

(43) International Publication Date  
18 September 2014 (18.09.2014)(51) International Patent Classification:  
*E21B 34/02* (2006.01)(21) International Application Number:  
PCT/US2014/028695(22) International Filing Date:  
14 March 2014 (14.03.2014)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:  
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506, Wheaton, IL 60187 (US).(81) Designated States (*unless otherwise indicated, for every  
kind of national protection available*): AE, AG, AL, AM,  
AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY,BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM,  
DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT,  
HN, HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KN, KP, KR,  
KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME,  
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.(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, SM,  
TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW,  
KM, ML, MR, NE, SN, TD, TG).

## 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))

[Continued on next page]

(54) Title: GATE VALVE ASSEMBLY COMPRISING A SUPPORT MEMBER

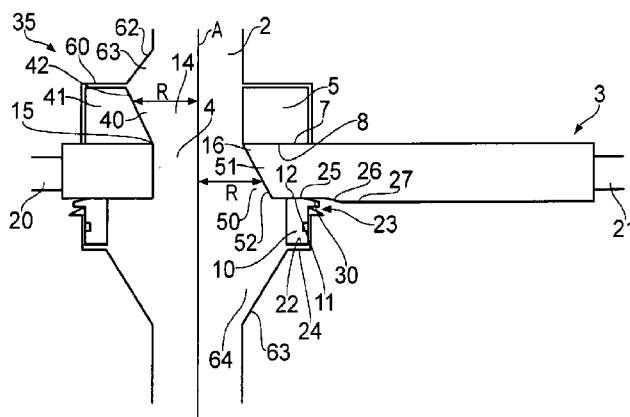


FIG. 1

(57) **Abstract:** A gate valve assembly having a through bore adapted for fluid communication with a well bore and prepared for receiving an elongated member. The gate valve assembly comprises a gate element which is movably arranged in a gate valve housing, wherein the gate element has a gate bore arranged for receiving the elongated member, wherein a cutting tool is arranged in the gate bore first and second seats, wherein at least one of the first or second seat is arranged to provide sealing contact with a sealing surface of the gate element. A support member arranged with an opening encompassing the through bore and an expanded opening portion which is open to the through bore in the axial direction of the through bore, wherein a reduced section of the support member defines the expanded opening portion, and the opening has a decreasing radius along the reduced section in the axial direction of the support member toward a contact surface area arranged at an end portion of the support member adjacent the cutting tool, wherein the radius of the opening corresponds essentially to the radius of the through bore. The contact surface area is prepared for engagement with the elongated member and provides a counter acting area interacting with the cutting tool when shearing the elongated member. The invention also includes a method.



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**Published:**

- *without international search report and to be republished  
upon receipt of that report (Rule 48.2(g))*

## GATE VALVE ASSEMBLY COMPRISING A SUPPORT MEMBER

The invention concerns gate valve assembly having a through bore adapted for fluid communication with a well bore and prepared for receiving an elongated member, as well as a method for shearing of an elongated member and moving the gate element into closing position.

An elongated member as used in the application described herein includes well related tubular formed elongated members such as a tubing, coiled tubing, drill pipes used in work over, drilling, completion, production or intervention operations. The elongated member may also be a wire line or the actual tools to be used when carrying out well related operations.

## BACKGROUND OF THE INVENTION

It is well known within the field to use a safety installment assembly such as for instance a Blow Out Preventer (BOP) or a LRP (lower riser package) in order to avoid a blow out from a well bore when a rapid shut down of the well is necessary, especially in an emergency situation.

Various kinds of safety installment assemblies on subsea wells are known from the prior art. BOP arrangements normally have a combined operation mode where cutting the tubing or the wire employed in the well first takes place with one element, for instance a ram arrangement, and thereafter closing the well to ensure a sealed closure to avoid fluid leakage of well fluid with another element in the BOP stack.

As an alternative to a BOP stack with several separate elements, a cutting gate valve arrangement may be used, wherein cutting devices for the cutting of a tubing or a wire line may be included in the gate valve arrangement for shearing of the tubing/wire line prior to closing and sealing the well bore. Such a gate valve arrangement may be provided in various ways. The gate valve arrangement may include one gate valve or plural gate valves. Further the gate valve may comprise a single gate element or plural gate elements for closing the gate valve.

In accordance with an established and well practiced solution, the cutting tool of the gate valve is formed at a front edge of the movable gate element of the gate valve, thereby the closing of the gate valve follows after the cutting of the tube has taken place. However when employing this solution it is necessary to make sure that the actual cutting is to be carried out properly and to ensure that

the cut parts of the tubing are properly separated and removed from the closing area of the gate valve before the closing of the gate valve takes place. If not, there is a risk that the cut parts of the tubular or wire line will be stuck during the closing of the gate element, in which case there is no proper closing of the gate valve and no satisfactory closing of the well.

Examples of prior art solutions include U.S. Patent No. 6,601,650; U.S. Patent No. 8,353,338; and U.S. Patent No. 8,567,490.

U.S. Patent No. 6,601,650 discloses a valve assembly with gate valves each arranged with a cutting edge at a front portion of the gate element. This publication describes the arrangement of providing the area close to the gate valve opening with inclined surfaces for moving the sheared pipe parts away from the gate valve before closing the gate valve.

