Feb. 12, 1952 W. G. MITCHELL 2,585,486

IMPACT TYPE CLUTCH

Filed March 17, 1949 3 Sheets-Sheet 1

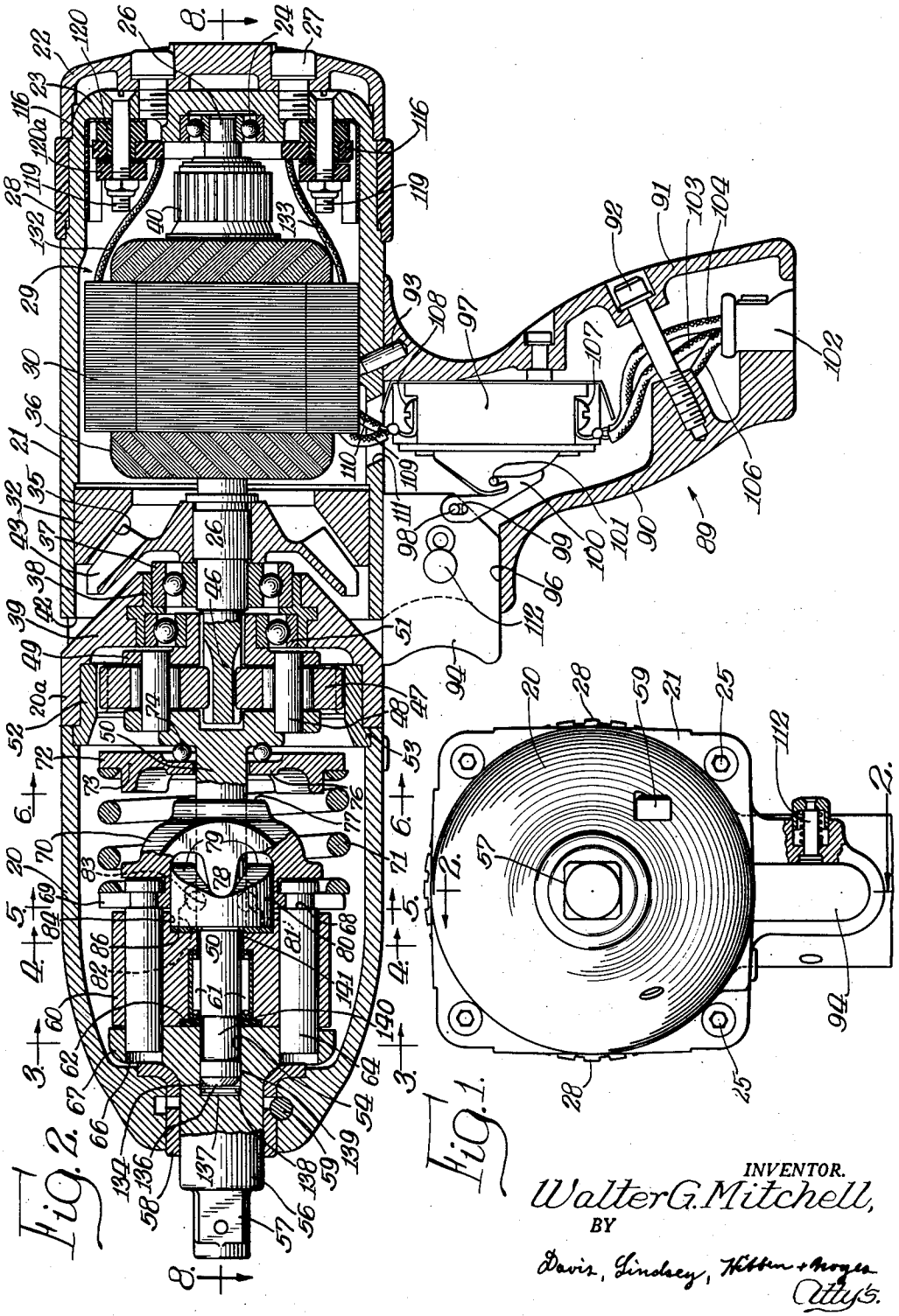


Fig. 2.

Fig. 1.

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IMPACT TYPE CLUTCH

Filed March 17, 1949 3 Sheets-Sheet 2

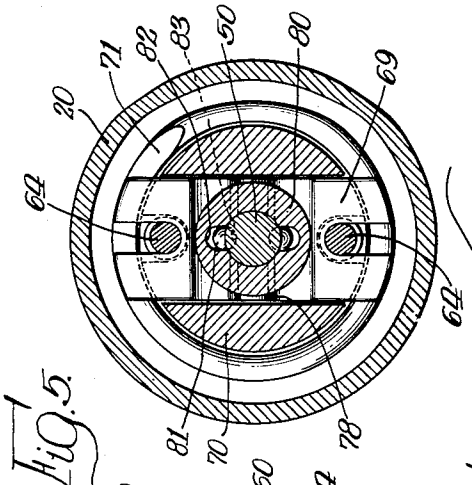


Fig. 5.

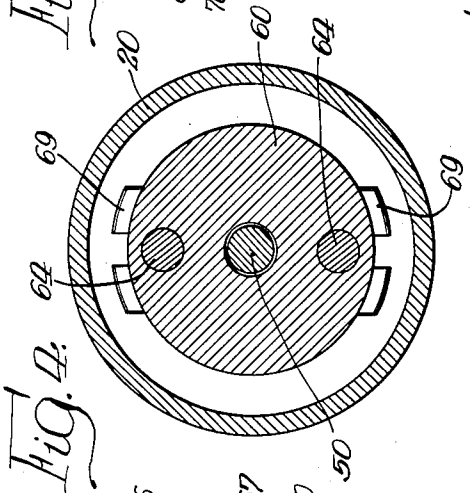


Fig. 4.

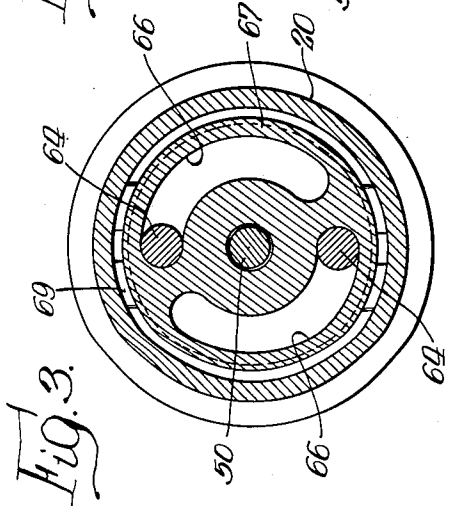


Fig. 3.

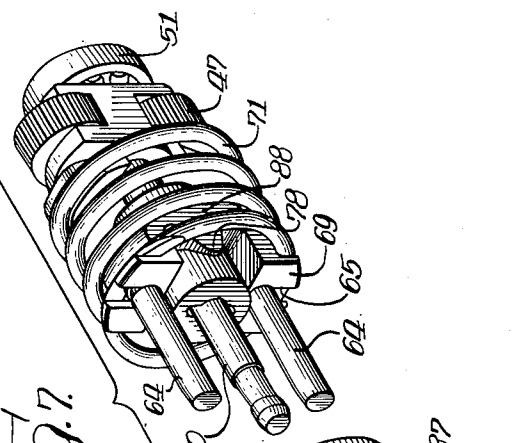


Fig. 7.

