Dec. 1, 1959 C. H. ANSINGH 2,914,984

SCREW SOCKET OF PYRAMIDAL CROSS SECTION
TERMINATING IN A CONICAL BOTTOM WALL

Filed Sept. 20, 1956 2 Sheets-Sheet 1

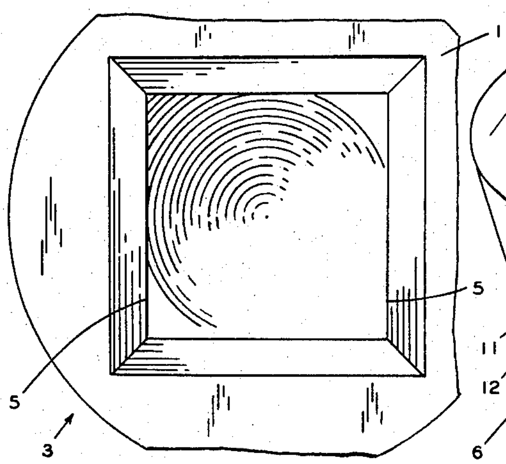

Fig. 1.

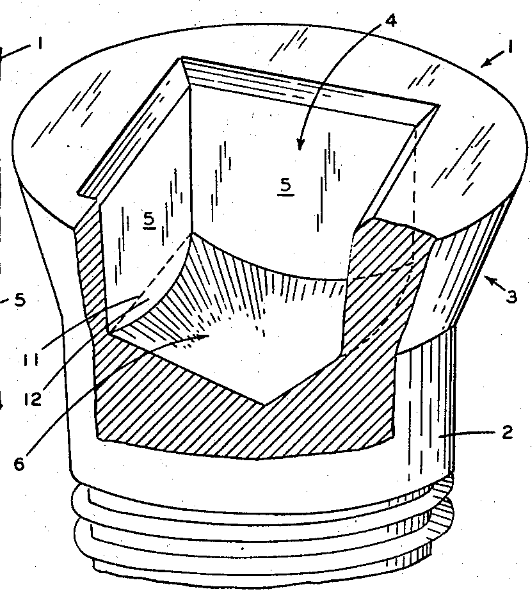

Fig. 3.

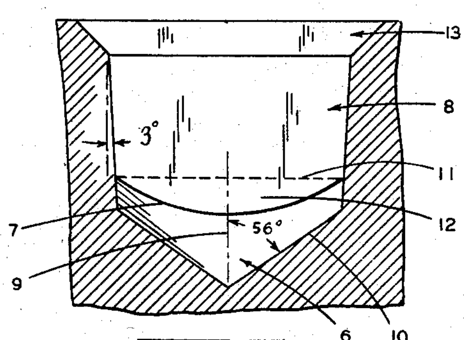

Fig. 2.

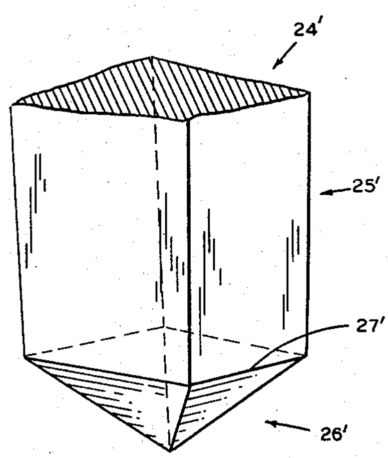

Fig. 5.

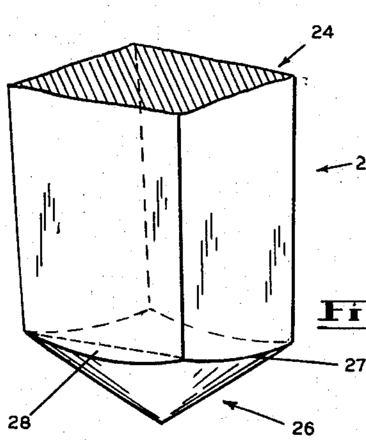

Fig. 4.

