

19



Europäisches Patentamt  
European Patent Office  
Office européen des brevets



11 Publication number:

**0 613 981 A1**

12

**EUROPEAN PATENT APPLICATION**

21 Application number: **94830097.5**

51 Int. Cl.<sup>5</sup>: **E01F 9/00**

22 Date of filing: **04.03.94**

30 Priority: **05.03.93 IT FI930039**

43 Date of publication of application:  
**07.09.94 Bulletin 94/36**

84 Designated Contracting States:  
**AT BE CH DE DK ES FR GB GR IE LI LU MC  
NL PT SE**

71 Applicant: **PRO.CO.GEN. PROGETTAZIONI E  
COSTRUZIONI GENERALI S.p.A.**  
**Via Vespasiano da Bisticci N. 6**  
**I-50136 Firenze (IT)**

72 Inventor: **Gentile, Gianpiero**

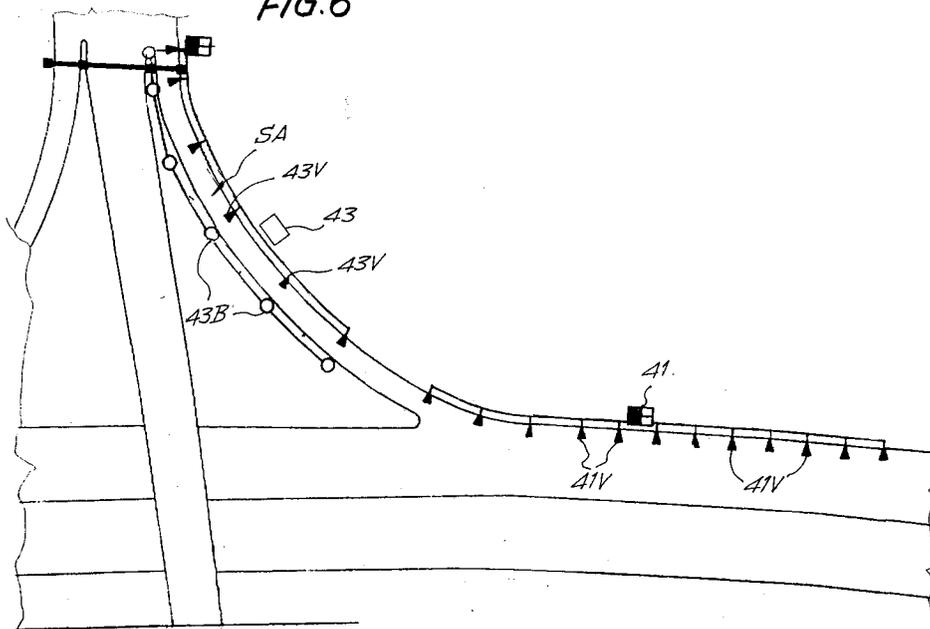
**Via Montecchio N.28**  
**I-50023 Impruneta, Firenze (IT)**  
Inventor: **Andreini, Guido**  
**Via O.da Pordenone N.36**  
**I-50127 Firenze (IT)**  
Inventor: **Marri, Giampiero**  
**Via di Poppiiano N.8.**  
**I-50025 Montespertoli, Firenze (IT)**

74 Representative: **Mannucci, Gianfranco,**  
**Dott.-Ing. et al**  
**Ufficio Tecnico Ing. A. Mannucci**  
**Via della Scala 4**  
**I-50123 Firenze (IT)**

54 **Laser system with fibre optic distribution for motorway signalling in fog.**

57 The system exploits the characteristics of the behaviour of laser light in fog, and makes use of laser sources (41, 43) of coherent light and fibre optic distribution from each of the said sources to a plurality of signalling light points (41V; 43V, 43B) with the emission of directed light beams with controlled divergence.

**FIG.6**



**EP 0 613 981 A1**

The invention relates to a road signalling system characterized in that it exploits particular properties of the collimated beams of photons characteristic of laser sources, which are much more penetrating than conventional diffused light, especially in conditions of poor visibility due to the presence of fog. Various and substantial advantages are obtained with this.

5 In the presence of fog, in other words water particles suspended in the air, normal light tends to be diffused, creating what is known as a "wall effect". By comparison with this, laser light, since it consists of collimated beams of photons, is much more directional, and therefore has a greater range through fog. With laser light it is possible to concentrate large quantities of light exactly at frequencies to which the eye is most sensitive, with a minimum energy consumption. The eye is approximately thirty times more sensitive  
10 to laser light than to diffused light, in night vision conditions, and approximately one hundred and fifty times more sensitive in daytime vision, for the same emitted energy.

