July 29, 1958 O. J. SWENSON 2,844,982

RATCHET-TYPE, MANUALLY ACTUATED, ROTARY IMPACT TOOL

Filed June 21, 1956 3 Sheets-Sheet 1

FIG. 1

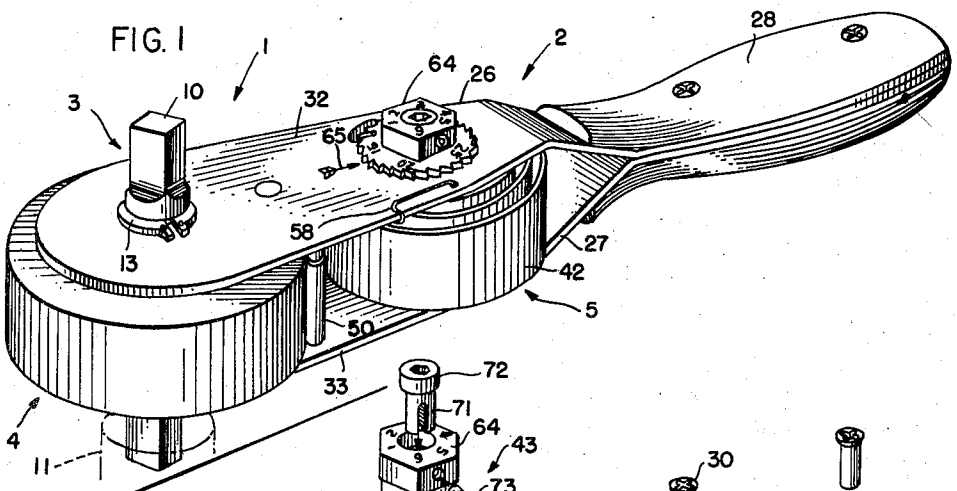
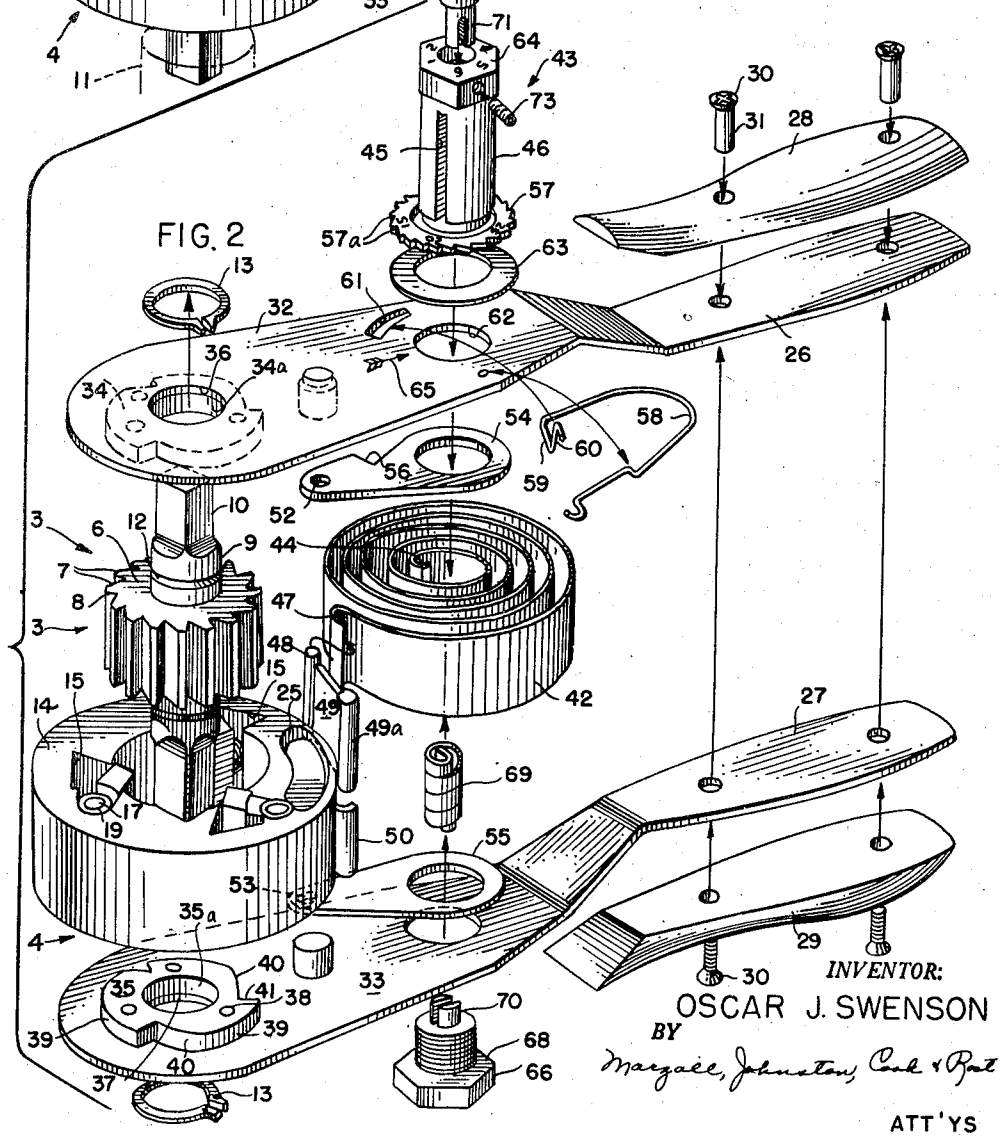


