Nov. 11, 1947. W. E. PUGH 2,430,480

RATCHET WRENCH

Filed Feb. 26, 1944

Fig. 1

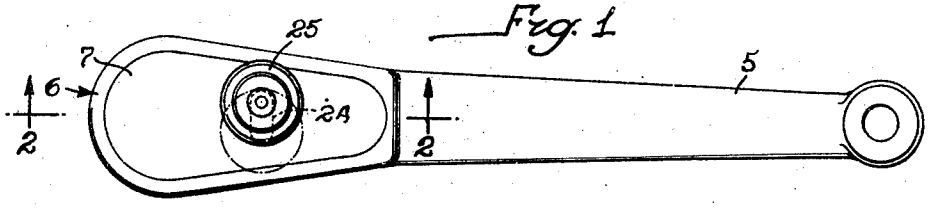


Fig. 2

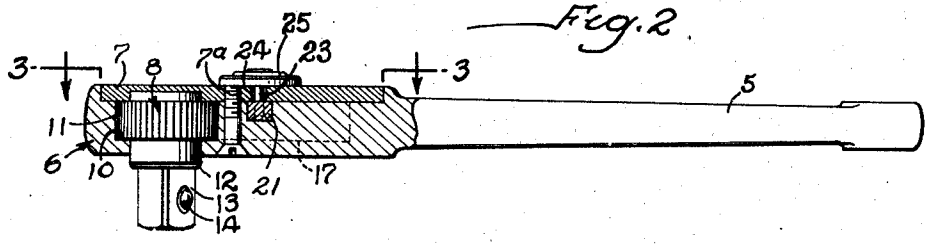


Fig. 4

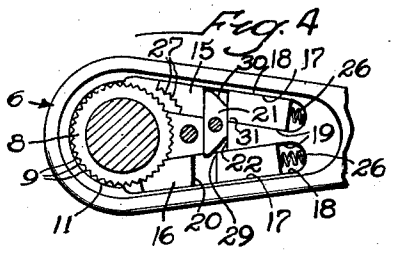


Fig. 3

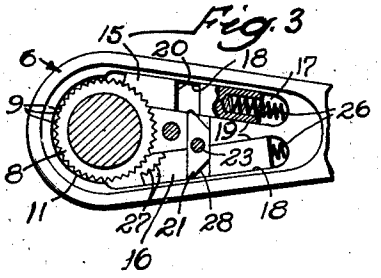


Fig. 5

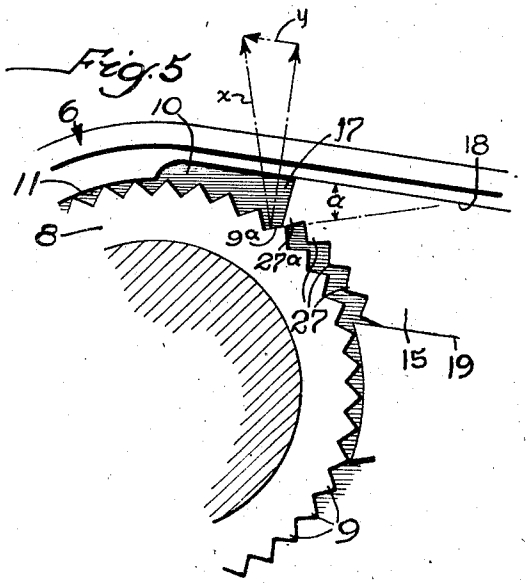
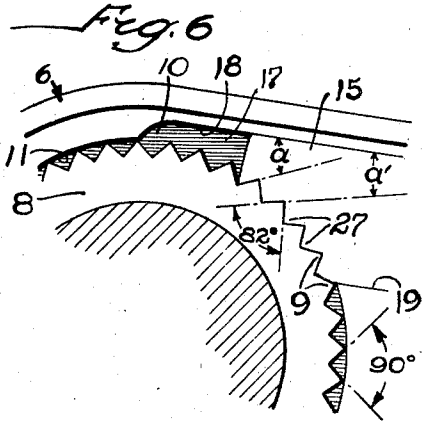


Fig. 6



INVENTOR

Walter E. Pugh

By Carlson, Pitzner, Hubbard & Wolfe

ATTORNEYS

Patented Nov. 11, 1947

2,430,480

UNITED STATES PATENT OFFICE

2,430,480

RATCHET WRENCH

Walter E. Pugh, Sabina, Ohio, assignor to
Honore C. Hubbard, Rockford, Ill.

