United States Patent [19]

Jennings

[11] **3,768,573**

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[54] **POWER TOOL CONTROL**

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[52] **U.S. Cl.** ..... **173/12,** 81/52.4 B

[51] **Int. Cl.** **B25b 23/14**

[58] **Field of Search** ..... 173/12; 81/52.4 B

[56] **References Cited**

UNITED STATES PATENTS

3,693,726	9/1972	Hornig et al.	173/12
3,623,557	11/1971	Allen	173/12
3,454,111	7/1969	Niess	173/12

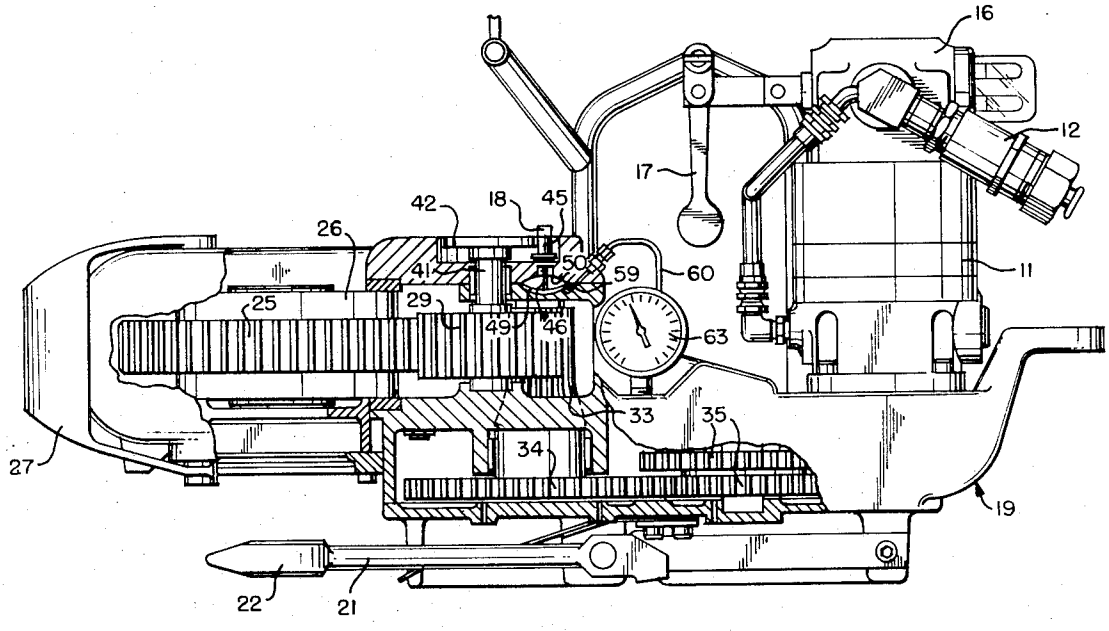
Primary Examiner—Ernest R. Purser

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[57] **ABSTRACT**

A power wrench that has a stationary part and a rotary part and a motor for rotating the latter, also has a switch for shutting off the power of the motor. The switch is actuated by a clutch-controlled arm that determines the degree of rotation of the rotary part after a preliminary tightening so that the degree of final tightening is closely controlled.

