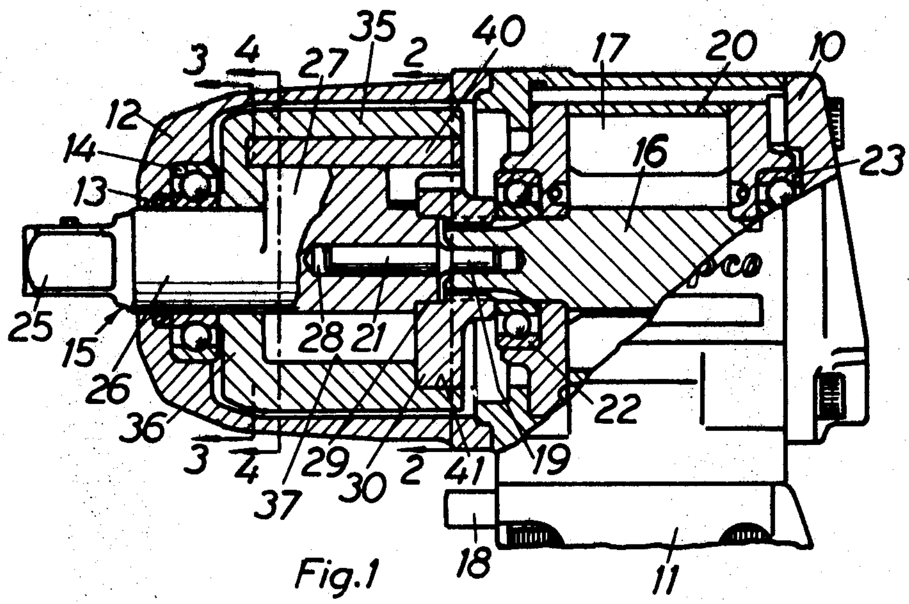

Fig.1

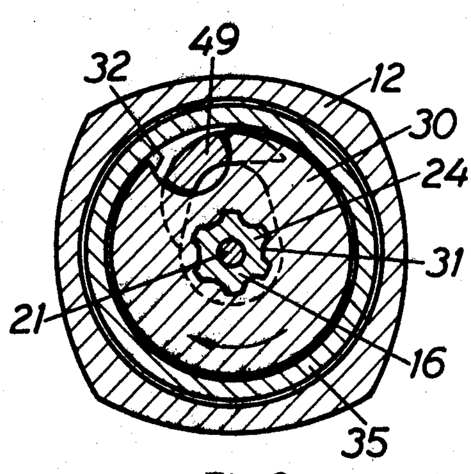

Fig.2

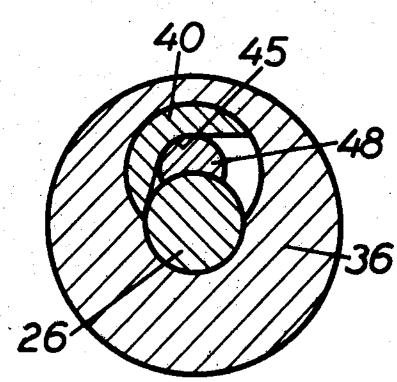

Fig.3

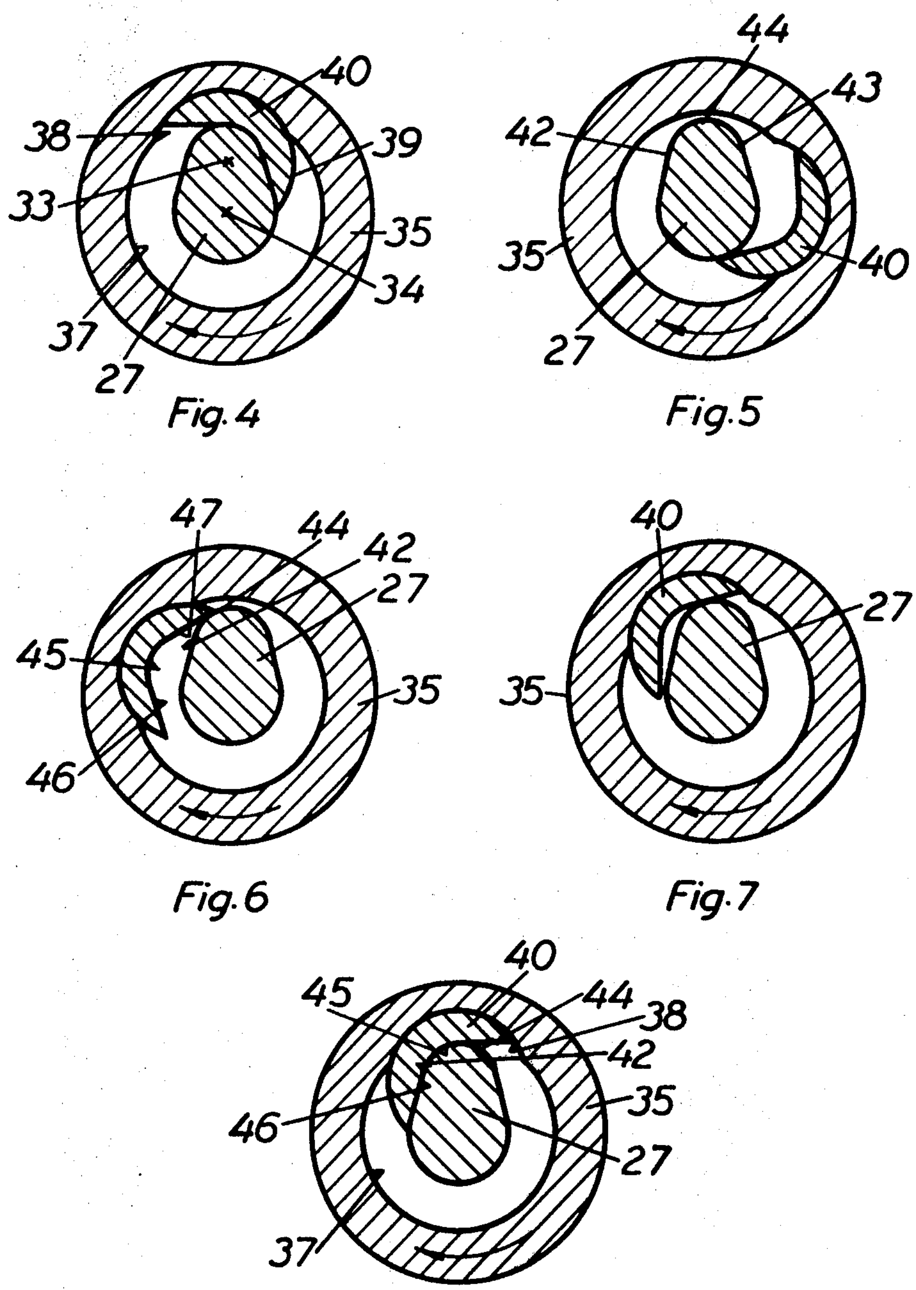

Fig. 4 Fig. 5 Fig. 6 Fig. 7 Fig. 8

United States Patent Office

3,606,931

Patented Sept. 21, 1971

3,606,931

ROTARY IMPACT MOTOR

Karl Gosta Karden, Nacka, Sweden, assignor to Atlas Copco Aktiebolag, Nacka, Sweden

Filed June 9, 1970, Ser. No. 45,047
Claims priority, application Sweden, June 19, 1969, 8,807/69
Int. Cl. B25d *15/00*
U.S. Cl. 173—93.5 5 Claims

ABSTRACT OF THE DISCLOSURE

In a rotary impact motor for power driven fastener setting tools an impact dog is arranged in a hammer body pivotally about an axis spaced from but parallel with the axis of rotation of the hammer body. The impact dog takes respectively impact and release position with respect to a cam flank on an anvil which anvil is coaxial with the hammer body. The cam flank has the dual function of providing an impact surface for the impact dog and a cam surface cooperating with the portion of the impact dog leading in the rotational direction for pivoting the trailing portion thereof to impact position against that very same flank.

The invention relates to a rotary impact motor of the kind used in connection with fastener setting tools, impact wrenches and the like. In such application is formerly known a type of rotary impact motor with impact action in both rotational directions thereof against the respective of two cam flanks on a rotatable anvil, in which a hammer body is rotatably carried coaxially with respect to the axis of rotation of the anvil, and an impact dog is journalled pivotally on the hammer body about an axis spaced from but parallel with said axis of rotation for taking respectively impact and release position with respect to the cam flanks, cam surfaces cooperating with the impact dog being arranged on the anvil for pivoting the impact dog towards the impact position, and a drive element being in engagement with the impact dog for rotating the latter together with the hammer body and arranged for pivoting the impact dog towards the release position.

