April 4, 1950 T. M. RAGAN 2,502,886

PRESSURE RELIEVING APPARATUS

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Fig. 1.

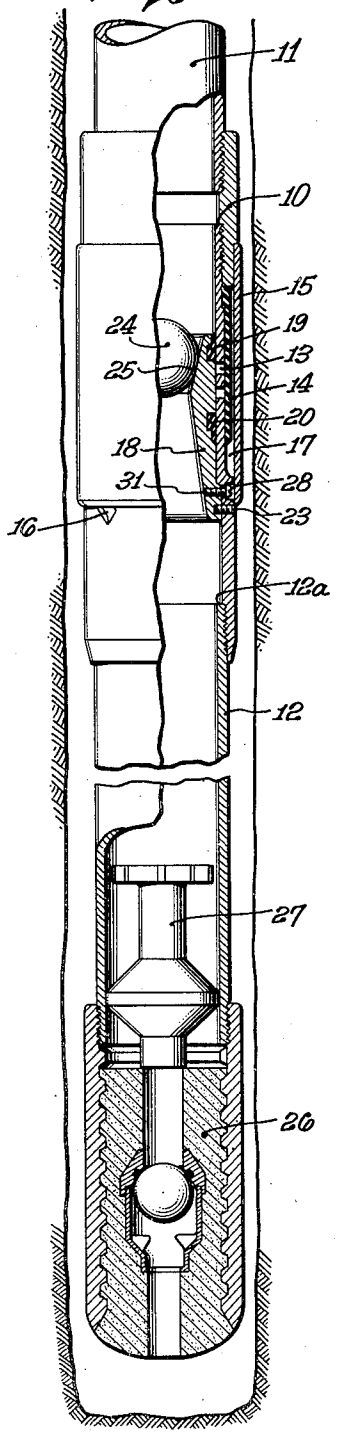


Fig. 2.

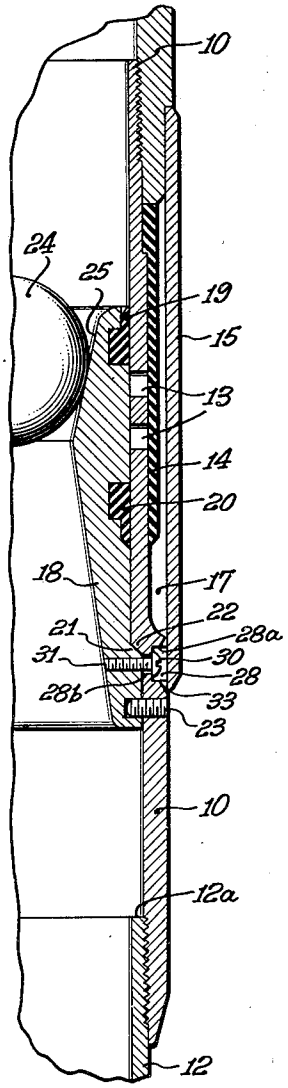
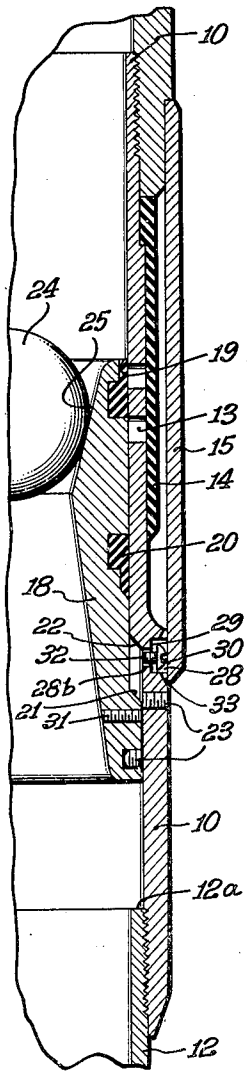


Fig. 3.



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Fig. 4.

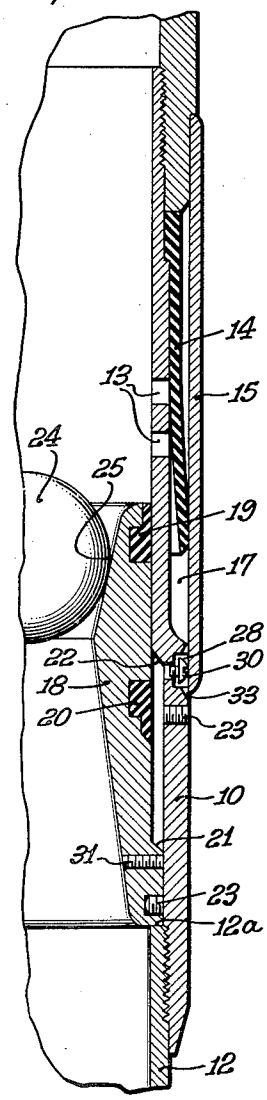


Fig. 5.

