April 12, 1960 J. J. SLEDZ 2,932,196

INTERNAL RECESSING TOOL AND HOLDER THEREFOR

Filed Aug. 12, 1955

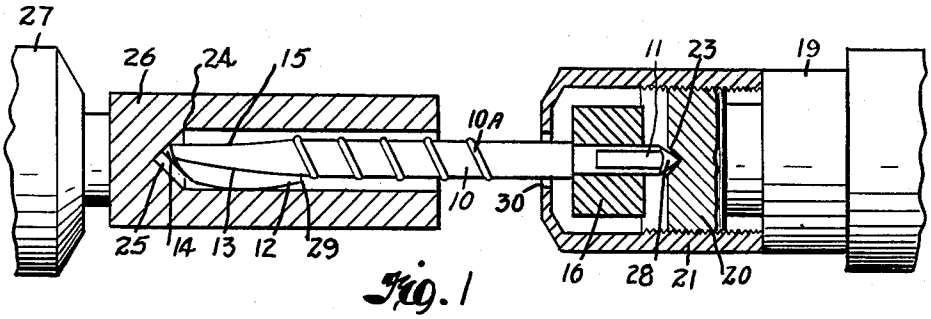


Fig. 1

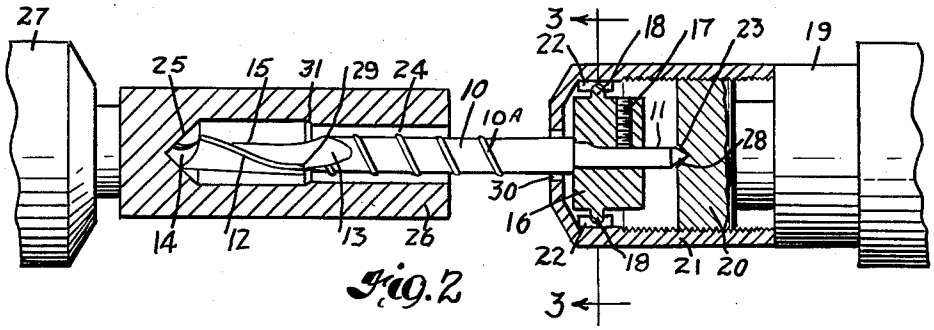


Fig. 2

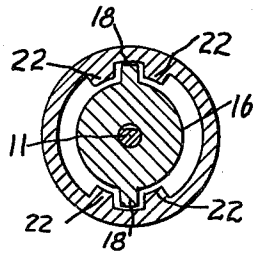


Fig. 3

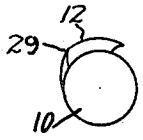


Fig. 4

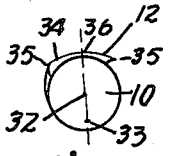


Fig. 5

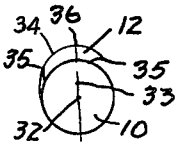


Fig. 7

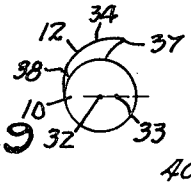


Fig. 9

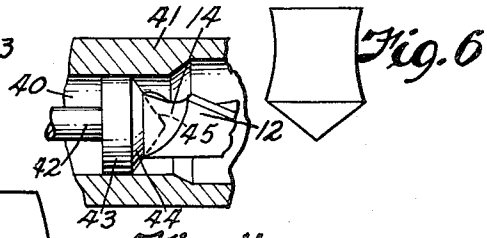


Fig. 11

Fig. 6

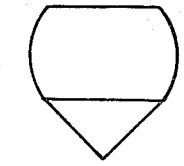


Fig. 8

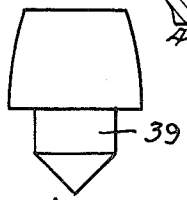


Fig. 10

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2,932,196

INTERNAL RECESSING TOOL AND HOLDER THEREFOR

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Application August 12, 1955, Serial No. 527,928

14 Claims. (Cl. 77—67)

This invention relates to tools and holders therefor for forming coaxial recesses in previously drilled holes. More specifically, this invention relates to tools and holders therefor for forming such recesses in previously drilled blind holes.

