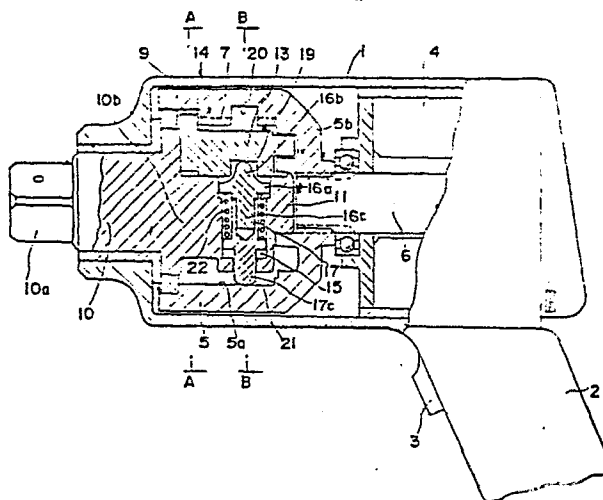


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FIG. 1



AN IMPACT WRENCH

BACKGROUND OF THE INVENTION

The present invention relates to an impact wrench for use in fastening or unfastening bolts or nuts. More particularly, the present invention relates to an impact wrench for such use, which includes a rotor driven by a motor thereby to cause the fasteners to be driven into the fixtures through the motion of the anvil hit by the rotor intermittently.

The known impact wrenches have a hammer portion provided by a rotor connected to a rotating shaft. While the rotor is rotated around the anvil, the hammer portion of the rotor is forced into engagement with the anvil under the action of a cam or any other similar device. The engagement of the hammer portion of the rotor occurs when the rotor rotates at a high speed, and the engagement is finished in a moment. In addition, the hammer portion is subjected to various forces while the same is in such a quick movement. Owing to these factors the fabricating of the rotor, particularly of the hammer portion, involves difficulties, and even if it is fabricated, differences in movement occur from rotor to rotor. Furthermore, as the rotor is partially abraded, it becomes difficult for the hammer portion to fall exactly on the anvil, which results in weak blows or even non-blows. This leads to incomplete fastening of fasteners.

In order to solve the problems mentioned above, the inventor has invented an improved impact wrench which has no hammer or hammer portion, disclosed in Japanese Laid-Open specification No. 127678/82. In the new type of wrench an anvil is placed inside the cylindrical rotor, such that it is ready to be hit by an projection provided on the inside surface of

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the rotor while the rotor rotates. The anvil is subjected to a relatively large spring load, against which the anvil is positioned, until the same comes into engagement with the side of the projection. Because of this spring-loaded situation, a frictional loss tends to occur between the anvil and the inside surface of the rotor, which retards its speed.

As a result, the impact expected to occur therebetween becomes weak. To improve it a larger torque will be required, which gives a detrimentally large reaction to the operator. In addition, at the moment when the anvil is about to come into engagement with the projection, the anvil is likely to displace wholly or partially from the projection due to the action of the spring. This leads to failure to hit or incomplete hitting.

OBJECTS AND SUMMARY OF THE INVENTION

The present invention is directed toward solving the problems pointed out with respect to the known impact wrenches, and has for its object to provide an improved impact wrench having an improved arrangement of adjusting the spring loads to be acted on the anvil member, thereby ensuring that a constantly regular impacts of a large strength are transmitted to the anvil.

Another object of the present invention is to provide an improved impact wrench capable of producing impacts without giving detrimental shocks to the operator's hands.

Other objects and advantages of the present invention will become apparent from the detailed description given hereinafter; it should be understood, however, that the detailed description and specific embodiment are given by way of illustration only, since various changes and modifications within the spirit and scope of the invention will become apparent to those skilled in the art from this detailed description.

