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(54) Apparatus and method for obtaining core samples

(57) An apparatus and method for obtaining core samples from a wellbore includes bringing a substance (3) into contact with the core sample. The substance (3) is adapted to retain at least a portion of fluids recovered with the core sample. A receptacle (2) such as a core barrel (2) contains the substance and is inserted into the wellbore and receiving the core sample in the receptacle (2). The substance may be sealed in the receptacle by a dissolvable plug mechanism (10). The substance (3) is transformable between a highly viscous state and a substantially solid matrix.

Item Number	Document Number	Title	Quantity
1	W1135	OUTER BARREL ASSY	1
2	W1157	TSS INNER BARREL ASSY - 7" BRL	1

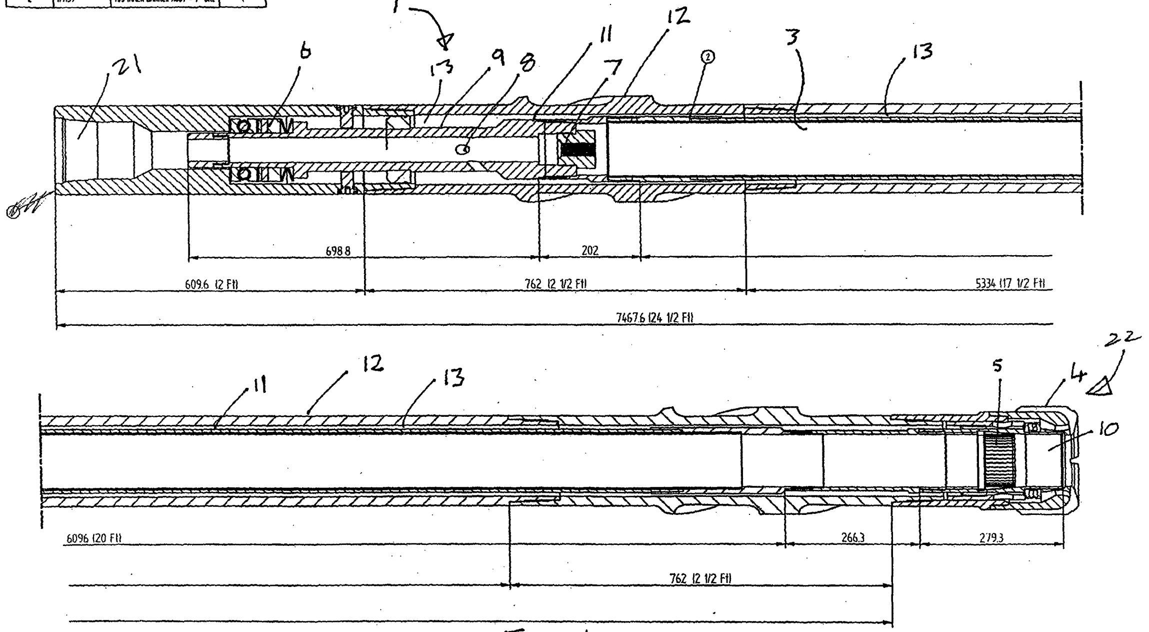


Fig: 1

Rev	Date	Drawn	Checked	Description

Material Type | Heat Treatment | Surface Treatment | Marking
DRAWN PC DATE 23/06/00
CHECKED DATE
CORPRO
Drawing Name COMPLETE CORE BARREL ASSY - 7" BRL TSS
A2 Drawing Number W1158 ISO Scale 1/4 Revision

EP 1 251 240 A2

Description

[0001] This invention relates to an apparatus and method for obtaining core samples from a wellbore, particularly formed in an oil or gas reservoir.

[0002] Extracting core samples from downhole wells is an important aspect of the drilling process to provide geological and geophysical data to establish reservoir models. However, difficulties arise where the drilling fluid used to cut the core displaces fluids held within the core sample. Moreover, as the coring equipment is recovered to the surface, the pressure inside the core barrel reduces, allowing gas to expand and expel fluid contained in the core sample from the core barrel. This reduces the authenticity of the sample recovered, and the accuracy of the data that can be gathered from it.

