(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 0 915 459 A1

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
12.05.1999 Bulletin 1999/19

(51) Int. Cl.^{6}: **G11B 7/135**, H01S 3/06, G03B 27/74

(21) Application number: **97309017.8**

(22) Date of filing: **10.11.1997**

(84) Designated Contracting States:
AT BE CH DE DK ES FI FR GB GR IE IT LI LU MC NL PT SE
Designated Extension States:
AL LT LV MK RO SI

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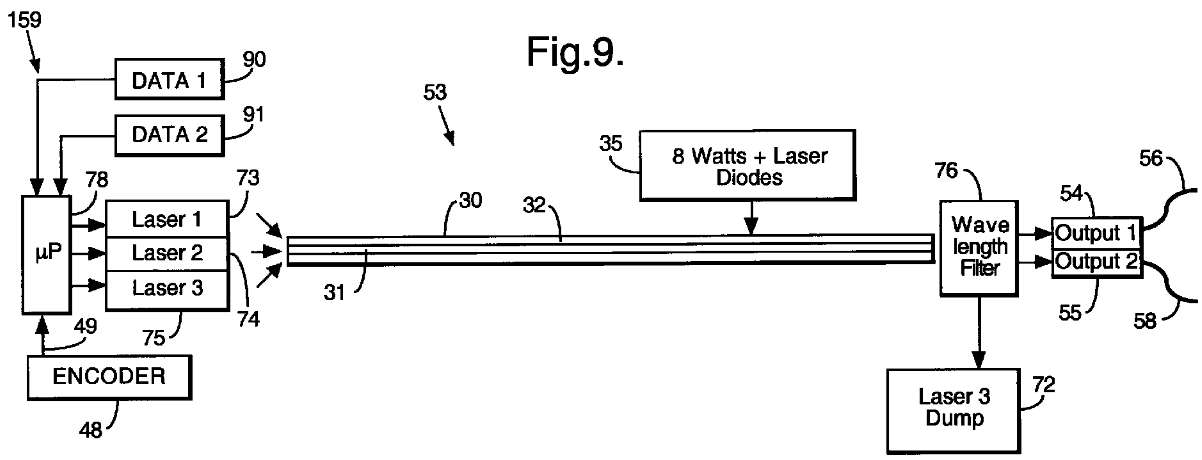
(54) Method and apparatus for exposing an image recording medium

(57) Apparatus for exposing an image recording medium, the apparatus comprising a radiation source (53); a routing device (76) comprising an input arranged to receive radiation from the radiation source, and a plurality of imaging outputs (54,55), wherein the routing device selectively routes the radiation received at the input to a selected one of the imaging outputs; and means (56,58) for directing the radiation from each imaging output onto the image recording medium to expose the image recording medium.

Fig.9.



EP 0 915 459 A1

Description

[0001] The present invention relates to a method and apparatus for exposing an image recording medium, such as a thermal printing plate.

[0002] Figure 1 is a side view of a conventional single beam internal drum imagesetter. A laser 1 generates a laser beam 2 which is directed onto an angled reflective surface 3 of a spinning mirror 4. The spinning mirror 4 is rotated by a motor 5 which is mounted on a carriage (not shown). The carriage (not shown) is driven parallel to the axis of a drum 7 by rotation of a lead screw 6. Items 3-6 are housed inside the drum 7. One or more image recording plates (not shown) are mounted on the inner surface of the drum 7. To expose the image recording plates on the drum 7, the motor 5 moves along the axis of the drum 7, and rotates the spinning mirror 4 about the axis of the drum 7 whereby the reflected laser beam 8 exposes a series of circumferential scan lines.

[0003] As can be seen in Figure 2, which is an end view of the apparatus shown in Figure 1, during the lower 80° of its revolution, the reflected laser beam 8 is blocked by the carriage 136. This creates a shadow area 9 which prevents the scanner from exposing a full 360° of the drum 7 and reduces the speed and efficiency of the system. The angle of the area outside the shadow area 9 is conventionally known as the "drum angle".

[0004] A known way of improving on the efficiency and scanning time of the system of Figure 1 is to add a second spinner and a second laser as illustrated in Figure 3.

[0005] Figure 3 illustrates the lower half 10 of a cylindrical drum. A first mirror 11 and a second mirror 12 are mounted at 180° to each other on a common shaft 13 which is rotated by a motor (not shown). A first laser 14 is directed at the spinning mirror 11, and a second laser 15 is directed at the spinning mirror 12. The distance between the reflective surfaces of the spinning mirrors 11,12 is equal to half the length of the drum. The laser 14 directs image radiation to the mirror 11 during one half cycle to expose a line on the upper half of the drum. The laser 15 directs image radiation to the mirror 12 during the next half cycle to expose another line on the upper half of the drum. The process continues until the right-hand spinner 12 has exposed the right-hand upper quarter of the drum, and the left-hand spinner 11 has exposed the left-hand upper quarter of the drum. Therefore the entire upper half of the drum can be exposed in half the time when compared with the system of Figure 1. In addition the overall efficiency is increased since the lower half of the drum (which includes the shadow area 9) is not exposed.

[0006] A problem associated with the system of Figure 3 is that two lasers 14,15 are required. The cost of lasers can be very high.

[0007] In accordance with a first aspect of the present invention there is provided apparatus for exposing an image recording medium, the apparatus comprising a radiation source; a routing device comprising an input arranged to receive radiation from the radiation source, and a plurality of imaging outputs, wherein the routing device selectively routes the radiation received at the input to a selected one of the imaging outputs; and means for directing the radiation from each imaging output onto the image recording medium to expose the image recording medium.

[0008] In accordance with a second aspect of the present invention, there is provided a method of exposing an image recording medium, the method comprising generating radiation in a radiation source; inputting the radiation to a routing device having a plurality of imaging outputs; routing the radiation during a first period to one or more selected ones of the imaging outputs; routing the radiation during a second period to one or more different selected ones of the imaging outputs; and exposing the image recording medium with radiation from the or each selected imaging output.

