Dec. 12, 1939. W. L. CHURCH 2,182,890

PRODUCING EQUIPMENT FOR WELLS

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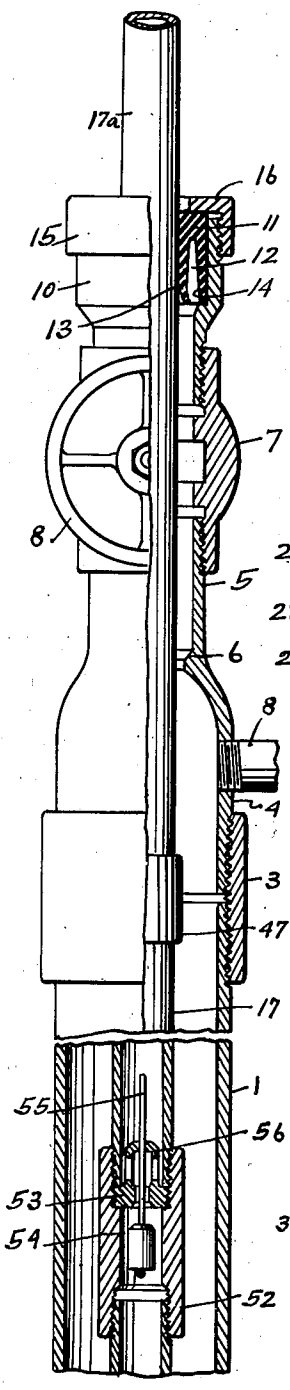


Fig. 1.

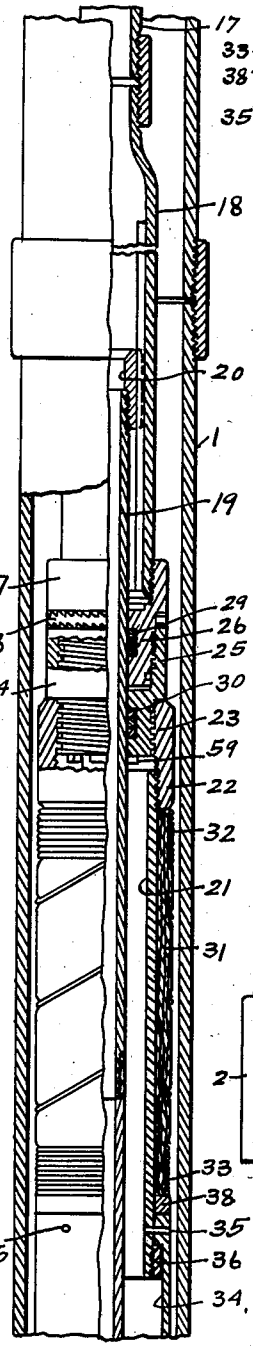


Fig. 2.

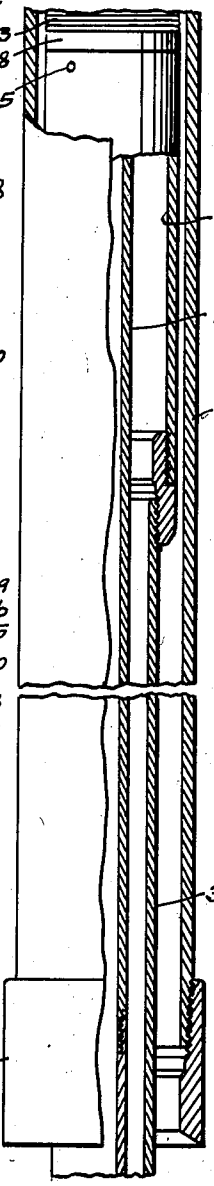


Fig. 3.

