Aug. 19, 1952 C. C. TAYLOR 2,607,425

WELL CEMENTING TOOL

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Fig. 1.

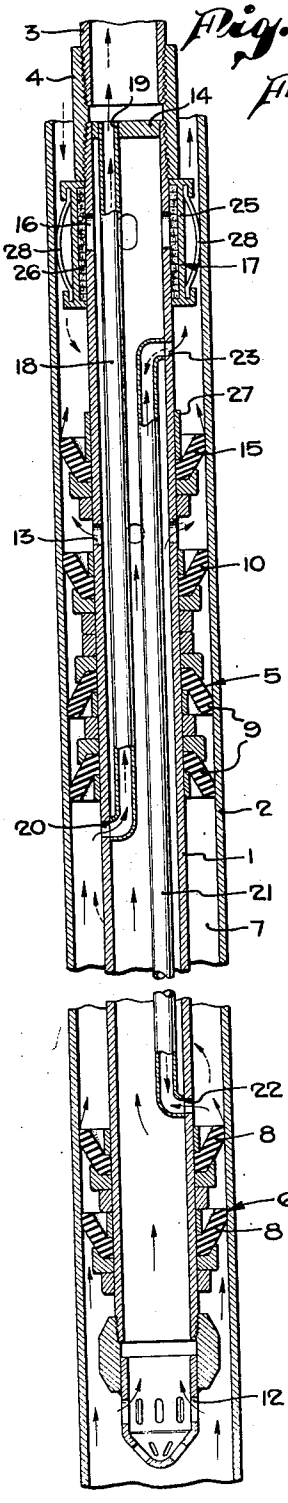


Fig. 3.

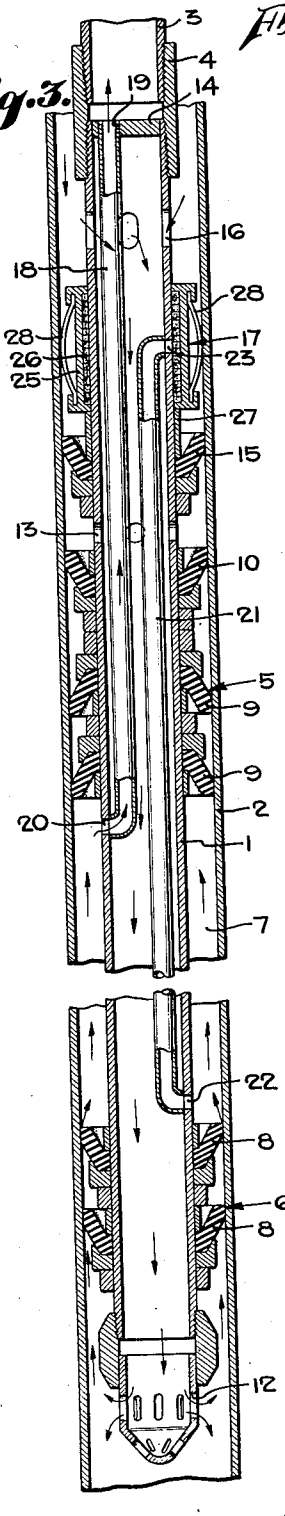
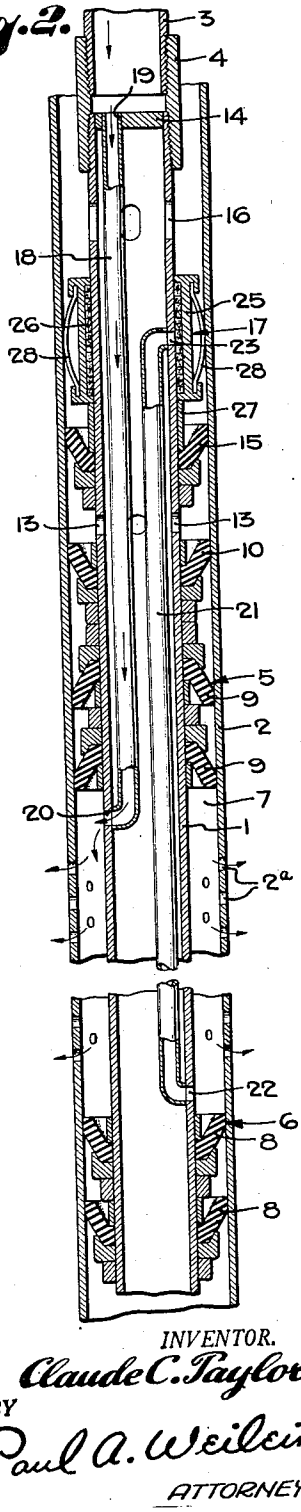


Fig. 2.



