Screw Socket

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This invention relates to screws and more particularly to screw head recesses and to the particular configuration of the recess walls whereby improved cooperation with a screw-driver is provided for the several purposes of retaining the screw on the driver bit for placement in awkward positions, for providing more effective driving torque, less throw-out pressure and superior results when used with any form of hand or power screw-driver.

It is a general object of the present invention to provide a novel and improved form of screw head recess.

More particularly it is an object of the invention to improve the conventional form of Phillips screw head recess whereby additional driving torque may be applied to the screw with less resulting throw-out force axially of the screw-driver.

Another object of the invention consists in the provision of an improved Phillips type recess wherein the walls to which the driving force of the bit is applied are so angled as to cooperate with the driving walls of the screw-driver bit wings to provide driving torque up to that capable of destroying the thread on the screw before the throw-out force becomes great enough to force the driver out of the recess.

As a corollary to the above object may be mentioned the disposition of the previously mentioned recess walls to accelerate withdrawal of the driver on its continued rotation when the screw has stopped moving and the driving torque is slightly reduced whereby defective power drivers are prevented from reaming the screw recess and so destroying the screw.

An important feature of the present invention resides in the compound angular disposition of the side walls of the recess groove whereby the results mentioned above are attained without adding to the difficulties of forming the recesses by a cold heading operation.

A further and extremely important feature of the invention consists in the relative dispositions of the several surfaces of the recess in relation to the bit portion of the driver whereby wedging cooperation for the purpose of retaining the screw on the driver is obtained under all conditions of wear on the driving surfaces of the bit blades so that irrespective of the wear conditions of those portions of the blade exerting the driving effort a screw may be securely held on the blade for insertion in places difficult to reach.

Other and further features and objects of the invention will be more apparent to those skilled in the art upon the consideration of the following specification and the accompanying drawings wherein is disclosed a single exemplary embodiment of the invention with the understanding that such changes may be made therein as fall within the scope of the appended claims without departing from the spirit of said invention.

In said drawings:

Figure 1 illustrates a screw and screw-driver constructed according to the present invention shown united for supporting the former from the latter for insertion by one hand or in difficult positions;

Figure 2 is a plan view on an exaggerated scale of the head of a screw provided with an improved recess constructed in accordance with the present invention and showing what will hereinafter be termed the "horizontal" wing angle;

Figure 3 is a vertical section taken on line 3—3 of Figure 2 or axially of the screw shank and showing the interior arrangement of the recess walls and ribs;

Figure 4 is an end view on a somewhat reduced scale of the bit portion of a screw-driver for cooperation with a recess such as shown in Figures 2 and 3;

Figure 5 illustrates the screw-driver of the form shown in Figure 4 cooperating with a recess of the type illustrated in Figures 2 and 3 shown in axial section on line 5—5 of Figure 4;

Figure 6 is a view similar to Figure 2, but showing the screw-driver bit positioned in the recess and sectioned in the plane of the top of the screw head;

Figure 7 is a vertical axial section on line 7—7 of Figure 6 illustrating, with that figure, the clearance between the end walls of the wing portions of the screw-driver bit and the grooves in the head recess;

Figure 8 is a section on line 8—8 of Figures 6 and 7;

Figure 9 is a vertical section on line 9—9 of Figure 3, showing what will hereinafter be termed the "vertical" angle of a recess wing or groove; and

Figures 10, 11 and 12 are diagrams illustrating the angular relationships hereinafter mentioned.

For years following the advent of the wood screw and its companion the machine screw, the conventional coupling between the head of the screw and the bit of a screw-driver was formed by a simple kerf cut entirely across the screw head and adapted to receive the substantially flat blade of a screw-driver. The walls of the kerf...
were parallel to each other in most cases since the cutting was done with a small circular saw, but the engaging walls of the driver blade included an appreciable angle, not only to prevent weakening the blade but for convenience in its construction, for the usual blade was flattened from a circular rod to provide additional width and to reduce the thickness. Sharpening, after wear, should normally follow the original surfaces but the tendency was to increase the included angle to reduce the amount of material necessary to be removed in the sharpening operation.

