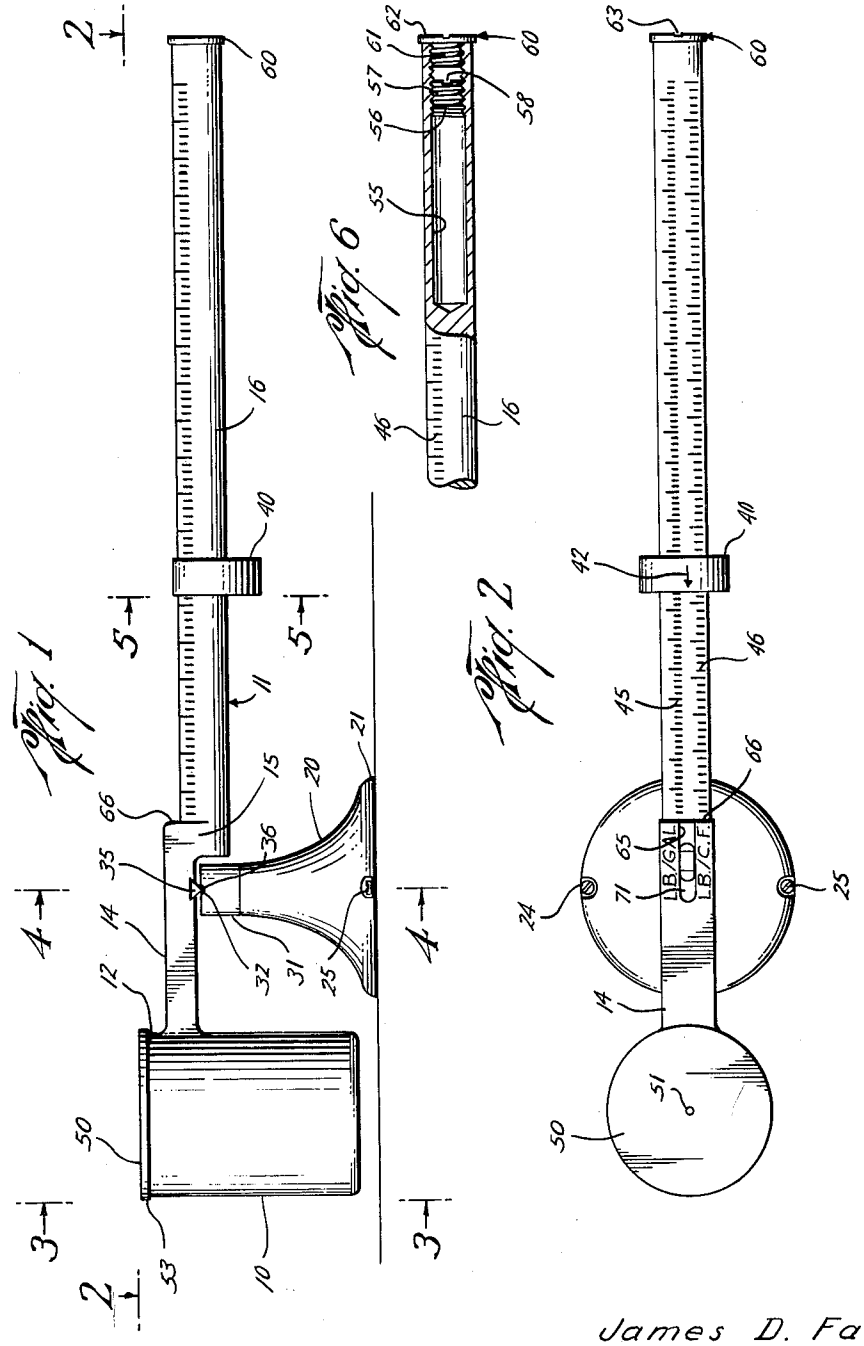
Oct. 9, 1962 J. D. FANN 3,057,421

WEIGHING APPARATUS

Filed Aug. 17, 1956 2 Sheets-Sheet 1



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Fig. 3

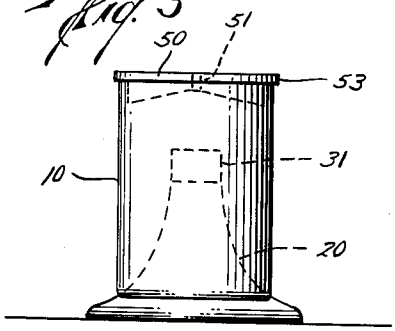


Fig. 4

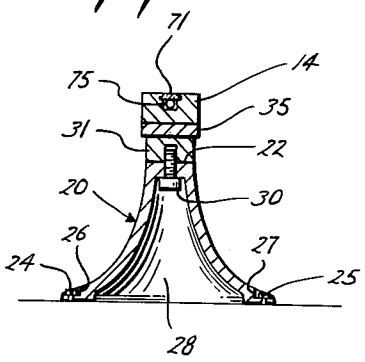


Fig. 5

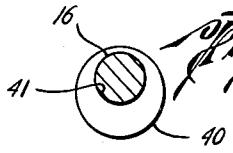


Fig. 7

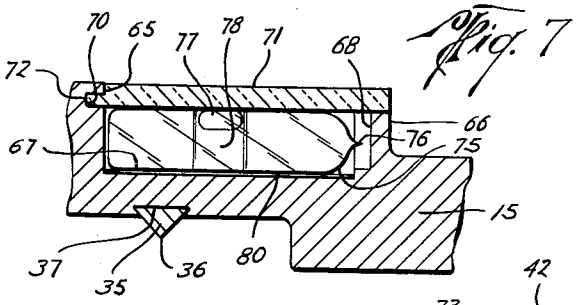


Fig. 8

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WEIGHING APPARATUS

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8 Claims. (Cl. 177—149)

This invention relates to weighing apparatus and particularly to balances for determing the weight or density of liquids such as drilling fluids.

In controlling the drilling of oil wells, control of the weight or density of the drilling fluid employed is of primary importance. Not only is the weight or density of the drilling fluid of importance in itself, but the weight or density of the drilling fluid is also correlated with other properties of the drilling fluid such as viscosity, thixotropy, concentrations, and plasticity. Control of all of these properties or characteristics is necessary to insure success of the drilling operation.

In determining the weight or density of the drilling fluid during the drilling of the well, it is necessary that the individual determinations be made rapidly and frequently and near the well site, usually under conditions such that the equipment by means of which the determinations are made is subjected to rugged conditions of weather, uncleanliness, and corrosion.

