Dec. 12, 1961 C. F. McLAREN, JR 3,012,608

ORIENTATION OF PERFORATING GUNS IN WELLS

Filed Dec. 1, 1958 3 Sheets-Sheet 1

FIG. 1.

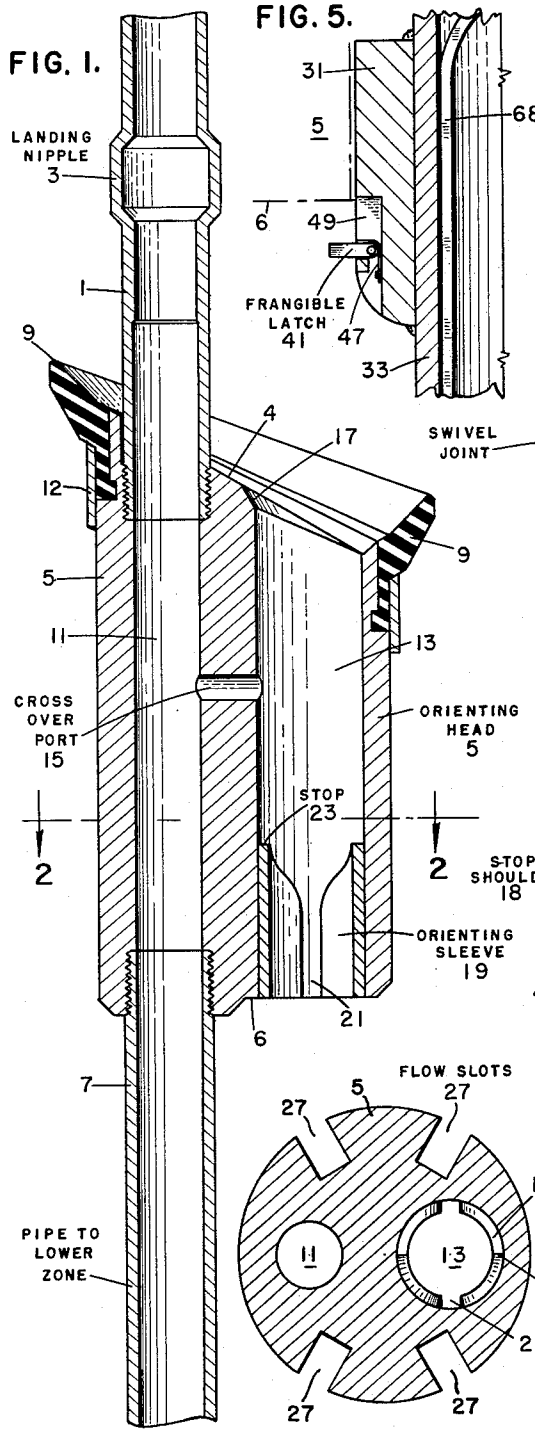


FIG. 5.

FIG. 3.

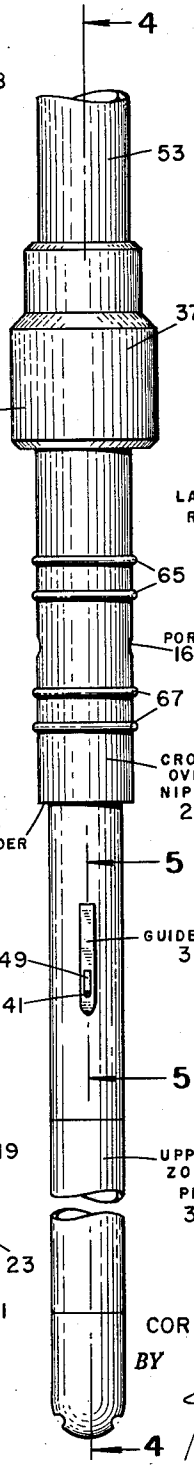


FIG. 4.

