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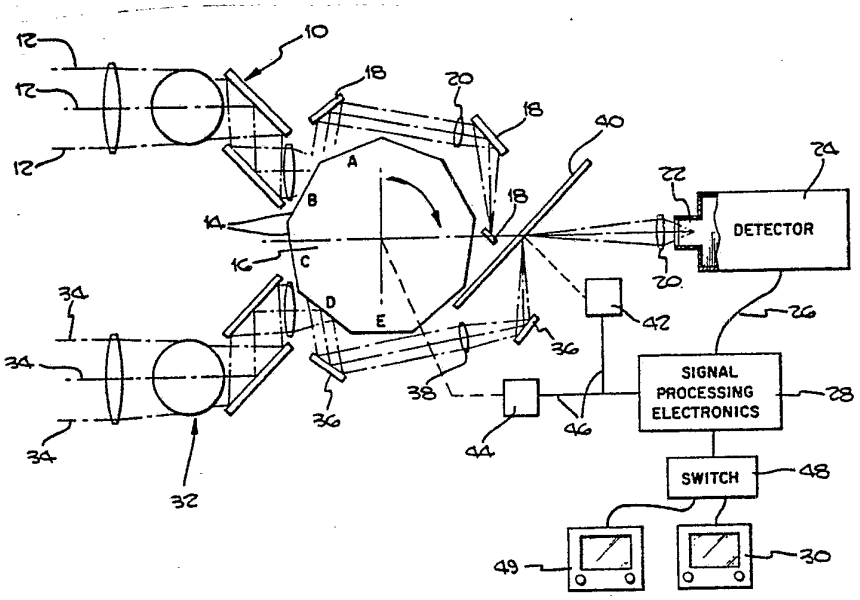
(54) Title: DUAL FIELD OF VIEW SENSOR

(57) Abstract

A dual field of view sensor particularly adapted for use as a night vision sensor. A single detector assembly (24) is employed for receiving a light signal and developing an output electrical signal (26) reflecting the light signal. A rotating polygon scanner (16) having a plurality of reflective facet surfaces (14) thereon is employed in conjunction with two separate optical systems (10). The two optical systems (10) are employed to receive and direct two separate light beams onto the facets (14) of the scanner (16) at positions offset by one-half the facet angle, such that the light beams alternately strike a facet and the juncture between two facets. The reflected light is then directed onto the detector (24) in an alternating, interleaved sweeping motion. In one embodiment, both optical systems include a steerable telescope (10) for giving views in two different directions. In that embodiment, the signals developed are split and used to drive two displays (30, 49), one for each field of view. In a second embodiment, a transparent display such as an LCD panel (60) is disposed in one light beam to impress a data image thereon and the signals developed from the two light beams are combined to drive a display (30) having the view from one light beam with information input to the in-line display superimposed thereon. In a third embodiment, the two light beams represent the input to a stereoscopic viewing system and the separate signals developed therefrom are used to drive a pair of small displays (92, 96) which are helmet-mounted for individual viewing by the left and right eyes of a wearer (98) in order to provide stereoscopic night vision viewing.



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DUAL FIELD OF VIEW SENSOR

BACKGROUND OF THE INVENTION

The present invention relates to electro-optical display systems and, more particularly, to infrared systems and systems employing two light beams and associated electronics such as those which provide stereoscopic viewing.

Scanning infrared sensors are known in the art. In such sensors, an electro-optical detector converts incident light or other electro-magnetic radiation into an electrical signal which is then processed by a signal processor and used to drive an image. A directionable telescope unit is employed to point the line of sight in a desired direction. The received light beam enters the telescope assembly wherein an optical system directs it onto a rotating polygon scanner having a reflective faceted surface thereon. The rotation of the scanner causes the beam to be swept across the sensitive detecting surface of a detector.

Such systems are both heavy and costly because of the above-described components. They are also notoriously inefficient, since the polygon scanner is typically only about 50% efficient because the line of sight is broken up by the passing corners of the scanner between facets.

