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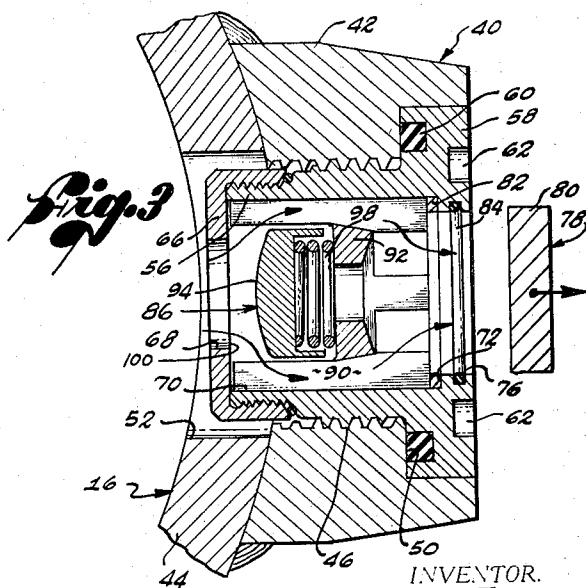
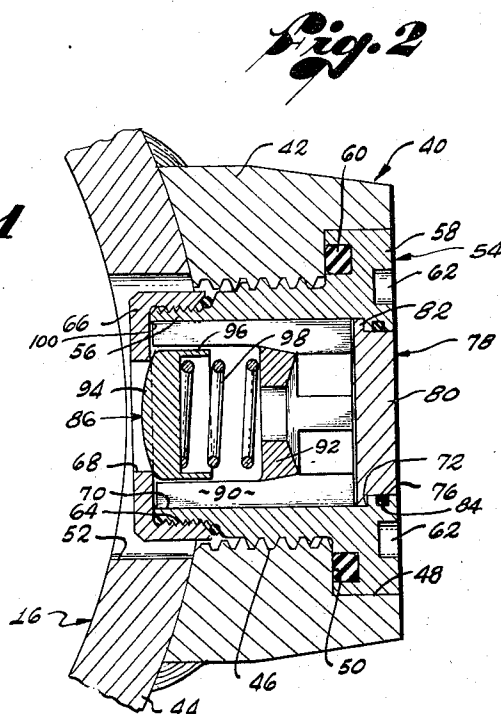
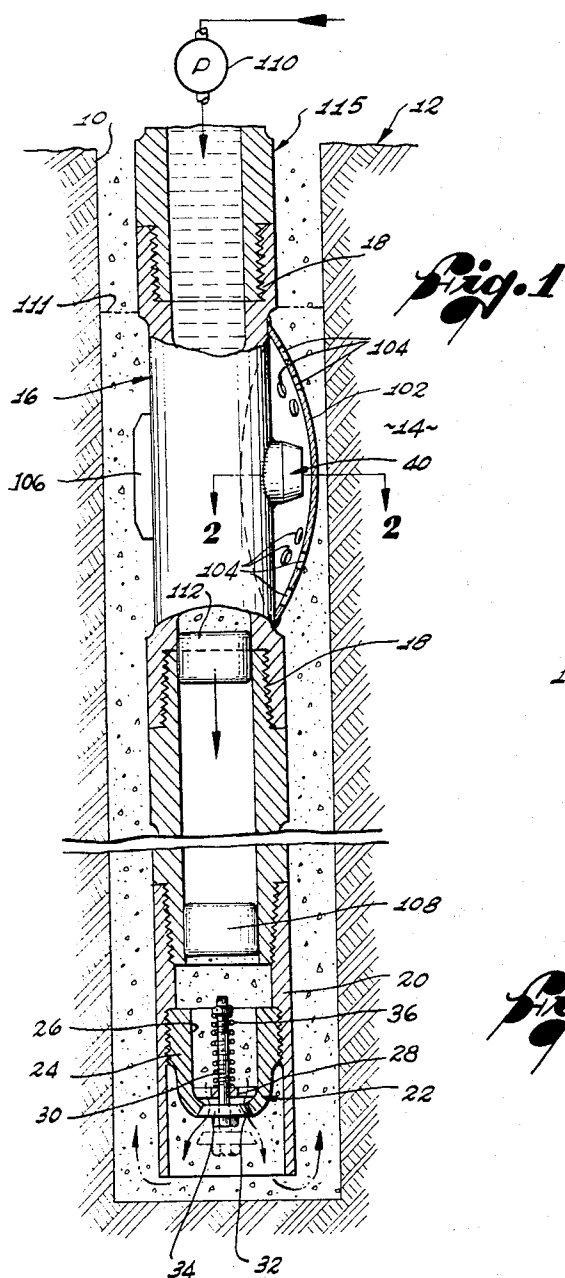
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3,358,770

