June 9, 1959 J. W. TURTON ET AL 2,889,725

CARBIDE DRILL

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Fig. 1.

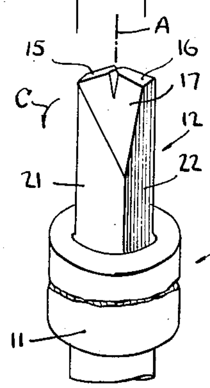
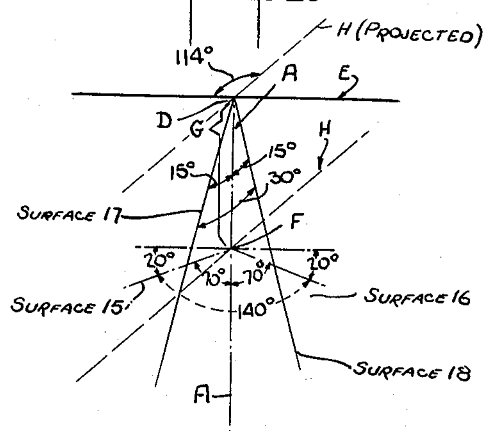


Fig. 2.



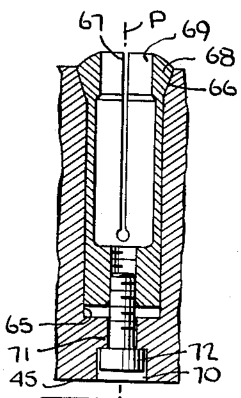
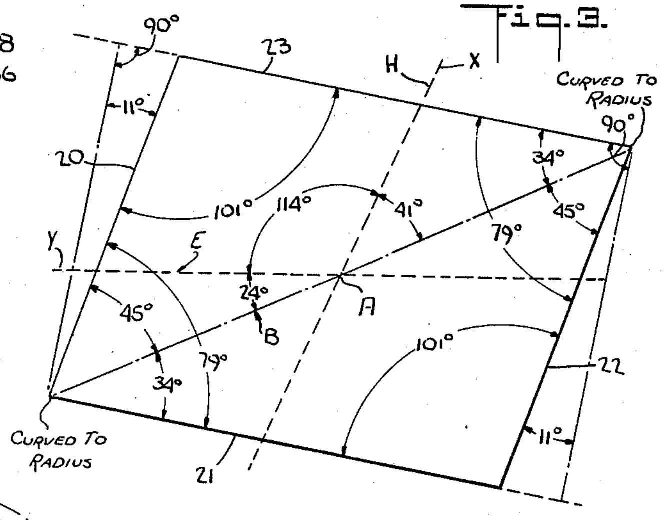


Fig. 16.

Fig. 3.



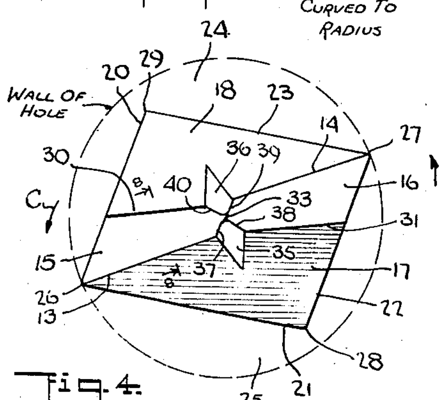


Fig. 4.

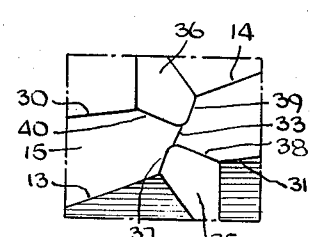


Fig. 5.

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Fig. 6.

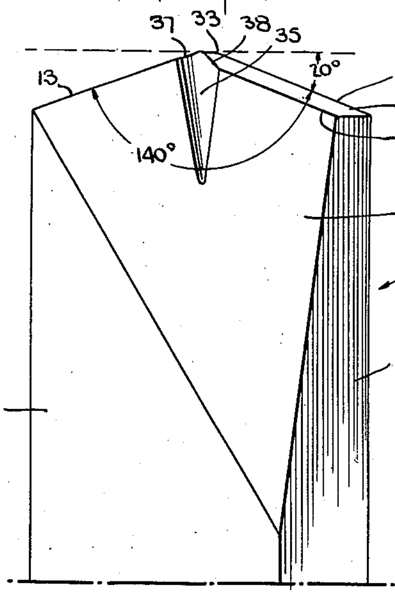

Fig. 7.

