June 30, 1953 G. E. BROWN 2,643,859

DEFLECTING TOOL

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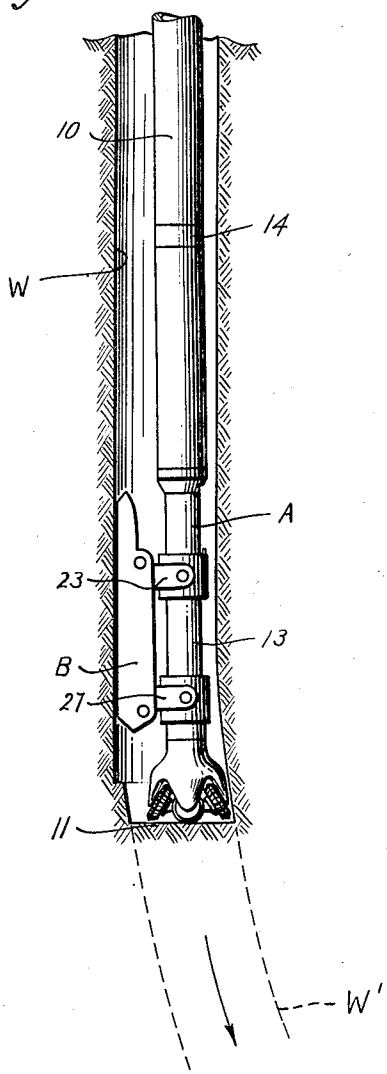
Fig. 1



