# United States Patent [19]

**Goddard**

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[54] **AUTOMATICALLY-EQUILIBRATING SUSPENDED LAMP**


[75] Inventor: **Stephen A. A. Goddard,** Minneapolis, Minn.

[73] Assignee: **Goddard Designs, Inc.,** Minneapolis, Minn.



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[52] **U.S. Cl.** ..... **240/10 C,** 240/6.4 R, 244/33

[51] **Int. Cl.** .. **A47g 29/122,** F21p 1/02, F21v 21/02

[58] **Field of Search** ..... 240/10 C, 6.4 R; 244/115, 244/116, 24, 30, 31, 33



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*Primary Examiner*—Joseph F. Peters, Jr.

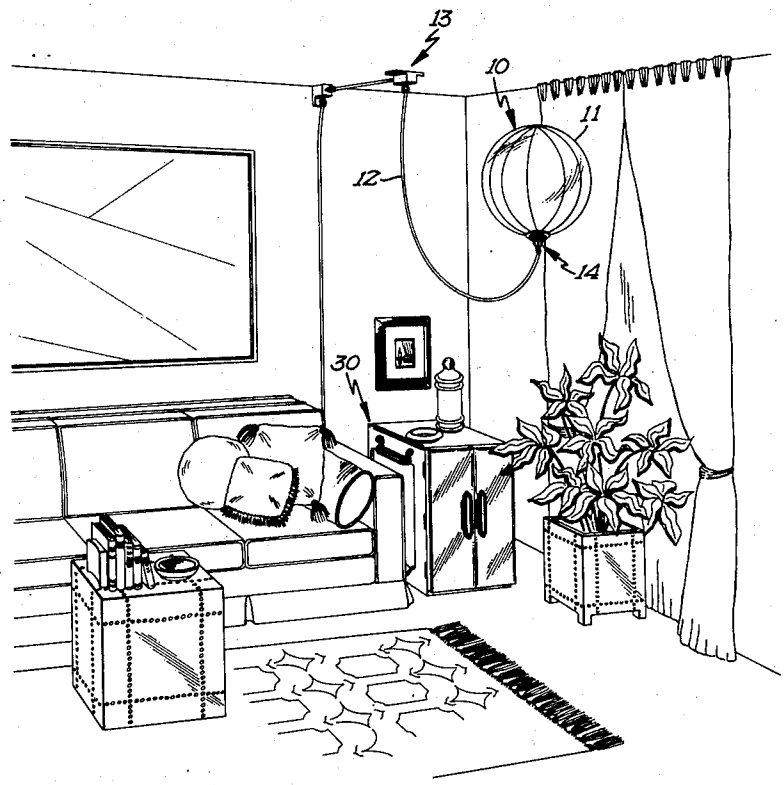
*Attorney, Agent, or Firm*—Dorsey, Marquart, Windhorst, West & Halladay



[57] **ABSTRACT**

An automatically equilibrating inflated suspended object. The inflated object is lighter than the surrounding medium. Equilibrium is automatically achieved by means of a flexible tether extending from a fixed elevated point to the object. Vertical movement of the object varies the portion of the weight of the tether supported by the object until the object supported weight of the tether equals the lift. The specific embodiment described is a floating lamp wherein the inflated object is formed of translucent sheet material and an incandescent bulb is disposed inside the object. A gas and electrical support system for the lamp also disclosed.


