Nov. 20, 1934. R. A. MUELLER 1,981,279

MEANS FOR CONTROLLING WELLS

Filed Jan. 6, 1933 3 Sheets-Sheet 1

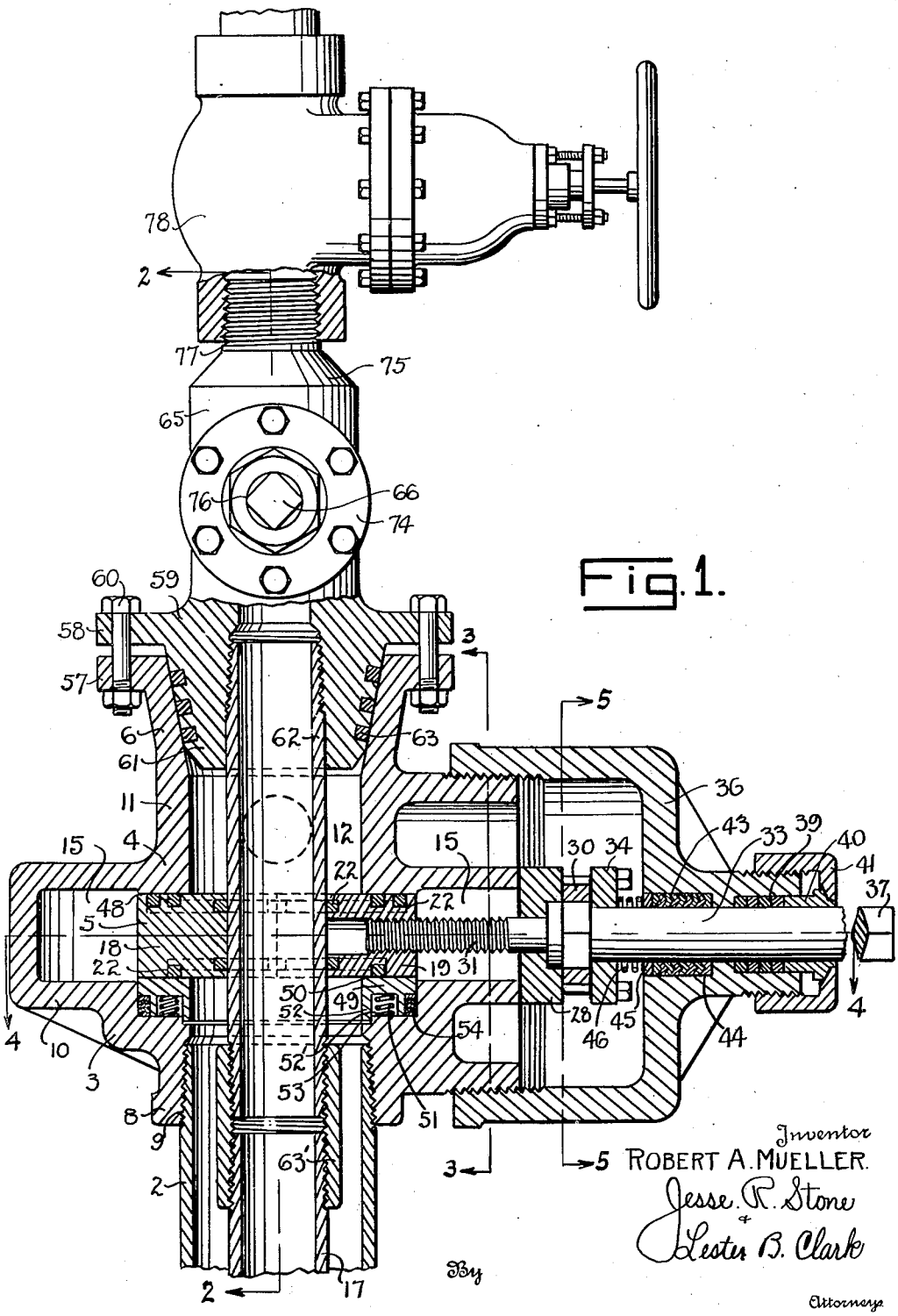


Fig. 1.