According to the present invention, there is provided an impact wrench, which comprises:

a cylindrical rotor coupled to a motor shaft, said cylindrical rotor including a projection on its inner surface, the projection having a circumferential width and an axial length;

an anvil coupled to said cylindrical rotor, the anvil including a hammer member capable of rocking therein, the hammer member being engageable with said projection; and

a spring-loaded pusher for urging said hammer member towards said projection, wherein a spring support slides either on a deep cam face or a shallow cam face both produced on said inner surface of the cylindrical rotor, thereby allowing said spring to become compressed or relaxed against said hammer member.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a vertical cross-section through an impact wrench embodying the present invention;

Figure 2 is a cross-sectional front view taken along the A-A line in Figure 1;

Figure 3 is a cross-sectional front view taken along the B-B line in Figure 1;

Figures 4 to 7 inclusive are views exemplifying the actions of the impact wrench of Figure 1, particularly showing interrelated actions of the internal components; and

Figure 8 is a chart showing the actions of the components.

DETAILED DESCRIPTION OF THE INVENTION

The impact wrench includes a casing 1 with a handle 2 and a trigger 3. A compressed air is introduced in the casing 1 through an inlet (not shown) in the known manner. With the supply of a compressed air, an air motor 4 is rotated at a high speed in a clockwise or a counter-clockwise direction by operating the trigger 3 and an adjusting valve (not shown).

The air motor 4 has a rotary shaft 6 which has a cylindrical rotor 5 integrally jointed thereto by means of splines. The cylindrical rotor 5 has a circular inner surface 5a, on which projection 7 is radially provided. The projection 7 has a circumferential width, and an axial length. The projection 7 has circular recesses 8a, 8b at its opposite sides, as best shown in Figure 3. The reference numeral 5b designates a tail portion of the cylindrical rotor 5.

The reference numeral 9 designates a guide groove produced in the projection 7, which connects between the recesses 8a and 8b at their forward sides (in Figure 1).

An anvil 10 is rotatively provided in the casing 1. The anvil 10 has a head 10a and a tail portion 11, which is fitted in the tail portion 5b of the cylindrical rotor 5, thereby effecting a unitary rotation. The head 10a is made so as to be fixed to a socket (not shown) for a bolt or a nut. The anvil 10 has a body portion 10b having a larger diameter, on which a groove 12 of semi-circle in cross-section is axially produced. A hammer member 13 is rotatively located in the groove 12 as best shown in Figure 6.

The hammer member 13 is a semi-circular rod, having the same radius of curvature as that of the circular recesses 8a, 8b, and at its circular surface it is in contact with the inner surface of the groove 12. The

hammer member 13 has shoulder edges 13a, 13b at its opposite sides, and an outer surface 13c. It is arranged that when a line connecting transversely between the shoulder edges 13a and 13b is perpendicular to a diametrical axis of the cylindrical rotor 5, the outer surface 13c is withdrawn against the projection 7. The hammer member 13 is additionally provided with a projection 14 at its forward end, which is adapted to pass through the guide groove 9. When the projection 14 is passing through the guide groove 9, its top portion and either of the shoulder edges 13a or 13b come into contact with the inner surface 5a, thereby forcing the hammer member 13 to tilt. When ^{it is} tilted, the shoulder edge 13a or 13b comes into engagement with either side of the projection 7 as shown in Figure 5.

The reference numeral 15 designates a bore produced in the bottom of the groove 12, the bore accommodating a pusher 16 against the hammer member 13 and a support 17 for a coil spring 22.

Referring to Figure 2, the pusher 16 is provided with a flange 16a which is adapted to slide on the inside surface of the bore 15, and with a pushing top 16b, which is kept in engagement with a curved bottom 19 of hammer member 13. The reference numeral 16c designates a shank portion which is slidably received in a slot axially produced in the support 17. The support 17 includes an extruding bottom 17c, which keeps contact with the inner surface of the cylindrical rotor 5.

The inner surface of the cylindrical rotor 5 includes a pair of continuous cam faces 20 and 21, wherein, as best shown in Figure 2, the cam face 20 is concaved with respect to another cam face 21, which is convexed with respect to the cam face 20, hereinafter the cam face 20 being referred to as the deep cam face and the cam face 21 being referred to the shallow cam face. The shallow cam face 21 is opposed to the projection 7, and has such a circumferential length as to enable to the extruding

bottom 7c of the support 17 to keep contact therewith in the period of time for which the hammer member 13 rotates from one side of the projection 7 to the other side thereof; actually, one shoulder edge 13a (or 13b) of hammer member 13 comes into contact with one side of the projection 7, and as the hammer member rotates, another shoulder edge 13b (or 13a) thereof comes into contact with another side of the projection 7.

