April 20, 1948. C. W. PORTER 2,439,823

IMPACT CLUTCH

Filed Dec. 2, 1942

Fig. 1

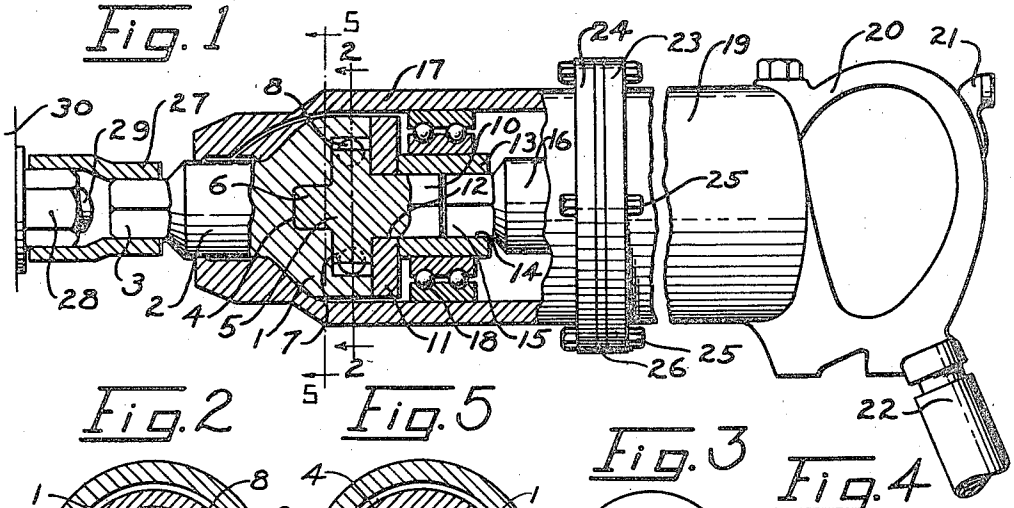


Fig. 2

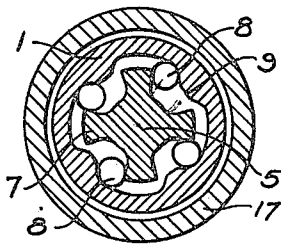


Fig. 5

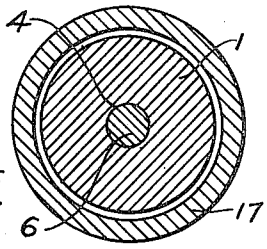


Fig. 3

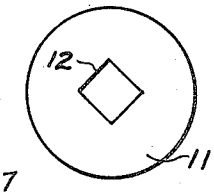


Fig. 4

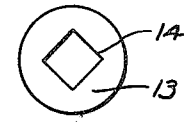


Fig. 6

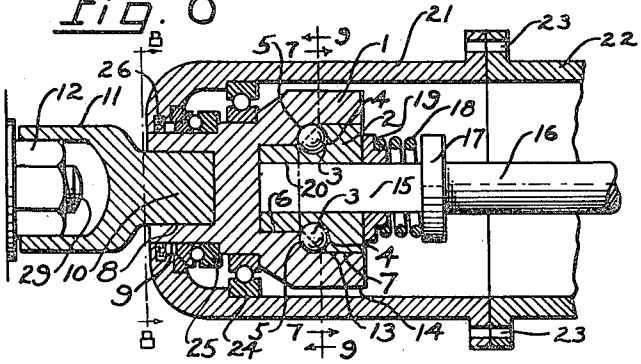


Fig. 7

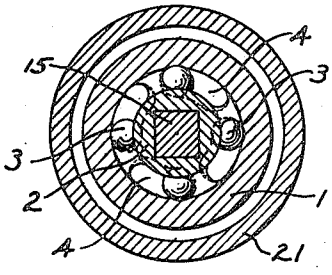


Fig. 8

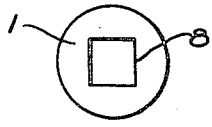
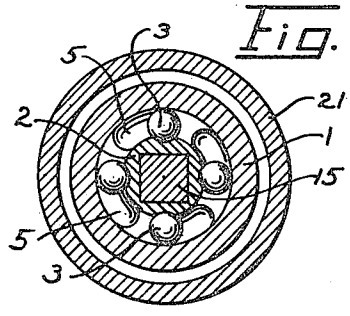


Fig. 9



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IMPACT CLUTCH

Carl Wesley Porter, Alexandria, Va.

Application December 2, 1942, Serial No. 467,659

6 Claims. (Cl. 192—30.5)

(Granted under the act of March 3, 1883, as amended April 30, 1928; 370 O. G. 757)

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The invention herein disclosed is a means for increasing the speed and personal safety and reducing manual fatigue of the operator in driving nuts or other rotarily wedged parts into place or loosening them therefrom after they have been tightened.

