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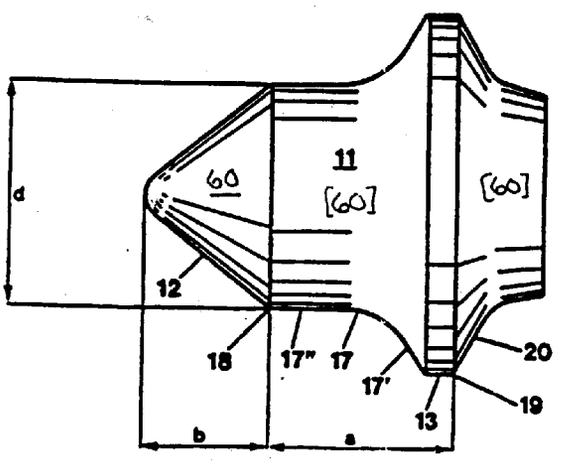
(54) Diamond/boron nitride coated excavating tool cutting insert.

(57) A diamond/cubic boron nitride coated low energy cutting insert for an excavating tool. The insert includes a generally conical tip portion, an elongated intermediate portion, a shoulder and a contact surface which attaches to a supporting surface of the tool body. The intermediate portion of the insert includes a concave surface portion and the coating is provided on the tip portion and optionally on the intermediate portion and the shoulder.

Fig.4



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Background of the Invention

This application is related to application Serial No. 07/708,058, filed May 30, 1991 (now U.S. Patent No. 5,161,859), a continuation of application Ser. No. 07/517,023, filed May 1, 1990, now abandoned, which is a continuation of application Ser. No. 06/586,818, filed Mar. 6, 1984 (now U.S. Pat. No. 4,938,538).

The present invention relates to a tool for breaking or excavating of hard material, such as asphalt, comprising a tool body and a cutting insert secured thereto, for instance by brazing. The cutting insert is formed with a generally conical tip portion and provided with a shoulder which in intended to rest against a supporting surface on the tool body.

The purpose of the invention is to provide a wear-resistant tool of the above type which requires a low cutting force at the same time as it is ensured that the risk is low that the cutting insert will get loose even during working in wear resistant material.

The invention is described in detail in the following with reference to the accompanying drawings, in which one embodiment is shown by way of example. It is to be understood that this embodiment is only illustrative of the invention and that various modifications thereof may be made within the scope of the claims.

Summary of the Invention

The invention provides a wear resistant rotatable excavating tool for breaking hard material, comprising an elongated tool body having an end with a diameter and a supporting surface, a cutting insert having a wear resistant layer on an exposed working surface thereof, the insert being of hard metal having a tip portion, an elongated intermediate portion and a shoulder, the tip portion being generally conical in shape, the shoulder having a diameter substantially larger than the maximum diameter of the tip portion, the intermediate portion being integral with and extending between the tip portion and the shoulder so as to define an abrupt transition from the tip portion, the intermediate portion having a maximum diameter which is substantially less than the diameter of the tool body end, the intermediate portion including a concave surface portion extending radially outwardly between the tip portion and the shoulder, the shoulder being integrally joined to the concave surface portion, and the insert including a rearwardly facing contact surface attached to the supporting surface of the tool body.

The invention also provides a wear resistant rotatable excavating tool for breaking hard material, comprising an elongated tool body having an end with a diameter and a supporting surface, a cutting insert having a wear resistant coating on an exposed working surface thereof, the insert being of hard metal having a generally conical tip portion, a shoulder with a diameter substantially larger than the maximum diameter of the tip portion, an elongated intermediate portion integral with and extending axially and radially between the conical tip portion and the shoulder, defining an abrupt transition from the generally conical tip portion, and having a maximum diameter which is substantially less than the diameter of the tool body end, the intermediate portion comprising a concave surface portion, the shoulder integrally joining the concave surface portion, and a rearwardly facing contact surface attached to the supporting surface of the tool body.