**5 Claims, 6 Drawing Figures**



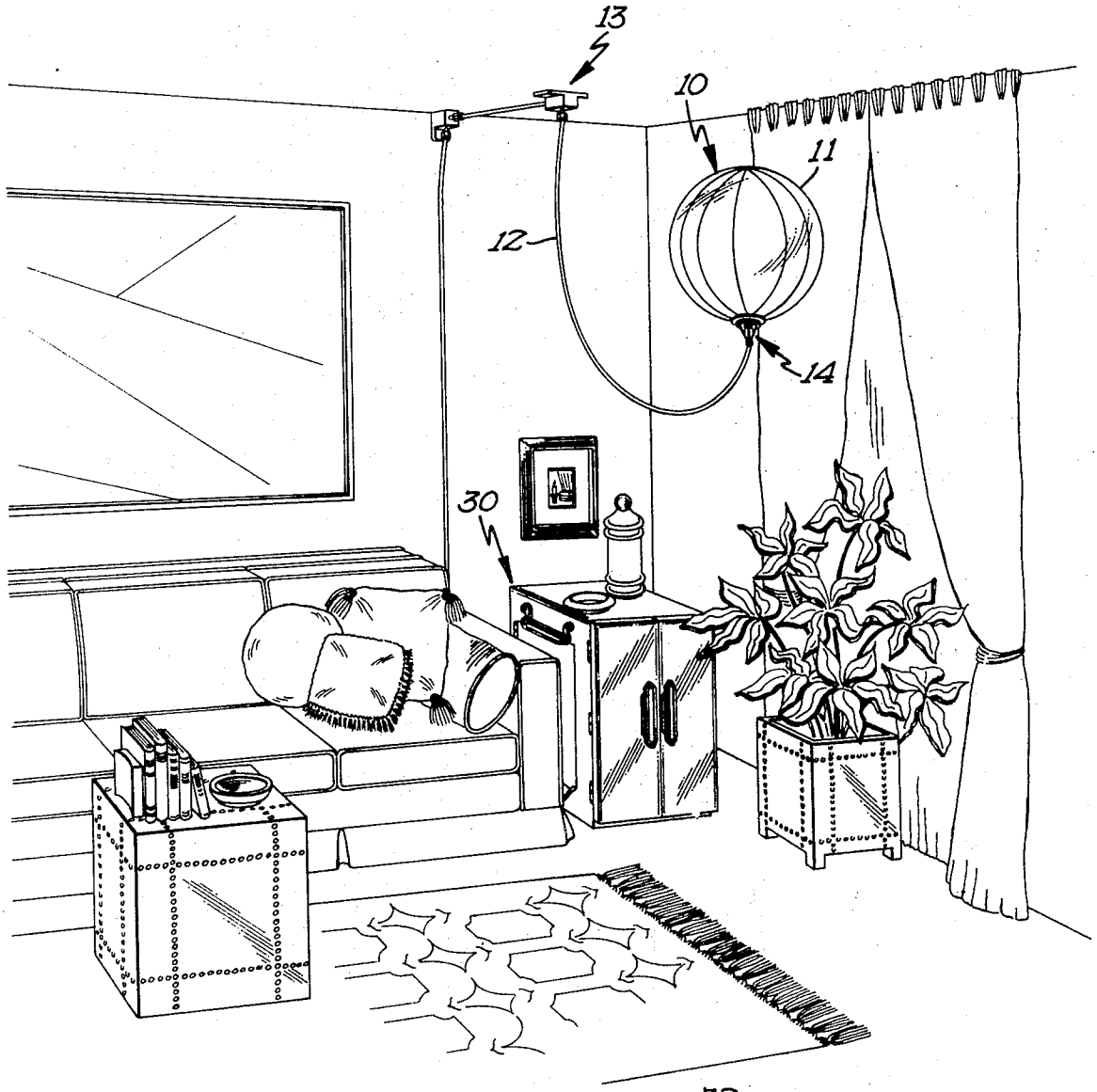

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Fig 1

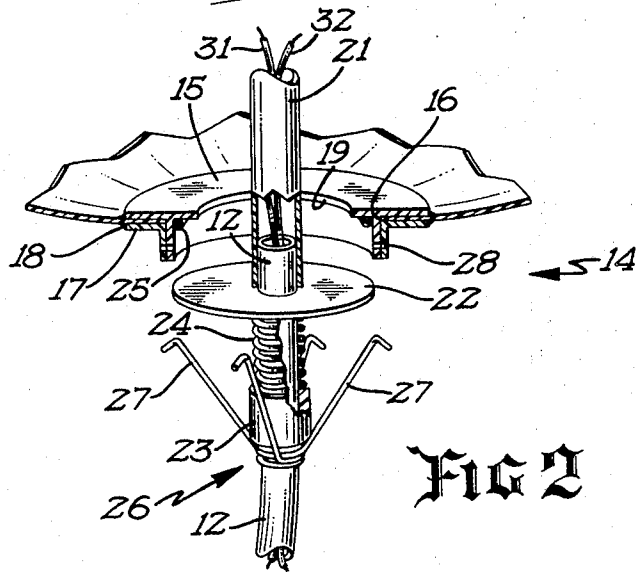

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Fig 2

FIG 4A




FIG 4B




FIG 4C




FIG 3

# AUTOMATICALLY-EQUILIBRATING SUSPENDED LAMP

## BACKGROUND OF THE INVENTION

In its broadest sense the invention is in the field of suspending objects, lighter than the surrounding medium, in the surrounding medium, and automatically reaching suspended equilibrium conditions through the use of an inverted tether. In a narrower sense, with particular reference to the preferred embodiment, the invention is in the field of suspended illumination devices, suspended typically in the atmosphere, which include an automatic equilibrating characteristic.

The prior art includes equilibrating variable ballast or tethers for use typically in mooring dirigibles. U.S. Pat. No. 1,734,812 issued to O. Krell on Nov. 5, 1929 is representative of this art. The prior art also includes illuminated floating balloons used typically for advertising purposes. U.S. Pat. No. 242,483 issued on June 7, 1881 to H. T. Sisson and U.S. Pat. No. 2,383,390 issued to H. E. Jacobs on Aug. 21, 1945 are representative of this art.

While the dirigible mooring art includes a tether which represents variable ballast supported in increasing amounts with a rise of the dirigible, the tether is not inverted. It extends upwardly from the supporting surface to the floating dirigible with the ballast provided by the tether increasing as the links are pulled off the supporting surface. Thus this prior art does not teach the unique and unobvious feature of providing variable ballast and automatic equilibration from a point above the suspended object. This feature allows for a great range of horizontal movement and provides a highly unique, unobvious and intriguing feature of the present invention particularly meaningful when the suspended object takes the form of modern atmospheric (mood) lighting apparatus.

