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METHOD OF MAKING WRENCH SOCKETS

Norris F. McNaught, Chicago, Ill., assignor to
Duro Metal Products Company, Chicago, Ill.,
a corporation of Illinois

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This invention relates to a method of making wrench sockets, and is particularly concerned with the formation of the nut-embracing portions of sockets which have been turned from bars or other initially solid metal stock.

The usual method of forming nut-embracing surfaces and corners in a suitably machined socket is forcibly to project a broach into the socket, while cold, to cut and tear chips from the interior of the socket. These chips are severed from the finished socket. Such severance, in some instances, has been accomplished by having the ingress of the broach terminate at an internal annular groove machined in the socket prior to the broaching operation. In other instances, such severance has been accomplished by a special and additional chip shearing operation performed with a power punch or with hand tools.

The aforesaid usual method of forming the nut-embracing surfaces and corners of sockets has been objectionable for a number of reasons. The nut-receiving corners of the sockets have not been sharply defined. The nut-embracing surfaces which converge to present such corners have been scratched, chattered marked and roughened by broach action. These undesirable results have been unavoidable when the broaches have been sharp, and have been aggravated when the broaches have become even slightly dulled. Chip removal has been an objectionable requirement of the usual method. When resort has been had to an annular groove in the machined socket, to permit the broach itself to remove the chips, the socket is undesirably weakened at a point where it should be strong, I.e., intermediate the points of nut engagement and the point where torsional strain is applied in the use of the socket. When the annular groove is not employed, chip removal necessitates an extra, and hence objectionable, operation. Furthermore, the projection of a broach into a cold socket has a distorting effect which tends to the production of imperfect and non-uniform finished sockets. Another shortcoming of the usual method has been that it has neither contemplated nor accomplished the rounding of the exterior corners of handle-stud-receiving openings of the sockets,—the rounding of these corners being highly desirable if it can be accomplished without the necessity of a special operation, but impractical if its accomplishment necessitates the expense of a special grinding or swaging operation.

According to the present invention, the duly machined sockets are brought to a red heat. Each properly heated socket is then placed within the snug embrace of a suitable retainer which serves to prevent lateral distortion or bulging of the socket during the broaching thereof. A broach is now forcibly projected into the hot and properly retained socket, to form the requisite nut-engaging surfaces and corners. The action and effects of the broach, however, are quite different from the action and effects realized when a broach is projected into a cold socket in accordance with the usual procedure. As the broach enters and progresses into the hot and properly retained socket, the metal in the immediate path of the leading face of the broach is displaced, without severance from the metal with respect to which it is displaced, and is gathered in annular form at the region where the inward movement of the broach terminates. By this accumulation of unsevered metal, the finished socket is materially strengthened at a region where it should be strong, I.e., at the region which lies between the points of the nut engagement and the point where torsional strain is applied to the socket when in use. When the broach is retracted, it leaves the socket with a broached opening characterized by clearly defined nut-receiving corners and nut-embracing surfaces of remarkable smoothness and perfection.

I prefer that the hot metal, which is displaced ahead of the leading face of the broach, as previously described, shall be gathered or accumulated in the form of an annulus which is coaxial with the broached portion of the finished socket, and is of definite internal diameter so that it will receive and pass the bolt of a nut to which the finished socket is applied. I also prefer to utilize the force applied to the socket in the broaching thereof to effect the rounding of the exterior corners of the polygonal opening with which the heads of wrench sockets are usually provided.

Other features, objects and advantages of my invention will appear from the following detailed description, wherein reference is made to the accompanying two sheets of drawings, wherein:

Figure 1 is a front elevational view of a conventional wrench socket as it appears after being turned from a bar but before being broached to form its nut-engaging portions;

Figure 2 is an axial sectional view taken on the line 2—2 of Figure 1;

Figure 3 is an axial sectional view of the said socket as it appears after being heated and properly positioned preparatory to application of the retainer by which it is confined during the broaching operation;

Figure 4 shows the retainer applied;
Figures 5 and 6 illustrate different stages in the performance of the broaching operation; Figure 7 is a front elevational view of the socket as it appears after the broaching thereof.