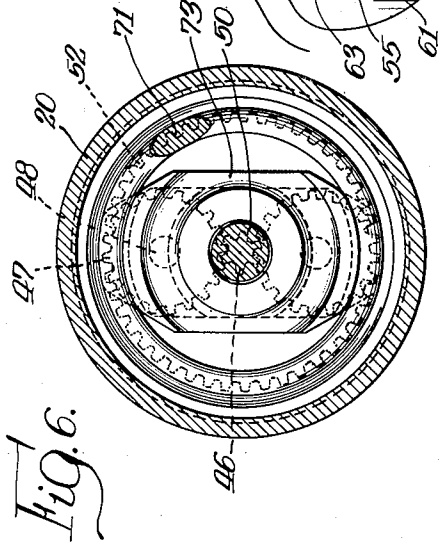


Fig. 6.

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IMPACT TYPE CLUTCH

Filed March 17, 1949 3 Sheets-Sheet 3

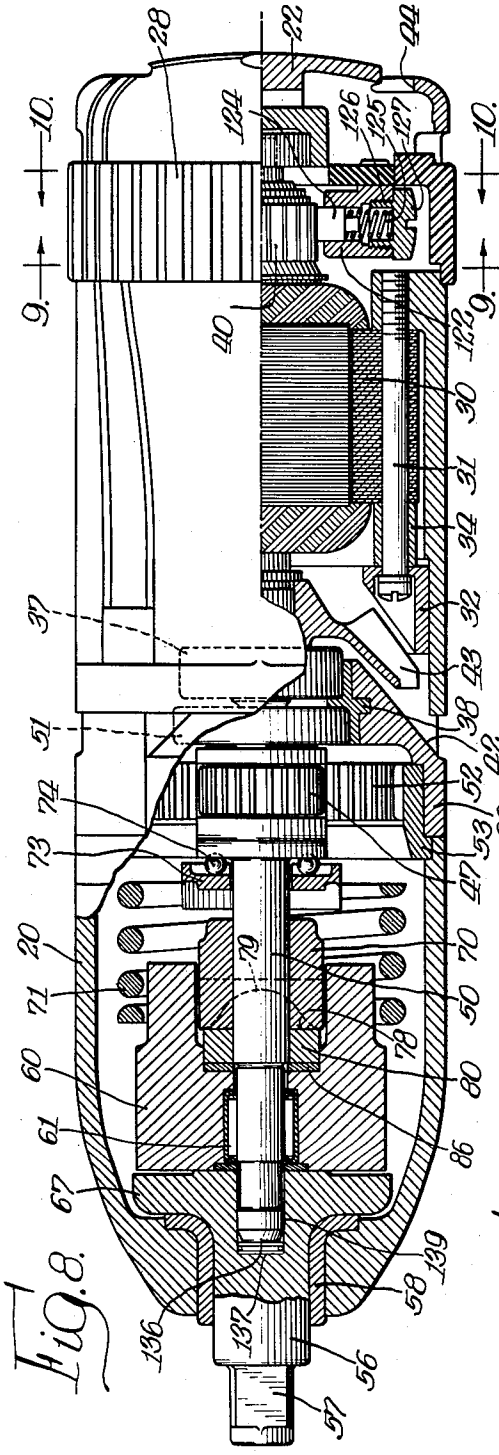


Fig. 8.

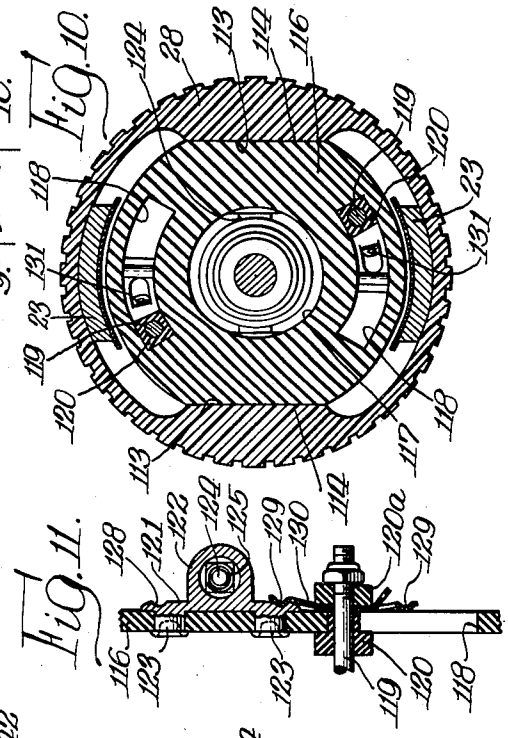


Fig. 10.

Fig. 11.

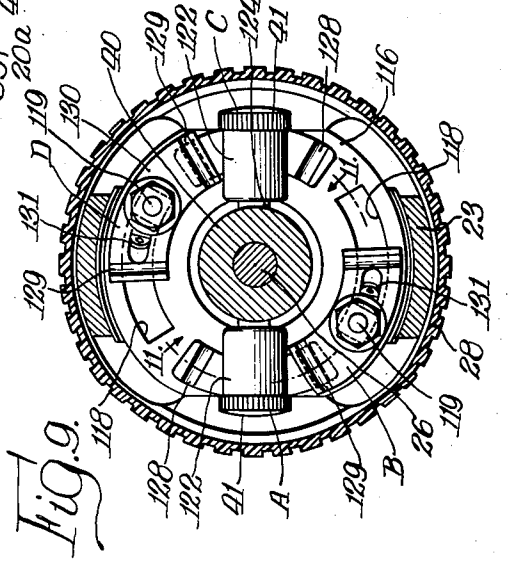


Fig. 9.

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UNITED STATES PATENT OFFICE

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IMPACT TYPE CLUTCH

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Application March 17, 1949, Serial No. 81,966

19 Claims. (Cl. 192—30.5)

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This invention relates to improvements in portable power operated impact tools for setting and removing nuts and bolts by power, and more particularly to an impact clutch mechanism employed in such impact tools for clutching and declutching the hammer and anvil members and for imparting rotational hammer blows on the anvil member to tighten or loosen a nut or bolt.

One of the principal objects of the present invention is to provide an impact clutch mechanism for tools of the foregoing character in which the hammer and anvil members are relatively rotatable with opposed wall surfaces and impact means are movable independently of the hammer relative to the opposed wall surfaces into and out of impacting engagement with the anvil member, there being cam means for withdrawing the impact means out of impacting engagement with the anvil member and spring means for urging and returning said impact means into engagement with said anvil member.

Another object of the invention is to provide an impact clutch mechanism of the foregoing character in which the various movable parts thereof are maintained in perfect alignment so that the tool will be free running with no consequent loss of power and efficiency.

Another object of the present invention is to provide an impact clutch mechanism of the foregoing character in which guiding means rotatable with the hammer serves to maintain an impact supporting means in proper alignment with the rotatable hammer member so that the impact means will be freely slidable in axial openings in the hammer at all times, particularly during axial movement thereof to and from impacting position.

Another object of the invention is to provide an impact clutch mechanism similar to that of the foregoing object in which guiding extensions are integrally formed with the hammer and serve to maintain the parts in alignment on the supporting spindle for free axial movement and to prevent rotative movement of the impact supporting means as it is cammed rearwardly or is pressed forwardly by the spring means.

Still another object of the invention is to provide an impact clutch mechanism for impact tools in which the hammer and anvil members are relatively rotatable and axially aligned and have axially opposed wall portions with abutments on the axially opposed wall portion of the anvil member, the hammer being of solid, massive cylindrical construction with a minimum number of longitudinal openings therethrough,

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one of said openings being at the axis to admit a supporting spindle and the other two openings being disposed on each side of the axial opening to receive slidable impact means which are axially movable into and out of the path of said abutments.

A further object of the present invention is to provide an impact clutch unit for an impact tool in which the various parts thereof may be assembled and held together on a spindle as a separate unit for ready assembly and disassembly.

