Jan. 22, 1974 L. B. BURGIN Re. 27,899

SLOPE SENSING DEVICE

Original Filed July 24, 1967

2 Sheets-Sheet 1

Fig. 1

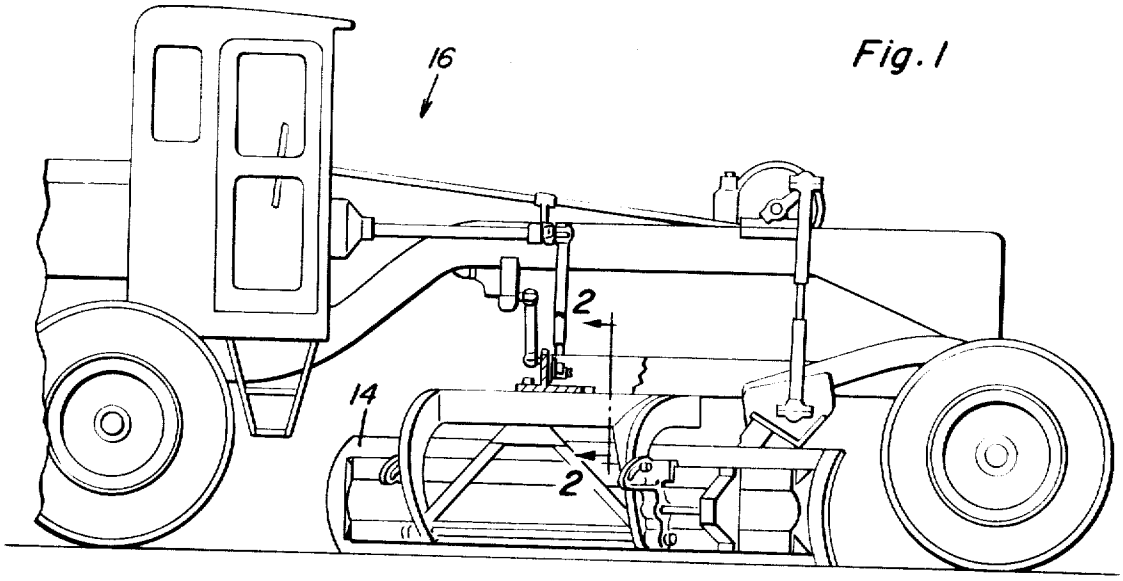


Fig. 2

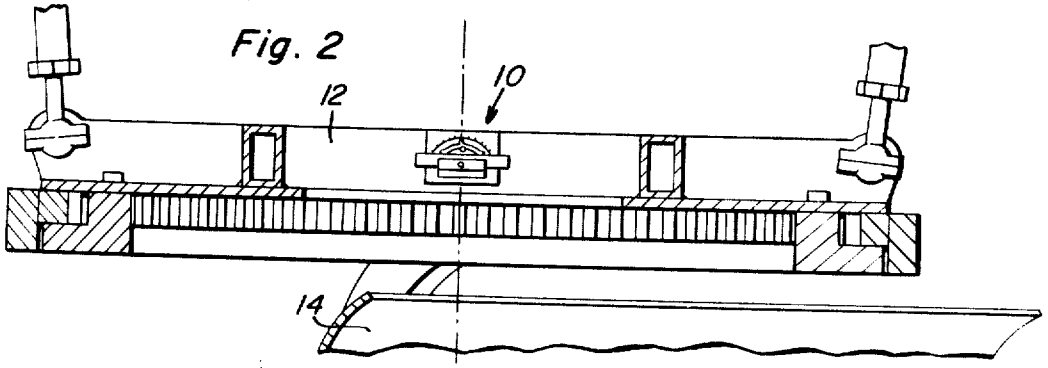
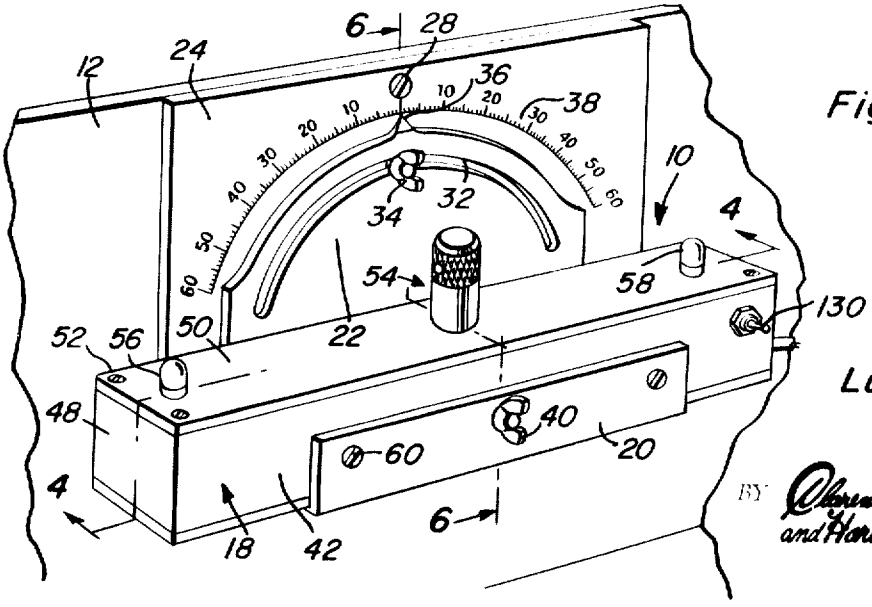


