BL O/185/06

7 July 2006

PATENTS ACT 1977

APPLICANT Schlumberger Holdings Limited

ISSUE Whether patent application number GB 0327108.7 complies with section 1(1)(b)

HEARING OFFICER R C Kennell

DECISION

Introduction

1 The above application was filed on 21 November 2003 and claimed a priority date of 19 December 2002 from an earlier US application. It was published under serial number GB 2396369 on 23 June 2004.

2 In the initial examination report dated 26 February 2004 the examiner found the claims unclear and cited two United States patent specifications:

US 2002/0096040 (Barker et al), published 25 July 2002
US 4960171 (Parrot et al), published 2 October 1990

(hereinafter "Barker" and "Parrott") to demonstrate possible lack of novelty or inventive step. The specification was subsequently amended to clarify the scope of the invention and a divisional application (not in suit) has been filed. However, the examiner maintained that even after amendment, the claims still lacked an inventive step as required by section 1(1)(b) of the Act.

3 Correspondence with the applicant's patent agent, Mr Brian D Stoole of Sensa, failed to resolve the matter, which therefore came before me at a hearing on 23 March 2006 attended by Mr Stoole and the examiner (Mr Robert Crowshaw).

4 At the hearing Mr Stoole argued that the claims as they then stood (ie as amended on 14 September 2005) were inventive over Barker and Parrott, but nevertheless proposed further amendments to bring out the difference more clearly. These limited the claims by reliance on a feature whose inventiveness was in some doubt and would need to be established. After the hearing the examiner conducted a partial supplementary search yielding three further United States specifications:

US 5964294 (Edwards et al), published 12 October 1999
US 4637478 (George), published 20 January 1987
US 4523649 (Stout), published 18 June 1985

(hereinafter "Edwards", "George" and "Stout") which appeared relevant to the matter. The Office therefore wrote to Mr Stoole on 10 April 2006 inviting his comments on these documents; Mr Stoole in his reply on 10 May did not think that they made out any case for lack of inventive step.

5 Since Mr Stoole has maintained that the claims as amended on 14 September 2005 were inventive, I propose to determine the allowability of both sets of claims.

The application as amended on 14 September 2005

The invention

6 The application is directed to perforating guns which are used to produce perforation tunnels in a subterranean formation for the extraction of well fluids. Such a gun comprises radially oriented shaped explosive charges which are detonated to produce perforating jets after the gun is lowered into a wellbore which extends through the formation. As the specification explains, the charges are generally arranged in a spiral "phasing pattern", along a helical path which circumscribes the longitudinal axis of the gun, although it is also conventional to use a planar phasing pattern, with the charges being located in planes whose surface normals are parallel to the longitudinal axis.

7 The performance of the gun is determined by parameters known as the shot density - the spacing between adjacent charges, typically expressed shots per foot - and the phasing angle - the angle between adjacent charges. As the specification explains, well productivity is relatively insensitive to the phasing angle, at least for spiral patterns over a phase angle range of 45 - 150˚. However, productivity is generally a function of the cross-sectional diameter of the perforation tunnels, and in general this is smaller, and the productivity lower, if the perforating jet has to propagate across a significant water "boundary" such as may exist between the perforating gun and the far inner surface of the casing string which lines the surface of the wellbore. (The term "boundary" is used in the specification but as Mr Stoole confirmed at the hearing it is more appropriate to regard this as a barrier rather than a boundary. For convenience, however, I will retain the term "boundary" in this decision.)

8 The solution proposed in the specification is to arrange the shaped charges so that they extend only partly around the longitudinal axis of the gun, typically by arranging for the phasing pattern to be non-existent over a particular arc or "wedge" around the axis; the gun is then oriented in the well so that the charges in the remaining portion are directed away from the water boundary. The well productivity has been found to be only slightly reduced by the provision of such a wedge provided the shot density is maintained constant.