Application February 26, 1944, Serial No. 523,962

9 Claims. (Cl. 192—43.2)

1

This invention relates to so-called ratchet wrenches and the general object is to provide such a wrench which is substantially more rugged in construction and durable in service operation than prior wrenches.

Another object is to provide for coaction of the pawl and ratchet teeth in a novel manner such as to insure full engagement under all conditions.

Other objects and advantages of the invention will become apparent from the following detailed description taken in connection with the accompanying drawings, in which

Figure 1 is an elevational view of a ratchet wrench embodying the present invention.

Fig. 2 is a section taken along the line 2—2 of Fig. 1.

Figs. 3 and 4 are fragmentary sections taken along the line 3—3 of Fig. 2 with the parts conditioned for operation of the wrench in opposite directions.

Figs. 5 and 6 are fragmentary views of parts of Fig. 3 showing the teeth partially and fully engaged on an enlarged scale.

While the invention is susceptible of various modifications and alternative constructions, I have shown in the drawings and will herein describe in detail the preferred embodiment. It is to be understood, however, that I do not intend to limit the invention by such disclosure but aim to cover all modifications and alternative constructions falling within the spirit and scope of the invention as expressed in the appended claims.

The improved wrench is of the same general shape as standard ratchet wrenches having a handle 5 forged integral with a hollow head 6 containing the pawl and ratchet mechanism and covered by a removable plate 7 secured to the head by a screw 7a. Herein a ratchet wheel 8 having fine V-shaped teeth 9 is disposed between the plate 7 and the bottom 10 of a circular recess 11 in the head and preferably is formed integral with a stud 12 journaled in the plate 7 and the head 6. The projecting end 13 of the stud is squared for reception in the usual socket fittings which are held on the wrench by ball detent 14. In the present instance, the ratchet teeth 9 are V-shaped having included angles of 82 degrees and intervening notches of 90 degrees.

The toothed periphery of the wheel 8 coacts with one of two pawls 15 and 16 which may be rendered active selectively to determine the direction of turning in which the wrench will be effective. These pawls comprise bars of generally

2

square cross-section slidable endwise in slots 17 which diverge along opposite edges of the wrench head 6 and extend generally tangentially of the wheel recess 11 into which the slots open. In this way, each pawl is held very rigidly against lateral displacement by the side walls 18 and 19 of the slots which walls are integral with the wrench head. Also, the wall 18 lies outwardly from the periphery of the ratchet wheel and coacts with the toothed surface of the latter to form a tapered recess into which the toothed end of the pawl becomes wedged during each active stroke of the wrench handle.

Intermediate its ends, each pawl is formed with a cross-slot 20 which is adapted to receive one pointed end of a cam bar 21 slidable transversely of the wrench head in a slot 22 which communicates at opposite ends with the pawl slots 17. A pin 23 rigid with the bar 21 projects through a slot 24 in the cover plate 7 and carries a button 25 by which the bar may be shifted back and forth between the positions shown in Figs. 3 and 4 to condition the wrench for turning of a nut or screw in opposite directions.

Each pawl is urged toward the ratchet wheel by a light compression spring 26 seated in the rear end of the pawl and acting against the closed end of the slot 17. The other or active end of the pawl extends diagonally of the slot 17 to conform approximately to the contour of the ratchet wheel and is formed with a plurality of fine teeth 27, four in the present instance, adapted to interfit with the ratchet teeth 9 thereby providing a substantial surface area of engagement between the pawl and ratchet. For this purpose, the teeth 27 include angles of 90 degrees complementing the angles of the ratchet notches. If the button 25 is shifted from the full line position shown in Fig. 1, an inclined cam surface 28 on the bar 21 will engage the corner 29 of the pawl 16 and cam the latter backwardly out of engagement with the ratchet wheel. At the same time, the other end of the bar will be withdrawn from the slot 20 in the pawl 15 permitting the latter to be urged forwardly by its spring and thus brought into active engagement with the wheel 8 (Fig. 3).

