

May 6, 1941.

R. SMITH

2,241,333

WELL HEAD

Original Filed July 24, 1934

2 Sheets-Sheet 1

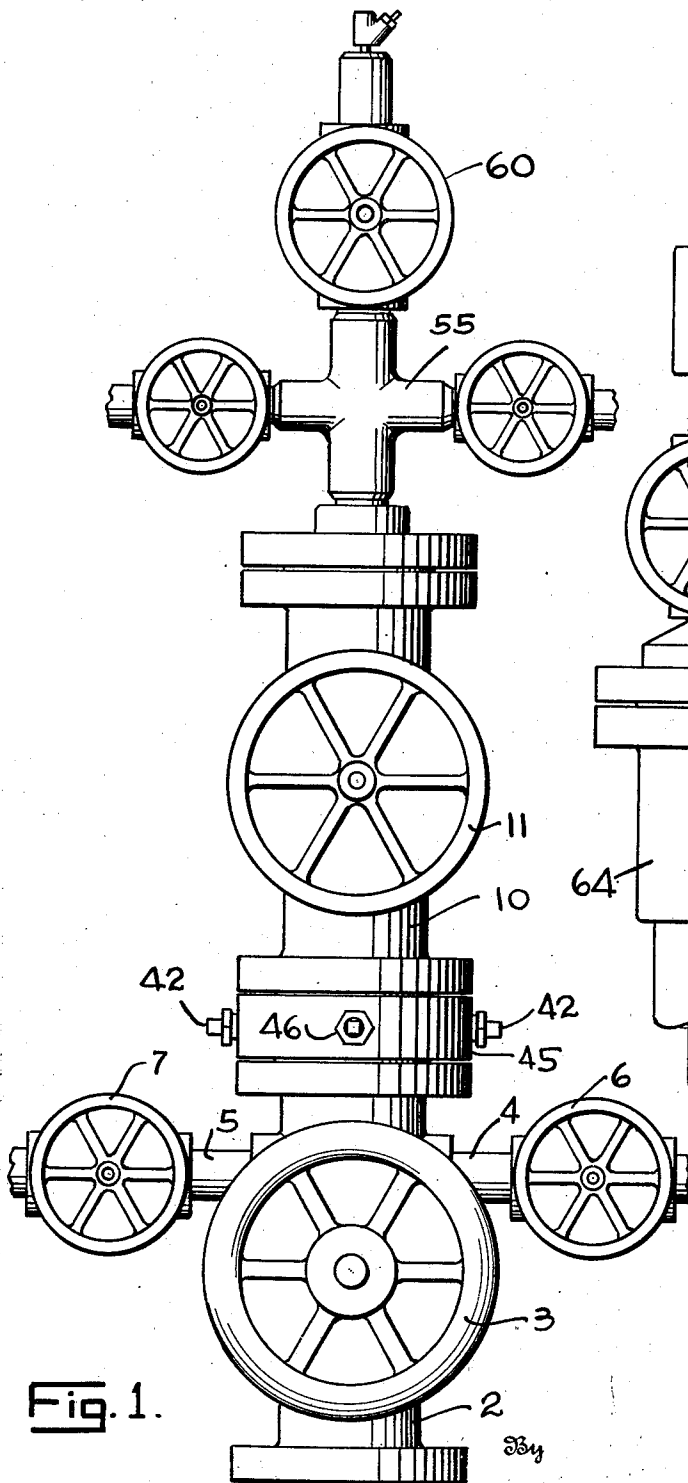
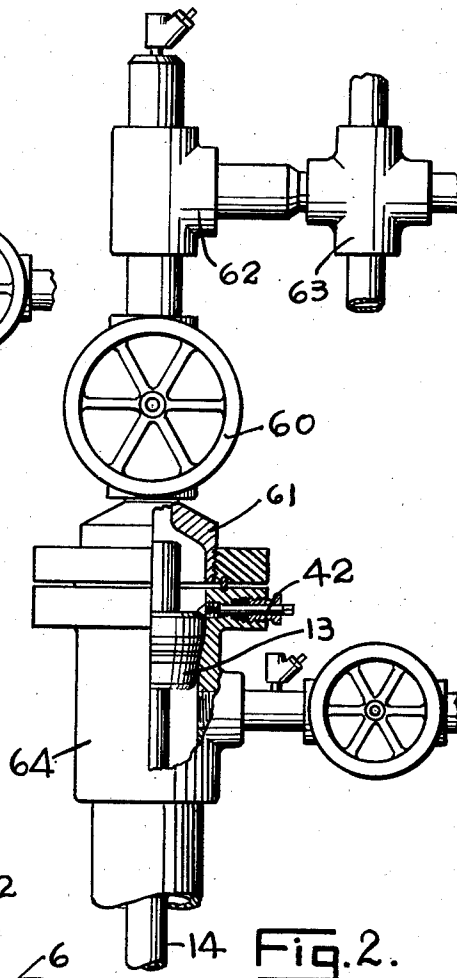


