HU000026844T2

(19) **HU**

(11) Lajstromszám: **E 026 844**

(13) **T2**

MAGYARORSZÁG
Szellemi Tulajdon Nemzeti Hivatala

EURÓPAI SZABADALOM
SZÖVEGÉNEK FORDÍTÁSA

(21) Magyar ügyszám: **E 06 701141**
(22) A bejelentés napja: **2006. 01. 18.**

(96) Az európai bejelentés bejelentési száma:
EP 20060701141
(97) Az európai bejelentés közzétételi adatai:
EP 1842004 A1 **2006. 07. 27.**
(97) Az európai szabadalom megadásának meghirdetési adatai:
EP 1842004 B1 **2015. 08. 26.**

(51) Int. Cl.: ***F21S 8/00*** *(2006.01)*
F03D 11/00 *(2006.01)*
F21W 111/06 *(2006.01)*

(86) A nemzetközi (PCT) bejelentési szám:
PCT/EP 06/000394
(87) A nemzetközi közzétételi szám:
WO 06077084

(30) Elsőbbségi adatok:
102005002650 **2005. 01. 19.** **DE**

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(54) **Rúdfény torony kivilágítására**

FLASH LIGHT FOR ILLUMINATING A TOWER

Description

The invention relates to a flash light for illuminating a tower, in particular of a wind turbine, having a rod-like retention member, at the first end of which illumination means are arranged and at the second end of which illumination means connections are arranged. It further relates to a wind turbine whose tower or tower element is characterised by at least two flash lights which are arranged in holes in a tower wall. The invention further relates to a method for fitting an illumination of a tower, in particular a wind turbine.

The towers of wind turbines which are currently conventional do not have a distinguishing night illumination. In order to protect air traffic in the vicinity of often very extensive wind parks, comprising a plurality of individual wind turbines, however, a lack of night identification is extremely disadvantageous since such regions have to be avoided by a large distance and in particular constitute an obstacle for recreational air traffic.

DE 103 58 962 A1 discloses a wind turbine having a tower which has at least one obstacle illumination which emits outwards, for which purpose there is provided in the tower at least one aperture, through which a supply line is laid outwards from the inner side of the tower. It is possible to guide, for example, a light source conductor through the aperture as a supply line, in place of electrical lines in order to then achieve desired emission characteristics using a prism or lens system.

Document US 1,874,571 A (MITCHEL GEORGE L) is known as additional prior art.

An object of the invention is to provide a technical solution which is as simple and cost-effective as possible in order to provide a tower, in particular a wind turbine which has already been erected, or a tower element for a wind turbine which has yet to be erected, with an illumination.

This object is achieved according to the invention with a device of the type mentioned in the introduction in that the flash light can be inserted from the inner side through a hole in the tower wall so that the illumination means emit in the environment of the tower. It is consequently possible in a very simple and cost-effective manner for a tower of a wind turbine which has already been erected to be retrofitted with an illumination which protects air traffic at different heights of the tower or to pre-fit a tower element of a wind turbine which has yet to be erected with such an illumination so that, in the erected state of the tower, only the illumination means connections have to be contacted.

The flash light according to the invention has illumination means at the first end thereof and illumination means connections at the second end thereof. The illumination means are preferably LEDs since these are nowadays available relatively cheaply and with high light intensities. LEDs have a long service-life with the result that the complexity of maintenance operations and replacement of flash lights is kept as low as possible. Furthermore, LEDs are very small so that a flash light, in spite of being provided with a plurality of illumination means of this type, has a small diameter. The flash light is intended to have the smallest possible diameter at the first end which can be inserted through the tower wall since, as a result of the statics of the tower, large holes in the tower wall are intended to be prevented.

The illumination means connections are connected by means of a connector to supply lines which are located inside the tower. These lines are connected to a central control cabinet, which takes over the control, preferably as constant current control, of the flash light. This embodiment is particularly advantageous since in this manner no electronic system is required inside the flash light. Such a flash light is particularly simple and

cheap to produce. The operator of the wind turbine can therefore replace a defective flash light with a new one in a rapid, simple and cost-effective manner.

The illumination means are preferably provided with a signal device in order to be able to inform the operator of the tower of the failure of an illumination means or the illumination means and to be able to replace the flash light as quickly as possible. This signal device may, for example, comprise a photo resistor which provides information relating to the function of the illumination means. A preferred embodiment is an extra communication line as a signal device, in addition to the supply lines, which is connected to the illumination means by way of the illumination means connections. The illumination means are arranged in series so that a failed illumination means interrupts the flow of current and the communication line transmits a corresponding signal to the central control cabinet and consequently to the operator. It would also be conceivable to have a parallel connection of the illumination means, which would have the advantage that, in the event of a failure of an illumination means, the remaining illumination means are not impaired in terms of their function.

A cap is preferably fitted over the illumination means as a protective layer which protects the illumination means which are exposed to weather conditions against environmental influences, in particular weather conditions. In this instance, a preferred embodiment of this cap is a protective layer which is cast with transparent material. A dome, preferably of glass, which is located above the illumination means is cast, preferably with transparent optical resin, which, on the one hand, protects the illumination means and seals it with respect to the environment but, on the other hand, also serves to fix the illumination means inside this dome.

Over this protective layer, there is preferably arranged a curved member, preferably produced from metal, in order to ensure protection of the illumination means and the protective cover, against mechanical influences, such as, for example, during crane operations on the pod or on the tower.

