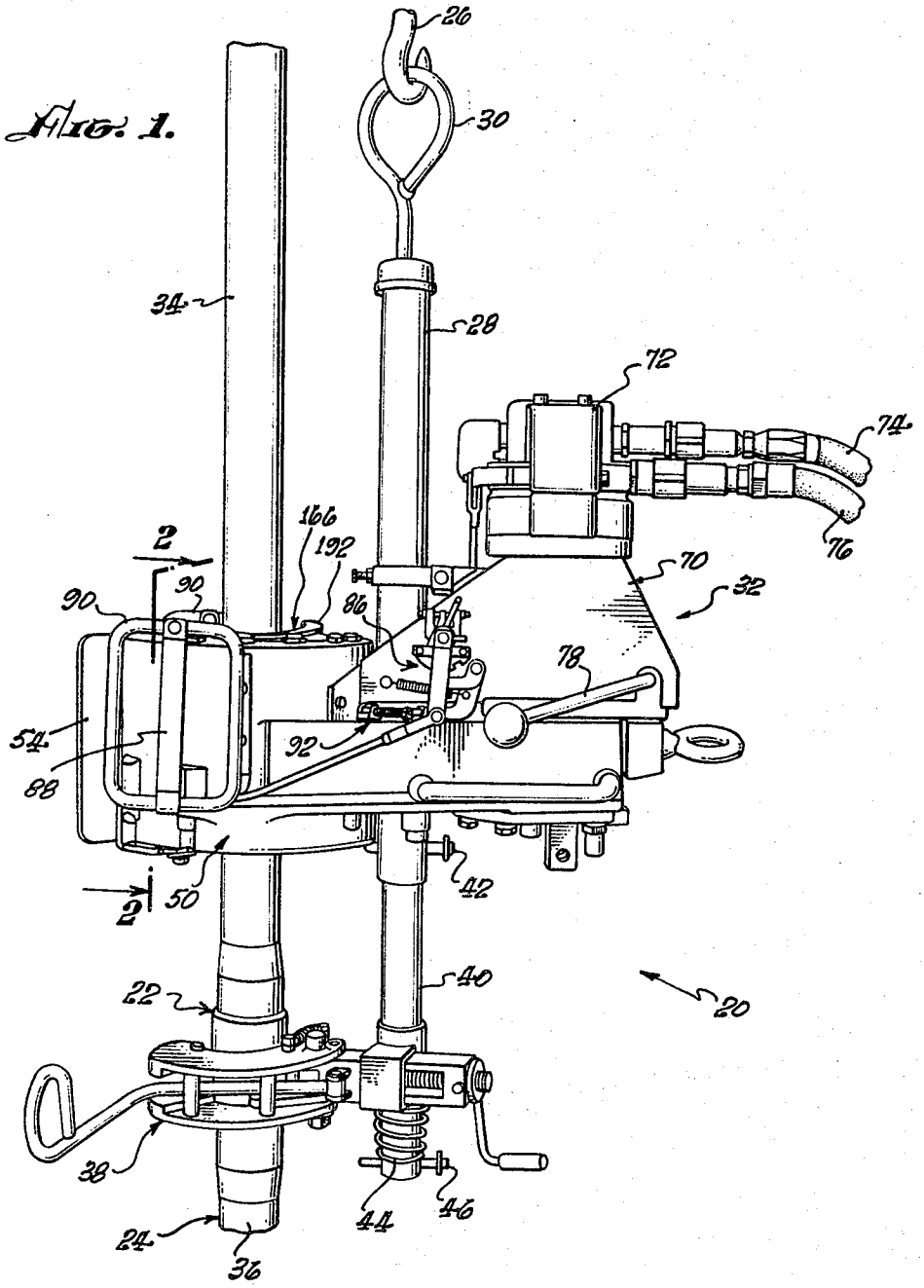
April 30, 1968 A. B. CAMPBELL 3,380,323

POWER WRENCH

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FIG. 1.



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POWER WRENCH

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FIG. 2.