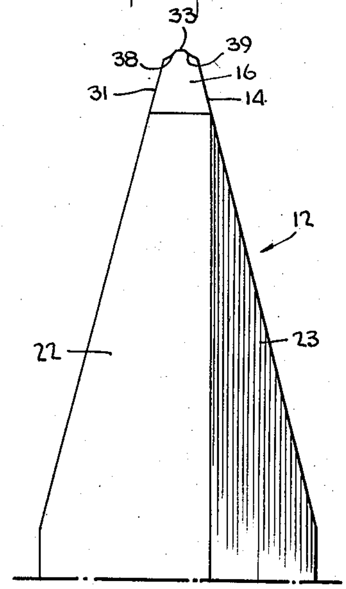

Fig. 8.

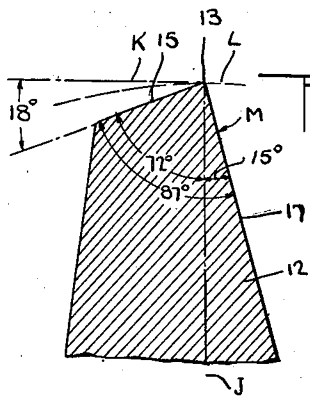

Fig. 9.

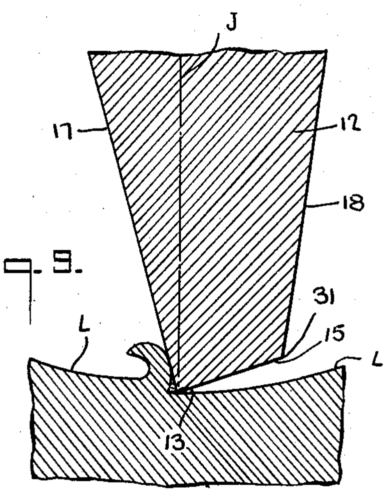

Fig. 15.

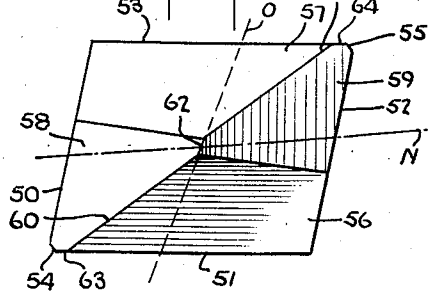

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Fig. 10.

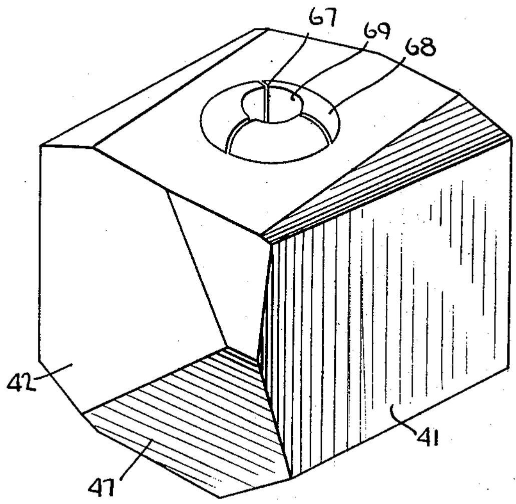


Fig. 13.

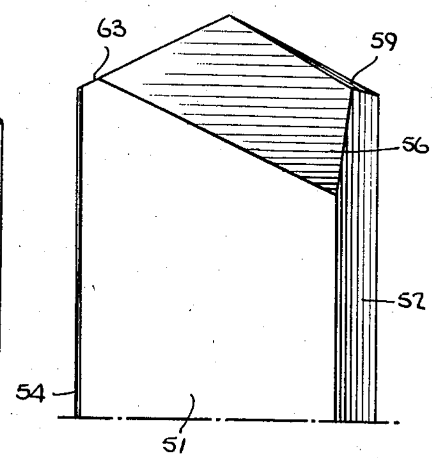


Fig. 11.