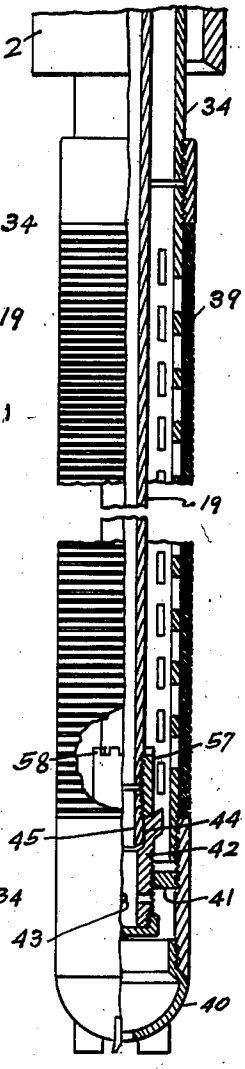


Fig. 4.

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PRODUCING EQUIPMENT FOR WELLS

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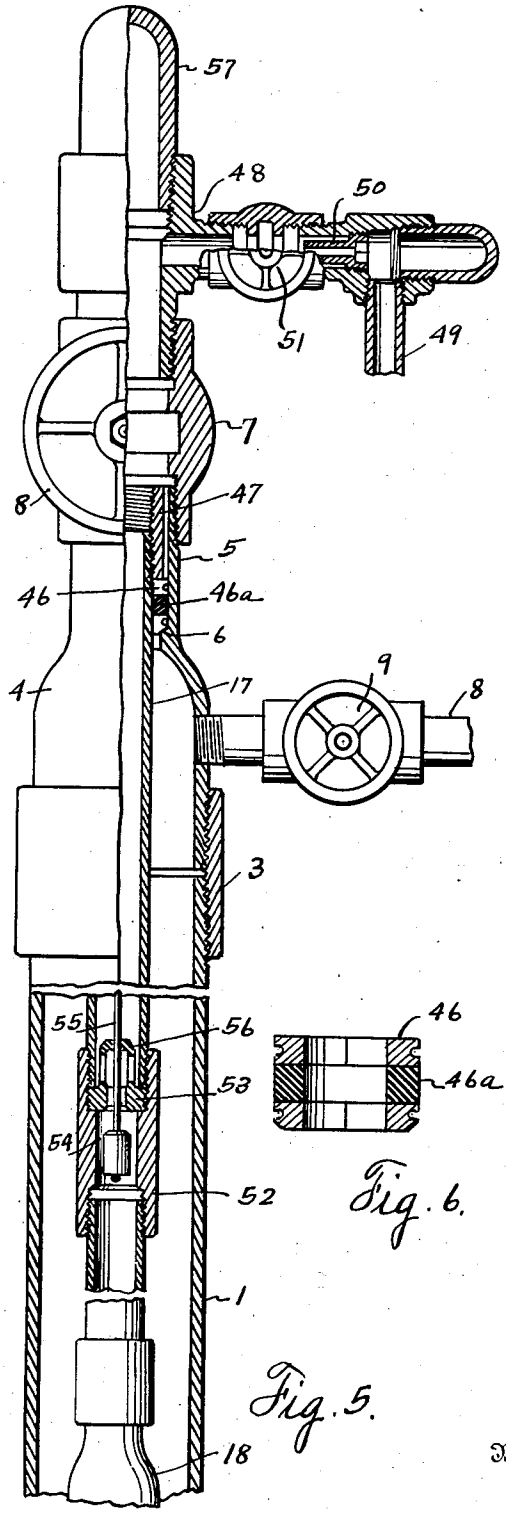


Fig. 5.

Fig. 6.

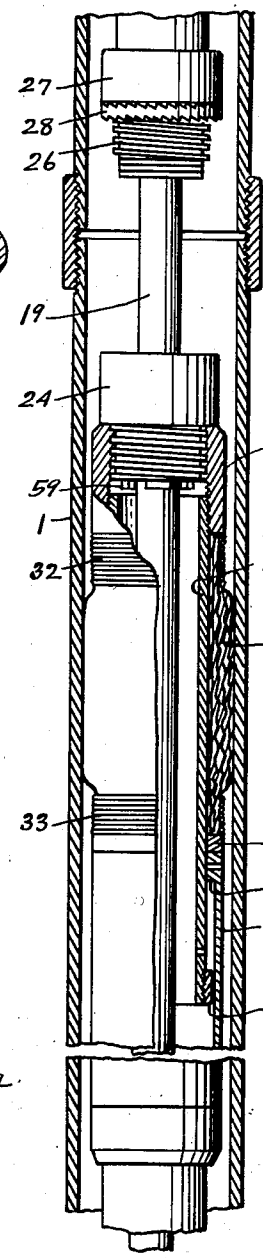


Fig. 7.

