April 12, 1932. H. C. OTIS 1,854,058

CONTROL HEAD

Filed Aug. 12, 1930 2 Sheets-Sheet 1

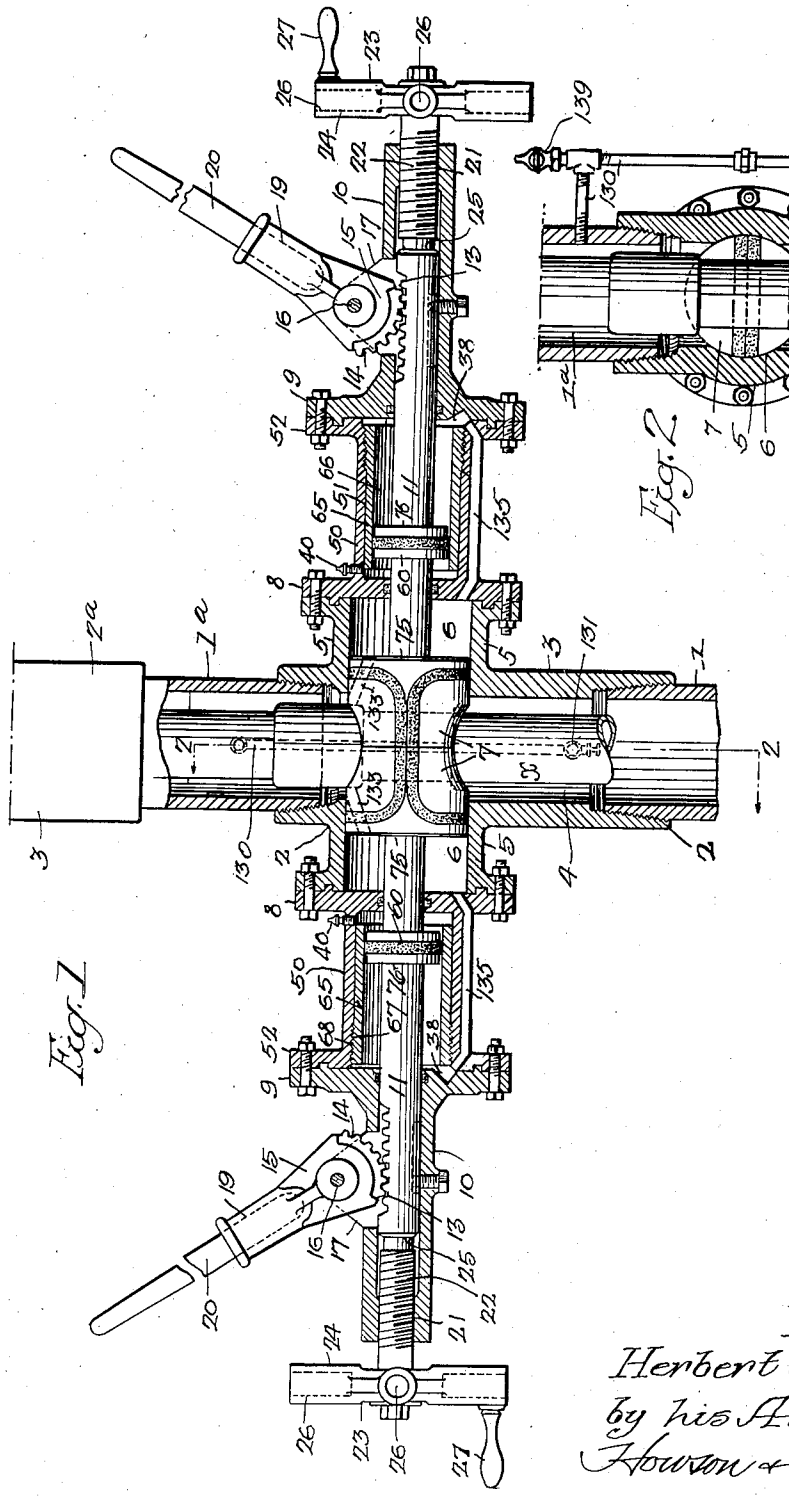

Fig. 1

Fig. 2

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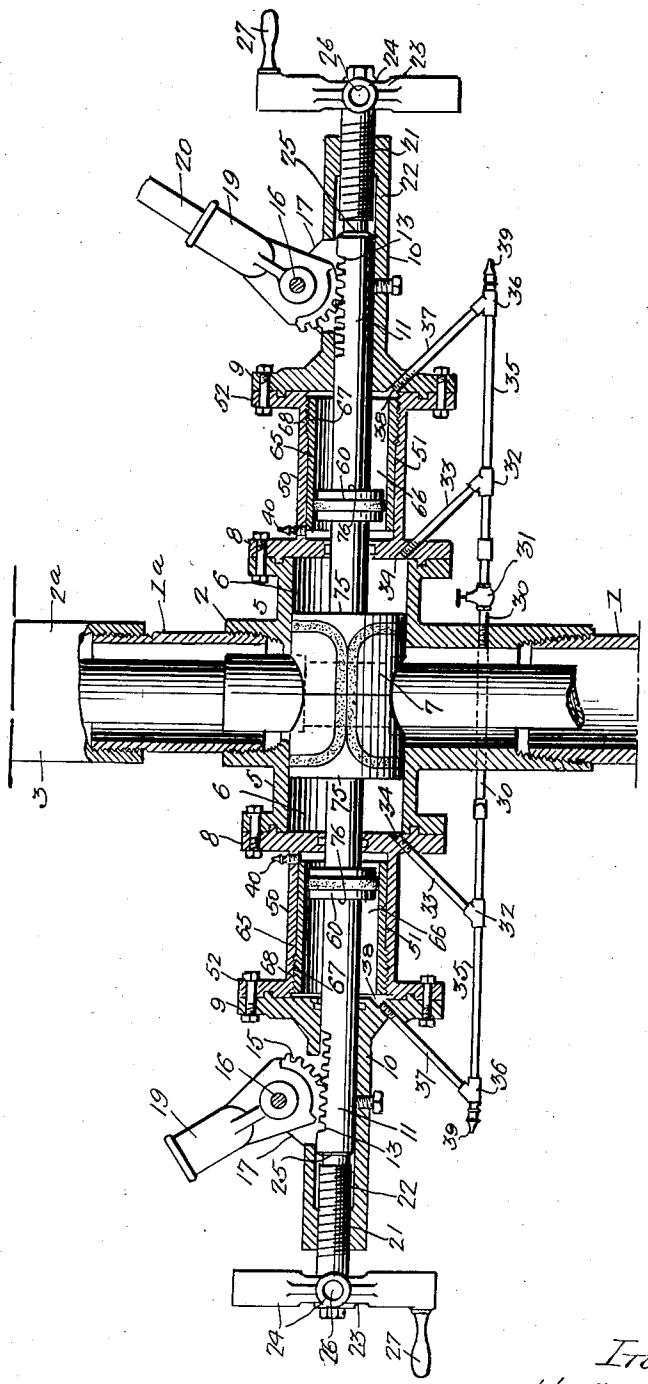

Fig. 3.

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UNITED STATES PATENT OFFICE

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CONTROL HEAD

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This invention relates to what is known in the oil fields as a tubing control head and blow-out preventer, the device covered by the present application being an improvement to a similar device shown and described in my co-pending application, Serial No. 319,865, filed November 16, 1928. Devices of this character are adapted for use with oil wells in which gas or other fluid under high pressure is encountered.

Usually there are two of these control heads employed, one control head being secured to the upper end of the well casing and the second control head being spaced from and supported above the first control head by a nipple which forms a continuation of the well casing.

Each control head comprises at least one pair of sealing elements which are disposed in diametrically opposed relation to each other and movable in opposite directions transversely of the well casing.

The sealing elements are adapted to have their opposed inner faces brought into sealing contact with each other, the said opposed inner faces of the respective sealing elements being grooved to receive and contact with the outer surface of a string of tubing, drill stem, or other device being run into, or moved longitudinally of, the well casing, to prevent the escape of fluid from the well casing around the string of tubing, etc.

In running a string of tubing into a well equipped with the above mentioned control heads, the sealing elements of one of the control heads are drawn away from the tubing to permit the passage of a coupling, or other protuberance in the string of tubing, to pass through the said control head, the sealing elements of the other control head being maintained in sealing contact with each other and with the string of tubing while the coupling, etc. is passing through the first mentioned control head.

In some instances the pressure of the gas or other fluid in the well is sufficiently high to render the control heads practically inoperative, the pressure exerted against and between the opposed inner ends of the sealing elements being so great as to make it impossible to move the sealing elements toward each other and into sealing contact with each other and with the string of tubing, thus preventing the running of the tubing into the well to draw out the oil.

