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KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME,

[Continued on next page]

(54) Title: SLIDING SLEEVE VALVE WITH FEATURE TO BLOCK FLOW THROUGH THE TOOL

(57) Abstract: Sliding sleeve valves that include a housing with an axial flowbore defined along its length and at least one lateral fluid port disposed through the housing. One or more sliding sleeve members are disposed within the flowbore and carry first and second ball seats. Landing a first ball onto the first ball seat will move the valve from a first position wherein lateral flow is blocked to a second position wherein lateral flow is permitted. Landing a second ball onto the second ball seat will move the valve to a third position wherein lateral flow is again blocked and axial flow is permitted.

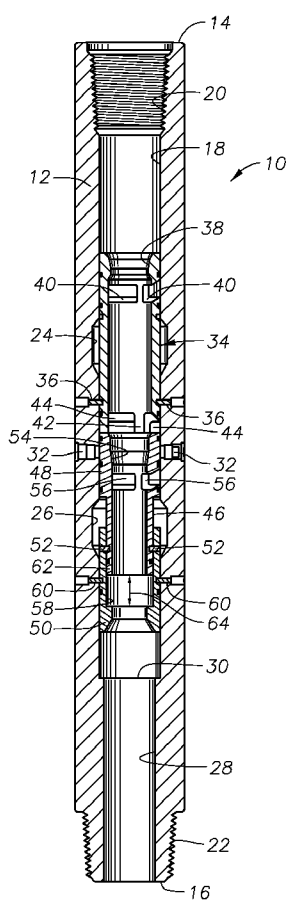


FIG. 1



MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

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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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(84) Designated States (*unless otherwise indicated, for every kind of regional protection available*): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK,

SLIDING SLEEVE VALVE WITH FEATURE TO BLOCK FLOW THROUGH THE TOOL

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of U.S. Application No. 13/633957, filed on October 3, 2012, which is incorporated herein by reference in its entirety.

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0002] The invention relates generally to the design of sliding sleeve valve tools.

2. Description of the Related Art

[0003] Wellbore tools have been developed that are operated by a ball or plug that is dropped into the tool and landed on a seat within the tool. The ball or plug serves to increase pressure and/or to redirect fluid flow through the tool in order to operate the tool. Tools of this type include circulation valves which are used to selectively open and close lateral fluid flow ports in a tool sub to permit fluid flowing axially through the tool to be diverted into the surrounding flowbore.

[0004] Jet sub tools are sliding sleeve tools that are used to clean the interior of a blowout preventer or other tubular member. Jet sub tools of this type are available commercially and include the Wellbore Cleanup-Wellbore Clean Out Full Function Valve, which is available from Baker Hughes Incorporated of Houston, Texas. Tools of this type are also described in U.S. Patent No. 7,954,555 issued to Ashy et al. The Ashy et al. patent is owned by the Assignee of the present application and is hereby incorporated by reference in its entirety.

[0005] The parent application to this one describes tools that operate by using balls or plugs of different sizes. The parent application to this application is U.S. Patent Application Ser. No. 12/826,020 filed June 29, 2010 (U.S. Patent Publ. No. 2011-0315389), which is incorporated herein by reference in its entirety.

SUMMARY OF THE INVENTION

[0006] The invention provides sliding sleeve devices and methods for use wherein a sliding sleeve valve is provided that permits selective lateral fluid communication through the valve as well as axial flow through the valve that can be blocked when lateral flow occurs.

This feature permits the valve to be used, for example, as an effective device for cleaning of tubular members using lateral fluid jets.

[0007] In a described embodiment, a valve in accordance with the present invention includes a housing with an axial flowbore and one or more lateral flow ports that permit fluid communication between the flowbore and the area radially surrounding the housing. Upper and lower sliding sleeves are moveably disposed within the flowbore. The lower sliding sleeve is split into upper and lower sleeve halves that are connected by frangible shear members. The lower sliding sleeve presents a ball seat that is shaped and sized to receive and retain a first, smaller ball. The upper sliding sleeve presents a ball seat that is shaped and sized to receive and retain a second, larger ball but will permit the first ball to pass through. Landing of the first and second balls onto the ball seats and fluid pressure behind them causes the upper and lower sliding sleeves to be moved axially within the flowbore. In addition, landing the first ball causes the sleeve halves of the lower sliding sleeve to be shifted.

[0008] A fluid bypass mechanism that permits fluid to flow axially around the first and second balls is provided by diametrical enlargements in the flowbore and fluid flow openings in the upper and lower sliding sleeves or sliding sleeve assembly. The fluid bypass mechanism is opened as the upper and lower sliding sleeves are shifted within the flowbore.

[0009] According to an exemplary method of operation, the sliding sleeve valve is run into a wellbore or other tubular in a run-in position wherein the flowbore is unblocked and axial fluid flow passes through the valve housing while lateral flow through the lateral flow ports is blocked. Landing the first ball upon the ball seat formed upon the lower sliding sleeve of the valve will block axial fluid flow through the valve housing and open the lateral fluid flow ports to allow lateral fluid flow. Landing the second ball upon the ball seal formed upon the upper sliding sleeve of the valve will again block lateral fluid flow and open the valve to axial fluid flow.

