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C. E. LINEBARGER

2,168,353

HYDROMETER

Filed Dec. 23, 1935

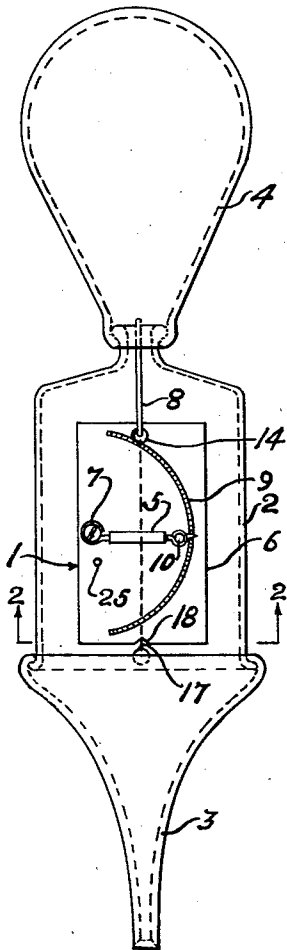


FIG. 1

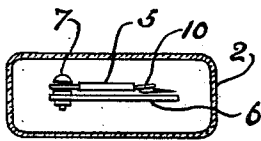


FIG. 2

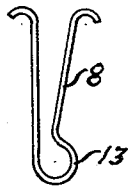


FIG. 4

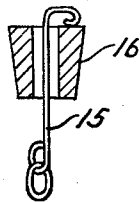


FIG. 5

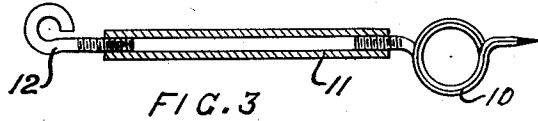


FIG. 3

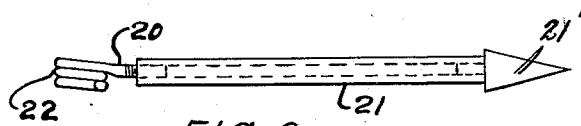


FIG. 6

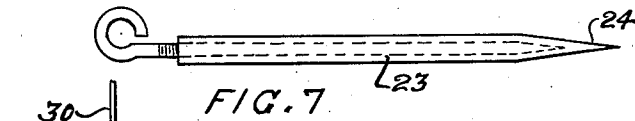


FIG. 7

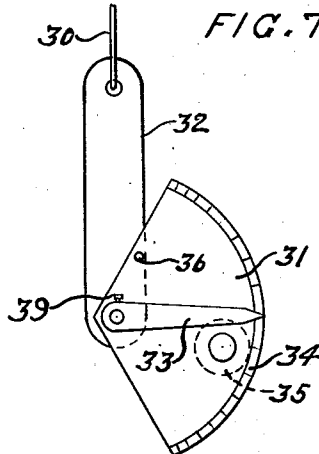


FIG. 8

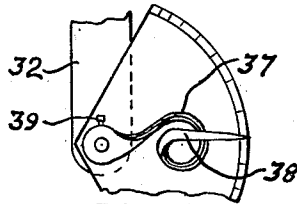


FIG. 10

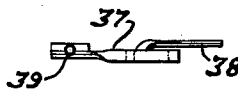


FIG. 11

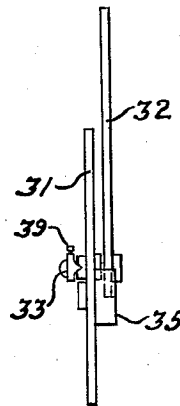


FIG. 9

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2,168,353

HYDROMETER

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3 Claims. (Cl. 265—45)

This invention relates to hydrometers, and particularly to such instruments as depend for their action upon the physical law of moments, the application of which is to mount a vane on a fixed horizontal axis so that the vane turns, when submerged in a liquid the density of which is to be determined, through angles the magnitudes of which depend upon the density of the liquid and also upon the distribution and density of the masses of the various parts of the vane with respect to its axis.

