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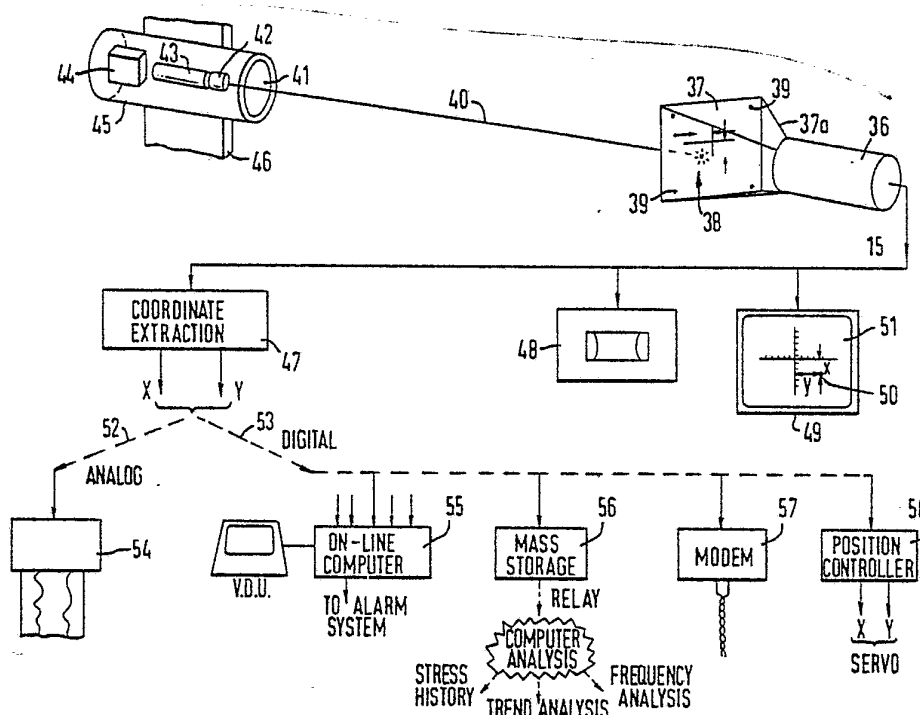
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(54) Title: METHOD AND APPARATUS FOR MONITORING MOVEMENT



(57) Abstract

Movement of a structure (46) is monitored by a laser (43) secured thereto and projecting a narrow light beam (40) onto a plane translucent screen (37) to produce a light spot (38). The x,y position of the spot (38) on the screen (37) is a function of movement of the structure (46). The screen (37) is imaged by a television camera (36), and x,y coordinates of the spot (38) are extracted from the resulting video signal (15).

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"Method and apparatus for monitoring movement"DESCRIPTION

5 This invention relates to a method and apparatus for monitoring movement in structures, particularly small twisting, deflection and displacement movements of large structures such as offshore oil rigs, dams and high rise buildings.

10 In the civil and mechanical engineering fields there are many instances where it is necessary to know the movement of a point or points on a large structure both with respect to distance (relative to some frame of reference) and to time. For example, such data may be important in determining the safety of a structure and in indicating any trend towards instability, or for
15 monitoring the movement in the components of a large structure during construction so that appropriate compensating action can be applied. It is well known to use lasers for measuring the alignment of large structures. However, known systems rely on using a detector target
20 which is essentially a point and which is precisely mechanically adjusted into alignment with the laser beam. These systems suffer from the disadvantage that it is necessary to use one or more operators to make such spot measurements. Hence existing techniques do not
25 lend themselves to continuous measurement and monitoring of relatively small movements in large structures.

It is also known from British patent no. 1 513 380 to make use of a laser beam, in machine guidance, in conjunction with a detector arrangement for measuring
30 x and y divergence of the beam from a datum point. However, the detector arrangement of this prior proposal has the disadvantages that (1) a rather complex optical system is required, which is subject to dirt and mechanical



shock in use, and (2) the x and y detectors are linear arrays of discrete elements, the system thus having a limited resolution and dynamic range.

An object of the invention is to overcome or
5 greatly reduce the above disadvantages.

The invention accordingly provides apparatus for continuously monitoring movement of a structure with respect to a given point, comprising:

light emitting means for emitting a narrow beam of
10 collimated light and being adapted to be rigidly mounted on said structure or at said point,

a target assembly adapted to be rigidly mounted at said point or on said structure respectively,

the target assembly comprising a target surface
15 having continuously extending length and breadth for intercepting the light beam to provide an incident light spot.

From another aspect, the invention provides a method of continuous monitoring of movement of a structure with
20 respect to a given point, comprising:

emitting a narrow light beam along a chosen path,
intercepting the light beam with a target surface,
having continuously extending length and breadth,

the light beam being emitted from the structure
25 and the target surface positioned at said point, or vice versa, and

monitoring movement of the incident light spot on the target surface.

Movement of the light spot on the target surface is
30 a function of movement of the structure, and can be monitored for example to provide an alarm when movement beyond a predetermined acceptable limit occurs. Suitably, the target surface is imaged by a raster scan device, and x,y coordinates of the light spot are extracted from the
35 resulting video signal.



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The term "continuous" is used herein in respect of both time and space; that is the apparatus is capable of detecting movement which is essentially infinitesimal with respect to the dimensions of the structure being
5 monitored. Furthermore, the maximum range of structural movement which can be measured using this technique is not limited in any way other than by the physical arrangement of the light source, detector and any optics if used and the size of the detector target.



Embodiments of the invention will now be described, by way of example, with reference to the accompanying drawings, in which:-

Figure 1 is a schematic perspective view and
5 electrical block diagram of one embodiment of the invention;

Figure 2 is a block diagram of a coordinate extraction unit used in the embodiment of Figure 1;

Figure 3 is a block diagram of an alternative form of coordinate extraction unit;

10 Figure 4 illustrates one application of the apparatus; and

Figure 5 illustrates a modified form of the apparatus in another application.