This type of coupling was subject to numerous faults, not the least of which was the lateral slipping of the driver through the open ends of the kerf resulting in the marring of the material to which the screw was being applied. When considerable resistance to the driving of the screw was encountered, the substantial taper of the driver blade and the relatively small contact of the same with the kerf, which in most cases, was considerably wider than the thickness of the blade, resulted in a high throw-out force tending to move the driver axially away from the screw. This again caused slipping and marring. When screws were driven almost entirely by hand, conditions were not so bad, but with the increased use of power screw-drivers they were materially augmented because of the higher speeds of driving and the greater torque applied. Even though greater torque was available for driving, no greater force could be applied manually to the screw-driver to hold the same in the kerf against the resultant increase in the throw-out force.

A number of efforts were made to change the type of head recess in screws better to accommodate the screw-driver to eliminate some of the above difficulties and to provide other advantages such as the ability to attach the screw to the driver blade temporarily for inserting the same in remote or difficulty accessible positions. The type of recess which received the most favorable commendation and which has now become almost standard, particularly for use on assembly lines and with both stationary and portable power drivers is that known as the Philips. It comprises a recess in plan of general cruciform shape including alternate grooves and intermediate ribs adapted to respectively accommodate wings and channels on a screw-driver bit. Such a recess is shown in Philips Patent 2,046,839 of July 7, 1936.

With the continued and increased use of these recesses in particularly difficult situations such as for very large sized screws and for the so-called self-tapping screws which are driven into sheet metal or even into the heavy solid metal in un-tapped holes sized considerably less than the shank diameter of the screw, excessive driving torques were sometimes required which increased the operator's difficulty of holding the driver against axial displacement. This resulted in spite of the improvements of the Philips recess over the conventional kerf because there was a considerable inclination between the shank axis and the line of cooperation between each wing of the driver blade and the corresponding side wall of the recess which produced an axial thrust component, increasing with the driving torque increase and not adequately resisted by the friction resulting from the driving torque between the recess and the cooperated surface.

With one type of the Philips recess the screw-driver bit was made to exactly conform to all of the side walls of the recess each of which was inclined to the screw axis. The extreme closeness of fit produced wedging which was relied on to initially hold the screw on the driver bit. In another form the included angle measured vertically between the bit wing walls was greater than the included angle between the walls of the grooves receiving the wings and a wedging action of a different type was called on to hold the screw on the driver for initial insertion. In both cases, however, this theoretically correct arrangement proved to be satisfactory only when the driver bits were new and nearly perfect.

The major wear on the driver bits takes place on the driving faces of the wings and to an increased degree radially outwardly thereon. As this wear increases beyond the thousandth of an inch or so originally provided on the walls which cooperate essentially for supporting the screw on the driver bit it becomes sufficient to permit the driver to bottom in the recess and the latter must be discarded or remade entirely and one of the big advantages of the Phillips recess is voided. This necessary rapid replacement of driver bits makes for excessively costly operation.

In accordance with the present invention both the disadvantage of excessive throw-out force and loss of engaging contact between the bit and head recess as a result of wear is eliminated by certain modifications in the recess and in the driver while otherwise improving the Phillips characteristics.

To appreciate the improvements reference should be had to the accompanying drawings showing in detail the disposition of the several recess and driver bit surfaces and their manner of cooperating to achieve the desired results. Figure 1 shows a more or less conventional hand screw-driver 10 and a wood screw 11 held together solely by the cooperating friction between the surface of the Philips type bit and the walls of the Philips type recess in the flat head of the screw. For purposes of simplicity, this invention will be described and shown in connection with the standard so-called flat headed screw although it is obviously equally applicable to all of the other well known types of screw heads and even may be applied to headless screws such as coned set screws and the like. The shape of the head has no bearing whatsoever on the shape or the manner of use of the recess.