FIG. 2



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RATCHET-TYPE, MANUALLY ACTUATED, ROTARY IMPACT TOOL

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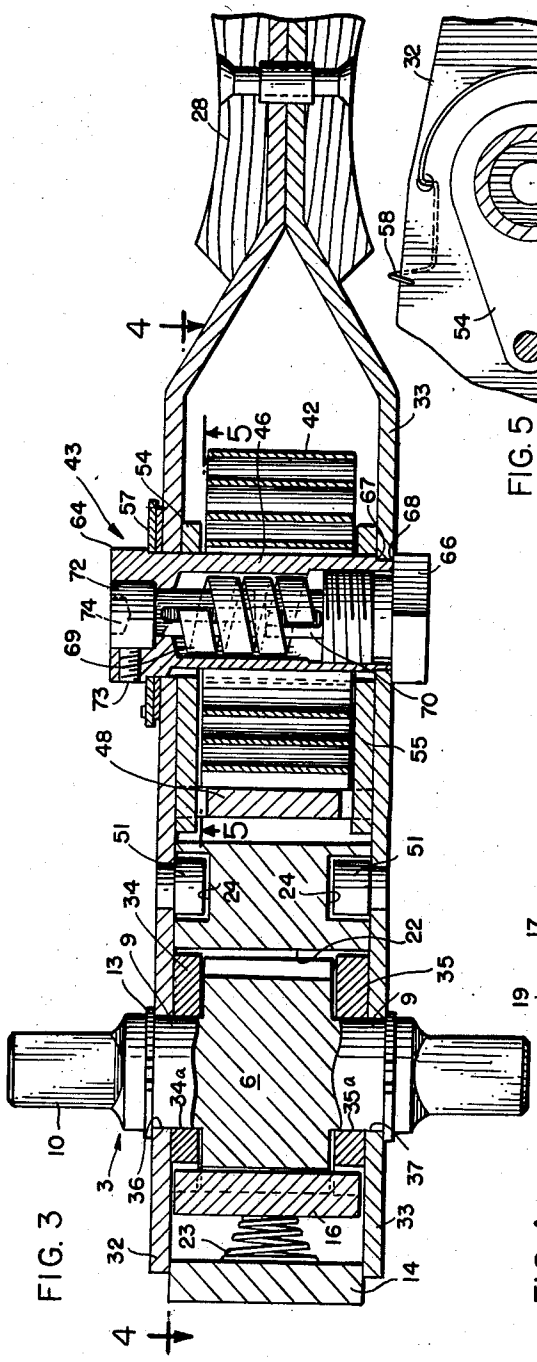


FIG. 3

FIG. 5

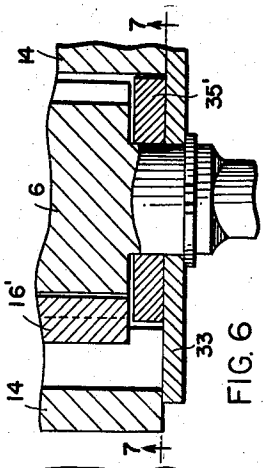


FIG. 6

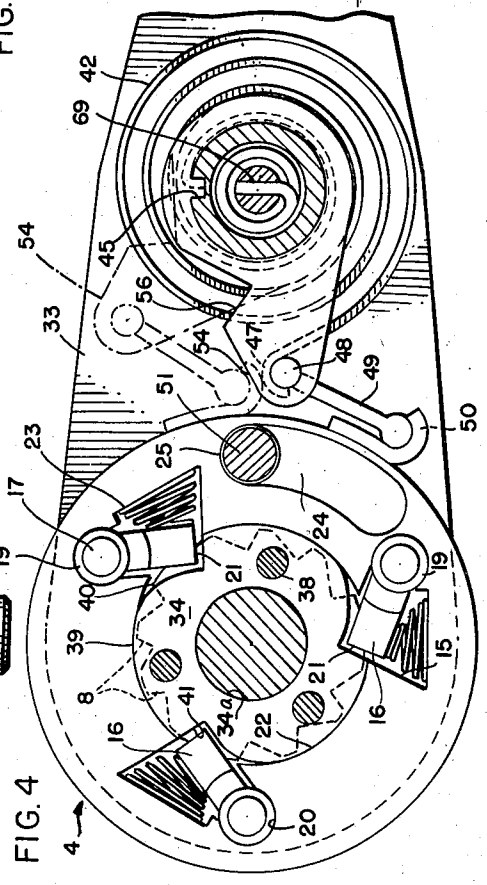


FIG. 4

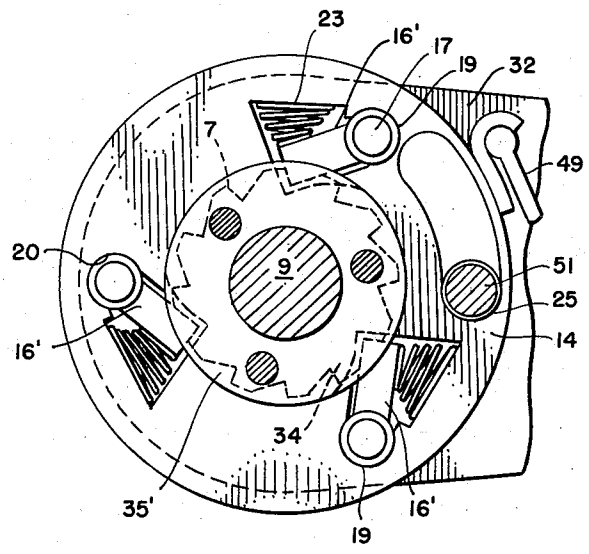
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RATCHET-TYPE, MANUALLY ACTUATED, ROTARY IMPACT TOOL

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FIG. 7



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United States Patent Office 2,844,982 Patented July 29, 1958

2,844,982

RATCHET-TYPE, MANUALLY ACTUATED, ROTARY IMPACT TOOL

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Application June 21, 1956, Serial No. 592,980

14 Claims. (Cl. 81—52.3)

This invention relates to impact tools and, particularly, to a manual or hand-operated tool for applying magnified force to threaded type fastenings. The invention is more particularly concerned with a ratchet type impact tool.

A tool of the type with which the present invention is concerned is shown in my U. S. Patent No. 2,661,647, December 8, 1953. An important object of the invention is to provide a new and improved manual impact tool, particularly, a tool furnishing improvements over the tool described in the aforesaid patent.

Another object is to provide an impact tool of the type described which functions in a more efficient manner, and which is especially well suited for commercial production.

An additional object is to provide an impact tool which is characterized by safety in operation and is very simple and convenient to operate.

A further object is to provide an impact tool having a minimum of parts and in which the parts perform multiple functions.

A particular object is to provide an impact tool of the type described which includes an advantageous cam-bearing for both operating and mounting parts of the tool.

Another particular object is to provide construction in a spring actuated impact tool of the type described adapted for rapid and safe adjustment of the spring tension.

A further particular object is to provide safeguards in an impact tool for preventing injury to the operator during operation of the tool.

Another object is to provide an impact tool including construction for automatically counting the number of impacts, so that a fastening may be tightened to a predetermined tension.

A further object is to provide a spring actuated impact tool including construction for minimizing the stress in the spring and prolonging its useful life.

These and other objects, advantages and functions of the invention will be apparent on reference to the specification taken in conjunction with the attached drawings, in which like parts are identified by like characters in each of the views and in which:

Figure 1 is a perspective view of a preferred embodiment of the impact tool of the invention.

Figure 2 is an exploded perspective view corresponding to Figure 1.

Figure 3 is a longitudinal elevational section through the impact tool.

Figure 4 is a cross sectional view taken on line 4—4 of Figure 3.

Figure 5 is a partial cross-sectional view on line 5—5 of Figure 3, illustrating the construction for counting the number of impacts;

Figure 6 is a partial elevational section of a tool portion, illustrating another embodiment of the invention; and

Figure 7 is a cross-sectional view taken on line 7—7 of Figure 6.

