March 25, 1941. G. D. JOHNSON 2,236,177

CONTROL VALVE FOR WELLS

Filed Dec. 21, 1936 3 Sheets-Sheet 1

Fig. 1.

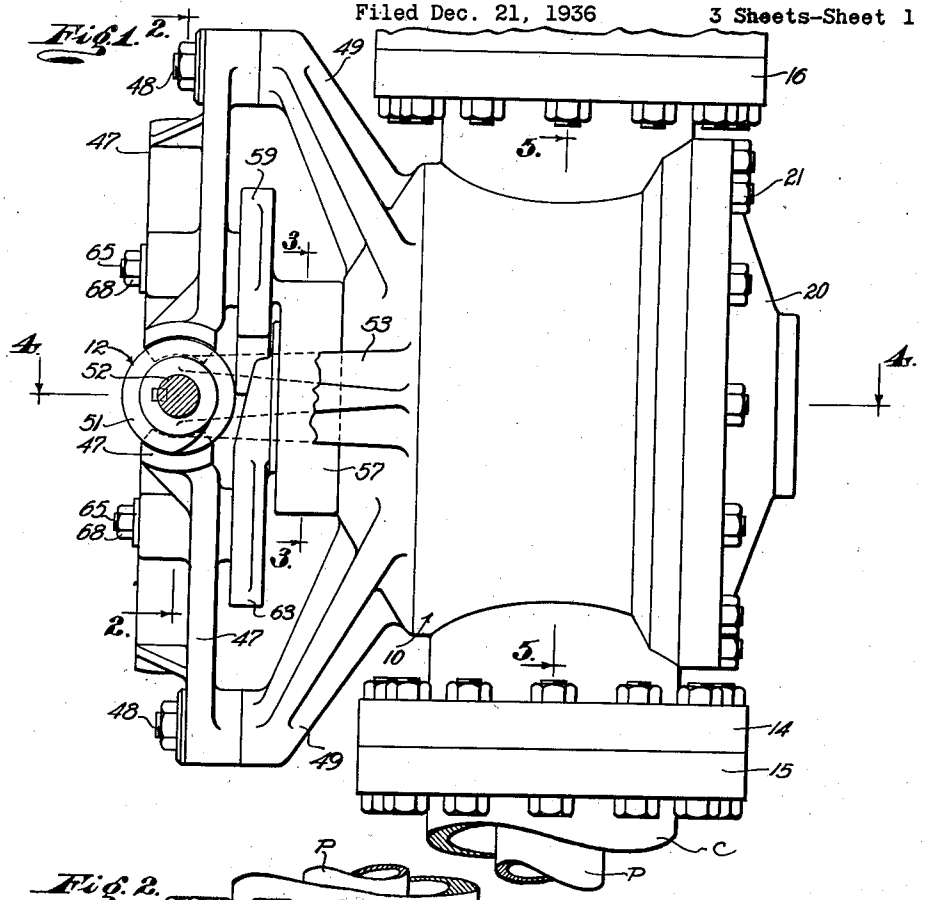


Fig. 2.

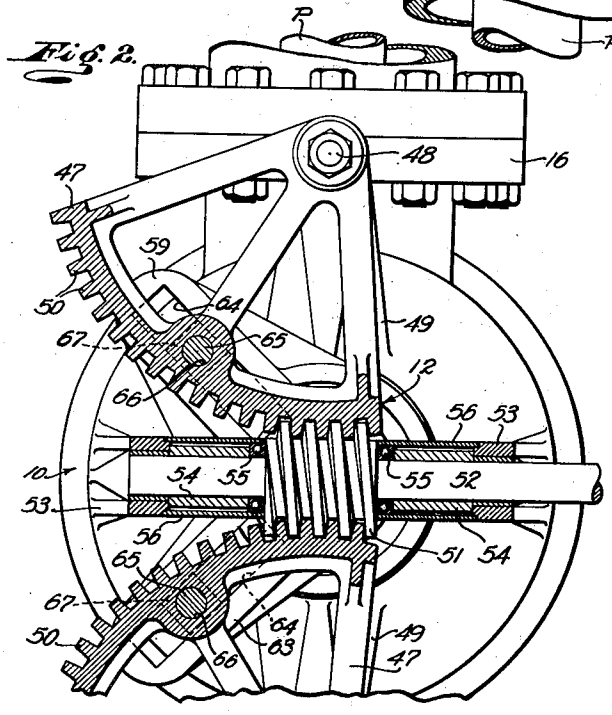
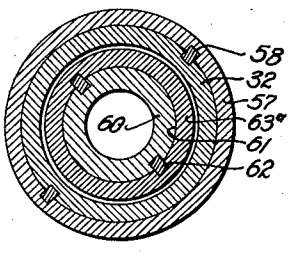


Fig. 3.



