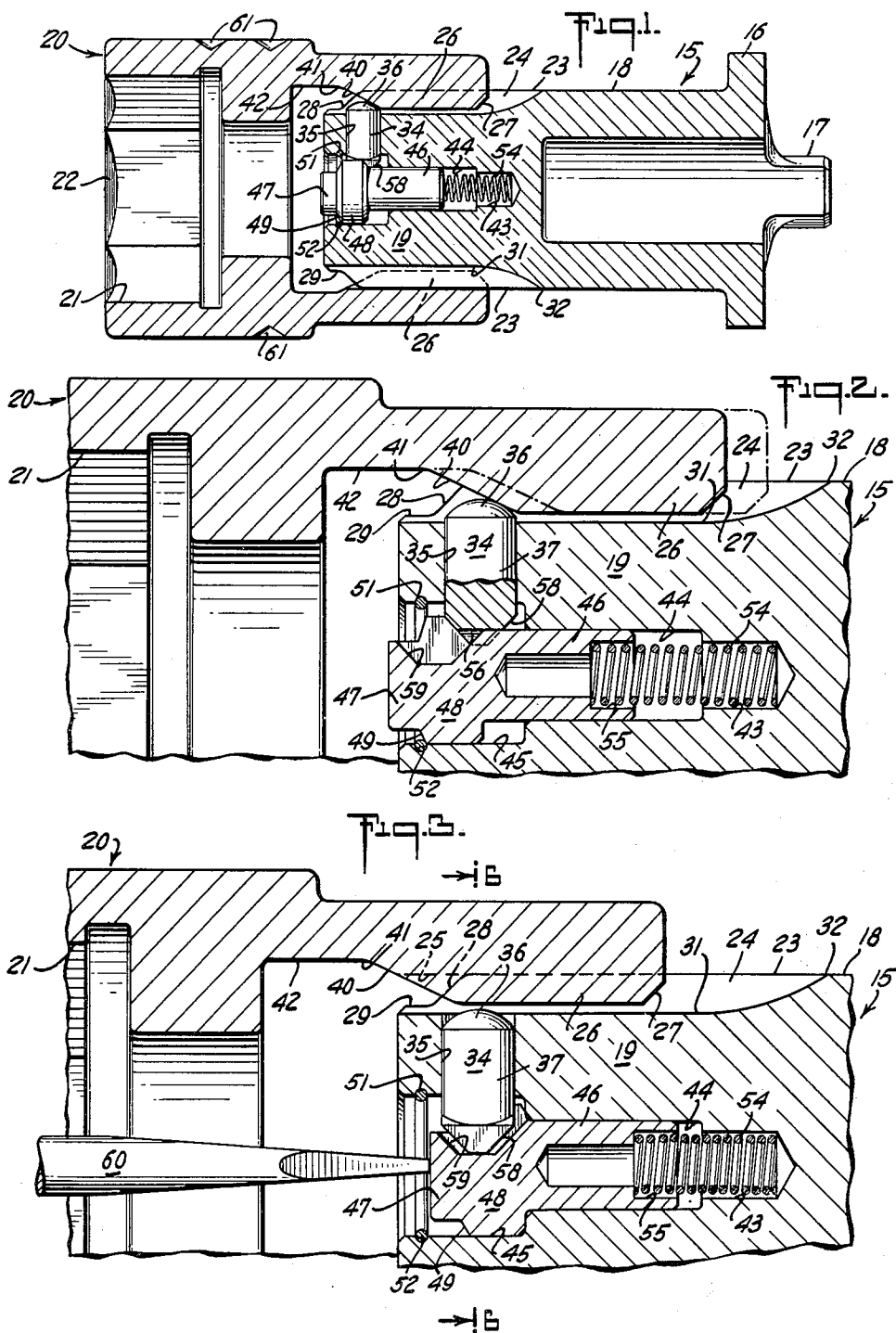


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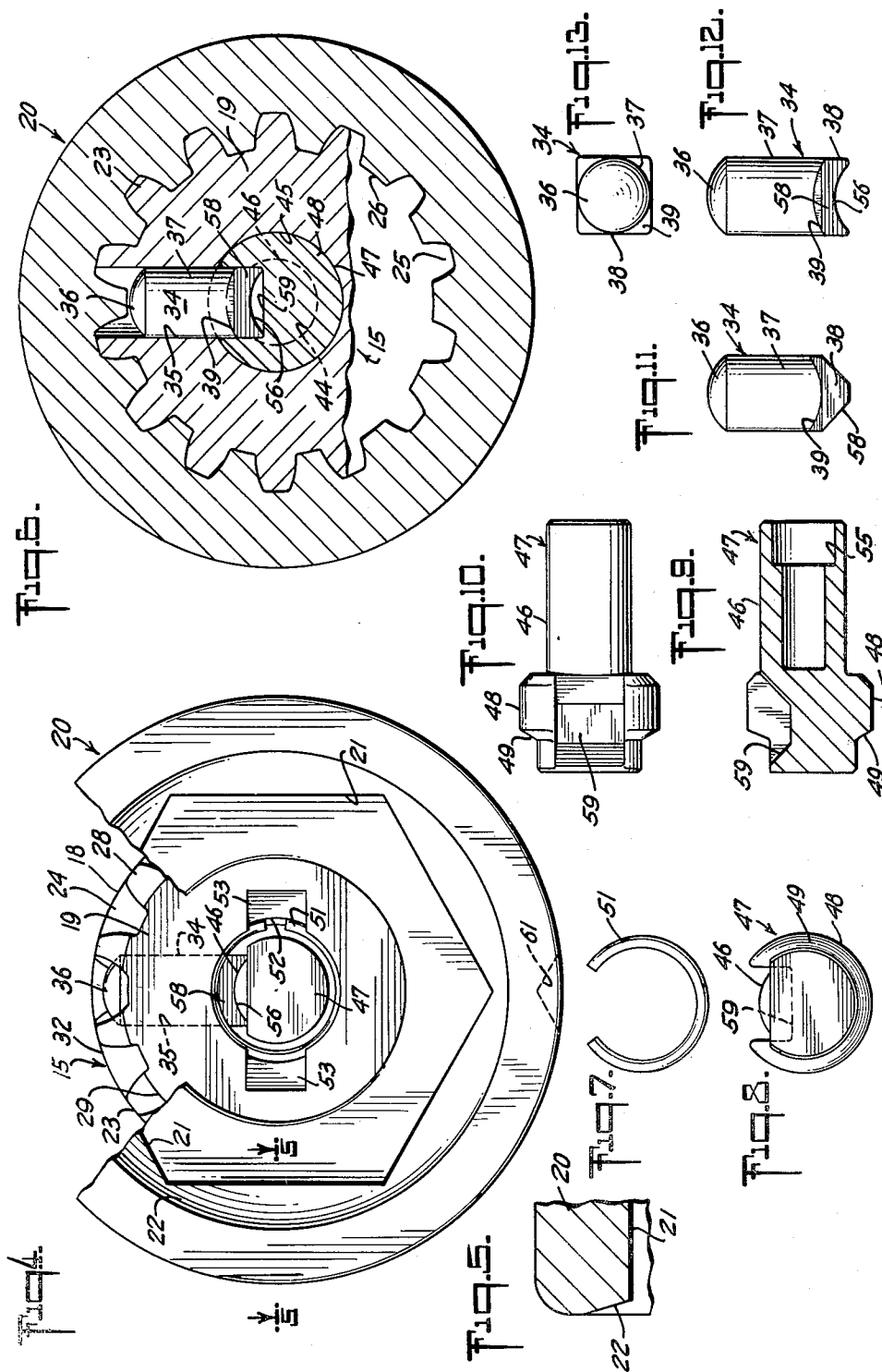
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SOCKET CONNECTING MEANS FOR A ROTARY IMPACT TOOL

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## SOCKET CONNECTING MEANS FOR A ROTARY IMPACT TOOL

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vided and this application Mar. 10, 1960, Ser. No. 14,110  
6 Claims. (Cl. 279—97)

This invention relates to rotary power operated impact tools and more particularly to a retaining means for locking an impact wrench socket against accidental separation from its driving shaft. This application is a division of parent application Serial No. 704,467, filed December 23, 1957, now Patent 2,954,994, granted October 4, 1960.

