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(54) Benævnelse: **REGN-/VÆSKESENSOR MED ABSORPTION AF INFRARØDT LYS**

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DESCRIPTION

[0001] The present invention relates to a rain/liquid sensor according to the preamble of claim 1, and to a weather station comprising such a rain/liquid sensor.

[0002] Such a sensor is known from EP 0 680 860 A2. The known sensor comprises a light transmitter having at least one LED which is arranged to transmit light of a certain intensity, and a light receiver which is arranged to receive the transmitted light after it has travelled through the outside air and convert it to an electric output signal which contains a measure of the absorption of the transmitted light signal experienced in the outside air. The sensor further comprises a circuit with a first input connected to the light receiver and an output for supplying an electric signal which comprises a measure of a current quantity of falling liquid or rain in the outside air per unit of time. The density of falling drops in combination with the average dimensions of these drops and the shapes of individual drops is reflected in the light energy absorption eventually measured on the falling drops. In the sensor the signal representing the level of the emitted light that is the reference signal (P_0) is derived from the received light.

[0003] It is an object of the invention to provide an improved rain/liquid sensor yielding up-to-date and more reliable results, and being suitable, in addition, for applications requiring greater accuracy.

[0004] To achieve this, the rain/liquid sensor according to the invention is characterized in that:

the circuit is a differential circuit having a second input connected to the light transmitter for supplying an electric differential signal based on signals on both said inputs, and

the rain sensor comprises an element for adjusting the transmitting current and a daylight sensor connected to said element, which daylight sensor measures the intensity of daylight in the outside air and uses this measurement to adjust, together with the adjusting element arranged for this purpose, the intensity of the light transmitted by the LED.

[0005] An advantage of the rain/liquid sensor according to the invention resides in that the absorption related to the original light intensity transmitted by the light transmitter provides the output signal of the differential circuit with a reliable measurement result for absorption of the transmission signal at the current amount of falling drops per unit of time within the surface area of the air or space receiving the light. In particular the circuit being a differential circuit has a second input which is connected to the light receiver. As a result, the rain/liquid sensor obtained is simple in terms of hardware, but it is up to date and accurately determines the amount of rain/liquid, and the rain/liquid sensor can also be used for applications which, more generally formulated, require greater accuracy and insight into the currently falling amounts of liquid into a liquid sensor.

[0006] Furthermore the adjusting member/element uses the measured daylight to adjust the current to the LED and hence the intensity of the emitted light. As a result, varying disturbing daylight has less or no effect at all on the captured light.

[0007] In practice, persons skilled in the art can produce the sensor according to the invention either in an analogue or digital way, depending on the requirements, by means of corresponding electronic components.

[0008] Further detailed, possible embodiments explained in the other claims are mentioned, together with the associated advantages, in the following description.

[0009] The rain/liquid sensor according to the present invention will now be explained in greater detail with reference to the figure mentioned below, in which corresponding elements are indicated by means of the same reference numerals, and in which:
Figure 1 is a diagrammatic view of a rain/liquid sensor according to the present invention which, in principle, can be technically constructed in various ways.

[0010] Figure 1 shows a diagrammatic view of a rain or liquid sensor 1. The sensor 1 comprises a light transmitter 2 comprising preferably one or more LEDs 3 as transmitting element, preferably transmitting infrared light to a space or the outside air 4 where rain drops D can fall and then interact with the transmitted light. If the sensor 1 is used as a liquid sensor, the interaction takes place with drops D falling in the (outside) air or in the space.

[0011] The sensor 1 further comprises a light receiver 5 comprising, for example, one or more photodiodes on which the transmitted light is incident after absorption at the rain drops D falling on the receiver 5, which photodiode converts said light into an electric output signal. This output signals contains an electric measure of the absorption of the transmitted light in the outside air 4, in particular at rain drops D falling in the outside air.

[0012] In figure 1, the diagrammatically shown light intensity or variation in light intensity as a function of time of the light received in the receiver 5 is used to determine the difference with the intensity of the transmitted light. For the latter use can be made, if necessary, of the DC-level of the received light intensity shown in the diagram. Said difference is caused by light absorption at the drops D travelling through the free space or air 4 and it is a measure of the currently falling amount of drops D per unit of time. In practice, the light receiver 5 comprises a differential circuit 6 having inputs 7, 8. One of the inputs is connected to the light receiver 5, and a signal which is representative of the intensity of the light emitted by the LED 3 is applied to the other input. The circuit 6 further comprises an output 9 to which an electric differential signal has to be applied which contains a measure of said light absorption which in turn is a measure of a current amount of falling drops D.

