

Dec. 14, 1943.

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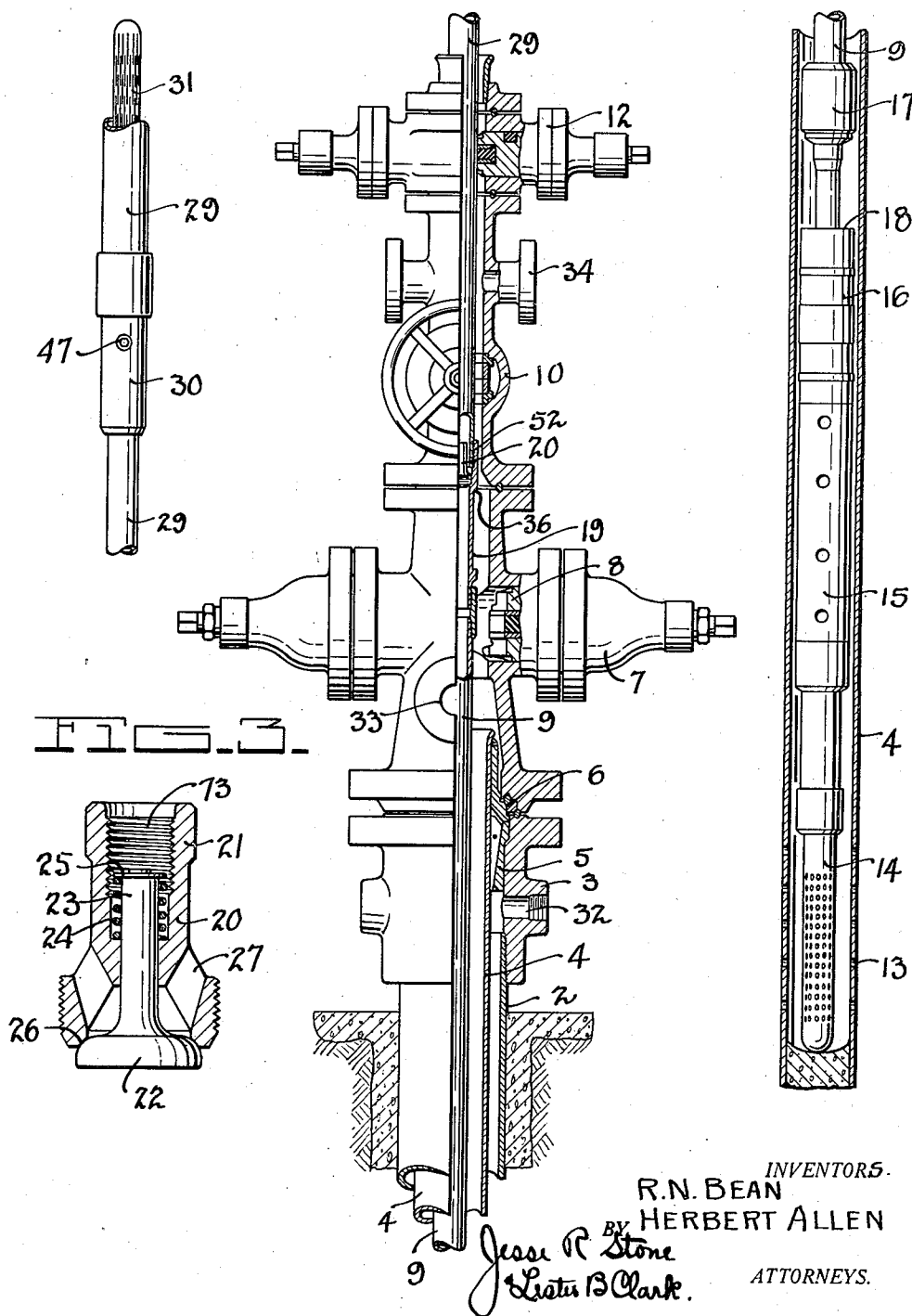
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SYSTEM FOR SETTING WELLS TO CONTROL TUBING PRESSURE

Original Filed May 9, 1939

4 Sheets-Sheet 1

FIG. 1. FIG. 2. FIG. 4.