These are many situations where it is desirable to form a recess or undercut in the wall of a hole that has already been drilled. Thus, for example, when the wall of a hole is to be ground or polished with a rotating wheel which is moved along axially extending portions of the wall of the hole, it is desirable to have a recess in the wall of the hole adjacent to the area to be ground or polished. This is particularly desirable in blind holes in order that the wheel will not damage itself by striking the bottom of the hole. In such situations, when a recess is provided, the wheel while grinding or polishing is moved along the walls of the hole from the mouth of the hole to the recess and back to the mouth.

When the hole, in the wall of which a recess is to be formed, is large enough in diameter, the recess may be cut in the wall by relative rotation and lateral movement of the workpiece and of a bit that is inserted into the hole and that is mounted in radially projecting relation from a shaft. When, however, the diameter of the hole is relatively small and/or the hole is relatively deep, this method cannot be used since the shaft and bit are too large to enter the hole and/or the shaft is so long and slender that the bit carried thereby cannot be effectively pressed radially outwardly for cutting the recess.

It is, therefore, the principal object of my invention to provide a simple one-piece tool for forming recesses in the walls of previously drilled holes.

It is a more particular object of my invention to provide a tool for forming coaxial recesses in blind holes.

It is a further object of my invention to provide a tool for forming coaxial recesses in blind holes by utilizing the concave or conical bottom of the hole as a cam surface for feeding the cutting edge of the tool into the wall of the hole.

It is a further object of this invention to provide an internal recessing tool which is effective to simultaneously form substantially the entire axial extent of the recess without any substantial axial movement of the tool with respect to the work while such recess is being formed.

It is a still further object of this invention to provide an internal recessing tool which, during its normal operation, will form an internal recess whose junction with the previously-formed hole is not a sharp corner, but instead in effect such junction is through a uniform taper integral with the body of the work.

It is still another object of this invention to provide an internal recessing tool which may be employed advantageously to form a non-cylindrical enlargement in a hole which extends entirely through the work.

It is another object of this invention to provide an internal recessing tool which may be employed to form a plurality of axially aligned recesses in the wall of a hole.

It is still another object of this invention to provide a tool of the character indicated and a floating holder therefore which provides a pivot for the shank end of the tool about which the cutting end swings when cammed laterally by reason of its engagement with the cam surface extending across the hole.

It is still another object of this invention to provide a tool of the character indicated and floating holder therefor which not only provides a pivot for the shank end of the tool about which the cutting end swings when cammed laterally by reason of its engagement with the cam surface extending across the hole but in which the shank end of the tool is held with limited radial and axial play or float and in which the holder, like the bottom of the drilled hole, is provided with a cam surface which enables insertion of the tool into the drilled hole and the starting of the recessing operation with its axis disposed generally parallel to the axis of the hole, this being especially advantageous in connection with deep holes wherein the body of the tool would bind against the mouth of the hole if required to be inserted with its axis tilted with respect to the axis of the hole.

Other objects and advantages of the present invention will become apparent as the following description proceeds.

To the accomplishment of the foregoing and related ends, the invention, then, comprises the features hereinafter fully described and particularly pointed out in the claims, the following description and the annexed drawings setting forth in detail certain illustrative embodiments of the invention, these being indicative, however, of but a few of the various ways in which the principle of the invention may be employed.

