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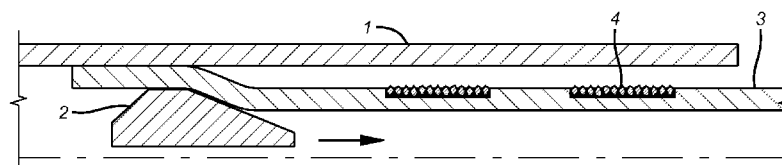
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(54) Title: EXPANDABLE LINER HANGER WITH ANCHORING FEATURE

**FIG. 1**

(57) Abstract: An expandable liner hanger features carbide or other hard particles adhered to the outer surface of a tubular mandrel that is expanded using vulcanized rubber to retain the carbide during run in or set. The rubber can be directly applied to the outer surface of the mandrel or to a split ring that is subsequently secured to the outer surface of the mandrel. The rubber can also be mounted in an exterior recess to protect the carbide during running in from being knocked off with impact. A binder can be applied to the carbide or to the rubber for better fixation of the carbide when vulcanizing the rubber. The rubber moves with the expanding mandrel while binding the carbide until contact of the carbide to the surrounding tubular transfers the liner string weight to the surrounding tubular through the carbide.



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EXPANDABLE LINER HANGER WITH ANCHORING FEATURE

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FIELD OF THE INVENTION

[0001] The field of the invention is liner hangers and more specifically liner hangers set by mandrel expansion and that feature an external hard material adhered in a manner to remain in position as expansion takes place.

BACKGROUND OF THE INVENTION

[0002] Different designs have been offered for expandable liner hangers. In one design a pattern of grooves with a sealing material are placed on the outer surface of the hanger. Surrounded by the groove are carbide segments that are fabricated into the tubular body or are buttons with teeth or using raised or serrated members on the outer surface of the tubular or hardened tooth patterns on the outer surface. Such designs are illustrated in USP 6,688,399 and 6691789. A similar design illustrating hardened inserts retained in pockets on the outer surface of a tubular are shown in USP 8443881. USP 6098717 illustrates an expandable liner hanger with a seal in some embodiments.

[0003] These designs are expensive to fabricate the complex pattern of grooves and the application of the seal material that fits in the grooves. The manner of applying the carbide was also prone to dislodge the particles.

[0004] Another design uses a series of rubber sleeves to seal and support the liner weight as indicated in USP 8371388. The use of rubber for both these functions requires many rings and long tool length with a resulting difficulty in running in in certain applications with limited weight capacity.

[0005] What is needed and provided by the present invention is a way to apply the hardened material or carbide so that it will stay put for run as well as during expansion. The mounting method involves taking uncured rubber into a slurry form with a fluid such as methyl ethyl ketone (MEK) and applying the slurry to the liner hanger body directly or to a support that is subsequently fitted on the hanger body. A bonding agent or adhesive is applied to the hardened particles or carbide and allowed to dry before adding such particles to the rubber slurry. The combination of the rubber slurry and carbide particles is autoclaved in an oven to vulcanize the rubber. In use the rubber retains the carbide during expansion and allows the load to be transferred from the

supported string through the carbide to the expanded mandrel. The assembly of carbide retained with the vulcanized rubber can be placed directly in a recess for protection against abrasion during running in. Alternatively, the assembly can be mounted to a support ring that can be disposed in a recess on the mandrel outer wall. Those skilled in the art will better appreciate additional aspects of the invention from a review of the description of the preferred embodiment and the associated drawings while recognizing that the full scope of the invention is to be determined from the appended claims.

SUMMARY OF THE INVENTION

[0006] An expandable liner hanger features carbide or other hard particles adhered to the outer surface of a tubular mandrel that is expanded using vulcanized rubber to retain the carbide during run in or set. The rubber can be directly applied to the outer surface of the mandrel or to a split ring that is subsequently secured to the outer surface of the mandrel. The rubber can also be mounted in an exterior recess to protect the carbide during running in from being knocked off with impact. A binder can be applied to the carbide or to the rubber for better fixation of the carbide when vulcanizing the rubber. The rubber moves with the expanding mandrel while binding the carbide until contact of the carbide to the surrounding tubular transfers the liner string weight to the surrounding tubular through the carbide.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] FIG. 1 shows the liner hanger in position at the initiation of expansion;

[0008] FIG. 2 is the view of FIG. 1 after expansion is completed;

[0009] FIG. 3 is a close up view of FIG. 1;

