Oct. 27, 1942. W. STEVER 2,299,956

SCREW-DRIVING OR NUT-TIGHTENING MACHINE

Filed July 13, 1940

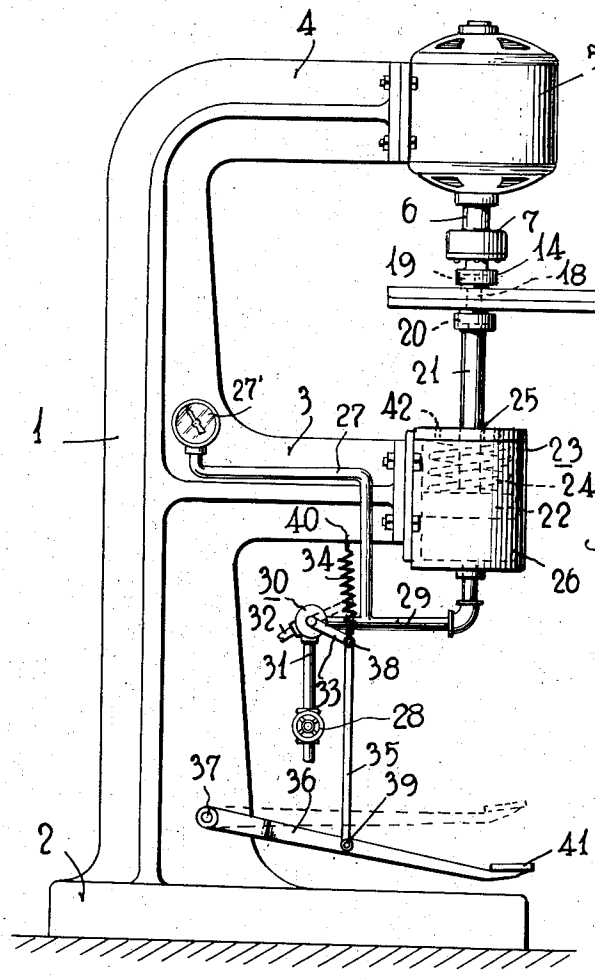


Fig. 1

Fig. 2

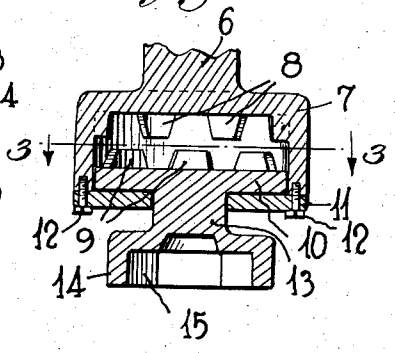


Fig. 3

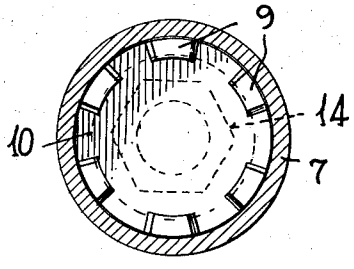
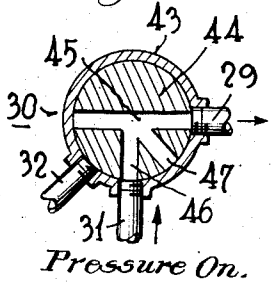
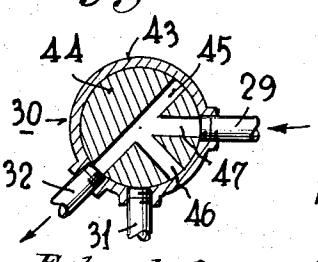


Fig. 4



Pressure On.

Fig. 5



Exhaust Open.

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SCREW-DRIVING OR NUT-TIGHTENING MACHINE

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6 Claims. (Cl. 81—54)

The present invention relates to means for driving screws, screwing nuts on bolts, and similar operations, wherein one threaded part is applied to its mate.

An object of the invention is to provide apparatus whereby screws, studs, nuts and the like may be screwed rapidly upon their companion elements and whereby a uniform degree of tightening of such elements may be attained, such degree however being capable of modification to fit the particular screw-threaded means at any time being manipulated, so that for example more force would be applied to the relatively large screw-threaded members and less to the smaller ones.

One object of the invention resides in providing a clutch which will prevent the moment of the force from exceeding a definite pre-set amount suitable for the work at the time being performed.

