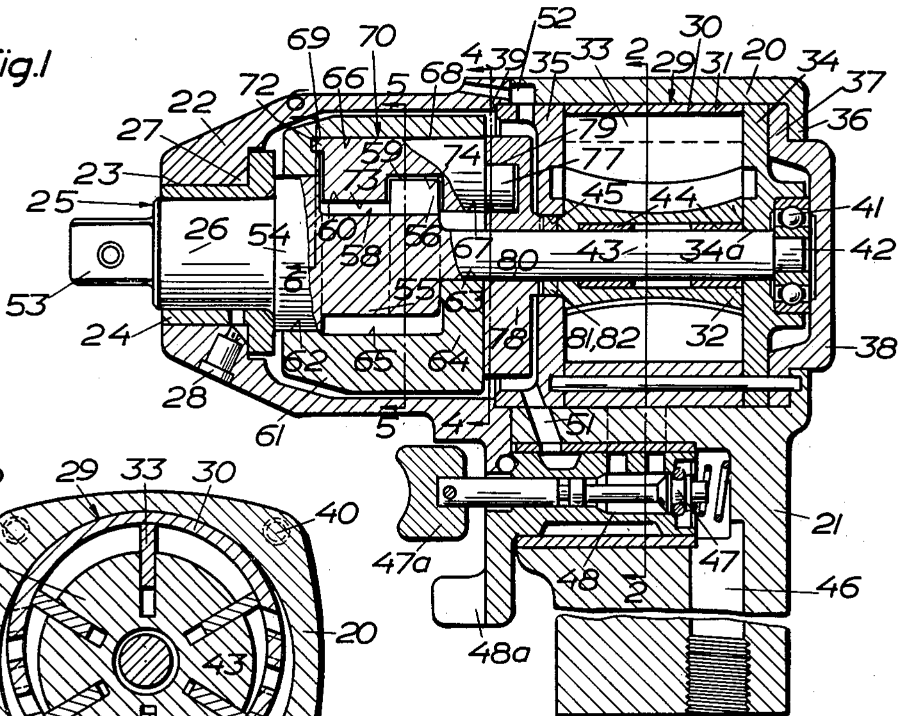
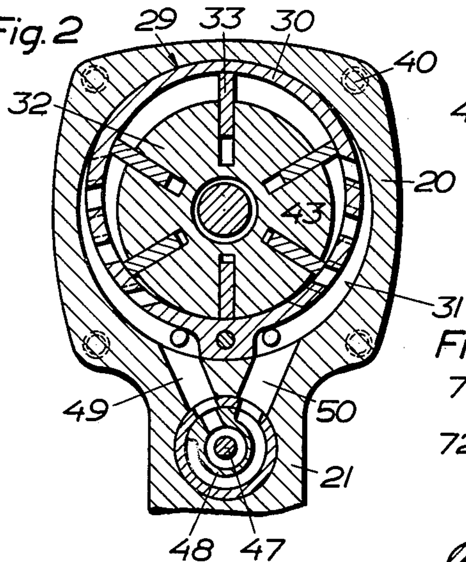
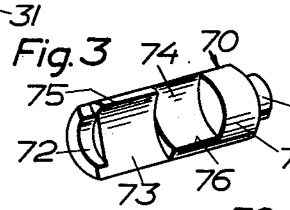
April 21, 1964 — K. G. KÅRDÉN — 3,129,796

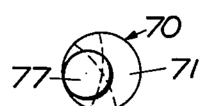
IMPACT CLUTCHES

Filed Oct. 18, 1960 — 4 Sheets-Sheet 1



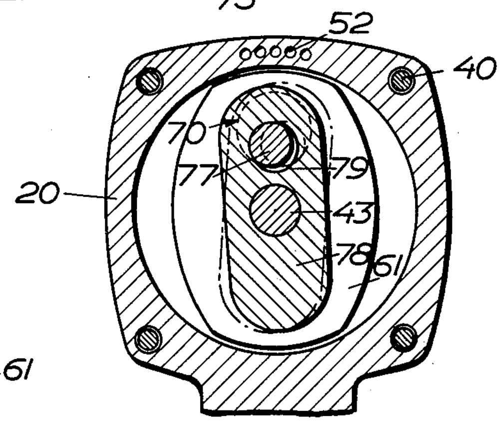




Fig.4

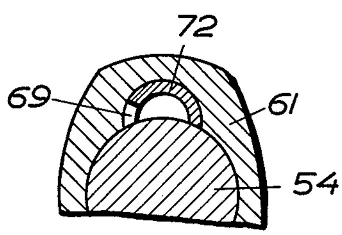



Fig.6

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April 21, 1964 | K. G. KÅRDÉN | 3,129,796

IMPACT CLUTCHES

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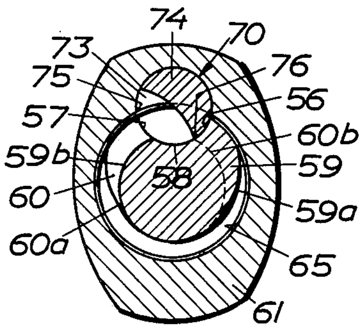



Fig.5

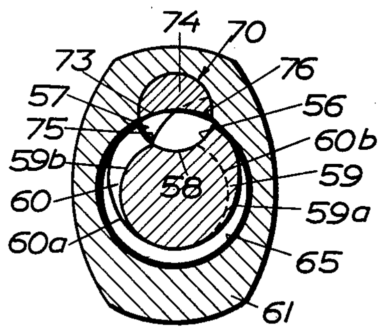



Fig.5a

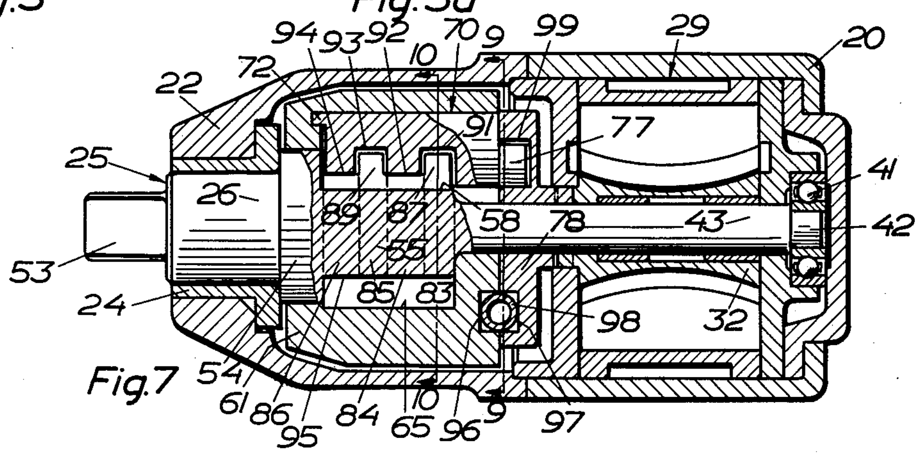
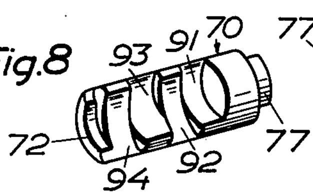