Fig. 3



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Fig. 4

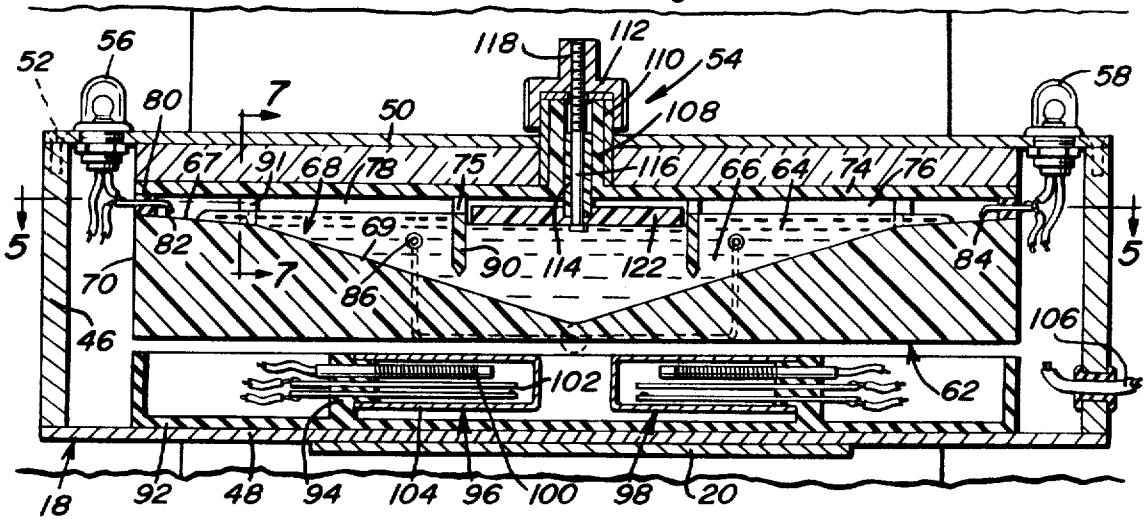


Fig. 5

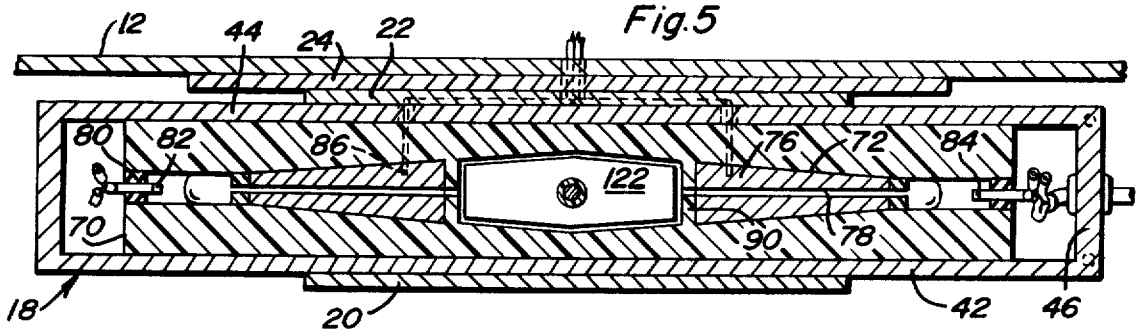


Fig. 6

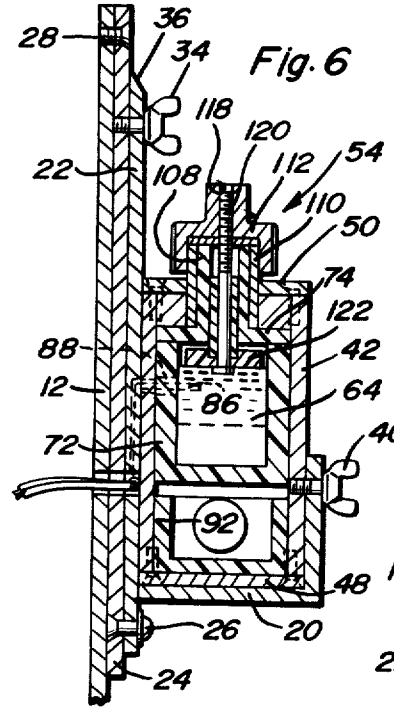


Fig. 8

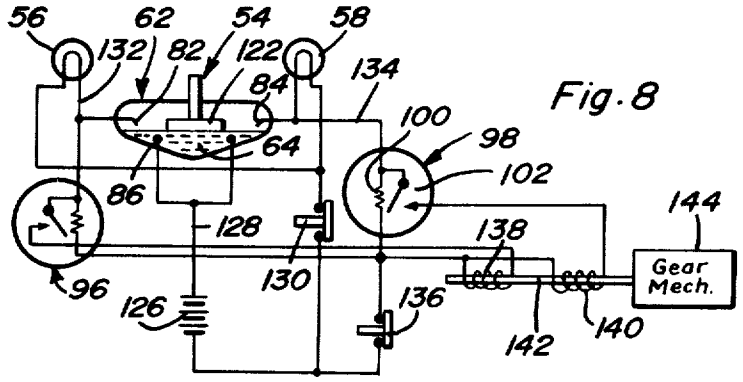
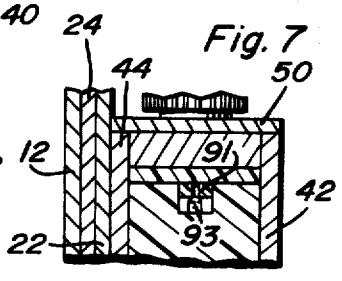


Fig. 7



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SLOPE SENSING DEVICE

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Original No. 3,564,531, dated Feb. 16, 1971, Ser. No. 659,284, July 24, 1967, which is a continuation-in-part of abandoned Ser. No. 572,143, Aug. 12, 1966. Application for reissue Feb. 12, 1973, Ser. No. 331,581
Int. Cl. G08b *21/00*
U.S. Cl. 340—282 17 Claims

Matter enclosed in heavy brackets [ ] appears in the original patent but forms no part of this reissue specification; matter printed in italics indicates the additions made by reissue.

ABSTRACT OF THE DISCLOSURE

A body of mercury, the movement of which is dampened by baffles, establishes a conductive path between contacts within a chamber the position of whch reflects tilting of a grading blade [of] *to* automatically correct the position of the blade. The sensitivity of the device is varied by adjusting the position of an element partially submerged in the mercury.

This application is a continuation-in-part of my prior copending application, U.S. Ser. No. 572,143, filed Aug. 12, 1966, now abandoned.

This invention relates to a position *or slope* sensing device for grading blades or the like (*e.g., for an element of any type of road-making machine or construction equipment, such as for the screed of an asphalt paver*) through which corrective control may be exercised over the blade positioning mechanism *so as to form a surface having a desired slope* (*i.e., the inclination of the surface transverse of the direction of travel of the machine*).

