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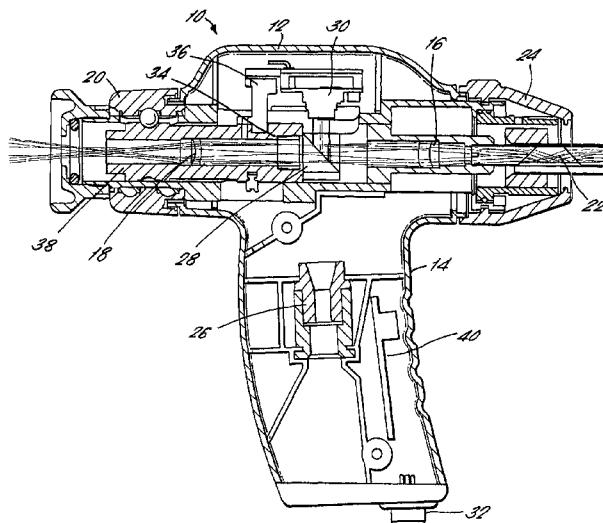
- with international search report

(72) Inventor; and

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

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(54) Title: BOROSCOPE WITH SIMULTANEOUS VIDEO AND DIRECT VIEWING



## BORESCOPE WITH SIMULTANEOUS VIDEO AND DIRECT VIEWING

The present invention relates to a borescope which simultaneously provides a virtual image for 5 direct viewing by an observer and a video image viewing on a display.

As used herein, the term borescope refers to any 10 form of optical instrument used to form an image of an object at an inaccessible or inconvenient location and to transmit the image to another more convenient location for viewing. Such instruments are often referred to by other names such as endoscope, 15 fibrescope, videoscope etc.

15 These instruments usually include an insertion tube, which may be rigid or flexible, with a housing at the proximal end. An objective lens system at the distal end of the insertion tube forms an image of an 20 object. This is transmitted to the proximal end for viewing. Borescopes generally fall into two categories, that is those including visual systems and those having video systems.

25 A visual system comprises three optical sections. First, an objective lens system is provided at the distal end of the insertion tube. This may include a prism arrangement to change the direction of view. The objective lens system forms an image of the 30 object. Secondly, a relay system is provided which transfers the image from the distal end of the insertion tube to the proximal end. This may be a train of lenses such as standard lenses, rod lenses or gradient index (GRIN) lenses, or a bundle of optical 35 fibres. Thirdly, an ocular lens system is provided in housing at the proximal end of the scope. This takes the real image from the end of the relay system and

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forms a virtual image for an observer's eye to view at a comfortable distance away, typically one metre, equivalent to -1 dioptre.

5        The benefits of a visual system include a high resolution image, a high dynamic range, i.e. the ability to see detail in both bright and dark areas of the image at the same time, a high brightness image, portability, lower cost and high temperature  
10      resistance of the insertion tube.

15      Video systems also comprise an objective lens system as in a visual scope, but in this case the image is formed on an image-to-video converter, such as a CCD (charge coupled device). The CCD turns the optical image into an electrical signal which can be passed by cable to the proximal end of the scope. An image processor is provided to process the video signal into a form that can be viewed on a display,  
20      such as a monitor screen.

25      The benefits of a video system include the ability to record and manipulate images and to display images on a screen and hence to have a large magnification of the object under inspection and the ability for multiple viewers to see the image at the same time. It also leads to a reduction in eye strain and a possible reduction in size of the housing of the scope, to allow the scope to be used in smaller  
30      spaces.

35      It is possible to attach a still or video camera to the eyepiece of a visual borescope to convert the image to a video signal. However, doing this removes the ability to examine a visual image at the same time. This also increases complexity and cost, and adapters are required to connect the camera to the

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scope. The additional size of the camera and adapter can also limit the usefulness of the scope in confined spaces.