9 This is illustrated in Figures 7 and 8

FIG. 7

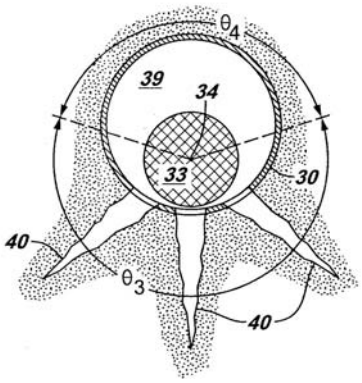
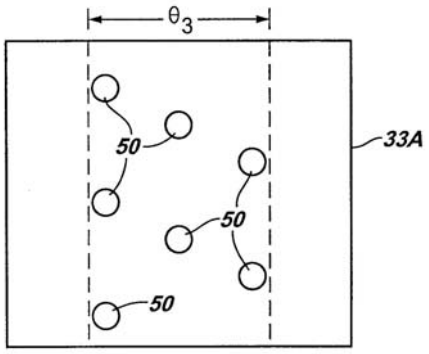


FIG. 8



where the gun 33 is arranged to produce tunnels 40 across angle θ3 but not across angle θ4 where there is a substantial water boundary 39 between the gun and the casing 33. The shaped charges 50 are spirally phased over angle θ3, with no charges being present in the portion of the gun which is outside that angle.

10 In the 14 September 2005 claims, claim 1 is the single independent claim and reads (emphasis added):

> "A method usable with a subterranean well, the method comprising:
> orienting shaped charges of a perforating gun to extend partially around a longitudinal axis of the gun so that the shaped charges have different angles about the longitudinal axis;
> **orienting the perforating gun in the well to direct the shaped charges away from a water boundary**; and
> after orienting the perforating gun, detonating the shaped charges."

11 The dispute centres around the highlighted integer of the claim, and to put this matter in context it will be helpful to quote in full the passage on page 7 of the specification which describes the orientation mechanism in more detail:

> "In some embodiments of the invention, the perforating gun 33 includes an orientation mechanism to orient the perforating gun 33 so that the arcuate section of the perforating gun 33 corresponding to the θ3 perforating angle is against or at least close to the inner wall of the casing string 30. More specifically, in some embodiments of the invention, this orientation mechanism may be a passive orientation system that responds to gravitational force to orient the perforating gun 33 so that the arcuate section of the perforating gun 33 corresponding to the θ3 perforating angle is rotated to rest on the bottom interior surface of the casing.
>
> As an example of one such orientation mechanism, the perforating gun 33 may include shaped charges 41 that include radially oriented shaped charges directed over the θ3 perforating angle. Between these sections 41 or alternatively distributed throughout these sections 41 are eccentering weights 58. A swivel 59 couples the perforating gun 33 to the string 56. In response

to the gravitational force on the perforating gun 33, the eccentering weights in combination with the swivel 59 rotate the perforating gun 33 so that the shaped charges of the perforating gun (over the θ3 perforating angle) are rotated to the rest of (*sic*) the bottom interior surface of the casing string 30. Other orienting mechanisms and orienting techniques may alternatively be used in other embodiments of the invention."

The citations

12 **Barker** is directed to a perforating gun in which the shaped charges are phased to maximize the production of oil and gas. Figure 6 illustrates the problem which Barker is trying to overcome: it shows a 60˚ phasing, in which six charges are each offset by 60˚ from the previous charge. However, because no well is perfectly vertical, gravity pulls the gun against the low side of the casing with the result that the three charges firing across the largest distances between the gun and the casing have little impact on the formation to be penetrated (see particularly paragraphs [0007], [0009]). With a view to overcoming this difficulty, the specification illustrates at Figures 5, 7 (see below) and 8 a number of charge offset patterns which orient the charges so that they produce perforating jets over only a restricted portion of the circumference of the gun, approximately in the location where the gun rests against the low side of the well.

