

March 9, 1954

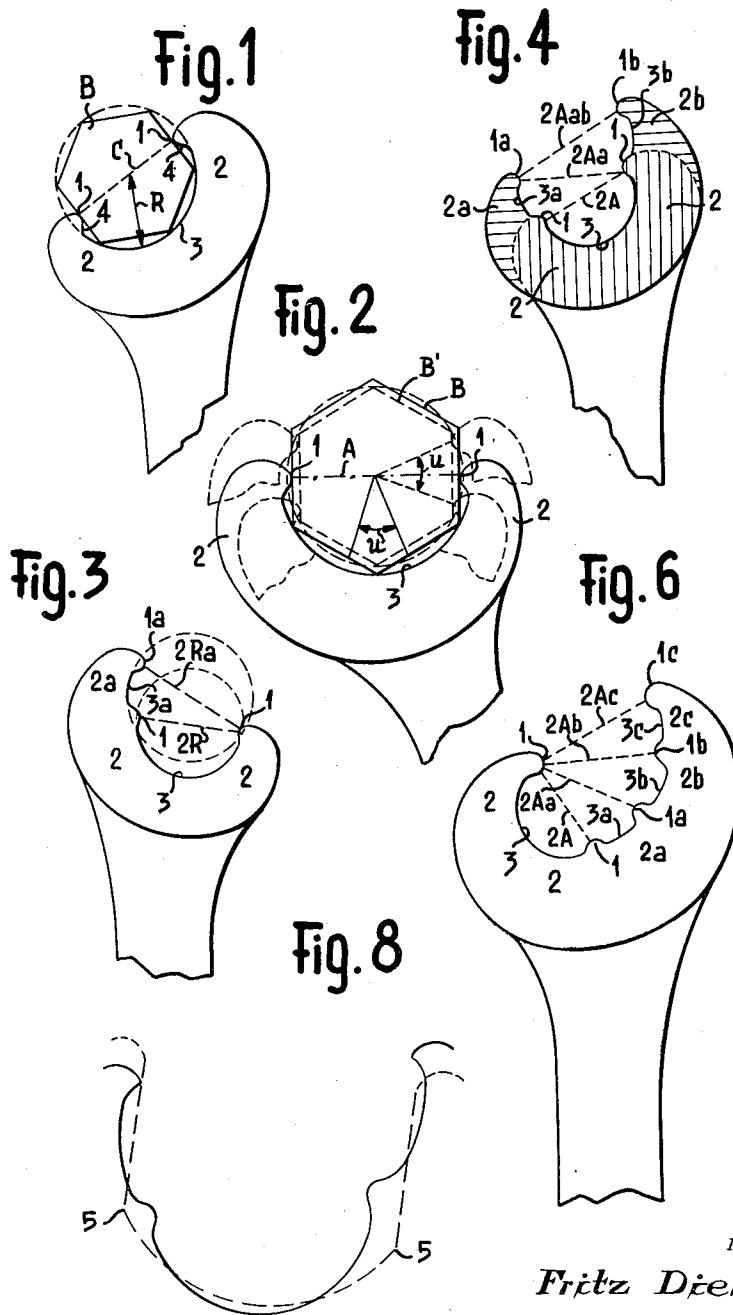
F. DIEBOLD

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WRENCH, INCLUDING MOVABLE OR STATIONARY JAWS

Filed Jan. 24, 1952

4 Sheets-Sheet 1



INVENTOR

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BY

ATTORNEY

March 9, 1954