[0003] US Patent No 5,360,074 discloses the use of a polyglycol additive inserted into a core barrel to encapsulate the core sample and protect it before recovery of the core barrel to the surface. However, this process relies on a temperature gradient during transportation of the sample from the sampled portion of the well to the surface and so does not provide a practical solution where the downhole temperature is outwith the operating parameters of such chemicals, or is unknown or difficult to predict. As a result, the integrity of the core sample may still be affected.

[0004] Further attempts to recover a representative sample of core from a well have been made by Park et al in a series of US Patent Nos. 4,392,414, 4,479,557 and 4,502,553. These describe the use of an absorbent member, normally a polyurethane foam sponge, which is adapted to absorb the production fluids contained in the core sample. In practice, however, the sponge is readily contaminated or "caked" by drilling fluid necessitating the requirement for additional features to protect the sponge. The absorbent member is also prone to damage and may tear away from the core barrel preventing recovery of meaningful data. Moreover, the barrel of the Park system may require evacuation prior to use, adding to the complexity of operations without satisfactorily absorbing the fluid contents of the core sample. There may also be limits on the downhole temperature in which the sponge can operate.

[0005] According to a first aspect of the present invention, there is provided a method for obtaining core samples from a wellbore or the like, comprising the steps of:-

> obtaining a core sample; and
> contacting a substance with the core sample, the substance being adapted to retain at least a portion of fluids recovered with the core sample.

[0006] Preferably, there is provided a receptacle for obtaining a core sample.

[0007] According to a second aspect of the present invention, there is provided an apparatus for obtaining core samples from a wellbore or the like, the apparatus comprising a receptacle for obtaining a core sample and a substance adapted to retain at least a portion of fluids recovered with the core sample.

[0008] Typically the core barrel is connected to an elongate member such as a tubular string and may be lowered into and raised from the wellbore as required. Typically the receptacle for obtaining a core sample is a core barrel. Typically the core barrel engages the wellbore or the like, to remove the core sample.

[0009] Preferably, the substance is contained in the core barrel. Preferably, the core barrel is substantially filled to capacity with the substance. Preferably, a plug is provided to seal the core barrel. Preferably, the plug is a wax plug. Preferably, the plug is adapted to melt or dissolve or otherwise dissipate in a pre-determined manner which may be at a specified temperature. Preferably, the plug dissipates at the portion of the wellbore where the core sample is to be recovered although the plug may dissipate at any time before reaching said portion of wellbore. Preferably, the core barrel has a means adapted to hold the core sample, such as a core catcher.

[0010] Preferably, the core barrel comprises a drill bit. Typically the drill bit is rotated by a drill string. Preferably, the substance adapted to retain fluids is less dense than the drilling mud used to rotate the drill bit provided on the core barrel.

[0011] Preferably, the substance adapted to retain the fluids is miscible with the fluids.

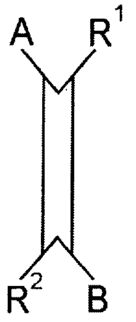
[0012] Preferably, the substance adapted to retain the fluids reacts with the fluids on a chemical level.

[0013] Preferably, the substance adapted to retain the fluids can form a highly viscous state or alternatively forms a substantially solid matrix. Preferably the substance is adapted to retain oil or the like. Typically, the substance does not substantially expand in extreme temperatures and is thermally stable. Preferably, the fluids are subsequently recoverable from the substance adapted to retain the fluids.

[0014] Preferably, the substance is a polymeric mixture. Typically, the polymeric mixture comprises a first polymeric material and a second polymeric material, and may or may not be in a solvent. Preferably, the first polymeric compound of the present invention is a first polymeric material as described in International Patent Application No WO 9812239A1, "Polymeric Material", (International Patent Application No '239) the disclosure of which is incorporated herein by reference. Preferably, the second polymeric compound of the present invention is a second polymeric compound as described in the International Patent Application No '239. Preferably the solvent of the present invention is the solvent as described in the '239 Application.

[0015] Preferably the method of preparing the polymeric mixture can be any method detailed in the '239 Application.

[0016] Preferably, the first polymeric compound is prepared by providing a compound of general formula



or a salt thereof where A and B are the same or different and at least one comprises a relatively polar atom or group and R^1 and R^2 independently comprise relatively non-polar atoms or groups, in a solvent of a type in which ethene itself is generally insoluble and causing the C=C groups to react with one another to form a polymeric compound.

