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(71) Applicant: **Simes-Senco, S.A.**
31486 Elcano-Navarra (ES)

(72) Inventor: **Corchón Zamora, Carlos**
31620 Huarte (Navarra) (ES)

(74) Representative: **Urteaga Simarro, José Antonio**
31, Principe de Vergara St.
28001 Madrid (ES)

(54) **Ring-forming tool with variable lever arm and variable torque**

(57) Ring-forming tool (1) for closing a ring (19), which comprises a top piece (2), a bottom piece (3), a top claw (4) and a lever (9), connected together by means of four pivot points (7, 8, 17, 18), three of which present a fixed position and one of which presents a variable position that enables the tool (1) to vary the lever arm and therefore vary the force exerted on the ring (19) for a same force exerted by the user. In this way, the inventive tool may provide decreasing forces on the ring (19) as the ring (19) closes and offers less resistance.

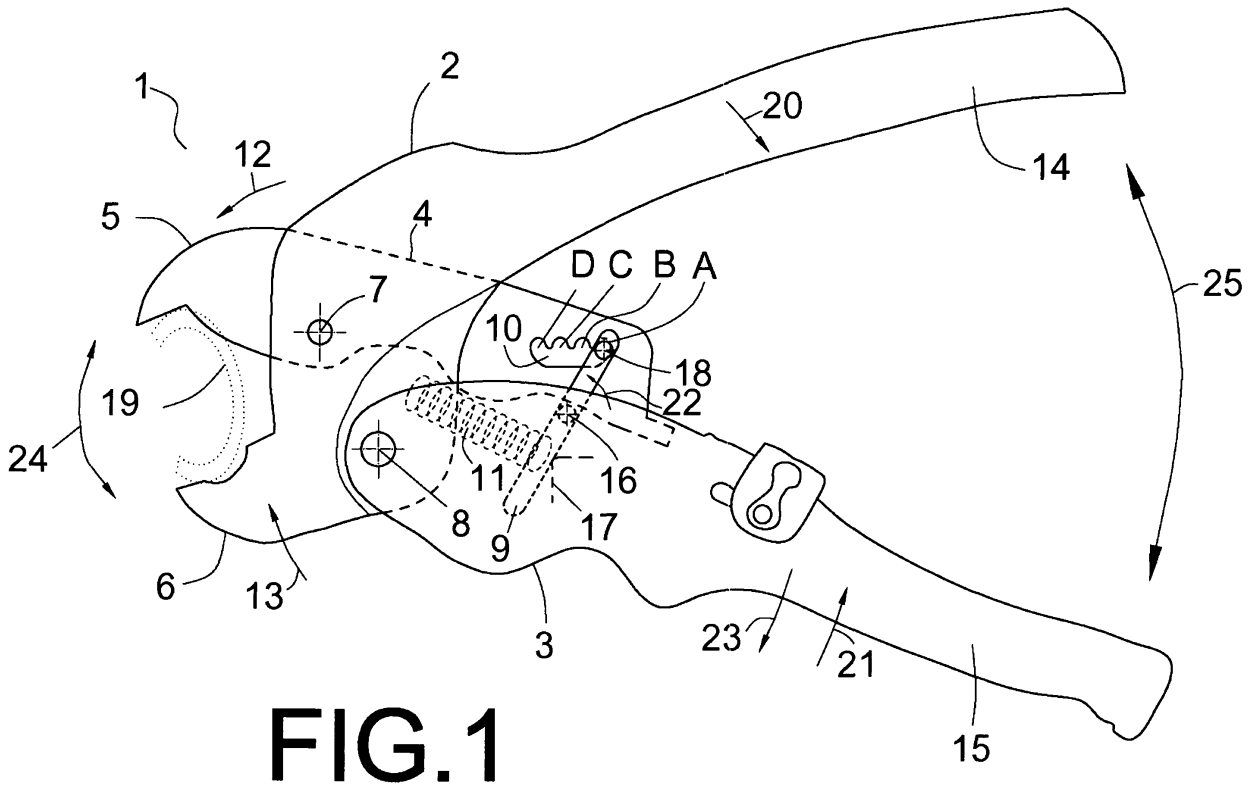

FIG.1

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Description

Technical field

[0001] The invention refers to a manual ring-forming tool with a variable lever arm, and therefore capably of applying a variable torque, for tightening a ring.