Broadly described, the apparatus consists of a tool, such as a screw driver bit or nut-receiving socket, means for rotating said tool about its axis, said means including a source of mechanical power and a clutch, and means for yieldably holding the driving and driven members of the clutch together so as to permit the clutch to slip when the screw-threaded element has been tightened to the desired degree, to prevent breakage of the said element as well as of the apparatus itself, and also to secure a substantially uniform degree of tightening in all the similar screw-threaded elements in any one type of work.

More specifically described, the invention comprises a supporting frame, a motor mounted thereon, preferably with its shaft vertical, a tool for engaging the screw-threaded element and a clutch connecting the shaft of the motor with said element, means for yieldably holding a work piece against said tool and means for actuating said last-named device comprising fluid pressure actuated mechanisms and instrumentalities for controlling the latter.

In a preferred form of the invention, two work-engaging tools are provided, so that for example one tool may engage the head of a bolt on one side of a work piece while the other engages a nut to be threaded upon said bolt, at the other side of the work piece. This is desirable in particular where the work pieces are difficult to manipulate because of their size, shape or weight.

A clear understanding of the invention may be obtained from the present specification and the drawing accompanying the same, disclosing a specific form of machine.

In said drawing:

Fig. 1 is a diagrammatic side elevation of the complete machine;

Fig. 2 is a fragmentary section, on an enlarged scale, through the clutch;

Fig. 3 is a horizontal section through the clutch on the plane indicated by the line 3—3 of Fig. 2;

Fig. 4 is a diagrammatic representation of a section through a control valve employed in the machine, the valve being shown in the position in which pressure fluid is being admitted to the cylinder of the machine; and

Fig. 5 is a similar view of the valve, in the position in which the pressure fluid is being discharged from the machine.

In all the figures, similar elements are designated by the same reference characters.

Referring to Fig. 1 it will be seen that the frame 1 of the machine here illustrated is shaped somewhat like the letter E, with a base 2, a central horizontal arm 3 and an upper horizontal arm 4.

The source of mechanical power in this example is shown as an electric motor 5, although it will be understood that this is merely illustrative and other sources of rotary power could be substituted if preferred or expedient in any particular instance.

This motor has a shaft 6 extending downward therefrom and terminating in a cup-shaped member 7 which forms one element of a clutch. In Fig. 2 it will be seen that a series of teeth or projections 8 is formed within the cup and that these teeth taper or narrow downwardly. Companion teeth 9 are carried by the driven member 10 of the clutch, which is located within the cup 7. This driven member may be retained within the cup 7 in any desired way, as by the cover plate 11, secured by the screws 12.

A shaft 13 projects downwardly from the plate 10 and terminates in a head 14 of suitable shape to engage a nut or the head of a bolt or screw. In the present instance it is shown as having a hexagonal socket 15 formed therein. It will be noted that in the position disclosed in Fig. 2 the teeth 8 and 9 are disengaged completely from one another. A point to be borne in mind is that the sides of the teeth should be at such angle that the tangent thereof exceeds the coefficient of friction of the material or materials of which the teeth are composed, so that when the teeth are in engagement, the exertion of

excessive force will cause them to disengage by moving in a generally vertical or axial direction.

A work piece consisting for example of the members 16 and 17 which are to be held together by bolts 18 and nuts 19, may be placed below the tool 14, as shown in Fig. 1, so that the nut 19 will be engaged in the socket 15.

A companion socket 20 fitting the head of the bolt cooperates with the mechanism above described, and is held on the piston rod 21 of a piston 22 mounted in a cylinder 23. This piston rod may be guided through a suitable bore 25 in the upper end of the cylinder, and may move upward against the force of a spring 24 if desired, to cause the piston to return downwardly with certainty when the pressure in the end 26 of the cylinder is relieved, should the weight of the piston itself not be sufficient to assure such return.

The pressure medium, preferably compressed air, may be supplied to the cylinder 23 through the pipes 31 and 29, a pressure control valve 28 being inserted in pipe 31 to permit manual or automatic control of the pressure, a branch pipe 27 leading to a pressure gauge 27' being inserted in pipe 29 and a special three-way valve 30 being interposed between pipes 29 and 31. The valve 30 has an operating arm 33 extending therefrom and pivotally attached at 38 to the upper end of a rod 35, which in turn is pivoted at 39 to a treadle lever 36 pivotally connected to the frame 1 at 37. A spring 34 may be attached at one end to the frame as shown at 40, and at its other end to the rod 35 at 38, and said spring normally will raise the treadle lever into the position shown in dotted lines, thereby likewise moving the valve lever 33 into its uppermost position, as shown in dotted lines.

