April 14, 1964 B. C. KEASLER 3,128,655

BLIND BOLT INSTALLATION TOOL WITH PRELOADED TORQUE-RESPONSIVE DRIVING MECHANISM

Filed June 22, 1962

Fig. 1.

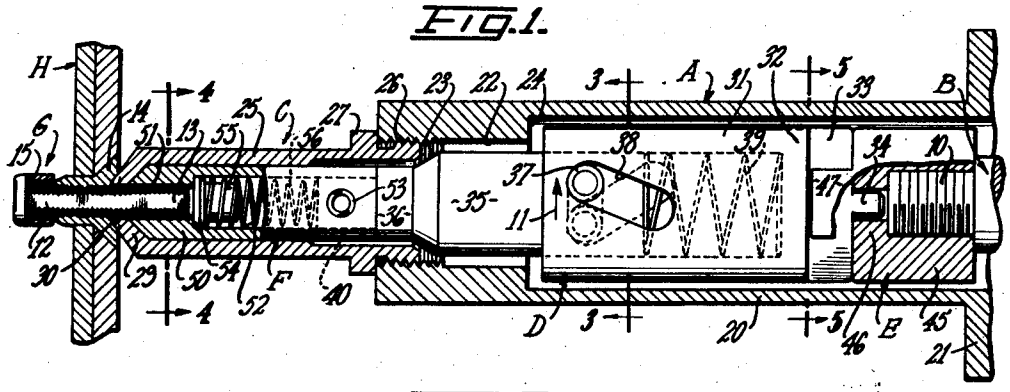


Fig. 2.

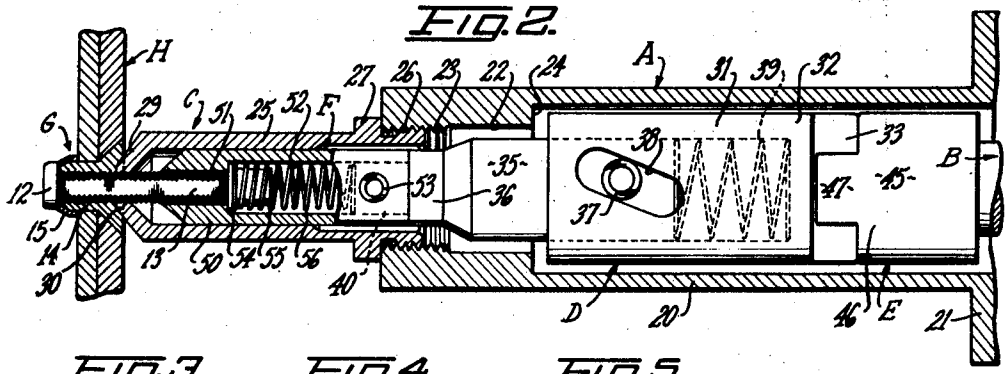


Fig. 3.

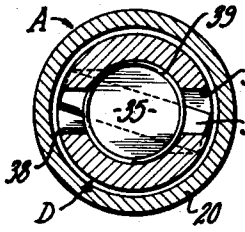


Fig. 4.

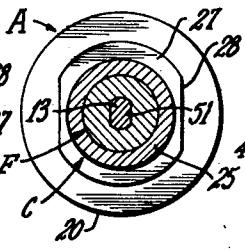


Fig. 5.

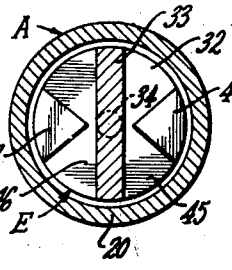


Fig. 8.

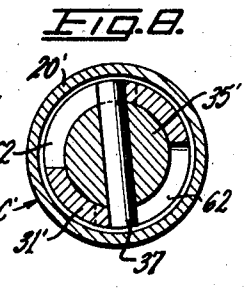


Fig. 6.