[0009] The present invention provides a routing device which enables a single radiation source to be used in a scanner of the type illustrated in Figure 3. This results in a much simplified system with reduced cost.

[0010] The radiation which exposes the image recording medium is generally encoded with image information to expose a desired pattern of pixels. The radiation may be encoded downstream of the routing device, for instance with an acousto-optic modulator. Preferably however the radiation which is input to the routing device is already encoded, for instance by suitable control of the radiation source. Typically the radiation source inputs radiation in the form of a series of pulses to the routing device. This enables pixels to be exposed on the image recording medium with short, high power pulses, resulting in low thermal leakage.

[0011] In a preferred embodiment the radiation source comprises an optical amplifier having a pump energy source. The average power of the optical amplifier can then be conveniently adjusted by adjusting the power input by the pump energy source. The pump energy source may input electrical pump energy into the amplifier, but preferably the pump energy source comprises a radiation source such as an array of laser diodes.

[0012] The radiation source may be operated in a continuous wave mode as illustrated schematically in Figure 4. A power source (not shown) provides a power signal on input line 16. When switch 17 is closed the laser cavity 18 outputs a laser beam 19. A problem with continuous wave mode is that the output beam 19 cannot have a power any greater than the power on input line 16. This is a particular problem in thermal printing imagesetters where high laser power may be required.

[0013] Therefore preferably the radiation source is operated in pulsed mode, as illustrated schematically in Figure 5. In this case a power source provides a power signal on input line 20 which is input continuously to the laser cavity 20. The laser cavity 21 stores the energy from input line 20 until switch 22 is closed to release the energy in the form of a high power pulsed laser beam 23. As a result, the power of the pulsed laser beam 23 can be higher than the power on input line 20. This enables pixels to be exposed on the image recording medium with short, high power pulses, resulting in low thermal leakage.

[0014] An example of a suitable radiation source is shown in Figure 6. Figure 6 illustrates a fibre amplifier of the type described in WO95/10868. The fibre amplifier comprises a fibre 30 having a Erbium-Ytterbium doped single-mode inner core 31 and a multi-mode concentric outer core 32. A single mode seed laser 33 directs an encoded laser beam 34 into the inner core 31. Pump radiation is provided by a pump source 35 (an array of multi-mode laser diodes) which is coupled, transversely with respect to the optical axis of the fibre 30, to the outer core 32. The method of coupling the pump source 35 to the fibre 30 is described in detail in WO96/20519. Pump radiation from the pump source 35 propagates through the outer core 32 and couples to the amplifying inner core 31, and pumps the active material in the inner core 31. Thus the fibre optic amplifier provides a highly amplified encoded output beam 36 at the wavelength of the beam 34.

[0015] The fibre optic amplifier illustrated in Figure 6 is primarily designed for use in telecommunications in which the encoded input laser beam 34 will not be off for a significant length of time. If the seed laser 33 is off for an extended period, the fibre 30 continues to accumulate energy from the pump source 35, and as a result the fibre 30 will go into spontaneous emission. This problem is common to all pulsed laser sources and as a result pulsed laser sources are generally not used in imaging applications where the laser may be off for an extended period of time.

[0016] In order to solve this problem, the apparatus preferably further comprising an energy dump; and means for directing the radiation from the radiation source either to the energy dump or to the image recording medium. This solves the spontaneous emission problem by providing an energy dump which is utilised to prevent excessive build up of energy in the radiation source.

[0017] Preferably the radiation source comprises one or more data radiation source(s) and a dump radiation source which generate encoded radiation at respective different wavelengths, and an optical amplifier which amplifies the encoded radiation; and wherein the means for directing the radiation either to the energy dump or to the image recording medium comprises a filter which directs the amplified radiation to the image recording medium or to the energy dump in accordance with the wavelength of the amplified radiation. In this case the apparatus typically further comprises means for encoding the radiation from the dump radiation source whereby radiation is only generated by the dump radiation source when radiation is not being generated by any of the data radiation sources. This increases efficiency and further reduces the risk of spontaneous emission.

[0018] Preferably the radiation source comprises a plurality of data radiation sources which generate encoded radiation at respective different wavelengths, and an optical amplifier which amplifies the encoded radiation; and the routing device comprises a filter which directs the amplified radiation to one or more of the imaging outputs in accordance with the wavelength of the amplified radiation. This is a particularly efficient and fast method of selectively routing the radiation from the radiation source. In particular, no acousto/optic modulators are required to encode the radiation from the radiation source. The filter may also direct the amplified radiation to an energy dump.

[0019] The radiation may be transmitted through air to the image recording medium, but preferably the means for directing the radiation from each imaging output onto the image recording medium comprises a plurality of fibre-optic cables, each coupled to a respective one of the imaging outputs. This arrangement improves coupling efficiency, reduces alignment problems, and makes the apparatus safer by confining the imaging radiation beams (which may have dangerously high power). Preferably the radiation source comprises a fibre laser which provides an output suitable for coupling to the fibre-optic cables.

[0020] The apparatus may be used in a conventional imagesetter. However it is particularly suited to a thermal imagesetter in which the radiation source generates radiation of a wavelength and power suitable for exposure of a thermal imaging plate. Suitable wavelengths are in the infrared region. Typically the image recording medium has a media sensitivity of 50-200$mJcm^{-2}$. Typically the average power delivered by the radiation source at the image recording medium is 2-10W (in the case where the image recording medium is exposed uniformly).