CEMENTING VALVE FOR OIL WELL CASING

Filed April 16, 1965

2 Sheets-Sheet 1



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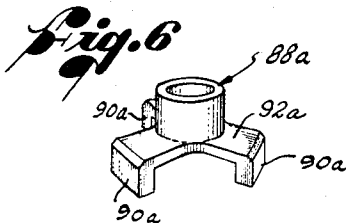
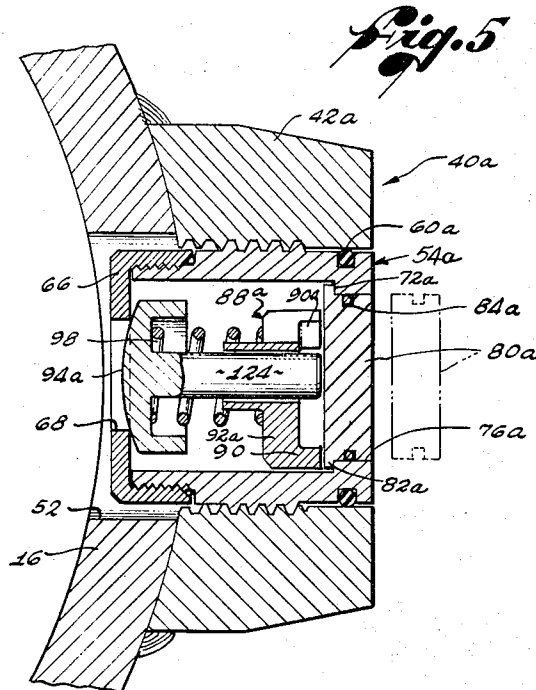
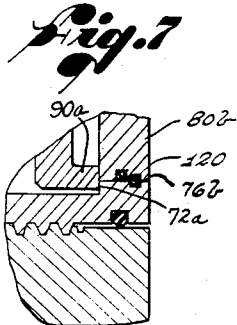
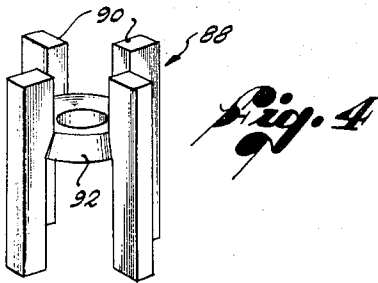
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CEMENTING VALVE FOR OIL WELL CASING

Filed April 16, 1965

2 Sheets-Sheet 2



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CEMENTING VALVE FOR OIL WELL CASING
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Canada, a corporation of Canada
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10 Claims. (Cl. 166-224)

ABSTRACT OF THE DISCLOSURE

The valve discharges radially outwardly of the casing and is very short and compact. It includes a normally closed check valve beyond which is a shear valve that opens at a predetermined internal pressure to allow cement to flow past the check valve and out of the discharge passage. The shear valve opens by shearing a flange that can be accurately controlled in size and consequently in shearing strength.

This invention relates generally to well cementing apparatus and is more particularly concerned with an improved lateral cement discharge device for use in a casing string adapted to multiple-stage well cementing operations.

When drilling a well, the well bore is commonly lined with casing which is cemented to the wall of the bore. This lining effectively isolates the production zone of the well from other well zones and from the surface. The cement bond between the well casing and the wall of the well bore serves a three-fold purpose. First, the cement bond and the casing act as a reinforcement to prevent inward collapse of the wall of the well bore. Secondly, the cement bond provides a physical barrier between the casing and the wall of the well bore which prevents the entrance into the production zone of water, rocks, sand, dirt and other foreign matter from other zones of the well and from the surface. Thirdly, the cement bond functions as a fluid seal between the well casing and the wall of the well bore which forces the fluid to enter and flow to the surface through the casing.