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SCREW SOCKET OF PYRAMIDAL CROSS SECTION TERMINATING IN A CONICAL BOTTOM WALL

Filed Sept. 20, 1956 2 Sheets-Sheet 2

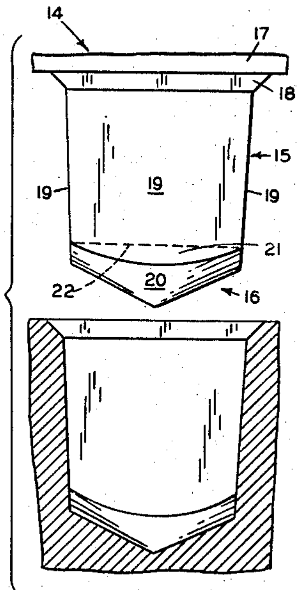

Fig. 6.

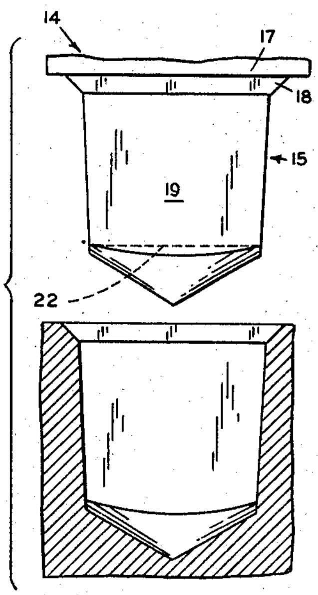

Fig. 7.

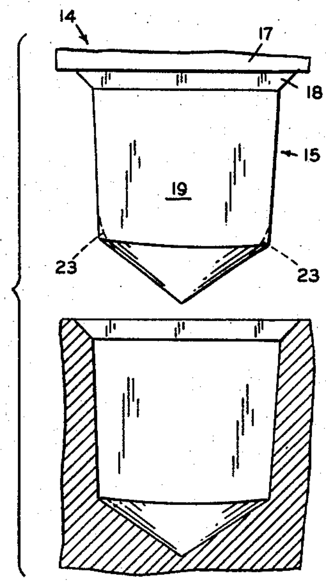

Fig. 8.

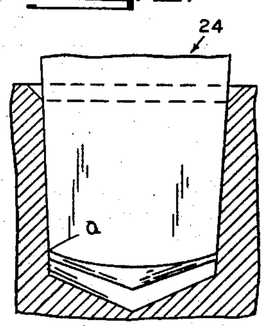

Fig. 9.

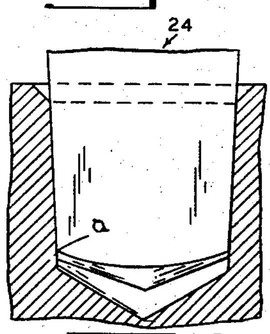

Fig. 10.

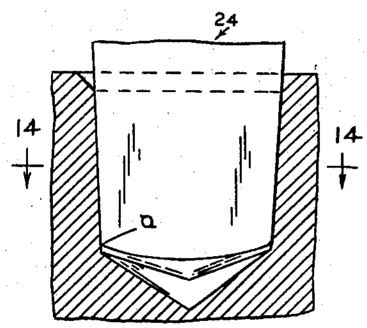

Fig. 11.

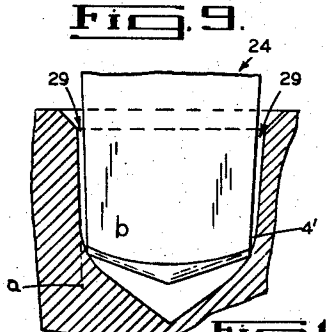

Fig. 12.

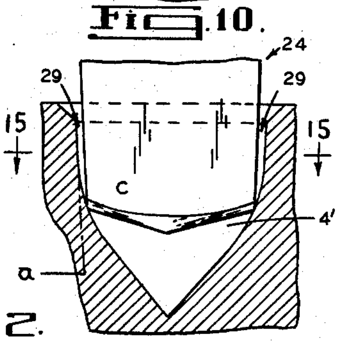

Fig. 13.

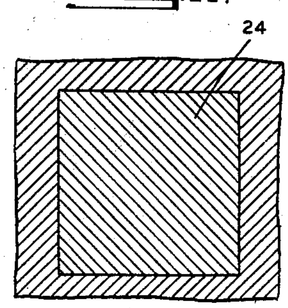

Fig. 14.

