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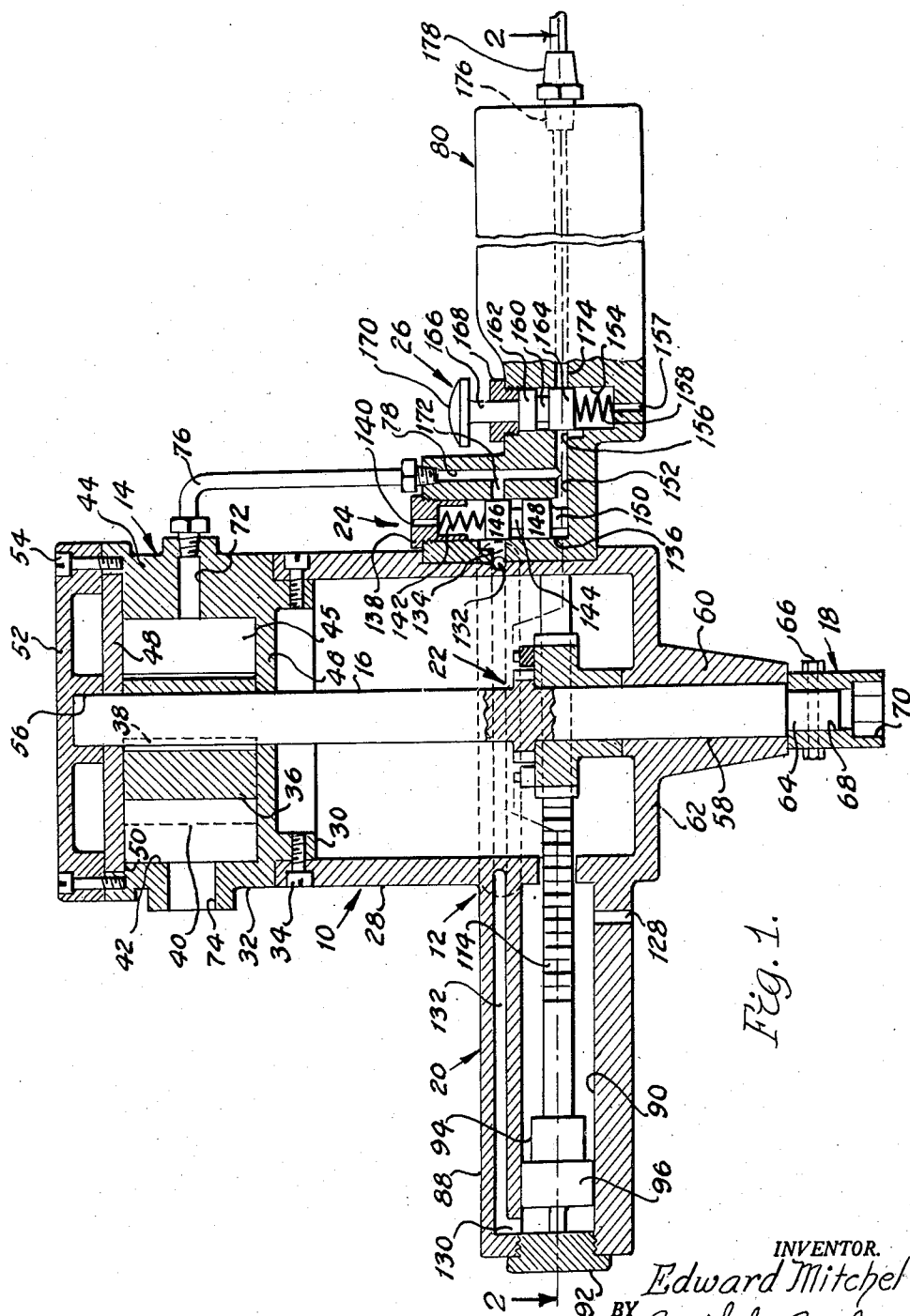
E. W. MITCHEL

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MULTISTAGE PREDETERMINED TORQUE RELEASE WRENCH

Filed March 10, 1958

2 Sheets-Sheet 1



INVENTOR.