6 Claims, 6 Drawing Figures



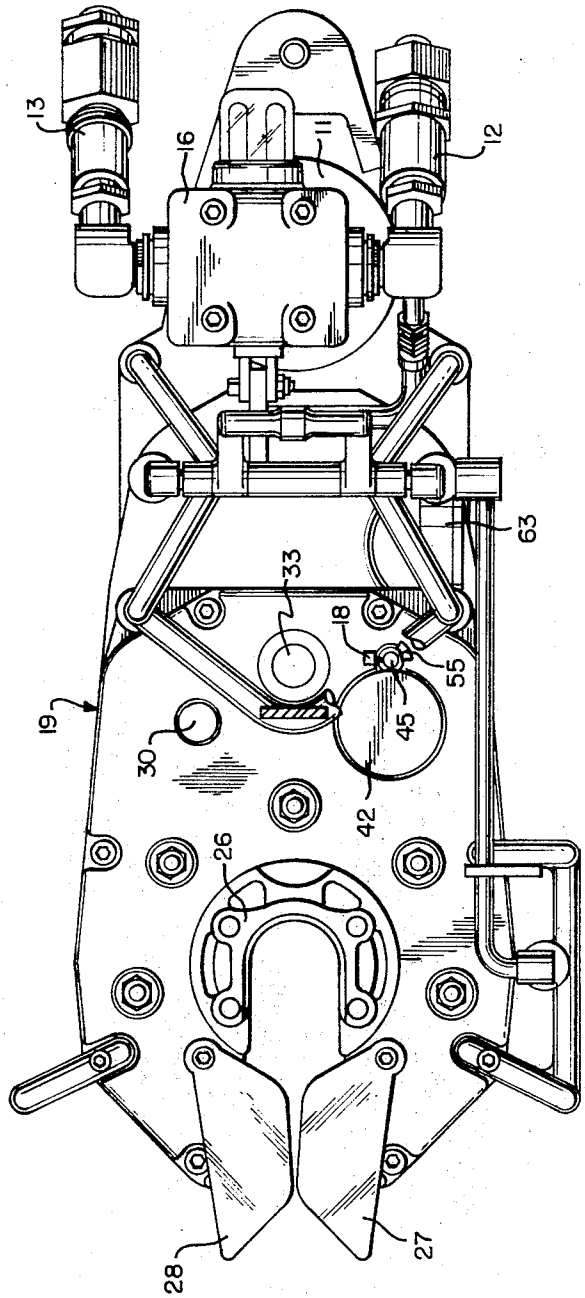


FIG. 1

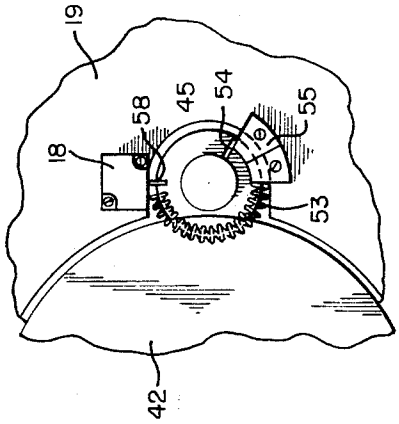


FIG. 4

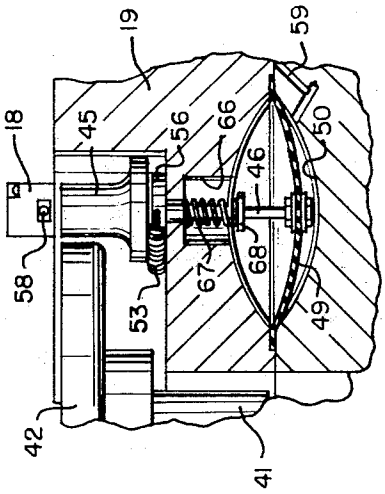


FIG. 3

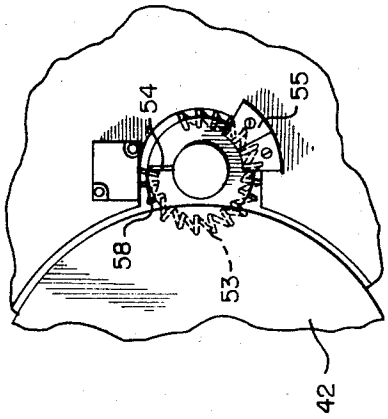


FIG. 6

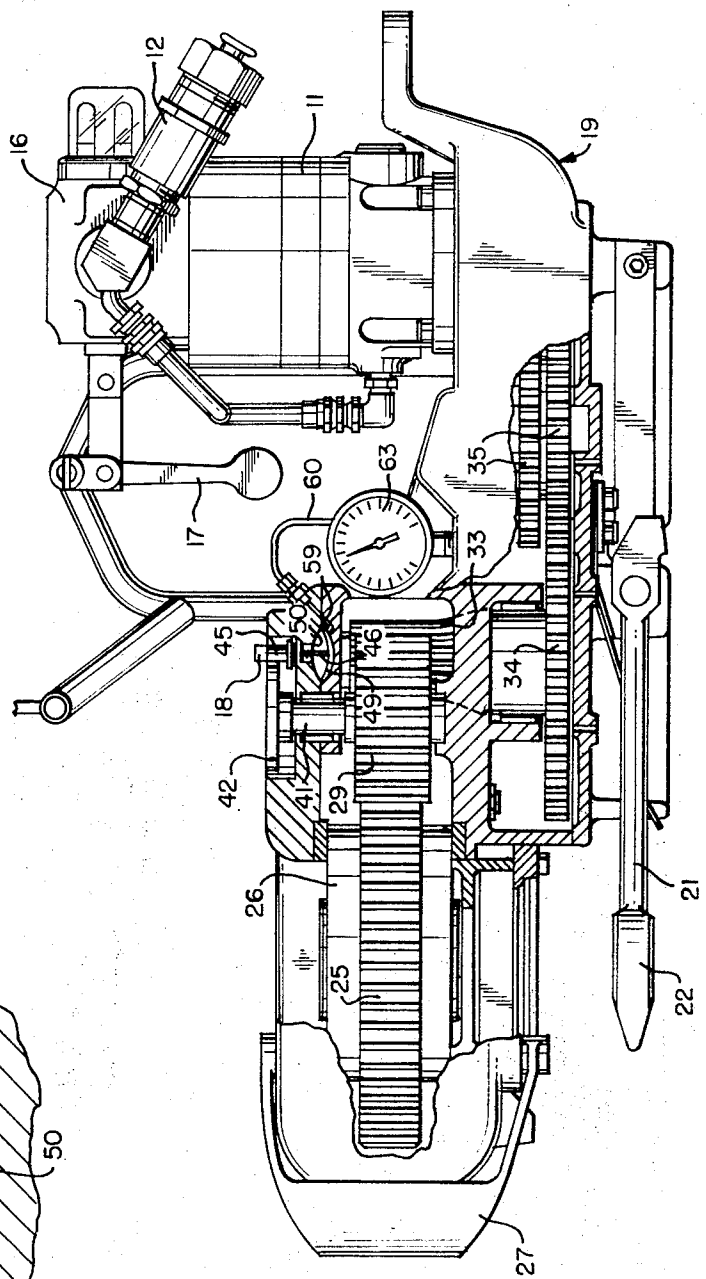


FIG. 2

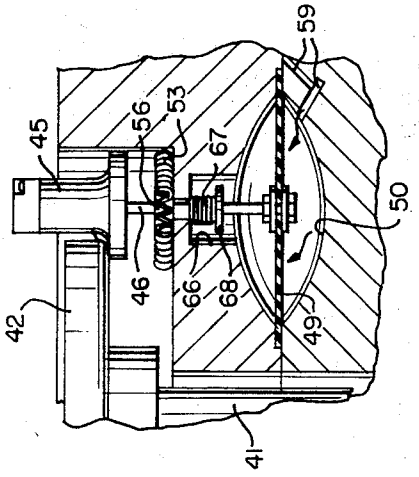


FIG. 5

POWER TOOL CONTROL

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention concerns power tools in general, and more specifically, relates to a power wrench of the type that rotates one part relative to another. A particular example is the type of tool that is used in tightening sucker rod joints. The common name for such a tool as employed in oil field operations, is "power tongs."

2. Description of the Prior Art

Heretofore it has been found that problems arise in making up sucker rod strings by reason of having the joints put together either too tight which causes failure, or too loose which permits disengagement. In either case the results can be quite expensive in time and equipment because of the resultant difficulties or loss of equipment.

Consequently, it is an object of this invention to provide a power wrench that can tighten a shoulder butt joint automatically for a predetermined degree of turning after a so-called hand-tight joint as been effected.

SUMMARY OF THE INVENTION

Briefly, the invention concerns an improvement that is in combination with a power tool. Such power tool has a stationary part, a rotary part, and a motor for rotating said rotary part relative to said stationary part. The tool includes means for supplying power to said motor as well as a switch for terminating application of said power. The improvement comprises means for actuating said switch after a predetermined amount of rotation of said rotary part, and such means comprises first means for measuring the amplitude of force being applied by said motor, and second means for measuring the amount of rotation of said rotary part commencing with a predetermined amplitude of said force being applied by said motor.

