United States Patent

Swisher

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[54] **IMPACT DRIVEN TOOL WITH REPLACEABLE CUTTING POINT**

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[52] **U.S. Cl.** **299/91,** 279/103, 287/126, 299/94

[51] **Int. Cl.** **E21c 37/26**

[58] **Field of Search** 299/91–94; 287/119, 126; 279/102, 103; 175/409, 414–419

[56] **References Cited**

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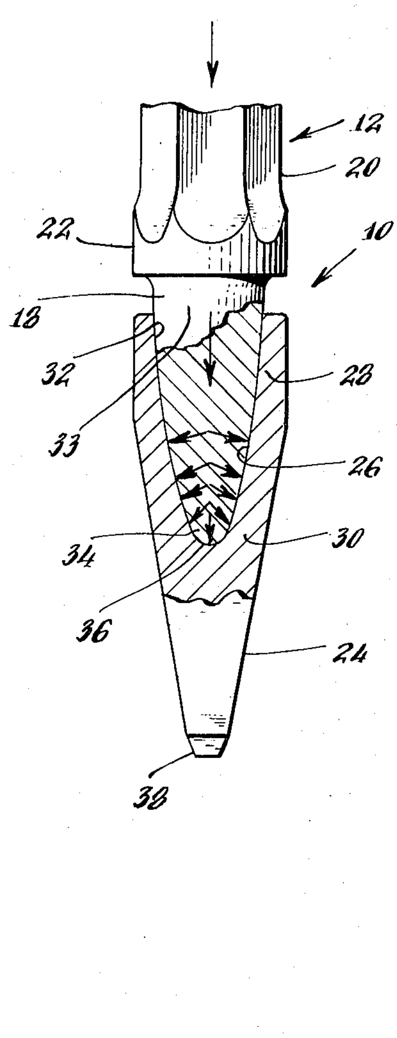
[57] **ABSTRACT**

The shaft and replaceable cutting point of an impact driven tool utilize half an ellipse as the outline of both the external cross-sectional configuration of the driving end of the shaft and the internal cross-sectional configuration of the recess in the tip. The tip is frictionally retained on the shaft driving end for effecting a driving connection therewith.

8 Claims, 4 Drawing Figures



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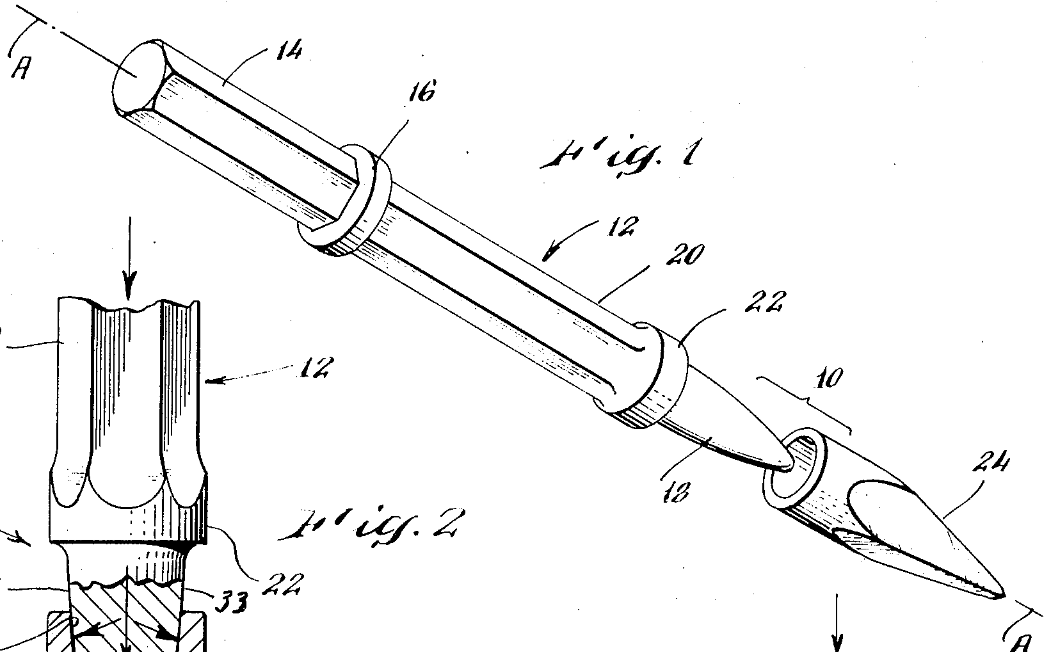

