(54) Title: IMPROVEMENTS IN OR RELATING TO TOOLS

(57) Abstract: A tool for use in the recovery of hydrocarbons from subterranean or subsea reservoirs, with a hard-facing on a surface of the tool, the surface of the tool (8) having opposing side edges (8') and the hard-facing (9) comprising a plurality of insert components applied to the surface of the tool, at least some of the insert components being applied at an inclined angle to the opposing edges of the surface of the tool.
IMPROVEMENTS IN OR RELATING TO TOOLS

This invention relates to improvements in relation to tools and particularly tools upon which a hard-facing protection is applied, and most particularly to tools intended to be used downhole in the recovery of hydrocarbons.

Metal parts frequently fail in their intended use, due not only to fracturing but also to wear and abrasion which results from use. Wear changes a metal part dimensionally and as the dimensions of the metal part change, the function and operation of the part will often inevitably change. Processes are known for repairing worn metal parts where a durable material, typically a harder or tougher material, is adhered to the degraded or worn surface to increase the lifespan of the part. For metal components, this is commonly known as hard-facing with the application or building up or wear-resistant material onto the surface of a part or component of a tool by means of welding, plating, spraying or some other known technique.

This bonds a layer of tougher material onto the worn component which can return the worn tool to a useable condition and lengthen the life of the tool. Tools intended for use in the recovery of hydrocarbons must be able to withstand and operate in extreme conditions of temperature and pressures and an increase in the working life of a tool, or the extension of time periods between recovery operations of a tool for repair or replacement, can lead to significant savings in relation to reduction of downtime of the recovery operation.

Hard-facing is particularly beneficial in relation to drilling tools such as hole openers and drill bits for example which have radial blades which rotate against the solid rock formations in which the hydrocarbon deposits are found. During use, the blades of the hole opener or drill bit become worn which can significantly reduce their effectiveness. This leads to lengthy operations to recover the hole opener or drill bit from the downhole well for repair or replacement.
Therefore as described above, hard-coating of a blade of a downhole tool can increase the operational life of the blade and therefore of the tool and can reduce downtime of the downhole operations in which the tool is utilised.

A tool may be hard-faced by applying a single metal component to the face of the tool. However, conventional hard-facing operations employ the use of a number of metal inserts applied to the tool by building up an array of components over the area of the tool which is intended to be protected or replaced.

The metal components are typically applied in a brick pattern with a first layer of metal inserts laid end to end parallel to the opposing side edges of the blade, with a small gap between each adjacent component. The next layer of components are then laid above the first, with each component offset longitudinally from the component below it in the first row. The process is continued over the surface of the blade in order to build up the brick work over the operational surface as required.

An unintended consequence of this pattern with spaces between the insert components of each row and each layer is that fluid pathways are defined from one side of the blade to the other and from the lower part of the blade (in use) to the top of the blade (in use). This can expose the blade to a process called washing in which fluids in the downhole well can be forced across the surface of the blade, between the ends of the inserts. These downhole fluids generally contain particulate materials such as drill cuttings and other corrosive materials used in the recovery process which can abrade and damage the surface of the blade, especially where they are forced along the small passageways across and along the blade that are provided in a regular brickwork pattern of inserts.

Therefore the present invention seeks to provide a tool with an improved hard-facing for metal components, and particularly a tool intended for use in the hydrocarbon recovery process which seeks to mitigate these problems and increase the lifespan of the hard-faced tool.
According to one aspect of the present invention there is provided a tool for use in the recovery of hydrocarbons from subterranean or subsea reservoirs, with a hard-facing on a surface of the tool, the surface of the tool having opposing side edges and the hard-facing comprising a plurality of insert components applied to the surface of the tool, at least some of the insert components being applied at an inclined angle to the opposing edges of the surface of the tool.

Preferably the insert components close off fluid paths directly across the blade from one side to another or over the blade from one end to the other.

Preferably the insert components are substantially rectangular in form.

Conveniently the insert components are applied in a chevron pattern over the surface of the tool.

 Preferably the chevron pattern of insert components runs from an upper end (in use) of the surface of the tool to a lower end (in use).

Alternatively, the insert components are substantially arcuate in form. Such insert components can be applied across the surface of the tool, extending from one opposing side edge to the other.

Advantageously the tool comprises one or more blades and the hard-facing is applied on the or each blade of the tool.
In some embodiments each insert component of the hard-facing will be inclined to the edges of the surface of the tool by substantially the same angle. In other embodiments, individual insert components of the hard-facing may be inclined by a greater or smaller angle to the opposing edges of the surface of the tool.

