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[72] Inventor **Robert L. Seeley**
San Diego, Calif.

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[73] Assignee **the United States of America as represented by the Secretary of the Navy**

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[54] **CONSTANT LIGHT INTENSITY SERVO CONTROL UNIT**
2 Claims, 2 Drawing Figs.

[52] **U.S. Cl.** **250/205**
315/151; 323/20, 323/21
[51] **Int. Cl.** **G05d 25/00,**
G05f 1/56, H05b 41/392
[50] **Field of Search** 315/151;
250/205; 317/20, 21

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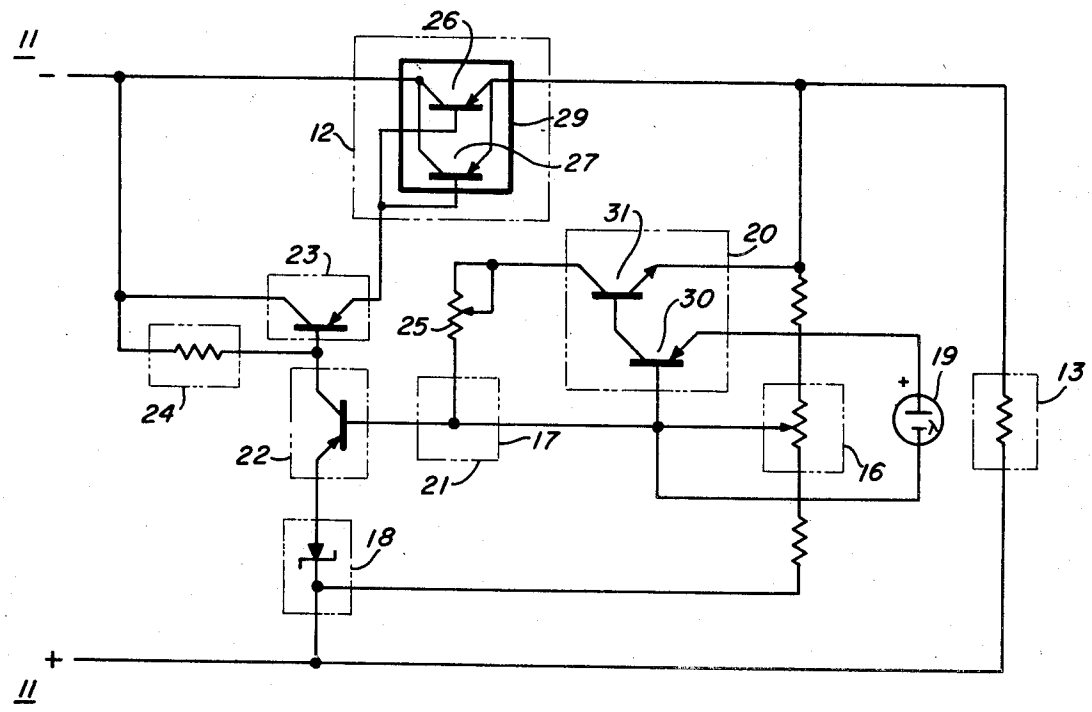
Primary Examiner—Roy Lake
Assistant Examiner—C. R. Campbell
Attorneys—R. S. Sciascia, E. F. Johnston and T. G. Keough

ABSTRACT: The present disclosure relates to devices for controlling the light intensity of a lamp, automatically, under unfavorable conditions. Electronic servocontrol circuits have been used to maintain associated circuit elements within certain operational limits. The disclosed invention, while generally being of this type, presents a rugged, compact, servocontrol unit designed to regulate the output of a storage battery to ensure a particular light intensity of a lamp contained in a pressure-resistant housing. Precise light intensity regulation, to a degree far in excess of that discernible by the human eye, is necessary where a lamp provides a source of illumination for a remotely located nephelometer, an instrument for determining the concentration or particle size of suspensions by means of transmitted or reflected light. Such precise light intensity regulation is achieved by a serially connected control unit formed of a pair of parallel power transistors controlled by a first and a second feedback loop coupled to their bases. The first feedback loop compares a desired potential provided by a Zener diode to the output of the control unit and develops a first control signal that functions to change the bias on the two parallel transistors until the output of the control unit substantially equals the desired potential. A second feedback loop, having a photocell positioned to receive impinging radiation from the lamp, produces an output signal indicative of the lamp's radiation intensity. A predetermined lamp intensity, causing the photocell to give a predetermined resultant signal, causes no current feedback to the control unit. A resultant signal caused by a deviation from the predetermined lamp intensity results in the creation and the transfer of a second signal to the control unit and consequent regulation of the lamp's intensity. Thus, a circuit ensuring internal potential regulation, as well as regulation of a lamp's intensity caused by deterioration of the lamp's elements, provides more stable and precise light intensity regulation than contemporary circuits.



