United States Patent

[11] **3,574,915**

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[21] Appl. No. **775,772**
[22] Filed **Nov. 14, 1968**
[45] Patented **Apr. 13, 1971**
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[32] Priority **Aug. 8, 1968**
[33] **Great Britain**
[31] **38,000/68**

[54] **FASTENER-PLACING APPARATUS**
3 Claims, 6 Drawing Figs.

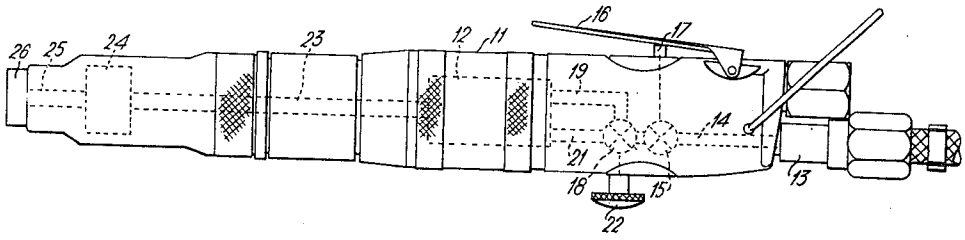
[52] **U.S. Cl.** **29/200,**
29/240, 29/413, 72/391
[51] **Int. Cl.** **B23p 19/00,**
B23p 19/04, B23p 17/00
[50] **Field of Search** 29/200,
208, 240, 413, 200 (B), 202; 72/391

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ABSTRACT: The invention provides an adapter for facilitating placing fasteners of the type comprising a threaded first part which is pulled into a second part to place the fastener. The adapter converts a standard rotary tool to provide separately both rotary and axial movement of a threaded mandrel engageable with the threaded first part of a fastener to be placed. The adapter comprises a body; a reciprocable and rotatable mandrel, one end of which is threaded to engage a fastener and the other end of which forms one part of a lead-screw device, the other part of the lead-screw device being driven to rotate by the rotary tool; and an abutment nose rotatable and reciprocable on the body and keyed for sliding on the mandrel. The abutment nose and the body form two parts of a dog clutch. The mandrel is normally rotated by the lead-screw device, but when a fastener is drawn up onto the mandrel and displaces the abutment nose, the dog clutch engages to prevent rotation of the mandrel, which is then retracted axially into the body, by the action of the lead-screw device, to place the fastener.



