

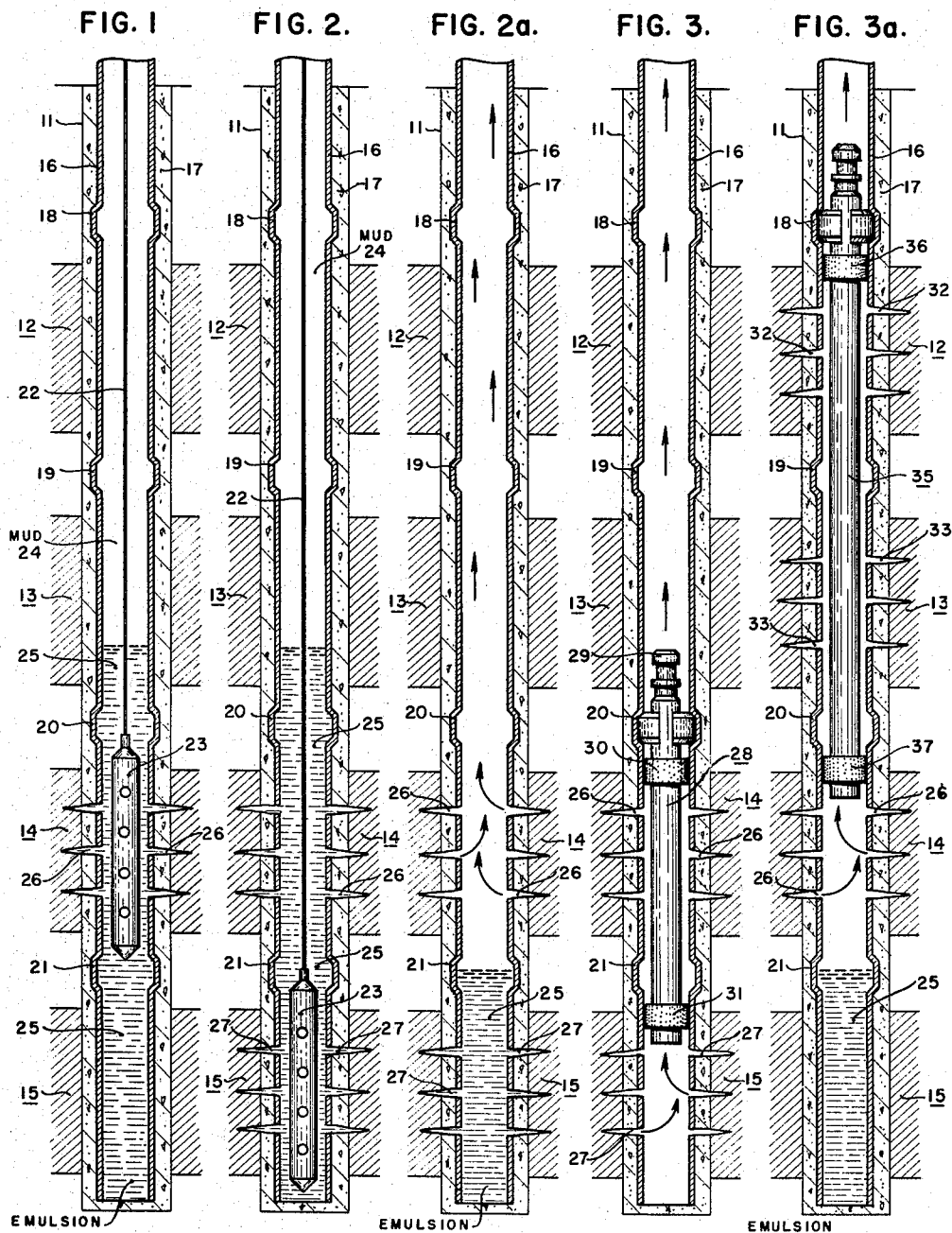
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COMPLETION OF TUBELESS WELLS

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COMPLETION OF TUBELESS WELLS

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The present invention is directed to a method for completion and working over of wells. More particularly, the invention is directed to completion and working over of tubeless wells. In its more specific aspects, the invention is concerned with a method for completing, working over, and producing from tubeless wells wherein cementing of perforated zones is avoided.

The present invention may be briefly described as a method for completing and working over a tubeless well penetrating a plurality of vertically spaced apart producing zones, the well having a casing therein lining the wall. In the present invention the casing is perforated in the first of said zones and also perforated in a second of the zones vertically spaced below the perforated first zone. A tubular member is lowered in the casing and sealingly positioned therein with its open upper end above and its open lower end below the perforated first zone to isolate the perforated first zone from the perforated second zone. Thereafter, well fluids are produced from the perforated second zone through the tubular member and the well casing.

