United States Patent [19]

Veprintsev et al.

[11] **3,885,637**

[45] **May 27, 1975**

[54] **BORING TOOLS AND METHOD OF MANUFACTURING THE SAME**

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[22] Filed: **Jan. 4, 1974**

[21] Appl. No.: **430,940**

[30] **Foreign Application Priority Data**

Jan. 3, 1973 U.S.S.R. 1862188

[52] **U.S. Cl.** .... **175/329;** 76/108 R

[51] **Int. Cl.** **E21b 9/36**

[58] **Field of Search** .... 76/101 R, 101 A, 108 A, 76/108 R; 175/329, 330, 374, 375

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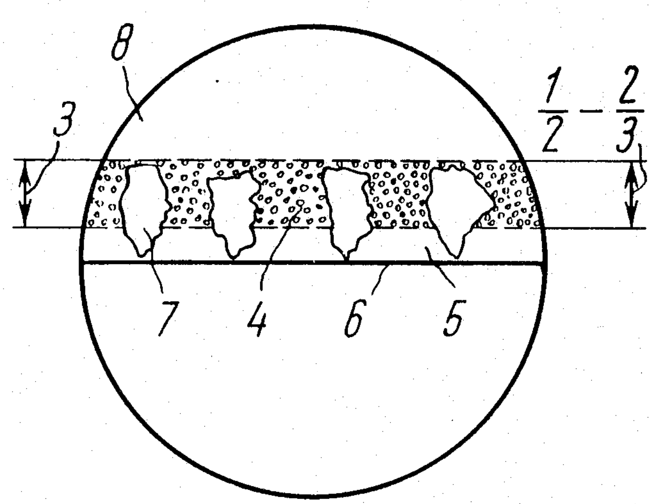
Primary Examiner—David H. Brown

[57] **ABSTRACT**

Boring tools in which the cutting elements defined by coarse abrasive grains are embedded at 1/2–2/3 of the height of the cutting grains in the matrix layer containing embedded fine abrasive grains, while the remaining portion of the grains is located in a metallic layer of the matrix arranged outside over the rock-destroying surface of the tool.

The advantage of such boring tools is that their wear resistance is 20–30 percent greater than that of the known boring tools.

4 Claims, 2 Drawing Figures



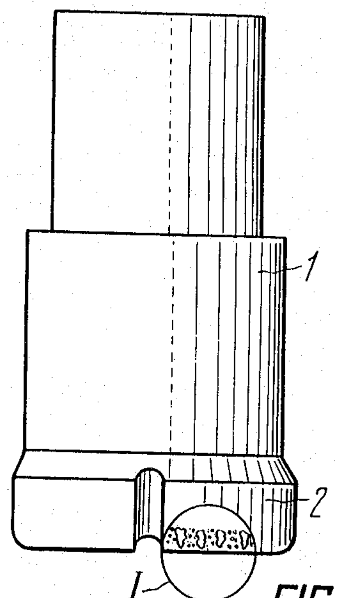


FIG. 1

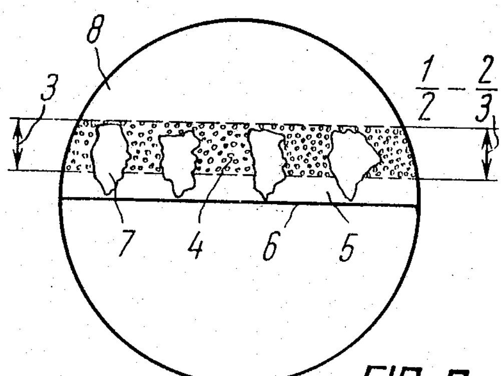


FIG. 2

BORING TOOLS AND METHOD OF MANUFACTURING THE SAME

BACKGROUND OF THE INVENTION

The invention relates to boring tools and to methods of manufacturing the same, and more particularly is concerned with those of such tools which are to be used for boring rocks of a hardness higher than medium one, as well as with a method of manufacturing such tools.

PRIOR ART

It is known to use a working member destroying the rock which comprises a matrix having embedded grains of an abrasive material.