In the annexed drawings:

Fig. 1 is a cross-sectional view illustrating the preferred form of my invention in conjunction with the means for securing and driving it and the workpiece in which it is to be used to form a recess, this figure showing the tool of my invention inserted in the hole in the workpiece before the recess has been formed;

Fig. 2 is a cross-sectional view illustrating the preferred form of my invention differing from Fig. 1 only in that the recess has been formed with the tool, which has been rotated to a position 90 degrees removed from the position illustrated in Fig. 1;

Fig. 3 is a cross-sectional view of the apparatus illustrated in Fig. 2 taken along the plane substantially indicated at 3—3 in Fig. 2;

Fig. 4 is a diagram of the axial projection of the preferred form of my invention;

Fig. 5 is a diagram of the axial projection of an alternative form of my invention;

Fig. 6 shows the shape described by rotating the form of my invention illustrated in Fig. 5 about its axis;

Fig. 7 is a diagram of the axial projection of another alternative form of my invention;

Fig. 8 shows the shape described by rotating the form of my invention illustrated in Fig. 7 about its axis;

Fig. 9 is a diagram of the axial projection of another alternative form of my invention;

Fig. 10 shows the shape described by rotating the form of my invention illustrated in Fig. 9 about its axis; and

Fig. 11 is a fragmentary cross-sectional view similar to Fig. 2 but illustrating an alternative form of my invention.

In the forms illustrated the cutting edges have been on cylindrical surfaces whose axes have been coincident with or parallel to the axis of the shank, however, it is within the contemplation of this invention to arrange the axis of the cylinder on which the cutting edge is formed angularly with respect to the axis of the shank with a resultant modification of the concave wall of the internal

recess, and also to use cutting edges which do not lie on cylinders.

The relative dimensions of the pairs of Figures 5 and 6, 7 and 8, and 9 and 10 have been exaggerated in order to make them more illustrative.

Broadly stated my invention comprises a cutting tool and a holder therefor in which the tool is adapted for insertion in a previously-formed hole and to form a recess in the wall of such hole, wherein the surface presented by the bottom of said hole or an insert therein is that formed by a line which intersects the axis of the hole at an angle other than 90° and which is rotated about such axis, which comprises: an elongated body having: (*a*) a shank by which the tool may be held; and (*b*) a cutting end terminating in a cam surface engageable with the aforesaid surface in said hole; and formed with a land of less than one-half turn formed with a cutting edge on one edge of said land of axial extent substantially equal to the axial extent of the recess to be formed by the tool and a tool holder by which the shank is held, the holder forming a pivot for the shank of the tool about which the tool swings by the interaction of the aforesaid cam surfaces.

With reference now to the annexed drawings and in particular to Figs. 1 and 2, **10** designates the shank of the internal recessing tool of my invention which may have, a chip-removing thread **10***a* thereon; **11** designates its flat; **12** designates its single land, **13** its flute, and **14** its tip. In the area, generally indicated at **15**, opposite the land **12** the body of the tool has been ground away so as to provide a relief or clearance space in which chips may accumulate and also to facilitate the free insertion of the cutting end into the hole. The tool is held in a clamp **16** by a set screw **17** which bears against the flat **11**. Protruding radially from the clamp **16** are two diametrically opposed bosses **18**.

A base **19** is provide for mounting the internal recessing tool, and it has extending axially therefrom a portion **20** which is externally threaded to receive an internally threaded cap **21**. On the inside of the cap **21** there are provided two pairs of lugs **22** which prevent the clamp **16** from rotating with respect to the cap **21**. The face of the portion **20** remote from the base **19** is provided with a depression **23** centrally thereof which herein is shown as being conical for reasons which will appear. In Figs. 1 and 2 the internal recessing tool is illustrated as being inserted in a hole **24** having a conical blind end **25** in a workpiece **26**. The workpiece **26** is mounted in any suitable chuck generally indicated at **27**.

The floating drive herein disclosed is such that the tool **10** together with clamp **16** is capable of swinging movement at the point of contact of the apex of the conical shank end **28** of the tool at the apex of the conical depression **23** in the end of the projection **20**, the included angle of depression **23** being greater than that of the conical end **28** to permit such swinging motion. The radial and axial clearances between the bosses **18** and the cap **21** enables the obtaining of a further advantage of the present invention and that is the lateral shifting of the axis of the tool **10** with respect to the axis of the drilled hole so that rib **10A** (if present) or the body of the shank may clear the mouth of the hole in the case of relatively deep holes. When the tool is thus laterally shifted and when axial force is applied thereon, the surface of the depression **23** constitutes a cam surface which cooperates with conical tip **28** to cam the tool laterally until the apex of tip **28** contacts the apex of the depression **23**. Thereafter, if not before, axial pressure on the tool will cause the tip **24** to move inwardly along the cam surface **25** swinging from the pivot of conical tip **28** in the depression **23**. Such swinging of the tool forces its cutting edge on land **12** to progressively move radially outwardly to cut a recess as best shown in Fig. 2.