Therefore, it is the object of the present invention to provide an optical scanning system for infrared scanning and the like which is of high efficiency and which also affords additional capabilities such as stereoscopic and component sharing.

SUMMARY OF THE INVENTION

The foregoing objectives have been accomplished in a scanning infrared sensor or the like employing a scanner, detector and signal processor in which a first optical assembly is employed to direct light entering from a first line of sight against the reflective surface of a rotating polygon scanner so that it is sequentially reflected from the facets of the scanner across the detector in a sweeping scan pattern to produce a signal therefrom, by the improvement of the present invention comprising a second optical assembly disposed to direct light entering from a second line of sight against the reflective surface of the scanner at a point displaced one-half its facet angle whereby the detector and signal processor are time-shared as a result of light from the first and second lines of sight being interleavedly swept across the detector.

In one embodiment of the invention, means for producing a combined image on a single display are employed.

In a second embodiment, two displays are employed in addition to means for separating signals from the first and second lines of sight and for displaying them on respective ones of the displays.

In yet another embodiment, the second optical assembly includes a directional telescope assembly for changing the line of sight of light entering therein whereby two independent lines of sight are provided.

In the preferred embodiment, beam interrupter means are disposed in the paths of the first and second light beams adjacent the detector.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a simplified drawing of the present invention according to the first embodiment.

FIG. 2 is a simplified drawing of the present invention in a second embodiment.

FIG. 3 is a simplified drawing of the present invention in yet a third embodiment.

DETAILED DESCRIPTION OF THE INVENTION

Turning first to FIG. 1, the present invention is shown in the preferred embodiment wherein two independent lines of sight produce separate images with shared components. The components, including an infrared sensor according to the prior art, comprise a first telescopic optic assembly, generally indicated as 10. Assembly 10 gathers and directs light 12 from a first line of sight onto the facets 14 of a polygon scanner 16, from where it is reflected from mirrors 18 and through lenses 20 onto the sensitive surface 22 of a detector 24 in a sweeping pattern. The electrical signal from detector 24 on line 26 is connected to signal processing electronics 28 which are used to drive a display such as that labelled 30. The techniques of the optics and electronics described hereinbefore are all well known to those skilled in the art and, therefore, to avoid redundancy, no further explanation thereof is included herein.

To accomplish the purposes of the present invention in this embodiment, a second telescopic optic assembly, generally indicated as 32, is provided and disposed to direct light 34 from a second line of sight onto the facets 14 of the polygon scanner 16 at a point displaced one-half the facet angle from the position of direct incidence of light 12 from telescopic optic assembly 10. Thus, as shown in FIG. 1, the light 34 is directly incident on the facet 14 labelled "D" whereas the light 12 from the first telescopic optic assembly 10 is incident on the juncture point between the facets 14 labelled "A" and "B". If the polygon scanner 16 rotates one-half the facet angle, light 12 will then be directly incident on the facet 14 labelled "B" while light 34 will now be incident on the juncture between the adjacent facets 14 labelled "D" and "E". Light 34 as reflected from the facets 14 of the polygon scanner 16 is directed by mirrors 36 and lens 38 against a rotating beam chopper 40. The beam chopper comprises a wheel with alternate open and reflective surfaces rotated by rotating means 42 in such a manner that light 12 and 34 is alternately directed through lens 20 onto the sensitive surface 22 in the above-described sweeping action.

Significantly, the rotation of the beam chopper 40 is synchronized with the rotation of the polygon scanner 16 so that only light from a full facet is transmitted to the detector 24, thus avoiding signal overlap between the two beams 12, 34 at the detector 24. For example, in FIG. 1, facet B of the polygon scanner 16 does not fully face the light beam 12 and, therefore, the beam chopper 40 blocks the light from facet B at the instant illustrated in FIG. 1. At the same instant, however, facet D of the polygon scanner 16 fully faces the light beam 34, and the beam chopper

40 permits the reflected light from facet D to be transmitted to the detector 24. The beams are alternately interleaved in their sweep across the surface 22 of detector 24.