[0010] FIG. 4 shows three bands of carbide imbedded in vulcanized rubber mounted on the exterior of a mandrel;

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0011] Referring to FIG. 1 the liner hanger **3** is positioned within a surrounding tubular **1** and then expanded with swage **2**. This expansion brings the sealing rings **4** against the surrounding tubular **1** as shown in FIG. 2. FIG. 3 illustrates the hardened particles or carbide **4a** retained by vulcanized rubber **4b** that is mounted in a recess **5**. The rubber **4b** can be vulcanized in the recess **5** or mounted on a split ring **6** that can then be snapped over the mandrel of the

liner hanger **3**. FIG. 4 illustrates three bands of carbide bound by the vulcanized rubber. As can be seen much of the carbide **4a** is visible on the exterior of the rubber while within the rubber the carbide **4a** is also supported on mandrel **3** of the liner hanger or on an intermediate support such as split ring **6**.

[0012] The assembly method involves bonding the carbide chips using a rubber binder. Rubber in an uncured state is mixed with an agent such as (MEK) or equivalent into liquid slurry. The rubber cement is then brushed on the hanger **3** outside diameter. The carbide chips **4a**, are soaked with bonding agent and dried and applied directly onto the rubber cement. The carbide chips with rubber cement are then vulcanized to the hanger outside diameter and placed inside an oven where the temperature is elevated.

[0013] Upon expansion of the hanger body during deployment of the liner hanger, the rubber is radially stretched as the hanger body is being swaged. The carbide chips remain bonded to the rubber and further trapped between the hanger body and the surrounding casing. The carbide chips penetrate into the surrounding casing as well as the hanger outside diameter. A groove **5** is machined in the mandrel outside diameter to trap the carbide chips for ease of manufacturing as well as preventing washout during running in hole. The carbide chips can enhance the hanging capacity over 2.3 times compared to a metal-to-metal press fit design.

[0014] Those skilled in the art will appreciate that other agents or materials can serve to make the slurry with the rubber that will act as the binder for the carbide. The bonding agent can be applied to the carbide or the rubber or both. Other hard particles or ceramics or diamonds can be used instead of tungsten carbide.

[0015] The use of an elastic material for a binder for the carbide or equivalent allows continuing fixation as the mandrel is expanded with retention of the particles until contact with the opposing tubular is contacted and the load of the hanging weight is transferred. The presence of the binder also assists in fixation of the carbide as it penetrates the opposing tubular and the liner hanger mandrel during the setting process involving expansion. While a fixed dimension swage is illustrated variable swages or other expansion techniques can be employed such as pressure applied between

spaced isolation devices or mechanical axial compression of the liner hanger in the vicinity of the bands of carbide. While three parallel bands are illustrated, differing number of band can be used. The width of the bands can be the same or different or the bands can be a series of spirals that are circumferentially spaced or a single spiral that wraps at least 360 degrees.

[0016] 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:

We claim:

1. An expandable liner hanger, comprising:
a tubular mandrel having an outer surface;
a plurality of hard particles fixated at least in part within a layer of a flexible material on said outer surface.
2. The hanger of claim 1, wherein:
said flexible material is affixed directly to said outer surface.
3. The hanger of claim 1, wherein:
said flexible material is affixed to an intermediate support member mounted to said outer surface.
4. The hanger of claim 3, wherein:
said intermediate support member comprises a split ring.
5. The hanger of claim 1, wherein:
said flexible material extends in at least one band that extends for at least 360 degrees around said outer surface.
6. The hanger of claim 5, wherein:
said at least one band comprises multiple bands having the same or different widths.
7. The hanger of claim 5, wherein:
said at least one band comprises a spiral.
8. The hanger of claim 1, wherein:
said outer surface comprises a recess;
said flexible material is disposed in said recess;
said hard particles extend from said flexible material and beyond said recess.
9. The hanger of claim 8, wherein:
said flexible material is affixed directly to said tubular mandrel within said recess.
10. The hanger of claim 8, wherein:
said flexible material is indirectly fixed to said tubular mandrel in said recess.
11. The hanger of claim 10, wherein:
said indirect fixation comprises a split ring.

12. The hanger of claim **1**, wherein:
said flexible material comprises rubber.
13. The hanger of claim **12**, wherein:
said hard particles comprise carbide.
14. The hanger of claim **13**, wherein:
said rubber is vulcanized with said carbide mounted at least in part in
said rubber.
15. The hanger of claim **14**, wherein:
an adhesive is placed on at least one of said rubber and said carbide.
16. The hanger of claim **12**, wherein:
said rubber is slurried with methyl ethyl ketone when mounted to said
mandrel with said hard particles.

