March 9, 1943. P. P. SHELBY 2,313,176

WELL TESTER

Filed July 19, 1940

Fig. 1.

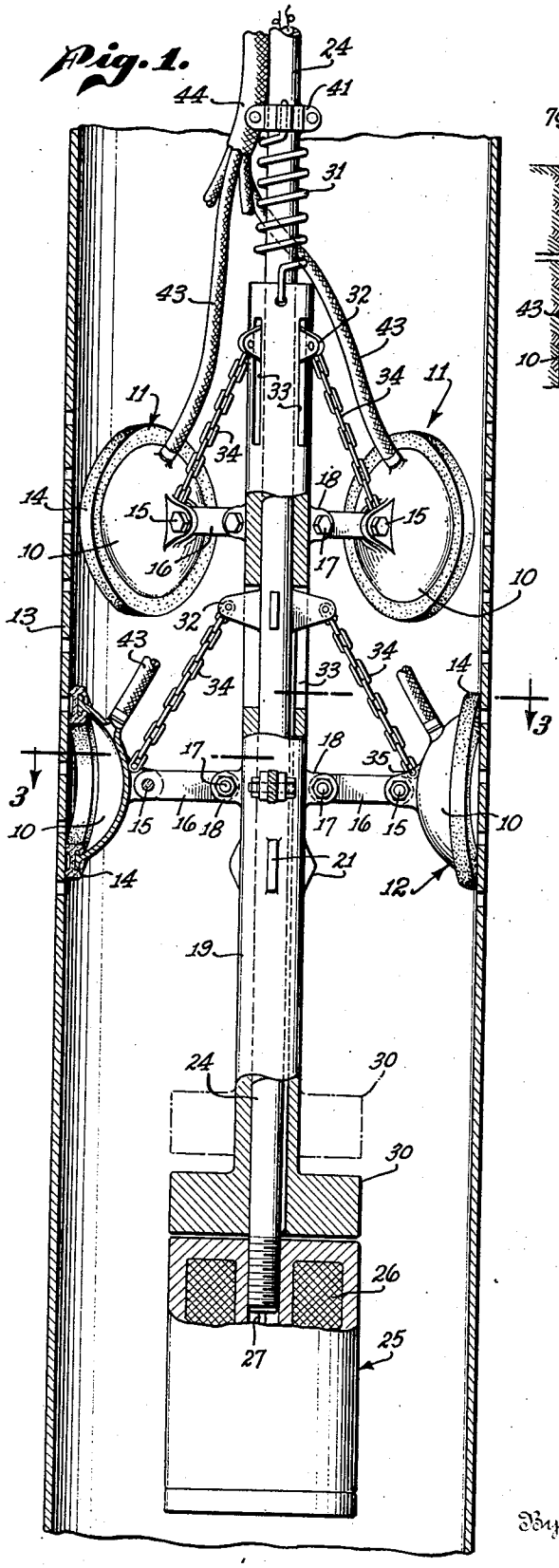


Fig. 4.

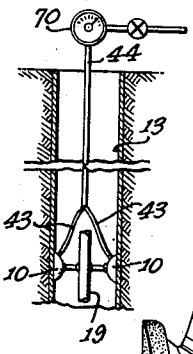


Fig. 2.

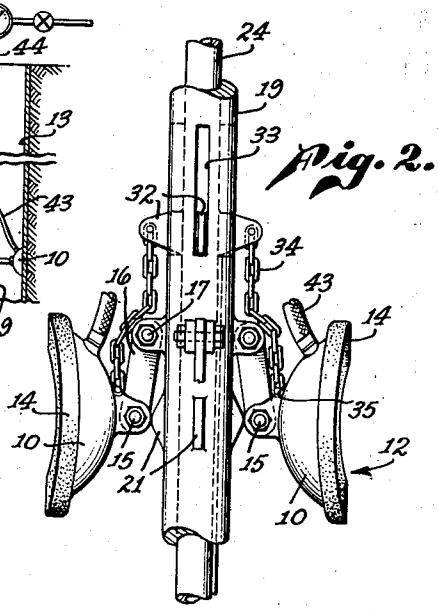
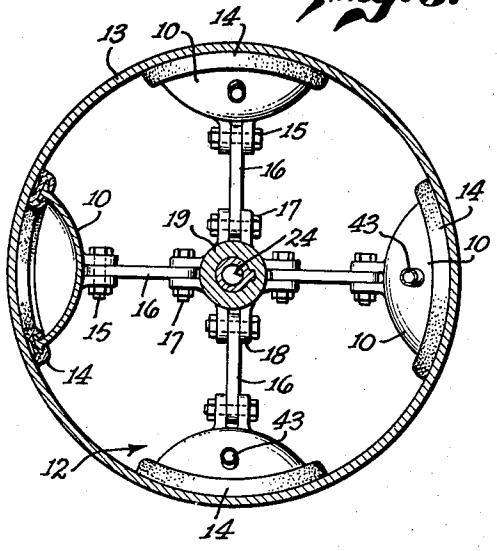


