Nov. 29, 1960 A. J. SERGAN 2,961,904

HYDRAULICALLY ACTUATED WRENCH

Filed Feb. 3, 1959 3 Sheets-Sheet 1

FIG. 1

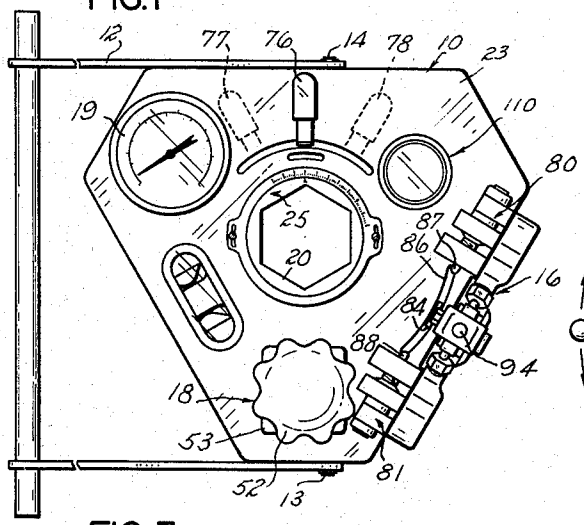


FIG. 2

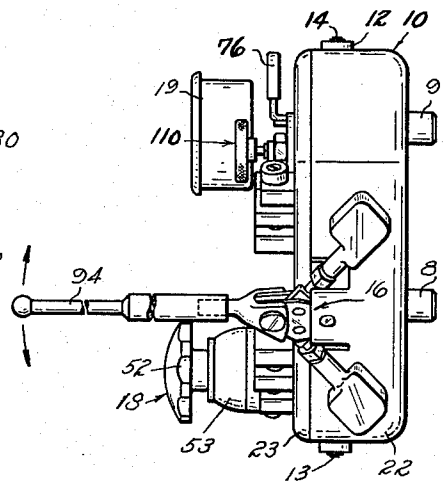
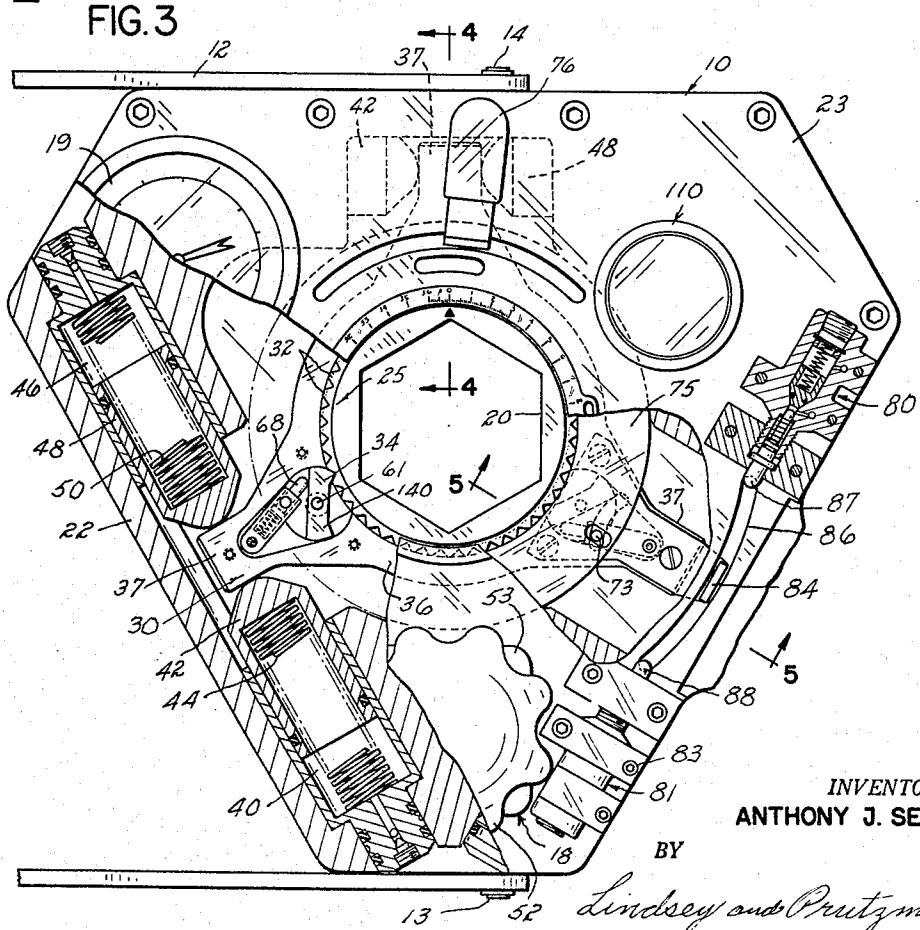