The invention contemplates a rotatable tool head for

engaging a threaded type fastening, manually actuated driving means and driving connections therebetween, an operating handle having means for disengaging the driving connections, and means for storing energy from movement of the handle and releasing the energy in the form of impact force transmitted through the driving connections.

Preferred features of the invention include the provision of a handle which also constitutes a protective cover for the driving connections. Also provided are cam means depending from the handle for disengaging the driving connections. Means inaccessible from the outside are provided for limiting relative movement between the handle and the apparatus which transmits the impact force.

In an especially advantageous embodiment, the cam means provides a bearing surface for the impact transmitting apparatus. The preferred construction also includes a mount for impact producing spring means, which is adjustable for varying the spring tension and which locks itself in position after being adjusted. Construction is provided for minimizing the stress in the spring means.

Referring to the drawings, a manual ratchet type impact tool **1** is illustrated which includes as its main components a handle assembly **2**, a tool head **3**, a rotor **4** and a spring assembly **5**. The impact tool **1** is designed for engagement with a threaded type fastening, for either tightening or loosening it. The tool operates initially in the manner of a common wrench, tightening the fastening merely by rotation of the tool in engagement therewith. The tool also includes ratchet and pawl members, for oscillating or reciprocating the tool to tighten or loosen the fastening, with no necessity for rotation in a complete circle or repeated removal of the tool. Most importantly, the tool includes construction for utilizing the ratchet and pawl members as anvil and hammer members, respectively, for operation as a hand impact tool, to provide magnified torque force for driving threaded type fastenings, such as nuts, bolts, screws and the like. The tool finds especially advantageous use in tightening and loosening fastenings subjected to considerable stresses, such as on high pressure equipment and operating machinery, particularly where large nuts and bolts are used, and in tightening fastenings where uniformity, reproducibility and accuracy of final stress values in the fastenings are important.

The tool head **3** is arranged transversely of the tool and includes a central cylindrical ratchet wheel **6** having a series of peripheral teeth **7**, there being twelve in the embodiment illustrated, which have impact surfaces **8**. Fastened to the ratchet wheel or integral therewith on opposite surfaces are axially extending shaft portions **9** terminating at opposite ends in square shaft extensions **10**, for engagement with a threaded type fastening having a complementary opening or recess. The shaft extensions **10** may engage a socket, such as the socket **11** illustrated in phantom in Figure 1, which is in turn recessed for engaging a nut or the like in known manner. The shaft extensions **10** may have any desired configuration for engaging corresponding openings or recesses in the driven member.

Circumferential slots **12** are provided on the tool head shaft portions **9** on opposite sides of the ratchet wheel, and they are engaged by retaining or confining split rings **13** for securing the tool assembly, as will be described subsequently in greater detail.

The tool head **3** and the ratchet teeth **7** thereof are surrounded by or enclosed within the rotor **4**. The rotor includes an annular body **14** provided with three recesses or slots **15**, recessed from the inner wall of the body, which extend in the direction of the axis of the body and which are spaced at equal angles around the body. Three

pawls **16** are pivotally mounted in the recesses, by means of cylindrical end pin portions **17** journalled in retaining tubular rings, sleeves or collars **19**, both at the upper and lower ends or opposite surfaces of the rotor body **14**. The recessed portions **15** provide corresponding semicircular seats **20** for the retaining rings, which are secured in the seats. The pawls **16** are mounted for pivotal oscillatory or reciprocatory motion from within the recesses **15** to a position in which their leading or innermost ends **21**, nearest the rotor axis, extend out of the recesses in a direction somewhat tangential to the inner wall **22** of the body **14**. The pawls **16** are spring pressed into normally inwardly protruding positions as illustrated, by corresponding compression springs **23**, which are seated in the recesses **15** and bear against the radially outer sides of the pawls.

The ratchet teeth **7**, the pawls **16** and the springs **23** constitute driving connections between the rotor **4** and the tool head **3**. These driving connections are thus arranged for engagement to prevent relative movement of the rotor and the head in one direction, corresponding to clockwise rotation of the rotor, as viewed from above in Figure 1. The ratchet and pawl members are also arranged to allow relative movement in the opposite direction, that is counterclockwise movement of the rotor relative to the tool head. In the following description and unless otherwise specified, reference to the direction of rotation contemplates the direction as viewed from above in Figures 1–3 and 6, and as viewed on the drawing in Figure 4.

The opposite plane surfaces of the rotor body **14** are provided with circumferentially arcuate kidney shaped recessed portions **24** which provide stop members or portions, particularly, a retaining shoulder **25**, for limiting the relative movement of the handle **2** and the rotor **4**, as will appear. In the embodiment illustrated, the construction is such that the upper and lower faces of the rotor body **14** are mirror images.

The operating handle **2** is constructed of two parallel elongated plates **26** and **27** which are united in their gripping portions and covered by grips **28** and **29**. The handle plates and the grips are secured together, thus securing the tool assembly, by pairs of opposed screws **30** which engage threaded collars **31** through corresponding holes in the members. From their gripping portions, the handle plates **26** and **27** branch into opposed parallel longitudinal flat bifurcations or forks **32** and **33** which serve as securing and mounting means for the remainder of the assembly and as cover plates.

Each of the mounting plates **32** and **33** is provided with a circular tool head mounting opening or hole, **36** and **37** respectively, adjacent its end remote from the gripping portions, in which the tool head **3** and the shaft portions **9** thereof are seated and secured in position by the split rings **13**. The tool head and the rotor **4** are are thus mounted on the handle **2**, and these members rotate about a common axis. The assembly so far described may be dismantled simply by removing the split rings **13** and the grip screws **30**.

The mounting plates **32** and **33** also serve as cover plates for the rotor **4** and the ratchet wheel **6** positioned between the plates, and particularly for the driving connections, to prevent obstruction by foreign material and eliminating the necessity for additional protective cover means.

Annular cams or cam-bearings **34** and **35** depend or extend inwardly from the inner surfaces of the respective mounting plates **32** and **33**, their central openings registering with the tool head mounting openings **36** and **37** of the plates. The cams or cam plates are fixed on or secured to the mounting plates by rivets **38** or the like, or they may be constructed integrally with the mounting plates or otherwise secured thereto, as by welding or brazing. Each cam is provided with three peripheral bearing surfaces **39**, and the same number of cam surfaces

40 and recesses **41**, each at equal angles around the periphery of the cams, corresponding to the disposition of the rotor body recesses **15** and the pawls **16** mounted therein.