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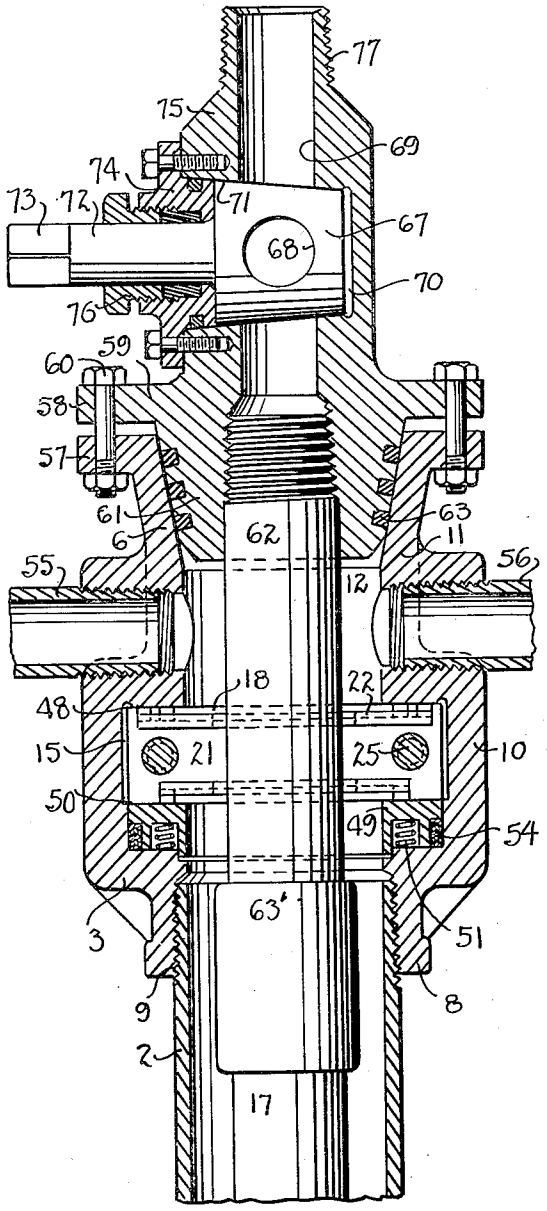


Fig. 2.

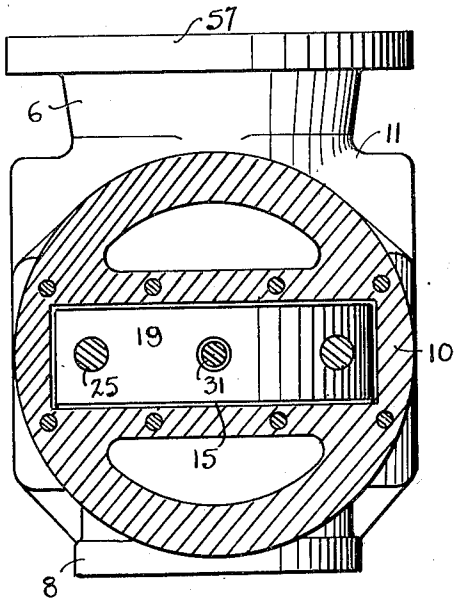


Fig. 3.