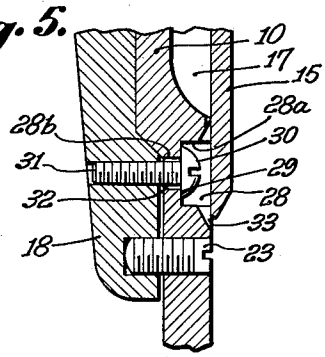


Fig. 6.

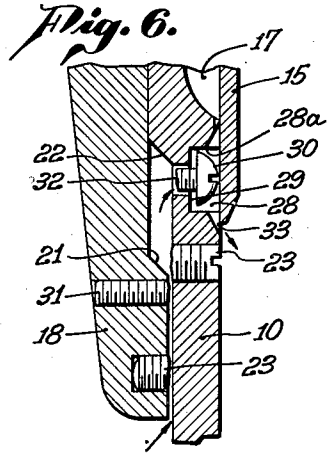


Fig. 8.

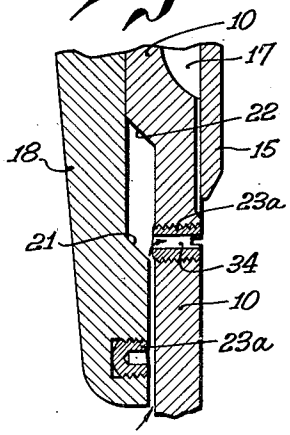


Fig. 7.

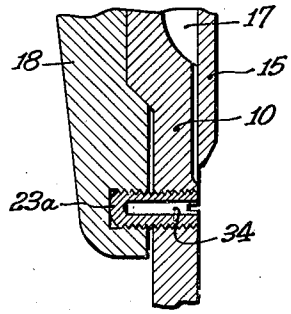


Fig. 9.

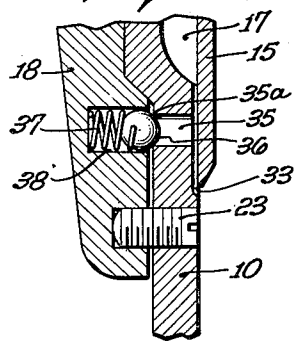
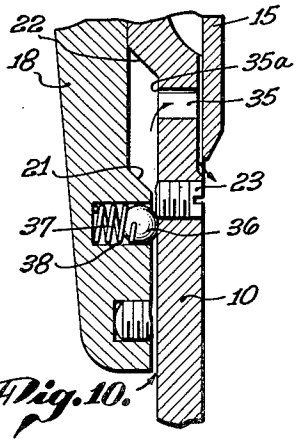


Fig. 10.



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PRESSURE RELIEVING APPARATUS

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Application April 4, 1946, Serial No. 659,543

12 Claims. (Cl. 166—1)

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The present invention relates to apparatus for cementing casings, liners, and similar conduits in well bores.

One form of apparatus for cementing casings and like conduits in well bores includes a collar, whose side ports are closed initially by an internal sleeve or similar valve. The ports are opened by applying a predetermined pressure to the fluid in the conduit above the sleeve valve to release a device holding the latter in closed position over the ports, and to shift the sleeve valve downwardly to port opening position.

Difficulties are sometimes encountered in moving the sleeve valve downwardly to port opening position, especially when a dead, or substantially immovable, column of fluid is disposed in the well casing below the sleeve valve; or, if the sleeve valve is shiftable hydraulically to port opening position, such action occurs against fluid resistance only at a pressure far greater than the predetermined value. These difficulties are believed caused by the substantial incompressibility of the dead column of fluid below the sleeve valve, which is subjected to a compressive force by the sleeve valve as it tends to move downwardly.

It is an object of the present invention to facilitate the opening of initially closed ports in a well conduit, particularly in the presence of a substantially dead column of fluid below the ports.

Another object of the invention is to provide a well apparatus embodying ports initially closed by a sleeve or similar valve, in which the valve may be readily shifted hydraulically to port opening position against the resistance of a substantially dead column of fluid.