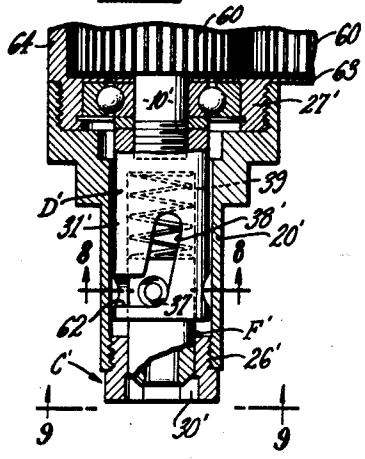


Fig. 7.

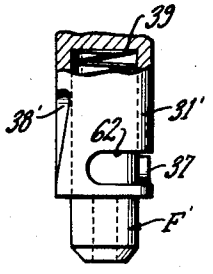
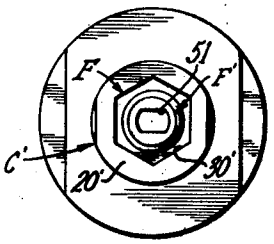


Fig. 9



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United States Patent Office 3,128,655 Patented Apr. 14, 1964

3,128,655

BLIND BOLT INSTALLATION TOOL WITH PRELOADED TORQUE-RESPONSIVE DRIVING MECHANISM

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Filed June 22, 1962, Ser. No. 204,479
10 Claims. (Cl. 81—55)

This invention relates to a power-operated nut-holding wrench for driving a blind bolt into a nut, of the general class exemplified by the wrench disclosed in a patent of Joseph La Torre No. 2,789,597, granted April 23, 1957.

The operation of blind bolt driving wrenches in common use during the past ten years has always required the application of considerable forward pressure against the driving gun to maintain the screw-rotating wrench tip and the nut-holding socket coupled to the respective parts of the blind bolt while rotational torque is applied to the screw and holding torque is applied to the nut. The amount of axial pressure which thus must be applied by the workman in order to set the bolt, in some of the larger sizes, is of such a magnitude as to make it impracticable to utilize the conventional power-driven tool and it is customary, with those sizes, for the workman to do the operation by hand, using one wrench for holding the nut and another wrench for turning the screw. This operation is quite time-consuming. The use of the motor driven tool, on the other hand, is tiring because of the necessity for the workman to lean his weight against the tool during the driving operation.

With the foregoing in mind, the principal object of this invention is to provide a motor-driven blind bolt driving tool embodying torque-energized mechanism for automatically applying an axial thrust against the screw-wrenching tip of the tool, neutralizing the normal resistance of the wrenching tip to the axial movement of the screw in entering the nut.

Other objects and advantages will become apparent in the ensuing specification and appended drawing in which:

FIG. 1 is an axial sectional view of a blind bolt wrenching tool embodying my invention, with portions of the screw-wrenching mechanism shown in elevation and at a starting point in a blind bolt-setting operation;

FIG. 2 is an axial sectional view of the same parts, moved to their relative positions at the end of a normal driving operation;

FIG. 3 is a cross-sectional view taken on the line 3—3 of FIG. 1;

FIG. 4 is a cross-sectional view on the line 4—4 of FIG. 1;

FIG. 5 is a cross-sectional view taken on the line 5—5 of FIG. 1;

FIG. 6 is a view, partially in axial section and partially in elevation, of a right-angle driver embodying a modified form of the invention;

FIG. 7 is a side view of the wrenching tip assembly, viewed at right angles to the line of sight in FIG. 6;

FIG. 8 is a cross-sectional view taken on the line 8—8 of FIG. 6; and

FIG. 9 is an end view of the driver of FIG. 6.

