

Sept. 19, 1961

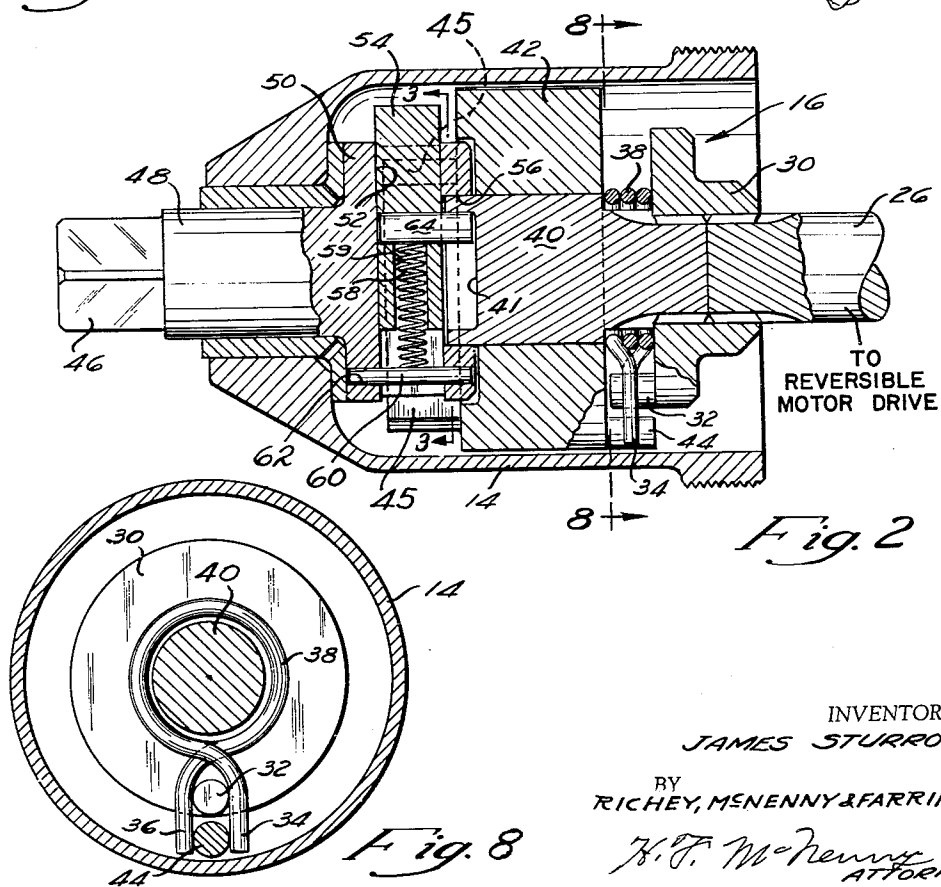
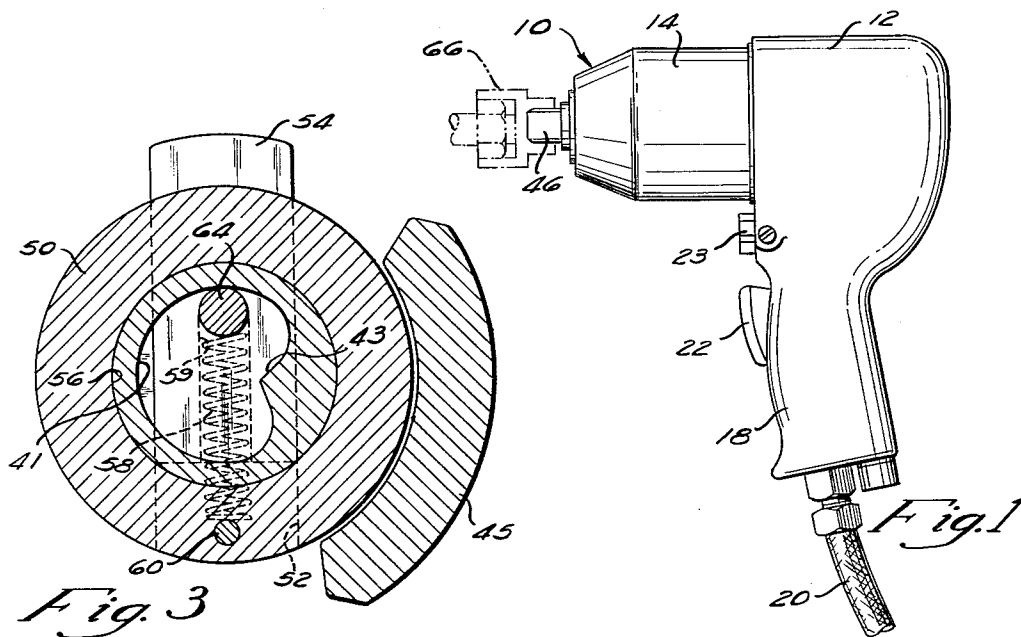
J. STURROCK

