

PATENT SPECIFICATION

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(54) STRAIN THRESHOLD ALARM DEVICE

(71) We, STANDARD TELEPHONES AND CABLES LIMITED, a British Company of 190 Strand, London WC2R 1DU, England, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to a strain threshold alarm device in which an alarm signal is generated if the strain in a structure incorporating the device exceeds a certain predetermined threshold.

According to the present invention there is provided a strain threshold alarm device wherein a structure whose strain is to be monitored has one or more optical fibres incorporated therein in such a way that strain of the structure in the axial direction of the fibre is coupled to the fibre or fibres, wherein a light source is provided at one end of the or each fibre, and a photo-detector at the other end of the or each fibre to receive the light transmitted therethrough, and wherein the electrical output of the or each photo-detector is connected to a level sensing device adapted to generate an alarm signal if the input level abruptly decreases by a proportion exceeding a predetermined threshold.

When such a structure is stressed in such a way as to subject at least one of the fibres to sufficient elongation to cause it to fracture, the transmission of light through the fibre is abruptly diminished. Experience shows even when the two broken ends remain in close register the increased loss consequent upon breakage is typically at least 2-3dB.

A feature of the alarm device is that the monitoring may be performed remote from the structure whose strain is being monitored, and hence the alarm device can be immune to electric/magnetic interference present in the neighbourhood of the structure. The breaking strain at which the alarm

is activated depends upon the strength of the fibres concerned, and by suitable preparation fibres can readily be made with a range of different breaking strains. Typically these can be arranged throughout the range 50 from 0.2% to 2.0% elongation.

This form of strain monitoring can be applied to a wide variety of different structures including land, sea, and air vehicles, large frame structures, for instance of steel or concrete, such as drilling production platforms, bridges, and dams. The optical fibre or fibres may be included as a small diameter cable bonded into the structure each with its associated photodetector.

A particular application for this form of strain monitoring lies in monitoring high pressure oil pipelines, particularly in the marine environment, where a pipe failure could give rise to extensive pollution of the environment.

A strain threshold alarm device for a high pressure oil pipeline is illustrated schematically in the drawing accompanying the Provisional Specification. An optical fibre cable 10 is helically wrapped around a pipeline 11 and covered with a protective sheath (not shown). Conveniently the wrapping around is in a double helix so that the two ends of the cable lie at the same end of the pipeline. Light from a source 12, such as a light emissive diode or injection laser, is directed into one end of the cable 10, and the light transmitted therethrough is received by a detector 14. The output of the detector 15 which generates an alarm signal at an output 16 if ever the received level abruptly diminishes by an amount exceeding a predetermined threshold. The light source does not need to be operated continuously, but can be pulsed if somewhere in the system the response is integrated sufficiently to smooth out the pulses.

In a modification of the above described

device, part of the light from the source 12 is directed straight to a second detector (not shown), and the outputs of the two photo-detectors and compared in a differential amplifier before the difference signal is fed to the level sensing device 15. This modification is provided to make the alarm insensitive to fluctuations in the intensity of output of the light source.

10 WHAT WE CLAIM IS:—

1. A strain threshold alarm device wherein a structure whose strain is to be monitored has one or more optical fibres incorporated therein in such a way that strain of the structure in the axial direction of the fibre is coupled to the fibre or fibres, wherein a light source is provided at one end of the or each fibre, and a photo-detector at the other end of the or each fibre to receive the light transmitted therethrough, and wherein the electrical output of the or each photo-detector is connected to a level sensing device adapted to generate an alarm signal if the input level abruptly decreases by a proportion exceeding a predetermined threshold.

2. An alarm device as claimed in claim 1 wherein associated with the or each fibre is a single light source and a pair of photo-detectors whose outputs are connected to the inputs of a differential amplifier that forms part of the level sensing device, and

wherein both detectors of said pair of detectors are positioned to receive light from said single light source but only one of them to receive said light via said fibre incorporated into the structure in such a way that strain of the structure in the axial direction of the fibre is coupled to the fibre.

3. A strain threshold alarm device substantially as hereinbefore described with reference to the drawings accompanying the Provisional Specification.

4. A vehicle incorporating an alarm device as claimed in any preceding claim.

5. A static structure incorporating an alarm device as claimed in claim 1, 2 or 3.

6. A static structure having one or more optical fibres incorporated therein in such a way that when stress is applied to the structure to strain it that strain produces longitudinal strain in said fibre or fibres, wherein the or each fibre has an associated photo detector receiving light transmitted through said fibre from a light source, the electrical output of which photo detector is connected to a level sensing device adapted to generate an alarm signal if the input level abruptly decreases by a proportion exceeding a predetermined threshold.

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2. An alarm device as claimed in claim 1 wherein associated with the or each fibre is a single light source and a pair of photo-detectors whose outputs are connected to the inputs of a differential amplifier that forms part of the level sensing device, and

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