PATENT SPECIFICATION

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(54) IMPROVEMENTS RELATING TO SOCKET HEAD FASTENERS

(71) We, TEXTRON INC. of 10, Dorrance Street, Providence, Rhode Island 02903, United States of America, a Corporation organised under the laws of the State of Delaware, United States of America, do hereby declare this invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed to be particularly described in and by the following statement:—

The present invention relates to socket head type fasteners and more particularly to a fastener drive arrangement, wherein a multi-lobular socket is provided for engagement by a correspondingly shaped, mating drive tool, with the end face of the socket head including an auxiliary or service slot thereby adapting the fastener to be driven by a standard tool engaged in said socket, such as a screwdriver or the like.

Socket head fasteners with a service slot type of auxiliary drive means are known, and often they have a primary drive socket which is defined by intersecting planar surfaces to provide either a hex or square drive. The hex or square type of drive system has been found to possess numerous disadvantages due to the relatively sharp corners employed and the attendant low efficiency in the converting of applied torque to driving torque. Also, the hex and square type of drive socket are subject to high radial stresses which can result in failure during driving. Accordingly, in recent years lobular type drive systems, such illustrated in Applicant's prior United States Patent No, 3,584,667 have been proved more efficient than the hex or square systems, and have gained industry-wide acceptance.

While lobular type drive arrangements with service slot auxiliary drive means have been proposed, the overall design of these drive systems involve the sacrifice of the efficiency of the primary drive system due to the presence of the slot. Such a slot tends to open into the socket at locations which in effect result in the removal of a volume of material which would normally provide a lobe surface portion against which the drive tool lobes will engage. As such, the operational characteristics of the primary drive systems are compromised, viz., its ability to withstand and transmit torque. In order to regain the overall strength for the primary drive system the socket has been deepened to increase the depth of engagement and surface area in contact. In some instances the circumferential wall which defines the socket has been thickened. These changes tend to complicate fabrication of the fastener, as well as the manufacture of the socket forming tools.

The present invention, as will be discussed in greater detail hereinafter, provides a lobular type socket with a service slot designed and located such that the resulting combination does not compromise the operational characteristics of the primary drive system. Thus there is no necessity to deepen the main socket, or thicken the circumferential wall defining the socket.

As alluded to above, lobular type drive systems are widely used. These systems employ lobes which in section include generally arcuate surface portions. The latter type is contemplated by the present invention. Drive systems utilizing arcuate lobes are possessed of certain advantages in that it is relatively easy to attain mating engagement of a drive tool in the socket. In this regard, industry-accepted standards and practices provide for the dimensioning of the drive tool end portion such that same is slightly smaller than the drive socket to facilitate engagement of the respective elements. During driving of the fastener, full surface-to-surface engagement of the respective lobe surfaces does not result, due to this dimensional difference. In fact, it has been found that the lobes will be in engagement only over relatively small surface areas, as defined by the length of engagement along the abutting surfaces and the depth of engagement of the drive tool in the fastener socket. It should be noted, however, that the degree of surface-to-surface engagement obtained with lobular drive systems is far greater than that achieved with more conventional hex or square systems. Also, as is discussed in considerable detail in Applicant's prior US Patent No. 3,584,667 with the drive system of the general type contemplated by the present invention, a low drive angle is obtained which results in the efficient conversion of applied torque to driving torque, and correspondingly reduces the radial stresses created during driving which can lead to fracture of the socket wall.

According to the present invention there is provided a socket head type fastener having an elongate shank and an enlarged head portion formed on one end of said shank, a multi-lobular drive socket formed in said enlarged head portion, with the peripheral wall surface of said lobular socket provided by a first series of inwardly convex, arcuate wall surfaces and a second series of outwardly concave, arcuate wall surfaces with said surfaces merging smoothly to define alternately disposed socket lobes and flutes, and at least two of said flutes being diametrically opposed, said socket being adapted to receive a drive tool end portion of a corresponding, multi-lobular mating configuration, with each lobe on said drive tool end portion being in engagement with the socket wall surface over a first surface area portion upon the clockwise rotation of said fastener, and in engagement with a second, oppositely disposed surface portion of said socket wall surface upon the counterclockwise rotation of said fastener, with said first and second surface area portions being defined primarily by said inwardly convex, arcuate wall surfaces, and auxiliary drive means formed in said head portion and including diametrically opposed first and second slot means adapted to cooperate with said socket to provide for the reception of an alternate drive tool such as a screwdriver or the like, in driving engagement with said fastener, one said slot means being associated with each said diametrically opposed flute, and said slot means opening into said socket through the outwardly concave, arcuately curved surfaces serving to define said flutes, each said slot means being defined partially by a pair of spaced, generally parallel side wall surfaces extending axially from the end face of said head portion and outwardly from said socket, said side wall surfaces intersecting said outwardly concave, arcuately curved surface of the associate flute at locations spaced along said surface, and disposed radially outward from said first and second surface area portions engaged by said drive tool lobes, such that the existence of said slots does not diminish the extent of said surface area portions available for engagement with the lobes on said drive tool.

