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Dalsgaard

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(54) **METHOD OF REDUCING SOUND FROM LIGHT FIXTURE WITH STEPPER MOTORS**

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Feb. 10, 2017 (DK) 2017 00092

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F21S 10/00	(2006.01)
F21V 21/15	(2006.01)
F21V 21/30	(2006.01)
H02K 37/24	(2006.01)
F21S 10/02	(2006.01)
F21V 14/06	(2006.01)
F21W 131/406	(2006.01)
F21Y 115/10	(2016.01)

(52) **U.S. Cl.**
CPC ***H02K 37/22*** (2013.01); ***F21S 10/007*** (2013.01); ***F21V 21/15*** (2013.01); ***F21V 21/30*** (2013.01); ***H02K 37/24*** (2013.01); *F21S 10/02* (2013.01); *F21V 14/06* (2013.01); *F21W 2131/406* (2013.01); *F21Y 2115/10* (2016.08)

(58) **Field of Classification Search**
USPC 362/277
See application file for complete search history.

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Primary Examiner — Tuyen K Vo
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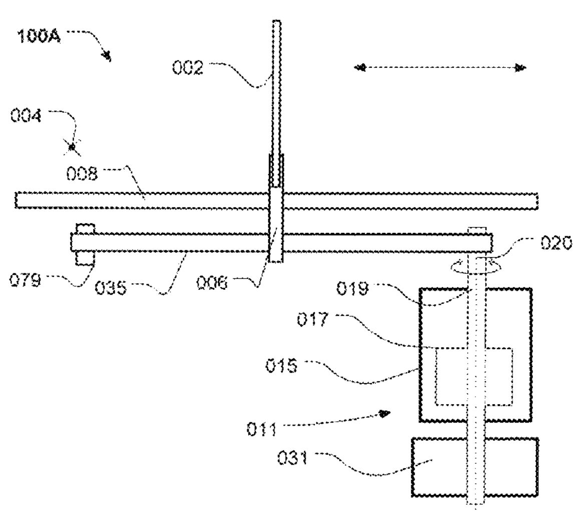
(57) **ABSTRACT**

A light fixture including a stepper motor comprising a stepper motor stator and a stepper motor rotor. The stepper motor rotor includes a stepper motor axle and is rotatable around a stepper motor axis. The stepper motor is connected to a movable object and is configured to move the movable object in relation to a reference point. A damping mass is attached to the stepper motor axle. The damping mass has a rotational inertia in relation to the stepper motor axis which is at least as large as the rotational inertia of the stepper motor rotor in relation to the stepper motor axis. A method of damping the sound generated by a light fixture comprising a step of attaching a damping mass to a stepper motor axle.

20 Claims, 11 Drawing Sheets



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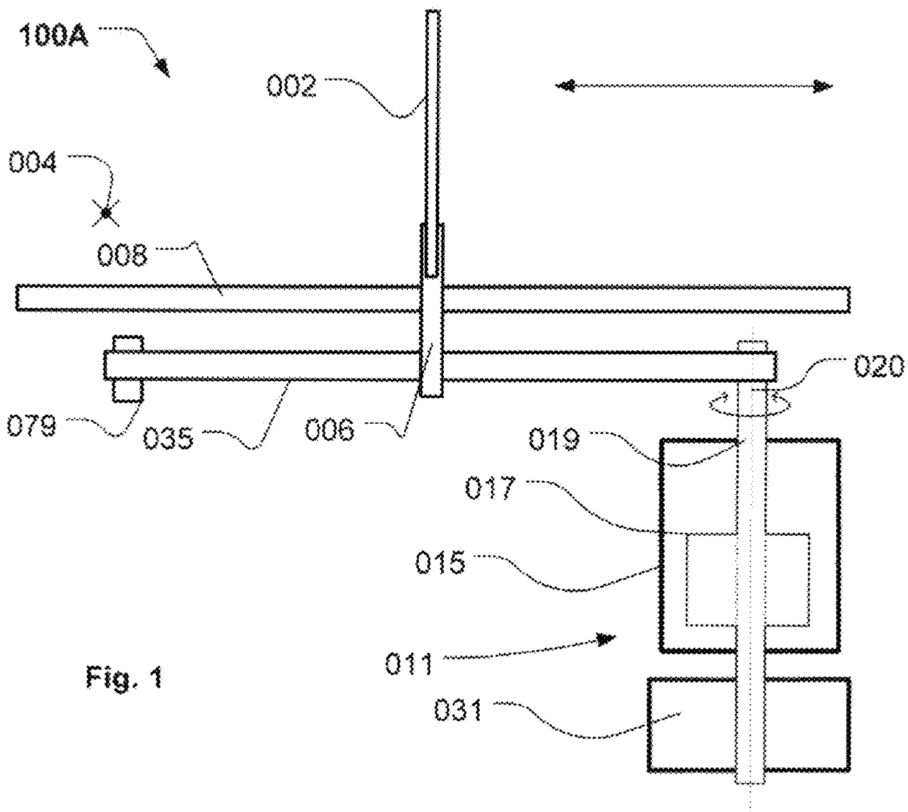
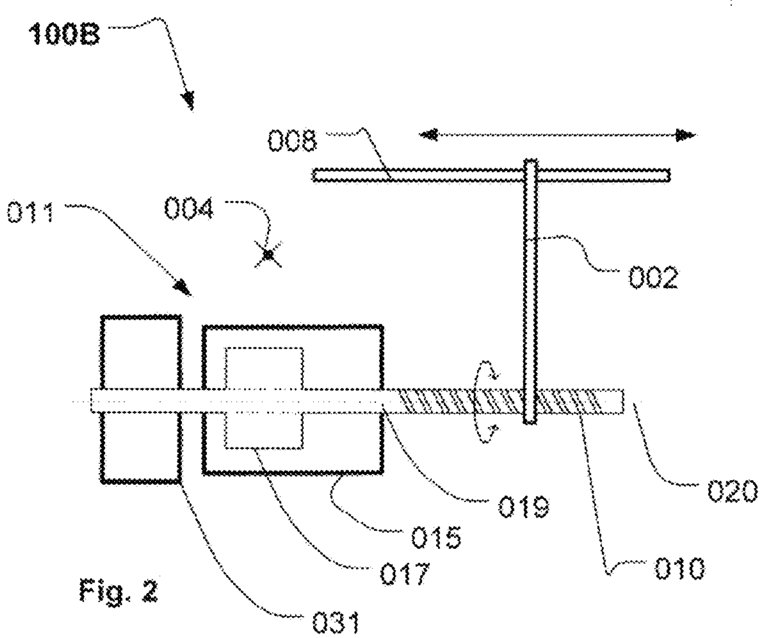

100A
002
004
008
079
035
006
020
019
017
015
011
031

Fig. 1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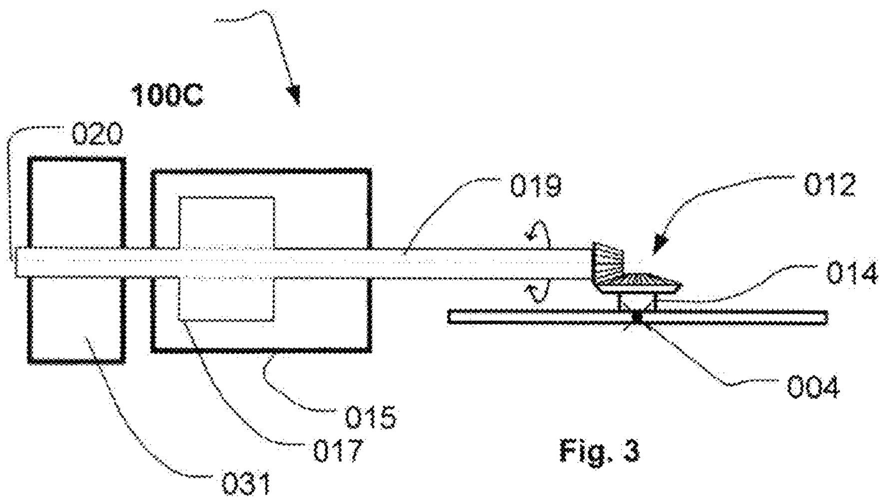
010
031

Fig. 2



100C
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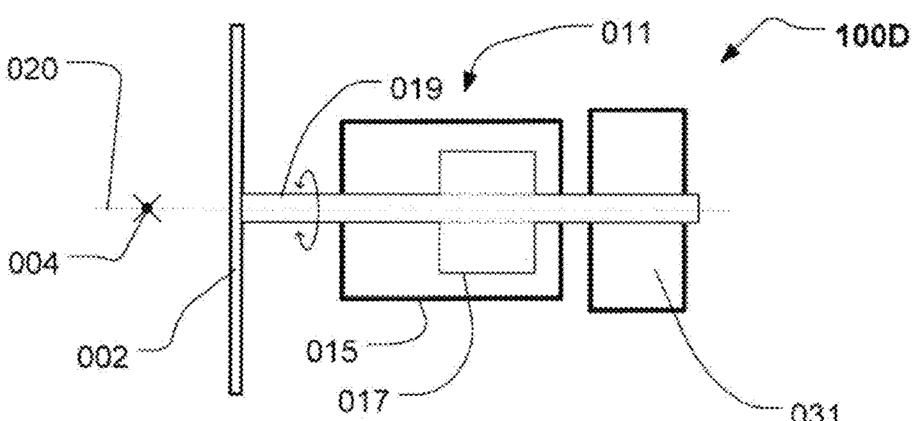
019
012
014
004
015
017
031

