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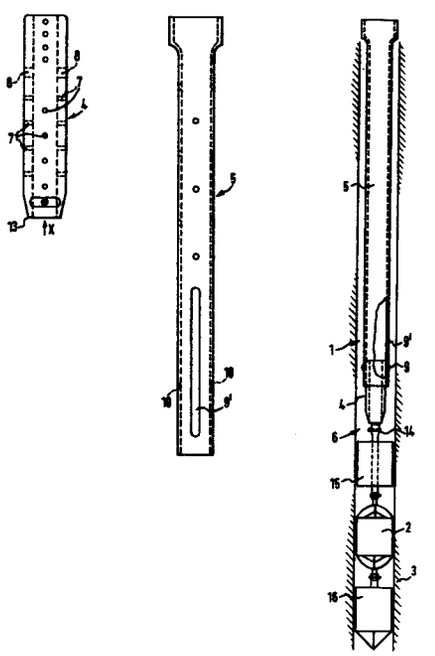
(71) Applicant: **C-E VETCO UK LIMITED, Devanha House Riverside Drive, Aberdeen, AB1 2SL Scotland (GB)**

(72) Inventor: **Smetham, James Nigel, 18, Western Place, Aberdeen, AB1 9QL Scotland (GB)**
Inventor: **Lazari, Lazaris, 135 Gairn Terrace, Aberdeen Scotland (GB)**

(74) Representative: **Johnson, Terence Leslie et al, Edward Evans & Co. Chancery House 53-64 Chancery Lane, London WC2A 1SD (GB)**

(54) Explosion compensator.

(57) A compensator 1 for supporting an explosive severing device 2 in a bore hole 3 below a well head (not shown) and for damping forces arising on explosion of the explosive severing device 2 in the bore hole. The compensator 1 comprises two parts 4 (Figs. 1 to 4) and 5 (Figs. 5 and 6) mounted for relative longitudinal slidable motion. One part 4 has means 6 for supporting the explosive device 2 in the bore hole 3, and at least one of the parts (in this case both parts 4 and 5) has means in the form of through holes 7 for dissipating laterally, upwardly directed forces arising on explosion of the device in the bore hole.



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EXPLOSION COMPENSATOR

The invention relates to a compensator for supporting an explosive severing device in a bore hole below a well head and for damping forces arising on explosion of the explosive severing device in the bore hole.

In the oil industry it is usually the practice in sub-sea drilling to remove a well head once a well is found to be dry or depleted of recoverable oil and/or gas reserves. The well is plugged, cemented and all structures above about 3 metres beneath the mudline are removed, often using an explosive severing device lowered into the bore hole or well. Such explosive devices are usually effective, but can have disadvantages such as through water shock, which can damage neighbouring structures such as ships in the vicinity.

It is accordingly an object of the invention to seek to mitigate this disadvantage.

According to one aspect of the invention there is provided a compensator for supporting an explosive severing device in a bore hole below a well head and for damping forces arising on explosion of the explosive severing device in the bore hole, comprising two parts mounted for relative longitudinal slidable motion one of which has means for supporting the explosive device in the bore hole, the arrangement of the two parts being such as to dissipate upwardly directed forces arising on explosion of the device in the bore hole.

The parts may comprise through holes each of which may have a central axis lying substantially at right angles to the axis of longitudinal slidable motion.

The two parts may comprise two cylindrical elements, mounted one within the other, and there may be guide means connecting the two parts for said longitudinal slidable motion.

The guide means may comprise opposed longitudinal slots in the external one of the parts and two opposed projecting locking pins of the internal one of the parts, each pin passing through a respective adjacent slot of said opposed longitudinal slots.

The pins may each include a restraining device preventing

removal thereof from the respective slot.

The restraining device may comprise a locking ring.

The inner one of the two cylindrical parts may have a tapered nose comprising said means for supporting the explosive device in the bore hole.

The tapered nose may include a transverse slot and opposite bore for receiving pin means for connecting the explosive device with the compensator.

The compensator may include means to ensure alignment of the compensator when landing the compensator in the bore hole.

The alignment means may comprise a shear pin means extending through the two parts transversely to the axis of longitudinal motion, whereby the pin shears on imposition of a longitudinal shear force.

According to a second aspect of the invention there is provided an explosive severing system including a compensator as hereinbefore defined, and an explosive device supported by the one part.