[0017] More preferably, the first polymeric compound is poly(1,4-di(4-(N-methylpyridinyl))-2,3-di(4-(1-formylphenyl) butylidene.

[0018] More preferably the second polymeric compound is polyvinyl alcohol.

[0019] More preferably the solvent consists essentially of water.

[0020] Preferably, the second polymeric compound may be mixed intimately with the first polymeric compound.

[0021] Preferably, the addition of the second polymeric compound to the first polymeric compound causes the substance to form a gel or a colloid. Preferably, the first and second polymeric compounds in the substance may react with one another, typically to form the gel or the colloid. Typically, said reaction is acid catalysed and, accordingly, an acid may be used. Any acid may be used although preferred acids include paratoluene sulphonic acid, hydrochloric acid, phosphoric acid, sulphonic acid and naphthalene sulphuric acids.

[0022] Typically, the concentration of acid used determines the rate of reaction of the first and second polymeric compounds and therefore the rate of the gel/colloid production. Preferably, the concentration of the acid used can vary the rate of reaction of the first and second polymeric compounds and therefore the rate of production of the gel/colloid from, for example, 10 minutes to 16 hours.

[0023] Preferably, the wt% of the first polymeric compound to that of the second polymeric compound is in the range of 0.3 to 20, although other concentrations may be used. Typically the ratio of first and second polymeric compounds used determines whether a gel or colloid is produced.

[0024] The first and second polymeric compound may be mixed typically to form the polymeric mixture by any method described in International Patent Application No '239. Preferably the polymeric mixture is added to a solvent. The polymeric mixture is then typically added to the core barrel and an acid typically added to catalyse the reaction between the first and second polymeric materials.

[0025] Preferably the core barrel is lowered down into the wellbore and driven into the geological formation to recover a portion of core into the core barrel. A portion of the substance typically contained in the core barrel may escape into the geological formation. Preferably, the core barrel has only one opening and so the introduction of a portion of core to the core barrel through the opening, results in the polymeric mixture being forced out of the core barrel through the same opening typically maximising the contact of the polymeric mixture with the core sample. The portion of the substance remaining in the core barrel typically contacts the core sample. Typically a core shutter is closed to hold the core sample in the core barrel.

[0026] The concentration of the acid used may be calculated to cause said reaction to occur after the core sample has been recovered into the core barrel before the core barrel is recovered to the surface. Once the reaction has occurred the resultant gel may emulsify up to 50wt% of oil. The gel formed typically holds the oil in a substantially solid matrix.

[0027] The core barrel is then typically recovered to the surface by conventional means, for example, recovering a string of tubulars, one end of which is attached to the core barrel.

[0028] The core sample is typically removed from the core barrel at the surface. Typically the gels may be destroyed by the process of periodate splitting of the second polymeric compound (which may be a poly(vinyl alcohol) chain). The solution produced has a low viscosity and is easily washed away with water. The oil may then be recovered and qualitatively and/or quantitatively analysed by conventional means.

[0029] An advantage of the present invention is that the decreased pressure in the upper portion of the well, which may cause gas in the core barrel to expand, does not result in the expulsion of oil from the core barrel because the oil is emulsified by the polymeric mixture. Thus a far more representative and authentic core sample is recovered from the wellbore.

[0030] According to a third aspect of the invention there is provided a method of obtaining a sample of a formation from a borehole or the like comprising the steps of:-

filling a portion of the borehole with a substance adapted to change state so as to absorb or trap fluids;

allowing the substance to absorb or trap fluids; and

removing said substance with absorbed or trapped fluids from the borehole.

[0031] Typically, the method according to the third aspect of the invention further comprises removing said substance with absorbed or trapped solids.

[0032] Preferably, the substance is the substance according to the first or second aspects of the invention. Preferably, the substance is removed from the borehole by drilling and recovering the drill cuttings.