[0021] A number of examples of the present invention will now be described with reference to the accompanying drawings, in which:-

Figure 1 is a side view of a conventional single mirror imagesetter;
Figure 2 is an end view of the imagesetter of Figure 1;
Figure 3 is a side view of a double mirror imagesetter;
Figure 4 is a schematic illustration of a continuous wave laser;
Figure 5 is a schematic illustration of a pulsed laser;
Figure 6 is a schematic illustration of a pulsed laser of the type described in WO95/10868 and WO96/20519;
Figure 7 is a schematic side view of a double mirror imagesetter incorporating an example of apparatus

according to the present invention;

Figure 8 illustrates the surface of the drum shown in Figure 7;

Figure 9 is an example of the radiation source and control means of Figure 7;

Figure 10 illustrates a first encoding scheme for the system of Figure 9; and

Figure 11 illustrates a second encoding scheme for the system of Figure 9;

[0022] Referring to Figure 7, an internal drum thermal imagesetter comprises a drum 50 carrying one or more thermal imaging plates (not shown) on its inner surface. Two spinning mirrors 51,52 are mounted at 180° to each other on a common shaft 45 which is rotated by a motor 46 on a carriage (not shown) which is driven by a lead screw 47. An encoder 48 encodes the angular position of the shaft 45 to provide a series of pulses which are frequency multiplied by a desired factor to generate a clock signal 49 at a desired frequency (typically 20-120MHz). A laser is schematically indicated at 53, and has a pair of imaging outputs 54,55. Radiation from the imaging output 54 is input to a fibre optic cable 56 which is fixed at its far end to a lens 57 which is fixed in relation to the spinning mirror 52. Radiation from the imaging output 55 is input to a fibre optic cable 58 which is fixed at its far end to a lens 59 which is fixed in relation to the spinning mirror 51. Control means schematically indicated at 159 controls the laser 53 such that encoded radiation is selectively directed to a selected one of the spinning mirrors 51,52.

[0023] Figure 8 is a flattened representation of the outer surface of the drum 50. The shadow area 9 lies between 140° and 220° and the upper half of the drum lies between 270° and 90°. Four thermal imaging plates 60-63 are mounted on the upper half of the drum. The left-hand mirror 51 exposes plates 60 and 61 (in the upper left quarter 64 of the drum) with cyan and magenta image separations, and the right-hand mirror 52 exposes plates 62 and 63 (in the upper right quarter 65 of the drum) with yellow and black image separations.

[0024] Figure 9 illustrates a first example of the radiation source 53 and control means 159 indicated schematically in Figure 7. The radiation source 53 comprises an optical fibre laser amplifier of the type illustrated in Figure 6 (like reference numerals being used for like components) and described in WO95/105868 and WO96/20519. A suitable radiation source is the IRE-Polus YLPM-Series Pulsed Yterrbium Doped Fibre laser. Three seed lasers 73-75 comprising a pair of data lasers 73,74 and a dump laser 75 are directed at one end of the inner core 31. The seed lasers 73-75 emit radiation at slightly different wavelengths centred around a desired infra-red wavelength of approximately 1015nm. In one example the data lasers 73,74 emit radiation at 1010nm and 1020nm, and the dump laser 75 emits radiation at 1030nm. A filter 76 filters the amplified beam output from the other end of the inner core 31 and directs radiation at the wavelength of the first data laser 73 to output 54, radiation at the wavelength of the second data laser 74 to output 55, and radiation at the wavelength of the dump laser 75 to an energy dump 72. The pair of imaging outputs 54,55 (output 1 and output 2) are coupled to the fibre-optic cables 56,58. The seed lasers 73-75 are low power single mode lasers which are switched by a microprocessor 78, as described below.

[0025] The power of the pump laser diodes 35 can be selected in accordance with the desired power to be delivered on the film. The required power is determined by the media sensitivity (typically 50-200mJcm^{-2}), drum angle (typically 209 degrees), resolution (typically 48-144 lines/mm), film height (typically 930mm), film width (typically 1130mm), spinner speed (typically 30,000 RPM), and optics efficiency (typically 90%). As a result the power of the pump diodes is typically selected to give an output power of 3-10W. In the example of Figure 9, the pump diodes 35 deliver 8W.

[0026] A first data store 90 contains binary image data to be recorded as a pattern of pixels on the upper left quarter of the drum 50 via first imaging output 54 (output 1). A second data store 91 contains binary image data to be recorded as a pattern of pixels on the upper right quarter of the drum via second imaging output 55 (output 2). The microprocessor 78 reads out the data from the stores 90,91 in response to the clock signal 49 from encoder 48. The microprocessor 78 controls the lasers 73-75 as described in the examples of Figures 10 and 11.

[0027] Figures 10 and 11 illustrate the radiation output by imaging output 54 (output 1), imaging output 55 (output 2) and dump output 72. The binary image data read out from data stores 90 (data 1) and 91 (data 2) are also shown, along with the clock signal 49 which has a clock period 130 of 20ns.

[0028] Figure 10 illustrates the encoding scheme when the data streams from stores 90,91 are non-overlapping, ie. when only the upper half of the drum is exposed. For the first half revolution of shaft 45 (to the left of line 110), mirror 52 (output 1) exposes a line on the upper right quarter 65 of the drum. Only part of the line is illustrated in Figure 10. For the second half revolution of shaft 45 (to the right of line 110), mirror 51 (output 2) exposes a line on the upper left quarter 64 of the drum.

[0029] The microprocessor 78 controls the seed lasers 73-75 such that a radiation pulse is output by the amplifier on each positive clock step. If data 1 is high, then a radiation pulse is output on the first output 54 to expose a single pixel. If data 2 is high, then a radiation pulse is output on the second output 55 to exposes a single pixel. If neither data lines are high, then a radiation pulse is output to energy dump 72. Therefore the dump laser 75 is encoded as NOT(DATA1 OR DATA2). In the encoding scheme of Figure 10 (in which only the upper half of the drum is exposed) it can be seen that data 1 and data 2 are never high at the same time.

[0030] For example, at the first positive clock step 100, neither data 1 nor data 2 are high. Therefore the microprocessor 78 causes the dump laser 75 to emit a 2ns pulse which is amplified to generate a 2ns amplified radiation pulse 101 to be output to the energy dump 72. After a short time lag 140 (exaggerated in Figure 10 for illustrative purposes) after the positive clock pulse 100, the microprocessor receives a pulse 103 from store 90. Hence at the second positive clock step 102, data 1 is high and the microprocessor 78 causes the laser 73 to emit a 2ns pulse which causes an amplified 2ns radiation pulse 104 to be emitted from output 54.