In the practice of the present invention well fluids may be produced from the perforated first zone prior to perforating the second zone. Likewise, well fluids may be produced from the perforated first zone after perforating the second zone and prior to lowering the tubular member.

The well fluids produced in accordance with the present invention are suitably oil, gas, water, and the like, and other desirable earth fluids which are usually produced by drilling wells. While hydrocarbons will be produced ordinarily, it is contemplated that the present invention is not limited thereto.

The present invention is quite advantageous and useful in that it is unnecessary to provide a tubing in the well and therefore the invention is particularly advantageous in so-called "slim hole" drilling operations. Moreover, in a method as described herein where tubing is not employed in the well, ordinarily cementing operations may not be accomplished except by lowering the cement in a bailer and then removing the excess cement by bailing or drilling out. One great advantage of the present invention is that it is unnecessary to use cement to seal off perforated intervals.

In the present invention where the terminology "producing zone or zones" is used, it is contemplated that this language shall mean a producing horizon, zone, stratum or strata, formation, sand, and the like from which desirable earth fluids such as liquid or gaseous hydrocarbons or valuable gases such as helium and the like may be obtained.

The present invention will be further illustrated by reference to the drawing in which:

Fig. 1 shows the perforation of a well in an upper zone;

Fig. 2 shows the well perforated in an upper and a lower zone;

Fig. 2a illustrates the production from an upper perforated zone while the lower perforated zone is protected;

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Fig. 3 illustrates the production from a lower zone while the upper zone is isolated by employment of a tubular member, and

Fig. 3a illustrates the production from an intermediate zone after production from two upper zones with the lower zone having emulsion therein prior to perforation.

Referring now to the drawing in which identical numerals will be employed to designate identical parts, numeral 11 designates a well bore drilled from the earth's surface, not shown, to penetrate a plurality of subsurface earth intervals 12, 13, 14, and 15, all of which may be assumed to contain productive quantities of hydrocarbons. Arranged in the well bore 11 is a casing string 16 which is cemented therein with primary cement 17. The casing 16 is provided with a plurality of landing nipples, supporting or anchoring means 18, 19, 20, and 21, it being noted that the landing nipples 18 to 21 are spaced above the productive intervals 12, 13, 14, and 15, respectively. These landing nipples may be of the type illustrated at page 4063 of the Composite Catalog of Oil Field and Pipe Line Equipment, 19th ed., published by World Oil, Gulf Publishing Company, 1952-53. In Fig. 1 there is shown lowered on a wire line 22 from the earth's surface a perforator 23 which is illustrated as a shaped charge perforator but which may be a bullet gun perforator, a mechanical perforator, or one of the chemical type. Prior to lowering the perforator 23 on the wire line 22, preferably a portion of the drilling fluid 24 in and filling the casing 16 is displaced by introducing a body 25 of a clean fluid such as a heat stable emulsion, oil, and the like, which will not contaminate the several producing formations 12 to 15, inclusive, when contacted therewith. The body 25 of the emulsion or clean fluid may suitably be introduced into the well casing 16 in a container or bailer as may be desired to displace the drilling fluid. Since the clean fluid 25 displaces the drilling fluid, it must be of a controllable density and have a weight and viscosity sufficient to remain in place and displace the drilling fluid.

The perforator 23 is then operated in the body 25 to form perforations 26, penetrating the casing 16, cement 17, and the producing zone 14. It may then be desirable to produce from the zone 14 by lowering the hydrostatic head of fluid in the well casing 16 such that the hydrostatic head is less than the pressure of the productive zone 14, which will cause at least a portion of the body 25 and the drilling fluid 24 to be displaced by the producing hydrocarbons. This lowering of the hydrostatic head may be done by swabbing or by reducing the height of the column of fluid in the well such as by bailing as is conventional in the art.

If desired, however, the body 25 of the clean emulsion may be retained in the well casing 16 as shown in Fig. 2 and the perforator 23 lowered on wire line 22 to the region of producing zone 15 and again operated to form perforations 27 penetrating the casing 16, cement 17, and the producing zone 15. If desired the hydrostatic head in the well casing 16 may be reduced sufficiently as outlined above to allow production from zone 14 but insufficiently to allow production from zone 15 with the body of the emulsion being removed to a level below the perforations 26 but not to a level sufficient to expose the perforations 27, it being understood, of course, that the wire line 22 and perforator 23 would be removed from the well casing 16. Thus, by lightening the column of drilled fluid 24 such as by introducing gas thereto or by swabbing, the hydrostatic head in the well is reduced and the pressure in the productive zones such as 14 and 15 forces the body 25 ahead of the hydrocarbons to the earth's surface.