3,000,244

POWER OPERATED ROTARY IMPACT WRENCH

Filed Sept. 22, 1958

2 Sheets-Sheet 1



INVENTOR.
JAMES STURROCK
BY
RICHEY, MENENNY & FARRINGTON
H. F. McHenry
ATTORNEYS

Sept. 19, 1961

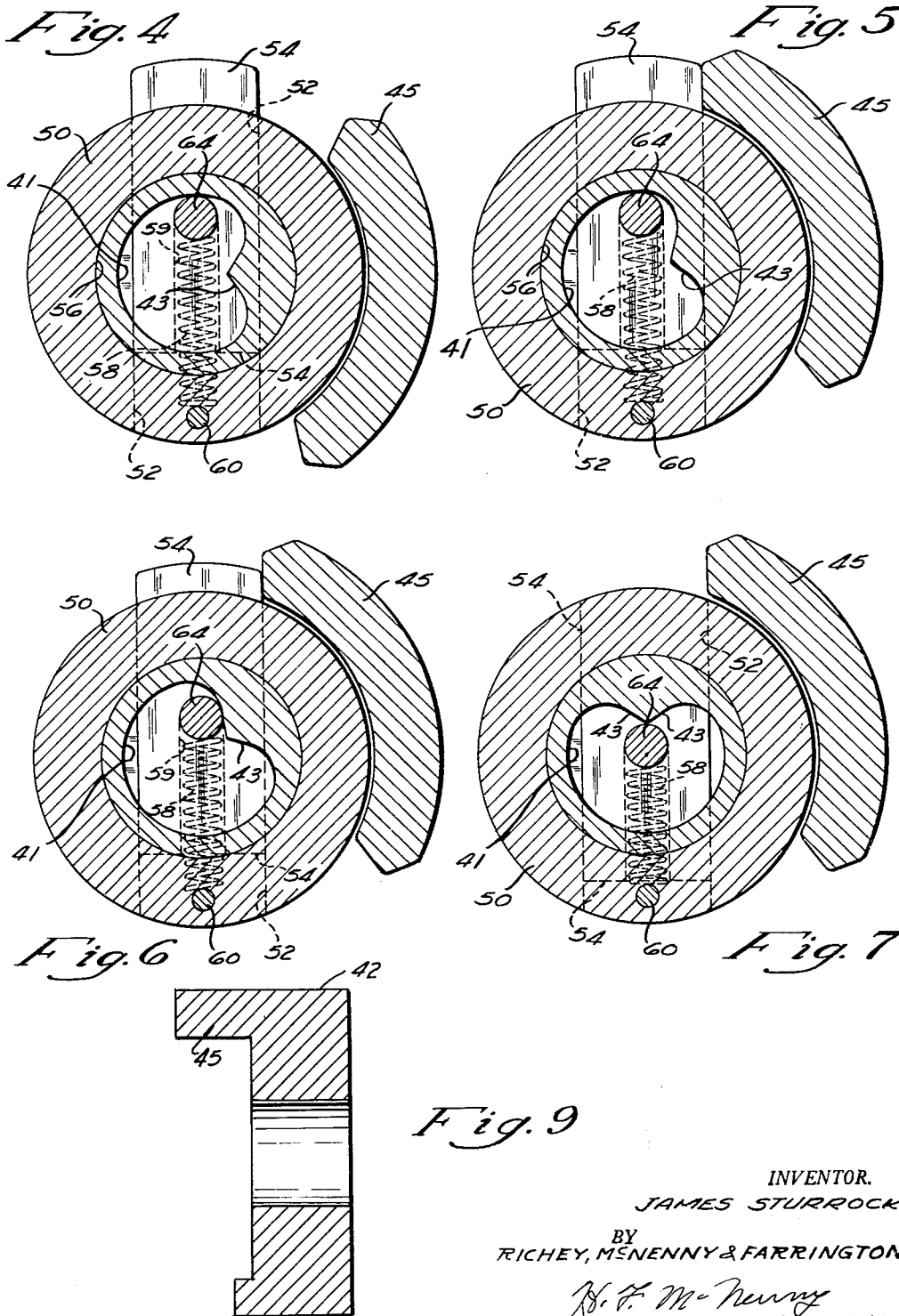
J. STURROCK

3,000,244

POWER OPERATED ROTARY IMPACT WRENCH

Filed Sept. 22, 1958

2 Sheets-Sheet 2



INVENTOR.

JAMES STURROCK

BY

RICHEY, McENENNY & FARRINGTON

H. F. McENENNY
ATTORNEYS

1

3,000,244

POWER OPERATED ROTARY IMPACT WRENCH
James Sturrock, Orwell, Ohio, assignor to Master Power Corporation, Bedford, Ohio, a corporation of Maryland
Filed Sept. 22, 1958, Ser. No. 762,518
2 Claims. (Cl. 81-52.3)

This invention relates to an impact wrench and more particularly to a novel clutch apparatus operable in an impact wrench for controlling application of impact torque to a tool spindle.

It is imperative for satisfactory operation of an impact wrench that the hammer or impact delivering element and the anvil or impact receiving element be immediately disengaged after each impact to enable the wrench to continue its cycle without involuntary interruption. Impact wrenches disengaged by spring means are susceptible to locking resulting from frictional engagement between the hammer and anvil greater than the force applied by the spring.

According to the present invention the anvil, or impact receiving element, is movably mounted in the driven spindle for movement into or out of the path of the striking surface of the hammer, and is positively moved to retracted position after each impact by the torque of the driving motor, thus eliminating any possibility of locking. In the preferred form, the structure is simplified by using a spring to advance the anvil into impact receiving position.