A primary object therefore of the present invention is to provide a position sensing device and associated control particularly adapted for controlling the vertical angle *or slope* of a grading blade *or other element*, the position sensing device being easily installed, reliable in operation and adjustable in accordance with different requirements.

In accordance with the foregoing object, the position sensing device of the present invention features a liquid containing chamber for a conductive liquid such as mercury through which an electrically conductive path is established between contacts when the device is displaced from a horizontal position. The shape of the liquid containing chamber is designed so as to render the position sensing device reliably responsive to tilting or angular displacement of the blade on which the device is mounted by amplifying displacement of the body of liquid in the plane in which the device is angularly displaced.

An additional object of the present invention is to provide a position sensing switch device containing a body of conductive liquid within a chamber provided with longitudinally spaced baffles preventing splashing of the liquid because of movement of the vehicle in which the device is mounted.

A further object of the present invention in accordance with the foregoing objects is to provide a position sensing switch device embodying time delay relay components through which operation of reversible controls in response to signals from the position sensing device is delayed in order to avoid premature and excessive corrective movement.

A still further object of the present invention is to provide in connection with the aforementioned position sensing device, a sensitivity selector which is operative to vary the space occupied by the body of conductive liquid within its chamber in order to change the spacing between the liquid body and the open contacts.

Yet another object of the present invention is to provide a position sensing switch device provided with directional indicators which signify establishment of a directional signal by the position sensing device.

These together with other objects and advantages which will become subsequently apparent reside in the details of construction and operation as more fully hereinafter described and claimed, reference being had to the accompanying drawings forming a part hereof, wherein like numerals refer to like parts throughout, and in which:

FIG. 1 is a side elevational view of a typical road grader showing one installational environment for the position sensing device of the present invention.

FIG. 2 is an enlarged partial sectional view taken substantially through a plane indicated by section line **2—2** in FIG. 1.

FIG. 3 is a perspective view of the installed position sensing device of the present invention.

FIG. 4 is an enlarged sectional view taken substantially through a plane indicated by section line **4—4** in FIG. 3.

FIG. 5 is a sectional view taken substantially through a plane indicated by section line **5—5** in FIG. 4.

FIG. 6 is a transverse sectional view taken substantially through a plane indicated by section line **6—6** in FIG. 3.

FIG. 7 is a partial transverse sectional view taken substantially through a plane indicated by section line **7—7** in FIG. 4.

FIG. 8 is an electrical circuit diagram associated with the position sensing device of the present invention.

Referring now to the drawings in detail, FIGS. 1 and 2 illustrate by way of example only, a typical installation for the position *or slope* sensing device of the present invention generally denoted by reference numeral **10**. As illustrated, the position sensing device **10** is mounted on a blade mounting member **12** through which *an element or* a grader blade **14** is angularly adjusted by means of the blade positioning mechanism associated with the road grader generally referred to by reference numeral **16**. It will of course be appreciated, that the positioning device **10** may be mounted on other types of *road-making or construction* equipment but in each case, it is operative to sense angular displacement or tilting in one plane in order to establish control signals for correctively operating the positioning mechanism in order to restore the *element or* blade to its adjusted position (*i.e., to its desired slope*).

As more clearly seen in FIGS. *3* and *6*, the position controlling switch device **10** is enclosed within an outer, elongated housing **18** projecting longitudinally from opposite ends of a bracket **20** by means of which the housing is secured to an angularly adjustable plate member **22** so that the position controlling device **10** may be *rotated about a horizontal axis extending transversely of the device, whereby it may be* adjusted to a level position for any desired angular position *or slope* of the blade with which it is associated. The plate member **22** is therefore pivotally mounted on a dial plate **24** by means of the pivot stud **26**, the dial plate **24** being secured to the mounting plate **12** by fastener **28** for example. Secured to the dial plate **24**, is a threaded stud **30** which projects through an arcuate slot **32** formed in the plate member **22** so that the plate member may be locked in any selected angular position by means of the wing nut **34**. The plate member **22** is therefore provided with a pointer **36** which cooperates with a protractor scale **38** formed on the dial plate **24**. Thus, the plate member **22** together with the housing **18** carried thereon by means of the bracket **20**, may be angularly displaced to a desired position and locked in such position. The housing **18** is there-

fore held in an aligned position on the bracket **20** and releasably locked thereto in this position by means of the locking element **40** extending through the bracket **20** and being threadedly received within the housing **18**.