The coil spring 22 is provided between the flange 16a and a flange produced in the pusher 17.

In operation, after compressed air is introduced in the casing 1, the trigger 3 and the adjusting valve (not shown) are operated to rotate the air motor 4 in a clockwise direction. As the rotary shaft 6 of the motor 4 rotates, the cylindrical rotor 5 associated therewith starts to rotate in a clockwise direction with respect to the hammer member 13 as shown in Figure 4. At this stage the hammer member 13 is tilted with its projection 14 and left-hand shoulder edge 13a being placed in contact with the inner surface 5a of the cylindrical rotor 5. As the cylindrical rotor 5 further rotates at a given angle, the left-hand shoulder edge 13a fits in the right-hand recess 8a, and then the projection 14 comes into the circular recess 8b. At the same time, the left-hand shoulder edge 13a comes into engagement with the right-hand side of the projection 7, thereby transmitting the motion of the cylindrical rotor 5 to the anvil 10 through the hammer member 13.

Before the hammer member 13 comes into engagement with the projection 7 of the cylindrical rotor 5, the extruding bottom 17c of the spring support 17 keeps contact with the deep cam face 20, thereby weakening the strength of the spring 22 because of an enlarged distance between the pusher 16 and the spring support 17. Thus a weaker pushing force acts on the curved bottom 19 of the hammer member 13. Under this weak spring support

the hammer member 13 comes into engagement with the projection 7 of the cylindrical rotor 5 as it holds its tilting posture. As soon as the extruding bottom 17c comes into contact with the shallow cam face 21, the spring 22 is caused to contract upwards thereby to enable the pusher 16 to act on the curved bottom 19 of the hammer member 13. In this way the projection 14 of the hammer member 13 is pushed upwards.

The period of time for which the cylindrical rotor 5 starts to rotate and allows its projection 7 to come into engagement with the hammer member 13, is instantaneous for a single rotation of the cylindrical rotor 5.

When the projection 14 of the hammer member 13 is pushed upwards by the force of the spring 22, the projection 14 of the hammer member 13 is urged to displace from the projection 7 of the cylindrical rotor 5. The strength of the spring 22 is previously adjusted so as to be larger than the static friction between the sides of the projection 7 and of hammer member 13, but smaller than the sum of the static friction and the centrifugal force of the cylindrical rotor 5. Accordingly, the hammer member 13 is kept in engagement with the projection 7, thereby effecting the associated rotation of the cylindrical rotor 5 and the hammer member 13. In this way the anvil 10 is rotated thereby to enable bolts or nuts to rotate through the socket (not shown).

When a resisting force occurs on the bolt or nut being fastened, it is transmitted to the anvil 10. In this case, so long as the engagement of the hammer member 13 with the projection 7 continues, the anvil 10 slows down, and almost comes to a standstill. This reduces the centrifugal force acting on the hammer member 13. As evident from the aforementioned formula, the returning force of the spring 22 overcomes the static friction between the projection 7 and the hammer member 13.

As a result, the hammer member 13 rotates in a counterclockwise direction, and displaces from the projection 7 of the cylindrical rotor 5. As shown in Figure 6, the cylindrical rotor 5 is in free rotation, wherein the projection 14 of the hammer member 13 passes through the guide groove 9.

After having passed through the guide groove 9, the projection 14 of the hammer member 13 enters the circular recess 8a, in which its top end comes into engagement with the outer end of the recess 8a. As a result, the hammer member 13 is again tilted. Immediately before it occurs, the extruding bottom 17c has been displaced on the deep cam face 20, thereby weakening the strength of the spring 22.

As a result of tilting, the shoulder edge 13a and the projection 7 of the hammer member 13 are placed in contact with the inner surface 5a of the cylindrical rotor 5, and as it is, the cylindrical rotor 5 is in free rotation until its projection 7 comes into engagement with the side of the hammer member 13.

