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(54) **Title:** FRICTION REDUCTION DEVICE FOR DRILL PIPE

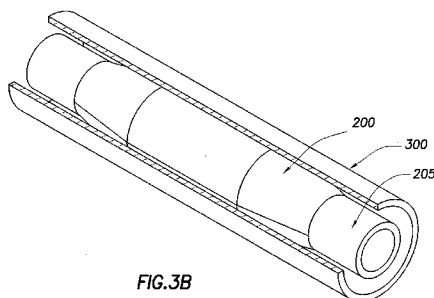


FIG. 3B

(57) **Abstract:** A device to couple to a rotatable drill pipe to control pressure of a drilling system is disclosed. The device includes an inner surface to wrap around a portion of a rotatable drill pipe and having an inner diameter. A first tapered portion is opposite a second tapered portion, with a middle portion therebetween including an outer diameter greater than the inner diameter. The first and second tapered portions each taper from the outer surface to the inner surface. The middle portion, the first tapered portion, and the second tapered portion form an outer surface to sealingly pass through a seal element of a controlled-pressure drilling system. At least a portion of the outer surface corresponding to the middle portion includes a low-friction material.



## FRICION REDUCTION DEVICE FOR DRILL PIPE

### BACKGROUND

5           The present disclosure generally relates to devices for tubulars in a well bore and, more particularly, to mechanical friction reduction devices for drilling tubulars in a well bore.

Managed pressure drilling and underbalanced drilling are well known approaches in the subterranean well drilling and completion art that control pressure downhole in a drilling system. These methods utilize sealing elements to control pressure in the well bore through  
10       which tubulars must pass. It is desirable to reduce friction, to reduce wear, and to prevent buckling associated with tubulars in a well bore, while allowing for effective pressure seals in managed pressure drilling and underbalanced drilling systems.

### FIGURES

15           Some specific exemplary embodiments of the disclosure may be understood by referring, in part, to the following description and the accompanying drawings.

Figure 1 is a cross-sectional schematic of part of an example drilling system.

Figure 2 is a side view of a friction reduction device coupled to a rotatable tubular, in accordance with certain embodiments of the present disclosure.

20           Figure 3A is a cross-sectional view of a friction reduction device coupled to a rotatable tubular disposed within a drill pipe, in accordance with certain embodiments of the present disclosure.

Figure 3B is an isometric cutaway view of the friction reduction device coupled to the rotatable tubular disposed within the drill pipe of Figure 3A, in accordance with certain  
25       embodiments of the present disclosure.

While embodiments of this disclosure have been depicted and described and are defined by reference to exemplary embodiments of the disclosure, such references do not imply a limitation on the disclosure, and no such limitation is to be inferred. The subject matter disclosed is capable of considerable modification, alteration, and equivalents in form and  
30       function, as will occur to those skilled in the pertinent art and having the benefit of this disclosure. The depicted and described embodiments of this disclosure are examples only, and not exhaustive of the scope of the disclosure.

## DETAILED DESCRIPTION

The present disclosure generally relates to devices for tubulars in a well bore and, more particularly, to mechanical friction reduction devices for drilling tubulars in a well bore.

Illustrative embodiments of the present disclosure are described in detail herein.

5 In the interest of clarity, not all features of an actual implementation may be described in this specification. It will of course be appreciated that in the development of any such actual embodiment, numerous implementation-specific decisions must be made to achieve the specific implementation goals, which will vary from one implementation to another. Moreover, it will be appreciated that such a development effort might be complex and time-consuming, but would  
10 nevertheless be a routine undertaking for those of ordinary skill in the art having the benefit of the present disclosure.

To facilitate a better understanding of the present disclosure, the following examples of certain embodiments are given. In no way should the following examples be read to limit, or define, the scope of the disclosure. Embodiments of the present disclosure may be  
15 applicable to horizontal, vertical, deviated, or otherwise nonlinear wellbores in any type of subterranean formation. Embodiments may be applicable to injection wells as well as production wells, including hydrocarbon wells.