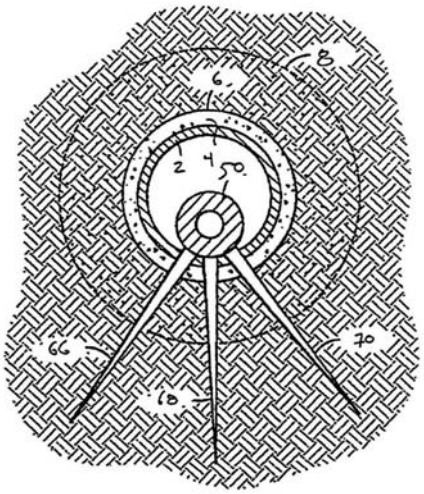


FIG. 5

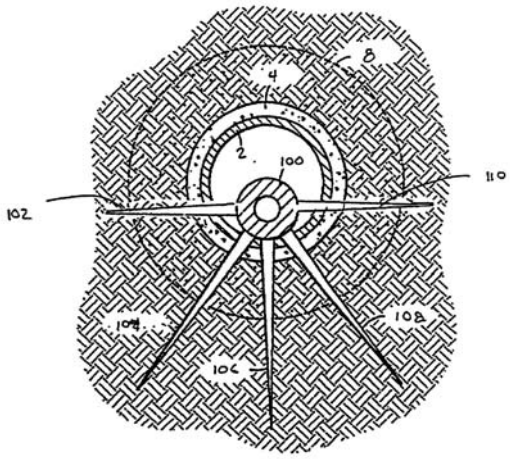
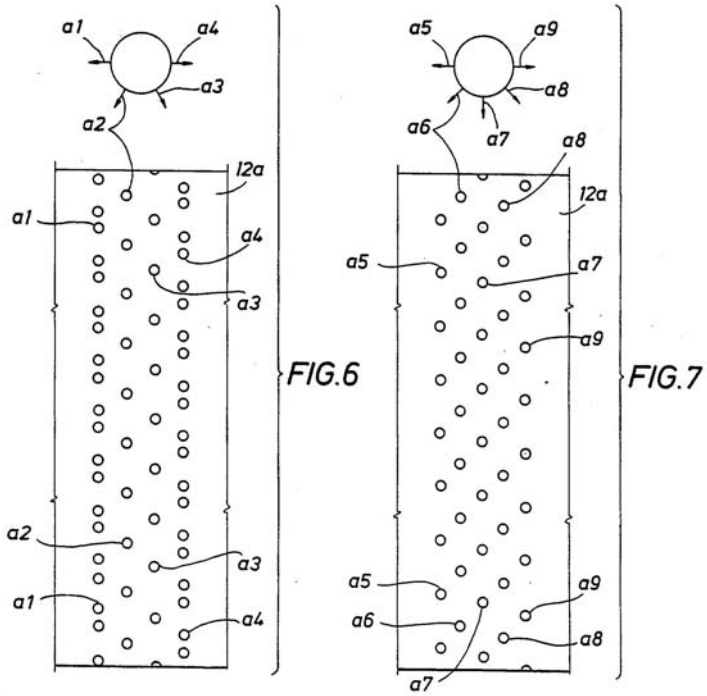


FIG. 7

No mention is made of any water boundary in the remaining area, or indeed of the possible presence of any extraneous fluids in the wellbore.

13 **Parrott** is directed to the selection of shot density and phasing pattern so as to optimize the flow rate of fluid from the formations being perforated and maintain adequate casing strength after perforation. It illustrates gun constructions in which the charges are disposed to produce jets across a portion only of the gun circumference, particularly in deviated or substantially horizontal wellbores in which gravity causes the gun to rest at the lowest portion of the bore. The closest embodiments to the present invention are

shown in Figures 6 and 7



14 In Figure 6 four rows of recesses a1, a2, a3, a4 accommodating the charges are disposed with an angular spacing of 60˚ and a density of 10 shots per foot over a 180˚ partial circumference of the gun, such that there are twice as many recesses in each of rows a1 and a4 as in either of rows a2 and a3; rows a2 and a3 normally rest on or near the surface of the casing in a deviated borehole. As the specification explains, this pattern is stated to prevent the casing from being split in half when the charges are detonated. The spaces between each of rows a1 and a4 and the casing include well fluids, whilst the corresponding spaces in the case of rows a2 and a3 contain very little, if any, well fluids. The specification states that the charges in a1 and a4 perform better than those in a2 and a3 because they are shooting through a relatively increased amount of wellbore fluid; this combined with the higher percentage of charges in a1 and a4 maximises gun performance even though only half the borehole is being perforated. The nature of the fluid is unspecified.

