Feb. 13, 1973 A. C. PERRICONE 3,716,486
BRINE DRILLING FLUID LUBRICANT AND PROCESS FOR
DRILLING SUBTERRANEAN WELLS WITH SAME
Filed March 18, 1971 4 Sheets-Sheet 1

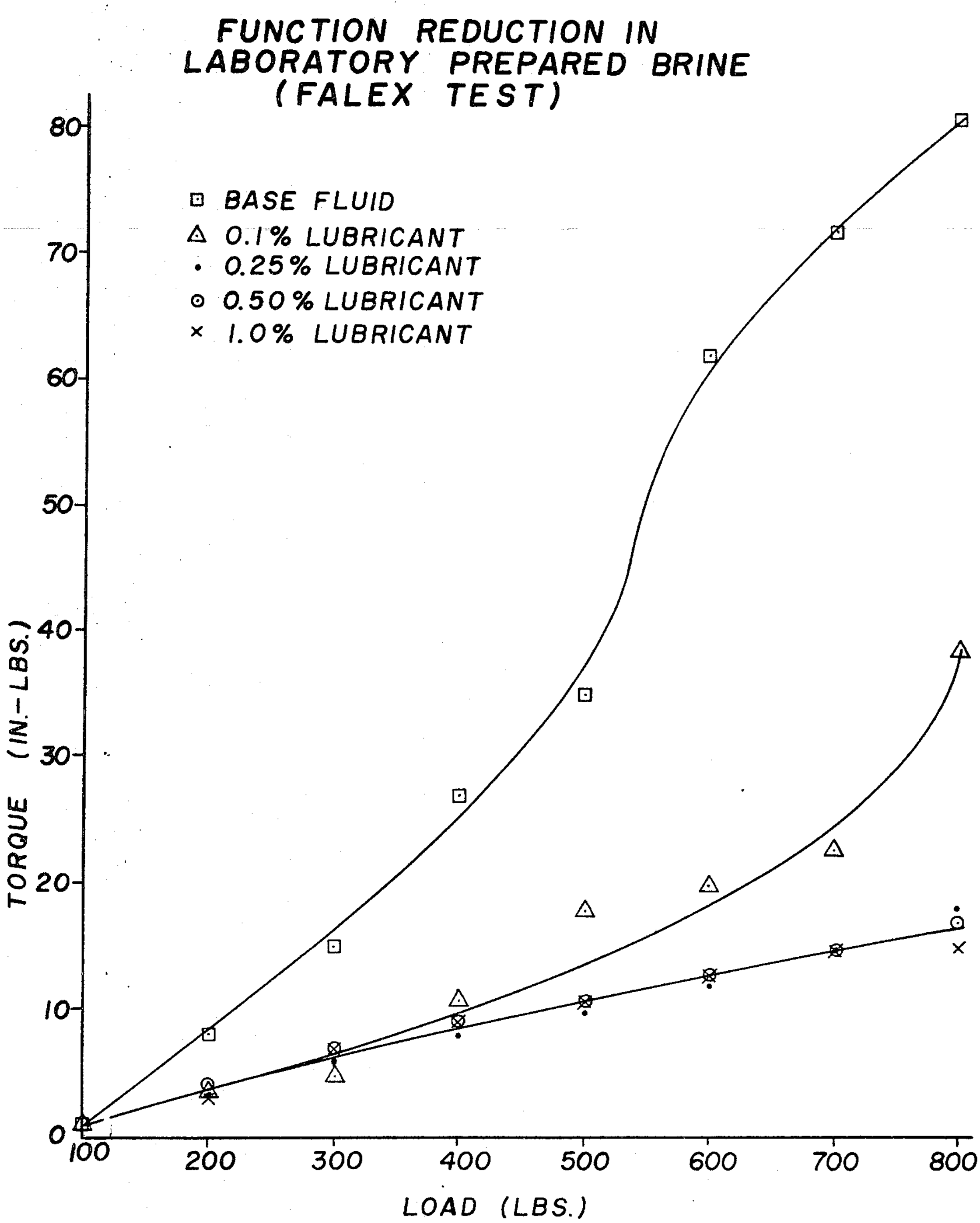

FIG. 1

ALPHONSE C. PERRICONE
INVENTOR.