The illuminated balloon advertising art discloses only a conventional tie-down for the floating balloon. No self-equilibrating feature is taught. Stabilization is achieved by tension in the tether, not by variable ballast. Thus, the art fails to teach the inverted tether equilibration feature of the present invention.

## SUMMARY OF THE INVENTION

The present invention consists of a self-equilibrating or stabilizing suspended assembly comprising a floating object and flexible tether means extending from an elevated point to the object which serves as a variable ballast for the object. The object typically contains a fluid substantially lighter than the surrounding fluid medium so that the weight of the displaced fluid is greater than the sum of the weight of the contained fluid and the weight of the object, thereby producing lift. The tether has a weight greater than the lift. Vertical movement of the object varies the portion of the weight of the tether supported by the object to automatically stabilize the object in suspension in the surrounding medium.

In its broadest aspects the present invention consists of a self-equilibrating suspended assembly characterized by an inverted variable-ballast tether for use in any fluid medium, including both air and water, as well as other fluid media. In a heavy fluid medium such as water, the object may be filled with air or may even be solid, that is, without any internal cavity.



In its narrower sense the invention consists of an illuminated floating lamp which includes the inverted equilibrating feature.

## BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of the self-equilibrating suspended lamp which embodies the present invention. The figure shows the floating suspended globe, its tether and support system in a representative interior setting.

FIG. 2 is an exploded sectional view of the connector assembly for connecting the tether to the globe.

