STUFFING BOX AND TOOL JOINT COMBINATION

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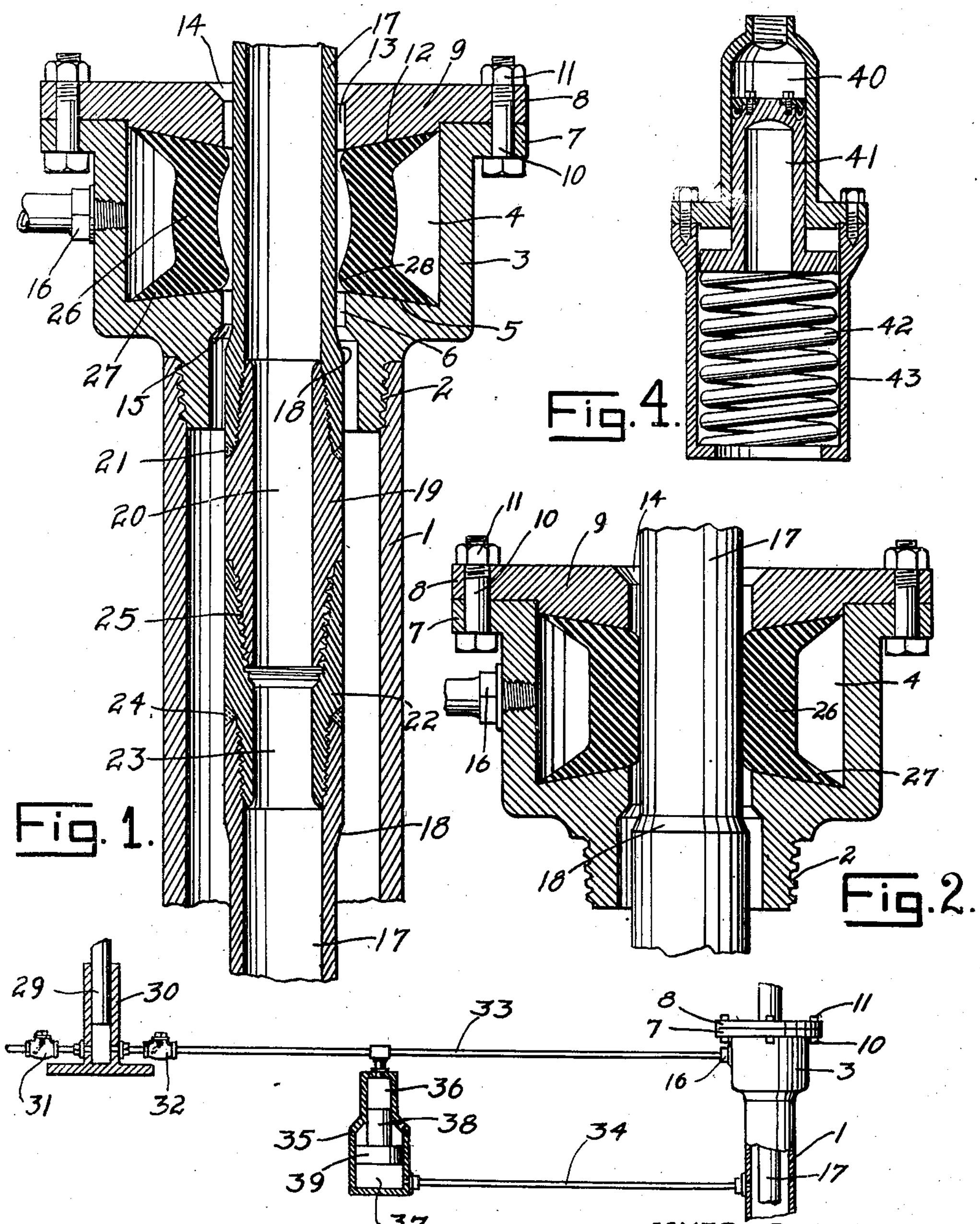

Fig. 1.