Edward Mitchell
Barthel + Bugbee
Attys

Barthel + Bugbee

Attys

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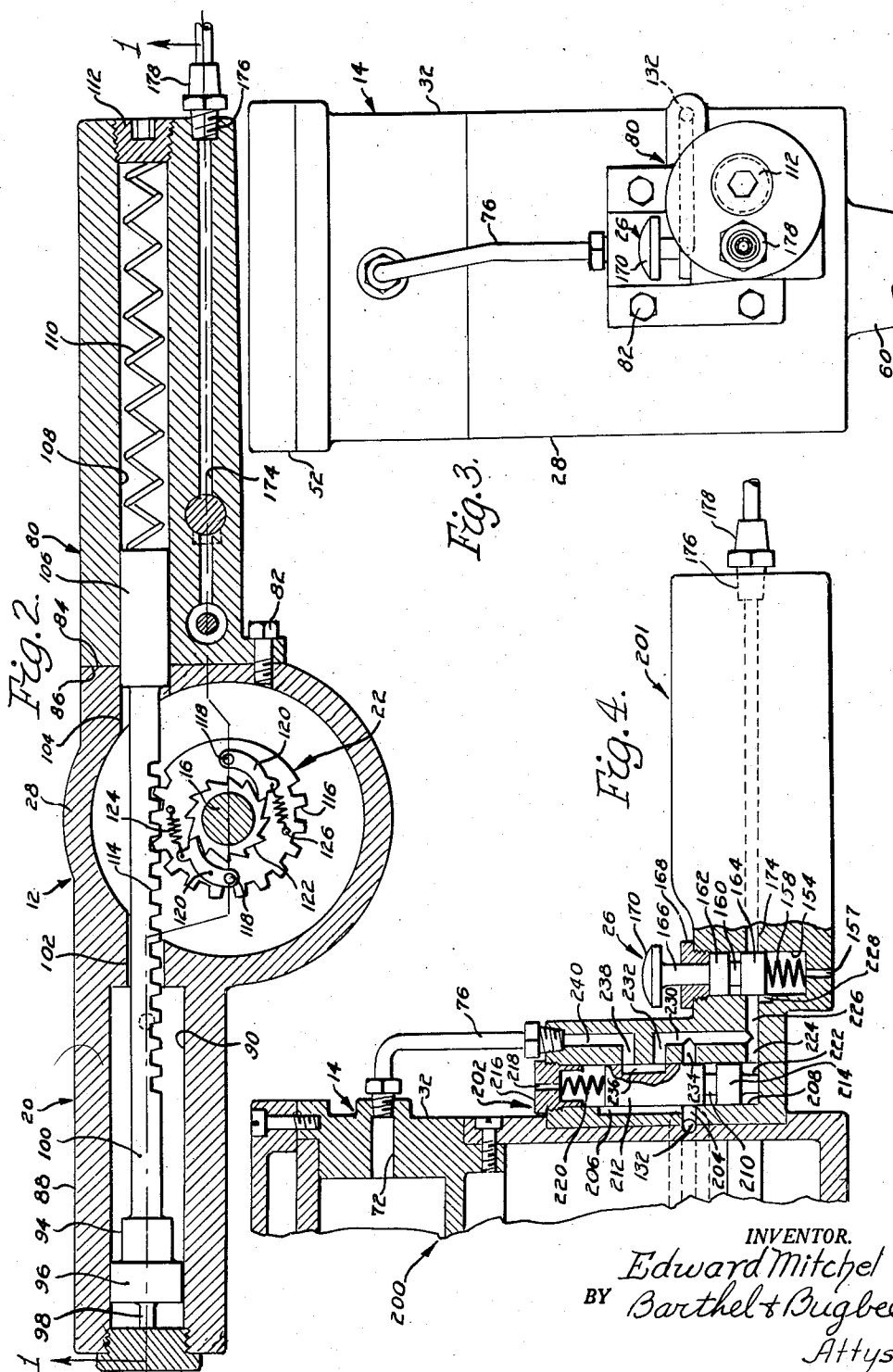
E. W. MITCHEL

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INVENTOR.
Edward Mitchel
BY Barthel & Bugbee
Attys

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**MULTISTAGE PREDETERMINED TORQUE
RELEASE WRENCH****Edward W. Mitchel, Detroit, Mich., assignor to The
Torcontrol Company, Detroit, Mich., a partnership****Filed Mar. 10, 1958, Ser. No. 720,202****2 Claims. (Cl. 81—52.4)**

This invention relates to power wrenches and, in particular, to fluid-pressure-operated power wrenches with controlled torque.