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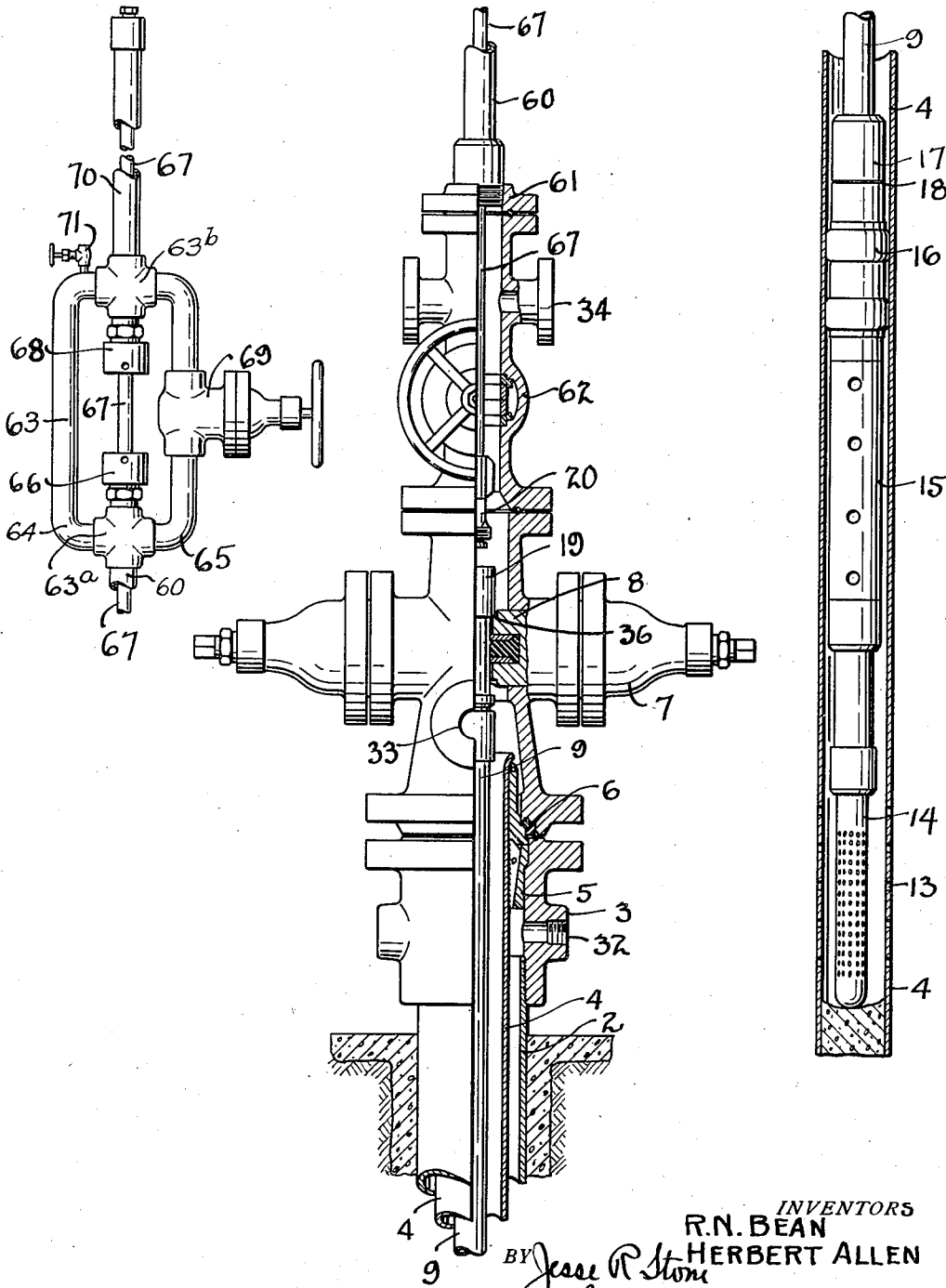
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FIG. 5. FIG. 6. FIG. 7.