BY Delmar L. Sroufe
ATTORNEY

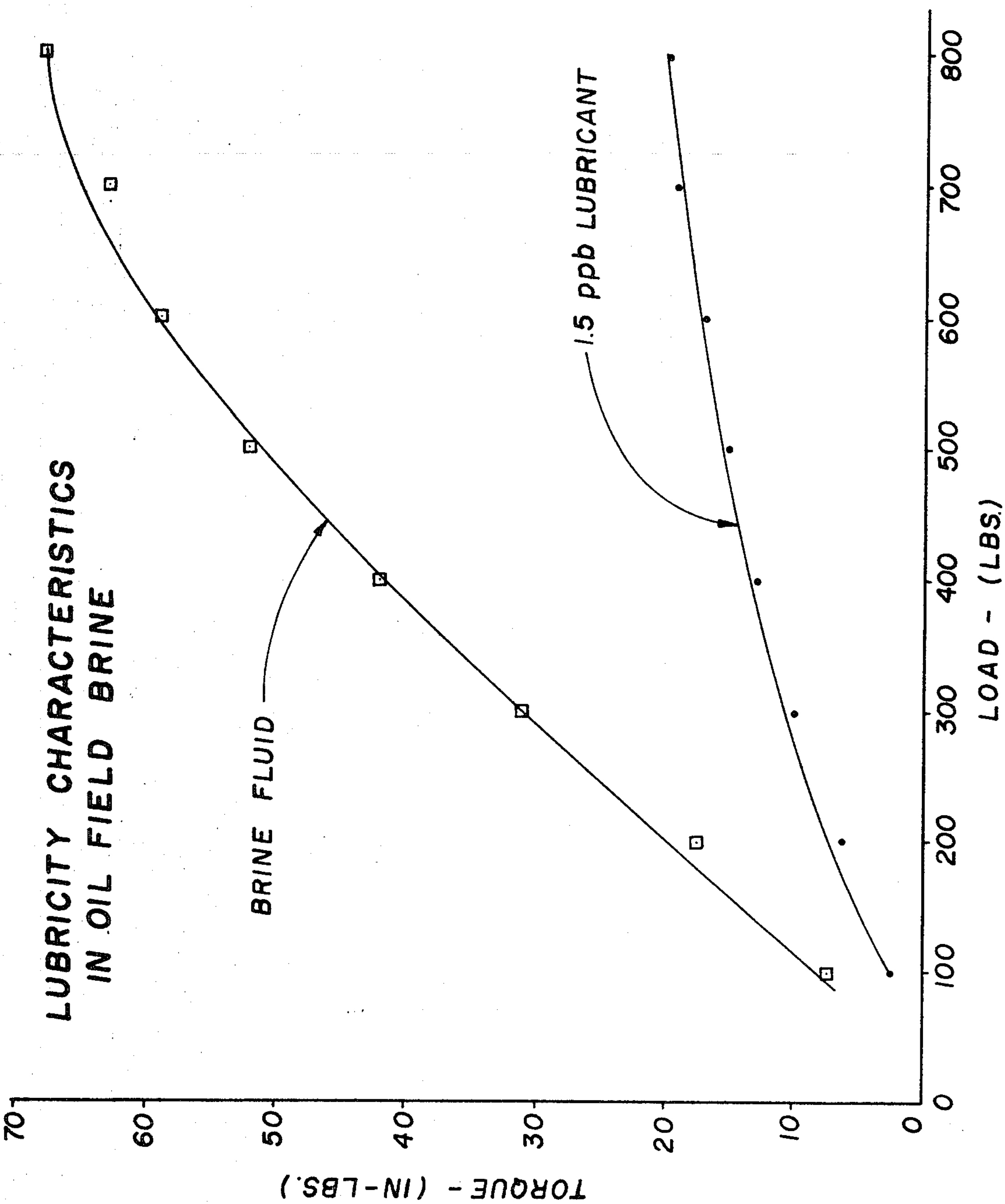

FIG. 2

ALPHONSE C. PERRICONE
INVENTOR.

BY Delmar L. Sroufe
ATTORNEY

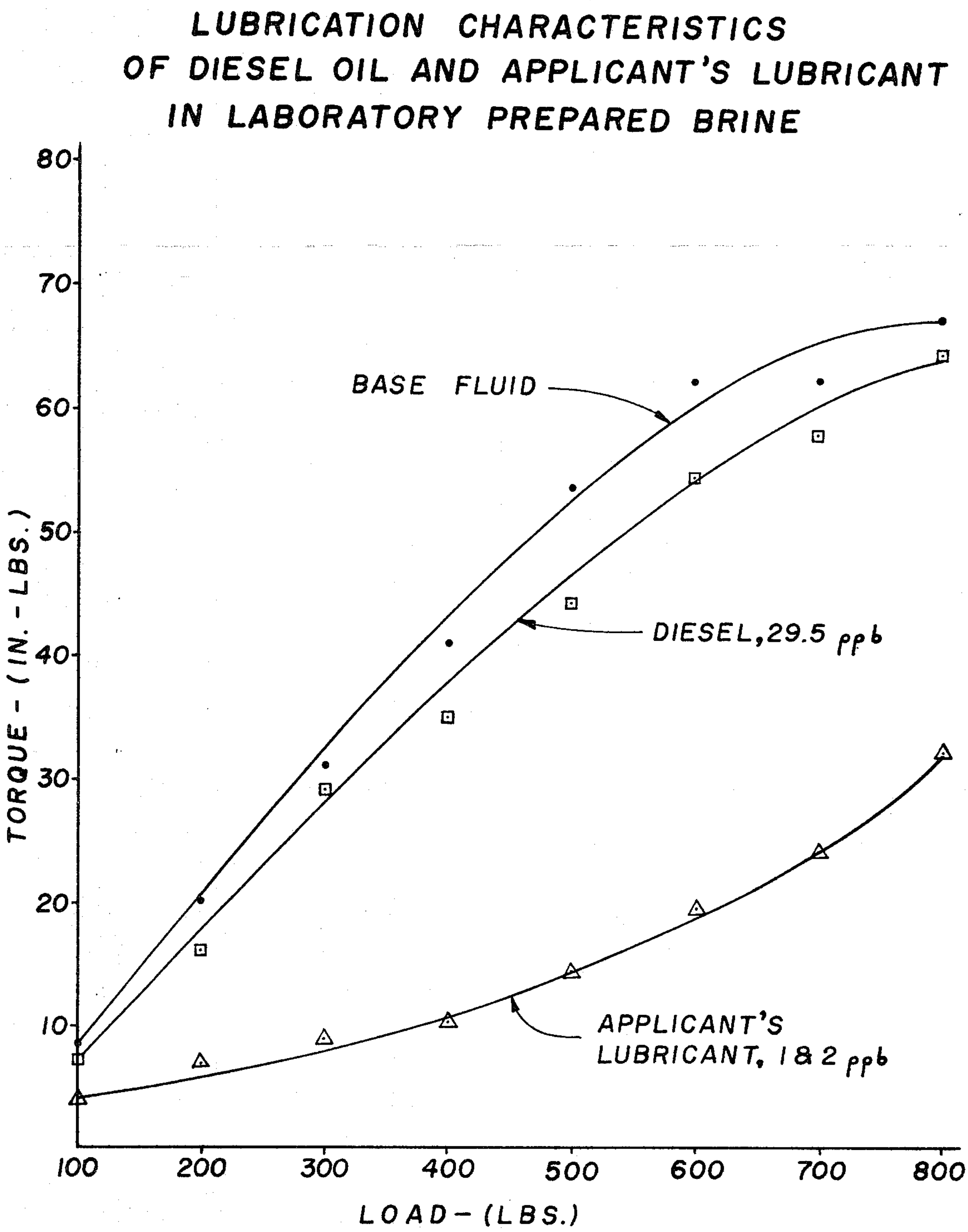

FIG. 3

ALPHONSE C. PERRICONE
INVENTOR.