Prior art

[0002] Conventional pliers are made up of two elongated pieces connected together by a central pivot point. The pieces are provided with gripping areas on one end, while on the opposite end they are provided with tightening tips. Consequently, when a user exerts force on the gripping areas to bring them closer together, as a result of a double lever effect the tightening tips come close and thus grip an object positioned between them.

[0003] A ring-forming tool is essentially a type of plier designed to close a staple, which initially open and takes the shape of a ring when closed. For this purpose, the ring-forming tool comprises tightening tips between which the staple-ring is initially positioned. Pressure is then exerted on the gripping areas of the ring-forming tool, causing the tightening tips to close against the staple. The tightening tips are closed with a force determined by the shape of the pliers and by the force exerted by the user on the gripping areas located on the end opposite to the tightening tips. The lever arm, i.e. the distance between the point at which the user applies the force (gripping areas) and the central pivot point, is fixed. Therefore, the ring-forming tool always exerts the same tightening force on the ring, regardless the tightening force exerted by the user. However, it should be taken into account that, due to their shape (thickness, etc), some rings are especially rigid when they are in a more open position, their rigidity decreasing as they are closed. It would therefore be convenient to provide a ring-forming tool with a variable lever arm for this type of rings.

[0004] The invention aims to provide a ring-forming tool with a variable lever arm that allows the tightening force exerted by the tightening tips on the ring to be variable and adaptable to the rigidity or resistance provided by the ring at each point. The invention thus aims to provide a ring-forming tool that allows the user to close the ring without having to exert considerable force, particularly at the beginning of the process.

Brief disclosure of the invention

[0005] It is an object of this invention to provide a ring-forming tool for closing a ring and which comprises a top piece, a bottom piece, a top claw and a lever, all of them connected together by four pivot points. Three of the pivot points present a fixed position, while the fourth pivot point presents a variable position that allows the tool to vary the lever arm and therefore vary the force exerted on a ring for the same force exerted by the user. The tool may thus deliver maximum force on the ring even when the ring is open and at its most rigid, while also providing reduced force and greater angular movement as the ring closes and becomes less rigid. Thanks to this variable means of operating, the tool is very easy and comfortable for the user to use.

Brief description of the drawings

[0006] Details of the invention can be seen in the accompanying non-limiting figures:

- Figure 1 shows a view of the preferred embodiment of the tool according to the invention, the tool being shown in its most open, or rest, position.
- Figure 2 shows another view of the preceding tool, shown in an intermediate position in which the ring has been partially closed.

Detailed disclosure of the invention

[0007] Figure 1 shows a view of the preferred embodiment of the tool according to the invention, shown in its most open, or rest, position. The tool (1) comprises four pieces that are connected together: a top piece (2), a bottom piece (3), a top claw (4) and a lever (9). The top piece (2) and the bottom piece (3) respectively comprise an upper arm (14) and a lower arm (15), said arms (14, 15) being the areas where the user exerts a manual tightening force. The top claw (4) and the top piece (2) respectively comprise a top tightening tip (5) and a bottom tightening tip (6), which are the areas by which the tool opens and closes a ring (19).

[0008] The four pieces (2, 3, 4, 9) mentioned above are connected together by means of four pivot points that form an articulated quadrilateral:

- a pivot point (8) between the top piece (2) and the bottom piece (3),
- a pivot point (7) between the top piece (2) and the top claw (4),
- a pivot point (16) between the lever (9) and the bottom piece (3),
- a pivot point (18) between the lever (9) and the top claw (4).

