

Aug. 27, 1940.

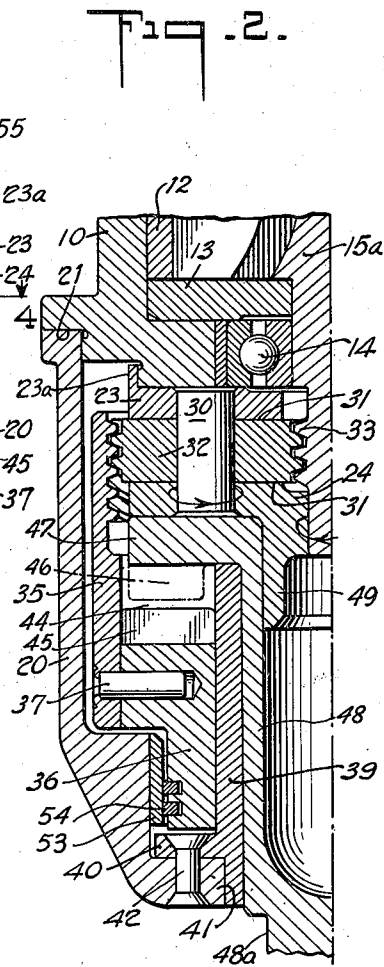
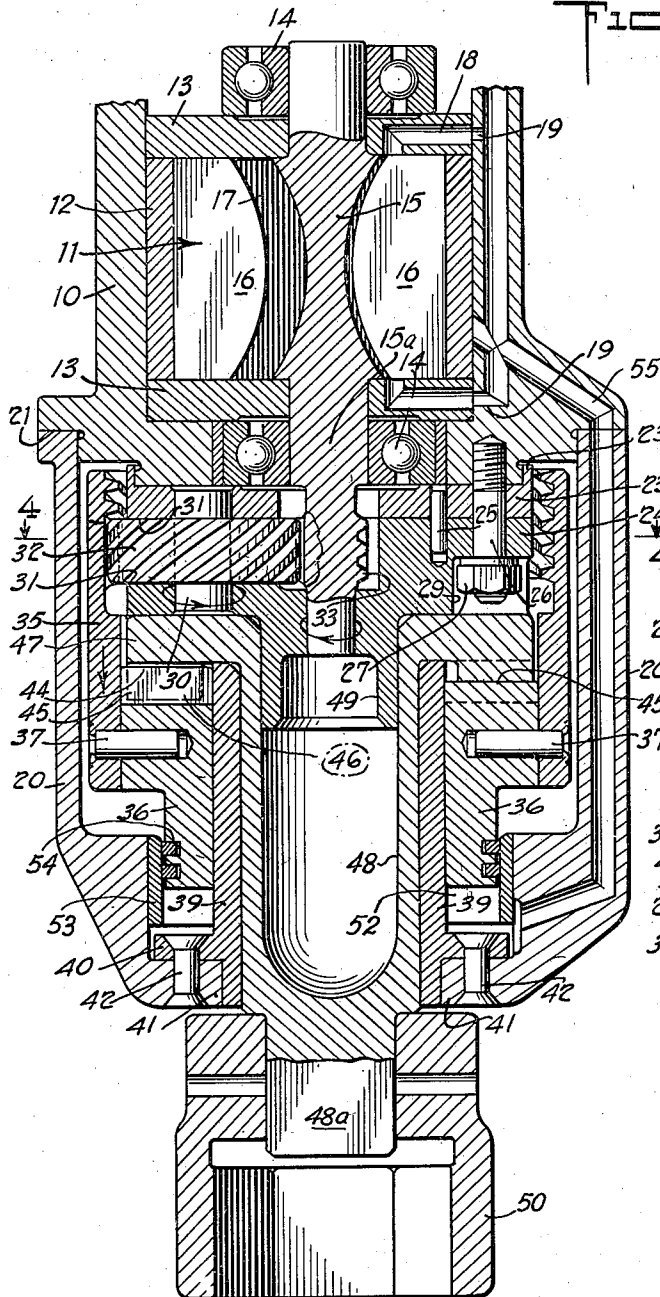
M. R. HUTCHISON, JR

2,212,919

IMPACT WRENCH

Filed Aug. 6, 1936

3 Sheets-Sheet 1



INVENTOR
Miller R. Hutchison Jr.

BY
Raymond L. Muller
ATTORNEY

8-58

Aug. 27, 1940.

M. R. HUTCHISON, JR

2,212,919

IMPACT WRENCH

Filed Aug. 6, 1936

3 Sheets-Sheet 2

Fig. 3.