BY Delmar L. Sroufe
ATTORNEY

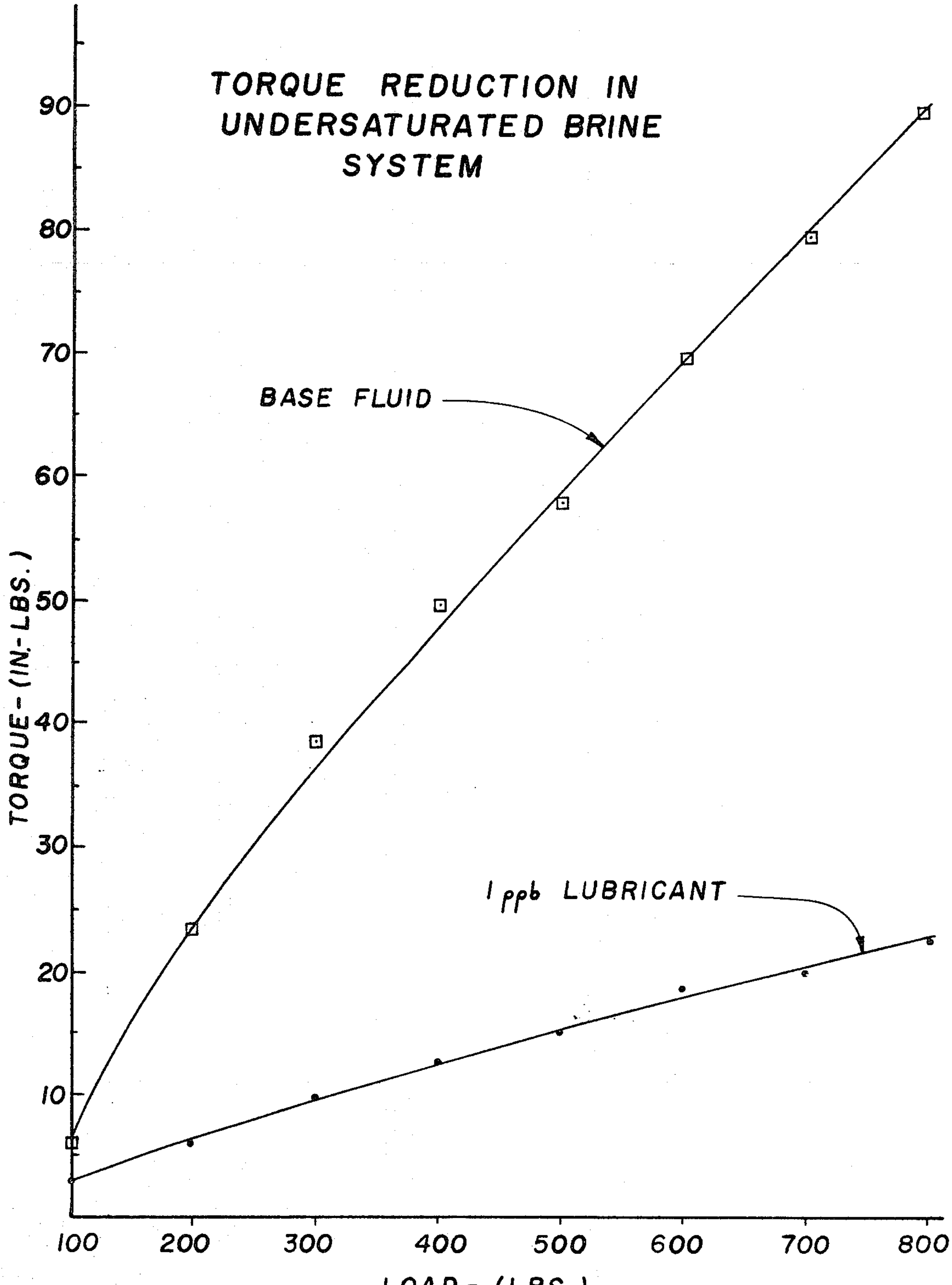

FIG. 4

INVENTOR.
ALPHONSE C. PERRICONE
BY
Delmar L. Sroufe
ATTORNEY

United States Patent Office

3,716,486

Patented Feb. 13, 1973

1

3,716,486

BRINE DRILLING FLUID LUBRICANT AND PROCESS FOR DRILLING SUBTERRANEAN WELLS WITH SAME

Alphonse C. Perricone, Houston, Tex., assignor to Milchem Incorporated, Houston, Tex.

Filed Mar. 18, 1971, Ser. No. 125,509
Int. Cl. C10m 3/40
U.S. Cl. 252—8.5 C 9 Claims

ABSTRACT OF THE DISCLOSURE

Enhanced lubricating properties can be obtained in a brine drilling fluid by utilizing an alkaline water soluble solution of a mono- and di-hydrogen phosphate ester of a five mole ethylene oxide adduct of a C_{10} linear saturated alcohol in a solvent selected from the class consisting of monohydric alcohols, water, and mixtures thereof and a silicone defoamer.

BACKGROUND OF THE INVENTION

(1) Field of the invention

This invention relates to brine drilling fluids having enhanced lubricating properties. In one aspect, this invention relates to brine drilling fluids containing an agent which imparts enhanced lubricating properties to said drilling fluid. In another aspect, this invention relates to a process of drilling a subterranean well with a brine drilling fluid incorporating a unique lubricating agent.