The polygon scanner 16 is rotated by rotating means 44. Positional information from the two rotating means 42, 44 can be input to the signal processing electronics through lines 46 as necessary. An electronic switch 48 is interposed between the signal processing electronics 28 and the two displays 30 and 49. Using techniques well known to those skilled in the art, the signals produced from the light beams 12 and 34 are separated and switched to respective ones of the imagers 30, 49 such that two separate images are created corresponding to the view in the line of sight of light 12 and light 34.

Turning now to FIG. 2, a second embodiment of the present invention is shown. In this embodiment, the second telescopic optic assembly 32 of FIG. 1 is replaced by a display generally indicated as 50. A collimated beam of light 52 is created by light source 54 and lens 56. A second lens 58 is used to project the light 52 onto a facet 14 displaced at one-half the facet angle as in the previous embodiment. A generally transparent display panel 60, such as a liquid crystal panel or the like, capable of being driven by a driver 62 in response to a signal in on line 64, is disposed in the collimated light beam 52. As the display driver 62 is fed input signals on line 64, the display 60 impresses the image on the collimated light beam 52 whereupon it is reflected into the detector 24 as in the previous embodiment. The switch 48 from the previous embodiment is replaced by a combining circuit 66 (again according

to techniques well known to those skilled in the art), the output of which is used to drive a single display 30. The result is a single image combining the image being observed through the telescopic assembly 10 with the image on the display 60 superimposed thereon. Such an arrangment is particularly useful for providing tank drivers and others with both a forward view and range information impressed thereupon, thus eliminating the necessity for the driver to remove his field of view from the forward scene being observed in order to obtain range and target information. It should be noted that, as previously mentioned, in this embodiment, the beam splitter wheel 40 has been replaced by piezo-electric controlled crystal 68, which is controlled by driver 70 to perform the same function as that performed by the beam chopper 40 of FIG. 1.

The display 50 may comprise a thermal reference source (rather than the light source 54, and the display panel 60) for use in periodically calibrating the detector 24 and the processing electronics 28.

Turning now to FIG. 3, the present invention is shown in its simplest and most compact embodiment as employed in a night vision goggle/helmet assembly providing stereoscopic dual field of vision. Light 72, corresponding to the view to be associated with the right eye, passes through lens 74, aperture 76, and lenses 78, by which it is transmitted to the facets 14 of the polygon scanner 16 at a first location. Light 80, corresponding to the view for the left eye, passes through lens 82, aperture 84, and lenses 86. It is then focused onto the facets 14 of the polygon scanner 16 at a second location, again one-half a facet angle relative to the orientation of the first position. Light 72, as reflected from the facets 14, is directed

by the optic system, generally indicated as 88, through lens 20 onto the sensitive surface 22 of detector 24 in a scanning sweep as hereinbefore decribed. Light 80, as reflected from the polygon scanner 16, is directed by a second optic system 90, which is a virtual mirrored image of the optic system 88, through lens 20 onto the surface 22 of detector 24. As previously described, the onehalf facet angle offset creates interleaved sweeping actions by the light 72 and 80. The outputs from the signal processing electronics 28 is passed through a right/left switch 48' (which is substantially identical to the switch 48 used in the embodiment of FIG. 1) and then used to drive respective ones of a pair of displays 92, 94 attached to helmet 96 worn by observer 98, such that each one of the imagers 92, 94 is disposed to be viewed by the respective ones of the observer's left and right eyes.

With the absence of the beam splitter wheel 40 or piezo-electric controlled crystal 68, there can be some overlap of the two light beams 72, 80 at the detector 24. However, field stops 99 defining the apertures 76 and 84 are positioned as illustratted in FIG. 3 so that, when one of the optical systems 88, 90 views a scene through a respective one of the apertures 76, 84, the other views only the field stop 99 and, therefore, senses only a low uniform background radiation level, corresponding to zero signal. For this purpose, the field stop 99 comprises low infrared emissivity material maintained at a uniform temperature.