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Fig. 4.

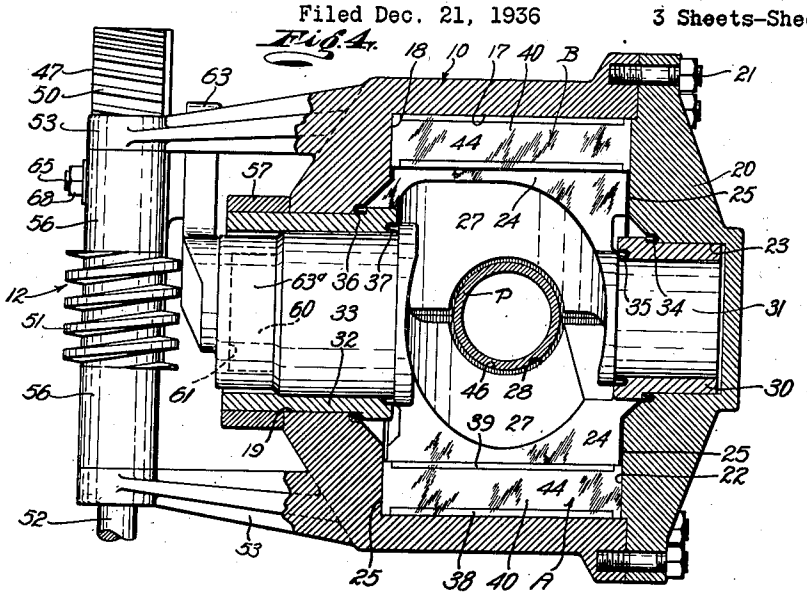
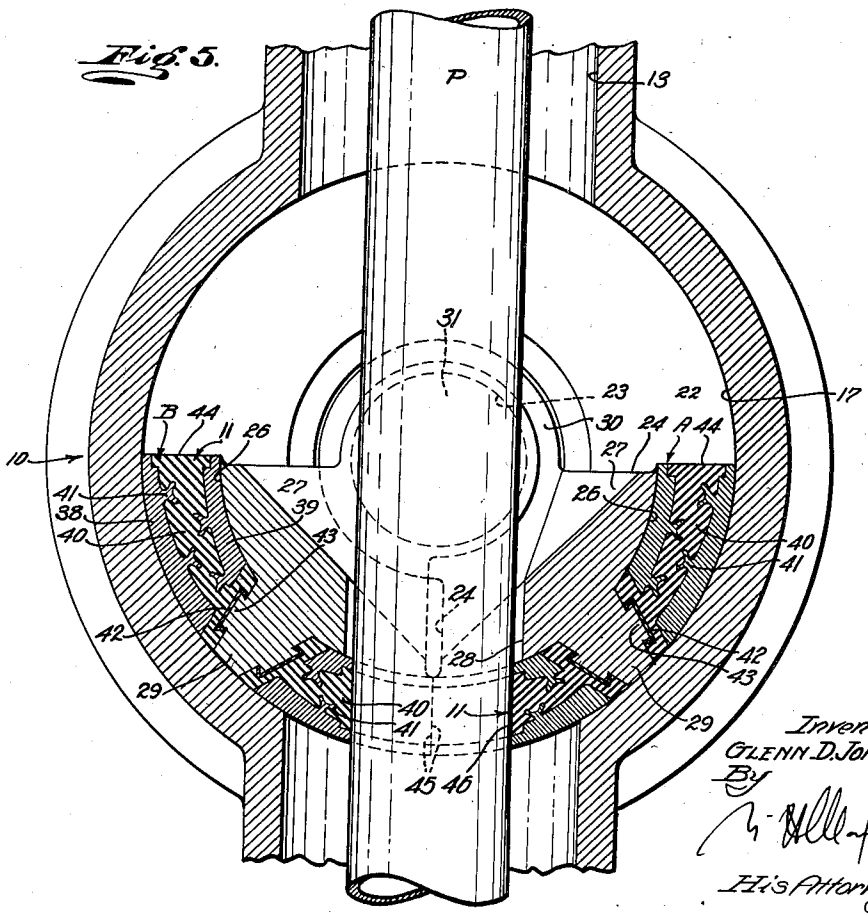


Fig. 5.