(2) Description of the prior art

When drilling, working over or completing subterranean wells in order to tap deposits of, for example, oil or gas, and in particular when utilizing a rotary drilling method comprising a bit to which is attached a drill stem, a drilling fluid is circulated to the bottom of the borehole, ejected through small openings in the drill bit at the bottom of the hole, and then returned to the surface through the annular space between the drill stem and the wall of the borehole where it may be mechanically and/or chemically treated and recirculated. When casing has been inserted into the hole, the fluid will be circulated between the drill stem and the internal wall of the casing. Reverse circulation, in which the drilling fluid is injected into the hole through the annular space and returned to the surface by means of the drill stem, is sometimes utilized.

Drilling fluids serve multi-functions and must have a variety of properties. For example, a drilling fluid for utilization as discussed above must be a liquid of such viscosity that it may serve as an effective transporter of cuttings from the borehole to the surface for removal. A drilling fluid must also prevent excessive amounts of fluid from flowing from the borehole into surrounding formations by depositing on the wall of the hole a thin but substantially impervious filter cake. In addition, a drilling fluid must also be able to hold solids in suspension, preventing their return into the bit area when the circulating rate is reduced or the drilling temporarily terminated. This property is obtained by utilizing additives which will give to the drilling fluid a gel structure. A drilling fluid must also provide a high density column, exerting pressure on the surrounding formations, thus preventing possible caving of the borehole by highly pressurized oil or gas in the formation. Finally, a drilling fluid also serves as a lubricating agent for the bearings utilized in the drill bit and on the surface of the bit teeth. It is to this last function that the present invention is directed.

2

Drilling fluids have been recently designed to lower drilling costs by aiding and enhancing penetration rates. Generally speaking, the higher the penetration rate, the lower the total cost of the complete drilling job. There seems to be little doubt that the highest penetration rates are obtained by using air drilling. However, air drilling is successful only at comparatively shallow depths. Increased depths generally require additional costly air compressors and other equipment. Air drilling is generally replaced by foam techniques or with aqueous or oil based drilling fluids at the increased depths.

Those skilled in the art of drilling generally agree that, with the exception of air drilling, the highest penetration rates are almost always obtained by using an aqueous drilling fluid which is essentially water. In some instances, this drilling fluid will be composed of available fresh water. When drilling on off-shore locations, sea water can be used. In some areas combinations of fresh water and brines or brackish water which is either obtained from commercial sources or is obtained at the well site can be utilized. This system has been particularly utilized in drilling oil wells in the West Texas area. The use of brine will sometimes cut costs when fresh water would have to otherwise be purchased and trucked or piped to the location. Additionally, the brine system will have a higher density than fresh water and thus may hold drilled solids in suspension more effectively than pure or fresh water.

One of the most significant steps in the direction of reduction of drilling costs is in providing a drilling fluid that permits an increased amount of rig time to be devoted to the actual operation of drilling. A substantial portion of the total time consumed during well drilling operations is taken up in the replacement of drill bits and as wells are being drilled to ever increasing depths, the economic losses attendant upon the increasing amount of time lost in making bit changes cannot be ignored. This is particularly true when utilizing aqueous brine drilling fluids for initial drilling, completion, or workover of subterranean wells. Frictional forces in the hole as a result of drilling through offsets, highly deviated holes and the like, or dog legs, may result in excessively costly delays or interruptions in the drilling operations.

Increased emphasis has recently been placed upon the property of lubricity. A large portion of the drilling time consumed during the drilling of a well is taken up in replacing drill bits. The amount of time consumed during drilling operations in replacing drill bits increases roughly in proportion to the depth drilled, because in order to replace a bit the entire drill string must be removed, the bit replaced and the entire drill string rerun. Furthermore, each time circulation of the drilling fluid is stopped and the drill string pulled, the likelihood of a cave-in is increased. Past experience has shown that a frequent factor in shortening the life of a drill bit is failure of the bit bearings. Such bearing failures frequently occur long before the cutting teeth are worn to such an extent as to require replacement of the bit. It is also important to reduce the frictional forces on the drill pipe. There exists considerable torque on said drill pipe due to the friction between the outside of the drill pipe and the wall of the well, where the said wall is represented by casing, open hole, cement, or other materials. A brine drilling fluid possessing enhanced lubrication properties would minimize these adverse frictional forces.

Most of the common lubricants used in drilling fluids such as sulfurized lard oil, isobutyl paraffins, asphalt, fatty acids, tall oil acid, or the like are brine insoluble. I have now discovered that brine drilling fluids, i.e., drilling fluids comprising water saturated with or containing a high concentration of sodium chloride or any strong saline solution containing other salts such as calcium chloride, zinc chloride, calcium nitrate, and the like, can be made to possess enhanced lubricating properties by incorporating therein a water soluble alkaline solution of a mono- and di-hydrogen phosphate ester of a five mole ethylene oxide adduct of a C_{10} linear saturated alcohol in a solvent selected from the class consisting of monohydric alcohols, water, and mixtures thereof and a silicone defoamer. A brine drilling fluid incorporating my lubricant can also contain clayey materials, weighting agents, or other materials which are commonly used in drilling fluids of this type according to the prior art.

An object of this invention is to provide an improved well drilling fluid.

Another object of this invention is to provide an improved brine drilling fluid having enhanced lubricating properties.

Still another object of this invention is to provide an additive for use in brine drilling fluids which will impart enhanced lubricating properties to said drilling fluid so that the said drilling fluid will more effectively lubricate the bearings of a rotary bit under conditions which are encountered during drilling operations employing rotary drilling processes.

Another object of this invention is to provide an additive for brine drilling fluids which will impart high torque and high load carrying capacity to said drilling fluid.

Still another object of this invention is to provide methods of using said drilling fluid in the drilling, completion or workover of subterranean wells.