General Description

Referring now to the drawings in detail, and in particular to FIGS. 1–4, I have shown therein, as an example of one form in which my invention may be embodied, a blind bolt driving tool of an in-line assembly type, embodying, in general, a housing barrel A attached to and projecting forwardly from a gun or motor, fragmentarily indicated at B; a nut-holding tip C mounted to the forward end of barrel A and projecting forwardly therefrom; a

torque-responsive wrenching drive transmitting assembly D adapted to receive rotary drive from the drive shaft of the gun B or motor through a dog clutch unit E; and a wrenching tip F detachably secured to the forward end of the drive unit D. The tool is shown in driving relation to a blind bolt G projecting through adjacent sheets of work H to be secured together.

The tool may utilize any conventional driving gun (a power unit embodying a motor, e.g. an air motor or other type of motor) encased in a housing to the forward end of which the barrel A is attached. Such housing may embody a suitable pistol grip or other means for holding and manipulating the tool, customarily provided as illustrated in the aforesaid La Torre Patent No. 2,789,597. The motor has a drive shaft projecting forwardly through the housing and terminating in a driving end which is shown herein as an externally threaded spindle **10**.

Rotation is clockwise as viewed by the operator holding the tool and facing the work. This direction is indicated by the arrow **11** in FIG. 1. The blind bolt G embodies a screw **12** having a left-hand thread and embodying flats or other driving means on a break-off stem **13** which is twisted loose or broken off from the screw **12** by increase in driving load when the bolt is fully set; a nut **14** threaded onto the screw **12**; and a fastener collar **15** (or a conical head on screw **12** to expand nut **14**). The collar **15** is expanded to form a head at the blind end of the bolt by expansion over a conical mandrel at the forward end of the nut **14** as the screw **13** is drawn rearwardly into the nut, the collar **15** being driven by the head of the screw **12**. The wrenching tip F is coupled to the stem **13** by suitable wrenching faces of a socket **51** (e.g. flat faces as shown, or grooves) engaging the non-cylindrical wrenching faces of the stem **13**, the rounded faces of the socket being out of engagement with the thread segments of the stem. The nut **14** is held stationary by a suitable wrenching connection between the holding tip C and the nut. As the screw is drawn rearwardly, the driving tip F is correspondingly urged rearwardly by the stem **13**, and this movement is facilitated by the torque-responsive action of the drive unit D, until it is retracted to the position shown in FIG. 2, at which point the resistance to the driving of the collar **15** or the conical head of screw **12** into nut **14** will sharply increase by abutting engagement of the collar **15** against the work H and the development of compression in the collar. Consequently the stem **13** will be twisted or broken off at a predetermined point, completing the operation, and the gun can then be withdrawn.

Detailed Description

Barrel A comprises a cylindrical body portion **20** having at its rear end a suitable coupling portion **21** (e.g. threaded or other attaching means) for coupling connection to the forward end of the housing of gun B, and having at its forward end a reduced throat **22** terminating in an internal thread **23** to receive and mount the holding tip C. An annular bearing shoulder **24** is provided between throat **22** and the major internal wall of body **20**.

Holding tip C comprises a body in the form of a cylindrical sleeve **25** having at its rear end an externally threaded nipple **26** for coupling it to the thread **23**; having, adjacent said nipple **26**, a suitable integral wrenching collar **27** with wrenching flats **28** (FIG. 4) for manipulating it into and attaching it to, also for detaching it from the barrel A; and having at its forward end an angled nose **29** provided with suitable wrenching jaws **30** engageable in drive recesses or protrusions of any suitable type in the rear end of the nut **14**, for establishing a holding connection therewith. A left hand thread in throat **22** and on the nipple **26** will provide for

maintaining a tight coupling connection between the parts C and A under the torque reaction load imposed on the holding tip C by the nut **14**.