As shown in Figs. 1 and 3, the wrench is conditioned for clockwise turning of a nut or screw. During such turning, the force of engagement between the pawl 15 and ratchet teeth is directed transversely of the pawl and outwardly toward the wall 18 which provides an extremely rigid backing sustaining this force and extending along the pawl 15 to a point immediately adjacent the

wheel periphery. Since the active pawl is also supported on the opposite side by the slot wall 19, there is no possibility of bending or tipping of the pawl or retraction of the latter such as to permit slippage between the engaged teeth.

Now, when the handle is turned reversely, that is, counterclockwise, the frictional resistance of the engaged nut or screw holds the ratchet wheel against turning with the handle and the pawl. As a result, the ratchet teeth act as cams on the pawl teeth and shift the pawl backwardly. The pawl teeth thus slip past the ratchet teeth and a new set of ratchet teeth is engaged by the pawl thereby again conditioning the wrench for clockwise turning of a nut.

To condition the wrench for operation in the opposite or counterclockwise direction, the button 25 is shifted from the dotted position back to the full line position shown in Fig. 1 so as to move the bar 21 into the slot 20 of the pawl 15 as shown in Fig. 4. In this movement, a cam surface 30 engages the pawl surface 31 and retracts the pawl while the other end of the bar is withdrawn from the slot 20 in the pawl 16 allowing the latter to move into active position. This pawl then acts in the manner above described to advance the wheel 8 in each counterclockwise motion of the handle.

Wrenches of the above character are used primarily to speed up the tightening of screws and nuts. Their operation is dependent on the existence of sufficient friction on the thread of the nut or screw to overcome the force of the pawl spring 26 and permit slippage of the active pawl past the ratchet teeth during retraction of the handle. Therefore, it is desirable to minimize the force exerted by the springs 26. On the other hand, it is desirable, in order to minimize wear on and avoid breakage of the pawl and ratchet teeth, that the teeth always be brought into full engagement before the full turning force becomes effective, and this, in spite of rapid oscillation of the handle as is customary in the service use of a tool of this character. In other words, partial engagement of one ratchet and pawl tooth as shown in Fig. 5 is to be avoided so that the full turning moment will not have to be sustained by such a small tooth area.

The present invention meets the foregoing requirements by a novel construction and arrangement of the pawl and ratchet teeth by which, the active pawl, if it does engage initially on the tip of only one ratchet tooth as shown in Fig. 5, will be drawn automatically and independently of the spring force, into full engagement with the ratchet teeth as shown in Fig. 6 before the full turning force becomes effective. To this end, the pawl teeth 27 are extended around the ratchet wheel toward the surface 18 far enough to insure in all degrees of engagement of the active pawl, the creation of a force component directed parallel to the surface 18 and of sufficient magnitude to overcome, with a safe margin, the friction between the pawl and this surface.

Such a force component may be derived independently of the spring 26 and from the turning moment applied to the wrench handle, by constructing the pawl and ratchet teeth and arranging the latter so that the angle a between the handle surface 18 and the face 9^a of the ratchet tooth first engaged by the pawl will be greater than a locking angle at the initial position of engagement with the pawl as shown in Fig. 5. This locking angle varies with the materials of which the coacting surfaces are composed, with

the degree of lubrication, and with the smoothness of the surfaces. For smooth lubricated steel surfaces, it is ordinarily considered as about 13 degrees. In the present instance, the angle is about 19 degrees thereby allowing an ample margin of safety for the various surface conditions which may be encountered in service use.

With such a large angle, the reactionary force x, which is directed perpendicular to the surface 9^a when the handle is turned, produces a component y which is directed parallel to the surface 18 and toward the ratchet and is of substantially greater magnitude than the opposing friction forces acting on the pawl. As a result of this force y, added to the force of the spring 26, the pawl is drawn forward positively into full contact with the ratchet as shown in Fig. 6 thereby insuring full contact of all of the pawl teeth before the full turning moment is applied even though the handle motion is so rapid that only the first pawl tooth engages the ratchet initially as shown in Fig. 5.

To ascertain the minimum value which the angle a must have in order to insure the positive drawing in of the pawl (the force of the spring 26 being neglected) it will first be observed that the outer side of the active pawl and the side of the first pawl tooth to engage the ratchet (see Fig. 5) constitutes a wedge whose effective angle is a. According to the law of wedges, it can be shown that the locking angle a or the angle at which there is no motion of the wedge in either direction is the angle whose tangent is

$$\frac{2u}{1-u^2}$$

where u is the coefficient of friction on the two sides of the wedge. For dry steel surfaces, the angle a is approximately seventeen degrees, being somewhat lower, that is approximately thirteen degrees as referred to above for lubricated steel surfaces.

