Quantum field fluctuation turbine

The invention relates to a device for driving a shaft comprising a laser for emitting squeezed light in the form of laser beams, a shaft and a mirror attached to the shaft, wherein the laser beams are reflected at the mirror.

Gas turbine engines or kerosene jet engines are known in the state of the art. Such turbines comprise a fan and a core which are in flow connection with each other. The core comprises a compression section, a combustion section, a turbine section and an exhaust section, which are arranged in series. During operation, at least part of the air is fed to the inlet of the core via the fan. This part of the air is gradually compressed by the compressors until it reaches the combustion section.
Fuel is mixed with compressed air and burned in the combustion section to produce combustion gases. From the combustion section, the combustion gases are passed through the turbine. The combustion gases are then discharged into the atmosphere via an exhaust section. However, turbines of this type are not sensitive enough to detect the quantum fluctuations of individual quantum particles and are therefore unable to convert the energy.

Quantum fluctuations are the random, pairwise creation and disappearance of quantum particles within the framework of Heisenberg's uncertainty principle. For example, a particle-antiparticle pair with a certain energy can emerge from the vacuum and disappear again after a certain period of time.
Energy uncertainty and time uncertainty must satisfy Heisenberg's uncertainty principle. This can result in both fermionic particle-antiparticle pairs and bosonic particle-antiparticle pairs. Squeezed light is a quantum mechanical state of light in which the uncertainty of the phase or amplitude of the light is squeezed, i.e. reduced, while the other uncertainty is increased. Squeezed light is used, for example, at the Laser Interferometer Gravitational-Wave Observatory (LIGO) to minimize the influence of quantum fluctuations on the mirrors used there. The light is phase squeezed, i.e. phase blurring is reduced as much as possible while amplitude blurring is increased. This is also based on the Heisenberg uncertainty principle, as the product of phase blur and amplitude blur must not fall below a certain minimum value. If one takes

If an increased blurring of one of the two parameters is accepted, the blurring of the other parameter can be reduced. In this way, the sensitivity of the mirrors to gravitational waves can be increased. The phase blur is noticeable in the transit time of the light between the laser and the mirror, whereas the amplitude blur leads to a slightly greater intensity of the light. It has been shown that a suitable squeezing of the light used can lead to a deflection of the 40 kg mirror by around 10^{-20} m.

It is the object of the present invention to provide a device which provides sufficient sensitivity to quantum fluctuations, in particular quantum fluctuations of photons in squeezed light.

This task is solved by a device according to claim 1. Preferred embodiments are given in the dependent claims and the description.

The device claimed in claim 1 has a mirror which is set in motion by the radiation pressure of the laser beams and by quantum fluctuations of the laser beams, thus causing the shaft to rotate. The mechanical rotational energy can subsequently be used as a drive mechanism, for example to drive a turbine. An advantage over the prior art is that the device according to the invention can also be used to detect quantum effects, in particular quantum fluctuations, by replacing the turbine blades with mirrors. In particular, phase-squeezed light is used so that amplitude fluctuations can transfer collisions to the mirror surface. Preferably, the laser used has a power of 200 kW or more. Radiation pressure is the pressure exerted on a surface by absorbed, emitted or reflected electromagnetic radiation. In the case of absorption and emission, the radiation pressure is equal to the intensity of the wave divided by the speed of light,

$$p_{St} = I / c,$$

and is measured in units of Pascal. In the particle model of light, the radiation pressure of a photon can be linked to its energy, whereby the energy is given by

$$E = h\,\nu$$

is given. In the wave model of light, the radiation pressure can be compared with the Maxwell's stress tensor:

$$p_{St}\, n_j = T_{ij}\, n_i,$$

where n_i is a vector normal to the surface on which the radiation pressure is exerted.

In a preferred embodiment, the mirror has a reflectivity of more than 80%, preferably more than 90%, particularly preferably more than 99%. The degree of reflectivity has a direct effect on the radiation pressure. For example, with complete reflectivity, the radiation pressure is twice as high as with complete absorption. The incoming photon transfers a certain momentum to the mirror and takes an equally large but oppositely directed momentum back with it, so that the momentum transfer amounts to twice the incoming momentum in total.

