Jan. 1, 1957 E. R. NETT 2,775,893

DENSITY INDICATING APPARATUS

Filed Dec. 7, 1953

Fig. 1

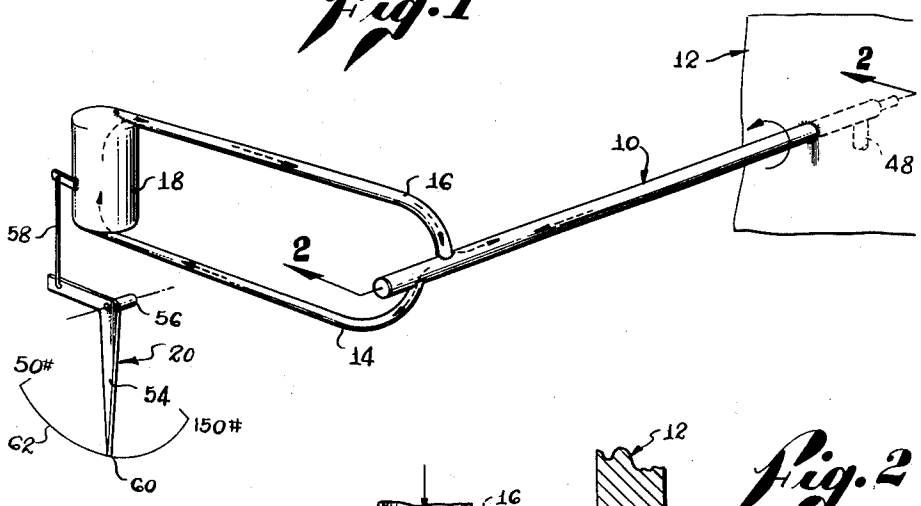
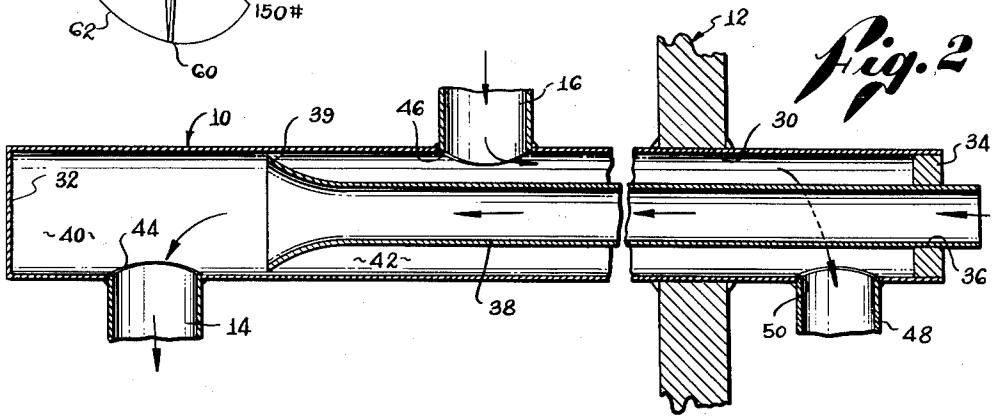