Production may be terminated from the zone 14 through perforations 26 and production initiated from

zone 15 either before or after zone 14 has been depleted of its productive capacity. It becomes necessary to isolate zone 14 from zone 15 and this is accomplished, as shown in Fig. 3, by lowering a tubular member 28, having wire line 22 attached thereto, by the fishing neck 29 and positioning the tubular member 28 with its upper end in the landing nipple 20 and sealingly engaged with the wall of the casing 16 with seal 30 and its lower end positioned in the landing nipple 21 and sealingly engaged with the wall of the casing 16 with seal 31. It is to be noted that the tubular member 28 is open on both ends and provides an opening for production of fluids therethrough and up the casing 16 to the well head. By adjusting the hydrostatic head of fluids in the well, it is now possible to produce from the zone 15 while isolating the zone 14 with the tubular member 28. This may be done by swabbing or by bailing to reduce the height of the column of fluid.

Referring now to Figs. 2 and 2a, it will be seen that zones 14 and 15 have been perforated to form perforations 26 and 27 as shown. The body of emulsion 25 has been reduced in level to above the perforations 27 but below the perforations 26 to allow production from the perforations 26 upwardly through the casing. When production is to be had from the perforations 27, the tubular member 28 would be positioned as shown in Fig. 3 and production obtained in accordance therewith.

Referring now to Fig. 3a, it may be assumed that production has been had sequentially from producing zones 12 and 13 and it is now desired to obtain production from producing zone 14, the production having been had through perforations 32 in zone 12, through perforations 33 in zone 13 and now it is desired to obtain production through perforations 26 in zone 14. To this end a tubular member 35 of sufficient length to extend through zones 12 and 13 is arranged with its upper end sealingly positioned in the landing nipple 18 and sealed adjacent its upper end with seals 36 and its lower end sealingly positioned on the landing nipple 20 and sealed adjacent its lower end with seals 37. It is now possible to produce from zone 14 with zones 12 and 13 isolated. When it is desired to produce from zone 15, which would be perforated as shown in Figs. 2, 2a and 3, a tubular member, such as 35 but of greater length, is placed in the well casing 16 with its lower end positioned on the landing nipple 21 and sealed with the wall of casing 16 and its upper end positioned on the landing nipple 18 and sealed with the wall of casing 16. In each instance in production from a particular zone, the hydrostatic head of fluid is reduced or lowered by swabbing or by bailing or by other means well known in the art such as by aerating the column of fluid or by inserting a small pipe string commonly known as a macaroni string of pipe and displacing the fluid in the well with a lighter fluid.

From the description taken with the drawing, it will be apparent that it is now possible to produce wells and recompleat in spaced apart productive zones without requiring the cementing of the wells. Also, it is possible to produce from several zones, using a well without a tubing, which results in a tremendous savings in expensive pipe. Furthermore, the operations such as shown in the description taken with the drawing avoids the use of expensive cement for recompletion operations, the perforated intervals are protected at all times from contaminating fluids and wire line operations may be used without maintaining an expensive derrick and lifting equipment on the well. The invention is, therefore, quite useful and advantageous.

The heat stable emulsion employed in the practice of the present invention may suitably be a fluid such as an emulsion of an oily phase and a water phase and the like. Suitable materials have been amply described in Serial No. 567,604, filed February 24, 1956, for Bryan E. Morgan and Gerald G. Priest, now U.S. Patent 2,805,722.

The fluids described in Serial No. 567,604 are eminently suitable in the practice of the present invention and comprise a stable emulsion of an oily medium and an aqueous medium which has a controllable density, the density of the emulsion being adjusted by dissolving a weighting agent in one of the phases of the emulsion to produce a solids-free emulsion. Other suitable protective fluids are described in pending application Serial No. 630,266, filed December 24, 1956, for Gerald G. Priest, Bryan E. Morgan and Bertie F. Birdwell, in which an emulsion of an oily phase and an aqueous phase is described and claimed, the emulsion in Serial No. 630,266 being a stable emulsion employing as an emulsifying agent a water-soluble salt of purified lignin sulfonic acid or a water-soluble salt of lignin sulfonic acid containing a certain amount of ash and reducing sugars. Other fluids suitable in the practice of the present invention are described in Serial No. 630,026, entitled "Well Completion Fluids" and filed December 24, 1956, for Gerald G. Priest, Bryan E. Morgan, Melba L. Lytle, Bertie F. Birdwell and Joseph A. Caldwell. In Serial No. 630,026 a heat stable, non-corrosive emulsion is described and claimed in which an emulsifying agent is employed and in which the oily phase of the emulsion comprises a substantial amount of tetrachloroethylene, with one of the phases of the emulsion containing a corrosion inhibitor. These several low filtration loss fluids described in the several applications have the characteristic of low filtration rate and further the characteristic of maintaining perforations open and exposed areas in wells protected without damaging or injuring the permeability and porosity of the formation or interval with which they come into contact. In short, the low fluid loss fluids suitable for use in the present invention have the characteristic of low filtration rate and of resisting entrance of other fluids into perforations in or into an earth formation. In addition, these fluids, particularly those described in the several applications, do not damage a formation or sand and the like with which they come into contact. These low fluid loss fluids, gels, or emulsions have the further property of forming a cohesive mass which does not readily substantially intermingle or mix with other fluids such as well fluids as exemplified by oil, gas, water and the like. The fluids or emulsions employed suitably have a low fluid loss, a weight at least equal to that of the normal working fluids employed for blowout protection in wells and are free of constituents which might permanently plug the formation or casing perforations. Thus, the fluids used in the practice of this invention block ingress of damaging fluids from the well to the formation but allow fluids from the formation to flow into the well bore on adjustment of the differential pressure into the well bore.