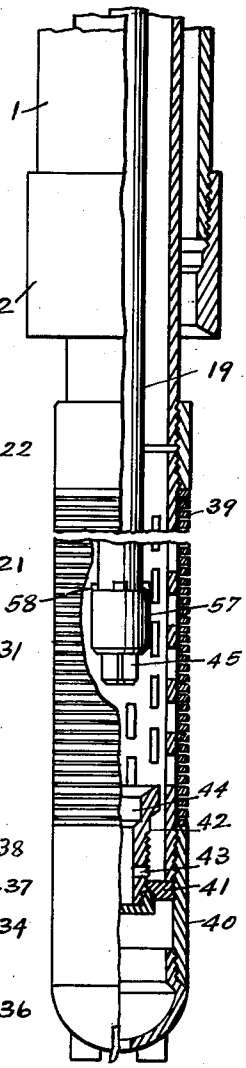


Fig. 8.

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UNITED STATES PATENT OFFICE

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PRODUCING EQUIPMENT FOR WELLS

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11 Claims. (Cl. 166—15)

This invention relates to producing equipment for wells.

An object of the invention is to provide producing equipment for wells particularly oil wells, wherein the liquid flows under pressure from the well; and relates also to the method of installing the equipment.

In the production of oil from flowing wells, it is usually necessary to restrain the flow in order to comply with proration regulations. The flow of oil from the well may be restricted by providing a choke in the flow line or the well may be permitted to flow until the daily allowable is produced and then closed. In either event the casing or outer string of pipe permanently set in the well is subjected to high pressure, usually from two thousand to three thousand five hundred pounds per square inch for long periods of time when production equipment now commonly used is employed. As a result the casing or outer string often develops leaks at the couplings and inasmuch as the liquid flowing from the well is usually laden with sand and grit, the passageways through which the leaks occur are quickly enlarged, thus causing a loss of the oil and sometimes completely ruining the well. It is one of the prime objects of this invention to provide equipment of the character described embodying a flow tubing within the casing through which the oil under pressure may flow from the well, said tubing being sealed or packed off from the casing both at its upper and lower ends, whereby the casing will be relieved of pressure of the liquid after the well is once completed, and is equipped for production.

It is another object of the invention to provide producing equipment of the character described wherein provision is made for reciprocating the tubing in the well, meanwhile maintaining said seals to relieve the casing of the well pressure. It is desirable to reciprocate the tubing as specified, that is, to adjust it so that its lower end will be submerged in the liquid in the well the required distance to obtain the best oil gas ratio.

Another object of the invention is to provide in apparatus of the character described, a flow valve assembly in the tubing arranged to be manually closed from the ground surface or to be automatically closed in case of increased velocity of the liquid flowing through the tubing.

It is a further object of the invention to provide production equipment of the character described wherein provision is made for detaching the tubing from the liner packer whereby the tubing and the appendants thereon may be withdrawn from the well for any reason, as, for example, when it is no longer necessary to prorate the well and it is desirable to place a pump in the well.

With the above and other objects in view the invention has particular relation to certain novel features of construction, operation and arrangement of parts, an example of which is given in this specification and illustrated in the accompanying drawings, wherein:

Figure 1 shows a side view partly in section of the upper end of the apparatus as equipped for lowering the tubing and showing the tubing therein.

Figure 2 shows a side view partly in section showing the liner packer connected to the tubing and in collapsed position.

Figure 3 shows a side view partly in section showing the lower end of the casing with the liner and wash pipe therein.

Figure 4 shows a fragmentary side view partly in section of the screen beneath the casing showing the wash pipe therein.

Figure 5 shows a side view partly in section illustrating the upper end of the equipment as installed for production.

