March 25, 1969 L. J. SANTIROCCO ET AL 3,434,777

ATTACHMENT FOR STEREOMICROSCOPES

Filed Oct. 31, 1966 Sheet 1 of 6

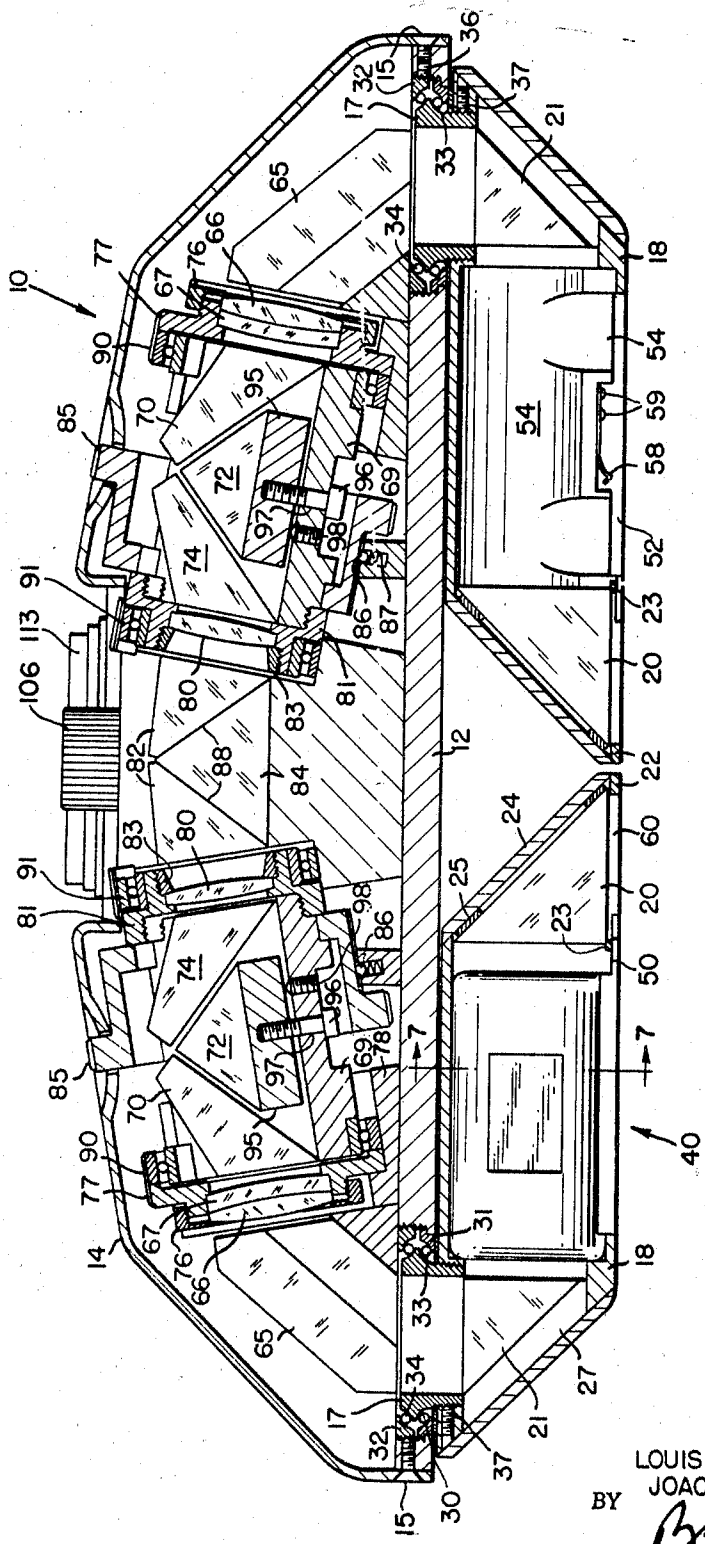


FIG. 1

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ATTACHMENT FOR STEREOMICROSCOPES