The presence of the service slot provided by the slot means does not materially affect the operating characteristics of the main system. With lobular drive systems, the area of surface-to-surface contact is disposed along the lobe at locations spaced inwardly from the apex of the lobe. Accordingly, with the present invention, the service slot is designed and positioned to intersect the socket wall at locations spaced radially outward of those at which engagement occurs during driving of the fastener. As such the socket lobe surface area available for engagement by the drive tool lobes is the same with the present invention as would be present if the service slot were not employed, and the operational characteristics of the primary socket is not impaired.

For a better understanding of the invention one embodiment will now be described, by way of example, with reference to the accompanying drawing, in which:

Figure 1 is a perspective view illustrating a fastener and the end portion of a drive tool engageable with said fastener;

Figure 2 is a top plan view of the driving head of the fastener illustrated in Figure 1;

Figure 3 is a partial sectional view of the fastener, also showing the end portion of the drive tool; and

Figure 4 is a partial sectional view taken through the driving head of the fastener with the drive tool engaged therewith, with the respective lobes in engagement as would occur during driving of the fastener in counterclockwise direction.

The invention will first be described with respect to the structural features of the drive system and the mating drive tool illustrated. A detailed discussion of the manner in which these structural features cooperate to provide the improved results discussed above, will be had with regard to Fig. 4.

In Fig. 1, there is illustrated a fastener 10 having an elongate shank 12 with an enlarged head portion 14 on one end thereof. The opposite end of the shank 12 may be provided with screw threads 16 of a conventional design or such other structure that may be desired to matingly engage the fastener with a work piece (not shown). The enlarged head portion 14 includes primary drive means in the form of a lobular socket, designated generally 20. A drive tool 22 is also illustrated, which includes an end portion 24 of a lobular configuration designed for mating engagement in the socket 20.

With reference to Figs. 2—4, the specific design of the socket 20 which provides the primary drive system for the fastener 10 can be seen. In this regard, socket 20 includes an inner peripheral wall surface which may be described as lobular, and is comprised of a plurality of alternating flutes 30 and lobes 32. The flutes 30 and lobes 32 are formed by a first series of concave surfaces 34 and a second series of convex surfaces 36 which merge smoothly, as shown in Fig. 4. The respective surfaces 34 and 36 extend axially of the socket, as shown in Fig. 2, with the bottom wall 37 of the socket being cone shaped.

With reference to Fig. 4, it can be seen that the radius of curvature 40 of the first series of surfaces 34 is considerably smaller than the radius of curvature 42 for the second series of surfaces 36. In the illustrated embodiment the ratios of said dimensions will be on the order of 4 or 5-to-1. Accordingly, the angular extent of said first series of surfaces 34 is much less than that of said second series of surfaces 36 with this relationship providing rather substantial, radially inward projecting lobes 32.

The particular design of the socket 20, as illustrated and as discussed above, is essentially that as shown in Applicant's prior United States Patent No. 3,584,667. It is intended, however, that the socket 20 as illustrated is but one type of lobular drive socket that can be employed with the present invention.

The end portion 24 of the drive tool 22 is of a corresponding, multi-lobular configuration. More specifically, said end portion 24 includes a series of alternating lobes and flutes 50 and 52, respectively, which are of course configured oppositely of those of the socket 20, so as to mate with the opposed lobes and flutes 32 and 30 of said socket 20. That is to say, while the surface 36 having the largest radius of curvature 42 forms the lobes 32 on the socket well, it is the surfaces with the smaller radius of curvature which provide the lobes 50 on the drive tool end portion.

In accordance with uniform, industry accepted standards and practices, the surfaces which provide the drive tool lobes 50 and flutes 52 are dimensioned to be slightly less than the dimensions of the corresponding surfaces of the socket which provide the opposed lobes 32 and flutes 30. This dimensioning practice is uniformly followed by all fastener and tool manufacturers, and it assures the presence of a slight clearance between the respective parts upon engagement of the tool end portion 24 in the socket 20. The radial clearance which is obtained, and visible in Fig. 4, will of course vary from part to part, depending upon the actual tolerances used in manufacture of the respective parts. Toward this end, fastener and tool manufactures have cooperated to develop dimensional standards for the various accepted drive systems, such as the disclosed embodiment marketed under the Trademark Torx.