Figure 6 shows a vertical sectional view of a type of seal employed.

Figure 7 shows a side view partly in section of the liner packer in expanded position and associated parts, and

Figure 8 shows a side view partly in section of the lower end of the casing and liner and the screen connected to the liner with the back pressure valve closed and the wash pipe in the position it will occupy when the tubing is anchored in elevated position.

Referring now more particularly to the drawings wherein like numerals of reference designate similar parts in each of the figures, the numeral 1 designates a well casing or outer string adapted to be permanently set in a well bore and having the set shoe 2 on the lower end thereof.

Connected to the upper end of the casing 1 by means of the coupling 3 there is a tubular head 4 whose upper end is reduced in diameter forming the neck 5 which has the inside seat 6.

Attached to the upper end of the neck 5 there is the valve casing 7 which is controlled by the conventional gate valve operable by the hand wheel 8 whereby the upper end of the casing may be opened or closed at will.

Beneath the seat 6 the head has the outflow line 8, to be opened and closed by the control valve 9.

While lowering the liner, screen and tubing there is a packing bowl 10 attached to the upper end of the valve casing 7 and containing an annular resilient packer 11 whose lower end is provided with an annular groove 12 forming the inner lip 13 to fit closely around the tubing and the outer lip 14 to fit closely within the bowl. The packing 11 is retained in place by an annular cap 15 which is screwed on to the upper end of the bowl 10 and which has an annular inwardly extended flange 16 which abuts the upper end of the packing. While the tubing is being lowered it will be closely surrounded by this packing to prevent the escape of gas or oil from the casing and this gas or oil may be relieved through the line 8.

The numeral 17 designates the tubing through which the production normally flows from the well. Attached to the lower end of this tubing there is a bell shaped nipple 18 whose lower end is telescoped over the upper end of the wash pipe 19. On the upper end of this wash pipe there is a tubular head 20 which has a splined connection with the nipple 18 as shown in Figure 2.

The numeral 21 designates a tubular packer body whose upper end is provided with an external coupling 22 which is screwed thereon and whose upper end has the internal, coarse, left hand threads 23 into which the lower end of the box member 24 of a tool joint is threaded. This box member has the internal coarse left hand threads 25 to receive the pin 26 of the pin member 27 of said tool joint. This pin member is screwed to the lower end of the nipple 18 and between the tool joint members 24, 26 there is an annular ratchet ring 28 which is mounted on the pin 26 and which has upper and lower ratchet teeth as shown in Figure 2 to engage the opposing annular faces of the pin and box members to prevent them from becoming too tightly screwed together. The wash pipe extends downwardly through said tool joint and is surrounded by the upper and lower packing 29 and 30 located within the pin and box members of the tool joint as also shown in Figure 2.

Around the packer body 21 there is an expansible sleeve like packer 31 whose upper and lower ends are suitably retained in place by the upper and lower wire wrapping 32, 33 or other suitable means.

A tubular liner 34 has its upper end pinned to the lower end of the packer body by means of suitable frangible pins as 35.

The lower end of the packer body has an external coupling 36 screwed thereon and the upper end of the liner is inwardly thickened forming an inside annular shoulder 37 adapted to rest on the coupling 36. A ring 38 surrounds the packer body and rests on the upper end of the liner and the expansible packer 31 is confined between this ring and the coupling 22 above.

Attached to the lower end of the liner is a screen 39 of any conventional type and the lower end of this screen is equipped with the conventional set shoe 40 having the transverse partition 41 anchored therein through which the tubular back pressure valve 42 is threaded. The lower end of this valve is closed and it is provided with the outlet ports 43. The upper end of the valve is formed with the polygonal socket 44 to receive the correspondingly shaped lower end 45 of the wash pipe 19.