The system may include a packer assembly between the one part and the explosive device.

There may be a further packer assembly suspended from the explosive device.

A compensator, and an explosive severing system embodying the invention is hereinafter described, by way of example, with reference to the accompanying drawings.

Fig. 1 is a side elevation of a first part of the compensator according to the invention;

Fig. 2 is a side elevation of the compensator part of Fig. 1; from a position at 90° to the elevation of Fig. 1;

Fig. 3 is a longitudinal sectional view of the compensator part of Figs. 1 and 2 taken on line AA of Fig. 4;

Fig. 4 is an end elevational view in the direction of arrow 'X' in Fig. 1;

Fig. 5 is an elevational view of a second compensator part according to the invention;

Fig. 6 is a longitudinal sectional view of the compensator part of Fig. 5;

Fig. 7 shows a split pin for use with the compensator;

Fig. 8 shows schemetically an elevational view, partly in section, of an explosive severing system including a compensator as shown in Figs. 1 to 7; and

Fig. 9 is an enlarged view of part of a further system for explosive severing.

Referring to the drawings in which like parts are identified by like numerals, there is shown (Fig. 8) a compensator 1 for supporting an explosive severing device 2 in a bore hole 3 below a well head (not shown) and for damping forces arising on explosion of the explosive severing device 2 in the bore hole. The compensator 1 comprises two parts 4 (Figs. 1 to 4) and 5 (Figs. 5 and 6) mounted for relative longitudinal slidable motion. One part 4 has means 6 for supporting the explosive device 2 in the bore hole 3, and at least one of the parts (in this case both parts 4 and 5) has means in the form of through holes 7 for dissipating laterally, upwardly directed forces arising on explosion of the device in the bore hole.

The one part 4 is an elongate member such as a rod or cylindrical tube, and the through holes 7 are arranged at 100 mm spacings along the length thereof, the holes 7 at one longitudinal position, being directed in a direction at 90° to the direction of the holes 7 at the next adjacent one, the axes of all the holes 7 being at 90° to the longitudinal axis of the part 4 (which axis coincides with the axis of longitudinal slidable motion). All the holes 7 thus extend from the external surface of the part 4 to intercept the bore of the part 4. The part 4 also has two further holes 8, larger in diameter than the diameter of the holes 7, which are seatings for locking pins 9 which are received in slots 9' in the part 5, which slots and pins provide means for connecting the two parts 4 and 5 for longitudinal slidable motion. The part 5 is a drill pipe and also has means in the form of spaced through holes 7 for dissipating laterally, upwardly directed forces arising on explosion of the device 2 in the bore hole 3. The through holes 7 in part 5 are arranged at 150 mm spacings longitudinally of the part 5, the holes 7 at one level also being offset by 90° with

respect to the holes 7 at the next adjacent level. The axes of all the holes 7 are thus directed to the longitudinal axis of the part 5, and the holes 7 all extend from the external surface of the part to intercept the bore thereof.

Both parts 4 and 5 have holes 10 (Figs. 5 and 6) which when the compensator 1 is initially assembled with the part 4 inside the part 5 are aligned and through which a shear pin 11 is inserted and held with a split pin 12 (Fig. 7).

The part 4 has a tapered (frusto-conical) nose 13 comprising part of the means 6 by which it is connected through an articulated joint including a connecting pin 14 and locking ring (not shown) with a first (top in use and as viewed in Fig. 8) packer 15, which in turn supports, via an articulated joint, the explosive severing device 2 in the form of an explosive charge. The charge 2 in turn supports a second (lower in use and as viewed in Fig. 8) packer 16.

In use to sever a sub-sea well head, the system of Fig. 8 is assembled as shown and is landed in the bore hole beneath the well head, the packers 15 and 16 providing a guide as they fit in the bore hole 3 with a sliding fit. The shear pin 11 ensures correct alignment of the compensator 1 when landing at the well head, and shears should the system be improperly aligned so preventing damage to the compensator, and well head.

As the system is sub-sea, the compensator 1 is full of water, in the bore hole. When the explosive device 2 is detonated, water being virtually incompressible, shock waves would normally be transmitted therethrough up the bore hole 3 with possible destruction of the compensator 1 and damage to the well head and surface or semi-submersible vessels above or in the vicinity of the explosion. However the compensator 1 embodying the invention described herein obviates this destructive force by the shear pin 11 shearing, so allowing the inner part 4 of the compensator to ride up inside the outer part 5 in relative longitudinal sliding motion.