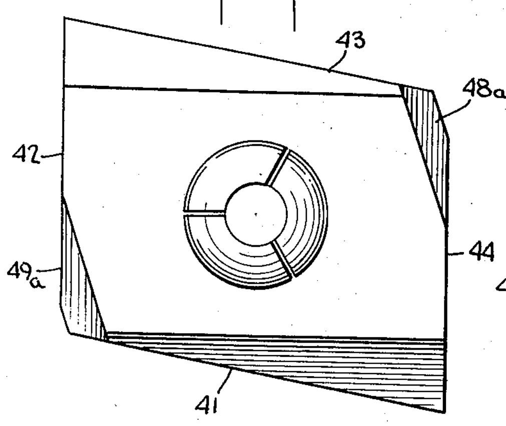
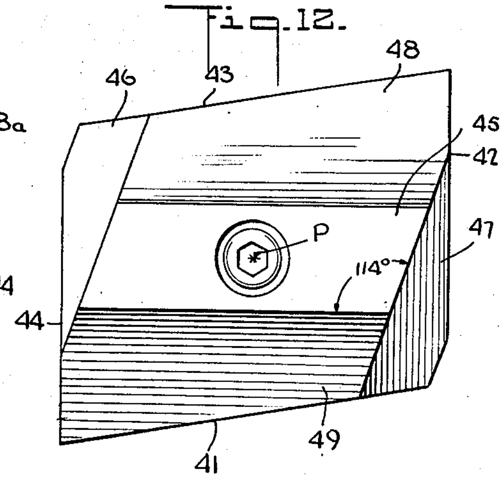


Fig. 12.



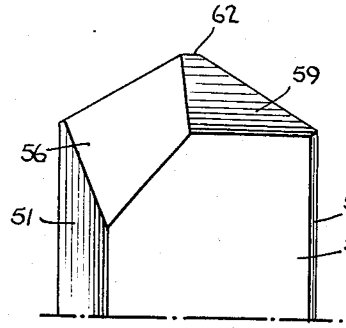


Fig. 14.

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CARBIDE DRILL

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Application May 9, 1958, Serial No. 734,214

8 Claims. (Cl. 77—67)

This invention relates to high speed drills of the carbide type.

Such a drill is required to bore a large number of holes successively and at a high rate of speed without becoming dull or breaking. In addition, the drill must be capable of being resharpened or reground to the proper surface angles without difficulty. Problems have been encountered in the repetitive boring of hard steels in the range of 50–65 Rockwell. The usual drills become dull and must be replaced after only a few holes have been bored.

An object of this invention is to provide a high speed drill that can be used repeatedly for drilling a large number of holes at high speeds in extremely hard metal and that can be easily reground to the original surface angles.

Other and further objects will become apparent from the following description taken in connection with the accompanying drawings in which:

Fig. 1 is a perspective view of the drill;

Fig. 2 is a perspective view illustrating the relationship between the planes of the end surfaces and the sloping side surfaces;

Fig. 3 is a geometric representation of the relationship of the side surfaces and the lines of intersection of the planes of the end surfaces and the sloping side surfaces to the diagonal determining the diameter of the drill;

Fig. 4 is an end view of the tip of the drill;

Fig. 5 is an enlarged fragmentary view of the point of the drill;

Fig. 6 is a side view of the end of the drill;

Fig. 7 is a side view illustrating the slope of the sloping side surfaces;

Fig. 8 is a sectional view illustrating the leading surfaces and the relief surfaces;

Fig. 9 is a sectional view illustrating the cutting action of the tip;

Figs. 10–12 illustrate the cutting block;

Figs. 13–15 are end and side views of another embodiment of the drill; and

Fig. 16 is a sectional view of the clamping means for holding the drill in the block.

The drill **10** comprises a steel shank **11** and a tungsten carbide tip **12** brazed in the end of the shank, or comprises a solid carbide tip and shank forming a single piece. The shank is adapted to fit in a chuck to rotate the drill about a central axis A for drilling holes in hard steels. The tip has a parallelogram cross section formed by the side surfaces **20**, **21**, **22** and **23**. The drill is rotated in the direction indicated by the arrow C and has two main cutting edges **13** and **14** formed by the end surfaces **15** and **16** intersecting with the sloping side surfaces **17** and **18**, respectively. The sloping side surfaces **17** and **18** also intersect the end surfaces **16** and **15**, respectively, to form the back edges **30** and **31**.

