Nov. 11, 1969 H. J. MODREY 3,477,486

RATCHET-ACTION TOOL HOLDER

Filed Oct. 27, 1967 2 Sheets-Sheet 1

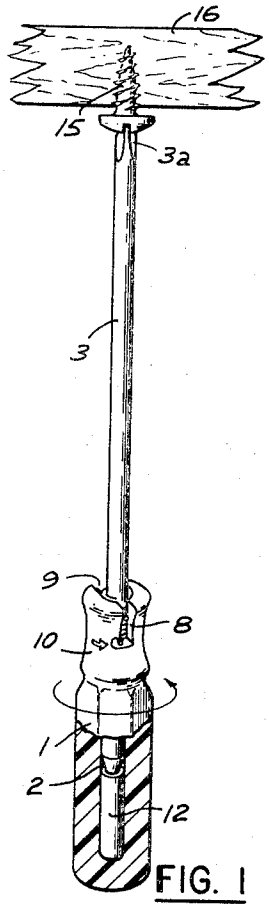

FIG. 1

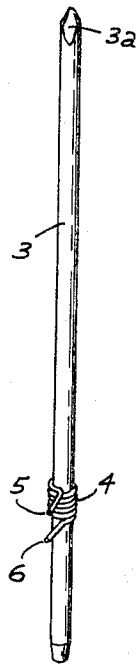

FIG. 2

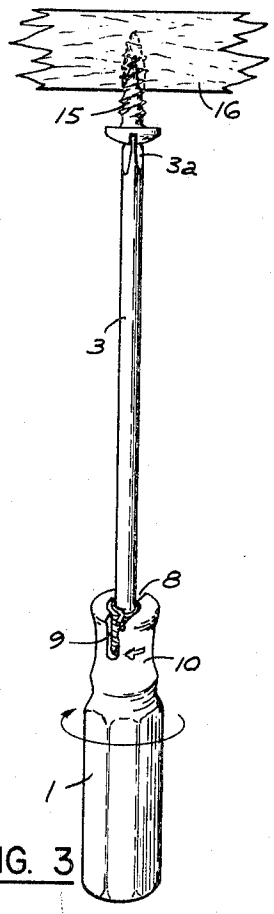

FIG. 3

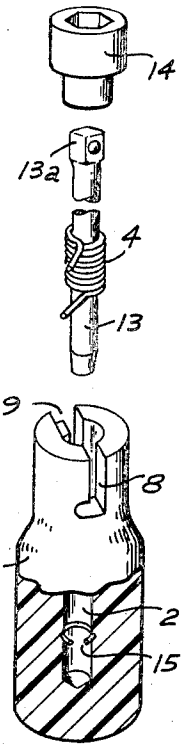

FIG. 8

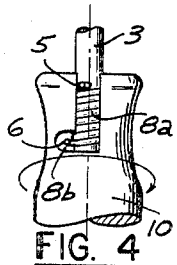

FIG. 4

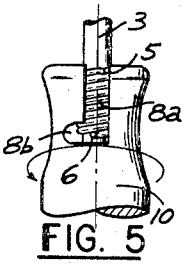

FIG. 5

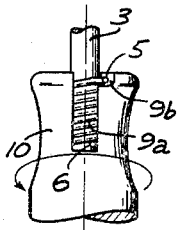

FIG. 6

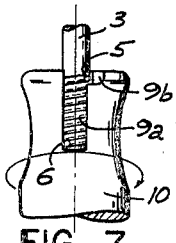

FIG. 7

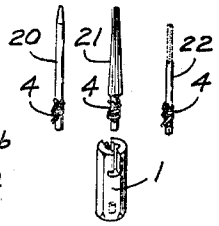

FIG. 9

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RATCHET-ACTION TOOL HOLDER

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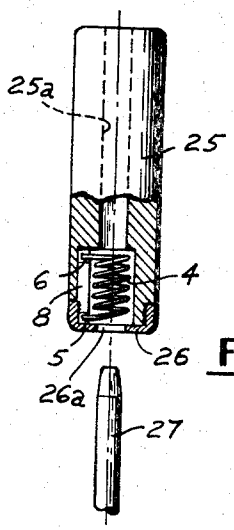