Another further object is to provide an assembled impact unit of the character defined in the preceding object comprising impact means axially movable into impacting engagement with an anvil and carried by a supporting member slidably mounted on a rotatable spindle, the lower limit of axial movement of the supporting member on the spindle being defined by a cam means fixed on the spindle and engageable therewith and the upper limit being defined by a spring plate, and a spring member compressed between said supporting member and said spring plate.

A still further object is to provide an impact unit of the foregoing character in which the impact means are received in slots in the supporting member and are held in assembled position in said slots by a compression spring.

Another object is to provide a rotary power tool in which the internal ring gear of a planetary gear train on the motor housing section may be utilized to assemble said section to the forward housing section of the tool.

Other and further objects and advantages of the present invention will become apparent hereinafter as the description progresses, reference being had to the accompanying drawings in which:

Figure 1 is a front elevational view of an impact tool comprising a preferred embodiment of the present invention;

Fig. 2 is a vertical, longitudinal sectional view of the impact tool, taken on the line 2—2 in Fig. 1 looking in the direction of the arrows;

Fig. 3 is a transverse, vertical sectional view taken on the line 3—3 in Fig. 2 adjacent the front end of the tool and looking in the direction of the arrows;

Fig. 4 is a transverse, vertical sectional view taken on the line 4—4 in Fig. 2 looking in the direction of the arrows;

Fig. 5 is a transverse, vertical sectional view

taken on the line 5—5 in Fig. 2 looking in the direction of the arrows;

Fig. 6 is a transverse, vertical sectional view taken on the line 6—6 in Fig. 2 looking in the direction of the arrows;

Fig. 7 is a perspective view of the impact unit and gear drive of the tool, showing the hammer in aligned but disassembled position with respect to the spindle and impact rods or jaws.

Fig. 8 is a horizontal, longitudinal sectional view of a portion of the tool taken on the line 8—8 in Fig. 2 looking in the direction of the arrows;

Fig. 9 is a transverse, vertical sectional view of the impact tool, taken on the line 9—9 in Fig. 8 looking rearwardly of the tool in the direction of the arrows and showing the reversing switch mechanism;

Fig. 10 is a transverse, vertical sectional view, taken on the line 10—10 in Fig. 8 looking forwardly of the tool in the direction of the arrows; and

Fig. 11 is a partial, sectional view showing the two positions of a portion of the reversing switch mechanism and taken on the line 11—11 in Fig. 9.

Referring now more specifically to Figs. 1, 2 and 8 of the drawings, the impact tool illustrated therein is a preferred embodiment of the present invention and comprises a four section housing including an impact unit section 20 at the forward portion of the tool, a gear section 20*a* at the intermediate portion thereof, a field case 21, and a cap 22 at the rear end thereof. The housing section 20 is secured to the forward end of the intermediate gear section 20*a* by means of screws 25 as seen best in Fig. 1. The field case 21 is integrally formed at its rearward end with a strong bridge 23 in which is centrally secured a ball bearing unit 24 rotatably supporting the rear end of an armature shaft 26. The rear cap 22 is retained in sealing position at the rear end of the housing section 21 by means of screws 27 extending therethrough into threaded engagement with the bridge 23. A motor reversing ring 28, which may be composed of plastic or other suitable material, abuts the extreme rearward end of the housing section 21 and is held in position thereagainst for limited rotative movement on the bridge 23 by the cap 22. As will be explained more fully hereinafter, relative rotative movement of the plastic ring 28 in one direction or the other serves to reverse the operational direction of the motor 29.

The electric motor 29 is of the reversible, universal type comprising a stator 30 fixedly secured within the housing section 21 by screws 31 (Fig. 8) extending through a cup shaped baffle plate 32, through the stator 30 and into threaded engagement with inwardly directed lugs 33 at the rearward end of the housing section 21. The baffle plate 32 at the forward end of the stator is in tight engagement with the inner periphery of the housing section 21 and is drawn up tightly by the screws 31 against sleeves 34 interposed between the stator 30 and the baffle plate 32. An armature 36 has its shaft 26 on its forward side journaled in a ball bearing unit 37 supported within a bushing 38 secured within the axial opening of an annular, cup-shaped cross portion 39 extending diagonally inwardly and readwardly from the forward end of the housing section 20*a*, the armature 36 thus being supported for free rotative movement within the stator 30. A commutator 40 is secured on the rearward portion of the armature shaft 26 and is engaged by cartridge type brush units 41 to be more fully described hereinafter.

Exhaust openings 42 are provided between the forward end of the housing section 21 and the gear section 20*a* and connect with a diagonally extending, annular passage 35 formed between the transverse housing portion 39 and the baffle plate 32, a fan 43 being fixed on the armature shaft 26 adjacent the ball bearing unit 37 and having its blades in the passage 35. The rear cap 22 is provided with air intake openings 44 through which cooling air is drawn by the fan 43 and forced around and between the stator 30 and the armature 36 and thence out through the exhaust openings 42.

Rotary motion of the electric motor 29 is transmitted to the impact unit within the forward housing section 20 by means of a planetary gear train. The forward end of the armature shaft 26 is shaped to provide a gear 46 in constant mesh with a pair of diametrically opposed, planetary gears 47 mounted for free rotative movement on short shafts 48 secured in a spider member 49. The spider member 49 is integrally formed as the upper or rearward end portion of a drive shaft 50 and its extreme rearward end is journaled for free rotative movement in a thrust ball bearing unit 51 also received in the bushing 38. The planetary gears 47 are also in constant mesh with an internal ring gear 52 secured in and projecting somewhat beyond the extreme forward open end of the housing section 20*a*. The ring gear 52 is provided with an outwardly directed annular shoulder 53 which forms a seat against which the rearward end of the impact housing section 20 may be drawn up into tight engagement by the screws 25. By this arrangement the assembly and disassembly of the tool is greatly facilitated. The entire front end of the tool including the impact mechanism, its housing section 20, the drive shaft 50, the spider 49, the planetary gears 47 and the ball bearing unit 51 may be withdrawn or separated as a unit from the rear portion of the tool merely by removing the screws 25 and sliding the planetary gears 47 relative to the pinion 46 and the ring gear 52 out of meshing engagement therewith. As will become apparent hereinafter, the impact mechanism may then be removed rearwardly out of the housing section 20.

The forward end of the drive shaft 50, comprising the main supporting member or stem of the impact unit, is received within an axial bore 54 of an impact spindle or anvil 56 which terminates in a square section 57 exteriorly of the housing section 20 and is adapted to mount and drive a nut or bolt engaging socket (not shown) in the usual manner. The impact spindle 56 is adapted to rotate within a bushing 58 secured by a set screw 59 within the axial opening at the forward end of the housing section 20. A rotatable hammer member 60 (Figs. 2, 4, 7 and 8) is mounted on the drive shaft 50 above the impact spindle 56 for free and independent rotative movement relative thereto, the hammer 60 being provided with an axially extending central opening 55 in which is secured a needle bearing 61 facilitating rotative movement between the parts. A thrust washer 62 is also mounted on the shaft 50 between the hammer 60 and the impact spindle 56.

As shown best in Figs. 2 and 7, the hammer 60 is provided with longitudinally extending openings 63 on diametrically opposite sides of the cen-

tral axial opening 55, the openings 55 and 63 thus being parallel and in alignment, and the hammer 60 thus being of solid, rugged construction and possessing great mass and inherently great strength. A pair of impacting rods or jaws 64 are slidably mounted within and extend through the hammer openings 63, the lower ends of the rods 64 being adapted to project when in impacting position, as shown in Figs. 2 and 3, beyond the forward end surface of the hammer 60 and into arcuate slotted openings 66 in a radially outwardly directed flanged portion 67 of the anvil 56. As will be explained in detail hereinafter, the impact rods 64 rotate with the hammer 60 and are adapted to strike the anvil 56 at the abutments formed by the ends of the arcuate slots 66 to cause rotation of the anvil.

