

Description

The present invention relates to apparatus for disconnecting conduit string and particularly to dual tubing release apparatus and actuating apparatus therefor for use in well operations.

In our European specification no. 217557A, well completion apparatus is described which includes apparatus for the simultaneous decoupling of concentric tubing strings through the use of a shifting tool run on a wireline or slickline in the well. One of the decoupling apparatus includes a movable sleeve positioned between the first and second tubing strings adjacent the couplings for releasing the lower sections thereof. As the movable sleeve is slid by the shifting tool run on a wireline or slickline within a chamber formed between the tubing strings, collet fingers on the detachable couplings are released allowing the lower tubing sections to fall to the bottom of the well with the perforating gun.

In another embodiment, the movable sleeve includes a plurality of lugs which extend through the second tubing string towards the center of the tubing. These lugs can be engaged by a positioning tool lowered on a wireline or slickline into the well. The wireline or slickline can then be raised or lowered causing the sleeve to shift and detach the tubing.

We have now devised an improved conduit disconnection apparatus and method, which uses fluid pressures to effect the disconnection.

United States patent application no. 4601492 discloses an apparatus for disconnecting a single conduit string installed in a well bore, the conduit string and the well bore having fluid therein, the apparatus comprising: a tubing release assembly connected in the conduit string and capable of being actuated to disconnect one portion of the conduit string from another portion of the conduit string upon the application of an increased fluid pressure to the tubing release assembly; and an actuating tool for use with the tubing release assembly, to enable an increased fluid pressure to be communicated to the tubing release assembly.

According to the present invention, there is provided apparatus for disconnecting a conduit string installed in a well bore, said conduit string and said well bore having fluid therein, said apparatus comprising: a tubing release assembly connected in said conduit string and capable of being actuated to disconnect one portion of said conduit string from another portion of said conduit string upon the application of a fluid pressure to the tubing release assembly which is greater than the hydrostatic pressure of said fluid in said well bore at the location in said conduit string at which the tubing release assembly is connected in said con-

duit string; and an actuating tool for use with the tubing release assembly, to enable a fluid pressure to be communicated to the tubing release assembly which is greater than the hydrostatic fluid pressure of said fluid in said well bore at the location in said conduit string at which the tubing release assembly is connected to said conduit string, characterised in that said conduit string comprises dual conduit strings, and such a said tubing release assembly is connected in each string of said dual conduit strings, wherein said actuating tool is used to actuate both tubing release assemblies, and further characterised in that one tubing release assembly comprises:

a housing having a portion thereof connected to a portion of one tubing string of said dual conduit strings and an adjustment nut having a portion thereof connected to another portion of one tubing string of said dual conduit strings; the other tubing release assembly comprises a pull tube mandrel having a portion thereof connected to a portion of the other tubing string of said dual conduit strings and a pull tube latch having a portion thereof connected to the other tubing string of said dual conduit strings; a release member is movable upon the communication of a fluid pressure to each said tubing release assembly; and a sleeve having a ball seat therein is supported within said tubing release assemblies; said release member, when in a first position in the housing, having a portion thereof abutting a lower housing to prevent the adjustment nut from disconnecting from the housing and having a portion thereof abutting the pull tube latch to prevent the pull tube latch from disconnecting from the pull tube adapter, and said release member, when in a second position in the housing, disengaging from contact with the inner housing and with the pull tube latch.

In order that the invention may be more fully understood, one embodiment thereof will now be described, by way of example only, with reference to the accompanying drawing, wherein:

FIGS. 1A and 1B are cross-sectional views of one embodiment of a tubing release assembly and actuating tool of the present invention.

Referring to the drawing, the embodiment assembly 1000 of the present invention is shown. Referring, more specifically, to FIG. 1A, a portion of a pull tube mandrel 1012, upper housing 1014, release sleeve 1016, and lower housing 1090 are shown.

As shown in FIG. 1A, the portion of the pull tube mandrel 1012 comprises an elongated annular cylindrical member having, on the exterior thereof, first cylindrical surface 1020, second cylindrical surface 1022 having, in turn, first annular recess 1024 therein and, on the interior thereof, first threaded bore 1028, first cylindrical bore 1030, and

second cylindrical bore 1032 having, in turn, annular recess 1034 therein, and third cylindrical bore 1036. The portion of the pull tube mandrel 1012 further includes a plurality of apertures 1038 which allow fluid communication between the exterior of the mandrel 1012 to the interior thereof.