One object of this invention is to provide a fluid-pressure-operated torque control power wrench with means associated therewith for automatically applying a predetermined final tightening torque to the nut, bolt or other threaded fastener after the wrench has completed an initial running of the fastener into or onto its mating thread at an attained torque which is below the desired final tightening torque.

Another object is to provide a fluid-pressure-operated torque control power wrench of the foregoing character wherein the final and precise fastener-tightening torque is applied by a slidable-plunger fluid pressure motor which comes into operation automatically upon the stalling of the rotary wrench motor at the attained fastener-running torque.

Another object is to provide a fluid-pressure-operated torque control power wrench of the foregoing character wherein the fastener-tightening motor is connected to the wrench motor shaft through a unidirectional clutch, such as a pawl-and-ratchet device, permitting the rotary wrench motor to operate freely up to its stalling point without affecting the fastener-tightening motor, yet permitting the slidable-plunger fastener-tightening motor to apply the desired predetermined tightening torque to the wrench motor shaft through the unidirectional clutch subsequent to the stalling of the rotary wrench motor.

Other objects and advantages of the invention will become apparent from the following description of the accompanying drawings, wherein:

Figure 1 is a central vertical section, partly in side elevation, through a fluid-pressure-operated power wrench with automatically controlled torque, according to one form of the invention;

Figure 2 is a horizontal section taken along the line 2—2 in Figure 1;

Figure 3 is a right-hand side elevation of the power wrench shown in Figure 1; and

Figure 4 is a fragmentary central vertical section, partly in side elevation, of a modification of the invention.

Hitherto, power wrenches driven by rotary fluid-pressure-operated motors, such as compressed air motors, have been widely used on industrial assembly lines, such as in automobile assembly plants because of the speed with which they tighten nuts, bolts, or other threaded fasteners. These conventional power wrenches, however, while speedy in operation are notoriously inaccurate as regards the torque actually applied to the fastener, varying as much as 26 foot pounds above or below the intended torque. As a result, in making delicate or accurate assemblies by means of fasteners installed by a conventional power wrench, the operator has hitherto followed the practice of setting the power wrench at a stalling torque, which is less than the desired tightening torque in order not to apply an excessive force which in turn might damage the machine or the fastener threads,

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after which he has used a manual torque wrench to apply the final and desired fastener-tightening torque. This, however, is too expensive a procedure to be generally followed. If, on the other hand, the conventional power wrench is set to rotate the fastener up to the final intended fastener-tightening torque, the momentum applied by its rotary motor often carries the nut or other fastener past the intended halting point to a tightened condition involving an excessive torque. Furthermore, conventional power wrenches often stall prematurely when rough portions of threads are encountered, thereby necessitating removal of the power wrench and application of a manual torque wrench in order to rotate the nut, bolt or other fastener past the rough thread portions. Moreover, torque variation arises from the variation of thread friction due to dimensional variations in the mated opposite threads, even within established tolerances, as well as from the presence of rust, dirt or plating on either thread.

In the torque control power wrench of the present invention, the rotary wrench motor is set at a stalling torque which is sufficiently lower than the required or desired torque to avoid any danger of excessive torque application, for example, about ten pounds less than the desired torque. The fluid-pressure-operated rotary wrench motor then runs the nut, bolt or other threaded fastener onto or into its mating thread and then stalls at its set torque, upon arriving at a location somewhat short of its intended tightened location or upon encountering a rough thread portion. Upon the stalling of the rotary fluid-pressure-operated wrench motor at its set pressure, a spring-pressed valve admits compressed air or other pressure fluid into a pipe leading to one end of a slidable-plunger torque-applying motor, moving the plunger thereof inward and applying a steady pull through a unidirectional clutch, such as a pawl-and-ratchet device, to the wrench motor shaft. Since the slidable-plunger fastener-tightening motor possesses substantially no momentum, its plunger stalls when it has exerted exactly the desired torque, because it has expended all of the pressure of the pressure fluid which was permitted by the valve to enter its cylinder. As a result, therefore, the fastener-tightening plunger accomplishes automatically, without removing the power wrench from the fastener, what has hitherto had to be separately accomplished by a manual torque wrench. Subsequent venting of the compressed air or other pressure fluid from the torque-applying motor cylinder results in retraction of the plunger thereof to its starting position by means of a resilient device, such as a compression spring.