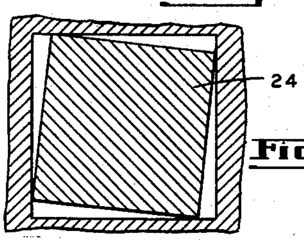

Fig. 15.

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SCREW SOCKET OF PYRAMIDAL CROSS SECTION TERMINATING IN A CONICAL BOTTOM WALL

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Application September 20, 1956, Serial No. 611,016

2 Claims. (Cl. 85—45)

This invention relates to improvements in screws and more particularly to screws of the square or Robertson socket type and to driver bits therefor.

This application is a continuation-in-part of application Serial No. 507,360, filed May 10, 1955, now abandoned.

There are presently several socket type screws sold commercially, and one of the universally accepted type is provided with a "square" socket which terminates in a pyramid point. The driving bit of the screw driver is likewise provided with a mating square shank terminating in a pyramid point to seat in the socket.

While this particular socket and driving bit have been widely used for many years, both the manufacture of the screws and screw drivers or bits and their use have presented long standing problems which, until the event of the present invention, have not been overcome.

One of the problems which has been experienced is that it has been impossible to maintain precisely accurate socket shapes and dimensions and in the field the user is faced with the problem of driving screws, the sockets of which have wide dimensional and shape differences. As a result to enable the screws to be driven a driver bit must be provided to fit the smallest socket dimensions and such a driver will not provide a proper driver bit to socket engagement. The result is a cornering effect as hereinafter more fully explained which limits the amount of torque that can be applied in driving the screw.

In addition the heading of the screws to form the sockets with the pyramidal points has caused the serious problem of setting up excessive points of strain at the four sides of the pyramid causing a misshaping of the head producing a bulging at the four sides. Also in the process of cold heading the screws in the event the punch was not accurately located with respect to the blank the punch would be non-uniformly stressed at one or other of the sides, placing undue stress, for instance, on one of the sharp angles of the punch either causing breakage or wearing of these angles or corners to materially shorten its tool life and providing high cost screw manufacture.

With respect to the driving bit, the pyramidal point has required machining operations. Usually each angle of the pyramid is formed by a ganged milling operation, and even with the greatest of care it is substantially impossible to produce a pyramid point which actually terminates in a point but rather in a flat nose having four corners. In the production of the pyramid point, moreover, a multiplicity of sharp angles and corners are formed (in addition to those at the nose) and all of these surfaces are readily fractured and subject to wear to greatly shorten the useful life of the driver.

Thus, while the prior art square socket screws have offered many advantages over the slot head type of screw and more complicated recess formations from the standpoint of improved driving torque and the minimizing of slippage of the driver bit off the screw head, nevertheless, because it has heretofore been impossible to consistently manufacture screws with precisely accurate

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socket or recess formations the full advantages of such screws have not been obtained.

In certain screw constructions complicated socket formations have been proposed providing a series of ridge and groove interlocks around the screw socket in an effort to increase driver bit to socket interlock. However, such screws require the use of a complicated punch having multiple surfaces, many of thin cross section and having multiple corners and angles. As a result the life of the forming punches is extremely short if any reasonable standard of accuracy is to be maintained in the socket and consequently the cost of production of such screws is high.

The object of the present invention is to overcome the above difficulties and to provide a bit point and socket formation for a screw head that will consistently provide a greater effective area of tool and screw head contact surface to resist turning of the bit in the socket and at the same time eliminate cornering and camming of the bit up out of the socket under torque applied to the tool.

Another and very important object is to provide a socket formation which will decrease the cost and difficulties presently experienced in the heading of the screw and also in the forming of the driver bit.

Again it is an important object to provide an improved socket headed screw as aforesaid which can be driven by means of conventional "square" type screw drivers or bits formed with pyramid points to consistently provide the increased effective area of driver bit to socket contact.

Again it is an important object to provide a screw socket and screw driver bit which will coact to ensure accurate centering or locating of the bit in the socket.