According to various features of the invention, the wear resistant coating can be of diamond and/or cubic boron nitride with or without one or more intermediate non-diamond layers such as Ti, TiC or TiN. The concave surface portion can have a constant radius of curvature. In addition, the distance (a) from the abrupt transition between the tip portion and the intermediate portion to the radially outermost portion of the rearwardly facing contact surface of the shoulder can be larger than the distance (b) from the abrupt transition to the axially forwardmost portion of the tip portion. The smallest diameter (d) of the concave surface portion can be smaller than the distance (a+b) from the axially forwardmost portion of the tip portion to the radially outermost portion of the rearwardly facing contact surface of the shoulder.

IN TRE DRAWINGS:

FIG. 1 shows a side view, partly in section, of a prior art tool for breaking hard material;

FIG. 2 shows a side view, partly in section, of another prior art tool;

FIG. 3 shows one embodiment of a tool according to the invention; and

FIG. 4 shows on an enlarged scale the cutting insert in the tool shown in FIG. 3.

Description of the Preferred Embodiments

Corresponding details in the various figures have been given the same reference numeral.

Tools of the type in question are usually mounted rotatably in a tool holder, which in turn is attached to an excavating machine, such as a road planing machine or a mining machine. Due to its rotation the tool is self-sharpening. The machine might be of the type disclosed in U.S. Patent No. 4,302,055, the disclosure of which is hereby incorporated by reference.

For breaking or excavating of wear resistant material, for instance for milling in poured asphalt (mastic), tools are used of the type shown in FIG. 1. This tool comprises a tool body 10A of steel and a cutting insert 11A of hard metal. The cutting insert 11A is provided with a conical tip portion 12A and a shoulder 13A which is intended to rest against a supporting surface 14A on the tool body 10A. The rear contact

surface 20A of the shoulder 13A is brazed to the supporting surface 14A. The cutting insert 11A is provided with a conical intermediate portion 15A which is located between the tip portion 12A and the shoulder 13A. The portion 15A protects the portion of the tool body 10A surrounding the cutting insert 11A from such wear that would cause the cutting insert 11A to get loose. When wear resistant material is excavated, for instance during milling in poured asphalt, the tip portion 12A becomes blunt-ended upon some wear of the cutting insert 11A. This wear increases the required cutting force. When milling in poured asphalt, the increase of the required cutting force might even have the result that the road planing machine does not manage to rotate the cutter upon which the tools are mounted.

One way of decreasing the cutting force required for worn tools would be to use a tool of the type shown in FIG. 2 since the cutting insert 11B has a smaller diameter than the cutting insert 11A. However, this should mean that the portion 16B of the tool body 10B surrounding the cutting insert 11B rapidly would be abraded, thereby causing the cutting insert 11B to get loose. Thus, cutting inserts of the type shown in FIG. 2 are suitable for use solely where the hard metal determines the life of the tool, for instance milling in concrete.

According to the invention, a low energy attack tool is provided which includes a wear resistant coating on a cutting insert in the form of a cap wherein the coating is of a material harder than the insert. For instance, the insert can be a cemented carbide and the coating can be diamond and/or cubic boron nitride. The coating can be applied on the exposed surface of the insert with or without one or more intermediate non-diamond layers such as Ti, TiC, TiN, etc. therebetween. The coating can be applied by PVD, CVD, high temperature/high pressure (HT/HP) or other conventional technique. The wear resistant coating and intermediate layers can each have a thickness of about 1,0 to about 100μm and the total thickness of the coating can reach 500μm or more depending on the thickness of each layer and number of layers. For instance, the coating can include several layers of diamond separated by non-diamond layers. U.S. Patent Nos. 5,154,245 and 4,707,384, the disclosures of which are hereby incorporated by reference, disclose several diamond coating techniques which can be used for applying the coating.

The wear resistant coating allows the geometry of the insert to be maintained for a longer time thus reducing the amount of dust created by the tool, reducing the cutting forces, reducing forces acting on the tool, reducing heat created by the cutting action of the tool and reducing the possibility of sparking which could otherwise occur due to the contact between the cemented carbide tool and the material being excavated.

As shown in FIGS. 3 and 4, the cutting insert 11 in a tool according to the invention is provided with an intermediate portion 17 between the tip portion 12 and the shoulder 13. The intermediate portion comprises a concave portion 17^1. Due to the intermediate surface portion 17, the required cutting force is maintained low even when the tip portion 12 becomes worn, since the tip size remains generally the same as the tip wears down along the intermediate surface portion 17. Due to this design it is also ensured that the steel in the tool body 10 surrounding the cutting insert is protected against premature abrasion. This protection is provided by the concave portion 17^1 and the shoulder 13.