U.S. Patent No. 8,353,338 shows two gate valves each with a moveable gate element provided with a cutting edge. The two gate valves are arranged at each side of the pipe to be sheared and positioned displaced relative to each other as seen in the axial direction of the pipe.

U.S. Patent No. 8,567,490 describes the provision of a knife edge at the gate element of the gate valve in order to obtain a clean cut when cutting the tube. This publication also describes the arrangement of spring elements to enhance the sealing force when closing the gate valve.

An objective of the invention is to provide a gate valve arrangement which obtains an efficient shearing of the elongated member. In some circumstances it is necessary to ensure that the efficient shearing of the elongated member is completed before the closing and sealing of the gate valve arrangement is carried out.

Another objective of the invention is to provide a gate valve arrangement with a compact construction, reliable working principles and a simple operation. It has been desirable to provide a gate valve arrangement which ensures that the cutting operation has been carried out efficiently before the closing of the gate valve is conducted to avoid the problems as described above.

Another objective is to ensure the integrity of the sealing functions of the gate valve.

## SUMMARY OF THE INVENTION

A gate valve assembly in accordance with the invention has a through bore which is adapted for fluid communication with a well bore and is prepared for receiving an elongated member. The gate valve assembly comprises a gate element which is movably arranged in a gate valve housing, wherein the gate element has a gate bore arranged for receiving the elongated member. A cutting tool is arranged in the gate bore.

The gate valve assembly is arranged with first and second seats for the movably arranged gate element, wherein at least one of the first and second seats is arranged to provide sealing contact with a sealing surface of the gate element. In one aspect the first seat may be provided as a cutting seat to be employed when cutting the elongated member. The first seat may then be arranged in sliding or sealing contact with the gate element or a combination of sliding and sealing contact with the gate element. In accordance with an aspect of this embodiment, the second seat may then be arranged to provide sealing contact with a sealing surface of the gate element.

However, it is possible to switch the functions of the first and second seats as described above, wherein the second seat is made a cutting seat and the first seat is in sealing contact with the gate element.

The gate valve assembly further comprises a support member which is located adjacent the cutting tool. The support member defines an opening for receiving the elongated member. The opening encompasses the through bore and an expanded opening portion which is open to the through bore in the axial direction of the through bore. A reduced section of the support member defines the expanded opening portion. The opening has a decreasing radius along the reduced section in the axial direction of the support member toward a contact surface area arranged at an end portion of the support member adjacent the cutting tool, wherein the radius of the opening at the location of the contact surface area corresponds essentially to the radius of the through bore. Thus the support member has a contact surface area arranged at the smallest radius of the opening. The contact surface area is prepared for engagement with the elongated member and provides a counteracting area interacting with the cutting surface when shearing the elongated member.

In one embodiment of the gate valve assembly the reduced section of the support element may be provided as a rectilinear inclined surface extending along a portion of the circumference of the opening of the support element.

By this arrangement of the gate valve assembly the shearing of the elongated member occurs efficiently before the closing of the movable gate element. The contact area in accordance with the invention provides for a restricted engagement between a surface of the elongated member and an opposing surface of the contact area. This restricted engagement area provides for a high concentration of forces at this area and a locally occurring constriction in the elongated member, thereby obtaining suitable conditions for conducting a satisfying shearing of the elongated member.

It should be noted that the shearing occurring in prior art gate valve assemblies, such as the one disclosed in U.S. Patent No. 6,601,650, has the elongated member supported against a support surface running along a relatively substantial portion of the length of the elongated member. By this arrangement, the shearing forces are distributed over a larger area, and experience has shown that deformation occurs instead of clear cut shearing in many cases, with the subsequently drawback of a gate element which does not close the through bore properly.

In accordance with an embodiment of the gate valve assembly the support member may be included in the first seat having an engagement surface arranged for contact with a first surface of the gate element. The first seat may comprise a cutting seat wherein the engagement surface may be arranged as a sliding contact surface. The first surface of the gate element may then be arranged as a sliding surface. The engagement surface may provide sealing in engagement with the first surface.

In an embodiment of the gate valve assembly which may be employed along with the above mentioned embodiment of the gate valve assembly where the support member may be included in the first seat, the cutting tool may be arranged in the gate bore. Further in accordance with this embodiment, the gate bore may encompass the through bore for receiving the elongated member and an expanded opening portion which may be open to the through bore in the axial direction of the through bore. A reduced section of the gate element defines the expanded opening portion, and the gate bore may have a decreasing radius

along the reduced section in the axial direction of the gate element toward the cutting tool, which may be arranged at an end portion of the gate element member adjacent the support member. The radius of the gate bore at the location of the cutting tool corresponds essentially to the radius of the through bore.

The gate valve assembly may be arranged so that the sheared elongated member parts are removed from the gate element before closing. This effect is obtained due to the increase in radius of the expanded opening portion of the first seat and/or the gate bore. The expanded opening portion of either the gate bore or the opening of the support member, or both, may in one aspect be defined by a surface which may be rectilinear or stepwise inclined. When conducting the shearing the inclined configuration of the opening of the first seat and/or the gate bore assists in moving the sheared elongated member parts away from the gate element when moving this into the closing position.