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Fig. 6.

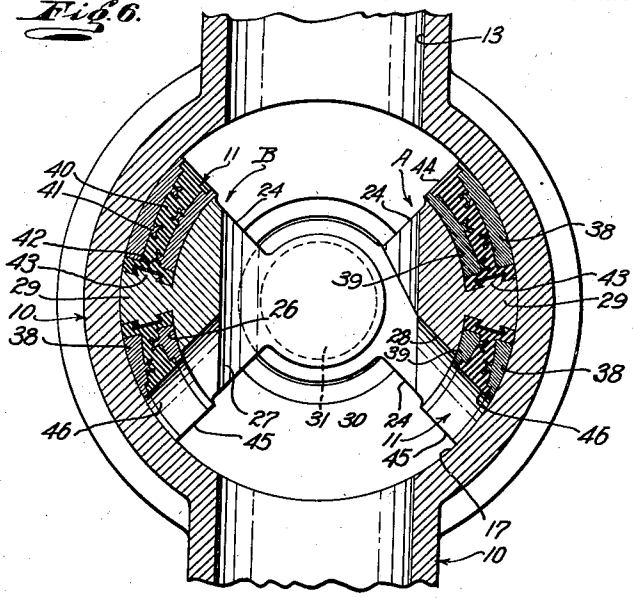


Fig. 7.

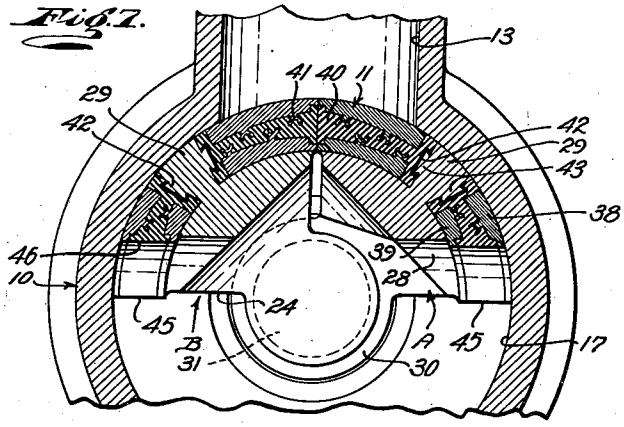
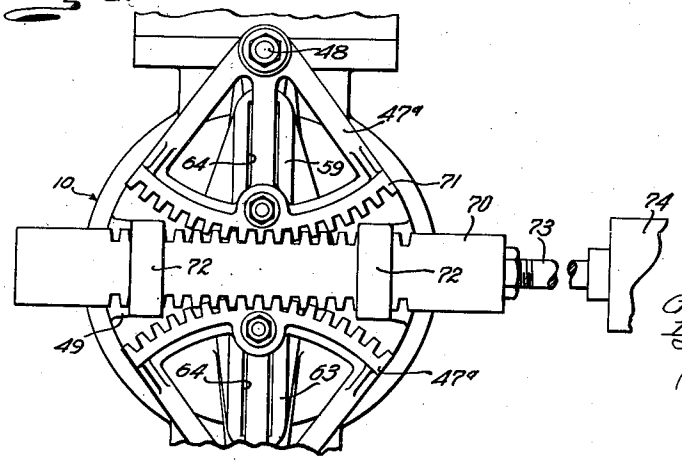


Fig. 8.



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UNITED STATES PATENT OFFICE

2,236,177

CONTROL VALVE FOR WELLS

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Application December 21, 1936, Serial No. 116,872

5 Claims. (Cl. 251—18)

This invention relates to well equipment and relates more particularly to a control gate or control valve for a well. A general object of this invention is to provide a simple, practical and dependable control gate or control valve for a well that is operable to control or prevent the discharge of fluid from the well when the drill pipe is extending into the well and when the drill pipe is removed from the well.

In deep well drilling operations it is the general practice to equip the upper end of the well casing with a large gate or valve operable to close off the casing when the drill pipe is removed from the well and a second gate or control valve for closing off the casing and for packing about the drill pipe when the latter extends into the casing. These two valve structures or gates are very costly and occupy substantial space in the upper end of the casing necessitating a deep cellar at the derrick or special means for mounting the drilling equipment.