The rotor body **14** and the inner wall **22** thereof (see Figure 4) are supported on the bearing surfaces **39** of the cams for relative rotation of the body and the cams. The inner walls **34***a* and **35***a* of the cams **34** and **35** also provide bearings for the shaft portions **9** of the tool head, in addition to the bearing function provided by the walls of the openings **36** and **37** of the mounting plates. Alternatively, the openings **36** and **37** may be made slightly larger than the cam inner walls **34***a* and **35***a* to cause the latter walls to furnish the sole bearing surfaces. This construction is of advantage in reducing stresses in the joint between cam-bearings **34** and **35** and their respective mounting plates **32** and **33** at the time of impact. The cam-bearings **34** and **35** thus rotatably support the ratchet wheel **6**, and this assembly is mounted within the rotor body **14**, as illustrated in Figure 3. In this position, the pawls **16** normally lie in the recessed portions **41** of the cams, with the leading ends **21** of the pawls contacting the impact or engaging surfaces **8** of the ratchet teeth **7**.

When the operating handle **2** is rotated in a clockwise direction, as viewed from above in Figure 1, the rotor **4** and the tool head **3** initially likewise rotate in the same direction, by the action of spring means to be described, and by engagement of the pawls **16** with the ratchet teeth **7**, thereby driving a threaded fastening through the connecting socket **11**. Eventually the resistance of the threaded fastening to further rotation reaches the predetermined force required to hold the tool head **3**, and rotor **4** through the connecting pawls **16**, stationary against the impetus of the spring means to be described which connect the rotor **4** and the handle **2**. At this time, the handle **2** and the cams **34** and **35**, movable in the clockwise direction relative to the rotor and tool head, continue to rotate, and the cam surfaces **40** cause the pawls **16** to be pressed into the recesses **15** of the rotor body against the action of the compression springs **23**. Ultimately, the pawls **16** are cammed out of engagement with the ratchet teeth **7**. Then, the rotor is free to rotate in the clockwise direction relative to the ratchet wheel **6**. The impact function of the tool is then obtained, by means to be described.

When the operating handle **2** is rotated in a counterclockwise direction, as viewed from above in Figure 1, the rotor **4** rotates in the same direction, by construction subsequently described. With the tool head **3** engaged with a threaded fastening through a socket **11**, as in Figure 1, continued counterclockwise rotation causes the pawls **16** to slide resiliently over the ratchet teeth **7** when the fastening offers sufficeint resistance to hold the tool head against the force required to slide the pawls over the ratchet teeth. In this manner, the ratchet function of the tool is obtained.

In the above and subsequent description, it is assumed that the threaded fastening engaged by the socket **11** has a right hand thread. The tool functions in like manner with a fastening having a left hand thread, but the tool is turned over, or rotated 180° about its longitudinal axis, to perform the same operations.

It will be observed from the above description that the cams **34** and **35** provide the three functions of camming the pawls **16**, serving as bearings for the rotor body **14**, and serving as bearings for the shaft portions **9** of the tool head. With the provision of cams which are pendant from the mounting plates **32** and **33**, as many equiangular cam surfaces **40**, bearing surfaces **39**, recessed portions **41** and pawls **16** as desired can be provided in the tool. Three of each disposed at angles of 120° are provided in the illustrated embodiments, and this construction serves very well to provide a durable and effective tool.

While the preferred construction illustrated in Figures

1–5 includes two cam-bearings **34** and **35**, only one cam-bearing such as that numbered **34** need be employed, and a bearing **35'** as illustrated in Figure 6 and Figure 7 may be substituted for the other. In this alternative embodiment, the bearing **35'** has no cam surfaces or recessed portions corresponding to the cam and recessed portions **40** and **41** of the cam-bearing **35**. The pawls **16** are then shortenen to provide the pawls **16'** in Figure 6 which terminate inwardly of the bearing **35'**. The remainder of the construction is the same as that illustrated in Figures 1–5. With this alternative construction, the cam-bearing **34** alone operates as described above to cam the pawls **16'** into the rotor body recesses **15**, by the action of the cam surfaces **40** on the pawls. Both the cam-bearing **34** and the bearing **35'** continue to furnish the bearing functions described above.

The spring assembly **5** is mounted between the mounting plates **32** and **33** and constitutes means connecting the operating handle **2** with the rotor **4** for rotating the tool head **3** and for furnishing the impact function of the tool. The spring assembly includes a spiral coil spring **42** normally in compression, mounted on an arbor **43** in turn adjustably mounted on the handle **2** and the mounting plates **32** and **33** thereof. At its inner end, the spring **42** is provided with a hook or bent portion **44** which seats in or engages a corresponding longitudinal groove or slot **45** extending transversely of the tool in the outer surface of a tubular arbor body **46**. The outer end of the coil spring **42** is provided with an arcuate hook or bent portion **47** in which is seated a cylindrical or pin shaped end portion **48** of a pivotal link **49**. The link is provided with a second opposite cylindrical portion **49*a*** which is pivotally seated in an arcuate link seat **50** fixed to the side of the rotor body **14**, as by welding.

When the arbor **43** is fixed relative to the mounting plates **32** and **33**, so that the coil spring **42** is under a predetermined tension, operation of the handle **2** causes the above described functions of the tool to be performed. Thus, with particular reference to Figure 4, when the tool is inserted in a socket **11** (Figure 1) for tightening a threaded fastening engaged by the socket, the handle is rotated clockwise. The force of the coil spring **42** is transmitted through the link **49** and the link seat **50** to the rotor **4**, which causes the rotor and the tool head **3** to rotate in the same direction. Continued clockwise rotation will tighten the fastening to the extent that the movement of the tool head **3** and the rotor **4** will be resisted. With sufficient resistance, pressure on the handle **2** will cause it and the cams **34** and **35** to rotate in the clockwise direction relative to the tool head and rotor, causing the pawls to be cammed out of engagement with the ratchet teeth **7**.

During this time, the coil spring **42** will be further compressed, storing up energy from the additional movement of the handle. With the pawls **16** disengaged, the rotor **4** will then be given a strong clockwise impetus by the coil spring, causing the pawls to advance relative to the tool head by one set of ratchet teeth, when they impact on the impact surfaces **8** of the next set of teeth to drive the tool head with greatly magnified force. At this time, the recessed portions **41** of the cams will be located to permit the impact and so that they in the positions illustrated in Figure 4. Continued clockwise rotation of the operating handle **2** produces a succession of like impacts on successive ratchet teeth.

The terminology "predetermined force" and "predetermined tension" as used herein has reference to the adjustable features of the spring assembly **5** in connection with the rotor **4** and the tool head **3**. The spiral coil spring **42** is adjusted to any desired tension for producing corresponding forces and overcoming or yielding to corresponding resistances. For example, the coil spring **42** is tightened, by adjusting the arbor **43**, to produce a given spring tension. When the handle **2** is initially rotated clockwise for tightening a fastening, force corresponding to the spring tension is transmitted to the rotor **4** and through the driving connections to the tool head **3**. Eventually the resistance furnished by the threaded fastening increases to the point that the tool head **3** and rotor **4** are held by the force of the resistance against the coil spring **42** tension. This resistance force is predetermined in accordance with the requirements of the job, and it is determined or fixed by the predetermined spring tension initially produced in the coil spring.