Fig. 1.



Inventor
ROGER SMITH

Jesse R. Stone
of
Lester B. Clark

Attorneys

May 6, 1941.

R. SMITH

2,241,333

WELL HEAD

Original Filed July 24, 1934

2 Sheets-Sheet 2

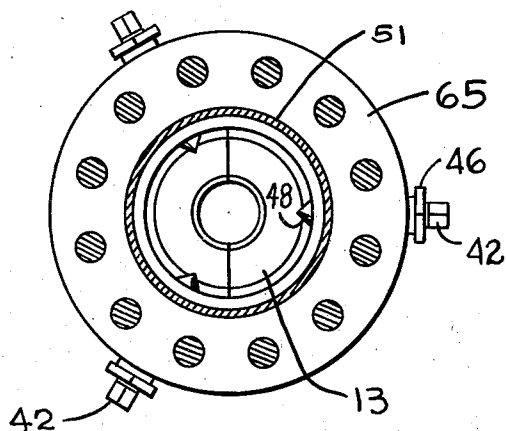


Fig. 4.

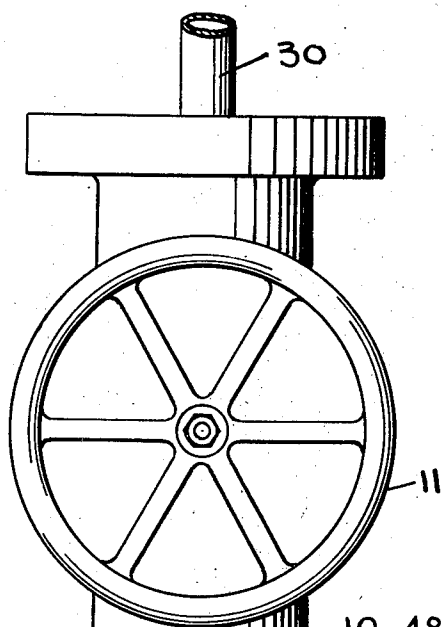


Fig. 5.

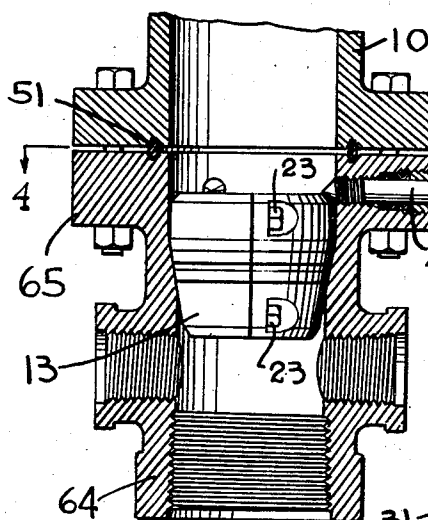


Fig. 3.