Fig. 4.

Fig. 2.

Fig. 3.

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STUFFING BOX AND TOOL JOINT COMBINATION

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This invention relates in general to well drilling equipment, and more particularly has reference to the construction and combination of a casing stuffing box and drill rod for use in rotary drilling.

Drill rods heretofore used in rotary drilling have either consisted of sections of pipe joined together by collar couplings, or flush-joint tubing in which the external diameter is the same throughout, the internal diameter being reduced at the ends to provide sufficient wall thickness at the joint to give the requisite strength.

Collar joint tubing has the objectionable feature that it is well nigh impossible for it to pass through a casing head stuffing box. Furthermore, in the uncased portion of the hole it produces what is known as "collar bind" if a cave-in occurs. The collars, because of their abrupt shoulders which project out a substantial distance from the pipe, also tend to scrape away the coat of sealing mud deposited on the walls of the hole from the drilling fluid.

Flush-joint rod, on the other hand, although not subject to the criticisms directed against collar joint tubing, has its own objectionable characteristics. Thus because of the reduction in internal diameter at the joints the resistance to passage of drilling fluid through the rod is greatly increased. Another disadvantage is that when pulling the drill rod it is difficult, particularly at night, to tell where the joints are. This slows up the pulling operation since each section must be engaged by suitable tongs and unscrewed as it comes out of the casing head. Still another disadvantage of flush-joint drill rod is that it does not clean a path for itself through the mud coating the walls of the bore and therefore sometimes binds in the hole.

Stuffing boxes have in the past been constructed so that they either would not pass a joint larger than the main portion of the pipe, or so that there was danger of pulling the packing out of the stuffing box during the movement of a drill rod therethrough.

A general object of this invention is to provide a stuffing box and drill rod which will facilitate rotary drilling operations and reduce their cost.

A further object is to provide a drill rod and a stuffing box which will be free from the objectionable characteristics of the prior art structures.

More specifically, it is an object of this invention to provide a combination of casing head packing box with a drill rod, both constructed in such a manner as to cooperate to the greatest advantage.

Another specific object of this invention is to provide a drill stem structure which will possess the necessary strength and the desired inner cross sectional area and still be capable of passing through a stuffing box.

It is a further object of this invention to provide a stuffing box in which the packing material will normally be under compression rather than under tension when sealed about a drill stem passing therethrough. It is also an object to provide a stuffing box capable of sealing about a drill stem and permitting the passage of tool joints of a larger diameter than said drill stem without stretching the material of the packing unduly either in tension or compression.

Another object of this invention is to provide a stuffing box construction for a casing head in which the degree of compression of the packing will be determined by fluid pressure, and to provide means for permitting said fluid to yield during the passage of a tool joint therethrough.

It is a further object to provide a packing box in which the degree of compression of the packing is controlled in accordance with the pressure existing within the casing.

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

In accordance with the present invention, we avoid to a large extent the objectionable features listed of prior drill rods by providing a novel drill rod joint construction in which the external diameter of the joint is slightly larger than that of the pipe but less than the diameter of a collar joint, with the external surface of the enlarged portion tapering gradually into the remainder of the pipe. Our construction necessitates only a slight diminution of the bore of the rod at the joint, thereby providing a relatively free fluid flow as compared to that obtainable in flush-joint construction. A stuffing box has also been provided in which the packing receptacle has openings large enough to permit passage of the joints referred to but not large enough to permit passage of a collar joint, and a special packing is placed therein especially constructed to cooperate with said receptacle and resist the tendency for it to be pulled through the annulus when a section of pipe between the joints is passing through the stuffing box. This packing is yieldingly urged to seal about the drill rod so that it may readily expand sufficiently to permit the passage of the drill joint referred to.

In the drawing:

Fig. 1 is a vertical cross section illustrating the stuffing box and drill stem combination constructed in accordance with this invention, the packing of the stuffing box in this instance being not sealed against the drill stem.