The upper ends of the impact rods 64 are each provided with an annular groove 68 into which are received the edges of bifurcated portions 69 extending radially from the forward end of an arched, cam lifter plate 70. The impact rods 64 may be readily mounted on the cam lifter plate 70 by sliding them inwardly into the slots 65 thereof from the outer edges of the bifurcated portions 69 and they are free to rotate relative thereto. The cam lifter plate 70 is provided with a central axial opening through which the drive shaft 50 extends, the plate 70 being slidable on the shaft 50 for axial movement relative thereto. A relatively heavy compression spring 71 encircles the cam plate 70 and the forward end thereof seats against the radial edge portions of the bifurcated portions 69 outwardly of the heads of the impact rods 64. By this arrangement the cam plate 70 is constantly urged forwardly so as to project the impact rods 60 into impacting position. The spring 71 also serves the further purpose of retaining the impact rods 60 in assembled position within the slot 65 of the bifurcated portions 69 during assembly of the various parts of the tool and permits the impact mechanism to be assembled and handled as an integral unit.

The upper end of the compression spring 71 bears and seats against radially directed flanges 72 of an upper spring plate 73, this plate 73 also being slidable on the drive shaft 50 and being separated from the forward end surface of the spider member 49 by thrust bearings 74. The upper spring plate 73 is flattened around the shaft 50 on the forward side thereof to provide a surface 76 for engagement with a flat cooperating surface 77 on the rearward end of the cam lifter plate 70, the surface 77 being adapted to be moved upwardly into such engagement upon extreme rearward movement of the lift plate 70.

On the forward or under side of the cam lifter plate 70 are two projecting cam members 78, one on each side of the drive shaft 50, which are forced forwardly into constant bearing engagement with cam surfaces 79 on a drive cam member or bushing 80 fixed on the drive shaft 50 for rotation therewith and restrained against axial movement relative thereto. The cam surfaces 79 slope upwardly in either direction from the low point thereof thus enabling the tool to be operated in a reversible manner in either direction of rotation. The cam bushing 80 is secured on the shaft 50 by means of balls 81 disposed within aligned and cooperating openings 82 and 83 in the bushing 80 and the drive shaft 50, respectively. The forward end of the cam bushing 80 is received within an annular recess 84 in the rearward end of the hammer 60 and bears against a thrust washer 86 at the back of the recess.

As shown clearly in Figs. 5, 7 and 8 of the drawings, the hammer 60 is provided with two diametrically opposed and aligned ears or projections 87 which extend rearwardly in parallel relationship up within the spring 71 and on each of the opposite sides of the cam bushing 80, the cam lifter plate 70 and its cam portions 78. The outer peripheries of the hammer ears 87 are curved so as to conform to the curvature of the spring coils but they are spaced therefrom to permit free relative movement between the spring 71 and the hammer 60. The inner surfaces of the hammer ears 87 are smooth, flat and parallel with each other and parallel with the drive shaft 50, and are in close, slidable engagement with the smooth, flattened surfaces 88 on the opposite sides of the cam lifter plate 70.

The hammer ears 87 thus serve to maintain the parts of the impact unit in perfect alignment and insure perfect alignment of the slots 65 of the bifurcated portions 69 of the cam lifter plate 70 with the axial hammer openings 63. As a consequence, the impact rods 64 are always maintained in perfect and absolute alignment within the hammer openings 63 for free relative slidable axial movement to and from impacting position. Since the parallel inner surfaces of the hammer ears are parallel with the axial openings 63 of the hammer 60 and bear against the opposite flat parallel surfaces of the cam lifter plate 70, absolute parallelism between the parts is maintained at all times. Any forces tending to rotate the hammer 60 in one direction relative to impact rods 64 so as to tend to effect their disalignment and to cause the rods to bear against one side of the hammer slots 63, also, through the hammer ears 87, tend to rotate the rod carrying cam lifter plate 70 in the same direction and with equal force, thus preventing any such disalignment or binding engagement. It is to be noted that the opposite longitudinal side edges of the cam portions 78 of the cam lifter plate extend slightly beyond the outer periphery of the driving cam bushing 80 so that the cam bushing 80 is out of engagement with inner surfaces of the hammer ears 87. The hammer ears 87 also guide the cam lifter plate 70 in a true axial direction when it is cammed upwardly by the cam bushing 80 and serve to restrain the plate 70 against rotative movement.

On the under side of the housing section 21 is a switch grip handle 89 designed and located for balanced control and having a non-slip surface on its rearward side for engagement with an operator's palm or glove. As shown in Fig. 2, the handle 89 is a hollow comprising a forward portion 90 integrally formed with and extending downwardly from the housing section 21 and a rear portion 91 which telescopes to a limited extent within the forward portion 90. The rear handle portion 91 is secured at its lower portion to the forward handle portion 90 by a screw 92 and is secured at its upper portion to the housing section 21 by a dowel 93.

A trigger block 94 is slidably received within an opening 96 in the front of the handle section 90 and is adapted to cooperate with a switch device 97 within the handle for closing and opening the electric circuit to the motor. The inner end of the trigger block 94 is provided with a recess having a cross pin 98 therein which is received with a slot 99 in the forward end of an actuating lever 100, which lever is mounted on a fulcrum pin 101. The trigger block 94 may be held in its inward position for continuous opera-

tion of the tool by a spring pressed locking plunger 112 extending through the forward handle portion 90 and may be quickly unlocked by depressing and releasing the trigger block 94.

A spring (not shown) is mounted on a fulcrum pin 101 and moves the lever 100 outwardly when the trigger block 94 is released by the operator. A tubular sleeve 102 is secured within an opening in the bottom of the handle 89 and the electric supply cable extends therethrough with the leads 103, 104 and 106 being connected up within the handle. The leads 103 and 104 are connected to the lower terminals 107 of the switch device 97 and the lead 106 is grounded to a handle terminal (not shown). The upper terminals 108 of the switch device 97 are connected to the stator terminals by leads 109 and 110 extending upwardly through an opening 111 in the bottom of the housing section 21.

Reversal of direction of rotation of the electric motor 29 is accomplished by rotation of the plastic ring 28 at the rear portion of the housing section 21 in one direction or the other. This permits the tool to be operated to loosen nuts, bolts and the like as well as to drive and impact them to tightened position. As shown best in Figs. 9 and 10 of the drawings, the reversing ring 28 is provided with diametrically opposite inwardly projecting flat portions 113 which are in constant abutting engagement with flat edge portions 114 of a brush holding plate 116 of insulating material. The brush holder 116 has a large central axial opening 117 to accommodate the armature shaft 26 and is also provided with diametrically opposite arcuate slots 118 which permit rotation of the brush holding plate 116 relative to its supporting bolts 119 (Fig. 2). The threaded ends of the bolts 119 are engaged in threaded openings in the bridge 23 and extend through bushings 120 and 120a of insulating material which serve to space the brush holder 116 inwardly from the bridge 23 and to support the holder for free rotative movement relative thereto.

The brush units 41, shown best in Figs. 8 to 11, inclusive, each comprise arcuate metal plate members 121 having integral cylindrical housings 122, the plate members 121 being secured to the brush holder plate 116 as at 123. A carbon brush 124 is slidably mounted in each housing 122 and is constantly urged into engagement with the commutator 40 by a spring 125 received within an adjustable threaded screw plug 126 having a head 127 of insulating material. Each plate member 121 has a radial groove or depression 128 adjacent each of its ends which are adapted to receive and hold the hooked ends of resilient contact members 129 formed on the opposite ends of contact plates 130.

