April 12, 1932. J. H. TUCKER 1,853,474

DEVICE FOR CONTROLLING THE FLOW OF WELLS

Filed April 25, 1930

Fig. 1.

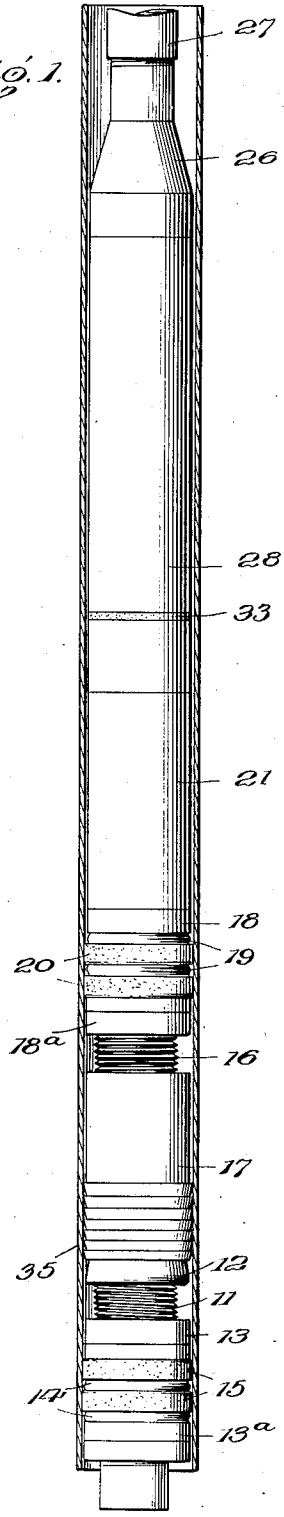

Fig. 2.

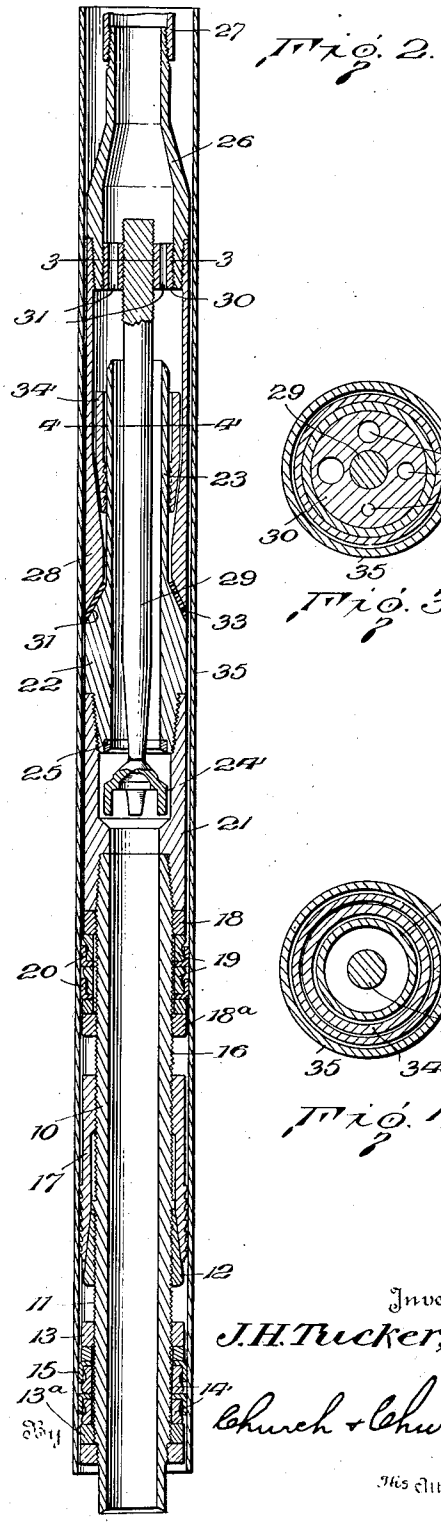

Fig. 3.

Fig. 4.

