EUROPEAN QUALIFYING EXAMINATION 2003

PAPER A
ELECTRICITY / MECHANICS

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CLIENT'S LETTER

Our company develops and produces electrical measurement and test devices for all kinds of industries and laboratories. Most of our devices are powered by electrical energy that is provided over standard electrical wires. Nevertheless, for particular applications, it is not possible to transport electrical energy to measurement or test devices that are installed in a confined environment. This is for instance the case when electromagnetic radiation is present in the areas to be traversed for supplying electrical energy. More specifically, electrical wires in those areas can act as antennae picking up external electromagnetic radiation and conducting it into the sensitive test environment, thereby unacceptably altering the test conditions.

A known alternative method to deliver energy and avoid the problems mentioned above is to transmit energy optically. Light, for instance light from a laser, is conveyed by an electrically non-conductive optical fibre to a photovoltaic cell which converts the optical energy into electrical energy.

However, such a cell produces a low voltage and many cells are required to be coupled in series to produce the desired voltage. Additionally, the voltage generated by the photovoltaic cells is a DC voltage (Direct Current) and is therefore not adapted to power most of our measurement and test devices which need a higher AC voltage (Alternating Current). Although there are DC to AC converters that can be used for converting a DC voltage generated by a photovoltaic cell into an AC voltage, these are temperature sensitive and require complicated electronic circuitry.

It is therefore desirable to directly convert optical energy into an AC voltage.

Figures 1 and 2 illustrate our system for converting optical energy into an AC vo
Figure 1 is a simplified diagram of the conversion system at rest and figure 2 is a simplified diagram of the system when supplied with energy in the form of a light beam.

As shown in figures 1 and 2, a laser 10, which is the sole source of energy for our conversion system, is arranged to direct light into an optical fibre 12. The fibre 12 conveys the light across a region 14 in which electromagnetic radiation is present and into a confined environment 16.

Once the light energy has entered the confined environment 16, it can be converted into electrical energy for supplying an electrical device 32, such as an instrument for measuring electromagnetic fields.

The conversion system comprises two prisms 20 and 22 disposed adjacent the end 24 of the optical fibre 12 for alternately receiving the light passing through the optical fibre 12. When light enters the prism 20 it reflects from the surface 20A to the photovoltaic cell 26 and when the light enters the prism 22 it reflects from the surface 22A to the cell 28. When illuminated, each cell 26, 28 converts the optical energy into a respective voltage.

The voltage output from the cells 26 and 28 is also supplied to electromagnetic coils 34 and 36, respectively. These coils act magnetically on ferrous elements 38 and 40 attached to the optical fibre 12, adjacent its end 24. The ferrous elements 38 and 40 are located on opposite sides of the optical fibre 12. They are positioned with respect to the coils 34 and 36 such that when current flows through one of the coils, the magnetic field generated by the coil will attract the associated element, drawing it towards the coil and thereby aligning the end 24 with the respective prism. In this manner the photovoltaic cells 26, 28 are alternately illuminated.

A clamp 35 provides a stationary pivot point 37 for the fibre 12. The pivot point is sufficiently close to the end 24 of the optical fibre 12 to maintain the movement of the fibre substantially within a single plane. This assures that the end 24 follows substantially the same path as it moves back and forth in response to the forces alternately generated by the coils 34 and 36.

The cells 26 and 28 are so connected that an output AC voltage is produced which then can be supplied to a transformer 30 to obtain the desired AC voltage for the device 32. The transformer 30 steps up the output AC voltage of the cells 26 and 28 to the level required by the device 32.

With the conversion system at rest, the fibre end 24 is slightly offset and faces the prism 20. In this manner, when the laser 10 is switched on, sufficient light is directed to the prism 20 and reflected to the photovoltaic cell 26 to initiate operation of the conversion system. The coil 34 is energized, drawing the optical fibre 12 towards it and thereby removing the light beam from the prism 20 and directing it to the prism 22. The light beam passing through the prism 22 illuminates the cell 28 which energizes the coil 36, drawing the optical fibre 12 towards it. This cycle repeats itself as long as the laser light enters into the conversion system, thereby oscillating the fibre end 24 back and forth between the coils 34 and 36.

The ferrous elements 38 and 40 need not be separate elements but can be a single ring or sleeve of ferrous material.

The prisms 20 and 22 may be replaced with mirrors. Alternatively, the cells 26 and 28 can be illuminated directly from the optical fibre 12 provided that the cells are suitably positioned close together.