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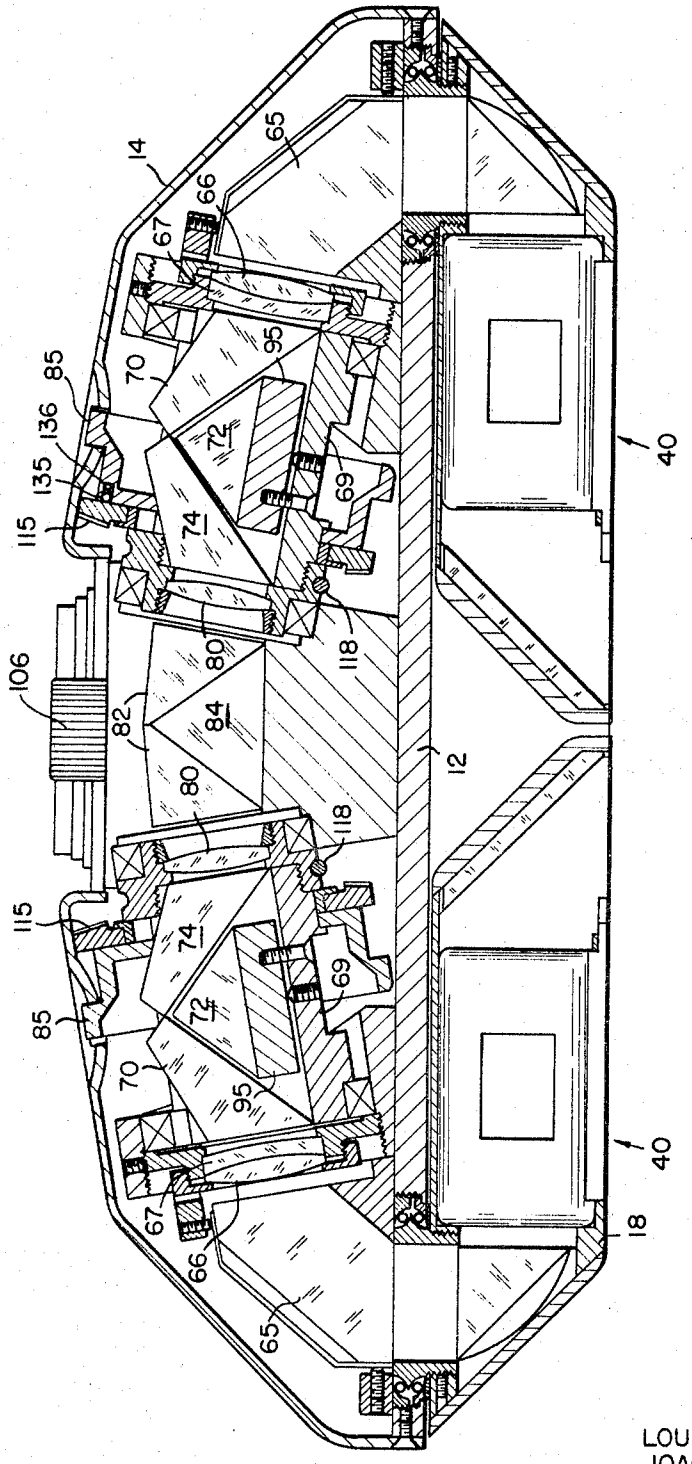


FIG. 2

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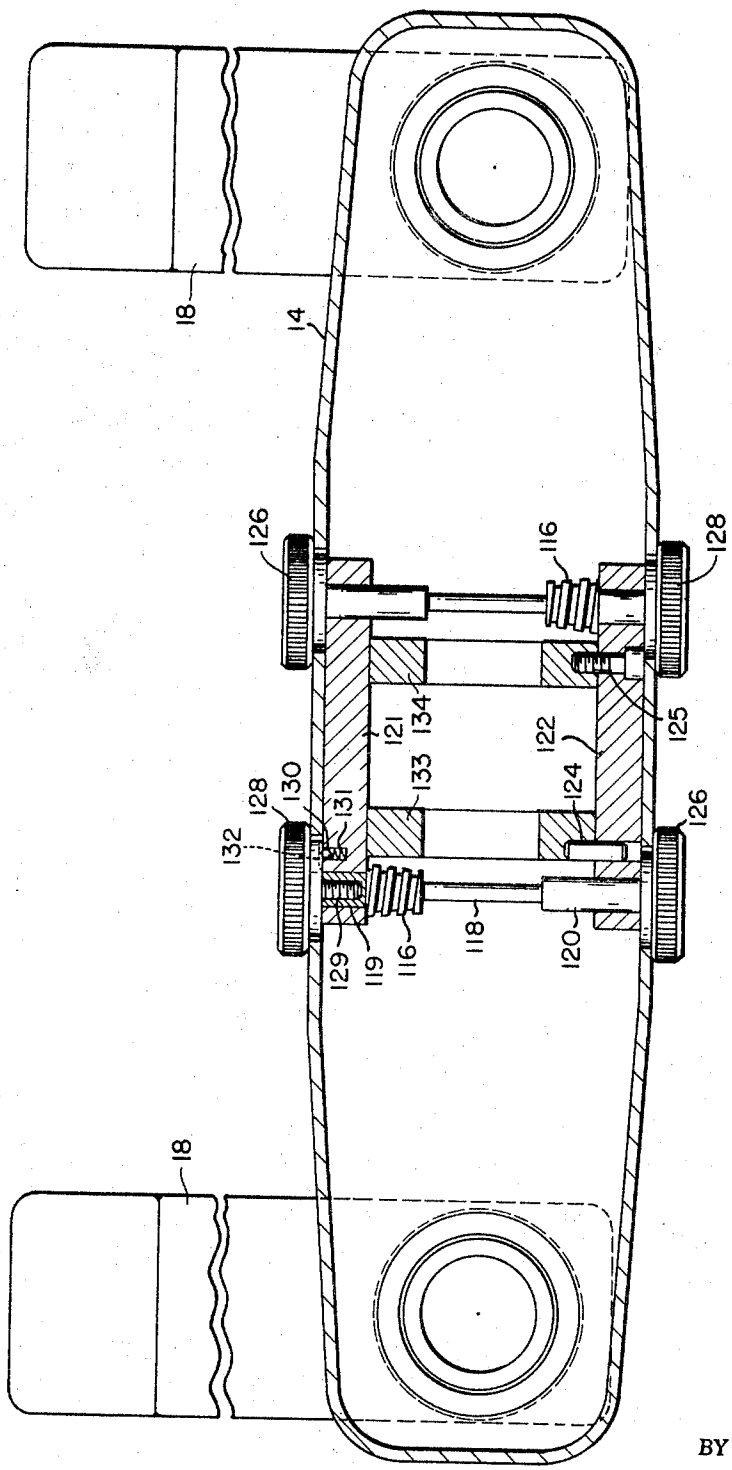


