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DESCRIPTION OF INVENTION

"IMPROVEMENTS IN OR RELATING TO A MILLING INSERT AND A MILLING TOOL"

THE PRESENT INVENTION relates to a milling insert and to a milling tool which utilises the insert. In particular, the invention relates to a milling insert and a milling tool of particular use in "down-hole" operations in the oil and gas well industry.

Many proposals have been made concerning the provision of different heights of "insert" for use on a milling tool. The insert is typically an element made of very hard material, such as Tungsten Carbide, which is secured to a blade of a milling tool, the insert actually cutting the metal that is to be milled away by the tool.

Very particular requirements exist in connection with cutting inserts intended for use on mills for use "down-hole". Whilst, of course, it is desired that the mill should operate as swiftly as possible, thus cutting away the maximum amount of metal in minimum time, the swarf or cuttings produced by the mill must be such that it can readily be carried out of the hole by the mud that flows through the hole. It is undesirable for the swarf or cuttings to be too long, since otherwise the swarf may form "birds' nests" which can give rise to significant difficulties.

It is also desirable to provide a mill which can operate with the expenditure of a minimum amount of energy.

The present invention seeks to provide an improved cutting insert, and a mill incorporating the improved cutting insert.

According to this invention there is provided a cutting insert for use on a mill, the cutting insert comprising an element formed of a hard material, the element defining a rear face, by means of which the element may be mounted in position, and a front face, the front face being provided with a plurality of substantially parallel transversely extending projections, each projection being of substantially triangular form in cross-section and presenting an upper front face inclined relative to the plane of the rear face, and a lower face substantially perpendicular to the plane of the rear face, each projection defining an apex, the distance between adjacent apices being between 3.17 and 1.60 millimetres.

The spacing between adjacent apices may be between 1.8 and 3 millimetres, preferably between 1.9 and 2.50 millimetres and is advantageously 2.38 millimetres.

The effective height of each projection may be between 1.06 and 0.53 millimetres, preferably between 0.90 and 0.60 millimetres and advantageously approximately 0.81 millimetres.

Preferably the front face of each projection makes an angle of approximately 19° with the plane defined by the rear face of the insert.

Conveniently the lower face of each insert defines an angle of approximately 3^0 with a plane which extends perpendicularly to the plane defined by the rear of the face of the insert.

Preferably the insert defines a top face and a bottom face, both faces being inclined at an angle of approximately 5^0 to the plane defined by the rear face of the insert.

Conveniently the total overall height of the insert is 9.52 millimetres.

The insert may carry 3, 4, 5 or 6 projections.

The invention also relates to a mill, such as a mill for use down-hole, the mill comprising a body carrying a plurality of blades, the blades each carrying cutting inserts as described above in a regular array.

The blades may be swinging or pivotally mounted blades but are preferably fixed blades which extend radially outwardly from the body.

The blades may be aligned with the axis of the mill or may have a negative rake, for example, at an angle of approximately 10^0 , to the axis of the mill.

In order that the invention may be more readily understood, and so that further features thereof may be appreciated, the invention will now be described, by way of example, with reference to the accompanying drawings in which

FIGURE 1 is a perspective view of a cutting insert in accordance with the invention,

FIGURE 2 is a side view of the cutting insert indicating various critical dimensions for the insert,

FIGURE 3 is a part sectional, part elevational view of a mill provided with cutting inserts of the type shown in Figures 1 and 2,

FIGURE 4 is an enlarged view of part of the mill of Figure 3,

FIGURE 5 is a side view of an alternative insert in accordance with the invention, and

FIGURE 6 is a side view of yet another alternative insert in accordance with the invention.

Referring now to Figures 1 and 2 of the accompanying drawings, a cutting insert 1 in accordance with the invention comprises an element made of a very hard material, such as Tungsten Carbide. The insert may be made in a conventional way, but the insert is made to have a novel shape and configuration, as will now be described.

The insert comprises a substantially cuboidal block of hard material. The rear face 2 of the block, which is a vertical face in the orientation illustrated, is substantially planar, and is used, as will be described hereinafter, for mounting the block in position. The top face 3 and the under-face 4 of the block are parallel with each other, but are not perpendicular to the plane defined by the rear face 2 of the block. The top face and the

under-face are inclined downwardly, from the rear face, at an angle 5 which is approximately 5° .

The side faces 6,7 of the block are parallel and extend perpendicularly to the plane defined by the rear face 2.