[0013] To counteract the incidence of daylight in the light receiver 5 as much as possible, the sensor 1 may comprise a daylight shielding element, such as an infrared filter 10, which is located in front of the light receiver 5. In practice, the wavelength of the light emitted by the

LED 3 is in the near-infrared range between 780 nm and 3 um, particularly near 850 nm. Daylight causes a slowly changing contribution of light energy as a function of time, which leads in the receiver 1 only to the detection of a direct-voltage level (DC level). As is shown in figure 1, said DC level is removed by incorporating a compensation circuit 11, diagrammatically shown, in the receiver 5. This could be a high-pass filter or band-pass filter which removes at least the DC component, and which removes the higher, possibly disturbing, frequencies from the received light signal, as long as these frequencies are not representative of the absorption of light at the drops D.

[0014] The sensor 1 may comprise an oscillator 12, which may or may not be pulsed, and which is connected to the light transmitter 2, said oscillator being in particular a pulse or block-wave oscillator. During actual pulses or block waves B, wherein the light is emitted by the LED, said light, which is at least partly absorbed by one or more drops D, is temporarily attenuated leading to light disturbances or dips 13, shown in figure 1, which are detected in the light receiver 5. Light absorption at small-size or large-size drops D leads to dips 13 having distinguishable depths and widths in the light-absorption pattern shown. The surface area of a disturbance 13 relative to the DC level has been found to be a reliable measure of the size of the falling rain drops D. Specifically, said surface area in combination with the frequency of falling drops D, i.e., the frequency of the dips 13, provides reliable information about, in particular, the amount of rainfall per surface area per unit of time. The electronic circuits arranged behind the light receiver 5 supply a signal containing said information to output 9. Any non-linearities between the surface area of the dips 13 or the frequency of the dips and the actual amount of precipitation can be corrected in the analogue or digital output signal.

[0015] In the case of pulsed operation, as mentioned hereinabove, the pulse frequency of the pulse-shaped or block-wave light transmitted by the transmitter 2 lies in the range of 0-10 KHz, in particular 0-5 KHz, to enable repeated measurements of the rain to be carried out.

[0016] If disturbing daylight is or can be incident on the receiver 5, then, in addition to the filter 10, a daylight sensor 14 measuring the daylight intensity in the space or the outside air 4 may offer a solution. In this case, the sensor 1 comprises an element 15 for adjusting the transmitting current, which adjusting element is located in the light transmitter 2 and is connected to the daylight sensor 14. The adjusting member 15 uses the measured daylight to adjust the current to the LED and hence the intensity of the emitted light. As a result, varying disturbing daylight has less or no effect at all on the captured light.

[0017] The present rain/liquid sensor 1 can be implemented by a person skilled in the art in an analogue or either partly or completely digital way. The figure shows diagrammatically an analogue implementation. In a further possible embodiment, the sensor 1 comprises an analogue-digital (A/D) converter, not shown in the figure, wherein the output of the differential circuit 6, if it is an analogue differential circuit, is connected to the A/D converter to supply a digital representation of the electric differential signal.

[0018] In, for example, remote weather stations at least the locally measured current volume

of rain is sent in a digital, often wireless, way to a processing central collector.

[0019] Dewatering- and watering systems, or drainage systems such as used for riding arenas will benefit if, immediately after a change in rain condition, local, accurate, quantitative action can be taken even before the adverse effects of a shower on the soil are noticeable.

REFERENCES CITED IN THE DESCRIPTION

Cited references

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Patent documents cited in the description

- EP0680860A2 [0002]

REGN-/VÆSKESENSOR MED ABSORPTION AF INFRARØDT LYS

PATENTKRAV

1. Regn-/væskesensor (1), der omfatter:

- en lyssender (2) med mindst én LED-diode (3), der er indrettet til at udsende lys af en vis intensitet,

- en lysmodtager (5), der er indrettet til at modtage det udsendte lys, efter at det har rejst gennem udeluften (4), og konvertere det til et elektrisk udgangssignal, der indeholder et mål for absorption af det udsendte lyssignal, der opleves i udeluften (4), og

- et kredsløb (6) med en første indgang (8), der er forbundet med lysmodtageren (5), og en udgang (9) til at levere et elektrisk signal, der omfatter et mål for en strømmængde af faldende væske eller regn i udeluften (4) pr. tidsenhed,

kendetegnet ved, at

kredsløbet (6) er et differentialkredsløb (6) med en anden indgang (7), der er forbundet med lyssenderen (2) for at levere et elektrisk differentialsignal baseret på signaler på begge indgange (7, 8), og

regnsensoren (1) yderligere omfatter et element (15) til justering af sendestrømmen og en dagslyssensor (14), der er forbundet med elementet (15), hvilken dagslyssensor (14) måler intensiteten af dagslys i udeluften (4) og bruger denne måling til sammen med justeringselementet (15), der er indrettet til dette formål, til at justere intensiteten af lyset, der udsendes af LED-dioden (3).