Drilling fluids being of a thixotropic or jell forming nature it is not generally convenient at a well site to make the density or gravity determinations with equipment not readily adaptable to rapid and frequent cleaning and to the abuses of drilling crews.

It is, therefore, a principal object of the invention to provide apparatus suitable for readily and accurately determining the density and gravity of drilling fluids.

Another object of the invention is to provide such apparatus of rugged design adaptable for use under extreme well site conditions.

Another object of the invention is to provide such apparatus which may be easily calibrated by unskilled operators.

Another object of the invention is to provide such apparatus which is light in weight and readily transportable, pleasing in appearance, and low in cost.

Other objects, uses, advantages, and improvements of the invention will appear from the following description of a preferred embodiment thereof, reference being made to the accompanying drawings, of which:

FIGURE 1 is a side elevation of the apparatus assembled for use;

FIGURE 2 is a plan view of the apparatus of FIGURE 1, taken at line 2—2 thereof;

FIGURE 3 is an end elevation of the apparatus taken at line 3—3 of FIGURE 1;

FIGURE 4 is a vertical section through the pedestal support, taken at line 4—4 of FIGURE 1;

FIGURE 5 is a vertical section taken at line 5—5 of FIGURE 1;

FIGURE 6 is a partial side view, partly in vertical section taken at the longitudinal axis of the balance arm, showing the tare weight adjustment;

FIGURE 7 is a vertical section through a central portion of the balance arm, taken at the center thereof, and showing the balance pivot and leveling means; and

FIGURE 8 is a perspective view showing a manner of using the apparatus.