The hole in the tower wall, through which the flash light according to the invention can be inserted, is preferably orientated horizontally, that is to say, parallel with the ground, in order to ensure a similarly horizontal orientation of the illumination means. In a preferred embodiment, there is arranged in a horizontal hole in the tower wall a sleeve which acts as a guide for the flash light which can be inserted into the tower wall. The flash light is the precisely fitting counter-piece to the sleeve, which predetermines the optimum positioning of the flash light in such a manner that the flash light is orientated horizontally in the transverse axis and the illumination means which are preferably arranged therein in a line are arranged horizontally.

There is further arranged on the sleeve or on the protective curved member a device which indicates the optimum position of the flash light in which the flash light protrudes so far from the tower that it emits at the largest possible spatial angle. At the inner side of the tower wall, there is arranged a support which enables an optimum adjustment of the sleeve or the flash light.

The illumination means are further preferably arranged in a line in order to ensure the best possible illumination in a horizontal direction. In such an embodiment, a tower, preferably a wind turbine, or a tower element is configured with at least two flash lights which are arranged thereon in a tower plane in such a manner that it can be illuminated at a spatial angle of 360°.

The fitting of an illumination of a tower, in particular a wind turbine, is carried out according to the invention in such a manner that the first end of a flash light is introduced from the inner side through a hole provided in the tower wall into a position which can be seen from the outer side and the illumination means

connections of the second end of the flash light are connected to supply lines which are arranged inside the tower. This enables simple and cost-effective retrofitting of a tower which has already been erected. To this end, there are only required operations which can be carried out from a platform which is arranged inside the tower so that no complex crane operations are required on the outer wall of the tower. A hole which is provided for the flash light is drilled into the tower wall, preferably with a diameter of only a few centimetres, in order not to impair the statics of the tower. The flash light has at the first end a small diameter in order to be able to be inserted into this hole in a precisely fitting manner. The portion which remains inside the tower serves to orientate the flash light.

Based on the flash light according to the invention, the invention relates to a wind turbine or a tower element, wherein at least two flash lights are fitted to a tower of a wind turbine or a tower element in such a manner that this tower or this tower element is visibly distinguished in all directions relevant to air traffic. The flash lights protrude in this instance to such an extent from the tower that, for example, two flash lights emit at 180°, respectively, or three flash lights at 120°, respectively, or similar embodiments in which at least two flash lights illuminate the complete outside space of the tower. An embodiment is preferred in which the fewest possible holes have to be introduced in the tower wall in order to illuminate the largest possible spatial angle.

A particularly advantageous aspect in the solution according to the invention is the simple and cost-effective manner in which a tower or a tower element, in particular of a wind turbine, can be retrofitted or set up. The illumination means are available at low cost and have a long service-life, which minimises the running costs for the maintenance of the device which has already been installed. Since the flash light according to the invention has a simple structure, it can be produced in large quantities at relatively low prices. The flash light according to the invention is particularly advantageous since, in the event of failure of a single illumination means, the complete light can be replaced in a rapid and simple manner from inside the tower.

Other advantageous embodiments of the invention are set out in additional dependent claims.

The advantage of the flash light according to the invention further involves both the individual tower elements being able to be provided with the flash light according to the invention before the tower assembly and the tower which has already been installed being able to be retrofitted therewith from the inner side.

An embodiment of the invention is explained in greater detail below with reference to the drawings, in which:

Figure 1 is a perspective view of a wind turbine tower which is provided with flash lights according to the invention which are arranged in two tower planes,

Figure 2 is a cross-section through the transverse axis of a tower with two flash lights according to the invention which are installed and which are not illustrated to scale,

Figure 3 is a cross-section through the longitudinal axis of a tower with a flash light according to the invention installed,

Figure 4 is a cross-section through the longitudinal axis of a flash light according to the invention,

Figure 5 is a cross-section through the tower wall and plan views of a ram protection and a pipe clamp,

Figure 6 shows various views of a flash light according to the invention,

Figure 7 is a cross-section through a tower wall and plan views of the ram protection and the pipe clamp with the flash light installed,

Figure 8 is a cross-section through a tower having ball races or gratings, and

Figure 9 shows cross-sections through a tower wall with ball races or gratings.

Figure 1 shows a tower 1 of a wind turbine which is erected on a foundation 5. At the upper end thereof is the machine pod 2 and the rotor blades 3 which are arranged thereon. Illumination means 4 are arranged in two tower planes on the tower so that the tower is visible to air traffic from a distance.

Figure 2 is a cross-section through the tower 1 of the wind turbine. In the tower wall 11 there are arranged two flash lights 10 which are inserted from the inner space 7 through holes in the tower wall 11 and which emit into the environment 9 of the tower. In order to protect the illumination means 14 of the flash light 10 against mechanical environmental influences, there is arranged above the flash light 10 a protection device 12 which can preferably at the same time also be used for correct positioning when the flash light 10 is installed in the tower wall 11.

Figure 3 shows the assembly of the flash light 10 according to the invention in the tower wall 11. The flash light 10 is located in a precisely fitting manner in a hole which is provided for it in the tower wall 11, wherein the precisely fitting and horizontally optimised adjustment of the flash light 10 is achieved by means of a sleeve (not shown) which is inserted into the hole and guiding means 16 which are fitted to the flash light. The first end of the flash light 10 which emits illumination into the environment 9 of the tower protrudes from the tower to such an extent that the illumination means 14 are visible from the outer side at the largest possible spatial angle. There is arranged above these illumination means 14 a protective layer 13, for example, an optical resin, in order to protect the illumination means 14 against weather influences. Over this portion of the flash light 10 protruding from the tower, a protective curved member 12 is fitted in order to protect the flash light 10 with the illumination means 14 and the protective layer 13 from mechanical damage. There are arranged at the second end of the flash light 10 protruding into the inner space 7 of the tower the illumination means connections 15 which are intended to be contacted with supply lines which are provided for this purpose at the inner side 7 of the tower.