The valve 30 is so designed that when the treadle 41 on lever 36 is depressed, the valve 30 will establish communication between pressure supply pipe 31 and the pipe 29 leading to the cylinder 23, while when the treadle is released the spring 34 will bring the valve into such position that the pipe 31 will be closed, and communication will be established between the cylinder 23 and the waste or exhaust pipe 32 so that the existing pressure medium in the cylinder will be discharged through said pipe 32 Thus the treadle will control the rising and falling of the piston 22 and thereby of the tool 20 attached thereto. In order to prevent compression of air in the cylinder 23 above the piston, the top of said cylinder may be in free communication with the outer atmosphere, either by being practically unobstructed or by having a special vent 42 for this purpose.

The specific structure of a treadle-controlled valve 30 suitable for the present purpose will be understood from Figs. 4 and 5.

The valve comprises a shell or casing 43, in which turns the plug 44, which is attached to or integral with the valve arm 33 already discussed. The plug 44 may have, for instance, a diametral bore or passage 45 and two radial bores communicating with said passage 45, for example a bore 46 extending at right angles to the bore 45, and a bore 47 extending at substantially 45° to the other two bores. When the arm 33 is in its lowermost position as shown in full lines in Fig. 1, the plug 44 will be in the position shown in Fig. 4 and it will be seen that thereby the pipe 31 is put in communication with the pipe 27 while the pipe 32 is closed.

When the valve lever 33 is in the dotted line position on the other hand, the plug 44 will be in the position shown in Fig. 5. Here the pipe 31 is closed while the passage 47 is in communication with the pipe 29 and the passage 45 is connected with the outlet pipe 32. Thus no further pressure medium can enter the cylinder 23 from the pipe 31, but on the contrary that already in the cylinder will be exhausted through the waste pipe 32.

While a specific simple type of valve has been disclosed, it should be understood that many other types of valves could be employed and that it might even be desirable in some cases to provide two separate valves, one to supply the pressure medium and the other to discharge it.

The operation of the machine is as follows:

When a bolt such as 18 has been inserted through the two work pieces 16 and 17 which are to be secured to one another, mechanical upward pressure is supplied through the piston 22 by depressing the treadle 41, whereupon the action described immediately above takes place. The head of the bolt 18 is engaged in the socket wrench 20, while the nut 19 is engaged in the cooperating socket 14 on the shaft 13. The pressure produced by the cylinder and piston will then raise the plate 10 until the teeth 9 thereon intermesh with the teeth 8 of the other clutch member 7. The member 7 may be in continuous rotation, if desired, by allowing the motor 5 to operate continuously or may be rotated only when actually in service, by starting and stopping the motor 5 when necessary, if preferred.

It will be clear that the pressure exerted by the socket 20 is dependent upon the pressure below the piston in the cylinder and this pressure will be pre-set or controlled to suit the work being done. When the nut reaches its seat on the work piece 16, the turning moment exerted through the clutch will rise rapidly until finally it will overcome the friction between the sloping sides of the teeth 8 and 9 and the upward pressure of the socket 20, so that the two members of the clutch will slip on one another, that is, the member 10 will stop while the member 7 may continue to rotate. Thereupon the operator will release the treadle 41, thus discharging the pressure medium from the end 26 of the cylinder and allowing the work piece 16, 17 to drop so that the next bolt may be inserted in place and its nut properly tightened in turn, and so on until all the bolts and nuts or the like are in place.

Where the air pressure supply connected to the pipe 31 is not already controllable to a definite desired value, a pressure regulator 28 of any well known type may be provided to predetermine the maximum pressure in the cylinder 23 and thus the corresponding degree of tightening of the nuts.

While socket wrenches have been disclosed at 14 and 20, it is clear that the other types of tools may be substituted at will, to conform to the types of screws or bolts being used. For example, a screw driver bit may be employed in place of the socket wrench 14 where slotted screws are to be screwed into the work piece from above, or likewise a screw driver bit may be substituted for the wrench 20 where the head of a slotted screw appears below the work piece 17, so that the wrench 14 may screw and tighten a nut on the upper end of such screw, etc.