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Filed Jan. 6, 1933 3 Sheets-Sheet 3

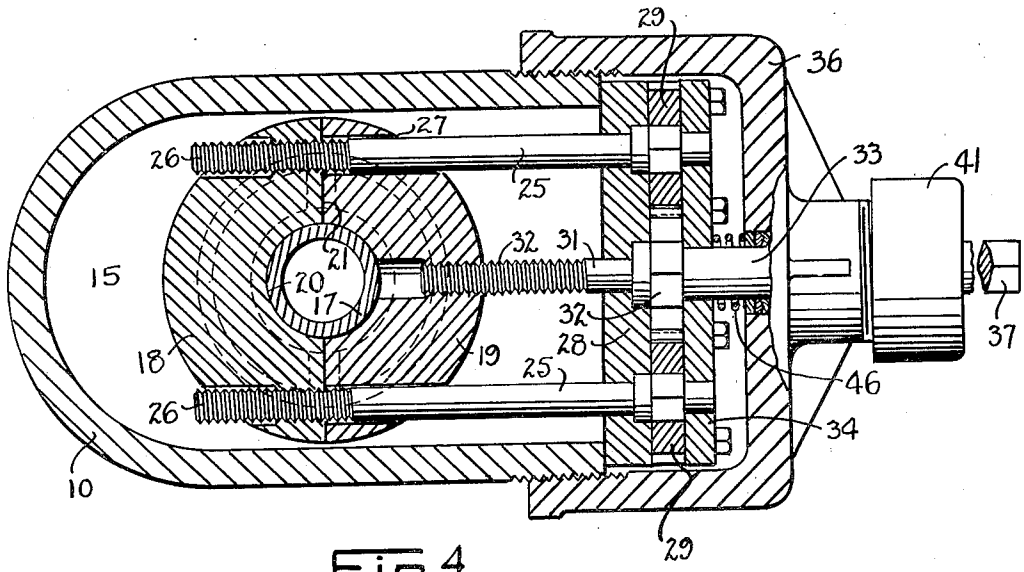


Fig. 4.

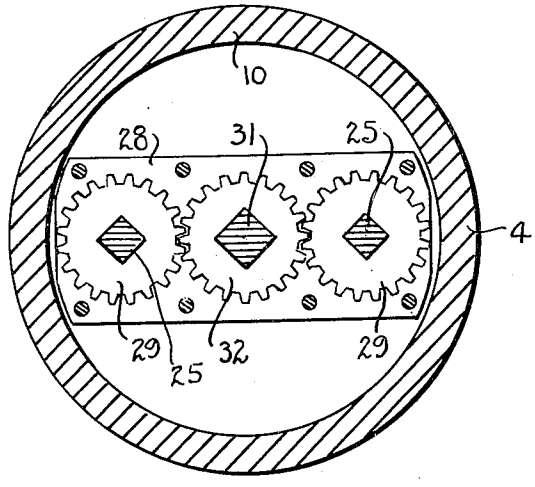


Fig. 5.

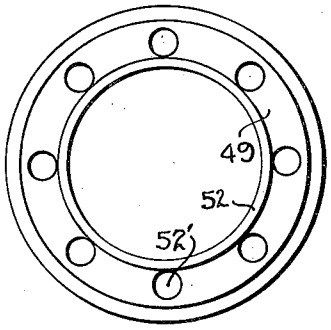


Fig. 6.

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UNITED STATES PATENT OFFICE

1,981,279

MEANS FOR CONTROLLING WELLS

Robert A. Mueller, Houston, Tex.

Application January 6, 1933, Serial No. 650,373

4 Claims. (Cl. 166—15)

The invention relates to an improvement in the means for controlling the flow from wells, and particularly at the time the tubing is being inserted in the well and the drilling mud removed therefrom after the drilling has been completed.

The present application is in the nature of a continuation in part as to all common subject matter of my prior copending application Serial No. 530,649, filed April 16, 1931, which has resulted in Patent No. 1,909,304, dated May 16, 1933, in which the apparatus is claimed broadly, as well as my application for Patent 571,099, filed October 26, 1931, in which the method of washing and bringing in a well is broadly claimed.