Comparing Figs. 5 and 6, it will be apparent that as the wedge moves in from the Fig. 5 position, the angle a becomes progressively larger and reaches a value of about twenty-five degrees. the component y thus increases correspondingly but this increase is offset to some extent by the fact that the wedge angles a' for the succeeding tooth are progressively smaller. However, the resultant force paralleling the surface 18 is always sufficient to overcome the friction forces opposing the wedge movement and under all conditions insure that the pawl will be drawn into full engagement with the ratchet even though the force exerted by the spring 26 is comparatively small.

The novel coaction above described between the pawl and ratchet insures even distribution of the turning movement over the full areas of all four of the interchanging teeth. As a result, the possibility of tooth breakage or excessive wearing off of the first pawl tooth is avoided. The construction will, therefore, withstand the most severe service use. Moreover, the strength of the springs 26 may be reduced to a minimum thereby greatly increasing the usefulness of the wrench.

I claim as my invention:

1. A ratchet wrench having, in combination, a handle with a hollow head thereon, a shaft journaled in said head with one end projecting therefrom, a ratchet wheel rigid with said shaft within said head and having V-shaped teeth around its periphery with the adjacent sides of

adjacent teeth intersecting each other, a guide slot formed in said head and extending generally longitudinally of said handle and tangentially of said wheel into communication with said wheel recess, said slot diverging from the longitudinal axis of said handle toward said wheel with its outer side wall disposed outwardly beyond a tangent to the wheel periphery, a pawl slidable in said slot and having a plurality of teeth complementing said ratchet teeth and arranged in a row extending diagonally of the pawl for full meshing engagement with the ratchet teeth, and a spring urging said pawl along said slot toward said wheel, said ratchet and pawl teeth being constructed and arranged so that the angle included between said outer side wall and the surface of the ratchet tooth in the position of initial engagement with the first tooth of the pawl is more than a locking angle, the surfaces of said pawl teeth being inclined so as to come into full surface contact with the mating ratchet tooth when the pawl and ratchet teeth are in full mesh.

2. A ratchet wrench having, in combination, an elongated handle with a hollow head thereon, a shaft journaled in said head with one end projecting therefrom, a ratchet wheel rigid with said shaft within said head and having teeth around its periphery, a guide slot formed in said head and extending generally longitudinally of said handle and tangentially of said wheel with its outer side wall disposed outwardly beyond a tangent to the wheel periphery, a pawl slidable in said slot, spring means urging said pawl toward said wheel, and teeth on the forward end of said pawl engageable with said ratchet teeth and coacting therewith in all degrees of engagement between the ratchet and pawl teeth to derive from the torque applied to said handle a force component directed along the pawl toward said wheel and having sufficient magnitude to overcome the friction between said side wall and the pawl and draw the pawl into full mesh with the ratchet teeth.

3. A ratchet wrench having, in combination, a handle with a head thereon, a ratchet wheel journaled in said head and having teeth around its periphery, a guide slot formed in said head and extending generally tangentially of said wheel into communication with said wheel recess, a pawl slidable in said slot, spring means urging said pawl toward said wheel, and teeth on the forward end of said pawl engageable successively with the teeth of said ratchet wheel as the pawl moves into full mesh therewith, the outer surface of said pawl and the oppositely facing side of the first pawl tooth diverging toward said ratchet wheel and constituting a wedge having an effective included angle which increases progressively from the initial to full engagement with a ratchet tooth and in all degrees of such engagement is greater than a locking angle.

4. A ratchet wrench having, in combination, an elongated handle with a head thereon, a ratchet wheel journaled in said head and having teeth around its periphery, a guide slot formed in said head and extending longitudinally of said handle and generally tangentially of said wheel into communication with said wheel recess, a pawl slidable in said slot, spring means urging said pawl toward said wheel, and a tooth on the forward end of said pawl engageable with a tooth of said ratchet wheel and forming with the opposite side of the pawl a wedge diverging toward said ratchet wheel and having an effective included angle which increases progressively after initial tip on tip engagament between said tooth and a tooth of said ratchet wheel and which, for all degrees of such engagement is greater than the locking angle for the pawl and guide slot surfaces.

