

March 1, 1966

L. W. RAMSTROM

3,237,703

ROTARY IMPACT TOOL

Filed April 7, 1964

2 Sheets-Sheet 1

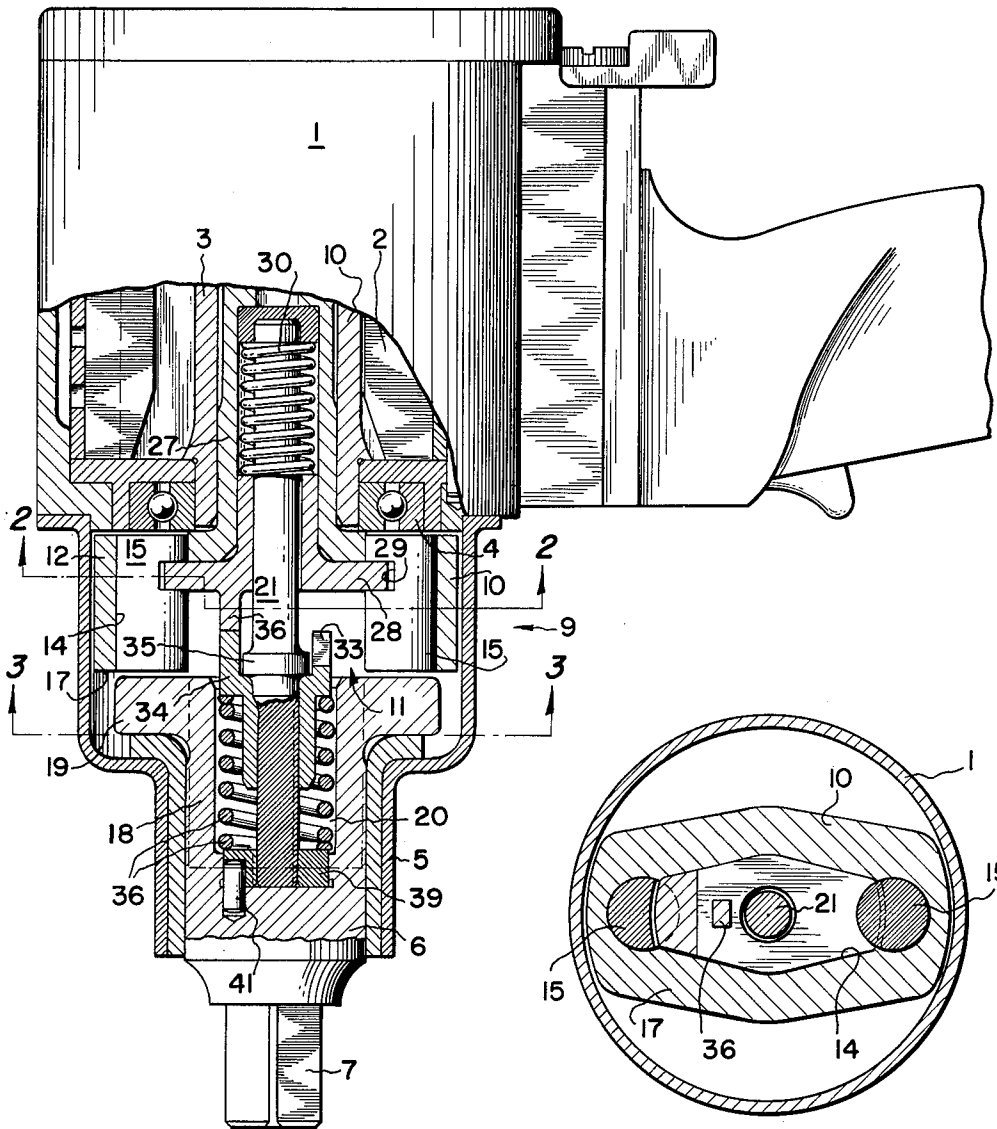


FIG. 1

FIG. 2

INVENTOR.
LEE W. RAMSTROM
 BY
David W. Tikhott
 ATTORNEY

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2 Sheets-Sheet 2

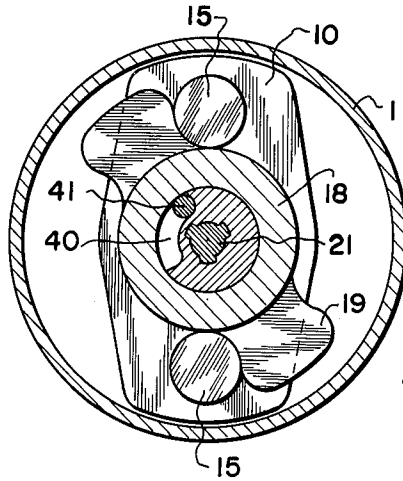


FIG. 3

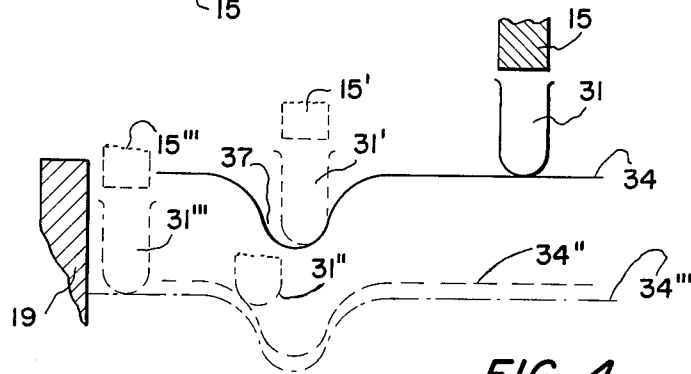


FIG. 4

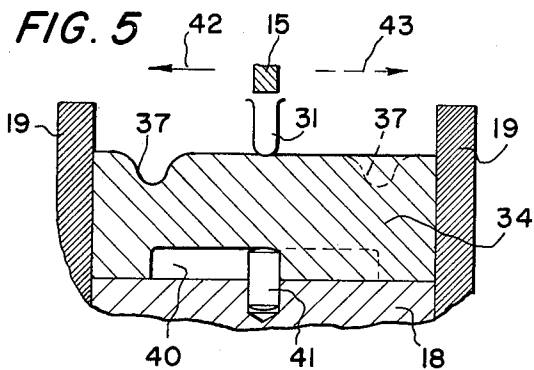


FIG. 5

INVENTOR.
LEE W. RAMSTROM
BY
Daniel W. Tibbott
ATTORNEY

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ROTARY IMPACT TOOL

Lee W. Ramstrom, Sayre, Pa., assignor to Ingersoll-Rand Company, New York, N.Y., a corporation of New Jersey

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This invention relates to a power-operated rotary impact tool for applying rotary or angular impacts to fasteners such as threaded nuts, bolts, etc. In particular, this invention relates to a rotary impact tool mechanism for changing the rotating torque of a rotary motor, such as an air-driven motor, to a series of rapid rotary impacts which can be applied to a threaded nut for either driving it tight or for removing it.

Most rotary impact mechanisms in use today contain an anvil adapted to be connected to a wrench socket and a hammer rotated by a motor. The hammer is alternately engaged and disengaged from the anvil, being engaged to impact the anvil, thereafter being disengaged from the anvil to gather rotary speed again prior to striking another impact to the anvil. Various means are used for accomplishing this alternate engagement and disengagement between the anvil and hammer.

One well-known impact mechanism used today is known as the "Pott" mechanism, being named after the inventor who received U.S. Patent Nos. 2,012,916, 2,049,273, and 2,158,303. A modern version of the "Pott" mechanism is shown in the U.S. Patent to Jimerson, No. 2,160,150. In the Jimerson patent, the hammer is mounted on a shaft driven by a motor and cam balls are mounted between the hammer and the shaft with the cam balls resting in V-shaped grooves formed on the shaft. Normally, a coil spring biases the hammer into engagement position with the anvil wherein the cam balls rest in the apexes of their grooves. After the hammer strikes the anvil, the shaft continues to rotate and relative rotation between the shaft and hammer causes the cam balls to ride up their grooves and pull the hammer axially rearward to disengagement position, thus compressing and storing potential energy in the hammer biasing spring. When the hammer is disengaged from the anvil, the combined energy in the compressed spring and the rotating shaft turns the hammer forward to deliver another impact to the anvil.

One disadvantage usually found in impact mechanisms using the concept of the Pott and Jimerson patents is that looseness or play can exist in the drive between the anvil and fastener before each impact. Such looseness results in an inefficient transfer of impact force from the anvil to the fastener.