In the device covered by the said co-pending application, the above mentioned condition is obviated by the provision of a by-pass which conducts the high pressure fluid from the well casing, below the sealing elements of the control head, to the rear or outer ends of the chambers in which the sealing elements are longitudinally movable, the object being to equalize the pressure at both ends of each of the sealing elements, so that the sealing elements can be readily moved, by manually operable means or by low powered mechanical means supplied for the purpose.

The provision of the pressure equalizing means has resulted in a more efficient operation of the control heads, at ordinary pressures and with wells containing fluids under relatively high pressure, for example, pressures up to and exceeding 1000 pounds per square inch.

During the course of usage of the device shown and described in the said co-pending application, extremely high pressures, approximating 2000 pounds per square inch, have been encountered. At these extremely high pressures great difficulties have been encountered in operating the control heads, due to the fact that, although the pressure is equalized at the opposite ends of each of the sealing rams, the force exerted upon the opposite ends of the respective rams is not equal, for the reason that the effective area on the front end of the sealing ram, upon which the fluid acts, is greater than the effective area on the back end of the ram, this

difference in area being substantially equal to the cross-sectional area of the ram rod. In the ordinary control head this difference in effective areas amounts to about 3 or 4 square inches. With a pressure approximately 2000 pounds per square inch prevailing in the well, this difference between the effective areas of the front and back ends of the ram will cause the force acting upon the front end of the ram to be about 6000 to 8000 pounds greater than the force acting on the back end of the ram, which makes the operation of the manually operable ram operating levers and jack screws or the low-powered mechanically operated means very difficult or impossible.

The object of the present invention is to provide means by which the difference in the effective areas of the opposite ends of each ram may be corrected, or compensated for, and for this purpose I have provided an auxiliary cylinder behind each of the chambers in which the rams operate, the ram rod in each instance being elongated to extend through the auxiliary cylinder, wherein a piston is mounted on and secured to the extension of the ram rod.

I provide a by-pass for conducting the gas from the well casing to the rear end of each of the chambers in which the rams are mounted, in the same general manner as disclosed in the said co-pending application, and in addition thereto I provide a by-pass affording communication between the rear end of each ram chamber and the rear end of the auxiliary cylinder associated therewith, so that the pressure in the said rear end of the auxiliary cylinder, behind the piston therein, will be the same as the pressure in the rear end of the ram chamber, behind the ram therein.

The diameter of the auxiliary cylinder and its piston may be such as to provide an effective area, which, when added to the effective area of the rear end of the sealing ram will substantially equalize the effective area of the front end of the sealing ram, thereby equalizing the opposing forces acting upon the opposite ends of the ram, so that the ram may be readily moved forward into the sealing position by the operating mechanism regardless of the pressure of the gas in the well, however high it may be.

At times it may be desirable to have the auxiliary cylinder and its piston larger than would be required for establishing a substantially perfect balance of the opposing forces, at which time the pressure acting upon the excess rear area would force the piston and the ram forward, thereby rendering the use of supplementary operating mechanisms unnecessary for the closing of the sealing rams around the tubing. It is, however, advisable to run the jack screw in, as the ram moves forward, to back up the ram rod and to positively lock the ram in sealing contact with the tubing.

At other times it may be desirable to have the auxiliary cylinder and its piston smaller, so that the force exerted on the back end of the ram will not quite equalize the opposing force exerted on the front end of the ram, which will maintain a small amount of resistance to the ram operating mechanism as the ram is advanced into sealing contact with the tubing.

In order to obviate the necessity for carrying differently sized control heads for each of the three conditions above noted, I have arranged the auxiliary cylinder in a manner to provide for such variations in its diameter, by providing liners or sleeves in the auxiliary cylinders. The outer diameter of each sleeve is substantially equal to the diameter of the bore of the cylinder, while the inner diameters of the linings may be of any desired diameters. Obviously I employ in each case a piston corresponding in size to the diameter of the bore of the lining being used, the piston being placed on and rigidly secured to the ram rod.

In the accompanying drawings:

Fig. 1 is a longitudinal sectional elevation through a control head showing auxiliary pistons coupled in tandem with the sealing rams;

Fig. 2 is a section taken on the line 2—2, Fig. 1; and

Fig. 3 illustrates an alternate form of the invention.