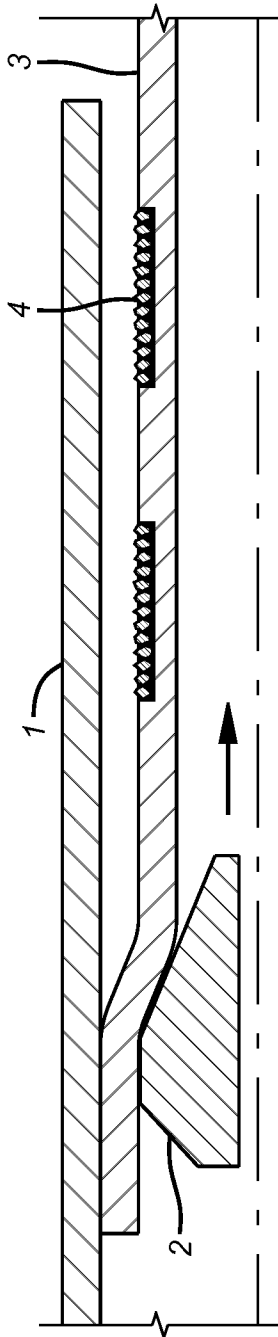


FIG. 1

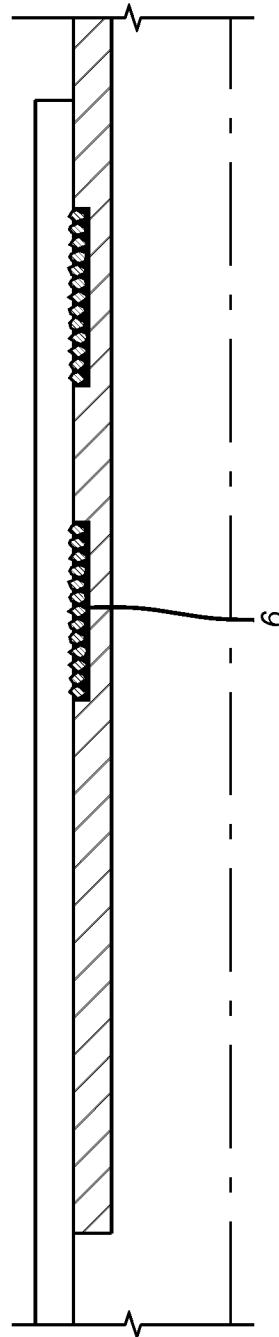


FIG. 2

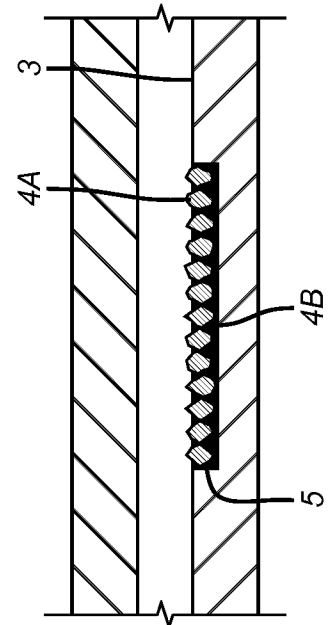


FIG. 3

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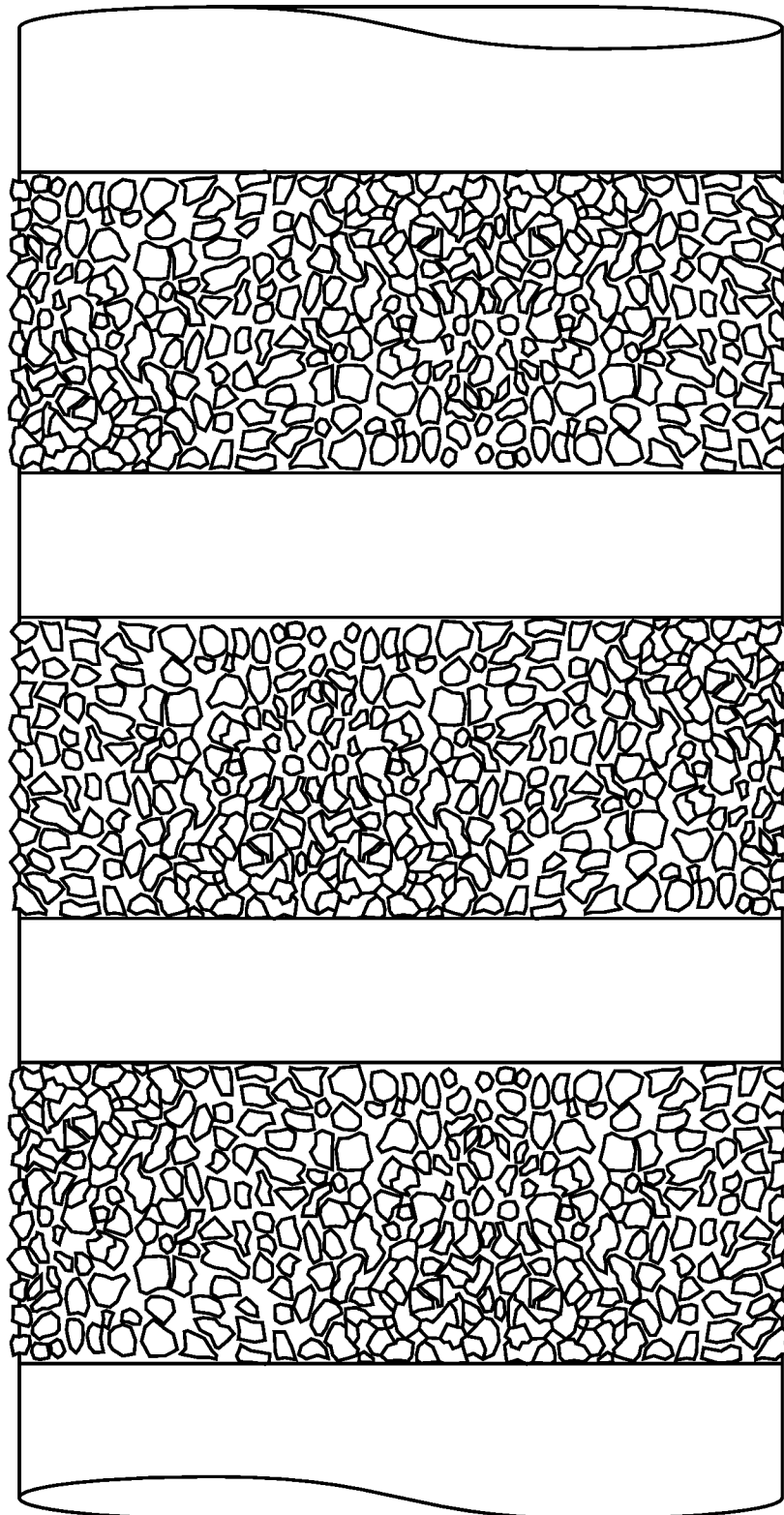


FIG. 4

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2014/049767**A. CLASSIFICATION OF SUBJECT MATTER****E21B 23/02(2006.01)i, E21B 43/10(2006.01)i**

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

B. FIELDS SEARCHEDMinimum documentation searched (classification system followed by classification symbols)
E21B 23/02; E21B 33/128; E21B 43/00; E21B 23/00; E21B 43/10; E21B 17/00; E21B 33/129Documentation 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 modelsElectronic data base consulted during the international search (name of data base and, where practicable, search terms used)
eKOMPASS(KIPO internal) & keywords: liner hanger, expandable, split ring, carbide, flexible, grip, and anchor**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 6691789 B2 (JACKSON et al.) 17 February 2004 See abstract, column 4, line 1 - column 5, line 18, and figures 1-2.	1-2, 8-10, 12-16
Y		3-7, 11
Y	US 7306034 B2 (GARCIA, DAVID A.) 11 December 2007 See abstract, column 2, lines 38-44, column 3, lines 32-35, and figures 1, 14.	3-7, 11
A	US 6513600 B2 (ROSS, RICHARD) 04 February 2003 See abstract, column 2, line 62 - column 3, line 30, and figures 1A-1B.	1-16
A	US 2008-0210440 A1 (STUART et al.) 04 September 2008 See abstract, paragraphs [0032]-[0033], and figures 1A-1B.	1-16
A	US 2011-0247832 A1 (HARRIS, MICHAEL J.) 13 October 2011 See abstract, paragraph [0041], and figure 6.	1-16

☐ 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

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"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

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

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