Referring now to FIGS. *4, 5,* 6 and 7, it will be observed that the housing **18** includes a front wall **42**, and a back wall **44** abuting the plate member **22**, the front and back walls being interconnected by the end walls **46** and a bottom wall **48**. The housing is closed by a top wall **50** secured by means of the fasteners **52** to the end walls **48**. The top wall **50** mounts a sensitivity selector device generally referred to by reference numeral **54** and a pair of directional indicator lamps **56** and **58**. The housing is also aligned on its mounting bracket **20** by means of a pair of alignment pins **60** (FIG. *3*) which extend therethrough, and received through apertures in the bracket **20** on opposite sides of the lock element **40**.

Fixedly mounted within the outer housing **18**, is a non-conductive container **62** within which a body of conductive liquid such as mercury **64** is enclosed. A chamber **66** is therefore formed internally of the container for the mercury of such a shape as to amplify displacement of the mercury in the direction in which the device **10** is angularly displaced with the blade. The chamber **66** is provided with symmetrical bottom wall surfaces **68** which extend downwardly from opposite ends **70** of the container toward a central location at which the depth of the body of mercury is greatest to lower the center of gravity of the body of liquid. The surfaces include shallow slope portions **67** adjacent the ends and steep slope portions **69**. *These shallow slope portions 67 constitute means for effecting increased lateral displacement of the mercury relative to the ends of chamber 66 in response to tilting of the container so as to render the slope sensing apparatus of this invention reliably responsive to slight changes in slope of the element or blade 14.* The chamber **66** is also defined between side walls **72** which diverge from the ends **70** of the container toward the central location aforementioned at which the walls are spaced apart a maximum distance, as shown in FIG. *5*. The chamber **66** is closed by means of a top closure lid **74** secured by fasteners to the [botom] *bottom* portion of the container mounting level regulating inserts **76** [formed with] *spaced from the lower surface 69 of chamber 66 to permit the mercury to flow thereunder toward whichever end of the chamber is lower. These inserts have* air vent slots **78** to prevent pressure and vacuum pockets in the mercury when the device is displaced from a level position. It will be apparent therefore that the upper surface of the body of liquid **64** will extend longitudinally into close spaced relation to the ends **70** of the container and that when the container is angularly displaced in a plane substantially parallel to its longitudinal axis, the spacing of the liquid from one end and from the top wall **74** adjacent said end will be reduced. Also, the reduction in this spacing will be produced by a directionally amplified displacement of the liquid inasmuch as the volume of the liquid adjacent the end portions of the container is reduced relative to the central portion because of the cross-sectional configuration of the chamber **66** as hereinbefore described.

The ends **70** of the container **62** are provided with sealing plugs **80** through which end contact elements **82** and **84** extend into the chamber **66** in close spaced relation to the body of liquid when disposed in a level position as shown in FIG. 4. Also, a pair of contact elements **86** project into the body of liquid through sealing plugs **88** in the side wall **72** of the chamber. It will be appreciated therefore, that a conductive path is established between the contact elements **86** and one of the contact elements **82** or **84** *and a signal is thereby generated* when the container **62** is angularly displaced *or tilted about a horizontal axis transverse of the length of chamber 66* in one direction or the other *from its level position in response to a change in position or slope of the blade or element from its desired position or slope.* However, in order to prevent establishment of a conductive path between the contact elements because of splashing of the liquid during forward movement of the vehicle on which the device is mounted, baffles **90** are formed on the closure lid **74** and project downwardly from the top wall **74** into close spaced relation to the bottom wall surface **68**. Slots **75** are formed in the baffles **90** aligned with slots **78** to form a restricted flow passage. Also projecting from the top wall are slotted end baffles **91** at the juncture of the slope portions **68** and **69** of the bottom surface. Each baffle **91** is provided with a lower portion of reduced thickness through which an aperture **93** is formed for restricted flow of mercury. The baffles **91** thus act as [dampeners] *means for damping and inhibiting splashing or sloshing of the mercury* without separating the mercury.