[0010] An alternative embodiment for the valve is described wherein there is a single sliding sleeve which is made up of upper and lower sleeve halves. The upper sleeve half carries ball seats that are capable of seating both the first, smaller and second, larger balls.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] For a thorough understanding of the present invention, reference is made to the following detailed description of the preferred embodiments, taken in conjunction with

the accompanying drawings, wherein like reference numerals designate like or similar elements throughout the several figures of the drawings and wherein:

[0012] Figure 1 is a side, cross-sectional view of an exemplary sliding sleeve valve constructed in accordance with the present invention, the sleeve valve being in an initial run-in position.

[0013] Figure 2 is a side, cross-sectional view of the sliding sleeve valve shown in Figure 1, now in a second position that allows lateral fluid flow through the valve but blocks axial flow therethrough.

[0014] Figure 3 is a side, cross-sectional view of the sliding sleeve valve shown in Figures 1 and 2 now in a third position that blocks lateral fluid flow through the valve but allows axial flow therethrough.

[0015] Figure 4 is a side, cross-sectional view of an alternative exemplary sliding sleeve valve constructed in accordance with the present invention, the sleeve valve being in an initial run-in position.

[0016] Figure 5 is a side, cross-sectional view of the sliding sleeve valve of Figure 4, now in a second position that allows lateral fluid flow through the valve but blocks axial flow therethrough.

[0017] Figure 6 is a side, cross-sectional view of the sliding sleeve valve of Figures 4 and 5, now in a third position that blocks lateral fluid flow through the valve and allows axial flow therethrough.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0018] Figures 1-3 depict an exemplary sliding sleeve valve 10 that may be useful as a BOP (blowout preventer) jet sub that can clean the interior of a BOP. The exemplary valve 10 includes a housing 12 having first and second axial ends 14, 16. A flowbore 18 is defined along the length of the housing 12. Threaded box and pin portions 20, 22 are provided at the first and second ends 14, 16, respectively in order to facilitate incorporation of the valve 10 into a work string and disposed into a wellbore, as is known in the art.

[0019] The flowbore 18 of the housing includes upper and lower enlarged diameter portions 24 and 26. In addition, the flowbore 18 includes a reduced diameter lower portion 28. A stop shoulder 30 is provided at the upper end of the lower portion 28. At least one lateral fluid flow port 32 is disposed through the housing 12. In particular embodiments, there are several lateral fluid flow ports 32. Also in particular embodiments, the lateral fluid

flow ports 32 are located axially between the upper and lower enlarged diameter portions 24, 26.

[0020] An upper sliding sleeve 34 is located within the flowbore 18. The upper sliding sleeve 34 is preferably releasably secured to an initial position, shown in Figure 1, by frangible shear members 36. The upper sliding sleeve 34 presents a ball seat 38 at its upper end. Upper lateral flow openings 40 are disposed through the upper sliding sleeve 34 and, in the depicted embodiment, are located just below the ball seat 38. In addition, the lower end of the upper sliding sleeve 34 presents axially extending fingers 42, and lower lateral flow openings 44 are defined angularly between the fingers 42.

[0021] A lower sliding sleeve 46 is also disposed within the flowbore 18. The lower sliding sleeve 46 is made up of upper and lower sleeve halves 48, 50 which are telescopically moveable with respect to each other and releasably affixed to each other by frangible shear members 52. The upper sleeve half 48 presents a ball seat 54 at its upper end. Lateral flow openings 56 are disposed through the upper sleeve half 48. In the depicted embodiment, the lateral flow openings 56 are located axially below the ball seat 54.

[0022] The lower sleeve half 50 defines a chamber 58 within and is releasably secured to the housing 18 via frangible shear members 60. The lower end 62 of the upper sleeve half 48 is disposed within the chamber 58 of the lower sleeve half 50. When the upper and lower sleeve halves 48, 50 are connected by the shear members 52, a gap 64 is defined between the lower end of the upper sleeve half 48 and the lower end of the chamber 58. It is noted that the shear members 52 are designed to rupture at a lower shear force than the shear members 36 and 60.

[0023] Figure 1 depicts the sliding sleeve valve 10 in a run-in position wherein fluid can flow axially through the valve 10. However, the lateral flow ports 32 are closed against fluid flow by the upper sleeve half 48 of the lower sliding sleeve 46. It should be understood that during operation/running in, fluid is being pumped from a surface pump (not shown) down through a work string of a type known in the art and into the valve 10. Figure 2 shows a first ball 66 having been landed onto the ball seat 54 of the lower sliding sleeve 46. The first ball 66 is sized to pass through the ball seat 38 of the upper sliding sleeve 34. Once the first ball 66 has been landed onto ball seat 54, fluid pressure builds behind the first ball 66 causing the shear members 52 to rupture. The upper sleeve half 48 moves downwardly with respect to the lower sleeve half 50 until the lower end of the upper sleeve half 48 contacts the lower end of the chamber 58. Axial fluid flow through the housing 12 of the valve 10 is now

blocked by the first ball 66. However, downward movement of the upper sleeve half 48 unblocks the lateral fluid flow ports 32. In this position (Figure 2), fluid flow axially into the valve 10 will exit the lateral fluid flow ports 32, as indicated by arrows 70 in Figure 2.