Still another object of the invention is to provide a relief device capable of permitting fluid to escape from a relatively dead hydraulic column below a sleeve valve initially closing side ports in a conduit.

Another object of the invention is to provide a relief device in connection with a column of fluid below a sleeve valve initially closing side ports in a wall casing, which will allow escape of some fluid to the exterior of the well casing upon downward shifting of the sleeve valve, but which will prevent return of fluid into the casing.

Another object of the invention is to provide for relief in a relatively dead column of fluid below a sleeve or similar valve closing side ports through a casing, in which the relief is prevented from occurring until desired, or until the sleeve valve is to be moved to port opening position.

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Yet another object of the invention is to relieve a dead column of fluid upon downward shifting of a sleeve valve initially closing side ports in a casing string, outward passage of such fluid before relief is desired being prevented, as well as return flow of fluid into the casing after the relieving purpose has been accomplished.

The invention has other objects that will become apparent from a consideration of the several embodiments shown in the drawings accompanying and forming part of the present specification. These embodiments will now be described in detail to illustrate the general principles of the invention, but it is to be understood that such detailed description is not to be taken in a limited sense, since the scope of the invention is best defined by the appended claims.

Referring to the drawings:

Figure 1 is a longitudinal section through a well bore, disclosing the invention applied to a string of casing;

Figure 2 is a partial longitudinal section through the casing collar shown in Figure 1;

Figure 3 is a view similar to Figure 2, with parts in an intermediate operative position;

Figure 4 is a view similar to Figure 2, with parts in still another position;

Figure 5 is a fragmentary longitudinal section, on an enlarged scale, of the fluid relieving device in its Figures 1 and 2 position;

Figure 6 is a fragmentary longitudinal section, on an enlarged scale, of the fluid relieving device in its Figure 3 position;

Figure 7 is a longitudinal section through a modified form of fluid relieving device in closed position;

Figure 8 is a view similar to Figure 7 of the fluid relieving device in open position;

Figure 9 is a longitudinal section through another embodiment of fluid relieving device in closed position; and

Figure 10 is a view similar to Figure 9 of the fluid relieving device in open position.

The invention is disclosed in the drawings as applied to a casing string, liner, or other conduit, which includes a collar 10 threadedly attached to upper and lower casing sections 11, 12, to hold them in spaced relation. The collar has a plurality of circularly arranged side ports 13 for establishing communication between its interior and exterior, over which is disposed a back pressure valve in the form of a rubber or similar elastic sleeve 14, whose upper end is suitably se-

cured to the collar and whose lower end is free to flex outwardly to permit outward passage of fluids through the collar ports. Return flow of fluids, however, is prevented by closing of the flexible sleeve 14 back over the ports.

As disclosed in the drawings, the flexible sleeve is protected by a relatively rigid, metallic sleeve 15, spaced from the collar 10 and sleeve 14 and secured to the upper portion of the collar in any suitable manner, as by welding. The lower end of the rigid member is disposed over a plurality of externally inclined grooves 16 in the collar 10 to form whirler ports or nozzles. Cement slurry or other fluids passing through the ports will flex the back pressure valve 14 outwardly and flow into the annular chamber 17 formed between the collar 10 and rigid sleeve 15, from where such fluid can pass through the whirler ports 16 to the exterior of the casing.

The collar ports 13 are closed initially against passage of fluid from the interior of the casing to its exterior by a sleeve valve 18 slidable along the inner wall of the collar and provided with suitable side seals 19, 20 on opposite sides of the ports 13 to prevent leakage of fluids along the exterior of the sleeve and into the ports. The lower end of this sleeve is provided with a shoulder 21 engaging a companion shoulder 22 on the collar to position the side seals 19, 20 on opposite sides of the ports when the sleeve is in closed position, and to prevent further upward movement or displacement of the sleeve valve 18. Movement of the sleeve valve 18 in a downward direction is initially prevented by releasable means in the form of shear screws 23 attached to the collar 10 and extending into the sleeve valve.

When the ports are to be opened, a suitable ball or other device 24 can be allowed to gravitate, or is otherwise lowered, through the fluid in the well casing into engagement with a tapered seat 25 in the upper portion of the sleeve valve, closing its central passage and allowing hydraulic pressure to be increased in the casing thereabove to a predetermined degree sufficient to shear the screws 23 and shift the sleeve valve 18 downwardly to a position in which its upper side seal 19 is below the ports 13, which is a port opening position. Such downward movement of the sleeve valve may be limited by its engagement with a suitable stop 12a, provided by the upper pin end of the lower casing section 12.