The critical time in bringing in a well to produce oil or gas is that time directly after the drilling of the well has been completed, and when the well bore is full of mud which has been used to maintain the walls of the well bore during the drilling operation, and to remove the cuttings from the bit. When the drilling has been completed the drill bit is removed by withdrawing the drill stem and it is then necessary to run in the tubing and liner, if a liner is to be used. It is usual to provide a screen or perforated area on the lower end of either the casing, tubing, or the liner, as the case may be, in order to allow the oil to enter or to filter out the sand encountered with the oil. The openings of these strainers or filters are very small in order to eliminate fine sands and are usually measured in thousandths of an inch. This strainer must be inserted in the well while the well is full of mud as the mud overcomes and holds back any pressure in the formation so that the tubing can be run into position. It seems apparent, therefore, that the strainer openings will be filled with mud and it is absolutely essential to wash the mud not only from the strainer, but also from the formation, in order that a full flow of oil will be obtained.

The present invention relates to a means and method of running in the perforated casing or filter screen, washing the same, and positioning the strainer tubing and tubing head in such a manner that positive and complete control of the flow from the well will be had at all times during the operation.

A great many wells are ruined at the critical period when the tubing or strainer is being run into the well, due to the fact that the well is not washed properly, and the mud clogs up the formation or the strainer, or both, and it is with the idea of providing an assembly of equipment and a method of manipulating the same which will permit complete washing of the well and positive control of the same during the period when the heavy mud is being removed and replaced by clear water, that the present method and structure has been devised.

It is one of the objects of the invention to provide a composite piece of equipment which can be positioned on the well head and, by manipulation of this equipment, complete control of the well may be had.

Another object of the invention is to provide a combined blowout preventer and casing head which is made up as a unitary structure so that the same will not occupy an excessive space on the well head.

Another object of the invention is to provide a combination casing head and blowout preventer wherein there are no flanged couplings exposed to the well pressure.

Another object of the invention is to provide a ram type blowout preventer wherein the rams are urged to sealing position against the housing at all times.

Still another object of the invention is to provide a combination blowout preventer and casing head so that the tubing may be supported in the head.

It is also an object of the invention to provide a combination cut off and tubing hanger wherein the hanger forms a continuation of the tubing and is provided with a valve for closing the passage at will.

Another object of the invention is to provide an apparatus which will permit the practicing of a novel method of bringing in wells by having complete control of the discharge openings from the wells at all times.

A still further object of the invention is to provide in a unitary construction mechanisms which will serve to close the casing about a pipe therein and also to close the passage through such pipe.

Still another object of the invention is to provide a means and method of performing the necessary operations in the bringing in of a well so that the well may be completely closed in for the purpose of changing any or all of the flow line fittings leading from the well head either simultaneously or independently.

It is to be understood that various other objects of the invention will appear as the detailed description of the invention proceeds and that various alterations and modifications of the method and apparatus may be used without departing from the spirit of the invention as disclosed in the following description and drawings wherein

Fig. 1 is a side elevation of a well head equipped with the mechanism for practicing the method and showing certain of the parts in section.

Fig. 2 is a vertical sectional view taken on the line 2—2 of Fig. 1.

Figs. 3, 4 and 5 are sections taken on the lines 3—3, 4—4, and 5—5, respectively, of Fig. 1.

Fig. 6 is a bottom plan view of the pressure ring used in combination with the blowout preventer rams.

The casing which is usually set in the well bore and serves as a foundation for the well head equipment is indicated generally at 2 in Fig. 1. This casing is of various diameters depending upon the size and depth of the well. It is usual to cement this casing in position so that it will be firmly anchored and so that the equipment carried by the casing will withstand the well pressures. Heretofore the well head has been equipped with numerous pieces of apparatus, each one performing a function by itself. The assembly of these various devices, one above the other on the casing, occupies a considerable elevation and not only make the well appear cumbersome but involve unnecessary couplings, nipples, flanges, and connections. With a view of simplifying the well head equipment and conditioning the same so that it will not only occupy a lesser elevation, but also simplifying the manipulation thereof, the present construction has been devised.

