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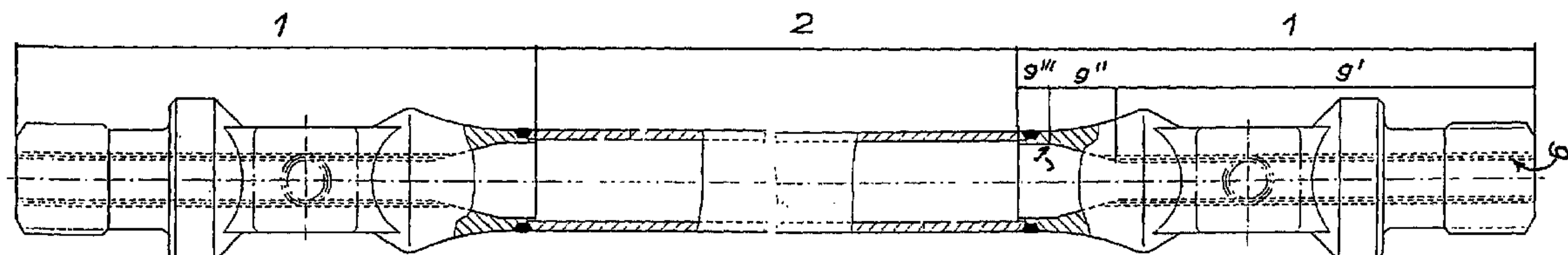
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(54) Titre : PROCEDE DE CONDITIONNEMENT DE FLUIDES DE Puits DE FORAGE ET TIGE DE POMPAGE
ASSOCIEE

(54) Title: METHOD FOR CONDITIONING WELLBORE FLUIDS AND SUCKER ROD THEREFORE



(57) **Abrégé/Abstract:**

Invention refers to a method for conditioning wellbore fluids and to a sucker rod to accomplish the method used in the field of petroleum production. The method the invention refers to involves fact that the injection of the conditioning fluids is done directly through the sucker rods, from the surface, concomitantly pumping (producing) the well, being possible that the conditioning fluid be distributed either in the production tubing, or in the wellbore or even in the reservoir rock around the wellbore, concomitantly pumping the well. The sucker rod designed for the application of the method is made of steel and it has two sucker rod heads (1) which are tubular, welded to the ends of a tube (2) made of steel, thus forming a continuous tube through which a fluid can flow or an electric or optical cable can be pulled through, or set inside.



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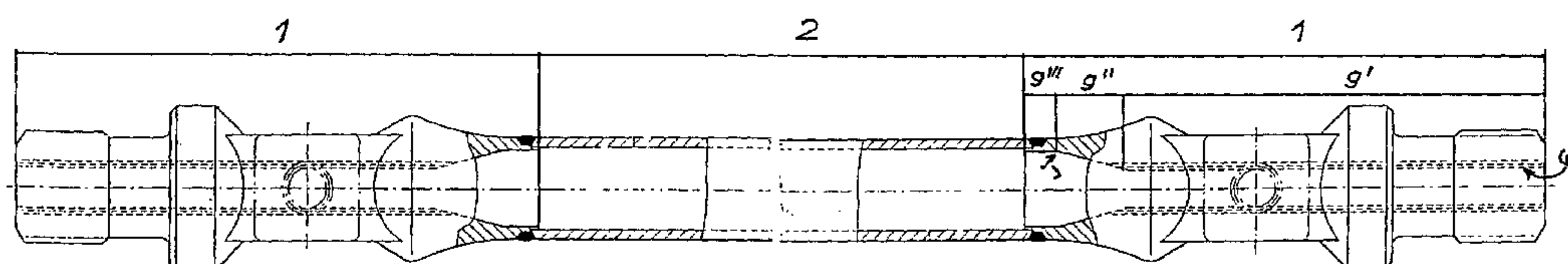
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(57) **Abstract:** Invention refers to a method for conditioning wellbore fluids and to a sucker rod to accomplish the method used in the field of petroleum production. The method the invention refers to involves fact that the injection of the conditioning fluids is done directly through the sucker rods, from the surface, concomitantly pumping (producing) the well, being possible that the conditioning fluid be distributed either in the production tubing, or in the wellbore or even in the reservoir rock around the wellbore, concomitantly pumping the well. The sucker rod designed for the application of the method is made of steel and it has two sucker rod heads (1) which are tubular, welded to the ends of a tube (2) made of steel, thus forming a continuous tube through which a fluid can flow or an electric or optical cable can be pulled through, or set inside.



