

DRILL WITH RELEASABLY MOUNTED CUTTING HEAD

5 FIELD OF THE INVENTION

The current invention relates to a rotary cutting tool in general and a drill in particular having a releasably mounted cutting head.

BACKGROUND OF THE INVENTION

10 Such a rotary cutting tool is disclosed in U.S Patent 5,957,631. The cutting tool comprises a cutting head and tool shank each having two coupling portions and two chip flutes defined therebetween. Each coupling portion of the cutting head and tool shank has a stepped configuration with a raised base surface adjacent one flute and a lowered base surface adjacent
15 the other flute. If the cutting head and tool shank are designed to be coupled together with both the raised and lowered base surfaces in contact, then these surfaces have to be manufactured such that the distance between them is the same to within a high degree of accuracy. If on the other hand, the cutting head and tool shank are designed to be coupled together with
20 only one of the raised and lowered base surfaces in contact, then the coupling will be less stable.

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

SUMMARY OF THE INVENTION

In accordance with one aspect of the present invention there is provided a drill comprising a cutting head releasably mounted on a forward end of a tool shank, having a common axis of rotation defining a direction of rotation,

5 the cutting head comprising a cap portion and a fixation portion, the cap portion comprising a head surface, a head base surface and a peripheral side surface extending therebetween, the head base surface being transverse to the axis of rotation, the fixation portion protruding rearwardly from the head base surface away from the head surface and comprising a head
10 fixation surface extending circumferentially relative to the axis of rotation;

 at least two head flutes extending along a periphery of the cap and fixation portions forming identical head segments between adjacent pairs of head flutes, each head segment comprising a cap recess opening out to the side surface and the head base surface and dividing the head base surface
15 into first and second head base surfaces, a head torque transmission wall extending along a portion of the cap recess transverse to the head base surface and generally facing opposite the direction of rotation, a head fixation recess dividing the head fixation surface into first and second head fixation surfaces;

20 at least two shank flutes extend along a periphery of the tool shank forming identical shank coupling portions between adjacent pairs of shank flutes, at the forward end of the tool shank, each shank coupling portion comprising a forwardly facing shank support surface and a shank fixation surface located axially rearwardly relative to the shank support surface, a
25 shank fixation recess divides the shank fixation surface into first and second shank fixation surfaces;

 a protuberance protrudes forwardly from each shank support surface, the protuberance dividing the shank support surface into first and second shank support surfaces, a shank torque transmission wall extending along a

portion of the protuberance transverse to the shank support surface and generally facing the direction of rotation;

wherein pairs of head segments and shank coupling portions are in mating relationship, and wherein for each such pair the first head base surface abuts the first shank support surface, the second head base surface abuts the second shank support surface, the head torque transmission wall abuts the shank torque transmission wall, the first head fixation surface abuts the first shank fixation surface and the second head fixation surface abuts the second shank fixation surface.

Generally, the cap recess may have a recess forward surface and the protuberance may have a protuberance forward surface, and there may be a gap between the recess forward surface and the protuberance forward surface.

If desired, the recess forward surface may be generally parallel to the head base surface and the protuberance forward surface may be generally parallel to the shank support surface.

Preferably, the head fixation surface may extend rearwardly away from the head base surface and outwardly away from the axis of rotation at a first cone angle $\beta 1$, and the shank fixation surface may extend rearwardly away from the shank support surface and outwardly away from the axis of rotation at a second cone angle $\beta 2$.

If desired, the first cone angle $\beta 1$ may be smaller than the second cone angle $\beta 2$.

Typically, the at least two head flutes and at least two shank flutes may extend in a general axial direction.

If desired, the at least two head flutes may be identical and the at least two shank flutes may be identical.

If desired, the drill may be provided with coolant channels.