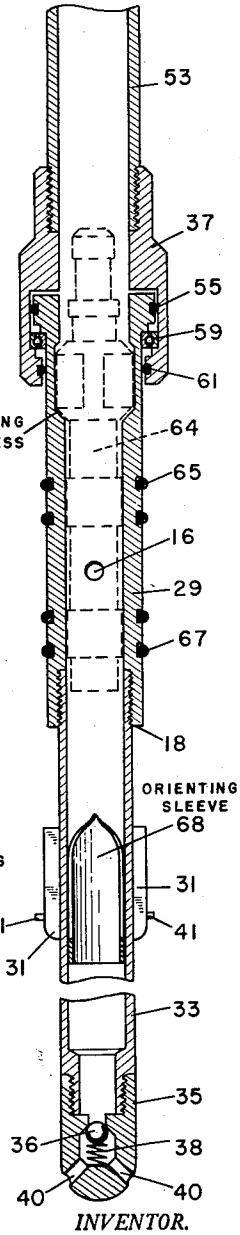


FIG. 2.

INVENTOR.
CORNELIUS F. McLAREN JR.,
BY John B. Davidson
ATTORNEY.

Dec. 12, 1961 C. F. McLAREN, JR 3,012,608

ORIENTATION OF PERFORATING GUNS IN WELLS

Filed Dec. 1, 1958 3 Sheets-Sheet 2

FIG. 9.

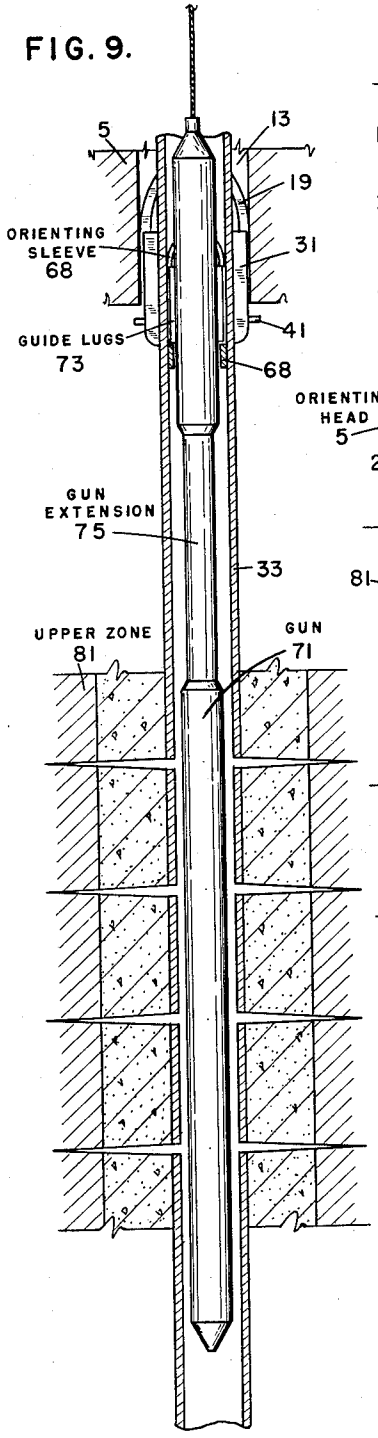


FIG. 6.

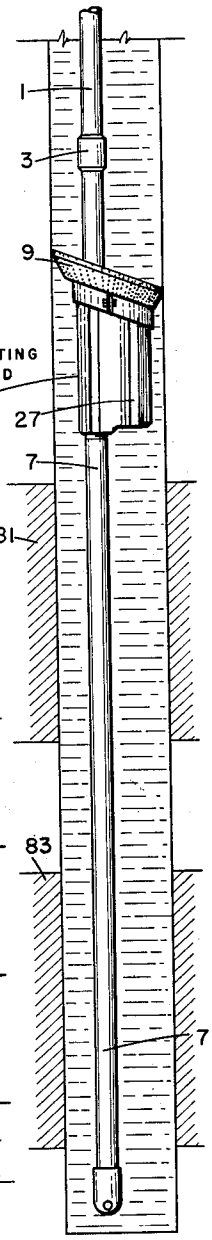


FIG. 7.