As aforesaid, when the internal recessing tool of my invention is used to make a recess in a previously formed

hole **24** in a workpiece **26**, the tool is mounted in the clamp **16** and secured therein by the set screw **17**. The opening **30** in the end of the cap **21** is made large enough that the cutting end of the tool can be passed therethrough. The cutting end of the tool is passed through the hole **30** from the inside of the cap **21**, and the clamp **16** is inserted into the cap **21** until the bosses **18** pass into the spaces between the respective pairs of lugs **22**. The cap **21** is then screwed onto the portion **20** until the end of the cap **21** remote from the hole **30** contacts the base **19**.

It should here be noted that while it is necessary that the tool be non-rotatable with respect to the base **19** it must be pivotal with respect thereto. The end **28** of the tool therefore extends into the depression **23** and the end of the clamp **16** adjacent to the cap **21** must not contact said cap. To further insure that the tool can pivot with respect to the base **19** it is desirable that the remote ends of the bosses **18** be rounded as is illustrated in Fig. 2. To insure that the end of the clamp **16** adjacent to the cap **21** does not contact the cap **21**, the length of the cap **21** is carefully chosen so that when it is screwed onto the portion **20** down to the base **19** the bosses **18** on the clamp **16** will engage in the central part of the spaces between the respective pairs of lugs **22**.

After the internal recessing tool is thus pivotally but non-rotatably secured to the base **19**, and after the workpiece **26** is mounted in the chuck **27**, the chuck **27** and the base **19** are moved together causing the tool to enter the hole **24**. It should be noted that entry of the tool into the hole is possible because since the tool has only one land, the circumferential extent of which is less than 180° and since the tool has a limited freedom of radial movement, it is able to enter the hole without interference with the wall of the hole, but as previously indicated, in the case of relatively deep holes the tool is capable of lateral shifting with respect to base **19** and cap **21** to prevent bending of shank **10** or binding of rib **10A**, if present at the mouth of hole **24**. As either the base **19** or the chuck **27** in Fig. 1 is rotated the cutting edge on the tool will not cut into the wall of the hole. When, however, the tip **14** of the tool is forced against the cam surface **25** of the hole **24**, the tip **14** of the tool will be moved toward the deepest point of apex of the hole and accordingly, toward the axis of the hole.

Generally, the deepest point of the hole lies on the axis of the hole since it is preferable to form the hole **24** with a drill which has a coaxial conical tip thereon. Therefore, as the tip **14** of the tool is forced against the conical bottom **25** of the hole, the axis of the tool will move toward the axis of the hole, feeding the cutting edge on land **12** radially away from the axis into the wall of the hole and forming a recess in said wall. As illustrated in Fig. 4, the cutting edge of the tool lies on a cylinder which is coaxial with the axis of the tool so that when the axis of the tool shank is being moved to coincide with the axis of the hole under the influence of the cam surfaces **23** and **25**, the relative rotation of the tool and the work-piece will form a cylindrical recess in the wall of the hole which is coaxial with the axis of the hole. It is apparent that throughout the entire recess forming operation the cutting edge of the tool receives its lateral support and guidance from the cam surface **25** and the opposing pivot **28**.

It should be noted that since the tool as it cuts into the wall of the hole is progressing axially along the hole until the tip **14** is engaged in the deepest point or apex of the cam surface **25** of the hole, a portion **31** of the recess thus formed remote from the cam surface **25** will have a frusto-conical surface complementary to the surface of the cam surface or taper **25**.