In accordance with another aspect of the present invention there is also provided a method for assembling a drill comprising the steps of:

providing a cutting head comprising a cap portion and a fixation portion, the cap portion comprising a head surface, a head base surface and a peripheral side surface extending therebetween, the head base surface being transverse to an axis of rotation, the fixation portion protruding rearwardly from the head base surface away from the head surface and comprising a head fixation surface extending circumferentially relative to the axis of rotation, at least two head flutes extending along a periphery of the cap and fixation portions forming identical head segments between adjacent pairs of head flutes, each head segment comprising a cap recess opening out to the side surface and the head base surface and dividing the head base surface into first and second head base surfaces, a head torque transmission wall extending along a portion of the cap recess transverse to the head base surface and generally facing a counter direction of rotation, a head fixation recess dividing the head fixation surface into first and second head fixation surfaces,

providing a tool shank with at least two shank flutes extending along a periphery of the tool shank forming identical shank coupling portions between adjacent pairs of shank flutes at the forward end of the tool shank, each shank coupling portion comprising a forwardly facing shank support surface and a shank fixation surface located axially rearwardly relative to the shank support surface, a shank fixation recess divides the shank fixation surface into first and second shank fixation surfaces, a protuberance protruding forwardly from each shank support surface, the protuberance dividing the shank support surface into first and second shank support surfaces, a shank torque transmission wall extending along a portion of the protuberance transverse to the shank support surface and generally facing the direction of rotation;

axially aligning the cutting head and tool shank until pairs of head segments and shank coupling portions are opposite each other such that for

each pair the first head fixation surface is above the shank fixation recess, the first head base surface is above the first shank support surface and the cap recess is above the protuberance;

for each pair, inserting the first head fixation surface into the shank
5 fixation recess, and the protuberance into the cap recess; and

rotating the cutting head until, for each pair, the head torque transmission wall abuts the shank torque transmission wall.

BRIEF DESCRIPTION OF THE DRAWINGS

10 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 perspective view of a drill in accordance with the present invention;

15 Fig. 2 is a perspective view of a cutting head in accordance with the present invention;

Fig. 3 is a top view of the cutting head shown in Fig. 2;

Fig. 4 is a bottom view of the cutting head shown in Fig. 2;

Fig. 5 is a perspective view of a forward end of a tool shank in
20 accordance with the present invention;

Fig. 6 is a top view of the tool shank shown in Fig. 5;

Fig. 7 is a cross sectional view of the cutting head taken along the line VII-VII in Fig. 3;

Fig. 8 is a partial cross sectional view of the tool shank taken along the
25 line VIII-VIII in Fig. 6; and

Fig. 9 is a longitudinal cross sectional view of the drill shown in Fig. 1, taken along a line similar to those of Figs. 7 and 8.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

Attention is drawn to the figures showing a drill 10 (Fig. 1) for drilling holes in metal work pieces. The drill 10 comprises a cutting head 12 releasably mounted on a forward end of a tool shank 14, having a common longitudinal axis of rotation 16 defining a direction of rotation R. The cutting head 12 is typically made of hard wear resistant material such as cemented carbide, and the tool shank 14 is typically made of steel.

The cutting head 12 (Fig. 2) comprises a cap portion 18 and a fixation portion 20. The cap portion 18 comprises a head surface 22, a head base surface 24 transverse to the axis of rotation 16 and a peripheral side surface 26 extending therebetween. The fixation portion 20 protrudes rearwardly from the head base surface 24 away from the head surface 22 and has a head fixation surface 28 that extends circumferentially relative to the axis of rotation 16. The head fixation surface 28 (Fig. 7) extends rearwardly away from the head base surface 24 and outwardly away from the axis of rotation 16 at a first cone angle β_1 to a convex shaped rear fixation surface 30. A head fixation recess 32 (Fig. 2) divides the head fixation surface 28 into a first head fixation surface 34 at a leading end and a second head fixation surface 36 at a trailing end thereof. Leading and trailing ends being defined relative to the direction of rotation R.