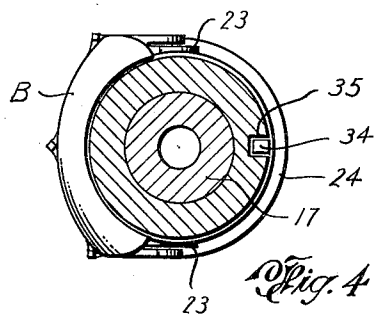


Fig. 4

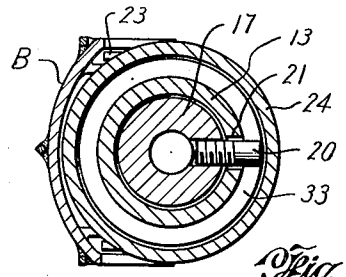


Fig. 5

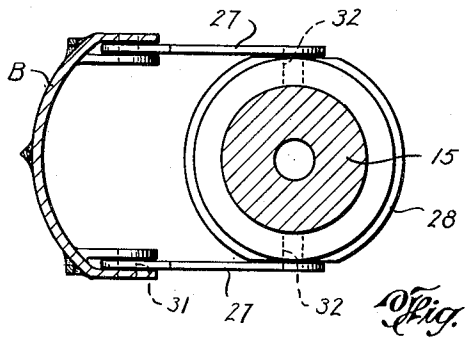


Fig. 6

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Fig. 2

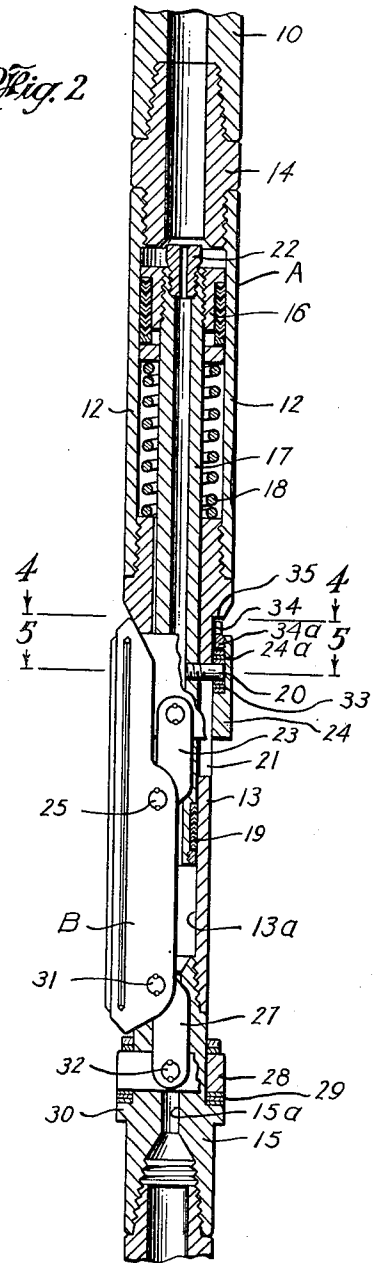
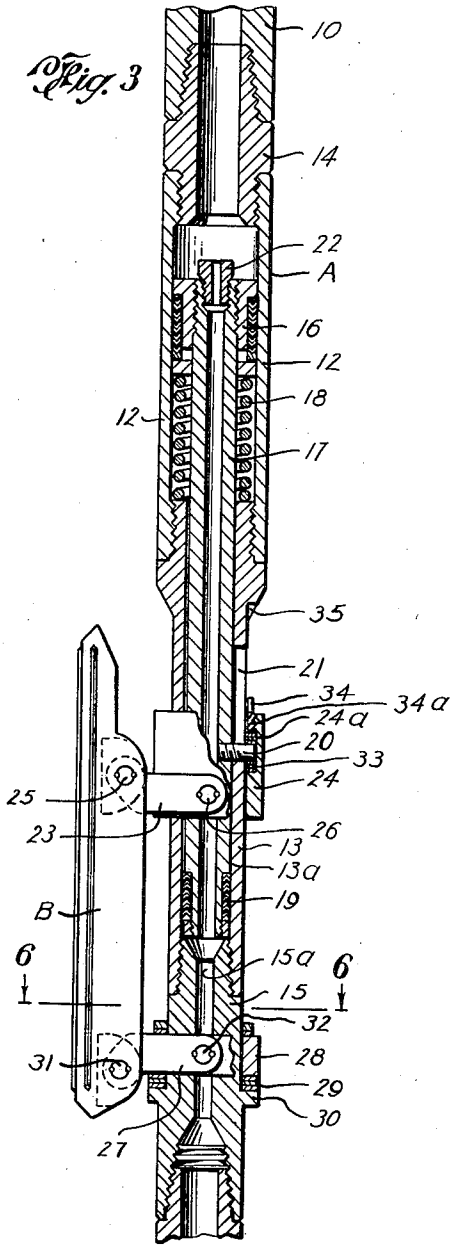


Fig. 3



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DEFLECTING TOOL

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15 Claims. (Cl. 255—1.6)

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This invention relates to new and useful improvements in deflecting tools.

One object of the invention is to provide an improved deflecting tool for effectively drilling a well bore at an angle from the vertical whereby directional drilling of the well may be accomplished.

An important object of the invention is to provide an improved deflecting tool adapted to be connected in the lower portion of a drill pipe or string and having means for urging the lower portion of the drill pipe and the drill bit attached thereto toward one side of the well bore, whereby subsequent rotation of the drill pipe and bit will result in drilling the well bore at an angle with respect to the remainder of said bore.

Still another object is to provide a deflecting tool including an expansible deflecting shoe which when moved to an expanded position offsets the lower portion of the drill pipe with respect to the drill bore together with means operated by the pressure of the normally circulated drilling fluid for actuating or expanding said deflecting shoe.

A further object is to provide a deflecting tool, of the character described, wherein the deflecting shoe is normally held in a retracted position and is adapted to be radially expanded by means of the pressure of the normally circulated drilling fluid, the mounting of said shoe being such that the shoe will remain stationary upon subsequent rotation of the drill pipe and drill bit to assure continued deflection of the bit during the subsequent directional drilling operation.

A still further object is to provide a deflecting tool of the character described which is extremely simple in construction and which comprises a unitary assembly which may be readily connected in the drill pipe.

Still another object is to provide a tool of the character described which is constructed so that the deflecting element or shoe may be properly oriented before it is actuated.

The construction designed to carry out the invention will be hereinafter described together with other features thereof.

The invention will be more readily understood from a reading of the following specification and by reference to the accompanying drawings forming a part thereof, wherein an example of the invention is shown, and wherein:

Figure 1 is an elevation of a deflecting tool constructed in accordance with the invention and illustrating the same connected in the drill pipe and moved to an expanded position within a well bore,

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Figure 2 is an enlarged view of the deflecting tool partly in section and partly in elevation with the deflecting element or shoe in a retracted position,

Figure 3 is a view similar to Figure 2 with the deflecting element or shoe in its expanded position,

Figure 4 is an enlarged horizontal view taken on the line 4—4 of Figure 2,

Figure 5 is an enlarged horizontal view taken on the line 5—5 of Figure 2, and

Figure 6 is an enlarged horizontal view taken on the line 6—6 of Figure 3.

