May 27, 1941.

F. W. HILD

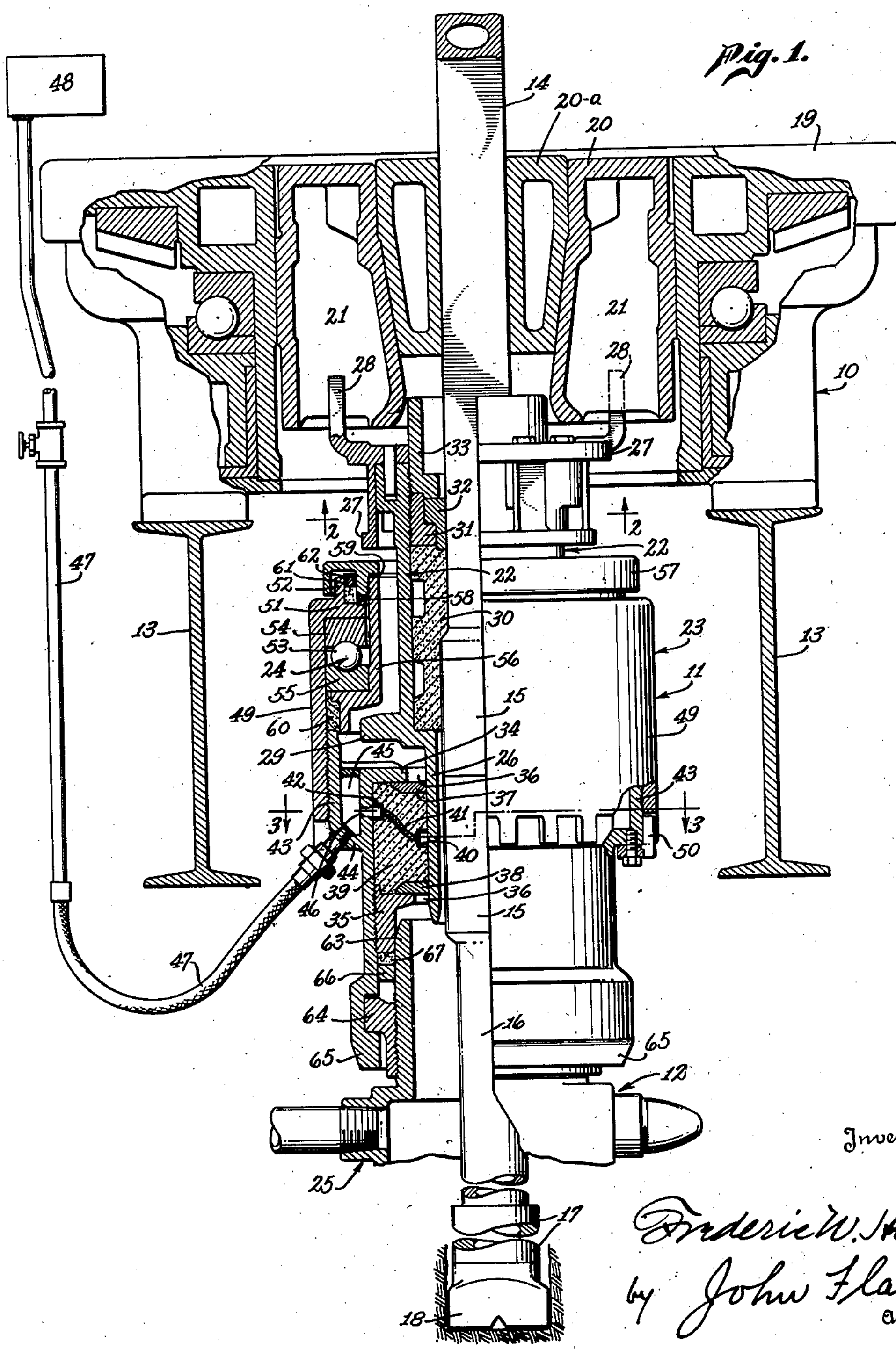
2,243,340

ROTARY BLOWOUT PREVENTER

Filed May 23, 1938

2 Sheets-Sheet 1

Fig. 1.



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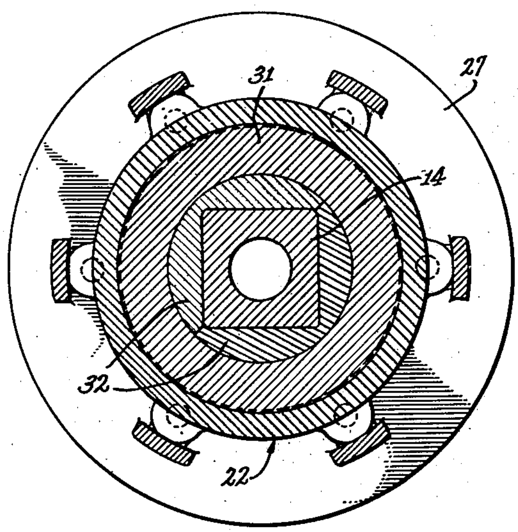

Fig. 2.