Fig.7

Fig.8



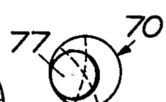




Fig.8a

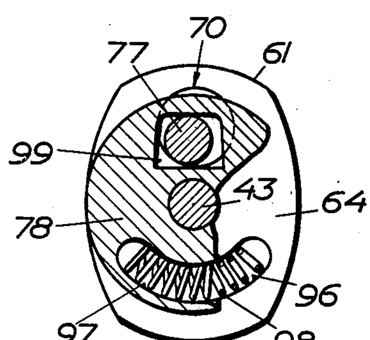



Fig.9

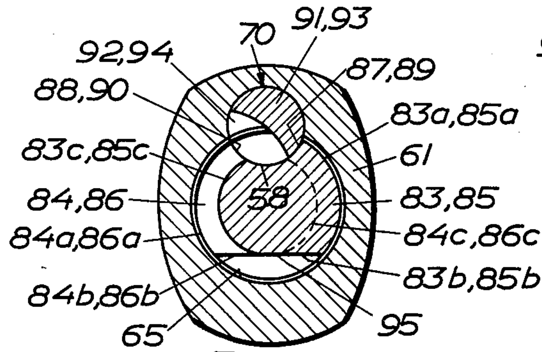



Fig.10

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IMPACT CLUTCHES

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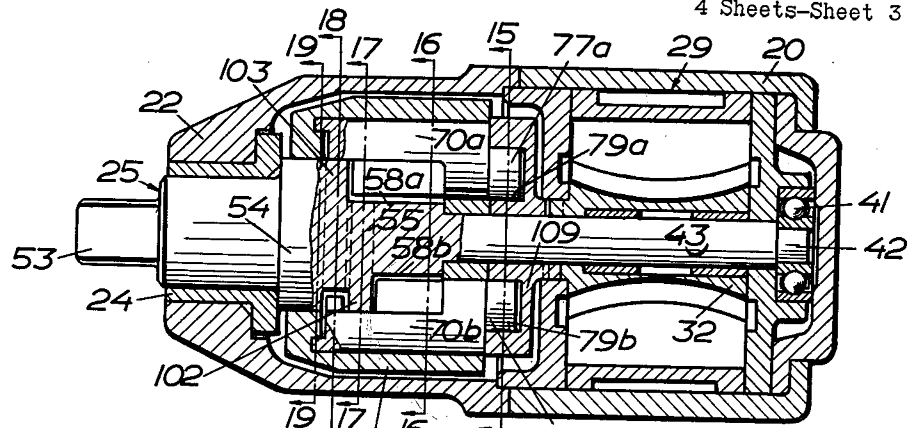


Fig.11

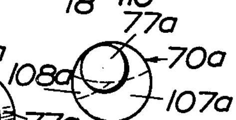


Fig.12a

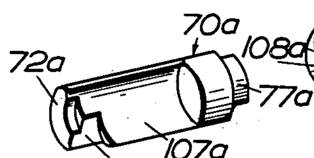


Fig.12

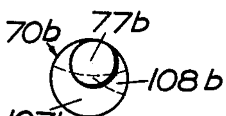


Fig.13a

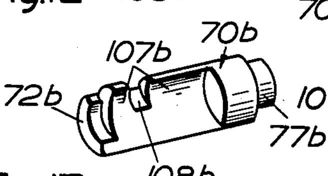


Fig.13

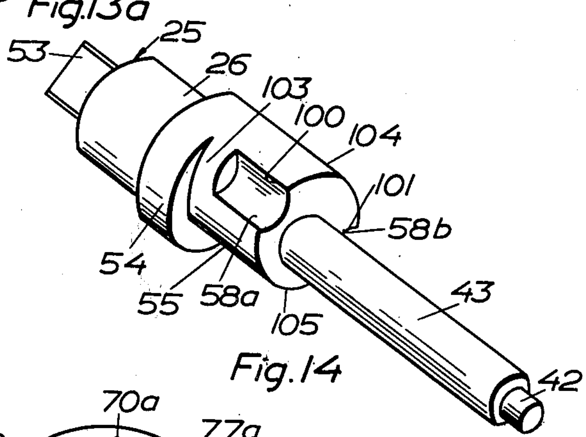


Fig.14

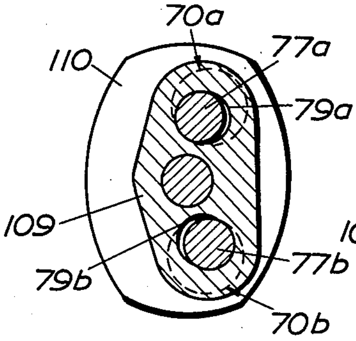


Fig.15

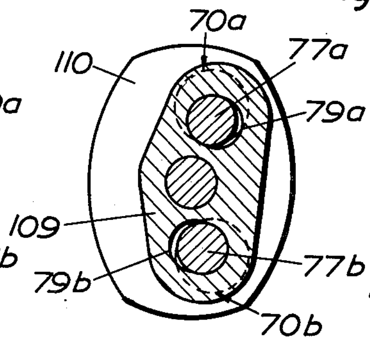


Fig.15a

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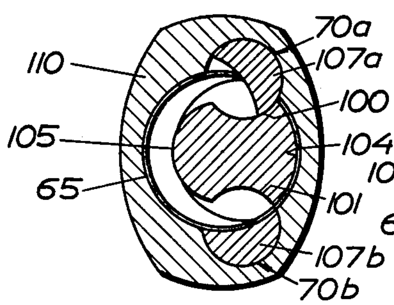