The contact plates 130 are secured on the bolts 119, respectively, circumferentially between the spaced brush units 41, and each is provided with a terminal 131 to which leads 132 and 133 from the stator are connected.

It is thus apparent that when the plastic ring 28 is in one of its extreme positions of rotation, the metal plate 121 of the brush unit 41, marked A in Fig. 9, will be in conducting engagement with the spring contact 129 of the contact plate 130, marked B in Fig. 9. In such position, the metal plate 121 of the other brush unit 41, marked C in Fig. 9, will be in conducting engagement with the spring contact plate 130, marked D in Fig. 9. When it is desired to reverse the direction of rotation of the motor 29, the ring 28 is then rotated to its other extreme position of rotation, the contacts above described being broken off and a new reverse circuit being established between the contact plate B and the brush unit plate C and between the contact plate D and the brush unit plate A. Thus, by rotation of the ring 28, one or the other of the terminals 131 is brought into electrical circuit with one or the other of the brush units 41.

The reversing mechanism above described is securely supported on the inner side of the strong bridge 23 for positive operation, and, while it is readily accessible for repair or adjustment merely by removal of the cap 22, it is protected against all damage and injury due to accident or rough handling. The switch mechanism and its mounting is thus of rugged construction and possesses a long operable life without requiring servicing or repair.

When a nut or bolt is to be tightened, the operator first places the socket (not shown), secured on the square 57, over a nut or bolt head and then presses the trigger block 94 inwardly to complete the electric circuit and effect operation of the motor 29. As the armature shaft 26 rotates, the pinion gear 46 on its forward end rotates the planetary gears 47, causing them to move bodily around within the ring gear 52 in a counterclockwise direction as viewed in Fig. 6 and thus causing rotation of the spider 49 and the drive shaft 50. This driving torque is further transmitted to the impact rods 64 and the hammer 60 through the cam bushing 80 and the cam lifter plate 70.

At the outset of the tightening operation, the impact rods 64 are maintained in projected position within the slots 66 of the impact spindle 56, as shown in Figs. 2 and 3, and abut against the respective ends thereof so as to rotate the impact spindle 56 and the socket and tighten the nut or bolt. As long as the nut or bolt is relatively free running, the impact rods 64 remain in constant engagement with the impact spindle 56 and the projecting cam portions 78 of the cam lifter plate 70 are disposed at the low points of the cam faces 79 of the bushing 80. However, when the nut or bolt approaches tightened position and resistance to rotation is sufficient to overcome the driving torque of the tool motor and the expansive force of the spring 71, rotation of the impact spindle 56, impact rods 64, hammer 60, and the cam lifter plate is arrested. But since the spindle 50 and the cam bushing 80 continue to rotate under the driving force of the motor 29, the cam lifter plate 70 will be cammed rearwardly in a straight longitudinal or axial direction under the guiding influence of the hammer ears 87. Since the cam lifter plate 70 carries and supports the impact rods 64, these rods also are moved rearwardly relative to the hammer 60 and they are thus withdrawn from the slots 66 to a point slightly above the rearward surface of the then stationary impact spindle 56. When the impact rods 64 are fully withdrawn the projecting cam members 78 of the cam lifter plate 70 engage the cam surfaces 79 of the bushing 80 near the top of their high points.

In this withdrawn rearward position, the impact rods 64 are out of driving engagement with the impact spindle 56 and hence are free to rotate under the driving torque of the drive shaft 50. The impact rods 64 and the hammer 60, consequently, resume rotation in a clockwise or tightening direction, pass over the narrow lands between the impact spindle slots 66 and then are projected under the urge of the spring 71 back

into the slots 66 so that the impact rods 64 will be impacted against the far end of the slots 66 upon continued rotation. From the time that driving engagement is broken off, as above described, until the rods 64 impact against the ends of the slots 66, the drive shaft 50 accelerates under the driving force of the motor 29 at an ever increasing rate so that the impact rods 64 strike the impact spindle 56 with great force. Because of the solid, massive construction of the hammer 60, this impacting force is of relatively great magnitude.

Because of the fact that the impact rods 64 are circular and are slidably received in the slots 65 of the cam lifter plate 70, they are free to rotate relative thereto. As a result of this rotative connection, the rods 64 are rotated slightly as they are moving into impacting position against the far ends of the slots 66, thus presenting different circumferential portions of the lower or blow delivering ends of the rods to the slot abutments for each blow. The rods, therefore, present new wearing surfaces and have a long operable life.

It is to be noted further that when the driving engagement is initially broken off between the impact rods 64 and the impact spindle 56, the cam portion 78 of the cam lifter plate 70 engages the cam bushing 80 near the high point on its cam surface. Consequently, as impact rods 64 again accelerate toward impacting engagement with the impacting spindle 56, the heavy spring 71 will force the cam lifter plate 70 axially forwardly, the cam portion 78 moving downwardly and forwardly over the cam surface of the cam bushing 80 toward its low point. The cam lifter plate 70 is thus caused to accelerate ahead of the drive shaft 50 and the impact rods 64 are caused to strike the impacting spindle 56 with an increased impacting force and at a rate of rotation over and above that of the drive shaft 50. After impact, which causes further limited rotative and tightening movement of the impact spindle 56, the impact rods 64 are again withdrawn as above described and are again rotated relative to the impact spindle 56 and thrown again into impacting engagement with the spindle 56 at the far ends of the next succeeding slots 66. The impact rods 64 thus strike the impact spindle 56 two impacting blows for every revolution of the hammer 60 and these blows may be repeated until the work has been tightened to the desired degree.

During the operation of the tool when the impacting blows are being delivered to the work, the impact rods 64 are freely slidable within the hammer slots 63 to and from spindle engaging position since they are maintained in perfect alignment therewith by the hammer ears 87 which engage the flat sides 88 of the cam lifter plate 70. The hammer ears 87 also by their slidable engagement with the flat sides of the cam lifter plate 70 cause that plate to move in a truly longitudinal direction and parallel to the inner sides of the hammer ears. Since the inner sides of the hammer ears 87 are also parallel with the hammer slots 63, the sliding movement of the rods 64 is also parallel therewith. Consequently, it is apparent that by the arrangement of the parts they are maintained in the desired alignment so that their free operation is achieved at all times and no binding of the rods 64 in the hammer slots 63 results.

When it is desired to utilize the tool for the purpose of loosening a nut or bolt, the operator need only rotate the plastic reversing ring 28 to its other position as above described, and the electric motor 29 will thus operate in the reverse direction and the drive shaft 50 will also be rotated in the reverse direction. Since the work is in a tightened state, the impact rods 64 will immediately commence imparting blows against the spindle 56 until the resistance to rotation offered by the work is less than the driving torque of the cam lifter plate 70, at which point the impacting blows cease and the impact rods 64 remain in constant free running engagement with the impact spindle 56. The tool may then be allowed to remain in engagement with the work until the work is entirely disengaged from a threaded opening.

