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[54] **ELECTRO-OPTICAL LIQUID ARTIFICIAL HORIZON**

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[52] **U.S. Cl.** **356/249;** 33/365; 33/377

[51] **Int. Cl.** **G01c 9/18**

[58] **Field of Search** 356/143, 148, 248, 249; 33/365, 366, 377, 384, 389

[56] **References Cited**

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[57] **ABSTRACT**

An electro-optical liquid artificial horizon utilizing a vidicon tube. An enclosed, leak-proof transparent, fluid container is attached to the face of the vidicon tube. A fluid partially fills the container. The surface of the fluid interferes with the optical image being resolved thereby creating an artificial horizon.

9 Claims, 2 Drawing Figures

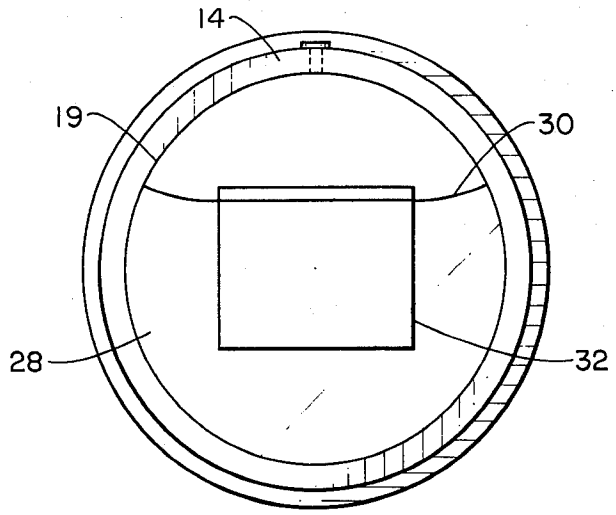


Fig. 1.

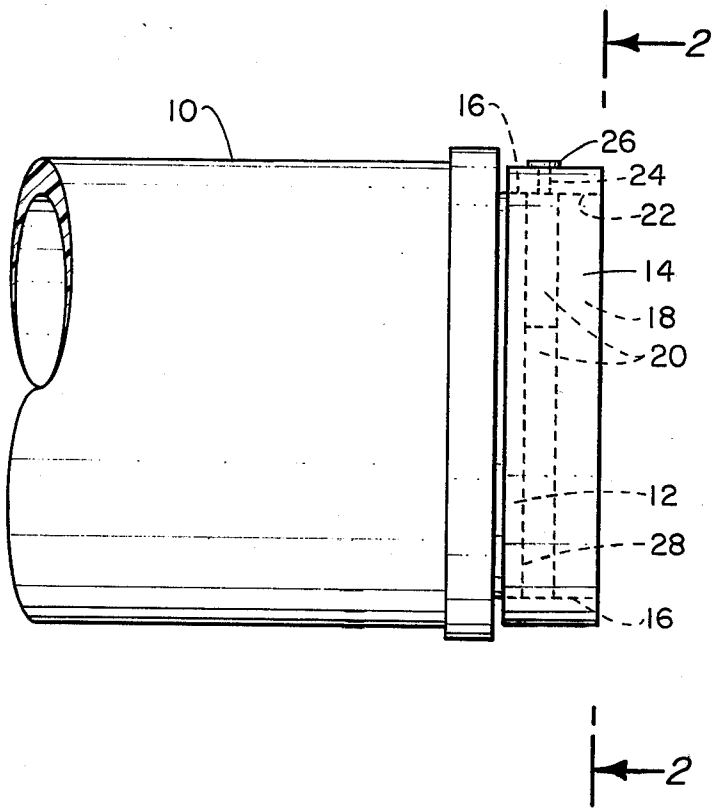
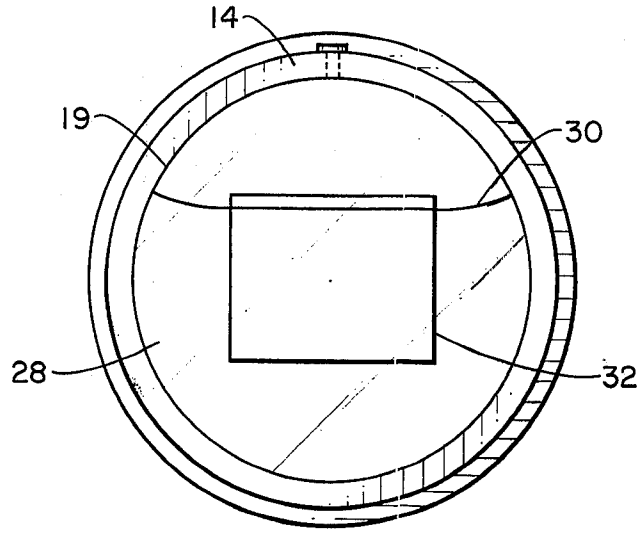


Fig. 2.