FIG. 3

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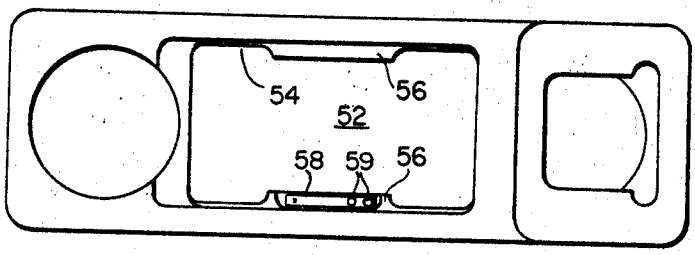


FIG. 4

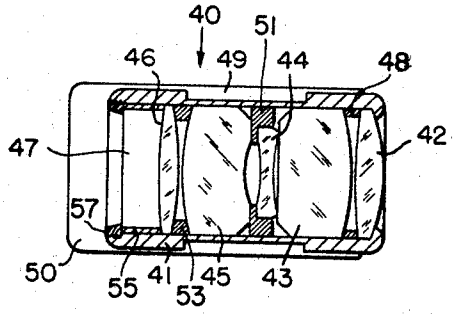


FIG. 5

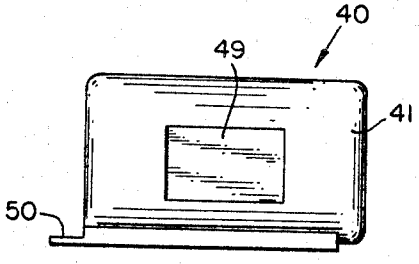


FIG. 6

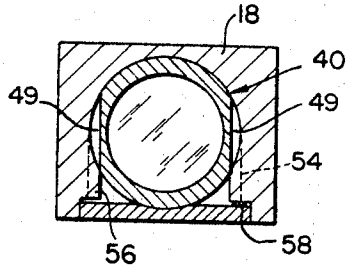


FIG. 7

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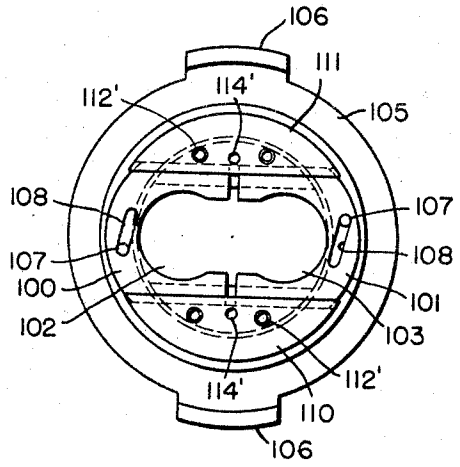


FIG. 8

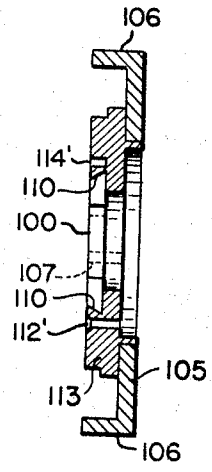


FIG. 9

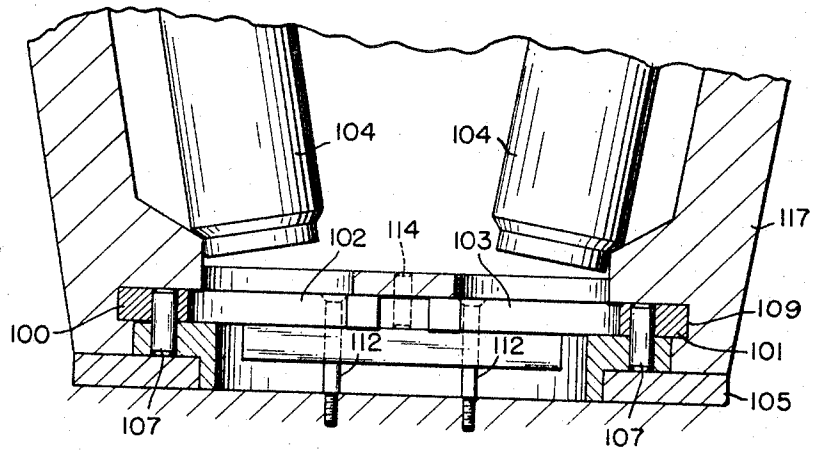


FIG. 10

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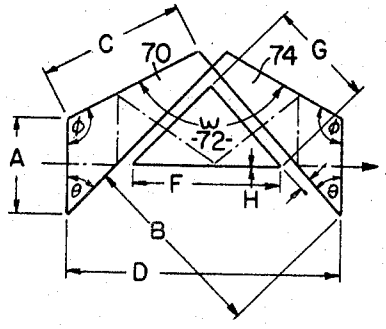