This effect is of course also present when the support member is included in other parts of the gate valve assembly, such as for instance in an embodiment of the gate valve assembly wherein the support member may be included in the gate element. In accordance with this embodiment of the gate valve assembly, the opening of the support member may be arranged as a portion of the gate bore. In addition, a transverse recess may be arranged in the gate bore for the positioning of the cutting tool. In an aspect of this embodiment, the cutting tool may be provided as a separate tool which may be movably arranged in the transverse recess to conduct the shearing. Also in this embodiment of the gate valve assembly, provisions may be made for being able to clear the sheared elongated member parts away from the gate element in order to avoid the parts getting stuck when closing the gate element after shearing of the elongated element. In an aspect of this embodiment of the gate valve assembly, the gate bore may be arranged with an expanded opening portion extending all along the circumference of the gate bore so that the inclined stepwise or rectilinear surface may be provided all the way around the gate bore circumference.

As a further aspect, both sides of the gate bore axially at each sides of the transverse recess may be arranged with an expanded opening portion extending all along the circumference of the gate bore. Thus, when shearing is conducted,

both the sheared elongated members will be pushed away from the gate element to avoid conflicting with the closing gate element.

In a further embodiment the gate valve assembly may comprise a second seat having a seal surface provided for sealing contact with a sealing surface of the gate element. This embodiment, which is elaborated below, is employable with all aspects of the embodiments as explained above.

In an embodiment of the gate valve assembly where a cutting tool may be arranged in the gate bore adjacent to the first seat, a temporary seal surface protection element may be provided to protect the seal surface of the second seat. This may be the case when the second seat has a dimension so that a portion of the seal surface of the second seat would be exposed to the well fluid when the gate element is in the open position. The temporary seal surface protection element may then be provided so that the seal surface of the second seat is protected when the gate element is open. For the shearing of the elongated member, the temporary seal surface protection element may need to be removed from the gate bore in order to be able to conduct the shearing of the elongated member. In one aspect of this embodiment the temporary seal surface protection may have a configuration which fills in the gate bore so that the inner radius of a portion of the gate bore corresponds to or is smaller than an inner radius of the second seat, thereby providing protection for the seal surface of the second seat. A releasable connection may be provided between the gate element in the gate bore area and the temporary seal surface protection element. The releasable connection may be used to remove the temporary seal surface protection element. For instance, the releasable connection may be provided for release when the elongated member is positioned in contact with the elongated member. As an alternative to the releasable connection or as a further security installment in addition to the releasable connection, the temporary seal surface protection element may be provided in a destroyable material which disintegrates or is easily destroyable, for instance a brittle material, which may be removed before conducting the shearing of the elongated member. The temporary seal surface protection element may be destroyed by the elongated member received in the through bore.

The gate valve housing may be provided with a support surface for accommodation of the second seat in the gate valve housing. In order to provide



sealing forces that ensures sufficient sealing in both the open and closed position of the gate element, an arrangement for sealing may be provided.

The gate valve assembly may be provided with additional sealing providing means. By this arrangement additional sealing forces may be provided  
5 between the sealing surface of the gate element and the seal surface of the second seat.

In order to provide an additional sealing force during some working modes of the gate valve assembly, for instance when the gate element is in a closed position, the gate valve assembly may be arranged with an activation  
10 arrangement for the activation of the additional sealing providing means. By activation of the additional sealing providing means an additional sealing force is provided in the seal surface of the second seat, thereby tightening the sealing contact with the gate element.

In one embodiment of the activation arrangement the sealing surface of  
15 the gate element may comprise an initial portion and an activating portion. In accordance with this embodiment the second seat may be arranged in sealing contact with the initial portion of the sealing surface of the gate element when the gate element is in an open position. Further, in a closed position of the gate element, the second seat may be arranged in sealing contact with the activating  
20 portion of the sealing surface.

In one aspect of this embodiment, the activating portion of the sealing surface may be positioned offset (axially closer) to the support surface which accommodates the second seat than the initial portion of the sealing surface. The support surface may be provided in the gate valve housing. In order to  
25 provide an activation portion which may be arranged offset or axially closer to the support surface of the sealing surface than the initial portion, the gate element may be provided with an enlarged portion, wherein the outline of the enlarged portion may comprise the activation portion, and wherein the initial portion of the sealing surface comprises a portion of the standard outline of the gate element  
30 which is not enlarged.

In an aspect of the invention, an initial portion of the sealing surface of the gate element may be connected to the activation portion of the sealing surface by a transfer surface. This arrangement provides for the smooth transfer of the sealing surface of the gate element in engagement with the seal surface of the

second seat and a gradual preparation of the activation of the additional sealing providing means.

In an aspect of the invention, the additional sealing providing means may be provided as compressible elements with a certain rigidity which in a  
5 compressed state provided a sealing force to the second seat. The compressible elements may comprise elements having elastic features, such as for instance spring means.

The spring means may in accordance with this aspect have an initial mode where the second seat is in contact with the initial portion of the sealing surface,  
10 and where the spring means may have an unloaded condition or is compressed to some degree. The transfer surface may serve as means for the gradual compression of the spring means in preparation for positioning the activation portion of the sealing surface in engagement with the seal surface of the second seat. When the second seat is in contact with the activating portion of the sealing  
15 surface, the spring means is caused to compress.

The additional sealing providing means may be provided by other means than compressible elements.

