Office de la Propriété Intellectuelle du Canada
Un organisme d'Industrie Canada

Canadian Intellectual Property Office
An agency of Industry Canada

CA 2596383 C 2010/04/06

(11)(21) **2 596 383**

(12) **BREVET CANADIEN**
CANADIAN PATENT

(13) **C**

(22) **Date de dépôt/Filing Date:** 2007/08/07

(41) **Mise à la disp. pub./Open to Public Insp.:** 2008/02/07

(45) **Date de délivrance/Issue Date:** 2010/04/06

(30) **Priorités/Priorities:** 2006/08/07 (CN200620130797.8); 2007/02/06 (CN200720139242.4); 2007/02/06 (CN200720139239.2)

(51) **Cl.Int./Int.Cl.** *E21B 34/06* (2006.01), *E21B 34/08* (2006.01), *E21B 34/12* (2006.01)

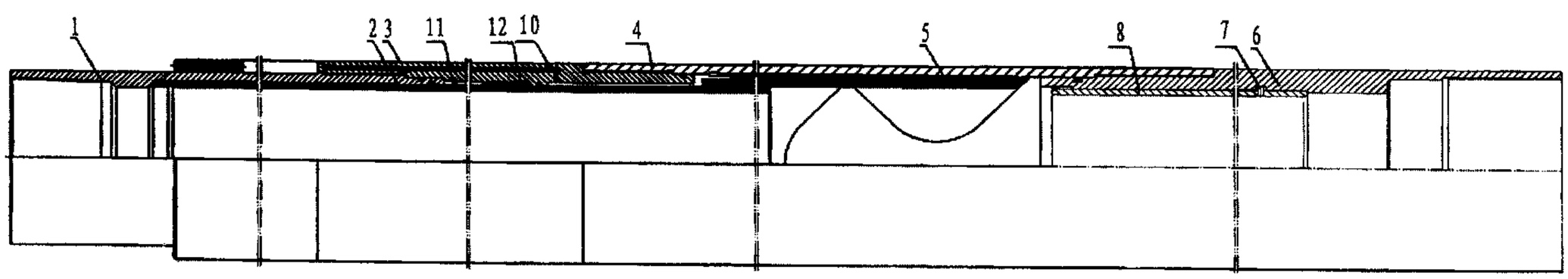
(72) **Inventeurs/Inventors:**
XU, SHUQIAN, CN;
CHEN, RUOMING, CN;
GAO, BENWEN, CN;
LI, XIAOJUN, CN;
NING, SHIPIN, CN

(73) **Propriétaire/Owner:**
DRILLING TECHNOLOGY RESEARCH INSTITUTE XINJIANG PETROLEUM ADMINISTRATION BUREAU, CN

(74) **Agent:** OGILVY RENAULT LLP/S.E.N.C.R.L.,S.R.L.

(54) **Titre :** FLOTTEUR A TUBE DE FOND DE TROU EN SOUS-PRESSION ET OUTIL POUR OUVERTURE FORCEE CONNEXE

(54) **Title:** UNDERBALANCED DOWNHOLE CASING VALVE AND FORCE OPEN TOOL THEREOF



(57) **Abrégé/Abstract:**

The present invention relates to an underbalanced downhole casing valve controlled hydraulically, wherein: a first hydraulic fluid chamber (11) formed between bosses in the inner chamber of an upper fitting and on the outer surface of an inner cylinder and on the inner surface of an upper outer cylinder; a second hydraulic fluid chamber (12) formed between the lower portion of the boss of the inner cylinder and an inner chamber of the upper outer cylinder; Axial bores are disposed on the upper end of the upper outer cylinder, two of them are respectively fluidly communicated with the first hydraulic fluid chamber (11) and the second hydraulic fluid chamber (12); a second annulus formed between the lower portion of the upper outer cylinder and the inner cylinder, which is communicated with the bore disposed in the upper outer cylinder and is communicated with a third annulus defined by the upper outer cylinder and the valve assembly. If one person wants to open/close the casing valve, he/she only pumps using one/the other pipe. When the casing valve is closed, the downhole pressure can be measured. When the underbalanced downhole casing valve is closed and can not be opened by the hydraulic pressure on the ground, the underbalanced downhole casing valve can be opened and locked in a permanent open state by the matched force open tool.