Fig. 2



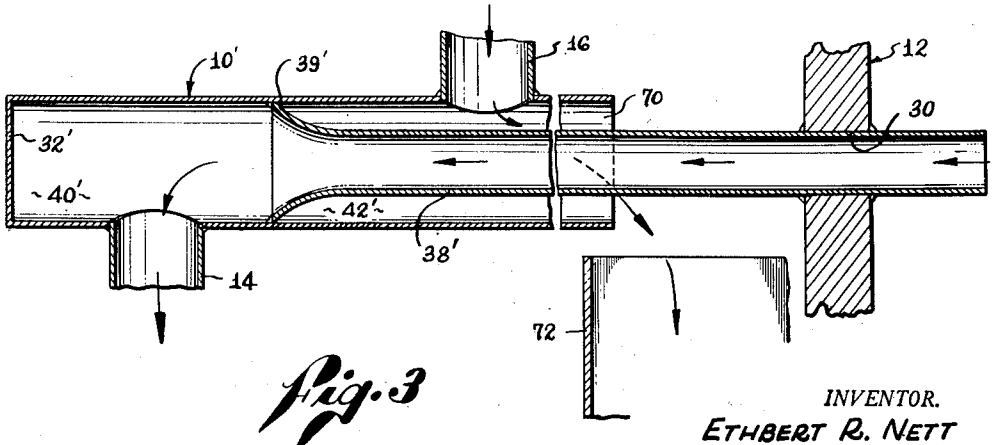


Fig. 3

INVENTOR.
ETHBERT R. NETT
BY Fulwider Mattingly & Babcock
Attorneys

United States Patent Office 2,775,893 Patented Jan. 1, 1957

2,775,893

DENSITY INDICATING APPARATUS

Ethbert R. Nett, Beverly Hills, Calif.

Application December 7, 1953, Serial No. 396,446

8 Claims. (Cl. 73—434)

The present invention relates generally to apparatus for indicating the density of a flowing fluid and more particularly to an apparatus adapted to provide a continuous indication of the density of oil well drilling mud.

In drilling an oil well by the rotary method, drilling mud is circulated downwardly through the drill pipe string and upwardly through the annular space surrounding the drill pipe string and the sidewalls of the bore hole. The drilling mud serves to remove the cuttings from the well bore and to prevent caving of the sidewalls of the well by providing sufficient hydrostatic pressure to overcome the pressure of the earth formations being penetrated by the drill bit. Close control of the density of the drilling mud is required throughout the drilling operation. It is necessary on the one hand that the weight of the drilling mud be sufficient to provide a hydrostatic pressure adequate to retain fluids, such as gas or water, within their formations in order to prevent a possible blow out from occurring; on the other hand, if the drilling mud becomes too heavy, it may be continuously forced into one or more of the formations being penetrated so as to result in the condition known as "lost circulation." Accordingly, it is necessary during the course of the drilling operation to frequently adjust the weight of the drilling mud by adding thereto weighting materials or by increasing its fluid content. It will therefore be apparent that a continuous and accurate indication of the mud density during the drilling operation is both desirable and necessary.

While there have been heretofore proposed various types of mud density indicating devices, these have proven to be generally unreliable and inaccurate in use. The inaccuracy of such devices has been due, in most cases, to the accumulation of suspensoids, usually solids, on the movable part of the device which actuates the scale member thereof. Other heretofore-proposed types of mud density indicating devices, while affording comparatively accurate results, are of a complex, costly and often bulky nature whereby they have failed to meet with widespread acceptance in the oil well trade.

It is a major object of the present invention to provide density indicating apparatus which will afford extremely accurate results for a comparatively long period of time without requiring any maintenance.

Another object is to provide density indicating apparatus which utilizes the torsional deflection of a tubular fluid carrying member to obtain a measurement of the density of such fluid.

A further object of the invention is to provide apparatus of this nature which is extremely simple of design and rugged of construction whereby it may afford a long and trouble-free service life.

An additional object is to provide density indicating apparatus which is comparatively small and compact whereby it may be readily portable.

Yet another object is to provide apparatus of this nature which is inexpensive to construct.

A further object is to provide density indicating apparatus through which the mud to be weighed may flow without requiring any type of sealing device.

Yet an additional object of the invention is to provide apparatus of this nature which is capable of providing accurate measurements regardless of the pressure and velocity of the fluid being measured.

These and other objects and advantages of the present invention will become apparent from the following detailed description, when taken in conjunction with the appended drawings wherein:

Figure 1 is a generally schematic, perspective view of a preferred form of density indicating apparatus embodying the present invention;

Figure 2 is an enlarged fragmentary, central vertical sectional view of said apparatus; and

Figure 3 is a fragmentary sectional view similar to Figure 2 but showing an alternate embodiment of said apparatus.

