Nov. 10, 1964 — O. J. SWENSON — 3,156,309

ROTARY IMPACT TOOLS

Filed Dec. 12, 1960 — 2 Sheets-Sheet 1

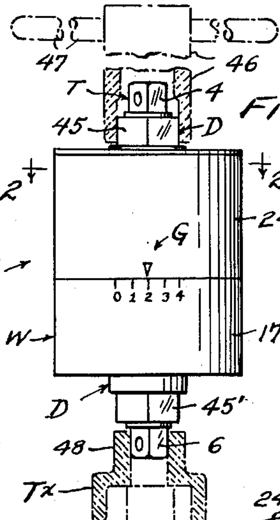

FIG-1

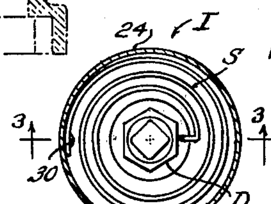

FIG-2

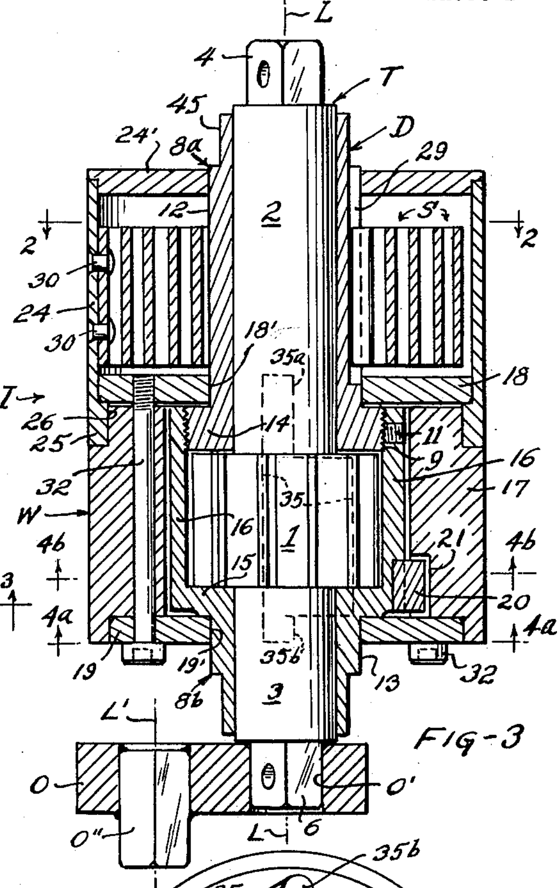

FIG-3

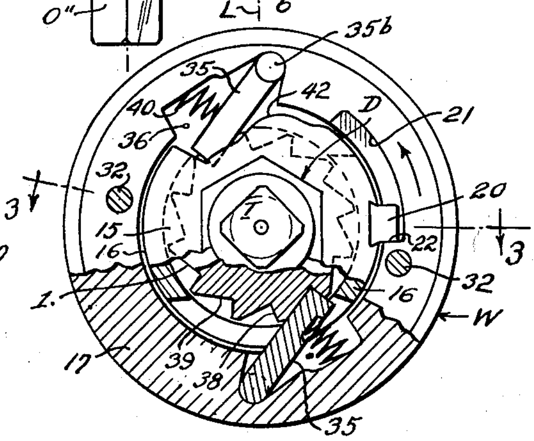

FIG-4

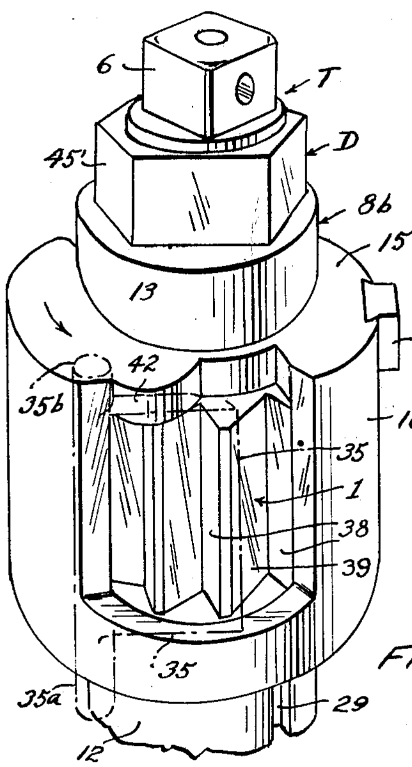

FIG-5

INVENTOR.