Fig. 3



011
100D
020
019
004
002
015
017
031

Fig. 4

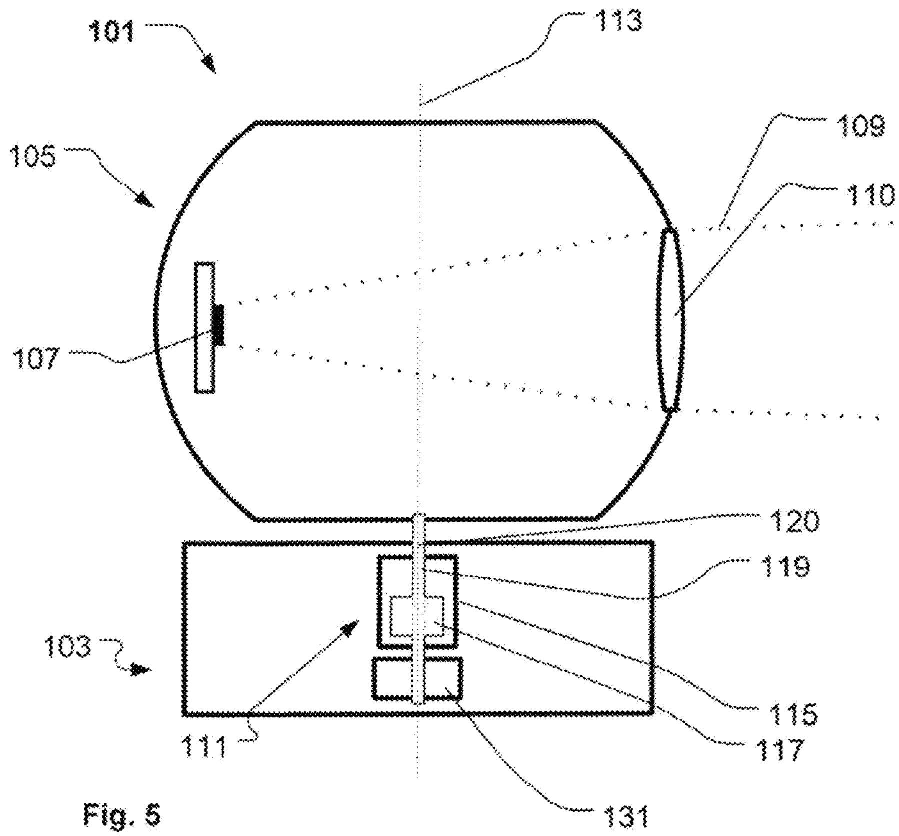


Fig. 5

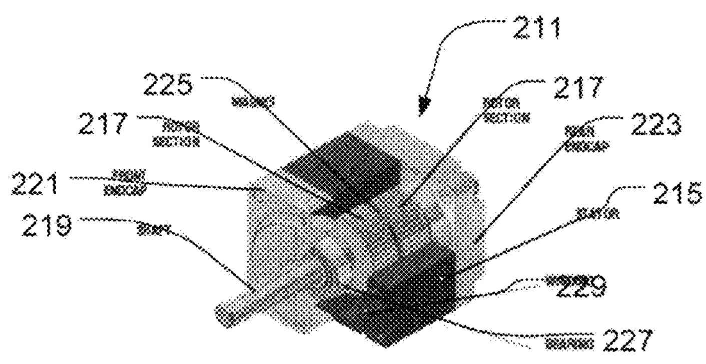
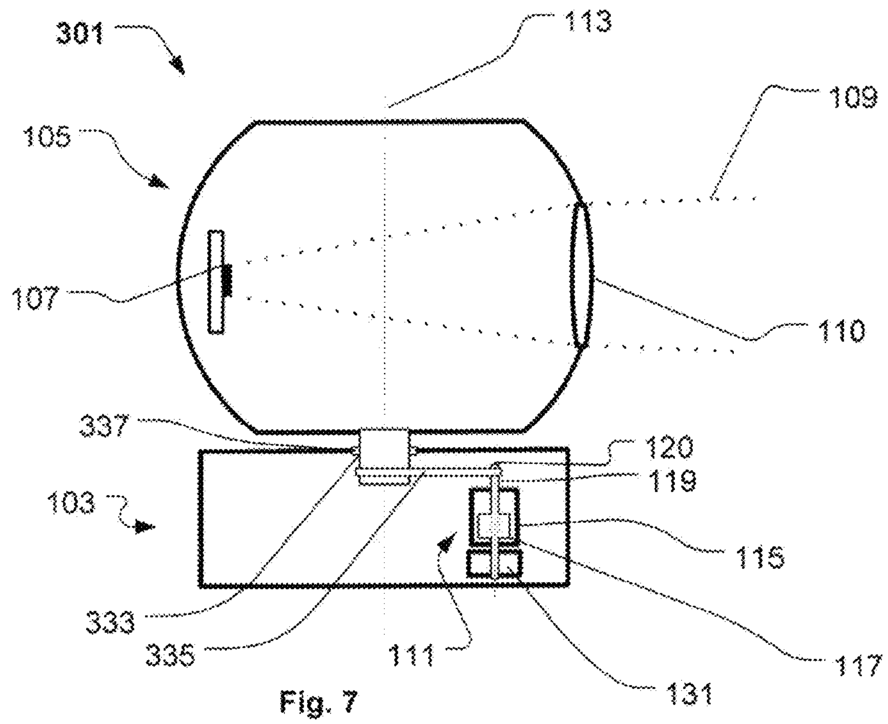


Fig. 6 (prior art)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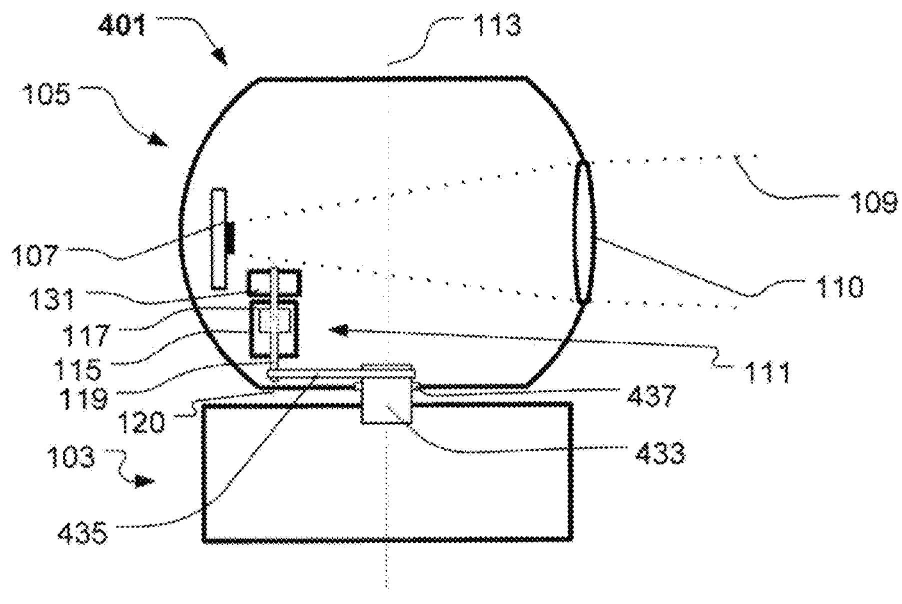
117
131

Fig. 7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433
103
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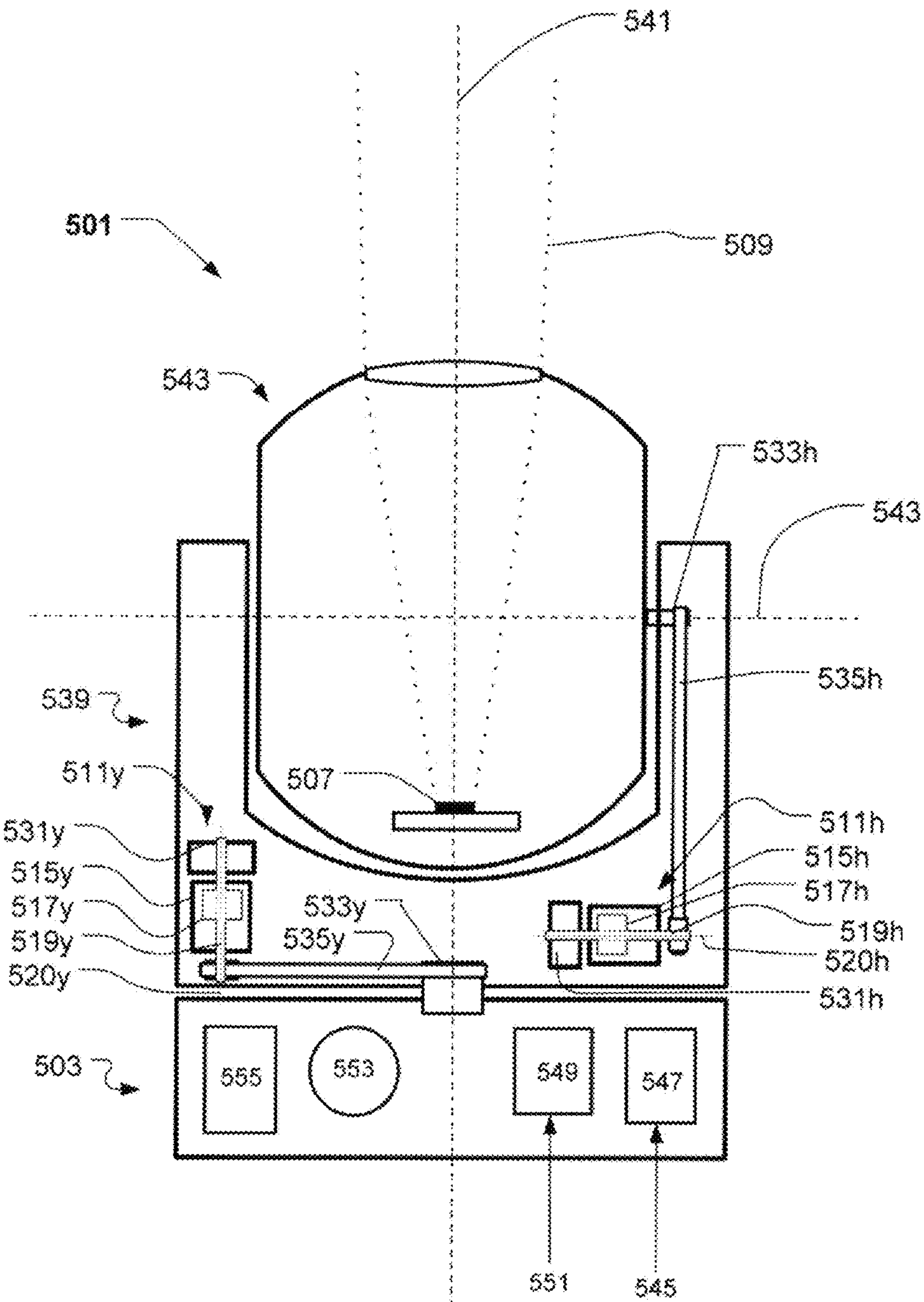
Fig. 8



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555
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545

