April 20, 1965 K. G. KÅRDÉN 3,179,219

IMPACT CLUTCHES

Filed April 2, 1962 2 Sheets-Sheet 1

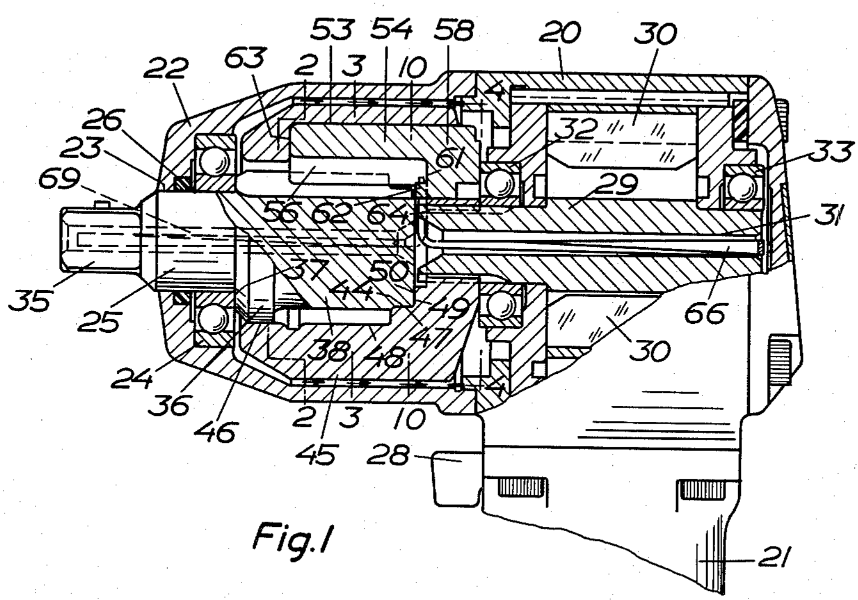

Fig. 1

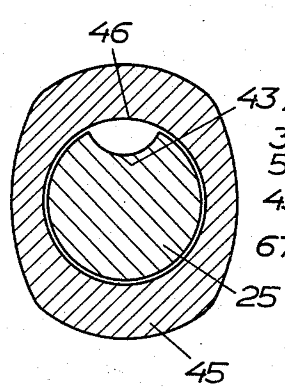

Fig. 2

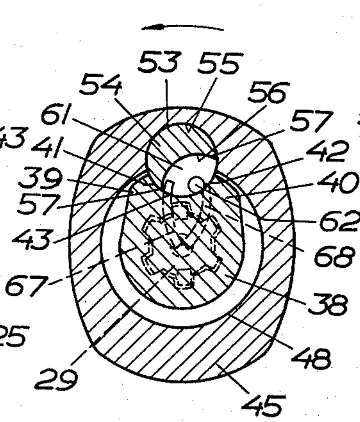

Fig. 3

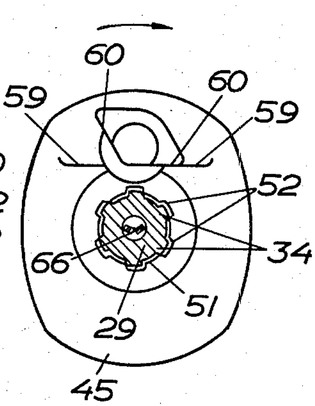

Fig. 4

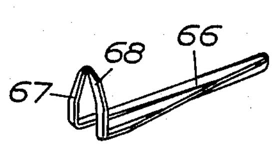

Fig. 5

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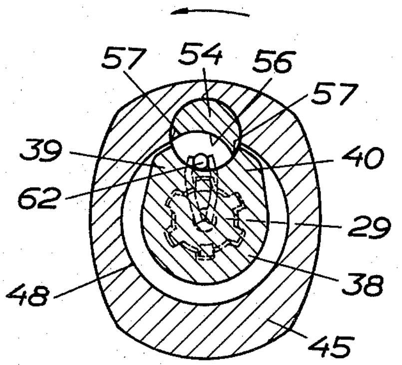

