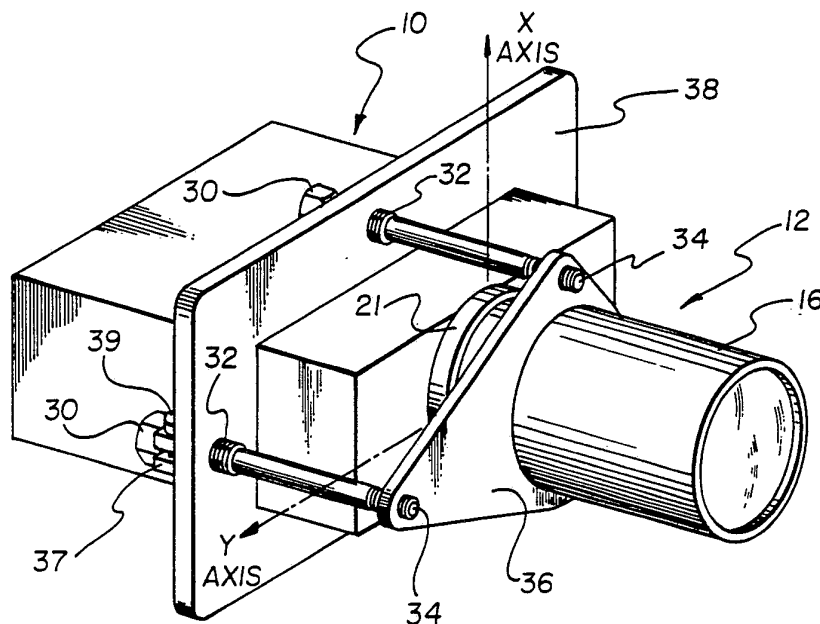




## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

<p>(51) International Patent Classification <sup>5</sup> : G02B 7/00, G03B 5/00</p>	<p>A1</p>	<p>(11) International Publication Number: WO 90/07722 (43) International Publication Date: 12 July 1990 (12.07.90)</p>
<p>(21) International Application Number: PCT/US89/05821 (22) International Filing Date: 26 December 1989 (26.12.89) (30) Priority data: 292,687 3 January 1989 (03.01.89) US (71) Applicant: EASTMAN KODAK COMPANY [US/US]; 343 State Street, Rochester, NY 14650 (US). (72) Inventor: JESSOP, Thomas, Clifton ; 940 Lake Road, Webster, NY 14580 (US). (74) Agent: SMITH, James, A.; 343 State Street, Rochester, NY 14650 (US). (81) Designated States: AT (European patent), BE (European patent), CH (European patent), DE (European patent), ES (European patent), FR (European patent), GB (European patent), IT (European patent), JP, LU (European patent), NL (European patent), SE (European patent).</p>		<p><b>Published</b> <i>With international search report.</i> <i>With amended claims and statement.</i></p>

## (54) Title: LENS ADJUSTMENT APPARATUS AND UNIVERSAL JOINT



## (57) Abstract

A lens assembly is connected to a housing containing an image sensor by a flexure means which provides for universal flexure of the lens assembly relative to the housing. A pair of compound screws rigidly couple the lens assembly to the housing and are rotatable to displace the lens assembly relative to the housing on said flexure means. Also disclosed is a universal joint for connecting two devices to permit universal movement of one relative to the other.