FIG. 3



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FIG. 4

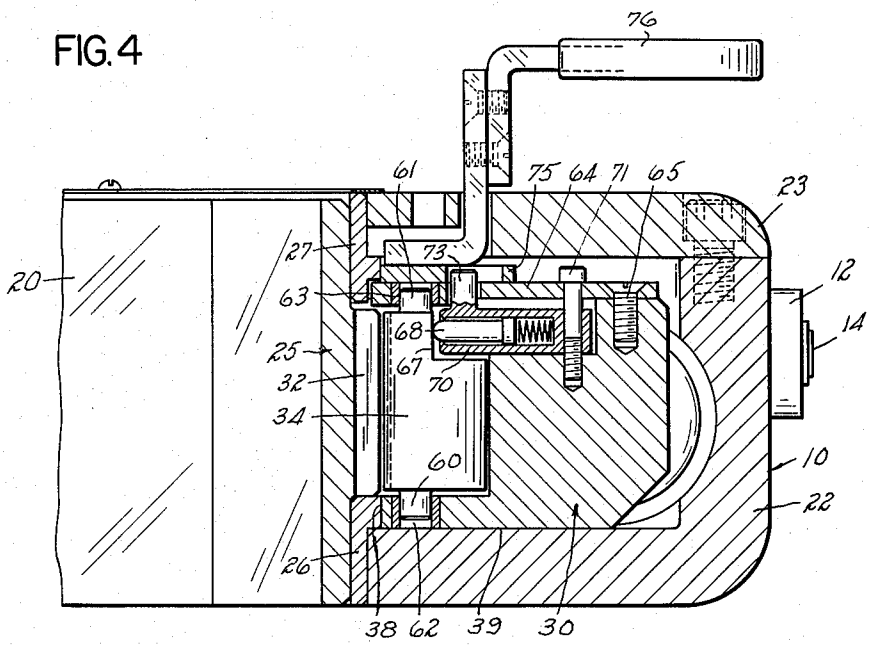
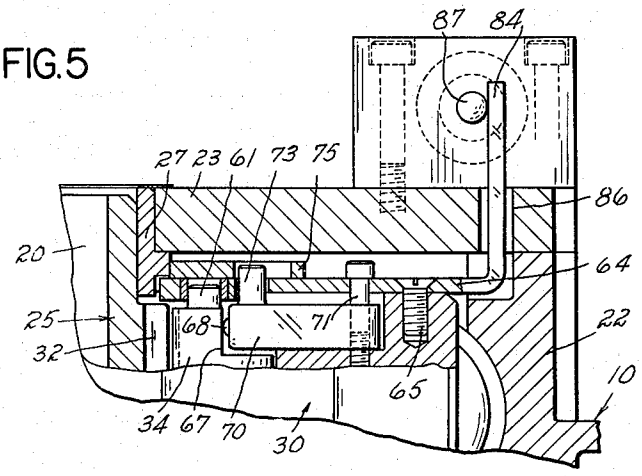