Figure 8 is an axial sectional view taken on the line 8-8 of Figure 7.

Figures 9 and 10 are views generally corresponding to Figures 5 and 6, but illustrating a modification of my new method;

Figure 11 is a more or less diagrammatic view illustrating apparatus which is particularly adapted for the performance of the present method upon tapered sockets of the kind shown in Figures 1 to 10 inclusive;

Figure 12 is a more or less diagrammatic view illustrating apparatus which is particularly adapted for the performance of the present method upon straight walled sockets;

Figures 13 and 14 are views generally corresponding to Figures 5 and 6, which illustrate the performance of the present method upon a straight walled socket;

Figure 15 is an end view of the broach shown in Figures 5, 6, 13, and 14; and

Figure 16 is an end view of the broach shown in Figures 6, 9, and 10.

Similar characters of reference refer to similar parts throughout the several views.

Figures 1 and 2 have shown a properly machined conventional wrench socket of the tapered type as it appears before being subjected to the operations contemplated by the present method. This socket, indicated as a whole at 10, may be regarded as machined from a bar of solid stock, preferably upon an automatic screw machine. It is provided with an axial bore 14, subsequently to be broached, and is also provided with a polygonal, and usually square, opening 17 for the reception of a correspondingly shaped stud on a wrench handle with which the finished socket is intended to cooperate. It will be noted that the exterior corners 18, 19 are at this stage square and sharp, as heretofore they have been on finished sockets for the reason that the prior art has provided no way to round these corners without resort to special operations which cannot be tolerated in commercial wrench socket production. As will hereinafter appear, I accomplish the rounding of these corners, for better cooperation with the wrench handle stud, as an incident to the broaching operation.

After being machined to the stage depicted in Figures 1 and 2, the partially completed socket is brought to a red heat, usually by being subjected to a temperature of from 1200° to 1800° F., depending upon the particular kind of steel employed in the socket, the size of the socket, and other variables.

The heated socket is then placed upon the work-support 18 of a suitable broaching machine, which may be in the nature of a conventional punch press, arbor press, hydraulic press, or the like, in order that the corners 18, 19 of the socket may be rounded, as an incident to the performance of the broaching operation. I prefer that the work-support 18 shall carry a stud 20 corresponding in shape with the opening 17 of the socket. The stud 20 is preferably provided with curved fillets 21, 21 against which the corners 18, 19 rest when the heated socket is properly positioned upon the stud, as depicted in Figure 3.

A retainer 22 is now caused to embrace the socket as depicted in Figure 4. When employed in connection with a tapered socket, the retainer may be, and preferably is, in the form of an integral metal body, having a tapered opening 23, which may move from above to take the socket into its embrace.

The next step is to project a broach 24 into the socket bore 16, with the leading end of the broach in metal displacing relation to the cylindrical wall of the socket bore 16. The broach 10 which I have exhibited is of a type capable of converting the socket bore 16 into a nut-receiving opening of the well known "12 point" or "double hex" variety. Of course, the broach may be shaped to produce a nut-receiving opening which is square, hexagonal, octagonal, or of any other shape suitable for cooperation with the nuts for which the socket is designed.

The broach may be entirely conventional, but preferably is different from a conventional broach in that its leading or socket penetrating end carries, as an integral part thereof, a pilot 25, which is preferably of frusto-conical form. The broach when approaching, engagement from the socket, preferably travels with its axis in exact alignment with the axis of the socket bore 16.

The first and immediate effect of the engagement of the broach with the hot socket is a slight downward movement of the socket upon stud 26, 30 until the lower end of the socket rests upon the work-support 18. When this occurs, the initially square corners 18, 19 of the socket opening 17 are nearly rounded by engagement with the stud fillets 21, 21, as shown in Figure 5. The retainer 22 is caused to descend with the hot socket, so that such retainer continues snugly to embrace the tapered wall of the socket, as illustrated in Figures 5 and 6.