At this stage, if a resisting torque acts on the anvil 10, of greater strength than the torque of the motor 4, the engagement of the hammer member 13 with the projection 7 of the cylindrical rotor 5 cannot last long because the centrifugal force required to effect the engagement of those only acts instantaneously. Thus the hammer member 13 is readily disengaged from the projection 7. But after one rotation, the hammer member 13 again comes into engagement with the projection 7. As the resisting torque becomes larger, the engagement of the hammer member 13 with the projection 7 involves larger impacts. The bolt or nut is tightened under the series of impacts.

When a bolt or nut is loosened, the air motor 4 is rotated in a counterclockwise direction.

Figure 8 diagrammatically shows the actions of the cylindrical rotor 5, the influences given by the hammer member 13 on the spring 22,

and the influences given by the cam faces 20, 21 on the rotation of the cylindrical rotor 5, which are represented by (a), (b) and (c), respectively. The graph (d) represents the actions of the spring 22 as a result of the synthesis of the two graphs (b) and (c).

Figure 8 shows that until a blow occurs, the cylindrical rotor 5 rotates in one direction, during which the force of the spring 22 is weak at the point indicated by (A). No substantial influences are given on the hammer member 13 and the cylindrical rotor 5. When blows occur on a bolt or a nut, the cylindrical rotor 5 rebounds, and simultaneously, the action of the spring 22 instantaneously becomes large. At the moment when the hammer member 13 is disengaged from the projection 7 of the cylindrical rotor 5 under the reaction of blows on the bolt (at the point (B)), the action of the spring 22 is still negligible. While the hammer member 13 passes through the guide groove 9 (at the point (C)), the force of the spring 22 becomes large, and the situation (A) is recovered in which the cylindrical rotor 5 is in free rotation.

CLAIMS:

1. An impact wrench for use in fastening bolts or nuts to a fixture, the impact wrench comprising:
a cylindrical rotor coupled to a motor shaft, said cylindrical rotor including a projection on its inner surface, the projection having a circumferential width and an axial length;
an anvil coupled to said cylindrical rotor, the anvil including a hammer member capable of rocking therein, the hammer member being engageable with said projection;
a spring-loaded pusher for urging said hammer member towards said projection, wherein a spring support slides either on a deep cam face or a shallow cam face both produced on said inner surface of the cylindrical rotor, thereby allowing said spring to become compressed or relaxed against said hammer member.
2. An impact wrench as defined in Claim 1, wherein an air motor is employed for a driving means.
3. An impact wrench as defined in Claim 1, wherein the whole body thereof is housed in a portable casing with a trigger extruding outside for manual operation.