The recess is shown in detail on an enlarged scale in Figures 2 and 3 and generally bears the reference character 12. This recess is of polygonal form in plan and may best be defined as a cruciform, including a center portion and a plurality of radiating channels or grooves 14 and an equal number of ribs and ridges 15 intermediate the channels. The walls of these ribs and ridges which are each preferably four in number define the side outlines of the recess and connect with a generally conical or concave bottom 16. The center portion of the recess is open throughout as clearly seen. Each groove or channel is defined by a pair of triangular side walls 18 and a sloping bottom wall 19 which because of its intersection with the surrounding groove wall of the recess in the outer side of the channel. The wall 19 merges with the concave bottom wall 16 at 20 and extending upward from the ends of this junction are the edges 21 defining the junctions of the walls 18 each with one of the plurality of rib walls 22 which are intermediate the walls 19 of adjacent grooves. The several rib walls 22 between each two grooves meet each other to form a generally
The walls of the several grooves are the ones which, in the driving, engage with the corresponding flanges or wings on the screw-driver bit, which will be later described. These walls provide the surfaces for transmitting the driving or removing forces to the screw. Each of the walls 18 is a plane. This plane is sloped on a compound angle. The intersections of the two planes 18 connecting the side walls of a wing groove with a plane at right angles to the axis of the screw shank, or with the surface of the head of a flat-headed screw, include an angle of between 2° and 4° as indicated in Figure 2 (2° as shown in Figure 10). Since this angle is measured in a plane at right angles to the axis of the screw it is convenient for the purposes of this description to refer to it as a "horizontal" angle. The apex of the angle in question, of course, lies at a point beyond the perimeter of the screw head. The lines 25-12B in Figure 2 represent the intersection of the walls 18 with the plane of the flat-head of the screw.

The planes 18 also converge toward each other downward from the surface of the head as clearly seen in Figures 3 and 11 where the intersection of the walls 18 is shown. The intersections of the two planes 18 with an imaginary plane X—X (Figure 10) extending parallel to the axis of the screw and at right angles to the radial plane of symmetry of the groove is approximately 8° to 10° as shown in Figure 11 and varies in accordance with the purpose for which the screw is made. Such intersections are shown dotted in Figure 11. It will be appreciated that if the planes 18 are extended until they form a dihedral angle of approximately 9° to 10°, their intersection will be a line Y—Y which will intersect the axis Z—Z of the screw beyond the bottom of the recess and at an angle varying between approximately 70° and 74° as seen in Figure 12.

The rib walls 22 flare outwardly from their intersections with the concave bottom of the recess at very moderate angles, the exact slope of which is unimportant for the purposes of the present invention.

The bottom wall 19 of each groove slopes outwardly and upwardly at an acute angle to the axis of the screw as clearly seen in Figure 3. This slope is formed during the heading operations on the screws by suitable punches, and sufficient slope is provided to each wall of the recess to permit adequate draft for the punch and to facilitate the flow of metal in the head during the punching operation. The recesses by virtue of this type of manufacture are constructed within precision limits so that they may accurately receive a similarly formed and sized bit on a screw-driver.

Such a screw-driver is shown in end plan in Figure 4 and in elevation and partial center section in Figure 5. The bit 30 shown in Figure 1 or with means to be gripped in the chuck of a power driver. In general, it may be said that the bit point at the end of the screw-driver is formed complementary to the recess in which it will be received, with certain exceptions which will be hereafter defined. Each size of screw-driver bit is constructed to operate with varying depths of recesses. These vary with the sizes of screws in which they are formed in order to provide adequate bearing surfaces for transmitting the torque necessary to drive the screws. On the extremely small or large screws it has been found desirable to make the size of recess proportionately smaller or larger, thereby necessitating the use of a smaller or larger bit whose dimensions correspond to those of the recess in the same manner as outlined herein. Looking now at Figure 4 it will be seen that each driver is provided with wings 33 equal in number and spacing to the grooves 14 in the screw head recess and intermediate these wings are channels 34, portions of which are provided with walls 35 complementary to the rib walls 22 of the recess. The bottom 37 of the screw-driver is formed with a conical point of similar shape to the bottom 16 of the recess.

The side walls of each bit wing 33 which correspond to and cooperate with the groove walls 18 are formed to the exact same angular disposition in both the vertical and horizontal planes. The wall of the wing corresponding to the outer wall 19 of the groove is likewise angled the same as this wall. The walls 35 of the channels in the bit are of the exact same angular disposition as the walls with which they cooperate, i.e., 22 in the recess. It might be considered from the above that the bit-end is the exact counterpart of the recess, but this is not quite true.

