Jan. 2, 1940. J. C. FORTUNE 2,185,173

BACK PRESSURE VALVE

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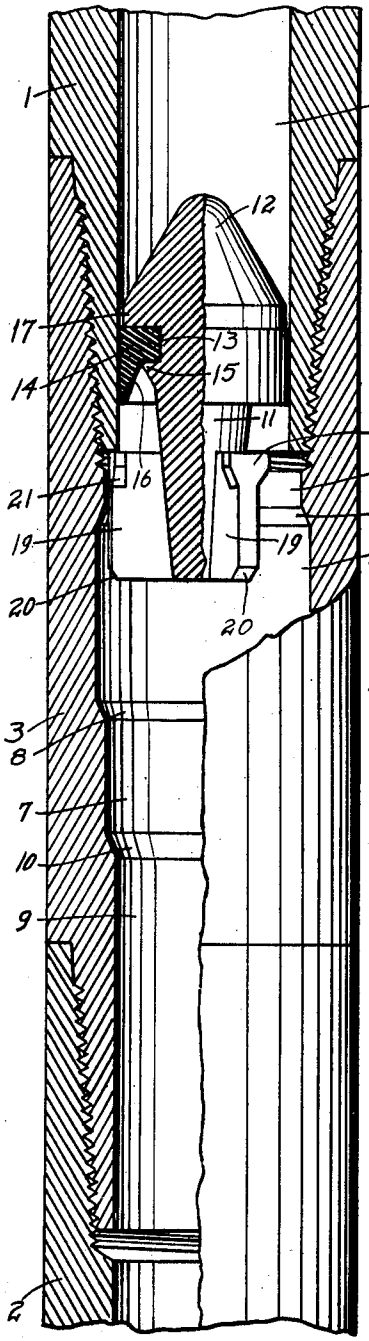

Fig. 1.

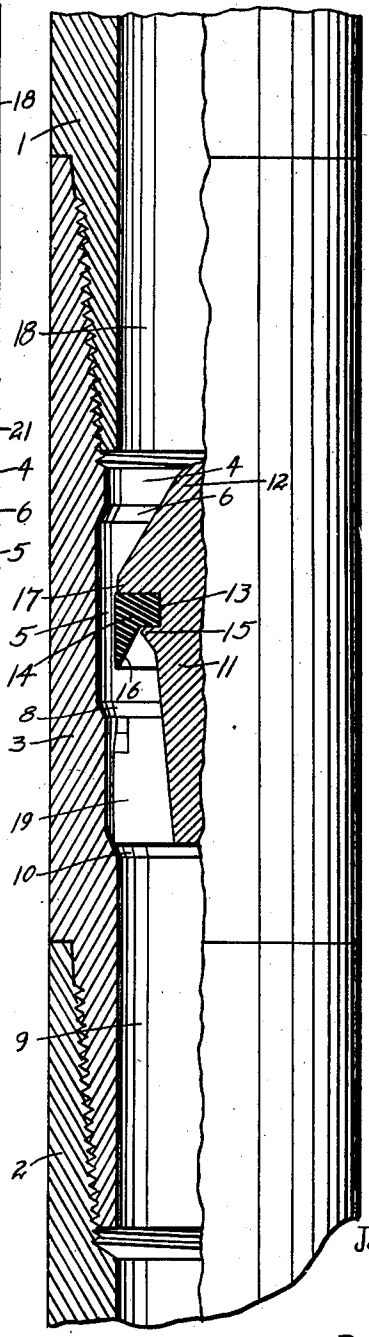

Fig. 2.

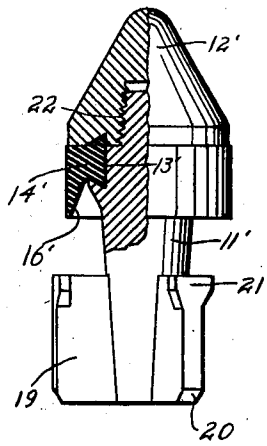

Fig. 3.