OSCAR J. SWENSON

BY George M. Soule

ATTORNEY

Nov. 10, 1964 O. J. SWENSON 3,156,309

ROTARY IMPACT TOOLS

Filed Dec. 12, 1960 2 Sheets-Sheet 2

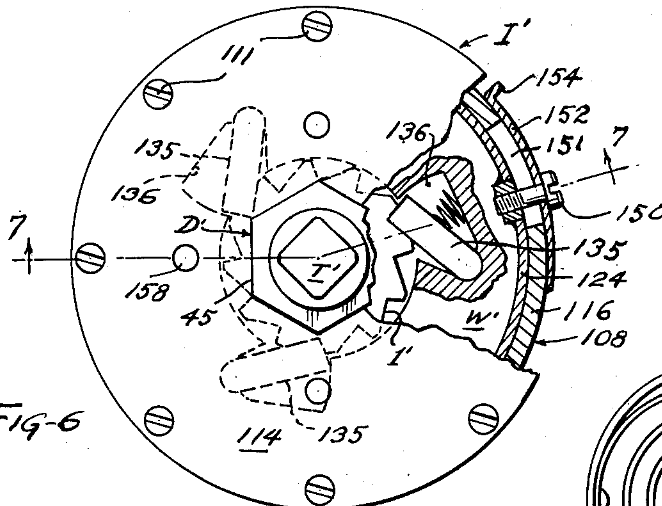

FIG-6

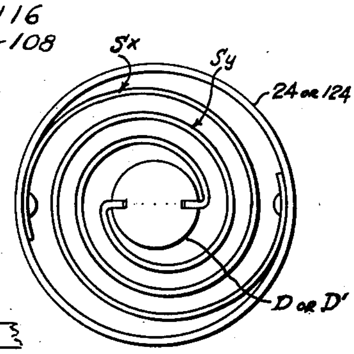

FIG-8

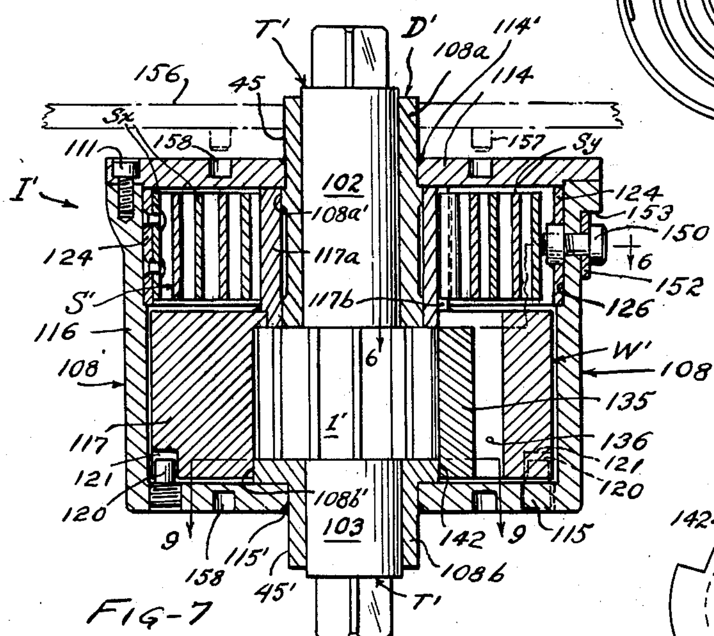

FIG-7

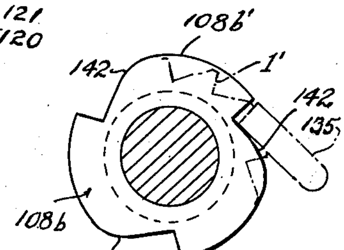

FIG-9

INVENTOR.
OSCAR J. SWENSON
BY George M. Soule
ATTORNEY

United States Patent Office

3,156,309

Patented Nov. 10, 1964

3,156,309

ROTARY IMPACT TOOLS

Oscar J. Swenson, Sunset Hill Drive, Branford, Conn.

Filed Dec. 12, 1960, Ser. No. 75,385

13 Claims. (Cl. 173—93)

This invention relates to an improved impact-producing tool utilizing the general principles of the tools shown and claimed in my U.S. Patents 2,661,647, Dec. 8, 1953 (No. 1 for reference in record); 2,844,982, July 29, 1958 (No. 2); and 2,954,714, Oct. 4, 1960 (No. 3). Each of those patents shows a manually operable impact wrench or equivalent tool assembly utilizing a main or power spring and an annular inertia or rotor member operated thereby and which carries one or more pawl elements operating on a ratchet-toothed portion of an output shaft or tool head to produce, through energy alternately stored in and released by the spring, successive sharp and powerful impacts via the tool head to, for example, threaded fasteners to be tightened or loosened.

The present impact tool construction or assembly, indicating one object of the invention, is oriented about a longitudinal working axis, being generally symmetrical and fully balanced if desired about such working axis. Thus the tool can be driven interchangeably by any power shaft (e.g. via a chuck thereon) or by any manually operable device such as a detachable handle or crank. Further the general exterior surfaces of the tool are circular and smooth, so that the tool can be used safely when driven at relatively high speeds, as by a motor. When applied to a threaded fastener or stud having an upright axis the present tool will remain upright without support other than by engagement with the work.

A further object is to provide a rotary impact wrench operable either unidirectionally or as a ratchet wrench (by indexing type input motion), and having improved provision for enabling application of input torque to opposite ends of the wrench close to its working axis and reversibly or in clockwise and counterclockwise directions from a given point of view in respect to the work.

Other objects include provision of a rotary tool operable as an impact wrench as in said patents and having an improved or simplified manner of adjustment of the power spring, thereby to enable tightening of screw threaded joints or fasteners to desired variable effective values independently of the amount or magnitude of force which may be applied as input to the tool.

