

Oct. 14, 1952

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MUD WEIGHING APPARATUS

2,613,530

Filed Jan. 6, 1950

2 SHEETS—SHEET 1

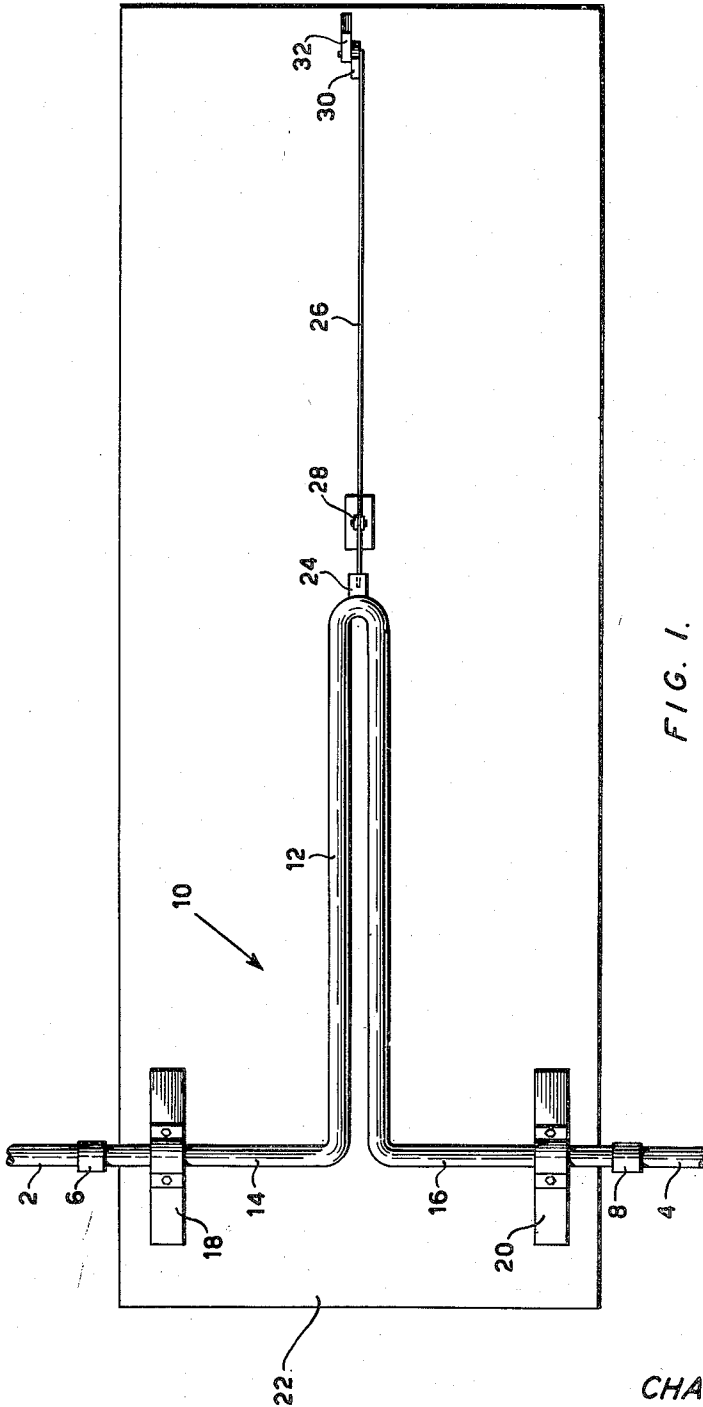


FIG. 1.

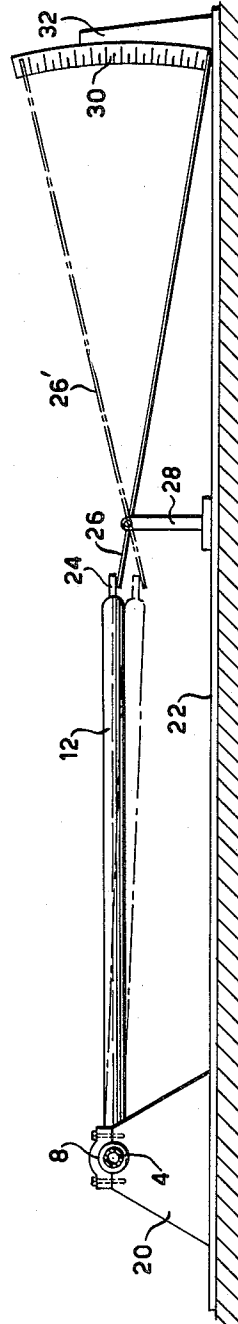


FIG. 2.