Fig. 9

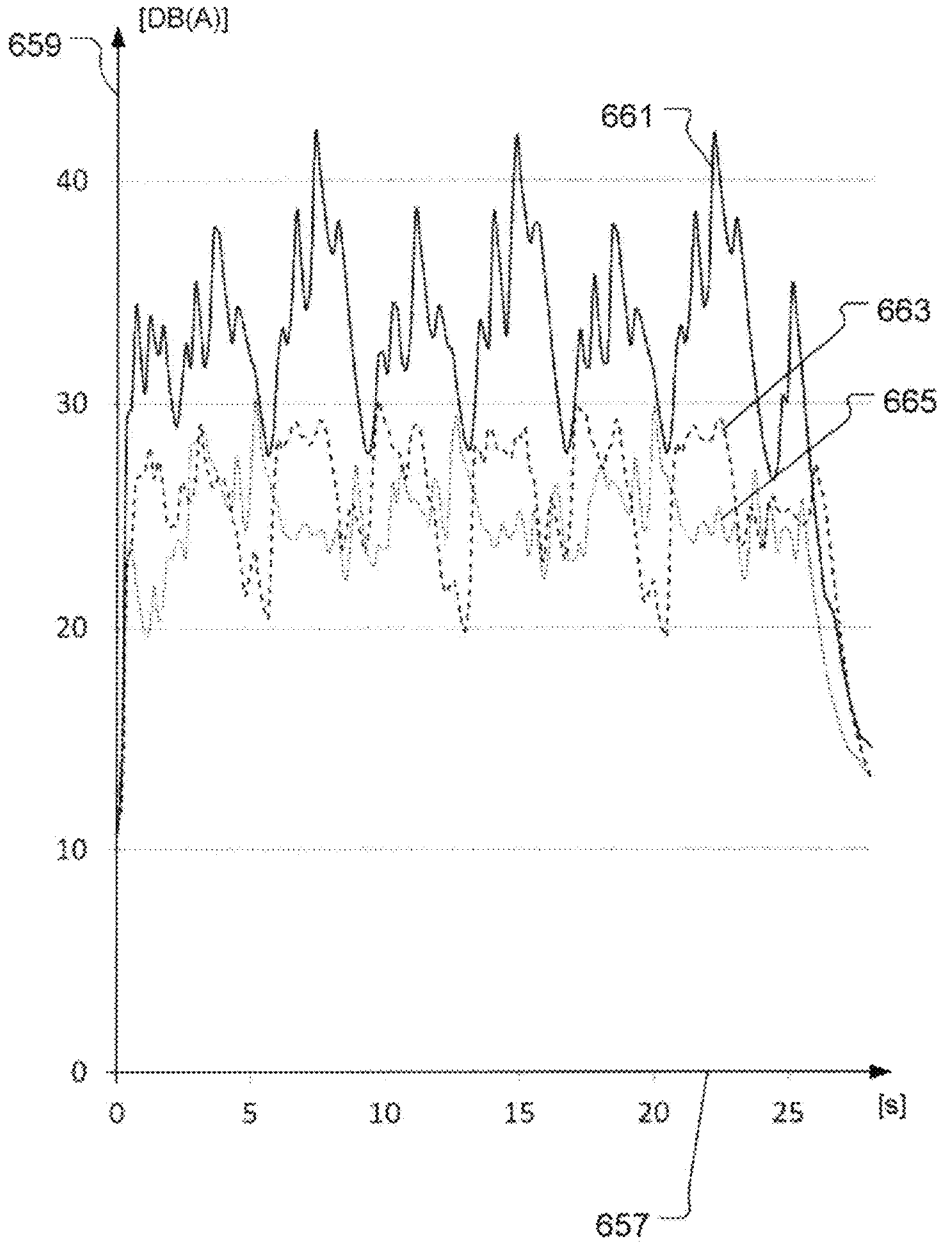

Fig. 10

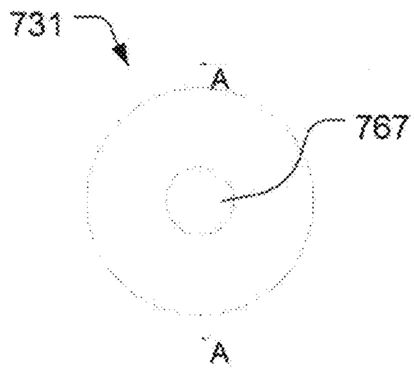

Fig. 11

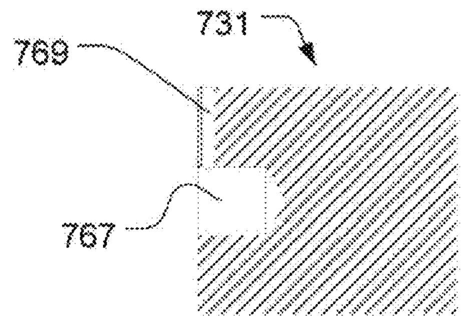

Fig. 12

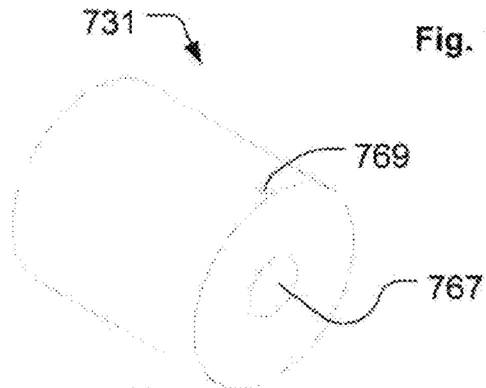

Fig. 13

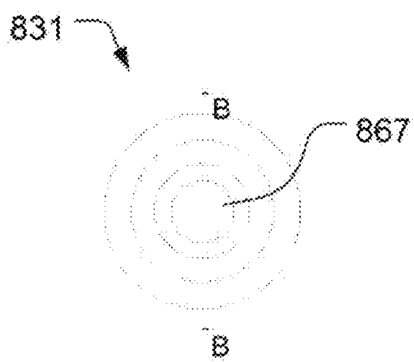

Fig. 14

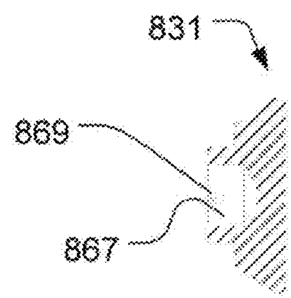

Fig. 15

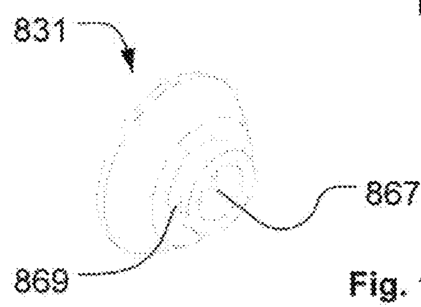

Fig. 16

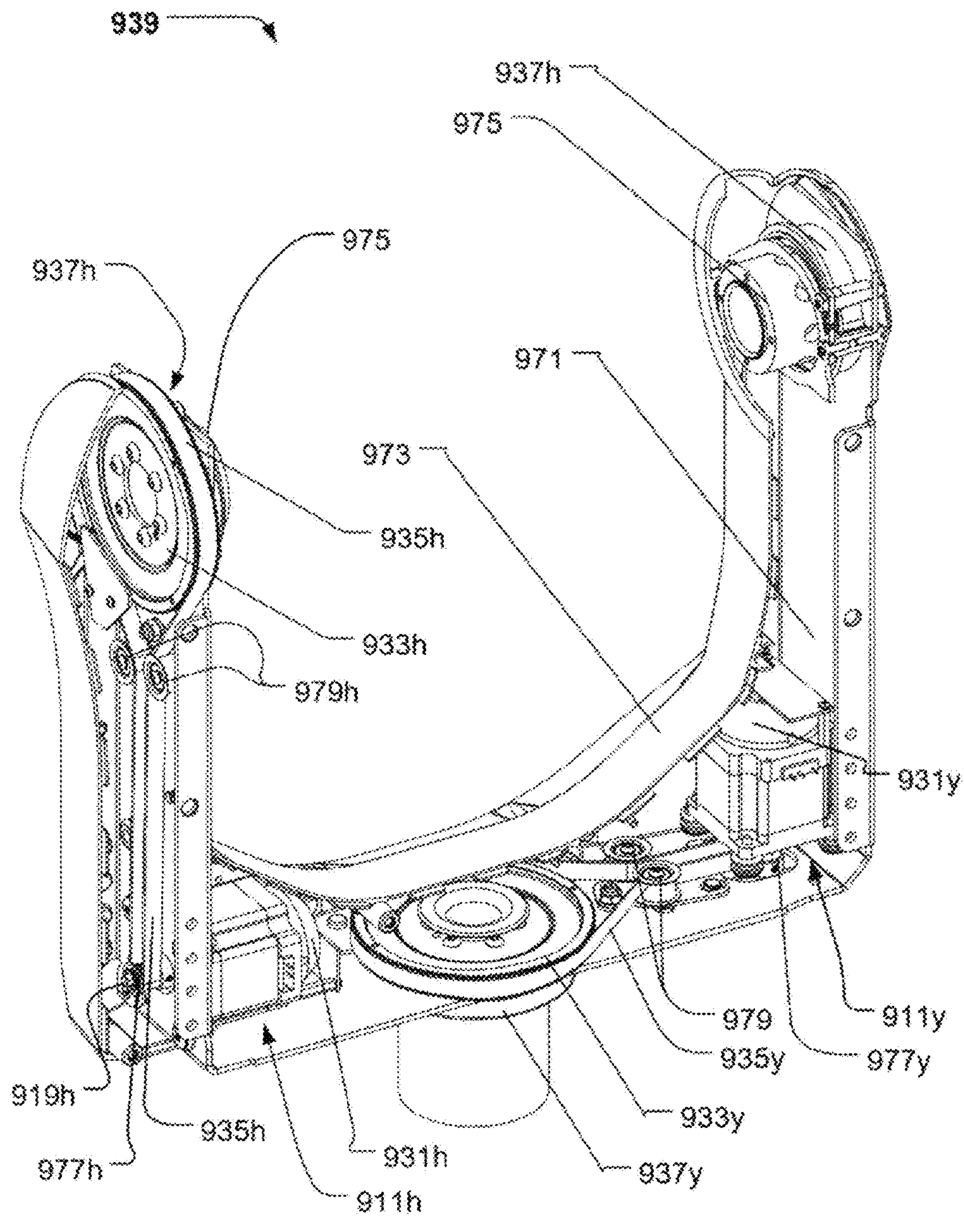
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Fig. 17