Figure 4 shows the illumination means 14 which is covered with a protective layer 13, for example, optical resin, at the first end of the flash light 10 according to the invention. In the embodiment shown, five LEDs are arranged in a line as illumination means 14 so that they emit in a horizontal plane at a spatial angle of 180°.

Based on the flash light according to the invention, the invention also relates to an embodiment in which, in a plurality of planes of the tower, flash lights are arranged in order to illuminate the tower. An illumination of the tower of less than 360° in the environment is further conceivable if, for example, such illumination is not required as a result of the tower environment. The illumination means of the flash light may be arranged other than in a horizontal line. The mechanical curved protection member may preferably be replaced by a mechanical protection device of another construction, for example, a grid or a transparent dome of a mechanically robust material.

An embodiment of the invention is described below in greater detail. Figure 5A shows a cross-section through the tower wall 11 of a concrete segment with a sleeve 17 which is cast therein and to the inner end 17A and outer end 17B of which a plate 18 or 19 is welded, respectively. This unit is cast during the production of the prefabricated concrete component and is then securely incorporated at the predetermined position with the required orientation. Each of the plates 18, 19 has through-holes 181 or 191 behind which nuts 182 or 192 are welded so that screws can be screwed through these plates.

The so-called ram protection 20 is screwed to the outer plate 19 and is shown as a plan view in Figure 5C. This ram protection 20 is preferably a plate having a central through-hole 201 for the flash light and protective curved members 202 which are arranged above and below this through-hole 201 and which form the actual ram protection. There are further provided holes 203 by means of which this ram protection 20 can be screwed to the outer plate 19.

The inner plate 18 is prepared for securing the flash light by means of the so-called pipe clamp 21, as shown as a plan view in Figure 5B. In the illustration of this pipe clamp 21, two screws 211 can be seen, by means of which the pipe clamp 21 can be screwed to the inner plate 18. In the centre of the pipe clamp 21 there is again an opening 212, through which the flash light can be guided and in which it can be fixed in the desired position by means of three screws and nuts 213 which are spaced apart in a uniform manner over the periphery of the opening 212. The flash light can therefore be inserted into the sleeve 17, orientated in a desired manner and finally fixed in the position by means of these three screws 213.

Figure 6 is a side view (Figure 6A) and a front view (Figure 6B) and a rear view (Figure 6C) of the flash light 10 itself. The flash light 10 is produced completely from metal. In the outer end 16B thereof, there is incorporated an emission opening 101, behind which the illumination means 14 are arranged so that they can emit into the environment 9. Furthermore, the flash light 10 has a peripheral ring 102 (stop ring) which precisely defines the extent to which the light 10 can be pushed into the sleeve 17. Consequently, the extent to which the illumination then protrudes from the tower is inevitably produced. Furthermore, a small shoulder 103 can be seen at the end 10A of the flash light 10 directed into the tower interior. This shoulder is, for example, constructed as a square which can clearly be seen in the rear view of Figure 6B.

As soon as the flash light 10 is inserted into the sleeve 17, the horizontal orientation thereof is already produced by the path of the sleeve 17. An adaptation of the orientation can and must then further be carried out about the longitudinal axis of the flash light 10 so that the emission opening at the other end of the flash light is orientated precisely in a horizontal manner. To this end, for example, a spirit level may be placed on the square 103 and the correct orientation may be found therewith. As soon as this orientation has been found, the flash light 10 is fixed by means of the pipe clamp 21 (see Figure 5B) and is consequently in the correct installation and operating position thereof.

The flash light is shown in Figure 7 in the installed state. In this instance, it can clearly be seen in the cross-section shown in Figure 7A how the flash light 10 is inserted into the sleeve 17. Furthermore, it is also possible to see an annular seal 22 which is arranged between the stop ring 102 and the outer plate 19. If the flash light 10 is disassembled, then a new seal 22 is always used when it is installed or a new flash light 10 is installed so that a tight fit of the flash light 10 in the sleeve 17 is always ensured and moisture cannot be introduced in this manner into the sleeve 17 and consequently into the wind turbine. Figures 7B and 7C each show plan views of the flash light 10 in the installed state from the inner side (Figure 7B) and from the outer side (Figure 7C).

It should further be noted with respect to the dimensions that the outer diameter of the stop ring 102 preferably substantially corresponds to the inner diameter of the sleeve 17.

With regard to the flash light 10, it should further be noted that three variants are conceivable. In the first variant, no electronic system at all is contained in the flash light 10. This flash light thereby becomes very simple in terms of its construction. However, the supply lines have to be provided in a correspondingly complex manner, particularly when the supply of the individual illumination means is intended to be carried out in a

manner as failsafe as possible and independently of each other, and even a return line, for example, for a photo resistor, is intended to be provided in order to enable a functional control.

In another variant of the flash light, an electronic system is provided in the flash light itself. In this instance, it is again possible to differentiate between an embodiment, in which the electronic system controls the illumination means in accordance with trigger signals which are in turn produced by a central control system, and a variant, in which the complete control is provided outside the flash light and the electronic system which is contained in the flash light substantially takes on driver functions for the illumination means.

In substantially all embodiments of the flash light, there is according to the invention the following assembly method:

1. In a first step, the sleeve 17 is also concreted in with the plates 18, 19 secured thereto during the production of the prefabricated concrete components. This is naturally not required in steel towers. In this instance, a corresponding hole, in which the sleeve 17 can be inserted, extends in the tower. In this instance, however, it should be noted that the steel tower has to be reinforced where applicable around the hole in order to ensure a reliable load transfer since the steel tower would otherwise be weakened by the hole or the holes.