Referring to the drawings, the upper portion of a well casing is illustrated at 1, on which the lower control head 2 is located, the upper control head 2*a* being disposed above the lower head 2 and connected thereto by a nipple 1*a*.

Each of the control heads comprises a vertical extending hollow cylindrical body portion 3, the bore 4 of which is axially alined with the well casing 1, the said bore being threaded to receive corresponding threads on the casing 1 and nipple 1*a*.

Each control head, in the present instance, is provided with a pair of axially alined and transversely, or radially extending portions 5, 5, which extend laterally and in diametrically opposed relation to each other from opposite sides of the vertical cylindrical body portion 3 of the control head.

In each of the lateral extensions 5 is formed a suitable ram chamber 6 which, at its forward end, communicates directly with the central bore 4 of the body portion 3 of the control head. In the present instance, each of the ram chambers 6 is of a cylindrical form, disposed with its axis extending radially from the vertically disposed axis of the central bore 4 of the body portion 3 of the control head.

Suitably mounted within each of the cylindrical ram chambers 6 is a longitudinal movable sealing jaw or ram 7, the said sealing

rams 7, 7 being located at opposite sides of the center of the central bore 4, and movable in opposite directions toward and away from each other within their respective chambers 6. The outer ends of the chambers 6 are respectively closed by removable closure heads 8, 8.

In the lower control head 2, each of the closure heads 8 constitutes a flanged integral head closing one end of an auxiliary cylinder 50. Each cylinder 50 has a bore 51 which extends inwardly from the opposite open flanged end 52 thereof to the said integral head 8 at the closed flanged end of the cylinder.

The open end 52 of each of the auxiliary cylinders 50 is closed by a removable closure head 9, which is provided with an elongated bearing 10 in which is slidably mounted a ram rod 11.

The ram-rod 11 projects from the rear end of the sealing ram 7, through the closure head 8 and the associated auxiliary cylinder 50, the outer or tail end of the said ram rod being slidably mounted in the bearing 10 as above noted.

The said tail end of each of the ram rods 11 is provided with a series of gear teeth 13, which are adapted to mesh with gear teeth 14 formed on a gear segment 15. The gear segment 15 is pivotally mounted on a short shaft or stud 16 carried by lugs 17 formed on the bearing 10.

Each of the gear segments 15 is provided with a socket 19 adapted to receive a suitable handle 20, which constitutes levers by which the segments 15 may be turned about their pivots, to move the sealing rams 7, 7 toward and away from each other, as above noted.

To assist in the movement of the rams 7, 7, toward each other and into sealing position around the string of tubing x, which in in the drawing is shown as being lowered into the casing 1 through the central bore 4 of the control head 2, and for the purpose of backing up the movement of the rams 7, and for maintaining the rams in their sealing positions with respect to the string of tubing, the outer end of each of the bearings 10 is internally threaded as at 21. These threads 21 are adapted to receive corresponding external threads formed on jack screws 22, 22.

The said jack screws 22 are axially aligned with the ram rods 11, 11, as shown in the drawings, and each jack screw 22 is provided on its outer end with a suitable spider or wheel 23, having radially extending arms 24 provided with sockets 26 adapted to receive a handle similar to the handle 20, whereby considerable leverage may be obtained to force the sealing rams into sealing contact with the string of tubing.

The jack screws 22 may also be rotated by means of handles 27 on the said spiders 23, so that the lead ends 25 of the jack screws 22 may be caused to follow the tail ends of the respective ram rods 11, when the sealing rams 7 are being moved by the levers 20, and when the gas pressure is not exceptionally high in the well casing 1.

When high gas pressure is encountered suitable lever handles may be applied to the sockets 26 of the spider 23 for supplying additional leverage for turning the jack screws 22, which, together with the operation of the handles 20 of the gear segments 15, will move the sealing jaws 7 in opposition to the high pressure existing in the well casing.

In order to eliminate the laborious manual operation, and to make possible the operation of the rams 7 against the force exerted on the front end of the rams by extremely high pressure in the well casing, the ram rods 11, 11 are provided with pistons 60 which are located in the auxiliary cylinders 50, 50 respectively, and the fluid pressure is admitted from the well casing 1 to the rear ends of the ram chambers 6, 6 and to the rear ends of the auxiliary cylinders 50, 50 respectively.