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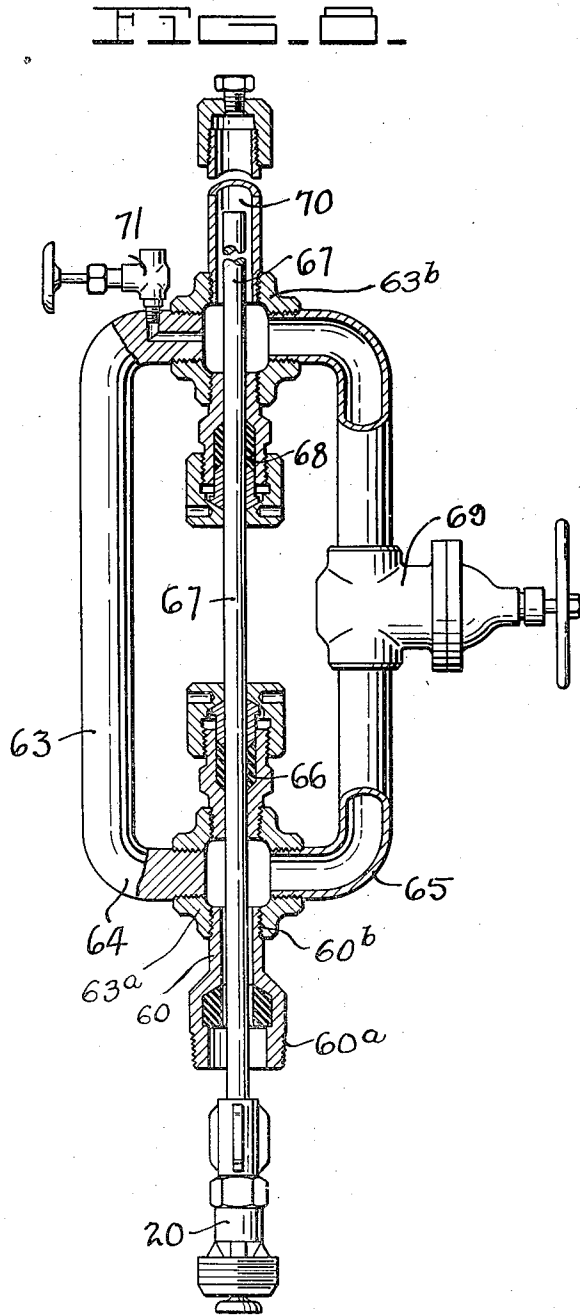
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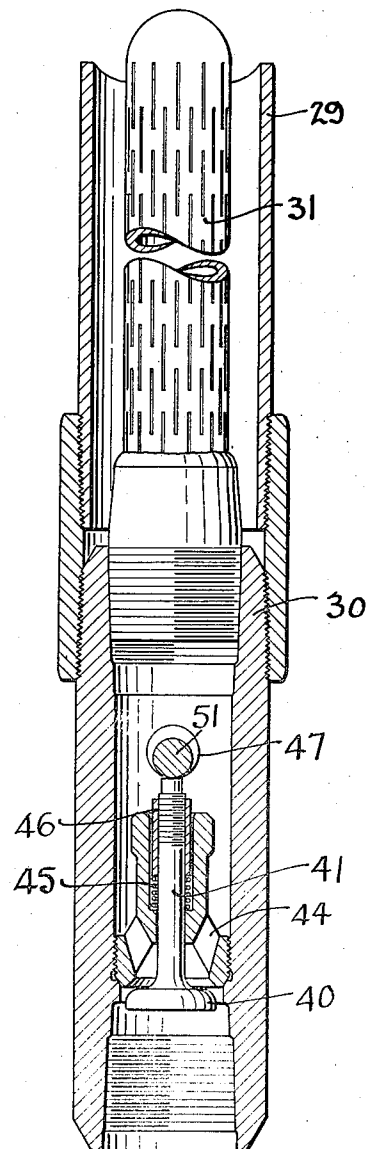
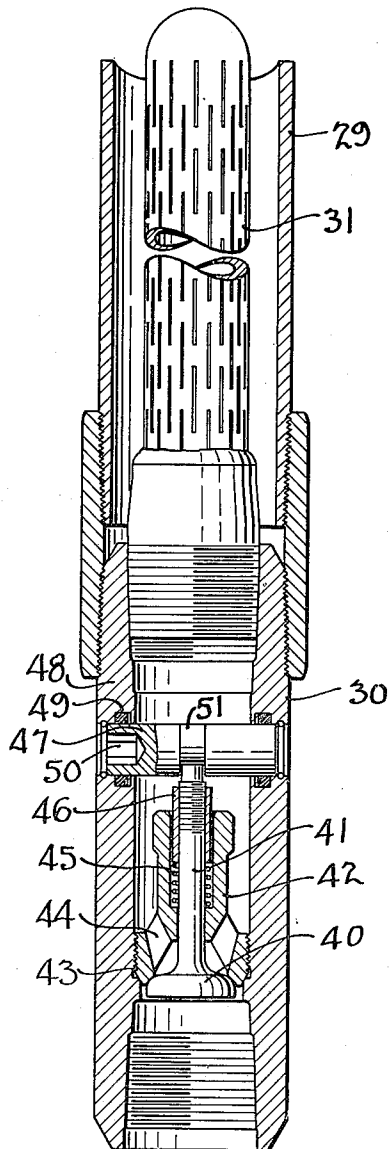
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FIG. 9.

