United States Patent

Berge

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[54] TWO LAMP LIGHT COMPARISON TYPE DENSITOMETER

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[73] Assignee: **GAF Corporation**, New York, N.Y.

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[52] **U.S. Cl.** .....**356/205**, 250/219 FR, 250/228, 356/212

[51] **Int. Cl.**.....**G01n 21/22**, G01n 21/48

[58] **Field of Search**.....356/201, 204, 205, 202, 195, 356/212; 250/228, 219 FR

[56] **References Cited**

UNITED STATES PATENTS

2,594,514	4/1952	Sweet	356/205
3,079,835	3/1963	Saperstein	356/152
3,413,482	11/1968	Ling	250/43.5 X

Primary Examiner—Ronald L. Wibert

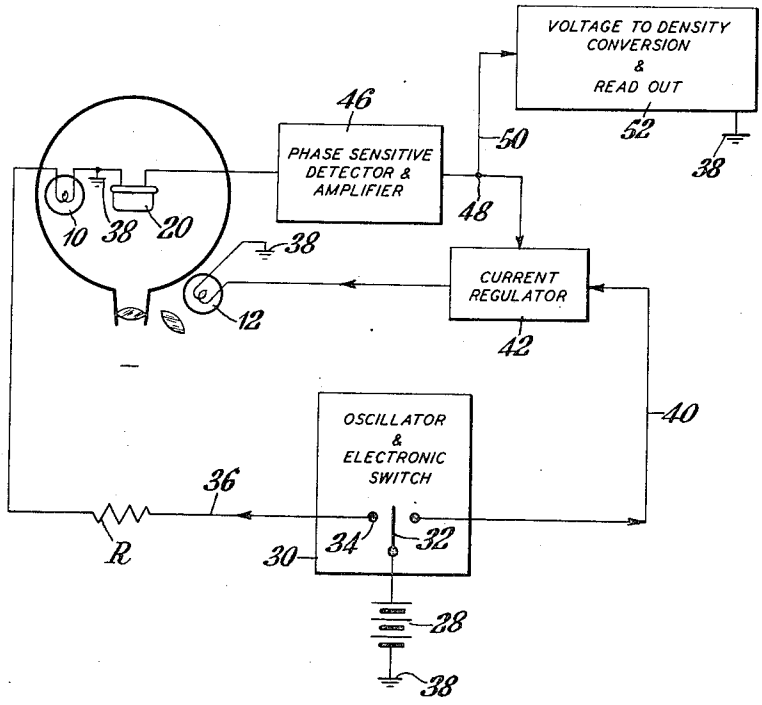
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[57] **ABSTRACT**

Two lamps are lighted alternately at controlled intensities, both lamps illuminate a common sensor and the light path from one lamp includes the density to be measured. When a minimum differential is detected, the ratio of the currents in the lamps is a function of the density being measured and current in either one or both lamp is servo-controlled to minimize the differential. The current or voltage ratios are converted and read out as density values.

2 Claims, 4 Drawing Figures



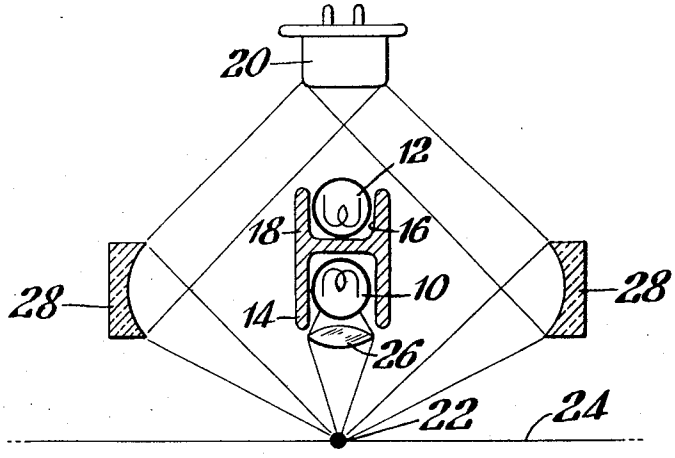


Fig. 1.