2. During the erection of the tower, the ram protection 20 is fitted in a second step.

3. After erection of the tower, the sealing ring 22 is placed on the front portion of the flash light 10 on the stop ring 102.

4. The light 10 is inserted into the sleeve 17 in the next step.

5. Afterwards, the pipe clamp 21 is positioned from the inner side 7 of the tower.

6. The light 10 is orientated using a spirit level and

7. the position of the flash light 10 found in this manner is fixed using the pipe clamp 21.

8. Then, the flash light further has to be connected and can then be operated.

In order to be able to reach the flash light according to the invention from the inner side of the tower, which is intended to be achieved by the invention, so that the access does not have to be carried out from the outer side with great complexity, such as, for example, a crane or a lifting platform, in a preferred embodiment at the inner side of the tower, with predetermined spacing below the flash light, ball races 23 (see Figure 8, left-hand half and 9A) or gratings 24 (see Figure 8, right-hand half and 9B) and an additional securing ring 25 are fitted. The ball races 23 are accessible via the climbing ladders which are provided in each wind turbine and are installed in such a manner that the flash light 10 is located substantially at the chest height of the technician standing on the ball races 23.

In Figure 9A, a cross-section of a portion of the tower wall shows an installed flash light 10 and the ram protection 20. Below the flash light 10, there is first provided a securing ring 25, which extends round at the inner periphery of the tower. Naturally, it may, for example, be interrupted in the region of the climbing ladders. This securing ring is secured to the tower wall 11 using first (short) consoles 26. Below the securing ring 25, there are provided second consoles 27, to which ball races 23 are secured in the embodiment illustrated in Figure 9A. These ball races may in turn extend round within the tower and are spaced apart from each other in such a manner that a technician can stand safely on them. The number (three in the embodiment shown in Figure 9A) is permitted in a totally random manner. Naturally, there may also be four, five or more ball races.

In the embodiment shown in Figure 9B, a grating 24 is shown in place of the ball races 23. This grating 24 may be segmented and be provided in place of the ball races 23 on the second console 27 as a walking surface for reaching the flash light 10.

In the plan view shown in Figure 8, flash lights 10 which are spaced apart from each other by 90° in each case are provided in the tower wall 11. In a state concentric relative to the tower wall, the securing ring 25 is secured to the tower wall 11 using the first console 26 and extends round once inside the tower. The climbing ladder has been omitted in this instance for reasons of simplicity.

The walking surface, which is secured to the tower wall 11 by means of the second consoles 27 is in this instance in the left-hand half of the tower illustrated in the form of ball races 23 whilst, in the right-hand half, there are provided grating segments 24 which as a result of their shape supplement each other to form a circle or circular ring. In a particular case, ball races or gratings which then accordingly extend completely round may be provided.

RÚDFÉNY TORONY KIVILÁGÍTÁSÁRA

Szabadalmi igénypontok

1. Rúdfény (10) alkalmazása torony (1), különösen szélturbina kivilágítására, melynek rúd alakú tartóeleme van, ahol a tartóelem első végén (10B) világítóeszközök (14) és a tartóelem második végén (10A) világítóeszköz-csatlakozók vannak olyan módon elrendezve és kialakítva, hogy a rúdfény (10) a rúd alakú tartóelem útján furaton keresztül belülről a toronyfalba (11) való behelyezésre alkalmas, így a világítóeszközök (14) a torony környezetébe (9) bocsátanak ki fényt, ahol a rúd alakú tartóelem lényegében henger alakú.

2. Az 1. igénypont szerinti alkalmazása a rúdfénynek (10), **azzal jellemezve**, hogy a világítóeszközökön (14) időjárásálló védőréteg (13) van.

3. A 2. igénypont szerinti alkalmazása a rúdfénynek (10), **azzal jellemezve**, hogy a védőrétegen (13) mechanikai behatások elleni védőszerkezet van elrendezve.

4. Az előző igénypontok bármelyike szerinti alkalmazása a rúdfénynek (10), **azzal jellemezve**, hogy a világítóeszközök (14) sorosan vannak kapcsolva.

5. Az előző igénypontok bármelyike szerinti alkalmazása a rúdfénynek (10), **azzal jellemezve**, hogy a világítóeszközök (14) LED-ek.

6. Az előző igénypontok bármelyike szerinti alkalmazása a rúdfénynek (10), **azzal jellemezve**, hogy a világítóeszközök (14) vonalban vannak elrendezve.

7. Az előző igénypontok bármelyike szerinti alkalmazása a rúdfénynek (10), **azzal jellemezve**, hogy a rúdfénynek (10) a rúdfény toronyfalban (11) kialakított furatbeli horizontális jusztírozásához vezetőszerve (16) van.

8. Az előző igénypontok bármelyike szerinti alkalmazása a rúdfénynek (10), **azzal jellemezve**, hogy a rúdfénynek (10) a világítóeszköz (14) működése monitorozásához jelzőszerkezete van.

9. Az előző igénypontok bármelyike szerinti alkalmazása a rúdfénynek (10), **azzal jellemezve**, hogy a második végen (10A) a rúdfény horizontális jusztírozásához eszközök vannak, különösen jusztírozóeszközök, például egy szintező elhelyezésére kiemelkedés (103) van.

10. Az előző igénypontok bármelyike szerinti alkalmazása a rúdfénynek (10), **azzal jellemezve**, hogy a toronyfalbeli (11) furatba való behelyezés mélysége meghatározásához az első vég (10B) közelében ütközőgyűrű (102) van elrendezve.