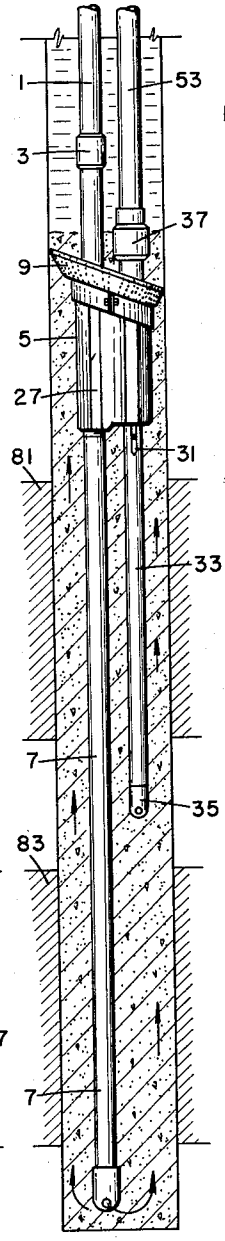
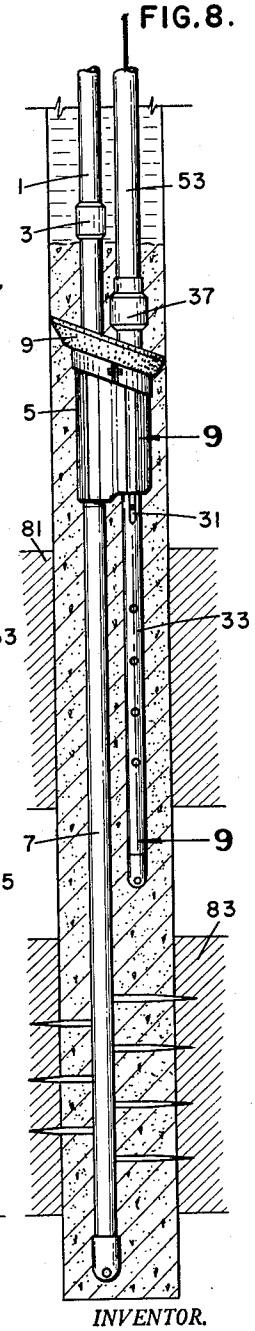


FIG. 8.



INVENTOR.
CORNELIUS F. McLAREN JR.,
BY John B. Davidson
ATTORNEY.

Dec. 12, 1961 C. F. McLAREN, JR 3,012,608

ORIENTATION OF PERFORATING GUNS IN WELLS

Filed Dec. 1, 1958 3 Sheets-Sheet 3

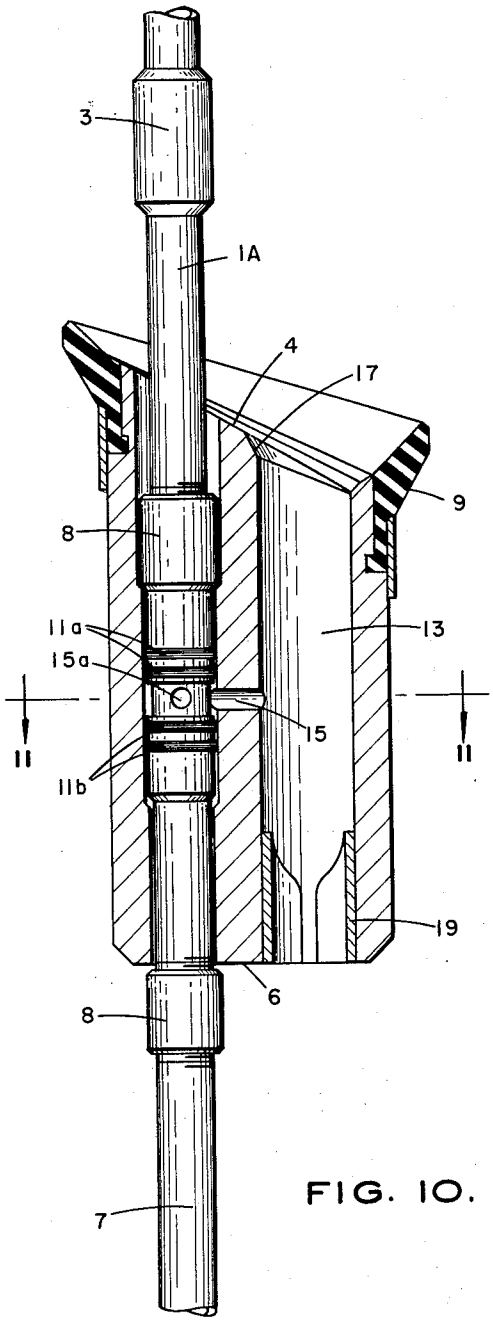


FIG. 10.