FIG.1

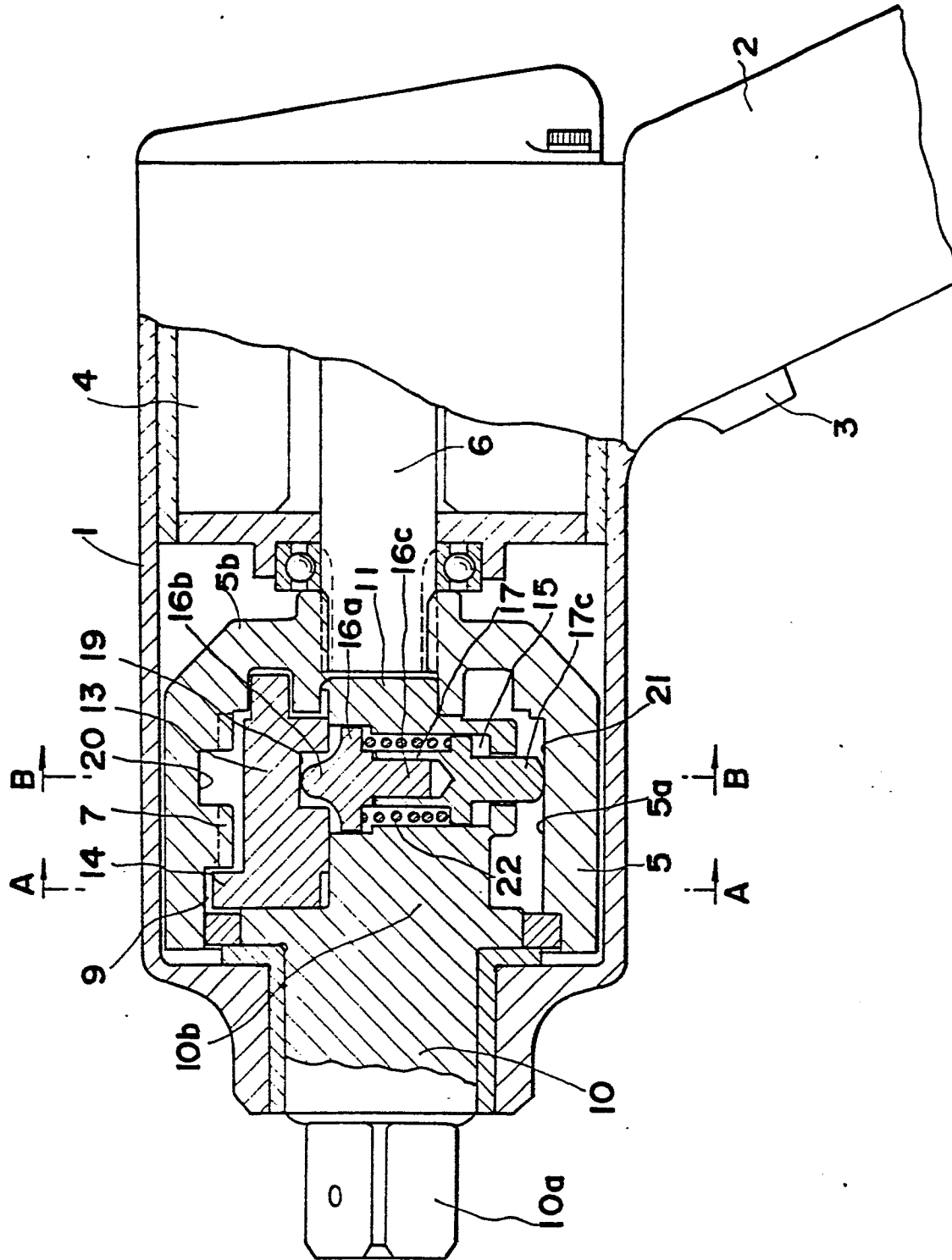


FIG.2

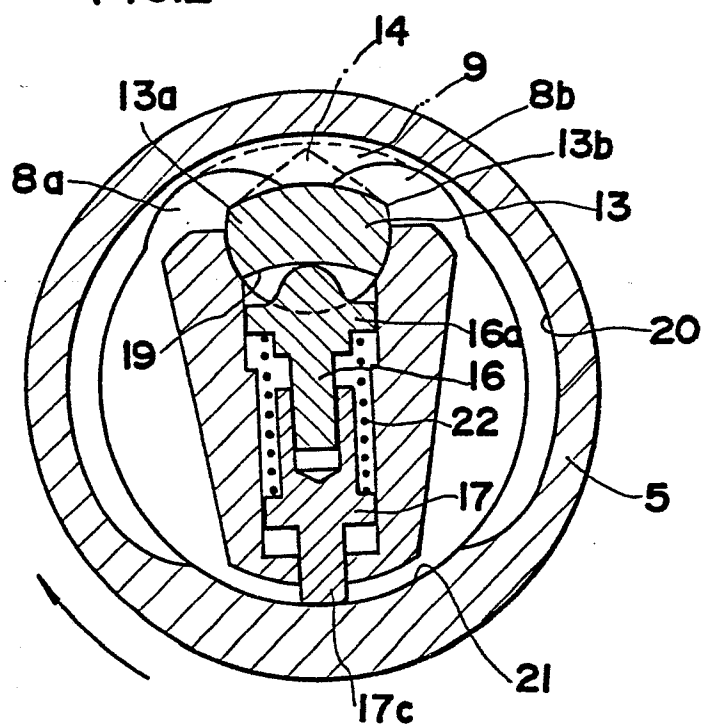


FIG.3