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UNITED STATES PATENT OFFICE

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DEVICE FOR CONTROLLING THE FLOW OF WELLS

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This invention relates to improvements in well drilling apparatus, and, particularly to a device for controlling the flow of fluid, such as gas or oil from a well.

On account of the high pressures encountered during the finishing of the drilling operations for gas or oil, it is necessary that means be provided to hold such pressures in abeyance until proper connections have been made for controlling and guiding the flow of oil or gas from the well. During the drilling operations this is accomplished usually by keeping the well hole filled with fluid heavily ladened with mud or other weighty substances and the natural pressure existing in the well not being great enough to lift the heavy column of mud ladened water or other fluid, the flow of the gas or oil is naturally held in check or under control at a point below the surface of the earth. When the drilling operations proper have been completed and preparations are being made for allowing the natural pressures existing in the well to raise the column of oil and gas to the surface, a string of pipe or what is known as well casing is run into the well hole. The lower end of the casing is either perforated or provided with a perforated closure such as a strainer or screen in order that the oil and gas in the sand formations penetrated by the well hole may enter the casing and flow therethrough to the surface of the ground. After the string of casing has been set on the bottom of the hole it is then necessary to replace the heavily mud ladened water in the hole with a lighter fluid, such as clear water. This operation is known in oil fields as washing the well and when the mud ladened fluid has been displaced by the water natural pressures existing in the well are generally sufficiently great to raise the column of fluid upwardly through the casing. In view of this there is, therefore, extreme danger that the well will get out of control during the time intervening between this so-called washing operation and the installation of the proper manifolds in the upper end of the casing for guiding or directing the flow from the well to the desired places of storage. It is these difficulties or rather this danger that the present invention seeks to eliminate by means that may be described broadly as a device for packing the bottom of the well hole and controlling the flow of oil and gas from the well during the lapse of time between the initiation of the washing operation and the installation of the necessary manifolds at the top of the well.

More specifically, the invention contemplates a combination packer and fluid control device embodying a main control valve that will normally be closed by natural pressures existing within the oil and gas producing formations but which may be opened by the pressure thereon of the mud ladened fluid, or which may be opened at will by a mechanical element constituting a portion of the present device.

The invention also seeks to provide what might be termed an auxiliary valve or a choke for reducing the flow of oil and gas that may pass through the main valve before mentioned.

A still further object of the invention is to provide means for releasing and removing the entire device from the well whereby the casing will be fully opened, a condition that is permissible and highly desirable when the natural pressures existing in the well have been reduced to a point where it is no longer necessary to use means for controlling the flow of oil and gas.

With these and other objects in view the invention consists in certain details of construction and combinations and arrangements of parts all as will hereinafter be more fully described and the novel features thereof particularly pointed out in the appended claims.

In the accompanying drawings which illustrate the preferred embodiment of the present invention,

Figure 1 is an elevational view of the entire control device, the well casing being shown in sections;

Fig. 2 is a longitudinal sectional view through the device and casing;

Fig. 3 is a transverse sectional view on the line 3—3 of Fig. 1, and

Fig. 4 is a similar view on the line 4—4 of Fig. 1.

In the form of apparatus shown in the accompanying drawings there is what will, for convenience, be termed a tubular supporting member 10 whose exterior is provided with lefthand screw threads 11 near one end thereof and screwed on this portion of the support is a tapered mandrel 12 and lock nuts 13, 13ª. The function of the nuts 13, 13ª is to retain on the support a series of cup supporting rings 14 and cups 15. Adjacent this portion of its exterior, said support is also provided with righthand screw threads 16, by means of which there is attached to the support a slip or gripping element 17 adapted to cooperate with the mandrel 12 as will hereinafter be more fully described. Also, attached to the support by these threads 16 are lock nuts or collars 18, 18ª, between which there are retained cup supporting ring 19 and cups 20.

Threaded on the end of support 10 beyond lock nut 18 is one section 21 of a valve cage, and threaded to said section 21 is the other section 22 of said cage, this section being of tubular formation and having an extension 23 formed thereon. Within the valve cage there is a valve seat, this seat indicated at 25 being of any desired material and preferably secured in section 22 of the cage. Loose within the cage there is also a valve member 24 and, as will be apparent, this valve 24 is free to move toward and from its seat 25 upon the application of pressure to either of its faces.