Frequently Presented Special Problem

In the practice of tightening or loosening threaded fasteners using either power driven or manually operated impact wrenches it is often not possible because of space limitations to attach the output elements of such wrenches directly to conventional sockets engaging the fasteners and aligned with the output elements. I have discovered a practical method of gaining accessibility in most of such situations by providing an offset drive connection device between the fastener (via a conventional socket engaged therewith) and the output member of the wrench which device has input and output connections having axes substantially parallel to one another but offset a suitable or sufficient distance to provide the required accessibility. Contrary to the opinions of qualified persons ranging from predictions that no input torque would be delivered to the work, or even that this torque would be delivered in the opposite direction to that of the input torque, it has been found as predicted by me that substantial portions of input torque are delivered to the work and always in the same direction as that of the applied torque. It has also been determined that the portion of the input torque delivered to the work decreases as the distance (offset) between the axes of the input and output elements of the

connection device is increased. Fortunately, however, in most cases the amount of offset required is small enough to preclude a substantial loss of input torque. Under many if not most practical conditions encountered substantially all of the input torque will be delivered through the offset connection device to the work.

Offset drives or connections have been in use for many years on ordinary manual or bar wrences. In this use however, the offset device behaves simply as an extension of the bar wrench viz: adding to the length of the wrench handle when the wrench handle extends transversely of the axis of the work generally in the same direction as does the offset device and subtracting from the effective length of the wrench handle when the bar handle is extended back over the offset past the axis of the work. Thus in the case of the manual bar wrench used with an offset drive device the resulting torque received by the fastener depends merely on the amount of force applied to the wrench handle multiplied by the length of the handle. The resultant torque also almost always depends upon a steadily applied force at the end of the handle with the fastener acting as a pivot around which the torque is applied. In the novel method hereof the operating principle differs from that obtaining in the case of the simple manual bar wrench. In using a rotary impact tool, pure torque is applied to the input end of the offset connection device. Thus a force couple is created about the axis of such input end portion which can be dissipated only by a rotation of the offset device about the axis of the fastener, since such end portion is the only part in the overall system of wrench, connection device and fastener having a degree of freedom enabling use as an outlet for energy imparted to the system. The difference in basic principle can be further illustrated by the fact that the output torque resulting from a specific force applied (e.g.) to a bar wrench handle, as earlier outlined above, will be dependent upon the relationship of the handle with the direction of extent of the offset device, whereas in the case of the application of pure torque to the input of the offset device with an impact wrench no such dependency exists. The behaviour of an offset connection device with a bar wrench, for already indicated reasons, is relatively simple and easily understood. The behaviour of the offset when used with an impact wrench, however, is not readily predictable. In this just mentioned instance, the torque results from the delivery of force to the output of the wrench symmetrically around the axis of the output of the impact tool. This symmetrical rotary force results from the impact which occurs when a rapidly revolving free body (rotor member of the tool) is suddenly decelerated by almost instantaneous contact with a relatively stationary work element or part connected thereto. Thus torque is developed in a manner differing from that occurring in the use e.g., of the simple bar wrench by the basic fact that torque results without any contact being required from outside the system involved, whereas the bar wrench or the like requires continuous application of a force from outside its associated system.

In view of the above discussion a further important object hereof is to provide a new fastener tightening or loosening method and apparatus utilizing a manually or power operated rotary impact tool on work in such locations or environments that, because of space limitations, it is impracticable to position the output shaft or tool head of the wrench in axial alignment with the work.

Various novel features not indicated above will become apparent from the following description of presently preferred constructions. The essential characteristics of the invention are summarized in the claims.

In the drawing,

FIG. 1 is a small scale side elevation of the present impact tool in one form and diagrammatically (by broken lines) typical devices for applying input torque to the tool and delivering output torque therefrom to the work.

FIG. 2 is a sectional plan or end view as indicated by the line 2—2 on FIG. 1.

FIG. 3 is an enlarged (e.g., full scale) longitudinal central sectional view taken substantially as indicated by the line 3—3 on FIGS. 2 and 4.

FIG. 4 is a "bottom" end view of the tool partly in transverse section, different portions being viewed as indicated by lines *4a—4a* and *4b—4b* respectively on FIG. 3.

FIG. 5 is a perspective fragmentary view in still larger scale, showing adjacent end portions of an input sleeve and cam unit and of a tool head, the view showing the preferred ratchet, pawl and the cam mechanism for successively producing torsional impacts on the tool head.

FIG. 6 is a plan view (partly broken away in transverse cross section as conventionally indicated on FIG. 7) showing a modified rotary impact tool.

FIG. 7 is principally a longitudinal central sectional view of the modified tool assembly according to FIG. 6.

FIG. 8 is a diagrammatic view similar to FIG. 2 showing one manner of arranging spiral or equivalent power spring members (as would be desirable or preferable in both illustrated forms of the present tool) so as approximately to balance the forces produced by the power spring means on bearing surfaces of the tool.

FIG. 9 is a transverse sectional detail view taken as at 9—9 on FIG. 7.

Impact Tool Assembly (FIGS. 1–5)

The impact tool hereof, indicated I in FIGS. 1 through 5, includes a central output shaft or tool head T having an enlarged diameter ratchet-toothed portion 1 between its ends; cylindrical journal portions 2 and 3, aligned on the working axis L, FIG. 3, and non-circular reduced end portions 4 and 6 shown as conventional socket-driving squares. Those end portions 4 and 6 operatingly engage the work interchangeably (e.g. threaded fasteners to tighten or loosen them) through detachable socket members such as shown at T*x* in FIG. 1 in case the output shaft T can be in alignment with the work or with an offset drive extension O as in FIG. 3 if the tool axis L (due for example to lack of working clearance) has to be disposed materially out of alignment with the axis of the work (e.g., axis L′ FIG. 3).