Another object of this invention is to provide a single compact control gate for a well casing that is operable to control or shut in the well when the drill pipe is extending into the casing and when the drill pipe is removed from the casing. The single valve or gate of the present invention is capable of dependably performing the functions of the two gates heretofore usually employed on well casings and yet is inexpensive and occupies a minimum of space at the upper end of the casing.

Another object of this invention is to provide a control gate or valve of the character mentioned that embodies novel closure elements that are mounted and shaped to leave the passage through the well casing entirely unobstructed when in the open or intermediate position and that are operable to fully close off the upper end of the casing when the drill pipe is out of the casing and to effectively seal about the drill pipe to close off the casing when the pipe is extending into the well.

Another object of this invention is to provide a control gate or valve of the character mentioned in which the closure members or valve members are provided with practical effective packing means for packing with the interior of the housing, for packing between the two valve members and for packing about the drill pipe when necessary.

Another object of this invention is to provide a casing gate or valve of the character mentioned in which the packing material on the closure members is efficiently confined by floating plates.

Another object of this invention is to provide an improved control head or valve of the character mentioned in which the packing assemblies of the valve members may be removed and replaced without dismantling the entire structure.

A further object of this invention is to provide an improved gate or valve for a well casing that is simple and inexpensive and that is easily installed and serviced.

The various objects and features of my invention will be fully understood from the following detailed description of typical preferred forms and applications of my invention, throughout which description reference is made to the accompanying drawings, in which:

Fig. 1 is a side elevation of one form of the casing valve of the invention. Fig. 2 is a fragmentary vertical, detailed, sectional view taken as indicated by line 2—2 on Fig. 1. Fig. 3 is a vertical, detailed sectional view taken as indicated by line 3—3 on Fig. 1. Fig. 4 is a horizontal detailed sectional view taken as indicated by line 4—4 on Fig. 1 showing the worm in elevation and illustrating the valve members sealing about the drill pipe. Fig. 5 is an enlarged fragmentary vertical detailed sectional view taken as indicated by line 5—5 on Fig. 1 showing the valve members packing about the drill pipe. Fig. 6 is a reduced view similar to Fig. 5 showing the valve members in the intermediate position. Fig. 7 is a view similar to Fig. 5 showing the valve members in the closed position when there is no drill pipe extending into the casing, and Fig. 8 is a reduced side elevation view illustrating another form of operating means.

The embodiment of the present invention illustrated in Figs. 1 to 7, inclusive, of the drawings includes, generally, a housing or body 10 to be applied to the upper end of a well casing C, oscillating closure members or valve members A and B in the body 10, packing means 11 on the valve members A and B and means 12 for shifting or operating the valve members A and B.

The housing or body 10 is a hollow or chambered structure intended to be connected with the upper end of the well casing C. The body is provided with a longitudinal or vertical opening 13 to register with the opening in the well casing. The opening 13 extends completely through the body 10 and is preferably cylindrical and of substantially the same diameter as the opening in the casing C. Suitable means is provided for connecting the body 10 with the casing C. In the structure illustrated, a flange 14 is provided on the lower end of the body 10 and is bolted to a

similar flange 15 on the upper end of the casing C. A flange 16 may be provided on the upper end of the body 10 around the opening 13 to facilitate the connection of fittings, etc., with the body.

In accordance with the invention the body 10 is provided with a transverse opening 17 intersecting the opening 13. The longitudinal axis of the opening 17 is preferably at right angles to the axis of the opening 13. The transverse opening 17 is relatively large in diameter and is preferably cylindrical. The opening 17 enters one side of the body 10 and a flat, substantially vertical wall 18 occurs at its inner end. An opening 19 of reduced diameter and in concentric relation to the opening 17 extends into the body 10 to have its inner end at the wall 18. The outer end of the transverse opening 17 is closed by a head or cap 20. The cap 20 may be removably secured to the body 10 by bolts or studs 21. The inner side of the cap 20 presents a flat, substantially vertical wall 22 at the end of the opening 17. A cylindrical socket 23 is provided in the inner side of the cap 20 in concentric relation with the opening 17. The large transverse opening 17 in the body 10 is provided to receive the valve members A and B while the opening 19 and the socket 23 are provided to receive the shafts or trunnions of the members, as will be hereinafter described.