Owing to the phenomenon of "physiological nystagmus", diffused light produces in the eye an impulse to scan the contours of the light halo; this does not occur with laser light, which appears to the eye as a clearly circumscribed and defined image, thus increasing the powers of perception of the human eye.

15 The object of the invention is therefore a motorway signalling system - capable of operating in fog - which is based on the use of a laser source of coherent light and on fibre optic distribution from the said source to a plurality of signal light points.

The signal light points are for the most part distributed along a route to be signalled, and at least one optical fibre runs to each of them.

20 The system comprises a multiple connector between the laser source and a bundle of fibres, and branches of single fibres from the said bundle with corresponding terminals for connection to supports for light points.

In a practical embodiment, a connecting terminal forming a light point comprises an optical system to create a desired aperture of the light energy beam emitted and protective means, such as a protective shell  
25 which is generally cylindrical.

A light point support may advantageously be a supporting member extending vertically, combined with means of articulation in at least two orthogonal axes, for angular orientation. The said support may be a pole with a telescopic upper part whose position is adjustable angularly about an approximately vertical axis and axially along the said axis; a terminal retaining bracket forming the light point is fitted to the said upper  
30 part in a configuration which is adjustable about a transverse axis.

The system may comprise a dichroic beam splitter or equivalent component at the output of the laser, or of a light point if necessary, to obtain emissions of different colours from a single laser source.

The invention will be more clearly understood on examining the description and the attached drawing which shows a non-restrictive practical example of the invention. In the drawing,

35 Figs. 1 and 2 show a cabinet to contain the laser to be used for the supply of a plurality of light points;  
Fig. 3 is a diagram of a device to graduate the supply voltage to the laser on switching on and off;  
Fig. 4 shows examples of the distribution of the energy emitted in coherent light from the laser;  
Fig. 5 shows a multiple connector between the laser and a beam of optical fibres for transmission;  
Fig. 6 is a diagram of a multiple system for an example of application to a road junction;  
40 Fig. 7 shows the application of a dichroic beam splitter to the output of the laser;  
Figs. 8 and 9 show, in a side elevation and partial vertical section, and in a plan view from above, a light point support pole.

The system uses an air-cooled laser source with a power suitable for the number of light points to be supplied, for example one for thirteen light points of 150 mW each; the laser source is housed together with  
45 the power supply device in a suitable cabinet 1, which may be shaped as illustrated in Figs. 1 and 2. These figures show schematically an internal case 3 which contains the laser 5, air intakes 7 with fans and a discharge tube 9 for the cooling air; an output part 5A of the laser, with a support 11 for a connector 13 from which extend the optical fibres of a bundle 15, the number of fibres being at least equal to the number of light points to be supplied. Other components, as described below, are housed in the said cabinet; these  
50 include the device for providing the transient for the gradual variation of the voltage on switching on and off, as indicated in Fig. 3. The cabinet 1 shown in Figs. 1 and 2 is provided with suitable apertures which enable the cooling air to circulate, in addition to the provision for the circulation, powered by suitable fans, for the laser device 5. The laser source is associated with the said device for the transients, which makes it possible - with mechanical means, such as a motor with a Variac, or with electronic means such as a  
55 converter - to gradually and automatically increase the control voltage at the laser input up to the nominal value; the device must also permit the reverse procedure at switch-off. By acting on the laser's thermal gradients, the device prolongs the active life of the laser. It may have the circuit shown in Fig. 3, essentially of any type known to those skilled in the art.

When selecting of the laser equipment, the sensitivity curve of the human eye must be taken into consideration. It appears preferable, in selecting the type of laser, to use an argon source from which it is possible to obtain blue light at 488 and 496 nanometres and green-green-yellow at 500.1 and 514 nanometres, the blue providing greatest sensitivity at the rods of the retina for night vision, and the green providing the greatest sensitivity at the cones of the retina for daytime vision. Any other type of laser source may be suitable for use, depending on the individual requirements to be met, which may relate to chromatic factors; for example, a red light can be obtained with a He-Ne laser for a danger signal.