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4 Sheets-Sheet 1

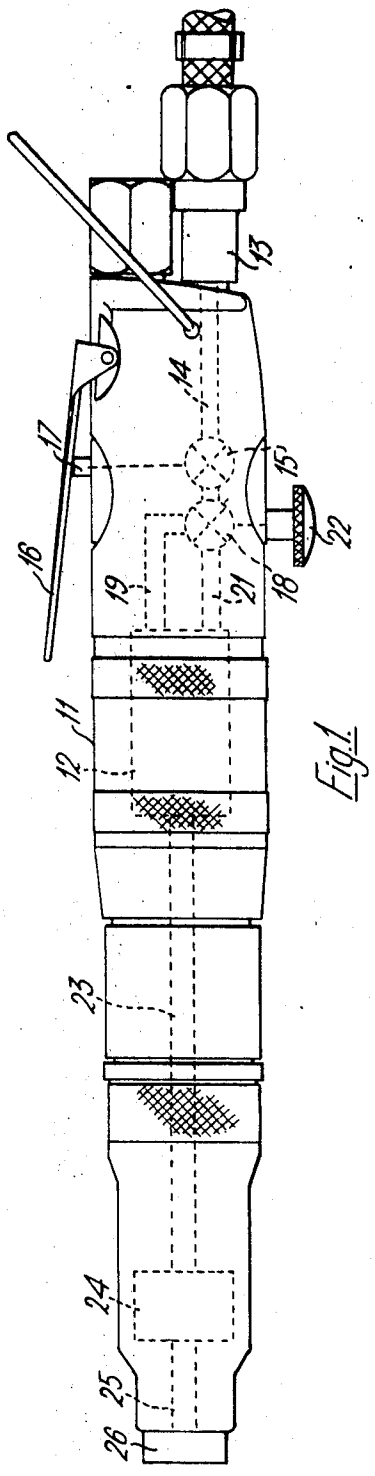


Fig.1

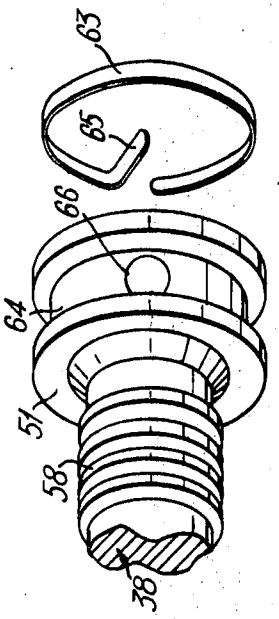


Fig.6

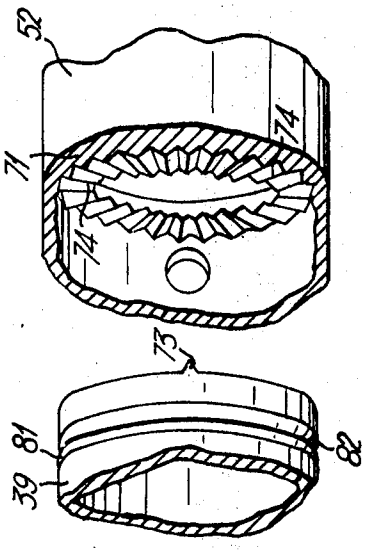


Fig.5

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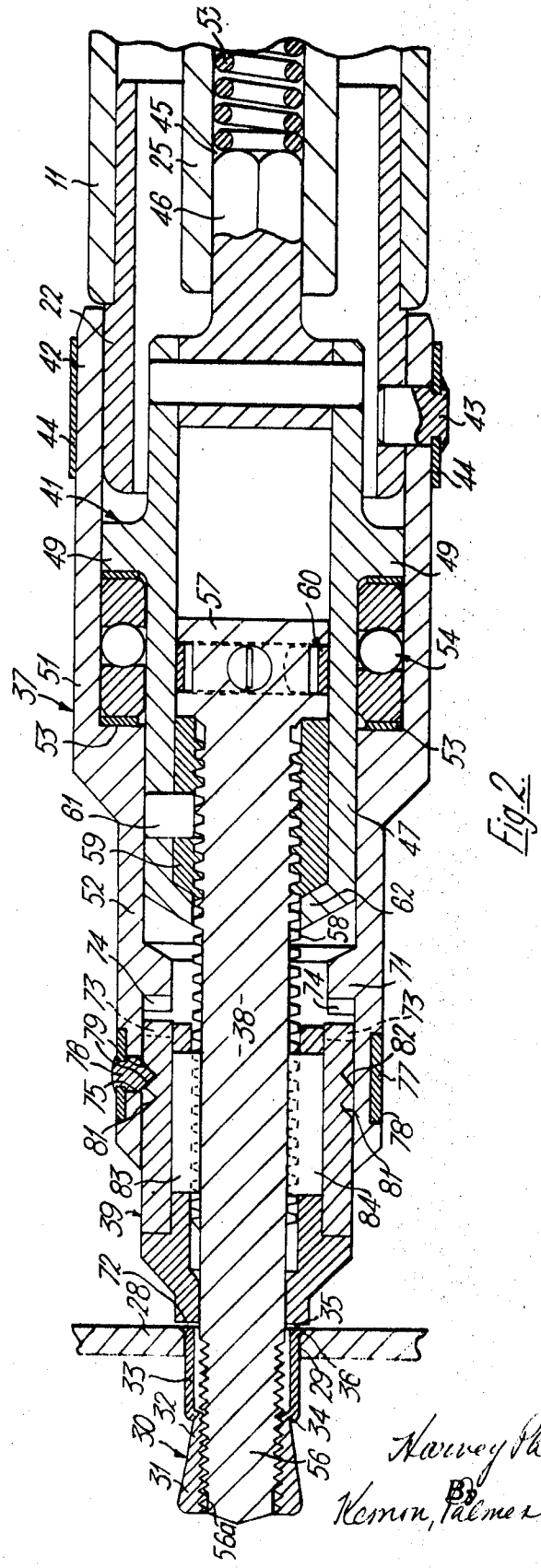
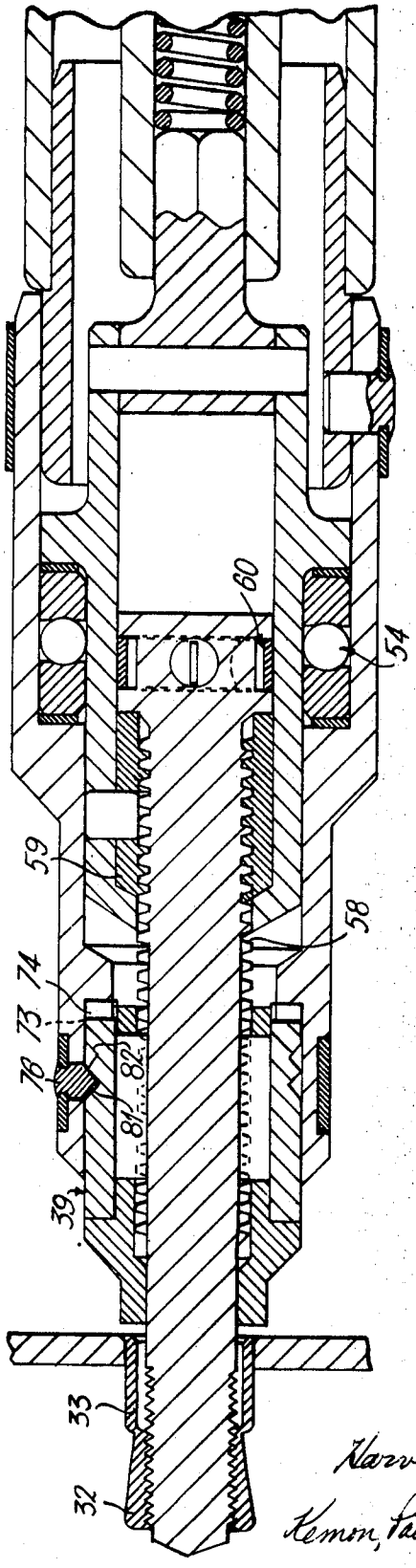