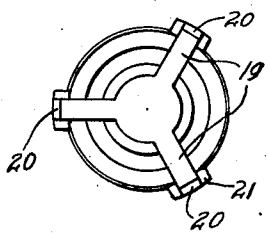

Fig. 4.

James C. Fortune
Inventor

By J. Vincent Martin
and
Ralph R. Browning
Attorneys

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BACK PRESSURE VALVE

James C. Fortune, Houston, Tex., assignor to Reed Roller Bit Company, Houston, Tex., a corporation of Texas

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8 Claims. (Cl. 137—69)

This invention relates to back pressure valves or check valves, and more particularly has reference to a valve adapted to be employed in a drill stem which is used for rotating a drill bit in drilling a well or the like.

In carrying out well drilling operations, it is customary to employ a string of pipe known as the drill stem, with a bit on the lower end thereof, and means at the upper end thereof for rotating the pipe and causing rotation of the bit. During the drilling operations it is necessary to circulate a fluid through the well, and this is ordinarily done by circulating the fluid downwardly through the drill stem and out through holes properly located with respect to the cutting portions of the bit, this fluid then passing upwardly through the drill hole about the drill stem and washing the cuttings upwardly therewith. Under many circumstances, it is highly desirable, if not imperative, that some means be provided within the drill stem for preventing a backward flow of this washing fluid upwardly through the drill stem. Various means are employed for controlling flow upwardly through the well around the outside of the drill stem, and it is necessary also to have some means within the drill stem so that in the event a high pressure formation is encountered during the drilling operation, this high pressure will be prevented from blowing out through the drill stem. Furthermore, by the use of a check valve adjacent the lower end of the drill stem, the same may be kept empty or partially so and its buoyancy employed to "float" it into the well.

Various types of valves have heretofore been employed for the purpose set forth. For the most part, these have consisted of balls or other valve-like members adapted to seat against a separate seat within the drill stem, and to move away from said seat upon downward flow of fluid through the drill stem. Naturally, valves of this type restrict to a considerable extent the cross section area of the interior of the drill stem at the point where the valve and the seat overlap radially therein. If the bore of the drill stem were restricted, for example, to provide a shoulder against which the ball or like valve member could seat, that would in itself provide a considerable restriction in the cross section area available for fluid flow. If on the other hand the bore of the drill stem were enlarged to provide the shoulder against which such a valve would seat, the valve would have to be made larger in diameter than the normal bore of the drill stem in order to seat against such a seat, and the valve seat would itself in such instances prove a means of restricting the available cross section area of the drill stem.

It is an object of this invention to provide a back pressure valve for a drill stem or other like conduit, in which the passageway through the drill stem may be made of the largest possible diameter and the valve member may be made of the smallest possible diameter with respect thereto.

It is a further object to provide a back pressure valve for a drill stem or the like which when opened will provide a maximum cross section area available for fluid flow through the drill stem.

It is a further object of this invention to provide a back pressure valve for a drill stem, which valve will offer the least possible resistance to flow of fluid through the drill stem.

Another object is to provide a valve of the nature set forth which will be to the greatest possible extent durable and trouble-free.

It is a further object to provide a valve in which worn parts may be replaced with a minimum of time and labor.

Other objects and advantages of this invention will become apparent from the following description taken in connection with the accompanying drawing, it being understood that said description and drawing are by way of illustration only, and that they are not to be taken as in any way a limitation upon the scope of this invention. Such scope is to be limited only by the prior art, and by the terms of the appended claims.

In the drawing:

Fig. 1 is a view partly in vertical cross section illustrating a section of drill pipe in which is installed a valve constructed in accordance with this invention.

Fig. 2 is a similar view illustrating the same structure with the valve in open position.

Fig. 3 is a view illustrating a slightly modified form of valve element.

Fig. 4 is a bottom plan view of the valve element illustrated in Figs. 1 to 3.

Referring more specifically to the drawing, there are shown at 1 and 2, respectively, the pin and box portions of a tool joint of conventional construction which is used for joining together the ends of two sections of drill pipe. These tool joint sections 1 and 2 are ordinarily threadedly connected to each other.