[0031] The duration of the pulses emitted by the seed lasers 73-75 can be adjusted by an RS 232 command before running an image. The pulse duration can be set equal to the clock period of 20ns, resulting in a continuous wave mode in which the pulses 101,104 are not temporally separated, and in which radiation is continuously input to the filter 76. However preferably the pulse duration is set to less than the 20ns clock period (for instance 2ns as shown in Figure 10), resulting in a pulsed mode in which the pulses are temporally separated (in the example of Figure 10 by 18ns) and in which radiation is input as a series of pulses to the filter 76. The total energy deposited over a 20ns clock cycle is the same in both continuous and pulsed mode, and is set by the power of the pump diodes 35 (in this case 8W*20ns=0.16 microjoules). However it is preferable to deposit this energy in a short time (eg. 1 or 2 ns) since this results in less thermal leakage. In addition the energy deposited on the film convolves less across the film when the pulse duration is short.

[0032] Figure 11 illustrates an alternative encoding scheme which is required when the data 1 and data 2 are overlapping (for instance if the drum is to be exposed in the complete area outside the shadow area 9, ie. from 220° to 140°). In this case the microprocessor 78 controls the seed lasers 73-75 such that a radiation pulse is output by the amplifier on each positive clock step and each negative clock step. If data 1 is high during a positive clock step, then a radiation pulse is output on the first output 54. If data 2 is high during a negative clock step, then a radiation pulse is output on the second output 55. Otherwise a radiation pulse is output to energy dump 72. As a result, due to the reduced storage time, the energy delivered by each pulse is half the energy delivered by the pulses in Figure 10.

[0033] For example, at negative clock step 120, data 1 and data 2 are both low and therefore the dump laser 75 emits a seed pulse which generates an amplified radiation pulse 121 which is directed to dump 72. At positive clock step 122, data 1 is high and therefore laser 73 emits a seed pulse which generates an amplified radiation pulse 123 which is directed to the first output 54. At the next negative clock step 124, data 2 is high and therefore laser 74 emits a seed pulse which generates an amplified radiation pulse 125 which is directed to the second output 55.

[0034] In the example of Figure 11, both edges of the clock are used but in a first alternative two clocks may be run in quadrature, each controlling one of the data channels; or in a second alternative the clock may be run at twice the frequency of the clock in Figure 10, each channel being controlled by alternate positive clock steps.

Claims

1. Apparatus for exposing an image recording medium, the apparatus comprising a radiation source; a routing device comprising an input arranged to receive radiation from the radiation source, and a plurality of imaging outputs, wherein the routing device selectively routes the radiation received at the input to a selected one of the imaging outputs; and means for directing the radiation from each imaging output onto the image recording medium to expose the image recording medium.

2. Apparatus according to claim 1 further comprising an energy dump; and means for directing the radiation from the radiation source either to the energy dump or to the image recording medium.

3. Apparatus according to claim 2 wherein the radiation source comprises one or more data radiation source(s) and a dump radiation source which generate encoded radiation at respective different wavelengths, and an optical amplifier which amplifies the encoded radiation; and wherein the means for directing the radiation either to the energy dump or to the image recording medium comprises a filter which directs the amplified radiation to the image recording medium or to the energy dump in accordance with the wavelength of the amplified radiation.

4. Apparatus according to claim 3 further comprising means for encoding the radiation from the dump radiation source whereby radiation is only generated by the dump radiation source when radiation is not being generated by any of the data radiation sources.

5. Apparatus according to any of the preceding claims wherein the radiation source comprises a plurality of data radiation sources which generate encoded radiation at respective different wavelengths, and an optical amplifier which amplifies the encoded radiation; and wherein the routing device comprises a filter which directs the amplified radiation to one or more of the imaging outputs in accordance with the wavelength of the amplified radiation.

6. Apparatus according to any of claims 3 to 5 further

comprising a pump radiation source which pumps the optical amplifier with pump radiation, wherein the power of the pump radiation source is greater than the power of the data radiation source(s) and the dump radiation source.

7. Apparatus according to any of the preceding claims wherein the means for directing the radiation from each imaging output onto the image recording medium comprises a plurality of fibre-optic cables, each coupled to a respective one of the imaging outputs.

8. Apparatus according to any of the preceding claims wherein the radiation source generates radiation of a wavelength and power suitable for exposure of a thermal imaging plate.

9. Apparatus according to any of the preceding claims wherein the radiation source inputs radiation in the form of a series of pulses to the routing device.

10. An imagesetter comprising a support for supporting an image recording medium to be exposed; and apparatus according to any of the preceding claims for exposing the image recording medium.

11. Apparatus according to any of the preceding claims, wherein the radiation source comprises an optical amplifier having a pump energy source.

12. A method of exposing an image recording medium, the method comprising generating radiation in a radiation source; inputting the radiation to a routing device having a plurality of imaging outputs; routing the radiation during a first period to one or more selected ones of the imaging outputs; routing the radiation during a second period to one or more different selected ones of the imaging outputs; and exposing the image recording medium with radiation from the or each selected imaging output.

13. A method according to claim 12 wherein the radiation is input to the routing device in the form of a series of pulses.

Fig.1.

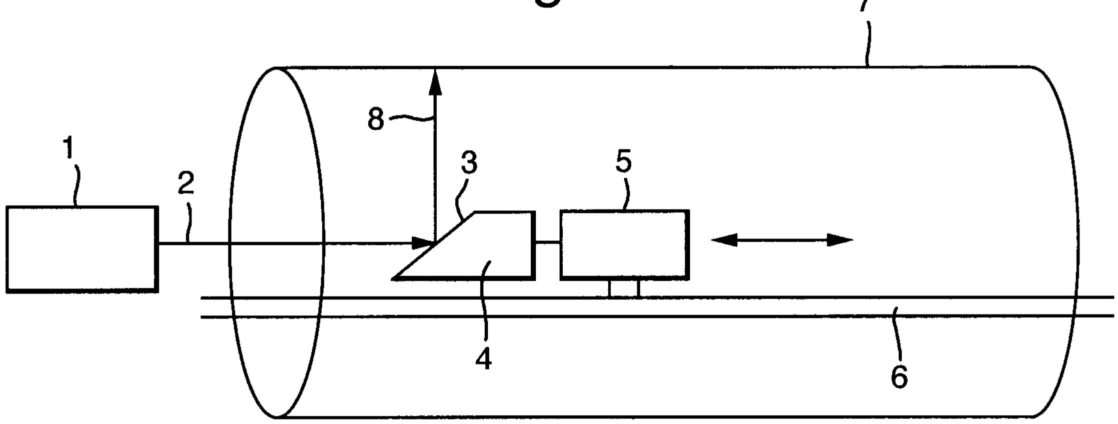


Fig.2.