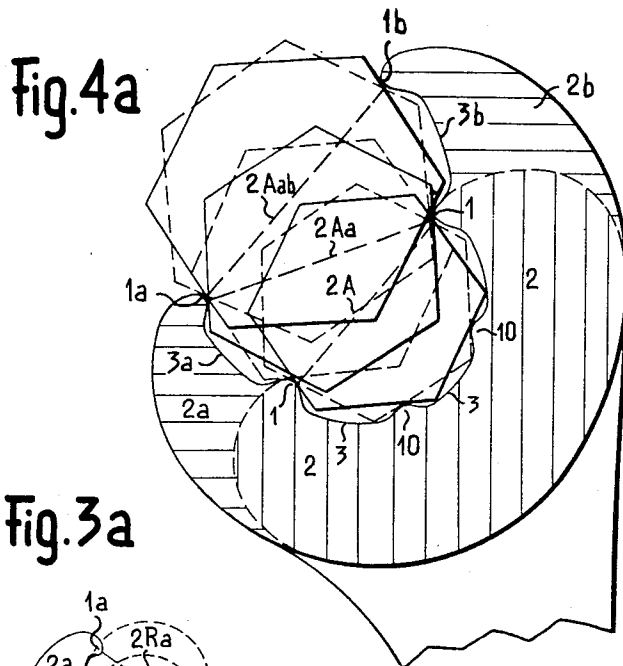
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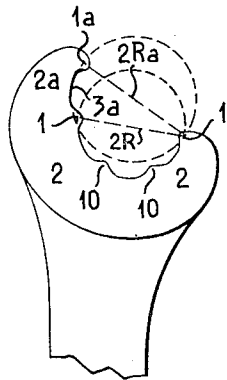
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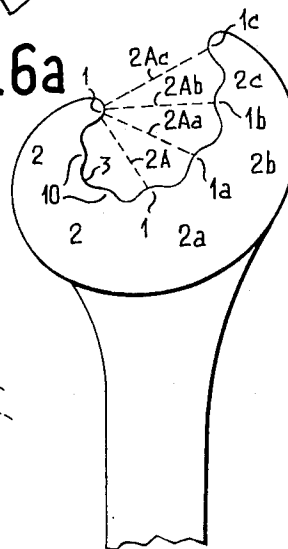
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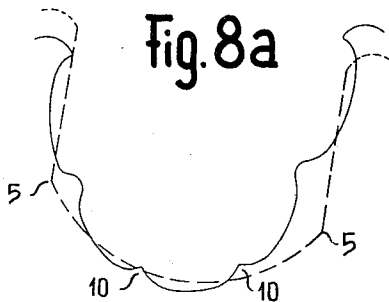
**Fig. 3a**