Another object of this invention is to provide a method of drilling, completing, and working over a well in which method a brine drilling fluid as disclosed herein is circulated in the wellbore.

Other objects and advantages of the present invention will be apparent to those skilled in the art after a reading of the specifications, the drawings, and the claims herein.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a graph illustrating the reduction of friction as measured by the Falex Lubricant Tester as described hereafter, by the brine lubricant of the present invention in a laboratory prepared brine.

FIG. 2 is a graph demonstrating lubricity characteristics of the brine lubricant of the present invention when incorporated in an actual West Texas oil field brine.

FIG. 3 is a graph comparing lubrication characteristics of diesel oil and the brine lubricant of the present invention in a laboratory prepared brine.

FIG. 4 is a graph illustrating the effective lubricating characteristics of an undersaturated brine drilling fluid incorporating the brine lubricant of the present invention.

SUMMARY OF THE INVENTION

The invention relates to brine drilling fluids having enhanced lubricating properties. In one aspect, the invention relates to aqueous brine drilling fluids containing an alkaline water soluble solution of a mono- and di-hydrogen phosphate ester of a five mole ethylene oxide adduct of a C_{10} linear saturated alcohol in a selected solvent and incorporating a silicone defoamer which imparts enhanced lubricating properties to said drilling fluid. In another aspect, this invention relates to a process of drilling a subterranean well with a brine drilling fluid incorporating a lubricating agent.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The present brine drilling fluid additive, composition and process incorporates as a lubricant an alkaline water soluble solution of a mono- and di-hydrogen phosphate ester of a five mole ethylene oxide adduct of a C_{10} linear saturated alcohol in a solvent and further incorporating a silicone defoamer.

The alcohols which may be utilized in the present invention are:

1-decyl alcohol, $CH_3(CH_2)_8CH_2OH$

2-decyl alcohol, $CH_3(CH_2)_7CHOHCH_3$

3-decyl alcohol, $CH_3(CH_2)_6CHOHCH_2CH_3$

4-decyl alcohol, $CH_3(CH_2)_5CHOH(CH_2)_2CH_3$; and

5-decyl alcohol, $CH_3(CH_2)_4CHOH(CH_2)_3CH_3$

and mixtures or blends thereof. Of the C_{10} linear saturated alcohols, we prefer to utilize 1-decyl alcohol,

$$CH_3(CH_2)_8CH_2OH$$

These alcohols are relatively basic starting materials for chemical reactions and can be satisfactorily prepared by utilizing a variety of processes which are known to those skilled in the art. For example, olefin, carbon monoxide, and hydrogen are fed into an oxo converter utilizing a cobalt catalyst and steam. This reaction is as follows:

$$C_9H_{18} + CO + H_2 \xrightarrow[\text{cobalt}]{\text{steam}} C_9H_{19}CHO$$

The feed olefin is sent to the reactor together with hydrogen and carbon monoxide. An oil-soluble cobalt salt, such as cobalt naphthenate is utilized as a system catalyst. The reactants are pressurized in the reaction vessel to 1,500 to 4,000 p.s.i. (pounds per square inch) at a temperature of about 170° C. During the reaction the cobalt naphthenate is transposed to cobalt hydrocarbonyl which will dissolve in the reaction medium and therefore must be continuously replaced. The resulting raw aldehyde produced in the reactor goes to a decobalting tower where the cobalt is separated from raw product which is then hydrogenated in the presence of a catalyst such as nickel or copper chromate. This reaction is as follows:

$$C_9H_{19}CHO + H_2 \xrightarrow{\text{Nickel}} C_9H_{19}CH_2OH$$

The hydrogenation products are separated by first removing light hydrocarbons and subsequently separating the alcohols from the heavy oils. Other processes such as the "alfol" process may also be utilized.

After preparing the alcohol, the material is then condensed with ethylene oxide to form an ethylene oxide adduct. The amount of ethylene oxide which is condensed with the C_{10} linear alcohol will depend primarily on the hydrophobic nature of the selected alcohol. However, this hydrophobic characteristic is normally satisfactorily reduced by utilizing an amount of ethylene oxide sufficient to produce about a 5 mole ethylene oxide to 1 mole saturated alcohol product. The amount of ethylene oxide required may be determined by preliminary testing and experimentation.

Phosphate esters prepared from the saturated C_{10} linear alcohols condensed with ethylene oxide may be obtained by utilizing a number of methods known to those skilled in the art. A satisfactory phosphate ester may be obtained by using from about 1 to about 5 moles of phosphorus pentoxide with about 1 mole of C_{10} saturated linear alcohol ethylene oxide adduct in the presence of water.

It is extremely important, and in fact critical, to the successful application of the present additive and process that the material be made soluble in brines. Such solubility in brines can be obtained by preparing a solution of the ethylene oxide-condensed saturated alcohol in a solvent of a monohydric alcohol or water, or mixtures thereof. The use of this class of solvents provides a material which has a reduced pour point which is achieved by diluting the material, thereby reducing undesirable gelling characteristics. Although any chemically compatible material which will reduce the pour point of the condensed alcohol may be utilized, I prefer to utilize a material selected from the following monohydric alcohols:

Name:	Formula
Methyl alcohol	CH_3OH.
Ethyl alcohol	CH_3CH_2OH.
n-Propyl alcohol	n-C_3H_7OH.
Isopropyl alcohol	i-C_3H_7OH.
Allyl alcohol	$CH_2{=}CHCH_2OH$.
n-Butyl alcohol	n-C_4H_9OH.
Isobutyl alcohol	$(CH_3)_2CHCH_2OH$.
sec-Butyl alcohol	$CH_3CH_2CH(OH)CH_3$.
t-Butyl alcohol	$(CH_3)_3COH$.
Isoamyl alcohol	$(CH_3)_2CHCH_2CH_2OH$.
t-Amyl alcohol	$CH_3CH_2C(OH)(CH_3)_2$.
n-Hexyl alcohol	n-$C_6H_{13}OH$.
Benzyl alcohol	$C_6H_5CH_2OH$.