At 3 there is illustrated a fitting which is inserted between the tool joint sections 1 and 2. This fitting 3 is internally threaded at its upper end to receive the pin section 1 of the tool joint,

and is externally threaded at its lower end to threadedly engage the box section 2 of the tool joint. This fitting 3 and a portion of the section 1 constitute the valve housing, to house the valve, which is to be interposed in the drill stem.

Within its upper end, the fitting 3 is provided with a relatively short zone having an internal diameter slightly greater than the inner diameter of the tool joint sections 1 and 2. Just below this zone 4 is a second zone 5 of somewhat greater extent longitudinally than the zone 4 and of a larger diameter, the zone 5 being joined to the zone 4 by a tapered portion 6. Below the lower end of the zone 5 is a third zone 7 which is of substantially the same diameter as the zone 4, and which is joined to the zone 5 by a tapered section 8. The lower portion of the fitting 3 is formed with an internal diameter 9 which is preferably substantially the same as the internal diameter of the zone through the tool joint. This lower portion is joined to the zone 7 by a tapered section 10.

The valve element which is positioned within the special fitting 3 consists principally of a body portion 11 having a tapered upwardly presented nose 12 thereon, and having a groove thereabout as shown at 13 for the purpose of receiving a packing cup 14. Formed on the body portion 11 just below the packing cup 14 and providing the lower wall of the groove 13 is an upwardly facing shoulder 15. This shoulder is of sufficiently small radial extent to provide space for the lower tapered edge portion 16 of the packing. Above the packing 14 and forming the upper wall of the groove 13 is a laterally extending flange 17. This flange is of only slightly less radial extent than the packing itself so as to form a substantially complete axial support for the packing to prevent the packing from being washed off the body 11 in an upwardly direction. It is to be noted that the packing is of substantially the same external diameter as the internal diameter of the bore 18 of the tool joint section 1.

On the lower end of the body portion 11 there are formed a plurality of radially extending vanes or guide wings 19, these wings preferably being beveled at their outer lower corners as shown at 20, and provided with enlarged heads or abutments adjacent their upper outer corners as illustrated at 21.

The form of the valve element illustrated in Fig. 3 is similar to that illustrated in Figs. 1 and 2, except for the fact that the upper end of the body portion 11' instead of being formed integral with the nose of the body portion is connected to the separable nose portion 12' by means of screw threaded connection 22. In this instance, the groove which is formed between the body portion 11' and the nose portion 12' is of dovetail cross section as illustrated at 13'. The packing 14' is correspondingly shaped, and is provided with a downwardly extending lip 16', this packing being locked in position when the nose 12' is threadedly engaged with the body portion 11'.

In operation, during the time that the washing fluid is being pumped downwardly through the drill stem, the valve element will occupy the position illustrated in Fig. 2. When in this position, the beveled lower corners of the guiding wings 19 will contact the tapered section 10 joining the zone 7 with the lower portion 9 of the fitting 3, and will maintain the valve element in such position that the packing 14 and the shoulder 17, which form the largest cross section area of the valve element, will lie within the zone 6, which is the zone of largest internal diameter. Although the difference in diameter between the exterior of the packing 14 and the interior of the zone 5 is not great, yet because this space is annular in form and is of larger mean diameter than the diameter of the tool joint passage, its cross sectional area may be so controlled that it will very closely approach and in the smaller sizes actually exceed the cross section area of the passage through the tool joint. In this connection, it is noted that the external diameter of the packing 14 is limited to substantially the same value as the internal diameter of the tool joint section 1, while the internal diameter of the zone 5 is limited only by the strength of the material of which the fitting 3 is formed.

When the downward flow through the drill stem ceases and upward flow begins, the upward flow will raise the valve element until the packing enters the bore through the tool joint section 1, and the upper ends 21 of the wings 19 on the valve element engage with the end of the tool joint section 1. When this occurs, the pressure below the valve element will expand the packing cup 14 and press the lower lip 16 thereof against the inner wall of the tool joint section 1, thus preventing further upward flow through the drill stem.