In the forming of sockets in screws it has been discovered that in cold heading with conventional punches which are intended to produce a socket in a single blow when the punch enters the metal or material of the screw head the metal is liable to "fall away" from the sides of the punch and the punch shape is frequently not accurately reproduced. Because of the variations in the condition of the metal in the screw head, the condition of the punch and the variations in punch blow such fall away produces socket formations having a wide range of internal dimensions preventing consistent socket formations from being obtained. It has been discovered that this fall away occurs due to the fact that it has been the objective in prior manufacture to maintain the punch sides near parallelism so that the side walls of the socket will be approximately parallel so that there will be a relatively small component of force acting upwardly on the bit as driving torque is applied.

According to the present invention it has been discovered that if the socket formation is convergent inwardly of the head in the form of a frustrum of a pyramid and has the side walls thereof inclined at an angle to the screw axis of not less than 3° and not greater than 3½° the socket can be punched at room temperature with a single blow so that the metal of the screw head will be progressively spread on entry of the punch sufficiently to overcome any tendency of the metal to "fall away" from the sides of the punch and positive punch to socket engagement for the full inward stroke of the punch will result. Thus this particular socket side wall angle enables the punch shape to be accurately reproduced and at the same time the upward component on the driver bit of the applied torque will not be sufficient to cam out the bit as the full driving torque which the screw is designed to withstand is applied.

Although the particular inclination of the side walls of the socket ensures accurate reproduction of the shape of the body of the punch, they do not in themselves ensure proper driver bit to socket engagement. In this connection, as the punch wears, the bottom portion of the socket changes as screw production continues, and while the driver bit will enter fully home in the first screws produced by present punches, after a run of screws the socket bottom formation will be so deformed that the driver bit can no longer be entered to the bottom of the socket with the result that there is presented a clearance between the driver bit and socket walls resulting in the cornering action above referred to.

According to the present invention, however, the socket formation of the screw is provided with a conical bottom portion which defines with the frustro-pyramidal portion at the bottom of each side wall thereof an area of elliptical shape which is absent in conventional square socket screws. Such a socket formation is produced by means of a punch having a frustro-pyramidal portion terminating in a conically pointed portion, again giving rise at each side of the pyramidal portion to an elliptical wear area over and above the area presented by a corresponding punch with a pyramidal point. The result is that with this socket formation having the conical point no change in the depth of the body of the socket at the socket corners is experienced, even though the elliptical side areas are decreased until such elliptical areas become straight lines. That is, as the punch wears in the production of the sockets, the wear occurs to reduce the elliptical side areas to straight lines, and while, during the wear the bottom formations of the sockets produced by the punch will be correspondingly altered, there will be no reduction in the effective depth of the socket, that is, the depth at the socket corners, and a driver bit will seat fully home within the socket with full bit to socket engagement whether the socket is produced by the punch in its initial form or after it has had its elliptical areas completely worn off.

In connection with the use of a punch having a conically pointed portion, it has been discovered that the punch point must have a requisite sharpness so that lubricating compounds used in the punching operation will not be trapped in the socket and so distort the lower end of the socket impression. On the other hand, it has been found that if the point of the punch exceeds a certain sharpness, it becomes impossible from a practical standpoint to harden the punch point sufficiently so that the punch point will maintain its initial shape when used in a cold heading operation. Deformation of the punch point, of course, will again distort the lower end of the screw impression.

Thus the requisite conical bottom socket formation together with the requisite side wall inclination enables screws with proper bit to socket contact to be consistently and economically manufactured.

The invention will be more fully understood with reference to the accompanying drawings in which:

Figure 1 is a plan view, partly broken away, of a screw having a socket formation therein formed according to the invention;

Figure 2 is a fragmentary vertical sectional view through the head of the screw of Figure 1 showing the vertical contour of the socket therein;

Figure 3 is a fragmented perspective view of the screw of Figure 1;

Figure 4 is a broken away, perspective view of one form of driver bit for use with the screw of Figures 1 to 3;

Figure 5 is a view similar to Figure 4 but showing a conventional form of bit which may also be used with the screw of Figures 1 to 3;

Figure 6 is a part elevational, part vertical sectional view, broken away, showing the form of punch used to produce the socket in a cold heading operation according to the invention and the corresponding socket formation produced by a single blow of the punch;

Figure 7 is a view similar to Figure 6, but showing the shape of the punch and corresponding socket shape after punch wear has occurred;