The four side surfaces **20**, **21**, **22** and **23** extend parallel to the central axis and are arranged in a parallelogram shape to form openings **24** and **25** between the sides of the tip and the wall of the drilled hole. The digonal B extending between the acute angles determines the diameter of the hole to be drilled. The side surfaces are positioned in relation to the diagonal B to form the surfaces **21** and **23** as leading side surfaces and the surfaces **20** and **22** as trailing side surfaces. The trailing side surfaces **20** and **22** are opposite to one another and parallel and at an angle of 45° to the diagonal. The leading side surfaces **21** and **23** are also on opposite sides of the tip and are parallel and at an angle of 34° with the diagonal. These angles provide ample room between the sides of the tip and the walls of the drilled hole for the removal of the steel chips. The trailing side surface **20** and the leading side surface **21** intersect to form the longitudinally extending edge **26** at one end of the diagonal and the trailing side surface **22** and the leading side surface **23** intersect to form the longitudinally extending edge **27** at the other end of the diagonal. The edges **26** and **27** extend parallel to the central axis and engage the wall of the drilled hole. The edges are curved to correspond to the radius of the drill and have a width of approximately .002 to .006 of an inch. The edges **29** and **28** are formed by the intersection of the surfaces **20** and **23** and **21** and **22**, respectively. With the edges **26** and **27** extending along the entire length of the drilled hole, the steel chips are prevented from passing between the wall of the hole and the edges **26** and **27**. The chips are carried around by the leading surfaces and the accompanying sloping surfaces of the drill.

The sloping side surfaces **17** and **18** are positioned on opposite sides of the central axis of the tip and are at an angle of 15° thereto so that the surfaces are at an angle of 30° with one another. The surfaces **17** and **18**, when extended, intersect the central axis A at point D to form a line of intersection E axially above the end of the tip. The line of intersection E is at an angle of approximately 24° to the diagonal B, as indicated in Fig. 3, and extends in a generally longitudinal relation to the leading side surfaces **21** and **23**.

The planes of the surfaces intersect to form a line of intersection H which appears as edge **33** in Fig. 4. The edge or line crosses the central axis at point F. The line of intersection extends laterally to the leading side surfaces **21** and **23** and is at an angle of 41° to the diagonal B. The end surfaces **15** and **16** are positioned in relation to the sloping side surfaces **17** and **18** so that the line of intersection H is at an angle of 114° to the line of intersection E of the surfaces **17** and **18**. The distance G between the points of intersection of the two sets of surfaces through the central axis is set to provide the proper width to the end surfaces **15** and **16**. These surfaces should have a width from one-sixth to one-quarter of the diameter of the drill. The sloping side surfaces are orientated in relation to the side surfaces of the tip so that the surface **17** intersects with the side surfaces **21** and **22** and the surface **18** intersects with the side surfaces **20** and **23**.

The drill is rotated about the central axis A to form a conically shaped surface L at the bottom of the drilled hole. The metal is severed by the cutting edges **13** and **14** and the surfaces immediately associated with the cutting edges. In Figs. 8 and 9 sectional views of the tip are taken in the plane at right angles to the edge **13** along lines 8—8 of Fig. 4. In these figures the relationship between the sloping side surface **17** and the end surface **15** is clearly illustrated. The broken line indicates the plane J parallel to the central axis and including the cutting edge **13**. The sloping side surface **17** is tilted forward at an angle of approximately 15° to this plane, thus forming a negative rake angle with respect to the cutting edge, The end surface 15 is at an angle of approximately 87° to the sloping side surface 17, or 72° to the parallel plane J on the opposite side to the surface 17. Since the plane is parallel to the axis and extends close thereto, it is nearly perpendicular to the plane K tangent to the conical work surface L at the line of intersection. The end surface 15 is at an angle of 18° to this tangential plane. However, the effective clearance is reduced due to the curvature of the worked surface L. The cutting edge 13 is beveled to form a 3° relief with the sloping side surface 17 and is approximately .002 to .004 of an inch in width. The sloping side surface 18 and the end surface 16 are at similar angles to one another and to the plane through the cutting edge 14 and the plane tangential thereto.