15 In Figure 7 there are five rows of recesses a5, a6, a7, a8, a9 with an angular spacing of 45˚ and a density of 9 shots per foot, again over 180˚ of the circumference. All the rows have an equal number of charges and in general each of the rows has fewer recesses per foot than rows a1 and a4 in Figure 6; this is stated to have the advantage over the Figure 6 embodiment of a higher remaining external collapse strength after perforation.

Arguments

16 The view taken by the examiner was that each of the citations showed a construction which oriented the charges towards the casing wall by means of gravity: this would displace any well fluid upwards so that the charges would be oriented away from any fluid boundary. Merely specifying the fluid as water

would not constitute an inventive step since – and I did not understand this to to be in dispute - it was well-known to operate perforating guns in all types of fluid, including water.

17 On the other hand Mr Stoole argued that the invention was distinguished from the citations because there was no clear teaching in them of either the orientation of the charges away from water or of how the orientation of the gun was carried out. On the first point, he said that Barker was equivocal on the subject, whilst Parrott pointed the other way since it specifically stated that the charges perform better after shooting through increased amounts of wellbore fluid. On the second point he said that both citations merely stated that the gun was oriented in a particular way without saying how it was done.

18 I observed at the hearing that the apparent difference between Parrott and the present invention might be explained by Figure 6 of the application in suit showing a graph of the cross-sectional diameter of the entrance hole of a perforation tunnel (a measure of productivity) versus the water clearance for the corresponding shot. This graph does indeed show that there is a point beyond which the larger is the water clearance the smaller is the entrance diameter. However the entrance diameter actually rises from a value of 0.6 at zero clearance to (approximately) 0.75 at a 0.75 clearance (the units of measurement are not specified) before falling sharply away as the clearance increases further. I suggested that the increased diameter region would probably correspond to the region of increased efficiency associated with rows a1 and a4 in Figure 6 of Parrott. Mr Stoole did not think this interpretation could be squared with the overall teaching of the citation which was not really concerned with minimizing the amount of fluid between the casing wall and the gun, and which also included arrangements in which charges were not biased in one direction.

19 Referring to Barker, the examiner drew attention at the hearing to the discussion of the prior art pattern of Figure 6 in paragraph [0009], which explained that because of the gun resting on the low side of the casing only three of the six phases shown would penetrate past the damaged zone caused by drilling and on into the hydrocarbon-bearing formation. Thus the examiner saw the idea underlying Barker as being to orient the charges away from the "wasted" upper regions of limited penetration and towards the bottom where there would be less fluid anyway – effectively the same reasons for orienting as in the present invention. Mr Stoole took the view that Barker was really all about the relative spacing of the charges from the damage zone, the lower ones but not the upper being close enough to penetrate it. The examiner however pointed out that these spacings would determine the diameters of the holes penetrating the formation, which would relate to the teaching of the application in suit about maximizing productivity.

Analysis

20 Having considered the above points I am not persuaded by Mr Stoole's arguments. On the point that there is no disclosure of how the gun is oriented, I accept that in neither of the citations does the orientation appear to happen other than by the passive action of gravity causing the gun to sink to the lowest

point. I am not entirely clear whether Mr Stoole is maintaining that such passive means cannot constitute an actual step of orienting which claim 1 specifically requires. However, I see no reason why that should be the case, and I note that the first paragraph of the passage from page 7 that I have quoted above refers to passive means.

21 More importantly, I do not think the absence from either of the citations of a specific direction that the charges are oriented away from a water boundary can of itself be relied on to distinguish them. It seems to me that the arrangements in the citations are essentially the same as that of the invention and must be presumed to produce the same effect with respect to any water boundary that is present - even if that effect is not their stated purpose. To my mind, Mr Stoole has produced no convincing argument or evidence to rebut that presumption.