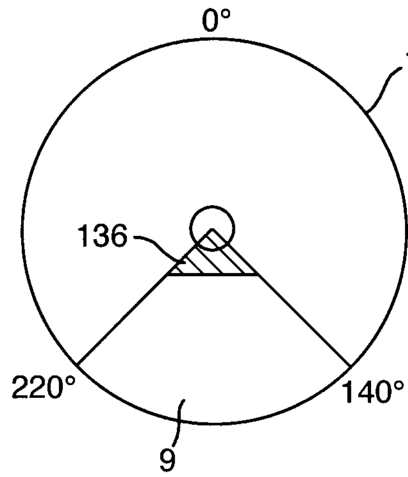


Fig.3.

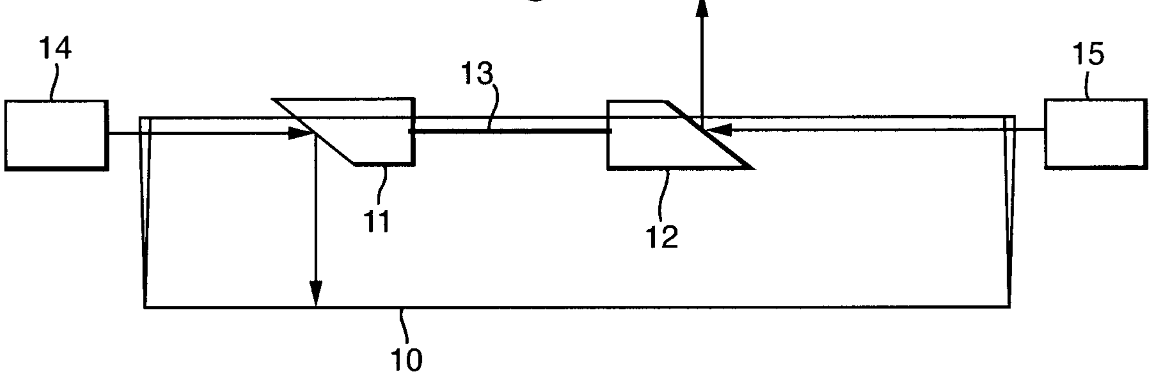


Fig.4.

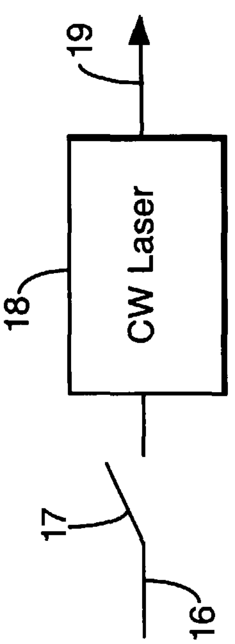


Fig.5.

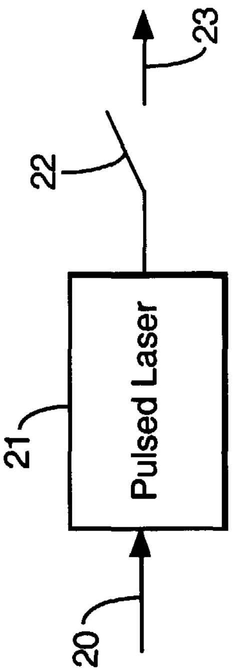


Fig.6.

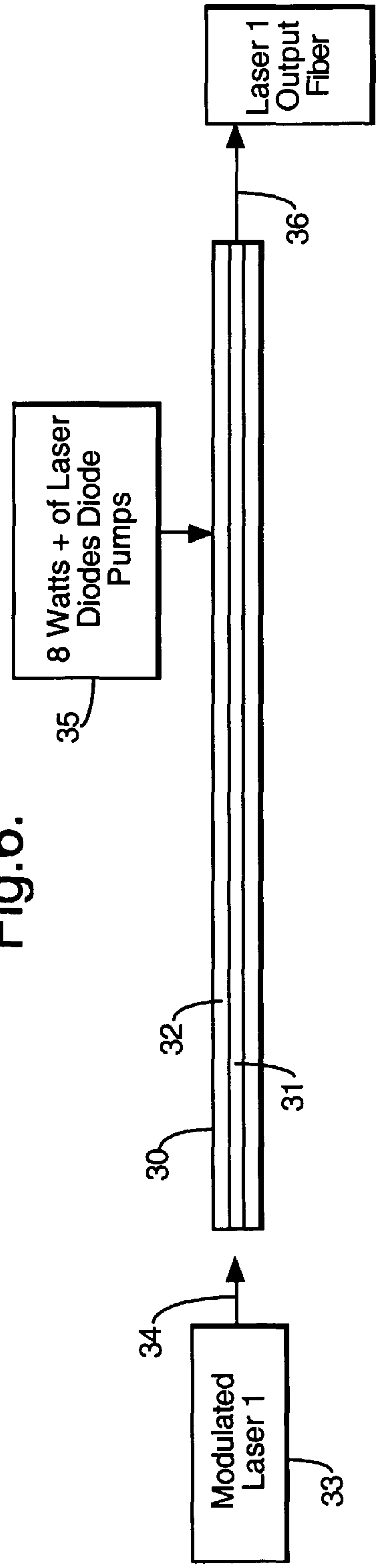


Fig.7.