FIG. 5



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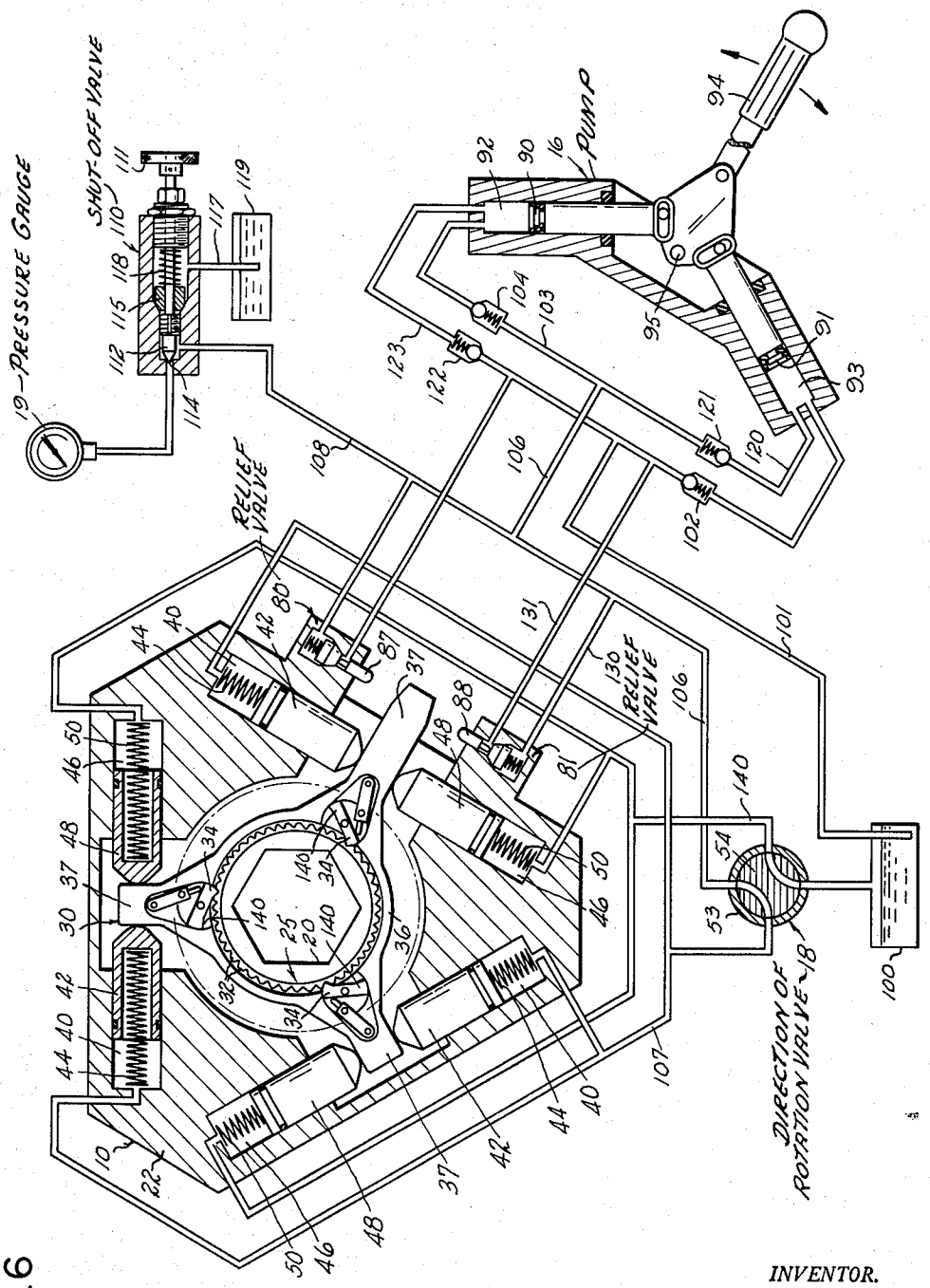


FIG. 6

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HYDRAULICALLY ACTUATED WRENCH

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11 Claims. (Cl. 81—60)

This invention relates to hydraulic wrenches and more particularly to an improved hydraulic wrench which applies balanced forces to a device that is to be rotated.