Advantageously further insert components may be provided on the surface of the tool parallel to the edge of the surface, between the inclined insert components.

Advantageously the tool is a hole opener or a drill bit used in the drilling or enlarging of a borehole during a well drilling operation.

Embodiments of the present invention will now be described with reference to and as shown in the accompanying drawings in which:

Figure 1 is a side view of a tool according to a first embodiment of the present invention;

Figure 2 is a side view of a tool according to a second embodiment of the present invention;

Figure 3 is a side view of a tool according to a third embodiment of the present invention;

Figure 4 is a side view of a tool according to a fourth embodiment of the present invention;

Figure 5 is a side view of a tool according to a fifth embodiment of the present invention;

Figure 6 is a side view of a tool according to a second embodiment of the present invention and
Figure 7 is a side view of a tool according to a second embodiment of the present invention.

A tool 1 according to the present invention is shown in Figure 1. The tool has a first end 2 and a second end 3. The ends of the tool may have conventional fittings such as pin and socket or threaded connections to allow the tool to be connected into a string with other pipes, tools or components having cooperating end fittings.

The body of the tool 4 between the end fittings, has a greater diameter than the ends of the tool. A plurality of channels 5 are formed in the body of the tool which defines a number of blades 6 on the outer surface of the tool, each blade being provided between two of the channels. In the embodiment shown, the blades and the channels extend both longitudinally along the body of the tool and also radially around the tool such that the upper end (in use) of the blade 6 is circumferentially offset from the lower end (in use) of the blade around the body of the tool and the ends of the channels are similarly circumferentially offset around the body of the tool.

A hard-facing is applied to the outer surface 8 of the blades of the tool, these being the surfaces that, in use, will typically come into contact with the wall of a wellbore. The surface has opposing edges 8' along the points where the blades and the channels meet around the outer surface of the body of the tool.

The hard-facing comprises a plurality of metal insert components 9 which are applied to the outer surface of the blade. Typically the metal selected for the insert components is a stronger and tougher metal than that of the tool. In the embodiment of Figure 1, the insert components are substantially rectangular in form and are laid in pairs along the length of the blade, with each pair of inserts having one end adjacent a respective one of the opposing sides of the blade and the other end (being the lower end (in use)) being angled inwardly towards the centre of the blade and thus are provided at an inclined angle to the edges of the surface of the tool. Preferably the insert components are inclined at an angle of between 10 to
70 degrees to the edge of the outer surface of the blade. The inclined insert components may be mounted with between \(\frac{1}{4}\) inch and \(\frac{1}{2}\) inch spacing between progressive inserts along an outer surface of the blade.

In the embodiment shown in figure 1, pairs of insert components are provided along the length of the blade pointing toward the lower end of the blade (in use) such that the inserts form a chevron pattern along the length of the blade.

A further insert component 10 is shown in this embodiment in the centre of the blade, between the two sets of inclined inert components. The central insert lies along the centreline of the blade. In some embodiments the central insert component may be left out.

By angling the insert components 9 inwards towards the centre line of the blade, and down towards the lower end of the blade (in use) and therefore at an angle to the opposing edges of the blade, rather than building up a conventional brick pattern on the surface of the blade which can allow fluids to pass over the blade from one side to the other, and also along the blade from bottom to top, the insert components deflect fluid away from the centre of the blade when the tool is rotating in a well bore and so disrupt the flow of fluid over the blade and this reduces the effects of washing in which debris in the wellbore can be pushed over the surface of the tool and particularly over the surface of the blades and between the insert components which has an abrasive effect on the surface of the blades. Therefore the pattern of the inserts closes off fluid paths across the blade from one side to the other and over the blade from top to bottom and mitigates against damage to the blades of the tool.

The application of a hard-facing to the operating surfaces of the blades of a tool in accordance with the present invention will now be described. The tool 1 may for example be a tool such as a hole opener or drill bit which has previously been used in downhole operations which have worn down the blades of the tool. The tool is initially pre heated and a metal bar, such as a steel bar is applied to the opposing
edges of the blades of the tool to act as a moat to retain the hard-facing material as described further below.

The blades 6 of the tool are then cleaned to remove any debris from the application of the steel bar and then sanded to remove contamination.