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WELL CEMENTING TOOL

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This invention relates to a tool for use in connection with oil well cementing or other operations involving fluids under pressure.

Tools for such operations, comprising opposed axially spaced packers on a tubular body or mandrel carried by a tubing string extending to the mouth of the well, for sealing between the body and the casing to form a pressure chamber in the casing communicating with the interior of the tubing, are known. Thus, fluid may be pumped down the tubing string and into the chamber, for example, to test the casing for leaks. If a cementing operation is to be performed, the tool is positioned so that the chamber straddles a perforated zone in the casing and cement slurry is pumped down the tubing and out through the perforations; or a liquid to clean the perforations may be used in a similar manner.

It is an object of this invention to provide an improved tool of this character.

It is another object of this invention to provide such a tool which does not require slips or the like to anchor the tool in the casing.

It is another object of this invention to provide such a tool having a mandrel of improved construction which does not require any joints in the pressure chamber.

It is another object of this invention to provide such a tool having improved means for by-passing the pressure chamber.

It is another object of this invention to provide such a tool having improved means for washing excess cement from the casing and tool after completing a cementing operation.

It is another object of this invention to provide such a tool wherein the circulation fluid for washing excess cement from the casing and tool after completing a cementing operation is prevented optionally from passing into the well below the tool.

This invention possesses many other advantages and has other objects which may be made more easily apparent from a consideration of one embodiment of the invention. For this purpose there is shown a form in the drawing accompanying and forming part of the present specification. This form will now be described in detail, illustrating the general principles of the invention; but it is to be understood that this detailed description is not to be taken in a limiting sense, since the scope of the invention is best defined by the appended claims.

In the drawing:

Figure 1 is an axial section of a tool, incorporating the features of the invention, in a well casing;

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Figure 2 is a similar view, but showing the tool arranged for a different operation; and

Figure 3 is a view similar to Figure 2, but showing the tool arranged for still another operation.

Referring to the drawing, the tool is shown as comprising a body or mandrel 1, supported for movement in a well casing 2, by means of a tubing string 3 which extends to the mouth of the well. The body 1 is attached to the lower end of the tubing string 3 by a coupling 4 and since the body is required to provide a plurality of flow passages, as will be discussed presently, it may be conveniently of tubular form.

Upper and lower packing means 5 and 6 are provided respectively in axially spaced relation on the body 1 and cooperate with the casing 2 to form a pressure chamber 7 about the lower portion of the body 1.

The lower packing means 6 may comprise one or more conventional packing cups 8, two being shown by way of example, suitably secured in spaced upwardly facing relation on the mandrel 1. The upper packer 5 comprises a similar pair of spaced cups 9, facing downwardly to oppose the cups 8. The upper packer 5 has additionally an upwardly facing cup 10 above the cups 9. Thus, the packer 5 will prevent fluid flow in either direction between the body 1 and the casing 2.

Means are provided forming a continuously open passage for by-passing well fluid upwardly with respect to the tool past the pressure chamber 7. Thus, the body 1 is open at its lower end, which may be provided with a strainer 12 or the like.

One or more openings 13 are provided in the wall of the body 1 above the packing means 5, the upper end of the body 1 being closed by a partition or head 14.

Obviously, fluid entering the open end of the body 1 will pass upwardly through the openings 13. To permit control of fluid by-passing chamber 7 downwardly, an upwardly facing packing cup 15 is provided on the body 1 above the openings 13 for sealing against the casing 2 to prevent such fluid entering the body through the openings 13. One or more ports 16 controlled by a valve 17 are provided in the body wall above the packer 15 for optionally establishing communication between the interior of the body 1 and the casing space above the packer 15, which space extends to the mouth of the well.

Means are provided forming a continuously open passage between the interior of the tubing string 3 and the pressure chamber 7. Such means are shown as comprising a tube 18 connecting an opening 19 in the partition 14 with an

opening 20 through the wall of the body 1 adjacent one end of the chamber 7.