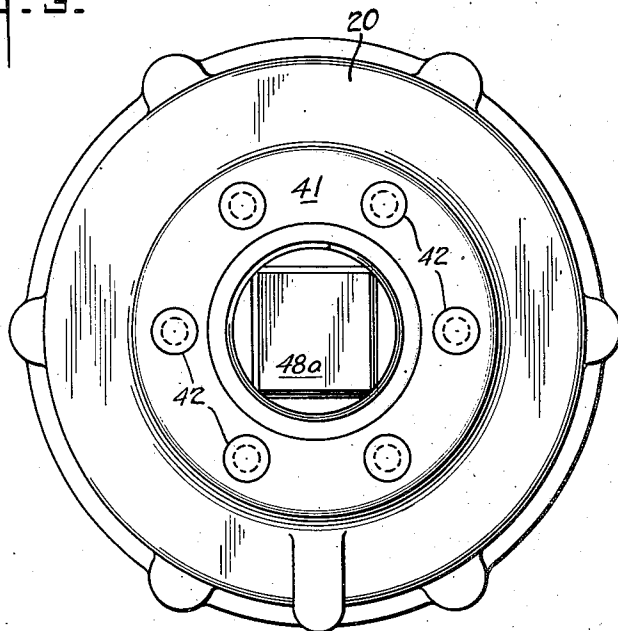
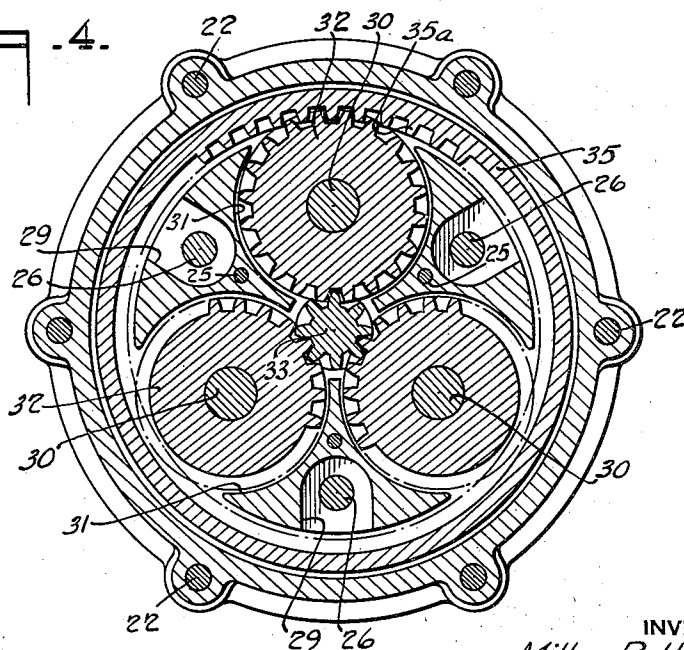


Fig. 4.



INVENTOR
Miller R. Hutchison, Jr.
BY
Raymond G. Mullee
ATTORNEY

Aug. 27, 1940.

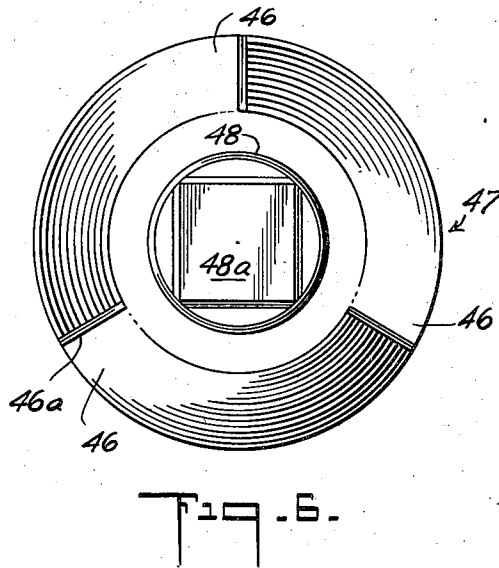
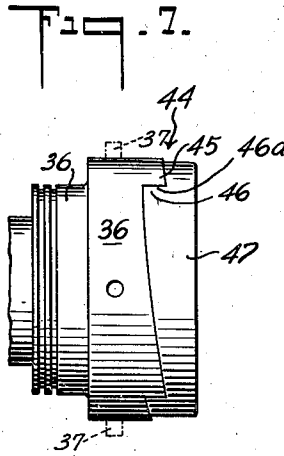
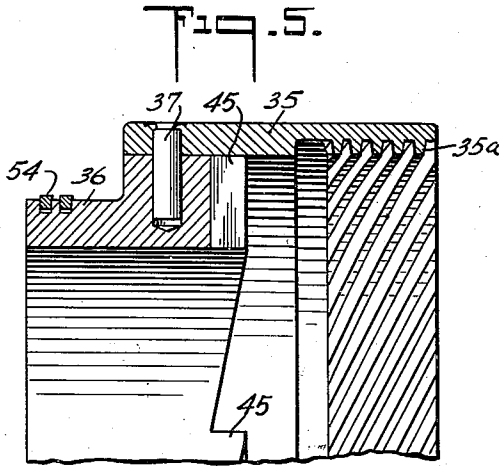
M. R. HUTCHISON, JR