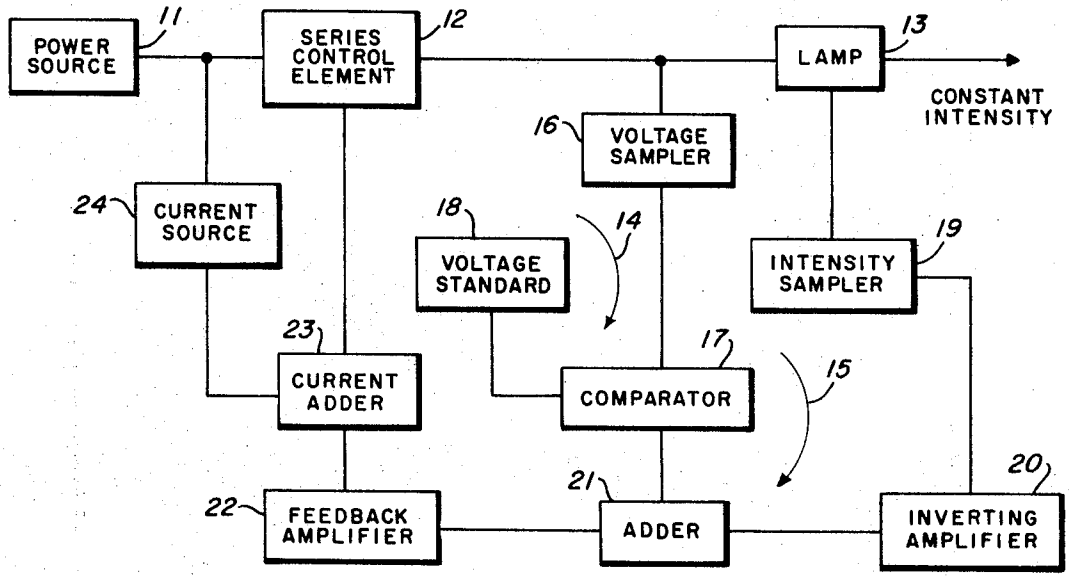


FIG. 1

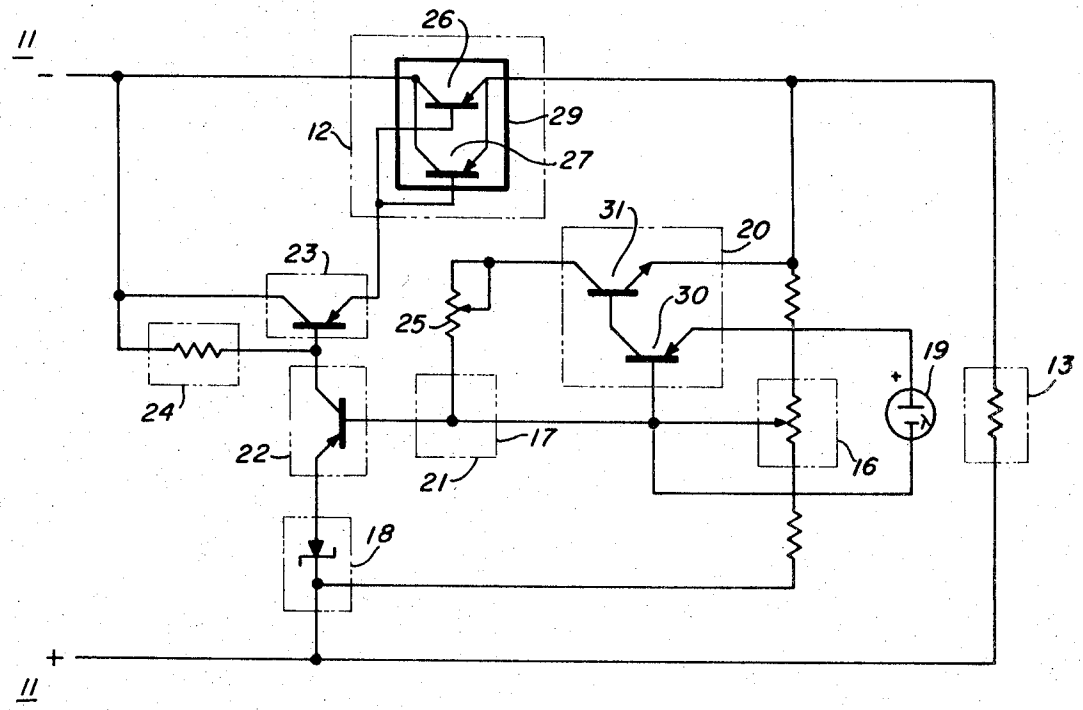


FIG. 2

INVENTOR.
ROBERT L. SEELEY
BY Thomas Glenn Keough
George J. Rubens
ATTORNEYS

CONSTANT LIGHT INTENSITY SERVO CONTROL UNIT

BACKGROUND OF THE INVENTION

The invention is adapted specifically, but not exclusively, for deep sea operations requiring a self-contained housing enclosing a power voltage source, regulating circuitry, and a lamp, all remotely located from supervisory control circuitry for providing a highly stable source of light at a given light intensity. Heretofore such light intensity, used with undersea photography or for scientific measurements, has been provided by placing a photocell in the radiation path of a source of light and noting changing variations in the radiant light on a connected ammeter, that is to say, as the intensity of the light varied, the reading on the ammeter varied. An operator, upon observing the ammeter's fluctuation, would change the setting of a potentiometer connected in series with a source of potential and the lamp to bring the intensity of the light back to the desired level. At great depths pressures usually prohibit first hand observation, or, if a pressurized habitat were available to protect an observer from the crushing pressures, electrical connections permitting adjustment of the light intensity unit must pierce the shell of the habitat, thereby greatly weakening its structural strength and greatly increasing its cost. In addition to the aforementioned disadvantages, an externally located photocell would be susceptible to damage and may incorrectly give readings representative of light intensity due to water cloudiness between the cell and the monitored lamp. All the present voltage regulation systems fail to provide a compact, two-feedback loop voltage regulation systems fail to provide a compact, two circuit, including a hermetically sealed photocell and serially connected power transistors mounted on a heat sink for regulating an interconnected lamp coupled to a source of potential.

SUMMARY OF THE INVENTION

The present invention is directed to providing an apparatus for controlling the light intensity of a lamp and includes a control unit having a pair of parallel-connected transistors forming an adjustable impedance, serially connecting a source of potential to a lamp. A first aid and a second feedback circuit monitor the output from the control unit to respectively provide a coarse control signal yielding a desired potential and a fine control signal for precisely adjusting the radiation intensity of the lamp. By adding the coarse and fine control signals and feeding the added signals to the control unit, such desired light intensity is achieved.

It is a prime object of the instant invention to provide a lamp intensity regulation circuit permitting superior regulation as compared to contemporary circuits.

Another object of the instant invention is to provide a circuit permitting precise lamp intensity regulation requiring no outside supervision or manipulation.