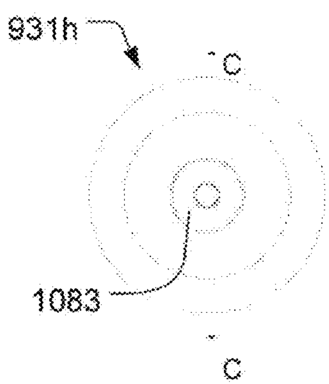


Fig. 18

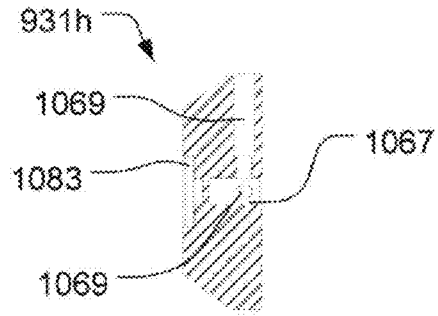


Fig. 19

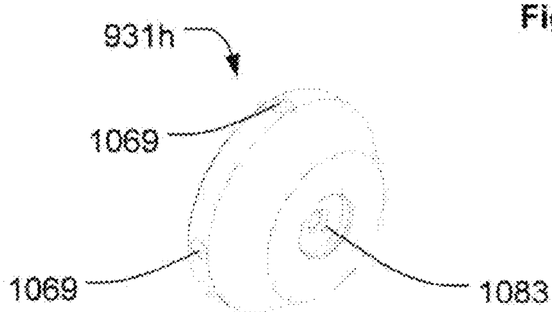


Fig. 20

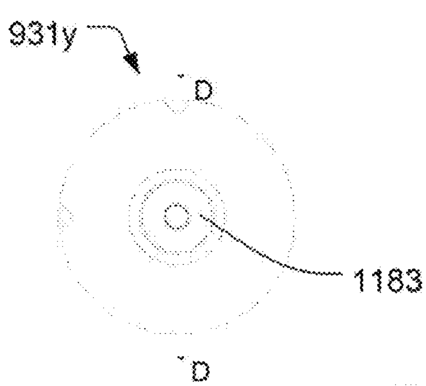


Fig. 21

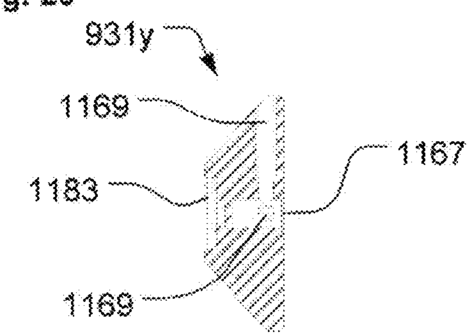


Fig. 22

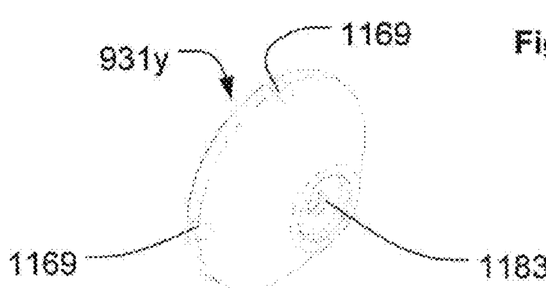
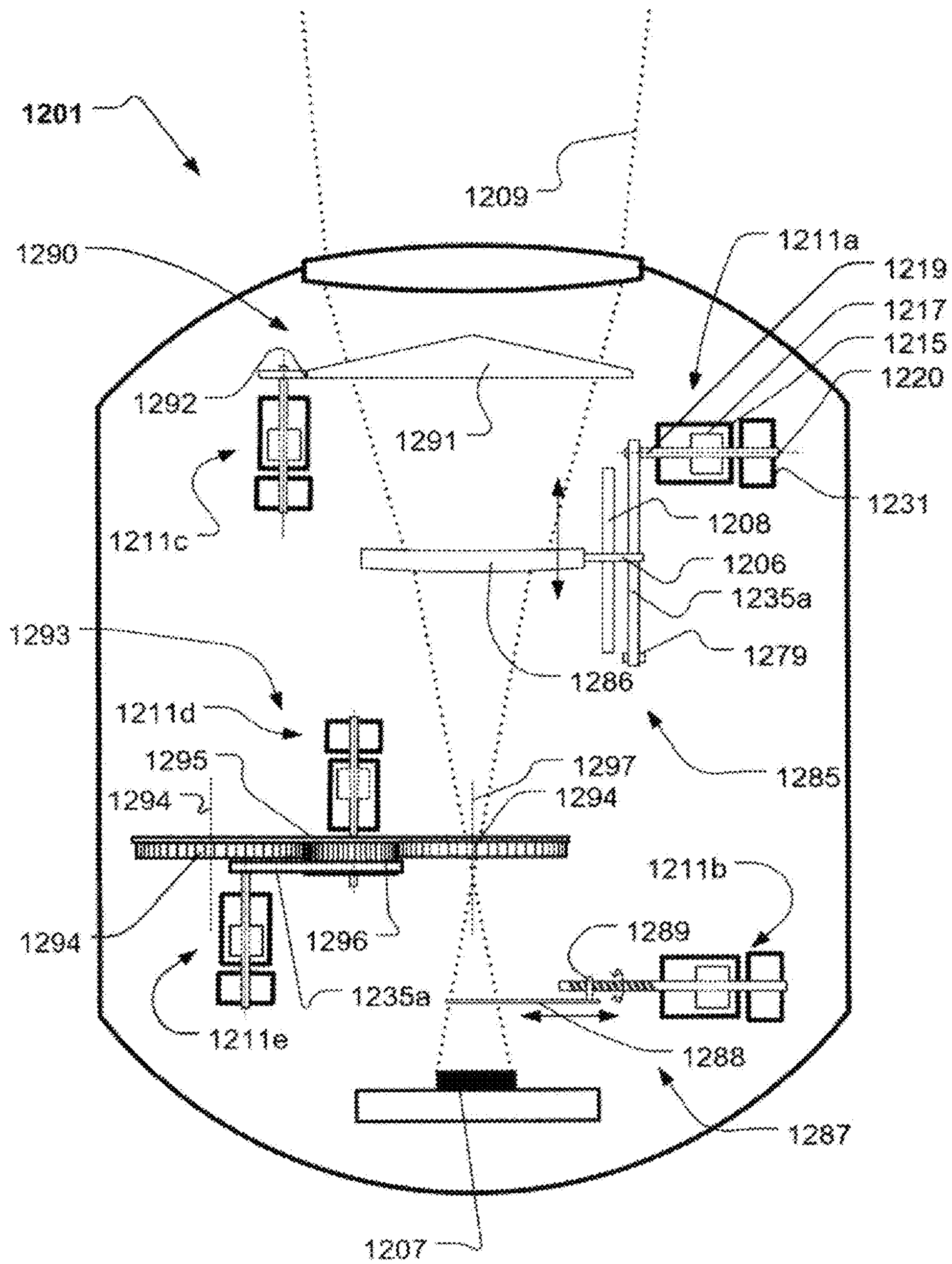


Fig. 23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1211d
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1211e
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1207

Fig. 24

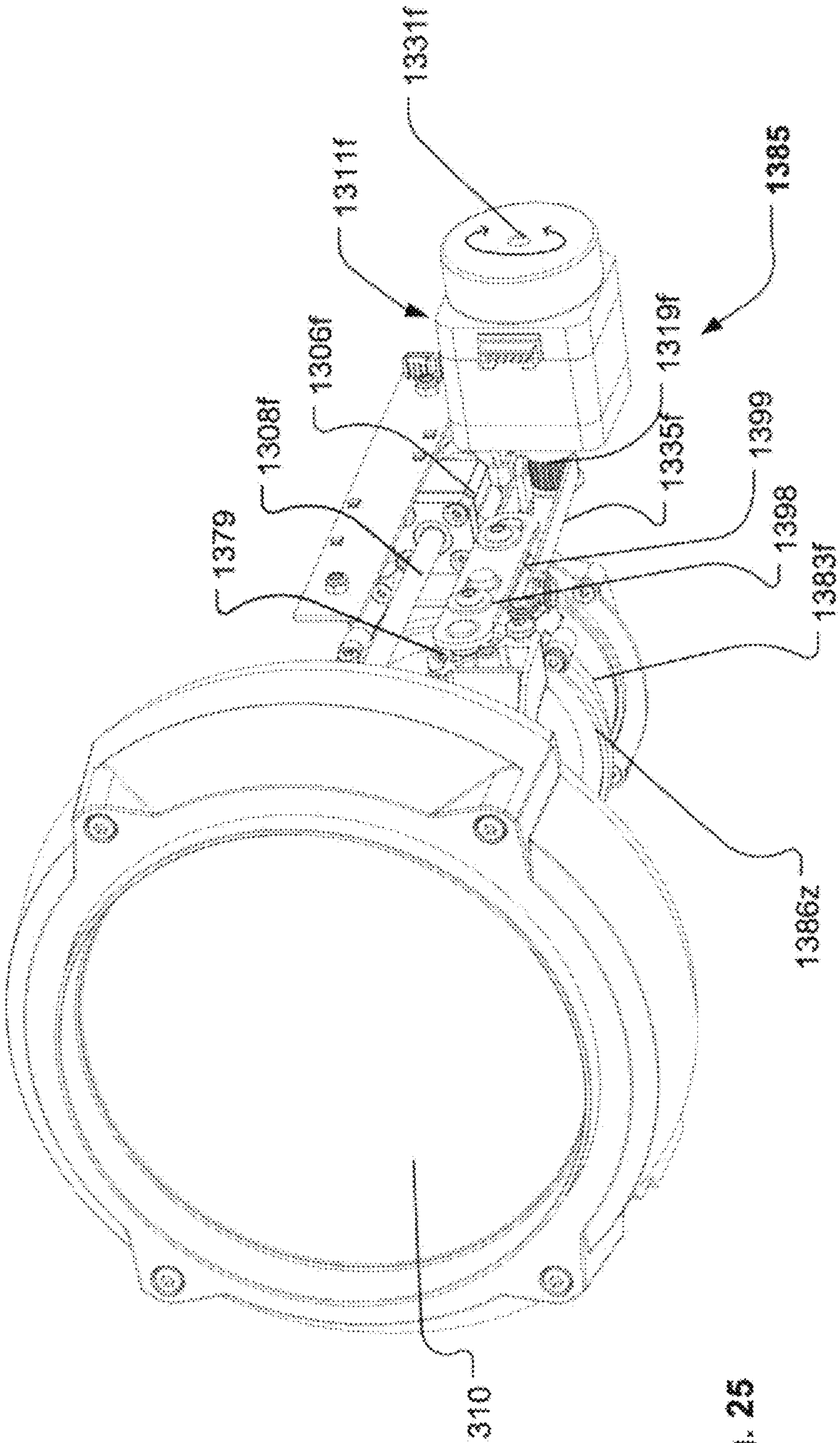
1331f
1311f
1385
1306f
1319f
1308f
1335f
1399
1379
1398
1383f
1386z
1310

Fig. 25

METHOD OF REDUCING SOUND FROM LIGHT FIXTURE WITH STEPPER MOTORS

CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims foreign priority benefits under 35 U.S.C. § 119(a)-(d) to DK Application Serial No. PA 201700088 filed Feb. 10, 2017, DK Application Serial No. PA 201700091 filed Feb. 10, 2017, and DK Application Serial No. PA 201700092 filed Feb. 10, 2017 the disclosure of which is hereby incorporated in its entirety by reference herein.

TECHNICAL FIELD

The present invention relates to light fixtures comprising a light source generating a light beam. The light fixture may comprise a support structure and a rotatable structure rotatably connected to the support structure, where a light source is arranged in the rotatable structure and creates a light beam. Such light fixture can for instance be a moving head light fixture comprising a base, a yoke and a head, where the yoke is rotatable in relation to the base around a yoke axis and the head is rotatable around a head axis in relation to the yoke.

BACKGROUND

In order to create various light effects and mood lighting in connection with concerts, live shows, TV shows, sport events or as a part of an architectural installation light fixtures creating various effects are getting more and more used in the entertainment industry. Typically, entertainment light fixtures create a light beam having a beam width and a divergence and can for instance be wash/flood fixtures creating a relatively wide light beam with a uniform light distribution or it can be profile fixtures adapted to project image onto a target surface.

Typically, such light fixtures comprise a least one light source generating a light beam propagating along an optical axis and an optical assembly configured to project the light beam along the optical axis. Light fixtures for entertainment can comprise a number of light effect components which are configured to be inserted into the light beam in order to provide different light effects. The light effect components can for instance be any light effects known in the art of intelligent/entertainments lighting, for instance a CMY color mixing system, color filters, gobos, animation effects wheels, iris diaphragms, focus lenses, zoom lenses, prism effect components, framing systems or any other light effects known in the art. Moving head light fixture comprising a base, a yoke and a head are often used in connection with entertainment lighting as they, in addition to the light effects described above, can also direct the light into various directions.

Light designers and programmers want as many effects as possible in a light fixture as this gives the light designer and programmers many options when creating light shows. Additionally light designers and programmers constantly also have a desire to have a silent light fixture were the noise generated by the light fixture is as low as possible.

U.S. Pat. No. 3,545,301 discloses a vibration damper for mounting on the output shaft of an electrical stepping motor wherein a viscoelastic absorber element is fixedly interposed between the motor output shaft and a damping mass, with the polar mass moment of inertia of the latter being a function of the polar mass moment of inertia of the motor armature. The polar mass momentum of inertia of damping mass is taken to be in the range of 10 to 60% (preferably 50%) of that of the motor.

SUMMARY

The object of the present invention is to provide a moving head light fixture and light effect system which reduces the limitations with the prior art moving head light fixtures and light effect systems.