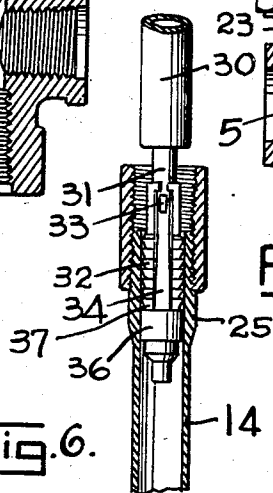


Fig. 6.

Inventor
ROGER SMITH

Jesse C. Stone
Lucius B. Clark

Attorneys.

UNITED STATES PATENT OFFICE

2,241,333

WELL HEAD

Roger Smith, Houston, Tex., assignor to Gray Tool
Company, Houston, Tex., a corporation

Application July 24, 1934, Serial No. 736,635
Renewed March 13, 1939

9 Claims. (Cl. 255—1.8)

The invention relates to an improvement in well heads and particularly of the type where it is desired to insert, hang, support and seal the tubing with respect to the well head as quickly as possible.

When a well is being completed where the producing formation releases a considerable pressure, great difficulty has been encountered in running the tubing into the well and supporting it in a sealed position so that there would be no possibility of a blowout. Various devices have been arranged for inserting and supporting the tubing in a simple and economical manner, but many of these are more or less complicated because of the necessity of large valves and complicated setting tools. With these objectionable features in mind the present invention has been devised and contemplates broadly that the tubing may be readily inserted and supported in well heads and locked in a sealed position so that it cannot be displaced.

It is one of the objects of the invention to provide a system of inserting and locking tubing in position in a well head in such a manner that the well head fittings may be readily removed or replaced while the tubing is being positioned.

Another object of the invention is to provide an improved support which may be locked in position.

Still another object of the invention is to provide an improved form of tubing hanger and seal.

It is also an object of the invention to provide a tubing hanger and seal which may be readily inserted through the drilling valve to suspend the tubing in the casing and to form a seal so that the drilling valve may be removed and replaced by a less costly valve of smaller diameter which will more readily withstand higher pressures than the larger valve.

Another object of the invention is to provide in combination with a well head a locking ring which may be positioned to latch the tubing hanger and seal in position in the well head.

Another object of the invention is to provide a tubing hanger lock which is operable from the exterior of the well head so that the hanger may be locked or unlocked at will without disturbing the other parts of the well head assembly.

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 a well head assembly illustrating the fittings arranged in accordance with one form of the invention.

Fig. 2 shows a well head assembly illustrating another manner in which the invention may be applied when the drilling valve has been removed and a permanent arrangement of the fittings is desired.

Fig. 3 shows a sectional view of one form of the combination tubing head, hanger and lock.

Fig. 4 is a section taken on the line 4—4 of Fig. 3 and looking in the direction of the arrows.

Fig. 5 is an enlarged broken sectional view of the invention applied to a head where the locking ring is positioned above the casing head and illustrates the manner of plugging the tubing and casing when fittings are to be altered.

Fig. 6 shows a sectional view of a special type of tubing plug which provides a closure for the tubing while the fittings are being changed.

Fig. 1 illustrates a side view of a casing head 2 which may be of any desired type. The form here illustrated, however, is a combination head and blowout preventer wherein the hand wheel 3 serves to operate the closure members for the casing. Extending from this head 2 are the outlets 4 and 5 which are closed by the valves 6 and 7 respectively. The head 2 serves as a closure for the well and is of sufficient diameter to permit the drilling operation to be carried on therethrough. During the drilling operation if a blowout is imminent the handwheel 3 may be operated to close the casing about the drill pipe. If there is no drill pipe in the well, however, and it is desired to close the well the drilling master valve 10 is provided and the handwheel 11 may be operated to close the casing. Thus, if the valves 6, 7 and 10 are closed the well will be completely closed when there is no pipe in the well. The passage through the valve 10 is at least as large as the casing on which it is positioned. If on the other hand a drill pipe is in the well the handwheel 3 will be operated to close the casing around the drill stem. A back pressure valve may be inserted in the drill pipe to prevent any upward flow of fluid therethrough. In this manner the well will be completely sealed during the drilling operation. The foregoing is usually designated as the drilling head because it is used to control the well during all of the drilling operations, and until the well is ready to be placed on production.

