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(54) **MULTI-OFFSET DRIVER TOOL**

(56) **References Cited**

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(\*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

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DE 3905633 8/1990

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**Related U.S. Application Data**

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(51) **Int. Cl.**  
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(57) **ABSTRACT**

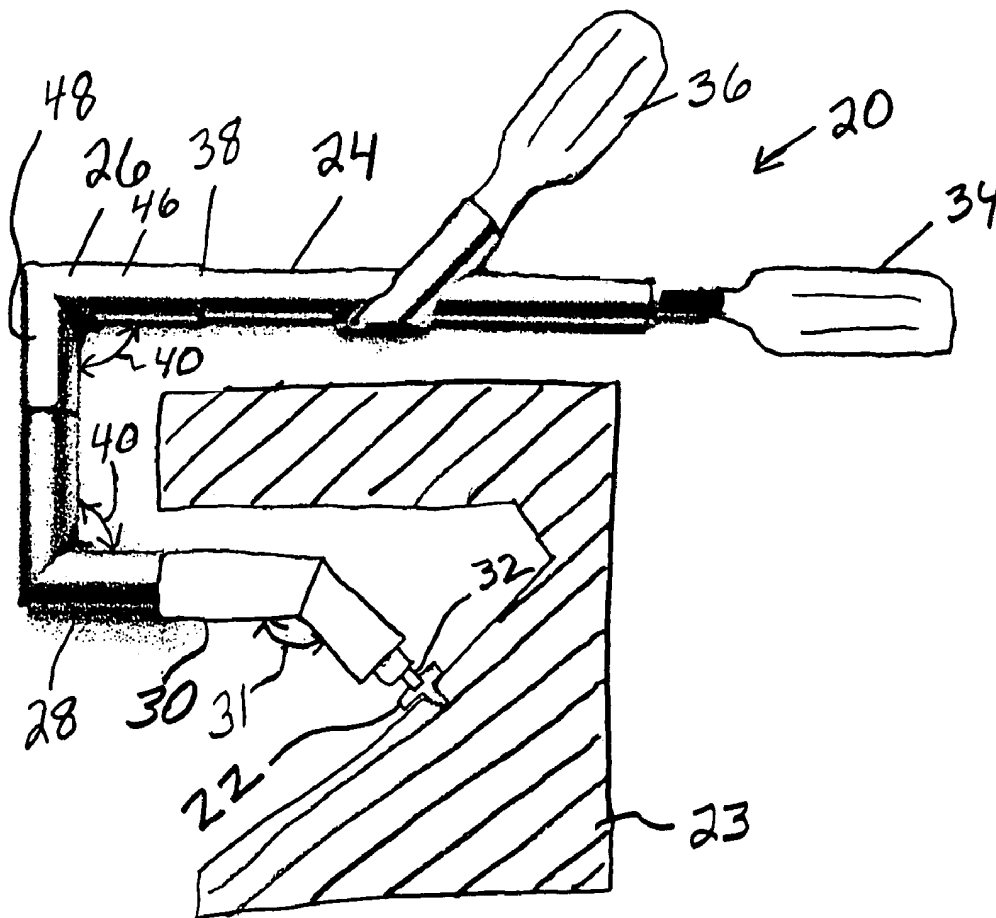
(52) **U.S. Cl.** ..... **81/52; 81/35; 81/73; 81/436**