[0009] The pivot points (8, 7, 16) are pivot points with fixed positions, in other words they do not move the tool (1) in any way but only rotate or enable the rotation of the pieces connected to them. The pivot point (18), however, is different to the preceding ones as its position may be varied when the tool (1) is being used, enabling the torque of the tool (1) to be altered. The top claw (4) presents a channel (10) with several recesses (A, B, C, D), and the pivot point (18) takes the shape of a rolling bar capable of rolling or jumping from one recess to the next all the way along the channel (10). As detailed at a later stage, the tool (1) exerts greater or smaller torque

on the ring (19) depending on the recess (A, B, C, D) in which the lever (9) is situated.

[0010] The lever (9) presents the pivot points (18, 16), respectively, on one end and in an intermediate area. On the end opposite the end on which the pivot point (18) is located the lever (9) comes up against an internal stopper (17) on the bottom piece (3). The tool (1) also comprises a spring (11) that acts under compression between the top piece (2) and the end of the lever (9). Said spring (11) keeps the lever (9) in the position of the figure, in other words, against the stopper (17). It therefore keeps the lever (9) in a position in which the pivot point (18) is located in the first recess (A). The spring (11) also keeps the pieces (2, 3) in the position shown in the figure, in other words with the arms (14, 15) open.

[0011] The tool (1) works as follows. A ring (19) is placed between the tightening tips (5, 6) as shown in Figure 1. The user starts exerting a force on the arms (14, 15), said force being fairly considerable as the ring (19) presents a certain rigidity or resistance to flexion. The force exerted on the arms (14, 15) causes the following effects:

- by means of the pivot point (8), the top piece (2) and the bottom piece (3) rotate respectively in the direction (20) and in the direction (21);
- the stopper (17) exerts a force against the end of the lever (9) so that the spring (11) is compressed;
- the rotation of the bottom piece (3) in the direction (21) causes the pivot point (18) of the end of the lever (9) to remain inside the first recess (A); the lever (9) pushes the top claw (4) causing its rotation in the direction (12) in relation to the pivot point (7).

[0012] As the ring (19) closes and due to its decreasing rigidity, it is necessary to exert less and less force in closing it. As a result, there comes a point at which the ring closes no further despite the user continuing to attempt to close it. There are two main reasons for this: the movement of the tightening tips (5, 6) has reached its limit and cannot continue, and the hand of the user closes it applies less and less force. The user perceives this as if the tool (1) reached a point at which it can close no further. At this point, the user slightly stops pressing on the arms (14, 15), thus causing the following effects:

- the spring (11) expands slightly causing the bottom piece (3) to rotate slightly in the direction (23) in relation to the pivot point (8); as a result, the lever (9) moves slightly, enabling the pivot point (18) to come out of the first recess (A).
- the force of the spring (11) then causes the lever (9) to rotate slightly in the direction (22). As a result, the pivot point (18) rolls along the channel (10) until it is housed in the second recess (B).

[0013] As can be seen in Figures 1 and 2, the distance between the point where the force is exerted on the top piece (2), which in this case is the area of the upper arm (14) that the user presses with their hand, and the pivot point (7) is fixed. In other words, in the tool (1) according to the invention, the action on the top piece (2) that causes the movement of the bottom tightening tip (6) is performed with a fixed lever arm. As a result, the relation between the tightening force exerted by the user on the upper arm (14) and the tightening force provided by the bottom tightening tip (6) is constant, as is the relation between the angle of rotation of the upper arm (14) and the angle of rotation of the tightening tip (6).

[0014] The operating of the tightening tip (5) is variable, however. In this case, the movement of the tightening tip (5) is caused by a force exerted on the top claw (4). More specifically, said force is exerted on the particular recess (A, B, C, D) in which the pivot point (18) is housed. As a result, the distance between the point on which the force is exerted and the pivot point (7) is variable. In other words, in the tool (1) according to the invention, the action on the top claw (4) that causes the movement of the upper tightening tip (5) is performed with a variable lever arm. Therefore, the upper tightening tip (5) rotates with greater or lesser torque depending on which recess (A, B, C, D) the pivot point (18) is positioned in.