When the drilling has been completed and the tubing is to be run, the tubing will be lowered through the drilling valve 10 and the head 2 until it reaches the desired elevation. It is necessary then to support the tubing in the head and it is

desirable to form a more or less permanent seal about the tubing.

Fig. 5 shows a sectional view of the structure illustrated in Fig. 1 with the flow lines 4 and 5 removed. It will be noted that the head 2 has a tapered seat 12 therein which is arranged to receive the combination well head closure and tubing hanger 13, and it is by means of this hanger 13 that the tubing 14 is supported. A collar 15 is shown on the tubing and this collar is arranged to engage the hanger 13 to form a rigid support for the tubing.

The hanger 13 is of special construction and embodies two half sections which cooperate together to form a complete ring around the tubing and to be engaged upon the seat 12. Each of these half sections is made up of a body portion 17 which has a tapered outer surface 18 to engage with the seat 12 and a vertical inner surface 19 to engage against the tubing. Suitable packing 20 is arranged in the outer periphery of the body 17 and a somewhat similar packing 21 is arranged on the inner periphery. As is usual with packing of this type it extends slightly beyond the surface of the body 17 so that a seal is formed when any pressure is applied to the body. These packings preferably are connected across the radial face of the section members by suitable packing 22 as seen in Fig. 5, whereby the faces are sealed together when clamped by the bolts 23, and are hydraulic types of packing so that no rubber or material subject to deterioration will be present in the sealing assembly. In the present instance the weight of the string of tubing 14 by means of the collar 15 will serve to move the sealing head downwardly in the seat 12 so that the packing 20 is compressed against the seat and the packing 21 is compressed against the tubing.

The two half sections making up the hanger are preferably assembled about the tubing before it is lowered into the head and may be clamped firmly about the tubing or may be arranged somewhat loosely thereon.

Fig. 5 shows this tubing hanger applied to externally upset tubing where the enlarged portion of the closure 13 received the upset portion 25 of the pipe. With the foregoing structure, as the tubing is being lowered in position at the desired elevation the closure 13 will be clamped about the section of tubing before it is run through the drill valve 10 so that it will be ready to be received in the seat 12.

When the tubing is to be lowered into the position shown in Fig. 5 an additional piece of tubing will be connected to the coupling 15 and the tubing in this manner lowered until the blow-out preventer or closure 13 is set in the head. This additional section of tubing or piece of pipe will then be unscrewed or removed, leaving the tubing suspended in the head.

In order that pressure accumulating in the casing between the tubing and casing in the area 40 will not create such a pressure as will tend to lift the blowout preventer 13, the locking bolts 42 have been provided. These bolts are arranged on the outer end at 43 to receive a suitable wrench so that they may be turned and are threaded at 44 into the ring 45.

A suitable stuffing box 46 is arranged about each bolt. The inner end of each bolt is tapered at 48 to engage the upper shoulder of the blow-out preventer 13. When the preventer or closure is positioned as shown, the bolt can be run in so that the beveled end will engage a similar

complementary bevel on top of the preventer 13. When a plurality of these bolts are provided they are positioned as described and then the tubing hanger or blowout preventer 13 will be securely locked in position, the downward movement being resisted because of the taper in the head 2, and the upward movement because of the wedging action of these bolts.

It will be noted that the bolts 42 in Figs. 1 and 5 are positioned within a suitable ring 45. This ring is of the same diameter as the head 2 and drilling valve 10 and is arranged to be inserted between the two with the hold-down bolts for the drilling valve passing through the locking ring. In this manner no large or complicated structure need be provided and it is only necessary to insert this ring between the standard form of equipment. Suitable seals 51 can be positioned on the upper and lower edges of the ring so that the complete sealing of the well passage will be obtained. When the parts are thus arranged if it is desired to wash the well by injecting washing fluid through the outlets 4 or 5 a complete seal of the well above these openings is maintained and fluid may be forced into the area 40 to cause a circulation upwardly through the tubing to wash the well.