Preferring now in detail to the drawings, a cup 10 is supported by a balance arm 11 integrally formed therewith and extending radially from one side of the cup below the upper circular lip 12 of the cup. Balance arm 11 is of elongated form, there being a rectangularly formed portion 14 next to cup 10, a downward offset 15, and a long cylindrical portion 16 outwardly of the offset

from the cup. The cup and balance arm are unitary, preferably being cast of a metal such as aluminum. This one piece construction of the cup and balance arm is very rigid and strong, so that it can be damaged only by severe abuse. It is also important to note that the cylindrical arm portion 16 is streamlined so that strong winds do not seriously affect the accuracy of determinations made with the apparatus. In addition, it is easier to scrape mud and other contamination from the round arm 16 than from a flat-sided arm so that the apparatus is easier to keep clean than is other similar apparatus.

The balance arm 11 is pivotally supported upon a pedestal support 20, which is flared downwardly to provide an enlarged lower flange 21 upon which the pedestal support rests, and diminishes upwardly to a small circular upper end 22. The bottom of cup 10 is above flange 21 when the apparatus is properly balanced. Support 20 has circular horizontal cross sections over its height, the sections having a common vertical axis. Through two opposite edges of flange 21, there are provided vertical screw holes 24, 25, each having an upper screw head recess 26, 27, respectively, screws being inserted through the screw holes to secure the pedestal support upon a flat surface. The underside of the support is hollow as at 28, the flared upper walls and top of the support being uniform in thickness. A screw 30 is threadingly received through the top of the support, there being a tapped screw hole vertically there through at the center of upper surface 22. The head of screw 30 is screwed flush against the upper surface of hollow opening 28 and between the flared sides of the pedestal support. The threaded end of screw 30 extends above surface 22, to be received into a lower tapped hole in one end of a cylindrical fulcrum 31. Fulcrum 31 has a diameter equal to the diameter of the upper end of pedestal support 20 and upper surface 22 thereof, so that the sides of the fulcrum and support meet flushly. At the upper end of fulcrum 31 there is provided a diametral groove 32 which has a rounded bottom against which a knife edge pivot of the balance arm may be engaged.

The member including the cup 10 and balance arm 11 is provided with a knife edge pivot at the underside of rectangular arm portion 14 and near arm offset 15. The knife edge pivot is provided by one longitudinal edge of a triangular pivot block 35, the knife edge 36, being between two equal faces of the block disposed at an angle of about 90° one to the other, and facing diagonally downwardly. The upper face of the pivot block faces upwardly and intersects both of the lower faces at angles of about 45°. The exact cross-section of the pivot block is not critical and the angles between the faces may be varied. A angular groove 37 laterally across the lower face of arm portion 14 corresponds in shape with the upper part of the pivot block 35. The upper part of the pivot block is press fitted tightly into the groove 37 so that it remains in place but is removeable for repair or replacement. The sides of groove 37 are angular one toward the other corresponding to the angle between the downwardly facing faces of the pivot block so that the pivot block cannot fall or be removed downwardly out of the groove. The press fit of the groove with the upper part of the pivot insures that the pivot block will remain firmly in place during use of the apparatus, without any screws whatever to hold it in place, even though the apparatus is subjected to extremely rough treatment. Knife edge 36 is placed within groove 32 of fulcrum 31 when a weight or gravity determination is to be made, the cup 10 and arm 11 being of such proportions and weights that a balance thereof may be attained by adjustment of a counterweight 40, to be described. Pivot block 35 and fulcrum 31 are preferably made of a hard non-corrodable material such as strainless steel or other alloy of similar

properties so that the pivot edge and groove are not easily damaged.

The knife edge **36** may be said to divide the balance arm **11** into a cup supporting portion at one side of the knife edge and a weight supporting portion at the other side of the knife edge. The weight supporting portion includes the tubular portion **16** carrying externally a counterweight and internally a taring weight as will now be described.

The elongated tubular portion **16** of balance arm **11** is fitted externally with the slidable counterweight **40**. Counterweight **40** is cylindrical in form and has an off-center circular hole **41** therethrough perpendicular to the flat ends of the cylinder. The hole **41** is of a diameter slightly greater than the diameter of arm portion **16**, which is received through the hole, and thus the counterweight can be slidably moved over the length of the tubular arm portion **16**. Arm portion **16** is calibrated over its length, and counterweight **40** has one of its flat ends indicated by an arrow **42** or other mark on the curved side of the counterweight nearest hole **41**, so that the flat end can be used as a mark in determining the position of the counterweight along the calibrated arm portion.