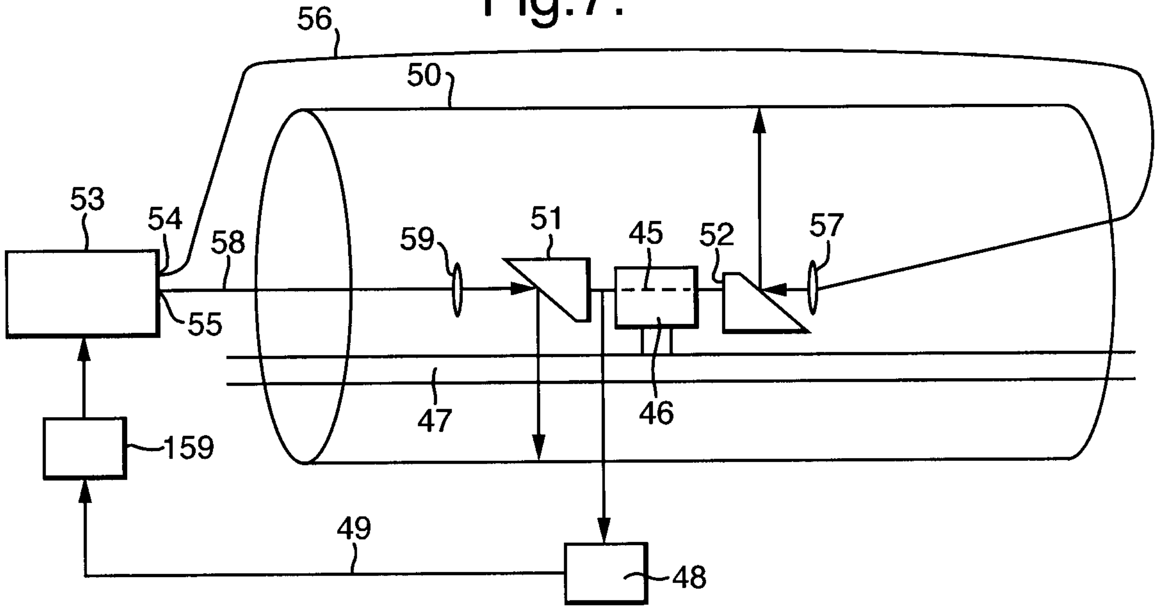
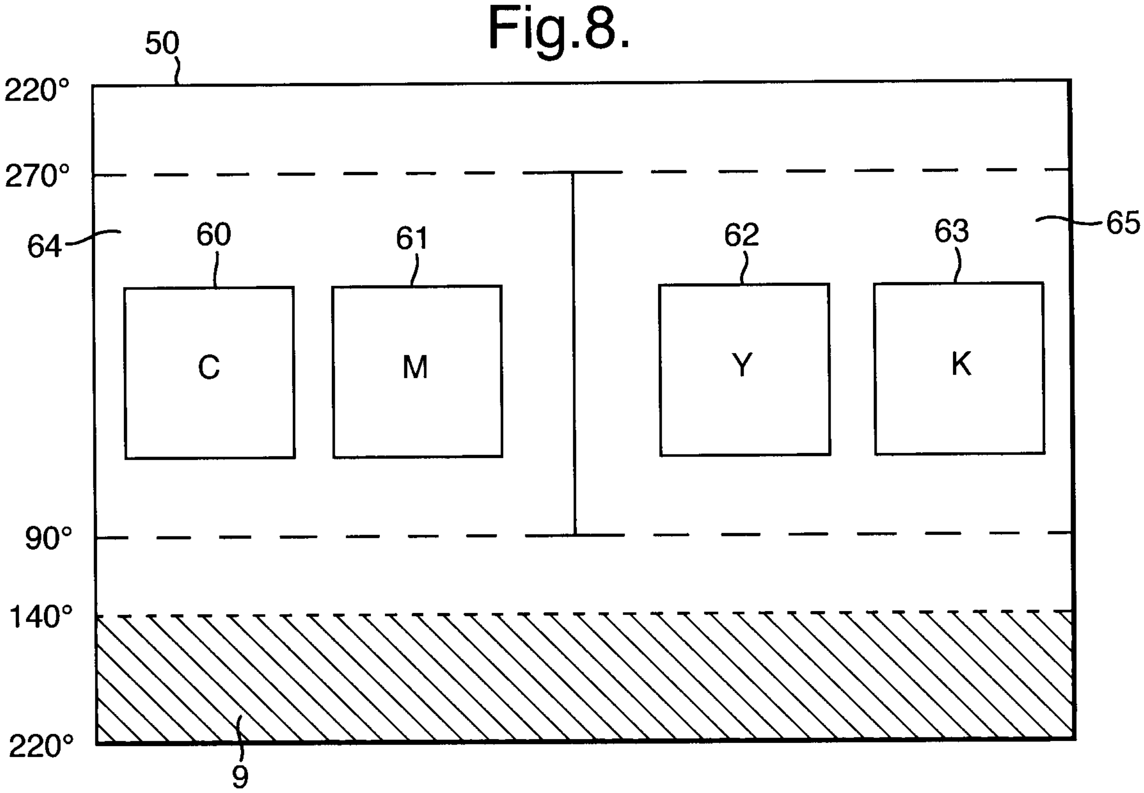
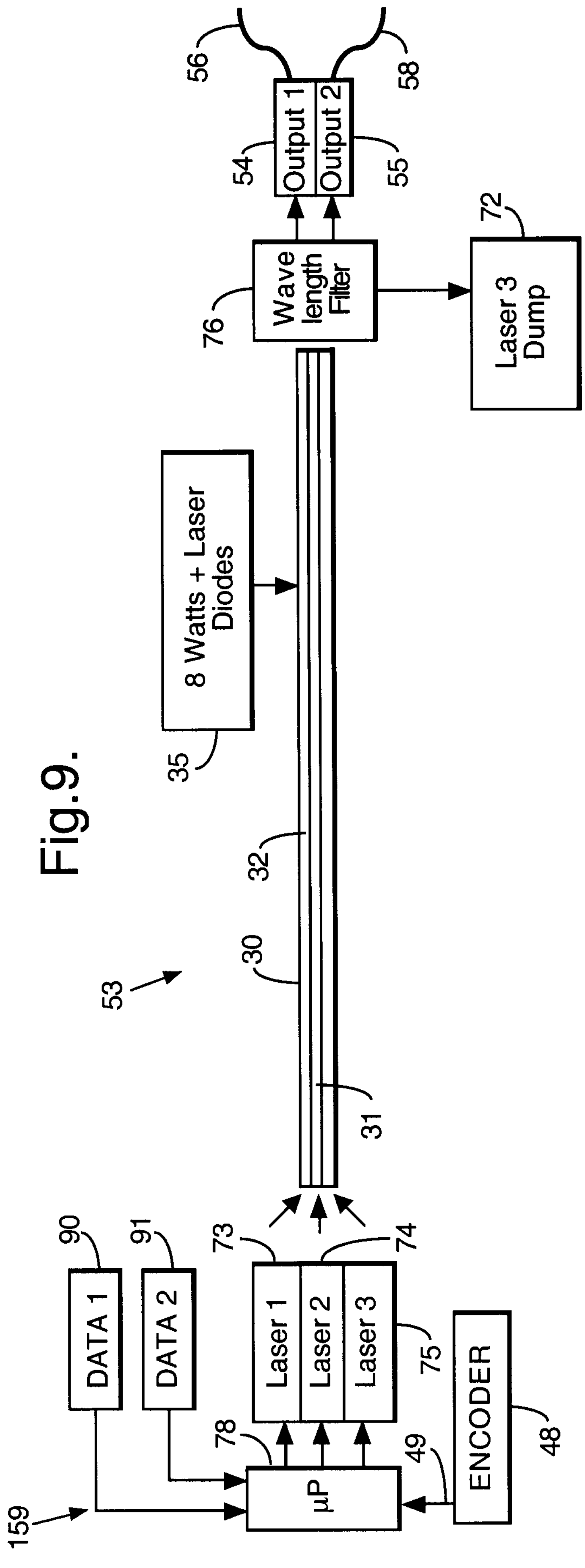