On the other hand if it is desired to wash the well by circulation downwardly through the tubing the pressure may be applied through the drilling valve and because of the seal 13 the fluid will be forced through the tubing and discharged from the openings 4 or 5. In this manner the well may be completely washed and the fittings attached as desired.

If the fittings are to be arranged as seen in Fig. 1 the washing fluid may be injected through any one of the outlets attached to the cross 55, it being understood that these fittings have been added as soon as the piece of setting pipe was removed and before the heavy drilling fluid was removed from the well so that the well was closed in prior to the most dangerous period after the well had been washed.

In some instances after the tubing is set it is desirable to remove the large drilling valve 10 because of its considerable cost and to replace it with a Christmas tree including a much smaller flow control valve such as the valve 60 of Fig. 2. If this is the case, as soon as the tubing has been landed and the locking bolts 42 run into position, then the drilling valve 10 may be removed and a swaged nipple such as 61 attached directly to the head 64. The small valve 60 may then be attached to the swedge nipple 61 and suitable fittings such as 62 and 63 added thereto in order to obtain the desired flow assembly.

Fig. 3 shows an enlarged view of the arrangement embodying the head 64 wherein the locking bolts 42 have been incorporated in the flange 65 of such head. The arrangement otherwise is the same as described in connection with the ring 45, it being desirable in some instances to economize in the size of the devices in order to minimize the space occupied.

In a great many instances, however, where the well is under considerable pressure or the tubing has been set or the well is in operation, it becomes necessary to repair or replace some of the parts on the well head. Under these circumstances it is quite often desirable to plug the tubing so that the flow therefrom will be cut off. In this manner the fittings can be removed or replaced as desired without working against the considerable pressures which occur

in any of the wells. In order to accomplish plugging of the tubing a plugging tool has been devised and is best seen in Fig. 6. This tool embodies a pipe 30 which has connected thereto a mandrel 31. A plurality of slips or jaws 32 are arranged for slight movement on this mandrel 31 and a releasing mechanism 33 is provided so that the slips may be released to move downwardly on the tapered portion 34 of the mandrel. In this manner the slips move outwardly and engage the inner surface of the pipe. Below the slip 32 is the packer portion 36 and extensions 37 on the jaw members are arranged to move into the packer so that when the jaws move downwardly they tend to expand the packer and form a seal with the inner portion of the tubing 14. This device will be known as a packer type spear and when it is inserted in the tubing and an upward pull exerted thereon a seal is formed. The mandrel 31 is preferably solid so that a complete sealing of the tubing is had.

When the blowout preventer seal 13 is locked in position the casing and tubing are then sealed so that the well is completely closed off and any of the fittings above the head 2 may be replaced at will.

When the hanger is locked and the tubing plugged the change from the large valve 10 to the smaller valve 60 can be made with safety and the large expensive valve 10 is thus required only during the drilling operation. Another advantage of the small valve with extremely high pressure wells is that the area of the gate member subjected to pressure is much smaller and the total pressure to be resisted is much less. It is well known that the larger size valves are not as safe as the smaller valves and that the danger of losing the well is much less with smaller valves and fittings.

The invention contemplates that the tubing may be locked in position and plugged in order to replace fittings on the well and to substitute less expensive fittings for the more expensive ones which have been used during the drilling operations.

What is claimed is:

1. A tapered tubing hanger and well head closure including a metallic body divided longitudinally into a pair of complementary body parts, means passing transversely through said body to bolt said parts together about a tubing, and strips of packing carried by said parts along the inner, outer and meeting faces to form a complete seal with the tubing, tubing seat, and with each other.