[0015] For example, as shown in Figure 1, the pivot point (18) is housed in the first recess (A). Said recess (A) is the furthest from the pivot point (7), thus creating a maximum lever arm. This allows the user to exert less force to begin the tightening of the ring (19), which, as stated above, is at its most rigid when it is completely open.

[0016] With reference to Figure 2, the ring (19) is partially closed and therefore is less rigid than in the situation shown in Figure 1. As explained above, the pivot point (18) has jumped to recess (B) and is thus closer to the pivot point (7). As a result, the lever arm is shorter in relation to the preceding figure. This means that a smaller force is supplied to the ring (19) for the same force exerted by the user (which is in accordance with the fact that the ring is now less rigid) and in return a greater angular advance of the top tightening tip (5) is achieved.

[0017] As a result, every time that the user reaches a point at which the ring (19) can be tightened no further, they gently release the arms (14, 15) allowing the lever (9) to position itself in the following recess. Thus, as the lever (9) advances from the first recess (A) to the fourth recess (D), the tool's lever arm becomes increasingly shorter, thus creating an increasingly larger angle (24) of advance. In other words, the lever arm or torque supplied by the tool (1) adapts to the rigidity of the ring (19), a rigidity that decreases as the ring (19) closes.

[0018] The inventive tool (1) may present other embodiments different to those shown in the figures. For example, it is envisaged that the tool (1) has an automatic ring loader built into it so that the chamber may be supplied by a ring cartridge, with said loader being capable of feeding the rings (19) to the tightening tips (5, 6) as said tips (5, 6) close each ring (19).

Claims

1. Ring-forming tool (1) for closing a ring (19), **characterised in that** it comprises:

   - a top piece (2) provided with an upper arm (14), and a bottom piece (3) provided with a lower arm (15), said arms (14, 15) serving as areas where a user exerts a manual tightening force,
   - a top claw (4) and
   - a lever (9),
   - where the top claw (4) is provided with a top tightening tip (5) and the top piece (2) is provided with a bottom tightening tip (6), said tips (5, 6) serving as areas by which the tool (1) performs the tightening and closing of the ring (19),
   - where the pieces (2, 3, 4, 9) are connected together by means of four pivot points (7, 8, 16, 18), a pivot point (8) existing between the top piece (2) and the bottom piece (3), a pivot point (7) between the top piece (2) and top claw (4), a pivot point (16) between the lever (9) and the bottom piece (3), and a pivot point (18) between the lever (9) and the top claw (4),
   - where the pivot points (7, 8, 16) present a fixed position and the pivot point (18) presents a variable position.

2. Ring-forming tool (1), according to claim 1, wherein the pivot points (2, 3, 4, 9) form a jointed quadrilateral.

3. Ring-forming tool (1), according to claim 1, wherein the top claw (4) comprises a channel (10) with various recesses (A, B, C, D), and the pivot point (18) may jump or roll from one recess to the next, along the channel (10), in order to change its position.

4. Ring-forming tool (1), according to claim 1, wherein the lever (9) presents the pivot points (18, 16), respectively, on one end and in an intermediate zone, and on the end opposite the end on which the pivot point (18) is located, the lever (9) comes up against an internal stopper (17) on the bottom piece (3), and where the tool (1) also comprises a spring (11) that keeps the lever (9) against the stopper (17).

5. Ring-forming tool (1), according to claim 4, wherein the spring (11) acts under compression between the top piece (2) and the end of the lever (9) opposite the end on which the pivot point (18) is located.