The monochromatic light beam generated by the laser is collimated with a bundle of optical fibres. For the selection of the optical fibres, the following characteristics must be taken into consideration:

- 10 A) low attenuation at the selected frequencies; the fibres most commonly used at present have three attenuation minima (windows) at 800, 1300, and 1500 nanometres, and are not particularly appropriate for the wavelengths which are to be used (488-514 nanometres) for the present application;
- 15 B) the diameter of the fibres, which must be sufficiently large to transmit the maximum quantity of energy, but small enough not to give rise to interference which produces attenuation; in the present case, 200/230 micron fibres with "tight" protection, which have been tested as the best compromise for distances of 100-200 metres, appear to be suitable; however, the diameter will be different for different distances, decreasing with the increase in the distance; the overall solution must be compatible with cost requirements;
- 20 C) disposition of the bundle of fibres with respect to the source, sufficient to "copy" as exactly as possible the profile of the emitter beam, which may have various characteristic sections, some typical examples of which are shown in Fig. 4;
- D) precise machining of the fibre terminals, in particular fine grinding, and their connection to the source by suitable optical means;
- 25 E) termination of the bundle of optical fibres joined to the source 5, 5A by means of a detachable multiple connector 13 (see Fig. 5) which will enable the transport and installation operations to be simplified.

In some cases, the two sides of the carriageway, or different groups of light points, have to be distinguished with different colours; for example, in the case of a motorway junction SA (see Fig. 6), two laser sources, 41 and 43, are provided; the source 41 must supply green light to the corresponding light points 41V, while the source 43 must supply green light to the light points 43V and blue light to the light points 45B. In the latter case, the main beam generated by the argon laser 43 is made to pass, before its collimation with the bundle of optical fibres, through a dichroic beam splitter 45, and the resulting beams at the two outputs from the prism (blue and green) are collimated with two fibre bundles terminating in two connectors 13V and 13B for distribution, in the case of a road crossing. In all cases, it is convenient to dispose the generator, such as 41 and 43, in an intermediate position of the area of the light points to be supplied. Particular care should be taken - by using suitable resins - to make the system consisting of the laser, beam splitter, and fibres into a rigid mechanical unit, even in the presence of expansion which may occur during thermal transients in the laser with respect to the external temperature.

A bundle of fibres 35 is collimated (Fig. 5) with the output 5A of the laser source by means of the connector 13. The fibres of the bundle 15 may be distributed to a suitable number of light points - from ten to fifteen, for example - where it is necessary to signal, in fog, the presence of a junction (see the example in Fig. 6), or the presence of a bend or an obstacle, with considerable advantages of visibility compared with a diffused source. For example, at a junction, it is possible to provide sources such as 41 and 43, each capable of supplying ten to fifteen light points. The orientation of the beams emitted and their aperture will have to be determined in accordance with the distances from the pathways of the vehicles for which the signals are intended, the effects of visibility and signalling, such as the mean inclination with respect to the driver's line of sight, the effects to be obtained (signal indicating an obstacle, the path to be followed, illumination of the travel zone, etc.).

The transmission fibres are connected both to the laser source - with a connector such as 13 in Fig. 5 - and to the light point support which may be a terminal support pole (see Figs. 8 and 9), for reasons of practicality of installation. The optical fibre 51 runs to a connector 53, which is fitted to a bracket 55. The termination of the fibre (at the opposite end to that which is connected to the laser) has a connector 53 which is fitted to its support; this may be a bracket 55 which can be joined to a pole 59 (Figs. 8 and 9) at a height above ground which, for reasons of safety, to prevent possible damage by emission of light from the connector 53 to an eye which is too close, is greater than the height of a person. The bracket 55 is fitted with a bolt 57 with an approximately horizontal axis, which permits an adjustment of inclination in an approximately vertical plane with respect to the pole. Further possibilities of angular adjustment in an approximately horizontal plane and of height adjustment may be provided by constructing the pole 59 from

two coaxial tubes 59A, 59B of stainless steel, which are fixed, after adjustment, with a suitable screw 59C. The light termination in the connector 53 may be provided with suitable converging lenses or with diffraction gratings as indicated by 60, which help to balance the brightness of the light point (penetration in fog) with its visibility from a greater or lesser angle of vision (angle of perception of the beam) and naturally to keep within the limits of danger for the eye, with suitable attenuation of the brightness per unit area of the section of the beam. The connector 53 is conveniently supplemented with a protective cylinder 61 for the emitting section of the fibre, to safeguard it from any deposits of dust and mud and exhaust emissions, without interfering with the outgoing light cone.