It should be noted that even if the embodiment as explained above provides efficient sealing of the gate valve assembly, alternative solutions for  
20 obtaining an efficient sealing arrangement could be provided. As an alternative to arranging the sealing surface with an initial portion and an activation portion which are relative to each other, the pressure for providing sufficient sealing contact with the second seat could be increased, thereby increasing the sealing force provided in contact between the second seat and the gate element.

25 The gate valve assembly may be provided with actuating means in order to move the movable gate between the open and closed position and carry out the shearing. In one aspect the actuating means comprises a first actuator arranged for providing a pulling force and a second actuator arranged for providing a pushing force.

30 In an embodiment of the gate valve assembly, the valve housing may have a first support surface for the first seat which provides a bore for the first seat. The support surface may be arranged in connection with a first inner surface, for instance provided as a continuation of the first support surface. The first inner surface may be arranged in the valve housing angled relative to the axial axis of

the through bore, wherein the first inner surface approaches the through bore in the axial direction away from the bore for the first seat. The first inner surface of the valve housing may be arranged to define a first enlarged opening portion of the through bore. The first enlarged opening portion of the through bore may be  
5 arranged facing the expanded opening portion of the opening of the support member.

In an embodiment of the gate valve assembly, the support surface for the second seat in the valve housing may be provided with a bore for the second seat. The bore for the second seat may have a radius larger than the radius of  
10 the through bore, wherein a minimum inner radius of the second seat corresponds to or is larger than the maximum radius of the gate bore.

In an embodiment of the gate valve assembly, the support surface for the second seat surface may be arranged in connection with a second inner surface provided in the valve housing and arranged angled relative to the axial axis of the  
15 through bore approaching the through bore in the axial direction away from the bore for the second seat. The second inner surface of the valve housing may be arranged to define a second enlarged opening portion of the through bore. The second inner surface of the through bore may be formed as an annular inclined surface.

20 Either of the first or the second seats, or both, may be provided as annular elements. An axial axis of the first and/or second seats coincides essentially with the axial axis of the through bore.

The second seat may be a bidirectional sealing element when the gate element is closed.

25 The invention also includes a method for shearing an elongated member arranged in a through bore of a gate valve arrangement comprising a movable gate element for closing the through bore, wherein the through bore is adapted for fluid communication with a well bore and is provided with an elongated member. The method comprises the following steps:

30 Arranging the elongated member through an opening in a support member located adjacent to a cutting tool which is arranged in a gate bore of the movable gate element. The opening encompasses the through bore and an expanded opening portion which is open to the through bore in the axial direction of the through bore. A reduced section of the support member defines the expanded

opening portion. Then, moving the cutting tool and arranging the elongated member in contact with a contact surface area of the support member. The opening has a decreasing radius along the reduced section in the axial direction of the support member toward the contact surface area arranged at an end portion of the support member. The radius of the opening at the location of the contact surface area corresponds essentially to the radius of the through bore. In this position, conducting the shearing of the elongated member by the cutting tool utilizes the counteracting effect of the contact surface area in engagement with the elongated member and provides a local concentration of shearing forces.

After the completion of the shearing, then closing the through bore by moving the movable gate element into closing position.

In an embodiment of the method in accordance with the invention, the method may comprise, when moving the gate element into the closing position, carrying out the following steps:

Moving the gate element from an initial position where an initial portion of a sealing surface of the gate element is in sealing contact with a second seat arranged with additional sealing providing means. Moving the gate element from the initial position so that a transfer portion continued from the initial portion of the sealing surface is arranged in contact with the second seat and initiates additional sealing of the sealing surface. Further moving the gate element so that an activation portion of the sealing surface continued from the transfer portion is in contact with the second seat, thereby fully activating the additional sealing providing means and providing an increased sealing force between the sealing surface of the gate element and the second seat.

These and other characteristics of the invention will be explained in more detail with reference to the attached drawings showing a non-restrictive example.

#### BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a side section view of a first embodiment of the gate valve arrangement of the present invention.

Figure 2 is a side section view of a second embodiment of the gate valve arrangement of the present invention.

Figure 3 is a side section view of a third embodiment of the gate valve arrangement of the present invention.

## DETAILED DESCRIPTION OF THE INVENTION

Figure 1 shows a first embodiment of a gate valve assembly 1 arranged with a through bore 2 for receiving an elongated member (not shown). A movable gate element 3 has a gate bore 4 for receiving the elongated member and arranged with a cutting tool 16. The minimum opening of the gate bore 4 is essentially equal to the through bore 2. A first seat 5 may be provided as a cutting seat and has an engagement surface 7 arranged in sliding contact with a first surface 8 of one side the gate element 3. A second seat 10 has a seal surface 11 arranged in sealing contact with a sealing surface 12 at the other side of the gate element 3. It is possible to provide the first seat 5 so that the engagement surface 7 provides a seal surface in sealing contact with the first surface of the gate element, in which event the first surface will then act as a sealing surface.

The first seat 5 is arranged as a support member with an opening 14 encompassing the through bore 2 and an expanded opening portion 40 which is open to the through bore 2 in the axial direction of the through bore 2. The expanded opening portion 40 is provided by a reduced section 41 of the first seat 5. The reduced section 41 is shown with an inclined surface 42 in figure 1 and extends along a portion of the circumference of the opening 14. The opening 14 has a decreasing radius  $R$  along the reduced section 41 in the axial direction of the first seat 5 toward a contact surface area 15 arranged at an end portion of the first seat 5 adjacent the cutting tool 16.