Yet another object is to provide a compact regulation circuit adapted to operate under severe environmental handicaps.

Still another object is to provide a regulation circuit having a coarse control feedback and a find control feedback additively enabling a more precise output control.

Yet another object is to provide a self-contained self-sustaining, rugged and highly reliable source of light at a precisely regulated, predetermined intensity.

A further object of the instant invention is to provide an illumination control unit ideally suited for operation under adverse conditions and adapted for enclosure in a unitized housing having no external control circuit.

These and other objects of the invention will become readily apparent by noting the accompanying drawings and the ensuing description in which:

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 shows a block diagram of the preferred embodiment of the invention;

FIG. 2 shows a schematic diagram of the FIG. 1 block diagram.

PREFERRED EMBODIMENT OF THE INVENTION

Turning now to the drawings, the invention permits the inclusion of a battery or similar power source **11**, a series potential control **12** and a flood lamp **13** within a watertight housing, not shown for sake of simplicity, without requiring outside control devices or remotely extending circuitry for regulating a precise light intensity of the flood lamp. This regulation is achieved by the unique electrical interaction of a first feedback loop and a second feedback loop generally designated by the arrows and reference characters **14** and **15**, respectively.

Loop **14** is responsible for the generation of a first feedback signal, a coarse feedback control signal, fed to the series voltage control element to regulate the control element's output voltage to a desired level. The loop includes a voltage sampler **16** bleeding off a portion of the output voltage and passing this sample to a comparator **17**. A voltage standard source **18** passes a signal having a desired voltage magnitude to the comparator within which a comparison of the two voltages is made and a first control signal representative of the difference between the desired voltage magnitude and the sample voltage is fed to an adder **21**.

Simultaneously, a radiation intensity sampler **19**, here an optical electric-transducing photocell, samples the light intensity of lamp **13**. A signal representative of the sampled radiated intensity is passed to an inverting amplifier **20** and the resultant signal, a second control signal, is passed to adder **21**. These two control signals, added to form a composite signal, are amplified in a feedback amplifier **22** and passed to a control current adder **23**. A current source **24**, connected power source **11**, passes an additive current to control current adder **23** to provide the proper biasing level within which the composite signal, when added to the additive current, can effectively vary the impedance of the series voltage control element voltage.