From the foregoing it will be noted that a back pressure valve combination has been provided in which there is no restriction or reduction of the size of the normal fluid conducting bore for the purpose of forming a valve seat, and that the valve element which is provided is of no greater diameter than the bore which is normally provided for the conduction of fluid. In fact, the valve element is of a diameter which is capable of passing through any portion of the fluid conducting passageway. It only seals against the walls of this passageway when it is stopped by the wings 19 in such a position that it lies within the smallest portion of the passageway.

When moved to its open position within the enlarged zone 5 provided for receiving the valve element when downward flow is taking place, this valve element offers the least possible resistance to the flow of fluid inasmuch as it is provided with a stream-lined front or upper end, and is of the least possible diameter for performing the fuction for which it is intended. It is noted that it is of a smaller diameter than would be necessary for any valve seating against a seat formed within a portion of the drill stem. In other words, if a valve were provided adapted to seat against a downwardly facing seat within the drill stem, this valve would necessarily be larger than the passageway through this seat, and hence would be larger than the minimum passageway available for the flow of fluid. In the present construction, the valve element is actually of no greater diameter than the minimum diameter of the passageway available for the flow of fluid. Because of the fact that the valve is of the least possible diameter with respect to the minimum internal diameter of the drill stem, the area available for the flow of fluid about the valve element when the valve is open is the maximum area which could be obtained.

It will thus be appreciated that while a valve element has been provided which is thoroughly efficient and capable of withstanding any back pressure which might be exerted thereon, and which is of such a nature to close quickly and otherwise provide an efficient back pressure valve

which at the same time offers the least possible resistance to flow when it is in its open position.

Having described my invention, I claim:

1. In a back pressure valve for a drill pipe, a valve housing comprising a fitting adapted to be connected between adjacent sections of the drill pipe, said housing including an adjacent end portion of one of said sections having a passage therethrough, a portion of which is of a diameter greater than the portion of the passage through said adjacent end portion, a valve element in said housing passage of a diameter less than the diameter of the passage through the said end portion and having a skeleton part in the passage through said housing of a diameter too great to enter said end portion, whereby movement of said valve element into said end portion will be limited, and said valve element having a part expansible into sealing engagement with the walls of said end portion when forced thereinto by fluid under pressure tending to enter said end portion from said fitting.

2. In a back pressure valve for a drill pipe, a valve housing comprising a fitting having threaded pin and box portions at its opposite ends, respectively, adapted to receive the respective sections of a tool joint, said housing including an adjacent end portion of that one of said sections which is adapted to be secured to the upper end of the fitting and having a passage therethrough, the upper portion of the passage through the fitting being of a diameter greater than the portion of the passage through said adjacent end portion, a valve element in said housing passage of a diameter less than the minimum diameter of the passage through the said end portion and having a skeleton part in the passage through said housing of a diameter too great to enter said end portion, whereby movement of said valve element into said end portion will be limited, and said valve element having a part expansible into sealing engagement with the walls of said end portion when forced thereinto by fluid under pressure tending to enter said end portion from said fitting.

3. In a back pressure valve for a drill pipe, a valve housing comprising a fitting adapted to be connected between adjacent sections of the drill pipe, said housing including an adjacent end portion of one of said sections and having a passage therethrough, a portion of which is of a diameter greater than the portion of the passage through said adjacent end portion, a valve element in said housing passage of a diameter less than the diameter of the passage through the said end portion and having a skeleton part in the passage through said housing of a diameter too great to enter said end portion, whereby movement of said valve element into the said end portion will be limited, and said valve element having a sealing cup expansible into sealing engagement with the walls of said end portion when forced thereinto by fluid under pressure tending to enter said end portion from said fitting.