In the form of the invention shown in Fig. 3, the fluid is conveyed by a suitable by-pass comprising a pipe 30 which is tapped into the body 3 of the control head 2 below the projections 5 thereon and communicates with the central bore 4 thereof. The flow of pressure from the bore 4 to the pipe 30 is controlled by a suitable valve 31.

The pipe 30 is provided with Y-fittings 32, 32 into one leg of each of which is fitted a pipe 33. The opposite end of each pipe 33 is tapped into an opening 34 formed in the head 8, which communicates with the rear end of the ram chamber 6, behind the ram 7 situated therein.

In the third leg of each Y-fitting 32 is threaded a pipe 35, on the outer end of which is mounted a Y-fitting 36. Into one leg of the Y-fitting 36 is threaded a pipe 37. The opposite end of the pipe 37 is threaded into an aperture 38 formed in the head 9 of the auxiliary cylinder 50, affording communication to the rear end of the bore 51 of the auxiliary cylinder 50 at the rear side of the piston 60 located within the said auxiliary cylinder 50.

In the third leg of the Y-fitting 36 is mounted a suitable relief valve 39 by which, when the valve 31 is closed, the pressure may be relieved from the rear ends of the chambers 6 and cylinders 50.

The forward end of the auxiliary cylinder 50 is provided with a pet cock 40 which functions as a breather for the portion of the cylinder 50 between the forward end of the piston 60 and the rear end of the head 8.

While the above described arrangement of the by-pass operates efficiently, when extremely high pressures are encountered, the pressure rushing upwardly between the opposed forward ends of the rams from the underside of the rams, as the rams start to move

apart, has a tendency to loosen the packing in the front ends of the rams 7, 7, and for this reason I employ means for equalizing the pressure above and below the rams in the bore 4 of the control head 2, as shown in Figs. 1 and 2, wherein a by-pass 130 is tapped at one end into the bore 4 of the body 3 of the control head 2 at a point below the sealing rams 7, 7 and is tapped at its opposite end into the bore 4 at a point above the sealing rams 7, 7. This by-pass is controlled by a valve 131 and is provided with a vent 139.

When the upper control head 2*a* and the vent 139 are closed and the valve 131 opened the pressure from the casing 1 passes to the upper end of the control head 2, thereby equalizing the pressure above and below the sealing rams 7, 7, thus, when the sealing rams start to open there is an equalized rush of pressure from both sides of the rams into the crevice formed between the opposed faces of the two moving rams, consequently no injury of the packing is effected.

I prefer also to by-pass the fluid from the upper end of the control head 2 through by-pass openings 133, 133, formed in the rams 7, 7, to the rear ends of the ram chambers 6, 6, thence through by-pass pipes 135, 135 from the rear ends of the chambers 6, 6 to the rear ends of the auxiliary cylinders 50, 50.

Obviously, when the valve 131 is opened as above noted, the pressure above, below and between the rams 7, 7, the pressure at the rear ends of the rams in the chambers 6, 6, and the pressure at the rear ends of the pistons 60, 60 in the auxiliary chambers 50, 50 will be equalized with the pressure in the well casing 1, and with the sum of the effective areas at the rear ends of the rams and pistons being substantially equal to the effective areas of the front ends of the rams no difficulty is found in operating the rams to either an open or a closed position.

Mounted in the bore 51 of each of the auxiliary cylinders 50 is an interchangeable sleeve or lining 65, the outer diameter of which is substantially equal to the diameter of the bore 51 of the cylinder 50, in order to have the lining 65 fit snugly within the said bore 51.

The bore 66 of the lining 65 may be of any desired diameter, depending upon the result desired, and the piston 60 on the ram rod 11 is adapted to be made with a diameter corresponding to the bore 66 of the lining 65 which is to be used.

In the present instance the lining 65 is provided with suitable threads 67 adjacent one of its ends and corresponding to and co-operating with similar threads 68 formed in the bore 51 of the auxiliary cylinder 50, adjacent the outer open end 52 thereof, whereby the said lining 65 may be held against longitudinal movement within the cylindrical bore 51.

As above noted the front or sealing end of each of the sealing rams 7 has a greater effective area, against which the gas pressure operates, than has the rear end 75 of the said ram, the difference in the areas of the two faces being substantially equal to the cross-sectional area of the ram rod 11.

