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[11] **3,924,677**

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[54] **DEVICE FOR USE IN THE COMPLETION OF AN OIL OR GAS WELL**

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[52] **U.S. Cl.** **166/100**

[51] **Int. Cl.²** **E21B 33/12**

[58] **Field of Search** 166/100, 223, 300, 315, 166/296

[56] **References Cited**

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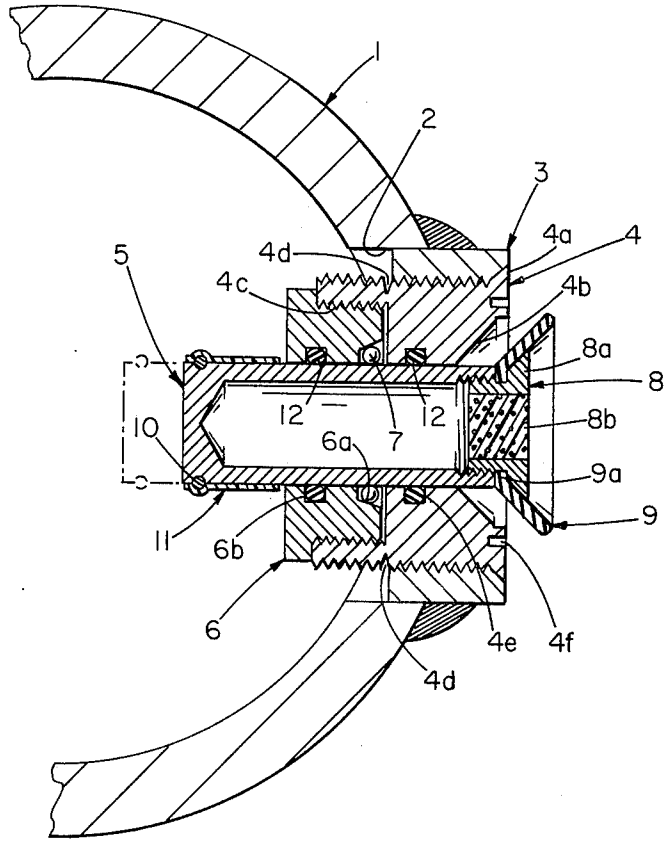
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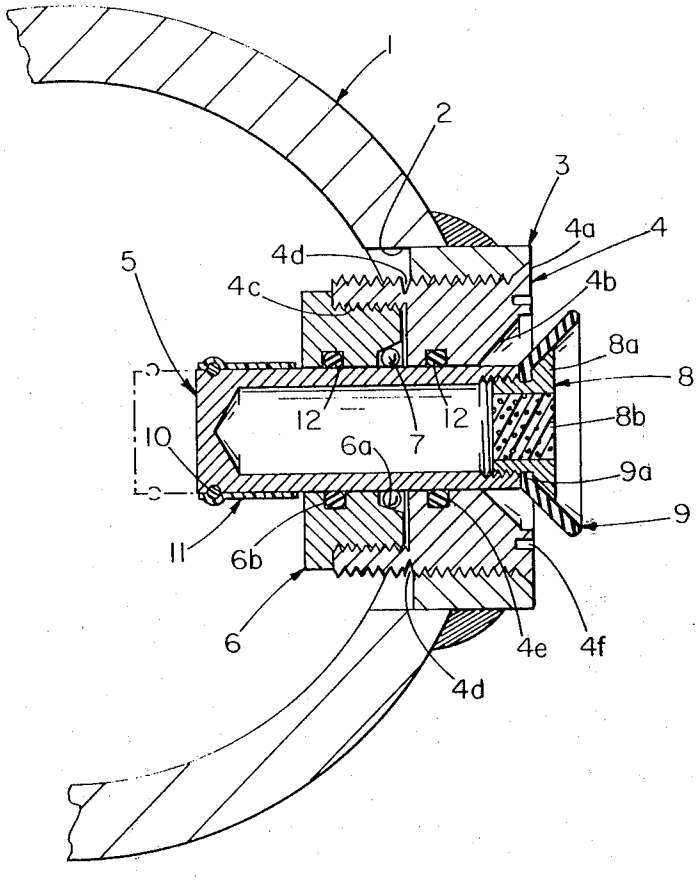
Primary Examiner—James A. Leppink

[57] **ABSTRACT**

Apparatus for providing a passage between an earth stratum and the interior of a well casing comprising a movable hollow conduit member mounted in the casing wall initially held retracted and immovable, while the casing is lowered, and subsequently, after the casing is set, extended outwardly from the casing wall to contact the stratum. A water soluable plug initially blocks the bore of the conduit member, and the apparatus includes removable means on each end of the plug for preventing premature contact of water with the plug.