The invention has especial application to impact wrenches of the type in which the anvil has an extended shank which drives the socket with a series of torsional impacts. During the transmission of impacts, the shank is twisted intermittently and therefore is liable to fatigue failure in areas where the strain is excessive, particularly alongside a hole in the shank, which may have been provided for the reception of a retaining pin.

Various arrangements have been proposed and used for detachably locking an impact wrench socket to its drive shank. Such prior locking devices usually have one or more undesirable characteristics as follows:

(1) Location of the locking pin and of the associated radial bore in the driving portion of the shank, where the shank is subjected to great torsional strains, with the resulting liability of breakage or fatigue failure adjacent the bore.

(2) A socket recess of limited axial depth for the reception of the locking pin or detent thus requiring a precise axial alignment of the shank and socket to make the locking device effective, which alignment may fail to occur if the parts are not made to close tolerances or if they become worn in use.

(3) The need for registration of the locking detent with a socket recess of limited circumferential extent with the result that the operator loses time in orienting or adjusting the socket into proper angular relation with the driving shank when he assembles the parts.

The general object of the present invention is to overcome the disadvantages of prior devices, as above mentioned. More specifically, an object of the invention is the provision of a wrench socket retaining device which is simple in construction, reliable and effective in operation; which does not require a hole in any part of the shank which might be unduly weakened thereby; which permits the socket to float axially upon the shank without loss of effectiveness of the retainer; and which automatically and securely locks into position when the parts are assembled.

Another object is the provision of a coupling between a driving shank and a wrench socket member which comprises a set of splines adapted to transmit torsional impacts, and a retaining device including a detent engageable with the socket member along a shoulder provided at the front end of the splines.

A further object is to adapt the locking device for engagement between the detent and any selected one of a set of circumferentially spaced splines thus making the locking device effective in any selected angular position of the socket member relative to the shank.

Still another object of the invention resides in a set of driven splines within the socket member, each spline having a chamfer or cam shoulder at its opposite ends for engagement with the locking bolt or detent to move the latter to retracted position.

In accordance with the above objects, the locking bolt or detent is so located that the radial hole in the shank

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which supports the detent lies forward of the part of the shank which is subjected to torsional strain and thereby avoids the danger of breakage or fatigue failure adjacent the hole.

In the accompanying drawings, which illustrate one embodiment of the invention, and in which FIG. 1 is drawn to a smaller scale than the remaining figures:

FIGURE 1 is a longitudinal section of a shaft and socket member, in assembled relation together with the retaining means, portions of the latter being shown in elevation;

FIG. 2 is an enlarged longitudinal section of the retaining means together with fragmentary portions of the socket member and shaft in assembled relation, also showing in broken lines the position of the socket member relative to the shaft after the splined connection has been loosened by wear;

FIG. 3 is a longitudinal section showing the position of the socket member and shaft in the process of being assembled, or disassembled, with a screwdriver holding the retaining means in non-locking position;

FIG. 4 is an elevational view of the front end of the assembly, shown in FIG. 1, part of the socket member being broken away;

FIG. 5 is a fragmentary longitudinal section as indicated by the arrows 5 in FIG. 4;

FIG. 6 is a cross-section as indicated by the arrows 6 in FIG. 3 with portions of the shaft broken away, the detent being shown in full lines in non-locking position;

FIG. 7 is a detail view of the snap ring which secures the spring pressed plunger within the shaft;

FIG. 8 is a front elevational view of the plunger;

FIG. 9 is a longitudinal section of the plunger;

FIG. 10 is a plan view of the plunger;

FIG. 11 is a side elevation of the locking bolt or detent;

FIG. 12 is a front elevational view of the detent; and  
FIG. 13 is a plan view of the detent.