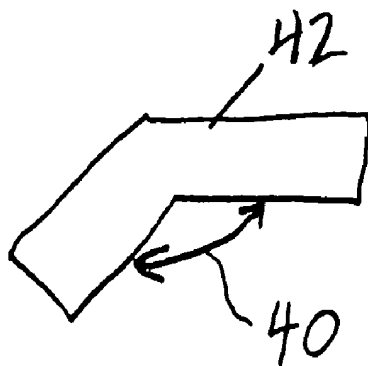
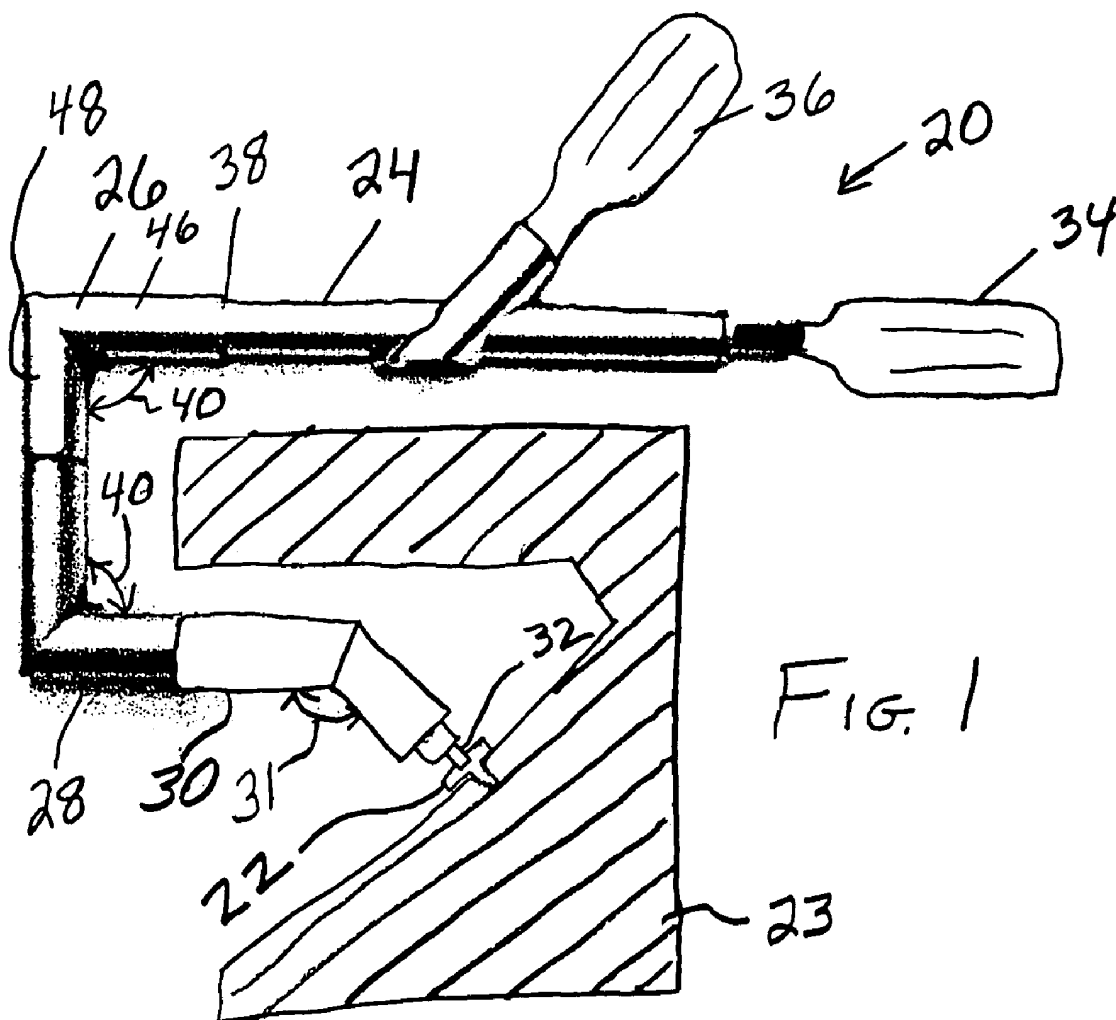
A fastener driving tool. At least one offset driven part is detachably attachable to an input part for accessing a fastener for driving thereof.

