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(54) **Well cementing tool.**

(57) A tool for cementing a casing or other well pipe in a well comprises a substantially tubular collar and a plurality of port openings passing through the wall of said collar, which openings are oriented at such an inclined position relative to the collar that during injection of a cement slurry from the interior of the collar into an annular space surrounding the collar the flow of cement slurry obtains a swirling motion through said annular space.

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WELL CEMENTING TOOL

This invention relates to a tool for use in well cementing operations. More particularly it relates to a cement injection collar that may be used for cementing a casing in a wellbore or for cementing a small diameter casing, liner, or other pipe inside a large diameter casing.

In well drilling and completion operations it is common practice to install a casing, or other pipe in a well by suspending it at a desired location within the well such that an annular space is formed surrounding the outer pipe surface and then injecting a cement slurry into said annular space via the pipe interior and radial port openings formed in a cement injection collar mounted near the bottom of the pipe. A procedure of this type is disclosed, for example, in US patent No. 2,363,269. When the cement finally sets in position around the pipe it forms a plug which is intended to completely fill said annular space around the pipe.

During the cementing operation and while the cement is being forced upwardly through said annular space it rises against the drilling mud which fills the hole at that time. In fact the cement slurry displaces this drilling mud by pushing it upwardly ahead of it. Due to various factors, such as the presence of gelled drilling mud in said annular space or the presence of a sticky mud cake along the well bore, the cement slurry does not always rise uniformly in the annular space, but instead the cement slurry sometimes channels upwardly through the mud or mud cake thereby impairing the sealing and bonding power of the cement plug when hardened.

The mechanical agitation forces necessary to clean the annular space and to prevent channelling of the cement slurry have traditionally been accomplished by the use of scratchers and turbulence generating devices on the exterior wall of the casing or other wellpipe. Turbulence generating devices of this type are disclosed for example in US patent Nos 2,312,600; 2,602,512; 3,072,195 and 3,176,771. The devices known from these patent specifications have helically formed blades mounted at spaced interials on the outer surface of the well pipe so as to induce the cement slurry to follow a spiralling flow path upon injection into said annular space. The main drawbacks with the presently known turbulence generating devices are their fragility and tendency to cause at least some flow restriction in said annular space. The presence of any flow restriction in said annular space is undesired since it has the consequence that with a certain pump pressure a lower cement circulation velocity is obtained.

Accordingly, it is a principle object of this invention to provide a novel form of well cementing tool for creating turbulence in cement or mud flow through in the annular space around a casing or other well pipe during cementing operations.

The cementing tool according to the invention consists of a collar having a tubular wall with a longitudinal axis, and a plurality of port openings for allowing a cement slurry to be injected from the interior of the collar into an annular space surrounding the collar, wherein each of said port openings has a central axis which crosses said longitudinal axis of the collar at a selected distance.

The arrangement of port openings in the collar according to the invention enables to inject the cement slurry such that it obtains a swirling motion through said annular space immediately upon injection thereof into said space.

The invention will now be explained in more detail, by way of example, with reference to the accompanying drawing, in which

Fig. 1 shows a longitudinal section of a well cementing tool embodying the invention, and

Fig. 2 shows a cross-section along line II-II of the tool of Fig. 1, seen in the direction of the arrows.

The well cementing tool shown in Fig. 1 and 2 consists of a substantially tubular cementing collar 1 provided at the upper and lower end thereof with a female and male tool joint 2, 3, respectively, for coupling the collar 1 to adjacent sections of a casing string (not shown). The collar 1 has a longitudinal axis I and is provided with a series of port openings 5 which enable a cement slurry which is pumped down through the casing string, as indicated by arrow III, to escape into an annular space 6 formed between the outer surface of the collar and a borehole wall 7 and then to migrate in upward direction through said annular space 6, as indicated by arrows IV.

Cementing collars of this type are usually indicated as multiple stage cementing collars and they can be mounted at several levels in a well casing to cement the casing inside a borehole along a selected distance, which distance usually spans either the spacing between two cementing collars or the interval between the uppermost collar and the casing top. To facilitate cement injection through the lowermost collar first and subsequently through collars located at higher levels, each collar is usually provided at the inside thereof with an opening sleeve and a closing sleeve (not shown) which sleeves can be moved axially in downward direction alongside the inner wall of the collar 1 by means of pump down plugs (not shown) so as to

open and close the port openings at will. Since multistage cementing procedures are known per se to those skilled in the art no detailed description thereof is required.