Referring to the drawings, the preferred form of density indicating apparatus embodying the present invention broadly comprises a substantially horizontally disposed main fluid conduit, generally designated **10**, having one of its ends rigidly secured to a frame member, generally designated **12**. First and second auxiliary conduits, **14** and **16**, respectively, extend away from one side of the main conduit **10**, in a substantially horizontal direction. A weighing container **18** is interposed between the ends of the first and second auxiliary conduits. An indicating mechanism, generally designated **20**, is operatively connected to the weighing container **18**. The interior of the main conduit **10** is formed with means to be fully described hereinafter for constantly circulating a fluid to be weighed through the first and second auxiliary conduits and the weighing container **18**. The presence of such liquid in the weighing container will exert a downward force upon the end of the main conduit remote from the frame member **12** by means of the auxiliary conduits so as to effect a torsional deflection or twisting of the main conduit relative to the frame member. The exact amount of such torsional deflection is proportional to the weight of the increment of fluid present in the weighing container at a given time. The indicating mechanism **20** serves to amplify the effect of such torsional deflection and convert it into desired scaler measurements.

More particularly, and with special reference to Figure 2, the main conduit **10** is of tubular cross-section and is rigidly secured as by welding within an aperture **30** formed in the frame member. The front end of the main conduit is closed by a vertical wall **32**, while its rear end is closed by a plug **34** wherein is formed a coaxial bore **36**. An inner tubular member **38** is coaxially disposed within the main conduit **10** so as to isolate its interior into separate front and rear chambers, designated **40** and **42**, respectively. The front end **39** of the inner tubular member **38** is flared radially outwardly and is in close proximity to the inner periphery of the main conduit at this point. The rear portion of this tubular member **38** is carried within the bore **36** of the plug **34**.

The first and second auxiliary conduits **14** and **16** are preferably of tubular cross-section and are rigidly secured as by welding within apertures **44** and **46** respectively, formed at spaced points within the main conduit. A downwardly extending discharge conduit **48** is shown rigidly secured within an aperture **50** formed in the rear chamber **42** of the main conduit.

The weighing container **18** is shown as being of cylindrical configuration having its top and bottom portions secured to the ends of the auxiliary conduits **14** and **16** remote from the main conduit. With this arrangement, as indicated by the directional arrows in Figures 1 and 2, the fluid to be weighed enters the front chamber **40** of the main conduit by means of the inner tubular member **38**. This fluid then flows outwardly through the first

auxiliary conduit **14** into the bottom of the weighing container **18** and upwardly therethrough into the outer end of the second auxiliary conduit **16**. Next, this fluid returns through the latter auxiliary conduit into the rear chamber **42** of the main conduit, leaving this chamber through the discharge conduit **48**. Thus, the fluid to be weighed is caused to constantly circulate through the main conduit, the auxiliary conduits, and the weighing conduit.

During such circulating action, the weight of the fluid within the weighing container and the first and second auxiliary conduits will effect a torsional deflection of the main conduit and a subsequent downward movement of the weighing container **18**. The pointer **54** of the indicating mechanism **20** is pivotally secured to a fixed point relative to the frame member **12** by a pivot pin **56**; and inasmuch as this point is in turn pivotally connected to the weighing container by a rod **58**, its free end **60** will move along the scale **62**. During such movement the free end **60** of the pointer will assume, for purposes of maximum deflection, a position adjacent the scale reading "150#" in Figure 1. It will be apparent that the scale **62** may be readily calibrated to read directly in terms of both fluid weight and density. It will be further apparent that various other forms of mechanical or electrial indicating mechanism may be utilized without departing from the scope of the present invention.

Referring now to Figure 3, there is shown an alternate embodiment of a density indicating apparatus embodying the present invention. This embodiment includes a main conduit **10'** wherein is concentrically disposed an inner tubular member **38'** of smaller diameter. The radially outwardly flared front end **39'** of the inner tubular member **38'** is rigidly secured to the inner periphery of the main conduit as by welding. The rear end of the main conduit **10'** is spaced from the frame member **12** in this embodiment and the main conduit is attached thereto solely by means of the inner tubular member **38'**. Thus, the latter is rigidly secured within an aperture **30** formed in the frame member as by welding. The inner tubular member serves to isolate the interior of the main conduit **10'** into separate chambers designated **40'** and **42'**.