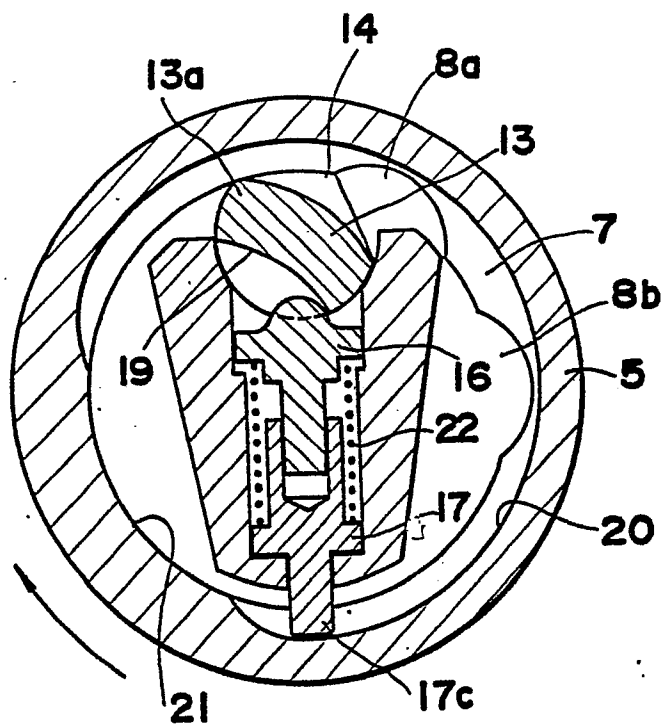


FIG.4

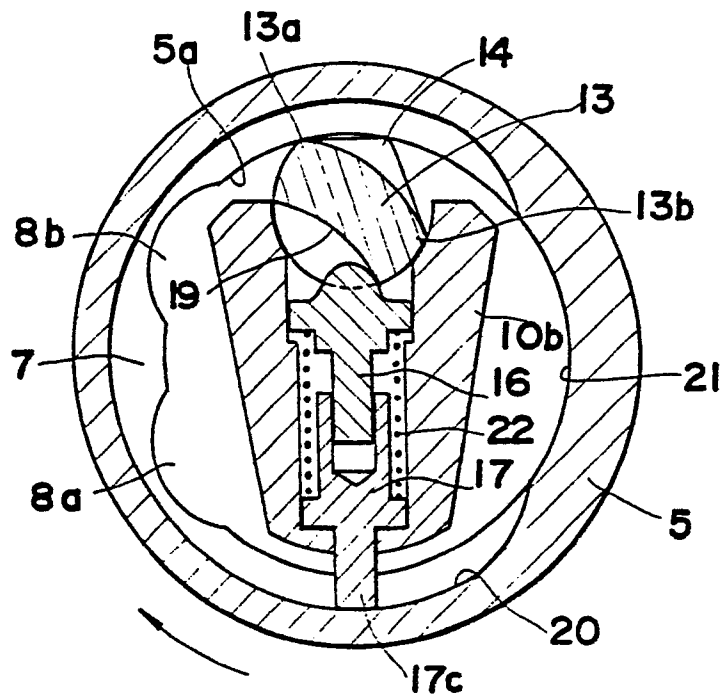


FIG.5

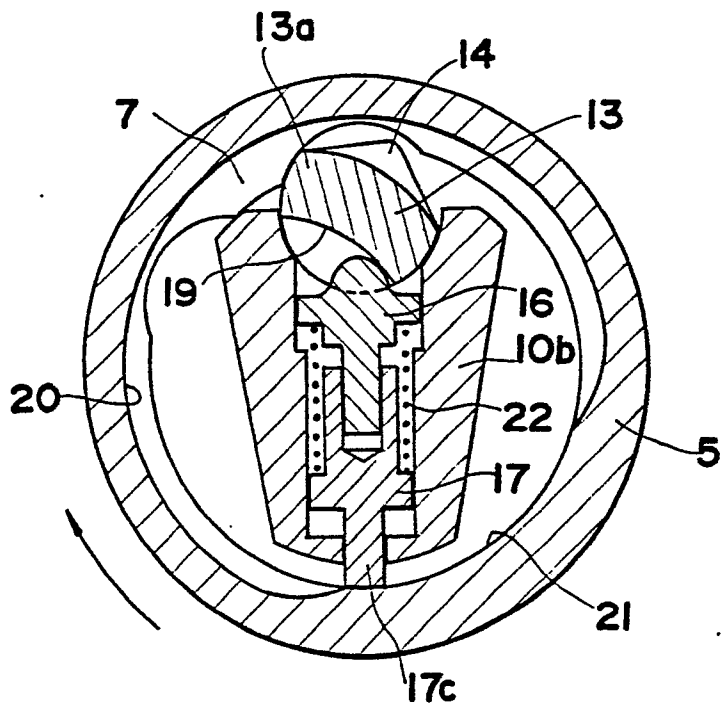


