CUTTING TOOL

FIELD OF THE INVENTION

The present invention relates to a cutting tool having an interchangeable cutting head.

BACKGROUND OF THE INVENTION

In such cutting tools, low repeatability in the location of the cutting head may affect cutting accuracy.

In addition, cutting forces acting on the cutting head during a cutting operation may displace the cutting head.

It is an object of the present invention to provide a cutting tool that significantly reduces or overcomes the aforementioned disadvantages.

The objects of the invention are attained with the subject matter in accordance with the respective claims.

SUMMARY OF THE INVENTION

In accordance with the present invention there is provided a cutting tool having a tool axis and comprising a cutting head detachably secured to a tool holder, the tool axis defining an axial forward to rear direction and a tangential direction thereabout,

the tool holder comprises a shank and an adaptor, the shank comprises shank cavity which opens out to a forward end thereof and the adaptor is threadingly engaged in the shank cavity,

the cutting head comprises a forward cutting portion and a rear fastening portion wherein the fastening portion is threadingly engaged in the adaptor.

Preferably, the fastening portion is integrally formed with the cutting portion.

Typically, the tool holder comprises a retaining element which is fixed in the shank cavity and at least a portion of the retaining element is located between portions of the adaptor.

Preferably, at least a portion of the retaining element is tangentially located between portions of the adaptor.

If desired, the retaining element is threadingly engaged in the shank cavity.

In accordance with the present invention there is also provided a method of assembling a cutting tool comprising the steps of:

providing a shank that comprises a shank cavity,

providing an adaptor that comprises a bore, the bore generally extending along a bore axis, the adaptor generally extending in a direction transverse to the bore axis,

providing a retaining element that comprises a hook, the hook generally extending along a hook axis,

axially aligning the retaining element and the adaptor along the hook and the bore axes until, in a view along the hook axis, at least a portion of the hook overlies at least a portion of the bore,

urging the retaining element along the hook axis until at least a portion of the hook in located in the bore,

threadingly engaging the adaptor and the retaining element in the shank cavity and threadingly engaging a cutting head in the adaptor.

In accordance with the present invention there is also provided a cutting tool having a tool axis and comprising a tool holder and a cutting head,

the tool holder comprising a shank, an adaptor and a retaining element,

the shank comprising an axially extending shank cavity,

the adaptor being threadingly engaged in the shank cavity,

the retaining element extending in a direction transverse to the tool axis between portions of the adaptor to limit the movement of the adaptor about the tool axis,

the cutting head being axially retained in tool holder by the adaptor.

Preferably, the adaptor upon axially retaining the cutting head in the tool holder axially abuts only the shank cavity.

The present invention provides the following preferred advantages. The threading engagement of the adapter in the shank cavity firmly secures the adaptor and consequently the cutting head in the cutting tool. The retaining element prevents the adaptor from being screwed out of the tool holder when the cutting head is being replaced. And, the adaptor has limited affect, if any, on the alignment of the cutting head when not engaging the retaining element.

BRIEF DESCRIPTION OF THE DRAWINGS

For a better understanding of the present invention and to show how the same may be carried out in practice, reference will now be made to the accompanying drawings, in which:

Fig. 1 is a side view of a reamer in accordance with the present invention;

Fig. 2 is a longitudinal cross sectional view of the reamer, taken in the plane of Fig. 1;

Fig. 3 is a perspective bottom view of a cutting head;

Fig. 4 is a longitudinal cross sectional view of a shank, taken in the plane of Fig. 1;

Fig. 5 is a perspective top view of an adaptor;

Fig. 6 is a cross sectional view of the adaptor taken in the plane VI-VI in Fig. 5;

Fig. 7 is a perspective top view of a retaining element;

Fig. 8 is a cross sectional view of the retaining element taken in the plane VIII-VIII in Fig. 7;

Fig. 9 is a perspective top view of the adaptor and retaining element;

Fig. 10 is a longitudinal cross sectional view of a tool holder, taken in the plane of Fig. 1;

Fig. 11 is a cross sectional view of the reamer taken along the line M-M in Fig. 2 showing a positive position of the adaptor in relation to the retaining element;

Fig. 12 is a cross sectional view of the reamer taken along the line M-M in Fig. 2 showing a neutral position of the adaptor in relation to the retaining element; and

Fig. 13 is a cross sectional view of the reamer taken along the line M-M in Fig. 2 showing a negative position of the adaptor in relation to the retaining element.

DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT

Attention is first drawn to Figs. 1 and 2 showing a reamer **10** having a longitudinal tool axis **A** defining an axial forward to rear direction and a tangential direction **T** thereabout. The reamer **10** has a forward cutting head **12** and a rear tool holder **14** which includes a shank **16**, an adaptor **18** and a retaining element **20** which are all located about the tool axis **A** when the reamer **10** is assembled. The cutting head **12** may be a form pressed and sintered hard metal body made from a carbide powder such as Tungsten Carbide; or like the shank **16**, the adaptor **18** and the retaining element **20** of the tool holder **14** may be formed of machined steel or other hard materials.

The present invention will be described herein with reference to the reamer **10** however it will be clear to the skilled person in the art that it may be applied to a variety of rotary or non-rotary cutting tools where releasable mounting of the cutting head **12** is required. In the case of a rotary cutting tool, such as the reamer, the longitudinal tool axis **A** may also be referred to as a longitudinal tool axis of rotation having a direction of rotation which is similar to the tangential direction **T**.

Each part of the reamer **10** will be described herein in its respective orientation in the assembled reamer **10** and therefore in relation to the tool axis **A** and to the forward, rear and tangential **T** directions. It should be noted that directional terms appearing throughout the specification and claims, e.g. "forward", "rear", "tangential" etc., (and derivatives thereof) are for illustrative purposes only, and are not intended to limit the scope of the appended claims.

Attention is now additionally drawn to Fig. 3. The cutting head **12** extends along the tool axis **A** and has a cutting portion **22** and a fastening portion **24**. The cutting portion **22** has a forwardly facing head face **26** at a forward end (best seen in Fig. 2), a rearwardly facing head annular face **28** at a rear end and an axially extending peripheral head surface **30** therebetween. A plurality of flutes **32**, symmetrically distributed about the tool axis **A**, extend axially along the peripheral head surface **30** and open out to a forward end and a rear end of the cutting portion **22**. Each flute **32** has a cutting insert **34** at a forward end thereof which is brazed thereto. Each cutting inserts **34** may also be detachably secured to a respective flute **32** by for example a screw or integrally formed therewith.

The fastening portion **24** has a support portion **36** and a threaded portion **38**. The support portion **36** extends rearwardly from the head annular face **28** and has a peripheral head support wall **40** which may lie on a peripheral surface of a rearwardly tapering truncated cone or on a peripheral surface of a cylinder. The threaded portion **38** extends rearwardly from a rear end of the support portion **36** to a rearwardly facing circular face **42** thereof which is located at a rear end of the cutting head **12**. The threaded portion **38** has an external thread formed on a peripheral surface thereof. The cutting head **12** has a head channel **44** which extends therethrough along the tool axis **A** and opens out to the head face **26** and to the circular face **42**.

Attention is now drawn to Fig. 4. The shank **16** has an axially extending cylindrical body which extends along the tool axis **A** and a forwardly facing shank annular face **46** which is located at a forward end thereof. In addition the shank **16**

has a shank cavity **48** and a shank channel **50** which are formed therein. The shank cavity **48** opens out to the shank annular face **46** via an aperture **52** and extends rearwardly therefrom along the tool axis **A**. The shank channel **50** extends rearwardly from a rear end of the shank cavity **48** and is coaxial therewith.

The shank cavity **48** has a support section **54**, a retaining section **56** and a middle section **58** therebetween. The support section **54** has a peripheral shank support wall **60** which may lie on a peripheral surface of a rearwardly tapering truncated cone or on a peripheral surface of a cylinder. The middle section **58** has an axially extending cylindrical shape having a middle diameter $\mathbf{D_M}$. The retaining section **56** has a retaining wall **62** and a stop wall **64**. The retaining wall **62** extends rearwardly from a rear end of the middle section **58** and lies of a peripheral surface of a cylinder. A retaining thread **66** is formed on the retaining wall **62**. The stop wall **64** extends rearwardly from the retaining wall **62** and lies on a peripheral surface of a rearwardly tapering truncated cone.