It is a primary object of this invention to provide a torque wrench having improved accuracy as well as being economical to manufacture, easy to operate, and durable in operation.

It is a further object of this invention to provide a torque wrench that minimizes errors due to inaccuracies in applied torque caused by application of unbalanced forces.

It is an additional object of this invention to provide a wrench that applies balanced forces to the device to be rotated regardless of whether the device is to be rotated in a clockwise or in a counterclockwise direction.

It is a further object of this invention to provide an easily transportable torque wrench which can be used to assemble aircraft, stationary, and locomotive engines as well as to install propellers or wherever an accurately measured high torque is required.

It is a still further object of this invention to provide an extremely accurate torque wrench that is virtually foolproof in operation while being safe and durable in use.

Other objects will be in part obvious and in part pointed out more in detail hereinafter.

The invention accordingly consists in the features of construction, combination of elements and arrangement of parts which will be exemplified in the construction hereafter set forth and the scope of the application of which will be indicated in the appended claims.

In the drawings:

Fig. 1 is a front plan view of a preferred embodiment of the wrench of this invention;

Fig. 2 is a side elevation view of the wrench of Fig. 1;

Fig. 3 is a partial cut away front view of the wrench of Fig. 1;

Fig. 4 is a partial cross section view taken along the lines 4—4 of Fig. 3;

Fig. 5 is a partial cross-section view taken along the lines 5—5 of Fig. 3; and

Fig. 6 is a schematic view of a preferred embodiment of the torque wrench showing the hydraulic circuit therefor.

Referring to the drawings and particularly Figs. 1 and 2, it is seen that a preferred embodiment of the wrench of this invention geenrally comprises a frame 10 having a handle assembly 12 pivotally secured thereto at points 13 and 14. Frame 10 supports a double-acting pump assembly 16, a torque direction selector 18, a pressure gauge 19 calibrated to indicate torque, and is provided with a central aperture 20 which cooperates with the device that is to be rotated. Frame 10 is also provided with a plurality of studs (two of which are shown at 8 and 9 of Fig. 2) on its rear surface which cooperate with a conventional adapter plate (not shown) to fixedly position frame 10 relatively to a supporting surface such as the frame of a diesel engine when the wrench is used to tighten head bolts. Such adapter plates are provided in a variety of sizes and configurations to insure flexibility of use of the wrench without requiring modification of the basic wrench structure.

Referring to Figs. 3, 4, and 5, it is seen that frame 10 includes a body member 22 and a top member 23, both of which are apertured to accept ratchet wheel 25 which is rotatably supported on the bearing surfaces 26 and 27 on body member 22 and top member 23. In the illustrated embodiment, ratchet wheel 25 is provided with a hexagonal opening, which opening can be used to directly engage a device such as a nut which is to be rotated or, alternatively, can be used to engage an auxiliary tool which carries an appropriately shaped work engaging element. Ratchet wheel 25 is also provided with a splined outer peripheral surface to define a plurality of teeth 32 which cooperate with the pawls 34 to establish driving connection between spider or drive member 30 and ratchet wheel 25. Drive member 30 has a central hub portion 36 from which three arms 37 extend radially at 120° intervals. Arms 37 cooperate with base member 22 so that the arms 37 are guided for rotary movement by the bearing surfaces 38 and 39.

The force to rotate drive member 30 is provided by two groups of hydraulic actuators which are fixedly positioned on base member 22 to engage the arms 37. The first group of actuators includes the three cylinders 40, each of which cooperates with a piston 42 that is urged towards each arm 37 by spring 44. Hydraulic fluid forced into each cylinder 40, as hereinafter explained, will tend to rotate drive member 30 in a clockwise direction. Counterclockwise rotation of drive member 30 is provided by a second group of hydraulic actuators, each having a cylinder 46 which cooperates with a piston 48 that is urged into engagement with arm 37 by spring 50. While Fig. 3 has been partially cut away to show one hydraulic actuator of each of the aforementioned groups, it is to be understood, as schematically shown in Fig. 6, that one hydraulic actuator of each group is disposed adjacent to each of the three arms 37 of spider 30.