Tubular arm portion **16** is preferably calibrated with two scales **45** and **46**, scale **45** indicating the weight or gravity of drilling fluid in cup **10** as pounds per gallon, and scale **46** indicating the weight or gravity as pounds per cubic foot. These particular scales are provided because they are usually most convenient for the drilling crew's use, but other scales may be used and additional scales may be provided if desired. A weight or gravity reading is made by slidingly moving the counterweight **40** along the tubular arm **16** to the position in which the balance arm and cup are balanced, and reading the weight or gravity on the appropriate scale at the point marked by the indicated end of counterweight **40** indicated by arrow **42**. The arrow **42** or other mark is automatically positioned above the scales at the top of the arm because of the greater weight of the counterweight at its side away from the off-center hole **41**.

Should the tubular arm **16** become covered with dirt or with a crust of mud or dried drilling fluid, the counterweight can be moved along and/or rotated about the arm to scrape it clean.

In making a weight or gravity determination, the cup **10** is always filled to capacity with drilling fluid in order that there will be a constant volume factor upon which the weight and gravity readings may be based, that is, weights and gravity determinations are always taken of the same volume of drilling fluid. Cup **10** has the upper edge or lip **12** around which fits a top **50** to cover the cup opening. The upper surface of the top (see FIGURE 3) is flat, and the lower surface of the top is conically beveled, converging upwardly, and has a small opening **51** therethrough at the apex. Around the conical-lower surface a part of the top is reduced to fit snugly within the top of the cup, while the upper unreduced flange portion **53** of the top fits snugly above the edge **12** of the cup. A constant measured volume of drilling fluid is obtained by filling the cup completely and then forcing down the top **50** until it is seated as described, the excess fluid in the cup flowing out through hole **51** while the top is being forced down so that the cup is full of fluid up to the top **50**, with no air spaced therewithin. Before a determination is made the exterior of the cup and top are cleaned by washing or wiping.

Top **50** is preferably made of molded hard rubber, which can be made of accurate form and weight such that top **50** is replaced without necessity of any alteration to the remainder of the apparatus to correct its balance.

At the end of tubular arm portion **16** there is provided a means for adjusting or taring the balance of the cup and balance arm. The end has an axial bore **55**, the outer end of the bore being provided with threads **56**. The threads may extend the full length of the bore. A taring weight in the form of a cylindrical exteriorly threaded plug a slug **57** of shorter length than the bore and threads is screwed into the threads **56** to serve as a weight adjusting means at the end of the balance arm. Plug **57** has a slot **58** at its outer end so that it may be turned and its axial position changed with an ordinary screwdriver. A cap **60** having threaded body **61** and outer overhanging flange **62** is screwed into the end of the bore to close the bore and to protect the plug **57** from corrosion and the like. The flange **62** extends beyond the sides of arm portion **16** so that counterweight **40** is retained thereon by flange **62** and by offset **15**. The outer face of the cap **60** has a slot **63** by means of which the cap may be screwed into and out of the threads. It is important to note that once the weight of the balance arm is adjusted by moving plug **57** to the proper position in threads **56**, and cap **60** is screwed into the end of the arm, the adjustment will not be disturbed by handling of the apparatus, since access to the plug **57** is blocked by cap **60**. Since drilling fluids commonly contain strong corrosive constituents such as sodium hydroxide the enclosed arrangement for weight adjustment plug **57** is exceedingly important, and it should be further poined out that adjustment of the plug never becomes difficult because the threads **56** are also enclosed.

At the upper face of rectangular arm portion **14** adjacent to offset **15** there is formed a slot **65** which extends toward the cup from the face **66** of the offset **15**. The slot **65** has a deeper portion **67** spaced from offset face **66**, there being a narrower offset slot **68** at the end of the deeper slot portion **67** toward face **66**. Above the deeper slot portion a groove **70** runs horizontally around the interior of the slot, extending along both sides of the slot and around its end. A cover **71** corresponding in shape with horizontal section of the slot, has an edge flange **72** receivable into groove **70** so that the cover can be inserted to cover the deeper slot portion **67** from face **66**. Cover **71** has a transparent center **73** through which the interior of the deeper slot portion may be viewed after the cover is in place. A level capsule **75** is cemented or glued in place within the deeper slot portion, the end seal nipple **76** of the capsule fitting within offset **68**. Cover **71** covers the capsule and the bubble **77** and index line **78** of the capsule can be observed through transparent center **73** of the cover to determine when the balance arm is level and therefore in correct balance.