The main object of the invention is to adapt the use of power means for supplying both intermittent impulses and smooth rotary motion as needed so that they may be applied to a wrench in a most practical manner.

A further object is to increase the speed and reduce the hazards of the present methods of tightening or loosening bolts, nuts, etc., and to provide in the same tool a means for turning nuts, etc., at a high rate of speed when they are loose enough to permit it, together with means for changing over from direct rotary connection in the power tool for driving the nut, to imparting intermittent impulses thereto, and vice versa, said means being operative automatically upon increase in resisting torque due to tightening of the nut or decrease in the resisting torque due to loosening thereof, respectively, the change-over being effected at a torque value in accordance with the speed of the power motor, said means further automatically increasing the energy supplied per impulse during intermittent operation as well as increasing the number of impulses upon increase in speed of rotation of the power motor.

In the accompanying drawings, two preferred forms of my invention are shown as arrangement "A," and arrangement "B." Figs. 1 to 5 illustrate arrangement "A" and Figs. 6 to 9 illustrate arrangement "B."

In the drawings:

Fig. 1 is an elevation of an assembly of the wrench according to arrangement "A," illustrating its application to a nut, and cut away to show the principal parts of the invention.

Fig. 2 is a transverse cross-section of this wrench taken at the section line 2—2 of Fig. 1,

Fig. 3 is a plan view of disc 11,

Fig. 4 is an end view of coupling or sleeve 13,

Fig. 5 is a transverse cross-section of this wrench taken at the section line 5—5 of Fig. 1,

Fig. 6 is an elevation of an assembly of another form of the wrench, in accordance with arrangement "B," illustrating its application to a nut, and cut away to show the principal parts of the invention,

Fig. 7 is a transverse cross-section taken at the section line 7—7 of Fig. 6,

Fig. 8 is a transverse cross-section of the torque block 1 taken at the section line 8—8 of Fig. 6,

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Fig. 9 is a transverse cross-section taken at section line 9—9 of Fig. 6.

It is my aim to provide an impact wrench attachable to a source of power (electric or compressed air) and so operable therefrom that this wrench may through its component parts, be used to impart blows or impacts to a nut in such a way as to turn or rotate the nut for tightening or loosening purposes.

It is further my aim to combine in this same tool, means for simple high-speed spinning of nuts on or off bolts, whenever the nut fits loose enough to permit such operation.

The advantages of this wrench over other tools for this purpose are its compactness, simplicity, effectiveness, efficiency, safety, smoothness of operation, speed and lack of fatigue with which my wrench can be operated.

Operation "A"

Referring to arrangement "A," Figs. 1 to 5 on the accompanying drawings, 1 is a cylindrical torque block, having a cylindrical bearing surface 2, and projective end-post 3 for attachment thereto of a socket wrench. 4 is a cylindrical axially aligned bore in the inside of the torque block forming a bearing, 5 is an impacter or driver, having a cylindrical projection 6 engaging the torque block by forming a companion with a bore for alignment purposes, and having splines 7, 7, etc., engaging impact transmtting rolling elements 8, 8, etc., such as balls or the like, and driving them. 9, 9, etc., are splines in the torque block concentrically placed with reference to splines 7, 7, etc., and are so placed as to engage and be impacted by the balls 8, 8, etc. 10 is a square projective end-post on the impacter 5.

11 is a disc for retaining balls 8, 8, etc., in place. 12 is a square hole in 11 for fitting over the square end-post 10. 13 is a coupling or sleeve, 14 being a square hole running axially through the center of sleeve 13. 15 is a square projective end-post on drive shaft 16 for driving the impacter 5 by common engagement therewith by means of sleeve 13 and end-post 10.

17 is the casing enclosing the various parts as shown and forming part of the body of the assembly. 18 is a ball bearing assembly shown for illustrative purposes, it being recognized that the bearing details and actual location are subject to variation.

19 is the casing or body of the motor which drives the rotating parts of the tool. 20 is the wrench handle, 21 is the motor operating trigger

or switch, 22 is a hose or cable connection, these parts being shown for illustrative purposes only. 23 is a flange on the casing 19, 24 is its companion on casing 17. 25, 25, etc., are assembly bolts, and 26 is a spacer between flanges 23 and 24. 27 is a socket wrench and 28 any nut it is desired to turn on any bolt 29 holding some part 30 to any other part.