Selective energization of either the first or second group of hydraulic actuators is provided by four-way valve 18 having an operating handle 52, a valve shell 53 and a rotary member 54 (see Fig. 6) which cooperate to selectively connect the hydraulic supply line of each actuator group either to the pump 16 or to an oil reservoir. Although it is unnecessary in all wrench applications to provide a ratchet drive between drive member 30 and ratchet wheel 25, greater flexibility of wrench operation results from the inclusion of a ratchet drive. Because the wrench can be reversed hydraulically to provide both clockwise and counterclockwise drive forces on drive member 30, it is necessary to provide pawls which can be reversed to accommodate clockwise and counterclockwise driving movement. As most clearly seen in the cut-away portions of Fig. 3 and Fig. 4, each pawl 34 is pivotally supported on hub 36 of drive member 30 by the cooperation of pivot pins 60 and 61, pin 60 being received in aperture 62 of hub 36 and pin 61 being received in aperture 63 of a cover plate 64 which is fastened to drive member 30 by a plurality of screws 65 and which close the recess which is provided in each arm 37 to accept the pawl structure. Each pawl 34 is provided with a recessed flat surface 67 upon which spring loaded plunger 68 operates. Plunger 68 is supported by plunger frame 70 which, in turn, is pivotally secured to arm 37 by bolt 71. The pivotal position of each plunger member 70 is controlled by the engagement of abutment 73 in pawl selector ring 75. Thus, rotation of handle 76, which is secured to ring 75 in any desired manner, to either the dotted line position 77 or 78 (see Fig. 1) determines whether the pawls are set for counterclockwise or clockwise driving position.

To prevent continued application of hydraulic force to the arms 37 of drive member 30 when the arms have reached their maximum limit of clockwise or counterclockwise movement, a pair of safety relief valves 80 and 81 are provided and are fastened to face plate 23 by fasteners 83. As most clearly seen in Figs. 3 and 5, one arm 37 is provided with extension 84 on the cover plate 64. Extension 84 is bent up and extends through slot 86 provided in face plate 23 so that arm 84 is engageable with either operating plunger 87 of valve 80 or with operating plunger 88 of valve 81.

A more complete understanding of the preferred embodiment of the wrench of this invention can best be obtained by describing the operation of the wrench in conjunction with the schematic diagram of Fig. 6. Double-acting pump 16 is provided with a pair of pistons 90 and 91 which cooperate with cylinders 92 and 93 so that movement of handle 94 about fulcrum pivot pin 95 causes a pressure stroke of one piston and a prime stroke of the other, depending upon the direction of pivotal movement. With selector valve rotor 54 rotated to the position shown and with pawl direction handle 76 moved to the dotted line position 78 of Fig. 1 so as to move pawls 34 to the position in Fig. 6, actuation of pump 16 will cause clockwise movement of drive member 30 and ratchet wheel 25. As pump handle 94 is pivoted about pin 95 to move piston 90 into cylinder 92, hydraulic fluid is drawn from reservoir 100 through line 101 and check valve 102 into cylinder 93. At the same time, the hydraulic fluid in cylinder 92 is expelled through line 103 and check valve 104 to selector valve 18 through line 106. From selector valve 18, the hydraulic fluid under pressure is distributed through line 107 to the cylinders 40 so as, because of identical cylinder and piston construction, to exert equal pressure on each piston 42 and apply a balanced distributed torque to drive member 30 and to ratchet wheel 25 through the pawls 34 tending to rotate ratchet wheel 25 and the device to which it is attached in a clockwise direction.

