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**Declarations under Rule 4.17**:

— *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))*

— *as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii))*

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(54) Title: HYDRAULIC SHOCK ABSORBER FOR SLIDING SLEEVES

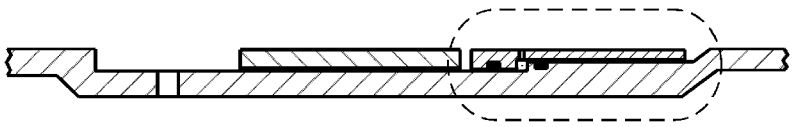


FIG. 4

(57) Abstract: A sliding sleeve has an associated shock absorber to limit shock loading to the shifting apparatus when the end of travel is reached. An adjacent sleeve defined an annular cavity in a manner that does not reduce the drift dimension of the shifting sleeve. The cavity has a fluid in it and the movement of the shifted sleeve causes the movement of the shock absorber sleeve to reduce the fluid volume in the annular cavity. The volume reduction forces fluid through a restriction to regulate the speed of the sliding sleeve as a travel stop is reached. The fluid can be a gas, an incompressible fluid or grease. The restriction can be temporarily covered such as with a rupture disc. Room to compensate for thermal expansion can be provided in the annular space.

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# HYDRAULIC SHOCK ABSORBER FOR SLIDING SLEEVES

## FIELD OF THE INVENTION

**[0001]** The field of the invention is sliding sleeves for subterranean use and more particularly an effective shock absorption device for pressure shifted sleeves.

## BACKGROUND OF THE INVENTION

**[0002]** Sliding sleeves valves provide selective access outside a tubing string for a variety of applications. One popular application is for formation access for fracturing. In the past these sliding sleeves were shifted in a variety of ways in a fracturing application. The sliding sleeves could have integral ball seats that get progressively larger from further downhole and in an uphole direction. The fracturing proceeded from bottom up and each time a bigger ball was dropped to land on the next higher sliding sleeve while isolating any previous sleeves shifted open in the same manner. When the fracturing is complete the well is put on production and the theory is that the balls on the seats are simply carried up to the surface past all the seats above their original location. This does not always happen and logjams can occur that can impede subsequent production.

**[0003]** As an alternative to using ball seats of gradually increasing size from well bottom to the surface a different shifting technique has been developed. One such device is the Multi-stage Unlimited Frac Isolation System from NCS Energy Service Inc. which combines a locator for finding the sliding sleeve with a bottom hole assembly and a resettable packer that can be set against the sleeve. Pressure is applied with the packer against the sleeve and the sleeve shifts to open a wall port. A ported sub is opened in the coiled tubing string and the frac fluid is delivered through the annulus to the port opened by the shifted sliding sleeve while the coiled tubing can be used as a dead string to measure frac pressure or it can be used to circulate or reverse circulate in the event of a screenout. An animation of this system is available at http://ncsfrac.com/videolink.html .

**[0004]** One issue with this system is that the acceleration and abrupt deceleration of the sliding sleeve as it hits a travel stop has created stress

failures in the coiled tubing or related fittings adjacent the packer that grabs the sliding sleeve. These failures have brought about a proposed solution for a shock absorber for the sliding sleeve that crumples a bellows on travel stop impact as illustrated in US Publication 2009/0266659. A related crumpling type shock absorber for a dropped string in a hole is shown in USP 7,779,907. There are limitations to the crumple design for a sliding sleeve and those are that the drift diameter is reduced from the crumpling so that travel of other tools past a sliding sleeve could be impeded and that the crumpling may stick the sleeve in the position before it is fully shifted or prevent the sleeve from being shifted in the reverse direction should there be a need to close the port with the sliding sleeve.

**[0005]** Other applications for shock absorbers have involved annular rubber rings that simply get compressed and bounce back after the shock loading is removed. These have been used in sliding sleeves that are closed with a mechanical shifting tool such as item 104 in FIG. 11 B of USP 5,549,161. On a much larger scale large annular rubber shapes have been used on jack-up rig legs such as item 46 in USP 4,195,950. Of general interest as to sliding sleeves is USP 7,108,067.