More specifically, the anvil is retracted after each impact thereagainst by motor torque applied through a cam and follower apparatus wherein the cam is driven by the motor shaft, the follower is coupled to the anvil and the hammer element is driven by the motor shaft through resilient means allowing rebound of the hammer and continued rotation of the motor shaft relative to the anvil after impact. Any frictional engagement between the impact elements is overcome by a positive drive of the wrench motor applied to the anvil through the cam means and the resilient means comprising a yieldable spring coupling between the motor shaft and hammer allows relative rotation therebetween subsequent to impact whereby locking or any other adverse influence arising from such engagement is avoided. During extension of the anvil it is disengaged from the hammer element, permitting the use of relatively light spring means to produce such extension.

Other objects and advantages will be appreciated from the following description taken in conjunction with the accompanying drawings in which,

FIG. 1 is a side elevation of an impact wrench incorporating this invention;

FIG. 2 is a cross-sectional side elevation of the clutch apparatus of this invention;

FIG. 3 is an enlarged sectional view of the clutch mechanism of this invention, taken on line 3-3 of FIG. 2, showing the disposition of the wrench hammer, anvil, cam lobe and follower pin in an idle condition;

FIG. 4 is an enlarged sectional view similar to FIG. 3 showing the disposition of the wrench hammer, anvil, cam lobe and follower pin during acceleration thereof by the wrench motor and prior to impact;

FIG. 5 is an enlarged sectional view similar to FIGS. 3 and 4 showing the disposition of the wrench hammer, anvil, cam lobe and follower pin at the instance of impact;

FIG. 6 is an enlarged sectional view similar to FIGS. 3, 4 and 5 showing the disposition of the wrench hammer, anvil, cam lobe and follower pin at an instant of time subsequent to impact;

FIG. 7 is an enlarged sectional view similar to FIGS.