ELECTRO-OPTICAL LIQUID ARTIFICIAL HORIZON

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates, generally, to artificial horizons and, more particularly, to electro-optical, liquid artificial horizons.

2. Description of the Prior Art

Some prior art artificial horizon systems utilize gyros and/or synchros to generate signals to a servomotor. The servomotor then positions a movable reticle with respect to a fixed reticle. Light passing through the reticles is reflected into the line of sight of an observer through a complex mirror system. Such systems require expensive mechanical components that must be custom manufactured to close tolerances. Moreover, extreme care must be exercised when the components are fitted together so that an accurate artificial horizon line will result. In addition, the system is subject to mechanical failure as well as mechanical wear creating an inaccurate or even a complete loss of the artificial horizon line.

Other prior art systems utilize a disc or sphere inside a fluid-filled container. The container bottom forms an arc upon which the disc or sphere rolls thereby indicating the true horizon. The fluid serves to dampen the movement of the disc or sphere. Such systems suffer from inaccuracies created by vibrations. Also, in such devices there is considerable rolling friction inasmuch as not only does the sphere or disc come into contact with the bottom of the container but there is considerable contact between the sphere or disc and the sides of the tube. Thus, intolerable inaccuracies may result from such systems.

Still other prior art systems utilize the surface of a fluid to form an artificial horizon. Such systems contemplate eye observation. This results in the introduction of parallax error. Also, mercury is utilized as the fluid. Mercury is a heavy, expensive and easily contaminable fluid. In addition, it is opaque which is undesirable in some environments.

SUMMARY OF THE INVENTION

The general purpose of this invention is to provide an artificial horizon that is more accurate and more reliable than prior art devices. To attain this, the present invention utilizes, according to one embodiment, a vidicon tube. A collar surrounds the perimeter of the vidicon tube face. A leak-proof seal is formed between the collar and the vidicon tube face. The collar projects outward from the vidicon tube face. A transparent plate is attached to the collar and spaced from the vidicon tube face. A leak-proof seal is formed between the plate and the collar. The resulting compartment is partially filled with a fluid. The fluid surface interferes with the optical image being resolved thereby creating an artificial horizon.

Accordingly, one object of the present invention is to reduce reliance on mechanical components.

Another object of the present invention is to reduce system complexity.

A further object of the present invention is to provide an inexpensive system.

Another object of the present invention is to eliminate reliance on mechanical precision of components.

A further object of the present invention is to eliminate vibrational induced inaccuracies.

Another object of the present invention is to eliminate parallax error.

A further object of the present invention is to provide a system with maximum reliability.

Another object of the present invention is to provide a system with maximum accuracy.

A further object of the present invention is to provide remote observation of the artificial horizon.

Other objects and a more complete appreciation of the present invention and its many attendant advantages will develop as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings wherein like reference numerals indicate like parts in the drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a side view of a specific embodiment of the present invention.

FIG. **2** is a front elevation of the specific embodiment shown in FIG. **1**.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Turning to FIG. **1**, the numeral **10** designates a vidicon tube having a face **12**. Vidicon tube **10** is utilized as an optical transducer that transforms light energy into electrical energy.

A collar **14** surrounds and is attached to the perimeter of face **12**. A leak-proof seal **16** is formed between face **12** and collar **14**.

A plate **18** shaped to fit the inside diameter **19** (FIG. **2**) of collar **14** is placed inside collar **14** but spaced from face **12**. A leak-proof seal **22** is formed between plate **18** and collar **14**. Plate **18** is transparent to light rays.

The chamber **20** bounded by face **12**, collar **14**, and plate **18** is a leak-proof fluid container.

Collar **14** contains a hole **24** communicating with chamber **20**. Cover **26** provides a leak-proof cover over hole **24**.

A fluid **28** partially fills chamber **20**. The fluid **28** is poured into chamber **20** through hole **24**. Fluid **28** may be mercury, alcohol, silicone oil or any other suitable fluid substance which will flow freely in chamber **20**. Fluid **28** has a fluid surface **30** (FIG. **2**). Fluid surface **30** (FIG. **2**) interferes with a portion of image **32** (FIG. **2**) being optically resolved on the vidicon target (not shown) of vidicon tube **10**. The result is a thin line that corresponds to the real horizon and is contained in the signal being generated by the vidicon tube **10**.

Preferably, the fluid **28** level will be near the top of chamber **20** since the image **32** focused on the vidicon face **12** is optically inverted. Thus, the artificial horizon line seen on a television monitor (not shown) will appear on the bottom of the picture. Another advantage of having the fluid **28** level near the top of chamber **20** is that constant wetting of vidicon face **12** and plate **18**, resulting in formation of droplets thereon, does not occur with consequent degrading of image quality.

It is noted that when vidicon tube **10** is rotated about its longitudinal axis the artificial horizon line observed on the television monitor (not shown) will appear to rotate.