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"Method for conditioning wellbore fluids and sucker rod to accomplish the method"

Invention refers to a method to condition wellbore fluids and sucker rod to accomplish the method, used in the field of petroleum production.

Downhole pumping of wellbore fluids is the most frequent method used for secondary recovery of crude oil in petroleum production. Downhole pumping involves procedures and devices through which the pumping energy gets to the wellbore fluids, so that wellbore fluids move up the downhole, to the surface, through production tubing. Devices used for this purpose are amongst the most diverse in the industry, though only few models made inroads thus getting standardized. They are generically known as downhole plunger pumps, PCP (Progressive Cavity Pumps), ESP (Electrical Submersible Pumps), and "screw" pumps.

From a constructive stand point, the devices used for downhole pumping, no matter the pumping option *per se*, have the following components: a part, the driver, where mechanical energy is generated, another part transmitting mechanical energy previously generated to the pump and the pump itself. Pump transfers the mechanical energy brought from surface to the wellbore fluids, turning it into pressure. In the oil field, the electrical motor imposed itself as the device of choice in generating mechanical energy to drive the pump, though there are many applications where one may see steam driving, hydraulic or pneumatic driving as alternate options to drive the pump. Mechanical energy from the driver can be delivered to the pump either through sucker rods (in this case the driver being at the surface and the pump downhole), or can be produced and used locally. This second option is so-called "bottom hole driver" or "direct drive"; e.g. PCP pumps driven through bottom hole drivers, 'screw' pumps driven through bottom hole drivers or ESP pumps driven in the same way.

Producing petroleum wells involves a wellbore to connect reservoir to surface. Wellbore breaks into the physical and chemical equilibrium between reservoir fluids and reservoir rock. Breaking physical equilibrium leads to an imbalance of pressures which in turn leads to a net flow, reservoir rock fluids flowing out into wellbore, until a new physical equilibrium reached (one should note too a temperature imbalance, but this is not relevant for scope of our discussion). At the on-start, the pressure imbalance between surface and reservoir rock is large enough and reservoir fluids reach surface at own expense. Over time, pressure imbalance decreases and at a certain juncture in time one needs to add energy to the reservoir fluid, to bring it to surface. That's the on-start of well pumping, various devices being in use for this service.

Breaking the chemical equilibrium brings a different set of imbalances, more difficult to lump into a simple pattern, though same equilibrium principle applies. Most common alteration encountered is a phase change. New phase occurs while producing reservoir fluids – e.g. dissolved gas may evolve from liquid; solubility of some components in the reservoir fluid mixture changes so drastically that a solid phase occurs - scale forms, both of organic and inorganic origin. Reservoir fluids also interact chemically with wellbore itself and wellbore equipment, corrosion being the most common phenomena encountered.

Another, more subtle consequence, is a change in the interaction degree between reservoir rock (matrix) and reservoir fluids trapped in. Reservoir matrix attrition occurs as soon as reservoir fluids start flowing and reservoir fluids mechanically entrap loose fragments off the reservoir matrix, in their flow to surface. Together they lead to a process known as reservoir matrix damage, which impact badly producing the well.

Science and technology tried to find ways and improve means to cope better with intricate consequences of producing a well, and particularly petroleum wells.