When the apparatus is assembled for lowering into the well the valve 42 is in its lower position with its outlet ports 43 beneath the partition 41 and with the lower end 45 of the wash pipe seated in the socket 44. The tool joint sections 24, 27 are connected as shown in Figure 2 and the liner 34 and screen 39 are suspended from the collar 36 on the packer body 21. The assembly is attached to the tubing 17 and lowered into the casing 1 and thereafter the head 4 with the valve 7 and the packing assembly 11 are installed and the assembly is gradually lowered as additional sections of the tubing are added to the string until the screen lands on bottom. The well is usually filled with drilling fluid when the screen is lowered and thereafter clean water is forced down through the tubing and wash pipe and out through the ports 43 and returns up between the tubing and casing, the drilling fluid being forced out through the outlet line 8 until the screen is washed free of clogging material. The weight of the tubing 17 is then released and this will cause the pins 35 to shear, the packer body moving downwardly relative to the liner 34 as indicated in Figure 7 and expanding the packer 31 and forming a fluid tight seal between the liner and the casing 1. The tubing 17 may then be turned to the right to disconnect the pin member 27 of the tool joint from the box member 24 thereof, simultaneously the lower end 45 of the wash pipe will turn the valve 42 which is threaded through the partition 41 with left hand threads, causing said valve to be elevated to carry the ports 43 above the partition 41 to prevent the inflow of drilling fluid through said valve into the screen and the tubing may be elevated as indicated in Figure 7. The sectional supporting slips 46, as shown in Figure 6, may then be inserted around the tubing on the seat 6 and a coupling 47 of the tubing then landed on said slips to support the tubing in its elevated position in the manner indicated in Figure 5. An annular packer 46a is embodied in the slips to form a seal between the upper end of the tubing and the neck 5 of the head 4. The upper section 17a of the tubing 17 may then be unscrewed from the coupling 22 and removed and the valve 7 closed and the bowl 10 removed and a Christmas tree 48 then installed on the casing of the valve 7 as illustrated in Figure 5. The well is now in condition to produce, if the internal pressure is sufficient to cause it to flow.

The Christmas tree is equipped with a flow line 49 which contains a choke 50 and which may be controlled by the valve 51.

Within the tubing 17 there is a special coupling 52 which is incorporated into the flow line and which forms a valve casing containing the annular seat 53 which is controlled by the downwardly opening valve 54. This valve has an upstanding stem 55 which extends on up through and projects above the guide 56 on the seat 53. The valve 54 is normally maintained open by gravity. If the well does not voluntarily start flowing the cap 57 may be removed from the Christmas tree and a swab lowered into the tubing and the tubing swabbed out to remove the liquid from it and to thus relieve the pressure on the producing formation and this will usually start the well to flowing.

It is desirable that the proper oil-gas ratio be maintained so as to obtain a maximum efficiency of the gas pressure to expel the oil from the well. This is determined by the amount of submergence of the lower end of the wash pipe 19 into the oil of the well. The tubing 17 may be elevated or lowered, as explained, to obtain the best result. When it is desired to shift the position of the tubing, that is to elevate or lower it, the valve 7

may be closed and the cap 57 may be removed and a stuffing box for a wire line substituted for the cap 57 and a releasable grappling tool may be run by said line into the tubing and engaged with the stem 55 and the valve 54 thereby lifted into closed position and the fluid above in the tubing being relieved through the flow line 49 the pressure of the liquid in the tubing beneath will hold said valve 54 closed. This will stop the outflow of oil from the well. The grappling tool may then be released from stem 55 and said tool and its stuffing box then removed and a lift string of pipe may then be connected into the coupling 47 and the tubing may be thereby manipulated to elevate or lower the same. The string of tubing may be elevated and a coupling beneath landed on the slips 46 and that portion of the tubing above broken out and removed, or if it be desired to lower the tubing, an additional section or sections may be screwed on the upper end thereof and the tubing lowered to land the selected coupling on said slips. The cap 57 may then be replaced and pressure applied through the line 49 to equalize the pressure above and beneath the valve 54 and said valve will drop by gravity into open position. This adjustment of the tubing may be made as the gas pressure, or liquid level in the well varies.

All of the operations hereinbefore described subsequent to the setting of the packer 31 may be carried on without exposing the casing 1 to the pressure of the well and the pressure of the fluid flowing from the well will be confined to the tubing by the liner packer 31 and the packers at the upper and lower ends of the tubing hereinabove described to the end that the casing set in the well will not be subjected to the constant pressure of the liquid flowing from the well.