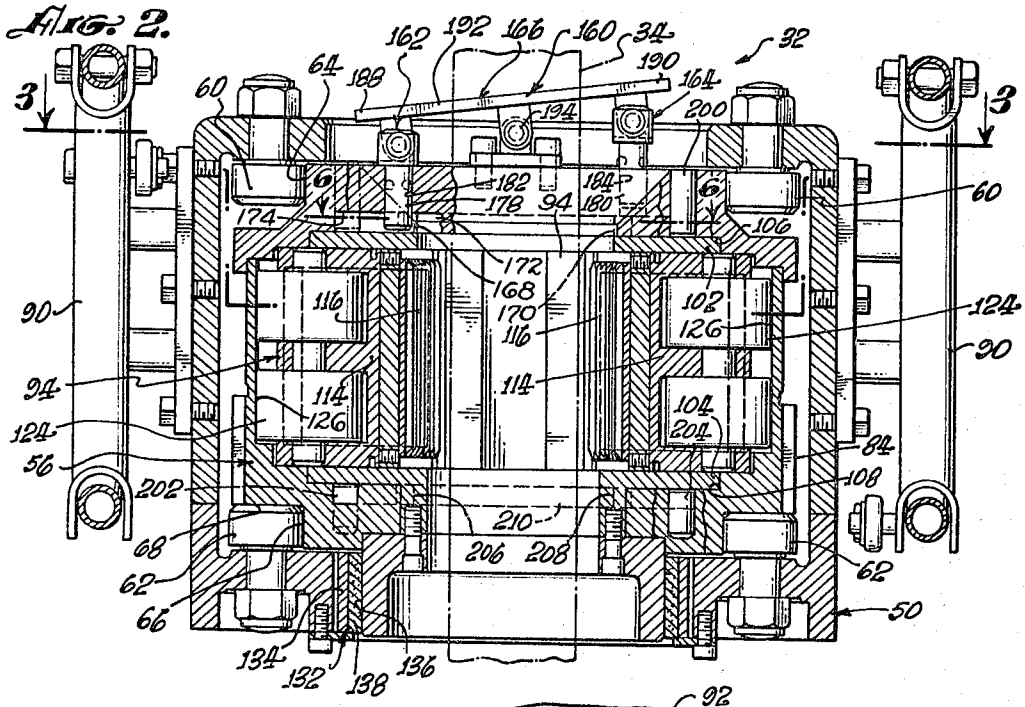
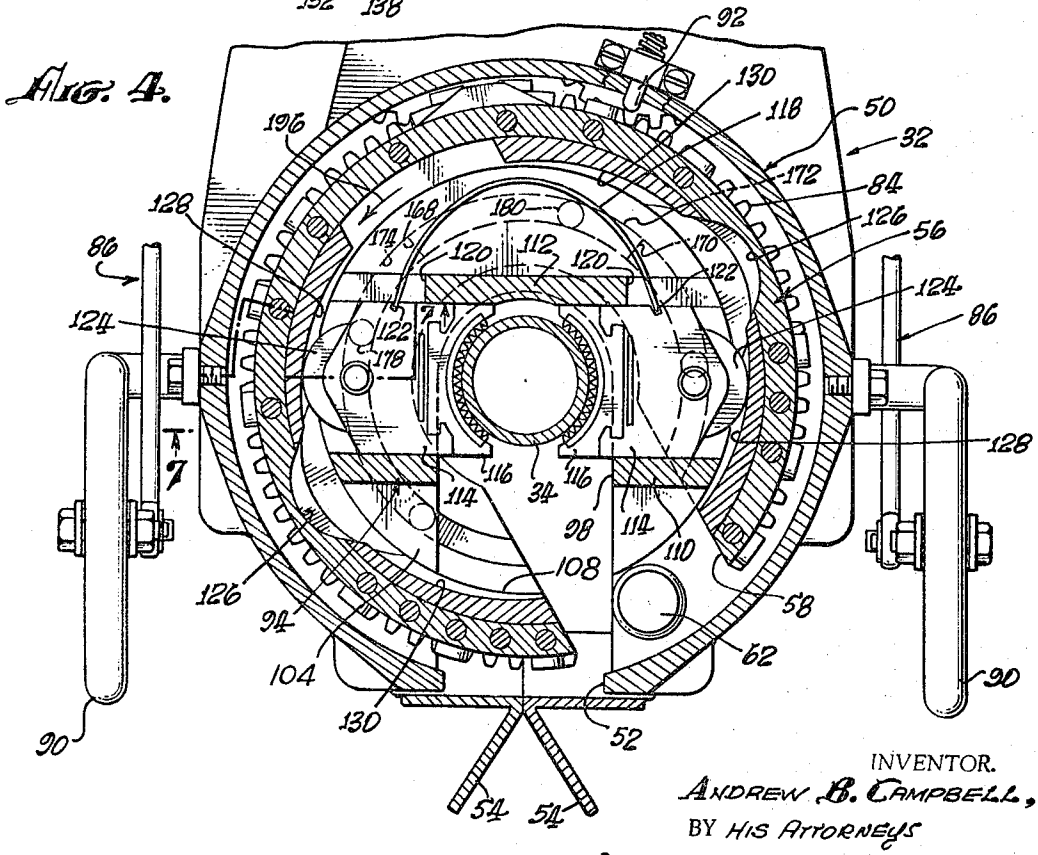


FIG. 4.



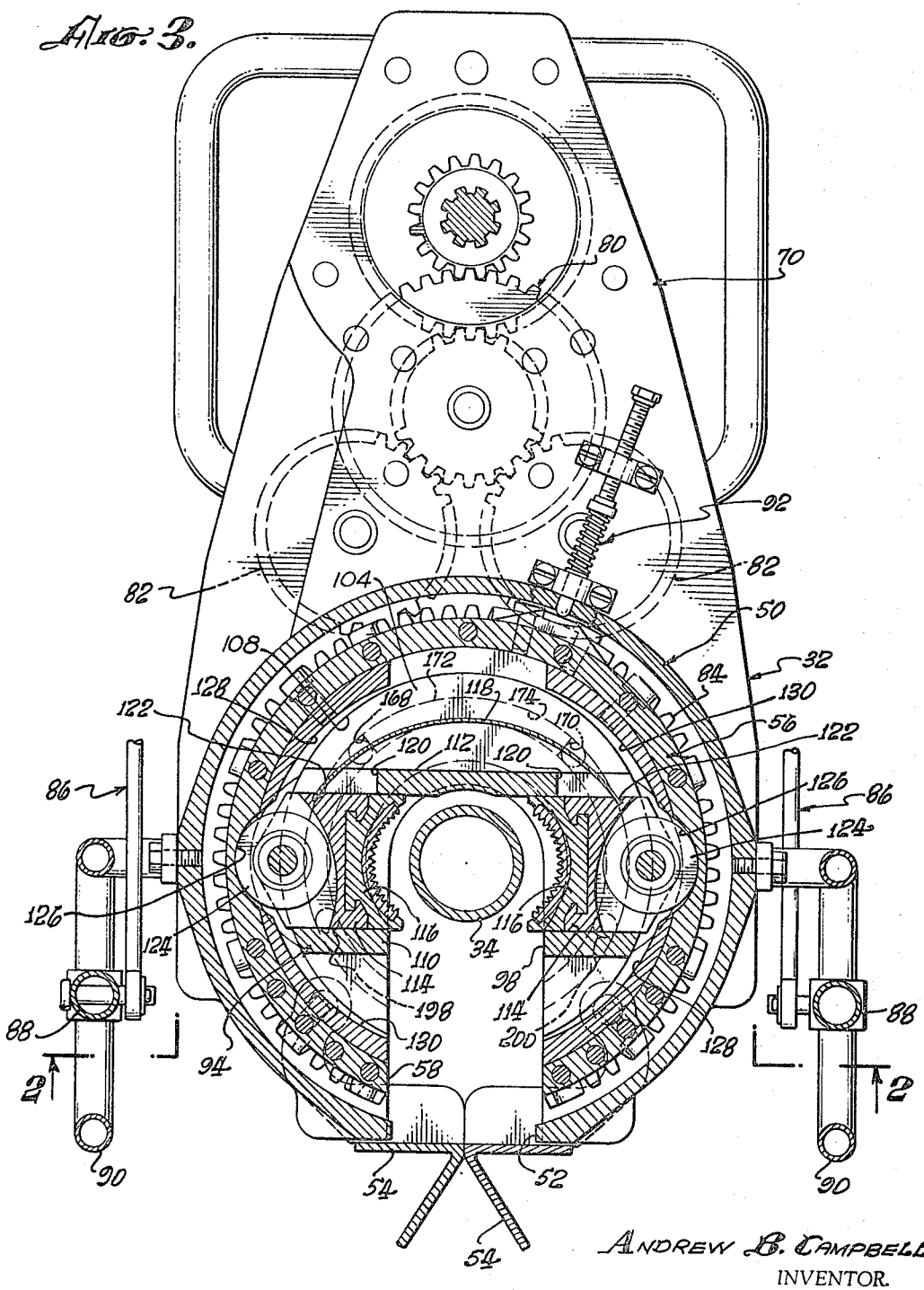
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Fig. 2.