Another well-known impact mechanism is disclosed in the U.S. patent to Amtsberg, No. 2,881,884. In this mechanism, the hammer is spring-biased axially away from the anvil to a disengaged position and cams operated by the relative rotation between the anvil and hammer cause the hammer to be periodically thrown axially forward to strike a rotary impact with the anvil.

One disadvantage found in some impact tools using the above Amtsberg mechanism is that if the hammer is driven slower than its design speed, the hammer teeth will not be thrown far enough axially forward to engage the anvil teeth properly upon impact. When the hammer teeth are not thrown far enough forward, they "top" or barely strike the anvil teeth which causes rapid wear of such teeth.

The principal object of this invention is to provide an impact mechanism which eliminates the disadvantages of the foregoing mechanisms and which operates according to a new concept.

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Other important objects include the following: to provide a rotary impact mechanism which inherently removes looseness between the anvil and fastener prior to each impact; to provide a rotary impact mechanism which will consistently provide a hammer mechanism which reduces friction tending to hold the hammer against the anvil after impact, this friction acting to slow the disengagement of the hammer from the anvil; and to provide a rotary impact mechanism which prevents the hammer from rebounding after impact and striking a secondary blow to the anvil.

The above objects are attained in an impact mechanism wherein the hammer is biased to normal engagement or impact position with the anvil, and cams are arranged between the anvil and hammer for normally raising the hammer clear of the anvil immediately before each impact. One of the cams is mounted by a resilient connection which allows it to move relative to the member that it is carried by, either the anvil or the hammer.

The cams are shaped to move axially together and then axially apart as the hammer approaches the anvil with the reversal of movements of the cams being accomplished sufficiently abruptly for the hammer to have sufficient axial movement toward its impact position to continue moving axially toward its impact position as the cams begin moving axially apart and to remain in the impact position long enough to impact the anvil.

The invention is disclosed in the accompanying drawings wherein:

FIG. 1 is an elevational view with parts being broken away of an embodiment of a rotary impact mechanism following the concepts of this invention;

FIG. 2 is a section of FIG. 1 taken along line 2-2;

FIG. 3 is a section of FIG. 1 taken along line 3-3;

FIG. 4 is a diagrammatic view illustrating the movements of the cam elements, the hammer, and the anvil dogs during the operation of the impact mechanism of FIG. 1, with various positions being shown in solid and dotted lines; and

FIG. 5 is a diagrammatic view illustrating alternate positions of the cam provided by the "lost motion" connection between the cam and anvil.

The rotary impact tool shown in FIG. 1 conventionally includes a casing 1 containing a rotary motor 2 having a motor shaft 3 rotatively mounted in a bearing 4. The motor 2 should be of a type which can be repeatedly stalled without being damaged, such as an air motor. The casing 1 further includes a front nose 5 containing a spindle 6 rotatively mounted therein. The spindle 6 has a square front end 7 adapting it for fitting into a conventional nut driving socket (not shown). The spindle 6 is interconnected to the motor shaft 3 by an impact mechanism 9 which changes the rotary torque of the motor 2 into a series of rotary impacts. This invention involves the impact mechanism 9.

The impact mechanism 9 includes a hammer rotor 10 of relatively large mass, splined to the motor shaft 3. Thus, the hammer rotor 10 is fixed to and is rotatively driven by the motor 2. The hammer rotor 10 is cup-shaped with a forwardly opening central cavity 11 surrounded by an oval-shaped rim or wall 12. The oval-shaped wall 12 is provided with a pair of axially extending pockets 14 which open forwardly and are located diagonally opposite each other on the long axis of the oval-shaped wall 12. A pair of hammer dogs or pins 15 are mounted in the pockets 14 for axially forward sliding movements between positions projecting forwardly from the front face 17 of the hammer 10 and positions housed entirely within the hammer. The pockets 14 are

shaped to snugly guide the pins 15 during their sliding movements.

The spindle 7 is fixed at its rear end to an anvil 18 which has a pair of rearwardly and radially projecting anvil teeth 19 adapted to engage the hammer dogs 15 for creating an impact blow. The anvil 18 contains a rearwardly opening cavity 20 in its rear end (top end in FIG. 1). The anvil 18 and the hammer rotor 10 are coaxially aligned by an axle 21 which runs axially between both and rotatably fits in a seat in the hammer 10. The axle 21 extends forwardly into the cavity 20 in the anvil 18 and is keyed to the anvil 18 by a "lost motion" connection which allows the axle to rotate relative to the anvil 18 through a limited angle. This "lost motion" connection will be described later.