Capsule **75** can be set in place in the deeper slot portion with a thin layer **80** of flexible cement, such as a rubber cement, applied beneath and around the capsule, in which case the capsule is protected from shock and breakage by the resilience of the cement. Alternatively, layer **80** may be porcelain or other hard cement, such as "Sauerisen" cement, in which case the capsule is protected by its rigid setting. The use of a porcelain cement has a further advantage in that the porcelain reflects light from below the capsule and makes it easier to read the level. Capsule **75** is ordinarily made of glass and contains immiscible liquid and gas to indicate true level in the conventional way. Capsule **75** is additionally protected by cover **71**, and should seldom be broken. However, should capsule **75** be broken, a new capsule may be easily installed. The broken capsule and cement layer may be pried from the slot, after which a new capsule may be set in the slot in the original manner and the cover **71** reinserted over the capsule. No screws or other threaded connection means are required to hold the level indicating elements in place.

As indicated by FIGURE 8 of the drawings, the tubular end **16** of balance arm **11** also serves as a handle by means of which the cup **10** may be manipulated to obtain samples of the drilling fluid. The arm and cup function as a dipper. After the cup is filled with drilling fluid as earlier described, and cleaned, knife edge **36** is set within fulcrum groove **32**, counterweight **40** is slid

along tubular arm **16** until bubble **77** and line **78** of capsule **75** are aligned indicating proper balance, and a reading made on one of the scales **45**, **46**, completing the weight or gravity determination.

While a preferred embodiment of the invention has been shown and described herein, many modifications thereof may be made by a person skilled in the art without departing from the spirit of the invention, and it is intended to protect by Letters Patent all forms of the invention falling within the scope of the following claims:

I claim:

1. An improved gravity balance comprising a balance arm,
the portion of the balance arm extending inwardly from one end thereof constituting a cup supporting portion,
said cup supporting portion having an upwardly opening cup affixed to said one end,
the portion of said balance arm extending inwardly from the other end thereof constituting a weight supporting portion,
said weight supporting portion having a counterweight movably mounted thereon,
said weight supporting portion being downwardly offset relative to said cup supporting portion forming a shoulder on the upper side of said arm at the juncture of said portions,
said cup supporting portion having a pivot means on the underside thereof,
the upper side of said cup supporting portion of said balance arm having a slot therein adjacent said shoulder,
a spirit level capsule disposed in said slot,
and a panel for closing the top of said slot,
said cup supporting portion having a panel receiving groove around the top of said slot and extending therebeyond to said shoulder adapted slidably to receive said panel, said panel being insertable and removable at the end of said slot adjacent said shoulder.

2. Apparatus according to claim 1 wherein said capsule is glued to the bottom of said slot.

3. Apparatus according to claim 1 wherein said pivot means is an elongated knife edge member of triangular cross section having plane sides, said cup supporting portion of said balance arm has a groove on the under side thereof, and said elongated knife edge member is removably press fitted in said groove.

4. An improved gravity balance including a receptacle,
a vented closure means to reduce the receptacle volume to a fixed amount,
a balance arm having a first end attached in integral relation to the receptacle,
a liquid filled level capsule disposed in externally viewable relation within the balance arm, said capsule being adapted to indicate a horizontal disposition of said arm,
a pivot means disposed intermediate the length of said arm, said pivot means being adapted for pivoted engagement with a complementary base,
a calibrated cylindrical second end portion of said arm having an axially disposed threaded bore extending to the terminus of said end defining a chamber totally closed except at said end,
threaded taring weight fitted within said bore in axially adjustable relation to said arm, said taring weight being connected solely to said threaded bore,
a cylindrical counterweight eccentrically disposed about said cylindrical end portion in close fitting reciprocative relation whereby said end portion may be cleaned of foreign material by movement of said counterweight,
and a retaining means removably connected to said second cylindrical end in longitudinal retaining relation to said counterweight and in closing relation with said chamber.