At present there are widely known boring tools having a rock-destroying member comprising a metallic matrix provided with embedded fine grins (50–800 μ) in the form of single-crystals or polycrystals of diamond or diamond-based abrasive materials, as well as of materials other than diamonds, such as cubic boron nitride and products on the bases thereof.

The main disadvantage of the above-described boring tools resides in their low efficiency in boring moderately abrasive and normally abrasive rocks. In the latter case, boring tools similar to those described above are generally used, with the only difference being that their matrix is provided with embedded coarse grains /1–2.5 mm/ of an abrasive material. These grains are arranged over the rock-destroying surface of the tool, that is, over that surface which is in contact with the rock being bored during the operation of the tool.

These tools have the main disadvantage which consists in a more or less intensive destruction of the matrix body depending upon the boring conditions and characteristics of the rock being destroyed, which results in corresponding losses of the cutting elements, abrasive grains.

There also exist widely known boring tools, wherein the matrix of the rock-destroying member is provided with both fine and coarse abrasive grains embedded therein, with the cutting elements function being, in this case, performed mainly by the coarse abrasive grains arranged over the rock-destroying surface of the tool.

The fine abrasive grains are used mainly to increase the strength of the matrix body.

The main disadvantage of these tools consists in the fact that, in order to ensure secure fastening in the matrix body, the coarse abrasive grains, cutting elements, are embedded at considerable depth therein, and but a very small portion of these grains projects from the rock-destroying surface. This results in considerable reduction of the boring efficiency.

Attempts were made to improve the efficiency of the operation of the tool in boring rock by increasing the amount of projection of the cutting elements from the matrix body. In this case, the projecting portions of the cutting elements are rapidly fractured, and these tools proved to be so unstable that they have not found practical application.

OBJECTS AND SUMMARY OF THE INVENTION

It is the main object of the invention to modify the structure of the matrix.

The practical objects of the invention consist in an increase of the service life of a boring tool, an extension of its working range, and in particular as applied to its

efficient use for boring moderately abrasive rocks, and an improvement of its efficiency on the whole in any rock, including moderately abrasive ones.

The thickness of the metallic layer arranged in the matrix over the rock-destroying surface of the tool is preferably substantially equal to the depth of penetration of the coarse abrasive grains therein.

During the manufacture of the boring tool comprising the steps of placing a metal charge containing coarse and fine abrasive grains into a mold, preliminarily pressing the charge against the tool body, impregnating the pressed charge with a metal melt and allowing it to stay until solidification, according to the invention at the step of placing the charge containing fine and coarse abrasive grains into the mold a layer of exclusively metallic charge is formed which is so arranged relative to the first charge that the layer of the exclusively metallic charge forms the rock-destroying surface of the tool, with the coarse abrasive grains being placed in such a manner as to penetrate at one half – two third into the charge layer containing fine abrasive grains at the boundary between the two charge layers, the remaining portion of the grains being located in said exclusively metallic charge layer.

The thickness of the metallic layer of the charge, which forms the rock-destroying surface of the tool is preferably substantially equal to the depth of penetration of the coarse abrasive grains therein.

The invention will now be described in greater details with reference to a specific embodiment thereof illustrated in the accompanying drawings, in which:

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** shows a boring tool which, in this case, comprises a core-boring bit according to the invention;

FIG. **2** is an enlarged detail view of the circled zone I in FIG. **1** illustrating the principle of arrangement of the layers and cutting elements in the matrix.

DETAILED DESCRIPTION OF THE INVENTION

As an example, the description refers to a core-boring bit. It comprises a steel body **1** supporting a rock-destructing member **2** made as a matrix with embedded abrasive grains. A part of the matrix body defined by a layer **3** contains embedded fine grains **4** uniformly distributed over the entire layer **3.**

A layer **5** of the matrix which is the outer layer relative to the layer **3** and which forms a rock-destructing surface **6** of the tool, is made exclusively of metal without fine embedded grains.