5. A ratchet wrench having, in combination, a handle with a hollow head thereon, a ratchet wheel journaled in said head and having teeth around its periphery, said head having a guide slot extending generally tangentially of said wheel and diverging from the longitudinal axis of said handle toward said wheel, a pawl slidable in said slot, spring means urging said pawl toward said wheel, and a tooth on the forward end of said pawl engageable with one side of a tooth on said ratchet wheel, the outer surface of said pawl and the engaged side of the ratchet tooth converging away from the wheel at an included angle which is greater than the angle at which the pawl is locked frictionally in engagement with the ratchet tooth and the surface of each pawl tooth being inclined to come substantially into full surface contact with the corresponding ratchet tooth when the teeth are in full mesh.

6. A ratchet wrench having, in combination, an elongated handle with a hollow head thereon, a ratchet wheel journaled in said head and having teeth around its periphery, said head having a guide slot extending longitudinally of the handle with its outer wall disposed generally tangentially of said wheel, a pawl slidable in said slot, means biasing said pawl toward said wheel, and a tooth on said pawl engageable with one side of a tooth on said wheel, said guide wall and the active surfaces of said pawl and ratchet teeth being positioned to coact in all engaged positions thereof and derive from the torque applied to said handle a force component supplementing said biasing means sufficiently to overcome the friction on said pawl and cause the latter to be moved into full engagement with the ratchet teeth.

7. A ratchet wrench having, in combination, a handle with a hollow head thereon, a ratchet wheel journaled in said head and having teeth around its periphery, said head having a guide slot extending generally tangentially of said wheel and diverging from the longitudinal axis of said handle toward said wheel, a pawl slidable in said slot, spring means urging said pawl toward said wheel, and a tooth formed on the forward end of said pawl for full surface engagement of its outer surface with one side of a tooth on said ratchet wheel when the teeth are in full mesh, the coacting surfaces of said pawl and ratchet being angularly related so that the angle a included between the engaged ratchet tooth surface and the outer surface of said guide slot at the point of initial engagement as shown in Fig. 5 is at least equal to the locking angle for the materials of which the coacting surfaces of said pawl, ratchet wheel, and head are composed.

8. A ratchet wrench having, in combination, a handle having a side recess in one end portion thereof, a ratchet wheel journaled on said handle in said recess and having V-shaped teeth around its periphery, a guide slot formed in said handle and extending generally tangentially of said wheel into communication with the wheel recess, a pawl slidable in said slot, a first V-shaped tooth on said pawl having a surface which is inclined relative to the mating ratchet tooth surface at the time of initial tip-to-tip

engagement with the ratchet tooth, the inclination of the pawl and ratchet surfaces relative to each other decreasing as the teeth are drawn into full mesh following said tip-to-tip engagement; and other teeth on said pawl engageable with the ratchet teeth as the pawl is drawn into full mesh with the ratchet wheel, the outer surface of said pawl being inclined at greater than a locking angle relative to the side of each ratchet tooth at the time of initial engagement with the tip of said first pawl tooth.

9. A ratchet wrench having, in combination, a handle having a side recess, a ratchet wheel journaled in said recess and having V-shaped approximately right angular teeth around its periphery, a guide slot formed in said handle and extending generally tangentially of said wheel into communication with the wheel recess, a pawl slidable in said slot, and an approximately right angular V-shaped tooth on said pawl having a surface adapted for point contact with the mating ratchet tooth surface at the time of initial engagement followed by full surface contact as the pawl tooth comes into full mesh with the

ratchet tooth, the inclination of the pawl and ratchet surfaces at the time of such initial engagement being related to the inclination of said slot as to convert the torque applied to said handle into a force component of sufficient magnitude and direction as to draw said pawl into full mesh with the ratchet teeth.

WALTER E. PUGH.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
2,193,984	Rhinevault	Mar. 19, 1940
1,388,836	Ripsch et al.	Aug. 23, 1921
1,090,578	Smythe	Mar. 17, 1914
300,771	Fray	June 24, 1884
2,201,705	Stone	May 21, 1940
395,865	Shrams	Jan. 8, 1889
657,512	Carter et al.	Sept. 11, 1900
333,961	Lussier	Jan. 5, 1886