In the drawings, the numeral 10 designates the usual drill pipe or stem which is adapted to extend through the well bore W and which is utilized to impart rotation to a drill bit 11. The improved deflecting tool A comprising the present invention is arranged to be interposed between the drill pipe 10 and the drill bit 11 and said tool includes a deflecting element or shoe B which is movable radially of the body between a retracted and expanded position. When in an expanded position the outer surface of the element or shoe engages one wall of the well bore W as shown in Figure 1 and functions to move the lower portion of the drill pipe 10 and the drill bit 11 toward the wall of the well bore one hundred and eighty degrees opposite the point of contact of said element or shoe with said wall. It is apparent that with the element or shoe B in its expanded position, the drill bit 11 is urged toward the wall of the well bore opposite the shoe and subsequent rotation of the drill pipe and bit results in a drilling of the well bore at an angle with respect to the main portion of said bore. The angular or inclined drilling which will be effected by subsequent rotation of the bit 11 after expansion of the shoe B is indicated by the dotted lines W' in Figure 1.

The deflecting tool A is clearly shown in Figures 2–6 and the upper portion of the tool includes an elongate sleeve or cylinder 12 which has its lower end connected by threads to the upper end of a tubular body portion 13. The upper end of the sleeve or cylinder is connected by a sub 14 with the drill pipe 10, while the lower end of the tubular body portion 13 has connection through a sub 15 with the drill bit 11. A movable piston 16 which is slidable within the cylinder 12 is attached to the upper end of a tubular guide stem 17, and said piston is normally held in a raised position therein by a coil spring 18 which surrounds the tubular stem and which is confined between the under side of the piston and the upper end of the tubular body por-

tion 13. The tubular stem 17 extends downwardly within the bore 13a of the body 13 and carries a suitable annular packing 19 at its lower end which seals off between the exterior of the stem and the bore of the body. The stem 17 is provided with a radially extending actuating pin 20 which projects outwardly through a vertical slot 21 formed in the body 13 and which has its outer end in a plane beyond the external surface of the body. When the stem and piston are in a raised position, being held so by the spring 18, the actuating pin 20 is at the upper end of the slot 21 (Figure 2) but upon downward movement of the piston, said pin 20 is moved downwardly within the slot 21 as shown in Figure 3.

The piston 16 is adapted to be moved downwardly against the tension of the spring 18 by the application of fluid pressure at its upper end and in order to assure that pressure fluid flowing downwardly through the drill stem will move the piston downwardly, the upper end of the tubular stem 17 may be restricted by a bored bushing 22 which is threaded into the stem. The axial bore through the bushing is of a restricted size and thus when fluid pressure is applied to the upper end of the piston 16, said piston is moved downwardly within its cylinder 12. The pressure fluid which is applied to the piston will be the usual drilling fluid which is pumped downwardly through the drill stem to the bit 11 and after actuation of the piston, the fluid is circulated downwardly through the bore of the stem 17 and into the lower portion of the body 13. From the body the fluid flows through an axial bore 15a provided in the connecting sub 15 and thence to the drill bit 11 in the usual manner. It will thus be evident that actuation of the piston 16 is effected by means of the usual drilling fluid which is normally circulated through the drill pipe and bit.

The deflecting element or shoe B is controlled in its actuation by the movement of the piston 16 and said shoe is generally arcuate in cross-section, as shown in Figures 4–6. The upper portion of the shoe is connected by diametrically opposed links 23 to an upper actuating collar 24. Each link 23 is pivoted at 25 to the shoe and is pivoted to the collar on studs 26. The lower portion of the shoe is connected by a pair of diametrically opposite links 27 to an anchoring collar 28 which is rotatably mounted on bearing plates 29 supported upon an annular flange or shoulder 30 on the sub 15. Each link 27 is pivotally connected at 31 to the shoe and has its opposite end pivotally mounted on a stud 32 extending outwardly from the anchoring collar 28. The collar 28, although rotatable about the sub, is incapable of a longitudinal movement with respect to the sub. The connecting links 23 and 27 which connect the element or shoe B with the respective collars 24 and 28 have their outer ends offset so that when the shoe is in its retracted position as shown in Figure 2, the points of pivotal connection 25 and 31 between the shoe and the links is offset from the longitudinal center line of the tool and offset with respect to the pivotal studs 26 and 32 by which the links are connected to said collars 24 and 28.