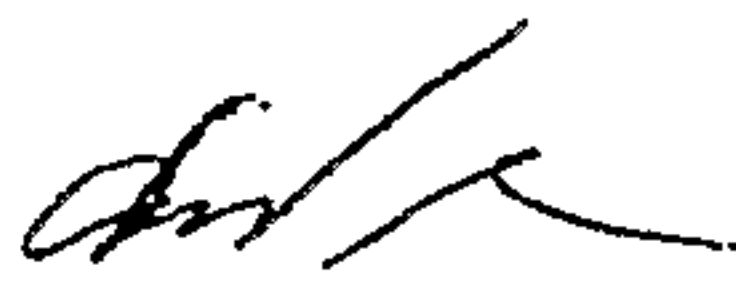
One such task is to pump wellbore fluids to surface concomitantly controlling their behavior and aggressivity, such that to counteract potential damages. Thus, the wellbore fluids, the wellbore itself or even the reservoir rock nearby, needs conditioning. More specifically, conditioning is done to control scaling of wellbore, pump, tubing string, and casing, to limit wellbore fluids corrosion or to improve their flowing properties. Conditioning nearby wellbore reservoir rock tries to maintain or improve reservoir matrix flow characteristics (filterability). In order to condition wellbore fluids, wellbore or wellbore reservoir rock nearby one has to add conditioning agents (dilutants, solvents, steam, hot water, specialty chemicals) to production tubing, casing or wellbore, or injected them into the reservoir rock, either continuously or in batches, either during pumping the well or when pump shuts down. Conditioning wellbore fluids and concomitantly pumping the well is not an easy task because conditioning process and its tools interfere with the pumping process, the pumping device and/or the pumping arrangement.

Attempts have been made to find answers to this challenge above. As such, patent US-A-5924490 discloses a solution for a tool to condition wellbore fluids upstream the pump (patent refers to a plunger pump), in the annulus formed between production tubing and sucking rods, as well as for conditioning wellbore and wellbore fluids for naturally erupting wells only (note: no pumping is required for naturally erupting wells). Authors achieve the task to condition the wellbore fluids flowing in the annulus between the production tubing and sucking rods by replacing some of the standard sucker rods with hollow sucker rods and injecting the conditioning agent through such hollow sucker rods train, down to a disbursement valve installed at the end of the hollow sucker rods train, upstream the plunger pump. This way the author only allows the conditioning agent to interact with the wellbore fluids inside production tubing. No conditioning of the wellbore or of the reservoir rock itself is possible under

such arrangement because tubing and plunger pump assembly form a closed container which only allows well's inflow to be transferred to surface.

Another patent, WO-A-011187, describes an invention where an alternate plunger pump arrangement is proposed, in order to cope better with presence of sand in the wellbore fluids, as sand extremely damaging to the sucker rods. To avoid sandy wellbore fluids interact with the sucker rods while pumping, the authors make use of a second string of production tubing, first production tubing string being used as an injection string and protector for sucker rods. A side embodiment of the invention describes an approach wherein the author proposes to use the new dual string production system in a different arrangement where one may replace plunger pump with a progressive cavity pumping system, and where, through adequate piping configuration, the production tubing connects to the progressive cavity pump hollow rotor and to the second production string. By its design, conditioning wellbore fluids downstream the pump it is possible but not the reservoir rock. The use of the second production tubing to prevent wellbore fluids from interacting with the sucker rods doubles the production string, turning it extremely expensive. It leaves application facing great challenges since substantial alteration of exiting field infrastructure requested.

Conditioning wellbore fluids, wellbore or reservoir rock nearby means production disruption in many instances: shut the well in, pull sucker rods string out, condition the wellbore or the formation, set sucker rods string and pump back into the well and resume production. Associated to production disruption is production loss. All these mean supplementary investment and costly logistics, thus leading to increased cost of producing the well. The above-mentioned disadvantages have as a starting point existing configuration of sucker rods and pump assembly used to pump the well.



For historical reasons, as well as because of infrastructure on site, delivering mechanical energy to PCPs or to screw pumps is done (nowadays) through the same sucker rods strings used for downhole plunger pumps. There is one major difference, though, and that has to be considered while comparing driving PCPs and "screw" pumps to plunger pumps. While transmitting mechanical energy to the pump, the sucker rods used to drive downhole plunger pumps move up and down, axially; the sucker rods used to drive PCPs or "screw" pumps rotate.

The sucker rods used in the oil field are nowadays standardized, all sucker rods manufacturers following API 11B standard (American Petroleum Institute).