Means are also provided forming a passage for optionally connecting the chamber 7 with the casing space extending to the mouth of the well. This means may comprise a tube 21 connecting an opening 22 through the wall of the body 1 adjacent the opposite end of the chamber 7 from opening 20, with an opening 23 through the body wall above the packer 15 and below ports 16.

The valve 17 controls the opening 23 as well as ports 16 and comprises a sleeve 25, freely slidable on the body 1 and maintained in fluid tight relation therewith by suitable packing 26, and arranged to close either the opening 23 or the ports 16, but not both. Thus, a collar or shoulder 27 is formed on the body 1 for limiting downward movement of the valve to a position where it closes opening 23 (see Figures 2 and 3). The coupling 4 provides a shoulder for limiting upward movement of the valve 17 to a position where it closes the ports 16 (see Fig. 1).

The sleeve 25 carries a plurality of conventional bow springs 28 which frictionally engage the casing 2 and restrain movement of the sleeve 25 therein. In this way, appropriate movement of the body 1 in the casing 2 serves to operate the valve 17.

The manner of using the tool will now be discussed. The tool is lowered in the casing 2 by means of the tubing string 3, the valve 17 being urged to its upper position by the friction of the springs 28 on the casing and uncovering the opening 23. Well fluid freely enters the lower end of the body 1, passing upwardly in the body out the openings 13, and thence upwardly past the packer 15 into the casing space which extends to the mouth of the well.

Well fluid also passes the upwardly directed packer cups 8 into the pressure chamber 7 and thence via tube 18 to the interior of the tubing string 3, and via tube 21 and opening 23 to the above mentioned casing space.

The total effective area of these fluid flow paths, indicated by the full line arrows in Figure 1, are large, and permit lowering of the tool at a rapid rate, as well as causing a flushing action by the fluid which keeps the tool free of foreign matter which may be in the well fluid.

During such lowering operation, the operator may quickly test the casing for leaks above the tool by stopping the tool at an appropriate depth, closing the outlets from the casing at the mouth of the well, and applying pressure to the fluid in the tubing 3. This pressure will act through the tube 18, on the fluid in the pressure chamber 7 and thence through the tube 21, on the fluid confined in the casing space between the casing 2 and the tubing 3 above the packer 15.

Testing as above is carried out at progressively increasing depths. When the tool has passed the point of leakage, there will be a drop in the pressure which can be maintained in the tubing. By noting the depth of the tool when such drop occurs, the point of leakage can be determined.

In a cementing operation, the tool is lowered to a position in the casing 2 with the pressure chamber 7 below a zone of perforations as 2–*a* in Figure 2, provided in the casing 2 for establishing communication with the space in the well bore outside the casing. The valve 17 will be in its upper position, as shown in Figure 1, due to this lowering movement, with ports 16 covered and opening 23 uncovered.

Circulation is established, as by pumping cement slurry down the tubing 3, the path of the circulation fluid being down the tubing 3 and tube 18 into the pressure chamber 7, and thence upwardly through tube 21 into the casing space above the packer 15 to the mouth of the well. The circulation fluid traverses the chamber 7 due to the entry and exit openings as 20 and 22 being at opposite ends, thus keeping the chamber clear.

After circulation has been established and it has been determined by appropriate means that the cement slurry has reached a point just above the tool, the tool is raised to a position such that the pressure chamber 7 straddles the perforations 2–*a*. This upward movement causes the valve 17 to move to its lower position, uncovering the ports 16 and covering the opening 23 (see Figure 2). Cement slurry may now be forced down the tubing string 3 and tube 18 into the pressure chamber 7 and out through the perforations 2–*a* into the space surrounding the casing 2, as indicated by the arrows in Figure 2, since the outlet provided by the tube 21 and opening 23 is now closed.

Upon completion of the cementing operation, all cement slurry remaining in the casing 2 and within the tool should be removed before it hardens or sets. This may be done optionally in any one of three ways.

Thus, with the valve 17 still in its lower or cementing position, reverse circulation or "back scuttling" may be employed. Appropriate liquid, such as mud laden water, is forced down the casing 2 outside the tubing 3 through the ports 16 into the body 1 and thence out the lower end of the body 1 into the casing space below the bottom packer 6. The cups 8 of this packer 6, as previously mentioned, yield to pressure from below, hence the circulation fluid flows upwardly past the packer 6 into the pressure chamber 7, through opening 20 and thence upwardly through tube 18 and the tubing string 3. This flow path is indicated by the arrows in Figure 3.