The radius of the opening 14 of the first seat 5 adjacent the gate element 3 corresponds essentially to the radius of the through bore 2. When preparing for the shearing of the elongated member, the elongated member will rest against the contact surface area 15 of the first seat 5.

The gate bore 4 encompasses the through bore 2 and an expanded opening portion 50 which is open to the through bore 2 in the axial direction of the through bore. The expanded opening portion 50 is provided by a reduced section 51 of the gate element 3. The reduced section 51 is shown with an inclined surface 52 in figure 1 and extends along a portion of the circumference of the gate bore 4. The gate bore has a decreasing radius  $R$  along the reduced section in the axial direction of the gate element 3 toward the cutting tool 16. The radius

of the gate bore 4 at the location of the cutting tool 16 corresponds essentially to the radius of the through bore 2.

When shearing of the elongated member is to take place, the elongated member is pushed by the cutting tool 16 until it engages the contact surface area 15, and the cutting tool then cuts the elongated member by moving the gate element 3 in a direction transverse to the through bore 2. The contact surface area 15 is located at a tip portion of the first seat 5, so that the contact surface area 15 protrudes relative to the neighboring portions of the first seat 5. The contact surface area 15 provides a counteracting area interacting with the cutting tool 16 and provides for a local concentration of shearing forces to take place when shearing the elongated member.

By the arrangement of the inclined surface 52 of the gate bore 4 and the inclined surface 42 of the first seat 5, the sheared parts of the elongated member are forced away from both sides of the gate element 3 when the gate element is moved into the closing position.

A valve housing 35 has a support surface 60 for the first seat 5 which provides a bore for the first seat. A first inner surface 62 is provided in the valve housing continuing from the inclined surface 42 and arranged at an angle relative to the axial axis A of the through bore 2. The first inner surface 62 approaches the through bore 2 in the axial direction away from bore for the first seat.

The first inner surface 62 provides a cut out such as a first enlarged opening portion 63 in the through bore 2 facing the expanded opening portion 40 of the first seat 5. The cut out provides a similar increase in the radius of the through bore as the inclined surface 42.

Two actuators are arranged for moving the gate element. A first actuator 20 moves the gate element 3 with a pulling force and a second actuator 21 moves the gate element with a pushing force. The actuators 20, 21 may be operated simultaneously. Alternatively, only one actuator may be provided for either pushing or pulling the gate valve for the shearing and closing of the gate valve.

The second seat 10 is arranged on a support surface 24 arranged in the gate valve housing 35 with additional sealing-providing means, such as for instance a spring element 23 and a sealing element 22 as shown in figure 1, or other means capable of preloading. The sealing surface 12 of the gate element 3

facing the second seat 10 has an initial portion 25 in contact with the seal surface 11 of the second seat 10 when the gate element is in the open position as shown in figure 1. The initial portion 25 of the sealing surface 12 is connected to a transfer surface 26 which is connected to an activation portion 27. The activation  
5 portion 27 is positioned offset/axially closer to the support surface 24 than the initial portion 25 of the sealing surface 12 of the gate element. The activation portion 27 may be provided as an enlarged portion of the gate element. When moving the gate element 3 into the closing position, the initial portion 25 of the sealing surface 12 is moved in contact with the seal surface 11 of the second  
10 seat 10. The second seat 10 also has a transfer portion 30 shaped to interact with the transfer surface 26. The transfer surface 26 moves along the seal surface 11 of the second seat 10, thereby bringing the activation portion 27 of the sealing surface 12 into contact with the seal surface 11. The contact between the activation portion 27 of the sealing surface 12 and the seal surface 11 of the  
15 second seat 10 causes compression of the spring element 23, thereby providing additional sealing force to the sealing between the second seat 10 and the sealing surface 12 of the gate element 3.

The contact surface 7 of the first seat 5 is protected from well fluid since it is covered by the body of the gate element 3 when the gate element is in the  
20 shown open position.

The seal surface of the 11 of the second seat 10 is protected from well fluid since the inner radius of the second seat is larger than the largest radius of the gate bore 4 as seen in figure 1. The support surface 24 for the second seat 10 is arranged as a bore for the second seat. A second inner surface 62' is  
25 provided in the valve housing 35 and is formed as an annular inclined surface and arranged at an angle relative to the axial axis of the through bore 2 approaching the through bore in the axial direction away from the support surface 24, thereby defining a second enlarged opening portion 64 of the through bore 2. The first and second seats are shown as annular elements. The second seat 10  
30 is a bidirectional sealing element when the gate element 3 is closed.

Figure 2 shows a second embodiment of the gate valve assembly 1. In this embodiment the first seat 5 and the second seat 10 have some configurations which may differ from the configurations shown in figure 1, but the overall components and the working principles for shearing the elongated

member described in connection with figure 1 are the same. The gate element 3 is in figure 2 shown partly moved from its open position to a closed position. The elongated member 80 to be cut is indicated in the drawing in abutment between the first seat 5 and the gate element 3. A temporary seal surface protection element 31 is arranged for protection of the seal surface 11 of the second seat 10 before the shearing of the elongated element is to take place. The temporary seal surface protection element 31 is arranged to be removed from the gate valve or possibly destroyed prior to the shearing of the elongated member. The protection element 31 may be provided as a brittle material which is easy to destroy. Another possibility is to provide the protection element 31 with a connection to the gate element 3 which is easily disconnected so that the protection element 31 is released from the gate element when it comes in contact with the elongated member 80 as the gate element is moved from its open position.