Referring to Figure 1 the structure 46 whose movement
15 is being observed has rigidly attached to it a housing 45 which contains a laser power supply unit 44, a laser (continuous mode type) 43, and suitable collimating/focussing optics 42. The end of the housing through which the laser beam passes is to all intents and purposes a transparent
20 window 41, mounted orthogonally to the laser beam. This avoids the creation of a multiple beam pattern due to refractive effects in the window material.

The collimated light beam 40 is projected onto a target 37 of a detector assembly which can be described as
25 being made up of the following units: target 37, television camera 36, and x,y coordinate extraction unit 47. The target 37 is, in this instance, made from a flat translucent material so that a light spot 38 is created on the rear (opposite side from incident beam) of the target 37 as a
30 result of the light beam 40 falling on it. The diameter of the light spot 38 is approximately the same as that of the collimated light beam 40. In practice, this diameter will normally be in the range from several millimeters to to several tens of millimeters.



The television camera 36 which acts as an imaging device is rigidly mounted (for example by legs 37a) to the target 37 so that there is a fixed relationship between the pattern of light intensity on the target and that projected onto the imaging element of the television camera. The camera 36 is of course focussed on the target 37. This being so any change in the information content of the video signal 15 will truly reflect the change in light pattern on the target.

The means by which a television camera operates is well known and will not be described here, other than to say that the video signal produced is understood to contain both information regarding the profile of light intensity across the surface of the target and the appropriate frame and line synchronisation data to internationally recognised standards such as C.C.I.R.

The camera 36 produced a video signal 15 which can be viewed on a monitor 49 for operator assessment and recorded by a standard video recorder 48. The video signal 15 is also passed to an extraction unit 47 (to be described in detail below) which processes the video information to extract the x,y coordinates of the light spot, in either analog or digital form. Figure 1 indicates various ways in which this information may be used, e.g. the coordinates may be recorded on a 2-channel chart recorder 54, supplied to an on-line computer 55, stored in any suitable mass storage medium 56 for off-line computer analysis, transmitted to a remote location via modem 57, or used to operate a position controller 58 to give servo outputs controlling a machine element.

Most television cameras still employ a vacuum tube as the imaging element; however, cameras are now being introduced which employ solid state integrated circuit arrays as imaging elements. The latter are more precise



geometrically and hence are more suited to this invention due to their higher accuracy and elimination of drift.

Where it is necessary to compensate for errors introduced by a vacuum tube device or any other distortions in the signal processing chain, from the target 37 onwards, this can be done by mounting a number of point light sources 39 at precisely known spots on the target 37. These light sources (typically light emitting diodes) when switched on, either singly or plurally, by either automatic or manual means, provide signals which refer to specific x and y coordinates within the field of the imaging device. Use can be made of this information to make either manual corrections to the observed beam position when the equipment is in normal use or alternatively to provide an automatic calibrator (built into the extraction unit 47 or subsequent data processing equipment such as that depicted at 55), with information to make the appropriate compensation for errors in the signal processing chain. As an alternative to point light sources, the target screen may be of translucent plastic, inscribed with lines for calibration, and provided with edge lighting which can be switched on to cause the inscribed lines to illuminate. Mechanical calibration marks are also provided on the target 37 so that it can be physically referenced to some frame of reference suitable to the application in hand.

The video signal 15 containing the x and y coordinates of the spot is normally scanned once every 1/50th of a second (1/60th sec. USA) and therefore beam movements of less than half this rate can be detected. Non-standard video scanning techniques in which higher frequencies of beam movement can be detected may also be used.

Referring to Figure 2 which illustrates one particular embodiment of the x,y coordinate extraction unit 47, the video signal 15 is simultaneously fed to a threshold comparator 16 and synchronisation separator 17. The synch. separator 17 extracts from the composite video signal the line and frame timing information from the video raster. This timing

information in conjunction with a crystal oscillator clock 60 provides the driving signals for an x counter 19 and a y counter 20. The clock 60 drives the x counter 19 at a rate which resolves each horizontal line of the video raster into 256 equal time intervals.

Similarly the y counter 20 is driven from a pulse train derived from the line frequency. These counters 19,20 are reset at the end of each respective line and frame.

The threshold comparator 16 continuously monitors the instantaneous brightness level of the video signal 15 and generates an output signal should the input video level exceed a preset threshold level. This threshold level 61 is either set manually or automatically as part of an autoranging facility which adjusts the level according to the average ambient light picked up by the television camera 36. (Also note that the T.V. camera has its own built-in automatic intensity level control which will compensate for some degree of brightness variation).

The embodiment referred to in Figure 2 is specifically implemented to handle only one light beam at one time on the detector target.

When the first point on the first line encountered during a raster scan exceeds the preset brightness amplitude threshold level, the comparator 16 generates an output signal which latches the values of the x counter 19 and y counter 20 at that time into the respective x latch 21 and y latch 22. The value held in the x latch 21 is the digital representation of the x coordinate value of the first point of the light spot and the value held in the y latch 22 is the digital representation of the y coordinate value of the first point of the light spot. Since the measure of structural movement is relative to a predetermined frame of reference, the x,y coordinates of the first point of the light spot is normally just as suitable as the x,y coordinates of the centre of the spot. The values of the



x and y coordinates are updated in the latches every 1/50th sec. (1/60th sec.). Their digital values 25 and 26 are directly available for output to a number of devices for processing as will be described shortly.

5 An alternative means of presenting the x and y coordinate information which is more suited to certain forms of subsequent treatment is the analog form of these signals. The x digital output 25 is applied to an x digital to analog converter 23 and the y digital output is applied
10 to the y digital to analog converter 24 hence producing the respective x and y analog voltages 27 and 28 which are proportional to the x and y coordinates of the first point of the light spot. In this embodiment should the light spot disappear from the target, the last x and y coordinate
15 values that the spot had on the target will be held at both the digital and analog outputs.