Fig. 1

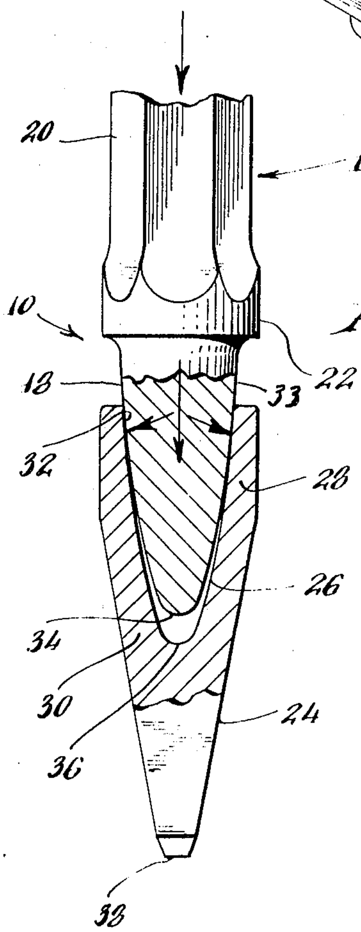

Fig. 2

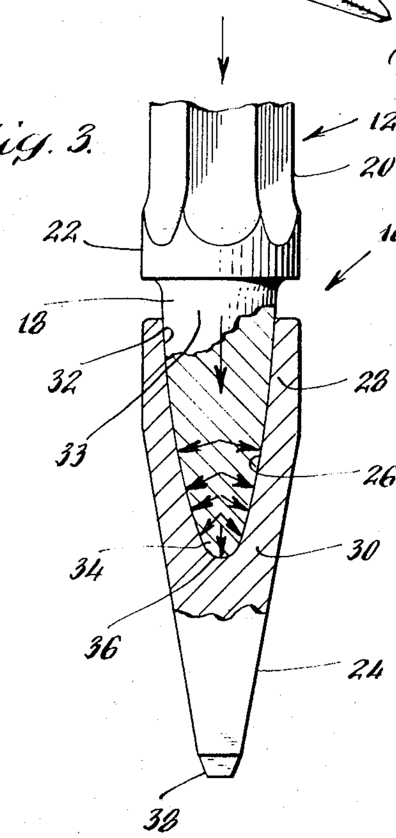

Fig. 3

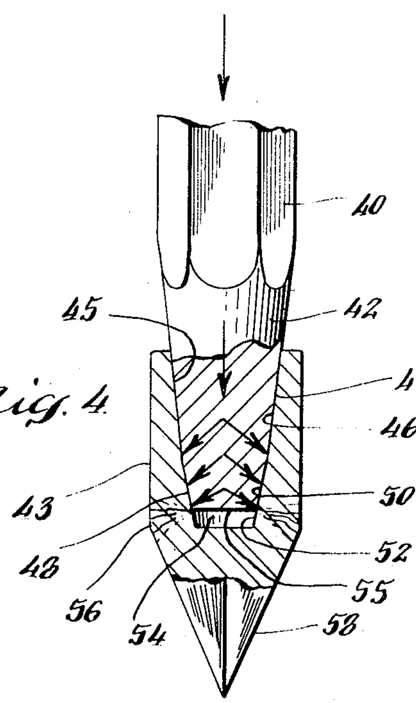

Fig. 4

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IMPACT DRIVEN TOOL WITH REPLACEABLE CUTTING POINT

BACKGROUND OF THE INVENTION

The invention relates to an improvement in impact driven tools having a replaceable, frictionally retained cutting point.

Such a tool is used in combination with a pneumatically powered hammer, drill, or the like, which forcibly drives the tool into reinforced concrete, rocks, and other similar hard materials.