Fig. 16

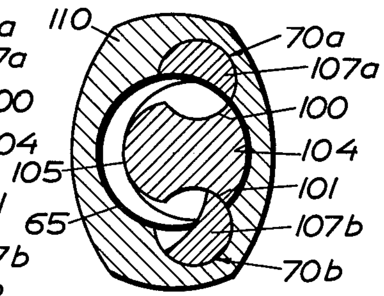


Fig. 16a

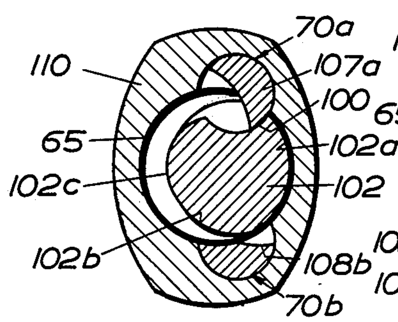


Fig. 17

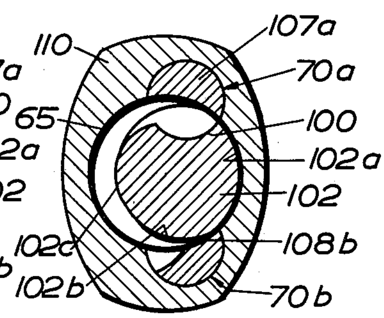


Fig. 17a

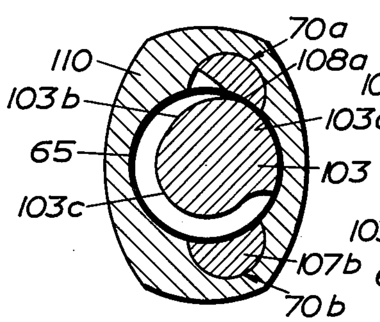


Fig. 18

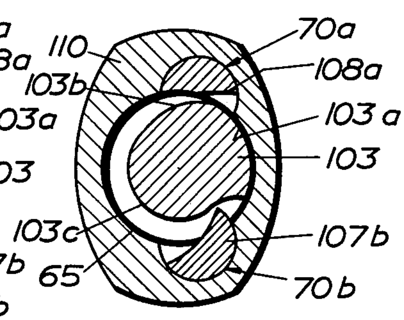


Fig. 18a

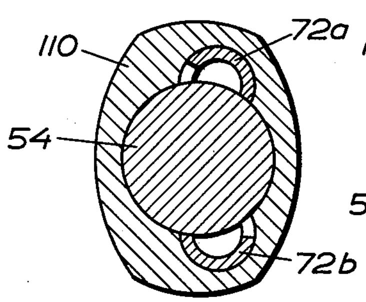


Fig. 19

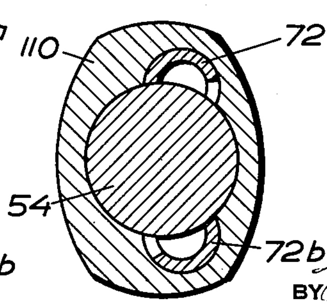


Fig. 19a

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Patented Apr. 21, 1964



3,129,796

# IMPACT CLUTCHES

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Filed Oct. 18, 1960, Ser. No. 63,309
9 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 an impact clutch operable for rotation in both clockwise and counter-clockwise directions and utilized 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, rugged and compact construction, which is effective and durable in operation and which permits economical manufacture.

A more specific object of the invention is to provide an improved impact clutch for power operated tools having comparatively large contact areas for transmitting the hammer blows to the anvil member.

Another more specific object of the invention is to provide an improved impact clutch of the foregoing character in which, for reliability of operation, the clutching and declutching movement of the impacting clutch member is controlled by a positive cam action.

A further more specific object of the invention is to provide an improved impact clutch for power operated rotary impact tools in which the operating parts are journalled in a simple manner for efficient operation over a long operable life.

The foregoing and further objects and advantages of the present invention will become apparent hereinafter as this description proceeds, reference being made to the accompanying drawings showing two embodiments of the invention which are illustrated by way of example but which do not limit the invention which may be carried out in many different ways within the scope of the claims.

In the drawings, wherein like parts are designated by like reference characters throughout the several views,

FIG. 1 is a vertical, longitudinal sectional view of an impact tool incorporating an impact clutch mechanism embodying this invention;

FIG. 2 is a transverse sectional view taken on the line 2—2 in FIG. 1 looking forwardly of the tool in the direction of the arrows;

FIG. 3 is a perspective view of an impact dog forming part of the impact clutch of the tool of FIG. 1;

FIG. 3*a* is a rear view of the impact dog of FIG. 3;

FIG. 4 is a transverse sectional view taken on the line 4—4 in FIG. 1 looking forwardly in the direction of the arrows;

FIG. 5 is a transverse sectional view taken on the line 5—5 in FIG. 1 looking forwardly in the direction of the arrows and showing the impact clutch in clutching or impact position;

FIG. 5*a* is a transverse sectional view corresponding to FIG. 5 but showing the impact clutch in release or declutching position immediately after impact;

FIG. 6 is a fragmentary transverse sectional view taken on the line 6—6 of FIG. 1;

FIG. 7 is a horizontal longitudinal sectional view of an impact tool incorporating a variation of the impact clutch of FIG. 1;

FIG. 8 is a perspective view of the impact dog forming part of the impact clutch of FIG. 7;



FIG. 8*a* is a rear view of the impact dog of FIG. 8;

FIG. 9 is a transverse sectional view, partly broken away to show underlying parts and taken on the line 9—9 of FIG. 7 looking forwardly in the direction of the arrows;

FIG. 10 is a transverse sectional view taken on the line 10—10 of FIG. 7 looking forwardly in the direction of the arrows;

FIG. 11 is a substantially horizontal, longitudinal sectional view of an impact tool incorporating another modification of the impact clutch of FIG. 1;

FIGS. 12 and 13 are perspective views of two impact dogs forming part of the impact clutch of the tool of FIG. 11;

FIGS. 12*a* and 13*a* are rear views of the respective impact dogs of FIGS. 12 and 13;

FIG. 14 is a perspective view of an anvil member forming part of the tool of FIG. 11;

FIGS. 15–19 are transverse sectional views through the impact mechanism of the tool, taken respectively on lines 15—15, 16—16, 17—17, 18—18 and 19—19 of FIG. 11 looking forwardly in the direction of the arrows and showing the mechanism in the clutching or impact position, and;

FIGS. 15*a*–19*a* are transverse sectional views through the impact mechanism of the tool corresponding to FIGS. 15–19 but showing the mechanism in the release or declutching position immediately after impact.

Referring now more specifically to FIGS. 1–6 of the drawings, the power operated impact tool illustrated therein incorporates an impact clutch according to one embodiment of the present invention and comprises a rear housing **20** having an integral handle portion **21** and a front housing **22**. The front housing **22** encloses the impact clutch and is provided with a central opening **23** at its forward end, in which is positioned a bushing **24** serving as a bearing for a rotatable impact spindle or anvil member **25** extending therethrough with a thickened portion **26**. The portion **26** is lubricated by a grease passage in the bushing **24** leading to an annular grease chamber **27** between the bushing **24** and the forward end of the front housing **22**. The grease chamber may be filled through a nipple **28**.