As shown more particularly in Fig. 2, of the drawing, the lower or forward end portion of the drive shaft 50 is of such construction as to permit limited tilting or cocking movement of the impacting spindle 56 relative to the drive shaft 50. When the tool is in operative engagement with the work and is in the hands of an operator, the impacting forces and the handling of the tool by the operator tends to force the impacting spindle 56 out of alignment with the drive shaft 50. Because of this inherent tendency toward misalignment which would cause binding of the impact spindle 56 if there was a tight fit between the parts and hence would reduce the effective output of the driven shaft 50 and the spindle 56, the extreme forward end of the driven shaft 50 is rounded or tapered as at 134 leaving a reduced flat end face 136 for abutting engagement with a thrust washer 137 of hardened metal retained within the forward end of the bore 54 of the impact spindle 56 by a spring ring 138. Immediately rearwardly of the tapered portions 134, the drive shaft 50 is provided with a relatively short, annular bearing surface 139 which is adapted to engage the walls of the spindle bore 54 over a limited area. This limited bearing surface 139 serves to prevent too loose a mounting between the spindle 56 and the shaft 50, but at the same time permits limited tilting movement therebetween. The forward and inward edges of the bearing surface 139 wear away or round off after a relatively short period of tool operation so that this bearing surface, as the tool wears in and the parts adjust themselves to each other, also becomes slightly rounded to the desired degree.

The portion 140 of the drive shaft 50 next above or rearwardly of the bearing surface 139 is of reduced diameter and is slightly spaced from the sides of the spindle bore 54 and the thrust washer 62 to provide clearance for the limited tilting movement. The diameter of the drive shaft portion 141 within the central bore 55 of the hammer 60 is also of lesser extent than the diameter of that bore so as to provide clearance therebetween and the needle bearing 61 serves to maintain the proper bearing relationship between the hammer 60 and the drive shaft 50. Also for the purpose of permitting the relative tilting movement, the marginal or radially outer portion of the annular flanges 67 of the impact spindle 56 are cut away so as not to extend rearwardly as far as the central portion thereof, thus providing a slight clearance between the opposed end faces of the hammer 60 and the spindle 56 at their outer portions and for engagement therebetween and with the thrust washer 62 only at their central portions around the drive shaft 50.

The above-described tool is of simple, rugged construction, possesses great efficiency and smoothness in operation and is capable of a long operable life in the hands of relatively inexperi-

enced operators. At the same time, it lends itself to ready assembly and disassembly for inexpensive production and for servicing, replacement and repair. The impact mechanism is all mounted as a unitary assembly on the drive shaft 50 and may be assembled on a separate production line and maintained as a stock sub-assembly for final assembly or replacement. The cam bushing 80 being fixed on the drive shaft 50 defines the lower or forward limit of axial movement of the cam lifter plate 70 under the urge of the spring 71 while the spider 49 serves as the upper or rearward abutting member for the upper spring plate 73. The spring 71 forces the lifter plate 70 into tight engagement with the cam bushing 80 and also serves to hold the impact rods in position on the lifter plates. The planetary gears 47 and the thrust bearing 51 are also carried by the spider 49 at the rearward end thereof, and hence it is apparent that the impact rods 64, the cam bushing 80, the lifter plate 70, the spring 71, the spring plate 73, the planetary gears 47 and the ball bearing 51 are all mounted and retained as a unitary assembly on the drive shaft 50 and its spider portion 49. This assembly may be readily handled without any possibility of the parts thereof becoming separated. Furthermore, hammer 60 may be readily slid upwardly or rearwardly over the drive shaft 50 and the impact rods 64 to become a part of the assembly and need not be secured thereto in any positive manner.

Moreover, this impact assembly may be quickly placed in operative engagement with the impact spindle 56 by inserting the assembly into the rear end of the housing section 20, aligning the drive shaft 50 and impact rods 64 with the bore 54 and the slots 66 of the impact spindle 56 and then moving the assembly axially toward the front end of the tool. Then the housing section 20 and the assembly may be aligned with and moved rearwardly relative to the housing section 20a and the motor 29, the planetary gears 47 sliding into meshed engagement with the ring gear 52 and the pinion gear 42 and the thrust bearing 51 sliding upwardly into seated position in the bushing 38. When the screws 25 are tightened, the tool is then ready for operation.

Conversely, in the event the impact mechanism requires servicing or repairs, the screws 25 may be loosened and the impact housing section 20 withdrawn from the section 20a. Thereafter, the section 20 may be inverted and the impact assembly may be readily slid therefrom out of the rearward end of the housing section 20.

It is to be further understood that while the preferred embodiment of the present invention has been described above as an impact wrench, the very same tool by means of special attachments secured on the square 57 may be adapted for other uses such as a screw driver, tapper, reamer, drill, sander, polisher or wire brush driver. When utilized for these latter purposes, the tool will be primarily free running without operation as an impacting wrench. However, such impacting features are permitted to become effective when used as a screw driver or when used as a drill and the drills or bits become frictionally held against rotation before the drill hole has been completed. The impacting blows of the hammer rods 64 then are applied to the drills and bits to overcome such frictional resistance and any overload on the motor is eliminated.

Although there has been described above and illustrated in the drawings a preferred embodiment of an impact tool comprising the present invention, it is apparent that modifications and changes may be made in the details of structure and mode of operation without departing from the spirit and scope of the appended claims.

I claim:

1. An impact clutch of the character described comprising relatively rotatable, axially aligned hammer and anvil members having axially opposed wall portions with abutments on the axially opposed wall portion of the anvil member, a plurality of impact means rotatably movable with said hammer and axially movable independently of said hammer into and out of the path of the abutments on the axially opposed wall portion of the anvil member for clutching and declutching said members and for imparting rotational hammer blows on the anvil member at said abutments, cam means for withdrawing the impact means out of the path of said abutments upon impact of said impact means with said abutments, a spring for urging and returning said impact means into the path of said abutments, and means for distributing the forces of said spring and said cam means evenly on said impact means.

2. An impact clutch of the character described comprising relatively rotatable, axially aligned hammer and anvil members having axially opposed wall portions with abutments on the axially opposed wall portion of the anvil member, impact means rotatably movable with said hammer and axially movable independently of said hammer into and out of the path of the abutments on the axially opposed wall portion of the anvil member for clutching and declutching said members and for imparting rotational hammer blows on the anvil member at said abutments, axially movable supporting means for said impact means operably engaged with and carrying said impact means, said impact means and said supporting means being movably axially as a unit, a rotatable driving member, cam means operably positioned between said supporting means and said driving member for effecting axial movement of said supporting means in one direction upon relative rotative movement therebetween to withdraw said impact means out of the path of movement of said abutments, and spring means operably connected with said supporting means for urging and returning said supporting means in the other axial direction to project the impact means into the path of said abutments.

3. An impact clutch of the character described comprising relatively rotatable, axially aligned hammer and anvil members having axially opposed wall portions with abutments on the axially opposed wall portion of the anvil member, impact means rotatably movable with said hammer and axially movable independently of said hammer into and out of the path of the abutments on the axially opposed wall portion of the anvil member for clutching and declutching said members and for imparting rotational hammer blows on the anvil member at said abutments, axially movable supporting means for said impact means operably engaged with and carrying said impact means, said impact means and said supporting means being movable axially as a unit, a rotatable driving member, driving cam means on said driving member, cooperating cam means on said supporting means engageable with said driving cam means, said cam means permitting relative rotation between the driving member and the hammer member upon impact and ef-

fecting axial movement of the supporting means relative to said hammer to withdraw the impact means out of the path of said abutments, and spring means operably engaging said supporting means for returning and urging said supporting means in the other axial direction to project the impact means into the path of said abutments.

4. An impact clutch of the character described comprising relatively rotatable axially aligned hammer and anvil members having axially opposed wall portions with abutments on the axially opposed wall portion of the anvil member, impact means rotatably movable with said hammer and axially movable independently of said hammer into and out of the path of the abutments on the axially opposed wall portion of the anvil member for clutching and declutching said members and for imparting rotational hammer blows on the anvil member at said abutments, axially movable supporting means for said impact means operably engaged with and carrying said impact means, said impact means and said supporting means being movable axially as a unit, a rotatable driving member, cam means secured on said driving member for rotation therewith and operably connected with said supporting means to effect axial movement of the supporting means relative to said hammer to withdraw the impact means out of the path of said abutments, and spring means operably connected with said supporting means for returning and urging said supporting means in the other axial direction to project the impact means into the path of said abutments.