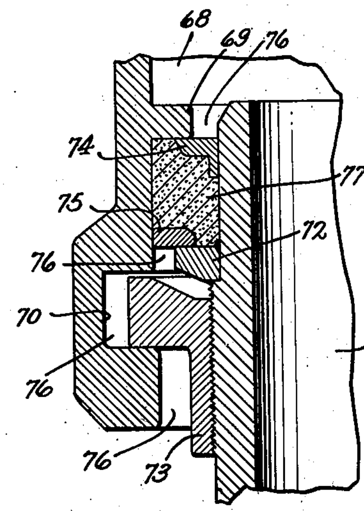

Fig. 4.

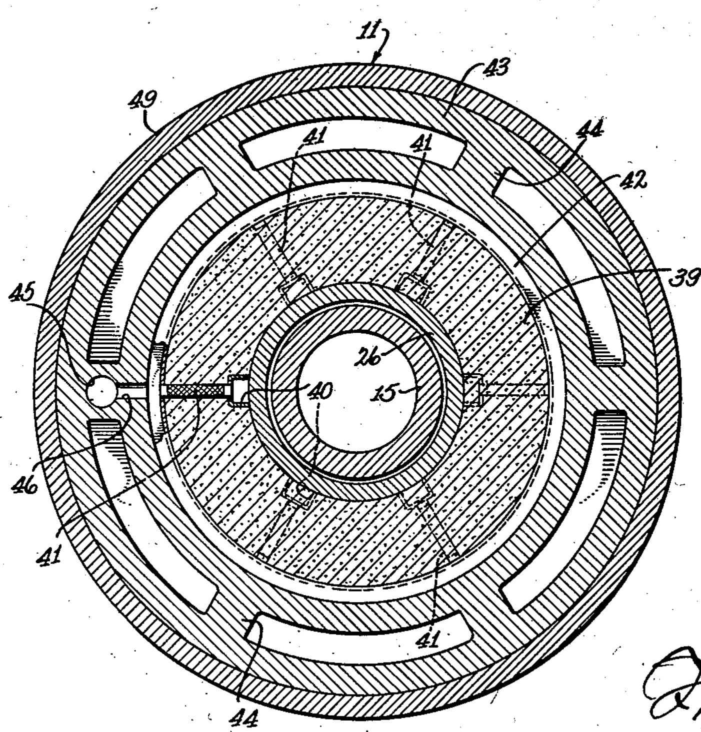

Fig. 3.

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Patented May 27, 1941 2,243,340

UNITED STATES PATENT OFFICE

2,243,340

ROTARY BLOWOUT PREVENTER

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Application May 23, 1938, Serial No. 209,540

5 Claims. (Cl. 255—1)

This invention relates to blowout prevention and more particularly to rotating preventers for the drill string during pressure drilling. This application is a continuation in part of my copending applications, Serial No. 747,339, filed October 8, 1934 and entitled Blow-out preventer, now Patent No. 2,207,149, granted July 9, 1940, and Serial No. 91,554, filed July 20, 1936, entitled Pressure drilling control, and Serial No. 138,995, filed April 6, 1937, and entitled Blow-out preventer, now Patent No. 2,207,199, granted July 9, 1940.

A common and serious difficulty encountered in well drilling by the rotary method is misalignment of the drill string with respect to the casing. Another very great difficulty is to effect and maintain seal on members having relative movement in high well pressures that may attain values of the order of 3,000 pounds per square inch. It is an object of the present invention to provide a rotating preventer that will allow ample misalignment and also maintain seal on the drill string against the high well pressures.

Misalignment is usually one or more of three principal kinds of departure from coincidence of the drill string axis with the casing axis. There are:

(1) The axes of the casing and the rotating drill string may be parallel.

(2) The axes of the casing and the drill string may be inclined and form an angle with each other.

(3) The kelly may be bent (a not unusual circumstance) whence the Kelly axis would describe a circular path for each revolution; that is the kelly rotation would be gyratory.

(4) The bent kelly may also have parallel or angular misalignment.