Input to the tool, interchangeably at opposite ends thereof, is via a rigid tubular input shaft and cam assembly unit D which, as shown, comprises parts or portions *8a* and *8b*. In order to enable application of input torque interchangeably to two ends of the tubular input unit D and so that the components of that unit can form journals for a rotor or inertia mass assembly or unit W (described later), and so that said components can be assembled onto the output shaft T from opposite ends as necessary if its ratchet toothed portion 1 is larger in diameter than the journal portions 2 and 3, the tubular parts or portions *8a* and *8b* of unit D have formed thereon respectively, at proximal portions of circular journal-forming surfaces 12 and 13 thereof, a circular flange 14 and a cup-like hollow drum 16. An end wall portion 15 of drum 16 lies opposite flange 14 axially of the input shaft assembly, and the proximal surfaces of the flange 14 and wall 15 limit axial movement of the ratchet toothed portion 1 to a negligible amount within the assembly or unit D.

A suitable detachable connection between the flange 14 and drum 16 of input unit D comprises, as illustrated, screw threads at 9 and grub or set screws or pins 11 (one shown at the right in FIG. 3) for locking the threads against unscrewing relative movement.

The inertia or rotor unit W is formed as a relatively heavy metal annulus comprising a main annular block or body member 17 and complementary circular disc or end plate members 18 and 19 fast on the block 17, as will be described, and having central bores 18′ and 19′ respectively in running fit contact with the cylindrical journal portions 12 and 13 of the drive or input unit D. The rotor or inertia mass assembly W, including plates 18 and 19, is thus capable of some free angular guided movement about the working axis L of the tool. The illustrated means for limiting the angular relative movement just mentioned above is, as shown in FIGS. 3 and 4, a lug or stop member 20 fast on the input member *8b* and movable in an internal slot 21 (see FIG. 4) in the ring 17 and having an initial or static-position-determining stop surface 22 for the rotor unit W.

In the upright position of the impact tool I as shown in FIGS. 1 and 3 the rotor assembly W is surmounted by an annular case 24 having if desired a separate end or top piece 24′ for a power spring S described later. For adjustment of the effective spring force or power level of it, the case 24 has a circular flange 25 in a peripheral groove 26 formed between the rotor member 17 and the upper end plate or disc 18 of the rotor unit. Thus any assumed angular relationship between the case 24 and the rotor W about the axis L can be changed by turning the case 24 relative to that unit in either direction. The power spring S as shown is formed as a conventional spiral metal spring member detachably connected between input or drive unit part *8a* and the case 24. As shown the inner convolution of spring S is detachably seated in a longitudinal slot 29 in the member *8a* intersecting the circular surface 12 of that member. The opposite or outer convolution of the spring S is fastened to the case 24 as by one or more rivets 30.

Since a single spiral spring S as shown in FIG. 2 would apply a substantial and undesirable side thrust to the bearing surfaces between the drive unit D and rotor unit W (as at 18′) it is preferable, assuming the power spring S is of spiral construction, to use at least two spring members attached at respective opposite ends to the associated elements of the tool 180° apart (or otherwise equally spaced if more than two such spring members are provided). Such two spring members S*x* and S*y*, as diagrammatically shown in FIG. 8, can, if desired for axial compactness, be in a common plane normal to the working axis L. The two spring members of FIG. 8 are, in effect, interwound and oppositely connected to the drive unit and rotor as clearly apparent from reference to FIG. 8.

Referring again to FIGS. 3 and 4, with the stop or lug 20 of the drive shaft assembly D in contact with the stop shoulder or abutment 22 of the rotor slot 21, the torsional stress in the power spring or spring assembly S can be increased as much as desired (assuming that rotor-assembly-attaching and clamping screws 32, FIG. 3, are loosened) by turning the rotor and drive unit members 17 and 24 angularly about the working axis L in the proper direction. The screws 32 when tightened force the plate 18 against the associated axial face of the rib 25 of case member 24 and holds the initial spring torque at a magnitude such that the peak value in operation is at an appropriate level. Various adjusted spring power levels can be indicated externally of the unit I as by graduations and index marks as shown at G in FIG. 1 on relatively adjacent exterior surfaces of the rotor body 17 and spring housing or case 24.

The ratchet and pawl operated escapement mechanism hereof, as best shown in FIGS. 4 and 5, comprises one or more plate like pawls 35 in cavities 36 of the rotor block 17 and having aligned pivot extension portions *35a* and *35b* fitting mating axial holes in the end plates 18 and 19 of the rotor unit. The pawls 35 as will be evident from comparison of FIGS. 3, 4 and 5 reach through radial window openings intersecting respective side wall portions of hollow drum 16 for operating engagement with a plurality (e.g. 12) of equally spaced abutment or tooth faces 38 on the ratchet wheel 1. Associated faces 39 on the ratchet wheel serve as arresting stops for the pawls 35 against which biasing springs 40 between the pawls and wall portions of the recesses 36 force the pawls inwardly toward the ratchet wheel.