[0024] If it desired to restore axial fluid flow through the valve 10, this is done by landing a second ball 68 onto the ball seat 38 of the upper sliding sleeve 34 (Figure 3). The second ball 68 is larger than the first ball 66 and will not pass through the ball seat 38 of the upper sliding sleeve 34. Fluid pressure behind the second ball 68 will rupture the shear members 36, allowing the upper sliding sleeve 34 to move axially downwardly within the flowbore 18 until the fingers 42 contact the upper end of the lower sliding sleeve 46. Fluid pressure behind the second ball 68 will then rupture the shear members 60, allowing upper sliding sleeve 34 and upper and lower sleeve halves 48 and 50 to move axially downwardly within the flowbore 18 until the bottom of the lower sleeve half 50 contacts the stop shoulder 30. In this position, the upper sliding sleeve 34 will block the lateral fluid ports 32 against fluid flow. Also, it is noted that fluid flowing axially downward into the valve housing 12 can flow freely through the housing 12 in an axial direction. The second ball 68 is bypassed as fluid flows radially outwardly into the upper enlarged diameter portion 24 of the flowbore and then radially inwardly through the lateral flow openings 40 (see arrows 72). The first ball 66 is bypassed as fluid flows radially outwardly through openings 44, into the lower enlarged diameter portion 26, and then radially inwardly through openings 56 (see arrows 74).

[0025] Figures 4-6 depict an alternative embodiment for a sliding sleeve valve 80 that is constructed in accordance with the present invention. Except where otherwise indicated, the sliding sleeve valve 80 is constructed and operates in the same manner as the sliding sleeve valve 10 described earlier. For clarity, the first and second axial ends of the housing 12 of the valve 80 are not shown. In this embodiment, the upper and lower sliding sleeves 34, 46 of the valve 10 are formed as a single sliding sleeve assembly 82. As a result, the sliding sleeve assembly 82 includes an axially elongated upper sleeve portion 84 and lower sleeve portion 50. Upper shear members 36 of the embodiment of valve 10 are not present.

[0026] In operation, the valve 80 is run into a surrounding tubular in the run-in position shown in Figure 4. In this position, the valve 80 permits axial fluid flow therethrough, but lateral fluid flow through the lateral fluid flow ports 32 is blocked by the sliding sleeve assembly 82. When first ball 66 is landed onto ball seat 54, fluid pressure behind the first ball 66 will rupture the shear members 52 and shift the lower end 62 of the

upper sleeve portion 84 of the sliding sleeve assembly 82 downward, as described above. Now the valve 80 is in the position shown in Figure 5. In this position, axial fluid flow through the valve 80 is blocked by the first ball 66. However, lateral fluid flow through ports 32 is now permitted.

[0027] When it is desired to reinstate axial flow through the valve 80 and again block lateral fluid flow, second ball 68 is landed upon the ball seat 38. Fluid pressure behind the second ball 68 will rupture the shear members 60 and move the sliding sleeve assembly 82 axially downwardly within the flowbore 18 until the lower end of the lower sleeve portion 50 contacts the stop shoulder 30 within the flowbore 18, as depicted in Figure 6. In this position, the lateral fluid ports 32 are blocked against fluid flow therethrough by the sliding sleeve assembly 82. The lateral fluid openings 40, 44 and 56 permit axial flow through the valve 80, as illustrated by arrows 86 in Figure 6.

[0028] Broadly, sliding sleeve valves constructed in accordance with the present invention include a housing 12 with an axial flowbore 18 defined along the length of the housing and at least one lateral fluid flow port 32 disposed through the housing which permits fluid communication between the flowbore 18 and an area radially surrounding the housing 12. In addition, valves constructed in accordance with the present invention include at least one sliding sleeve member that is disposed within the flowbore and which presents first and second ball seats 38, 54. The at least one sliding sleeve member could be in the form of upper and lower sliding sleeves 34, 46. Alternatively, the at least one sliding sleeve member could take the form of sliding sleeve assembly 82. The first ball seat 54 is shaped and sized to receive and retain a first ball 66. The second ball seat 38 is shaped and sized to receive and retain a second ball 68 but will allow the first ball 66 to pass through.

[0029] According to exemplary methods of operation, a valve constructed in accordance with the present invention can be operated to move from an initial position, wherein axial flow through the valve is permitted, but lateral fluid flow through the valve is blocked, to a second position, wherein lateral flow through the valve is permitted but axial flow through the valve is blocked. In addition, the valve can be moved from the second position to a third position wherein axial flow through the valve is permitted, but lateral fluid flow through the valve is blocked. In described embodiments, the valve is moved from the first position to the second position by the first ball and is moved from the second position to the third position by the second ball.

[0030] A fluid bypass mechanism that permits fluid to flow axially around the first and second balls is provided by diametrical enlargements 24, 26 in the flowbore 18 and fluid flow openings 40, 44, 56 in the upper and lower sliding sleeve. The fluid bypass mechanism is opened as the upper and lower sliding sleeves 34, 46 are shifted within the flowbore 18.