Already known in the art are impact tools having replaceable, frictionally retained tool points. In order to attain a suitable reliable friction fit between the tool point and the driving end of the tool shaft, both the exterior of the driving end and the interior of the recess in the tool point are provided either with one set of tapered interfitting surfaces or two sets of variously tapered interfitting surfaces. Those which utilize one set of tapered surfaces have the disadvantage that when too much taper is used, unwanted separation of the cutting point results and, on the other hand, when a generally shallow taper is used, the cutting point is too tightly interfitted with the driving end of the shaft and can only be forcibly removed from such end which oftentimes results in breaking of the point or the tool shank. Exact dimensioning of the taper angle of such surfaces is difficult and, in addition, the cutting point of such impact tool, of necessity, requires an overall relatively thick-walled construction to adequately absorb and transmit the percussive forces necessary to drive the tool. Those impact tools which utilize more than one set of tapered surfaces employ cutting points which include a portion of relatively thin-walled construction which functions to hold the shank end and the cutting point together, and a portion of relatively thicker construction which serves to transmit the tool driving forces. The latter type impact tools are rather complicated as regards the construction of their multi-tapered surfaces and, as will be appreciated, require extremely severe manufacturing tolerance requirements. Furthermore, such construction is easily subject to stress raiser forming and consequent material fatigue and possible breaking of the shaft or cutting point on account of the complexity of the variously tapered surfaces on the shaft and the cutting point.

SUMMARY OF THE INVENTION

The object of the invention is to overcome the above disadvantages and to provide an improved percussion tool which provides a positive driving connection between the replaceable point and the tool shank, which are rupture-free and securely connected in operation.

Such percussion tool comprises a shaft with a drive end surface formed by a half ellipse of revolution and a cutting point with a recess surface formed by a half ellipse of revolution releasably interfittingly engaging the drive end surface for effecting a driving connection between the shaft and the point formed by continuously curved fully mating surfaces.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of a percussion tool according to the invention, illustrating the shaft and replaceable tip in disassembled condition but axially aligned for assembly;

FIG. 2 is a composite fragmentary view of the tool of FIG. 1, with portions removed to show the respective cross-sectional configurations of the driving end of the shaft and the recessed tip;

FIG. 3 is a composite fragmentary view similar to FIG. 2, showing the tip fully seated and frictionally retained on the shaft;

FIG. 4 is a composite fragmentary view of a known percussion tool with replaceable tip.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to the drawings in which like reference numerals index like parts and with attention firstly directed to

FIG. 1, the percussion tool embodying the present invention and indicated generally at 10, initially is seen to comprise an elongated shaft section 12 having a conventional hexagonal bitter end 14 arranged to be operatively received in the usual tool holding member of a pneumetically powered jackhammer or the like. A peripheral collar 16 bounds the bitter end 14 and is operative to properly lengthwise position the tool 10 in the tool holding member of the power hammer. Provided intermediate the driving end 18 of the shaft 12 and the collar 16 is a hexagonal extended portion 20 which terminates into a gradual upset 22. The driving end 18 of the shaft has a substantially semi-elliptical external cross-sectional configuration, i.e. is formed by a half ellipse of revolution. The shaft is made of a suitably hard material, such as a high speed drill or chisel grade steel.

The cutting point or tip section 24 of the tool 10 is seen to comprise a recess 26 which, as clearly shown in FIGS. 2 and 3, has a substantially semi-elliptical internal cross-sectional configuration substantially corresponding to that of driving end 18 of the shaft. The upper annular wall section 28 of the tip is relatively thin while its lower contiguous wall secton 30 is relatively thicker and of greater area. The tip 24 is initially loosely placed onto the driving end 18 (FIG. 2) with the main axes of the two sections axially aligned along the line A—A, FIG. 1. The thin-walled area 28 of the tip is designed such that when initially assembled it has an inner upper diameter 32 which is somewhat smaller than the external diameter of upper portion 33 of the driving end 18. During operation of the tool 10, and due to the axial percussive forces exerted on the tool 10, the driving end 18 penetrates deeper into the cavity of the tip until 100 percent bearing i.e. full continuously curved mating between the respective surfaces of the tip and driving end is achieved (FIG. 3), in which condition the apex 34 of the shank abuttingly engages the extreme innermost end 36 of the recess 26.