FIG. 11

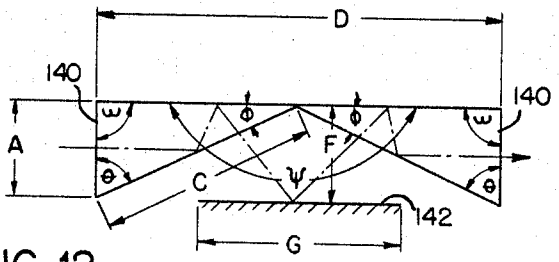


FIG. 12

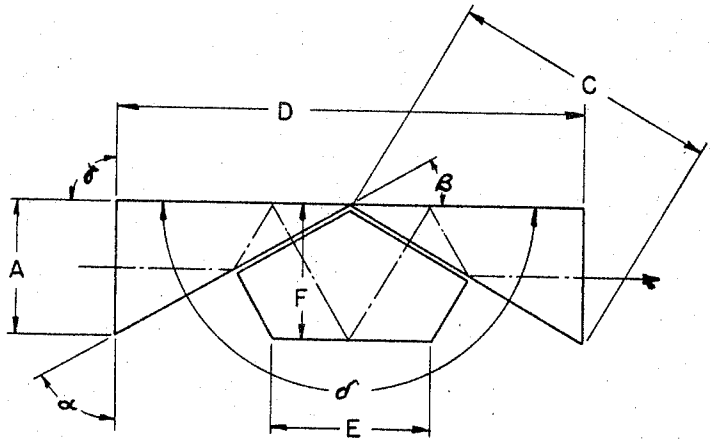


FIG. 13

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United States Patent Office 3,434,777
Patented Mar. 25, 1969

3,434,777

ATTACHMENT FOR STEREOMICROSCOPES

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Filed Oct. 31, 1966, Ser. No. 590,987
Int. Cl. G02b 27/22
U.S. Cl. 350—136
12 Claims

ABSTRACT OF THE DISCLOSURE

A stereoscopic attachment for a stereomicroscope is disclosed having two lens holders rotatably mounted in it, and two objective carrying arms swingably mounted on it. Each lens holder has a prism at each end and an intermediate reflecting member which may also be a prism. Each arm has an opening at its free end, and a right angular prism registering with the opening. A second right angular prism at the pivotable end of each arm registers with an opening through the bearing on which the arm swivels. An objective is removably mounted in each arm between and in registry with its prisms. A roof prism reflects the light traveling through each arm into the associated lens holder, and from the lens holders the light is reflected by prisms into the eyepieces of the stereomicroscope.

The present invention relates to optical systems, and more particularly to optical image rotating devices. In a still more specific aspect, the invention relates to a stereoscopic attachment for stereomicroscopes with image rotating capability.

For map making, and for study of terrain as, for instance, enemy-occupied territory, it is usual for airplanes on a photographic mission to take a series of pictures, each having approximately a sixty percent overlap of the next succeeding and the next preceding picture. For study purposes, successive pictures may be placed under a stereomicroscope having a stereoscopic attachment with a rotational feature so as to permit alignment of successive images of an object with one another for viewing through the microstereoscope. This gives, in effect, a three-dimensional view of the object.

Heretofore Pechan, Schmidt, or Dove prisms have been used as image rotating devices. These will invert and revert the image. Moreover, for mounting them on a microscope, the structure becomes usually rather bulky, long, wide and deep. This makes them costly.

One object of the present invention is to provide an image rotating stereoscopic attachment for stereomicroscopes, which will be smaller and less costly, than previously known such attachments.

Another object of the invention is to provide a stereoscopic attachment of the character described which will permit the use of interchangeable objectives, allowing different magnifications.

Another object of the invention is to provide an optical system for stereoscopic attachments which will permit image rotating and which can be used with divergent or convergent light as well as with parallel light.

More broadly stated, another object of the invention is to provide a prism arrangement for image rotating devices which will permit a greater tolerance of angular deviation, which is easily adjustable in all planes, and with which the mechanical dimensions may be kept to a minimum.

A further object of the invention is to provide an image rotating device of the character described which is compact enough to be used in compact optical instruments like telescopes, mciroscopes, and the like.

Other objects of the invention will be apparent hereinafter from the specification and from the recital of the appended claims, particularly when read in conjunction with the accompanying drawings.