Figure 1 is a cross-sectional schematic of part of an example drilling system 100 for drilling a borehole traversing earth formations (not shown). The drilling system 100 may be  
20 a managed pressure drilling system, an underbalanced drilling system, or any drilling system where a tubular passes through a seal element. In the schematic, only major components are shown, with details of standard type found in typical drilling systems omitted. Managed pressure drilling and underbalanced drilling are well known approaches in the subterranean well drilling and completion art that control pressure downhole in a drilling system. These methods  
25 utilize sealing elements to control pressure in the well bore through which tubulars must pass.

A rotatable tubular 105 is shown in an example position in which it may be during a drilling process. The rotatable tubular 105 may be coupled to a drill bit (not shown). In certain applications, the rotatable tubular 105 may be coupled to one or more other rotatable tubulars (not shown) in a drill string. The rotatable tubular 105 may extend through section 110, which  
30 may be a riser or a drill pipe, for example. The rotatable tubular 105 also may extend past a seal element 115, which may be any seal element or assembly suitable for the controlled-pressure application of the drilling system 100. For example without limitation, the seal element 115 may be an active or passive sealing element, may include one or more rubber elements, and/or may be part of a safety device that can be closed around the rotatable tubular 105, such as an annular

BOP, a ram BOP, or an active RCD device.

Friction from the rotation of the rotatable tubular 105 and contact with exterior surfaces can reduce the effective torque of the drill string and can cause wear and/or damage. The friction due to the tubular 105 sliding on surfaces during changes in along-hole depth also  
5 can cause wear and/or damage and inhibit movement. In addition, the tubular 105 impacting other surfaces due to the variations and vibrations of the drilling process can be another cause of wear and/or damage.

Figure 2 is a side view of a friction reduction device 200 coupled to a rotatable tubular 205, in accordance with certain embodiments of the present disclosure. In certain  
10 embodiments, the tubular 205 may correspond to the tubular 105 of drilling system 100. Figure 3A is a cross-sectional view of the friction reduction device 200 coupled to a rotatable tubular 205 disposed within a drill pipe 300, in accordance with certain embodiments of the present disclosure. Figure 3B is a corresponding isometric cutaway view.

The friction reduction device 200 may be generally cylindrical with a cylindrical  
15 surface contacting an outer cylindrical surface of the tubular 205. The friction reduction device 200 may be removably attached or fixedly attached to the tubular 205. In certain embodiments, the friction reduction device 200 may be designed as compression fitting sleeve or integrally formed with the tubular 205. In certain embodiments, the friction reduction device 200 may be attached by way of a suitable adhesion and/or catalyst/resin binding process.

The friction reduction device 200 may include a middle or wide portion 210 with  
20 an outer diameter 210A and having an outer cylindrical surface 210B. The outer cylindrical surface 210B may be parallel to an inner cylindrical surface 210C of the friction reduction device 200. The outer cylindrical surface 210B may be generally parallel or at least radially exterior to the inner cylindrical surface 210C in certain embodiments. The inner cylindrical surface 210C  
25 may abut an outer diameter 205A of the tubular 205. The friction reduction device 200 may include a tapered portion 215A opposite a tapered portion 215B, with the middle portion 210 therebetween. The tapered portions 215A, 215B may taper from the outer cylindrical surface 210A to the inner cylindrical surface 210B, forming a smooth frusto-conical outer surface. As such, the friction reduction device 200 may form a protective sleeve about a portion of the  
30 tubular 205.

As depicted, the combined longitudinal length of the tapered portions 215A, 215B may be greater than the longitudinal length of the middle portion 210. In alternative embodiments, the combined longitudinal length of the tapered portions 215A, 215B may be less than or equal to the longitudinal length of the middle portion 210. As depicted, the tapered

portions 215A, 215B may be symmetrical about the middle portion 210. In alternative embodiments, the tapered portions 215A, 215B may be asymmetrical. Moreover, while the friction reduction device 200 is depicted as having a uniform, solid interior, certain alternative embodiments may have interiors that are not uniformly solid. And, while friction reduction device 200 is shown disposed within the drill pipe 300, certain embodiments may be used in applications without an exterior drill pipe, for example, where the rotatable tubular is exposed to a casing or a borehole wall.