Disposed within the rear housing **20** is a rotary motor, preferably as shown a pneumatic motor **29** of the reversible sliding vane type. The motor is fitted in a bore **31** in the rear housing section **20** and comprises a cylinder **30**, within which a rotor **32** equipped with radially slidable vanes **33** is rotatable. The ends of the motor cylinder **30** are closed by rear and forward end plates **34**, **35** also fitted in the bore **31**. The bore **31** ends rearwardly at an inwardly protruding collar **36**, formed by the rear housing **20**, and a flange **37** on an end cover **38** abuts against said collar and closes the rear end of the bore **31**. The cover **38**, the end plate **34**, the motor cylinder **30** and the end plate **35** are clamped axially in the bore **31** between the collar **37** and a shoulder **39** on the front housing **22**, which is bolted to the housing **20** by bolts **40** indicated in FIGS. 2 and 4. The end plate **34** has a central opening **34*a*** and supports centrally an anti-friction bearing **41**. In this bearing **41** is journalled the rearmost reduced end portion **42** of the anvil member **25**. Adjacent the portion **42** the anvil member **25** has a reduced portion **43** of larger diameter than the portion **42** passing freely through the central opening **34*a*** of the end plate **34**. The rotor **32** is rotatably journalled around and on the portion **43** on self-lubricating bushings **44**. The forward end plate **35** of the cylinder **30** has a central opening **45** forming an annular space around the anvil member portion **43**.

Pressure fluid for operation of the motor **29** is supplied from a suitable source (not shown) to the outer end of passage 46 in the handle 21. The admission of pressure fluid to the motor is under the control of a valve assembly incorporating a central throttle valve 47 mounted for reciprocation in a pivotable reversing and exhaust controlling valve 48. The valves 47, 48 are provided with a trigger 47*a* and a lever 48*a*, respectively, for convenient manipulation. Pressure fluid from the throttle and reversing valve assembly 47, 48 is admitted into the rotor chamber alternatively through one of a pair of ports 49, 50, as obvious from FIG. 2, and fluid is exhausted by the other port back to the reversing valve 48, then through a passage 51 to the forward end of the motor end plate 35 and from there by exhaust passages 52 to the atmosphere.

The integral anvil member 25, which is journalled with the forward portion 26 and the rearmost reduced portion 42 in the housing, has at its foremost end a polygonal end portion 53 for receiving and carrying various removable tools, such as a socket wrench which fits on the end portion 53. Adjacent the front bearing portion 26 the anvil member 25 has a circular collar 54 disposed inside the front housing 22. Between this collar 54 and the reduced portion 43, on which the motor rotor 32 is journalled, the anvil member 25 forms a cam portion 55 having a pair of radially disposed, opposite and axially offset impact receiving faces 56, 57 of which one, 56, is turned to receive impacts in clockwise direction, when looking from the rear of the anvil member forwardly, while the other, 57, is turned to receive impacts in counterclockwise direction. The faces 56, 57 are arcuate and formed by an axial generally semi-cylindrical recess 58 formed in the cam portion 55 along an axis parallel to the axis of rotation of the anvil member 25. The cam portion 55 incorporates two axially offset radial cams 59, 60, see FIGS. 1 and 5, which are symmetrically arranged with respect to a plane through the axis of the recess 58 and the axis of the anvil member 25. Each of the cams 59, 60 incorporates one of the impact receiving faces 56, 57 and extends from the high point of the cam surface 59*a*, 60*a* merging in a cylindrical portion 59*b*, 60*b*, respectively, concentric with the anvil member, ending in the axial recess 58.

A hammer mass 61 is arranged coaxially around the anvil member 25 and is journalled on the anvil member 25 for relative rotation with respect thereto. The hammer mass 61 preferably is of oval shape having a central forward bore 62, by which the forward end of the hammer mass 61 is rotatably journalled on the collar 54 of the anvil member 25. The rear end of the hammer mass 61 is journalled on the reduced portion 43 adjacent and behind the cam portion 55 of the anvil member, for which purpose the hammer mass has a reduced bore 63 in its rear wall 64. The hammer mass surrounds the cam portion 55 by a cylindrical cavity 65, which is slightly wider than the bore 62. An axial bore 66 along the generatrix of the forward bore 62, having a radius equal to the radius of the recess 58 of the anvil member 25, is formed in the hammer mass 61 and extends forwardly from the rear end of the hammer mass forming a circular opening 67 in the rear wall 64 and a generally semi-cylindrical axial recess 68 in the wall of the cavity 65 facing the cam portion 55 of the anvil member 25. At the bottom of the bore 66 there is formed a generally semi-circular groove 69 open at its ends towards the collar 54 of the anvil member 25, as shown in FIG. 6.

An impact transmitting dog 70, FIG. 3, is pivotally journalled in the axial bore 66 of the hammer mass 61. The dog 70 has a cylindrical end 71, which is journalled in the opening 67 in the rear wall 64 of the hammer mass 61, while the forward end of the dog 70 is journalled in the groove 69 by an integral axial arc-shaped flange 72. Additionally the axial flange 72, by alternatively coming into contact with the collar 54 of the anvil member 25 with its leading or trailing flange end, functions as a stop for limiting the pivotal oscillations of the dog 70, as obvious from FIG. 6. The dog 70 is recessed to form axially offset in cross-section generally semi-cylindrical parts 73, 74 or impact elements, each adapted to cooperate with one of the faces 56, 57 and cam surfaces 59*a*, 60*a* of the cam portion 55 on the anvil member 25. The semi-cylindrical parts 73, 74 are preferably crescent-shaped in cross-section, the shorter arc of the crescent having a radius equal to the radius of the cylindrical cavity 65 of the hammer mass 61. The crescent shaped parts 73, 74 are angularly as well as axially offset, forming protruding opposite edges 75, 76, adjacent to which the radially outer cylindrical mantle surface of the dog 70 forms a continuous bearing surface which functions as an impact transmitting surface cooperating with the arcuate faces 56, 57 of the anvil member 25. The angle between the central planes of the crescent shaped parts 73, 74 is acute and preferably equal to the angle described by the dog 70 when one of its crescent shaped parts, 73 or 74, is rocked from having its shorter arc flush with the cavity 65 of the hammer mass into a position for establishing contact between its protruding edge, 75 or 76, and the corresponding cylindrical portion 59*b* or 60*b*, respectively, of the anvil member cams 59, 60. As a result of being angularly offset in this way one of the protruding edges 75, 76 is always brought into the path of one of the impact faces 56, 57 of the anvil member 25 and their respective cams 59, 60 as soon as the other edge is brought flush with the cavity 65. At the rear face of the impact dog 70 a pivot 77 is formed integrally with the dog, said pivot having its axis intermediate the pivotal axis of the impact dog 70 and the central axis of the hammer mass 61 and symmetrically arranged with respect to the crescent-shaped parts 73, 74.