One object of the invention is to provide a hydrometer, either in combination with a syringe or without, to conveniently measure the density of liquids, particularly those having low densities, such as gasoline, naphtha, kerosene, alcohol, acetone and other organic compounds; or aqueous solutions of methanol, ethanol, glycerine, ethylene glycol, and similar and allied products which are used with other ingredients in lesser proportions for the manufacture of anti-freeze mixtures.

For this purpose the hydrometer, if desired, is provided with a buoyant means for decreasing the mean specific gravity or density of the vane as a whole, or certain parts thereof. It may also be provided with thermostatic means for compensating for variations in the density of the liquid being tested because of variations in temperature thereof; or with magnetic means for overcoming the sticking of the movable part of the hydrometer.

Investigations which I have made show that the range of densities to be determined is limited by the density of the material composing the hydrometer vane, or portions thereof, and hence much attention must be given to such materials. Vanes made of various kinds of wood which have been impregnated with oils, greases, or similar substances, or coated with paints, varnishes, lacquers, or the like, are unable to withstand prolonged exposure to the liquids being tested. Wooden vanes, in such cases, have their densities changed so much as to render them unreliable for hydrometric purposes. Also vanes made from compositions of certain synthetic waxes mixed with gums, resins, or other organic substances, are deficient in mechanical strength and workability. They may be used to advantage in special cases, but are not adapted for general application. The number of homogeneous substances possessing the requisite density, inertness, strength, workability, and other desirable qualities for making hydrometric vanes, is very limited.

But when vanes are fabricated out of relatively dense materials, and their mean densities, or densities as a whole, are reduced by attaching to them, or incorporating in them, air chambers, suitable materials for the purpose are obtainable. In such cases it is permissible, in general, to select for vanes material which is physically and chemically inert to atmospheric action, as well as to that of the liquid in which the vane is to be immersed, and is capable of being fabricated into forms and shapes having hollow spaces that may enclose gases or other preferred materials.

Among the classes of materials which are thus suitable for making the vanes are metals and their alloys, plastics, and other similar and allied products; some examples are aluminum, Monel metal, hard rubber, "Bakelite", and the like. The solid parts of the vanes may be fabricated from any suitable material into any preferred shapes, sizes and thicknesses; and the chambers of the hollow casings may be filled with any preferred gases, solids or liquids which are suitable for the purpose. The distribution of the masses of the casings and their contents can be arranged in any way calculated to contribute to the proper action of the instrument as a whole.

The casing, that is, the hollow part of the vane, has two functions when in use: it varies the mean density of the entire vane, or, at least, the unbalanced portion thereof, by a preferred amount; and it varies the relationships of the moments of force of the vane.

Of the accompanying drawing, Fig. 1 is an elevation of a syringe in which is installed a hand-type hydrometer, embodying the features of my invention; Fig. 2 is a sectional view along the line 2—2 of Fig. 1; Fig. 3 is an enlarged sectional view of the vane of the hydrometer of Fig. 1; Fig. 4 is an enlarged view of the supporting member of the hydrometer of Fig. 1; Fig. 5 shows a modified means for supporting the hydrometer; Figs. 6 and 7 show modified forms of the vane of the hydrometer; Fig. 8 illustrates a hydrometer of the dial-type of vane; Fig. 9 is an edge view of the same; Fig. 10 shows a modified pointer for the dial-type of hydrometer, which compensates for temperature differences in the liquid being tested; Fig. 11 is a top view of the pointer of Fig. 10.

Referring to the drawing, and more particularly to Fig. 1, the hydrometer 1 is mounted in a transparent barrel 2, preferably having two broad flat sides, of a hydrometer syringe. On the lower

end of the barrel is mounted a nozzle or tip 3 through which some of the liquid to be tested is drawn into the barrel by means of the rubber suction bulb 4 fixed to the other end of the barrel.