In another preferred embodiment, several mirrors are arranged in a ring around the shaft. This results in a higher mirror density and means that more energy can be converted into rotational energy of the shaft, which corresponds to a higher efficiency.

In another preferred embodiment, two or more lasers are used whose emitted laser beams are not parallel to each other. This has the advantage that the laser beams detect the mirror at different angles. If the shaft rotates in the course of irradiation by a first laser, a second laser can be oriented in such a way that its laser beams still detect the rotated mirror at an angle of incidence of 90°. If several mirrors are used, the two or more lasers can be aligned in such a way that they simultaneously irradiate different mirrors at an angle of incidence of 90°.

In another preferred embodiment, the mirror is a concave mirror. If several such mirrors are used, the arrangement of the mirrors together with the shaft is geometrically similar to a Pelton turbine.

In a further preferred embodiment, a detector is attached to the shaft, with the detector preferably being attached to the shaft instead of the mirror. The advantage of this is that the laser not only drives the shaft, but also detects properties of the laser beam, for example intensity, angle of incidence or position at the detector, can be measured by the detector.

The invention is explained in more detail below with reference to the embodiments shown in the drawings.

Fig. 1 schematically shows the structure of a Michelson interferometer from the state of the art.
Fig. 2 schematically shows the structure of a preferred embodiment.
Fig. 3 shows a preferred embodiment in which several mirrors and several lasers are used.
Fig. 4 shows a preferred embodiment in which the mirrors do not run parallel to the axis of the shaft.

Fig. 1 shows a schematic structure of a Michelson interferometer as known in the prior art. A laser 2 emits laser beams which are split by a beam splitter 3b. The split laser beams are reflected by mirrors 3a and arrive together at the detector 5. There, the measured interference pattern is analyzed, allowing conclusions to be drawn about the path taken by the light.

Fig. 2 shows a preferred embodiment of the device 1 according to the invention. A laser 2 generates first laser beams 2a, which are reflected by a mirror 3 mounted on a shaft 4. The reflected, second laser beams 2b are then detected by a detector 5. By transferring their energy to the mirror 3, the photons of the laser beam 2a, 2b cause the shaft 4 to rotate, which is indicated by a curved arrow in Fig. 2. The mechanical energy of the rotation can then be converted into another form of energy, for example to drive a turbine.

Fig. 3 shows a preferred embodiment of the device 1 according to the invention, wherein several mirrors 3 are attached to the shaft 4 and several lasers 2 are provided for emitting laser beams 2a. The increased number of lasers 2 and mirrors 3 has the advantage that several laser beams 2a can simultaneously emit their energy to the mirrors 3 and thus to the shaft 4, thereby exciting the shaft 4 to rotate. In the design example shown, the mirrors are curved in a similar way to a Pelton turbine.

Fig. 4 shows a preferred embodiment of the shaft 4 in which the mirrors 3 are not parallel to the axis of the shaft 4. With this arrangement, several lasers can be used (not shown in Fig. 4) to set the shaft into a rotational movement.

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List of reference signs

1 Device
2 Laser
2afirst laser beams
2bsecond laser
beams
3 Mirror
3a Mirror
3b Beam splitter
4 Shaft
5 Detector

Patent claims

1. A device (1) for driving a shaft (4), comprising a laser (2) for emitting squeezed light in the form of laser beams (2a, 2b), a shaft (4) and a mirror (3) which is attached to the shaft (4), the laser beams (2a, 2b) being reflected at the mirror (3), characterized in that the mirror (3) is set in motion by the radiation pressure of the laser beams (2a, 2b) and by quantum fluctuations of the laser beams (2a, 2b) and thus causes a rotation of the shaft (4).

2. Device according to claim 1, characterized in that the mirror (3) has a reflectivity of more than 80%, preferably more than 90%, particularly preferably more than 99%.

3. Device according to one of claims 1 or 2, characterized in that several mirrors (3) are arranged in a ring around the shaft (4).

4. Device according to one of claims 1 to 3, characterized in that two or more lasers (2) are used whose emitted laser beams (2a) are not parallel to each other.