In the drawings:

FIG. 1 is a vertical sectional view through a stereoscopic attachment built according to one embodiment of this invention, the arms of this attachment being shown in folded position, and the objective carried by one of these arms being removed therefrom;

FIG. 2 is a vertical sectional view through a stereoscopic attachment for stereomicroscopes made according to another embodiment of the invention, the objectives being shown mounted in both arms;

FIG. 3 is a section, laid out in a plane, through the device of FIG. 2 with parts removed for clarity of illustration, both arms being shown extended outwardly;

FIG. 4 is a bottom plan view of one of the arms with the lenses removed therefrom;

FIG. 5 is an axial sectional view of one of the objective lens barrel assemblies;

FIG. 6 is a side elevation of this objective lens barrel;

FIG. 7 is a transverse section showing a lens barrel mounted in its arm;

FIG. 8 is a fragmentary view showing the means for locking either the attachment of FIG. 1 or FIG. 2 to a stereomicroscope;

FIG. 9 is a diametral transverse section through the parts shown in FIG. 8;

FIG. 10 is a fragmentary sectional view showing how either attachment may be secured, with the illustrated locking means, to a stereomicroscope;

FIG. 11 is a view showing the prisms in the image rotating portions of both attachments and illustrating diagrammatically their action;

FIG. 12 is a similar view illustrating an alternative arrangement of prisms and a mirror in an image rotating device built according to a modification of the invention; and

FIG. 13 is a view similar to FIGS. 11 and 12 illustrating a still further arrangement of prisms for an image rotating device.

In the embodiment of the invention illustrated in FIG. 1 of the drawings, there are two arms pivotally mounted on the body of the attachment for swinging movement about parallel vertical axes, each, through 360°. Each arm has an objective lens barrel mounted in it for removal and exchange so that objectives of different magnification can be substituted and employed. In each arm there are mounted two prisms, disposed, respectively, at opposite ends of the objective lens barrel. One of the prisms of each arm registers with the annular bearing or trunnion on which the arm pivots. Mounted in the body of the attachment above each trunnion and in registry with its bore is a roof prism. Mounted in the body of the attachment, also, are two rotatable lens holders, each of which carries, at one end, lenses registering with one of the roof prisms. Mounted in each lens holder, also are three cooperating prisms. A double convex lens is mounted in the other end of each lens holder for transmitting light therefrom to a fixed prism, one of which is associated with each lens holder. Between these two fixed prisms is another fixed prism which cooperates with both. Light entering each arm is reflected by the prism at the free end of the arm through the objective lens barrel to the prism at the pivot of the arm, and thence through the associated roof prism and the associated lens holder to one of the fixed prisms. The light reflected by the two fixed prisms is reflected to the intermediate fixed prism, whence it passes into the two barrels or tubes of the stereomicroscope to which the attachment is secured. The

axes of rotation of the lens holders are inclined to one another; and the three prisms in each lens holder are so disposed to one another that the reflected light, in effect, travels in a straight line through the lens holder. The arms can be swung on the body to dispose the prisms at the free ends of the arms and the openings in the arms, through which light enters these prisms, over the portions of the photographs which are to be viewed. By rotation of the lens holders two photographic views of an object can be aligned so that when viewed through the microscope they will appear enlarged and three-dimensional.

The attachment shown in FIG. 2 is similar to that illustrated in FIG. 1, differing only in the respect that for more precise rotary adjustment of the lens holders, each lens holder is adjustable also through manipulation of a pair of hypoid gears instead of being merely rotatable manually by a knurled ring secured to the lens holder.

Instead of using three cooperating prisms in each lens holder, two prisms and a mirror may be substituted therefor, as shown in FIG. 12, the mirror being disposed between the two prisms to reflect light from one prism to the other.

Instead of using a mirror with the two prisms, a third prism may be disposed instead between them, as shown in FIG. 13. This last embodiment is particularly useful for various types of optical instruments including telecopes, and the like.

Referring now to the drawings by numerals of reference, **10** denotes a casing having a body section **12** and a cover portion **14** secured to the body section by screws **15**. Rotatably mounted on the body section by annular trunnions or journals **17** are two arms **18**. Mounted in each arm **18** is a prism **20** and a prism **21**.

The arms and the parts mounted therein are identical. Hence the structure and parts of only one arm will be described in detail here.

The prisms **20** are mounted in their respective arms on ledges **22** and **23** and are held in place in the arms by end plates **24**. A rubber gasket **25** may be interposed between each of the plates **24** and the adjoining side of the associated prism **20**. Each of the prisms **21** is mounted on a gasket **27** and held in place by the ring bushing **17**.

Each of the bushings **17** has a peripheral rib **30** and is mounted by means of this rib on a preloaded ball bearing, which comprises a lower ring **31**, an upper ring **32** and lower and upper sets of balls **33** and **34**, respectively. The ring **32** threads rotatably into the housing section **12** in order to preload the bearings. A setscrew **36** serves to lock each ring **32** in adjusted position. This setscrew is aligned with the fastening screw **15** so as to be readily accessible. Each arm **18** is threaded to its ring bearing to rotate therewith and is secured in position by a setscrew **37**.

The arms are adapted to carry identical objectives mounted between prisms **20** and **21**. The objectives are interchangeable so as to permit interchanging objectives of different magnifications from .5×, for instance, through .75× and 1× to 2×.

A typical objective is shown in FIGS. 5, 6 and 7 at **40**. It comprises a housing **41** in which are mounted the lenses **42**, **43**, **44**, **45** and **46**. One end of the housing provides a seat for lens **42**. A spacer ring **48** is disposed between lenses **42** and **43**. Lens **44** is mounted in a ring **51** against which lens **45** seats. A spacer ring **53** is interposed between lenses **45** and **46**. A spacer ring **55** holds lens **46** in place; and an annular nut **57**, which threads into barrel **40**, serves to hold all the lenses and rings in place in the lens barrel. For ease in handling, the side walls of the housing are provided with diametrally opposed rectangular recesses **49**. At one end each housing has a ledge **50**.