The apparatus may be used in the performance of a multiple stage cementing operation. With the sleeve valve 18 held in closed position over the ports 13 by the shear screws 23, a first charge of cement slurry may be pumped down through the casing for ejection from the casing shoe 26 (or collar) and for upward passage around the casing string. A flexible top cementing plug 27 may be placed at the upper end of this charge of cement slurry to prevent its commingling with the displacement fluid. This plug can squeeze through the sleeve valve 18 without disrupting the shear screws 23 and eventually strikes the casing shoe 26, preventing further pumping of fluid down through the casing and providing an indication to the operator at the top of the well bore, through a rise in fluid pressure within the casing, that all the required cement slurry for the lower cementing stage has been disposed behind the casing.

A second charge of cement slurry is to be ejected from the casing through the collar ports 13. To accomplish this purpose it is first necessary to allow the trip ball 24 to gravitate through the fluid in the casing into engagement with the sleeve valve seat 25, whereupon the increasing of the fluid pressure above the sleeve valve to the required degree shears the screws 23 and shifts the sleeve valve 18 downwardly to port opening position, permitting circulating fluids and cement slurry to be pumped out through the open ports 13.

Since the column of fluid in the casing below the sleeve valve 18 is a dead column of fluid, because its displacement from the casing is prevented by the flexible top cementing plug 27 engaging the shoe 26, or by the settling and hardening of the lower cement slurry around the casing string (in the event that no top cementing plug is employed), the sleeve valve 18 with its engaged trip ball 24 can move downwardly to port opening position only if this dead column of fluid can be compressed sufficiently. The degree of compression depends upon the character of the fluid below the sleeve valve. If it is water, very little compression can take place, and shifting of the sleeve valve downwardly to port opening position would be extremely difficult, or could not take place.

The present invention overcomes the above noted undesirable condition by allowing escape of some of the entrapped fluid in the dead column below the sleeve valve 18 to the exterior of the casing apparatus upon relatively slight downward movement of the sleeve valve. In the embodiment shown in Figures 1 to 6, inclusive, a bleeder hole 28 is provided through the collar below the ports and the lower side seal on the sleeve valve. The outer portion 28a of the hole has a larger diameter than the inner portion 28b to form a shoulder 29 against which the head 30 of a frangible pin or shear screw 31 may engage, the shank 32 of the shear screw extending through the inner portion 28b of the bleeder hole into threaded attachment with the sleeve valve 18. The diameter of the shank portion 32 of the shear screw is substantially less than the diameter of the inner portion 28b of the bleeder hole to allow ample clearance for fluid passage around the shear screw.

The headed shear screw 31 functions as a valve in connection with the bleeder hole 28 and its shoulder 29. When the sleeve valve 18 is in closed position over the ports 13 and the shear screws 23 intact, the bleeder valve 31 is threaded completely into the sleeve valve with its head 30 in engagement with the shoulder 29, thereby preventing any fluids from passing through the slight running clearance provided between the lower end of the sleeve valve and the inner wall of the collar, and through the bleeder hole to the exterior of the collar. After the trip ball 24 has engaged its companion sleeve seat 25 and pressure of a predetermined degree imposed on the ball and sleeve valve, the shear screws 23 and the shear valve 31 are both disrupted, which allows fluid below the sleeve valve 18 to pass through the clearance space between the sleeve valve and collar and through the clearance space in the bleeder hole around the shank 32 of the valve, forcing the valve head 30 from its shoulder seat 29 and passing into the enlarged portion 28a of the bleeder hole around the valve head, from where this fluid may flow through a small space 33 provided between the lower end of the outer rigid sleeve 15 and the collar 10 to the exterior of the latter.

The length of the shank portion of the bleeder

screw 31 remaining attached to the head 30 after it has been sheared in two is much greater than the distance between the bleeder valve head 30 and the rigid sleeve 15, which prevents the bled fluid from completely removing the bleeder valve 31 from the bleeder hole 28 after it has been freed from the sleeve valve 18. This headed portion 30 also functions as a back pressure valve by preventing fluids from passing back into the collar through the bleeder hole. Any tendency for fluid to return therethrough would force the bleeder valve head 30 back against its seat 29.

The rigid sleeve 15 not only serves the purposes of protecting the elastic back pressure valve 14, forming of whirler ports with the inclined collar grooves 16, and providing an annular chamber 17 within which cement slurry may harden to close the ports 13, but it also acts as a stop, limiting the extent of outward movement of the bleeder valve screw 31.