When it is desired to equalize the force exerted by the gas at the opposite ends of each of the sealing rams 7 a lining 65 is placed in the cylinder 50 which will have an area substantially twice as great as the cross-sectional area of the ram rod 11, which, when the ineffective cross-sectional area of the ram rod is deducted, for the reason that the ram rod passes completely through the cylinder 50, leaves a remaining effective area of the piston 60 which will be substantially equal to the cross-sectional area of the ram rod 11, and this effective area of the piston added to the effective area of the face 75 of the ram 7 produces a total effective surface area for the rear end of the sealing ram 7 which is substantially equal to the effective surface areas of the front end of the said ram 7. Thus, with the gas passing to the rear ends of the chambers 6 and cylinders 50, and acting against the effective rear surfaces 75 of the sealing rams 7 and the effective rear surfaces 76 of the pistons 60 there will be a counter-balancing of the pressure and the force exerted thereby at each end of each of the sealing rams 7, which will permit the said rams to be readily moved by operation of the handles 20, the jack screws 22, in such instances, being used merely to back up the movement of the rams 7 and to lock the same in sealing contact with the string of tubing *x*.

Obviously if it is desired to have the force exerted on the rear end of each of the sealing rams 7 slightly less than the force exerted on the front end of the said sealing rams a liner 65 of smaller bore diameter and a correspondingly sized piston 60 will be used, whereby the sum of the effective areas of the surfaces 75 and 76 of the sealing ram 7 and piston 60 respectively will be less than the effective area of the front sealing face of each ram.

On the other hand, if it is desired to have a greater force exerted at the rear of the sealing ram 7, whereby the rams will be moved into sealing contact with the string of tubing by the pressure in the well alone, the bore diameter 66 of the inserted lining 65 will be increased, or the lining 65 will be entirely eliminated, and a correspondingly sized piston 60 applied to the ram rod 11, whereby the sum of the effective areas 75 and 76 of the ram 7 and piston 60 respectively will be greater than the effective area of the front or sealing surface of the ram 7, consequently the force exerted against these surfaces 75 and 76 will be greater than the force exerted against the sealing surface of the ram 7,

and, even though the pressures at each end of the said sealing ram 7 will be equal, or substantially so, this pressure acting against the combined effective areas of the surfaces 75 and 76 will exert a force thereon which will be sufficiently greater than the force exerted against the front sealing surface of the ram 7 to cause the ram 7 to move forwardly into sealing contact with the string of tubing *x*.

From the above description, it will be obvious that by making the lining 65 interchangeable and the pistons 60 also interchangeable to agree with the lining I may vary the area of the effective surface of the piston 60 to any desired degree for obtaining any of the desired results above noted.

Obviously any of the well known means for detachably securing a piston to a piston rod may be employed for removably securing the pistons 60 to the ram rods 11, or the pistons may be permanently attached to the ram rods, and when a differently sized lining 65 is to be used the ram rod may be detached from the ram 7 and the entire ram rod 11 with the permanent piston therein may be replaced by a similar ram rod having a piston corresponding in diameter to the bore of the new lining to be used, the ram rod 11 being threaded into or otherwise secured in the ram 7.

I claim:

1. A control head, for well casings, having a passageway communicating with the well casing and a chamber extending laterally from and communicating with said passageway, a sealing element in said chamber adapted to have its front end projected into said passageway, a rod projecting through said chamber from the rear end of said sealing element, an auxiliary cylinder, a piston in said auxiliary cylinder and operatively connected to said rod, and means affording intercommunication between the rear ends of the chamber and auxiliary cylinder and between said rear ends and the well casing for conducting fluid from the well casing to the rear ends of the said chamber and the auxiliary cylinder equalizing the pressures in said rear ends behind the sealing element and piston with the pressure in the well casing and at the exposed end of the sealing element projecting into said passageway.

2. A control head, for well casings, having a passageway communicating with the well casing and a chamber extending laterally from and communicating with said passageway, a sealing element in said chamber adapted to have its front end projected into said passageway, a rod projecting through said chamber from the rear end of said sealing element, an auxiliary cylinder, a piston in said auxiliary cylinder and operatively connected to said rod, means affording intercommunication between the rear ends of the chamber and auxiliary cylinder and between said rear ends and the well casing for conducting fluid from the well casing to the rear ends of the said chamber and the auxiliary cylinder equalizing the pressures in said rear ends behind the sealing element and piston with the pressure in the well casing and at the exposed end of the sealing element projecting into said passageway, and means for controlling the flow of fluid through the conducting means.