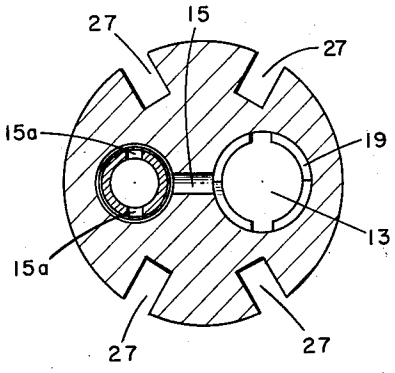


FIG. 11.

INVENTOR.
CORNELIUS F. McLAREN JR.

BY John B Davidson

ATTORNEY.

United States Patent Office 3,012,608
Patented Dec. 12, 1961

3,012,608
ORIENTATION OF PERFORATING GUNS IN WELLS

Cornelius F. McLaren, Jr., Houston, Tex., assignor, by mesne assignments, to Jersey Production Research Company, Tulsa, Okla., a corporation of Delaware

Filed Dec. 1, 1958, Ser. No. 777,470
7 Claims. (Cl. 166—55)

This invention relates to the completion of wells in the earth, and more particularly to the orienting of a perforating gun in one of a plurality of pipe strings in a borehole so that only the pipe string enclosing the gun will be perforated thereby.

When it is desired to complete a well for the production of hydrocarbons such as natural gas and petroleum, it is customary to bond a casing to the earth with cement and to perforate the casing and cement at depths whereat the casing is surrounded by hydrocarbon-containing earth formations. When more than one casing is to be lowered into a single borehole, the perforating gun, or other perforating means, must be oriented to perforate only the casing within which the gun is disposed. It is possible to simultaneously lower a plurality of mechanically interconnected pipe strings into the earth with mechanical orienting means incorporated therein; however, this is a very slow and difficult operation and suffers from the disadvantage that mud circulation must be stopped for a very long time. Manifestly, it is more desirable to quickly lower a single pipe string into the earth, recommence mud circulation, and then lower the other string or strings into the hole. The well then can be cemented and the pipe strings individually perforated. Manifestly, the perforating means must be positively oriented so that only the pipe string within which the perforating means is disposed will be perforated.

This invention contemplates the use of an orienting head attached to a pipe string (casing). The orienting head may be integral with a coupling member for the pipe string, or may be mechanically affixed to the pipe string in any convenient manner. Within a longitudinal bore in the orienting head is included a pipe section orienting means such as a slotted orienting sleeve adapted to receive the lower end of a second pipe string to be stabbed into the bore. The stabbing extension of the second pipe string is similarly equipped with mechanical orienting means for a perforating device to be lowered through the second pipe string. Thus, the stabbing extension of the second pipe string may be oriented by the relatively simple operation of stabbing it into the longitudinal bore. The perforating gun may be lowered through the second pipe string and will be oriented with respect to the first pipe string when it engages the mechanical orienting device in the second pipe string.

To facilitate stabbing the second pipe string into the longitudinal bore, the upper face of the orienting head may be dished toward the bore and a semi-flexible, upwardly extending skirt or flange is fitted about the upper edge of the orienting head. The stabbing extension of the second pipe string will engage the flange and will be guided toward the head, and the dished portion of the head thereafter will guide the stabbing extension toward the longitudinal bore.

The invention will be described in detail with reference to the accompanying drawings, wherein:

FIG. 1 is a cross-sectional side view of a pipe orienting head and well pipe sections used in connection with the invention;

FIG. 2 is a cross-sectional view taken along section 2—2 of FIG. 1;

FIG. 3 is an elevational view of a gun orienting stabbing section;

FIG. 4 is a cross-sectional view taken along section 4—4 of FIG. 3;

FIG. 5 is an enlarged cross-sectional view taken along section 5—5 of FIG. 3;

FIGS. 6, 7, and 8 illustrate successive operations in a borehole for completing a well in accordance with the teachings of this invention; and

FIG. 9, taken along the line 9—9 of FIG. 8, is a view of a perforating gun positioned in a pipe in accordance with the present invention.