FIG. 3 is a schematic view of the support system for the lamp, and

FIG. 4 is a diagram showing three conditions which illustrate the basic feature of the invention. FIG. 4A illustrates a stabilized condition in which the floating object moves neither up nor down. In FIG. 4A the portion of the weight of the tether supported by the floating object ($W_t/n$) equals to lift (L). FIG. 4B illustrates an unstabilized condition where the floating object is moving upwardly, seeking equilibrium conditions, in which the weight of the portion of the tether supported by the object ($W_t/n$) is less than the lift (L). FIG. 4C represents an unstable condition opposite to that shown in FIG. 4B, in which the object is moving downwardly, seeking a stabilized condition, because the weight of the portion of the tether supported by the object ($W_t/n$) is greater than the lift (L). It should be noted that $n$ is not constant throughout FIG. 4, representing various fractions of the weight of the tether throughout the figure.

## DESCRIPTION OF PREFERRED EMBODIMENT

### GENERAL DESCRIPTION

The major components of the present invention, along with its general operation, may be readily understood with reference to FIG. 1, in which the invention is shown in the form of a suspended or floating lamp **10.** Lamp **10** consists of an inflated, spherical balloon-like object or globe **11** formed of transparent or translucent sheet material on a spherical frame. Globe **11** is inflated with a lighter-than-air gas, typically helium, so that the combined weight of globe **11** and its contained fluid (helium) is less than the weight of the displaced ambient air. Globe **11,** therefore, has lift and tends to rise in the surrounding medium (air).

Flexible tether **12** extends from a fixed elevated point at manifold **13,** to globe **11** and is attached to globe **11** by means of connector assembly **14.** Tether **12** is chosen so that its weight is greater than the difference between the weight of the displaced medium and the sum of the weight of globe **11** and the contained fluid, and its length is greater than one-half the circumference of globe **11.**

Globe **11** automatically reaches suspended equilibrium when the portion of the weight of tether **12** supported by globe **11** equals the lift. This occurs at some elevation below fixed point **13,** because as globe **11** rises it supports an increasing portion of the weight of tether **12,** and less of the weight is supported at point **13;** and as globe **11** falls, the opposite is true. It thus seeks an elevation (equilibrium conditions) at which the weight of the portion of tether **12** supported by globe **11** equals the lift. These conditions are shown in FIG. **4.**

Thus, the general equilibrating characteristic of the present invention may be described by the following set of equations in which:

$W_c$ = Weight of the container or globe

$W_{cf}$ = Weight of the contained fluid

$W_{df}$ = Weight of the displaced fluid

$W_t$ = Weight of the tether

$L$ = Lift

$n$ = Any number greater than one

The components are chosen so that:

$$W_c + W_{cf} < W_{df}, \text{ and}$$

$$W_t > L \text{ where}$$

$$L = W_{df} - (W_c + W_{cf})$$

Thus equilibrium conditions exist when:

$$W_t / n = L$$

The final major component of the present invention is support system **30**, shown generally in FIG. **1**, which includes a source of gas under pressure for inflating globe **11**, and means for isolating the gas supply and opening or breaking the electrical circuit in the event of rupture of globe **11** or tether **12**. Support system **30** also includes other features described in greater detail below.

## DETAILED DESCRIPTION

The detailed design and construction of the various components of the invention may be understood with reference to FIGS. **1–3**. With reference first to FIGS. **1** and **2**, inflated object or globe **11** is formed of transparent or translucent sheet material impermeable to the contained fluid which, when the system is designed for use in air, is a lighter-than-air gas, typically helium. The sheet material must be light weight yet reasonably resistant to puncture and tearing. It may be mounted on rib-like, arcuate, frame members which serve as a skeleton for the spherical shape of globe **11**. While other sheet material may be suitable, a metalized polyester in a thickness of 50–200 gauge (0.0005 – 0.002 inches) sold under the trademark MYLAR has proven to be satisfactory for a globe designed for atmospheric use inflated with helium.

While not shown, globe **11** may be formed in various configurations and painted or decorated in various ways. In the case of a spherical configuration, it may be painted to represent or simulate a globe of the world, the moon, a beach ball, or many other pleasing designs.

In the specific embodiment shown, globe **11** is inflated with helium to a pressure of approximately 10 inches of water (0.36 psig). In general a range of ¼ to ½ psig is satisfactory. Other gases or liquids may be contained in globe **11** for use in air and other fluid media. Helium is preferred, however, for use as a lamp suspended in ambient air.