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POWER WRENCH

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FIG. 5.

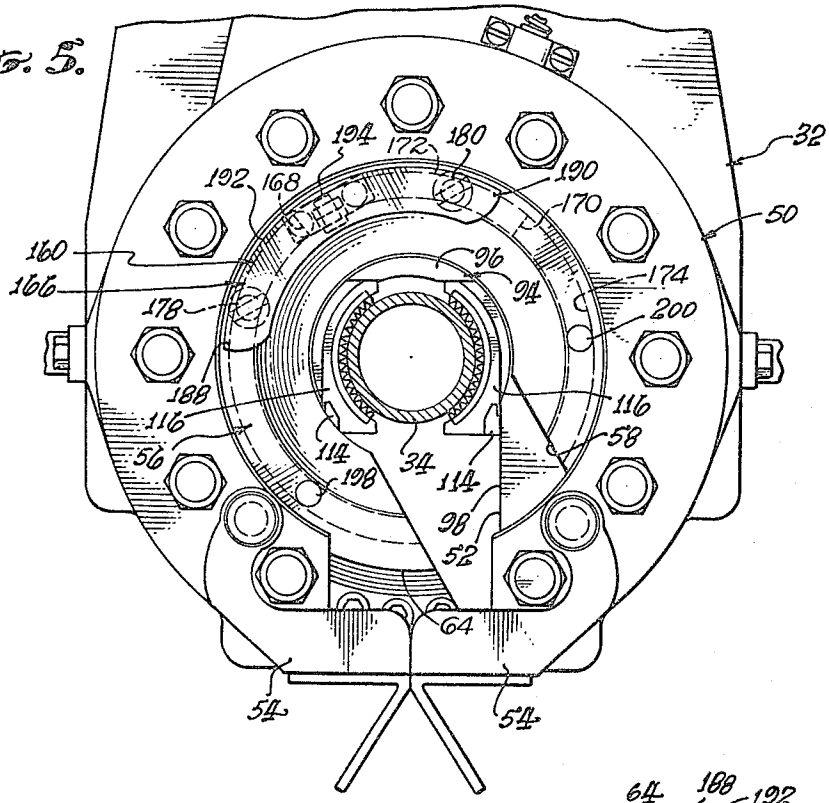


FIG. 6.

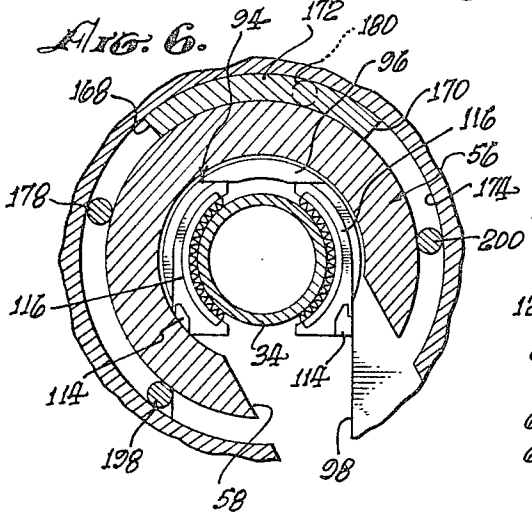
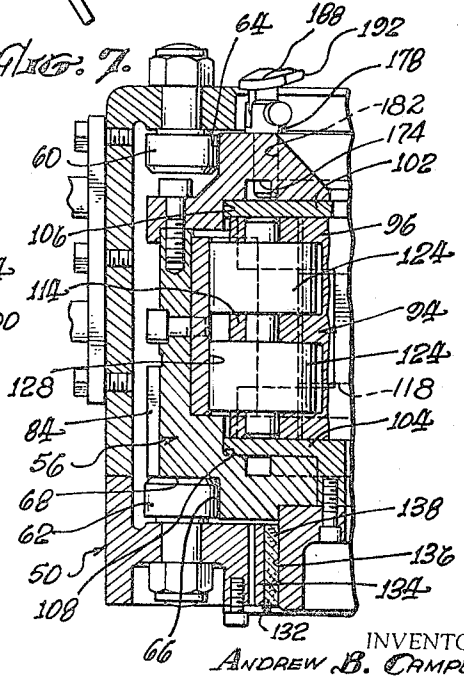


FIG. 7.



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POWER WRENCH

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FIG. 8.

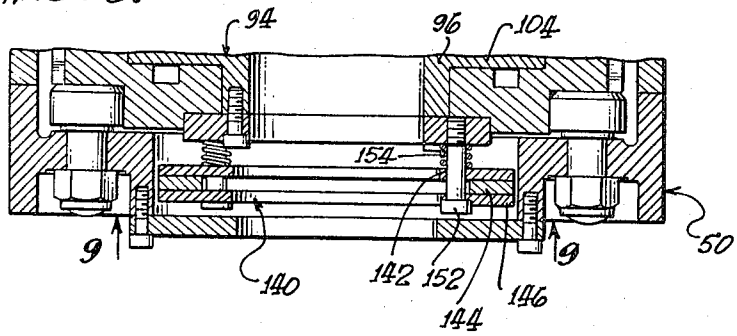


FIG. 9.