FIG. 10

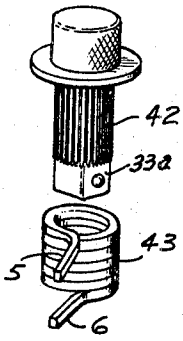

FIG. 14

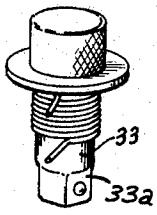

FIG. 12

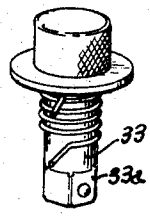

FIG. 13

FIG. 11

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3,477,486

RATCHET-ACTION TOOL HOLDER

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Filed Oct. 27, 1967, Ser. No. 678,687
Int. Cl. B25b 15/04, 23/16
U.S. Cl. 145—50 14 Claims

ABSTRACT OF THE DISCLOSURE

There is disclosed a tool for applying a rotary force to a work piece. According to one form a round driver is rotatably fitted into a holder and a coil tightly encompasses rotatably fitted into a holder and a coil spring tightly encompasses the round driver portion within the holder with a plurality of turns. A tang extending from one end of the coil spring engages a slot in the holder whereby turning of the holder in one direction with the driver applied to a work piece causes tightening of the coil spring thereby transmitting a turning force to the driver and turning of the holder in opposite direction causes partial loosening of the coil spring so that the driver is held stationary by the work piece while the holder is turned.

The invention relates to tools which advance a rotary tool held by a holder when the holder is rotated in one direction and leave the tool stationary when the holder is rotated in the opposite direction. More particularly, the invention relates to tools having a ratchet mechanism.

Ratchet tools of the general kind above referred to as heretofore known require a rather complex ratchet mechanism such as coacting spring-loaded pawls and ratchet wheels for unidirectional transmission of the torque applied to the holder to the tool proper.

The required mechanism becomes more complex when the tool holder is designed for reversal of the working direction of the tool. Practical experience shows that the torque transmitting components of the ratchet mechanism are subjected to heavy wear and thus have a comparatively short useful life. Moreover, operation of conventional ratchet wrenches is sometimes inconvenient if sufficient space is not available to swing the long wrench handle through the arc required for engagement of the next ratchet tooth.

Another shortcoming of tool holders as now known is that the required ratchet mechanism does not permit reduction of the holder to a very small size. This is a serious drawback in view of the present trend toward miniaturization.

All the above disadvantages and shortcomings apply to an even higher degree when torque limiting capability of the tools is required, as obviously the mechanism for such tools is far more complex. Moreover, torque limiting mechanisms as now known require periodical resetting, in many cases at short intervals. As a result, screwdrivers, nut drivers and wrenches embodying a torque limiting mechanism are expensive to manufacture and expensive in use.

It is a broad object of the invention to provide a novel and improved tool of the general kind above referred to which has a greatly simplified mechanism, does not require high wear components such as ratchets and pawls, is stepless in operation and has an infinitely variable operating arc, can be manufactured at a fraction of the costs of tools as now known, and is highly efficient and long-lasting.

A more specific object of the invention is to provide a novel and improved tool of the general kind above referred to, the operating direction of which is reversible without rendering the mechanism of the tool more complex and without increasing the manufacturing costs of the tool.

Another more specific object of the invention is to provide a novel and improved tool of the general kind above referred to which has torque limiting capability which can be conveniently varied at will.

Another more specific object of the invention is to provide a novel and improved driving or torque limiting tool of the general kind above referred to, the mechanism of which can be manufactured in miniature size thereby making ratchet tools available for types of work for which such tools as heretofore known could not be used, such as for assembly of watches, cameras and small and delicate components in general.

Another more specific object of the invention is to provide a novel and improved tool of the general kind above referred to which can be easily and conveniently set for a selected torque limit and will hold such limit for a more prolonged period of use than torque limiting tools as heretofore known.