The upper or actuating collar 24 surrounds the body 13 and has a counterbore 24a in its upper portion and the actuating pin 20 which is connected with the tubular stem 17 and which extends through the slot 21 in the body projects into this counterbore. The pin 20 is confined between bearing plates 33 which are disposed within the counterbore 24a and with this arrangement a downward movement of the actuating pin will cause the collar 24 to slide downwardly on the body; however, the pin, guide stem 17 and tubular body 13 may rotate with respect to the collar 24 since the pin is rotatable on the bearing plates 33 within the counterbore 24a.

For orienting the collar 24 and the deflecting element or shoe B which is attached to said collar with respect to the drill pipe when the element or shoe is in its retracted position, the collar 24 is provided with an upstanding lug 34 formed upon a ring carrier 34a threaded into the counterbore 24a and this lug is adapted to engage a radial recess 35 formed on the enlarged upper end of the tubular body 13 (Figure 4). The engagement of the lug within the recess locks the collar 24 and the deflecting shoe B against rotation on the tubular body when the shoe is in its retracted position (Figure 2) and thus, during the lowering of the drill pipe and tool A within the well the deflecting shoe may be in a known radial position with respect to the drill pipe. The drill pipe may be oriented into the well bore W to provide knowledge of the compass position of the shoe when the latter reaches bottom or if desired, a bottom hole orientation method, such as is in common use in the well surveying field and as shown in the prior patents to Miller, 2,327,658, or Hyer, 2,120,670, may be employed for determining the compass position of said shoe. With a bottom hole method of orientation, it would only be necessary to locate the position of the lug and after such position is know the drill pipe may be rotated to properly locate the deflecting shoe before said shoe is moved into a radially expanded position.

In operation the deflecting tool A is connected in the drill string between the lower end of the drill pipe 10 and the drill bit 11 and the coil spring 18 maintains the operating piston 16 in its upper position whereby the deflecting element or shoe is retracted (Figure 2). The deflecting element or shoe is locked against rotation on the tubular body 13 by the engagement of the lug 34 with the recess 35 and the drill pipe may be oriented as it is lowered in the well bore by usual drill pipe orientation methods or after lowering the position of the orienting lug 34 may be ascertained so that the compass position of the shoe may be determined and known when the deflecting tool reaches the lower end of the well bore W. In some instances, such as in a side tracking operation the compass position of the deflecting element is unimportant in which event no orientation need be carried out.

When the deflecting element or shoe is properly positioned and is to be radially expanded, it is only necessary to circulate the usual drilling fluid under pressure downwardly through the drill pipe 10 and this fluid will be directed against the upper end of the piston 16 and also through the restricted bore of the bushing 22. Because of the restricted bore the application of pump pressure will move the piston 16 downwardly against the tension of the spring 18 whereby the piston and its tubular guide stem 17 are moved downwardly within the cylinder 12 and body 13. Because the radially extending actuating pin 20 is connected to the tubular stem 17 downward movement of the stem will impart a similar downward movement to the pin which, through its engagement with the actuating collar 24, will cause a downward sliding movement of said collar 24 on the tubular body. As has been noted, the pivotal con-

nections 25 and 31 between the links 23 and 27, respectively, and the deflecting element or shoe are located off center with respect to the other pivots 26 and 32 which connect the links to the collars 24 and 28. The lower or anchoring collar 28 is not slidable on the body and downward movement of the actuating collar 24 with respect thereto swings the outer ends of the links 23 and 27 outwardly with the result that the deflecting element or shoe B will be moved radially outward of the body 13 as shown in Figure 3. The outer arcuate surface of the deflecting shoe may be provided with longitudinal ribs 35 which may have their edges sharpened to firmly engage the wall of the formation.