It will be understood that the entire disclosure is highly diagrammatic, and suitable changes, omissions and additions may be made wherever desired. The motor 5 as already stated need not

be of the electric type, nor need the shaft 6 turn at the full speed produced by the rotary element of the motor, since speed changing means may be interposed, for example, reduction gearing of the type well known in portable drills and the like. It is also clear that the clutch need not be of the type diagrammatically disclosed, but merely need have the characteristic that when a desired degree of tightening of the screw-threaded element has been reached it will give way in axial direction against the predetermined elastic pressure of the piston and then slip.

Therefore it should be clearly understood that the scope of the invention is not limited to the specific devices illustrated, but is defined solely in the following claims.

What I claim is:

1. In a machine for screwing a threaded element to its mate; a base, a tool for engaging the threaded element, means for engaging the mate; said tool comprising a driven shaft, a head for actually engaging the threaded element and a clutch between said shaft and said head; said clutch being of the type having two members axially movable relatively to each other, having at least the one member provided with surfaces extending in circumferential direction and being inclined with respect to the axis of rotation, said surfaces being engaged by projecting portions of the other element so that torsional forces are positively transmitted when the two elements are held by an axial force against one another but so that the members become disengaged when the torsional force surpasses a certain ratio with respect to the axial force; said shaft being axially substantially immovably supported on said base; means for holding against rotation on said base said means for engaging the mate and for forcing the latter means by a predetermined resilient force toward said tool so that, upon reaching a predetermined torsional force exerted by said driven shaft, the resilient axial force is overcome by said clutch members and the latter become disengaged.

2. In a machine for screwing a threaded element to its mate; a base, a first means for engaging the threaded element, a second means for engaging the mate; said first means comprising a driven shaft, a head for actually engaging the threaded element and a clutch between said shaft and said head; said clutch being of the type having two members axially movable relatively to each other, having at least the one member provided with surfaces extending in circumferential direction and being inclined with respect to the axis of rotation, said surfaces being engaged by projecting portions of the other element so that torsional forces are positively transmitted when the two elements are held by an axial force against one another but so that the members become disengaged when the torsional force surpasses a certain ratio with respect to the axial force; means for supporting said shaft on said base; means for supporting said second engaging means substantially non-rotatably on said base; means adapted to axially move one of said engaging means and to exert a predetermined resilient axial force in the direction of said other engaging means; the arrangement being such that upon reaching a predetermined turning moment, the axial force is overcome by said clutch members and the latter become disengaged; said means for exerting the axial force being simultaneously adapted to move said engaging means toward and away from each other for bringing them into and out of engagement with the threaded element and its mate.

3. In a machine according to claim 2, said means for exerting the predetermined axial force and for moving one of said engaging means toward and away from said other engaging means, comprising a chamber to be filled with a compressible fluid-pressure medium such as compressed air.

4. In a machine for screwing a pair of mating threaded elements together and for tightening the connection to a predetermined degree; a base, a pair of tools for engaging respectively the threaded element and the mate; means for rotating said tools relatively to each other and for supporting them on said base; means adapted for forcing said tools toward each other by a predetermined resilient force; a clutch between one of said tools and said means for relatively rotating and supporting it relatively to said other tool; said clutch being of the type having two members axially movable relatively to each other and adapted to positively transmit torsional forces when an axial force forces the two clutch members toward each other but becoming automatically disengaged when the ratio of the torsional force to the axial force surpases a certain amount.

5. In a machine for screwing a threaded element to its mate and for tightening the element to a predetermined degree; a base, a first tool for engaging the threaded element, a second tool for engaging the mate; means for rotating said first tool and for preventing the second tool from rotating and for supporting said tools on said base; means adapted for forcing said second tool toward the first tool by a predetermined resilient force; a clutch between said first tool and said means for rotating it; said clutch being of the type having two members axially movable relatively to each other and adapted to positively transmit torsional forces when an axial force forces the two clutch members toward each other but becoming automatically disengaged when the ratio of the torsional force to the axial force surpasses a certain amount.

6. In a machine for screwing a threaded element to its mate and for tightening the connection to a predetermined degree; a base, a tool for engaging the threaded element, and means for supporting the mate on said base; means for rotating said tool and for supporting it on said base; means adapted for forcing said tool and said mate supporting means toward each other by a predetermined resilient force; a tooth clutch between said tool and said means for relatively rotating it; said clutch being of the type having two members axially movable relatively to each other and adapted to positively transmit torsional forces when an axial force forces the two clutch members toward each other but becoming automatically disengaged when the ratio of the torsional force to the axial force surpasses a certain amount.

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