Again, briefly, the invention relates to a combination with a power wrench which has a stationary part, a rotary part and power means for driving said rotary part in rotation relative to said stationary part. It is also in combination with means for tightening a shoulder butt joint a predetermined fixed amount. The combination comprises switch means for releasing application of said power means, and means for driving said rotary part until said shoulder butt joint has made contact. It also comprises means for actuating said switch means after a predetermined degree of rotation of said rotary part, following said butt-joint contact.

Once more, briefly, the invention concerns the combination with a fluid motor powered rotary tool having a rotating part and a stationary part. The tool also comprises means for automatically driving said rotating part for a predetermined degree of rotation after a predetermined amplitude of force has been reached. The combination also comprises a switch for shutting off said fluid motor, and said switch has an actuator therefor. The combination also comprises a shaft having an enlarged rotor on one end thereof and being shiftable longitudinally for placing said rotor into contact with said rotating part. It also comprises a diaphragm attached to the other end of said shaft for shifting same when fluid pressure is applied, and a spring for urging said shaft against the force applied by said diaphragm. The said spring has sufficient strength to permit preliminary rotation of said rotating part without shifting said shaft. It also comprises a radial arm carried by said shaft and adapted for contacting said switch actuator after a predetermined degree of rotation of said shaft when shifted so that said rotor is in contact with said rotating part, and a return spring for biasing said shaft in rotation to a starting position prior to said rotation when the rotor is in contact with said rotating part. It also comprises means for adjusting said starting position in order to predetermine the degree of rotation of said power tool after said amplitude of force has been reached.

BRIEF DESCRIPTION OF THE DRAWINGS

The foregoing and other objects and benefits of the invention will be more fully set forth below in connection with the best mode contemplated by the inventor of carrying out the invention, and in connection with which there are illustrations provided in the drawings, wherein:

FIG. **1** is a plan view of a power tool that includes the invention therewith;

FIG. **2** is a side elevation of the tool illustrated in FIG. **1**, partly broken away in cross-section;

FIG. **3** is an enlarged fragmentary cross-section, showing some of the principal elements of the invention as related to the tool shown in FIGS. **1** and **2**;

FIG. **4** is a fragmentary enlarged plan view of the invention as shown in FIG. **3**;

FIG. **5** is another enlarged fragmentary cross-section view like FIG. **3**, but showing the parts in a shifted position after a given pressure has been applied; and

FIG. **6** is a fragmentary enlarged plan view like FIG. **4**, but showing the parts in the final position as a switch for cutting off power is being actuated.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to FIGS. **1** and **2**, it is pointed out that this invention may be applied to conventional power tongs of the type illustrated. Such power tongs are well known in oil field operations and, in the particular application of this invention, the tool is being applied to tightening the joints of a sucker rod string (not shown). However, it will be appreciated that the invention may be applied equally to other power tools, and particularly those tools where the joints to be tightened are the butt-joint type. Those skilled in the mechanical arts generally will appreciate that, in shoulder-butt joint connections, the first threading action will require very little power until the shoulders of the joint have come in contact. The shoulder contact position is often referred to as a hand-tight joint, since the first threading may be carried out manually. Thereafter, when this invention is employed, the joint may be tightened automatically for a predetermined degree of rotation exactly. In this manner, a string of sucker rods, for example, can be made up with a consistent and exact tightness at every joint which will prevent either failure from overstressed joints or uncoupling from having a joint too loosely made up.

The power tool illustrated in FIGS. **1** and **2** may be pneumatic or hydraulic. It includes a motor **11** that has a pair of hose couplings **12** and **13** that are connected as generally indicated, for introducing the flow of power fluid. Energization of the motor is controlled by a valve **16** which has a control lever **17** (FIG. **2**). In addition, it is to be particularly noted that although it is

not shown, there would be an actuator that is under control of a switch **18.** It will be understood that switch **18** might be a fluid relay, or an electrical switch if the valve **16** should be controlled electrically. In either event actuation of valve **16** would be carried out under the control of the switch **18** by any feasible arrangement (not shown) which depends on whether switch **18** were electrical or fluid type, i.e., pneumatic or hydraulic. Thus, it will be clear to one skilled in the art that conventional equipment (not shown) would be employed to permit the switch **18** to control actuation of the valve **16** to cut off power to the motor **11** when the switch is operated.