The seal surface protection element 31 has a configuration which fills in the gate bore so that the inner radius of the gate bore corresponds to or is smaller than the inner radius of the second seat 10, thereby protecting the seal surface 11 when the gate element 3 is in the open position. The seal surface protection element 31 also has a shape which provides a fully open through bore through the valve assembly 1 when the gate element 3 is in an open position. The protection element 31 and the gate element 3 with the cutting tool 16 may also be configured such that there are no protruding parts into the through bore 2 of the valve assembly in an open position of the gate element. When gate element 3 is moved from the open position, the protection element 31 and the gate element are so configured that the protection element is the first to interact with the elongated member 80, if present in the through bore 2. This interaction initiates a removal of the protection element 31, either by releasing it from the gate element 3 or destroying it. The connection between the gate element 3 and the protection element 31, or the protection element itself, may also be arranged such that the protection element is not released from the gate element when the gate element is in an open position. When the protection element 31 is removed or destroyed, the cutting tool 16 of the gate element 3 will interact with the elongated member, cutting it, during further closing of the gate element. The protection element 31 provides a possibility to arrange the gate element with an



inclined surface 17 relative to an axial axis of the through bore, extending from the cutting tool 16 and into the gate element, thereby providing an expanded gate bore 4 of the gate element 3 compared with the through bore 2. In addition, this arrangement ensures the protection of the seal surface of the second seat 10, as  
5 the protection element 31 provides an additional sealing surface 51 working initially with the sealing surface 12 of the gate element, and at the same time being able to provide the second seat 10 with an inner radius essentially corresponding to the radius of the through bore 2 of the gate valve arrangement.

Figure 3 shows a third embodiment of the invention, in which the cutting  
10 tool 46 is movably arranged in a transverse recess 32 in the gate element 3 opening into the gate bore 4. The cutting tool 46 is arranged to be separately moveable relative to the gate element 3. The gate bore 4 has an inclined surface 77 providing the gate bore 4 with a varying radius in the axial direction of the gate bore.

15 The support member is arranged in the gate element 3 with the opening 44 encompassing the through bore 2 for receiving the elongated member and an expanded opening portion 70 which is open to the through bore 2 in the axial direction of the through bore. A reduced section 75 of the support member has an inclined surface 71, 72 which defines the expanded opening portion 70. The  
20 opening 44 has a decreasing radius along the reduced section in the axial direction of the support member toward a contact surface area 45 arranged at an end portion of the support member adjacent the cutting tool 46 at both sides of the transverse recess 32. The radius of the opening 44 at the location of the contact surface area 45 corresponds essentially to the radius of the through bore  
25 2. The contact surface area 45 is configured for engagement with the elongated member. The support member has inclined surfaces 71, 72 arranged on the opposite sides of the transverse recess 32 seen in the axial direction of the through bore 2.

When preparing for the shearing of the elongated member, the elongated  
30 member will be pushed towards the contact surface area 45. The cutting tool 46 will be moved in the transvers recess 32, and the elongated member will engage the contact surface area 45 while the cutting tool is moved in a direction transverse to the through bore 2 for the shearing to take place. The contact surface area 45 located at the protruding portion of the support member provides

a counteracting area interacting with the cutting tool 46 and provides for a local concentration of shearing forces to take place when shearing the elongated member. The support member as shown in figure 3 is arranged as a part of the gate element 3. The inclined surfaces 71, 72 of the support member and the  
5 inclined surface 77 of the gate element are arranged to expand the gate bore 4 all around the circumference of the gate bore on both sides of the transverse recess 32.

First and second seats 5, 10 are arranged at opposite sides of the gate element 3. At least one of the first and second seats 5, 10 is arranged to provide  
10 sealing contact with a sealing surface of the gate element 3 or contact with a first surface of the gate element. The seats are provided with an inner radius corresponding to the maximum radius of the gate bore 4 of the gate element 3. The maximum radius of the gate bore 4 is larger than the radius of the through bore 2 of the valve assembly. The valve housing 35 is also provided with cut  
15 outs 47 to provide a transition from the larger radius of the opening of the first and second seats 5, 10 to the through bore 2 of the valve assembly at the side of the first and second seats facing away from the gate element 3. The gate element 3 and the first and second seats 5, 10 are arranged such that the sealing/engagement surfaces of the first and second seats are covered by the  
20 gate element in an open position of the gate element.

A person skilled in the art will understand that there may be made alterations and modifications to the embodiments that are within the scope of the invention as defined in the attached claims, and elements or features of the different embodiments may be combined in any configuration.

25

## CLAIMS

1. A gate valve assembly having a through bore adapted for fluid communication with a well bore and configured for receiving an elongated member, the gate valve assembly comprising:

5 a gate element which is movably arranged in a gate valve housing, wherein the gate element has a gate bore arranged for receiving the elongated member, and wherein a cutting tool is arranged in the gate bore;

first and second seats for the movable gate element, wherein at least one of the first and second seats is arranged to provide sealing contact with  
10 a sealing surface of the gate element;

a support member comprising an opening encompassing the through bore and an expanded opening portion which is open to the through bore in the axial direction of the through bore, wherein a reduced section of the support member defines the expanded opening portion, wherein the opening has  
15 a decreasing radius along the reduced section in the axial direction of the support member toward a contact surface area arranged at an end portion of the support member adjacent the cutting tool, and wherein the radius of the opening corresponds essentially to the radius of the through bore;

wherein the contact surface area is configured for engagement with  
20 the elongated member and provides a counteracting area interacting with the cutting tool during shearing of the elongated member.