Referring to the drawings in detail, Figures 1 to 3 inclusive show a fluid-pressure-operated torque control power wrench, generally designated 10, according to one form of the invention as including a housing structure, generally designated 12, having in its upper portion a fluid-pressure-operated rotary wrench motor, generally designated 14, drivingly connected to a rotary wrench shaft 16 journaled in the housing 12 and carrying at its lower end a wrench socket member 18 of one of a large number of different sizes and types. The housing structure 12 near its lower portion is provided with a fluid-pressure-operated slidable-plunger fastener-tightening motor, generally designated 20, drivingly connected to the rotary wrench shaft 16 through a geared unidirectional clutching device, generally designated 22. The supplying of fluid pressure, such as compressed air, is automatically regulated by a pressure-responsive automatic control device, generally designated 24, while the admission and discharge of pressure fluid is manually controlled by a manual control valve, generally designated 26.

The housing structure 12 has a generally vertical cylindrical portion 28 at the top of which is received the depending flange 30 on the bottom of the generally

cylindrical housing 32 of the rotary wrench motor 14 and secured in position by the screws or other fasteners 34. The rotary wrench motor 14 is conventional and its details are beyond the scope of the present invention except as they enter into combination with the elements subsequently to be described in detail. It is sufficient for the purpose of the present invention to state that the fluid-pressure-operated rotary wrench motor 14 is of the vane type having a rotor 36 keyed or otherwise drivingly secured at 38 to the upper portion of the rotary wrench shaft 16 and having one or more approximately radially-slidable vanes 40 spring-pressed into sealing engagement with the cylindrical internal surface 42 of the side wall 44 of the motor housing 32. The latter has a rotor chamber 45 closed at the bottom by a lower end wall 46 integral with the side wall 44 and at the top by an upper end wall 48 which is removably held in an annular recess 50 in the housing 32 by a disc-shaped end plate 52 bolted or otherwise secured thereto, as by the fasteners 54.

The upper and lower end walls 48 and 46 of the rotary wrench motor housing 32 are bored coaxially for the passage of the rotary wrench shaft 16. The upper end portion of the wrench shaft 16 is journaled in a central bearing recess 56 of cup-shaped form in the end plate 52 while the lower portion is journaled in a bearing bore 58 in a tapered bearing boss 60 depending from the lower end wall 62 of the housing 12. The rotary wrench shaft 16 has a lower end portion 64 of reduced diameter which is bored radially to receive a radial fastener 66, such as a bolt, by which the wrench socket member 18 is removably secured to the wrench shaft 16. The socket member 18 has a bore 68 telescopically engaging the reduced diameter shaft portion 64, and has a hexagonal fastener socket 70 at its lower end adapted to receive and fit the conventional hexagonal head of a nut, cap screw, bolt or other fastener. It will be understood, however, that the socket member 18 represents only one of a large number of different sizes, types and shapes of socket members and may be replaced by a conventional screw driver (not shown) for driving screws with slotted or socketed heads of any conventional type.

The side wall 44 of the rotary wrench motor housing 32 of the fluid-pressure-operated rotary wrench motor 14 has diametrically opposite pressure fluid inlet and outlet ports 72 and 74 respectively (Figure 1), the former being threaded to receive the threaded upper end of a pressure-fluid supply pipe 76, the threaded lower end of which is threaded into the upper end of a vertical pressure-fluid passageway 78. The latter is formed in an auxiliary housing, generally designated 80, which is removably secured as by fasteners 82 (Figure 3) at an end face 84 fitting the side face 86 of the housing structure 12 (Figure 2).