22 With the above in mind, if I adopt the well-known structured analysis in *Windsurfing International v Tabur Marine* [1985] RPC 59, the difference between the invention as defined in claim 1 and the prior art lies in orienting the charges so as to be directed away from a water boundary – the other features of claim 1 are present in each of the cited documents. Would this step have been obvious to the man skilled in the art of well-drilling? In the absence of any indication as to a particular meaning to be attached to "water", I construe the claim as requiring that the method be carried out in a well actually containing water as such, as distinct from any mud or fluid which may contain some water, and I accept that neither citation makes a specific reference to water as such being present in the well. However, it does not seem to be in dispute that fluids will generally be present in the course of drilling a well – indeed Mr Stoole accepted at the hearing that almost invariably some mud or fluid would be present - or that perforating guns can be operated in the presence of all types of fluid likely to be encountered downhole, including water. Neither specification places any restriction on the wellbore conditions for which the gun is appropriate, and in my view the man skilled in the art of well drilling would read either of them with the expectation that the drilling methods they describe could be carried out in a wellbore containing water. By doing this he would be led to carry out a method which would inevitably orient the gun and the charges so as to direct the charges away from a water boundary. Even if that was not a result he would have expected, such a method would still be within the ambit of claim 1. The "unexpected bonus" does not impart an inventive step.

23 I therefore conclude that claim 1 lacks inventive step over both Barker and Parrott.

24 The examiner considered also that the remaining claims 2-11 lacked inventive step. However this matter was not argued in depth either before or at the hearing, although Mr Stoole accepted that some of these were unsatisfactory and proposed to delete them. I will return to the remaining dependent claims later.

The proposed further amendments

25 As I have mentioned, at the hearing Mr Stoole proposed to amend the claims further. Although not accepting that the claims as they stood lacked inventive step, he wished to clarify how the orientation was achieved. To that end he proposed to amend the claims as follows:

> "1. A method of operating a perforating gun which is eccentrically positioned in a subterranean well, the method comprising:
> orienting shaped charges of the perforating gun to extend partially around the longitudinal axis of the gun in a phasing pattern that has a missing arcuate section;
> **using a gravity operated swiveling orientation mechanism to rotate the perforating gun in the well** so as to direct the shaped charges away from a water boundary; and
> after rotating the perforating gun, detonating the shaped charges.
>
> 2. The method of claim 1, further comprising:
> selecting a shot density; and
> orienting the shaped charges to maintain the shot density.
>
> 3. The method of claim 1, wherein orienting the shaped charges comprises orienting the shaped charges to have a spiral phasing pattern.
>
> 4. The method of claim 1, wherein orienting the shaped charges comprises orienting the shaped charges to have a planar phasing pattern.
>
> 5. The method of claim 1, wherein the perforating gun is eccentrically disposed with respect to the longitudinal axis of a casing string within the well.
>
> 6. The method of claim 5, wherein the water boundary comprises water between an inner surface of the casing string and the exterior of the perforating gun."

26 It will be seen that the difference from previous claim 1 lies essentially in the use of a gravity operated swiveling mechanism to direct the charges. At the hearing there was some speculation that the use of swivels and weights might now be commonplace, but it was common ground that a supplementary search would be necessary to establish whether this was so at the priority date of the application. After the hearing the examiner carried out a partial search which yielded the three further documents mentioned above.

The further citations

27 **Edwards** is directed to the accurate positioning of downhole tools, noting that a horizontal well perforated on the lower side of the casing is less likely to become plugged with sand or to collapse the adjacent formation than one perforated on its upper side. To that end the tool may include a ballast chamber containing dense flowable particulate material such as tungsten or depleted uranium to offset the gravitational centre of the tool from its longitudinal axis so that it can be rotated to the appropriate position. A swivel mechanism may be provided between the firing head and the tool to enable

the tool to rotate and to reduce the length of the rotating components. No reference is made to the presence or otherwise of fluids in the well.