The amount of alcohol which is sufficient to impart a satisfactory pour point and to provide a brine-soluble, low viscosity product, will, of course, depend on many factors, one of which is the selection of the particular monohydric alcohol. Another important factor is the selection of the C_{10} linear alcohol. Other factors influencing the amount of monohydric alcohol to be utilized are (1) the particular brine solution at hand, (2) drilling depth, and (3) other additives which might be incorporated into the brine drilling fluid composition. Generally speaking, about a 1 to 1 weight ratio of ethoxylated C_{10} alcohol-to-monohydric alcohol, water, or mixtures thereof should be utilized.

The above prepared material must be utilized in a neutralized form of an alkali metal or alkaline earth metal in order to prevent an otherwise acidic material from being produced. Frequently it may not be necessary to neutralize the material because the additives incorporated in the drilling fluid and/or the brine base itself may provide a sufficiently alkaline system to produce a neutral environment. Additionally, an amine form of the C_{10} alcohol may also be utilized. Exemplary of the metal salts which may be utilized are sodium, potassium lithium, calcium, strontium, barium, magnesium, iron, tin, cadmium, aluminum, antimony, chromium, manganese, mercury, nickel and ammonia. Examples of organic amines which can be used are amines such as mono, di and triethylamines, ethylamines, propylamines, butylamines, hexylamines, octylamines, decylamines, laurylamines, stearylamines, ethanolamines, propanolamines, butanolamines, hexanolamines, cyclohexylamines, phenylamines, and the like. By "C_{10} alcohol" I mean to incorporate and claim these salt and amine forms as well as the alcohols themselves.

A typical preparation of my alkaline brine lubricant, as in Example I below, will have the following physical properties:

Color: water white
pH 7.1±0.1
Solids: 47.5±0.2%
Density: 0.999 at 75° F. (8.34 lbs./gal.)
Viscosity: 49 cps. at 75° F. (Brookfield LVF #1 spindle, 30 r.p.m.)
Pour point: −30° F. (ASTM-D 97-57)
Flash point: 64° F. (ASTM-D 93-62 closed cup)

It has been observed that the material utilized in the present invention will produce a foam which would be extremely undesirable and deleterious in brine drilling applications. It is, therefore, critical and absolutely essential to the successful performance of our additive and process that a foam inhibitor be incorporated therein.

Generally acceptable defoaming can be achieved by utilizing a dilute kerosene solution of silicones such as dimethylpolysiloxane which has the following basic formula:

$$CH_3-\underset{CH_3}{\overset{CH_3}{\underset{|}{\overset{|}{Si}}}}-O-\left[\underset{CH_3}{\overset{CH_3}{\underset{|}{\overset{|}{Si}}}}\right]_n-O-\underset{CH_3}{\overset{CH_3}{\underset{|}{\overset{|}{Si}}}}-CH_3$$

wherein n is the degree of polymerization. Generally, the silicone material will be a polymer having a viscosity in the range of 800 to 50,000 centistokes. When utilizing a dimethyl silicone polymer solution as a defoamer, I prefer that the material have a viscosity of about 1,000 centistokes. The silicone defoamer is preferably in a hydrocarbon solution, specifically, kerosene. Although the amount of silicone material in the solution will vary depending on the particular lubricant utilized, the characteristics of the particular well site, the composition of the brine, the salt or amine utilized, and the like, I have found that a ratio of 10-to-90% silicone to 90-to-10% hydrocarbon will be sufficient to produce a foam inhibitor for the present lubricant. Preferably, from about 20% to 80% silicone is utilized in the solution.

The amount of silicone defoamer utilized will vary and an exact amount which will be needed cannot be determined unless many factors are taken into consideration. It is, however, known that the presence of foam in the brine drilling system will adversely affect the pump system and penetration rates, thus increasing drilling costs. Thus, at least an amount of silicone defoamer should be incorporated such that penetration rates when drilling with a brine fluid incorporating the lubricant of the present invention are at least equal to the penetration rates for similar drilling rigs using only a brine without the lubricant. In my laboratory testing I have found that incremental additions of about 1% silicone defoamer solution (5% silicone), based on the total weight of the brine drilling fluid will be sufficient to provide a foam-free lubricant.

The silicone defoamer can be reacted with the other lubricant components directly to avoid initial foam buildup before incorporation of the lubricant into the drilling fluid. Alternatively, equally effective is the addition of the silicone defoamer after the other lubricant components and the brine have been circulated throughout the system. Additional amounts of silicone defoamer may be added to the system from time to time when and if needed.

The present invention also incorporates a process for lubrication of drilling apparatuses utilized in the drilling of subterranean wells. The lubricant is added to the brine fluid and circulated throughout the wellbore. Additional amounts of lubricant can be added if needed. In order to properly protect drilling equipment from torque and stress caused by lack of lubrication the lubricant should preferably be added to the drilling fluid before initial circulation is begun. However, this method is not mandatory. Equally effective is the introduction of the material into a brine drilling fluid which has been previously circulated throughout the well.

The amount of brine lubricant utilized will vary with the particular drilling environment at hand. Formation characteristics, borehole properties, drilling depth, brine concentration, temperatures and pressures encountered and the like, will greatly influence the determination of quantities of brine lubricant to be utilized to achieve satisfactory lubricity. Additionally, the particular properties of the selected C_{10} linear alcohol will also influence the quantity to be utilized in our process. Because of this, it is impossible to specifically state nominal usage levels under all circumstances. Those skilled in the art of drilling will be able to easily determine the desired quantity of lubricant by testing samples obtained from the borehole, checking formation characteristics, temperatures and pressures, and by otherwise determining factors which might affect lubricity. Nevertheless, it can be stated that, under most brine drilling conditions, about a 1 p.p.b. (pounds per barrel) to about a 5 p.p.b. treatment should be sufficient. It is possible under some circumstances to use concentrations less than 1 p.p.b.