**[0006]** What is needed and provided by the present invention is a hydraulic shock absorber for a sliding sleeve that does not reduce drift and that addresses the stress failure in the coiled tubing and associated components from shock loading at the end of the movement of the sliding sleeve. Those skilled in the art will better understand additional aspects of the present invention from a description of the preferred embodiment and the associated drawings with the understanding that the full scope of the invention is given by the appended claims.

SUMMARY OF THE INVENTION

**[0007]** A sliding sleeve has an associated shock absorber to limit shock loading to the shifting apparatus when the end of travel is reached. An adjacent sleeve defined an annular cavity in a manner that does not reduce the drift dimension of the shifting sleeve. The cavity has a fluid in it and the movement of the shifted sleeve causes the movement of the shock absorber sleeve to reduce the fluid volume in the annular cavity. The volume reduction

forces fluid through a restriction to regulate the speed of the sliding sleeve as a travel stop is reached. The fluid can be a gas, an incompressible fluid or grease. The restriction can be temporarily covered such as with a rupture disc. Room to compensate for thermal expansion can be provided in the annular space.

BRIEF DESCRIPTION OF THE DRAWINGS

**[0008]** FIG. 1 shows an existing sliding sleeve design in the port closed position;

**[0009]** FIG. 2 show an existing method of engaging a packer run on coiled tubing to the sliding sleeve to shift the sliding sleeve with pressure;

**[0010]** FIG. 3 shows a sliding sleeve with a shock absorber in the closed position;

**[0011]** FIG. 4 shows the sliding sleeve of FIG. 3 in the open position;

**[0012]** FIG. 5 is a detailed view of the shock absorber with the sleeve in the closed position; and

**[0013]** FIG. 6 is a detailed view of the shock absorber with the sleeve in the open position.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

**[0014]** The known sliding sleeve **10** design is shown in FIG. 1 with the port **12** in the closed position and the sleeve **10** disposed in a recess **14** so as not to reduce the drift diameter of the tubular string **16**. One way to move the sleeve **10** to the open position is with a resettable packer such as an inflatable packer **18** that is delivered to the sleeve **10** on a coiled tubing string **20**. Below the packer **18** is a coiled tubing extension **22** leading to a locating tool that is well known in the art for proper placement of the packer **18** in alignment with the sleeve **10** for shifting the sleeve **10** to the open position shown in FIG. 2. At this point the fracturing can begin through port **12** as indicated by arrow **24**.

**[0015]** The problem with the shifting device in FIG. 2 was that stress cracks and failures were experienced in the coiled tubing **20** and connections in the vicinity of the packer **18**. As mentioned previously the crush type shock absorbers were tried but the design had drawbacks such as a reduction of the drift dimension after the crushing and the potential of getting in the way of

trying to operate the now open sleeve such as **10** back to the position where the port **12** was closed.

**[0016]** FIGS. 3-6 illustrate a sliding sleeve **30** to cover a port **32** and to be operated by the same packer **18** on coiled tubing **20** as shown in FIG. 2. Other shifting tools delivered by conveyances different than coiled tubing **20** are also contemplated. The shock absorber assembly **34** is best seen in detail in FIGS. 3 and 5 for the closed position of the port **32**. It is an annular sleeve **36** with an internal recess **38** to define a variable volume **42** that has an outlet **40**. Seals **44** and **46** allow the sleeve **36** to move and reduce the volume **42** and as a result build pressure inside to expel the fluid contents **49** through the vent **40**. The vent **40** can be open or it can have a removable barrier such as a rupture disk or a floating piston that can move in opposed directions to compensate for thermal expansion and contraction before getting expelled when pressure builds in volume **42** as the volume decreases. The volume decrease occurs as a result of the sleeve **30** bumping the sleeve **36** when actuated such as in the manner shown in FIG. 2. Sleeve **36** can move up to the travel stop **48** or to a location short of stop **48**. The volume **42** can contain grease, an incompressible liquid or gas or combinations. The material can have Newtonian or Non-Newtonian characteristics. A gas layer above a liquid can also act as a thermal expansion compensation system in lieu of a device placed in the passage **40** such as a floating piston or rupture disc, either of which can blow out with the fluid from the volume **42** as the sliding sleeve **30** drives the shock absorber. Both the sliding sleeve **30** and the shock absorber sleeve **36** are in a recess **50** so that neither reduces the drift diameter such as at **52**. In other words, the internal diameter of sleeve **36** is at least as large as the internal diameter of sleeve **30**.