The operation of my device is as follows: Referring to Fig. 1 and assuming 28 is a nut which it is desired to turn on bolt 29, and that the wrench is attached to a source of power as at 22, the operator may select the proper size socket wrench 27 and place it on the projective end-post 3 and then engage wrench 27 with nut 28. Then, by pressing the trigger 21, the motor will start up and revolve drive shaft 16, and consequently the impacter 5, this part being positively engaged with shaft 16 through end-post 15, sleeve 13 and end-post 10. Referring to Fig. 2 assume balls 8, 8, etc., are at the bottom of the openings between splines 7, 7, etc., i. e., nearest the axis of rotation of the impacter 5. As soon as the impacter comes up to a certain speed, balls 8, 8, etc., will be thrown outward by centrifugal force until they drop into the slots between splines 9, 9, etc., in the torque block. However, the balls cannot get out of reach of splines 7, 7, etc., and will therefore be driven in a circular path inside the torque block until they impact splines 9, 9, etc. At this instant the balls are in shear between splines 7, 7, etc., and splines 9, 9, etc. The wedging action thus produced on the balls will, due to their position with relation to the respective splines, force the balls back toward the center of rotation, and thus out of engagement with splines 9, 9, etc., whereupon 5 will regain any speed lost and above cycle of events will be repeated. This cycle will be repeated at a rate depending on the speed of the driving motor. A major part of the force of impact of the balls with the splines 9, 9, etc., will be transmitted through the torque block to the wrench and the nut 28, which will be broken loose if it is "frozen," and rotated. The looser the nut becomes, the faster it will be driven, finally approaching the speed of the driving motor.

The nut 28 may be turned in a direction opposite to that above described simply by reversing the motor.

The depth of the grooves formed by the splines 9 on the outer members is less than the radius of the balls 8, whereas the depth of the grooves formed by the splines 7 on the inner member is slightly greater than the diameter of the balls 8. The edges of the splines 7 on the inner member are formed with sharp squared corners against which the balls 8 will be wedged at the time of impact.

Arrangement "B"

The aims as set forth above apply for arrangement "B," and in addition thereto it is my aim to provide in arrangement "B" a means for more positively locking the driving and driven members of the wrench together in order to cause the driven member to rotate at the same speed as the driving member without impacts, whenever the nut being turned is lose enough to permit. It is further my aim to provide a means for causing the change-over from impacting the nut to full speed rotation of the nut and vice versa automatically.

The advantages of arrangement "B" are the same as mentioned above, and in addition thereto, the positive locking feature of arrangement "B" has the further advantage of greater speed and efficiency under certain operating conditions.

Referring to arrangement "B," Figs. 6 to 9 on the accompanying drawings, 1 is a cylindrical torque block; 2 is a cylindrical impacter or ball driver; 3, 3, etc., are impact transmitting balls; 4, 4, etc., are slots or pockets in the impacter 2 for holding and carrying the balls; 5, 5, etc., are companion slots or pockets in the torque block for receiving the balls; 6 is a cylindrical bore in the torque block of smaller diameter than 7 which is also a cylindrical bore in 1. The centers of both bores coincide with the center of rotation of the torque block and the impacter. 8 is a square hole in the torque block, centrally located in the outer end thereof. 9 is a cylindrical bearing surface at the outer end of the torque block. 10 is a square projective end-post of socket wrench 11, and serves to engage the torque block positively in the square hole 8 and is a snug fit therein. 12 is any nut to be turned, and is shown for illustrative purposes only.

13 is the greater cylindrical section of the impacter 2, being of slightly smaller diameter than bore 7 for clearance. 14 is the greater cylindrical section of the torque block. 15 is a square end-section of drive or motor shaft 16. 17 is a shoulder or collar on shaft 16, forming the inner seat for coil spring 18, 19 being the outer seat which is freely slidable axially on section 15. 20 is a square hole centered axially through the impacter for engaging section 15, making the impacter freely slidable axially on said section.

21 is the outer casing of the assembly of parts as shown, and forms part of the body of the wrench. 22 is the motor casing or frame, having handle, power attachment, trigger, etc., as 20, 22 and 21 in arrangement "A," Fig. 1. 23, 23, etc., are bores for receiving assembly bolts like 25 in arrangement "A," Fig. 1; 24 and 25 are bearing assemblies shown for illustration, possible variation in their details and locations being recognized. 26 is a grease packing and dirt seal.

29 is any bolt engaged with nut 12 for the purpose of holding any part 30 to any other part, these parts being shown for illustrative purposes.

The operation of arrangement "B" of my invention is as follows: Assuming that the tool is attached to a source of power, and the socket wrench 11 is in place on nut 12, the operator may press the trigger and start the motor, whereupon shaft 16 will be rotated, and consequently the impacter 2. Spring 18 and seat 19 will likewise be rotated. If the nut 12 resists turning sufficiently, wrench 11 and consequently torque block 1 will resist also.