The lower end 45 of the wash pipe is connected to the wash pipe by means of the outside coupling 51. The upper end of this coupling and the lower end of the tool joint section 24 have the interengaging clutch jaws 58, 59 respectively. If it be desired to remove the tubing from the well the Christmas tree may be removed and a lift string connected to the coupling 47 and the tubing elevated to clutch the jaws 58, 59 and upon rotation to the right the box member 24 of the tool joint will be unscrewed from the coupling 22 and the entire string of tubing including the wash pipe may be thereupon removed from the well.

While the well is producing should it become necessary to remove and replace, or repair, any of the fittings of the Christmas tree or flow tubes at the ground surface, the control valve 51 may be opened wider to permit an increase of flow and the increased velocity of the liquid flowing through the tubing 17 will automatically lift and close the valve 54 so as to stop the flow until the repairs have been made. Thereupon the pressure above and below the valve 54 may be equalized as hereinabove explained so that the valve 54 will drop by gravity into open position.

The drawings and description disclose what is now considered to be a preferred form of the invention by way of illustration only, while the broad principle of the invention will be defined by the appended claims.

What I claim is:

1. Equipment for producing liquid, under pressure, from a well comprising a casing set in the well, a string of tubing in the casing, a seal between the tubing and the upper end of the casing, a packer body, means for attaching the body to the tubing, a liner suspended from the body, a packer on the body, the body being movable downwardly relative to the liner to expand the packer to form a seal between the liner and casing, said tubing having a tubular extension through the attaching means into the liner and means forming a fluid tight seal between the packer body and said extension.

2. Equipment for a well comprising an outer casing set in the well, an inner tubular string in the casing comprising a liner and a flow tubing extended from the liner to the ground surface, a packing means on the liner adapted to be set by manipulation of the tubing to form a fluid tight joint between the liner and casing, an upper seal arranged to form a fluid tight joint between the tubing and casing, a lower seal arranged to form a fluid tight joint between the tubing and said packing means, said tubing and upper and lower seals forming means to shield the casing, between said seals, from the pressure of the liquid in the well.

3. Equipment for a well comprising an outer casing set in the well, an inner tubular string in the casing comprising a liner and a flow tubing extended from the liner to the ground surface, a packing means on the liner adapted to be set by manipulation of the tubing to form a fluid tight joint between the liner and casing, an upper seal arranged to form a fluid tight joint between the tubing and casing, a lower seal arranged to form a fluid tight joint between the tubing and said packing means, said tubing and upper and lower seals forming means to shield the casing, between said seals, from the pressure of the liquid in the well, the tubing being arranged to be longitudinally adjustable while maintaining the seals.

4. Equipment for a well comprising an outer casing set in the well, an inner tubular string in the casing comprising a liner beneath the casing and a flow tubing extended from the liner to the ground surface, packing means on the liner adapted to be set by manipulation of the tubing to form a fluid tight joint between the liner and casing, an upper seal arranged to form a fluid tight joint between the tubing and casing, a lower seal arranged to form a fluid tight joint between the tubing and said packing means, said tubing and upper and lower seals forming means to shield the casing, between said seals, from the pressure of the liquid in the well, the tubing being arranged to be longitudinally adjustable while maintaining the seals and a valve in the tubing normally held open by gravity and adapted to be closed by the flow of liquid through the tubing to stop the flow of liquid therethrough while so adjusting the tubing.

5. In well producing apparatus, a tubular string adapted to be lowered into a well and including a tubular packer body, a tubular liner, said body and liner having interengaging abutments whereby the liner is suspended from the body, an expansible packer around the body, said body being movable downwardly relative to the liner, abutments on the body confining the packer whereby said packer is expanded upon such downward movement, a flow tube extending to the ground surface, a releasable coupling for connecting the lower end of said tube to the upper end of the packer body a valve in the tubing accessible, through the tubing, from the ground surface and arranged to open to permit fluid to be forced downwardly through the tubing into the well and to close to prevent the upward flow of fluid from the well through the tubing.