The portion of the upper housing 1014 comprises an elongated annular cylindrical member having, on the exterior thereof, cylindrical surface 1042 and, on the interior thereof, threaded bore 1044, first cylindrical bore 1046 having, in turn, annular recess 1048 therein containing annular elastomeric seal 1050 which sealingly engages second cylindrical surface 1022 of pull tube mandrel 1012, second cylindrical bore 1052, third cylindrical bore 1054, fourth cylindrical bore 1056, fifth cylindrical bore 1058, sixth cylindrical bore 1060 having a diameter smaller than bore 1058 and seventh cylindrical bore 1062 having a diameter greater than bore 1060. The portion of the upper housing 1014 shown further includes a plurality of first threaded apertures 1064 threadedly receiving a plurality of threaded fasteners 1066 therein, a plurality of second threaded apertures 1068 receiving a plurality of threaded set screws 1070 therein and a plurality of apertures 1072 which allow fluid communication from the exterior of the upper housing 1014 to the interior thereof.

The portion of the release sleeve 1016 comprises an elongated annular cylindrical member having on the exterior thereof first cylindrical surface 1074 having, in turn, annular recesses 1076 containing annular elastomeric seals 1078 therein and annular recess 1080 and second cylindrical surface 1082 and, on the interior thereof, cylindrical bore 1084 having, in turn, first annular recesses 1086 therein containing annular elastomeric seals 1088 therein. The release sleeve 1016 further includes a plurality of apertures 1110 therethrough to allow fluid communication from the interior to the exterior thereof.

The portion of the lower housing 1090 comprises a plurality of collet fingers 1092 having enlarged heads 1094 thereon having, in turn, exterior surfaces 1096 which engage fifth cylindrical bore 1058 of upper housing 1014 and interior surfaces 1098 which slidably engage second cylindrical surface 1082 of release sleeve 1016.

Referring to FIG. 1B, the remaining portion of the tubing release assembly 1000 is shown.

The remaining portion of the tubing release assembly 1000 comprises a portion of pull tube mandrel 1012, a portion of upper housing 1014, a portion of release sleeve 1016, a portion of lower housing 1090, adjustment nut 1100, pull tube adapter 1102, and pull tube latch 1104.

The portion of pull tube mandrel 1012 comprises an elongated annular cylindrical member

having, on the exterior thereof, a continuation of second cylindrical surface 1022, and, on the interior thereof, a continuation of third cylindrical bore 1036 and second threaded bore 1040.

The portion of the upper housing 1014 comprises an elongated annular cylindrical member having, on the exterior thereof, a continuation of cylindrical surface 1042 and, on the interior thereof, a continuation of seventh cylindrical bore 1062. The upper housing 1014 further includes annular end surface 1108.

The portion of the release sleeve 1016 comprises an elongated annular member having, on the exterior thereof, a continuation of second cylindrical surface 1082 and, on the interior thereof, a continuation of cylindrical bore 1084.

The portion of the lower housing 1090 comprises an elongated annular cylindrical member having, connected to one end thereof, a plurality of collet fingers 1092, on the exterior thereof, first cylindrical surface 1114 which slidably, sealingly engages seventh cylindrical bore 1062 of upper housing 1014 and has annular recess 1015 containing an annular elastomeric seal therein, second cylindrical surface 1116, and third cylindrical surface 1118, and, on the interior thereof, first cylindrical bore 1120 which slidably, sealingly mates with second cylindrical surface 1082 of release sleeve 1016 and has annular recess 1121 containing annular elastomeric seal 1122 therein, and second cylindrical bore 1124.

The adjustment nut 1100 comprises an elongated annular cylindrical member having, on the exterior thereof, first cylindrical surface 1126, second cylindrical surface 1128 and threaded surface 1130 and, on the interior thereof, threaded bore 1132 which releasably, threadedly engages threaded surface 1118 of lower housing 1090 and cylindrical bore 1134. The adjustment nut 1100 further includes a plurality of threaded apertures 1131 which releasably, threadedly engage a plurality of set screws 1133 installed therein which in turn, have one end thereof engaging third cylindrical surface 1118 of lower housing 1090.