The sloping side surface 17 engages the metal over an area spaced from the cutting edge 13 to shear the metal chip from the work piece. The cutting edge smoothes and finishes the surface. The metal chip engages the sloping side surface 17 over an area spaced from the cutting edge. The forces applied to the worked metal are normal to the sloping side surface 17 which applies a shearing force along the thickness M of the tip. The tip is of a sufficient thickness to resist the breaking of the tool. The surfaces 17 and 18 diverge from the end of the tip to increase its width. This increased width withstands the tensile forces created in the tip by the moment of the shearing force applied to the surface 17, thus strengthening the carbide tip. The 15° angle of the sloping side surfaces applies the force to the work surface in the proper manner to separate the metal chip from the work piece and the clearance of 18° prevents undue wear along the land of the surface bearing against the work piece. Thus, the tip will withstand extended usage without breaking or becoming dull at a rapid rate. The angles are precisely determined and provide a strong tip which may be repeatedly used to drill holes in hard steels. The side edges 26 and 27 bear against the cylindrical wall of the drilled hole. During the cutting of the hole the chips accumulate along the sloping side surfaces 17 and 18 and are forced up along the surfaces and out past the space between the wall of the drilled hole and the surfaces 20 and 23 for the sloping side surface 18, and the surfaces 21 and 22 for the sloping side surface 17. The parallelogram shape of the tip provides space for the chips to remain clear of the surface being cut so that there is no jamming or interference by the chips with the cutting action.

In order to reduce the thrust and torque, notch surfaces 35 and 36 are cut in the surfaces 17 and 18. The notches have a generally conical contour and extend longitudinally along the tip. The surface 35 intersects with the end surfaces 15 to form an edge 37 and with the end surface 16 to form an edge 38. The surface 36 intersects with the end surfaces 15 and 16 to form the edges 40 and 39. The cutting edges 37 and 39 cut the center portion of the work surface and the edge formed by the intersection of the surfaces 20 and 21. The edges 37 and 39 are substantially normal to the movement of the work surface so that it readily shears the metal to cut the hole. The cutting edges 37 and 39 are on opposite sides of edge 33. The edge 37 is at an angle to the cutting edge 13 and is curved at the end to intersect the straight edge 33 at an angle and, similarly, the edge 39 is at an angle to the cutting edge 14 and is curved at the end to intersect the straight edge 33. Thus, the edges 37 and 39 are connected by the straight edge 33 so that a continuous edge is formed between the inner ends of the cutting edges 13 and 14.

The drill is formed by fitting an unfinished cylindrical carbide piece and brazing it in the shank 11 of the drill. The steel shank is then turned or ground true with the carbide insert by holding the carbide insert in a chuck and rotating it, and turning or grinding the shank. The surfaces of the drill are then ground by mounting the drill in a block shaped to have surfaces complementary to the surfaces of the tip. The block has a generally cylindrical bore 65 with a flared opening forming a conical surface 66. A keyway extends longitudinally along the side of the bore. A generally cylindrical clamping means has a cylindrical bore and longitudinally extending slots 67 to render the walls of the clamp flexible. The clamping means has a flared portion 68 engaging the surface 66. The flared portion has gripping surfaces 69 for firmly holding the shank 11 of the drill. On the opposite side of the block a bore 70 is provided with a reduced portion 71 through which a bolt 72 extends to thread in the inner end of the clamp to draw the flared portion 68 against the flared surface 66 so that the surfaces 69 firmly lock the shank in the block. The bore and clamping means have a central axis P with which the central axis A of the tool coincides so that the surfaces ground on the drill will be complementary to the surfaces of the block.