FIG. 6

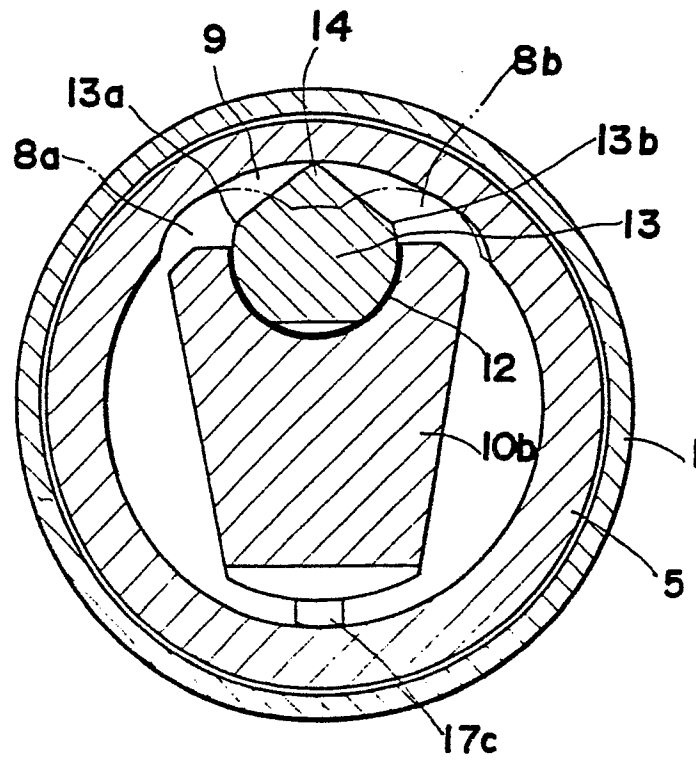
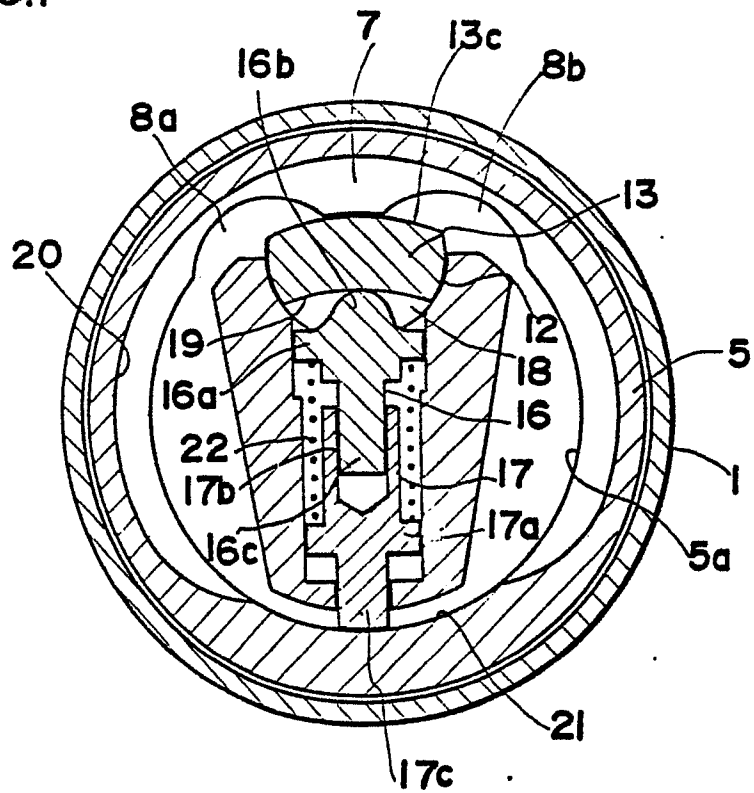