[0033] An embodiment of the invention will now be described by way of example only with reference to the accompanying drawings, wherein-

> Fig. 1 is a perspective view of a coring assembly for use with the first aspect of the present invention, and according to the second aspect of the present invention;
> Fig. 2a shows the structure of five 4-(4-formylphenylethenyl)-1-methylpyridinium methosulphate (SbQ) molecules with the anions removed for clarity;
> Fig. 2b shows the structure of poly(1-,4-di (4-(N-methylpyridinyl))-2,3-di(4-(1-formylphenyl) butylidene with the anions removed for clarity;
> Fig. 2c shows the structure of poly(vinyl alcohol); and,
> Fig. 3 shows a reaction scheme of the Fig. 2b polymer reacting with the Fig. 2c polymer to form a substantially solid matrix.

[0034] Referring now to Fig. 1, a first embodiment of an apparatus in accordance with the second aspect of the present invention shows a coring assembly 1, comprising an inner assembly 11 and an outer assembly 12.

[0035] The inner assembly 11 comprises an inner tubular 9, a core barrel 2 which is filled with a polymeric mixture 3 adapted to retain oil fluids, a plug 10 formed of wax and a core catcher 5 to catch a core sample (not shown) inside the core barrel 2.

[0036] The outer assembly 12 encloses the inner assembly 11 and has a drill bit 4 at its lower end 22. The drill bit 4 engages a geological formation (not shown) to cut the core sample so that it may be recovered into the core barrel 2.

[0037] The inner tubular 9 comprises a second plug 7 and aperture 8 to allow drilling fluid pumped through the tubular 9 to pass into the annulus 13 between the inner 11 and outer 12 assemblies. The second plug 7 resists the flow of drilling fluid into the core barrel 2, thus forcing the fluid to proceed through the aperture 8.

[0038] A polymeric substance 3 adapted to retain production fluids is prepared as described in example 3 of International Patent Publication No WO 9812239 and such a method is summarised below.

[0039] Poly(1-4-di(4-N-methylpyridinyl)-2,3-di (1-formylphenyl)butylidene is prepared by exposing an aqueous solution of 4-(4-formylphenylethenyl)-1-methylpyridinium methosulphate (SbQ) to ultraviolet light. A photochemical reaction between adjacent carbon-carbon double bonds of the SbQ molecules results to form the aforementioned polymer.

[0040] The polymer shown in Fig. 2b, is then mixed with poly(vinyl alcohol), shown in Fig. 2c. The resultant poly(l-4-di(4-N-methylpyridinyl)-2,3-di(1-formylphenyl) butylidene/poly(vinyl alcohol) mixture ("polymeric mixture") may be cast as a film on PTFE sheet and dried under vacuum. Certain embodiments of the invention use up to 50 wt% collagen instead of poly(vinyl alcohol) to add rigidity to the gel finally formed.

[0041] The polymeric mixture is dissolved in water and an acid catalyst, such as paratoluene sulphuric acid, is added. The concentration of the acid added is inversely proportional to the time taken for the poly(vinyl alcohol) to react with the poly(1-4-di(4-N-methylpyridinyl)-2,3-di(1-formylphenyl)butylidene. After this reaction, the polymeric substance 3 adapted to retain oil fluids is formed.

[0042] The polymeric substance 3 reacts with, and retains, the oil by way of an emulsification reaction.

[0043] In use, the acid is added to the polymeric mixture at the surface before the polymeric mixture is added to the core barrel 2, although other embodiments of the invention comprise an acid reservoir (not shown) within the inner assembly 11 to allow the acid to be added to the core barrel 2 downhole. The amount of catalyst added depends on the time calculated for the coring assembly 2 to be lowered from the surface to the portion of the wellbore from which the core sample is taken, and for the core sample to be collected in the core barrel; ie the downward trip and coring time. For example, if it is calculated that the downward trip and coring time would total 16 hours then 0.1 wt% of acid would typically cause said reaction to occur to form the gel after such a time. Depending on the rigidity of the gel which will be ultimately formed, the acid may be added to form the gel at the surface, before the downhole trip. 1 wt% of acid would typically result in the formation of the gel from the polymeric mixture after 10 minutes.