In the above system, the optical fibre is reciprocated. However, other arrangeme[...] possible, provided that the light beam exiting the optical fibre is alternately directed t[...] the photovoltaic cells. For example, the prisms or photovoltaic cells may be reciprocated instead of the optical fibre.

We have just been informed that the problem of directly converting light energy into an AC voltage has already been addressed in the document D1 which is attached to this letter for your information.

As evidence of the suitability of an optical fibre to reciprocate, we have also enclosed the document D2.

CLIENT'S DRAWINGS

1/2

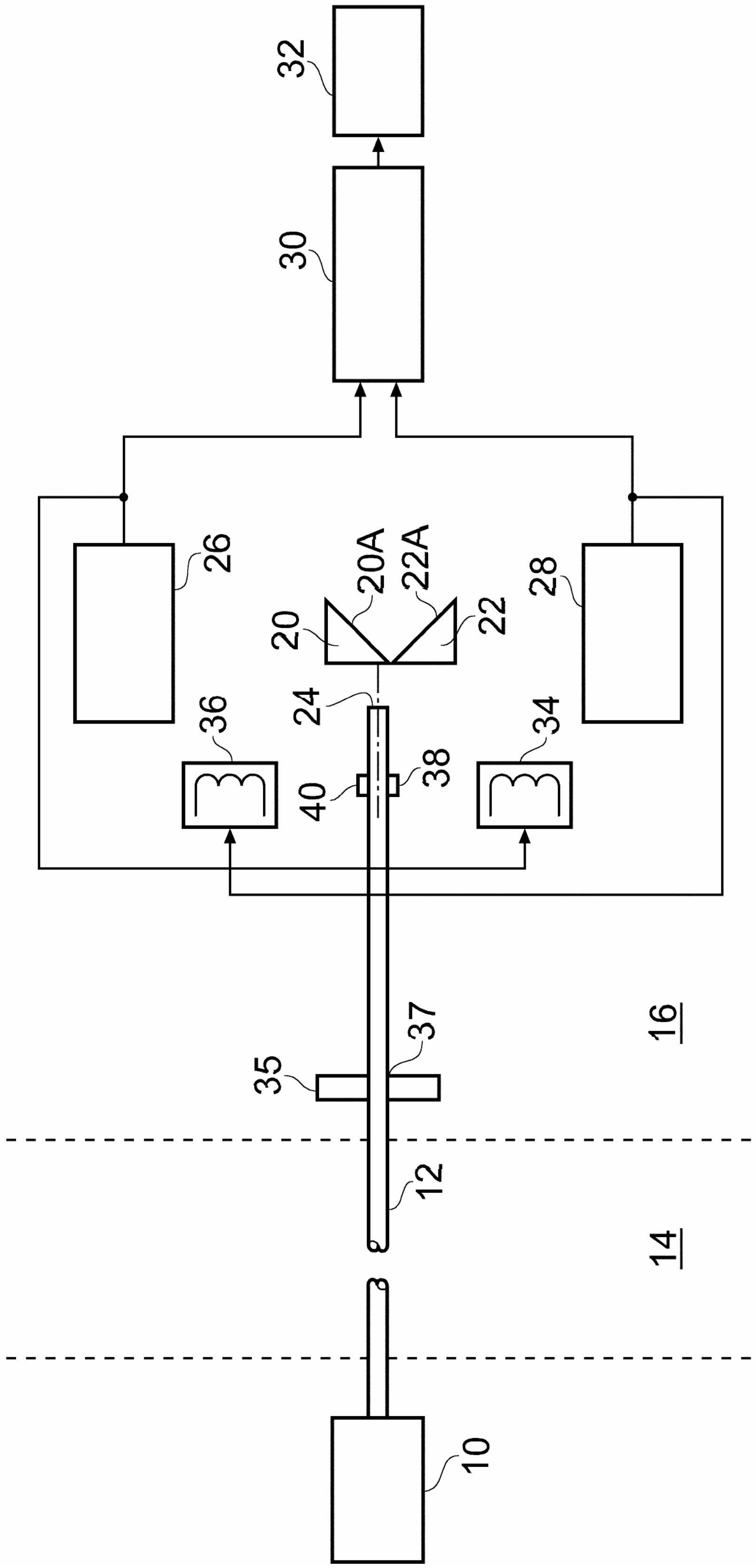

Fig. 1

CLIENT'S DRAWINGS

2/2

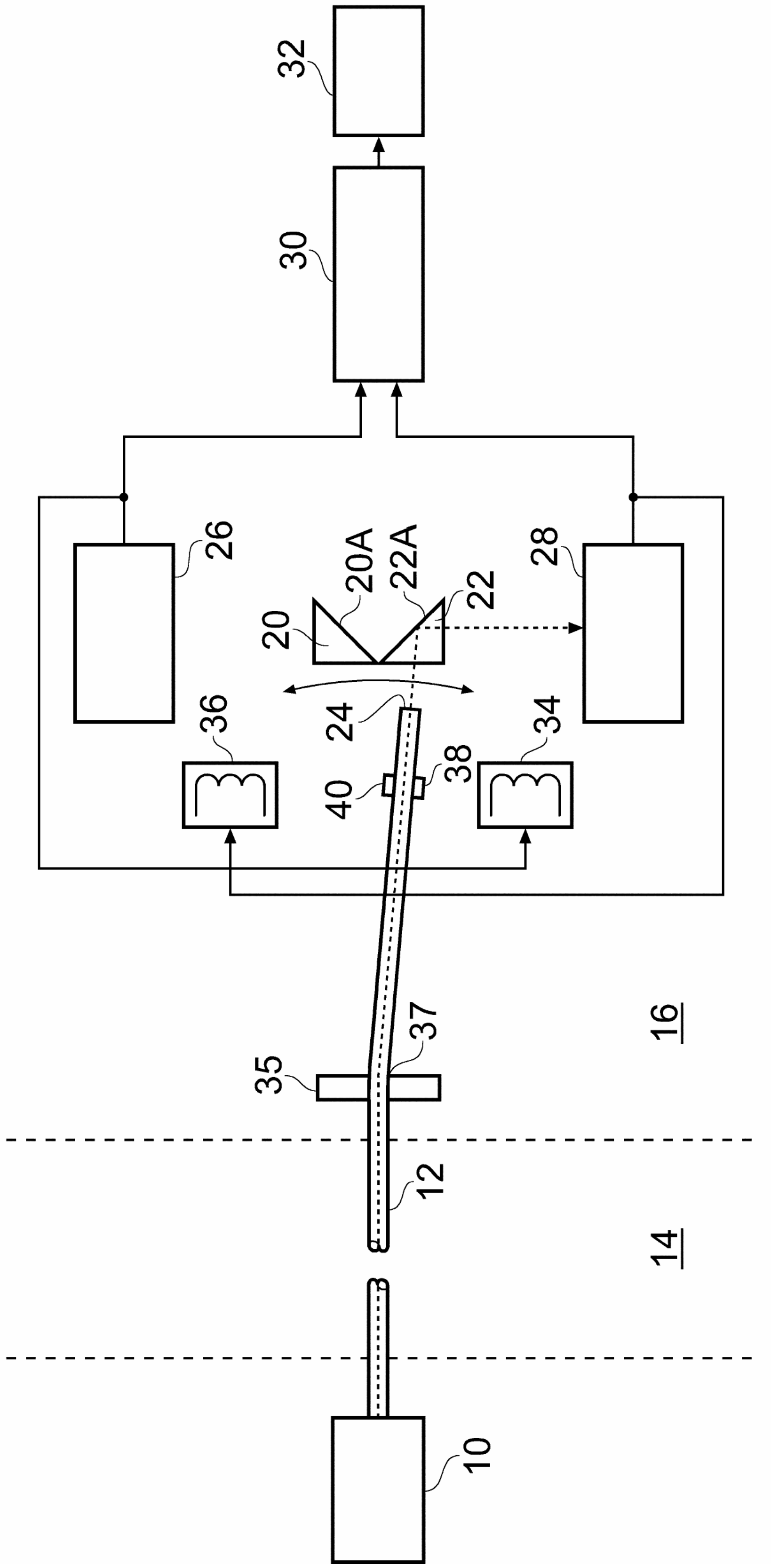

Fig. 2

DOCUMENT D1 (State of the Art)

The present invention relates to the known phenomena of photovoltaic current generation due to the absorption of light energy. This is usually achieved with a photovoltaic cell, commonly referred to as a solar cell, which converts light energy into electrical energy.

Solar cells generate a DC voltage. A DC to AC voltage conversion must be made for those electrical devices requiring AC voltage.

The invention provides a simple yet effective solar cell system in which light is converted to an AC voltage without any DC to AC converter.

Figure 1 is a schematic diagram of a solar cell system constructed in accordance with the invention.

The solar cell system 2 includes a pair of solar cells 4 and 6 connected with reversed polarities between a pair of terminals T1 and T2. Means are provided for directing light alternately onto the solar cells to generate an AC voltage across terminals T1 and T2.