LBS:blm

[76-27]

CLAIMS

What is Claimed is:

1. A dual path optical sensor system comprising:

a) detector means for receiving a light signal at an input surface thereof and for outputting an electrical signal reflecting said light signal at an output thereof;

b) a rotatable polygon scanner having a plurality of substantially equal reflective facet surfaces thereon;

c) means for rotating said scanner at a constant speed;

d) first optical means for receiving a first light beam and for directing said first light beam on said facets at a first positon;

e) second optical means for receiving said first light beam as it is reflected from said facets at said first position and for directing said first light beam onto said input surface of said detector means;

f) third optical means for receiving a second light beam and for directing said second light beam onto said facets at a second positon which is related to said first position such that when said first light beam is impinging directly on one of said facets, said second light beam is impinging on the mid-point between two adjacent other ones of said facets;

g) fourth optical means for receiving said second light beam as it is reflected from said facets at said second position and for directing said second light beam onto said input surface of said detector means; and

h) outputting means connected to said output of said detector means for receiving and processing signals resulting from said first and second light beams

2. The sensor system of Claim 1 additionally comprising:

beam splitter means disposed in the paths of said first and second light beams for passing ones of said light beams that are being reflected from one of said facets and for blocking ones of said light beams that are impinging on the junction between two adjacent ones of said facets.

3. The sensor system of Claim 1 wherein:

a) said first and second optical means include independent controllable inlet means for selecting the direction of field of view for receiving an incoming light beam, whereby two different fields of view can be selected simultaneously; and

b) said outputting means includes a pair of displays for viewing and means for directing said signal resulting from said first light beam to drive one of said displays and said signal resulting from said second light beam to drive the other of said displays.

4. The sensor system of Claim 1 additionally comprising:

display means disposed in the path of said second light beam for receiving an electrical signal at an input thereof and for impressing an optical representation of said light signal onto said second light beam, whereby the information in said electrical signal is included in the display image created by said outputting and imaging means.

5. In a scanning infra-red sensor employing a detector and a signal processor in which a first optical assembly is employed to direct light entering from a first line of sight against the reflective surface of a rotating polygon scanner so that it is sequentially reflected from the facets of the scanner across the detector in a sweeping scan pattern to produce a signal therefrom, the improvement comprising:

a second optical assembly disposed to direct light entering from a second line of sight against the reflective surface of the scanner with repsect to the orientation of the point of reflection of the light from the first line of sight displaced one-half the facet angle of the scanner, whereby the detector and signal processor are time-shared as a result of the light from said first and second lines of sight being interleavedly swept across the detector.

6. The improvement of Claim 5 additionally comprising:

means for producing a combined image on a single display from the signal output from the detector as a result of the light from said first and second lines of sight.

7. The improvement of Claim 5 additionally comprising:

a) a pair of displays; and

b) means for processing the signals output from the detector as a result of the light from said first and second lines of sight and for displaying them on respective ones of the displays.

8. The improvement of Claim 7 wherein:

the first optical assembly and said second optical assembly both include a directional telescope assembly for changing the line of sight of light entering therein.

9. The improvement of Claim 5 additionally comprising:

beam splitter means disposed in the paths of the light from said first and second lines of sight for passing ones of said beams that are being reflected from one of said facets and for blocking ones of said light beams that are impinging on the junction between two adjacent ones of said facets.

10. A dual path optical sensor system comprising:

a) an electro-optical sensor having an input surface for receiving impinging light and an output at which an electrical signal is produced as a function of light impinging on said input surface;

b) a first optical system disposed to receive light from a first line of sight, to direct it along a first path and to focus it on said input surface;

c) a second optical system disposed to receive light from a second line of sight, to direct it along a second path and to focus it on said input surface; and

d) a rotating polygon scanner disposed to intercept and reflect the light in said first and second paths at a one-half facet angle offset between said first and second paths, whereby the light from said first and second paths is swept across said input surface in interleaved, alternating sweeps.

11. The optical sensor system of Claim 10 additionally comprising:

means for producing a combined image from the signal output from said sensor as a result of the light from said first and second lines of sight on a single imager.