[0031] A sliding sleeve valve constructed in accordance with the present invention can be used, for example, as a cleaning apparatus for a blowout preventer (BOP) or other tubular member. Valves in accordance with the present invention are particularly useful for this application since they close off axial flow through the valve while lateral flow is occurring, thereby allowing for greater fluid cleaning force from the lateral flow ports. In addition, sliding sleeve valves constructed in accordance with the present invention could be used as a circulation valve within a wellbore. It is noted as well that, while spherical balls 66 and 68 are depicted in the described embodiment, one could also use non-spherical plugs or other members of various shapes, and such should be considered to be within the scope of the term "ball" in the claims which follow.

[0032] Those of skill in the art will recognize that numerous modifications and changes may be made to the exemplary designs and embodiments described herein and that the invention is limited only by the claims that follow and any equivalents thereof.

CLAIMS

What is claimed is:

1. A sliding sleeve valve comprising:
 - a housing defining an axial flowbore;
 - a lateral fluid port disposed through the housing that provides fluid communication between the flowbore and an area radially surrounding the housing;
 - at least one sliding sleeve member moveably disposed within the flowbore, the at least one sliding sleeve member presenting a first ball seat and a second ball seat;
 - the sliding sleeve valve being moved from a) a first position wherein axial fluid flow through the flowbore is permitted and flow through the lateral fluid port is blocked to b) a second position wherein flow through the lateral fluid port is permitted but axial flow through the flowbore is blocked by landing a first ball onto the first ball seat; and
 - the sliding sleeve valve being moved from the second position to a third position wherein axial fluid flow is permitted through the flowbore and flow through the lateral fluid port is blocked when a second ball is landed onto the second ball seat.
2. The sliding sleeve valve of claim 1 wherein the at least one sliding sleeve member further comprises:
 - an upper sliding sleeve that carries the second ball seat; and
 - a lower sliding sleeve that carries the first ball seat.
3. The sliding sleeve valve of claim 1 wherein the first ball is smaller than the second ball.
4. The sliding sleeve valve of claim 1 wherein:
 - the first ball seat is shaped and sized to receive and retain the first ball; and
 - the second ball seat is shaped and sized to receive and retain the second ball and permit the first ball to pass through.
5. The sliding sleeve valve of claim 1 wherein a fluid bypass mechanism is opened when the valve is in the third position to allow fluid to flow around the first and second balls and thereby flow axially through the flowbore.
6. The sliding sleeve valve of claim 5 wherein the fluid bypass mechanism comprises:
 - an enlarged diameter portion within the flowbore; and
 - a fluid flow opening disposed through the at least one sliding sleeve member;

such that fluid can pass from the flowbore through the fluid flow opening and into the enlarged diameter portion to bypass a ball.

7. The sliding sleeve valve of claim 1 wherein the at least one sliding sleeve member further comprises a sliding sleeve assembly that carries the first and second ball seats.

8. The sliding sleeve valve of claim 2 wherein the lower sliding sleeve further comprises upper and lower sleeve halves that are telescopically moveable with respect to each other.

9. The sliding sleeve of claim 7 wherein the sliding sleeve assembly containing the first and second ball seats is telescopically moveable with respect to a lower sleeve portion.

10. A sliding sleeve valve comprising:
a housing defining an axial flowbore;
a lateral fluid port disposed through the housing that provides fluid communication between the flowbore and an area radially surrounding the housing;
at least one sliding sleeve member moveably disposed within the flowbore, the at least one sliding sleeve member presenting a first ball seat and a second ball seat;
a first ball;
a second ball that is larger than the first ball;
the sliding sleeve valve being moved from a) a first position wherein axial fluid flow through the flowbore is permitted and flow through the lateral fluid port is blocked to b) a second position wherein flow through the lateral fluid port is permitted but axial flow through the flowbore is blocked by landing the first ball onto the first ball seat;
the sliding sleeve valve being moved from the second position to a third position wherein axial fluid flow is permitted through the flowbore and flow through the lateral fluid port is blocked when the second ball is landed onto the second ball seat.

11. The sliding sleeve valve of claim 10 wherein the at least one sliding sleeve member further comprises:

an upper sliding sleeve that carries the second ball seat; and
a lower sliding sleeve that carries the first ball seat.

12. The sliding sleeve valve of claim 10 wherein:
the first ball seat is shaped and sized to receive and retain the first ball; and

the second ball seat is shaped and sized to receive and retain the second ball and permit the first ball to pass through.

13. The sliding sleeve valve of claim 10 wherein a fluid bypass mechanism is opened when the valve is in the third position to allow fluid to flow around the first and second balls and thereby flow axially through the flowbore.

14. The sliding sleeve valve of claim 13 wherein the fluid bypass mechanism comprises:

an enlarged diameter portion within the flowbore; and

a fluid flow opening disposed through the at least one sliding sleeve member;

such that fluid can pass from the flowbore through the fluid flow opening and into the enlarged diameter portion to bypass a ball.

15. The sliding sleeve valve of claim 10 wherein the at least one sliding sleeve member further comprises a sliding sleeve assembly that carries the first and second ball seats.

16. The sliding sleeve valve of claim 11 wherein the lower sliding sleeve further comprises upper and lower sleeve halves that are telescopically moveable with respect to each other.