Fig.6

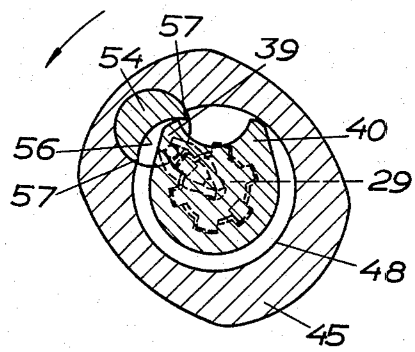

Fig.7

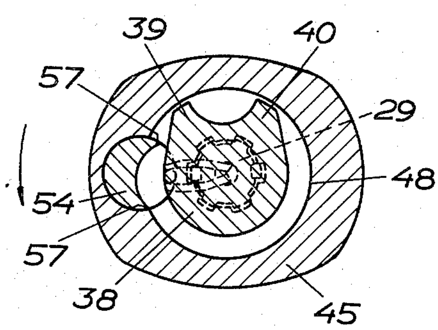

Fig.8

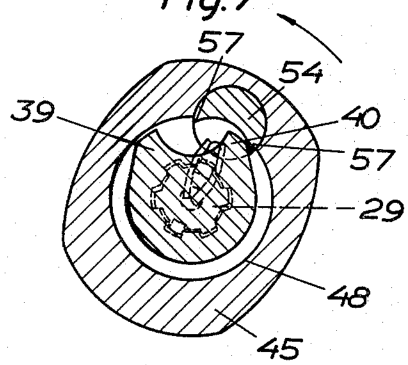

Fig.9

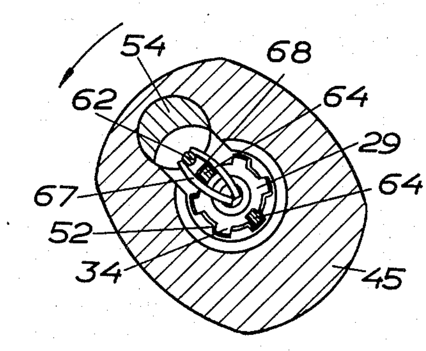

Fig.10

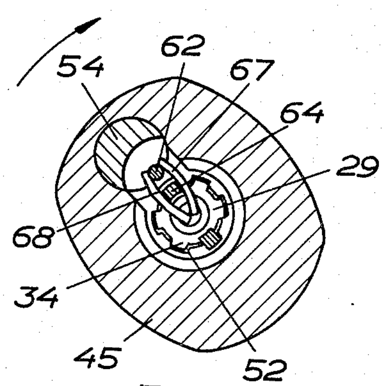

Fig.11

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IMPACT CLUTCHES

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13 Claims. (Cl. 192—30.5)

This invention relates to improvements in power operated impact tools such as wrenches for tightening or loosening nuts or bolts by power, and more particularly to a reversible impact clutch utilised in such impact tools for clutching and declutching the hammer member and the anvil member and for producing rotary blows to the anvil member.

It is a general object of the present invention to provide an improved impact clutch for power operated tools which is characterized particularly by its simple and compact construction. A more specific object of the invention is to provide an improved impact clutch for power operated tools in which for simplicity of operation the clutching movement of the impacting clutch member is controlled by a positive cam action while the declutching movement is performed by means of a spring. A further more specific object of the invention is to provide an improved impact clutch of the foregoing character in which the spring for safeguarding declutching movement is a torsion spring arranged in a simple manner for effective operation over a long operable life and operable for rotation in both clockwise and counterclockwise directions.

The above and other objects of the invention will become obvious from the following description and from the accompanying drawings in which an embodiment of the invention is illustrated by way of example. It should be understood that this embodiment is only illustrative of the invention and that various modifications may be made within the scope of the claims without departing from the scope of the invention.