Fig. 2.

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Fig. 3



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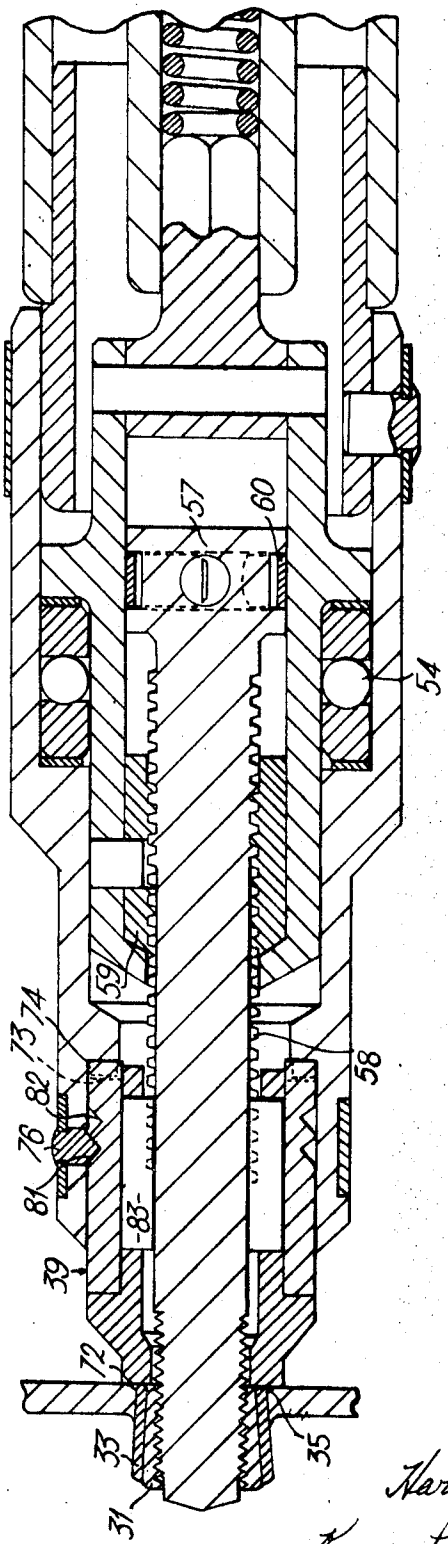


Fig. 4.