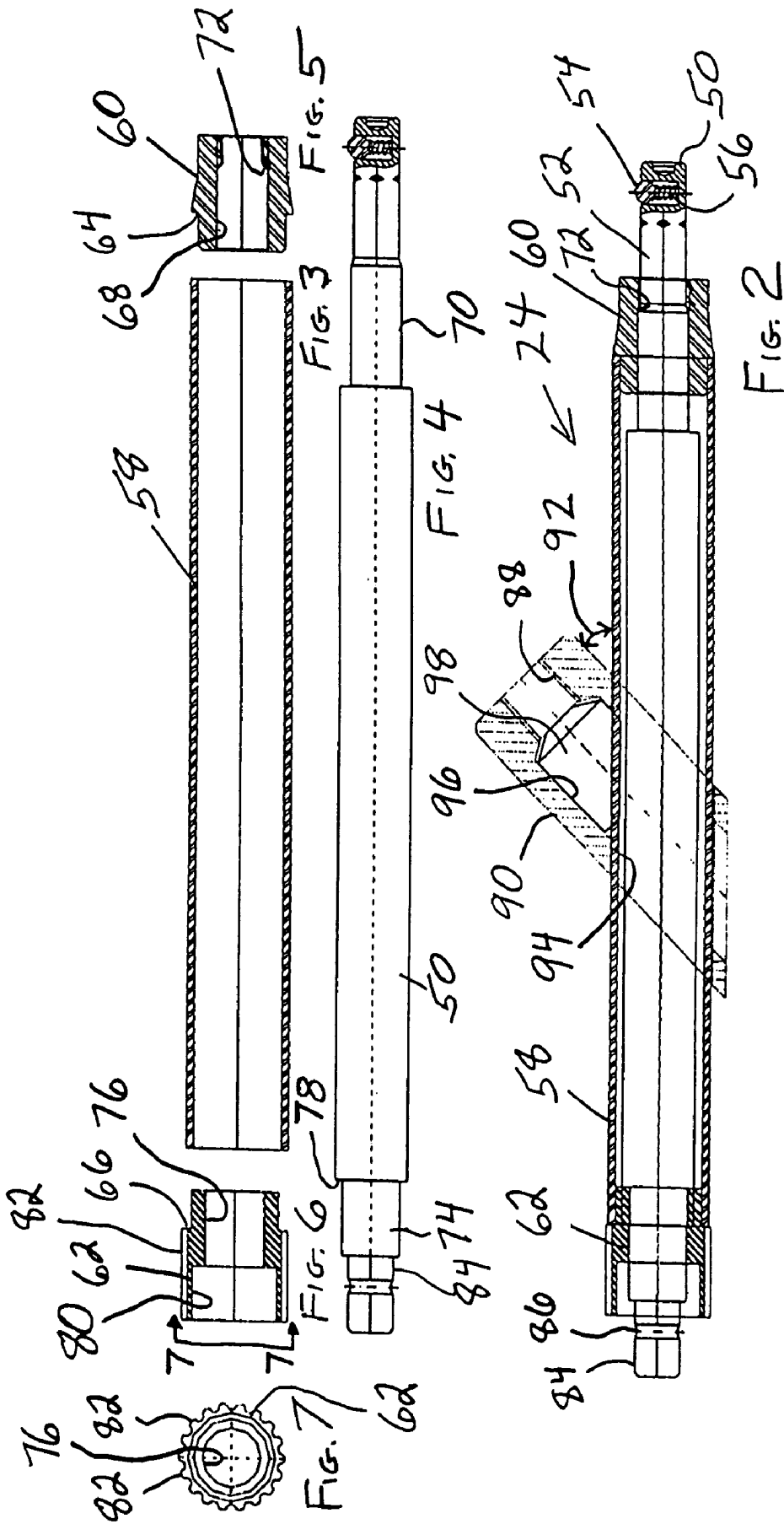
(58) **Field of Classification Search** ..... 881/35, 881/52, 73, 436

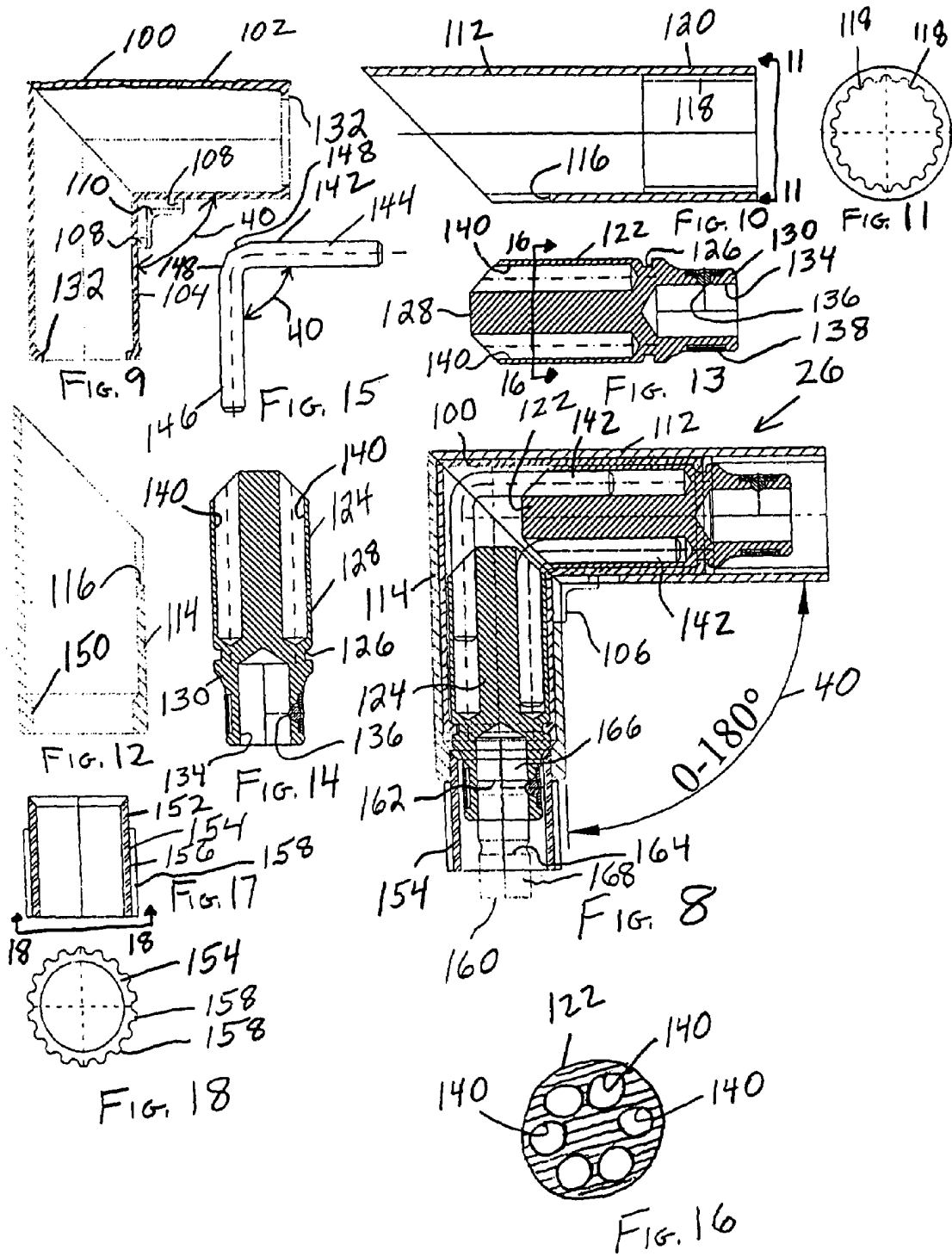
See application file for complete search history.