In the alternative form of my invention illustrated in Fig. 11, the tool is used to form a recess in a hole **40** which has been drilled completely through the work piece **41**. Inserted into the hole **40** from one end is a rod **42** carrying a cylindrical block **43** on the end there-

of. The block 43 fits tightly against the walls of the hole 40 and the rod 42 is restrained against movement out of the hole 40 by any suitable means such as a cap on the end of the hole 40. The face 44 of the block 43 remote from the rod 42 has the shape of a convex cone coaxial with the axis of the block 43. The tool of my invention which is used to form the recess in the hole 40 is identical to the tool of Figs. 1 and 2, except that the tip 14 of the tool is provided with a concave surface 45 therein having the shape of a cone coaxial with the axis of the tool. The operation of this tool is similar to the operation of the tool of Figs. 1 and 2, differing in that the point of the surface 44 of the block 43 initially contacts a point on the surface 45 of the tool not on the axis of the tool, and as the recess is formed the point of the surface 44 guides the tool toward the axis of the hole 40 until the point of the surface 44 contacts the vertex of the surface 45 of the tool.

In the alternative form of my invention diagrammatically illustrated in Fig. 5, 10 designates the shank of the tool with its axis at 32, and 12 designates the helical land on the tool with its axis at 33. The cutting edge of the tool is formed along the edge of the land indicated by the line 34 in Fig. 5, and the characters 35 and 36 are used to designate the end points and the center point respectively of the cutting edge. Since the axis 33 of the cutting edge lies on the side of the axis 32 of the shank remote from the cutting edge 34, the points 35 are farther from the axis 32 of the shank than is the point 36.

The surface generated by rotating the cutting edge 34 about the shank 32 is therefore concave as is illustrated in Fig. 6. If the diameter of the hole 24 is less than the smallest diameter of the concave shape illustrated in Fig. 6, the tool will cut a recess having that shape. If the diameter of the hole 24 is greater than the smallest diameter of the concave shape illustrated in Fig. 6 but less than its greatest diameter, the tool will cut two small recesses in the wall of the hole. These two small recesses will have the shapes of the portions of the surface in Fig. 6 which would be internally bounded by a cylinder whose radius equaled the radius of the hole 24. The shapes of these two small recesses would also reflect the shape of a surface complementary to the shape of the bottom 25 of the hole 24, for the same reason as those discussed above.

In the alternative form of my invention diagrammatically illustrated in Fig. 7, like reference characters designate parts similar to the parts described in connection with Fig. 5. Since the axis 33 of the cutting edge lies between the cutting edge 34 and the axis 32 of the shank, the remote points 35 of the cutting edge will be closer to the shank axis 32 than the center point 36 will. Therefore, the shape, illustrated generally in Fig. 8, formed by rotating the cutting edge 34 of this figure about the shank axis will be generally convex.

In the alternative form of my invention illustrated in Fig. 9, 10 designates the shank of the tool with its axis at 32; 12 designates the land with its axis at 33, and 34 designates the cutting edge on the land. The character 37 designates the end of the cutting edge 34 which is adjacent to the tip 14 of the tool, and 38 designates the end of the cutting edge 34 which is remote from the tip 14 of the tool. The end 38 of the cutting edge 34 is closer to the axis 32 of the shank than is the end 37, and all the intermediate points on the cutting edge between the points 38 and 37 are at different distances from the axis 32.

The shape of the surface formed by rotating the cutting edge 34 of this figure about the axis 32 is that of a solid whose opposite walls are downwardly divergent as is illustrated in Fig. 10. It will be noted that this solid includes a cylindrical portion 39 the diameter of which is equal to the diameter of the shank. This portion 39

is generated by a spacer formed integrally with the tool. As the length of the spacer is increased, the distance of the recess, which the tool will cut, from the blind end of the hole 24 is increased.