Fig. 3.



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WELL TESTER

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5 Claims. (Cl. 73—51)

My invention relates to apparatus for use in testing oil wells and the like.

As is well known in the oil industry, after a well has been completed certain conditions arise in the well that affect the quantity or quality of the oil produced. That is, it may be that in certain zones the pressure inside the well is greater than the surrounding sands in which case a portion of the oil in the casing is dispersed in the sands. It frequently happens also that water enters a well at some undetermined region thereby lowering the quality of the oil produced. When such condition exists the pressure at the point of entrance into the casing is greater than that in the open casing. This is true whether oil, water or gas is entering the well at that point. It is an object of my invention to locate the places in the well where these different conditions exist by lowering into the well an instrument capable of giving a sensible indication of pressures encountered which may be freely raised and lowered in the well casing throughout its length.

It is an object of this invention to provide a simple and efficient means of testing a well by measuring the pressure at different zones in the well. This is done by lowering into the well a device by means of which portions of the well on the inside of the casing are blocked off or isolated. The device is so arranged that the pressure in such blocked off or isolated areas is either transmitted to the top of the well, where means are provided for giving sensible indications of the pressure in such blocked off areas, or is recorded on a pressure meter near the device itself.

The principle of my invention resides in the obtainment and comparison of the pressures existent in different parts of the well and the use of such data to determine the rate of production of the well, the specific gravity of the fluid in the casing for a given region, the places of entrance of fluid into the casing, the places of possible loss of fluid from the casing, the relative pressures of various formations and the nature of the fluids entering the well.

It is a particular object of this invention to provide apparatus by means of which the pressures existent both interiorly and exteriorly of a perforate well casing may be determined and by means of which samples may be taken of the fluid entering or in the casing at any given region.

These and other objects, and advantages will appear hereinafter from the drawing and the following description thereof. Referring to the drawing, which is for illustrative purposes only—

Fig. 1 is a vertical sectional view of a well casing showing a device embodying a form of the apparatus of this invention;

Fig. 2 is a view of a portion of the device shown in Fig. 1 showing the cups in collapsed position;

Fig. 3 is a sectional plan view on line 3—3 of Fig. 1;

Fig. 4 is a diagrammatic sectional elevation showing the pressure gauge and its connections;

Fig. 5 is a vertical sectional view of a device embodying a modified form of my invention;

Fig. 6 is a sectional plan view on line 6—6 of Fig. 5; and

Fig. 7 is a diagrammatic view of a portion of the electrical means used for determining irregularities in the shape of the casing.

The form of device shown in Figs. 1 to 4 inclusive is particularly designed for use in wells where the casing may have become deformed by pressure or injured during the drilling operations so that the casing has not retained its original cylindrical form. To meet the conditions under such circumstances the apparatus is provided with a series of cups indicated at 10, there being an upper series or set of cups, generally indicated at 11 and a lower series generally indicated at 12. The cups of the upper series are staggered with relation to the cups in the lower series so that a substantial part of inner surface of the casing indicated at 13, within any certain zone, is engaged by the cups of the two series. Each cup is provided at its edge with a rubber cushion 14 for engagement with the inner face of the casing. By means of a pin 15 each cup is pivotally mounted on an arm 16 pivotally connected at its inner end by means of a pin 17 to ears or lugs 18 mounted or built upon a sleeve or cup member 19. As shown in Fig. 2 the cups are in what may be termed collapsed position. In this position the arms 16 rest against lugs 21 formed on the sleeve 19. 24 is a hollow rod or supporting member upon which the sleeve 19 is freely slidable. This rod 24 extends upwardly through the sleeve and may be connected at its upper end to a cable, not shown, or to the hose hereinafter referred to, by means of which the apparatus may be lowered into and raised from the well. The lower end of the rod 24 is threaded into or otherwise secured to a hollow member 25 in which are arranged coils 26 which are connected through wires 27 to the surface of the ground. Upon energization of the coils 26 the member 25 becomes a magnet which acts upon an armature 30 on the lower end of the sleeve 19. The sleeve 19 is normally yieldably held in its upper position by a spring 31 with the armature 30 spaced above