**Fig. 6a**



**Fig. 8a**



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Fig. 7

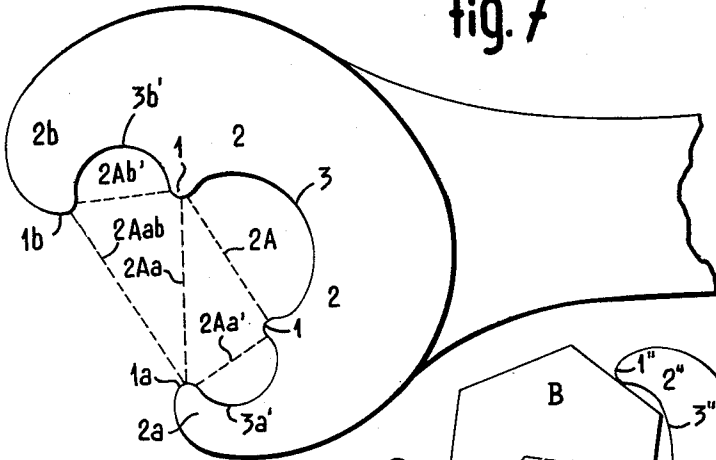


Fig. 5

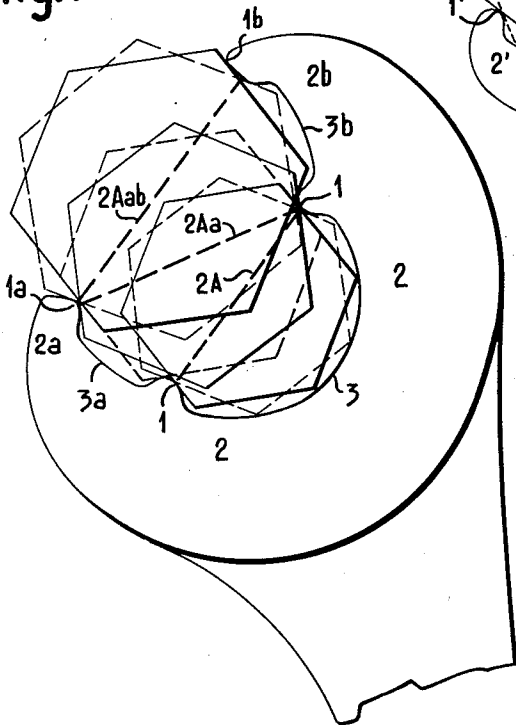
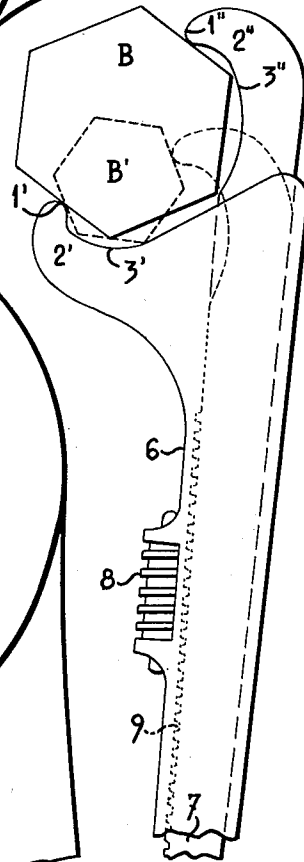


Fig. 9



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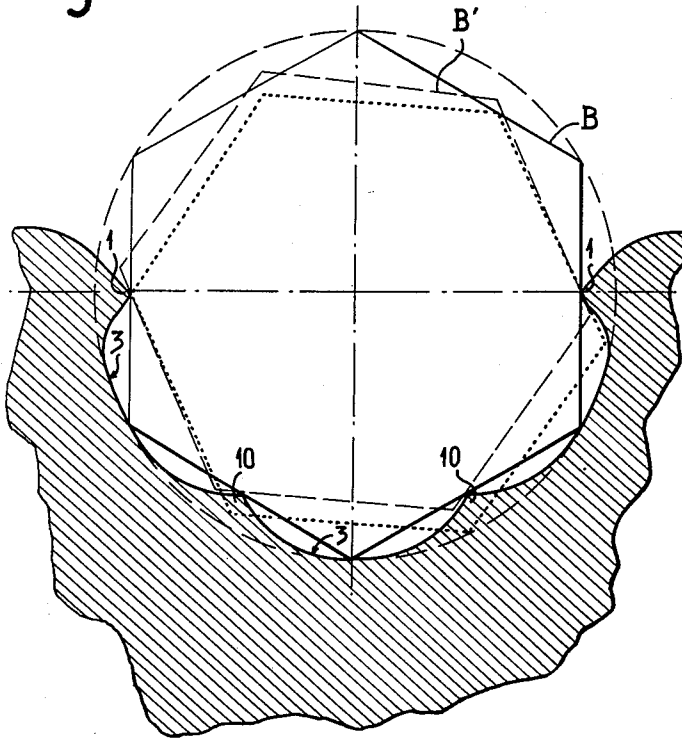
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Fig. 10



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# UNITED STATES PATENT OFFICE

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## WRENCH, INCLUDING MOVABLE OR STATIONARY JAWS

Fritz Diebold, Geneva, Switzerland

Application January 24, 1952, Serial No. 267,987

Claims priority, application Switzerland  
March 12, 1951

6 Claims. (Cl. 81—119)

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Conventional fork wrenches for polygonal nuts or bolt heads owing to required clearances engage such polygonal member at the corners instead of at the sides and thereby deform the corners of the member which is usually of a metal of lesser hardness than that of the wrench.

My invention relates to an improved wrench overcoming the drawbacks of the conventional wrenches by engaging the polygonal member at the sides and substantially remote from the corners. The wrench head constituting the embodiment of my invention is provided with a generally semi-cylindrical recess and a pair of diametrically opposite parts each projecting adjacent one of the jaws of the recess inwardly of same for engagement with a side face of the polygonal member, the corners of which are cleared by the recess surface. The wrench embodying my invention may also include other parts projecting inwardly of the recess surface and clearing the corners of the polygonal member, but engaging other sides thereof.