After the deflecting element or shoe is moved radially outwardly, continued circulation of the fluid under pressure causes said fluid to pass downwardly through the tubular guide stem 17, through the bore 15a of the sub 15 and to the bit 11 so that a normal circulation of drilling fluid through the drill bit may be accomplished. As the deflecting shoe engages the wall of the well bore W, it will be evident that the lower end of the drill pipe and the bit are moved in a direction 180 degrees opposite the point of contact between the shoe and the wall of the bore and thus the bit is forced to one side of the well bore. The downward movement of the actuating collar 24 which results in the radial movement of the deflecting shoe disconnects the orienting lug 34 from the recess 35 so that the collar 24 is again rotatable with respect to the body 13. Thus the rotation of the drill pipe to perform the subsequent drilling operation will permit the body 13 to rotate with respect to the collars 24 and 28 which are, of course, held stationary by the contact of the shoe B with the formation. The actuating pin 20 carried by the rotating guide stem merely rotates between the bearing plates 23 within the counterbore 24a of the actuating collar. It is thus obvious that a subsequent drilling operation may be carried out in the usual manner without interference from the deflecting shoe which will function to maintain the bit 11 in a position at one side of the well bore. As the drilling continues, the shoe or element B will merely slide down the wall of the formation and so long as fluid under pressure is being circulated downwardly through the drill stem, the shoe will remain in its expanded position.

After the directional drilling operation is complete, it is only necessary to discontinue circulation and when this is done the pressure above the piston 16 is relieved whereby the spring 18 may return the piston to its upper position. By means of the actuating pin 20 and actuating collar 24 the connecting links 23 are again swung inwardly to retract the deflecting shoe and the device may be readily brought to the surface as the drill pipe is withdrawn from the well bore.

From the foregoing it will be seen that a simple and effective tool for carrying out a directional drilling operation is provided. The tool is actuated by means of the usual drilling fluid which is circulated downwardly through the drill pipe and is moved to an expanded position and held in such position so long as circulation continues; when circulation is stopped the deflecting shoe is automatically retracted to permit removal of the device from the well bore.

From the foregoing it will be seen that this invention is one well adapted to attain all of the ends and objects hereinabove set forth, together with other advantages which are obvious and which are inherent to the structure.

It will be understood that certain features and subcombinations are of utility and may be employed without reference to other features and subcombinations. This is contemplated by and is within the scope of the claims.

As many possible embodiments may be made of the invention without departing from the scope thereof, it is to be understood that all matter herein set forth or shown in the accompanying drawings is to be interpreted as illustrative and not in a limiting sense.

Having described the invention, I claim:

1. A deflecting tool including, a tubular body, an anchoring collar rotatably confined on the lower portion of the body, an actuating collar rotatable and longitudinally movable with respect to the body and spaced from the anchoring collar, an arcuate deflecting element, pivoted links connecting the deflecting element to the anchoring collar and to the actuating collar, and means for moving the actuating collar with respect to the anchoring collar for swinging said links to effect an outward radial movement of the deflecting element.

2. A deflecting tool including, a tubular body, an anchoring collar rotatably confined on the lower portion of the body, an actuating collar rotatable and longitudinally movable with respect to the body and spaced from the anchoring collar, an arcuate deflecting element, pivoted links connecting the deflecting element to the anchoring collar and to the actuating collar, movement of the actuating collar with respect to the anchoring collar resulting in an outward radial movement of the deflecting element, and pressure-actuated means within the bore of the body having an operative connection through the wall of the body with the actuating collar for imparting movement to said actuating collar.

3. A deflecting tool including, a tubular body, an anchoring collar rotatably confined on the lower portion of the body, an actuating collar rotatable and longitudinally movable with respect to the body and spaced from the anchoring collar, an arcuate deflecting element, pivoted links connecting the deflecting element to the anchoring collar and to the actuating collar, resilient means for maintaining the collars in spaced relation on the body to maintain the deflecting element in a retracted position, and fluid pressure-actuated means within the bore of the body and having an operative connection through the wall of the body with the actuating collar for moving said collar toward the anchoring collar, whereby the deflecting element is moved radially outwardly of the body.