Tether **12** is formed of a flexible, tubular gas impermeable cord having a uniform weight throughout its length and a degree of stiffness to insure that the globe does not engage the tether. The length of tether **12** is sufficiently long to form a bight throughout a reasonable range of verticle movement of globe **11**. For this purpose, tether **12** must be greater than one-half the circumference of globe **11**. The weight of tether **12** must also be greater than the lift of globe **11** so that the weight of the portion of tether **12** supported by globe **11** is sufficient to counter-balance or offset the lift. In the specific embodiment shown, tether **12** is formed of a ⅛ inch tube sold under the trademark NYLON.

Tether **12** is connected to globe **11** by means of connector assembly **14** shown in FIG. **2**. Connector assembly **14** includes flanged collar **15** which overlaps the marginal portion of coaxial opening **16** of globe **11**. Flanged collar **15**, together with angular collar **17**, which engages the opposite marginal portion of coaxial opening **16**, grip the marginal portion in sealing relationship. This sealing relationship is insured by adhesive or sealant **18** placed in th interface between the marginal portion of opening **16** and flanged collar **15** and angular collar **17**, respectively. Access opening **19** in flanged collar **15** provides for access to the interior of globe **11**. Rigid mounting tube **21** extends through access opening **19** into the interior of globe **11** (for a purpose to be described below). Tether **12** is press fit and sealed with an adhesive inside mounting tube **21**, as shown in FIG. **2**, to provide a secure, gas impermeable joint. Rigid sealing disc **22** is coaxially mounted and sealed to the lower end of mounting tube **21** about tether **12**, and has an outside diameter slightly less than the inside diameter defined by the flange of flanged collar **15**. Sleeve **23** is slidably mounted about tether **12** spaced beneath disc **22**. Coil spring **24** is disposed about mounting tube **21** between sealing disc **22** and sleeve **23**. O-ring **25** is disposed beneath flanged collar **15**. Wire bale **26** extends from a coil below sleeve **23** radially upwardly and outwardly through hooked legs **27**. A series of radially extending openings **28** are formed in flanged collar **15** and angular collar **17**. Openings **28** register when flanged collar **15** and angular collar **17** are pressed into engagement with the marginal portion of opening **16** in globe **11**.

Connector assembly **14** is assembled by moving wire bale **26**, tether **12** and mounting tube **21** upwardly to move sealing disc **22** into engagement with O-ring **25**. Continued upward movement of wire bale **26** urges sleeve **23** into engagement with coil spring **24** and compresses coil spring **24** against sealing disc **22**, pushing disc **22** into tight sealing engagement with O-ring **25**. The hook portion of legs **27** are urged inwardly, to register with registered openings **28** in flanged collar **15** and angular collar **17**, and are allowed to expand into openings **28** thereby securing connector assembly **14** and mounting tube **21** in position.

With reference to FIG. **3**, an illumination source in the form of incandescent bulb **28** is mounted in socket **29** on mounting tube **21**. Leads **31**, a common ground, and **32** extend from socket **29** through mounting tube **21**, tether **12** and pressure sensing manifold **13** to support system **30**. Various sources and arrangement of illumination means may be used within obvious weight limitations. Moreover, in the case of a helium filled object or globe **11**, bare tungsten filaments may be used without an enclosing glass bulb with the helium contained in globe **11** serving as the "bulb." Bulb **28** may be replaced by disassembling connector assembly **14** and removing mounting tube **21** through access opening **19**.