The pull tube adapter 1102 comprises an elongated annular cylindrical member having, on the exterior thereof, threaded surface 1136 which releasably, threadedly engages second threaded bore 1040 of pull tube mandrel 1012, cylindrical surface 1138, having, in turn, annular recess 1140 therein and, on the interior thereof, cylindrical bore 1142.

The pull tube adapter 1102 further includes annular cylindrical ball seat 1144 having, on the exterior thereof, a cylindrical surface having, in turn, annular recess 1146 containing annular elastomeric seal 1147 therein sealingly engaging bore 1142 of the adapter 1102 and annular recess

1148 and, on the interior thereof, annular frustoconical ball seal 1141 and bore 1149 therethrough. The annular cylindrical ball seal 1144 is releasably retained within the bore 1142 of pull tube adapter 1102 by a plurality of shear pins 1103 which, in turn, are releasably retained within threaded apertures 1139 of adapter 1102 and have a portion thereof engaging annular recess 1148 of seal 1144.

The pull tube latch 1104 comprises an elongated annular cylindrical member having, on one end thereof, a plurality of collet fingers 1150 having, in turn, enlarged heads 1152 thereon which releasably engage annular recess 1140 in the cylindrical surface 1138 of pull tube adapter 1102 and enlarged interior projections 1154 which abut the end 1156 and pull tube adapter 1102, the collet fingers 1150 being separated from each other by a plurality of longitudinal slots 1158 and, on the exterior thereof, cylindrical surface 1160 and threaded surface 1162, and, on the interior thereof, cylindrical bore 1164.

Referring to FIGS. 1A and 1B, the operation of the tubing release assembly 1000 of the present invention by the ball 2000 and increased fluid pressure actuating thereon will be described.

When in use, the tubing release assembly 1000 has tubing filled with fluid connected to first threaded bore 1028 of pull tube mandrel 1012 and threaded bore 1044 of upper housing 1014 and threaded fasteners 1066 are disengaged from annular recess 1024 of pull tube mandrel 1012.

The ball 2000 is inserted and falls into the tubing release assembly 1000 until it seats on ball seat 1144.

After the ball 2000 lands on frusto-conical annular seat 1141 of ball seat 1144, the fluid pressure in the tubing is increased and acts through apertures 1038 in pull tube mandrel 1012 and apertures 1110 of release sleeve 1016, thereby causing a pressure differential across release sleeve 1016 since release sleeve 1016 has hydrostatic fluid pressure acting on one side thereof through apertures 1072 in upper housing 1014. When this pressure differential across release sleeve 1016 is sufficient to cause shearing of shear pins 1070, the release sleeve 1016 moves upwardly through annular chamber 1015 into the upper enlarged portion thereof with the end surface 1075 of release sleeve 1016 possibly abutting an annular surface of upper housing 1014.

When the release sleeve 1016 no longer has a portion thereof abutting enlarged heads 1152 of collet fingers 1150 of pull tube latch 1104, the collet fingers 1150 are cammed outwardly to disengage annular recess 1140 of the pull tube adapter 1102 by the weight of the tubing string attached to pull tube latch 1104 thereby releasing the latch 1104 from adapter 1102.

Similarly, since the end of release sleeve 1016 moves upwardly past enlarged heads 1094 of collet fingers 1092 of lower housing 1090, due to the weight of the tubing string attached to adjustment nut 1100, the enlarged heads 1094 disengage annular frusto-conical surface 1059 and move past sixth cylindrical bore 1060 of upper housing 1014 thereby releasing the upper housing 1014 from lower housing 1090.

Also, when release sleeve 1016 moves upwardly through annular chamber 1015 and abuts the end surface of upper housing 1014, since the annular elastomeric seals 1078 of sleeve 1016 no longer sealingly engage fourth cylindrical bore 1056 of upper housing 1014, fluid is free to bypass through apertures 1072 in upper housing 1014 and around the release sleeve 1016 thereby relieving the pressure differential around sleeve 1016.

While the invention has been illustrated with respect to the presently preferred embodiment, it will be appreciated that numerous modifications and changes could be made without departing from the spirit or essential characteristics of the invention. For example, elevated pressure could be provided in many ways within the tubing e.g. by using a tool 700 as described in our copending European filed on even date herewith, and arranging for the outlet ports from its reservoir 700 to supply pressurized fluid to apertures 1038 in mandrel 1012.