The first and second auxiliary conduits **14** and **16**, as well as the weighing container (not shown), and the indexing mechanism (not shown) may be of similar construction to their counterparts described hereinbefore in conjunction with Figures 1 and 2. The rear end of the main conduit **10'** is open, as indicated at **70**, whereby as shown by the directional arrows, fluid to be weighed may be discharged therethrough into the top of an open discharge-receiving receptacle **72**.

The operation of this alternate embodiment is substantially the same as that heretofore described with respect to the preferred embodiment. The fluid to be weighed enters the front chamber **40'** of the main conduit **10'** by means of the inner tubular member **38'**. This fluid, after circulating through the first auxiliary conduit, the weighing container, and the second auxiliary conduit, returns to the rear chamber **42'** of the main conduit. Finally, this fluid is discharged through the rear end of the main conduit and enters the receptacle **72**.

Although the alternate embodiment incorporates an open fluid system rather than the closed fluid system contemplated by the preferred embodiment, if it is necessary or desirable that such system be closed, the rear end of the main conduit **10'** may be provided with a suitable rotary seal and a discharge pipe connected with such seal. In this manner the discharge pipe may be placed in closed communication with the flow of the fluid being measured.

It should be noted that by virtue of the reduced diameter of the inner tubular member **38'** of the alternate embodiment, as compared with the diameter of the main conduit **10** of the preferred embodiment, for a given change in weight of the fluid being measured, greater torsional deflection of the tubular member **38'** will occur

than will take place with the main conduit **10**. Accordingly, it is possible to construct a more compact density indicating apparatus for the same range of accuracy where the alternate embodiment of the invention is utilized.

While the weighing container **18** is shown as being of generally cylindrical configuration in the appended drawings, it should be observed that the shape of this bottle may be so selected as to provide for self-cleaning thereof by means of the natural turbulence created therein by the fluid being measured. Both embodiments of the invention described herein provide simple and practical apparatus which may readily be made portable in nature and easily assembled in the field by the oil well drilling crew.

While there has been shown and described a preferred and alternate embodiment of the present invention, it will be apparent that various modifications and changes may be made without departing from the spirit of the invention or the scope of the following claims.

I claim:

1. Apparatus for indicating the density of a fluid, comprising: a frame member; a substantially horizontally disposed tubular main conduit supported by said frame member; first and second auxiliary conduits rigidly connected to said main conduit and extending away from one side of said main conduit in a substantially horizontal direction; means connecting said auxiliary conduits together at their ends remote from said main conduit for fluid flow therethrough from one auxiliary conduit to the other; an inner tubular conduit coaxially disposed within said main conduit and isolating the interior thereof into two separate coaxial chambers, the first auxiliary conduit being in communication with one of said chambers and the second auxiliary conduit being in communication with the other of said chambers whereby a fluid to be weighed may pass from one of said chambers to the other by means of the said auxiliary conduits; and indicating means operatively connected to said auxiliary conduits and responsive to movement thereof resulting from torsional deflection of one of said coaxial tubular conduits.

2. Apparatus for indicating the density of a fluid, comprising: a frame member; a substantially horizontally disposed tubular main conduit rigidly secured at its rear portion to said frame member; first and second rigid auxiliary conduits rigidly connected to said main conduit and extending away from one side of said main conduit in a substantially horizontal direction; means connecting said auxiliary conduits together at their ends remote from said main conduit for fluid flow therethrough from one auxiliary conduit to the other; an inner tubular conduit coaxially disposed within said main conduit and isolating the interior thereof into two separate longitudinally spaced coaxial chambers; and the first auxiliary conduit being in communication with one of said chambers and the second auxiliary conduit being in communication with the other of said chambers whereby a fluid to be weighed may pass from one of said chambers to the other by means of the said auxiliary conduits; and indicating means operatively connected to said auxiliary conduits and responsive to movement thereof resulting from torsional deflection of one of said coaxial tubular conduits.