2

3 through 6, showing the disposition of the hammer and anvil at the point of full retraction of the anvil by the cam lobe;

FIG. 8 is a sectional view taken along line 8-8 of FIG. 2 and illustrating the yieldable spring coupling between the wrench motor and impact delivering element; and

FIGURE 9 is a fragmentary axial section of the impact element, including the projecting hammer integral therewith.

Referring now to the drawings for a detailed description of the invention, 10 represents generally an impact wrench incorporating features of this invention and including a stock section 12 for enclosing a reversible wrench motor (not shown), and a barrel section 14 threadedly connected to stock section 12 and enclosing the wrench clutch mechanism shown generally at 16 in FIG. 2. A handle section 18 is preferably formed integral with the stock section 12. The wrench motor is preferably a reversible pneumatic sliding vane rotary motor of conventional type. Such a motor is disclosed in my co-pending application Serial No. 719,967, filed March 7, 1958, now Patent No. 2,973,069, February 28, 1961, to which reference is made for the motor structure. It is a characteristic of such motors that the delivered torque has its maximum value when the motor is substantially stalled and decreases with increase of motor speed. Any other pneumatic, electric or other type motor whose delivered torque decreases with increase of speed may be used. A flexible conduit 20 is provided for conducting power to the motor under the control of a trigger valve (not shown) linked to a manually manipulable trigger 22 and a reversing valve adjustable by a knob 23. Trigger 22 may be depressed to supply motive power to the motor and may be released to interrupt the flow of such power.

The wrench motor includes a rotor drivingly connected to a shaft 26 which extends forwardly in the wrench to the clutch 16 and is splined to a coupling element 30 which is generally cylindrical in shape with a lug 32 extending axially forward near the outer periphery thereof for engagement with one of the radial arms 34 or 36 of a spring 38. Coupling member 30 is also splined to a cam member 40 to effect a direct driving engagement between this cam member and motor shaft 26. Cam member 40 is provided with a recess 41 at a forward end portion having a cam lobe 43 projecting radially inwardly into the recess. An impact element 42, having a forward impacting projection or hammer 45, is journaled about the member 40 and driven by the wrench motor through a rearwardly extending axial lug 44 near the outer periphery of the hammer, engageable with an arm 34 or 36 of spring 38. It is noted that during the direct drive of cam 40 by shaft 26 through coupling element 30, hammer 45 is rotatively driven by shaft 26 through coupling element 30 and spring 38. Lug 32 on element 30 in its rotation drives either arm 34 or 36, depending upon its direction of rotation, which tends to wind the spring 38 about cam member 40 and accordingly impart a torque against lug 44 to drive hammer 45 through the other of arms 34 and 36.

The spring 38 is preferably coiled about the shank of the cam element 40 as illustrated in FIGS. 2 and 8, although other forms and locations of spring may be used. In the illustrated embodiment, the spring is pre-stressed so that in idle position the ends 34 and 36 of the spring urge the lugs 32 and 44 into radial alinement. Relative angular displacement of the lugs 32 and 44 in either direction further stresses the spring, increasing the force urging the lugs into alinement in proportion to the extent of the relative displacement. Preferably the num-

ber of coils and their spacing from the shank of the cam member 40 is sufficient to permit a relative displacement of the lugs of substantially less than one revolution, after which the coils tighten on the member 40 and prevent further displacement.

The strength of the spring 38, or the force it exerts on the lugs 32 and 44 in its pre-stressed condition, and the spring rate, or increase of force with displacement of the lugs 32 and 44, are chosen with respect to the torque of the motor and the shape of the cam lobe 43 so that the delivered motor torque when the motor is stalled, or substantially stalled, exceeds the force of the spring 38 by an amount greater than the force required to turn the cam lobe 43 into alignment with the pin 64 and thereby slide the anvil 54 into retracted position against the friction created by the hammer 45 pressing against the anvil 54 under the force of the spring 38. At the same time, the strength and rate of the spring are chosen so that the spring force exceeds the motor torque delivered through the spring 38 to the hammer 45 at the speed achieved by the motor, after accelerating through less than about one-half a revolution so that the spring 38 accelerates the hammer 45 faster than the motor accelerates the cam element 40 during the remainder of the revolution, or until the hammer 45 has substantially caught up with the cam member 40 and returned the lugs 32 and 44 substantially into alignment. A substantial range of forces for the spring 38 is available between these limits, since the motor torque decreases with increased speed, and the torque delivered through the spring 38 at any instant during acceleration is the motor torque at that speed less the torque required to accelerate the motor itself against its own friction and inertia.