Fig. 4 illustrates the condition of engagement of the respective lobes 32 and 50, upon rotation of the driver in a counter-clockwise direction. It is important to note, that the respective lobes 32 and 50 will be in engagement only along the surface portions 60, as illustrated in Fig. 4. This results due to the slightly smaller dimensional tolerances held with respect to the end portion 24, in order to provide the radial clearance necessary for ease in the obtaining of mating engagement. The area of mutual engagement 60 is disposed radially outward of the innermost point on the lobe 32, and with respect to lobe 50, radially inward of the outermost point on said lobe. As an additional point, when the driver 22 is rotated in the opposite direction, as would be the case in seating of the fastener 10, the areas of engagement will be on the opposite sides of the respective lobes 50 and 32, as indicated by reference 60′.

As an additional matter, the head portion 14 may include if desired, a slight countersink 64, as illustrated in Figs. 1 and 2, to further aid in the engagement of the tool and the socket 20. Also, as can be seen in Fig. 2 the upper surfaces of the lobes 32 on said socket are provided with a taper surface 65 to facilitate further engagement of the end portion 24 in said socket. While the aforementioned taper surface 65 and countersink 64 are desirable, they are of course optional features with respect to the present invention.

Attention is now directed to the auxiliary or secondary drive means employed in conjunction with the primary drive system provided by the lobular socket 20. In this regard, it will be noted that the lobular design of the socket 20 is such that at least one pair of flutes 30 are diametrically opposed. Accordingly, first and second slot means 74 and 72 are formed in the end face of the enlarged head portion 14, which slots preferably align radially with the center of curvature for the outward concaved, arcuate surface 34 serving to form the associated flutes 30. As such, with the tool 22 removed, the slots 74 and 72, in conjunction with the socket 20, provide a space for reception of a secondary drive tool (not shown) in the form of a screwdriver, or the like.

Each said slot is defined by a pair of spaced, generally parallel side walls 75 and 76, Fig. 4, a tapered or slanted end wall 78, and a planar bottom wall 80 disposed generally perpendicular to said side walls 75 and 76. The side walls 75 and 76 extend axially from the end face 82 of the enlarged head portion 14, and radially inward from the tapered end wall 78 to the outwardly concave, arcuate surfaces 36 which define the associated flute.

Most importantly, said side walls 75 and 76 intersect the arcuate surface 36 at locations 84 and 86, Fig. 4. These locations 84 and 86, are disposed along the surface 36 radially outward of the surface portions of surfaces 36 and 34 which define the areas of engagement, 60 and 60′. Thus, when the driver 22 is engaged with the socket wall 20, the normal full surface area of the socket lobes 32 is provided for resistive engagement with the lobe 50, even though the auxiliary or service slots 74 and 72 are present. Therefore, as was discussed previously in the introductory portion of the application, the operational characteristics of the primary drive system provided by the socket 20 are not compromised, in any way, by the presence of the auxiliary drive means afforded by the slots 74 and 72.

As an additional point, it should be noted that the slots 74 and 72 terminate short of the outer peripheral wall 90 of the enlarged head portion 14. Accordingly, the resulting wall structure provided by the head portion 14 and slot 20 is circumferentially continuous. This is a significant feature, as designs employing slots which extend entirely through the wall structure of the enlarged head tend to reduce the overall strength of the fastener. More specifically, when the fastener is engaged and is torqued to achieve a tight, clamped engagement with the work piece, the shank 12 is stressed in tension with the enlarged head 14 engaged against the work piece. If the service slots extended entirely through the head, the stresses established upon the enlarged head portion tend to collapse or otherwise deform the wall structure defining said slots, thereby preclude subsequent engagement of an auxiliary tool therein.

The specific design of the socket 20 as discussed above corresponds to that as illustrated in Applicant's prior patent, and sold under the Trademark Torx. This design, results in the attainment of a drive angle 92 on the order of 10—20°. In the fastener art, the drive angle is defined by a line extending generally along the engaged surfaces 60 and the radial axis or the associated lobe 50. In practice, the lower the drive angle 92, the greater the efficiency of the drive system, viz. the ratio of applied torque to driving torque transmitted to the fastener. That is to say, the applied torque transmitted from the tool to the fastener can be broken down into a radial vector, which serves no useful function, and a tangential vector, which is the driving torque applied to the fastener. The lower the drive angle 92, the greater the tangential vector, and thus the greater the efficiency of the drive system.