In the drawings FIG. 1 shows a longitudinal sectional view of an impact tool incorporating an impact clutch mechanism embodying the invention. FIG. 2 is a transverse sectional view taken on the line 2—2 in FIG. 1. FIG. 3 is a transverse sectional view on the line 3—3 in FIG. 1 and showing the impact clutch at the moment of impact. FIG. 4 is a rear view and section substantially on the line 4—4 in FIG. 1. FIG. 5 is a perspective view of a torsion spring incorporated in the impact clutch mechanism of FIG. 1. FIG. 6 is a transverse sectional view corresponding to FIG. 3 but showing the impact clutch mechanism in declutching position immediately after impact. FIG. 7 is a transverse sectional view corresponding to FIG. 6 but showing the impact clutch in one of its normal drive positions with the impact dog ready for riding over one of the cam ridges of the anvil member. FIG. 8 is a transverse sectional view corresponding to FIG. 7 but showing the impact dog in an angular position past said one cam ridge. FIG. 9 shows a transverse sectional view corresponding to FIG. 8 but showing the impact dog in the other of its drive positions ready for riding over the other cam ridge of the anvil member. FIG. 10 shows a transverse sectional view taken on the line 10—10 in FIG. 1 during rotation of the impact clutch in one direction with the impact dog in a position corresponding to FIG. 7. FIG. 11, finally, shows a transverse sectional view corresponding to FIG. 10 but illustrating rotation in the reverse direction.

The power operated impact tool illustrated in FIG. 1 incorporates an impact clutch according to the present invention and comprises a rear housing 20 having a handle portion 21 and a front housing 22. The front housing 22 encloses the impact clutch proper and is pro-

vided with a central opening 23 at its forward end through which an anvil member 25 protrudes. The anvil member 25 is supported by a ball bearing 24 carried inside of and by the front housing 22. In order to prevent intrusion of dirt into the front housing 22 a ring seal 26 is provided around the opening 23 and tightens against the anvil member 25.

Disposed within the rear housing 20 is a reversible rotary motor, preferably as shown a pneumatic motor including a rotor or driving member 29 carrying radial vanes or blades 30 slidably supported within suitable grooves formed in the rotor. Through the medium of the vanes 30 the driving member is driven by compressed air admitted to the motor in a conventional manner, preferably through the handle portion 21 and under control of a trigger valve, not shown, and the usual reversing valve 28. The constructional features of the motor per se form no part of the present invention and may be carried out in any suitable conventional manner.

The driving member 29 has an axial bore 31 therethrough and is supported in the rear housing 20 at its opposite ends by ball bearings 32 and 33. The forward end of the driving member 29 extends through the ball bearing 32 and is formed with parallel splines 34, FIG. 4, on its protruding mantle portion. The front end of the anvil member 25 carries a polygonal end portion 35 for receiving and carrying various removable tools, such as a socket wrench, not shown, which fits on the end portion 35. Adjacent the ball bearing 24 the anvil member 25 has a cylindrical collar 36 resting axially against said ball bearing 24 by means of a shoulder 37 and preventing outward axial movement of the anvil member 25. Behind the collar 36 the anvil member 25 forms a cam portion 38 of substantially cylindrical configuration but provided with a pair of axially extending spaced apart cam ridges 39 and 40. The cam ridges 39, 40 are provided with radially disposed opposite impact receiving faces 41 and 42, respectively, of which one, 41, is turned to receive impacts in clockwise direction, when looking from the rear housing 20 forwardly, while the other, 42 is turned to receive impacts in counterclockwise direction. The faces 41, 42 are arcuate and formed by an axial partially cylindrical recess 43 formed in the cam portion 38 along an axis parallel to the axis of rotation of the anvil member 25. At its rearmost portion the anvil member 25 forms a slightly reduced cylindrical bearing portion 44.

A hammer mass 45 is arranged coaxially around the anvil member 25 and extends from the collar portion 36 thereof to the rear. The hammer mass 45 is journalled by means of cylindrical bearing portions 46 and 47 on the collar 36 and the cylindrical bearing portion 44, respectively, for relative rotation with respect to the anvil member 25. The hammer mass 45 preferably is of oval shape and is provided with a central bore 48 therein surrounding the cam portion 38 and allowing free rotation of the cam portion 38 and the cam ridges 39, 40 in the bore 48. Adjacent the bearing portion 47 there is provided in the hammer mass 45 a shoulder 49 cooperating with the rear face 50 of the anvil member 25 for preventing forward displacement of the hammer mass 45 on the anvil member 25. By means of a central bore 51 the rear portion of the hammer mass 45 is supported on the protruding end of the driving member 29. In order to form a driving connection the bore 51 is provided with longitudinally extending grooves 52 which receive the splines 34 of the driving member 29. The grooves 52 are somewhat broader in circumferential direction than the corresponding splines 34, whereby a slight circumferential play or lost motion is created in the driving connection between the driving member 29 and the hammer mass 45 for a purpose to be explained further on. An axial bore having a radius equal to the radius of the recess 43 of the anvil member 25 extends in parallel relation with the axis of the bore 48 and forms a partially cylindrical recess 53 in the hammer mass which recess 53 faces the cam portion 38 of the anvil member.