17. A method of operating a sliding sleeve valve having a housing defining an axial flowbore, a lateral fluid port disposed through the housing that provides fluid communication between the flowbore and an area radially surrounding the housing, and at least one sliding sleeve member moveably disposed within the flowbore and presenting a first ball seat and a second ball seat, the method comprising the steps of:

releasably securing the at least one sliding sleeve member of the sliding sleeve valve in a first position wherein axial flow through the flowbore is permitted and flow through the lateral fluid port is blocked;

landing a first ball onto the first ball seat to move the sliding sleeve member to a second position wherein axial flow through the flowbore is blocked and flow through the lateral flow port is permitted; and

landing a second ball onto the second ball seat to move the sliding sleeve member to a third position wherein axial flow through the flowbore is permitted and flow through the lateral fluid port is blocked.

18. The method of claim 17 wherein the step of landing the first ball onto the first ball seat further comprises passing the first ball through the second ball seat.

19. The method of claim 17 further comprising the step of opening a fluid bypass mechanism within the valve so that fluid can flow axially past the first and second balls when the sliding sleeve member is moved to the third position.

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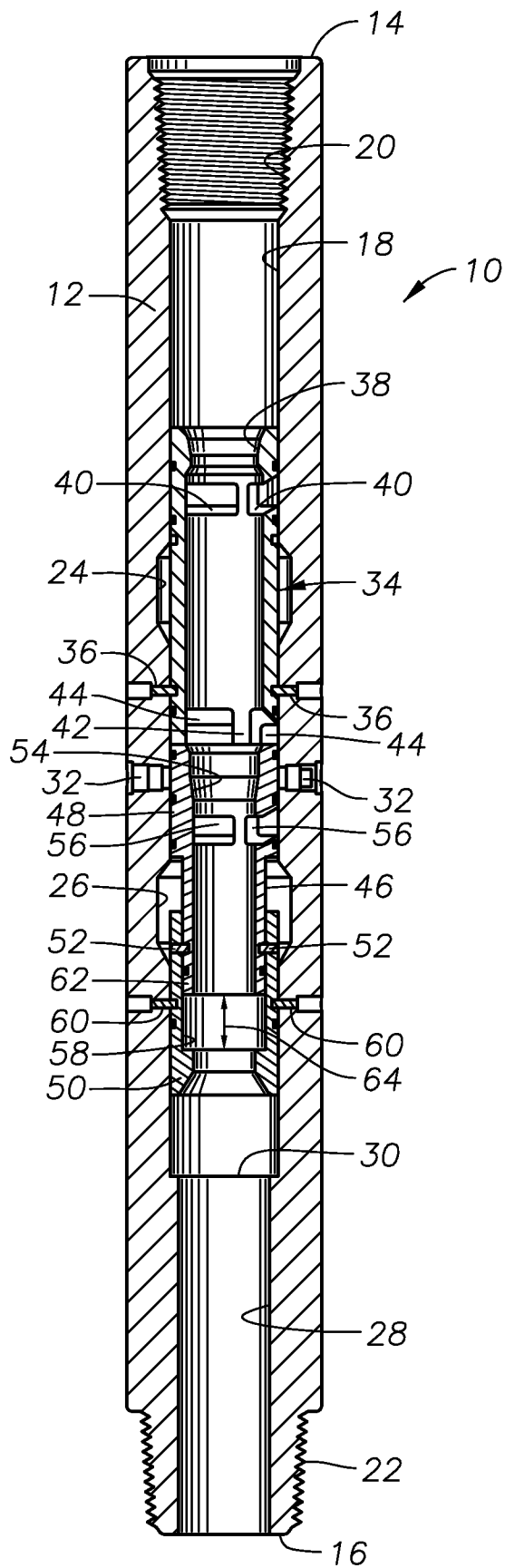