When rotation of the handle **2** is continued from that point of resistance to movement of the tool head **3** by a predetermined force, the compression of the coil spring **42** increases until the pawls **16** are disengaged and the rotor **4** is released from its connection with the tool head **3**, and an impact is produced, as described above. The force of this impact is determined by the tension produced in the coil spring by this time, which in turn is a function of the aforementioned predetermined initial spring tension. The impact force increases with increasing initial spring tension, and vice versa.

A pair of pendant stop pins **51** are affixed to the mounting plates **32** and **33**, and they are engaged or seated in the corresponding recesses **24** in the surfaces of the rotor body **14**. The stop pins **51** and the recessed portions **24** serve two purposes, one of which is to prevent the rotor from rotating relative to the handle under the normal compression of the coil spring **42**, the pins **51** being held by the shoulders **25** of the recesses for this purpose. These means for limiting the relative movement of the handle and the rotor also cooperate in the ratchet function of the tool. When it is desired to operate the tool by reciprocating the handle **2**, instead of rotating the handle in a circle, the rotor **4** carrying the pawl means may be rotated in the counterclockwise direction relative to the tool head **3** by the counterclockwise action of the handle and engagement of the stop pins **51** with the recessed shoulders **25**. The pawls **16** then slide over the ratchet teeth **7**, reengaging the teeth at any desired location, for further clockwise rotation.

From the point where the pawls **16** are just released or disengaged from the ratchet teeth **7**, the rotor advances angularly until the pawls engage the next set of teeth, plus the angle moved by the threaded fastening being driven. There being **12** equally spaced ratchet teeth **7**, the angle is 30° plus the small angle moved by the fastening. The compression of the coil spring **42** and the movement of the stop pin **51** in the recess **24** are such that the stop pin has advanced about 37° relative to the rotor just prior to release. Consequently, when impact takes place, the stop pin is not struck by the shoulder **25** of the recess, but several degrees of freedom remain.

As noted previously, the recessed portions **41** of the cams are located to permit impact of the pawls on the ratchet teeth, the pawls thus not striking the recessed portions. The pawls are also not contacted by the recessed portions **41** during counterclockwise rotation of the handle **2**, being prevented from so doing by the engagement of the stop pins **51** with the shoulders **25**. In this manner, the movement of the pawls **16** over the ratchet teeth during counterclockwise rotation is not interfered with by contact of the pawl ends **21** and the recessed portions **41**.

In connection with the stop pin **51** and recess **24** construction, it will be noted that the respective members are wholly enclosed within the construction, and are inaccessible from the outside. This is very important, as it precludes catching or pinching an outside member therebetween when the rotor is released, particularly, there is no danger of catching the operator's finger between the members.

In the foregoing operation, the pivotal link **49** operatively connecting the rotor **4** and the handle **2** serves

an important purpose in minimizing stress in the coil spring **42**. With the construction of the outer end **47** of the spring directly connected to the rotor body **14**, the spring is forced to follow the path of the surface of the rotor around its axis, rather than around the axis of the arbor **43**. This causes flexing of the spring adjacent its outer extremity with variation in stress, making the spring vulnerable to failure by fatigue. With the link construction of the present invention, further compression of the spring with movement of the handle merely causes the spring to tighten in the same direction around the arbor axis, as illustrated in phantom in Figure 4. In tests aimed at destruction, a spring failed at about 25,000 cycles when connected directly to the rotor, whereas the construction illustrated withstood over 100,000 cycles without failure. The link construction has the further advantage of permitting desirable arrangement of the relationship between the spring forces acting on rotor body **14** at the beginning, during and at the end of the compression and decompression cycle of the spring by proper choice of sizes and positional relationship of the component parts.

The link pin portion **48** seated in the hook **47** of the coil spring is journaled at its opposite ends in corresponding openings **52** and **53** in two longitudinally extending pivot arms **54** and **55**. The pivot arms are provided with circular openings adjacent one end, for mounting in a freely rotatable manner on the arbor **43**, on the opposite surfaces or edges of the coil spring and within the mounting plates **32** and **33**.

As previously stated, an important function and application of the tool herein described is to tighten threaded fastenings to accurately predeterminable and reproducible stresses in the fastenings. Achievement of this function depends on the fact that a definite amount of energy is required to be expended on a threaded screw fastening to tighten it to a specific stress or tension in the fastening. The total amount of energy so required is the sum of the energy required to overcome the friction between surfaces of the moving parts in the fastening, such as between thread and nut surfaces, plus the energy stored as a result of strain produced in the fastener and the parts engaged by it. The total amount of energy applied by the tool and manner of operation herein described is equal to the sum of the individual energies of each of the succession of impacts applied by the tool, or, since the energy released by each impact is a constant for any specific setting of the spring means of the tool, this total energy is also equal to the amount of energy released per impact multiplied by the number of impacts applied to the fastening. Thus, it is possible to determine and control the amount of energy applied to a fastener by the tool by counting the number of impacts applied and multiplying this number by the known value of the energy applied by each impact, and hence control or predetermine the final stress achieved in the fastener.

During the operation of the tool **1**, a clearly audible sound it produced on each impact, so it is a simple matter for the operator to count the number of impacts delivered as operation proceeds and to stop the operation when the desired number has been reached. In some cases, however, it is desirable to relieve the operator of this counting task by providing a counting device that automatically counts and records the number of impacts delivered up to any point in the operation. Such an impact counting construction in the new tool is described below.

One of the pivot arms numbered **54**, is notched to provide an operating shoulder **56** for operating a ratchet wheel impact counter **57**. A spring pawl **58** cooperates, and it is hooked and fastened to one of the mounting plates, numbered **32**, and looped and bent to provide a terminal pawl part **60** seating in the teeth **57***a* of the counter. As the notched pivot arm **54** is moved to the position shown in phantom in Figure 4, the operating shoulder **56** bears on a depending shoulder portion **59** of the spring pawl, to move it, the pawl part **60** and thus the ratchet wheel counter **57** one notch in the clockwise direction (see Figure 5). When the pivot arm **54** returns to its normal position upon release of the coil spring **42** energy and upon impact, the resilient action of the spring pawl **58** causes the depending portion **59** and the pawl part **60** of the spring pawl to spring back one notch, after which the operation repeats for each coil spring cocking and release.