FIG. 10.



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2,336,977

SYSTEM FOR SETTING WELLS TO CONTROL TUBING PRESSURE

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Continuation of application Serial No. 272,577,
May 9, 1939. This application October 14, 1940,
Serial No. 361,128

5 Claims. (Cl. 166—15)

The invention relates to a system for setting wells to control the tubing pressure so that the well may be completed in order to produce after the drilling has been finished without releasing the pressure from the formation which is present in the well.

This application is a continuation application for our prior application Serial No. 272,577 filed May 9, 1939.

In the rotary method of drilling the heavy drilling mud is present in the well when the drilling is finished. This heavy mud overcomes the pressure from the formation which is present in the well. It is necessary, however, to replace this drilling mud with water or to otherwise wash the mud out of the well and when this is done the lighter liquid which replaces the mud is usually insufficient to overcome the pressure in the well so that as the drilling equipment is removed from the well and the flowing equipment added it is necessary to maintain a closure at the upper end of the well or at the well head.

The usual practice is to run a strainer, packer and string of tubing into the well so that the strainer will be located at the elevation of the producing formation and a packer is set about the upper end of the strainer in the well casing to compel the flow to pass through the strainer and into a string of tubing. This equipment must be lowered into the well bore and suitably positioned while the pressure is on the well bore. When it is understood that these pressures are sometimes as great as five thousand pounds per square inch it is apparent that every precaution must be taken to manipulate the parts while maintaining a seal to prevent this pressure from escaping and ruining the well.

It is particularly necessary that the pressure be controlled after the well has been washed to remove the heavy drilling fluid and the present invention concerns itself particularly with the type of equipment used at the well head in order to maintain the pressure in the well bore while connecting and disconnecting the various fittings.

An object of the invention is to provide a system for completing wells wherein the washing of the well, the landing of the tubing, and the replacement of the drilling equipment is accomplished while maintaining a seal on the well.

Another object of the invention is to provide various pieces of detailed equipment which are particularly useful in completing a well under pressure.

Another object of the invention is to provide

a release valve for setting nipples used in completing wells.

Another object of the invention is to provide an equalizer unit to be connected to a well head in order to remove a tubing back pressure valve without releasing the pressure in the well.

Other and further objects of the invention will be readily apparent when the following description is considered in connection with the accompanying drawings wherein:

Fig. 1 is a side elevation of the release valve for the setting nipple used in practicing the invention.

Fig. 2 is a side elevation with certain parts in section illustrating the washing of the well and is a continuation of the lower end of Fig. 1.

Fig. 3 is a vertical section of the tubing back pressure valve which is removably carried by the upper end of the tubing.

Fig. 4 is a side elevation showing the casing in section and illustrating the position of the well bottom assembly when the well is being washed as shown in Fig. 2.

Fig. 5 is a side elevation of the pressure equalizer unit used in removing the tubing back pressure valve.

Fig. 6 is a side elevation partly in section illustrating the manner of removing the tubing back pressure valve after the tubing has been landed and the production fittings attached to the well head.

Fig. 7 shows the well bottom assembly with the packer set by the landing of the tubing when the parts are in the position of Fig. 6.

Fig. 8 is an enlarged view partly in section of the pressure equalizing unit of Fig. 5.

Figs. 9 and 10 are vertical sectional views of the setting nipple release valve, Fig. 9 showing the valve closed and Fig. 10 showing the valve open.