Several embodiments of wrenches according to my invention are described hereinafter by way of examples and by no means in a limiting sense, reference being made to accompanying drawings, wherein:

Fig. 1 illustrates a single-acting wrench.

Fig. 2 is an explanatory diagram relating to such a single-acting wrench.

Figs. 3 to 7 illustrate various embodiments of multiple wrenches.

Figs. 3a, 4a and 6a represent modified constructions of the wrenches shown, respectively, in Figs. 3, 4 and 6.

Fig. 8 is an explanatory diagram relating to a multiple wrench.

Fig. 8a represents a modification of the diagram shown in Fig. 8.

Fig. 9 illustrates a wrench with movable jaws.

Fig. 10 illustrates diagrammatically a further embodiment of a single-acting wrench.

The single-acting wrench illustrated in Fig. 1 is a fork wrench comprising a shank carrying two legs which are not provided as in conventional wrenches with inner parallel surfaces, but form jaws 2 provided with projecting operative parts 1 closing partly a recess bounded by an edge 3, i. e. the recess formed in the head of the wrench between the two legs of the fork in order to engage a portion of a member B to be taken hold of. Stated in a more accurate wording, the inner edge 3 of this wrench, having two jaws 2 rigid with each other as illustrated, connects the operative parts 1 and defines a substantially semi-circular

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recess having a radius R and being partly closed on either side by the two operative parts 1 projecting towards each other in the direction of a diametrical line C bounding the recess. The opening of these jaws 2, i. e. the gap between the two operative parts 1 as measured along the diameter C is less than  $2R$ . When the wrench is provided for six-sided members, as in the case of Fig. 1, said gap is preferably equal to  $R\sqrt{3}$ . Under such conditions and in the case of a six-sided member B, the distance between the opposite sides of which is just equal to the spacing between the operative parts 1 on the jaws 2, the recess is sufficiently wide and sufficiently deep for such a member, that when such member is urged in a direction parallel with two opposite sides of its polygonal cross-section and perpendicular to the diametrical line C connecting the operative parts, it will enter the gap between the jaws and will not be stopped by the edge 3 before the center of said member B has reached said diametrical line C.

If another six-sided member the size of which is smaller than that of said member B enters in a similar manner the recess inside the head of the wrench, the center of said member can assume a position beyond the diametrical line C without the member impinging against the edge 3.

In Fig. 1, the circle of which one half forms the edge of the recess, is continued by an interrupted line over the other half.

It is apparent that in the case of an opening the length of which is equal to  $R\sqrt{3}$ , and of a six-sided member B, the side-to-opposite-side diameter of which is just equal to the breadth of the opening, said member may be driven into rotation by the wrench without the latter engaging the corner ridges of the member, provided said member has not been urged into contact with the bottom of the recess in the head of the wrench. It is also apparent that the same member B may be taken hold of by the operative parts of the wrench engaging diametrically opposed points of the member without any contact between the wrench and the corner ridges of the member, even when the opening between the jaws is very slightly more than  $R\sqrt{3}$ .

If, as illustrated in interrupted lines in Fig. 2, a wrench is caused to act on a member B', the size of which is slightly less than that of the member B passing exactly between the operative parts, none of the corner ridges of said member B' is submitted to any stress whatever.

If B and B' are six-sided members, a simple

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geometrical deduction shows that if A designates the gap between the operative parts and also the distance between diametrically opposed sides of the member B, it is theoretically possible to act on members B' which vary in size between A and

$$A \frac{\sqrt{3}}{2}$$

i. e. 0.866A. In practice, the wrench may act on six-sided members the size of which ranges between A and 0.9A; for instance, a wrench the opening of which is equal to 20 mm. may be used for nuts of 19 mm. and even of 18 mm.

If the wrench is intended for use with square members, it is easy to ascertain that a wrench, the operative opening in which is A, may be applied to square members having widths ranging between A and 0.75A. For instance, a wrench the operative opening of which is equal to 20 mm. may also serve for squares of 19, 18, 17, 16 and even 15 mm.