The hydrometer, in this instance, comprises a hand vane 5 which is pivotally mounted on a scale sheet 6 by means of a pivot 7. Herein by the term "vane" I refer to the entire movable member. The sheet may consist of any suitable material, such as Celluloid, and it is freely suspended in the barrel by any means such as the hook 8. A scale 9 is formed on the sheet. When the barrel is filled with the liquid to be tested, the vane will be revolved counter-clockwise around the pivot 7, and the pointer 10 will indicate, by the scale the density of the liquid.

The vane comprises a hollow casing member 11 which is sealed at its ends, and is filled with air or gas or other substance which is less dense than the liquid to be tested. In this case one end of the casing is sealed by the pointer 10 and the other end by the hook 12, the hook end of the member 12 being rotatably mounted on the pivot 7. The axis of the pivot is preferably above the axis of the hook and casing when the vane is horizontal. Preferably the arrangement is such that, when the liquid is at its minimum density the pointer 10 points to the scale adjacent the lower end thereof, and when the liquid is at its maximum density the pointer points towards the upper end of the scale.

As the entire vane may be made of material denser than the liquid to be tested, the volume of the casing chamber must be sufficient to cause the vane to be buoyed up more or less by the liquid when it is submerged therein. That is, the buoyant force of the liquid must be sufficient to force upwardly the casing together with the pointer 10 and the unbalanced portion of the hook 12. As the density of the material of the pointer and the hook may be materially greater than that of the liquid, the mean density of the casing and its contents must be correspondingly less than that of the liquid.

The sheet 6 is suspended in the barrel by means of the hook 8 so that it will always be nearly vertical even though the barrel is held somewhat inclined. For this purpose the loop 13 of the hook is made large and the wire of the loop is materially smaller than the opening 14 of the sheet, thus forming a frictionless universal joint. If desired, a wire 15 may be suspended to the mouth of the barrel 2 by a perforated stopper 16 to support the sheet, as indicated in Fig. 5. The arrangement should be such that the sheet is freely suspended as long as the hydrometer does not come in contact with the wall of the barrel. If desired a plumb line 17 may be suspended from the hook 8 which, when it registers with the notch 18, will indicate that the sheet is vertical.

If desired, the buoyant member, or vane, may be formed as indicated in Figs. 6 or 7. In Fig. 6, 20 indicates a wire of inert material of suitable gage fitting snugly in the tube 21, so as to make an air-tight joint, with the outer end bent into a plurality of coils 22 of equal size so as to make a suitable bearing for turning on the pivot of the supporting sheet. This arrangement forms a line contact between the inside surface of the coils with the pivot. In the outer end of the tube 21 is mounted an arrow head pointer 21'.

Fig. 7 indicates another type of vane, which consists of a tube 23, the end 24 being sealed by pressing together the walls of the tube. It will

be understood that all of the members of the hydrometer are composed of materials that are inert to the liquid that is to be tested; and that the dimensions of the various members are suitable. Also the mean density of the casing or tube 23 and its contents are suitable. The mean density of the casing may be varied by varying the material of which it is composed, and its buoyancy may be varied by varying its volume. Thus, in this case the volume of that casing may be decreased by pressing together the walls thereof, as it is made of collapsible material.

Any suitable means may be used to insure revolving the buoyant member in the right direction. The operator can tip the barrel sufficiently, or a pin 25, Fig. 1, may be set in the sheet so as to hold the vane to the right of the dead center position.

Fig. 8 illustrates a modified form of hydrometer which may be supported by hand by means of the wire 30, or it may be thus supported in the barrel 2. In this case the scale sheet 31 forms the vane, and it is pivoted to the supporting bar 32, and a pointer 33 is fixed by one end to the bar by means of the pivot, or by any other suitable means. The other end of the pointer coacts with the scale 34. Fixed to the sheet 31 is a hollow casing 35 which is so adjusted that, if the mean density of the unbalanced portion of the scale sheet is greater than that of the liquid, the mean density of the casing 35 and its contents will be correspondingly less, so that the mean density of the casing and contents together with that of the unbalanced portion of the scale sheet will be about that of the liquid to be tested.