**3 Claims, 3 Drawing Sheets**









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**MULTI-OFFSET DRIVER TOOL**

Priority of U.S. provisional application No. 60/569,393, filed May 7, 2004, the disclosure of which is hereby incorporated herein by reference, is hereby claimed.

The present invention relates generally to tools. Examples of tools to which the present invention is directed include drilling, sinking, threading, and fastener driving tools such as, for example, screwdrivers, drill bit holders, and socket wrenches. More particularly, the present invention relates to offset tools, i.e., tools wherein the direction to which rotary motion is applied to drive (tighten, loosen, etc.) fasteners is changed in order to access fasteners in difficult to reach places.

Offset screwdrivers typically have bevel gearing or other direct toothed gearing to achieve the offset wherein only one pair of teeth serves to transmit the torque. Such gearing undesirably allow very small torques or, when larger bevel-gear modules are used, are so voluminous at the articulation point that they are no longer usable in confined and difficult places. Offset screwdrivers also typically have counter-handles for positioning of thereof and for applying pressure to the fastener.

Spectools of West Bridgewater, Mass. sells offset tools including a screwdriver kit providing combinations of straight and offset drivers for use manually or with a battery operated driver (see www.spectools.com, for example, tool no. WPK-2603). The gear sets in the Spectools offset screwdrivers are also disadvantageously very large.

Offset screwdrivers and other offset tools have been provided for many years by Pontex Consulting & Trading GmbH of Munchen, Germany. Their German patent DE3905633, which is hereby incorporated herein by reference, discloses such an offset screwdriver wherein, for the transmission of forces or torque, not only one pair of teeth, but always a multiplicity of hardened cylindrical pins in the form of a closed bundle are continuously in full engagement over the entire rotation. Such an offset screwdriver allows angling up to 90 degrees with very small external dimensions and allows transmission of considerably greater torques than comparable bevel-gear pairings.

The torque transmission mechanism at the articulation point of the offset screwdriver of the above patent is not only unduly complex but is still disadvantageously larger than desired.

For various fastener driving applications in various hard to reach places, the offset angle required may vary from 30 to 60 to 90 to 150 degrees to some angle inbetween. The above offset tools disadvantageously require that a separate tool be provided for each offset angle, thus requiring a customer to purchase several such tools for different applications he or she may encounter.

It is accordingly an object of the present invention to provide a tool which has a universal driver for a variety of offset angles for driving fasteners in hard to reach places.

It is a further object of the present invention to provide an offset tool for driving fasteners wherein the torque transmission mechanism at the articulation point is compact so that the tool is easily usable in difficult to reach places and wherein adequate torque is provided to easily and firmly tighten and loosen the fasteners.

It is another object of the present invention to provide such an offset tool which is rugged, reliable, simple in construction, and which is easily usable.