The geometry of the friction reduction device 200 allows for an effective pressure seal with seal elements of managed pressure drilling systems and/or underbalanced drilling systems, such as drilling system 100 where the tubular 105 passes through the seal element 115. For example, the tapered portions 215A, 215B and the middle portion 210 may provide a plurality of continuous circular surfaces that facilitate the passage through the seal element 115 while maintaining an effective pressure seal. Maintaining an effective pressure seal is very important in controlling bottom hole pressure in such systems. While providing friction reduction, the friction reduction device 200 coupled to the tubular 205 may sealingly pass through the sealing element 115, *i.e.*, pass without breaking the effective seal of that element and without allowing for pressure bypass that would render managed pressure drilling and underbalanced drilling ineffective.

The friction reduction device 200 may be made from any suitable material, including a suitable abrasion-resistant material. During the drilling process, the rotatable tubular 205 may be subject to various forces such as compressive, tensile and shear forces. The geometry and material of the friction reduction device 200 may reinforce the tubular 205 to resist or prevent buckling or other damages due to the forces.

The friction reduction device 200 may or may not include a low-friction material including but not limited to: Teflon, ceramics, poly carbonate, plastics, carbon fiber or resins or any other suitable material with a low coefficient of friction. The low-friction coefficient of one or more of the middle portion 210 and tapered portions 215A, 215B may further facilitate the passage through the seal element 115 while maintaining an effective pressure seal. In certain embodiments, only the middle portion 210 may be made from or include low-friction material. And, in certain embodiments, one or more of the outer surfaces of the friction reduction device 200 may be made from or include low-friction material and, *e.g.*, may be plated or coated with the low-friction material.

Accordingly, the geometry and low-friction material of the friction reduction device 200 may reduce friction associated with the movement of the rotatable tubular 105. With

the outer diameter of the friction reduction device 200 greater than the diameter 205A of the rotatable tubular 205, the friction reduction device 200 may contact an inner diameter 305A drill pipe 300 instead of the tubular 205 contacting the drill pipe 300. By reducing friction associated with rotation, the friction reduction device 200 allows for increased torque. The friction reduction device 200 also reduces friction associated with traversing along the drill pipe 300 or another surface, thereby facilitating the sliding of the tubular 105. Thus, the friction reduction device 200 increases the efficiency of drilling while facilitating the central alignment of the tubular 205 and protecting the tubular 105 from damage due to abrasion and impacts with the exterior drill pipe 300.

10 Therefore, the present disclosure is well adapted to attain the ends and advantages mentioned as well as those that are inherent therein. The particular embodiments disclosed above are illustrative only, as the present disclosure may be modified and practiced in different but equivalent manners apparent to those skilled in the art having the benefit of the teachings herein. Furthermore, no limitations are intended to the details of construction or design herein  
15 shown, other than as described in the claims below. It is therefore evident that the particular illustrative embodiments disclosed above may be altered or modified and all such variations are considered within the scope and spirit of the present disclosure. Also, the terms in the claims have their plain, ordinary meaning unless otherwise explicitly and clearly defined by the patentee. The indefinite articles "a" or "an," as used in the claims, are defined herein to mean  
20 one or more than one of the element that it introduces.

## WHAT IS CLAIMED IS:

1. A device to couple to a rotatable drill pipe to control pressure of a drilling system, the device comprising:

5 an inner surface to wrap around a portion of a rotatable drill pipe and having an inner diameter; and

a first tapered portion opposite a second tapered portion, with a middle portion therebetween comprising an outer diameter greater than the inner diameter;

wherein:

10 the first and second tapered portions each taper from the outer surface to the inner surface;

the middle portion, the first tapered portion, and the second tapered portion form an outer surface to sealingly pass through a seal element of a controlled-pressure drilling system; and

15 at least a portion of the outer surface corresponding to the middle portion comprises a low-friction material.