In Fig. 2 the well surface casing is indicated generally at 2 and serves as a support and hold-down for the well head 3. This head is illustrated as carrying the well casing 4 which is landed on a hanger 5 and clamped in place by the hold-down assembly 6. This assembly is in turn held in place by a blowout preventer or other form of closure 7 which has movable rams 8 to close about the string of tubing 9 which is to be hung in the well.

A master valve 10 is mounted on the blowout preventer and this is in turn surmounted by a second blowout preventer 12.

The equipment just described is that which may have been positioned on the well during

the drilling operation or there may have been other and heavier equipment on the well. As seen in Fig. 2, the drilling operation has just been completed, and the well bottom assembly and the tubing string have just been run into the well which still contains the drilling mud.

The well bottom assembly is best seen in Fig. 4, wherein the well casing 4 is illustrated as having been perforated at 13 to permit the entry of fluid from the formation. The well bottom assembly includes the strainer 14, the inlet control valve 15, the packer 16, and the sealing valve 17. The wash pipe or tubing 9 supports these parts as they are being lowered into the well bore and the valve 17 which is arranged to seat at 18 is open so that the well may be washed and mud circulated from the bottom of the well bore. The particular construction of this well bottom assembly is disclosed in the copending application of Herbert Allen Serial No. 291,180 filed August 21, 1939, for a Tubing valve and a continuation thereof Ser. No. 499,393 filed August 20, 1943 for Circulating type packer and valve therefor.

When the well bottom assembly and tubing is lowered into the well bore the coupling 19 at the upper end of the tubing will be equipped with a back pressure valve indicated generally at 20 in Fig. 2 and shown in detail in Fig. 3. This back pressure valve includes a housing 21 and a valve member 22, which includes the stem 23. A spring 24 seated in a recess in the housing bears against a flange 25 on the valve stem to normally hold the valve member raised and in engagement with the valve seat 26. This closes off the passages 27 through the valve. The valve opens downwardly and will be normally closed except when it is forced open by pressure from above. In this manner upward flow through the tubing 9 is normally cut off.

Above the valve 20 a setting nipple 29 is connected to coupling 19 in order to manipulate the string of tubing 9. The upper end of this setting nipple 29 is best seen in Fig. 1 and carries a valve housing 48 which incorporates a particular valve 30 shown in Figs. 9 and 10, and which will be later described. Above the valve 30 the setting nipple is provided with an internal strainer 31 which keeps any extraneous matter from entering into the tubing and wash line during the washing operation. The upper end of this nipple will be connected to a suitable swivel or other device so that liquid under pressure may be pumped into the well to displace the heavy drilling mud which is in the well when the drilling operation is finished.

It is desirable to support only a certain portion of the weight of the tubing on the bottom of the well and to support the remainder in a suitable hanger such as the blowout preventer 7. To accomplish this the setting nipple 29 is manipulated until the strainer 14 rests on the bottom of the well, as seen in Fig. 4, and then the tubing is raised the desired amount and the section or coupling 19 inserted, which is of a suitable length so as to provide a shoulder 36 on the tubing which can be supported upon the rams 8 of the blowout preventer 7 as seen in Fig. 6.

In order to wash the well the upper blowout preventer 12 is closed about the setting nipple to form a seal and the washing liquid is then returned upwardly and may discharge from the outlet 33 in the blowout preventer 7 or some may discharge from the flow connections 34 above the master valve 10, or as another alter-

native the blowout preventer 7 instead of the preventer 12 may be closed about the coupling 19.

It should be borne in mind that during this entire manipulation the heavy drilling mud has prevented the formation pressure from blowing out and that now during the washing operation when the heavy drilling mud is displaced by water or other lighter liquid, the well approaches its most dangerous condition and the greatest precaution must be taken. The outlets 33 and 34 will be suitably controlled by valves so that they may be closed at any time, and, of course, the seal of the blowout preventer 12 about the setting nipple 29 completely closes off the well. The flow line connections 32 of the well head 3 will of course be closed.

When the washing operation is completed it is now necessary to land the tubing in suitable position, it being understood that during the washing operation the tubing was raised from the position in which it would eventually land and in some instances it is raised and lowered during the washing operation to agitate the well and may be rotated because of the non-rigid support or connection with the blowout preventer which is both closing about the pipe and acting as a support.