Also mounted within the outer housing **18** below the container **62**, is a non-conductive enclosure **92** within which a pair of longitudinally spaced mounting projections **94** are formed for mouting a pair of time delay relays **96** and **98**. Each of the relays includes therefore, a heating element **100** and a thermally operated, normally opened switch **102** mounted by the projection **94** and enclosed within a casing **104** as shown in FIG. 4. The relays **96** and **98** are wired to the contact elements **82** and **84** and electrical leads extend from the relays [,] and the indicator lamps **56** and **58** into an electrical cable **106** which extends out of the housing **18** for connection to a source of current and to a reversible control device through which the blade may be correctively repositioned by the blade positioning mechanism associated therewith.

As more clearly seen in FIGS. 4 and 6, the selective sensitivity control **54** includes a tubular projection **108** fixed to the top wall **74** supporting a bearing sleeve **110** to rotatably mount an externally knurled selector knob **112**. A threaded bore **118** is formed in the knob threadedly receiving an axially movable screw **120** rotatably mounted by bearing sleeve **114** in the tubular projection **108**. The screw member **120** is connected at its inner end to a liquid [displacing] *displacement member or* element **122** partially submerged within the liquid in container **62**. The element closely fits between the side walls **72** and the baffles **90** so as to prevent rotation of the screw member **120** to which it is connected. It will be apparent therefore, that upon rotation of the selector knob **112**, the screw member **120** and the element **122** connected thereto will be axially displaced in one or the other direction in order to vary the quantity of liquid **64** displaced by the partially submerged element **122**. In this fashion, the vertical spacing between the upper surface of the body of liquid and [to] *the* top wall **74** as well as the longitudinal extent of the liquid **64** may be varied in order to change the spacing of the liquid from the contact elements **82** and **84** and the sensitivity of the position controlling device. *Thus, the selective sensitivity control 54 constitutes liquid displacing means adjustably mounted within container 62 for submergence within the mercury to vary the depth and longitudinal extent of the mercury in chamber 66.*

With reference to FIG. 8, operation of the position sensing device as hereinbefore described will become apparent. It will be noted therefore, that the pair of contact elements **86** are connected to a source of current such as the positive terminal of battery **126** by means of the conductor **128**. The negative terminal of the battery **126** on the other hand is connected to both of the indicator lamps **56** and **58** through an indicator cutout switch **130** which may be mounted on the housing **18** as shown in FIG. 3. Energizing circuits may therefore be completed through the indicator lamps when a conductive path is established between the contact elements **86** and one or the other of the contact elements **82** or **84** through the body of liquid **64** *as occasioned by tilting of the element or blade 14 from its desired slope and thus generating a signal,* the contact elements **82** and **84** therefore being respectively

connected to the indicator lamps by conductors **132** and **134**. The conductors **132** and **134** are also connected to the relays **96** and **98** respectively in order to complete an energizing circuit through the heater elements **100** associated therewith simultaneously with illumination of an associated indicator lamp **56** or **58**. The heater elements of the relays are therefore both connected to the negative terminal of the battery **126** through a solenoid cut out switch **136** as shown in FIG. 8. It will be apparent therefore, that after the heater element of one or the other of the relays is energized, the associated thermal switch **102** will close after elapse of a predetermined period of time and *thus generate a signal in delayed response to contact between the mercury 64 and whichever end contact 82 or 84 is lower,* thereby *to* complete an energizing circuit through one of the two solenoid coils **138** and **140**. The solenoid coils are wound in opposite directions so as to effect displacement of a plunger **142** in opposite directions in order to control a reversing gear mechanism **144** for example through which angular movement is imparted to the blade in opposite directions. Once the desired position of the blade is restored [therefor], the conductive paths between the contact elements in the position controlling device are opened *and generation of the signal ceases* so as to de-energize the solenoid through which corrective displacement of the blade is effected. By opening the indicator cut out switch **130**, the indicator lamps which indicate operation of the position controlling device in one direciton or the other will be disabled. On the other hand, if corrective displacement of the blade is not desired, the cutout switch **136** may be opened to prevent energization of the solenoid coils **138** and **140**. The solenoid coils while described in connection with a gear mechanism, may of course be associated with other types of corrective control mechanisms.