The recess 53 receives pivotally therein an impact transmitting dog 54 which is journalled in said recess by means of a partially cylindrical rear bearing portion 55 thereon. The main portion of the impact dog 54 extending over the rear end of the anvil member 25 has a crescent shaped cross section and the dog 54 faces the cam portion 38 with the concave recess 56 defining the shorter arc of the crescent shaped cross section. The concave recess 56 merges into the rear bearing portion 55 by a pair of spaced apart edges 57. The concave recess 56 is provided in order to enable the impact dog 54 to rotate past and ride over the cam ridges 39, 40. When the impact dog 54 occupies a symmetric position with respect to the longer axis of symmetry of the cross section of the hammer mass 45 both its edges 57 protrude inside of the bore 48 of the hammer mass. The rear portion 58 of the impact dog 54 is fully cylindrical and is journalled in a corresponding fully cylindrical rear part of the bore defining the recess 53. Adjacent and at opposite sides of the impact dog 54 the rear face of the hammer mass 45 forms abutments 59, FIG. 4. On the rear portion 58 of the impact dog 54 there are provided corresponding angularly offset abutments 60 cooperating with the abutments 59 and defining the maximum swing of the impact dog 54 in both directions.

The rear portion 58 has a forwardly directed surface 61 which has formed thereon an axially and forwardly protruding pin 62 adjacent the periphery of the rear portion 58 and lying in the plane of symmetry of the concave recessed portion 56 of the impact dog 54. The rear end of the hammer mass 45 rests against the inner ring of the ball bearing 32 while the impact dog 54 is kept in place axially between the outer ring of the ball bearing 32 and an end surface 63 provided in the hammer mass 45.

The rotor or driving member 29 carries at its splined end a pair of diametrically opposed projections 64, FIG. 10, each aligned with one of the splines 34. In the axial bore 31 of the driving member 29 is inserted an elongated torsion spring 66 having a rectangular cross section and being bent in hair pin fashion. The ends of the torsion spring 66 are bent at right angles and form shanks 67 and 68 extending in a transverse plane with respect to the axis of the spring 66 with the longer sides of the rectangular cross section of the shanks 67, 68 in parallel relation to said plane. The arrangement of the spring 66 is such that when the spring 66 is inserted in the axial bore 31 the shanks 67, 68 will protrude radially between the rear face 50 of the anvil member 25 and the forward end of the driving member 29, the shanks 67, 68 extending alongside each other and embracing under a certain precompression or twisting of the torsion spring 66 opposed abutments on one of the projections 64 on the driving member 29 and diametrically opposed portions or abutments of the pin 62 on the impact dog 54, FIG. 10.

In considering the operation of the tool illustrated in the figures, let it be assumed that a bolt to be run down and tightened by the tool has a right hand thread. With the reversing valve 28 set in the correct position the motor will rotate in a clockwise direction, when viewed from the rear housing 20 forwardly, as soon as the operator, having seized the tool by the handle 21, has positioned the socket wrench, not shown, carried by the end portion 35 over the bolt head and has started the fluid motor by pressing the trigger, not shown. Assuming the various parts of the impact clutch mechanism to be in the positions shown in FIGS. 10 and 7, the driving member 29 rotating in the direction of the arrows rotates the hammer mass 45 together with the impact dog 54 through direct engagement between the splines 34 and the grooves 52. As long as the bolt to be tightened rotates with comparative ease, as during the running down period, the mantle surface of the concave recess 56 on the impact dog 54 will engage the ridge 39 of the anvil member 25 as viewed in FIG. 7 and will remain in this clutching position owing to the pin 62 being kept firmly between the shanks 67 and 68 of the torsion spring 66 in a position slightly offset in the direction of the arrow, FIG. 10, with respect to the central plane extending through the axis of rotation of the hammer mass 45 and the pivotal axis of the impact dog 54. Such angularly offset position of the pin 62 is defined by the driving engagement between the splines 34 and the grooves 52 in the hammer mass and causes the impact dog to occupy the driving position of FIG. 7 with the trailing edge 57 of the impact dog 54 inside of the cylindrical central bore 48 and the leading edge 57 outside of said bore 48. The impact dog 54 and the anvil member 25 will remain in engagement so that the bolt is rotated constantly until it is run down and the resistance to rotation increases above some predetermined value.