Turning again to Fig. 2, it is apparent that during the complete angular shifting by an amplitude  $u$  to which the wrench is submitted for operatively engaging in either direction diametrically opposed surfaces of the member or nut B', no portion of the head of the wrench comes into contact with a corner ridge of the nut B'. This condition is satisfied if, for an angular shifting of the nut by an angle

$$\frac{u}{2}$$

to either side of a mean position, none of its corner ridges meets the edge 3 of the recess in the head of the wrench.

In the embodiment illustrated in Fig. 3 for which the above-mentioned condition is satisfied, the wrench includes a further additional jaw 2a adapted to cooperate with one of the above-mentioned jaws 2, i. e. the jaw located on the right hand side of said Fig. 3. The jaw 2a is provided with an operative projecting part 1a and is connected with the adjacent jaw 2 through the surface 3a which defines a recess, the diameter of which is equal to the distance 2Ra, extending between the jaw 2a and the jaw 2 on the opposite side of the wrench. In accordance with the above-disclosed condition, the operative part 1 on the left hand side projects on the outside of the angles  $u$  (Fig. 2) corresponding to the six-sided members held fast between the base operative part 1, on the right hand side and the additional operative part 1a and consequently no corner ridge of a six-sided nut engaged by such a wrench may come into contact with the jaw 2 on the left hand side of the wrench so that it cannot be damaged by the projection 1 carried thereby inside the recess of the wrench.

If, for instance, the distance between the parts 1 is equal to 10 mm. while the distance between the projection 1a and the projection 1 on the right hand side is equal to 12 mm., the same wrench may take hold of six-sided nuts, the width of which is equal to 12 or even to 11 mm. between last-mentioned projecting parts 1 and 1a and also of six-sided nuts, having side lengths of 10 mm. or 9 mm. between the two projecting parts 1.

Fig. 4 shows a further embodiment wherein each jaw 2 is associated with an additional jaw extension 2a or 2b including a projecting operative part 1a or 1b connected with the projection 1 adjacent thereto through a surface 3a or 3b defining the edge of the recess. The arrange-

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ment of each additional jaw extension 2a and 2b with reference with the associated jaw 2 is identical with that of the jaw 2a on the wrench illustrated in Fig. 3 and is submitted to the same conditions. For sake of clarity, I have illustrated in Fig. 4, the base jaw system forming a wrench of the type illustrated in Fig. 1 through a vertical hatching while the jaw extensions or additional jaws are shown by horizontal hatchings. I have illustrated, between the projecting parts 1, 1a and 1b of these jaws that are adapted to cooperate for acting on members having different sizes, the openings of the semi-circular recesses defined by the surface 3, 3a and 3b separating the successive projecting parts. The openings of these recesses have been designated by the reference 2A, 2Aa, 2Aab.

Fig. 5 shows on a larger scale, for the same wrench and for each of the combinations provided by the openings 2A, 2Aa, 2Aab, the extreme positions of a six-sided nut taken hold of by the wrench with the maximum allowable clearance, to wit 10%. It is apparent that these six-sided members may be engaged along three sides simultaneously by three different operative projections, but in no case can the surfaces 3, 3a, 3b exert on the corner ridges located inside the recesses any stress capable of damaging said corner ridges.

In the embodiment illustrated in Fig. 6, the additional jaws are all arranged on the same side of the wrench head. The jaws 2a, 2b, 2c provided with operative parts 1a, 1b, 1c, are connected with one another through the surfaces 3a, 3b, 3c forming the outline of the recess. In this arrangement, each of the additional operative projecting parts 1a, 1b, 1c cooperates with the same base operative projection 1 that is located on the other side of the wrench head. It is possible to provide thus a plurality of openings 2A, 2Aa, 2Ab and 2Ac.

