced axially from said radial flange, an internal circumferential shoulder in said cylindrical portion at a location between said flange and said groove and spaced axially from both of them, said shoulder being faced toward said groove, a resilient retaining ring seated in said groove, an operating ring rotatably mounted within said cylindrical portion of said casing and having peripheral bearing engagement with the inner surface of said cylindrical portion and having axial bearing engagement with said shoulder and said retaining ring and being retained thereby against substantial axial movement in either direction, said operating ring having a series of substantially radial slots formed in the face thereof which is faced toward said radial flange of said casing, and a series of diaphragm leaves mounted in overlapping relation to each other in the space between said operating ring and said radial flange, alternate ones of said leaves being of steel and the other leaves being of brass, each leaf being of elongated curved shape and having substantially at one end a pivot stud projecting forwardly and rotatably seated in an opening in said radial flange of said casing and having substantially at its other end an operating stud projecting rearwardly and seated in one of said radial slots in said operating ring, so that rotation of said operating ring within said casing will move said leaves to vary the size of the aperture defined by the collective leaves.

2. A construction as defined in claim 1, in which the surfaces of said leaves which engage each other are coated with molybdenum disulphide.

3. A construction as defined in claim 1, in which said operating ring is relatively thick in an axial direction and has a periphery which is relieved circumferentially in a location intermediate its length so that its periphery bears on said cylindrical portion of said casing only at spaced locations substantially at the front and rear edges of the periphery of the ring.

4. A construction as defined in claim 3, in which said ring has a substantially radial bore extending inwardly from its periphery so that an operating stud may be seated in said bore, and in which said cylindrical portion of said casing has a circumferentially elongated slot opposite said bore so that an operating stud seated in said bore may extend out of said casing through said slot.

5. An iris diaphragm assembly for controlling passage of light, comprising a generally cylindrical housing having an inwardly extending radial flange in fixed position, said flange having a central opening for passage of light along

an optical axis, an operating ring rotatable within said housing about said optical axis as a center and spaced axially from said flange, a series of holes in said flange, a series of slots in said ring, and a series of iris diaphragm leaves mounted in overlapping relation to each other in the space between said flange and said ring, each leaf having adjacent one end a pivot stud pivotally engaged in one of the holes in said flange and having adjacent its other end an operating stud slidably engaged in one of the slots in said ring, there being an even number of said leaves, alternating ones of said leaves being of hard and relatively rigid metal, and the intermediate leaves being of softer and more flexible metal.

6. A construction as defined in claim 5, in which alternate leaves are of stainless steel and intermediate leaves are of brass.

7. A construction as defined in claim 6, in which the surfaces of the leaves which contact with each other are coated with molybdenum disulphide.

8. An iris diaphragm assembly for controlling passage of light, comprising a generally cylindrical housing having an inwardly extending radial flange in fixed position, said flange having a central opening for passage of light along an optical axis, an operating ring rotatable within said housing about said optical axis as a center and spaced axially from said flange, said operating ring being relatively thick in an axial direction and having a peripheral edge formed to provide circumferential bearing ridges substantially only at the forward and rear edges of said ring, to make rotary bearing contact with said housing, the portion of said peripheral edge between said bearing ridges being relieved and out of contact with said housing, a series of slots in said ring, a series of holes in said flange, and a series of iris diaphragm leaves mounted in overlapping relation to each other in the space between said ring and said flange, each leaf being of elongated arcuate shape relatively narrow in a radial direction as compared with its length in a circumferential direction and having inner and outer arcuate edges which are substantially concentric with each other, each leaf having a pivot stud pivotally engaged in one of the holes in said flange and an operating stud slidably engaged in one of the slots in said ring, successive diaphragm leaves being constructed alternately of steel and of brass.

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NORTON ANSHER, *Primary Examiner.*

J. F. PETERS, *Assistant Examiner.*