 The x,y coordinate extraction unit of Figure 3 is much more versatile than the embodiment described in Figure 2 and has the capability of distinguishing and simultaneously
20 measuring the coordinates of several light spots impinging on the same target. Furthermore, it has greater capability to differentiate between the true beams and extraneous optical ambient noise. Where it is necessary to determine the coordinates of the centre of the light spot using 'mean' or centre of gravity techniques, then this can also be
25 handled with this embodiment. This embodiment is centred on the use of a microprocessor 30 which, in this instance, is defined in the broadest sense of the word. That is it encompasses the processor unit, programme and data memory,
30 internal clock and suitable input/output interfaces: in the following, the word microprocessor will be used in this sense. Details of the internal structure of the microprocessor and its programming are not given here because there are many ways of implementing these and the

principles are well known.

The purpose of the microprocessor 30 is to store in memory a complete picture of the light intensity pattern of the entire target. Depending on the application more than one frame may be stored. The microprocessor also carries out the appropriate data manipulation on the information thus stored in memory to carry out one or more of the following functions:-

1. To generate, either in series or parallel, the x and y coordinate outputs for one or more light beams impinging on the target. In the embodiment shown in Figure 3 only one x coordinate latch 33 and one y coordinate latch 34 are shown. In the instance where several beam coordinates are being presented serially at these latches a suitable beam identification code would appear at the status outputs 35 simultaneously with the respective coordinate value.
2. To monitor the status of one or more light beams and bring up appropriate 'beam lost' indications and alarms as determined by operator input from the operator's controls 31.
3. To store and carry out at the operator's request, a number of algorithms yielding different treatments to beam spot coordinate measurement.
4. To act as a versatile interface between the measurement system and subsequent data treatment equipment via input/output bus 35A.

Returning to the video input 15, this is simultaneously fed to a synch., separator 62 (which feeds the relevant line and frame timing to the microprocessor) and to a high speed analog to digital converter 29 which takes a number of samples (typically 256) of each line of the raster and assigns a digital number (typically 8 bits) to the brightness level of that sample. Therefore, each frame is digitised and stored in a matrix in memory with the digital value of



each sample being proportional of the light intensity at that point.

One or more frames may be stored with these being replaced on a first in, first out basis as new frames are
5 scanned.

Where the coordinates of several light beams on one target are being determined this can be done by setting each beam at a different intensity and using the microprocessor to differentiate on this basis. Alternatively, each beam
10 can be modulated in a time or frequency division multiplexed manner with an input to the microprocessor to provide synchronisation 59 so that each beam can be identified. The microprocessor would then be programmed to look for either a beam intensity varying at a given frequency or look for
15 its time of appearance in order to identify it.

One typical application of the invention is in monitoring movement between the legs of a semisubmersible oilfield rig, as illustrated in Figure 4. From a safety point of view it is desired to monitor the relative movements
20 of adjacent rig legs 12 and to raise an alarm condition should any of these movements become greater than a predetermined limit. A laser 10 is rigidly mounted to each leg 12 and the light beam 14 transmitted to a companion detector 11 mounted on each adjacent leg. Signals from
25 all of the detectors 11 are cabled back to a central monitoring and alarm unit situated in the Control Room 13. The relative motion of each rig leg is continuously compared with preset acceptability limits which have been determined by the rig designers. Any movement detected
30 beyond these limits indicates a possible pending structural failure and a suitable alarm will be automatically raised. Subsequent evacuation and remedial action may then take place instead of possibly a catastrophic alternative.

Another application is illustrated in Figure 5

in which the plan view of a dam is illustrated, the dam wall 1 holding back upstream water 2 which is applying a horizontal force to the former. It has been deemed necessary to continuously monitor the movement at the top centre of the dam wall. This is done by mounting a mirror assembly 3 at that point in such a manner that the incident light beam 6 from the laser 4 is returned along a parallel path to the detector 5. The mirror assembly 3 is comprised of two face silvered mirrors 8 rigidly mounted with respect to each other and to the dam wall. They are also mounted vertically with respect to the laser beam and the top of the dam wall. By angling the two mirrors at 45° to the beam path (i.e. 90° to each other) the reflected beam 7 will exhibit a horizontal movement y which equals $2x$ where x is the horizontal movement of the dam wall. The reflected beam movement is picked up at the detector 5 and subsequently recorded, analysed, etc. in the recorder/alarm unit 9.

Thus, in the example of Figure 5 the light source and detector are both mounted off the structure of interest, and a reflector is used on the structure. It will be appreciated that the operation is essentially the same as with a direct light path.

Modifications may of course be made to the above embodiments within the scope of the invention as defined by the claims.

The most suitable light source is a laser, since this gives a narrow beam of high intensity. However other light sources could be used. for example a high intensity halogen lamp with collimating and focussing lenses.

The target may be of any convenient shape and need not be plane, e.g. it could be a curved surface. If necessary, it may be mounted in a plane not orthogonal to the light beam; this will lead to calibration differences



in the x and y directions, which can be allowed for in the extraction circuitry.

Instead of a translucent (diffuse transmissive) screen, the target could comprise a diffuse reflective
5 screen with the television camera or other imaging device viewing the front of the screen.

The imaging device may be a complete conventional television camera, that is including optics, imaging
device (tube or solid state), video processing circuitry
10 and synch. signal generator. More equally, the imaging device may be more dedicated and simply embody a vacuum tube, or solid state 2-dimensional imaging element having a limited dynamic range combined with suitable optics to focus the light spot on the target on to the element
15 and associated electronic circuitry to generate a suitable signal from which the coordinates of the light spot may be determined. This latter arrangement although suitable for dedicated applications (e.g. low cost, high volume) is limited when compared to the television camera because
20 (a) the television camera has a greater dynamic range than a simple detector and (b) the standard video output of a television camera can be handled by universally available video systems and equipment, e.g. V.T.R.s, monitors, etc.. The imaging device will normally be mounted centrally
25 and with its axis orthogonal to the translucent target so that the field of view of the imaging device is that of the target. The television camera could be equipped with a motorised zoom lens to allow the whole target to be imaged for general use or the central part of the target
30 to be imaged as a high-resolution mode.