Such sucker rod is a continuous full bodied metallic bar, with both ends profiled and threaded to allow end-to-end connection in a sucker rods string. String thus made is used to transmit mechanical energy from the driver (at surface) to the pump (downhole).

Using full bodied sucker rods strings leads to extra cost, involves supplementary, costly logistics, and special operations and lost production is associated with, whenever the wellbore fluids, the wellbore itself or the formation pay zone has to be conditioned, as outlined above.

Another disadvantage of using classical sucker rods pumping technology is that it renders as expensive and non-attractive live data gathering for parameters like the bottom hole temperature and pressure, flowing properties of the wellbore fluids, or the pumping regime. Bringing the information from bottom hole transducers to the surface, while pumping the well, it involves the use of special data cables inserted in the annulus between the production tubing and the production casing, and designed to stand the aggressivity of wellbore fluids, as well as the combined effect of temperature and pressure. For special purpose applications alternatives exist but they involve converting the electric signals from bottom hole transducers in sonic or electromagnetic waves beamed to the surface, option even more expensive and difficult to implement.

One may encounter similar troubles when direct drive applications are considered for PCPs, screw pumps or ESPs where the use of bottom hole electric motors is needed. Bringing the power to the bottom hole electric motors requires power cables usually inserted in the hole through annulus and designed to stand the aggressivity of wellbore fluids, as well as the combined effect of temperature and pressure. These cables are very expensive and sometimes this renders bottom hole direct drive technique as non-attractive.

An alternative option to driving downhole pumps (no matter whether plunger, PCP, screw or ESP) has been designed and it involves the use of flexible coiled tubing instead of classical sucker rods. This option is more expensive than traditional sucker rods driving and consequently of limited use. To compound the issue, using coiled tubing means that special infrastructure must be available on site. Because of that the cost of replacing the classical sucker rods technology becomes prohibitive.

The technical problem this invention intends to solve addresses devising a method to condition wellbore fluids, or the wellbore itself or the reservoir rock, concomitantly pumping the well, with a special emphasis on using the existing infrastructure in place in the oil field. To these ends devising a sucker rod designed to help achieving this task is needed.

Conditioning the wellbore fluids, the wellbore itself or the reservoir rock and concomitantly pumping the well, as devised through this invention, involves injecting the conditioning fluid from surface into the wellbore, directly through the sucker rods. Thus solving the technical problems described above. Injecting pressure of conditioning fluid will be adjusted from the surface, in accordance with the scope of injection, whether placing conditioning fluid in the tubing, or wellbore or injecting it into the reservoir rock. Through adequate devices, conditioning fluid can be distributed either in the production tubing, wellbore or injected into the reservoir rock, as needed.

The sucker rod as devised through the present invention consists of a single continuous flowing tube made of two sucker rod heads attached by welding to both ends of a steel tube. The conditioning fluid can flow through this continuous tube, thus achieving the scope of conditioning the wellbore fluids or the wellbore and concomitantly pumping the well. The sucker rod head has a hole drilled into. This hole is cylindrical through the whole section between the beginning of the thread of the sucker rod head, through the wrench square and the lower third height of the sucker rod head. The hole continues conical through the rest of the sucker rod head height and ends cylindrical in the welding section of the sucker rod head. A radius connects the conical section of the hole to the last cylindrical section, designed to function as a stress relief section.

The conditioning method presented in this invention and the hollow sucker rods devised for it can be applied directly in oil filed pumping applications using the infrastructure and logistics available on site to handle traditional sucker rods. Simultaneously, using hollow sucker rods creates a premise to condition wellbore fluids while pumping the well (through injecting the conditioning fluid through the hollow sucker rods) still using the infrastructure and logistics available on site to handle traditional sucker rods. In the case of PC pumping technology, using hollow sucker rods creates a premise to condition the wellbore or even the reservoir rock without pulling the sucker rods string out the well. Thus, the immediate advantage of using hollow sucker rods for wells already equipped with PCP. Plunger pumping as well as screw pumping technologies will also benefit using hollow sucker rods and conditioning method presented in this patent application.