Drive transmission unit D comprises a cylindrical socket **31** which may, as in the form shown in FIG. 1, be of cup shape including a closed rear end portion **32** terminating in a diametrically extending integral clutch jaw **33** for a clutching connection to the clutch device E, and terminating in an axially disposed pilot pin **34**. Rotatably mounted in a cylindrical bore within the socket **31**, and projecting forwardly through the open end thereof, is a driven shaft **35** which has a reduced forward end portion **36** terminating in a cylindrical tang **40** projecting into the rear end portion of wrenching tip F. A drive pin **37** (FIG. 3) projects diametrically through the driven shaft **35**, is securely mounted in a diametral bore therein, and has projecting end portions engaged in helical slots **38** in the driving socket **31**. A light coil spring **39** is interposed under compression between the rear end of driven shaft **35** and the bottom of socket **31** defined by end member **32**. Spring **39** normally projects the driven shaft **35** to a forward position shown in FIG. 1, but yields to permit the retraction of the driven shaft **35** to the retracted position shown in FIG. 2. The direction of helical inclination of slots **38** is so related to the direction of drive rotation **11** as to develop, by camming action against the projecting ends of pin **37**, a rearward pull against the driven shaft **35**.

Clutch E comprises a cylindrical body **45** having an internally threaded socket for coupling it to the threaded spindle **10** of the gun drive shaft. Forwardly of the socket, it has a head **46** provided with a central bore to receive the pilot **34** of drive socket **31**. Head **46** has a pair of integral clutch jaws **47** of approximately 90 degree quadrant form, in diametrically opposed relation, projecting forwardly therefrom and embracing the diametral clutch jaw **33** of socket **31** with a rotary lost-motion driving connection which accommodates indexing of the driving tip F into wrenching position in relation to the holding tip C when the gun is initially applied to the bolt.

Driving Tip F comprises a cylindrical body **50** journalled for rotation in the bore of the holding tip C, having a wrenching socket **51** broached therein along its longitudinal axis, to fit the cross sectional contour of stem **13**, receiving the same and providing driving connection therewith. In its rear end, the body **50** has a counterbore **52** (FIG. 2) receiving the coupling tang **40** of drive unit D and secured thereto by a fastener pin **53** driven through registering bores in the coupled parts. The rear end of the broached socket **51** is normally blocked by an ejector plug **54** (FIG. 2) which, as indicated in FIGS. 1 and 2, may be slidable in the counterbore **52**. Plug **54** has a stem **55**, and is yieldingly supported by a coil spring **56** interposed under compression between the plug **55** and the forward end of coupling tang **40** and encircling the stem **55**.

In normal operations of the tool, the wrenching socket **51**, open and unobstructed in its rear portion, offers no opposition to rearward sliding movement of the stem **13** in the socket except for the torque-energized cramping grip of the wrenching faces of the socket **51** against the flat faces of stem **13**. The axial thrust transmitted from the stem **13** to the wrenching tip F through such cramping grip will be sufficient, when added to the camming action of drive pin **37** and slots **38**, to cause the wrenching tip F and driven shaft **35** to retract.

Where a screw of abnormal length, such that its rear end will engage and retract the plug **54** when the tool is applied to nut **14**, is being driven, the rearward thrust of the stem **13** against the plug **54**, transmitted to the driven shaft **35**, will retract it against the compression of spring **39**, the camming action between the drive pin **37** and the helical slots **38** being operative to assist such retracting movement of the shaft **35** into the socket **31** by neutralizing resistance thereto. As a still further alternative, it is possible to utilize an unyielding bottom at the rear end of socket **51** (as by extending tang **40** down to the position of plug **54** and eliminating the spring **56** and plug **54** so as to provide, in effect, an integral bottom for the socket). In the operation of the tool in this instance, the retracting movement of stem **13** will be positively transmitted to the wrenching tip F through the bottom of its socket, but the reactive thrust against the tool in the hands of the workman will be balanced out by the camming action between drive pin **37** and helical slots **38**.