2,212,919

IMPACT WRENCH

Filed Aug. 6, 1936

3 Sheets-Sheet 3



INVENTOR
Miller R. Hutchison, Jr.
BY
Raymond G. Muller
ATTORNEY

UNITED STATES PATENT OFFICE

2,212,919

IMPACT WRENCH

Miller R. Hutchison, Jr., Madison, N. J., assignor to Chicago Pneumatic Tool Company, New York, N. Y., a corporation of New Jersey

Application August 6, 1936, Serial No. 94,498

8 Claims. (Cl. 192—30.5)

This invention relates to power transmission systems and more particularly to fluid pressure operated tools for nut running, screw driving, and the like, which are adapted to deliver torsional impacts to the driven element.

An object of the invention is the provision of a power transmission mechanism between a rotary motor and a driven element (such as a wrench socket) adapted to deliver a series of rotary hammer blows to the driven element under an approximately constant torque of the motor.

Another object is to increase the force of the blow against the driven element without increasing the maximum instantaneous torque of the motor whereby a small light weight motor may be used in a portable tool.

A common form of portable impact wrench comprises a periodically engageable and disengageable impact clutch consisting of an anvil element and a hammer element, the former being connected to a wrench socket and the latter through an energy accumulator to a prime mover. Part of the energy for driving the hammer is stored in the accumulator while the clutch elements are engaged and the resistance to rotation of the hammer is increasing. Heretofore such accumulators have comprised springs or rubber elements which offer a variable resistance to distortion, increasing from a negligible amount to a maximum as the prime mover rotates ahead of the hammer and, vice versa, while the impact clutch is released. Thus the average value of torque transmitted to the accumulator and subsequently released thereby is only approximately one-half the maximum torque delivered to it while the clutch elements are engaged.

In accordance with the present invention the motor is connected to the hammer through a novel transmission which utilizes air under constant pressure for applying a substantially uniform resistance to relative rotation between the hammer and prime mover, while the hammer is held against rotation and for delivering a substantially constant torque to the hammer during the time that the impact clutch is disengaged.

Among the advantages of the air-operated power transmission system for accelerating the hammer is that the force of the blow against the anvil may be varied by correspondingly altering the air pressure.

A further object is to enable a fluid pressure motor to operate the power transmission system at different speeds in response to varying pressures in the air supply line. In accordance with

this invention the prime mover and the air chamber in the power transmission are connected to a common source of fluid pressure and are so arranged that the speed of rotation of the prime mover and the force tending intermittently to accelerate the hammer are directly related. In prior devices, the spring for accelerating the hammer necessitated the operation of the motor at a particular speed in order that the clutch elements would reengage when they had obtained the proper phase relation.

A still further object is the provision of an improved type of gearing designed to impart to the hammer a component of force tending to rotate it and another component tending to move it axially toward declutching position in opposition to the air pressure. The gears also serve the purpose of a speed reduction unit. In the preferred form of the invention, the gears connecting the motor shaft with the rotatable hammer have teeth of helical shape.

Still another object of the invention is the provision of a power transmission system adapted in one direction of rotation to deliver a torque to the driven element corresponding to the torque of the prime mover and, in the opposite direction, to rotate the driven element at a plurality of torque ratios, dependent upon the resistance offered to the driven element. Thus the device of the present invention may be used advantageously to remove a "frozen" nut by delivering torsional impacts in a left-hand direction and subsequently to replace the nut by driving it in a right-hand direction without torsional impacts.

Other objects and features of the invention will appear more clearly from the following description taken in connection with the accompanying drawings and appended claims.