Abstract

The present invention relates to an underbalanced downhole casing valve controlled hydraulically, wherein: a first hydraulic fluid chamber (11) formed between bosses in the inner chamber of an upper fitting and on the outer surface of an inner cylinder and on the inner surface of an upper outer cylinder; a second hydraulic fluid chamber (12) formed between the lower portion of the boss of the inner cylinder and an inner chamber of the upper outer cylinder; Axial bores are disposed on the upper end of the upper outer cylinder, two of them are respectively fluidly communicated with the first hydraulic fluid chamber (11) and the second hydraulic fluid chamber (12); a second annulus formed between the lower portion of the upper outer cylinder and the inner cylinder, which is communicated with the bore disposed in the upper outer cylinder and is communicated with a third annulus defined by the upper outer cylinder and the valve assembly. If one person wants to open/close the casing valve, he/she only pumps using one/the other pipe. When the casing valve is closed, the downhole pressure can be measured. When the underbalanced downhole casing valve is closed and can not be opened by the hydraulic pressure on the ground, the underbalanced downhole casing valve can be opened and locked in a permanent open state by the matched force open tool.

Description

Underbalanced downhole casing valve and force open tool thereof

Field of the Invention

The present invention relates to a hole-closure device used during under-balanced drilling and well completion operation, in particular, to an underbalanced down-hole casing valve and a force open tool used during drilling and well completion in oil and gas field.

Background of the Invention

Recently, underbalanced drilling technology has been developed rapidly. Especially, an underbalanced downhole hole-closure device is applied to underbalanced drilling operation, which makes overall process of underbalanced drilling operation complete successfully. A hole-closure device, such as an underbalanced downhole casing valve, can entirely separate fluid above a wellbore from that under it at a specific position of cylinderan intermediate casing, which ensures tripping and running complete well pipes in an underbalanced state, and effectively reduces damage to oil storage layer as a result of controlling well using weighted mud for balancing downhole pressure when tripping and running complete well pipes are being done in an underbalanced state.

However, the technique of the underbalanced downhole hole-closure device is not perfect. During use of the underbalanced downhole hole-closure device, on the one hand, after a tongue board of the underbalanced downhole hole-closure device is closed for a long time, negative pressure is produced as a result of gas moving in stratums. Overhigh negative pressure under the tongue board can damage the tongue board, and the longer time the tongue board is closed, the higher the negative pressure. On the other hand, one person on the ground can not know the value of the negative pressure under the tongue board, so he/she can not control the pressure of the wellbore exactly, which can bring hidden trouble to switches of the

tongue board in the underbalanced downhole hole-closure device. If the switches are operated falsely, the tongue board will be damaged. Furthermore, during opening or closing the underbalanced downhole hole-closure device, one person on the ground can not know whether the tongue board has been opened. If drilling has been started when the tongue board has not been opened entirely, the tongue board also can be shattered. Therefore, the tongue board of the casing valve can not be opened when the underbalanced downhole hole-closure device, especially the underbalanced downhole casing valve goes wrong in hydraulic controlling pipe , at this time, a match tool will be required to force to open the downhole casing valve and lock it in a permanent open state.

Summary of the Invention

An object of the present invention is to provide an underbalanced downhole casing valve controlled hydraulically. The casing valve can entirely separate fluid above a wellbore from that under it at a specific position of an intermediate casing, which ensures tripping and running complete well pipes in an underbalanced state, and effectively reduces damage to oil storage layer as a result of controlling well using weighted mud for balancing downhole pressure when tripping and running complete well pipes are being done in an underbalanced state. Furthermore, when the hydraulic pressure on the ground can not open the underbalanced downhole casing valve, the underbalanced downhole casing valve can be opened and locked in a permanent open state by matched force open tool.

The underbalanced downhole casing valve of the present invention can also measure the downhole pressure so that the downhole pressure can be effectively inspected during drilling operation.

According to one aspect of the present invent, an underbalanced downhole casing valve controlled hydraulically is provided, which comprises an upper fitting, an inner cylindercylinder, an upper outer cylinder, a lower outer cylinder, a valve assembly and a lower fitting, wherein steps machined on the inner surface of the upper outer cylinder; the valve assembly situated within a first annulus defined by

the upper outer cylinder, the lower outer cylinder and the inner cylinder; bosses respectively disposed in the inner surface of the upper fitting and on the outer surface of the inner cylinder, the upper outer cylinder and the inner cylinder being clearance fit; a first hydraulic fluid chamber (11) formed between the bosses in the inner surface of the upper fitting boss and on the outer surface of the inner cylinder and the inner surface of the upper outer cylinder; a second hydraulic fluid chamber (12) formed between the lower portion of the bosses in the inner cylinder and the inner surface of the upper outer cylinder ; axial bores disposed on the upper end of the upper outer cylinder; hydraulic controlling systems connected to the axial bores by pipes, two of the axial bores respectively fluidly communicated with the first hydraulic fluid chamber (11) and the second hydraulic fluid chamber (12); a second annulus formed between the lower portion of the upper outer cylinder and the inner cylinder, the second annulus fluidly communicated with the bore disposed in the upper outer cylinder, and fluidly communicated with a third annulus defined by the upper outer cylinder and the valve assembly.