Two head flutes 38 extend generally axially rearwardly along a periphery of the cap portion 18 and fixation portion 20, forming two identical head segments 40 therebetween (Fig. 3). Each head segment 40 comprises a cutting edge 42 formed along an intersection of an adjacent rake surface 43 with the head surface 22. A cap recess 44 (Fig. 4) opening out to the peripheral side surface 26 and to the head base surface 24 divides the head base surface 24 into a first head base surface 46 at a leading end and a second head base surface 48 at a trailing end thereof. A head coolant channel 50 (Fig. 2) opens out to the head surface 22, peripheral side surface

26, and second head base surface 48 and intersects the cap recess 44. A head torque transmission wall 52 adjacent the first head base surface 46 extends along a portion of the cap recess 44 transverse to the head base surface 24 and generally faces opposite the direction of rotation R. A cap recess forward surface 54 adjacent the head torque transmission wall 52 is generally parallel to the head base surface 24.

The tool shank 14 (Fig. 5) comprises, at a forward end thereof, two diametrically disposed shank coupling portions 56 each peripherally bound by a shank peripheral surface 58 and two shank flutes 60. Each shank coupling portion 56 has a forwardly facing shank support surface 62 extending from the shank peripheral surface 58 generally transversely inwardly to a shank support recess 64 formed between the shank coupling portions 56.

The shank support recess 64 (Fig. 8) is formed by a forward recess surface 66 extending inwardly and rearwardly from each shank support surface 62, a shank fixation surface 68 extending from each forward recess surface 66 axially rearwardly and radially outwardly at a second cone angle β_2 , and a concave rear recess surface 70 extending between the shank fixation surfaces 68 of the shank coupling portions 56. The shape of the shank support recess 64 is such that a narrow neck region 72 is formed in each shank coupling portion 56 adjacent the join between the shank fixation surface 68 and the rear recess surface 70. The narrow neck region 72 makes the shank coupling portions 56 resiliently displaceable.

A protuberance 74 (Fig. 5) protrudes forwardly from each shank support surface 62 and a depression 79 having a forwardly facing depression face 81 is formed in each shank support surface 62 at a trailing end of the protuberance 74. The protuberance 74 and the depression 79 divide the shank support surface 62 into a first shank support surface 76 at a leading end and a second shank support surface 78 at a trailing end thereof.

A shank coolant channel 80 opens out to the depression face 81 for communicating with the head coolant channel 50. A shank torque transmission wall 82 adjacent the first shank support surface 76 extends along a portion of the protuberance 74. The shank torque transmission wall 82 is transverse to the shank support surface 62 and generally faces the direction of rotation R. A protuberance forward surface 84 merges with the shank torque transmission wall 82 via a beveled surface 83, and is generally parallel to the shank support surface 62. In planes perpendicular to the axis of rotation 16, an angular extension 01 of the cap recess 44 (Fig. 4) is larger than an angular extension 02 of the protuberance 74 (Fig. 6).

A shank fixation recess 86 (Fig. 5) divides the shank fixation surface 68 into a first shank fixation surface 88 at a leading end and a second shank fixation surface 90 at a trailing end thereof. In planes (Fig. 4 for cutting head 12, and Fig. 6 for tool shank 14) perpendicular to the axis of rotation 16, an angular extension 03 of the head fixation recess 32 is larger than an angular extension 04 of the first shank fixation surface 88 and an angular extension 05 of the second head fixation surface 36 is smaller than an angular extension 06 of the shank fixation recess 86.

In order to mount the cutting head 12 on the tool shank 14, the cutting head 12 and tool shank 14 are axially aligned so that the head segments 40 and shank coupling portions 56 are arranged in opposing pairs, and so that for each pair, the cap recess 44, second head fixation surface 36, head fixation recess 32 and second head base surface 48 of the cutting head 12 are directly above the protuberance 74, shank fixation recess 86, first shank fixation surface 88 and depression 79 of the tool shank 14, respectively. The cutting head 12 and tool shank 14 are then urged towards each other so that the protuberance 74 is inserted into the cap recess 44, the second head fixation surface 36 is inserted into the shank fixation recess 86, the first shank fixation surface 88 is inserted into the head fixation recess