The rotating preventer being the topmost member of the casing control column and intended to effect fluid tight closure on the revolving kelly, obviously receives the brunt of the stresses due to the misalignment. These stresses may be transmitted to the other members of the control column down to the anchored casingheads unless provision is made to absorb them.

The most important and longest step in the solution of the problem of allowing for and sealing on the misaligned or non-centric kelly is the elimination from the rotating preventer of metallic radial bearings, as disclosed in both of my aforesaid co-pending applications both of which teach the use of the resilient packer as the radial bearing for the rotative or drill string bushing of the preventer.

In my aforesaid co-pending application, Serial No. 138,995 is shown and described a rotating preventer having a rotative packer bushing for the drill string suspended from and rotated by the master drive bushing of the rotary drilling machine, and utilizing the bearings of the rotary machine for taking the vertical thrust of the rotative packer bushing, the latter bushing being journaled in a resilient stationary packer of the preventer and having no other radial bearings.

All rotary drilling machines have bearings which will take heavy down thrust forces and also moderate up thrust forces; but not all rotaries are designed to take large up thrust forces such as might be caused by high well pressures acting on the rotative drill string bushing. It is an object of the present invention to provide a rotating preventer having a drill string bushing adapted to engage and be rotated by the rotary drilling machine and having its own set of thrust bearings for taking vertical thrust independently of the rotary machine bearings.

It has long been recognized that one of the most troublesome and serious difficulties encountered in well drilling equipment is the requirement for a satisfactory packing against the well fluid pressures, and against fluids which usually carry gritty and abrasive particles, and particularly where it is necessary to seal between members having relative motion. When, in addition, clearance space must be allowed between metallic parts of a packer, as for example, to pass objects of different diameters like drill pipe having outside couplings, the sealing capacity is obviously less and the packer is limited to moderate fluid pressures. This is a controlling reason why the operators perforce have had to use the less favored flush joint drill pipe with outside couplings, for casinghead pressures above 250 pounds per square inch.

Flush joint pipe and the round kelly permit the use of the conventional non-rotatable stuffing box having rubber packing and metallic glands or followers. However, the gripping devices for rotating the round kelly scarify and roughen the Kelly surface which, while rotating and passing through the stuffing box, cuts and greatly wears the packing, resulting in lessening the effectiveness of seal and lowering the pressure holding capacity.

When to all the foregoing packing difficulties is added the further complication caused by misalignment of the drill string and kelly, the problem has seemed hitherto insuperable. The present invention overcomes the apparently insuperable and provides a packer arranged to allow for the aforesaid misalignment, and having means for maintaining seal against very high well pressures on members having relative movement. Another object is to provide a like packer for non-rotative members.

Other objects, advantages and benefits will become apparent from the following description and the accompanying drawings, in which:

Figure 1 is an elevational view in part section showing an embodiment of the invention in conjunction with a rotary drilling machine;

Fig. 2 is a horizontal section on the line **2—2** of Fig. 1;

Fig. 3 is a horizontal section on the line **3—3** of Fig. 1;

Figure 4 shows an arrangement of the flexible high pressure universal joint for two members between which there is no relative rotation.

Referring to Figures 1, 2 and 3, the rotary drilling machine **10** is in driving engagement with the rotating preventer **11**, the latter being the topmost member of the casing control column **12**. The rotary machine rests on the derrick floor beams **13**. The drill string comprising the kelly **14**, the couplings or tool joints **15**, the drill pipe **16** and the drill collar **17**, extends through the machine, the preventer, the control column and into the well. A bit **18** is secured to the lower end of the drill collar.

Seated in the turn table **19** of the rotary machine is the conventional split, master drive bushing **20** which is adapted to receive the usual Kelly bushing **20***a*, for driving the kelly rotatively. The master drive bushing **20** comprises two castings, the lower portion of each being cored hollow and having suitable vertical webs or ribs **21**.

The rotating preventer **11** comprises the rotatable drill string bushing **22**, the stationary packinghead **23** into which the bushing **22** extends and is journaled, and the detachable thrust unitary bearing structure **24** on the packinghead for receiving the vertical thrust and limiting the vertical movement of the bushing **22**. The packinghead **23** may be detachably secured to the next lower member of the control column, as for example the flow cross **25**. The drill string bushing **22** is slidably mounted on and seals on the drill string. The packinghead **23** receives the lower and smallest diametered portion or journal **26** of the bushing **22**, effecting seal thereon and providing a radial bearing for it.

Secured to the upper end of the bushing **22** is the down thrust ring **27** which has upwardly extending horns **28** that project into the hollow spaces of drive bushing **20**, so as to intercept the vertical ribs **21**. The drill string bushing **22** has an outwardly extending flange **29** located at the upper end of journal **26** for transmitting upward thrust. Both thrust ring **27** and thrust flange **29** are disposed so as to be intercepted by the thrust bearings **24**.