The underbalanced downhole casing valve of the present invention further comprises a lock collar and a shear pin, wherein: the lock collar installed within the lower fitting; steps formed on the inner surface of the lower fitting , and the lower end surface of the lock collar positioned on the step on the inner surface of the lower fitting; The lower fitting connected with the lock collar by the shear pin; inverted teeth machined on the outer surface of the upper end of the lock collar and on the inner surface of the lower fitting; the outer diameter of the lock collar is smaller than the inner diameter of the valve assembly.

A force open tool used for the underbalanced downhole casing valve of the present invention is also provided, which comprises a body, a spring block, a hydraulic anchor, a resilient sleeve, a ball seat and a guide head, wherein: Steps provided on the outer surface of the body; the spring block and the hydraulic anchor respectively fixed to the upper portion and the middle portion of the body; the resilient sleeve covering the outer surface of the lower portion of the body, a

boss disposed on the middle portion of the outer surface of the resilient sleeve, thru slots distributed equably around the circumference throughout the entire length of the boss; the boss disposed on the middle outer surface of the resilient sleeve mating with a groove right disposed in the underbalanced downhole casing valve according to the present invention; the ball seat mounted within the lower portion of the body; the guide head mounted on the end portion of the body.

The advantage of the present invention is that: during using the casing valve, if one person wants to open the casing valve which has been closed, he/she can only pump using one of the pipes. Pressure is applied through one of two assistant pipes, and the pressure will enter into the first hydraulic fluid chamber 11 through the upper outer cylinder 3 and pushes the inner cylinder 2 downwardly moving, in turn the inner cylinder 2 pushes the tongue board on the valve assembly 5 open. If one person wants to close the casing valve, he/she can only pump using the other pipe. Pressure is applied through the other assistant pipe, and the pressure will enter into the second hydraulic fluid chamber 12 through bores disposed in the upper outer cylinder 2 and pushes the inner cylinder 2 upwardly moving. The tongue board on the valve assembly 5 is closed under the action of an assistant spring.

When the casing valve is closed, the downhole pressure can be measured through the radial bores 10 on the upper outer cylinder 3.

When the underbalanced downhole casing valve is closed and can not be opened by the hydraulic pressure on the ground, the underbalanced downhole casing valve can be opened and locked in a permanent open state by matched force open tool.

Brief Description of the Drawings

Figure 1 is a partial section view showing an underbalanced downhole casing valve according to the present invention;

Figure 1A and 1B are section views showing clearly all the part of the valve respectively;

Figure 2 is a partial section view showing a force open tool for the underbalanced downhole casing valve according to the present invention.

Figure 3 and 4 are section views showing how the axis bores are communicated with hydraulic fluid chamber 11 and 12 respectively;

Figure 5 are a section view showing how the radial bore is communicated with the downhole pressure when the valve is closed.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Hereinafter, a preferred embodiment of the present invention will be described in detail with reference to the drawings.

Fig.1 is a section view of an underbalanced downhole casing valve controlled by hydraulic pressure for measuring downhole pressure. Figure 1A and 1B are section views showing clearly all the part of the valve respectively. The casing valve includes an upper fitting 1, an inner cylinder 2, a upper outer cylinder 3, a lower outer cylinder 4, a valve assembly 5 and a lower fitting 6. The upper fitting 1 and the upper outer cylinder 3, the upper outer cylinder 3 and the lower outer cylinder 4 and the lower outer cylinder 4 and the lower fitting 6 are respectively engaged each other by screw thread and the like. There are steps on the inner surface of the upper outer cylinder 3. The valve assembly 5 is disposed within a first annulus defined by the upper outer cylinder 3, the lower outer cylinder 4 and the inner cylinder 2, and which covers the outer surface of the inner cylinder 2 and is positioned on the step on the inner surface of the lower outer cylinder 4. Two bosses are respectively disposed in the inner surface of the upper fitting 1 and on the outer surface of the inner cylinder 2. Sealing loops can be disposed on the bosses. Clearance fit is provided between the upper outer cylinder 3 and the inner cylinder 2. A first hydraulic fluid chamber 11 is formed on the bosses in the inner surface of the upper fitting 1 and on the outer surface of the inner cylinder 2 and the inner surface of the upper outer cylinder 3; a second hydraulic fluid chamber 12 is formed between the lower portion of the boss on the inner cylinder 2 and the inner surface of the upper outer cylinder 3. Several axial bores are disposed on the upper

end of the upper outer cylinder 3. A hydraulic controlling system is fluidly communicated with the bores by pipes. Two of the bores are respectively fluidly communicated with the first hydraulic fluid chamber 11 and the second hydraulic fluid chamber 12. A second annulus is formed between the lower portion of the upper outer cylinder 3 and the inner cylinder 2. The second annulus is communicated with a radial bore 10 disposed in the upper outer cylinder 3 and communicated with a third annulus defined by the upper outer cylinder 3 and the valve assembly 5., as best shown in Figure 3 and 4.