2. In apparatus for completing a well having casing and a flow tubing therein, in formation having high pressure, a casing head, a hanger seat in said head, a drilling master valve mounted on said head above said seat, means on said head with which said valve is removably secured, said means being also adapted to connect with a Christmas tree including a smaller flow control valve supported on said head, said head and seat and drilling master valve having bores at least as large as that of the casing to permit operations prior to completion such as passing a drill substantially as large as the casing bore therethrough, a hanger adapted to be secured to the flow tubing and of diameter adapting it for lowering through said drilling master valve for disposition in said seat to seal the well against flow of fluid from the casing, and means operable while said drilling master valve is mounted on said head for locking said hanger in said seat

against upward movement under well pressure, whereby said securing means on said casing head may be disengaged for removal of said drilling master valve, and engaged with the Christmas tree supported on said head including a smaller flow control valve having a smaller pressure subject area for use when the well is flowed through the tubing.

3. In apparatus for completing a well in formation having high pressure, a casing, a casing head, a hanger seat in said head, a drilling master valve of size corresponding with said casing mounted on said head above said seat, means on said head with which said valve is removably secured, said means being also adapted to connect with a Christmas tree including a smaller flow control valve supported on said head, said head and drilling master valve having bores at least as large as that of said casing to permit operations prior to completion such as passing a drill substantially as large as the casing bore therethrough, a flow tubing in said casing, a hanger on said tubing of diameter adapting it for lowering through said drilling master valve for disposition in said seat to seal the well against flow of fluid from said casing, and means operable while said drilling master valve is mounted on said head for locking said hanger in said seat against upward movement under well pressure, whereby said securing means on said casing head may be disengaged for removal of said drilling master valve, and engaged with the Christmas tree supported on said head including a smaller flow control valve of size corresponding with the tubing for use during the flowing of the well under natural formation pressure through said tubing.

4. In apparatus for completing a well in formation having high pressure, a casing, a casing head, a hanger seat in said head, a drilling master valve mounted on said head above said seat, means on said head with which said valve is removably secured, said means being also adapted to connect with a Christmas tree including a smaller flow control valve supported on said head, said head, seat and drilling master valve having bores at least as large as that of said casing to permit operations prior to completion such as passing a drill substantially as large as the casing bore therethrough, a flow tubing in said casing, a hanger on said tubing of diameter adapting it for lowering through said drilling master valve for disposition in said seat to seal the well against flow of fluid from said casing, means operable while said drilling master valve is mounted on said head for locking said hanger in said seat against upward movement under well pressure, and means in said tubing for closing the same against flow of fluid from the well, whereby said securing means on said casing head may be disengaged for removal of said drilling master valve, and engaged with the Christmas tree supported on said head including a smaller flow control valve having a smaller pressure subject area for use when the well is flowed through said tubing when the latter is opened.

5. In apparatus for completing a well in formation having high pressure, a casing, a casing head, a hanger seat in said head, a drilling master valve mounted on said head above said seat, flanged securing means on said head with which said valve is removably connected, said means being adapted to also connect with a Christmas tree including a smaller flow control valve supported on said head, said head and drilling mas-

ter valve having bores at least as large as that of said casing to permit operations prior to completion such as passing a drill substantially as large as the casing bore therethrough, a flow tubing in said casing, a hanger on said tubing of diameter adapting it for lowering through said drilling master valve for disposition in said seat to seal the well against flow of fluid from said casing, means operable exteriorly of said head while said drilling master valve is mounted thereon to lock said hanger in said seat against upward movement under well pressure, and removable means in said tubing for closing the same against flow of fluid from the well, whereby said securing means on said casing head may be disengaged for removal of said drilling master valve and engaged with a Christmas tree supported on said head as a foundation including a smaller flow control valve having a smaller pressure subject area for use when the well is flowed under natural formation pressure through said tubing after the removal of said tubing closure means.