The block with the blank drill is mounted on a flat work table to position the tip in relation to the grinding wheel to grind the surface at the desired angle. The block is shifted to each surface to finish the tip. The surface 45 on the bottom of the block extends normal to the central axis P of the block and of the tip fitting in the block. The surfaces 46 and 47 extend at a 15° angle to the surface 45 and are positioned at opposite corners of the block. These surfaces are complementary to the corresponding surfaces 17 and 18 on the drill. The surfaces 48 and 49 are at 20° to the surface 45 and form lines of intersection with the surface 45 which form an obtuse angle of approximately 114° with the lines of intersection of the surfaces 46 and 47. These bottom surfaces determine the shape of the end of the tool. The side surfaces of the tip are formed complementary to the side surfaces 41, 42, 43 and 44 of the cylinder block. The carbide tip is ground by first successively grinding the sides to form the parallelogram cross sectional shape, as illustrated in Figs. 3 and 4. The leading surfaces 21 and 23 may then be ground and finally the trailing surfaces 20 and 22. Thus, the major surfaces of the tool are formed. After the parallelogram is ground, the surfaces 15 and 16 are ground (with 3° relief angle) to give 140° included point angle. The included point angle may be from 125° to 155°. After this, surfaces 17 and 18 are ground to bring the cutting edge to outside diameter radius. Then the notches are ground. The notches 35 and 36 may be cut by setting the block on the corner surfaces 48*a* and 49*a*, respectively, for each notch.

A modification of the invention is illustrated in Figs. 13–15 in which the carbide tip is ground to a parallelogram shape, as illustrated in Fig. 15, with the sides 50 and 51 at an acute angle of 79° and the sides 52 and 53 at an acute angle of 79°. The ends 54 and 55 on the longest diagonal are ground to form end surfaces having a width of approximately .002 to .004 of an inch. The sloping side surfaces 56 and 57 extend approximately 61° to the axis and intersect beyond the end of the tip in a line N. The end surfaces 58 and 59 are at an angle of approximately 64° to the central axis and intersect along a line O forming an edge 62 which is rotated 115° with respect to the line of intersection N of the planes of the sloping side surfaces. As in the preferred embodiment, the intersections with the central axis are spaced to provide a proper width to the end surfaces 54 and 55. The surfaces 56 and 58 intersect to form cutting edge 60 and the surfaces 57 and 59 intersect to form cutting surface 61. The end surface 58 and the leading surface 56 are at an angle of approximately 105° in the section taken by a plane normal to the cutting edge 60, and the surface 57 is at a corresponding angle with the end surface 59. The cutting edges 60 and 61 extend to intersect with the side surfaces 51 and 53 to form short cutting surfaces 63 and 64, respectively, of approximately .004 of an inch.

Thus, this embodiment is substantially the same and functions in a manner similar to the above described preferred embodiment.

The foregoing embodiments are specific illustrations of the invention and the embodiment shown in Figs. 1, 4, 5, 6, 7 and 8 is the preferred form. The angles set forth in the preferred embodiment may be varied. The angle of the end surfaces with respect to the central axis may have a range from 64° to 73° and the sloping side surfaces with respect to the central axis may have a range from 15° to 20°. This will produce a variation in the angle between the sloping side surface and the end surface from about 85° to 95°. This will correspondingly affect the other angles of the drill.

The above described embodiments of the drill may be made in a range of sizes from 1⁄16 of an inch to 3⁄4 of an inch. The drill has many advantages and desirable characteristics which result in an improved drilling process for hard steels and a consequent reduction in the cost of manufacturing products requiring the drilling of a large number of holes by a single drill. The drill has a substantially reduced thrust for forcing the drill into the material and also provides for a substantial reduction in the amount of heat generated at the drilling point over the present drills used for penetrating hard steels. The drill also provides for a uniform hole size throughout its depth and renders an improved surface finish to the walls of the drilled hole. The drill may be used repeatedly to drill a large number of holes in hard steels without substantially impairing the above mentioned characteristics of the drill and without becoming excessively dull. An important characteristic resulting in the reduction of costs in manufacturing processes is the ease of regrinding the surfaces and edges of the drill. The drill may be resharpened a great number of times before it must be discarded. Another important characteristic is the parallelogram cross sectional shape of the tip of the drill which provides a large chip space for removing the chips of steel from the cutting surfaces to reduce the wear on the tip. This increase in chip discharge space is produced without reducing the strength of the drill. The form of the tip provided by the angles of the sloping and end surfaces provides a strong tip which is resistant to breakage. Thus, these improved characteristics of the drill substantially extend its life.