The underbalanced downhole casing valve of Fig.1 further includes a shear pin 7 and a lock collar 8. The lock collar 8 is installed within the lower fitting 6. Inverted teeth are machined on the outer surface of the upper end of the lock collar 8 and on the inner surface of the lower fitting 6. Steps are also formed on the inner surface of the lower fitting 6. The lower end surface of the lock collar 8 is positioned on the step on the inner surface of the lower fitting 6. The lower fitting 6 is connected to the lock collar 8 by the shear pin 7. The outer diameter of the lock collar 8 is slightly smaller than the inner diameter of the valve assembly 5.

The casing valve is pre-connected to an intermediate casing before the intermediate casing is ran. Two assistant pipes are connected to an annulus between the casing valve and a previous stage cylinder. If one person wants to open the casing valve which has been closed, he/she can only pump using one of the pipes. TPressure is applied through one of the two assistant pipes, and the pressure will enter into the first hydraulic fluid chamber 11 through the upper outer cylinder 3 and pushes the inner cylinder 2 downwardly moving, in turn the inner cylinder 2 pushes the tongue board on the valve assembly 5 open. If one person wants to close the casing valve, he/she can only pump using the other pipe. Pressure is applied through the other assistant pipe, and the pressure will enter into the second hydraulic fluid chamber 12 through the bores disposed in the upper outer cylinder 2 and pushes the inner cylinder 2 upwardly moving. The tongue board on the valve assembly 5 is closed under the action of an assistant spring. Figure 5 are a section

view showing how the radial bore is communicated with the downhole pressure when the valve is closed. When the casing valve is closed, the bores on the upper outer cylinder 3 are fluidly communicated with a second annulus formed between the lower portion of the upper outer cylinder 3 and the inner cylinder 2, and the secondannulus is fluidly communicated with a third annulus formed between the upper outer cylinder 3 and the valve assembly 5, so the downhole pressure can be measured through the radial bore 10 on the upper outer cylinder 3.

Fig.2 shows a force open tool for the underbalance downhole casing valve of the present invention. The force open tool includes a body 13, a spring block 14, a hydraulic anchor 15, a resilient sleeve 16, a ball seat 17 and a guide head 18. The guide head 18 is connected to one end of the body 13 by screw threas or the other like manner. The outer surface of the body 13 is provided with steps. The spring block 14 and the hydraulic anchor 15 are respectively fixed to the upper portion and the middle portion of the body 13 by bolts. The resilient sleeve 16 covers the outer surface of the lower portion of the body 13. A boss is disposed on the middle portion of the outer surface of the resilient sleeve 16. There are predetermined numbers thru slot distributed equably around the circumference throughout the entire length of the boss. The stage disposed on the middle outer surface of the resilient sleeve 16 can mate with a groove right disposed in the underbalanced downhole casing valve. The ball seat 17 is mounted within the lower portion of the body 13.

The casing valve is connected to the intermediate casing in advance before the intermediate casing is ran. When the casing valve is closed and can not be opened by controlling hydraulic pressure on the ground, the force open tool for the underbalanced downhole casing valve can be ran. When the force open tool is ran, the resilient sleeve 16 and the spring block 14 are contracted and the force open tool enters into the underbalanced downhole casing valve. The lower end of the guide head forces the tongue board of the downhole casing valve open. When the boss of the resilient sleeve 16 enters into a groove in the downhole casing valve, a

pump is opened to increase pressure in the pump and anchor flukes of the hydraulic anchor are protruded to support within the lock collar 8 in the downhole casing valve. Then the force open tool is lifted along with the lock collar 8. The shear pins 7 are cut. Then the lock collar 8 comes into the valve assembly 5. The lock collar 8 can only be moved upwardly because inverted teeth are provided on the outer surface of the lock collar 8 and the inner surface of the lower fitting 6. Therefore, the underbalanced downhole casing valve will be locked in the open state permanently. If the pump is stopped, the anchor flukes of the hydraulic anchor are contracted, while the force open tool can be pulled out successfully.