12. The optical sensor system of Claim 10 additionally comprising:

a) a pair of displays; and

b) means for processing the signals output from said sensor as a result of the light from said first and second lines of sight and for displaying them on respective ones of the displays.

13. The optical sensor system of Claim 10 wherein:

said first optical system and said second optical system both include a directional telescope assembly for changing the line of sight of light entering therein.

14. The optical system of Claim 10 additionally comprising:

beam chopper means disposed in said first and second paths for passing light in said beams that is being reflected from one of said facets and for blocking light in said beams that is impinging on the junction between two adjacent ones of said facets.

15. A dual path scanning electro-optical sensor system comprising:

a) an electro-optical sensor having an input surface for receiving impinging light and an output at which an electrical signal is produced as a function of light impinging on said input surface;

b) a first optical system disposed to receive light from a first line of sight, to direct it along a first path and to focus it on said input surface;

c) a second optical system disposed to receive light from a first line of sight, to direct it along a first path and to focus it on said input surface; and

d) a rotating polygon scanner disposed to intercept and reflect the light in said first and second paths at a one-half facet angle offset between said first and second paths whereby the light from said first and second paths is swept across said input surface in interleaved, alternating sweeps.

16. The dual path sensor system of Claim 15 additionally comprising:

means for producing a combined image from the signal output from said sensor as a result of the light from said first and second lines of sight on a single imager.

17. The dual path sensor system of Claim 15 additionally comprising:

a) a pair of displays; and

b) means for processing the signals output from said sensor as a result of the light from said first and second lines of sight and for displaying them on respective ones of the displays.

18. The dual path sensor system of Claim 15 wherein:

said first optical system and said second optical system both include a directional telescope assembly for changing the line of sight of light entering therein.

19. The dual path system of Claim 15 additionally comprising:

beam chopper means disposed in said first and second paths for passing light in said beams that is being reflected from one of said facets and for blocking light in said beams that is impinging on the junction between two adjacent ones of said facets.