The wear resistant coating 60 can be applied on the outer surface of the tip 12, the intermediate portion 17 and/or the shoulder 13 in any desirable pattern which completely covers or partially covers the working surface. Preferably, at least the tip 12 is completely covered with the coating 60.

As shown in FIG. 4, the portion 17 can comprise a circular-cylindrical portion 17^{11} located adjacent to the tip portion 12. In this embodiment, the distance "a" from the transition 18 between the tip portion 12 and the intermediate portion 17 to the radially outermost portion 19 of the rear contact surface 20 of the shoulder 13 is larger than the distance "b" from the transition 18 to the axially forwardmost portion of the tip portion 12. The rear contact surface 20 is intended to rest against the supporting surface 14 of the tool body 10.

Further, in the illustrated embodiment, the smallest diameter "d" of the concave portion 17^1 is smaller than the sum of the above-defined distances "a" and "b". The concave portion 17^1 is provided with a constant radius of curvature, which is smaller than 1,5 d but bigger than 0,5 d.

The enveloping surface of the cylindrical portion 17^{11} extends tangentially to the arc-shaped portion 17^1.

In the illustrated embodiment the cutting insert is provided with a rear portion projecting rearwardly from the shoulder 13. The end surface of this portion is planar. It might, however, be recessed, for instance it could be half-spherical or of the general W-shape illustrated in Swedish Patent Application No. 8400269-0. The bottom of the recess might rest against a correspondingly shaped protrusion on the tool body, or, alternatively, the recess might provide a cavity.

In a further modification, the cutting insert might be made without a rear projection. The rear end surface of the cutting insert, i.e. the end surface of the shoulder, and the cooperating front surface of the tool body might be designed according to any of the above alternatives.

Although the present invention has been described in connection with preferred embodiments thereof, it will be appreciated by those skilled in the art that

additions, modifications, substitutions, and deletions not specifically described may be made without departing from the spirit and scope of the invention as defined in the appended claims.

Claims

1. A rotatable excavating tool for breaking hard material, comprising:

an elongated tool body having an end with a diameter and a supporting surface;

a cutting insert of hard metal having a tip portion, an elongated intermediate portion and a shoulder, the tip portion being generally conical in shape, the shoulder having a diameter substantially larger than the maximum diameter of the tip portion, the intermediate portion being integral with and extending between the tip portion and the shoulder so as to define an abrupt transition from the tip portion, the intermediate portion having a maximum diameter which is substantially less than the diameter of the tool body end, the intermediate portion including a concave surface portion extending radially outwardly between the tip portion and the shoulder, the shoulder being integrally joined to the concave surface portion, and the cutting insert having a rearwardly facing contact surface attached to the supporting surface of the tool body; and

a wear resistant coating of material harder than the cutting insert, the coating being on at least an exposed working surface of the tip portion.

2. A tool according to claim 1, wherein the coating comprises at least one layer of diamond and/or cubic boron nitride with or without one or more non-diamond intermediate layers.

3. A tool according to claim 2, wherein the coating comprises a single layer of diamond.

4. A tool according to claim 1, wherein the concave surface portion has a constant radius of curvature.

5. A tool according to claim 1, wherein a distance (a) from the abrupt transition between the tip portion and the intermediate portion to the radially outermost portion of the rearwardly facing contact surface of the shoulder is larger than a distance (b) from the abrupt transition to the axially forwardmost portion of the tip portion.

6. A tool according to claim 5, wherein a smallest diameter (d) of the concave surface portion is smaller than the distance (a+b) from the axially forwardmost portion of the tip portion to the radially outermost portion of the rearwardly facing contact surface of the shoulder.

7. A tool according to claim 1, wherein the coating only covers the tip portion.

8. A tool according to claim 1, wherein the coating completely covers the tip portion and the intermediate portion.

9. A tool according to claim 1, wherein the coating completely covers the tip portion, the intermediate portion and the shoulder.