Claims

1. An underbalanced downhole casing valve controlled hydraulically, comprising: an upper fitting, an inner cylinder, an upper outer cylinder, a lower outer cylinder, a valve assembly and a lower fitting, wherein,

steps and a boss machined on the inner surface of the upper outer cylinder;

the valve assembly situated within a first annulus defined by the upper outer cylinder, the lower outer cylinder and the inner cylinder;

bosses respectively disposed on the inner surface of the upper fitting and on the outer surface of the inner cylinder, the upper outer cylinder and the inner cylinder being clearance fit;

a first hydraulic fluid chamber formed between the bosses on the inner surface of the upper fitting and bosses on the outer surface of the inner cylinder and the inner surface of the upper outer cylinder;

a second hydraulic fluid chamber formed between the lower portion of the bosses on the inner cylinder and the boss on the inner surface of the upper outer cylinder;

axial bores disposed on the upper end of the upper outer cylinder; hydraulic controlling systems connected to the axial bores by pipes, two of the axial bores respectively fluidly communicated with the first hydraulic fluid chamber and the second hydraulic fluid chamber;

during use of the casing valve, if one person wants to open the casing valve which has been closed, he/she can only pump using one of the pipes, pressure is applied through the one of the pipes, and the pressure will enter into the first hydraulic fluid chamber through the upper outer cylinder and pushes the inner cylinder downwardly moving, in turn the inner cylinder pushes a tongue board on the valve assembly open; if one person wants to close the casing valve, he/she can only pump using the other pipe, pressure is applied through the other pipe, and the pressure will enter into the second hydraulic fluid chamber through bores disposed

in the upper outer cylinder and pushes the inner cylinder upwardly moving, and then the tongue board on the valve assembly is closed under the action of an assistant spring;

a second annulus formed between the lower portion of the boss on the inner surface of the upper outer cylinder and the inner cylinder, the second annulus fluidly communicated with a radial bore disposed in the upper outer cylinder and fluidly communicated with a third annulus defined by the upper outer cylinder and the valve assembly, when the casing valve is closed, the downhole pressure can be measured through the radial bore.

2. The underbalanced downhole casing valve according to claim 1, further comprising a lock collar and a shear pin, wherein:

the lock collar installed within the lower fitting;

steps formed on the inner surface of the lower fitting , and the lower end surface of the lock collar positioned on the step on the inner surface of the lower fitting;

the lower fitting connected with the lock collar by the shear pin;

inverted teeth machined on the outer surface of the upper end of the lock collar and on the inner surface of the lower fitting;

the outer diameter of the lock collar is smaller than the inner diameter of the valve assembly.

3. A force open tool for the underbalanced downhole casing valve according to claim 2, comprising: a body, a spring block, a hydraulic anchor, a resilient sleeve, a ball seat and a guide head, wherein:

Steps provided on the outer surface of the body;

the spring block and the hydraulic anchor respectively fixed to the upper portion and the middle portion of the body;

the resilient sleeve covering the outer surface of the lower portion of the body, and a boss disposed on the middle portion of the outer surface of the resilient

sleeve, thru slots distributed equably around the circumference throughout the entire length of the boss;

the boss located in a corresponding groove disposed in the underbalanced downhole casing valve;

the ball seat mounted within the lower portion of the body;

the guide head mounted on the end portion of the body.