In order to provide a tool which has a universal driver for a variety of offset angles for driving fasteners in hard to reach places, in accordance with the present invention, the

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tool has an input part and at least one offset driven part detachably attachable to the input part for accessing a fastener for driving thereof. The input and driven parts may be parts of a tool kit containing input parts of different lengths and a plurality of driven parts providing a plurality of offsets at different angles for connection in tandem.

In order to provide an offset tool for driving fasteners wherein the torque transmission mechanism at the articulation point is both simple in construction for ruggedness and reliability and compact so that the tool is easily usable in difficult to reach places and wherein adequate torque is provided to easily and firmly tighten and loosen fasteners, in accordance with the present invention, offsetting shafts of the driven part are connected only by pins (i.e., without any gearing).

The above and other objects, features, and advantages of the present invention will be apparent in the following detailed description of the preferred embodiment thereof when read in conjunction with the accompanying drawings wherein the same reference numerals denote the same or similar parts throughout the several views.

**BRIEF DESCRIPTION OF THE DRAWINGS**

FIG. 1 is a perspective view of a tool which embodies the present invention.

FIG. 2 is a sectional view of the input part thereof, with the shaft therefor shown partly in side view and partly in section.

FIG. 3 is a sectional view of the housing for the input part.

FIG. 4 is a side view, partly in section, of the shaft for the input part.

FIGS. 5 and 6 are sectional views of bearings at opposite ends of the housing for the shaft.

FIG. 7 is an end view, taken along lines 7-7 of FIG. 6, of the bearing of FIG. 6.

FIG. 8 is a sectional view of an intermediate part therefor, with pins thereof shown in side view.

FIGS. 9, 10, and 12 are sectional views of housing portions for the intermediate part.

FIG. 11 is an end view, taken along lines 11-11 of FIGS. 10 and 12, of the housing portion of FIG. 10, the similar end view of the housing portion of FIG. 12 being similar thereto.

FIGS. 13 and 14 are sectional views of offset shafts for the intermediate part.

FIG. 15 is a side view of a pin for the intermediate part.

FIG. 16 is a sectional view, taken along lines 16-16 of FIG. 13, of the shaft of FIG. 13.

FIG. 17 is a sectional view of a connector member for connecting the intermediate part in series to another intermediate part.

FIG. 18 is an end view, taken along lines 18-18 in FIG. 17, of the connector member.

FIG. 19 is a schematic view of an alternative embodiment of an intermediate part.

**DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT**

Referring to FIG. 1, there is illustrated generally at 20 a tool for driving a fastener such as a nut or such as the screw illustrated at 22 into a workpiece 23. The tool 20 includes an input or driving part 24, a first intermediate part 26 detachably attached to the input part 24, a second intermediate part 28 detachably attached to the first intermediate part 26, and an output part 30 detachably attached to the second intermediate part 28 and terminating in a screwdriver blade 32 or

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other suitable fastener engagement means such as a socket for connecting to the screw **22** or other fastener for driving or loosening thereof. Alternatively, the driving part **24** may be connected directly to an output part **30** to form a complete system without any intermediate parts. Moreover, the intermediate parts **26** may allow attachment of output tools such as screwdriver bits or socket attachments. Thus, the driving part **24** may be connected in tandem with any combination of driven parts (intermediate and output parts) terminating in an output part. Thus, for the purposes of this specification and the claims, a "driven part" is defined as being either an intermediate or an output part. The tool **20** is provided with a suitable handle **34** for transmitting rotary motion to the blade **32** for turning thereof. The tool **20** may be provided with other suitable rotary motion transmitting means such as a wrench, power drive tool (power drill), or ratchet wrench. As apparent in FIG. 1, the tool **20** allows fasteners in hard-to-reach places or otherwise inaccessible places to be accessed. The tool **20** is also provided with a positioning handle **36** for use in holding the tool **20** in position and for applying pressure to the fastener **22** for driving or loosening thereof.