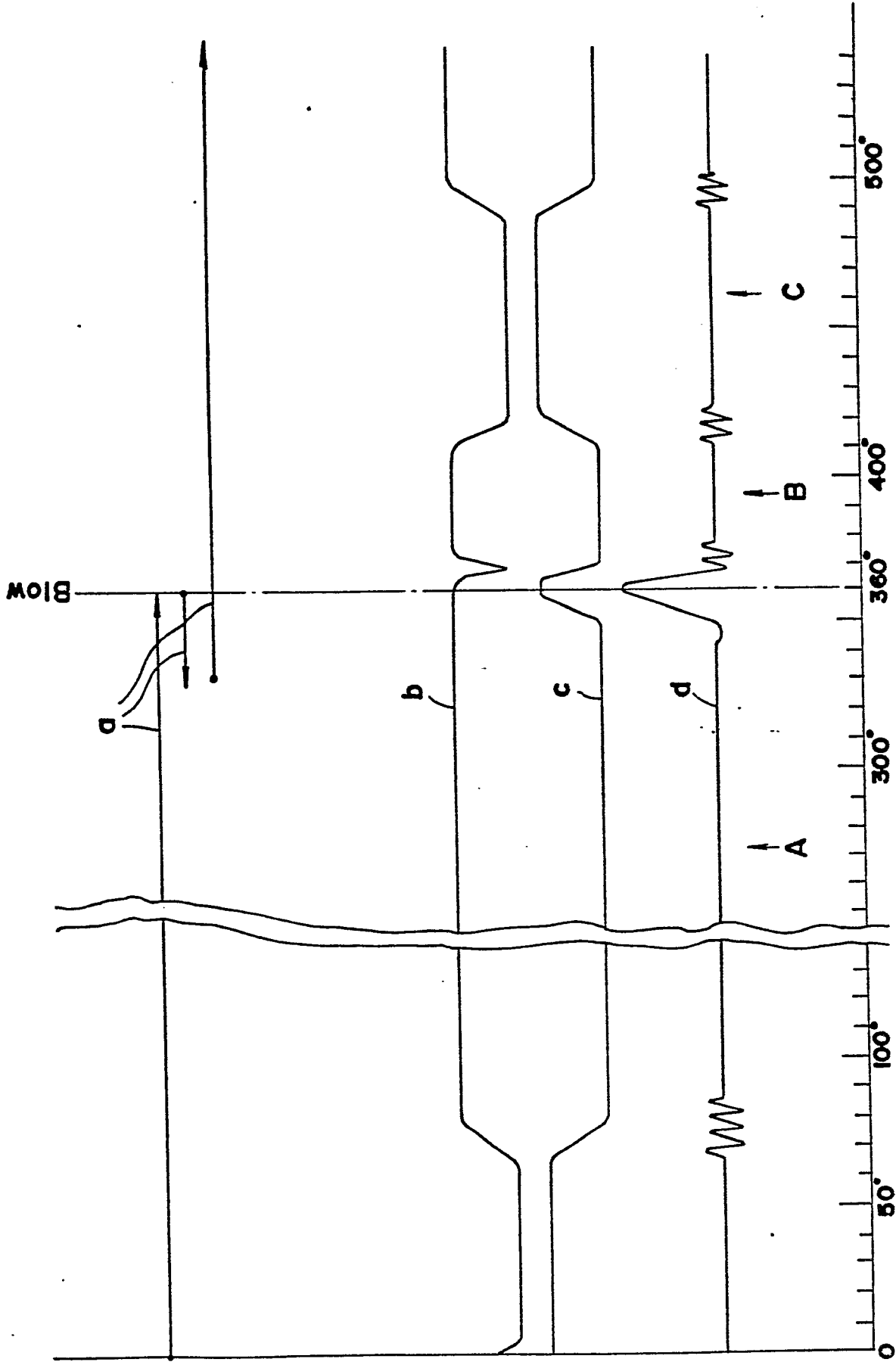
FIG. 7



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FIG.8



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