Globe **11** together with tether **12**, connector assembly **14**, bulb **28** and leads **31** and **32** serves as a self-equilibrating, suspended lamp without any additional

apparatus or hardware. Such an assembly, however, while embodying all the basic principles of the present invention, lacks certain conveniences and safety measures which are provided by support system **30.**

Support system **30,** shown schematically in FIG. **3,** includes a network for supplying and regulating gas to globe **11,** and an electrical network for supplying and regulating electrical energy to the illumination source, bulb **28.**

The gas supply network includes tank **35,** which in the embodiment shown contains helium under pressure up to approximately 2,000 psig. Value **36** serves as the basic manually-operated, shut-off valve for tank **35.** Conduit **37** leads to high pressure regulator **38** and pressure gauge **39** which serves to indicate the pressure remaining in tank **35.** Conduit **40** leads from high pressure regulator **38** to solenoid controlled valve **41.** Conduit **42** connects solenoid controlled valve **41** with low pressure regulator **43** and conduit **44,** in turn, connects low pressure regulator **43** with valve **45.** Valve **45** may be set to connect bypass conduit **46** with conduit **47,** or to connect conduit **44** with conduit **47,** for a purpose described below. Conduit **47** communicates with electrical-pressure manifold **48.** Conduit **49** runs from electrical-pressure manifold **48** to pressure sensing manifold **13** to thereby complete the gas pressure circuit or network from tank **35** to tether **12** and globe **11.**

The electrical network includes means for supplying current to bulb **28,** means for opening the circuit in the event of a rupture of tether **12** or globe **11,** means for closing the gas supply circuit in the event of rupture, means for regulating the intensity of the illumination source and various indicator means. For purposes of the following description, normal conditions are operating conditions with gas pressure in tether **12** and globe **11** and with all electrical circuits energized.

The current supply circuit includes power source plug **50,** common ground **31,** and positive lead **51** interrupted by basic on-off switch **52** leading to positive lead **53.** Relay **54** includes two pair of contacts which are closed when relay **54** is energized by energizing circuit **51, 53** and **55** leading to common ground **31** through normally-closed, pressure-actuated switch **56** in pressure sensing manifold **13.** Thus, with the system connected to a source of electrical energy and switch **52** and pressure-actuated switch **56** both closed, relay **54** is energized to connect lead **53** with lead **57,** and to connect lead **53** with lead **58.** When relay **54** is deenergized, these respective leads are opened or disconnected. Thus, when relay **54** is energized the circuit to bulb **28** is closed resulting in illumination of globe **11.** Also solenoid **59** is energized which opens valve **41** thereby providing for the flow of gas to globe **11.**

In the event of rupture of globe **11** or tether **12** the pressure in pressure sensing manifold **13** drops and this drop in pressure is sensed by normally-closed, pressure-actuated switch **56.** Switch **56** is sensitive to low pressure and opens at a gauge pressure of about 3 inches water (0.11 psig). Pressure-actuated switch **56** opens to break the relay energizing circuit between lead **55** and common ground **31.** Thus, relay **54** is deenergized and the illumination circuit is broken between leads **53** and **57.** The solenoid energizing circuit is broken between leads **53** and **58** and solenoid **59** is deenergized closing valve **41.** The flow of electrical energy is thus stopped, and with valve **45** set to connect conduit **44** and conduit **47,** the closing of valve **41** isolates the gas under pressure in tank **35** from conduits **47** and **49,** and tether **12.** Thus, any rupture in balloon **11** or tether **12** is sensed and support system **30** automatically opens the electrical circuit to bulb **28** and closes the gas supply circuit.

Rheostat **60,** connecting leads **57** and **32,** serves as means for regulating the intensity of bulb **28.** Indicator light **61,** connected in parallel with bulb **28,** between leads **31** and **32,** when illuminated, indicates an energized condition of relay **54** and bulb **28.** Indicator light **62,** when illuminated, serves to indicate that the basic on-off switch **52** is closed, and indicator light **63,** in parallel with solenoid **59,** when lighted, indicates an energized condition of solenoid **59.**

Reset switch **64** serves to energize solenoid **59,** bypassing relay **54,** to open valve **41** and supply gas to tether **12** and globe **11** after a repair of a rupture. After pressure builds up in pressure sensing manifold **13** to close normally-closed, pressure-actuated switch **56,** relay **54** becomes energized, connecting leads **53** and **58,** bypassing reset switch **64.** Reset switch **64** may then be opened with the system now operating under normal conditions.