Well cementing operations are usually carried out as either single-stage or multiple-stage operations. In a typical single stage cementing operation, the well casing is filled with a measured charge of cement slurry which is calculated to fill, to a predetermined level, the annular space between the casing and the wall of the well bore. A plug is then placed in the casing and is driven down through the casing by hydraulic pressure. The cement slurry is thereby expelled from the casing through an opening in the lower end of the casing and flows upwardly between the casing and the wall of the well bore. In some cases, the well casing may be cemented one section at a time at different stages in the drilling operation, so that the drilling may be continued after cementing of each of the several casing sections. In this event, the plug for expelling the cement slurry from the casing is retained in the lower end of the casing by hydraulic pressure until the cement sets, to prevent backflow of the cement into the casing. During the subsequent drilling operation, the plug is simply drilled away. In other cases, a check valve is commonly installed in the lower end of the casing to prevent the backflow of cement into the casing and the cement expelling plug is simply driven downwardly to the check valve and left there.

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Single stage cementing operations are limited as to the overall length of casing which may be successfully cemented. Cementing a greater length of casing in a single stage operation, besides requiring undesirably high pump pressures, may result in channeling in the annular cement column about the casing and in other undesirable effects which produce an unsatisfactory bond between the casing and the wall of the well bore.

When the length of casing to be cemented exceeds the length which may be successfully cemented in a single stage cementing operation, resort is had to a multiple-stage cementing operation. Such a multiple-stage cementing operation involves a first cementing stage, carried out in precisely the same way as in a single stage cementing operation discussed above, and one or more additional successive cementing stages, during which successive upper lengths of the casing are cemented by expelling cement slurry through lateral openings in the casing. Thus, in a typical two-stage cementing operation, the casing is filled with an initial measured charge of cement slurry sufficient to cement a length of casing approximately equal to the maximum casing length permitted in a single stage cementing operation. A first plug is then driven downwardly through the casing to expel this initial charge of slurry through the lower end of the casing, thereby to cement the lower length of the casing to the wall of the well bore. Thereafter, a second plug may be set in the casing at a level just below the lateral casing opening for the second cementing stage. The second plug is fixed in position, as by seating against an internal shoulder in the casing, to close the casing below the lateral casing opening. The casing above the plug is then filled with a second measured charge of cement slurry which is expelled through the lateral opening in the casing. If necessary, additional successive cementing stages may be utilized to cement successive upper portions of the casing.

The lateral discharge opening for the second and any subsequent cementing stage may be located approximately at or about the level to which the cement slurry rises during the previous cementing stage. Preferably, however, each lateral casing opening is located a short distance below this level so that the cement slurry expelled during the second and any subsequent stage rises through the upper portion of the slurry from the previous cementing stage. This results in a continuous, monolithic body of cement, even if placed in multiple stages.

Regardless of the location of each lateral casing opening for multiple-stage cementing operations, however, some means must be employed to open and subsequently to close a discharge opening to allow exit and prevent re-entry of cement slurry into the casing. In the present disclosure, such a structure is referred to as a lateral casing valve structure, or simply a lateral casing valve.

It is a general object of this invention to provide an improved lateral casing valve combination for use in multiple stage well cementing operations.

Another object of the invention is to provide a well casing section and lateral casing valve combination for the purpose described which is characterized by its simplicity of construction, economy of manufacture, reliability of operation, damage resistance, immunity to erosion of the opposing wall of the well bore by the laterally discharging cement slurry, and other highly beneficial characteristics.

Other objects, advantages, and features of the inven-

tion will become readily apparent as the description proceeds.

Briefly, the objects of the invention are obtained by providing a laterally ported and valved well casing section to be connected in a well casing string for insertion into a well bore. This casing section is a laterally opening discharge port through which cement slurry is adapted to be expelled during one stage of a multiple-stage cementing operation. Flow of the cement slurry through this port is controlled by an improved and simplified lateral casing valve assembly according to the invention. This valve assembly includes a check valve and a shear valve arranged in series within a housing which is welded or otherwise joined to the outer surface of the casing section.

In use, the present casing section is connected into a casing string which is lowered into a well bore in the usual way. At the proper stage in the cementing operation a plug may be driven down through the casing string to a position just below the casing valve. A measured charge of cement slurry is then introduced into the string and is pressurized sufficiently to unseat the check valve and rupture the shear valve in the lateral casing valve assembly. The cement slurry is then expelled laterally from the casing into the annular space between the casing and the wall of the well bore. At the conclusion of the respective stage of the cementing operation, the check valve reseats to prevent backflow of the slurry into the casing.