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FASTENER-PLACING APPARATUS

The invention relates to fastener-placing apparatus, more particularly for placing fasteners of the type comprising a threaded first part which is pulled into a second part in order to place the fastener. Such a fastener is hereinafter referred to as "a fastener of the type defined."

It is an object of the invention to provide an adapter for use with a standard rotary motor unit or tool, which adapter will provide separately both rotary and axial movement of a threaded mandrel engaged with the threaded first part of a fastener, thereby to place the fastener more quickly and more efficiently.

It is a further object of the invention to provide such an adapter which is of simple, rugged construction and easy, automatic and foolproof operation.

It is a further object of the invention to provide such an adapter which is easy and quick to attach and remove from a standard rotary tool.

Other objects of the invention will become apparent from the following description of one way of putting the invention into practice.

A specific embodiment of the invention, in the form of a demountable adapter and a hand-held pneumatic rotary motor unit for use therewith, will now be described by way of example and with reference to the accompanying drawings, in which:

FIG. 1 is an outline view of a hand-held pneumatic rotary motor unit, showing schematically the essential working parts thereof;

FIGS. 2, 3 and 4 are axial longitudinal sections through the adapter attached to the motor unit and engaged with a fastener, at different stages in the cycle of placing the fastener; and

FIGS. 5 and 6 are exploded perspective views of particular parts of the adapter.

The hand-held pneumatic rotary motor unit illustrated in FIG. 1 (which is on a smaller scale than the rest of the FIGS.) includes a body 11 containing a reversible air motor 12, and a pneumatic inlet 14 connected by a conduit 14, to an on/off valve 15. The on/off valve 15 is spring biassed into the off or closed position and can be held in the on or open position by pressing an exterior lever 16 which is connected to the valve 15 by means of a push rod 17. The output side of the on/off valve 15 is connected to a reversing valve 18, the output of which is connected by two conduits 19, 21 to the reversible air motor 12. The reversing valve 18 is spring biassed into the position in which it feeds compressed air to the motor 12 to make the latter rotate in a clockwise direction (for use with right-handed screw threads). Depression of an exterior reversing button 22 connected to the reversing valve 18 changes the reversing valve to alter the supply of air to the motor and reverse the motor to rotate in a counterclockwise direction. The rotary drive from the motor 12 is transmitted through an intermediate shaft 23 and through a torque-limiting device to a final drive shaft 25. The torque-limiting device is in the form of a torque overload clutch 24 which will slip upon the loading of a torque between the shafts 25 and 23 of more than a predetermined amount. Surrounding the final drive shaft is a circular collar 26 secured to the body 11. Any convenient form of adapter to utilize the rotary drive from the motor may be attached to this collar, for example to provide a screwdriver tool or a nut-runner tool. Such a rotary motor unit is well known and is commonly used in the mechanical assembly industry.

The threaded fastener which the adapter of the present example is intended to place is illustrated in FIGS. 2, 3 and 4. It comprises an internally threaded nut portion 31 the external surface 32 of which is tapered. Formed integrally with the nut portion is a tubular body portion 33 which is coaxial with, and joined to, the nut portion at its narrower end by a shearable web 34. The free end of the body portion 33 remote from the nut is formed with a head in the form of an outwardly extending annular flange 36, providing a flat annular face 35 on the head of the fastener and a tapered face to mate with a countersunk hole. Such a fastener is commercially obtainable under the registered trademark NUTSERT.