The front face 8 of the block is defined by a plurality of transversely extending parallel protrusions 9,10,11,12, each of substantially triangular section.

Each protrusion defines a front inclined upper face, such as the face 13 which is inclined to the plane defined by the rear face 2 by an angle 14 of approximately 19° , and a lower face. Thus the front face 13 of the protrusion 12 is interconnected with the front face 15 of the protrusion 11 by means of a lower substantially horizontal face 16, and this construction is repeated for the adjacent protrusions. Each lower face is inclined at an angle 17 of approximately 3° to a plane which is perpendicular to the plane defined by the rear face 2 of the block.

It is preferred that the overall height of the block H between the lower-most point of the projection 12 and the upper-most point of the upper surface 13 is 9.62 millimetres. The operative height of the block OH, between the lowest point on the projection 13 and the top of the projection 9 is 9.52 millimetres.

The thickness of the block T, that is to say the distance from the apex of each projection 9,10,11,12 to the plane defined by the rear face 2 of the block in a direction perpendicular to that plane, is 6.35 millimetres.

The spacing 5 between the apices of the adjacent projections 9,10,11,12, is, in this embodiment, 2.38 millimetres. The height h of each projection, that is to say the distance as measured in a plane perpendicular to the plane defined by the rear face 2 of the block between the apex of one projection and the lower-most point of the next projection, is 0.81 millimetres.

A plurality of blocks 1 as described with reference to Figures 1 and 2 may be mounted on a mill 20 as shown in Figure 2. The mill 20 comprises a generally cylindrical body 21 provided, at its upper end, with a threaded pin 22 to enable the body to be connected to another part of a drilling string, as is conventional. As is also conventional the body is provided with a central flow passage 23 for mud or other drilling fluid.

The body is provided, adjacent its lower end, with a plurality of stabiliser blades 24 of a conventional design. The body is provided, towards its upper end, with a plurality of substantially radially outwardly directed cutter blades 25, these blades having a slight negative rake, of approximately 10^0 as is again conventional. In an alternative embodiment each blade is aligned with the axis of the mill. Each cutter blade has a substantially radially outwardly extending lower surface 26 comprising a cutter surface.

Mounted on the front of each of the blades 25 is a regular array 27 of cutting inserts 1 as shown in Figure 1. The cutting inserts may be welded or brazed to the blade 25. The cutting inserts are closely abutting, with the under-surface 4 of one insert being located in firm contact with the top face 3 of the next adjacent insert. The under-faces and top faces are inclined, but are

parallel to each other, and this assists in firmly bonding the inserts in position.

The inserts are mounted on the blade in a regular array of evenly spaced rows and columns, in abutting relationship.

It is found when a mill of this type is used the swarf or cuttings that are generated are relatively cool, as compared with the temperature of cuttings produced by prior art mills. It is also found that less power has to be provided to the mill to provide a predetermined cutting effect, when compared with a typical prior art mill.

It is found that the cuttings or swarf generated by the mill, when cutting a typical pipe as found down-hole in an oil or gas well are relatively short, typically being of the order of 1 millimetre long.

It is believed that this is caused by the close spacing between the various protrusions on the front of the block constituting each cutting insert.

The mill, when it is to be used, may be provided with an assembly located beneath the mill as illustrated.

It is to be understood that in use of the mill, the mill and any assembly located beneath the mill is lowered down-hole and the lower part of the body 21 is inserted into a pipe that is to be milled away. The stabiliser blades 24 serve to stabilise the mill as it is rotated. The mill is lowered in position until the cutting surface 26 at the bottom of the blades 25 rests upon the top of the pipe to be milled away. As the mill is then rotated, in a clock-wise direction as viewed from above,

the cutting inserts provided on the leading face of each blade will engage the metal of the pipe, especially in view of the negative rake of the blades which tends to pitch the cutting elements forwardly, so that the cutting inserts firmly engage the metal of the pipe. As the mill is rotated the cutting inserts cut away the metal of the pipe. During this operation the cutting inserts are worn away and also the supporting blade 25 is worn away. The supporting blade is made of a material that is softer than the material of the cutting inserts to ensure that the material of the blade does wear away when the cutting inserts wear away.

It is only the lower-most part of the lower-most cutting insert that will contact the pipe at any time. Thus, at any instant, the cutting is accomplished by the lower-most projection such as, for example, the projection 12. The maximum distance between this projection and the lower face 16 of the next projection is present when the mill starts operation, that distance being 2.38 millimetres. As the mill operates that distance will gradually reduce until the projection 12 is totally worn away, when cutting will continue with the projection 11.