It is also an object of the invention to provide novel and improved torque limiting ratchet tools in which the torque is transmitted to the driving stud of the tool by the simplified coupling mechanism of the invention as hereinbefore referred to, and in which the driving stud carries a part of the mechanism controlling the limit of the transmitted torque. This has the advantage that by the simple expedient of exchanging the driving stud the screwdriver or wrench can be set for any selected maximal torque.

Summary of the invention

Broadly, the invention resides according to one exemplification thereof, in mounting on the tool proper such as a driver for tightening or loosening a screw or nut, etc., a coil spring having a plurality of turns tightly encompassing a round portion of the driver.

The driver is rotatably and detachably fitted in a holder or handle, and a tang laterally protruding from one end of the coil spring protrudes into a slot (forward slot) in the holder. When after insertion of the driver into the work piece to which the rotary force is to be applied, the holder is turned in one direction, the tang is pressed against one wall of the slot. When the holder is turned in the opposite direction the tang is pressed against the opposite wall of the slot. The application of a turning force in one direction (working direction) will cause a tightening of the coil turns on the driver which increases with the continuing force thereby transmitting the turning force applied to the holder to the driver and rotating the same jointly with the holder. The application of a continued turning force in the opposite direction (idling direction) will loosen some of the coil turns adjacent to the tang. Such partial loosening of the coil spring reduces the frictional grip between the coil spring and the driver to such an extent that the driver is held stationary by the restraining force of the work piece such as a screw to which the driver is applied, when and while the holder is turned in the idling direction. The screw is therefore tightened in a conventional manner by imparting an oscillating movement to the holder.

If it is desired to reverse the working and idling directions of the tool, a second laterally protruding tang is provided at the other end of the coil spring and extended into a second slot (reversing slot) of the holder. As is evident, the second tang performs the same function as the first tang, though in reverse, the first tang remaining idle while the second tang is driving and vice versa, as will be more fully explained hereinafter.

Other and further objects, features and advantages of the invention will be pointed out hereinafter and set forth in the appended claims constituting part of the invention.

In the accompanying drawing, several preferred embodiments of the invention are shown by way of illustration and not by way of limitation.

In the drawing:

FIG. 1 is a perspective view of a ratchet screwdriver according to the invention, set for driving in clockwise direction;

FIG. 2 is a view of the driving shaft of the tool according to FIG. 1;

FIG. 2*a* is a plan view of the tool according to FIG. 1;

FIG. 3 is a perspective view of the tool according to FIG. 1 showing the tool set for counterclockwise driving direction;

FIGS. 4 and 5 show diagrammatically the torque transmitting coupling mechanism driving the tool when the holder is turned in clockwise direction and the tool remains stationary when the holder is turned in the opposite direction;

FIGS. 6 and 7 show diagrammatically the corresponding positions of the mechanism when the holder is turned in counter-clockwise direction and clockwise direction respectively;

FIG. 8 is a perspective exploded view of a modification of the tool according to the invention;

FIG. 9 is a diagrammatic view of a miniaturized tool holder according to the invention and of three exchangeable tools insertable into the holder;

FIG. 10 is a diagrammatic view, partly in section, of a collet according to the invention, for use in a lathe or drill press;

FIG. 11 is a perspective exploded view of a reversible wrench according to the invention; and

FIGS. 12, 13 and 14 are exchangeable driving studs for the wrench according to FIG. 11 to vary the torque limits thereof.

Referring now more in detail to FIGS. 1 through 7 inclusive, these figures exemplify the application of the concept of the invention to a screwdriver. The exemplified screwdriver comprises a holder **1** shown as a one-piece holder of a type conventional for screwdrivers and other hand tools. The front part **10** of holder **1** includes a lengthwise receiving opening **2** into which a driver **3** is releasably inserted. The driver is shown as a round driving shaft or stud designed at its end **3***a* as a Phillips screwdriver. However, the driver may also be designed as a driving stud or shaft for many other types of tools as will be more fully explained hereinafter.