In such rotary impact motors there is normally had, in immediate sequence to the impact, a rebound of the hammer and the impact dog which causes that the angle of acceleration for the next impact is increased and for example in connection with motors working on one impact per revolution can exceed 360 degrees. As a result thereof the impact motor produces a steep rise of the tightening torque applied per impact. In tightening operations in which the final tension of the fastening means has to lie within relatively narrow limits, for example in certain nut and screw setting applications, this is apt to cause large deviation of the final tension in a group of fastening means tightened under similar conditions and renders difficult the application of simple torque control means which can be had for example by variable throttling of the air pressure of the air entering into the drive motor of the impact motor.

It is an object of the invention to provide a rotary impact motor having a substantially more level characteristic curve for the torque-time parameters so that control sufficiently exact for practical use may be had of the final torque solely by adjustment of the pressure entering into the drive motor of the impact motor.

For the above and other purposes there is according to the invention provided a rotary impact motor with impact action in both rotational directions thereof comprising a housing, a rotatable anvil in said housing, opposed cam flanks on said anvil, a hammer body rotatably carried in said housing coaxially with respect to the axis of rotation of said anvil and around said cam flanks thereof, an impact dog pivotally journalled on said hammer body about an axis spaced from but parallel with said axis of rotation for taking respectively impact and release positions with respect to said cam flanks, a recess on said impact dog facing said anvil and defining opposed portions on said impact dog respectively leading and trailing in the rotational direction thereof, the flank that meets the rotation of said impact dog during rotation of said hammer body relative to said anvil cooperating with the leading portion of said impact dog for pivoting the trailing portion thereof to impact position against that very same flank, and rotatable drive means in said housing in operative engagement with said impact dog for rotating it together with said hammer body and for pivoting said impact dog towards said release position.

By this novel arrangement the impact dog at the moment of impact is given an impulse to roll over the cam flank receiving the impact so that the rebound is eliminated. This over-rolling produces, as a matter of fact, a reverse torque by reason of the portion of the impact dog leading in the rotational direction hitting against the anvil beyond the flank against which the impact was applied in the first place and thus delivering a torque impulse in a direction opposite to the drive direction, replacing the rebound. The reverse torque is an advantage for example during threading operations in which experience shows that the reverse torque pulses cause breaking of the chips and thus are apt to improve the cutting effect.

The above and other purposes 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 thereof may be made within the scope of the appended claims.

In the drawings FIG. 1 shows a longitudinal section through an impact tool including a rotary impact motor according to the invention. FIG. 2 is a cross section on the line 2—2 in FIG. 1. FIG. 3 is a partial section seen on line 3—3 in FIG. 1. FIG. 4 is a cross section through the rotary impact motor in release position after the delivery of an impact and seen on the line 4—4 in FIG. 1. FIGS. 5–8 show various relative positions of the parts in FIG. 4 up to an impact being delivered in the impact position shown in FIG. 8.

The impact tool in FIG. 1 is an impact wrench including a back piece **10** provided with a handle **11** and a front piece **12**. The front piece **12** encloses the rotary impact motor or impact clutch and is provided with a central forward opening **13** through which a rotatable anvil **15** projects. The anvil **15** is journalled in a roller bearing **14** carried by the front piece **12**.

In the back piece **10** is affixed a rotation motor **20** preferably a reversible pneumatic or electric motor having a rotor **16** arranged therein. The rotor **16** in the case of a pneumatic motor has radial grooves taking up vanes **17** and is rotated in the usual way by the vanes **17** through actuation of compressed air delivered to the motor **20** and suitably introduced through the handle **11**. The motor **20** is controlled by a throttle valve, not shown, and by a conventional reversing slide **18**.

At the ends thereof the rotor **16** is journalled in the back piece **10** in roller bearings **22** and **23** and the forward end thereof is extended through the roller bearing **22** and carries parallel axially extending splines **24**, FIG. 2. The rotor **16** has a forward axial bore **19** which rotatably takes up a guide pin **21**. The forward end of the anvil **15** carries a polygonal end portion **25** for the application of a socket wrench, not shown. At the roller bearing **14** the anvil **15** has a cylindrical portion **26** which within the front piece **12** passes over into a radial cam **27**. The rear end of the anvil **15** is provided with an axial bore **28** which takes up the pin **21** with a press fit, the rear end having a cylindrical reduced portion **29** which is surrounded rotatably by a cylindrical drive element **30**. The drive element **30** has a partly cylindrical recess **32** at the periphery thereof and is by axial grooves **31** at a rear hub portion thereof in engagement with the splines **24**, FIG. 2, of the rotor **16**.