Live data gathering as well as PCPs, screw pumps or ESPs direct drive applications will benefit from using hollow sucker rods. Information from bottom hole transducers can now be transmitted to surface via adequate electric or optical data cables inserted through the hollow sucker rod string, while pumping

the well. When direct drive applications are considered, one has to bear in mind that electric motors have to be attached directly to the pump, downhole. If hollow sucker rods technology considered, the power can be brought and delivered to the bottom hole electric motor via power cables inserted into the hollow sucker rod string. Data and power cables protection can thus become lighter since no need for cables to stand the aggressivity of the wellbore fluids or combined effect of temperature or pressure, thus the cost of these special cables dropping. Bottom hole live data gathering or direct drive becomes more attractive and easier to implement.

Examples depicting the conditioning method presented in this application and the hollow sucker rods devised for it are presented following after in figures 1-3:

- Figure 1, shows a front view of a hollow sucker rod;
- Figure 2, shows a front view & partial resection of hollow sucker rod from Figure 1;
- Figure 3, shows a schematic view of a typical PCP pumping arrangement using a hollow sucker rods string.

The conditioning method as devised through the present application involves the preparation of conditioning fluid, dozing and pumping it into the wellbore while producing the well, interacting the conditioning fluid with wellbore fluids, the wellbore itself or the reservoir rock and changing accordingly the properties of wellbore fluids or reservoir rock around the wellbore. Specific to the method is the pumping phase of the conditioning fluid. The conditioning fluid flows directly into the wellbore, through the hollow sucker rods, concomitantly with pumping wellbore fluids to surface. Transmitting the power needed for pumping from surface to the point of use (the downhole pump) concomitantly with conditioning the wellbore fluids becomes thus possible through this new approach. Conditioning fluid that is pumped into the wellbore through the hollow sucker rods can be directed into the production tubing or the wellbore while pumping the well, or can be injected into the reservoir rock around the wellbore without pulling out the hollow sucker rods string. Adjusting the injection pressure and

using adequate fluid diverting devices controls the place where the conditioning fluid is disbursed into the wellbore. All conditioning and pumping phases are done traditionally.

The shape and size of hollow sucker rod as devised through the present invention follow API 11B standard. The hollow sucker rod consists of two tubular pieces 1 named sucker-rod head attached to a steel tube 2. Wall thickness of the steel tube is sized adequately to serve the process. Attaching sucker-rod heads to steel tube is by welding, thus obtaining the final product, a continuous tube through which fluid can flow - the hollow sucker rod. Assembling hollow sucker rods together results into a hollow sucker rod string that can transmit power from the surface to the point of use (the downhole pump) concomitantly allowing fluid to flow through it. Length of hollow sucker rods is between 8.32 meters and 9.99 meters, shorter versions ("hollow pony rods") being possible to be made through same process (the equivalent of pony rods from API 11B).

The sucker-rod head 1 consists of a threaded pin section a (thread as per API 11B), that continues with a section b that serves as a stress relieve section, after which section c continues, called shoulder, followed by a "wrench square" d. Wrench square d allows the application of torque, via a wrench, when assembling/dis-assembling hollow sucker rods into a string. Wrench square d continues with a thicker section e, called "bead", and a welding section f, cylindrical. Inner hollow g of the sucker-rod head 1 is cylindrical through out section g', from top end of threaded pin all along last third of the "bead" e, continues conical through out section g" and terminates with another cylindrical section g'" through out the welding section f. Between section g" and g'" a radius r is allowed, to act as a stress relieve section. The steel the hollow sucker rod is made of is selected such that all prerequisites in terms of torque, elongation and combined torque and elongation should be fulfilled, including fatigue and corrosion resistance.