The protruding outer end of the housing of the present lateral casing valve assembly is covered by a perforated guard or shield which serves the two-fold purpose of shielding the valve assembly against damage by contact with the wall of the well bore when the casing string is lowered into the bore and of vertically deflecting the stream of emerging cement slurry, thereby to prevent erosion of the wall of the well bore by the emerging stream.

The invention will now be described in greater detail with reference to the attached drawings wherein:

FIG. 1 is a fragmentary vertical section taken through a well bore and a casing string therein, including the present laterally ported and valved casing section;

FIG. 2 is an enlarged fragmentary transverse section, taken on line 2—2 in FIG. 1, through the lateral casing valve assembly embodied in the present casing section and illustrating the parts of the valve assembly in their normal closed positions;

FIG. 3 is a view similar to FIG. 2 illustrating the parts of the valve assembly in the open positions which they occupy when cement slurry is being expelled through the valve assembly;

FIG. 4 is an enlarged perspective view of the valve spider embodied in the valve assembly of FIGS. 2 and 3;

FIG. 5 is an enlarged fragmentary transverse section, similar to FIG. 2, through a variational construction of casing valve showing the parts of the valve assembly in their normal closed positions;

FIG. 6 is an enlarged perspective view of the valve spider embodied in the form of valve illustrated in FIG. 5; and

FIG. 7 is a fragmentary view similar to FIG. 5 illustrating a further variational form of the invention.

Referring now to these drawings, there is illustrated a well bore 10 extending downwardly through an earth formation 12 containing the fluid to be extracted from a production zone of this well designated by the reference numeral 14. Contained within this well bore is a casing string 115, the upper end of which extends to the surface (not shown). A casing string of this type is typically composed of a number of sections threadedly joined end to end. One of these sections of the casing string includes the laterally ported and valved casing section 16 of this invention.

The present well casing section 16 is constructed from

a short length of standard well casing joined by a coupling 18 at each end to the casing above and below. Within the terminal casing section 20 is a check valve assembly 22, which may be of any design. This check valve assembly typically comprises a generally tubular valve body 24 which is threadedly secured to the sleeve section 20, as shown. Extending across the lower end of the central opening 26 through the valve body 24 is a spider 28. This spider slidably supports a valve stem 30 for movement along the axis of the valve body 24. The lower end of the valve stem 30 extends through a lower opening in the valve body 24, the wall of which opening is tapered, as shown, to form a seat 32 about the opening. Mounted on the lower end of the valve stem 30 is a valve disc 34 having a bevelled peripheral seating face which is engageable with the valve seat 32, to close the central passage 26 through the valve body 24, when the valve disc occupies its solid line closed position of FIG. 1. The valve disc is yieldably retained in this closed position by a compression spring 36 which encircles the valve stem 30 above the spider 28 and seats at its lower end against the spider and at its upper end against a shoulder 38 on the upper end of the valve stem. The valve disc 34 is movable to its phantom line open position of FIG. 1 against the action of the valve spring 36.

Mounted on the well casing section 16 of this invention is one embodiment of a lateral casing valve assembly designated generally 40. As shown best in FIGS. 2 and 3, valve assembly 40 comprises a valve mounting pad 42 in the form of a boss of generally circular cross section which is welded or otherwise integrally joined to the outer surface 44 of the casing section 16. Extending axially through boss 42 is a threaded bore 46. The outer end of the threaded bore 46 is counterbored at 48. Threaded bore 46 and counterbore 48 define therebetween an annular shoulder 50. Extending through the cylindrical wall of the casing section 16, on the axis of the threaded bore 46 and the counterbore 48 of the boss 42 is a discharge opening or port 52. The diameter of this port may be slightly greater than the diameter of the threaded bore 46, as shown.

Contained within boss 42 is a hollow valve housing or body designated generally at 54 and including an externally threaded tubular section 56 which is threaded in the bore 46 and an outer radial flange 58 which enters the counterbore 48 of the boss and seats against the shoulder 50. An O-ring 60, contained within an annular groove in the inner surface of the body flange 58, seals the valve body 54 to the mounting boss 42. Extending axially into the flange 58 are sockets 62 which are adapted to receive the driving lugs on a spanner wrench, or the like, for tightening the valve body in the valve mounting boss.

The inner end of the body section 56 is externally reduced and threaded at 64. Threaded on this reduced inner end of the body is a cap 66 which has an opening 68 extending therethrough on the axis of the valve body 54. This cap opening is somewhat smaller in diameter than the central opening 70 through the valve body.