In conditions of good collimation of the beam leaving an optical fibre, obtained by means of a suitable lens, with a fibre length of the order of a hundred metres, the mean intensity of the perceptible radiation at a distance of 100 metres for different depths of fog is as follows:

VISIBILITY CONDITIONS (METRES)	INTENSITY OF LIGHT POINT (mW/cm <sup>2</sup> )
5	40 x 10 <sup>-6</sup>
25	63 x 10 <sup>-6</sup>
50	125 x 10 <sup>-6</sup>
75	188 x 10 <sup>-6</sup>
1000	750 x 10 <sup>-6</sup>

As a general guide, 100 x 10<sup>-6</sup> mW/cm<sup>2</sup> is clearly visible even in daylight, while 10 x 10<sup>-6</sup> mW/cm<sup>2</sup> is still visible at night. Additionally, in daytime fog the light beam has the characteristic of being visible in the form of luminous solids (truncated cones) which facilitate the identification of the obstacle being signalled. The ample possibilities of adjustment of the system and the efficiency of the collimated light beams make the system particularly useful for increasing motorway safety.

The objects and advantages of distribution by fibre according to the invention include the following:

A) transport of light beams over a distance for a number of light points from a single source located in a protected position, where installation is relatively simple and is similar to the techniques used in telecommunications;

B) flexibility of adaptation of the pattern of laser points to any route to be indicated;

C) automatic limiting of the intensity transmitted by the laser point to the values permitted by the law to protect the eyes; in fact, the individual fibre uses a calibrated fraction of the energy emitted by the laser and transmits an even smaller fraction of it; finally, the light termination may be such that it diffuses with a suitable adjustable angle, so that the specific emitted energy remains below the danger level (approximately 1 mW/cm<sup>2</sup> for one second);

D) absence of electrical energy along the motorway lanes, with evident advantages in respect of safety, since only light energy is present along the lane.

It is to be understood that the drawing shows only an example provided solely as a practical demonstration of the invention, and that this invention may be varied in its forms and dispositions without departure from the scope of the guiding concept of the invention.

### Claims

1. Motorway signalling system capable of operating in fog, characterized by the use of a laser source of coherent light and fibre optic distribution from the said source to a plurality of signal light points.
2. System according to Claim 1, characterized in that the signal light points are distributed along a route to be signalled, and at least one optical fibre runs to each of them.
3. System according to Claim 1 or 2, comprising a multiple connector between the laser source and a bundle of fibres, and branches of single fibres from the said bundle with corresponding terminals for connection to supports for light points.
4. System according to Claim 3, characterized in that a connecting terminal forming a light point comprises an optical system to create a desired aperture of the light energy beam emitted and protective means, such as a protective shell which is generally cylindrical.

## EP 0 613 981 A1

5. System according to Claim 3 or 4, characterized in that a light point support comprises a supporting member extending vertically and means of articulation in at least two orthogonal axes, for angular orientation;
- 5 6. System according to Claim 5, characterized in that the said support is a pole with a telescopic upper part whose position is adjustable angularly and axially, a terminal retaining bracket forming the light point being fitted to the said upper part in a configuration which is adjustable about a transverse axis.
- 10 7. System according to at least Claim 3, characterized in that it comprises a dichroic beam splitter or equivalent component at the output of the laser or of a light point, to obtain emissions of different colours from a single laser source.