During such penetration of the driving end 18 into the tip 24, the upper thin-walled portion 28 of the tip is impactively slightly stretched by driving end portion 33 and, upon fully seating of the driving end in the tip, wall portion 28 permits a friction or tension retaining action on this end by exerting radial compressive forces thereon that grippingly hold the shaft and the tip together, even under the most adverse conditions, including heavy pneumatic hammer driving vibration.

The dimension of the inner diameter 32 of thin-walled portion 28 is further advantageous in that it substantially reduces the possibility of a stress raiser forming in adjacent shank portion 33 when the shaft end is fully seated in the tip.

During operation of the tool, and as a result of the maximum mating surfaces of the tip and driving end, the axial percussive forces exerted on the tip by the shaft have maximum transmission area between the respective surfaces in the region of thick-walled area 30 of the tip and between the apex 34 of the shaft and the innermost end 36 of the tip. Such maximum transmission of the tool driving forces is indicated by the arrows in the tip in FIG. 3.

This maximum surface mating between the tip and shaft end further provides maximum transfer areas for and even dissipation of shocks and frictional heat generated during operation of the tool.

The surfaces of the driving end 18 and recess 26 are dimensioned such as to enable easy initial installation of the tip on the shaft and also its later removal therefrom. Such surfaces are mathematically generated by intersecting a cone with a plane which forms a half ellipse or parabola which is the locus of the points in this particular embodiment. It is self-evident that in addition to such particular half ellipse or parabola other sections may be generated by utilizing different parabolas, ellipses and hyperbolas, each of which could be used, i.e. revolved to achieve surfaces that lie within the framework of the invention:

The tip 24 terminates into an apex 38 which constitutes a blade-shaped cutting edge and is configurated such that during operation of the tool the axial percussive forces are advantageously distributed over and dissipated from the entire width of the cutting edge to prevent premature material failure of the tip.

For practical purposes and by way of example, the tip of the invention can be manufactured from AISI No. S1, a Tungsten-type shock resistant steel. With proper heat-treating, the point area of the tip can be hardened to a Rockwell hardness of 56–62 Rc-Scale which has been found extremely favorable for improving the durability of the tip. The shank area of the tip preferably is of a lesser Rockwell hardness, for example 20–25 C-Scale, which permits a predetermined interference fit between the mating surfaces of the tip and the shaft to be realized without the risk of possible breakage of the tip resulting from an excessive hardness of the shank portion of the tip.

The gradual upset **22** of shaft **12** serves to ease the abrupt transition between the larger core diameter of extended hexagonal portion **20** of the shaft and the smaller diameter of upper portion **33** of driving end **18**.

By utilizing the semi-elliptical outline for both the external cross-sectional configuration of the shaft driving end and the internal cross-sectional configuration of the tip recess, considerable advantages are obtained in addition to those already hereinbefore described. For example, as the tip wears and the material properties deteriorate due to shock, frictional heat, abrasion, and the like, the shank moves deeper into the cavity which enlarges the mating area between the respective surfaces and thereby reduces the unit stress. The possibility of stress raiser forming is furthermore greatly reduced as a result of the absence of abrupt changes in the diameters of the mating surfaces at any given point.