4. A deflecting tool including, a tubular body, an anchoring collar rotatably confined on the lower portion of the body, an actuating collar rotatable and longitudinally movable with respect to the body and spaced from the anchoring collar, an arcuate deflecting element, pivoted links connecting the deflecting element to the anchoring collar and to the actuating collar, movement of the actuating collar with respect to the anchoring collar resulting in an outward radial movement of the deflecting element, a piston slidable within the bore of the body and adapted to be moved therein by the application of fluid pressure thereto, and an operative connection between said piston and the actuating collar and extending through the wall of the body, whereby movement of the piston imparts a movement to

the actuating collar with respect to the anchoring collar and thereby expands the deflecting element radially outwardly.

5. A deflecting tool as set forth in claim 1, together with means for orienting the deflecting element with respect to the body when the deflecting element is in its retracted position.

6. A deflecting tool as set forth in claim 3, together with means for locking the actuating collar and its attached deflecting element in a predetermined known position on the collar when the element is in a retracted position.

7. A deflecting tool including, a tubular body adapted to be connected in a drill string between the drill pipe and the drill bit, a radially expansible deflecting element mounted on the exterior of said body, and fluid pressure-actuated means movable within the bore of the body and having an operative connection through the wall of the body with the deflecting element whereby said means may be utilized to expand the deflecting element, said operative connection including a pair of collars on the body and pivoted links connecting said collars to said element, said pressure-actuated means having a flow passage therethrough whereby drilling fluid circulated downwardly through the drill pipe and body will operate said means and may then flow therethrough to the drill bit below the body.

8. A deflecting tool including, a tubular body adapted to be connected in a drill string between the drill pipe and the drill bit, a radially expansible deflecting element mounted on the exterior of said body, fluid pressure-actuated means movable within the bore of the body and having an operative connection through the wall of the body with the deflecting element whereby said means may be utilized to expand the deflecting element, said operative connection including a pair of collars on the body and pivoted links connecting said collars to said element, said pressure-actuated means having a flow passage therethrough whereby drilling fluid circulated downwardly through the drill pipe and body will operate said means and may then flow therethrough to the drill bit below the body, and means for rotatably mounting the deflecting element on the body whereby after the element is expanded subsequent rotation of the drill pipe may be accomplished without rotation of the deflecting element.

9. A deflecting tool as set forth in claim 8, together with means for locking the deflecting element against rotation on the body when the element is in a retracted position, whereby orientation of the drill pipe and element may be carried out prior to expansion of said element.

10. A deflecting tool including, a tubular body, an anchoring collar rotatably confined on the lower portion of the body, an actuating collar rotatable and longitudinally movable with respect to the body and spaced from the anchoring collar, an arcuate deflecting element, a pair of lower connecting links between the anchoring collar and the lower portion of the deflecting element and pivotally attached to said collar and element, a pair of upper connecting links between the actuating collar and the upper portion of the deflecting element and pivotally connected to said actuating collar and said element, and means for moving said actuating collar the pivot points of both upper and lower links being so disposed with respect to each other that movement of the actuating collar toward the anchoring collar swings said links to move the deflecting element outwardly in a radial direction.

11. A deflecting tool as set forth in claim 10, wherein said means for moving said actuating collar is a pressure actuated means within the tubular body having operative connection with the actuating collar for imparting movement to said collar.

12. A deflecting tool as set forth in claim 10, wherein said means for moving said actuating collar is a pressure actuated means within the tubular body having operative connection with the actuating collar for imparting movement to said collar, and spring means acting upon the pressure actuated means urging said means in a direction separating the actuating collar from the anchoring collar which urges the deflecting element toward a retracted position.

13. A deflecting tool including, a tubular body adapted to be connected in a drill pipe, an actuating piston disposed within the bore of the body and adapted to be moved therein by the application of fluid pressure thereto, a radially expansible deflecting element, a pair of collars on said body adapted to move axially relative to each other, pivoted links connecting said collars to said element, and means connecting said piston to said links for moving said collars axially relative to each other to effect movement of said element radially outward.

14. The tool as set forth in claim 13, including means for normally maintaining the element in a retracted position.

15. The tool as set forth in claim 13, including means for mounting said element on said body rotatively whereby the body is rotatable with respect to said element.

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