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## LENS ADJUSTMENT APPARATUS AND UNIVERSAL JOINT

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### CROSS REFERENCE TO RELATED APPLICATIONS

Reference is made to the following commonly assigned copending applications:

- 5 1. U.S. Serial No. 122,995, entitled  
ENLARGING PHOTOGRAPHIC PRINTER, filed November 19,  
1987, in the names of Shaun M. Amos, Richard J.  
Backus and Thomas C. Jessop.
- 10 2. U.S. Serial No. 122,996, entitled  
METHOD AND APPARATUS FOR MEASURING CHARACTERISTICS  
OF PHOTOGRAPHIC NEGATIVES, filed November 19, 1987  
in the names of Patrick A. Cosgrove and Richard J.  
Backus.
- 15 3. U.S. Serial No. 246,575, entitled LENS  
FOCUS ADJUSTMENT MEANS, filed September 19, 1988 in  
the name of Thomas C. Jessop.
- 20 4. U.S. Serial No. 292,803, entitled  
METHOD AND APPARATUS FOR ALIGNING A ZOOM LENS WITH  
AN IMAGE SENSOR, filed January 3, 1989 in the name  
of Martin L. Miller.

### TECHNICAL FIELD

This invention relates to adjustment  
apparatus and more specifically to apparatus for  
adjusting a lens relative to an image sensing device  
25 in a video camera.

### BACKGROUND ART

In a video camera employing a solid state  
image sensor and a zoom lens, it is important to  
have the optical center of the zoom lens line up  
30 with the optical center of the sensor. If there is  
error in alignment, the image will wander on the  
video screen when the user changes the magnification  
of the zoom lens while composing. Wander of the  
image produces composition error. Such errors are  
35 not significant in video cameras used for recording

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moving scenes since the user simply aims the camera to compensate for zoom induced scene shifts. However, in the case of precision systems for making enlargements from prints of the type disclosed in commonly assigned copending applications Serial Nos. 5 122,995 and 122,996, such misalignments can result in prints that do not correspond with images that appeared on the monitor during composition of the images.

## 10 DISCLOSURE OF THE INVENTION

It is an object of the present invention to provide a simple and reliable device for aligning the optical centers of two devices.

Another object of the invention is to 15 provide a simple low-cost universal joint.

In the disclosed embodiment of the invention, a lens assembly is connected to a housing containing an image sensor by a flexure means providing for universal flexure of the lens assembly 20 relative to the housing. A pair of compound screws rigidly couple the lens assembly to the housing and are rotatable to displace the lens assembly relative to the housing on said flexure means.

## BRIEF DESCRIPTION OF THE DRAWINGS

25 Other objects and advantages of the invention will become apparent from the following description taken in connection with the accompanying drawings wherein:

30 FIG. 1 is an exploded perspective view of a video camera incorporating an alignment means in accordance with the invention;

FIG. 2 is a perspective view of the apparatus shown in FIG. 1 assembled;

35 FIG. 3 is a side view of the apparatus shown in FIGS. 1 and 2 in partial section;

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FIG. 4 is a perspective view of the universal coupling joint shown in FIGS. 1 and 2;

FIG. 5 is an end view of the apparatus shown in FIG. 4; and

5 FIG. 6 is a section taken along the line 6-6 of FIG. 5.

#### BEST MODE OF CARRYING OUT THE INVENTION

Referring to the drawings and initially to FIGS. 1 and 2, there is shown a video camera 10  
10 having a zoom lens assembly 12 for producing an image on a charge coupled device (CCD) 14. As discussed above, it is important that the optical axis of the lens assembly be aligned with the optical center of the CCD 14 to prevent misalignment  
15 during zooming. Such an alignment procedure is disclosed and claimed in commonly assigned copending application Serial No. 292,803 entitled METHOD AND APPARATUS FOR ALIGNING A ZOOM LENS WITH AN IMAGE  
20 SENSOR, filed January 3, 1989 in the name of Martin L. Miller. The disclosure of that application is incorporated herein by reference.

The lens assembly 12 comprises a typical zoom lens having a lens barrel 16 containing a plurality of lens elements and having a part axially  
25 or rotatably movable to vary the magnification of the image composed on CCD 14. Such lens assemblies are well known in the art and further description is deemed unnecessary.