Line 106 also communicates through line 108 with gauge 19 through the combination safety relief and shut-off valve 110 shown schematically in Fig. 6. Valve 110 is manually adjustable by rotating knob 111 to advance needle 112 to vary and, if desired, close passageway 114 leading to the pressure gauge 19. An additional feature of this valve is the provision of spring loaded valve member 115 which normally closes the pathway of communication between line 108 and exhaust line 117. By varying the force on spring 118, a variable upper pressure safety limit is determined for the hydraulic system beyond which valve member 115 is moved against spring 118 to allow hydraulic fluid to escape through line 117 into reservoir 119. Because the dimensions of drive member 30 and ratchet wheel 25 are known and the position of each hydraulic cylinder is fixed, it is possible to calibrate pressure gauge 19 in terms of foot pounds of torque applied to the device that is driven by ratchet wheel 25.

On the next stroke of pump 16 during which piston 91 is forced into cylinder 93, it is seen that the hydraulic fluid expelled from cylinder 93 is driven through line 120, check valve 121 and into line 106 which communicates, as previously described, with each cylinder 40. Fluid is prevented from returning to line 101 and reservoir 100 by check valve 102 and fluid is prevented from returning to cylinder 92 by check valve 104. During this same stroke of the pump, movement of piston 90 out of cylinder 92 causes hydraulic fluid from reservoir 100 to pass through line 101 through check valve 122 and line 123 into cylinder 92 thereby to prime cylinder 92 for the next pressure stroke.

From the foregoing description of clockwise operation, it is apparent that continued operation of pump 16 will continue to increase the torque applied to ratchet wheel 25 until the pressure reaches the desired applied torque indication shown on gauge 19 or until the pressure exceeds the predetermined safety limit of valve 110, at which time the valve 110 opens to allow fluid to escape through line 117.

In the event that the arms 37 of drive member 30 are at the extreme limit of clockwise movement allowed by the construction of the wrench, it is seen that extension 84 will engage plunger 88 of bumper valve 81 so as to open valve 81 and permit line 106 to be vented through line 130, valve 81 and line 131 thereby to by-pass the cylinders 40 and deliver the fluid under pressure from pump 16 back to the reservoir. Thus, the bumper valve 81 prevents inadvertent overloading of the hydraulic system caused by overtravel of arms 37 of drive member 30.

Counter clockwise movement of drive member 30 and ratchet wheel 25 is accomplished by rotating the four-way selector valve 54 counterclockwise so that line 106 is in communication with line 140 which communicates with each cylinder 46 and so that line 107 communicates with the hydraulic fluid reservoir 100. In addition, pawl operating handle 76 is rotated to the dotted line position 77 (see Fig. 1) thereby pivoting each plunger housing 70 to move each plunger 68 into housing 70 against the spring bias. Each pawl 34 will remain in the position shown in Fig. 6 until the force applied to ratchet wheel 25 is released, at which time the spring pressure will force plunger 68 out of housing 70 to pivot end 140 of each pawl 34 into driving engagement with the ratchet wheel. Under the counterclockwise operating conditions, operation of pump 16 will force fluid under pressure into line 106 as previously described and into line 140 to energize each piston 48 thereby to urge drive member 30 and ratchet wheel 25 in a counterclockwise direction. Bumper valve 80 functions in the same manner to prevent overloading and false torque readings in a counterclockwise direction as explained for bumper valve 81 in a clockwise direction.

If the limit of travel in either direction is reached for drive member 30 before the desired torque has been applied, it is merely necessary to reverse selector valve 54 without changing the position of the pawl operating handle 76 and to operate pump 16 thereby to rotate drive member 30 in the reverse direction without moving ratchet wheel 25. When the maximum limit of reverse travel is reached, selector valve 54 is returned to its original position and torque can again be applied in the desired direction by operating pump 16.

It is apparent that several hydraulic actuators can be vertically aligned to operate on each arm 37 of drive member 30 in each direction; that is, the foregoing structure is easily modified to accept additional cylinder-piston combinations so as to enable greater force to be applied to each arm 37 with a remarkably small increase in the over-all dimensions of the wrench. Further, the above recited structure comprehends the provision of the necessary hydraulic lines as drilled passageways in the various housing members thereby to provide great structural strength for the hydraulic lines and enable pressures to be effectively utilized. The bumper valves and safety relief valve can be utilized as accessories depending upon the application of the wrench.