At least one end portion of each pawl 35 (as shown somewhat diagrammatically in FIG. 5) extends axially of the input shaft or sleeve assembly D a sufficient distance to enable engagement by cams 42 on drive unit D arranged essentially as in my said patents. Such cams 42 can be formed on wall 15 of drum portion 16 of the drive unit. The cam surfaces 42 (one for each pawl) are designed so that, during relative angular movement between the input or driving unit D and the illustrated and described inertia unit assembly W somewhat more than 30 degrees (assuming a direction such as indicated by the arrow on inertia member 17 in FIG. 4 or on drum portion 16, FIG. 5), escapement and resultant impact operation of the pawls on successively engaged ratchet toothed surfaces 38 occurs as a result of energy stored in the power spring S followed by triggering action of the cams 42 on the pawls 35 to release the stored energy and cause the impacts.

Operation (Usual)

The two ends of the input sleeve or bushing unit D have, as shown by way of example, hexagonally formed faces 45 for engagement with a manually operated driving tool such as a tubular wrench body 46, FIG. 1, having a double handle constituted by a cross bar 47. A nut or other threaded fastener (not shown) engaged by a socket or extension 48 (part of device Tx detachably fitting the driving square, 6, FIG. 1), will be subjected to tightening force assuming the nut or fastener has a right hand thread. After the fastener has been tightened a predetermined amount, application of further torque (e.g., steadily or gradually, as by hand) to move the input assembly D will not produce further movement of the fastener but will store energy in the power spring during the time the input assembly temporarily overruns or angularly overhauls the stationary output unit T and the fastener. The fastener is abruptly moved further to tighten it when the cams 42 as moved by the input unit relative to the inertia member or rotor have pushed the pawls 35 out of engagement with one set of ratchet tooth abutment faces 38. The thereby released power spring energy then rapidly accelerates the rotor unit W, hence the pawls 35, until the pawls strike the next adjacent pair of tooth faces 38.

When the tool I is inverted and the members 46 and 48 are relocated, as will be evident, and the direction of driving (via hex. 45′) is reversed, loosening impacts will be delivered to the work by essentially the same operations as just above described.

Male-Female Offset Drive (and Operation)

In applying the impact tool W to work such as threaded fasteners when there is insufficient lateral clearance so that a socket such as Tx can be used to connect the driving squares 4 or 6 with the work then an offset extension, one form of which is generally indicated O in FIG. 3, can, as already described earlier herein, be used to transmit to the work a surprisingly large percentage, forcewise, of each torsional impact capable of being delivered by output shaft or unit T at a given adjustment level of spring S. The loss between input torque (along axis L) and output torque (along axis L′) probably increases as the square of the offset distance as from the center of opening O′ to the center of square stub O″. Such distance from a practical standpoint, never needs to be so great as to occasion a more than 50% loss. If the axis L′ of the offset extension intersects a portion of the body of the rotor W as it does when the tool assembly I and extension O are proportionally related as shown in FIG. 3, or if the outlying end of the offset extension O is approximately flush with the peripheral surface of rotor body 17, there will usually be sufficient working clearance for the impact

wrench unit to operate effectually and there will be no substantial torque loss (i.e. there will be less than 50% loss).

The effectiveness of the impact torque via an offset extension such as O, FIG. 3 is practically independent of the length of the handles such as 47, FIG. 1 (or other handle as in my said patents) or in other words is essentially independent of the manner in which input force or torque is delivered to the tool. If the tool is operated manually for example there is practically a zero force relationship between the operator's hands and the handle or handles at the instant of delivery of impact to the work. The tool (e.g. impact wrench unit I), when operating through an offset extension device such as O, must, while impacts are being delivered, be free to move orbitally about the axis of the fastener being worked upon. Thus repositioning of the tool I in reference to the fastener, via the extension O and/or connected socket, between successive impacts or groups of impacts may be necessary; and appropriate relocation of the handle or handles is enabled by employing whatever simple ratcheting operations of the tool I are required.

Modified Form (FIGS. 6 and 7)

The modified construction according to FIGS. 6 and 7 differs from that of the earlier described views principally by the fact that the input torque receiving unit or assembly D′ comprises a drum-like casing 108 having axially opposite input torque receiving extension portions 45 and 45′ of bushing members 108*a* and 108*b* integral with the casing 108 and operatively corresponding to the members 8*a* and 8*b* in FIG. 3. The bushing members telescope circular journal surface portions 102 and 103 of the output shaft or tool head T′ FIGS. 6 and 7 very much as in the previously described form. The drum like casing 108 contains the inertia member or rotor unit W′ and power spring means or spring unit S′. The bearing or bushing members of the housing 108 form journal supports for the rotor block 117 as at external circular surface portions 108*a*′ and 108*b*′ of the bushing members. The block 117 of unit W′, as shown, has a tubular extension 117*a* operatingly integral with the main portion of the block and disposed in telescoping relation to the portion of bearing member 108*a* which extends within the housing 108. The interwound convolute spring members S*x* and S*y* are arranged as diagrammatically shown by FIG. 8, being connected between a sleeve or collar 124 in the casing 108 and the tubular extension 117*a* of the rotor block. The extension has diametrically opposite axially extending slots, one indicated at 117*b*, for receiving inner bent ends or hooked portions of the leaf spring members S*x* and S*y*.