Hollow sucker rods can be assembled into a hollow sucker rods string and this is presented in figure 3 for a typical PCP application. One can see that the pumping unit consists of a drive unit A, made of an electrical motor 3 delivering power to a gear box, a coupling 4 and a drive head 5. Stuffing box B on the hollow polished rod 6 insures that injection fluid can be pumped through the hollow sucker rod string without leaking. Stuffing box C seals the hollow polished rod 6 against the production tubing, such that no wellbore fluids spill into the environment. Hollow polished rod 6 connects to the hollow sucker rod string D via a shorter hollow sucker rod, similar to a pony rod but hollow. Hollow sucker rod string D inserts into the production tubing 7 and is made of hollow sucker rods 8 connected together via standard threaded connectors. Hollow sucker rod string can be terminated with an injection valve 9, through which conditioning fluid can be disbursed in the annulus between the production tubing and the sucker rod string, above the PCP pump. Power is transmitted from surface to the PCP pump E via the hollow sucker rod string D. PCP pump E can be either traditional or hollow rotor PCP. Anchor F and stabilizer 11 anchors and centers the PCP downhole. In this later case conditioning fluid can be disbursed either in the production tubing or downhole into the wellbore while pumping the well. Reservoir rock around the wellbore can also be conditioned if when conditioning fluid injected via hollow sucker rod string.

If live data gathering is to be considered, data cables transmitting information from downhole transducers to surface run through the hollow sucker rod string. Data cables, either electric or optical, are thus protected against the aggressivity of the wellbore fluids and the impact of pressure. Similarly, when direct drive applications considered the power cable runs through the hollow sucker rod string, connecting electric motor downhole to surface power.

When a plunger pump considered the PCP pump E has to be replaced with a downhole plunger pump, and the drive unit with a pump jack, the rest of the configuration staying same. In the case of a "screw" pump the PCP pump E is replaced by the screw pump itself, not other changes being necessary to

configuration presented in figure 3. In both cases (downhole plunger pump and "screw" pump) one can condition the wellbore fluids while pumping, injecting conditioning fluid through the hollow sucker rod string D into annulus between production tubing and hollow sucker rod string, through injection valve 9, above the pump. Because of the way these pumps are designed, conditioning the wellbore or the reservoir rock around the wellbore through injecting conditioning fluid through hollow sucker rod string is no longer possible.

AMENDED CLAIMS under Art.19(1)

1. (Amended) Method for conditioning wellbore fluids and/or wellbore itself or reservoir rock around the wellbore, including preparation of conditioning fluid, dosing and pumping conditioning fluid under pressure into the wellbore, interacting the conditioning fluid with the wellbore fluids, the wellbore itself or the reservoir rock around the wellbore, followed by consequent and adequate change of their properties **characterized by the fact that**, through a continuous tube connecting surface to the wellbore, tube consisting of a train of hollow sucker rods assembled together with a hollow PCP rotor, conditioning fluid can be pumped directly from the surface into the wellbore concomitantly with pumping (producing) the well, thus being possible to distribute the conditioning fluid either in the wellbore or even in the reservoir rock around the wellbore, concomitantly with pumping (producing) the well.
2. (Unchanged) Method as per claim 1, **characterized by the fact that** through adjusting conditioning fluid injection pressure, one can adjust the place where the conditioning fluid is placed in the wellbore/interacted with the wellbore fluids, the wellbore itself or reservoir rock around the wellbore.
3. (Unchanged) Sucker rod, made of steel, profiled and threaded at both ends, **characterized by the fact that** it has two sucker rod heads (1) which are tubular, welded to the ends of a tube (2) made of steel, thus forming a continuous tube through which a fluid can flow or an electric or optical cable can be pulled through, or set inside.
4. (Unchanged) Sucker rod as per claim 3, **characterized by the fact that** the head of the sucker rod (1) has an inner hole (g), cylindrical in the section (g') from the top end of the sucker rod (1) thread (a)

down to approx. the lower end of the upset bead (e) of the head of the sucker rod (1), the cylindrical section (g') being followed by a conical section (g'') and ending with a section (g'''), cylindrical all the way through the welding zone (f) of the head of the sucker rod, between zone (g'') and (g''') existing a radius (r) which works as a stress relief.