Near the outer end of the valve body 54 is an internal annular shoulder 72 presenting an inwardly facing annular surface. The central opening through the body is reduced in diameter at 76, outwardly of the shoulder 72; and at this reduced diameter portion is a shear valve 78. Shear valve 78 includes circular, disc-like body 80 which is slidably fitted in the opening 76 and an inner annular, radially projecting flange 82 which seats against the shoulder 72. An O-ring 84, contained within an annular groove in the wall of the opening 76, seals the shear valve 78 to the wall of opening 76.

Disposed within the central opening 70 through the body 54, between the cap 66 and the shoulder 72, is a check valve assembly 86. Check valve assembly 86 includes a spider 88 having a plurality of legs 90 bridged by an intervening, annular spring seat 92 disposed in a

plane generally normal to the legs. Spider 88 is dimensioned to be slidably received in the valve body 54, in the manner illustrated in FIGS. 2 and 3, where it will be observed that the peripheral surfaces of the legs engage the cylindrical wall of the opening 70 and the opposite ends of the legs are disposed in close proximity to or about the cap 66 and the shear valve 78.

Disposed between the cap 66 and the spring seat 92 of the spider 88 is a check valve member 94 having a circumferential, axially extending skirt 96. Held between the spring seat and valve member is a compression spring 98 which normally urges the valve member to its closed position of FIG. 2, wherein the member engages an annular valve seat 100 on the cap 66, about its opening 68, thereby to close this opening. The check valve member is movable to its open position of FIG. 3, against the action of the valve spring. The skirt 96 on the valve member 94 surrounds the adjacent end of the valve spring 98, thereby to retain the valve member and the spring in coaxial alignment during movement of the valve member between its closed position of FIG. 2 and its open position of FIG. 3. The inner ends of the spider legs 90, in turn, laterally confine and guide the valve member 94 during its movement between these positions.

At this point, it has become apparent that spider legs 90 serve several purposes, to wit, supporting the spring seat 92, guiding the check valve member 94 during its movement between its open and closed positions, and restraining the shear valve 78 against inward movement in response to fluid pressure outside the casing. The fits and tolerances are such as to enable the legs to perform these functions. If desired, the valve member 94 may be guided and the shear valve 78 may be restrained against inward movement by means other than the spider legs, as in the embodiment described below. Also, while the illustrated valve spider 88 is equipped with four legs, only three legs may be preferred in order to increase the effective flow area through the check valve assembly.

The shear valve 78 is so designed that its flange 82 will shear, and thereby permit the shear valve disc to be expelled outwardly from the valve insert 54 in the manner illustrated in FIG. 3, in response to a predetermined pressure on the inner surface of the shear valve. In a typical embodiment of the invention, for example, the shear valve usually will be designed to shear at an internal pressure on the general order of 3,000-3,500 pounds per square inch. It is apparent, of course, that the shear pressure of the valve may be varied by varying thickness of the flange 82. The valve itself is constructed of any suitable material capable of shearing at the desired internal pressure. However, the valve is typically constructed of magnesium or aluminum.

Secured to the outer surface of the casing section 16 is a perforated guard or shield 102 which covers the protruding lateral casing valve 40. Shield 102 has a number of upwardly and downwardly opening perforations 104 above and below, respectively, the valve 40 and preferably has a solid wall section 106 directly opposite the valve. Shield 102 serves the dual function of protecting the valve 40 against damage by contact with the wall of the well bore 10 when the casing string 16 is lowered into the bore and vertically diverting the stream of cement slurry which emerges from the valve during a well cementing operation so as to prevent erosion by the stream of the wall of the well bore in the region directly opposite the valve.

During a typical well cementing operation, an initial charge of cement slurry, sufficient to cement a predetermined length of the lower end of the casing string 16, is introduced into the upper end of the string. The plug 108 is then driven downwardly through the string, as by connecting the upper end of the string to a pump 110 for pumping fluid under pressure into the string. As the plug 108 descends through the string, the slurry is expelled through the check valve 22 at the lower end of the string

and rises through the annular space between the casing string and the wall of the well bore 10 to source level as indicated at 111. Eventually, the plug 108 is forced to its lower limiting position shown in FIG. 1 to complete the first stage of the cementing operation, with water or other fluid, not a cement slurry, above plug 108.