Referring to FIG. 1, the invention is illustrated as applied to a rotatable shaft 15 adapted to form the driven element of a power operated impact wrench, the shaft having at its rear end the usual anvil portion 16 comprising one or more jaws 17 adapted to be driven by a rotatable hammer (not shown). The shaft has a cylindrical portion 18, adapted to be supported for rotation in the impact wrench housing (not shown), and has a forwardly extending shank 19 adapted to project within the rear portion of the wrench socket member 20. The front portion of the socket member is provided with an hexagonal recess 21 to receive and drive a nut or bolt (not shown). To facilitate insertion of the latter into the socket member the recess is formed with a chamfered portion 22 shown best in FIGS. 4 and 5. The chamfered portion 22 comprises six frusto-conical surfaces each bounded by two planes at right angles to each other.

In order to provide a detachable driving connection between the shaft 15 and the socket member 20, the shank portion 19 is provided with a series of circumferentially spaced longitudinally extending splines 23 separated by longitudinal grooves 24. The driving splines 23 extend into complementary longitudinal grooves 25 (FIG. 6) formed in the wrench socket member, the latter grooves being separated by driven splines 26 extending inwardly from the socket member 20 and engaging between the driving splines 23 on the shaft. The splined connection 23, 24, 25, 26 permits relative longitudinal or axial movement between the shaft 15 and socket member 20 but prevents any appreciable relative movement in a rotary direction, whereby the full force of the torsional impacts are transmitted from the shaft to the socket member without being attenuated on account of any lost motion connection.

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To facilitate reception of the shank 19 into the socket member 20, the socket splines 26 are provided with a chamfer or inclined shoulder 27 on their rear ends, the chamfered faces forming discrete segments of a cone projecting forwardly toward an apex co-axial with the center of the shank and socket member. A similar chamfer or inclined shoulder 28 is formed near the front end of the driving splines 23 on the shank, but is separated from the front extremity of the shank by a pilot portion 29. The pilot portion consists of cylindrical surfaces broken up by the bottom portions of the longitudinal grooves 24, as best seen in FIG. 4.

The longitudinal grooves 24 in the shank are cut by a conventional hobbing machine with the result that the bottom of each longitudinal groove 24 extends in a straight line from the front extremity of the shank 19 up to the point 31 (FIGS. 2 and 3) beyond which the groove curves with increasing slope until it vanishes or merges with the cylindrical portion 18 at the point 32. Preferably the bottom of the groove 24, between the points 31 and 32, is in the shape of a circular arc tangent at the point 31 with the straight part of the bottom of the groove. When the parts are new, the splined shank may be inserted into the socket only to the extent indicated in full lines in FIG. 2 where the point of tangency 31 lies adjacent the vertex of the angle formed by the longitudinal inner edge of the driven spline 26 and the chamfer 27. As the splined connection becomes worn in use, however, the main part of the driven spline 26 gradually penetrates into the restricted part of groove 24 between the points 31 and 32. In using this invention, the operator presses the tool, including the driving shank 19, against the socket member 20, and the axial thrust is sustained by the rear ends 27 of the driven splines against the wash-out portion of the hobbled grooves 24. The invention makes it possible for the thrust to be sustained in this manner because it does not put any axial thrust upon a retaining pin. The final position of the worn out socket member relative to the shank 19 is illustrated in dot-dash lines in FIG. 2.

In order to prevent the socket member 20 from becoming accidentally detached from the driving shaft 15, the present invention provides a locking bolt or detent 34 mounted for sliding movement in a transverse or radial bore 35 in the shank 19. The axis of the transverse bore 35 lies in the same plane as one of the longitudinal grooves 24. As shown in FIGS. 3, 11, 12 and 13, the detent has a convex upper tip 36 preferably shaped as a spherical zone, a cylindrical portion 37 lying below the convex tip and fitting the radial bore 35, and a base portion 38 separated from the cylindrical portion by a shoulder 39. As seen in FIG. 6, the center of the radial bore 35 lies midway between two adjacent driving splines 23 with the result that only a small part of both splines is cut away. As seen in FIGS. 1, 2 and 3, the radial bore 35 is situated near the front end of the shank 19, a part of the bore opening into the chamfered portion 28 of the driving splines 23. This location is forward of the area where the torque is transmitted through the splines, and therefore obviates or lessens the danger of breakage or fatigue of the shank 19 because the latter is not subjected to any substantial torsional strain in the cross sectional area which includes the radial bore.