**[0017]** The above description is illustrative of the preferred embodiment and many modifications may be made by those skilled in the art without departing from the invention whose scope is to be determined from the literal and equivalent scope of the claims below:

I claim:

1. An assembly of a sliding sleeve and a shock absorber for use in a subterranean location comprising:

a housing having at least one selectively open wall opening in response to movement of a sliding sleeve adjacent a passage through said housing;

a hydraulic shock absorber adjacent said passage actuated by movement of said sliding sleeve with respect to said port.

2. The assembly of claim **1**, wherein:

said passage has a drift diameter adjacent at least one end connection and said hydraulic shock absorber is disposed about said passage in a manner that does not significantly reduce said drift diameter.

3. The assembly of claim **1**, wherein:

said shock absorber defining a variable volume adjacent said passage.

4. The assembly of claim **1**, wherein:

said sliding sleeve impacts said shock absorber when shifted between a first and second positions.

5. The assembly of claim **1**, wherein:

said shock absorber retards movement of said sliding sleeve by dissipating pressure built up internally in said shock absorber through a restriction.

6. The assembly of claim **1**, wherein:

said shock absorber displaces at least one of gas, incompressible liquid and grease.

7. The assembly of claim **3**, wherein:

said variable volume comprises at least one of gas, incompressible liquid and grease.

8. The assembly of claim **3**, wherein:

said variable volume comprises at least one of a Newtonian and a non-Newtonian material.

9. The assembly of claim **3**, wherein:

said variable volume is formed between a sleeve movable upon impact from said sliding sleeve and said housing.

10. The assembly of claim **9**, wherein:

said sleeve has an internal diameter at least as large as said sliding sleeve.

11. The assembly of claim **10**, wherein:

said sliding sleeve and said shock absorber are disposed in a recess in said housing so that both are outside said passage.

12. The assembly of claim **11**, wherein:

said sleeve and said sliding sleeve are initially spaced apart before movement of said sliding sleeve.

13. The assembly of claim **11**, wherein:

said sliding sleeve impacts said shock absorber when shifted between a first and second positions.

14. The assembly of claim **13**, wherein:

said shock absorber retards movement of said sliding sleeve by dissipating pressure built up internally in said shock absorber through a restriction.

15. The assembly of claim **14**, wherein:

said variable volume comprises at least one of gas, incompressible liquid and grease.

16. The assembly of claim **15**, wherein:

said variable volume is formed between a sleeve movable upon impact from said sliding sleeve and said housing.

17. The assembly of claim **16**, wherein:

said sliding sleeve and said shock absorber are disposed in a recess in said housing so that both are outside said passage.

18. The assembly of claim **17**, wherein:

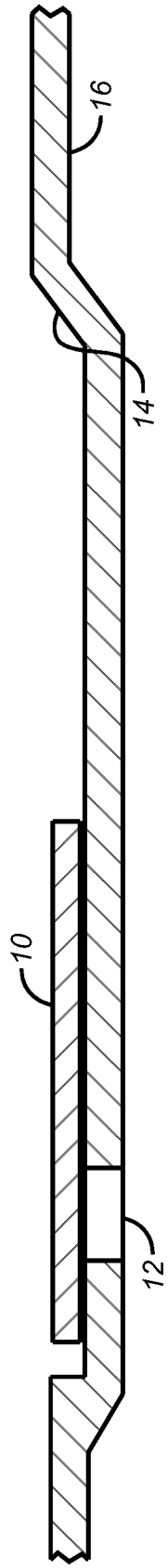
said variable volume comprises an outlet with a frangible member or a floating piston that clear said outlet when said variable volume decreases.