Fig. 7 shows a further embodiment that allows the same wrench head to operate on members, the sizes of which correspond to five openings of different spans. As in the case of the embodiment illustrated in Fig. 4, the head of the wrench is provided with two base jaws 2 connected through a surface 3 satisfying the above-mentioned conditions as disclosed with reference to the embodiment of Fig. 1. As in the case of Fig. 4, the left hand leg of the wrench includes an additional jaw 2a provided with an operative projecting part 1a that is connected with the adjacent base jaw 2 through the recess-bounding surface 3a' while the right hand leg of the wrench includes an additional jaw 2b provided with an operative projecting part 1b that is connected with the adjacent base jaw 2 through the recess-bounding surface 3b'. In this wrench, the operative projecting parts 1, 1a and 1b may cooperate in a manner similar to that described with reference to Fig. 4 in order to act on nuts adapted to engage respectively the openings 2A, 2Aa, and 2Aab. The difference distinguishing the wrenches illustrated in Figs. 4 and 7 consists however in the fact that the jaws associated pairwise to either side of the wrench head are adapted to engage polygonal members. In other words, the operative parts 1, 1a of the jaws 2 and 2a forming part of the same leg are separated by a gap, the length of which is less than the diameter of the semi-circular recess that is left free between said projecting parts by the connecting surface 3a'; the same is the case for the projections 1 and 1b on the jaws 2 and 2b located on the other

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leg and connected through the surface 3b'. It is thus possible to take hold of members corresponding to wrench openings that are smaller and that are measured by the gap 2Aa' on the wrench leg carrying the jaw 2a and by the gap 2Ab' on the leg carrying the jaw 2b.

In such a wrench, the operative projecting parts 1 of the base jaws, where at least one additional jaw is being used, lie either beyond the range of the polygonal members thus acted upon, or outside the possible angle of shift  $u$  of each of the corner ridges of a member held between the operative jaws, the angle  $u$  being that defined with reference to Fig. 2.

A wrench head according to my invention and that may be used for instance with openings of three different sizes and consequently for a larger number of nut sizes, does not require a more resistant structure than a conventional wrench head which can be used only for a single nut size. This is ascribable to the fact that:

The area of recess in which the nut is to be housed inside the wrench head is no larger than in conventional wrenches;

The mechanical conditions under which the nut is engaged by the wrench are improved on one hand by the cutting out of any inner ridge inside the wrench recess and, on the other hand, because the radial component of the stress exerted on the nut is smaller at each operative point.

Fig. 8 illustrates in solid lines, by way of comparison, the edge of the recess in a wrench head adapted to be used for all six-sided nuts corresponding to three openings of different breadths of the type illustrated in Fig. 4 and, on the other hand, it shows in interrupted lines the edge of the recess in a wrench head of standard outline adapted for use with the larger size of nuts adapted to be actuated by the former wrench executed in conformity with my invention. As apparent, the inner recessed portions have sizes that are substantially similar and the two objectionable inner edges or corners 5, at which breaks may be initiated in conventional wrenches, are eliminated in the wrench according to my invention.

Fig. 9 shows an adjustable wrench in which the jaws 2'' and 2' are respectively rigid with two wrench elements 6 and 7 slidingly carried by each other, the relative shifting of said latter elements being controlled by a worm 8 carried by the element 6 and meshing with the rack 9 provided on the element 7. The corresponding inner surfaces 3'' and 3' of the recesses formed in the corresponding jaws 2'' and 2', assume a curvature such that the recess left free between the two jaws for any of the openings that may be used in the wrench may be at least as wide and at least as deep as the recess defined with reference to Fig. 1; in other words, the outline of the recess leaves at least a half circle free, the diameter of which is larger than the distance between the cooperating operative projecting parts 1'' and 1' on the jaws. I have illustrated in solid lines in Fig. 9 the wrench in the adjusted position corresponding to the largest opening of the jaws engaging a nut B. On the other hand, I have shown in interrupted lines the other extreme position of the jaw 2'' with reference to the jaw 2', which latter is assumed to remain in the same position, in the case of the wrench engaging a nut B' of the smallest size engageable by the wrench.

It is clearly apparent that it is possible within

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the scope of the present invention to provide further embodiments of wrench heads operating in accordance with the same principle as the wrench illustrated in Fig. 9.

Fig. 10 is a diagram showing how it is also possible within the scope of the invention to design the shape of the recess that is left free between the jaws of the wrench head.