32, and the second head base surface 48 and depression face 81 abut. Finally, the cutting head 12 is brought into a fully mounted position (Fig. 1) by rotating it relative to the tool shank 14 until the head and shank torque transmission walls 52, 82 abut. It will be appreciated that an angular extension of each depression face 81 is larger than an angular extension of its associated second head base surface 48. As the cutting head 12 is rotated relative to the tool shank 14, the second head base surfaces 48 move out of the depressions 79 and onto the second shank support surfaces 78. This in turn causes the fixation portion 20 of the cutting head 12 to contact and displace the resilient shank coupling portions 56 in a generally radially outward direction and the head and shank fixation surfaces 28, 68 of each opposing pair to engage each other in an interlocking male-female fashion. In the fully mounted position the cutting head 12 is retained in a self clamping manner by the tool shank 14 in a dovetail, or bayonet fashion. If desired, the head and shank fixation surfaces 28, 68 can be forced to engage each other at forward portions thereof by making the first cone angle $\beta 1$ smaller than the second cone angle $\beta 2$.

In the fully mounted position, for each of the opposing pairs of head segments 40 and shank coupling portions 56, in addition to the abutment of the head and shank torque transmission walls 52, 82; the first head base surface 46 and first shank support surface 76 abut, the second head base surface 48 and second shank support surface 78 abut, and the first and second head fixation surfaces 34, 36 and the first and second shank fixation surfaces 88, 90; respectively abut each other to provide a self-clamping of the cutting head 12 on the tool shank 14.

It should be noted that in the fully mounted position, the rear fixation surface 30 and the rear recess surface 70 are not in abutment so that a space exists between them (Fig. 9). This space is preferably small so that chips cut from a workpiece will not become lodged in the space. It should

also be noted that in the fully mounted position (Fig. 1), for each of the opposing pairs of head segments 40 and shank coupling portions 56, there is a gap between the protuberance forward surface 84 and the cap recess forward surface 54. Consequently, the cutting head 12 is axially supported
5 by the tool shank 14 at four spaced apart axial support regions on the shank support surfaces 62, formed by the abutment of the first and second head base surfaces 46, 48 with the first and second shank support surfaces 76, 78; respectively, of each of the opposing pairs of head segments 40 and shank coupling portions 56. With four spaced apart axial support regions the
10 cutting head 12 is stably coupled to the tool shank 14.

Each shank support surface 62 is preferably flat and the two shank support surfaces 76, 78 are preferably coplanar. Similarly, each head base surface 24 is preferably flat and the two head base surfaces 46, 48 are preferably coplanar. Flat and coplanar axial support surfaces are
15 advantageous over non-coplanar axial support surfaces since it is easier to achieve the required tolerances for coplanar surfaces than it is for non-coplanar surfaces.

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

CLAIMS:

1. A drill comprising
a cutting head releasably mounted on a forward end of a tool shank,
having a common axis of rotation defining a direction of rotation,
the cutting head comprising a cap portion and a fixation portion, the
cap portion comprising a head surface, a head base surface and a peripheral
side surface extending therebetween, the head base surface being
transverse to the axis of rotation, the fixation portion protruding
rearwardly from the head base surface away from the head surface and
comprising a head fixation surface extending circumferentially relative to
the axis of rotation;
at least two head flutes extending along a periphery of the cap and
fixation portions forming identical head segments between adjacent pairs of
head flutes, each head segment comprising a cap recess opening out to the
side surface and the head base surface and dividing the head base surface
into first and second head base surfaces, a head torque transmission wall
extending along a portion of the cap recess transverse to the head base
surface and generally facing opposite the direction of rotation, a head
fixation recess dividing the head fixation surface into first and second
head fixation surfaces;
at least two shank flutes extend along a periphery of the tool shank
forming identical shank coupling portions between adjacent pairs of shank
flutes, at the forward end of the tool shank, each shank coupling portion
comprising a forwardly facing shank support surface and a shank fixation
surface located axially rearwardly relative to the shank support surface,
a shank fixation recess