However, regardless of what modifications are utilized with the previously described wrench, it is apparent that true torque readings can be obtained simply by measuring the hydraulic pressure. This unique advantage is obtained by utilizing a drive member having three arms equally spaced about the periphery of the drive member so that a distributed, balanced pressure is applied at equal radii from the axis of rotation of the ratchet wheel thereby to assure the application of balanced torque. The use of three points of pressure application determines a fixed plane thereby to eliminate twisting and bending moments in the drive mechanism that would otherwise cause erroneous torque readings.

The structure of the foregoing wrench, while provid-

ing extremely accurate operation, is clearly rugged and easy to operate while being comparatively small in size and virtually self-contained so as to enable the wrench to be portable and inexpensive to manufacture.

As will be apparent to persons skilled in the art, various modifications and adaptations of the structure above described will become readily apparent without departure from the spirit and scope of the invention, the scope of which is defined in the appended claims.

I claim:

1. In a wrench, the combination comprising a frame, a drive member having means adapted for driving connection with a device to be rotated, said drive member being supported on said frame for rotation about an axis, a first radially extending arm on said drive member, a plurality of additional radially extending arms on said drive member, a plurality of hydraulic cylinders supported on said frame in spaced relationship to each other wherein one cylinder is positioned adjacent each of said arms, each of said cylinders having a piston drivingly engageable with the adjacent arm to cause rotation of said drive member in one direction, and means for supplying hydraulic fluid to each cylinder thereby to cause each piston to exert a force on said drive member tending to rotate the device.

2. In a wrench, the combination comprising a frame, a drive member having means adapted for connection with a device to be rotated, said drive member being supported on said frame for rotation about an axis, three radially extending arms on said drive member, three hydraulic cylinders supported on said frame in spaced relationship to each other wherein one cylinder is positioned adjacent each arm, each of said cylinders having a piston drivingly engageable with the adjacent arm to cause rotation of said drive member in one direction, the point of contact of the respective pistons with each of said arms being equally distant from the drive member axis of rotation, and means for supplying hydraulic fluid under pressure to each of said cylinders thereby to exert a force on the drive member tending to rotate the device.

3. In a wrench, the combination comprising a frame, a drive member supported on said frame for rotation about an axis, said drive member having three radially extending arms and being adapted for driving connection with a device to be rotated, a first group of three hydraulic cylinders supported by said frame in spaced relationship to each other with one cylinder positioned adjacent each arm, each of said cylinders having a piston drivingly engageable with its associated arm to effect clockwise rotation of the drive member, a second group of three cylinders supported by said frame in spaced relationship with each other so that one cylinder is positioned adjacent each arm opposite to the corresponding cylinder of said first group, each said cylinder of said second group having a piston drivingly engageable with the associated arm to effect counterclockwise rotation of said drive member, and means for selectively supplying hydraulic fluid under pressure to one of said groups of cylinders thereby to exert a force on said drive member tending to rotate the device.

4. The wrench as set forth in claim 3 wherein both groups of cylinders are positioned on the frame so that the point of contact of each of said pistons of both groups with the associated arm is at a point the same distance from the axis of rotation of the drive member as each other point of contact.

5. In a wrench, the combination comprising a frame, a drive member supported on said frame for rotation about an axis, said drive member having three radially extending arms and having a central aperture, a ratchet wheel supported for rotation within said central aperture and being adapted for connection with a device to be rotated, a plurality of pawls pivotally supported on said drive member, each of said pawls being selectively movable to first and second positions to provide driving engagement between said drive member and said ratchet wheel in a clockwise direction when in said first position and being movable to said second position to provide driving engagement between said drive member and said ratchet wheel in a counterclockwise direction, a first group of three cylinders supported by said frame in spaced relationship to each other so that one cylinder of the group is adjacent each arm of said drive member, each of said cylinders having a piston drivingly engageable with the associated arm to effect clockwise rotation of said drive member and said ratchet wheel when each of said pawls is in said first position, a second group of three cylinders supported on said frame in spaced relationship to each other so that one cylinder is adjacent each arm of said drive member and positioned opposite to the corresponding cylinder in said first group, each of said cylinders in said second group having a piston drivingly engageable with the associated arm to effect counterclockwise rotation of said drive member and ratchet wheel when each of said pawls is in said second position, manual means for simultaneously positioning each of said pawls in one of said positions, and means for selectively supplying hydraulic fluid to one of said groups of cylinders thereby to urge the device to rotate in predetermined direction.