However, when vidicon tube **10** is rotated about an axis parallel to fluid surface **30** and perpendicular to its longitudinal axis, the artificial horizon line observed on the television monitor (assuming a transparent or translucent fluid) will become thicker and then split into two lines. One line will move upward on the television monitor while the other will move downward on the television monitor. For example, as vidicon tube **10** rotates clockwise about the axis parallel to fluid surface **30** but perpendicular to its longitudinal axis, the interface of fluid surface **30** with respect to face **12** moves downward while the interface of fluid surface **30** with respect to plate **18** moves upward. Thus, as the interfaces of fluid surface **30** with respect to plate **18** and face **12** move, the artificial horizon line on the television monitor appears to widen. However, as vidicon **10** continues to rotate at some point (depending on the physical parameters of the fluid), the interfaces of fluid surface **30** with plate **18** and face **12** will cause two separate artificial horizon lines to appear on the television monitor. Then, as vidicon tube **10** rotates still further, these two lines will move farther apart on the television monitor. The direction of rotation cannot be observed from the television monitor but it can be discerned by rotating the vidicon tube about the axis and observing the movement of the two artificial horizon lines on the television monitor.

Further, it is noted that when vidicon tube **10** rotates clockwise about an axis perpendicular to both its longitudinal axis and fluid surface **30,** fluid surface **30** will rotate within chamber **20** such that, as viewed from vidicon tube **10,** the right side moves upward while the left side moves downward. Of course, a counterclockwise rotation about the above stated axis would result in fluid surface **30** moving upward on the left side of chamber **20** and downward on the right side of chamber **20.**

The viscosity of fluid **28** imparts two significant parameters to the system. An increase in viscosity of fluid **28** will produce a change in reaction time by increased damping, e.g., if the vidicon tube **10** were to change position, the higher the viscosity of fluid **28,** the slower fluid **28** would move to assume the new equilibrium position. Of course, a lower viscosity would result in a faster fluid movement. Also, as the viscosity of fluid **28** increases, so does the artificial horizons line width, as seen on the television monitor (not shown) and visa versa.

Other factors affecting the artificial horizon line width are the surface tension of fluid **28** and the distance between fluid **28** and the target (not shown) of vidicon tube **10.**

It is envisioned that a transparent, fluid container physically separated from vidicon tube **10** may be utilized to form a chamber for fluid **28.** The container must be placed adjacent to vidicon tube **10** so that the light from the image resolved by vidicon tube **10** passes through the container before impinging upon the vidicon tube.

Fluid **28** may also be transparent, translucent, or opaque, depending upon the environment and use contemplated.

Some uses of the present invention, among others, include applications in the fields of surveying, optical tracking, and in-flight-simulation trainers as well as remote drone flying, and undersea devices.

In summary, fluid surface **30** (FIG. **2**) in chamber **20** interferes with the image being resolved by vidicon tube **10** thereby creating an artificial horizon line corresponding to fluid surface **30** (FIG. **2**).

Obviously numerous modifications and variations of the present invention are possible in light of the above teachings. It is therefore to be understood that within the scope of the appended claims the invention may be practiced otherwise than as specifically described herein.

I claim:

1. An instrument for generating an artificial horizon line comprising:

a vidicon tube having a face;

a volume of fluid; and

an enclosed, transparent, leak-proof fluid container positioned adjacent to said face of said vidicon tube such that light rays, incident upon said vidicon tube, pass first through said fluid container, said fluid container being partially filled with said fluid so that a horizontal fluid surface forms in said container at a fluid-air interface, said fluid surface interfering with a portion of an image being optically resolved by said vidicon tube creating an artificial horizon line capable of being visually observed on a television monitor.

2. The instrument of claim **1** wherein said fluid container comprises:

a collar connected to said vidicon tube surrounding the perimeter of said vidicon tube face, said collar projecting outward from said vidicon tube face;

means between said collar and said vidicon tube face to provide a leak-proof seal;

a transparent plate connected to said collar forming an enclosed compartment between said plate and said vidicon tube face, said compartment being partially filled with said fluid; and

means between said collar and said plate to provide a leak-proof seal.

3. The instrument of claim **2** wherein said fluid is transparent.

4. The instrument of claim **2** wherein said fluid is translucent.

5. The instrument of claim **2** wherein said fluid is opaque.

6. The instrument of claim **1** wherein said fluid is transparent.

7. The instrument of claim **1** wherein said fluid is translucent.

8. The instrument of claim **1** wherein said fluid is opaque.

9. A method for generating an artificial horizon line comprising:

partially filling an enclosed, transparent, leak-proof container with a fluid thereby forming a horizontal fluid surface within said container at a fluid-air interface; and

positioning said container in the path of light rays from an optical image impinging upon a vidicon tube, said fluid surface interfering with a portion of an image being optically resolved by said transducer creating an artificial horizon line capable of being visually observed on a television monitor.

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