The adapter comprises a generally tubular body 37, a draw bolt 38 which is both reciprocable and rotatable within the body, abutment means in the form of a nose assembly 39 reciprocable with respect to the body, and a nut assembly 41 within the body for rotating and reciprocating the drawbolt. The rear end 42 of the adapter body 37 fits over the projecting collar 22 of the motor unit and is retained thereon by means of a peg 43 fitting into aligned holes in the collar 22 and the rear end 42 of the adapter body. The peg 43 is resiliently held in place by means of a spring circlip 44 which extends around the rear end of the adapter body and carries the peg 43 near one end. If required, the adapter can be removed from the motor unit by levering up the end of the clip 44 and disengaging the peg 43 from the hole in the collar 22. The front end of the final drive shaft 25 of the motor unit is formed with a hexagonal section axial recess or key 45 which receives and drives a hexagon shaft 46 which forms the rearmost part of the nut assembly 41. The nut assembly 41 is provided by a steel tube 47 to the rear end of which the hexagonal shaft 46 is secured by means of a transverse steel pin 48, and a bronze nut 59 at its forward end. The tube 47 is formed with an outwardly extending radial flange 49 positioned about two-thirds of the way along its length from its front end. The adapter body 37 has its rear part 51 of diameter than its forward part 52, and at the junction of the parts 51 and 52 there is provided a rearward-facing internal annular shoulder 53 in the adapter body. Between the shoulder 53 of the adapter body and the forward side of the external flange 49 on the tube 47 on the nut assembly there is situated a ball race 54, which provides a low-friction rotary thrust bearing between the nut assembly and the adapter body. The nut assembly 41 is pressed forwardly within the adapter body by means of a strong helical compression spring 55 within the hexagonal bore 45 of the motor unit drive shaft 25, thus keeping the ball race 54 from falling apart.

The drawbolt 38 has its forward part 56, which projects forwardly from the nose piece 39 of the adapter externally threaded to engage with the internal thread on the nut portion 31 of the fastener to be placed. The extreme end portion 56 *a* is plain and of root diameter to facilitate entry into a nut. The other end of the drawbolt 38 inside the adapter body and the tubular body 47 of the nut assembly is formed with an enlarged head 57 of circular cross section which is a sliding fit within the tube 47. The major part of the length of the drawbolt body is formed with an Acme screw thread 58 mating with the nut 59 of the nut assembly 41 which is positioned inside the forward end of the nut assembly tube 47 and secured thereto by means of a steel pin 61 passing through both the tube 47 and the nut 59. The forward end of the tube 47 is also turned inwardly to form a flange 62 covering the forward end of the nut 59. A frictional rotational drive 60 is provided between the nut assembly tube 47 and the head 57 of the drawbolt 38. This is shown in exploded form in FIG. 6. It is provided by a part-circular spring steel clip 63 received within a circumferential groove 64 around the head 57 of the drawbolt. The spring clip 63 extends around rather less than the whole of the circumference of the groove 64, and one end 65 of the clip is bent inwardly in a radial direction and received within a radial bore 66 opening from the floor of the groove 64. The spring clip 63 has a natural unstressed diameter larger than that of the cylindrical interior of the tube 47 around the head of the drawbolt, so that the spring clip 63 tends to expand into frictional engagement with the interior of the tube 47. The spring clip 63 is positioned into the groove 64 in the drawbolt head so that, when viewed from the rear of the drawbolt in a forward-looking direction (i.e. from right to left as viewed in FIGS. 2, 3, and 4), it extends from its end 65 which is retained in the drawbolt in an anticlockwise direction around the drawbolt head groove 64. If the nut assembly 41 is rotated in a clockwise direction with respect to the drawbolt, the spring is in a "leading" position, and the frictional

engagement between the spring **63** and the interior of the drawbolt tube tends to uncoil the spring, i.e. to make it increase in diameter, and therefore wedge between the drawbolt head and the interior of the nut-assembly-tube **47**. This increases the frictional engagement between the spring **63** and the nut assembly, so that the clockwise rotation of the nut assembly is drivingly transmitted to the drawbolt. When the nut assembly is rotated in the opposite direction, i.e. anticlockwise with respect to the drawbolt, the spring clip **63** does not tend to increase in diameter (since it is then in a "trailing" position), so that it does not wedge between the drawbolt head and the interior of the tube **47**. Consequently the frictional engagement between the nut assembly **41** and the drawbolt is less for such anticlockwise rotation than for clockwise rotation of the nut assembly.