Referring to the accompanying drawings wherein is illustrated a preferred embodiment of the invention:

Fig. 1 is a longitudinal section of a portable power operated wrench arranged to deliver torsional impacts in a left-hand direction, the clutch elements being shown in the engaged position, the upper end of the device being broken away;

Fig. 2 is a fragmentary section, similar to Fig. 1, but showing the clutch elements in disengaged position;

Fig. 3 is a bottom view of the device shown in Fig. 1 with the wrench socket omitted;

Fig. 4 is a cross-section, as indicated by the arrows 4—4 in Fig. 1.

Fig. 5 is a fragmentary longitudinal section of the rotatable impact hammer;

Fig. 6 is a bottom view of the anvil member; and

Fig. 7 is an elevation on a smaller scale showing the clutch elements formed on the hammer and anvil respectively in their normal driving relation.

The illustrative embodiment of the invention is a fluid pressure operated wrench comprising a motor casing 10 in which is mounted a rotary air motor 11 of any suitable type. Briefly described, the motor comprises a cylinder 12, end plates 13, bearings 14, a rotor 15 having a shaft 15a mounted on said bearings eccentrically with respect to the cylinder, said rotor carrying movable blades 16 mounted in radial slots 17. Cooperating ports 18 and 19 in the motor and casing respectively serve to admit pressure fluid to the interior of the cylinder for driving the rotor. For a more complete description of a suitable type of rotary motor, reference is made to Amtsberg application Serial No. 35,920, filed August 13, 1935.

A transmission housing 20 is seated at its rear end on an annular shoulder 21 formed on the motor casing 10. Bolts 22 (see Fig. 4) secure the housing to the motor casing. A bearing assembly comprising a rear bearing block 23 and a front bearing block 24 is enclosed within the transmission housing and supported by the motor casing. The rear bearing block 23 has a flange 23a sleeved over a cylindrical extension on the casing 10 to hold the bearing assembly against lateral displacement. The two bearing blocks are held in alignment by three dowel pins 25. The bearing assembly is secured to the motor casing by three studs 26 and cooperating nuts 27, the latter being positioned in recesses 29 in the block 24.

The bearing blocks 23 and 24 support three equally spaced shafts 30 concentric with and extending across recesses 31 in the blocks. An idler gear 32 is mounted to rotate on each of the shafts and is supported against axial thrusts by engagement with the side walls of the recesses 31. The gears are driven by a pinion 33 integral with the rotor shaft 15a which projects forwardly from the motor 11 and is supported at its front end by the bearing block 24.

The idler gears 32 drive an inertia member 50 which comprises a sleeve portion 35 and a hammer portion 36 attached to each other by pins 37. The sleeve 35 has internal gear teeth 35a meshing with the gears 32. The shape of the teeth 35a as well as of the teeth on the gears 32 and pinion 33 is helical, whereby rotation of the pinion causes the inertia member either to rotate in the same direction or to move forwardly, or to move with combined rotary and axial components of motion, the relative extent of the motions being determined by the respective resistances offered thereto.

The hammer portion 36 has a close sliding and rotating fit around a fixed supporting sleeve 39 axially aligned with the pinion 33. The sleeve 39 is supported at its front end by a shoulder 40 seated against an internal flange 41 on the transmission housing 20 and secured to the flange by rivets 42.

The upper or rear face of the hammer 36 forms part of an impact clutch 44 and for that purpose is provided with clutch jaws 45. Cooperating clutch jaws 46 are provided on a clutch driven plate 47 which serves as an anvil receiving rotary hammer blows from the hammer 36. The anvil plate 47 is supported against axial movement

between sleeve 39 and bearing block 24. A cylindrical projection 48 on the anvil has a close running fit on its periphery with the sleeve 39 and on its inside with a pilot portion 49 on the bearing block 24. Thus the hammer 36, sleeve 39, anvil member 47, and bearing block 24 cooperate with each other to hold the hammer and anvil axially in alignment with the rotor 15. The projection 48 on the anvil extends outside the transmission housing 20 terminating in a tool head 48a connected to a wrench socket 50 adapted for attachment to a nut or bolt (not shown) to be driven.

As shown in Figs. 6 and 7, the clutch jaws 46 on the anvil 47 are equally spaced and comprise driving faces 46a in planes approximately radial with respect to the axis of rotation, the jaws sloping gradually from the crest of one jaw to the trough of the succeeding jaw. The jaws 45 on the hammer 36 are similarly shaped. There are preferably three jaws on the hammer and on the anvil, but the invention is not limited to any particular number.