The work load driven by the wrench is coupled to a polygonal head 46 of a spindle 48 rotatively mounted at the forward end of the hammer. A rearward enlarged portion 50 of spindle 48 is transversely milled to form a rectangular opening 52 to slidably receive the anvil 54. The rearward end of the spindle 48 is formed with a recess 56 within which is journaled the forward end of cam member 40.

Anvil 54 is continuously urged radially outwardly from bore 52 by a coil spring 58 which is received in a bore 59 in anvil 54 and is in abutment at its outer end with a pin 60 disposed in an axial bore 62 in enlargement 50 and at its inner end with a follower pin 64 received in an axial bore in anvil 54. Rotation of cam 40 relative to spindle 48 is effective to drive anvil 54 radially inwardly by engagement between lobe 43 and follower pin 64 while spring 58 is effective to move anvil 54 outwardly when the lobe 43 is not in alignment with pin 64.

Prior to operation of the wrench, the relative angular disposition of the cam lobe 43 and hammer 45 is as shown in FIG. 3 of the drawings, the point of the cam lobe 43 being centered between the opposite side striking faces of the hammer 45. In the operation of the wrench, the operator holds the same by the handle 18 and applies a socket shown in phantom at 66 to head 46. The socket is engaged with a load such as a nut, bolt or the like and the wrench reversing valve is positioned by knob 23 according to the direction in which it is desired to drive the load. The motor 12 is energized by depressing trigger 22 whereby shaft 26 and coupling element 30 are directly driven by the motor and hammer 45 is driven through the coupling comprising lug 32 of coupling element 30, spring 38 and hammer 45. During the acceleration of the hammer 45 prior to impact between the hammer and anvil 54 the hammer 45 may angularly lag the lobe 43 slightly with respect to its idle position as shown in FIG. 3, but the lag is small because the force of the spring 38 exceeds the torque delivered through it during acceleration as explained above. Assuming a counterclockwise rotation of the motor, as viewed from the rear of the wrench, this condition is shown in FIG. 4 wherein hammer 45 lags lobe 43 slightly as compared with the position of these elements shown in FIG. 3.

The hammer 45 and cam 40 occupy substantially this relative position when the hammer 45 strikes the anvil 54, which in these circumstances is held in its outer or extended position by spring 58 as above described. The disposition of the clutch elements in these circumstances is as shown in FIG. 5 of the drawings. At impact, a driving torque is imparted to the load through anvil 54 and spindle 48. If the load driven by the spindle is very light, the motor continues to rotate and drive the spindle at motor speed through the engagement of hammer 45 with anvil 54, but the cam member 40 may advance angularly relative to hammer 45 due to added compression of spring 38 resulting from the added resistance to rotation of the load member driven through it. In this condition the elements assume positions as shown in FIG. 6 of the drawings, in which the lobe 43 of cam 40 has engaged pin 64 and pressed the same radially inwardly a slight amount against the resistance of the spring 58. This relation of the parts occurs during running down a nut, for example, which may be accomplished very quickly since in two or three revolutions the driving speed approaches the maximum free speed of the motor, which is preferably about 6,000 to 7,000 revolutions per minute.