The setting nipple 29 is now lowered somewhat so that when the strainer 14 rests on the well bottom as seen in Fig. 7, the tubing 9 will telescope downwardly inside of the packing 16 moving the valve 17 so that it contacts the seat at 18. The weight of the string of tubing thus serves to expand the packers 16, as seen in Fig. 7, to form a seal with the casing. The rams 8 of the blowout preventer 7 are now moved inwardly so as to receive the shoulder 36 of the upper end 19 of the tubing so that the desired proportion of the weight of the string of tubing will be carried by the rams and the entire weight will not be supported on the bottom of the well.

The tubing is now properly landed and is supported on the rams 8, as seen in Fig. 6. The washing liquid has been forced through the setting nipple 29, the valve 30 and the valve 20 under pressure, and after the tubing is landed this fluid pressure is still present in these parts and it is necessary to release the pressure in the setting nipple 29 before it can be unscrewed from the upper end 19 of the string of tubing. To accomplish this end the valve 30 is manipulated to release this pressure.

The valve 30 is best seen in Figs. 9 and 10 and includes a valve member 40, which is carried on a stem 41 slidably mounted in the body 42. The valve member engages a seat 43 so as to close the ports 44, while the coil spring 45 normally urges the valve to seating position. The pressure on the spring 45 may be adjusted by turning a sleeve 46 to adjust the compression on the spring.

During these operations the valve 30 will generally be exposed above the top of the uppermost fitting 12 on the well and the valve 30 is so arranged that it may be opened or closed from the outside of the nipple. To accomplish this a shaft 47 is rotatably mounted in the walls of the coupling 48 and suitable packing 49 prevents leaking around this shaft. A non-circular opening 50 will admit a suitable tool so that this shaft 47 may be rotated. The stem 41 is connected to an eccentric portion 51 of the shaft 47 so that as this shaft is turned the valve will be forced downwardly as seen in Fig. 10. In this manner any pressure present in the setting nipple below the valve 30 may be released by turning of the

shaft 47 to open the valve. When the shaft 47 has thus been turned it is possible to unscrew the setting nipple at 52 in Fig. 2 from its connection with the coupling 19 at the upper end of the tubing. The back pressure valve 20 connected into coupling 19 prevents the escape of pressure through the inside of the tubing and the fact that the blowout preventer rams 8 are closed about the portion 19, as seen in Fig. 6, prevents any escape whatever of pressure from the well.

The setting nipple 29 can be removed and any fittings above the blowout preventer 7 can also be removed because the well is completely closed by the rams 8 and the valve 20. The usual practice is to remove the larger fittings such as a large valve 10 and the blowout preventer 12 and to replace these with smaller valves which will merely permit the passage of the tubing 9, whereas the larger valves present during the drilling operation would permit the passage of the drill stem and drill bit.

When the suitable fittings for the production of oil have been added it is then desirable to open up the tubing so as to permit a flow of oil or gas from the well. To accomplish this a pressure equalizer unit is connected to the upper end of the master valve 62 of the well casing apparatus. This unit is shown in elevation in Fig. 5 and the detailed construction thereof in Fig. 8.

This equalizer unit includes a tubular element 60 having a lower externally threaded area 60a, connected into a flange 61 and an upper threaded area 60b connected into a hollow lower union 63a and communicating therewith. Flange 61 is mounted upon the upper flange of a gate valve or master valve 62 which may be the same as the valve 10 but is preferably a valve of somewhat smaller size. In any event this equalizing unit is made up of a body 63, which comprises a solid arm 64 and a hollow arm 65 which are in the form of a yoke with their adjacent lower ends threaded into said hollow lower union, into which is also threaded the lower stuffing box 66 through which a rod or stem 67 is arranged for sliding movement. The passage in hollow arm 65 communicates with the hollow lower union.

The upper portions of the arms are connected into a hollow upper union 63b, which also carries a stuffing box 68 aligned with stuffing box 66 and slidably sealing about the rod 67 at its upper end. A valve 69 in hollow arm 65 may be closed to cut off the flow of fluid through this hollow arm. The upper end of the stem 67 runs into a chamber 70 which may be of any desired length and communicates with hollow arm 65 through the upper union. A needle valve 71 is connected into the arm 64 and a fluid passage in the arm leads from valve 71 into the chamber 70 so that fluid pressure may be released from this chamber.