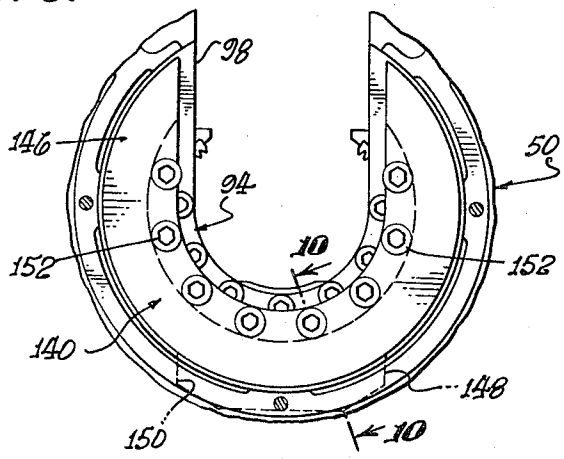
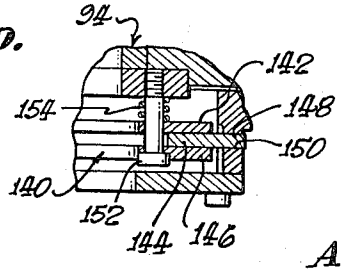


FIG. 10.



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United States Patent Office 3,380,323 Patented Apr. 30, 1968

3,380,323

POWER WRENCH

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Filed Feb. 15, 1966, Ser. No. 527,720
2 Claims. (Cl. 81—54)

ABSTRACT OF THE DISCLOSURE

A power wrench comprising a housing, an annular rotor rotatable relative to the housing, a reversible motor for rotating the rotor in either direction, a jaw assembly carried by the rotor and rotatable relative thereto about the rotor axis, a brake for restraining the jaw assembly to enable the rotor to rotate relative thereto, a double acting cam system for closing the jaw assembly in response to rotation of the rotor relative to the jaw assembly in either direction, a first set of stops on the rotor and the jaw assembly for preventing rotation of the rotor relative to the jaw assembly in one direction to prevent the cam system from closing the jaw assembly, a second set of stops on the rotor and the jaw assembly for preventing rotation of the rotor relative to the jaw assembly in the other direction to prevent the cam assembly from closing the jaw assembly, and a control system for selectively interengaging the stops of the first set and the stops of the second set. The control system includes a control lever extending circumferentially of the rotor and sloping downwardly in the direction of jaw-closing rotor rotation.

Background of invention

The present invention relates in general to power tongs or wrenches and, more particularly, to a power wrench for making or breaking threaded joints in pipe or rod strings when running such strings into or out of oil wells, for example. Still more particularly, the invention relates to a power wrench capable of lateral engagement with and disengagement from the pipe or rod string, as by mounting it for lateral swinging movement into and out of engagement with the pipe or rod string.

The invention contemplates a power wrench of the foregoing type which includes a housing, an annular rotor carried by the housing, reversible drive means for rotating the rotor in either direction, jaw means mounted on the rotor in such a manner as to permit limited rotation of the rotor relative to the jaw means in either direction, double-acting cam means for closing the jaw means in response to limited rotation of the rotor relative to the jaw means in either direction from a neutral position, braking means for restraining the jaw means upon rotation of the rotor in either direction to actuate the cam means and thus close the jaw means, and spring means for biasing the jaw means open in opposition to the action of the cam means so that the jaw means opens when it is in its neutral position relative to the rotor. Preferably, the housing, the rotor and the jaw means are provided with registerable radial throats permitting radial insertion of a pipe or rod string into the jaw means into a position to be gripped by the jaw means upon closing thereof.

With the foregoing construction, the double-acting cam means closes the jaw means in response to rotation of the rotor in either direction, as long as the braking means restrains the jaw means in order to permit the rotor to rotate relative to the jaw means in either direction from the relative neutral positions of the rotor and the jaw means. Consequently, the power wrench can be used for making or breaking a joint in a pipe or rod string merely by reversing the direction of rotation of the rotor.

Preferably, the braking means acts on the jaw means continuously so that the braking means continuously tends to produce rotation of the rotor relative to the jaw means upon rotation of the rotor in either direction. With this construction, the double-acting cam means automatically tends to close the jaw means in response to rotation of the rotor in either direction. Consequently, no means for actuating the braking means is required.

However, there are times during the operation of a power wrench of the foregoing nature when it is necessary or desirable to rotate the rotor in one direction or the other without closing the jaw means on a pipe or rod string therein. For example, after making or breaking a joint in a pipe or rod string, it is necessary to reverse the direction of rotor rotation to register the radial throats in the rotor and the jaw means with the radial throat in the housing so that the power wrench may be laterally disengaged from the pipe or rod string. Initially, such reversed rotor rotation opens the jaw means to disengage same from the pipe or rod string, and it is necessary to keep the jaw means open as the reversed rotor rotation continues to register the radial throats in the jaw means and the rotor with the radial throat in the housing. Otherwise, the previously-completed joint making or breaking operation would be at least partially reversed, which obviously would be undesirable.

Summary and objects of invention

With the foregoing as background, the primary object of the invention is to provide means for preventing rotation of the rotor relative to the jaw means, in opposition to the continuous drag exerted on the jaw means by the braking means, when closing of the jaw means is not desired. This permits concurrent rotation of the rotor and the jaw means, with the jaw means open, for the purpose of aligning the radial throats in the jaw means and the rotor with the radial throat in the housing, or for other purposes, which is an important feature of the invention.

More particularly, an important object of the invention is to provide means for preventing jaw-means-closing rotation of the rotor relative to the jaw means which includes: first interengageable stop means on the rotor and the jaw means for preventing rotation of the rotor relative to the jaw means in one direction to prevent the cam means from closing the jaw means; second interengageable stop means on the rotor and the jaw means for preventing rotation of the rotor relative to the jaw means in the other direction to prevent the cam means from closing the jaw means; and control means for selectively interengaging the first stop means and the second stop means.

Another important object of the invention is to provide a power wrench of the foregoing nature wherein: the first stop means includes a first fixed stop on the jaw means, and includes a first movable stop carried by the rotor and movable relative to the rotor from an extended position wherein it is engageable with the first fixed stop to a retracted position; the second stop means includes a second fixed stop on the jaw means, and includes a second movable stop carried by the rotor and movable relative to the rotor from an extended position wherein it is engageable with the second fixed stop to a retracted position; and the control means includes a control lever which has first and second ends respectively connected to the first and second movable stops, and which is pivotally mounted on the rotor intermediate its ends.