FIG. 1

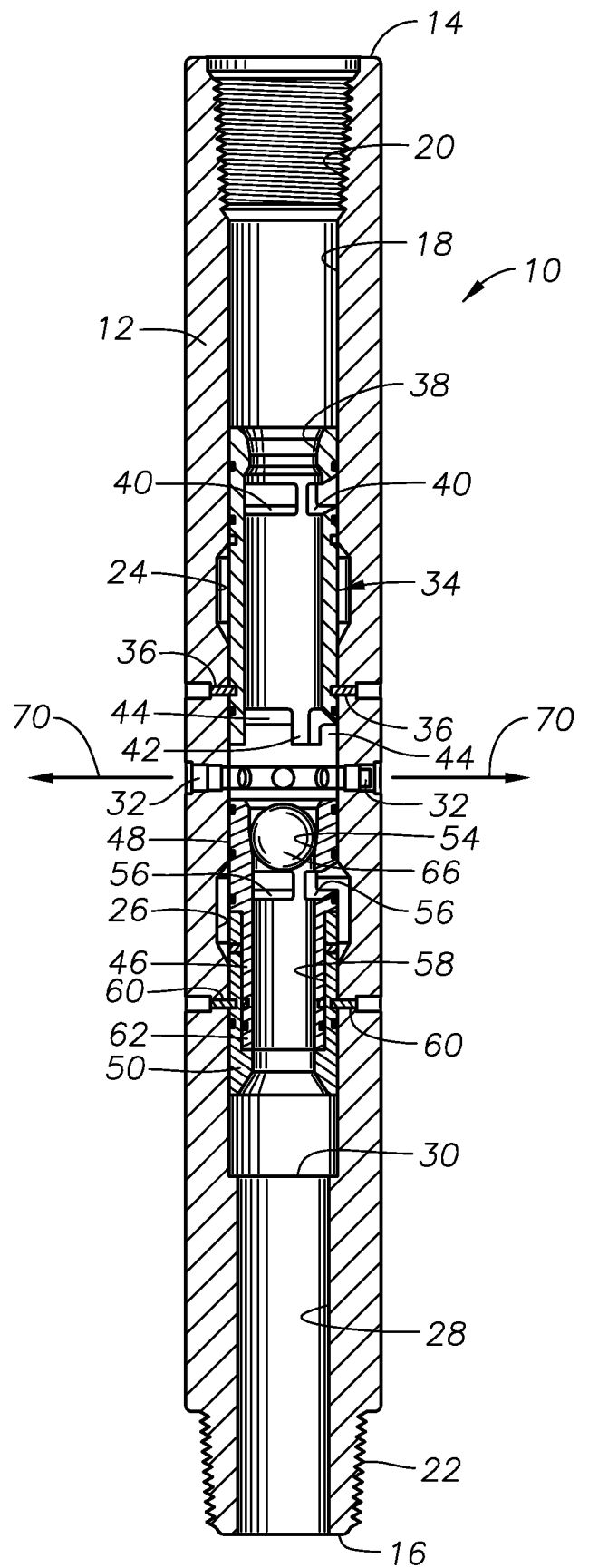


FIG. 2

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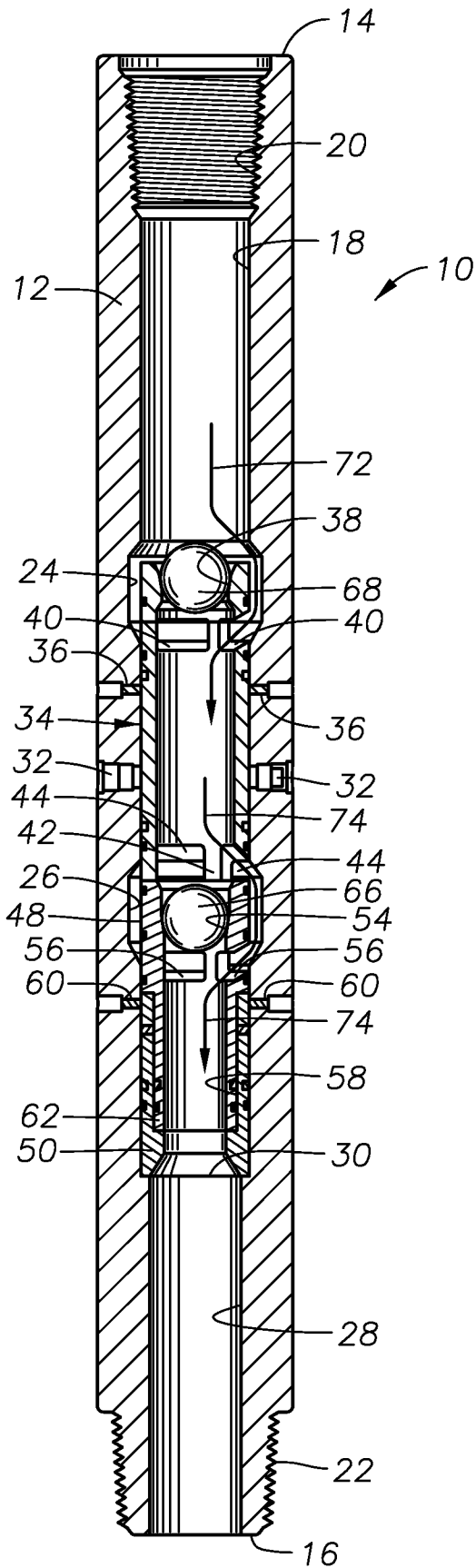