The closure elements or valve members A and B are provided to close off the opening 13 communicating with the upper end of the casing C in the event that high pressures suddenly develop in the well. The valve members A and B are alike or complementary in shape and have the general configuration of sectors of an annulus or ring. The sides 24 of the members A and B are generally flat and are radial relative to the longitudinal axis of the opening 17. The ends 25 of the members A and B are flat and substantially parallel to the adjacent opposing end walls 18 and 22 of the opening 17. The outer sides or peripheries 26 of the members A and B are cylindrically curved and are concentric with the cylindrically curved wall of the opening 17. It is a feature that the inner sides or interiors of the members A and B have grooves 27 with cylindrically curved walls that are concentric with and coincident with or outward of the cylindrical plane of the wall of the opening 13 when the members A and B are in their open or intermediate positions illustrated in Fig. 6 of the drawings. When the members A and B are in the positions illustrated in Fig. 6 the notches or grooves 27 in effect constitute continuations of the opening 13 so that drill pipe and other equipment may be operated through the casing C without interference. The lower sides of the members A and B are provided with complementary grooves 28 having cylindrically curved walls. The grooves 28 are adapted to more or less freely receive the drill pipe P when the members A and B are in the operative positions illustrated in Figs. 4 and 5 of the drawings. An axially extending rib 29 projects from the periphery 26 of each member A and B. The ribs 29 are located substantially midway between the sides 24 of the members. The outer surfaces of the ribs 29 may be cylindrically curved and may slidably engage the wall of the body opening 17. The sides of the projecting ribs 29 preferably converge inwardly toward the longitudinal axis of the body opening 17.

The invention provides effective means for supporting the members A and B for oscillatory movement about a common horizontal axis coincident with the axis of the opening 17. The valve member A is provided with a tubular boss or trunnion 30 rotatable or turnable in the above described socket 23. The trunnion 30 is rigid with the member A and in practice may be integral with the member A. The valve member B is provided with a horizontally projecting stub shaft or trunnion 31 turnable in the opening of the tubular trunnion 30. The trunnion 31 may be integral with the member B. The end of the member B adjacent or opposing the wall 18 has a horizontally projecting tubular trunnion 32 rotatably or turnable in the opening 19. The trunnion 32 is rigid with the member B and may be integral with the member. The tubular trunnion 32 extends completely through the opening 19 to project from the exterior of the body 10. The valve member A is provided with a horizontally projecting shaft or trunnion 33 turnable in the tubular trunnion 32. The trunnion 33 extends completely through the trunnion 32 and may be integral with the member A. From the above it will be seen that the two valve members A and B have telescopically arranged journals or trunnions supporting them for oscillatory movement about the longitudinal axis of the opening 17.

The invention preferably includes means for sealing about the supporting parts or trunnions of the members A and B. A channeled sealing leather or washer 34 is recessed in the inner portion of the opening 23 to seal about the trunnion 30. The inner wall 22 of the cap 20 may be bevelled outwardly to the washer 34 and the trunnion 30 may be shouldered at the washer 34 as illustrated. A similar channeled washer 35 is recessed in the inner end of the trunnion 30 to seal about the trunnion 31. A grooved or channeled sealing washer 36 is recessed in the inner portion of the opening 19 to pack about the inner part of the trunnion 32. The body wall 18 may be bevelled outwardly to the washer 36 and the trunnion 32 may be shouldered at or adjacent the washer. A similar channeled washer 37 is recessed in the inner end of the trunnion 32 to seal about the trunnion 33. The washers 34, 35, 36 and 37 are expanded or conditioned by internal fluid pressures to prevent the leakage of fluid outwardly around the several trunnions.

The packing means 11 are carried by the members A and B to seal with the internal walls of the body 10 and to cooperate to fully pack or seal off the opening 13 and, therefore, the upper end of the casing C when there is no drill pipe or other equipment in the well and to seal with the internal walls of the body 10 and to pack about the pipe P when the same is extending into the casing C. The packing means 11 includes two units or assemblies on the periphery of each of the members A and B. Each packing assembly includes an outer floating plate 38 and an inner plate 39. The outer plates 38 have cylindrically curved outer surfaces adapted to slidably engage the wall of the opening 17. The inner plates 39 are shaped to conform to and seat on the cylindrical peripheries 26 of the members A and B. The plates 38 and 39 extend circumferentially from adjacent the ribs 29 to planes beyond the sides of the members and extend axially or longitudinally of the members to have their ends slightly inset from the ends of the members.