6. In apparatus for completing a well having casing and a flow tubing therein, in formation having high pressure, a casing head, a downwardly tapered hanger seat in said head and integral therewith, a drilling master valve mounted on said head above said seat, means on said head with which said valve is removably secured, said means being adapted to also connect with a Christmas tree including a smaller flow control valve supported on said head, the bore of said seat being substantially as large as that of the casing, said casing head above said seat and said drilling master valve having bores larger than that of the casing permitting operations prior to completion such as passing therethrough a drill substantially as large as the casing bore, a downwardly tapered hanger adapted to be secured to the flow tubing and of larger size than the casing bore but of diameter adapting it for lowering through said drilling master valve for disposition in said seat to seal the well against upward flow of fluid from the casing, and means operable while said drilling master valve is mounted on said head for locking said hanger in said seat against upward movement under well pressure, whereby said securing means on said casing head may be disengaged for removal of said drilling master valve and engaged with a Christmas tree supported on said head including a smaller flow control valve having a smaller pressure subject area for use when the well is flowed under natural formation pressure through the tubing.

7. In apparatus for completing a well having casing and a flow tubing therein, in formation having high pressure, a casing head, a downwardly tapered hanger seat in said head and integral therewith, a drilling master valve mounted directly on said head above said seat, flanged securing means on said head with which said valve is removably connected, said means being also adapted to connect with a Christmas tree supported directly on said head, said head and seat and drilling master valve having bores at least as large as that of the casing to permit operations prior to completion such as passing a drill substantially as large as the casing bore therethrough, a downwardly tapered hanger having means for rigid attachment with the flow tubing and of diameter adapting it for lowering through said drilling master valve for disposition

in said seat to seal the well against flow of fluid from the casing, and means extending laterally through and sealed in said head adjacent said seat and operable while said drilling master valve is mounted on said head, for locking said hanger in said seat against upward movement under well pressure, whereby said securing means on said casing head may be disengaged for removal of said drilling master valve and engaged with the Christmas tree supported on said head including a smaller flow control valve having a smaller pressure subject area for use when the well is flowed through said tubing.

8. In apparatus for completing a well in formation having high pressure, a casing, a casing head having a bore therein at least as large as the interior of said casing and tapering upwardly and outwardly from the interior of said casing to form a hanger seat, a drilling master valve mounted on said head above said seat, flanged securing means on said head with which said valve is removably connected, said means being also adapted to connect with a Christmas tree including a smaller flow control valve supported on said head, said drilling master valve having a bore substantially as large as that of said casing head at the upper end of said seat, said bores permitting operations prior to completion such as passing a drill substantially as large as the casing bore therethrough, a flow tubing in said casing, a hanger on said tubing of tapered form corresponding with said seat and of diameter adapting it for lowering through said drilling master valve for disposition in said seat to seal the well against flow of fluid from said casing, and means on said casing head operable while said drilling master valve is mounted thereon for locking said hanger in said seat against upward movement under well pressure, whereby said securing means on said casing head may be disengaged for removal of said drilling master valve, and engaged with the Christmas tree supported on said head including a smaller flow control valve having a smaller pressure subject area for use when the well is flowed under natural formation pressure through said tubing.

9. The method of bringing in a well in formation having high pressure, provided with a casing, casing head and drilling master valve positioned on and above the same having bores to permit of drilling therethrough, comprising drilling through the casing head and valve, removing the drill and leaving the valve in place on the casing head, lowering flow tubing equipped with a hanger into the well through said valve, hanging said tubing in the casing head below said valve, simultaneously forming a seal with said hanger between the same and the casing head below said valve by the weight of the flow tubing, making permanent said last named seal against upward movement of the hanger under well pressure which could be great enough to overcome the weight of the tubing by locking said hanger in the casing head while the drilling master valve is still mounted on the casing head, thereafter removing the drilling master valve while the well is still under high formation pressure, and replacing said valve with a smaller flow control valve having a smaller pressure subject area for use when the well is flowed under natural formation pressure through the tubing.

ROGER SMITH.