This is achieved by providing a light fixture according to the claimed invention where the light fixture comprises: at least one light source generating a light beam, and a stepper motor comprising a stepper motor stator and a stepper motor rotor. The stepper motor rotor in which a stepper motor axle and is rotatable around a stepper motor axis. The stepper motor is connected to a movable object and is configured to move the movable object in relation to a reference point. A damping mass is attached to the stepper motor axle. The damping mass has a rotational inertia in relation to the stepper motor axis which is at least as large as the rotational inertia of the stepper motor rotor in relation to the stepper motor axis.

Additionally, this is achieved by a method of damping the sound generated by a light fixture according to the claimed invention, where the light fixture includes: at least one light source generating a light beam, a movable object, and a stepper motor that is configured to move the movable object. The stepper motor includes a stepper motor stator and a stepper motor rotor. The stepper motor rotor includes a stepper motor axle and is rotatable around a stepper motor axis.

The method includes the step of attaching a damping mass to the stepper motor axle where the damping mass has a rotational inertia in relation to the stepper motor axis which is at least as large as the rotational inertia of the stepper motor rotor in relation to the stepper motor axis.

Providing a damping mass having a rotational inertia in relation to the stepper motor axis which is at least as large as the rotational inertia of the stepper motor rotor in relation to the stepper motor axis, results in the effect that the vibrations created by the stepper motor are reduced whereby the sound generated by the light system is reduced.

The advantages and benefits of the invention are described in more detail in the detailed description of the invention and the dependent claims describe further embodiments of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** illustrates a stepper motor system used in the light fixture according to the present invention;

FIG. **2** illustrates a stepper motor system used in the light fixture according to the present invention.

FIG. **3** illustrates a stepper motor system used in the light fixture according to the present invention.

FIG. **4** illustrates a stepper motor system used in the light fixture according to the present invention.

FIG. **5** illustrates a light fixture where a rotatable structure is rotated by a stepper motor system;

FIG. **6** illustrates a stepper motor according to the prior art;

FIG. **7** illustrates another embodiment of a light fixture where a rotatable structure is rotated by a stepper motor system;

FIG. **8** illustrates another embodiment of a light fixture where a rotatable structure is rotated by a stepper motor system;

FIG. **9** illustrates a moving head light fixture where a head is rotatable by a stepper motor system in relation to a yoke and where the yoke is rotatable in relation to a base by a stepper motor system;

FIG. **10** illustrates graphs of the sound level generated by a moving head light fixture during rotation of a head in relation to a yoke;

FIG. **11** illustrates a damping mass for a stepper motor system of a light fixture;

FIG. **12** illustrates a damping mass for a stepper motor system of a light fixture;

FIG. **13** illustrates a damping mass for a stepper motor system of a light fixture;

FIG. **14** illustrates another damping mass for a stepper motor system of a light fixture;

FIG. **15** illustrates another damping mass for a stepper motor system of a light fixture;

FIG. **16** illustrates another damping mass for a stepper motor system of a light fixture;

FIG. **17** illustrates a yoke of a moving head light fixture;

FIG. **18** illustrates another damping mass for a stepper motor system of a light fixture;

FIG. **19** illustrates another damping mass for a stepper motor system of a light fixture;

FIG. **20** illustrates another damping mass for a stepper motor system of a light fixture;

FIG. **21** illustrates another damping mass for a stepper motor system of a light fixture;

FIG. **22** illustrates another damping mass for a stepper motor system of a light fixture;

FIG. **23** illustrates another damping mass for a stepper motor system of a light fixture;

FIG. **24** illustrates a light fixture where light modifying elements are movable in relation to a light beam by a stepper motor system; and

FIG. **25** illustrates a zoom/focus system of a light fixture where a zoom/focus lens is movable in relation to a light beam by a stepper motor system.

DETAILED DESCRIPTION

The present invention is described in view of exemplary embodiments only intended to illustrate the principles of the present invention. The skilled person will be able to provide several embodiments within the scope of the claims. In the illustrated embodiments the illustrated light beams and optical means do only serve to illustrate the principles of the invention rather than illustrating exact and precise light beams and optical means. Throughout the description the reference numbers of similar elements providing similar effects have the same last two digits.

FIGS. **1-4** illustrate structural diagrams of different embodiments of a stepper motor system **100**A-**100**D according to the present invention. Each of the stepper motor systems **100**A-**100**D comprises a stepper motor **011** comprising a stepper motor stator **015** and a stepper motor rotor **017**. The stepper motor rotor **017** comprises a stepper motor axle **019** rotatable around a motor axis **020**. The stepper motor **011** can be any stepper motor known in the art of stepper motors for instance similar to the stepper motor illustrated in FIG. **6** illustrating a stepper motor **211** according to the prior art. The skilled person also realizes that the stepper motor is controlled by some electronics (not shown) for instance driving circuits and/or micro controllers as known in the art of stepper motors.

The stepper motor **011** is connected to a movable object **002** and is configured to move the movable object **002** in relation to a reference point **004**. The movable object **002** can be any object which can be moved in relation to the reference point **004**, for instance, components of a light fixture where for instance light modifying elements are moved in relation to a light beam in order to modify the light beam, in moving head light fixtures where a movable structure can be moved in relation to a stationary structure. The reference point **004** is illustrated as an arbitrary point and it is to be understood that the reference point can be any point in relation to which the movable object **002** is movable by translation and/or rotation.

A damping mass **031** is attached to the stepper motor axle **019** and has a rotational inertia in relation to the stepper motor axis **020** which is at least as large as the rotational inertia of the stepper motor rotor **017** in relation to the stepper motor axis **020**. The damping mass reduces the sound generated by the stepper motor **011** system during movement of the movable object **002** in relation to the reference point, as the damping mass reduces the vibrations generated by the stepper motor **011** upon rotation of the stepper motor rotor **017**. These vibrations are typically transferred into soundwaves hearable by the human ear. The stepper motor **011** is connected to the other parts of the stepper motor system and also typically forms part of an apparatus such as light fixtures, and the vibrations can thus be transferred to other parts of the stepper motor system or apparatus and thereby enhance the sound waves. Reducing the vibration caused by vibration of the stepper motor rotor **017** upon rotation of the stepper motor **011** will thus reduce the hearable sound generated upon movement of the movable object **002**. Adding the damping mass with an inertia at least as large at the inertia of the stepper motor rotor **017** reduces the vibrations of the stepper motor rotor **017** as the angular momentum generated by the additional inertia takes up the vibrations as the forces from vibrations need to change the angular momentum of the rotating damping mass angular momentum and thus less vibrations can be transformed into soundwaves. That the inertia of the damping mass is at least as large at the inertia of the stepper motor rotor **017** ensures that the angular momentum provided by the damping mass is at least as large as the angular momentum of the stepper motor rotor **017** and the damping mass is thus capable of taking up vibrations caused by the stepper motor **011**.

As can be seen from the drawings, the damping mass can be attached to stepper motor axle **019** at a position outside the stepper motor stator. As a consequence the damping mass can be applied to the stepper motor **011** without modifying the stepper motor **011** and the damping mass can thus be applied to any standard stepper motor. This makes is further possible to apply the damping mass to existing light fixtures comprising stepper motors whereby the sound generated during use of the stepper motor can be reduced.

In the embodiment shown in FIG. **1**, the stepper motor **011** is connected to the movable object **002** via a belt mechanism comprising a belt **035** suspended by the stepper motor axle **019** and a pulley **079**. Rotation of the stepper motor axle by the stepper motor causes the belt to rotate around the stepper motor axle **019** and the pulley. A carrier **006** is movably connected to a guiding track **008** and is fixed to the belt **035**, as a consequence the carrier **006** will move along the guiding track upon rotation of the belt. The carrier **006** is configured to carry the movable object **002** which as a consequence moves along the guiding track upon rotation of the belt by the stepper motor **011**. Thus, the stepper motor **001** is configured to transitionally move the movable object in relation to the reference point.

In the embodiment shown in FIG. **2**, the stepper motor axle **019** is formed as a spindle **010** having a thread. The movable object is connected to the spindle **010** via a mating mechanism (not shown) which can be screwed on to the thread of the spindle **010**. The other end of the mating mechanism is movably connected to a guiding track **008** which is substantially parallel with the spindle **010**. Rotation of the stepper motor axle **019** by the stepper motor **011** causes the spindle **010** to rotate and the movable object to move along the guiding track and the spindle.

In the embodiment shown in FIG. **3**, the stepper motor **011** is connected to the movable object **002** via a gearing mechanism formed as a bevel gear **012** where the axes of the two shafts intersect and are angled in relation to each other. Here, the motor axle **019** constitutes one axle and a second axle **014** constitutes the other axle. The movable object **002** is connected to the end of the second axle **014** and rotates thus in relation to the axis of the second axle **014** and the reference point is here positioned at the second axle **014** and at the center of the movable object. Thus, the stepper motor is configured to rotate the movable object in relation to the reference point. It is noted that any gearing mechanisms can be used, for instance, a mechanism where the stepper motor axle **019** and the second axle **014** are parallel or systems where the coupling between the stepper motor axle **019** and the second axle **014** is provided vie belts, chains or the like.

In the embodiment shown in FIG. **4**, the movable object **002** is coupled directly to the end to the stepper motor axle **019** and is thus rotated directly by the stepper motor **011**.

In one embodiment, the damping mass has a mass which is at least as large as the mass of the stepper motor rotor **017**. This ensures that the physical dimensions of the damping mass can be provided to have the substantially the same size as the stepper motor rotor **017**.

In one embodiment, the damping mass is rotationally symmetric around the rotation axis of the stepper motor axle **019**. As a result, vibrations caused by rotation of the damping mass **031** in relation to the rotation of the stepper motor **017** can be avoided.

The damping mass **031** can also be provided as a "wheel" having a rim and a number of spokes where most of the mass is provided in the rim. This makes it possible to provide a damping mass **031** having a high rotational inertia at a lower weight as by arranging more of the mass at larger distance from the center of rotation the inertia is increased. It is noted that the inner part of the damping mass as an alternative to the spokes can be provided as a thin disc where the rim then is thicker than the disc. Additional holes/opening can also be provided at the center part of the damping mass **031** in order to reduce the mass without reducing the rotational inertia too much.

FIG. **5** illustrates a structural diagram of a light fixture **101** according to one aspect of the present invention. The light fixture **101** comprises a support structure **103** and a rotatable structure **105**. The rotatable structure **105** comprises at least one light source **107** generating a light beam **109** (illustrated in dotted lines). The light source **107** is illustrated as a LED (light emitting diode) arranged inside the rotatable structure **105** and the light beam **109** exits the rotatable structure **105** through an emitting window **110**. The light source **107** can be any kind of light source **107**, for instance incandescent lamps, discharge lamps, plasma lamps, LEDs (light emitting diodes), OLEDs (organic LEDs), PLEDs (polymer LEDs) or combinations thereof. The emitting window **110** is shown as an optical lens configured to deflect the light beam **109**, however, it is noticed that the light emitting window **110** can be provided as any component allowing the light beam **109** to propagate through the head housing, such as optical lenses, clear areas, or as an opening in the housing. Additionally, it is noticed that the light source **107** can also be arranged at the outer surface of the rotatable structure **105**.