Accordingly, when the present invention is employed in conjunction with the specific type of drive system as illustrated in the drawings and as described in detail in Applicants' prior patent, certain additional advantages are obtained. More specifically, since the radial force or torque components are extremely low, the thickness of the wall structure may be reduced thereby resulting in a substantial savings of raw material. Further, due to the absence of damaging radial stress it is possible to have the slots 74 and 72 extend to a point closely adjacent to the outer peripheral wall surface, without the danger of weakening the drive head. Accordingly, the range of the size of the tools that can be utilized with the auxilliary drive slots is increased.

While there has been described a preferred embodiment of the present invention, it should be understood that various modifications or alterations may be employed without departing from the scope of the invention. More specifically, the particular type of lobular socket or auxiliary drive slot utilized may vary from that as illustrated, even though particular advantages follow from the use of the disclosed primary drive system. Therefore, although a preferred embodiment has been illustrated and described, it is to be understood, and indeed is intended, that various alterations in the detail or dimension may be made.

WHAT WE CLAIM IS:—

1. A socket head type fastener having an elongate shank and an enlarged head portion formed on one end of said shank, a multi-lobular drive socket formed in said enlarged head portion, with the peripheral wall surface of said lobular socket provided by a first series of inwardly convex, arcuate wall surfaces and a second series of outwardly concave, arcuate wall surfaces with said surfaces merging smoothly to define alternately disposed socket lobes and flutes, and at least two of said flutes being diametrically opposed, said socket being adapted to receive a drive tool end portion of a corresponding, multi-lobular mating configuration, with each lobe on said drive tool end portion being in engagement with the socket wall surface over a first surface area portion upon the clockwise rotation of said fastener, and in engagement with a second, oppositely disposed surface portion of said socket wall surface upon the counter-clockwise rotation of said fastener,

with said first and second surface area portions being defined primarily by said inwardly convex, arcuate wall surfaces, and auxiliary drive means formed in said head portion and including diametrically opposed first and second slot means adapted to cooperate with said socket to provide for the reception of an alternate drive tool such as a screwdriver or the like, in driving engagement with said fastener, one said slot means being associated with each said diametrically opposed flute, and said slot means opening into said socket through the outwardly concave, arcuately curved surfaces serving to define said flutes, each said slot means being defined partially by a pair of spaced, generally parallel side wall surfaces extending axially from the end face of said head portion and outwardly from said socket, said side wall surfaces intersecting said outwardly concave, arcuately curved surface of the associate flute at locations spaced along said surface, and disposed radially outward from said first and second surface area portions engaged by said drive tool lobes, such that the existence of said slots does not diminish the extent of said surface area portions available for engagement with the lobes on said drive tool.

2. A fastener according to claim 1 wherein each said slot includes an end wall surface disposed inwardly of the outer peripheral surface of said socket, thereby to provide a continuous segment of wall structure about the entire circumference of said socket.

3. A fastener according to claim 1, wherein the radius of curvature of said first series of surfaces is at least twice as great as the radius of curvature of said second series of surfaces such that the arcuate extent of said inwardly extending lobes is materially greater than the arcuate extent of said flutes.

4. A socket head type fastener according to claims 1—3 wherein said shank portion includes a threaded segment thereon.

5. A socket head type fastener according to claims 1—3 wherein each slot includes a planar bottom wall surface which is disposed substantially at right angles to said side wall surfaces and the axis of said socket.

6. A socket head type fastener substantially as hereinbefore described with reference to the accompanying drawings.

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1564684 COMPLETE SPECIFICATION

1 SHEET *This drawing is a reproduction of the Original on a reduced scale*

FIG. 1.

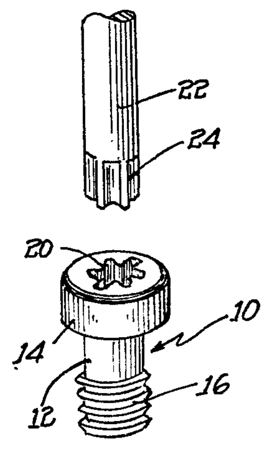

FIG. 3.

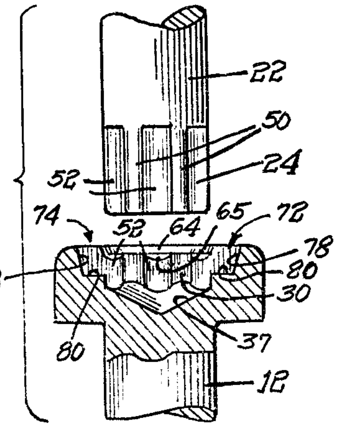

FIG. 2.

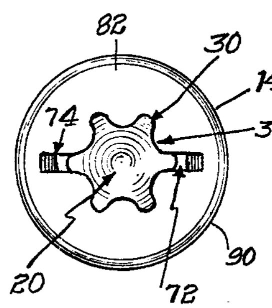

FIG. 4.