A hammer body **35** is coaxially rotatably journalled about the anvil **15** and sits by way of a forward hub portion **36** rotatable on the cylindrical portion **26** of the anvil **15** behind the roller bearing **14**. The hammer body **35** is provided with a rotation cavity **37** coaxial with the axis of rotation thereof which cavity surrounds the radial cam **27** and permits free rotation of the latter relative to the hammer body **35** within the cavity **37**. Out into the rotation cavity **37** there opens a journalling cavity **38** provided by a cylinder surface and intended for an impact dog **40** which by means of a cylindrical back portion **39** along the entire length thereof is slidably supported by the cylinder surface of the journalling cavity **38** pivotally about an axis **33**, FIG. 4, coaxial therewith, falling within the rotation cavity **37**, and in parallel relation to the axis **34** of rotation of the hammer body **35**. The rotation cavity **37** rearwardly thereof is terminated by an enlarged cylindrical portion **41** which rotatably takes support against the periphery of the drive element **30**.

The radial cam **27** of the anvil **15** is single-lobed relatively narrow peripherally and is with respect to a diametrical plane symmetrically bordered by two opposed cam flanks **42**, **43** which pass over into a cylindrical central cam ridge **44** with the centre of curvature in said diametrical plane. The impact dog **40** is recessed somewhat similarly to turbine blade shape with internally flattened limbs and the recess thereof has on the one hand a concave cylindrical middle surface **45** with the same radius of curvature as the cam ridge **44** and coaxial with the journalling cavity **38**, and on the other hand flat sides **46**, **47** diverging outwardly from the middle surface **45**, the sides **46**, **47** and the middle surface **45** being intended for impacting against the respective cam flanks **42**, **43** and the adjacent portion of the cam ridge **44**.

The forward end of the impact dog **40** is supported pivotally in the journalling cavity **38** by a pivot portion **48**, FIG. 3, projecting rearwardly from the hub portion **36** into the journalling cavity **38**, the pivot portion **48** having the same radius as the middle surface **45** of the impact dog. The rear end of the impact dog **40** has a central extension **49**, FIG. 2, which falls into the cylindrical recess **32** of the drive element **30** and is in camming engagement therewith.

Let it be supposed that the rotor **16** in operation rotates the rotary impact motor and thereby the anvil **15** thereof in clockwise direction by the driving connection consisting of the splines **24** and the grooves **31** and that the polygonal end portion **25** of the anvil **15** through a socket wrench, not shown, transmits the rotation to a threaded fastener. If the parts of the rotary impact motor are in the impact position shown in FIGS. 2 and 8, the middle surface **45** and side **46** of the impact dog recess will remain in impact position as long as the screw rotates easily and in engagement with the flank **42** of the radial cam **27** and the adjoining part of the cam ridge **44**. The rotation of the drive element **30** is transmitted at the recess **32** thereof and at the extension **49** of the impact dog **40** to the impact dog **40** and thence via the radial cam **27** to the anvil **15**, the socket wrench, and the fastener. Thus the impact dog **40** transmits the rotation to the radial cam **27** via the portion thereof trailing in the rotational direction, in which portion the side **46** provides the main driving surface. It is true that the drive element **30** during driving strives to turn the impact dog **40** over the cam ridge **44** to the released position. This is so because the driving engagement betweeen the cylinder surface of the recess **32** and the extension **49**, FIG. 2, which engagement takes place radially at opposite side of the pivoting axis **33** of the impact clutch **40** with respect to the axis **34** of rotation of the hammer body **35**, in lever-like manner strives to turn the impact dog **40** about the axis of the cam ridge **44** which in the impact position shown, FIG. 8, coincides with the pivotal axis of the impact clutch **40** and the geometrical axis **33**, FIG. 4, of the journalling cavity **38**. Through friction between the impact clutch **40** and the radial cam **27** these parts, however, remain in engagement with each other substantially in the position shown in FIG. 8 so that the fastener is rotated continuously until it has been screwed down and the resistance to rotation increases.

At sufficiently large rotational resistance the anvil **15** stops while the rotor **16** forces the drive element **30** to continue its rotation. This causes the impact dog **40**, due to cam action between the cylinder surface of the recess **32** and the extension **49** of the impact dog **40**, to be swung over the radial cam **27** from the impact position in FIGS. 2 and 8 to release position in FIG. 4. The side **47** of the impact dog leading in the rotational direction is now pivoted to take support against the radial cam **27** of the anvil **15** at and beyond the flank **43** and the leading edge of the side **47** is successively forced to slide around the radial cam **27** while the hammer body **35** in an accelerated movement is rotated around the anvil **15** by the drive element **30**. The acceleration course is illustrated in the FIGS. 4–7. Near the end of the acceleration cycle the side edge of the impact dog **40** leading in the rotational direction runs up on the cam flank **42** and the cam ridge **44**, FIG. 6, of the radial cam **27**, which causes a reverse swinging of the impact dog **40** about its pivotal axis **33** followed by a simultaneously performed forward turning and still further acceleration of the hammer body **35** in the rotational direction additional to the acceleration produced by the drive element **30**. Immediately thereafter the impact dog **40**, FIG. 8, hits with its side **46** trailing in the rotational direction and the adjoining middle portion **45** thereof against the cam flank **42** and the cam ridge **44** so that the kinetic energy of the hammer is delivered to the anvil **15** by way of a rotational impact which is transmitted to the socket wrench and the fastener.