2. A gate valve assembly in accordance with claim 1, wherein the support member is included in the first seat having an engagement surface provided for contact with a first surface of the gate element.

25 3. A gate valve assembly in accordance with claim 1 or 2, wherein the cutting tool is arranged in the gate bore, wherein the gate bore encompasses the through bore for receiving the elongated member and an expanded opening portion which is open to the through bore in the axial direction of the through bore, wherein a reduced section of the gate element member defines the  
30 expanded opening portion, wherein the gate bore has a decreasing radius along the reduced section in the axial direction of the gate element toward the cutting tool arranged at an end portion of the gate element member adjacent the support member, and wherein the radius of the gate bore at the location of the cutting tool corresponds essentially to the radius of the through bore.

4. A gate valve assembly in accordance with claim 1, wherein the support member is included in the gate element, and wherein the opening of the support member is a portion of the gate bore and a transverse recess is arranged in the gate element for positioning of the cutting tool.

5 5. A gate valve assembly in accordance with one of the preceding claims, wherein the reduced section of the support element is provided as an rectilinear inclined surface extending along a portion of the circumference of the opening of the support element.

6. A gate valve assembly in accordance with one of claims 3 or 5,  
10 wherein the reduced section of the gate element is provided as a rectilinear inclined surface extending along a portion of the circumference of the gate bore.

7. A gate valve assembly in accordance with one of the preceding claims, wherein a temporary seal surface protection element is arranged for removal prior to the shearing of the elongated member, wherein the seal surface  
15 protection element has a configuration filling in the gate bore so that the radius of the gate bore corresponds to or is smaller than an inner radius of the second seat for protection of the seal surface of the second seat.

8. A gate valve assembly in accordance with one of the preceding claims, wherein the second seat is provided with additional sealing providing  
20 means.

9. A gate valve assembly in accordance with claim 8, comprising an activation arrangement for the activation of the additional sealing providing means in the closed position of the gate element.

10. A gate valve assembly in accordance with claim 9, wherein the  
25 activation arrangement comprises an activating portion of the sealing surface, wherein the second seat is arranged in sealing contact with an initial portion of the sealing surface of the gate element in an open position of the gate element, and wherein in a closed position of the gate element the second seat is in sealing contact with an activating portion of the sealing surface.

30 11. A gate valve assembly in accordance with claim 10, wherein the activation portion of the sealing surface is positioned offset closer to a support surface for the second seat provided in the gate valve housing than the initial portion of the sealing surface.

12. A gate valve assembly in accordance with one of claims 10-11, wherein the initial portion of the sealing surface of the gate element is connected to the activating portion of the sealing surface by a transfer surface.

5 13. A gate valve assembly in accordance with one of claims 10-12, wherein the additional sealing providing means comprises spring means which has an initial mode when the second seat is in contact with the initial portion of the sealing surface, and a compressed mode when the second seat is in contact with the activating portion of the sealing surface.

10 14. A gate valve assembly in accordance with one of the preceding claims, wherein the movable gate is provided with a first actuator arranged for providing a pulling force and a second actuator arranged for providing a pushing force.

15 15. A gate valve assembly in accordance with one of the preceding claims, wherein the valve housing has a support surface for the first seat providing a bore for the first seat, wherein the support surface is arranged in connection with a first inner surface provided in the valve housing and angled relative to the axial axis of the through bore, and wherein the first inner surface approaches the through bore in the axial direction away from bore for the first seat.

20 16. A gate valve assembly in accordance with claim 15, wherein the first inner surface of the valve housing defines a first enlarged opening portion of the through bore.

25 17. A gate valve assembly in accordance with claim 16, wherein the first enlarged opening portion of the through bore is arranged facing the expanded opening portion.

30 18. A gate valve assembly in accordance with one of claims 11-17, wherein the support surface for the second seat in the valve housing provides a bore for the second seat, wherein the second seat bore has a radius larger than the radius of the through bore, and wherein a minimum inner radius of the second seat corresponds to or is larger than the maximum radius of the gate bore.

19. A gate valve assembly in accordance with claim 18, wherein the support surface for the second seat is arranged in connection with a second inner surface provided in the valve housing and arranged at an angle relative to the

axial axis of the through bore approaching the through bore in the axial direction away from bore for the second seat.

20. A gate valve assembly in accordance with claim 19, wherein the second inner surface of the valve housing defines a second enlarged opening portion of the through bore.

21. A gate valve assembly in accordance with claim 19 or 20, wherein the second inner surface of the through bore is formed as an annular inclined surface.

22. A gate valve assembly in accordance with one of the preceding claims, wherein at least one of the first and second seats is an annular element, and wherein an axial axis of said at least one of the first and second seats essentially coincides with the axial axis of the through bore.