Figures 5 and 6 illustrate two alternate forms of insert. Referring initially to Figure 5, the insert 30 is in the form of a block having the same overall dimensions as the block 1 illustrated in Figure 1, but provided with five projections instead of the four projections of the embodiment of Figure 1. This means that the spacing S between adjacent projections 1.90 millimetres and the height h of each projection is 0.63 millimetres.

Similarly, in Figure 6 the block 31 has the same size as the block 1 of the embodiment of Figure 1 but is

provided with six projections. The distance between adjacent projections S is 1.60 millimetres and the height h is 0.53 millimetres.

It has been found particularly advantageous for the distance between adjacent projections to be between 3.17 and 1.60 millimetres, with the associated height of the projections being between 1.06 and 0.53 millimetres.

Whilst the invention has been described with reference to a mill which incorporates fixed blades it is to be appreciated that the invention may find an equal application to mills which include swinging or pivotally mounted blades, such as a cutter adapted to cut through a pipe at an intermediate position.

CLAIMS:



1. A cutting insert for use on a mill, the cutting insert comprising an element formed of a hard material, the element defining a rear face, by means of which the element may be mounted in position, and a front face, the front face being provided with a plurality of substantially parallel transversely extending projections, each projection being of substantially triangular form in cross-section and presenting an upper front face inclined relative to the plane of the rear face, and a lower face substantially perpendicular to the plane of the rear face, each projection defining an apex, the distance between adjacent apices being between 3.17 and 1.60 millimetres.
2. An insert according to Claim 1 wherein the spacing between adjacent apices is between 1.80 and 3.00 millimetres.
3. A mill insert according to Claim 2 wherein the spacing between the adjacent apices is between 1.90 and 2.50 millimetres.
4. A mill insert according to Claim 3 wherein the spacing between adjacent apices is 2.38 millimetres.
5. A mill insert according to any one of the preceding Claims wherein the effective height of each projection is between 1.06 and 0.53 millimetres.
6. An insert according to Claim 5 wherein the height of each projection is between 0.90 and 0.60 millimetres.



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7. A mill insert according to Claim 6 wherein the height of each projection is approximately 0.81 millimetres.

8. A mill insert according to any one of the preceding Claims wherein the front face of each projection makes an angle of approximately 19° with the plane defined by the rear face of the insert.

9. An insert according to any one of the preceding Claims wherein the saw tooth face of each insert defines an angle of approximately 3° with a plane which extends perpendicularly to the plane defined by the rear of the face of the insert.

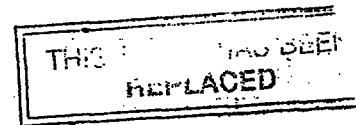
10. A mill insert according to any one of the preceding Claims wherein the insert defines a top face and a bottom face, both faces being inclined at an angle of approximately 5° to the plane defined by the rear face of the insert.

11. An insert according to any one of the preceding Claims wherein the total overall height of the insert is 9.52 millimetres.

12. An insert according to any one of the preceding Claims wherein the insert carries 3, 4, 5 or 6 projections.

13. A mill, the mill comprising a body carrying a plurality of blades, the blades each carrying cutting inserts according to any one of Claims 1 to 12 in a regular array.

14. A mill according to Claim 13 wherein the blades are swinging or pivotally mounted blades.



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15. A mill according to Claim 13 wherein the blades are fixed blades which extend radially outwardly from the body.
16. A mill according to Claim 15 wherein the blades are substantially aligned with the axis of the mill.
17. A mill according to Claim 15 wherein the blades exhibit a negative rake relative to the axis of the mill.
18. A mill according to Claim 17 wherein the blades exhibit a negative rake of approximately 10^0 .
19. A cutting insert substantially as herein described with reference to and as shown in Figures 1 and 2 of the accompanying drawings.
20. A cutting insert substantially as herein described with reference to and as shown in Figure 5 of the accompanying drawings.
21. A cutting insert substantially as herein described with reference to and as shown in Figure 6 of the accompanying drawings.
22. A mill substantially as herein described with reference to and as shown in Figures 3 and 4 of the accompanying drawings when provided with cutting inserts according to Figures 1 and 2, or Figure 5 or Figure 6 of the accompanying drawings.
23. Any novel feature or combination of features disclosed herein.

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