11. Szélturbina, melynek tornya (1) van, **azzal jellemezve**, hogy toronysíkban toronykivilágításhoz elhelyezett furatokban legalább két rúdfény (10) van elrendezve, ahol a rúdfények (10) rúd alakú tartóelemmel rendelkeznek, amely tartóelem első végén (10B) világítóeszközök (14) és a tartóelem második végén (10A) világítóeszköz-csatlakozók (15) vannak olyan módon elrendezve és kialakítva, hogy a rúdfény (10) a torony (1) toronyfalában (11) lévő furatba belülről helyezhető bele, így a világítóeszközök (14) a torony környezetébe (9) bocsátanak ki fényt.

12. A 11. igénypont szerinti szélturbina, **azzal jellemezve**, hogy a rúdfény (10) horizontális jusztírozásához a toronyfalbeli (11) furatban hüvely van elrendezve.

13. A 11. vagy a 12. igénypont szerinti szélturbina, **azzal jellemezve**, hogy a furatok olyan módon vannak elhelyezve, hogy a bennük elrendezett rúdfények (10) 360°-os térszögben bocsátanak ki fényt.

14. A 11-13. igénypontok bármelyike szerinti szélturbina, **azzal jellemezve**, hogy a torony belső falán a furat körül egy a rúdfény (10) horizontális jusztírozására és rögzítésére szolgáló eszközökkel (213) ellátott csőszorító (21) van elhelyezve.

15. A 11-14. igénypontok bármelyike szerinti szélturbina, **azzal jellemezve**, hogy a torony külső falán a furat körül egy a rúdfény (10) külső vége (10B) mechanikai károsodásokkal szembeni védelmét szolgáló eszközökkel (202) ellátott ütközés elleni védelem (20) van elhelyezve.

16. A 11-15. igénypontok bármelyike szerinti szélturbina, **azzal jellemezve**, hogy a torony belső falán járóeszközök, különösen futógyűrűk (23) vagy rácsrostélyok (24) vannak elhelyezve.

17. Toronyszegmens, különösen szélturbina-toronyszegmens, **azzal jellemezve**, hogy toronysíkban toronykivilágításhoz elhelyezett furatokban legalább két 1. igénypont szerinti rúdfény (10) van elrendezve.

18. Eljárás torony, különösen szélturbina kivilágításának felszerelésére, **azzal jellemezve**, hogy egy az 1. igénypont szerint alkalmazott rúdfény (10) első végét belülről a toronyfalban (11) kiképzett furaton keresztül egy kívülről látható pozícióba juttatjuk, továbbá a rúdfény (10) második végének világítóeszköz-csatlakozóit (15) a torony (7) belsejében elrendezett tápvezetékekkel csatlakoztatjuk.

19. A 18. igénypont szerinti eljárás torony, különösen szélturbina kivilágításának felszerelésére, **azzal jellemezve**, hogy

– a toronyfalba hüvelyt vezetünk be, továbbá a toronyfalban furatot hozunk létre;
– a furat külső nyílása köré ütközés elleni védelmet szerelünk fel;
– a rúdfényt a hüvelybe betoljuk;
– a torony belsejében a furat köré csőszorítót szerelünk fel;
– a rúdfényt horizontálisan jusztírozzuk és a pozíciót rögzítjük;
– az tápvezetékeket a torony belsejéből kifelé a rúdfényekre csatlakoztatjuk.