This dial type of hydrometer can be fabricated from various classes of materials by suitable processes. Thus, the rotating vane can be made by casting in molds, either with or without a core, compositions of waxes, resins, gums and similar and allied organic substances blended in proportions to produce a preferred density, and also by stamping or drawing inert sheet metals, as, for example, aluminum, stainless steel, Monel metal, and the like, the preferred mean density being obtained by incorporating a suitable sealed casing in the vane.

With the modification of Fig. 8, when immersed in the liquid, the buoyant casing, carrying with it the scale, will be forced upwardly by the liquid to a position of equilibrium, and the pointer will indicate by the scale the density of the liquid. A pin 36, fixed to the scale sheet, will insure rotation of the sheet in the right direction.

It may happen that the rotating member of the hydrometer sticks at times somewhat. This can ordinarily be overcome by shaking the barrel or the hydrometer; but to make the effect more positive, some portion of the vane may be made of magnetic material and the sticking can be overcome by bringing the device close to a magnet. Or, if desired, the magnetic material may be magnetized and the sticking then may be overcome by bringing this magnetized material near any piece of iron or steel. In this case the pin 36 may be of magnetic material, and may be magnetized or not as desired. Or a magnetic substance may be inserted in the casing 35, if desired. Inasmuch as the temperature of the liquid affects its buoyant force, it is at times desirable to increase the density readings of the hydrometer when the temperature of the liquid is above the normal temperature in order to correct for the decreased buoyant force. For this

purpose I provide certain correcting means. The pointer 10 in Fig. 1 comprises a coiled bimetal thermostat which is so arranged that it coils more as it heats. As a consequence, when the temperature of the liquid is above normal, and thus the density less, the end of the pointer will rise sufficiently on the scale to correct the reading for the temperature difference.

Also the pointer 37 of Fig. 10 is a thermostat and is arranged to unwind as the temperature rises and thus to elevate the end 38, and the adjustment is such that this action increases the reading of the scale corresponding to the decrease in the buoyant force of the liquid as the temperature rises, so that the reading is suitably corrected for the temperature change.

In this case, as in case of Fig. 8, a set screw 39 for adjustably fixing the pointer to the supporting bar 32 is provided. This screw acts to set the pointer on the pivot which is fixed to the bar. It is not claimed that this device will indicate the density correctly for all temperatures; but by suitably forming and adjusting the pointer it will read correctly for certain temperatures and will materially reduce the error at other temperatures.

It is to be understood that, with each type of vane herein described, the densities, shapes, and volumes of the elements of the vanes, and

the positions of the elements with reference to each other and to the pivot, are adjusted to suit the density of the particular liquid that is to be tested. Increasing the mass of the pointer or its distance from the pivot increases its retarding effect; and increasing the volume of the casing member increases its buoyant effect. In the case of Fig. 7 the buoyant effect is varied by varying the length of the buoyant portion of the casing by pinching more or less of it together.

I claim as my invention:

1. A hydrometer comprising a transparent syringe, a universal joint member, a scale sheet suspended in the syringe by said member, a hollow vane having a pointer fixed to one end and a coiled wire bearing fixed to the other end, said bearing being pivoted to the scale sheet.

2. A hydrometer as claimed in claim 1, the pointer of which is constructed of thermostatic bi-metal.

3. A hydrometer comprising a transparent syringe, a support, a scale sheet suspended in the syringe by said support and having a scale thereon, a hollow vane having a pointer one end and a bearing on the other end, the bearing being pivoted to the scale sheet with the pointer co-acting with the scale.

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