When the resistance to rotation of the anvil member 25 exceeds said predetermined value, the driving member 29 and the hammer mass 45 force the impact dog 54 to follow the rotation of the hammer mass 45. As a result the mantle surface of the concave recess 56 is forced to slide over the ridge 39 causing pivotal movement of the impact dog 54 on its axis against the action of the torsion spring 66, which by its shank 68 opposes the pivotal movement imposed by the passage over the cam ridge 39. As soon as the trailing edge 57 of the impact dog has passed the ridge 39, FIG. 8, the spring shank 68 immediately urges the pin 62 back to its relative position of FIG. 10 and the trailing edge 57 is again pivoted inside of the cylindrical central bore 48. The driving member 29 now quickly accelerates the hammer mass 45 by rotating it around the now stationary anvil member 25 until the mantle surface of the concave recess 56 and the trailing edge 57 of the impact dog forcefully run against the cam ridge 40 of the cam portion 38, FIG. 9. Against the action of the spring shank 68 the pin 62 together with the impact dog 54 is now pivoted in a manner to bring the leading edge 57 of the impact dog 54 inside of the cylindrical central bore 48 while the trailing edge 57 is pivoted and accelerated radially away from the ridge 40, whereupon at the next moment the hammer mass 45 delivers an impact against the recessed portion 43 of the cam ridge 39 by means of the rear bearing portion 55 adjacent the leading edge 57 of the impact dog 54, FIG. 3.

Rebound of the impact dog upon impact creates a force distribution which enables the shank 68 of the torsion spring 66 to force the pin 62 back to its normal drive position, FIG. 6, which brings the leading edge 57 of the impact dog 54 outside of the cylindrical central bore 48 while the trailing edge 57 is brought inside of said bore. Immediately thereupon the continued rotation of the driving member 29 and the hammer mass 45 brings the impact dog back to its normal drive position, FIG. 7. The hammer mass 45, having delivered by means of the dog 54 a rotational blow to the anvil member 25, continues now rotation of the bolt to be tightened until, again, the camming force exerted by the cam ridge 39 on the impact dog 54 overcomes the force of the torsion spring 66 exerted by its shanks 68, whereupon the impact dog again overrides the cam ridge 39 and repeats the impact cycle. The position of the impact dog 54 in FIG. 9 may also be occupied during running down of the nut. The first impact which with increased resistance to rotation follows upon such drive position will obviously be a weak one because of the angular nearness of the impact position. The powerful blow received by the portions of the impact dog adjacent the trailing edge 57 after full acceleration from the position of FIG. 6 or FIG. 7 to the position of FIG. 9 is prevented from rocking the impact dog 54 and its pin 62 too far against the action of the spring shank 68 by means of the abutments 60 on the rear end 58 of the impact dog 54. These abutments 60 will be arrested by the cooperating abutments 59 on the hammer mass 45 as soon as the cam action of the cam ridge 40 and the inertial forces caused by the blow have rocked the leading edge of the impact dog 54 to the proper depth into the cylindrical central bore 48 for the impact, FIG. 3.

The operation of the impact clutch in the reverse direction is, owing to the symmetry of the impacting and camming portions of the impact dog 54 and the symmetry of the cam ridges 39, 40 and of the recess 43 on the cam portion 38, identical with operation in clockwise direction. Of course impacting now occurs against the surface 42 of the cylindrical recess 43 adjacent the ridge 40, while the cam ridge 39 now in its turn acts as a cam for positively rocking and accelerating the impact dog 54 into clutching position. As seen in FIG. 11 the driving member 29 when driving in the reverse direction or the direction of the arrow moves by means of the projection 64 and the spring shanks 67, 68 the pin 62 to an angular position offset in the direction of rotation with respect to the central plane through the axis of rotation of the hammer mass 45 and the pivotal axis of the impact dog 54. Obviously the pin 62 has now to counteract the spring action of the shank 67 of the torsion spring 66 during the rocking movement of the impact dog 54 into clutching or impact position as well as during overriding of the cam ridge 40. In the driving position of FIG. 11 the displacement of the pin 62 in the direction of rotation is attained by the circumferential play or lost motion in the drive connection between the splines 34 and the broad grooves 52, the width of which is calculated to give a play resulting in a suitable angle of attack of the trailing edge portions of the impact dog and movement of the leading edge to a position outside of the central bore 48. The diametrically opposed double arrangement of the projections 64 is provided for creating alternative positions during assembly of the impact clutch mechanism parts. Each projection 64, when straddled by the shanks 67, 68 of the torsion spring 66, forms opposed abutments for the spring shanks, of which one abutment always holds one shank of the spring stationary while the other abutment forms an end stop for the movement of the other spring shank when performing return of the pin 62 to normal drive position.