At this point balls 3, 3, etc., will be in shear between the opposing edges of the slots or grooves 4, 4, etc., and 5, 5, etc., and there will be a wedging action set up by the balls being forced out of grooves 5, 5, etc. Consequently, the impacter will slide on section 15 away from the torque block 1, and seat 19 will move with the impacter, and the spring will be compressed. The depth and shape of the grooves are such that due to the limited axial movement of the impacter, the balls will be forced to leave the shallower grooves 5, 5, etc., but remain in the deeper grooves 4, 4, etc., moving with the impacter.

As soon as the balls clear the outer edges of grooves 5, 5, etc., the motor will speed up due to lessened resistance to its turning, and the rotation of the impacter with respect to the

torque block will be accelerated. However, as soon as the balls have been rotated to a position opposite the next forward set of grooves 5, 5, etc., they will be rammed into these grooves by the force of the spring 18 assisted by the centrifugal force of the balls due to their rotation. The impact of the balls on the leading edges of grooves 5, 5, etc. will rotate the torque block and therefore the nut 12.

The above cycle of events will be continuously repeated at a rate proportional to the speed of rotation of the drive shaft 16, until the nut is loose enough to turn with the torque block without impacts, after which the pressure of the spring 18 will hold the balls in the grooves 5, 5, etc., and all the elements will rotate together at the speed of shaft 16.

If it is desired to turn nut 12 in the direction opposite to that above described, the operator may simply reverse the motor, and the above described cycle of events will take place just as before, except in the proper order for reverse rotation of the nut.

It is to be understood that the above devices represent but two forms of the invention which includes all other forms and obvious modifications within the scope of the claims appended hereto. A third form is shown and claimed in Patent No. 2,399,251 issued April 30, 1946, as a division of this patent.

The invention described herein may be manufactured and used by or for the Government of the United States for governmental purposes without the payment to me of any royalties thereon or therefor.

What I claim is:

1. In a reversible variable speed power tool for turning, tightening and loosening parts; a coupling between the driving and driven members comprising a pair of aligned rotatable members attached respectively thereto and having closely adjacent opposed circumferential surfaces, there being a similar series of grooves equally spaced around the circumference of each of said surfaces, an anti-friction element for each of the grooves in one of said surfaces, the latter grooves being of a depth sufficient to contain the anti-friction elements, the other grooves being slightly less than half of such depth, said deeper grooves having sharp edges for simultaneously snapping all the elements out of their shallow grooves in cooperation with the opposed end edges thereof.

2. In a reversible variable speed power tool for turning, tightening and loosening parts, a coupling between the driving and driven means comprising a pair of aligned rotatable members attached respectively thereto and having closely adjacent opposed surfaces of revolution, there being similar series of grooves equally spaced around the circumference of each of said surfaces, a rolling element for each of the grooves in one of said surfaces, the latter grooves having a depth extending in a direction having a radially inward component, the other grooves having angular sides which sides are also angular to the adjacent sides of the next adjacent grooves and are slightly less than half the depth equivalent to the diameter of said rolling elements and extending in a direction having a radially outward component, all said deeper grooves having sharp edges, the cross-section at any point of said edges defining an angle of not more than 90 degrees so that upon sufficient pressure being exerted on a rolling element caught in the end of one of said other grooves by the edge at the end of the opposed groove, the said rolling element will be caught in shear between the sharp edge of said other groove and the angular side of said opposed groove and thereby will be snapped out of the said other groove into the opposed one and thus the two surfaces will move relative to each other after imparting a sharp impact to the driven member.

3. The combination of claim 2 wherein the surfaces of revolution are parallel to the axis of rotation.

4. The combination of claim 2 wherein the surfaces of revolution are parallel to the axis of rotation and the grooves in the inner member are deep enough to contain the rolling elements.

5. In a reversible variable speed power tool for turning, tightening and loosening parts; a coupling between the driving and driven members comprising a pair of aligned rotatable members attached respectively thereto and having closely adjacent opposed circumferential surfaces, there being a similar series of grooves equally spaced around the circumference of each of said surfaces, an anti-friction element for each of the grooves in one of said surfaces, the latter grooves being of a slightly greater depth than the diameter of the anti-friction elements, the other grooves being of a depth slightly less than the radius of said elements, all of said latter grooves having sharp edges at their ends.

6. In a reversible speed power tool for turning, tightening and loosening parts; a coupling between the driving and driven members comprising a pair of aligned rotatable members attached respectively thereto and having closely adjacent opposed surfaces of revolution, there being a similar series of grooves equally spaced around the circumference of each of said surfaces, a rolling element for each of the grooves in one of said surfaces, the latter grooves being of a depth sufficient to contain said rolling elements, the other grooves being slightly less than half of such depth, all said latter grooves having sharp edges at their ends.

CARL WESLEY PORTER.

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