Whether or not the hammer dogs 15 impact the anvil teeth 19 depends on the axial position of the hammer dogs 15 in the hammer rotor 10. Moving the hammer dogs 15 forward to place the hammer dogs in the rotary path of the anvil teeth 19 causes them to collide as the hammer rotor rotates. There is no impact when the hammer dogs 15 are moved axially rearward in the hammer rotor 10 to remove them from the rotary path of the anvil teeth 19 so that the dogs 15 clear the anvil teeth as the hammer rotor 10 rotates.

A cam follower or sleeve 27 is rotatable and slidable on the axle 21 and is seated in the cavity 11 of the hammer 10. The cam sleeve 27 includes a front flange 28 which extends diagonally outward and fits in notches 29 formed in the hammer dogs 15. As a result of this structure, the hammer dogs 15 are forced to move axially with the cam sleeve 27. The cam sleeve 27 is biased forwardly toward the anvil 18 by a coil spring 30 seated in the cavity 11 and surrounding the axle 21 above the cam sleeve 27, looking at FIG. 1. The internal cavity 11 in the hammer 10 is shaped to fit the oblong or oval shape of the front flange 28 on the cam sleeve so that the cam sleeve 27 is keyed to the hammer 10. Thus, the cam sleeve 27 can slide relative to the hammer 10 but is forced to rotate with it.

The front end of the cam follower or sleeve 27 is formed with a forwardly projecting cam lobe 31 which rides on an annular cam surface 33 integrally formed on a tubular cam 34. The tubular cam 34 is slidably splined to the axle 21 in front of the cam sleeve 27 and is biased rearwardly against a stop shoulder 35 formed on the axle 21. This biasing force is provided by a spring 36 which surrounds the axle 21 in front of the tubular cam 34 (below the cam 34 in FIG. 1) and is seated in the cavity 20 in the anvil 18. The annular cam surface 33 of the tubular cam 34 includes a U-shaped notch 37 adapted to receive the cam lobe 31 as the cam sleeve 27 rotates on the cam 34. The notch 37 is positioned relative to the anvil teeth 19 to allow the hammer dogs 15 to move forwardly into the path of the anvil teeth 19 as the dogs 15 near the anvil teeth 19, whereby the dogs 15 will impact the anvil teeth 19. The cam notch 37 is about the same shape as the cam lobe 31 and just a little wider. The notch 37 is shaped so that the cam lobe 31 will ride down into it, without jumping substantially and, after reaching the bottom of the notch 37, will immediately start climbing out of it. This action will be further explained in the description of the operation of the impact mechanism 9.

The front end of the axle 21 is keyed to the anvil 18 by a "lost motion" connection. This "lost motion" connection includes an enlarged foot 39 fixed on the front end of the axle 21 and including an arcuate slot 40 which receives a key pin 41 mounted in the bottom of the anvil cavity 20. The key pin 41 extends rearwardly into the arcuate slot 40 and the axle 21 can rotate relative to the anvil 18 through a limited angle determined by the length of the arcuate slot 40.

FIG. 5 illustrates the purpose of the "lost motion" connection of the axle 21 to the anvil 18. This figure

diagrammatically illustrates the anvil 18 and its teeth 19, the cam sleeve lobe 31 and the cam 34 as if these elements are moving in a linear or straight path. When the hammer 10 rotates in the left-hand direction as indicated by the solid-line arrow 42 in FIG. 5, the tubular cam 34 is moved to the position shown by solid lines wherein the cam notch 37 is near the left-hand anvil tooth 19. If the hammer is rotated in the reverse direction, as indicated by the dotted-line arrow 43, the tubular cam 34 is rotated relative to the anvil 18, through its "lost motion" connection, to the position shown in dotted lines wherein the cam notch 37 is near the right-hand anvil tooth, shown in FIG. 5. If the "lost motion" connection between the axle 21 and anvil 18 were eliminated, the cam notch 37 would have to be positioned wherein the hammer 15 is halfway between the anvil teeth 19 when the cam lobe 31 drops into the cam notch 37, in order for the impact mechanism to operate in both directions of rotation. Normally, when only two anvil teeth 19 are used, moving the hammer dogs 15 forward halfway between the anvil teeth 19 is too early to insure proper impact with the anvil teeth 19 under various operating conditions. It is more desirable to wait until the dogs 15 are nearer the anvil teeth 19 before moving them forward and this is accomplished by the foregoing "lost motion" connection. This "lost motion" connection could be eliminated if the impact mechanism is to be limited to operation in one direction of rotation.