5        The present invention provides an assembly for a borescope, comprising a body having a distal end for connection to an insertion tube and a proximal end providing an eyepiece into which an observer may look, the body containing a relay lens for receiving light  
10      from a relay system in the insertion tube, an ocular lens for creating a virtual image for viewing by an observer and a beam splitter device mounted in the optical path between the relay lens and the ocular lens and operable to divert a proportion of light  
15      received from the relay lens to an image-to-video conversion device mounted laterally to the optical path, and wherein the ocular lens, beam splitting device and image-to-video conversion device are located in a common mounting translatable in a  
20      direction parallel to the optical path to allow for focussing.

25        In this way, the advantages of visual and video scopes can be achieved with a single, compact unit and focussing can be achieved simultaneously for the visible image path and for the video image path for different working ranges of the scope.

30        Preferably, a collar is rotatably mounted on the body and coupled to the common mounting such that rotation of the collar causes translation of the mounting in a direction parallel to the opt+

      In a preferred embodiment, the beam splitter

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device is a beam splitter cube operable to divert a proportion of light at substantially 90° to the optical path.

5 Conveniently, the beam splitter device is operable to divert approximately 50% of light received to the image-to-video conversion device.

10 Advantageously, the beam splitter device is adjustable to alter the proportion of light diverted to the image-to-video conversion device.

15 In one embodiment, the beam splitter device comprises a first element operable to transmit all light received from the relay lens along the optical path to the ocular lens, a second element operable to transmit a first proportion of light along the optical path and to divert a second proportion of light to the image-to-video conversion device and a third element  
20 operable to divert all the light received to the image-to-video diversion device, wherein the first, second and third elements are selectively moveable to position one element at a time in the optical path.

25 In this way, depending upon the application, the user can select whether simultaneous visual and video images are obtained or whether to optimise any one form of image.

30 Conveniently, the image-to-video conversion device comprises CCD board camera which preferably comprises a full digital signal processing means, for compactness.

35 To accommodate use with borescopes that include a prism at the distal end of the insertion tube for lateral viewing, the image-to-video conversion device

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may be programmable to allow for correction of image inversion.

5 Alternatively, the beam splitter device may be configured to ensure an image received by the image-to-video conversion device has been reflected an even number of times.

10 Additionally, an inversion correction device may be mounted in the body proximal to the ocular lens, to ensure correction of the image viewed directly by an observer.

15 To provide a clear defined edge to the image, a field mask is mounted in the optical path at the location of the final real image, between the last relay lens and the beam splitter device.

20 The present invention also provides a borescope comprising an insertion tube connected to an assembly of the type described above.

25 The invention will now be described in detail, by way of example only, with reference to the accompanying drawings in which:

30 Figure 1 is a schematic cross-sectional view of the housing of a borescope in accordance with a first embodiment of the present invention;

Figure 2 is a schematic side view of an arrangement of lenses and prisms for use in a second embodiment of the invention; and

35 Figure 3 is a schematic perspective view of an arrangement of lenses and prisms for use in a third embodiment of the present invention.

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Figure 1 shows an assembly 10 provided at the proximal end of a borescope. The assembly 10 comprises a housing 12 and a handle portion 14 which can be grasped by a user's hand. An insertion tube (not shown) is connected to the distal end of the housing 12, shown on the left hand side in the figure.

The insertion tube contains a conventional visual system, that is a viewing window at the distal end, an objective lens system forming an image of an object and a relay system for transmitting the image to the proximal end of the insertion tube and into the housing 12 where the last relay lens 16 of the relay system is mounted.

15

An ocular lens 18 is provided towards the proximal end of the housing 12, shown on the right hand side in the figure. As is known in the art, the last relay lens 16 and ocular lens 18 may each be a single lens, or a combination of two or more lenses.

20 A focus collar 20 is rotatably mounted on the housing 12 and is described further below.

25

If the scope has a lateral direction of view, i.e. it views objects to the side of the insertion tube, it will contain a prism at the distal end of the insertion tube which inverts the image. To correct this inversion, a corrective system such as a dove prism 22 is provided, in this case, in the housing 12 proximal to the ocular lens 18. Furthermore, if the insertion tube is rotatable about its longitudinal axis to provide orbital scanning, a scan control collar 24 may be rotatably mounted on the housing 12.