During one possible sequence of steps involved in performing the next stage of the cementing operation, a new charge of cement slurry is introduced into the upper end of the casing string 16 following a second plug 112 which is driven downwardly through the casing string to a position just below valve 40. Fluid above plug 108 may be exhausted as required through permeators or by any means, not shown. The plug 112 may be positioned in any suitable means. According to another technique, plug 112 is omitted. The pressure on the slurry is increased and eventually becomes sufficient to shear the flange 82 on the shear valve 78, the disc of which is then ejected outwardly from the valve 54, in the manner illustrated in FIG. 3. In order to permit the shear valve 78 to be expelled in this manner, it is necessary for the pressure of the cement slurry in the casing section 16 to act on the valve. It is apparent that this is accomplished by unseating the check valve 94 in response to the pressure of the slurry and thereby permit the slurry to flow into body 54. However, if the check valve 94 were to open during the initial cementing stage it could be filled with the cement slurry during the first cementing stage. This may be undesirable for the reason that the slurry may set in the valve. To avoid this problem, it is preferred to fill the entire internal cavity or opening 70 in the valve body 54 with an incompressible fluid, such as grease, to prevent the entrance of cement slurry into the valve until the fluid pressure is raised to such a value that shear valve 78 is expelled. In this case, obviously, the pressure of the cement slurry in the casing section 16 is transmitted to the shear valve 78 through the intervening incompressible fluid contained within the valve insert 54.

When the shear valve 78 is ejected, the cement slurry flows from the casing section 16, through the outlet port 52 in the casing and the lateral casing valve 40 into the annular space between the casing string and the wall of the well bore 10, thereby to cement the portion of the string above that cemented in the first stage of the cementing operation. As noted earlier, each lateral casing valve 40 may be located approximately at the level 111 to which the cement slurry rises during the preceding cementing stage. Preferably, however, the cementing valve is located slightly below this level 111, as shown, to provide a completely homogeneous bond between the two stages of cement. The second stage is performed while the cement from the earlier stage is still fluid, for this purpose. At the conclusion of each cementing stage, the check valve 94 of the corresponding lateral casing valve 40 re-closes to prevent backflow of cement slurry into the casing string.

In the embodiment of the invention described above, it is contemplated that valve body 54 will be screwed into mounting boss 42 prior to affixing guard 106 to the exterior of the casing. Since this guard is welded in place normally, this sequence of operations may be undesirable. In order to provide a construction of the valve in which it can be inserted and removed without affecting the guard 106, the construction may be altered as shown in FIG. 5 which discloses a valve that can be added after the guard 106 is in place by screwing the valve into the mounting pad from the inside of the casing.

For this reason, the cementing valve is either used in connection with a short length of casing, or is located sufficiently close to the end of a longer length of casing that the opening 52 in the casing wall is within reach of the end of the casing and an operator can simply, by inserting his arm in the end of the casing, thread the cementing valve into the mounting boss.

Referring particularly now to FIG. 5, there is shown a casing valve assembly 40a mounted on a length of cas-

ing by means of boss 42a. This valve assembly is constructed as previously described, except for certain changes and modifications which will now be noted. In this construction, the mounting boss is not counterbored at 48 but has a generally uniform diameter central opening. Consequently, valve body 54a has been modified by eliminating the radially extending flange 58 and adding a peripheral groove to receive sealing means in the form of O-ring 60a to effect a fluid-tight seal between the body and the mounting boss.

It will also be noted that O-ring 84a has been placed in the shear disc rather than in the valve body without changing its function.

The embodiment of the valve illustrated in FIG. 5 also contains other changes which, if desired, may be incorporated in the embodiment of the invention already described. For example, spider 88a has only three legs 90a, instead of four; and these legs are much shorter since they extend only from the spring seat 92a into engagement with shear flange 82 inside the valve body 54a. These legs thus are not relied upon to hold the shear valve in place against external fluid pressure.

This latter function is now taken over by valve 94a to which has been added in axially extending stem 124. The length of this stem is such that when the valve member is in contact with and seated against the inner rim of opening 68, valve stem 124 is in close proximity to the inner face of shear valve disc 80a. Valve stem 124 may be relied upon to hold the shear valve 80a at all times against being moved inwardly by external fluid pressure. Of course, valve stem 124 also takes up the function of guiding the valve as it moves from the closed position of FIG. 5 to the open position in response to pressure inside the casing in order to permit cement to flow through the valve and out into the annular space surrounding casing string 15.

The use of this valve is substantially the same as already described and consequently no further description of this character is required. It will be apparent from the foregoing description how the shear plate 80a is moved outwardly from the valve to open the valve to the flow of cement slurry, after the shear flange 82a has been sheared by the buildup of the fluid pressure inside casing string 15 to a predetermined value.