From the foregoing description, the operation, construction and utility of the position controlling device of the present invention will be apparent. It will be appreciated therefore, that the position controlling device will be particularly useful in connection with grading machines and since it does not involve any moving parts, it may better withstand the severe physical conditions of its intended installation as well as the adverse effects of moisture and atmospheric conditions. Further, the device may be easily mounted on different types of *road-making or construction* equipment and because of its delay action will maintain a close grade when utilized in connection with road graders.

The foregoing is considered as illustrative only of the principles of the invention. Further, since numerous modifications and changes will readily occur to those skilled in the art, it is not desired to limit the invention to the exact construction and operation shown and described, and accordingly all suitable modifications and equivalents may be resorted to, falling within the scope of the invention as claimed.

What is claimed as new is as follows:

1. A [blade angle control] *slope sensing* device for grading machines *or the like* comprising[,] a non-conductive container having a chamber enclosing a body of conductive liquid, said chamber varying in vertical depth and horizontal width from a minimum value at opposite longitudinal ends to a maximum value intermediate said ends, a contact element mounted by the container within said body of liquid intermediate said ends of the chamber, a pair of end contacts mounted by the container at said ends of the chamber closely spaced from said body of liquid in a level position of the container, and liquid displacing means adjustably mounted by the container for submergence within the liquid to vary the depth and longitudinal extent of said body of liquid within the chamber.

2. The combination of claim **1** including longitudinally spaced baffle members mounted by the container and projecting into the body of liquid within the chamber to prevent splashing of the liquid.

[**3.** The combination of claim **2** including a source of electrical current connected to said contact element, indicator lamps connected between said source and the end contacts, time delay means connected in parallel with each of said indicator lamps for energization thereof simultaneously with illumination of said lamps, and reversible control means connected to the relay means for operation in delayed response to contact between said body of liquid and one of the end contacts.]

[**4.** The combination of claim **1** including a source of electrical current connected to said contact element, indicator lamps connected between said source and the end contacts, time delay relay means connected in parallel with each of said indicator lamps for energization thereof simultaneously with illumination of said lamps, and reversible control means connected to the relay means for operation in delayed response to contact between said body of liquid and one of the end contacts.]

5. A [blade angle control] *slope sensing* device for grading machines *or the like* comprising[,] a non-conductive container having a horizontally elongated chamber formed by a bottom wall inclined downwardly from opposite ends of the container to a central location, side walls diverging from said ends to said central location, and a horizontal top wall, liquid level regulating means mounted on said top wall, a body of conductive liquid within said chamber having an upper surface spaced below said top wall and extending longitudinally toward said ends of the container, a pair of end contacts projecting into said container at said ends closely spaced from said body of liquid when the upper surface thereof is substantially parallel to the top wall, a contact element projetcing into said body of liquid from one of the side walls, a liquid displacing element centrally positioned by the top wall in adjustably spaced relation above the bottom wall, and selective positioning means connected to said liquid displacing element for varying the amount of liquid displaced thereby to change the spacing of said upper surface of the body of liquid relative to the end contacts when parallel to the top wall.

6. The combination of claim **5** including baffle members mounted by the top wall and projecting into the body of liquid in spaced relation above the bottom wall, said baffles being provided with slots aligned with the level regulating means to form a restricted flow passage.

[**7.** The combination of claim **6** including a source of electrical current connected to said contact element, indicator lamps connected between said source and the end contacts, time delay relay means connected in parallel with each of said indicator lamps for energization thereof simultaneously with illumination of said lamps, and reversible control means connected to the relay means for operation in delayed response to contact between said body of liquid and one of the end contacts.]

[**8.** The combination of claim **5** including a source of electrical current connected to said contact element indicator lamps connected between said source and the end contacts, time delay relay means connected in parallel with each of said indicator lamps for energization thereof simultaneously with illumination of said lamps, and reversible control means connected to the relay means for operation in delayed response to contact between said body of liquid and one of the end contacts.]