In accordance with the invention, a flexure  
30 means comprising a universal joint 18 is mounted between the camera 10 and lens assembly. The joint 18 shown in detail in FIGS. 4, 5 and 6 comprises a first cylindrical ring portion 20 which is received in a recess in the end of the lens barrel 16 and  
35 rigidly retained therein by a cylindrical cap 21

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threaded on the end of the lens barrel 16. The joint 18 includes an integral second ring portion 22 extending coaxially from portion 20 and connected to portion 20 by two integral diametrically opposite  
5 tabs 24. The tabs 24 have sufficient flexibility to permit pivotal movement of the second ring portion 22 relative to portion 20 about an X-axis extending through the tabs 24.

The joint 18 further comprises a third ring  
10 portion 26 formed integrally with portions 20 and 22 and extending coaxially from portion 22. The ring portion 26 is provided with external threads and is threaded into an opening in the end of camera 10. In the disclosed embodiment, ring portion 26 is  
15 formed as an integral extension of ring portion 22 and connected thereto by diametrically opposite flexible tabs 28 formed by removing material from the periphery of the joint assembly. The tabs 28 define a Y-axis angularly spaced approximately 90  
20 degrees from tabs 24 and have sufficient flexibility to permit pivotal movement of the ring portion 26 relative to ring portion 22 about the Y-axis. The tabs 24 and 28 thus effectively provide for a universal movement of ring portion 26 relative to  
25 ring portion 20.

To provide for adjustment of the lens assembly 12 relative to the camera 10, the lens assembly 12 and camera 10 are coupled by a pair of compound screws 30. Each screw 30 has two threaded  
30 portions 32 and 34 differing in pitch by a predetermined amount. The portion 34 of each screw is threaded into a flange 36 of the lens assembly 12 and the portion 32 of each screw is threaded received by a clamp 37 housing clamping screw 39  
35 attached to a flange 38 of the camera 10. The

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screws 30 thus provide a rigid coupling of the lens assembly to the camera and effectively support the lens assembly on the camera.

The screws 30 are preferably radially spaced 90 degrees apart on a circle coaxial with the optical axis of the lens assembly 12. The angular position of the screws is not critical. They can be located anywhere as long as they are positioned approximately 90 degrees apart and so that rotation of one screw produces motion of the optical axis of the lens assembly horizontally across the CCD and the other produces motion of the optical axis vertically across the CCD.

In operation, rotation of the screws 30 will produce displacement of the lens assembly 12 relative to the camera 10 through flexure of tabs 24 and 28. The location of the tabs at 90 degrees relative to each other provide for X and Y displacement components with a universal joint type of action. The location of the screws 30 substantially 90 degrees relative to each other produce adjusting force components also at substantially 90 degrees orientation relative to each other. The threaded portions 32 and 34 of different pitch cause each screw rotation to produce a displacement corresponding to the difference in pitch of the two portions. Thus, rotation of the screws result in very precision micro-adjustments of the lens assembly. While various pitch combinations will provide adequate results, a pitch of 28 threads per inch in portion 32 and a pitch of 32 threads per inch in portion 34 produces desired precision in the adjustments.

After the necessary adjustments have been effected, screws 30 can be clamped to retain the

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alignment by tightening screws 39.

It will thus be apparent that the invention provides for simple precision adjustment of a lens assembly relative to the image sensor of a video  
5 camera.

While the invention has been particularly shown and described with reference to a preferred embodiment thereof, it will be understood by those skilled in the art that various changes may be made  
10 without departing from the scope of the invention as defined by the appended claims.

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## CLAIMS:

1. Apparatus for adjustably supporting a lens assembly on the housing of a camera containing an image sensor, comprising:

5 flexure means positioned between the lens assembly and housing for permitting universal displacement of the lens assembly relative to the housing; and

10 a pair of compound screws each having two threaded portions of different pitch, one portion of each screw being threaded in said housing and the other portion being threaded in said lens assembly, said screws being angularly spaced relative to the optical axis of said lens assembly to provide for  
15 displacement of the lens assembly relative to the camera by said flexure means.