When the detent 34 is in its retracted position, shown in FIGS. 3 and 6, the convex tip 36 lies below the longitudinal groove 24 of the shank and out of the path of movement of the driven splines 26, and therefore does not interfere with axial movement of the socket member 20 in either direction relative to the shaft 15. When the detent 34 is extended, however, as shown in FIGS. 2 and 4, the convex tip 36 lies in the direct path of movement of one of the driven splines 26. In its extended position the convex tip 36 is adapted to engage an inclined shoulder 40 formed on the front end of the associated driven spline 26. Preferably, there is a similar

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inclined shoulder 40 formed on each of the driven splines so that the detent may be effective in any selected angular relation between the driving shaft 15 and the socket member 20. The shoulders 40 are arranged to form discrete segments of a cone tapering rearward toward an apex in line with the center of the socket member. Each shoulder 40 extends from the crest of the driven spline 26 outward and rearward to the root of the driven spline where the inclined shoulder 40 meets a rounded corner 41 connected to an annular recess 42 formed in the socket member 20 near the mid-portion thereof. Preferably, the recess 42 is of cylindrical shape and has a diameter slightly exceeding the depth of the longitudinal grooves 25. In the process of manufacture of the socket member 20, the cylindrical, frusto-conical and toroidal surfaces are formed by a machining operation, and then the longitudinal grooves 25 are cut by a broaching operation to form the driven splines 26. In the operating condition of the parts, as shown in FIG. 2, the convex tip 36 on the detent engages the associated inclined shoulder 40 when the parts are new but lies forward of the shoulder 40 in operating condition when the parts are worn. If desired, however, the detent may be positioned to lie forward of the inclined shoulder even when the parts are new, the relative axial position not being critical. Upon application of a force tending to remove the socket member 20 from the shank 19, the inclined shoulder 40 engages the detent with a camming action and thus tends to move it downward or radially inward. As long as the detent is locked against such downward movement, however, the socket member is positively locked against separation from the shank.

When the socket member 20 is pulled away from the shank 19 with sufficient force to overcome friction, the inclined shoulder 40 acts as a cam to force the detent downward to retracted position, and thus permits removal of the socket, provided, however, that the inner end of the detent is unopposed in such motion.

The means for selectively permitting movement of the detent 34 to retracted position, or for positively locking it in extended position, will now be described. For the reception of such selective means, the shaft 15 is provided with an axial bore 43, an intermediate counterbore 44 in front of said bore, and a larger counterbore 45 extending to the front extremity of the driving shaft 15. The intermediate counterbore supports for relative axial (but not relative rotative) movement, the cylindrical or stem portion 46 of a plunger 47, which is shown in detail in FIGS. 8, 9 and 10. The plunger has a head portion 48 generally of cylindrical shape and slidably fitting the large counterbore 45, the front end of said head terminating in a shoulder 49 normally seated against a snap ring 51 (FIG. 7). The snap ring is mounted in an annular groove 52 formed in the large counterbore 45. To facilitate removal of the snap ring, the front extremity of the drive shaft 15 is provided with a pair of recesses 53 (FIG. 4) permitting the reception of an implement such as a screwdriver (not shown) between the snap ring and the surrounding annular groove 52. The plunger shoulder 49 is yieldingly held in its extreme forward position, in engagement with the snap ring 51, by means of a compression spring 54 interposed between the driving shaft 15 and the plunger 47, the rear portion of the spring fitting within the axial bore 43 and the front portion fitting within a counterbore 55 (FIG. 9) formed at the rear end of the plunger 47. When the plunger is in its normal forward position, as shown in FIG. 2, the cylindrical stem 46 thereof fits within a cylindrical recess 56 (FIG. 12) at the inner end of the detent 34, and thus positively locks the detent in its extended position, while the detent in turn acts as a positive lock upon the inclined shoulder 40. The detent shoulder 39 is in the shape of a square whose sides are each equal in length to the diameter of the cylindrical portion 37 of the detent but whose corners project outwardly a substantial distance beyond the