Each arm **18** has a cylindrically bored chamber **54** in which the associated lens barrel **40** is adapted to be mounted; and it is formed with two opposed ledge portions **56** at opposite sides, respectively, of the chamber **54**. Each chamber **54** is open at its bottom as indicated at **52**.

To mount an objective in an arm, the recesses **49** in the barrel **40** are registered with the ledges **56** of the chamber **54**, and the objective is pushed up through the opening **52** into the arm. The objective is then slid axially in the chamber **54** so that the recesses **49** in the objective **40** are offset axially of the ledges **56** in the arm. Thus, each lens barrel assembly will be held from dropping out of its arm. A leaf spring **58** (FIGS. 1, 4 and 7), which is secured by screws **59** to one of the ledges **56**, and which presses down on the base of the lens barrel, serves to hold the lens barrel frictionally in place in the arm. Ledge **50** of the lens barrel engages under ledge **23** of its arm when the lens barrel is in proper position in the arm. The ledge **50**, which is at one end only of the lens barrel insures that each lens barrel is put in its arm in proper end-to-end position.

Light enters the system through a circular opening **60** in each arm. This opening registers with the prism **20** of the arm.

Rays of light entering the opening **60** in each arm are reflected by prism **20**, pass through the objective **40**, and are reflected by the prism **21** through the bore of the bearing ring **17** onto a roof prism **65**, whence they are reflected through the field lenses **66** and **67** into a lens barrel **69**. Mounted in this lens barrel are three lens prisms **70**, **72** and **74**.

The two lens barrels **69** and the parts mounted therein are identical. Hence only one lens barrel **69** and its parts will be described in detail here.

The lenses **66** and **67** are fixed and held in place by the ring clamp **76** which is threaded onto the ring member **77** that is fastened in any suitable manner to a seat **78** which is secured to the housing **12**.

The lenses **70**, **72** and **74** are so designed and mounted that light passing through the lenses **66** and **67** is directed to lens **70** and is reflected in lens **70** twice to the lens **72**, and from lens **72** to the lens **74** and from lens **74** is reflected, as shown by the arrows in FIG. 11. The light thus travels, in effect, in a straight line through prisms **70**, **72** and **74**. From prism **74**, the light passes through a double convex lens **80** into a prismatic lens **82**. The straight line of effective travel of the light through prisms **70**, **72**, **74** coincides with the axis of lens barrel **69**. Each lens **80** is secured in a ring **81** that is threadedly fastened on the lens barrel **69**; and this lens is held in the ring **81** by a ring nut **83**.

Two prismatic lenses **82**, which are silvered at **88**, are disposed at opposite sides of the prismatic lens **84** with the result that the light is reflected from the prisms **82** into the objectives **104** (FIG. 10) of the stereomicroscope, to which the attachment is secured, as shown by the broken line and arrow in FIG. 11.

Each of the lens barrels **69** is rotatable by means of a knurled ring **85** that is secured to the barrel in any suitable manner. Rotation of the lens barrel permits rotating the image seen through the lens system associated with this lens barrel. A click stop in the form of a ball **86**, which is resiliently urged into engagement with peripheral recesses on the ring **85**, serves to hold the ring **85** and the barrel **69** in any adjusted position. The ball is urged into the engaging position by a coil spring **87**.

Each lens barrel **69** is rotatably journaled in the housing **12** by a ball bearing **90**, which surrounds the barrel at one end, and by a ball bearing **91**, which surrounds the ring **81**.

The click stop **86** not only holds each barrel in any adjusted position, but by feeling the clicks it is possible to precisely position each lens barrel in the housing.

To precisely align the prisms **70**, **72** and **74** of each set, the block **95**, on which each prism **72** is mounted, is made adjustable in the associated lens barrel **69**. A stud **96** is threaded into each block **95** and passes through an

enlarged hole **97** in the corresponding lens barrel. Three screws **98** are threaded into the associated lens barrel **69** and disposed equiangularly about the stud **96**. Each of these screws has a pointed end engaging the associated block **95**. By adjustment of these screws, the block **95** can be tilted, to precisely adjust each prism **72** relative to the associated prisms **70** and **74** so as to have the light beams, which are reflected from a prism **70**, reflected by associated prisms **72** and **74** in such mnaner as to in effect pass in the desired straight line through these prisms, as shown by the arrows in FIG. 11.

The attachment is secured to the stereomicroscope by a pair of slidable clamp members **100**, **101** (FIGS. 8, 9 and 10), which are recessed, as indicated at **102** and **103**, to permit light rays to pass from the attachment into the tubes or barrels **104** of the stereomicroscope. These clamping members are manipulated by a rotary ring member **105** which has two diametrally disposed knurled lugs or projections **106** thereon by which it may be manipulated. The ring **105** is connected by pins **107** with the clamping members **100** and **101**. These pins engage in straight inclined slots **108** in the clamping members so that when the ring is rotated in one direction, the clamping members are moved away from one another to clamp the attachment to the stereomicroscope, and when the ring is rotated in the opposite direction, the clamping members are released. In clamping position, the clamping members engage at their outsides in an internal groove **109** (FIG. 10) formed in the cover or housing **117** of the stereomicroscope as shown in FIG. 10.