FIGS. 10 and 11 are views similar to FIGS. 1 and 2 illustrating a modification of the present invention.

With reference to FIG. 1, there is shown a well pipe comprising sections 1 and 7 connected together by orienting head or body member 5 through a longitudinal bore 11 therein. Another longitudinal bore 13 in the orienting head is interconnected with bore 11 through crossover port 15. Upper pipe section 1 may have a landing nipple 3 for landing permanent well completion tools when permanent well completion operations are contemplated and/or for landing a blank-off sleeve when it is desired to shut off the crossover port 15 in the orienting head 5 through pipe section 1. Pipe sections 1 and 7, respectively, may be screw-threaded into orienting head 5 at the upper and lower ends of bore 11 to provide a continuous passageway from pipe 1 to pipe 7.

Orienting head 5 may be provided with an upper face 4 that is slanted with respect to lower face 6. Bore 11 opens into face 4 at the upper end of the slanted section thereof, and bore 13 opens into face 4 at the lower end of the slanted face. At least a portion 17 of the upper face may be dished toward bore 13 to facilitate the stabbing operations to be described below. A similar dished face construction for a packer is shown at page 936 of the 1957 edition of the "Composite Catalog of Oil Field Equipment and Services."

To further facilitate the stabbing operation to be described below, a semi-flexible, upwardly extending skirt or flange 9 is affixed around the upper end of orienting head 5 by a clamp 12. The flange should form a continuous dished surface with the upper face of the orienting head 5, and may extend outwardly from orienting head 5 toward the sides of a borehole within which the pipe is to be lowered. The flange need not seal the borehole but should extend near the side of the borehole to prevent the stabbing section from passing below the orienting head. The flange may be constructed of a rubber-like material, such as neoprene or other synthetic compound, and may be reinforced, if necessary, to prevent the stabbing section to be described below from passing the orienting head as it is lowered into the well. One reason that the flange should be semi-flexible is to prevent hang-ups when the orienting head is lowered through the narrow sections of the borehole. The orienting head may be integral with a coupling member for pipe sections 1 and 7, as shown in FIG. 1. However, if it is so desired, the pipe sections 1 and 7 may be joined together by a pipe coupling section 1A (see FIGS. 10 and 11), and the orienting head may be clamped to one of the pipes by clamping collars 8 screw-threadedly engaging the coupling section. If the operational advantages of crossover port 15 are to be retained with this latter manner of construction, ports 15A opening into an annular groove in the coupling section, cooperating with crossover port 15, must be provided along with suitable sealing means 11 and 11B between the well pipe and the orienting head above and below the ports 15A.

As shown in FIG. 2, flow slots 27 are provided in orienting head 5 for the purpose of circulating fluid past

the orienting head 5 and flexible skirt 9. The flow slots are deep enough to run beneath skirt 9.

A pipe orienting means, shown here as an inserted orienting sleeve member 19, is affixed to orienting head 5 at the lower end of bore 13. Sleeve 19 has an upper stop shoulder 23 and an orienting slot or camming surface 21. Slot 21 is rather wide at the top end of sleeve 19 and is tapered downwardly to facilitate engagement of an orienting guide lug or cam.

A second pipe string 53 to be lowered into a borehole with pipe string 1 is affixed by swivel coupling 37 to a stabbing extension including crossover nipple 29 affixed to an upper zone pipe 33. The crossover nipple 29 and upper zone pipe 33 may be screw-threaded together as shown in FIG. 4. A port 16 may be provided in crossover nipple 29 for the purpose of providing fluid communication between the interiors of pipe 53 and pipe 1. Sealing means 65 and 67 are positioned above and below port 15 to provide a fluid seal between the crossover nipple and the sides of bore 13. Crossover nipple 29 should have an outside diameter slightly less than the inside diameter of bore 13. Likewise, upper zone pipe 33 should have an outside diameter slightly less than the inside diameter of orienting sleeve 19.