16 Claims, 1 Drawing Figure




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4a
4
4d
4c
4b
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8a
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12
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8b
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6a
9a
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11
6b
6
4e
4f
4d

DEVICE FOR USE IN THE COMPLETION OF AN OIL OR GAS WELL

The present invention concerns a device used in the completion of an oil or gas well, in particular a device which is destined to form a passage between the oil- or gas-bearing strata and the interior of the well casing.

There are known a number of methods for completing oil or gas wells, as well as devices used in these methods. In general, the known methods comprise drilling a bore hole, lowering a casing provided with transversely mounted strata-connecting devices into the well, applying hydraulic pressure whereby the said devices are extended to make contact with said permeable strata, and cementing the annulus by forcing cement from the interior of the casing downwardly and around its bottom into the annular space between the casing and the bore hole. After the cement has set, the part of the connecting devices which are located within the casing must be removed by drilling apparatus lowered into the casing, or by acids or other chemicals which dissolve this part without damaging either other parts of the devices or the casing itself.

The requirements of said device for oil well completion are as follows: they must be easily adaptable to the differences in depth and spacing of oil or gas strata, i.e. the said devices must be easily and quickly mountable at the required positions in the casing wall at the drill site; they must provide a leakage-proof connection between the casing and the strata; they must be quickly and conveniently released, and after being released must permit any parts which extend into the casing to be quickly removed in order to leave the casing entirely free for the passage of production tools.

In one of the known methods, which is described and claimed in U.S. Pat. No. 2,707,997, the connecting device used therein is supported in the casing wall by a screw thread. This necessitates, on the one hand, a sufficiently thick casing wall to provide enough threads to support the device, and, on the other hand, the tapping of a hole in the casing wall at the drill site, an operation which is complicated and expensive. Furthermore, the removal of the parts of the connecting device, which extend into the casing after the device has been released, must be carried out by drilling, which is time-consuming and costly, or by the provision of an acid or other chemical, which may be dangerous and requires special precautionary measures. Moreover, in this known device, a filler substance, which seals the connection after the device has been released, requires dissolution by acid to open the passage between the oil- or gas-bearing strata and the casing. Extra equipment for acid and time for dissolving the substance must therefore be provided.

In another known method, described and claimed in U.S. Pat. No. 3,312,280, a connecting tool is provided having a connector sleeve mounted in, and transversely slidable relative to the casing wall by means of a spring mechanism held inactive by a link which is adapted to be destroyed by a chemical to release said mechanism to effect the connection between the casing and the oil-bearing strata. The bore hole must be made considerably larger than the diameter of the casing in order to provide room for the connecting tool and for the cementation, which is accomplished entirely exterior of the casing. Among the drawbacks of the connecting tool are its complicated construction and the fact that

casing sections of suitable lengths to correspond with the distance between the oil-bearing strata must be threaded at their ends in order to insert the section which includes said tool. This is both time consuming and expensive in operation. Furthermore, since cementation has never been carried out from the outside of the casing; suitable machinery is not readily available.

It is an object of the present invention to provide a technique for completing an oil or gas well which can be carried out quickly and effectively at the drilling site.

It is a further object of the present invention to provide a device for connecting the oil- or gas-bearing strata in wells with the interior of the casing, which device is extremely simple in construction overcoming all the above-mentioned drawbacks without sacrificing the fulfilment of any of the above-mentioned requirements.

The invention concerns a device used in the completion of an oil or gas well to provide a passage between the oil- or gas-bearing strata and the interior of the well casing. The device comprises a member mounted in the casing wall, but held immovable therein during the lowering of the casing into the well and being adapted for sliding transversely outwardly therefrom to contact said strata. The member is hollow, is initially closed at its inner end, and is held in means screwed into a mounting sleeve which is attached by welding around the hole in the casing wall. The member includes a stopper nut containing a mixture of salt and epoxy resin, the mixture being protected during the circulation and cementing processes carried out to complete the well. Upon breaking of the inner end of said member, the mixture will dissolve to provide a free passage between the casing and said strata through said member.