The pawl part **60** operates in a circumferentially arcuate slot **61**, about an intermediate circular opening **62** in the mounting plate **32**, in which opening the arbor **43** is mounted. The ratchet wheel counter **57** rotates around the arbor and is mounted on the outer surface of the mounting plate. A spring washer **63** is located between the counter **57** and the surface of the mounting plate **32**, to provide sufficient friction to hold the counter against free movement. The ratchet wheel counter **57** is also held in place by the shouldered portion of a hexagonal or otherwise shaped head **64** on the arbor.

The impact counter has a graduated dial on its upper or outer surface, with the numbers ascending in a counterclockwise direction, and a witness mark or arrow **65** is provided on the outer surface of the mounting plate **32**, for indicating the number of impacts. In this manner, a series of impacts is automatically counted, so that the operator need not keep track of them, and threaded fastenings can be tightened uniformly to the same precise predetermined tension, which is a function of the number of impacts and the tension of the coil spring **42**.

The foregoing constitutes a new and improved method and means for tightening fastenings to predetermined tensions, considerably more accurately and uniformly than prior methods and constructions. In particular, application is made of the accompanying discovery that by proper selection of impact tool size and impact energy, as determined, for example, by the coil spring setting in the illustrative embodiment, with relationship to the dimensions of the threaded fastening, the curve defined by plotting the number of impacts against the stress or tension in the fastening on log-log paper is a straight line in the region of the stress ultimately desired in the fastening. In this manner, the desired stress can be achieved with remarkable accuracy and reproducibility. There is no longer any requirement for less accurate and limited regulation of stress based upon impacting until tightening ceases and the fastening absorbs no further energy as tension upon impact, or for less accurate and more cumbersome measurement of the torque or twist applied to the fastening.

In this new method, the energy or force applied on each impact is fixed at or adjusted to a predetermined value, the number of impacts is counted, and operation is discontinued following a number of impacts which is predetermined according to the tension ultimately desired in the fastening. Means are provided for fixing or adjusting the impact energy and for counting the number of impacts. The method and means are more broadly applicable in the operation and construction of power driven impact tools and other manual impact tools as well.

The preceding references to accurately reproducible stresses are relative to presently available apparatus and methods. It is recognized that factors such as imperfections in threads and condition of threads with regard to smoothness, fit and lubrication affect the final stress achieved in a threaded fastener by the application of a specific amount of energy in tightening the fastener. Mathematical analysis indicates that the stress produced in a threaded fastener by the application of a specific amount of energy in tightening it is substantially proportional to the square root of the frictional forces between threads and other surfaces moving during tightening, and that the stress produced by the application of a specific

torque value to tighten the fastener is substantially proportional to the first power of these frictional forces. Thus, a difference in frictional condition between two outwardly similar fasteners will always result in a lesser variation in stress between these fasteners if application of the same amount of energy to tighten each is used as the criterion of stress, than if application of the same torque value to each is used as the criterion of stress in the fastener.

As previously described, the arbor **43** is adjustably mounted on the mounting plates **32** and **33** of the operating handle **2** for adjusting the tension of the coil spring **42** to a desired predetermined value. Both the resistance which will retard the tool head and the rotor, and the impact force are determined by the coil spring tension. Greater spring tension requires greater resistance and produces greater impact force. The arbor construction in the preferred embodiment illustrated constitutes an especially advantageous and novel component of the invention which contributes importantly to the ease of operation and safety of the tool.

The arbor is adjustable on the handle by means of the arbor body **46** and a lock nut **66** threadedly engaging the body, the two component parts frictionally engaging the handle therebetween. As illustrated in Figure 3, an annular ledge or shoulder **67** is provided on the arbor body **46**, and an annular shoulder **68** is provided on the lock nut. The shoulders frictionally engage the lower mounting plate **33** between them, to hold the coil spring **42** in compression. The lock nut **66** illustrated has a right hand thread, and the operation described subsequently has reference thereto. By appropriate reversal of parts, a nut and arbor body having left hand threads can be used as well.

When the arbor engages the handle in this manner and with no other forces holding the arbor, there is danger in adjusting the spring tension, that inadvertent release of adjusting wrenches with consequent release of the spring energy will cause injury to the operator. To overcome this problem and provide an entirely safe tool, construction is provided for connecting the component parts so that the arbor **43** is self-locking. In particular, the arbor body **46** and the lock nut **66** are connected by a torsion spring **69** for locking the arbor. One end of the spring is connected to a vertically slotted extension **70** of the lock nut, and the other end is connected to a vertically slotted extension **71** of an adjustable arbor body spring connector **72**. The spring connector is secured in a desired rotational position in the arbor body by a set screw **73** in the side of the hexagonal head **64** of the body. The relative rotation of the spring connector **72** is adjusted by inserting a wrench in a wrench opening or recess **74** in the outer end of the connector, loosening the set screw for this purpose. The torsion spring **69** can thus be adjusted to any desired tension, for urging the arbor body **46** and the lock nut **66** into threaded engagement.

The construction of the arbor **43** is such that the torsion spring **69** causes the shoulders **67** and **68** of the parts to bear on the surfaces of the mounting plate **33** with sufficient pressure to resist any tendency for clockwise rotation of the arbor due to the torsional reaction of the coil spring **42**. When it is desired to increase the spring tension, a wrench is applied to the arbor head **64**, and it is rotated in a counterclockwise direction (viewed from the top of the tool as shown in Figure 3). This causes the lock nut **66** to unthread slightly and loosen its frictional hold on the mounting plate **33**, so that it also rotates under the torsional impetus of the arbor locking spring **69**. When rotation of the arbor is discontinued, the coil spring **42** acts to rotate the arbor body **46** clockwise and thread it on the lock nut **66**, while the friction at the shoulder **68** of the lock nut, increased by the torsion spring **69**, holds the lock nut sufficiently to cause the arbor to automatically lock. The coil spring **42** is loosened by applying a wrench to the lock nut **66**, and rotating it in a counterclockwise direction, as viewed from the head of the lock nut (from the bottom of Figure 3). When this rotation is stopped, the tension of the coil spring **42** causes the arbor body **46** to thread on the lock nut, and the same frictional forces and tension of the torsion spring **69** hold the lock nut **66** for automatically locking the arbor.

By the described construction, it is insured that the torque required to slide the shoulder **68** of the lock nut is at least equal to, preferably greater than the torque required to turn the male threads on the lock nut further into the female threads of the arbor body **46**, so that it becomes self-locking in the manner described. The arbor constitutes a simple and unique construction to permit tightening or loosening of the coil spring by rotating the arbor body or the lock nut, respectively, with the arbor locking automatically at the terminal position in either case. The face or outer surface of the arbor body head **64** bears a graduated dial ascending in the clockwise direction, for setting the coil spring at the desired degree of tension. The witness mark **65** can serve as the reference point.