2. The device of claim 1, wherein the middle portion forms an outer cylindrical surface portion.

20 3. The device of claim 1, wherein the middle portion forms an outer surface portion that is parallel to the inner surface.

4. The device of claim 1, wherein the low-friction material is Teflon.

25 5. The device of claim 1, wherein the middle portion forms an outer surface portion having a single radius, and the first and second tapered portions each comprise an outer frusto-conical surface portion.

30 6. The device of claim 1, wherein the outer surface comprises a low-friction material.

7. A reduced-friction rotatable tubular system for a controlled-pressure drilling system, comprising:

a drill pipe to be disposed in a wellbore and having an inside diameter;

5 a rotatable tubular extending through at least a portion of the drill pipe and having an outside diameter;

a friction reduction device disposed around a portion of the rotatable tubular, wherein the friction reduction device comprises:

an inner surface having an inner diameter; and

10 a first tapered portion opposite a second tapered portion, with a middle portion therebetween comprising an outer diameter greater than the inner diameter;

wherein the middle portion, the first tapered portion, and the second tapered portion form an outer surface to sealingly pass through a seal element of a controlled-pressure drilling system; and

15 wherein at least a portion of the outer surface corresponding to the middle portion comprises a low-friction material.

8. The reduced-friction rotatable tubular system of claim 7, wherein the friction reduction device prevents the rotatable tubular from contacting the drill pipe.

20 9. The reduced-friction rotatable tubular system of claim 7, wherein the first and second tapered portions each taper from the outer surface to the inner surface of the friction reduction device.

25 10. The reduced-friction rotatable tubular system of claim 7, wherein the middle portion forms an outer cylindrical surface portion.

11. The reduced-friction rotatable tubular system of claim 7, wherein the middle portion forms an outer surface portion that is parallel to the inner surface.

30 12. The reduced-friction rotatable tubular system of claim 7, wherein the low-friction material is Teflon.



13. The reduced-friction rotatable tubular system of claim 7, wherein the middle portion forms an outer surface portion having a single radius, and the first and second tapered portions each comprise an outer frusto-conical surface portion.

5 14. The reduced-friction rotatable tubular system of claim 7, wherein the outer surface comprises a low-friction material.

15. A method of reducing friction in a controlled-pressure drilling system, the method comprising:

10 disposing a drill pipe in a wellbore, the drill pipe having an inside diameter;  
extending a rotatable tubular through at least a portion of the drill pipe, the rotatable tubular having an outside diameter;

coupling a friction reduction device to a portion of the rotatable tubular, wherein the friction reduction device comprises:

15 an inner surface having an inner diameter; and  
a first tapered portion opposite a second tapered portion, with a middle portion therebetween comprising an outer diameter greater than the inner diameter;

20 wherein the middle portion, the first tapered portion, and the second tapered portion form an outer surface to sealingly pass through a seal element of a controlled-pressure drilling system; and

wherein at least a portion of the outer surface corresponding to the middle portion comprises a low-friction material.