FIG. 7 illustrates a further modification in which the shear valve has been changed somewhat by eliminating shear flange 82a and substituting therefor a separate shear wire 120 which is held in mating grooves cut in the periphery of shear valve disc 80b and the opening 76b of the valve body. The shear element 120 may be a full circle or it may be less than a full circle. An advantage of this construction is that the strength of the shear element cannot only be very closely controlled but the force required to break the shear element and move disc 80b outwardly can be easily regulated in the field to suit any desired conditions by varying the circumferential length of the shear element 120. This shear element may be used in either form of valve already described.

Legs 90a of the spider now bear directly against shoulder 72a on the valve body 54a.

It is apparent, therefore, that the invention herein described and illustrated is fully capable of attaining the several objects and advantages preliminarily set forth.

While presently preferred embodiments of the invention have been disclosed for illustrative purposes, it should be understood that the disclosure is not limitative on the invention since various modifications in the design, arrangement of parts, and instrumentalities of the invention are possible within the spirit and scope of the following claims.

What is claimed as new in support of Letters Patent is:

1. A cementing valve for use in a multiple stage well cementing operation, comprising:

a tubular well casing section adapted for connection in a casing string;

a valve housing joined to said casing section and projecting outwardly therefrom,

there being a flow passage extending laterally of said casing section through said housing to the exterior of said section;

check valve means mounted in the inner end of said passage which unseats in a direction to permit outward flow through said passage; and

shear valve means fixed in the outer end of said passage adapted to be expelled outwardly from said passage in response to a predetermined pressure on the inner surface of said shear valve means, said shear valve means comprising a disc with an annular flange engaging the valve housing and shearing in response to said predetermined pressure.

2. Well cementing apparatus for use in a multiple stage well cementing operation, comprising:

a tubular well casing section having terminal coupling means for connecting said section in a casing string;

a valve housing rigidly joined to the outer surface of said casing section,

there being aligned openings extending through the wall of said casing section and said valve housing;

a tubular valve body threaded in said housing;

said body having an internal, inwardly presented annular shoulder surface adjacent the outer end of the central opening through said body;

a shear valve positioned in the outer end of said opening and having a circumferentially extending, radially projecting shear flange seating against said shoulder surface;

means restraining said shear valve against inward movement in said opening;

a cap secured to the inner end of said body and having a central opening therethrough, said cap providing a valve seat around said opening therethrough;

a spider mounted within said opening between said shear valve and said cap and defining an inwardly presented spring seat facing and axially spaced from said cap;

a movable valve member disposed between said shear valve and said cap and adapted for movement toward said cap to a position of seating engagement with said cap about said opening therethrough;

a spring acting between said spring seat and valve member for urging said valve member toward said valve seat;

means for guiding said valve member in its movement into and out of engagement with said valve seat; and

said spider including a plurality of legs extending between said shear valve and said cap, the outer ends of said legs comprising said restraining means and the inner ends of said legs comprising said guiding means.

3. Well cementing apparatus for use in a multiple stage well cementing operation, comprising:

a tubular casing section having a lateral discharge port in its wall;

a valve housing secured to the outer surface of said casing section in line with said port,

said housing having a threaded bore extending there-through on the axis of said port, the inner end of said bore opening to said port and the outer end of said bore being counterbored and opening to the exterior of said casing section;

a valve body including an inner tubular body threaded in said housing bore and an outer circumferentially extending, radially projecting flange engaging in said counterbore,

said body having an internal, inwardly presented annular shoulder surface at the outer end of the opening through said body;

a shear valve positioned in the outer end of said opening and having a circumferentially extending, radially

projecting shear flange engaging said shoulder surface;
 means for restraining said shear valve against inward movement in said opening;
 a cap secured to the inner end of said body and having 5
 a central opening therethrough;
 a spider within said body opening defining a spring seat spaced from and presented toward said cap;
 a valve member disposed between said spring seat and cap and adapted for movement toward said cap 10
 to a position of seating engagement with a valve seat about said cap opening;
 a spring acting between said spring seat and valve member for urging said valve member toward said 15
 valve seat;
 and means for guiding said valve member in its movement toward and away from said valve seat.