As the broach continues to move into the hot socket, the metal of the socket which lies in the path of the leading face of the broach is displaced, without being severed from the socket, to a position immediately adjacent the inner ends of the nut-receiving corners 20, 22 and the nut-embracing surfaces 24, 24, in the socket by the operation of the broach. In Figure 6 the broach has reached the end of its travel into the hot socket, and the accumulated displaced metal, indicated at 28, has been finally located.

When the broach is provided with a pilot, as indicated at 29, the metal displaced by broach action is gathered and compressed by the pilot into an annular shoulder which will receive and pass any bolt (associated with a nut to which the finished socket is applied) which is of greater diameter than the smallest diameter of the pilot.

An interesting result of the method, when the broach pilot 28 is employed, is that the inner surface of the annular shoulder 28 presents neat and uniform scallops 29, 29, which lend a finished and attractive appearance to the completed socket.

The broach is now withdrawn from the hot socket, a nd the socket is divorced from the stud 28 and the retainer 22, and is permitted to cool. Upon inspection, the socket corners 20, 22 found to be very sharply defined and the surfaces 27, 27 are found to be smooth and remarkably free from imperfections. Moreover, the metal of the broached portion of the socket is found to be much more dense than would be the case had the same socket been broached by the usual
method. Such sharp definition of the corners 26, 26, the remarkable smoothness of the surfaces 27, 27, and the density of the broached portion of the socket are doubtless attributable to a number of causes, including:

(a) The action of the broach in displacing hot metal, as distinguished from cutting or tearing it;

(b) The polishing action upon the hot metal of the many lateral surfaces of the broach as the broach enters and recedes from the hot socket;

(c) The tendency of the hot socket to lose some of its initial heat and hence shrink upon the broach during the broaching operation; and

(d) The retainer 22 which insures that the side wall of the socket shall not bulge, or otherwise be distorted by broaching action.

In those instances where it is desired that the broach displace the socket metal so as to pass bolts of unusually large diameter, resort may be had to that variation of my method which is illustrated in Figures 9 and 10. Figures 9 and 10 correspond in general to Figures 5 and 6. In this variation of my method, the partially completed socket, as it comes from the automatic screw machine, or other machine wherein it was turned from a bar or other solid stock, is provided with an internal annular groove indicated by the numeral 30 in Figure 11. In this instance, it is provided with a frusto-conical pilot 25—a, having a base which, in its relation to the associated broach, is of greater diameter than the base of the pilot 25, which has been illustrated in Figures 5 and 6. See Figs. 15 and 16, which are end views, respectively, of the broach of Figs. 5 and 6 and the broach of Figs. 9 and 10. Aside from the provision of the annular groove 30, and the changed form of the pilot 25—a, the procedure, in following the teachings of Figures 9 and 10, does not differ from the procedure in following the teachings of Figures 1 to 6 inclusive. However, when the socket is provided with the groove 30, and a broach having the pilot 25—a is employed, the metal which is pushed ahead of the broach as it enters the socket is finally gathered and compressed in the annular groove 30 substantially to fill the same, as indicated at 26—a in Figure 10.

In Figure 11 I have diagrammatically illustrated a number of the elements of a conventional punch press which has been suitably adapted for the performance of the method of the present invention. In Figure 11 the reference numerals 30 and 31 indicate fragments of the press frame. The portion 30 of the frame carries the work-support or bed plate 32, which in turn carries the stud 33, to which reference was made in describing the successive steps in my new method. The press ram is indicated at 33—such ram carrying the broach 24 in the usual or any suitable manner. Carried by the ram, but capable of lost motion relative thereto, is a bar 34, which freely carries the socket 35, to which reference previously has been made. The lost motion connection between the ram 33 and the bar 34 is provided by pins 35, 35, and a second bar 36, which is disposed directly above the first mentioned bar 34. Bar 36 is rigidly attached to ram 33. Pins 35, 35 have their lower ends threaded or otherwise anchored in bar 34,—the upper ends of said pins 35, 35 extending freely through apertures in the bar 36 and being provided with nuts 37, 37, or their equivalent, which are adapted to rest upon the bar 36 when the several parts of the apparatus are in the positions illustrated in Figure 11. If desired, compression springs 38, 38 may encircle the pins 35, 35,—said springs tending when compressed to move the bar 34 away from the bar 36.