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diameter of portion 37 as shown in FIG. 13. The radial bore 35 (FIG. 2) in shank 19 has the same diameter as the cylindrical portion 37 with the result that the detent shoulder 39 cannot enter into the radial bore but instead is adapted to abut against the large counterbore 45 to limit outward movement of the detent toward extended position when such movement is not otherwise limited by engagement with the socket member 20. Below the shoulder 39, the detent has a tapered portion 58 adapted to be received within a correspondingly tapered recess 59 provided in the plunger 47, when the latter is forcibly displaced against the pressure of spring 54, to the unlocking position shown in FIGS. 3 and 6.

In the use of the present invention, when the operator desires to attach the socket member 20 to the shaft 15, he holds these two elements approximately in axial alignment and moves them together until the pilot portion 29 abuts against the chamfer 27 and starts to enter the central opening which is surrounded by the driven splines 26. The socket member and shaft are then aligned axially with the beveled front edges 28 of the driving splines 23 seated against the chamfered shoulder 27. The operator then orients the socket member 20 and shaft 15 to bring the driving splines 23 into alignment with the grooves 25 between the driven splines 26 and vice versa. The splines move a slight distance into inter-engaging relation when axial motion is arrested by engagement of the convex tip 36 of the locking bolt or detent 34 with the chamfered shoulder 27. At this time, the detent is positively locked against inward or retracting movement by the plunger 47. Outward movement of the detent, however, is limited by engagement of shoulder 39 with the large counterbore 45 so that the detent does not engage any part of the socket member outwardly of the chamfered shoulder 27.

The operator then releases the plunger by inserting his finger, or a suitable implement such as a screwdriver 60 (FIG. 3), through the front end of the socket member 20 to engage the front face of the plunger 47 and move it away from the snap ring 51 with the plunger recess 59 positioned to receive the tapered portion 58 at the inner end of the detent. Thereupon the chamfered shoulder 27 reacts upon the convex tip 36 to displace the detent 34 to its inward or retracted position by a camming action, and the splined shank 19 may be inserted freely into the splined portion of the socket member 20. As soon as the detent 34 passes beyond the chamfered shoulder 27 and engages the longitudinal crest of the associated driven spline 26, the screwdriver 60 may be released, as the engagement with the driven spline prevents the detent from being extended. After the detent passes the main part of the driven spline 26 and starts to engage the inclined shoulder 40, the detent is released for movement to the extended or locking position. Assuming that the manual force has been removed from the plunger 47, the detent is moved outwardly by the camming action of the rear part of tapered recess 59 on the tapered portion 58 of the detent, as the spring 54 moves the plunger 47 forward into or toward engagement with the snap ring 51. The parts then occupy the position shown in FIG. 2 with the stem 46 of the plunger locking the detent 34 against inward or retracting movement, and the detent acting on the inclined shoulder 40 to lock the socket member 20 against separation from the driving shank or anvil. To remove the socket member, the operator simply unseats the plunger as illustrated in FIG. 3 and separates the socket member from the shank with a pulling or hammer action. Axial movement of the socket member in a releasing direction causes the inclined shoulder 40 to cam the detent 34 toward release position, as described in connection with the chamfered shoulder 27.

If desired, the periphery of the socket member 20 may be provided with depressions or recesses 61 for the reception of a bright plastic material (not shown) to enable the operator to count the number of turns, or half turns,

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of the socket member under impacting conditions and thus control the tightness of the nut or bolt (not shown) driven by the socket member.

While the invention has been described with reference to a single embodiment, it is susceptible of variations and modifications.

What is claimed is:

1. In a rotary impact tool, an anvil having a shank at its front end, a socket member detachably mounted on the shank, interengaging driving means between the shank and socket member for the transmission of torsional impacts, and retaining means for locking the socket member against accidental displacement from the shank, said retaining means comprising a shoulder in the socket member in front of the driving connection, a detent mounted in a radial bore in the shank and adapted to project outward beyond said bore into locking engagement with the shoulder, said radial bore being disposed forward of the interengaging means and forward of the region of maximum torsional strain of the shank under impact, whereby to obviate breakage and fatigue failure of the shank around the bore.