4. A cementing valve for use in a well cementing operation, comprising:
 a hollow valve body having a flow passage extending 20
 through said body to the exterior of said body;
 check valve means mounted in one end of said passage which unseats in a direction to permit outward flow through said passage; and
 a shear valve means fixed in the other end of said pas- 25
 sage including a disc slidably received in said body and closing said passage and adapted to be expelled outwardly from said passage in response to a predetermined pressure within said passage on the inner surface of said shear valve means; 30
 said disc having an annular flange engaging the valve body and resisting in shear internal pressure on the disc, the shear resistance being proportional to the axial thickness of the flange.

5. A cementing valve for use in a well cementing operation, comprising:
 a tubular casing section;
 a tubular valve housing adapted to be mounted on said 40
 tubular casing section to protrude outwardly therebeyond, there being a flow passage extending radially of the casing section and longitudinally of said housing to the exterior thereof;
 shear valve means fixed in one end of said passage to 45
 close the passage and adapted to be expelled outwardly from said passage in response to a predetermined pressure in said passage on the inner surface of said shear valve means;
 check valve means mounted in said passage but spaced 50
 radially inwardly of the casing section from the shear valve means;
 spring means biasing the check valve means to a closed position but yielding in response to internal pressure to permit fluid flow through the passage past the valve means to the shear valve means;
 and a perforated guard over the protruding valve housing on and exteriorly of the casing section, said guard 55
 having openings both above and below the flow passage in the housing.

6. A cementing valve as in claim 5 that also includes an abutment on the casing section directly opposite the valve housing and projecting outwardly from the casing section.

7. A cementing valve for use in a well cementing operation, comprising:
 a hollow valve body having a flow passage extending 65
 through said body to the exterior of said body;
 check valve means mounted in one end of said passage which unseats in a direction to permit outward flow through said passage;
 a shear valve means fixed in the other end of said pas- 70
 sage including a disc closing said passage and adapted to be expelled outwardly from said passage in response to a predetermined pressure within said passage on the inner surface of said shear valve means;
 and a plurality of rigid members bearing at one end 75

against the valve body and at the other end against the shear valve means to prevent the shear valve means from being displaced inwardly of said body by external pressure thereon.

8. A cementing valve for use in a well cementing operation, comprising:
 a hollow valve body having a flow passage extending through said body to the exterior of said body;
 check valve means mounted in one end of said passage which unseats in a direction to permit outward flow through said passage;
 a shear valve means fixed in the other end of said passage including a disc closing said passage and adapted to be expelled outwardly from said passage in response to a predetermined pressure within said passage on the inner surface of said shear valve means; and a rigid stem on said check valve means engageable with the shear valve means to prevent the shear valve from being displaced inwardly of said body by external pressure thereon.

9. Well cementing apparatus for use in a well cementing operation, comprising:
 a tubular well casing section having terminal coupling means for connecting said section in a casing string;
 a valve housing rigidly joined to the outer surface of said casing section;
 there being aligned openings extending through the wall of said casing section and said valve housing to form a substantially radially extending opening to the exterior of the casing section;
 a tubular valve body threaded in said housing providing a substantially radially extending cement discharge passage;
 said body having an internal, inwardly presented annular shoulder surface adjacent the outer end of the passage through said body;
 a shear valve slidably received in the outer end of said passage and having a circumferentially extending, radially projecting shear flange seating against said shoulder surface;
 a cap secured to the inner end of said valve body and having a central opening therethrough, the cap defining an inwardly presented valve around the central opening;
 means bearing against the cap and resisting in compression inward movement of said shear valve in said passage;
 a movable valve member disposed between said shear valve and said cap and adapted for movement toward said cap to a position of seating engagement with said cap about said central opening there-through;
 and a spring urging said valve member toward said valve seat;
 said valve body, cap and movable valve member all being disposed outwardly of the inside surface of said casing section at all times whereby the full inside diameter of the casing section is available to pass tools.

10. A cementing valve for use in a well cementing operation, comprising:
 a hollow valve body having a flow passage extending through said body to the exterior of said body;
 check valve means mounted in one end of said passage which unseats in a direction to permit outward flow through said passage;
 and a shear valve means fixed in the other end of said passage including a disc slidably received in said body and closing said passage and adapted to be expelled outwardly from said passage in response to a predetermined pressure within said passage on the inner surface of said shear valve means;
 said shear valve means including an arcuate shear member engaging said disc at the circumference thereof and the surrounding valve body to resist in shear outward movement of the disc, the shear resistance

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being proportional to the circumferential length of the arcuate shear member.

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