The following examples will further illustrate the novel qualities of the lubricant, drilling fluid, and process of the present invention.

EXAMPLE I

The present example demonstrates the excellent lubricity obtained when using the brine lubricant of the present invention. A laboratory formulated artificial brine was prepared using 95% saturated sodium chloride water containing 1,000 p.p.m. calcium ion added as calcium chloride. The base fluid was treated with 0.1, 0.25, 0.5 and 1.0% respectively of an alkaline mono- and dihydrogen phosphate ester of a 5 mole ethylene oxide adduct of decyl alcohol in a 50–50 isopropyl alcohol-water solution. To the base fluid was additionally added 1% dimethyl polysiloxane in a kerosene solution, added incrementally over a 30 minute period, which was sufficient to eliminate foaming tendencies. The base and base-treated samples were tested for lubricity characteristics by utilizing the Falex Lubricant Tester manufactured by the Faville-LeVally Corporation of Bellwood, Ill. This testing apparatus provides for the measurement of torque at increasing loads applied to a journal-V block assembly during prescribed time intervals. The test sample is placed into an auxiliary reservoir and pumped into the test cup. Circulation through the test cup is maintained at a constant rate. A load of 100 pounds is applied to the journal-V block assembly by means of a ratchet wheel loader. A constant loading rate is provided by the eccentric loading arm at the top of the machine. A constant load of 100 pounds is maintained for a three minute time interval and immediately thereafter a torque reading is recorded. Subsequent loads from 100 pounds to 800 pounds are applied in 100 pound increments and held for three minutes each. Lubrication properties are evaluated by comparing torque measurements at the loading increments among a series of test samples, including the base fluid sample. A reduction in torque is indicative of an increase in lubrication effectiveness. The torque reading is read in "inch pounds," i.e., the amount of friction, in pounds, per square inch of surface area. The results of this test indicated that the brine lubricant was effective at all levels in drastically reducing friction. This reduction was dramatically noticeable as the load was increased. This is visually illustrated in FIG. 1. The results of this test are further indicated in the following table.

TABLE 1

Sample	Load level							
	100	200	300	400	500	600	700	800
Base fluid	1	8	15	27	35	62	72	81
B.F. plus 0.1% lubricant	1	3	5	11	18	20	23	39
B.F. plus 0.25% lubricant	1	4	7	8	10	12	15	18
B.F. plus 0.50% lubricant	1	4	8	9	11	13	15	17
B.F. plus 1.0% lubricant	1	3	7	9	11	13	15	15

NOTE.—B.F.=Base fluid.

EXAMPLE II

The present example demonstrates lubricity characteristics of the brine lubricant of the present invention when incorporated in an actual West Texas oil field brine. An analysis of the brine before testing revealed the following characteristics:

Calcium content, mg./liter	17×10^2
Magnesium content, mg./liter	6.5×10^2
Sodium content, mg./liter	68×10^3
Potassium content, mg./liter	3.5×10^2
Chloride content, mg./liter	172×10^3
CO_3 content, mg./lter	<5.0
HCO_3 content	61

The brine was tested alone as a base or check. To the base brine fluid was added 1.5 pounds per barrel of the brine lubricant as in Example I. The samples were tested as in Example I. The results of this test indicated that the brine lubricant of the present invention drastically reduced friction and wear even at loads as high as 700 to 800 pounds. FIG. 2 graphically shows the results of this test. The results are further illustrated in the table below:

TABLE 2

Sample	Load level							
	100	200	300	400	500	600	700	800
Base fluid	7	17	31	42	52	59	63	68
Base fluid plus 1.5 p.p.b. lubricant	2	6	10	13	15	17	19	20

EXAMPLE III

As discussed earlier, diesel oil has been used as a brine lubricant by those skilled in the art. However, the use of hydrocarbons such as diesel oil has several disadvantages. Diesel oil fails to give completely satisfactory lubrication. In addition, in light of recent legislation, the addition of this material into subterranean wells is sometimes prohibited because of its high pollution potential. The present test was conducted in order to determine the effectiveness of the brine lubricant of the present invention when compared to the use of diesel oil. When using diesel as a brine lubricant, it has been customary field practice to utilize it at a 10% by volume treatment level. This is equivalent to 29.5 pounds per barrel. This level of treatment was utilized in the present test. The brine lubricant was tested at the 1 and 2 p.p.b. levels. A synthetic brine was prepared using saturated sodium chloride water to which was added 1 p.p.b. of lime. Four samples were prepared. The first sample contained only the brine fluid which was not treated with a lubrication additive. The second sample contained 10% diesel oil while the third and fourth samples contained 1 and 2 p.p.b. treatments of the brine lubricant of the present invention, as in Example I, respectively. The test samples were made up at the prescribed concentrations and stirred twenty to thirty minutes. Each test sample was poured into the circulation reservoir and pumped into the sample cup. An initial load of 100 pounds was immediately applied to the wear pin V-block assembly. Subsequent loads from 100 pounds to 800 pounds were applied in 100 pound increments and held for three minutes each. Torque readings were recorded at the end of each three minute load interval. The results of these tests indicated that the diesel oil treatment, though somewhat effective in reducing friction, was drastically inferior to both the 1 and 2 p.p.b. treatments of the brine lubricant of the present invention. Additionally, it was shown that a 1 p.p.b. treatment of the brine lubricant was sufficient to provide very satisfactory lubrication. The 2 p.p.b. treatment did not noticeably enhance lubrication characteristics. FIG. 3 illustrates the results of this test which are also given in the table below.