2. Apparatus as claimed in Claim 1 wherein said flexure means comprises:

20 a first ring member attached to said lens assembly;

a second ring member;

25 first yieldable means connecting said second ring to said first ring member to permit movement of said first ring member relative to said second ring in a first direction;

a third ring member attached to said camera; and

30 second yieldable means connecting said second ring member to said third ring member to permit movement of said second ring member relative to said third ring member in a second direction.

3. Apparatus as claimed in Claim 2 wherein said first and second yieldable means each comprise a pair of diametrically opposite flexible tabs  
35 extending between the rings they connect.

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4. Apparatus as claimed in Claim 3 wherein said ring members and said tabs are integrally formed as a single unitary structure.

5. A universal joint for connecting two devices to permit universal movement of one relative to the other, said joint comprising:

a first ring member attached to one of the devices;

a second ring member;

10 first yieldable means connecting said second ring to said first ring member to permit movement of said first ring member relative to said second ring in a first direction;

a third ring member attached to the other device; and

15 second yieldable means connecting said second ring member to said third ring member to permit movement of said second ring member relative to said third ring member in a second direction.

20 6. A universal joint as claimed in Claim 5 wherein said first and second yieldable means each comprise a pair of diametrically opposite flexible tabs extending between the rings they connect.

7. A universal joint as claimed in Claim 6 25 wherein said ring members and said tabs are integrally formed as a single unitary structure.

8. Apparatus for adjustably supporting a lens assembly on the housing of a camera comprising:

30 flexure means positioned between the lens assembly and housing for permitting universal displacement of the lens assembly relative to the housing;

a first ring member attached to said lens assembly;

35 a second ring member;

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first yieldable means connecting said second ring to said first ring member to permit movement of said first ring member relative to said second ring in a first direction;

5 a third ring member attached to said camera; and

second yieldable means connecting said second ring member to said third ring member to permit movement of said second ring member relative to said third ring member in a second direction.

10 9. Apparatus as claimed in Claim 8 further including a pair of screws threaded received by said housing and said lens assembly rotatable to effect such universal displacement.

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## AMENDED CLAIMS

[received by the International Bureau on 13 June 1990 (13.06.90)  
new claims 10-13 added; other claims unchanged (2 pages)]

first yieldable means connecting said  
second ring to said first ring member to permit  
movement of said first ring member relative to said  
second ring in a first direction;

5 a third ring member attached to said  
camera; and

second yieldable means connecting said  
second ring member to said third ring member to  
permit movement of said second ring member relative  
10 to said third ring member in a second direction.

9. Apparatus as claimed in Claim 8 further  
including a pair of screws threaded received by said  
housing and said lens assembly rotatable to effect  
such universal displacement.

15 10. Apparatus for supporting an optical  
assembly on a housing, said apparatus comprising:

flexure means positioned between the  
optical assembly and the housing for permitting  
universal displacement of optical assembly relative  
20 to the housing; and

a pair of compound screws each having two  
threaded portions of different pitch, one portion of  
each screw being threaded in the housing and the  
other portion being threaded in the optical  
25 assembly, said screws being angularly spaced  
relative to an optical axis of the optical assembly  
to provide for displacement of the optical assembly  
relative to the housing by said flexure means.

30 11. Apparatus as claimed in Claim 10  
wherein said flexure means comprises:

a first ring member attached to the optical  
assembly;

a second ring member;

35 first yieldable means connecting said  
second ring to said first ring member to permit

movement of said first ring member relative to said second ring in a first direction;

a third ring member attached to the housing; and

5 second yieldable means connecting said second ring member to said third ring member to permit movement of said second ring member relative to said third ring member in a second direction.

12. Apparatus as claimed in Claim 11  
10 wherein said first and second yieldable means each comprise a pair of diametrically opposite flexible tabs extending between the rings they connect.

13. Apparatus as claimed in Claim 12  
15 wherein said ring members and said tabs are integrally formed as a single unitary structure.