6. Ring-forming tool (1), according to claim 1, wherein it also comprises an automatic ring loader.

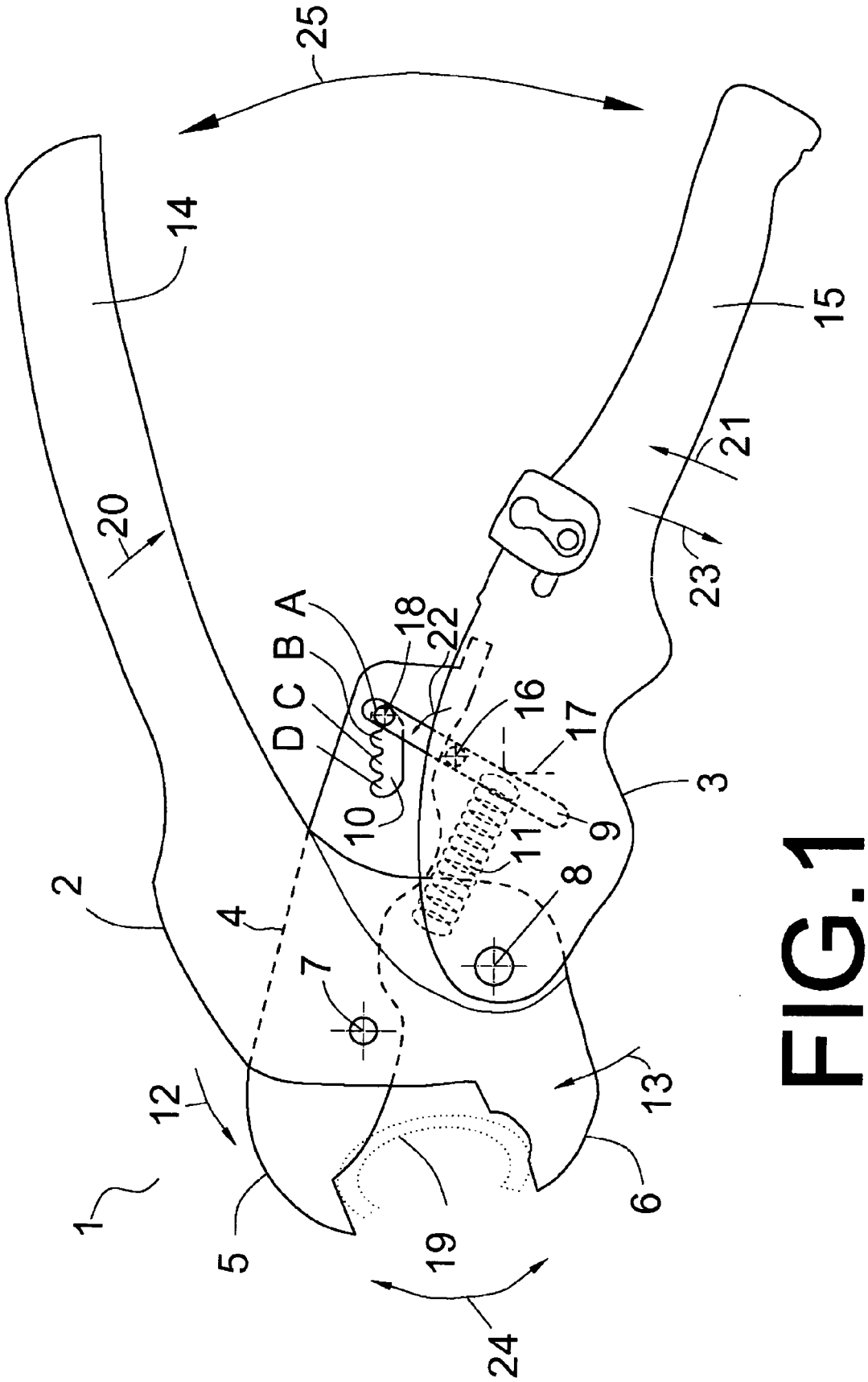

FIG.1

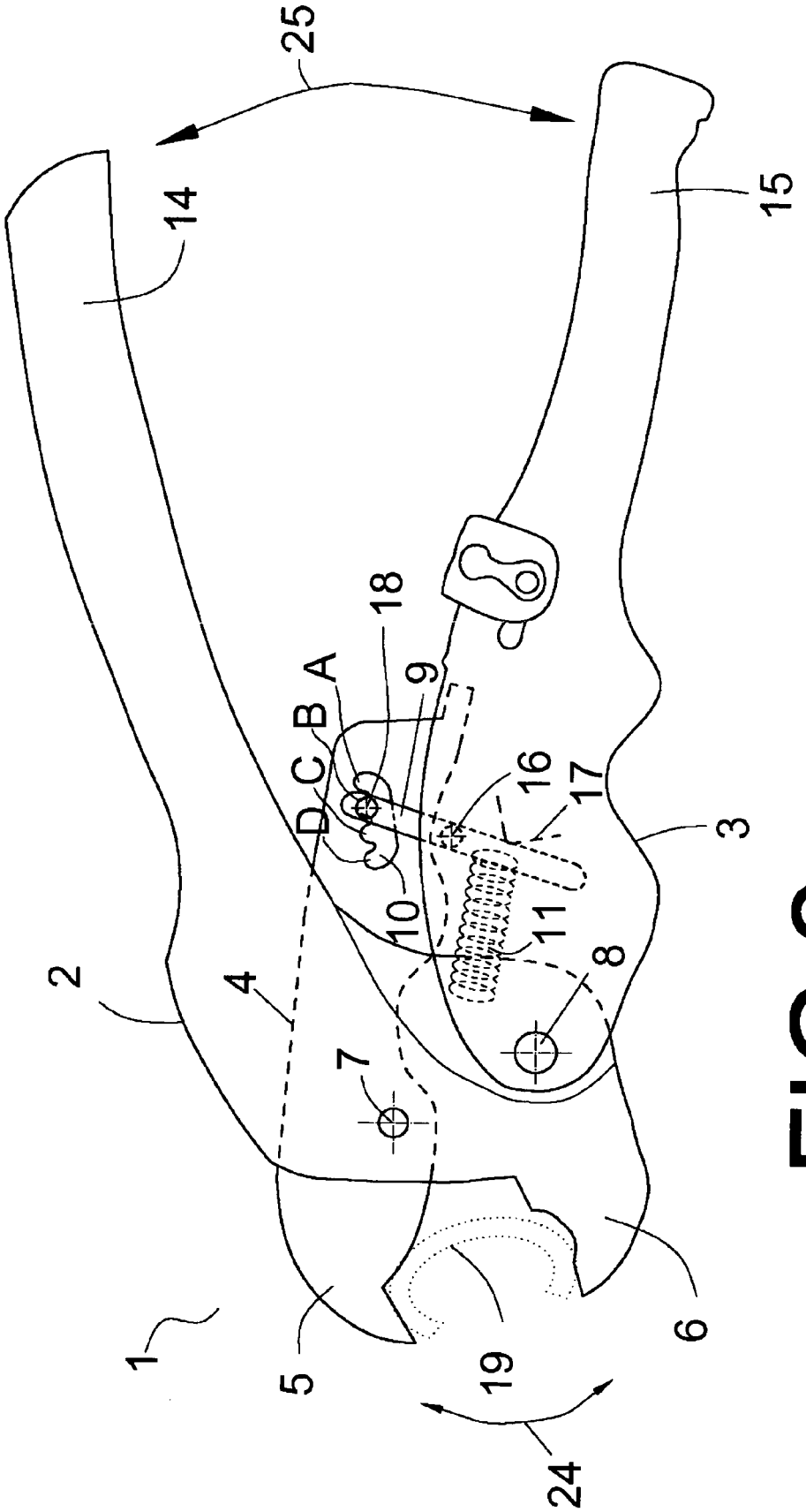

FIG.2