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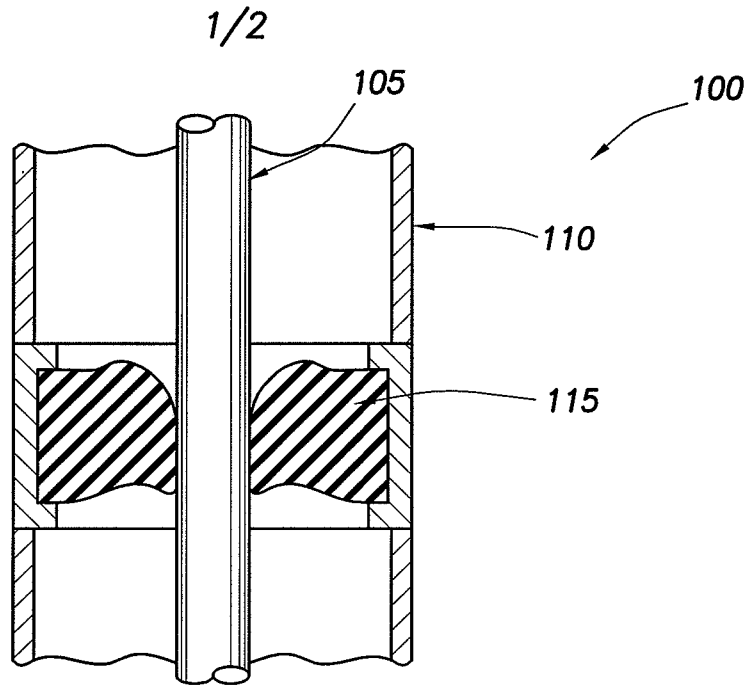


FIG. 1

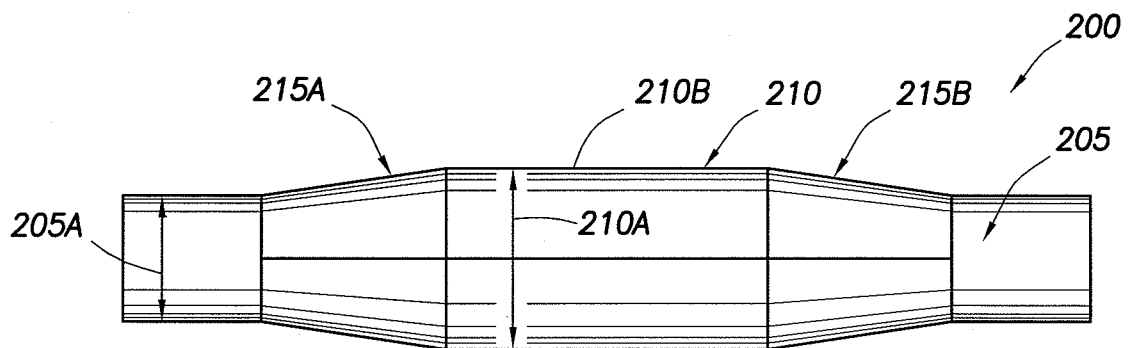


FIG. 2

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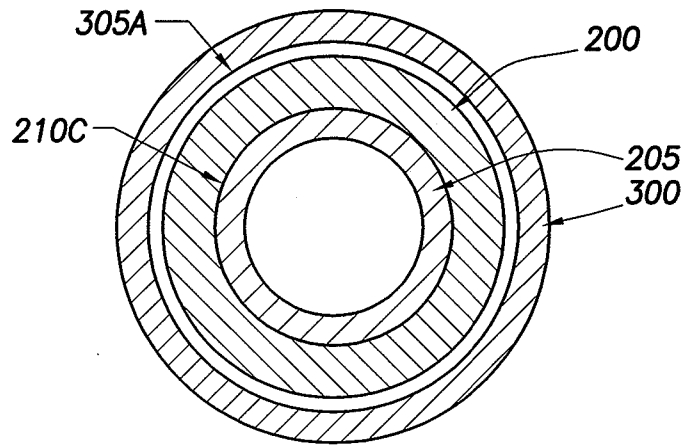