The invention is illustrated, by way of example only, in the accompanying drawings, in which:

FIG. 1 is a cross-section of part of a well casing provided with the device according to the invention, the device shown in a partially extended position.

A well casing 1 of known construction is provided with a hole 2 in its wall. This hole is made by means of a torch at the drilling site, the location of the hole and its spacing along the casing from other such holes being determined by means of conventional electronic logging equipment which determines the levels of the potential production strata. Into hole 2 the mounting sleeve 3 for the device is welded in a manner so as to extend outwardly for not more than one-half inch. The sleeve 3 is provided with an internal screw thread which is counter-sunk at the outer edge. A bearing nut 4, to house the transveresely-sliding member 5 in its axial bore, is screwed into mounting sleeve 3 from the outside. This bearing nut has a tapered outward flange 4*a* which sits in the counter-sunk part of sleeve 3. The bearing nut 4 has an axial conical depression 4*b* in its outer end and an axial internally threaded bore 4*c* at its inner end into which a check nut 6 is screwed. A peripheral groove 4*d* is made in the outer surface of bearing nut 4 in the vicinity of the bottom of bore 4*c* for a purpose to be described hereinafter.

The check nut 6 has an enlarged bore 6*a* surrounding its axial bore at its outer end, i.e., the end facing the outside of casing 1, the walls of said bore 6*a* being slightly conical and housing a plurality of check balls 7 for a purpose which will become clear hereinafter.

The sliding member 5, which extends through bearing nut 4 and check nut 6 is formed as a hollow tube

closed toward the inside. A salt stopper nut **8** is screwed into the open outer end of member **5** with the interposition of a substantially conical cup **9** held by its inner rim **9***a* between the member **5** and the stopper nut **8.** This stopper nut has an outer conical flange **8***a* which sits in, and is guarded by, the cup **9** and which is provided in its central bore with a filter **8***b* of salt held together by epoxy resin and protected by means of grease inserted into the member **5.**

Near the inner end of member **5,** an outer peripheral groove is provided in which a retaining ring **10** is disposed. The ring prevents the member **5** from falling out of the casing in case the member **5** is too short to reach the strata and also holds in position an elastic friction sleeve **11** slipped onto the inner end of member **5.**

Internal grooves **4***e* and **6***b* are provided in bearing nut **4** and check nut **6,** respectively to house O-rings **12** for preventing leakage and protecting check balls **7** against mud and cement, as will become clear hereinafter.

The device above described will be operated in the following manner:

After the well has been bored and logged, holes **2** are made in casing **1** by a torch at the required locations and sleeves **3** are fixed in said holes by welding. The device is now assembled, all parts except sliding members **5** being the same for all conditions. The diameter of said sliding member **5** will be constant, but its length will be chosen according to casing size and the space between the casing outer surface and the well bore. After the device has been assembled into the bearing nut **4** so that cup **9** sits in depression **4***b*, the said nut is screwed into sleeve **3,** recesses **4***f* being provided in the outer face of the nut so that a spanner wrench can be applied to tighten it.

The friction sleeve **11,** which is preferably made of a tube of PVC, prevents the member **5** from sliding outwardly during the lowering of the casing into the bore.

A known flexiflow fill up collar, equipped with a shear plate, and a known rubber seal-off plate on top of the collar is added above the casing before the latter is lowered into the bore hole. Since, normally, the casing is empty or only partly filled during this lowering operation, the external pressure will hold the member **5** in place and prevent it from sliding outwardly prior to the circulation operation, which, conventionally is effected as soon as the casing is in place. At this stage the shear plate will have built up enough pressure to push the sliding member **5** outwardly, overcoming the resistance of sleeve **11.**

Normally, during circulation enough pressure is created to force the member **5** outwardly. The use of the known shear plate which creates a higher pressure, assures that there is enough pressure to penetrate the mud cakes which are found opposite the permeable strata.