28 **George** is directed to a construction of perforating gun for use in a deviated, substantially horizontal portion of a borehole so as to direct the charges substantially downward. Rotatable charge carriers in the gun each have a plurality of charges oriented to fire in a pattern encompassing less than 180˚ and are constructed so that the centre of gravity is below the geometrical centre. The charge carriers will therefore adjust and ride inside the housing of the gun as it is passed into the well. The specification refers (see column 1) to the necessity of keeping a string of perforating guns hermetically sealed to prevent water from entering the gun string and damaging the detonating cord, and of being able to operate in an environment where the borehole is filled with well fluids such as mud. A flushing fluid can also be sent downhole (see S in Figure 1). However no clear reference is made to operating in a well where water as such is present.

29 **Stout** is also directed to securing the downward direction of the charges in a perforating gun disposed in a non-vertical part of the well casing. A swivel connects the gun to a tubular conduit extending from the well head, thus allowing the gun to rotate. Three rows of charge containers in the gun are angularly spaced by 120˚ and a rib on the exterior of the gun biases the gun to rotate gravitationally to position where the rib is uppermost and the bottom of the gun contacts the casing. The rib in this position lies above a row of blank containers so that the charges in the remaining rows are directed downwards. No reference is made to the presence or otherwise of fluids in the well, except in relation to the prior art (see reference to well flushing and gravel packing fluids at column 1)

Argument and analysis

30 Mr Stoole submitted that in none of these documents is the gun rotated so as to direct the charges away from a water boundary and that the selection of these (and indeed the earlier citations) is an example of ex post facto analysis based on hindsight.

31 I do not believe this to be the case of ex post facto analysis. As with the earlier citations I accept that none of the documents disclose orientation away from a water boundary. However, as with Barker and Parrott, the three new citations are directed to the use of perforating guns in non-vertical boreholes so as to direct the charges downwards. It appears to me that for the reasons I have explained above they would also have the effect of directing charges away from a fluid boundary. In consequence, and since in each case a gravity-operated swiveling mechanism to orient the gun is specifically disclosed, I consider that the proposed amended claim 1 lacks inventive step over each of the new citations.

32 Alternatively, in my view these documents are such as would be read and considered in combination with Barker and Parrott by the man skilled in the art of well drilling – all five documents are concerned with perforating deviated

boreholes and are not restricted as to the wellbore conditions in which the gun may be used. I believe that the skilled man reading Edwards, George and Stout would appreciate that a gravity operated swiveling mechanism could be used to orient the charges in either Barker or Parrott. I do not therefore believe that the introduction of this feature into claim 1 imparts an inventive step over Barker or Parrott.

Conclusion and next steps

33 In conclusion, I find that claim 1, both as amended on 14 September 2005 and as proposed to be further amended, does not involve an inventive step.

34 I will make no finding on whether any of the remaining claims lack inventive step as this matter was not fully argued before me. However as regards those dependent claims which Mr Stoole is proposing to retain (claims 2-6, corresponding to previous claims 2-4/10,11) it seems to me arguable that some at least of these relate to conventional features or arrangements.

35 I will therefore give the applicant a period of **two months** from the date of this decision to submit amendments to overcome my finding. Since it is specified in relation to proceedings before the comptroller, by virtue of section 117B(5) of the Act this period cannot be extended as of right under section 117B(2). If no amendment is filed, the application will be treated at the end of the period prescribed by rule 34 as having been refused under section 20(1).

Other matters

36 There are a number of other matters outstanding. For example, the description will eventually need revision to bring it into accord with the claims. Also, and this was a point which arose at the hearing, it appeared to be common ground that the term “water boundary” was misleading, since the aim of the invention was to direct the charges away from a body or barrier of water rather than from a boundary between water and something else. If the application proceeds I will refer it to the examiner to deal with this and any other outstanding matters.

37 In the correspondence prior to the hearing, the examiner drew attention to the file wrapper correspondence in the USPTO public access site pertaining to prosecution of the equivalent US application, which had raised similar objections. It emerged at the hearing that a patent had now been granted on that application. However, no argument based on the US examination was put to me, and I therefore take no account of it in reaching this decision. If the present application proceeds, it will be for the examiner to consider whether any of the file wrapper correspondence is still relevant to its prosecution.

Appeal

38 Under the Practice Direction to Part 52 of the Civil Procedure Rules, any

appeal must be lodged within 28 days.

R C KENNELL
Deputy Director acting for the Comptroller