The nature and objects of the present invention having been completely described and illustrated, what I wish to claim as new and useful and secure by Letters Patent is:

1. A method for completing and working over a tubeless well penetrating a plurality of vertically spaced apart producing zones and having a casing therein, which comprises perforating said casing in a first of said zones and producing well fluids from said perforated first zone, terminating production from said first perforated zone by applying to said perforated first zone fluid pressure greater than the pressure of said perforated first zone and perforating said casing in a second zone vertically spaced below the perforated first zone, lowering a tubular member in said casing and sealingly positioning it in said casing with its open upper end sealed above and its open lower end sealed below the perforated first zone to isolate the perforated first zone from the perforated second zone, said perforated first zone being isolated while maintaining each of said perforated zones always open to said casing and then producing well fluids from the perforated second zone through the tubular member and the well casing.

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2. A method for completing and working over a tubeless well penetrating a plurality of vertically spaced apart producing zones and having a casing therein, which comprises perforating said casing in a first and second of said zones while maintaining said zones under control with a hydrostatic head of fluid greater than the pressure of said zones, the second zone being spaced vertically below the first zone, lowering a tubular member in said casing and sealingly positioning it in said casing with its open upper end sealed above and its open lower end sealed below the perforated first zone to isolate the perforated first zone from the perforated second zone, said perforated first zone being isolated while maintaining each of said perforated zones always open to said casing, producing well fluids from the perforated second zone through the tubular member and the well casing, terminating production from the perforated second zone by applying to said perforated second zone fluid pressure greater than the pressure of said perforated second zone, removing the tubular member from the well, and then producing well fluids from the perforated first zone.

3. A method for completing and working over a tubeless well penetrating a plurality of vertically spaced apart producing zones and having a casing therein, which comprises perforating said casing in a first of said zones and producing well fluids from said perforated first zone, terminating production from said first perforated zone by applying to said perforated first zone fluid pressure greater than the pressure of said perforated first zone and perforating said casing in a second zone vertically spaced below the perforated first zone, lowering a tubular member in said casing and sealingly positioning it in said casing with its open upper end sealed above and its open lower end sealed below the perforated first zone to isolate the perforated first zone from the perforated second zone, said perforated first zone being isolated while maintaining each of said perforated zones always open to said casing producing well fluids from the perforated second zone through the tubular member and the well casing, terminating production from said perforated second perforated zone by applying to said perforated second

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zone fluid pressure greater than the pressure of said perforated second zone, removing the tubular member from the well, and then resuming production of well fluids from the perforated first zone.

4. A method for completing and working over a tubeless well penetrating a plurality of vertically spaced apart producing zones and having a casing therein, which comprises perforating said casing in a first of said zones and perforating said casing in a second zone vertically spaced below the perforated first zone while maintaining said zones under control with a hydrostatic head of fluid greater than the pressure of said zones, lowering a tubular member in said casing and sealingly positioning it in said casing with its open upper end sealed above and its open lower end sealed below the perforated first zone to isolate the perforated first zone from the perforated second zone, said perforated first zone being isolated while maintaining each of said perforated zones always open to said casing and producing well fluids from the perforated second zone through the tubular member and the well casing.

5. A method in accordance with claim 4 in which well fluids are produced from the perforated first zone and production of said well fluids from said perforated first zone is terminated by applying to said perforated first zone fluid pressure greater than the pressure of said perforated first zone prior to perforating the second zone.

6. A method in accordance with claim 4 in which well fluids are produced from the perforated first zone after perforating the second zone and after production from said perforated second zone is terminated by applying to said perforated second zone fluid pressure greater than the pressure of said perforated second zone and prior to lowering the tubular member.

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