In the known cement injecting collars the port openings consist of bores drilled in radial direction through the tubular wall of the collar. This causes the cement slurry injected through the collar to splash at high speed against the borehole wall and to subsequently migrate in upward direction through the annular space surrounding the casing string. As is known in the art, for example from US patent 3,072,195, the cement slurry, after injection thereof into the annular space may be forced to follow a spiralling flow path through the annular space by means of blades which are mounted on the outside of the casing string and are inclined relative to the longitudinal axis thereof.

In accordance with the invention the port openings 5 are drilled at such an inclined orientation through the tubular wall of the collar 1 that the cement slurry, immediately upon injection through the port openings 5 follows a swirling flow path through the annular space 6. Thereto the orientation of the port openings 5 is selected such that the central axis V of each port opening 5 crosses the longitudinal axis I of the collar 1 at a selected distance.

In the example shown in the drawing this is achieved by drilling the port openings 5 such that the central axis V thereof are tangential to the surface a hypothetical mathematical cone, illustrated by phantom lines X, which cone points, when the collar 1 is installed in a well casing string, towards the bottom of the well. Said mathematical cone has a top angle A which is preferably selected between 60° and 120°. The port openings 5 moreover have each a similar orientation relative to the longitudinal axis I of the collar 1, which orientation is selected such that the central axis V of each opening 5 crosses the longitudinal axis at a predetermined angle which is between 0° and 90°. Said predetermined angle is preferably selected between 30° and 60°.

The purpose of the inclined arrangement of the port openings 5 in accordance to the invention is to create a vortex in the flow through the annular space 6 of cement slurry and/or of a cleaning or drilling liquid pushed ahead of the slug of cement slurry during cementation. Due to said vortex high liquid velocities are obtained in said annular space so that the mud cake, gelled drilling mud or other contaminations are flushed away from the borehole wall and outer surface of the casing and a good bonding of the cement to said wall and surface is obtained. Creating a vortex by means of the inclined port openings according to the invention eliminates the necessity of the use of spiralling ribs on the outer surface of the casing at least in the region close to the port openings. Such spiralling ribs have a tendency to cause at least some flow restriction in the annular space 6. Elimination of flow restriction in said annular space has the advantage that with a certain pump pressure of the cement injection pumps a higher cement circulation velocity can be obtained which is beneficial for an uniform rising of the cement slurry through the annular space and for optimized cleaning of the annular space.

It will be understood that the embodiment of the invention shown is only examplary and that various modifications of the present invention will become apparent to those skilled in the art from the foregoing description and accompanying drawing. Such modification are intended to fall within the scope of the appended claims.

Claims

1. A cement injection collar for use in well cementing operations, said collar having a tubular wall with a longitudinal axis, and a plurality of port openings formed in said tubular wall for allowing a cement slurry to be injected from the interior of said collar into an annular space surrounding the collar, wherein each of said port openings has a central axis which crosses said longitudinal axis of the collar at a selected distance.

2. The collar of claim 1, wherein the central axes of said port openings are located tangentially to a mathematical cone having an axis of symmetry which is co-axial to said longitudinal axis of the collar.

3. The collar of claim 2, wherein said mathematical cone has a top angle between 60 and 120°.

4. The collar of claim 3, wherein the port openings are arranged such that, when the collar is installed in a well, the top of said mathematical cone points towards the bottom of the well.

5. The collar of claim 1, wherein said port openings have a substantially cylindrical shape.

6. The collar of claim 1, wherein the central axes of said port openings cross the longitudinal axis of the collar at substantially similar distances.

7. The collar of claim 6, wherein the port openings have substantially similar orientations relative to said longitudinal axis.

8. A cement injection collar according to claim 1, substantially as described hereinbefore with reference to the accompanying drawing.