56
50
53
54
58
59
51
45
52
57
55
47
46
159
49
48

Fig.8.


50
220°
270°
64
60
61
62
63
65
C
M
Y
K
90°
140°
220°
9



DATA 1
DATA 2
µP
Laser 1
Laser 2
Laser 3
ENCODER
8 Watts + Laser Diodes
Wave length Filter
Output 1
Output 2
Laser 3 Dump
159
90
91
78
73
74
75
49
48
31
30
53
32
35
76
72
54
55
56
58

Fig.9.

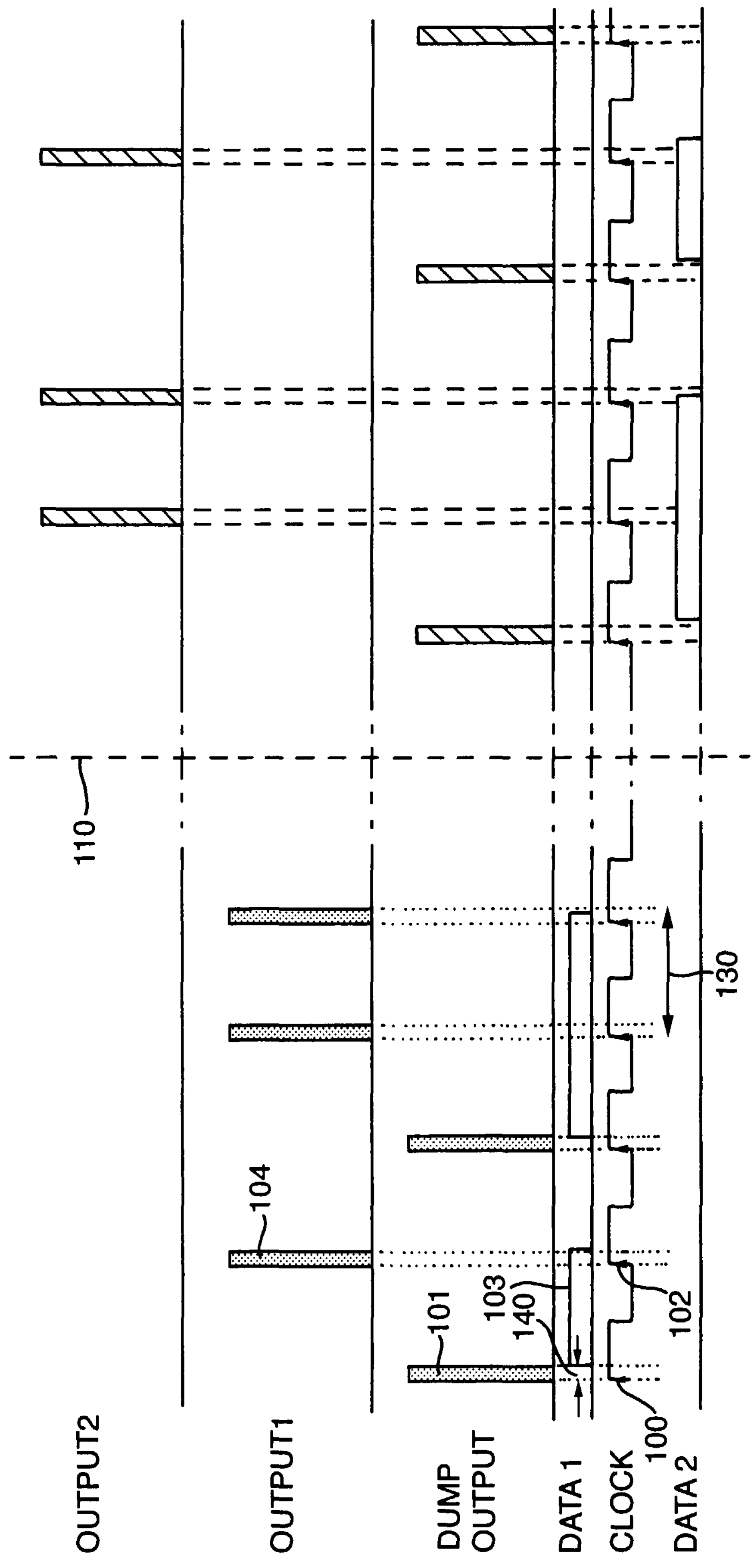

OUTPUT2
OUTPUT1
DUMP OUTPUT
DATA 1
CLOCK
DATA 2
100
101
102
103
104
110
130
140

Fig.10.