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**STATEMENT UNDER ARTICLE 19**

Claims 1 through 9 remain unchanged. Claims 10 through 13 have been added.

Claims 10 through 13 have been added to better distinguish over the prior art cited in the International Search Report dated May 11, 1990.

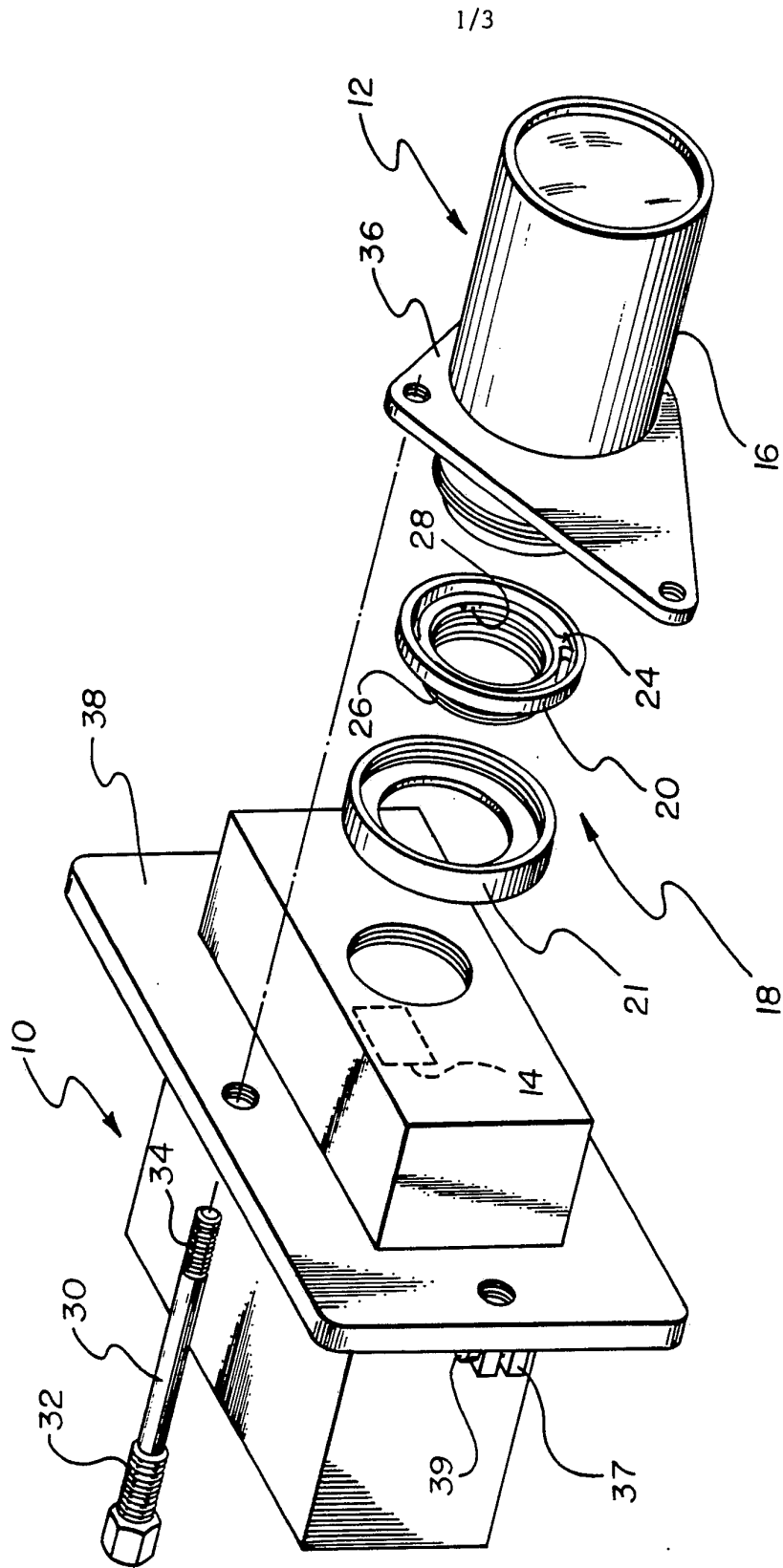
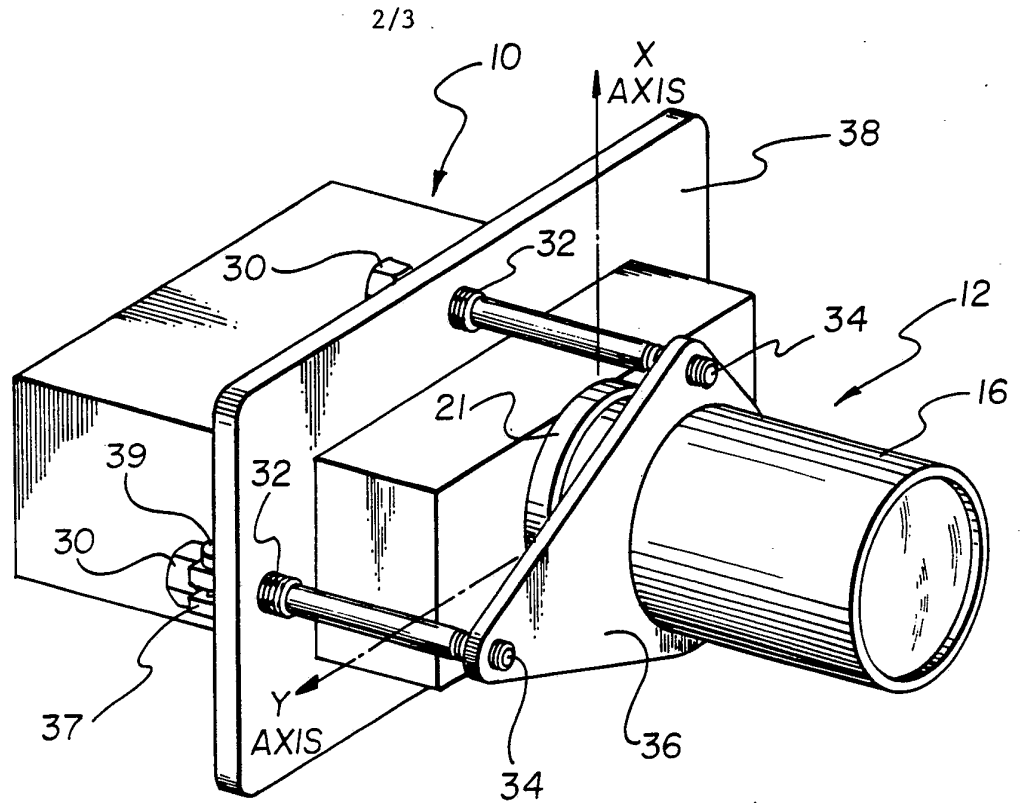
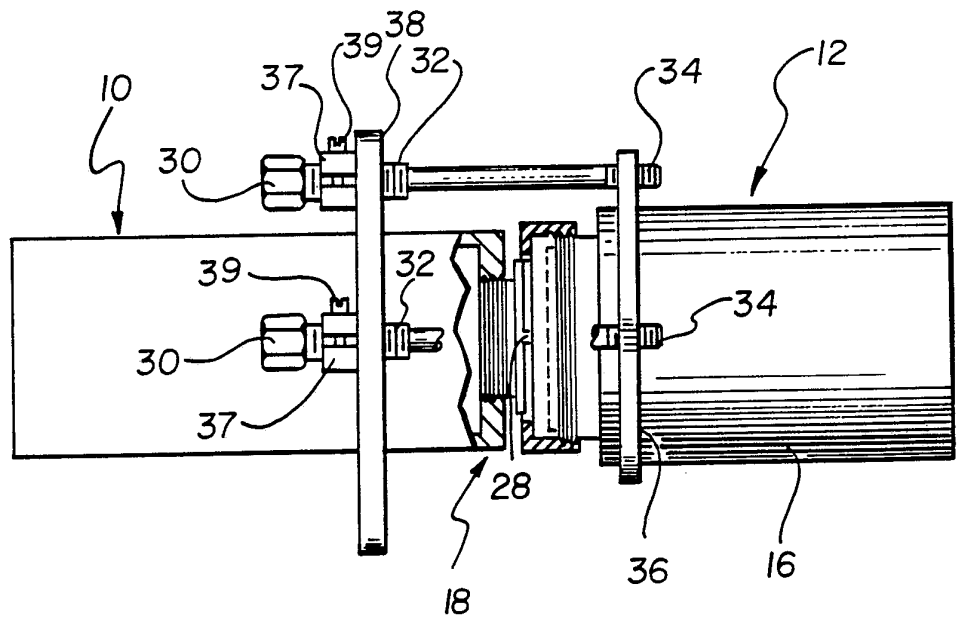