[0044] The coring assembly 1 is lowered on a drill string (not shown), through risers (not shown) and then down through the well to the portion where a core sample is required, as is conventional in the art. While the coring assembly 1 is being lowered downhole, drilling fluid is typically pumped through the first end 21 of the coring assembly 1, into the inner tubular 9 and from there through the aperture 8 into the annulus 13 between the inner 11 and outer 12 assemblies. The drilling fluid continues through said annulus 13 and exits at the second 22 opposite end proximate to the drill bit 4. The drilling fluid then flows between the outer surface of the coring assembly 1 and the drilled hole (not shown) and from there back to the surface. The drilling fluid eases the lowering of the assembly 1, into the well, and whilst drilling to obtain the core sample, the function of the drilling fluid is two-fold, firstly it keeps the drill bit cool while cutting and secondly it removes drill cuttings which would otherwise hamper the cutting action of the drill bit 4.

[0045] When the coring assembly 1 has reached the required depth in the wellbore, the temperature in the well will cause the wax plug 10 to dissolve so that a core sample may be taken. In the event that the wax plug dissolves before the coring assembly 1 has reached the point in the well that the core sample is required, little polymeric mixture will be lost due to the lighter weight of the polymeric mixture compared to that of the drilling fluid. Certain embodiments of the invention may employ other types of plugs (not shown) to plug the core barrel 2.

[0046] To cut the core sample, the drill bit 4 is rotated to cut the sample and the coring assembly 1 forced towards the geological formation so that a sample of core enters the core barrel 2. The substance 3 contained in the core barrel 2 contacts the sample of core. As the core enters the core barrel, a portion of the substance 3 is forced out via the second end 22 of the coring assembly 1. Once the sample has been recovered, the core catcher 5 is closed.

[0047] Preferably, it is at this point that the substance changes state to form e.g. a gel. The polymeric mixture normally has the capacity to emulsify 50 wt% oil. The coring assembly 1 may be left in this position until the time calculated for the gel to set has passed.

[0048] Once the gel has set, the production fluids are held in a substantially solid matrix by the substance 3 and the coring assembly 1 is removed from the well by conventional methods. As the oil fluids in the core sample are held by the substance 3, the pressure reduction encountered on raising the coring assembly 1 does not result in a significant leak of fluids, in particular oil from the core barrel 2. Therefore, a far more representative sample of the organic fluids from the portion in the well is recovered to the surface. At the surface, the core can be recovered and the oil conveniently recovered from the substantially solid matrix by the addition of a periodate solution to cause periodate splitting.

[0049] A further embodiment according to a third aspect of the invention may also be used. The polymeric mixture, described above in relation to the other embodiment, is pumped down a hole or well. The polymeric mixture is allowed to harden to form the substantially solid matrix which absorbs surrounding oil. The solid may then be recovered to the surface by for example, drilling it out such that the drill cuttings are flushed back to the surface by the drilling fluid, or by other means.

[0050] In all embodiments described herein the oil/production fluids are recovered from the matrix and can be analysed to determine their chemical and physical properties. An accurate calculation of the quantity and quality of the oil/production fluids in the core sample and therefore the geological formation which the core sample represents can be obtained.

[0051] Modifications and improvements may be made without departing from the scope of the invention.

Claims

1. A method for obtaining core samples from a wellbore or the like, comprising the steps of:-

> obtaining a core sample from the wellbore; and bringing a substance (3) into contact with the core sample, the substance (3) being adapted to retain at least a portion of fluids recovered with the core sample.

2. A method according to Claim 1, comprising inserting a receptacle (2) into the wellbore and receiving the core sample in the receptacle (2).

3. A method according to Claim 2, wherein the substance (3) is contained in the receptacle (2).

4. A method according to Claim 3, wherein substance is sealed in the receptacle by a plug mechanism (10).

5. A method according to Claim 4, comprising the step of removing the plug mechanism (10) after inserting the receptacle into the wellbore.

6. A method according to any preceding Claim, wherein the substance (3) is less dense than drilling mud.

7. A method according to any preceding claim wherein the substance (3) is miscible with the fluids.

8. A method according to any preceding claim wherein the substance (3) undergoes a chemical reaction with the fluids.

9. A method according to any preceding claim, wherein the substance (3) is transformable between a highly viscous state and a substantially solid matrix.

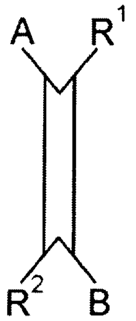
10. A method according to any preceding claim, wherein the substance (3) is adapted to retain oil.