For simple observational applications it may be possible to use the video output signal directly in conjunction with conventional video equipment. As an example the video signal may be fed directly into a

television monitor and the light spot indicating the beam position observed on the screen. This may be assisted by placing a transparent overlay on the monitor screen, the overlay being ruled with calibrations appropriate to the application. The video signal may also be directly recorded either in real-time or in time lapse fashion. Using the latter technique and subsequently replaying the recording on to a monitor in real time, the performance 'envelope' for the structure's movement can be observed. This information is of direct usefulness in setting up alarm limits for abnormal deviations and may be preprogrammed into an automatic system.

Interruption of the light beam(s) has also been catered for. Under certain circumstances such as the obscuring of the light beam by say a wave or vehicle, the x, y coordinate extraction unit applies a hold to the last computed x and y coordinates. Whenever the light spot re-appears on the target the coordinates will resume being updated. In the event of a prolonged disappearance of the light beam which may signify equipment failure such as a laser, an alarm output may be raised after a preset time. In any event, a signal is always made available during beam loss or that this fact can be recorded if necessary.

Other applications for which this invention can be used are the down hole survey of onshore and offshore wells, the guidance of drilling equipment for onshore and offshore petrochemical exploration, monitoring of structures such as bridges and tunnels, and monitoring of earthquake, landslip and subsidence zones. As mentioned earlier, the invention can also be used in the feed-back loop for the control of large machinery.

It also goes without saying that the invention can be used to monitor structural movement both in air and in



water and other fluids, where the transmission of the laser beam is not excessively impeded by attenuation through the medium.

Finally, it should be pointed out that the scope of
5 the invention also includes the use of laser beams whose radiation is not in the visible part of the spectrum. Under these circumstances the detector would also have a spectral response matched to that of the laser beam. By using a laser beam whose frequency lies outside the visible
10 spectrum it is possible, under certain circumstances, to overcome ambient light noise from extraneous sources whose frequency does not match that of the beam.

CLAIMS

1. A method of continuous monitoring of movement of a structure with respect to a given point, comprising:
emitting a narrow light beam along a chosen path,
intercepting the light beam with a target surface
5 having continuously extending length and breadth,
the light beam being emitted from the structure
and the target surface positioned at said point, or vice versa, and
monitoring movement of the incident light spot on
10 the target surface.
2. The method of claim 1, in which the light beam is emitted by rigidly securing a light source to the structure.
3. The method of claim 1, in which the light beam is emitted by rigidly securing an optical element such as a reflector to the structure and directing a light beam onto the optical element from a distance.
4. The method of any preceding claim, including imaging the target surface on a video image converter to produce a cyclic video signal representing the target surface, and extracting from the video signal x and y
5 coordinates of the light spot.
5. Apparatus for continuously monitoring movement of a structure with respect to a given point, comprising:
light emitting means for emitting a narrow beam of collimated light and being adapted to be rigidly mounted
5 on said structure or at said point,
a target assembly adapted to be rigidly mounted at said point or on said structure respectively,
the target assembly comprising a target surface having continuously extending length and breadth for
10 intercepting the light beam to produce an incident light spot.
6. The apparatus of claim 5, in which the target assembly includes a video imaging device focussed on the

on the target surface to provide a video signal representing the target surface.

7. The apparatus of claim 6, further including coordinate extraction circuit means arranged to receive the video signal and to extract therefrom x and y coordinates representing the position of the light spot on the target surface.

8. The apparatus of claim 7, in which the video imaging device is a raster scanned television camera; and the coordinate extraction circuit means comprises a threshold circuit responsive to the video signal to produce a threshold signal representing the edge of the light spot, an x counter and a y counter, the x counter being arranged to count clock pulses during each line until the threshold signal occurs, and the y counter being arranged to count lines until the threshold signal occurs.

9. The apparatus of claim 6, further including a digital computing apparatus connected to receive the video signal via an analog-to-digital converter, and operative to extract from the video signal x and y coordinates representing the position of the light spot on the target surface.

10. The apparatus of any of claims 5 to 9, in which the light emitting means comprises an optical element such as a reflector fixed to the structure and a light source at a spaced location projecting a narrow beam of collimated light onto the optical element and thence to the target assembly.