Still another object of the invention is to provide a power wrench wherein the first and second movable stops are spaced apart circumferentially of the rotor and the first and second fixed stops are spaced apart circumferentially of the jaw means, and wherein the control lever extends circumferentially of the rotor.

An additional object is to provide a construction of the foregoing nature wherein tilting the control lever relative to the rotor in a particular circumferential direction will result in closing of the jaw means when the rotor is rotated relative to the housing in that direction. Thus, it is a simple matter for the operator to determine visually whether the jaw means will close or not upon rotation of the rotor in one direction or the other, which is an important feature.

Another object of the invention is to provide first and second fixed stops on the rotor respectively engageable with the first and second fixed stops on the jaw means, after predetermined rotational displacements of the rotor relative to the jaw means in opposite directions, to limit the maximum rotational displacement of the rotor relative to the jaw means which can occur.

Yet another object of the invention is to provide a jaw means which includes two jaws and to provide a double-acting cam means which includes means for closing both jaws in response to rotation of the rotor relative to the jaw means in either direction from a neutral position.

A further object of the invention is to provide a braking means which includes a stack of three flat, annular, disc-like braking elements having their planes perpendicular to the axis of rotation of the rotor, and which includes spring means for clamping the intermediate braking element between the other two, whereby the braking elements cooperate to restrain the jaw means, upon rotation of the rotor in either direction, to actuate the cam means for closing the jaw means. A related object is to provide a braking means of the foregoing character wherein at least one of the braking elements, preferably the intermediate braking element, is carried by the housing, the remainder being carried by the jaw means.

The foregoing objects, advantages, features and results of the present invention, together with various other objects, advantages, features and results of the invention which will be evident to those skilled in the power wrench art in the light of this disclosure, may be achieved with the exemplary embodiments of the invention described in detail hereinafter and illustrated in the accompanying drawings.

Description of drawings

In the drawings:

FIG. 1 is a perspective view of an apparatus for making or breaking threaded joints in pipe or rod strings when running such strings into or out of oil wells, for example, which apparatus includes the power wrench of the invention;

FIG. 2 is a vertical sectional view of the power wrench which is taken as indicated by the arrowed lines **2—2** of FIGS. 1 and 3;

FIG. 3 is a sectional view taken as indicated by the arrowed line **3—3** of FIG. 2, and shows a jaw means of the power wrench of the invention in its open position;

FIG. 4 is a fragmentary sectional view similar to FIG. 3, and shows the jaw means in its closed position;

FIG. 5 is a fragmentary plan view of the portion of the power wrench of the invention which is shown in FIG. 4;

FIG. 6 is a fragmentary sectional view taken as indicated by the arrowed line **6—6** of FIG. 2;

FIG. 7 is a fragmentary sectional view taken as indicated by the arrowed line **7—7** of FIG. 4;

FIG. 8 is a fragmentary sectional view similar to the bottom part of FIG. 2, but showing an alternative and presently preferred braking means of the invention;

FIG. 9 is a sectional view taken as indicated by the arrowed line **9—9** of FIG. 8; and

FIG. 10 is a fragmentary sectional view taken as indicated by the arrowed line **10—10** of FIG. 9 of the drawings.

Description of preferred embodiment of invention

Referring initially to FIG. 1 of the drawings, illustrated therein is an apparatus **20** of the invention for making or breaking threaded joints in pipe or rod strings, such as a threaded joint **22** in a drill string **24**. The entire apparatus **20** is shown as suspended from a hook **26** at the lower end of a cable, not shown, so that it may be swung laterally into and out of engagement with the drill string **24**.

More particularly, the apparatus **20** includes a vertical post **28** shown as having at its upper end an eye **30** engageable with the hook **26**. The power tongs or wrench of the invention is designated generally by the numeral **32** and is suitably carried by the post **28**. As will become apparent, the power wrench **32** is designed to be engaged with or disengaged from an upper section **34** of the drill string **24** by swinging it to the left or right, as viewed in FIG. 1 of the drawings. It will be noted that, in the particular construction illustrated, the power wrench **32** is intended to engage the upper drill-string section **34** above the threaded joint **22** between the upper section **34** and a lower section **36**. The threaded joint **22** may be of the usual pin and box type, the pin being formed at the lower end of the upper section **34** and the box being formed at the upper end of the lower section **36**.

The apparatus **20** is also shown as including a back-up tongs or wrench **38** engageable with the box at the upper end of the lower drill-string section **36** to prevent rotation thereof while making or breaking the joint **22**. The back-up wrench **38**, which is more fully described and claimed by my co-pending application Ser. No. 543,329, filed Apr. 18, 1966, is pivotable about a subpost **40** into and out of engagement with the box at the upper end of the lower drill-string section **36**, after the power wrench **32** has been swung laterally into engagement with the upper drill-string section **34**. The subpost **40** is telescoped upwardly into a socket aligned with the post **28** and is detachably connected thereto by a suitable connector **42**. The back-up wrench **38** is supported on the subpost **40** by a compression spring **44** seated on a removable pin **46**. By removing the pin **46** and the spring **44**, the back-up wrench **38** may be slipped downwardly off the lower end of the subpost **40** so that it can be turned over and re-installed on the subpost upside down relative to the position shown in FIG. 1 of the drawings. With this construction, the position of the back-up wrench **38** on the subpost **40** can be reversed readily when switching from making threaded joints to breaking them, or vice versa. The back-up wrench **38** per se forms no part of the present invention, and since it is fully disclosed in my aforementioned co-pending application, it will not be described further herein.

Considering the power wrench **32** of the invention more specifically now, with particular reference to FIGS. 3 to 6 of the drawings, it includes a housing **50** carried by the post **28** and provided with a radial throat **52** for lateral application of the power wrench to and lateral disengagement thereof from the upper drill-string section **34**. The outer end of the radial throat **52** is normally closed by two pivoted, spring-biased guards **54** which open and close automatically as the power wrench **32** is applied to and disengaged from the upper drill-string section **34**. Guards of this nature are well known in the power tongs art so that a further description of the guards **54** is not necessary.