23. A method for shearing an elongated member arranged in a through bore of a gate valve arrangement comprising a movable gate element for closing the through bore, wherein the through bore is adapted for fluid communication with a well bore, the method comprising the steps of:

arranging the elongated member through an opening in a support member located adjacent to a cutting tool which is arranged in a gate bore of the movable gate element, wherein the opening encompasses the through bore and an expanded opening portion which is open to the through bore in the axial direction of the through bore, and wherein a reduced section of the support member defines the expanded opening portion;

moving the cutting tool and arranging the elongated member in contact with a contact surface area of the support member, wherein the opening has a decreasing radius along the reduced section in the axial direction of the support member toward the contact surface area arranged at an end portion of the support member, and wherein the radius of the opening at the location of the contact surface area corresponds essentially to the radius of the through bore;

conducting the shearing of the elongated member by the cutting tool thereby utilizing the counteracting effect of the contact surface area in engagement with the elongated member and thereby providing a local concentration of shearing forces; and

closing the through bore by moving the movable gate element into closing position.

24. The method in accordance with claim 23, further comprising carrying out the following steps when moving the gate element into closing position:

moving the gate element from an initial position where an initial  
5 portion of a sealing surface of the gate element is in sealing contact with a second seat arranged with additional sealing providing means;

moving the gate element from the initial position so that a transfer  
portion continued from the initial portion of the sealing surface is arranged in  
contact with the second seat and initiating additional sealing of the sealing  
10 surface; and

further moving the gate element so that an activation portion of the  
sealing surface continued from the transfer portion is in contact with the second  
seat thereby fully activating the additional sealing providing means and providing  
an increased sealing force between the sealing surface of the gate element and  
15 the second seat.

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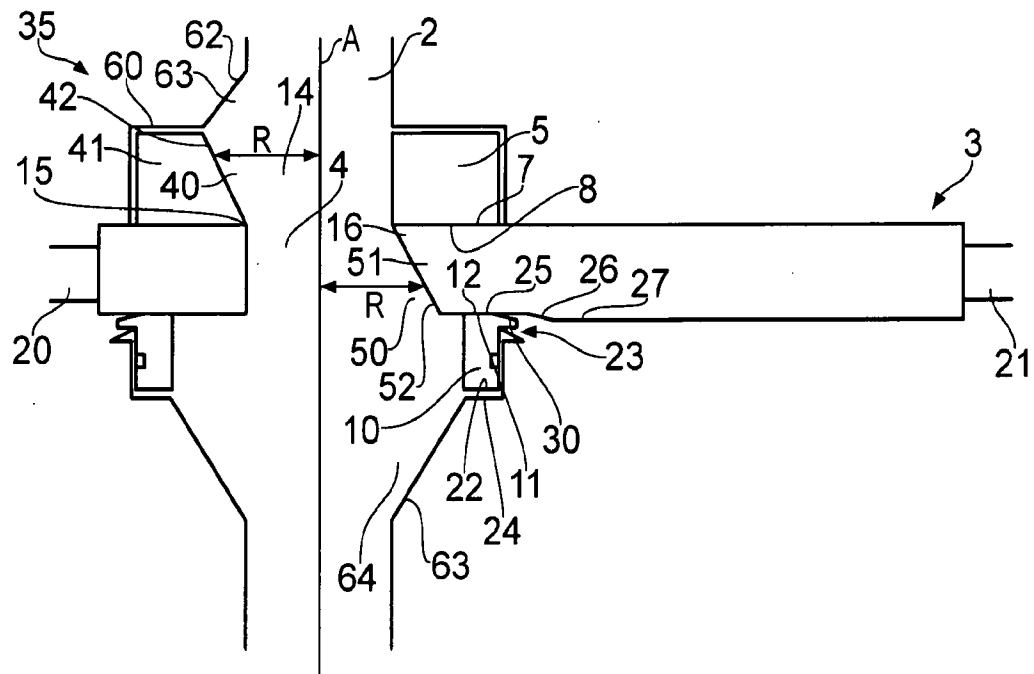


FIG. 1

REPLACEMENT SHEET

SUBSTITUTE SHEET (RULE 26)



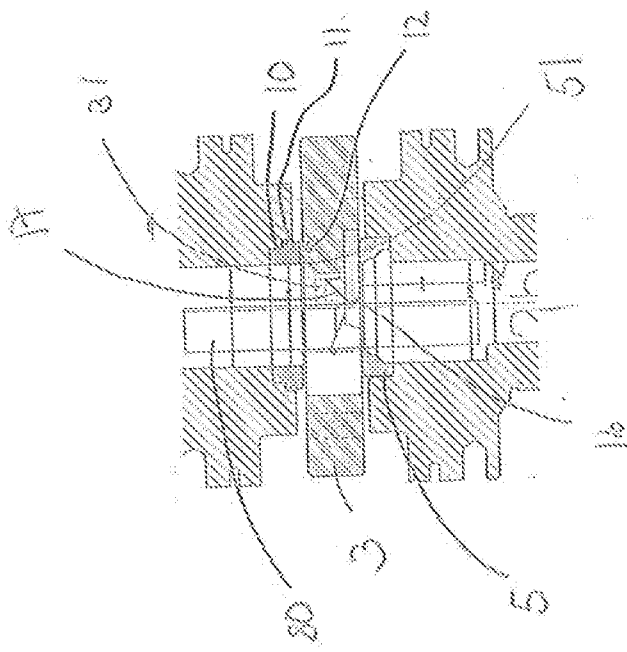


Fig. 2