The principal portion of the apparatus includes the casing head 3. This casing head is made up in a compact form and comprises a housing 4, which is adapted to contain the blowout preventer rams 5, and the tubing hanger socket 6. This, in itself, is believed to be a novel arrangement because a considerable elevation has been saved by making the socket 6 and the blowout preventer. 4 as a single piece of equipment.

Attention is particularly directed to the housing 4 for the blowout preventer rams 5. This housing has its lower end 8 threaded at 9 for connection to the casing 2. This lower end 8 merges with the body 10 of the housing as well as the upper end 11 of the blowout preventer. A central passage 12 is provided through the blowout preventer which is preferably of the same diameter as the inside of the casing 2. It is through this passage that the drilling operations are performed, because it is contemplated that this casing head 3 will be positioned on the casing and will be present during the drilling operation, because during this operation the rams 5 can be operated as a blowout preventer to close about the drill pipe in event of excessive well pressure. The body 4 is provided with a transverse chamber 15 which is adapted to receive the rams 5. This chamber 15 intersects the passage 12 at right angles and is best seen in Fig. 4. A ram or valve member 18 is positioned in the lefthand side of the passage 12, as viewed in Fig. 1, and a somewhat similar ram or valve member 19 is positioned on the righthand side. These valve members may have any desired configuration, but as here seen in Figs. 1, 3 and 4, they are somewhat flat semi-circular members having a semi-circular opening 20 adjacent the center thereof.

Beyond the opening 20 the flat faces 21 are provided so that the corresponding faces on the opposite rams will come into engagement with each other to maintain a seal. The rams will be of such configuration that they will fit about the diameter of the drill stem or tubing 17, which is being used in the particular well upon which the apparatus is positioned. The ram members 18 and 19 are provided with a plurality of grooves 22 on their upper and lower faces as well as on the contacting faces which abut each other. These grooves are adapted to receive a suitable packing, it being intended that some form of hydraulic packing or metallic packing may be used. It is understood that where a permanent hook up is being made on a well which produces certain types of oil that rubber packing is entirely unsatisfactory. It is with this in mind that the present type of ram construction has been provided, so that it will suitably support hydraulic packing which packing will withstand the acids encountered.

In order to move the rams 18 and 19 from inoperative to operative position and return, a pair of spindles 25 have been provided. These spindles have been threaded as at 26, which threads engage with corresponding threads in the valve member 18. As seen in Fig. 4, these spindles pass loosely through the openings 27 in the valve member 19. The righthand end of these spindles as viewed in Fig. 4 are carried in a bearing plate 28 and have fastened thereon the pinion gears 29.

These pinion gears are arranged to mesh with the central drive pinion 30, which is mounted on a central shaft 31. This central shaft is threaded at 32 for engagement with the valve member 19. The threads 26 and 32 are so arranged on the spindles that when the central shaft 28 is caused to rotate in one direction to retract the valve member 19 the valve member 18 will also be retracted by rotation of the spindles 25, the same being true when these spindles are rotated in the reverse direction to cause the valve members to move to closed position. In order to impart rotation to the central pinion 30, the shaft 31 is extended as at 33. This extension passes through a retainer plate 34, which serves as a bearing for the ends of the spindles 25 and 31. The extension 33 also projects through the housing cap or bonnet 36, and the end 37 thereof is formed to receive a suitable handle or tool so that the spindle may be rotated. As is well known in the art, any suitable light handle may be attached to this shaft, so that in event of fire the valve can be operated from a considerable distance.