15

20

25

30

35

40

45

50

55

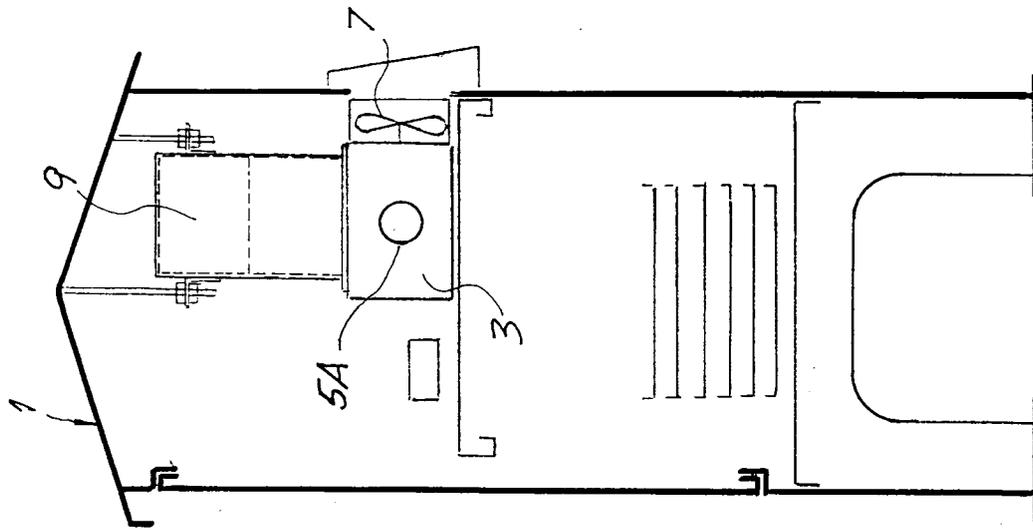


FIG. 2

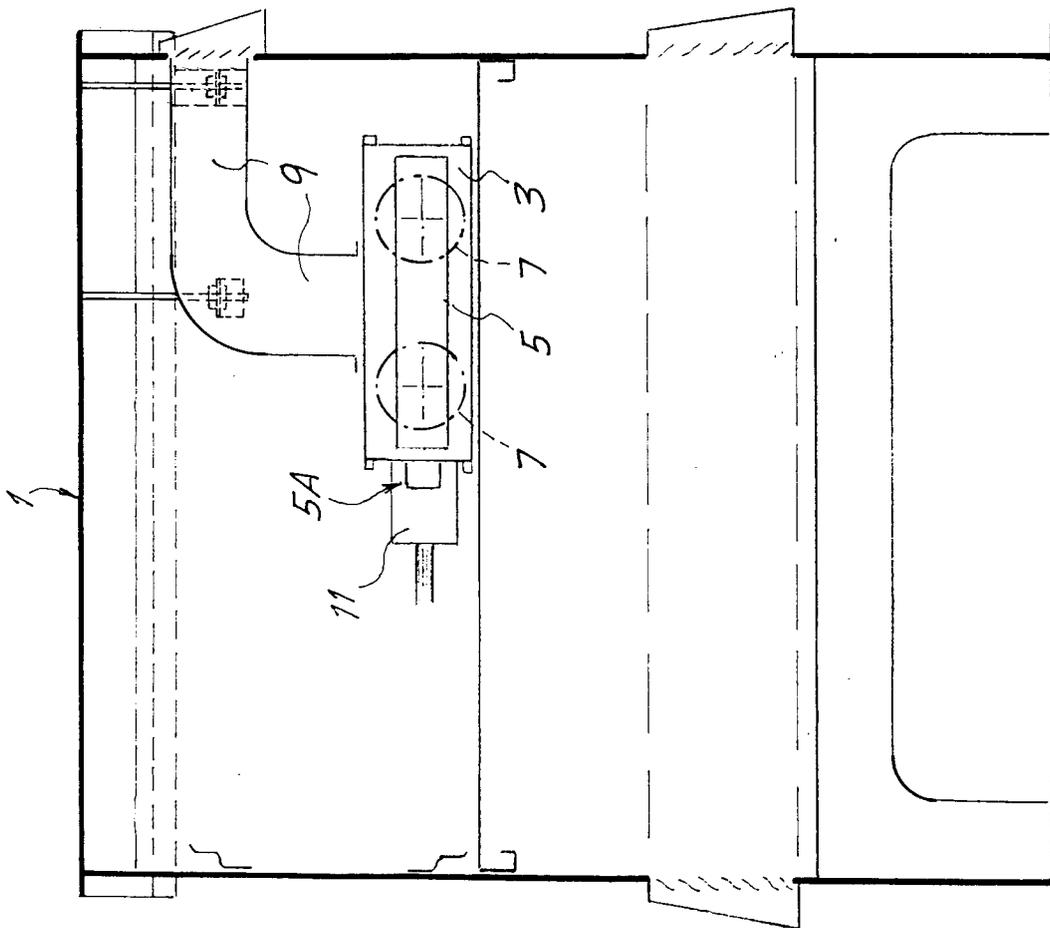


FIG. 1

FIG. 3

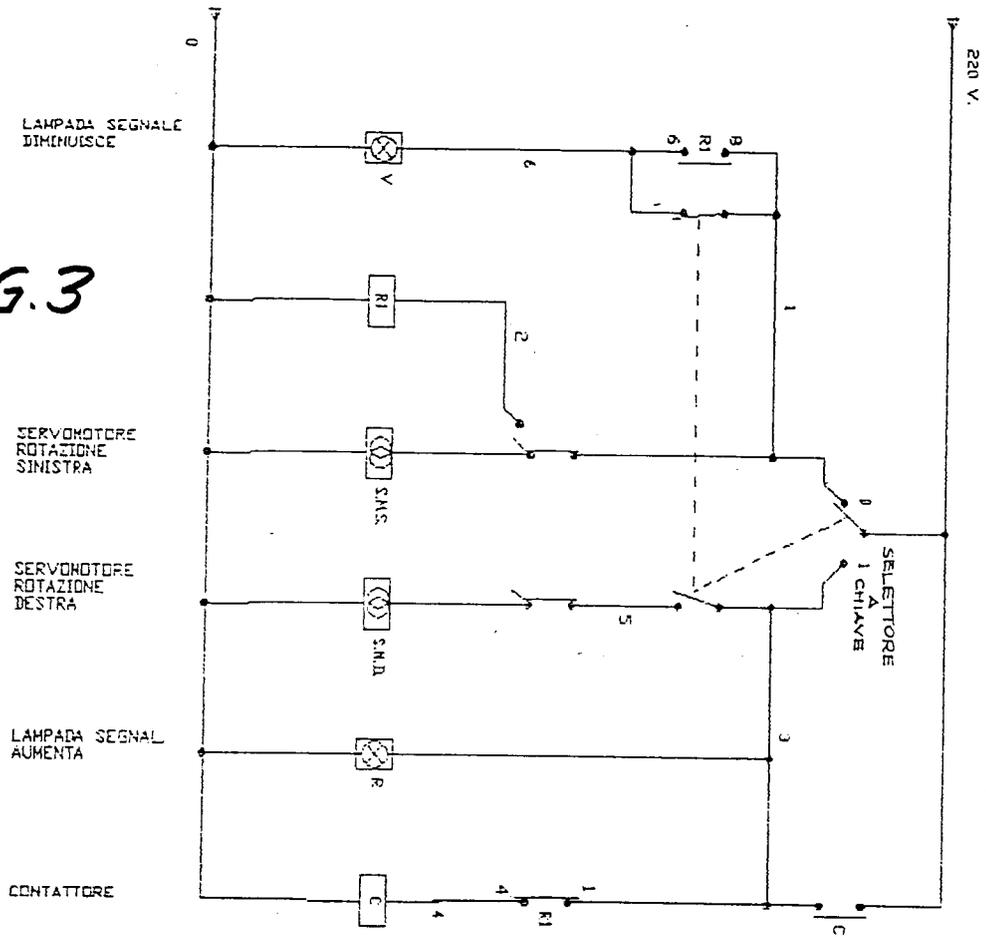


FIG. 4

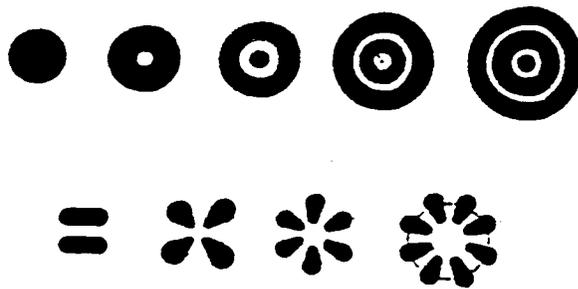
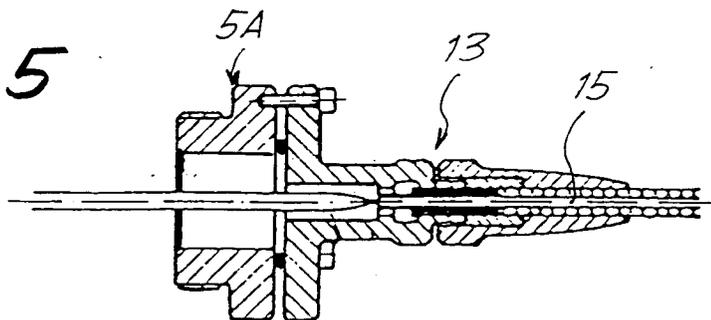
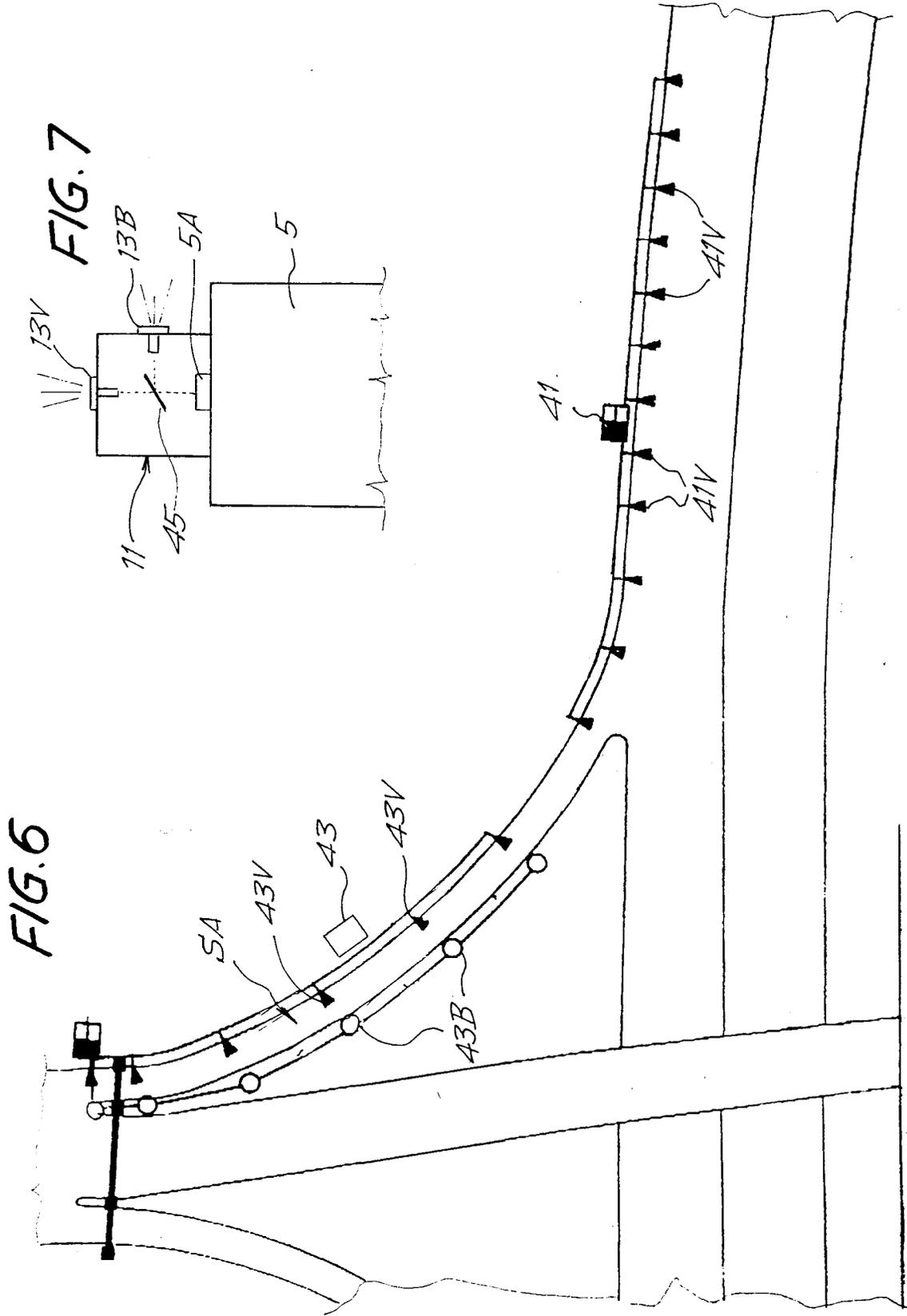
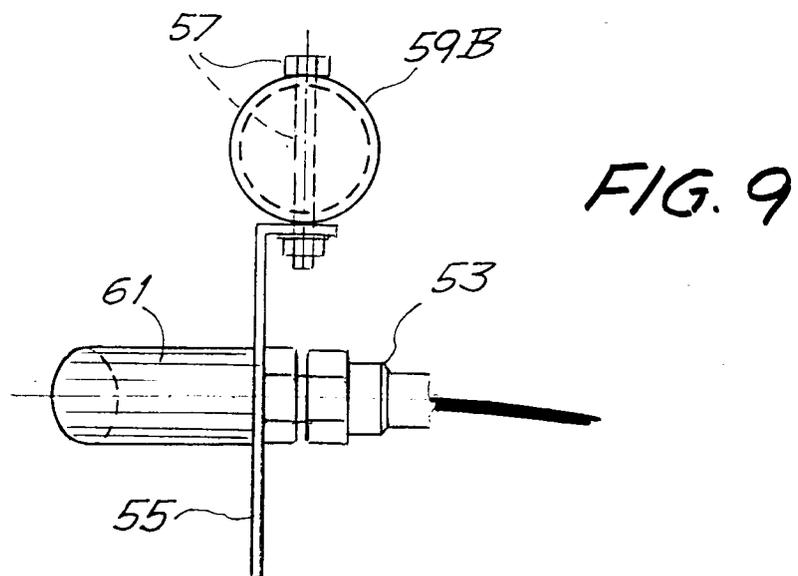