At impact, FIG. 8, there is normally generated no reverse angular movement due to rebound of the hammer body **35** and the impact dog **40** relative to the radial cam **42** of the anvil **15**. In direct sequence to the impact the impact dog, as a matter of fact, is pivoted over the ridge **44** of the radial cam **27** to the position shown in FIG. 4, and the recoil upon impact is thus transformed into an angular acceleration of the impact dog **40**, the latter delivering its kinetic energy in the form of a rearwardly directed impact by means of the side **47** of the impact dog **40** leading in the rotational direction and against the cam flank **43**, FIG. 4. At this instant there is generated a momentary reverse torque. Thereupon the next acceleration and impact courses are performed in analogy with the above described cycle until the desired tightening torque has been reached in the fastener. Thanks to the fact that the acceleration angle of the rotary impact motor remains substantially uninfluenced by rebound at the moment of impact, one receives an evenly and only gradually increasing tightening torque in the screw so that an effective torque control can be had solely by the adjustment of the air pressure before the vanes **17** of the rotor **16**.

The symmetrical design of the rotary impact motor assures corresponding impact action at rotation in counterclockwise direction. Now the impacts are delivered by the side **43** of the impact dog **40** trailing in the rotational direction and against the flank **43**, while the portion of the impact dog at the outer edge of the side **46** leading in the rotational direction causes turning of the impact dog to impact position.

I claim:

1. A rotary impact motor with impact action in both rotational directions thereof comprising a housing, a rotatable anvil in said housing, opposed cam flanks on said anvil, a hammer body rotatably carried in said housing coaxially with respect to the axis of rotation of said anvil and around said cam flanks thereof, an impact dog pivotally journalled on said hammer body about an axis spaced from but parallel with said axis of rotation for taking respectively impact and release positions with respect to said cam flanks, a recess on said impact dog facing said anvil and defining opposed portions on said impact dog respectively leading and trailing in the rotational direction thereof, the flank that meets the rotation of said impact dog during rotation of said hammer body relative to said anvil cooperating with the leading portion of said impact dog for pivoting the trailing portion thereof to impact position against that very same flank, and rotatable drive means in said housing in operative engagement with said impact dog for rotating it together with said hammer body and for pivoting said impact dog towards said release position.

2. A rotary impact motor according to claim 1 in which said cam flanks form the opposite sides of a single-lobed radial cam on said anvil, said radial cam forming a cam ridge falling concentrically into said recess of said impact dog in the impact position thereof and being symmetric with respect to a diametrical plane through the axis of rotation of said anvil and said cam ridge.

3. A rotary impact motor according to claim 2 in which said hammer body is provided with a cylindrical rotation cavity surrounding said radial cam and a journalling cavity opening out into said rotation cavity and bordered by a cylinder surface coaxial with the pivotal axis of said impact dog, the back portion of said impact dog during pivotal movement thereof being slidably supported by said journalling cavity, and the geometrical axis of the cylinder surface of the journalling cavity being disposed within the rotation cavity and in impact position of said impact dog falling radially within said cam ridge of said radial cam.

4. A rotary impact motor according to claim 3 in which said cam ridge is cylindrical and in impact position of said impact dog is substantially coaxial with the geometrical axis of said journalling cavity, the recess of said impact dog comprising a central cylindrical middle surface coaxial with said geometrical axis of said journalling cavity and sides diverging outwardly therefrom.

5. A rotary impact motor according to claim 1 in which said drive means is a drive element in camming engagement with said impact dog radially at opposite side of the pivotal axis thereof with respect to the axis of rotation of said hammer body and anvil.

References Cited

UNITED STATES PATENTS

2,343,596	3/1944	Van Sittert et al. ____	173—93.5
2,768,546	10/1956	Amtsberg __________	173—93.5
3,129,796	4/1964	Karden ____________	173—93.5
3,179,219	4/1965	Karden ____________	173—93.5
3,533,479	10/1970	Madsen et al. _______	173—93.5

JAMES A. LEPPINK, Primary Examiner