Within the drill string bushing **22** is the packer **30** for sealing on the drill string and is substantially the same as that shown and described in my aforesaid co-pending application Serial No. 138,995. The packer **30** which is forced onto the drill string and into the packer bushing **22**, obviously has inherent sealing fit on both due to its own natural resiliency. The surface of the packer **30**, which bears against the inner wall of rotatable bushing **22**, is recessed to provide openings or spaces into which the packer material may flow when the drill string members, with their different shapes and diameters are forced through the packer. The packer at its lower end is exposed to well pressure which also adds to the sealing effect. But primarily and essentially, the sealing pressure of the packer **30** is mechanical, being caused by laterally directed mechanical pressure due to the reactive forces of the drill string transmitted through the resilient packer to the bushing, in brief, the packer is squeezed by the drill string and the bushing **22**.

The packer is held in place by a threaded flanged retainer **31** which is screwed into the upper end of the drill string bushing. The retainer flange is bored for sliding fit on the couplings and tool joints **15** and the drill collar **17** all of which in practice have the same diameter for a given size of drill pipe. Thus when a coupling, tool joint or drill collar is in the bushing, the small clearance of the sliding fit prevents escaping "flow" of the rubber of the packer by even the highest well pressure.

When the kelly **14** is in the bushing **22**, a split washer **32** having sliding fit on the kelly is inserted into the retainer **31**. The split washer is held in place by threaded locking ring **33** which also serves as a jam nut on the retainer **31**. Here also, the clearances are sufficiently small that the packer rubber is confined against escaping flow no matter what the well pressure may be on it. Inasmuch as the drive bushing **20** rotates both the kelly and the drill string bushing **22**, it is evident that there is no torque effort on the packer **30** nor the other parts intervening between the drill string and the drill string bushing.

The stationary packinghead **23** has an upper flange **34** and also a lower threaded flange **35**, both flanges projecting inwardly toward the journal **26** of the drill string bushing, but allowing substantial clearance space **36** for lateral and angular deviation of the drill string bushing **22**. An upper float ring **37** bears against the underside of head flange **34**; and a lower float ring **38** bears against the upperside of threaded flange **35**, both float rings have bearing or sliding contacts on the journal **26**. Between the two flanges and their respective float rings is the packing **39** which seals on the journal **26** and serves as a resilient radial bearing for the rotative drill string bushing **22**. The lower threaded flange **35** may be utilized for compressing the packing **39** to the desired sealing contact on the journal **25**. It is plain that the packing **39** is so fully confined that escaping flow of the packing rubber cannot occur no matter how great the well pressure and no matter how far the bushing **22** may be displaced laterally or angularly with respect to the head **23**.

Provision for lubricating and cooling the rubbing surfaces of the packing **39** and the journal **26** is similar to that shown and described in my aforesaid co-pending application. However, the present arrangement embodied certain improvements so as to adequately withstand the compressive force of the high well pressures which might squeeze the lubrication spaces in packer **39**. First the several lubricating pockets or recesses in the face of the packing **39** contain metallic thimbles **40** which are connected by the flexible metallic conduits **41** to a common metallic channel ring **42** which is positioned on the packing head **39** at the inner bore of head **23**.

The head has an outer cylindrical shell 43 which is joined to the inner portion of the head by webs 44. A hole 45 in one of these webs communicates with a hole 46 leading into the channel ring 42. A pipe 47 threaded into the hole 45 leads a suitable supply of lubricant from a tank 48 to the thimbles 40.

The thrust bearing structure 24 comprises the body 49 which is threaded onto the shell 43. The lower end of the body has slots like a castellated nut so that a lug 50 may be inserted into one of the slots and also bolted to the shell 43, thus locking the threaded body and the shell against relative rotation. The body 49 has at its upper end an inwardly extending flange 51 from the top of which a cylindrical collar 52 projects upwardly.

Within the body 49 are the ball bearings 53 for upthrust duty, and comprising the stationary race 54 against the underside of flange 51, then the balls and then the revolving race 55. The races and balls are enclosed within the body 49 by the rotatable thrust shell 56 to which is secured the revolving race 55. The thrust shell at the top has threaded into it the cap 57, the two rotating together as one. A bronze disc bearing 58 transmits down thrust from the cap 57 to the body flange 51. The cap 57, together with shims 59 between the cap and the shell, enable correct adjustment of the bearings. For excluding mud and other foreign material from the bearings, a packing 60 between thrust shell 56, body 49 and packing head 23 perform this duty at the lower end of the bearings group; and packing 61 and gland 62 between the cap 57 and the collar 52 perform this service at the upper part of the group.