Carried by the bar 36, and being capable of lost motion relative thereto, is a bar 36, which freely carries a stripper 40. The lost motion connection between bar 33, and the bar 36 is provided by bolts 41, 41, which extend freely through apertures in the bar 36 and have their lower ends threaded or otherwise anchored in the stripper-carrying bar 39.

The heads of the bolts 41, 41 are adapted to engage pins 42, 42 during the upward or downward movement of the ram 33. Pins 42, 42 are illustrated as being carried by the press frame portions 31, 31. The bar 38, and its stripper 40 are provided with aligned openings for the passage of the broach 24.

It may be assumed that the ram 33 is on its upward or recessional movement, that the broach 24 has just functioned upon a hot socket 16, and that the stripper 40 is about to eject the duly broached hot socket 16 from the retainer 22. This occurs upon the engagement of bolts 41, 41 with their cooperating pins 42, 42.

Prior to the next descending movement of the ram 33, a hot socket 15 is placed upon stud 20. When the ram descends, the retainer 22 snugly embraces the hot socket to be broached.

With the bar 34 in the dotted line position, and with the springs 35, 35 compressing, the ram 33 continues to descend to carry the broach 24 against and then into the hot socket 15 to form the nut-engaging portions thereof, and round the corners 18, 18, in the manner heretofore discussed in considerable detail. As the hot socket moves downwardly under the initial pressure of the broach, the bar 34, and its associated retainer 22 respond to gravity and the springs 35, 35 and thus accommodate themselves to the slightly changed position of the hot socket. Upon the next upward movement of the ram 33, the stripper 40 acts to eject the duly broached socket from its retainer 22, if the socket has not already dropped from such retainer as the result of its own slight shrinkage and gravity.

It is the purpose of Figure 11, which is quite diagrammatic as hereinbefore stated, to reveal how the procedure of Figures 1 to 6 inclusive, and the slightly modified procedure of Figures 9 and 10, may be practiced upon a more or less conventional but rearranged press of a kind to be found in practically every shop.

In Figures 13 and 14 I have illustrated how a straight wall socket 15—a, which has been initially turned from a bar or other solid stock, may have its nut-receiving bore 16 duly broached, and the corners 18, 18 of its polygonal opening 17 duly rounded, in accordance with the teachings of the present invention. In operating upon a straight wall socket, I prefer to place it upon a stud 20 of the kind and for the purpose heretofore described. The side wall retainer, which embraces the hot socket while it is undergoing the broaching operation, in this instance consists of a plurality of movable elements or die blocks 22—a, 23—a which are caused to move laterally, snugly to embrace the hot straight wall socket between them, prior to the application of the broach to the hot socket. The only essential difference in the treatment of a straight wall socket, as distinguished from a tapered socket, consists in the specific manner of retaining the
hot socket against lateral bulging or distortion during the broaching operation.

In Figure 12 I have diagrammatically illustrated various parts of a conventional press which has been adapted for use in performing the method of the present invention upon straight wall sockets. Portions of the press frame are indicated at 28 and 31. The bed plate is shown at 32, and the ram at 33,—the latter carrying the broach 24. Mounted upon the bed plate 28, for reciprocation toward and away from each other, is a pair of die blocks 22—a, 22—a, which together may constitute the retainer for the hot socket to be broached. The stud 26, in this instance, appears upon the upper end of a cylindrical support 43 which rises from the bed plate 28 and is so located as to be received between the opposed cylindrical faces of the die blocks 22—a, 22—a when the latter are brought together snugly to embrace a hot socket 16—a which has been located upon the stud 26. Springs 44, 44, acting between the die blocks 22—a, 22—a and the bed plate 28, normally tend to urge the die blocks 22—a, 22—a to their separated positions.