An oblong driving member 78, having an axial centre bore 80, rests against the rear wall 64 of the hammer mass 61 and is rotatably journalled coaxially therewith on the reduced portion 43 of the anvil member 25. The driving member 78 is in driving and camming engagement with the pivot 77 of the impact dog 70 by an enlarged or radially slightly oblong recess 79 giving the pivot 77 some play with respect to the driving member 78. As obvious from FIG. 4, this play makes possible a limited angular movement or lost motion from the full line to the dotted line position between the driving member 78 and the hammer mass 61 when the hammer dog 70 is cammed and rocked by the driving member 78 and the pivot 77. Said play is great enough to permit rocking of the hammer dog 70 substantially through the acute angle mentioned above. The rear end of the driving member 78 is provided with axial clutch teeth 81 reaching into the central opening 45 of the forward end plate 35 of the motor 29 and engaging corresponding clutch teeth 82 protruding forwardly into the opening 45 from the fluid motor rotor 32.

In considering the operation of the tool illustrated in FIGS. 1–6, let it be assumed that a bolt to be run down and tightened by the tool has a right hand thread. With the valve assembly 47, 48 set in the position of FIG. 2, the motor will rotate in a clockwise direction. The operator, having grasped the tool by the handle 21, has to position the socket wrench (not shown), which is carried by the polygonal end portion 53 of the anvil member 25, over the bolt head, whereupon he starts the fluid motor 29 by pressing the trigger 47*a*. The motor rotor 32 then imparts a clockwise rotation to the driving member 78. Assuming the various parts of the impact clutch mechanism to be in the positions shown in FIGS. 4 (solid lines), 5 and 6, the driving member 78 rotates the hammer mass 61 together with the impact dog 70 by engaging the pivot 77 of the dog. As long as the bolt to be tightened rotates with comparative ease, as during the running down period, the mantle portion of the crescent shaped part 74 of the dog 70 adjacent its leading edge 76 will engage the face 56 of the anvil member 25 as viewed in FIG. 5, and will remain in this clutching position owing to the frictional force between the crescent-shaped part 74 and the jaw 56 and the friction between the impact dog 70 and the semi-cylindrical recess 68 of the hammer mass 61 resisting the tendency of the driving member 78 to rock the crescent shaped part 74 flush with the cavity 65 of the hammer mass 61. Said tendency is caused by the camming contact of the driving member 78 with the pivot 77, which tends to eliminate the lost motion between the driving member 78 and the hammer mass 61 and to rock the impact dog 70. Accordingly, the hammer mass 61 and the anvil member 25 will remain engaged 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 78, acting on the pivot 77 of the impact dog 70, eliminates the lost motion and turns the dog 70 with respect to the hammer 61 to the dotted line position shown in FIG. 4 and, consequently, rocks the dog 70 into the position shown in FIG. 5*a*. The rocking motion will be limited by the semi-circular axial flange 72 of the dog 70 changing position in FIG. 6 and coming into contact with the collar 54 of the anvil member 25 with its trailing flange-end. In this position the crescent-shaped portion 74 will be flush with the cavity 65 of the hammer mass 61, out of the path of the anvil face 56 and in position for passing over the cam surface 59*a*. Simultaneously the angularly and axially offset integral crescent shaped part 73 of the dog 70 together with its trailing edge 75, which in the position in FIG. 5 was flush with the cavity 65, will now be rocked into the path of the cam surface 60*a* into position for contacting the cylindrical cam portion 60*b* of the cam 60. The rotor 32 of the fluid motor 29, rotating freely around the reduced portion 43 of the now stationary anvil member 25, will then quickly accelerate the hammer mass 61 through 360 degrees so that the hammer mass 61 is moving on the anvil member 25 at substantially the maximum speed of rotation of the fluid motor 29 prior to delivering the rotary hammer blow to the anvil by means of the impact dog 70. During this rotation of the hammer mass 61 the trailing edge 75 of the crescent shaped portion 73 at first comes into contact with the cylindrical portion 60*b* of the cam 60 and then with the cam surface 60*a*, said latter contact gradually and positively causing the impact dog 70 to be rocked until the crescent shaped part 73 is flush with the cavity 65 as shown in FIG. 5. Simultaneously, this rocking motion by means of the pivot 77 again builds up the lost motion between the driving member 78 and the hammer mass 61 by accelerating the hammer mass 61 to rotate somewhat ahead of the driving member 78 so that the driving member 78, with respect to the hammer mass 61, is returned to its full line position of FIG. 4. Furthermore, the leading edge 76 of the crescent shaped portion 74, being integral with the crescent shaped portion 73, is simultaneously positively rocked into the path of the face 56 immediately prior to impact between the mantle of the dog 70 adjacent the edge 76 and the anvil face 56. The rocking movement of the dog 70 is arrested by the leading flange-end of the circular flange 72 coming into contact with the collar 54 of the anvil member 25, as viewed in FIG. 6.

The hammer mass 61 delivering by means of the dog 70 a rotational blow to the anvil member 25 rotates the bolt to be tightened until, again, the camming force exerted by the driving member 78 on the pivot 77 of the impact dog 70 overcomes the frictional forces between the mantle of the crescent shaped part 74 of the dog 70 and the recess 68 and face 56 so that the lost motion between the driving member 78 and the hammer mass 61 is eliminated and the edge 76 is rocked flush with the cavity 65 out of the path of the anvil jaw 56, whereupon the impact cycle is repeated. In the case of the bolt having been driven relatively tight there is a tendency of the dog 70 to rebound after impact, and the dog will be rocked to releasing or declutching position during such rebound with great ease.



The operation of the impact clutch in the counterclockwise direction is, owing to the symmetry of the impacting and camming portions of the impact dog and the symmetry of the corresponding faces and cams on the cam portion 55 of the anvil member 25, identical with operation in clockwise direction with the exception, of course, that impacting now occurs between the mantle portion adjacent the edge 75 of the impact dog 70, now in its turn being the leading edge, and the face 57 of the anvil member 25 while the edge 76, now the trailing edge, will cooperate with the cam 59 of the cam portion 55 of the anvil member 25.

In FIGS. 7–10 is illustrated a tool similar in structure and operation to the tool illustrated in FIGS. 1–6, but with some minor constructional differences relating to the number and configuration of the anvil member cams and to the connection between the driving member and the hammer mass, which differences will now be described.