Fig. 2 is a view similar to the upper portion of Fig. 1 illustrating the packing in sealed position with respect to the drill stem.

Fig. 3 is a diagrammatic illustration of one means for regulating the degree of compression of the packing, parts of the construction being shown in section for purposes of illustration.

Fig. 4 is a vertical cross section of a modified form of regulating element for regulating the pressure of the fluid exerted upon the packing.

In Fig. 1 there is illustrated a well casing 1 which may be of any conventional design, and which is shown as internally threaded at 2 adjacent its upper end for the purpose of receiving the lower threaded pin portion of the packing box 3. It will be understood that any desired form of attachment can be employed between the casing 1 and the packing box 3.

The packing box 3 is provided with a chamber 4 forming a packing receptacle, the lower end wall 5 of this chamber sloping upwardly and inwardly toward the drill stem, and being apertured at 6 to provide for the passage of the drill stem. At its upper end, the packing box 3 is provided with an external flange 7 for the purpose of receiving the flange 8 of the head 9 of the stuffing box. These flanges 7 and 8 are secured together by means of bolts 10 having nuts 11 provided thereon. The lower surface of the head 9 which forms the upper end wall of the chamber 4 is inclined downwardly and inwardly as illustrated at 12, and is apertured at 13 to provide for the passage of the drill stem, this aperture 13 being in alignment with the aperture 6 in the lower end of the packing box. It is to be noted at this point that the disposition of the lower and upper end walls 5 and 12 with respect to each other will cause the packing chamber 4 to be of decreasing axial extent in a radially inward direction for a purpose which will be hereinafter set forth.

It is noted that the aperture 13 in the head 9 is provided with a countersunk tapered portion 14 at its upper end for the purpose of guiding the tool joints hereinafter described into the aperture 13 as the drill stem moves downwardly, and that the packing box 3 is likewise provided with a countersunk tapered portion 15 for exercising the same function as the drill stem moves upwardly. The packing box 3 is also provided adjacent its outer periphery with a fitting 16 communicating with the packing chamber 4 and adapted to supply fluid under pressure to said packing chamber in a manner which will be described.

The drill stem is composed of drill pipe sections 17 exteriorly upset adjacent their ends as illustrated at 18. One upset end of each drill pipe section is interiorly threaded for the purpose of receiving one of the tool joint sections 19. It will be noted that the tool joint section 19 is of the same external diameter as the upset end portion of the drill pipe section 17, but that its internal diameter as shown at 20 is somewhat smaller than the internal diameter of the drill pipe. It is not, however, as small as would be necessary if the external diameter were made the same as the diameter of the major portion of the drill pipe. Thus, there is formed a tool joint in which excessive throttling of the fluid passing therethrough will be avoided, and at the same time the external diameter of the tool joint will be held to a minimum. This tool joint section 19 after being screwed into place is preferably welded or otherwise secured to the drill pipe as shown at 21.

At the other end of each section of drill pipe the same is internally threaded to receive the other tool joint section 22. This second tool joint section is likewise of the same external diameter as the upset end portion of the drill pipe, and is of an internal diameter 23 corresponding to the internal diameter 20 of the section 19. Likewise also it is welded or otherwise secured as at 24 to the end of the drill pipe section 17.

It will be readily appreciated that the two sections 19 and 22 of the tool joint are complementary, one forming the box and the other the pin portion of the tool joint, and the threads 25 being provided for the interengagement of these sections in a well known manner.

It is to be noted that the externally upset end portions of the drill pipe sections do not form abrupt shoulders with the main portions of these sections, but that there is a tapered portion joining the portion of larger diameter with that of the smaller diameter.