In accordance with the present invention, the hammer 36 is constantly urged rearwardly, thereby yieldingly holding the jaws of the impact clutch 44 in driving engagement. To this end a fluid pressure cylinder 52 is provided within the front end of the transmission housing 20 between the sleeve 39 and a cylinder liner 53 fixed to the housing, and between the flange 40 and the hammer 36. The front end of the hammer 36, which serves as a piston, is provided with rings 54 engaging the liner. Pressure fluid is admitted to the cylinder 52 through a passageway 55 which also supplies pressure fluid to the rotary motor 11 through ports 19 as heretofore described.

In operation, a throttle valve, not shown, is opened to admit live air or similar pressure fluid through passageway 55 to the rotary motor 11 and to the cylinder 52, the air admitted to the latter holding the hammer 36 in driving engagement with the anvil 47 with a force corresponding to air line pressure. Rotation of the rotor shaft 15a in a clockwise direction (looking toward the socket 50) causes the pinion 33 to drive the idler gears 32 and the hammer sleeve 35 counterclockwise so that the socket 50 is driven in a left-hand direction. Due to the helical shape of the teeth on the idler gears and on the hammer sleeve 35, an axial component of force is imparted to the hammer tending to move it forwardly to declutch the impact clutch 44. The axial component of force imparted by the gears is proportional to the rotary or torque component and, when the torque delivered to the hammer is less than a predetermined value, the axial component is insufficient to overcome the pressure in the cylinder 52. Therefore, when the wrench socket 50 meets with little resistance to rotation, the hammer 36, anvil 47 and socket rotate in unison with the impact clutch 44 fully engaged.

Let it be supposed that the socket is connected to a nut or bolt which offers a resistance to turning in excess of the torque upon the hammer sleeve due to the tangential component of the force applied by gears 32. The hammer sleeve stops turning. The gears 32 do not stop turning but rotate at a slower speed as the resistance to rotation increases. Now, the prime mover is so designed that the torque delivered by it increases as the resistance of the driven elements to rotation increases. This result may be attained by the use of a conventional throttling governor. In the illustrative embodiment of the invention, throttling is effected by the restricted ports 19

leading to the air motor, which cause a drop in pressure of the fluid supplied to the rotary motor 11, which reduction is a function of the air consumption and therefore the speed of rotation of the rotor 15 and gears 32. With the hammer sleeve held against rotation, the increased torque of the motor 11 causes a corresponding increase in the axial component of thrust against the hammer sleeve 35 which overcomes the constant pressure in cylinder 52. The continued rotation of the gears 32 moves the hammer sleeve endwise, forwardly, until the jaws of the clutch 44 become disengaged.

The hammer is free to rotate and to move endwise as soon as the clutch 44 is open.

It will be understood that the speed and torque ratios between the driving gears and the driven hammer depend upon the rate of linear displacement of the latter. Rearward movement of the hammer, independent of the turning of the gears 32, imparts a counterclockwise rotation to the hammer and such movement while the gears are driving the hammer counterclockwise, as they normally do, will add to the counterclockwise angular velocity of the hammer while it persists.

The hammer unit 35 and 36 has a large moment of inertia and upon completion of the rotary movement of the hammer it delivers a powerful rotative impact blow to the driving faces 46a on the anvil 47. When the impact clutch 44 has reengaged, the gears 32 meet with a sudden increase in resistance to rotation and, assuming that torque transmitted through the gears is insufficient to turn the hammer, they again move the hammer axially, thereby causing a succession of rotary impact blows against the anvil.

After the nut has been loosened sufficiently so that the rotary resistance is less than a predetermined amount, the hammer action discontinues and the hammer and anvil rotate in unison until the nut has been removed from its associated bolt.

The amount of resistance to rotation of the socket 50, which is necessary to cause disengagement of the impact clutch 44, may be determined by selecting a corresponding air pressure in the cylinder.

To replace the driven nut the direction of rotation of the rotary motor 11 is reversed. In the reverse direction the helical gears 10 tend to move the hammer toward engagement with the anvil, thereby supplementing the action of the pressure fluid in the cylinder 52. As a result, the hammer and anvil rotate in unison, in a right-hand direction, without any impact action as heretofore described. Although the torque in the clockwise direction is not nearly as great as the maximum torque delivered counterclockwise due to impact, it is sufficient for most purposes inasmuch as usually less torque is required to seat a nut than to return one that has been rusted.

An advantage in arranging the device to deliver impacts in one direction only is that it is possible to use a helical toothed clutch which permits the hammer to start moving toward reengagement with the anvil just as soon as the driving connection is broken.