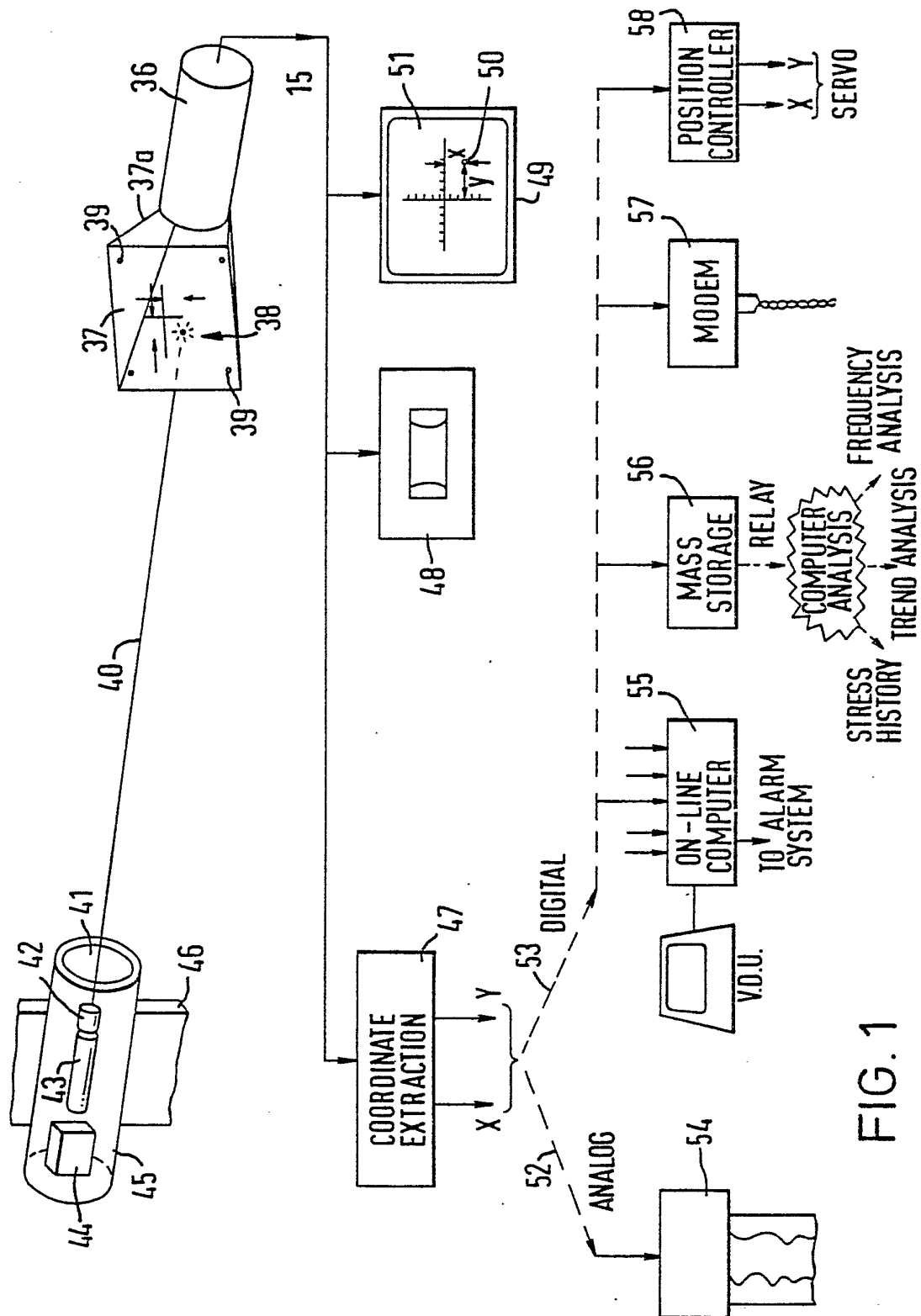
11. The apparatus of any of claims 5 to 10, in which the light emitting means comprises a laser.

12. The apparatus of any of claims 5 to 11, in which the target surface is provided with a plurality of light sources at predetermined locations for use in calibration.

13. The apparatus of any of claims 5 to 12, in which the target surface is a translucent screen and the light spot is imaged from the rear.



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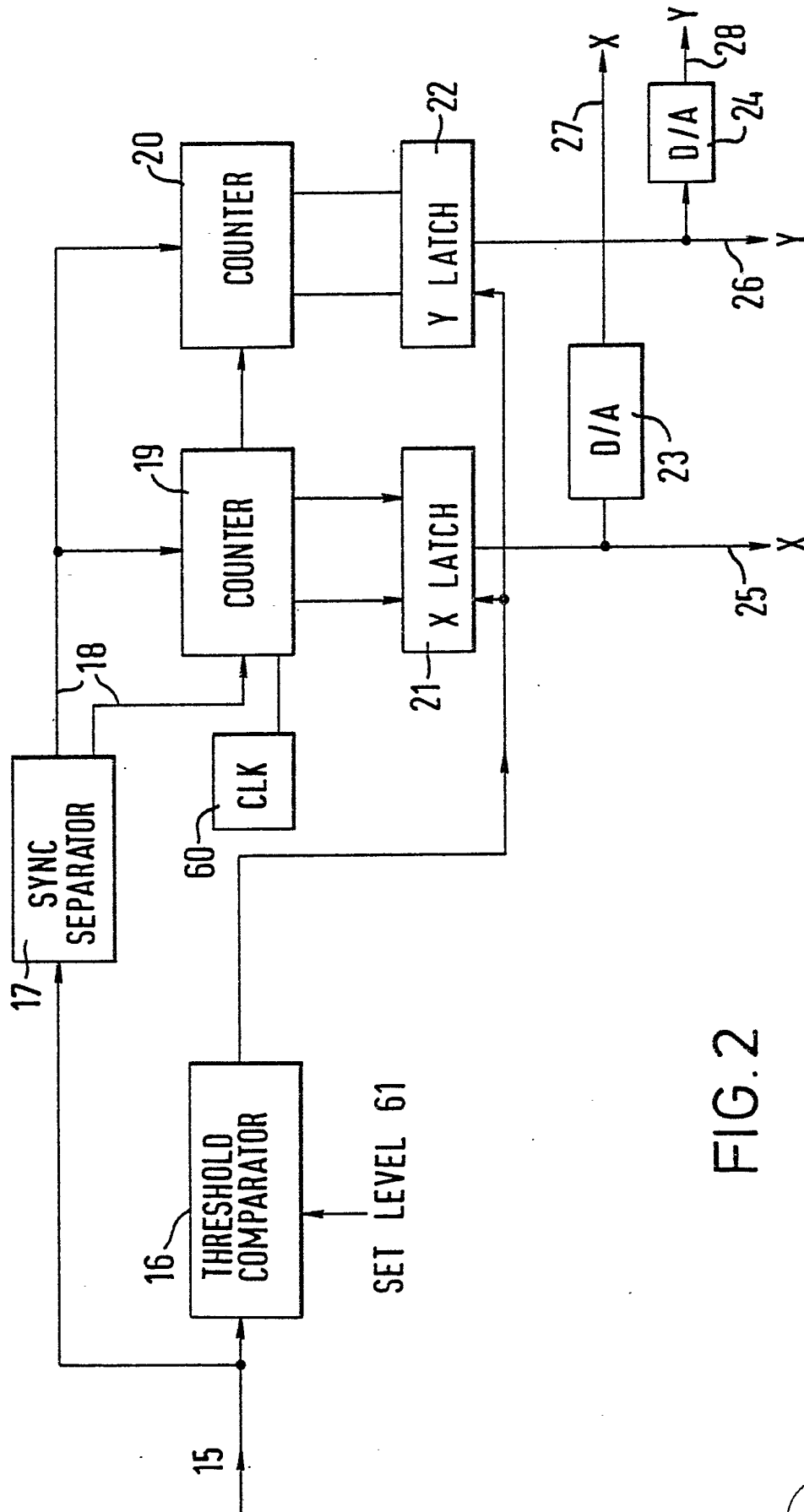