Disposed within the packing chamber 4 there is a packing member 26 preferably formed of rubber or similar distortable material, and of annular channel-shaped formation. The intermediate or web portion of this channel-shaped cross section is of barrel shape, as will be readily seen in Fig. 1 when the packing is not otherwise distorted. The flanges of the channel-shaped cross section taper outwardly to a very thin or knife edge, as illustrated at 27 in the drawing, and the juncture between the inner surface of the web and the ends of the packing are filleted or curved as illustrated at 28.

Referring now to Fig. 3, there is illustrated a pump plunger 29 operating in a cylinder 30 having an intake valve 31 and an exhaust valve 32, and connected by means of a line 33 with the fitting 16 on the packing box, this pump construction being for the purpose of supplying the fluid under pressure to the packing box in the annular space surrounding the packing 26 so that the packing may be forced against the drill pipe to form a seal about the same as shown in Fig. 2. In Fig. 3, a second pipe line 34 is connected to the casing 1 at a point below the packing box 3, and at its opposite end is connected to a regulator mechanism 35 having an upper cylinder 36 and a lower cylinder 37, and having a compound piston the upper portion 38 of which is of a size to fit within the cylinder 36, and the lower portion 39 of which is of a size to fit within the cylinder 37. This pipe 34 is connected to the lower cylindrical portion 37, and the upper cylindrical portion 36 is connected to the pipe 33. It will be seen that any fluctuation in the pressure within the casing 1 will be transmitted through the pipe 34, and will cause the compound piston 38—39 to be either raised or lowered. It will further be seen that such raising or lowering of the compound piston will either raise or lower the pressure existing within the pipe 33 and the packing chamber 4. Thus, in this disclosure the pressure exerted against the packing will be dependent upon the pressure existing within the casing, and will fluctuate in accordance with the fluctuations of the casing pressure.

In Fig. 4 there is shown a device whereby the pressure maintained within the chamber 4 will be maintained at a constant value, instead of being controlled by the pressure within the casing as shown in Fig. 3. In Fig. 4 the upper cylindrical portion 40 would be connected to the line 33 in the place of upper cylindrical portion 36 of the regulator 35. Within this upper cylindrical portion 40 there is provided a piston 41, and this piston is constantly pressed upwardly by means of a spring 42. The spring 42 is confined within the chamber 43 provided for that purpose. It will readily be seen that the spring 42 would in this form of regulator determine the pressure of fluid being exerted on the packing 26, and will yield to accommodate the displacement of fluid when a tool joint is passing through the stuffing box.

In operation, after the drill stem has been inserted through the openings 13 and 6, pressure will be forced through the line 33 and into the packing chamber 4 by means of the pump piston 29 until the pressure within the packing chamber 4 reaches the desired value and the packing 26 is compressed against the drill pipe as illustrated in Fig. 2. It will be noted that the greater the pressure exerted against the packing 26, the more firmly the lips or flanges 27 will be pressed against the tapered end walls 5 and 12 of the packing chamber 4. It will further be noted that when this packing is forced into the position shown in Fig. 2, the material of the packing will be under pressure in a circumferential direction so that in the event any roughness is present on the drill stem which would cause cutting or abrasion of the packing, the tendency will be for this packing under compression to close any such cuts or abrasions rather than to open the same, as would be the case if the packing were under tension. This is because the packing in its normal shape has an inner diameter which is larger than the diameter of the main portion of the drill pipe.

It is further to be noted that when pressure is pressed upon this packing as described, the web or intermediate portion of the packing will move toward the drill pipe, but that the flanges 27, being pressed against the tapered end walls by the pressure of the fluid and having considerable friction with those end walls, in addition to the fact that they are held by the very shape of the end walls, will not be moved appreciably toward the drill stem. Instead, the movement of the intermediate portion will simply cause a distortion adjacent the flanges so that the intermediate portion will move into contact with the drill stem without movement of the flanges.