4. In a back pressure valve for a drill pipe, a valve housing comprising a fitting having threaded pin and box portions in its opposite ends, respectively, adapted to receive the respective sections of a tool joint, said housing including an adjacent end portion of that one of said sections which is adapted to be secured to the upper end of the fitting and having a passage therethrough, the upper portion of the passage through the fitting being of a diameter greater than the portion of the passage through said adjacent end portion, a valve element in said housing passage of a diameter less than the minimum diameter of the passage through said end portion and having a skeleton part in the passage through said housing of a diameter too great to enter said end portion, whereby movement of said valve element into said end portion will be limited, and said valve element having a sealing cup expansible into engagement with the walls of said end portion when forced thereinto by fluid under pressure tending to enter said end portion from said fitting.

5. In a back pressure valve for a drill pipe, a valve housing comprising a fitting having threaded pin and box portions at its opposite ends, respectively, adapted to receive the respective sections of a tool joint, said housing including an adjacent end portion of that one of said sections which is adapted to be secured to the upper end of the fitting and having a passage therethrough, the upper portion of the passage through the fitting being of a diameter greater than the portion of the passage through said adjacent end portion and the lower portion of which is of a smaller diameter than the passage through the said upper portion of the fitting, a valve element in said housing passage of a diameter less than the minimum diameter of the passage through said end portion and having a skeleton part in the upper portion of the passage through said fitting of a diameter too great to enter said end portion or said lower portion of the fitting, whereby movement of said valve element into said end portion will be limited and movement into the lower portion of said fitting will be prevented, and said valve element having a part expansible into sealing engagement with the walls of said end portion when forced thereinto by fluid under pressure tending to enter said end portion from said fitting.

6. In a back pressure valve for a drill pipe, a valve housing comprising a fitting adapted to be connected between adjacent sections of the drill pipe, said housing including an adjacent end portion of one of said sections and having a passage therethrough, a portion of which is of a diameter greater than the portion of the passage through said adjacent end portion, a valve element in said housing passage of a diameter less than the diameter of the passage through the said end portion and having a skeleton part in the passage through said housing of a diameter too great to enter said end portion, whereby movement of said valve element into said end portion will be limited, and said valve element having a part expansible into sealing engagement with the walls of said end portion when forced thereinto by fluid under pressure tending to enter said end portion from said fitting, said skeleton part and the remainder of said valve element being joined together to form a dart-like element and said valve element having a streamlined upper end to facilitate flow of fluid past the same when it is located within the larger portion of said passage through the housing.

7. In a back pressure valve for a drill pipe, a valve housing comprising a fitting adapted to be connected between adjacent sections of the drill pipe, said housing including an adjacent end portion of one of said sections and having a passage therethrough, a portion of which is of a diameter greater than the portion of the passage through said adjacent end portion, a valve element in said housing passage of a diameter less than the diameter of the passage through the said end por-

tion and having a skeleton part in the passage through said housing of a diameter too great to enter said end portion, whereby movement of said valve element of the said end portion will be limited, and said valve element having a sealing cup expansible into sealing engagement with the walls of said end portion when forced thereinto by fluid under pressure tending to enter said end portion from said fitting, said skeleton-like part and the remainder of said valve being integrally joined together to form a dart-like element, said valve element having a streamlined upper end to facilitate flow of fluid downwardly past the same when said valve element is within that portion of the housing passage of larger diameter, and said packing cup having a flexible downwardly extending lip to permit ready passage of over-size solid objects.

8. In a back pressure valve for a drill pipe, a valve housing comprising a fitting adapted to be connected between adjacent sections of said drill pipe, said housing including an adjacent end portion of one of said sections and having a passage therethrough, a portion of which is of a diameter greater than the portion of the passage through said adjacent end portion, a valve element in said housing passage of a diameter less than the diameter of the passage through said end portion and having a skeleton part joined thereto and disposed in the passage through said housing, said skeleton part being of a diameter too great to enter said end portion, whereby movement of said valve element into said end portion will be limited, said valve element being formed in two separable parts and having an expansible sealing cup disposed between said parts and expansible into sealing engagement with the walls of said end portion when forced thereinto by fluid under pressure tending to enter said end portion from said fitting.

JAMES C. FORTUNE.