divides the shank fixation surface into first and second shank fixation surfaces;

a protuberance protrudes forwardly from each shank support surface, the protuberance dividing the shank support surface into first and second shank support surfaces, a shank torque transmission wall extending along a portion of the protuberance transverse to the shank support surface and generally facing the direction of rotation;

wherein pairs of head segments and shank coupling portions are in mating relationship, and wherein for each such pair the first head base surface abuts the first shank support surface, the second head base surface abuts the second shank support surface, the head torque transmission wall abuts the shank torque transmission wall, the first head fixation surface abuts the first shank fixation surface and the second head fixation surface abuts the second shank fixation surface.

2. The drill according to claim 1, wherein the cap recess has a recess forward surface and the protuberance has a protuberance forward surface, and there is a gap between the recess forward surface and the protuberance forward surface.
3. The drill according to claim 1, wherein the first and second shank support surfaces are flat.
4. The drill according to claim 1, wherein the head base surfaces are flat.
5. The drill according to claim 1, wherein the first and second shank support surfaces are coplanar.
6. The drill according to claim 1, wherein the head base surfaces are coplanar.

7. The drill according to claim 2, wherein the recess forward surface is generally parallel to the head base surface and the protuberance forward surface is generally parallel to the shank support surface.
8. The drill according to claim 1, wherein the head fixation surface extends rearwardly away from the head base surface and outwardly away from the axis of rotation at a first cone angle $\beta 1$, and the shank fixation surface extends rearwardly away from the shank support surface and outwardly away from the axis of rotation at a second cone angle $\beta 2$.
9. The drill according to claim 8, wherein the first cone angle $\beta 1$ is smaller than the second cone angle $\beta 2$.
10. The drill according to claim 1, wherein the at least two head flutes and at least two shank flutes extend in a general axial direction.
11. The drill according to claim 10, wherein the at least two head flutes are identical and the at least two shank flutes are identical.
12. The drill according to claim 1, wherein the drill is provided with coolant channels.
13. The drill according to claim 1, wherein a depression is formed in each shank support surface at a trailing end of the protuberance.
14. A method for assembling a drill comprising the steps of:
 - providing a cutting head comprising a cap portion and a fixation portion, the cap portion comprising a head surface, a head base surface and a peripheral side surface extending therebetween, the head base surface being transverse to an axis of rotation, the fixation portion protruding rearwardly from the head base

surface away from the head surface and comprising a head fixation surface extending circumferentially relative to the axis of rotation, at least two head flutes extending along a periphery of the cap and fixation portions forming identical head segments between adjacent pairs of head flutes, each head segment comprising a cap recess opening out to the side surface and the head base surface and dividing the head base surface into first and second head base surfaces, a head torque transmission wall extending along a portion of the cap recess transverse to the head base surface and generally facing a counter direction of rotation, a head fixation recess dividing the head fixation surface into first and second head fixation surfaces,

providing a tool shank with at least two shank flutes extending along a periphery of the tool shank forming identical shank coupling portions between adjacent pairs of shank flutes at the forward end of the tool shank, each shank coupling portion comprising a forwardly facing shank support surface and a shank fixation surface located axially rearwardly relative to the shank support surface, a shank fixation recess divides the shank fixation surface into first and second shank fixation surfaces, a protuberance protruding forwardly from each shank support surface, the protuberance dividing the shank support surface into first and second shank support surfaces, a shank torque transmission wall extending along a portion of the protuberance transverse to the shank support surface and generally facing the direction of rotation;

axially aligning the cutting head and tool shank until pairs of head segments and shank coupling portions are opposite each other such that for each pair the first head fixation surface is above the shank fixation recess, the first head base surface is above the first

shank support surface and the cap recess is above the protuberance ;

for each pair, inserting the first head fixation surface into the shank fixation recess, and the protuberance into the cap recess; and

rotating the cutting head until, for each pair, the head torque transmission wall abuts the shank torque transmission wall.