Modified form—FIGS. 6–9.—Referring now to FIGS. 6–9, there are shown therein a number of modified features that may be embodied in the invention. Principally, the modification arises in the adaptation of the invention to an angle driver instead of the in-line type shown in FIGS. 1–5. In this arrangement the drive comes through gears **60** extending at right angles to the driving axis of the tool, from the motor to the terminal drive shaft element having the threaded drive spindle **10'** thereon. Since this type of tool is customarily utilized in confined spaces where the axial depth of the tool along the axis of its driving tip is held to a minimum, the lost-motion clutch unit E is eliminated and the drive socket **31'** is directly coupled to the threaded drive spindle **10'** at its rear end. In lieu of the lost motion clutch unit E, there is provided in the drive socket **31'** a pair of circumferentially extending slots **62** communicating with the forward ends of the helical camming slots **38'**. The driving pin **37** of wrenching tip F' is oscillatable in the circumferential slots **62** in the initial stage of application of the tool to the blind bolt, to provide the lost motion self-indexing action of the clutch unit E, and the rearwardly extending slots **38'** perform the function of slots **38** of FIG. 1. The somewhat modified form of nut-holding means (a non-cylindrical socket **30'**) which in its specific aspect forms no part of the present invention, is disclosed in FIG. 6 as an alternative to the holding jaws **30** of FIG. 1. It may have a threaded connection **26'** with barrel **20'**. The coupling ferrule **27'** in this arrangement is shown as an integral part of cover plate **63** of the gear case **64** which corresponds broadly to the gun housing (referred to but not disclosed) of FIGS. 1 and 2. The barrel portion **20'** is bored to receive the entire torque-responsive drive unit D' of the modification, and is directly coupled to the gear case **64** as shown, through a threaded collar at its rear end. In other respects, the invention of FIG. 6 embodies the features of the apparatus shown in FIGS. 1–4 except as stated hereinafter.

Operation

The improvement in operation of my tool over the conventional tool will be better understood by first considering more in detail the operation of the conventional tool. In a tool, such as that shown in the La Torre patent referred to above, wherein the rotating wrenching tip and the fixed holding tip remain in axially-fixed relation while the stem of the screw is drawn axially into the driving socket of the holding tip, retracting a spring-loaded ejector pin in doing so, the torque load transmitted between the driving faces of the wrenching socket and the corresponding faces of the screw stem, causes these faces to frictionally grip one another, creating a drag between the stem and the wrenching socket which gradually increases with increasing torque as the collar **15** is pushed further onto the angled end of nut **14**, and since the screw is being positively driven through the nut by the wrenching action, this drag transmits a corresponding backward axial thrust from the screw stem to the wrenching tip F tending to uncouple the tool **29** from the nut **14**, thus allowing assembly G to rotate with driver F, and damaging the driving end of nut **14**. The backward thrust must be overcome by the operator as he leans forwardly against the tool, in order to prevent the tool releasing itself from the nut **14**. In addition, to this drag-induced thrust, the operator must overcome the spring load on the ejector pin which is being retracted by the rearward movement of

the screw stem. As previously stated, the aggregate axial counter-thrust that is developed in the conventional tool during a bolt driving operation is of such magnitude that it becomes impractical for the average workman to drive some of the larger sizes of blind bolts, using the conventional tool.

In the operation of my improved tool, the camming angle of slots **38** (as subtended from the driving axis of the tool-coaxial with tips C and F) is such as to develop a camming effect sufficient to equal the counter-thrust developed in the conventional tool, and to make it unnecessary for the workman to exert a forward thrust in excess of the relatively mild forward thrust required for maintaining the holding jaws **30** of the holding tip C socketed in the nut recess or otherwise coupled to the head of nut **14**. I find that a camming angle in the range between 10° and 30° may be utilized.

In normal operation of the tool, as the screw **12** is threaded into the nut **14**, its axial movement will be matched by a corresponding retracting movement of the wrenching tip F, transmitted to it from screw **12**. This will occur regardless of whether the stem **13** engages an integral bottom of socket **51**, transmits movement through pin **54** and spring **56**, or transmits axial movement through frictional engagement against the side walls of socket **51** under the torque transmitted between the wrenching tip F and the stem **13**.