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2 SHEETS—SHEET 2

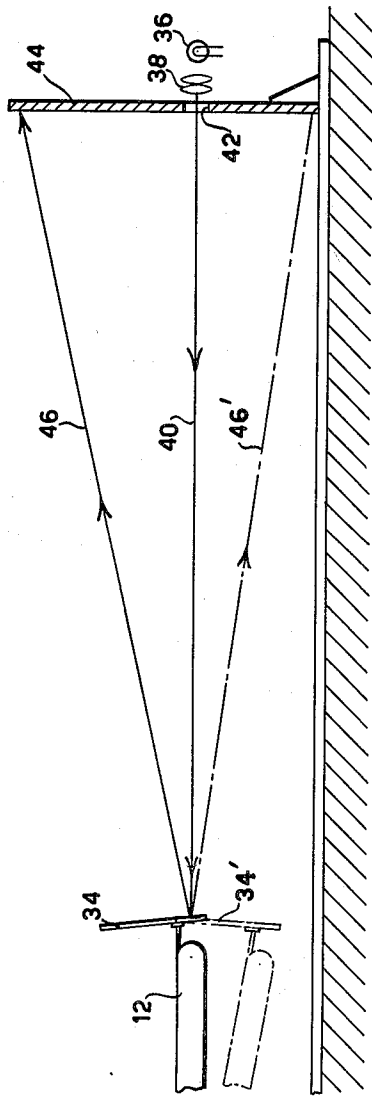


FIG. 3.

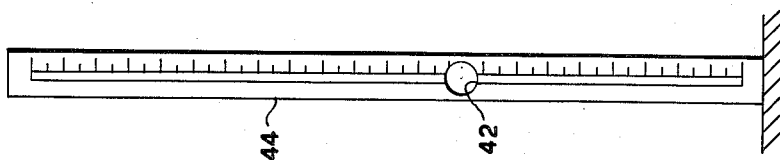


FIG. 4.

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MUD WEIGHING APPARATUS

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4 Claims. (Cl. 73—32)

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This invention relates to a device for automatically and continuously indicating the density of well drilling fluid.

In drilling wells by the rotary method, drilling mud is circulated down through the drill pipe and up through the annular space between the drill pipe and borehole. The mud functions to remove the cuttings from the borehole, to prevent caving of the borehole wall and to provide sufficient hydrostatic pressure to overcome the pressure of the formations penetrated. A close control of the density of the drilling mud throughout the drilling operation is generally highly desirable. On the one hand, it is necessary that the weight of the drilling mud be sufficient to provide a hydrostatic pressure adequate to hold back fluids such as gas or water in the formations encountered in order to prevent a blowout of the borehole. On the other hand, if the drilling mud becomes too heavy, the drilling fluid may be continuously forced into one or more of the formations penetrated resulting in the condition known as "lost circulation." During the course of the drilling frequent adjustment of the weight of the mud, as by the addition of weighting materials, is required to meet the varying conditions encountered. For instance, upon penetration of a gas sand, the mud stream may become considerably lighter due to absorption of gas, in which case it is important that the change in density of the mud fluid be detected immediately so that the proper steps may be taken to increase the weight of the circulating mud and prevent a blowout. In some cases a variation in mud weight of only a small fraction of a pound per gallon may be sufficiently important to constitute the difference between satisfactory and unsatisfactory drilling progress. It is evident, therefore, that a continual accurate measurement of the mud density during the drilling operation is highly desirable.

Heretofore various devices have been employed in the measurement of density of drilling muds involving various degrees of complication. The principal difficulties encountered in the use of these mud weight indicators arise as a result of plugging or clogging of small lines or ports, jelling of the mud when circulation is arrested or when the mud lies static in parts of the apparatus, and channelling of the mud such as occurs when a portion of the mud in a container jells resulting in a restricted passage through which the mud flows.