The illustrated power tool is largely conventional. As will be apparent, it has what may be termed a stationary part, i.e., the housing **19,** in general. There is attached to the housing **19** (underneath as viewed in FIG. **1**) an arm **21** that has end wrench jaws **22** at the extremity thereof. These jaws **22** will engage the flat sides of the lower joint (not shown) of a sucker rod string (not shown) that is being made up. The wrench jaws **22** will hold the lower joint stationary against rotation while an upper joint (not shown) is threaded into the lower. Rotation of the upper joint is carried out by a ring gear **25** (FIG. **2**) that has attached thereto concentrically an inner ring element **26** which is designed to support a pair of pivotally mounted jaws (not shown) that are designed to engage the square-sided portion of the upper joint of the sucker rod string. It may be noted that the ring gear **25** has an opening in alignment with the opening in ring element **26.** This is to permit the upper sucker rod joint to be placed into the tool at the beginning of a tightening operation, through a pair of pivoted jaws **27** and **28.**

Power for rotating the ring gear **25** comes from the motor **11** via a gear train, as shown, which includes a pair of idler gears **29** and **30** that mesh with ring gear **25.** Next, there is a pinion **33** that is formed on the upper extension of a gear **34** (FIG. **2**) that is in the train of gears from the motor **11.** The gear train includes a compound gear **35** (FIG. **2**) that is driven directly by a pinion (not shown), which is carried on the shaft of the motor **11.**

It should be understood that the usual operation of the power tool so far described, is straightforward and well known. Control of motor **11** could be manual, i.e., by means of the lever **17** which controls valve **16.** However, there is usually a pressure switch (not shown) that controls the amount of torque applied. But it does not give accurate makeup or satisfactory results since some 80 to 90 percent of the applied torque is necessary to overcome friction in the joint. On the other hand, by use of this invention a shoulder-butt joint may be made up and will automatically be tightened for a predetermined degree of rotation after the joint has become "hand-tight" by cutting off the application of power at that point.

In order to accomplish the foregoing, there is structure in accordance with this invention including a clutch-like arrangement to automatically operate the switch **18** after the foregoing degree of rotation has taken place. It will be appreciated that various other structures for carrying out the invention might be employed without departing from the principles involved. Thus, it will be understood that the particular elements illustrated are schematic and the dimensions or particular arrangement might be varied. For example, it would probably be more practical to reverse the relative sizes of the diameters of rotors **42** and **45,** which will be described in more detail below.

There is a shaft **41** that carries the idler gear **29.** This shaft **41** has an enlarged rotor **42** at the extremity thereof. Rotor **42** has the switch **18** located adjacent thereto in order to provide desired clutching action, as will apear below. There is a rotor **45** that is attached to the end of a shaft **46** (FIGS. **3** and **5**) which shaft is attached at the other end thereof to the center of a diaphragm which divides a cavity **50** in half.

The shaft **46** and rotor **45** are secured together in a fixed manner so that no relative rotation can take place between them. But the shaft **46** is rotatable by being mounted in any feasible manner to permit it. However, the rotation is restrained by a coil spring **53** which urges the shaft **46** in clockwise rotation (when viewed as shown in FIGS. **4** and **6**) so as to hold a radial arm **54** which extends from the rotor **45,** to be in contact with a stop **55** so long as the rotor **45** is not rotated against the spring action.

It will be observed that the spring **53** acts in conjunction with a collar **56** (FIGS. **3** and **5**) that is keyed to the shaft **46** with a sliding fit so that the shaft may slide vertically (as viewed in the drawings) while being held for no relative rotation with respect to the collar **56.** Also, it will be noted that when the two rotors **42** and **45** are in contact with one another, the arm **54** which extends radially from the upper hub portion of rotor **45,** will be rotated in an arc counterclockwise (as viewed in FIGS. **4** and **6**) and in the same plane as an actuating arm, or lever, **58** of the switch **18.**

It will be observed that the lower portion (as viewed in the drawings) of the cavity **50** is connected by passageways **59** and a pipe **60** (FIG. **2**) to a fluid pressure meter **63** (FIG. **2**) that indicates the amplitude of the fluid pressure that is being applied to the motor **11.** The meter **63** is, of course, also connected by internal passages, etc., (not shown) to the motor **11** in such a way that the effective load on the motor will be indicated by the pressure reading and which same pressure is being applied to the diaphragm **49** on the underside. This pressure will act against the force of a spring **67,** to be described hereafter.