5. An improved gravity balance including a receptacle,
a vented closure means to reduce the receptacle volume to a fixed amount,
a first end of a balance arm attached in integral relation to the receptacle,
a liquid level capsule viewably disposed in internal relation with the balance arm, said capsule being adapted to indicate a horizontal disposition of said arm,
a pivot means disposed intermediate the length of said arm, said pivot means being adapted for pivoted engagement with a complementary base,
a cylindrical second end portion of said arm defining an enclosable chamber extending to the terminus of said end,
a weight fitted within said chamber in longitudinally adjustable relation to said arm,
a counterweight disposed about said cylindrical end in close fitting reciprocative relation,
and retaining means disposed at said second cylindrical end in retaining relation to said counterweight, said retaining means also totally closing said chamber and preventing adjustment and accidental displacement of said weight therein.

6. An improved gravity balance, comprising,
a balance arm,
level means on said arm to indicate horizontal disposition of said arm,
pivot means on said arm dividing the arm into a receptacle supporting portion at one side of said pivot means and a weight supporting portion at the other side of said pivot means,
a receptacle rigidly connected to said receptacle supporting portion of the balance arm,
a counter weight on said weight supporting portion movable therealong between a first position nearer to the pivot means and a second position nearer to the end of said weight supporting portion farthest from said pivot means,
the portion of said balance arm between said first position and said second position constituting the counterweight travel portion of the balance arm,
a bore extending inwardly from said end of said weight supporting portion of the balance arm toward said pivot means,
said bore having an internally threaded portion disposed within said weight travel portion of said arm,
a taring weight in the form of a slug inserted in said bore and having a maximum diameter conforming to the inside diameter of said bore,
the portion of said slug having the maximum diameter being threaded its full length correlative to said threaded portion of the bore,
said slug lying entirely within said bore,
threaded removable closure means at the end of said weight supporting portion of the balance arm to totally close said bore,
said closure means being unconnected to said slug,
said balance arm including an offset in the weight supporting portion thereof forming a stop limiting the travel of said counter-weight at said first position, and
said threaded closure means for the bore receiving the taring weight also providing a stop for said counterweight at said second position thereof.

7. Combination of claim 6 wherein said weight travel portion of said balance arm is cylindrical concentric with said bore that receives said taring weight,
said weight travel portion having graduations therealong adjacent the top thereof,
said counter weight has a cylindrical aperture correlative to the cylindrical shape of said weight travel portion of the balance arm but eccentrically dis-

posed relative to the center of gravity of the counter weight,

whereby said weight travel portion of said balance arm is cleaned of foreign material by movement of said counterweight along said weight travel portion of the said arm exposing said graduations and said counter weight gravitation to a position where its thinnest wall is at the top adjacent said graduations to facilitate determination of the position of an edge of said counterweight relative to said weight travel portion of the balance arm.

8. An improved gravity balance including,

a receptacle in the form of a cup having a circular lip,

a cover for said cup having a portion telescopically engaging said lip,

a balance arm having a first end attached in integral relation to the receptacle,

a liquid level capsule adapted to indicate a horizontal disposition of said arm fixedly disposed thereon in viewable position,

a pivot means disposed intermediate the length of said arm, said pivot means being adapted for pivoted engagement with a complementary base,

a portion of said arm having an exterior surface that is cylindrically curved, said portion defining an enclosable chamber extending to the terminus of the arm at a second end thereof opposite from said first end,

a taring weight fitted within said chamber in longitudinally adjustable relation to said arm,

a counter-weight disposed on said arm in reciprocative relation to said cylindrically curved portion of the arm,

means disposed at said second end of said arm closing said chamber to prevent accidental displacement of said taring weight therein, the last said means being unconnected to said taring weight,

the portion of said chamber within which said taring weight is fitted being internally threaded,

said taring weight being in the form of a slug having a maximum diameter conforming to the inside diameter of said threaded portion of said chamber,

the portion of said slug having the maximum diameter being threaded its full length correlative to said threaded portion of the chamber,

said slug lying entirely within said chamber.

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