5. An impact clutch of the character described comprising relatively rotatable, axially aligned hammer and anvil members having axially opposed wall portions with abutments on the axially opposed wall portion of the anvil member, a driving spindle extending through the axial portion of said hammer member, impact means rotatable with said hammer and axially movable independently of said hammer into and out of the path of the abutments for clutching and declutching said members, supporting means operably engaged with and carrying said impact means and having an opening therethrough for said spindle, said supporting means and said impact means being movable axially as a unit relative to said hammer member and the spindle and said supporting means having a cam means, a cooperating cam means secured on said driving spindle and engageable with said first cam means for effecting axial movement of the supporting means away from said hammer to withdraw the impact means out of the path of said abutments, and spring means operably connected with said supporting means for returning and urging said supporting means in the direction of said hammer to project the impact means into the path of said abutments.

6. An impact clutch of the character described comprising relatively rotatable hammer and anvil members arranged for rotation about a common axis and having axially opposed wall portions with abutments on the axially opposed wall portion of the anvil member, impact rods slidably mounted on the hammer member on opposite sides of the axis and movable substantially parallel thereto into and out of the path of said abutments for clutching and declutching said members and for imparting rotational hammer blows on the anvil member at said abutments, a cross-member carrying and connecting said rods and adapted for axial movement relative to said hammer member, said cross-member and said impact rods being movable axially as a unit during clutching and declutching movement, a rotatable driving member, can means operably connecting the driving member and said cross-member for effecting axial movement of said cross-member in one direction to withdraw said impact rods out of the path of said abutments, and spring means for urging and returning said cross-member in the other direction to project said impact means into the path of said abutments.

7. An impact clutch of the character described comprising relatively rotatable, axially aligned hammer and anvil members having axially opposed wall portions with abutments on the axially opposed wall portion of the anvil member and said hammer member having axially extending and diametrically spaced guiding portions, impact means rotatable with said hammer and axially movable independently thereof into and out of the path of the abutments for clutching and declutching said members and for imparting rotational hammer blows on the anvil member at said abutments, supporting means operably engaged with and carrying said impact means, said impact means and said supporting means being movable axially as a unit and said supporting means being positioned and confined between said hammer guiding portions for axial movement therebetween relative to said hammer member, cam means for effecting axial movement of said supporting means in one direction to withdraw the impact means out of the path of said abutments, and means for returning said supporting means in the other axial direction to project said impact means into the path of said abutments, said spaced guiding portions of said hammer serving to prevent rotative movement of the supporting means relative to the hammer member during axial movement thereof.

8. An impact clutch of the character described comprising relatively rotatable hammer and anvil members arranged for rotation about a common axis and having axially opposed wall portions with abutments on the axially opposed wall portion of the anvil member, said hammer member having longitudinal openings on the opposite sides of said axis and in substantially parallel relationship therewith and longitudinally extending and diametrically opposed spaced guiding portions with said openings between said guiding portions, impact rods rotatable with said hammer and axially slidable in said hammer openings into and out of the path of the abutments for clutching and declutching said members and for imparting rotational hammer blows on the anvil member at said abutments, supporting means connecting said impact rods and positioned and confined between and engaging the inner opposed faces of said hammer guiding portions for slidable axial movement therebetween relative to said hammer member, cam means for effecting axial movement of the rod supporting means in one direction to withdraw the rods out of the path of said abutments, and means for returning said rod supporting means in the other axial direction to project said rods into the path of said abutments, said spaced guiding portions of the hammer serving to prevent rotative movement of the rod supporting means relative to the hammer member and to maintain said rods in alignment with said hammer openings during relative axial movement therebetween.

9. An impact clutch of the character described

comprising relatively rotatable hammer and anvil members arranged for rotation about a common axis and having axially opposed wall portions with abutments on the axially opposed wall portion of the anvil member, said hammer member having longitudinally extending openings on opposite sides of said axis and in substantially parallel relationship therewith, impact rods rotatable with said hammer and axially slidable in said hammer openings into and out of the path of the abutments for clutching and declutching said members and for imparting rotational hammer blows on the anvil member at said abutments, axially movable supporting means for said impact rods, said impact rods and said supporting means being movable axially as a unit, cam means for effecting axial movement of the rod supporting means in one direction to withdraw the rods out of the path of said abutments, means for returning said rod supporting means in the other axial direction to project said rods into the path of said abutments, and guiding means carried by and rotatable with said hammer and engageable with said rod supporting means to prevent rotative movement of the supporting means relative to the hammer member and to maintain said rods in alignment with said hammer openings during relative axial movement therebetween.

10. An impact clutch of the character described comprising relatively rotatable hammer and anvil members arranged for rotation about a common axis and having axially opposed wall portions with abutments on the axially opposed wall portion of the anvil member, said hammer member having longitudinally extending openings on opposite sides of said axis and in parallel relationship therewith and axially extending and diametrically spaced extensions having flat opposed faces in parallel relationship with said axis and said hammer openings and with said openings between said extensions, impact rods rotatable with said hammer and axially slidable in said hammer openings into and out of the path of the abutments for clutching and declutching said members and for imparting rotational hammer blows on the anvil member at said abutments, supporting means carrying and connecting said impact rods and positioned and confined between and having the sides thereof engaging the inner opposed faces of said hammer extensions for slidable axial movement therebetween, cam means for effecting axial movement of the rod supporting means in one direction to withdraw the rods out of the path of said abutments, and means for returning said rod supporting means in the other axial direction to project said rods into the path of said abutments, said extensions serving to prevent rotative movement of the supporting means relative to the hammer member and to maintain said rods in alignment with the hammer openings during relative axial movement therebetween.

11. An impact clutch of the character described comprising relatively rotatable hammer and anvil members arranged for rotation about a common axis and having axially opposed wall portions with abutments on the axially opposed wall portion of the anvil member, said hammer member having longitudinally extending openings on opposite sides of said axis and in parallel relationship therewith and axially extending and diametrically spaced extensions having flat opposed faces in parallel relationship with said axis and said hammer openings and with said openings between said extensions, impact rods rotatable with said hammer and axially slidable in said hammer openings into and out of the path of the abutments for clutching and declutching said members and for imparting rotational hammer blows on the anvil member at said abutments, supporting means carrying and connecting said impact rods and positioned and having the sides thereof engaging the inner opposed faces of said hammer extensions for slidable axial movement therebetween, and having edge portions projecting radially outwardly of said hammer extensions cam means for effecting axial movement of the rod supporting means in one direction to withdraw the rods out of the path of said abutments, and a compression spring encircling said hammer extensions and engaging the edge portions of said rod supporting means for urging and returning said rod supporting means in the other axial direction to project said rods into the path of said abutments, said extensions serving to prevent rotative movement of the supporting means relative to the hammer member and to maintain said rods in alignment with the hammer openings during relative axial movement therebetween.