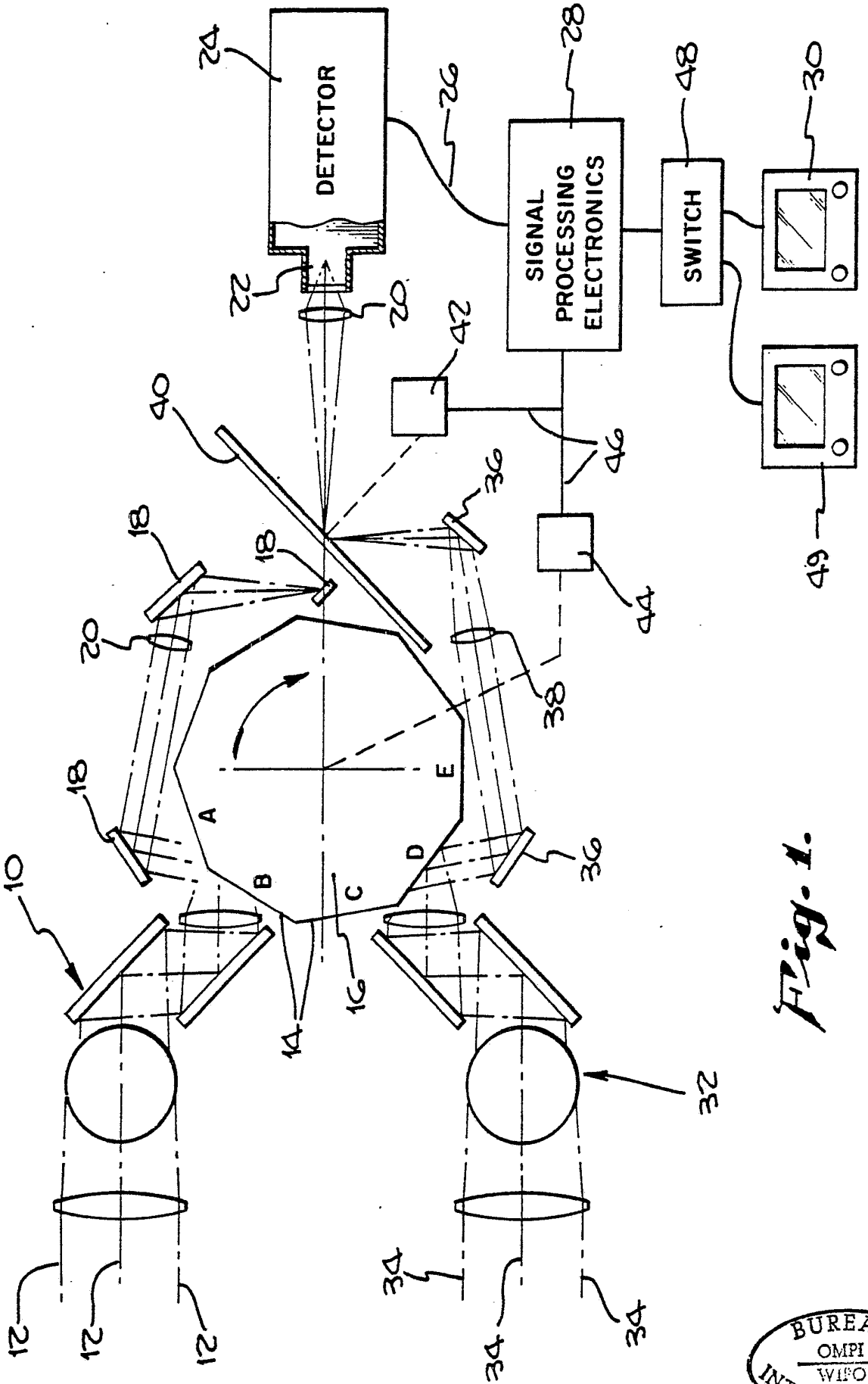

Fig. 1.