Light is collected and focussed by a pair of lenses 8 and 10 to form a beam 12. A mirror 14 is pivoted about an axis 16 by a cam 18 driven by a motor 20. In the first mirror position the beam 12 is reflected along the path 22 to the solar cell 4. In the second mirror position the beam 12 is reflected along the path 24 to the solar cell 6. The light thus alternately impinges on the solar cells 4 and 6.

Alternatively, the light can be collected at a remote place or generated remotely by a laser. In such cases, it is transmitted to the mirror 14 through a wave guide, such as an optical fibre, and the lenses 8 and 10 can of course be omitted.

The motor 20 is a low power DC motor that is powered by a simple replaceable battery 26.

If necessary, the generated AC voltage can be stepped up by connecting a transformer between the terminals T1 and T2.

DRAWING DOCUMENT D1

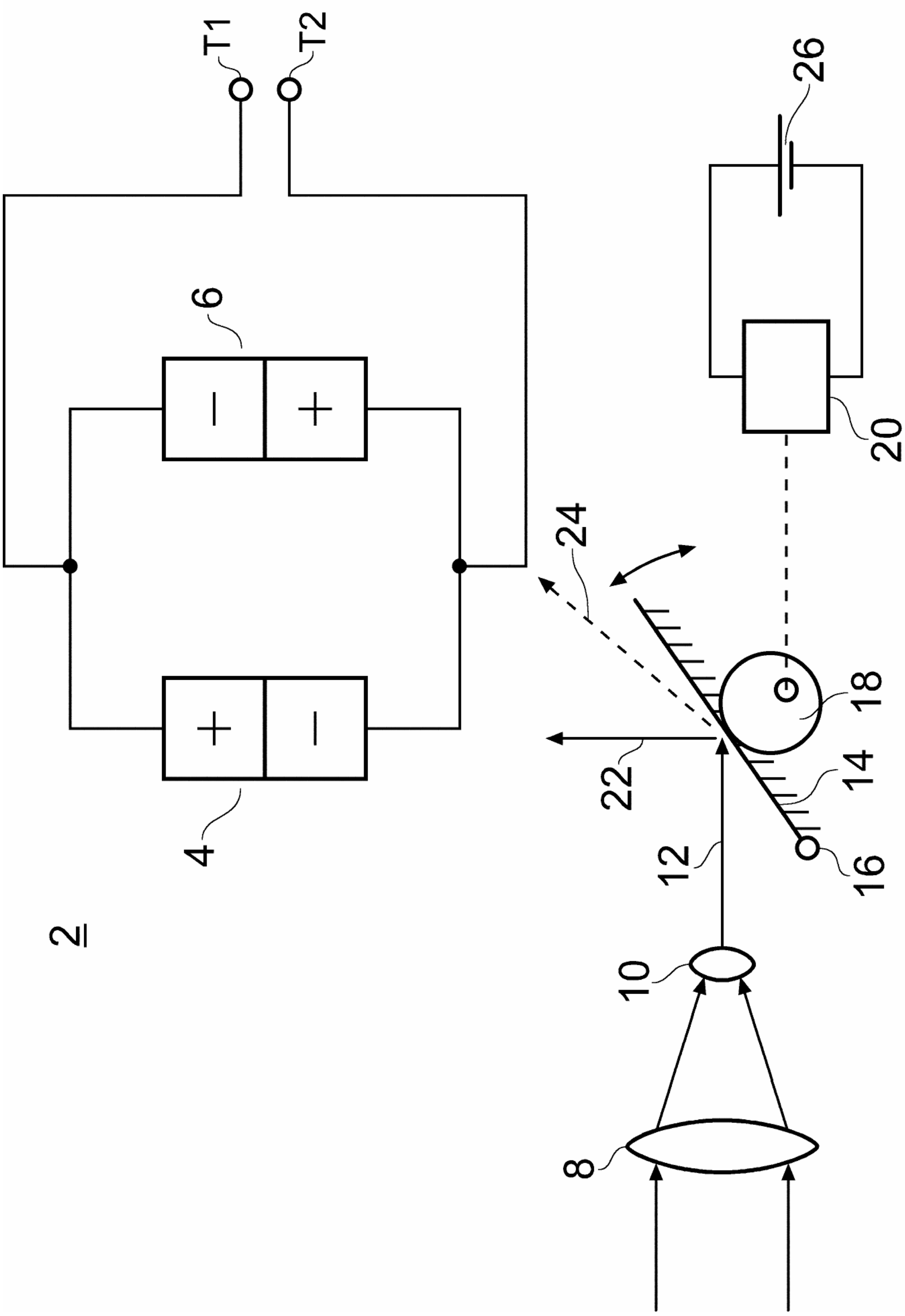

Fig. 1

DOCUMENT D2 (State of the Art)

The invention relates to a device for producing a flashing light at a remote location using optical fibres.