In the above description it has been assumed that the axis of the conical tip 14 of the tool is coincident with the axis of the tool shank. In the variations of my invention illustrated in Figs. 5 through 10, the reference character 32 has designated the axis of the shank 10. Equally within the scope of each of these variations are the alternatives where 32 designates the axis of rotation of the tool, that is the line connecting the point of the tool tip 14 to the point on the end 28 of the tool, and 33 designates the axis of the cutting edge, regardless of where the axis of the tool shank is located.

The embodiment of this invention which has been chosen for purposes of illustration and which has been described above may be modified in numerous ways while still retaining the basic principles of the invention. Among the several ways in which such illustrated embodiment may be modified may be mentioned the following.

The body of the tool adjacent to the area occupied by the land and rearwardly on the shank from such area may be provided with flutes for the purpose of carrying away chips formed during the recessing operation.

Instead of operating in a blind hole as described it is within the contemplation of the invention to operate the tool also in holes which have been drilled all the way through the work after which an insert is placed in the hole which will present to the tip of the recessing tool a supporting and guiding surface like those which have been described which may be present in the bottom of a blind hole.

The body of the tool may be provided with an oil hole whereby oil to lubricate and/or flush-out chips may be introduced into the hole during the recessing operation.

The cutting edge relied upon to perform the recessing operation may be either straight, that is, it may be a straight-line parallel to the longitudinal axis of the tool or it may be helical. It is within the contemplation of the invention to utilize a plurality of cutting edges which, for example, may be formed on a plurality of longitudinally extending lands provided that the space occupied by such plural lands or by a single helical land is less than 180° of the circumferential extent of the tool in such land area. Such plurality of longitudinally extending cutting edges may be used to produce a plurality of recesses in the wall of the hole. When utilizing a plurality of straight cutting edges, it is within the contemplation of this invention also to have one arranged outwardly with respect to the other so that they progressively perform the cutting operations. The cutting edges themselves may have a rake angle between −20° and plus 20°. Also if the cutting edge is formed on a helical land, such land may be either right hand or left hand, and this tool may be either a right-hand cut or a left-hand cut, as desired.

The complementary guiding and supporting surfaces respectively formed on the tip of the tool and in the bottom of the hole or the face of the insert have been shown in the illustrated embodiment of the invention and described as being substantially conical. It should be noted as previously stated, that the supporting and guiding surface in the bottom of the hole or on the insert may be any surface formed by the rotation of a straight or curved line which in the case of a straight line intersects the axis of the hole at an angle other than 90° line is rotated about such axis. The relationship of the two surfaces may, therefore, be reversed from that shown in the drawing, namely, the point may occur in the work and the complementary depression may be in the tip of the tool. The line whose rotation generates either or both of the supporting and guiding surfaces need not be

straight since it may be curved to the extent of generating substantially a hemisphere on either or both of the elements, and it is not essential that the two surfaces be truly complementary in that if the depression is conical, the end of the point of the tool may be hemispherical and vice versa. Whatever form the respective supporting and guiding surfaces may assume, it is important that they engage and exert a camming or a supporting and guiding effect on the end of the tool as the cutting edges engage the wall of the hole.

In all of the illustrated embodiments of the invention, the cutting edge has been defined in each instance as lying on a clyinder whose axis is either parallel to or coincident with the axis of rotation of the tool. It is within the contemplation of the invention also to form the cutting edges so that they lie on geometric figures other than cylinders as for example, if a straight cutting edge is used, it may be inclined at an angle to the axis of the rotation of the tool.

It is contemplated that in operation the workpiece may be held stationary while the tool revolves or in the case of turret lathe or automatic machine work the tool may be held stationary while the workpiece revolves.

Other modes of applying the principle of the invention may be employed, change being made as regards the details described, provided the features stated in any of the following claims or the equivalent of such be employed.