9. The combination of claim **5** wherein said bottom wall of the chamber includes at least two portions of different slope, the portions of shallowest slope extending downwardly from the ends of the chamber toward said central location.

10. The combination of claim **9** including baffle members mounted by the top wall and projecting into the body of liquid in spaced relation above the bottom wall, said

baffles being provided with slots aligned with the level regulating means to form a restricted flow passage.

11. The combination of claim **10** wherein at least one of said baffles is provided with a restricted flow aperture at the juncture between said slope portions of the bottom wall.

12. Apparatus for sensing the position of an element of a road-making machine or the like comprising an electrically nonconductive container having a chamber varyig in vertical depth from a minimum value at opposite longitudinal ends to a maximum value intermediate said ends with the slope of the lower surface of the end portions of the chamber being relatively shallow and sloping toward the center of the chamber, a body of electrically conductive liquid in said chamber, an electrical contact positioned in the container within said body of liquid intermediate said ends of the chamber, an end electrical contact positioned at each end of the chamber, each of said end contacts being spaced from said body of liquid when the container is in a generally level position, this level position of the container corresponding to a desired slope of said element so that upon, tilting of the container about a horizontal transverse axis from its said level position in response to a change in slope of the element from its desired slope, said liquid flows in the chamber toward one end thereof constituting the lower end of the chamber and makes contact with the end contact at the lower end of the chamber thereby to complete an electrical circuit between the last-mentioned end contact and the intermediate contact so as to generate a signal, said shallow slope end portions of the chamber constituting means for effecting increased lateral displacement of the liquid relative to the end contacts in response to tilting of the container so as to render the apparatus reliably responsive to slight changes in slope of said element, and liquid displacing means adjustably mounted within the container for submergence within the liquid to vary the depth and longitudinal extent of said body of liquid within the chamber.

13. The apparatus of claim 12 wherein said container includes baffle means projecting into the body of liquid within the chamber for damping and inhibiting splashing of the liquid.

14. The apparatus of claim 13 which includes an electrical power source connected to said electrical contact, respective indicator lamps connected between said source and each end contact, and time delay relay means connected in parallel with each of said indicator lamps for energization thereof simultaneously with illumination of said lamps thereby to generate said signal in delayed response to contact between said body of liquid and whichever end contact is lower.

15. The apparatus of claim 13 wherein said baffle means comprises a plurality of baffle members mounted within said chamber and projecting into the body of liquid in spaced relation above the lower surface thereof, said baffles being provided with slots to form a restricted flow passage for the liquid as it flows toward and away from the ends of the chamber.

16. The apparatus of claim 12 wherein said lower surface of the chamber includes at least two portions of different slope, with said shallow slope portions at the ends of the chamber and with an intermediate steeper slope portion sloping downwardly from the lower end of each shallow slope portion toward the center of the chamber.

17. The apparatus of claim 16 wherein one of said baffles is provided at each juncture between said shallow and steep slope portions of the lower surface of the chamber.

18. The apparatus of claim 12 wherein said container further comprises generally vertical side walls defining the sides of said chamber, said side walls diverging outwardly from the ends of the chamber to the center thereof, whereby the chamber is wider at its center than at its ends.

19. The apparatus as set forth in claim 18 wherein said liquid displacing means comprises a liquid displacement member and selectively adjustable screw means carrying said liquid displacing member for vertical movement within said chamber thereby to vary the position of the liquid relative to the end contacts when the container is in said generally level position so as to selectively change the sensitivity of the apparatus.

20. The apparatus as set forth in claim 12 further comprising means for mounting said container on said machine in such manner that the apparatus is responsive to changes in slope of said element, said mounting means being rotatably adjustable about a horizontal axis to effect rotation of said container relative to the machine thereby to establish said desired slope of said element whereby with said element positioned at its desired slope said container is in its said generally level position.

21. The apparatus as set forth in claim 17 further comprising an insert positioned within the chamber between each outer end and the center thereof, said insert being spaced from the lower surface of the chamber to permit said liquid to flow thereunder toward said lower end and having an air passage providing communication between the center and end portions of the chamber.

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DAVID L. TRAFTON, Primary Examiner

U.S. Cl. X.R.

33—366; 172—4.5; 200—61.47