We claim:

1. A high speed drill for forming cylindrical holes in hard steels and comprising a carbide tip having end relief surfaces on opposite sides of the central axis and at an angle of 70° thereto and intersecting therewith, sloping side surfaces on opposite sides of said axis and at an angle of 15° thereto and intersecting at a point on said axis spaced axially outward from the intersection of said end relief surfaces to form cutting edges with said end relief surfaces for severing the hard steel metal from the bottom of the drilled hole.

2. A high speed drill for cutting cylindrical holes in hard steels and comprising a carbide tip rotatable about a central axis and having end relief surfaces on opposite sides of said central axis at an angle of 70° thereto and intersecting with said axis, sloping side surfaces on opposite sides of said central axis at an angle of 15° to said central axis with the planes of said surfaces intersecting in a plane spaced from the end of said end relief surfaces to form a cutting edge extending generally radially and positioning each of said sloping side surfaces at a negative rake angle of 15° to a plane normal to the cut surface and extending through the cutting edge, and each of said end surfaces at an angle of 87° to a respective sloping side surface and at an angle of 18° in relation to the plane tangent to the bottom of the opening at the point of contact of the cutting blade.

3. A high speed drill comprising a carbide tip rotatable about a central axis and having end relief surfaces at an angle of 70° thereto on opposite sides of said axis and intersecting along a line passing through the central axis, sloping side surfaces on opposite sides of the central axis and at 15° thereto and intersecting in a line spaced from the end of the tip which is at an angle of 114° to the intersection of the end relief surfaces to form cutting end surfaces, said end surfaces cooperating with said sloping side surfaces to sever the metal from the bottom of the hole, said tip having side surfaces formed in the shape of a parallelogram with the diagonally opposite edges of the sides of the smaller angle engaging the wall of the hole and the diagonally opposite edges of the sides of the greater angle spaced from the walls of the hole to provide space for the holding of the severed chips and for passage of the chips out of the drilled hole.

4. A drill as set forth in claim 3 wherein said side surfaces form diagonally opposite acute angles of 79° and diagonally opposite obtuse angles of 101°.

5. A high speed drill comprising a steel shank, a tungsten carbide tip brazed in said shank and rotatable about the central axis, said tip having four side surfaces extending parallel to the central axis with the diagonally opposite acute angles between the surfaces being 79° and the diagonally opposite obtuse angles being 101°, sloping side surfaces on opposite sides of the central axis and at 15° thereto and relief end surfaces on opposite sides of the central axis and at 70° thereto, said sloping side surfaces and said end relief surfaces oriented in relation to said side surfaces and to one another to form cutting edges extending longitudinally to the diagonal between said acute angles and on opposite sides thereof, said sloping side surface and said relief end surface at an angle of 87° to one another and the sloping side surface at approximately 15° forward of the plane normal to a plane perpendicular to the axis to form a drill capable of repetitively cutting hard steels at high speeds.

6. A high speed drill as set forth in claim 5 wherein said relief end surfaces intersect along a line at approximately 41° to the diagonal between the edges having acute angles and said sloping side surfaces being at an angle of 114° thereto and spaced an axial distance from said relief end surface line.

7. A high speed drill for forming cylindrical holes in hard steels and comprising a carbide tip having end relief surfaces on opposite sides of the central axis and at an angle of from 64° to 75° thereto and intersecting therewith, sloping side surfaces on opposite sides of said axis and at an angle of from 15° to 20° thereto and intersecting at a point on said axis spaced axially outward from the intersection of said end relief surfaces to form cutting edges with said end relief surfaces for severing the hard steel metal from the bottom of the drilled hole.

8. A high speed drill for cutting cylindrical holes in hard steels and comprising a carbide tip rotatable about a central axis and having end relief surfaces on opposite sides of said central axis and intersecting with said axis, sloping side surfaces on opposite sides of said central axis with the planes of said surfaces intersecting in a plane spaced from the end of said end relief surfaces to form a cutting edge extending generally radially and positioning each of said sloping side surfaces at a negative rake angle of approximately 15° to a plane normal to the cut surface and extending through the cutting edge to form a cutting surface.

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