I find that the tool can be operated as readily on the largest sizes of blind bolts as on the smaller sizes for which the conventional tool is most satisfactorily adaptable. Also, it may be noted that by selecting different sizes of holding tip C and wrenching tip F, and by utilizing the detachable couplings of these tips of the driving unit D and the barrel A respectively, it becomes possible to use the same gun for the various sizes of bolts.

Where the spring-loaded plug **54** is incorporated in the tool, it can under some circumstances be utilized as an ejector device. For example, if the stem **13** has a length sufficient to displace the plug **54** rearwardly in the starting position of FIG. 1, the application of the tool into coupling engagement with the blind bolt G will result in the plug **54** being retracted against the compression of spring **56**. In this instance, the angle of inclination of slots **38** may be sufficient to absorb the load of spring **56** as well as the normal resistance to retraction of driving shaft **35**. As torque is applied following the coupling connection of the tool with the bolt G, the torque-induced drag between wrenching tip F and stem **13** normally is such as to hold the parts in the relative positions attained by the coupling of the tool to the bolt, with the plug **54** remaining in its original position and the wrenching tip F being retracted with the assistance of the torque reactive action in driving unit D, in step with the movement of screw **12** into the nut.

Where ejector plug **54** is retracted by a long screw, it would be held retracted up to the point of twist-off of stem **13**, thus releasing the part and, as the tool is withdrawn from the work, the plug **54** would become operative to eject the severed stem **13** from the forward end of the tool, assisted by the bodily forward movement of shaft **35** under the propulsive effect of spring **39**. In the preferred form of the invention shown herein, the camming slots **38** have an angle such that the torque reaction between the pin **37** and slots **38** just neutralizes the resistance to retraction of the shaft **35** into the socket **31** (developed in the torque-loaded drive-transmitting coupling between the drive parts **31** and **35**) in addition to overcoming the load of spring **39**. Thus the shaft **35**, while being driven at full torque, is free to retract in unison with the axial movement of screw **13**, offering no resistance to such axial movement. By thus balancing the torque-energized axial pull of socket **31** on shaft **35** against the spring load and the torque-loaded resistance to retraction of shaft **35**, it is possible for the drive unit D to operate in this manner without utilizing

an end-thrust bearing at its forward end to restrain it from forward creeping during a driving operation. Annular bearing shoulder **24** limits any possible forward drift of socket **31**.

I claim:

1. In a tool for setting a bolt-type fastener comprising respective nut and screw elements having wrenching surfaces at the same end of the fastener, in combination: inner and outer wrenching members, one telescoped within the other; means for holding one of said members against rotation; and means for transmitting rotation to the other member, said last means comprising parts relatively shiftable axially and having limited rotative movement with respect to one another, one of said parts transmitting drive to said other member and the other of said parts receiving drive from a motor, and torque-reactive means comprising interengaging surfaces of said parts, at least one of which has an angular inclination with reference to the driving axis of the tool, thereby coupling said parts in a manner to substantially eliminate resistance to retraction of said one part when transmitting torque, whereby said one part may retract in unison with the axial movement of one of said fastener elements with respect to the other as the fastener is closed against parts to be fastened.

2. In a tool for setting a bolt-type fastener comprising respective nut and screw elements having wrenching surfaces at the same end of the fastener, in combination: inner and outer wrenching members, one telescoped within the other; means for holding one of said members against rotation; and means for transmitting rotation to the other member, said last means comprising a tubular part and a shaft part socketed in said tubular part for limited rotary and axial movements therein, a helical camming groove in said tubular part, a drive projection extending radially from said shaft part into said groove, a rotary drive connection between one of said parts and said other member; and means for transmitting rotary drive to the other part, said camming groove being pitched so as to resolve the drive torque into an axial component balancing out the resistance of the torque-loaded coupling connection between said parts to the axial drawing of said parts together, whereby one of said parts may retract in unison with the axial movement of one of said fastener elements as the fastener is closed against interposed work parts, without resisting such axial movement.