As shown most perspicuously in FIG. 5, an orienting guide lug 31 is affixed to the exterior of upper zone pipe 33. When stop shoulder 18 abuts against stop 23, the guide lug should project slightly below lower face 6 of orienting head 5. A spring biased frangible latch 41 is pivotally mounted at the bottom of a recess 49 in guide lug 31. When the guide lug is in position within the orienting sleeve 19, the latch snaps outwardly under the impetus of spring 47 to oppose upward movement of upper zone pipe 33.

The lower end of upper zone pipe 33 may include a valve section 35. Valve section 35 includes a ball check valve comprising ball member 36 spring biased into position by spring 38. The ball check valve permits fluid flow downwardly through the interior of upper zone pipe 33 and outwardly through ports 40, but prevents fluids from passing upwardly through the upper zone pipe 33.

The swivel coupling 37 includes a bearing race 59 and sealing members 55 and 61. The purpose of the swivel coupling is to allow the crossover nipple 29 and upper zone pipe 33 to rotate freely to facilitate engagement of guide lug 31 in slot 21 and to facilitate orientation of the crossover nipple and upper zone pipe.

Within the upper zone pipe 33 near the upper end thereof there is provided an orienting sleeve 68 similar to orienting sleeve 19. The function of orienting sleeve 68 is to orient a perforating gun or other device which may be lowered through well pipe 53 into upper zone pipe 33. Like orienting sleeve 19, orienting sleeve 68 has a tapered groove for the purpose of engaging lugs on a perforating gun to orient the gun within the sleeve. Near the upper end of crossover nipple 29 a landing recess 63 may be provided to receive a pack-off nipple 64 that functions to seal off port 15 when it is not desired to use the crossover port. For example, when it is desired to produce through pipe string 53, pack-off nipple 64 may be inserted into the pipe until it lands in landing recess 63. The pack-off nipple has conventional sealing means similar to sealing means 65 and 67, that are adapted to be above and below port 15 when the landing means thereof is in landing recess 63. A suitable pack-off nipple is the Otis side door choke nipple with retrieving head described at page 4140 of the "Composite Catalog of Oil Field Equipment and Services," 1957 edition. The side port will thus be blocked to adapt the pipe 53 and pipe 1 for aligned flow. The pack-off nipple may be similarly inserted through pipe 1 and landed in landing nipple 3 if insertion in this manner is more convenient.

Where the plug method of cementing is used and crossover port 15 in incorporated in orienting head 5, a frangible disc or plug will be required to be inserted in the entrance from bore 11 to crossover port 15. This cementing method requires a full bore for passage of the cementing plug so that use of pack-off nipple 64 would be too restrictive. The frangible disc or plug would be so constructed that it could be blown from crossover port 15 after completion of the cementing process by application of pressure in either string 1 or 53 to an amount in excess of that required during the cementing process.

FIGS. 6, 7, and 8 show successive steps in a well completion operation utilizing the orienting means for the present invention. As shown in FIG. 6, pipe string 1 is lowered into the well until orienting head 5 is a predetermined distance above upper producing zone 81. Pipe string 53 is thereupon lowered into the well and stabbed into bore 13 of orienting head 5. The crossover nipple and upper zone pipe 33 will swivel until orienting lug 31 fits into orienting groove 21. Upper zone pipe 33 will protrude past the orienting head to the depth of the upper producing zone 81. Cement may be circulated down pipe string 1 and up the borehole, through flow slots 27 (FIG. 2) until it fills the borehole either to the earth's surface or to a given distance above orienting head 5. Cement may also be circulated to properly protect formation 83 through pipe string 1 and then through string 53 to properly protect formation 81; this method of cementing may be used when a long interval exists between the two formations. A perforating gun thereupon may be lowered into pipe 1 past the orienting head to the depth of lower zone 83, as shown in FIG. 8, and detonated to perforate the lower portion of pipe string 1 and the surrounding cement; the gun orienting lugs 73 and gun extension 75 are not required for the operation. The gun 71 then may be retracted and lowered into pipe string 53. The guide lugs 73 on the gun will engage the slots in orienting sleeve 68, as shown in FIG. 9, and the gun will turn on its wire line until it has been properly oriented by the sleeve 68. The gun thereupon may be detonated to perforate upper zone pipe 33 and the surrounding cement.