The channel walls may be considered as spaced apart laterally on opposite sides of the bit just sufficient to be the first to engage with the rib walls of the recess when the driver is inserted and their spacing apart is such as to first prevent bottoming of the driver in the recess and, second, to prevent the wings from being inserted into contact with the walls of the grooves in the recess. Looked at in another light it may be considered that the wings are thinner than the grooves and hence do not engage the walls of the latter when the driver is stopped by having its channel walls engaging the rib walls of the recess. In any event, as illustrated in Figure 6, contact between the driver and the recess occurs over the full areas of the surfaces indicated by the arrows while for the whole of the rib and groove sections there is a very slight and uniform clearance preferably of about .001 in.

This appears in Figure 6 shown only at the surface of the head. Figure 7 shows the clearance at 40 between the outer or bottom walls of the driver ribs and the groove bottoms 19, while Figure 8 shows in section a rib fitting in a groove with a continuous uniform clearance on all sides.

The result of this arrangement is that on introducing the driver into the screw recess a wedging action takes place only on the rib walls of the recess and this wedging is adequate to hold the driver and screw engaged sufficiently tightly so that the screw can be inserted in any position by its hold on the driver. The only surfaces of the driver which are subject to wear from continued use are the faces of the wings which engage the walls 18 of the recess grooves to produce the driving torque. Since these driving faces are not relied on for retaining the screw on the driver the retention qualities remain good even though the driver is so badly worn on the wings that it needs replacement. Because of the adequate clearance between the rib tops and the bottom of the recess, as shown at 42 in Figure 7, a small amount of wear on the engaging surfaces between the driver and the recess is permitted before the driver bottoms and prevents this holding engagement. Any slight additional movement of the driver into the recess
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... reduce the clearance between the wing walls and those of the sides of the grooves because of their very slight vertical angularity.

This .001 inch clearance between the driver walls and the corresponding walls of the grooves is quickly taken up when driving torque is applied and the wings are forced against the driving walls of the recesses where they make their maximum frictional engagement at their greatest radius, thereby offering the best driving effort for both the metal of the screw head and that of the driver.

Axial thrust endeavoring to force a screw-driver out of the screw recess as a resultant of the driving torque is usually referred to as "throw-out" and is present in greater or less degree in every type of screw recess and driver unless zero vertical angle is used on all engaging driving faces or the friction between the driver and recess walls is greater than the axial component of the driving torque. This throw-out is reduced in the present construction to the lowest factor consistent with good engineering principles and commercial operation as a result of the small included horizontal and vertical angles between the walls of the recess grooves and bit wings. The exactness of contact between these cooperating surfaces provides a considerable friction factor which serves to counteract the remaining component of axial thrust so that under extreme driving conditions where the friction is increased by the added torque the operator is not required to exert any considerable effort to retain the driver bit in the recess.

Most power screw-drivers are provided with a slipping clutch which may be adjusted to begin slipping before the driving torque is great enough to break the screw or to ream the recess, but unfortunately these clutches are subject to a number of variables so that they cannot always be given or maintain an exact setting. It is the tendency of the operators to set them to slip at too great a torque rather than too little to be sure of driving all screws completely home. The small amount of throw-out retained in the present combination of recess and driver bit is proper to overcome the difficulties explained at the beginning of this specification. Thus there is sufficient throw-out effort to force the driver clear of the screw recess on the application of excessive driving torque and thereby prevent reaming or marring of the recess and any damage to the driver blade.

If power screw drivers were perfect and clutches gave no trouble and the operators were always on the job, it would be possible to provide zero vertical angles in the recess grooves, but where these have been tried, unsatisfactory results on assembly lines have always prevailed since the drivers were not thrown out in time to prevent spoiling of the screw or bit or both when the clutches failed to slip. The superior results achieved by the present construction are dependent upon the proven characteristics of the Phillips recess with changes including reducing the horizontal included angle of the groove walls from approximately 14° to an angle not greater than 4°, and the concomitant reduction of the vertical angle between the groove walls to not greater than 10°.