5. (Amended) Sucker rod as per claim 3 and 4, **characterized by the fact** that it can be assembled into a hollow pumping string which, when applied together with a hollow rotor of a PCP pump, it can be used to pump the well concomitantly with injecting conditioning fluids or, if necessary to protect electrical/optical cables passing through, cables transmitting to the surface signals about properties of the wellbore fluids or pump status, signals generated by adequate transducers mounted on the sucker rod string or pump itself, or transmitting power from surface downhole, to the downhole electrical motors used to drive PCP, "screw" or ESP pumps.
6. (New) Hollow PCP pumping string made of steel **characterized by the fact** that it consists of a PCP rotor which is hollow, made of steel, assembled together with a train of hollow sucker rods, each sucker rod being made of steel, profiled and threaded at both ends and, having two sucker rod heads (1) which are tubular, welded to the ends of a tube (2) made of steel, thus forming a continuous tube connecting surface to the wellbore, through which a fluid can flow or an electric or optical cable can be pulled through or set inside.
7. (New) Hollow PCP pumping string as per claim 6, **characterized by the fact that**, concomitantly with pumping the well, it can be used to inject conditioning agents or, if necessary, to protect electrical/optical cables passing through, electrical cables that transmit to the surface the electrical signals about properties of the wellbore fluids or pump status, generated by adequate transducers mounted on the sucker rod string or pump itself, or that transmit power from the surface downhole to the downhole electrical motors used to drive PCT, "screw" or ESP pumps.