Attention is directed to the construction of the extension 33 as it passes through the bonnet 36 in Fig. 1. In this form it is intended that a suitable packing will be provided as at 39 to maintain a seal about the outer end of the shaft 33. This packing 33 is arranged to be compressed by the gland 40, which is in turn caused to press against the packing by the bonnet cap 41. To prevent the escape of pressure from within the bonnet 36 a suitable packing 43 is provided in the recess 44 in the bonnet. This is shown as a V-type packing with the apex of the V extending outwardly so that any pressure tends to expand the packing and increase the sealing effect thereof. A compression ring 45 is provided which is held in position by a spring 46 which bears against the retainer plate 34. This construction is best seen in Fig. 1.

The chamber 15 is of such size, as seen in Fig. 3, that the rams 18 and 19 can be passed laterally into the chamber in assembling the device. After the rams have been positioned the bearing plate 28, the spindles and the retainer plate, as well as the bonnet 36 are affixed to the apparatus. This particular arrangement is of advantage because this avoids the assembling of the parts with bolted flanges, each of which must be provided with a packing and in event of excessive pressure or fire these flanged connections have been found to be unsatisfactory. With the applicant's device, however, there are absolutely no flanged connections exposed to pressure and because of this it has been found that the applicant's construction is exceptionally satisfactory and is free from leaks and danger of blowout from excessive pressures or heat.

In order to retain the rams 18 and 19 in the position shown in Fig. 1, abutting against the upper seat 48, a spring-pressed ring 49 has been provided. This ring is of a diameter that it may be inserted into the chamber 15 from the side the same as the rams 18 and 19. It is intended, however, that this ring 49 will be urged upwardly against the rams so that the upper face 50 thereof serves as a seat for the rams. In this manner the seats 48 and 50 will be maintained in contact with the rams at all times, because the ring 49 is urged upwardly by a series of small coil springs 51. These springs are disposed in the recesses 52' in the lower side of the ring 49. The inside of the ring 49 is composed of a downwardly extending flange 52, which serves to protect the springs 51 and this flange is arranged to move down against the shoulder 53 when the ring is in its lowermost position. The outer periphery of the ring 49 is cut away to receive the packing 54, which may be of any desired type, so that it will prevent the escape of pressure around the underside of the ring 49. This construction provides for a more or less resilient mounting of the rams and in event of excessive pressure in the well the pressure will pass underneath the ring 49 and increase the pressure on the seats 48 and 50. It is to be understood that the mounting of the rams and spindles in the housing will permit this limited vertical movement of the rams.

Above the chamber 15 the upper part of the housing 11 of the apparatus 4 has been provided with the flow lines 55 and 56, which extend in opposite directions from the housing. These flow lines may be used during the drill-operation to lead off the flow of flushing mud or they can be used in leading off a flow of any fluid from the casing 2. Directly above these flow lines 55 and 56 is the casing head socket or slip bowl 6. This bowl is preferably tapered in a manner well known and is provided with a flange 57, which is adapted to receive the flange 58 of the closure member or tubing hanger 59. Suitable bolts 60 are provided to connect the flanges 57 and 58.

The lower portion 61 of the closure member or tubing hanger 59 is of a type well known and is provided with a central opening to receive a piece of pipe 62, which is a continuation of the drill pipe or tubing 17. A coupling 63' serves to connect this piece of pipe 62 with the string of pipe which extends downwardly into the well. The periphery of the portion 61 is provided with suitable packing 63 to form a seal with the socket or bowl 6. Tubing hangers having this type of connection are well known, but in the present instance the closure member 59 has been constructed with an upper portion 65, which contains the plug valve 66. This valve is best seen in Fig. 2 and includes the rotor 67, which has an opening 68 therein of the same size as the opening 69 in the closure member.

The rotor 67 in the closure member is mounted with one end in the recess 70 and the opposite end in the recess 71, these recesses being on opposite sides of the passage 69. The rotor 7 is provided with a stem 72 which is arranged to receive a handle or tool at 73 to permit its rotation. A suitable retainer cap 74 is shown as being bolted to the body 75 in order to retain the rotor in proper position. A suitable packing assembly 76 seals about the stem 72 to prevent any leakage.