With a device as thus far described the flow of oil and gas from a well may be held totally in check. For instance, before the casing is lowered in the ground the device described may be installed therein at a point located above that point at which the oil and gas enter said casing when it is set on the bottom of the well hole. The device is secured in the section of casing by inserting it therein by rotating support 10 in a direction that will cause the slip 17 to move downwardly over mandrel 12 until the slip takes a firm grip on the inner surface of the casing. This manipulation of the slip not only secures the device in the casing but, as will be appreciated, the packing rings and cups 19, 20 above the slip and the rings and cups 14, 15 below the mandrel 12 will effectually pack or seal the casing and prevent the passage of oil and gas therebetween. Likewise, when the clear water is forced down through the casing to wash the well the pressure of such water on the upper surface of valve 24 will unseat the same so that the excessive pressure of clear water will not only wash the mud ladened water out of the hole but will also prevent the flow of oil and gas from the well. When the pressure of the clear water on valve 24 is relieved so that the natural pressures within the well predominate, valve 24, of course, will be immediately seated and completely check the flow of oil and gas from the well through the casing. By thus having the flow of oil and gas held in full check ample time may be had for installing the necessary connections at the upper end of the casing for the transportation of the oil and gas to the desired places of storage.

After these connections, such as the usual manifolds and the like are made at the surface a swedge 26 attached to the lower end of a string of tubing 27 is lowered in the casing and depending from said swedge is a slip socket 28 and a plunger or valve stem 29, the stem or plunger 29 protruding beyond the lower end of the socket 28 a distance sufficient to permit it to project through the central bore in valve cage section 22 and engage and displace valve 24 from its seat 25. By thus unseating the valve 24 and maintaining it opened with the plunger 29 it will be apparent that the full force of the natural pressures within the well may be utilized to the utmost in forcing oil and gas upwardly through the tubing and casing. Often times it is, however, desirable to partially hold in check or choke the flow of oil and gas that will take place by reason of the excessive pressures existing in the well. For this reason plunger 29 is suspended from swedge 26 by having its upper end threaded in a choke device 30 which, in turn, is screwed into the interior of swedge 26. This choke device 30 is shown in section in Fig. 3 and consists of an annular member having a series of openings or ports 31 therein, these openings being of any desired cross-sectional area and, if preferred, of different sizes as shown in Fig. 4. It is also intended that choke members 30 differing from one another in that the openings 31 in one choke member may be larger or smaller than the openings in other choke members, may be used interchangeably in a device. As will be apparent the swedge, slip socket and plunger may be withdrawn at any time to permit one choke device to be substituted for another as the withdrawal of this portion of the device from the casing will permit valve 24 to close immediately under the influence of the pressure then existing in the well, it being understood that the entire device is not to be removed from the well until after the natural pressures in the well have dropped to a point where they will no longer automatically close the valve 24.

After the well has been flowed long enough for the natural pressures to drop to a point where valve 24 will not be forced to close, the entire device may be removed from the casing by withdrawing the swedge 26, plunger 29 and socket 28 and placing within said socket a slip 34. This assembly is then lowered into the casing and after slip 34 engages around extension 23 or valve cage section 22, upward tension on slip socket 28 will cause a binding of the socket and slip on said extension 23.

Under these conditions rotation of the device in a direction opposite to that in which it was rotated to secure it in the casing will cause mandrel 12 to be screwed downwardly with respect to slip 17 as the latter will be locked against movement by its frictional engagement with the wall of the casing. This relative movement of slip 17 and mandrel 12 will release the entire device so that the complete assembly may be raised and removed from the casing. It will be understood that slip 34 should not be used in the assembly so long as there is a possibility of it being desirable to interchange the choke device 30 and in order to obtain an effective seal between socket 28 and cage section 22 at times when slip 34 is not used, said cage extension 22 is formed on its exterior with a shoulder 32, said shoulder constituting a seat for packing material 33 against which the lower end of slip socket 28 may rest.