The die blocks 22—a, 22—a are provided with cam surfaces 46, 46 arranged to cooperate with complementary cam surfaces 48, 48 formed upon the lower ends of arms 47, 47 which are fixedly carried by the extremities of a bar 48. Bar 48 is rigidly attached to the press ram 33. Arms 47, 47 have vertical inner faces 49, 49 which cooperate with vertical outer faces 50, 50 of the die blocks.

I prefer that each of the cooperating die blocks 22—a, 22—a shall carry a stripper plate 51, the stripper plates partially overlying the upper end of the hot socket during the broaching operation and during the recession of the broach 24 from the socket after the performance of the broaching operation.

In the light of what previously has appeared in this specification, it is believed that persons skilled in the construction and operation of punch presses will have no difficulty in constructing an apparatus of the kind diagrammatically illustrated in Figure 12, or in operating the same to perform the socket broaching method which is the subject-matter of the present invention. Sufficiently to say that the hot socket 16—a is placed on the stud 26 while the ram 23 is in its elevated or retracted position. Upon the descent of the ram, the arms 47, 47 co-operate with the die blocks 22—a, 22—a to cause the latter snugly to embrace the socket to be broached. As the ram continues to descend, the broach 24 enters the properly retained hot socket and performs its novel function as hereinafore described. Upon recession of the broach from the hot socket, the stripper plates 51, 51 prevent the broached socket from following the broach. As the upward movement of the ram continues, the die blocks 22—a, 22—a separate to permit the removal of the duly broached socket and the placement upon the stud 26 of another socket to be broached. The just described operation of the apparatus is then repeated.

The purpose of Figure 12 is to reveal how an ordinary shop press readily may be adapted for use in practicing the method of the present invention. Those skilled in the art will appreciate that the details of the press and its accessories may vary within wide limits. For example, persons familiar with the construction and operation of punch presses and the like will appreciate that the pair of die blocks indicated at 22—a, 22—a may be replaced by a multiplicity of die blocks suitably cooperating to perform the same function as the pair of die blocks which I have elected to illustrate.

While I have elected to describe my invention in connection with the production of wrench sockets intended for use in conjunction with suitable handles or the like having studs for reception in the polygonal openings 11 of the sockets, I wish to have it understood that the method of the present invention may be employed for the formation of wrench sockets which are formed in one piece with the handles or other instrumentalities whereby they are manipulated.

Having thus illustrated and described my invention, what I claim is new and desire to secure by Letters Patent of the United States is:

1. The method which consists in heating to forging temperature a hollow socket turned from stock, confining the exterior of the socket in a side wall retainer, and conforming the interior of the socket for nut embracement by the forcible insertion of a broaching tool which acts to shift hot metal from the nut receiving region of the socket to an adjacent interior region thereof.

2. The method of wrench manufacture which consists in machining from stock a socket which is hollow at its end intended for nut reception and provided at its other end with an opening for the reception of a wrench handle stud, heating the socket to forging temperature, and broaching the hot socket and simultaneously rounding the exterior corners of said opening.

3. The method of manufacturing a wrench socket which comprises heating a machine turned metal blank, of the exterior form desired for the finished socket and having an internal opening of circular cross-section somewhat smaller than the desired nut receiving opening of the finished socket, heating the blank to a temperature at which the metal thereof may be displaced or flowed without fracturing or chipping, surrounding said heated socket with means conforming to its exterior to preserve the precision of its machined finish, and inserting a broaching tool axially into said opening to displace metal ahead of the tool and thereby form nut engaging faces on the interior of the socket.

4. The method which consists in heating to forging temperature a hollow socket turned from stock, confining the exterior of the socket in a side wall retainer, and conforming the interior of the socket for nut embracement by the forcible insertion of a broaching tool which acts to shift hot metal from the nut receiving region of the socket to an adjacent interior region thereof and to gather the shifted hot metal in annular form and as an integral part of the socket at said adjacent interior region of the socket.

NORRIS P. McNaught.
CERTIFICATE OF CORRECTION.

NORRIS F. McNAUGHT.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 4, second column, line 54, claim 3, after "form" insert the words and polish; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 18th day of February, A. D. 1936.

Leslie Frazer
Acting Commissioner of Patents.