The packinghead 23 at its lower end is detachably secured to the flow cross 25 by a threaded breech lock of the type described and claimed in my co-pending application, Serial No. 747,339, filed October 8, 1934. The flow cross has an upwardly extending collar 63 on which is threaded the inner breech lock member 64. The lower end of packinghead 23 forms the outer breech lock member 65. Welded to the flow cross collar 63 and above the breech lock thread is an outwardly extending flange 66. Resting on this flange and interposed between the flow cross collar and the packinghead 23 is a packing 67, which bears against the lower end of the threaded flange 35 of the packinghead. Rotation of the packinghead first engages the breech lock and continued rotation forces one packing 67 into effective seal.

Figure 4 shows a flexible packing joint in which an upper member 68 of the casing control column 12 has inwardly projecting flange 69, the member at its lower end forming the outer half of breech lock 70. The next lower member 71 of the control column normally in axial alignment with member 68, has a shoulder 72 extending outwardly toward the member 68. Below this shoulder the lower member is threaded to receive the threaded collar 73 which constitutes the inner half of the breech lock. An upper float ring 74 has sliding fit on member 71 and also bears against the underside of flange 69 of member 68. A lower float ring 75 has sliding fit on member 69 and also bears against the upper side of shoulder 72 of member 71. Spaces 76 indicate the normal horizontal clearance between members 68 with its float ring 75 on the one hand, and member 71, float ring 75 and breech lock 73 on the other hand.

Interposed between the flange 69 and the shoulder 72 and their respective float rings, is the resilient rubber packing 77. Rotation of either member 68 or 71 or breech lock collar 73, first engages the breech lock and continued rotation forces the packing 77 into effective seal on both members 68 and 71. Should either or both members 68 or 71 be forced out of normal axial alignment, the resultant displacement is cumulative upwardly, so that with several flexible joints in the control column, a considerable permissive departure from axial co-incidence is thereby provided for the top member without breaking the seal and without loss of pressure.

Referring to Fig. 1, the Kelley bushing *20a* may be any conventional gripping device for rotating the kelly, whether square, slotted or round, and since there is no relative rotation between the kelly 14 and the rotative bushing 22, the packer 30 is not subject to the cutting and wear such as commonly experienced with other types of preventer for the rotating drill stem or kelly. It is manifest that the rotating preventer herein described may be used with either conventional or flush joint drill pipe or a mixed string of both kinds of pipe, and with square, slotted or round kelly; and moreover will permit large deviation of the Kelly axis and yet maintain effective seal for the highest well pressures.

What is claimed is:

1. In a preventer for a drill string, adapted to be associated with a rotary drilling machine, a rotatable bushing having packing adapted to seal on said string, a stationary packer for sealing on the rotative bushing and having anti-friction bearing means arranged to allow substantial displacement of the rotative bushing in any direction, said rotative bushing having engaging means adapted to engage a rotative member of the rotary machine in a manner to permit said displacement.

2. In a preventer for a drill string adapted to be associated with a rotary drilling machine having means for gripping and rotating said string, a rotative bushing having a packing adapted to seal on said string, a stationary packer for sealing on the bushing and having thrust bearings for limiting the vertical movement of the rotative bushing, said bushing having intercepting means adapted to engage a rotative element of the rotary drilling machine for rotating said bushing.

3. In a preventer for a drill pipe having an angular faced kelly, a rotative bushing, conformable packing in the bushing adapted to pass the pipe and the kelly and to maintain seal thereon against well pressure during said passage, confining means in the bushing for confining the packing against undesired distortion by said pressure, said confining means comprising a retainer bored for sliding fit on the couplings of said pipe, and a filler member having sliding fit on the kelly, said filler member being removable for passing the pipe.

4. In a rotating casing head structure for use in rotary drilling operation in a well, the combination of an outer casing head member arranged to be secured to a well casing, a sleeve rotatably supported in said outer casing head, a rotary drill string extending through said sleeve, a packing between the sleeve and said drill string, and independent means for imparting rotary movement directly to said sleeve and directly to

said drill string to prevent relative rotary movement therebetween.

5. In rotary well drilling apparatus the combination of a casing head arranged to be secured to a well casing, a sleeve rotatably supported in said casing head, a rotary driving mechanism mounted above said casing head, a driving connection between said driving mechanism and said sleeve, a rotary drill string extending into the well through said sleeve, a direct driving connection between the drill string and said driving mechanism, and a packing in said sleeve for sealing the drill string.

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