As used herein when applied to flange or skirt 9, the term "semi-flexible" means that the flange or skirt 9 is sufficiently flexible to yield to downward pushing of the pipe string 1 when the diameter of the borehole becomes less than the normal diameter of the skirt 9 so that the skirt can be lowered to its operating depth in the borehole, but not so flexible that it will yield to the force of pipe string 53 and permit the pipe string 53 to pass between the skirt and the sides of the borehole.

There has been described an apparatus and method for perforating a pipe string in a borehole containing more than one pipe string, without damaging the other pipe string that may be producing hydrocarbons from a different, lower producing zone. Manifestly, pipe strings do not need to be simultaneously run into a borehole when the present invention is followed. The apparatus is simple and straightforward and free of operational complexities.

While one embodiment of the invention has been described, manifestly various modifications may be made without departing from the spirit and scope of the invention. Therefore, the foregoing description is to be considered as illustrative and not in a limiting sense.

What is claimed is:

1. Apparatus for orienting a perforating gun in a first pipe string in a borehole relative to a second pipe string in the same borehole, comprising: a body member affixed to the second pipe string, said body member having a longitudinal bore extending therethrough substantially parallel to the second pipe string; an elongated gun orienting member connected to the first pipe string, and operatively fitting into said longitudinal bore, said gun orienting member having orienting lug means protruding therefrom, and having orienting means therein for mechanically orienting a perforating gun therewithin; and an orienting sleeve within said bore, said sleeve includ-

ing camming surface means adapted to engage said orienting lug means to orient said gun orienting member relative to the second pipe string.

2. Apparatus for orienting a perforating gun in a first pipe string in a borehole relative to a second pipe string in the same borehole, comprising: a body member affixed to the second pipe string, said body member having an inclined upper face and a longitudinal bore extending therethrough substantially parallel to the second pipe string; an elongated gun orienting member connected to the first pipe string operatively fitting into said longitudinal bore; at least a portion of said inclined upper face being downwardly dished toward said longitudinal bore to facilitate stabbing of said elongated gun orienting member into said longitudinal bore by guiding the lower end of said gun orienting member toward said bore as said gun orienting member is lowered in the borehole after contacting said inclined face, said gun orienting member having orienting lug means protruding therefrom and having orienting means therein for mechanically orienting a perforating gun therewithin; and an orienting sleeve within said bore, said sleeve including camming surface means adapted to engage said orienting lug means to orient said gun orienting member relative to the second pipe string.

3. Apparatus for orienting a perforating gun in a first pipe string in a bore hole relative to a second pipe string in the same borehole, comprising: a body member affixed to the second pipe string, said body member having an inclined upper face; a longitudinal bore extending through said body member substantially parallel to the second pipe string; an elongated gun orienting member connected to the first pipe string and operatively fitting into said longitudinal bore; at least a portion of said inclined upper face being downwardly dished toward said longitudinal bore to facilitate stabbing of said elongated gun orienting member into said longitudinal bore by guiding the lower end of said gun orienting member toward the bore as said gun orienting member is lowered in the borehole after contacting said inclined face, said gun orienting member having orienting lug means protruding therefrom and having orienting means therein for mechanically orienting a perforating gun therewithin; an orienting sleeve within said bore, said sleeve including camming surface means adapted to engage said orienting lug means to orient said gun orienting member relative to the second pipe string; a semi-flexible skirt extending upwardly from said inclined face toward the sides of said borehole, said skirt being adapted to facilitate the directing of said gun orienting member toward the dished portion of said inclined face; and at least one flow slot through said body member adapted to permit passage of fluids past said body member and skirt.