Housing 108, as shown, comprises a cup shaped part 116 having (in the position of it illustrated in FIG. 7) a top wall 114 and a bottom wall 115, one of the walls, for example 114, being secured to the main body or side wall portion 116 as by a series of screws 111. Since the bearing portion 108*a* of the housing 108 has to extend a considerable distance inwardly as from its supporting wall 114 of the housing in view of the necessary space axially of the tool occupied by the power spring means S′ the bearing member 108*a* should either be made an integral part of the end wall member 114 or (if made separately) be rigidly joined thereto as by brazing at 114′. Bearing or bushing member 108*b* in view of having the pawl-escapement-producing cams 142 formed thereon (see FIG. 9) as well as circular bearing or journal surfaces 108*b*′ for the rotor W′ is formed as a separate part of the housing and bearing assembly unit D′ and is joined to the bottom wall 115 as by brazing at 115′. The housing and bearing construction just above described has been found to be very effectual in avoiding imposition of deflections tending to bind the ratchet mechanism or interfere with free angular and independent movement of the input unit D', the output shaft or tool head T' and the rotor unit W'.

Initial positioning and angular-motion-limiting devices (pins 120 and slots 121) corresponding to the lug and slot elements 20 and 21 of FIG. 4 are indicated as being disposed diametrically opposite each other and carried respectively by the bottom wall 115 of the housing and in the rotor block 117. The same paired arrangement of motion limiting devices would also be preferable in making the tool according to FIGS. 1 through 5 in order better to balance the radial loads imposed when the stop lug and abutment surfaces such as 20 and 22 (see FIG. 4) come together with considerable force.

The preferred arrangement for adjusting the power level of the spring means S' and indicating various adjusted positions comprises as shown in FIGS. 6 and 7 a radial pin (screw 150) connected to the spring-attached ring 124 and extending outwardly through a circumferential slot 151 in the wall of the casing part 116 so that the position of the pin with reference to an external mark on the casing (not shown) will indicate the adjusted power level. The shank of the screw 150 extends through a hole in an arcuate rectangular plate 152 which may be guided by a shoulder 153, FIG. 7, adjacent an upper thickened wall portion of the casing wall 116. The plate 152 covers the slot 151 in all positions of the screw 150; and in order to facilitate adjustment of the power level indicator assembly 124, 150, 152 the plate 152 has a lug or lip 154 at one end as shown in FIG. 6 for engagement by a spanner device or other tool. The power-spring-connected ring or sleeve 124 may be secured in its trough-like guide 126 between the casing part 116 and cover 114 when the cover securing screws 111 are tightened to fasten the cover in place (i.e. similarly as in the case of sleeve 24 of FIG. 3). However if the pin 150 is a screw as shown it can clamp the washer 152 and the ring or sleeve 124 against the case in opposite radial directions to maintain the adjusted power level.

In the construction according to the FIG. 6 and 7 three pawls 135 are preferably used, thus requiring three cam surfaces 142 on the flange portion of bushing part 108*b* as shown by FIG. 9 circumferentially between the circular rotor-guiding surfaces 108*b*'. The pawls 135 are preferably held in place for pivotal movement solely or principally by associated wall portions of the cavities 136 (see FIG. 6) or in a manner essentially identical to that disclosed in my pending application Ser. No. 64,119, filed October 21, 1960, now Patent No. 3,108,506. The ends of the pawls 135 (uppermost ends when tool is in the position shown in FIG. 7) lying axially opposite those engaged by the cam surfaces 142 underhang portions of the rotor assembly (block 117 and sleeve 117*a*) so that the pawls are prevented from moving axially out of position in the cavities 136 when the unit R' is inverted or disposed in some position other than as in FIG. 7.

For receiving input torque the axially exposed portions 45 and 45' of bushing members 108*a* and 108*b* may be hexagonal or as shown in FIG. 6 for engagement with a socket wrench or the like as illustrated in FIG. 1. If the externally exposed side face portions are of some other shape, for example cylindrical for engagement by a conventional power tool chuck, or collet, then manual application of input torque for tightening and loosening fasteners or doing other work requiring powerful torsional impact operation can be accomplished by the use of a bar wrench such as 156 having spanner lugs thereon located for engagement with mating sockets 158 in the end walls 114 and 115.

By making the input member D or D', output member T or T' and the interia member approximately symmetrical about their common axis of angular movement or rotation, the present tool can be accommodated for operation in work spaces such as would be inaccessible to the tools of each of my hereinbefore identified patents and said application, greatly increasing the potential field of use thereover as well as enabling selective employment of various already available power drive devices and equally well known manual torque applying tools operating axially (e.g. "Yankee" screw drivers and the like) for application of input torque.

I claim:

1. A rotary impact tool comprising an input member, an output member, and an inertia member, all approximately symmetrical about a common axis and journalled upon each other at mating mutually telescoping circular surfaces thereof for independent angular movement about said axis, a circular series of teeth on the output member about said axis, a circular shell coaxial with the output, input and inertia members and affixed to one of the last two mentioned members, spring means housed by the shell and yieldably interconnecting the inertia member and input member so as increasingly to resist angular relative movement thereof in one direction from an initial relative position, a pawl carried by the inertia member for angular movement therewith and spring-biased for engagement with said teeth and capable of movement to disengage the teeth, and a cam on the input member operative on the pawl as a function of said relative movement of the input member and inertia member in said direction to force the pawl out of engagement with one tooth of the series, whereby to enable the inertia member to produce a forcible impact through engagememnt of the pawl with another tooth of the series.