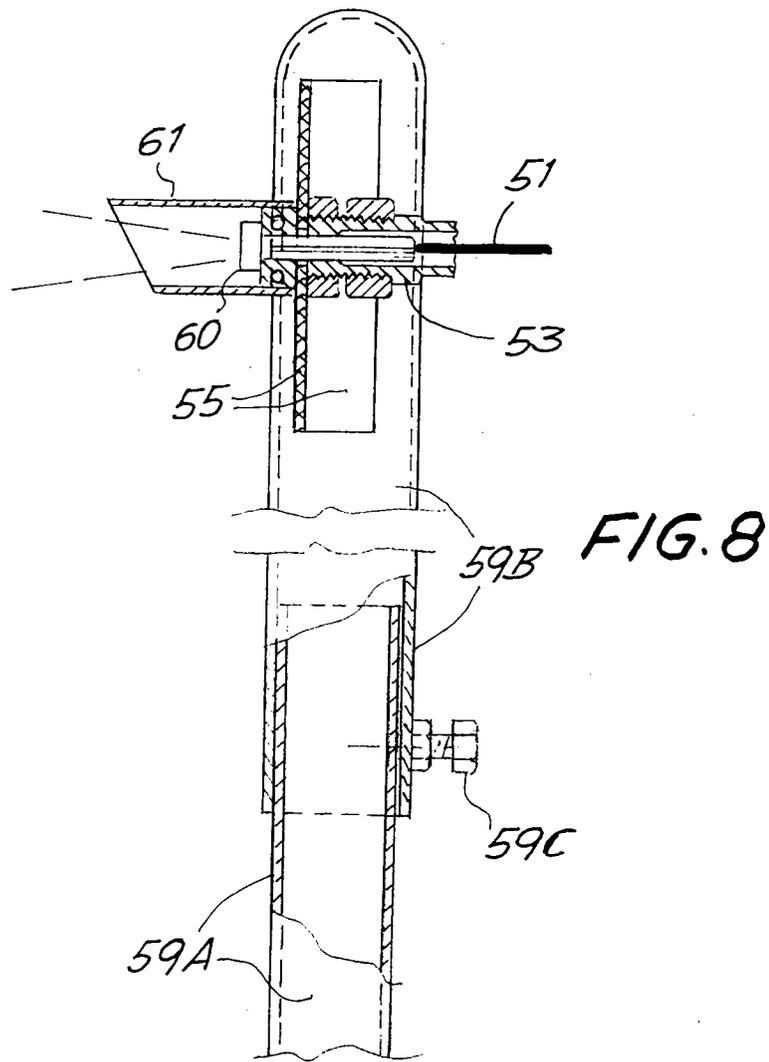


FIG. 5









European Patent  
Office

EUROPEAN SEARCH REPORT

Application Number  
EP 94 83 0097

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.5)
X	DE-A-24 18 327 (W. BRITSCH)	1-4	E01F9/00
Y	* the whole document *	5-7	
Y	DE-A-24 10 627 (G. HEIDT) * page 3, paragraph 3; figures *	5,6	
Y	DE-A-30 31 246 (B. FRITTEL)	7	
A	* page 12, paragraph 1; figures 1,2 *	1	
A	WO-A-87 04230 (THE SECRETARY OF STATE FOR TRANSPORT) * page 4, line 26 - page 5, line 31; figures *	1-3	
A	US-A-5 105 350 (D. E. TOLMAN) * figure 10 *	4	
The present search report has been drawn up for all claims			
Place of search		Date of completion of the search	Examiner
THE HAGUE		7 June 1994	Verveer, D
CATEGORY OF CITED DOCUMENTS		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons ..... & : member of the same patent family, corresponding document	
X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document			

TECHNICAL FIELDS  
SEARCHED (Int.Cl.5)

E01F

EPO FORM 1503 03.82 (F04C01)