I, therefore, particularly point out and distinctly claim as my invention:

1. A cutting tool adapted to be freely inserted in a previously-formed cylindrical hole wherein the surface presented by the bottom of said hole is a surface of revolution coaxial with the axis of said hole, which comprises a solid elongated body with: rigid shank by which the tool may be held, the rearward end of such shank being formed with a generally conical surface adapted to engage a mating cam surface; the end of said tool opposite its shank terminating in a generally conical surface coaxial with said shank and engageable with the aforesaid surface in said hole to be suported and guided thereby; a helical land of less than one-half turn on said body; a helical cutting edge formed on one edge of said land, the axial extent of such cutting edge being substantially equal to the axial extent of the recess to be formed by the tool; and a relief in the outer surface of the body of the tool in the area opposite said land, said relief lying inwardly of the surface generated by said cutting edge upon rotation of said tool.

2. A cutting tool for forming a recess in the wall of a previously formed cylindrical hole in a workpiece comprising an elongated rigid body, one end portion of which is adapted to be freely inserted into such hole and the other end portion of which is adapted to be mounted in a tool holder, said one end portion of said body being formed with a radially projecting axially extending cutting edge on one side only of the longitudinal axis of said body, having a relief on the opposite side thereof, and terminating in a generally conical surface which, when eccentrically engaged with a complementary generally conical surface in the hole and when the workpiece and body are relatively rotated and axial pressure is applied is effective to move said body to engage said cutting edge with the surrounding portion of the wall of the hole and form a recess therein, said other end portion likewise terminating in a generally conical surface adapted to form a pivot about which said body moves as aforesaid.

3. A tool assembly for cutting an annular recess in the wall of a cylindrical hole in a workpiece comprising means providing a cam surface adjacent to the wall portion of the hole to be recessed; a tool having an end adapted to be inserted into such hole to any desired depth, the inserted end of said tool being formed with a radially projecting cutting edge, with a relief diametrically opposite such cutting edge, and with a mating tip formed to contact such cam surface at a zone such that, upon relative rotation of said tool and workpiece and exertion of axial force on said tool, the inserted end of said tool is shifted laterally to force such cutting edge outwardly against the wall of the hole to form such annular recess therein, the shank end of said tool also terminating in a tip loosely mating with a cam surface in a tool holder providing a pivot in axial alignment with the center of the cam surface in the hole about which pivot said tool swings as the cutting edge thereof is forced outwardly as aforesaid.

4. The tool assembly of claim 3 wherein said tool holder additionally provides for radial and axial float of the shank end of the tool by means of interfitted surfaces of revolution on said tool and holder.

5. A tool assembly for cutting an annular recess in the wall of a cylindrical hole in a workpiece comprising means providing a cam surface adjacent to the wall portion of the hole to be recessed; a tool having an end adapted to be freely inserted into such hole to any desired depth, the inserted end of said tool being formed with a radially projecting cutting edge that extends helically less than about one-half turn, with a relief diametrically oposite such cutting edge, and with a mating tip formed to contact such cam surface at a zone such that, upon relative rotation of said tool and workpiece and exertion of axial force on said tool, the inserted end of said tool is shifted laterally to force such cutting edge outwardly against the wall of the hole to form such annular recess therein, the shank end of said tool also terminating in a tip mating with a cam surface in a tool holder providing a pivot in axial alignment with the center of the cam surface in the hole about which pivot said tool swings as the cutting edge thereof is forced outwardly as aforesaid.

6. A floating tool holder comprising a base; generally conical tool camming means formed in and disposed at the longitudinal axis of said base; a cap encompassing the portion of said base in which said tool camming means are formed, said cap having therein an opening for passage of the tool in alignment with the longitudinal axis of said tool camming means; tool clamping means in the zone between said opening and said tool camming means, said clamping means having limited freedom of movement toward and from said tool camming means; and restraining means holding said clamping means against substantial rotation relative to said base.

7. A floating tool holder comprising a base adapted to be held in a power driven machine; generally conical tool camming means formed in and disposed at the longitudinal axis of the forward end of said base; a removable cap encompassing the portion of said base in which said tool camming means are formed, said cap having therein an opening, for the passage and radial floating of the shank of a tool, in axial alignment with said tool camming means; tool shank clamping means in the zone of said cap between said opening and said tool camming means, said clamping means having limited radial freedom of movement within the confines of said cap and limited axial freedom of movement toward and from said tool camming means; and restraining means holding said clamping means against rotation independently of said cap.