11. A method according to any preceding claim, wherein the fluids are subsequently recoverable from the substance (3) adapted to retain the fluids.

12. A method according to any preceding claim, wherein the substance (3) is a polymeric mixture (3).

13. A method according to claim 12, wherein the polymeric mixture (3) comprises a first polymeric material and a second polymeric material.

14. A method according to claim 13, wherein the first polymeric material comprises a compound of general formula



or a salt thereof where A and B are the same or different and at least one comprises a relatively polar atom or group and R^1 and R^2 independently comprise relatively non-polar atoms or groups.

15. A method according to claim 14, wherein the first polymeric material is dissolved in a generally hydrophillic solvent whereby the C=C groups react with one another to form a polymeric material.

16. A method according to any of claims 13 to 15, wherein the first polymeric material is poly(1,4-di (4-(N-methylpyridinyl))-2,3-di(4-(1-formylphenyl) butylidene.

17. A method according to any of claims 13 to 16, wherein the second polymeric material is polyvinyl alcohol.

18. A method according to claim 15 or to either of claims 16 and 17 when dependent upon claim 15, wherein the solvent consists substantially of water.

19. A method according to any of claims 13 to 18, wherein the addition of the second polymeric material to the first polymeric material causes the substance (3) to form one of a gel and a colloid.

20. A method according to claim 19, wherein the first and second polymeric materials in the substance (3) react with one another, said reaction being catalysed by an acid.

21. A method according to claim 20, comprising controlling the rate of reaction of the first and second polymeric materials by controlling the concentration of acid to catalyse the rate of the formation of the gel/colloid.

22. A method according to any of claims 13 to 21, wherein the wt% of the first polymeric material to that of the second polymeric material is in the range of 0.3 to 20.

23. A method according to claim 20 or to either of claims 21 or 22 when dependent upon claim 20, wherein the polymeric mixture (3) is added to a solvent, and thereafter the polymeric mixture (3) is then added to the receptacle (2) and thereafter an acid is added to catalyse the reaction between the first and second polymeric materials.

24. A method of obtaining a sample of a formation from a borehole or the like comprising the steps of:-

filling a portion of the borehole with a substance (3) adapted to change state so as to absorb or trap fluids;
allowing the substance (3) to absorb or trap fluids; and
removing said substance (3) with absorbed or trapped fluids from the borehole.

25. An apparatus for obtaining core samples from a wellbore or the like, the apparatus comprising a receptacle (2) for obtaining a core sample and a substance (3) adapted to retain at least a portion of fluids recovered with the core sample.

26. An apparatus according to claim 25, wherein the receptacle (2) is a core barrel (2) and is connected to an elongate member capable of being lowered into and raised from the wellbore.

27. An apparatus according to claim 26, wherein the core barrel (2) is connected to a tubular string and the core barrel (2) engages the wellbore to remove the core sample.

28. An apparatus according to either of claims 26 or 27, wherein the core barrel (2) is substantially filled to capacity with the substance (3).

29. An apparatus according to any of claims 26 to 28, wherein a plug mechanism (10) is provided to seal the core barrel (2).

30. An apparatus according to claim 29, wherein the plug mechanism (10) is adapted to dissipate in a pre-determined manner.

31. The use of a substance (3) to stabilise a core sample recovered from a wellbore, the substance (3) being transformable between a highly viscous state and a substantially solid matrix.

32. A substance (3) for stabilising a core sample recovered from a wellbore, the substance (3) being transformable between a highly viscous state and a substantially solid matrix.

33. A wellbore core sample stabilising device comprising a substance (3) which is transformable between a highly viscous state and a substantially solid matrix.