The improved recess and screw-driver bit are available for all types of screws, even those having the shallowest heads. The area of the wings eliminates the need of great depth of penetration and is so remote from the screw-axis as to materially decrease the unit pressure. This also increases the strength of the screw-head. The changed horizontal angle provides relatively large openings between the recess ribs increasing the ease of insertion of the bit, increases the bit life, locates the center of pressure on the wing farther away from the axis and materially decreases the possibility of burring at the mouth of the recess.

Having thus described the invention, what is claimed as new and desired to be secured by Letters Patent is:

1. A screw having a socket extending into its upper end along its longitudinal axis and comprising a central portion and grooves radiating therefrom, the side walls of said grooves converging toward each other outwardly of the said central portion so that their intersections with a plane normal to said axis define an angle not greater than 4° nor less than 2°.

2. A screw having a socket extending into its upper end along its longitudinal axis and comprising a central portion and grooves radiating therefrom, the side walls of said grooves converging toward each other outwardly of the said central portion so that their intersections with a plane normal to said axis define an angle not greater than 4° nor less than 2°. Said side walls also converging toward the opposite end of the screw such that their intersections with a plane parallel to the axis and transverse to the groove define an angle not greater than 10°.

3. A screw having a socket extending into its upper end along its longitudinal axis and comprising a central portion and grooves radiating therefrom, the side walls of said grooves comprising plane surfaces converging toward each other outwardly of said central portion at an included angle of substantially 8°½ - 10°½, the intersection of said surfaces with a plane normal to the said axis defining an angle not substantially less than 2° nor substantially greater than 4°.

4. A screw having a socket extending into its upper end along its longitudinal axis and comprising a central portion and grooves radiating therefrom, the side walls of said grooves comprising plane surfaces converging toward each other outwardly of said central portion, the line of intersection of said planes intersecting said axis at an angle of substantially 70°, the included angle between said plan s being such that torque applied by a screw-driver of complemental shape to said recess and of sufficient length to drive said screw under normal conditions of resistance does not produce a substantial throw-out force axial of the screw-driver.

5. A screw having a generally inwardly tapering recess extending into its upper end along its longitudinal axis, the walls of said recess comprising alternate ribs and grooves converging toward a concave bottom, each groove having tapered side walls and a tapered bottom wall and being of gradually increasing width from the outer edge thereof toward the axis, the intersection lines of the side walls with a plane normal
to the axis including an angle of between 2° and 4°, each rib having a plurality of contiguous walls intermediate the grooves and merging at an angle with the edges of the side walls of the adjacent grooves, said rib walls flaring from the concave bottom at an acute angle to said axis.

7. A screw having a generally inwardly tapering recess extending into its upper end along its longitudinal axis, the walls of said recess comprising alternate ribs and grooves converging toward a concave bottom, each groove having tapered side walls and a tapered bottom wall and being of gradually increasing width from the outer edge thereof toward the axis, the intersection lines of the side walls with a plane normal to the axis including an angle of between 2° and 4°, the side walls of the grooves also converging from top to bottom with an included angle between the lines of intersection thereof on a vertical plane of substantially 8° to 10°, each rib having a plurality of contiguous walls intermediate the grooves and merging at an angle with the edges of the side walls of the adjacent grooves, said rib walls flaring from the concave bottom at an acute angle to said axis.

8. A screw having a generally inwardly tapering recess extending into its upper end long its longitudinal axis, the walls of said recess comprising alternate ribs and grooves converging toward a concave bottom, each groove having plane, tapered side walls and a tapered bottom wall, the side walls of each groove converging toward each other outwardly and downwardly so that their intersections with a plane normal to the screw axis defines an angle of 2° to 4° and their intersections with a plane parallel to the axis and transverse to the groove define an angle not greater than 10°, each rib having a plurality of contiguous walls intermediate the grooves and merging at an angle with the edges of the side walls of the adjacent grooves, said walls flaring outwardly from the concave bottom at an acute angle to said axis.

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

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<thead>
<tr>
<th>Number</th>
<th>Name</th>
<th>Date</th>
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<tbody>
<tr>
<td>2,046,837</td>
<td>Phillips</td>
<td>July 7, 1936</td>
</tr>
<tr>
<td>2,058,197</td>
<td>West</td>
<td>Oct. 20, 1936</td>
</tr>
<tr>
<td>2,206,887</td>
<td>West</td>
<td>Sept. 29, 1942</td>
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