10. A rotatable excavating tool for breaking hard material, comprising:

an elongated tool body having an end with a diameter and a supporting surface;

a cutting insert of hard metal having a generally conical tip portion, a shoulder with a diameter substantially larger than the maximum diameter of the tip portion, an elongated intermediate portion integral with and extending axially and radially between the conical tip portion and the shoulder so as to define an abrupt transition from the tip portion, the intermediate portion having a maximum diameter which is substantially less than the diameter of the tool body end and the intermediate portion including a concave surface portion, the shoulder integrally joining the concave surface portion, and the insert including a rearwardly facing contact surface attached to the supporting surface of the tool body; and

a wear resistant coating of material harder than the cutting insert, the coating being on at least an exposed working surface of the tip portion.

11. A tool according to claim 10, wherein the coating comprises at least one layer of diamond and/or cubic boron nitride with or without one or more non-diamond intermediate layers.

12. A tool according to claim 11, wherein the coating comprises a single layer of diamond.

13. A tool according to claim 10, wherein the concave surface portion has a constant radius of curvature.

14. A tool according to claim 10, wherein a distance (a) from the abrupt transition between the tip portion and the intermediate portion to the radially outermost portion of the rearwardly facing contact surface of the shoulder is larger than a distance (b) from the abrupt transition to the axially forwardmost portion of the generally conical tip

portion.

15. A tool according to claim 14, wherein a smallest diameter (d) of the concave surface portion is smaller than the distance (a+b) from the axially forwardmost portion of the tip portion to the radially outermost portion of the rearwardly facing contact surface of the shoulder.

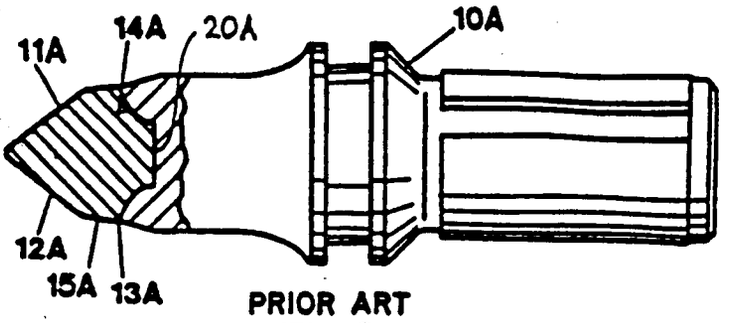
16. A tool according to claim 10, wherein the coating only covers the tip portion.

17. A tool according to claim 10, wherein the coating completely covers the tip portion and the intermediate portion.

18. A tool according to claim 10, wherein the coating completely covers the tip portion, the intermediate portion and the shoulder.

PRIOR ART

Fig.1



PRIOR ART

Fig.2

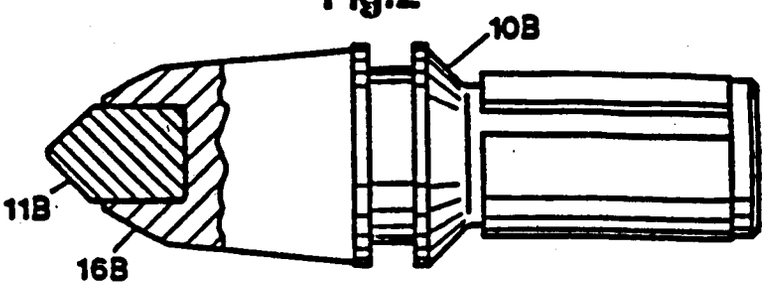


Fig.3

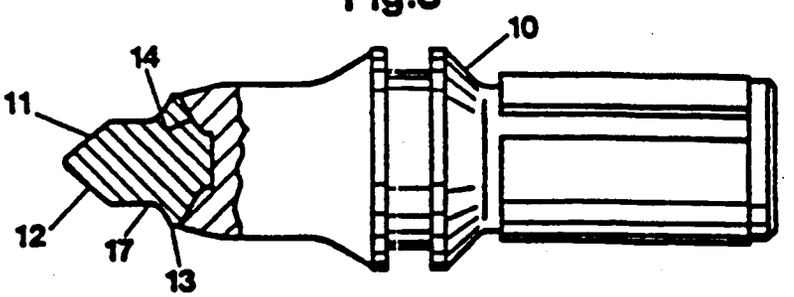


Fig.4