The first intermediate part **26** is detachably attached to the input part **24** at **38** and is shown as elbow-shaped (angle **40** of 90 degrees) wherein it has two legs **46** and **48** to change the tool direction accordingly, i.e., the intermediate part **26** is offset. By "offset" of a part is meant, as used in this specification or in the claims, a bend or change of direction of the part which allows the direction to which rotary motion for turning a fastener is applied by a tool to be re-directed by the part to a different direction. Thus, it is a change of direction or offset of a tool part which causes the tool itself to be offset. The second intermediate part **28** is similarly elbow-shaped or offset to again change direction of rotary motion application to reach the fastener **22**. It should be understood that only one intermediate part need be provided for the tool **20** or even none may be provided, or any number of intermediate parts may be provided and connected in tandem, depending on the location of the fastener **22** and the number of intermediate parts needed to access it. It should also be understood that, while an elbow shape is shown for each of the intermediate parts **26** and **28**, the intermediate parts may have any number of shapes wherein the legs **46** and **48** form angles, illustrated at **40**, within the range, as practical, of 0 to 180 degrees, for example, an angle **40** of 90 degrees for each of intermediate parts **26** and **28**, as illustrated in FIG. 1, or, for another example, an angle **40** of 135 degrees for intermediate part **42** shown in FIG. 19, or, for other examples, angles of 30, 45, and 60 degrees. Thus, a kit of an input part **24** along with a variety of driven parts having various angles **40** or offsets may be provided so that one or more driven parts each appropriately shaped may be selected to achieve the needed access for a given task. One or more of the driven parts may be straight (i.e., angle **40** being 180 degrees) to provide length extension or extensions. In addition, the kit may also contain a number of output parts **30** for various functions such as screwdriver, socket wrenches of different sizes, etc. Moreover, the kit may contain input parts of different lengths.

Offset tools that have heretofore been provided have an offset input part which has a first leg to which the handle for turning a screwdriver blade or the like is attached and a second leg forming an angle with the first leg to provide the offset and to which an output part is attached. Such tools undesirably require the purchaser to purchase a separate tool (offset input part) for each of various offset angles which may be desired. In order to substantially reduce the resulting

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expense, in accordance with the present invention, the customer desirably need only purchase a single input part and a variety of less expensive offset driven parts.

Referring to FIGS. 2 to 7, the input or actionating part **24** includes a rotatable generally cylindrical shaft **50** having a cross-sectionally polygon-shaped (for example, hexagonal) end portion **52** to which a similarly shaped internal portion (not shown) of the handle **34** is connected. The end portion **52** has a ball detent **54** which is spring-loaded (by spring **56**) to be engaged in a notch (not shown) in the handle internal portion for releasably holding the handle **34** on the shaft **50** in a manner commonly known in the art to which this invention pertains.

The shaft **50** is received within a tubular housing **58** which is closed at the handle and intermediate part ends by a pair of bearings **60** and **62** respectively for rotatably receiving the shaft **50**. Where the term "tubular" or "cylindrical" is used in this specification and the claims, it is meant to include, as applicable, any other suitable shape, such as square, cylindrical, hexagonal, and octagonal. The bearings are suitably attached to the shaft such as by tapered press fits. Bearings **60** and **62** are partially received within the respective housing ends and are formed to have shoulders, illustrated at **64** and **66** respectively, on their radially outer surfaces to engage the respective ends of the housing **58** to fix their positions relative thereto. Bearing **60** has a bore **68** in which a reduced diameter portion **70** of the shaft **50** is bearingly rotatably received and defines a shoulder **72** which engages the radially inner end of the bearing **64** to fix its position axially relative thereto. A reduced diameter portion **74** of the shaft **50** is bearingly rotatably received in a bore **76** of the bearing **62** and defines a shoulder **78** which engages the radially inner end of the bearing **62** to fix its position axially relative thereto.

The bearing **62** has an increased diameter bore portion **80** defining the axially outwardly terminal end portion thereof. The outer surface of the bearing **62** from the shoulder **66** axially outwardly has a plurality of axially extending teeth **82** spaced circumferentially about the bearing surface for engaging the intermediate part **26** as discussed hereinafter.

Adjacent the reduced diameter shaft portion **74** is a further reduced diameter (diameter subtended when rotated) portion **84** which is polygon shaped in cross-section (similar in shape to that of portion **52**) and with a circumferentially extending groove **86** therein for engaging the intermediate part **26** as discussed hereinafter.

The positioning handle **36** has a threaded end portion (not shown) which is threadedly received in a threaded bore, illustrated at **88**, in an end of a generally cylindrical housing **90** which is suitably provided to extend at a suitable angle, illustrated at **92**, for application of positioning force, for example, about 45 degrees. A bore, illustrated at **94**, extends through the housing **90** in which the input part housing **58** is slidably received. An increased diameter bore, illustrated at **96**, extends from bore **88** through the other end of the housing **90**. A pressure member **98** is sized and shaped to be received in the bore **96** between the bore **88** and the input part housing **58** and flush with the cylindrical surface thereof to effectively transmit force from the handle **36** to the input part housing **58** to tightly secure the housing **90** to the input part housing **58** in accordance with principles commonly known to those of ordinary skill in the art to which this invention pertains.