As can best be seen in FIG. 2, a coil spring **4** tightly encompasses the round driver shaft with a plurality of turns. The spring is preferably prewound with a smaller inner diameter than that of the shaft so that the shaft is held in the spring with a strong frictional grip when it is pushed through the coil as shown in FIG. 2. The coil spring serves as a coupling between the shaft and the holder and is provided for this purpose at its ends with two substantially radially extending and generally lengthwise aligned tangs **5** and **6**. Either one of the tangs may be selectively inserted into either one of two preferably diametrically opposite slots **8** (forward slot) and **9** (reversing slot) extending from the upper rim of holder **1**.

Each slot is generally L-shaped, having a long branch **8***a* and **9***a* respectively, and a short branch **8***b* and **9***b* respectively. The two L-shaped slots are reversed in reference to each other as can best be seen in FIGS. 4 to 7. The length of slot branches **8***a* and **9***a* is such that tang **5** will be located either in the long branch **8***a* of slot **8** or in the short branch **9***b* of slot **9**, depending upon whether the tangs are inserted into slot **8** (FIGS. 4 and 5) or into slot **9** (FIGS. 6 and 7). Similarly, tang **6** will be located either in the short branch **8***b* of slot **8** or in the long branch **9***a* of slot **9**.

To retain shaft **3** releasably in the receiving opening of the holder, suitable fastening means may be provided such as a permanent magnet **12** at the bottom of the opening, as shown in FIG. 1.

The function of the tool as hereinbefore described is as follows:

Let it be assumed that it is desired to drive a wood screw **15** into a block of wood **16**. To effect turning of the driver shaft, holder **1** must be turned in clockwise direction and the turning force applied to the holder must be transmitted to shaft **3**. Transmission of the turning force from the holder to the shaft is effected by the coupling mechanism constituted by coil spring **4**, its tang **5** and the coaction thereof with forward slot **8** in the handle.

To explain the function of the coupling mechanism which replaces the conventionally used pawl and ratchet wheel mechanism, tang **6** and reversing slot **9** are disregarded for the time being.

When holder **1** with the screwdriver end **2***a* inserted into the Phillips cross of the screw is turned in clockwise direction, tang **5** will be moved into pressure engagement with the lefthand side wall of forward slot **8***a*, as shown in FIG. 4. Continued turning of the holder tightens the turns adjoining tang **5** of coupler coil **4**. At its other end, the coil spring remains anchored solely by the friction of the wire turns adjacent tang **6**, against drive shaft **2**, and not by tang **6** which is free to move in slot branch **8***b* without touching its sidewalls. The small angular displacement available to tang **5** inside slot **8***a* is sufficient to effect a firm coupling between holder **1** and driver shaft **2**. A very slight angular movement of 1–2° suffices to tighten the coil coupling.

The coupling mechanism according to the invention is, in fact, a servo mechanism, in which a very small force applied to tang **5** suffices to initiate a coupling action between drive shaft **2** and holder **1** which gets firmer as the driving torque increases, through the increasing tightening of the spring coils.

Let it now be assumed that the operator has turned holder **1** in the clockwise or working direction as far as convenient and that he begins to turn the holder in the counterclockwise or idling direction. Such turning causes tang **5** to be moved from pressure engagement with the lefthand side of slot branch **8***a* into pressure engagement with the righthand side of the slot branch, as is shown in FIG. 5. As is evident, continued turning of the holder in the idling direction applies to the tang a force loosening the coil. Such loosening of the coil is limited to a few turns adjacent to tang **5** but the remainder of the coil turns remain unaffected. As a result of the partial loosening of the coil, the gripping force of the coupling decreases and coil **4** begins to slip on drive shaft **3**. Accordingly, turning of holder **1** in the idling direction leaves shaft **3** stationary.

By applying a reciprocating, oscillatory movement to holder **1**, coil **4** is alternatively tightened and released. Contrary to the conventional ratchet mechanism, these motions do not impose any noticeable wear and tear on the coacting parts.