Figure 8 is a view similar to Figure 7 but showing the punch and socket formation after further punch wear has occurred;

Figure 9 is a fragmentary part elevational, part vertical section showing the bit to socket engagement when the bit of Figure 4 is employed with the socket formation of Figure 6;

Figure 10 is a view similar to Figure 9 but showing the bit to socket engagement when the socket formation has changed to that of Figure 7;

Figure 11 is a view similar to Figure 10 but showing the bit to socket engagement with the socket formation of Figure 8;

Figures 12 and 13 are views similar to Figure 11, but showing the bit to socket engagement after punch wear has occurred beyond that shown in Figure 8 to produce radically deformed screw socket formations;

Figure 14 is a transverse sectional view on the line 14—14 of Figure 11;

Figure 15 is a transverse sectional view on the line 15—15 of Figure 13 illustrating the cornering effect resulting from the improper bit to socket engagement illustrated in Figure 13.

With reference to Figures 1 to 3, the screw **1** depicted for purposes of illustrating the invention comprises a threaded body portion **2** and a flat head portion **3**. It will be understood, however, that the particular shape of the head is immaterial, and it may be domed or assume any other desired formation, depending on the purpose or use of the screw.

The head **3** is formed with a socket generally designated at **4**, the body of the socket being defined by four walls **5** with adjoining walls being in right angular relation meeting at sharp corners and the horizontal cross section through the body portion of the socket defined by the walls **5** cuts a square opening.

The socket **4** terminates in a conically pointed portion **6** with the base of the cone being, in effect, a diagonal of the square formed by the walls **5**, with the result that the juncture between the walls **5** and the conically pointed portion **6** lies along the arcuate line **7**, as best seen in Figure 3. These curves or arcuate lines extend downwardly from the edges of the walls **5**, that is, from the bottom corners of the major socket portion **8** defined by the walls **5** to a maximum depth at the median planes of the walls.

As shown particularly in Figure 2, the socket **4** is centered on the longitudinal axis **9** of the screw and the side walls **5** defining the major socket portion **8** converge inwardly of the socket to define an angle of at least 3° with the screw axis **9**. Thus the major portion **8** of the socket **4** is in the form of the frustrum of a pyramid, the sides of which converge inwardly of the socket. It has been found that, unless the inclination of these side walls is at least substantially 3°, then during the punching operation to form the socket, the metal or material of the screw head will fall away from the punch form, the degree of fall away varying from screw to screw, so that there will be a wide variation in the dimensions of the body portion of the socket.

However, it has been found that when the inclination of the side walls **5** reaches the 3° incline relative to the screw axis, the spreading of the metal of the screw head as the punch progressively enters the screw head at room temperature so stresses the metal that it clings or precisely conforms to the forming punch, and the punch form is consistently and accurately reproduced in the socket formation even though the socket has been formed with a single punch blow. By maintaining the inclination of the side walls **5** at an angle not less than substantially 3° and not greater than substantially 3½°, the problem of fall away is overcome and at the same time the upward component on the driving bit during driving of the screw as torque is applied through the bit is sufficiently minimized to prevent any problem with upward bit displacement out of the socket.

The inclination of the conical wall **10** of the conical bottom portion **6** is preferably maintained at an angle of substantially 56° to the axis of the screw, which angle will decrease according to the amount of wear which has taken place on the punch from which the socket is formed, as hereinafter more fully explained.

By virtue of the fact that the major portion **8** of the socket is in the form of a frustrum of a pyramid and the bottom portion **6** is of conical form, the intersection of these two geometrical configurations as defined by the line **7** is technically a part of an ellipse but may be considered as a curve simulating a small segment of a circle of large radius. Dotted lines **11** in Figure 3 illustrate the line of juncture which would occur if the bottom portion **6** of the socket were of pyramidal form rather than conical form. It will thus be seen that by virtue of the provision of the conical bottom portion **6**, there is provided at the bottom of each side wall an area **12** which is generally semi-elliptical and which constitutes a tolerance area as hereinafter more fully explained.