Attention is now drawn to Figs. 5 and 6. The adaptor **18** extends along the tool axis **A** and has a forward first section **68**, a rear second section **70** and neck section **72** therebetween. The first section **68** has a forwardly facing first surface **74**, an axially extending cylindrical body having an adaptor diameter $\mathbf{D_A}$ and a first cavity **76** which is formed therein along the tool axis **A**. The adaptor diameter $\mathbf{D_A}$ is smaller than the middle diameter $\mathbf{D_M}$ of the middle section **58** of the shank cavity **48**. The first cavity **76** has a cylindrically shaped axially extending first wall **78** having a first thread **80** which is formed thereon.

The second section **70** of the adaptor **18** has a generally cylindrical peripheral second surface **82** which extends axially along the tool axis **A** to a rearwardly facing section face **84**. The second surface **82** has a second diameter $\mathbf{D_S}$ smaller than the adaptor diameter $\mathbf{D_A}$ and a second thread **86** which is formed thereon. A bore **88** having a bore axis **B** which perpendicularly intersects the tool axis **A** is formed in the second section **70**. The adaptor **18** has mirror symmetry about a first plane **P1** which includes the tool and the bore axes **A**, **B**. The bore **88** has a major portion **90**

and a minor portion **92** extending along the bore axis **B** and opening out to opposing sides of the second surface **82**. The minor portion **92** additionally opens out to the section face **84** and communicates with the major portion **90**.

The major portion **90** of the bore **88** has two generally parallel major faces **94** on opposing sides of the first plane **P1** and the minor portion **92** of the bore **88** has two generally parallel minor faces **96** on opposing sides of the first plane **P1**. The major faces **94** are spaced apart by a major width W_1 and the minor faces **96** are spaced apart by a minor width W_2 which is smaller than the major width W_1. An adaptor channel **98** having an axially extending cylindrical shape extends along the tool axis **A** and communicates with the first cavity **76** and with the major portion **90** of the bore **88**. A key way **100** extending parallel to the bore axis **B** is formed on the first surface **74** of the first section **68** of the adaptor **18**.

Attention is now drawn to Fig. 7 and 8. The retaining element **20** extends along the tool axis **A** and has a forward hook **102**, a rear tube **104** and a bulge **106** therebetween. The hook **102** has a forward cap **108**, a rear stem **110** and a hook axis **H** which perpendicularly intersects the tool axis **A**. The retaining element **20** has mirror symmetry about a second plane **P2** which includes the tool and the hook axes **A, H**. The cap **108** has a forwardly facing cap surface **112**, a rearwardly facing back face **114** and two cap side faces **116** which extend therebetween on opposing sides of the second plane **P2**. The stem **110** extends rearwardly from the back face **114** of the cap **108** and has two generally parallel stem side faces **118** which are located on opposing sides of the second plane **P2**. The cap **108** and the stem **110** extend along the hook axis **H** and the cap side faces **116** are spaced apart by a cap width $W_{1'}$ and the stem side faces **118** are spaced apart by a stem width $W_{2'}$ which is smaller than the cap width $W_{1'}$. In addition, the cap width $W_{1'}$ is smaller than the major width W_1 of the bore **88** and the stem width $W_{2'}$ is smaller than the minor width W_2 of the bore **88** so that the hook **102** may slide into the bore **88** of the adaptor **18** (as will be described herein below).

The bulge **106** has a generally axially extending cylindrical shape having peripheral bulge surface **120**. A bulge thread **122** is formed on the bulge surface **120**. The tube **104** has an axially extending cylindrical shape and a rearwardly facing tube face **124** at a rear end thereof. A cylindrical shaped retaining channel **126** which is formed in the retaining element **20** along the tool axis **A** opens out to the cap surface **112** and to the tube face **124**.