In FIG. 7 the cam portion 55 of the anvil member 25 is provided with the axial semi-cylindrical recess 58 and incorporates four axially offset radial cams 83—86 arranged so, that adjacent cams are symmetrically arranged with respect to a plane through the axis of the recess 58 and the rotational axis of the anvil member 25, see FIG. 10. Opposite the recess 58 the cam portion 55 is flattened along a plane 95 parallel to the rotational axis of the anvil member and perpendicular to said plane of symmetry. The cylindrical recess 58 intersecting the cams 83—86 at right angles, forms a pair of arcuate impact receiving anvil faces 87, 89 on the cams 83, 85 arranged to receive rotary impacts in a clockwise direction, when looking from the rear of the anvil member 25 forwardly, and another pair of impact receiving arcuate anvil faces 88, 90 on the cams 84, 86 arranged to receive impacts in a counterclockwise direction. Each of the cams 83—86 has an elevated cylindrical portion 83*a*—86*a* adjacent the faces 87—90 with a radius somewhat smaller than the radius of the cavity 65 in the hammer mass 61, and a reduced cylindrical portion 83*c*—86*c* ending in the axial recess 58. These cylindrical portions are interconnected by flattened cam portions 83*b*—86*b* lying in the plane 95, the flattened portions being tangential to the reduced cylindrical portions 83*c*—86*c* and being rounded at the transition to the elevated portions 83*a*—86*a*.

The impact dog 70 is journalled in and supported by the hammer mass 61 in the same way as in FIG. 1. The dog is recessed to form four axially and angularly offset in cross-section preferably crescent-shaped parts 91—94 or impact elements facing the anvil member, each cooperating with one of the cams 83—86 and their respective faces 87—90. The crescent-shaped parts 91—94 have their central planes located in two planes forming an acute angle with one another, which means, as viewed in FIG. 8, that the central planes of the crescent shaped parts 91, 93 are in the same plane, while the central planes of the adjacent crescent shaped parts 92, 94 are in another plane, the latter forming an acute angle with the former. This acute angle is preferably equal to the angle through which the impact dog 70 is moved when the crescent shaped parts 91, 93 or 92, 94 are rocked from having their shorter arcs flush with the cavity 65 of the hammer mass into a position for establishing contact between the crescent shaped parts and the reduced cam portions 83*c*—86*c* of the cams 83—86. The pivot 77 of the impact dog 70 is symmetrically arranged with respect to the crescent shaped parts 91—94.

An arcuate groove 96 is formed in the rear wall 64 of the hammer mass 61 and a corresponding groove 97 is formed in the adjacent wall of the driving member 78, which has cylindrical configuration. A coil spring 98 is tightly fitted in the grooves 96, 97 and constitutes a resilient driving connection directly between the driving member 78 and the hammer mass 61. The driving member has a camming recess 99 cooperating with the pivot 77 of the impact dog 70. This camming recess 99 has radial as well as tangential play with respect to the pivot 77 which in the normal driving position of the driving member 78 is large enough to permit free rocking motion of the pivot 77 in the recess 99 caused by the positive movement of the dog 70 in the clutching direction. The recess 99 is kept in place in normal driving position with respect to the pivot 77 by the resilient groove and spring connection 96—98. Said play makes possible a limited angular movement or lost motion between the driving member 78 and the hammer mass 61.

The modified impact clutch operates briefly as follows. The driving member 78 rotates the hammer mass 61, say in clockwise direction as viewed in FIGS. 9, 10 by direct engagement through the groove and spring connection 96—98. As long as there is small resistance to rotation the pair of leading crescent-shaped parts 91, 93 will engage the respective anvil faces 87, 89 to rotate the anvil member 25 together with the hammer mass 61. During this rotation there is no driving contact between the camming recess 99 of the driving member 78 and the pivot 77 of the impact dog.

When the resistance to rotation of the anvil member 25 exceeds a predetermined value, the driving member 78 compresses the spring 98 of the spring and groove connection 96—98, contacts the pivot 77 by the camming recess 99 and rocks the impact dog 70 by camming the pivot 77 in the releasing direction, that is the counter-clockwise direction as viewed in FIGS. 9, 10, thereby eliminating the until then existing lost motion between the driving member 78 and the hammer mass 61. This will bring the leading crescent shaped parts 91, 93 flush with the hammer mass cavity 65 out of the paths of the anvil faces 87, 89 and in position for passing over the elevated respective cam portions 83*a*, 85*a*. Simultaneously the angularly and axially offset trailing crescent-shaped parts 92, 94 of the dog 70 will be rocked into the paths of the flattened corresponding cam portions 84*b*, 86*b* into position for passing over the corresponding reduced cam portions 84*c*, 86*c*. The hammer mass 61 is now quickly accelerated through 360 degrees rotating around the cam portion 55 of the anvil member 25. During this rotation the spring 98, now being free to expand, accelerates the hammer mass 61 to rotate somewhat ahead of the driving member 78, so that the lost motion between said mass and said member is restored. The pivot 77 remains stationary with respect to the hammer mass 61 until the trailing crescent-shaped parts 92, 94 of the dog 70 run against the corresponding flattened cam portions 84*b*, 86*b* and are rocked flush with the cavity 65 into position for passing over the corresponding elevated cam portions 84*a*, 86*a*. Simultaneously the leading crescent shaped parts 91, 93 are returned into clutching position for impacting the pertaining anvil faces 87, 89 passing prior to impact over the reduced cam portions 83*c*, 85*c*, whereupon the hammer mass 61 delivers a rotational blow to the anvil member 25. This cycle of operation is repeated as long as the resistance to rotation exceeds a predetermined value. The rocking oscillations of the impact dog 70 will be limited by the leading and trailing ends of the axial flange 72 in turn contacting the collar 54 of the anvil member 25 as previously described in connection with FIG. 6.

The increased number of impact transmitting surfaces effects an improved force distribution at the moment of impact, while the groove and spring connection relieves the hammer dog from driving forces and from building up the lost motion between the driving member and the hammer mass after declutching upon impact. It is readily seen that the symmetric arrangement of the impact clutch parts permits an equally efficient operation in the counter-clockwise direction.

In FIGS. 11–19, 12*a*, 13*a* and 15*a*–19*a* is illustrated another modification of the tool having the same general operating principles as the impact clutch of FIGS. 1–6 with the difference, however, that the number of impact dogs is doubled so that each of them in turn, depending on the direction of rotation, performs the impacting task while the other dog has the task of bringing said impacting dog into clutching position. In the impact clutch of FIGS. 1–6 as well as FIGS. 7–9, described above, these tasks are performed by different portions of a single impact dog.

In FIGS. 11 and 14 the cam portion 55 of the anvil member 25 has formed therein two spaced apart cylindrical axial recesses 58*a*, 58*b* forming concave impact receiving anvil faces 100 and 101 and incorporates two axially offset radial cams 102 and 103. The recess 58*a* extends from the rear of the cam portion 55 to the cam 103, while the recess 58*b* extends to the cam 102 so that the face 100 is axially somewhat longer than the face 101. Between the faces 100, 101 the cam portion 55 has a cylindrical portion 104 with a radius equal to the radius of the collar 54 of the anvil member 25 while the opposite side of the cam portion 55 is provided with a reduced cylindrical portion 105. The recesses 58*a*, 58*b* and the cam portions are symmetrically arranged with respect to a common central plane through the anvil member. The configuration of the cams 102 and 103 is readily seen from FIGS. 17 and 18. The cams are symmetrical with respect to a common plane of symmetry through the recesses 58*a*, 58*b*. Each cam has an elevated cylindrical portion 102*a*, 103*a* forming a continuation of the cylindrical portion 104 and a reduced cylindrical portion 102*c*, 103*c* forming a continuation of the reduced cylindrical portion 105. These cylindrical cam portions are interconnected by radially curved cam portions 102*b*, 103*b*.