TABLE 3

Sample	Load level							
	100	200	300	400	500	600	700	800
Base fluid	9	19	31	41	53	62	62	67
B.F. plus diesel	8	16	29	35	44	54	57	64
B.F. plus 1 p.p.b. lubricant	4	7	9	10.5	14	19	24	32
B.F. plus 2 p.p.b. lubricant	4	7	9	10.5	14	19	24	32

NOTE.—B.F.=Base fluid.

EXAMPLE IV

The testing procedure used in the previous examples was again utilized to determine the effectiveness of the brine lubricant of the present invention in an undersaturated artificial or "light" brine containing 100,000 p.p.m. sodium chloride. The results of this test again showed the drastic reduction in torque when utilizing the brine lubricant. The results are graphically shown in FIG. 4 and are given in the table below.

TABLE 4

Sample	Load level 100	200	300	400	500	600	700	800
Base fluid	6	24	39	51	59	70	80	91
B.F. plus 1 p.p.b. lubricant	3	6	10	12.5	15	19	20	22.5

NOTE.—B.F.=Base fluid.

EXAMPLE V

I have also discovered that use of the alkaline brine lubricant will greatly reduce metallic corrosion. To illustrate this characteristic a dynamic corrosion test utilizing aeration by oxygenation was conducted. A dynamic corrosion test consists of a fluid system which is exposed only to Teflon and glass and is agitated by means of a mechanical stirrer. Into this system is placed a clean, pre-weighed steel coupon. The system was allowed to react for 64 hours and the coupon removed, cleaned and reweighed. Any weight loss and deformation of the steel is considered to be due to corrosion. This weight loss may be expressed in terms such as mils per year where

$$\text{Mils per year} = \frac{1437 \times \text{weight loss (mg.)}}{\text{Coupon Surface Area (dm.}^2) \times \text{Exposure time (days)} \times \text{Density of metal}}$$

Test samples were made by utilizing 9.5 p.p.g. saturated salt water containing 100 p.p.m. calcium ion to create a synthetic brine drilling fluid. This sample had a pH of 8.4 before testing. This sample served as a "base" or "check" to determine corrosion prevention by the addition to a similar sample of a 0.25% by weight treatment of the brine lubricant of the present invention in the form utilized in Example I. The results of this test indicated that the alkaline brine lubricant of the present invention greatly reduced corrosion of metal. The results of these tests are further described in the following table.

TABLE 5

	Sample: Base fluid	Base fluid plus lubricant
Loss, gm	0.1545	0.0459
Loss, m.p.y	49.4	14.7
Loss, lb./ft.²/yr	2.01	0.60
pH before test	8.4	4.3
Adjusted to	8.4	8.4
pH before measurements taken	7.3	7.6

Although the invention has been described in terms of specified embodiments which are set forth in detail, it should be understood that this is by illustration only and that the invention is not necessarily limited thereto, since alternative embodiments and operating techniques will become apparent to those skilled in the art in view of the disclosure. Accordingly, modifications are contemplated which can be made without departing from the spirit of the described invention.

What I claim is:

1. An additive for brine drilling fluids consisting essentially of (1) a mono- and di-hydrogen phosphate ester of

a 5 mole ethylene oxide adduct of a C_{10} linear alkyl alcohol in (2) a solvent selected from the class consisting of methyl, ethyl, N-propyl, isopropyl, allyl, N-butyl, isoamyl, T-amyl, N-hexyl, benzyl alcohols, water and mixtures thereof, the ratio of said solvent to said ester being about one-to-one, and (3) a dimethylpolysiloxane defoamer in an amount sufficient to prevent foaming of said ester, the pH of said additive being from about 7.0 to about 11.0.

2. The additive of claim 1 wherein the said C_{10} linear alkyl alcohol is 1-decyl alcohol.

3. The additive of claim 1 wherein the said solvent is isopropyl alcohol.

4. The additive of claim 1 wherein the said solvent is a mixture of water and isopropyl alcohol.

5. An additive for brine drilling fluids consisting essentially of (1) a mono- and di-hydrogen phosphate ester of a 5 mole ethylene oxide adduct of 1-decyl alcohol in (2) a solvent consisting essentially of 50% by volume of water and 50% by volume of isopropyl alcohol, the ratio of said solvent to said ester being about 1-to-1, and (3) dimethylpolysiloxane in an amount sufficient to prevent foaming of said ester, the pH of said additive being from about 7.0 to about 11.0.

6. An aqueous drilling fluid consisting essentially of (1) brine and (2) the additive of claim 1 in an amount of from between about 1 p.p.b. and 5 p.p.b.

7. An aqueous drilling fluid consisting essentially of (1) brine and (2) the additive of claim 5 in an amount of from between about 1 p.p.b. and about 5 p.p.b.

8. In the process of drilling a subterranean well wherein there is circulated in the bore hole of said well a brine drilling fluid, the steps of providing lubrication of the surfaces of metallic drilling tools by said drilling fluid which comprises admixing with said drilling fluid from about 1 p.p.b. to about 5 p.p.b. of the additive of claim 1, and circulating said drilling fluid throughout said well.

9. In the process of drilling a subterranean well wherein there is circulated in the bore hole of said well a brine drilling fluid, the steps of providing lubrication of the surfaces of metallic drilling tools by said drilling fluid which comprises admixing with said drilling fluid from about 1 p.p.b. to about 5 p.p.b. of the additive of claim 5 and circulating said drilling fluid throughout said well.

References Cited

UNITED STATES PATENTS

3,091,589	5/1963	Brukner	252—8.5
3,010,903	11/1961	Clark et al.	252—49.9
3,236,769	2/1966	Burdyn et al.	252—8.5
3,004,056	10/1961	Nunn et al.	260—461

OTHER REFERENCES

Rosenberg et al.: article in Journal of Petroleum Technology, vol. 11, August 1959, pp. 195–202.

HERBERT B. GUYNN, Primary Examiner

U.S. Cl. X.R.

252—8.5 A, 363.5