FIG. 3

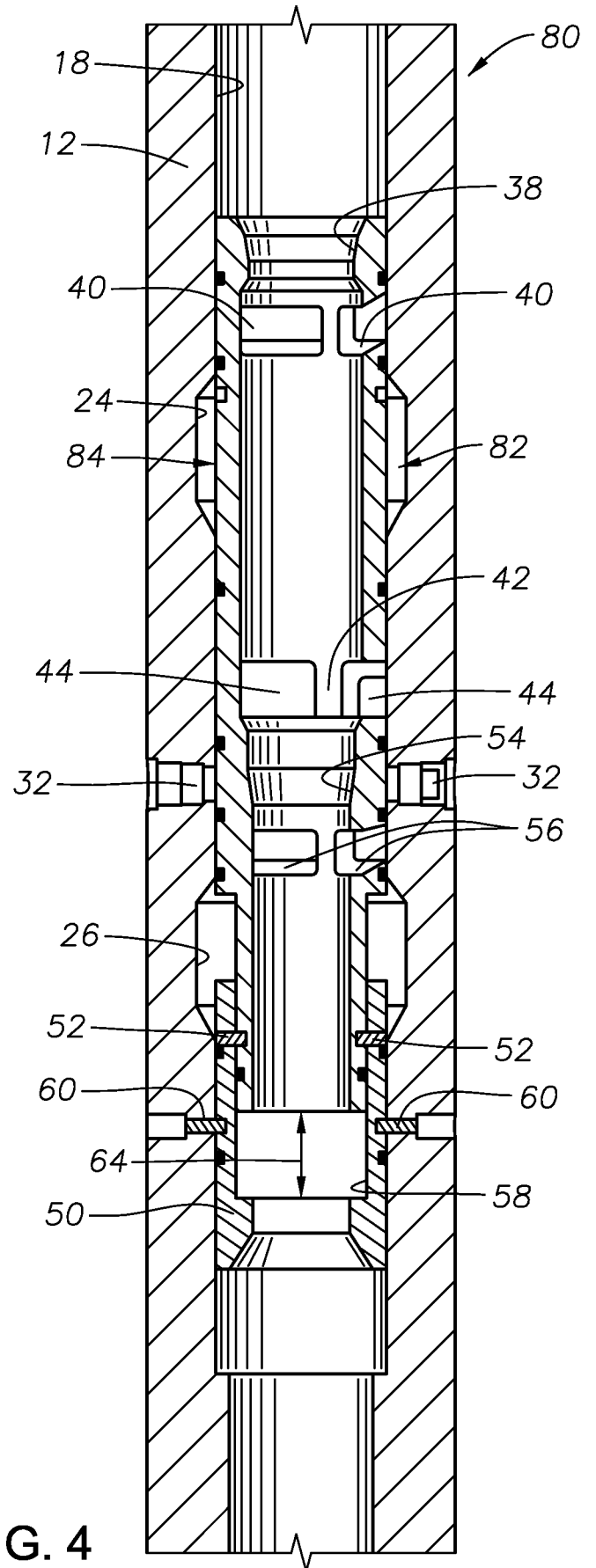
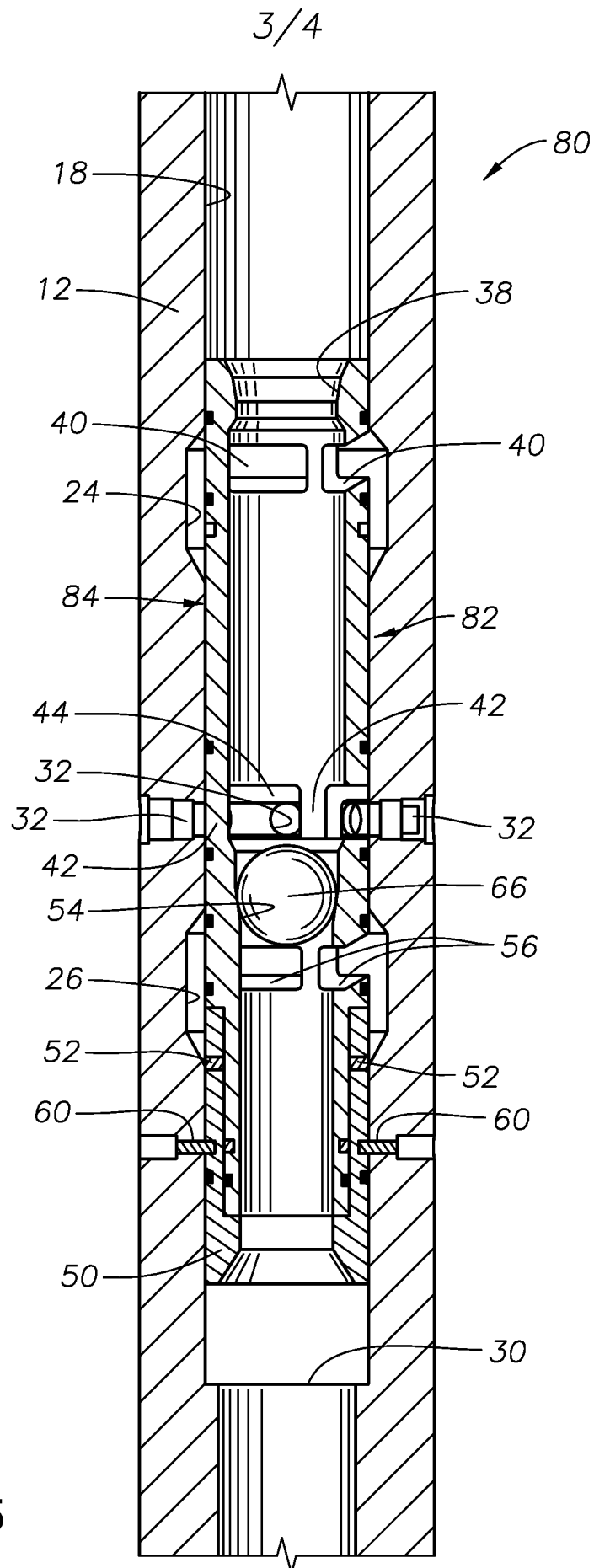