To summarize the operation of the impact tool, it is inserted in a threaded fastening or a socket such as **11**, and the handle **2** of the tool is rotated clockwise to tighten the fastening. Initially, the tension of the coil spring **42** causes the handle **2**, the rotor **4**, the tool head **3** and the fastening to rotate together. The tool can be reciprocated, in the manner of a ratchet wrench. Ultimately, the fastening becomes tight, and the tool head **3** and the rotor **4** are restrained. At this time, the handle **2** and the cams **34** and **35** advance relative to the rotor and tool head, cocking the coil spring **42**, until the pawls **16** are cammed out of engagement with the ratchet wheel **6**. The rotor is then free to rotate clockwise, and the spring **42** uncoils and rotates the rotor to a position where each of the pawls **16** engages the next tooth **7** with the transmission of considerable impact force. Continued operation produces a series of impacts. Each impact is automatically recorded by the counter **57** by the action of the notched pivot arm **54** on the spring pawl **58** engaging the counter.

To loosen a threaded fastening, the tool is simply turned over, and the opposite shaft extension **10** is inserted in the fastening. The tool then operates in the same manner to loosen the fitting, except that with a tight fastening, the impacts will be achieved first, until the fastening is sufficiently loose that the tool removes it in the manner of a ratchet wrench.

The tool is very readily disassembled, and this constitutes a feature of the invention. After loosening the coil spring **42** and the torsion spring **69**, as described leaving the arbor body spring connector **72** free to rotate, the lock nut **66** is unthreaded and removed. The handle screws **30** and one of the split spring steel snap rings **13** are removed, and the tool is simply pulled apart, somewhat as illustrated in the exploded view of Figure 2.

The new construction of the manually operable ratchet type impact tool is characterized by a number of advantages and improvements. The mounting plates **32** and **33** serve for mounting the assembly and as cover plates for the driving connections, reducing the number of parts to a minimum. The construction of pendant cams **34** and **35** permits of any desired number of equally spaced cam and bearing surfaces, and pawls, providing a durable and efficient construction, with the load uniformly distributed and the parts arranged symmetrically. The cams serve as such, as bearings for the rotor **4**, and as bearings for the shaft portions **9**. This construction permits the use of a longer and more rugged ratchet wheel **6** within the same overall width of the tool. The discontinuous bearing surface between the cams and the rotor has the advantage of furnishing a disengaging space for particles of foreign matter which

which might otherwise cause galling or seizing of the parts.

The arbor assembly is convenient and safe, automatically locking after each adjustment. The adjustment of the coil spring tension can be made with but one wrench, there being no need for wrenches at both ends of the arbor. The danger that a wrench might slip and cause injury to the operator due to release of the coil spring has been eliminated.

A further feature furnishing increased safety is the provision of inaccessible construction for limiting the relative movement of the handle and the rotor, precluding injury to the operator upon movement of the parts at the time of impact.

The construction is such as to have a long useful life, and the parts are durable and not subject to excessive wear. The coil spring life is greatly prolonged by the provision of a link connection which minimizes variation in stress in the spring. The construction is especially well suited for widespread practical application as a manual impact tool.

The invention is hereby claimed as follows:

1. In a manually operable impact tool, the combination of a rotatable tool head for engaging a threaded type fastening, manually actuated driving means including a rotor surrounding said tool head, driving connections between said rotor and said tool head, an operating handle movable relative to said rotor and being a protective cover for said driving connections, cam means depending from said handle for disengaging said driving connections when movement of said head is resisted by a predetermined force, said rotor being movable relative to said tool head upon said disengagement, spring means coupling said handle and said rotor for storing energy from said relative movement of the handle, means for releasing said stored energy upon said disengagement of driving connections to move said rotor relative to said tool head, and means for re-engaging said driving connections to convert kinetic energy of said rotor movement to impact force on said tool head.

2. In a manually operable impact tool, the combination of a rotatable tool head for engaging a threaded type fastening, manually actuated driving means including a rotor surrounding said tool head, driving connections between said rotor and said tool head including ratchet and pawl members arranged for engagement to prevent relative movement of said rotor and said head in one direction and to allow relative movement thereof in another direction, an operating handle movable relative to said rotor and being a protective cover for said driving connections, cam means depending from said handle for disengaging said ratchet and pawl members when movement of said head is resisted by a predetermined force, said rotor being movable relative to said tool head in said first-named direction upon said disengagement, spring means coupling said handle and said rotor for driving the rotor, said spring means storing energy from said relative movement of the handle, means for releasing said stored energy upon said disengagement of ratchet and pawl members to move said rotor relative to said tool head in said first-named direction, and means for re-engaging said ratchet and pawl members to convert kinetic energy of said rotor movement to impact force on said tool head.

3. An impact tool as defined in claim 1 including means inaccessible from the outside for limiting the relative movement of said handle and said rotor, said limiting means including enclosed interengaging stop members on the handle and rotor, respectively.

4. An impact tool as defined in claim 1 wherein said cam means provides a bearing surface for said rotor.

5. An impact tool as defined in claim 1 wherein said spring means comprises a spiral coil spring connected at its ends to the handle and rotor through an interposed pivotal link.

6. In a manually operable impact tool, the combination of a rotatable tool head for engaging a threaded type fastening, manually actuated driving means including a rotor surrounding said tool head, driving connections between said rotor and said tool head including ratchet and pawl members arranged for engagement to prevent relative movement of said rotor and said head in one direction and to allow relative movement thereof in another direction, an operating handle movable relative to said rotor, a cam-bearing depending from said handle for disengaging said ratchet and pawl members when movement of said head is resisted by a predetermined force, said cam-bearing also being a bearing for said rotor, said rotor being movable relative to said tool head in said first-named direction upon said disengagement, spring means coupling said handle and said rotor for driving the rotor, said spring means storing energy from said relative movement of the handle, means for releasing said stored energy upon said disengagement of ratchet and pawl members to move said rotor relative to said tool head in said first-named direction, and means for re-engaging said ratchet and pawl members to convert kinetic energy of said rotor movement to impact force on said tool head.

7. In a manually operable impact tool, the combination of a rotatable tool head for engaging a threaded type fastening, manually actuated driving means including a rotor surrounding said tool head, driving connections between said rotor and said tool head, an operating handle movable relative to said rotor and being a protective cover for said driving connections, cam means depending from said handle for disengaging said driving connections when movement of said head is resisted by a predetermined force, said rotor being movable relative to said tool head upon said disengagement, spring means coupling said handle and said rotor for storing energy from said relative movement of the handle, means for releasing said stored energy upon said disengagement of driving connections to move said rotor relative to said tool head, means for re-engaging said driving connections to convert kinetic energy of said rotor movement to impact force on said tool head, and an impact counter responsive to said relative movement of said handle and said rotor.