Aligned with the removable auxiliary housing 80 is the laterally-projecting cylinder 88 of the slidable-plunger fastener-tightening motor 20. The removable auxiliary housing 80 and cylinder 88 project from opposite sides of the cylindrical vertical housing portion 28 of the housing structure 12 in such a manner as to serve as handles for receiving the hands of the operator. The cylinder 88 contains a cylinder bore 90 (Figures 1 and 2) closed at its outer end by a threaded plug 92 which also serves as a stop for the slidable plunger 94 of the motor 20. The plunger 94 is provided with a piston head 96 having a central stop boss 98 projecting from the outer side thereof into engageability with the end plug 92 and on the opposite side is provided with a piston rod 100 which passes through aligned bores 102 and 104 in the opposite sides of the housing portion 28 (Figure 2) and terminate in an enlarged bearing head 106 slidably mounted in a bore 108 within the auxiliary housing 80 and coaxial with the cylinder bore 90. A helical compression spring 110 mounted in the bore 108 serves to retract the plunger

94 to the starting position shown in Figures 1 and 2, as explained below in connection with the operation of the invention. One end of the spring 110 engages the head 106 and the other end engages a threaded plug 112 closing the threaded outer end of the bore 108.

The geared unidirectional clutching device 22 includes a toothed rack portion 114 on the piston rod 100 which meshes with a pinion 116 (Figure 2), the teeth of which extend only partially around the circumference thereof because only a partial revolution of the pinion 116 is required during operation, as explained below. Mounted on the upper face of the pinion 116 on diametrically opposite sides of the wrench shaft 16 are two pivot pins 118 pivotally supporting arcuate toothed pawls 120 which are urged into yielding engagement with a toothed ratchet wheel 122 (Figure 2) by tension springs 124 secured at one end to each pawl 120 and at its opposite end to an anchor pin 126 seated in the upper face of the pinion 116.

The cylinder 88 of the slidable-plunger fastener-tightening motor 20 near the housing portion 28 (Figure 1) is provided with a vent or air discharge port 128 and at its outer end with a fluid inlet port 130 connected by a longitudinal passageway 132 which passes through the cylindrical housing portion 28 to a vertically-elongated port 134 in approximately the mid-portion of a vertical cylindrical bore 136 forming a part of the pressure-responsive automatic control device 24. The upper end of the bore 136 is threaded and closed by a screw plug 138 having a central vent port 140 therethrough and also serving as an abutment for a helical compression spring 142, the lower end of which engages the upper end of a double-headed valve spool 144 with spaced upper and lower heads 146 and 148 respectively. Below the lower head 148 is a short stop stem 150 which prevents the head 148 from contacting the lower end of the bore 136, and also leaves open a horizontal lower passageway 152 leading from the lower end of the bore 136 past the lower end of the vertical passageway 78 to a vertically-elongated port 156 in the approximate mid-portion of a vertical manual valve bore 154.

The manual valve bore 154 has a vent port 157 at its lower end and contains a helical compression spring 158 engaging the lower end of a manual double spool valve member 160 forming the movable part of the manual control valve 26. The double spool valve member 160 has spaced upper and lower heads 162 and 164 connected to a stem 166 passing through a screw plug 168 threaded into the threaded upper end of the valve bore 154 and equipped with an external button 170 for the application of the operator's thumb.

The inner port 134 at the inner end of the passageway 132 (Figure 1) is normally closed by the upper head 146 of the valve spool 144, the head 146 in the same position also closing a horizontal intermediate port 172 extending from the approximate mid-portion of the valve bore 136 to the vertical passageway 78. A passageway 174 leads from the approximate mid-portion of the manual valve bore 154 directly opposite the port 156 through the auxiliary housing 80 to a threaded port 176 into which is threaded the end of a pressure-fluid supply pipe 178. The latter is connected to a source of suitable pressure fluid, such as compressed air from an air compressor or the like.

In the operation of the invention, let it be assumed that the compression spring 142 which urges the double-headed valve spool 144 downward (Figure 1) is capable of exerting a force which is a predetermined amount below the force required to produce the desired torque upon the fastener being threaded into or onto its corresponding threaded portion by the wrench socket 18 by the fluid-pressure-operated rotary wrench motor 14. Assuming that the pipe 178 is supplied with pressure fluid, such as compressed air from a suitable source, to

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drive the fastener, the operator grasps the cylinder 88 in one hand and the auxiliary housing 80 in the opposite hand, and lowers the socket 70 of the socket member 18 over the fastener to be driven. He then depresses the button 170 with his thumb, shifting the manual double-headed valve spool 160 downward so that its lower valve spool head 164 uncovers the opposite ports 174 and 156, thereby admitting pressure fluid to the passageways 152 and 78, from the latter of which the pressure fluid flows through the pipe 76 and inlet port 72 into the rotary wrench motor housing 32, rotating the rotor 36 and wrench shaft 16 keyed thereto, and escaping through the discharge port 74. The rotation of the wrench shaft 16 consequently spins the wrench socket 18 and runs the fastener connected thereto into or onto its mating thread. At this time the teeth of the ratchet wheel 122 click loosely past the spring-urged pawls 120 (Figure 2).