FIG.3A

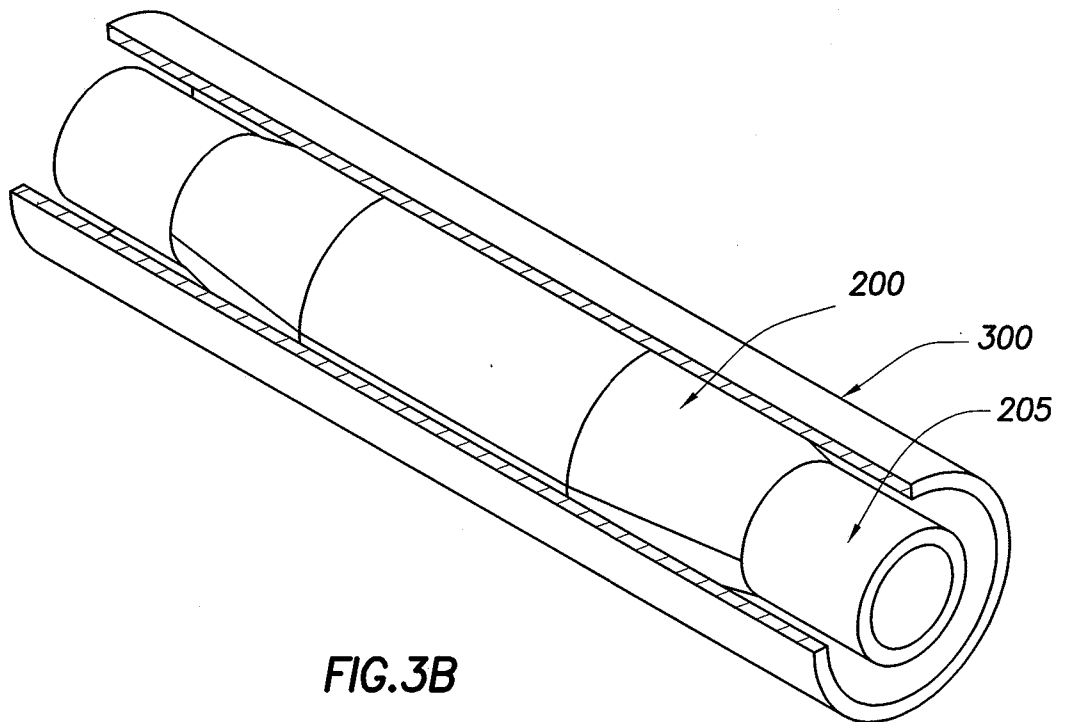


FIG.3B

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INTERNATIONAL SEARCH REPORT

International application No  
PCT/US2011/045298

A. CLASSIFICATION OF SUBJECT MATTER  
INV. E21B33/08 E21B17/10  
ADD.  
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)  
E21B

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

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)  
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 265 466 A (RICHTER DAVID L [US] ET AL) 30 November 1993 (1993-11-30) column 3, line 54 - column 4, line 19; figures 3-10	1-15
X	EP 0 439 279 A1 (RUDOLPH E KRUEGER INC [US] WESTERN WELL TOOL INC [US]) 31 July 1991 (1991-07-31) claim 1; figure 3	1,7,15
X	WO 00/01239 A2 (DRILLTECH SERVICES ASIA PTE LT [SG]; APPLETON ROBERT P [GB]) 13 January 2000 (2000-01-13) claim 1; figures 1-3	1,7,15
A	US 5 740 862 A (SABLE DONALD E [US]) 21 April 1998 (1998-04-21) claim 1; figures 1-4	1-15

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
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- "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
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- "&" document member of the same patent family

Date of the actual completion of the international search  16 March 2012	Date of mailing of the international search report  10/04/2012
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# INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/US2011/045298

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 5265466	A	30-11-1993	NONE
-----			
EP 0439279	A1	31-07-1991	CA 2034817 A1 25-07-1991
			DE 69118932 D1 30-05-1996
			DK 0439279 T3 13-05-1996
			EP 0439279 A1 31-07-1991
			NO 910250 A 25-07-1991
			US 5069297 A 03-12-1991
-----			
WO 0001239	A2	13-01-2000	AU 4632299 A 24-01-2000
			GB 2338970 A 12-01-2000
			WO 0001239 A2 13-01-2000
-----			
US 5740862	A	21-04-1998	CA 2152964 A1 18-07-1996
			US 5740862 A 21-04-1998
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