When the light load described increases, as when a nut has been run down into engagement with a fixed surface, the motor speed is reduced until its torque delivered to the cam element 40 is sufficient to further wind up the spring 38 and advance the cam lobe 43 relative to the hammer 45 into the position shown in FIG. 7, fully retracting the anvil 54 against the force of spring 58 and the friction between the anvil 54 and the hammer 45. Upon complete retraction of the anvil 54 as shown in FIG. 7, the path of hammer 45 is unobstructed and it is free to rotate without driving the spindle 48. The force of spring 38 accelerates the hammer faster than the motor accelerates the cam element 40 bringing the hammer substantially to an angular position relative to the cam lobe 43 as shown in FIG. 4 of the drawings before the parts have turned a full revolution. At the end of a revolution impact between hammer 45 and anvil 54 again occurs in the relative positions shown in FIG. 5, after which anvil 54 is again retracted by the lobe 43 on the cam member 40. After impact and during the short duration of time of retraction of anvil 54, hammer 45 may remain in frictional engagement with the anvil or may rebound, depending upon the rate at which the load absorbs the energy imparted by the blow to the spindle 48. When the deceleration is rapid, the hammer 45 rebounds and tightens the spring 38, which may stall or even slightly reverse the motor. In either event, the anvil is fully retracted by the cam action of lobe 43 against pin 64 before the spring 38 can advance the hammer relative to the cam lobe 43 far enough to strike a second blow. Thereafter hammer 45 is again accelerated to gain energy for another impact which occurs in the manner described. This sequence of events recurs many times in rapid succession until sufficient torque is imparted to the load after which the operator of the wrench releases trigger 22 to interrupt the flow of power to the wrench and accordingly to interrupt operation of the wrench.

According to this invention, the positive retractive drive of the anvil exceeds the frictional forces occurring by reason of engagement between the hammer 45 and anvil 54 under any circumstances and accordingly the wrench is not subject to involuntary interruption by locking due to such frictional forces.

It is also to be observed that an entirely similar sequence of events occurs during the reverse rotation of the motor and accordingly a detailed description thereof is not presented.

Although a preferred embodiment of the invention has been described in detail, it is to be understood that equivalents or modifications of, or substitutions or rearrangements of parts may be used without departing from the

5

scope of the invention as set forth in the following claims.

I claim:

1. In an impact wrench, co-axial rotatable driving and driven members, one of said members having an impact surface spaced from its axis of rotation, an impact element slidably mounted in the other of said members for movement into and out of the path of said impact surface, said driving member including an inertia mass for delivering an impact blow, a drive shaft rotatable with a predetermined torque varying inversely with the speed of rotation thereof, a resilient coupling between said drive shaft and said driving member, cam means operably associated with said drive shaft, said driven member and said impact element, said cam means being operable by rotation of said drive shaft relative to said driving and driven members to retract said impact element out of the path of said impact surface, said resilient coupling resisting such rotation relative to the driving member by a force less than the torque of said drive shaft when substantially stalled and greater than the torque of said drive shaft after free acceleration of said drive shaft and driving member through about one-half a revolution.

2. In the impact wrench, a rotatable driving member having a hammer surface spaced from its axis of rotation, a rotatable driven member co-axial with said driving member, an anvil slidably mounted in said driven member for movement into and out of the path of said hammer surface, said driving member including an inertia

6

mass for delivering an impact blow, a drive shaft rotatable with a predetermined torque varying inversely with the speed of rotation thereof, a resilient coupling between said drive shaft and said driving member, cam means operably associated with said drive shaft, said driven member and said anvil, said cam means being operable by rotation of said drive shaft relative to said driving and driven members to retract said anvil out of the path of said hammer surface, said resilient coupling resisting such rotation relative to the driving member by a force less than the torque of said drive shaft when substantially stalled and greater than the torque of said drive shaft after free acceleration of said drive shaft and driving member through about one-half a revolution.

References Cited in the file of this patent

UNITED STATES PATENTS

2,256,496	Robinson	Sept. 23, 1941
2,425,793	Fosnot	Aug. 19, 1947
2,514,914	VanSittert	July 11, 1950
2,543,979	Maurer	Mar. 6, 1951
2,636,583	Whitledge	Apr. 28, 1953
2,711,662	Shaff	June 28, 1955
2,786,376	Roggenburk	Mar. 26, 1957
2,821,276	Reynolds	Jan. 28, 1958
2,842,994	Stine	July 15, 1958