Item Number	Document Number	Title	Quantity
1	W1135	OUTER BARREL ASSY	1
2	W1157	TSS INNER BARREL ASSY - 7" BRL	1

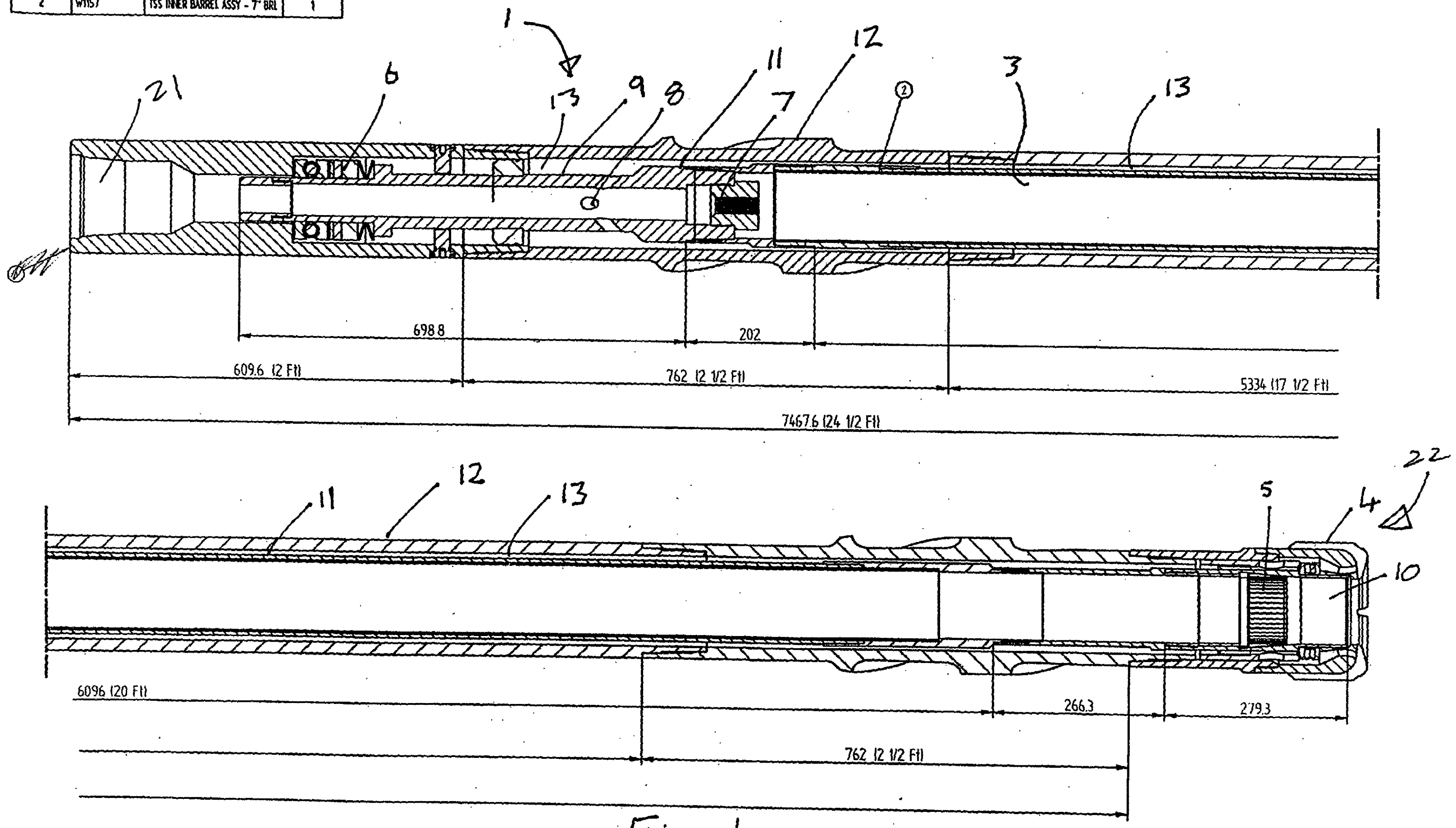


Fig: 1

Material Type	Heat Treatment	Surface Treatment	Marking	DRAWN PC CHECKED	DATE 23/06/00 DATE
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A2	Drawing Number	W1158	ISO	Scale 1/4	