8. In a manually operable impact tool, the combination of a rotatable tool head for engaging a threaded type fastening, manually actuated driving means including a rotor surrounding said tool head, driving connections between said rotor and said tool head, an operating handle movable relative to said rotor and being a protective cover for said driving connections, cam means depending from said handle for disengaging said driving connections when movement of said head is resisted by a predetermined force, said rotor being movable relative to said tool head upon said disengagement, a spring assembly coupling said handle and said rotor for storing energy from said relative movement of the handle, means for releasing said stored energy upon said disengagement of driving connections to move said rotor relative to said tool head, means for re-engaging said driving connections to convert kinetic energy of said rotor movement to impact force on said tool head, said spring assembly including spring means coupling said handle and said rotor and mounted on an arbor mount adjustable on said handle for varying the spring tension, and an impact counter mounted on said handle and responsive to the action of said spring means in said storage and release of energy.

9. In a manually operable impact tool, the combination of a rotatable tool head for engaging a threaded type fastening, manually actuated driving means including a rotor surrounding said tool head, driving connections between said rotor and said tool head, an operating handle movable relative to said rotor and being a protective cover for said driving connections, cam means depending from said handle for disengaging said driving connections when movement of said head is resisted by a predetermined force, said rotor being movable relative to said tool head

upon said disengagement, a spring assembly coupling said handle and said rotor for storing energy from said relative movement of the handle, means for releasing said stored energy upon said disengagement of driving connections to move said rotor relative to said tool head, means for re-engaging said driving connections to convert kinetic energy of said rotor movement to impact force on said tool head, said spring assembly including spring means coupling said handle and said rotor and mounted on an arbor mount on said handle, said spring means being connected to said rotor by a pivotal link, an arm rotatable on said arbor mount and carrying said link, and an impact counter rotatable on said arbor mount and responsive to the action of said arm.

10. In a manually operable impact tool, the combination of a rotatable tool head for engaging a threaded type fastening, manually actuated driving means including a rotor surrounding said tool head, driving connections between said rotor and said tool head, an operating handle movable relative to said rotor, cam means depending from said handle for disengaging said driving connections when movement of said head is resisted by a predetermined force, said rotor being movable relative to said tool head upon said disengagement, a spring assembly coupling said handle and said rotor for storing energy from said relative movement of the handle, means for releasing said stored energy upon said disengagement of driving connections to move said rotor relative to said tool head, means for re-engaging said driving connections to convert kinetic energy of said rotor movement to impact force on said tool head, said spring assembly including spring means coupling said handle and said rotor and mounted on an arbor mount adjustable on said handle for varying the spring tension, said arbor mount comprising threadedly engaging component parts frictionally engaging said handle therebetween, and torsion spring means connecting said parts for urging them into threaded engagement.

11. In an impact tool whose impact blows are delivered from energy stored in and released from a spring means and having an operating handle, an arbor mount for said spring means and adjustable on said handle for varying the spring tension, said arbor mount comprising threadedly engaging component parts frictionally engaging said handle therebetween, and torsion spring means connecting said parts for urging them into threaded engagement.

12. In an impact tool whose blows are delivered from energy stored in and released from a spring means and having an operating handle, an arbor mount for said spring means and adjustable on said handle for varying the spring tension, said arbor mount comprising a tubular body threadely engaging lock nut means for frictionally engaging said handle therebetween, torsion spring means in said body and connecting it with said lock nut means for urging them into threaded engagement, and means on said arbor mount for varying the tension of said torsion spring means.

13. In a manually operable impact tool, the combination of a rotatable tool head for engaging a threaded type fastening, manually actuated driving means including a rotor surrounding said tool head, driving connections between said rotor and said tool head including ratchet and pawl members arranged for engagement to prevent relative movement of said rotor and said head in one direction and to allow relative movement thereof in another direction, an operating handle movable relative to said rotor, cam means depending from said handle for disengaging said ratchet and pawl members when movement of said head is resisted by a predetermined force, said cam means providing a bearing surface for said rotor, said rotor being moveble relative to said tool head in said first-named direction upon said disengagement, means inaccessible from the outside for limiting the relative movement of said handle and said rotor, said limiting means including enclosed interengaging stop members on the handle and rotor, respectively a spring assembly coupling said handle and said rotor for driving the rotor, said spring means storing energy from said relative movement of the handle, means for releasing said stored energy upon said disengagement of ratchet and pawl members to move said rotor relative to said tool head in said first-named direction, means for re-engaging said ratchet and pawl members to convert kinetic energy of said rotor movement to impact force on said tool head, said spring assembly including spring means coupling said handle and said rotor and mounted on an arbor mount adjustable on said handle for varying the spring tension, said arbor mount comprising threadedly engaging component parts frictionally engaging said handle therebetween, and torsion spring means connecting said parts for urging them into threaded engagement.

14. In a manually operable ampact tool, the combination of a rotatable tool head for engaging a threaded type fastening, manually actuated driving means including a rotor surrounding said tool head, driving connections between said rotor and said tool head including ratchet and pawl members arranged for engagement to prevent relative movement of said rotor and said head in one direction and to allow relative movement thereof in another direction, an operating handle movable relative to said rotor, a cam-bearing depending from said handle for disengaging said ratchet and pawl members when movement of said head is resisted by a predetermined force, said cam-bearing also being a bearing for said rotor, said rotor being movable relative to said tool head in said first-named direction upon said disengagement, means inaccessible from the outside for limiting the relative movement of said handle and said rotor, said limiting means including enclosed interengaging stop members on the handle and rotor, respectively, a spring assembly coupling said handle and said rotor for driving the rotor, said spring means storing energy from said relative movement of the handle, means for releasing said stored energy upon said disengagement of ratchet and pawl members to move said rotor relative to said tool head in said first-named direction, means for re-engaging said ratchet and pawl members to convert kinetic energy of said rotor movement to impact force on said tool head, said spring assembly including a coil spring coupling said handle and said rotor and mounted on an arbor mount adjustable on said handle for varying the spring tension, said coil spring being connected to said rotor by a pivotal link, said arbor mount comprising threadedly engaging component parts frictionally engaging said handle therebetween, torsion spring means connecting said parts for urging them into threaded engagement, and an impact counter mounted on said handle and responsive to the action of said coil spring in said storage and release of energy.

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UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 2,844,982

Oscar J. Swenson

July 29, 1958

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 4, line 54, for "sufficeint" read -- sufficient --; column 5, line 8, for "shortenen" read -- shortened --; column 13, line 47, for "whose blows" read -- whose impact blows --; line 71, for "being moveble" read -- being movable --; column 14, line 5, after "respectively" insert a comma; line 21, for "ampact tool" read -- impact tool --.

Signed and sealed this 4th day of November 1958.

(SEAL)
Attest:

KARL H. AXLINE
Attesting Officer

ROBERT C. WATSON
Commissioner of Patents