12. An impact clutch of the character described comprising relatively rotatable hammer and anvil members arranged for rotation about a common axis and having axially opposed wall portions with abutments on the axially opposed wall portion of the anvil member, said hammer member having an axial bore and longitudinally extending openings on opposite sides of said bore and in parallel relationship therewith and having axially extending and diametrically spaced guiding extensions, a rotary driving spindle extending into said hammer bore between said guiding extensions, impact means rotatable with said hammer and axially movable in said hammer openings into and out of the path of the abutments for clutching and declutching said members and for imparting rotational hammer blows on the anvil member at said abutments, supporting means for said impact means confined between and engageable with said hammer extensions for axial movement therebetween relative to said hammer member and said spindle, said impact means and said supporting means being movable axially as a unit, cam means carried on said spindle between said hammer extensions and engageable with said supporting means for effecting axial movement of said supporting means in one direction to withdraw the impact means out of the path of said abutments, and means for returning said supporting means in the other axial direction to project said impact means into the path of said abutments, said hammer extensions serving to prevent rotational movement of the supporting means relative to the hammer member during axial movement thereof and to maintain said hammer impact means and supporting means in alignment on the spindle.

13. An impact clutch of the character described comprising relatively rotatable hammer and anvil members arranged for rotation about a common axis and having axially opposed wall portions with abutments on the axially opposed wall portion of the anvil member, said hammer member having an axial bore and longitudinally extending openings on opposite sides of said axis and in parallel relationship therewith and axially extending and diametrically spaced guiding

extensions, a rotary driving spindle extending into said hammer bore between said guiding extensions, impact means rotatable with said hammer and axially movable in hammer openings into and out of the path of the abutments for clutching and declutching said members and for imparting rotational hammer blows on the anvil member at said abutments, supporting means for said impact means surrounding said spindle and confined between and engageable with said hammer extensions for axial movement therebetween relative to said hammer and said spindle, said impact means and said supporting means being movable axially as a unit, cam means carried on said spindle between said hammer extensions and engageable with said supporting means for effecting axial movement of said supporting means in one direction to withdraw the impact means out of the path of said abutments, a spring stop positioned in axially fixed and spaced relation from said supporting means and said cam means and spring means surrounding said spindle and compressed between said spring stop and said supporting means for returning and urging said supporting means into the path of said abutments, said hammer extensions serving to prevent rotative movement of the supporting means relative to the hammer member during axial movement thereof and to maintain said hammer, impact means and supporting means in alignment on the spindle.

14. An impact clutch of the character described comprising relatively rotatable hammer and anvil members arranged for rotation about a common axis and having axially opposed wall portions with abutments on the axially opposed wall portion of the anvil member, said hammer member having an axial bore and longitudinally extending openings on opposite sides of said axis and in parallel relationship therewith, a rotary driving spindle extending into said hammer bore, impact means rotatable with said hammer and axially movable in said hammer openings into and out of the path of the abutments for clutching and declutching said members and for imparting rotational hammer blows on the anvil member at said abutments, supporting means for said impact means extending transversely to and around said spindle for axial movement relative to said hammer member, said impact means and said supporting means being movable axially as a unit cam means secured to said spindle and engageable with said supporting means for effecting axial movement of said supporting means in one direction to withdraw the impact means out of the path of said abutments, a spring stop mounted on said spindle against axial movement and in axially spaced relation from said supporting means, and spring means surrounding said spindle and compressed betwen said spring stop and said supporting means for returning and urging said supporting means in the other axial direction to project said impact means into the path of said abutments.

15. An impact clutch of the character described comprising an impact unit adapted to be engaged and disengaged with abutments on an axially aligned anvil and assembled and disassembled therefrom as a unitary assembly, said impact unit comprising a driving spindle, a rotatable hammer member having an axial bore for reception of said spindle and longitudinal openings therethrough on opposite sides of said bore, impact rods rotatable with said hammer and axially movable in said hammer openings

into and out of the path of the abutments, supporting means for said impact rods mounted on said spindle for axial movement relative to said hammer and having radial slots for receiving said impact rods, cam means secured to said driving spindle for rotation therewith between said hammer member and said supporting means and engageable with said supporting means for effecting axial movement of said supporting means in one direction to withdraw the impact means out of the path of said abutments, a spring plate spaced from said cam member and said supporting means and mounted on said spindle against axial movement relative thereto, a spring compressed between said supporting means and said spring plate and engaging the outer side edges of said impact rods for holding said rods in position in said slots and for maintaining said supporting means in engagement with said cam member and urging said impact rods into the path of said abutments.

16. An impact clutch of the character described comprising relatively rotatable, axially aligned hammer and anvil members having axially opposed wall portions with abutments on the axially opposed wall portion of the anvil member, a plurality of impact means rotatably movable with said hammer and axially movable independently of said hammer into and out of the path of the abutments on the axially opposed wall portion of the anvil member for clutching and declutching said members and for imparting rotational hammer blows on the anvil member at said abutments, an axially movable supporting member for said impact means, said member and said impact means being movable axially as a unit, a rotatable driving member, cam means between said supporting member and said driving member for effecting axial movement of said supporting member in one direction upon relative rotative movement therebetween to withdraw said impact means out of the path of movement of said abutments, and a coil spring operably connected to said supporting member for urging and returning said supporting member in the other axial direction to project the impact means into the path of said abutments, the forces of said cam and said spring being distributed evenly on said impact means.

17. An impact clutch of the character described comprising relatively rotatable, axially aligned hammer and anvil members having axially opposed wall portions with abutments on the axially opposed wall portion of the anvil member, said hammer member having longitudinally extending bores on opposite sides of said axis and in substantially parallel relationship therewith, impact rods rotatable with said hammer and axially slidable in said hammer openings into and out of the path of said members for clutching and declutching said members and for imparting rotational hammer blows on the anvil member at said abutments, axially movable supporting means operably connected to and carrying said impact rods, said impact rods and said supporting means being movable axially as a unit, cam means for effecting axial movement of the rod supporting means in one direction to withdraw the rods out of the path of said abutments, means for returning said rod supporting means in the other axial direction to project said rods into the path of said abutments, and guide means on the hammer and rod supporting means preventing rotative movement of the supporting means relative to the hammer member and

maintaining said rods in alignment with the hammer bores during relative axial movement therebetween.

18. An impact clutch of the character described comprising relatively rotatable hammer and anvil members arranged for rotation about a common axis and having axially opposed wall portions with abutments on the axially opposed wall portion of the anvil member, impact rods rotatably movable with said hammer and axially movable independently of said hammer into and out of the path of the abutments on the axially opposed wall portion of the anvil member for clutching and declutching said members and for imparting rotational hammer blows on the anvil member at said abutments, axially movable supporting means operably engaged with and carrying said impact means and having slots on opposite sides of the axis thereof for receiving and holding said impact rods, said impact rods and said supporting means being movable axially as a unit, cam means for effecting axial movement of the supporting means in one direction to withdraw the impact means out of the path of said abutments, and a coil spring engaging the supporting means and the impact rods and holding said rods in supported position in said slots and urging said supporting means axially to project the impact rods into the path of said abutments.

19. An impact clutch of the character described comprising relatively rotatable, axially aligned hammer and anvil members having axially opposed wall portions with abutments on the axially opposed wall portion of the anvil member, impact rods rotatable with said hammer and slidably mounted therein for axial movement independently of said hammer to project

the lower ends of said impact rods forwardly into and rearwardly out of the path of the abutments for clutching and declutching said members and for imparting rotational hammer blows on the anvil member at said abutments, a rotatable driving member, supporting means engageable with and carrying the upper ends of said rods and mounted for axial movement rearwardly of said hammer member, said rods and said supporting means being movable axially as a unit, cam means secured on said driving member between said hammer and said supporting means and engageable with said supporting means to effect rearward axial movement of the supporting means away from said hammer to withdraw the impact rods out of the path of said abutments, and spring means operably connected to said supporting means for returning and urging said supporting means forwardly in an axial direction to project the impact rods into the path of said abutments.

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