During the intermittent action of the impact clutch, the front end of the hammer 36 acts as a piston, forcing the air from the cylinder 52 through passageway 55 back to the air line (not shown) and subsequently returning as the air in the cylinder is replaced. Thus, the air cylinder 52 accomplishes the same result as an energy accumulator in that it receives energy from the

prime mover 11 during the time the impact clutch is engaged and delivers a corresponding amount of energy to the hammer 36 while the impact clutch is released and supplements the torque exerted upon the hammer by the prime mover.

One of the advantages of the air cylinder 52 over spring elements, as employed in prior devices, is that the torsional resiliency between the hammer 36 and the driving gears 32 is constant throughout the movement of the hammer toward or from the anvil. In the case of a spring, the load on the prime mover increases from a minimum to a maximum as the hammer moves away from the anvil, the load being dependent upon the extent to which the spring is strained. Conversely, the turning force of the spring against the hammer varies from a maximum to a minimum when it releases the energy stored therein. In the present invention, however, the torque of the prime mover is more nearly constant during the time it moves the hammer axially as well as while the hammer is being rotated and, since the force of the blows depend upon the average instantaneous torque of the prime mover, the maximum torque of the motor need not be as great as heretofore.

It is obvious that many adaptations and modifications of the illustrative embodiment of the invention may be made without departing from the spirit of the invention or the scope of the appended claims. For example, the clutch jaws and the taper of the gears may be reversed to provide impacts in a clockwise direction, if desired. Furthermore, the power transmission system of the present invention is not limited to a wrench or to a portable power operated tool, but is of general application. If desired, the helical gears may be replaced by cams of well known construction for driving the hammer with both rotary and axial components without sacrificing all of the important advantages of the invention.

What is claimed is:

1. In an impact wrench, the combination of a rotatable anvil, a rotatable impact hammer arranged to deliver a series of blows to said anvil to rotate the same, and means for rotatably driving said hammer, said means comprising a constantly rotatable driving shaft and a torsionally resilient connection between the driving shaft and hammer, said connection including means for exerting a constant torque resisting relative rotary displacement of the hammer with respect to the driving shaft.

2. A power operated tool for nut running and the like comprising a rotatable anvil, a rotary driving shaft for driving said anvil, and means for impressing additional rotative impact force to said anvil, said means comprising a cylinder, a piston reciprocating therein, and means converting the reciprocations of the piston into rotary impact blows against the anvil, said piston being operated by pressure fluid under substantially constant pressure.

3. A power operated tool comprising a rotatable tool head, a rotatable anvil connected with said head, a rotatable hammer adapted to deliver a succession of rotary impacts to said anvil, a rotary fluid pressure motor, a driving connection between the motor and the hammer adapted to impart to the hammer a rotary component of motion and an axial component away from the anvil, the speed of rotation of the hammer thereby increasing or decreasing as it moves toward or from the anvil, a piston for moving the ham-

mer toward the anvil, and a common source of pressure fluid for operating said piston and for driving said rotary motor.

5 4. An impact tool comprising a clutch having a driving and a driven plate, said plates having jaws separated by spaces providing lost motion between the plates following disengagement and prior to reengagement of the jaws, driving means
10 means holding the clutch plates in engagement, and declutching means constructed and arranged automatically to move said clutch plates apart in opposition to said constant pressure means whenever the resistance to rotation of the head attains
15 a predetermined value.

5. A power operated tool comprising a rotatable anvil, a rotatable hammer adapted to deliver a succession of rotary impacts to said anvil, fluid pressure means for urging the hammer toward
20 said anvil and normally holding the hammer in engagement with the anvil, means for driving said hammer with a rotary component of motion and with an axial component tending to move the hammer periodically away from the anvil,

said driving means comprising mechanism adapted to convert the axial movement of the hammer toward the anvil into rotary motion.

6. A power operated tool according to claim 5 in which the fluid pressure means is maintained at a constant pressure irrespective of the movement of the hammer.

7. A power operated tool according to claim 5 in which said mechanism comprises helical gears.

8. In a tool of the character described, the combination of a rotary driving shaft, a rotatable anvil member, driving clutch means between said shaft and member capable of release to enable relative rotation therebetween, compression means for automatically effecting the reengagement of said clutch means, and cam means co-operating with said compression means for imparting additional rotative power to said member upon the re-engagement aforesaid, said compression means having substantially the same force while said clutch means are engaged as when said clutch means are released.

MILLER R. HUTCHISON, JR.