Referring to FIGS. 8 to 18, the intermediate part **26** provides an offset corresponding to angle **40**. By "offset" is meant, for the purposes of this specification and the claims, the re-direction or changing of the direction to which rotary motion is applied to drive (tighten, loosen, etc.) fasteners.

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The offset intermediate part **26** comprises two cylindrical housing members **100** formed to have a pair of generally tubular legs **102** and **104** in which the angle there between corresponds to the angle **40**, i.e., leg **104** is offset relative to leg **102**, that is, leg **104** contains means (described herein-after) for changing the direction to which rotation is applied to drive fasteners. In the special case where the angle **40** is 180 degrees for increasing the effective length of the tool **20** to extend the reach thereof, the member **100** would be tubular in shape (i.e., not having two offsetting legs).

A clip **106** has a pair of post portions **108** integrally or otherwise suitably attached to the legs **102** and **104** respectively and interconnected by bridging portion **110**. The legs **102** and **104** are tightly or snugly received in generally tubular members **112** and **114** respectively to fix the cylindrical parts and provide increased rigidity, with each member **112** and **114** extending outwardly beyond the end of the respective leg. Each member **112** and **114** has a slot, illustrated at **116**, having a width which is tapered and which is equal to approximately the diameter of the respective post **108**. The clip **106** is received in the slots **116** to prevent rotational movement of the members **112** and **114**, and the clip **106** is suitably longitudinally split so that the split portions must be squeezed together to be wedgedly received in the respective tapered slot so as to be tightly wedged in the slots **116** respectively so that members **112** and **114** are prevented from axial movement. Of course, other suitable means may be provided to prevent rotational and axial movement of the members **112** and **114**.

Axially extending teeth **118** are formed internally of and circumferentially about the outer end portion **120** of member **112** which extends beyond the outer end of leg **102**. These teeth **118** are complementary to teeth **82** on input part bearing **62** to mesh therewith for non-rotatably and detachably attaching bearing **62** and accordingly the input part housing **58** to the intermediate part member **112**.

A pair of identical rotation transmission members **122** and **124** are rotatably but snugly received in the housing member legs **102** and **104** respectively. Each of the members **122** and **124** has a circumferential groove, illustrated at **126**, intermediate the length thereof and dividing the member into a first portion **128** which is within the respective leg **102** and **104** and a second portion **130** which extends from the respective leg. The grooves **126** are engaged by circumferential ridges **132** on the inner surfaces of the legs **102** and **104** respectively on the terminal ends thereof to locate the members **122** and **124** axially and to prevent axial movement thereof. The ridges **132** are snap-fit or clicked into the grooves **126** respectively after which the members **112** and **114** are attached to fix the cylindrical parts and increase the rigidity so that the ridges **132** do not inadvertently release from the grooves **126** respectively.

Each rotation transmission member second portion **130** has a bore, illustrated at **134**, therein. As discussed herein-after, the bore **134** may alternatively be a female hex. A spring-loaded detent ball **136** (the spring is illustrated at **138** and is a non-continuous steel band which extends circumferentially all the way around the radially outer surface of the second portion **130**) is suitably provided in the bore surface. By "non-continuous" is meant that the band **138** has two ends which may touch or have a gap therebetween.

The bore **134** in rotation transmission member **122** is provided for receiving input part shaft portion **84**, with the shaft portion **84** detachably attached to the rotation transmission member **122** by the detent ball **136** thereof being received in the shaft portion groove **86**, the shaft portion **84**

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being attachable and detachable by overcoming the force of spring **138**. Thus, rotation of the rotation transmission member **122** is effected by the rotation of the shaft **50**.

As previously pointed out, each rotation transmission member second portion **130** may instead of a bore **134** have a female hex therein and a groove to fix a ring. The female hex in rotation transmission member **122** is provided for receiving input part shaft portion **84**, with the shaft portion **84** detachably attached to the rotation transmission member **122** by the ring thereof being received in the shaft portion groove **86**, the shaft portion **84** being attachable and detachable by overcoming the force of the ring. Thus, rotation of the rotation transmission member **122** is effected by the rotation of the shaft **50**.