The shaft 16 rotates rapidly in response to the rotation of the rotor 36 until the fastener either encounters a rough thread portion or approaches the end of its desired travel, at which point it stalls at the set limiting torque of the rotary wrench motor 14 below the desired final tightening torque to be applied to the fastener, for example, 10 foot pounds below the desired tightening torque. Upon such stalling, and in response thereto, the pressure builds up in the passageway 152 and valve bore 136 and engages the under side of the lower head 148 of the spool 144 until it is sufficient to overcome the thrust of the compression spring 142, whereupon it lifts the spool 144. This causes the upper head 146 to uncover the intermediate port 172 (Figure 1) and connect it across the bore 136 to the opposite port 134. As a result, pressure fluid flows through the passageway 132 and end port 130 into the outer end of the cylinder bore 90 where it acts against the piston head 96 and moves the plunger 94 to the right, the otherwise entrapped air on the opposite side of the piston head 96 being vented through the vent port 128 (Figure 1).

The consequent rectilinear motion of the piston rod 100 to the right (Figure 2) compresses its retraction spring 110 and rotates the pinion 116 through its meshing engagement with the rack 114, causing the pawls 120 to drivingly engage the teeth of the ratchet wheel 122, and rotating the wrench shaft 16 a partial revolution proportionate to the stroke of the piston head 96. This action applies the desired final tightening torque to the fastener without any overrunning effect, because of the substantial lack of momentum of the plunger 94 in comparison with the momentum of the rotor 36 of the rotary wrench motor 14.

When the final tightening torque has thus been imparted to the fastener by way of the wrench shaft 16 and socket member 18, the operator releases the button 170 of the manual valve stem 166 of the manual control valve 26, causing the heads 162 and 164 to rise, closing off the pressure fluid inlet port and passageway 174 and permitting any pressure fluid remaining in the passageways 78 and 152 to be vented through the vent port 157 (Figure 1) by the overlapped extension of the vertically-elongated port 156 beneath the lower manual valve head 164. Upon such release of pressure fluid, the compression spring 142 forces the double-headed valve spool 144 downward to its lowermost position, causing the upper head 146 to close off the port 172 (Figure 1) and permitting any air in the passageway 132 and outer end of the cylinder bore 90 to be vented through the vent port 140 by the overlapped effect of the vertically-elongated port 134 extending above the upper head 146. This release of the pressure fluid from the outer end of the cylinder bore 90 permits the retraction spring 110 (Figure 2) to return the plunger 94 to its starting position shown in Figures 1 and 2.

The modified torque control power wrench, generally

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designated 200, shown in Figure 4 is generally similar as regards most of its parts to the power wrench 10 of Figures 1 to 3 inclusive, and consequently such similar parts are designated with the same reference numerals. The modified power wrench 200 differs from the power wrench 10 in having a removable auxiliary housing, generally designated 201, containing a modified pressure-responsive automatic control device, generally designated 202, which automatically cuts off the flow of pressure fluid to the rotary motor 14 in response to the stalling of the fastener-rotating shaft 16 thereof, as is seen by a comparison of the lower left-hand portion of Figure 4 with the lower right-hand portion of Figure 1. In Figure 4, the passageway 132 from the outer end of the cylinder bore 90 terminates in a port 204 which has an elongated upward overlap portion 206 extending nearly to the top of the valve bore 208. Slidably mounted in the valve bore 208 is a double-headed valve spool 210 having an elongated upper head 212 spaced apart from a considerably shorter lower head 214. The upper end of the valve bore 208 is threaded to receive a cup-shaped screw plug 216 containing a vent port 218 and serving as an abutment for the upper end of a compression spring 220, the lower end of which engages the upper end of the upper head 212 and urges the valve spool 210 downward so that its stop boss 222 engages the bottom of the valve bore 208 while leaving open a port 224 at one end of a passageway 226 corresponding to the passageway 152 of Figure 1 and similarly terminating at an overlap port 228 opening into the manual control valve bore 154, as before.