Valve **45** is provided to bypass valve **41** and low pressure regulator **43** to serve as means for quickly filling globe **11** with gas under high pressure from tank **35.**

## OPERATION

The operation of the present invention should be readily apparent from the foregoing description of the design, construction and characteristics of the various components. Nevertheless, the following summary of the operation may be useful.

Gas is introduced into tether **12** and globe **11** by opening valve **36** of tank **35.** Valve **45** is set to introduce high pressure from bypass conduit **46** to conduit **47** and tether **12.** Valve **45** is then set to its normal operating position connecting conduit **44** with conduit **47.** With power source plug **50** connected to conventional voltage and switch **52** closed, pressure builds up in pressure-sensing manifold **13** closing switch **56** which energizes relay **54.** Relay **54** closes lighting bulb **28** and energizing solenoid **59.** Energized solenoid **59** opens valve **41.** Thus, with low pressure regulator set at the pressure desired in globe **11** (¼ – ⅛ psig), gas is automatically fed to globe **11** to compensate for leakage and variations in temperature thereby maintaining the pressure in globe **11** at a constant level.

Globe **11** then seeks a stabilized condition as illustrated in FIG. **4** and, with bulb **28** lighted, serves as a unique floating lamp.

In the event of rupture, pressure-actuated switch **56** opens, due to the pressure drop in pressure sensing manifold **13,** thereby deenergizing relay **54.** Relay **54** opens thereby breaking the circuit to bulb **28** and solenoid **59.** Deenergization of solenoid **59** results in the closing of valve **41** thereby isolating the gas supply in tank **35** from tether **12** and globe **11.** After a rupture is repaired, the system is reset by means of reset switch **64** as described above.

Indicator lights **61, 62** and **63** serve to indicate the conditions referred to above and bulb **28** may be replaced by disconnecting connector assembly **14,** also as described previously.

## VARIATIONS

Variations in the form of the specific embodiment

may be made without departing from the scope of the invention. For example, in certain heavy media there would be no need for inflating globe **11** with any gas. The illumination source may vary considerably being either inside or outside but supported by globe **11**, and the illumination source may vary in number and style. Thus one or more incandescent, fluorescent, or bare tungsten filament (in helium) illumination sources might be employed by those skilled in the art. In addition there might be a plurality of floating objects per tether and, of course, the shape or configuration as well as the surface markings of the floating object can vary considerably. Many variations in the design of the support system are possible and other changes may be made by those skilled in the art without departing from the scope of the invention as claimed.

I claim as my invention:

**1.** A self-equilibrating suspended lamp comprising:

a hollow object formed of non-opaque sheet material supporting an illumination source and containing a lighter-than-air gas substantially lighter than the surrounding air such that the weight of the displaced air is greater than the sum of the weight of the object, the contained gas and the illumination source, thereby producing lift;

flexible tether means formed of tubular material extending from a fixed elevated point to the object, having a weight uniform throughout its length greater than the lift, such that verticle movement of the object varies the portion of the weight of the tether supported by the object and the portion of the weight of the tether supported by the object equals the lift before the object reaches the elevation of the fixed elevated point to automatically reach equilibrium conditions; and

a support system including a source of gas under greater than atmospheric pressure and means for introducing the gas from the source through the tubular tether to the object.

**2.** The self-equilibrating suspended lamp of claim **1** wherein the support system also includes means for varying the intensity of the illumination source.

**3.** The self-equilibrating suspended lamp of claim **2** wherein the support system includes means for automatically regulating the pressure of the lighter-than-air gas in the object.

**4.** The self-equilibrating suspended lamp of claim **3** wherein the support system includes means for automatically closing the source of lighter-than-air gas and isolating the source from the object in the event of rupture of the tether or object.

**5.** The self-equilibrating suspended lamp of claim **4** wherein the support system includes means for automatically opening the electrical conductors in the event of rupture of the tether or object.

* * * * *