In this case, the circulation fluid is prevented from entering the pressure chamber 7 from above past the downwardly facing cups 9 by the upwardly facing packers 10 and 15. If this occurred, the fluid would pass directly out through the opening 20 without cleaning the chamber 7.

Optionally, the tool may be lowered in the casing 2 until the valve 17 is in its upper position, the ports 16 being covered and the opening 23 uncovered (as shown in Figure 1), and reverse circulation the short way employed. In this case the circulation fluid is forced down the casing 2 as before, thence via opening 23, tube 21 and opening 22 into the pressure chamber 7, returning via opening 20, tube 18, and the tubing string 3. In this case the packer 15 prevents the circulation fluid from entering the body 1 through the ports 13 and thence passing into the casing space below the lower packer 6. Thus, the casing space below the tool is not subjected to the pressure of the circulation. The flow path in this case is indicated by the broken arrows in Figure 1.

With the valve 17 in its upper position, straight circulation, such as established preceding the cementing operation and described in connection therewith, may be utilized if desired to wash the cement from the interior of the casing 2 and from the tool. In this method also the casing space below the tool is not subjected to the pressure of the circulation, since the fluid can not pass the lower packer 6.

By locating the openings 20 and 22 by which fluid enters and leaves the pressure chamber 7

adjacent the opposite ends of the chamber, fluid is caused to traverse the chamber from end to end, insuring a complete removal of the cement.

In bringing the tool out of the well, the valve 17 moves to and remains at its lower position, with the ports 16 uncovered. The well fluid above the tool enters the body 1 freely through these ports 16 and passes outwardly through the lower end of the body 1. Due to the large area of the passages thus provided the well fluid flows through the tool with little resistance, facilitating rapid withdrawal of the tool.

I claim:

1. In a well tool: a body adapted for connection with a tubing string for positioning in a well casing; upper and lower packing means secured in spaced relation on said body for sealing between the body and the casing to form a pressure chamber; said body having a passage, said passage being communicable with the interior of the casing below said chamber, an opening in said body for communicating said passage with the casing space above said upper packing means; means mounted on said body above said upper packing means to block flow from the casing through said opening into said passage and to allow flow from said passage through said opening into the casing; a port through said body for communicating said passage with the casing space extending to the mouth of the well; and valve means for optionally controlling said port.

2. In a well tool: a body adapted for connection with a tubing string for positioning in a well casing; upper and lower packing means secured in spaced relation on said body for sealing between the body and the casing to form a pressure chamber; said body having a passage, said passage being communicable with the interior of the casing below said lower packing means, said body having an opening for communicating said passage with the interior of the casing above said upper packing means, said upper packing means preventing fluid flow in either direction between the interior of said casing and said pressure chamber; and means preventing fluid flow downwardly through said passage comprising, an upwardly directed packing element on the body above said opening for sealing against the casing.

3. In a well tool: a body adapted for connection with a tubing string for positioning in a well casing; upper and lower packing means secured in spaced relation on said body for sealing between the body and the casing to form a pressure chamber; said body having a passage, said passage being adapted to communicate with the interior of the casing below said lower packing means, an opening in said body for communicating said passage with the interior of the casing above said upper packing means, said upper packing means preventing fluid flow in either direction between the interior of said casing and said pressure chamber; means preventing fluid flow from the interior of the casing downwardly through said opening into said passage comprising, an upwardly directed packing element on said body above said opening for sealing against said casing, said body having a port for communicating said passage with the interior of the casing above said upwardly directed packing element; and valve means for optionally controlling said port.

4. In a well tool: a body adapted for connection with a tubing string for positioning in a well

casing; upper and lower packing means secured in spaced relation on said body for sealing between the body and the casing to form a pressure chamber; said body having a passage forming a by-pass for passing well fluid past said chamber; said upper packing means preventing fluid flow between the body and the casing in either direction; means mounted on said body for restricting fluid flow in said by-pass to movement upwardly with respect to the body; said body having means for maintaining communication between said chamber and said tubing string; means forming a passageway in said body for communicating with said chamber, said body having an opening above said upper packing means for communicating said passageway with the interior of said casing; there being a port in said body spaced from said opening and connected with said by-pass; and valve means on said body, operable in response to movement of said body in the casing for optionally closing said opening or said port.