The ratchet motion produced by this coupling mechanism is both stepless and infinitely variable. In a ratchet tool of known type, the angular displacement required in either direction must always correspond to the width of at least one ratchet tooth or to multiples of this distance. If space is restricted, it is frequently impossible to turn the holder through a large arc. As a result, the tool may fail to operate altogether, or may operate only slowly in small increments. In ratchet tools according to the invention the turning arc in both directions is as small or as large as the operator desires for convenient operation and as circumstances permit. Clockwise motion imparted to the holder will instantly effect a firm coupling with the driver and counterclockwise motion will instantly release the coupling and permit the driver to remain stationary.

Referring now to the function of tang **6**, this tang remains idle when and while the handle is turned either in the direction for screwing-in or in the idling direction during a screwing-in operation. In tools designed only for tightening and not for removing screws, tang **6** may be

omitted altogether, as shown in FIG. 9 at tool **21**. As previously described, the lower part of the coil turns remain unaffected when coil **4** is partially loosened. Hence, tang **6** remains stationary in reference to shaft **3**, but it moves in reference to front part **10** of holder **1** through a distance corresponding to the movement of tang **5** from the position of FIG. 4 into the position of FIG. 5. Branch **8***b* of slot **8** permits such movement of tang **6**, as is evident from a comparison of FIGS. 4 and 5.

Let it now be assumed that it is desired to unscrew screw **15**. To effect such operation, stud **3** is lifted slightly out of the handle and reinserted after being turned through 180° so that tangs **5** and **6** now engage reversing slot **9**. As is evident from the previous description, turning of holder **1** in the working direction will force tang **6** into pressure engagement with one side of slot branch **9***a*, and turning of the holder in the idling direction during a screwing-out operation will force the tang into pressure engagement with the opposite side of slot branch **9***a*. Tang **5** is now the idling tang and is free to move in slot branch **9***b*.

The functions of the coupling mechanism formed by coil **4**, its tangs and slot **9** are evident from the previous description. The positions of the tangs are clearly shown in FIGS. 6 and 7.

The tool of FIG. 8 is provided with the same coupling mechanism as previously described. The tool has a drive shaft **13** designed as a shaft for interchangeable nut driving sockets **14**.

In this embodiment, drive shaft **13** is retained in holder **1** by alternative fastening means shown as a spring ring **15**. It is, of course, also possible to use magnetic retention by magnet **12**, or vice versa spring ring **15** may also be used in the screwdriver, as shown in FIGS. 1 to 7.

FIG. 9 shows a miniaturized tool utilizing the coupler mechanism according to the invention. The holder **1** should be visualized as being constructed in one piece, as previously described. There are shown, by way of example, three tool shafts such as a screwdriver **20**, a fluted reamer **21**, and a tap **22**, each mounting a coil spring **4** as previously described.

The incremental movement afforded by ratchet-motion tools is very favorable for the operation of reamers and taps. Various other tools, the shaft of which is insertable into holder **1**, can be readily visualized. Reamer **21** is shown with a coupling coil **4** with only one (driving) tang **5** since reversing motion is generally not required for reamers. Tap **22** is removed from a previously tapped hole by lifting the holder and turning it by 180° so that the reversing slot is engaged.

FIG. 10 shows a utilization of the concept of the invention which is distinguished from the previously shown exemplifications in that coil **4** is fitted in a holder **25** rather than mounted upon a tool shaft. The coil has tangs **5** and **6** which coact with two slots, only slot **8** being shown in the figure. The coil is retained in the holder by a closure cap **26** having in its bottom wall an opening **26***a* for passage of a tool shaft **27**.

The structure of FIG. 10 lends itself for use with machine tools. The receiving opening **25***a* in the holder extends through the same so that the holder constitutes in effect a simplified collet for use in a drill press, lathe or other suitable machine tool which is self-tightening by the action of the coupling spring **4**. The tool shaft **27** is simply pushed into the collet to any desired depth where it is retained by the pressure of the coil spring as previously described.