Claims

1. Apparatus for disconnecting a conduit string installed in a well bore, said conduit string and said well bore having fluid therein, said apparatus comprising: a tubing release assembly (1000) connected in said conduit string and capable of being actuated to disconnect one portion of said conduit string from another portion of said conduit string upon the application of a fluid pressure to the tubing release assembly which is greater than the hydrostatic pressure of said fluid in said well bore at the location in said conduit string at which the tubing release assembly is connected in said conduit string; and an actuating tool (2000) for use with the tubing release assembly, to enable a fluid pressure to be communicated to the tubing release assembly which is greater than the hydrostatic fluid pressure of said fluid in said well bore at the location in said conduit string at which the tubular release assembly is connected to said conduit string; characterised in that said conduit string comprises dual conduit strings, and such a said tubing release assembly (1000) is connected in each string of said dual conduit strings, wherein said actuating tool (2000) is used to actuate both tubing



1148 and, on the interior thereof, annular frustoconical ball seal 1141 and bore 1149 therethrough. The annular cylindrical ball seal 1144 is releasably retained within the bore 1142 of pull tube adapter 1102 by a plurality of shear pins 1103 which, in turn, are releasably retained within threaded apertures 1139 of adapter 1102 and have a portion thereof engaging annular recess 1148 of seal 1144.

The pull tube latch 1104 comprises an elongated annular cylindrical member having, on one end thereof, a plurality of collet fingers 1150 having, in turn, enlarged heads 1152 thereon which releasably engage annular recess 1140 in the cylindrical surface 1138 of pull tube adapter 1102 and enlarged interior projections 1154 which abut the end 1156 and pull tube adapter 1102, the collet fingers 1150 being separated from each other by a plurality of longitudinal slots 1158 and, on the exterior thereof, cylindrical surface 1160 and threaded surface 1162, and, on the interior thereof, cylindrical bore 1164.

Referring to FIGS. 1A and 1B, the operation of the tubing release assembly 1000 of the present invention by the ball 2000 and increased fluid pressure actuating thereon will be described.

When in use, the tubing release assembly 1000 has tubing filled with fluid connected to first threaded bore 1028 of pull tube mandrel 1012 and threaded bore 1044 of upper housing 1014 and threaded fasteners 1066 are disengaged from annular recess 1024 of pull tube mandrel 1012.

The ball 2000 is inserted and falls into the tubing release assembly 1000 until it seats on ball seat 1144.

After the ball 2000 lands on frusto-conical annular seat 1141 of ball seat 1144, the fluid pressure in the tubing is increased and acts through apertures 1038 in pull tube mandrel 1012 and apertures 1110 of release sleeve 1016, thereby causing a pressure differential across release sleeve 1016 since release sleeve 1016 has hydrostatic fluid pressure acting on one side thereof through apertures 1072 in upper housing 1014. When this pressure differential across release sleeve 1016 is sufficient to cause shearing of shear pins 1070, the release sleeve 1016 moves upwardly through annular chamber 1015 into the upper enlarged portion thereof with the end surface 1075 of release sleeve 1016 possibly abutting an annular surface of upper housing 1014.

When the release sleeve 1016 no longer has a portion thereof abutting enlarged heads 1152 of collet fingers 1150 of pull tube latch 1104, the collet fingers 1150 are cammed outwardly to disengage annular recess 1140 of the pull tube adapter 1102 by the weight of the tubing string attached to pull tube latch 1104 thereby releasing the latch 1104 from adapter 1102.

Similarly, since the end of release sleeve 1016 moves upwardly past enlarged heads 1094 of collet fingers 1092 of lower housing 1090, due to the weight of the tubing string attached to adjustment nut 1100, the enlarged heads 1094 disengage annular frusto-conical surface 1059 and move past sixth cylindrical bore 1060 of upper housing 1014 thereby releasing the upper housing 1014 from lower housing 1090.

Also, when release sleeve 1016 moves upwardly through annular chamber 1015 and abuts the end surface of upper housing 1014, since the annular elastomeric seals 1078 of sleeve 1016 no longer sealingly engage fourth cylindrical bore 1056 of upper housing 1014, fluid is free to bypass through apertures 1072 in upper housing 1014 and around the release sleeve 1016 thereby relieving the pressure differential around sleeve 1016.