By providing an axial hole 69 through the anvil member 25 the spring 66 may alternatively be mounted in the hole 69 of the anvil member 25. For making possible easy rotation of the spring with respect to the anvil member 25 in such arrangement there may be journalled in the hole 69 a tube, not shown, into which the spring 66 may be inserted.

The impact clutch embodiment above described and illustrated in the drawings should only be considered as an example and the invention may be modified in several different ways within the scope of the following claims.

What I claim is:

1. An impact clutch comprising a rotatable anvil member, a rotatable hammer mass coaxially supported with respect to said anvil member, rotatable driving means for said hammer mass, an impact dog pivotally mounted on said hammer mass for rotation therewith and movable relative thereto in clutching and declutching direction about an axis offset from but parallel with the axis of rotation of said anvil member, cam means between said anvil member and said dog for positively pivoting the dog in the clutching direction, and a torsion spring extending axially of said clutch, said torsion spring being rotatable with said hammer mass for engaging and pivoting said impact dog in the declutching direction.

2. An impact clutch comprising a rotatable anvil member, a rotatable hammer mass coaxially supported with respect to said anvil member, a rotatable driving member, a drive connection incorporating some degree of play for providing a constantly engaged direct drive between said driving member and said hammer mass except for said play, an impact dog pivotally mounted on said hammer mass for rotation therewith and movable relative thereto in clutching and declutching direction about an axis offset from but parallel with the axis of rotation of said anvil member, cam means between said anvil member and said dog for positively pivoting said dog in the clutching direction, and spring means rotatable by and with said hammer mass for engaging and pivoting said impact dog in the declutching direction.

3. An impact clutch comprising a rotatable anvil member, a rotatable hammer mass coaxially supported with respect to said anvil member, rotatable driving means for said hammer mass coaxially supported with respect to said hammer mass, an impact dog pivotally mounted on said hammer mass for rotation therewith and movable relative thereto in clutching and declutching direction about an axis offset from but parallel with the axis of rotation of said anvil member, a first abutment on said impact dog intermediate the pivotal axis of said impact dog and the axis of rotation of said hammer mass, a second abutment on said driving means adjacent said first abutment, cam means between said anvil member and said dog for positively pivoting said dog in the clutching direction, and spring means extending between said first and said second abutments and in engagement therewith for pivoting said impact dog in the declutching direction.

4. A reversible impact clutch comprising a rotatable anvil member, a rotatable hammer mass coaxially supported with respect to said anvil member, a rotatable driving member coaxially supported with respect to said hammer mass, a drive connection incorporating some degree of play for providing a constantly engaged direct drive between said driving member and said hammer mass except for said play, an impact dog pivotally mounted on said hammer mass for rotation therewith and movable relative thereto in clutching and declutching direction about an axis offset from but parallel with the axis of rotation of said anvil member, an extension on said impact dog forming a first pair of opposed abutment surfaces intermediate the pivotal axis of said impact dog and the axis of rotation of said hammer mass, an extension on said driving member adjacent said extension on said impact dog forming a second pair of abutment surfaces, cam means between said anvil member and said dog for positively pivoting said dog in the clutching direction, and a torsion spring extending between said first pair and second pair of abutment surfaces for engaging and pivoting said impact dog in the declutching direction.

5. An impact clutch as set forth in claim 4 in which the ends of said torsion spring are provided with laterally protruding shanks extending in parallel relation to a transverse plane extending with respect to the axis of said spring and spaced from each other with said first and second pair of opposed abutment surfaces therebetween.