35

Typically, illumination of an object being viewed is provided by a bundle of optical fibres transmitting

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light along the insertion tube from a light guide. In a conventional manner, a light guide connector 26 can be incorporated in the handle 14 coupling the optical fibre bundle (not shown) to a cable from an external 5 light source (also not shown).

Thus, as in a conventional visual system, in the borescope of the present invention light from the relay lens 16 is passed to the ocular lens system 18, 10 through the dove prism 22 for correction and then to an observer's eye positioned adjacent an eye piece at the proximal end of the assembly 10.

However, in addition, the present invention 15 incorporates a beam splitter device 28 mounted between the last relay lens 16 and the ocular lens 18. This diverts a proportion of the light received from the last relay lens 16 substantially perpendicular to the optical path between the relay lens 16 and ocular lens 20 18, to an image-to-video conversion device such as a CCD 30 mounted at 90° to the optical path. The beam splitter device 28 may be of any type, although it is currently preferred for this to be a beam splitter 25 cube, formed of two right-angled prisms with a coating on their interface plane.

A cable 32 connected to the handle portion 14 provides power input for, and receives a video output from, the CCD 30 for transmission to a display monitor 30 (not shown). Thus, at the same time that an observer can directly view an image through the eyepiece, a video signal of the image can also be viewed on a display monitor.

35 Preferably, the system is designed to overfill the CCD 30, so as to give a full screen image on the display monitor. Also, to provide a clear defined

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edge to the image seen by an observer looking into the eyepiece, a field mask 34, i.e. a plate with a circular aperture, is placed at the location of the final real image of the system, between the last relay 5 lens 16 and the beam splitter 28. The ocular lens 18 is designed to form a virtual image of both the field mask 34 and the final image at the same eye field of view as a conventional visual scope.

10        Preferably, the CCD 30 is mounted on a support column 36, itself connected to a mounting carriage 38 which carries the ocular lens 18, field mask 34 and beam splitter 28. This carriage 38 is translatable in a direction parallel to the main optical path through 15 the scope. This translation is achieved by the focus collar 20 which is coupled to the carriage 38 so that rotation of the focus collar 20 causes linear translation of the carriage 38. Thus, focussing can be achieved simultaneously for the CCD and the visible 20 image paths for different working ranges of the scope. The lenses are designed such that the focus travel of both the CCD and ocular lens are the same for the required working range of specifications of the scope.

25        Furthermore, the optical design is such that spherical aberrations caused by the beam splitter device 28 are removed. A telecentric design is used such that the light rays from the last relay lens 16 are all parallel, in order to remove off axis 30 aberrations such as astigmatism, coma and distortion that would otherwise be present when using a beam splitter device.

35        The image-to-video conversion device is a CCD board camera 30 which has a full digital signal processor (DSP) set. This means that the device is compact and only requires a power input and a video

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output cable 32. In the preferred embodiment, a power conversion board 40 is placed in the handle portion 14 such that a voltage range of 7-30 volts can be used as the input.

5

The CCD 30 is programmable to allow for correction of image inversion which occurs if an odd number of reflections appears in the system, as when the scope has a prism at the distal end for lateral viewing.

10 Alternatively, the beam splitter 28 can be configured so as to ensure an even number of reflections occur before light encounters the CCD 30, 15 as shown in the second embodiment illustrated in Figure 2. Here a first reflection occurs in the prism at the distal end of the insertion tube, and a second reflection in a dove prism 44 which is part of the relay lens system. Thus, light passing to ocular lens 20 18 has undergone two reflections. The beam splitter 28 is arranged to provide two further reflections to ensure that the CCD receives an even number of image reflections.

25

Typically, the beam splitter 28 will be configured to transmit approximately 50% of light it receives through to the ocular lens 18, and to divert the other 50% of the light towards the CCD 30. However, it is anticipated that future CCD sensors may 30 become more sensitive and if so the ratio can be altered to maximise the image brightness for both the visual and video systems.