3. A control head, for well casings, having a passageway communicating with the well casing and a chamber extending laterally from and communicating with said passageway, a sealing element in said chamber adapted to have its front end projected into said passageway, a rod projecting through said chamber from the rear end of said sealing element, an auxiliary cylinder, a piston in said auxiliary cylinder and operatively connected to said rod, means affording intercommunication between the rear ends of the chamber and auxiliary cylinder and between said rear ends and the well casing for conducting fluid from the well casing to the rear ends of the said chamber and the auxiliary cylinder equalizing the pressures in said rear ends behind the sealing element and piston with the pressure in the well casing and at the exposed end of the sealing element projecting into said passageway, means for controlling the flow of fluid through the conducting means, and means for exhausting the fluid from the rear end of the chamber and the auxiliary cylinder.

4. A control head, for well casings, having a passageway communicating with the well casing and a chamber extending laterally from and communicating with said passageway, a sealing element in said chamber adapted to have its front end projected into said passageway, a rod projecting through said chamber from the rear end of said sealing element, an auxiliary cylinder, a piston in said auxiliary cylinder and operatively connected to said rod, means affording intercommunication between the rear ends of the chamber and auxiliary cylinder and between said rear ends and the well casing for conducting fluid from the well casing to the rear ends of the said chamber and the auxiliary cylinder equalizing the pressures in said rear ends behind the sealing element and piston with the pressure in the well casing and at the exposed end of the sealing element projecting into said passageway, means for controlling the flow of fluid through the conducting means, means for exhausting the fluid from the rear end of the chamber and the auxiliary cylinder, and means for venting the opposite end of the auxiliary cylinder.

5. A control head, for well casings, having a passageway communicating with the well casing and a chamber extending laterally from and communicating with said passage-

way, a sealing element in said chamber adapted to have its front end projected into said passageway, a rod projecting through said chamber from the rear end of said sealing element, an auxiliary cylinder, a piston in said auxiliary cylinder and operatively connected to said rod, and means for conducting fluid from the well casing to the rear ends of the said chamber and the auxiliary cylinder, the sum of the effective areas of the rear end of the sealing element and the piston being substantially equal to the effective area of the front end surface of the sealing element.

6. A control head, for well casings, having a passageway communicating with the well casing and a chamber extending laterally from and communicating with said passageway, a sealing element in said chamber adapted to have its front end projected into said passageway, a rod projecting through said chamber from the rear end of said sealing element, an auxiliary cylinder, a piston in said auxiliarly cylinder and operatively connected to said rod, means for conducting fluid from the well casing to the rear ends of the said chamber and the auxiliary cylinder, the sum of the effective areas of the rear end of the sealing element and the piston being substantially equal to the effective area of the front end surface of the sealing element, and means for varying the effective area of the piston.

7. A control head, for well casings, having a passageway communicating with the well casing and a chamber extending laterally from and communicating with said passageway, a sealing element in said chamber adapted to have its front end projected into said passageway, a rod projecting through said chamber from the rear end of said sealing element, an auxiliary cylinder, a piston in said auxiliary cylinder and operatively connected to said rod, means for conducting fluid from the well casing to the rear ends of the said chamber and the auxiliary cylinder, the sum of the effective areas of the rear end of the sealing element and the piston being substantially equal to the effective area of the front end surface of the sealing element, and an interchangeable lining in the cylinder for varying the effective area of the piston.

8. A control head, for well casings, comprising a body portion having a central bore substantially aligned with the bore of the well casing and a chamber extending laterally from said central bore, a sealing ram in said lateral chamber and adapted to have its forward end projected from the lateral chamber across the said central bore, an auxiliary cylinder substantially aligned with said lateral chamber, a rod extending from the rear end of the sealing ram through the lateral chamber and the auxiliary cylinder, a piston on the ram rod in said auxiliary cylinder, and means affording intercommunication between the rear ends of the chamber and auxiliary cylinder and between said rear ends and the well casing for conducting fluid pressure from the well casing to the rear ends of the lateral chamber and the auxiliary cylinder respectively, equalizing the pressures in said rear ends behind the sealing element and piston with the pressure in the well casing and at the exposed end of the sealing element projecting into said passageway.

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