The clamping members slide in dove-tailed guideways **110** machined into the block or plate **113** on which the ring **105** is rotatable. The plate or block **113** is fastened to the attachment by screws **112** which pass through holes **112'** in the block **113**. Pins **114** in the stereomicroscope engage in holes **114'** in the block or plate **113** to locate the attachment precisely on the stereomicroscope.

For finer adjustment of the image rotating part of the attachment than is possible with the attachment of FIG. 1, a construction, such as shown in FIGS. 2 and 3, may be used. This attachment is identical with the attachment of FIG. 1 except that each lens barrel **69** may be precisely adjusted by means of a hypoid gear and pinion **115**, **116**. The hypoid pinion is mounted on a shaft **118** which is journaled by means of the bearing portions **119** and **120** in plates **121** and **122**, respectively, that are connected in any suitable manner to the body **12**. A dowel **124** and screw **125** secure plates **121** and **122** to body **12** which forms part of the mount for the prisms **82** and **84**. A knurled knob **126** is fastened to one end of each shaft **118**; and a knurled knob **128** is connected to the opposite end of each shaft **118** by stud **129** which is integral with the knob **128** and is threaded into the portion **119** of the shaft. A ball **130**, which is urged by a coil spring **131** into engagement with equiangularly spaced recesses **132** in a collar portion of each knob **128**, serves as a click stop to hold the hypoid pinion in any adjusted position and also as a means for assisting in quickly locating the desired position of rotation of the associated barrel **69**.

The hypoid gear **115** itself is journaled on the barrel **69** and is frictionally connected thereto by a ball **135** which is constantly urged by spring **136** into engagement with one of the equiangularly spaced recesses in the back of the gear. This produces enough friction to take the barrel **69** along with the gear **115** when the gear is rotated. However, it permits independent rough adjustment of the barrel by rotating it by means of the knurled portion **85**.

The section of FIG. 3 is a developed sectional view, the axes of the two lens barrels **69** which are, of course, inclined to one another, being shown in a common plane.

In FIG. 3, the arms **18** are shown swung to 90° positions. Each can be rotated through 360° to view any portion of any picture beneath the microstereoscope.

Instead of using the prism arrangement shown in FIGS. 1 and 2, a prism arrangement such as shown in FIG. 12 may be used. Here two prisms **140** are employed, each of which is a 30°, 60°, 90° prism. These two prisms are used in conjunction with a mirror **142**, which takes the places of the prism **72**. The sides of the two prisms enclosed by the 90° and 30° angles, have to be silvered in order to obtain reflection. When mounted in the manner shown in FIG. 12, reflections are obtained which produce image rotation along an undeviated optical axis when aligned properly. Alignment of the unit can be obtained by shifting and tilting the mirror since it is not fixed or cemented to the prisms.

This arrangement can replace the conventional dove prism since its mechanical perimeter is almost equal to that of a dove prism and its length is somewhat shorter. This unit has the advantage over dove prisms, however, that it can be used with divergent or convergent beams of light as well as with parallel beams.

In the rotating system of FIG. 12, if the aperture $A=1$ and the refractive index $n=1.517$, then $\theta=60°$, $\varphi=30°$, $\omega=90°$, $\psi=180°$, $B=1.73205$, $C=2$, $D=2B=3.4641$, $F=A=1.000$, and $G=1.15469$. The light path in this system equals $t=5.19608$; and $t/n=4.01554$. F and D are related to each other. If n, the refractive index of the glass, is changed, t/n is the only dimension that is affected, since n is related to t/n.

To further shorten the mechanical length of the image rotating system, two 45° prisms in conjunction with a 90° prism may be used. As shown in FIG. 11 this, however, will increase the mechanical perimeter of the system to that of a Pechan prism.

The prism arrangement shown in FIG. 11, which is that illustrated in FIGS. 1 and 2, will work exactly like the prism arrangement of FIG. 12 but here the mirror is replaced by a 90° prism **72** which makes t/n shorter.

If the aperture diameter $A=1$ and the refractive index $n=1.517$, $\theta=45°$, $\varphi=112°30'$, $\omega=135°$, and $H=0.02202$, then $B=1.7250$, $C=1.100$, $G=1.000$, $F=1.41421$, $D=2.4672$. The light path in this system equals $t=4.40038$; and $t/n=2.91434$.

FIG. 13 shows a still third image rotating system which has all of the advantages of the previously described systems, and, in addition, since the t/n value equals the overall distance or D value, this arrangement can be placed in any existing instrument without changing the dimensional configurations of it. In other words, this system can be used on any microscope regardless of the tube length of the microscope without change in the tube length. Here $A=1.0$, $\alpha=60°$, $\beta=30°$, $\gamma=90°$, $\delta=180°$, and $H=0.02202$. Then $B=1.73051$, $C=2.0$,

$$D=2B=3.464102$$

$E=1.1547$, $F=1.0$, $t=5.1961$ and $t/n=3.46383$.