The lower end of the stem 67 is externally threaded and the stem passes downwardly through the tubular element 60 and engages within the threads 73 inside the housing 21 of the tubing back pressure valve 20, Fig. 8 showing the valve 20 as connected to the lower end of the stem. The lower threaded end of the stem 67 is of sufficient length so that when it is turned relative to the threads 73 in one direction it will engage the stem 23 of the valve member 22 and cause the valve to move to open position if the stem is threaded into the valve body 21 a sufficient distance. This equalizer unit when connected to the flange 61 is arranged to remove the tubing back pressure valve 20. When the valve

20 is opened as has just been described the fluid pressure will flow upwardly along the stem 67 and into the arm 65. In order to prevent excessive pressure on the stem 67, however, the valve 69 will be opened so that this pressure is available in the chamber 70 and therefore the pressure on the cross sectional area of the stem 67 will be equalized and there will be no tendency for the well pressure to blow the stem 67 upwardly. The stem 67 can be manipulated by connecting a suitable wrench to it between the stuffing boxes 66 and 68.

With the parts in the position just described the well pressure is now available in the arm 65 and the chamber 70 and back pressure valve 20 can be readily unscrewed from coupling 19 by turning the stem 67. When the back pressure valve has been unscrewed from coupling 19 it is then desirable to raise it a sufficient distance so that the master valve 62 may be closed to completely cut off the well. To accomplish this the valve 69 is now closed and the needle valve 71 is gradually opened to release the fluid pressure from the chamber 70. This release causes a reduction in pressure on the upper end of the stem 67 so that the well pressure will automatically move the stem upwardly or it may be raised manually to raise the valve 20 above the gate member in the master valve 62. The master valve can now be closed and the well is completely cut off with the well pressure available in the head. The valve 69 is now open so as to release the pressure in the lower part of the arm 65 and if desired this pressure can in turn be released through the needle valve 71. In this manner pressure on the equalizer unit is removed and the entire unit can be disconnected from the well. A suitable bull plug or flow line can then be used to close the upper end of the valve 62 in Fig. 6. The well has now been completely washed, the tubing landed and is ready to be turned into production.

If the production of the well is to pass through the flow lines above the master valve it is only necessary now to open the master valve and open the flow line valves which will be connected on the outlets 34 and the well is ready to produce under its own pressure. The procedure just described may be reversed if the tubing is to be removed or the well reworked.

What is claimed is:

1. In an assembly of equipment for completing wells under pressure, a string of tubing, a tubing back pressure valve at the upper end thereof to prevent upward flow therethrough, a setting nipple connected above said valve to said tubing so that liquid under pressure may be pumped into said tubing, and a release valve in said nipple normally closed to upward pressure in the nipple and operable whereby the pressure residing within the nipple after the washing operation may be released without releasing the well pressure in the tubing below said back pressure valve.

2. A pressure equalizer unit for completing wells under pressure including a body made up of spaced arms, a packing gland at each end of the body, a stem slidable in said glands, an enclosure for one end of the stem, a passage from one end of said body around said glands to said enclosure, a valve in the passage for controlling flow therethrough, and a release valve operable to release the fluid under pressure from the enclosure.

3. A pressure equalizer unit for completing wells under pressure including a body made up

of spaced arms, a packing gland at each end of the body, a stem slidable through said glands, an enclosure for one end of the stem, a passage through said body and one of the arms, a valve in the passage in said one of the arms for controlling flow therethrough, a release valve to release the fluid under pressure from the enclosure, said body being arranged to be connected to a well tubing to communicate said passage in said body with said tubing, and means on said stem to engage a valve member positioned in said tubing.

4. A pressure equalizer unit for completing wells under pressure including a body made up of spaced arms, a packing gland at each end of the body, a stem slidable in said glands and exposed between the glands to be engaged for movement thereof, an enclosure for one end of

the stem, a passage from one end of said body to said enclosure at the other end, and a release valve operable to release the fluid under pressure from the enclosure.

5. A pressure equalizer unit including a body having aligned spaced openings with packing means therein and an open space therebetween, a stem slidable in said openings and sealed about by said packing means and exposed in the space between the packing means to be engaged for movement thereof, an enclosure for one end of the stem, and means connecting and providing a passage from one end of said body past said packing means to said enclosure at the other end, and a release valve operable to release the fluid under pressure from the enclosure.

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