Above the major portion of the socket **8**, the socket has a shallow pyramidal portion **13**, the side walls of which are inclined at an angle of substantially 45° to the axis of the screw. The importance of the incorporation in the screw socket of the tolerance areas **12** will be understood with reference to Figures 6 to 15. In Figure 6 there is illustrated a punch **14** having a major frusto pyramidal portion **15** and terminating in a conically pointed portion **16**.

Above the pyramidal portion **15** of the punch and beneath the punch head **17** there is formed a frustro pyramidal punch portion **18**. The punch, of course, has the side walls **19** of the pyramidal portion **15** inclined at an angle to the punch axis within the preferred tolerances from 3° to 3½°. The initial inclination of the conical wall **20** of the conically pointed portion **16** to the punch axis is substantially 56° and the juncture of the conically pointed portion **16** and the pyramidal portion **15** provides elliptical, or rather semi-elliptical, areas **21** at the bottom of each side wall **19**, which areas would be absent if the pointed portion of the punch were of pyramidal form rather than conical form to provide a juncture indicated by dotted lines **22**.

The areas **21** on the punch form wear areas which progressively decrease as wear occurs on the punch in the punching of the screw sockets. Figures 7 and 8 illustrate the punch after it has had progressively increased wear and the same figures illustrate the socket formations produced by such punches, such sockets having decreasingly smaller tolerance areas **12**. Further wear on the punch beyond that shown by the solid line in Figure 8 will provide a punch formation as illustrated by the dotted lines **23** in Figure 8 to produce the socket formations designated at **4'** in Figures 12 and 13.

The drivers used to drive screws of the type disclosed may have either the form shown in Figure 4 or that shown in Figure 5, the latter comprising the general form of the conventional driver which may be utilized with the screw.

Referring to Figure 4, the driver, or rather the bit of the driver, is indicated generally as **24** and comprises a frustro pyramidal portion **25** terminating in a conical point **26**. The sides of the pyramidal portion **25** are formed to incline at an angle of a maximum of 3° to the axis of the driver or bit so that the bit will conform to the socket **4** of the screw as illustrated in Figures 9 to 11. The conical point **26** of the bit is a relatively shallow point, so that the lines of juncture indicated at **27** in Figure 4 between this portion and the pyramidal portion **25** are approaching straight lines having but a small degree of curvature.

An angle of the order of 70° defined between the

slope of the wall of the conical point **26** and the bit axis has been found to provide a satisfactory point for the bit.

The bit of Figure 5 generally designated at **24'** again has a pyramidal portion **25'** corresponding to the portion **25** of the bit **24**, but instead of having a conical point, the bit **24'** is provided with a pyramidal point **26'** and the juncture between the bit portions **25'** and **26'** is defined by the straight lines **27'**. Thus in the case of the bit of Figure 4, small additional semi-elliptical areas are provided at the bottom of each side of the pyramidal portion **25** of the bit of **24** over and above the side areas presented by the portion **25'** of the bit **24'**, these areas being indicated at **28**.

By forming the bit in the shape of that illustrated in Figure 4, the number of angles presented by the bit is greatly reduced from the number present in the more or less conventional bit form of Figure 5, to correspondingly reduce the incidence of breakage and rate of wear on the bit. In this connection it is to be noted that not only does the conical point **26** of the bit include a single angle only, but the curved juncture lines **27** between the cone point **26** and the pyramidal portion **25** eliminate the sharp readily fracturable corners presented by the bit of Figure 5.

Referring to Figures 9 to 11, it will be seen that as the bit, shown as a bit corresponding to the shape of Figure 4, is introduced into the screw socket, it will seat down into the socket in each case to the same point *a*. In the case of the socket of Figure 9, produced by the punch **14** of Figure 6 having its initial shape, there will be at each side of the major portion **8** of the socket below the bit an elliptical tolerance area **12** substantially of the same magnitude as shown in Figures 2 and 3. If the driving bit employed were of the shape of the bit of **24'** of Figure 5, then the tolerance areas below the bit at each side wall **5** of the socket would be exactly the same as the tolerance areas shown in Figures 2 and 3. With the bit **24** of Figure 4, the tolerance area below the bit at each side wall **5** of the socket will be slightly less due to the slight downward curvature of the sides of the bit portion **25**, as indicated by the juncture lines **27**.