While the invention has been illustrated with respect to the presently preferred embodiment, it will be appreciated that numerous modifications and changes could be made without departing from the spirit or essential characteristics of the invention. For example, elevated pressure could be provided in many ways within the tubing e.g. by using a tool 700 as described in our copending European filed on even date herewith, and arranging for the outlet ports from its reservoir 700 to supply pressurized fluid to apertures 1038 in mandrel 1012.

Claims

1. Apparatus for disconnecting a conduit string installed in a well bore, said conduit string and said well bore having fluid therein, said apparatus comprising: a tubing release assembly (1000) connected in said conduit string and capable of being actuated to disconnect one portion of said conduit string from another portion of said conduit string upon the application of a fluid pressure to the tubing release assembly which is greater than the hydrostatic pressure of said fluid in said well bore at the location in said conduit string at which the tubing release assembly is connected in said conduit string; and an actuating tool (2000) for use with the tubing release assembly, to enable a fluid pressure to be communicated to the tubing release assembly which is greater than the hydrostatic fluid pressure of said fluid in said well bore at the location in said conduit string at which the tubular release assembly is connected to said conduit string; characterised in that said conduit string comprises dual conduit strings, and such a said tubing release assembly (1000) is connected in each string of said dual conduit strings, wherein said actuating tool (2000) is used to actuate both tubing

release assemblies (1000), and further characterised in that one tubing release assembly comprises a housing (1014) having a portion thereof connected to a portion of one tubing string of said dual conduit strings and an adjustment nut (1100) having a portion thereof connected to another portion of one tubing string of said dual conduit strings; the other tubing release assembly comprises a pull tube mandrel (1012) having a portion thereof connected to a portion of the other tubing string of said dual conduit strings and a pull tube latch (1104) having a portion thereof connected to a pull tube adapter (1102) and another portion thereof connected to the other tubing string of said dual conduit strings; a release member (1016) is movable upon the communication of a fluid pressure to each said tubing release assembly; and a sleeve having a ball seat (1144) therein is supported within said tubing release assemblies said release member, when in a first position in the housing, having a portion thereof abutting a lower housing (1090) to prevent the adjustment nut from disconnecting from the housing and having a portion thereof abutting the pull tube latch to prevent the pull tube latch from disconnecting from the pull tube adapter, and said release member, when in a second position in the housing, disengaging from contact with the inner housing and with the pull tube latch.

2. Apparatus according to claim 1, wherein the actuating tool (2000) comprises a spherical member capable of sealingly engaging the ball seat (1144).

Patentansprüche

1. Vorrichtung zur Abtrennung eines Rohrstranges, der in einer Bohrung eingebaut ist, wobei der Rohrstrang und die Bohrung ein Fluid enthalten, enthaltend: eine in dem Rohrstrang verbundene Rohrlösungsanordnung (1000), die zur Abtrennung eines Teils des Rohrstranges bei Anlegen eines Fluiddruckes an die Rohrlösungsanordnung betätigbar ist, der größer ist als der hydrostatische Druck des Fluids in der Bohrung an der Stelle in dem Rohrstrang, an der die Rohrlösungsanordnung in dem Rohrstrang verbunden ist; und ein Betätigungswerkzeug (2000) zur Verwendung mit der Rohrlösungsanordnung, mittels dessen ein Fluidruck, der größer ist als der hydrostatische Fluidruck des Fluids in der Bohrung an der Stelle in dem Rohrstrang, an der die Rohrlösungsanordnung mit dem Rohrstrang verbunden

den ist, auf die Rohrlösungsanordnung übertragbar ist;