5. In a well tool: a tubular body adapted for connection with a tubing string for positioning in a well casing, said body being closed at its upper end to prevent communication with the tubing string and open at its lower end for communication with the interior of the casing; upper and lower packing means secured in spaced relation on said body for sealing between the body and the casing to form a pressure chamber; passage means in said body for maintaining communication between said chamber and the interior of the tubing string; means forming a passageway in said body for communicating said chamber with an opening through the wall of the body above said upper packing means; a port through the wall of the body axially spaced from said opening for establishing communication between the interior of the body and the interior of said casing; and a valve on said body, operable in response to movement of said body in the casing, for selectively closing said opening and said port.

6. In a well tool: a body adapted for connection with a tubing string for positioning in a well casing; spaced packing means carried by the body for sealing between the body and the casing to form a pressure chamber; passage means in said body for maintaining free communication between said chamber and the interior of said tubing string; said body having a passage forming a by-pass for freely by-passing well fluid upwardly past said chamber; and means for optionally passing fluid between said chamber and the interior of the casing above said packing means, or for by-passing well fluid downwardly past said chamber, including a passage in said body independent of the first named passage, a port in the body for communicating said by-pass with the interior of the casing, and a valve movable on the body for selectively opening and closing said last named passage and said port.

7. In a well tool: a body adapted for connection with a tubing string for positioning in a well casing; spaced packing means carried by the body for sealing between the body and the casing to form a pressure chamber; passage means in said body for maintaining free communication between said chamber and the interior of said tubing string; said body having a passage forming a by-pass for freely by-passing well fluid upwardly past said chamber; passage means in said body independent of said first named passage means and said by-pass for passing well fluid

between said chamber and the interior of the casing above said packing means, said body having a port for communicating the by-pass with the interior of the casing for by-passing well fluid downwardly past said chamber; and valve means on the body operable in response to movement of the body in the casing for optionally controlling said port and said independent passage means for directing fluid flow between the interior of the casing above the packing means and said chamber, or through said port and by-pass past said chamber.

8. In a well tool: a body adapted for connection with a tubing string for positioning in a well casing; spaced packing means carried by the body for sealing between the body and the casing to form a pressure chamber; said body having a passage forming a by-pass for freely passing well fluid upwardly past said chamber; means in the body forming a passage between the interior of said tubing string and an opening into said chamber; means in the body forming a passage independent of the second named passage and providing communication between the interior of the casing and a second opening into said chamber; said body having a port connected with said by-pass for passing fluid downwardly past said chamber; and valve means for optionally closing said port or said third named passage, said openings being located respectively adjacent the opposite ends of said chamber, whereby fluid flow between said second and third named passages traverses said chamber.

9. In a well tool: a tubular body adapted for connection with a tubing string for positioning in a well casing, said body being closed at its upper end to prevent communication with the interior of the tubing string and open at its lower end for communication with the interior of said casing; spaced packing means carried by the body for sealing between the body and the casing to form a pressure chamber; means in the body for forming a fluid flow passage between the interior of said tubing string and said pressure chamber; means in the body forming a fluid flow passage independent of the first named passage for communicating said chamber with the interior of the casing above said chamber; valve means for optionally closing the last mentioned passage; said body having a by-pass opening above said chamber; means on the body adjacent said by-pass opening for preventing flow from the interior of said casing through said by-pass opening; and means for by-passing well fluid past said chamber in a downward direction, comprising a port opening through the wall of said body into the interior of said body at a point such that it will be opened by said valve means when said valve means is in position to close said second named passage.

10. In a well tool: a tubular body adapted for connection with a tubing string for positioning in a well casing, said body being closed at its upper end to prevent communication with the tubing string and open at its lower end; upper and lower packing means secured in spaced relation on said body for sealing between the body and the casing to form a pressure chamber; the upper of said packing means being adapted to prevent fluid flow in either direction between the body and the casing; passage means in the body for maintaining free communication between said chamber and said tubing string; there being an opening through the wall of said body above said upper packing means; an upwardly directed packing element on said body above said opening to prevent downward fluid flow between the body and the casing to said opening, and means carried by the body for optionally establishing communication between the interior of the casing above said upwardly directed packer and the interior of said body or said pressure chamber.