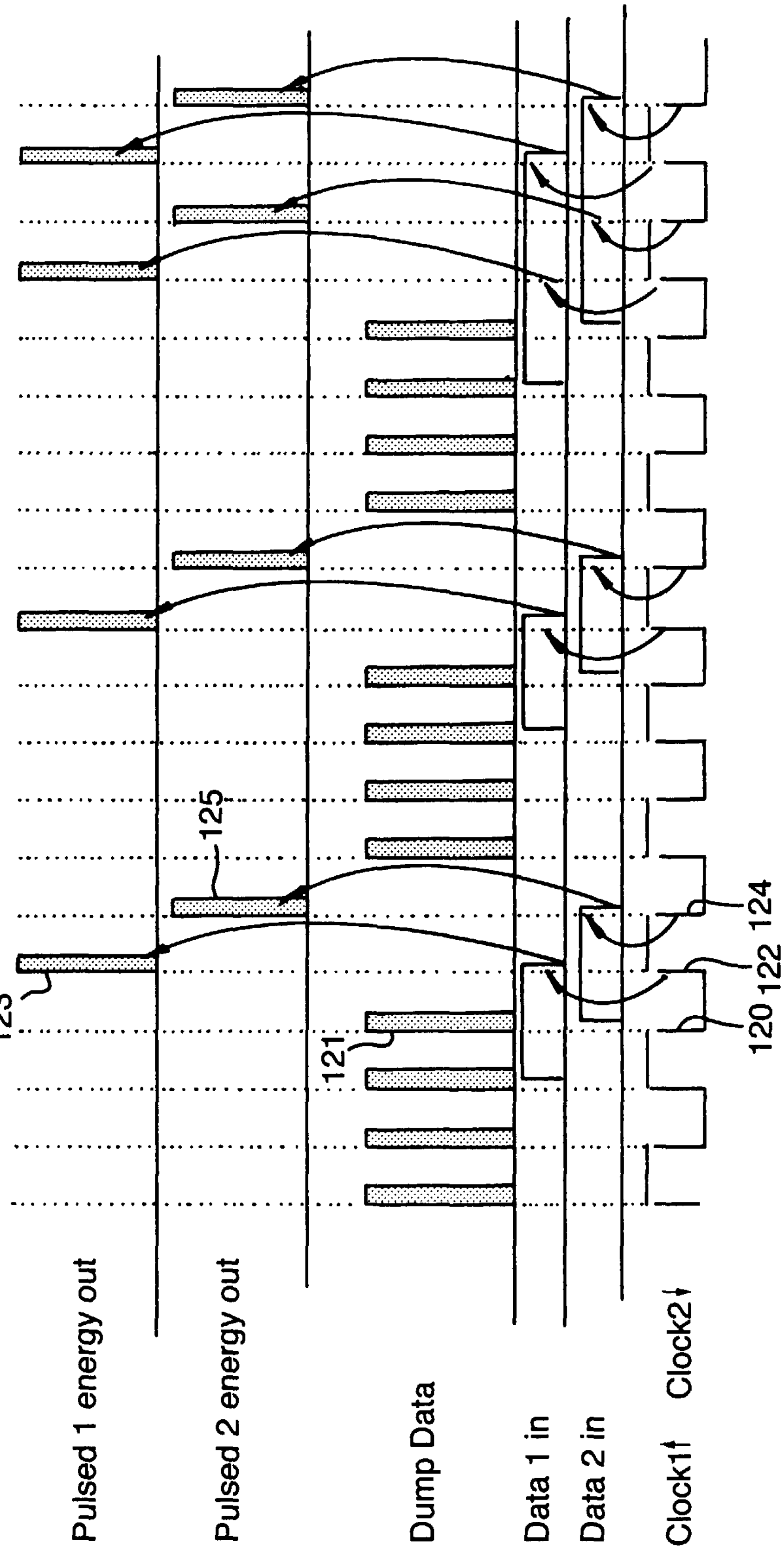

Pulsed 1 energy out
Pulsed 2 energy out
Dump Data
Data 1 in
Data 2 in
Clock1↑ Clock2↓
123
125
121
120
122
124

Fig.11.

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 97 30 9017

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
X	EP 0 656 833 B (ICI PLC) 14 June 1995 * page 2, line 31 - line 40 * * page 2, line 59 - page 3, line 32 * * page 3, line 45 - line 59 * * page 4, line 22 - line 43; figures 1,4 *	1,7-11	G11B7/135 H01S3/06 G03B27/74
Y		2-6,12, 13	
Y	EP 0 772 264 A (NIPPON ELECTRIC CO) 7 May 1997 * column 1, line 49 - column 2, line 59 * * column 8, line 31 - column 9, line 31 * * column 11, line 7 - line 25; claims 1-6,12-16; figures 8-12 *	2-6,12, 13	
A	PATENT ABSTRACTS OF JAPAN vol. 018, no. 577 (E-1625), 4 November 1994 & JP 06 216452 A (SUMITOMO CEMENT CO LTD), 5 August 1994, * abstract *	2-6,12, 13	
			TECHNICAL FIELDS SEARCHED (Int.Cl.6)
A	PATENT ABSTRACTS OF JAPAN vol. 018, no. 464 (E-1598), 29 August 1994 & JP 06 152034 A (SUMITOMO CEMENT CO LTD), 31 May 1994, * abstract *	2-6,12, 13	G11B H01S G03B G02B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
BERLIN	28 April 1998	Manntz, W

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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