As is now evident, the collet constitutes a very simple quick-acting, self-tightening holder for exchangeable tools having the same shaft diameter. It may also be used for chucking round work pieces in a lathe. As the drive shaft **27** or the work piece itself is automatically held by the coil spring in any desired lengthwise position as previously described, long rods can be accommodated through the through-opening **25***a*.

FIGS. 11 to 14 show the application of the invention to ratchet wrenches. The holder of the tool is formed by a drop-forged socket **30** which includes slots **8** and **9** as previously described. The holder can be turned in a conventional fashion by a handle **31**.

The driver for the tool is shown as a stud **33** on which is mounted coupling coil **4**. The stud is insertable into the opening of the socket with tangs **5** and **6** lodged either in forward slot **8** or reversing slot **9**. The stud has at one end a conventional driving portion **33***a* for releasably fitting thereupon conventional driving attachments such as nut driver socket **34**.

The stud is retained in the socket by suitable fastening means such as a spring clip or a magnetic washer **36** abutting against the top wall of the socket, assuming that the same is at least partly made of magnetizable material.

Turning of the wrench in one direction constitutes the working stroke, and turning in the opposite direction constitutes the idling stroke. Reversal of direction is effected by lifting stud **33** at its knurled head **40** and turning it by 180°, thus inserting tangs **5** and **6** into the other slot of the socket.

Head **40** of stud **33** also serves as an automatic ejector mechanism for driving attachments. By lifting the head far enough, attachments such as nut driver **34** are conveniently removed from the driving portion **33***a* of the stud. The driver stud **33** is long enough for the stud to be lifted and reversed before automatic ejection of attachments occurs.

The function of the wrench and the coupling mechanism thereof is evident from the previous description. The aforegoing description refers to ordinary ratchet tools with positive drive. In point of fact, however, all tools according to this invention are inherently torque limiting tools.

Transmittal of operating torque from holder to drive shaft is effected by the coupling coil **4**. There is however, an upper limit at which slip occurs and the shaft is no longer driven by the coil. This limit depends on the configuration of the spring, and in particular on the following factors: gauge of the wire, number of turns, and tightness of attachment to drive shaft (viz. prewinding diameter). By changing one or several of these factors, the torque limit can be changed at will. The spring configuration for a given limiting torque can be determined easily and exactly by means of a simple torque measuring fixture, and the required spring configuration can be duplicated in production on a spring-winding machine. A torque limiting screwdriver may therefore be furnished with a number of exchangeable driver shafts **3**, each carrying a spring of different torque calibration, or alternatively with one driver and a number of loose, calibrated springs which the user pushes upon the drive shaft.

Wrenches can be furnished with a number of exchangeable driver studs as shown in FIGS. 12, 13 and 14 each of which has been fitted with a spring with different torque calibration. This method is infinitely simpler and cheaper than conventional torque limiting tools, quite especially since the torque limit of a given coupling spring remains constant and is not effected by use.

In fact, the system is so inexpensive that the use of torque limiting tools can be easily extended from production to repair and assembly operations. Torque limiting tools in small and sub-miniature sizes which this invention makes technically and economically feasible due to the utter simplicity and small size of the components, are likewise highly desirable. For example, all electrical terminal screws should be tightened to a given torque which establishes good contact without compressing the conductor beyond its elastic recovery. Due to the high costs and inconvenience of conventional torque limiting tools, this is presently done only in certain advanced sectors of electric technology. A screwdriver according to the invention would make the process automatic without increasing the cost.

The basis of variation for different maximum torques

can be broadened by two further factors. Friction between the coupling coil 4 and the drive shaft 3 can be increased by selecting spring wire of flat, rectangular or square cross-section which increases the friction surface, or by increasing the friction offered by the coacting surface of the drive shaft, for example by knurling or grooving as shown in FIG. 14. However, the first-mentioned method for varying the torque by changing the configuration of an ordinary coil spring, is so ample for all general purposes that these additional methods are largely restricted to over-size torque limiting tools for use in heavy construction and ship building. There is no upper limit to the application of the torque limiting system according to the invention.