The advantages of the invention may be best understood by a discussion of a well known prior art percussive tool shown in FIG. **4**. This percussive tool is seen to comprise a shank portion **40**, a driving end **42** and a recessed replaceable cutting point or tip **43** fitted on the end **42**. Both the driving end **42** and the recess **45** have first and second flat surfaces, **44**, **48**, and **46**, **50**, respectively, each having an angular disposition relative to the main axes of the shank and tip. In assembled condition of the shaft and tip, the first surfaces, **44** and **46**, interfittingly engage and constitute a first set of tapered portions having a smaller taper angle, and the second surfaces, **48** and **50**, interfittingly engage and constitute a second set of tapered portions having a greater taper angle. The second surface **50** of the tip is substantially longer than complimentary surface **48** of the shaft leaving a non-engaged portion **52** forming a void **54**, so that the shank does not bottom in the tip. The first set of interfitted surfaces, **44** and **46**, serve to establish radial compressive forces that grippingly hold the tip and shaft together and the second set of interfitted surfaces, **48** and **50**, serve as the transmission area for the axial percussive or tool driving forces. This construction is disadvantageous in that it does not attain 100 percent bearing of the mating surfaces and, consequently, does not provide maximum transmission of percussive forces due to the presence of void **54** in an area extremely essential for the transmission of such forces. Since no mating of surfaces takes place in the area between the extreme shank end **42** and the innermost end of recess **45**, unavoidable movement of the end **42** into the recess **45** results during operation of the tool, and as the shank end penetrates deeper into the tip, considerable pressure is exerted onto the inner tip surface **50** by the lowermost peripheral edge **55** of driving end **42**. This pressure ultimately results in a fulcrum of vector forces set up in the region of edge **55**, which, coupled with percussive vibration and frictional heat results in fatigue of the tip material and ultimate breaking of the tip. Such breaking of the tip has been found to usually take place in that region of the tip indicated by reference numeral **56** where the vector forces are most damaging. A further disadvantage of this prior art percussive tool resides in the fact that the void **54** restricts the transfer of heat in an area most subject to frictional heat generated during use of the tool. The intense heat thus concentrated between the extreme shank end and the innermost end of recess **45** anneals and softens the tip and shank end. Moreover, the heat weakens the retaining and stopping properties of the mating surfaces, allowing the shank to penetrate considerably deeper into the tip than its design allows, which, again, results in material fatigue and ultimate breaking of the tip. A still further disadvantage is that the tip **43** has an inner upper cavity diameter which generally corresponds with the outer diameter of the shank end **42**, which considerably enhances the possibility of stress raiser forming in the shank in the upper cavity region of the tip. Also disadvantageous is the sharp-pointed outline of the apex **58** of the tip **42** in that due to its extreme shape, the axial percussive forces work directly at that point causing premature material failure resulting from an extremely poor heat and force dissipation.

From the foregoing description of the invention and the discussion of the prior art percussive tool, the numerous advantages and improvements incident to the invention will now be apparent to those skilled in the art.

Accordingly, the above description of the invention is to be construed as illustrative only rather than limiting. This invention is limited only by the scope of the following claims.

I claim

1. An impact driven tool comprising an elongated shaft having a driving end with a single substantially continuously curved conical surface formed by revolving a curve, and a cutting point having a recess with a single substantially continuously curved conical surface formed by revolving a curve concentrically frictionally interengaging the shaft end surface such as to provide total mating of said surfaces relative to each other and to effect a positive driving connection between said shaft and said cutting point.

2. The tool as define in claim **1**, wherein said driving end has a substantially semi-elliptical external cross-sectional configuration and wherein said recess has a substantially semi-elliptical internal cross-sectional configuration substantially corresponding to said external configuration of said driving end.

3. The tool as defined in claim **1**, wherein said surfaces of said recess and said driving end include base portions and vertexes interengaging each other.

4. The tool as defined in claim **1**, wherein said cutting point includes a wall area surrounding said driving end, said wall area including a relatively thin-walled portion impactively slightly stretched by said driving end for effecting radial compressive forces that frictionally retain said cutting point on said driving end, and including a relatively thick-walled portion cooperating with an adjacent portion of said driving end for the transmission of percussive forces from such adjacent drive end portion to said thick-walled portion.

5. The tool as defined in claim **4**, wherein said thick-walled portion of said wall area includes the innermost end portion of said recess, and wherein said adjacent drive end portion includes the apex of said driving end abutting said innermost end portion.

6. The tool as defined in claim **1**, wherein said cutting point includes an outer peripheral surface having a base portion at one end and terminating into an apex at the opposite end, and said apex constituting a blade-shaped cutting edge.

7. The tool as defined in claim **1**, wherein said cutting point includes a hardened point area and a relatively less hardened wall area surrounding said driving end.

8. The tool as defined in claim **1**, wherein said shaft includes an extended hexagonal portion adjacent said driving end, said extended portion having a core diameter larger than the largest diameter of said driving end, and wherein said shaft further includes a gradual upset portion intermediate said extended portion and said driving end to ease the abrupt transition between such varying diameters.

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