The individual insert components 9 of the hard-facing are then laid onto the surface 8 of the blade. As each insert component 9 is mounted on the surface of the tool it is bonded onto the tool using known technique or bonding agent such as a known fusing powder which is commercially available and would be known to the skilled person.

A filler material such as tungsten carbide based abrasion resistant rope is then placed onto the surface of the tool around the insert components until it reaches the height of the steel bar applied to the opposing edges of the surface of the blade. All of the inserts may be covered by the filler material or alternatively the filler material may extend between the insert components and the opposing outer edges of the blade, leaving the insert components standing proud of the filler material.

The tool is then allowed to cool and finally undergoes a grinding process to finish the tool ready for use.

The embodiment shown in Figure 1 of the application shows a tool with a hard-facing formed of a plurality of insert components laid in a chevron pattern along the blade of the tool with the lower ends (in use) of each insert touching or almost touching the lower end of its neighbouring insert. The filler material is not shown for ease of reference. Alternative embodiments are shown in Figures 2-7 as described below. The embodiment of Figure 2 is similar to that of Figure 1, except in this embodiment instead of a single central insert component, a plurality of insert components 110 are mounted along the centre line of the blade substantially equidistant from each opposing edge of the blade but parallel to the edges to further breakup and disrupt the fluid flow across the blade.
In Figure 3, a further series of insert components 300 are laid end to end along each of the opposing outer edges of the blade which further limits the opportunity for washing of the blade by interrupting the flow path of fluids over the surface of the blade. By providing additional insert components on the surface of the blade of the tool, the wear resistance of the hard-facing will increase which provides significant advantages particularly when the tool is used in aggressive well formations.

In the tool 401 shown in the embodiment of figure 4, arcuate insert components 400 are provided on the surface of the blade each insert component extending substantially from one opposing side edge to the other. As with earlier embodiments, the insert components act to disrupt fluid flow across and over the blade and thus mitigate against the damage from washing of the blade with debris filled fluids in the well bore. In this embodiment a central insert component 410 is provided similar to the central insert component of the first embodiment. In the tool 501 shown in figure 5, a plurality of central insert components 510 are provided, with one such component located between each of the arcuate insert components 500 and in the embodiment shown in figure 6, an array of three such central insert components 610 are provided.

In figure 7, the insert components 700 are substantially L-shaped, with the two legs of the component having equal length and extending substantially at right angles to each other. The components are mounted on the surface of the blade with the apex of the legs pointing along the central line of the blade towards the lower end (in use) of the blade such that the insert components resemble a series of arrows along the blade. Central insert components 710 are provided between each of the L-shaped insert components.

In all of the above embodiments, the insert components being inclined at an angle to the outer opposing edges of the blade, act to disrupt fluid flow over the blade and thus provide a protective hard-facing to the surface of the blade which mitigates
against washing of abrasive particulates over the surface of the blade which can lead to wearing and damage to the blades of the tool.
CLAIMS

1. A tool for use in the recovery of hydrocarbons from subterranean or subsea reservoirs, with a hard-facing on a surface of the tool, the surface of the tool having opposing side edges and the hard-facing comprising a plurality of insert components applied to the surface of the tool, at least some of the insert components being applied at an inclined angle to the opposing edges of the surface of the tool.

2. A tool according to claim 1, wherein the insert components are substantially rectangular in form.

3. A tool according to claim 1 or 2, wherein the insert components are applied in a chevron pattern over the surface of the tool.

4. A tool according to claim 3, wherein the chevron pattern of insert components runs from an upper end (in use) of the surface of the tool to a lower end (in use).

5. A tool according to claim 1, wherein the insert components are substantially arcuate in form.

6. A tool according to claim 5, wherein the insert components are applied across the surface of the tool, extending from one opposing side edge to the other.

7. A tool according to any of the preceding claims, wherein the tool comprises one or more blades and the hard-facing is applied on the or each blade of the tool.

8. A tool according to any of the preceding claims, wherein each insert component of the hard-facing is inclined to the edges of the surface of the tool by substantially the same angle.
9. A tool according to any of claims 1-7, wherein individual insert components of the hard-facing are inclined by a greater or smaller angle to the opposing edges of the surface of the tool.

10. A tool according to any of the preceding claims, wherein further insert components may be provided on the surface of the tool parallel to the edge of the surface, between the inclined insert components.

11. A tool according to any of the preceding claims, wherein the tool is a hole opener, stabilizer, drill bit, centralizer or collar.

12. A tool substantially as hereinbefore described with reference to any of Figures 1-7 of the accompanying drawings.