3. Apparatus for continuously indicating the density of a flowing fluid, comprising: a frame member; a substantially horizontally disposed tubular main conduit rigidly supported by said frame member; a discharge opening formed in the rear of said main conduit; first and second auxiliary conduits rigidly connected to said main conduit and extending away from one side of said main conduit in a substantially horizontal direction at points spaced forwardly of the point of connection of said main conduit to said frame member; a weighing container interposed between the ends of said auxiliary conduits remote from said main conduit; an inner tubular member coaxially disposed within said main conduit, said tubular member hav-

ing a radially outwardly extending front end that abuts the inner periphery of said main conduit and isolates the interior thereof into front and rear chambers, the first auxiliary conduit being in communication with one of said chambers and the second auxiliary conduit being in communication with the other of said chambers whereby a fluid to be weighed may enter said first chamber through said inner tubular member, pass from said front chamber to said rear chamber by means of said auxiliary conduits and said weighing container, then flow out of said rear chamber through said discharge opening; and an indicating mechanism operatively connected to said weighing container and responsive to the movement thereof resulting from the weight of fluid passing through said auxiliary conduits and said weighing container.

4. Apparatus for continuously indicating the density of a flowing fluid, comprising: a frame member; a substantially horizontally disposed tubular main conduit rigidly supported by said frame member; a discharge opening formed in the rear of said main conduit; first and second auxiliary conduits rigidly connected to said main conduit and extending away from one side of said main conduit in a substantially horizontal direction at points spaced forwardly of the point of connection of said main conduit to said frame member; a weighing container interposed between the ends of said auxiliary conduits remote from said main conduit, the average cross-sectional area of said container being considerably greater than that of said auxiliary conduits, and the top and bottom portions of said container being in communication with said ends; an inner tubular member coaxially disposed within said main conduit, said tubular member having a radially outwardly extending front end that abuts the inner periphery of said main conduit and isolates the interior thereof into front and rear chambers, the first auxiliary conduit being in communication with one of said chambers and the second auxiliary conduit being in communication with the other of said chambers whereby a fluid to be weighed may enter said first chamber through said inner tubular member, pass from said front chamber to said rear chamber by means of said auxiliary conduits and said weighing container, then flow out of said rear chamber through said discharge opening; and an indicating mechanism operatively connected to said weighing container and responsive to the movement thereof resulting from the weight of fluid passing through said auxiliary conduits and said weighing container.

5. Apparatus for continuously indicating the density of a flowing fluid, comprising: a frame member; a substantially horizontally disposed tubular main conduit rigidly supported at one point along its length; a discharge opening formed in the rear portion of said main conduit; first and second auxiliary conduits rigidly connected to said main conduit and extending away from one side of said main conduit in a substantially horizontal direction at points spaced forwardly of the point of connection of said main conduit to said frame member; a weighing container interposed between the ends of said auxiliary conduits remote from said main conduit, the average cross-sectional area of said container being considerably greater than that of said auxiliary conduits, and the top and bottom portions of said container being in communication with said ends; an inner tubular member coaxially disposed within said main conduit, said tubular member having a radially outwardly extending front end that abuts the inner periphery of said main conduit and isolates the interior thereof into front and rear chambers, the first auxiliary conduit being in communication with one of said chambers and the second auxiliary conduit being in communication with the other of said chambers whereby a fluid to be weighed may enter said first chamber through said inner tubular member, pass from said front chamber to said rear chamber by means of said auxiliary conduits and said weighing container, then flow out of said rear chamber through said discharge opening; and an indicating mechanism operatively connected to said weighing container and responsive to the movement thereof resulting from the torsional deflection of the main conduit relative to the frame member due to the weight of the fluid passing through said auxiliary conduits and said weighing container.