Rotatable in the housing **50** about an axis paralleling that of the post **28** is an annular rotor **56** having a radial throat **58** registerable with the radial throat **52**, as shown in FIG. 3, when the power wrench **32** is to be applied to or disengaged from the drill string **24**. As shown in FIGS. 2 and 7 of the drawings, the rotor **56** is rotatably mounted in the housing **50** by means of upper and lower rollers **60** and **62** respectively engageable with upper and lower cylindrical surfaces **64** and **66** of the

rotor, which cylindrical surfaces are, of course, interrupted by the radial throat **58**. The weight of the rotor **56** is supported by the upper ends of the lower rollers **62**, which engage an annular surface **68** of the rotor **56** in a plane perpendicular to the axis of rotation of the rotor. The foregoing mounting of the rotor **56** in the housing **50** is generally conventional so that a detailed description is not required.

The power wrench **32** includes a reversible drive means **70** for rotating the rotor **56** relative to the housing **50** in either direction. Referring to FIG. 1, the reversible drive means **70** includes a suitable motor **72** mounted on the housing **50**. Preferably, the motor **72** is a hydraulic motor having connected thereto supply and return lines **74** and **76** which are flexible to permit lateral swinging of the power wrench **32** into and out of engagement with the drill string **24**.

The motor **72** may be reversible to drive the rotor **56** in either direction, or a suitable reversing means, not shown, may be interposed between the motor and the rotor. In either event, the direction of rotation of the rotor **56** is controlled by a suitable control lever **78**, FIG. 1, carried by the housing **50**.

Continuing to consider the reversible drive means **70**, it includes a suitable gear train **80**, FIG. 3, one end of which is appropriately connected to the motor **72** and the other, or output, end of which is connected to the rotor **56**. More particularly, the output end of the gear train **80** includes two circumferentially spaced gears **82** meshed with a peripheral gear **84** on the rotor **56**. Providing the output end of the gear train **80** with the two circumferentially spaced gears **82** insures that one of them will always be in mesh with the peripheral gear **84** on the rotor **56**, which peripheral gear is interrupted by the radial throat **58** in the rotor. The foregoing connections between the rotor **56** and the motor **72** are more-or-less conventional so that a further description is unnecessary.

The power wrench **32** includes a control system **86** for starting and stopping the motor **72**, which control system comprises pivoted control levers **88** carried by hand grips **90** on the housing **50** on opposite sides of the radial throat **52** therein. The control system **86** also includes means **92**, FIGS. 3 and 4, for stopping the rotor **56** with its radial throat **58** in register with the radial throat **52** in the housing **50**. The control system **86** is more fully described and claimed in the co-pending application of Fred J. Hillman, Ser. No. 543,280, filed Apr. 18, 1966, and assigned to the same assignee as the present application. The disclosure of the co-pending application just mentioned is incorporated herein by reference the same as if it were fully set forth herein.

The power wrench **32** further includes jaw means **94** mounted on the rotor **56** in such a manner as to permit limited rotation of the rotor relative to the jaw means in either direction. More particularly, the jaw means **94** includes a jaw carrier **96** having a radial throat **98** registerable with the radial throat **58** in the rotor **56** when the jaw carrier is in a neutral position relative to the rotor. The jaw carrier **96** is provided with cylindrical upper and lower ends **102** and **104** (interrupted by the radial throat **98**) which are rotatable relative to the rotor **56** in combined journal and thrust bearing recesses **106** and **108**, respectively, in the rotor.

The cylindrical upper and lower ends **102** and **104** of the jaw carrier **96** are interconnected by spaced, parallel, chordal guide walls **110** and **112** located on opposite sides of the common axis of rotation of the rotor **56** and the jaw carrier. The radial throat **98** is formed in the guide wall **110**.

Disposed between the guide walls **110** and **112** are two radially - inwardly - and - outwardly - movable, diametrically-opposed jaw members **114** carrying jaws **116** engageable with the drill string **24**. The jaws **116** are shown in engagement with the upper drill-string section **34** in FIGS. 4 and 6 of the drawings, and are shown out of engagement with such drill-string section in FIG. 3 thereof. Preferably, the jaws **116** comprise removable inserts secured to the jaw members **114** by means of dovetail-like joints. With this construction, other jaws, not shown, for other pipe or rod sizes may be substituted for the jaws **116**.

The jaw members **114** are biased apart, i.e., toward their open positions, by a leaf spring **118** disposed between the cylindrical upper and lower ends **102** and **104** of the jaw carrier **96** on the opposite side of the jaw carrier from the radial throat **98** therein. The ends of the leaf spring **118** project through windows **120** in the guide wall **112** into grooves **122** in the respective jaw members **114**. The leaf spring **118** normally assumes the configuration shown in FIG. 3 of the drawings to bias the jaw members **114** outwardly into their open positions. When the jaw members **114** are forced inwardly into their closed positions in a manner to be described, the leaf spring **118** assumes the configuration shown in FIG. 4 of the drawings.

The power wrench **32** further includes double-acting cam means for closing the jaw means **94** upon rotation of the rotor **56** relative to the jaw means in either direction away from the relative neutral positions of the rotor and the jaw means. This double-acting cam means includes two roller cam followers **124** respectively carried by the jaw members **114** and respectively disposed in diametrically-opposite detent recesses **126** in the rotor **56** when the rotor and the jaw means **94** are in their relative neutral positions. Upon rotation of the rotor **56** in the counterclockwise direction relative to the jaw means **94**, as shown in FIG. 4 of the drawings, the cam followers **124** respectively engage radially-inwardly-spiraling cams **128** on the rotor **56** to close the jaws **116** on the drill string **24**. Conversely, upon clockwise rotation of the rotor **56** relative to the jaw means **94** from their relative neutral positions, the cam followers **124** respectively engage radially-inwardly-spiraling cams **130** on the rotor, which cams also act to close the jaws **116**. Thus, upon rotation of the rotor **56** relative to the jaw means **94** in either direction, the jaws **116** are closed, being closed by the interaction of the cam followers **124** and the cams **128** in one direction of relative rotation, and being closed by the interaction of the cam followers and the cams **130** in the other direction of relative rotation.