I have designated by 1 the operative projecting parts of a wrench head adapted to act on a nut B through two diametrically opposed sides thereof. It is also possible to take hold of a somewhat smaller nut B' with the same wrench of constant width of opening. If the recess defined by the surface 3 is given the normal semi-circular shape, this nut B' might, if it were urged too far inside the recess, assume the position illustrated in dotted lines, which position would lead to a difficult and objectionable operation.

In order to prevent this drawback, it is possible to leave along the edge of the recess and outside the angles  $u$ , that were defined with reference to Fig. 2 and that correspond to the maximum angular shifting of the corner ridges of the members engaged by the wrench, portions 10 that project slightly inwardly of the recess and serve as abutments for the nut B' in order to constrain it to assume the position illustrated in interrupted lines. It is apparent from the drawing that the nut B' is then engaged symmetrically by the operative projecting parts 1. The slightly projecting portions 10 lying outside the angles  $u$  engage no longer the corner ridges of the nut but its sides. They exert on said nut no stress urging it into rotation.

Further modifications may be provided for my improved wrench without unduly widening thereby the scope of the invention as claimed in accompanying claims. Thus, for instance, in a wrench such as that illustrated in Fig. 3, it is possible to provide an arrangement incorporating parts 10 which correspond to those shown at 10 in Fig. 10, such modified construction being illustrated in Fig. 3a and similar modifications of Figs. 4, 6 and 8 being illustrated, respectively, in Figs. 4a, 6a and 8a. Also, in Fig. 7, it is possible to provide an arrangement incorporating projecting parts similar to those shown at 10 in Fig. 10 not only along the recess-bounding surface 3 but also along the outer surfaces 3a' and 3b' connecting the operative parts 1, 1a and 1, 1b. Also one or both movable legs of the wrench according to Fig. 9 may include a plurality of additional projecting nut-engaging parts in accordance with the arrangement disclosed with reference to the wrenches having stationary jaws, as illustrated in Figs. 3, 4 and 6.

In all the wrenches executed in accordance with the present invention, the operative parts of the jaws of the wrench head bite slightly into the sides of the nuts by reason of the fact that the metal of the wrench is harder than that of the nut and thus they form surfaces acted upon by the tangential components of the operative forces. This explains why the radial component at each point of engagement is smaller than in conventional wrenches so that consequently it is possible, for a predetermined opening of the wrench, to reduce the external size of the wrench head, without any risk of breaking, both in the case of a single-acting wrench and in the case of a multiple wrench.

Obviously, in all the embodiments of my invention, the operative parts of the jaws may assume a shape different from that illustrated in

the drawings, provided its design is such that during operation no portion of the wrench head may exert a stress on the corner ridges of the nuts.

I claim:

1. A wrench for engaging solely the faces of a polygonal member turned thereby and remaining free from engagement with the corner edges of the member and operable in either direction and comprising a handle, a pair of spaced basal jaws carried by the handle and defining between them a generally semi-circular recess and carrying on the diameter of the semi-circle opposed elements projecting inwardly of the semi-circle on the ends of the diameter and symmetrically engaging the sides of the polygonal member, the diagonal distance between the projecting elements equaling R times the root of one half of the number of the sides of the polygonal members wherein R is the radius of the semi-cylindrical surface, and at least one portion projecting into the semi-circular recess and thereby interrupting the semi-cylindrical surface between the first elements so as to form at least one abutment that guides the nut to a correct symmetrical position in the recess.

2. The wrench according to claim 1 and also comprising at least a supplementary jaw having generally an inner concave surface and extending beyond one of the basal jaws and carrying spaced from one of the first projections of the base jaws a second engaging element projecting beyond the concave surface.

3. The wrench according to claim 1 and also

comprising a plurality of supplementary jaws with inner concave surfaces and extending beyond one of the basal jaws and each carrying at its outer end an element projecting beyond the respective concave surface.

4. The wrench according to claim 1 and also comprising at least one supplementary jaw extending beyond each basal jaw and having an inner concave surface and carrying spaced from the projection of the basal jaw a projection projecting beyond its concave surface.

5. The wrench according to claim 1 and also comprising operable means displacing one of the jaws relatively to the other.

6. The wrench according to claim 1 and wherein the surfaces between the elements are free from the corner edges of the nut engaged by the elements.

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