FIG. 4



4/4

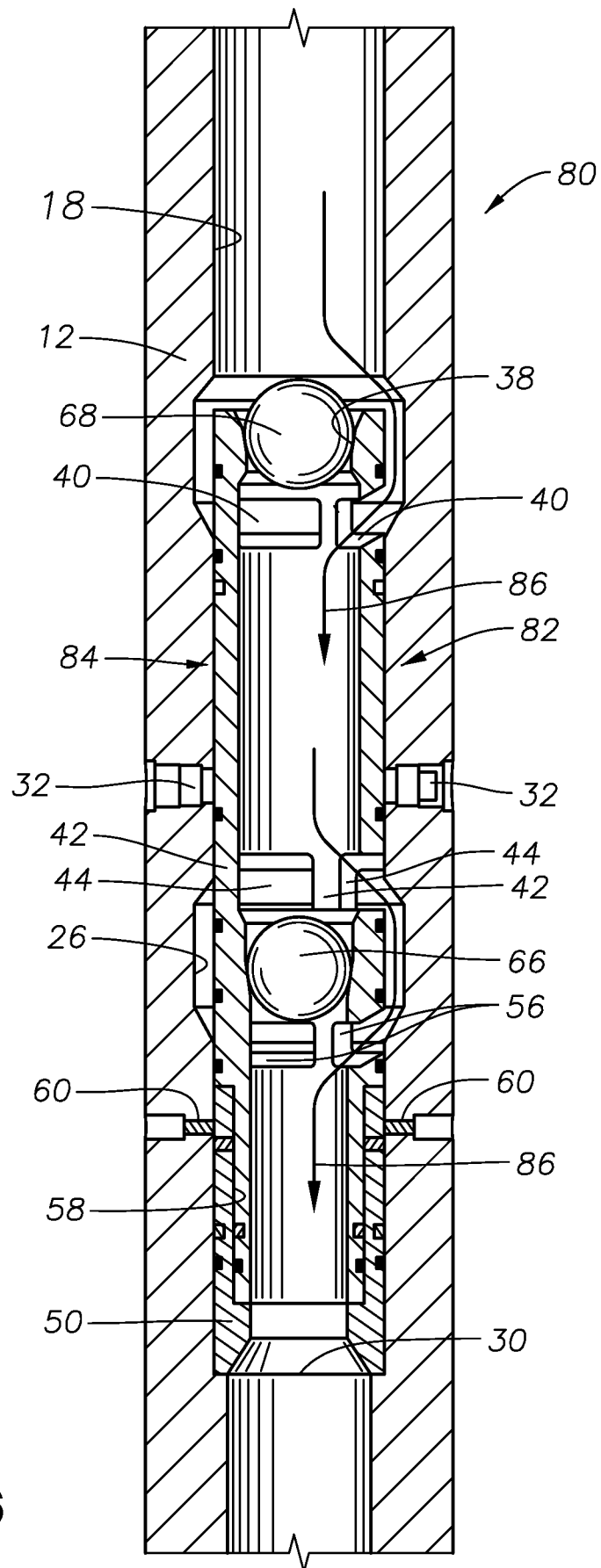


FIG. 6

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2013/057942**A. CLASSIFICATION OF SUBJECT MATTER****E21B 34/06(2006.01)i, E21B 34/14(2006.01)i, E21B 34/08(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)

E21B 34/06; E21B 43/04; E21B 34/00; E21B 43/26; E21B 34/14; 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: sliding sleeve, ball, seat, bypass, shear, and fluid circulation

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2011-0278010 A1 (FEHR et al.) 17 November 2011 See abstract, paragraphs [0061]–[0064], and figures 3a–3b.	1–19
A	US 2004-0000406 A1 (ALLAMON et al.) 01 January 2004 See abstract, paragraphs [0035]–[0038], and figures 2,5.	1–19
A	US 2011-0192613 A1 (GARCIA et al.) 11 August 2011 See abstract, paragraphs [0029]–[0034], and figures 2A,3A.	1–19
A	US 2011-0284232 A1 (HUANG, TIANPING) 24 November 2011 See abstract, paragraphs [0021]–[0023], and figures 1–2.	1–19
A	US 6216785 B1 (ACHEE, JR. et al.) 17 April 2001 See abstract, column 7, lines 1–15, and figure 5B.	1–19



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

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"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

21 November 2013 (21.11.2013)

Date of mailing of the international search report

21 November 2013 (21.11.2013)

Name and mailing address of the ISA/KR

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US2013/057942

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2011-0278010 A1	17/11/2011	CA 2412072 A1 CA 2412072 C US 2003-0127227 A1 US 2005-0178552 A1 US 2007-0151734 A1 US 2008-0277110 A1 US 2009-0283280 A1 US 2010-0065276 A1 US 2013-0180718 A1 US 6907936 B2 US 7134505 B2 US 7543634 B2 US 7571765 B2 US 7832472 B2 US 7861774 B2 US 8397820 B2	19/05/2003 19/06/2012 10/07/2003 18/08/2005 05/07/2007 13/11/2008 19/11/2009 18/03/2010 18/07/2013 21/06/2005 14/11/2006 09/06/2009 11/08/2009 16/11/2010 04/01/2011 19/03/2013
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