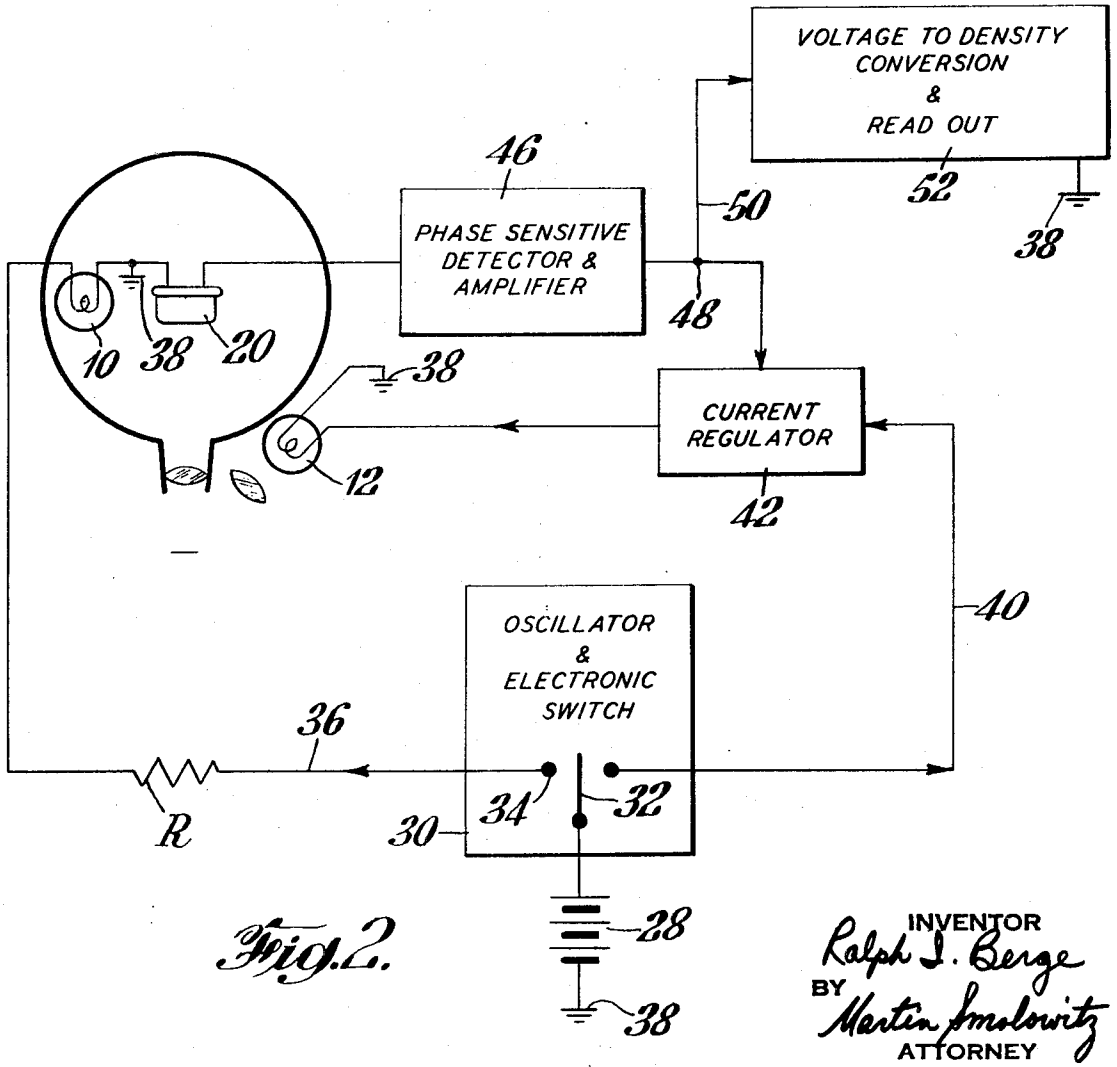
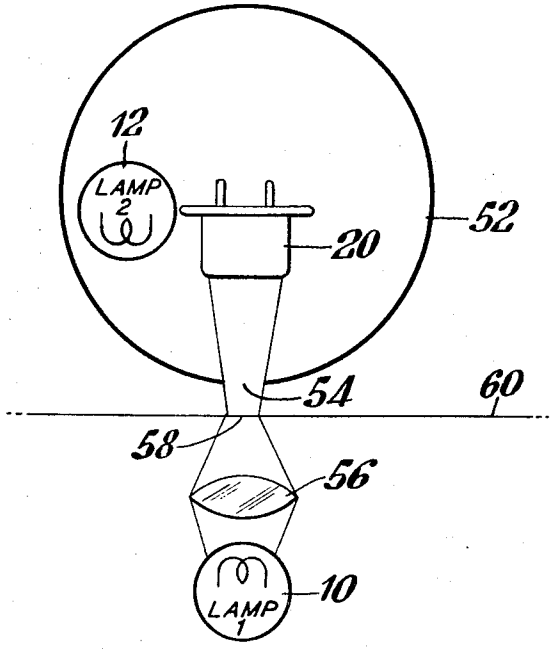