In the upper part of the cavity **50,** there is a recess **66** which accommodates the coil spring **67** that surrounds the shaft **46** and bears against the collar **68.** Collar **68** is carried by the shaft **46** and holds the spring **67** in compression because the other end of the spring **67** bears against the end wall of the recess **66.** Consequently, the spring **67** urges displacement of the shaft **46** and its attached rotor **45,** along with the flexible diaphragm **49,** downward (as viewed in the drawings) toward the position illustrated in FIG. **3.**

On the other hand, when sufficient fluid pressure is applied to the lower portion of cavity **50,** beneath the diaphragm **49** (via passageway **59** and pipe **60**), it will lift the shaft **46** against the force of spring **67** and bring the rotor **45** into contact with the other rotor **42.** In this manner, after the preliminary tightening of a joint has taken place, the pressure of power fluid to the motor **11** will increase and become sufficient to cause the foregoing clutching action for engaging the rotors so that after the arm **54** has been swung around from its at-rest position, it will come in contact with the actuating arm **58** of the switch **18.** Then the actuation of switch **18** will cut off the power to motor **11** and the

tightening of the joint will be completed. It will have automatically been tightened with a predetermined fixed degree of rotation.

It will be appreciated that the degree of rotation is controllable and may be set for a predetermined amount that may be adjustable by having different sized stops **55** for holding the arm **54** in its starting or at-rest position.

OPERATION

In order to help clarify the invention, it may be noted that operation of the illustrated embodiment is as follows:

Beginning with the situation where a joint (not shown) to be tightened is placed in the tool, the upper end of a sucker rod or other member having a shoulder butt or other butt-type threaded coupler, will be placed into the jaws of the end wrench **22.** The lower end of another sucker rod or other member to be attached to the first will be placed into jaws (not shown) carried by the ring element **26.** Then, after the threads of the couplers have been started, the first step will be application of fluid power to the motor **11,** so as to cause preliminary rotation of the upper half of the joint. During this preliminary action, there will be very little resistance to the tightening rotation, and the pressure reading from the motor **11** will be much less than that required to force the diaphragm **49** to raise the shaft **46** against the spring pressure of spring **67.** Consequently, as the upper rod is being rotated during such preliminary tightening, the rotor **42** will, of course, be rotated, but without any contact thereagainst by the declutched rotor **45.** Consequently, this preliminary rotation may vary to almost any extent, e.g., for many complete revolutions as the threads are being started, without affecting the operation of the final tightening action.

In order to control the degree of final tightening for a predetermined amount of rotation after the shoulders of the butt joint have come in contact, it is the increase in pressure of the fluid as applied to the motor **11** that will be sufficient to overcome the spring pressure of spring **67.** This will raise shaft **46** and place rotor **45** into contact with rotor **42,** as shown in FIG. **5.** As soon as these rotors make contact, it will cause rotor **45** to be rotated along with the radial arm **54** (now raised up into the same plane as the switch arm **58**) against the spring action of the spring **53.** Such rotation will continue, along with the tightening action of the tool, until the radial arm **54** contacts switch actuator **58.** The actuation of switch **18** will control the cut-off of power to the motor **11** and, consequently, stop further rotation of the tool. This will then have caused a given degree of rotation of the joint beyond the condition of abutment of the shoulder butt elements, and this rotation will have been closely controlled for a predetermined degree of rotation.