6. The wrench as set forth in claim 5 wherein both groups of cylinders are positioned on the frame so that the point of contact of each of said pistons of both groups with the associated arm is at a point the same distance from the axis of rotation of the drive member as each other point of contact.

7. The wrench as set forth in claim 5 wherein the means for supplying hydraulic fluid to a selected group of cylinders includes a pressure gauge calibrated to read applied "torque."

8. The wrench as set forth in claim 5 wherein said means for supplying hydraulic fluid to the selected group of cylinders includes first and second by-pass valves supported on said frame on opposite sides of one of the drive member arms, said first by-pass valve being operable by said arm after a predetermined arc of movement in a clockwise direction and said second bypass valve being operable by said arm after a predetermined arc of movement in a counterclockwise direction to by-pass hydraulic fluid from the selected group of cylinders.

9. The wrench as set forth in claim 3 wherein said means for supplying hydraulic fluid to the selected group of cylinders includes first and second by-pass valves supported on said frame on opposite sides of one of the drive member arms, said first by-pass valve being operable by said arm after a predetermined arc of movement in a clockwise direction and said second by-pass valve being operable by said arm after a predetermined arc of movement in a counterclockwise direction to by-pass hydraulic fluid from the selected group of cylinders.

10. In a wrench, the combination comprising a frame, a drive member supported on said frame for rotation about an axis, said drive member having a central aperture and three radially extending arms, a ratchet wheel supported for rotation within said drive member aperture and adapted for connection with a device to be rotated, a plurality of pawls pivotally supported on said drive member, one of said pawls being positioned in radial alignment with each arm of said drive member, means urging each of said pawls into engagement with said ratchet wheel to effect driving connection of said drive member with said ratchet wheel in one direction, three hydraulic cylinders supported on said frame in spaced relationship to each other and positioned so that one cylinder is adjacent each arm, each said cylinder having a piston drivingly engageable with the adjacent arm to cause rotation of said drive member and said ratchet wheel in said one direction, the point of contact between each said piston and its associated arm being equally distant from the axis of rotation of said

drive member, and means for supplying hydraulic fluid to said cylinders to effect rotation of the device.

11. In a wrench, the combination comprising a frame, a drive member supported on said frame for rotation about an axis, said drive member having three radially extending arms spaced at 120° intervals and having a central aperture, a ratchet wheel supported for rotation within said central aperture and being adapted for connection with a device to be rotated, a plurality of pawls pivotally supported on said drive member, one of said pawls being positioned at a point in radial alignment with each arm of said drive member, each of said pawls being selectively movable to first and second positions to provide driving engagement between said drive member and said ratchet wheel in a clockwise direction when in said first position and being movable to said second position to provide driving engagement between said drive member and said ratchet wheel in a counterclockwise direction, a first group of three cylinders supported by said frame in spaced relationship to each other so that one cylinder of the group is adjacent each arm of said drive member, each of said cylinders having a piston drivingly engageable with the

associated arm to effect clockwise rotation of said drive member and said ratchet wheel when said pawl is in said first position, a second group of three cylinders supported on said frame in spaced relationship to each other so that one cylinder is adjacent each arm of said drive member and positioned opposite to the corresponding cylinder in said first group, each of said cylinders in said second group having a piston drivingly engageable with the associated arm to effect counterclockwise rotation of said drive member and ratchet wheel when said pawl is in said second position, manual means for simultaneously positioning said pawl in one of said positions, and means for selectively supplying hydraulic fluid to one of said groups of cylinders thereby to urge the device to rotate in predetermined direction.

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