6. An impact clutch comprising a rotatable anvil member, a rotatable hammer mass coaxially supported with respect to said anvil member, a rotatable driving member coaxially supported with respect to said hammer mass, a drive connection directly between said driving member and said hammer mass, an impact dog pivotally mounted on said hammer mass for rotation therewith and movable relative thereto in clutching and declutching direction about an axis offset from but parallel with the axis of rotation of said anvil member, cam means between said anvil member and said dog for positively pivoting said dog in the clutching direction, and a torsion spring oriented coaxially with said anvil member and said driving member and arranged between said driving member and said impact dog for pivoting said impact dog in the declutching direction.

7. An impact clutch as set forth in claim 6 in which said torsion spring is concentric with said driving member.

8. An impact clutch as set forth in claim 6 in which said torsion spring is concentric with said anvil member.

9. An impact clutch comprising a rotatable anvil member, a rotatable hammer mass coaxially supported with respect to said anvil member, a rotatable driving member coaxially supported with respect to said hammer mass, a drive connection directly between said driving member and said hammer mass, a partially cylindrical axial recess in said hammer mass facing said anvil member, an impact transmitting dog having a partial cylindrical rear bearing portion thereon, said dog being journalled by said bearing portion in said hammer mass recess and supported therein for movement in clutching and declutching direction, a recessed front portion on said impact dog facing the anvil member and merging into said rear portion by a pair of spaced apart edges, cam means between said anvil member and one of said edges for pivoting said other edge in clutching direction, and a torsion spring oriented coaxially with said anvil member and said driving member and arranged between said driving member and said impact dog for pivoting said impact dog in the declutching direction.

10. A reversible impact clutch comprising a rotatable anvil member, a rotatable hammer mass coaxially supported with respect to said anvil member, a rotatable driving member coaxially supported with respect to said hammer mass, a drive connection incorporating some degree of play for providing a constantly engaged direct drive between said driving member and said hammer mass except for said play, a partially cylindrical axial recess in said hammer mass facing said anvil member, an impact transmitting dog having a partially cylindrical rear bearing portion thereon, said dog being journalled by said bearing portion in said hammer mass recess and supported therein for movement in clutching and declutching direction, a recessed front portion on said impact dog facing the anvil member and merging into said rear portion by a pair of spaced apart edges, a pin on said impact dog intermediate the pivotal axis of said impact dog and the axis of rotation of said hammer mass forming a first pair of opposed abutment surfaces, a forwardly extending projection on said driving member adjacent said pin forming a second pair of opposed abutment surfaces, cam means between said anvil member and one of said edges for pivoting said other edge in clutching direction, and a torsion spring extending between said first and second pair of abutments for pivoting said impact dog in the declutching direction.

11. An impact clutch as set forth in claim 10 in which the ends of said torsion spring form laterally parallel to a transverse plane through the axis of said spring and spaced from each other with protruding shanks extending in said first pair and second pair of opposed abutment surfaces disposed therebetween.

12. In an impact clutch apparatus of the character described having a reversible motor with a rotatable driving member extending therefrom, a rotatable anvil member coaxially supported with respect to said driving member and a rotatable hammer mass coaxially supported with respect to said anvil member, the combination which comprises a driving connection incorporating some degree of play for providing a constantly engaged direct drive between said driving member and said hammer mass except for said play, an impact dog pivotally mounted in said hammer mass about an axis offset from but parallel with the axis of rotation of said anvil member in a clutching and a declutching direction, a pin extending from said impact dog intermediate the pivotal axis thereof and the axis of said hammer mass forming a pair of opposed abutment surfaces, cam means disposed and operative between said anvil member and the trailing edge of said impact dog for positively pivoting the leading edge of said impact dog in a clutching direction, and spring means rotatable with said driving member and extending between said driving member and said opposed abutment surfaces for moving said trailing edge of said impact dog into the path of said cam means for driving engagement and for pivoting said impact dog in a declutching direction.

13. Apparatus as described in claim 12 in which said spring means comprises a torsion spring coaxially disposed in said driving member, and laterally protruding shanks extending in parallel to a transverse plane extending through the axis of said spring from the end thereof with said opposed abutment surfaces disposed therebetween.

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