the magnet 25 as shown in broken lines in Fig. 1. When the sleeve is in the elevated position the cups are in the inward or collapsed position shown in Fig. 2. Welded or otherwise mounted on the rod 24 are lugs or ears 32 which project outwardly through slots 33 formed in the sleeve 19 thereby permitting longitudinal movement of the sleeve on the rod, but preventing relative rotation of these parts. Attached to each ear 32 is a chain 34, or similar flexible tension member, the other end of the chain being attached to a cup as indicated at 35.

When the magnet is energized and the armature 30 is influenced by the magnet to move downwardly from the broken line position, shown in Fig. 1, to the full line position, such downward movement of the sleeve carries the cups downwardly as shown in Fig. 2, and by reason of the chains 34 being attached to the cups, the cups are caused to swing outwardly from the position shown in Fig. 2 to the position shown in Fig. 1, where they are forced against the inner wall of the casing. A deenergization of the magnet permits the sleeve to move upwardly under the action of spring 31, one end of which is secured in any suitable manner to the upper end of the sleeve 19 and the other end is secured to a clamp 41 attached to the rod 24. Each cup is connected by means of a branch hose 43 to a main hose 44 which extends to the surface of the ground or to any desired point where it is provided with any suitable pressure indicating instrument, as shown at 70 in Fig. 4.

The function of the apparatus, above described, is to form an isolated or blocked off area on the inside of the perforated casing so that the pressure in such area can be determined.

When the device, shown in Figs. 1 to 3, is lowered into the well the cups are in what may be termed collapsed position, as shown in Fig. 2, out of engagement with the well casing. When in this position the various pressures encountered are indicated at the top of the well or on other indicating means by reason of the fact that at such times the tubes are in open communication with the fluid in the casing. Consequently, when the device arrives at the liquid level of the well the change of pressure indicated would disclose such fact. If after a known internal of time the liquid level is again determined in the above manner and is found to be at a different point than at the previous determination, the question of whether the well is producing or losing fluid can be determined. Knowing the interval of time elapsed between such determinations, the rate of production or loss may be calculated.

With the device still in the collapsed position, the average specific gravity of the liquid in given portions of the well can be determined from pressure data obtained. When the cups are against the casing should the pressure in the cups be more than the pressure in the open casing it would indicate that fluid is entering the well at that point. The nature of such fluid can be determined by reducing the pressure in the tubes thereby permitting the fluid within the cup to enter the tubes which, upon removal of the apparatus from the well, can be examined for determining the character of the fluid.

On the other hand, should the pressure within the cups be less than the pressure in the open casing, such low pressure would indicate that at that point in the well a portion at least of the well fluid is passing through the casing into the formation with consequent loss of fluid. Similarly should there be no difference in pressure within the cups and in the open casing, such condition would indicate the perforations at that point were plugged or some condition exists that means loss of efficiency.

The value of the information obtainable by my device will be readily appreciated when it is understood that by moving the device throughout the length of the entire casing a complete log can be obtained by means of which steps may be accurately taken to remedy the undesirable conditions as may be found.

If desired the form of device shown in Figs. 1 to 3 may be provided with means for approximately determining the cross sectional dimensions of the casing. This is accomplished by mounting a rheostat coil 45 on the lower end of the hollow rod 24, one end of this coil being connected to the coil 26 of the magnet 25 as shown diagrammatically in Fig. 7. The other end of the magnet coil is connected through one of the wires 27 to any suitable instrument indicated at 46, and the end of the other wire 27 is connected to the contact 47 mounted on the sleeve 19 movable over the rheostat coil 45. By means of this arrangement, the amount of current passing through the rheostat will be indicated on the instrument 46 and as such current will vary directly with the distance betwen the flange 30 and magnet 25 which is determined by the amount of movement of the cups, the inner diameter of the casing may be readily determined.