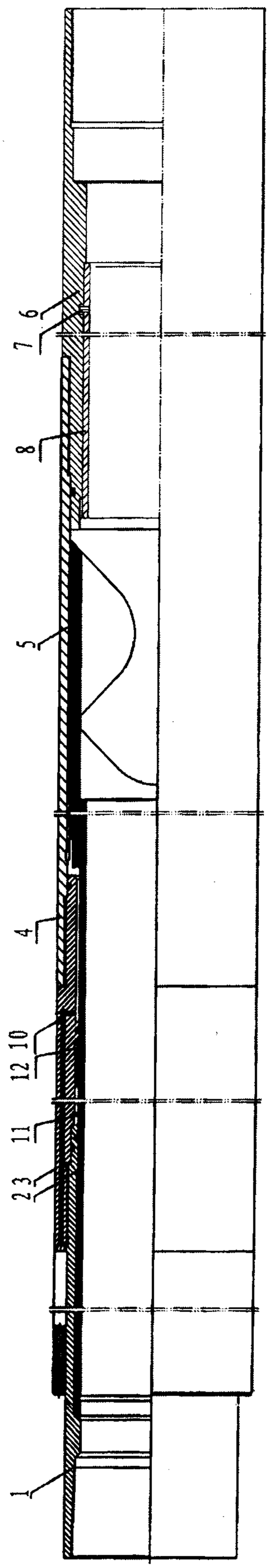


Fig. 1

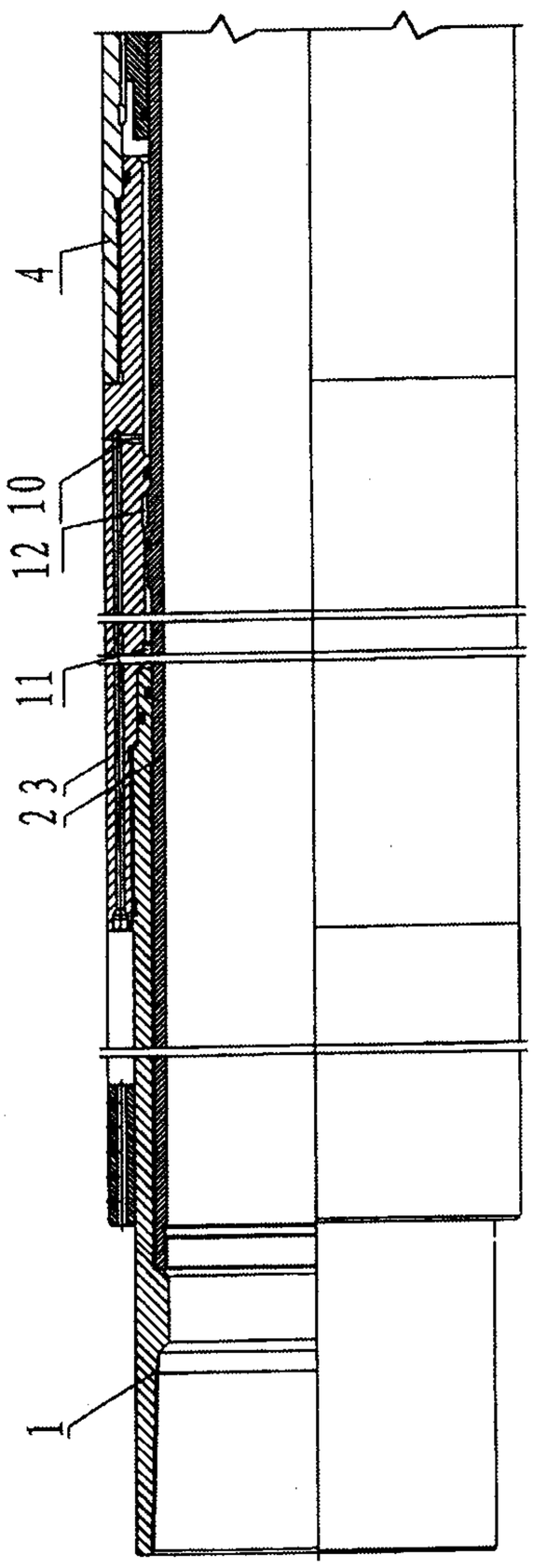


Fig. 1A

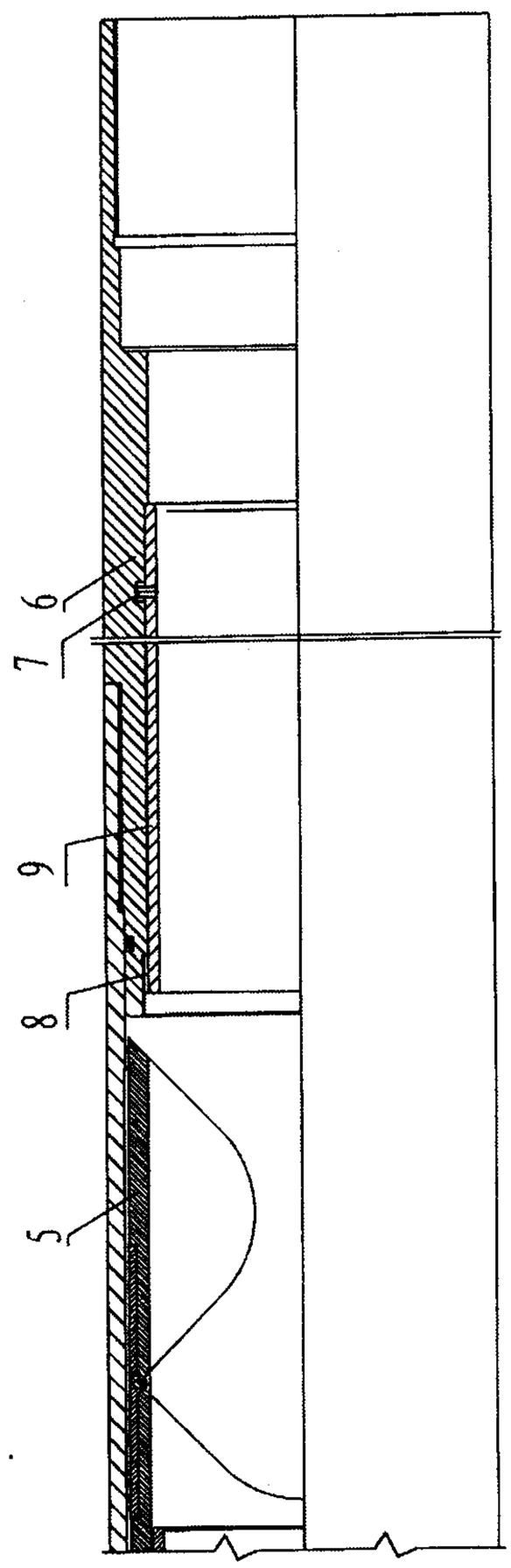