2. In a power operated impact wrench, a rotatable shaft having an anvil portion at its rear end provided with one or more impact receiving jaws, and having a shank portion at its front end for reception within a driven socket member, said shank portion having a plurality of longitudinally extending driving splines interrupted by longitudinal grooves, and having a pilot portion of reduced diameter in front of the splined portion, each spline having a straight crest extending parallel to the axis of rotation of the shank and having an inclined shoulder extending from the front of the straight crest to the pilot portion of the shank, said shank having a transverse bore for the reception of a locking bolt or detent engageable with the socket member, the outer end of said transverse bore lying adjacent the inclined shoulder of any selected one of the associated splines and forward of the area of the splined shank subjected to torsional strains under impact, whereby to minimize the danger of breakage or fatigue failure of the shank adjacent the transverse bore.

3. A rotatable shaft as defined in claim 2, in which the axis of the transverse bore lies in the same plane as one of the longitudinal grooves and is centrally located between the crests of two adjacent splines, portions of said splines being cut away along the cylindrical wall of the transverse bore, said cut away portions extending to the crests to permit the detent to be projected beyond the crests.

4. A power operated impact wrench comprising a rotatable shaft having an anvil portion at its rear end provided with one or more impact receiving jaws, and having a cylindrical portion in front of the anvil portion, and having a shank portion in front of the cylindrical portion; a socket member detachably mounted on the shank; interengaging driving means between the shank and socket member, said interengaging means comprising a plurality of evenly spaced longitudinally extending driving splines integral with the shank, the crests of said splines forming discrete segments of a cylindrical surface, interrupted by longitudinal grooves between the splines; said interengaging means also including a plurality of longitudinally extending driven splines projecting inward from the socket member, the crests of the driven splines forming discrete segments of a cylindrical surface interrupted by longitudinal grooves between the driven splines, each of said driven splines having a shoulder portion at the front end of the cylindrical crest, each of said driven splines also having a chamfer portion extending rearwardly and outwardly from the rear end of the cylindrical crest; each of the longitudinal grooves in the shank having a bottom edge extending from the front extremity of the shank in a straight line adjacent the

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crest of the driven spline, the rear end of the longitudinal groove in the shank having a wash-out portion formed by a hobbing operation, the wash-out portion being in the shape of an arc which is tangent to the straight line portion and which curves outwardly and rearwardly; the driving and driven splines interfitting snugly in a circumferential sense to provide for transmission of torsional impacts from the shank to the socket member without attenuation due to lost motion, the driving and driven splines being arranged to permit relative axial movement between the shaft and socket member, the driven splines being arranged to engage the wash-out portions of the longitudinal grooves between the driving splines to limit such axial movement in one direction; and releasable retaining means for limiting such relative axial movement in the other direction, said releasable retaining means comprising a detent mounted in a transverse bore in the shank, the outer end of the detent being engageable selectively with the shoulder portion of any one of the driven splines, the outer end of the said transverse bore lying forwardly of the cylindrical crest portions of the driven splines and therefore forwardly of the region of the shank subjected to the maximum torsional strains.

5. A power operated impact wrench according to claim 4, in which the shoulder portions on the driven splines are inclined to form discrete segments of a

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conical surface interrupted by the grooves between the driven splines, and in which the outer end of the detent has a convex surface, whereby movement of the shaft and detent in a rearward direction relative to the socket member causes the inclined shoulder portions to exert a camming force on the detent which tends to move the latter to releasing position.

6. A power operated impact wrench according to claim 5, in which the shank has an axial bore open at its front end and has a rear bore communicating with the axial bore, said axial bore being adapted for the reception of a reciprocable plunger selectively interposed in the path of movement of the detent, said rear bore being adapted for the reception of a spring for actuating the plunger, the rear bore being of less diameter than the axial bore to provide greater cross-sectional area of the shank in a region of relatively greater torsional strain.

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