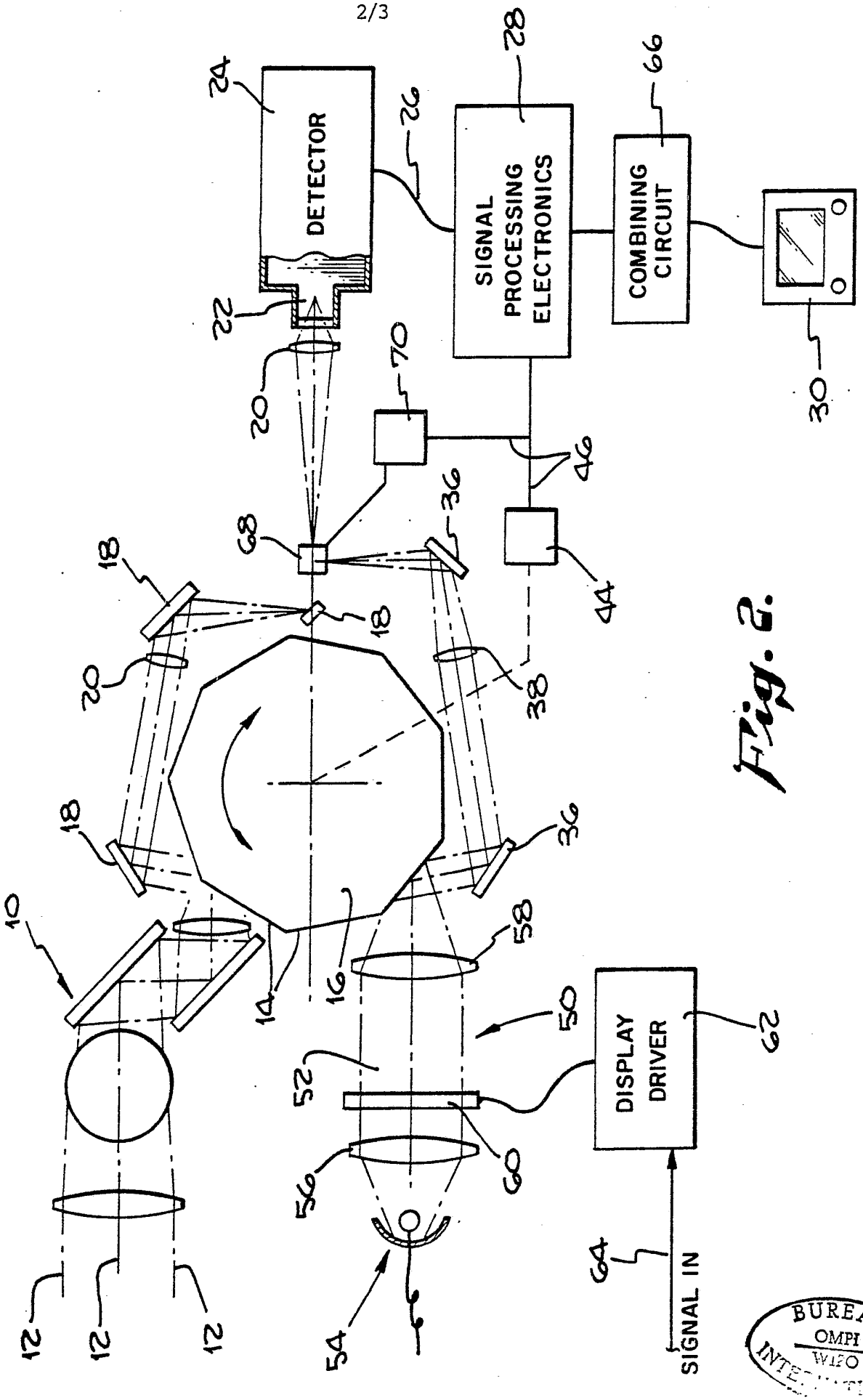

Fig. 2.