Attention is now drawn to Figs. 9 and 10 to show how an assembled state the tool holder **14** may be reached. At first, a sub assembly of the adaptor **18** and the retaining element **20** is performed. The retaining element **20** and the adaptor **18** are manually positioned so that the cap surface **112** and the first surface **74** generally face the same direction, the hook and the bore axes **H**, **B** are generally parallel and in a view along the hook axis **H** the cap **108** of the hook **102** overlies the major portion **90** of the bore **88**. From this position the sub assembly is reached by manually urging the retaining element **20** along the hook axis **H** until the cap **108** of the retaining element **20** is located in the major portion **90** of the bore **88** of the adaptor **18**.

The sub assembly is then placed, with the retaining element **20** leading, through the aperture **52** into the shank cavity **48** until the bulge thread **122** of the retaining element **20** meets the retaining thread **66** of the shank cavity **48**. The adaptor **18** and consequently the retaining element **20** are then rotated in a direction counter to the tangential direction **T** by a key (not shown) which matches the key ways **100** of the adaptor **18**. As a result, the bulge thread **122** of the retaining element **20**, followed by the second thread **86** of the adaptor **18**, screw into the retaining thread **66** until the tube face **124** of the retaining element **20** abuts the stop wall **64** of the shank cavity **48** and the assembled state of the tool holder **14** is reached.

Attention is now drawn to Figs. 11 to 13. In the reamer **10** which is described herein the hook **102** of the retaining element **20** is tangentially located between portions of the bore **88** of the adaptor **18**, or in other words the hook **102** extends

along the hook axis **H** in a direction transverse to the tool axis **A** between portions of the bore **88** of the adaptor **18**. In addition, the difference between the minor width W_2 of the bore **88** and the stem width $W_{2'}$ of hook **102** is smaller than the difference between the major width W_1 of the bore **88** and the cap width $W_{1'}$ of the hook **102** so that rotation of the adaptor **18** about the tool axis **A** may lead to tangential abutment between the stem side faces **118** of the hook **102** and the minor faces **96** of the bore **88**. However, it will be understood that the tangential abutment may alternatively occur between the cap side faces **116** of the hook **102** and the major faces **94** of the bore **88** if so designed.

In the reamer **10** the adaptor **18** may have a positive position, a neutral position or a negative position in relation to the retaining element **20**. In the positive position, portions of the minor faces **96** of the bore **88** facing the tangential direction **T** abut portions of the stem side faces **118** of the hook **102** facing the direction counter to the tangential direction **T** (Fig. 11). In the neutral position, the minor faces **96** of the bore **88** do not abut the stem side faces **118** of the hook **102** (Fig. 12). In the negative position, portions of the minor faces **96** of the bore **88** facing the direction counter to the tangential direction **T** abut portions of the stem side faces **118** of the hook **102** facing the tangential direction **T** (Fig. 13).

The retaining element **20** is therefore used, inter alia, to limit the movement of the adaptor **18** in the tangential direction **T** between the positive and the negative positions which means that the adaptor **18** will generally remain in a fixed position in the retaining thread **66** when subjected to screwing forces in the direction counter to the tangential direction **T** or unscrewing forces in the tangential direction **T**. It is noted that other objects, which may be fixed in the shank cavity **48** and tangentially located between portions of the adaptor **18**, may also be used to limit the movement of the adaptor **18** along the tangential direction **T**. A pin (not shown) which passes through the shank **16** and the bore **88** in a transverse direction to the tool axis **A** is an example of such an object. If such an object is used in the reamer **10**, the

retaining element **20** may not be required any more and the bore **88** of the adaptor **18** may have a shape which does not open out to the section face **84**.

Attention is now additionally drawn back to Fig. 2. If between the negative and the positive positions, the adaptor **18** and the retaining element **20** do not axially abut then the adaptor **18** is defined as being in a floating state. In the floating state, axial support of the adaptor **18** in the shank cavity **48** is only affected by the second thread **86** which, as known in the art, is freely fitted in the retaining thread **66**. This freedom may allow the adaptor **18**, in the floating state, to slightly adjust its orientation when axially retaining objects in the shank cavity **48**. In addition it is noted that the threading retainment of the adaptor **18** in the shank cavity **48** provides a firm grip for the adaptor **18** against forces acting thereupon along the tool axis **A**.