It follows from the foregoing that all drive tools according to the invention are, in fact, torque limiting tools. For ordinary purposes where torque limiting is not required, the tool is simply fitted with a coupling coil 4 the maximum torque of which lies beyond the practical limit so that, to all intents and purposes, the drive is positive. For example, in a screwdriver with a drive shaft of 3/16" dia., a coupling coil consisting of 10 turns of .040" gauge wire prewound to a diameter of 1/64" below that of the drive shaft, will operate very conveniently as a ratchet mechanism but will have a maximum torque which cannot be approached by a screwdriver of this size.

While the invention has been described in detail with respect to certain now preferred examples and embodiments of the invention, it will be understood by those skilled in the art, after understanding the invention, that various changes and modifications may be made without departing from the spirit and scope of the invention, and it is intended, therefore, to cover all such changes and modifications in the appended claims.

What is claimed is:

1. A tool for applying a rotary force to a work piece, said tool comprising in combination:

a holder having a receiving opening, a wall portion of the holder defining said opening including a first slot and a second slot peripherally spaced from the first slot;

an elongated driver rotatably inserted into said receiving opening; and

a coil spring having a plurality of turns tightly encompassing the driver portion inserted into said opening, said coil spring having at one end a laterally extending first tang and at the other end a laterally extending second tang in substantially lengthwise alignment with the first tang, either one of said tangs being selectively insertable into either one of said slots for movement of either one of the tangs into pressure engagement with one or the other of opposite side walls of the respective slot in response to a turning of the holder in one or the other direction in reference to the drive, the respective other tang idling in the respective other slot.

2. The tool according to claim **1** wherein both said slots have a substantially L-shaped configuration, one branch of each of said slots extending parallel to the depth of said receiving opening in the holder, the other branch of the slots extending from opposite ends of said one branch of the slots in the direction of movement of the tangs, said one branch of each slot constituting a working branch and said other branch of each slot constituting an idling branch to permit free movement of one tang in the respective idling branch when the holder is turned for placing the other tang into pressure engagement with either side wall of the working branch of the respective slot.

3. The tool according to claim **1** and comprising releasable fastening means for retaining the driver portion in said receiving opening.

4. The tool according to claim **3** wherein said fastening means are magnetic means in said receiving opening for attracting the driver portion inserted thereinto.

5. The tool according to claim **3** wherein said fastening means comprise spring means engageable with the inserted driver portion by a frictional grip.

6. The tool according to claim **1** wherein said holder comprises a tool grip having in one end said receiving opening for the driver, said slot extending from the rim of the receiving opening.

7. The tool according to claim **1** wherein said driver comprises a tool shaft, the end portion of the shaft inserted into said receiving opening mounting said coil spring with a tight fit, the other end portion of the shaft being arranged to coact with the work piece.

8. The tool according to claim **1** wherein said coil spring is disposed within said receiving opening of the holder, and wherein a closure cap having in its base wall an opening for passage of the driver is secured upon said receiving opening to hold the coil spring captive therein.

9. The tool according to claim **8** wherein said holder comprises a collet for use with a machine tool.

10. The tool according to claim **1** wherein said holder comprises a wrench socket, and wherein said driver comprises a stud releasably insertable into the opening of the socket, said slot being in a wall portion of the socket bounding the opening thereof.

11. The holder according to claim **10** wherein said coil spring is carried by said stud.

12. The tool according to claim **11** wherein the wall surface of the stud encompassed by the coil spring is a roughened surface.

13. The tool according to claim **10** and comprising fastening means releasably retaining the stud in the socket opening.

14. The tool according to claim **13** wherein said socket and said stud are made at least partly of magnetizable material, said stud having an enlarged end portion protruding from the socket when the stud is inserted into the same, and wherein said fastening means comprises a magnetic member interposed between said enlarged end portion and the adjacent wall portion of the socket.

References Cited

UNITED STATES PATENTS

2,595,213	4/1952	Raynor	145—76 X
2,810,463	10/1957	Williams	81—58 X
3,372,781	3/1968	Fulton	145—70 X

FOREIGN PATENTS

693,464	8/1930	France.

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