Rev	Date	Drawn	Checked	Description

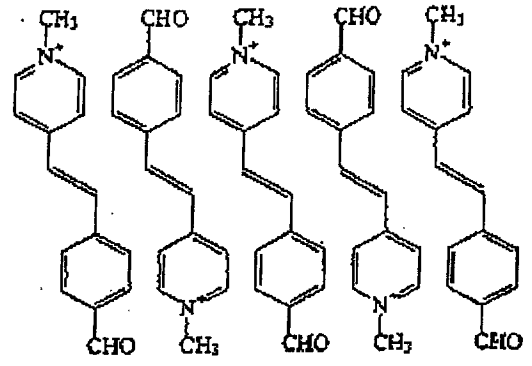


Fig. 2a

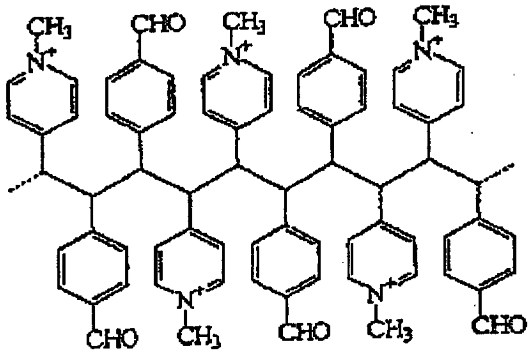


Fig. 2b

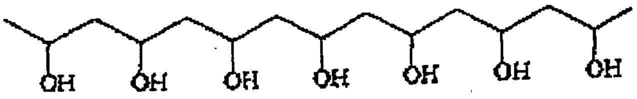
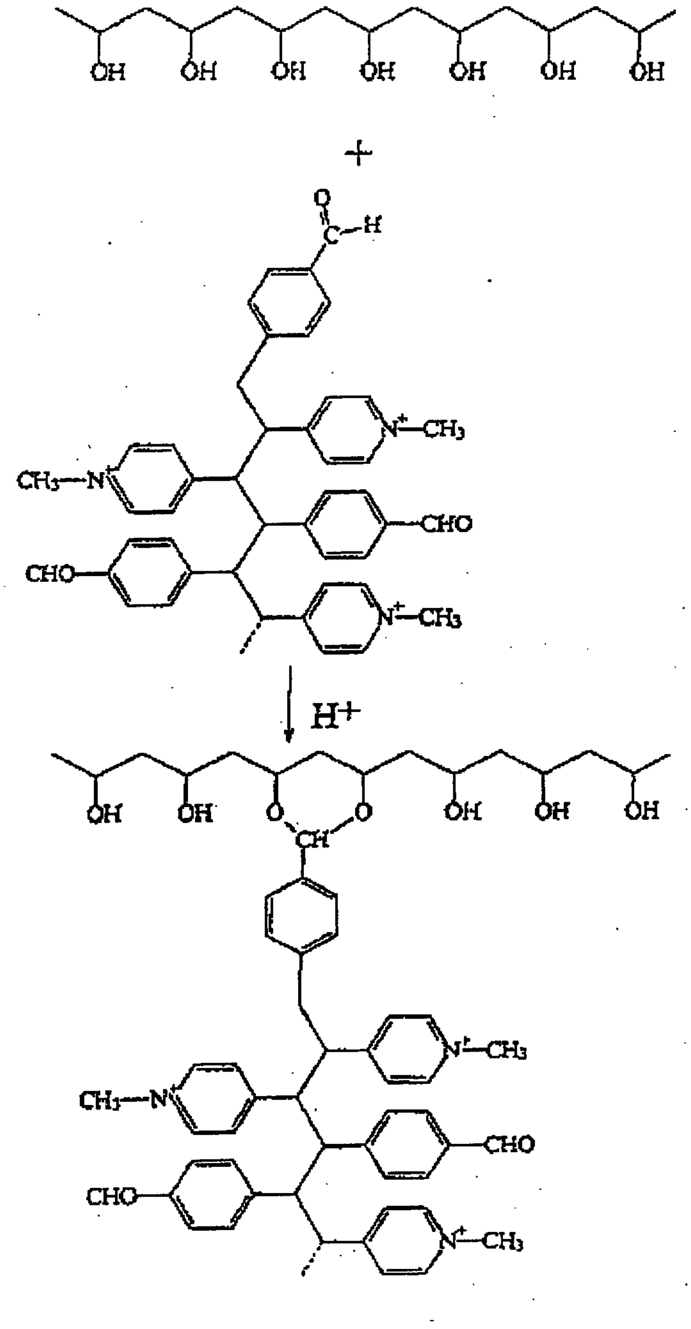


Fig. 2c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CHO
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N+—CH₃

Fig. 3