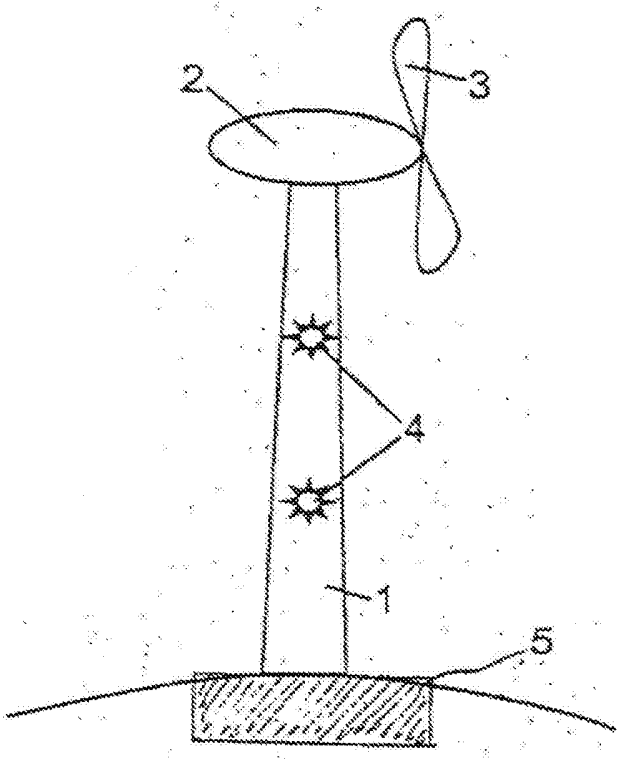

Fig.1

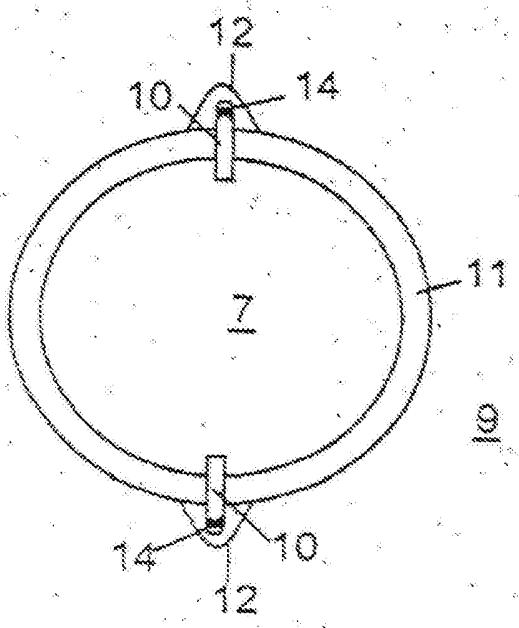

Fig.2

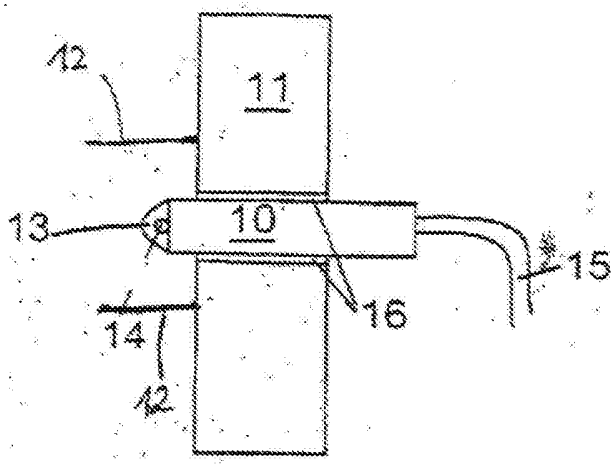

Fig.3

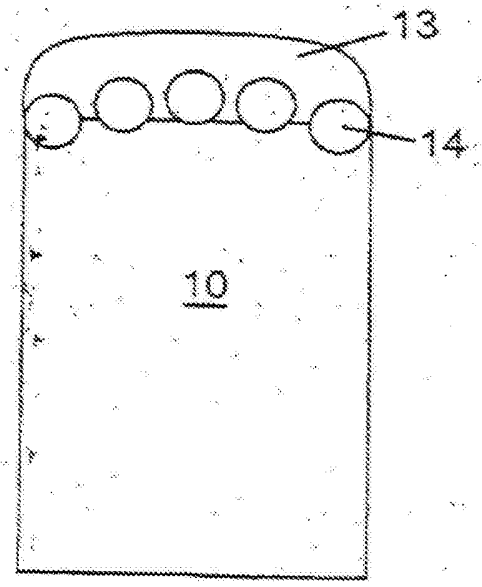

Fig.4

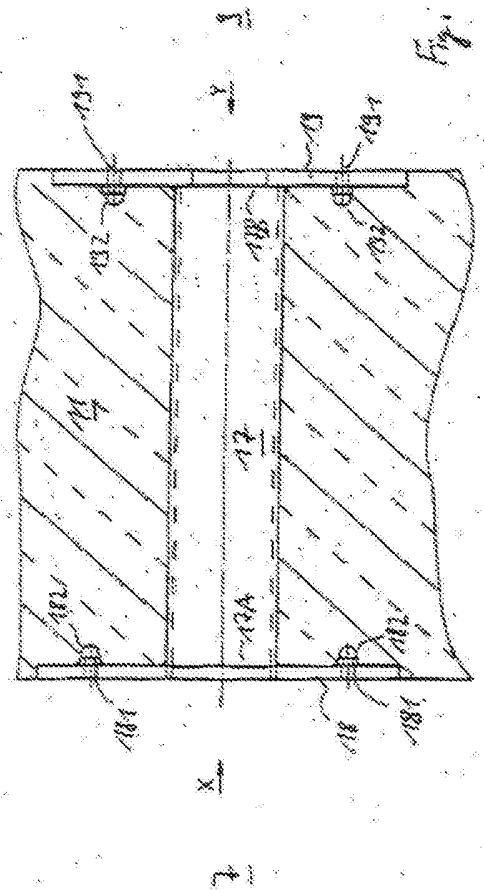

Fig. 5A

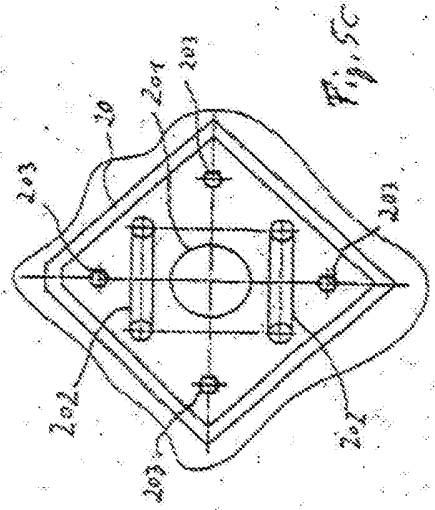

Fig. 5C