Fig. 2.

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Fig. 3.



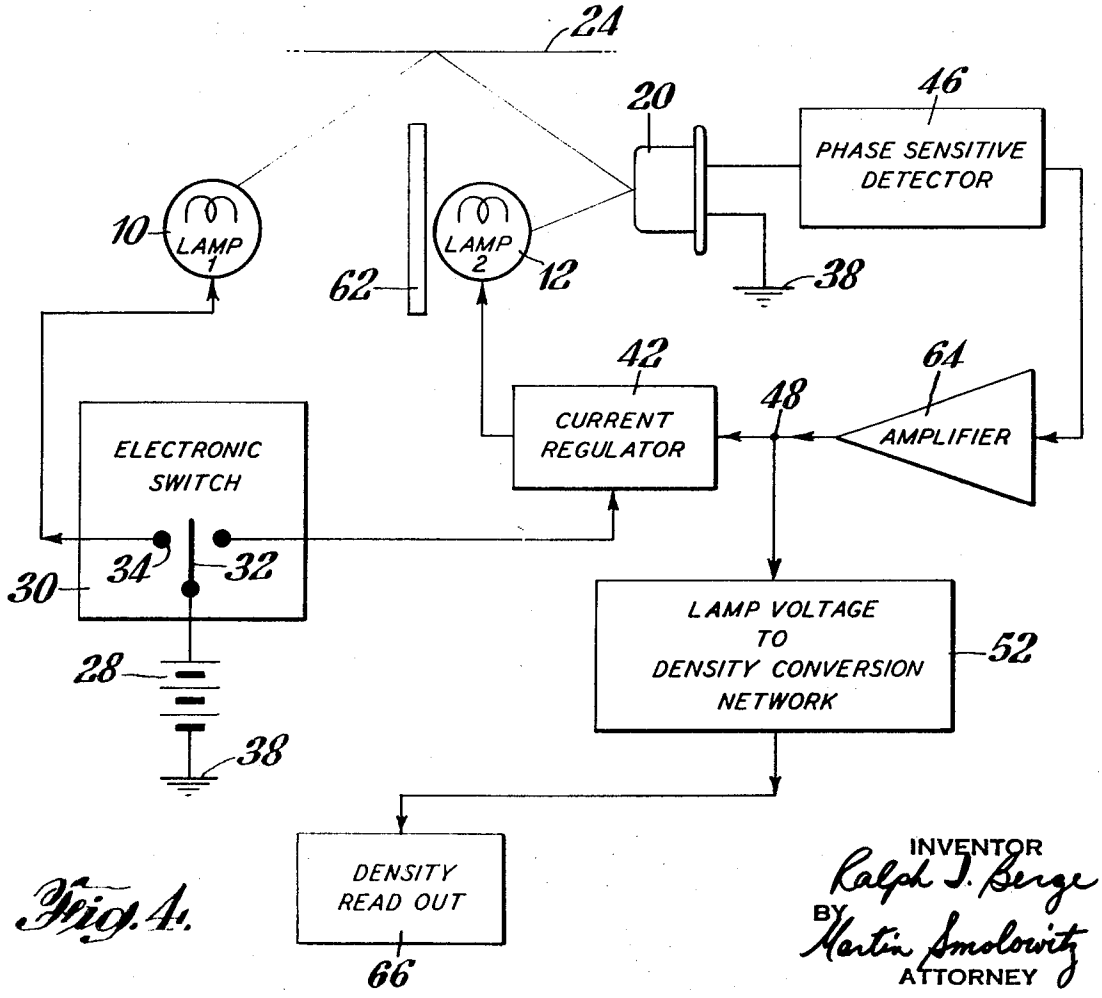


Fig. 4.

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TWO LAMP LIGHT COMPARISON TYPE DENSITOMETER

This invention relates to light comparison meters and particularly to two lamp densitometers.

It has been proposed to use two series-connected lamps in a light brightness meter to illuminate a sample and a photocell, respectively, and then adjust the current flowing through such lamps from a common source of supply until the sample visually matches a comparison spot in color. Whereupon the output of the photocell provides a measure of the brightness of such sample. Such proposal is disclosed by U.S. Pat. No. 2,933,010, to Petro Vlahos, dated Apr. 19, 1960.

Comparison photometers employing visual indicating means to an observer are also disclosed by U.S. patents to Cooper, Jr., U.S. Pat. No. 3,323,430 (1967), and Biber et al., U.S. Pat. No. 3,413,066 (1968), for example.

Comparison densitometers are also known that mechanically chop light from a common source such as a lamp, for illuminating a sensor to compare a sample with a standard.

In any case movable mechanical parts used in prior comparison densitometers have limited the availability due to cost thereof where accuracy was a factor. The present invention solves such problem by providing a low-cost, accurate, comparison densitometer having no moving mechanical parts.

SUMMARY

According to the invention, a primary lamp and a reference lamp are alternately electrically energized. Both lamps are arranged to illuminate the same sensor. The reference lamp is servo-powered to minimize the A.C. error difference sensed by the sensor, a "CDS" Cell. The level of the reference drive voltage is, therefore, a function of the reflection, or transmission path, of the primary light. Since the turn-off and turn-on time of small lamps is of the order of 0.01 seconds, the sampling frequency can be any rate below 50 ~.