FIG. 1



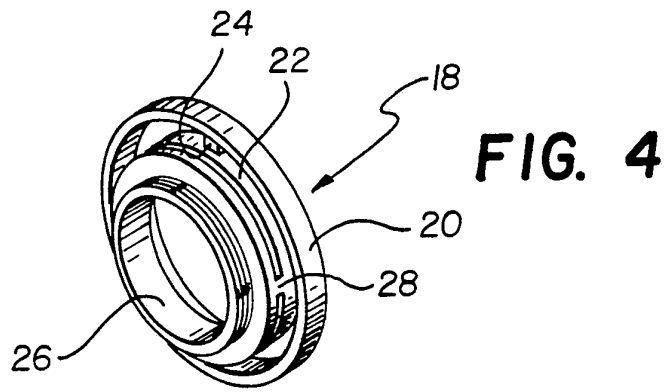
**FIG. 2**



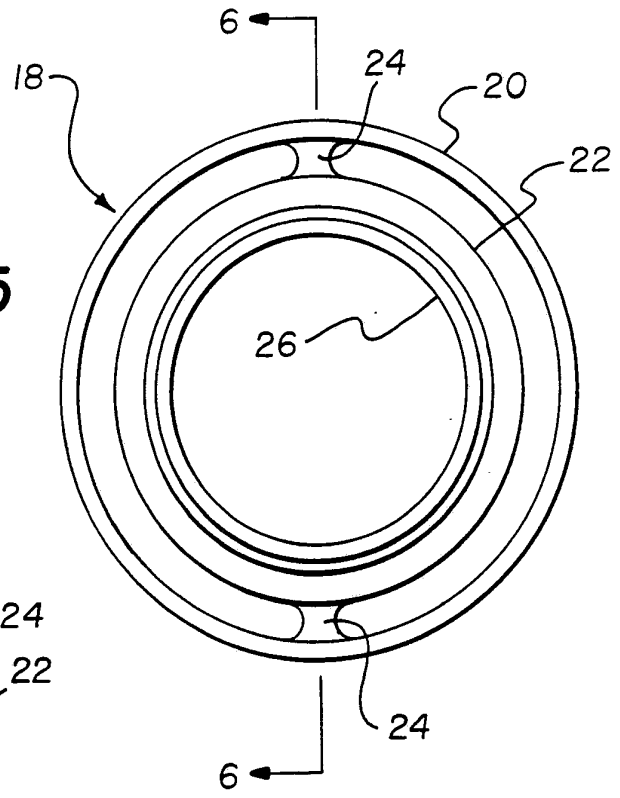
**FIG. 3**



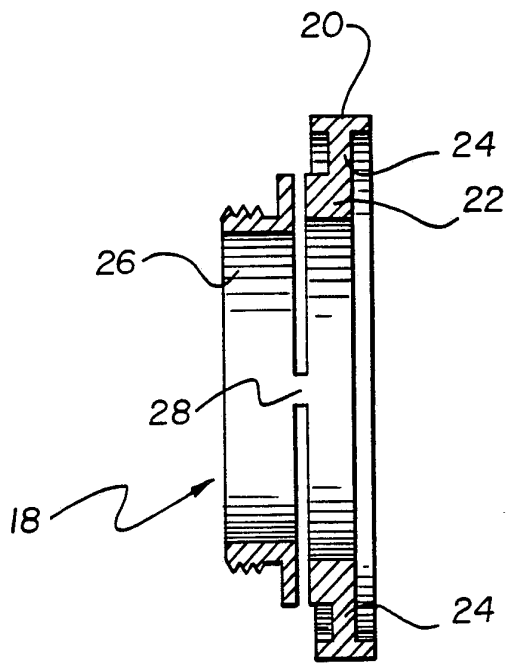
3/3



**FIG. 4**



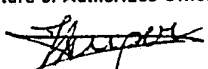
**FIG. 5**



**FIG. 6**

# INTERNATIONAL SEARCH REPORT

International Application No PCT/US 89/05821

<b>I. CLASSIFICATION OF SUBJECT MATTER</b> (if several classification symbols apply, indicate all) <sup>6</sup>		
According to International Patent Classification (IPC) or to both National Classification and IPC		
IPC5: G 02 B 7/00, G 03 B 5/00		
<b>II. FIELDS SEARCHED</b>		
Minimum Documentation Searched <sup>7</sup>		
Classification System	Classification Symbols	
IPC5	G 02 B; G 03 B; G 01 M	
Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in Fields Searched <sup>8</sup>		
<b>III. DOCUMENTS CONSIDERED TO BE RELEVANT<sup>9</sup></b>		
Category <sup>10</sup>	Citation of Document, <sup>11</sup> with indication, where appropriate, of the relevant passages <sup>12</sup>	Relevant to Claim No. <sup>13</sup>
Y	US, A, 465548 (JUE) 7 April 1987, see the whole document  --	1-2,5,8-9
Y	US, A, 730583 (H. STENDER) 9 June 1903, see the whole document  --	1-2,5,8-9
A	US, A, 3407018 (J.V. MILLER) 22 October 1968, see the whole document  --	5
A	Derwent's abstract, No. 86-224 311/34, SU 1 205 096, publ. week 8634 (GUSEV O N)  --	6-7