Each rotation transmission member first portion **128** has three or more (for example, six) circumferentially spaced bores, illustrated at **140**, in the adjacent terminal ends thereof. Three or more (for example, six) angular pins **142** are received in corresponding pairs of bores **140** respectively. Each pin **142** has a pair of legs **144** and **146** corresponding to housing legs **102** and **104** respectively and having the same angle **40** therebetween. Interference-preventing chamfers, illustrated at **148**, are provided, as necessary, at the corners (intersections of the legs **144** and **146**). One leg **144** is slidably and rotatably received in a bore **140** in rotation transmission member **122**, and the other leg **146** is slidably and rotatably received in the corresponding bore **140** in the other rotation transmission member **124** for transmission of rotation from rotation transmission member **122** to rotation transmission member **124**. Thus, during rotation through half a turn, the positions of the pins **142** as seen in FIG. 8 would interchange. Thus, the angular pins **142** without gearing or other rotation transmission means are provided to simplify the construction while providing reliable and rugged use, achieving high torque transmission for effective use, and minimizing space taken up by the tool **20** at the articulation point so that the tool may be more effectively and easily used in confined and hard-to-reach places.

Axially extending teeth, illustrated at **150**, are formed internally of and circumferentially about the outer end portion of member **114** which extends beyond the outer end of leg **104**. These teeth **150** are complementary to teeth **158** of member **152**. In order to be able to detachably attach another intermediate part, such as part **28** in FIG. 1, to intermediate part **26**, member **152** is provided with the axially extending teeth **158** circumferentially about the radially outer surface thereof for meshing engagement with teeth (similar to teeth **118**) of the succeeding intermediate part (if such is added to the tool) so that rotation and axial movement does not occur. If such a succeeding intermediate part is added, then an interconnecting cylindrical or hexagonal member **160** is provided which has a pair of axially spaced circumferential grooves, illustrated at **162** and **164**. The end portion **166** of the member **160** which contains groove **162** is received in the bore **134** or female hex of rotation transmission member **124** and detachably attached therein by snap-fitting or clicking of spring-loaded ball detent **136** or the previously discussed alternative spring-loaded ring into groove **162**. The other end portion **168** of member **160** which contains groove **164** is received in the bore **134** or female hex of rotation transmission member **122** of the succeeding intermediate part **28** and detachably attached therein by snap-fitting or clicking of spring-loaded ball detent **136** or the previously discussed alternative spring-loaded ring into groove **162**. It should be understood that other suitable attachment fittings may be provided.

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It should be understood that the output part 30 may be similar to the intermediate part 26 with the exception that the second portion 130 of member 124 is suitably formed, in accordance with principles commonly known to those of ordinary skill in the art to which this invention pertains, to carry the screwdriver blade 32 (or other suitable tooling) such as, for example, by the tooling being integrally formed therewith. It should of course be understood that the output part 30 does not require the members 152 or 160. Alternative to being connected to one or more intermediate parts 26 the last one of which is connected to an output part 30, as illustrated in FIG. 1, the input part 24 may be connected directly to an output part 30 to provide a complete tool without intermediate parts.

Thus, there is provided a fastener driving tool which may inexpensively yet ruggedly and reliably utilize a universal input part and provide access to various hard-to-reach fasteners by the use for a given task of one or more of a number of driven (intermediate and output) parts providing various offsets, yet be able to transmit the torque loads necessary for tightening and loosening the fasteners and be streamlined (not too large or bulky) at the articulation point for effective use in difficult and confined places.

It should be understood that, while the present invention has been described in detail herein, the invention can be embodied otherwise without departing from the principles thereof, and such other embodiments are meant to come within the scope of the present invention as defined by the appended claims.

What is claimed is:

- 1. A fastener driving tool, comprising:
  - an input part having an internal transmission member;
  - a first offset driven part operatively arranged to be detachably attachable to said input part, said first offset driven part having an internal transmission member operatively arranged to be linked to and driven by said input

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- part internal transmission member when said first offset driven part is attached to said input part; and,
- a second offset driven part operatively arranged to be detachably attachable to said first offset driven part, said second offset driven part having an internal transmission member operatively arranged to be linked to and driven by said first input part internal transmission member when said second offset driven part is attached to said first offset driven part;
- wherein said first offset driven part and said second offset driven part further comprises a plurality of pins rotatably connected between said rotation transmission member.

- 2. A fastener driving tool, comprising:
  - an input part having an internal transmission member:
    - a first offset driven part operatively arranged to be detachably attachable to said input part, said first offset driven part having an internal transmission member operatively arranged to be linked to and driven by said input part internal transmission member when said first offset driven part is attached to said input part;
    - a second offset driven part operatively arranged to be detachably attachable to said first offset driven part, said second offset driven part having an internal transmission member operatively arranged to be linked to and driven by said first input part internal transmission member when said second offset driven part is attached to said first offset driven part; and,
    - a detachably attachable slidable rotatable positioning handle wherein said positioning handle location is fixed by the application of a user controlled force.

- 3. The fastener driving tool according to claim 2, wherein said user controllable force is the axial displacement of a rotatable threaded rod.

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