An actuator **111** is adapted to rotate the rotatable structure **105** around a rotation axis **113**. The actuator **111** is a stepper motor comprising a stepper motor stator **115** and a stepper motor rotor **117**. The stepper motor rotor **117** comprises a stepper motor axle **119** rotatable around a motor axis **120** (aligned with the rotation axis **113**). The stepper motor can be any stepper motor known in the art of stepper motors, for instance similar to the stepper motor illustrated in FIG. **6** illustrating a stepper motor **211** according to the prior art. The stepper motor **211** comprises a stepper motor stator **215** connected to a front endcap **221** and a rear endcap **223**. A part of the stator **215** and the front endcap **221** has been cut away allowing seeing into the stepper motor **211** where the stepper motor rotor **215** is arranged. The stepper motor rotor **215** comprises a magnet **225** attached to the stepper motor axle **219** and a part of the stepper motor axle **219** extends through the front endcap **221** and/or the rear endcap **223**. At least one bearing **227** rotationally supports the stepper motor rotor in relation to the stepper motor stator. The stator comprises a number of windings **229** which can be electrically energized causing the stepper motor to rotate as known in the art. The stepper motor **211** illustrated in FIG. **6** illustrates only one possible embodiment of the stepper motor **211** and the skilled person understands that any kind of stepper motor can be used. The skilled person also realizes that the stepper motor is controlled by some electronics (not shown), for instance driving circuits and/or micro controllers as known in the art of stepper motors.

Returning to FIG. **5**, a damping mass **131** is attached to the stepper motor axle **119** and the damping mass **131** has a rotational inertia in relation to the stepper motor axis **120** which is at least as large as the rotational inertia in relation to the stepper motor axis **120** of the stepper motor rotor **117**.

The damping mass **131** reduces the sound generated by the light fixture **101** during rotation of the rotatable structure **105** in relation to the support structure **103**, as the damping reduces the vibrations generated by the stepper motor upon rotation of the stepper motor rotor **115**. These vibrations are typically transferred into soundwaves hearable by the human ear. The stepper motor is connected to the support structure **103** and the rotatable structure **105** and the vibrations can thus be transferred to these parts of the light fixture **101** and thereby enhance the sound waves. Reducing the vibration caused by vibration of the stepper motor rotor **115** upon rotation of the stepper motor will thus reduce the hearable sound generated upon rotation of the rotatable structure **105** in relation to the support structure **103**. Adding the damping mass **131** with a rotational inertia at least as large as the rotational inertia of the stepper motor rotor **115** reduces the vibrations of the stepper motor rotor **115** as the angular momentum generated by the additional inertia takes up the vibrations as the forces from vibrations need to change the angular momentum of the rotating damping mass **131** and thus less vibrations can be transformed into soundwaves. That the rotational inertia of the damping mass **131** is at least as large at the inertia of the stepper motor rotor **117** ensures that the angular momentum provided by the damping mass **131** is at least as large as the angular momentum of the stepper motor rotor **117** and the damping mass **131** is thus capable of taking up vibrations caused by the stepper motor.

In FIG. **5** the stepper motor is arranged in the stationary structure, however, it is to be understood that the stepper motor also can be arranged in the rotatable structure **105** and rotate together with rotatable structure **105**.

FIG. **7** illustrates a structural diagram of a light fixture **301**. The light fixture **301** is substantially identical to the light fixture **101** illustrated in FIG. **5** and identical features have been given the same reference numbers as in FIG. **5** and will not be described further. In this embodiment, the stepper motor **111** is connected to a rotation wheel **333** via a belt **335** and the rotation wheel **333** is aligned with the rotation axis **113**. The stepper motor **111** is arranged at the support structure **103** and the stepper motor **111** is configured to drive the belt **335** in relation to the rotation wheel **333** causing the rotatable structure **105** to rotate around the rotation axis **113**. The rotation wheel **333** is fixed to the rotatable structure **105** and is formed as a shaft or attached to a shaft which is rotatably mounted in the stationary structure **103**; for instance via a bearing **337** or any other structure allowing the rotation of the rotatable structure **105** in relation to the stationary structure.

FIG. **8** illustrates a structural diagram of a light fixture **401**. The light fixture **401** is substantially identical to the light fixture **101** illustrated in FIG. **5** and identical features have been given the same reference numbers as in FIG. **5** and will not be described further. In this embodiment, the stepper motor **111** is connected to a rotation wheel **433** via a belt **435** and the rotation wheel **433** is aligned with the rotation axis **113**. The stepper motor **111** is arranged at the rotatable structure **105** and the stepper motor **111** is configured to drive the belt **435** in relation to the rotation wheel causing the rotatable structure **105** to rotate around the rotation axis **113**. The rotation wheel **433** is fixed to the stationary structure **103** and is formed as a shaft or attached to a shaft which is fixed to the stationary structure **103**. The rotatable structure **105** is rotatably connected to rotation wheel **433**, for instance via a bearing **437** or any other structure allowing the rotation of the rotatable structure **105** in relation to the stationary structure. Upon activation of the stepper motor **111**, the rotation of the belt **435** results in the rotatable structure **105** rotating around the rotation wheel **435** and it is noted that the stepper motor **111** also rotates around the rotation axis **113**.

FIG. **9** illustrates a structural diagram of a moving head light fixture **501** comprising a base **503**, a yoke **539** rotatable around a yoke axis **541** by a stepper motor **511***y*. In the illustrated embodiment, the stepper motor **511***y* is connected to a rotation wheel **533***y* through a belt **535***y*. The rotation wheel **533***y* is formed as a shaft (or attached to a shaft) which is fixed in relation to the base **503** and rotatably connected to the yoke **539**. The stepper motor **511***y* comprises a stepper motor stator **515***y* and a stepper motor rotor **517***y*. The rotor **517***y* comprises a stepper motor axle **519***y* rotatable around a motor axis **520***y*. The stepper motor **511***y* can be any stepper motor known in the art of stepper motors, for instance similar to the stepper motor illustrated in FIG. **6**. A damping mass **531***y* is attached to the stepper motor axle **519***y* and the damping mass **531***y* has a rotational inertia in relation to the stepper motor axis which is at least as large as the rotational inertia in relation to the stepper motor axis of the stepper motor rotor **517***y*. As described previously, the damping mass **531***y* results in the effect that the sound generated by the moving head light fixture **501** upon rotation of the yoke **539** in relation to the base **503** is reduced.

A head **543** is connected rotatably around a head axis **545** to the yoke **539** and is rotatable in relation to the yoke by a stepper motor **511***h*. The head **543** comprises at least one light source **507** generating a light beam **509** (illustrated in dotted lines). In the illustrated embodiment the stepper motor **511***h* is connected to a rotation wheel **533***h* through a belt **535***h*. The rotation wheel **533***h* is formed as a shaft (or attached to a shaft) which is fixed to the head **543** and is rotatably connected to the yoke **539**. The stepper motor **511***h* comprises a stepper motor stator **515***h* and a stepper motor rotor **517***h*. The stepper motor rotor **517***h* comprises a stepper motor axle **519***h* rotatable around a motor axis **520***h*. The stepper motor **511***h* can be any stepper motor known in the art of stepper motors, for instance similar to the stepper motor illustrated in FIG. **6**. A damping mass **531***h* is attached to the stepper motor axle **519***h* and the damping mass **531***h* has a rotational inertia in relation to the stepper motor axis which is at least as large as the rotational inertia in relation to the stepper motor axis of the stepper motor rotor **517***h*. As described previously, the damping mass **531***h* results in the effect that the sound generated by the moving head light fixture **501** upon rotation of the head **543** in relation to the yoke **539** is reduced.

The base **503** forms a stationary structure of the moving head light fixture **501** and the yoke **539** and head **543** form a rotatable structure of the moving head light fixture **501**. Rotation of the head **543** in relation the yoke **539** results in rotation of the light beam **509** around the yoke axis **541** and rotation of the yoke **539** in relation to the base results in rotation of the light beam **509** in relation the yoke axis **541**.

As known in the prior art, the moving head light fixture **501** receives electrical power **545** from an external power supply (not shown). The electrical power is received by an internal power supply **547** which adapts and distributes electrical power through internal powerlines (not shown) to the subsystems of the moving head **543**. The internal power system can be provided in many different ways, for instance, by connecting all subsystems to the same power line. The skilled person will, however, realize that some of the subsystems in the moving head need different kind of power and that a ground line also can be used. The light source **507** will for instance in most applications need different kind of power than the step motors and driver circuits.

The moving head light fixture **501** also comprises a controller **549** which controls the components (other subsystems) in the moving head light fixture based on an input signal **551** indicative of light effect parameters, such as beam effect parameters, position parameters and other parameters related to the moving head lighting fixture **501**. The beam effect parameters relate to the light effects that the light beam **509** should generate and may for instance be color, dimming level, prism effects, gobo effects, iris effects, animation effects, etc. It is noticed that eventual components generating these light effects have not been shown. The input signal **551** also can indicate at least one position parameter related to the position of the head **543** and yoke **539**. The input signal **551** can be provided as separate signals (not shown) comprising different parameters or can be provided internally within the light fixture **501**, for instance in form of instructions stored in a memory of the light fixture **501**. The moving head light fixture **501** also can comprise user input device **553** enabling a user to interact directly with the moving head **543** instead of a light controller to communicate with the moving head **543**. The user input device **553** can, for instance, be buttons, joysticks, touch pads, keyboards, mice, etc. The user input device **553** can also be supported by a display **555** enabling the user to interact with the moving head light fixture **501** through a menu system shown on the display using the user input device **553**. The display device **555** and user input device **553** can in one embodiment also be integrated as a touch screen.

FIG. **10** illustrates a graph showing the results of sound measurements made of a moving head light fixture similar to the one illustrated in FIG. **9** made during rotation of the head in relation to the yoke. The sound measurements were made by measuring the dB A-weighted sound level generated by the moving head during identical rotation patterns of the head in relation to the yoke **539**, where the head **543**:

1. started from a 0 degree position in relation to the yoke,
2. rotated 135 degrees in a first direction,
3. rotated 270 degrees in a second direction (opposite the first direction);
4. rotated 270 degrees in the first direction,
5. rotated 270 degrees in the second direction,
6. rotated 270 degrees in the first direction,
7. rotated 270 degrees in the second direction,
8. rotated 270 degrees in the first direction,
9. rotated 135 degrees in the second direction,
10. stopped in the 0 degree position.

In the 0 degree position, the light beam **509** is emitted straight upward in relation to the base **503** and corresponds to the situation shown in FIG. **9**.

The horizontal axis **657** indicates the time in seconds [s], and the vertical axis **659** indicates the A-weighted sound level in dB [dB(A)].

The solid graph **661** illustrates the measured sound level during the rotation pattern with the stepper motor **511***y* rotating the head **543** in relation to the yoke **539** without adding a damping mass **531** to the stepper motor axle **520**.

The dashed graph **663** illustrates the measured sound level during the rotation pattern with the stepper motor rotating the head in relation to the yoke with the damping mass **731** illustrated in FIG. **10-12** added to the stepper motor axle.

The dotted graph **665** illustrates the measured sound level during the rotation pattern with the stepper motor rotating the head in relation to the yoke with the damping mass **831** illustrated in FIG. **14-16** added to the stepper motor axle.

The graphs clearly show that the sound is reduced when adding the damping masses **731** or **831** to the motor axle of the moving head as the sound level during the rotations of the head in relation to the head without the damping mass primarily lies within the 30-40 dB range, whereas the sound level with either damping mass **731** or **831** primarily lies within the 20-30 dB range. Thus the sound level generated during rotation of the head of a moving head light fixture can clearly be reduced by adding a damping mass to the motor axle of the stepper motor.