FIG. 2

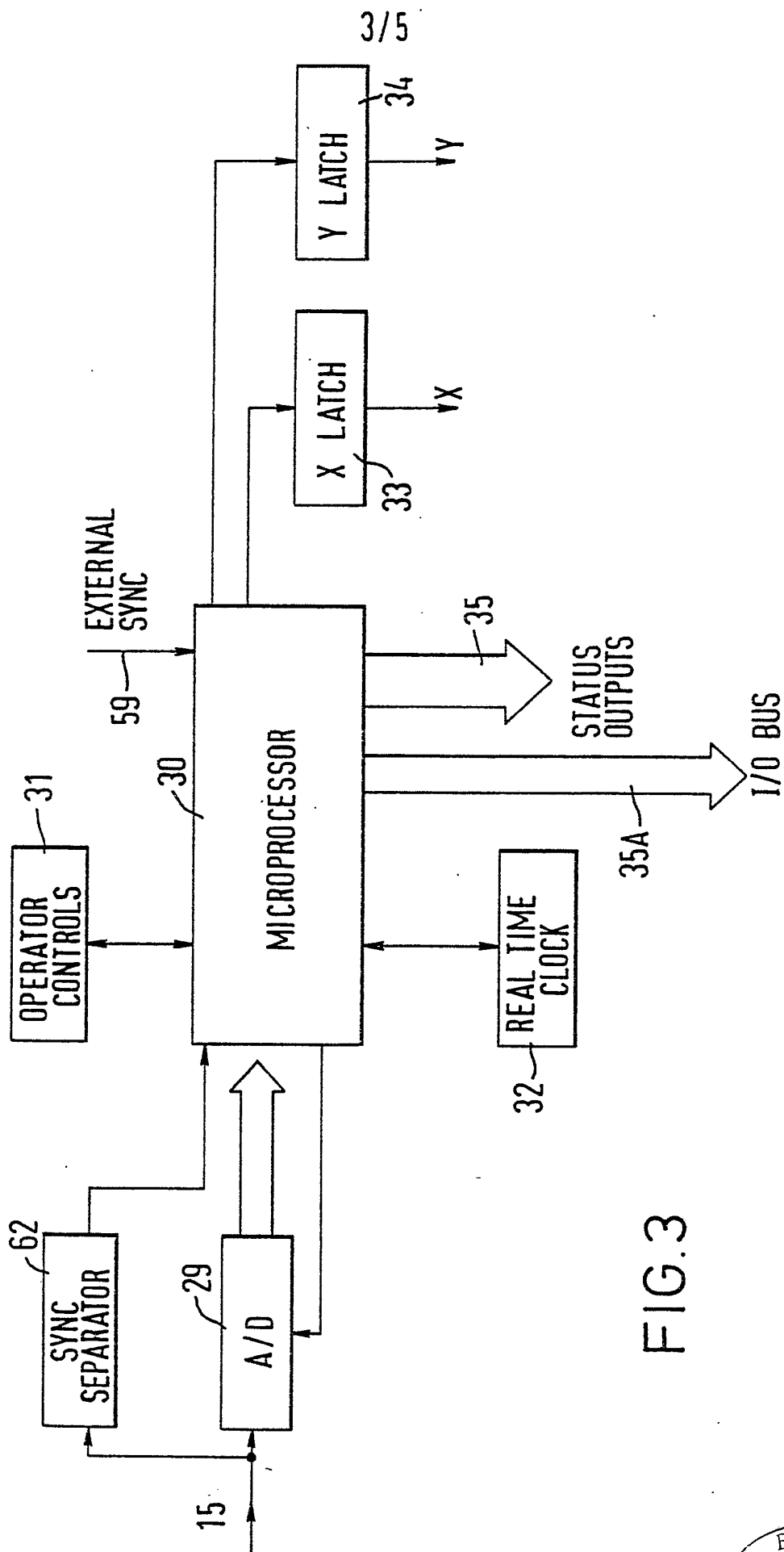


FIG.3

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