The power wrench **32** is provided with continuously-operating braking means **132** for restraining the jaw means **94** upon rotation of the rotor **56** in either direction so that the cams **128**, or the cams **130**, close the jaws **116**.

As suggested in FIGS. 2 and 4, the braking means **132** may comprise a brake band **134** secured to the housing **50** and encircling a brake drum **136** on the jaw carrier **96**, the brake band **134** being provided with a brake lining **138** engageable with the brake drum. The brake band **134** is suitably secured at its ends to the housing **50** on opposite sides of the radial throat **52** in the housing, as disclosed, for example, in Patent No. 2,618,468, granted Nov. 18, 1952, to Chester A. Lundeen.

An alternative, and presently preferred, braking means **140** of the invention is illustrated in FIGS. 8 to 10 of the drawings. The braking means **140** comprises flat, annular, disc-like braking elements **142**, **144** and **146** having their planes perpendicular to the axis of rotation of the rotor **56** and positioned in stacked relation with the braking element **144** between the braking elements **142** and **146**. The intermediate braking element **144** is secured to the housing **50**, as by inserting a lug **148** thereon into an opening **150** in the housing. It will be understood that the intermediate braking element **144** has a gap therein corresponding to the radial throat **52** in the housing **50**. The other braking elements **142** and **146**, which have gaps therein coinciding with the radial throat **98** in the jaw carrier **96**, are carried by screws **152** threaded into the lower end of the jaw carrier. The screws **152** are sur-

rounded by compression springs **154** which are seated at their upper ends against the lower end of the jaw carrier **96** and which are seated at their lower ends against the braking element **142** to clamp the intermediate braking element **144** between the upper and lower braking elements **142** and **146**. Thus, the braking means **140** exerts a continuous restraint on the jaw means **94** tending to produce rotation of the rotor **56** relative to the jaw means upon rotation of the rotor relative to the housing **50**.

The description which follows is applicable irrespective of whether the braking means **132** of FIGS. 2 to 7, or the braking means **140** of FIGS. 8 to 10, is used.

As will be apparent, irrespective of the direction of rotation of the rotor **56**, the braking means **132** or **140** restrains the jaw means **94** against rotation to cause the cams **128** or **130** to close the jaws **116** on the drill string **24**. Consequently, the power wrench **32** may be used for making or breaking the threaded joint **22** merely by reversing the direction of rotation of the rotor **56**. In either case, the jaws **116** grip the drill string section to which the power wrench **32** is applied with a clamping force proportional to the torque applied to the rotor **56**.

As hereinbefore outlined, there are times during the operation of the power wrench **32** when it is necessary or desirable to rotate the rotor **56** in one direction or the other without closing the jaw means **94** on a pipe or rod string therein. For example, after making or breaking the threaded joint **22**, it is necessary to reverse the direction of rotor rotation to first open the jaws **116** and to then register the radial throats **98** and **58** in the jaw means **94** and the rotor **56** with the radial throat **52** in the housing **50** so that the power wrench **32** can be disengaged from the drill string **24**. During this throat-registering operation, the jaw means **94** must be kept open to prevent at least partial reversal of the previously-completed joint making or breaking operation.

The invention provides means **160** for preventing rotation of the rotor **56** relative to the jaw means **94**, in opposition to the continuous drag exerted on the jaw means by the braking means **132** or **140**, when closing of the jaw means is not desired. This permits concurrent rotation of the rotor **56** and the jaw means **94**, with the jaws **116** open, for the purpose of aligning the radial throats **98** and **58** in the jaw means **94** and rotor **56** with the radial throat **52** in the housing **50**, or for other purposes. For example, it may simply be desirable under some circumstances to rotate the rotor **56** in one direction or the other without rotating it relative to the jaw means **94** to close the jaw means.

More particularly, the means **160** for preventing jaw-closing rotation of the rotor **56** relative to the jaw means **94** includes: first interengageable stop means **162** on the rotor and the jaw means for preventing rotation of the rotor relative to the jaw means in the clockwise direction to prevent the cams **130** from closing the jaw means; second interengageable stop means **164** on the rotor and the jaw means for preventing rotation of the rotor relative to the jaw means in the counterclockwise direction to prevent the cams **128** from closing the jaw means; and control means **166** for selectively interengaging the first stop means and the second stop means.

As best shown in FIG. 6 of the drawings, the first and second stop means **162** and **164** respectively include first and second fixed stops **168** and **170** on the jaw means **94**, these fixed stops being formed by circumferentially spaced ends of an arcuate, circumferentially extending rib **172** on the jaw carrier **96** and disposed in a circumferential groove **174** in the rotor **56**. The first and second stop means **162** and **164** also include first and second movable stops **178** and **180** movable vertically between extended and retracted positions and respectively engageable with the fixed stops **168** and **170**, when in their extended positions, in response to clockwise and counterclockwise rotation, respectively, of the rotor **56** relative to the jaw means **94**. As best shown in FIGS. 2 and 5 of the drawings, the first and second movable stops **178** and **180** comprise pins vertically movable between upper, retracted and lower, extended positions in bores **182** and **184** in the rotor **56**. The upper ends of the first and second movable stops **178** and **180** are pivotally connected to first and second ends **188** and **190** of a circumferentially-extending control lever **192** which constitutes the control means **166** and which is pivotally mounted intermediate its ends, at **194**, on the rotor **56**.

Considering the operation of the means **160** for preventing jaw-closing rotation of the rotor **56** relative to the jaw means **94**, and referring particularly to FIGS. 2 and 4 of the drawings, it will be assumed that the control lever **192** is in the position shown in FIG. 2 and that the rotor **56** is being rotated in the counterclockwise direction, as indicated by the arrow **196** in FIG. 4. Under such conditions, the jaw means **94** is restrained by the braking means **132** or **140** to cause the cam followers **124** and the cams **128** to cooperate to close the jaws **116** on the drill-string section **34**. It will be noted that with the control lever **192** in the position shown in FIG. 2, the second movable stop **180** is in its retracted position so that it cannot engage the second fixed stop **170** to prevent closure of the jaw means **94**. It will also be noted that the control lever **192** is tilted relative to the rotor **56** in the direction of rotor rotation which will produce closing of the jaw means **94**. Thus, it is a simple matter for the operator to determine visually that the jaw means **94** will close when the control lever **192** is tilted downwardly in the counterclockwise direction and the rotor **56** is rotated in that direction.