With the arrangement disclosed, it is only necessary for the sleeve valve 18 to move downwardly a slight extent before the bleeder hole 28 is open. This distance is less than the diameter of the shear screws 23, since the latter will be sheared upon longitudinal movement of the sleeve valve 18 only a portion of their diameter. Downward sleeve movement against the dead fluid column to the slight extent required to shear the screws 23 takes place readily, and its further downward movement is facilitated by allowing some of the dead column of fluid to escape between the sleeve valve 18 and collar 10, through the bleeder hole 28, to the exterior of the casing. It is unnecessary to compress the dead column of fluid and foreshorten its length to the extent necessary to move the sleeve valve downwardly to full port opening position.

The bleeder arrangement disclosed in Figures 1 to 6, inclusive, offers a very simple manner of avoiding compression of the dead column of fluid to effect opening of the ports 13, and allows shearing of the screws 23 and movement of the sleeve valve 18 to port opening position upon subjecting the fluid in the casing to the predetermined degree necessary to shear the screws. The arrangement disclosed not only allows a small portion of the fluid to escape or bleed through the hole 28, but it also prevents such passage of fluid through the bleeder hole 28 until the sleeve valve 18 is to be moved to port opening position; so that no fluid can escape during the first cementing operation through the casing shoe 26. Moreover, it also prevents return flow of fluids back into the collar through the bleeder hole after the bleeder shear valve has been disrupted.

Although it is preferred to employ the embodiment disclosed in Figures 1 to 6, inclusive, other bleeder arrangements may be used effectively. As shown in the form of invention illustrated in Figures 7 and 8, one of the shear screws 23*a* initially holding the sleeve valve 18 in closed position over the ports has a lengthwise hole 34 in its outer portion extending through the collar 10, in order that shearing of this screw would open the hole 34 through which part of the dead column of fluid could be displaced upon hydraulic downward movement of the sleeve valve 18. This bleeder passage 34 is closed initially, and allows the required amount of fluid to be bled from the interior of the casing string; but it does not provide the positive assurance against return flow of fluid through the bleeder hole

offered by the other embodiment of the invention. However, the running clearance between the lower exterior surface of the sleeve valve 18 and the inner wall of the collar 10 is so slight that very little, if any, cement slurry pumped from the casing through the open ports 13 could flow back through the bleeder hole 34 and around the exterior of the sleeve valve 18 into the casing string.

Another bleeder arrangement is shown in Figures 9 and 10, in which a bleeder hole 35 is provided in the collar 10 through which part of the dead column of fluid may escape. Such escape of fluid is prevented initially by a ball valve 36 urged into engagement with the inner end of the hole 35 by a helical spring 37 disposed within a socket 38 in the sleeve valve. Prior to disruption of the shear screws 23, the ball valve 36 is urged into engagement with its companion seat 35*a* by the fluid pressure within the casing string, preventing passage of fluids through the bleeder hole 35 during the performance of the lower stage cementing operation. Upon disruption of the shear screws 23 and shifting of the sleeve valve 18 downwardly, the ball 36 is carried by the sleeve valve 18 out of cooperation with the bleeder hole 35, allowing fluid in the dead column to pass outwardly therethrough. As in the Figures 7 and 8 embodiment, this modification does not positively prevent return flow of cement slurry into the casing string, but such action would not occur to any appreciable extent, if at all, because of the small annular clearance space provided between the lower end of the sleeve 18 and the inner wall of the collar 10.

Having thus described my invention, what I claim and desire to secure by Letters Patent is:

1. Well apparatus, including a ported tubular member adapted to form part of a casing string, a sleeve valve within said member initially closing its port, said tubular member having a bleeder hole below its port, and means initially closing said bleeder hole and operable by said sleeve valve to open said bleeder hole upon movement of said sleeve valve to port opening position.

2. Well apparatus, including a ported tubular member adapted to form part of a casing string, a sleeve valve within said member initially closing its port, said tubular member having a bleeder hole below its port, and means carried by said sleeve valve for initially closing said bleeder hole, movement of said sleeve valve to port opening position effecting movement of said means to bleeder hole opening position.

3. Well apparatus, including a ported tubular member adapted to form part of a casing string, a sleeve valve within said member initially closing its port, said tubular member having a bleeder hole below its port, valve means carried by said sleeve valve for initially closing said bleeder hole, and means for effecting hydraulic downward movement of said sleeve valve to port opening position to move said valve means to bleeder hole opening position.