While I have shown and described the blocked off area in the casing as having a hose connection and pressure indicating means associated therewith it is to be understood that other means may be associated with the blocked off area in either form of the invention disclosed for registering or indicating the pressures existing in such areas.

While I have not shown electrical apparatus for supplying electric energy to the magnet 25 it is to be understood that any common source of electric energy and switch means may be employed.

I claim as my invention:

1. In a well tester: a rod adapted to be suspended in the well casing; a sleeve slidably mounted on said rod; a series of arms pivotally connected to said sleeve; a cup pivotally mounted on the outer end of each of said arms, the rim of each cup having a contour to conform to the interior surface of a well casing and carrying means to make a fluid tight seal with the casing; yieldable means connecting each cup to said rod; means for yieldingly holding said sleeve in an elevated position; means for moving said sleeve downwardly to take up the slack in said yieldable means and move said cups into engagement with the inner face of said casing; and fluid pressure conduits communicating with the interior of the cups for transmitting the pressures inside the cups to a measuring device.

2. In a well tester, a supporting rod for suspension in a well casing; a sleeve slidably mounted on the rod; a plurality of spaced arms pivotally connected at one end to the sleeve; a cup pivotally connected at the opposite end of each arm, the rim of each cup having a contour to conform to the interior surface of a well casing and carrying means to make a fluid tight seal with the casing; a yieldable link connecting each cup with the supporting rod at a point spaced above the cup carrying arms; a coil spring connected to the upper end of the sleeve and to the

rod to hold the sleeve suspended on the rod; an electromagnet supported by the rod adjacent the lower end of the sleeve, a coperating armature member supported by the lower end of the sleeve, and means for energizing the electromagnet to attract its armature for sliding the sleeve on the rod against the tension of the spring, whereby the cup carrying arms are spread apart to seal the cups against the side of the casing; and fluid pressure conduits communicatng with the interior of the cups for transmitting the pressures inside the cups to a measuring device.

3. In a well tester, a supporting member for suspension in a well casing; a supported member slidably mounted on the supporting member; a plurality of spaced arms pivotally connected at one end to one of said members; a cup pivotally connected at the opposite end of each arm, the rim of each cup having a contour to conform to the interior surface of a well casing and carrying means to make a fluid tight seal with the casing; a yieldable link connecting each cup with the other of said members; means for yieldably holding said supporting and supported members in a given position with said arms and cups adjacent thereto; means associated with said supporting and supported members for causing relative longitudinal movement thereof against the force of said yieldable means, whereby the cup carrying arms are spread apart to seal the cups against the side of the casing; and means for giving a sensible indication of the pressures inside the cups including fluid pressure conduits communicating with the interior of each cup and extending to a measuring device.

4. In a well tester, a supporting member for suspension in a well casing; a supported member slidably mounted on the supporting member; a plurality of spaced arms pivotally connected at one end to one of said members; a cup pivotally connected at the opposite end of each arm, the rim of each cup having a contour to conform to the interior surface of a well casing and carrying means to make a fluid tight seal with the casing; a yieldable link connecting each cup with the other of said members; means for yieldably holding said members in a given positon with said arms and cups adjacent thereto; an electromagnet on one of said members spaced adjacent an end of the other member and when energized being adapted to attract an armature member supported by the lower end of said other member, for causing relative movement between the members against the force of said yieldable holding means, whereby the cup carrying arms are spread apart to seal the cups against the side of the casing; and fluid pressure conduits communicating with the interior of the cups for transmitting the pressures inside the cups to a measuring device.

5. In a well tester, a supporting member for suspension in a well casing; a cup supporting structure mounted on said member and movable to an outer and an inner position; a plurality of cups mounted on said cup supporting structure, the rim of each cup having a contour to conform to the interior surface of a well casing and carrying means to make a fluid tight seal with the casing; means cooperatively associated with said cup supporting structure and said supporting member for moving said cups to an outer position to seal the cups against the side of the casing; and fluid pressure conduits communicating with the interior of the cups for transmitting the pressure inside the cups to a measuring device.

PETER P. SHELBY.