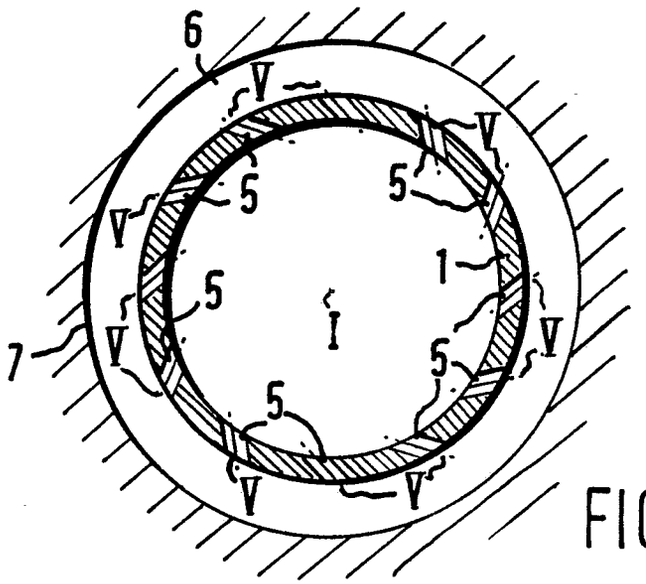

FIG.2

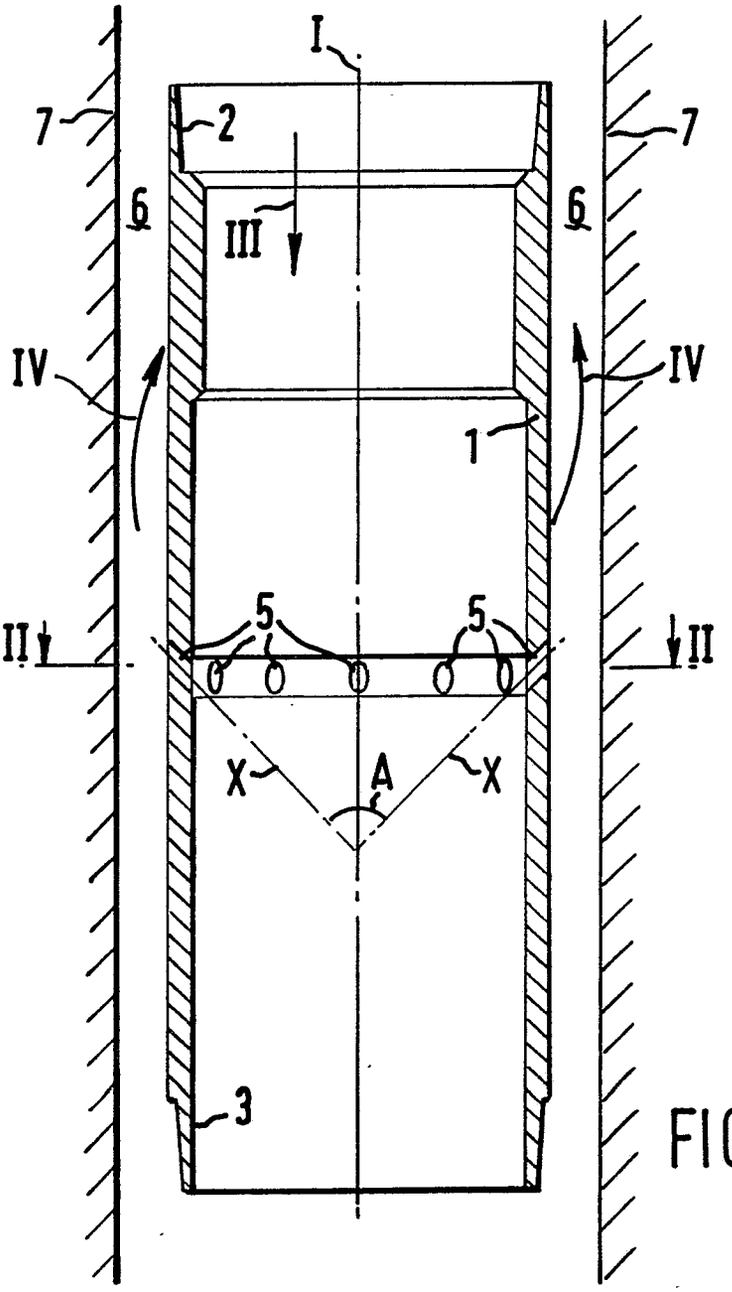

FIG.1