The nose assembly **39** is received within the forward end of the part **52** of the adapter body, forwardly of the flange **71**. The nose assembly **39** is generally cylindrical and is a sliding fit within the forward end of the adapter body. The forward end of the nosepiece assembly **39** tapers inwardly and is provided at its forward end with a flat annular face **72** of an appropriate diameter to abut and overlie the annular flathead end face **35** of the fastener to be placed. The rearmost end of the nose assembly **39** is provided with two projecting dogs **73** positioned diametrically opposite each other. These dogs have sloping side faces and can engage between corresponding similarly shaped dogs **74** provided completely around the forward-facing face of the flange **71** within the front of the adapter body. These two sets of dogs form a dog clutch, which is illustrated in exploded form in FIG. **5**. Means for releasably retaining the nose assembly **39** so that the dog clutch is either engaged or disengaged is provided in the form of a spring detent. The front end of the front part **52** of the adapter body has a radial hole **75** in which is received a detent pin **76** which is supported and urged inwardly by means of a circular spring **77** received in a shallow circumferential groove **78** around the outside of the adapter body. Towards its rear end the nose assembly **39** is provided with two annular grooves **81**, **82** each of V cross section to match the tapered inner end faces **79** of the detent pin **76**. The two grooves are immediately next to each other so that there is no "land" between them, only an inverted V crest. When the nose assembly **39** is in a forward position with respect to the adapter body (as illustrated in FIG. **2**) with the detent pin **76** engaged in the rearward groove **82**, the dog clutch is disengaged and the nose assembly **39** is free to rotate with respect to the adapter body. When the nose assembly is in a rearward position with respect to the adapter body, with the detent pin **76** engaged in the forward groove **81**, the dog clutch is engaged, with the two dogs **73** of the nose assembly engaging the dogs **74** on the adapter body. The detent pin holds the dog clutch in engagement, thus preventing relative rotation between the nose assembly **39** and the adapter body, unless a sufficient torque is applied to the nose assembly with respect to the adapter body to cause the dogs **73** to ride up the sloping face into the dogs **74** and make the detent pin **76** ride up the sloping face of the groove **81** until it passes over the crest between the two grooves and falls down into the groove **82**, thus disengaging the dog clutch.

The nose assembly **39** is keyed to the drawbolt **38** by means of two diametrically opposed axial keys **83**, **84**, which allow it to reciprocate axially with respect to the drawbolt at least to the extent of movement between the two positions defined by engagement of the detent pin **76** in the grooves **81** and **82** respectively which either engages or disengages the dogs, as described above.

It will be apparent from the foregoing description that when the nose assembly **39** is in its forward position with the dog clutch disengaged (as illustrated in FIG. **2**) the drawbolt **38** is free to rotate with respect to the adapter body. Consequently when the nut assembly **41** is rotated in a clockwise direction with respect to the adapter body, the drive will be transmitted through the frictional drive **60** to the drawbolt, which will rotate with the nut assembly, so that there is no relative rotation between the drawbolt and the nut **59**. When the nose assembly **39** is in its rearward position with the dog clutch engaged (as illustrated in FIGS. **3** and **4**), the drawbolt **38** is prevented from rotating. Consequently a sufficiently strong clockwise rotational drive applied to the nut assembly **41** with respect to the adapter body will overcome the frictional drive **60** between the nut assembly **41** and the nonrotatable drawbolt and will cause relative rotation of the nut **59** and the drawbolt. The drawbolt and the nut then act as a lead-screw device, the relative clockwise rotation of the nut causing the nonrotating drawbolt to be retracted rearwardly into the adapter body.