After the rotor **56** has been rotated in the counterclockwise direction sufficiently to break the threaded joint **22** completely, the direction of rotor rotation is reversed, without changing the position of the control lever **192**. Initially, the rotor **56** rotates relative to the jaw means **94** until the rotor and the jaw means are in their relative neutral positions, with the cam followers **124** in their detent recesses **126**. Under such circumstances, the jaw means **94** is fully open. Continued rotor rotation in the clockwise direction under such circumstances cannot result in re-closing of the jaw means **94** because of the fact that the first movable stop **178** engages the first fixed stop **168** to prevent jaw-closing rotation of the rotor **56** relative to the jaw means **94**. In other words, the first stop means **162**, comprising the first fixed stop **168** and the first movable stop **178**, precludes jaw-closing rotation of the rotor **56** relative to the jaw means **94**.

The power wrench **32** has a similar mode of operation when it is desired to make the joint **22**. Under such conditions, the control lever **192** is tilted downwardly in the clockwise direction so that the first movable stop **178** can clear the first fixed stop **168** when the rotor **56** is rotated in the clockwise direction. Under such conditions, the jaw means **94** closes on the drill string section **34**. Upon reversed rotation, however, the jaw means **94** opens and does not re-close upon continued reversed rotation.

Thus, in either case, the rotor **56** can rotate relative to the jaw means **94** to close the jaw means as long as the direction of rotor rotation corresponds to the direction of downward inclination of the control lever **192**. However, if the direction of rotor rotation is the reverse of the direction of downward inclination of the control lever **192**, the jaw means **94** merely opens and then remains open upon continued reversed rotation of the rotor. This permits registering the radial throats **98** and **58** in the jaw means **94** and rotor **56** without re-closing of the jaw means, which is an important feature of the invention.

The power wrench **32** also includes circumferentially-spaced first and second fixed stops **198** and **200** on the rotor **56** and respectively engageable with the first and second fixed stops **168** and **170** on the jaw means **94** to limit the maximum possible relative rotation of the rotor relative to the jaw means in the clockwise and counterclockwise directions, respectively. Preferably, the fixed stops **198** and **200** are simply fixed pins carried by the

rotor and respectively engageable with the ends **168** and **170** of the arcuate, circumferentially extending rib **172**. Considering the purpose of the fixed stops **198** and **200** with reference to FIG. 4 of the drawings, if the rotor **56** were inadvertently driven in the counterclockwise direction without a pipe or rod between the jaws **116**, it would be possible for the cam followers **124** to run off the ends of the cams **128**. However, this is prevented by engagement of the fixed stop **200** on the rotor **56** with the fixed stop **170** on the jaw means **94**. These fixed stops produce rotation of the jaw means **94** with the rotor **56** in opposition to the restraining action of the braking means **132** or **140**, thereby preventing the cam followers **124** from running off the ends of the cams **128**. The fixed stops **168** and **198** perform a similar function during clockwise rotation of the rotor **56** with no pipe or rod between the jaws **116**.

Referring to FIG. 2 of the drawings, the relative-rotation-limiting actions of the fixed stops **198** and **200** are supplemented by fixed stops **202** and **204** on the rotor **56** and respectively engageable with fixed stops **206** and **208** on the jaw means **94**. The fixed stops **202** and **204** are preferably fixed pins aligned with the fixed pins **198** and **200**, and the fixed stops **206** and **208** are preferably the ends of an arcuate, circumferentially extending rib **210** coinciding with the rib **172**.

Although exemplary embodiments of the invention have been disclosed herein for purposes of illustration, it will be understood that various changes, modifications and substitutions may be incorporated in such embodiments without departing from the spirit of the invention as defined by the claims which follow.

I claim as my invention:

1. In a power wrench, the combination of:

(a) a housing;

(b) a generally horizontal annular rotor carried by said housing and rotatable relative to said housing about a generally vertical axis;

(c) reversible drive means carried by said housing for rotating said rotor in either direction;

(d) outwardly openable and inwardly closable jaw means carried by said rotor and rotatable relative to said rotor about said axis;

(e) braking means on said housing and said jaw means for restraining said jaw means upon rotation of said rotor in either direction to enable said rotor to rotate relative to said jaw means in either direction;

(f) double-acting cam means on said rotor and said jaw means for closing said jaw means in response to rotation of said rotor relative to said jaw means in either direction from a neutral position;

(g) first interengageable stop means on said rotor and said jaw means for preventing rotation of said rotor relative to said jaw means in one direction to prevent said cam means from closing said jaw means;

(h) second interengageable stop means on said rotor and said jaw means for preventing rotation of said rotor relative to said jaw means in the other direction to prevent said cam means from closing said jaw means;

(i) control means for selectively interengaging said first stop means and said second stop means;

(j) said first stop means including a first fixed stop on said jaw means, and including a first movable stop carried by said rotor and movable relative to said rotor from a lower, extended position wherein it is engageable with said first fixed stop to an upper, retracted position;

(k) said second stop means including a second fixed stop on said jaw means, and including a second movable stop carried by said rotor and movable relative to said rotor from a lower, extended position wherein it is engageable with said second fixed stop to an upper, retracted position;

(l) said first and second movable stops being spaced apart circumferentially of said rotor and said first and second fixed stops being spaced apart circumferentially of said jaw means;

(m) said control means including a control lever which extends circumferentially of said rotor, which has first and second ends respectively connected to said first and second movable stops, and which is pivotally mounted on said rotor intermediate its ends;

(n) said control lever sloping circumferentially downwardly toward said first movable stop when said first movable stop is in its lower, extended position and said second movable stop is in its upper, retracted position, and said control lever sloping circumferentially downwardly toward said second movable stop when said second movable stop is in its lower, extended position and said first movable stop is in its upper, retracted position; and

(o) whereby the circumferential direction of downward inclination of said control lever corresponds to the direction of rotation of said rotor required to close said jaw means.

2. A power wrench according to claim **1** wherein said control lever is an arcuate member the center of curvature of which lies on the axis of rotation of said rotor.

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