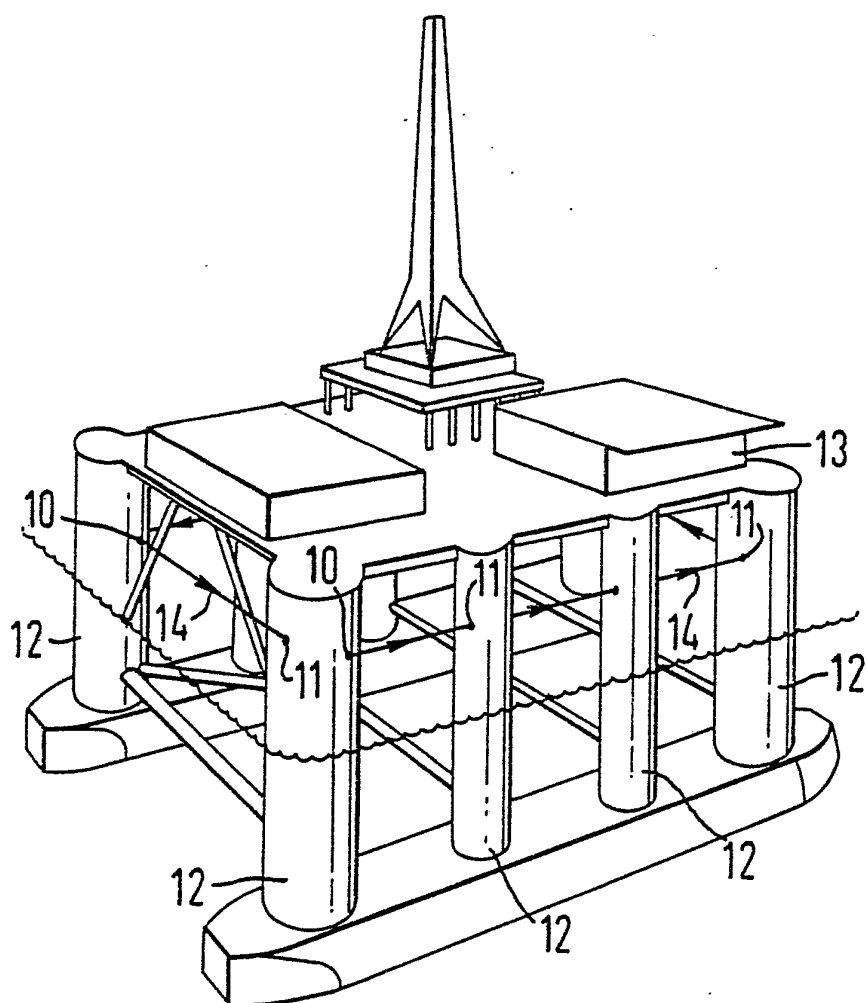
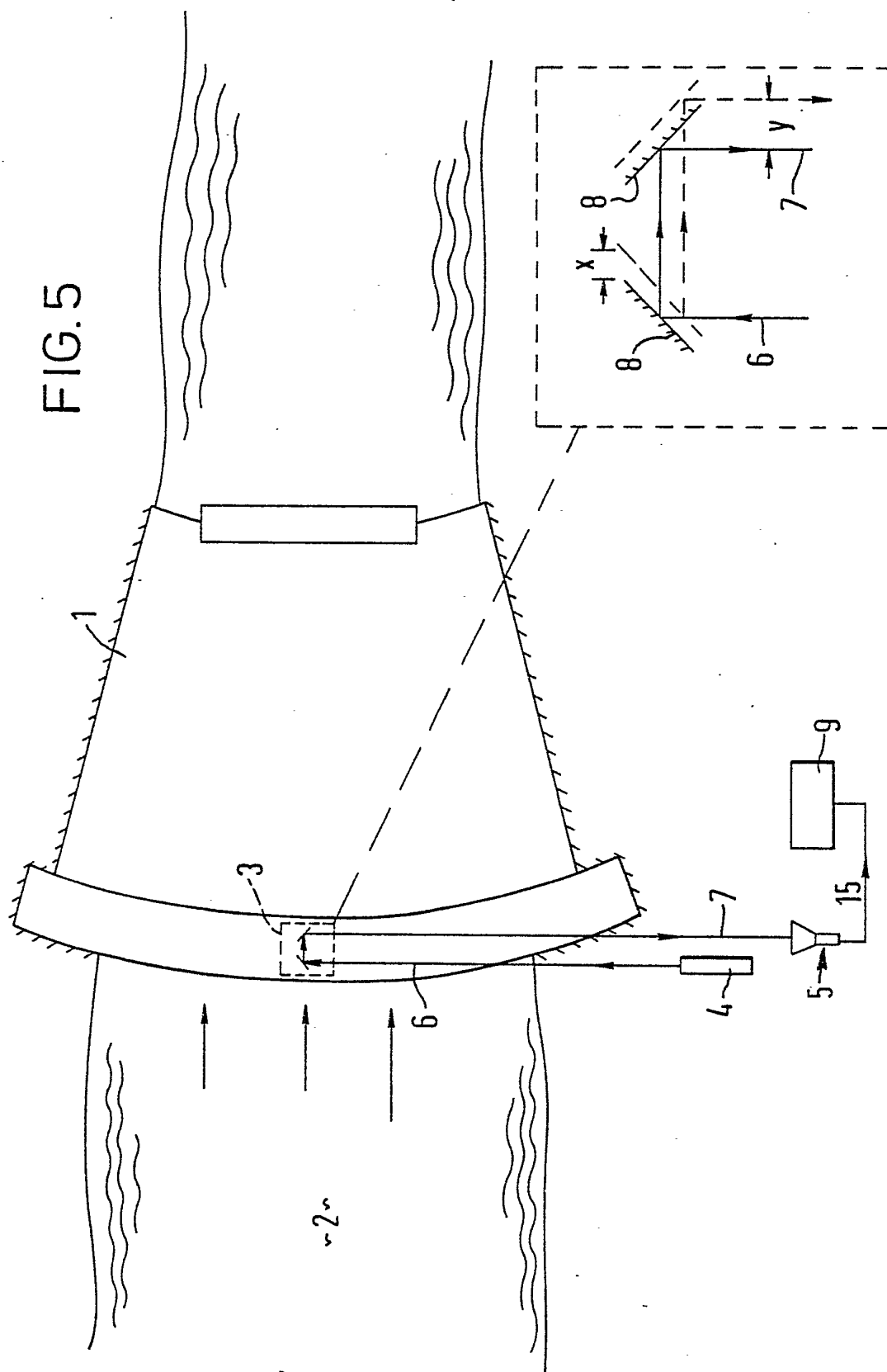