Coarse abrasive grains **7** are located at the boundary between the matirx layers **3** and **5** so as to penetrate at one half – two thirds into the layer **3**, with the remaining portion of the grains being located in the layer **5.**

Fine and coarse abrasive grains may comprise grains of any abrasive materials, such as natural and synthetic diamonds, artificial materials on the basis of diamond and materials other than diamonds, such as cubic boron nitride and products on the basis thereof, and the like. Abrasive grains may be in the form of a crumb of single-crystals or polycrystals. Normally employed fine abrasive grains of a size of from 50 to 800 μ may be used.

A size of the coarse abrasive grains may be from **1** to 2.5 mm as usual.

The metallic portion of the matrix may consist of nickel, iron and tungsten carbide, or of tungsten carbide and cobalt.

Detailed characteristics of the composition of the metallic part of the matrix are not given herein, since such information is well known to those skilled in the art and is readily available.

A layer **8** adjoining the tool body **1** is located over the layer **3** and consists also exclusively of metal to spare the abrasive material because the layer **8** takes practically no part in the destruction of rock.

The coarse abrasive grains serve as the cutting elements, while the fine grains are used mainly to improve the matrix strength.

The total thickness of the layers **3** and **5** is substantially equal to the depth of penetration of the coarse abrasive grains **7** therein.

Any further increase in the thickness of these layers will be impractical.

In practice, with a size of the coarse abrasive grains **7** of from 1 to 2.0 mm, the thickness of the layer **3** is of from 1.0 to 1.8 mm and a thickness of the layer **5** is of from 0.3 to 0.6 mm.

The boring tool according to the invention is manufactured by the following method:

A metallic charge, which does not contain abrasive grains, is placed on the bottom plate of a graphite mold to form a layer **5** of from 0.3 to 0.6 mm depending on the size of the coarse abrasive grains, and the charge is then compacted.

Coarse diamond grains are embedded into this charge layer, with the grains being dipped at the entire depth of this layer by known methods.

Then, the layer **3** of metallic charge containing the fine abrasive grains is poured over this layer **5.**

A concentration of the abrasive grains in the metallic charge is as normally used and is equal to 50–100 percent. After the formation of the layer **3** it is also compacted. The remaining part of the graphite mold is filled with an exclusively metallic charge.

The charge, which is so placed, is pressed against the tool body **1.** The pressing force normally does not exceed 50–60 kg/cm^2.

The above-described order of placing of the charge is preferable, but it will be apparent that the charge may be placed in the reversed order with the same dimensional ratio as mentioned above. In the latter case the charge is poured from the bit body side in the following order.

A layer of metallic charge, which does not contain abrasive material, then a layer of charge containing fine abrasive material, then the coarse abrasive grains are embedded at the entire depth of the layers **3** and **5,** and thereafter the layer of exclusively metallic charge is placed.

Due to the fact that the thickness of the layers depends upon the size of the coarse abrasive grains, as mentioned above, a predetermined penetration at one half – two thirds will be maintained in each of the two layers.

After the pressing of all the layers of charge, which are still in the graphite mold, they are impregnated with a melt of metal. Normally melts of copper, copper and nickel, copper with nickel and zinc, copper and silver and the like are used for that purpose. The compositions of these alloys are widely known and readily available for those skilled in the art.

During the cooling in the air at the environment temperature the steel body is united with the matrix of the rock-destroying member. Then, a necessary machining of the boring tool is performed, and the tool is ready for operation.

The boring tool manufactured according to the invention posseses advantages as compared with known boring tools. Under similar operating conditions, it is characterized by a reduced consumption of abrasive material per unit of the boring depth by 30–50 percent due to more complete utilization of the coarse abrasive grains since the performance thereof at the last stage, when the protective metallic layer **5** is destroyed, is facilitated by the presence of the exposed abrasive grains embedded in the layer **3.**

The following examples illustrate the boring tools according to the invention.

EXAMPLE 1

In this and other examples the tool has a normal steel body.

Matrix material was tungsten carbide and copper.

Fine and coarse abrasive grains were natural diamond grains.

Size of the fine abrasive grains was 150–250 μ.

Size of the coarse abrasive grains was 1.5–2.0 mm.