6. Apparatus for continuously indicating the density of a flowing fluid, comprising: a frame member formed with an aperture; a substantially horizontally disposed tubular main conduit rigidly secured at its rear portion within said aperture; a discharge opening formed in the rear portion of said main conduit; first and second auxiliary conduits rigidly connected to said main conduit and extending away from one side of said main conduit in a substantially horizontal direction at points spaced forwardly of the point of connection of said main conduit to said frame member; a weighing container interposed between the ends of said auxiliary conduits remote from said main conduit; an inner tubular member coaxially disposed within said main conduit, said tubular member having a radially outwardly extending front end that abuts the inner periphery of said main conduit and isolates the interior thereof into front and rear chambers, the first auxiliary conduit being in communication with one of said chambers and the second auxiliary conduit being in communication with the other of said chambers whereby a fluid to be weighed may enter said first chamber through said inner tubular member, pass from said front chamber to said rear chamber by means of said auxiliary conduits and said weighing container, then flow out of said rear chamber through said discharge opening; and an indicating mechanism operatively connected to said weighing container and responsive to the movement thereof resulting from the torsional deflection of the main conduit relative to the frame member due to the weight of the fluid passing through said auxiliary conduits and said weighing container.

7. Apparatus for continuously indicating the density of a flowing fluid, comprising: a frame member; a substantially horizontally disposed main conduit formed with a discharge opening at its rear portion; first and second auxiliary conduits rigidly connected to said main conduit and extending away from one side of said main conduit in a substantially horizontal direction; a weighing container interposed between the ends of said auxiliary conduits remote from said main conduit; an inner tubular member disposed within said main conduit and having its rear portion rigidly secured to said frame member; a radially outwardly extending front end formed on said inner tubular member having its outer extremity rigidly secured to the inner periphery of said main conduit and isolating the interior thereof into separate front and rear chambers, the first auxiliary conduit being in communication with one of said chambers and the second auxiliary conduit being in communication with the other of said chambers whereby a fluid to be weighed may enter said first chamber through said inner tubular member, pass from said first chamber to said rear chamber by means of said auxiliary conduits and said weighing container, then flow out of said rear chamber through said discharge opening; and an indicating mechanism operatively connected to said weighing container and responsive to the movement thereof resulting from the torsional deflection of said inner tubular member relative to said frame member due to the weight of fluid passing through said auxiliary conduits and said weighing container.

8. Apparatus for continuously indicating the density of a flowing fluid, comprising: a frame member formed with an aperture; a substantially horizontally disposed tubular main conduit having its rear end open and spaced longitudinally forwardly of said frame member, said open rear end forming a discharge opening; first and second auxiliary conduits rigidly connected to said main conduit and extending away from one side of said main conduit in a substantially horizontal direction; a weigh-

ing container interposed between the ends of said auxiliary conduits remote from said main conduit, the average cross-sectional area of said container being considerably greater than that of said auxiliary conduits, and the top and bottom portions of said container being in communication with said ends; an inner tubular member disposed within said main conduit and having its rear portion rigidly secured to said frame member; a radially outwardly extending front end formed on said inner tubular member having its outer extremity rigidly secured to the inner periphery of said main conduit and isolating the interior thereof into separate front and rear chambers, the first auxiliary conduit being in communication with one of said chambers and the second auxiliary conduit being in communication with the other of said chambers whereby a fluid to be weighed may enter said first chamber through said inner tubular member, pass from said front

chamber to said rear chamber by means of said auxiliary conduits and said weighing container, then flow out of said rear chamber through said discharge opening; and an indicating mechanism having a pointer that is pivotally mounted to a fixed point relative to said frame, and a rod pivotally interconnecting said pointer and said weighing container.

References Cited in the file of this patent

UNITED STATES PATENTS

1,511,604	Ganucheau	Oct. 14, 1924
2,613,530	Nichols	Oct. 14, 1952
2,669,118	Nichols	Feb. 16, 1954

FOREIGN PATENTS

82,473	Sweden	Jan. 29, 1935