The stepper motor rotor of the stepper motor of the moving head light fixture used for the measure sound level measurements has rotational inertia in relation to the stepper motor axis of 26 kg mm^2 and the weight to the stepper motor rotor is 190 g.

FIGS. **11-13** illustrate a damping mass **731** which can be used as a damping mass of the light fixture according to the present invention; where FIG. **11** illustrates a top view, FIG. **12** illustrates a cross sectional view through line A-A, and FIG. **13** illustrates a perspective view. The damping mass **731** is formed as a substantial cylindrical body having a mounting hole **767** wherein a stepper motor axle can be arranged allowing the damping mass **731** to be attached to the stepper motor axle. The damping mass comprises threaded hole **769** ending in a mounting hole. A screw can then be inserted into the threaded hole and be screwed onto the stepper motor axle in order to fix the damping mass to the stepper motor axle.

The damping mass illustrated in FIGS. **11-13** was used when measuring the sound level indicated by the dashed graph **663** of FIG. **10**. The damping mass was made of aluminum and has a weight of 723 g and a rotational inertia in relation to the stepper motor axis of 406 kg mm^2. As a consequence, in an embodiment the damping mass has a rotational inertia in relation to the stepper motor axis, which is at least 15 times larger than the rotational inertia in relation to the stepper motor axis of the stepper motor rotor. Also, the damping mass has a mass which is at least 3 times larger than the mass of the stepper motor.

FIGS. **14-16** illustrate a damping mass **831** which can be used as a damping mass of the light fixture according to the present invention; where FIG. **14** illustrates a top view, FIG. **8***b* illustrates a cross sectional view through line B-B, and FIG. **15** illustrates a perspective view. The damping mass **831** is formed as a cone frustrum with a top cylinder and a bottom cylinder. A mounting hole **867** has been made in the top cylinder and a stepper motor axle can be arranged in the mounting hole allowing the damping mass to be attached to the stepper motor axle. The damping mass comprises threaded hole **869** ending the mounting hole. A screw can then be inserted into the threaded hole and be screwed onto the stepper motor axle to fix the damping mass to the stepper motor axle.

The damping mass illustrated in FIGS. **14-16** was used when measuring the sound level indicated by the dotted graph **665** of FIG. **10**. The damping mass was made of steel and has a weight of 259 g and a rotational inertia in relation the stepper motor axis of 89 kg mm^2. As a consequence, in an embodiment, the damping mass has a rotational inertia in relation to the stepper motor axis which is at least 3 times larger than the rotational inertia in relation to the stepper motor axis of the stepper motor rotor. Also, the damping mass has a mass which is at least 1.3 times larger than the mass of the stepper motor.

FIG. **17** illustrates a perspective view of the yoke **939** for a moving head light fixture. The yoke **939** comprises a frame **971** supporting the components arranged at the yoke **939**. The frame is covered by a pair of yoke shells **973** where one of them has been removed in order to make the components inside the yoke shells **973** visible.

The yoke arms support two bearings **937***h* which are rotatably connected to a head shaft **975** to which a head (not shown) can be fixed allowing the head to rotate in relation to the yoke **939**. A rotation wheel **933***h* is fixed to the head shaft and connected to a stepper motor **911***h* via a belt **935***h*. The stepper motor **911***h* can be any stepper motor known in the art of stepper motors, for instance, similar to the stepper motor illustrated in FIG. **6**, and comprises a stepper motor stator and a stepper motor rotor. The rotor comprises a stepper motor axle **919***h* rotatable around a motor axis. A damping mass **931***h* is attached to the stepper motor axle **919***h* and has a rotational inertia in relation to the stepper motor axis which is at least as large as the rotational inertia in relation to the stepper motor axis of the stepper motor rotor. The damping mass **931***h* is illustrated in further detail in FIGS. **10***a*-**10***c* and results in the effect that the sound generated by the moving head light fixture upon rotation of the head in relation to the yoke is reduced. A toothed wheel **977***h* has also been added to the motor axle and serves to drive the belt **935***h*, which comprises mating tooth and a number of pulleys **979***h* that serve to guide the belt.

The yoke **939** is rotatably connected to yoke shaft **981** via a bearing **937***h* and a rotation wheel **933***y* is fixed to the yoke shaft **981**. The yoke shaft **981** is fixed to a base (not shown) and the yoke **939** can thus rotate in relation to the yoke shaft **981**, the rotation wheel **933***y* and the base. The rotation wheel **933***y* is connected to a stepper motor **911***y* via a belt **935***y*. The stepper motor **911***y* can be any stepper motor known in the art of stepper motors, for instance similar to the stepper motor illustrated in FIG. **6** and comprises a stepper motor stator and a stepper motor rotor. The rotor comprises a stepper motor axle (not visible) rotatable around a motor axis. A damping mass **931***y* is attached to the stepper motor axle and has a rotational inertia in relation to the stepper motor axis which is at least as large as the rotational inertia in relation to the stepper motor axis of the stepper motor rotor. The damping mass **931***y* is illustrated in further detail in FIGS. **21-23** and results in the effect that the sound generated by the moving head light fixture upon rotation of the head in relation to the yoke **939** is reduced. A toothed wheel **977***y* has also been added to the motor axle and serves to drive the belt **935***y*, which comprises mating tooth and a number of pulleys **979***y* that serve to guide the belt **935***y*.

The stepper motor rotors of stepper motors used in this yoke **939** have rotational inertia in relation to the stepper motor axis of 26 kg mm^2 and the weight to the stepper motor rotor is 190 g.

FIGS. **18-20** illustrate a damping mass **931***h* which can be used as a damping mass of the light fixture according to the present invention; where FIG. **18** illustrates a top view, FIG. **19** illustrates a cross sectional view through line C-C, and FIG. **20** illustrates a perspective view. The damping mass **931***h* is used in the yoke **939** illustrated in FIG. **17** and is formed as a cone frustrum with a bottom cylinder. A mounting hole **1067** has been made in the bottom cylinder and a stepper motor axle can be arranged in the mounting hole allowing the damping mass to be attached to the stepper motor axle. The damping mass **931***h* comprises two perpendicular threaded holes **1069** ending in the mounting hole. A screw can then be inserted into the threaded holes and be screwed onto the stepper motor axle in order to fix the damping mass to the stepper motor axle and due to the fact that threaded holes are perpendicular the damping mass is prevented from tilting in relation to the stepper motor axle. The damping mass **931***h* comprises also a hole **1083** in the upper part which can be used to accommodate a magnet and eventually also a magnetic sensor which is used for encoding the angular position of the stepper motor axle as known in the art of moving head light fixtures. The shape of the damping mass **931***h* has been designed to provide as large rotational inertia as possible within the given allowed space within the yoke shells, for instance the conical shape of the damping mass **931***h* has been provided in order for the damping mass to fit with inside the yoke shell of the yoke shown in FIG. **17**.

The damping mass **931***h* is made of steel, has a weight of 257 g and a rotational inertia in relation to the stepper motor axis of 84 kg mm^2. As a consequence, in an embodiment, the damping mass **931***h* has a rotational inertia in relation to the stepper motor axis which is at least 3 times larger than the rotational inertia in relation to the stepper motor axis of the stepper motor rotor. Also, the damping mass has a mass which is at least 1.3 times larger than the mass of the stepper motor.

FIGS. **21-23** illustrate a damping mass **931***y* which can be used as a damping mass of the light fixture according to the present invention; where FIG. **21** illustrates a top view, FIG. **22** illustrates a cross sectional view through line C-C, and FIG. **23** illustrates a perspective view. The damping mass **931***h* is formed as a cone frustrum with a bottom cylinder. A mounting hole **1167** has been made in the bottom cylinder and a stepper motor axle can be arranged in the mounting hole **1167** allowing the damping mass to be attached to the stepper motor axle. The damping mass comprises two perpendicular threaded holes **1169** ending in the mounting hole. A screw can then be inserted into each of the threaded holes **1169** and be screwed onto the stepper motor axle in order to fix the damping mass to the stepper motor axle and due to the fact that threaded holes **1169** are perpendicular, the damping mass is prevented from tilting in relation to the stepper motor axle. The damping mass comprises also a hole **1183** in the upper part which can be used to accommodate a magnet and eventual a magnetic encoder which is used for encoding the angular position of the stepper motor axle as known in the art of moving head light fixtures.

The damping mass is made of steel, has a weight of weight of 191 g and a rotational inertia in relation to the stepper motor axis of 55 kg mm^2. As a consequence, in an embodiment, the damping mass has a rotational inertia in relation to the stepper motor axis which is at least 2 times larger than the rotational inertia in relation to the stepper motor axis of the stepper motor rotor. Also, the damping mass has a mass which is substantially equal to the mass of the stepper motor.

The damping mass is illustrated to be attached to stepper motor axle at the back side of the stepper motor, however, it is noted that the damping mass also can be attached at the front side of the stepper motor. Additionally, is it noted that the damping mass can be made of any material capable of providing a sufficiently large rotational inertia in relation the stepper motor axle.

FIG. **24** illustrates a structural diagram of a light fixture **1201** according to one aspect of the present invention. The light fixture comprises a light source **1207** generating a light beam **1209**.

The light fixture **1201** comprises a number of stepper motor systems (similar to the ones shown in FIGS. **1-4**) and each stepper motor system comprises at least one stepper motor **1211***a*-**1211***e* comprising a stepper motor stator **1215** and a stepper motor rotor **1217**. The stepper motor rotor comprises a stepper motor axle **1219** rotatable around a motor axis **1220**. The stepper motor is connected to a movable object and is configured to move the movable object in relation to a reference point. The reference numbers **1215**, **1217**, **1219** and **1220** have only been indicated for one of the stepper motor systems, as the stepper motors in FIG. **24** are illustrated identically. The movable object is provided as different kinds of light modifying elements capable of modifying the light beam and the light beam constitutes the reference point. As described previously the stepper motor comprises a damping mass **1231** configured to reduce the sound generated by the stepper motor system. The light modifying elements can for instance be optical elements such as optical lenses, light mixing rods, optical prisms. The light modifying elements can also be color flites filtering different color of the light, beam forming elements such as gobos, framing blades, animation wheels, irises, and textured glass structures, etc.

The light fixture **1201** comprises an optical zoom/focus system **1285** where the light modifying element is provided as an optical lens **1286** which can be moved along the light beam **1209** in order to provide a zoom/focus effect to the light beam **1209**. The optical lens **1286** is connected to a carrier **1206** which is movably connected to a guiding track **1208** and is fixed to a belt **1235***a*. The belt **1235***a* is rotatable around the stepper motor axle and a pulley **1279**. As a consequence, the stepper motor can move the optical lens **1286** along the light beam **1209**.

The light fixture **1201** comprises a color system **1287** where a color filter **1288** can be moved into the light beam **1209**. Stepper motor axle is formed as a spindle **1210** having a thread and the color filter is connected to the spindle via a mating mechanism **1289** which can be screwed on to the thread of the spindle **1210** causing the color filter to be moved in and out of the light beam **1209** upon rotation of the spindle **1210**. The color filter can be any kind of color filter capable of providing some filtering of the spectral components of the light beam **1209**.

The light fixture **1201** comprises a prism system **1290** comprising an optical prism **1291** capable of diffracting the light beam **1209**, for instance, to create a multiple number of projections of a GOBO pattern. The optical prism is rotatable in relation to the light beam **1209** by the stepper motor **1211***c*, for instance by a gear **1292** or the like interacting with the peripheral edge of the prism, e.g. through a toothed wheel (not shown) or belt (not shown).