When the drill stem is moved upwardly or downwardly so that one of the joints approaches the stuffing box, such joint will be guided into the aperture 6 or 13 by the tapered portion 15 or 14, as the case may be. This tool joint will then enter the opening in the packing and because of the tapered shape at the end of the enlargement of the tool joint and the curved or filleted corner on the packing, it will be enabled to enter the packing itself and cause the expansion of the packing. Since the packing is normally of larger internal diameter than the external diameter of the drill pipe, the first portion of this movement will simply be an expansion of the packing to its normal size. However, the minimum normal internal diameter of the packing is less than the external diameter of the tool joint so that when the tool joint has fully entered the packing, portions of the packing will be expanded beyond their normal size so as to accommodate the tool joint. All this movement of the packing takes place through movement of the web and distortion of the material of the packing without movement of the flanges thereof. Because of the fact that the packing when surrounding the drill pipe proper is under compression, and when surrounding the tool joints is under tension, the packing will be distorted from its normal shape by the least possible amount upon passage of a tool joint. Preferably, the minimum internal diameter of the packing is midway between the external diameter of the drill pipe and the external diameter of a tool joint, so that when the packing surrounds the drill pipe it will be compressed by substantially the same amount that it will be expanded when it surrounds the tool joint.

From the above it will be seen that since the external diameter of our rod at the joints is only slightly greater than the diameter intermediate of the joints and that the joint portions taper smoothly into the intermediate portions, the joints pass much more readily through the casing head stuffing box referred to, the rod is less subject to collar-bind in case of a cave-in, and does not scrape away the sealing mud from the walls of the hole to an appreciable extent. As previously indicated, our joint construction has the substantial advantage over previously known flush-joint rod in that the internal bore is substantially greater at the joints, thereby reducing the resistance to flow of the drilling fluid. Our construction has the further advantage over flush-joint tubing that there is no difficulty in ascertaining where the joints are located when the rod is pulled. By virtue of their slightly increased diameter, the joint sections of our rod clean a path for the major portion of the rod through the mud coating the walls of the bore hole.

Thus it will be seen that a means has been provided for carrying out all the objects and advantages of this invention, and that there has been provided a tool joint and stuffing box each of which is constructed for cooperation with the other.

Having described our invention, we claim:

1. In a well equipment, a casing, a packing receptacle thereon having a packing chamber therein of decreasing axial extent in a radially inward direction, a drill stem passing through said receptacle, a packing within said receptacle and adapted to seal about said drill stem, said packing being of decreasing axial extent in a radially inward direction, and having its end surfaces bearing against the inner end walls of said chamber, said packing intermediate its ends being normally bulged radially outwardly, and means for yieldingly urging said packing radially inwardly to cause the packing to seal about the drill stem.

2. In a well equipment, a casing, a packing receptacle thereon having a packing chamber therein of decreasing axial extent in a radially inward direction, a drill stem passing through said receptacle, a packing within said receptacle and adapted to seal about said drill stem, said

packing being of decreasing axial extent in a radially inward direction and having its end surfaces bearing against the inner end walls of said chamber, the packing intermediate its ends being normally bulged radially outwardly, and the ends of said packing having sealing lips extending radially outwardly to seal against the end walls of said chamber, and means for introducing fluid under pressure in said chamber about said packing to urge the packing radially inwardly and to cause it to seal about said drill stem.

3. In a well equipment, a casing, a packing receptacle thereon having a packing chamber therein of decreasing axial extent in a radially inward direction, a drill stem passing through said receptacle, a packing within said receptacle and adapted to seal about said drill stem, said packing being of decreasing axial extent in a radially inward direction and having its end surfaces bearing against the inner end walls of said chamber, the packing intermediate its ends being normally bulged radially outwardly, the ends of said packing having sealing lips extending radially outwardly to seal against the end walls of said chamber, the edges of said packing at the ends of the opening through which said drill stem passes being rounded to prevent portions of said packing from being squeezed into the openings through the end walls of said packing receptacle when said drill stem is drawn therethrough, and means for introducing fluid under pressure in said chamber about said packing to urge the packing radially inwardly and to cause it to seal about said drill stem.

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