2. The tool according to claim 1 wherein one of the two first mentioned members projects beyond the other at each end thereof, both ends of each of said input and output members having respective operatingly identical torque transmitting portions such that either end portion of the input member can be driven by a single torque transmitting means and either end portion of the output member can be operatingly connected with a single work element for turning such element in either of two directions.

3. In a torque transmitting impact tool, a torque input member of tubular form having an enlarged hollow drum portion between its ends, an elongated torque output member supported within the input member for angular movement about its longitudinal axis and having torque transmitting portions disposed beyond respective ends of the input member, said output member having a series of equally circumferentially spaced teeth within said hollow drum portion, an inertia member of annular form surrounding said drum portion and guided by external peripheral surfaces of the input member adjacent respective ends of the drum portion, said inertia member having a pawl pivotally supported thereby and extending through an opening in a circumferentially extending wall of the drum portion for engagement with said teeth and movefent out of engagement therewith, a spring, torque-connecting the inertia member with the input member, and a cam on the drum portion operative to push the pawl out of engagement with one tooth for subsequent engagement with another tooth as a function of spring-force-increasing relative angular movement between the input member and inertia member in a predetermined direction.

4. A tool in the class of rotary impact wrenches, comprising a torque input member, a torque output member and an inertia member symmetrically arranged for relative angular movement about a common axis, the input member being tubular and having bearing surfaces respectively supporting the output member and the inertia member on said axis, the output member having a series of equally, circumferentially spaced teeth, a pawl carried by the inertia member and biased for movement toward the teeth, and power mechanism symmetrically arranged about said axis, said mechanism including a spring connected between the input member and inertia member and a cam on the input member operating as a function of overrunning movement on part of the input member rela-

tive to the other two members to cause escapement and impact-producing reengagement of the pawl with the teeth.

5. A tool according to claim 4 wherein the input member and the output member have, respectively, operatingly identical formations exposed in opposite directions axially of the tool in a manner to be capable of reversible operation both to receive and to transmit torque, as for tightening and loosening threaded fasteners.

6. In a torque transmitting impact tool, a tubular torque input member approximately symmetrical about its rotational axis, an output member having a series of equally spaced circumferentially disposed teeth within the input member and having operatingly identical relatively opposed terminal portions exposed for torque transmission to the work along said axis, and an inertia member of annular form, said input member consisting a bearing between the output member and inertia member guiding said three members for relative angular movement about the rotational axis of the input member, a pawl carried by the inertia member and spring biased toward said teeth for movement into and out of abutting relationship therewith, a power spring operatively connecting the input member with the inertia member, a cam on the input member arranged to cause escapement and impact-producing reengagement of the pawl with said teeth as a function of angular movement of the input member in one direction in overrunning or overhauling relation to the output member and inertia member, a circular shell supported by the inertia member coaxial thereof having the spring housed therein and with said spring yieldably connecting the shell to the input member, and means mounted on and supported by the inertia member for releasably clamping the shell to the inertia member in a plurality of adjusted positions to vary the strength of impacts producible by the spring.

7. A rotary impact tool comprising a central output shaft member, a tubular input shaft member, and an inertia member, all approximately symmetrical about a common axis, the output shaft member and the inertia member being journalled upon circular surfaces of the input shaft member for independent angular movement of all three members about said axis, a circular series of teeth on the output shaft member about said axis, a power spring operably interconnecting the inertia member and input shaft member so as increasingly to resist angular relative movement thereof in one direction from an initial relative position, a pawl carried by the inertia member for angular movement therewith and spring-biased for engagement with said teeth and capable of movement to disengage the teeth, and a cam on the input member operative on the pawl as a function of said relative movement of the input shaft member and inertia member in said direction to force the pawl out of engagement with one tooth of the series, whereby to enable the inertia member to produce a forcible impact through engagement of the pawl with another tooth of the series, said input shaft having a drum portion operatingly integral with its two ends and constituting a casing around the inertia member and the power spring.

8. A rotary impact tool comprising a central output shaft member, a tubular input shaft member, and an inertia member, all approximately symmetrical about a common axis, the output shaft member and the inertia member being journalled upon circular surfaces of the input shaft member for independent angular movement of all three members about said axis, a circular series of teeth on the output shaft member about said axis, a power spring operably interconnecting the inertia member and input shaft member so as increasingly to resist angular relative movement thereof in one direction from an initial relative position, a pawl carried by the inertia member for angular movement therewith and spring-biased for engagement with said teeth and capable of movement to disengage the teeth, and a cam on the input member operative on the pawl as a function of said relative movement of the input shaft member and inertia member in said direction to force the pawl out of engagement with one tooth of the series, whereby to enable the inertia member to produce a forcible impact through engagement of the pawl with another tooth of the series, said input shaft having a drum portion operatingly integral with its two ends and constituting a casing around the inertia member and the power spring, the power spring being of spiral form and having a radially outward convolution connected to the drum portion by adjustable means visible from a point externally of the drum portion.