<p><sup>10</sup> Special categories of cited documents:</p> <p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier document but published on or after the international filing date</p> <p>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p> <p>"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</p> <p>"X" document of particular relevance, the claimed invention cannot be considered novel or cannot be considered to involve an inventive step</p> <p>"Y" document of particular relevance, the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.</p> <p>"&amp;" document member of the same patent family</p>		
<b>IV. CERTIFICATION</b>		
Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report	
25th April 1990	11 MAY 1990	
International Searching Authority	Signature of Authorized Officer	
EUROPEAN PATENT OFFICE	 Mme N. KUIPER	

III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)		
Category *	Citation of Document, with indication, where appropriate, of the relevant passages	Relevant to Claim No
P	US, A, 4832452 (EISLER) 23 May 1989, see the whole document  --  -----	5

**ANNEX TO THE INTERNATIONAL SEARCH REPORT  
ON INTERNATIONAL PATENT APPLICATION NO.PCT/US 89/05821**

SA 34110

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report.  
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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US-A- 4655548	07/04/87	AU-D- 4878885 CA-A- 1259843 EP-A- 0179426 JP-A- 61105398	01/05/86 26/09/89 30/04/86 23/05/86
US-A- 730583	09/06/03	NONE	
US-A- 3407018	22/10/68	NONE	
US-A- 4832452	23/05/89	DE-A- 3804242	25/08/88

For more details about this annex : see Official Journal of the European patent Office, No. 12/82