35

Furthermore, in certain applications it may be preferable to maximise the light throughput either through the visual or video systems. In a third embodiment of the invention illustrated in Figure 3,

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an additional device 46 is provided which provides three alternative elements, mounted side by side. In the centre is a beam splitter cube 28, which transmits a portion of light received from the relay lens 16 on 5 to the ocular lens 18 and diverts the remaining portion to the CCD. On one side, an element 48 such as a glass cube transmits all the light and diverts none. On the other side, a third element 50, such as a prism, diverts all the light to the CCD 30 and 10 transmits none to the ocular lens 18. The dimensions of these elements 28, 48, 50 are such that the optical path length to the final image remains the same. The device 46 can then be moved in a direction perpendicular to the optical path, as indicated by the 15 arrows, such that a user may select which element 28, 48, 50 is placed in the optical path and thus whether all the light is diverted to the CCD 30, or all the light is passed to the eye, or whether there is a split between the two.

20

Thus, the present invention provides a borescope with combined visual and video capability in a single compact arrangement. The benefits of both visual and video systems are available simultaneously. The 25 skilled reader will appreciate that a number of alterations and modifications may be made to the precise details prescribed, without departing from the scope of the invention as set out in the claims.

30

**CLAIMS**

1. An assembly for a borescope, comprising a body having a distal end for connection to an insertion tube and a proximal end providing an eyepiece into which an observer may look, the body containing a relay lens for receiving light from a relay system in the insertion tube, an ocular lens for creating a virtual image for viewing by an observer and a beam splitter device mounted in the optical path between the relay lens and the ocular lens and operable to divert a proportion of light received from the relay lens to an image-to-video conversion device mounted laterally to the optical path, and wherein the ocular lens, beam splitting device and image-to-video conversion device are located in a common mounting translatable in a direction parallel to the optical path to allow for focussing.
2. An assembly as claimed in claim 1, further comprising a collar rotatably mounted on the body and coupled to the common mounting such that rotation of the collar causes translation of the mounting in a direction parallel to the optical path.
3. An assembly as claimed in any preceding claim, wherein the beam splitter device is a beam splitter cube operable to divert a proportion of light at substantially 90° to the optical path.
4. An assembly as claimed in any preceding claim, wherein the beam splitter device is operable to divert approximately 50% of light received to the image-to-video conversion device.
5. An assembly as claimed in any preceding claim, wherein the beam splitter device is adjustable to

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alter the proportion of light diverted to the image-to-video conversion device.

6. An assembly as claimed in any preceding claim,  
5 wherein the beam splitter device comprises a first  
element operable to transmit all light received from  
the relay lens along the optical path to the ocular  
lens, a second element operable to transmit a first  
10 proportion of light along the optical path and to  
divert a second proportion of light to the image-to-  
video conversion device and a third element operable  
to divert all the light received to the image-to-video  
diversion device, wherein the first, second and third  
15 elements are selectively moveable to position one  
element at a time in the optical path.

7. An assembly as claimed in any preceding claim,  
wherein the image-to-video conversion device comprises  
a CCD board camera.

20 8. An assembly as claimed in claim 7, wherein the  
CCD board camera comprises a full digital signal  
processing means.

25 9. An assembly as claimed in any preceding claim,  
wherein the image-to-video conversion device is  
programmable to allow for correction of image  
inversion.

30 10. An assembly as claimed in any of claims 1-8,  
wherein the beam splitter device is configured to  
ensure an image received by the image-to-video  
conversion device has been reflected an even number of  
times.

35 11. An assembly as claimed in any preceding claim,  
further comprising an inversion correction device

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mounted in the body proximal to the ocular lens.

12. An assembly as claimed in any preceding claim,  
further comprising a field mask mounted in the optical  
5 path at the location of the final real image, between  
the last relay lens and the beam splitter device.

13. A borescope comprising an insertion tube  
connected to an assembly as claimed in any preceding  
10 claim.

14. An assembly for a borescope substantially as  
herein before described and with reference to the  
accompanying drawings.