Fig. 1B

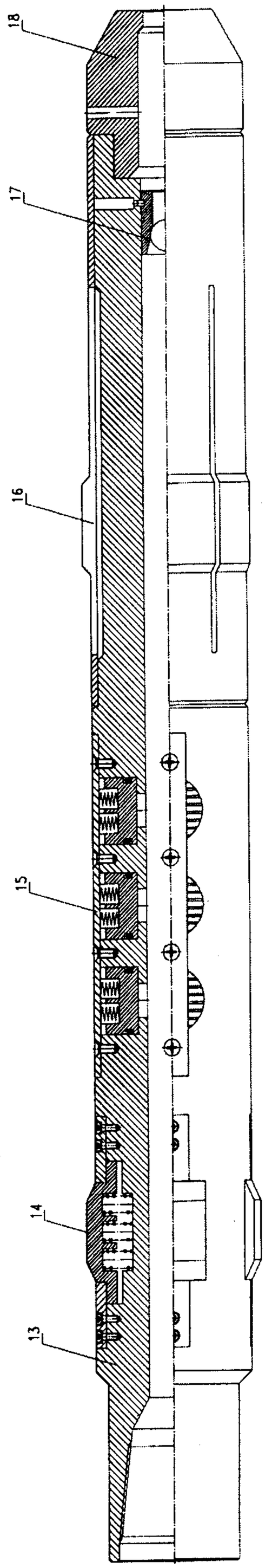


Fig. 2

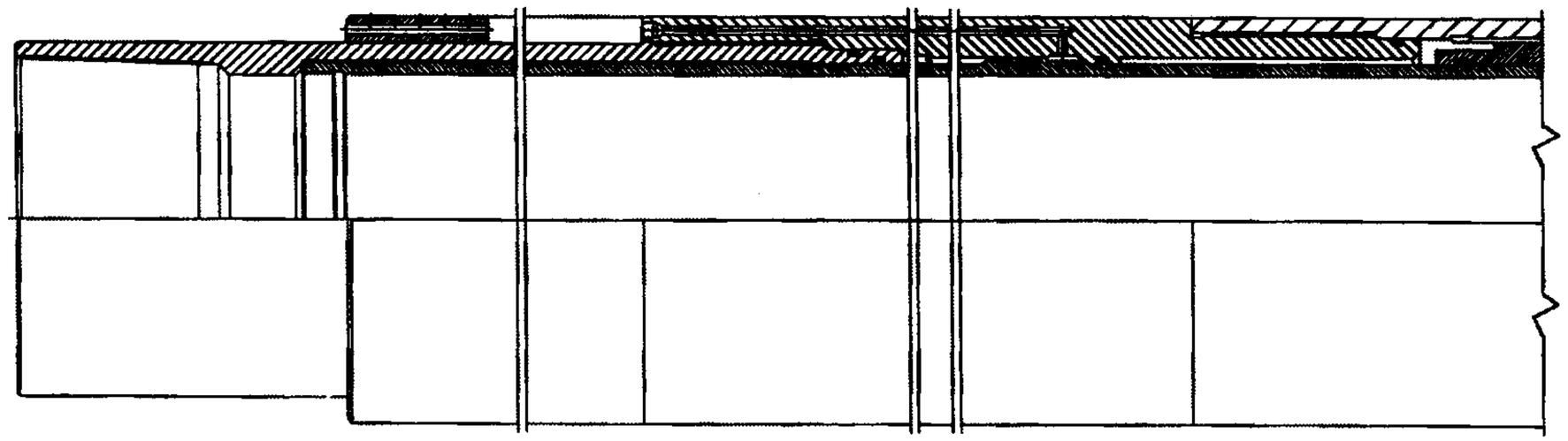


Fig. 3

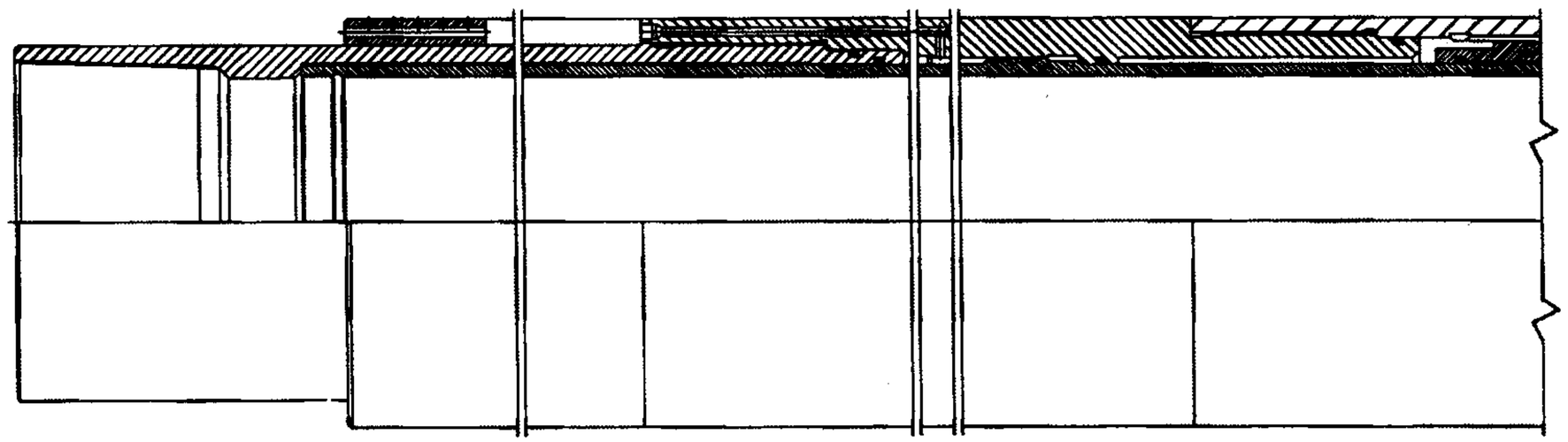