19. The assembly of claim **1**, wherein:

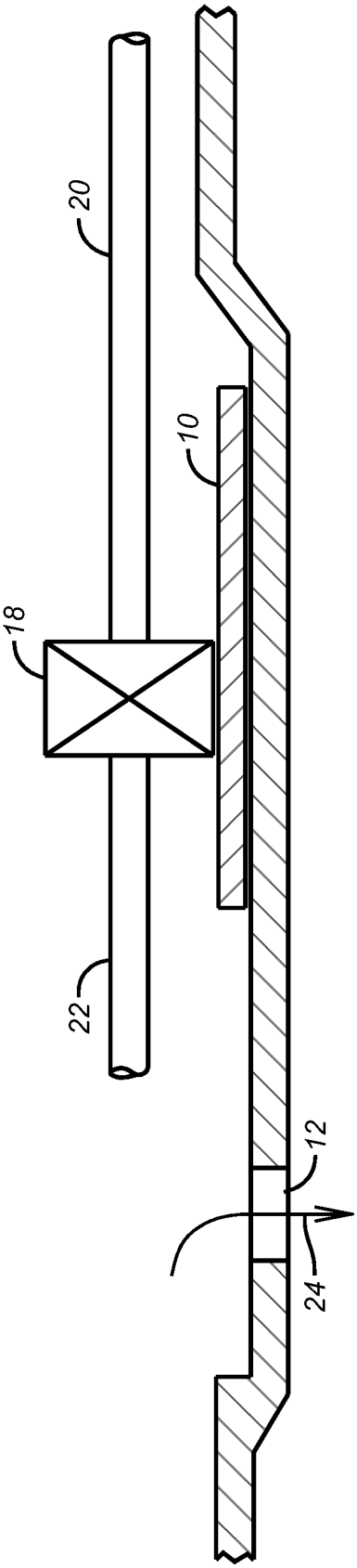
said variable volume comprises an outlet with a frangible member or a floating piston that clear said outlet when said variable volume decreases.

20. The assembly of claim **1**, wherein:

said sliding sleeve and said shock absorber are initially in contact for tandem movement with respect to said port.