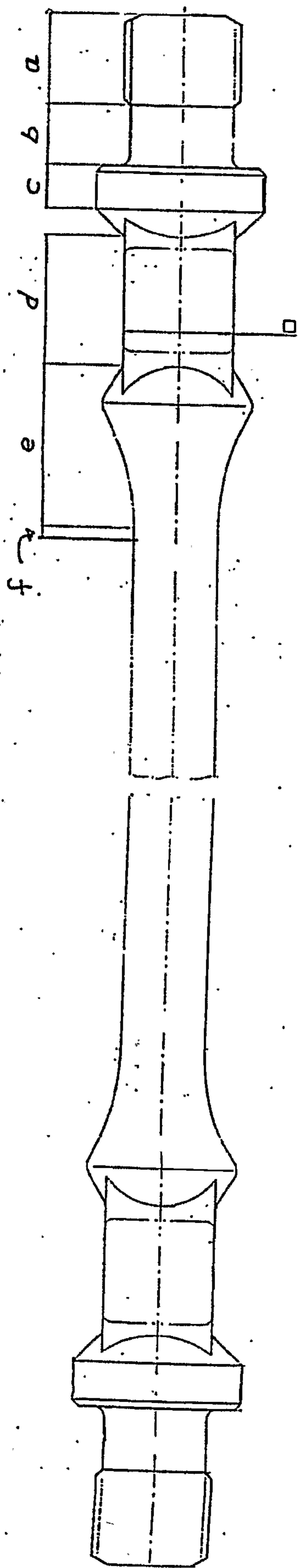


Fig. 1

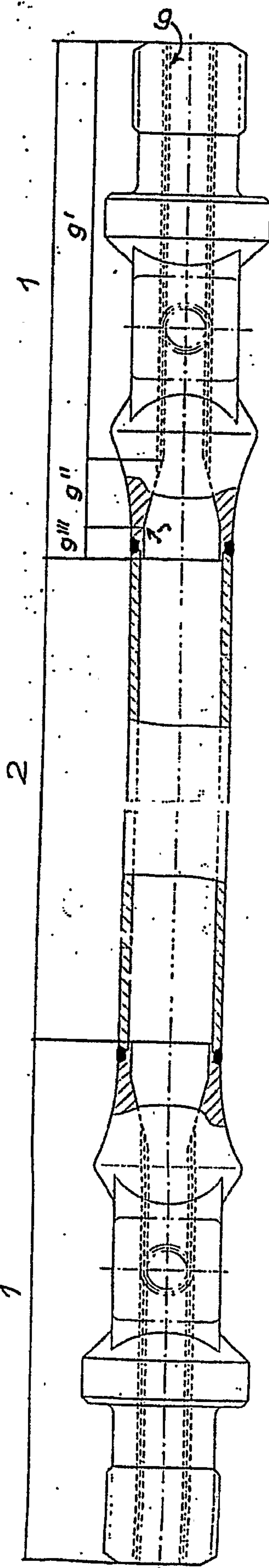


Fig. 2

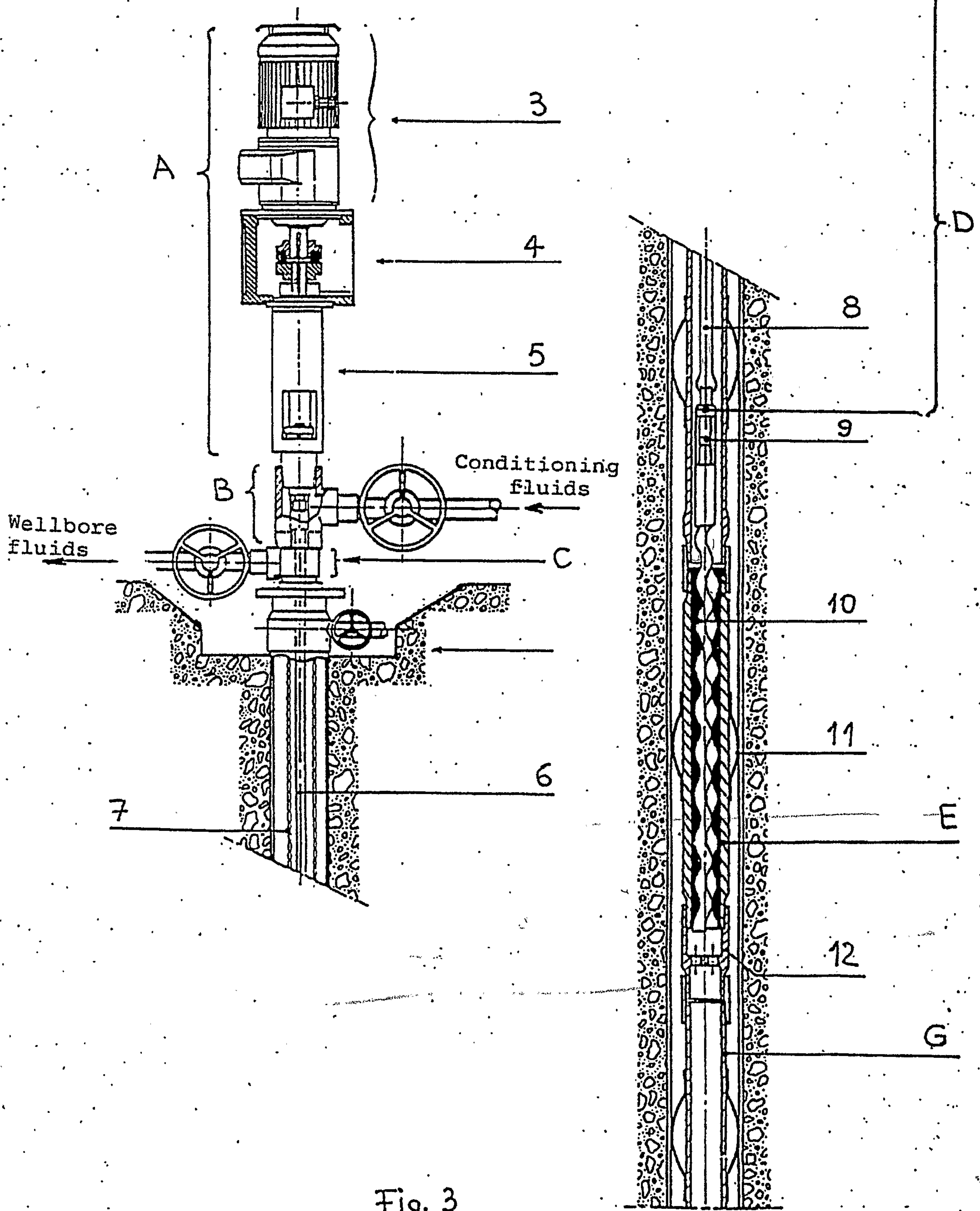


Fig. 3