The operation of the complete tool in the placing of a fastener **30** within an aperture **29** in a panel **28** is as follows. A suitable countersunk hole **29** having been drilled in the panel **28** with a slightly larger diameter than the external diameter of the body **33** of the fastener, the fastener is inserted in the hole from the right-hand side as viewed in FIGS. **2**, **3** and **4**, until its head **34** lies within the countersink and its head end face **35** is approximately flush with the face of the panel. The operator then switches on the pneumatic tool to rotate in a clockwise direction, by depressing the lever **16** alone. This causes the drawbolt to rotate in a clockwise direction at high speed. The end of the threaded external portion **56** of the drawbolt is offered into the fastener, through the interior of the body part **33** and into the threaded part of the nut **31** so that the threaded part **56** of the drawbolt screws itself into the nut portion, bringing the whole tool towards the nut and panel, the operator giving a slight forward pressure on the tool. FIG. **2** illustrates the relative positions of the adapter and the various parts thereof, and the fastener, just before the anvil face **72** of the nose of the tool meets the head face **35** of the fastener. (It will be noted that the nose assembly **39** is in its forward position, and that the drawbolt **38** is in its most forward position with respect to the nut assembly, so that the forward face of the head **57** is in contact with the rear end of the nut **59**. These parts are left in these positions at the end of the previous operation of the tool in placing a fastener, as will be described below.) As the rotating drawbolt continues to screw its way into the fastener, the anvil face **72** of the nose assembly **39** meets the head face **35** of the fastener, and as the tool is drawn towards the fastener the action of the detent between the nose assembly and the adapter body is overcome, so that the nose assembly is pushed into the tool. The detent pin **76** rides up the forward face of the rear groove **82** in which it is engaged and drops down into the groove **81**, thus engaging the dogs **73** on the nose assembly with the dogs **74** on the adapter body. This position is illustrated in FIG. **3**. (It should be noted that the inward urging of the detent pin **76** by the spring **77** as the pin enters the groove **81** may cause the nose assembly **39** to move rearwardly very rapidly for a short period of time until the dogs engage, so that the anvil face **72** may separate from the head face **36** of the fastener momentarily.) When the dogs engage, the drawbolt stops rotating and the friction drive between the nut assembly and the drawbolt is overcome. The consequent relative rotation between the nut **59** and the threaded portion **58** of the drawbolt causes the drawbolt to be retracted into the adapter body. This immediately brings the head face **36** of the fastener into contact with the anvil face **72** on the nose assembly (if contact has been lost as described above). Pull on the nut portion **31** of the fastener with respect to the head face **35** causes the fastener to shear at the junction **34** and the nut portion to enter the body portion. This expands the body portion within the aperture **29** in the panel **28** so that the body portion is securely engaged in the panel. The axial reaction between the adapter body and the drawbolt is supported through the ball race **54**. The resistance to the retraction of the drawbolt into the adapter body increases as the tapered nut portion of the fastener is progressively drawn into the body portion, thus increasing the torque resistance to rotation of the nut assembly. Eventually this torque increases to the point where the preset torque clutch **24** in the pneumatic motor unit slips, so that rotation of the nut

assembly **41** ceases and the drawbolt retraction stops. The extent to which the nut portion has been pulled into the body portion of the fastener when this stage is reached will depend upon the material and dimensions of the particular fastener, but the furthest possible is when the headmost end of the nut reaches the headmost end of the body portion and abuts the anvil face **72** of the nose assembly of the adapter. This position is illustrated in FIG. **4**.

The slipping of the preset torque clutch **24** is apparent to the operator by the distinctive clicking noise which occurs, and the operator then reverses the direction of rotation of the motor by pressing the reversing button **22**, still keeping the lever **16** depressed. The pneumatic motor **12** reverses its direction of rotation to anticlockwise, the preset torque clutch **24** picks up again and the nut assembly **41** of the adapter is rotated in an anticlockwise direction. Since rotation of the nose assembly and the drawbolt is still prevented by the engaged dog clutch, the frictional drive **60** is overcome (it is weaker in this direction), and the anticlockwise rotation of the nut **59** with respect to the nonrotating drawbolt drives the drawbolt forward again, pushing the tool body away from the placed fastener and panel. This movement continues until the drawbolt is again in its most forward position where the forward face of the head contacts the rear end of the nut **59**. The threaded part **58** of the drawbolt is thus screwed completely into the nut **59**, so that further rotation of the nut with respect to the drawbolt is absolutely prevented. Thus the full anticlockwise driving torque from the pneumatic rotary tool is applied to the drawbolt. This torque is sufficient to make the dogs **73** on the nose assembly climb up the dogs **74** on the adapter body and overcome the resistance of the detent pin **76**, as previously described. The nose assembly **39** is thus forcibly returned to its forward position and is then free to rotate with respect to the adapter body. This allows the drawbolt to rotate at high speed in an anticlockwise direction, the frictional drive **60** being sufficiently strong to achieve this at low load, thus unscrewing the forward end **56** of the drawbolt from the placed fastener. When the drawbolt is free of the placed fastener, the operator then releases both the lever **16** and the button **22** to stop the tool. Both the nose assembly and the drawbolt are thus left in their most forward positions ready for a further operation of the tool to place another fastener.