5. Device according to one of claims 1 to 4, characterized in that the mirror (3) is a concave mirror.

6. Device according to one of claims 1 to 5, characterized in that a detector (5) is attached to the shaft, the detector (5) preferably being attached to the shaft instead of the mirror (3).

Summary

A device (1) for driving a shaft (4), comprising a laser (2) for emitting squeezed light in the form of laser beams (2a, 2b), a shaft (4) and a mirror (3) fixed to the shaft (4), wherein the laser beams (2a, 2b) are reflected at the mirror (3), the mirror (3) being set in motion by the radiation pressure of the laser beams (2a, 2b) and by quantum fluctuations of the laser beams (2a, 2b) and thus causing a rotation of the wave (4).

(Fig. 3)

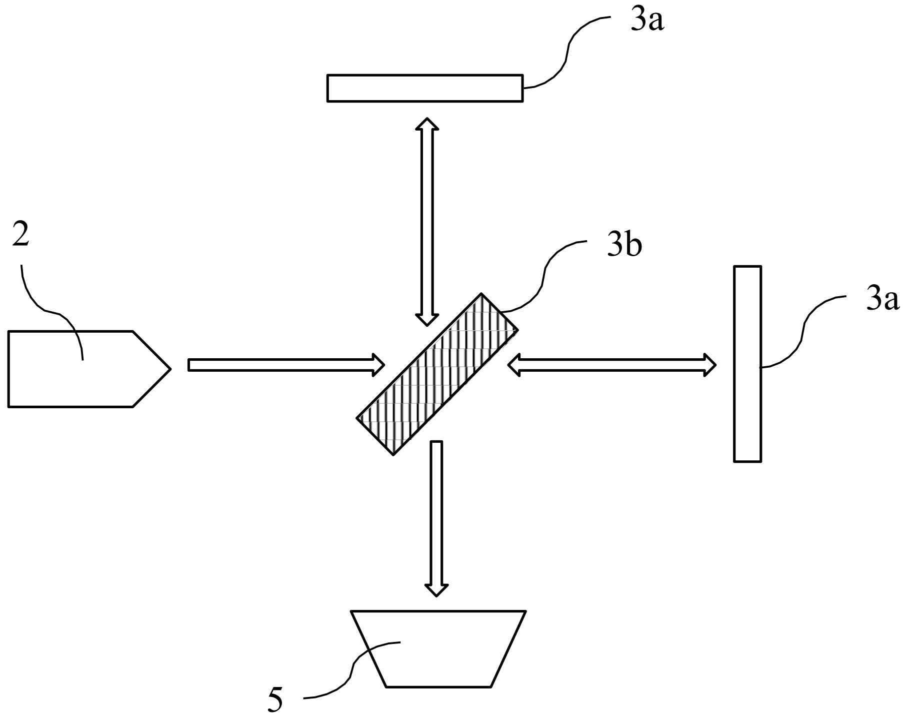

Fig. 1

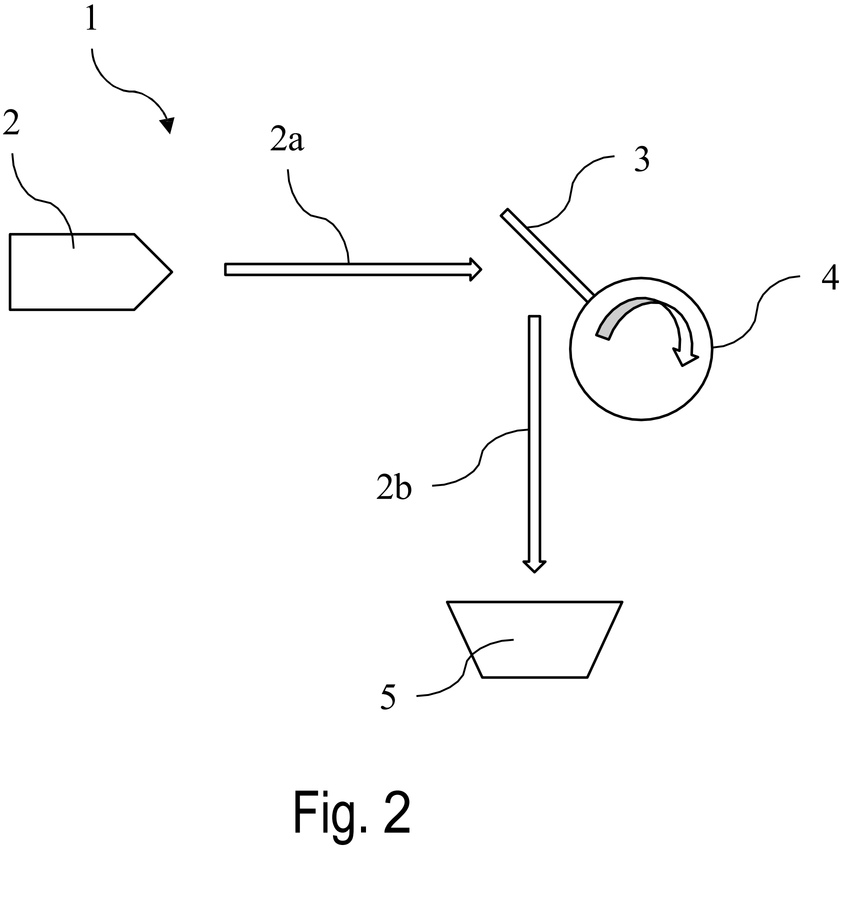

Fig. 2

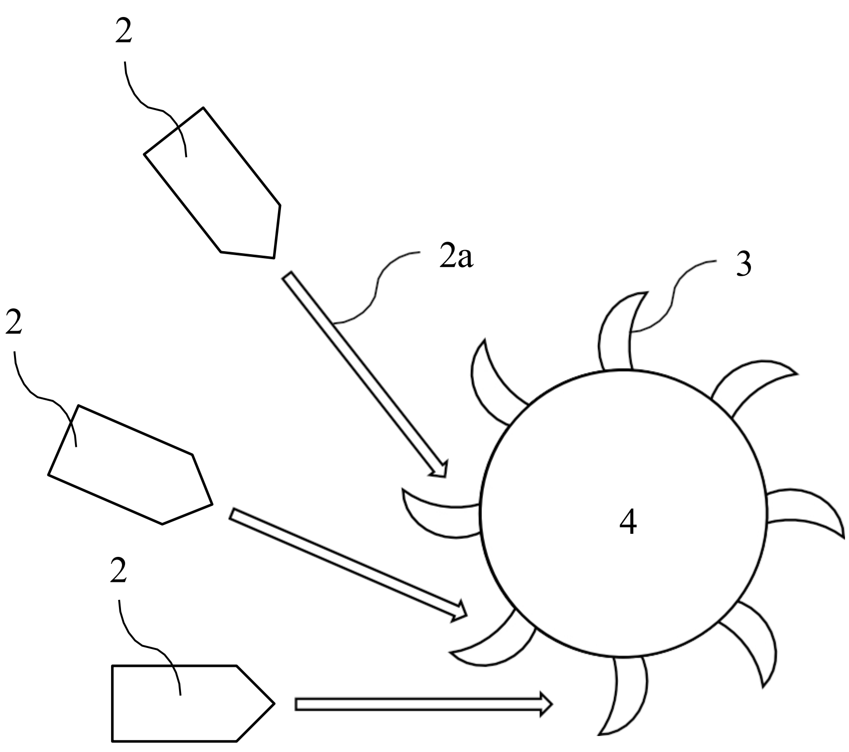

Fig. 3

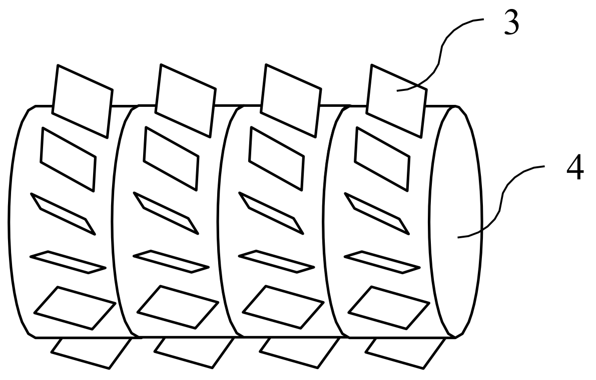

Fig. 4