Operation

To prepare the impact tool of FIG. 1 for operation, it is fitted with a socket of the correct size to fit the nut or bolt which is going to receive the socket. For convenience, it is assumed that the workpiece is a nut which should be tightened. The impact tool is initially adjusted to drive the nut in a clockwise or tightening direction.

Thereafter, the impact tool is manipulated to fit the socket over the nut and the motor 2 is suitably energized, depending on the type of motor. As the motor begins to rotate, the hammer rotor 10 rotates the hammer dogs 15 and the cam sleeve 27 to cause the lobe 31 on the cam sleeve 27 to ride down into the notch 37 on the tubular cam 34. Thereafter, the hammer rotor 10 drives the anvil 18 through the cam lobe 31 and cam notch 37 until the nut is tight enough to develop a torque resistance sufficient to cause the cam lobe 31 to ride out of the cam notch 37. The amount of torque sufficient to cause the cam lobe 31 to ride out of the notch 37 is dependent on the strength of the spring 30.

As the torque load rises to a magnitude to cause the cam lobe 31 to ride up and out of the cam notch 37, the rearward movement of the cam sleeve 27 is transmitted to the hammer dogs 15 to force them to move rearwardly substantially in unison with the cam sleeve 27. The rearward movement of the hammer dogs 15 lifts them clear of the anvil teeth 19 so that they fail to collide and impact. It is important to recognize that the reason for the rearward movement of the cam sleeve 27 and the hammer dogs 15 in this instance is because of the slow relative speed between the cam sleeve 27 and cam 34 as the cam lobe 31 rides up and out of the cam notch 37.

After the cam lobe 31 clears the cam notch 37, the hammer rotor 10 can turn freely for substantially a full turn before the cam lobe 31 again rides down into the cam notch 37. Thus, the hammer rotor 10 can develop a substantially high rotative speed during its freedom from load.

FIG. 4 illustrates the operation of the impact mechanism during an impact. This figure diagrammatically illustrates parts of the impact mechanism as if these elements were moving in a straight path. The hammer dog 15 and cam lobe 31 are moving toward the left as indicated by the arrow and are initially shown in solid lines as they approach the anvil tooth 19 and before the cam lobe rides down into the cam notch 37.

Thereafter, as the hammer dog 15 nears the anvil tooth 19, the cam lobe 31 rides down into the cam notch 37 and allows the hammer dog 15 to move axially forward. The hammer dog and cam lobe are shown in dotted lines as 15' and 31' as the cam lobe reaches the bottom of the cam notch 37. At this time, the hammer dogs 15 and cam sleeve 27, carrying the cam lobe 31, have a substantial amount of forward axial velocity.

As a result of the forward axial velocity and the larger mass of the hammer dogs 15 and cam sleeve 27, the cam 34 begins to move axially forward as the cam lobe 31 begins climbing (relative to the cam 34) out of the cam notch 37. This forward axial movement of the cam 34 is allowed by its resilient mounting provided by the spring 36. The cam lobe is shown in FIG. 4 by the reference number 31'' as it is climbing out of the cam notch 37. At this time, the tubular cam has moved forward to the dotted-line position shown by 34''.

The reference numbers 15''' and 31''' show the hammer dog and cam lobe as the dog is about to impact the anvil tooth 19. At this time, the tubular cam is in the dotted-line position indicated by 34'''. After the impact, the cam sleeve 27 and hammer dog 15 are moved rearwardly out of the path of the anvil tooth 19 by the spring 36 which forces the tubular cam 34 rearwardly to its former position resting against the stop shoulder 35 on the axle 21. Thereafter, the hammer 10 will regain rotary speed for almost a complete revolution and the foregoing impact operation will be repeated.

The important feature of the foregoing operation is that the cam lobe 31 and hammer dog 15 have an axial velocity component as the cam lobe 31 begins climbing out of the cam notch 37. This forward velocity provides kinetic energy acting to move the tubular cam 34 axially forward as the cam lobe 31 climbs out of the cam notch 37 so that the hammer dogs 15 continue moving axially forward for a sufficient time to be in a position to impact the anvil teeth 19, as they rotate toward the anvil teeth 19.