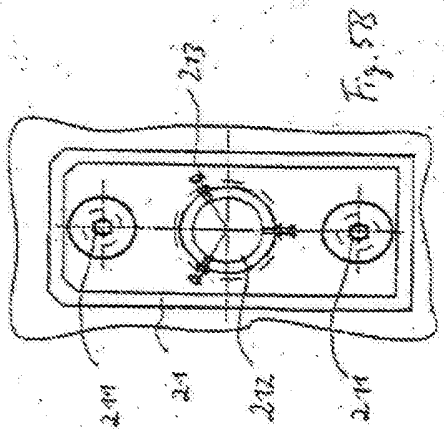

Fig. 5B

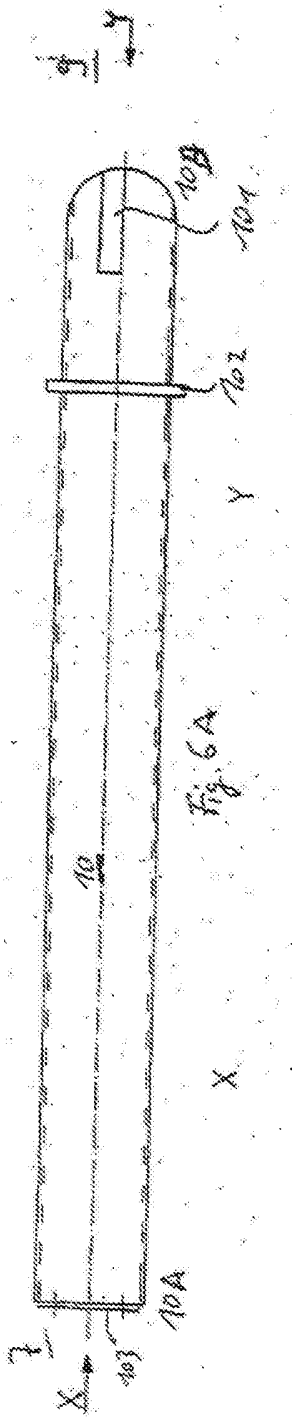

Fig. 6A

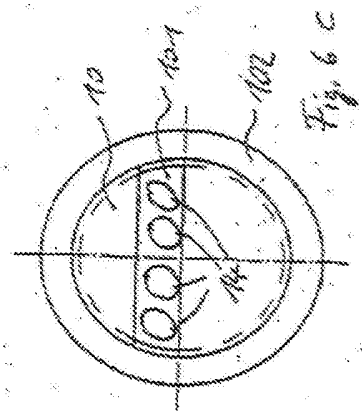

Fig. 6C

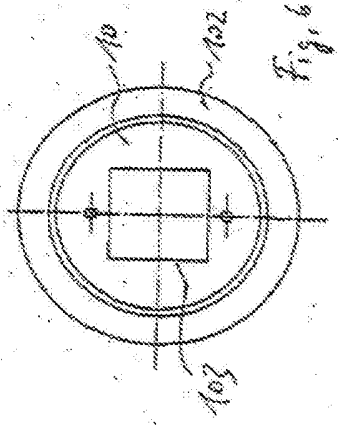

Fig. 6B

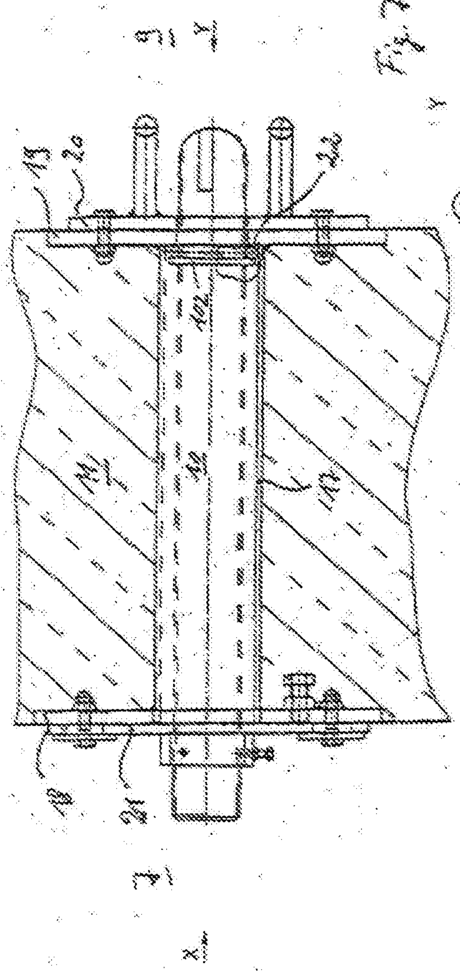

Fig. 7A

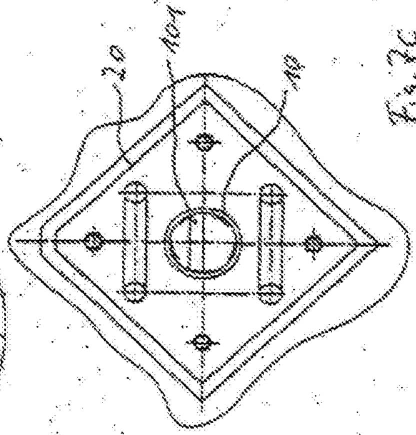

Fig. 7C