Fig. 4

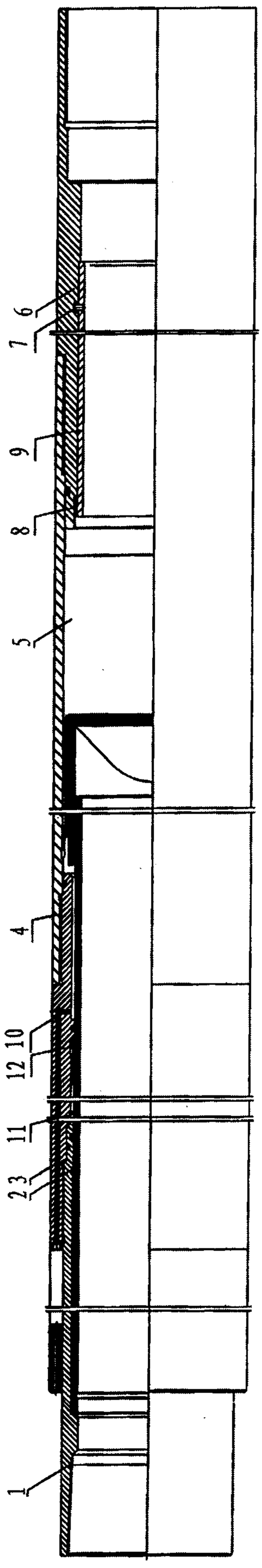
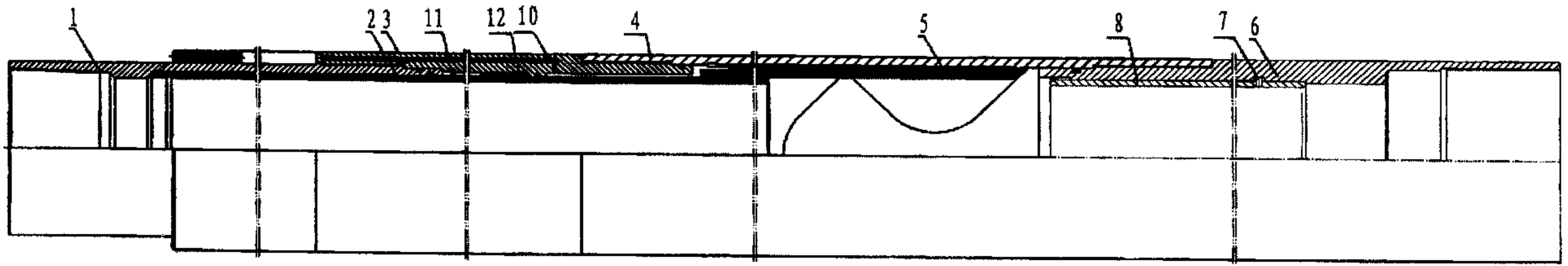


Fig. 5


1
2 3
11
12 10
4
5
8
7
6