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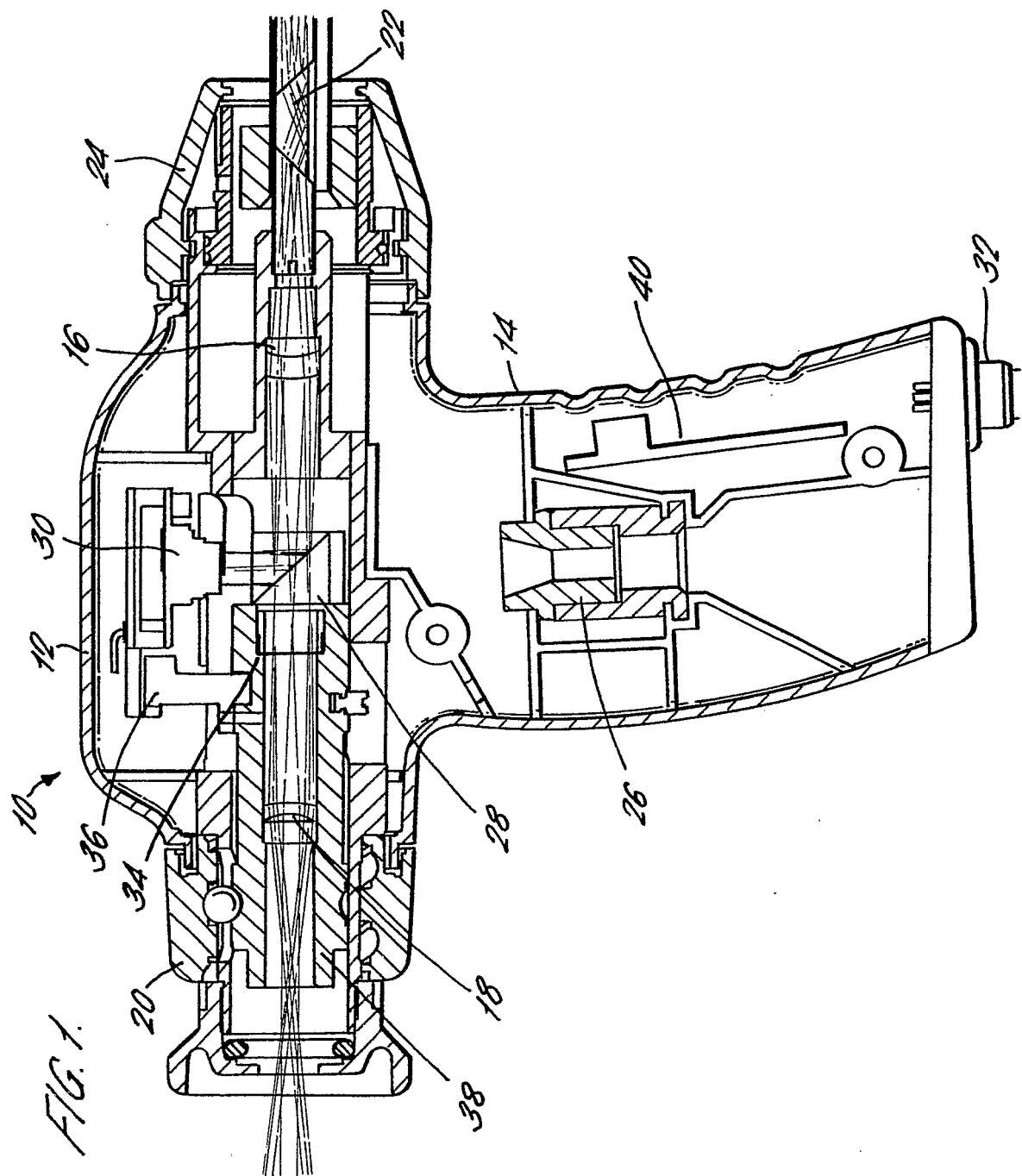


FIG. 2.