Attention is directed to the sturdy construction of this tubing hanger and plug valve, so that they will not be damaged by falling equipment and will withstand the enormous pressures encountered in the type of wells now being drilled.

The upper end of the body 75 may be threaded as at 77 to receive a valve 78. This valve may be closed when desired to cut off a flow of fluid through the tubing and serves as a base for the Christmas tree assembly which is part of the usual well head equipment.

The present invention contemplates a novel method of bringing in wells so that complete control may be had of the well during all the steps of such operation. It is to be understood that while the well is being drilled the well bore is filled with a heavy mud which is circulated to carry away the cuttings and overcome the pressures encountered in the productive formations being drilled.

When, however, the drilling operation is completed it is necessary to remove this mud and position the screen and tubing in the well to the oil or gas. The screen must be located in the bottom of the well and cleared of the heavy mud which tends to clog the same. In so doing it is the usual practice to run the tubing and screen into the well while the well is filled with mud and then to gradually replace the mud with clear water. This operation is known as washing the well and the screen is washed during this same operation.

A critical time in bringing in a well is that period after the drilling has been completed and when the drill stem must be removed from the well and the screen and tubing run into position. During this operation it is necessary to have provided a control apparatus so that in event the pressure exerted by gas in the formation in the bottom of the well is greater than the weight of the column of liquid in the well, the casing and tubing may both be quickly closed. In practicing the present method the rams 18 and 19 are present and may be quickly closed about the pipe which may be the drill stem or the tubing. If the blowout is imminent at the time the drill stem is being removed, the rams may be quickly closed about the pipe and the first coupling below the rams will then abut against the lower side of the rams and prevent further upward movement of the drill pipe. The closure member 59 can then be connected to the projecting upper end of the drill pipe which is typified in the construction by the piece of pipe 62. After the closure 59 has been screwed onto the piece of pipe, the plug valve 67 could be turned to closed position and the area outside of the pipe and within the casing would be closed by the rams, whereas the passage through the drill pipe would be closed by the plug valve.

The most dangerous period, however, in bringing in the well is that period when the tubing and strainer are being landed and after the heavy mud has been washed from the well. The specific gravity of the water which has been used to replace the mud is much less than the mud so that if a considerable pressure is present in the formation it tends to blow out the column of water. The pressure against the formation is less at this period than at any other time during the drilling or tubing operations. It is at this period of setting the tubing and washing the well that a majority of the blowouts occur. The present method contemplates a manner of bringing in the well which will permit almost immediate closing of the complete well. Thus, if the pipe 17 is a string of tubing being run into the well, then the coupling 63 will be the uppermost

member on the uppermost section of the pipe. As this pipe is being lowered to its final position, if the operator believes that a blowout is imminent, he may quickly pick up the closure head 59, which will preferably have the pipe 62 connected thereto, and it will only be necessary to thread the pipe 62 into the coupling 63 in order to attach the closure member, it being understood that a set of slips are usually employed in the slip socket 6 to support the string of tubing 17 while it is being lowered into the well. Thus, at any stage of the lowering operation of the tubing, if the operator believes that the well pressure is overcoming the weight of the column of liquid in the well, he may quickly procure the closing member 59 and merely attach it to the uppermost coupling.

Elevators are used to handle this closure member 59 and as soon as it has been attached to the coupling 63' the elevators may be raised slightly to release the slips which will be supporting the pipe 17 below the coupling 63' in the slip bowl 6. As soon as these slips are removed, then the closure 59 may be lowered to the position shown in Fig. 1 and the bolts 60 quickly drawn up. As soon as the coupling 63' has passed the elevation of the rams, the rams can be quickly closed and the operator will have complete control of his well by merely turning the plug valve 66.