After the power has been cut off, the pressure is concomitamtly reduced and, consequently, the spring **67** will return the diaphragm **49,** along with the other elements carried by the shaft, to the lowermost position, as illustrated in FIG. **3.** When the rotor **45** no longer contacts the other rotor **42,** shaft **46** and the elements attached to it will be free to rotate. Then the spring **53** will return arm **54** back to its starting position in contact with stop **55,** as illustrated in FIG. **4.** Thereafter, the tool will be ready to carry out another tightening operation.

As mentioned above, it will be appreciated that particular design features including dimensional aspects of the elements relating to automatic rotation control according to this invention, might vary considerably from that illustrated in the drawings without departing from the principles of the invention. For example, it may be impractible to employ a rotor **42** with as large a relative diameter as that indicated in the drawings. Thus, the showing is made with a view to setting forth clearly only the principles of the invention. Also, as indicated, the details of controlling power cut-off by means of the switch **18** have not been shown. These could take various forms within the purview of one skilled in the art.

It will also be appreciated that the directions of threads at a joint being automatically tightened by the tool, might be reversed. In such case the arrangement of the parts relating to the clutch and actuator for control switch **18** would also be reversed to accommodate the opposite rotation involved.

While a particular embodiment of the invention has been described in considerable detail above, this is not to be taken as in any way limiting the invention, but merely as being descriptive thereof.

What I claim is:

1. In combination with a power tool having a stationary part, a rotary part and a motor for rotating said rotary part relative to said stationary part, including means for supplying power to said motor and a switch for terminating application of said power, the improvement comprising:

means for actuating said switch after a predetermined amount of rotation of said rotary part following a substantial and sudden increase in force applied, comprising

first means for measuring the amplitude of force being applied by said motor comprising clutch means having a shaft with a rotatable member attached thereto, and means for displacing said shaft longitudinally, and means for biasing said clutch means to a disengaged state unless said amplitude of force exceeds a predetermined amount,

second means for measuring the amount of rotation of said rotary part commencing with a predetermined amplitude of said force being applied by said motor, comprising means actuated by said clutch means when engaged, including means actuated by said rotatable member when said shaft is displaced for actuating said switch.

2. The invention according to claim **1,** wherein said shaft-displacing means is a diaphragm, said biasing means is a spring, and said means actuated by said rotatable member comprises

a rotor attached to said shaft for contacting said rotatable member, and

a radial arm extending from said shaft for actuating said switch.

3. The invention according to claim **2,** further including

a return spring for said shaft to bias it into a starting rotary position, and

means for adjusting said starting rotary position.

4. In combination with a power wrench having a stationary part, a rotary part, and power means for driving said rotary part in rotation relative to said stationary part,

means for tightening a shoulder butt joint a predetermined fixed amount, comprising

switch means for releasing application of said power means,

means for driving said rotary part until said shoulder butt joint has made contact,

a rotor adapted for being coupled and uncoupled with said rotary part,

a plunger for actuating said rotor from uncoupled to coupled position,

means for biasing said plunger to uncouple said rotor until said butt joint contact, and

an arm actuated by said rotor for contacting said switch after a predetermined amount of rotation of said rotary part.

5. The invention according to claim **4,** wherein said switch-actuating means further comprises

a spring for returning said arm to a starting position, and

means for setting said starting position for adjusting the amount of rotation of said rotary part.

6. In combination with a fluid motor powered rotary tool having a rotating part and a stationary part,

means for automatically driving said rotating part for a predetermined degree of rotation after a predetermined amplitude of force has been reacted, comprising in combination

a switch for shutting off said fluid motor,

said switch having an actuator therefor,

a shaft having an enlarged rotor on one end thereof and being shiftable longitudinally for placing said rotor into contact with said tool-rotating part,

a diaphragm attached to the other end of said shaft for shifting same when fluid pressure is applied,

a spring for urging said shaft against the force applied by said diaphragm,

said spring having sufficient strength to permit preliminary rotation of said tool-rotating part without shifting said shaft,

a radial arm carried by said shaft and adapted for contacting said switch actuator after a predetermined degree of rotation of said shaft when shifted so that said rotor is in contact with said tool-rotating part,

a return spring for biasing said shaft in rotation to a starting position prior to said rotation when the rotor is in contact with said tool-rotating part, and

means for adjusting said starting position in order to predetermine the degree of rotation of said power tool after said amplitude of force has been reacted.

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