Bodies or layers 40 of rubber or other packing material are interposed between the plates 38 and 39. In accordance with the invention the layers 40 of packing material may be vulcanized

on the opposing surfaces of the plates 38 and 39. Dove-tailed tongues 41 may be provided on the opposing surfaces of the plates 38 and 39 to be embedded in the layers 40 of packing. Inserts 42 of dove-tailed cross-sectional configuration are molded or vulcanized in the inner longitudinal edges of the layers 40 and are adapted to receive or cooperate with dove-tailed tongues 43 on the convergent sides of the ribs 29 to secure the packing assemblies to the ribs. The layers 40 of rubber or packing material extend to the opposite ends of the sections A and B and project beyond the ends of the plates 38 and 39. The end portions of the layers 40 may overlie the ends of the plates 38 and 39 and present flat end surfaces for cooperating with the walls 18 and 22 as best illustrated in Fig. 4 of the drawings.

The upper longitudinal edges or sides 44 of the layers 40 of the uppermost packing assemblies are straight, flat and unbroken and are adapted to abut or cooperate when the members A and B are swung to the positions illustrated in Fig. 7 of the drawings. The upper edge portions of these layers may be notched or inset in the edge portions of the plates 38 and 39 as illustrated, to present extensive sides 44. When the sides or surfaces 44 of the uppermost packing layers 40 are in cooperation they effectively prevent the upward passage of fluid through the opening 17. The lower longitudinal sides 45 of the layers 40 of the lower packing assemblies are flat and straight, being substantially radial relative to the axis of movement of the members A and B. Notches 46 are provided in the lower sides of the lower packing assemblies to interrupt the surfaces 45 and the lower surfaces or edges of the plates 38 and 39. The notches 46 are partially cylindrical and their walls are curved concentric with the walls of the above described grooves 28. The packing layers 40 of the lower packing assemblies may be recessed or inset in the lower edges of the plates 38 and 39 to present extensive sealing surfaces 45. When the members A and B are operated to the positions illustrated in Figs. 4 and 5 of the drawings the grooves 28 and the notches 46 receive the drill pipe P so that the surfaces 45 come into sealing cooperation. The surfaces of the layers 40 partially defining the notches 46 contact and seal about the pipe P as clearly illustrated in Figs. 4 and 5.

The plates 38 and 39 effectively confine the layers 40 of the packing assemblies and yet may move or float inwardly toward the ribs 29 when the assemblies are subjected to active compression strains whereby the cooperating surfaces and the sealing surfaces of the packing layers 40 may effectively operate. It will be observed that the above described packing assemblies may be readily assembled on and removed from the members A and B. When the plate 20 is removed from the body 10 the packing assemblies may be readily slid from the members A and B, the inserts 42 freely sliding off the tongues 43. New or replacement packing assemblies may be slid into place so that the inserts 42 slide over or receive the tongues 43.

The means for operating the members A and B is operable to swing the members from the intermediate positions illustrated in Fig. 6 of the drawings to the operative positions illustrated in Fig. 7 and Figs. 4 and 5. In the embodiment of the invention illustrated in Figs. 1 to 7, inclusive, of the drawings, the operating means 12 includes two quadrant gears 47. The gears 47 are supported for oscillatory movement about horizontal axes by shafts 48 which in turn are carried by arms 49 projecting from the body 10. The gears 47 are in spaced opposition and are provided with worm gear teeth 50. A rotatable worm 51 is located between the quadrant gears 47 to mesh with their teeth 50. A shaft 52 drives the worm 51 and is adapted to be rotated by manual means or any other suitable operating means. The shaft 52 is journalled in arms 53 projecting from the body 10. Bushings 54 are provided on the shaft 52 and engage against the arms 53. Thrust bearings 55 are arranged between the ends of the worm 50 and the inner ends of the bushings 54 for the transmission of the end thrusts on the worm. Sleeves 56 may enclose the bushings 54 and the bearings 55.