dadurch gekennzeichnet, daß der Rohrstrang einen doppelten Rohrstrang aufweist und die Rohrlösungsanordnung (1000) in jedem Strang des doppelten Rohrstranges verbunden ist, wobei das Betätigungswerkzeug (2000) zur Betätigung beider Rohrlösungsanordnungen (1000) dient, und weiter dadurch gekennzeichnet, daß eine Rohrlösungsanordnung ein Gehäuse (1014) aufweist, dessen einer Teil mit einem Teil eines Rohrstranges des doppelten Rohrstranges verbunden ist, und eine Stellmutter (1100), deren einer Teil mit einem anderen Teil des einen Rohrstranges des doppelten Rohrstranges verbunden ist; die andere Rohrlösungsanordnung einen Zugrohrdorn (1012) aufweist, dessen einer Teil mit einem Teil des anderen Rohrstranges des doppelten Rohrstranges verbunden ist, und einen Zugrohrriegel (1104), dessen einer Teil mit einem Zugrohradapter (1102) verbunden ist und dessen anderer Teil mit dem anderen Rohrstrang des doppelten Rohrstranges verbunden ist; ein Trennglied (1016), das bei Übertragung eines Fluiddruckes auf jede Rohrlösungsanordnung bewegbar ist; und eine Hülse mit einem Kugelsitz (1144) innerhalb der Rohrlösungsanordnungen abgestützt ist; das Trennglied in einer ersten Stellung in dem Gehäuse mit einem Teil an ein unteres Gehäuse (1090) stößt, um zu verhindern, daß sich die Stellmutter von dem Gehäuse löst, mit einem Teil an den Zugrohrriegel stößt, um zu verhindern, daß sich der Zugrohrriegel von dem Zugrohradapter löst, und sich in einer zweiten Stellung in dem Gehäuse aus der Berührung mit dem inneren Gehäuse und dem Zugrohrriegel löst.

2. Vorrichtung nach Anspruch 1, dadurch gekennzeichnet, daß das Betätigungswerkzeug ein kugelförmiges Glied aufweist, das abdichtend an den Kugelsitz (1144) anlegbar ist.

Revendications

1. Dispositif pour déconnecter un train de tubes installé dans un alésage de puits, ledit train de tubes et ledit alésage de puits contenant un fluide, ledit dispositif comportant : un ensemble (1000) de libération de tubes connecté dans ledit train de tubes et capable d'être actionné pour déconnecter une partie dudit train de tubes de l'autre partie dudit train de tubes par application d'une pression de fluide à l'ensemble de libération de tubes qui est plus grande que la pression hydrostatique dudit fluide situé dans ledit alésage de puits à



l'endroit dudit train de tubes auquel l'ensemble de libération de tubes est connecté dans ledit train de tubes; et un outil d'actionnement (2000) destiné à être utilisé avec l'ensemble de libération de tubes, pour permettre qu'une pression de fluide soit communiquée à l'ensemble de libération de tubes, qui est plus grande que la pression hydrostatique de fluide dudit fluide situé dans ledit alésage de puits à l'endroit dans ledit train de tubes auquel l'ensemble de libération de tubes est connecté audit train de tubes, caractérisé en ce que ledit train de tubes comporte deux trains de tubes tels qu'un ensemble de libération (1000) de tubes est connecté dans chaque train desdits trains de tubes, ledit outil d'actionnement (2000) étant utilisé pour actionner les deux ensembles (1000) de libération de tubes, et en outre caractérisé en ce qu'un ensemble de libération de tubes comporte : un boîtier (1014) ayant une partie connectée à une partie d'un premier train de tubes desdits trains de tubes et un écrou (1100) de réglage ayant une partie connectée à une autre partie du premier train de tubes desdits trains de tubes; l'autre ensemble de libération de tubes comporte un mandrin (1012) de tube de tirage ayant une partie connectée à une partie de l'autre train de tubes desdits trains de tubes et un verrou (1104) de tube de tirage ayant une partie connectée à un adaptateur (1102) de tube de tirage et une autre partie connectée à l'autre train de tubes desdits trains de tubes; un élément de libération (1016) est déplaçable par communication d'une pression de fluide à chaque ensemble de libération de tubes; et un manchon ayant un siège (1144) pour bille situé à l'intérieur, est supporté dans lesdits ensembles de libération de tubes, ledit élément de libération, lorsqu'il est dans une première position dans le boîtier, ayant une partie venant en butée contre un boîtier inférieur (1090) pour empêcher l'écrou de réglage de se déconnecter du boîtier et ayant une partie venant en butée contre le verrou de tube de tirage pour empêcher le verrou de tube de tirage d'être déconnecté de l'adaptateur de tube de tirage, et ledit élément de libération, lorsqu'il est dans une seconde position dans le boîtier, supprimant la prise provenant du contact avec le boîtier inférieur et avec le verrou de tube de tirage.

2. Dispositif selon la revendication 1, dans lequel l'outil d'actionnement (2000) comporte un élément sphérique capable de venir en contact de manière étanche avec le siège (1144) pour bille.