In the device shown in Figure 1 an input optical fibre 50 conducts light from a source (not shown) and is movable between first and second positions 52a and 52a'. In the first position 52a the fibre 50 is aligned with an output optical fibre 51. In the second position 52a' the fibre 50 is aligned with a photodetector 114, such as a photovoltaic cell. The photodetector 114 is connected to an electromagnet 118. A ferrous sleeve 120 is provided around the input fibre 50.

As long as the light source is not activated, the input fibre 50 is held in its second position 52a´ by a spring 116.

When the light source is activated, the illuminated photodetector 114 energizes the electromagnet 118 to attract the sleeve 120 and move the input fibre 50 about a fixed point 140 to its first position 52a. The light transmitted through the input fibre 50 thus passes through the output fibre 51 to a desired remote location (not shown). When the light from the input fibre 50 is removed from the photodetector 114 the spring 116 restores the input fibre to its second position 52a´, in which the photodetector 114 is illuminated but the output fibre 51 is not. The input fibre 50 thus oscillates back and forth between the first and second positions, such that a flashing light is produced at the desired location.

DRAWING DOCUMENT D2

1/1

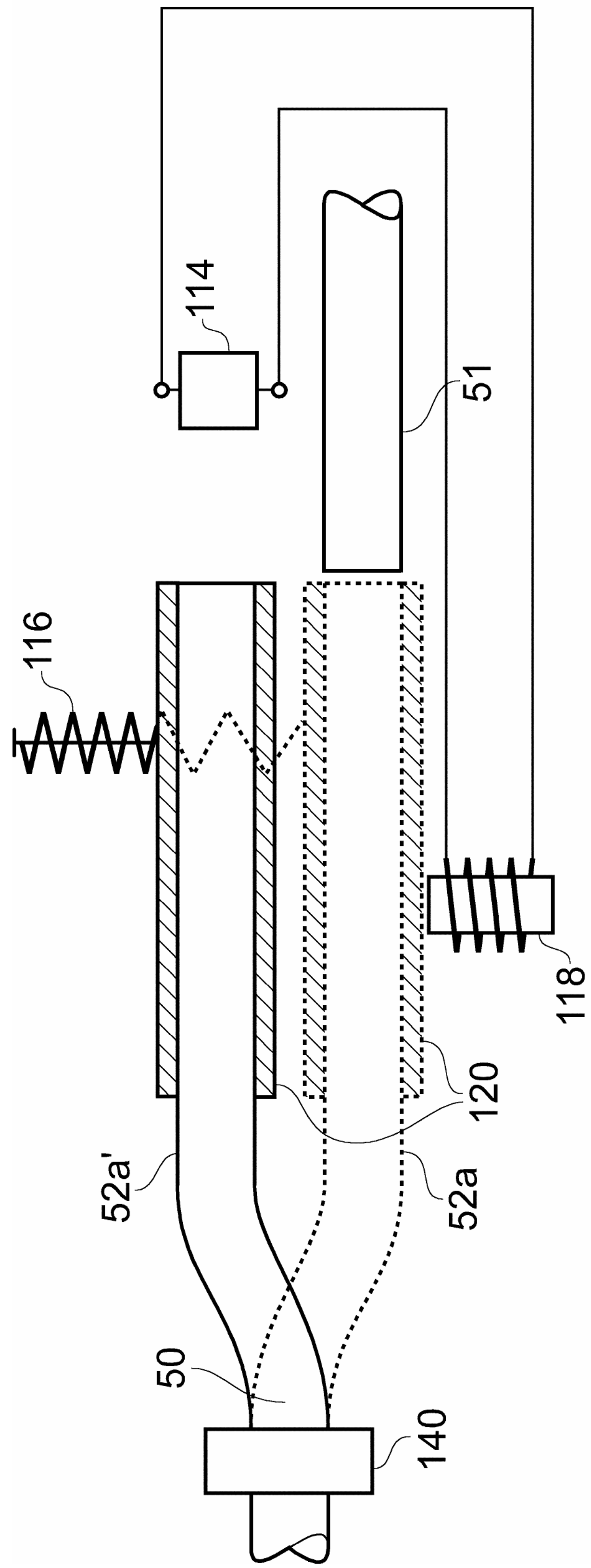

Fig. 1