There are various crown glasses available which are close to the mean index of 1.49998 of this system, such as K–11, BK–3, BK–4, BK–10, K–10, etc.

This last-described image rotating system may be used on various optical instruments such as telescopes, microscopes, and the like.

With any of the attachments described and their lens systems with its 360° image rotation feature, randomly oriented uncut film can readily be viewed and analyzed.

While the invention has been described in connection with different embodiments thereof, it will be understood that it is capable of further modification, and this application is intended to cover any variations, uses, or adaptations of the invention following, in general, the principles of the invention and including such departures from the present disclosure as come within known or customary practice in the art to which the invention pertains and as may be applied to the essential features hereinbefore set forth, and as fall within the scope of the invention or the limits of the appended claims.

Having thus described our invention, what we claim is:

1. A stereoscopic attachment for stereo microscopes, comprising:

a body,

two hollow arms pivoted on parallel axes on said body, and each having a free end opposite from said pivot

an objective lens mount in each arm,

an optical, image-rotating device associated with each arm, and aligned therewith

the two image-rotating devices being rotatably mounted in said body and each comprising a rotary lens barrel open at both ends, two prisms disposed in operative relation to the two ends of the barrel, respectively, and a reflecting member disposed between the two prisms to reflect light from one prism to the other so that the light travels in the direction of the axis of the respective barrel,

the free end of each arm having an opening therein for admitting light into each arm,

a first reflector mounted in each arm in optical registry with its opening for reflecting light into one end of the associated objective lens mount,

a second reflector in each arm optically aligned with said first reflector and objective lens for reflecting light received from said first reflector into one end of the associated lens barrel, and

means optically aligned with said two lens barrels for reflecting the light therefrom into a stereomicroscope to which the attachment is secured.

2. An attachment as claimed in claim 1, wherein the means for reflecting light from said opposite ends of the two barrels into a stereomicroscope comprises a central prismatic lens and two other prismatic lenses disposed each with one side contiguous to opposite sides, respectively, of said central prismatic lens, the sides of said other prismatic lenses which are contiguous to the sides of said central prismatic lens being silvered to reflect the light into the two objectives, respectively, of the stereomicroscope.

3. An attachment as claimed in claim 1, wherein:

(a) wherein each arm has a cylindrical bore for the section thereof, in which the objective lens mount is mounted,

(b) each objective lens mount is cylindrical, and

(c) for the purpose of insertion of each objective lens mount into its arm, the arm has an opening therein of substantially the same length and diameter as the lens mount, each arm has two ledges formed at opposite sides of its bore projecting thereinto, and each objective lens mount has diametral recesses at opposite sides thereof, whereby each lens mount may be inserted in its arm by aligning its recesses with the ledges of the arm, and the lens amount may be held in the arm after insertion thereinto by moving the lens mount axially to offset the recesses axially from the ledges.

4. An attachment as claimed in claim 1, wherein each arm is pivotable through 360° about an axis perpendicular to the optical axis of the associated objective lens mount on an annular bearing through the bore of which light passes from the arm to the rotary lens barrel.

5. An attachment as claimed in claim 4, wherein:

(a) each arm has a ring bearing member secured to it whose bore is coaxial with the pivotal axis of the arm,

(b) said ring bearing member has an external peripheral rib, whose opposite sides are of concave profile,

(c) two ring race members are mounted in said body at opposite sides respectively of each ring bearing member to be coaxial therewith, and

(d) ball bearings are mounted between each race member and the opposed side of the associated ring bearing member,

(e) one of said race members of each pair of cooperating ring race members being adjustable axially in said body to adjust the load on said bearings.

6. An attachment as claimed in claim 1, wherein the means for admitting light into the free end of each arm and for reflecting it into the associated objective lens mount includes an aperture in the arm and a prism registering optically both with said opening and with said one end of said objective lens mount.

7. An attachment as claimed in claim 6, wherein the means for directing light from each objective lens mount into one end of each rotary lens barrel includes another prism.

8. An attachment as claimed in claim 4, wherein the means for directing light from each objective lens mount into said one end of each rotary lens barrel includes another prism disposed in its arm to reflect the light through the bore of said annular bearing.

9. An attachment as claimed in claim 8, wherein the means for directing light from each objective lens mount into one end of each rotary lens barrel includes a roof prism disposed in said body to reflect the light passing through said bearing into said one end of the associated lens barrel.

10. An attachment as claimed in claim 1, wherein:

(a) the two prisms in each lens barrel are 60°, 90°, 30° prisms, and

(b) the reflecting member is a plane mirror having its reflecting surface opposed to the hypotenuse sides of these two prisms.

11. An attachment as claimed in claim 1, wherein:

(a) the two prisms in each lens barrel are 45° prisms, and

(b) the reflecting member is a 90° prism.

12. An attachment as claimed in claim 11, wherein the refractive index of the prisms in each lens barrel are so selected that the length of the light path through the prisms divided by the refractive index of the glass is equal to the overall length of the prism system.

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