11. In a well tool: a tubular body adapted for connection with a tubing string for positioning in a well casing, said body being closed at its upper end to prevent communication with the tubing string and open at its lower end; upper and lower packing means secured in spaced relation on said body for sealing between the body and the casing to form a pressure chamber; the upper of said packing means being adapted to prevent fluid flow in either direction between the body and the casing; passage means in the body for maintaining free communication between said chamber and said tubing string; there being an opening through the wall of said body above said upper packing means; means on said body for preventing downward fluid flow from the interior of said casing through said opening; there being a port through the wall of said body above said opening, means forming a passage for communicating said pressure chamber with the interior of the casing above said opening, and optionally operable valve means for closing either said passage or said port.

12. In a well tool: a body adapted for connection with a tubing string for positioning in a well casing; upper and lower packing means secured in spaced relation on said body for sealing between the body and the casing to form a pressure chamber; said body having a passage, said passage being communicable with the interior of the casing below said chamber, an opening in said body for communicating said passage with the casing space above said upper packing means; means mounted on said body above said upper packing means to block flow from the casing through said opening into said passage and to allow flow from said passage through said opening into the casing; said body having a port for communicating said passage with the interior of the casing, and valve means for opening and closing said port.

13. In a well tool, a tubular body adapted for connection with a tubing string for operation in a well casing, spaced upper and lower packing means for sealing with the casing, said body having a by-pass extending from below the lower packing means to above the upper packing means, means in the body forming a passage for conducting fluid between the tubing string and the space between said upper and lower packing means, and also between said space and an opening through the wall of the body outside said space, said body having flow control means outside said space for preventing the downward flow of fluid into the zone below the body and allowing upward flow of fluid through said by-pass, said body having a port through the wall thereof outside said space, said port and said body being cooperable for conducting fluid downwardly past said control means into the interior of the casing below said body, and a valve member movable on the body for selectively opening and closing said passage and said port.

14. In a well tool, a tubular body adapted for connection with a tubing string for operation in a well casing, spaced upper and lower packing means for sealing with the casing, said body

having a by-pass extending from below the lower packing means to above the upper packing means, means in the body forming a passage for conducting fluid between the tubing string and the space between said upper and lower packing means, and also between said space and an opening through the wall of the body outside said space, said body having flow control means outside said space including packing means on said body adapted to seal against the casing for preventing the downward flow of fluid into the zone below the body and allowing upward flow of fluid through said by-pass, said body having a port through the wall thereof outside said space, said port and said body being cooperable for conducting fluid downwardly past said control means into the interior of the casing below said body, and a valve member movable on the body for selectively opening and closing said passage and said port.

15. In a well tool, a tubular body adapted for connection with a tubing string for operation in a well casing, spaced upper and lower packing means for sealing with the casing, said body having a by-pass extending from below the lower packing means to above the upper packing means, means in the body forming a passage for conducting fluid between the tubing string and the space between said upper and lower packing means, and also between said space and an opening through the wall of the body outside said space, said body having flow control means outside said space including an upwardly facing packing cup on the body adapted to seal against the casing for preventing the downward flow of fluid into the zone below the body and allowing upward flow of fluid through said by-pass, said body having a port through the wall thereof outside said space, said port and said body being cooperable for conducting fluid downwardly past said control means into the interior of the casing below said body, and a valve member movable on the body for selectively opening and closing said passage and said port.

16. In a well tool, a tubular body adapted for connection with a tubing string for operation in a well casing, spaced upper and lower packing means for sealing with the casing, said body having a by-pass extending from below the lower packing means to above the upper packing means, means in the body forming a passage for conducting fluid between the tubing string and the space between said upper and lower packing means, and also between said space and an opening through the wall of the body outside said space, said body having flow control means outside said space for preventing the downward flow of fluid into the zone below the body and allowing upward flow of fluid through said by-pass, said body having a port through the wall thereof outside said space, said port and said body being cooperable for conducting fluid downwardly past said control means into the interior of the casing below said body, and a valve member movable on the body for selectively opening and closing said passage and said port, said control means and said body being cooperable to prevent downward flow of fluid below said body when said port is closed.

CLAUDE C. TAYLOR.

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