These characteristics of drilling mud are well known.

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In my application Serial No. 77,397, filed February 19, 1949, there is disclosed a device comprising a U-shaped pipe having non-rigid mountings adjacent to the ends of the U and having the curved portion of the U supported by weighing means such as, for example, a conventional type of weighing scales. The weighing scales are set to a zero position when supporting only the weight of the empty pipe. When drilling mud is passed through the pipe, the weighing scale will provide an indication of the density of the mud.

It is an object of this invention to provide an improved means wherein the deflection of a pipe section under the load of the mud contained therein is employed for determining the weight and density of the mud within a U-shaped section of the pipe.

It is a further object of this invention to provide a mud weight indicator of such proportions as to be reasonably portable.

These and other objects of the invention will become apparent from the following description when read in conjunction with the accompanying drawing in which:

Figure 1 is a plan view of the apparatus involved employing mechanical indicating means;

Figure 2 is a side elevation of the apparatus shown in Figure 1;

Figure 3 is a fragmentary elevation of the apparatus, partly in section, showing the invention employing optical indicating means; and

Figure 4 is an enlarged view of the indicating scale shown at the right hand portion of Figure 3.

Referring to Figures 1 and 2, pipe line 2 carries drilling mud the density of which is to be measured to the measuring apparatus generally indicated at 10 in Figure 1 and pipe line 4 carries the mud away from the apparatus. The apparatus includes the U-shaped tubular member 12 having the extended leg portions 14 and 16. The leg portion 14 is joined to the pipe line 2 by the coupling 6 and the leg portion 16 is joined to the pipe line 4 by a coupling 8. The leg members 14 and 16 are rigidly mounted within the mounting members 18 and 20 respectively. The members 18 and 20 are affixed to the base plate 22.

The apparatus may be included in a bleed-off line taken from the flow line to the well or in a bleed-off line taken from the discharge from the well or in both of these positions providing simultaneous indications of the weight or density of the mud both entering or leaving the well. The tubing 12, 14 and 16 is made of a material such as high carbon steel to provide suitable rigidity to prevent the tubular member from being deflected

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by the weight of the mud therein to a point at which it will take on a permanent set.

It should be noted that while the angle between the portions 12 and 14 of the tubing and that the angle between the portions 12 and 16 of the tubing are both drawn as approximately 90° angle, it is not necessary that the angle be restricted to 90°. Various angles may be employed, the pertinent consideration being that the two angles be identical in order that the impact forces of fluids in the two bends will be balanced.

Affixed to the end of the hairpin loop is the member 24 which is adapted to bear upon one end of the lever arm 26. The lever arm 26 is pivotally mounted on the supporting post 28 which is, in turn, affixed to the base plate 22. Mounted adjacent to the other end of the lever arm 26 is the indicating scale 30 which is supported by the supporting member 32 affixed to the base plate 22. As will be observed in Figure 2 when the tubular member 12 is empty and unloaded, the apparatus is arranged in such a fashion that the lever arm 26 will lie adjacent to the lowermost indication on the scale 30. When drilling mud is passed through the tubular member the weight of the mud within the extended hairpin portion 12 of the tubing will cause a torsional deflection in the extended tubular members 14 and 16 and a downward deflection of the hairpin portion 12. As a result of these deflections the member 24 will move downwardly causing the lever member 26 to assume, for conditions of maximum deflection, a position shown in construction lines at 26'. At this position the end of the lever 26 will lie adjacent to the uppermost mark on the scale 30. The deflection of the tubing will vary with the weight of the mud being passed through the tubing and the scale 30 may be readily calibrated to read directly in terms of both drilling mud weight and density.

It will be apparent that the mechanical indicating means previously described is but one of numerous types of indicating means which may be employed and calibrated to provide direct readings of the density of fluid flowing through a pipe and causing the deflection of an extended portion thereof. An alternate form of indicator can be provided by the use of a beam of light as shown in Figure 3 wherein there is affixed to the end of the hairpin portion 12 of the tubular member a mirror 34 which, as the tubular member deflects, will assume a position at maximum deflection as shown in construction lines 34'.