Unlike the construction shown in Figures 1 to 3 inclusive, a vertical lower passageway 230 runs from the horizontal passageway 226 to intermediate and lower ports 232 and 234 opening into the valve bore 208 at vertically-spaced locations. The port 234 is located diametrically opposite the port 204 at the end of the passageway 132, whereas the intermediate port 232 opens into a longitudinal or axial passageway 236, the upper end of which communicates with an upper port 238 at the lower end of an upper vertical passageway 240 when the valve spool 210 is in its lowered position (Figure 4). Threaded into the threaded upper end of the latter is the lower end of the pressure-fluid supply pipe 76, the upper end of which is threaded as before into the inlet port 72 of the casing 32 of the fluid-pressure-operated rotary wrench motor 14, as described above in connection with Figure 1. As before, also, the passageway 174 leads from a location opposite the port 228 to the threaded inlet port 176 of the pressure-fluid supply pipe 178.

In the operation of the modified torque control power wrench 200, the operator grasps the wrench 200 in the same manner as before and pushes downward with his thumb upon the button 170, shifting the manual valve spool 160 downward so as to connect the port 228 with the now uncovered pressure-fluid inlet passageway 174 across the manual control valve bore 154. As a result, pressure fluid, such as compressed air, flows through the lower horizontal passageway 226, the lower vertical passageway 230, the longitudinal spool passageway 236 by way of the ports 232 and 238 and passageway 240 to the pipe 76, delivering pressure fluid to the rotary wrench motor 14 and rotating the wrench shaft 16 as before, until stalling occurs by an encounter with a roughened thread or by a near approach to the end of the run of the fastener along its mating thread. When this occurs, pressure building up within the passageway 226 and engaging the lower side of the lower head 214 (Figure 4) overcomes the downward thrust of the compression spring 220 and raises the valve spool 210, causing the upper head 212 to rise and cut off communication between the ports 232 and 238 and immediately thereafter to uncover and open

communication between the opposite ports 234 and 204. This action cuts off the flow of pressure fluid to the rotary motor 14 and initiates the flow of pressure fluid through the passageway 132 leading to the outer end of the cylinder bore 90 of the slidable-plunger fastener-tightening motor 20 (Figures 1 and 2). As a consequence, the torque-applying plunger 94 of the torque-applying motor 20 moves to the right as before, applying the final tightening torque to the fastener in the manner described above. Venting occurs in a similar way to that described above when the operator releases the manual control valve button 170 to permit the compression spring 158 to move the valve member 160 upward and close off the supply of compressed air or other pressure fluid from the passageway 174.

It will be understood that another type of conventional unidirectional power-transmitting device may be substituted for the pawl-and-ratchet device 120, 122, such as, for example, a conventional overrunning clutch such as a cam-and-roller overrunning clutch.

What I claim is:

1. A pressure-fluid-operated torque control power wrench for running and tightening a threaded fastener upon its mating thread, comprising a housing structure, a rotary fastener-driving shaft journaled in said structure and having a connection thereon adapted to receive a fastener-driving member, a rotary fluid-pressure-operated fastener running motor mounted in said structure and operatively connected to said shaft, a slidable-plunger fluid-pressure-operated fastener-tightening motor mounted in said structure and having a slidable motive member, sliding-to-rotary motion-converting mechanism operatively

connecting said motive member to said shaft and including a unidirectional power-transmitting device, a pressure fluid supply conduit connected to said rotary motor, and means responsive to the build-up of a predetermined opposing torque resisting further running of the fastener along its mating thread by rotation of said rotary motor for supplying pressure fluid from said supply conduit to said slidable-plunger motor, said slidable-plunger motor having a cylinder projecting horizontally from one side of said housing structure and said housing structure having a valve casing projecting horizontally from the opposite side of said housing structure, said cylinder and said casing also forming handles for the grasping and manipulation of the power wrench.

2. A pressure-fluid-operated torque control power wrench according to claim 1, wherein said housing structure has a shaft bearing depending therefrom below said cylinder and valve casing, said bearing rotatably supporting the lower end portion of said shaft.

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