4. Apparatus for orienting a perforating gun in a first pipe string in a borehole relative to a second pipe string in the same borehole, comprising: a body member affixed to the second pipe string, said body member having an inclined upper face and a longitudinal bore extending therethrough substantially parallel to the second pipe string; an elongated gun orienting member connected to the first pipe string, and operatively fitting into said longitudinal bore; at least a portion of said inclined upper face being downwardly dished toward said longitudinal bore to facilitate stabbing of said elongated gun orienting member into said longitudinal bore by guiding the lower end of said gun orienting member toward the bore as said gun orienting member is lowered in the borehole after contacting said inclined face, said gun orienting member having orienting lug means protruding therefrom and having orienting means therein for mechanically orienting a perforating gun therewithin; an orienting sleeve within said bore, said sleeve including camming surface means adapted to engage said orienting lug means to orient said gun orienting member relative to the second pipe string; a semi-flexible skirt extending upwardly from said inclined face toward the sides of said borehole, said skirt being adapted to facilitate the directing of said gun orienting member toward the dished portion of said inclined face; and at least one flow slot through said body member adapted to permit passage of fluids past said body member and skirt; and a crossover port in said body member adapted to permit fluid passage between said longitudinal bore and said second pipe string.

5. Apparatus for orienting a perforating gun in a first pipe string in a borehole relative to a second pipe string in the same borehole, comprising: a body member affixed to the second pipe string, said body member having an inclined upper face and a longitudinal bore extending therethrough substantially parallel to the second pipe string; an elongated gun orienting member connected to the first pipe string operatively fitting into said longitudinal bore; at least a portion of said inclined upper face being downwardly dished toward said longitudinal bore to facilitate stabbing of said elongated gun orienting member into said longitudinal bore, said gun orienting member having orienting lug means protruding therefrom and having orienting means therein for mechanically orienting a perforating gun therewithin; an orienting sleeve within said bore, said sleeve including camming surface means adapted to engage said orienting lug means to orient said gun orienting member relative to the second pipe string; a semi-flexible skirt extending upwardly from said inclined face toward the sides of said borehole to facilitate the directing of said gun orienting member toward the dished portion of said inclined face by guiding the lower end of said gun orienting member toward the bore as said gun orienting member is lowered in the borehole after contacting said inclined face; at least one flow slot through said body member adapted to permit passage of fluids past said body member and skirt; a crossover port in said body member adapted to permit fluid passage between said longitudinal bore and said second pipe string; first and second sealing means on said elongated gun orienting member positioned between said gun orienting member and the surface of said bore, said first and second sealing means being respectively above and below said crossover port; and a second port in said gun orienting member between said sealing means adapted to permit fluid communication between said crossover port and the interior of said gun orienting member.

6. Apparatus for orienting a perforating gun in a first pipe string in a borehole relative to a second pipe string in the same borehole, comprising: a body member affixed to the second pipe string, said body member having a longitudinal bore extending therethrough substantially parallel to the second pipe string; an elongated gun orienting member operatively fitting into said longitudinal bore; a swivel coupling connecting said gun orienting member to said first pipe string; said gun orienting member having orienting lug means protruding therefrom and having orienting means therein for mechanically orienting a perforating gun therewith; and an orienting sleeve within said bore, said sleeve including camming surface means adapted to engage said orienting lug means to orient said gun orienting member relative to the second pipe string.

7. Apparatus for orienting a perforating gun in a first pipe string in a borehole relative to a second pipe string in the same borehole, comprising: a body member affixed to the second pipe string, said body member having a longitudinal bore therewithin substantially parallel to the second pipe string; an elongated gun orienting member operatively fitting into said longitudinal bore; gun orienting means within said gun orienting member for mechanically orienting a perforating gun therewithin; a cam on said gun orienting member; and an orienting member within said bore having a camming surface for

engaging said cam to orient said gun orienting member relative to the second pipe string.

References Cited in the file of this patent

UNITED STATES PATENTS

1,318,352	Cameron et al.	Oct. 14, 1919
1,896,104	Simmons	Feb. 7, 1933
2,178,540	McNeese et al.	Nov. 7, 1939
2,212,491	Appleby	Aug. 27, 1940
2,500,754	Huber	Mar. 14, 1950
2,785,754	True	Mar. 19, 1957
2,828,698	Bryan	Apr. 1, 1958
2,850,099	Brown	Sept. 2, 1958
2,922,479	Kinley	Jan. 26, 1960
2,938,584	Tausch et al.	May 31, 1960