The means 12 includes operative connections between the members A and B and the quadrant gears 47. A collar 57 surrounds the projecting portion of the trunnion 32 and is connected thereto by keys 58. The collar 57 carries a crank arm or crank 59. A pin 60 on the trunnion 33 fits an axial socket 61 in a boss 63a on a crank 63 and is connected thereto by keys 62. The crank 63 is similar to the crank 59. The crank 59 projects upwardly relative to the axis of rotation of the members A and B while the crank 63 projects downwardly relative to the said axis. Each crank 59 and 63 has an elongate slot 64. Pins 65 are turnable in openings 66 in the quadrant gears 47 and carry heads or blocks 67 which slidably operate in the slots 64. Nuts 68 prevent the loss or displacement of the pins 65 from the gears 47 and prevent displacement of the blocks 67 from the slots 64.

It will be apparent that turning of the worm 51 results in simultaneous swinging of the quadrant gears 47 in opposite directions about their axes. This movement of the gears 47 is translated into swinging movement of the cranks 59 and 63 by the blocks 67 moving in the slots 64. When the members A and B are in their normal positions illustrated in Fig. 6 of the drawings the cranks 59 and 63 are substantially vertical. Upon turning of the worm 51 in one direction the cranks 59 are simultaneously swung to the right or to the left to move the members A and B to operative positions, it being understood that the direction of movement of the members A and B depends upon the direction of turning of the worm 51. It is to be particularly noted that an increase in leverage or mechanical advantage is obtained in the operation of the members A and B as the members approach the closed or operative positions. As the members A and B are operated the blocks 67 move outwardly in the slots 64 and when the members A and B approach their closed positions the blocks 67 are moving in the outer portions of the slots and therefore, are greater distances from the axis of movement of the cranks so that increased leverage is obtained and an increasingly greater mechanical advantage results due to the changing relationship between the gears 47 and the related crank arms. The above described operating means 12 is capable of developing great force or power to operate the members A and B to their closed positions against high internal pressures that may be present in the body 10.

Fig. 8 of the drawings illustrates a form of construction in which the gears 47a are operated by a translatable rack 70. The gears 47a may be the same as the above described gears 47 except

that they have gear teeth 71 suited to mesh with the teeth on the double rack 70. The rack 70 is supported and guided for movement by bearings or guides 72 which may be carried by the above described arms 49. The gears 47a are operatively associated with the cranks 59 and 63 in the same manner as the gears 47. In the structure illustrated in Fig. 8 of the drawings the rack 70 may be operated by a cylinder and piston mechanism. As illustrated in the drawings an operating rod 73 is connected with the rack 70 and extends to a cylinder and piston mechanism 74. The rod 73 may be connected with the piston rod of the mechanism 74 or may constitute the piston rod of the same. It is believed that it will be understood how the cylinder and piston mechanism 74 is operable to move the rack 70 in either direction to effect the desired movement of the valve members A and B.

It is believed that the operation of the device or valve provided by this invention will be understood from the foregoing detailed description. Under normal drilling conditions the members A and B are in the intermediate positions illustrated in Fig. 6 of the drawings where their grooves 27 are aligned with the opening 13 whereby drill pipe and other equipment may be passed through the casing C without interfering with the members. Thus the presence of the valve at the upper end of the casing does not interfere with the usual or normal well drilling operations. In the event that high pressures suddenly develop in the well it may be deemed desirable to close off the upper end of the casing. If the drill pipe P is extending through the casing C when the high pressures develop the shaft 52 is turned in a direction to move the gears 47 to the positions illustrated in Fig. 2. During the movement of the gears 47 from their normal positions toward the positions illustrated in Fig. 2 the blocks 67 cooperate with the slots 61 to cause turning of the cranks 59 and 63. This turning of the cranks 59 and 63 is accompanied by a corresponding and simultaneous turning of the members A and B. Thus the members A and B are simultaneously swung to the positions illustrated in Figs. 4 and 5 of the drawings. When the members A and B approach these positions the pipe P is received in the notches 28 and 46 and the layers 40 of packing material contact and seal about the pipe P at the walls of the notches 46. The surfaces 45 of the layers 40 of packing material cooperate to close off the space about the pipe P. It is to be understood that the shaft 52 may be turned until the layers 40 of packing material in the lower packing assemblies are compressed to tightly and effectively seal about the pipe P and to close off the opening 13 about the pipe. As pointed out above, the leverage or mechanical advantage of the blocks 67 operating in the slots 64 increases as the members A and B approach the closed positions so that a considerable force may be imposed on the members to assure the proper and complete closing off of the upper end of the casing about the pipe P. The layers 40 of packing material in the lower packing assemblies, in addition to sealing about the pipe P and cooperating with one another, seal with the peripheral walls of the opening 17 and the end walls 18 and 22 so that the well pressures are prevented from passing upwardly through the body. It will be observed that the members A and B may be rapidly swung to the closed position about the pipe P without the adjusting or positioning of any parts.