3. In a tool for setting a bolt-type fastener comprising respective nut and screw elements having wrenching surfaces at the same end of the fastener, in combination: inner and outer wrenching members, one telescoped within the other; means for holding one of said members against rotation; and means for transmitting rotation to the other member, said last means comprising a tubular part and a shaft part socketed in said tubular part for limited rotary and axial movements therein, a helical camming groove in said tubular part, a drive projection extending radially from said shaft part into said groove, means spring-loading said parts for relative axial movement in which said projection assumes one limit position of helical movement in said slot, and a rotary drive connection between one of said parts and said other member; and means for transmitting rotary drive to the other part, said camming groove being pitched so as to resolve the drive torque into an axial component balancing out the resistance of the torque-loaded coupling connection between said parts to the axial drawing of said parts together, whereby one of said parts may retract in unison with the axial movement of one of said fastener elements as the fastener is closed against interposed work parts, without resisting such axial movement.

4. In a tool for setting a bolt-type fastener comprising respective nut and screw elements having wrenching surfaces at the same end of the fastener, in combination: inner and outer wrenching members, one telescoped

within the other; means for holding the outer member against rotation; and means for transmitting rotation to the inner member, said last means comprising a driving socket adapted to receive drive from a power source at its rear end and a shaft part telescoped in its forward end for limited rotative and axial movements therein, a helical camming groove in said socket, a drive projection extending radially from said shaft part into said groove, and a coil spring under compression between the rear end of said shaft part and said socket and normally projecting said shaft part to a forward limit of axial movement, said shaft part being coupled to said other wrenching member; said camming groove being pitched so as to resolve the drive torque into an axial pull on said shaft part balancing out the resistance to retraction of said shaft part developed in the transmission of torque from said socket to said shaft part, whereby said shaft part and said other wrenching member may retract in unison with the axial movement of said screw element into said nut element in response to rotation of the screw, without resistance to such axial movement.

5. A tool as defined in claim 4, wherein the said camming slot is pitched at an angle in the range between 10° and 30° as subtended from the drive axis, whereby the torque-energized pull on said shaft part is just sufficient to overcome said resistance to retracting movement.

6. A tool as defined in claim 4, wherein said socket has a slot extending circumferentially from the forward end of said helical camming slot in cooperating with said projection to provide a self-indexing lost motion rotary connection between said socket and shaft part for facilitating the coupling of said other driving element to said screw.

7. In a tool for setting a bolt-type fastener comprising respective nut and screw elements having wrenching surfaces at the same end of the fastener, in combination: inner and outer wrenching members, one telescoped within the other; means for holding one of said members against rotation; and means for transmitting rotation to the other member, said last means comprising parts relatively shiftable axially and having limited rotative movement with respect to one another, one of said parts transmitting drive to said other member; means for transmitting rotary drive to the other part; and torque-reactive means comprising a helical surface and a projection on the respective parts, said projection being engageable with said helical surface, said helical surface being pitched so as to resolve the drive torque into an axial thrust component substantially balancing out the resistance of the torque-loading coupling connection between said parts to the axial drawing of said parts together, whereby one of said parts may retract in unison with the axial movement of one of said fastener elements as the fastener is closed against interposed work parts, without resisting such axial movement.

8. A tool as defined in claim 7, including means spring-loading said parts for relative axial movement in which said projection assumes one limit position of movement along said helical surface.

9. A tool as defined in claim 8, wherein said wrenching members and said drive-transmitting means are arranged coaxially in an in-line assembly.

10. A tool as defined in claim 7, wherein said torque-reactive means comprises an L-shaped slot having said helical surface in one portion thereof and having a circumferentially extending slot as the other portion thereof, said projection extending radially into said L-shaped slot and being movable in said circumferentially extending slot to provide a self-indexing lost motion rotary connection between said socket and shaft part for facilitating the coupling of said other driving element to said screw.

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