Initially, at rest, the inner part 4 lies at the bottom (as viewed) of the hollow outer part and is in compression. When the explosive charge 2. is detonated, the shock waves travel

longitudinally internally of the part 4, placing it under tension rather than compression, and the tensile stresses start it moving, rapidly, upwardly in the outer part 5. If it was solid with this part, the forces would be transmitted up the drill pipe to the surface with possibly disastrous destructive results. However, it is not solid with the pipe it can ride freely upwardly therein, being guided by the pins 9 in the slots 9'. The shock waves which are engendered in the part 4, place it in motion and under tension, rapidly arrive at its upper planar face. As the part 4 is not solid with the part 5, these waves cannot be transmitted upwardly. They are thus reflected internally and travel back down the part 4 to its lower end. Thus its direction of rotation is reversed and it moves back rapidly towards the sea bed. When the shock waves reach the lower end, again there is nowhere for them to go, so they are reflected internally again, back towards the upper surface, and the part 4 reverses its motion in synchronism therewith and hence starts to move upwards. Reversal of motion again occurs as described for the initial upward movement, with the net result that the explosive forces released in the system are dissipated non-destructively by the oscillation of the part 4 in the part 5, as shown by the arrows 'X', Fig. 9. The whole system, including installations at the rig or vessel at the surface is thus protected.

The system shown in Fig. 9 is similar to that shown in Fig. 8, and acts in exactly the same way to dissipate the explosive forces, by oscillation of part 4. The part 4 in this embodiment is however connected to the top packer 3 by an additional elongate member or pipe 18 which is destroyed when the explosive charge 2 is detonated. This "disconnects" the system, and sets the part 4 in motion as described with respect to the Fig. 8 embodiment.

It will be appreciated that most of the tensile forces are internally reflected, but some are transmitted into the water. Moreover, as the part 4 moves, water in part 5 is squeezed out through the holes 7 and slots 9', laterally of the compensator 1 and thus of the system so that there is no upward transmission of

the upwardly directed explosive forces. These forces are dissipated laterally as shown by arrows 'Y', Fig. 9. The rising of the inner part 4 in relative longitudinal sliding motion with respect to the outer part 5 also effectively damps the explosion. This also provides for maintenance of the structural integrity of the compensator 1 itself, in other words it is not itself destroyed by the explosion.

CLAIMS

1. A compensator for supporting an explosive severing device in a bore hole below a well head and for damping forces arising on explosion of the explosive severing device in the bore hole, characterised by two parts(4,5) mounted for relative longitudinal slidable motion by one device (4) having means for supporting the explosive device (2) in the bore hole, and by the two parts (4,5) being arranged to dissipate upwardly directed forces arising on explosion of the device (2) in the bore hole.

2. A compensator according to claim 1, characterised by through holes (7) each having a central axis lying substantially at right angles to the axis of longitudinal slidable motion.

3. A compensator according to claim 1 or claim 2, characterised by the two parts (4,5) comprising two cylindrical elements, mounted one within the other, and by guide means (9, 9') connecting the two parts (4,5) for said longitudinal slidable motion.

4. A compensator according to claim 3, characterised by the guide means comprising opposed longitudinal slots (9') in the external one (5) of the parts (4,5) and by two opposed projecting locking pins (9) of the internal one (4) of the parts (4,5), and by each pin (7) passing through a respective adjacent slot (9') of said opposed longitudinal slots.

5. A compensator according to any of claims 2 to 4, characterised by the inner one (4) of the two cylindrical parts (4,5) having a tapered nose (13) comprising said means for supporting the explosive device (2) in the bore hole.

6. A compensator according to claim 5, characterised by the tapered nose including a transverse slot and opposite bore for

receiving pin means (14) for connecting the explosive device (2) with the compensator (1).

7. A compensator according to any preceding claim, characterised by means (11) to ensure alignment of the compensator when landing the compensator in the bore hole.

8. A compensator acccording to claim 7, characterised by the alignment means (11) comprising a shear pin means extending through the two parts (4,5) transversely to the axis of longitudinal motion, whereby the pin shears (11) on imposition of a longitudinal shear force.

9. An explosive severing system, characterised by a compensator according to any preceding claim, and an explosive device (2) supported by the one part (4).