In the event that high pressures suddenly develop in the well when there is no drill pipe or other equipment extending into the casing C the shaft 52 may be turned in a direction to cause the gears 47 to effect swinging of the cranks 59 and 63 in a direction to turn the members A and B to the positions illustrated in Fig. 7 of the drawings. When the members A and B assume the positions illustrated in Fig. 7 the side surfaces 44 of the layers 40 of packing material come into cooperation to effectively seal between the two members. The layers 40 of packing material of the two upper packing assemblies also seal with the wall of the opening 17 and with the internal walls 18 and 22 of the body so that the members A and B operate to fully close off the opening 13 against the upward passage of fluid pressure. The means 12 is such that the members A and B may be tightly urged against one another when in the positions illustrated in Fig. 7 to assure the complete closing off of the well.

The gate or control valve of the present invention is a simple, compact unit that may be readily connected with the upper end of the casing. The valve occupies but little space and may be readily arranged in the cellar of a typical well derrick. The packing assemblies of the means 11 are removably arranged on the members A and B so that they may be easily and quickly replaced when necessary without removing the members from the body 10. The floating plates 38 effectively confine the layers 40 of packing material and yet allow the packing material to operate effectively. The means 12 for operating the members A and B between their open and closed positions is positive and is such that considerable force may be applied to the members in the event that high pressures are present in the casing C. In the event that very high pressures may be encountered in the well it may be found advisable to operate the means 12 by a cylinder and piston mechanism in the manner illustrated in Fig. 8, so that the members A and B may be moved to their closed positions against any pressures that may be encountered.

The operating means 12 and the operating means disclosed in Fig. 8 are fully described and claimed in my divisional application entitled Valve actuating mechanism, Serial No. 161,263, filed August 27, 1937, now Patent 2,157,263, granted May 9, 1939.

Having described only typical preferred forms and applications of my invention, I do not wish to be limited or restricted to the specific details herein set forth, but wish to reserve to myself any variations or modifications that may appear to those skilled in the art or fall within the scope of the following claims.

Having described my invention, I claim:

1. A control gate for a well casing including, a body to be connected with the casing and having an opening to form a continuation of the opening in the casing, a transverse opening intersecting the first named opening, a socket in one end of the transverse opening and a reduced bore at the other end of the opening, a pair of valve members in the transverse opening, means supporting the members for swinging movement between open positions and positions where they cooperate to close off the first named opening when the same is empty and positions where they cooperate to seal about an object extending through the

first named opening to close off the opening, said supporting means comprising a tubular trunnion on one member turnable in said socket, a trunnion on the other member turnable in the tubular trunnion, a tubular trunnion on said other member turnable in the bore, and a trunnion on the first mentioned member turnable in the last named tubular trunnion, and means for swinging the valve members between said positions.

2. A control gate for a well casing including, a body to be connected with the casing and having an opening to form a continuation of the opening in the casing and a transverse opening intersecting the first named opening and having its opposite ends closed, a pair of valve members in the transverse opening, means supporting the members for swinging movement between open positions and positions where they cooperate to close off the first named opening when the same is empty and positions where they cooperate to seal about an object extending through the first named opening to close off the opening, said means including pairs of telescopically related trunnions projecting from the members at said opposite ends of the transverse opening, and means for swinging the valve members between said positions.

3. A closure element for a control gate comprising a substantially sector shaped closure, a packing assembly on the periphery of the closure including, a part seated on the periphery of the closure, a body of packing on said part, and a plate on the said body to partially confine the same, an axially extending rib on the periphery of the closure forming an abutment for the said body, a dovetailed tongue on the rib, and an insert in said body receiving the tongue to removably hold the assembly on the closure.

4. A packing assembly for a valve member comprising a part bearing on the member, a body of packing on said part, and a confining plate on said body, and means removably holding the assembly on the member comprising an insert in the said body and a tongue and groove connection between said insert and the member.

5. A packing assembly for a substantially sector shaped closure including, a part seated on the periphery of the closure, a body of packing on said part, and a plate on the outer surface of the body to partially confine the body, and an axially extending tongue and groove connection between the closure and the assembly for removably holding the assembly on the closure.

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