In various types of equipment now in general use a lift nipple is required to support the pipe or tubing in a hanger below the gate member or rams of the blowout preventer. No such equipment is required with the present method and apparatus and there are several instances where a well has blown out due to difficulty in manipulation of these lift nipples. This applicant has avoided this construction and, as an additional feature of safety has a back pressure valve on a frangible disc which may be positioned at any elevation in the tubing while it is being lowered into the well.

My device is constructed to meet emergencies which are encountered in the production of oil and gas even where the gas is under high pressure. The outlets 55 and 56 from the casing head allow flow of fluid from within the casing and outside the tubing. They are usually equipped with valves which can be closed to shut off the escape of fluid through these outlets. However, the valves may wear and become unsafe and have to be replaced. The wearing of the valves sometimes takes place very quickly due to the high pressure with which gas and abrasive material blows through very slight leaks therein. This necessitates the replacing of the valves and in my structure the closing of the blowout preventer below these outlets will allow me to change valves or repair leaks.

Also, the valves which are connected in the flow line or Christmas tree, which is usually connected above the nipple 77, are apt to leak or become broken. This may happen through the flow of abrasive material through leaks in the valves, or objects may be dropped from the derrick upon these fittings and render it necessary to replace the same. In applicant's device the outlets 55 and 56 may be opened and the valve 67 closed and any repairs desired in the flow line may be accomplished. I am thus enabled to make repairs and prevent blowouts at any time in the operation of my device without danger.

It is also a dangerous circumstance when the pressures encountered in the well attain an excessive amount. The ordinary casing is tested to about two thousand pounds pressure per square inch. In some gas field pressures as high as three thousand pounds are encountered. After the valves and blowout preventers have been closed, there is still great danger of a blowout and the operator may observe gas bubbling up around the well which has escaped upwardly around or through the casing and outside of the well equipment. The only thing to do in this case is to provide a vent for the gas and this is done by opening valves either in the casing or the tubing or both. However, due to the high pressures which tend to blow out through the fittings, wear occurs quickly, and it is dangerous to shut off both the outlets from the casing and the tubing simultaneously. However, with my arrangement, the valves in the flow lines 55 and 56 may be repaired by closing the blowout preventer and allowing flow through the valve 67 or if the valves in the flow line or tubing become defective the valve 67 may be closed and the flow may take place through the outlets from the casing head with the blowout preventer open. I am thus enabled to provide a vent for excessive pressures without danger of blowout and without the necessity of killing the well by pumping heavy mud therein through the outlets. This assembly of devices accomplishing this purpose is an important feature of my invention.

While a particular apparatus has been shown and described as being used in practicing the present method, it is to be understood that any desired equipment may be used in practicing the method and that the invention is to be limited only by the appended claims.

I claim:

1. In combination, a well casing, a casing head thereon, lateral outlets from said casing head, a tubing in said casing, means on said tubing forming a seal with the upper end of said casing head, a blowout preventer forming part of said casing head and below said outlets in said casing head, and a valve in said tubing controlling the flow of fluid therethrough.

2. A well casing, a casing head thereon, lateral outlets in said casing head, a tubing in said casing, a blowout preventer in said casing head below said outlets to close the space about said tubing, a tubing hanger adapted to support said tubing and to form a fluid tight seal in said casing head, an upper threaded extension on said hanger to connect with a flow line, and a valve in said extension above said casing head.

3. A well casing, a casing head thereon, a tubular member in said casing, lateral outlets from said casing head, a tubing hanger on said member engaging within said casing head and closing the upper end thereof, means to control the passage of fluid through said tubular member, and means in said casing head below said outlets to control the passage of fluid upwardly in said casing to said outlets.

4. A well head closure assembly including a combination tubing hanger and closure, casing head and blowout preventer, comprising a housing, a casing connection on the lower side thereof, a hanger seat on the upper side thereof, rams disposed in said casing to close about the tubing as a blowout preventer, a tubing hanger seated in said hanger seat, and a tubing suspended therefrom, and about which said rams are adapted to close, and means on said hanger to close the tubing.

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