Novel optical systems are provided to shade the lamps from each other, while at the same time, the light rays therefrom are directed and/or focused on the eye of the same sensor. The primary light may either pass through a sample, or be reflected by a sample depending upon the nature or type of density being measured. In either case, no moving parts, such as light chopping means are needed; and an accurate reading is obtained.

BRIEF DESCRIPTION OF THE DRAWINGS

FIGS. **1** and **2** are optical and circuit diagrams, respectively, of apparatus illustrative of the invention;

FIG. **3** is a diagram of a modified optical system in which the primary light passes through the sample;

FIG. **4** is a diagram of another modification.

PREFERRED EMBODIMENT

As shown in FIG. **1**, a primary lamp **10** and a reference lamp **12** are located in the opposing recesses **14** and **16** of a light impervious shade **18**, so that light from the reference lamp shines directly on a sensor **20**. Light from the primary lamp **10** is directed toward a spot **22** on sample **24**, through a double convex lens **26**. Light reflected from the sample spot **22** is directed toward the sensor **20** by a plurality of spheric mirrors **28,28** that are spaced from opposite sides of the shade **18**.

The lamps **10** and **12**, FIG. **2**, are alternately energized from a common source of supply, such as a battery **28**, by the operation of an electronic switch **30**, typically composed of a multivibrator and two transistor switches.

For example, when the switch reed or blade **31** touches contact **34**, circuit **36** conducts current from the battery or stable supply **28** to lamp **10**. The return flow of such current is through ground connection **38**. Such current energizes and lights lamp **10**. However, when switch blade **32** leaves contact **34**, such current flow to lamp **10** ceases and current flow is established in circuit **40**, which leads to lamp **12** through a voltage regulator **42**. Thus, as the switch blade swings from one contact to the other, the lamps **10** and **12** are alternately energized, so that the corresponding light from each is alternately applied to the same sensor **20**.