The first loop is responsive to the output voltage of the control element to bring the output voltage to a desired potential established within the first feedback loop. In the second loop, however, the second control signal is generated from an optical-to-electrical conversion representative of the light- light's intensity. Empirically, it has been discovered that irrespective of the fact that if the potential impressed across a lamp is precisely regulated, the magnitude of light intensity is subject to fluctuation or diminishment caused by deterioration of the lamp's reflective surfaces. This problem is especially prevalent in the instant invention where the lamp is used in a corrosive environment. Therefore, the second feedback loop is necessary to preserve a constant level of light intensity by providing a second second control signal representative of changing light intensity due to deterioration of the lamp. A hermetically sealed selenium photocell installed within the housing provides the necessary degree of light intensity control. However, since such a photocell has a linear response over a limited range of light intensity, the output potential provided by the first feedback loop is of a magnitude that ensures the lamp's operation within this limited range.

Looking now at the schematic diagram in FIG. 2, the boxed in phantom, having identical reference characters as shown in FIG. 1, contain the principal circuit elements. The output current of the series voltage control is the sum of the current originating in current source **24** and the feedback current originating in feedback loops **14** and **15**. When the output voltage is greater than a desired voltage established by the voltage standard source **18** or the light intensity is greater than a desired intensity determined by selective adjustment of a variable series resistor **25**, the negative feedback current from the two loops lowers the control current passed from current adder **23** to the bases of parallel transistors **26** and **27** forming the series control elements. The lowering of the total control current passed to the series voltage control element lowers the

output voltage impressed across lamp **13**, schematically represented by a resistor. The voltage sampler **16**, depicted as a potentiometer tapping off a portion of the series control element's output voltage, passes the sample to a comparator junction point designated by the numeral **17**. A voltage standard source is established by a Zener diode having breakdown voltage equal to the desired voltage and this magnitude of voltage is fed to the comparator junction. It is readily observed that an "over voltage" transferred by the voltage sampler results in a negative feedback current being delivered to the feedback amplifier and a consequent lowering of the total control current passed to the series voltage control element. The voltage sampler's transferring of an "under voltage," with respect to the desired voltage as established by voltage standard source **18**, results in a lesser amount of feedback current to permit a greater total control current transfer to the control electrodes of the two power transistors **26** and **27**. Linear operation of the power transistors is ensured by the supporting heat sink **29**.

The output current from the intensity sampler, a hermetically sealed selenium photocell **19**, is fed to a common base transistor **30** presenting a low impedance load and to a second transistor **31** functioning as an inverting amplifier. The output signal produced by the interconnected photocell circuit is passed to an adder **21** for algebraic addition to the first signal originating in the first feedback loop and results in the transfer of a composite signal to control current adder **23**. Here, it should be pointed out that the junction enclosed by the phantom box designated both **17** and **21**, performs the dual function of being a voltage comparator **17** for the first feedback loop and as an adder **21** for the first control signal originating in the first feedback loop and the second control signal originating in the second feedback loop.

The photocell's constant monitoring of the flood lamp's radiated intensity permits a feedback indicative of lamp deterioration independent of fluctuations in output voltage of the power source of or of the series voltage control element. Thus, independent, dual control of the light intensity is simultaneously occurring to ensure a constant light intensity output.

It is understood that the invention has been described without giving representative values to circuit elements in FIG. **2**. Given the values of a particular power source and a desired light intensity, the choice of circuit components operatively duplicating the inventive concept set forth in the present disclosure, is well within the purview of one skilled in the art and such changes and modifications may be made without departing from the scope of the invention as defined by appended claims.

I claim:

1. An apparatus for controlling the light intensity of a lamp isolated from external control comprising:

a storage battery similarly isolated from external control;

an adjustable impedance including first and second power transistors connected in parallel with their respective collectors electrically connected to said storage battery and their emitters electrically connected to said lamp for transferring an output signal thereto;

a first feedback means including a Zener diode having a breakdown voltage equal to a desired potential, a voltage sampler connected to said emitters bleeding off a portion of said output signal, and a voltage comparator coupled to said Zener diode and said voltage sampler for comparing said desired potential with said portion to pass a first signal representative of their deviation to the bases of said first and second transistors to adjust said impedance for ensuring the transfer of an output potential equal in magnitude to said desired potential;

a second feedback means including an internally carried photocell having a linear response over a limited range of light intensity to simultaneously generate a linear second signal representative of light intensity deviations from a desired light intensity caused by deterioration of said lamp, electrically connected to said bases; and

means for adding said first signal and said second signal to produce a composite signal electrically connecting said bases to said first and second feedback means for additively controlling said impedance to provide a lamp potential ensuring said desired light intensity.

2. An apparatus according to claim **1** further including: a source of current deriving its power from said source of potential and interposed between said adjustable impedance and said first feedback means and said second feedback means, said source of current producing a current additive to said composite signal for driving said control unit.