8. A floating tool holder comprising a base, a cap and tool clamping means enclosed by said cap, said base providing camming means coaxial with it which take the form of a surface of revolution, said cap encompassing said camming means and having therein an opening in the surface opposite said base in alignment with the axis of said camming means through which a tool may be inserted, said cap also loosely enclosing said tool clamping means which preclude the rotation of said tool independently of said tool holder.

9. A floating tool holder which will permit the free

entry of a recessing tool into a previously formed deep hole with its axis parallel to but offset from the axis of said hole and as cutting proceeds will force the tool back into alignment with the axis of said hole, comprising a base; camming means on said base, said camming means taking the form of a surface of revolution coaxial with said base, said base camming means mating with camming means on the shank of said tool; a cap through which said tool may be inserted encompassing said camming means; and tool clamping means which preclude rotation of said tool independently of said tool holder.

10. A floating tool holder comprising a base; camming means on said base, said camming means taking the form of a surface of revolution disposed at the longitudinal axis of the base; a cap encompassing said camming means, said cap having therein an opening for passage of the tool in alignment with the longitudinal axis of the base; tool clamping means between said tool opening and said surface of revolution, said tool clamping means fitting loosely in the space therebetween; and restraining means on said tool clamping means precluding substantial rotation of said tool clamping means relative to said base.

11. A floating tool holder as in claim 10 in which said restraining means take the form of radial projections on said clamping means.

12. A floating tool holder as in claim 11 in which recesses formed in an adjacent surface receive said radial projections.

13. A cutting tool adapted for free insertion in a previously formed relatively deep cylindrical hole in a workpiece to form a recess in the wall of such hole, wherein the surface presented by the bottom of said hole is a cone coaxial with the axis of said hole, which comprises a solid elongated body with: a rigid shank by which the tool may be held, the rearward end of such shank being formed with a conical surface adapted to loosely engage a mating cam surface in a holder and pivot therein; the end of said tool oposite its shank comprising the cutting end and terminating in a conical surface engageable with the aforesaid surface in said hole to be supported and guided thereby, the diametrical extent of said cutting end being less than the diameter of said preformed hole to permit it to freely enter the hole to any desired depth with its axis parallel to the axis of the hole without cutting or scoring the wall of the hole and without distortion of the shank; a helical land of less than one-half turn on the body of said cutting end and a helical cutting edge formed on said land, the axial extent of said cutting edge being substantially equal to the axial extent of the recess to be formed by the

tool; and the outer surface of the remainder of the body of the cutting end diametrically opposite the cutting edge being relieved to provide chip room and to facilitate entrance of the cutting end into the previously formed hole.

14. A cutting tool adapted for free insertion in previously formed relatively deep cylindrical holes to form recesses of substantial axial extent in the walls of such holes without substantial relative axial movement between tool and workpiece, wherein the surface presented by the bottom of said hole is a cone coaxial with the axis of said hole, which comprises a solid elongated body with: a rigid shank by which the tool may be held, the rearward end of such shank being formed with a conical surface adapted to loosely engage a mating cam surface in a holder and pivot therein; the end of said tool opposite its shank terminating in a conical surface engageable with the aforesaid surface in the bottom of said hole to be supported and guided thereby; a cutting portion located on said body between said conical ends having at least one axially spaced land radially extending from said body and a cutting edge on said land the axial extent of which is substantially equal to the axial extent of the recess to be formed, the location of said land and cutting edge on the body being axially spaced from the conical surface on the end opposite the shank to provide any desired location of the recesses between the bottom and the top of the previously formed hole; and the surface of said body diametrically opposite the cutting edge being relieved to provide chip room and to reduce the diametrical extent of said cutting end, thereby facilitating free entrance of the cutting end into said previously formed hole to any desired depth without scoring the wall of the hole and without distortion of the shank.

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