The adapter described in the foregoing example is highly advantageous in practice. It will be seen that the fastener-placing tool provided is completely automatic in operation and does not require the judgement or the experience of the operator in deciding the correct point at which to retract the drawbolt. The action of retracting the drawbolt into the adapter body to place the fastener is completely automatically actuated by the placed fastener being drawn towards the body of the adapter. Furthermore the drawbolt is retracted only when it is not rotating, so that the high-tension load between the threads **56** on the end of the drawbolt and the nut of the fastener is applied when those threads are not relatively rotating, thus reducing considerably the wear on the threads **56** of the drawbolt, compared with tools which rely upon merely the action of a continuously rotating threaded mandrel screwing into the nut of a fastener to pull the nut into the fastener body. The adapter is relatively simple in construction and operation and any servicing or maintenance required can be easily carried out. The drawbolt and nose assembly may readily be removed and replaced by others with different size of screw thread and anvil diameter, to enable the placing of fasteners of different sizes.

Provided that sufficient space is left within the nut assembly tube **47** behind the drawbolt head **57**, the drawbolt may be retracted into the head sufficiently far to retract the threaded portion **56** of the drawbolt inside the nosepiece **39**, to protect the threads from accidental damage while the tool is being stored or transported. This retraction is achieved by the operator pushing in the nosepiece to engage the dog clutch and then running the tool in the clockwise direction to completely retract the drawbolt. Running the tool anticlockwise restores the drawbolt for operation.

The strong compression spring **55** also gives relief against axial impact on the end of the drawbolt.

The invention is not restricted to the details of the foregoing example. For instance, the threaded part of the drawbolt which engages the fastener need not be formed integrally with the first part of the lead-screw device, but could be a separate part connected to it. The part of the nose assembly which forms the anvil face need not be formed integrally with the associated part of the dog clutch.

Fastener-placing apparatus according to the invention may be provided in the form of an adapter which may be removably mounted on and driven by a rotary motor unit to form a fastener-placing tool. Alternatively the apparatus may be provided in the form of a fastener-placing tool having an integral motor. In either case the motor may be of any convenient type, e.g. electric or pneumatic, and the tool may be arranged for hand holding or bench mounting.

I claim:

1. Apparatus for placing fasteners of the type comprising an internally threaded first part which is pulled into a second part to place the fastener in a workpiece comprising:

a body member;

a drawbolt having an externally threaded outer end to engage with the threaded first part of a fastener to be placed, said drawbolt being mounted in aid body so as to be rotatable and reciprocable with respect thereto;

a nose assembly carried by said body for abutting the second part of the fastener, said nose assembly being longitudinally displaceable toward said body member by the second part of the fastener when the second part of the fastener is drawn towards the body by rotation of the drawbolt when engaged with the first part of the fastener;

a lead-screw device and nut within said body, said device being at least connected to said drawbolt;

means establishing a nonrotatable connection between said drawbolt and said nose assembly, said nose assembly when in its position displaced toward said body member being restrained from rotation with respect to said body member to thereby prevent rotation of said drawbolt but permitting axial movement of said drawbolt in response to rotation of said lead screw;

a dog clutch directly connecting said nose assembly and said body member, said dog clutch comprising interengaging teeth on said body member and nose assembly, said dog clutch preventing rotation of said nose assembly with respect to said body member when said nose assembly is in its position displaced towards said body member;

a detent groove on said nose assembly;

a spring detent pin on said body member engageable in said groove to retain said nose assembly displaced toward said body member when said dog clutch is engaged; and

means to overcome the retaining action of said spring detent and disengage said dog clutch only upon return of said drawbolt to its forwardmost position.

2. Apparatus as claimed in claim **1**, in which:

both said sets of interengaging teeth of the dog clutch have sloping faces, and the detent groove has a sloping wall, whereby when the teeth of the dog clutch are engaged and sufficient torque is applied to the nose assembly with respect to the body member, the teeth on the nose assembly climb up the teeth on the body member thus moving the nose assembly away from said body member and causing said detent pin to ride up the wall of said detent groove to throw said dog clutch out of engagement; and in which

said drawbolt has a head which, when the drawbolt is in its forwardmost position, contacts the rear end of said nut of said lead-screw device so that said nut drives said drawbolt to rotate with it in the direction of unscrewing the threaded outer end from the fastener, thereby applying torque to said drawbolt to throw said dog clutch

out of engagement only when said drawbolt has returned to its forwardmost position.

3. Apparatus as claimed in claim 1, including a second detent groove on said nose assembly which said detent pin engages to retain said nose assembly in its position away from said body member.