9. A rotary impact tool comprising a central output shaft member, a tubular input shaft member, and an inertia member, all approximately symmetrical about a common axis, the output shaft member and the inertia member being journalled upon circular surfaces of the input shaft member for independent angular movement of all three members about said axis, a circular series of teeth on the output shaft member about said axis, a power spring operably interconnecting the inertia member and input shaft member so as increasingly to resist angular relative movement thereof in one direction from an initial relative position, a pawl carried by the inertia member for angular movement therewith and spring-biased for engagement with said teeth and capable of movement to disengage the teeth, and a cam on the input member operative on the pawl as a function of said relative movement of the input shaft member and inertia member in said direction to force the pawl out of engagement with one tooth of the series, whereby to enable the inertia member to produce a forcible impact through engagement of the pawl with another tooth of the series, one of the shaft members projecting beyond the other at each end thereof with both ends of each of said shaft members having respective operatingly identical torque transmitting portions such that either end portion of the input shaft member can be driven by a single torque transmitting means and either end portion of the output shaft can be operatingly connected with a single work element for turning such element in either of two directions.

10. A rotary impact tool comprising an input member, an output member, and an inertia member, all approximately symmetrical about a common axis and journalled upon each other at mating mutually telescoping circular surfaces thereof for independent angular movement about said axis, a circular series of teeth on the output member about said axis, spring means interconnecting the inertia member and input member so as increasingly to resist angular relative movement thereof in one direction from an initial relative position, a pawl carried by the inertia member for angular movement therewith and spring-biased for engagement with said teeth and capable of movement to disengage the teeth, and a cam on the input member operative on the pawl as a function of said relative movement of the input member and inertia member in said direction to force the pawl out of engagement with one tooth of the series, whereby to enable the inertia member to produce a forcible impact through engagement of the pawl with another tooth of the series, said spring means comprising a plurality of leaf spring members of generally spiral form, the opposite ends of the spring members being attached respectively to the inertia and input members in equally spaced apart angular relationship about the working axis of the tool (such as 180 degrees apart in case there are two such spring members).

11. A rotary impact tool comprising an input member, an output member and an inertia member, all approximately symmetrical about a common axis and journalled upon each other at mating mutually telescoping circular surfaces thereof for independent angular movement about said axis, a circular series of teeth on the output member about said axis, spring means interconnecting the inertia member and input member so as increasingly to resist angular relative movement thereof in one direction from one initial relative position, a pawl carried by the inertia

member for angular movement therewith and spring-biased for engagement with said teeth and capable of movement to disengage the teeth, and a cam on the input member operative on the pawl as a function of said relative movement of the input member and inertia member in said direction to force the pawl out of engagement with one tooth of the series, whereby to enable the inertia member to produce a forcible impact through engagement of the pawl with another tooth of the series, said spring means comprising interwound leaf spring spiral members lying in a common plane disposed normal to the working axis of the tool, the opposite ends of the spring members being attached respectively to the inertia and input members in equally spaced apart angular relationship about the working axis of the tool (such as 180 degrees apart in case there are two such spring members).

12. A rotary impact tool comprising an input member, an output member, and an inertia member, all approximately symmetrical about a common axis and journalled upon each other at mating mutually telescoping circular surfaces thereof for independent angular movement about said axis, a circular series of teeth on the output member about said axis, spring means interconnecting the inertia member and input member so as increasingly to resist angular relative movement thereof in one direction from an initial relative position, a pawl carried by the inertia member for angular movement therewith and spring-biased for engagement with said teeth and capable of movement to disengage the teeth, and a cam on the input member operative on the pawl as a function of said relative movement of the input member and inertia member in said direction to force the pawl out of engagement with one tooth of the series, whereby to enable the inertia member to produce a forcible impact through engagement of the pawl with another tooth of the series, said spring means comprising a leaf spring wound spirally about said common axis.

13. In a torque transmitting impact tool, a tubular torque input member approximately symmetrical about its rotational axis, an output member having a series of

equally spaced circumferentially disposed teeth within the input member and having operatingly identical relatively opposed terminal portions exposed for torque transmisison to the work along said axis, and an inertia member of annular form, said input member constituting a bearing between the output member and inertia member guiding said three members for relative angular movement about the rotational axis of the input member, a pawl carried by the inertia member and spring biased toward said teeth for movement into and out of abutment relationship therewith, at least one spirally round leaf spring coaxial with the input, output and inertia members and operatively connecting the input and inertia members, and a cam on the input member arranged to cause escapement and impact producing reengagement of the pawl with said teeth as a function of angular movement of the input member in one direction in overrunning or overhauling relation to the output member and inertia member.

References Cited in the file of this patent

UNITED STATES PATENTS

1,775,402	Mandl	Sept. 9, 1930
1,923,122	Smith	Aug. 22, 1933
2,112,693	Douglass	Mar. 29, 1938
2,256,496	Robinson	Sept. 23, 1941
2,271,803	Pfeiffer et al.	Feb. 3, 1942
2,463,656	Thomas	Mar. 8, 1949
2,539,930	Robinson	Jan. 30, 1951
2,661,647	Swenson	Dec. 8, 1953
2,664,020	De Note	Dec. 29, 1953
2,671,949	Welton	Mar. 16, 1954
2,688,268	Lear	Sept. 7, 1954
2,697,369	Knott	Dec. 21, 1954
2,776,588	Livermont	Jan. 8, 1957
2,844,982	Swenson	July 29, 1958
2,910,901	Ryd	Nov. 3, 1959
2,948,059	Bodine	Aug. 9, 1960
2,954,714	Swenson	Oct. 4, 1960
2,955,496	La Torre	Oct. 11, 1960
3,094,021	Young	June 18, 1963