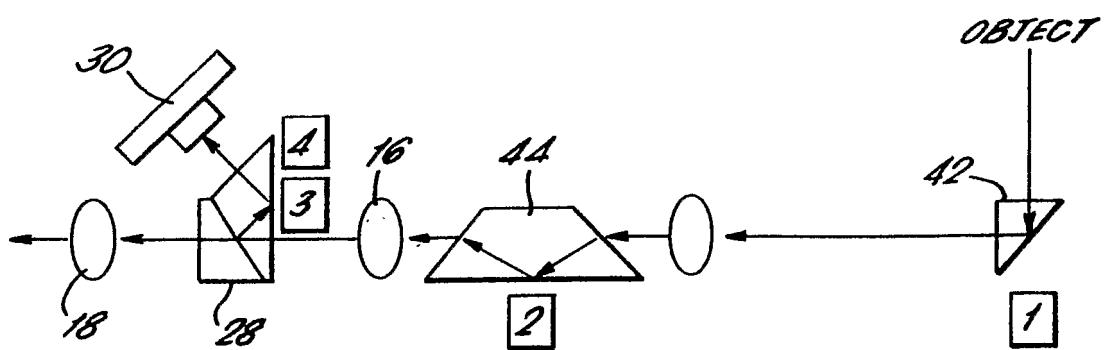
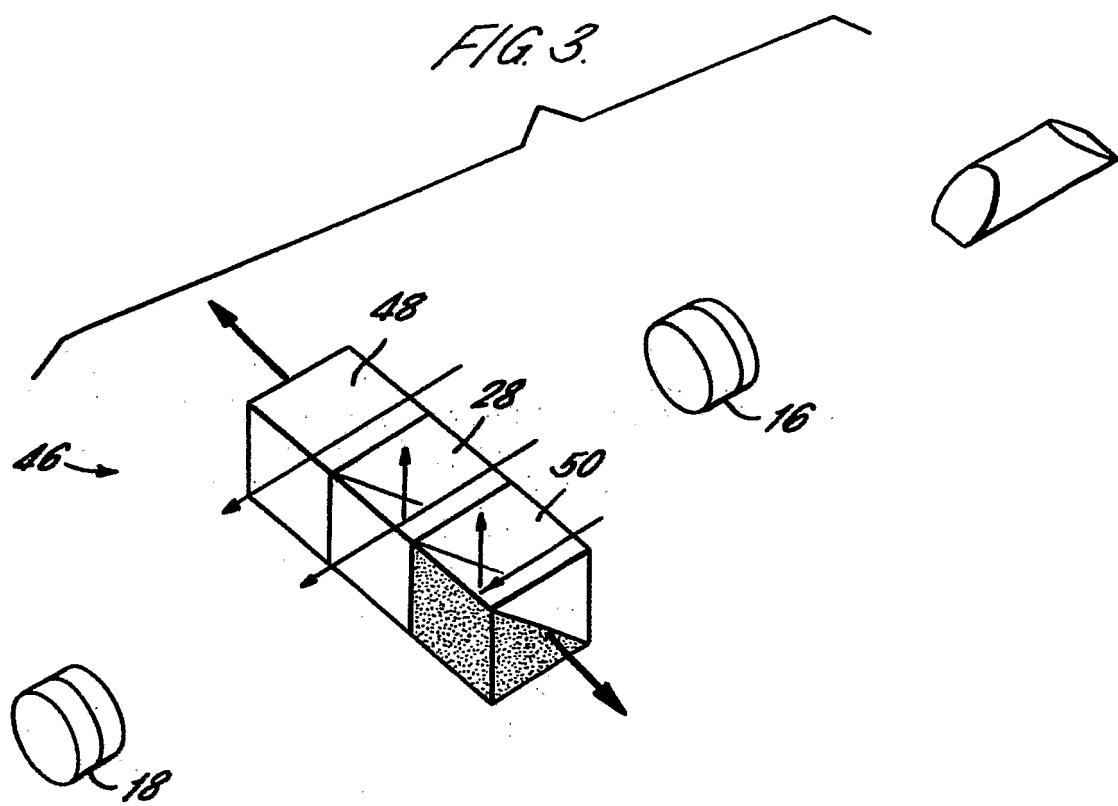


FIG. 3.