Although a preferred embodiment of the invention has been illustrated and described in detail, it will be understood that the invention is not limited simply to this embodiment but contemplates other embodiments and variations which utilize the concepts and teachings of this invention.

Having described my invention, I claim:

1. A rotary impact tool comprising:
 - (a) a casing;
 - (b) a rotary motor in said casing;
 - (c) a rotor driven by said motor;
 - (d) an anvil member rotatably mounted on said casing adjacent said rotor and having a spindle adapted to apply a series of rotary impacts to a workpiece;
 - (e) an anvil tooth integrally fixed on said anvil member adapted to receive rotary impacts;
 - (f) a hammer member including an integral hammer dog mounted in said rotor in a manner causing the hammer member to rotate with the rotor and allowing the hammer member to move axially relative to said rotor toward and away from said anvil member between alternate positions, one position being an impact position wherein the hammer dog is located to strike said anvil tooth as said rotor turns and the other position being a non-impact position wherein the hammer dog clears said anvil tooth as the rotor turns;
 - (g) first resilient means biasing said hammer member toward its impact position;
 - (h) a pair of cam elements cooperating to normally hold said hammer member in its non-impact position as said rotor turns relative to said anvil member, one of said cam elements being connected to said anvil member and the other cam element being connected to said hammer member;
 - (i) second resilient means biasing said cam elements and said hammer member toward the non-impact

position of said hammer member and overcoming said first resilient means; and

- (j) said cam elements having means causing them to move axially together and then apart in sequence as said hammer dog approaches the anvil tooth, the movement of said cam elements axially together causing said hammer member to move axially toward its impact position, the reversal of movements of the cam elements being accomplished sufficiently abruptly for the hammer member to have sufficient axial movement toward its impact position to continue moving axially toward its impact position as said cam elements begin moving axially apart and to remain in said impact position long enough to impact said anvil tooth, said second resilient means disengaging said hammer dog from said anvil tooth after impact.
2. The impact mechanism of claim 1 including:
 - (a) means movably mounting said one cam element on said anvil member for movement relative to said anvil member from its normal position on the anvil member.
3. The impact mechanism of claim 2 wherein:
 - (a) said means movably mounting the cam element on said anvil member allows said one cam element to move axially relative to the anvil member and keys said one cam element to the anvil member;
 - (b) and said second resilient means is supported on said anvil member and biases the cam element on the anvil member to its normal position.
4. The impact mechanism of claim 3 wherein:
 - (a) said means movably mounting the cam element on said anvil member allows said one cam element to rotate for a limited rotary movement relative to the anvil member;
 - (b) and said second resilient means is supported on said anvil member and rotatively biases said cam element on the anvil member to its normal position on the anvil member.
5. The impact mechanism of claim 1 wherein:
 - (a) said hammer member includes a plurality of angularly spaced hammer dogs and said anvil member includes a corresponding number of angularly spaced anvil teeth; and
 - (b) said cam elements have means to prevent the hammer dogs from impacting the anvil teeth as the hammer dogs approach the anvil teeth in at least one angular relationship of the hammer dogs and anvil teeth.
6. A rotary impact tool comprising:
 - (a) a casing;
 - (b) a rotary motor in said casing and a rotor driven by said motor;
 - (c) an anvil rotatably mounted on said casing for rotation relative to said rotor;
 - (d) a hammer mounted on said rotor for positive rotation with it and for movement toward and away from said anvil between an impact position wherein said hammer delivers a rotary impact to said anvil and a non-impact position wherein the hammer can rotate free of the anvil;
 - (e) a pair of cam elements interconnected between said anvil and hammer and arranged to normally move said hammer to said non-impact position when said rotor turns at a relatively slow speed;
 - (f) resilient means mounting said cam elements for moving relative to said anvil when engaged at high speed of said rotor whereby said cam elements fail to move said hammer out of the way of said anvil resulting in said hammer impacting said anvil;
 - (g) said cam elements having means causing them to move axially together and then axially apart in sequence as said hammer approaches said anvil, the movement of said cam elements axially together causing said hammer to move axially toward its impact

position, the reversal of movements of the cam elements being accomplished sufficiently abruptly for the hammer to have sufficient axial movement toward its impact position to continue moving axially toward its impact position as said cam elements begin moving axially apart and to remain in said impact position long enough to impact said anvil. 5

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DAVID J. WILLIAMOWSKY, *Primary Examiner.*