After circulation is established and the member **5** is extended, cementation of the annulus is performed, as known per se. During this operation the cup **9** protects the salt stopper nut **8.** Following cementation, a cementing ball, as used in the known cement retainer and having the ability to float on the cement and to sink in the mud, is inserted on top of the cement, the size of the said ball being chosen so that it can pass by the parts of the device which protrude into the interior of the casing. Thereafter the displacement operation is carried out, at the end of which said ball will hit the known rubber seal-off plate, whereby an over displacement is prevented while sufficient pressure is built up to hold the sliding member **5** in its extended position. However, should this pressure be reduced for any reason, the check balls **7** will prevent the return of member **5** since they are forced by the slanted wall of bore **6***a* against the wall of member **5** to hold it in place by friction.

After the cement has set, a bit is lowered into the casing to knock off the part of the device extending into the casing, an operation which is made very easy and exact because of groove **4***d* provided in bearing nut **4** and the fact that member **5** is preferably made of relatively fragile material, such as cast iron, which has the additional advantage of being easily drilled with conventional drill bits, in case the break is not clean. Thus, the casing is free for the passage of production tools, such as packers, bridge plugs, etc. The casing is swabbed, as known per se, which will cause the salt plugs to dissolve to open member **5** from both sides. Where the casing is swabbed dry, and acidation or other stimulation is required, the stimulating fluid will easily penetrate the formation through the permeable salt plugs and will dissolve them.

It can be seen that the assembly of this device is simple and its mounting into the casing wall can be effected quickly, since only the sleeve **3** needs to be welded into the casing at the site. The operation of the device is automatic, leakage of mud or liquid cement into the interior of the casing through the bores of the bearing and check nuts being prevented by the O-rings.

We claim:

1. An apparatus for providing a passage between an earth stratum and the interior of a well casing comprising a movable hollow conduit member mounted in the casing wall initially held retracted and immovable while the casing is lowered and subsequently after the casing is set extended outwardly from the casing wall to contact said stratum, a dissolvable plug initially blocking the bore of said conduit member, the improvement wherein said plug is water soluable and said apparatus includes removable means on each end of said plug which prevent premature contact of said plug by water.

2. The improvement as claimed in claim **1** wherein said plug comprises a mixture of salt and a bonding agent.

3. The improvement as claimed in claim **2** wherein said bonding agent is an epoxy resin.

4. The improvement as claimed in claim **1** wherein said means protecting said plug comprises a layer of grease disposed on the outer end of said plug.

5. The improvement as claimed in claim **4** wherein said means further comprise an end cap on the inner end of said conduit member.

6. The improvement as claimed in claim **5** wherein said end cap is integral with said conduit member.

7. The improvement as claimed in claim **1** wherein said conduit member is movably supported in a hollow mounting unit disposed in a hole in said casing wall, a peripheral groove being provided around the outer surface of said mounting unit.

8. The improvement as claimed in claim **1** wherein said conduit member is movably supported in a hollow mounting unit disposed in a hole in said casing wall, said mounting unit comprising a mounting sleeve in a bearing nut disposed therewithin and supporting said conduit member, said bearing nut being flush at the outside with said sleeve and extending into the casing, a bore being provided at its inner end, a check nut dis-

posed in said bore, the conduit member being held in the axial bores of the bearing nut and check nut.

9. The improvement as claimed in claim **8** wherein a peripheral groove is provided around the outside of the check nut.

10. The improvement as claimed in claim **8** wherein internal grooves are provided in the axial bores of the bearing and check nuts and sealing rings are disposed in said grooves.

11. The improvement as claimed in claim **8** including check means to prevent movement of said conduit member toward the interior of said casing wall.

12. The improvement as claimed in claim **11** wherein the outer end of said check nut is provided with an enlarged bore surrounding its axial bore, the walls of said enlarged bore being slightly conical, said check means comprising a plurality of check balls disposed in said enlarged bore.

13. The improvement as claimed in claim **1** wherein near the inner end of said conduit member retaining means are provided for preventing the overextension of said conduit member.

14. The improvement as claimed in claim **13** wherein said retaining means comprise an outer peripheral groove in said conduit member and a retaining ring disposed in said groove.

15. The improvement as claimed in claim **1** including restraining means to prevent the premature outward sliding of said conduit member, said restraining means comprising a plastic sleeve disposed around the outer surface of the inner end of said conduit member.

16. The improvement as claimed in claim **15** further including an outer peripheral groove in said conduit member near the inner end thereof and a retaining ring disposed in said groove, a portion of said plastic sleeve overlying said restraining ring.

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