4. Well apparatus, including a ported tubular member adapted to form part of a casing string, a sleeve valve within said member initially closing its ports, said tubular member having a bleeder hole below its port, and frangible means secured to said sleeve valve for initially closing said bleeder hole, and means for shifting said sleeve valve to port opening position to disrupt said frangible means and open said bleeder hole.

5. Well apparatus, including a ported tubular

member adapted to form part of a casing string, a sleeve valve within said member initially closing its port, said tubular member having a bleeder hole below its port, and frangible means secured to said sleeve valve and initially closing said bleeder hole, said frangible means comprising a back pressure valve for preventing fluid from passing through said bleeder hole from the exterior of said tubular member after said frangible means has been disrupted by movement of said sleeve valve, said back pressure valve allowing fluid to pass outwardly through said bleeder hole.

6. Well apparatus, including a ported tubular member adapted to form part of a casing string, a sleeve valve having a central passage and disposed within said member over said port, frangible means securing said sleeve valve to said member in port closing position, said tubular member having a bleeder hole below its port, a second frangible means secured to said sleeve valve and initially closing said bleeder hole, and means for closing the central passage through said sleeve valve to enable hydraulic pressure to be imposed thereon to disrupt both of said frangible means to open said bleeder hole and to shift said sleeve valve downwardly to port opening position.

7. Well apparatus, including a ported tubular member adapted to form part of a casing string, a sleeve valve within said member disposed initially in closed position over said tubular member port, said tubular member having a bleeder hole below its port, and valve means for preventing passage of fluid through said bleeder hole from the exterior of said tubular member, said valve means allowing fluid to pass outwardly through said bleeder hole.

8. Well apparatus, including a ported tubular member adapted to form part of a casing string, a sleeve valve within said member initially closing its port, said tubular member having a bleeder hole below its port for relieving fluid in said casing string upon downward movement of said sleeve valve therewithin, and valve means secured to said sleeve valve for preventing passage of fluid through said bleeder hole from the exterior of said tubular member, and means engageable with said sleeve valve for effecting its downward movement to port opening position to open said valve means and allow outward passage of fluid through said bleeder hole.

9. Well apparatus, including a tubular member adapted to form part of a casing string positioned in a well, said tubular member containing a port, a valve positioned within said member and normally closing said port, means defining a relief opening in said member below said port for relieving fluid in said casing string below said valve, closure means initially obstructing said opening, and means interconnecting said valve and closure means operable to move said closure means to uncover said opening upon initiation of the movement of said valve towards port opening position and prior to location of said valve in port opening position to afford an outlet for fluid trapped below said valve.

10. Well apparatus, including a tubular member adapted to form part of a casing string, said

tubular member containing a port, a downwardly movable sleeve valve having an axial passage therethrough, said valve being positioned within said member and normally closing said port, means defining a relief opening in said member below said port for relieving fluid in said casing string below said sleeve valve, closure means initially obstructing said opening, means interconnecting said valve and closure means operable to move said closure means to uncover said opening upon initiation of the downward movement of said valve towards port opening position and prior to sufficient downward movement of said valve to a location opening said port, and means adapted to be sent down the casing string into engagement with said sleeve valve to close said passage and enable it to be shifted downwardly hydraulically.

11. Well apparatus, including a tubular member adapted to form part of a casing string, said tubular member containing a port, a downwardly movable sleeve valve having an axial passage therethrough, said valve being positioned within said member and normally closing said port, means defining a relief opening in said member below said port for relieving fluid in said casing string below said sleeve valve, closure means initially obstructing said opening, means interconnecting said valve and closure means operable to move said closure means to uncover said opening upon initiation of the downward movement of said valve towards port opening position and prior to sufficient downward movement of said valve to a location opening said port, and means adapted to close said passage and enable said valve to be shifted downwardly.

12. Well apparatus, including a casing string having a lower outlet and an upper tubular member, said casing string being imperforate between said outlet and member, said tubular member containing a port, a sleeve valve within said member disposed over and initially closing said port, said sleeve valve having a passage therethrough, said tubular member containing a bleeder hole below said port for relieving fluid in said imperforate portion of said casing string upon downward movement of said sleeve valve to open said port, closure means for said bleeder hole, means adapted to be sent down said casing string into engagement with said sleeve valve to close its said passage and enable it to be shifted downwardly hydraulically, and means interconnecting said closure means with said sleeve valve to effect opening of said bleeder hole upon movement of said sleeve valve.

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