The hammer mass 110 is journalled around the anvil member on the collar 54 and the reduced portion 43. Two impact dogs 70*a*, 70*b*, which are journalled in and supported by the hammer mass 110 in analogy with the single impact dog arrangement described above with reference to FIGS. 1 and 7, are arranged in spaced apart position corresponding to the position of the recesses 58*a*, 58*b* of the anvil member. The impact dog 70*a* (FIGS. 12, 12*a*) has formed thereon a recessed part 107*a* or impact element with a crescent-shaped cross section facing the anvil member and cooperating with the anvil face 100 and the cam 102. Opposite to the cam 103 the dog 70*a* has a recess 108*a* providing clearance with respect to the cam 103 when the dog is rocked into clutching or impact position with respect to the anvil face 100. The dog 70*b* has formed thereon a recessed part 107*b* or impact element facing the anvil member, having a crescent-shaped cross section and cooperating with the anvil face 101 and the cam 103. A recess 108*b* gives the dog 70*b* clearance with respect to the cam 102 when the dog is rocked into clutching or impact position with respect to the face 101. At the rear end each of the impact dogs 70*a*, 70*b* has formed integrally therewith a pivot 77*a*, 77*b*, respectively, said pivots having their axes intermediate the pivotal axis of the corresponding impact dog and the rotational axis of the hammer mass 110. The arrangement of the axial flanges 72*a*, 72*b* of the dogs 70*a*, 70*b* as well as the general arrangement of a driving member 109 on the reduced portion 43 of the anvil member 25 for camming the pivots 77*a*, 77*b* is in full analogy with the embodiment of FIG. 1 and is therefore not described again.

The driving member 109 has an oblong shape and is provided with a pair of recesses 79*a* and 79*b* in camming engagement with the pertaining pivots 77*a* and 77*b*. The recesses 79*a* and 79*b* are slightly greater in diameter than the pivots 77*a* and 77*b*, as shown in FIGS. 15 and 15*a*, this giving the pivots 77*a*, 77*b* some play with respect to the driving member 109. As shown in FIGS. 15 and 15*a* said play makes possible a limited angular movement or lost motion from the FIG. 15 to the FIG. 15*a* position between the driving member 109 and the hammer mass

110 when the hammer dogs 70a, 70b are cammed and rocked by the driving member 109. Said play is great enough to permit rocking of the hammer dogs 70a, 70b, from the impact or clutching position to a position flush with the cavity 65 of the hammer mass 110. The pivots 77a and 77b, as readily seen from FIGS. 12a and 13a, are angularly offset with respect to the plane of symmetry of the crescent shaped parts 107a, 107b in the direction of the recesses 108a, 108b, to such an extent that, when the pivots are in the FIG. 15 position, the crescent-shaped part 107a of the dog 70a will be in impact or clutching position (see FIG. 16) and the crescent-shaped part 107b of the impact dog 70b will be flush with the cavity 65, while, when the pivots are in the FIG. 15a position, the respective crescent-shaped parts 107a, 107b will be in the positions shown in FIG. 16a. Furthermore, the play between the pivots 77a, 77b and the recesses 79a, 79b of the driving member is small enough to secure that when the crescent shaped part 107b of the dog 70b is rocked back from the position of FIG. 16a into the flush position of FIG. 16, this rocking motion will be transmitted by the pivot 77b to the driving member 109 which thereby will be brought back from the FIG. 15a position to the FIG. 15 position. Simultaneously the crescent-shaped part 107a of the dog 70a will be rocked by the driving member 109 and the pivot 77a from the FIG. 16a position into the clutching or impact position of FIG. 16.

The modified impact clutch operates briefly as follows, reference being made especially to FIGS. 15–19 and FIGS. 15a–19a. The driving member 109 rotates the hammer mass 110, say in clockwise direction as viewed in said figures, by directly engaging the pivots 77a, 77b of the impact dogs 70a, 70b. As long as there is little resistance to rotation, the leading edge of crescent-shaped part 107a of the impact dog 70a will remain in clutching position and in contact with the anvil member face 100 (FIG. 16), the friction between the crescent-shaped part 107a and the face 100 and between the impact dogs 70a, 70b and the hammer mass 110 resisting the tendency of the driving member 109 to rock the dogs 70a, 70b by camming the pivots 77a, 77b from the FIG. 15 to the FIG. 15a position. Accordingly, the hammer mass 110 and the anvil member 25 will remain engaged and the bolt is rotated constantly until the resistance to rotation increases above some predetermined value.

When the resistance to rotation of the anvil member exceeds said predetermined value the driving member 109 will eliminate the lost motion between the driving member 109 and the hammer mass 110 by camming the impact dogs 70a, 70b and will turn to the position of FIG. 15a, rocking the dogs 70a, 70b into the position of FIGS. 15a–19a. The dog 70a is rocked into releasing direction bringing the crescent-shaped part 107a flush with the cavity 65 out of the path of the anvil face 100 and in position for passing over the elevated cam portion 102a of the cam 102, and the cylindrical part 104, FIG. 16a. Simultaneously the dog 70b is rocked to bring the trailing edge of the crescent-shaped part 107b inward in radial direction, a part of the trailing edge falling into the path of the cam 103, FIG. 18a, while the recess 108b keeps the dog 70b clear of the cam 102, FIGS. 11 and 17a. The rocking motion of the dogs is arrested by the axial arc-shaped flanges 72a, 72b coming into contact with the collar 54, FIGS. 19, 19a, of the anvil member 25. The hammer mass is now quickly accelerated through 360 degrees rotating around the cam portion 55 of the anvil member 25. During this rotation the trailing edge of the crescent-shaped part 107b follows the cylindrical reduced portion 105, FIG. 16a, and the reduced cam portion 103c, FIG. 18a, until it runs against the cam portion 103b, FIG. 18, which positively rocks the crescent shaped part 107b flush with the cavity 65. The pivot 77b of the dog 70b transmits this rocking motion to the driving member 109, rocking said member and restoring thereby the lost motion between the driving member 109 and the hammer mass 110 and bringing the driving member 109 from the position of FIG. 15a back into the position of FIG. 15. Simultaneously the pivotal return movement of the driving member 109 is transmitted to the pivot 77a so that the leading edge of the crescent- shaped part 107a of the dog 70a is rocked back into the clutching positions for impacting the face 100, FIG. 16, whereupon the hammer mass 110 strikes a rotational blow on the anvil member 25. The recess 108a, FIG. 18, keeps the dog 70a clear of the cam 103 during the rotation. The cycle of operation described is repeated as long as the resistance to rotation exceeds the predetermined value.