## INTERNATIONAL SEARCH REPORT

PCT/GB 03/01891

A. CLASSIFICATION OF SUBJECT MATTER  
 IPC 7 G02B23/24 A61B1/04

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 G02B A61B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, PAJ, WPI Data

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 4 905 082 A (KUSUNOKI HIROYUKI ET AL) 27 February 1990 (1990-02-27) column 15, line 27 -column 19, line 47; figures 18-22 --- DE 39 28 421 A (STORZ KARL GMBH & CO) 2 May 1991 (1991-05-02) column 4, line 46 -column 5, line 34; figures 1,2 ---	1,3,5,7, 8,12,13 1,3,4,6, 13
A		

 Further documents are listed in the continuation of box C. Patent family members are listed in annex.

## ° Special categories of cited documents :

- \*A\* document defining the general state of the art which is not considered to be of particular relevance
- \*E\* earlier document but published on or after the International filing date
- \*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)
- \*O\* document referring to an oral disclosure, use, exhibition or other means
- \*P\* document published prior to the international filing date but later than the priority date claimed

- \*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
- \*X\* document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- \*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.
- \*&\* document member of the same patent family

Date of the actual completion of the international search  21 July 2003	Date of mailing of the international search report  28/07/2003
Name and mailing address of the ISA  European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Authorized officer  von Moers, F

## INTERNATIONAL SEARCH REPORT

PCT/GB 03/01891

### Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1.  Claims Nos.: because they relate to subject matter not required to be searched by this Authority, namely:
  
2.  Claims Nos.: 14 because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful International Search can be carried out, specifically:  
see FURTHER INFORMATION sheet PCT/ISA/210
  
3.  Claims Nos.: because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

### Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1.  As all required additional search fees were timely paid by the applicant, this International Search Report covers all searchable claims.
  
2.  As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
  
3.  As only some of the required additional search fees were timely paid by the applicant, this International Search Report covers only those claims for which fees were paid, specifically claims Nos.:
  
4.  No required additional search fees were timely paid by the applicant. Consequently, this International Search Report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

#### Remark on Protest

The additional search fees were accompanied by the applicant's protest.

No protest accompanied the payment of additional search fees.

**FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210**

Continuation of Box I.2

Claims Nos.: 14

Claim 14 contravenes Article 6 and Rule 6.2 PCT. It is not clear which features are claimed.

The applicant's attention is drawn to the fact that claims, or parts of claims, relating to inventions in respect of which no international search report has been established need not be the subject of an international preliminary examination (Rule 66.1(e) PCT). The applicant is advised that the EPO policy when acting as an International Preliminary Examining Authority is normally not to carry out a preliminary examination on matter which has not been searched. This is the case irrespective of whether or not the claims are amended following receipt of the search report or during any Chapter II procedure.

## INTERNATIONAL SEARCH REPORT

PCT/GB 03/01891

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专利名称(译)	管道镜具有同步视频和直接观看功能		
公开(公告)号	<a href="#">EP1514150A1</a>	公开(公告)日	2005-03-16
申请号	EP2003727635	申请日	2003-05-02
[标]申请(专利权)人(译)	卡麦德(医疗器械)有限公司		
申请(专利权)人(译)	KEYMED ( 医疗及工业设备 ) 有限公司		
当前申请(专利权)人(译)	KEYMED ( 医疗及工业设备 ) 有限公司		
[标]发明人	SPENCER LEE		
发明人	SPENCER, LEE		
IPC分类号	A61B1/00 A61B1/04 G02B23/24 G02B23/26 G02B27/10		
CPC分类号	A61B1/00188 A61B1/042 G02B23/2484		
优先权	2002013982 2002-06-18 GB		
其他公开文献	EP1514150B1		
外部链接	<a href="#">Espacenet</a>		

### 摘要(译)

描述了一种用于连接到管道镜的组件，以同时提供用于观察者直接观看的虚拟图像和用于在显示器上观看的视频图像。组件(10)包括主体(12)，主体(12)具有用于连接到管道镜的插入管的远端和提供观察者可以看到的目镜的近端。主体包含中继透镜(16)和目镜(18)。分束器(28)安装在中继透镜(16)和目镜(18)之间的光路中，并将从中继透镜(16)接收的一部分光转向到图像-视频转换装置(30)横向安装在光路上。目镜(18)、分束装置(28)和图像-视频转换装置(30)都位于共同的安装件(38)中，该安装件可以在平行于光路的方向上平移，以允许聚焦。