An assembled position of the reamer **10**, in which the cutting head **12** is in a secured position in the tool holder **14** will now be described. To reach the assembled position, the cutting head **12** is first placed with the threaded portion **38** leading through the aperture **52** into the shank cavity **48** until the circular face **42** of the cutting head **12** meets the first thread **80** of the adaptor **18**. From this position the cutting head **12** is rotated in the direction counter to the tangential direction **T** causing the threaded portion **38** of the cutting head **12** to screw into the first thread **80** of the adaptor **18** until the cutting head **12** reaches the secured position. In the secured position, the head support wall **40** and the head annular face **28** axially align the cutting head **12** in the tool holder **14** by respectively abutting the shank support wall **60** and the shank annular face **46**. It is noted the adaptor **18** may have a small effect, if any, on the axial alignment of the cutting head **12** in the tool holder **14** when the adaptor **18** is in the floating state.

Through the assembled rear **10** a continues passage is formed along the tool axis by the shank channel **50**, the retaining channel **126**, the major portion **90** of the bore **88**, the adaptor channel **98**, the first cavity **76** and the head channel **44**. Through this passage coolant fluid may be supplied to the cutting head **12**.

Although the present invention has been described to a certain degree of particularity, it should be understood that various alterations and modifications could be made without departing from the scope of the invention as hereinafter claimed.

CLAIMS:

1. A cutting tool (10) having a tool axis (A) and comprising a cutting head (12) detachably secured to a tool holder (14), the tool axis (A) defining an axial forward to rear direction and a tangential direction (T) thereabout,

the tool holder (14) comprises a shank (16) and an adaptor (18), the shank (16) comprises shank cavity (48) which opens out to a forward end thereof and the adaptor (18) is threadingly engaged in the shank cavity (48),

the cutting head (12) comprises a forward cutting portion (22) and a rear fastening portion (24) wherein the fastening portion (24) is threadingly engaged in the adaptor (18).

2. The cutting tool (10) according to claim 1, wherein the fastening portion (24) is integrally formed with the cutting portion (22).

3. The cutting tool (10) according to claim 1, wherein the tool holder (14) comprises a retaining element (20) which is fixed in the shank cavity (48) and at least a portion of the retaining element (20) is located between portions of the adaptor (18).

4. The cutting tool (10) according to claim 3, wherein at least a portion of the retaining element (20) is tangentially located between portions of the adaptor (18).

5. The cutting tool (10) according to claim 3, wherein the retaining element (20) is threadingly engaged in the shank cavity (48).

6. A method of assembling a cutting tool (10) comprising the steps of:

providing a cutting head (12),

providing a shank (16) that comprises a shank cavity (48),

providing an adaptor (18) that comprises a bore (88), the bore (88) generally extending along a bore axis (B), the adaptor (18) generally extending in a direction transverse to the bore axis (B),

providing a retaining element (20) that comprises a hook (102), the hook (102) generally extending along a hook axis (H),

axially aligning the retaining element (20) and the adaptor (18) along the hook and the bore axes (H, B) until, in a view along the hook axis (H), at least a portion of the hook (102) overlies at least a portion of the bore (88),

urging the retaining element (20) along the hook axis (H) until at least a portion of the hook (102) in located in the bore (88),

threadingly engaging the adaptor (18) and the retaining element (20) in the shank cavity (48) and threadingly engaging the cutting head (12) and the adaptor (18).

7. A cutting tool (10) having a tool axis (A) and comprising a tool holder (14) and a cutting head (12),

the tool holder (14) comprising a shank (16), an adaptor (18) and a retaining element (20),

the shank (16) comprising an axially extending shank cavity (48),

the adaptor (18) being threadingly engaged in the shank cavity (48),

the retaining element (20) extending in a direction transverse to the tool axis (A) between portions of the adaptor (18) to limit the movement of the adaptor (18) about the tool axis (A),

the cutting head (12) being axially retained in tool holder (14) by the adaptor (18).

8. The cutting tool (10) according to claim 7, wherein the adaptor (18) upon axially retaining the cutting head (12) in the tool holder (14) axially abuts only the shank cavity (48).