The sensor **20** is connected between ground **38** and a circuit **4** containing a phase sensitive detector **46** and the current regulator **42**. Such circuit functions as a servo-power source to minimize the A.C. error difference sensed by the sensor **20**, such as a "CDS" cell. As a result, the level of the reference drive voltage at terminal **48** is a function of the density of the reflection of the primary light which originates in lamp **10**. Such voltage is applied via lead **50** to a desnity conversion and read out circuit **52** that is connection also to ground **38**. The "read out" indicates the density of the spot **22** of sample **24**.

TRANSMISSION DENSITOMETER

As shown in FIG. **3**, sensor is located within an internally mirrored sphere **52** having an opening **54** through which light shines on the eye of the sensor **20** from a double convex lens **56**. The lens **56** collects light from the primary lamp **10**, which passes through spot **58** in a sample **60** whose density is to be measured. In this modification, the reference lamp **12** is located within the sphere **52** so that the latter reflects light from the lamp into the eye of the sensor **20**.

The operation of the system is similar to that of FIG. **2**, the lamps being alternately energized from a common battery, and the "read out" indicating the density of the transmission path of the primary light through sample spot **58**.

APPARATUS MODIFICATION

As shown in FIG. **4**, a light shield **62** is disposed between the lamps **10** and **12**, so that light from lamp **12** shines directly in the eye of sensor **20**, while that from lamp **10** is reflected from sample **24** above the shield **62** into such eye. Output from the sensor **20** goes to the phase sensitive detector, and from the latter to amplifier **64**. The lamp **12** is energized by battery **28** through the electronic switch **30** and voltage regulator **42**; while the lamp **10** is also energized through such switch **36**.

Thus, reference lamp **12** is automatically energized so that its light output equals that of the primary lamp **10** as reflected by the sample **24**, by a corresponding change in the voltage applied to such lamp **12**. Such voltage is transmitted to to a lamp-voltage-to-density-conversion network **64** which operates a density read out device **66**. The latter thus, indicates the density of the sample **24**, as the electronic switch alternately connects the lamps **10** and **12** to the battery **28**.

In some applications an arrangement where the sensor light level is constant will be useful. The current and intensity of the reference lamp is held at a low level by resistor R. The intensity of the primary lamp or lamps is controlled to compliment the density of the sample. The primary lamp would shine through the sample for transmission measurement, or be clustered about the sensor shell for reflection measurement, as shown.

For the purpose of reading color densities, complimentary filters are interposed into the primary light path. At the same time the voltage to density conversion network is switched to provide a matching conversion for each color.

ADVANTAGES OF THE INVENTION

The invention makes possible an accurate densitometer in which no moving parts are present, inasmuch as solid elements can be used throughout the system.

Another major advantage is that the system can be made at low cost.

Light weight and compactness constitute additional advantages, especially where portability and space savings are factors.

What is claimed is:

1. A comparison densitometer comprising, in combination:

a sensing means for comparing light of a sample with that of a standard;

means including one electric lamp for illuminating said sensor with reference light;

means including another electric lamp;

optical means for illuminating said sensor with sample light for comparison with such reference light, said optical means including light impervious shade means disposed between said lamps;

lens means for concentrating the sample light on a circuited portion of the sample, circuit means for electrically energizing said lamps alternately from a common source of supply at a rate sufficiently low to turn the light of said lamps on and off; and

an internally mirrored sphere having disposed therein, said sensor and one of said lamps, said sphere having an opening for light originating in the other lamp.

2. The invention as defined by claim 1, in which

the lamp within the sphere produces the reference light, and

the lamp outside of the sphere produces the sample light which passes through such selected portion of the sample and then through such opening in the sphere on its way toward said senses.

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Disclaimer

3,653,772.—*Ralph I. Berge,* Binghamton, N.Y. TWO LAMP LIGHT COMPARISON TYPE DENSITOMETER. Patent dated Apr. 4, 1972. Disclaimer filed Sept. 30, 1982, by the assignee, *Eastman Kodak Co.*

Hereby enters this disclaimer to all claims of said patent.

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