10. An explosive severing system according to claim 9, characterised by a packer assembly (15) between the one part (4) and the explosive device (2).

11. An explosive severing system according to claim 10, characterised by a further packer assembly (16) suspended from the explosive device (2).

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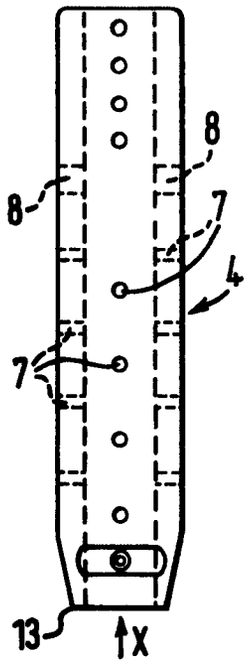

FIG.1.

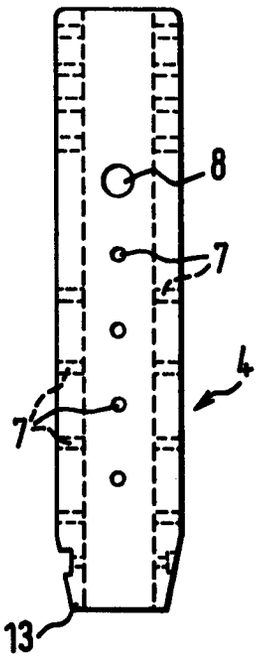

FIG.2.

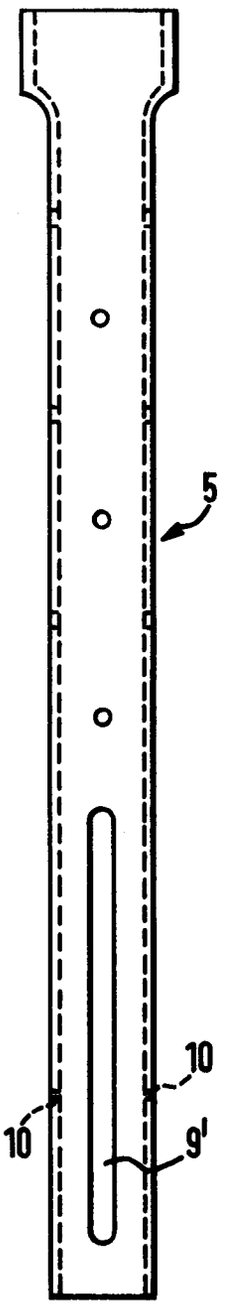

FIG.5.

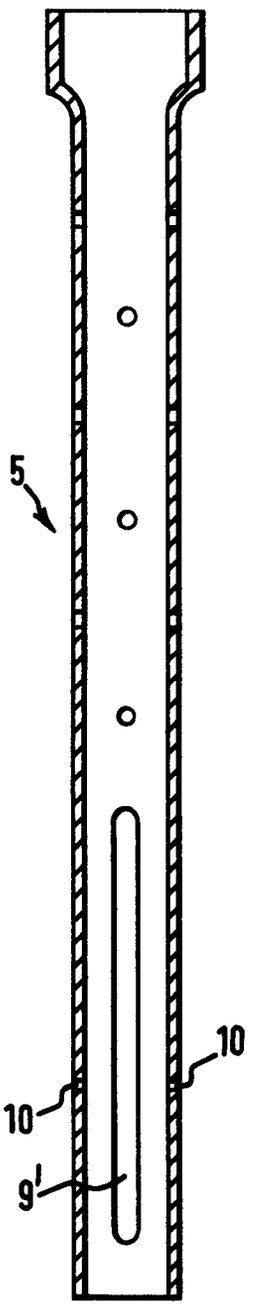

FIG.6.

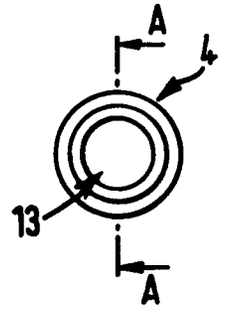

FIG.4.