With this type of indicator there is employed a lamp 36 providing a beam of light 40 which passes through the lenses 38 through the aperture 42 and which is reflected by the mirror 34 and focused upon the vertical scale 44. When there is no mud passing through the tubular member the reflected beam from the mirror 34 will travel along the path 46 and strike the indicating scale 44 at the uppermost point of its calibration. When the tubular member is carrying mud of maximum weight, the mirror 34 will be moved downwardly to the maximum position shown in construction lines and indicated as 34'. With this position of the mirror the beam of light 40 will be deflected from the mirror along the path 46' and will strike the scale at its lowermost point of calibration.

It will be understood that the present invention should not be limited to use with the mechanical or the optical types of indicating means described herein. Various other means for indicating deflection may be used, for example, electrical means may be employed wherein the deflection of

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the tubular member is adapted to cause a variation of a resistance, capacitance of inductance of an electrical element.

This invention provides a simple and practical apparatus which can be readily assembled in the field by the drilling crew for continuously indicating the weight of the drilling mud. The apparatus is simple and foolproof and it may be constructed with tube diameters as small as one-half inch and with the lengths of the wishbone of approximately one foot. However, the invention should not be construed as limited by these proportions. Thus, the apparatus may be made portable thereby facilitating transportation and installation in the field. There is further provided an apparatus which is not susceptible to plugging, jelling or channelling of the mud or to other similar problems generally encountered in the operation of conventional mud weighing apparatus.

What is claimed is:

1. Apparatus for indicating the density of well drilling fluid comprising fluid conducting means, said fluid conducting means including a substantially horizontally disposed conduit having a looped center portion and laterally extending end portions, said end portions of said conducting means being adapted to be connected to fluid supply means and fluid disposal means, means rigidly mounting said conducting means adjacent to said end portions thereof, and means indicating the displacement of the looped center portion of said fluid conducting means resulting from the deflection of said conducting means between said mounting means due to the weight of the fluid passing therethrough.

2. Apparatus for indicating the density of well drilling fluid comprising fluid conducting means, said fluid conducting means comprising a substantially horizontally disposed conduit having a looped center portion and laterally extending end portions, said end portions of said conducting means being adapted to be connected to fluid supply means and fluid disposal means, means rigidly mounting said conducting means adjacent to said end portions thereof, and indicating means responsive to the displacement of the looped center portion of said fluid conducting means resulting from the deflection of said conducting means between said mounting means due to the weight of the fluid passing therethrough for indicating the density of said fluid.

3. Apparatus for indicating the density of well drilling fluid comprising fluid conducting means, said fluid conducting means including a substantially horizontally disposed conduit having a looped center portion and laterally extending end portions, said end portions of said conducting means being adapted to be connected to fluid supply means and fluid disposal means, means rigidly mounting said conducting means adjacent to said end portions thereof, and means indicating the displacement of the looped center portion of said fluid conducting means resulting from the deflection of said conducting means between said mounting means due to the weight of the fluid passing therethrough, said indicating means including a mirror movable by deflection of said looped center portion of the conduit, a light source and an indicating scale, said light source being adapted to project a beam of light upon the mirror and the indicating scale being positioned to receive the light beam reflected from the mirror to provide a greatly mag-

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nified indication of deflection of said looped center portion of the conduit.

4. Apparatus for indicating the density of well drilling fluid comprising fluid conducting means, said fluid conducting means including a substantially horizontally disposed conduit having a looped center portion and laterally extending end portions, said end portions of said conducting means being adapted to be connected to fluid supply means and fluid disposal means, means 10 rigidly mounting said conducting means adjacent to said end portions thereof, and means indicating the displacement of the looped center portion of said fluid conducting means resulting from the deflection of said conducting means between said mounting means due to the weight 15 of the fluid passing therethrough, said indicating means including a mirror mounted on said looped center portion of the conduit and movable therewith, a light source and an indicating

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scale, said light source being adapted to project a beam of light upon the mirror and the indicating scale being positioned to receive the light beam reflected from the mirror to provide a 5 greatly magnified indication of deflection of said looped center portion of the conduit.

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