(PRIOR ART)
FIG. 1




(PRIOR ART)
FIG. 2

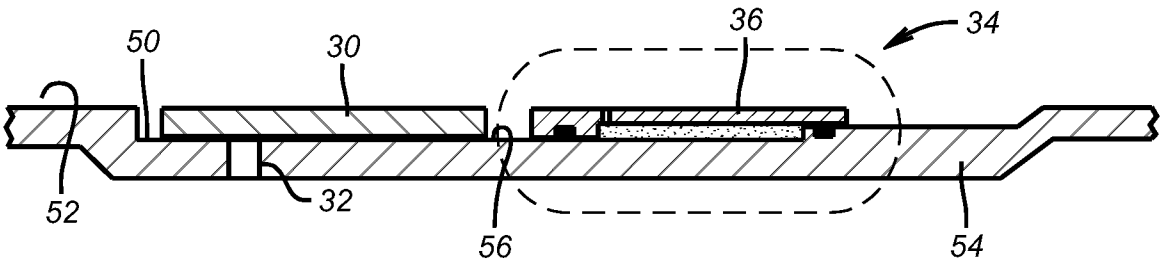



FIG. 3

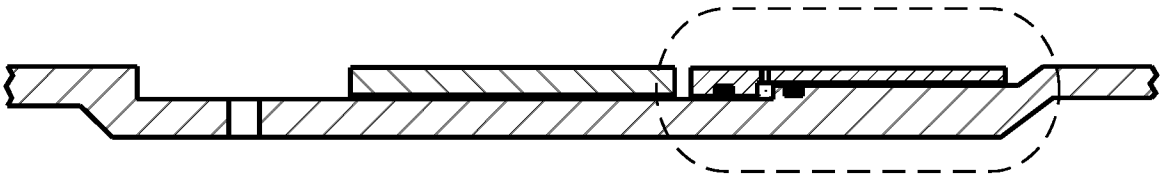


FIG. 4

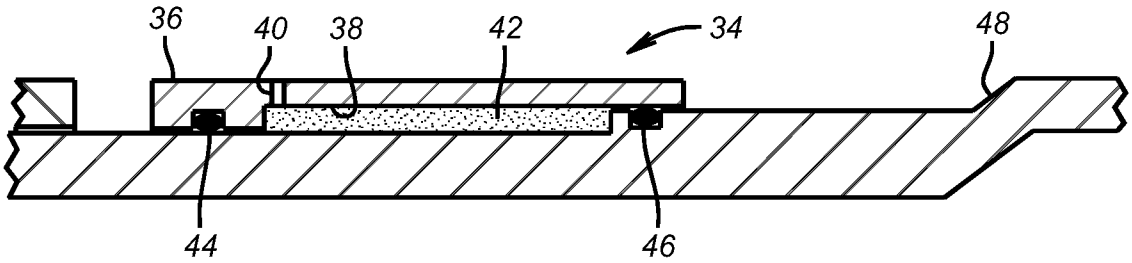



FIG. 5

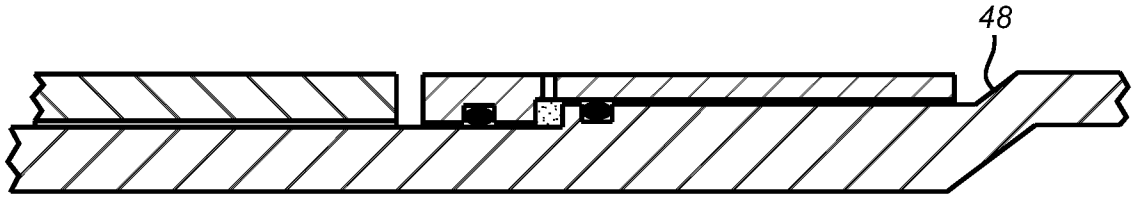



FIG. 6

**INTERNATIONAL SEARCH REPORT**

International application No.
**PCT/US2013/021753**

**A. CLASSIFICATION OF SUBJECT MATTER**

***E21B 34/14(2006.01)i, E21B 43/12(2006.01)i***

According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)

IPC: E21B 34/14; E21B 43/116; E21B 34/00; E21B 21/00; E21B 47/06; E21B 43/26; E21B 34/08

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Korean utility models and applications for utility models

Japanese utility models and applications for utility models

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

eKOMPASS(KIPO internal) & Keywords: subterranean location, sliding sleeve, hydraulic shock absorber, restriction, and frangible member

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
| X<br>Y<br>A | US 2011-0315390 A1 (GUILLORY, JEREMY J. et al.) 29 December 2011<br>See paragraphs [0030], [0033], [0040]-[0042] and figures 1, 3, 5-6. | 1-2,20<br>3,5-8<br>4,9-19 |
| Y | US 2005-0126787 A1 (GOMEZ, ALFREDO) 16 June 2005<br>See paragraphs [0017], [0021] and figures 4-6. | 3,5-8 |
| A | US 2006-0243455 A1 (TELFER, GEORGE et al.) 02 November 2006<br>See paragraphs [0094], [0096]-[0097] and figures 3(a)-3(c). | 1-20 |
| A | US 3970147 A (JESSUP, ROBERT L. et al.) 20 July 1976<br>See column 6, lines 15-54 and figures 4-5. | 1-20 |
| A | US 4512406 A (VANN, ROY R. et al.) 23 April 1985<br>See column 10, lines 21-39 and figures 3-4. | 1-20 |

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents,such combination being obvious to a person skilled in the art

"&" document member of the same patent family

| Date of the actual completion of the international search | Date of mailing of the international search report |
|---|---|
| 26 April 2013 (26.04.2013) | **26 April 2013 (26.04.2013)** |

| Name and mailing address of the ISA/KR | Authorized officer |
|---|---|
| Korean Intellectual Property Office<br>189 Cheongsa-ro, Seo-gu, Daejeon Metropolitan City, 302-701, Republic of Korea<br>Facsimile No. 82-42-472-7140 | PARK, Hye Lyun<br>Telephone No. 82-42-481-3463 |

**INTERNATIONAL SEARCH REPORT**

Information on patent family members

International application No.

**PCT/US2013/021753**

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