2. Sensor (1) ifølge krav 1, kendetegnet ved, at den mindst ene LED-diode er en infrarød LED-diode (3).

3. Sensor (1) ifølge krav 1 eller 2, kendetegnet ved, at bølgelængden af lyset, der udsendes af LED-dioden (3), er i det nærinfrarøde område mellem 780 nm og 3 µm, især nær 850 nm.

4. Sensor (1) ifølge et hvilket som helst af kravene 1-3, kendetegnet ved, at differentialkredsløbet (6) er et digitalt eller analogt differentialkredsløb.

5. Sensor (1) ifølge et hvilket som helst af kravene 1-4, kendetegnet ved, at regnsensoren (1) omfatter en analog til digital (AD)-konverter, og udgangen (9) af

differentialkredsløbet (6), hvis det er et analogt differentialkredsløb, er forbundet med AD-konverteren for at levere en digital repræsentation af det elektriske differentialsignal.

6. Sensor (1) ifølge et hvilket som helst af kravene 1-5, kendetegnet ved, at regnsensoren (1) omfatter et dagslysblokerende element, såsom et infrarødt filter (10), foran lysmodtageren (5).

7. Sensor (1) ifølge et hvilket som helst af kravene 1-6, kendetegnet ved, at regnsensoren (1) omfatter en AC-spændingsgenerator (12), der kan være pulseret eller ikke-pulseret, eller en puls- eller blokbølgegenerator (12), der er forbundet med lyssenderen (2), og et kompensationskredsløb (11), der er indrettet til at fjerne DC-niveauet, der er repræsentativt for dagslys modtaget af lysmodtageren (5), fra signalet modtaget af lysmodtageren (5).

8. Sensor (1) ifølge krav 7, kendetegnet ved, at pulsfrekvensen af det puls- eller blokformede lys, der udsendes af lyssenderen (2), ligger i området 0-10 KHz, især i området 0-5 KHz.

9. Vejrstation, der omfatter en regn-/væskesensor (1) ifølge et hvilket som helst af kravene 1-8.

DRAWINGS

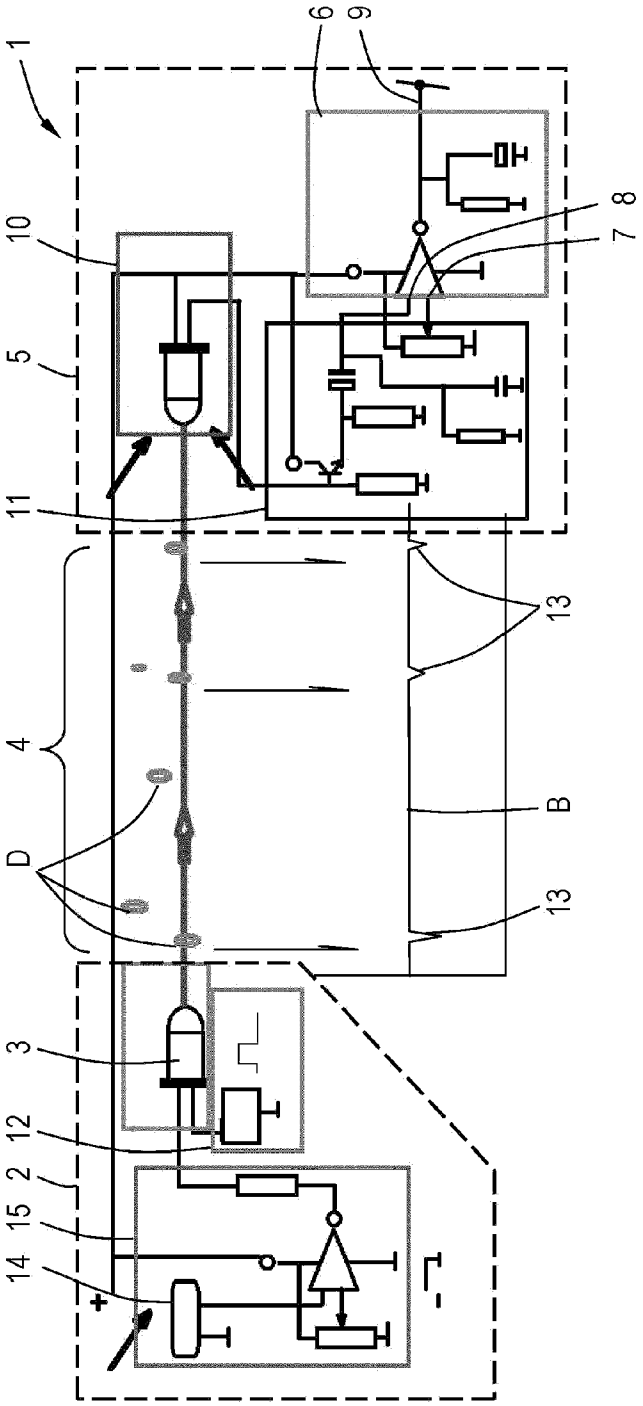

Fig.1