The light fixture **1201** comprises a rotating gobo system **1293** where a number of rotating gobos **1294** is arranged at a gobo wheel **1295**. The gobo wheel **1295** is connected to the end of the stepper motor axle of stepper motor **1211***d* and stepper motor **1211***d* can thus rotate the gobo wheel in relation to the light beam whereby different gobos can be arranged into the light beam. The gobo wheel comprises a center gear **1296** configured to rotate the gobos around a gobo axis **1297**. The center gear **1296** is rotated by stepper motor **1211***e* which rotates the center gear via a belt **1235***e*. The gobo system can, for instance, be provided as shown in WO 0137032 A2.

The illustrated systems are only examples of light modifying systems where a stepper motor is configured to move a light modifying element in relation to the light beam and the skilled person will realize the stepper motor system comprising a damping mass attached to the stepper motor axle can be used in a kind of light modifying system where a stepper motor is configured to move a light modifying element, for instance iris systems, framing systems, dimmer systems, animation systems, CMY color mixing systems, color systems, gobos, prism, zoom/focus systems, etc.

FIG. **25** illustrates a zoom/focus system **1385** of a light fixture comprising a light source (not shown) generating a light beam (not shown). The light beam passes through the zoom/focus system **1385** before leaving the light fixture through a front lens **1310**. The zoom/focus system **1385** comprises a zoom lens **1386***z* and a focus lens **1386***f* which are movable along the light beam. The focus lens **1386***f* is connected to a carrier **1306***f* which is movably connected to a guiding track **1608***f* and is fixed to a belt **1335***f* The belt **1335***f* is rotatable around the stepper motor axle **1319***f* and a pulley **1379**. The pulley **1379** is attached to a belt tighten mechanism **1398** comprising a belt tighten spring **1399** configured (barely visible) to provide a tighten force to the pulley **1379** in order to hold the belt **1335***f* tight. As a consequence, the stepper motor can move the optical lens along the light beam. The stepper motor **1311***f* comprises a damping mass **1331***f* configured to reduce the sound generated by the stepper motor system as described previously. The zoom lens **1386***z* is connected to a similar stepper motor system, however, these features are not visible in the drawing.

Another aspect of the present invention relates to a method of damping the sound generated by a light fixture, where the light fixture includes: at least one light source generating a light beam, a movable object, and a stepper motor configured to move the movable object. The stepper motor comprises a stepper motor stator and a stepper motor rotor, and the stepper motor rotor comprises a stepper motor axle and is rotatable around a stepper motor axis.

The method includes the step of attaching a damping mass to the stepper motor axle where the damping mass has a rotational inertia in relation to the stepper motor axis which is at least as large as the rotational inertia of the stepper motor rotor in relation to the stepper motor axis.

The method makes it possible to reduce the sound generated by a light fixture when a stepper motor moves a movable object of the light fixture. As described previously, this is achieved as by attaching the damping mass to the stepper motor axle resulting in the fact that the vibration generated by the stepper motor is reduced whereby less sound is generated.

The method can further include a step of arranging the damping mass rotational symmetric in relation to the stepper motor axle as this results in the fact that the damping mass does not itself generate additional vibrations potentially generating additional sound.

The method can further include a step of providing the movable object as a light modifying element configured to modify the light beam and the step of moving the light modifying element in relation to the light beam using the stepper motor.

The method can further include a step of providing the movable object as a rotatable structure rotatably connected to a support structure; where the rotatable structure comprises the light source; and the step of rotating the rotatable structure in relation to the support structure around a rotation axis using the stepper motor. This makes it possible to reduce the sound generated by rotating the head and/or yoke of a moving head light fixture.

The method can be used to ensure that sound of new light fixtures is minimized and also to reduce the sound generated by existing light fixtures as a damping mass can be added relatively easy to existing stepper motors of light fixtures.

It is noticed that the stepper motor systems illustrated in FIGS. **1-4** also can be used in connection with other devices where a movable structure is moved by a stepper motor, for instance, in surveillance cameras where the cameras can be moved in pan or tilt directions, in printing machines where a printer head is movable in relation to a paper, in 3D printing machines where the 3D printing head is moved in relation to the object being printed, in laser or water jets cutting machines where a laser or water jet is moved in relation to the object being cut, or in the field of robotics where the robots comprise movable objects. A common issue with a stepper motor system used in this field of technology is that the stepper motor system generates sound which can be annoying to persons near such devices. Thus, the stepper motor system disclosed herein can also be used to reduce the sound generated by such systems, for instance, by a stepper motor system according to the following statements:

Statement 1:

A stepper motor system comprising a stepper motor, where the stepper motor comprises a stepper motor stator and a stepper motor rotor, where the stepper motor rotor comprises a stepper motor axle and is rotatable around a stepper motor axis; the stepper motor is connected to a movable object and is configured to move the movable object in relation to a reference point, wherein a damping mass is attached to the stepper motor axle, the damping mass having a rotational inertia in relation to the stepper motor axis which is at least as large as the rotational inertia of the stepper motor rotor in relation to the stepper motor axis.

Statement 2:

The stepper motor system where the damping mass has a mass at least as large as the mass of the stepper motor rotor.

Statement 3:

The stepper motor system where the damping mass is rotational symmetric around the rotational axis of the stepper motor axle.

Statement 4:

The stepper motor system where the stepper motor is configured to transitionally move the movable object in relation to the reference point.

Statement 5:

The stepper motor system where the stepper motor is configured to rotate the movable object in relation to the reference point.

Statement 6:

The stepper motor system where the stepper motor is connected to the movable object via a belt mechanism, and the stepper motor is configured to drive the belt causing the movable object to move in relation to the reference point.

Statement 7:

A method of damping the sound generated by movement of a movable object by a stepper motor. The method includes the steps of: configuring a stepper motor to move the movable object in relation to a reference point by connecting the stepper motor to the movable object, where the stepper motor comprises a stepper motor stator and a stepper motor rotor, where the stepper motor rotor comprises a stepper motor axle and is rotatable around a stepper motor axis. The method further includes: attaching a damping mass to the stepper motor axle where the damping mass has a rotational inertia in relation to the stepper motor axis which is at least as large as the rotational inertia of the stepper motor rotor in relation to the stepper motor axis.

Statement 8:

The method where the damping mass has a mass at least as large as the mass of the stepper motor rotor.

Statement 9:

The method where the step of attaching the damping mass to the stepper motor axle comprises a step of arranging the damping mass rotationally symmetric in relation to the stepper motor axle.

Statement 10:

The method further including the step of transitionally moving the movable object in relation to the reference point is performed using the stepper motor.

Statement 11:

The method further including the step of rotating the movable object in relation to the reference point.

What is claimed is:

1. A light fixture comprising:

at least one light source generating a light beam; and

a stepper motor including a stepper motor stator and a stepper motor rotor, where the stepper motor rotor comprises a stepper motor axle and is rotatable around a stepper motor axis; the stepper motor is connected to a movable object and is configured to move the movable object in relation to a reference point to modify the light beam as generated by the at least one light source;

wherein a damping mass is attached to the stepper motor axle, the damping mass having a rotational inertia in relation to the stepper motor axis which is at least as large as the rotational inertia of the stepper motor rotor in relation to the stepper motor axis.

2. The light fixture according to claim **1**, wherein the damping mass has a mass at least as large as the mass of the stepper motor rotor.

3. The light fixture according to claim **1**, wherein the damping mass is attached to the stepper motor axle at a position outside the stepper motor stator.

4. The light fixture according to claim **1**, wherein the damping mass is rotationally symmetric around a rotational axis of the stepper motor axle.

5. The light fixture according to claim **1**, wherein the stepper motor is connected to the movable object via a belt mechanism, and the stepper motor is configured to drive the belt causing the movable object to move in relation to the reference point.

6. The light fixture according to claim **1**, wherein the movable object comprises a light modifying element configured to modify the light beam and wherein the light modifying element is movable in relation to the light beam.

7. The light fixture according to claim **6**, wherein the light modifying element comprises an optical element movable in relation to the light beam.

8. The light fixture according to claim **6**, wherein the light modifying element comprises a color flag which is movable in relation to the light beam.

9. The light fixture according to claim **6**, wherein the light modifying element comprises a gobo which is movable in relation to the light beam.

10. The light fixture according to claim **1** comprising;

a support structure; and

a rotatable structure rotatably connected to the support structure; the rotatable structure comprises the light source;

wherein the movable object comprises the rotatable structure and where the stepper motor is configured to rotate the rotatable structure in relation to the support structure around a rotation axis.

11. The light fixture according to claim **10**, wherein the stepper motor is connected to a rotation wheel via a belt, the rotation wheel is aligned with the rotation axis and the stepper motor is configured to drive the belt in relation to the rotation wheel causing the rotatable structure to rotate around the rotation axis.

12. The light fixture according to claim **10**, wherein the support structure is formed as a base of a moving head light fixture, where a yoke is rotatably connected to the base, and where the rotatable structure forms a head rotatably connected to the yoke; wherein the stepper motor is provided as at least one of the following:

a yoke stepper motor configured to rotate the yoke in relation to the base, and

a head stepper motor configured to rotate the head in relation to the yoke.

13. A method of damping sound generated by a light fixture comprising:

generating a light beam with at least one light source;

moving a moveable object with a stepper motor to modify the light beam as generated by the at least one light source; where the stepper motor includes a stepper motor stator and a stepper motor rotor, and where the stepper motor rotor comprises a stepper motor axle and is rotatable around a stepper motor axis; and

attaching a damping mass to the stepper motor axle where the damping mass has a rotational inertia in relation to the stepper motor axis which is at least as large as the rotational inertia of the stepper motor rotor in relation to the stepper motor axis.

14. The method according to claim **13**, wherein the damping mass has a mass at least as large as the mass of the stepper motor rotor.

15. The method according to claim **13**, wherein the step of attaching the damping mass to the stepper motor axle comprises a step of arranging the damping mass rotationally symmetric in relation to the stepper motor axle.

16. The method according to claim **13**, wherein the method includes the step of providing the moveable object as a light modifying element configured to modify the light beam and the step of moving the light modifying element in relation to the light beam using the stepper motor.

17. The method according to claim **13**, wherein the method comprises the step of providing the moveable object as a rotatable structure rotatably connected to a support structure; the rotatable structure comprises the light source; and the step of rotating the rotatable structure in relation to the support structure around a rotation axis using the stepper motor.

18. A light fixture comprising:

at least one light source generating a light beam; and

a stepper motor including a stepper motor rotor, where the stepper motor rotor comprises a stepper motor axle and is rotatable around a stepper motor axis; the stepper motor is connected to a movable object and is configured to move the movable object in relation to a reference point to modify the light beam as generated by the at least one light source;

wherein a damping mass is attached to the stepper motor axle, the damping mass having a rotational inertia in relation to the stepper motor axis which is at least as large as the rotational inertia of the stepper motor rotor in relation to the stepper motor axis.

19. The light fixture according to claim **18**, wherein the damping mass includes a mass at least as large as the mass of the stepper motor rotor.

20. The light fixture according to claim **18**, wherein the damping mass is attached to the stepper motor axle at a position outside of a stepper motor stator of the stepper motor.

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