What I claim is:

1. A combination packer and fluid control device comprising a tubular supporting member, gripping means on said member for securing the same in a well casing, packing elements on said member adapted to form a seal between the member and said casing, a valve cage carried by said member, a valve seat on said cage, a valve in said cage movable against its seat by upward pressure beneath said valve and means associated with said valve and operable from without the well for positively holding said valve unseated in opposition to upward flow through said tubular member tending to seat said valve.

2. A combination packer and fluid control device comprising a tubular supporting member, gripping means on said member for securing the same in a well casing, packing elements on said member adapted to form a seal between the member and said casing, a valve cage carried by said member, a valve seat on said cage, and a valve in said cage movable against its seat by upward pressure beneath said valve, and means engageable with said valve and operable independently of well pressures for holding said valve unseated and positively controlling the amount of flow past said valve seat.

3. A combination packer and fluid control device comprising a tubular supporting member, cooperating gripping elements carried by said supporting member for engaging the interior of a well casing to secure the device therein, said gripping elements being rendered operative upon rotation of their support in one direction and inoperative upon rotation thereof in the opposite direction, means for sealing the space between said member and casing, a valve cage on said member, a valve seat, a valve in said cage movable against said seat by upward pressure beneath said valve to close the opening in the tubular support, and means associated with said valve and adjustable from without said well for positively controlling the flow past said valve seat independently of pressure tending to move said valve to seat.

4. A combination packer and fluid control device comprising a tubular support, means for securing the support in a well casing, means for sealing the space between the support and casing, a valve cage on said support, a tubular extension on said cage, a valve seat on said extension, a valve in said cage movable against said seat by upward pressure beneath said valve, and means insertable in said tubular extension for unseating said valve.

5. A combination packer and fluid control device comprising a tubular support, means for securing said support in a well casing, means for sealing the space between said support and casing, a valve cage on said support, an extension on said cage, a valve seat on said extension, a valve in said cage movable against said seat by upward pressure beneath said valve, and means engageable with said valve and operable independently of well pressures for holding said valve unseated and positively controlling flow past said valve seat, said extension having a central bore therein through which said last mentioned means extends to engage said valve.

6. A combination packer and fluid control device comprising a support having a central bore, means for securing said support in a well casing, means for sealing the space between said support and casing, a valve seat carried by said support, a valve movable against said seat by upward pressure beneath said valve to prevent the flow of fluid through said support, means for unseating said valve, and means adapted to be positioned in the casing above said valve for reducing the flow of fluid through the support when said valve is opened.

7. A combination packer and fluid control device comprising a support having a central bore, means for securing said support in a well casing, means for sealing the space between said support and casing, a valve seat carried by said support, a valve movable against said seat by upward pressure beneath said valve to prevent the flow of fluid through said support, means adapted to be positioned in the casing above said valve for reducing the flow of fluid upwardly through the support when said valve is unseated, and a plunger carried by the last mentioned means for engaging and unseating said valve.

8. A combination packer and fluid control device comprising a support having a central bore, means for securing and sealing said support in a well casing, a valve seat on said support, a valve movable against said seat by upward pressure beneath said valve

and movable away from said seat by downward pressure above said valve when in excess of the upward pressure beneath said valve, and means engageable with said valve for retaining the same unseated in the absence of superior downward pressure.

9. A combination packer and fluid control device comprising a support having a central bore, means for securing and sealing said support in a well casing, a valve seat on said support, a valve movable against said seat by upward pressure beneath said valve and movable away from said seat by downward pressure above said valve when in excess of the upward pressure beneath said valve, and means engageable with said valve for retaining the same unseated in the absence of superior downward pressure, and means adapted to be positioned in the casing above said valve for reducing the flow of fluid past said valve when the latter is engaged and unseated by said last mentioned means.

10. A combination packer and fluid control device comprising a tubular support, means for securing and sealing said support in a well casing, a valve cage on said support, a tubular extension on said cage, a valve in said cage movable against its seat by upward pressure beneath said valve, and movable from its seat by downward pressure above said valve when in excess of the upward pressure beneath the valve, means for unseating said valve in the absence of superior downward pressure, and means engageable with said extension for removing the same, together with said support and cage, from the casing.

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