The operation of the modified impact clutch in the counter-clockwise direction is, owing to the symmetry of the mechanisms involved, identical with operation in clockwise direction with the exception, that impacting now occurs between the leading edge of the crescent-shaped part 107b of the dog 70b and the anvil member jaw 101, while the cam 102 has the task of positively rocking the dog 70a flush by camming the trailing edge of its crescent-shaped part 107a, thereby effecting through the intermediary driving member 109 the rocking of the dog 70b into impact position.

The use of two dogs, one for performing the impacting task and the other for bringing said impacting dog into clutching position, results primarily in an increase of the available impact areas on the impacting dog.

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

What I claim is:

1. In an impact clutch having rotating driving means and a rotatable anvil member, the combination for torque transmission therebetween which comprises a rotatable hammer mass mounted in said clutch coaxially with said anvil member, means forming a driving engagement between said driving means and said hammer mass for rotation thereof, a generally cylindrical impact dog, means for mounting said dog in said hammer mass for rotation therewith and angular movement with respect thereto about the axis of said dog in both clutching and declutching directions, the axis of said dog being radially offset from but parallel with the axis of rotation of said anvil member and said hammer mass, the radially inwardly disposed side of said dog facing said anvil member being recessed to form axially and angularly offset oppositely directed impact edge portions a different one of which transmits impact to said anvil member in each direction of rotation of said hammer mass, cam means on said anvil member for engaging in each direction of rotation one of said impact edge portions other than the one which transmits impact in that direction of rotation effecting angular movement of said dog in said clutching direction, means for moving said dog in said declutching direction, and a bearing surface on said hammer mass for engaging the radially outwardly disposed side of said dog substantially throughout the entire length thereof.

2. An impact clutch as recited in claim 1 in which said means for mounting said generally cylindrical impact dog in said hammer mass includes a semi-cylindrical recess in said hammer mass and disposed axially thereof and radially outwardly of said anvil member, and means for retaining said dog in said recess for said angular movement of said dog in said recess in both said clutching and declutching directions.

3. An impact clutch as recited in claim 1 in which said impact dog includes at least two of said angularly and axially offset impact portions, and in which said cam means on said anvil member is disposed thereon for engagement with at least one of said impact portions on said dog for effecting said angular movement of said dog to move another of said impact portions thereon in said clutching direction.

4. An impact clutch as recited in claim 1 in which an end portion of said impact dog also forms a part of said means forming a driving engagement between said driving means and said hammer mass for rotation thereof.

5. An impact clutch as recited in claim 1 in which said means forming a driving engagement between said driving means and said hammer mass includes lost motion means therein, and in which said means for moving said dog in said declutching direction includes means responsive to a decrease in the amount of lost motion between said driving means and said hammer mass effecting said angular movement of said dog in said declutching direction.

6. In an impact clutch having rotating driving means and a rotatable anvil member, the combination for torque transmission therebetween which comprises a rotatable hammer mass mounted in said clutch coaxially with said anvil member, means forming a continuously connected driving engagement between said driving means and said hammer mass for rotation thereof, a pair of spaced apart impact-transmitting and generally cylindrical dogs, means for mounting said dogs in said hammer mass for rotation therewith and angular movement with respect thereto about the axes of said dogs in both clutching and declutching directions, the axes of said dogs being radially offset from but parallel with the axis of rotation of said anvil member and said hammer mass, the radially inwardly disposed side of each dog facing said anvil member being recessed to form angularly offset and oppositely directed impact edge portions with one of said impact edge portions on one of said dogs transmitting impact to said anvil member in one direction of rotation of said hammer mass and an impact edge portion on the other of said dogs transmitting impact to said anvil member in the opposite direction of rotation of said hammer mass, cam means on said anvil member for engaging in each direction of rotation an edge portion of the one of said dogs which does not transmit said impact in that direction of rotation effecting angular movement of said dog, additional cam means on said anvil member for engaging in each direction of rotation said impact edge portions on the other said dog effecting angular movement thereof, and means interconnecting said dogs effecting angular movement of one upon angular movement of the other whereby the one of said dogs which transmits impact is moved into clutching direction by said interconnecting means upon movement of said other dog by said additional cam means.

7. An impact clutch comprising a rotatable anvil member, a rotatable hammer mass coaxially supported with respect to the anvil member, rotatable driving means for the hammer mass, a pair of spaced apart impact transmitting dogs pivotally mounted on the 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 the anvil member, axial recesses in the impact dogs facing the anvil member and forming opposed spaced apart edges on said dogs, cam means on the anvil member for positively pivoting one edge of one of said dogs in one direction upon each revolution of said hammer mass, interconnecting means for pivoting one edge of the other of said dogs in the clutching direction in response to said pivoting movement of said first dog, and additional cam means for pivoting said other dog in the releasing direction, said additional cam means also forming a driving connection between said driving means and said hammer mass and engaging each said dog intermediate the pivotal axis of each dog and the pivotal axis of said hammer mass.

8. In an impact clutch having rotating drive means and a rotatable anvil member, the combination for torque transmission therebetween which comprises a rotatable hammer mass mounted in said clutch coaxially with said anvil member and radially outwardly spaced therearound, means forming a continuously connected driving engagement between said driving means and said hammer mass for rotation thereof, an axially disposed semi-cylindrical recess in the radially inner surface of said hammer mass facing said anvil member, a generally cylindrical impact dog disposed in said recess for rotation with said hammer mass and for angular movement with respect thereto in both clutching and declutching directions about an axis substantially parallel to but radially spaced from said anvil member and said hammer mass, said recess in said hammer mass and radially outwardly disposed cylindrical surface of said dog being in bearing engagement substantially throughout the entire axial extent of said dog during impact thereof, an axial recess along the radially inwardly disposed side of said dog facing said anvil member and forming oppositely directed axial impact edge portions on said dog a different one of which transmits impact to said anvil member in each direction of rotation of said hammer mass, cam means on said anvil member for engaging in each direction of rotation the one of said impact edge portions on said dog which does not transmit impact in that direction of rotation effecting angular movement of said dog in said clutching direction whereby impact is imparted to said anvil member by said other impact edge portion on said dog, and means for effecting angular movement of said dog in said declutching direction.

9. An impact clutch as recited in claim 8 in which said dog comprises the sole driving connection between said driving means and said hammer mass and between said hammer mass and said anvil means.

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