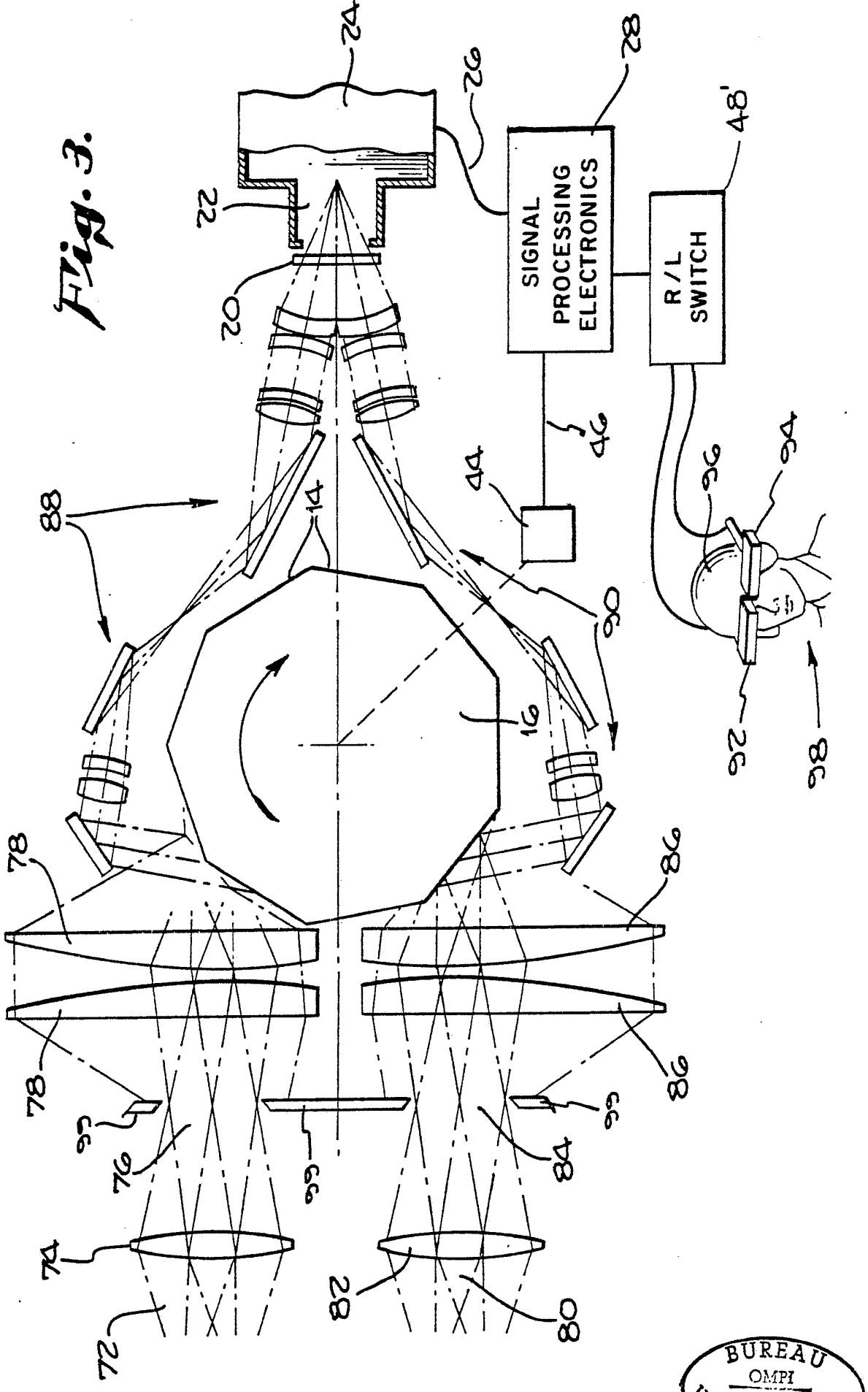

Fig. 3.

INTERNATIONAL SEARCH REPORT

International Application No PCT/US 84/00428

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [3]

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC[3]: G 02 B 23/12; H 04 N 3/08

II. FIELDS SEARCHED

Minimum Documentation Searched [4]

Classification System	Classification Symbols
IPC[3]	G 02 B; H 04 N

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [5]

III. DOCUMENTS CONSIDERED TO BE RELEVANT [14]

Category *	Citation of Document, [16] with indication, where appropriate, of the relevant passages [17]	Relevant to Claim No. [18]
A	EP, A, 0017340 (SPERRY CORPORATION) 15 October 1980 see the whole document	1,4-6,10,11, 14-16,19
A	US, A, 4156142 (CHARLES M. HANSON) 22 May 1979 see the whole document	1,2,5-7,9, 10,12,15,17
A	DE, A, 1522286 (TELEFUNKEN) 7 August 1969 see the whole document	1-3,6,8-11, 14-16,18,19
A	FR, A, 2273291 (SOPELEM) 26 December 1975 see the whole document	1,2,4-6,8-11 15,16
A	DE, A, 2017848 (FUJI SHASHIN) 28 October 1971 see pages 9-12; figures 6-8	1,2,5,6,10, 11

* Special categories of cited documents: [15]

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IV. CERTIFICATION

Date of the Actual Completion of the International Search [3]	Date of Mailing of this International Search Report [3]
3rd July 1984	20 JUIL. 1984
International Searching Authority [1]	**Signature of Authorized Officer [20]**
EUROPEAN PATENT OFFICE	G.L.M. Kruydenberg

ANNEX TO THE INTERNATIONAL SEARCH REPORT ON

INTERNATIONAL APPLICATION NO. PCT/US 84/00428 (SA 6897)

This Annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the European Patent Office EDP file on 13/07/84

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Patent document cited in search report	Publication date	Patent family member(s)		Publication date
EP-A- 0017340	15/10/80	GB-A,B	2047911	03/12/80
		US-A-	4237492	02/12/80
US-A- 4156142	22/05/79	None		
DE-A- 1522286	07/08/69	None		
FR-A- 2273291	26/12/75	None		
DE-A- 2017848	28/10/71	None		