A thickness of the layer **3** containing embedded fine abrasive grains varied from 0.8 to 1.3 mm.

A thickness of the metallic layer **5** arranged over the rock-destroying surface of the tool varied from 0.4 to 0.7 mm. A depth of penetration of the coarse abrasive grains in each of the layers **3** and **5** of the matrix varied from 1/2 to 2/3 of the height of the cutting grains.

These tools, as well as the tools of other examples, were made as indicated in the description with the thickness of the layers **3** and **5** of the charge complying with the requirements of the method, this thickness being equal to the thickness of the corresponding layers in the matrix of the finished tool.

In this and in the other examples, the charge was impregnated with copper melt.

During the tests in medium hardness rocks, the tool had the consumption of abrasive material per unit of the boring depth of 0.26 karat/m.

EXAMPLE 2

Fine and coarse abrasive grains were grains of polycrystalline diamonds.

A size of the fine abrasive grains was 300–400 μ. A size of the coarse abrasive grains was 1.5–2.0 mm.

A thickness of the layer **3** containing embedded fine abrasive grains varied from 0.8 to 1.5 mm.

A thickness of the metallic layer **5** arranged over the rock-destroying surface of the tool varied from 0.3 to 0.7 mm.

A depth of penetration of the coarse abrasive grains in each of the layers **3** and **5** of the matrix varied from ½ to ⅔ of the height of the cutting grains.

During the tests, this tool had the consumption of the abrasive material per unit of the boring depth of 0.21 karat/m when operating in medium hardness rocks.

EXAMPLE 3

Fine abrasive grains were grains of cast tungsten carbide.

Coarse abrasive grains were polycrystalline diamonds.

A size of the fine abrasive grains was 400–500 μ.

A size of the coarse abrasive grains was 1.5–2.0 mm.

A thickness of the layer **3** containing embedded fine abrasive grains varied from 0.7 to 1.6 mm.

A thickness of the metallic layer **5** arranged over the rock-destructing surface of the tool varied from 0.4 to 0.6 mm.

A depth of penetration of the coarse abrasive grains in each of the matrix layers **3** and **5** varied from ½ to ⅔ of the height of the cutting grains.

During the tests, this tool had the consumption of a abrasive material per unit of the boring depth of 0.31 karat/m when operating in hard abrasive rocks.

What is claimed is:

1. A boring tool comprising: a body; a rock-destroying member secured to the body; a matrix of said rock-destroying member; a first metallic layer in said matrix arranged over a rock-destroying surface of the rock-destroying member; a second metallic layer in the matrix containing embedded fine abrasive grains and arranged internally relative to the first metallic layer; cutting elements comprising coarse abrasive grains which are located at the boundary of said two layers and penetrate at ½ – ⅔ in the matrix layer containing embedded grains, while the remaining portion of the coarse grains are located in the exclusively metallic layer of the matrix.

2. The tool according to claim **1**, wherein the thickness of the first metallic layer of the matrix, which is arranged over the rock-destroying surface of the tool, is substantially equal to the depth of penetration of the coarse abrasive grains therein.

3. A method of manufacturing a boring tool including a body and a rock-destroying member comprising the steps of placing a metallic charge for molding of a matrix in two layers; one layer being formed of an exclusively metallic charge and being so arranged as to form a rock-destroying surface of the rock-destroying member; the other charge layer being of metal and containing embedded fine abrasive grains uniformly distributed over said charge; said second layer being arranged internally relative to said exclusively metallic layer; placing coarse abrasive grains at the boundary between the metallic layer and the layer containing embedded fine abrasive grains in such a manner that the coarse abrasive grains penetrate into the charge layer containing the fine abrasive grains at ½ – ⅔, while the remaining portion thereof is located in said exclusively metallic charge layer; pressing the charge in a mold against the tool body; and impregnating the charge with a metal melt with subsequent curing until solidification and machining of the tool.

4. The method according to claim **3**, wherein the thickness of the metallic charge layer forming the rock-destroying surface of the tool is substantially equal to the depth of penetration of the coarse abrasive grains therein.

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