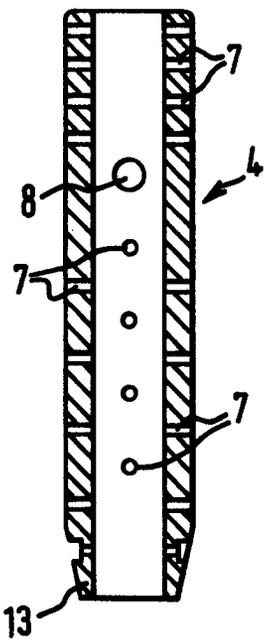

FIG.3.

FIG.7.

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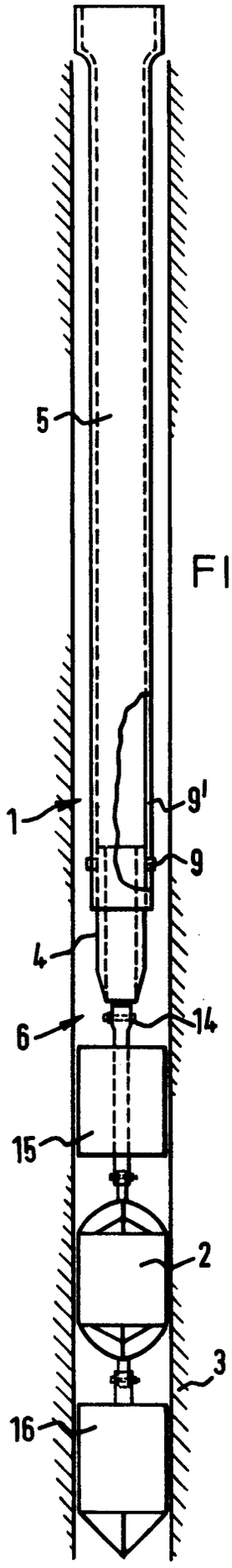

FIG.8.

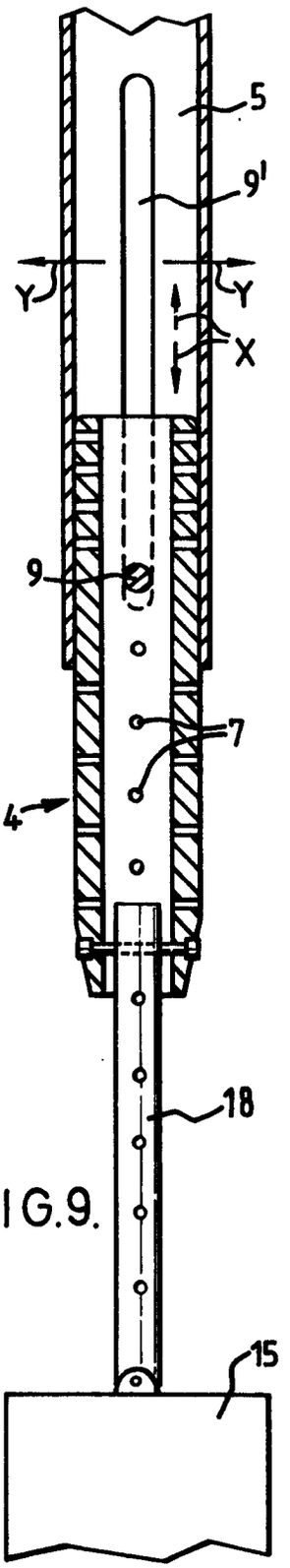

FIG.9.

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EUROPEAN SEARCH REPORT

0212811
Application number

EP 86 30 5065

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.4)
A	US-A-1 856 912 (GREBE) * Claim 1 *	1,9	E 21 B 29/02 E 21 B 29/12 F 42 D 5/00
A	US-A-2 191 781 (TURECHEK) * Claim 1 *	1,9	
A	US-A-4 510 999 (GEORGE) * Column 7, lines 5-11 *	1-3,9, 10	
A	FR-A-2 534 624 (COMMISSARIAT A L'ENERGIE ATOMIQUE) * Page 8, lines 7-14; page 4, lines 10-16 *	1,9,10	
A	WORLD OIL, vol. 188, no. 6, May 1979, pages 72-74, Houston, Texas, US; E.F. BRIEGER: "New perforator anchor allows high backsurge pressures" * Figures 2,3 with text *	1,3,4, 7,9	TECHNICAL FIELDS SEARCHED (Int. Cl.4) E 21 B F 42 D
A	GB-A-2 125 470 (GEO VANN INC.) * Abstract *	1-3,7-10	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	29-10-1986	SOGNO M.G.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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