When the bit **24** is introduced into the socket formation of Figure 10, there will be a smaller elliptical tolerance area below the bit due to the fact that wear on the punch as illustrated in Figure 7 will have reduced the area of the wall portion **12** according to the punch wear. However, the bit still seats fully home in the socket down to the point *a*. Similarly, as shown in Figure 11, the bit **24** is seated down to the point *a* in the socket, but in this case the tolerance area **12** at the bottom of each side wall **5** of the socket has been reduced to equal the area **28** at the bottom of each side of the punch, and there will be no excess socket tolerance areas.

After the punch **14** has worn beyond the solid line showing of Figure 8, then the socket formations of Figures 12 and 13 are produced in the screw heads, the figures showing further successive stages of wear. In both cases the bit **24** will no longer seat fully down to the intended point *a*, but will be displaced above this point to the point *b* in Figure 12 and to the point *c* in Figure 13. The upward displacement in each causes a clearance **29** to be obtained between the bit and socket. The result of the clearance is to provide the cornering action shown in Figure 15. That is, when the bit **24** is turned, the corner portions of the bit engage limited areas of the socket walls **5** with the result that the concentrated force of the socket walls will cause a deformation of the socket before full torque is developed in the bit and the bit will turn in the socket as the socket metal is reamed upwardly and outwardly.

While Figure 15 illustrates the cornering effect which results when the bit **24** is prevented from seating fully home into the socket, the same cornering effect will be achieved if the socket walls **5** are more divergent than the walls of the pyramidal portion **25** of the bit. Thus, where fall away of the metal of the socket occurs in screw manufacture as described above in connection with the prior art, this same cornering effect, because of the lack of positive bit to socket contact, again results in the inability to develop full torque through to the screw.

By the provision of the tolerance areas **12** in the socket, a large number of screws can be produced despite the fact that wear occurs on the punch while still maintaining the proper positive driver bit to socket engagement as illustrated in Figure 14.

In addition to the provision of the tolerance areas **12** in the socket the socket formation **4** enables the socket to be punched in the screw head without setting up the high concentration of stress experienced when a punch having a pyramidal point is driven into the metal of the screw head so that the ability of the metal of the screw head to withstand torques applied thereto is increased beyond that of screws having pyramidal pointed sockets.

In addition, by having the conical wall of the socket bottom define an inclined angle of approximately 112° between opposite sides thereof, it is possible to accurately punch the socket without excessive stress on the punch and with exact reproduction of the punch form in the socket bottom.

In this connection it will be understood that the punch must be carefully hardened, and if the point **16** were substantially sharper than the 112° angle shown herein between opposite sides of the wall **20**, it would be extremely difficult to provide the requisite hardness in the point due to the sharp contrast in area between this pointed portion and the remainder of the punch.

On the other hand, if the inclined angle between opposite sides of the wall **20** of the point **16** is increased substantially greater than the 112° it has been found that on entry of the punch the blunt point will trap the lubricating compounds used in the punching operation within the socket and such compounds will not be squeezed out around the punch and when so trapped prevent the material of the screw head from conforming to the lower end of the punch distorting the lower end of the socket.

It will be understood that the actual dimensions of the socket formation **4** of the screw and the dimensions of the bit **24** or bit **24'** may be varied according to the size of the screw, and such variations in detail may be made without departing from the spirit of the invention as set forth in the appended claims.

What I claim as my invention is:

1. A screw having a socket punched by substantially a single blow in the head thereof while at substantially room temperature and centered on the longitudinal axis of the screw, said socket being in the shape of a frustrum of a pyramid square in cross-section for a major portion of its depth to present four flat uninterrupted side walls meeting at sharp corners and mutually converging inwardly of the socket with each side wall being inclined at an angle of between 3° and 3½° to the longitudinal screw axis, said major pyramidal portion terminating in a conically pointed bottom portion presenting a conical bottom wall inclined at an angle between 50° and 56° to the longitudinal screw axis, the juncture of said major pyramidal and bottom conical portions defining at the bottom of each side wall a segment of a circle.

2. A screw as claimed in claim 1 in which said socket is formed at the top of said major socket portion with an outwardly diverging portion in the form of a frustrum of a pyramid with the walls of said latter portion being inclined to the screw axis at an angle of approximately 45°.

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