6. Producing equipment for a well comprising an outer casing set in the well, an inner tubular string in the casing comprising a liner within and extended beneath the casing and a flow tube extending from the liner to the ground surface, a packer on the liner adapted to be set by manipulation of the tubing to form a fluid tight joint between the liner and casing, a seal at the upper end of the casing forming a fluid tight joint between said tubing in the casing, a lower seal arranged to form a fluid tight joint between the tubing and packer, said tubing, upper and lower seals and packer forming means to shield the casing above the packer from the pressure of the well liquid, the tubing and upper and lower seals being so arranged that the tubing may be longitudinally adjusted and the seals maintained to exclude the pressure of the well liquid from the casing above the packer while said adjustment is being made and a velocity valve in the tubing normally held open by gravity but arranged to automatically close by an increase of the velocity of the liquid flowing through the tubing to stop such flow.

7. Producing equipment for a well comprising an outer casing set in the well, an inner tubular string in the casing comprising a liner within and extended beneath the casing and a flow tube extending from the liner to the ground surface, a packer on the liner adapted to be set by manipulation of the tubing to form a fluid tight joint between the liner and casing, a seal at the upper end of the casing forming a fluid tight joint between said tubing in the casing, a lower seal arranged to form a fluid tight joint between the tubing and packer, said tubing, upper and lower seals and packer forming means to shield the casing above the packer from the pressure of the well liquid, the tubing and upper and lower seals being so arranged that the tubing may be longitudinally adjusted and the seals maintained to exclude the pressure of the well liquid from the casing above the packer while said adjustment is being made and a velocity valve in the tubing normally held open by gravity but arranged to automatically close by an increase of the velocity of the liquid flowing through the tubing to stop such flow, and means whereby said velocity valve may be manually closed from the ground surface.

8. Equipment for producing liquid, which is under pressure, from a well and comprising a casing set in the well, a tubing in the casing through which the liquid may flow from the producing stratum, a fluid tight seal between the casing and tubing at the upper end thereof, a fluid tight seal between the tubing and casing adjacent the lower end of the tubing, said tubing and seals forming means for excluding the liquid, under pressure, from the casing between said seals and valve means in the tubing, accessible from the ground surface, arranged to open to permit the flow of fluid downwardly through the tubing and to close to prevent the flow of fluid upwardly through the tubing.

9. Equipment for producing liquid, which is under pressure, from a well comprising a casing set in the well, a liner beneath the casing and whose upper end extends up into the casing, a tubing in the casing whose lower end is arranged adjacent the upper end of the liner, sealing means forming a fluid tight seal between the adjacent ends of the liner and tubing and the surrounding casing and sealing means between the upper end of the casing and the upper end of the tubing, said tubing and seals forming means for excluding the liquid, under pressure, from the casing.

10. Equipment for producing liquid, which is under pressure, from a well comprising a casing set in the well, a liner whose upper end is in the casing, a tubing in the casing whose lower end is arranged adjacent the upper end of the liner, sealing means forming a fluid tight seal between the adjacent ends of the liner and tubing and the surrounding casing and sealing means between the upper end of the casing and the upper end of the tubing, said tubing and seals forming means for excluding the liquid, under pressure, from the casing and valve means in the tubing, accessible from the ground surface, arranged to open to permit the flow of fluid downwardly through the tubing and to close to prevent the flow of fluid upwardly through the tubing.

11. Equipment for producing liquid, which is under pressure, from a well and comprising a casing set in the well, a tubing in the casing through which the liquid may flow from the producing stratum, a fluid tight seal between the casing and tubing at the upper end thereof, a fluid tight seal between the tubing and casing adjacent the lower end thereof, said tubing being adjustable longitudinally through the lower seal and said lower seal and tubing being formed to maintain a fluid tight joint between them at all points of adjustment of the tubing relative to the lower seal, said tubing and seals forming means for excluding the liquid, under pressure, from the casing between the upper and lower seals.

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