FIG. 4

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INTERNATIONAL SEARCH REPORT

International Application No. PCT/GB 81/00093

I. CLASSIFICATION OF SUBJECT MATTER (If several classification symbols apply, indicate all) ² According to International Patent Classification (IPC) or to both National Classification and IPC Int.Cl.³: G 01 C 15/00; G 01 B 11/16																				
II. FIELDS SEARCHED Minimum Documentation Searched ⁴ <table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 20%; border-bottom: 1px solid black; font-size: 0.8em;">Classification System</td> <td style="border-bottom: 1px solid black; font-size: 0.8em;">Classification Symbols</td> </tr> <tr> <td style="padding: 5px; vertical-align: top;">Int.Cl.³</td> <td style="padding: 5px; vertical-align: top;">G 01 C 15/00; G 01 B 11/16; G 01 B 11/02; G 01 B 11/26; G 01 S 11/00; G 01 S 3/78</td> </tr> </table> Documentation Searched other than Minimum Documentation to the extent that such Documents are Included in the Fields Searched ⁵			Classification System	Classification Symbols	Int.Cl. ³	G 01 C 15/00; G 01 B 11/16; G 01 B 11/02; G 01 B 11/26; G 01 S 11/00; G 01 S 3/78														
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III. DOCUMENTS CONSIDERED TO BE RELEVANT ¹⁴ <table style="width: 100%; border-collapse: collapse;"> <tr> <th style="width: 10%; font-size: 0.8em;">Category ⁶</th> <th style="width: 70%; font-size: 0.8em;">Citation of Document, ¹⁰ with indication, where appropriate, of the relevant passages ¹¹</th> <th style="width: 20%; font-size: 0.8em;">Relevant to Claim No. ¹³</th> </tr> <tr> <td></td> <td>US, A, 3799674, published April 26, 1974, see column 2, line 14 to column 3, line 18, Guillet et al. ---</td> <td style="text-align: center; vertical-align: top;">1,5,11</td> </tr> <tr> <td></td> <td>DE, A, 2636429, published February 16, 1978, see pages 5,6, Fraunhofer-Gesellschaft zur Förderung der angewandten Forschung ---</td> <td style="text-align: center; vertical-align: top;">1,2,4-8</td> </tr> <tr> <td></td> <td>NAVY TECHNICAL DISCLOSURE BULLETIN, volume 4, no. 4, April 1979 (US), G.E. Warren "Electro optical biaxial deflectometer" pages 9-13, see pages 10,11 ---</td> <td style="text-align: center; vertical-align: top;">1,3</td> </tr> <tr> <td style="text-align: center; vertical-align: top;">A</td> <td>GB, A, 1447490, published August 25, 1976, see page 2, line 102 to page 3, line 89, Solartron ---</td> <td style="text-align: center; vertical-align: top;">1</td> </tr> <tr> <td style="text-align: center; vertical-align: top;">A</td> <td>US, A, 3709607, published January 9, 1973, see column 6, line 31 to column 7, line 22, McConnell et al. ---</td> <td style="text-align: center; vertical-align: top;">1 ./.</td> </tr> </table>			Category ⁶	Citation of Document, ¹⁰ with indication, where appropriate, of the relevant passages ¹¹	Relevant to Claim No. ¹³		US, A, 3799674, published April 26, 1974, see column 2, line 14 to column 3, line 18, Guillet et al. ---	1,5,11		DE, A, 2636429, published February 16, 1978, see pages 5,6, Fraunhofer-Gesellschaft zur Förderung der angewandten Forschung ---	1,2,4-8		NAVY TECHNICAL DISCLOSURE BULLETIN, volume 4, no. 4, April 1979 (US), G.E. Warren "Electro optical biaxial deflectometer" pages 9-13, see pages 10,11 ---	1,3	A	GB, A, 1447490, published August 25, 1976, see page 2, line 102 to page 3, line 89, Solartron ---	1	A	US, A, 3709607, published January 9, 1973, see column 6, line 31 to column 7, line 22, McConnell et al. ---	1 ./.
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A	GB, A, 1447490, published August 25, 1976, see page 2, line 102 to page 3, line 89, Solartron ---	1																		
A	US, A, 3709607, published January 9, 1973, see column 6, line 31 to column 7, line 22, McConnell et al. ---	1 ./.																		
[*] Special categories of cited documents: ¹² "A" document defining the general state of the art "E" earlier document but published on or after the international filing date "L" document cited for special reason other than those referred to in the other categories "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but on or after the priority date claimed "T" later document published on or after the international filing date or priority date and not in conflict with the application, but cited to understate the principle or theory underlying the invention "X" document of particular relevance																				
IV. CERTIFICATION <table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 50%; border-bottom: 1px solid black; font-size: 0.8em;">Date of the Actual Completion of the International Search ¹</td> <td style="width: 50%; border-bottom: 1px solid black; font-size: 0.8em;">Date of Mailing of this International Search Report ²</td> </tr> <tr> <td style="text-align: center; padding: 5px;">August 19, 1981</td> <td style="text-align: center; padding: 5px;">September 2, 1981</td> </tr> <tr> <td style="border-bottom: 1px solid black; font-size: 0.8em;">International Searching Authority ¹ EUROPEAN PATENT OFFICE Branch at The Hague P.O.Box 5818 Patentlaan, 2 2280 HV RIJSWIJK (ZH) The Netherlands</td> <td style="border-bottom: 1px solid black; font-size: 0.8em;">Signature of Authorized Officer ² G. M. Kruidenberg </td> </tr> </table>			Date of the Actual Completion of the International Search ¹	Date of Mailing of this International Search Report ²	August 19, 1981	September 2, 1981	International Searching Authority ¹ EUROPEAN PATENT OFFICE Branch at The Hague P.O.Box 5818 Patentlaan, 2 2280 HV RIJSWIJK (ZH) The Netherlands	Signature of Authorized Officer ² G. M. Kruidenberg												
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III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)		
Category *	Citation of Document, ¹⁶ with indication, where appropriate, of the relevant passages ¹⁷	Relevant to Claim No ¹⁸
A	IBM Technical Disclosure Bulletin, volume 19, no. 7, December 1976, F.S. Luecke "Contour inspection system", pages 2680, 2681, see the whole document -----	1