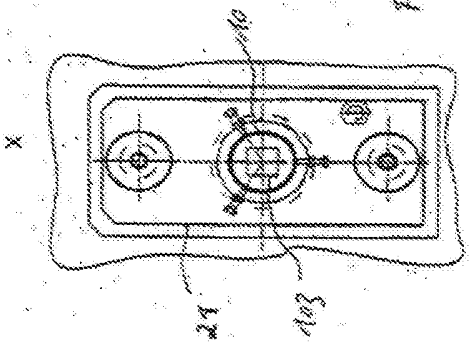

Fig. 7B

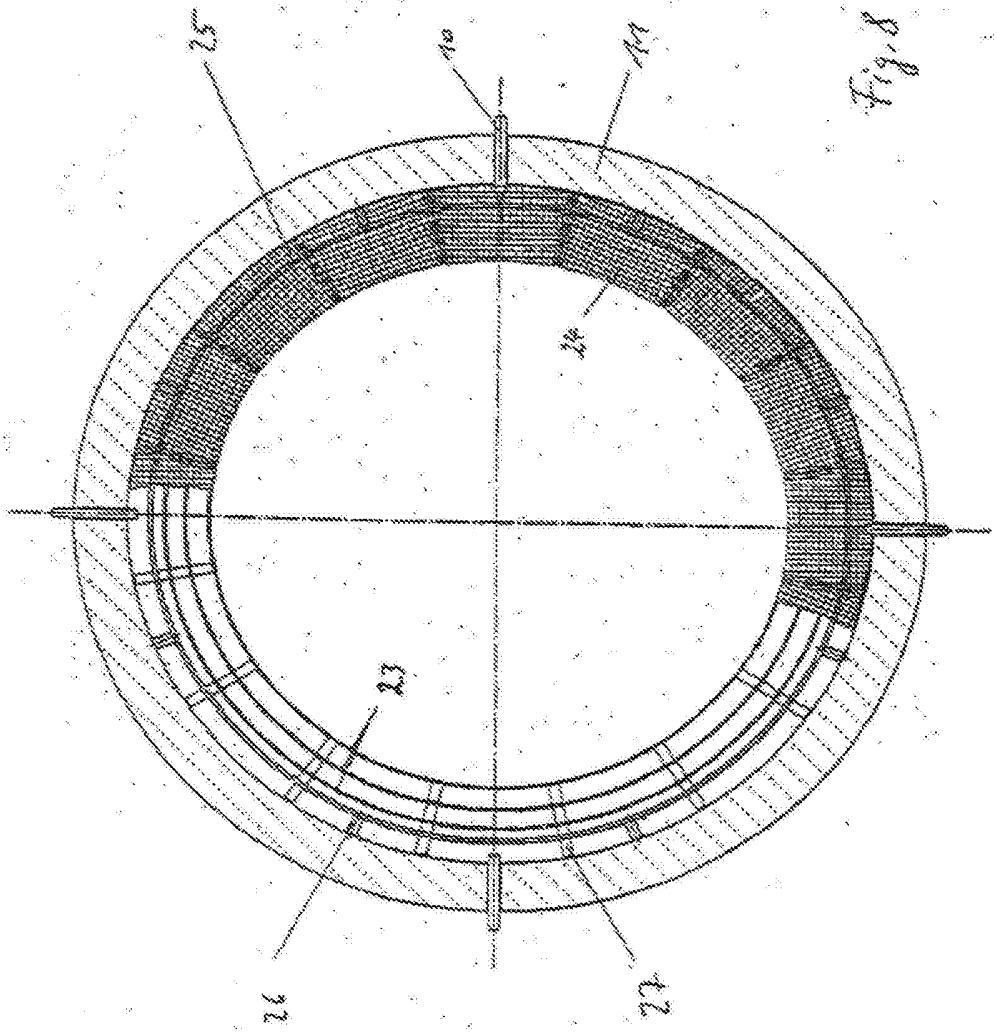

Fig. 8

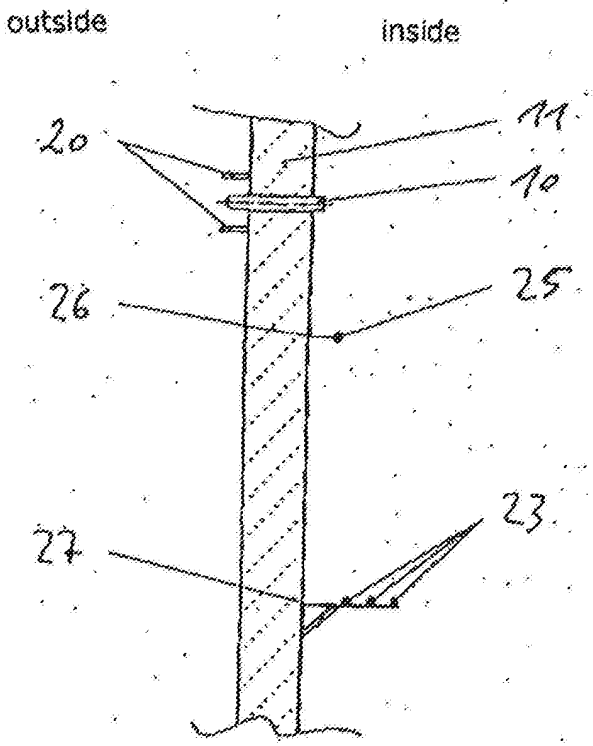
outside
inside
20
11
10
25
26
23
27

Fig. 3A

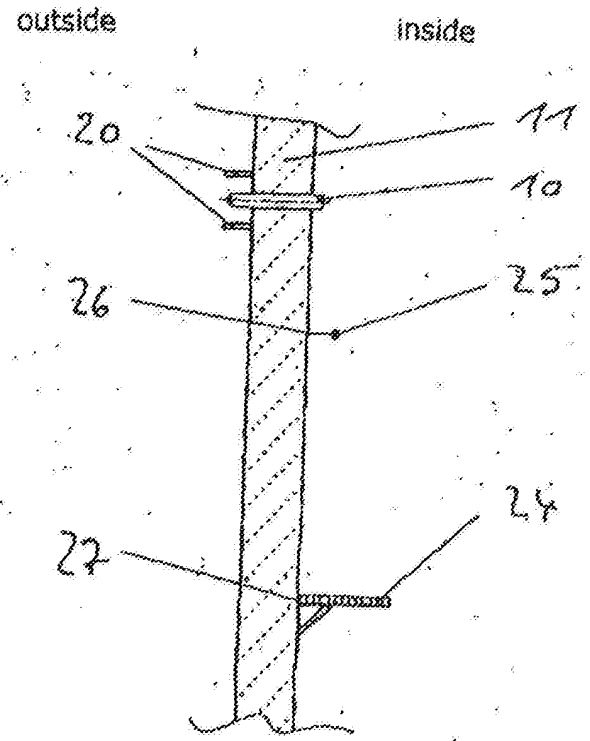
outside
inside
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Fig. 3B